CONFIDENTIAL

FLEET SUBMARINE
GENERAL INFORMATION

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GENERAL INFORMATION BOOK

FLEET SUBMARINES

SS381

SS382

SS383

ACCORDING TO

GENERAL SPECIFICATIONS - APPENDIX 16-JULY 1931

UNITED STATES NAVY YARD

PORTSMOUTH, NEW HAMPSHIRE

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U. S. Navy Yard, Portsmouth, N. H. - 1943

ABBREVIATIONS

AER - After Engine Room
Aft. - After
ATR - After Torpedo Room
B - Bow Planes, on Ind. Light
B/P - Bow Plane
B&S - Bow & Stern
C.J. - Cone Joint
C/L - Center Line
COC - Obsolete term for CR
Comp. - Compressor
Conn. - Connection
Cont. - Control
C/R - Control Room
C/T - Conning Tower
Cyl. - Cylinder
D.P. - Dripproof
Emergy. - Emergency
Eng.Air Int. - Engine Air Intake
FBT - Fuel Ballast Tank
FER - Forward Engine Room
F.O.-Fuel Oil
FTR - Forward Torpedo Room
Fwd. - Forward
H/P - High Pressure
Hull Vent. Exh. - Hull Ventilation Exhaust
Hyd. - Hydraulic
ID - Inside Diameter
Ind. - Indicator
L.O. - Lube Oil
L.R. - Left Rudder
LTG - Lighting
Man. - Manifold
MBT - Main Ballast Tank
OD - Outside Diameter
P.-Pressure
P/B - Push Button
P.P. - Pressure Proof
psi - Per Square Inch
Pwr. - Power
Reg. - Regulator
Replen. - Replenishing
R.R. - Right Rudder
S/M - Submarine or submerged
Sym. - Symbol
T/T - Torpedo Tube
W - Windlass on Ind. Light
Wind. & Cap. - Windlass and Capstan
W/T - Watertight

Section A-1

GENERAL

Fire Power - The ship's maximum fire power is a broadside of 10 torpedoes, delivered at intervals of 10 seconds, on the beam within the arc 30 to 150, or 210 to 330 degrees, from any depth to 180 feet.

Torpedo Control is concentrated at C/T, Periscope No. 2 (or 1).

Problem Solving is electro-mechanical and based on the principle of continuous solution, by mathematical integration of all constants and variables, with synchronous setting of gyro angles, by nests, up to the instant of firing. Range limits are from 300 to 8000 yards, target speed 40K. and track angle 0 to 180°.

The Approach and Problem Solving - Number One nest carries 6 - Mark 34 tubes; Nest No. Two carries 4 - Mark 35 torpedo tubes. No fire control facilities in Control Room. The bridge is equipped with two target designation teloruses which, for surface torpedo attack, give synchronous visual registration at the TDC in the conning tower.

The Submerged Attack, Normal, is conducted by sight from the C/T by the Commanding Officer at No. 2 periscope. Alternative methods of enemy detection are SJ radar and supersonic echo and listening, controls for which are in C/T. The medium of sonics may also be used where provided. The attack consists of two phases (1) the approach and problem solving, and (2) delivery of torpedoes. The torpedo control systems problem solving circuit makes a mathematical analysis of the factors involved in the approach and applies to the torpedo gyro pot (by nests), a continuously correct angle for delivery of the torpedo. This is accomplished by benefit of the electro-mechanical integration of the ship and target movements respectively. Enemy range and bearings may be obtained by medium of sight or sound or radar or all combined.

This method gives maximum opportunity for use of the periscope for reconnaissance and security purposes.

The Problem Solving Circuit (GA) integrates two groups of principal variables (1) target movement and (2) ship movement. Target movement is the subject of personal estimate from observation, viz., target (1) course (2) speed and (3) initial bearing. Ship movement is fed into the problem solving circuit electrically by means of branches off the gyro compass circuit and the underwater log, respectively.

Torpedo Data Computer in the C/T resolves the variables contained in the attack problem and delivers the correct solution to a gyro angle indicator regulator at Nest One (and mechanical duplicate - Nest Two). This instrument transmits gyro angles to all tubes of Nest One simultaneously, and up to instant FIRE. Mechanical withdrawal of the gyro setting spindle is accomplished on first movement of T/T stop rod.

Ship Control is concentrated at the Diving Station in the control room. The ship is designed for service operation at 400 axial, or 412 feet depth gage.

Equilibrium and Ballasting. - The various extreme conditions of loading and density of water under which the ship is designed to operate are to be found in the booklet of Inclining Experiment Data.

Shockproof mounting consists of mounting the motor and the driven unit on a common bedplate by means of body-bound bolts. This is to prevent damage or dislocation from depth charge shock and is not to be confused with soundproof rubber mounting. Most critical items in this matter are:-

Pump, Trim
Pump, Drain
Compressor, L.P. Air
Pump, Hydraulic and Motor, Steering.
Training Gear, JK and JC
Blowers, Battery Ventilation

LIGHTENING AND LIMBER HOLES. Care has been taken to arrange air holes in structure in the main ballast tanks, bow-buoyancy tank, superstructure, and conning tower fairwater, so as to permit quick and thorough venting when the tanks are flooded.

SUPERSTRUCTURE is free flooding. Exception: The bow buoyancy tank is fitted with vents in the forecastle decks and flooding ports on the surface water line. All flooding ports and vent holes are adequate to meet the diving time. Tests conducted on a submarine have indicated that little, if any, improvement may be expected from increasing the size or number of these holes.

Fairwater being the principal factor in the ship's silhouette is minimized so far as is consistant with reasonable streamlining of the parts of the ship which are in the fairwater. It is free-flooding and spray-tight. A partial deck is fitted at the main deck level and air ducts are installed in C.T. fairwater to draw air from under the bridge deck. The object is to prevent water from being drawn into the engine air induction valve. Design insures low air velocity. Access is provided by means of doors and portable plates. Bridge deck over and bulkhead forward of this space is spraytight.

BILGE KEELS. Bilge keels are fitted on the outside plating in extent and location as indicated on plans and are attached by welding. They consist of 15-pound plate with 1-1/4" round bar welded on the outer edge. The overall depth is 15 inches. The bilge keels follow the stream lines of the ship. The inboard portion of the bilge keels is cut away as necessary to allow for the escape of air from the flood valves and in way of sea connections for engine circulating water to permit escape of air which might otherwise find its way into the sea connections.

Extreme Temperature Conditions. All machinery is designed to operate satisfactorily with sea water at 85° F. So far as practicable, outboard auxiliary gear is designed to insure operation also when the vessel is coated with ice.

INSULATION -

Compressed cork slats are applied to:
(a) Inner surface of the pressure hull, above the platform deck in all compartments. Exception: Engine rooms.
(b) Inner surface of the conning tower above the walking flat.
(c) The inner surface of the pressure hull, in storerooms.
(d) Magazines.

Cork Sheathing, 1/2 inch, protected by galvanized steel rubbing plates, is applied to:
(1) Forward access trunk.
(2) Gun access trunk.
(3) All hatch trunks.
(4) Ship ventilation supply ducts, bulkhead to bulkhead, Forward Torpedo Room to After Torpedo Room.

Cork Paint is applied to: -
(1) Frames, on single hull ends of ships.
(2) Hangers, brackets, clips secured to hull.
(3) Water Piping where drips would affect electrical equipment, or cable.

The thickness of insulation of the refrigerated space is 5 inches on bulkheads adjacent to magazines, and the thickness of insulation of the bulkhead between the refrigerated space and the cool room is 2 inches. The entire inside of the cold-storage space is sheathed with nickel-copper alloy.

PAINTING -

Painting subsequent to delivery should be done in accordance with Appendix 6. General Specifications for Building Vessels (latest edition, Nov., 1942.) Instructions for Painting and Cementing.

RADIO - Radio entering leads for the wiring antennae are led through the conning tower fairwater and pressure hull into the radio room.

The vertical Radio Antenna is carried on a special housing mast.

RADAR. Directional and non-directional radar equipment is provided.

UNDERWATER LOG. The rod meter of the pitometer log is so located (See Section A-1 Measurements) that it will not be affected by the turbulence of other underwater fitting such as sound gear, or by overboard discharges.

ELECTROLYTIC ACTION INHIBITORS - Mild Steel Protectors, 10 inches in diameter, of 15-pound plate, are fitted under the ends of fuel compensating piping in all tanks to which compensating lines connect.

LOCK WASHER, or other locking device is provided for any bolt or nut used in connection with auxiliary machinery, operating gear, shafting (including supports), and in similar conditions. After disassembly of any parts, care should be exercised to replace all locking devices.

BATTERY TANKS - The bottom of the storage-battery tanks are arranged in steps to form the foundation for the battery cells. The foundation is suitably reinforced to support and distribute battery weights. The space between the foundation and the shell plating is treated to prevent corrosion and filled with ground cork and cement. The tank surface in way of the rubber lining is of steel. To prevent squeezing the battery jars when the circular hull is distorted during depth charge attack, the bulkheads which form the sides of the battery tanks are connected to the inner shell only at the bottom. They are supported by three partial bulkheads extending across the tanks between the rows of cells.

Provisions and Stores for crew for 75 days can be carried in Ship's storerooms

DECKS. Platform deck. The platform deck in the officers' quarters and crew's quarters and in the control room except for necessary openings, is watertight, but not pressure-proof. In the control room 6-inch coamings are provided around openings for groups of piping and cables to prevent slop water from damaging machinery in the space below. Portions of the platform deck are made portable to permit removal of equipment as necessary. The deck plating over the battery cells is portable and arranged in panels to suit conditions. Maintenance of the storage batteries, including access to each cell for testing and watering, is provided by crawling space and insulated flat above the cell tops.

Bulkheads are designed for 194 pounds pressure applied on either side.

Deadlights in the watertight doors provide ready vision from one compartment to the other.

NONSTRUCTURAL BULKHEADS. Bulkheads over battery decks are portable except such portions as are clear of the battery tank and battery cell handling gear, which portions are made fixed.

TOWING, WARPING AND MOORING. The forward access hatch is fitted with a bracket and eye on the forward side for attachment of the towing pendant. A suitable eye is provided on the main deck aft for towing another vessel.

BOW CLEAT is fitted on the bow buoyancy tank top centerline for use when taking a riding line from the tender when the ship is nested; roller chocks provide facility to unfavorable lead of lines.

A BOW CHOCK, single, closed and a closed stern chock are fitted for use during towing operations. A chain towing pendant, long enough to extend from either eye through the towing chock is stowed inside the superstructure near the forward access trunk.

GAGES. All gages are furnished with phenolic material cases.

LIQUIDOMETERS. Balanced hydraulic type gages are installed in the variable ballast tanks (consisting of the auxiliary, trim tanks and W.R.T. tanks), the negative tank, the fuel oil collecting and expansion tanks, the clean fuel oil tank, and the lube oil sump tanks. The indicators for the auxiliary trimming and negative tank

gages is located in the control room.

Graduated sounding rods are provided for lube oil tanks and sanitary tanks.

Depth gages are itemized as follows:

Size, Range and Location

16"-150 ft. Control Room Forward
16"-150 ft. Control Room Aft
8"-600 ft. Control Room
8"-150 ft. Conning Tower
8"-600 ft. C.O. Stateroom

Trim Indicators:

Type and Location

15° Control Room Ford. Station
5° Control Room Ford. Station
15° Control Room After Station
5° Control Room After Station

Clinometers, Itemized:

Type and Location

Spirit, Low Press. Blow Manifold, Control Room.
Spirit, Low Press. Conning Tower.
Mechanical - Control Room.

Reference Plans:

Ports.No.	BuShips No.	Title
201-285	490769	Main Ballast Tanks - Lead Ballast Stowage
305-285	544522	Chart Table and Stowage of Chronometers in Conning Tower
651-228	386541	Displacement and Other Curves
652-228	386542	Cross Curves of Stability
653-228	386543	Curves of Capacity Center of Gravity - Moments Inertia - Main Ballast and Safety Tank
654-228	386544	Curves of Capacity - Center of Gravity - Moments of Inertia - Trim - W.R.T. Aux., Fresh Water and Sanitary Tanks
655-228	386545	Curves of Capacity - Center of Gravity - Moments of Inertia - Fuel Oil Tanks
656-285	490430	Curves of Capacity - Center of Gravity - Moments of Inertia - Lube Oil Tanks
658-285		Moment Diagram

GENERAL - Measurements.

Designer's water line is the normal water line, namely, that which corresponds to designed normal load and draft.

Forward Perpendicular	12" Forward Frame 0
After Perpendicular	6" Aft. Frame 137
Middle Perpendicular	12" Aft. Frame 69
Molded Base Line above	The bottom of the keel - 1"

The datum line from which drafts are measured is at the bottom of the keel. The base line is 1" above the bottom of the keel.

The estimated drafts at mean trial displacement are 14 feet 10½ inches forward and 15 feet 8 inches aft. The trim by the stern is 9½ inches. Mean draft, corrected for trim 15 feet 3¼ inches normal diving trim.

PROJECTIONS BELOW KEEL

(1) QB sound projector, (extended), frame 34 - 20½" below base line.
(2) JK-QC sound projector, (extended), frame 34 - 20½" below base line.

PROJECTIONS OUTSIDE UNDERWATER BODY

(1) Rodmeter, (extended), 6-9/16" aft of Frame 33, to port of C.L.(5'7") - 2'-8-15/16" below outer hull, (16-11/16" AB).

	Feet	Inches
Length overall	311	8
Length between perpendiculars	307	0
Extension of vessel beyond F.P.	4	8
Extension of vessel beyond A.P.	0	0
Length on L.W.L.	307	0
Beam, extreme, 12 feet above base	27	3½"
Beam, molded, 12 feet A.B.	27	1⅜"
Depth, molded amidships, Fr. 53	22	11-3/8"
Midship section is forward of Fr. 69 inches		12
Freeboard at bow 27½ A.B. (14'-7½")	12	6
Freeboard at stern 22-3-5/8 A.B. (15'-7")	6	8-5/8"
Frame spacing -		
Frame 0 to 35 inches		24
35 to 62 "		30
62 to 69 "		24
69 to 103 "		30
103 to 104 "		24
104 to 106 "		30
106 to 136		24
Frames, No. of		139
Keel, Bottom of, below the base line inches		1"
Fuel Oil, fuel capacity (normal) gals.		55,586
Fuel Oil, reserve, capacity "		38,530
Fuel oil, total capacity - max.		94,110
Lube Oil, capacity (tanks 95%, sumps 75%) max.		5,787
Potable water tanks		4,099
Battery water tanks		1,197
Shafts, inclination, down and aft		1°-30'
Shafts, divergence of, from C.L.		1°-39'
Rudder, area of - sq. ft.		98.22
Mast, after stub from A.P. ft. in.		79'-0"
Ballast tanks, main, capacity, tons		475.68
Ballast tanks, variable, capacity, tons		118.05
Negative tank, tons		8.06
Heights: above base line		
D.W.L. normal forward	14	8-3/8
D.W.L. normal aft	15	8-1/8
D.W.L. midships	15	2¼
Mast, vertical antenna, up	56	7⅜
Mast, vertical antenna, down	44	6½
Gun, 4" axis	27	11-7/8
Guns (2) 20 M.M. AA - Frs. 48 & 59	33	7⅜
Masthead light, high, center of	44	2-5/8

47.5
15.3
32
7¾
56.3
15.4¼
41'

Heights: above base line (continued)

	Feet	Inches
Highest Point, fixed part of ship, periscope support	47	2½
Anchor light, stern Fr. 122	25	10-1/8
Bow Anchor Light, Fr. 10½.	34	6-5/8
Deck, platform, control room	11	5-13/16
Deck, conning tower, (C.L. of C.T.)	24	3½
Deck, Bridge Forward	29	3¼
Deck, bridge aft	29	3¼
Periscope Nos. 1 & 2 - up, top	66	8-1/16
Periscope Nos. 1 & 2 - up, Optical Center -	66	5½
Periscope Nos. 1 & 2 - down, top	47	2½

Calculated data, from displacement curves:

	Diving Trim Normal	Diving Trim Emergency
Draft, mean, feet, inches	15'-3"	16' - 2½"
Draft, forward, feet, inches	14'-10½"	15' - 11½"
Draft, Aft.	15'-7½"	16' - 5½"
Immersion tons per inch	12.45	11.82
Water plane area, sq. ft.	5250	4980
Moment to alter trim 1", ft. tons	210	205
C.B. above base line, feet	9.18	9.70
Water plane, C.G. aft of Fr. 69	5.90	6.50

Displacement:

Submerged Ship, displacement tons	2419	2419
Main Ballast & Safety Tanks corrected for lead Ballast and Residual water		
Displacement tons	612.80	466.31
C.G. from Fr. 69 ft. Aft.	1.38	1.64
Moment about Fr. 69 ft. tons	845 Aft	765 Aft
(a) Surface, diving trim		
Displacement tons	1806.20	1952.69
C.G. from Fr. 69 ft.	2.22 Aft	2.09 Aft
Moment about Fr. 69	4009	4085
Center of buoyancy, Fr. 69	1.12 Aft	1.46 Aft
(b) Trimming lever	1.10	.63
Trimming moment, by stern ft. tons (axb)	2020	1230
*Metacentric height - transverse		
Surface, normal diving trim		1.89 Ft.
Surface, emergency diving trim		1.44 "
Submerged, normal diving trim		.94 "
Submerged, emergency diving trim		.93 "
Submerging and emerging (min.)		.87 "

*Typical for class; subject to correction by actual inclining experiment.

Metacenter, transverse, above C.B. (1806.20)	3.22 Ft.
Metacenter, longitudinal above C.B. (1806.20)	371.00 "
Metacentric, height, longitudinal, above base	380.16 "
Midship section, immersed area, NDT sq. ft.	340 "
Wetted surface NDT sq. ft.	11543 "
Ratio, length between perpendiculars and beam, molded	11.37 "

In connection with the inclining experiment, the necessary data is taken and calculations made to show that the vessel has adequate metacentric height in any condition of trim through which she may pass during the operation of submerging or emerging; at no point in this operation is the metacentric height less than 10½ inches.

The displacement of the vessel used in the determination of the submerged metacentric height, based upon the surface inclining experiment, is the displacement of the "always buoyant" pressure hull and appendages, plus the capacity of the main ballast, safety, fuel-ballast and external fuel and lube oil tanks at 35 cubic feet per ton.

The surface condition, normal, diving trim, is defined as follows:

The main ballast, fuel-ballast, negative and safety tanks shall be empty; the variable ballast tanks shall contain such water as will permit the vessel, by flooding the main ballast, fuel-ballast, and safety tanks, to dive with safety and handle at slow speed submerged. Other weights on board shall be as specified for condition VI(b) of the inclining experiment.

GENERAL - Propelling Machinery:

	Manufacturer
Diesel Engines, Main	Fairbanks, Morse & Company
Auxiliary Engine	Fairbanks, Morse & Company
Scavenger Blower	Fairbanks, Morse & Company
Main Motors	Elliot Company & General Electric Co.
Main Controls (1)	Westinghouse Co.
Reduction Gears	Westinghouse Electric & Mfg. Company & G. E. Co.
Shafting (finished work)	Navy Yard, Portsmouth, New Hampshire
Propellers	Navy Yard, Mare Island, California
Main Storage Batteries	(1) Electric Storage Battery Company &(Exide) (2) National Battery Co. (Gould)

Diesel Engine Data:

	Main	Auxiliary
Type	Model 38D8-1/8 Vert. O.P. S.A.	300 KW Model 38E5¼ Vert. O.P. S.A.
Cycle	2	2
BHP	1600	440
RPM	720	1200
No. Cyl.	10	7
Dia. Cyl. Inches	8-1/8"	5¼"
Stroke inches	10	7¼"
Compression ratio	14.23:1	15.3:1
Scavenger blower	Gear driven Impellers	Gear driven Impellers

Main Motors (Uniform Spec. Ports.)

Rating Normal	1375 H.P.
Amperes	2600
Volts	415
RPM	1200 (Propeller RPM - 280)

Type and Class: MPC, compound wound, continuous duty, self-ventilated, sea water ccoled.

Main Controls:

Westinghouse Elec. & Mfg. Co. 35-J-672 - Control Equipment, consists of motor group, instrument panel, operating deck controls, P&S motor starters, battery selector switches, P & S motor reverser switches, motor and battery relays.

Reduction Gears (2 Pinion):

	Gear	Pinion
Pitch dia.	39.8996	9.3244
Ratio	4.2790	1
No. teeth	184	43
R.P.M. Forward	280	1189.1
SHP at cplg.	2700	2700 (two)

Shafting:

	Dia. Inches
Crankshaft, main engine	7.995
Crank pin, main engine	6.746
Line Shafting, 1 section	9-1/16 O.D.
	10.00 over sleeve
Axial holes	5" max.
	2¼" min.

Vulcanized rubber covering on shaft between stern tube bearing sleeves.

1/4

SECTION II DATA

Specifications and Ratings

	9-cylinder	10-cylinder
Model number	38D8⅛	38D8⅛
Type	Opposed Piston	Opposed piston
Cycle	Two	Two
Bore and stroke	8⅛" x 10"	8⅛" x 10"
Number of cylinders	9	10
Rated speed	720 r.p.m.	720 r.p.m.
Displacement per minute	3889 cu. ft.	4321 cu. ft.
Total piston displacement	9333 cu. in.	10370 cu. in.
Piston speed per minute	1200 ft.	1200 ft.
Speed factor	8.60	8.60
Output at rated speed	1600 hp.	1600 hp.
Compression ratio	12.6 - 14.9 to 1	12.6 - 14.9 to 1
Brake mean effective pressure at rated load and speed	94.3 p.s.i.	84.9 p.s.i.
Firing order: L.H. rotation engine	* 1, 9, 2, 7, 4, 5, 6, 3, 8	*1, 8, 7, 3, 5, 9, 4, 2, 10, 6
R.H. rotation engine	* 1, 8, 3, 6, 5, 4, 7, 2, 9	*1, 6, 10, 2, 4, 9, 5, 3, 7, 8
Weight (dry) of engine only	30500 lbs.	33200 lbs.
Weight (wet) of engine only	30770 lbs.	33600 lbs.
Weight of lubricating oil in engine passages	350 lbs	350 lbs.
Cylinder relief valve setting	2000 p.s.i.	2000 p.s.i.
Lubricating oil filter relief valve set for differential of	10 p.s.i.	10 p.s.i.

*Cylinders are numbered from 1 to 9 or from 1 to 10, with No. 1 at the control end.

Non-reversible

Blower

Type	Positive displacement	Positive displacement
Capacity per minute	5500 cu. ft.	6000 cu. ft.
Speed	1320 r.p.m.	1450 r.p.m.
Power required to drive at rated load and speed	116 hp.	127 hp.
Displacement per revolution of impellers	4.80 cu. ft.	4.80 cu. ft.
Scavenging pressure	3.6 to 6 p.s.i.	3.6 to 6 p.s.i.

Fuel Oil Pump

Type	Gear	Gear
Capacity	6 g.p.m.	6 g.p.m.
Speed	1200 r.p.m.	1200 r.p.m.
Discharge pressure	25 p.s.i.	25 p.s.i.
Power required to drive at rated load and speed	.35 hp.	.35 hp.
Suction lift	15" Hg.	15" Hg.
Hydrostatic test pressure	200 p.s.i.	200 p.s.i.
Approx. mechanical efficiency	33%	33%
Temperature range	35° to 100° F.	35° to 100° F.
Viscosity range	35 to 100 S.S.U.	35 to 100 S.S.U.

Injection Nozzle

Three tip holes at 15° angles. Diameter	.0225"	.0225"
Discharge pressure	3000 p.s.i.	3000 p.s.i.

Jacket Water Pump

Type	Centrifugal	Centrifugal
Capacity	500 g.p.m.	525 g.p.m.
Speed (at engine speed of 720 r.p.m.)	1745 r.p.m.	1745 r.p.m.
Power required to drive at rated load and speed	7.75 hp.	16.2 hp.
Head including 6½-ft. suction lift	45 ft.	45 ft.
Test pressure	200 p.s.i.	100 p.s.i.
Efficiency at 100° F.	74.5%	46%

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Ex: FM-No 42 N3800D8⅛

95 381-404; 405-410
411-416; 417-424
425-434 275-280(9)

Lubricating Oil Pump

	9-Cylinder	10-Cylinder
Type	Herringbone gear	Herringbone gear
Capacity	215 g.p.m.	280 g.p.m.
Speed (at engine speed of 720 r.p.m.)	1280 r.p.m.	1280 r.p.m.
Power required to drive at rated load and speed	14 hp.	18.5 hp.
Relief valve setting	60 p.s.i.	60 p.s.i.
Suction lift	10" Hg.	10" Hg.
Temperature range	100° to 150° F.	100° to 150° F.
Viscosity range	400 to 130 S.S.U.	400 to 130 S.S.U.
Approximate mechanical efficiency	47%	47%
Approximate volume efficiency	80%	80%
Hydrostatic test pressure	60 p.s.i.	60 p.s.i.

Sea Water Pump

Type	Centrifugal	Centrifugal
Capacity	500 g.p.m.	525 g.p.m.
Speed (at engine speed of 720 r.p.m.)	1745 r.p.m.	1745 r.p.m.
Power required to drive at rated load and speed	7.9 hp.	16.5 hp.
Head including 6½-ft. suction lift	45 ft.	45 ft.
Test pressure	200 p.s.i.	100 p.s.i.
Efficiency at 85° F.	74.5%	46%

Dimensions of Principal Parts

Camshaft Bearings

	Size	Clearance
Bearing diameter	2.500" +.0005" −.001"	.0035" to .006"
Camshaft diameter	2.4955" +.000" −.001"	

Connecting Rod Bearings, crank end

Bearing diameter	6.752" +.0005" −.001"	*.005" to .008"
Crankshaft diameter	6.746" +.000" −.001"	

Connecting Rod Bearing Diameter, piston end, needle bearing type

Bushing diameter	3.6945" +.0005" −.0000"	.002" to .0034"
Roller diameter	.250" +.0000" −.0002"	
Piston pin diameter	3.1925" +.0000" −.0005"	

Connecting Rod Bearing Diameter, piston end, lined bushing type

Bushing diameter	3.198" +.0005" −.0000"	.0045" to .0065"
Piston pin diameter	3.1925" +.0000" −.0005"	

Connecting Rod Bearing Length, piston end

Slot in bracket	3.625" ±.004"	.014" to .031"
Retaining ring thickness	.210" +.000" −.002"	
Piston pin bushing length	3.187" +.000" −.005"	

Connecting rod bore tolerance added

Non-reversible

Non-reversible

Main and Thrust Bearing Diameter

	Size		Clearance
Bearing diameter	8.005"	+.0005" −.001"	*.009" to .012"
Crankshaft diameter	7.995"	+.000" −.001"	

Thrust Bearing Width

Crankshaft width	4.000"	+.003" −.000"	.005" to .010"
Bearing width	3.995"	+.000" −.002"	

Blower

	Size	Backlash	Clearance
Between Impellers			.028" to .032"
Timing Gears		.002" to .008"	
Impeller to housing			.025" to .029"
Impeller to bearing plate			.028" to .032"
Impeller to outer bearing plate			.021" to .025"

Blower Flexible Drive

Drive gear to pinion			.002" to .008"	
Inside diameter of drive gear wearing ring	8.500"	+.001" −.000"		.0045" to .0065"
Drive hub outside diameter	8.495"	±.0005"		
Inside diameter of end plate wearing ring	10.000"	+.001" −.000"		.0045" to .0065"
Drive hub outside diameter	9.995"	±.0005"		

Crankshaft Vertical Drive ..... .012" to .016"

Injection Nozzle

Needle diameter (lapped together)	.281"		
Sleeve diameter (lapped together)	.281"		
Body diameter	.5625"	±.0005"	.003" to .0045"
Filter diameter at longitudinal grooves	.559"	+.0000" −.0005"	

Injection Pump

Plunger barrel diameter (lapped together)	.5000"
Plunger diameter (lapped together)	.5000"

Jacket Water and Sea Water Pumps for 9-cylinder engine

Volute wearing ring inside diameter	5.000"	+.0005" −.002"	.030" to .0355"
Impeller wearing ring outside diameter	4.968"	+.000" −.003"	

Jacket Water and Sea Water Pumps for 10-cylinder engine

Volute wearing ring inside diameter	5.500"	+.000" −.002"	.030" to .035"
Impeller wearing ring outside diameter	5.468"	+.000" −.003"	

*Block bore tolerance added

1 1/8

Ex: FM-Na 42 N3800 D8 5/8

95 381-404; 405-410
411-416; 417-424
425-434 275-280(9)

Lubricating Oil Pump

	Size	Backlash	Clearance
Impellers		.0005" to .003"	
Impeller to inner or outer wearing plate			.002" to .004"
Impeller to pump body			.003" to .0015"
Timing Gears		.0005" to .002"	

Piston

Liner diameter	8.125"	+.002" −.000"	.0085" to .0135"
Piston diameter (with tin plate)	8.115"	±.0015"	

Piston Rings

Nos. 1 and 2 compression rings	side	.008" to .0110"
	end	.030" to .040"
Nos. 3 and 4 compression rings	side	.005" to .0080"
	end	.030" to .040"
Oil ring	side	.0015" to .0045"
	end	.015" to .025"
Oil drain rings	side	.0015" to .0045"
	end	.015" to .025"

Pump Flexible Drive

All gears		.002" to .006"	
Gear bushing diameter	6.250"	+.001" −.000"	.006" to .008"
Drive hub diameter	6.244"	+.000" −.001"	

Non-reversible

Summary of Operating Figures

A summary of normal operating figures covering these engines at full load and full speed (except as noted) is given below for reference.

Pressures	Read at:	Pressure
Firing pressure	Portable instrument	Max., †1250 p.s.i.
Fuel oil at injection pump inlet	Gauge board	5 to 20 p.s.i.
Hot engine compression at half speed	Portable instrument	*440 to 560 p.s.i.
Hot engine compression at full speed	Portable instrument	*Max., 750 p.s.i.
Jacket water at pump discharge	Gauge board	‡8 to 29 p.s.i.
Lubricating oil at engine upper header	Gauge board	17 to 32 p.s.i.
Pressure drop across fuel/oil filter		2 p.s.i.
Pressure drop across lubricating oil filter		5 p.s.i.
Sea water at pump discharge	Gauge board	‡8 to 35 p.s.i.
Starting air at flask or header	Gauge board	3000 p.s.i.
Starting air at reducing valve outlet	Gauge board	250 p.s.i.

† 120 p.s.i. maximum variation between cylinders on any one engine.
‡ Varies with piping arrangements.
* 40 p.s.i. maximum variation between cylinders on any one engine.

Temperatures	Read at:	Temperature
Exhaust, combined, at nozzle	Pyrometer	430° to 770° F.
Exhaust, individual cylinder	Pyrometer	†Max., 770° F.
Jacket water outlet	Piping	140° to 170° F.
Jacket water outlet preferred range	Piping	to 160° F.
Jacket water differential inlet to outlet	Pipin	Max., 30° F.
Jacket water preferred differential, inlet to outlet	Piping	Max., 10° F.
Lubricating oil outlet	Piping	140° to 180° F.
Lubricating oil outlet preferred range	Piping	to 165° F.
Lubricating oil differential, inlet to outlet	Piping	Max., 40° F.
Lubricating oil preferred differential, inlet to outlet	Piping	Max., 30° F.

† 100° F. maximum variation between cylinders on any one engine.

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Ex: FM-No 42 N5600 D 8 1/8

SS 381-404; 405-410
411-416; 417-424
425-434 275-280(9)

Fuel Consumption at Various Loads and Speeds

B.H.P.	R.P.M.	*Generator	†Generator	Fuel (Average) per Brake Hp.-Hr. 9-Cylinder	10-Cylinder
1600	720	1133 Kw.	1125 Kw.	.375 lbs.	.375 lbs.
1200	720	847 Kw.	847 Kw.	.380 lbs.	.381 lbs.
800	720	560 Kw.	563 Kw.	.418 lbs.	.419 lbs.
400	720	269 Kw.	267 Kw.	.555 lbs.	.555 lbs.
1280	648	906 Kw.	903 Kw.	.365 lbs.	.364 lbs.
960	648	677 Kw.	678 Kw.	.376 lbs.	.368 lbs.
720	648	506 Kw.	506 Kw.	.403 lbs.	.405 lbs.
360	648	246 Kw.	245 Kw.	.530 lbs.	.529 lbs.
800	576	564 Kw.	564 Kw.	.373 lbs.	.371 lbs.

* Elliott † General Electric

Miscellaneous	9-Cylinder	10-Cylinder
Blower suction, vacuum	.75" to 5.6" water	.75" to 5.6" water
Exhaust gas volume per minute at 570°F.	11,700 cu. ft	12,100 cu. ft.
Exhaust line back-pressure at engine nozzle	40" water	40" water
Overspeed governor trips at	800 r.p.m.	800 r.p.m.
Ratio of air to fuel	42 to 1	47 to 1

Generator Data

The generators furnished with the 9-cylinder engines on contract NObs 699 were manufactured by the Elliott Co. of Ridgeway, Pa.; those with the 10-cylinder engines, by the General Electric Co., Schenectady, N. Y. Information on the operation and maintenance of the generators is furnished by these companies.

Non-reversible

ENGINE DATA

B. DATA

1. Engine Data

a. Specifications and Ratings

Output at Rated R.P.M.	300 K.W.
Model No.	38E5¼
Type	Opposed Piston
Cycle	Two

Rating

Bore and Stroke—Inches	5¼x7¼
Number of Cylinders	7
Rated R.P.M.	1200
Displacement—Cu. Ft. Per Min.	1526
Total Piston Displacement—Cu. In.	2197
Piston Speed—Ft. Per Min.	1450
Speed Factor	17.4
Compression Ratio	13.2 to 15.3 to 1
B.M.E.P. at Rated Load and Speed—Lbs. Per Sq. In.	64.3

Blower

Type	Positive Displacement
Capacity—Cu. Ft. Per Min.	2280
R.P.M.	2065
Horse Power to Drive (At Rated Load and Speed)	62
Displacement per Revolution of Impeller—Cu. Ft.	1.10
Scavenging Pressure—Lbs. Per Sq. In.	3

Injection Nozzle Tip Hole

Number at 15° angle .018" Dia.	3

Pump—Fuel Oil

Type	Gear
Capacity—Gals. per Min.	2
R.P.M.	1600
Horse Power to Drive (At Rated Load and Speed)	¼
Discharge Pressure—Lbs. per Sq. In.	25
Suction—Inches Mercury	15
Fuel Temp. Range—Fahrenheit	35°-100°
Fuel Viscosity Range—S.S.U.	100-35
Test Pressures—Lbs. per Sq. In.	200

Pump—Generator Bearing Drain

Type	Gear
Capacity—Gals. per Min.	2
R.P.M.	1600
Horse Power to Drive (At Rated Load and Speed)	¼
Discharge Pressure—Lbs. per Sq. In.	25
Suction—Inches Mercury	10
Oil Temp. Range—Fahrenheit	60°-160°
Oil Viscosity Range—S.S.U.	3100-130
Test Pressure—Lbs. per Sq. In.	200

Pump—Fresh Water

Type	Centrifugal
Capacity—Gals. per Min.	140
R.P.M.	2571
Horse Power to Drive (At Rated Load and Speed)	3.0
Suction Pressure—Lbs. per Sq. In.	0.7
Total Head—Ft.	49
Test Pressure—Lbs. per Sq. In.	200

Pump—Lubricating Oil

Type	Gear
Capacity—Gals. per Min.	74
R.P.M.	1600
Horse Power to Drive (At Rated Load and Speed)	3.5
Discharge Pressure—Lbs. per Sq. In.	40
App. Mach. Eff.	50%

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Ex: FM-Inst. No. 42H3800 E5¼

SS 381-404, 405-410
411-416, 417-424
425-434, SS 275-280

Engine Data (Continued)

App. Vol. Eff.	80%
Hydrostatic Test Pressure—Lbs. per Sq. In.	150
Relief Valve Set at Lbs. per Sq. In.	60

Pump—Sea Water

Type	Centrifugal
Capacity—Gals. per Min.	18[illegible]
R.P.M.	2571
Suction Pressure—Lbs. per Sq. In.	0[illegible]
Horse Power to Drive (At Rated Load and Speed)	3.85
Total Head—Ft.	4[illegible]
Test Pressure—Lbs. per Sq. In.	200

b. Dimensions and Clearances of Principal Engine Parts

Bearing—Camshaft	Size	Backlash	Clearance
Bearing diameter	2.0615" to 2.0613"		.0015" to .004"
Camshaft diameter	2.059" to 2.060"		
Bearings—Connecting Rod—Crank End			
Bearing diameter crank end	4.251" to 4.2525"		.003" to .0055"
Crankshaft diameter	4.247" to 4.248"		
Bearings—Connecting Rod—Piston End			
Bushing diameter	2.4075" to 2.408"		.0015" to .0029"
Roller diameter	.1248" to .125"		
Piston pin diameter	2.1555" to 2.156"		
Bearings—Connecting Rod—Piston End—Side			
Slot in Bracket	2.059" to 2.065"		.006" to .018"
Retaining ring—thickness	.087" to .089"		
Bushing—length	1.873" to 1.875"		
Bearings—Main—Diameter			
Bearing diameter	5.004" to 5.0055"		.007" to .0095"
Crankshaft diameter	4.996" to 4.997"		
Bearings—Main—Thrust			
Crankshaft width	2.3125" to 2.3155"		.005" to .011"
Bearing width	2.3045" to 2.3075"		
Main Bearing Thickness Shell and Lining	.49775" to .49825"		
Blower			
Between impellers			.014" to .018"
Timing gears		.001" to .002"	
Drive gear to pinion		.002" to .008"	
Impeller to housing			.012" to .016"
Impeller to inner bearing plate			.018" to .022"
Impeller to outer bearing plate			.010" to .014"
Blower Drive—Flexible			
Wearing ring diameter	5.75" to 5.751"		.0045" to .0065"
Drive hub diameter	5.7445" to 7.455"		
Crankshaft Drive—Vertical Gear		.003" to .010"	
Flexible Pump Drive—Attached—Governor and Pumps			
All gears		.002" to .006"	
Gear bushing	4.625" to 4.626"		.006" to .008"
Drive hub diameter	4.618" to 4.619"		

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Ex: FM-Inst. No. 42N3800 E5¼

SS 381-404, 405-410
411-416, 417-424
425-434, SS 275-280

Engine Data (Continued)

Injection Nozzle	Size	Backlash	Clearance
Needle diameter (lapped with sleeve)	.281"		
Sleeve diameter			
Body diameter	.562" to .563"		.003" to .0045"
Filter diameter	.5585" to .559"		
Injection Pump			
Barrel diameter (lapped with plunger) 10 m/m			
Plunger diameter			
Lubricating Oil Pump			
Impellers		.0005" to .003"	
Impellers bearing to wear plate			.003" min.
Impellers to bearing plate inner			.002" to .005"
Impellers to bearing plate—outer			.002" to .005"
Impeller housing			.0015" to .003"
Timing gears		.0005" to .002"	
Piston			
Liner diameter	5.2495" to 5.2505"		.008" to .010"
Piston diameter open end (with tin plate)	5.2405" to 5.2415"		
Piston			
Liner diameter	5.2495" to 5.2505"		.0475" to .0535"
Piston diameter closed end	5.197" to 5.202"		
Piston Rings			
Ring #1 compression, side			.009" to .011"
Ring #1 compression, end			.020" to .030"
Rings #2, #3, #4, compression, side			.007" to .009"
Rings #2, #3, #4, compression, end			.020" to .030"
Ring oil cutter, side			.0005" to .002"
Ring oil cutter, end			.025" to .030"
Ring oil drain, side			.003" to .041"
Ring oil drain, end			.015" to .025"
Ring oil scraper, side			.003" to .0036"
Ring oil scraper, end			.020" to .030"
Water Pump			
Volute ring diameter	3.998" to 4.0005"		.030" to .0345"
Impeller ring diameter	3.966" to 3.968"		

2. Summary of Operating Figures

A summary of the normal engine operating figures of the generator sets as determined by factory tests at 1200 R.P.M.

a. Pressures

	Read At	Lbs. Per Sq. In. Range
Fresh Water at Pump Discharge to Engine Inlet	Gauge Board	13 to 25
Sea Water at Pump Dicharge	Gauge Board	14 to 25
Fuel Oil at Injection Pump Inlet	Gauge Board	7 to 21
Scavenging Air	Gauge Board	2.2 to 5.0
Hot Engine Compression—½ speed	Gauge Board	470 to 580
Hot Engine Compression—Full speed	Gauge Board	750
Maximum variation on any one engine	Gauge Board	30
Firing—Maximum	Gauge Board	1225
Maximum variation on any one engine	Gauge Board	60
Lubricating Oil at Engine upper header	Gauge Board	21 to 47

b. Temperatures

	Read At	Degrees Fahrenheit Range
Lubricating Oil Outlet to Cooler	Gauge Board	140 to 180
Lubricating Oil Outlet—Preferred	Gauge Board	165

Engine Data (Continued)

	Read At	Degrees Fahrenheit Range
Lubricating Oil Differential—In-Out	Gauge Board	40 Max.
Lubricating Oil Differential—In-Out-Preferred	Gauge Board	25
Fresh Water Outlet to Cooler	Gauge Board	140 to 170
Fresh Water Outlet to Cooler—Preferred	Gauge Board	160
Fresh Water Differential—In-Out	Gauge Board	20 Max.
Fresh Water Differential—In-Out-Preferred	Gauge Board	10
Exhaust (Combined at Exhaust Nozzle or Nozzles)	Gauge Board	360 to 590.
Exhaust Variation at Any One Engine	Gauge Board	100 Max.
Exhaust Maximum	Gauge Board	590

c. Miscellaneous

Overspeed Governor Trips at R.P.M.	1290 - 1370
Blower Suction—Vacuum—Inches of Water	.5 to 4.3
Back Pressure in Exhaust Line at Engine Exhaust Nozzle—Inches of Water	40
Volume of Exhaust Gas—Cu. Ft. per Minute	4190
Ratio of Air to Fuel	61.5 to 1
Lubricating Oil Strainer—Wire wound type—Relief Valve Set to By-pass after Differential across Filter—Lbs. per Sq. Inch	10 to 12
Total Displacement—Cu. Ft. per Minute	2197
Piston Head Clearance when cold—No crank lead	.122 to .157
Piston Head Clearance Max. variation any one Engine	.015

3. Firing Order and Rotation

This engine rotates L.H. or counter clockwise when viewed from the coupling end. The firing order of the cylinders is 1-7-2-5-4-3-6 (Illus. B1).

4. Ordering Engine Repairs

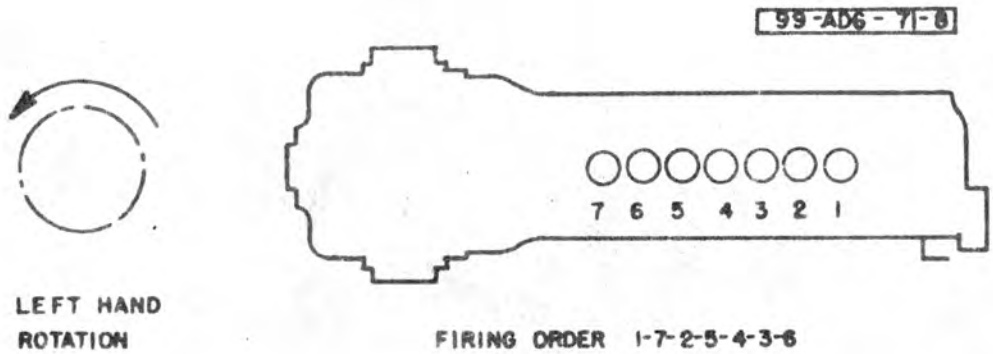
All Supply Officers Should Read the First Page in this Book "ATTENTION — ALL SUPPLY OFFICERS" and Use Volume II Repair Parts List of This Instruction 32N3800E5¼.

5. Generator Data

Manufacturer—Elliott Co.—Contract NObs 354
300 K.W.—260 V. 1154 Amps. 1200 R.P.M.

Manufacturer—General Electric Co.—Contracts NObs 698, 699, 750.
Type CY277—HL. 6P. 300 K.W. 260 V. 1154 Amps. 1200 R.P.M.

Manufacturer—Allis Chalmers—Contract NObs 296
300 K.W.—260 V. 1154 Amps. 1200 R.P.M.



Illus. B1 Firing Order and Rotation

Propellers:

Number	1 Starboard R.H. 1 Port, L.H.
Type	Solid, 4 Blad, Mn-C, 280 R.P.M.
Diameter	7.791 ft.
Pitch (design)	8.812 ft. at 33.5" R.
Immersion	C.L. of hub at NDT 8 Ft. 10½"
Height - lower tip above keel - 2 ft. 11¼"	

Storage Batteries: General Data - for details see AUXILIARIES Record of Electrical SS381.

Type: Gould or Exide.	2
Number of Cells - 2 Groups - 126 cells	252
Voltage, Max. Sp.gr. at 120° F - 1.250	262.5 V

Hours	½	1	3	5	10	20	36	48	
Amperes	8050	5320	2420	1410	930	512	305	235	Discharge rates

Weight, av. per cell - 1660, 126 cells, lbs. 209,160

DIMENSIONS (MISCELLANEOUS)

Breadth, Moulded, maximum at D.W.L.	26'-0"
Depth of Inner Bottom, Molded - Fr. 53	3'-9"
Shafts to C/L Frame 107	4'-5.5121"
Shafts to C/L Frame 128	5'-8.000"
Shaft Height Above Base Line at Frame 107	7'-10.1707"
Shaft Height Above Base Line at Frame 128	6'-9.000"

HEIGHTS (MISCELLANEOUS)

Lowest Point of Keel to Top of Inner Hull Amidships on Center Line	19'-10"
Lowest Point of Keel to Top of Bridge Flat	29'-4-1/4"
Lowest Point of Keel to Top of Conning Tower Plating at Frame 53 on Center Line of Ship	28'-4-1/2"
Lowest Point of Keel to Top of Pilot House Top	33'-8-3/4"
Lowest Point of Keel to Top of Vertical Antenna Mast Extended	56'-8-3/4"
Lowest Point of Keel to Top of #1 & #2 Periscope Supports	47'-3-1/2"
Lowest Point of Keel to Top of Vertical Antenna Mast Support	42'-10-1/2"

HOSE CONNECTIONS (AIR)

Service	Location	No.	Size
Grease Gun Connection	For'd. Torpedo Room	1	1/4"
Grease Gun Connection	Officers Quarters	1	1/4"
Grease Gun Connection	Control Room	1	1/4"
Grease Gun Connection	Crew's Mess	1	1/4"
Grease Gun Connection	Crew's Quarters	1	1/4"
Grease Gun Connection	For'd. Engine Room	1	1/4"
Grease Gun Connection	Aft. Engine Room	1	1/4"
Grease Gun Connection	Maneuvering Room	1	1/4"
Grease Gun Connection	After Torpedo Room	1	1/4"
Pneumatic Air	For'd Engine Room	1	1/2"
Pneumatic Air	After Engine Room	1	1/2"
Pneumatic Air	Maneuvering and Motor Room	1	1/2"

HOSE CONNECTIONS (WATER)

Service	Location	No.	Size
Compt. Hose Connection	For'd. Torpedo Room	1	1-1/2"
Compt. Hose Connection	Officer's Quarters	1	1-1/2"
Compt. Hose Connection	Control Room	1	1-1/2"
Compt. Hose Connection	Crew's Quarters	1	1-1/2"
Compt. Hose Connection	For'd. Engine Room	1	1-1/2"
Compt. Hose Connection	After Engine Room	1	1-1/2"
Compt. Hose Connection	Maneuvering Room	1	1-1/2"
Compt. Hose Connection	After Torpedo Room	1	1-1/2"

ARMAMENT

Description	No.
21" Mk. XXXIV - Mod. 3 - Bow Torpedo Tubes	6
21" Mk. XXXV - Mod. 3 - Stern Torpedo Tubes	4
4"/50 Cal. Gun Mount - Mk. 12 - Mods. 38 to 41	1
20 MM. Anti-Aircraft Machine Gun Mounts Mk. 10	2

TORPEDOES, ETC.

	No.
21" Torpedo, Mk. 14-1 or 3	24
War Heads, Mark 16	24
Exploder Mech. Mark 6-1	24
Warhead Exten., Mk. 1	24
Torp. Igniter, Mark 6-2	24
Detonator, Mark, 7	24
Booster Charges	24

SMALL ARMS

Description	Stowage Provided For
Rifles, .30 Cal. Model 1903	6
Pistols, .45 Cal. Colt Automatic	12
Machine Guns, .30 Cal. Browning M1919A4	2
Automatic Rifles, .30 Cal. Browning M1918	2
Submachine Gun, .45 Cal. Thompson M1928	2
Pistol, .22 Cal. Gallery Target	1
Shotgun, Riot, 12-gauge, M1897	2

LINE THROWING EQUIPMENT

Description	No.
Rifle, .45 Cal. Line Throwing	1
Projectiles, Cal..45 Line Throwing	10
Blank Cartridges for .45 Cal. Line Throwing Rifle	50

ALLOWANCE OF AMMUNITION

Description	Quantity
4"-50 Cal. Cartridges in Tanks, Mk. 4	100
4"-50 Cal. Short Cartridge Cases in Modified Tanks	2

SMALL ARMS AMMUNITION - SERVICE

.45 Cal. Cartridge, Ball, for Colt Automatic Pistol	2000
.30 Cal. Cartridge, Ball	19,500
20 MM. Cartridges - Consisting of 1/3 A.P.T., & 1/3 H.E.T., and 1/3 H.E.I.	3,960
12 Gauge Shells (No.00 Buckshot)	50

TRAINING

4"-50 Cal. Dummy Drill Cartridges, Mk.3, in Mk. 4 Tanks	4
4"-50 Cal. Test Cartridge Cases, Mk. 2, in Mk. 4 Tanks	2
Primers, Lock, Drill (Annual Allowance)	
20 MM. Cartridges, Dummy Drill, in Mk. 3 Boxes	60

PYROTECHNICS

	Quantity
Submarine Identification Signals, Mark 2, Mod. 2 with Grenades, Mk. 5 (12 each red, green and yellow	36
Flare Signals - Mk. 10 & Mods. (10 each red, green and yellow)	30
Rocket Signals - 12 each red, green and yellow	36
Rocket Pistols	2
Very's Night Signalling Apparatus (Complete)	1 Box

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COMPLEMENT

	No.	Total
Commanding Officer	1	
Wardroom Officers	6	7
Gunners Mate 1st Class	1	
Torpedoman Mate - Chief	1	
Torpedoman Mate - 1st Class	2	
Torpedoman Mate - 2nd Class	3	
Torpedoman Mate - 3rd Class	4	
Quartermaster - 1st Class	1	
Quartermaster - 2nd Class	1	
Quartermaster - 3rd Class	1	
Signalman - 1st Class	1	
Fire Control Man - (Material) 1st Class	1	
Seaman - 1st Class	10	26
Electricians Mate - Chief	2	
Electricians Mate - 1st Class	2	
Electricians Mate - 2nd Class	3	
Electricians Mate - 3rd Class	3	
Radioman - Chief	1	
Radioman - 1st Class	1	
Radioman - 2nd Class	1	
Radioman - 3rd Class	1	
Radio Technician - 1st Class	1	
Radio Technician - 2nd Class	1	16
Motor Machinists Mate - Chief	2	
Motor Machinists Mate - 1st Class	6	
Motor Machinists Mate - 2nd Class	5	
Fireman - 1st Class	7	20
Yeoman - 1st Class	1	
Pharmacists Mate - 1st Class	1	2
Baker - 1st Class	1	
Ships Cook - 1st Class	1	
Ships Cook - 3rd Class	1	3
Stewards Mate - 1st Class	1	
Stewards Mate - 2nd Class	1	2

Total Ship's Officers	7
Total Ship's Crew	69
Total Ship's Complement	76

VARIABLE TANKS

Tanks	CAPACITY Cu.Ft.	Lbs.	Tons S.W.	Tons F.W.	C.G. Above Bot. Keel	C.G. From Fr. 66½ Fwd.	Aft	
Fwd. Trim	860	55040	24.57		9.58	113.18		
Fwd. W.R.T.	175	11200	5.00		5.63	98.35		
Aux. No. 1	1094	70016	31.26		9.12	-	-	
Aux. No. 2	1094	70016	31.26		9.12	-	-	
After W.R.T.	185	11840	5.28		9.75		120.75	
After Trim	724	46334	20.68		15.48		139.11	
Total Variable	4132	264448	118.05					
Negative Tank	282	18048	8.06		3.08	36.50		

FRESH WATER TANKS

Ships F.W. No. 1	132	8210		3.67	8.45	75.05		
Ships F.W. No. 2	132	8210		3.67	8.45	75.05		
Ships F.W. No. 3	132	8210		3.67	8.45	20.22		
Ships F.W. No. 4	132	8210		3.67	8.45	20.22		
Batt. F.W. Fwd.	80	4976		2.22	10.56	60.80		
Batt. F.W. Aft	80	4976		2.22	10.56		8.17	
Total F.W.	688	42792		19.12				

SANITARY TANKS

San. No. 1	43	2675		1.19	7.92	77.50		
San. No. 2	147	9143		4.08	7.90		24.41	

TORPEDO TUBES

Fwd. Tubes	314	20096	8.97		12.08	117.09		
Fwd. W.R.T.	86	5504	2.46		12.08	114.40		
Fwd. W.R.M.	206	13184	5.89		12.08	117.06		1 Mine in each Tube
After Tubes	229	14656	6.55		14.83		138.58	
After W.R.T.	77	4928	2.20		14.83		138.84	
After W.R.M.	157	10048	4.49		14.83		139.03	1 Mine in each Tube

MAIN BALLAST TANKS INCLUDING VENT PIPING

								LEAD DEDUCTION Cu.Ft.	Tons S.W.
M.B.T. No. 1	1700		48.58		6.85	85.84			
M.B.T. No. 2A	1128		32.22		9.92	41.26		16.33	.47
M.B.T. No. 2B	1128		32.22		9.92	41.26		16.45	.47
M.B.T. No. 2C	1166		33.31		9.24	27.61		19.01	.54
M.B.T. No. 2D	1166		33.31		9.24	27.61		19.17	.55
F.B.T. No. 3A	1310		37.42		9.14	15.19			
F.B.T. No. 3B	1310		37.42		9.14	15.19			
M.B.T. No. 4A	1586		45.31		9.17		12.48	16.60	.47
M.B.T. No. 4B	1586		45.31		9.17		12.48	16.67	.48
F.B.T. No. 5A	1319		37.68		9.13		26.20		
F.B.T. No. 5B	1319		37.68		9.13		26.20		
M.B.T. No. 6A	1197		34.19		9.21		38.69	30.98	.88
M.B.T. No. 6B	1197		34.19		9.21		38.69	31.28	.89
M.B.T. No. 6C	1260		36.00		9.05		52.31	21.45	.61
M.B.T. No. 6D	1260		36.00		9.05		52.31	21.15	.60
M.B.T. No. 7	1430		40.85		8.80		108.90	13.11	.37
Safety	847		24.19		9.34	7.00			
Total M.B. & S.	21909		625.88					222.26	6.37

From Ports.No, 658-308 - Subject to correction for SS381-404.

NORMAL FUEL OIL TANKS

TANK	CAPACITY Cu.Ft.	CAPACITY Gals.	CAPACITY Tons Oil	CAPACITY Tons S.W.	C.G. Above Bot. Keel	C.G. From Fr. 66½ Fwd.	C.G. From Fr. 66½ Aft
N.F.O. No. 1	1524	11400	36.31	43.54	8.71	68.43	
N.F.O. NO. 2	1745	13050	41.48	49.86	8.92	55.00	
N.F.O. NO. 6	1992	14900	47.46	56.91	8.98		72.08
N.F.O. No. 7	1246	9320	29.69	35.60	9.85		87.48
Collecting	398	2980	9.48	11.37	8.98		62.40
Expansion	398	2980	9.48	11.37	8.98		62.40
C.F.O. No. 1 95%	64	475	1.52	1.83	5.27		30.32
C.F.O. No. 2 95%	64	475	1.52	1.83	5.27		74.19
Total N.F.O.	7431	55580	177.04	212.31			

FUEL BALLAST TANKS

F.B.T. No. 3A	1285	9610	30.62	37.42	9.11	15.19	
F.B.T. No. 3B	1285	9610	30.62	37.42	9.11	15.19	
F.B.T. No. 5A	1291	9655	30.76	37.68	9.10		26.20
F.B.T. No. 5B	1291	9655	30.76	37.68	9.10		26.20
TOTAL F.B.T.	5152	38530	122.76	150.20			
Maximum F.O.	12583	94110	299.80	362.51			

* Corrected for water seal

LUBRICATING OIL STOWAGE TANKS 95% CAPACITY

N.L.O. No. 1	64	475	1.65		5.27		28.54
N.L.O. No. 2	64	475	1.65		5.27		75.97
N.L.O. No. 3	134	1002	3.44		7.40		80.09
N.L.O. No. 4	197	1473	5.06		8.10		99.97
M. & R. G. No. 1	52	390	1.34		3.68		96.70
TOTAL N.L.O.	511	3815	13.14				

LUBE OIL SUMP TANKS 75% CAPACITY

L.O. Sump No. 1	54	401	1.39		6.07		38.92
L.O. Sump No. 2	54	401	1.39		6.07		38.92
L.O. Sump No. 3	54	401	1.39		6.07		65.52
L.O. Sump No. 4	54	401	1.39		6.07		65.52
M. & R.G. Sump 1	25	184	.64		3.20		91.79
M. & R.G. Sump 2	25	184	.64		3.20		91.79
TOTAL Sump	266	1972	6.84				
Maximum L.O.	777	5787	19.98				

COMPARTMENT CAPACITIES AFT FR. 66½ (FLOODABLE VOLUME)

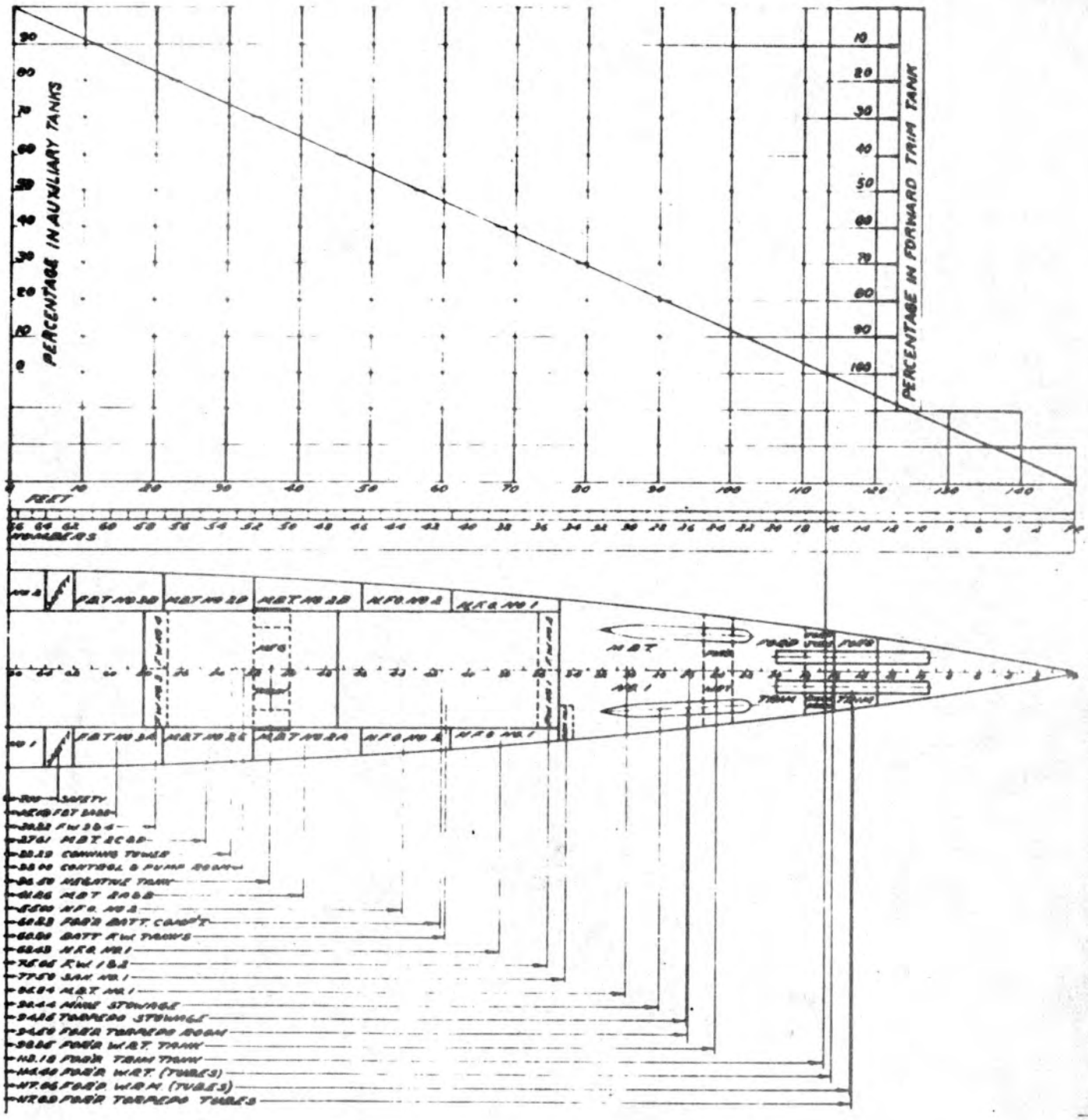
COMPARTMENT	Frames	Capacity Cu.Ft.	Capacity Tons S.W.	C.G. Above Bot. Keel	C.G. Aft Fr. 66½	Permeability
Aft Batt. Comp't	58-77	6290	179.8	13.19	2.95	73.4
Fwd. Eng. Room	77-87	3781	108.0	12.37	38.20	83.0
Aft Eng. Room	87-98	4306	123.0	12.29	64.78	83.0
Motor & Man. Room	98-107	3140	89.7	12.15	91.00	83.0
Aft. Torp. Room	107-125	3590	102.6	15.30	115.50	86.4

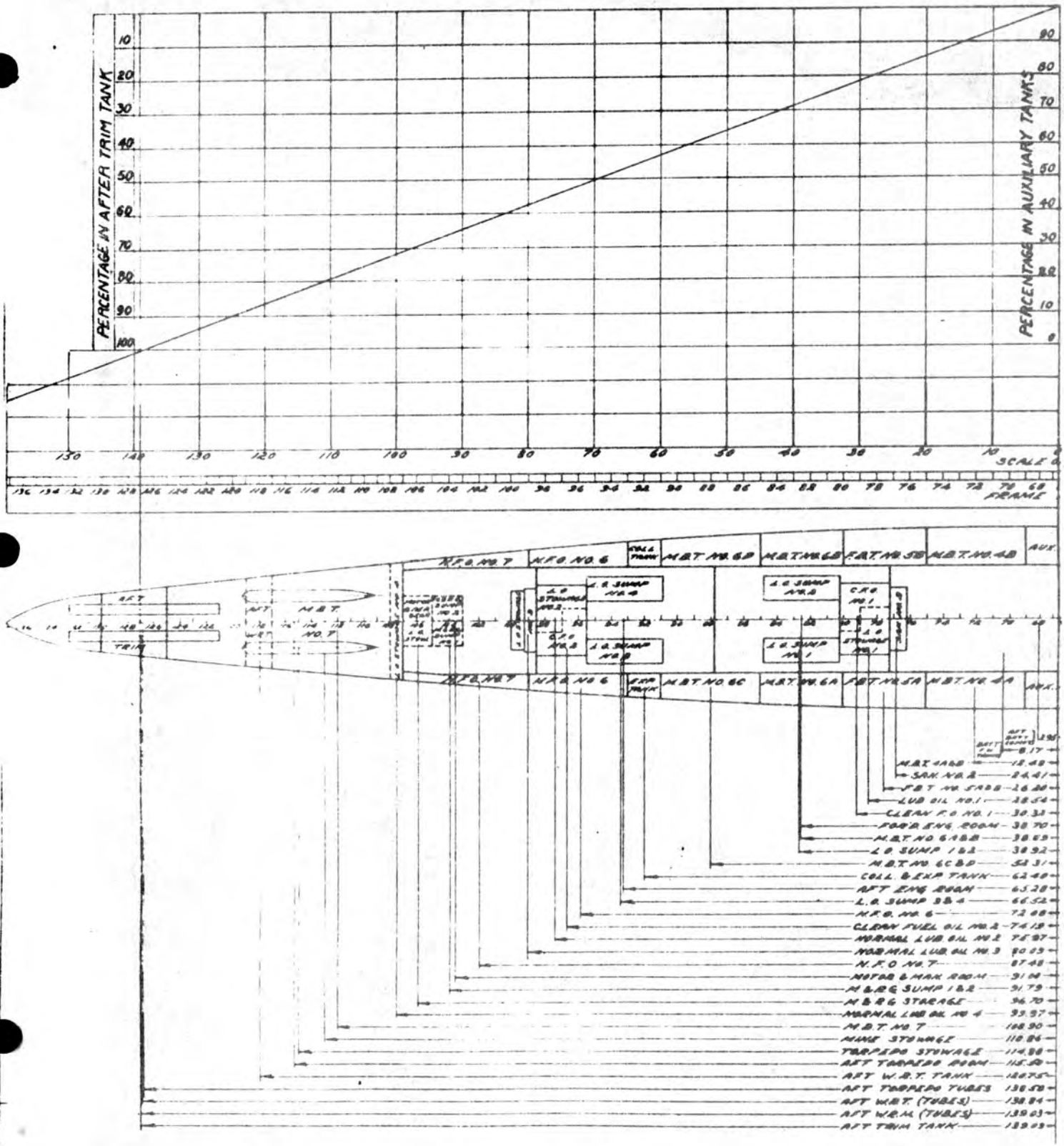
COMPARTMENT CAPACITIES FWD. FR. 66½ (FLOODABLE VOLUME)

Fwd. Torp Room	16-35	4460	127.4	13.00	94.50	82.2
Fwd. Batt. Room	35-47	4150	118.5	13.60	60.23	71.3
Control & Pump	47-58	3950	112.8	12.19	33.00	78.8
Conning Tower	49-56	670	19.1	24.38	27.65	85.0

From - Ports.No. 658-308 - Subject to correction for - SS381-404

MOMENT DIAGRAM





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GIB 38-434 A-1 1945 SEPT 14

U. S. NAVY YARD, PORTSMOUTH, N.H.

TYPICAL SHIP (SS285)
FLOODING EFFECTS
FROM FLOODABLE EFFECTS DIAGRAM - PORTS. NO. 661-285.

VIIb NORMAL DIVING TRIM : RES.BUOYANCY-607 T. VIIb EMERG'Y. DIVING TRIM. RES. BUOYANCY-458 T.

COMPT. OR TANK	VOLUME GROSS	VOLUME FLOODED TOTAL	EFFECT LIST DEG.	EFFECT TRIM FT.-IN.	EFFECT DRAFT MEAN FT.-IN.	RESERVE BUOYANCY AFTER TONS	VOLUME GROSS	VOLUME FLOODED TOTAL	EFFECT LIST DEG.	EFFECT TRIM FT.-IN.	EFFECT DRAFT MEAN FT.-IN.	RESERVE BUOYANCY AFTER TONS
Ford. Tr.	141	116	0	4-4	16-3	494	155	127	0	6-11	17-7	331
Ford. Tr. & MBT No. 1	155	175	0	7-11	16-10	432	155	175	0	Up End	-	283
Ford. Tr. Fwd. Batt Rm. Off. Qtrs.	332	246	0	Up End	-	361	332	246	0	Up End	-	361
Ford.Batt. Rm. Off Qtrs. F.O.T. No. 2 (SW)	141	103	0	2-2	16-1	504	155	116	0	3-4	17-4	342
Off. Qtrs. Fwd. Batt. Pump Room Control Rm. MBT 2A	296	251	5	6-8	17-5	356	296	251	-	Up End	-	195
Pump Rm. Control Rm. MBT 2C	119	125	5	0-18	16-3	482	130	134	5	2-4	17-5	323
Aft.Batt.Rm.& Mag. Crew's Qtrs. MBT 4-A	208	190	8	0-4	16-6	418	223	203	9	0-2	17-8	254
Pump Rm. ControlRm. Aft. Batt.& Mag. FBT 3A (SW)	343	293	8	2-7	17-6	314	379	295	-	Up End	-	163
Aft. Batt. & Mag. Crew's Qtrs. F.E.R. FBT 5A	339	292	10	1-9	17-5	315	363	283	4	1-7	18-8	174
F.E.R. MBT 6A	113	131	8	2-2	16-2	476	132	142	6	3-0	17-6	316
A.E.R. MBT 6C	118	133	7	4-2	16-3	474	127	141	8	4-2	17-4	317
F.E.R. A.E.R. MBT 2C	257	249	13	5-8	17-0	358	285	271	-	Up End	-	187
A.E.R. Man.& Motor Rm. F.O.T. No. 6	234	203	0	7-1	16-10	403	241	210	-	Up End	-	248
Man. & Motor Rm. F.O.T. No. 7	91	82	0	3-5	15-10	526	100	89	0	3-8	16-11	369
Man. & Motor Rm. A.T.R. F.O.T. No. 7	227	198	0	10-1	16-10	409	227	198	-	Up End	-	260
A.T.R.	90	78	0	4-3	15-10	530	104	90	0	4-9	15-12	368
A.T.R. MBT No. 7	104	129	0	6-6	16-1	478	119	142	0	9-0	17-8	316

Section A-1-a

GENERAL - WEIGHTS

Tabulation of Weights in Ship:

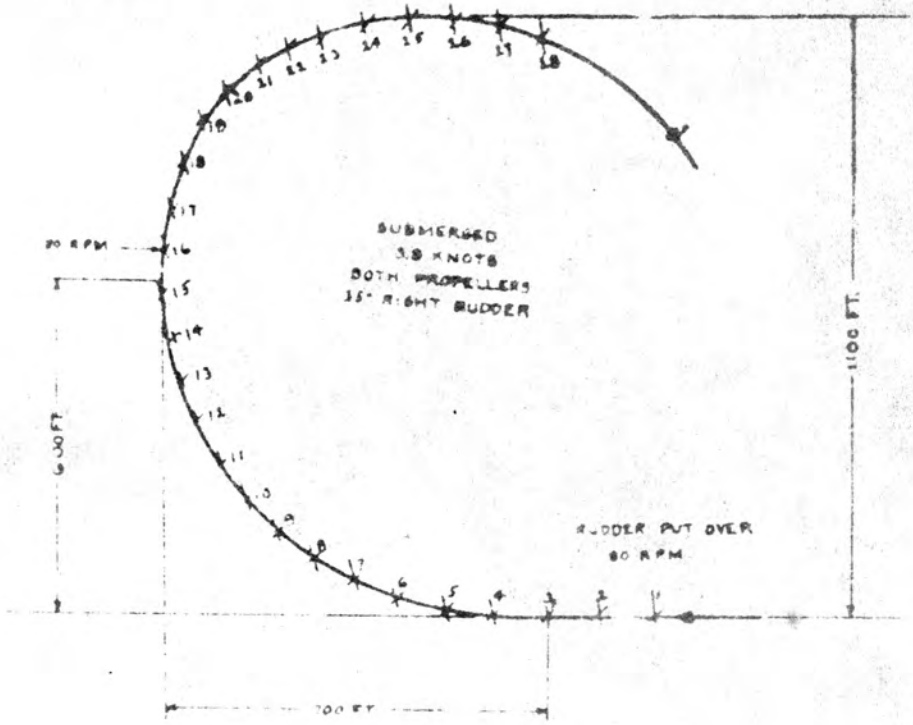
	Normal Diving Trim Tons	
	Surface	Emergency
(1) Air, Oil Water in System	22.4	
(2) Officers, Men & Effects	7.8	
(3) Ammunition	7.5	
(4) Torpedoes, Mk. 14-1	34.0	
(5) Provisions, 2/3 allowance	9.3	
(6) General Stores	4.0	
(7) Potable water	16.6	
(8) Battery water	4.4	
(9) Fuel Oil	175.5	304.0
(10) Lube Oil	16.2	16.0
(11) Emergency Provisions & F.W.	1.20	
Variable Ballast, estimated		
F.W.R.T. Tank	2.5	2.5
A.W.R.T. Tank	2.2	2.2
Forward Trim	3.7	7.4
Auxiliary	18.4	38.4
A.T.	11.1	15.1
Variable Ballast, Total (designed)	41.00	57.00
Main Ballast		
Nos. 1, 2, 3, 4, 5, 6 & 7) Safety)	612.80	466.31
Negative	0	0

CONFIDENTIAL

STANDARDIZATION TRIALS
27 SEP 43

FLEET SUBMARINE GENERAL INFORMATION

TACTICAL DIAMETERS
USS BATFISH (SS 310)



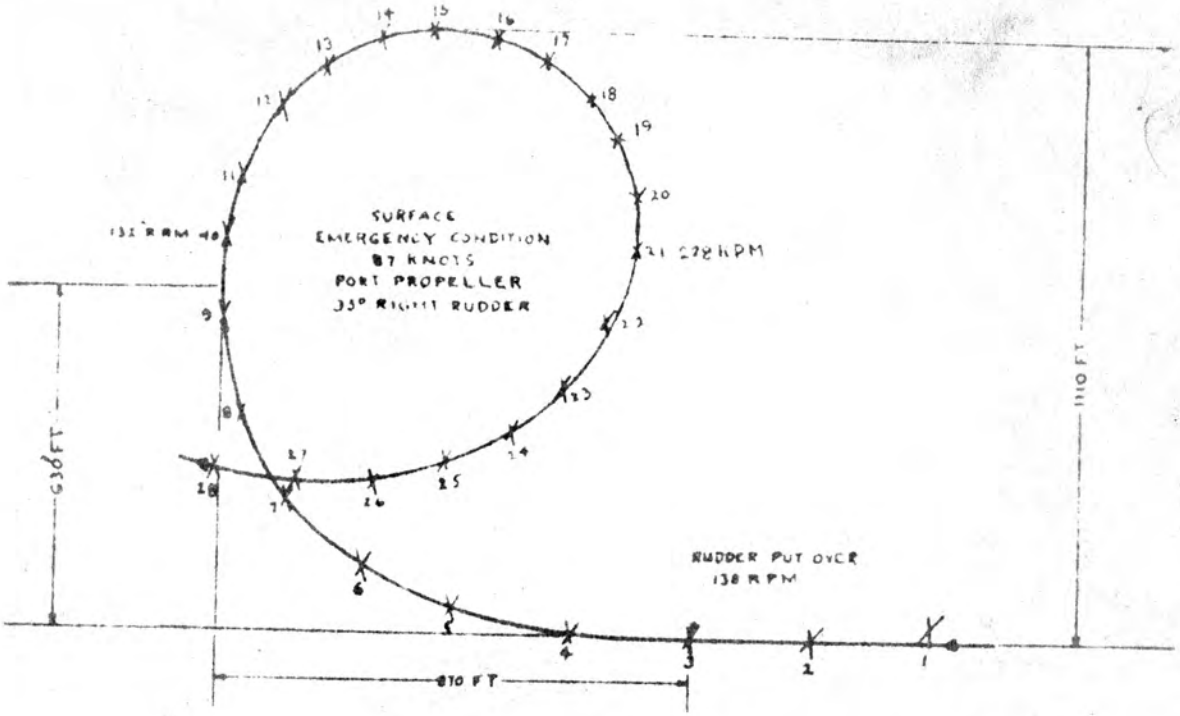
BOARD OF INSPECTION AND SURVEY
NAVY DEPARTMENT

TACTICAL DIAMETERS
OF THE
USS BATFISH
27 SEPTEMBER 1943
SCALE 1" = 200 FT

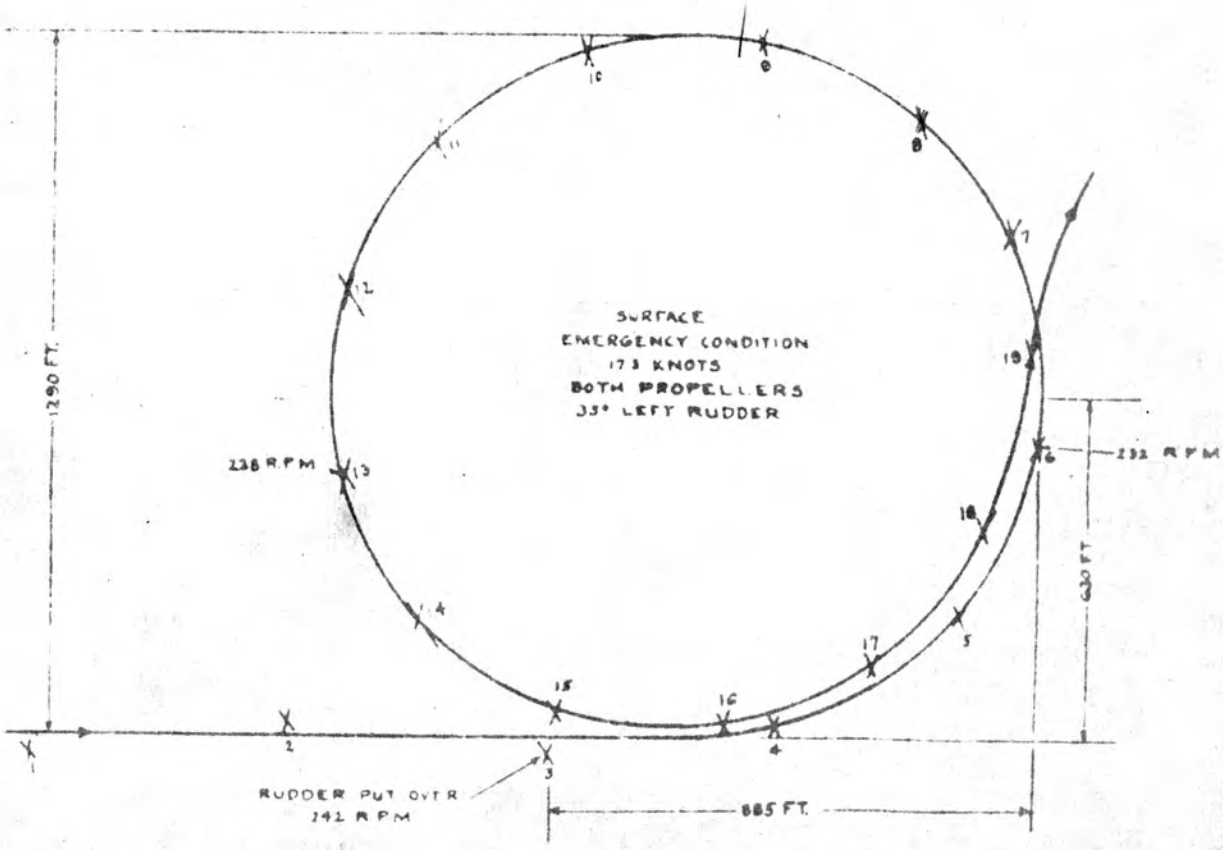
DRAWN BY [illegible]
APPROVED [illegible] NOVEMBER 1943

RECORDER [illegible] CAPTAIN USN

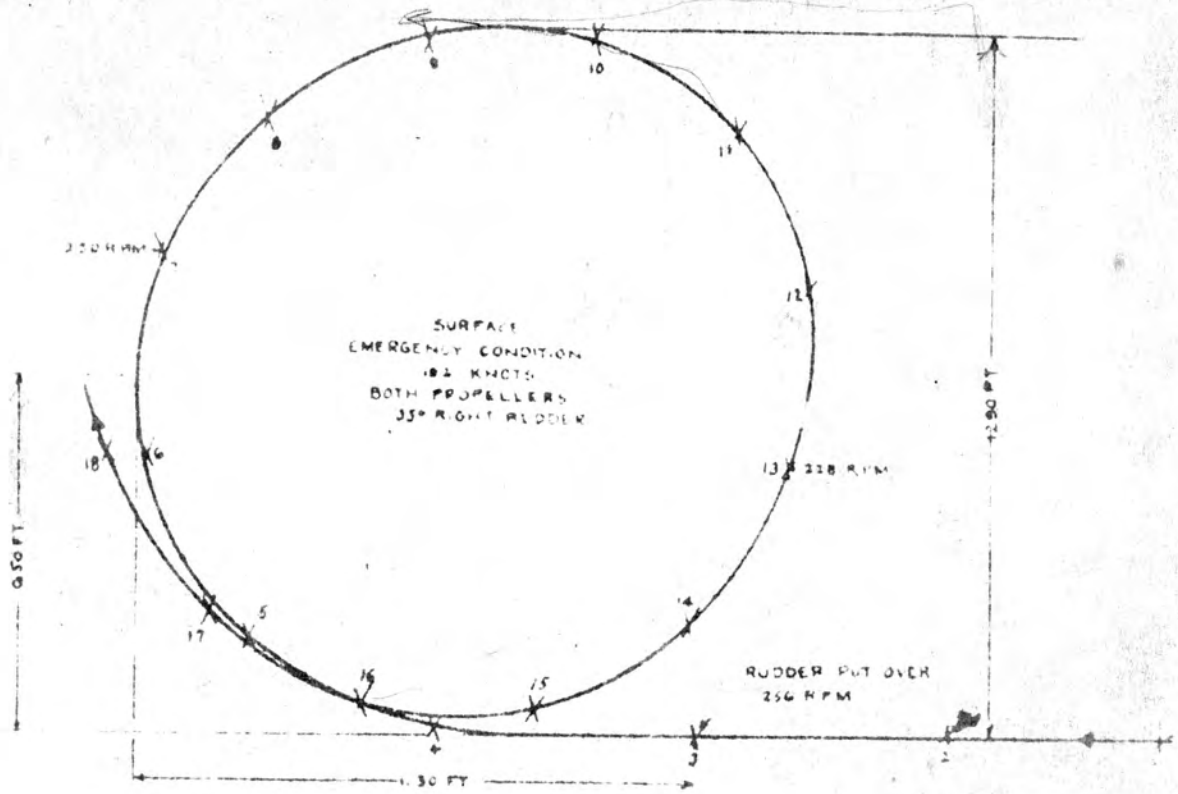
U.S. NAVY YARD PORTSMOUTH, N.H.



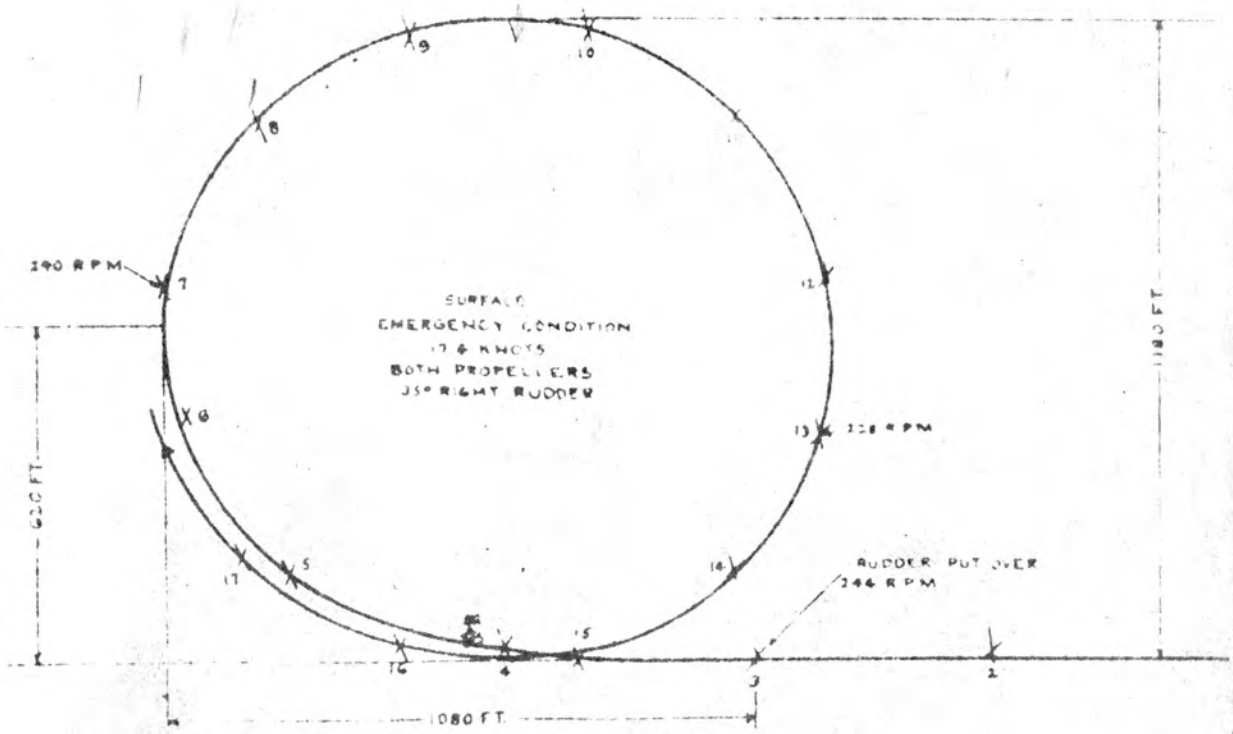
TIME TO COMPLETE CIRCLE
6 MIN. 0 SEC.



TIME TO COMPLETE CIRCLE
3 MIN. 13 SEC



TIME TO COMPLETE CIRCLE
3 MIN 16 SEC



TIME TO COMPLETE CIRCLE
3 MIN 5 SEC

BOARD OF INSPECTION AND SURVEY
NAVY DEPARTMENT

STANDARIZATION CURVES OF THE

U.S.S. BATFISH

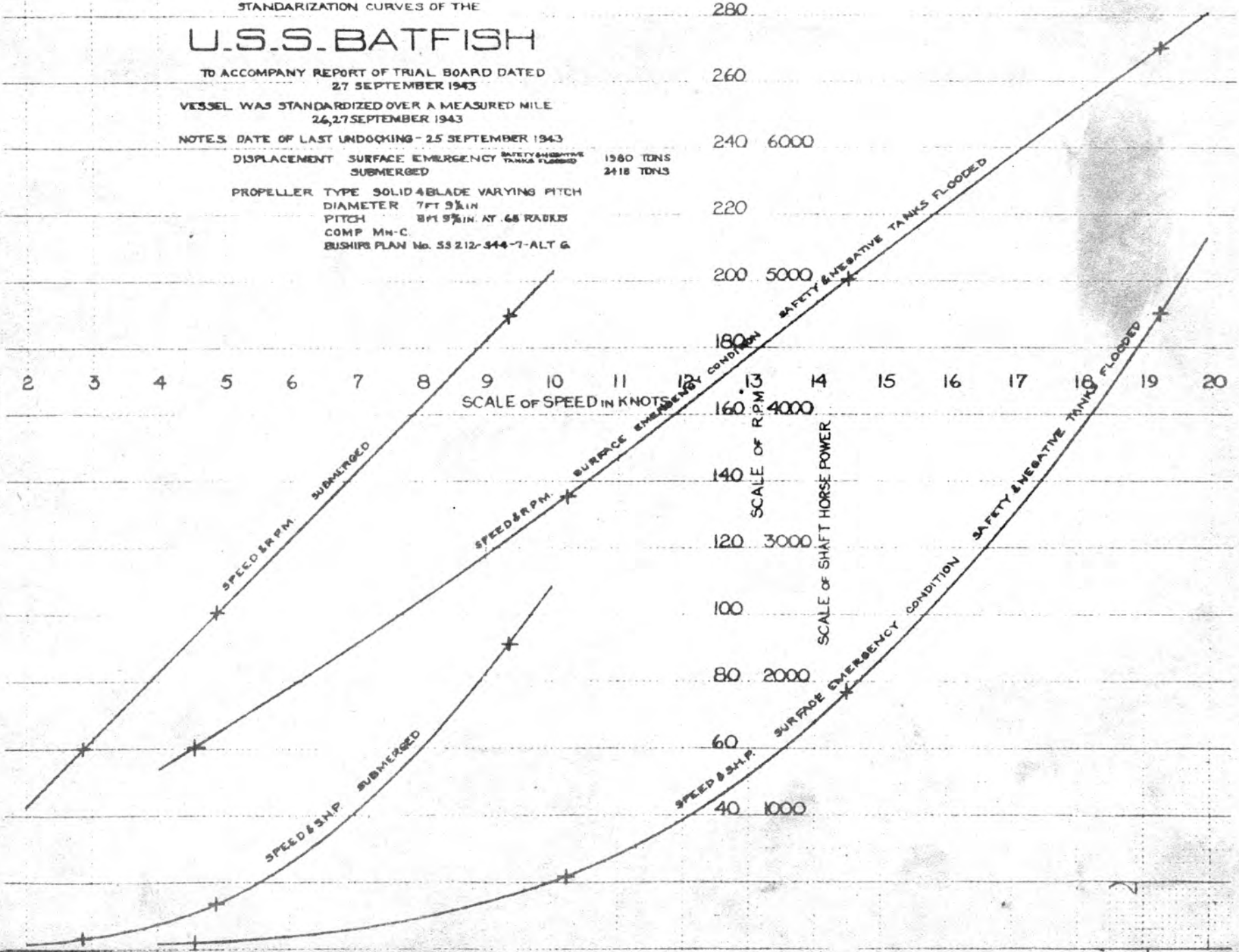
TO ACCOMPANY REPORT OF TRIAL BOARD DATED
27 SEPTEMBER 1943

VESSEL WAS STANDARDIZED OVER A MEASURED MILE
26,27 SEPTEMBER 1943

NOTES. DATE OF LAST UNDOCKING - 25 SEPTEMBER 1943

DISPLACEMENT SURFACE EMERGENCY (SAFETY & NEGATIVE TANKS FLOODED) 1980 TONS
SUBMERGED 2418 TONS

PROPELLER TYPE SOLID 4 BLADE VARYING PITCH
DIAMETER 7 FT 9 1/8 IN
PITCH 8 FT 9 5/8 IN. AT .68 RADIUS
COMP Mn-C
BUSHIPS PLAN No. SS 212-344-7-ALT G



Section A-2

DOCKING

Reference (a) Docking Plan for the Individual Ship.
(b) Appendix 6, General Specification for Building Vessels of the Navy. (Nov. 1942 or later edition)
(c) Painting Schedule SS381-404 (Pl. 110-285).
(d) Section on Magazine Flooding.

The Ship's Knuckles are at 4½" forward of Frame 37, and at 2½" abaft Frame 100. Between these points the keel is a straight horizontal line, in docking.

The Design Position of the ship for docking is with ship's after knuckle on Pier Block No.27. Variation in actual dimension of knuckle to C/L of pier block is according to individual ships. In order to clean and paint the entire bottom of the vessel, three successive dockings on Positions 1, 2 and 3 are necessary.

Blocks	No.	Ft. Spaced	Location (Position No.1)
Keel Blocks	23	6	Fr. 38 to 98½
Pier Blocks	6	Fwd. 18'	Fr. 19¼ to 24
		Aft. 24' & 6'	Fr. 99½ to 115
Bilge Blocks	5	16	Fr. 54 to 81, P & S
or	7	12	Fr. 52½ to 82¾" P & S

PAINTING - Preparation for (Ref. (c)). As the dock is unwatered, examine the skin of the ship.

Fouling Species - Note the varieties present, i.e. - Algae (green moss), Algae (brown moss), Annelids (worm tubes) Barnicles, Bryozoa (Coral patches), Hydroids (colorless plant) Mollusks (shellfish), tunicates (sea squirts).

Fouling Resistance - Note prevalancy of fouling and whether it is on the antifouling film, or only where antifouling film is missing.

Anti-Fouling Paint Film - Note percent of total area of AF paint missing and whether due to one of the following failures: (1) to adhere to under coat, (2) failure of under coat to adhere to hull, (3) too soft, washes off, (4) too brittle, flakes off.

Anti-Corrosive Under Coats, - Note any defects, i.e.: (1) rust streaks through antifouling, (2) Black Oxide beneath paint, (3) rusty areas where antifouling coat is missing, (4) adhering qualities.

Repainting (instructions as of 1943) -
Apply (1) Priming coat - #84D zinc, chromate.
(2) Anti-corrosive - #14 dark.
(3) Anti-fouling - Formula #145A - cold plastic. (Below 12'-0" waterline).
Cold plastic - Formula #146 (Above 12'-0" waterline).

Reference Plans:

Ports. No.	BuShips No.	Title
55-308	544532	Bilge Keels & Stringers
110-285		Painting Schedule
308-381		Docking Plan, (Each ship has individual docking plan SS381-404)

OPENING IN THE SHELL
Ref. 308

Item	Service	Size of Hole	Location Fwd	Location Aft	Fr.No.	Athwart Ships	P	S
1	Torp. Tube Outboard Vent	2" D.		12"	20	5'-0"	X	
2	For'd.Torp.Rm. Sea Press. Gauge	1-9/32" D	10"		23	7'-0"		X
3	Submerged Log	5-5/8" D		6-9/16"	33	5'-7"	X	
4	Model (QCM-1) (WDA) Equipt.	1'-9½" D		3"	34	2'-6"	X	X
5	#1 Sanitary Tank Disch.	3¼" D		6-7/8"	35	11'-2¼"		X
6	Officer's W.C. Flood	4-1/8" D		7"	34			X
7	Depth Gauge	1-15/16" D	10½"		51		X	
8	Depth Gauge	1-15/16" D		7½"	53		X	
9	Sea Press. Gauge	1-15/16" D	16"		52			X
10	Model NM-13 Equipt. Proj.	22-¾"x 12-3/8"		12-1/8"	21	On CL		
11	Negative Tank Flood Valve	12" x 17"		15"	50	9"	X	
12	Comb. Refrig. Air Cond. & H.P. Air Comp. Sea Suction	11"x6-3/8"	9"		53	5'-6"	X	
13	Trim Pump Manifold	18¾" x 8¼"	11"		55	4'-10"	X	
14	Safety Tank Flood Valve	18" x 3'8"			63	15"	X	X
15	M.B.T. Flooding Hole	13" x 19"		12"	29	12"	X	X
16	" " "	17" x 19"		12"	30	14"	X	X
17	" " "	21" x 19"		12"	31	15½"	X	X
18	" " "	19" x 25"		12"	32	17½"	X	X
19	" " "	20" x 26"		15"	46	16"	X	X
20	" " "	"		15"	47	16"	X	X
21	" " "	"		15"	48	16"	X	X
22	" " "	"		15"	49	16"	X	X
23	" " "	"		15"	53	16¼"	X	X
24	" " "	"		15"	54	22"	X	X
25	" " "	"		15"	55	21¼	X	X
26	" " "	20" x 26"		15"	56	16"	X	X
27	M.B.T. Flood Valve	24" x 36"		5"	58	2'-0½"	X	X
28	" " "	"		5"	60	2'-0½"	X	X
29	" " "	"	5"		70	2'-0½"	X	X
30	" " "	"	5"		72	2'-0½"	X	X
31	" " "	"	5"		74	2'-0½"	X	X
32	" " "	"		5"	76	2'-0½"	X	X
33	" " "	"	5"		79	2'-0½"	X	X
34	M.B.T. Flooding Hole	18" x 25"		15"	80	14¾"	X	X
35	" " "	"		15"	81	14¾"	X	X
36	" " "	"		15"	83	14¾"	X	X
37	M.B.T. Flooding Hole	18" x 25"		15"	84	14¾"	X	X
38	" " "	"		15"	85	14¾"	X	X
39	" " "	"		15"	86	14¾"	X	X
40	" " "	"		15"	88	14¾"	X	X
41	" " "	18" x 25"		15"	89	14¾"	X	X
42	" " "	19" x 25"		12"	108	18¾"	X	X
43	" " "	16" x 19"		12"	109	13¼"	X	X
44	" " "	10" x 19"		12"	110	10½"	X	X
45	Flush Type Manhole to Normal Fuel Oil No. 1	20¼" x 16¼"		15"	30	20"		X
46	Flush Type Manhole to Normal Fuel Oil No. 2	"		15"	43	24"	X	
47	Flush Type Manhole to Fuel Oil Collection	"	15"		92	3'-1"	X	
48	Flush Type Manhole to Fuel Oil Expansion	"	15"		92	3'-1"		X
49	Flush Type Manhole to Normal Fuel Oil No. 6.	"	15"		95	21"		X
50	Flush Type Manhole to Normal Fuel Oil No. 7	20¼" x 16¼"	15"		102	20"	X	

OPENING In the SHELL (Continued)

Item	Service	Size of Hole	Fwd.	Aft	Fr.No.	Athwart Ships	P	S
51	Crew's W.C. Flood	6¾" D		10½"	73			X
52	C.W. Suct. M.B. Aux. Engs.	2'-2¾" x 2'-5¾"		15"	89	7'-1½" to 9'-8"	X	
53	C.W. Suct. M.B. Aux. Engs.	2'-2¾" x 2'-5¾"		15"	89	7'-1½" to 9'-8"		X
54	Sanitary Tank No. 2 Disch.	2"		10½"	73			X
55	Motor Rm. C. W. Pump Suct.	16" x 12"	12"		107	4'-7¾"	X	X
56	Torpedo Tube Outboard Vent	2" D		8"	119	19"		X

Reference Plans:

Ports. No.	BuShips No.	Title
55-308	544532	Bilge Keels & Stringers
110-285		Painting Schedule
308-381	SS381-S0700-68100	Docking Plan
308-382	SS382-S0700-68120	Docking Plan
308-383	SS383-S0700-68140	Docking Plan
308-384	SS384-S0700-68160	Docking Plan
308-385	SS385-S0700-68180	Docking Plan
308-386	SS386-S0700-68200	Docking Plan
308-387	SS387-S0700-68220	Docking Plan
308-388	SS388-S0700-68240	Docking Plan
308-389	SS389-S0700-68260	Docking Plan
308-390	SS390-S0700-68200	Docking Plan
308-391	SS391-S0700-68300	Docking Plan
308-392	SS392-S0700-68320	Docking Plan
308-393	SS393-S0700-68340	Docking Plan
308-394	SS394-S0700-68360	Docking Plan
308-395	SS395-S0700-68380	Docking Plan
308-396	SS396-S0700-68400	Docking Plan
308-397	SS397-S0700-68420	Docking Plan
308-398	SS398-S0700-68440	Docking Plan
308-399	SS399-S0700-68460	Docking Plan
308-400	SS400-S0700-68480	Docking Plan
308-401	SS401-S0700-68500	Docking Plan
308-402	SS402-S0700-68520	Docking Plan
308-403	SS403-S0700-68540	Docking Plan
308-404	SS404-S0700-68560	Docking Plan

Section A-5

TORPEDO CONTROL SYSTEM

Ref: Section S71-1 Electrical Auxiliaries.

Torpedo Control (Electrical)

Purpose of System - The torpedo control system provides means for - (a) determining the course, speed and the position of the enemy with reference to the firing ship at any instant; (b) computing the torpedo gyro angle to cause the torpedo to hit, using instantaneous generated values of the target elements; (c) continuous setting of torpedo gyro angles; (d) firing torpedoes with automatic withdrawal of gyro setting spindles; (e) the control officer to issue orders to the tube stations and receive back reports therefrom.

METHOD OF OPERATION

(a) Periscope Method - The conning officer through the periscope observes enemy and determines the bearing, the range, the angle on the bow, and the speed of the enemy, and transmits these values orally. The operator introduces them manually into the TDC. The TDC takes course and speed of own ship's circuits and keeps the position of the target relative to own ship; computes continuously for each tube nest the Torpedo Gyro Angle Order, Torpedo Run and Track Angle, transmits Torpedo Gyro Angle Order to the Gyro Setting Indicator Regulator at each tube nest.

(b) Sound Method - The Sound Method is the same as the periscope method except that the input data for the TDC are received from the sound equipment and the Data Computer will correct the sound bearing for parallax.

LIMITS OF OPERATION

The following are the operational limits and conditions within which the system are effective:

Own Ship Speed	
Target Speed	0 to ~~25~~ 40 kts.
Present Range	0 to 8000 yds.
Present Range (for Generation of Bearing)	300 to 8000 yds.
Gyro Angle	210° - 0° - 150°
Torpedo Gyro Angle Order	210° - 0° - 150°
Torpedo Run	300 to 4500 yds.
Spread Offset Angle	0° - 40° R. or L.
Time of Torpedo Run (Max.)	200 seconds

INSTRUMENT DETAILS

The Periscope (No. 1 & 2) is used for observing target and measuring relative bearing, range, and estimated course and speed of enemy.

The Battle Order Transmitters transmit to Battle Order Indicators at both tube nests various orders, receive acknowledgements and reports of execution from same, contain tube selective fire switches and interlocks.

The Battle Order Indicators are for use in the torpedo rooms to receive orders and transmit acknowledgement of receipt and execution of orders to the Battle Order Transmitter to which it is connected.

Firing keys, portable and fixed, are provided in the conning tower and control room to fire the torpedo tubes singly by forward and after nests.

The Sound Receivers are for use in determining the range and bearing of the enemy; WDA, Echo Ranging, Listening, Sounding, QC, JK and QB.

1/4

The Gyro Setting Mechanisms and Torpedo Tube fittings serve as follows:

(a) Simultaneous setting of gyro angle on all tubes of the nest.
(b) Automatic withdrawals of gyro setting spindle when tube is fired.
(c) Switch for lighting a signal light on the Battle Order Transmitter when the gyro setting spindle is engaged.
(d) A switch on the firing interlock to close a break in the firing circuit.
(e) A switch on the Torpedo Tube interlocks to light the "Ready for Local Firing Window" and to energize the ready light circuit in the Battle Order Indicator when the Torpedo Tube is ready to FIRE.

Gyro Setting Indicator Regulator, hereinafter termed Gyro Setter, conforms to the requirements shown by Bureau of Ordnance Sketch No. 263457.

The Gyro Setter serves as an indicator under MANUAL operation and as a motor driven gyro angle setter under AUTOMATIC - Power motor, follow-ups, limit stops, overload protection, local line switch are included in the gyro setter.

The Gyro Setter are:

1. Torpedo Gyro Angle Order (Indicating) - electrically at 1 and 36 speeds.
2. Torpedo Gyro Angle Order (Automatic) - electrically at 1 and 36 speeds.
3. Manual drive, mechanically for stand-by.

The Gyro Setter rotates the T/T Gyro Spindle, mechanically.

Gyro Setter markings and mountings of synchro motors and dials are as follows:

1. Low and high speed dials (electrical) are mounted upon the rotors of the high and low speed receiver motors. Clockwise rotation signifies increasing gyro angle toward the right. The low speed dial bears a pointer only. The high speed dial bears a pointer and markings for 20 minutes on either side of the pointer.
2. Low and high speed dial (Mechanical), ring dials concentric with the low and high speed dials (electrical), for follow the pointer use, are driven mechanically by the response mechanism. The low speed dial is graduated on its outer edge counter clockwise from 0° - 105° in green for right gyro angles and 210° - 360° in red for left gyro angles, graduated every five degrees, numbered every ten degrees. The high speed dial is graduated on its outer edge from 0° - 10° counter clockwise, graduated every 10 minutes, numbered every degree with an extra long graduation at 30 minutes.

The Gyro Setter has an index engraved on the dial mask between the low and high speed dials against which actual gyro angles may be read at three o'clock on the low speed dial and nine o'clock on the high speed dial.

The Gyro Setter output shaft on AUTO. follows all movements of the torpedo gyro angle order.

The Gyro Setter hand drive on MANUAL rotates the output shaft. The right crank turns clockwise for right gyro angle. The hand drive torque, all parts, (tested) is 100 pounds on the handcrank handle, with the output shaft seized.

The Gyro Setter selector is controlled by a hand lever having two set positions, namely, AUTO. and HAND. The auto. and hand drives cannot be engaged at the same time. The selector is held in either of its two set positions by detents which insure that the selector does not jar loose under vibration.

A Gyro Setter stop positively limits the setting of gyro angle at the limits of arc.

The Gyro Setter response mechanism mechanically transmits rotation of the output shaft to rotation of the mechanical dials.

The Gyro Setter performs as follows:

(1) Torque, output shaft - running between 0-450 R.P.M. - Max. 10 ft. lbs.
(2) Torque, output shaft - starting - Max. 14 ft. lbs.
(3) Torque, output shaft - Min. 1.0 ft. lbs.
(4) Speed, output shaft - allowable - Max. 800 R.P.M.
(5) Rate, setting, under 8 lbs. ft., gyro angle per second required - 5 degrees.
(6) Rise, temperature, motor windings, under max. allowed load, for one hour - 55°C.
(7) Error, at 5° gyro angle per second allowed - 20 Min.
(8) Error, at 3° gyro angle per second allowed - 12 Min.
(9) Error, at 1° gyro angle per second allowed - 4 Min.
(10) Overrun of limit stop setting of gyro angle - 3.5°.
(11) Ratio, speed, handwheel to output shaft - 1 to 1.
(12) Revs. of output shaft for 360° gyro angle - 504.
(13) Range, adjustment of limit stops for increasing gyro angle - degrees 80 to 150.
(14) Range, adjustment, of limit stop for decreasing gyro angle - degrees 280 to 210.

The Gyro Setter line switch controls the power supply to the driving motor. Overload protection is also provided. Slowing controls are provided.

Gyro Setter connection boxes are integral with the casings. Electrical connection can be made without disturbing watertight integrity.

The Gyro Setter is weather-proof except as follows:

1. The motor is waterproof.
2. Housing containing gearing and no electrical equipment is oil tight.

The Gyro Setter transmission gearing is housed and arranged for bath type lubrication. Filling and drain plugs are provided on such housings.

Gyro Setter parts requiring adjustment are accessible through covers on the front of the instrument. Opening the gyro setter without express authority is prohibited.

The Gyro Setter right hand crank is a firing key, Mark 16, Mod. 9, which operates a signal light in the Battle Order Transmitter. The operator keeps this firing key closed whenever his pointers are matched.

Torpedo Data Computer Mark III - The computer solves the torpedo control problem for both the forward and after tube nests.

The TDC will perform as follows:

1. Apply to the initial range and bearing of enemy the changes due to own (known) and enemy (estimated) ship movements and compute continuously the present range and bearing, of enemy at all instants thereafter.
2. Compute continuously for each tube nest the correct gyro angle, track angle and torpedo predicted run to hit, within the effective run of the torpedo, for the instantaneous generated values of bearing, range, course and speed of the enemy, taking into account own ship's parallax between the No. 2 periscope and the muzzle of each tube nest, the tactical radius and speed of the torpedo including speed corrections for depth setting. The same speed correction for depth setting may be used in both forward and aft angle solvers.
3. Correct the relative sound bearing for parallax between the No. 2 periscope and the sound receivers and for a variable distance of 50 - 250 yards between the propellers and the center of an average target. The instrument computes and indicates the sound bearing which corresponds to the periscope bearing, target course, and target length that are set into the instrument.
4. Provide a means to apply a spread offset angle from 0° to 35° right or left to the torpedo gyro angle order forward and aft. A detent is provided at 0° offset.

The TDC inputs are:

1. Own course, synchronic off the gyro compass circuit (or hand).
2. Own speed, synthetic off the pitometer log (or hand).
3. Angle on the bow (enemy course), by hand.
4. Enemy speed, by hand.
5. Initial and subsequent observed range (distance), by hand.
6. Initial and subsequent observed relative bearing, by hand.
7. Keel depth, by hand.
8. Target length, by hand.
9. Spread offset angle, by hand.
10. Depth setting, by hand.

The TDC Outputs are:

1. Torpedo gyro angle order for forward tubes.
2. Torpedo gyro angle order for after tubes.

The TDC registers visually the following:

1. Own course.
2. Own Speed.
3. Angle on the bow.
4. Enemy course.
5. Enemy speed.
6. Relative bearing.
7. Relative bearing (sound).
8. Keel depth.
9. Present range.
10. Target length.
11. Torpedo gyro angle order (fwd. and aft).
12. Track angle (fwd. and aft).
13. Torpedo Run (fwd. and aft).
14. Time.
15. Depth settings.
16. Spread offset angle (fwd. and aft).
17. Correct solution indication (fwd. and aft) (a light).

The TDC presents on its face a visual picture, not to scale, of the relations existing, between line of bearing and both own and enemy ship's course and gyro angle (both tube nests).

The TDC dials and pointers are legible at 2 feet.

The TDC outputs are transmitted as follows: The torpedo gyro angle order, by synchro type transmitters at 1 and 36 speeds to the Gyro Setters with the separate circuits for indicating and control.

The TDC will -

1. Provide a determinate solution.
2. Make a solution that is correct for all conditions within the operational limits.

The TDC indicates to the operator when a shot is impossible because -

1. The computed torpedo run is less than 300 yards of more than 4,500 yards.
2. The intercept point requires a gyro angle greater than the prescribed maximum.

The TDC operating limits, least graduations and numbered graduations of the various elements, are tabulated below:

Elements	Units	Operational Limits	Least Graduations
Own course	Degs. & Mins.	0-360	10'
Enemy course	Degrees	0-360	2°
True bearings	Degrees	0-360	10'
Enemy speed	Knots	0-40	
Own speed	Knots	0-22	
Depth speed Variation	Knots	0-4	
Depth Variation	Feet	10-50	1
Present range	Yards	0-8000	(Counters)
Predicted run	Yards	300-4500	100
Relative bearing sound	Degrees	0-360	2°
Relative Bearing	Degs. & Mins.	0-360	10'
Angle on Bow	Degrees	0-180	2°
Track Angle	Degrees	0-180	2°
*Gyro Angle	Degs. & Mins.	210-0-150	10'
Time	Mins. & Sec.	0-60	1 sec. 5 min.
Target length	Feet	300-1000	10

TDC Switches are listed below:

1. Torpedo Gyro Angle Order (Aft) switch -
   (1) Gyro Angle Indicating.
   (2) Off.
   (3) Gyro Angle Control.
   (4) Both (1) and (3)
2. Torpedo Gyro Angle (forward) switch -
   (1) Gyro Angle Indicating.
   (2) Off.
   (3) Gyro Angle Control.
   (4) Both (1) and (3).
3. Power or Starting Switch -
   (1) Position Keeper Power Supply.
   (2) Off.
   (3) Angle Solver Power Supply.
   (4) Both (1) and (3).
4. Own Ship's Course and Speed Switch -
   (1) Own ship's course.
   (2) Off.
   (3) Own Speed.
   (4) Both (1) and (3).
5. Time system switch.

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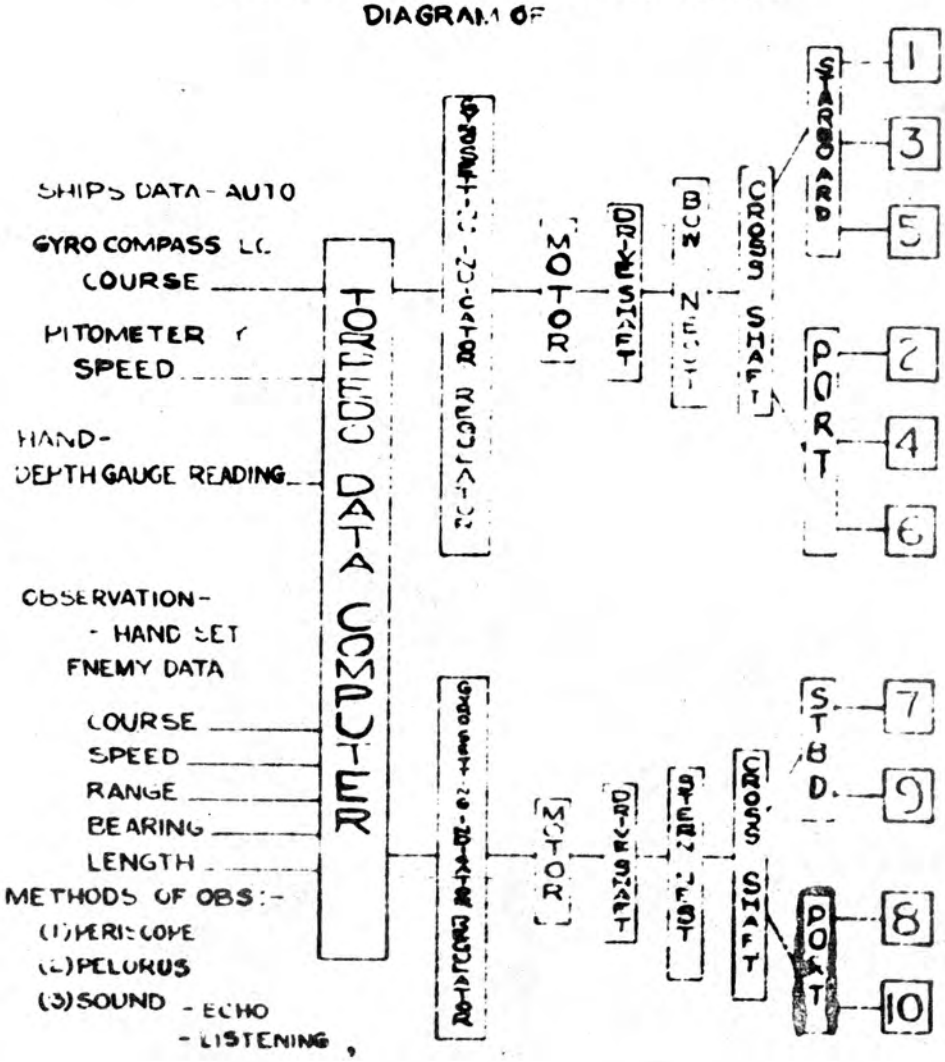
SUBMARINE TORPEDO TUBE
MK 34-1,2 & 3 BOW
MK 35-1,2 & 3 STERN

GYRO SETTING MECHANISM MK 15 MOD 6-BOW
POWER OPERATED 15-MOD 7-STERN

ELECTRO MECHANICAL TRANSMISSION
DIAGRAM OF



Section B-1

PLANS

Certain plans are listed below as being pertinent to preliminary instructions when fitting out.

I. GENERAL PLANS

(a) Docking plan
(b) Booklet of general plans
(c) Compartment and access plans
(d) Compartments and tanks, testing requirements

II. DIAGRAM OF SYSTEMS

(e) H.P. Air System
(f) Service air System
(g) L.P. Air System
(h) Salvage and compartment air systems
(i) Main ballast tank blowing systems
(j) Main ballast flooding and venting system
(k) Fuel oil and lube oil system.
(l) Variable ballast and trimming system
(m) Fresh water and plumbing system and battery F.W. system
(n) Ventilation and air conditioning system
(o) Escape and rescue arrangements
(p) Oxygen system
(q) Hydraulic system

III. DESIGN CHARACTERISTICS

(r) Displacement and other curves
(s) Draft diagram
(t) Moment diagram
(u) Cross curves of stability
(v) Flooding effect diagram

The diagram of a system will give the information required for preliminary instruction on the ship. The plan has a reference list giving Yard number and BuShips number of the working plan upon which details of the system are shown.

Tests of electrical machinery and reports of tests of auxiliaries (hull and machinery) are compiled by the Building Yard. The title of the booklet is "Record of Electrical Auxiliaries, with Performance Data". Vol. II.

Instruction books are furnished for main and auxiliary machinery. These instruction books contain instructions as to the operation and care of the equipment, including cuts and descriptive matter to indicate the correct operation and maintenance procedure.

"MICROFILM -Technical requirements for photographing are as follows:

(a) The term "Master Film" refers to the original microfilm made directly from the drawings. (The terms "Master Negative", "negative" and "original" have been used previously when referring to the original microfilm.)

(b) The term "Duplicate Film", refers to a microfilm made directly from the "Master Film". (The terms "positive" and "duplicate" have been used previously when referring to duplicate films.)

(c) Plans shall be photographed uniformly along the length of a roll of film regardless of the size of the original plans.

(d) In the event a drawing requires more than one exposure, the left section shall be photographed first followed in order by the remaining sections. (If the "Recordak" camera is used the doors of the camera shall always face to the rear.) Consecutive sections of one print should have a minimum overlap of three inches and in all cases the entire length of the frames shall be used. The "title block" shall always be the last section photographed.

(e) Reduction shall be such that a plan 27" x 40" shall be photographed by a single exposure. The reduction shall be between 25 to 30 diameters. However, for a 8½" x 13½" index section the reduction shall be between 15 to 20 diameters.

(f) A space of approximately 1/8" shall be used between exposures. There shall be an additional space of one frame's length between "REEL STARTS" and the title frame, between the title frame and the first frame of the index, and between the last frame of the index and the first drawing. In the middle of the film and at the end similar spacing should be used.

(g) 35 mm, non-perforated clear base, acetate (safety) film with a minimum resolving power of 140 lines per mm shall be used.

(h) The background density of the "Master Film" shall be between 1.1 and 1.3 and entirely void of so-called "hot spots " caused by uneven illumination.

(i) Contrast shall be such that frames of the duplicate rolls will make good enlargements back to the original size. There shall be no distortion of the image.

(j) The number of splices shall be kept to a minimum.

The film shall be spooled on metal reels, or a satisfactory substitute, and shall be delivered in separate cardboard containers legibly marked with that information included in the title frame.

(k) The box of the original microfilm shall be plainly marked "Master Film"."

The BuShips furnishes microfilm equipment. The BuShips will provide microfilm of all plans of a new construction submarine to each ship, Navy Yard, tender, and base concerned.

Microfilms will be filed in boxes, or drawers as follows:

(a) Hull plans.
(b) Master plans
(c) Ship's plans.

(1) by Ship's Nos. (1st block Number)
(2) by Filing Manual Classification (2nd block Number)
(3) by numeric order in class (3rd block number)

The Yard will furnish reduced size or full size prints, hull, machinery, and electrical, in accordance with BuShips instructions if the microfilms or equipment cannot be supplied by BuShips before completion of the ship.

Reduced sized prints (12" x 20½"), about 2400, consist of:

Hull Plans - Volumes 1, 2 & 3 arranged by Bureau Numbers, with cross index.
Machinery - Volumes 1, 2 & 3 arranged according to filing manual.
Electrical - Volume 1.
Torpedo Tubes - Volume 1.

The text of the General Information Book is in the most part, derived from plans. Any plan number found in the text should be available in reduced size prints or microfilm.

List of Instruction Books

	Contractor
HULL (Mechanical)	
(1) Periscopes	Kollmorgen
(2) H.P. Air Compressor	Hardie-Tynes
(3) L.P. Air Compressor	Roots-Connersville
(4) Air Compressor 225 lb.	Ingersoll-Rand
(5) Trim Pump	Gardner-Denver
(6) Drain Pump	Gardner-Denver
(7) Reduction Valves	Grove
(8) 21" S/M T/T Mk. 34 & 35, Description of.	PNY No. P-3149
(9) Airflow Meter	Republic Flowmeter Co.
HULL (Electrical)	
(10) Electric Range	Edison G.E. Co.
(11) Electric Coffee Urn	Blickman
(12) Electric Refrigerator (WR)	York
(13) Electric H.W. Heaters	Automatic Elec. Heater
MACHINERY	
Main Engines	Fairbanks, Morse
Electrical Propulsion	Elliott Co.
Auxiliary Engine	Fairbanks, Morse
L.P. Purifiers	Sharples
Refrigeration (cold storage)	York
Refrigeration (Air Cond.)	York
Kleinschmidt Still	E.R. Badger
**Motor Boat Engine	NY Nor., Va.
Lathe 14"	Stokes Industries

MACHINERY (Electrical)	Contractor
Electric Plant Data - S/H - NBS 605	BuShips
*Motor Generator, A.C.	Elec. Dynamic
*Speed and Voltage Reg. A.C.M.G.	Ward Leonard
Circuit Breakers - Type AL - 24	G.E.

**Furnished with engine, [illegible]
*Description in Auxiliaries (Record of Electrical) - Vol. I

Hydrogen Detector	Mine Safety Appliance Co. or Cities' Service
General Announcing	Radio Corp. of America
Telephone, Sound Powered	Auto. Elec.
Electric Telegraph	Henschel
Shaft Rev. Ind.	Electric Tachometer
Searchlight	G.E.
Underwater Log	Bendix
Gyro Compass	Arma
Radar Equipment SD	RCA
Radar Equipment SJ	Western Electric
Radio Trans. TBL 7	Westinghouse
Radio Rec'g, RAK/RAL 6	RCA
Radio Direction Finder	RCA
Calibrated Freq. Indicator Mod. LM-11	Bendix
Sound Echo Ranging & Listening WCA & WCA-1	Sub. Signal
Machinery History Binder	F. Morse
Shipboard Tests - Machinery	NYPNN
Radio Broadcast Receiving, Model RBO Loop Switching Adapter, Loop Coupling	E.H. Scott Radio Lab.
Unit for use with RAK equipment	Nat.Elec. Machine Shops
ϕSubmarine Bathythermograph	Bristol Co.

ORDNANCE	
Torpedo Data Computer	Arma
Gyro Angle Indicator Regulator	Arma
D.R. Analyzer	Arma

BOOKS COMPILED OR ISSUED BY NAVY YARD, PORTSMOUTH, N. H.

2. Allowance List, Hull.
3. Allowance List, Hull (Ex-S and A).
4. Allowance List, Hull (Ex-Nav).
5. Allowance List, Machinery.
6. Allowance List, Ordnance.
7. General Information Book.
8. Auxiliaries (Record of Electrical) Volume I - Description.
9. Auxiliaries (Record of Electrical) Volume II - Performance Data.
10. Inclining Experiment Booklet.
11. Flooding Effect - Diagram.

ϕ Furnished with Equipment.

BOOKS ISSUED BY THE NAVY YARD.

1. Instructions for Painting & Cementing Vessels, Appendix 6.
2. Navy Department Specifications 17C10, 17M10, 17M17, 17C17.
3. Sailors Manual of Paints and Painting.
4. Specifications for Riveting, Part I
   Appendix 4 Part II
5. Specifications for Welding, Part I
   Appendix 5 Part II
6. GSS - Appendix 9, Gaskets and Packing.
7. GSS - Appendix 10, Nomenclature of Decks, Labeling.
8. Specifications 17M10, 17C10, 17M17, and 17C17.
9. Plans: Displacement & Other Curves.
   Docking Plan

Note: Detail Hull Specifications, according to BuShips instructions are no longer furnished.

Section D-1

TESTS

Reference: (a) "Shipboard Tests" - 308-312 - Navy Yard, Portsmouth, N.H.

See plan: Tests - Built in Tanks and Compartments - Portsmouth No. 109-381
BuShips No. 490922 Alt. IV.

Strength and tightness tests - Main divisional bulkheads are designed for a pressure of 194 pounds per square inch, with a maximum stress of not more than 27,000 pounds per square inch. In general, due to the high pressure involved, strength tests of compartments are not made.

The tanks listed hereunder are tested for strength and tightness by being subjected to the pressure or heads indicated.

Tank	Testing Medium	Test Feet	Head Pounds
Auxiliary ballast, individually	Water	412	
Fresh Water, Ship's	Air		30
Fresh Water, Battery	Air		30
Fuel oil, fuel-ballast, collecting, expansion, individually	Water	102	
Fuel oil, clean, individually	Water	60	
Motor & Red. gear sumps	Water	412	
Main engine sumps	Water	35	
Engine lube oil stow. Nos. 1, 2, 3, 4	Water	35	
Main Ballast, individually	Air		15
Negative	Water	412	
Safety	Water	412	
Sanitary, including gages and fittings	Water	412	
Trimming	Water	412	
W.R.T.	Water	412	
Motor & Red. gear L.O. Stowage	Water	412	

(1) Miscellaneous Auxiliaries

Item	Hydrostatic Pressure Pounds per sq. inch
** Doors, W.T. (External) 30" Dia.	300
*** Covers, hatch, W.T.	300
* Doors, W.T.	198
Waterclosets, waste receivers	300
Water jackets, H.P. air compressor	225
Signal ejector, hull casting	300
Tubes, torpedo, parts prior to assembly (Shop test).	300
Tubes, torpedo, after installation	20# Air
Tubes, radio entering, external	300
Valves, outboard and hull, ship's ventilation, with trunks	300
Valves, safety tank and variable ballast tank, flood and vent (Inboard)	198
Valves, (including safety Tk.) main ballast tank, main vent	30
Valves, safety tank emergency vent	300

(2) Compartments

Individual compartments (Allowable drop 4 oz. in 10 min.) 15 lbs.

Hull is tested for external resistance on the deep dive 400 feet, at which time a pressure of 176 pounds is imposed.

Main bulkheads are designed for 194 pounds per square inch but are not tested at this pressure after installation.

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* One door of this design is tested to 225# psi anti-closure.
** One door of this design has been tested to 400# psi tending to force door on its seat and tested to 45# psi tending to force door off its seat.
*** One cover of this design has been tested to 400# psi tending to force cover on its seat.

TABLE OF STRENGTH AND TIGHTNESS TESTS, POUNDS UNDER:

System	Air S	Air T	Fr. Water S	Fr. Water T	Oil S	Oil T
(1) Piping Misc.						
Air, H.P.	4500	4500				
Air Banks		3000	5000			
Air L.P. blow from hull valves out			300	300		
Air L.P. blow from hull valve to manifold		300				
Air, 225 lb.	338	338				
Air, 225 lbs. volume tanks	676	676				
Air, salvage				300		
Air, M.B. blow, incl.stop check and regulator valves			900	900		
Air, M.E. Starting						
(1) Complete to eng. red. valves		4500	4500			
(2) Red. Valve to starting valve		450				
Circ. Water, sea. M.E.			300	300		
Circ. Water, sea, Main Motors			300	300		
Circ. Water, fresh, M.E.			75	75		
Drainage suction lines between sea & pump	300	300				
Fuel oil lines					300	300
Lube oil Sys., filling & distributing					150	150
Lube oil Sys., M.E. to & incl. checks in sump tanks					150	150
Oxygen System, each compt.		338				
Refrigerating F12 piping,						
Pressure side	225	225				
Suction side		225				
Torpedo impulse piping & tanks			900	900		
Ventilation, ships outside pressure hull, valves gagged			200			
Ventilation, ships, piping & hull valves		18				
(2) Hydraulic						
Accumulator, air side		2900				
Accumulator, oil side					1200	1200
Main pressure					1200	1200
Mains, working side					1200	1200
Replenishing line, not incl.supply tank					150	150
(3) Steering Gear						
Control Cyl. & Lines to change valve					900	
Ram Cyl., piping, manifolds, & valves						1800
Replenishing & vent lines, Valves & fittings					150	150
3(a) Bow Diving - Same						
3(b) Stern Diving - Same						
3(c) Windlass & Capstan - Same						

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Above is general information. For test pressure on individual items of systems see detailed plans.

Air Flasks: The test gang charges HP air flasks to 3000 psi and allow them to stand for 24 hours. After ambient temperature has been obtained, the pressure drop is limited to 30 psi per 24 hours.

Ventilation Systems: For details see Ref. (a). The shop tests main bulkhead valves for strength and water-tightness on both sides to 300 psi. The test gang tests same for gas tightness at pressure slightly above atmosphere in the ship.

Battery Ventilation: The test gang makes a volumetric test of battery ventilation in the ship. Cells are filled to normal level, and gassing conditions are obtained as of the finishing rate of charge.

Anchor gear: - The gear is required to handle the anchor or the capstan but not the capstan and the anchor simultaneously.

As part of completion schedule the following tests are conducted under the supervision of forces afloat.

Dummy torpedoes are fired from all tubes at 62 feet (depth gage) and at a depth of 120 feet by gage. Shots are fired with the poppet valve cocked. The impulse pressure is 300 psi down to 67 feet and 400 psi from 67 feet to 120 feet. For each shot the pressure in the tube and the velocity of the torpedo is recorded for each foot of travel of the torpedo within the tube. The tube pressure is 45# per square inch minimum and 60# per square inch maximum, when firing with 300# impulse flask pressure and 55 psi, minimum, 70 psi maximum, plus the static head when firing with 400# impulse flask pressure. The clearing velocity is 30 fs, minimum and 40 fs, maximum, at 120 feet. "Clearing velocity" is the velocity of the torpedo at the instant the tail passes through the plane of the muzzle face.

Apparatus for the determination of tube pressure and torpedo ejection velocities is described in OD 717 T/T testing sets, Mark I. Mod. I, 2 and 3, 12 November 1941.

The dummy torpedoes shall clear the ship without damage. More evidence of contact between dummy torpedoes and the tubes or shutters is not sufficient evidence of failure.

In all dummy shots the starting lever must be fully thrown by the tripping latch.

Cleats - 30,000 lbs.

Crane, torpedo, 6370 lbs. suspended for 10 min. 4778 lbs. hoisted, lowered and rotated.
Davit, hatch - 2000 lbs. suspended.
Storage battery handling gear 2400 lbs. static load suspended for 10 minutes and 1600 lbs. moving load.

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PORTABLE PLATE, "Soft Patch"

Portable plates are provided as necessary for removing parts of engines, main motors, generators, battery cells, radio equipment, steering gear, master gyro, torpedo data computer, windlass gear and torpedo fire control gear. No opening, however, requires cutting of more than two adjacent frames.

Portable plates are riveted except in way of battery rooms, where they are bolted. The size of plates, location of butts and seams, and the arrangement of framing is such that each plate can be removed with the least disturbance to adjacent structure and fittings. The joints of the longitudinal seams of portable plates are fitted metal-to-metal.

All portable plates irrespective of size follow a similar style of construction; viz; a 35.7# shell plate with metal-to-metal longitudinal joint with hull, with lifting pad eye 1½" dia., a frame section (or sections) welded thereto and a 20.4# outer strap also welded intact, and a separate single piece inner 20.4# plate strap. End plates of frame sections carry a steel liner. Holes (7/8" dia.) are through and through (except in way of frame sections) for body bound bolts or rivets as the case may be, on 3½" centers.

A portable plate 7/8" x 3" Ni-Cu Class A, body-bound bolt in detail from seaside to inner hull is as follows: head, steel washer lampwick and red lead grommet outer strap, shell, canvas and red lead gasket, inner strap, lampwick and red lead grommet, steel washer, hex nut Ni-Cu Class B. This applies to bolted plates only.

A portable plate rivet is 7/8". The whole joint is metal-to-metal.

Portable plates in detail:

(1) Portable plate (bolted) on frame 39. (Forward battery space). On Ship's centerline - clear opening - 2' - 4" fore and aft and 3'-0" athwartship, with 3" R. on corners. In way of frame 39, the portable plate is secured with 4 - 1" x 2½" Ni-Cu tap bolts. There is a 1/8" thick med. steel liner between frame end-plates and they are secured by 7/8" x 3" Ni-Cu bolts with no washer under the head and with a steel washer, a thin lock nut and heavy standard nut (in the order named) to the fixed side. Joint carries gaskets and grommets.

(2) Portable plate (riveted) Frames 56 to 58. (Radio Room.) Clear Opening 2'-2-7/8" x 3'-4½" with corners on a 6" R. The inboard run of the hole stands 13½" of ship's centerline to starboard. Forward edge of the hole stands 6" abaft frame 56 and the after edge stands 7-5/8" Forward Frame 56. It is a riveted job (7/8") with metal-to-metal edges and no gasket. (Ref.57).

(3) Portable plate (bolted) between frames 69 and 70. (After battery space). Clear opening 17½" x 27" (13½" each side of ship's centerline) and a body bound bolt job (abt. 98. (Ref. 57.)).

(4) Portable plate (riveted) frames 83 to 86. (Forward E.R. Clear opening 5'-6" along ship's centerline by 6'-6" athwartships.

(5) Portable plate (riveted) frames 93 to 96, (Aft. E.R.) similar to above (4) except it carries the 30" dia. Eng. Room hatch trunk. (Ref. 56).

(6) Portable plate (riveted) frames 103 to 106). (Motor and maneuvering room) Clear opening 5'-6" along ship's centerline by 4'-00" athwartships. Forward edge 9" abaft frame 103 and after edge 9" forward frame 106. The 35.7# shell plate carries portable sections of frame 103 and 105 and the outer 20.4# strap.

Reference Plans:

Ports.No.	BuShips No.	Title
56-381	490920	Portable Plates - Frames 84 to 87 - 93 to 96 - 103 to 106.
57-308	490880	Portable Plates - Frames 38 to 40 - 56 to 58 - 69½.
58-381		Access Hatches at Frames #64½ and 94½.
72-285	387252	Torpedo Loading Hatches.
161-381	544567	Access Hatch & Cover to Cool Room.
170-285	387269	Access & Escape Hatch (with Rescue Chamber Seating & Skirt) - After Torpedo Room - Frames 115-116.
288-381	544688	Hatch Davit (Portable) Location, Details and Installation.

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Section M-3

RUDDER

See Section on Steering

The Rudder is 10'-8" high O.A. and 7'-6" from C.L. to trailing edge, 5'-11" from C.L. to leading tip (triangular balancing fin, 4'-11" high), rudder area 100 sq.ft., weight 11,000 lbs. in air.

The Rudder Torque (in inch lbs.) varies from minus 150,000 (20K. ahead, 5° rudder) to 1,900,000 (11 K. backing, 35° rudder). There is zero torque amidships and at point of hydro-dynamic balance, viz. 20 K. ahead, 13° rudder. (BuShips 312983)

Table of
Transfer of Stress - Rudder to Ship

From	To	Dimensions Inches
Water Pressure	Rudder	100 sq. ft.
Rudder	Key (tip of stock)	1-1/8 x 1½ x 18½
Key (tip of stock)	Rudder Stock Taper	8.98 D x 19-5/8
Taper (tip)	Stock (head)	9.0 x 7' - 8-1/8
Stock	Stern Post:	
	Lower Bearing (wood)	9.78 D x 19-5/8
	Upper Bearing (wood)	9.78 D x 12
	Pintle Bearing (wood)	7.14 x 15¼
Stock (tip)	Key (at head)	1-1/8 x 1½ x 20-3/8
Key (head)	Cross Head	9.0 D x 21 high
Cross Head	Conn. Rod Pins (2)	2.375 D x 9½
Rudder Wgt. (11,000 lb.)	Stern Post Casting Thrust Ball Race	16 Balls, 1½ D x 12⅞ PD

The Rudder is built up from a frame of 5 steel castings welded together. The frame is plated with 12 lb. side plates. Void space is filled with white pine imbedded in hot pitch. Waterline sections through the rudder and stern post casting are on streamlined, air foil contours.

Hard-over Stops are cast on the rudder frame for limits of 38° R. and L.

A Lifting Hole (2¼" D) stands in the upper part of the trailing edge and the upper tip of the leading edge.

Unshipping and shipping the rudder involves refinement of control over breaking and remaking the fixed joints standing heavy stress.

The Rudder Assembly and the details of the supporting joints should be given careful study.

The Rigging Job calls for hairline refinement in three dimensional control, with shockless movements within limits of one eighth inch.

Reference plans:

Ports. No.	BuShips No.	Title
645-201	312983	Steering Gear Rudder - Calculations and Curves
848-201	312335	Steering Gear - Rudder and Rudder Stock - Details
849-201	312336	Steering Gear - Rudder Stock Crosshead and Details

Section M-4

DIVING PLANE - Bow

Ref. (a) Bow Plane Gear - Section U-26.
(b) Plate - 3.

The Bow Plane (62 sq. ft. each) is a hydro-dynamically and hydrostatically balance, streamlined hydro-foil of built-up bat wing, construction - cast steel hub and web, fabricated arms finished all over with 10.2# plate, rabbeted and welded to an edge filler and ground down flush. The plane is watertight. The interior is packed with white pine imbedded in hot vegetable pitch.

Bow Planes - Typical Dimensions:

	Misc.	Ft.	Inches
Bow Plane Area, sq. ft. each	62	-	-
Bow Plane, each max. torque (24°) in lbs., 9K	95,000	-	-
Bow Planes, each min. torque (12°) in lbs., 9K	0	-	-
Bow Planes, each negative torque (5°) in lbs., 9K	16,000	-	-
Bow Planes, each max. sea slap torque in lbs.	1,426,000	-	- (design fig.)
Bow Plane wgt. complete, lbs.	5,800	-	-
Bow Plane Stock, C.L. Position - Fwd. of Fr. 18	-	-	11
Bow Plane Hinge Pin, A.B.	-	17	0
Bow Plane, length OA	-	10	4¼
Bow Plane, width, hinge pin axis to outer edge	-	8	1
Bow Plane Stock (each) length to C.L. hinge pin	Port	5	5'-2-7/8"
	Stbd.	5	5'-2-7/8"
Bow Plane Stock dia., effective	-	-	8.750
Bow Plane Hinge Pin - length	-	2	7-1/8
Bow Plane Hinge Pin - dia. (effective)	-	-	5.718

DIVING PLANE - Stern (2)

Ref. (a) Section U-26 - Diving Gear - Stern.

The Stern Planes are mounted on a single stock supported in the stern post casting. Location and O.A. dimensions are shown in the table which follows.

The Stern Plane starboard (port identical to other hand) is a statically balanced (submerged), hydraulically balance, streamlined, hydro-foil, 13" effective thickness at the hub and tapering to feather edge. The design represents the best features as to balance and minimum torque, as selected from competitive designs tested by Model Basin, Carderock, Maryland. The effective area (abaft the stock) is in cross section symmetrical. The leading edge is unsymmetrical in cross section, as it has a pitched down nose, for purpose of contra-propeller effect.

The Stern Plane construction is of the cast steel sectional frame (rectangular lines) rabbeted and built up watertight with 10.2# plate, welded and ground down flush. The interior is packed with white pine set in pitch.

A Wedge Key (12" x 1" x 4" x 3½") draws the plane on to the stock. Complete familiarity with the design of the slot and wedge joint is essential to efficient workmanship in removing a stern plane from its stock.

Stern Plane - Common Statistics:

	Ft.	In.	Misc.
Plane, area (stbd.) sq.ft.			52
Plane, length. O.A.	8	3	
Plane, width, O.A.	7	1	
Stock, length O.A.	8	2	
Stock, dia. O.A.		8.5	
Stock, axis, fwd. of frame 131		6	
Stock, axis A.B. (also propeller hub)	6	9	
Plane, width extreme, off ship's CL	8	0	
Propeller, hub tip, off ship's CL	5	8	
Plane, torque, max. (sea slap) in lbs. (designed)			1,200,000
Plane, torque, max. positive 25°, 9K			60,000
Plane, torque, zero, angle of, 9K			12.5°
Plane, torque, max. negative 5° 9K			10,000
Plane, counter-balance, leading edge lead approx. lbs.			1,600
Plane, pressure, max. 25° 9K lbs.			12,500

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Reference Plans: (Bow Planes)

Ports.No.	BuShips No.	Title
713-381	312200	Bow Diving Gear - Arrgt. Forward.
723-381	312210	Ditto-Tiller & Plane Stock - Details.
724-201	312211	Ditto-Sector Gears & Connecting Rod Details.
725-201	312212	Ditto-Bearings for Plane Stocks.

Reference Plans: (Stern Planes)

Ports.No.	BuShips No.	Title
922-234	386746	Stern Diving Gear - Plane Details.

Section 0-2

CONNING TOWER

References: (a) For C.T. Hatch, see Section on Hatches.

The C.T. is the ship's primary battle station.

Enemy Detection by sight, radar or sound; target designation, torpedo problem solving, battle orders, torpedo ready light, gyro setting indication, gyro spindle release indication, torpedo firing and ship control circuits and services are consolidated in the conning tower to give maximum resource and flexibility to the submerged attack. The same is true, with modifications, for surface attack.

Sight Approach (submerged) is based on No. 2 and No. 1 Periscopes.

Sound Approach (submerged) is based on the use of:

QC - Echo Ranging - Automatic - Red Light Method
QB - Echo Ranging - Automatic - Red Light Method
QC - Echo Ranging - Automatic - White Light Method
QB - Echo Ranging - Automatic - White Light Method
QC - Ranging - Manual Keying
QB - Ranging - Manual Keying
QC - Sound Listening - Propeller Vibrations (Supersonic)
QB - Sound Listening - Propeller Vibrations (Supersonic)
JK - Sound Listening - Propeller Vibrations (Supersonic)

Sight Approach (surface) (low visibility) is based on the target designation system (circuit GT) and one of two dummy pelorus on the bridge, range according to visibility.

Sound Approach (surface) (low visibility) same as submerged.

Radar Approach (surface) (low visibility) is based on the "SJ" Radar (directional) in the C.T., range - Horizon limits.

Radar, Detection by, submerged (periscope depth) - "SD" Radar Indicator (COC) is non-directional, range 30 mi. - primarily for reconnoitering for aircraft and ships prior to surfacing.

Conning Tower contains following equipment:

TORPEDO ATTACK - By Sight - (CT)

Periscope No. 1 with items Listed Under #2 Periscope
Periscope No. 2
Periscope No. 2 control p.b. fixed
Periscope No. 2 control p.b. portable
Periscope No. 2 4-Pt. Coupling for Portable P.B. Control
Periscope No. 2 slack wire switch
Periscope No. 2, winch, motor and brake
Periscope No. 2, upper limit switch
Periscope No. 2, stabilized azimuth motor
Periscope No. 2, sheaves
Controllers:
- Periscope No. 2 azimuth lighting
- Periscope No. 2 pushbutton
- Periscope No. 1 & 2, 5 point polarized plug
- Periscope No. 2 - Portable pushbutton

TORPEDO ATTACK - By Sound - (CT)

Underwater sound: (supersonic) (assembled in one stack of five units): -
- Audible indicator for JK-QC and Q3 equipment (built into remote control unit)
- Range indicator QB-QC
- Receiver amplifier, QB
- Receiver amplifier, JK-QC
- Remote control unit QB
- Remote control unit JK-QC
- Hand key

TORPEDO ATTACK - RADAR - "SJ" - DIRECTIONAL (CT)

(1) Radar, Transmitter unit
(2) Radar, control unit
(3) Radar, indicator unit
(4) Radar, range unit
(5) Radar, bearing indicator (mechanical)
(6) Radar, wave guide
(7) Radar, training gear and shafting
(8) Radar, training motor & indicator gear
(9) Radar, training motor supply snap switch.

TORPEDO ATTACK - DELIVERY - (CT)

Telephone, selective switch
Telephone, jack boxes, JA and XJA circuits
Telephone, headset
Telephone, handset
Telephone, call bell 2½
Battle order transmitter - forward tubes
Battle order transmitter - after tubes
Torpedo firing contact maker, portable
Torpedo firing contact maker, fixed
Torpedo firing contact maker, 4 point coupling for Buzzer, type Z2.

TORPEDO ATTACK - TORPEDO CONTROL (CT)

Gyro compass input
Torpedo data computer
Target bearing indicator
Motor selsyn for stabilized azimuth No. 1 and No. 2 periscopes
Pitometer log input
ALTERNATIVES: (BuOrd)
Submarine attack course finder, Mark 1 - Mod. 3, Angle Solver Mark 8.

TORPEDO ATTACK - SHIP CONTROL

Gyro compass:
Repeater, steering, Mk. VI-0 (double dial concentric)
Repeater, sound station No. 1 - with 5 point plug
Repeater, sound station No. 2 - with 5 point plug
Conn. Box and switch - steering repeater
Conn. Box and dimmer switch - Mk. VII-1 - for p.p. pelorus Mark II-3 on bridge
Conn. Box and dimmer switch - Mk. VII-1 for repeater conning station, bridge
Plug and cable to stabilized azimuth line, periscope #1 and No. 2.

NAVIGATION - Equipment - (CT)

Barometer
Binoculars (2)
Clock
Clock and barometer in case
Chart portfolio, stowage (1)
Chart table light with shield
Instruments, navigation and stowage
Spray shield chart table
Pitometer log, speed and distance indicator

COMPASS - Magnetic

Boat Compass

COMMUNICATIONS (CT)

Radio: Input remote unit for TBL-7 transmitter not installed.
Vertical Antenna Mast Trunk

VISUAL

Searchlight, rotary snap

SHIP SERVICES (CT)

General Announcing System:
(a) Contact maker - (a) Collision (b) Diving (c) General Alarm
Switch cut out for bridge mike
Switch, snap, for diving alarm push button on bridge
Contact maker, indicator light, upper hatch
Gauge - compartment - Air pressure, caisson 0-500 ft.
Gauge - escape - 0-500 ft. Gauge - depth - 8" - 150 ft-
Hatch, upper
Hatch, lower
Steering wheel, clutch and stand
Steering gear motor indicator light
Rudder angle indicator
Searchlight, switch, rotary snap for
Valve vent for escape
Valve for blow and vent line
Valve, C.T. blow
Valves, drain to periscope trunks
Ventilation, supply duct

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SHIP SERVICES (CT) (Continued)
Switch box, containing following switches:
Anchor lights (2)
Masthead light
Running lights (2) one green-one red
Switch box, containing following switches:
Conning tower lights - port and starboard
Periscope #2 double receptacle for azimuth circle
Chartboard Light
Red light

DOMESTIC SERVICES (CT)

Heater, air and connection box
Switch, rotary snap for heater, 25 A.
Oxygen regulator
Oxygen manifold
Respirators, submarine, lungs plus accessories (4)
Rail, hand - lower hatch
Valve, flood and hand wheel
Deck fixtures, (lights) (4)
Door, W.T. escape
Ladder, to upper hatch
Seat, folding and swivel
Seat, swing out, swivel
CO_2 absorbent container
Light, emergency, p.p. (2)
Light fixture - Red
Misc. electrical fittings, conn. and junction boxes

Reference Plans:

Ports.No.	BuShips No.	Title
108-285	490352	Conning Tower - Arrangement.
305-285	544522	Chart Table.
128-285	490322	Conning Tower - Fairwater and Bridge - Joiner work - Gratings.
409-381	490205	Air system - Piping Arrangement in Conning Tower.
447-285	490214	Ventilation System - Control Room - Conning Tower and Pump Room - Arrangement (Piping).

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Section 0-3

ESCAPE STATIONS

References: (a) Plate 24
(b) BuShips (Hull) Manual - Section I - Instructions for the use of Air Purifying Apparatus and of Compressed Air in Submarines.
(c) Same - Section II - Air Purification and Oxygen Replenishment in Submarines Escape Compartments under submerged abandon ship conditions.
(d) BuShips Pamphlet - Submarine Safety Respiration and Rescue Devices - 1938.

Design and equipment provides for relief of the crew from accidental sinking by two methods, collective rescue; and individual escape. Reference (d) gives description of rescue chamber.

Escape Equipment, itemized:

	Ship	F.T.R.	A.T.R.
For collective rescue:			
(1) Flange, 63", on hatch		1 (fr. 27-1/2)	1 (fr. 115-1/2)
(2) Submarine Rescue Chamber		-	-
For individual escape:			
Special escape trunk		1 (fr. 27-1/2)	-
(3) Skirt, on hatch		-	1 (fr. 115-1/2)
(4) Escape Buoy, balsa wood		1	1
(5) Ascending line		1	1
(6) Escape Depth Gage,		1	1
(7) Caisson Gage		1	1
(8) Oxygen Manifold	2	1	1
(9) Chucks, Oxygen, Schrader		4	4
(10) Lungs, per man	2	1	1
(11) Goggles, per man	2	1	1
(12) Divers' knife		1	1
(13) Portable lantern		2	2
(14) Oxygen, Cyl. 200 cu.ft.	11	2	2
(15) CO_2 Absorbent, per man (lbs.)	7.2		
(16) Oxygen Manifolds		1	1
(17) Regulators, Oxygen, with attached gages		2	2
(18) Lung Repair Kit	1		
(19) CO_2 Testing Outfit	1		
	1		
Communications:			
Signal Ejector	1		
QB & QC Projectors	1		

U. S. Navy Yard, Portsmouth, N.H. - 1943.

NOTE: Weigh CO_2 absorbent containers semi-annually for moisture content. Do not paint CO_2 absorbent container.

While awaiting collective rescue, the principal items of note (reference (b)) are:

Limitation of CO_2 concentration - 3 per cent (Max.).
Limitation of oxygen content of air - 17 per cent (Min.), 20% (Max.).
Rate of air replenishment from banks - 31 cu.ft. per man hour.
Rate of oxygen replenishment from bottles - 0.9 cu. ft. per man hour.
Capacity of compartments for air space (net) - 35,000 cu. ft. See Plan 658-381.
Based on total capacity of 35,000 cu. ft., 77 men, the time for the ship to reach a 3 per cent saturation of CO_2, 18.2 hours.

Notes on CO_2 absorbent:

Size of absorbent container 6 x 12 x 12 inches - 15 lbs. Amount
Amount required to absorb one man hour of CO_2 - 0.10 lbs.
Purifying capacity one container, 77 men - 2 hours.
Effect as a dust - irritating, not harmful.
Effect as a caustic, cuts or eyes - harmful.
Amount to spread on each mattress cover - 3-1/2 lbs.

Physical Systems:

(1) Oxygen deficiency (less than 17%) gives no warning; the results are abrupt.
(2) CO_2 concentration of 3 per cent gives increased depth of breathing.

Individual Escape

See reference (d) for instructions on use of lung.
See reference (c) for detailed instructions as to preparation of air prior to flooding an escape compartment.

Principal items of note:

(1) Remove all excess CO_2 from compartment prior to flooding.
(2) Distribute CO_2 absorbent above the bubble line.
(3) Breathe through the lung if dust is irritating.
(4) CO2 absorbent and sea water solution is harmless.
(5) No advantage or economy in delaying absorption of CO_2 until concentrate is high.
(6) Prolonged breathing of undiluted oxygen in excess of 2 atmospheres may be dangerous.
(7) Never allow oxygen content of an escape compartment to exceed the normal 20 per cent.

Special appliances at escape hatches - the access hatch in the after torpedo room is fitted with a skirt at the bottom. This skirt extends below the top of the pressure hull and is designated to trap an air bubble in the top of the compartment.

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The access hatches in the forward and after torpedo rooms are fitted with a flange 63 inches in outside diameter, on which the submarine rescue chamber may be seated and secured. A wood mock-up of the lower portion of the submarine rescue chamber is placed in position on this flange after all work in the vicinity has been completed, to insure that the rescue chamber may be landed without interferences.

In the forward and after torpedo rooms the following equipment is installed for use in connection with the submarine escape appliance:

(a) An escape depth gage.
(b) Oxygen manifold with four Schrader chucks.
(c) A caisson gage, (0-600 ft.)
(d) Two brackets for portable lanterns.
(e) Divers knife.

These instruments are grouped together and are located above the bubble line corresponding to submergence to 400 feet, to the axis of the vessel.

Stowage in After Torpedo Room and For'd Escape Trunk is provided for the submarine escape line buoy and 510 feet of ascending line. The buoy is in accordance with plan, Bureau No. 526286, and the ascending line is in accordance with Navy Department Leaflet Specification 21L3, Type "B".

Access and Escape Trunk

The access and escape trunk is on top centerline of the forward torpedo room (Fr. 27-1/2).

The trunk is designed to permit the escape of men from the ship in groups of four. Before a trunk is so used, an escape lung must be put on by each man and the escape buoy and reel of line must be brough up from the torpedo room and held in the escape trunk ready for streaming. The following listed valves must be closed:

Escape trunk blow valve in escape trunk
Escape trunk vent valve in escape trunk
Escape trunk compartment blow & vent valve in torpedo room
Escape trunk flood valve
Escape trunk drain valve

The following listed valves must be open:

Stop valve on escape trunk blow line in torpedo room
Stop valve at bottom of escape trunk vent pipe in torpedo room.

Reference to the 225 lb. air system diagram, Plate 9, will make clear the meaning of these valves.

Carbon Dioxide Testing Outfit

Component parts:

4 Standard tubes, indicating, 1, 2, 3 and 4 per cent of CO_2.
2 Hard rubber bottles for sodium bicarbonate solution with indicator.
1 Atomizer bulb, foot ball bladder and pinch cock.
2 Test tubes
3 Slender glass tubes.
Small glass ampules of concentrated solution.
1 metal box, container.

Principle of Operation:

The sodium bicarbonate solution will change color in the presence of an air sample in proportion to percentage of carbon dioxide carried by the sample. Point of saturation is reached when change of color ceases. Time to reach saturation point is about one minute. Percentage of CO_2 is determined by color comparison with set of standard tubes.

Directions for use of CO_2 Testing Outfit:

(1) Use atomizer bulb and bladder to trap a sample of air, behind the pinch cock. Discard first sample and refill bladder.

(2) Sodium bicarbonate "Test Solution" is carried in hard rubber bottles. Pour about 1½ inches of solution into a small test tube.

(3) Bubble air from bladder slowly through the test tube until point of saturation is reached.

(4) Standard color tubes and rack should then be placed in a good light. Watch test tube color to determine its place in the rack.

(5) Read off percentage of CO_2 from marking on the rack. Interpolate for fractions.

General Notes:

The solution will last four months in hard rubber bottles.
The same solution may be used for several tests, not to exceed 20.
Do not keep solution in test tube more than 6 hours.
Accuracy is about two-tenths of one percent when using ordinary care.

The accuracy with which the amount of carbon dioxide in air may be determined by this method is about two-tenths of a per cent when using ordinary care in making the determination.

The solution and standard tubes are standardized for a temperature of from 68 to 76 degrees F. A temperature of 60-degrees F. gives readings about 10% too high and a temperature of 85 degrees gives readings about 10% too low. A temperature of from 68 to 76-degrees may be obtained by immersing the tubes in water.

Changes in humidity do not affect the readings.

In case the barometer reads higher than 800 mm. or lower than 730 mm. the correct reading in per cent of carbon dioxide may be obtained by the formula: the

$$\frac{\text{Barometer reading} \times \%\ CO_2 \text{ read}}{750} = \text{correct percentage}$$

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Interpretation of Readings for Submarines. One (1%) per cent, or less, is harmless and an effort should be made to keep the percentage of carbon dioxide from going above this amount. In case it is necessary to save soda-lime the percentage of carbon dioxide may be allowed to increase during the last few hours of a submergence, reaching 3% at the time of coming to the surface.

Two (2%) per cent may cause discomfort, especially if work is attempted.

Three (3%) per cent is dangerous. The amount of carbon dioxide should never be allowed to exceed this amount and should be kept at this amount as short a time as possible.

Four (4%) per cent, or more, is very dangerous and may prove fatal.

Directions for Making-up Test Solutions from the Concentrated Solution. One of the small glass ampules labeled "Concentrated Solution to be Diluted in Accordance with Directions to Form Test Solution" is opened by scratching the glass at the constriction with a small file and then breaking off the tip of the ampule. The contents of the ampule are diluted with 55 cubic centimeters of distilled water. Care should be taken that none of the contents of the small ampule are lost. If a device for measuring 55 cubic centimeters of distilled water is not available, the contents of the small ampule may be poured directly into one of the hard rubber bottles, the ampule rinsed with distilled water and the rinsing also added to the solution in the hard rubber bottle. The bottle should then be filled just to the shoulder with distilled water. The bottle may be then closed and the solution thoroughly mixed by shaking.

.Section P-1

.MAST, ANTENNA

· The vertical antenna mast is mechanically similar in design and operation to a 6"-O.D. CRS periscope tube. The equipment attached to and installed in the mast is of a secret nature. For information pertaining to same see RADAR EQUIPMENT - Model 30 - Preliminary Instructions.

· Hoisting gear for this mast is practically identical with that for a periscope. It consists of a 7½ H.P. motor with positive grip, magnetic, disc brake; with worm drive to double winch drums, grooved. The electric circuit carries also an upper limit switch, lower limit switch, slack wire switches, suitable dynamic braking, and electro-protective devices.

· The winch is mounted in the pump room on #2 periscope well. The mast travels in a self sealing grease-packed hydraulic type stuffing box mounted in the hull casting. The bottom of the mast carries a lifting ring, to which is attached two flexible wire cables. Each cable passes over its sheave on the hull bearing casting, and inside the hull, and downward through an opening in the control room flat, and thence to the winch drums. Limits of travel are regulated by suitably mounted switches.

· SPEED

· The speed of raising and lowering at periscope depth is 9 inches per second; and at 75 feet and 6 knots is 7½ inches per second. Design calls for hoisting in about 30 seconds, lowering about 20 seconds.

· Cushioning for shock at the lower limit of travel is provided. A rubber and reaction spring buffer is installed at the bottom of the inner hull, and arranged to prevent injury to electrical connections.

MEASUREMENTS

· Travel of mast 12' - 1¼".
· Top of antenna section (raised position) 41' - 5¼" above 15' - 2½" mean WL.
. Top of antenna section (lowered position) 29' - 4" above 15' - 2½" mean WL.

Reference Plans:

Ports.No.	BuShips No.	Title
819-285	490465	Mast for Vertical Antenna - Arrangement
820-285	490570	Mast for Vertical Antenna - Sheave, Brackets and Limit Switch - Details
821-201	312308	Mast for Vertical Antenna - Hull Bearing Details
35932	490464	Mast for Vertical Antenna - Details of Mast
823-285	490466	Mast for Vertical Antenna - Hull Bearing & Upper Limit Switch - Arrangement
824-285	490467	Mast for Vertical Antenna - Spring Buffer & Lower Limit Switch - Arrangement
825-285	490468	Mast for Vertical Antenna - Spring Buffer Details

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Section P-2

BOAT & TORPEDO HANDLING DERRICK

A portable derrick is provided for handling fully assembled torpedoes and mines and 20 Ft. Motor boat, on a single whip. The necessary pad eyes and deck tackle are provided for applying power by means of the capstan.

Fittings and sockets are provided forward and aft for use of the derrick in either position.

Stowage for derrick is provided in superstructure forward (Ref. 347).

Item	Frame	Hoisting Speed	Max. Wkg. Load, Lbs.
In Forward Socket	40	12 Ft./Min.	3185 (Torpedo)
In Forward Socket	40	12 Ft./Min.	4550 (Boat)
In After Socket	100	12 Ft./Min.	3185 (Torpedo)

Reference Plans:

Ports.No.	BuShips No.	Title
187-275	490949	Boat & Torpedo Derrick - Arrangement
189-381	544533	Boat & Torpedo Derrick - Details
190-275	SS275-S7503-67544	Torpedo Derrick - Aft Stress - Diagram & Data
191-275	387033	Stowage for 20 Ft. Motor Boat
194-275	491113	Boat & Forward Torpedo Handling Derrick - Stress Diagram & Data
216-381	544535	Boat & Torpedo Handling - Metal Blocks
217-285	544704	Torpedo Handling & Stowage - Forward Deck Skid - Arrangement & Details
218-381	544534	Boat & Torpedo Derrick - Rigging
219-275	490924	Boat & Torpedo Derrick - Kingpost Foundations
347-275	490913	Stowage in Superstructure for Boat & Torpedo Derrick

Section R-1

WATERTIGHT DOORS

See Section U-12-a, FLOODING AND VENTING.

Watertight doors are fitted in all structural bulkheads.

Doors are 20 by 38 inches in size and are of the single-acting type.

An interlock is incorporated in the design of the door which prevents personnel from carelessly turning the operating handle when the door is open. This device restricts the angular movement of the handle so that the dogs cannot be placed in position to prevent closure of the door.

Quick-operating catches, which can be readily released in an emergency, provide for holding the doors in the open position. Spring latches, with handles on both sides of the door, are also provided to hold the doors in the closed position until the operating gear can be set up.

List of W.T. Doors (Ref. 746-381)

Location	Fr. No.	Hand Right or Left	Type of Frame	Size	Pressure p.s.i. Under the Seat	Pressure p.s.i. Against the Seat	No. of Dogs	With or Without Deadlight
For'd Escape Trunk		LH	curved (cyl.)	30" D	0	(a) 300	4	W.O.
Gun Access Trunk		RH		30" D	0	(a) 300	4	W.O.
Bulkhead at	35	RH	flat	20x38	(b) 198	0	8	W.
Bulkhead 9" Aft.	47	LH	"	"	"	0	8	W.
Bulkhead 3" Aft.	58	RH	"	"	"	0	8	W.
Bulkhead 7¼" Aft.	77	RH	"	"	"	0	8	W.
Bulkhead 6½" Fwd.	88	LH	"	"	"	0	8	W.
Bulkhead 13½" Fwd.	99	LH	"	"	"	0	8	W.
Bulkhead at	107	RH	"	"	"	0	8	W.

(a) Design door tested to 400 lbs. hydrostatic forcing it on its seat.
(b) Each door tested to 198 lbs. hydrostatic tending to force door off its seat.

A compartment Watertight Door (20" x 38") is a weldment mounted on a cast steel door frame and hung by two slip-hinges. Water seal is by (7/8" B. x 3/8" x 11/16" deep) rubber gasket (8' - 7¾" long) with end vulcanized. The knife edge is a CRS built-up weld on the door frame, on a 25° bevel. (Ref. 42070)

The Compartment Watertight Door Latch is a single swinging hand operated (from either side) dog on upper swinging corners of the door, to hold the door on its seat while toggle system is set up. Care should be taken that latch adjusting screw does not strike gasket seat on door frame when in unlatched position. (Ref. 42071)

The Compartment Watertight Door when seating with sea pressure takes the full weight of pressure on the gasket. When seated against sea pressure, the weight is taken on eight dogs. The door when closed and set up is wedged in between the knife edge and suitable projections of the door frame, by cam action of the dogs, actuated from toggles, gear worm and door handles. A force of 86 lbs. is required on the handle to set-up the door against a pressure of 198 p.s.i. forcing the door off its seat (actual shop test 225 p.s.i.) Ref. Ports. No. S-4745.

The Compartment W.T. Door Gear is hand operated. A double-knobbed handle which swings a worm shaft is mounted in a stuffing-boxed boss in the middle of the door. Muscular force is transmitted to the dogs through a single-worm, on four gears, and toggle joint systems in multiples of four, transmitting bell crank action to dogs in multiples of two, total effect eight. Each toggle is adjustable and the jam action of each dog is adjustable. 4 turns of handle are required to unlock. (Ref. 42070)

The Compartment W.T. Door Interlock mounted on the bottom of the door is a spring loaded, cam-lever actuated by contact with a projection of the door frame. When the door closes the lever strikes and frees toggle system. When door leaves seat the spring rocks the interlock lever where it jams an adjacent toggle arm and renders the whole system inoperative. (Ref. 42070)

The Escape Trunk and Gun Access W.T. Door seats with sea pressure and, being designed for stress on sea side, is fitted with only four dogs. There is no wedging action of the dog as in the compartment watertight door. The principle of the linkage is the same as in the compartment watertight door previously described, four worm geared, toggle joint, bell crank dogs, actuated by a single shaft through the middle of the door. Each dog locks over an insert in the door frame and individual contact is adjustable by tap screw ($1\frac{1}{4}$" x $\frac{3}{4}$" D.). (Ref.35954)

The Escape Trunk Door and Gun Access Interlock is similar in principle to compartment watertight door interlock. It is spiral spring-loaded, bell-crank trigger type, latch which locks over the projecting end of an adjacent dog pin. This immobilizes the linkage systems. When the door closes the latch strikes door frame and releases. (Ref.35955).

The Escape Trunk and Gun Access Door Latch is a single standard handswing W.T. door dog in upper corner of the door. It holds the door on its seat while linkage system is being set up. (Ref. 35957)

The Escape Trunk Door Inboard Closing Device is best understood from the plan, (Ref. 742-285). In principle this is a lever arm acting on sea side of door, the lever being actuated by shafting and mitre gears leading to an operating lever (4'-0 long x $2\frac{1}{4}$" wide) frame 29. The door opens 100°. The lever swings 90° to close the door. On the outer operating handle of the door is a catch for holding the door open. To hold the door open: turn door handle in TO LOCK direction until lug will slip over projection on lever arm. The handle will not jar loose but can be disengaged by a slight force. (Ref. 742-285)

The Gun Access Watertight Door is same size (30" D) as Escape Trunk Door. Its appurtenances and operating gear are identical - Exception: this door is <u>not</u> fitted with inboard closing device, nor with an Outside Operating Crank Handle.

Reference Plans:

Ports. No.	BuShips No.	Title
741-285	490427	W.T. Door - Forward Escape Trunk - Door Frame Details
742-285	490431	W.T. Door - Forward Escape Trunk-Inboard Closing Device-Arrgt.
743-201	312230	W.T. Door - Conning Tower & Escape Trunk - Inboard Closing Device - Gear Case Details
744-275	386915	W.T. Door - Conning Tower & Escape Trunk - Inboard Closing Device - Lever & Indicator Details.
745-381		W.T. Doors - Stops & Catches for Wide Open Position
746-381	491105	W.T. Doors - List of
747-285	490429	W.T. Doors - Forward Escape Trunk - Inboard Closing Device - Shaft & Universal Joint Details
808-285	491103	W.T. Doors - Gun Access Trunk - Door Frame Details
35954	490387	W.T. Doors - Exterior - Circular-30" Dia. - Arrangement
35955	490388	W.T. Doors - Exterior - Circular-30" Dia. - Door Details
35956	490389	W.T. Doors - Exterior - Circular-30" Dia. Gear Details
35957	490390	W.T. Doors - Exterior - Circular-30"Dia.-Latch & Misc. Dts.
42070		W.T. Doors - 198 lb. Test - General Arrgt. (Welded Type)
42071		W.T. Doors - Details of Door (Welded Type)
42078		W.T. Doors - Door Frame Details
42076		W.T. Doors - Gear Details
42072		W.T. Doors - Latch Details
35080	448712	W.T. Doors - Stop, Latch & Buffer - Arrgt. and Details
42077		W.T. Doors - Fixed Deadlight

Section R-3

HATCHES

Eight hatches seal pressure hull against sea pressure, on a dive.

Location	Pressure: Lbs. psi: Above	Hatch Opening: Size	Hatch Opening: Shape	Construction of Cover	Number of Dogs	With Latch to hold open worked from above.	With Latch to hold open worked from below with lanyard.	Ports No.	BuShips No.
Escape Trunk Forward Upper Hatch	300	25"	Circ.	Dished	3	No	No	35973	490414
Escape Trunk Fwd. Lower Hatch	300	21"x 27"	Oval	Cast	2	No	Yes	35746	466331
Torpedo Loading Hatch - Fwd.	300	25"	Circ.	Dished	3	No	No	35973	490414
Conning Tower Upper Hatch	300	25"	Circ.	Dished	3	Yes	Yes	35977	490418
Conning Tower Lower Hatch	300	21"x 27"	Oval	Cast	2	No	Yes	35746	466331
Galley & Mess Room Hatch	300	25"	Circ.	Dished	3	No	No	35973	490414
Gun Access Trunk - Lower Hatch	300	21"x 27"	Oval	Cast	2	No	Yes	35746	466331
After Engine Room Hatch	300	25"	Circ.	Dished	3	No	No	35973	490414
Torpedo Loading Hatch - Aft	300	25"	Circ.	Dished	3	No	No	35973	490414
Torpedo Room Hatch - Aft	300	25"	Circ.	Dished	3	No	No	35973	490414
Gun Access Trunk - Upper Hatch	300	25"	Circ.	Dished	3	Yes	Yes	35977	490418

All Sea Pressure Hatches have in common:

(1) 25" diameter clear opening, circular.
(2) Hinged on forward side (except torpedo loading, hinged on bottom).
(3) Spring balanced - ratchet adjustment of tension, except Torp. loading.
(4) Single action, 3-dog, spider operating gear.
(5) Automatic, simple, gravity-operated, handwheel lock to prevent careless turn of handwheel while cover is up - locks as cover goes up, unlocks as cover comes down.
(6) Projections obstructing passage reduced to minimum.
(7) Stuffing boxes packed with flax.
(8) Gasket, anti-rolling, molded strip, ends vulcanized., 88" long, ⅜" flat face, flat seat, rubber gasket, 1/8" projecting.
(9) Designed to withstand concussion from depth charges.

The Conning Tower Upper & Gun Access Trunk Upper Hatch have special fittings, viz:

(1) Additional lock:
  (1) to hold hatch open (pulled by inside toggle), not on Gun Access Trunk.
  (2) latch to hold hatch closed (outside trip, pedal operated).
(2) Folding spinner on inside wheel.

The Torpedo Loading Hatch Trunk (Fwd. & Aft) special heavy stiffening worked into hull frames.

The Torpedo Loading Hatch has screw-jack and hinged struts in way of pressure hull.

OPERATING NOTE: Transfer a compressive load to torpedo loading hatch struts before submerging.

Two individual Escape Hatches are built to take sea pressure, viz:

21 x 27 Oval, 2-Dog, Spring Loaded Hatch

(1) Escape Trunk, lower Fr. 27 Wgt. 279 Finished to take war head
(2) C.T. Lower Fr. 50½ Wgt. 279
(3) Gun Access Trunk Wgt. 279

The Individual Escape Hatch has following features, viz.:

(1) 21" x 27", elliptical, clear opening.
(2) Dogs (2), operable from top and bottom sides.
(3) Dog has a spring loaded clicker pin for open position, also a stop for dog handle for cover in wide open position.
(4) Deadlight 4", with gear operated cover, from bottom side.

Hatch davit. - The hatch davit stepped in its socket will suspend for 10 minutes a load of 2,000 lbs.; designed working load, 1000 lbs.

Shutters. - Hinged shutters of manholes are provided in the main deck for access to the stowage spaces, chain lockers, operating gear, for inspection, overhaul, and preservation. These, with the exception of the forward torpedo hatch shutter, are hinged on the forward edge and are provided with adequate locking devices of rugged construction to insure that shutters will not work loose when submerged or in a seaway. Shutters over mooring lines are provided with an opening which permits the hatch to close with the line passing through.

Reference Plans:

Ports.No..	BuShips No.	Title
35875	490416	Hatch Cover - 25" Dia. Dished Plate - Misc. Details
35976	490417	Hatch Cover - Standard, Escape & Torpedo Loading, Springs & Misc. Details
35746	466331	Hatch Cover, 21" x 27" Oval - General Arrangement
35747	466332	Hatch Cover - Cover Details
35748	466333	Hatch Cover - Miscellaneous Details
35749	466334	Hatch Cover - Latch Details
35877		Hatch Cover - 25" Diameter Dished Plate for C.T. & G.A. Trunk - General Arrangement
35978		Ditto - Cover Details
35979		Hatch Cover - 25" Diameter Dished Plate for C.T. & G.A. Trunk - Miscellaneous Details.
35132	390466	Access Hatch 15" x 23" - Flush Type - Welded
554-201	312141	1" Manifold - Divers Connections - Escape Trunk
1077-285	490481	Hatch Cover - 21" x 27" Oval - Location Stop for Dog Handle in Wide Open Position
35973	35974	Hatch Cover - 25" Dia. Dished Plate-General Arrgt.
35974		Ditto - Cover, Spider & Toggle Details
756-285	490449	Hatches - Frames & Covers List.

MANHOLES

See Plan "Compartment and Access".

Manholes are of size, type, and locations as indicated on plan, (Ref. 61). In general, the minimum size of manholes is 12" x 16". All manhole and handhole cover plates, other than boiler type manholes otherwise specified below, which are subjected to pressure when submerged have flat gasket seats.

Bolted manholes are fitted with stiffening rings where necessary, and the covers are held in place by stud bolts and made watertight or oiltight as required, with suitable packing. Manholes for the main and variable ballast tanks, where they afford access from the interior of the vessel, are of the hinged boiler type and are arranged to seat with the pressure inside the tank.

Manholes in outer shell for access to tanks are closed by bolted covers secured by stud bolts of rolled nickel copper with rolled nickel copper nuts for flush type manholes, and galvanized steel bolts and nuts on dished plate manholes.

Means are provided for starting bolted manhole covers without damaging the gaskets.

List of Manholes:

BOILER TYPE MANHOLES

No.	Tank	Located
1	Forward Trim	Forward Torpedo Tank Top
2	Forward W.R.T.or W.R.M.	Forward Torpedo Tank Top
3	Sanitary No. 1	Forward Torpedo Tank Top
4	Aft. W.R.T. or W.R.M.	After Torpedo Tank Top
5	Sanitary No. 2	Bulkhead 7¼" Aft Fr. 77

DISHED PLATE MANHOLES

No.	Tank	Located
1	Forward Trim	Outer Hull (Top)
2	Fresh Water No. 1	Bulkhead 35 (Starboard)
3	Fresh Water No. 2	Bulkhead 35 (Port)
4	Negative	Frames 51-52-53 (Long. Bhd.)(Starboard)
5	Negative	Frames 51-52-53 (Long. BHD.)(Port)
6	Fresh Water No. 3	Bulkhead 9¾" Forward Frame 57 (Starboard)
7	Fresh Water No. 4	Bulkhead 9¾" Forward Frame 57 (Port)
8	Auxiliary No. 1	Outer Hull (Port)
9	Auxiliary No. 2	Outer Hull (Starboard)
10	Mot. & Red. Gear L.O. Sump 1	Inner Hull
11	Mot.& Red.Gear L.O. Sump 2	Inner Hull
12	Mot.& Red.Gear L.O.Stow.	Inner Hull
13	Eng. L.O. Stowage No. 4	Bulkhead 107 (Tank Top)
14	Aft Trim Tank	Outer Hull (Top)
15	Safety	Outer Hull
16	Safety	Outer Hull
17	Access to W.C. Drain	Bhd. 7¼" Aft. Fr. 77

FLAT PLATE MANHOLES

No.	Tank	Located
1	Bow Buoyancy	Main Deck
2	Bilge for Torp.Tube Drains	Forward Torpedo Tank Top
3	Main Ballast No. 4A	Outer Hull (Tank Top) (Starboard)
4	Main Ballast No. 4B	Outer Hull (Tank Top) (Port)
5	Clean Fuel Oil	Engine Foundation (Forward Engine Room)
6	Lub. Oil Sump No. 1	Engine Foundation (Forward Eng.Rm.Stbd. Fr. 80)
7	Lub. Oil Sump No. 1	Engine Foundation (Forward Eng. Rm.Stbd.Fr. 83)
8	Lub. Oil Sump No. 2	Engine Foundation (For'd Eng. Room-Port Fr. 80)
9	Lub. Oil Sump No. 2	Engine Foundation (For'd Eng. Room-Port Fr. 83)

List of Manholes (Continued):

FLAT PLATE MANHOLES

No.	Tank	Location
11	Lub. Oil Sump No. 3	Engine Foundation (After Eng. Rm.- Stbd. Fr. 91)
12	Lub. Oil Sump No. 3	Engine Foundation (After Eng. Rm.-Stbd. Fr. 94)
13	Lub. Oil Sump No. 4	Engine Foundation (After Eng. Rm.- Port Fr. 91)
14	Lub. Oil Sump No. 4	Engine Foundation (After Eng. Rm.-Port Fr. 94)
15	Engine Lub. Oil Stow. No. 1	Engine Foundation (Forward Engine Room)
16	Engine Lub. Oil Stow. No. 2	Engine Foundation (After Engine Room)
17	Engine Lub. Oil Stow. No. 3	Bhd. 13½" Forward Fr. 99 (Tank Top) Starboard

FLUSH TYPE MANHOLES

No.	Tank	Location
1	Normal Fuel Oil No. 1	Outer Hull (Bottom Starboard)
2	Normal Fuel Oil No. 2	Outer Hull (Bottom Port)
3	Fuel Oil Expansion	Outer Hull (Bottom Starboard)
4	Fuel Oil Collection	Outer Hull (Bottom Port)
5	Normal Fuel Oil No. 6	Outer Hull (Bottom Starboard)
6	Normal Fuel Oil No. 7	Outer Hull (Bottom Port)

Reference Plans:

Ports.No.	BuShips No.	Title
61-381	490935	Manhole List - Boiler Type - Flat Plate - Dished Plate & Flush Type
100-381	544805	Compartment & Access
92-381	490900	Foundation & Tanks for Main & Aux. Generating Sets
74-285	387254	Forward Torpedo Room Tank Top
75-285	387255	After Torpedo Room Tank Top
53-381	490885	Outer Shell Expansion
59-285	490815	Manholes - Flat Plate, Dished Plate & Boiler Type
97-285	490820	Flush Type Manhole

U. S. NAVY YARD, PORTSMOUTH, N. H. 1943

Section T-3

TORPEDO TUBE, Marks 34 - Mod.3 - Bow, 35 - Mod.3 - Stern

For Torpedo Control, See Section A-5.
For Tests, See Section D-1.
For Torpedo Stowage, See Section U-1.
For Torpedo Handling, See Section U-2.
For Pumping and Flooding, See Section U-12.
For Air Systems, See Section U-19.
For Description of Tubes, See Ordnance Pamphlet 586, Ports. No. 3149.
For Lubrication Instructions, See Section V-5 - Plate 20.
For Torpedo Tube Plans see Ord. Sketch 45027

T-3-a. General. The Ship's major weapon is the U. S. Navy torpedo Mark 14 and 14-1 and 14-3. The Mark 10-3 may also be used.

Extracts from Torpedo Characteristics.

		Mark 14 Mark 14-1	Mark 14-3	Mark 10-3
Ordnance pamphlet		617		237
Diameter		21"		21"
Length		20'-00	20'-6"	16'-03"2
WEIGHTS, IN LBS.				
Explosive Charge		496		497.35
Torpedo, ready for war shot	Mark 14-1	3048	3185	2215
	Mark 14	3012		-
Torpedo, ready for exercise shot		2875	3071	2060
Torpedo, buoyancy, max. end of exercise run		293		255
Torpedo, buoyancy, end of exercise run, normal		250		-
Torpedo, negative buoyancy, end of exercise run, head not blown		(-) 42		-

Characteristics of tubes		Bow		Stern
Number in Nest		6		4
Mark	34-Mod.3		35-Mod.3	
Capacity - lbs. SW.		3225		3530
Capacity - length - max.		20'-10 3/8"		22'-10 3/8"
Stowage, torpedoes		6		4
W.R.T., Mark 14, war shot, Mark 14, Head 14		795		1100
Mark 14-3		709		1014

For complete description of:

21-inch S/M T/T Marks 34 and 35, Mods. 2 and 3:

See Pamphlet B-3149 by Navy Yard, Portsmouth, N.H. of January 1943. This description is based on the 12 x 20 T/T prints according to Ordnance Sketch 45027

TORPEDOES - ELECTRIC

Reference: Auxiliaries - SS285-312.

Electric Torpedoes Servicing Requirements are as follows:

(a) Freshening Charge - Each torpedo requires a battery freshening charge once a week, i.e., 2 hours at 15 amps. and 155 to 220 volts. Torpedoes stored in tubes must be partially withdrawn to allow insertion of the charging plug. (BuShips Standard Receptacle Plug 9-S-4859-L (Type A1 - 25 Amps. 250 V. - 2-pole polarized).

(b) Venting - The battery compartment of the torpedo will be vented during the charge. A small portable blow, such as those usually carried on board will be suitable.

(c) Heating - In cold weather, the torpedo battery requires heating prior to a shot. Torpedoes carry electric heaters, 2.5 amps. at 220 V., thermostat control.

Section T-5

PERISCOPES

The ship has one periscope position: No. 1 and No. 2, Conning Tower.

Principal measurements, feet and inches:

Position	No. 1	No. 2
Location	0-9-3/16 Fwd. Fr. 53	0-4-11/16 Fwd. Fr. 54
Diameter	0-7½	0-7½
Length, optical	40-00	40-00
Eyepiece, above deck (designed)	5 - 3	5 - 3
Eyepiece, above base line	26' - 5½"	26 - 5½
C.T. flat, A.B.	21 - 2½	21-2½
Top raised, A.B.	66' - 8-1/16"	66 - 8-1/16
Top lowered, A.B.	47 - 2	47 - 2
Bottom lowered, A.B.	5 - 6-3/16	5 - 6-3/16
Fairwater, A.B.	47 - 2½	47 - 2½
Antenna Mast Raised A.B.	56 - 7⅜"	-

Characteristics of Periscope:

Optical length	40' - 00	40' - 00
Diameter of head section	1.99	1.414
Magnification, low power (& field)	1.5 x 32°	1.5 x 32°
Magnification, high power (& field)	6.0 x 8°	6.0 x 8°
Line of sight, max. elevation & depression	45° - 10°	45° - 10°

Ray Filters: Clear, red, green, yellow, polarizing, dark neutral.
Material of main body & reduced section - C.R.S.

Periscope (the instrument). This type of periscope is built for high power and low power observations, and is equipped with a tilting prism for elevation or depression of the line of sight. Other features comprise a built in stadimeter for estimating range and course angle of the target, a stabilized line for estimating speed of the target, and interchangeable ray filters for special condition of observation.

The supports are of rugged weldments, so designed, constructed, and secured to the special framing within the conning tower fairwater that the maximum practicable rigidity is obtained. After all welding has been completed and before machining and installation, the entire assembly is stress relief annealed. The height of the periscope supports are such that in the lowered position the periscopes are completely housed. The supports are thoroughly stiffened by transverse and longitudinal webs so as to provide the maximum practicable rigidity in every plane and are sufficiently rigid to prevent objectionable vibration at all speeds submerged up to 6 knots with either periscope fully extended, and with 4 feet of the periscope exposed. They are surrounded by a streamlined fairwater of steel plating. The supports are accurately machined and provided with bronze bushings to suit the periscopes. The final boring of the supports for alignment and of the inside bore of the bushings is done after the supports have been installed.

The design of bearings is such as to support the periscopes rigidly and permit their rotation with a minimum of friction. The upper inside edge of each bearing, except the upper bearing, is provided with a sharp lip to scrape off any foreign matter and keep it out of the bearings. The inside diameter of the bearing is 7.50 inches, with a tolerance of plus 0.002 inch and minus 0.000 inch. The alignment is such that the periscope will run true.

Clearance is provided around each periscope to permit a clear sweep by the operator throughout the entire circle of train, particular care being taken not to interfere with the operator's head at any angle. The radius of the walk-around is 19½ inches.

The raising and lowering speeds are 9 inches per second when the vessel's speed is 6 knots at periscope depth and 7½ inches per second when the vessel is submerged to a depth of 75 feet over the keel and running at a speed of 6 knots.

The periscope hoist, in principle, is the single whip, applied in duplicate and rove off in parallel, over sheaves and idlers from drum to periscope butt. Two wire ropes reel and unreel over a double drum winch. The drive is a vertical, reversible, watertight, series wound, remote control, electric motor on a worm gear to right and left handed single lay drums. The motor winch is assembled as a unit, exclusive of controls. Hoist is by power. Lower is by gravity. With armature current off, the motor is locked by a spring loaded disc brake. When armature current is on, the springs are unloaded by magnetic force. When motor is overhauled by gravity, a dynamic brake governs.

No. 1 and No. 2 periscope winches stand in C.T. starboard side. (Ref. 827)

No. 1 and No. 2 periscope hoist control is in the C.T. The push button is marked RAISE - EMERGENCY LOWER - LOWER. Contacts of the EMERGENCY LOWER button are in parallel with LOWER button. EMERGENCY LOWER button when pressed latches down mechanically and the lower limit switch takes charge. Pressing the RAISE button releases the latch.

Emergency by-pass switch in conning tower shorts out lower limit switch.

Pressing a push button energizes a coil and closes contactors in the armature and brake circuits. Releasing the push button opens the contactors and stops the motor and sets the brake. The motor is made reversible by providing two pairs of contactors, which allow opposite direction of current flow in the armature circuit. One pair of contactors is energized by the "Lower" button, and the other by the "Hoist" button. They are mechanically interlocked so that only one pair can be closed at a time.

Magnetic motor controller (located in pump room).

No. 1 and No. 2 Periscopes carry short extensions on their bases.

The hoisting and lowering motions are controlled by pressing push buttons marked RAISE and LOWER respectively. The control is of the reversing type and arranged so that operation continues only so long as the push button is held down. Closure of the hoist switch connects the motor to the line through two steps of starting resistor which are cut out after successive current in-rushes, closing the second accelerating contactor, connect the motor directly to the line. Releasing the HOIST button stops the motor, sets the brake.

No acceleration is provided for the lowering direction of the motor but the starting resistor is connected permanently in series with the motor, which in turn has resistor R10 - R11 in parallel with the armature thus assuring a safe lowering speed. Releasing the lowering button stops the motor, sets brake.

The operation of the motor is subject at all times to the operation of the overload relay which opens the circuit to the hoist and lowering contactors, on excessive overload. The overload relay does not reset until the push button in use is released. The motor can then be started from either the HOIST or LOWER push button.

The upper and lower limit switches are provided. They protect against forcing the hoists beyond normal travel.

Slack wire switches are provided. They stop the motor if the cables become slack or deranged.

NOTE: There is a lower limit emergency by-pass switch provided on SS285 and subsequent vessels.

Detailed description of various parts:

The Hoisting Gear for each periscope is a 7.5 H.P. - 600 r.p.m. - (250 V. - 30 A. - DC) motor-driven, worm-geared, double-drum winch.

The two grooved drums, worm and gear, the motor, and the disc brake are mounted as single ball-bearing unit.

The drums and the worm shaft (integral with armature shaft) run on ball bearings, lub. oil symbol 1150. The shaft at the armature end runs on a ball race which is fitted with a grease cup (grease grade B).

The Periscope Hoist Gear Motor is enclosed, watertight, vertical, varying speed, series wound. Its voltage range is from 160 to 245 volts. Amperage - 48.

The Hoisting Motor Shaft carries a friction disc brake, mechanically (spring) set, and electrically released. A single disc 13" D. with a friction lining of Metallic Asbestos on each face is attached to the hub of the brake so there is no relative rotation but so the disc may move axially on the hub. The exposed friction lining faces engage with non-rotatable friction faces on the mounting plate and the adjustable friction plate providing a holding power of 70 ft. lbs. The amount of pressure and the resulting torque is adjustable by changing the spring compression. The field, armature and coil constitute an electro magnet which overcomes the spring force and releases the brake when the armature current is on.

Hoist Ropes are high grade plow steel, fibre core, uncoated, 7/16" D, 6 strands of 37 wires each. The length of each cable is cut to suit. Dead end consists of one full turn, 6.8 turns are required to raise. The ropes are attached to the hoisting yoke with a nut and thimble furnished with the periscope. The sockets are attached strictly in accordance with the practice of John A. Roeblings Sons Co. and are tested to a static load of 8000 lbs. On the drum end the rope is secured to hub of drum by threading through a hole in drum, and secured to itself by a wire rope clamp provided. (Ref. 839)

Note: The length of each hoisting rope on the periscopes are sufficient to lower the periscopes to bottom of extension and allow one full turn on the drum. 6.8 turns are required to raise.

Sheaves are of comp. G, 6¾" effective diameter, with a 1" greased grooved hole. The sheaves pin is of steel, grade M, with .002 clearance, 4-5/8" long (for double sheaves). It is drilled with 3/16" D teed grease holes feeding all bearing surfaces and is fitted with a 1/8" nickel copper alloy grease fitting. The periscope sheaves are mounted on the C.T. shell are swivelled to accommodate the difference in angularity of rope when reeving off of drum.

Adjustment of Slack in a hoist rope can be obtained at two points, 1. The thimble on the hoisting yoke and 2. The readily adjustable eccentricity (½") of the sheave pin as mounted on the hull casting stuffing box. Design is such that excessive adjustment is not necessary.

Hoisting Yoke is furnished with the periscope. It transmits the entire weight and resistance of the instrument to the hoisting gear. It is slotted in wake of the hoisting cables to permit emergency exchange of hoisting ropes. It is self-aligning.

No. 1 and No. 2 Periscope Wells (fr. 53) and (fr. 54) are fixed and W.T. from flat keel to C.T. flat.

The Controller is rated as 250 V., 7½ H.P. shock proof class 50 (not damageable by class 150 shock), magnetic contactor, starting and reversing, semi-automatic control circuit, push button control, heavy starting, low voltage release, magnetic brake, hoisting and dynamic lowering.

The master switch is molded phenolic, phenolic insulated, waterproof, momentary contact, dual push button, "Raise - Lower".

The Overload Relay cuts out at 60 amperes. The overload relay resets only when the push button is released.

The Low Voltage Release cuts out at 25 volts, but will restart on return of voltage if the push button is held down.

Upper Limit Switch stops the winch when the periscope eye piece reaches a height of 5'3" above the deck and prevents forcing the hoist beyond its normal travel. The switch electrically is a set of cam operated, spring released, coin-silver double contact points, in series with both sides of the hoist coil circuit. The cam must rotate approximately 19° between "closed" and "open", but can rotate without damage through 360°. This switch is dripproof, mounted on a frame attached to the periscope hull casting. Mechanically the switch works as follows: The periscope hoisting yoke on its up travel strikes a pin on a vertical spring-compressed plunger. The plunger moves upward, at the same time the plunger strikes the external lever of switch, it rotates cam, and breaks circuit. (Ref.840)(Ref.1425)

Lower Limit Switch stops the winch when the periscope strikes the rubber cushion on the top of the buffer standing 12-5/8" above the keel plate. Electrically the contact maker is in series with the control circuit of the lowering contactor. The mechanical appurtenance of the switches' cam is mounted on the buffer head. A tripping lever, an offset lever, an extension rod, and the switch lever are interconnected adjustably for correct point of cut off. A spring steel, 58 coils, 8½" x 7/8" I.D. spring, 11" assembled with an initial pull of 19 pounds (60 pounds maximum) attaches to the outer wall of the periscope well and engages the switch lever. Principle of operation for No. 1 and No. 2 periscopes is the same: the periscope extension drops on the tripping lever, the coil spring gives way and the contact maker cuts off the lowering contactor in the controller. Location of the contact maker is outside of the periscope well. The location and other details are the same for No. 1 and No. 2 periscopes.

NOTE: Emergency by-pass (lower limit switch).

The tripping lever in the "down" position recesses in a slot in the rubber cushion in the buffer head. (Ref. 832)

The Buffer which sets at the bottom of the periscope well has an assembled height of 12-5/8", and compressed, 11". It consists of a base (18-5/8" L. x 16-15/16" D.) of Comp. G, and a buffer head. Between the two are mounted six 19 coil (2" O.D. x 1-3/8" I.D. x 5/16") spring steel nickel plated springs. Three have a free height of 8½", and three 7½". Resistance to shock progresses from (4½" x 1¼") cushion rubber pad (4½" D x 1¼" thick) (on buffer head) to 3 high springs, thence to three low springs. The total possible deflection of buffer, 1-5/8". The buffer is secured in the bottom of the well by welding of 4 fins to side of well. (Ref. 833)

The Slack Wire Switch protects the periscope from injury in case a hoisting cable fouls. There is one switch on each cable. This device electrically is a pressure contact maker, in the power supply to the raise and lower contactors. The contact maker is actuated by a shaft on which is an arm carrying roller guide pulley. Normal strain on the pulley maintains closed circuit. Slack wire causes the contact maker to tumble and open the circuit. These switches are mounted on or near the head of the winch. (Ref. 1436)

The Hull Casting Stuffing Boxes work against sea pressure. The seal is made up of: (Top to bottom), (Ref. 829) (Ref. 1067)

1.	Bushing	Comp. Oz-C	7" long.0075
2.	Ring	Bronze	¾" long 1/64
3.	Flax	-	5/8" long 1 turn
4.	Ring	Bronze	3¾" long 1/64 turn and ½" grease
5.	Flax	-	5/8" long 1 turn
6.	Gland	Bronze	1¾" long 1/64
7.	Wiper	Leather	5/8"

There are 1/8 grease fittings at various locations, see lubrication chart for details.

The Azimuth Circle Extension Ring (15-13/16" D x 7/16" th.) is bolted to the bottom of the hull casting. (Ref. 1337)

The Azimuth Circle Support (16-1/16" D x 2-15/16" high) is bolted to the azimuth circle extension ring. It carries a sump and a drain boss, drain pipe and a leather wiper ring for leakage disposal. It also carries a light shield, a parabolic reflector, six candelabra lamps, for indirect lighting of the azimuth circle.

The Periscope Azimuth Circle is bolted to the support with slotted holes for lubber line adjustment. It is fitted with a fixed relative bearing scale, and a sliding gyro angle scale, graduated 0 to 55° right and left, and a sliding target bearing pointer which is superimposed on the gyro angle scale. The azimuth circle also carries a scale filled with red cement, to enable the operator to make observations from the forward side of the periscope.

The sliding scale is spring-notched every ten degrees. The material is nickel silver.

Bench Marks are installed to permit bore sighting of periscopes with torpedo tubes.

Operating Notes - Care of Periscope. The periscope should be hoisted and inspected daily, even while in port, by a qualified officer, to make sure that it works smoothly in its bearings, and that all parts are in perfect working order. The head window, eye piece window and ray filters should be cleaned as often as necessary, all such surfaces being readily accessible. The glass may be cleaned with alcohol and wiped with Selvyt cloth, or lens paper. Unnecessary cleaning should be avoided owing to the danger of scratching the glass.

Packing Glands. It is important, in the care of the periscope that the packing glands on shafts entering the eye piece box be periodically tightened. The packing glands should be tightened upon installation of the periscope and about every 60 days thereafter. This should be done only on strict accordance with instruction contained in the manufacturers instruction book. The Gas Pressure should be checked at the same interval. Normal pressure is 5 to 7 p.s.i. at 70° F. A pressure below 2 p.s.i. is hazardous since temperature changes may cause the periscope to"breath" in damp air. In such cases the instrument should be recharged using dry nitrogen or nitrogen-air mixture and admitting it very slowly to minimize internal currents.

Underneath both stadimeter scales will be found grease fittings of the Zerk type. A soft water pump grease should be forced into these fittings occasionally to lubricate and prevent corrosion of the stadimeter scales. The surplus grease will emerge between the scales and should be wiped off. No polish or other abrasive should be used on the stadimeter scales.

Top bearing, protection of. To prevent dirt and other foreign matter from getting into the top bearing while at dock, the red paint mark on the hoisting ropes must be brought in line with bottom of azimuth circle. The periscope butt will then stand 11'-3-11/16". (Ref. 827)

Lubrication Note: Once a month apply graphite wheel rope grease to the hoisting ropes. (Ref. 827)

OBSERVING WITH PERISCOPE

The observer should determine the best focus for his eye, and make the proper setting on the diopter scale before starting observation. The diopter scale is located on the hub of the focusing knob. The stadimeter should of course be in the observing position.

The power shift is operated by the grip on the right training handle, which should be rotated to the limit of its travel in each position. The prism tilt is operated by the grip on the left training handle.

Each large division on the telemeter scale corresponds to an angle of 1° at high power, and 4° at low power. Each subdivision corresponds to an angle of 15' at high power, and 1° at low power.

The use of the ray filter is recommended under conditions of visibility impaired by fog, haze or other conditions. The polarizing filter is intended to cut off the glare of sunlight reflected from the sea or other shiny surface. It may also be used in place of the light neutral filter formerly supplied.

PRINCIPLES OF STADIMETER

The principle of the stadimeter is that of duplicate images, the distance between which can be carried so that, for instance, the waterline of a vessel in one image can be brought into apparent contact with the masthead as seen in the other image. The amount of displacement necessary to effect this is translated on the stadimeter dials to the range of the vessel as read against the known distance between masthead and waterline. In this case the images are displaced vertically. However, a similar displacement can be produced horizontally, and the bow and stern of a vessel may be brought into apparent contact on the two images. The length of the vessel being known, and its range having just been found, the course angle can now be read on the proper scale of the stadimeter dials.

DESCRIPTION OF STABILIZED AZIMUTH LINE

The stabilized azimuth line provides in effect a "line in space" in the field of view. Irrespective of the range of course angle of the target, its apparent time of passage across this line and its known length serve as factors on which to calculate the speed of the target.

The azimuth line is actuated by a self synchronous motor which in turn is governed by the gyro compass of the submarine. The position of the line is thus independent of changes in the course of the submarine, but if the periscope is rotated in its bearings the azimuth line will of course move against the field. Like the stadimeter, this device is intended only for use in the high power magnification. The controls of the azimuth line consist of a setting knob with which the line is placed where desired in the field of view, and a clutch by which the line is disconnected from the setting knob and connected to the motor.

Further instructions are available in the Kollmorgen pamphlet, covering the design designations of the periscopes installed.

All new periscopes delivered subsequent to latter part of 1942 have a coating of optics to increase light transmission. Periscopes which have been so treated have a modification of the design designation by addition of the letter "T" after the figures which show the optical length. For example: one modified design designation will be 89KA40T/1.99.

Reference Plans:

Ports.No.	BuShips No.	Title
78-285	387257	Periscope & Vertical Antenna Mast Wells.
122-285	387265	C.T. Structural Details.
207-285		Foundations for supports for Periscopes, Vertical Ant.Mast & Radar.
208-381		Supports for No. 1 & No. 2 Periscopes, Vertical Ant. Mast & Radar.
827-381		No. 1 & No. 2 Periscopes - General Arrangement.
828-381		No. 1 & No. 2 Periscopes - Arrgt. - Lower End.
829-285	490428	No. 1 & No. 2 Periscopes - Stuffing Box and Misc. Details.
832-285	490438	No. 1 & 2 Periscopes - Lower Limit Switch - Arrangement.
833-285	490437	No. 1 & 2 Periscopes - Bumper and Misc. Details.
836-201	312323	No. 1 & 2 Periscopes - Azimuth Circle - Arrgt. and Details.
839-285	491124	No. 1 & 2 Periscopes - Sheave & Bracket - Details.
840-381	544616	No. 1 & 2 Periscopes - Upper Limit Switch - Arrgt. & Details.
1422-201	312856	Pushbutton - Portable - W.T. - 2 Gang - for Periscope Hoist Motors.
1425-228	387179	Upper Limit Switch - Quick Break Double Pole for Periscope.Hoists - Assembly & Details.
1436-201	312870	Slack Wire Switch for Radio Mast and Periscope Hoist.
1467-381	387197	Periscope Hoist - Motor Control - Elementary Wiring Diagram.
1650-381	389955	Periscope & Antenna Mast Hoist - Motor - Sectional Assembly - Specifications & Wiring Diagram.
1677-381	389905	Periscope & Vertical Antenna Mast Hoist - Motor - Drippproof D.C. Magnetic Controller - Outline, Specifications & Wiring Diagram.
1066-285	490435	No. 1 & 2 Periscopes Lower Limit Switch - Details.
1067-381		No. 1 & 2 Periscopes Null Castings Stuffing Box and Misc. Details.
1610-228	389905	Control Panel and Fixed Push Buttons.
30470	313275	Limit Switch - Quick Break.
-	-	Kollmorgen pamphlet - Submarine Periscope - Bureau of Ships Manual (Null) - Section XII.
1339-285	490445	No. 1 Periscope - Arrangement Lower End in Conning Tower.
1337-285	490444	No. 1 & No. 2 Periscope - Azimuth Circle - Support & Extension Ring Details.
1068-285	490443	No. 1 & No. 2 Periscope - Light Shield Details.
1336-381	-	No. 1 & No. 2 Periscopes - Bracket and Foundation - Details in Conning Tower.

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MAGAZINES

For specific quantities of ammunition see BuOrd Allowance Lists.
For instructions, handling of explosives, see BuOrd Manual.
For Stowage Arrgt., see plan "Ammunition & Ordnance Stowage".
For Safety Precautions, see Navy Regulations.
For Sprinkling System, see Section U-12-a.
For Torpedo Allowance, see Section T-3.

Magazine space is between frames 58 and 61½ below platform deck (mess room and galley), and extends across the ship, exclusive of wing wireways. There are 4 subdivisions in the magazine group.

Explosives are stowed in 2 spaces, viz: access off handling room.

(1) 4" Magazine.
4" - 50 Cal. Common, High Capacity & Short Cartridge Cases.
(2) Small Arms, 30 Cal., 45 Cal. and 20 MM Ammunition.

Small Arms and miscellaneous equipment are stowed in two compartments -

(3) Handling Room Racks for small arms, access by 15 x 23 hatch.
(4) Ordnance Storeroom - miscellaneous small arm accessories, access by 15 x 23 hatch.

The Ordnance Ready Service Locker, COC (fr. 54-55 port) is a steel inclosure (4-2½ W. x 18" deep x 6' 4" high). The design stowage allows for:

(1) 20 MM A.A. Machine Gun, Mk. IV (complete) 1
(2) 20 MM Spare Barrels 2
(3) 20 MM Magazines 6
(4) 45 Cal. Thompson Sub. Machine Gun 2
(5) 45 Cal. Line Throwing Gun 1
(6) 45 Cal. Line Throwing Gun Accessories 1
(7) 30 Cal. Browning Machine Gun M1919A4 2
(8) 30 Cal. Browning Machine Gun M1919A4 Spare Barrels 2
(9) 30 Cal. Browning Machine Gun M1919A4 Carriage Mk. XIV 2
(10) 30 Cal. Browning Machine Gun M1919A4 Magazine 2
(11) Identification Signals - Box 1
(12) Very's Signals - Box 1
(13) Distress Signal Hand Light, Red Box 1
(14) 12 Gauge Riot Shotgun M1897 1

The Ordnance Ready Service Locker - Officers' Quarters - (Frs. 45¾ to 46½ C/L of Ship) is a steel inclosure (17" W. x 9½" deep x 5' 7¼" high). The stowage allows for:

(1) 20 MM AA Machine Gun, Mk. IV (complete) 1
(2) 20 MM Spare Barrels 2
(3) 12 Gauge Riot Shotgun M1897 1

Torpedo equipment involving explosives is as follows:

(1) War heads - attached to torpedoes.
(2) Detonators - Stowage outside torpedo rooms in WT cases at least 10 ft. apart.
(3) War Head exploder mechanisms - stowage provided with gyros.
(4) War Head booster charges sealed in copper boxes of six charges - stowage - moisture-proof lockers in torpedo rooms.
(5) Igniters - moisture-proof lockers - 2 boxes f.t.r., 1 box a.t.r.

The pyrotechnic magazine is located in the storeroom below platform deck, frs. 55½ - 57 starboard. Stowage is provided for 3 boxes of emergency identification signals, 2 boxes emergency identification flares and 3 boxes rocket signals - chameleon.

Reference Plans:

Ports.No.	BuShips No.	Title
77-285	490806	Magazine - Meat & Cool Rooms - Bulkheads - Doors & Flat.
101-285	490837	Ammunition & Ordnance Stowage.
154-275	544693	Ordnance Ready Service Lockers - Control Room & Officers Quarters.
505-308	490969	Magazine Sprinkling System - Piping Arrangement.

Section U-2

TORPEDO AND MINE HANDLING

Ship's allowance of torpedoes is 24; 16 forward and 8 aft.

The torpedo crane specified in Section A-3 is used for handling torpedoes.

The arrangements for handling and loading torpedoes, for taking them on board the ship, and for withdrawing them through the loading hatches for transfer from one torpedo room to the other, are designed to accomplish these operations with the minimum of effort and with the maximum safety to both personnel and material. Special efforts have been made to facilitate reloading the tubes in the minimum time.

The handling arrangements will handle conveniently 21-inch by 20'-6" torpedoes and 21-inch by 16½ ft. torpedoes, with or without heads attached. The facilities in both torpedo rooms are suitable for handling 20-13/16" D x 9'-10½" mines (Mk.10) (contact) and 20-13/16" D x 7' 10¼" mines (Mk.12) (magnetic). The latter includes taking the mines on board, striking them down into the torpedo rooms, stowing them in the racks, loading them into and withdrawing them from the tubes, and transferring them from the stowage racks to the main deck. Suitable means are provided for securing mines in stowage position in torpedo tubes.

The hinged sections of the deck in way of the torpedo hatches are provided with chocks, so that when hinged up they will form supports and guides for the torpedoes and mines. These hinged sections are supported at the free end so that the torpedo resting on them will be in line with the torpedo hatch.

The torpedo and mine handling arrangements in the torpedo rooms consist of a system of portable tracks and portable cradles. The cradles are arranged for lifting from lower to upper tracks, and vice versa, by means of chain hoists. Rollers are provided on the cradle for sliding the torpedo or mines onto the cradle and to enable the cradle to be run athwartships on the portable tracks. The portable cradles are fitted for securing the torpedoes or mines to them, and provisions are made for locking the cradles in their stowage and in their loading positions. 12 cradles are provided for the forward torpedo room; 10 torpedoes are ordinarily stowed on them and the other cradles are carried as spares for use when a torpedo is withdrawn from a tube, or when mines are removed from tubes. 6 cradles are provided in the after torpedo room, 2 as spares.

Chain hoists, & portable tracks are provided in each torpedo room.

Roller brackets are provided so that torpedoes or mines may readily be rolled from the cradles to the roller brackets and thence to the tubes. The roller brackets are provided with rollers which are made adjustable to compensate for wear or slight inaccuracies. To facilitate the handling of mines, the maximum spacing of the rollers is 30 inches.

Pad eyes are provided in both torpedo rooms, so that a torpedo can be hoisted to permit swinging it through a total angle of 20° for testing gyro, and the vertical rudder throw.

Pad eyes, cleats, blocks and falls are provided for handling and stowage of torpedoes, both inside and outside the hull. Portable gear is readily set up and taken down, stowage is provided for it when not in use, and it is conspicuously stamped for identification and assembling.

MINE HANDLING

For Mark 10, Mod. I, mine, see Ordnance Pamphlet.
For Mark 12 mine, see Ordnance Pamphlet.

Principal dimensions of mines adapted to submarines (March 1943) are:

	Mark 10-1	Mark 12
Length overall - inches	118-5	94.25
Diameter, inches	20-13/16	20.812
Weight, lbs.	1760	1500
Displacement, sea water	1150	1080
Weight, Overboard	610	420
Center of gravity, inches, from base end	30½"	54¼
Explosive charge, lbs., TNT cast	300	1130
Booster charge, lb., TNT granular	2.5	2.5
Detonator	Mk. I, Mod. I	Mk. I, Mod. I
Arming period, minutes	50	45

In general, whether in a tube or in a cradle, the stowage space for one torpedo is adapted to take two mines.

It is impossible to predetermine the exact arrangement of mines and torpedoes that will be employed in any particular set of circumstances surrounding service conditions. For purposes of ballasting, the 20-20 plus 4 arrangement is taken as normal loading. By this premise, twenty mines are carried forward and twenty aft. Torpedoes are carries in tubes 3, 4, 5 and 6. Before mining, tubes 3 and 5 are emptied and the torpedoes stowed on the lower level, ready for reload to tubes 5 and 6. Tubes 5 and 6 are for torpedoes only.

A mine is fired from a torpedo tube in the same manner as a torpedo, singly.

Mines are delivered to a submarine completely assembled.

Mines are handled, stowed, or loaded in tubes according to special instructions of the Bureau of Ordnance pamphlets.

Handling of mines without recourse to special information contained in the mines' descriptive pamphlet is prohibited.

Preliminary training of crew with dummy mines is essential to a successful mine plant.

In a mine plant, the interval between units is usually 100 to 300 yards; at 3 knots this requires firing of a mine every 60 seconds.

No specific rules can be laid down as to planting mines. Conditions and procedure are subject to considerable variation. This is due to variation in number of torpedoes retained on board, alterations, and improvement in the type of mine and stowage of same.

The special conditions encountered in depth control are:

(1) Abnormal amount of ballast to be taken in.
(2) Abnormal demand on trimming facilities.
(3) Excessive use of air.
(4) Excessive rise in barometer.
(5) Variation in weights of water blown to sea on individual shots.
(6) Variation in weights of water taken in bilge through poppet valves.
(7) Difficulty in maintaining depth in shallow water.

Contact Mine, Mark 10, Mod. 1 - Safety features are provided for:

(1) Premature separation of case and anchor.
(2) Maintaining mine within 34 feet of bottom for 5 minutes.
(3) Isolating detonator from booster during ejection.
(4) Keeping electric circuit open for 50 minutes (maximum) after ejection.
(5) Protection of horns during launching.
(6) Protection against detonation if glass tube is cracked only.
(7) Prevention of firing due to crushing of horn during ejection.

Contact Mine, Mark 10, Mod. 1 - General

In general, the following conditions prevail as regards the Mark 10, Mod. 1 mine, on a typical plant:

Least distance between keel and ocean floor, 40 ft.

Best speeds; Bow tube 3 to 4K, stern tube 1 to 6K.

Mines are designed to stand same submergence as the ship.

Mine laying leaves an air-slick on the water, readily visible during daylight.

For Mark 10, Mod. 1, mine, following notes concern the mechanics of the planting operation:

(1) On ejection, rise of mine's nose above center line of tube (maximum) - 12 feet.
(2) Speed 0; impulse air 250 lbs.; Position of mine 2 seconds after ejection - 25 to 50 ft. out, vertical.
(3) Time for mine assembly to reach bottom, 500 feet - 55 seconds.

(4) Length of time after ejection for case and anchor to separate - 2 seconds.

(5) Length of time after ejection to unreel first 24 ft. cable - 5 minutes.
Speed of unreeling after 5 minutes - 20 feet per second.
Least depth that top of case must descend to arm mine - 5 feet.

(6) Travel of mine to contact between anchor starting lever and tripping latch - 2"

(7) Recommend impulse pressure - 250 lbs. (plus).

(8) Minimum impulse permissible with stern tube only - 150 lbs.

Principal appurtenances on Mark X, Mod. 1, anchor which are involved in handling and loading processes:

(1) Safety screw - part of mine anchor.

(2) Guide latch assembly - positive fix between tube stop bolt and mine.

(3) Horn guards - mechanism for arming horns after mine is free.

(4) Tripping latch pocket - recess for tripping latch used for double assembly tube stowage.

(5) Eyebolts - one in the base of anchor, one in the nose.

(6) Loading pole (Ports. Plan No. 27931).

(7) Connecting link - for stowage of mines in double assembly, attached to anchor of each mine.

(8) ½ Contours - for roller trip, two on anchor.

(9) 2 Starting lever - anchor release mechanism.

(10) Adapter plug (Ports. Plan No. 1143-201) for use with double assembly in a tube; fits over anchor eyebolt, butts against tail stop.

(11) Mine gauge (Ports. Plan No. 1143-201) for use with double assembly in a tube - for locating the after mine's tripping latch pocket directly beneath the tube tripping latch; i.e. with base of mine ".45 inside the bead on the breech end of T.T.

Contact Mine, Mark 10, Mod. 1, Striking Mine below, precedure:

(1) Both torpedo rooms and both torpedo loading skids are rigged in the manner used for torpedoes. The sliding parts of all cradles should be lightly greased before shipping to make loading easier.

(2) To take aboard: put a torpedo strap around the mine case at the c.g. 30"5 forward of the anchor base, with guide stud uppermost.

(3) Attach a guy line to each eyebolt.

(4) With torpedo crane lower the mine to the loading skid. This places the bridge of the anchor on the bottom thereby giving a fair surface for lowering into the shipping cradle.

(5) Insert a shackle in the forward eyebolt while mine is resting on skid and still held by crane.

(6) Attach snubbing lines to shackle from top and lead aft on each side of the lanyard guard and between the lanyard guard and the two uppermost horn guards, to prevent the snubbers from slipping down the side of the mine case and jamming in the skid.

(7) Remove wire strap when snubbers are secure.

(8) The tail guy line - use this as a preventer.

(9) Lower the mine into the shipping cradle controlling with snubbers.

(10) Two mines may be skidded and secured in turn before the shipping cradle is lowered away.

(11) Forward torpedo room - lower the first mine into the cradle until the forward end of the cylindrical mine case is approximately 20 inches beyond the forward end of the cradle. This brings to approximate alignment the after ends of the second mine and cradle respectively. (End of mine overhangs cradle 3".)

(12) The first mine being in place, secure the straps, remove snubbing lines. Use inside snubbing lines as a safety measure while the second mine is being loaded.

(13) Lower second mine into cradle and secure, using the mine connecting link between.

(14) Lower the shipping cradle away by chain falls and swing into place for loading in a tube or stowing in the racks.

Contact Mine, Mark 10, Mod. 1; Stowing a Double Assembly in the T/T:

(1) The connector (attached to the anchor) - insert this between the two mines.

(2) The torpedo stop bolt must be raised (to clear the guide latch assembly on mine one). This may be accomplished by disconnecting the "Firing Interlock Bolt" and, with ship's 200# service on the torpedo stop cylinder, holding the firing key in the firing position with impulse flask not charged. (no impulse stop valve). Thus the torpedo stop bolt will be held in the raised position while the guide latch assembly on mine one is moved clear to stowed position.

(3) The adapter plug (Ports. Plan No. 1143-201) - insert this in mine two.

(4) The tube tail stop handwheel - back this full out.

(5) The mine gauge (Ports. Plan No. 1143-201) - use this to establish lineal position of mine two.

(6) The tripping latch pocket of mine two must be directly beneath the tube tripping latch.

(7) The double assembly being loaded to proper position close the breech door, take up tightly on the tube tail stop, then back off 1/8 turn.

(8) The double assembly is properly locked in lineal position between two opposing stops on mine two, i.e. tail stop - adapter plug and tripping latch, tripping latch pocket.

CONTACT MINE, MARK 10, MOD. 1 - Loading of:

(1) The mine in the loaded position fulfills following conditions:

(a) Safety screw is removed from the mine.

(b) Mine inserted in tube to a distance of 48".94.

(c) The tripping latch (52".375 from breech end) engages mine starting lever (3".44 from base of anchor).

(d) Stop bolt engages guide latch assembly.

MINE LAYING - Notes on practical experience with, (March, 1943):

(1) Torpedo data computer is useful to generate range spacing for laying mines.

(2) The current set anddrift may be introduced as target course and speed.

(3) Compensation amidships during mine plant will be at the rate of about 1500 pounds per minute, through auxiliary.

(4) Bow buoyancy tank vents, if not used, should be left open.

(5) Negative tank flood may be left open during laying mines, to help adjusting overall trim, by blowing and venting in conjunction with auxiliary tank.

(6) The dash pot in the anchor must be allowed sufficient opportunity to flood before the mine is fired. The dash pot fills through 4 - 3/16" holes, and when full gives a two-second delayed action on anchor and case separation. If the dash pot is empty on firing, the case will leave the tube, and the anchor will very likely be rammed back into the tube by water pressure, causing damage to roller trip arm and tripping latch.

(7) Insufficient impulse air may cause condition similar to above.

THE DRILL MINE, Mark X, consists of the following:

(1) Anchor
(2) Case
(3) Hydrostat
(4) 3 Dummy Horns
(5) Extender opening blanking plate and gasket

The drill assembly will operate in every way except actual firing, exactly as a service assembly.

For drill plants the hydrostat should be set to release the bight of cable at a depth of 10 feet. This will anchor the case with its conical end just above the surface, thus facilitating recovery.

MAGNETIC MINE, Mark 12. The following notes are cited as being of interest in regard to the mechanics of planting operations:

(1) The mine is designed to strike bottom at about 25 to 50 feet horizontally from the point of firing.

(2) The clock starter functions at 15 foot depth.

(3) The detonator slides into the booster can at 15 foot depth.

(4) Military features of the mine are given in the Ordnance Pamphlet.

Reference Plans:

Ports.No.	BuShips No.	Title
956-275	386851	Torpedo & Mine Handling and Stowage - Forward Arrangement
957-275	386877	Torpedo & Mine Handling and Stowage - Forward - Upper Tracks - Arrgt.
959-228	386636	Torpedo & Mine Handling & Stowage - Forward - Roller Brackets -Arrgt.
961-201	312448	Torpedo Handling & Stowage - Nose piece & Loading Pole - Details
962-275	387437	Torpedo & Mine Handling & Stowage - Aft. - Loading Chocks - Arrgt.
963-275	387434	Torpedo & Mine Handling & Stowage - Forward & Aft Cradle - Arrgt.
965-275	386960	Torpedo Servicing Cradle - Arrangement & Details
967-201	312454	Torpedo Handling & Stowage - Nose Piece - Details
968-228	386708	Torpedo & Mine Handling & Stowage - Fwd. - Loading Chocks - Arrgt.
973-275	386879	Torpedo & Mine Handling & Stowage - Aft. - Upper Tracks - Arrgt.
976-285	490447	Torpedo Room - Arrangement - Aft.
1138-308	544548	Torpedo & Mine Handling & Stowage - Fwd. & Aft. - Lashing Strap Saddles - Details
1139-308	544549	Torpedo & Mine Handling & Stowage - Fwd. & Aft. - Lashing Strap - Dtls.
1143-285	490258	Fwd. & Aft. Wrenches - Gauge Plug & Cradle Plate
1147-275	386954	Fwd. & Aft. Lashing Straps - Arrgt.
1162-275	386883	Torpedo & Mine Handling & Stowage - Aft. - Tracks at Fr. #110 - Arrgt.
1166-275	386886	Torpedo & Mine Handling & Stowage - Aft. - Tracks at Fr. #117 - Arrgt.
1173-228	386645	Torpedo & Mine Handling & Stowage - Aft. - Roller Brackets - Arrgt.
1180-205	367966	Torpedo & Mine Handling & Stowage - Fwd. & Aft. - Special Block for Breech Ring
1186-275	386855	Torpedo & Mine Handling & Stowage - Fwd.- Tracks at Frame #24-Arrgt.
1197-275	387465	Torpedo & Mine Handling & Stowage - Fwd. - Tracks at Fr. 31 - Arrgt.
27931	386904	Mine Handling & Stowage - Forward & Aft. - Mine Loading Pole.
1146-275	386949	Torpedo & Mine Handling & Stowage - Lashing Strap - Saddle for Mark XII Mine
1147-275	386954	Torpedo & Mine Handling & Stowage - Lashing Straps - Arrgt.
1196-275	387436	Torpedo & Mine Handling & Stowage - Fwd. & Aft. - Cradle Details - Chocks & Cleats
27931	386904	Mine Handling & Stowage - Fwd. & Aft. - Mine Loading Pole

Section U-6

CAPSTANS

Two capstans are provided on the main deck, one 6" Aft. of Frame 16, and the other 9" forward of Frame 119. Stern permanent fixture mounted on vertical shaft. The heads are 15¼" in diameter for a rope speed of 60 feet per minute.

The forward capstan is driven by the hydraulic windlass gear.

The after capstan is driven by the stern diving gear electric motor. This motor driving through a speed reducer of 5 to 1 ratio operates the shaft carrying the capstan gear chain sprocket, clutch arrangement and capstan gear. The clutch has two positions: Hydraulic drive for the diving planes; and motor drive for the capstan. Control of the motor for capstan is by a shaft extending from the after torpedo room to main deck and operated by a socket wrench. To operate capstan, torque bolts are to be engaged by sliding forward into chain sprocket which is attached to the electric motor shaft.

ANCHOR GEAR - Plate 3.

This class of boat is furnished with only one anchor.

The Anchor Cable upon leaving the chain locker passes through a closed fairlead upon which are mounted two jaws operated by a traveling nut on a screw to act as a chain compressor for securing the cable. This chain compressor is operated by gears and shafting from the main deck. A socket wrench connection is provided on the main deck. An indicator is provided on the main deck, operated from the chain compressor jaw shaft.

The Bitter End of the cable is secured by a pin with a wire cable running to the deck with a handle for pulling pin clear for slipping the cable when on the surface.

The Hydraulic Pump is controlled by a socket wrench from the main deck. The speed of the gear may be controlled from zero revolutions to full speed.

The Ground Tackle consists of a 2,200 pound stockless anchor and 105 fathoms of 1-inch die-lock steel chain. The anchor is housed in the hawse pipe in the superstructure on the port side. The anchor cable is self-stowing in the chain locker which is located between frames 10 and 11½.

The Windlass consists of a wildcat driven through gearing by a variable-stroke hydraulic pump and hydraulic motor. The forward capstan is driven by the same hydraulic gear. A 15 H.P., 1750 R.P.M. electric motor drives the Northern hydraulic pump Size 7220 through a set of reduction gears. The Northern hydraulic motor Size 7330 is connected directly to the pump by a hydraulic manifold. The hydraulic motor drives two sets of bevel gears which in turn operate a vertical shaft fitted with two flexible joints, passing through the Inner Hull. This shaft drives through a clutch, either a pair of bevel gears connected by a drive shaft to the wildcat, or a set of spur gears which in turn drive the capstan.

The Electric Motor is clutched in the reduction gear housing so that it can be clutched to the bow plane rigging gear. For this purpose the motor is reversible but drives in a clockwise direction for the windlass and capstan gear.

A sprocket and chain is provided for emergency operation.

A Pressure Regulator (torque governor) is fitted to the pump control shaft. If the pressure in the system exceeds the setting of the regulating springs, the forged governor tends to center and reduce the stroke of the pump.

A Supply and a Return Pipe Line lead from the ship's hydraulic plant to the manifold connecting the hydraulic pump to the hydraulic motor and can be used to operate the windlass gear in case of an emergency.

A Clutch Operating Rod, with an indicator on the main deck, operates a clutch on the vertical windlass drive shaft to unclutch the windlass. The capstan head being driven direct by the vertical windlass drive shaft can be operated independent of the wildcat. By means of a combined locking and jacking bolt the capstan head is portable and can be stowed in the superstructure. The clutch rod is operated from deck by a socket wrench.

The Wildcat carries a snubber brake band which is operated by gears and a line of shafting to the main deck. The main deck end of the shafting is equipped for a socket wrench.

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Section U-6 WINDLASS & CAPSTAN

Reference Plans:

Ports. No.	BuShips No.	Title
1010-275	387278	Windlass & Capstan - General Arrgt.
1011-285	490625	Windlass & Capstan - Hydraulic Power Plant - Arrgt.
1012-285	490268	Windlass & Capstan - Hydraulic Power Plant - General Arrgt. of Piping
1013-275	387279	Windlass & Capstan - Hawse Pipe - Outboard Section
1014-275	387280	Windlass & Capstan - Hawse Pipe - Inboard Section
1015-275	387281	Windlass & Capstan - Wildcat Clutch - Bracket Details
1016-275	387282	Windlass & Capstan - Wildcat Frame Details
1017-275	387283	Windlass & Capstan - Wildcat & Spur Gear - Details
1018-285	SS285-S2000 67700	Windlass & Capstan - Greasing Arrgt
1019-275	387285	Windlass & Capstan - Chain Compressor - Arrgt. and Details
1020-275	387286	Windlass & Capstan - Chain Compressor - Frame Details
1022-275	387288	Windlass & Capstan - Band Brake Gear Case Details
1023-275	387289	Windlass & Capstan - Band Brake & Gear Details
1028-275	387290	Windlass & Capstan - Wildcat Clutch Details
1030-308	491045	Windlass & Capstan - Wildcat & Band Brake - Arrgt.
1031-308	491046	Windlass & Capstan - Capstan Gear Case - Arrangement
1032-308	491047	Windlass & Capstan - Capstan Gear Case - Details
1034-275	387295	Windlass & Capstan - Capstan Shaft & Gear Details
1035-308	491048	Windlass & Capstan - Capstan Head Details
1036-308	491049	Windlass & Capstan - Main Drive - Bevel Gear Case - Details
1037-308	491050	Windlass & Capstan - Main Drive - Bevel Gear Cases - Arrgt.
1039-308	491051	Windlass & Capstan - Main Drive - Bulkhead #16 - Gear Case Details
1040-308	491052	Windlass & Capstan - Anchor Chain ind. Gear Case Details
1043-308	491093	Windlass & Capstan - Chain Compressor - Gear Case Details
1045-275	387303	Windlass & Capstan - Chain Compressor - Deck Indicator Details
1047-275	387304	Windlass & Capstan - Anchor Chain Deck Indicator and Gear Details
1050-275	387306	Windlass & Capstan - Chain Slip - Arrangement
1051-275	387307	Windlass & Capstan - Chain Slip - Details
1055-285	490257	Windlass & Capstan - Hydraulic Power Plant - Planetary Gear Case - Details
1056-275	387309	Windlass & Capstan - Hydraulic Power Plant - Windlass & Bow Rigging - Clutch Details - Sheet #1
1057-285	490263	Windlass & Capstan - Windlass & Bow Rigging - Clutch Details - Sheet #2
1058-285	491134	Windlass & Capstan - Hydraulic Power Plant - Hand Gear Details
1060-275	387312	Windlass & Capstan - Hydraulic Power Plant - Planetary Gear Details
1061-285	490264	Windlass & Capstan - Hydraulic Power Plant - Planetary Gear Case Arrgt.
1062-275	387314	Windlass & Capstan - Hydraulic Power Plant - Clutch Shaft & Coupling Details
1063-275	387315	Windlass & Capstan - Hydraulic Power Plant - Pressure Regulator Arrgt.
1064-275	387316	Windlass & Capstan - Hydraulic Power Plant - Pressure Regulator - Details
1065-275	387317	Windlass & Capstan - Hydraulic Power Plant - Control Shaft Details
1069-275	387318	Windlass & Capstan - Hydraulic Power Plant - Main Manifold - Arrgt.
1070-275	387319	Windlass & Capstan - Hydraulic Power Plant - Main Manifold - Body Details
1072-275	387320	Windlass & Capstan - Hydraulic Power Plant-Control Valve - Arrgt. - Emergency
1073-275	387321	Windlass & Capstan - Hydraulic Power Plant - Control Valve Body Details - Emergency
1074-275	387322	Windlass & Capstan - Hydraulic Power Plant - Cont.Valve Cover Details - Emergency
1075-275	387323	Windlass & Capstan - Hydraulic Power Plant - Control Valve Shaft Details - Emergency
1076-275	387324	Windlass & Capstan - Hydraulic Power Plant -Flanges & Special Fittings - Details
1132-275	387325	Windlass & Capstan - Main Drive - Bevel Gear Details
1152-201	312639	Stern Capstan - Worm Gear - Arrgt. & Details
1153-201	312640	Stern Capstan - Worm Gear Case - Details
1154-201	312641	Stern Capstan - Head Shaft and Shaft Bearing Details
1167-228	386762	Stern Capstan - Control Switch Operating Mechanism - Arrgt.
1168-228	386763	Stern Capstan - Control Switch Operating Mechanism - Details

Section U-8

STEERING GEAR - GENERAL

See Section U-27, Hydraulic System.
See Plate 4 - Steering Gear.
See Plate 5 - Steering Gear in After Torpedo Room.
See Plate 5a - Steering Gear - Wiring Diagram.
See Engraved CRS Plates. Control Room, and After Torpedo Room (Ports. No. 911-381 - BuShips No. 490294).
See Shipboard Tests (SS228-235) Section S-22.

Steering of the ship can be done from two stations only.

C.T. and Control Room.

Steering from each station can be done by three methods:

POWER, HAND and EMERGENCY.

Steering gear control selective units are concentrated at the steering stand in the C.R., i.e.:

(1) Hand powered hydraulic pump (on steering wheel shaft).
(a) Pump Stroke lever (displacement adjustment).
(2) Change Valve - for POWER - HAND - EMERGENCY
(3) Emergency Steering control valve (for distribution of ships' hydraulic system power to steering gear).

Steering Gear power application units are concentrated in the ATR listed as follows:

(4) Main Ram Starboard, Main Ram Port.
(5) Steering Gear Main Manifold (for segregation of individual ram cylinder.
(6) Steering Gear Variable Displacement Hydraulic Pump (Motor driven continuous running).
(7) Steering Gear Control Cylinder (hydraulically responsive to hand pump, item 1.)

Torque is imposed on the rudder stock by means of hydraulic rams (two) mounted starboard and port in the A.T.R., frame 121. Each ram is double ended (Maximum travel 38° rudder 19°7) and connects by suitable rod and guide to a crosshead on the rudder stock (radius 2'-8").

Distribution of hydraulic pressure to main rams is through the main (steering) manifold (C/L frame 125). This manifold provides flexibility of application of main rams--parts of the system may be segregated and by-passed by manipulations of the proper valves on this manifold.

The main (steering) manifold takes hydraulic pressure from three sources:

Direct:--
(1) POWER - from Steering Gear, Hydraulic Pump - Motor Drive - Frame 123 ATR.

Via Change Valve in CR:--
(2) HAND - from Hydraulic Pump at Steering Stand CR.
(3) EMERGENCY - from a Supply Valve on Ship's Main Hydraulic Manifold.

The Change Valve in the steering stand in the CR is the selective switching unit by which each form of power may be applied to the main (steering) manifold as desired.

The Steering Gear Change Valve (889) in principle is a double shunt and blank across the steering stand hydraulic pump output. It is bolted to the control pump body (CR). It is a 3-position hand-wheel operated, 3 throw, 6 port, piston valve (travelling nut type).

On POWER the piston valve is at top stroke. The ports connect the steering stand hydraulic pump across the control cylinder unit. The ram ports are sealed.

Note: There is a cross connection and by-pass valve on the ends of the control cylinder, at the unit, but these are used for filling and venting only.

ON HAND the ports connect the control pump across the main manifolds (Ref.905) thence to the main rams. On this setting (bottom stroke) the piston valve short circuits the control cylinders.

ON EMERGENCY the pump is blanked, and the control cylinders are shorted. (Ref. 905). In this position the change valve itself is shorted out and the hydraulic system is connected across the main (ram) manifold through the EMERGENCY steering control valve. The operator (CR) should shut down the steering gear hydraulic pump motor for EMERGENCY. The change valve is operated from the CR only.

Instructions for Operation:

Consult the engraved plates in the control room and ATR.
Consult the Lubrication Chart of the ship for greasing instructions.
Consult ship plans (especially Ref. 911 and 854).

Relief valves are placed in both sides of the main manifold, set at 1200 p.s.i.

There is also one in the pump casing, set at 48 pounds per square inch.

Extracts from Ship's Rudder Calculations

	Ahead, 20 Knots				Astern	10 Knots
	5°	10°	15°	35°	10°	35°
Pressure, lbs.	(-)40000	(-) 50000	-	140000	30000	45000
C.P. from axis	(-) 5"	(-) 2"	0	13"	60"	45"
Torque, units (relative)	10"	(-)* 8"	0	110	100	150
32" Tiller, Stress, Lbs.	--	--		22000	22000	40000

* 100,000 inch pounds.

The Rudder is never in balance in backing, is in perfect hydrodynamic equilibrium at 13°, going ahead 20 K. and has negative torque, going ahead, from 0 to 13° approximately. Conditions of torque varies within limit of these extremes depending on angle and speed. Ahead with 15° rudder is minimum stress on the rudder and steering. Backing at 11 knots puts more strain on the steering gear than 20 knots ahead.

The connection imposes the extreme degree of strain on the steering mechanism when at full speed astern. RIGHT RUDDER, Full is immediately followed by LEFT RUDDER, Full. The steering ram absorbs the reverse pressure hydraulically, but the gear is subjected to its extreme mechanical stress. The shattering effect of these strains is absorbed by relief valves.

POWER Steering.

The Steering Gear Power Unit in the after torpedo room is continuous electromotor drive, intermittent hydraulic action, with self-neutralizing, spring loaded, Control cylinder and tilting box.

The Tilting Box of the motor driven variable stroke hydraulic pump (ATR) is the critical and governing element as to RIGHT and LEFT and rate of rudder throw. With tilting box at 90°, swash plate stroke is zero, action zero. Power varies with the size of the angle.

RUDDER AMIDSHIP, as a position point in the steering mechanism description has no particular importance mechanically identified. For purposes of description the only fixed point of rudder throw is "neutral", - any angle of the rudder, at which the tilting box is in neutral and the rudder is steadied.

General Description of Operation:

HAND

"HAND from the Control Room" contains the elementals of the system. In principle, the steering wheel in HAND is a hydraulic jack applied to the rudder crosshead. One turn of the wheel gives (tilting box on 1/4 stroke) 5 cu. in. of hydraulic

displacement. The stroke adjusting screw will regulate this to suit the working capacity of the individual helmsman. The change valve (fr. 48) switches the jecking effect to proper pipe lines to reach the rams (ATR) via the steering manifold (fr. 124). This manifold selects and distributes delivery to the rams. The rams apply power to the rudder crosshead. The hardover stops on the stern casting limit travel to 38° R. or L. There is no follow-up. The helmsman provides the only control. In HAND steering the motor drive of the power pump (fr. 120) must be cut out by the steersman (sw. in CR). At normal surface speed and hand steering, from 25° R. to 25° L. is 78.5 turns of the handwheel, elapsed time 120 seconds.

Statistics, calculated, HAND:-

Ram (Diameter 6-1/2"D.) displacement per inch - - - - - -	33.183 cu. in.
Stroke, 35° R. to 35° L. -	36.67 in.
Stroke, 25° R. to 25° L. -	27.00
Displacement 35° R. to 35° L.- - - - - - - - - - - - - - - - - - - -	2410 cu. in.
Displacement 25°R. to 25° L. -	1775 cu. in.
Displacement, pump, per turn -	22.6 cu. in.
Displacement, rates of Ram to Pump - - - - - - - - - - - - - - - - -	78.5
Efficiency - percent -	85
Turns of wheel, 25° R. to 25° L. - - - - - - - - - - - - - - - - - -	95
Turns of wheel, rate, to meet Specified time of 120 seconds - 25° R. to 25° L.- -	47 R.P.M.

EMERGENCY

EMERGENCY steering is the application of the ships hydraulic system to the steering gear rams. From the control room station: the change valve, being set on EMERGENCY, blanks (fr. 48) off POWER and HAND lines. The emergency steering control valve, operated by emergency steering handwheel (CR), (fr. 48) distributes the ships hydraulic power to the respective rams, via the Main Manifold (fr. 124). There is no follow-up gear. The only stops are the hard-over stops. The only protection is the hydraulic system and steering system relief valves.

POWER

In Power Steering the handwheel operated control pump (CR) (fr. 48) is set by the helmsman to POWER (1/4 stroke). It is then applied as hydraulic remote control over an identical unit in the ATR (fr. 124) which acts as a motor driven, continuous running, variable displacement, hydraulic pump, applying power direct to the rams. Distribution of the pump's output is through the steering gear main manifold (fr. 124). All other lines are segregated.

Control Transmission System - For power operation the sequence of effect is as follows: The helmsman turns the steering wheel one turn; this gives one revolution and one complete set of strokes to a variable stroke hydraulic pump in the steering stand (fr. 48); direction of flow is positively consistent with direction of wheel rotation; oil flow, in closed circuit with the control cylinder (fr. 124), displaces its plunger; the plunger carries the lever which governs the tilting box of the motor driven hydraulic pump oil flow displaces main rams; main rams effect angular displacement of tiller.

The Steering Gear, when using POWER will swing the rudder between the limit stops in 20 seconds with the ship going ahead 20 K, and through the same range, in no specified time, with the ship going astern at 11 knots.

The Steering Gear Hydraulic System piping valves and mechanism being cross-connected with Ship's Main Hydraulic System - it is essential that the operator thoroughly understands the inter-relationship of the two. This will prevent excessive leakage through an idle steering gear pump when steering by HAND, or by EMERGENCY, also excessive pressure in the casing of the idle pump (relief valve).

An itemized account of action follows:

This is for power steering, the rudder being at any angle and steady.

<u>Action,</u> in sequence, right rudder.

The helmsman moves the wheel to right. This spins the swash plate of the hydraulic control pump.

The swash plate action raises a pressure differential and the control cylinder plunger moves forward.

The Steering Gear Hydraulic Pump tilting box spindle moves up.

The Tilting-Box moves down, each piston takes up its stroke, and drives pressure on the after end of the starboard main ram, forward side of port main ram.

The Ram pulls the connecting rod, crosshead, and rudder.

Reaction: When the helmsman (1) releases or reverses hand pressure on the wheel, (2) the centering spring takes charge, (3) the control plunger moves to mid position, (4) the tilting box comes to neutral, (90°), (5) oil flow to rams ceases, and (6) rudder steadies.

Operation Procedure --

AIR - The hydraulics of the Steering Gear will function according to design only if the system is free of air. Air in the oil produces creeping, imprecise, abnormal operation. The working side of the hydraulic cycle must be a solid column of incompressible fluid, i.e. pure mineral oil free from air, in suspension or in pockets. No action of the system or of any unit is of value as a criterion of performance unless this condition is fulfilled.

AIR IN SUSPENSION is a defect which must be eliminated by an independent operation viz.: recirculation through the Supply Tank under no pressure, vents closed - described later.

AIR IN POCKETS, at high points (lines or units), is a defect which must be relieved by an independent process, viz: venting under pressure. A vent valve if improperly used is a source of air suction. Open a vent only when that vent is under pressure. In venting air pockets, the operator should open each vent, as necessary, to give progressive results. A portable drip can of ample size to permit liberal overflow at a vent is requisite.

STEERING STATIONS, PROCEDURE FOR SHIFTING
(Ref. 871)

In proper sequence, viz: POWER to HAND to EMERGENCY

- Part -		Power CT	Power CR	Hand CT	Hand CR	Emergy CT	Emergy CR
(1) WHEEL, Steering, Conning Tower.	IN	X		X		X	
	OUT		X		X		
(2) WHEEL, Steering, Control Room							
(a) CLUTCH, Locking Pin	IN		X		X		
	OUT	X		X		X	X
(b) ARM, Locking	LOCKED	X		X		X	X
	UNLOCKED		X		X		
(c) HANDLE, Spinner	FOLDED	X		X		X	X
	OUT		X		X		
(3) STEERING STAND CR.							
(a) Change Valve	POWER	X	X				
	HAND			X	X		
	EMERGY					X	X
(b) PUMP							
(1) LEVER, Tilting Box	HAND			X	X		
	POWER	X	X				
(2) STROKE, Locking Wheel	HAND (adj.)			X	X		
	(½) POWER (adj.)	X	X				
(c) CLUTCH, Lever, (CT Drive Shaft)							
(1) Butterfly	LOCKED UP	X		X			X
	LOCKED DOWN		X		X	X	
(2) Bolt, Locking	UP LOCKED	X		X			
	UP UNLOCKED						X
	DOWN LOCKED		X		X		
	DOWN UNLOCKED						
(4) MOTOR SWITCH, Power							
(a) Control Room Station	START	X	X				
	STOP			X	X	X	X
(b) ATR Station.	START						
	STOP	←Local Standby→					
(c) Indicator Light C.R.	ON	X	X				
	OFF			X	X	X	X

U.S. Navy Yard, Portsmouth, N.H. 1943.

FILLING AND AIR ELIMINATION by Recirculation (Ref. 911-381)

Parts of the piping system to which recirculation applies are:

(1) Pipe Lines (control) between Change Valve (A), (on steering stand CR), and control cylinder at Power Plant (ATR) including the By-pass manifold.

The circuit is as follows: Suction is taken from supply tank through vent and replenishing line, through by-pass manifold (F) to pump. Delivery is through control line, aft; through by-pass valve K forward; through by-pass manifold Valve F; to supply tank. The air is thus driven into the supply tank and the line filled with solid oil. The operator must turn the steering wheel (CR) as for right rudder at 60 R.P.M. for about one hour.

(2) Pipe Lines, HAND and EMERGENCY, between change valve (CR) (A) and main manifold (steering) ATR.

The circuit is from valve (C) (CR) to EMERGENCY control valve (B) to HAND and EMERGENCY lines and aft through (G) back to (B) and to (D) and thence to supply tank. The Ship's Hydraulic System is used for pressure.

FILLING AND/OR VENTING - Procedure for Pipe Lines,
Position of Valves (Ref. 91)

Location	Location of Instruction CR	Location of Instruction ATR	Service	Valve Positions for Pipe Lines (1) Control	Valve Positions for Pipe Lines (2) Hand & Emergency
Steering Stand	A		Change Valve	HOLD	EMERGENCY
	B		Control Valve, Emerg.	NEUTRAL	R. Rudder full
Ship's Hyd.	C		Emerg. Steering Supply		Open
Manifold	D		Emerg. Steering Return		Open
By-Pass	E		Stop across "Rudder Right"	Closed	
Manifold	F		Shunt from "Rudder Right" to Tank	Open	
	F		Shunt from "Rudder Left" to Tank	Open	
			Steer. Wheel, Right, spin at 60 rpm, 1 hr.		
Main Manifold (Steering)		A	Ram cut-out stb. Fore	Open	
		B	Ram cut-out stb. Aft	Open	
		C	Ram cut-out port Fore	"	
		D	Ram cut-out port Aft	"	
		E	H.&E. cut-out, Rudder right	"	
		F	H.&E. cut-out, Rudder left	"	
		G	By-Pass	"	Open
		H	Relief, Rudder Right		
		J	Relief, Rudder Left		
Control Cylinder		K		Open	
Oil Vent and Surge Tank		L	Cut-out, Replenishing Line	Open	Open
			Ship's Hydraulic System		On

Operation Notes:

(1) LUBRICATION - comply with requirements of lubrication chart - Ports. Plan 1523-275.

(2) Air in the system gives roughness and unreliability of operation. Vent the system as required and at all points.

(3) PACKING, Hydraulic Rams, see description and reference plan. A pressure of 1200 p.s.i. seals this stuffing box, therefore, the gland need be set only HAND taut. This packing is designed to be set up only enough to insure that all packing rings bear on the adjacent rings and that the packing bears on the bottom of the stuffing box and on the stuffing box gland. Compression of this type of packing will distort it, will cause leakage, and will increase the effort required from the helmsman to steer the vessel. When the packing leaks it should be renewed.

(4) The RAM PLUNGERS, when secured over a period of days, should be slushed with rust inhibitor.

(5) Stuffing Boxes on the vertical steering shafts should be lubricated weekly.

(6) Cut-Out Valves in the vent and replenishing lines should be kept open at all times.

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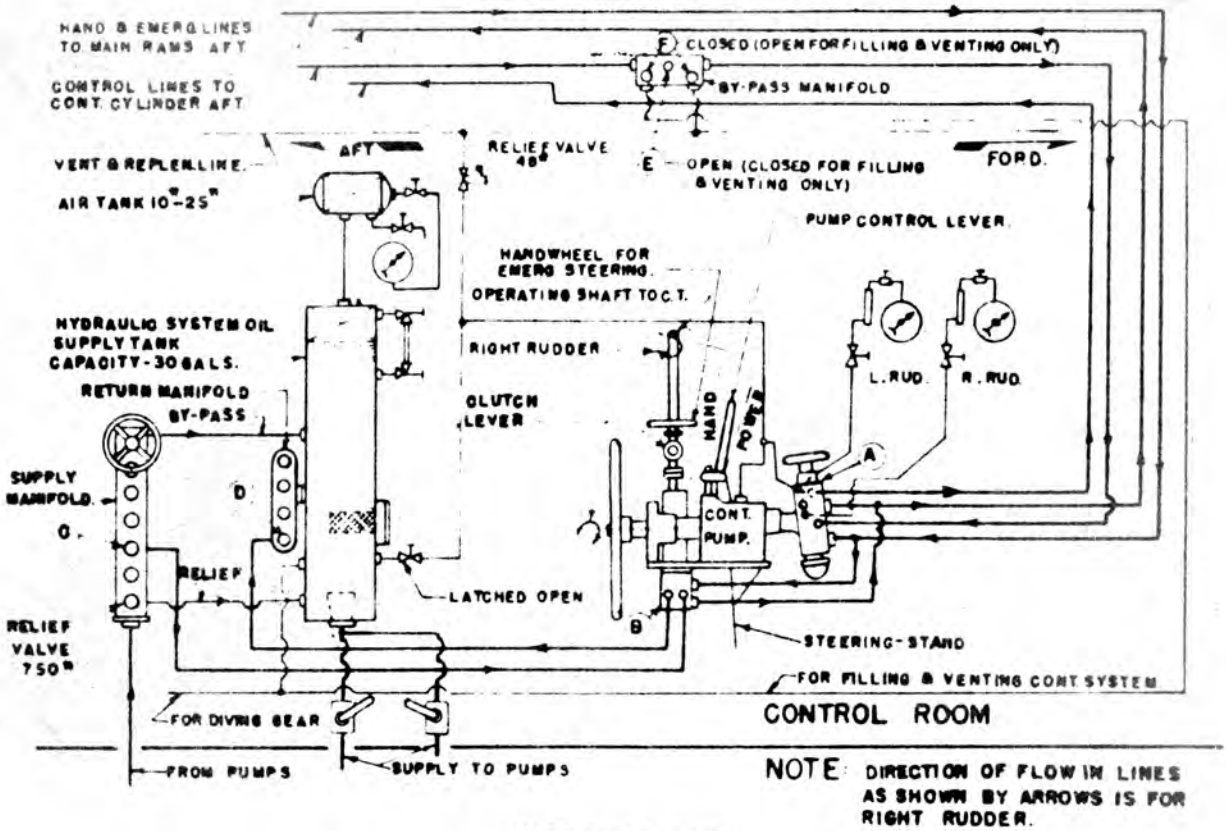
STEERING GEAR



NOTE: DIRECTION OF FLOW IN LINES AS SHOWN BY ARROWS IS FOR RIGHT RUDDER.

INSTRUCTIONS

-VENTING-

VENT ALL HIGH SPOTS IN LINES, VALVES, MANIFOLDS, CONTROL CYLINDER, AND MAIN RAMS AFT, TO PREVENT SUCKING AIR, NEVER VENT PRESSURE LINES OR GEAR WITHOUT PRESSURE ON LINES.

- POWER STEERING-

1 - SHIFT CHANGE VALVE A TO POWER POSITION.
2 - SET PUMP CONTROL LEVER TO POWER POSITION.
3 - TO STEER FROM CONTROL ROOM, THROW CLUTCH UP.
4 - TO STEER FROM CONNING TOWER THROW CLUTCH DOWN.

-HAND STEERING-

1 - SHIFT CHANGE VALVE A TO HAND POSITION.
2 - TO INCREASE STROKE OF PUMP, SHIFT PUMP CONTROL LEVER TO HAND POSITION.
3 - TO STEER FROM CONTROL ROOM, THROW CLUTCH UP.
4 - TO STEER FROM CONNING TOWER, THROW CLUTCH DOWN.

-EMERGENCY STEERING-

POWER SUPPLIED FROM SHIPS HYDRAULIC SYSTEM.

1 - SHIFT CHANGE VALVE A TO EMERGENCY POSITION.
2 - UNLOCK EMERGENCY CONTROL VALVE SHAFT.
3 - TO STEER FROM CONTROL ROOM, THROW CLUTCH DOWN.
4 - TO STEER FROM CONNING TOWER, THROW CLUTCH UP.

CAUTION

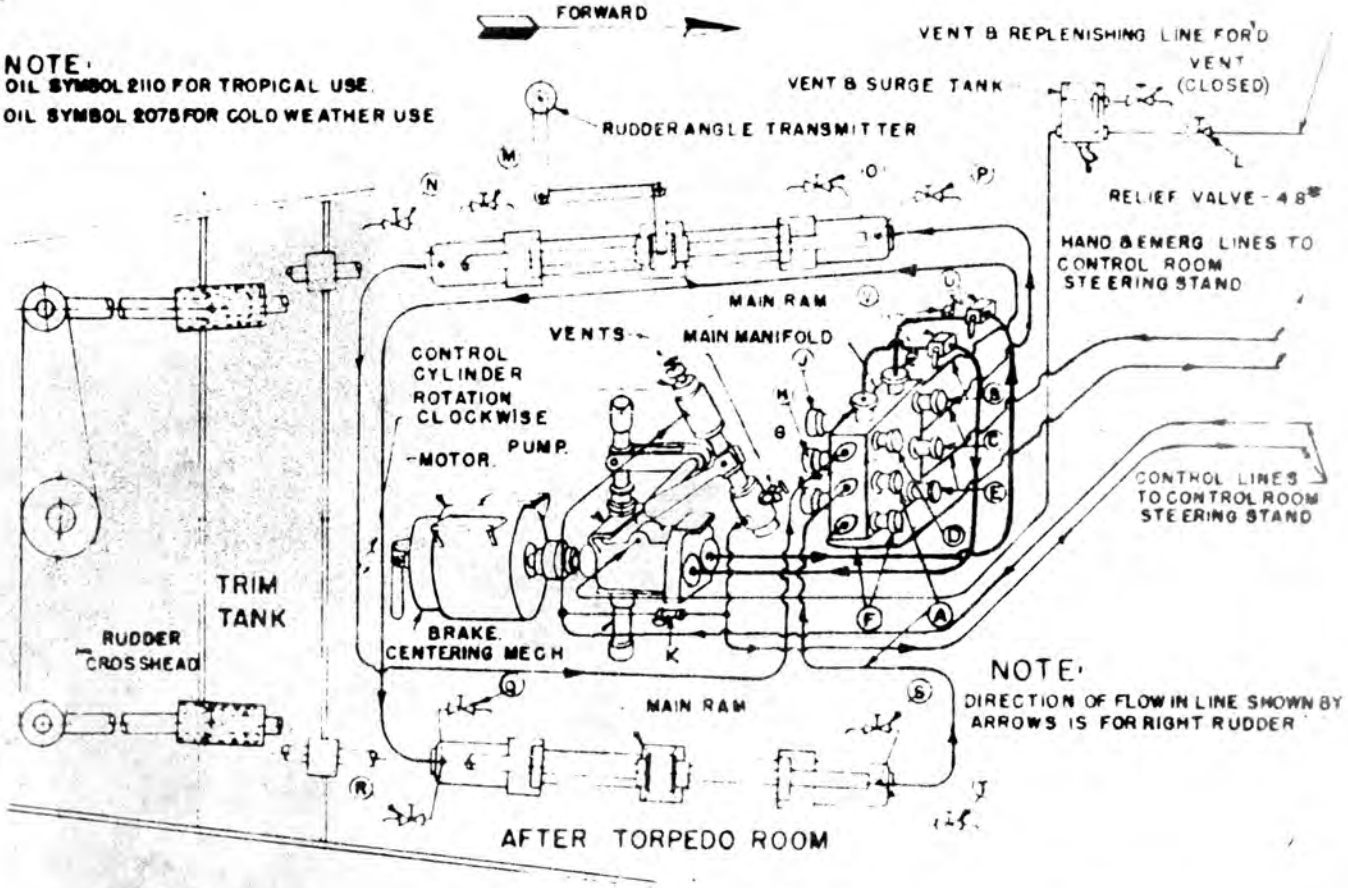
VALVE SETTINGS MUST BE IN ACCORDANCE WITH TABLE FOR METHOD OF OPERATION DESIRED.

-VALVES-

LOCATION	MARK	SERVICE	POSITION OF VALVES WHEN OPERATING BY: POWER	HAND	EMERG. GEAR
PUMP	A	CHANGE VALVE FOR POWER & HAND.	OPEN TO CONTROL LINES	OPEN TO MAIN RAMS AFT	EMERGENCY
STEERING STAND	B	CONTROL VALVE FOR EMERG. STEER BY SHIPS HYD SYS.	SECURED IN NEUTRAL	SECURED IN NEUTRAL	LEFT-NEUT-RT.
SHIPS HYD.	C	EMERG. STEERING SUPPLY CUT-OUT	OPEN	OPEN	OPEN
MAIN RAM	D	EMERG. STEERING RETURN CUT-OUT	OPEN	OPEN	OPEN
BY-PASS MAN.	E	FOR VENTING & FILLING (ONLY)	OPEN	OPEN	OPEN
CONT. LINES	F	FOR VENTING & FILLING (ONLY)	CLOSED	CLOSED	CLOSED

STEER GEAR-HYD. SYSTEM U-8

STEERING GEAR



CAUTION:

VALVE SETTINGS MUST BE IN ACCORDANCE WITH TABLES & INSTRUCTIONS 1 & 2 BELOW. VALVE K LOCKED CLOSED, OPEN FOR FILLING & VENTING ONLY. VALVES U & V LOCKED OPEN, CLOSE FOR REPAIRS TO LINES FROM PUMP TO PUMP MANIFOLD ONLY.

- VALVES -

ALL VALVE SETTINGS ARE THE SAME FOR POWER, HAND & EMERGENCY STEERING

LOCATION	MARK	SERVICE	POSITION NORM. OPER.
PUMP MANIFOLD	A	FORD. ST'BD. RAM CUT-OUT.	OPEN
	B	AFTER ST'BD. RAM CUT-OUT.	OPEN
	C	FORD. PORT RAM CUT-OUT	OPEN
	D	AFTER PORT RAM CUT-OUT	OPEN
	E	H. & E. R RUDDER CUT-OUT	OPEN
	F	H. & E. L. RUDDER CUT-OUT.	OPEN
	G	BY-PASS.	CLOSED
	H	RELIEF R. RUDDER 1200#	SPRING LOAD
	J	RELIEF L. RUDDER 1200#	SPRING LOAD
CONT. LINES	K	FOR FILLING LINES (ONLY).	CLOSED
NEAR VENT TK.	L	VENT & REPLEN. LINE CUT-OUT.	OPEN

LOCATION	MARK	SERVICE	POSITION NORM. OPER.
AFTER PORT RAM	M	DRAIN.	CLOSED
	N	VENT	CLOSED
FORD. PORT RAM	O	DRAIN	CLOSED
	P	VENT	CLOSED
AFTER ST'B'D. RAM	Q	DRAIN.	CLOSED
	R	VENT	CLOSED
FORD ST'B'D RAM	S	DRAIN	CLOSED
	T	VENT	CLOSED
PUMP MANIFOLD	U	PUMP CUT-OUT-R. RUDDER.	OPEN
	V	PUMP CUT-OUT-L RUDDER	OPEN

1.- STEERING BY PORT RAM ONLY:
CLOSE PUMP MANIFOLD VALVES A & B AND OPEN DRAIN VALVES Q & S.

2.- STEERING BY ST'B'D. RAM ONLY:
CLOSE PUMP MANIFOLD VALVES C & D AND OPEN DRAIN VALVES M & O

SS425-434
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1 3/4

Steering Gear, Details of Various Units

The 15 H.P. Motor (ATR) is the prime mover to the electro-hydraulic steering gear. Rating follows: Volts 250, Amps. 56, RPM 440, disc type brake mechanically set, electrically released with a brake release handle for manual control. Grease cups, two, overload, automatic reset, cuts at 200 per cent load. (Ref.1704).

A Flexible Coupling keys to the speed reducer out-put shaft. (This consists of one fixed half on reducer shaft, one fixed half on pump shaft and a center piece (2-1/16" D. with 1/32" end play) with 1/16" accommodation. The coupling is felt packed, grease fitted. (Ref. 775))

The Steering Gear Hydraulic lower comes from a variable displacement reversible action, tilting-box, gimbal-mounted rotary swashplate, nine cylinder, reciprocating pump, the A-end of a variable speed gear. Its shaft keys to the out-put side of the speed reducer flexible coupling. This pump has 440 rpm, max. working pressure, 1200 lbs. relief valve pressure. The full travel of the control shaft is 1".17, only part of which is used. The pump tolerances run to 0.0002", and if out of repair should be replaced by the spare. Extensive overhaul is a shop job. Operation is as follows:

The Steering Gear Pump Control Shaft rocks a tilting-box on which are carried 50 thrust rollers and 45 radial rollers. By means of the trunnion block mounted on the main shaft pin, the socket ring is given a gimbal bearing on the shaft. This flexible drive enables the socket ring to spin against the tilting-box thrust in an inclined plane, the angle of which can be varied by the control shaft. Nine connecting rods transmit the reciprocating swashplate motion to nine pistons in the cylinder block. Ports in the cylinder barrel and in valve plate respectively produce the hydraulic action. (Ref. 1570)

The Steering Gear Main Manifold stands overhead on ships C/L frame 120, A.T.R. It is flanged to the valve plate of the steering gear main hydraulic pump. It has 9 valves - 1 by-pass, 2 reliefs (right and left rudder), 2 hand cut-outs, and 4 ram cut-outs. Bonnet and locking cap wrenches are provided with stowage adjacent to valve body. (Ref. 905)

The Main Steering Manifold serves the following purposes:

(1) By-pass valve, cross connects pressure and return sides of hydraulic power pump and the rams.

(2) By-pass valve (1), cross connects pressure and return of HAND steering pump.

(3) Relief Valves (2), (Spring Loaded) 1200 lbs. protect against excessive pressures.

(4) Hand Cut-outs (2) segregate rams and steering gear change valve.

(5) Power Cut-outs (4) segregate starboard and port rams (respectively) from system.

(6) Needle valve vents (2) are fitted in high point for bleeding air out of the system.

Ram Pressure Lines leading from the steering gear manifold are 1" copper and tested to 1800 lbs. Hand and emergency power lines leading to control room are similar. Vent and drain lines are 1/2" copper. All lines are as straight as possible. All high points in lines are fitted with vent valves. Where vent valves are installed, pipes are raised to form distinct air traps. All vent and replenishing lines are pitched to provide easy air escape. All vent valves are fitted with drain lines.

The oil used in steering gear and hydraulic system is light lube oil, Navy Symbol 2110, see Hydraulic System.

The Vent and Surge Tank, setting above T.R. deck at frame 119, is connected, without valve, to the pump housing. This is a closed steel tank, 200 p.s.i. (working) (5-1/8" I.D. by 10" ht.) fitted with a 1/2" gauge glass, max. oil level under normal pressure is 5" from C/L of gauge glass valve. The relief valve is set for 48 lbs. It is tapped for a vent outlet connection on side at the oil level. It has a 1/2" pipe plug on the bottom, center. The bottom edge is drilled and tapped for the following connections:

Steering Gear Pump Casing Vent.
Relief Valve.
Main Vent and Replenishing line forward.
Main Vent and Replenishing line aft.

The Vent and Surge Tank is a make-up feed reservoir and air cushion on the RETURN side of the main hydraulic system. The vent and surge tank also provides cushioning against excessive surge and pressure, in pump casing and vent lines.

The following notes give details of various bearings and joints on steering gear. Description starts aft and follows forward.

Steering Gear Cross Head Yoke Arm Bearing - First contact between rudder and power application. The maximum torque applied is 1,900,000 inch-pounds (backing 10K, 35° rudder). Oscillation is +38°-38° (Max.). On a 32" radius (C. to C.) from rudder stock, the tiller arm carries a (10" x 3.37" Dia.) CRS-1 pin. This pin makes a running fit in a (4" x 3.385") grease grooved bearing-metal bushing carried by forced fit in the connecting link. The pin is drilled with special grease-pocketing holes supplied from grease line. These parts are exposed to sea water.

Steering Gear Connecting Rod Guide Bearing (oscillating joint, 10° max.) - The rod carries, similar to above, a (4" x 3.885") bearing-metal bushing, force fit. The guide piston carries a solid pin (8-13/16" x 3.375) push fit, and floating. This pin is drilled 3/8" axially and diametrically and slotted on the ends for grease supply. The piston in wake of pin is ringed and recessed 1/16" deep to supply grease to the slots and axial hole of the pin. This bearing can be gunned only when the guide piston is in midship position. The line is shown on greasing diagrams. Grease comes from annular space between piston and guide-cylinder liner. These parts are exposed to sea water.

Steering Gear Guide Cylinder absorbs the thwartship component of the steering gear connecting rod thrust. It is steel case (5'-4"l. x 8-7/8"I.D.), bronze liner, Piston travel 19.7", plus and minus. The gear end extends 2'-3" abaft sea side of bulkhead 130. See lube chart for greasing conn. (Ref. 853)

The Guide Cylinder Head is bronze and bolted to cylinder, cupped to accept the

(4-1/2" x 6.0" Dia.) piston boss, carries a (4-1/2" x 3.39" I.D.), bronze bushing for the steering gear connecting rod. It also carries a 2-1/2" I.D neck and flange for the equalizing pipe which cross connects starboard and port guide cylinders. These parts are exposed to sea water.

The Steering Gear Guide Piston - A hollow bronze piston (17-1/2" x 8.860" D.) bearing length 13". It carries the (8-13/16" x 3.37") connecting link bearing pin and is ringed and recessed 1/16" for grease in way of bearing pin boss. The head is a 6" D. boss drilled to fit the (6-3/4" long x 3-1/2" O.D.) threaded male end of the connecting rod. This piston head is drilled axially with four (4) 5/8" drain holes to relieve sea water behind the piston. The piston travel is +19.7" and -19.7" for 38°. Grease line serving piston walls and piston pin is shown on greasing diagram. Exposed to sea water.

Steering Gear Connecting Rod - It is a nickel-copper alloy rod, (21'-6-3/8" x 3"O.D.). It carries the guide piston and the ram. The travel is -19.7". This rod from frame 126 to frame 128 is sheathed in a copper pipe, tinned inside and out. This pipe must not come in contact with any steel work on the ship. This pipe is grease-packed. It is exposed to sea pressure inside. At frame 126 there is flanged to this pipe a (2'-4-1/8" x 3.90" I.D.) bronze sliding sleeve. This piece has a sliding fit with the connecting rod inside, and sliding fit outside with the steel forged and weld-mounted bulkhead bearing, bulkhead 125. At this point there are two stuffing boxes. One between sleeve and rod, consists of a bronze grease retaining ring, one turn of square leather, two of cupped leather, and another of square leather, a follower ring and gland. This seals the boat from sea pressure which follows surface of the connecting rod to this point. The gland is threaded. The stuffing box between sleeve and bearing consists of 6 turns of square flax, and a gland, set up with 6 studs. This joint relieves ship strains on the connecting rod, and the gland seals the grease pocket. It has its own grease fitting equipped with a globe valve. (Ref. 813).

Connecting Rod Bearing in the Ram Cylinder Housing - This bearing is a composition H sleeve pressed into the cylinder housing, grooved and greased. Location at frames 120 and 123. (Ref. 850)

The Connecting Rod and Hydraulic Plunger connection is solid, but adjustable by means of a steel spannered sleeve nut and a retainer nut. This joint is made up to suit relative location of guide piston. Location, frame 121. (Ref. 850)

The Hydraulic Plunger is a solid double-ended steel billet 10' long x 6.5" D.) (ground) with an integral circular yoke on center (5" thick and 9" high) and drilled to take the connecting rod. This centers on frame 122. (Ref. 851).

The Ram consists of two cylindersand two housings assembled on a cylinder foundation with two tie rods. There is also the plunger, stuffing boxes, connecting rod, and piping. There is a "Right" and "Left" bronze graduated 5° to 35° sliding rudder angle indicator, with pointer, attached to the forward end of the port ram cylinder. (Ref. 851)

The Main Ram Cylinder Housing (there are two for each ram) is a heavy cast steel cylinder (16.75" x 8.875" I.D.) webbed for eight (1-1/4") body bound, holding down bolts, flanged fit to 1-3/4" tie rods, and superimposed by a boss (10-1/2" x 4.130" I.D.) for a connecting rod sleeve bearing. It is these castings that hold the rams to the ships hull. (Ref. 851)

The Main Ram Cylinder is a special steel case (4' - 5-1/2" long x 7.75" I.D.). The O.D. is a press fit into the cylinder housing. The I.D. is a press fit with the plunger bushing.. This bushing is of composition H, which is a sliding fit with the plunger. The bushing is held in the cylinder by threaded and spannered steel retainer ring. Next to this retainer ring is the plunger stuffing box. (Ref. 851)

The Main Ram Plunger Stuffing Box, (Ref. 951), from bottom to top, is assembled as follows: Square leather ring, leather ring cupped against pressure, square leather bronze grease retainer ring, leather ring cupped against gland, square leather, follower ring, and a threaded and spannered gland, bronze. This gland is screwed into the gland retainer (steel). This retainer is webbed for eight (5/8") studs which set into the cylinder end. The whole set of packing is locked by a steel locked pin which goes under one stud and fits into a spanner hole of the gland ring. This packing is commercial processed, self-adjusting. Abnormal leakage calls for renewal. There is one set for each end of the rams. Maximum working pressure 1200 lbs. As this pressure seats the packing, the gland is set hand taut only.

The Steering Gear Control Cylinder is a simple double ended, hydraulic ram (1-1/2" D.) of built-up, tie rod and bracket construction. This unit is located at the steering gear hydraulic pump (A.T.R.) and has the function of precision control over the steering gear hydraulic pump. (Ref. 856)

The Steering Gear Pump Control Shaft Centering Spring is mounted on the pump housing. Its function is to mechanically reset the tilting box spindle on neutral when hydraulic force is not acting, i.e., when the helmsman releases hand torque on the wheel. The centering spring unit works on the accordion principle. In neutral, the steel spring (1/4" D. x 1-5/8" O.D. x 9-3/8" assembled) is under 300# compression between seats in the centering spring housing. Travel of the control cylinder plunger butts the spring against its seats. If plunger is held off center by hydraulic pressure from helmsman's station, the spring cannot act. If helmsman releases wheel, spring neutralizes pump control shaft. (Ref. 863). Notes as to adjustments - (Reference (Ports. Plan MS-9641 and MS-9595.)

The Steering Gear Control Cylinder (two) Casting is grade M steel (7-3/8" OA x 1.5 effective diameter) Spanner gland, hydraulic packed (with grease ring) (Ref. 948-275), bushed, capped (copper gasket) and bracketed with tie rods. It is tapped for 1/4" steel pipe plug, 1/4" vent valve and a 3/4" pressure line. (Ref. 858).

Special notes for specific parts -
Max. Travel - each side of neutral:

Plunger of control cylinder (horizontal)	1.053"
Shaft, pump control, (vertical) 75% stroke	.8775"
Limit Stop, control pump (vertical)	.5665"
Centering Spring Pull Rods	1.053"

The Steering Gear Control Cylinder Plunger is a solid steel, double ended, (1.7498 D. x 7-7/8" L.) slotted center yoke, precision ground, billet. The yoke carries a steel grease-grooved sliding block (1.7499 x 1-3/4" x 1.375" thick). The sliding block engages the lever arm (9" b.c.). (Ref. 857)

The Steering Gear Control Cylinder Plunger Lever Arm (vertical) keys to its shaft (1-3/8" D. x 14-7/8"). This shaft is keyed, bushed and borne for the purpose of transmitting the control plunger action to the steering gear pump control shaft.

The Control Cylinder Plunger Lever Arm Shaft (vertical carries a lever arm, horizontal (7.5 b.c. x 2" wide). The lever arm carries a boss (.7999) on this shank (limit stop) and a slotted, roller-flexed, connection on the end which takes the steering gear pump control shaft extension (2-3/16" O.D. x 5-1/2" L.), the trunnion collar (2.1875 effective dia. x 5" O.A. effective length). (Ref. 862)

The Steering Gear Pump Control Shaft Extension has a travel of .8775" (vertical) on each side of neutral for 75% stroke. This piece controls an important adjustment. (Ref. 856). In assembling, care must be taken that control cylinder and pump are in proper alignment. With pump in neutral position adjust pump control shaft extension to suit lever arm when same is in neutral position. Adjustment on the horizontal can be accomplished by slacking off the lock nut on the trunnion and rotating the trunnion.

The Steering Control Pump is an A-end of a variable speed gear identical with that installed in the after torpedo room. The main drive of this pump is keyed to a drive gear in the steering stand gear casing. This drive gear gets its power from a gear (1 to 1 ratio) on the steering wheel shafts (CR) frame 48. The change valve is bolted to the delivery end of the control pump. This pump on POWER is connected directly across the two ends of the control cylinder plunger. ON HAND, it connects directly across the two ends of the main rams. On EMERGENCY. it is blanked off. This disposition is made by the change valve. (Ref. 881)

The Steering Control Pump Stroke Lever has two settings, marked by an engraved plate POWER, HAND - mounted on a bracket on the top of the pump; it rocks on a fulcrum pin, and throws the control shaft pin. Control of the pump stroke is positive and adjustable. Measuring from top of spindle to CL of pump, the neutral position is 9-1/2", 1/4" stroke is 9.2075". Min. stroke used is 0.295", max. - .8775". (Ref.887)

The Steering Stand (CR) Gear Case carries or attaches to the following assemblies: (Ref. 871)

Name	Function	Approx. Size
1. Horizontal miter gear	CT drive	5" PD
2. Vertical miter gear	Steering wheel	5" PD
3. Vertical gear	Pump drive	5" PD
4. Gear Case cover	Shaft bearing	5" PD
5. Control valve	Emerg. Strg.	7" x 7"
6. Foundation	Deck support	8 x 7

Miter Gears are ball bearing. The CR Steering Wheel is clutched to the shaft and held IN or OUT by a locking pin. A (3/8") square felt ring under a cover plate seals this shaft against oil leakage. Lube Oil - Navy Symbol 2110, Keep Level at 5-1/4".

The Emergency Steering Control Valve Locking Arm assembles on the clutch lever bracket. The Locking Gear engages the square face of the control valve shaft and freezes the emergency steering control valve in neutral for POWER or HAND. For a full throw of the rudder this locking face revolves about 160°. It stands athwartships for neutral. NEUTRAL is marked on the bracket with a matching pointer on after side of the control valve shaft.

The Emergency Steering Control valve shaft and 1 to 1 bronze gears (6" D.) are mounted on the gear-case-cover bracket and keyed to driven gear. The driving gear on upper side is heavily (6-5/32") bossed, and on the under side is cut to suit sliding member of the jaw clutch, 13/16" lift. The hub, the inside (1.378") makes a running fit with the CT drive shaft; the outside (2.125") makes a running fit on the bracket. Riding on the top of the bracket is the Emergency Steering Hand Wheel, (14" D.), inscribed "Right Rudder" with arrow (Ref. 871)

The Emergency Control Valve, Steering Stand (CR), is a spool piston with 19/32" stroke. The half stroke is delivered by a half turn of the control shaft acting as a fixed screw in the piston as a travelling nut. There are four pipe connections, one hydraulic pressure, leading central, one return leading to extreme ends and one "R. Rudder", and one "L. Rudder" entering intermediate. For bottom stroke, the action is - "pressure" and "right rudder" ports connected under spool, "return" and "port rudder" connected on top of piston. For port rudder, action is reversed. This valve distributes ships hydraulic system pressures to main rams for right and left rudder. (Ref. 878)

The Emergency Control Valve Body is an open ended bronze cylinder bored (2.5") to suit piston, with (8) oil grooves on circumference. The walls are pierced by five semicircumferential ports (5/16" wide) i.e. 2 pressures, 2 returns and one supply. The bottom cover carries a heavy boss one inch high, square in cross section (1.25" x 1.25") which takes the piston's square guide. This resists the piston's torque under its screw drive. (Ref. 894)

The Emergency Control Piston Valve is a steel spool (5-7/16" x 2-1/4" D.) with a hollow square shank (2" long) guide. The piston triple acme R.H. threads of 0.666" lead and assembles on the 1-1/8" D.) end of the control valve shaft. The whole assembly, shaft, washers, thrust cover and piston are secured in place by the control valve cover. The cover carries a boss gland nut, 5 rings of plastic metallic packing and a follower ring. The gland nut is spannered, and locked with a clip. A case hardened, 5-1/2" spanner wrench is provided marked "Emerg. Steer. Gear", - Stowage behind steering wheel. The vent valve (1/8" needle), leads off the top of the valve body. (Ref. 895)

The Steering Gear Universal Joints are, where exposed to sea water, non-corrosive. The 1-1/2" universal joint female forks are CRS #1, and the flanges are Comp. G.

All Universal Joint Bearings are grooved and grease fitted and those exposed to sea water wear a canvas boot. To provide flexibility, the fit on the shaft in some cases is keyed and sliding. In case of a rigid joint, the taper pin is used.

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The Steering Shaft Stuffing Box (vertical) at frame 48 resists sea pressure and provides a frictionless thrust. It consists of a steel casting (8" x 6" OA). Its cylindrical trunk carries (3-3/32" D. By 5-3/4" deep) two ball races and a stuffing box. The assembly includes a bearing metal bushing (4-1/8" x 2.835" D.) with bottom lip on which rests a non-corrosive ball race (20-5/16" balls). On this is a nickel spacer (1-29/32" x 2-9/16" D.) for the outer race, and also a smiliar spacer (1-29/32" x 1.390) for the inner race. A comp. N-r separator ring, (5/8" long x 2-15/16" O.D.) threaded and spannered on top, screws into the bushing and secures the separator down on the outer races. This separator forms the bottom of the stuffing box. On top of this is placed 3 square and 2 bevelled rings of plastic metallic packing. A dog-eared two stud (5/8") bronze gland secures this assembly around the vertical CRS shaft (19-3/8" x 1.378" D.). This shaft has a special collar (5-5/16" x 2.0" D.) in way of the stuffing box and 45° shoulder (1/8" face) which rides on the inner race of the upper bearing and drives the downward thrust to the bottom ball race. The upward thrust is transmitted by an upper square shoulder of the collar against the bottom bearing of the gear case. This stuffing box stands in salt water and calls for periodic inspection. (Ref. 900)

The bottom section of the Hull Casting (2-3/4" O.D. x 2-1/4" long) is bored for the shaft (1-13/32" D.) and for a small stuffing box (2" D. x 1-1/2" deep) and carries a boss (7/8" D.) which is drilled (1/4") with a long grease hole and fitting that reaches the ball races. This section of the casting is welded into the pressure hull. The stuffing box consists of 3 turns of square and one turn bevelled of plastic packing and 2 studded dog-eared gland. (Ref. 900)

Rudder Angle Indicators

A Mechanical Indicator, fixed scale-sliding pointer - 0°, 5°, 35°, is attached to port main ram, after torpedo room.

An electrical rudder angle transmitter is located at frame 123 port. The transmitter is rotary in principle. A 2'-8" swinging arm moving in a vertical plane is fixed to the transmitter shaft. To the swing arm is fitted a connecting rod (adjustable length) which is driven by a pad on the port main ram plunger yoke. (Ref. 867)

U. S. Navy Yard, Portsmouth, N.H. 1943.

Reference Plans:

Ports.No.	BuShips No.	Title
812-308	386905	Steering Gear - Cylinder & Plunger - Arrangement.
813-308	312300	Steering Gear - Connecting Rod & Guide Details - Sheet #2.
815-381	386871	Steering Gear - Power Plant - Main Foundation.
818-201	312305	Steering Gear, Hydraulic System - Bow & Stern Diving Gears - Windlass & Capstan & Bow (Plane) Tilting - Vent & Surge Tanks - Arrangement & Details.
847-201	312334	Stern Post Casting - Details.
848-201	312335	Steering Gear - Rudder and Rudder Stock - Details.
849-201	312336	Steering Gear - Rudder Stock Crosshead & Details.
850-381	386872	Steering Gear - Arrangement - Aft.
851-275	386903	Steering Gear - Cylinder & Plunger - Details - Sheet 1.
852-275	386906	Steering Gear - Cylinder Foundations - Details.
853-308	490607	Steering Gear - Connecting Rods & Guide Details - Sheet #1.
854-381	490293	Steering Gear - General Arrangement and Diag. Arrangement of Piping.
856-381	386863	Steering Gear - Control Cylinder and Pump Control Arrangement.
857-275	386864	Steering Gear - Control Cylinder - Details - Sheet #1.
858-275	386865	Steering Gear - Control Cylinder - Details - Sheet #2.
862-275	387397	Steering Gear - Pump Control - Details.
863-285	386921	Steering Gear - Control Cyl. - Details - Sheet #3.
864-285	490566	Steering Gear & Hydraulic System - Reserve Oil Tank - Arrangement.
865-285	490567	Steering Gear & Hydraulic System - Reserve Oil Tank - Details.
867-381	386875	Steering Gear - Rudder Angle - Transmitter - Arrangement.
868-381	386876	Steering Gear - Rudder Angle - Transmitter - Details.
869-381	386873	Steering Gear - Flanges & Special Fittings - Details.
870-285	490268	Steering Gear - Conning Tower and Control Room Steering Stand - Shafting Arrangement.
871-285	490269	Steering Gear - Control Room Steering Stand - Arrangement.
872-285	490270	Steering Gear - Control Room Steering Stand - Details Sheet #1.
873-285	490271	Steering Gear - Control Room Steering Stand - Details Sheet #2.
874-285	490272	Steering Gear - Control Room Steering Stand - Details Sheet #3.
875-285	490281	Steering Gear - Control Room Steering Stand - Details Sheet #4.
876-285	490282	Steering Gear - Control Room Steering Stand - Details Sheet #5.
877-285	490286	Steering Gear - Control Room Steering Stand - Details Sheet #6.
878-285	490287	Steering Gear & Hydraulic System - Emergency Steering Gear Control Valve Arrangement.
879-285	490288	Steering Gear & Hydraulic System - Emergency Steering Gear Control Valve Details Sheet #1.
880-285	490289	Steering Gear & Hydraulic System - Emergency Steering Gear - Control Valve Details Sheet #2.
881-285	490290	Steering Gear & Hydraulic System - Emergency Steering Gear - Control Valve Details Sheet #3.
882-285	490291	Steering Gear - Pump Control Lever - Arrangement.
883-285	490292	Steering Gear - Pump Control Lever - Details.
885-285	490442	Steering Gear - Conning Tower Steering Stand - Arrangement.
889-275	387442	Steering Gear - Change Valve - Arrangement.
890-275	387443	Steering Gear - Change Valve Body.
891-275	387444	Steering Gear - Change Valve - Details.
900-275	386857	Steering Gear - Drive Shaft - Details Sheet #2
905-275	387361	Steering Gear - Pump Manifold - Arrangement.
906-275	387362	Steering Gear - Pump Manifold - Body Casting.
907-275	387363	Steering Gear - Pump Manifold Valve Details.
909-381	386898	Steering Gear Power Plant - Bed Plate.
911-381	386874	Steering Gear & Hydraulic System Instruction Plates & Name Plates.
912-201	312399	Stern Diving Gear - General Arrangement.
949-275	386914	Steering Gear - Drive Shaft - Details Sheet #3.
950-201	312437	Steering Gear - Connecting Rod & Guide Details Sheet #3.
951-201	312438	Steering Gear - Cylinder & Plunger - Details Sheet #2.
42024	490274	Steering Gear - Handwheel & Details.

Section U-8-f

GYRO COMPASS

Ref: (a) ARMA Corporation Instruction Book complete description of the system.
(b) Auxiliaries. Record of Electrical
(c) Circuit LC - Ports. No. 5826-381.
(d) Circuit LC - Ports. No. 6779-381.
(e) Auxiliary Gyro Compass - Ports. No. use 6779-381.

Component parts:

Master Gyro - in CR & Aux. Gyro.
Repeaters:
Bridge (p.p.) - 1
C.T. 1
COC 1
Radio Room 1
C.O. S.R. 1
Fwd. Torp. Rm. 1
Dead Reckoning Analyzer - CR
Stabilized line - Periscope No. 1
Stabilized line - Periscope No. 2

Steering Station	Kind of Steering	Compasses	Rudder Indicator
Bridge		1 Gyro Repeater P.P. Pelorus, Portable	Electric
Conning Tower	Power, Hand & Emergency	Gyro Repeater	Electric
Control Room	Power, Hand & Emergency	1 Gyro Repeater	Electric
After Torpedo Room			Mechanical

DEAD RECKONING ANALYZER

"Arma Dead Reckoning System, Mk. V, Mod. 0": A description of the Equipment and instructions for the operation, care and adjustment is provided by book of the above title, issued by ARMA Corporation, Brooklyn, New York.

The Dead Reckoning Analyzer indicates on dials the ship's latitude and longitude and total distance run.

Section U-9

PIPING SYSTEMS AND PUMPS (Hull)

Reference:
(a) Section U-10 F.O. & L.O. Piping.
(b) Section U-19 - Air Systems.
(c) Section U-27 - Hydraulic System.
(d) Trim Pump - Gardner-Denver - Instruction Book.
(e) Drain Pump - Gardner- Denver - Instruction Book.
(f) List of Plates.

Following is itemized description of Pumps (Hull).

Descriptive Item	Trim Pump	Drain Pump
No. of cylinders & Single acting plungers	2	2
Source	Gardner-Denver	
Capacity - gal.per min. - Max. at 176#	100	35
Discharge Head - feet	500	500
Location	Pump Room	Pump Room
Plan No., Portsmouth	1738-381	1758-381
	1739-381	1759-381
	1740-381	1760-381
		1761-381
Motor - rated speed r.p.m.	1500	1150
Motor - rated H.P.	20	10
Rated working speed r.p.m.	94	81
Worm drive - Ratio	16 to 1	14.25 to 1
Maximum working pressure	225	225
Bore - inches	5½	4¼
Stroke - inches	5¾	4-7/8
Suction - inches	4	3
Discharge - inches	3	2
Clearance, Worm thrust - inches	.000	.000
Main bearing - (total) inches	.003-.001	.0035 to .0025
Conn. Rod bearing - (total)in.	.002-.000	.004 to .0025
Wrist pin -(total inches)	.0015 to .0005	.0005 to .0010
Temperature, main bearing - °F		
(C.W. - 70° F.)	92	84
Conn. rod bearing	104	90
Worm	117	100
Room	66	64
Lube Oil Sump - °F		
(C.W. - 74 °F)		100
Valves, Spring loaded, disc type		
Valves, lift - inches	½	3/8
lift suction - inches		
lift discharge - inches		
Setting, Relief valve	225	225
Test Pressure (hydro) completed pump.	350	350

Section U-9

TANKS

NAME	Extent: Fr.-Fr.	Side	Capacity: Tons (S.W. unless otherwise noted)	Fuel Oil (Tons)
Bow Buoyancy Tank	Stem-10	Both	30.20	
Forward Trim	13-23	"	24.57	
Forward W.R.T.	23-25	"	5.00	
M.B.T. #1	25-35	"	*48.58	
Normal F.O. #1	35-41	"	43.53	36.31
Normal F.O. #2	41-46	"	49.83	41.56
M.B.T. #2A & 2B	46-52	S&P	*32.22 each	
Negative Tank	50-52	Both	8.06	
M.B.T. #2C & 2D	52-57	S&P	*33.31 each	
F.B.T. #3A & 3B	57-62	"	*37.42 each	30.62 each
Safety Tank	62-64	Both	24.19	
Aux. #1	64-69	S	31.26	
Aux. #2	64-69	P	31.26	
M.B.T. #4A & 4B	69-75	S&P	*45.31 each	
F.B.T #5A & 5B	75-80	"	37.68 each	30.75 ea.
M.B.T. #6A & 6B	80-85	"	*34.19 each	
M.B.T. #6C & 6D	85-91	"	*36.00 each	
F.O. Expansion Tank	91-93	S	11.38	9.49
F.O. Collecting Tank	91-93	P	11.38	9.49
Normal F.O. #6	93-99	Both	56.89	47.45
Normal F.O. #7	99-107	"	35.59	29.68
M.B.T. #7	108-117	"	*40.85	
Aft W.R.T.	117-119	"	5.28	
Aft Trim	125-130	"	20.68	
			Gals. / Tons	
Sanitary #1	34-35	S	320 / 1.19	
	76½			
Sanitary #2	77½	P&S	1100 / 4.08	
			Gals.FW: / TonsFW:	
Fresh Water Tank #1	35-36	S	990 / 3.68	
Fresh Water Tank #2	35-36	P	990 / 3.68	
Fresh Water Tank #3	57-58	S	990 / 3.68	
Fresh Water Tank #4	57-58	P	990 / 3.68	
Battery Fresh Water	36-47	Both	598 / 2.22	
Fwd. Battery				
After Battery	64-76	"	598 / 2.22	

* M.B. Tank capacities given are gross and include vent piping but no deductions for lead ballast.

For further data on tanks, see the ship's capacity curves.

Interior Coating of Tanks

For the treatment and the interior coatings of the variable tanks, see the Painting Schedule. It will be noted that in general the interior coating of tanks is divided into four main classes.

(1) Bare metal (fuel oil, lubricating oil and battery water tanks).

(2) Bitumastic (bow buoyancy (WT flat only) and sanitary tanks).

(3) Special Aluminum paint (main ballast, variable tanks, bow buoyancy).

(4) Special metallic brown paint (ship's fresh water tanks).

Soundings

Liquidometer gauges are provided for:

L.O. sumps
Trim tanks
Auxiliary tanks
W.R.T. tanks
Collecting tank
Clean Fuel Oil Tanks
Expansion Tank
Negative Tank

Try cocks are provided for fresh water tanks.

Static head type tank level indicating systems are provided for Sanitary Tanks.

No sounding gauges are provided for safety and main ballast tanks. Battery water tanks are sounded by means of petcocks.

Instructions for the care and operation of liquidometer gauges are contained in a separate pamphlet issued the ship at the time of commissioning.

Fuel oil tanks are fitted with trycocks.

Reference Plans:

Ports. No.	BuShips No.	Title
52-381		Compartments and tanks
470-381		Pump Room - Arrangement.

U-9

LIQUIDOMETER
TANK CAPACITY GAUGES-BALANCED TYPE

GAUGE LIST

	TYPE	TEST PRESSURE	GRADUATION	NAME OF TANK	LOCATION OF GAUGE
	ROUND DIAL	450 FT.	1000 LBS.	FOR'D. TRIM TANK	FOR'D. TORPEDO ROOM
	"	450 FT.	"	" " "	CONTROL ROOM
	"	450 FT.	"	AFTER TRIM TANK	AFTER TORPEDO ROOM
	"	450 FT.	"	" " "	CONTROL ROOM
	"	450 FT.	1000 LBS	NO. 1 AUXILIARY TANK	" "
	"	450 FT.	"	NO. 2 AUXILIARY TANK	" "
II	"	450 FT.	1000 LBS. & 2000	SAFETY TANK	" "
	ROUND DIAL	450 FT.	1000 LBS	W.B.T. TANK	FOR'D. TORPEDO ROOM
	"	450 FT.	"	W.B.T. TANK	AFT. TORPEDO ROOM
	"	450 FT.	GALLONS	F.O. COLLECTING TANK	ENGINE ROOM-AFT.
	"	450 FT.	"	F.O. EXPANSION TANK	" " "
	"	15 LBS.	"	CLEAN FUEL OIL TANK	" " FOR'D.
	"	15 LBS.	"	LUB. OIL SUMP TANK NO. 1	" " "
	"	15 LBS.	"	LUB. OIL SUMP TANK NO. 2	" " "
	"	15 LBS.	"	LUB. OIL SUMP TANK NO. 3	" " AFT.
	"	15 LBS.	"	LUB. OIL SUMP TANK NO. 4	" " "
FOR SUBS 381 TO 404 AND 411 TO 416 ONLY.	"	15 LBS.	"	MOT. & RED. GEAR L.O. SUMP #1	MANEUVERING ROOM
	"	15 LBS.	"	MOT. & RED. GEAR L.O. SUMP #2	" "
III	"	450 FT.	1000 LBS. & 2000 LBS.	NEGATIVE TANK	CONTROL ROOM
	"	15 LBS.	GALLONS	CLEAN FUEL OIL TANK	ENGINE ROOM-AFT
FOR SUBS SS 405 TO SS 410 SS 425 TO SS 434	"	15 LBS	"	MAIN MOT. SUMP No. 1 OUTSIDE MOTOR TYPE	MANEUVERING ROOM
	"	15 LBS	"	MAIN MOT. SUMP No. 2 OUTSIDE MOTOR TYPE	" "

TANK CAPACITIES AND CURVES OF CAPACITIES TO BE FURNISHED CONTRACTOR.

SS425-434
381-416

Section U-10-a

FUEL OIL SYSTEM

Ref. (a) Plate 12 - F.O. Piping Diagram.
(b) BuShips Plan No. 386476 - Fuel Oil System Diagram.
(c) Section U-9- (List of F.O. Tanks).
(d) Section U-10-b - Fueling at Sea.
(e) BuShips Plan SS285-S55-30, Alt. 1 - Fuel Oil System Piping Diagram Eng. Rm.
(f) Section U-12-a - Flooding and Venting.

Fuel Oil Capacity of Ship, total, is 300 tons, carried in saddle tanks under sea pressure. Only 1% (clean F.O. Tanks) is carried inside the pressure hull. Distribution is as follows:

Fuel Oil Tanks (BuShips Plan 387234)

Normal Fuel	Gallons	Fuel Ballast	Gallons
No. 1	11,400	No. 3A and 3B	19,220
No. 2	13,050	No. 5A and 5B	19,310
No. 6	14,900		
No. 7	9,320		
Collecting	2,980		
Expansion	2,980		
Total	54,630		38,530
Total			93,160
		Allowance for water seal deducted (deep pipe 2" above flood valve seats)	
Clean Fuel Oil Tanks Nos. 1 & 2		95% Cap.	948

Fuel Oil Capacity is divided into two classes, (1) Normal Fuel (6 tanks) and (2) Fuel Ballast (2 tanks). All are external tanks with structural strength for surface operation only (36 p.s.i.). All fuel tanks are cross connected at the vertical keel.

The Fuel Oil System provides a neutral hydraulic stress on the outer skin of the saddle tanks in the presence of a complete range of hydrostatics, and cubical expansion due to variable sea pressure and temperatures respectively, also, a self-regulating compensation for change of trim due to daily fuel consumption. The system has continuous and unobstructed opening to atmosphere or (S/M) to sea.

The Fuel Oil System is a consolidation of 8 tanks into a bilateral (fuel & water) variable pressure (surface & S/M) uniflow (oil bubble on water) unit, which is designed to meet automatically a variety of contingencies, listed in part below:

Working or Test Limits - Fuel Oil System - List Of:

Sea Pressure

Condition	Working Depth Gage Feet	Working psi	Test Depth Gage Feet	Test psi	Fuel Oil Cubic Feet	Trim Tons (Wgt.)
Surface	16	7				
Deep Dive, working	416	183				
Deep Dive, piping Tests, Max.			675	300		
Fuel Cap. Max.					12,468	
Fuel Cap. Cubical Expansion from 28° F. to 85°F: (Max.)					349	
Fuel Cap.Max.(296.7)						0
Fuel Cap.Min. (0)						
Change in Weight of Ship						59.0 62.11

The Fuel Oil System is in effect, an open-ended hydraulic syphon, operating under a 10 foot head, but resistant to 675 foot head. The tops of all fuel tanks are consolidated in a single fuel transfer line (3") carrying only fuel. The bottoms of the tanks, through a deep pipe in each are consolidated in a compensating line (3" Fr. 36 to 99) carrying only sea water. Each fuel tank is thus coordinated to operate, in effect, as a stratified oil and water column in which sea pressure is communicated to the bottom and fuel is siphoned off the top. Piping is such that on the way to delivery all fuel is gravitated through the collecting tank (2,980 gal.) Fr. 91-93 Port. Sea water on its way to the compensating water line is relayed through the expansion tank (2,980 gal.) Fr. 91-93 starboard. The only communication between the collecting tank and the expansion tank is through the contents of one or more fuel tanks. It is therefore imperative to the safety of the collecting tank that one fuel tank shall be open to the fuel transfer line at all times.

The Collecting Tank is two frame spaces wide (Fr. 91-93) Port, and is in effect a settling tank and delivery point to the engine room fuel system. It carries a deep pipe and stop valve through which oil enters, and a delivery and stop from a high point. Between these two stops is a bypass valve. These valves are locked in position for normal operation, and used only to isolate the collecting tank from the system. There is a deep drain.

The Collecting Tank Drain Valve (Fr. 91-92 Port) sight glass and pipe line to the ship's drain line, is shown on Plate 16. The operator uses this line to keep the tank clear of water or sludge. Normal condition locked CLOSED.

The Expansion Tank (Fr. 91-93 Starboard) is two frame spaces wide and carries stops for deep pipe, top connection, locked OPEN and a bypass locked CLOSED. The valves are for isolation of the tank. The deep pipe carries the water tower and the deck connection (3"). The top connection carries a sight glass and a pipe to the compensating water tine. There is no drain line in the expansion tank. The expansion tank through the compensating line, cushions the entire fuel load, against thermometric cubical expansion, variation in hydrostatic pressures, and relays water tower pressure head to the system. The expansion tank will trap oil which gains admission to the compensating line through an over-full fuel tank. It will not deliver oil directly to the fuel oil transfer line. It may be used to carry oil.

The Fuel Oil Transfer Line (3" steel) runs from Fr. 40 to Fr. 99 and takes a starboard and port stop off six fuel tanks.

ONE FUEL OIL TANK MUST BE OPEN TO THE TRANSFER LINE AT ALL TIMES - To provide equalization of pressure in the collecting tank on a dive. The operator may otherwise select tanks to be carried on the transfer line at discretion.

The Fuel Oil Filling Connection is a 2½" female hose thread (Navy Dept. Spec. 34F3) and is fitted with a stop valve and sampling valve. There are two on the fuel transfer line and in the main deck; one at Fr. 47 and one at Fr. 98.

The Fuel Oil System Compensating Water Line (3") runs from Fr. 40 to Fr. 100. It carries clear lead to the top of the expansion tank, and a clear lead to the deep pipe, to the bottom of the six fuel tanks. The operator should keep all valves on the compensating line OPEN. Exception: Expansion Tank - Bypass Valve - This should be locked CLOSED.

The Compensating Line Water Tower (3") spills overboard in a high gooseneck in the fairwater Fr. 58-59 and provides a constant working head for the fuel oil system, under cruising conditions, engines running.

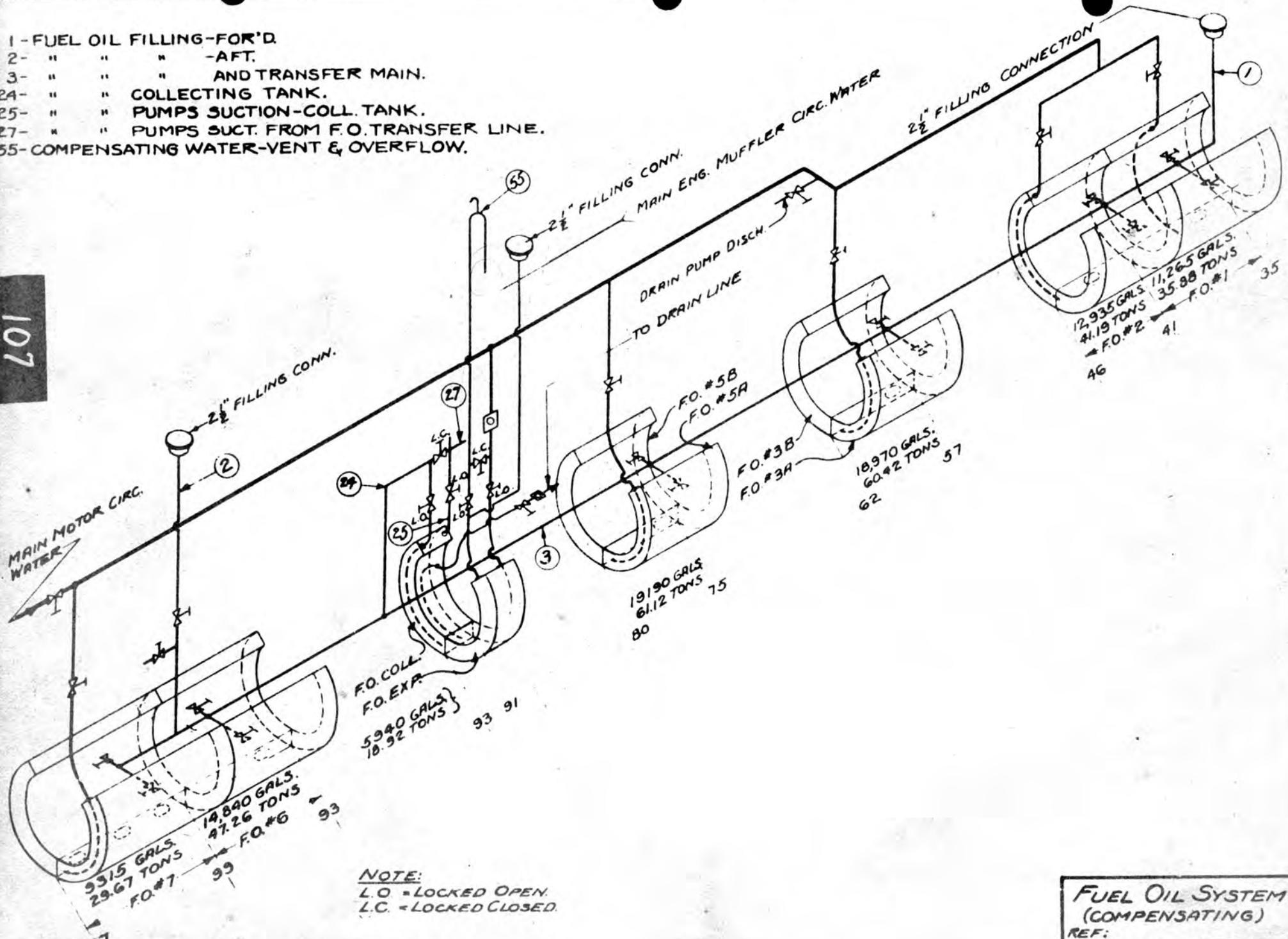
The Main Engine Muffler Circulating Water Connection to the water tower, Frame 90, provides constant pressure head for the system. The circulating water from the mufflers discharges into this tower, and the water not used by the compensating system discharges through a combined vent and overflow line leading from a return bend located in the bridge fairwater at a point just below the bridge deck level. A drain from the overflow and vent leads to a discharge at the tank top.

The Main Motor Auxiliary Circulating Pump Connection Fr. 99-100 Starboard to the compensating water line, provides a secondary source of water pressure for the water tower. The motor room carries two such pumps, starboard and port.

The Drain Pump Discharge Connection, Frames 53-54 Port, to the compensating water line provides a means for blowing fuel oil tanks to overboard through M.B. Tank No.2 D. The drain pump is a high pressure reciprocating and if improperly applied to the system, its pressure is capable of structural damage to the ship.

1¼

1 - FUEL OIL FILLING - FOR'D.
2 - " " " - AFT.
3 - " " " AND TRANSFER MAIN.
24 - " " COLLECTING TANK.
25 - " " PUMPS SUCTION - COLL. TANK.
27 - " " PUMPS SUCT. FROM F.O. TRANSFER LINE.
55 - COMPENSATING WATER - VENT & OVERFLOW.



NOTE:
L.O. = LOCKED OPEN.
L.C. = LOCKED CLOSED.

FUEL OIL SYSTEM
(COMPENSATING)
REF:
BU SHIPS 386476

The Compensating Water Line Hose Connection (2½") main deck, Fr. 88-89, is a direct lead without intervening valve to the bottom of the expansion tank. In fueling alongside a dock, this connection is available to take a hose to carry off displaced water, avoiding harbor pollution.

The Sight Glass at Frame 97, starboard, is carried between the compensating water line (3") and the top of the expansion tank. This glass will register oil only when the fuel system is completely full including the expansion tank or when the distribution in the system is abnormal in some particular.

Normal Fuel Oil Tank No. 6 Fr. 93 to 99 carried 47.45 tons of oil. It is a saddle tank, lightened at the keel for equalization. List of appurtenances follows: (402-308)

(1) A Fuel Line Stop Valve (Stbd. & Port).
(2) A Fuel Line (2") and funnel to high point. (Stbd. & Port)
(3) A Vent Pipe (¼") terminates 1" above top of funnel in same frame space with (2). (Stbd. & Port)
(4) Same as (3), a 15# blow. (Stbd. & Port)
(5) Test Manifold, Drain Cock and Piping (.405" O.D.) for taking samples at intervals of 5,000 gallons - (Port and Starboard)
(6) A Stop Valve and Deep Pipe (3") to bottom of tank - (Starboard)

Technical Duplicates: N.F.O. Tanks 1,2 & 7, F.B. 3A and 3B, 5A and 5B. All fuel tanks are cross connected through the vertical keel, including F.B. Tanks.

Fuel Ballast Tanks 3A and 3B (Fr. 57-62) carries 19,220 gallons of fuel (61.24 Tons) or 2,570 cubic feet. Description of this tank is given in Section U-12-a, Flooding & Venting. Note the description of the blank flange for the vent valve. Note the paragraph on emergency vent valve cover and the spring-loaded (20#) ¼" relief valves installed to absorb thermal expansion of oil. Note that gaskets on the flood valves are Neoprene synthetic oil-resisting rubber. The tank is one complete unit. The vertical keel is lightened for equalization. The deep pipe in this tank ends 2" above the line of the flood valve seat. For additional appurtenances see the list under paragraph on N.F.O. Tank No. 6.

Fuel Ballast Tanks 5A and 5B is a technical duplicate of 3A and 3B.

Fuel Oil System - Operation of.

Filling System: To avoid harbor pollution or similar consequences, the water compensation deck fitting (2½") should be connected with hose. One or both fuel deck fittings are connected to hose and the stop valve opened. With suitable pressure on the fueling line the water in the system will be displaced by fuel.

Expansion Tank - Filling with Oil. One of the normal tanks must first be filled and the oil forced through its deep pipe tank, to the compensating line, to the expansion tank. An over full expansion tank will force oil from the bottom of the tank, up through the deep pipe to the water tower, and overboard.

Normal Fuel Tank - Blowing of. The operator uses the 15# blow valve to each tank, using drain pump discharge valve (Fr. 47) in the compensating water line. No air should be left pocketted in the system. Transfer of oil between respective tanks by blowing can be accomplished only through the compensating line.

Fuel Oil - Transfer from tank to tank - This should be done with the compensating system. The main motor auxiliary circulating water pump connection (Fr. 98) may be used for a source of head on the water tower, if main engine circulating water is secured.

Expansion Tank - Pumping Bilges Through - To avoid oil slicks or harbor pollution, the bilges may be pumped through the drain pump discharge connection to the compensating line. This operation should be conducted with great care and only after careful supervision of personnel has assured that the drain pumps discharge to any ~~part of~~ the compensating system shall not exceed 15 psi. Fuel tanks are tested to only 36 psi.

Rig for Diving - When the ship submerges, sea water enters the compensating water tower through its overboard discharge and from the tower conveys pressure via the compensating water line to the inverted pipes of the fuel oil tanks, and the expansion and collecting tanks. Before the ship is submerged the proper stop valves must be OPEN to allow sea pressure to reach these tanks

Clean Fuel Oil Tanks, Filling of - To fill the engine clean fuel tanks, the fuel oil pumps take suction from the top of the collecting tank, this tank being fed from the normal tanks. Compensating water pressure at the bottom of the tank in use forces oil at the top of that tank out into the filling and transfer line and from there to the bottom of the collecting tank. The oil entering at the bottom of the collecting tank forces the oil at the top out to the pump suction line.

Collecting Tank - By-Passing of - This tank can be by-passed in case of necessity.

Normal & Reserve Tanks - sounding of - Soundings are made by a try cock manifold fitted to each fuel tank. Six try cocks are incorporated in each manifold with tail pipes leading to six different tank levels. Portsmouth Plan 461-228, BuShips No. 386437, indicates the amount of oil present for the various try cocks for each fuel oil tank.

Fuel Oil Purifiers - Two motor driven fuel oil purifiers are located in the engine rooms, supplied by use of the two motor driven fuel oil transfer pumps or by compensating pressure from the collecting tank. Oil refined by the purifiers drains to the clean oil tanks. Water from the purifiers drain to the engine room bilge.

Two motor driven gear fuel oil transfer pumps located in the engine rooms move the oil from the ship's tanks through strainers and meters to engine fuel oil purifiers thence by gravity to engine clean oil tanks, from which fuel oil is supplied to the main and auxiliary engines by the attached engine fuel oil booster pumps.

These two motor driven gear fuel oil transfer pumps are also used for priming the engine fuel oil system and to substitute for any attached engine booster pump. These pumps can also take suction directly from the collecting tank, or, by means of the filling and transfer line, from any other fuel tank, normal or reserve.

On main and auxiliary engines all oil leakage from engine fuel oil system is returned to salvage tanks by gravity.

A Cross-connection with the necessary valves is provided to allow the water from the head box to flow directly to the compensating water line to prevent the escape of compensating water in case of bilging the fuel oil expansion tank. This by-pass valve is normally locked closed.

The fuel oil piping is so arranged as to trap a minimum amount of oil in the tanks.

1/4

COMPENSATING LINES - POSITION OF VALVES
(Ref. Plan 490242)

MK.	VALVE	POSITION	Cruising	Rig for Diving	Fueling	Discharging	Exp. Tank Bilged	Pumping Bilges	REMARKS
33	Exp.Tank, Stop Valve (Deep Pipe)	Open	X	X	X	X			Locked
		Closed					X		
38	Exp.Tank, Stop(Top)	Open	X	X	X	X			Locked
		Closed					X		
35	Exp.Tank, By-Pass	Open					X		Locked
		Closed	X	X	X	X			
49	Sight Glass Shows	Water	X	X	X		X		
		Oil				X			
31	Circ.Water, Main Mufflers	On	X	X			X		Normal
		Off			X	X			
51	Circ.Water, Main Motors	On				X			Standby
		Off	X	X	X				
31	Water Tower, Overflow	Open	X	X	X	X	X		In Fairwater
55	Vent on Stand Pipe	Open	X	X	X	X	X		
40	Drain Pump Discharge	Open							For Blowing Tanks. Avoid Heavy (30#) Pump Press.
		Closed	X	X	X	X	X		
36	Comp.Water 2-1/2 Hose Conn.	Dis.Hose			X				Female Navy Specs 34F3
		On							
		Closed	X	X		X	X		
	F.O. Tanks, Stop to Deep Pipe All Tanks	Open	X	X	X	X	X		
		Closed							
42 to 52	N.F.O. 1 N.F.O. 2 F.B. 3A & 3B F.B. 5A & 5B N.F.O. #6 N.F.O. #7								
24	Collecting Tank, (Deep Pipe) Stop	Open	X	X	X	X		X	Locked
		Close					X		
25	Collecting Tank (Top) Stop	Open	X	X	X	X		X	Locked
		Close					X		
18	Coll. Tank By-Pass Valve	Open	X	X	X	X		X	Locked
		Close					X		
1	Filling Conn. 2-1/2"(Deck)Ford.	Hose Connected			X	X			Female Spec.34F3
2	Filling Conn. 2-1/2"(Deck)Aft.	Hose Conn.			X	X			Female, Spec.34F3
		Close							
	Filling Conn. Stop	Open			X	X			
	Collecting Tank Drain Pump Conn	Open							For Pumping Water Overboard
		Close	X	X	X	X	X	X	
	F.O. Tanks, F.O. Stops, Stb.& Port								
5 10 13 to & to 8 11 22	At Least One Tank	Open	X	X	X	X	X	X	
	Remaining Tanks Selective								

VALVE AND MANIFOLD LIST - (Hull)

CONTROL ROOM - 426-285 BuShips No. 386515

Service	Size	Type	Location
Trim System	-	Manifold	53-55 P
Drain Pump Suction	3"	Spec. Globe	54-55 P
Trim Pump Suct. & Disch.	5"	Spec. Sea	54-55 P
Magazine Sprinkler Supply	4"	Gate	55 P
Pyrotechnic Locker Flood	1½"	Gate	55 P
Drain Line Cutout	2-2"	Gate Sold'd.	54-55 P
Hose Conn. (Locked closed)	1½"	Globe Hose	50-51 P
Conning Tower Hatch Drain	1"	Globe	51-52 P
Radio Entering Tube Drain	½"	Globe	56-57 P
Trim Pump Gauge Lines	¼"	Globe	55 P
Gun Access Trunk Drain	⅜"	Sea - Angle	47-48 P
Magazine & Pyrotechnic Locker test casting drain	4-3/8"	Globe	55-56 P

AFTER BATTERY ROOM - 429-381 BuShips No. 490751

Sanitary Tk. #2 Disch. Overboard	2"	Angle Stop Chk.	77S
Sanitary Tk. #2 Disch. Overboard	2"	Angle-Sea	74-75S
Compt. Hose Trim Line	1½"	Hose Globe(LC)	76-77P

FORWARD ENGINE ROOM - 430-381 BuShips No. 491055

F.O. Transfer #5B F.B. Tank	2"	Sea Valve	78-79P
F.O. Transfer #5B F.B. Tank	2"	Sea Valve	79-80S
Comp Water #5A & 5B F.B. Tank	3"	Sea Valve	78-79S
Trim Line Hose Conn.	1½"	Globe Hose	86-87P
Drain Line Hull Vent.	⅜"	Globe	80-81S
Drain Line Air Induction	⅜"	Globe	82-83P
Bilge Suction	2"	Manifold	86-87P

AFTER ENGINE ROOM - 431-381 BuShips No. 491056

F.O. Filling	2½"	Angle Sea	98-99S
Comp. Water to F.O. Tank #6	3"	Angle Sea (Locked Open)	97-98S
F.O. Transfer F.O. Tank #6	1-2"	Angle Sea	97-98S
Test Valve F.O. Filling	¼"	Angle	98-99S
Drain Pump from Coll. Tank	2"	Spec. Angle Sea	91-92P
Coll. Tank Suction	1¼"	Angle Relief	97-98P
F.O. Transfer F.O. Tank #6	2"	Manifold	97-98P
Compensating Water	3"	Manifold	97-98S
Fuel Oil	1¼"	Manifold	97-98P
Bilge Suction	2"	Manifold	89P
Trim Line Hose Conn.	1½"	Globe Hose (LC)	89-90P
Eng. Air Induction Valve Dr.	⅜"	Angle Screw	92-93P

FORWARD BATTERY ROOM - 425-285 BuShips No. 386514

Comp. Water Normal, F.O. Tanks #1-2	3"	Manifold	40-41P
F.O. Transfer	2"	Manifold	40-41P
F.O. Transfer	2"	Manifold	41S
F.O. Filling	2½"	Spec. Flg. Ang.	46-47P
Trim Line Comp. Hose	1½"	Flg. Ang. Hose	47-48S
Test F.O. Fill	¼"	Scr. Ang. St.	47-48P

CREW'S MESS, GALLEY & SCULLERY - 428-310 BuShips No. 544888

F.O. Fill & Trans.Fuel Bal. Tank #3B	2"	Spec. Angle	60-61P
F.O. Fill & Trans. Fuel Bal. Tank #3A	2"	Spec. Angle	60-61S
Comp. Water Fuel Bal. Tank #3A-3B	3"	Spec. Angle (LO)	60-61S
Fl.& Dr.Aux. Tank #2	3"	Spec. Angle (LO)	64-65P
Fl.& Dr.Safety Tank #2	3"	Angle Sea	62-63P

VALVE AND MANIFOLD LIST - (Hull)

CREW'S MESS, GALLEY & SCULLERY - 428-310 BuShips No. 544888 (Cont'd)

Service	Size	Type	Location
Fl. & Dr. Aux. Tank #1	3"	Spec. Angle (LO)	64-65S
Vent Trunk Drain	1"	Screw Gl. Check	59-60S
Vent Trunk Drain	¾"	Screw Globe	59-60S C/L

MOTOR & MANEUVERING ROOMS - 512-285 BuShips No. 490159

Comp. Water to F.O. Tk. #7 (Locked Open)	3"	Ang. Sea Valve	99-100S
F.O. Trans. to F.O. Tk. #7	2-2"	Ang. Sea Valve	99-100 P&S
Wash Deck	1½"	Globe Hose Flg. L.C.	100-101P
Sea Water to Comp. Water	1"	Globe Valve	99-100S
Dr. from Eng. Air. Ind. Valve	¾"	Globe Valve	105-106S
Bilge Suction	2"	Manifold	99-100P

FORWARD TORPEDO ROOM - 424-285 BuShips No. 386513

Trim Lines	3"	Manifold	21-22P
Port Torp. Tube Drains	5"	L.H. Manifold	19-20P
Stbd. Torp. Tube Drains	5"	R.H. Manifold	19-20S
Torp. Tubes Dr. To W.R.T. Tank	5"	L.P. Globe	21-22P
W.R.T. Tk. Overflow	5"	Special Angle	22-23P
Escape Trunk Fl.	3"	L.P. Ang. Spec.	26-27 C/L
Escape Trunk Dr.	3"	L.P. Angle	28-29S
No. 1 Sant. Tk. Disch. Overboard	2"	Angle Sea	34-35S
No. 1 Sant. Tk. Disch. Overboard	2"	L.P. Ang. Stop Chk.	34-35S
Bilge Suct.	2"	L.P. Cross Stop Chk.	33-34P
Bilge Suct.	2"	L.P. Ang. Stop Chk.	19-20P
Trim Line Hose Conn.	1½"	Globe Hose (LC)	21-22P

PUMP ROOM - 427-381 BuShips No. 544612

Bilge Suction	2"	Manifold	55P
Conning Tower Drain	3"	Flg. Ang. St.	53-54S
Trim Pump Discharge	3"	Globe Silver Sold'd	54-55P
Dr. Pump Suct.	3"	Flg. Globe St.	54-55P
Dr. Pump Disch. Overbd.	2"	Flg. Angle St.	55-56P
Dr. Pump Disch.	2"	Globe St. Silver Sold'd	53-54P
Dr. Pump Disch. to Comp. Water	2"	Sold'd Globe St.	53-54P
Dr. Pump Disch. to Trim Pump Disch.	2"	Sold'd Angle St.	54-55P
No. 1 Periscope Well Drain	1"	Flg. Angle	53-54C/L
Drain Pump Gauge Lines	2-¼"	Globe Screw	55-56P
Negative Tank Flood & Drain	3"	Angle - Sea	51-52P

AFTER TORPEDO ROOM - 432-285 BuShips No. 386527

Trim Lines	3"	Manifold	120P
Stbd. Torp. Tube Drains	5"	L.H. Manifold	121-122S
Port. Torp. Tube Drains	5"	R.H. Manifold	121-122P
Torp. Tubes Dr. to W.R.T. Tk.	5"	L.P. Globe	120-121P
W.R.T. Tk. Overflow	5"	Spec. Angle	120-121S
Bilge Suction	2"	L.P. Ang. Stop Chk.	119-120P
Trim Line Hose Conn. to Compt. (LC)	1½"	Globe Hose	109-110P

Reference Plans:

Ports.No.	BuShips No.	Title
147-275	387388	Stowage of Fuel Oil Filling Hose
423-381	490240	Fuel Oil System - Diagram (Piping)
425-285	386514	Fuel Oil, Water & Drainage - Piping Arrgt. Officers' Quarters
426-285	386515	Fuel Oil, Water & Drainage - Piping Arrgt. - Control Room
428-310	544888	Fuel Oil, Water & Drainage - Piping Arrgt. - Crew's Mess, Galley & Scullery
429-381	490751	Fuel Oil, Water & Drainage - Piping Arrgt. - Aft Battery Room
430-381	491055	Fuel Oil, Water & Drainage - Piping Arrgt. - Fwd. Eng. Room
431-381	491056	Fuel Oil, Water & Drainage - After Engine Rm. (Piping Arrgt.)
495-381	544884	Fuel Oil, Water & Drainage System - Special Fittings - Sheet #1
496-228	386472	Fuel Oil, Compensating System Manifolds
508-292	490183	Manifold - 3" - Fuel Oil System
35177	448713	Fuel Oil Tanks - Blow, Vent & Test Manifold
35681	490400	2" Gooseneck Valve - Fuel Oil System Drainage System

Section U-10-b

FUELING AT SEA

Ref. (a) BuShips Plan 517889. Type Plan - Fueling at Sea Between Tender and Submarine or Tanker and Submarine.
(b) Submarine Scouting Force letter No. 33-41 of September 25, 1941, Oiling Procedure.
(c) Atlantic Fleet Memo 54-42 - Test for Fueling at Sea - 13 Oct. 1942.

Facilities for fueling at sea are designed, plan reference (a), to meet adverse weather conditions and cover tender or tanker. General arrangement is based on best deep sea practice and sufficiently complete in engineering detail to meet all common contingencies. No hauling stresses are imposed on the hose. Line throwing gun is provided the towing ship for the first pass. The hose is slung in a bight and fitted with a quick release coupling for emergency.

A marker is installed in the towing ship showing the position of the submarine C.T. One cleat, only, (forward C.T.) is used on the submarine for the breast and the towing line. In minimum position the submarine stands off with a breast 30 feet long, with oil hose 150 feet long, with a 60 ft. bight topped up in saddles from crane on towing ship.

Submarines may fuel from either side of towing ship (or both).

Two hoses are provided, forward and after.

The Oil Hose carries a combination of services, married with a frapping line, viz: 3½" manila hauling line, 2½" oil hose, (4" may be used) 1½" fresh water hose, ⅜" battery water hose, (2½" gasoline hose may be included for submarine using the service).

A sound powered phone with cord is provided for passing from ship to ship.

Adapters (2½") are provided the submarine in case 4" hose is used.

Female End of Quick Release Coupling is to be passed from tender (or tanker) (all quick release couplings are interchangeable). Advance Information should indicate whether male, female or complete coupling will be passed from fueling ship.

PIPE LIST

MARK	NOM. SIZE	SERVICE	LBS. TEST PRESSURE
1	2½"	Fuel Oil Filling - Forward	300
2	2½"	Fuel Oil Filling - Aft	300
3	3"	Fuel Oil Filling and Transfer Main	300
4	2½"	Fuel Oil Transfer Nos.1 & 2 Fuel Oil Tanks	300
5	2"	Fuel Oil Transfer Nos.3B Fuel Oil Tanks	300
6	2"	Fuel Oil - Normal Fuel Oil Tank #1	-
7	2"	Fuel Oil - Normal Fuel Oil Tank #2	-
8	2"	Fuel Oil - Normal Fuel Oil Tank #2	-
9	¼"	Fuel Oil - Filling Test	300
10	2"	Fuel Oil No. 3A Fuel Ballast Tank	
11	2"	Fuel Oil No. 3A Fuel Ballast Tank	-
13	2"	Fuel Oil No. 3B Fuel Ballast Tank	-
14	2"	Fuel Oil No. 5A Fuel Ballast Tank	300
15	2"	Fuel Oil No. 5A Fuel Ballast Tank	-
16	2"	Fuel Oil No. 5B Fuel Ballast Tank	300
17	2"	Fuel Oil No. 5B Fuel Ballast Tank	-
18	2"	Fuel Oil No. 6 Fuel Oil Tank	300
19	2"	Fuel Oil No. 6 Fuel Oil Tank	-
20	2"	Fuel Oil No. 7 Fuel Oil Tank	300
21	2"	Fuel Oil No. 7 Fuel Oil Tank	-
22	2½"	Fuel Oil No. 6 & 7 Fuel Oil Tanks	300
24	1¼"	Fuel Oil to Collecting Tank	-
25	1¼"	Fuel Oil Pumps Suction Collecting Tank	-
27	1¼"	F.O. Pumps Suction Fr. F.O. Transfer Line	300
30	½"	Comp. Water Standpipe Drain	-
31	3"	Comp. Water Standpipe Vent & Overflow	-
32	3"	Comp. Water To Fuel Oil Expansion Tank	-
33	3"	Comp. Water To Fuel Oil Expansion Tank	-
34	3"	Comp. Water Fuel Oil Exp. Tank By-pass	-
35	3"	Comp. Water Fuel Oil Exp. Tank By-pass	-
36	2½"	Comp. Water Discharge	-
38	3"	Comp. Water from Expansion Tank	-
39	3"	Comp. Water to Main	300
40	3"	Comp. Water Main	300
42	3"	Comp. Water Normal Fuel Oil Tank #1	-
43	3"	Comp. Water Normal Fuel Oil Tank #2	-
44	3"	Comp. Water Normal Fuel Oil Tank #2	-
45	3"	Comp. Water to Fuel Ballast Tanks Nos. 3A & 3B	300
46	3"	Comp. Water to Fuel Ballast Tanks Nos. 3A & 3B	-
47	3"	Comp. Water to Fuel Ballast Tanks Nos. 5A & 5B	300
48	3"	Comp. Water to Fuel Ballast Tanks Nos. 5A & 5B	-
49	3"	Comp. Water to Normal Fuel Oil Tank No. 6	300
50	3"	Comp. Water to Normal Fuel Oil Tank No. 6	-
51	3"	Comp. Water to Normal Fuel Oil Tank No. 7	300
52	3"	Comp. Water to Normal Fuel Oil Tank No. 7	-
53	1/8"	Fuel Oil Test Piping	-
55	1"	Comp. Water Vent & Overflow	-

CAPACITIES & VOLUMES OF TANKS

Fuel Oil Tanks	Cu.Ft.	Tons Oil.	Tons S.Water
No.1 Fuel Oil Tank	1525	36.31	
No.2 Fuel Oil Tank	1744	41.56	
No.6 Fuel Oil Tank	1992	47.45	
No.7 Fuel Oil Tank	1243	29.62	
Collecting	398	9.49	
Expansion	398	9.49	
Clean 95% Net Cap.			
Total			

LUBE OIL SYSTEM

Ref: (a) Plate 14.
(b) Piping Diagram (BuShips SS228-S45-091 - Alt. 1).
(c) Section U-9 (Lube Oil Tanks).
(d) Instruction Books, Sharples L.O. Purifier.

The Lube Oil System, Main Machinery carries two main subdivisions according to application, viz:

Main & Aux. Gen. Engines & Generators (F.E.R. Main 1 & 2) (A.E.R. Main 3 & 4 & Aux. 300 K.W.)
Main Red. Gear & Main Motors (Stbd. MM 1 & 3 Red. Gear #1)(Port MM 2 & 4 Red. Gear #2.)

The Lube Oil System has two additional subdivisions of piping and appurtenances according to technical service rendered, viz:

Lube Oil Purifier System, #1 (FER) #2 AFR.
Stowage & Sump Tanks Transfer, filling & suction (MM & Red. Gear Standby Sys.)

The Lube Oil System Operating Unit is the main generator engine (1,2,3,4) and likewise main reduction gear No.1 with motors, similarly No.2. The lube oil service of each unit is integral and can be independent for purposes of operation. For purposes of reinforcement, replenishment, and distribution, each unit is connected to the filling and transfer line. For purposes of cleaning and servicing the lube oil, the transfer lines are connected to the lube oil purifier system. This gives practically unlimited resources as to servicing distribution and application of lube oil in all parts of the system. (Ref.b)

The Lube Oil System Operating Unit - Main Generator Engine (1,2,3,4). Each engine carries integral with design, an independent lube oil cycle, including attached pump, and filtering and cooling services, and sump. The sump is the structural foundation under the engine. Under Generators 1 & 2 is a reserve oil tank making a complete unit for the Forward Engine Room (Technical duplicate AER).

Main Generator Engines (F.M.C. 10 Cyl. Mod. 38D8-1/8) (1600 BHP)

Designate	Cal. Cap. Sump Under	Attached Pump GPM	L.O. Strainer GPM	Cooler	L.P. Alarm
Forward E.R.					
ME #1	444	215	215	X	X
ME #2	444	215	215	X	X
Aft E. R.					
ME #3	444	215	215	X	X
ME #4	444	215	215	X	X
300 KW	Crankcase built in	74	74	X	X

Each Main Engine Attached Pump driven from its crankshaft supplies oil to its own system when the engine is running. Each attached pump takes a suction through check valve from hot oil in sump tank and discharges through strainer to cooler, then to engine. After passing through the engine lube system, the oil drains through a coarse strainer in engine pan and back to the sump.

The Lube Oil System Operating Unit - Propelling Machinery is Main Reduction Gear #1 (Westinghouse) and Main Motor #1 & 3 (Elliott). This unit sets on its own sump (a section of the double bottom under) carries its own attached pump and lube oil service equipment. (Technical duplicate Reduction Gear #2 and MM 2 & 4).

Reduction Gears Thrusts & Main Motors - L.O. System Parts

Designate	Cal. Cap. Sump Under	Attached Pump	Strainer	Absorbent Filter (Cotton)	Cooler
Red. Gear #1	184	X	X	X	X
Main Motor #3					
Main Motor #1					
Red. Gear #2	184	X	X	X	X
Main Motor #2					
Main Motor #4					

The Lube Oil Purifier Unit is a Purifier #1 (FER) with heater and pumps (listed below) and piping of sufficient resource to permit application of centrifuge cleaning to any part of the whole lube oil system. (Technical duplicate Purifier #2, AER).

(Lube Oil Purifier System Sharples 250 gph) (Motor 2½" H.P.)

Designate	Location	Purifier Pumps: Built in Disch.	Purifier Pumps: Supply & Flushing	Filters: Knife Edge	Filters: Absorbent Cellulose	Heater
Purifier #1	FER	X	15 gpm	X	XX	X
Purifier #2	AER	X	15 gpm	X	XX	X

A Lube Oil Filling and a Lube Oil Suction line extends the whole limit of engine room and motor room spaces, serves all tanks and units, and operates through the standby pump. Motor Room application of this service is tabulated below:

Lube Oil Reserve Tanks & General Service

Designate	Location Fr.	Capacity Gals	Capacity Tons	Remarks
ME Stowage #1	86-88	479	1.65	
ME Stowage #2	95-99	814	2.70	
ME Stowage #3	Blkhd.99-100	990	3.40	
ME Stowage #4	Blkhd. 107	1466	5.05	
MM & Red. Gear	105-107	390	1.34	
General Service Pump Standby and Transfer	M.R. IMO Pump			Standby Pump substitutes for any attached pump and for distribution of reserve oil and general utility purpose
Strainer, Macomb	M.R.			Stand between outboard filling connection & the stand-by pump carries By-Pass
Pump, Hand	M.R.			Sampling pump (both sumps for removing water)
Filling Conn. (and Disch.)	Main Deck Fr. 107			Takes a 2½" Standard hose connection (N.D. Specs. 34F3) (counter-sunk in deck)
Filling Valve	19" Fwd. Fr. 107			A 2" aea angle valve, 2 ft. to port C/L Upper
Soundings	Sump Tank			Liquidometer gauge for engine sumps
Sounding	Sump & Tank			Each tank carries a 1½ sounding tube and rod calibrated in gals.

Lube Oil System Statistics

Extreme condition of roll or pitch allowable:

Permanent trim by head or stern surface. . . . . 7°
Permanent List, submerged . . . . . 15°
Pitch, max., plus or minus . . . . . 10°
Roll, Max. . . . . 45°

Lube Oil - Table of Temperature Ranges
Degrees Farenheit

Name	In	Out	Difference
Main Engines	138	166	28
Aux. Engines	136	160	24
Main Motor	120	126	6

Lube Oil Consumption - Pounds per BHP per hr 0.0021

Reserve Oil Tanks — Gallons

M.E. Sumps (4) Total, 75° net cap. 1776
M.E. Reserve Tanks, 95% net cap 3749
M&M & Red. Gears Sumps, 75% net cap 368
M.M. & Red. Gear Reserve, 95% net cap 390
M.E. & M.M. Sump & Reserve, total (21.50 tons) 6283

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Operation Note:

Operation of Reduction Gear Lube Oil System.

- WARNING -

As a military precaution, Sluice Valve between Sump Tank #1 and Sump Tank #2 must be kept closed during normal operation.

Sluice Valve Standby Pump Suction and Standby Pump Discharge must be open while Standby Pump is serving No.1 Reduction Gear and No.2 Reduction Gear Jointly. (SS228-S45-091)

Operating Note: - Cleanliness.

After a major overhaul involving draining of, and repairs to the lube oil system, the greatest care should be taken to cleanse all parts of the system and to insure that all pockets, such as coolers, strainers, filters are free from water, dirt, and other foreign matter. As a final means of cleaning the system before any part of the machinery is operated, lube oil should be circulated through the entire system continuously for a period of not less than 6 hours. After which all oil should be pumped from the system and all tanks, subject to contamination, wiped out with clean rags (not waste). All filters, strainers, and coolers should be cleaned where there is any possibility of shipyard contamination.

1/4

Reference Plans:

Ports.No.	BuShips No.	Title
52-381	490889	Compartments & Tanks.
533-209	312432	Lube Oil System - 2" Macomb Strainer.
5053-381	SS381-S4501-12235	Piping Diagram - Lube Oil System, Machinery Spaces.
5074-381		Engine L.O. System - Piping Arrgt. - M.R.
5059-381	SS381-S4500-67902	Engine L.O. System - Piping Arrgt. - F.E.R.
5061-381		L.O. Purifier & Transfer System - Piping Arrgt. - F.E.R.
5067-381	SS381-S4501-12234	Engine L.O. System - Piping Arrgt. - A.E.R.
5069-381	SS381-S4504-67923	L.O. Purifier & Transfer System - Piping Arrgt. - F.E.R.

Section U-11

DRAINAGE SYSTEM

For diagram - see Plate 16.
For pumps - see section U-9.
For plans - see section U-11.

General - The drainage system is shown on Plate 16.

Drain Line. The ship's drain line runs along the port side of the ship from about frame 20 to frame 120. It is of copper-nickel tubing, with an outside diameter of 2.375 inches and a test pressure of 300 pounds per square inch.

Drain Line Suctions lead to low point in compartment bilges to periscope wells, fuel oil collecting tank, and trim manifold.

Drain (and Trim) Pump Suction carries a macomb strainer.

Drain Line consists of a section, forward; a Section aft, an inter-connecting manifold, carrying the drain pump.

Drain Line Stop Valves are provided for isolating the forward section, or after section of the line.

A Bilge Suction, drain line, is fitted as follows:

(1) A Bilge Well of such size and location (and number) so that each compartment can be kept dry under average conditions of trim.
(2) A Strainer, portable, galvanized steel cage, readily cleaned.
(3) A Stop Check Valve to prevent inter-compartment flooding.

Special Note: Care should be taken to prevent the accumulation of bilge water under the auxiliary generators and main motors.

A Deck Drain leading to a sanitary tank is provided in the crew's washroom, showers, and water closets.

The Sanitary Tanks are fitted to permit emptying by blowing through separate sea connections. Distant reading gages are provided.

The Cross Connection lead from the drain line to the trim manifold allows the drain pump to take suction from the variable tanks and the torpedo tubes in case the trim pump is disabled. The drain pump discharge connection to the trim line makes it possible to empty the bilges into the variable tanks when it is not desired to pump dirty or oily water to sea. If bilges are to be pumped to a harbor barge the drain pump discharges into the trim line and thence into one of the hose connections.

Bilges, Pumping of. A connection is provided from the discharge side of the drainage pump to the compensating water line to permit pumping bilges overboard through the expansion tank and water tower after separation of oil from the bilge water in the fuel oil expansion tank.

The Fuel Oil Collecting Tank is fitted with gages to show the cleavage plane between the oil and water. The collecting tank is provided with a low-suction pipe from the drainage pump to enable the water to be pumped out. This connection is fitted with a sight glass to show whether oil or water is flowing.

List of Bilge Suctions and Cut-out Valves

Suctions

Compartment & Description	Frame	Side	Size	Type of Strainer
Forward Torpedo Room				
Bilge Suction	17-18	P	2.375"OD	Galv.Steel
Control Room				
Trim Manifold	53-55	P	3.5"OD	None
Pump Room				
Trim Pump Suction	54	P	3.50"OD	Macomb
Drain Pump Suction	54-55	P	3.50"OD	Macomb
Bilge Suction	54-55	P	2.375"OD	Sump Galv.Steel
Bilge Suction	47-48	S	2.375"OD	Sump Galv.Steel
Forward Engine Room				
Bilge Suction Ford.	77-78	P	2.375"OD	Galv.Steel
Bilge Suction Aft.	84-85	S	2.375"OD	Galv.Steel
After Engine Room				
Bilge Suction Forward	88-89	P	2.375"OD	Galv.Steel
Bilge Suction Aft	96-97	C	2.375"OD	Galv.Steel
Drain Pump Suction from Coll. Tank	89-91	P	2.375"OD	None
Motor & Maneuvering Room				
Bilge Suction Forward	100-101	P	2.375"OD	Galv.Steel
Bilge Suction Aft	104-105	C	2.375"OD	Galv.Steel
After Torpedo Room				
Bilge Suction	119-120	C-P	2.375"OD	Galv.Steel

Forward Torpedo Room — Cut-out Valves

Bilge Suction For'd	19-20	P	2"	L.P.Angle Check
Bilge Suction Pit.Log Well	33-34	P	2"	L.P.Cross Stop Chk.
Control Room				
Drain Line-Cut-out F&A	54-55	P	2-2"	Gate Sold'd.
Pump Room				
Bilge Suction Aft.	55-56	P	2"	Manifold Stop Chk.
Bilge Suction For'd.	54-55	P	2"	Manifold Stop Chk.
After Battery Room				
San.Tk.#2 Disch.Overbd.	74-75	S	2"	Angle Sea
San.Tk.#2 Discharge	77	S	2"	Angle Stop Chk.

List of Bilge Suctions and Cut-out Valves

Compartment & Description	Frame	Side	Size	Cut-out Valves Type
Ford. Engine Room				
Bilge Suction Forward	77-78	P	2"	Stop Chk.
Bilge Suction Aft	87-88	P	2"	Stop Chk.
After Engine Room				
Bilge Suction Forward	88-90	P	2"	Manifold
Bilge Suction Aft	88-90	P	2"	Manifold
Drain Line Suction from Coll. Tank	88-90	P	2"	Manifold
Drain Line Suction from Coll. Tank	91-92	P	2"	Spec.Angle
Motor & Maneuvering Room				
Bilge Suction	99-100	P	2"	Manifold Stop Chk.
Bilge Suction	99-100	P	2"	Manifold Stop Chk.
After Torpedo Room				
Bilge Suction	119-120	P	2"	Angle Stop Chk.

Reference Plans:

Ports.No.	BuShips No.	Title
[illegible]	490814	Sumps - Secondary Drainage System
[illegible]	490259	Ballast, Trimming & Drainage - Diagram
424-285	38651	Water & Drainage - Piping Arrgt. - Forward Torpedo Room
427-381	544612	Water & Drainage - Piping Arrgt. - Pump Room
432-285	386527	Water & Drainage - Piping Arrgt. - After Torpedo Room
475-275	387451	Water & Drainage - Forward & Aft Torpedo Rooms - Special Fittings
512-285	490159	Water & Drainage System - Piping Arrgt. - Motor & Maneuvering Rooms
549-201	312136	Water & Drainage System - Bilge Suction Manifold - 2" - Two Valve.
35163	490393	Macomb Strainer - 3" Nominal Size

PIPE LIST

MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
1	3"	Cu Ni	Trim Line Forward	300
2	3"	Cu Ni	Trim Line Aft	300
3	2"	Cu Ni	Drain Line	300
4	3"	Cu Ni	Forward Trim Tank Flood & Drain	300
* 5	3"	Cu Ni	Trim Pump Suct. Fr. Torpedo Tube Drain X-Conn.	300
6	5"	Cu Ni	Torpedo Tubes Drain Manifold Cross Conn.	300
* 7	5"	Cu Ni	W.R.T. Tank Flood & Drain	300
8	5"	Cu Ni	W.R.T. Tank Flood & Drain	-
* 9	3½"	Cu Ni	Torpedo Tubes Drain - Forward	300
10	3½"	Cu Ni	Torpedo Tubes Drain - Forward	300
11	5"	Cu Ni	Torpedo Tubes Drain - Forward	300
14	2"	Cu Ni	No.1 Sanitary Tank Overboard Disch.	-
15	2"	Cu Ni	No.1 Sanitary Tank Overboard Disch.	300
16	2"	Steel Galv.	Bilge Suction Forward Torpedo Room	-
18	1"	Steel Galv.	Bilge Suction Pitometer Log Well	300
19	2"	Cu Ni	Tank Top Drain to Bilge Forward Torpedo Room	-
20	2"	Cu Ni	Tank Top Drain to Bilge Forward Torpedo Room	-
21	2"	Cu Ni	Tank Top Drain to Bilge Forward Torpedo Room	-
22	3"	Cu Ni	Escape Trunk Flood	-
23	3"	-	Escape Trunk Drain	-
24	5"	-	W.R.T. Tank Overflow to Trim Tank	300
25	1½"	Cu Ni	Trim Line Hose Conn. to Compartments	300
30	5"	Cu Ni	Trim Manifold Sea Conn.	300
31	4"	Cu Ni	Trim Manifold Suction & Discharge	300
32	3"	Cu Ni	Trim Pump Suction	300
33	3"	Cu Ni	Trim Pump Discharge	300
34	3"	Cu Ni	Safety Tank Flood & Drain	300
35	3"	Cu Ni	Aux. Ballast Tank No.2 Flood & Drain	300
36	3"	Cu Ni	Aux. Ballast Tank No.1 Flood & Drain	300
37	3"	Cu Ni	Negative Tank Flood & Drain	300
38	3"	Cu Ni	Negative Tank Flood & Drain	300
39	3"	Cu Ni	Drain Pump Suction	300
40	2"	Cu Ni	Drain Pump Discharge	300
41	2"	Cu Ni	Drain Pump Discharge	-
42	2"	Cu Ni	Drain Pump Discharge to Trim Pump Dis.	300
43	2"	Cu Ni	Drain Pump Discharge to Comp. Water System	300
44	3"	Cu Ni	Cross Conn. Drain Line to Trim Manifold	300
45	1"	Brass	Gun Access Trunk Drain	-
46	1"	Brass	Conning Tower Hatch Drain	-
47	3"	-	Conning Tower Drain	300
48	1½"	Steel Galv.	Deck Drain From Control Room	-
49	2"	Cu Ni	Drain Pump Suction from Manifold	300
50	1"	Brass	No.1 Periscope Well Drain to Bilge	-
53	2"	Steel Galv.	Bilge Suction Pump Room	-
54	2"	" "	Bilge Suction Pump Room	-
55		Copper	Trim & Drain Pump Gauge Conn's	300
56	4"	Cu Ni	Magazine Sprinkling Supply	300
57	1½"	Steel Galv.	Pyrotechnic Magazine Sprinkler Supply	300
58	3"	Cu Ni	Safety Tank Flood & Drain	-
64	¾"	Brass	Main Air Int. & Ships Vent. Sup. Outb'd V.Drain	-
65	1"	Brass	Main Air Int. & Ships Vent. Sup. Outb'd V.Drain	-

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PIPE LIST (Continued)

MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
66	2"	Cu Ni	No.2 Sanitary Tank Overboard Discharge Line	
67	2"	Cu Ni	No.2 Sanitary Tank Overboard Discharge Line	
68	1"	Brass	Air Conditioning Cooler Drain Tank Overflow	
71	1"	Brass	Drain from Air Conditioning Cooler	-
72	2"	Cu Ni	Drain Line Suction from Forward Engine Room	300
73	2"	Steel Galv.	Bilge Suction Forward Engine Room	-
74	2"	"	Bilge suction Forward Engine Room	-
75	¾"	Brass	Drain from Main Engine Air Induction valve	-
76	¾"	Brass	Drain from Ships Ventilation Supply Hull V.	-
77	1"	Brass	Drain from Air Conditioning Cooler	-
78	¾"	Brass	Drain from Main Engine Air Induction Valve	-
79	2"	Cu.Ni.	Drain Line Suction from After Engine Room	300
80	2"	Steel Galv.	Bilge Suction After Engine Room	-
81	2"	" "	Bilge Suction After Engine Room	-
82	2"	Cu Ni	Drain Line Suction Fr. Collecting Tank	300
83	¾"	Brass	Drain From Main Engine Air Induction	-
84	2"	Steel Galv	Bilge Suction Motor Room	-
85	2"	" "	Bilge Suction Motor Room	-
86	3"	Cu Ni	After Trim Tank Flood and Drain	300
87	3"	Cu Ni	Trim Pump Suction Fr. T.T. Drain Cross Conn.	300
88	5"	Cu Ni	W.R.T. Tank Flood & Drain	300
89	5"	Cu Ni	W.R.T. Tank Flood & Drain	300
90	3½"	Cu Ni	Torpedo Tube Drain Aft	300
91	3½"	Cu Ni	Torpedo Tube Drain Aft	300
92	5"	Cu Ni	Torpedo Tube Drain Aft	300
93	5"	Cu Ni	W.R.T. Tank Overflow to Trim Tank	300
94	2"	Steel Galv.	Bilge Suction After Torpedo Room	-
95	½"	Brass	Drain from Radio Entering Tube	-
97	2"	Cu Ni	Drain Line Suction from Motor Room	300
98	¾"	Brass	Drain from Air Conditioning Cooler	-
99	1/8"	Copper	Drain from Bh'd Vent. Supply Valve	-
100	2"	Cu Ni	No.2 Sanitary Tank Overboard Discharge Line	-
101	2"	Cu Ni	No.2 Sanitary Tank Overboard Discharge Line	-

* - Pipes subject to external pressure.

MATERIAL SCHEDULE

NAME	MATERIAL	CONN.	TEST PRESS.	PLAN OR SPEC. NO.	P.N.Y.NO.
Piping	Copper Nickel		300#	44T40	
Manifold	Comp. M	Flanged	300#	Valve Parts 45V9	
Globe, Angle & Cross Valves	Comp. M	Flanged	400#	45V9	
Check Valve	Comp. M	Flanged	400#		
Sight Glass	Comp. M	Flanged	300#		12555
Macomb Strainer	Comp. M	Flanged	300#		35161
Stop Check Valve	Comp. M	Flanged	400#	45V9	
Shock Absorber for Press. Gauge					35934
Trap	Brass			44P12	
Waterseal	Brass			44P12	
Funnel	Copper			47C2	

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MATERIAL SCHEDULE (Continued)

NAME	MATERIAL	CONN.	TEST PRESS.	PLAN OR SPEC. NO.	P.N.Y. NO.
Waterseal with Vent Floor Drain	Brass			44P12	
Bilge Strainer	Steel Galv.			BuShips No. 386471	495-228
Pressure Gauge	Phenolic			45G1	
Flanges	Comp. M			45F14	
Bhd. Conn's.	Comp. M	Flanged		SS172-S48-310	S977
Fittings	Comp. M	Flanged		B104 45F12	
	Comp. M	Soldered Tube			
Gaskets Fuel Oil & Water	Compressed Asbestos Sheet			33P13	
Gaskets - Water	"			33P13	
Bolts & Studs	CL.B Steel(inside & above bilges)			43B11	
	CU Si Hard(outside & in bilges)				
Nuts Not in Salt Water or Bilge	CLC Steel			43B11	
Nuts in Salt Water or Bilge	Cu Si Hard			43B11	
¾" Flexible Steam Hose for Battery Vent Fans drains				ZZH541	
Tubing - Bilge Suctions	Steel Galv.	Flanged		44T43	
Silencing Joint	Comp. & Rubber	Flanged	350#		42004

TRIM PUMP DATA

Type - Vertical - Duplex Single Acting Worm Drive
No. of Cyl. 2
Bore 5½"
Stroke 5¾"
Suction 4" NOM.
Discharge 3" NOM.
Maximum Working Pressure 220# Per Sq. In.
Capacity 100 Gal Per Min at 220#
Rated Working Speed 93.8 R.P.M.
Motor Speed 1500 R.P.M.
H.P. of Motor 20 H.P.

DRAIN PUMP DATA

Type - Vertical - Duplex - Single Acting Worm Drive
No. of Cyl. 2
Bore 4¼"
Stroke 4-7/8"
Suction 3" NOM.
Discharge 2" NOM.
Max. Working Pressure 220# Per Sq. In.
Capacity 35 Gal. Per Min. at 220#
Rated Working Speed 80.75 R.P.M.
Motor Speed 1150 R.P.M.
H.P. of Motor 10 H.P.

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BALLAST, TRIMMING & DRAINAGE
See Diagram

GAUGE LIST

MARK	NO. REQ.	DIA. DIAL	SERVICE	ENGRAVING	READING	RED HAND SETTING
A	1	4½"	Water	Trim Pump Suction	30-300#	220#
B	1	4½"	Water	Trim Pump Discharge	0-300#	220#
C	1	4½"	Water	Drain Pump Suction	30-300#	220#
D	1	4½"	Water	Drain Pump Discharge	0-300#	220#

CAPACITIES & VOLUMES OF TANKS

	CUBIC FEET	OIL	TONS SEA WATER
Negative	282		~~8.00~~ 12
Safety	847		24.19
Auxiliary No. 1	1094		31.26
Auxiliary No. 2	1094		31.26
Forward Trim	860		24.57
Forward W.R.T.	176		5.00
After Trim	733		20.94
After W.R.T.	185		5.28
Fuel Oil Collecting	398	9.49	
No.1 Sanitary	42		1.19
No.2 Sanitary	143		4.09

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Section U-12-a

FLOODING AND VENTING

For M.B. Flooding and Venting see Plates 7 and 8.
For Hydraulic System see Section U-27.

MAIN BALLAST - VENTS - List of

Tank		Emergency Vents		Main Vents - Power					
M.B. No.	F.B.No.	Size	Operating Units	Size	Valve Units	Power Units	Control Unit	Capacity	Flooding Type
BB		None	None	13½	X X	X	X	30.2	Free
1		None	None	13½	X	X			
2A & 2B		11¼"	X X	11¼	X X	X	X	178.20	Free
2C & 2D		11¼"	X X	11¼	X X	X			
6A & 6B		11¼	X X	11¼	X X	X			
6C & 6D		11¼	X X	11¼	X X	X	X	181.14	Free
7		None	None	11¼	X	X			
Negative		3-3/16	X X (angle)	4-5/8	X	Hand		8.06	Sea Check
Safety		7"	X X (gate)	9¾	X	X	X	23.83	Sea Check
4A		14½	X	14½	X	X	X	90.28	Pressure Check
4B		14½	X	14½	X	X			
	3A & 3B	11¼	X X	11¼	X X	X			
	5A & 5B	11¼ (plus reliefs)	X X	11¼	X X	X	X	149.20	Pressure Check

Main Ballast Vent Valve Operating Gear and Control, Check-Off List:

For harbor security, see Columns 5, 7, 10 and 11.
For operating condition, see Columns 4, 6, 7, 8 and 9.
For test of hand operation, see Column 3.
For security of system against drainage through a ruptured line, see Column 6A.

Tank M.B. No.	VENTS											
	POWER - VENT VALVES									HAND-VENT VALVES		
		Lock For			Hydraulic Control							
	Blank Flange	HAND	POWER	Hand& POWER	Open	Emer-gency	HAND	Close		Open	Close	Lock
Col. No. 1	2	3	4	5	6	6A	7	8		9	10	11
1		X	X	X								
2A		X	X	X	X	X	X	X		X	X	
2B										X	X	
2C		X	X	X						X	X	
2D										X	X	
F.B. 3A	X	X	X	X							X	X
F.B. 3B	X										X	X
						X	X					
F.B. 5A	X	X	X	X							X	X
F.B. 5B	X										X	X
4A		X	X	X	X	X	X	X		X	X	
4B		X	X	X						X	X	
6A		X	X	X						X	X	
6B										X	X	
					X	X	X	X				
6C		X	X	X						X	X	
6D										X	X	
7		X	X	X								
Safety		X	X	X	X	X	X	X		X	X	
Nega-tive		X								X	X	X
B.B.		X	X	X	X	X	X	X				

Main Ballast Indicator System (Circuit TP) Control Room Indicator:

X Indicates Contactor Type P.
Intermediate position for Vents shows RED, for Flood Valves DARK.

Designate	Tank Extent Frames	Emergy Vents Frame	VENTS Hydraulic Frame	VENTS Hydraulic Circuit TP	FLOOD VALVES Hand Frame	FLOOD VALVES Hand Circuit TP	
B.B.	0-10	None	25	X	Free		
M.B. 1	25-35	None	32	X	Free		
M.B. 2A M.B. 2B	46-52S P	52S P	49	X	Free		
Negative	50-52	51S 51P	Hand	X	51	X	Power
M.B. 2C M.B. 2D	52-57S P	56S P	61	X	Free		
F.B. 3A F.B. 3B	57-62S P	62S P	62	X	58-60S P		Neoprene gaskets
Safety	62-64	64	64	X	63 P & S	X X	Power
M.B. 4A M.B. 4B	69-75S P	75S P	75S P	X X	70-72-74S P		Extra Fldg. Capacity
F.B. 5A F.B. 5B	75-80S P	79	76	X	76-79S 76-79P		Neoprene Gaskets
M.B. 6A M.B. 6B	80-85S P	84	86	X	Free		
M.B. 6C M.B. 6D	85-91S P	90	87	X	Free		
M.B. 7	108-117	None	119	X	Free		
Total				13			

Hull Opening Indicator System (Circuit TR) Showing units on the circuit and indicators itemized according to location:

RIG FOR DIVING	Indicator In C.R.	Fwd. F.R.	Aft E.R.	Mnvg. Room	Intermediate Position Shows Red	Dark
Hatches & Doors						
Escape Trunk Door Fwd. Torpedo Room	X				X	
Escape Trunk Hatch Fwd. Torpedo Room	X				X	
Gun Trunk Hatch	X				X	
Gun Trunk Door	X				X	
Crew's Space Hatch	X				X	
Aft E.R. Hatch	X				X	
Aft T.R. Hatch	X				X	
Dive						
Conning Tower Upper Hatch	X				X	
Eng. Air Ind. Vent Exhaust & Hull Supply Outboard	X	X	X			X
Main & Aux. Exhs.						
No. 1 M.E.	X	X				X
No. 2 M.E.	X	X				X
No. 3 M.E.	X		X			X
No. 4 M.E.	X		X			X
Aux.	X		X			X
Inboard Valves						
Hull Supply Inboard	X	X				X
Air Induction, Fwd. E.R. Inboard	X	X				X
Air Induction, Aft E.R. Inboard	X		X			X
Air Induction, Manvg. Rm. Inboard	X					X

The ship is practically free flooding as to main ballast. Flooding holes are cut in the bottoms of the tanks. (Ref.977) These holes are approximately 20" x 26".

	Flooding Holes					
	No.	Frames	Area Sq. Ft.	Cap. Tons	Total	Total
Forward Group						
MBT No. 1	8	29-33	16.54	48.34		
MBT No. 2A & 2B	8	46-50	12.08	31.90		
2C & 2D	8	53-57	12.08	33.03	178.20	
After Group						
6A & 6B	8	80 & 81: 83 & 84:	10.56	34.09		
6C & 6D		85 & 86: 88 & 89:	10.56	36.15		
7	6	108 & 111:	11.32	40.66	181.14	224.17 Tons

The vents of each of the above groups are thrown from a single lever at the ship's hydraulic manifold. Harbor security is provided in the hand vents.

M.B. Tank No. 4A and 4B stands at the ship's center of buoyancy (1.1 ft. abaft of Frame 59). This tank carries 150% of normal venting capacity, with consequent speed in flooding. For diving purposes it concentrates a rapid negative effect at the center of buoyancy. Six flapper flood valves, hand operated, (pressure seated) are fitted to this tank, as a reserve of security where positive buoyancy is a consideration.

Hand gear, only, is applied to following harbor security valves:

(a) Floods, main ballast 4A and 4B, Fuel Ballast 3A and 3B - 5A and 5B.
(b) Vents, emergency, main ballast.

Hydraulic, remote control power is applied to:

(a) Master vents - BB- MB groups 1 and 2, MB No. 4, safety.
(b) Flood Valve - Safety tank.
(c) Flood Valve - negative tank.
(d) (Exception) Vent valve - negative tank (Quick Opening, Hand; only.)

An electric indicator system is fitted to all vent valves as described in machinery plans.

Time for flooding main ballast tanks, including time necessary to open vents is (speed 0 to 6 K.):

Forward Main Ballast Group - (#1, 2 & 3) - 17 sec. (Max.)
After Main Ballast Group - (#4, 5, 6 & 7) - 25 sec. (Max.)
Safety Tank (Opening flood and vents) - 20 sec. (Max.)
Negative Tank (at 48 feet axial) - 10 sec. (Max.)

Rubber gaskets are fitted to all M.B. safety and negative tank floods and vents.

Oil-resisting synthetic rubber is used for similar purpose on fuel ballast tanks.

Pad locks are fitted to all flood and main vents, on all main ballast tanks and on emergency vents of F.B. tanks only.

All vent valves for M.B. and F.O. ballast tanks seat with tank pressure.

All vent valves for M.B. and F.O. Ballast tanks are protected against shock load from depth charges. This consists of coil springs interposed between operating gear and the flapper valve leverage. When open, the flapper recesses in a pocket clear of the streamline.

Seven control valves (hydraulic in C.R. operate M.B. vents in groups as follows: (see Hydraulic System)

(1) Vent - B.B. Tank.
(2) Vents - M.B. Tanks No.1, 2A, 2B, 2C & 2D. (MBT Group 1)
(3) Vent - Safety Tank.
(4) Vents - F.O. Ballast Tanks Nos. 3A, 3B, 5A & 5B.
(5) Vents - M.B. Tanks No. 4A & 4B.
(6) Vents - M.B. Tanks Nos. 6A, 6B, 6C & 6D. (MBT Group 2)
(7) Vent - M.B. Tank No.7.

Wire mesh guards are fitted to protect all main vents from fouling. Design is protective against ice.

Blank flanges are provided for use on vent valves of F.O. ballast tanks when carrying fuel.

A relief valve ($\frac{1}{4}$" ID), spring loaded, ball check, lifting at 20 lbs. perforates each F.O. ballast tank emergency vent valve disc; one relieving inboard to tank and one relieving outboard to vent pipe between main & emergency vents.

Venting inboard (only) at blow manifolds is provided for:

(1) Variable ballast tanks.
(2) Auxiliary tanks.
(3) W.R.T. Tanks.
(4) Negative Tank (quick opening valve, C.R.).

Bow buoyancy tank vents are hinged flapper, in two units, on a single operating gear, hydraulic powered from the C.R., and hand from F.T.R. Valves are screened against fouling.

Deflecting screens, scoop shaped, are fitted inside the BB tank flooding holes to prevent torpedo impulse air from partially blowing the tanks.

Main Ballast Tank 2C, frames 52 to 57 starboard, has a capacity of 1156 cu.ft. or 33.03 tons S.W. only. There are four flooding holes, about 20" x 26", oval, between frames, adjacent to keel, cut during the ship's first docking, (Ref. 977)

Main Ballast Tank No. 2D is identical except to the left hand.

Tanks with flooding holes similar to MBT 2C but varied to suit location are: 2A and 2B, 2C and 2D, 6A and 6B, and 6C and 6D. MBT 1 and 7, being on sharper contours, have varied sizes of holes to suit.

Main Ballast Tank No. 4A carries 3 flapper floods. The cover is oval (about 24" x 36" effective on the gasket), flexibly hinged, 9" from keel line and opening upward and inboard 20". The gasket (⅜")(flush with knife edge contact) is molded oversize 1/32" to 3/64" and cemented (R.B. Rubber Cement - LaFavorite Rubber Co., Patterson, New Jersey) in the wedge shaped groove. (Ref. 792)

M.B. Tank No. 4B is identical to other hand.

Main Ballast Tank No. 4A, Flood Valve Cover, has 14 duplicated in the ship, viz:

FBT 3A & 3B - 5" Aft. Fr. 58 - 2
5" Aft. Fr. 60 - 2
MBT 4A and 4B- 5" Forward Fr. 70 - 2
5" Forward Fr. 72 - 2
5" Forward Fr. 74 - 2
FBT 5A and 5B- 5" Aft. Fr. 76 - 2
5" Forward Fr. 79 - 2

Variation: FBT carry neoprene synthetic oil resisting gaskets.

Main Ballast Tank No. 4A Flood Valve Hand Operating Gear is built on the rotating nut, travelling screw-thread principle. The travel of the operating shaft is 5". It pushes the bell crank to close and pulls to open the flood valve. The operating shaft (1.37" dia.) carries a crosshead guide, a stuffing box (through pressure hull), an indicator arm. The indicator arm carries an indicator rod that links to the mechanical indicator. There is a spring loaded locking pin and a chain tethered padlock. (Ref. 1104)

Flood Valve Operating Gear is so adjusted that in the closed position of the valve the toggle joint above the valve cover is moved to a point 1½" before dead center, thus keeping a constant pressure on the valve and assuring non-leakage of water. Each flood valve except safety and negative tanks takes up against a positive stop in the open position in the form of a lug welded to the tank floor in the inner hull. It prevents lost motion in the linkage, prevents the inflowing water from putting a strain on the linkage, and prevents the valve from opening far enough to foul the operating shaft.

Main Ballast Tank No. 4A Flood Valve and Gear is typical also for full ballast tanks, modifications and variations being local to suit conditions.

Main Ballast Tank No. 2C Emergency Vent Valve seat welds into the tank top between the inner hull plating and the knuckle line of the outer hull. The valve seat is 11¼" ID and its center is 12½" forward of Frame 57 and 6'-6-25/32" from centerline of ship. The flange of the vent pipe leading to the master vent valve bolts to the emergency vent valve seat casting. The valve seat is a knife edge to face a rubber gasket. (Ref. 981)

Main Ballast Tank No. 2C Emergency Vent Valve Cover is a circular, dished flapper, webbed and fitted for a toggle link, hinged (elongated hole for flexibility), and gasketted with "T" shaped gaskets. The valve seat casting carries two brackets which mount gear described below. (Ref.982, 983).

NOTE: Fuel Oil Ballast Tanks Nos. 3A, 3B, 5A and 5B - The emergency valve covers are tapped for two spring loaded ball check relief valves (¼" x 1½" high) which lift at 20 lbs. One relieves inboard to tank and the other outboard to vent pipe. They protect the vent pipe against unbalanced expansion pressures.

Main Ballast Tank No. 2C Emergency Vent Valve Gear is a flexible-hinged flapper, with a worm and pinion bell-crank-operated toggle joint. Four grease connections protect this mechanism which is exposed to salt water immersion. The worm (2.25" O.D. x 3-7/8" L.) is N.C. alloy and the worm wheel (8¾" O.D. x 180°) is of phosphor bronze. The assembly is supported on valve seat casting brackets. The worm shaft (1" O.D. x 10" L.) is N.C. and ends in a flexible (double pin and knock-hole) coupling which engages the handwheel shaft. The handwheel shaft assembles in a stuffing box welded into the pressure hull (50° angle from horizontal). It takes a 26 lb. pull and 7½ revolutions on the handwheel to open. The toggle has a positive stop to prevent the joint from moving beyond a point ½" before reaching dead center.

Similar valves are fitted, with variations due to locality, on all saddle tanks. Some are operated by a T-wrench conveniently stowed. 4A and 4B are 14½" in diameter. There are 14 emergency vent valves in the ship, total.

Main Ballast Tank No. 2C - Master Vent Valve stands 13" to Starboard of Ship's C.L. above the pressure hull (21'-3" AB, C.L. of Hull at this point is 11'-9" AB). (Ref. 978).

Main Ballast Tank No. 2C Vent Valve Cover is circular Comp. G disc (12-17/32" O.D.) dished against sea pressure, webbed, loose (double) hinged from top. It carries a molded rubber "T" shaped gasket (½" face) with a retainer ring. The valve cover in the close position hangs at an angle of 15° from vertical, the bottom edge outboard. When open it swings outward through 54°, and recesses clear of the air stream. (Ref. 987).

Application, general: M.B. Nos. 1, 7, 2A,B,C,D, 3A,B, 4A,B, 5A,B, 6A,B,C,D, and 7, Safety.

Variation: Fuel Ballast No. 3 and 5 have synthetic oil resisting gaskets.

Main Ballast Tank No. 2C Vent Valve Body is a comp. G casting flanged (11¼" ID) to the pipe leading to the emergency vent valve. It supports the valve cover, the bell crank mechanism which operates the valve cover, has a flat champered seat for the valve cover rubber "T" shaped gasket, and a rectangular access hole (and cover) through which the valve cover may be removed. It has a 10 lb. blow flange (3½" D. bore) and brace lugs. The valve body carries two lugs which support the bell crank on a fulcrum pin. (Ref. 987)

Main Ballast Tank No. 2D is identical except to opposite hand.

Main Ballast Tanks 2A,B,C,D, 3A,B, 4A,B, 5A,B, 6A,B,C,D and 7, are similar except as to local variations.

Fuel Ballast Tanks 3 and 5 are a variation. Being fuel tanks, a blank flange (14¼" x ½" thick) is marked "cover for Vent Valve Fuel Ballast Tank No. 3A", and fitted with a double lug (on inside) to take the valve cover connecting link. The cover has tied to it a bag containing 15-¾" tap bolts, stowage is inside the ship. To fit the cover, detach the connecting link and attach to cover, force cover on face of valve body (this stows the valve cover in its open position) and bolt up. Lash the spring units on the operating shaft together. Keep all empty holes filled with tallow. (Ref. 985)

Main Ballast Tank No. 2C vent valve operating gear is a vertical shaft (1.49" D. x 24-7/16") and crosshead (adjustable) mounted on a cast frame bolted to a pad on the pressure hull. Stuffing box and grease connections are fitted. Force is applied to the crosshead double-swing link (3½" L.) connection to a slotted link (7½" b.c.). The slots' case hardened rollers (1.623" D) ride on a compound bell crank (4-11/16" rad. b.c.) which is pinned to the ball and socket connecting rod of the hydraulic piston (3¾" D. x 3½" stroke) mounted at 30° from level on the frame. When operating on POWER, a HAND lever (2'-4½" L.) rests horizontal in its fulcrum pin and a tethered locking pin (.785" D. x 5-9/16" L.). The lower arms of the bell crank float across the HAND lever in POWER operation. In HAND operation the locking pin is used to consolidate the hand lever with the bell crank and the piston floats on the assembly when the hydraulic pressure is properly by-passed. The bell crank carries also a drilled ear suited to the locking pin and meshed with the frame web. This provides for security and POWER or HAND operation in the closed position. The linkage is so designed that failure of the power system does not render the valve self-overhauling. Time of POWER operation calculated, 1.2 secs.

Main Ballast Tank Vent - General - Operating Note:- In event of a casualty disarranging the foundation supporting the vent valves or distorting the pressure hull thereby tending to keep the valve open, provision has been made whereby the vertical shaft may be adjusted within certain limits (½" up or down from neutral position, which position is the designed installed position) to permit the tight closing of the vent valve cover. This is accomplished by removing the vertical shaft locking bolt, Pc. C3-Pl. 998-381 and then turning the vertical shaft in or out, within the limits of adjustment until the valve is closed and again in proper operation.

Main Ballast Tank No. 2C Vent Valve Operating Gear Socket Wrench stows on spring clips on the frame. It is a T-wrench for ¾" hex to suit the lower end of the operating shaft, and 3/8" hex to suit the main ballast No. 2C vent valve operating shaft, which locks the shafts vertical dimension in the crosshead. (Ref. 995) This wrench also has a hex to be used to operate the Emergency Vent Valves in the Compartment which are not fitted with Handwheels.

Main Fuel Ballast And Safety Tank Vent Valve Operating Gear assemblies in the ship are (with variations in operating shafts) No.1, 2A-2B, 2C-2D, 3A-3B, 4A, 4B, 5A-5B, 6A-6B, 6C-6D, No. 7 and Safety.

Main Ballast Tank No. 2C Vent Valve Operating Shaft at its upper end is fitted with a spiral spring (3-5/16" M.D. x 8¾" assembled Ht.) (1680 lb. initial stress) drag link connection to the valve cover bell crank, to protect against depth charges. The flexibility is ¼" at the end of the operating shaft.

Note on Assembly: Care to be taken that when valve is fully closed the dimension between finished surfaces of gage pads measures 8". (Ref. 985)

The vents enumerated in paragraph above have similar springs.

All main ballast vents have connections for 10-pound blow lines. The 600-pound M.B. blow line leads directly to the top of each tank and has no connection with the vent system.

Main vents are enclosed in protecting boxes of galvanized steel mesh.

The Safety Tank Flood Valve, starboard (at Frame 63) Cover is oval, Comp. M, diagonally webbed and double hinged and hung from the top in a vertical plane when open (16" opening off seat). The cover seats with sea pressure. The knife edge is built-up bronze on steel. The rubber gasket is T-shaped, cemented in place in a T slot and held by a phosphor bronze screwed insertion. There are two of these valves P & S (Ref.793).

The Safety Tank Flood Valve Hydraulic Operating Gear (also SS281-284) consists of an operating shaft (1.5" D x 3' - 8-13/16") with hydraulic piston (5.25" D. x 5½" stroke) on the outboard end, and single acme threads (3 per in. L.H. for 15 turns) on the inboard end, and a crosshead in the middle. The crosshead is double connected to the bell crank system in the tank and to the valve cover. Hydraulic POWER action is simple and direct. HAND action is on the split nut principle. Split nut is engaged when handles are in open position, and disengaged when handles are folded. There is a locking pin (.370 D. x 3-11/16" L.) that actuates a sliding block (1.684" x 2½") which locks the assembly for either POWER or HAND operation and is supplied with a hasp hole and tethered padlock. Mechanical lever indicator combined with electric contact maker are part of the assembly. (Ref. 795).

Assembly Note: Operate by hand and set pointer against positive stop on indicator plate when piston is ⅛" from end of cylinder. This allows indicator light to show when strain on handwheel crank is released to allow releasing split nut from screw threads when changing from HAND to POWER operation. (Ref. 795).

Safety Tank Emergency Vent Valve, starboard (Frame 63) (Port valve identical) a handwheel operated, mechanical indicated, travelling nut, wedge action, built-in-ship, 7" gate valve. The body of this valve forms part of the pressure hull.
The valve disc and stem can be removed from inside the ship. (Ref. 990,991)

Safety Tank Vent Valve (at Frame 63) is a 7" flapper, design as described under typical vent, M.B. No. 2C. Variation is that there is only one flapper common to both sides of the tank.

Safety Tank Vent Valve Operating Gear is same as described under M.B. Tank No. 2C, with variation to suit locality.

The Negative Tank is fixed ballast, normal condition, empty. In diving trim it carries weight zero, with a capacity of 8.06. The tank covers the space between Frames 50 and 52, rising to a 45° longitudinal, only, on port and starboard sides. With the negative tank a diving moment of 294 foot tons can be flooded in 8 seconds and discharged in 3 seconds.

The Negative Tank is supplied with all the appurtenances of a fixed ballast tank, with the added feature of a hydraulic flood valve which opens against the sea.

The Negative Tank Flood Valve Cover is a vertical flapper (16" D.) mounted on the vertical keel, hinged at top and hanging vertical when closed on a rubber gasket knife edge joint. The valve cover swings from starboard to port in a special recess. The opening is 11". The mechanism is bell crank. (Ref. 1122)

1/4

The Negative Tank Flood Valve Operating Gear is a system of straight and bell-crank leverage, with a vertical shaft passing through the pressure hull and stuffing box at Frame 50 keel line. The hydraulic piston and cylinder stand immediately above. The same gear provides hand operation, and contactor for valve indicator circuit. The operating gear is a modified form of the POWER-HAND mechanism described under Safety Tank Flood Valve.

A Negative Tank Drain Connection is provided. A deep suction leads to the bottom of tank just off the keel line at Frame 51. This is connected to the drain line through connections in the control room.

The Negative Tank H.P. Blow Line enters the tank through a ½" H.P. travelling bushing angle valve in a bulkhead cone fitting in the pressure hull at Frame 51, starboard. A valve for the pressure gauge leads into the tank at the same point. The negative tank blow line is thence connected to the H.P. air manifold, CR.

The Negative Tank Inboard Vent Valve (4½" D. Disc. x 1-3/16" lift) is a goose-neck globe valve with rubber gasket knife edge disc, seating against sea, with a push stem actuated by a latched farm machinery grip handle lever swinging through 41°. Component forces are resolved in a roller on the valve stem travelling in a slotted link on the handle. (Ref. 486)

The Negative Tank Vent Line takes off the high point of the bounding longitudinal, port side at frame 51 (starboard side at Frame 50) enters the pressure hull through an angle valve, follows forward to Frame 49, where it ties into starboard-port cross connection, and rises through the deck to the quick-opening valve, through a sight box thence through a goose-neck to the bilge.

Main Ballast Tank No. 1 Vent Valve is a variation in size only, 13¼" D., and by reason of being a single unit mounted on a tee in the vent pipes, port and starboard. Typical design of the valve body and cover is given in M.B. Vent No. 2C. This valve and gear stands at Frame 32. (Ref. 1100)

Main Ballast Tank No. 1 Vent Valve Operating Gear is same as described under M.B. Vent No. 2C.

Main Ballast Tank No. 1 has no emergency vents.

The Bow Buoyancy Vent Valve is a (14¼" D.P.C.) valve seat and valve seat cover (Comp. G disc with rubber "T" shaped gasket and composition built-up knife edge) double, slotted, hinged on forward rim. The valve cover pushes up from the bottom to seat in a horizontal position against the sea. The valve cover mechanism is a simple, vertical lever swinging fore and aft and jamming the flapper shut with a toggle joint, the stop lugs of which are set short of ¼" from dead center. The valve seats are at Frame 0½ port (11¾" off C.L.) and Frame 8½, 7¼" starboard (7¼" off C.L.). The bow buoyancy tank vent operating gear stands inside the pressure hull 75 feet abaft the forward valve and the intervening rods and levers are extensive and are best seen on the plan. (Ref. 704)

The Bow Buoyancy Vent Valve Operating Gear stands overhead in T.R. Frame 25½ (18'-6¼" AB). The POWER is hydraulic and the alternative is HAND. The principle and design is the same as that described under Main Ballast Tank Vent No. 2C (hydraulic piston, bell crank, slotted lever action). The piston of the B.B. vent valve operating gear is only 2.25" D. The operating shaft stands vertical and pierces the pressure hull to actuate the series of rods, flexible joints and bell cranks that extend from frame 25½ to frame 10 (B.B. bulkhead) single and thence double to reach the valve cover levers. Similar to a M.B. vent valve gear, the B.B. vent valve operating gear can be locked with its pin for (1) HAND (2) for POWER (3) and against either HAND or POWER. HAND operation load is 38 lbs. Oil pressure for operation against 6 psi on valve equals 200 lbs. Time for operation 1 second.

Assembly NOTE: When piston is against its stop, the clearance between roller and the end of the slot in the slotted link should be 1/16". (Ref. 711)

Main Ballast Tank No. 7 Vent (Frame 116) is a single standard main ballast vent unit, complete with operating gear, teed into the starboard-port vent pipes. There are no emergency vent valve. (Ref. 810)

Prudential Rules for Flooding Down:

(1) Maintain a reserve for blowing: do not open Safety, BB and MBT vents all at same time.
(2) Vents on No. 4 MBT should be kept closed until all hull openings are closed and there is definite pressure in the boat.
(3) Main Air Induction - Ships Vent.Exh. and Supply, Outboard Valve. Close before opening No. 4 vents.
(4) BB vents should be closed as soon as flooded.

Prudential Rule for Maneuvering in Close Waters:

(1) When in danger of collision: present the bow.

Section U-12-a

TRIMMING - Plate 16

The Trim Manifold provides flexibility and resourcefulness of control over the trim pump, drain pump, all items of variable ballast in the ship, including torpedo tubes, fuel oil compensating system, all bilge and tank suction, all sea connections on the trim or drain line, forward and aft.

The Trim Manifold principal branches:

(1) Fixed and Variable Ballast amidships, deep suction to:
  (a) Safety, Negative and Auxiliary Tanks
(2) Main body of manifold carrying:
  (a) Root valve
  (b) Sea Connection
  (c) Trim Pump connection
  (d) Forward Trim line
  (e) After Trim line
(3) Cross connection trunk to Drain Pump, i.e.:
  (a) Root Valve
  (b) Drain Pump connection
  (c) Crossovers to Trim Pump, Forward Drain Line and After Drain Line.

The piping is installed in short lengths to facilitate renewal of sections.

Particular care is taken in the installation of the trimming line to avoid sharp bends in the piping in order to prevent water hammer from the pump.

The trimming pump controller is located in the control room adjacent to the trimming manifold. A distant reading revolution counter for the pump is provided in full view of the manifold operator so that the pump revolutions may be used as a measure of the amount of water passing through it. The dial of this counter reads in pounds and has a resetting device.

Total miscellaneous connections off the trim line are itemized on Plate 16.

Variable Ballast Tanks - Flood and Drain Connections:

Name and Number	Extent Fr.	Side	Manifold from which flooded & pumped	Size
Aux. No. 1	64-69	S	Trim manifold in COC	3"
Aux. No. 2	64-69	P	Trim manifold in COC	3"
Forward Trim	13-23	P&S	Trim manifold in COC & Overflow Fr. W.R.T.	3"-5"
Forward W.R.T.	23-25	P&S	Trim manifold in COC & drain manifold in F.T.R.	3"-5"
Aft Trim	125-130	P&S	Trim manifold in COC and Overflow from W.R.T.	3"-5"
Aft W.R.T.	117-119	P&S	Trim manifold in COC and drain manifold in A.T.R.	

Variable Ballast Tanks - Blow and Vent Connections:

Name and Number	Extent Fr.-Fr.	Side	Manifold from which blown and vented	Size
Aux. No. 1	64-69	S	225-lb. Service manifold in COC	1"
Aux. No. 2	64-69	P	225-lb. Service manifold in COC	1"
Forward Trim	13-23	P&S	225-lb. Service manifold in COC, 225-lb. svc. manifold in F.T.R.	1½"
Forward W.R.T.	23-25	P&S	225-lb. Service manifold in F.T.R.	1¼" Blow 1½" Vent
Aft. Trim	125-130	P&S	225-lb. Service manifold in A.T.R., 225-lb. Service manifold in COC	1½"
Aft. W.R.T.	117-119	P&S	225-lb. Service manifold in A.T.R.	1¼" Blow 1½" Vent

MAIN BALLAST TANKS

Tank MBT No.	Frames	Side	Flood Valves: Frames	Flood Valves: Side	Flood Valves: Size sq.ft. of each Valve	Flood Valves: Flood Valve Area, each tank, (Sq.Ft.)
1	25-35	P&S		P&S		
2A	46-52	S	Flooding Holes	S		
2C	52-57	S		S		
2B	46-52	P		P		
2D	52-57	P		P		
Safety Tank	62-64	P&S	63	P&S	3.86	7.72
3A	57-62	S	58 & 60	S	5.14	10.28
3B	57-62	P	58 & 60	P	5.14	10.28
4A	69-75	S	70, 72 & 74	P	5.14	15.42
Bow Buoyancy Tank	Free Flooding From Sea					
Neg. Tank	50-52	P&S	51	C.L.	1.40	1.40
4B	69-75	P	70,72,74		5.14	15.42
5A	75-80	S	76,79		5.14	10.28
5B	75-80	P	76,79		5.14	10.28
6A	80-85	S				
6B	80-85	P				
6C	85-91	S				
6D	85-91	P				
7	108-117	P&S				

	Vent Valves: Frames	Vent Valves: Side	Vent Valves: Size	Vent Valves: Area Sq. Ft.
1	32	S	13¼"	.96
2A	49	S	11¼"	.69
2C	61	S	11¼"	.69
2B	49	P	11¼"	.69
2D	61	P	11¼"	.69
Safety Tank	104	CL	9¾"	.519
3A	51-62	S	11¼"	.69
3B	61-62	P	11¼"	.69
Bow Buoyancy Tank	9-10	S	13½"	.99
	0-A	P	13½"	.99
4A	74-75	S	14-7/8"	1.2
4B	74-75	P	14-7/8"	1.2
5A	75-76	S	11¼"	.69
5B	75-76	P	11¼"	.69
6A	86-87	S	11¼"	.69
6B	86-87	P	11¼"	.69
6C	87-88	S	11¼"	.69
6D	87-88	P	11¼"	.69
7	118	S	11¼"	.69

MOULDED GASKETS FOR ONE VESSEL

PC. NO.	PORTS. PLAN NO.	SPARES	SERVICE	TYPES A B C D E F G	MATERIAL	SIZE: DIAM. FOR ONE GASKET	SIZE: EXP. LENGTH for ONE GASKET	GASKETS PC. & PLAN NO'S.	APPLYING TO SUBMARINES	SPEC. NO'S.
A_3	1101-205		M. B. Tank #1 Vent Valve Cover	1	Moulded Rubber	13.1875"		Pc.B_3 MS 9551	SS205	33R4 Sym.#1304
B_3	987-205		M. B. Tank #2 & #4 Vent Valve Cover	8	Moulded Rubber	9.9375"		Pc.B_3 MS 9551	SS205	do.
C_3	710-205		Bow Buoyancy Vent Valve Cover	1	Moulded Rubber	14.250"		Pc.D_3 MS 9551	SS205	do.
D_3	994-205		Safety Tk. & M.B. #5 Vent Valve Cover	2	Moulded Rubber	7.6875"		Pc.B_3 MS 9551	SS205	do.
E_3	1165-205		Bow Buoyancy Vent Valve Cover	1	Moulded Rubber	8.750"		Pc.D_3 MS 9551	SS205	do.
F_3	987-205		Fuel Ballast Tk. Vent Valve Cover	2	Oil Resisting	9.9375"		Pc.C_3 MS 9551	SS205	33G7
G_3	5112-231	4	M.Eng.Exh.Sys. 15" Outside Valve Disc	4	Oil Resisting		4' 11.95"	Pc.C_3 PL.5112-231	SS233,235,292-303 incl.&307-312 incl	33G7
H_3	5112-381	4	M.Eng.Exh.Sys. 15" Outside Valve Disc	4	Oil Resisting		4' 11.95"	Pc.K_3 PL.5112-381	SS381 to 434 incl.	33G7
J_3	793-275	2	Flood Valve Cover Safety Tank	2	Moulded Rubber		7' 3.67"	Pc.H_3 PL. 793-275	SS285-312 incl. & 381-434 incl.	33R4 Sym.#1304
K_3	1122-201	1	Flood Valve Cover Negative Tank	1	Moulded Rubber	16.750"		Pc.G_3 PL.1122-201	SS201-203 incl.209-211 incl. 228-239: incl. 275-312 incl. 381-434 incl.	do.
L_3	987-275	9	M.B.Tks.2A,2B,2C,2D,6A,6B,6C,6D & 7 Vent Valve Covers	9	Moulded Rubber	11.1875"		Pc.D_4 PL. 987-275	SS285 to 312 inclusive	do.
M_3	987-381	9	M.B.Tks.2A,2B,2C,2D,6A,6B,6C,6D & 7 Vent Valve Covers	9	Moulded Rubber	11.1875"		Pc.D_4 PL. 987-381	SS381 to 434 inclusive	do.
N_3	994-201	1	Safety Tank, Vent Valve Cover	1	Moulded Rubber	9.6875"		Pc.V_3 PL.994-201	SS285-312 incl. & 381-434 incl.	do.
O_3	710-201	2	Bow Buoyancy Vent Valve Cover	2	Moulded Rubber	14.250"		Pc.A PL.710-201	SS285-312 incl. & 381-434 incl.	do.
P_3	1005-228	2	M.B.Tks.4A & 4B Vent Valve Cover	2	Moulded Rubber	14.4375"		Pc.W_3 PL.1005-228	SS308-312 incl. & 381-434 incl.	do.
Q_3	1101-201	1	M.B.Tk.#1 Vent Valve Cover	1	Moulded Rubber	13.1875"		Pc.B_4 PL.1101-201	SS285 to 312 inclusive	do.
R_3	1101-381	1	M.B.Tk.#1 Vent Valve Cover	1	Moulded Rubber	13.1875"		Pc.B_3 PL.1101-381	SS381 to 434 inclusive	do.
S_3	987-275	4	Fuel Ballast Tks.3A,3B,5A & 5B Vent Val.Cvr.	4	Oil Resisting	11.1875"		Pc.E_4 PL.987-275	SS285 to 312 inclusive	33G7
T_3	987-381	4	Fuel Ballast Tks. do.	4	Oil Resisting	11.1875"		Pc.E_4 PL.987-381	SS381 to 434 inclusive	33G7
U_3	479-201	14	Torpedo Tube Blow & Vent Manifold	14	Moulded Rubber	2.3437"		Pc.Z_3 PL.479-201	SS228-239 incl.275-312 incl. & SS381-434 incl.	33R4 Sym.#1304
V_3	486-228	1	Inbd.Vent Valve Negative Tank	1	Moulded Rubber	4.703"		Pc.T_4 PL.486-228	SS285-312 incl. & 381-390 incl.	do.
W_3	486-228	1	Inbd.Vent Valve Negative Tank	1	Moulded Rubber	4.703"		Pc.E_4 PL.486-228	SS391-434 inclusive	do.
X_3	25855	1	2" Hull Stop Valve, Valve Disc (L.P. Blow)	1	Moulded Rubber	2.5781"		Pc.Z_3 PL.25855		do.
Y_3	25856	1	2½" " " " " " "	1	Moulded Rubber	2.8906"		Pc.Z_3 PL.25856	SS228-238 incl.,275-312 incl., & 381-434 incl.	do.
Z_3	25857	1	3" " " " " " "	1	Moulded Rubber	3.7656"		Pc.A_4 PL.25857	SS228-239 incl., do.	do.
A_4	25858	1	3½" " " " " " "	1	Moulded Rubber	4.2656"		Pc.Z_3 PL.25858	do. 285-312 incl.,	do.
B_4	25859	1	4½" " " " " " "	1	Moulded Rubber	5.2656"		Pc.Z_3 PL.25859	do. 275-312 incl.,	do.
C_4	5112-304	4	M.Eng.Exh.Syst. 15" Outside Val.Disc	4	Oil Resisting		5' 0.73"	Pc.Q_3 PL.5112-304	SS304-307 incl.(Ref.M.I.Conf.Desp. No. 052014 of Aug.9,1943(74116))	33G7 See Note 1

See Note 8 (MS 9551)

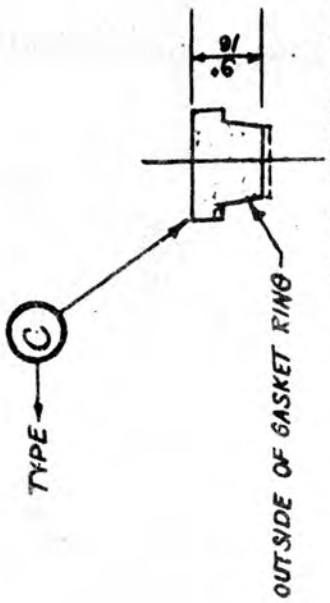
See Note 1 (MS 9530)

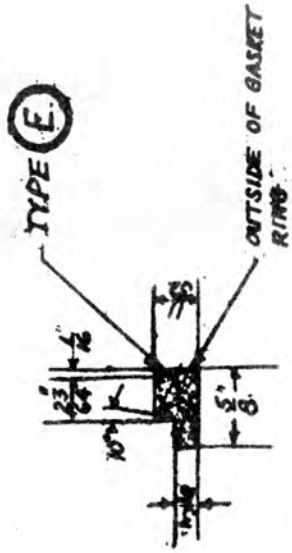
See Note 9

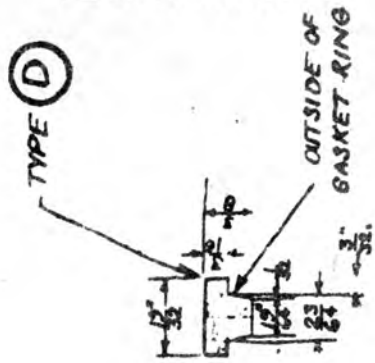
1. All Eng. Exh. & Fuel Ballast Gaskets made with special oil resisting compound, similar to "Neoprene" packing G.O.P. 100-K, as made by Manhattan Rubber Co., Boston, Mass., to withstand a temperature of 200°F., or oil resistant rubber (Ameripol) as made by Goodrich Rubber Co., Akron, Ohio. Fasten gaskets in groove with cement similar to R.B. Rubber Cement furnished by LaFavorite Rubber Mfg. Co. of Patterson, N.J.
2. All vent valve gaskets for subs SS285 to 434 incl. are to be furnished with 100% spares.
4. Where gaskets are moulded or purchased in strip form additional allowance must be made over tabulated developed length for overlap of vulcanized ends.
5. Pcs.G_3-H_3-J_3 & C_4 may be molded in continuous rings of a diameter to fit properly in gasket groove assembly.
6. Pc's. A_3 to E_3 incl., J_3 to R_3 & U_3 to B_4 incl. to be in accordance with leaflet spec's. 33R4 except hardness to be (Durometer 45) Ref. BuShips Let. SS/348 - 1 (515) SS/375-2 of 17 Aug. 43 (78223) Permissible Tolerances on Gaskets ±.005" on overall dimensions.

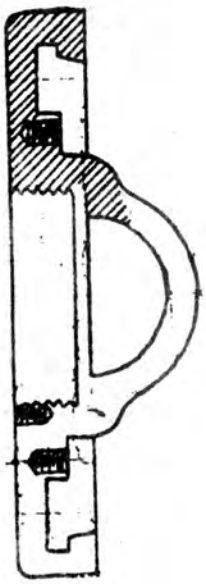
MOULDED RUBBER GASKETS
SPECIAL
TEE & ANGLE

U-12-A

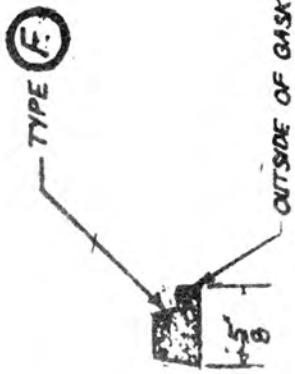


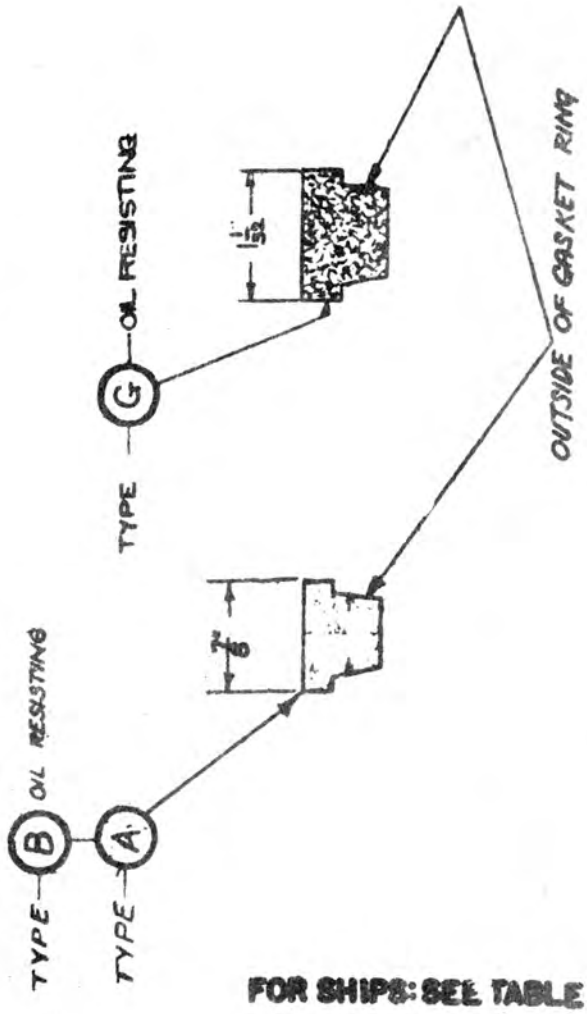






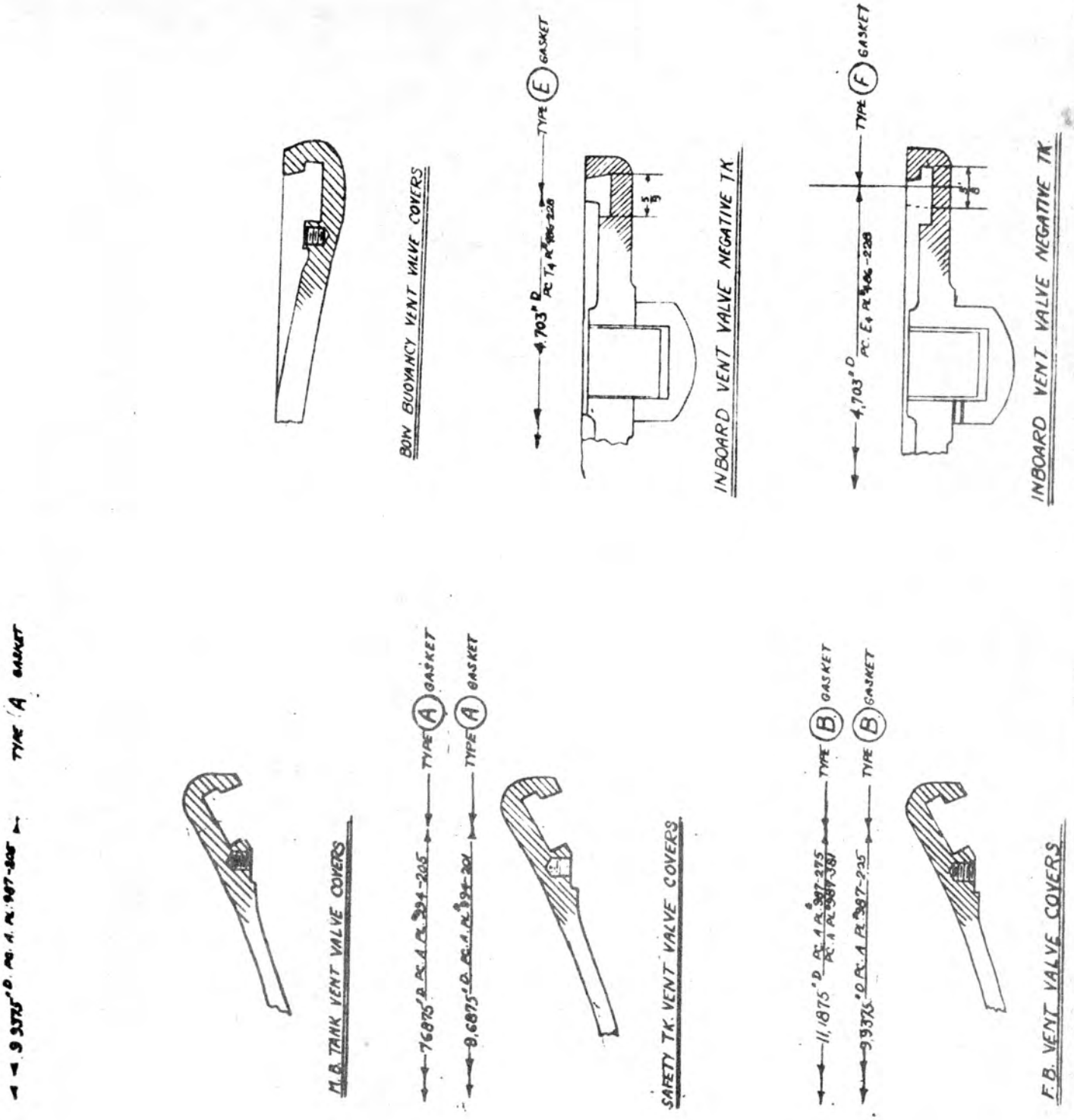
HULL STOP VALVE QUICK OPERTG.
L.P. BLOW





FOR SHIPS: SEE TABLE

MOULDED RUBBER GASKETS U-12-A
SPECIAL
TEE & ANGLE



FOR SHIPS: SEE TABLE

2

Reference Plans:

Ports.No.	BuShips No.	Title
486-228	386462	Inboard Vent Valve - Negative Tank
494-228	386470	Negative Tank Vent Valve - Control Room - Arrgt. of Contact Maker
497-228	386473	Trimming System - Sea Connection
516-201	312103	Trim Manifolds - 3" - Two Valve - Forward and Aft Torpedo Rooms
546-228	386522	Sea Valve - 5" Size
547-285	490200	Locking Devices for Standard & Commercial Valves
548-201	312135	Trim System - Drain Pump Suction - 3" Special Globe Valve
704-275	387425	Bow Buoyancy Tank Vent Valves - Arrgt.
705-275	387433	Bow Buoyancy Tank Vent Valve - Bearing - Rocker Arm and Bell Crank-Dts.
706-381	544587	Bow Buoyancy Tank Vent Valve - Operating Gear - Frame Details
707-381	544588	Bow Buoyancy Tank Vent Valve - Operating Gear - Cylinder & Piston Dts.
708-381	544589	Bow Buoyancy Tank Vent Valve - Operating Gear - Crosshead & link Dts.
709-381	544590	Bow Buoyancy Tank Vent Valve - Operating Gear - Foundations and Misc. Details.
710-201	312197	Bow Buoyancy Tank Vent Valve - Valve - Valve Cover & Grating - Details
711-381	544591	Bow Buoyancy Tank Vent Valve - Operating Gear - Arrgt.
712-275	387424	Bow Buoyancy Tank Vent Valve - Shaft - Fork and Link - Details
753-381	544617	Emergency Vent Valve - M.B. #6A & B - Duct Details
754-381	544551	Emergency Vent Valve - M.B. Group #6 Arrgt.
755-381	544552	Emergency Vent Valve - M.B. Group #6 Valve Details
786-275	387333	Flood Valves - Arrgt. at Frames 58 and 60 (P&S)
787-275	387334	Flood Valves - Safety Tank - Arrgt. at Frame 63 (Port & Starboard) for SS308-309.
787-310		Flood Valves - Safety Tank - Arrgt. at Fr. 63 (P&S)
788-275	387335	Flood Valves - Arrgt. at Frames 70-72 & 74 (P&S)
789-275	387336	Flood Valves - Arrgt. at Frames 76&79 (P&S)
792-275	387339	Main Ballast Tank Flood Valves - Valve Cover - Details
793-275	387340	Main Ballast Tank Flood Valves - Seat&Cover Details (Safety Tank)
794-275	387341	Main Ballast Tank Flood Valves - Frame & Seat Details
795-285	490249	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Arrgt. (Safety Tank)
796-201	312283	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Bracket Details (Safety Tank)
797-201	312284	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Cylinder & Cover Details (Safety Tank)
798-201	312285	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Piston and Hand Crank Details (Safety Tank)
799-285	490250	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Open Rod and Crosshead Details - (Safety Tank)
801-228	386637	Main Ballast Tank Flood Valves - Hand Operating Gear - Extension Shaft Arrgt.
802-228	386638	Main Ballast Tank Flood Valves - Crankshaft Details
803-228	386639	Main Ballast Tank Flood Valves - Cover Toggle Link Details
804-228	386640	Main Ballast Tank Flood Valves - Bell Crank - Foundations and Shops
805-228	386641	Main Ballast Tank Flood Valves - Bell Crank - Details
806-228	386642	Main Ballast Tank Flood Valves - Connecting Rod and Bearing Details
807-228	386643	Flood Valves - Main Ballast Tank - Hand Operating Gear - Extension Shaft & Bearing Details
809-285	490304	Main Ballast Tank Vent Valve - Main Ballast No. 1 & 7 - Hull Castings
810-285	490299	Main Ballast Tank Vent Valve - Main Ballast No. 7 - Installation.
977-275	387343	Main Ballast Tank - Flood & Vent Valves - General Arrangement
978-308	490609	Main & Fuel Ballast Tanks - Vent Valves - Main & Emergency - Main Ballast Group #2 - Arrangement
979-381	544547	Main & Fuel Ballast Tank - Vent Valves - Main & Emergency - F.B. Group #3 & M.B. Group #4 - Arrangement
980-381	544545	Main & Fuel Ballast Tank - Vent Valves - Main & Emergency - F.B. Group #5 & M.B. Group #6 - Arrgt.
981-381	544553	Emergency Vent Valve - Main Ballast Tank - Group #2 6C-6D - Fuel Ballast Tank - Groups #3-5-Arrgt.

Reference Plans (Continued):

Ports.No.	BuShips No.	Title
982-308	490496	Emergency Vent Valve - Main Ballast - Group #2 - Fuel Ballast Groups #3 & 5 - Valve Details & M.B. #6 6C & 6D
983-308	490497	Emergency Vent Valve - Main Ballast - Group #2 - Valve Cover, Shaft & Misc. Details (FBT Groups #3 & 5)
984-308	490498	Emergency Vent Valve - Main Ballast - Groups #2-6 - Fuel Ballast - Groups #3-5 - Handwheel, Stuffing Box & Misc. Details
985-381	490744	Main Ballast - Groups #2, 6 & 7 - Fuel Ballast - Groups #3 & 5 Vent Valve - Arrgt.
986-381	490475	Main & Fuel Ballast Vent Valve - Main Ballast - Groups #2, 6 & 7 - Fuel Ballast Groups #3 & 5 - Valve Body Details
987-381	490476	Main & Fuel Ballast Vent Valve - Main Ballast Groups #2, 6 & 7 - Fuel Ballast Groups #3 & 5 - Valve Cover & Link Details
988-381	544554	Main & Fuel Ballast Vent Valves - M.B. 2A-2B-2C-2D - F.B. 3A-3B-5A-5B - Foundations
989-381	544596	Main & Fuel Ballast Vent Valves - Safety Tank - M.B. 1-4A-4B-6A-6B-6C-6D- & 7 Foundations
990-308	490564	Safety Tank Vent Valve - Main & Emergency - Arrgt.
991-285	490305	Safety Tank - Emergency Vent Valve - Arrgt. & Details
992-201	312479	Safety Tank Vent Valve - Arrgt.
993-201	312480	Safety Tank Vent Valve - Valve Body Details
994-201	312481	Safety Tank Vent Valve - Valve Cover & Link Details
995-381	491098	Main, Fuel Ballast & Safety Tank Vent Valve - Operating Gear - Arrgt. 3¾" D x 3½" & 3" D x 3½" Cyls.
996-381	491099	Main Fuel Ballast & Safety Tank - Vent Valve Operating Gear - Frame Details
997-381	544105	Main, Fuel Ballast and Safety Tank - Vent Valve Operating Gear - Cylinder & Piston Details (3¾" x 3½" Cyl.)
998-381	491100	Main, Fuel Ballast and Safety Tank - Vent Valve Operating Gear - Crosshead and link Details
999-381	544555	Main, Fuel Ballast and Safety Tank - Vent Valve Operating Gear - Foundations.
1001-381	544606	Main, Fuel Ballast and Safety Tank - Vent Valve Operating Gear - Cylinder
1002-381	491101	Main, Fuel Ballast and Safety Tank - Vent Valve Operating Gear - Hand Lever & Misc. Details
1003-228	386674	Main Ballast Tank Vent Valve - Main Ballast 4A-4B - Arrgt.
1004-228	386675	Main Ballast Tank Vent Valve - Main Ballast 4A & 4B - Valve Body Dts.
1005-228	386676	Main Ballast Tank Vent Valve - Main Ballast 4A & 4B - Valve Cover and Link Details
1006-308	490575	Emergency Vent Valve - Main Ballast Tank - 4A & 4B - Arrgt.
1007-308	490576	Emergency Vent Valve - Main Ballast Tank - 4A & 4B - Valve Details
1008-228	386670	Emergency Vent Valve - Main Ballast Tank - 4A & 4B - Valve - Cover - Shafts and Misc. Details -
1009-228	386671	Emergency Vent Valve - Main Ballast Tank - 4A & 4B - Wrench, Stuffing Box & Misc Details
1094-228	386658	Flood Valves - Hand Operating Gear - Hand Crank Details
1096-285	490426	M.B. Safety Tank - Emergency Vent Valve - Valve & Liner Details
1099-381	490571	Main Ballast Tank Vent Valve - Tank No. 1 - Arrgt. & Installation
1100-201	312587	Main Ballast Tank Vent Valve - Tank No. 1 - Body (Valve) Details
1101-381	490494	Main Ballast Tank Vent Valve - Tank No. 1 - Valve Cover & Link Dts.
1102-201	312589	Main Ballast Tank Vent Valve - Tank No. 7 - Special Tee - Details
1104-285	490255	Flood Valves - M.B. Tank - Hand Operating Gear - Arrgt. (Hull Mtd.)
1105-285	490256	Flood Valves - M.B. Tank - Hand Operating Gear - Indicator Details
1117-205	367903	Flood Valves - Hand Operate Gear - Bracket Details
1118-228	386661	Flood Valves - Main Ballast Tank - Hand Operating Gear - Operating Screw Details
1121-285	490251	Negative Tank - Flood Valves - Arrgt.
1122-201	312609	Negative Tank - Flood Valves - Seat and Cover Details
1123-285	490252	Negative Tank - Flood Valve - Hydraulic Operating Cyl. & Piston Dts.
1124-201	312611	Negative Tank - Flood Valves - Hydraulic Operating Gear - Handcrank Dts.
1125-201	312612	Negative Tank - Flood Valves - Connecting Rod & Bearing Details
1126-201	312613	Main Ballast Tank Flood Valves - Hydraulic Operating Gear - Extension Shaft Details (Safety Tank).
1169-201	312656	Bow Buoyancy Tank Vent Valve - Operating Link & Shaft Details
1170-275	387423	Bow Buoyancy Tank Vent Valve - Misc. Foundations.

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Section U-12-b

MAGAZINE FLOODING

(a) Navy Reg. - Art. 1078, Par. 3-1, Part 1333, Par. 4.
(b) BuShips Manual (Hull) - Art. 636.
(c) BuOrd Manual - Art. 1489, p. 185.
(d) See Plate 13 - Magazine Flooding System - Diagram.

The magazines lie between 58 and 62 below platform deck.

The sprinkler system is designed to completely flood the magazines in 10 minutes, with the ship on the surface and with the sprinkler system under sea pressure alone. Water for sprinkling is taken directly from the sea through a 5-inch special sea valve located in the control room at trim pump sea connection. This sea valve should be kept open. Water under sea pressure is then available at the flood and sprinkling supply valve.

The supply valve stem is turned by a crank and is inclosed in a locked case with a glass door.

To flood the magazines (the system sea valve is locked open), break the glass door, crank, and open the supply valve. Water will then flow from the supply line into the magazines, where feed pipes for the magazines will carry the water to a network of sprinkler pipes installed overhead. The entire system is thus supplied at one time.

To drain the magazines, a suction hose from the 1½" hose connection on the drain line in the control room, is led down to the magazines.

The magazine ventilation pipes and the hatch to the after battery act as overflow and air escapes when the magazines are being flooded.

Test pressure of system - 300 pounds per square inch.

Valve Data

Name	Location of Valve and Operating Gear		
	Compartment	Frame	Side
Magazine Flood and Sprinkling Supply	Control Room	55	Port
Test Connections	Control Room	55-56	Port

Magazine Flood Valve Test Casting: to test the sprinkling system, close the supply valve. Remove the plug cap from the test casting. Place "Handle and spanner" on valve stem at lower part of casting, lift up on handle and spanner until no further motion is possible. Insert wedge-bar to fullest extent and tap in firmly. Open supply valve to system. Drain cocks on casting will indicate whether water is available to sprinkling system.

To provide water for Magazine Sprinkling when vessel is in dry dock, connect yard water system to any of the 1½" hose valves on ship's trim line. Connect trim line to sea connection at trim manifold in control room and close the 5" sea valve to the sea chest.

Reference Plans:

Ports.No.	BuShips No.	Title
428-310	544888	Fuel Oil Water & Drainage-Piping Arrgt. Crew's Mess, Galley,
426-285	386515	Fuel Oil, Water & Drainage - Control Room (Scullery & Magazine Spaces
505-308	490969	Magazine Sprinkling - Operating System - Arrangement and Details

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Section U-15

FRESH WATER SYSTEM

For list of F.W. tanks see Section U-9.
For capacity of pumps see Section U-9.
For sanitary tanks see Section U-16.
For diagram of F. W. Piping see Plate 11.
Fresh water tanks are listed, with capacities, on Plate 11.

General - In general, all fresh water outlets are of the self-closing handwheel type.

Water Heaters, Immersion Type, Electric. Cold water from the ship's fresh water lines is supplied to four (4) separate hot water tanks located to service the following compartments:

One 10-gallon tank for the Officers' Pantry.
One 15-gallon tank for the Officers' Showers & Lavs.
One 20-gallon tank for the Galley.
One 25-gallon tank for the Crew's Space Showers.

Each water heater consists of a galv. iron tank covered with magnesia insulation with an outer lagging of galvanized sheet steel.

Two (2) 1500 watt (3KW) immersion type, 275 volt continuous duty, heating units are secured through the side (at the lower end) of the 10-gallon tank in the Officers' Pantry, port side, & 15-gallon tank in the Officers' showers.

Four (4) 1000 watt (4KW) immersion type, 275 volt continuous duty, heating units are secured through the side (at the lower end) of the 20-gallon tank for the Galley located in the Crew's Mess storeroom.

Five (5) 1000 watt (5KW) immersion type, 275 volt, continuous duty, heating units are secured through the side (at the lower end) of the 25-gallon tank in the Crew's space wash room.

Connections are provided at the top of each tank, for a cold water inlet and hot water outlet, allowing in-coming cold water to be delivered to the bottom of the tank, and outgoing hot water to be drawn off the top of the tank, no circulating coil is used inside the tanks; fresh water under service line pressure fills the tank and surrounds the heating elements, the heated water rises to the top where it is available for use.

Other fittings on the tank comprise one ½" std. relief valve adjustable from 10 pounds to 30 pounds pressure, ½" drain valve and one automatic temperature control.

The automatic temperature control consists of a thermostat, of the immersion type, inserted through the vertical side of the tank and maintains the water temperature at approximately 180F.

The heaters for each tank are energized and controlled by a control panel consisting of one 60 Amp. line switch, tumbler type operated by an external handle; one magnetic contactor and two (2) 60 A-250 V. line fuses.

See Instruction Book for electric Heaters, for description of operation and wiring diagrams. Portsmouth No. S-2759, Navy Contract No. 102s-35080 - 100 with the Automatic Elec.Heater Co., Pottstown, Pa.

Supply from the fresh water tanks is delivered by means of air pressure in the tanks. The air connections are from the service air line and are each fitted with a stop valve and a reducing valve. The pressure on the fresh water system is regulated by the valves supplying air to the tanks. The tanks are fitted with relief valves set at 24 pounds and with gages with red hand set at 20 pounds.

A line is provided in each torpedo room from the freshwater system to a position near the torpedo tubes. A hose bibb to take a rubber hose is provided in order that this line may be used to fill the firing valves and water compartments of the torpedoes.

The fresh water system is divided into two parts - potable water, and battery water.

(1) Potable Water. The fresh water filling line is 1½" brass pipe which extends from the fresh water tank connections in aft.end of control room along the port side of ship through forward bulkhead, thence to fresh water tank connections in forward end of forward battery compartment and through bulkhead to forward torpedo room.

It has the following listed connections:

Location	Purpose
Forward Torpedo Room	Filling connection from hose valve. F.W. service to F.T.R. F.W. service line aft.
Forward Battery Compartment	Supply connection for ship's F.W. Tanks.
Control Room	Supply connection for ship's F.W. Tanks. There is a separate ¾" brass filling line from distilling plant in Forward Engine Room with connections to F.W. tanks in after end of Control Room Compartment and Battery F.W. Tanks.

The fresh water service line is combined with the 1½" filling line forward of the fresh water tanks in Control Room. A one inch brass pipe line is continued aft. along the port side of the vessel decreasing to ¾" brass pipe through the engine rooms and then to ½" brass pipe to terminate in the after torpedo room. Stop Valves are provided in this line Fwd. of F.W. Tanks in Control Room, and Aft. of connections to Galley and Scullery to permit Shutting off F.W. Fwd. and Aft. while Galley is still being serviced. Service line supplies water to the following connections:

Location	Purpose
Forward Torpedo Room	Hose valve - F.W. filling.
" " "	Stop valve for forward emergency F.W. tank filling.
" " "	Hose bibb for torpedo filling.
" " "	Cold water to Lavatory.
" " "	Cold water to Officers' Shower.
Forward Battery Room	Cold water supply to hot water tank in pantry.
" " "	Cold water supply to drinking water cooling coils.
" " "	Cold water supply to officers' pantry.
" " "	Connection to fresh water tanks.
" " "	Cold water to Officers' & C.P.O. lavatories & hot water tank.
Control Room	Connection to F.W. tanks.
Mess Room and Galley	Cold water supply to galley, scullery, hot water tank, drinking water cooling coils, and coffee urn.
After Battery Room	Cold water to hot water tank, showers, bucket faucet, washing machine, and lavatories in Crew's Wash Room.
Forward Engine Room	Connections for F.W. feed to distillers.
" " "	Connections for Engine cooling & Lub. Oil Purifier priming.
After Engine Room	Connections for engine cooling system and sub-aid purifier priming.
After Torpedo Room	Connection for after emergency F.W. tank filling.
" " "	Hose bibb for torpedo filling.
" " "	Cold water to crew's lavatory.

18 Gal. F.W. Tanks are located in Crew's Wash Room and Aft.Eng.Room to receive the drain water from Air Conditioning Coolers. Tanks are provided with overflow pipe to plumbing drain or bilge and faucets for Auxiliary F.W. use.

(2) Battery Water. For each main battery a port and a starboard group of battery water tanks are installed. The estimated capacity of the forward groups of tanks is 598 gallons. The capacity of the after groups is the same.

The two tanks which make up a group are in tandem, with a vent and blow line connecting the tops of adjacent tanks and a drain line connecting the bottoms. Each group is connected at one end with Globe Valve in line, for attaching the battery filling hose.

A blow and vent connection is installed on the top of each after tank of each group.

The tanks are filled from a hose connection in the Crew's Mess, which has a lead to the battery water filling and transfer line. At its forward and after ends this line taps into a cross-connection between the port and starboard tanks.

A ¾" brass line leads from the distiller test tanks in the Fwd. Eng. Rm. to the control room where it is connected to No.3 and No.4 F.W. Tanks. No connection is made to No.1 and No.2 F.W. Tanks and these tanks can be filled from the ships distillers only by first placing the water in No.3 or No.4 F.W. tank and then blowing it through the 1½" filling line to No.1 or No.2 F.W. Tank.

The tandem grouping and the cross-connection allow any group of tanks to supply water to any other group.

Battery water tanks can be supplied from the ship's distilling plant.*

(3) Air Pressure. Air is used to force water from the fresh water tank to the fresh water service line, and from the battery water tanks to the battery filling hose connections.

A connection on the 225 lb. line in the crew's space is equipped with a reducer set for 225lbs. - 20 lbs., a relief valve set at 24 lbs., and a gauge. This 20-lb. air is led to the port group and starboard group of after battery water tanks. A similar system is located in Control Room for ships' F.W. tanks in that compartment. With pressure on the 225 lb. line and with open stop valves between the 225 lb. line and the tanks, constant pressure of 20 pounds may be kept on the fresh water and battery water systems.

In the wardroom country, a similar air pressure system is installed to serve the battery water tanks and the ship's fresh water tanks.

Service & Compartment	Size	Type	Location
Forward Torpedo Room - Ports. No. 472-285, BuShips No. 490152			
F.W. to Emergency F.W. Tanks	1/2"	Angle Scrd.	25-26P
F.W. to Torpedoes	1/2"	Hose Bibb Scrd.	22P
Hot & Cold Water to Off. Showers	1/2"	Horz. Chk. Scrd.	32-33 S
Hot & Cold Water to Off. Showers	1/2"	Globe Needle Scrd.	32-33 S
Hot & Cold Water to Off. Shower Head	1/2"	Cross Scrd.	32-33 S
F.W. Filling	1 1/2"	Ang. Hose Scrd.	34-35 P
Hot Water Tk. Set @ 30	1/2"	Relief Scrd.	33-34 S
Forward Battery Compartment - Ports. No. 454-285, BuShips No. 490217			
F.W. Tank #2 Filling	1 1/2"	Cross Scrd.	36 P
F.W. Tank #1 Filling	1 1/2"	Angle Scrd.	36 P
Cold Water to Sink	1/2"	Globe Scrd.	36 P
Cold Water to Lavs.	3/8"	Globe Scrd.	44 P 40-41 S
Supply to Port Hot Water Tank	1/2"	Globe Chk. Scrd.	35-36 P
Supply to Stbd. Hot Water Tank	3/4"	Angle Scrd.	35-36 S
Supply to Stbd. H.W. Tank	3/4"	Horz. Chk.	35-36 S
Supply to Refrig. Cool Coil	1/4"	Angle Scrd.	35-36 P
Port Hot Water Tank Set @ 30	1/2"	Relief Scrd.	35-36 P
Batt. F.W. Tk. Fill Below Deck	1/2"	Globe Scrd.	45-46 C
Batt. Tank Fill Conn.	5/8"	Globe Valve	45-46 C
Pantry Sink H & C water	1/2"	Sw. Type Faucet Set. Scrd.	36-37 P
Pantry Sink	1/4"	Drink. Fix. Scrd.	35-36 P
Drain from H.W. Tanks	1/2"	Globe Scrd.	35-36 P & S
Control Room - Ports. No. 455-381, BuShips No. 431059			
F.W. Fill F.W. Tank #3	1 1/2"	Ang. Stop Scrd.	57-58 P
F.W. Fill F.W. Tank #4	1 1/2"	Cross Scrd.	57-58 P
Distilled Water to F.W. Tank #3	1/2"	Ang. Stop Chk. Scrd.	57-58 P
Distilled Water to F.W. Tank #4	1/2"	Ang. Stop Chk. Scrd.	57-58 P
Distilled Water to For'd Battery F.W. Tanks	1/2"	Globe Scrd.	56-57 P
Shut-off, F.W. Fwd.	1 1/2"	Globe Scrd.	52 P

Through a connection between the battery water filling line and the 2" line from the distillers to No.3 and No.4 F.W. Tanks.

Service & Compartment	Size	Type	Location
Crew's Mess, Galley, Scullery - Ports.No. 456-381, BuShips No. 491074			
F.W.Supply to Hot Water Tank	¾"	Globe Chk. Scrd.	65 S
Battery F.W. Tank Filling	¾"	Globe Hose Scrd.	62-63 P
F.W. Supply to Scullery Sink	½"	Globe Scrd.	65-66 S
F.W. Supply to Galley Sink	½"	Globe Scrd.	59-60 P
F.W. Supply to Coffee Urn	½"	Globe Scrd.	58-59 C
F.W. Supply to Cooling Coils in cool room	3/8"	Ang. Scrd.	61-62 C
Galley & Scullery Sinks	½"	Sw. Type - Faucet Set	59-60 P & 61-62 S
Hot Water Tank Relief	½"	Relief Scrd.	65 S
Battery F.W. to Aft Batt. F.W. Tanks	½"	Ang. Scrd.	64-65 P
Crew's Drinking Water	3/8"	Drink Fount.	60-61 C
Drain from H.W. Tank	½"	Globe Scrd.	64-65 S
Shut-off - F.W. Aft	1"	Globe Scrd.	64 P
Crew's Quarters & Aft Battery Compartment - Ports.No. 457-381, BuShips No. 491064			
Cold Water to Hot Water Tank	¾"	Globe Stop Chk. Scrd.	77 P
Hot & Cold Water to Shower	½"	Needle Scrd.	77 P
Hot & Cold Water to Shower	½"	Horz. Chk. Scrd.	77 P
Cold Water to Fixed Lavatories	½"	Globe Scrd.	75-76 P
Cold Water to Showers	½"	Globe Scrd.	76-77 P
Cold Water to Fixed Lavatories	½"	S.C. Basin Faucet	75-76 P
H&C Water to Wash. Mach.	½"	Sw'g. Type Faucet Set	75-76 P
Cold Water to Wash. Mach.	½"	Globe Scrd.	75-76 P
F. Water from Air Conditioning Cooler Drain Tank	½"	Plain Bibb	75-76 P
hot & Cold Water for Bucket Use	½"	S.C. Plain Bibb	76-77 S
Hot Water Tank Set at 30#	½"	Relief Scrd.	76-77 P
Batt. F.W. Tank Fill P&S	½"	Globe Scrd.	64-65 P-S
Batt. Fill Conn.	¾"	Globe Valve	64-65 C
Hot & Cold Water to Shower Head	½"	Cross Scrd.	77 P
Drain from H.W. Tank	½"	Globe Scrd.	76-77 P
Forward Engine Room - Ports. No. 458-381, BuShips No. 491065			
F.W. Fill. Engines & Dist'l'r Feed	¾"	Globe Scrd. (L.C.)	87-88 P
F.W. for Oil Purifier Priming	¼"	Globe Scrd.	77-78 P
F.W. from air conditioning Cooler Drain Tk.	½"	Plain Bibb	87 S
Aft Engine Room - Ports. No. 459-381, BuShips No. 491066			
F.W. Fill. Engines	¾"	Globe Scrd. (L.C.)	89-90 P
F.W. Purifier Priming	¼"	Globe Scrd.	98-99 P
After Torpedo Room - Ports. No. 473-285, BuShips No. 490153			
" 473-425, "			
Cold Water to Fold. Lavatory	3/8"	Globe Scrd.	107-108 S
F.W. to Emergency F.W. Tanks	½"	Angle Scrd.	111-112 S
F.W. to Torpedoes	½"	Hose Bibb	120-121 S

MARK	NOM. SIZE	SERVICE	TEST	LOCATION
1	1½"	Ships F.W. Tank Filling Connection (For hose)	50#	F.T.R.
2	1½"	Ships F.W. Tank Filling & Ships Service	50#	O.Q. C.R.
3	1½"	Filling & Service Conn. to & From Forward F.W. Tanks	50#	O.Q.
4	1½"	Filling & Service Conn. to & From Aft F.W. Tanks	50#	C.R.
5	¾"	Battery F.W. Tank Filling Conn. (for hose)	50#	C.Q.
6	½"	Filling Line to Forward Battery F.W. Tanks	50#	O.Q. C.R.
7	½"	Forward Battery F.W. Tank Piping (Below flat)	30#	O.Q.
8	½"	Filling Line to Aft Battery F.W. Tanks	50#	C.M.
9	½"	Aft Battery F.W. Tank Piping (Below flat)	30#	C.Q.
10	½"	F.W. Service Line - Forward	50#	F.T.R.
11	1"	F.W. Service Line - Aft	50#	C.R.,C.M.,C.Q.
12	¾"	F.W. Service Line - Aft	50#	C.Q.,FER,AER
13	½"	F.W. Service Line - Aft	50#	AER,M.R.,ATR
14	¾"	Distilled Water to Battery F.W. Fill Line (Forward)	50#	FER,C.Q.,C.M.,C.R.
15	¾"	Distilled Water to After F.W. Tanks	50#	C.R.
16	3/8"	Cold Water to Lavatory in Forward Torpedo Room	50#	F.T.R.
17	1"	Drain from Lav. in Forward Torpedo Room	-	F.T.R.
18	½"	F.W. To Emergency F.W. Tank in Forward Torpedo Room	50#	F.T.R.
19	½"	F.W. To Torpedoes	50#	F.T.R.
20	1¼"	Urinal Drain Superstructure	-	Sup'r F.T.R.
21	1¼"	Urinal Drain Bridge-Fairwater	-	F.W.
22	¾"	F.W. Supply to Lavs.H.W. Tank & Shower (Starboard Side)	50#	O.Q.
23	3/8"	F.W. Supply to Lavs. P. & S.	50#	O.Q.
24	3/8"	Cold Water Conns. to Lavs. P. & S.	50#	O.Q.
25	¾"	Cold Water to H.W. Tank Starboard Side	50#	O.Q.
26	½"	Cold Water to Shower (F.T.R.)	50#	F.T.R.
27	¾"	F.W. Supply to Officer's Pantry	50#	O.Q.
28	½"	C.W. Conn. to Pantry Hot Water Tank	50#	O.Q.
29	½"	C.W. Conn. to Pantry Sink	50#	O.Q.
30	¼"	F.W. To Refrig. Coil. Officer's Pantry	50#	O.Q.
31	¼"	Cooled Water from Refrig. Coil to Fixture	50#	O.Q.
32	½"	H.W. to Pantry Sink & F.T.R. (Port)	50#	O.Q.
33	3/8"	H.W. to Lav. in Forward Torpedo Room	50#	F.T.R.
34	½"	Relief Valve Disch. - Hot Water Tanks	-	F.T.R.,O.Q.
35	½"	H.W. to Lavs. Officer's Quarters	50#	O.Q.
36	3/8"	H.W. Conn. to Lavs.	50#	O.Q.
37	½"	H.W. Conn. to Shower F.T.R.	50#	F.T.R.,O.Q.
38	3/8"	H.W. Recirculating Line	50#	O.Q.
39	½"	H & C Water to Shower Head	-	F.T.R.
40	1"	Drain from Lavs. - Officer's Quarters	-	O.Q.
41	1¼"	Drain from Lavs. - Officer's Quarters	-	O.Q.
43	1½"	Drain from Pantry Sink	-	O.Q.
44	2"	Main Drain - Port Side to F.T.R. San. Tank	-	O.Q.
45	1½"	Drain from F.W. Tank Vent Valves	-	O.Q.
46	1½"	Main Drain - Starboard Side to F.T.R. San. Tank	300#	F.T.R.,O.Q.
47	2"	Shower Drain	300#	F.T.R.
48	1½"	W.C. Floor Drain	300#	F.T.R.
49	2	Sanitary Tank Drain Conn.	300#	F.T.R.
50	1"	W. C. Flush - Forward Torpedo Room	300#	F.T.R.
51	2"	Main Drain Port Side to F.T.R. & San. Tank	300#	F.T.R.,O.Q.
53	¾"	Cold Water to H.W. Tank & Scullery Sink	50#	C.M.
54	¾"	Cold Water to H.W. Tank	50#	C.M.
55	½"	Cold Water to Scullery Sink	50#	C.M.
56	½"	F.W. to Coffee Urn - Galley	50#	C.M.
57	3/8"	F.W.-Cooling Coils & Drinking Fountain	50#	C.M.
58	½"	Cold Water to Galley Sink	50#	C.M.
59	¾"	Hot Water to Galley & Scullery Sinks	50#	C.M.
60	½"	Hot Water to Galley Sink	50#	C.M.

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SS425-434 incl.
SS381-416 incl.

PIPE LIST (Continued)

MARK	NOM. SIZE	SERVICE	TEST	LOCATION
61	½"	Hot Water to Scullery Sink	50#	C.M.
62	½"	Drain from Coffee Urn & Tray	-	C.M.
63	½"	Drain from Drinking Fountain	-	C.M.
64	1½"	Drain from Galley Sink	-	C.M.
65	1½"	Drain - Port Side	-	C.M.,C.Q.
66	1½"	Drain from Scullery Sink	-	C.M.
67	½"	H.W. Tank Relief Valve Disch.	-	C.M.,C.Q.
68	1"	Drain from Hull Ventilation Outboard Valve Trunk	-	C.M.
69	1½"	Drain - Starboard Side	-	C.Q.
70	⅜"	Cold Water to Hot Water Tank & Showers	50#	C.Q.
71	⅜"	Cold Water to Hot Water Tank	50#	C.Q.
72	⅜"	Hot Water Supply to Wash Room	50#	C.Q.
73	½"	H.& C. Water to Showers, Lav. & Bucket Faucets	50#	C.Q.
74	½"	H.& C. Water to Lavatory	50#	C.Q.
75	½"	H.& C. Water to Washing Mach. & Lavs.	50#	C.Q.
76	3/8"	H.& C. Water to Lavs.	50#	C.Q.
77	1"	Drain from Lavs.	-	C.Q.
78	1"	Drain from Wash. Mach. & Overflow from F.W. Tank	-	C.Q.
79	1½"	Drain from Lavs.	-	C.Q.
80	1½"	Drain from Lavs. & Wash. Mach.	-	C.Q.
81	1½"	Drain from Wash Room & W.C. Floors	-	C.Q.
82	1½"	Drain from Shower Floors	-	C.Q.
83	2"	Port Drain to San Tank	-	C.Q.
84	2"	Starboard Drain to San Tank	-	C.Q.
85	1"	W.C. Flush - Crew's Space	300#	C.Q.
86	1"	W.C. Flush - Crew's Space	-	M.B.T.
87	3"	W.C. Disch - Crew's Space	300#	C.Q.
88	4"	W.C. Disch - Crew's Space	300#	C.Q.
89	1"	W.C. Flush - After Torpedo Room	300#	A.T.R.
90	2"	W.C. Disch.- After Torpedo Room	300#	A.T.R.
93	3/8"	Cold Water to Lav. - Aft Torp. Room	50#	A.T.R.
94	½"	F.W. To Emergency F.W. Tank	50#	A.T.R.
95	½"	F.W. To Torpedoes	50#	A.T.R.
96	1"	Overflow from F.W. Tank - Ventilation Air Cooler Drain	-	A.E.R.
97	1"	Water Closet Flush		C.Q.& F.E.R.
98	1"	Water Closet Flush		M.B.T.No.6A
99	3/8"	Hot Water Conn. to Lavatory	50#	O.Q.
100	3/8"	Cold Water Conn. to Lavatory	50#	O.Q.
101	3/8"	Cold Water Conn. to Lavatory	50#	O.Q.
102	3/8"	Drain from Lavatory - Starboard	50#	O.Q.
103	3/8"	Cold Water to Lavatory	50#	A.T.R.

CAPACITIES OF TANKS-FRESH WATER & PLUMBING SYSTEM

Fresh Water	Cu.Ft.	Gals	Tons	Test
Fresh Water Tank #1 & #2		2000	7.42	30#
Fresh Water Tank #3 & #4		2000	7.42	30#
Total		4000	14.84	
Battery Fresh Water				
Battery F.W. Tanks - Forward			2.22	30#
Battery F.W. Tanks - Aft			2.22	30#
			4.44	
Emergency Fresh Water				
Forward Torpedo Room		120		
After Engine Room		20		
Maneuvering Room		18		
After Torpedo Room		120		

SS425-434 incl.
SS381-416 incl.

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CAPACITIES OF TANKS - FRESH WATER & PLUMBING SYSTEM (Continued)

Sanitary Tanks	Gals.	Test
No.1 Sanitary Tank - Forward	320	200#
No.2 Sanitary Tank - Midship	1100	200#
Total	1420	

	Gals.
Auxiliary Fresh Water from Air Conditioning Cooler Drain	
Crew's Quarters - Wash Room	20
Aft. Engine Room	20

MATERIAL SCHEDULE

DESCRIPTION	Material	Conn.	Test Press.	U.S.N. Specs.
Globe & Cross Valve	Comp. M	Flanged or Scrd.	150#) 300#)	45V9 45V14
Angle Valve	Comp. M	"		" "
Gate Valve	Comp. M	"	300#	45V17
Stop Check Valve	Comp. M	"	150#	45V9
Hose Valve Globe	Comp. M	Screwed	150#	45V9
Check Valve	Comp. M	"	150#	45V5
Relief Valve	Comp. M	"	150#	45V26
Plug Valve - Easy Operated Lubricated Type	Comp. M	Flanged or Scrd.	300#	Comm.
Self Closing Bibb	Comp.	Screwed	50#	45F9
Hose Bibb	Comp.	"	50#	"
Self Closing Basin Faucet	Comp.	"	50#	"
Folding Lavatory	C.R.S.	-	-	47S20
Water Closet (Air Expulsion Type)	-	-	-	30W1
Floor Drain Valve & W. Seal	Comp. M	Screwed	300#	46B8
Shower Head	Brass	"	-	30S1
Pot Trap	Comp.M Cu.	"	-	44P2 46B8
"S" Trap	Brass	"	-	44P12
"P" Trap	Brass	"	-	"
Running Trap	Brass	"	-	"
Hose Valve Angle	Comp.M	"	150#	45V9
Sink Faucet Set (Swing Type)	Comp.	"	50#	-
Floor Drain Trap	Comp.M	"	-	46B8
Water Closet (Special Type)	Comp.M	Flanged	300#	San.Tank Disch.
Plain Bibb	Comp.	Screwed	50#	45F9

PIPING

SYSTEM	MATERIAL	CONN.	TEST PRESS.	U.S.N. SPECS.	WORKING PRESSURE
Battery Fresh Water	Brass	Screwed	30# 50#	44P12	20#
Fresh Water Service	Brass	Screwed	30# 50#	44P12	20#
Water Closet Flush	Cu.Ni.	Sil.Brazed	300#	44T40	200#
Water Closet Disch.	Cu.Ni.	Flgd."Sil."	200#	44T40	200#
Drains to Sanitary Tanks	Brass	Screwed	200#	44P12	200#

SS425-434 Incl.
SS381-416 Incl.

Reference Plans:

Ports.No.	BuShips No.	Title
102-228	386135	Battery Fresh Water Tanks
453-381	491057	Fresh Water and Plumbing Systems - Diagram
454-285	490217	Fresh Water and Plumbing System - Piping Arrgt. - Officers' Quarters & Forward Battery Compt.
455-381	491059	Fresh Water & Plumbing - Piping Arrgt. - Control Room
456-381	491074	Fresh Water & Plumbing - Gen. Arrgt. Crew's Mess, Galley & Scullery.
457-381	491064	Fresh Water & Plumbing - Piping Arrgt. Crew's Quarters & Aft Battery Compartment
458-381	491065	Fresh Water & Plumbing - Piping Arrgt. Forward Engine Room.
459-381	491066	Fresh Water & Plumbing - Piping Arrgt. After Engine Room.
463-285	386537	Gauge List for C&R Piping System
472-285	490152	Fresh Water & Plumbing - Piping Arrgt. - Forward Torpedo Room.
473-425	490153	Fresh Water & Plumbing - Piping Arrgt. - After Torpedo Room
488-228	386464	Fresh Water Tanks - Try Cock System
514-228	386490	Fresh Water & Plumbing - Piping Arrgt. Maneuvering Room
541-381	491073	Fresh Water & Plumbing System - Special Fittings
558-201	312145	Fresh Water Tank - Blow & Vent Manifold
35919	386951	Fresh Water Tanks - Test Manifold

Section U-16

PLUMBING

Plumbing System includes drains from lavatories, showers, washing machine, drinking fountain, sinks, etc. These units drain by gravity to the sanitary tanks which in turn are emptied by blowing with air from the 225# Service line. Drains at sanitary tank are provided with shut-off and check valves. Floor drain branches have check in line to prevent water backing up on floors. Drains from Officers' Quarters passing through bulkhead to forward torpedo room have shut-off valve close to bulkhead on each side for use in case of flooding of either compartment.

Two sanitary tanks are provided, #1 in the Forward Torpedo Room receiving drainage from the Officers' Quarters, also water closet, shower and lavatory in Forward Torpedo Room. #2 Sanitary Tank, located in Aft. Battery Compartment receives drainage from Galley, Scullery, Wash Room and Crew's W.C.'s (midship).

Water Closets - The Ship's Water Closets are of two types - air expulsion and direct discharge to Sanitary Tank. Closets are flushed with salt water from sea and discharged through pump chamber to sea or direct to sanitary tank. For the air expulsion closet, air from the 225# Service line is admitted to a measuring tank to the required pressure and in turn the air in measuring tank is discharged to W. C. expulsion chamber. In lieu of air expulsion, the hand pump can be used to discharge water closet against sea pressure. The Officers' W.C. is located in the Forward Torpedo Room and discharged direct to Sanitary Tank #1. Two crew's W.C.'s are located in Crew's space and discharge to sanitary tank #2. Flapper valve in the base of these closets acts as stop valve when sanitary tank is under pressure. An air expulsion Water Closet located in after Torpedo Room discharges to the sea.

Forward Torpedo Room - Ports. No. 472-285, BuShips No. 490152.

Service & Compartment	Size	Type	Location
Officers' Shower & Port Drain	2"	Horz. Ck. Scrd.	33-34-35 P&S
Officers' W.C. & Stbd. Drain	1½"	Horz. Ck. Scrd.	33-34-35 P&S
Drain - Port Side	2"	Plug Valve Scrd. Lub Type	34-35 P
Drain Stbd. Side	1½"	Plug Valve Scrd. Lub Type	34-35 S
Drain at Sanitary Tank	2"	Gate Flgd.	34-35 S
Drain from Lav.	1"	Horz. Ck. Scrd.	33-34 P
Sanitary Tank Sound Tube	1"	Gate Sold.	34-35 S
W.C. Flush Valve	1"	Angle Sold.	34-35 S
W.C. Flush (Sea)	1"	Globe Flgd.	34-35 S

Forward Battery Compartment - Ports. No. 454-285, BuShips No. 490217.

Drain - Port Side	2"	Plug Valve Scrd. Lub Type	35-36 P
Drain - Stbd. Side	1½"	Plug Valve Scrd. Lub Type	35-36 S
Drain from Refrig.	½"	Globe Scrd.	35-36 P

Crew's Mess, Galley, Scullery - Ports. No. 456-381, BuShips No. 491074.

Drain from Coffee Urn	½"	Globe Scrd.	58-59 C

Crew's Quarters & Aft Batt. Compartment - Ports. No. 457-381, BuShips No. 491064.

Drain from Shower Floor	1½"	Horz. Ck. Scrd.	77 P
Drains to Sanitary Tank	2"	Horz. Ck. Scrd.	77 S
Drains from W.C. and Wash. Room Floor	1½"	Horz. Ck. Scrd.	75-76 P&S
Drains to Sanitary Tank	2"	Plug Valve Flgd. Lub Type	77 S
W.C. Flush (Sea)	1"	Angle Flgd.	74-75 S
W.C. Flush Valve	1"	Globe Sold.	75-77 S
Sanitary Tank Sounding	1"	Gate Sold.	76-77 S

Service & Compartment	Size	Type	Location
After Torpedo Room W.C. - Ports.No. 520-381, BuShips No. SS381-53601-67928			
W.C. Discharge	2"	Plug Valve Flgd. Lub Type	107-108 P
W.C. Flush Valve	1"	Angle Sold.	108-109 P
Stop in Flush. Line	1"	Globe Sold.	108-109 P
W.C. Disch. - Vent	¼"	Globe Scrd.	107-108 P
W.C. - Air Tank Drain	¼"	Globe Scrd.	108-109 P
W.C. - Air to Rocker Valve	½"	Globe Scrd.	108-109 P
W.C.-Gauges	¼"	Globe Scrd.	108-109 P
W.C.-Air	½"	Rocker Valve	108-109 P
W.C. Discharge (Sea)	2"	Gate Flgd.	107-108 P
Sea Chest Blow & Gauge Conn.	¼"	Globe Scrd.	108-109 P

Reference Plans:

Ports.No.	BuShips No.	Title
453-381	491057	Diagram
472-285	490152	Forward Torpedo Room
454-285	490217	Forward Battery Space
455-381	491059	Control Room and Conning Tower
456-381	491074	Crew's Mess, Galley & Scullery
457-381	491064	After Battery Space
458-381	386434	Forward Engine Room
459-381	386435	After Engine Room
514-228	386490	Maneuvering Room
473-425	490153	After Torpedo Room
35118	390464	Hot Water Tanks, Elec. Heated
520-381	SS381-53601-67929	Crew's Aft Water Closet
462-285	490207	W.C. Clapper Valve Box

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Section U-19

3000 LB. AIR

Reference: (a) BuShips Manual (Hull) Art. 641.
(b) Plate

Air Systems Itemized:
3000 lbs. H. P. Air System
225 lb. Service Air System
600 lb. Main Ballast Blow
10 lb. Blow
Salvage Air System

List of Air Compressors:

H.P. Hardie Tynes Mfg. Co, 20 cu. ft. 3000 lbs.	Pump Room Forward End Stbd.
H.P. same	Pump Room Forward End Port
L.P. Air Compressor	Pump Room After End Stbd.

The H.P. Air Receiving Manifold has:
7 Valves: Air Bank No. 1, No. 2, No. 3, No. 4, No. 5 connection from H.P. air compressors in pump room and 1 outboard connection and 2 cross connections, duplicates to the distributing manifold.

The H.P. Air Distributing Manifold is built in two sections and has 10 connections and one spare, viz:

(1) Bow buoyancy tank
(2) Negative tank
(3) Safety tank
(4) 3000# service forward
(5) 3000# service aft.
(6) 3000# supply to 600# manifold
(7) 3000# supply to 600# manifold
(8) 3000# supply to 200# manifold
(9) 3000# supply to 200# manifold
(10) By-pass around 200# reducers

The H.P. Air Compressors located in the pump room (starboard and port) are motor driven. They pump through an air strainer, an air separator, a check valve and stop valve, to the cross connection between two compressors. The cross connection feeds to the H. P. air receiving manifold in the control room.

The torpedo impulse manifold 3000-400# reducer in each torpedo room is provided with cut-out and by-pass valves. The setting on reducing valves can be adjusted to meet the following torpedo firing conditions:

(a) 300# per sq. in. down to and including periscope depth
(b) 400# per sq. in. below periscope depth to 120 ft.
(c) 525# per sq. in from 120 ft. to 180 ft. depth

The manifold can thus be supplied direct from 3000# service line, forward or aft.

The torpedo charging air connections come off the service line in the forward and after torpedo rooms, respectively.

Air flasks are of chrome vanadium seamless steel. The mouth of each flask contains a screwed-in-plug of Class C steel, with a copper gasket. Flasks are coated internally with red lead and tested hydrostatically to 5000 pounds per square inch before installation. An internal drain line extends down to a point near the bottom of each flask and a needle valve for this line is installed in the plug at the top of the flask. Air pressure within the flask causes impurities and water settled at the bottom to be forced up the drain line and out the flask when the needle valve is opened.

A master valve for each air bank, located in the high-pressure air receiving manifold in the control room, controls all the flasks for that bank. The flasks do not have individual cut-out valves.

H. P. AIR COMPRESSOR

References: (a) Plate
(b) H.P. Air Compressor - Description of: "Instructions for the Operation and Maintenance of the High Pressure Air Compressors" supplied by Hardie-Tynes Manufacturing Company, Birmingham, Alabama.
(c) Starting Box, for Motor Driving, for H.P. Air Compressor.

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H.P. air is supplied by a 20 cu.ft., 3000 p.s.i., 55 H.P., 550 r.p.m., motor driven, direct connected, vertical, reciprocating, marine-type, 180° crank and spherical gudgeon, 4½" stroke. A 4-stage, double effect, balanced differential cycle, inter and after cooled H.P. air compressor, with water cooled filtered, integral rotary pump pressure lubrication for the drive, and sight forced feed lubricator for piston and valves.

There are two complete units - (Hardie-Tynes) - pump room.

Statistics on Hardie-Tynes H.P. air compressor:

Max. capacity (overload condition), 17 cu. ft. at 3500 p.s.i.
Piston-Displacement 5176 cu.ft. free air per hour.
Piston Speed approx. 412 ft. per min.
Brake Horse Power - 46.
Bore 6½, 5-7/16, 2½ and 1¼, stroke 4½ inches.

AIR SYSTEMS 3000 LB

CAPACITY OF AIR BANKS

Bank No.	Cubic Feet
1	125.20
2	109.55
3	109.55
4	109.55
5	108.55
Total	563.40

AIR FLASK DATA

Location	No. of Flasks	Length of Flask	Outside Dia. of Flask	Cap. each Flask	Total Cap. Cu. Ft.
M.B.T. No. 2A	2	11 Ft.3 In.	18 Inches	15.65 Cu.Ft.	31.30
M.B.T. No. 2B	2	"	"	"	31.30
M.B.T. No. 2C	3	"	"	"	46.95
M.B.T. No. 2D	3	"	"	"	46.95
M.B.T. No. 4A	2	"	"	"	31.30
M.B.T. No. 4B	2	"	"	"	31.30
M.B.T. No. 6A	3	"	"	"	46.95
M.B.T. No. 6B	3	"	"	"	46.95
M.B.T. No. 6C	4	"	"	"	62.60
M.B.T. No. 6D	4	"	"	"	62.60
Fwd. Battery Space	4	"	"	"	62.60
After Battery Space	4	"	"	"	62.60
TOTAL	36	"	"	"	563.40

IMPULSE AIR FLASKS

Location	No.	Length	Outside Dia.	Cap. Each	Total Cap.
Superstructure - Forward	6	5'- 3"	18"	7 Cu. Ft.	42 Cu. Ft.
After Torpedo Room	4	5'- 3"	18"	7 Cu. Ft.	28 Cu. Ft.
				TOTAL	70 Cu. Ft.

HYDRAULIC ACCUMULATOR

Location	No.	Length	Dia.	Capacity
Pump Room	1		18" O.D.	7 Cu. Ft.

AIR SEPARATORS

Location	No.	Length	Dia.	Capacity
H. P. Air Compressors Pump Room	2	3'-7½"	5¼" I.D.	.994 Cu. Ft.
Torpedo Rooms	2	3'-7½"	5¼" I.D.	.994 Cu. Ft.
			TOTAL	1.988 Cu. Ft.

RELIEF VALVE LIST

NO. REQ.	SIZE	INLET	OUTLET	DESIGNED SET PRESSURE	ABSOLUTE TIGHT PRESSURE	SERVICE
1	3/8" I.P.S.	Male	Fem.Side	2000#	1750#	Hydraulic Accumulator Air Flask
2	½" I.P.S.	Male	Fem.Side	720#	630#	Torpedo Impulse Air

AIR FLASK DATA

Location	NO. OF FLASKS	LENGTH OF FLASK	OUTSIDE DIA. OF FLASK	CAPACITY EACH FLASK	TOTAL CAPACITY CU. FT.
M.B.T. NO.2A	2	11' 3"	18"	15.65 Cu.Ft.	31.30
" " 2B	2	"	"	"	31.30
" " 2C	3	"	"	"	46.95
" " 2D	3	"	"	"	46.95
" " 4A	2	"	"	"	31.30
" " 4B	2	"	"	"	31.30
" " 6A	3	"	"	"	46.95
" " 6B	3	"	"	"	46.95
" " 6C	4	"	"	"	62.60
" " 6D	4	"	"	"	62.60
Fwd.Battery Space	4	"	"	"	62.60
After Battery Space	4	"	"	"	62.60
Total	36	"	"	"	563.40

IMPULSE AIR FLASKS

Location	NO.	LENGTH	DIA.	CAP.EACH	TOTAL CAP.
Superstructure - Forward	6	5'-10"	16"I.D.	7 Cu.Ft.	42 Cu.Ft.
After Torpedo Room	4	5'- 3"	18"O.D.	7 Cu.Ft.	28 Cu.Ft.
				Total	70 Cu.Ft.

HYDRAULIC ACCUMULATOR

Location	NO.	LENGTH	DIAMETER	CAPACITY
Pump Room	1	5'-8"	18"O.D.	7 Cu.Ft.

AIR SEPARATORS

Location	NO.	LENGTH	DIAMETER	CAPACITY
H.P. Air Compressors Pump Room	2	3'-7½"	5¼" I.D.	.994 Cu.Ft.
Torpedo Rooms	2	3'-7½"	5¼" I.D.	.994 Cu.Ft.
			Total	1.988 Cu.Ft.

CAPACITY OF AIR BANKS

Bank No.	Cubic Feet
1	125.20
2	109.55
3	109.55
4	109.55
5	109.55
TOTAL	563.40

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SS425-434 incl.
SS381-416 incl.

GAUGE LIST

MARK	NO. REQ.	DIA. DIAL	SERVICE	READING	RED HAND SETTING
A	8	4½"	H.P. Air Banks, Service Fwd. & Aft, Dist. Manifold	0-4000#	3000#
B	4	4½"	H.P. Torpedo Charging	0-4000#	3000#
D	1	4½"	H.P. Air to Hydraulic Accumulator	0-3000#	1850#
E	12	3½"	Impulse Air	0-600#	400#
F	1	3½"	Safety Tank	0-300#	200#
G	1	3½"	Negative Tank	0-300#	200#

REDUCING VALVES

NO. REQ.	INLET	OUTLET	SUPPLY PRESS.	DEL'Y PRESS.	CU.FT. Per Min. DEL'D	SERVICE
2	1" Union End	1¼" Fl'g	3000#	225#	200	225# Air Service
2	½" Union End	½" Union End	3000#	300# 400# 525#	15	Torpedo Impulse

CAPACITIES & VOLUMES OF TANKS

NAME	CU.FT.	TONS S.W.
Safety Tank	847	24.19
Negative Tank	282	8.06
Bow Buoyancy Tank	1057	30.2

MATERIAL SCHEDULE

NAME	MATERIAL	CONNECTION	U.S.N. SPEC.	PORT. NO.	TEST PRESS.	REMARKS
SHIPS Air Flask	Steel	Threaded	Type A 51F10	-	5000#	
Impulse Air Flask	Steel	Flanged	51F10 Type B	-	1200#	After Torpedo Room
Impulse Air Flask	Non-Shatter-able Steel	Flanged	51F5 Type B	-	1200#	Superstructure Forward
Air Separator	Steel	Union End	4951	42026	5000#	
Air Strainer	Comp.M-r	Union End	46B6	42026	5000#	Air Comp. & Torpedo Charging & Reducing Valves
H.P. Globe Angle, Cross Valves	Comp.M-r	Union End	46B6	42036	4500#	
H.P. Globe "	Comp.M	Flanged	Comm.		1200#	Impulse Air
Reducing Valve	Comp.	Union End & Flanged	45V28		5000#	
Check Valve	Comp.	Flanged	Comm.		1200#	
Quick Opening Angle	Comp.M	Flanged	46B8	486-228 BuNo386-462	400#	Negative Tank Vent
Relief	Comp.M	Flanged or Screwed	45B26		1200#	Impulse Air
Angle Check, Spec.	Comp.M	Flanged & Union End	46B8		4500#	Tank Blows
Angle Stop	Comp.M-r	Union End	46B6		4500#	H.P. Banks
Manifold	Comp.Mn-c CuSi	" " Flanged	49B5 46B28		4500# 900#	H.P. Manifold Impulse Air
Pipe .405" O.D.	Copper		44T12		4500# 900#	
Fittings	Various	Union End	Comm.		4500#	
Hull Conn.	Steel Pipe Brass " Copper "	Silver Soldered	44P10 44T12&16	S-6093 S-7014	4500# 900#	
Fittings-Tube	Comp.M.	"		S-6094 & Comm.	4500#	
Tubing .540" O.D. & Up	Brass		44T16			
Air Strainer	Comp.M-r	Union End	46B6	25968	5000#	Air Banks to Receiving MFD.

PIPE LIST

MARK	NOM. SIZE	MATERIAL	SERVICE	LBS.TEST PRESSURE
1	½"	Brass	H.P. Air from Compressors	4500
2	½"	Brass	H.P. Air from Compressors	4500
3	1/8"	Copper	H.P. Separators Drain	4500
4	1"	Brass	H.P. Air Bank No. 1	4500
5	¾"	Brass	H.P. Air Bank No. 1	4500
6	1"	Brass	H.P. Air Bank No. 2	4500
7	¾"	Brass	H.P. Air Bank No. 2	4500
8	1"	Brass	H.P. Air Bank No. 3	4500
9	¾"	Brass	H.P. Air Bank No. 3	4500
10	1"	Brass	H.P. Air Bank No. 4	4500
11	¾"	Brass	H.P. Air Bank No. 4	4500
12	1"	Brass	H.P. Air Bank No. 5	4500
13	¾"	Brass	H.P. Air Bank No. 5	4500
14	½"	Brass	H.P. Air External Connection	4500
15	1½"	Brass	H.P. Air Manifolds Cross Connections	4500
16	½"	Brass	H.P. Air to Hydraulic Accumulator Flask	4500
17	½"	Brass	H.P. Air To Hydraulic Accumulator Flask	2750
18	½"	Brass	H.P. Air to Hydraulic Accumulator	2750
19	1/8"	Copper	Hydraulic Accumulator Air Flask Drain	-
20	1/8"	Copper	Accumulator Bleeder	-
21	½"	Brass	H.P. Air Service Forward	4500
22	¾"	Brass	H.P. Air Service Aft Cont. Rm. to Eng. Rm.	4500
23	½"	Brass	H.P. Air Service Aft Eng. Rm to Aft Torp. Rm.	4500
24	1"	Brass	H.P. Air to 3000# - 225# Reducers	4500
25	1"	Brass	H.P. Air to 3000# - 225# Reducers	4500
26	1"	Brass	3000# - 225# Reducers By-pass	338
27	1½"	Brass	H.P. Air to 600# M.B.Blow Manifold	4500
28	1½"	Brass	H.P. Air to 600# M.B. Blow Manifold, Emergency	4500
29	1"	Brass	H.P. Bow Buoyancy Blow	4500
30	1"	Brass	H.P. Bow Buoyancy External	-
31	1"	Brass	H.P. Safety Tank Blow	4500
32	½"	Brass	H.P. Negative Tank Blow	4500
33	4"	Cu.Ni.	Negative Tank Vent	300
34				
35	½"	Brass	H.P. Air Torpedo Charging	4500
36	½"	Brass	H.P. Air to 3000# - 400# Reducer - Impulse Air	4500
37	½"	Brass	H.P. Air to 3000# - 400# Reducer - By-pass	900
38	½"	Brass	400 lbs. Impulse Air to Manifold	900
39	½"	Brass	Torpedo Impulse Flasks Charging Lines	900
40	4"	Brass	Torpedo Impulse Air (Outboard)	900
41	4"	Brass	Torpedo Impulse Air (Inboard)	900
42	1/8"	Copper	Ships Air Flasks Drain	4500
43	1/8"	Copper	Impulse Air Flasks Drain	900
44	-	Copper	H.P. Gauge Lines	4500
45	-	Copper	Safety Tank Gauge Line	300
46	-	Copper	Negative Tank Gauge Line	300
47	-	Copper	Impulse Air Gauge Line	900
48	3"	Cu.Ni.	Negative Tank Vent	300
49	¼"	Brass	After T.R. Impulse Flasks Internal Drain Pipe	-
50	4"	Cu.Ni.	Negative Tank Drain to Bilge	-

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600 LB. AIR (Ref. Plan 401)

See Plate 15.
See Reference Plan 401.

The 600 lb. air system gets its supply from two lines off the 3000# distribution manifold without benefit of reducers. Relief valves provide necessary control of pressure. There are 2 sentinels set for 610# and tight at 600#, and 2 reliefs set for 720# and tight at 630#.

The Forward Group 600# main ballast blow manifold (Control Room) feeds from the 3000# manifold. The Forward Group M.B. blow manifold has four valves, viz:

(1) No. 1 M.B.
(2) 2A and 2C M.B.
(3) 2B and 2D M.B.
(4) Fuel Ballast Tanks Nos. 3A & 3B.

The After Group 600# M.B. blow manifold feeds from 3000# manifold.

The After Group 600# M.B. blow manifold has five valves, viz:

(1) No. 7 M.B.T.
(2) No. 6B and 6D M.B.T.
(3) No. 6A and 6C M.B.T.
(4) No. 5A and 5B F.B.T.
(5) No. 4A and 4B M.B.T.

The blow line enters, with a stop valve, each tank at any convenient point.

The 600# blow system provides list control.

The 600# blow system provides flexibility of control in cases of emergency by means of cross connections.

10 LB. MAIN BALLAST BLOW 10# AIR

Reference: L.P. Blower, Roots-Connersville, Instruction Book, See Plate 15.

A 10# blow line leads to each main ballast tank, and enters the vent line. Each has a stop and check valve.

Component parts of system:

L.P.Blower	Pump Room
Intake Silencer	On intake
L.P. Cut-out - flap valve	
List Control Valves.	

The L.P. Blow Manifold is provided with six connections, the branches from these connections being arranged to blow the tanks in groups as follows:

(1) M.B.T. #1
(2) M.B.T. #2A, 2B, 2C and 2D
(3) Fuel Ballast Tanks #3A and 3B
(4) Fuel Ballast Tanks #5A and 5B
(5) M.B.T. #4A, 4B, 6A, 6B, 6C, and 6D
(6) M.B.T. #7

Number 2 and 6 groups are arranged for list control operation.

Branches from the manifold are led through the pressure hull and fitted with lever operated flap valves where they pierce the pressure hull, for controlling the flow of air. These flap valves seat with the tank pressures. A flap Valve with a positive gagging device is provided at the compressor connection to the manifold.

The branches of the 10 pound blow pipes to the individual vent valves of the number 2, 4 and 6 groups are provided with stop valves. The valve stems terminate with square ends at the deck without hand wheels.

List Control. Two lines lead to the list control manifolds which are split in the form of "Ys". One branch from each of the list control manifolds leads to the port forward and aft. Groups of tanks and one line from each of the list control manifolds leads to the starboard, forward and aft groups of tanks. Lever-operated list control dampers are provided in these

fittings and arranged to be held in the center or neutral position by means of a spring. These dampers are arranged so as to restrict the flow of air to either the port or the starboard tanks when it is necessary to correct the list of the vessel while blowing.

To bring the ship to the surface, main ballast tanks are partially blown by means of the 600 lb. manifold.

Low Pressure Blower (Turbo-Blow). There is one L.P. air compressor designed for 25" intermittent service. The L.P. air compressor is a Roots-Connersville nominally rated 6", single stage, single suction, rotary compressor, direct driven by a 90 H.P. Star Compound-wound motor, 1750 R.P.M. normal running speed. Compressor and motor are mounted on a box-type welded steel base.

The tested capacity of the compressor is 1600 cu. ft. of free air per minute at 10 p.s.i. above atmospheric kilowatt input to motor of 76 KW.

L.P. Air Compressor, notes on operation of:

Always keep as many main ballast tank groups open to the compressor discharge as possible, even though the flood and vent valves on some groups may be closed.

L.P. Air Compressor Motor Control

The motor control for this unit is manufactured by the Navy Yard, Portsmouth, N.H. Its features are:

(a) An "On" and "Off" lever which must be held in the "On" position while the motor is being started. It is moved to the "Off" position to stop the motor.

(b) A starting handle which is rotated to cut out successive starting resistances in the armature circuit. This Handle must be turned 5 revolutions until it comes to a stop, to bring the motor up to speed, and to automatically hold the "On" and "Off" lever to the "On" position.

Further data on the motor controller is contained in Record of Electrical Auxiliaries, Vol. I.

SALVAGE AIR SYSTEM

See Plate 9 - 225 lb. Air System.
See Plate 21 - Air Salvage System.

Ports. Plan 466-381, Bureau of Ships No. Salvage System general arrangement gives complete information as to the salvage facilities provided for the ship.

There are 16 salvage air connections for the eight main compartments of the ship, one high and one low lead. Each is marked with a nameplate. For compartments the touch indentification is by button heads on the plate.

The M.B.T. safety tank and compartment salvage air connections total 29. Their touch identification is in lugs.

See "Deck Plate Marking" on reference plan.

See "List of Wrenches for Salvage Connections" on reference plan. This list shows that tools are provided (and locations of stowagesis shown) for use as follows:

Wrenches: Engine Air Induction & Ships Ventilation Supply & Exhaust Trunk.
Salvage Air, Compartments.
Main Engine Exhaust Valve, Starboard.
Main Engine Exhaust Valves - Port.
Auxiliary Engine Exhaust Valve.

See "Hull Valves and number of turns necessary to secure", reference plan.

Diver's connections for salvage system are fitted for 1¼ in. standard pipe thread.

The salvage air system may be divided into the following groups:

(1) Provision for blowing the main ballast tanks from outside the vessel.
(2) Provision for blowing compartments from outside the vessel.
(3) Provision for blowing compartments from inside the vessel.

Groups (1) and (2) are supplied externally by means of connections secured by a diver, Group (1) is provided with a separate connection with a stop valve operated externally so that each main ballast tank may be blown separately. Group (2) is provided with a separate connection, with a stop valve operated externally or internally, for blowing the compartments of the vessel. Group (3) consists of special bulkhead valves located on transverse pressure bulkheads and connected to the vessel's 225 pound air service line. It provides means for blowing any compartment from that or the adjacent compartment.

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GAUGE LIST

MARK	NO. REQ.	DIA. DIAL	SERVICE	READING	RED HAND SETTING
B	1	3½"	L.P. Blow Manifold	0-60#	10#
C	2	3½"	M.B. Blow Manifold	0-800#	600#

CAPACITIES & VOLUMES OF TANKS

	CUBIC FEET	TONS OIL	TONS S.W.
Main Ballast Tank No. 1	1700		48.58
Main Ballast Tanks Nos. 2A & 2B	2255		64.44
Main Ballast Tanks Nos. 2C & 2D	2332		66.62
Fuel Ballast Tanks Nos. 3A & 3B	2619		74.84
Main Ballast Tanks Nos. 4A & 4B	3172		90.62
Fuel Ballast Tanks Nos. 5A & 5B	2638		75.36
Main Ballast Tanks Nos. 6A & 6B	2398		68.52
Main Ballast Tanks Nos. 6C & 6D	2540		72.58
Main Ballast Tanks No. 7	1430		40.85
Safety Tank	847		24.19
	21,931		626.60

L. P. BLOWER
Rotary Type - Capacity 1600 Cu.Ft. per min. - 1750 R.P.M. - 10# psi pressure

PIPE LIST

MARK	NOM. SIZE	SERVICE	PRESSURE WORK	PRESSURE TEST
1	1"	600# Blow to No.1 M.B.Tank	600	900
2	1"	600# Blow to Nos.2A & 2C M.B. Tanks	600	900
3	1"	600# Blow to Nos.2B & 2D M.B. Tanks	600	900
4	1"	600# Blow to Nos.3A & 3B Fuel Ballast Tanks	600	900
5	1"	600# Blow to Nos.4A & 4B Main Ballast Tanks	600	900
6	1"	600# Blow to Nos.5A & 5B Fuel Ballast Tanks	600	900
7	1"	600# Blow to Nos.6A & 6C Main Ballast Tanks	600	900
8	1"	600# Blow to Nos.6B & 6D Ballast Tanks	600	900
9	1"	600# Blow to No. 7 M.B. Tank	600	900
14	6"	10# Air From Blower	10	15
16	2½"	10# Blow to No. 1 M.B.T.	10	300
17	2½"	10# Blow to No. 1 M.B.T.	10	300
18	2½"	10# Blow to Nos. 2A & 2C M.B. Tanks	10	300
19	2½"	10# Blow to Nos. 2A & 2C M.B. Tanks	10	300
20	2"	10# Blow to Nos. 2A & 2C M.B. Tanks	10	300
21	2½"	10# Blow to Nos. 2B & 2D M.B. Tanks	10	300
22	2½"	10# Blow to Nos. 2B & 2D M.B. Tanks	10	300
23	2"	10# Blow to Nos. 2B & 2D M.B. Tanks	10	300
24	2½"	10# Blow to Nos. 3A & 3B F.B. Tanks	10	300
25	2½"	10# Blow to Nos. 3A & 3B F.B. Tanks	10	300
26	2"	10# Blow to Nos. 3A & 3B F.B. Tanks	10	300
27	2½"	10# Blow to Nos. 5A & 5B F.B. Tanks	10	300
28	2½"	10# Blow to Nos. 5A & 5B F.B. Tanks	10	300
29	2"	10# Blow to Nos. 5A & 5B F.B. Tanks	10	300
30	3"	10# Blow to Nos. 4A, 6A & 6C M.B. Tanks	10	300
31	3"	10# Blow to Nos. 4A, 6A & 6C M.B. Tanks	10	300
32	2½"	10# Blow to Nos. 6A & 6C M.B. Tanks	10	300
33	2"	10# Blow to Nos. 4A, 6A & 6C M.B. Tanks	10	300
34	3"	10# Blow to Nos. 4B, 6B & 6D M.B. Tanks	10	300
35	3"	10# Blow to Nos. 4B, 6B & 6D M.B. Tanks	10	300
36	2½"	10# Blow to Nos. 6B & 6D M.B. Tanks	10	300
37	2"	10# Blow to Nos. 4B, 6B & 6D M.B. Tanks	10	300
38	2½"	10# Blow to No. 7 M.B. Tank	10	300
39	2½"	10# Blow to No. 7 M.B. Tank	10	300
41	¾"	Safety Tank Inboard Vent	-	-
42	½"	Fuel Ballast Tanks Inboard Vent	200	300
43	-	Gauge Line 600# M.B. Blow Manifolds	600	900
54	-	Gauge Line - L.P. Blower	10	15
55	9"	No. 1 M.B.T. Vent	200	300
56	8"	No. 7 M.B.T. Vent	200	300
57	1"	600# Blow to Nos. 4A-4B Fuel Ballast Tanks	600	900
58	1/8"	Vents - 600# Blow F.B.T's 3, 4, & 5	600	900

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Section U-19

225 LB. AIR

Ref: Ports. No. 402-381 - 225 Lb. Air. - Diagram.

The 225 lb. service air system takes its supply from the H.P. air distribution manifold and an auxiliary 225# air compressor. The reducers are set for 225# and each has a delivery of 200 cu. ft. per minute, total 400 cu. ft. Each is fitted with strainer and cut-out valves. Around both reducers there is leading to the 225# manifold a by-pass direct from the 3000# manifold.

The 225# air system has military character as furnishing the blow for -

10 Torpedo tubes and stop cylinders
Forward and aft trim tanks and WRT tanks
Auxiliary tank No. 1, No. 2.

Service functions as blow for -

F.W. and battery water tanks
Fuel oil tanks
Sanitary tanks

A spare connection is piped to the pump room for 225# air to compartment.

An auxiliary 225# air compressor located in the pump room is motor driven - Belt connected - 2 stage - 2 cyl. - V type - air cooled, Ingersoll-Rand Company Model #234 - 3" & 1$\frac{3}{16}$" x 2$\frac{3}{16}$" - Type 30 - 800 r.p.m. - Cap. 9 cu. ft. per minute (P.D.) - discharge pressure 170-225#. Pressure switch cuts in at 170#, cuts out at 225#.

Operating instructions for type 30 compressors furnished by Ingersoll-Rand Company (Form 2108-B) Ports. No. B-2752.

CAPACITIES & VOLUMES OF TANKS

Variable Ballast Tanks	CUBIC FEET		TONS S.W.
Auxiliary Tank No. 1	1094		31.26
Auxiliary Tank No. 2	1094		31.26
Forward Trim Tank	860		24.57
Forward W.R.T.	176		5.00
After Trim Tank	733		20.94
After W.R.T.	185		5.28
Normal Fuel Oil	Cu.Ft.	Gals.	Tons
No. 1	1525	11400	36.31
No. 2	1744	13050	41.56
No. 6	1992	14900	47.45
No. 7	1243	9300	29.62
Collecting	398	2980	9.49
Expansion	398	2980	9.49
Fuel Ballast			
No. 3A & 3B	2619	19550	62.26
No. 5A & 5B	2638	19680	62.68
Fresh Water Tanks	Gals.	Tons	
No. 1 & 2	2000	7.44	
No. 3 & 4	2450	9.12	
Forward Battery	600	2.22	
After Battery	600	2.22	
Sanitary Tanks			
No. 1	320	1.19	
No. 2	1100	4.09	

MATERIAL SCHEDULE

	MATERIAL	CONN.	USN Spec.	PLAN NO.	TEST	REMARKS
Globe, Angle & Cross Valves	Comp.M	Flanged or Scwd.	45V9 45V14		200# 450#	
Relief Valve	Comp.M	Screwed	45V26		450#	
Stop Check Valve	Comp.M	Flanged or Scwd.	45V9 45V14		200# 450#	
Check Valve	Comp.M	Flanged or Scwd.	Comm.		400#	
Reducing Valve	Comp.M	Screwed	45V28		338#	
Hull Conn. & Angle Valve	Comp.M	Flanged	46B8	25861	300#	
Quick Opening Gate	Bronze	Screwed	45V1		100#	Signal Ejector Drain
Spec. Quick Opening	Comp.M	Cone J.T.	46B8	845-201	338#	Signal Ejector Blow
Siren Control Valve	Comp.M	Flanged	Comm.		338#	
Drain Cock	Brass	Screwed	45C5			F.O. Tanks Test Manifold
Deodorant Chamber	Copper Container filled with Deodorant			35403		San.Tank Vent
Pressure Gauge	Phenolic	Screwed	45G1			
Fittings Bh'd	Steel	Silver Soldered	44P10	S-6093	338#	
Fittings Soldered Tube	Comp.N-r	Silver Soldered	46B6 45F12	Comm. S-6094	338#	
Unions	Steel Bronze	Silver Soldered	Comm.		338#	
Flanges	Comp.M		45F14			
Bolts	CuSi		46B27			
Nuts	CuSi		46B27			
Gaskets	Comp.Asbestos Sheet		33P13			
Tubing	Brass-Copper		44T15 44T12			

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MATERIAL SCHEDULE (Cont.) See Diagram

	MATERIAL	CONN.	USN SPEC.	PLAN NO.	TEST	REMARKS
Pipe Locked Open Locked Closed	Brass		44P12			
Hose	Rubber			S7710		Aux. Air. Comp. Disch.

GAUGE LIST

MARK	NO. REQ.	DIA. DIAL	SERVICE		READING	RED HAND SETTING
A	3	3½"	Air	Air Service	0-400#	225#
B	22	3½"	Air	Compartments & Variable Tanks	0-300#	200#
C	4	4½"	Water	Sea Pressure	0-400#	225#
D	10	3½"	Water	Torpedo Tubes	0-300#	200#
E	10	3½"	Air	Fuel Oil Tanks	0-300#	15#
F	1	3½"	Air	Fresh Water	0-60#	20#
G	1	3½"	Air	Battery Fresh Water	0-60#	20#
H	1	3½"	Air	W. C. Measuring & Tank	0-400#	225#
J	2	16"	Water	Depth Gauge (Control Room)	15-165 Ft.	
K	2	8"	Water	Depth Gauge (C.R. & C.O.S.R.)	0-600 Ft.	
L	2	3½"	Air	Sanitary Tanks	0-300#	200#
M	1	3½"	Air	Pneumatic Tools	0-300#	100#
N	2	3½"	Air	Torpedo Ventilating	0-60#	-
O	3	6"	Water	Escape Depth Gauge	0-600 Ft.	
P	3	6"	Air	Caisson Type	0-600 Ft.	
Q	1	8"	Water	Depth Gauge (Conning Tower)	26-176 Ft.	
R	1	3½"	Air	Fresh Water & Battery F.W.	0-60#	20#

REDUCING VALVES

INLET	OUTLET	SUPPLY PRESS.	DEL'V'D PRESS.	C.F.M. DEL'D	SERVICE	NO. REQ.
½"I.P.S. Fem.	½" I.P.S. Fem.	225	100#	6	Pneumatic Tools	1
¼"I.P.S. Fem.	¼" I.P.S. Fem.	225	20#	5	Battery Fresh Water	1
¼"I.P.S. Fem.	¼" I.P.S. Fem.	225	20#	5	Fresh Water	2
⅜"I.P.S. Fem.	⅜" I.P.S. Fem.	225	5#	5	Torpedo Ventilating	2

RELIEF VALVES

NO. REQ.	SIZE	INLET	OUTLET	DESIGNED SET PRESSURE	ABSOLUTE TIGHT PRESSURE	SERVICE
2	1¼"I.P.S.	Male	Fem-side	270#	240#	225# Air
1	¼"I.P.S.	Male	Fem-side	235#	225#	Sentinel
2	3/8"I.P.S.	Male	Fem-side	10#	6#	Torpedo Ventilating
1	½"I.P.S.	Male	Fem-side	120#	105#	Pneumatic Tools
1	½"I.P.S.	Male	Fem-side	270#	240#	225# Aux. Air Comp.
3	¼"I.P.S.	Male	Fem-side	24#	21#	B.F.W. & F.W. Tanks

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225# AIR SYSTEM
See Diagram

PIPE LIST

MARK	NOM. SIZE	SERVICE	TEST
1	1¼"	225# Air Service Forward	338
2	1¼"	225# Air Service After	338
3	½"	225# Air Service	338
4	2"	225# Air Manifold Vents Drain	-
5	1"	225# Air Manifold Vents Drains	-
9	1"	225# Blow & Vent No.1 Auxiliary Tank	338
10	1"	225# Blow & Vent No.2 Auxiliary Tank	338
11	1"	225# Blow & Vent Forward Trim Tank	338
12	1"	225# Blow & Vent After Trim Tank	338
13	1/8"	225# Air Service Control Room	338
14	1/8"	225# Blow Depth Gauge Sea Connection	338
17	1/8"	225# Blow Gauges Sea Connection	338
18	½"	225# Air to Signal Ejector	338
19	½"	225# Air to Signal Ejector - Impulse	338
20	½"	225# Air to Signal Ejector - Blow Down	338
21	¾"	Signal Ejector Drain	-
22	¼"	225# Air to Hydraulic Pressure Tank Cut-Out Valve	338
23	1"	225# Air Service Main	338
24	3/8"	225# Air Aux. Air Comp. Disch. to Volume Tank	338
25	½"	225# Aux. Air Comp. Disch. Fr. Vol. Tank to Manifold	338
26	¼"	225# Aux. Air Comp. Volume Tank Drain	-
27	¼"	225# Air to 200# - 20# Reducer Nos.3 & 4 F.W. Tanks	338
28	¼"	225# - 20# Reducer By-pass	338
29	¼"	20# Blow Nos.3 & 4 F.W. Tanks	30
30	1½"	Nos. 3 & 4 F. W. Tanks Vent & Blow	-
31	1½"	Nos. 3 & 4 F.W. Tanks Combined Vent	-
32	¼"	Grease Gun Conn.	338
33	¾"	225# Compartment Air Supply	338
34	¾"	225# Air Service	338
35	¼"	225# Air Service	338
36	½"	Gauge Line - Sea Pressure Conn.	338
37	¾"	225# Air to 225# - 5# Reducer - Torpedo Ventilating	338
38	¾"	5# Air - Torpedo Ventilating	10
39		225# Blow to Hydro Static Type Gauge for Sanitary Tank #1	338
40		225# Blow to Hydro Static Type Gauge for Sanitary Tank #2	338
43	¾"	225# Air to Whistle & Siren	338
44	¾"	225# Air to Whistle	338
45	¾"	225# Air to Siren	338
46	1/8"	225# Blow - Depth Gauge Sea Conn. in C.T.	338
47	¾"	225# Air Service	338
48	1¼"	225# Air to Torpedo Tubes Blow & Vent Manifold	338
49	1½"	225# Blow & Vent, Torpedo Tubes F. & A.	200
50	1½"	Torpedo Tubes Muzzle Vent	200
51	1"	Torpedo Tubes Outboard Vent	200
52	1½"	Torpedo Tubes Inboard Vent	200
53	½"	225# Air to Torpedo Tube Stop Cylinders	338
54	1"	Torpedo Tubes Stop Cylinders Vents	-
55	1½"	225# Blow & Vent W.R.T. Tanks	200
56	1¼"	225# Blow W.R.T. Tank	200
57	¼"	225# Blow W.R.T. Tank Drain	-
58	1½"	225# Blow & Vent Trim Tanks from Torpedo Room	200
59	1"	225# Air to Escape Trunk	338
60	1"	225# ~~Blow~~ & Vent Escape Trunk Fr. Torpedo Room	-
61	1"	Escape Trunk Vent	200
62	1"	225# Blow, Escape Trunk, from Trunk	338
63	1/8"	225# Blow, Escape Depth Gauge Sea Conn.	200
64	1¼"	225# Air to Volume Tanks Forward & Aft	338
65	1/8"	225# Blow Sea Pressure Gauges Forward & Aft	338

SS425-434 Incl.
SS381-416 Incl.

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PIPE LIST (Continued)

MARK	NOM. SIZE	SERVICE	TEST
66	½"	225# Blow Sanitary Tank No. 1	338
67	½"	Sanitary Tank Inboard Vent	-
68	1"	Sanitary Tank Outboard Vent	200
69			338
70	½"	Volume Tank Drain Forward and Aft	-
71	½"	Echo Ranging Trunk Equalizer Vent	165
72	½"	225# Air to Measuring Valves, W.C.	338
73	½"	Air to Measuring Tanks W.C.	300
74	½"	Air to W.C.	300
76	½"	Vent from Rocker Valve, W.C.	-
77	¼"	225# Air to 200#-20# Reducer, F.W. & B.F.W. Tanks	338
78	¼"	225#-20# Reducer By-pass	338
79	¼"	20# Blow Battery F.W. Tanks	30
80	½"	20# Blow & Vent Battery F.W. Tanks	30
81	½"	Vent, Battery F.W. Tanks	30
82	¼"	20# Blow Fresh Water Tanks Nos. 1 & 2	30
83	1½"	Vent, Fresh Water Tanks Nos. 1 & 2	30
85	½"	225# Air to Fuel Oil Tanks Nos. 1 & 2	338
86	1/8"	15# Blow & Vent Fuel Oil Tank No. 1-Port	
87	1/8"	15# Blow & Vent Fuel Oil Tank No. 1-Starboard	
88	1/8"	15# Blow & Vent Fuel Oil Tank No. 2-Port	
89	1/8"	15# Blow & Vent Fuel Oil Tank No. 2-Starboard	
90	¼"	225# Air to 200#-20# Reducer Battery F.W. Tanks	338
91	¼"	225#-20# Reducer By-pass	338
92	¼"	20# Blow Battery Fresh Water Tanks	30
93	½"	Battery F.W. Tanks Vent & Blow	30
94	1/8"	Inboard Vent Fuel Ballast Tank No. 3A	
95	1/8"	Inboard Vent Fuel Ballast Tank No. 3B	
96	1/8"	Inboard Vent Fuel Ballast Tank No. 5A	
97	1/8"	Inboard Vent Fuel Ballast Tank No. 5B	
98	½"	225# Blow Sanitary Tank No.2	338
99	½"	Sanitary Tank Inboard Vent	
100	1"	Sanitary Tank Outboard Vent	200
102	¼"	225# Air to 225# -20# Reducer Test Tank	338
103	½"	225# Air to 200# - 100# Reducer- Pneumatic Tools	338
104	½"	225# -100# Reducer By-pass	338
105	½"	100# Air to Pneumatic Motors for Engine Jacking Gear Motor Reduction Gear, Propeller Shaft Turning Gear	150
107	½"	225# Air to Fuel Oil Tanks Nos.6 & 7, Exp. & Coll. Tanks	338
108	1/8"	15# Blow & Vent Fuel Oil Tank No. 6 - Starboard	
109	1/8"	15# Blow & Vent Fuel Oil Tank No. 6 - Port	
110	½"	15# Blow & Vent Collecting Tank	
111	½"	15# Blow & Vent Expansion Tank	
112	1/8"	15# Blow & Vent Fuel Oil Tank No. 7 - Starboard	338
113	1/8"	15# Blow & Vent Fuel Oil Tank No. 7 - Port	338
114	½"	225# Air to Emergency Stop	338
116	1½"	After Torpedo Tubes Vent & Blow Manifold Connecting Pipe	200
117	1/8"	Gauge Line, 16" Depth Gauge	200
118	½"	Gauge Line, 16" Depth Gauge	200
119	1/8"	Gauge Line, 8" & 16" Depth Gauge	200
120	½"	Gauge Line, 8" & 16" Depth Gauge	200
121	1/8"	Gauge Line, Sea Pressure Gauge	200
122	1/8"	Gauge Line, 8" Depth Gauge	200
123	1/8"	Gauge Line, 8" Depth Gauge Conning Tower	200
124	¼"	Gauge Line, Escape Depth Gauge - C.T.	200
125		Gauge Line, Auxiliary Tank No. 1	200

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PIPE LIST (Continued)

MARK	NOM. SIZE	SERVICE	TEST
126		Gauge Line, Auxiliary Tank No. 2	200
127		Gauge Line, Forward Trim Tank	200
128		Gauge Line, After Trim Tank	200
129		Gauge Line, 225# Air Manifold	338
130		Gauge Line, Sea Pressure Gauges, W.C.	338
131		Gauge Line, Forward Trim Tank	200
132		Gauge Line, W.R.T. Tank	200
133		Gauge Line, Sea Pressure Gauge	200
134		Gauge Line, 225# Air Service Forward & Aft	338
135		Gauge Line, Sanitary Tanks	200
136		Gauge Line, Escape Depths Gauges	200
137		Gauge Line, Compartment Gauges	200
138	1/4"	Gauge Line, W.C. Measuring Tank	338
139	1/4"	Gauge Line, Fuel Oil Tanks	200
140	1/4"	Gauge Line, Pneumatic Tools	150
141		Gauge Line, After Trim Tank	200
142		Gauge Line, W.R.T. Tank	200
143	1/8"	Gauge Line, 8" Depth Gauge, C.O.S.R.	200
144	1/8"	225# Blow Pitometer Log & Grease Gun Connection	338
145	1/8"	225# Air to Trim and Drain Pump Air Chambers	338
146	1/8"	Blow & Vent - Drain Pump Air Chamber	338
147	1/8"	Blow & Vent - Trim Pump Air Chamber	338
148	1 1/4"	Pressure Equalization (Compartment)	-
149	3/4"	Gun Access Trunk Drain	-

AUXILIARY 225# AIR COMPRESSOR

Location - Pump Room
Ingersoll Rand Co. Model #234 - Type 30
Motor Driven- Belt Connected - 800 R.P.M.
2 Stage - 2 Cyl. - V Type - Air Cooled
Piston Dia's. & Stroke - 3" & 1 3/4" x 2 3/4"
Capacity - 9 Cu. Ft. Per Min. (PD)
Disch. Pressure - 170-225#

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SS425-434 incl.
SS381-416 incl.

Reference Plans:

Ports.No.	BuShips No.	Title
60-285	387241	Ship's Air Flasks - Stowage in Main Ballast Tanks.
42032		18" Air Flasks - Plug & Drain Pipe.
94-285	387261	L.P. Air Compressor - Foundation.
400-381		3000# Air System - Diagram (Piping).
401-381		600# and 10# Main Ballast Tank Blow System - Diagram (Piping).
402-381		200# Air System - Diagram (Piping).
403-381		Salvage Air System - Diagram (Piping).
404-381		Torpedo Firing System - Impulse Air Piping Arrgt.-Fwd. Torpedo Rm.
405-381		Air System - Piping Arrgt. - Forward Torpedo Room.
406-381		Air Piping Arrgt. - Officers' Quarters and Forward Battery Space. (Piping)
407-381		600#, 3000# and Oxygen Air - Piping Arrgt. - Control Room.
408-381		10# and 200# Air Piping Arrangement - Control Room.
409-381		Air System - Piping Arrgt. in Conning Tower.
410-381		Air System - Piping Arrangement - Pump Room.
411-381		Air System - Piping Arrangement - Crew's Mess, Galley & Scullery.
412-381		Air - Piping Arrangement - Crew's Space & After Battery Space.
412-381		After Battery Space
413-381		Air Piping Arrgt. - Forward Engine Room.
414-381		Air System - Piping Arrangement After Engine Room.
415-381		Air System - Piping Arrangement - After Torpedo Room.
416-381		Torpedo Firing System - Impulse Air Piping arrangement - After Torpedo Rm.
417-381		Air, Oil, Water and Vent Systems - Piping in Superstructure - Forward of Frame 70.
418-381		Air, Oil, Water and Vent Systems - Piping in Superstructure -After of Frame 69.
419-381		Piping in Outside Tanks - Forward.
420-381		Piping in Outside Tanks - Aft.
464-285	490244	Air System - L.P. Blow Manifold - Assembly.
465-285	490231	Air System - L.P. Blow Manifold - Clapper Valve - Details.
476-381		3000 lb. Air System - High Pressure Air Receiving Manifold - Body.
477-381		3000 lb. Air System - High Pressure Air Distributing Manifold Body - Sheet #1.
478-381		3000 lb. Air System - High Pressure Air Distributing Manifold Body - Sheet #2 (Union Ends).
479-201	312066	Manifold - Forward Torpedo Room - Torpedo Tube Blow & Vent - Assembly & Details.
480-201	312067	Manifold - Forward & Aft Torpedo Rooms - Torpedo Tube Blow & Vent Details.
481-285	490157	Gauge Boards - Control Room.
482-381		600 lb. Air System - Main Ballast Tank Group Manifolds - Bodies.
483-381		600 lb. Air System - M.B.T. Group - Manifolds - Details.
484-228	386460	Manifold - 200# Air Service - Sheet #1.
485-228	386461	Manifold - 200# Air Service - Sheet #2.
486-228	386462	Inboard Vent Valve - Negative Tank.
502-381		3000# Air System - H.P. Air Manifolds - Details.

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HULL VENTILATION

See Plate 10

The Hull Ventilation System is designed for sufficient flexibility to meet any anticipated condition of operation, surface or submerged.

Valve and Damper Operation instructions are tabulated on Plate 10. The system has additional resources which may be developed to meet special conditions as necessary.

Actual Performance as checked against data listed on Plate 10 (or Ref. Dwg. 442) is but a guide as to whether the system is functioning with efficiency.

List of Hull Valves, Inboard:

(1) Hull Valve (inboard) - Engine Air Induction - Forward Engine Room.
(2) Hull Valve (inboard) - Ships Ventilation - Forward Engine Room.
(3) Hull Valve (inboard) - Engine Air Inductioh - Aft Engine Room.
(4) Hull Valve (inboard) - Engine Air Induction - Maneuvering Room.

Upon Submerging All Ventilation System Hull Valves - Inboard - Must be Closed.

The ventilation of the ship may be broken down into four systems:

(1) The engine air supply.
(2) The ship's supply.
(3) The ship's exhaust.
(4) The main battery exhaust.

Ventilation System

Name	Takes Suction from	Discharge to	Capacity C.F.M.	Static Pressure	Reference Plan Number
Ship's Supply	Atmosphere or exhaust line	Ship's Compartment	4000 C.F.M.	3"	Ports. 1717-285 BuShips
Ship's Exhaust	Ship's Compartments	Engine Rm. or Ship's Supply	2560 C.F.M.	3"	Ports. 1717-285 BuShips
Battery Exhaust	Battery Cells	Ship's Exhaust Line	375 Min. 500 Min.	6" water 2.66" water	Ports. 1657-228 BuShips 390060P

The Engine Air Supply begins by the air passing through openings in the superstructure deck, through the C.T. sheers and into the fairwater to the 36" main induction valve.

Spray and Splash Proofing of 36" Main Induction Valve (at Fr. 58): below the bridge deck at Fr. 56 is a large screened air duct, with baffle and skirt, that keeps air suction in a horizontal plane to a maximum consistent with other necessary features of flooding and draining the fairwater.

The Main Engines Air Induction - 36" Outboard Valve carries two 22" I.D. pipes, and one 15-1/2" I.D. pipe; viz.:

(1) Port: Leads to Engine Air Induction Hull Valve - Forward Engine Room (Port).
(2) Starboard: Leads to Engine Air Induction Hull Valve - Aft Engine Room - Port and Engine Air Induction Valve Maneuvering room starboard via 15-1/2" diameter branch.
(3) C/L of Ship: Leads to Hull Ventilation Supply Hull Valve - For'd Engine Room.

The Ship's Ventilation Supply Hull Valve is located in the Forward Engine Room (starboard). To this hull valve is connected:

(1) Ship's Ventilation Exhaust Fan Discharge and Damper.
(2) Ship's Ventilation Supply Fan Suction.

The Ship's Ventilation Exhaust Fan (2560 CFM) in the forward engine room takes suction from the 13" D. exhaust main which goes forward on the starboard side. Terminals on this line are enumerated on reference plan 442. The discharge from this fan may be directed:

(1) Outboard through ship's ventilation supply hull valve.
(2) Inboard through forward engine room space.
(3) Inboard through the ship's ventilation supply fan (as in recirculating submerged).

The Battery Exhaust is cross-connected into the ship's exhaust line.

The Ship's Ventilation Supply Fan (complete data on ref. 442) connects to:

(1) Ship's ventilation supply hull valve.
(2) Ship's ventilation exhaust fan by damper.
(3) Air Conditioning coils forward and forward supply line.
(4) Air conditioning coils aft and after supply line.

The Ship's Supply System, inside the vessel, begins with a 4000 C.F.M. ship's ventilation supply fan. The duct into which this fan discharges is proportioned to conduct 2560 C.F.M. forward and 1440 C.F.M. aft when the engines are not running. The supply main to the aft torpedo room discharges air through terminals, fitted with air tight dampers, to all compartments aft of the crew's quarters. The terminal in the aft torpedo room is fitted with a non-airtight damper. The supply main on the port side to the forward torpedo room ventilates the forward compartments. The supply mains are each fitted with units to cool and dry the air discharged from these mains. The coolers are located one in the crew's quarters, the other in the For'd engine room.

The Ship's Exhaust System lies mostly on the starboard side from the forward torpedo room to the forward engine room, with branches to each compartment as indicated on Plate K, (or reference Plan 442). The system is served by 2560 C.F.M. exhaust fan, see previous paragraph.

The Ship's Exhaust System aft of the forward engine room is by free circulation through p.p. valve of the clam shell type in each of the structural bulkheads, except Bhd. 88 where this valve is omitted.

Quick-closing Valves are provided in the ventilation ducts where they pierce main watertight bulkheads. These valves are operable from either side of the bulkhead, and they are capable of withstanding from either side the pressure for which the particular bulkhead is designed; they are also tight against gas at low pressure. The valves are designed to permit the passage of the full volume of air, with, however, a certain loss of energy.

All Flap Valves have operating shafts of rectangular section where passing through the disk.

All Outboard Ventilation Trunks are provided with two valves, an outboard valve and a hull valve. All valves are of quick-closing type. They seat with the external pressure, are absolutely tight, and are capable of withstanding the full submergence pressure externally. The hull valves are operated locally by hand gear.

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The Engine Air Induction and Ship's Ventilation Supply and Exhaust Outboard Valve is provided with means for positively locking the valve in both the open and closed positions, both hydraulically from the control room and mechanically, by hand, at the valve. When the valve is locked mechanically in either the open or closed positions, the mechanical operating gear is capable of being set in a "neutral" position whereby the valve may be operated hydraulically without first releasing the mechanical lock by hand.

The Engine Induction and Ship's Ventilation Outboard Valve is operated by hydraulic power from the control room and locally by hand gear.

Provided on all outboard and hull valves is the electrically operated indicating system.

The Outboard Valve for Ventilation Systems is provided with means for closing and securing it from the outside of the hull in addition to the operating gear on the inside of the hull, and regardless of the setting of the latter gear. The external gear is so designed as to permit the valve to be opened or closed normally, operating it from the inside. Operating gear for outboard and hull valves is capable of holding the valve tightly closed against a pressure equal to a head of water from the top of the valve to the bottom of the inner hull plus 5 pounds. The outside closing device does not prevent closing the valve from inside the vessel regardless of the position of the valve.

The Mechanical Operating Gear for the outboard valve is such that the time required to close the valve from the full open position does not require more than 15 seconds. The operating stations for inboard valves are so located as to be clear of any water that may enter through the valves; furthermore, inboard valves are so designed that entering water will not prevent or delay their closing.

The Rim Force Handwheel required to close the valve is 40 pounds (max.)

The Main Induction and Ship's Supply and Exhaust Outboard Valve is operated hydraulically and by hand. The power operating gear for this valve is so designed that the valve is locked open or closed by a toggle at the end of the hydraulic piston stroke. The hydraulic gear is of the double acting plunger type. The hand gear, to raise and lower the main induction valve consists of a handwheel, reduction gear, worm, quadrant, cross-shaft, lever, roll and slotted link connected to a stem by a sliding crosshead and two links.

To operate the gear by hand the hydraulic control valve in the control room should be in "hand" position.

The operating gear for the valve is fitted with a contact maker for indicator lights in the control room to show locked open and locked closed positions.

The operating gears for the engine Air Induction and Ship's Ventilation Supply Hull Valves consist of a quick closing lever, which is located about six feet from the edge of the hull openings, and a jaw, which is part of the operating lever, engaging a clutch dog attached to the operating shaft, closing the valves. A handnut and screw operated from inside the ship is provided only for gagging these valves tight on the seat. When ungagging valves this latter gear must be placed in its neutral position before attempting to open valve with quick closing lever. At no time is the valve disc prevented from being closed with the quick closing lever, after the latter has been released from the pistol grip latch.

The Engine Air Induction and Ship's Ventilation Supply Hull Valves are locked open by a slotted lever and a latch which engages the operating lever when the valve is fully open.

The operating gear for each hull valve is fitted with a contact maker for Indicator Lights in the control room to show open and closed positions.

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Supply terminals in machinery spaces are fitted with special air-tight dampers to insure absolute tightness against pull of engines.

AIR CONDITIONING

Characteristics of the cooling coils are:

	Forward Coil	After Coil
CFM air	2560	1440
Face velocity fpm	488	468
Face area sq. ft.	5.25	3.10
Air, temp., entering, °F	91!8° - 46%	91!8° - 46%
Air, temp., leaving °F	67° - 85%	67° - 85%
Refrigeration, moisture, tons	1.34	.77
Refrigeration, sensible, tons	3.76	2.13
Refrigeration, total	5.1	2.9
Evaporating Temp., °F	5' - 9-1/2"	3' - 5"

The Air Conditioning Coils are rated to 8 tons but calculations indicate adequacy to 12 tons.

A drain line led to a salvage tank is provided in the discharge of the coolers for removal of water of condensation.

The Air Conditioning Refrigerating Unit is 2-4 ton Freon Units.

Cooling Coils, Cleaning of:

Inspection-prescribed interval for - 30 days.
Cleaning - prescribed interval for - 90 days.

Dirt on a cooling coil lowers operating efficiency. A thin film will reduce capacity and the effect is cumulative due to condensation. Air flow is also adversely affected.

Cleaning procedure:

Ref. (a) Navy Aero Spec. RM-70 Ether, Alkylated, Phenolic (for cleaning air craft) or revised substitute.

(1) The recommended cleaning agents are non-toxic and may be safely used in a closed compartment with ventilation operating, whenever conditions do not permit open doors and hatches.

(2) When cleaning the cooling coils do not shut off the compressor as cleaning agent RM-70 is volatile.

(3) Prepare a bucket of solution of RM-70, a non-toxic solvent, (reference (a)) in warm water (about 100°F.) in the proportion 4 ounces of RM-70 per gallon of water. Provide an ordinary gas welding torch, with a piece of hose attached to the gas connection sufficiently long to reach conveniently into the bucket. Attach the oxygen connection to a source of air at about 60 pounds. Bleed in air so that a fine slow spray is produced. Wet down the entire coil surface, working from the air discharge side of the coil, and allow to stand for about five minutes. Readjust the torch to produce a spray of very high velocity and wash the coils with clean water, blowing from the air discharge to the air inlet side. If found necessary, provide some means to prevent the blast of dirty solution carrying past the coil and up the supply duct. Drain off and wipe away any of the solution remaining. Allow the coils to dry and replace the access plates. The Bureau of Aeronautics is now developing the equivalent of RM-70 which will not involve the use of critical materials.

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(4) If RM-70 is not procurable, the coil may be cleaned in a similar manner using a solution of trisodium phosphate, in the proportion of 1/2 lb. of crystals to three gallons of warm water (about 100°F.). If the trisodium phosphate solution is used the operation requires more time and is more difficult. In addition, the coils should be thoroughly rinsed with warm water, using the torch, after cleaning with the solution.

Reference Plans:

Ports.No.	BuShips No.	Title
442-381	490239	Ventilation System Diagram.
1252-381	490592	Ship's Ventilation System - 12¼" Bulkhead Valves - Disc, Arm, Lever, and Shaft.
1253-381	490591	Ship's Ventilation System - 12¼" Bulkhead Valves - Bulkhead 7¼" Aft of Frame 77 - Arrangement.
1254-285	490613	Ship's Ventilation System - 9½", 11", & 12¼" Bulkhead Valves - Operating Gear, Latch & Brackets.
1262-285	490615	Ship's Ventilation System - 11" Bulkhead Valves - Bulkhead 9" Aft Frame 47 - Arrangement.
1263-381	491042	Ship's Ventilation System - 11" Bulkhead Valves - Bulkhead 3" Aft Frame 58 - Arrangement.
1264-381	491004	Ship's Ventilation System - 11" Bulkhead Valves - Bulkhead 6½" Forward Frame 88 - Arrangement.
1265-381	491043	Ship's Ventilation System - 11" Bulkhead Valves - Bulkhead 13½" Forward Frame 99 - Arrangement.
1266-381	491044	Ship's Ventilation System - 9½" Bulkhead Valves - Bulkhead 107 - Arrangement.
1267-381	491039	Ship's Ventilation System - 9" and 9½" Bulkhead Valves - Bulkheads 35 & 107 - Bulkhead Castings.
1268-381	491005	Ship's Ventilation System - 11" Bulkhead Valve - Bulkheads 47, 58, 88, & 99 - Bulkhead Casting, Valve Disc & Arm.
1269-381	490593	Ship's Ventilation System - 12¼" Bulkhead Valves - Bulkhead Castings.
1270-381	491040	Ventilation System - 9" & 9½" Bulkhead Valves - Valve Disc and Valve Disc Arms.
1271-381	491006	Ventilation System - 9", 9½", 11" & 12¼" Bulkhead Valves - Gears - Glands & Bushings.
1272-381	490594	Ventilation System - 9", 9½", 11" & 12¼" Bulkhead Valves - Levers & Shafts.
1273-381	490595	Ship's Ventilation System - 9", 9½", 11"& 12¼" Bulkhead Valves - Operating Gear - Brackets & Latch.
1274-381	491007	Ship's Ventilation System - 9", 9½" and 11" Bulkhead Valves - Details of Hoods.
1275-381	490596	Ventilation System - 12¼" Bulkhead Valves - Bulkhead 7¼" Aft Frame 77 - Hoods (Forward).
1276-381	490597	Ventilation System - 12¼" Bulkhead Valves - Hoods (Aft.).
1278-285	490678	Ship's Ventilation System - 11" Bulkhead Valve at Bulkhead 47 - Valve Seat.
1279-285	490679	Ship's Ventilation System - 11" Bulkhead Valve at Bulkhead 47 - Hood.
1280-285	490680	Ship's Ventilation System - 11" Bulkhead Valve at Bulkhead 47 - Shaft, Arm & Disc.
1281-285	491117	Ship's Ventilation System - 11" Bulkhead Valve at Bulkhead 47 - Gears, Brackets & Levers.
1282-285	491122	Ship's Ventilation System - 11" Bulkhead Valve at Bulkhead 47 - Housing.
1290-381	491008	Ventilation System - Engine Air Supply - 22" Hull Valve - After Eng. Room - Arrangement.
1291-381	491009	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Assembly at Frames 82 & 92.
1292-381		Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Valve Disc - Link & Bushings.
1293-381	491011	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Valve Cover.
1294-381	491012	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Valve Seat.
1295-381	491013	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Slotted Link & Lever.
1296-381	491014	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Hand Lever, Dog & Shafts.
1297-381	491015	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Hoods.
1298-381	491016	Ventilation System - Ship's Exhaust & Engine Air Supply - 22" Hull Valves - Indicator - Gag Screw & Foundations.

Reference Plans (Continued):

Ports. No.	BuShips No.	Title
1299-381	491017	Ship's Ventilation System - Engine Air Supply - 22" & 15½" Hull Valves - Gears & Gear Boxes.
1300-381		Ship's Ventilation System - 15½" & 22" Hull Valves - Spring Detent - Arrangement & Details.
1302-381	491018	Ship's Ventilation System - Ship's Supply 15½" Hull Valve - Hand Lever, Dog & Shaft.
1303-381	491019	Ship's Ventilation System - Ship's Supply 15½" Hull Valve - Levers, Brackets & Foundations.
1304-381	491020	Ship's Ventilation System - Hull Valves - Forward Engine Room - Arrangement.
1305-381	491021	Ship's Ventilation System - Engine Air Supply - 15½" Hull Valve - Maneuvering Room - Arrangement
1306-381	491022	Ship's Ventilation System - Engine Air Supply & Ship's Supply - 15½" Hull Valve - Assembly.
1307-381	491023	Ship's Ventilation System - Engine Air Supply - 15½" Hull Valve - Valve Seat.
1308-381	491024	Ship's Ventilation System - Ship's Supply - 15½" Hull Valve - Valve Seat.
1309-381	491025	Ship's Ventilation System - Ship's Supply - 15½" Hull Valve - Cover.
1310-381	491026	Ventilation System - Ship's Supply & Engine Air Supply - 15½" Hull Valve - Valve Disc - Lever - Slotted Link & Pins.
1311-381	491027	Ship's Ventilation System - Engine Air Supply & Ship's Supply - 15½" Hull Valves - Hand Lever Dog & Shafts.
1312-381	491028	Ship's Ventilation System - Ship's Supply - 15½" Hull Valve - Assembly.
1313-381	491029	Ship's Ventilation System - Engine Air Supply and Ship's Supply - 15½" Hull Valve - Foundations.
1314-285	490667	Ship's Ventilation System - Hull Valves - Operating Gear - Positive Latch - Assembly & Details.
1315-381	491030	Ship's Ventilation System - Ship's Supply - 15½" Hull Valve - Valve Disc, Lever & Slotted Link.
1316-381	491031	Ship's Ventilation System - Engine Air Supply and Ship's Supply - 15½" Hull Valve - Cone - Shafts - Gag Screws and Foundations.
1317-381	491032	Ship's Ventilation System - Engine Air Supply 15½" Hull Valve - Cover.
1318-381	491033	Ship's Ventilation System - Engine Air Supply & Ship's Supply - 15½" Hull Valve - Gears & Gear Boxes.
1319-308	491081	Ship's Ventilation System - 36" Supply Exhaust Induction Valve - Outboard - Arrangement.
1342-308	491083	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Trunk.
1343-308	491084	Ship's Ventilation System - 36" Exhaust Valve (Outboard) - Hull Casting - Streamline Plate & Yoke.
1344-308	491037	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Valve Seat & Disc.
1345-308	491085	Ship's Ventilation System - 36" Exhaust Valve (Outboard) - Deck Pad - Plug - Supporting Plates & Spindle.
1346-308	491086	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Operating Gear - Hand & Hydraulic Arrangement.
1347-308	491087	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Operating Gear - Frame.
1348-308	491088	Ship's Ventilation System - 32" & 36" Exhaust Valve - Outboard - Operating Gear - Cylinder & Piston.
1349-308	491089	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Operating Gear - Lever, Slotted Link & Pins.
1350-308	491090	Ship's Ventilation System - 32" & 36" Exhaust Valve - Outboard - Operating Gear - Handcrank & Gears.
1351-308	491090	Ship's Ventilation System - 32" & 36" Exhaust Valve - Outboard - Operating Gear Casing & Covers.
1352-308	491092	Ship's Ventilation System - 36" Exhaust Valve - Outboard - Operating Gear - Indicator & Drip Pan.

Reference Plans (Continued):

Ports.No.	BuShips No.	Title
6075-228	389907	Air Conditioning Plant - Fin Cooling Coil - Assembly & Details.
506-381	491053	Ship's Ventilation System - Air Conditioning Coolers - Casing.
1261-381	491041	Ship's Ventilation System - 9" Bulkhead Valves - Bulkhead 35 - Arrangement.
25786	-	Ventilation Terminals - (Throttle Damper) (Cross Connection).
442-381	490239	Ventilation Diagram.
449-381	490991	Ventilation System - Aft Battery Room & Crew's Quarters - Arrgt.
560-381	490975	Battery Ventilation System - Cross Connection.
1657-228	390060P	Battery Ventilation Sets.
534-228	490182	Hydrogen Detector - Arrgt. of Piping
517-228	386493	Air-flow Meter Piping Arrangement.

Section U-21-b

OXYGEN SYSTEM

See Plate 24 - Escape Arrangement.
See Oxygen System - Diagram - Ports. No. 444-228, BuShips No. 386420.
See BuShips (Hull) Manual - Section 11 - Air Purification and Oxygen Replenishment in Submarines Escape Compartments Under Submerged Abandon Ship Conditions.

Ship's Capacity of Oxygen:

No. Flasks	11
Capacity of each Flask (2600 cu.in.min.)	1.504 cu.ft.
Total capacity - 11 Flasks (at 2000 p.s.i.)	16.544 cu.ft.
Total Volume at Atmospheric Pressure	2267.3 cu.ft.
No. of Men - Officers & Crew	77
Volume per Man at Atmospheric Pressure	29.5

Tabulated List of Equipment:

Space	Frames	Flask & Regulator	Manifold & Needle Valves	4 Chucks & Hoses
Fwd. Torpedo Room	32-33P	2		
Fwd. Escape Trunk	27½	0	1	1
Officers' Quarters	46-47S	1		
Control Room	47-48P	2		
Conning Tower	49-56	0	1	1
Crew's Quarters	73-75S	1		(For charging
Fwd. E. R.	81-82S	1		Navy Standard
Aft. E. R.	95-97P	1		escape lungs)
Maneuvering Room	106-107P	1		
Aft. Torpedo Room	117-118S	2	1	1

Oxygen flasks and oxygen regulators are tested to 3000 lbs.

Manifolds, needle valves, cross valves, bulkhead connections, fittings, hose, Schrader tire chucks and copper piping (cone joint) are tested to 338 lbs. for SS308 to SS312.

The forward escape trunk, the conning tower and the after torpedo room are fitted for escape as follows: Two oxygen flasks are connected to manifolds each having four valves for charging the Navy Standard escape appliances. Each valve is connected to a six-foot length of rubber hose, fitted with a self-closing chuck of the Schrader type. The manifolds are near the forward and after access trunks, and located above the 400-foot bubble line.

Oxygen flasks from compartment to compartment are not inter-connected.

THE OXYGEN SYSTEM MUST BE PROTECTED AT ALL TIMES AGAINST OIL AND GREASE.

Special care shall be taken to insure that all of the oxygen equipment is entirely free from grease and oil. No oil whatever shall be used in the assembly of oxygen fittings, and any oil which may have accumulated in piping and fittings during course of manufacture shall be carefully and thoroughly removed before any oxygen is placed in the system. Oxygen containers shall be so stowed that their neck fittings, including discharge valves and connections, will be entirely free from oil or grease in service. Where any lube oil or fuel oil lines, containing valves, fittings or flanges are located over oxygen containers, a shield shall be fitted to prevent oil from dripping onto the head, the valves, or the connections of the container.

REASON: Oxygen under pressure has a high affinity for hydrocarbons in oil and chemical reaction is violent.

BATTERY VENTILATION

Section U-21-d

Reference: (a) Manual of Engineering Instructions, Chapter 29 - Articles 29-170 and 29-175 - Ventilation and Charging Procedure.

The volume of air necessary to maintain less than 3 per cent of hydrogen in the battery exhaust piping is determined in accordance with the instructions contained in reference (a).

Normal finishing rate equals - 500 C.F.M.
Normal finishing rate x 150% - 750 C.F.M.

Battery Ventilation Inboard, only, is provided.

Battery Ventilation. The unit of operation in battery ventilation is the individual cell. Each cell top is equipped with a breather pipe and a suction line. The cell's suction pipe is connected into a hard rubber trunk to the suction side of the battery ventilation set. The breather pipe intake air comes from the natural supply from the battery tank space above the cells.

The Breather pipe to each cell is adjustable as to orifice for equalization.

The Battery Blower is the unit of power which applies force to move and to regulate the volume of air drafted off the individual cell top.

A battery blower (4 per ship) consists of:

Fan Casing (NiCu alloy), gas tight, with rigid motor connection.
Fan Rotor (NiCu alloy) (11-1/16" dia. x 2-7/32").
Motor, 1.25 H.P. and controller.
Capacity - 500 CFM - 6" static press. - 2900 rpm.
100 CFM - .24" static press. - 580 rpm.

The Battery Blower Set is the unit of ventilation service to the After Battery (technical duplicate - Fw'd. Battery). It is composed of two blowers, and it is customary to run the blowers in parallel. In case one blower stops for any cause, the service is not interrupted.

The Battery Blower Set drafts upon the cell tops as consolidated in a 12" duct and discharges through a damper into the ship's exhaust (main 13"). The battery tank air space that the individual breather pipe drafts upon measures 1100 cubic feet. The battery compartment living space that the battery tank drafts upon measures 3500 cubic feet.

A battery blower set consists of: (2 per ship)

2 Fans and Motors on Individual Sound Isolation Foundations.
Rubber lined steel duct off the cell suction header.
Rubber lined steel tee - suction side of fan.
Rubber spool moulded between fan and suction duct.
Rubber spool moulded between fan and discharge duct.
Acid-proofed Wye - combines two fan discharges.
Throttle Damper (Streamlined CuSil) and Wye forms cross connection.
7-1/2" x 13" Wye - into ship's exhaust main.
Hydrogen detector connection.

BATTERY VENTILATION

The motors of the battery fans are arranged for independent operation. The controllers for these fans are located in the maneuvering room. The speed regulation of the fans is such that rated capacities can be obtained, and 21 speeds are provided. Speed control provides a slow speed such that each fan may deliver only 100 c.f.m.

The Fan Rotors are readily accessible for inspections and cleaning by means of portable plates on the fan casings.

Air is supplied to the battery tanks through stand pipes, one at each end of the space, taking air from the living compartments.

The Battery Vent cross connection which is a double Wye combines the two fan discharges (3-3/4" x 6-1/16") into a throttle damper (7" D.) and thence through a Wye to the ship's exhaust main (13" D.).

The Ship Exhaust Main discharges into the forward engine room or into the ship's ventilation supply blower.

A Regulating Damper is provided in the cross connection between battery exhaust and ship's ventilation exhaust line. The damper is designed so that, when closed, with engines running at full power, with battery fans shut down and with hull exhaust fans operating at full speed, it will reduce the flow of air to the minimum required for ventilating the battery inboard. When open, the damper offers minimum resistance to flow of air in the cross connection.

The Damper in the cross connection is a simple butterfly 1/2" smaller than pipe in diameter, to permit minimum flow around damper when damper is closed.

The Air Flow Meter is carried by each battery vent set. The indicator (frame 100) (Republic Flowmeter Co.) is a differential (diaphragm) manometer. The fixed scale reads in inches of water and is a function of the instrument under bench calibration with a standard manometer. The parallel, or calibrated, scale is in cubic feet per minute of air flow through orifice plate in the after battery exhaust (Fw'd. Battery same). The calibrated readings are taken off an empirical curve for the individual boat, or the typical boat of a group. A copy of the curve should be on board. In case of any modification to any part of the battery ventilation system of the ship, a new test and new curve should be made.

The Air Flow Meter is based on the principle of differential pressures above and below a sharp edge orifice (1" restriction on diameter). The differential is of a low order (2" max.). Condensation at the orifice plate (point X - sketch marked BATTERY VENTILATION) or in the air flow meter piping is a possible source of obstruction.

The Air Flow Meter Indicator is a delicate instrument. A sudden blast of air may mean damage or impairment. If necessary to blow the lines through drain valve (F-3 - AIR FLOW METER) observe the necessary precaution to close off both valves to the indicator. No excessive unbalanced pressures are permitted on the diaphragm of the instrument.

The ship is allowed a pamphlet of instructions for installing and operating the air flow indicator - a commercial product.

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Section U-26

BOW DIVING GEAR

Ref: (a) Section M-4, for description of bow planes.
(b) AUXILIARIES, Record of Electrical.

General:

The Bow Plane has two unrelated movements RIGGING & TILTING. In TILTING, the tiller shaft acts as a solid axis free to rotate the bow plane through RISE & DIVE (25° max.). In RIGGING, the tiller shaft, by means of a knuckle, is a fore and aft, horizontal hinge, on which the bow plane is rigged vertically from IN (81°) to OUT (0°).

Bow Plane Rigging is mechanical. The windlass hydraulic motor (Fr.25) does this service as a secondary function to anchor handling. The selective unit for RIGGING or WINDLASS is in the F.T.R. (Fr.23). This consists of a floating jaw clutch, with hand lever. The operator has choice of RIG, neutral or WINDLASS. In shifting the clutch, the hand lever also shifts, by means of a push rod, (Fr.24) the change valve (Fr.25). The clutch carries the mechanical drive of the hydraulic motor (Fr.25). The change valve (Fr.25) carries the hydraulic feed of the same motor.

Bow Plane Rigging gear stands on C/L outside pressure hull (in superstructure). (Fr.18) It carries a pair of gear driven eccentrics and connecting rods (Fr.18) operating in a vertical plane athwart-ships. A worm & pinion (Fr.23) and bevel gears (Fr.18) supply the necessary torque (713).

Bow Plane Tilting carries a hydraulic ram (Fr.17). Pressure supply to the ram is selective, viz. (1) HAND, (2) EMERGENCY, (3) POWER. HAND displacement comes from the hand pump (Fr.52). EMERGENCY displacement comes off the ships accumulator (Fr.52). POWER displacement comes off an electric driven Bow Plane TILT pump(Fr.23).

Bow Plane INTERLOCKS of mechanical hydraulic design drive off the rigging worm (Fr.23) and the tilting shaft (Fr.18) respectively. These interlocks cross connect RIG & TILT hydraulically and prevent accidental interference.
The plane can be rigged IN only on 0° Tilt.
The plane can be tilted on going OUT only after it has reached 15°.
The plane can be tilted on going IN only at angles less than 8°.

The Emergency control valve (Fr.52) can be used only when the change valve (Fr.52) is in neutral (mechanical lock).
The Windlass can be used when the B/P Rig is disconnected.
The B/P Rig can be used only when the Windlass is disconnected.

The B/P Tilting-HAND - This is application of hand pump (Fr.52) displacement to the tilting cylinder (Fr.17).

Sequence of action follows:

Operator turns hand pump (Waterbury A-End)(Fr.52).
Pump discharges through B/P Tilt change valve (Fr.52).
Change Valve (Fr.52) delivers to hand and emergency lines (Fr.52 to Fr.17).
Hand & Emergency lines deliver to the Tilting lines (F.T.R.).
Tilting lines deliver through interlock valves to the Tilting Stop Valve(Fr.17).
Tilting Stop Valve delivers to the tilting cylinder (Fr.17).
Tilting cylinder rocks planes (Fr.18).

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Bow Plane Tilting - Emergency - This is the application of ships accumulator (Fr.52) to the B/P Tilting cylinder (Fr.17). The sequence of action is as follows:

The operator sets change valve (Fr.52) on EMERGENCY.
This blanks off the hand wheel pump (Fr.52).
The operator opens the B/P change valve's supply, and return respectively, on manifold (Fr.52).
This puts accumulator in circuit with Emergency control valve (Fr.52).
The operator works Emergency control valve (Fr.52).
This drives displacement to the tilt cylinder (Fr.17).
The Emergency control valve (Fr.52) is a reversing unit and gives RISE - neutral - DIVE to TILT cylinder (Fr.17).
The hard stop is contact between piston & cylinder cap (Fr.17).

Bow Plane Tilting - Power - This is the application of a motor-driven Hydraulic pump (Fr.23) to the tilt cylinder (Fr.17) the sequence of action is as follows:

The operator starts the motor driven hydraulic pump (Fr.25).
The operator sets the change valve (Fr.52) on POWER.
The hand pump (Fr.52) delivers to the control cylinder (Fr.23).
The operator in turning hand wheel (Fr.52) actuates control cylinder (Fr.23).
The control cylinder (Fr.23) varies angle of swash plate in hydraulic pump (Fr.23).
The hydraulic pump (Fr.23) displacement gives RISE-neutral-DIVE to tilt cylinder (Fr.17).

The accessories to this operation not mentioned above are:

(1) Rigging interlock valve (Fr.22 C/L).
(2) B/P hydraulic pump manifold & reliefs (750#)(Fr.22).
(3) Tilting Stop Valve (Fr.17).
(4) Control Cylinder centering device (Fr.17)(713).

The Rigging Interlock Valve (Fr.22) cross connects the RIG & TILT lines, respectively and acts as a automatic hydraulic control unit. It has six leads, viz: Rig OUT (2), Rig IN (2), and TILT (2). It is a piston slide valve. By means of suitable ports, it cuts off hydraulic pressure - on the Rig OUT at 0°, on the Rig IN at 81°. On rig OUT it opens the Tilt lines at 15°; on rig IN it cuts the tilt line at 8°. It is an irregular piston valve. This valve drives off a cam mechanism on the vertical pinion shaft (Fr.23). Its movement is on precision adjustment for exact co-incidence with the bow plane RIG movements (for adjustments see Ref.719).

DIVE TILT

The Tilting Interlock Valve (Fr.18) prevents the operator from rigging IN unless the bow plane is on 0-14° ~~zero~~ tilt. This valve stands in the rigging line. It carries two checks in the same valve body, operating in parallel. One is a mechanical spool piston which blocks the rigging line at all positions except 0°-14° ~~zero tilt (1½°~~ tolerance). On zero tilt a cam on the bow plane tiller shaft (Fr.17) slides this mechanical check OPEN. The other check is a spring-loaded poppet set with flow to rig OUT, and set against flow to rig IN. The tilting interlock valve has no control over rigging OUT (729).

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The bow plane tilting cylinder (Fr.17) is a ten ton hydraulic ram, working on a 21" tiller. The piston is fixed, the piston rod is hollow and carries the rise and dive ports. The cylinder moves vertically and carries linkage and guides to operate bow plane tiller. The hard stop is between piston and cylinder head. (250)(adjustable)

Operating Note: Venting of the bow plane tilt cylinder; proceed as follows: Put planes in hard dive position; with pressure as the lines open two needle vents (1) on side of the cylinder, (2) on the cylinder cap. Open needle vent on top end of tilt cylinder piston rod. (728)

The rigging control valve (Fr.52) stands across the ship's hydraulic mains (forward) and delivers to the Windlass (and B/P Rig) change valve (Fr.25), thence to the windlass hydraulic motor (Fr.25). This valve is a Hydraulic differential reversing unit. It has three positions Rig OUT, Neutral, and Rig IN. The valve is single spool piston, with linkage drive. It is operated by a tee-handle. It is fitted with a pad-lock. (1054).

The Bow (& Stern) Diving Gear Hydraulic Control Valve (Tilting)(Fr.52) stands across ship's hydraulic mains (supply & return) and delivers through the hand (& Emergency) Tilting lines to the ram (Fr.16). This valve is a reversing unit and thereby delivers RISE, neutral, and DIVE. It is a single spool-piston, lever operated, 4-ported valve. Operating unit (Fr.52) is an 8" wheel (934).

The Bow (& Stern) Gear Hydraulic change valve (Fr.52) stands across the delivery lines of the hand pump (Fr.52). It is the selective distribution unit for choice of hand, (neutral) Emergency & Power. It is a 6-ported, hand-lever operated, piston valve. It opens and closes ports as shown in set-up table below.

SETUP TABLE FOR BOW (& STERN) GEAR HYD. CHANGE VALVE (931)

Unit	Lines	HAND			EMERGENCY			POWER		
		Open	Closed	By-Pass	Open	Closed	By-Pass	Open	Closed	By-Pass
Hand Pump (Fr. 52)	1	X				X		X		
	2	X				X		X		
Control Cyl.(Fr.23) Bow	Rise			X			X	X		
	Dive			X			X	X		
Ram (Fr.16)	Rise	X				X			X	
	Dive	X				X			X	

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BOW PLANE RIGGING - Component Parts & Setup Table

Item	Name	Position	Setups for:- Rig Out	Rig In	Neut.	Wind-lass	Capacity	Use	Frame	Plan
1	Supply Manifold Valve E	Open	X	X				Distribution point from Accumulator	CR	434
		Close			X	X				
2	Change Valve	P: B/P Rig	X	X				Switches control of "9" from "8" through neut. to "19".	25	1072
		Neutral			X					
		Windlass				X				
3	Clutch	B/P	X	X				Jaw Clutch (sliding)	23	720
		Neutral			X					
		Windlass				X				
4	Clutch Lever	Q: B/P	X	X				Throws clutch & change valve	23	720
		Neutral			X					
		Windlass				X				
5	Push Rod	Q: B/P	X	X				Connects (2) & (3) above	24	
		Windlass				X				
6	Contact Maker #1	R: B/P	X	X				Works off "5", lights "7"	23Stb	739
		Windlass				X				
7	Pilot Light	B/P	X	X				Works off "6"	52	-
		Windlass				X				
8	Rigging Control Valve	J: Out	X						CR	
		Neutral			X			At operator's hand lever		
		In		X						
9	Hydraulic Motor	CC	X				9 Cyl. 10 B-end	Spins worm shaft	25	MS-9382
		C		X			350 rpm			
10	Worm & Pinion 20 to 1	CC	X				124 turns	Raises torque 20 to 1	23	720
		C		X						
11	Bevel Gears 3 to 1	CC	X				2 turns	Raises torque 3 to 1	23	732
		C		X						
12	Sector Gear	186	X				186°	Drives connecting rod	18	724
		0		X						
13	Bow Plane	81	X				81°	Rigs from 81° to 0°	18	721
		0		X						
14	Rigging Interlock Valve	N: Out	X				6 leads	Controls at 0°, 8°, 15°, & 81°	22½	718
		In		X						
15	Contact Maker #2	S: Out	X					Makes pilot light (16)	23 C/L	739
		In		X						
16	Pilot Light	Out	X					Works off "15"	52	735
		In		X						
17	Hard Stops	Out					0°	Port Sector gear carries IN & OUT lugs that strike foundations	18	724
		In					81°			
18	Bumpers, rubber	In						2 per plane as superstructure	18	721
19	Windlass Control Valve	O: Hoist				X		Handles from deck	25	1072
		Neutral				X				
		Lower				X				

*CC indicates counter clockwise
C indicates clockwise

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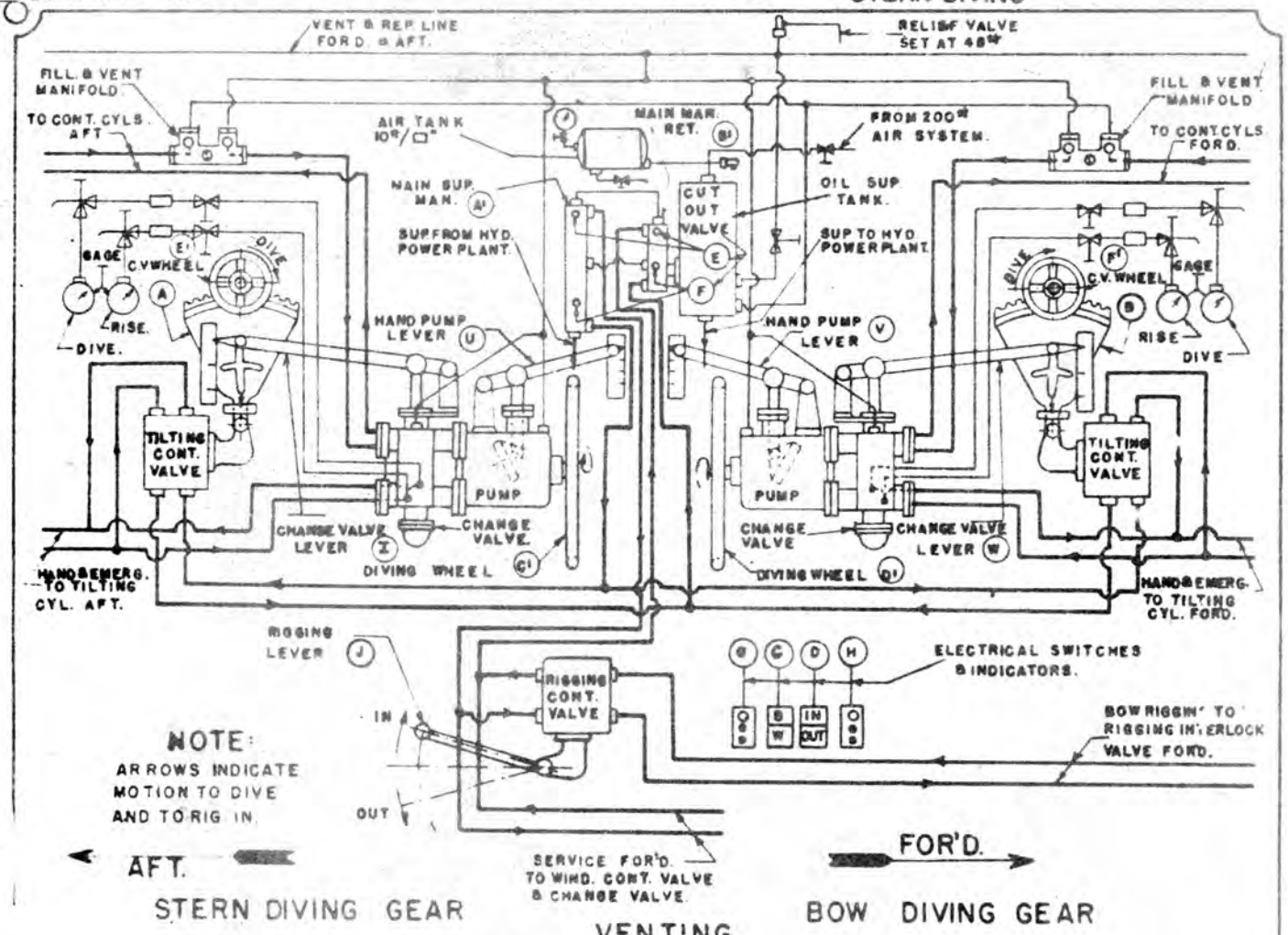
BOW PLANE TILTING - Component Parts & Setup Table

Item	Components Name		Setup for:- HAND	EMERGY	POWER	Neut.	Use	Capacity	Frame	Plan
1	Hand Wheel Pump	IN:	X		X		Hyd.displacement, hand		52	716
		OUT:		X						
2	Hand Pump Lever	Stroke 0:					Adjusts rate of displace-		52	716
		½:	X				ment of (1)			
		1:			X					
3	Change Valve	HAND:	X				Selection Unit for hand,		52	716
		(Neut.)EMERGY:		X			Emergy, & Power			
		POWER:			X					
4	Switch, B/P Motor	START:			X		Closes contactors on panel		52	
		STOP:	X	X		X				
5	Control Valve, Tilt, Emergy	IN:		X			Gives RISE & DIVE on Emergy		52	
		OUT:	X		X					
7	Interlock Lever "C"									
		Locked:	X		X		Mechanical Lock on Lever of "3"		52	716
		Unlocked:		X						
8	Interlock Switch "B"	ON:			X		Switch in Motor Starting Circuit (4)		52	912
		OFF:	X	X						
9	Rigging Interlock Valve									
		IN:	X	X	X		Automatic control over IN & OUT		22	714
10	Tilting Interlock Valve	0:					Prevents Rig IN except on		17	729
		Off 0:	X	X	X		Zero tilt: 1½ degrees Tolerance			
11	Lines, Hand & Emergy	OPEN:	X	X			Connect Change Valve to Ram (13)		S2-17	713
		CLOSED:			X					
13	Tilting Cylinder (Ram)	ON:	X	X	X		10 Ton hydraulic ram		16	726
14	Positive Stops	ON:	X	X	X		Inside the ram at 25° & 25°D.		16	
15	Plane Angle Trans.	ON:	X	X	X		Drives off quadrant on B/P Shaft		17	715
16	Lines, Power Tilting	OPEN:			X		Connects change valve to Control Cylinder			
		CLOSED:	X	X						
17	Manifold, Ship's Supply	OPEN	X	X	X		Supplies Ship's Hydraulic SYC fwd. same for Return Lines		CR	-
	" " Return	CLOSED								
18	B/P Control Cylinder	ON:			X		Throws Swash plate of Pump (19)		23	736
		OFF:	X	X						
19	B/P Hydraulic Pump	ON:			X		Variable reversible Pressure to "13"		23	MS9382
		OFF:	X	X						
20	B/P Hyd. Pump Motor	ON:			X		Direct drive to "19"	7.1 H.P. 440 RPM	23	1705
		OFF:	X	X						
21	Centering Device	ON:			X		Spring-loaded Swash Plate Neutralizer (19)		23	35819
		OFF:	X	X						
22	Relief Valve Manifold	ON:	X	X	X		Safety Valves	750 psi	23	928
23	Vent & Replenishing Lines	ON:			X		Keeps pump (19) full of Oil			
24	By-pass Valve	OPEN:					For filling & venting Control Cyl.		23	
		CLOSED:								
25	Manifold, Fill & Vent	OPEN:					For filling operation only			
		CLOSED:	X	X	X					

BOW DIVING
STERN DIVING



NOTE:
ARROWS INDICATE MOTION TO DIVE AND TO RIG IN.

VENTING

OPEN AIR VENT ONLY WHEN PRESSURE IS ON SYSTEM.

CAUTION

1. CIRCUIT OF SWITCH (Z) TO BE BROKEN WHEN CLUTCHING OUT BOLT (Y) IS BEING ENGAGED OR DISENGAGED. (LOCATION AFTER TORP. ROOM).

1. CHECK LIGHTS (C) & (D) BEFORE OPER. RIGGING OR TILTING GEAR.

RIGGING

1. IND. LIGHT (C) SHOWS CLUTCH IN RIGGING OR WINDLASS.
2. IND. LIGHT (D) SHOWS DIVING PLANES IN OR OUT.
3. VALVES (E) ON MAIN MANIFOLDS (A') & (B') TO BE OPEN.
4. RIG BY MOVEMENT OF CONT. VALVE RIGGING LEVER (J)

POWER TILTING

(X) (Y) (Z)
ARE IN AFTER TORPEDO ROOM

1. SET HAND PUMP LEVERS (U) & (V) TO STROKE.
2. SET CHANGE VALVE LEVERS (I) & (W) TO POWER.
3. START MOTOR BY SWITCHES (G) & (H).
4. TILT BY SLIGHT MOVEMENT OF D.W. (C') & (D')

(K) (L) (M) (N) (O) (P) (Q) (Q') (R) (S) (T)
ARE IN FOR'D. TORPEDO ROOM

EMERGENCY TILTING. (BOW & STERN).

1. VALVE (F) ON MAIN MANIFOLDS (A') & (B') TO BE OPEN.
2. SET CHANGE VALVE LEVERS (I) & (W) TO EMERGENCY.
3. TILT BY MOVEMENT OF CONT. VALVE WHEELS (E') & (F').

HAND TILTING. (BOW & STERN).

1. SET HAND PUMP LEVERS (U) & (V) TO STROKE.
2. SET CHANGE VALVE LEVERS (I) & (W) TO HAND.
3. TILT BY REVOLVING DIVING WHEELS (C') & (D')

MISCELLANEOUS

1. VALVES (X) PREVENT DAMAGE TO GEAR BY RELIEVING PRESSURE WHEN PLANE IS AT HARD STOP OR OIL PRESSURE EXCEEDS 900#/□".
2. INTERLOCK LEVER (A) & CHANGE VALVE (I) FOR HAND, POWER OR EMERGENCY SYSTEMS PERMIT OPERATION OF ONLY ONE SYSTEM AT A TIME.

1. VALVES (M) PREVENT DAMAGE TO GEAR BY RELIEVING PRESSURE WHEN CYLINDER IS AT HARD STOP OR OIL PRESSURE EXCEEDS 750#/□".
2. INTERLOCK LEVER (B) & CHANGE VALVE (W) FOR HAND POWER OR EMERGENCY SYSTEMS PERMIT OPERATION OF ONLY ONE SYSTEM AT A TIME.

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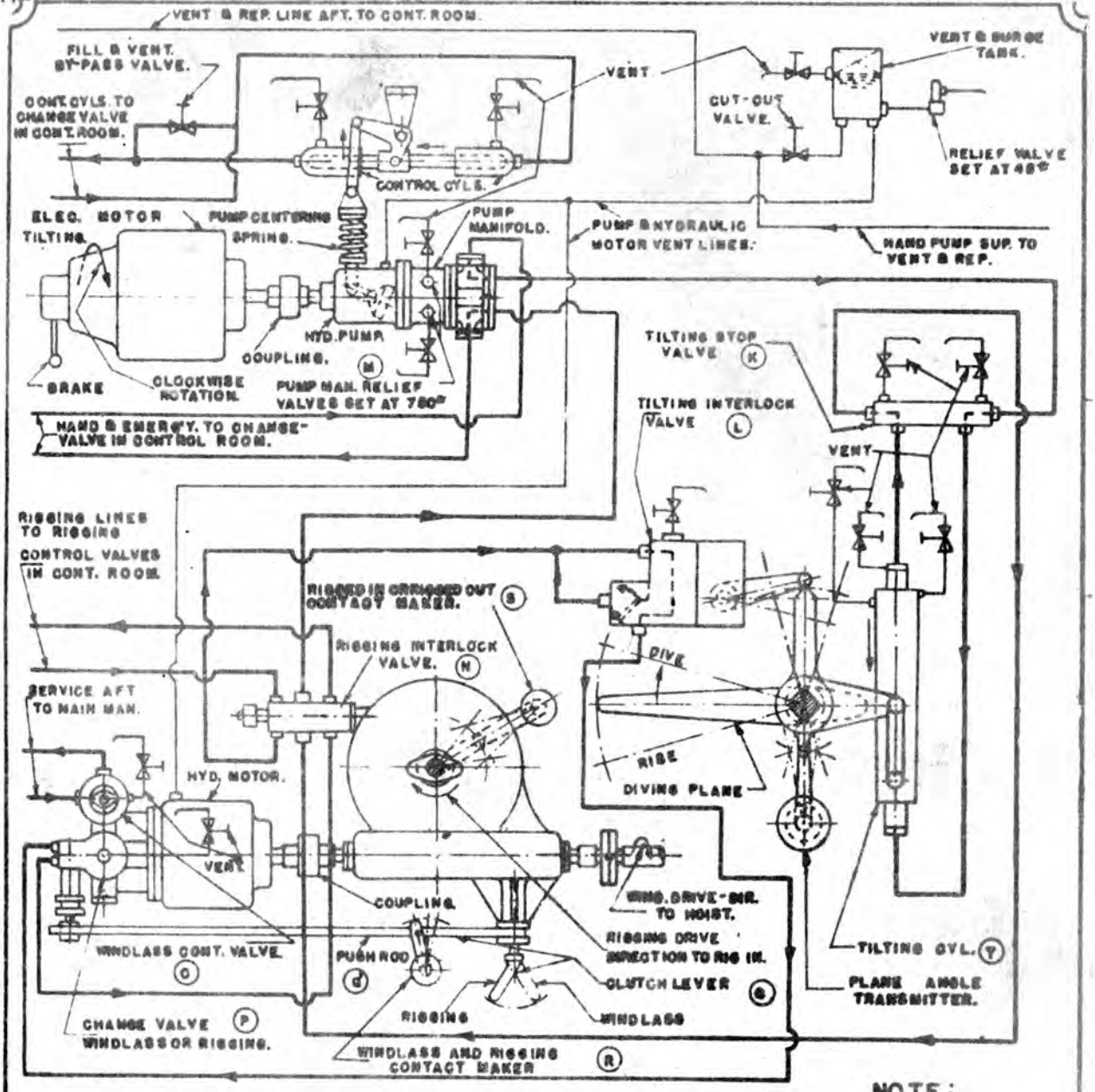


BOW DIVING GEAR
RIGGING & TILTING

NOTE:
ARROWS INDICATE MOTION TO DIVE AND TO RIG IN.

1. RIGGING INTERLOCK VALVE (N) PREVENTS TILTING OF PLANES, EXCEPT WHEN FULLY RIGGED OUT (WITHIN 15° OF RIGGED OUT POSITION) ALSO STOPS RIGGING HYDRAULIC MOTOR WHEN PLANES HAVE REACHED RIGGED IN OR RIGGED OUT POSITIONS.

-14° DIVE

2. TILTING INTERLOCK VALVE (L) PREVENTS RIGGING IN EXCEPT WHEN PLANES ARE AT 0° TILT (WITHIN 1½° OF 0° TILT) BUT TILTING INTERLOCK VALVE (L) DOES NOT PREVENT RIGGING OUT OF PLANES.

3. CHANGE VALVE (P) IS OPERATED BY CLUTCH LEVER (Q) & PUSH ROD (Q') WHEN SHIFTING TO WINDLASS OR RIGGING. CONTACT MAKER (R) OPERATES INDICATOR LIGHTS IN CONTROL ROOM SHOWING CHANGE VALVE (P) & CLUTCH LEVER (Q) AND PUSH ROD (Q') EITHER IN WINDLASS OR RIGGING POSITION.

4. WINDLASS CONTROL VALVE (O) CONTROLS WINDLASS OPERATION ONLY WHEN CHANGE VALVE (P), CLUTCH LEVER (Q) AND PUSH ROD (Q') ARE IN WINDLASS POSITION.

5. TILTING STOP VALVE (K) PREVENTS OVERHAULING OF TILTING CYLINDER (T) BY SEA SLAP ON PLANES.

6. RIGGED IN OR RIGGED OUT CONTACT MAKER (S) OPERATES INDICATOR LIGHTS IN CONTROL ROOM SHOWING PLANES EITHER IN RIGGED IN OR RIGGED OUT POSITION.

7. PUMP MANIFOLD RELIEF VALVES (M) PREVENT DAMAGE TO TILTING GEAR BY RELIEVING PRESSURE WHEN CYLINDER IS AT HARD STOP OR OIL PRESSURE IN LINES EXCEEDS 750#/□".

1¾

SS 475 TO 544
SS 381 TO 434

Reference Plans:

Ports.No.	BuShips No.	Title
713-381	544557	Bow Diving Gear - Arrangement Forward
714-381	544558	Bow Diving Gear - Tilting Stop Valve - Arrangement and Details
715-381		Bow Diving Gear - Plane Angle Transmitters - Operating Gear Dts.
716-381	490747	Bow and Stern Diving Gear - Control and Indicating Mechanism in Control Room - Arrangement
717-381	544559	Bow Diving Gear - Flanges & Special Fittings
718-381	544560	Bow Diving Gear - Rigging Interlock Valve & Bracket - Details
719-381	544561	Bow Diving Gear - Rigging Gear - Inboard Arrangement
720-381	544562	Bow Diving Gear - Rigging & Windlass - Worm Gear & Clutch Details
721-228	386624	Bow Diving Gear - Plane Details
722-381	544564	Bow Diving Gear - Hydraulic Piping - Arrangement - Forward
723-381	544565	Bow Diving Gear - Tiller, Links & Plane Stock - Details
724-201	312211	Bow Diving Gear - Sector Gears & Connecting Rod - Details
725-201	312212	Bow Diving Gear - Bearings for Plane Stocks
726-381	544568	Bow Diving Gear - Guide Bearing & Misc. Details
727-381	544569	Bow Diving Gear - Tilting Piston - Piston Rod, etc.
728-381	544570	Bow Diving Gear - Tilting Cylinder - Details
729-381		Tilting Interlock Valve - Arrangement & Details
730-381	544572	Bow Diving Gear - Arrangement of Tilting Gear in Forward Torpedo Compartment
731-381	544573	Bow Diving Gear - Tilting Indicator - Arrangement & Details
732-201	312219	Bow Diving Gear - Bevel Gears - Shafts & Bearing Casting for Rigging
733-201	312220	Bow Diving Gear - Rigging Gear - Bevel Gear Casing - Worm Gear, etc.
734-381	544576	Bow Diving Gear - Rigging Gear - Shaft & Hull Fitting - Details
735-381	544577	Bow Diving Gear - Rigging Indicator & Valve Operating Gear - Misc. Details
736-381	544578	Bow Diving Gear - Tilting Control Cylinders & Power Plant - Assembly
737-228	386626	Location Table for Clinometer & Trim Indicator Tubes
738-228	386625	Bow Diving Gear - Shear Pin Device for Horizontal Rigging Shaft

Section U-26

DIVING GEAR - STERN

See Plate 1

1. Stern Diving Gear

The two stern planes are keyed on the ends of a horizontal athwartships stock which passes through the stern post casting and is carried in bearings on each side of the casting. Each plane is secured by a taper pin held in place by a welded cover plate.

The planes are tilted by a tiller keyed to the stock and a connecting rod and crosshead, all inclosed within the stern post casting. Positive stops on the stern post casting limit the travel of the planes to 27° either side of zero angle but the travel should never exceed 25°.

The tilting rod has its outer end threaded into the guide cylinder piston and passing through the bulkhead stuffing box, has its inner end threaded through the main ram piston.

The tilting gear consists of a hydraulically operated ram, which forces tilting rod in or out by pressure being applied on the piston in accordance with delivery of a #5 A-end pump driven by a 7.1 horse power electric motor, with rotation counter clockwise. Time element for 25° dive to 25° rise is about 20 seconds.

Hydraulic power for operating this motor is furnished by three different systems, "Power", "Hand", and "Emergency". These systems are so connected and controlled by interlocking levers and switches that only one system can furnish power at a time.

The "Power" system consists of a size 5 Waterbury A-end variable stroke pump driven by a 7.1 H.P., 440 R.P.M., non-reversible motor. A clutch between the speed reducer and pump operates either the capstan, electrically through a silent chain drive of 1 to 1 ratio, or the hydraulic pump for tilting planes. This clutch operates capstan. Torque bolt is engaged by sliding forward into chain sprocket which is attached to electric motor shaft.

2. Stern Plane Tilting Control

The control of the hydraulic pump is similar to that of the steering and bow diving gears.

3. Hand Tilting

The hand tilting system for the stern planes is similar to that for the steering gear and for the bow plane tilting.

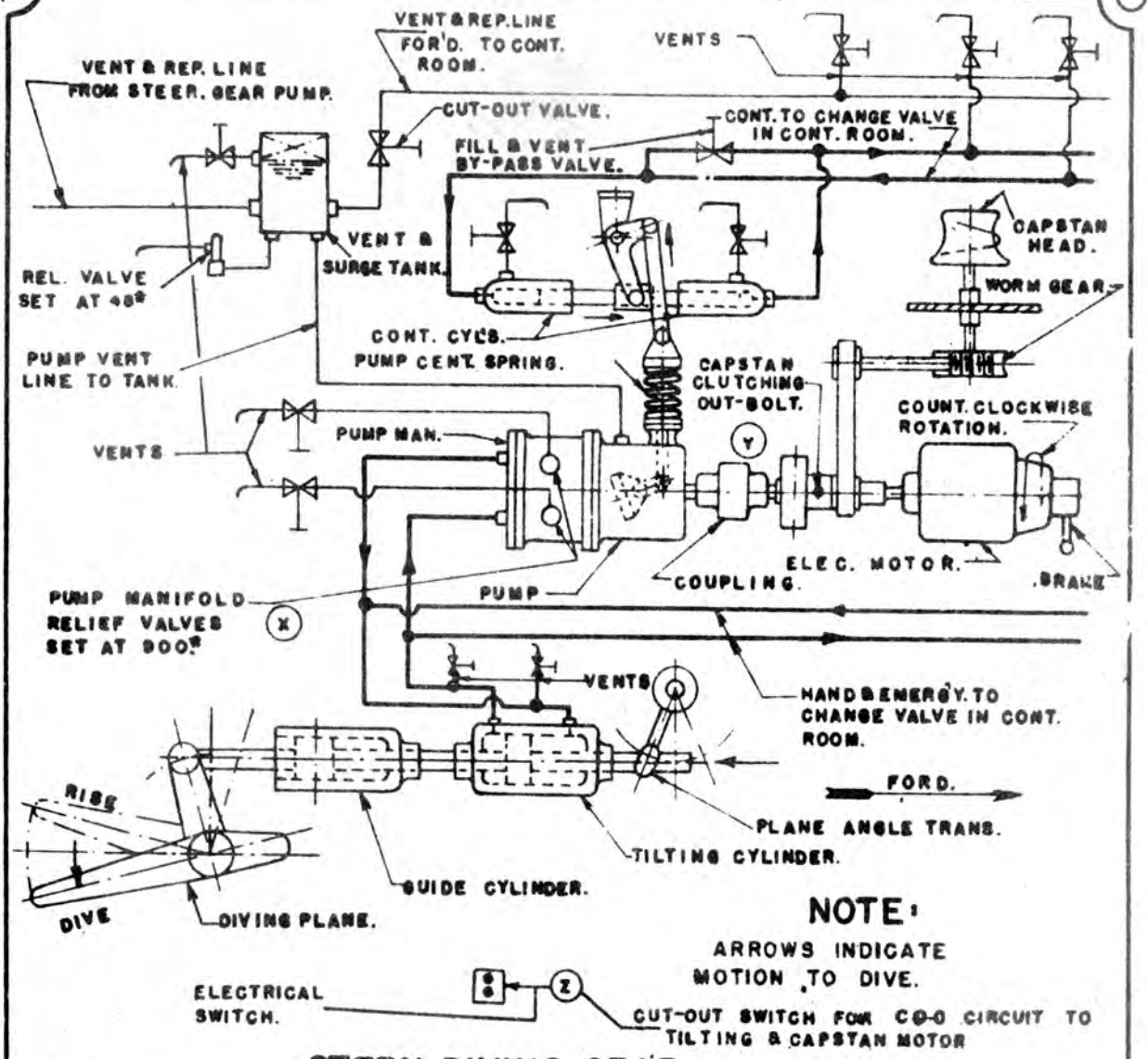
4. Emergency Tilting

The "Emergency" system consists of an emergency control valve located at the diving station between the main hydraulic manifold and the pipe lines which run aft This valve, interlocked with the change valve, can function only when the "Hand" and "Power" systems are inoperative. Setting the change valve to the "Emergency" position and holding the emergency control valve to either "rise" or "dive" position causes oil to flow from the main power plant to the hydraulic motor thereby tilting the planes as desired.

A spring loaded relief valve is mounted on the end of the "Power" pump which serves all three systems. If the pressure exceeds 900 lbs. per square inch, this valve allows the oil to pass directly from the pressure line to the return line.

5. Trim Indicators

Two spirit-level indicators filled with colored alcohol are provided for the bow planesman and two for the stern planesman at the diving station in the control room. The indicators read from zero to five degrees and from zero to fifteen degrees respectively.



STERN DIVING GEAR

1. VALVES (X) PREVENT DAMAGE TO GEAR BY RELIEVING PRESSURE WHEN PLANE IS AT HARD STOP OR OIL PRESSURE IN LINE EXCEEDS 900#/□".
2. CLUTCHING OUT BOLT (Y) TO BE ENGAGED ONLY WHEN CAPSTAN IS BEING OPERATED, OTHERWISE DISENGAGED.
3. FOR VENTING, OPEN AIR VENTS ONLY WHEN PRESSURE IS ON SYSTEM.
4. CIRCUIT OF SWITCH (Z) TO BE BROKEN WHEN CLUTCHING OUT BOLT (Y) IS BEING ENGAGED OR DISENGAGED.

SECTION U-26-b
DIVING GEAR-STERN

The Stern Plane Tilting Gear in principle is a duplicate of the Bow Diving Gear; for details refer to that subject.

The Stern Plane Tilting Cylinder is a simple inside packed, fore and aft, horizontal, 15 ton hydraulic ram, direct connected on the bell-crank lever principle. The piston (8" D) (fr.123) carries a double ended rod (4" D) and provides travel forward for hard rise, 25° (10.354") and hard stop, 27° (11.123")

The Stern Plane Tilting is selective according to source of hydraulic displacement applied to the ram, viz:

Kind	Displacement from:	Fr.	Drive from:
HAND	22.6 cu. in. A. end	52	manpower
EMERG'Y	1000 cu. in. Accumulator	52	IMO pump
POWER	22.6 cu. in. A. end	119	electric motor

The Stern Plane Diving Gear Change Valve (fr.52) is the selective unit for HAND, Emerg'y and Power. This valve is a duplicate of the bow diving gear change valve, described under that subject.

The Stern Diving Gear Control Valve EMERG'Y is a duplicate of the same unit under Bow Diving.

The Stern Diving Gear Connecting Rod Stuffing Box (salt water) stands at bulkhead 125 (CL) and carries two glands i.e.: one (expansion) on tube around the rod carries flax packing (If flax not available, use cotton 1270-spec. 33P2) (ref. 925-275); the stuffing box around the tilting rod is a standard piston rod packing (ref. 948-381). It is self adjusting formed leather chevron packing. The gland nut is pulled down tight at installation without any allowance for adjustment. If the original installation is correct, no adjustment is necessary. If it leaks, it should be renewed with the spare.

The Stern Diving Gear Guide Cylinder (fr.128) (8.75 D" x 35-3/4 l) stands integral with the stern post casting (847). This is a comp Mn-6 crosshead (8".73 D x 14" b) working on a comp G liner, in salt water. The grease fitting is at frame 125 and should be gunned only when the stern plane is at zero tilt or 1-1/2° DIVE (ref.912).

The Stern Plane Mechanical Indicator is attached to the ram piston rod (fr.124) and the scale shows on mounting at bulkhead 125. A plane angle transmitter drives off the mechanical indicators (ref. 915).

The Stern Diving Hydraulic Pump Motor (fr.117) has a secondary function. It drives, by means of a chain to a worm and pinion, the after capstan.

STERN DIVING

After Capstan Clutch - Procedure for shifting - SS381-434 only.

(1) Release stern diving gear electric motor brake.

(2) Turn stern diving gear electric motor to OFF, inside controller, A.T.R.

(3) Drop the portable chain guard.

(4) With the aid of a packing bar, rotate stern diving gear electric motor shaft until clutching bolt engages, or disengages, with capstan idle gear.

(5) Release portable chain guard, return stern diving gear electric switch to ON.

(6) Set brake on stern diving gear electric motor.

COMPONENT PARTS & SETUP TABLE FOR STERN DIVING GEAR

SETUP FOR:

Item	Name	Aft.	Hand	Energy	Power	Filling	Purpose	Capacity	Fr.No.	Plan
1	Pump, Hyd. Hand	IN OUT	X	X	X		Drives off hand wheel (23)	22.6 Cu.in. per rev.	53	716
2	Pump Stroke (variable)	¼ 1	X		X		Varies displacement of " "	-	53	716
3	Lever, Interlock (Neut.)	HAND ENERGY POWER	X	X	X		Shifts HAND, ENERGY, POWER (Mechanical)		53	716
4	Change Valve (Neut.)	HAND ENERGY POWER	X	X	X		Shifts, Hand, ENERGY, POWER (Hydraulic)		53	831
5	Tilting Cylinder		X	X	X		Horizontal ram to tiller	15 ton	122	915
6	Valve, Main Supply Man. Emergy Bow & Stern Diving Gear	OPEN CLOSED	X	X	X		Throws diving gear on ships hydraulic system		52	759-285
7	Valve, Main Return Man. Emergy Bow & Stern Diving Gear	OPEN CLOSED	X	X	X		Throws diving gear on ships return mains & supply tank		52	757-281
8	Control Valve, Emergy	IN OUT	X	X	X		Gives RISE & DIVE on ENERGY		52	836
9	Pump, Hyd.	ON OFF	X	X	X		Drives off electric motor (11)	22.6 Cu.in. per rev.	119	912
10	Relief, Pump Manifold	IN	X	X	X		Overload protection	1200#	119	912
11	Motor, Electric (CC)	ON OFF	X	X	X		Drives pump (9)	7.1 HP .840 RPM	117	912
* 12	Clutch, Aft Capstan	OUT IN	X	X	X		Shifts motor (11) to Capstan		118	913-281
13	Tank, Vent & Surge	ON	X	X	X		Hydraulic cushion	relieve at 5#S	119	912
14	Centering Spring	ON			X		Neutralizes Swashplate (9)		119	913-281
15	Control Cylinder	IN OUT	X	X	X		Hydraulic relay		119	736
16	By-Pass, Control Cyl	OPEN CLOSED	X	X	X	X	For filling & venting the system		118	912
17	Manifold, Fill & Vent	OPEN CLOSED	X	X	X	X	For filling & venting			912
18	Guide Cylinder		X	X	X		Grease at zero tilt only		129	915
19	Stuffing Box-Bhd 125		X	X	X		Expansion & sea water joints		125	195
20	Drift Stop						Secures for surface cruising		129	930-285
21	Brake, Motor, 13" Disc.	ON Off	X	X	X		Magnetic brake on (11)			
22	Hard Stops						27° rise & dive		131	867
23	Hand Wheel	IN OUT	X	X	X		¼ stroke, 72 turns 1 min. equals 25° tilt.		53	716
24	Tiller		X	X	X		24½" radius		131	924
25	Plane, Stern		X	X	X		52 sq. ft.		132	922-239
26	Indicator, Mechanical		X	X	X		Shows angle at Fr.125		125	943-281
27	Transmitter, Angle		X	X	X		Shows angle at Fr.52		125	9029-281

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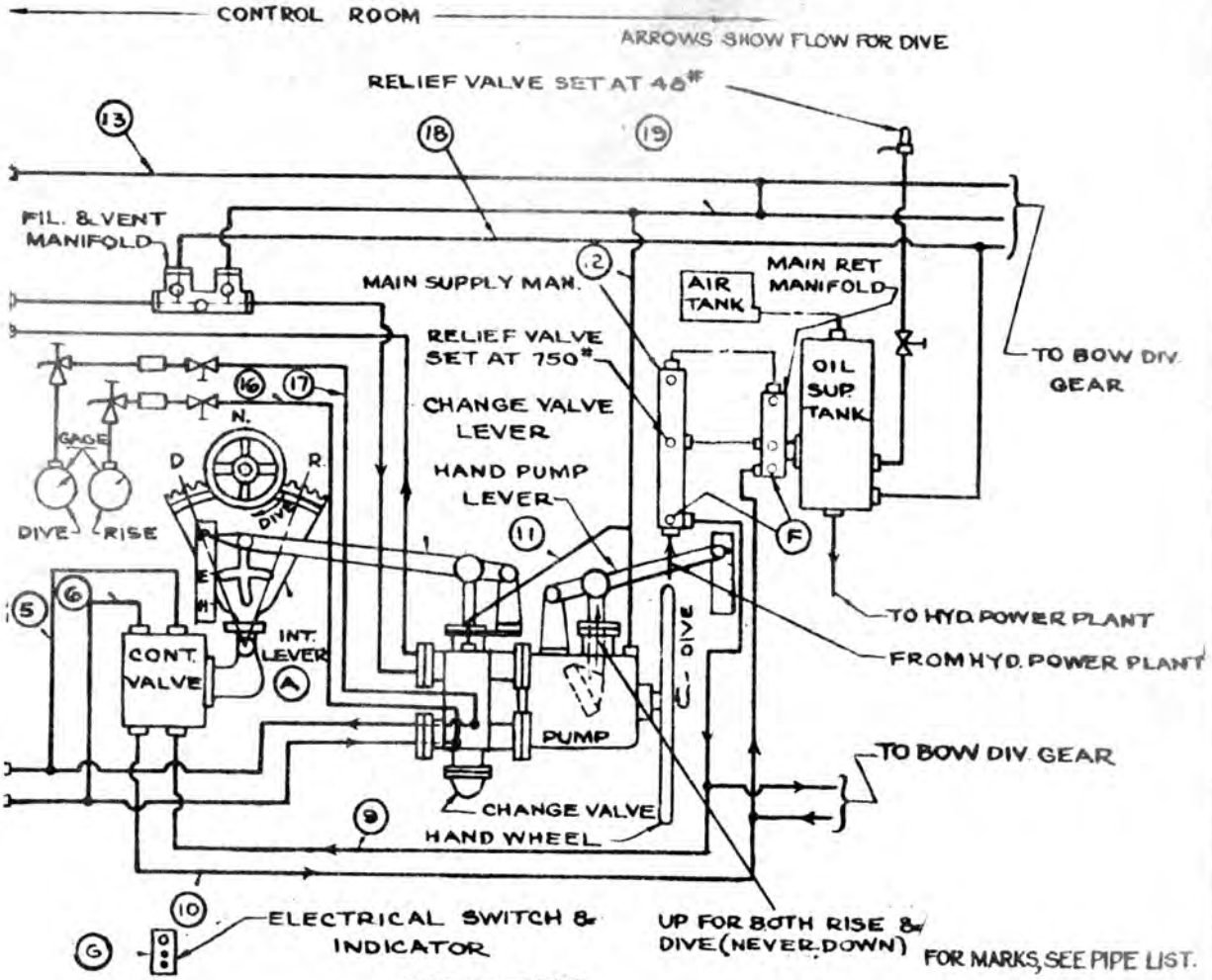
STERN DIVING GEAR



SET-UP TABLE

	HAND	EMERGY	POWER	FUNCTION
HAND PUMP LEVER STROKE ½	X			REGULATES PUMPS
STROKE			X	DISPLACEMENT
MOTOR ELECTRIC SWITCH ON			X	DRIVES STERN DIVING
OFF	X	X		PUMP
CHANGE VALVE HAND	X			HYDRAULIC SWITCHING
EMERGY		X		UNIT
POWER			X	
VALVES (F) MANIFOLD OPEN		X		HYDRAULIC SUPPLY
CLOSED				FROM ACCUMULATOR
CONTROL VALVE LEVER (A) LOCKED	X		X	INTERLOCKS ALLOW ONLY
UNLOCKED		X		ONE SYSTEM TO WORK AT A TIME
DISC. BRAKE, ELECTRIC MOTOR ON			X	LOCKS THE PUMP WHEN
OFF	X	X		NOT RUNNING

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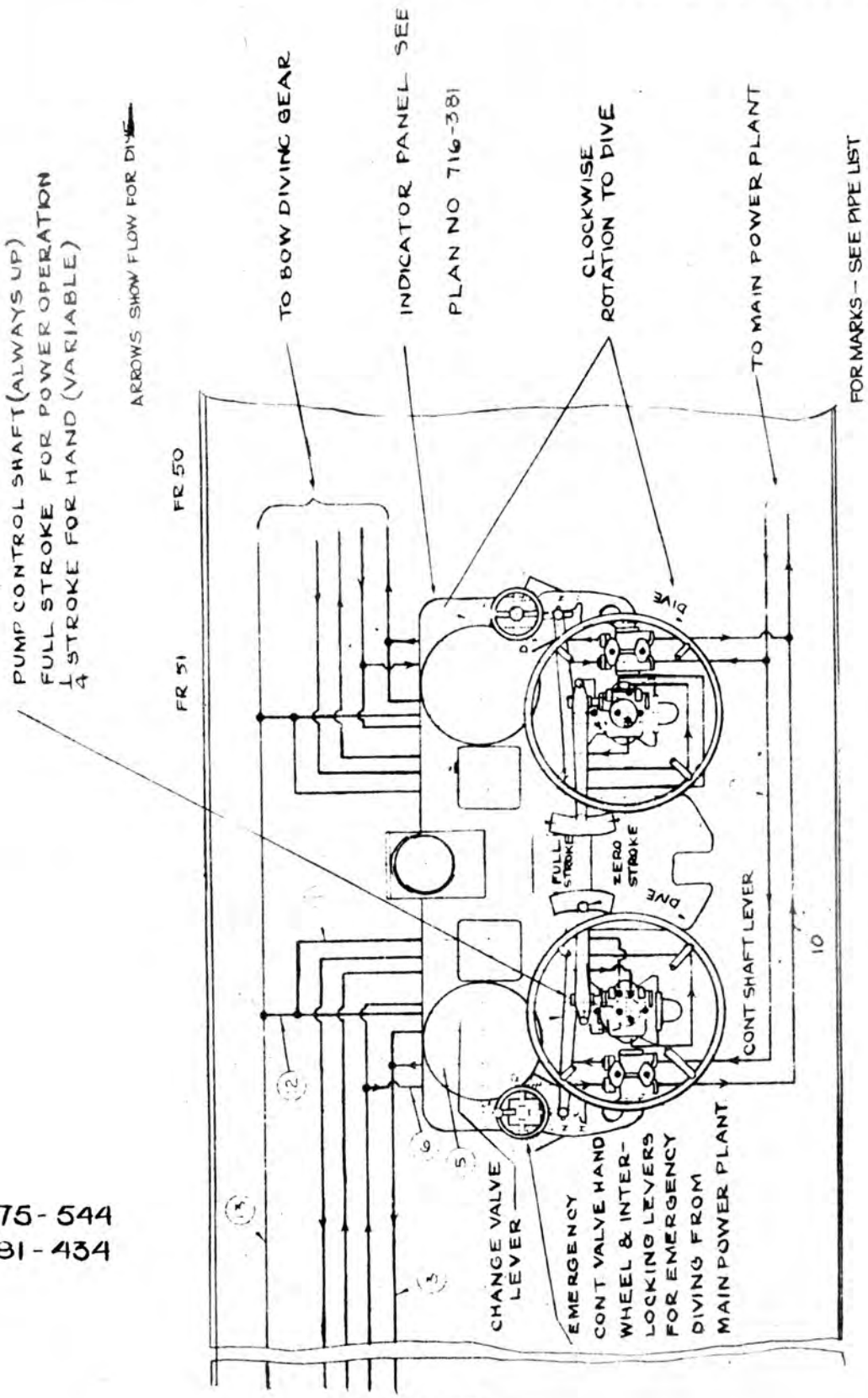
STERN DIVING GEAR



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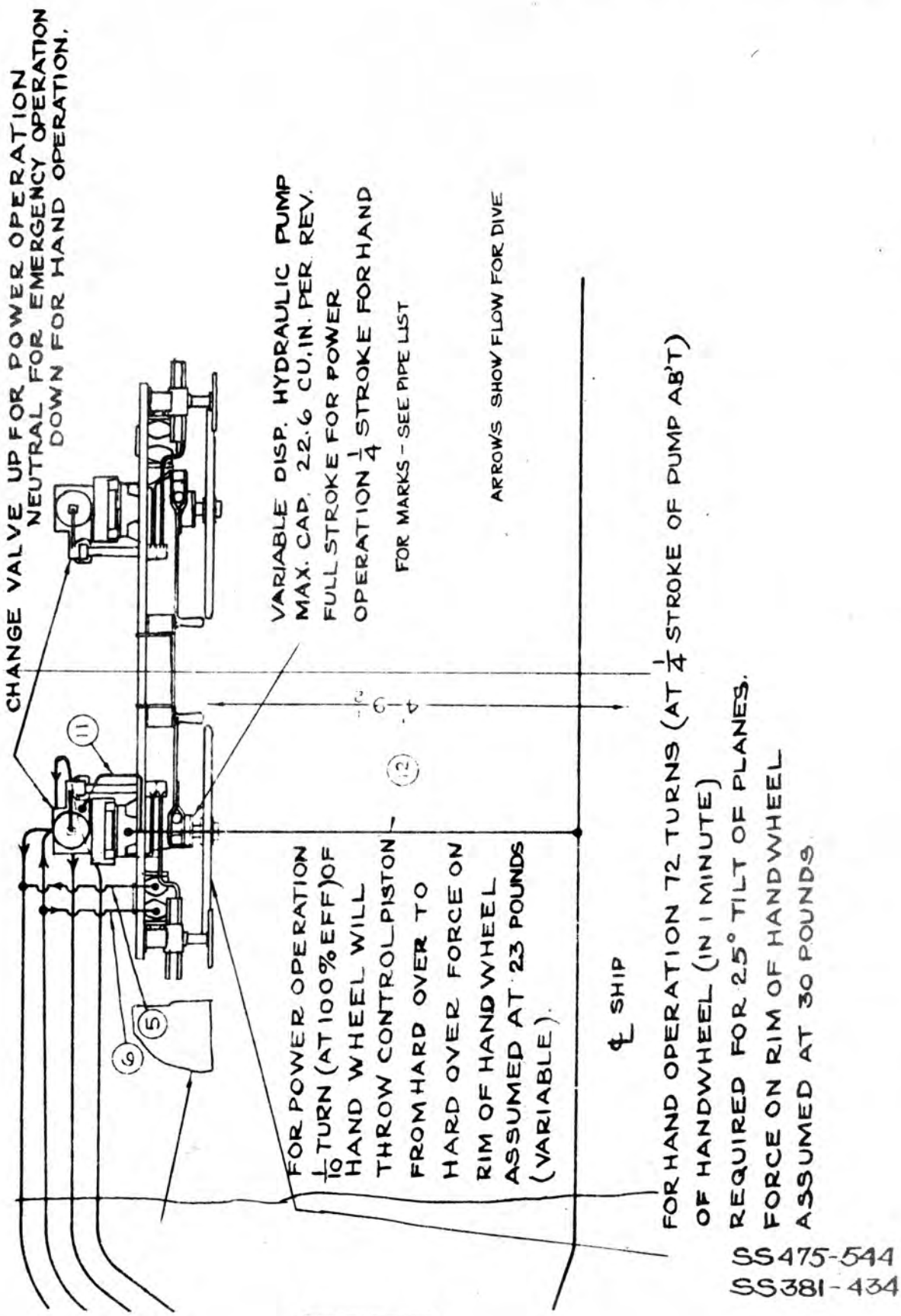
STERN DIVING GEAR



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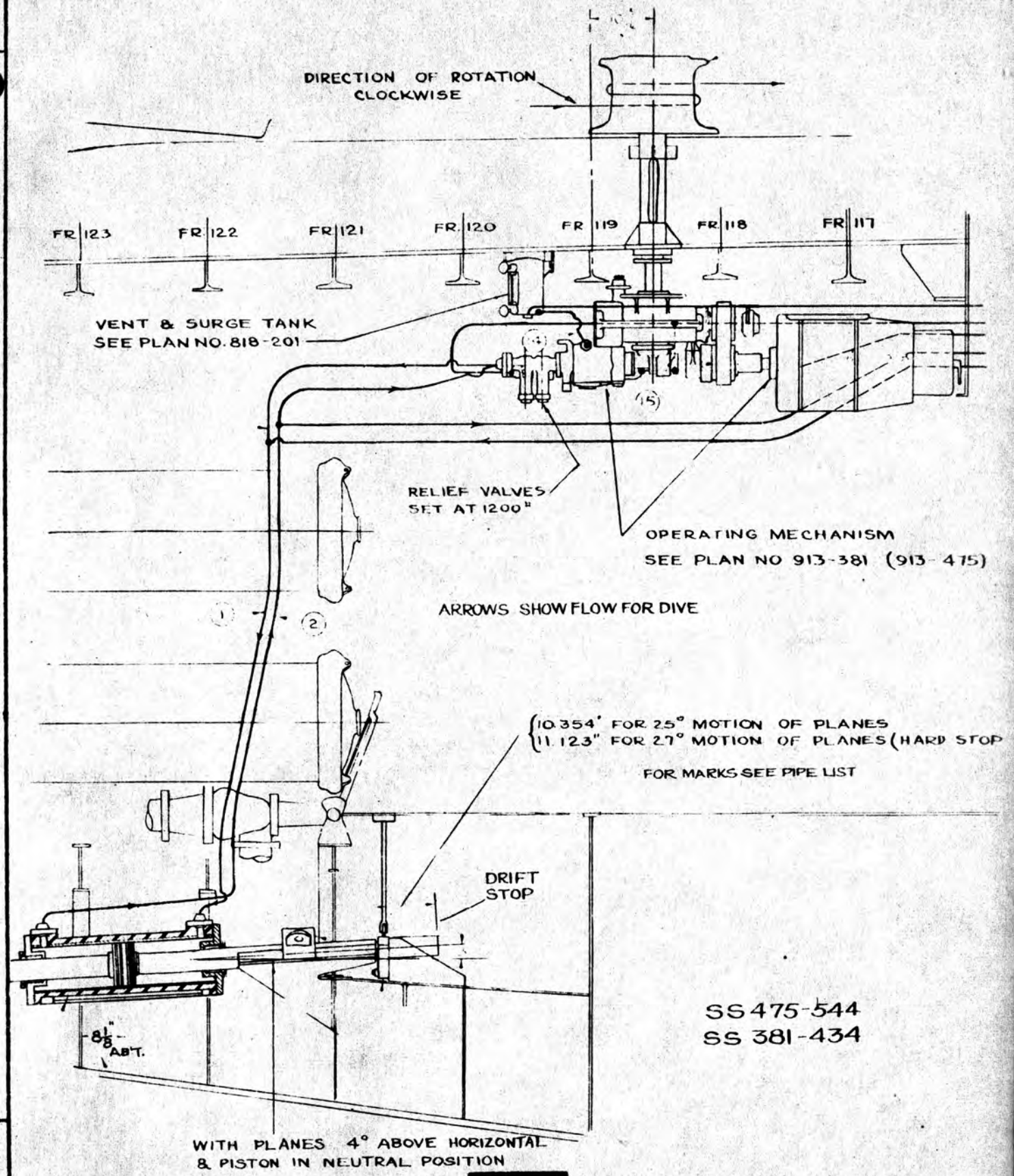
FLEET SUBMARINE
GENERAL INFORMATION

STERN DIVING GEAR



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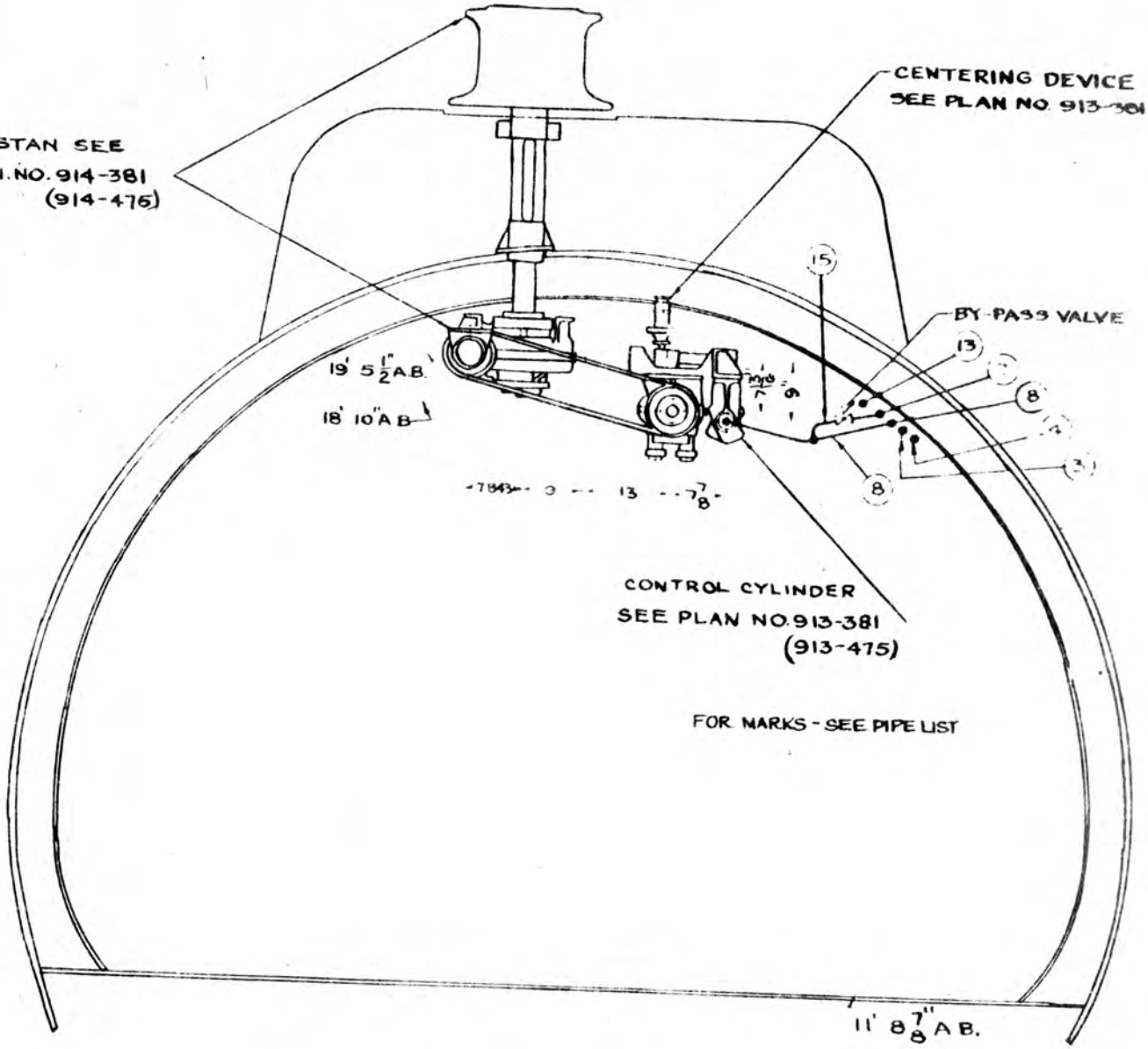
STERN DIVING GEAR



SECTION AT FR. 118

LOOKING AFT

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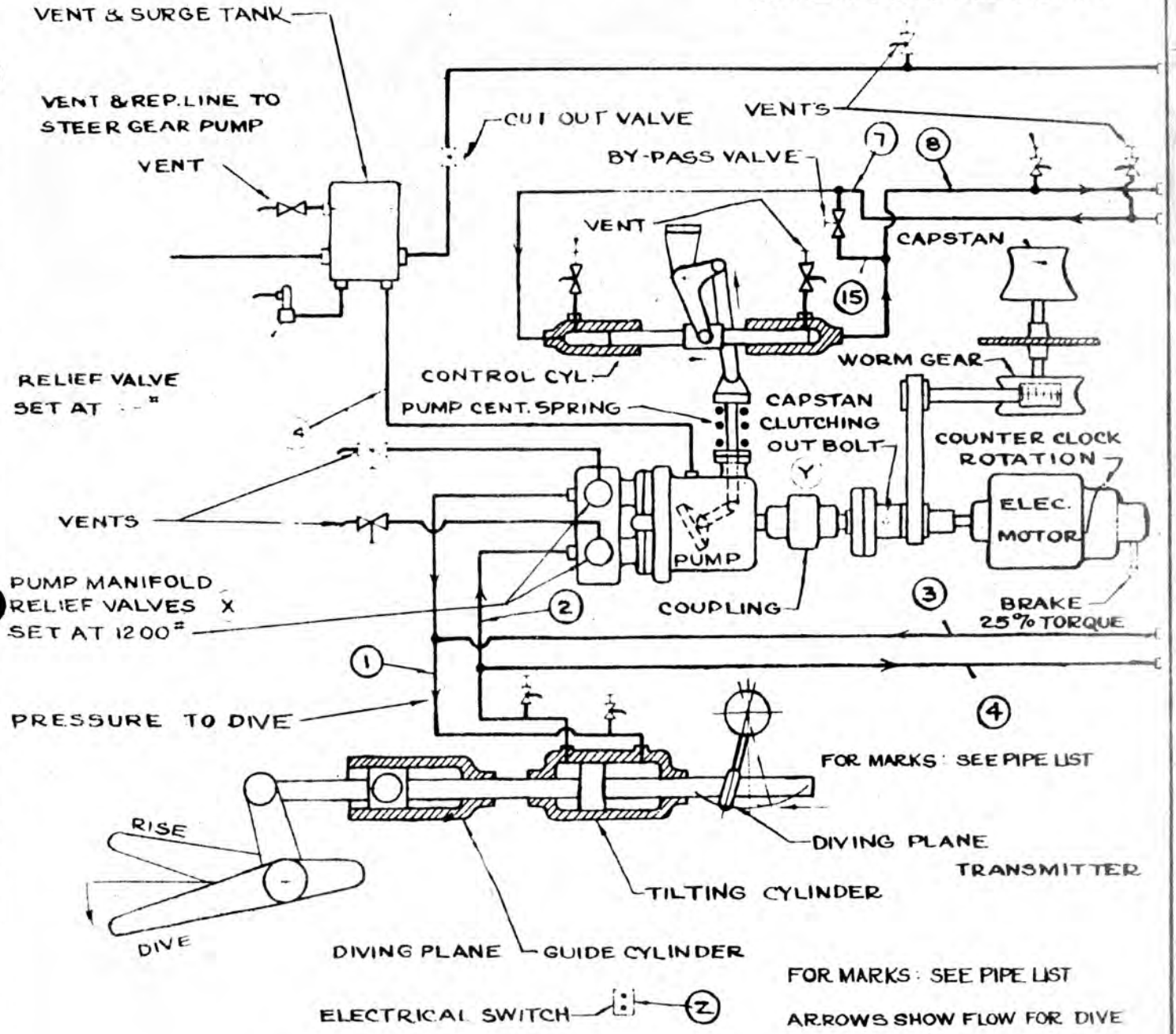
CONFIDENTIAL

FLEET SUBMARINE
GENERAL INFORMATION

STERN DIVING GEAR



1. VALVE ⊗ PREVENTS DAMAGE TO GEAR BY RELIEVING PRESSURE WHEN GEAR STRIKES HARD STOP OR OIL PRESSURE IN LINE EXCEEDS 1200#/
2. CLUTCHING OUT BOLT Ⓨ TO BE ENGAGED ONLY WHEN CAPSTAN IS BEING OPERATED OTHERWISE DISENGAGED (CAPSTAN CHAIN TO BE TAKEN OFF WHEN IN COMBAT AREA.
3. FOR VENTING, OPEN AIR VENTS ONLY WHEN PRESSURE IS ON SYSTEM.
4. CIRCUIT OF SWITCH Ⓩ TO BE BROKEN WHEN CLUTCHING OUT BOLT Ⓨ IS BEING ENGAGED OR DISENGAGED.

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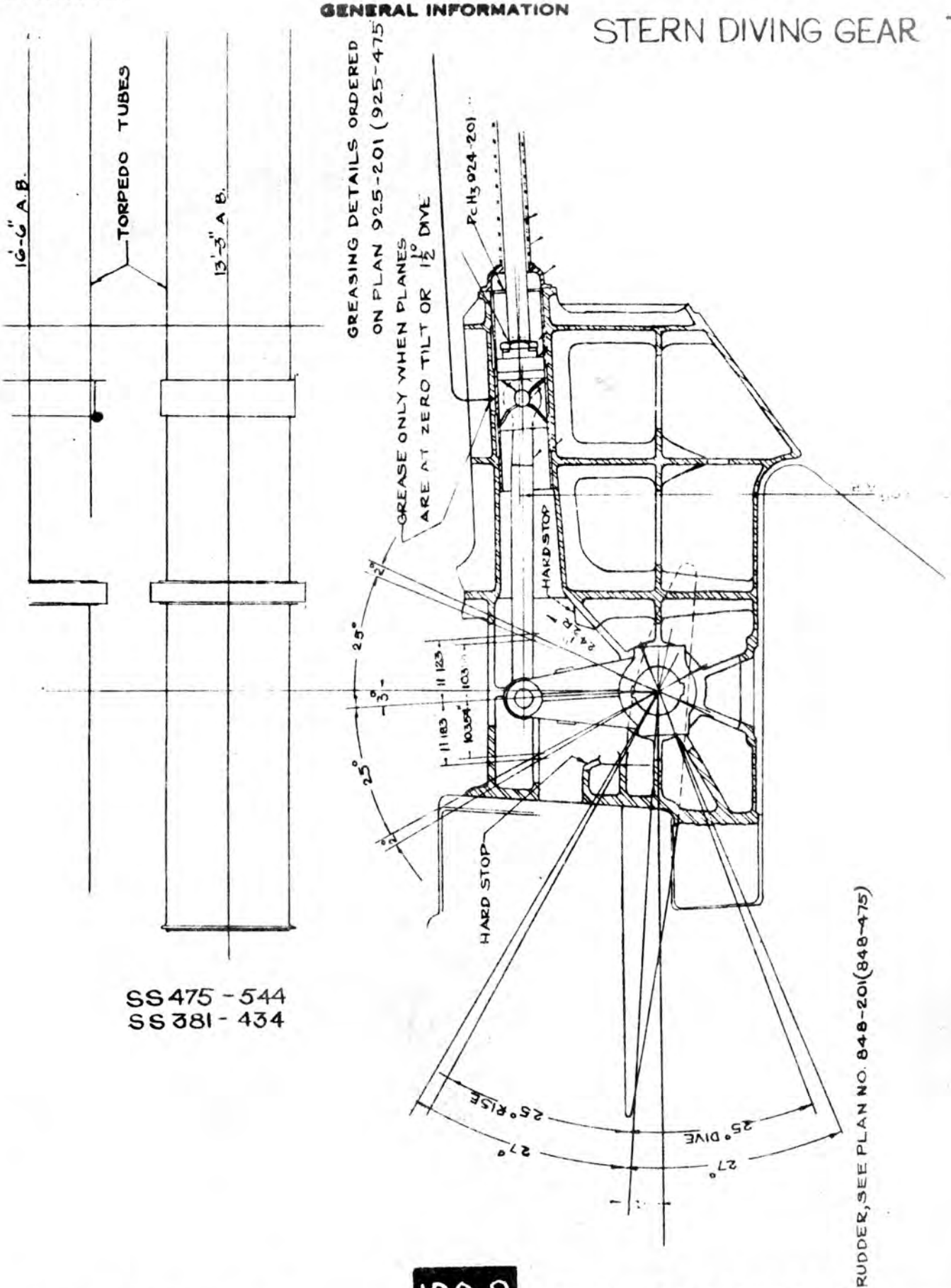
FLEET SUBMARINE
GENERAL INFORMATION

STERN DIVING GEAR



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PIPE LIST - STERN DIVING GEAR - PORTS NO 912-381

MARK	NOM. SIZE	SERVICE OF LINES	TEST
1	1"	PRESSURE RELIEF MANIFOLD TO RAM	1800#
2	1"	RETURN RAM TO RELIEF MANIFOLD	1800#
3	3/4"	PRESSURE - CHANGE VALVE TO RAM	1800#
4	3/4"	RETURN - RAM TO CHANGE VALVE	1800#
5	1/2"	PRESSURE EMERGENCY CONTROL VALVE TO RAM	1800#
6	1/2"	RETURN RAM TO EMERGENCY CONTROL VALVE	1800#
7	1/2"	PRESSURE CHANGE VALVE TO CONTROL CYLINDER	900#
8	1/2"	RETURN CONTROL CYLINDER TO CHANGE VALVE	900#
9	1/2"	PRESSURE - MAIN MANIFOLD TO EMERGENCY CONTROL VALVE	1800#
10	1/2"	RETURN EMERGENCY CONTROL VALVE TO MAIN MANIFOLD	150#
11	1/8"	VENT CHANGE VALVE TO REPLENISHING LINE	150#
12	1/2"	VENT PUMP TO REPLENISHING LINE	150#
13	3/4"	VENT & REPLENISHING LINE	150#
14	1/2"	VENT - PUMP TO REPLENISHING TANK	150#
15	1/2"	CONTROL CYLINDER BY-PASS	900#
16	—	PRESSURE - CHANGE VALVE TO GAUGE	1800#
17	—	PRESSURE - CHANGE VALVE TO GAUGE	1800#
18	1/2"	VENT & FILL LINES	150#
19	1/2"	VENT & FILL LINES	150#

OPERATION NOTES —

(1) CAPSTAN (AFTER) CONTROLLED FROM TOPSIDE, FRAME, BY EXTENSION TO ELECTRIC MOTOR CONTROLLER.

(2) IN HAND OR EMERGENCY - STOP THE STERN DIVING GEAR. THIS SETS THE BRAKE.

(3) SEE SHIPS INSTRUCTION PLATES (PORTS. 1130-381)

(4) HYDRAULIC SYSTEM OIL SPECIFIED: FOR 50°F & BELOW-NAVY SYMBOL 2075
FOR 50°F & ABOVE-NAVY SYMBOL 2110

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(a) Reference Plans

Ports.No.	BuShips No.	Title
		Bow Plane
713-381	544557	Bow Diving Gear - Arrangement - Forward.
722-381	544564	Bow Diving Gear - Hydraulic Piping Arrangement - Fwd.
716-381	490747	Bow and Stern Diving Gear - Control and Indicating Mechanism in Control Room - Arrangement.
730-381	544572	Bow Diving Gear - Arrangement of Tilting Gear - in Forward Torpedo Room.
719-381	544561	Bow Diving Gear - Rigging Gear Inboard Arrangement
		Stern Plane
716-381	490747	Bow & Stern Diving Gear - Control and Indicating Mechanism in Control Room - Arrangement.
912-381	490748	Stern Diving - General Arrangement.
913-275	386930	Bow and Stern Diving Gear - Speed Reducer, Clutch & Control Cylinders - Arrangement.
914-275	386931	Stern Diving Gear & Capstan - Mechanism - arrangement.
915-275	387450	Stern Diving Gear - Tilting Gear - Arrangement.
928-201	312415	Bow & Stern Diving Gear - Hydraulic Relief Valve Manifold - Arrangement.
931-285	490454	Bow & Stern Diving Gear - Hydraulic Change Valve - Arrgt.
934-381	490743	Bow & Stern Diving Gear - Hydraulic Control Valve - Arrgt.
1149-381	491096	Stern Diving Gear - Hydraulic Piping Arrangement in After Torpedo Room.

Section U-27

HYDRAULIC SYSTEM

Ref: Plates 6, 7 and 8.
Hydraulic System Instruction Plate (CR).
Section U-12-a - Flooding and Venting.
Section U-8 - Steering Gear.

Oil prescribed for the hydraulic system is light lube oil:

(1) Navy Symbol #2110 for ambient temperature of 50°F. and above (110 sec. Saybolt at 130° F.)
(2) Navy Symbol #2075 for cold weather conditions (75 sec. Saybolt at 130°F.)

Use of either of these oils is authorized as operating conditions may dictate. General characteristics of an hydraulic oil are described elsewhere in this section.

The Ship's Hydraulic System is a central source of hydraulic power to points where ship services are beyond capacity of manual operation. A hydraulic system as regards manipulation is governed by the same working principles as reciprocating steam machinery, i.e. central reservoir of pressure feeding a working side of the cycle, a return side, and the differential applied to local units by a slide valve, hand operated.

The Ship's Hydraulic Power Plant primary application is to:

(1) VENTS, M.B.T., F.B.T. and B.B. and Safety - 12 units.
(2) FLOOD, Safety and Negative Tanks only - 2 units.
(3) HULL VALVES, Main Induction, Ship's Supply- 2 units.
(4) SOUND Projectors (2) QB and QC - 2 units.
(5) T/T Muzzle Door Operating Gear - 10 units.

The Ship's Hydraulic Power Plant secondary application is the supplementary (emergency) power supply to:

(1) Steering Rams - 2 units.
(2) Bow Plane Tilting - 1 unit.
(3) Stern Plane Tilting Hydraulic Ram - 1 unit.
(4) Windlass and Capstan Hydraulic Motor - 1 unit.

The Ship's Hydraulic System derives power from a volume of oil under a pressure of about 500 lbs. working, 650 lbs. top working and 750 lbs. maximum pressure. Static head is maintained by a H.P. air cushioned (1000 cu.in.) double chambered, reciprocating, self-regulating accumulator. Air loading is by 7 cu.ft. flank at 1750 p.s.i. Oil pressure should be 10% above max operating requirements. Back pressure 10# with accumulator loaded.

The Hydraulic Cycle has two sides, (1) working and (2) return. A working side is a solid column of oil under static pressure, entrapped between an accumulator head, a hand operated control valve (two-way) and a working piston. The oil in the working side to be as rigid as a solid substance must be free from leakage and free from air. The working side of the system carries a 750 p.s.i. relief, which shunts pump DELIVERY back to pump SUCTION.

The return side of the cycle provides, (1) displacement, (2) replenishment, (3) air elimination, (4) water elimination, (5) dirt elimination, (6) air cushioning and (7) refilling. The return side of the system carries 10 lbs. air pressure (variable) and reliefs are set at 48 p.s.i.

The differential in pressures is sealed at the piston clearances throughout the system (operating pistons and control pistons).

Effective operation of the hydraulic system is dependent on the preservation of precision in the working cycle. This can be destroyed by:

(1) Improper manipulation of valves (breaking down the differential between working and return sides of the cycle.)
(2) Leakage.
(3) Air.
(4) Water.
(5) Contamination.
(6) Low viscosity due to change in temperature.
(7) Idleness (formation of sludge).

The Hydraulic System power supply two pump units, continuous running, with intermittent delivery (and intervening by-pass) (mechanically controlled) to the accumulator.

The Hydraulic Pump is a 2-1/2/2 A3IH deLaval IMO Pump, a screw pump with a single power and two idler, rotors, 1750 rpm. 27.2 gpm at 80 viscosity, 38 gpm at 750 viscosity, 650 lbs. working pressure.

The Hydraulic Pump and the motor (15 H.P. - 1750 rpm) are carefully adjusted for dynamic balance and smooth operation and are mounted in a common bedplate, 1112-285 - 490285 Foundation. The bedplate is rubber mounted and flexibly connected with solid mounting available as a standby in case of emergency. No grounding of the rubber mounted bedplate is permitted via floor plates, gauges, piping, cables, or incidentals stored adjacent. Feeder leads are flexible and reach the unit in a loop.

The Hydraulic Pump Bedplate carries four compression type rubber mounts #8409 (type A, Ports. No. 35951 - BuShips No. 512527). In this type of mount each corner of the bedplate floats in suspension between two compressed rubber pads. The rubber is structural stock, compounded for this purpose, with hardness equal to 45 Durometer. Pad and bushing are coated with oil resistent compound (Neoprene) to 1/32" (min.) bonded to the rubber. No. 8409 carries 1" bolt, 4" D. pad, 1-1/8" thick.

Rubber mounts must not be painted.

The Hydraulic Pump Bedplate Locking Device (BuShips No. 386249) consists of a (3/8" D. x 3-7/8" L.) bolt at each corner. Each bolt carries 4 nuts. When rubber mount is in operation this bolt is in a position of STOWAGE on the foundation bracket. For rigid mount, the operator uses two of nuts as inside spacers and two as binders, and bolts the bedplate to the bracket.

The Hydraulic Pump Flexible Connection isolates the pump from the ship (BuShips No.386892) when the rubber mounts are in effect. The delivery side is an outlet to the automatic by-pass valve.

The Hydraulic Pump Rigid Delivery Connection is a portable standby part. In case of rupture of both delivery connection - procedure: Shut down motor, close supply tank cut-out valve. Isolate the damage by closing cut-offs. Remove the flexible connection and insert the rigid connection. Lock the bed plate rigid to the ship.

The Hydraulic Pump Relief Valve (750#) is mounted on the discharge side of the main manifold.

The Ship's Hydraulic Main Manifold (CR) (701) (Ref. 386892) consolidates all main branches carrying the working cycle. Its functions are:

(1) Distribution (by unit valve) to:
  (1) Steering gear change valve (CR) (Emergency).
  (2) Bow and Stern diving change valve (CR) (Emergency).
  (3) Service Forward.
  (4) Service Aft.

(2) Segregation, as follows:
  (1) Hand cut-outs to all points listed under (1).
  (2) Cut-out Valve, Pull & Throw: This is a spring loaded ground and lap-fitted plug cock directly across the line of supply to the tops of the valve discs in the manifold. As there is no individual valve leading to the control manifold this serves as cut for the:
  (3) Supply line to the ship's control manifold (vents, outboard valves and two floods).

(3) Regulation:
  (1) By-pass Valve: A handwheel stop leading direct to top of the hydraulic system oil circulating tank. This valve is fitted with a locking cap that jams the handwheel and freezes the position of the valve.

A box Wrench and a Socket Wrench are provided with this manifold to fit the locking caps.

The Ship's Hydraulic Main Return Manifold (CR) consolidates all branches of the return cycle and delivers surplus oil to the supply tank by four lines, viz.: (fitted with unit valves).

(1) Steering Gear Change Valve (CR) (Emergency).
(2) Bow and Stern Diving Change Valve (respectively) (emergency).
(3) Service Aft.
(4) Service forward.

The Return Manifold must be used in case any of the above lines are to be segregated from the system.

The Ship's Hydraulic System oil replenishment is self-feeding, self-regulating and continuous by means of reservoirs and air cushioning tanks which float on the return side of the system, viz.:

(1) Oil Supply Tank 50 gal. (super.Fr.49). Reserve oil content 35 gal. Variable displacement capacity to allow for accumulator discharge and expansion (10 gal.).

(2) Back Pressure Tank (1800 cu.in.) (super. Fr.49) working pressure 10 p.s.i. (Pneumatic cushion for oil surface, supply tank).

(3) Vent and Surge Tank F.T.R. (5½" D. x 10" high) (normal oil level, ½ full) to accommodate variations in displacement, provides air venting and air cushioning in the forward service line return.

(4) Vent and Surge Tank A.T.R., same as above for service line return, aft.

Purification:

The Oil Supply Tank traps water and provides hand drain to bilge. (Should be tapped weekly.)

The Oil Supply Tank carries strainer for sediment.

Component Parts - In Control Room (701-275)

Item	Name	Description or Purpose	Ports. Plan No.
1	PUMP	IMO.	
2	MOTOR	15 H.P. 1750 r.p.m. mounted on same bed plate with pump, flexible cplg.	1703-381
3	MOUNTING, Rubber	For use with flexible hose connection only.	
4	MOUNTING, Solid	Rigid pipe connection is an alternative with this mounting.	
5	RELIEF, Valve	Adjustable Spring loaded ground seat valve, 750 p.s.i., main manifold.	
6	VALVE, Cut-out #1	Segregates flexible hose No.1 in case of rupture.	
7	VALVE, Cut-out #2	Segregates flexible hose No.2 in case of rupture.	
8	HOSE, Flexible #1	Sound isolation.	
9	HOSE, Flexible #2	Sound isolation.	
10	RIGID, Pipe Connection	Standby hook-up, replaces 8 when rubber mounting is locked rigid.	
11	BY-PASS, AUTOMATIC		
14	PILOT VALVE		
15	ACCUMULATOR	1000 cu.in. 750 p.s.i.	
16	AIR FLASK	7 cu.ft. 1750 p.s.i.	407-275 407-285
17	MANIFOLD, SUPPLY		
18	VALVE, Steering	EMERGENCY Steering supply to the Steering Gear Control Valve.	
19	VALVE, Diving, Bow & Stern (Emergy.)	EMERGENCY Diving Gear supply Bow & Stern respectively.	
20	VALVE, SVC, Fwd.	Supply to service line forward.	
21	VALVE, SVC, Aft.	Supply to service line Aft.	
22	VALVE, Main cut-out	A stop valve across supply from pump to the manifold.	
23	VALVE, By-pass	For shunting supply from Pump to supply tank.	
24	MANIFOLD, RETURN		
25	VALVE, Steering, Emergency	Return from Steering gear control valve, Emergency	
26	VALVE, Diving, Bow & Stern	Return from Diving gear, Bow & Stern, respectively.	
27	VALVE, SVC, Fwd.	Return from service line forward.	
28	VALVE, SVC, Aft.	Return from service line aft.	
29	TANK, Supply	Oil reservoir, Connection to auto by-pass is through a Check Valve.	898-275
30	TANK, Back pressure	Air cushion on Supply Tank.	899-228

31	MANIFOLD, Control (Upper section)	Handle	To Open Pull	Tank or Valve
(1)	Handle, Vent Valve	Straight	Toward	BB Tank
(2)	Handle, Vent Valve Group	Straight	Toward	MB#1, 2A & 2B 2C & 2D
(3)	Handle, Vent Valve Group	Straight	Toward	F.O.B. #3A & 3B, 5A & 5B
(4)	Handle, Vent Valve Group	Straight	Toward	MB 4A & 4B
(5)	Handle, Vent Valve Group	Straight	Toward	MB 6A & 6B, & #7
(6)	Handle, Vent Valve	Straight	Toward	Safety Tank.
	MANIFOLD, Control (Lower Section)			
(7)	Handle, & latch CLOSED	BALL	AWAY	Main Induction Valve & Ships, Sup.
(8)	Handle	TEE	AWAY	Flood Valve, Negative Tank.
(9)	Handle	Straight	Toward	Flood Valve, Safety Tank

Interrelation of Ship's Hydraulic System (CR) individual units in other parts of the ship are indicated by the following tabulation:

System	Elec. Motor Drive RPM	Speed Red.	Hyd. Pump IMO 1750	Supply Water-bury	Delivery	Remote Control A-End Hand	Remote Control Tele-motor
Hydraulic System	15 HP 1750		X			Local Control	
Steering	15 HP 1750			A-end	Ram	CR	ATR
Bow Plane Tilt	10 HP 1750	X		A-end	[redacted]	CR	FTR
Stern Plane Tilt	10 HP 1750	X		A-end	Ram	CR	ATR
Windlass & Capstan	15 HP 1750	X		A-end	S-end	Local Control	

The Ship's Hydraulic Control Manifold (CR) is one of two principal diving stations of of the boat. Certain prudential rules govern the handling of the controls of this station, details of which are subject to special study and training. Basic principle of operation is the maintenance of continuity of security by judicious openings of group vents, in succession, rather than collectively. Also the assurance of security prior to final venting of last group of tanks, i.e. the operator should be sure that the main induction is CLOSED, before the ship goes under.

The Ship's Hydraulic Control Manifolds are at Frame 49, Control Room.

The Ship's Hydraulic Control Manifold (upper section) has 1 group of 6 levers, right to left, (they are all straight handles) --

(1) Vent Bow Buoyancy Tank

(2) Vents, (MB No. 1
(MB 2A & 2B
(MB 2C & 2D

(3) Vents, F.O. Tanks 3A & 3B
5A & 5B

(4) Vents, (MB 4A & 4B (extra large vents on this tank)).

(5) Vents, MB 6A & 6B, & 7

(6) Vent, Safety Tank

The Ship's Hydraulic Control Manifold (lower section) has 3 handles, right to left --

(7) (Hull ventilation valve — handle with a ball
(Engine air induction valve

(8) Flood, negative tank — handle with a tee

(9) Flood, Safety tank — straight handle

The Ship's Hydraulic Control Manifold (top and bottom) consists of a set of hand operated piston valves (Ref. Plan No. 312248).

Number of pistons -- 9, lap-fitted
Dimensions: -- 2.5 D. x 4-1/8" lg.
Special feature: 3/16" D. by-pass from piston core to return side of system. This distributes the inequality of volume in operating piston displacement due to piston rods.
Piston operation by: link (5-1/8" lg.) lever (22" lg.) and handle
Piston travel = for HAND = 0" (neutral)
for OPEN or CLOSE = 2" max.
For EMERGENCY = 7/32". In this position the 3/16" equalizing by-pass in the piston valve is blanked. This prevents draining of the hydraulic system tank and return side in case of a ruptured line. HAND operation is possible in this position.

Distribution of pressure: the spool of the piston valve is always on the working side supporting and distributing pressure. The core, and ends, are always on the return side of system.

The Ship's Main Hydraulic Control Manifold Levers relative direction of operations are:

Vents (all) and Flood, Safety = pull toward operator for OPEN.
Main Induction and Flood Negative = push away for OPEN.
See table of Components (CR)

The Handles of the manifold are latched for each respective position and are provided with means for padlocking. The outboard ventilation valve lever is provided with a positive latching device in the CLOSE position to prevent inadvertent throwing of the lever to the neutral or open position.

The Hydraulic Control Manifold Hand Lever Shafts (.748" D.) are fitted with a stuffing box and brass slotted gland (1-9/16" D.) with steel locking screw and steel cotter pin. A special spanner wrench (6" long) marked FLOOD & VENT MANIFOLD is furnished to take this gland. The wrench is stowed in a location convenient to the manifold.

The IMO Pump takes oil from the supply tank and delivers to the AUTOMATIC By-Pass (globe type valve 1 1/8" D. x 5/8" lift). This is a noiseless, spring loaded, double piston, oil cushioned, pilot controlled balancing valve, (Ref. 767-275). By pilot valve control from the accumulator, the auto. by-pass valve maintains a static head on the system by alternately shunting pump pressure -- (1) to accumulator, and (2) the non-return valve saves the oil in case of rupture to the flexible hose connection

The Non-Return Valve (in the auto-by-pass valve body) is a noiseless spring loaded, flat seated, check 1-1/8" lift seating with pressure from accumulator.

The Hydraulic System Accumulator, capacity 1000 cu.in. (5 ft. 1 3/8" high x 10-7/8" OD of cylinder) is located in pump room. Principal parts are:

(1) The oil cylinder (9 3/8" ID). This takes the accumulator oil supply connection.
(2) The plunger (9 1/8" OD). This member slides in the packing, oil on outside, air in inside.
(3) The plunger packing is leather, mineral tanned similar to VIM, mfd. by E.F. Houghton Co., Phila., Pa. Continuous rings to be installed when time and conditions permit, disassembly split rings to be installed for emergency repairs only. Assembled length packing 2-1/8".
(4) Air cylinder (7 1/8" ID). This is the inside dia. of the plunger.
(5) Air plunger (5 3/8" OD). This takes the same type of packing as the plunger. The inside diameter is 4 1/4" and into this leads air flask pressure, 1750 lbs. (approx.). Packing consists of (bottom to top) flat cushion ring (leather), U-packing ring (leather), filler ring (flax), gland ring (brass).
(6) The drain for oil cylinder - a 1/8" needle valve.
(7) The drain to lubricator and water trap - a 1/8" globe valve.
(8) Oiling instruction plate
(9) Lubricator and water trap
(10) 2 - 1 oz. grease cups with zerk fitting for tie rods (Ports. Plan 35154).
(11) Copper lubricator (5-13/16" ID x 2 1/2" high) perforated copper dipper packed with cotton on the bottom of the plunger
(12) Lube oil sump, formed by a heavy lip on the air plunger casing (Plan 35152). The surface of the lube oil in this sump should be 3/8" below edge of the lip.

The Ship's Hydraulic System Pilot Valve of auto. by-pass is a two port, lap-fitted trunk, cam operated, slide valve (1.25" D. x 11-5/8"). The assembly (13" lg. x 6" wide) is adjustable on a foundation (accumulator tie rod). The auto. by-pass valve working piston head port in the valve body is always open. The pilot shunts it from pressure to exhaust according to cam action.

	When Auto. By-Pass is:			
	Loading		By-Passing	
Pilot Valve Port	Open	Closed	Open	Closed
(1) To Piston Head, (auto. by-pass valve)	X		X	
(2) To Working Pressure		X	X	
(3) To Back Pressure	X			X

The operation of the pilot valve is cam type off the accumulator plunger, travel 15".

Operation Procedure

Accumulator, Recharging by Manipulation

(1) With the automatic by-pass valve closed and the accumulator ready for recharging, open the manual by-pass at the hydraulic main manifold and allow oil from the vent and replenishing tank to flow to the accumulator.

(2) Close the valve in the air line and open the 1/8" vent valve on the pressure side of the accumulator to bleed down the air pressure. This will permit the oil to replenish the accumulator.

(3) When the automatic by-pass valve is open, close the manual by-pass at the vent control manifold.

(4) Close the air vent valve and open the valve in the air line to the accumulator, thus charging the accumulator. The pressure in the accumulator air flask drops from normal and by cracking the air loading valve the pressure is brought back to the proper amount.

(5) This method of charging the accumulator is very satisfactory in case of failure of the main power plant and has been accomplished in one minute and forty seconds from the time the accumulator is ready for recharging to the time the accumulator is charged to 600 lbs. pressure and the pressure in the accumulator air flask is brought up to the proper amount, time given is exclusive of time required to bleed down.

Ship's Hydraulic System - operation by hand - The accumulator may be loaded by means of the steering stand pump (CR). Number of turns required, about 200 - time, 3 minutes.

Instruction Plate - Hydraulic System (Ref. 911) covers essential features of operation of the plant.

Ship's Hydraulic Manifold (CR) - Vent, flood and hull valve mechanisms, note:

For HAND operation of hydraulic valve gear place control lever in HAND position. This floats the unit piston on a neutral by-pass.

Ship's Hydraulic System --

Start, secure, and vent according to Instruction Plates.

To Start:

(1) Check air pressure on accumulator.
(2) Open quick throw cut-out - main manifold (CR).

(3) Start Ship's Hydraulic System pump motor.

To Secure:

(1) Cease operation - all units.
(2) Put all control levers on NEUTRAL.
(3) See Auto. By-Pass Valve OPEN.
(4) Close Quick Throw Cut-out, main manifold (CR) (to hold pressure).

Venting:

(1) Vents are located at all high spots in the system, i.e., lines, valves, manifolds, accumulator, gauges, control gears, operating gears.
(2) Before venting, put working pressure on the system.
(3) Vent persistently to relieve system of air. Work units repeatedly by hand and power during this process and vent often. Air in system will cause rough, noisy operation. Two or three days may be required to get air out of a newly filled system.
(4) Vent system each time the plant has been idle over a period of several days.
(5) Vent pipe lines by recirculation, as per instructions, as requisite.

Water: Water to such an extent as to cloud the oil is objectionable. Detection of water in the oil calls for centrifuge test.

Protection: (1) Relief valves (spring loaded) safeguard the system and individual pumps.
(2) A relief valve (488) protects waterbury pump & motor casings where a stop intercepts the replenishing line.

Accumulator: Accumulator, air side -- care should be observed, that the oil seal on the air cylinder packing is preserved. Instruction plate covers this feature.

Accumulator, air side -- Keep this drained of water.

1/4

Outside Packed Hydraulic Rams:

(1) This style of hydraulic packing is self-sealing. The gland sustains but exerts no pressure. This stuffing box is filled with chevron ring packing and seals under internal pressure. Set up on the gland nuts by hand only without a wrench. Mashing the packing will not stop leaks. Excessive leakage calls for renewal.

Cleanliness: All units must be clean internally.

Oil:

The Hydraulic Systems hold about 150 gals. of oil including the supply tank. Reserve tanks in FTR room carry 135 gals. Only the regular hydraulic oil supplied for the purpose should be used in hydraulic systems. Reserve stock oil should be kept tightly sealed in original containers.

Units should be opened as briefly as possible for making connections and reconnected as quickly as possible. Do not permit dirty work in the vicinity while making repairs to hydraulic system.

Oil must be kept clean, neutral and free of residue. Examine strainers periodically. When a ship returns to base after a cruise, oil samples should be drawn off for examination. All residue, metal particles and other foreign matter found in strainers should be identified for source and to make diagnosis of any trouble. Ship should send sample to tender if there is any cause to doubt condition of the oil.

Oil which has been drained from hydraulic system during overhaul is normally considered satisfactory for furtheruse after careful straining through a 200 mesh screen to remove sediment and other foreign matter.

Care must be taken when filling hydraulic system. Oil must be free of sediment and water. Oil should be given individual examination prior to use even when oil is new and taken from contractor's containers. Possibility of contamination, for the purpose of sabotage, must be borne in mind.

Oil specified by current instructions or plans may not under certain conditions be available. In such a case, the index by which to select an oil is the temperature-viscosity characteristic of the prescribed oil. 100% mineral oils, only, should be used. As a guide (for use when deprived of specific instructions) the following table may be of service:

OIL FOR HYDRAULIC TRANSMISSION OF POWER

Oil Navy Symbol	Pour Point °F.	S.S.U. Viscosity at °F. 50	100	130	210	
O.S. 1113	(-)40	750	200	135	50	Hydraulic oil, BuOrd.
2110	0	750	160	110	45	Hydraulic oil, S/M
1042	0	550	130	75	42	Substitute for 2110
2075	(-)10	750	160	75	42	Hydraulic oil, S/M
1047	0	1500	320	150	47	Substitute for 2075

A Hydraulic System may not operate satisfactorily below a certain temperature which varies between 25 and 50°F. depending on the type of gear and its condition. Upon the approach of conditions, which would reduce the temperature of the interior of the ship and the hydraulic system to a temperature of 50°F., every effort should be made to keep the interior of the ship warm. Electric heaters should be used and the equipment operated sufficiently to circulate the oil and warm it. It is preferable to take action before extreme weather has had a chance to thoroughly chill the oil and mechanisms.

Disassembling any part of the system, while system is loaded in whole or in part, may result in considerable damage, due to upsetting the balance between working pressure and back pressure in an individual unit in a remote part of the system.

Reserve Oil Tanks, Hydraulic System

The Hydraulic System Reserve Oil Tanks (864-275) three total, in FTR, total capacity 135 gals. The storage is a unit with standard fixtures per tank with common filling, draining, and pumping. Filling is done through the torpedo loading hatch and pumping is through a hand pump to the hydraulic system. Details are shown below:

HYDRAULIC OIL RESERVE TANKS (864-275) - LIST OF

Shape	Material	Gal. Cap.	Fr.No.	Side	High Suction	Filling Conn.	Vent	Test P.
(1)Shell	Cu.	45	26-27	S	X	-	X	6 p.s.i.
(2)Shell	Cu.	45	28-29	S	X	X	X	6 p.s.i.
(3)Shell	M.S.	45	29-30	S	X	Fr. 33		6 p.s.i.

FIXTURES COMMON TO HYD. OIL RESERVE TANKS (3)

Name	Frame	Side	Purpose
(1) Drain	32	S	For drawing off water & sediment
(2) Hand Pump	32	S	Rotary Pump (Rumsey or equal) from high suctions to replenishing line of Hydraulic System
(3) Strainer	32	S	Silbraz hyd. strainer 1", #36 mesh
(4) Stop Valve	32	S	1" Hyd. valve, stop against the hyd. system replenishing line
(5) Filling Conn.	33	C/L	Adjacent to Torpedo Loading Hatch
(6) Funnel	Portable	C/L	With 3'8" pipe to lead down the Torpedo Loading Hatch
(7) Gage			Or Sounding Rod

The Ship's Hydraulic System is piped to distribute service according to the table below:

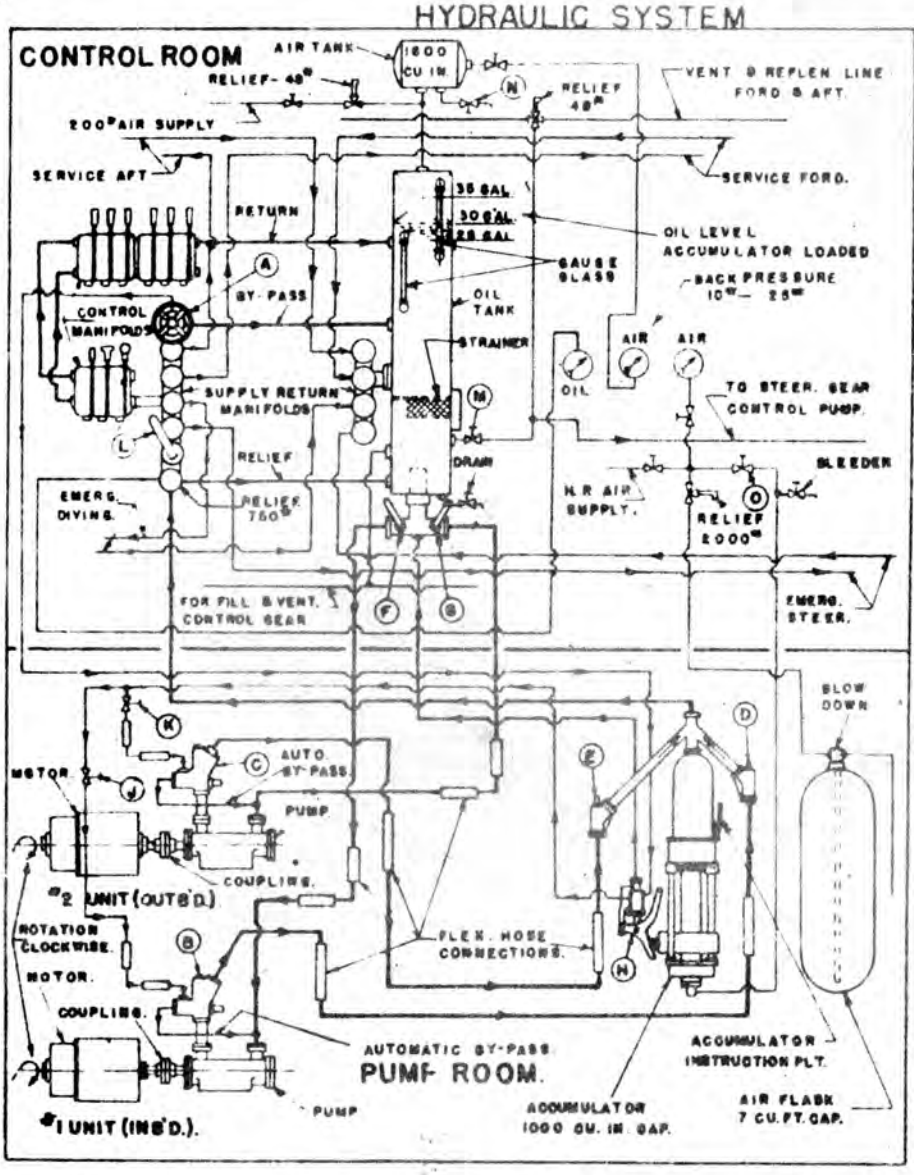
Table of Hydraulic Service

Unit Served	Type of Valve or Gear Served: Vent Valve	Grp. Control	Flood Valve	Outbd Valve	Exh. Valve	Change Valve	Rigging	Muzzle Door	Type of Application
VENTS									
MBT 1	X								Piston
MBT 2A & 2B	X	X							"
MBT 2C & 2D	X								"
FBT 3A & 3B	X								"
FBT 5A & 5B	X	X							"
MBT 4A & 4B	X X	X							"
MBT 6A & 6B	X								"
MBT 6B & 6D	X	X							"
MBT 7	X								"
BB	X	X							"
SAFETY	X	X	X						"
NEGATIVE			X						"
VENTILATION									
ME Air Ind				X					"
Ship's Supply				X					"
EXHAUSTS									
M.E. No.1					X				"
No.2					X				"
No.3					X				"
No.4					X				"
POWER									
Gear, Steering						X			Ram
Gear, Diving Bow						X			[redacted]
Gear, Diving Stern						X			Ram
Gear, Windlass						X			Rotary
Projector, 0B							X		Ram
Projector, 0C							X		Ram
TUBES									
Fwd. Nest									
T.T. #1								X	Piston
3								X	"
5								X	"
2								X	"
4								X	"
6								X	"
After Nest									
T.T. #7								X	"
9								X	"
8								X	"
10								X	"

ACCUMULATOR OPERATION - Tabulation of

Unit	Variation	ACCUMULATOR							
		Loaded & Unloading				Unloaded & Loading			
		Cycle of Stroke		Valve		Stroke		Valve	
		Top	Bottom	Open	Closed	Top	Bottom	Open	Closed
Accumulator									
(1) Plunger, stroke, in.	15		X			X			
(2) Oil Cap. cu. in.	1000	X					X		
(3) Air flask cu. ft.	7		X			X			
(4) Oil, p.s.i.	500-700	X					X		
(5) Air, p.s.i.	1500-1750	X					X		
Supply Tank									
(1) Oil cap. gals.	35-45		X			X			
(2) Air cap. cu. in.	1000	X					X		
Back Press. Tank									
(1) Cap. cu. in.	1800		X			X			
(2) Air, p.s.i.	10-70		X			X			
Pilot Valve									
(1) Throw, in.	1		X						
(2) Cam, in.	3½		X						
Auto. By-Pass Valve									
(1) Disc (1½" D.) in.	25/32			X					X
(2) Spring, in.	25/32		X				X		
(3) Piston, in.	25/32		X				X		
Non-return valve									
(1) Disc	7/8"				X			X	
(2) Spring	7/8"		X						

HYDRAULIC SYSTEM



INSTRUCTIONS

1. OIL PRESSURE SHOULD BE ABOUT 10% ABOVE MAX. OPERATING REQUIREMENTS (APPROX. 500-600#/□") BACK PRESSURE 10#/□" WITH ACCUMULATOR LOADED. AT RIG FOR DIVE CHECK BOTH PRESSURES.
2. FUNCTION AND SETTING OF VALVES.
   VALVE A - BY-PASS TO OIL TANK. CLOSED EXCEPT WHEN WARMING UP PLANT AND TESTING PUMPS.
   B & C - AUTOMATIC BY-PASS FOR DISCHARGE FROM PUMP UNITS #1 & #2 RESPECTIVELY.
   D & E - NON-RETURN VALVES FOR PUMP DISCHARGE FROM PUMP UNITS #1 & #2 RESPECTIVELY.
   F & G - OIL SUPPLY CONTROL FOR PUMP UNITS #1 & #2 RESPECTIVELY. OPEN DURING OPERATION.
   H - PILOT VALVE. CONTROLS OPERATION OF VALVES B & C.
   J & K - CUT-OUT FOR PILOT VALVE PRESSURE TO AUTOMATIC BY-PASS VALVES ON PUMP UNITS #1 & #2 RESPECTIVELY. LATCH OPEN EXCEPT WHEN WHEN WORKING ON LINE OR BY-PASS VALVE.
   L - CUT-OUT FOR OIL SUPPLY, TO HOLD ACCUMULATOR PRESS. FOR LONG PERIODS OF TIME. OPEN WHEN OPERATING.
   M - VENT & REPLENISHING CUT-OUT. LATCH OPEN EXCEPT WHEN REPAIRING SYSTEM.
   N - BACK PRESSURE RELEASE - NORMALLY CLOSED.
   O - STOP FOR AIR FLASK TO HOLD PRESSURE DURING LONG SHUT-DOWN INTERVALS. OPEN DURING OPERATION.
   P - FILLING VALVE - LATCH CLOSED EXCEPT WHEN FILLING OR TRANSFERRING.
   Q - VENT & TRY COCKS FOR RESERVE OIL TANKS - LATCH CLOSED EXCEPT WHEN FILLING OR TRANSFERRING.
   S - DRAIN FOR RESERVE OIL TANKS (SEE NOTE 5).
   T - TAP TO FURNISH OIL FOR LUBRICATION. NORMALLY CLOSED
3. BEFORE STARTING PUMP UNIT #1 COMPLETELY OPEN VALVES F, J, L, M, & O. BEFORE STARTING PUMP UNIT #2 COMPLETELY OPEN VALVES G, K, L, M & O.
4. IN CASE OF FAILURE OF FLEXIBLE HOSE CONNECTIONS, STOP PUMP AND CLOSE VALVE F OR G AS APPROPRIATE.
5. TO ADD OIL TO SYSTEM: FULLY CHARGE ACCUMULATOR, CLOSE VALVE L, OPEN ALL VALVES R, TRY VALVE S AND DRAIN OUT ALL WATER, MAN HAND PUMP BEFORE OPENING VALVE P. OPEN VALVE P AND PUMP OIL. WHEN FINISHED CLOSE P & R (RESET OIL LEVEL IN SURGE TANKS IN EACH TORPEDO ROOM) CHECK AIR TANK BACK PRESSURE.
6. WHEN VENTING AIR FROM SYSTEM, ALWAYS HAVE SUPPLY PRESSURE (LOADED ACCUMULATOR) AND BACK PRESSURE ON THE SYSTEM TO PREVENT SUCKING AIR.
7. CHECK OIL TANK DRAIN FOR WATER.
8. KEEP ACCUMULATOR RAM LUBRICATED AND CLEAN, SEE ACCUMULATOR INSTRUCTION PLATE.
9. CLEAN OIL TANK STRAINER & STRAINER Q AT REGULAR NAVY YARD OVERHAULS AND WHENEVER SYSTEM IS DRAINED.
10. USE OIL SYMBOL 2110 FOR TROPICAL USE, AND OIL SYMBOL 2075 FOR COLD WEATHER USE.

SS425-434
381-416

2

DRILL FOR 4-#10 (.190"D.)-24 R.H. MACH. SCREWS, PC. K3.

PIPE LIST

SHIPS HYDRAULIC SYSTEM

MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
1	1½"	Steel	Pump Discharge to Auto By-Pass Valve	1200#
2	¾"	Brass	Supply Manifold By-Pass to Supply Tank	150#
3	2"	Brass	Supply Line to Pump from Tank	150#
4	1½"	Steel	Supply to Main Manifold from Pump	1200#
5	1½"	Brass	Pump By-Pass to Oil Supply Tank	150#
6	1½"	Steel	Pressure Line to Manifold, from Flood M. to Vent M.	1200#
7	1"	Brass	Return Line from Vents Man. to Flood Man.	150#
8	¾"	Brass	Main Supply Manifold Relief	150#
9	½"	Brass	Air Pressure Conn. to Circ. Oil Tank	150#
10	-	Copper	Tank Gauge Conn.	150#
11	¼"	Copper	Vent from Bow Diving Rigging Gr. Cont.	150#
12	½"	Brass	Emergency Steering Supply	1800#
13	½"	Brass	Emergency Steering Return	1800#
14	¾"	Brass	Press. Line to After T.T. Muzzle Doors Cont.	1200#
15	¾"	Brass	Return Line Fr. After T.T. Muzzle Doors Cont.	150#
16	½"	Brass	Press Line to After T.T. Muzzle Doors Cont.	1200#
17	½"	Brass	Return Line Fr. After T.T. Muzzle Doors Cont.	150#
18		Copper	Oil Gauge Conn.	1200#
19		Copper	Air Gauge Conn.	2750#
20	1/8"	Copper	Air Flask Drain	2750#
21	½"	Brass	Air Flask Conn.	2750#
22	½"	Brass	Air to Accumulator	2750#
23	1¼"	Brass	Service Supply Forward	1200#
24	1¼"	Brass	Service Return Forward	150#
25	1"	Brass	Service Supply Aft	1200#
26	1"	Brass	Service Return Aft	150#
27	½"	Brass	Diving Gears Emergency Supply	1800#
28	½"	Brass	Diving Gears Emergency Return	1800#
29	½"	Brass	Bow Diving Gear Emergency Supply	1800#
30	½"	Brass	Bow Diving Gear Emergency Return	1800#
31	½"	Brass	Stern Diving Gear Emergency Supply	1800#
32	½"	Brass	Stern Diving Gear Emergency Return	1800#
33	½"	Brass	Telemotor Vent & Replenishing, Steering Gear	150#
34	½"	Brass	Telemotor Vent & Replenishing, Bow Diving Gear	150#
35	½"	Brass	Telemotor Vent & Replenishing, Stern Diving Gear	150#
36	½"	Brass	Drain from Supply Tank	-
37	½"	Brass	Bow Buoyancy Tank Vent Valve-Open	1200#
38	½"	Brass	Bow Buoyancy Tank Vent Valve-Close	1200#
39	¼"	Brass	Bow Buoyancy Tank Vent Valve-Open	1200#
40	¼"	Brass	Bow Buoyancy Tank Vent Valve-Close	1200#
41	½"	Brass	No.1,2A & 2B, 2C & 2D M.B. Tanks Vents - Open	1200#
42	½"	Brass	No.1,2A & 2B, 2C & 2D M.B. Tanks Vents - Close	1200#
43	¼"	Brass	No.1 M.B. Tank Vent - Open	1200#
44	¼"	Brass	No.1 M.B. Tank Vent - Close	1200#
45	¼"	Brass	No.2A & 2B M.B. Tanks Vents - Open	1200#
46	¼"	Brass	No.2A & 2B M.B. Tanks Vents - Close	1200#
47	¼"	Brass	No.2C & 2D M.B. Tanks Vents - Open	1200#
48	¼"	Brass	No.2C & 2D M.B. Tanks Vents - Close	1200#
49	½"	Brass	No.3A & 3B, 5A & 5B F.B. Tanks Vents - Open	1200#
50	½"	Brass	No.3A & 3B, 5A & 5B F.B. Tanks Vents - Close	1200#
51	¼"	Brass	No.3A & 3B F.B. Tanks Vents - Open	1200#
52	¼"	Brass	No.3A & 3B F.B. Tanks Vents - Close	1200#
53	¼"	Brass	No.5A & 5B F.B. Tanks Vents - Open	1200#
54	¼"	Brass	No.5A & 5B F.B. Tanks Vents - Close	1200#
55	½"	Brass	No.4A & 4B M.B.T. Vents - Open	1200#

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PIPE LIST (Continued)

	MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
SHIPS HYDRAULIC SYSTEM	56	1/4"	Brass	No. 4A & 4B M.B. Tanks Vents - Close	1200#
	57	1/4"	Brass	No. 4A & 4B M.B. Tanks Vents - Open	1200#
	58	1/4"	Brass	No. 4A & 4B M.B. Tanks Vents - Close	1200#
	59	1/2"	Brass	No. 6A & 6B, 6C & 6D & 7 M.B. Tanks Vents - Open	1200#
	60	1/2"	Brass	No. 6A & 6B, 6C & 6D & 7 M.B. Tanks Vents - Close	1200#
	61	1/4"	Brass	No. 6A & 6B M.B.T. Vents - Open	1200#
	62	1/4"	Brass	No. 6A & 6B M.B.T. Vents - Close	1200#
	63	1/4"	Brass	No. 6C & 6D M.B.T. Vent - Open	1200#
	64	1/4"	Brass	No. 6C & 6D M.B.T. Vent - Close	1200#
	65	1/4"	Brass	No. 7 M.B.T. Vent - Open	1200#
	66	1/4"	Brass	No. 7 M.B.T. Vent - Close	1200#
	67	1/4"	Brass	Safety Tank Vent Valve - Open	1200#
	68	1/4"	Brass	Safety Tank Vent Valve - Close	1200#
	69	1/2"	Brass	Eng. Air Int., Hull Vent Supply - Open	1200#
	70	1/2"	Brass	Eng. Air Int., Hull Vent Supply - Close	1200#
	71	1/2"	Brass	No.6A, 6B, 6C, 6D M.B.T. Vent - Open	1200#
	72	1/2"	Brass	No.6A, 6B, 6C, 6D M. B. T. Vent - Close	1200#
	73				
	74				
	75	1/4"	Brass	Negative Tank Flood Valve - Open	1200#
	76	1/4"	Brass	Negative Tank Flood Valve - Close	1200#
	77	1/2"	Brass	Safety Tank Flood Valve - Open	1200#
	78	1/2"	Brass	Safety Tank Flood Valve - Close	1200#
	79	1/4"	Brass	Safety Tank Flood Valve - Open	1200#
	80	1/4"	Brass	Safety Tank Flood Valve - Close	1200#
	81	1"	Brass	Pressure Line Forward T.T. Muzzle Doors - Cont.	1200#
	82	1"	Brass	Return Line Forward T.T. Muzzle Doors - Cont.	150#
	83	1"	Brass	Press. Line After T.T. Muzzle Doors - Cont.	1200#
	84	1"	Brass	Return Line After T.T. Muzzle Doors - Cont.	150#
	85	1"	Brass	Vent & Replen. Conn. to Circulating Tank	150#
	86	1/4"	Brass	Air Tank Bleeder	150#
	87	3/8"	Brass	Relief Valve Drain	-
	88	1"	Brass	Press. Line to Forward T.T. Muzzle Doors Cont. V.	1200#
	89	1"	Brass	Return Line Fr. Forward T.T. Muzzle Doors Cont. V.	150#
	90	3/4"	Brass	Press. Line to Forward T.T. Muzzle Doors Cont. V.	1200#
	91	3/4"	Brass	Return Line Fr. Forward T.T. Muzzle Doors Cont. V.	150#
	92	1/2"	Brass	Press. Line to Forward T.T. Muzzle Doors Cont. V.	1200#
BOW DIVING GEAR	93	3/4"	Brass	Press. Line to Bow Diving Rigging Gear Cont.	1200#
	94	3/4"	Brass	Return Line Fr. Bow Diving Rigging Gear Cont.	150#
	95	3/4"	Brass	Bow Diving Rigging Gear - Pressure - Rig Out	1200#
	96	3/4"	Brass	Bow Diving Rigging Gear - Pressure - Rig In	1200#
	97	1/2"	Brass	Vent Line from Hyd. Windlass & Rigging Motor	150#
	98	1/2"	Brass	Vent Line from Interlock Valve	150#
	99				
	100				
	102	1/8"	Copper	Vent Line - Vent Tank - Forward	150#
	103	1/2"	Brass	Return Line from Forward T.T. Muzzle D.C.V.	150#
	104	3/8"	Brass	Control Valve to Muzzle Doors Cylinders	1200#
STEERING GEAR	105	1"	Brass	Main Man. to Aft. Starboard Ram - Press. R.R.	1800#
	106	1"	Brass	Forward Starboard Ram to Main Man. - Return R.R.	1800#
	107	1"	Brass	Main Man. to Forward Port Ram - Press R.R.	1800#
	108	1"	Brass	Aft Port Ram to Main Man. - Return R.R.	1800#
	109	3/4"	Brass	Hand Line - Press. R.R.	1800#
	110	3/4"	Brass	Hand Line - Return R.R.	1800#
	111	3/4"	Brass	Hand & Emergency Line - Press. R.R.	1800#
	112	3/4"	Brass	Hand & Emergency Line - Return R.R.	1800#
	113	1/2"	Brass	Emergency Line - Press.R.R.	1800#
	114	1/2"	Brass	Emergency Line - Return R.R.	1800#
	115	3/8	Brass	Vent & Replen. Line - Aft	150#

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PIPE LIST (Continued)

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	MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
STEERING GEAR	116	1/8"	Copper	Change Valve Vent	150#
	117	½"	Brass	Control Line - Change Valve to By-Pass Valve Press. R.R.	900#
	118	½"	Brass	Control Line - By-Pass Valve to Change Valve-Return R.R.	900#
	123	½"	Brass	Vent & Fill Line - Vent & Fill Man. to Vent & Replen.Line	150#
	124	½"	Brass	Vent & Fill Line - Vent & Fill Man. to Oil Circ. Tank	150#
	125	1"	Brass	Hand Pump Disch. to Vent & Replen. Line	150#
	126	½"	Brass	Vent Lines for Rams	1800#
	127	½"	Brass	Drain Lines from Rams	1800#
	128	½"	Brass	Vent Line from Pump	150#
	129	1/8"	Copper	Vent Line - Vent Tank	150#
	130	1/8"	Copper	Vent Line - Reserve Oil Tank	
	131				
	132				
	133		Copper	Main Cyl. Line - Change Valve to Press. Gauge	1800#
	134				
	135				
	136	1"	Brass	Reserve Oil Tank Filling	-
	137	1¼"	Brass	Reserve Oil Tank Filling	-
	138	1/8"	Copper	Supply to Pilot Valve	1200#
	139	1/8"	Copper	Supply from Pilot Valve to By-Pass Valve	1200#
	140	1/8"	Copper	Pilot Valve Vent	150#
	141	¾"	Brass	Hand Pump Suction from Reserve Oil Tanks	150#
	142	1"	Brass	Hand Pump Suction from Reserve Oil Tanks	150#
	143	½"	Brass	Reserve Oil Tanks Drain	-
BOW DIVING GEAR	144	1"	Steel	Manifold to Ram Press - Dive	1800#
	145	1"	Steel	Ram to Manifold - Return-Dive	1800#
	146	¾"	Brass	Hand Line - Press-Dive	1800#
	147	¾"	Brass	Hand Line - Return-Dive	1800#
	148	¾"	Brass	Hand & Emergency Line - Press-Dive	1800#
	149	¾"	Brass	Hand & Emergency Line - Return-Dive	1800#
	150	½"	Brass	Emergency Line - Press-Dive	1800#
	151	½"	Brass	Emergency Line - Return-Dive	1800#
	152	½"	Brass	Control Line to By-pass Valve - Press-Dive	900#
	153	½"	Brass	Control Line By-pass Valve to Control Cyl.-Press-Dive	900#
	154	½"	Brass	Control Line Control Cyl. to By-pass Valve - Return-Dive	900#
	155	½"	Brass	Control Line By-pass Valve to Change Valve - Return-Dive	900#
	156	½"	Brass	Vent Line from Hydraulic Pump	150#
	158	-	Copper	Gauge Lines from Change Valve	900#
	159	½"	Brass	Vent & Fill Control Lines	150#
	160	½"	Brass	Vent & Fill Control Lines	150#
	161	½"	Brass	Vent & Fill Control Lines	150#
	162	½"	Brass	Vent & Fill Control Lines-Steering-Diving	150#
	163	½"	Brass	Combined Vent Diving Gears	150#
	164	1"	Brass	Vent & Replenishing Line-Forward	150#
	165	¾"	Brass	Vent & Replenishing Line-Forward	150#
	166	1/8"	Copper	Change Valve Vent	150#
STERN DIVING GEAR	167	1"	Steel	Stern Diving Gear Pump to Ram Pressure-Dive	1800#
	168	1"	Steel	Ram to Pump - Return-Dive	1800#
	169	¾"	Brass	Hand Line-Press-Dive	1800#
	170	¾"	Brass	Hand Line-Return-Dive	1800#
	171	¾"	Brass	Hand & Emergency Line - Press-Dive	1800#
	172	¾"	Brass	Hand & Emergency Line - Return-Dive	1800#
	173	½"	Brass	Emergency Line - Pressure-Dive	1800#
	174	½"	Brass	Emergency Line - Return-Dive	1800#
	175	½"	Brass	Control Line Change Valve to By-pass Valve-Press.-Dive	900#
	176	½"	Brass	Control Line By-pass Valve to Control Cyl.-Press.-Dive	900#
	177	½"	Brass	Control Line Control Cyl. to By-pass Valve-Return-Dive	900#
	178	½"	Brass	Control Line By-pass Valve to Change Valve-Return-Dive	900#

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STERN DIVING GEAR

MARK	NOM. SIZE	MATERIAL	SERVICE	TEST
179	½"	Brass	Vent Line from Hydraulic Pump	150#
180	1/8"	Copper	Change Valve Vent	150#
181	-	Copper	Gauge Lines from Change Valve	1800#
182	½"	Brass	Vent & Fill Control Lines	150#
183	½"	Brass	Vent & Fill Control Lines	150#

GAUGE LIST

MARK	NO. REQ.	DIA. DIAL	SERV.	ENGRAVING	READING	RED HAND SETTING
A	1	4½"	Oil	Hydraulic Main Manifold	0-1500#	750#
B	1	4½"	Air	Air Tank	0-60#	
C	1	4½"	Air	Hydraulic Accumulator - Air	0-3000#	1850#
D	2	4½"	Oil	Windlass & Capstan	0-1800#	1200#
E	2	4½"	Oil	Hydraulic System	0-1500#	750#
F	2	4½"	Oil	Steering Gear - Main Cylinders	0-3000#	1500#
G	2	4½"	Oil	Bow Diving Gear - Change Valve	0-1500#	750#
H	2	4½"	Oil	Stern Diving Gear - Change Valve	0-1500#	750#

RELIEF VALVE LIST

NO. REQ.	SIZE I.P.S.	INLET	OUTLET	DESIGN SET PRESSURE	ABSOLUTE TIGHT PRESS.	SERVICE
1	3/8"	Male	Female	2000#	1750#	Hyd. Accum. Air Flask
1	3/8"	Male	Female	48#	40#	Steering & Diving Gear & Hyd. Pumps in C.R.
1	3/8"	Male	Female	48#	40#	Steering & Diving Gear Pumps After Torp. Rm..
1	3/8"	Male	Female	48#	40#	Wind. & Cap. Pump & Motor Diving Gear Pump & Motor
1	3/8"	Male	Female	48#	40#	Oil Circulating Tank

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Reference Plans:

Ports.No.	BuShips No.	Title
433-381	490241	Hydraulic System - Diagram - Piping
434-381	544873	Hydraulic System - Piping Arrangement - Forward Torpedo Room
435-381	544875	Hydraulic System - Piping Arrangement - Officer's Quarters
436-381	544875	Hydraulic System - Piping Arrangement - Control Room
437-381	544876	Hydraulic System - Piping Arrangement - Crew's Mess, Galley, Scullery & Wash Room
438-381	544877	Hydraulic System - Piping Arrangement - Crew's Space
439-381	544878	Hydraulic System - Piping Arrangement - Forward Engine Room
440-381	544879	Hydraulic System - Piping Arrangement - After Engine Room
441-381	544880	Hydraulic System - Piping Arrangement - Aft. Torpedo Room
511-381	544881	Hydraulic System - Piping Arrangement - Maneuvering Room
701-381	386892	Hydraulic System - Main Power Plant - Arrgt. - Piping
722-228	312209	Bow Diving Gear - Hydraulic System - Piping - Arrangement Forward
757-381	490298	Hydraulic System - Main Return Manifold - Arrangement
758-381	386690	Hydraulic System - Main Return Manifold - Body
759-285	490297	Hydraulic System - Main Supply Manifold - Arrangement
760-381	386692	Hydraulic System - Main Supply Manifold - Body
765-228	386693	Hydraulic System - Main Manifold - Details - Sheet #1
766-228	386694	Hydraulic System - Main Manifold - Details - Sheet #2
767-277	386774	Hydraulic System - Automatic By-Pass and Non-Return Valve - Arrgt.
768-277	386775	Hydraulic System - Body - Details Sheet #1
769-277	386776	Hydraulic System - Details Sheet #2
770-381	386777	Hydraulic System - Flanges and Special Fittings - Sheet #3
771 275	386963	Hydraulic System - Pilot Valves for Automatic By-Pass Valve - Arrangement and Details
772-275	386964	Hydraulic System - Pilot Valves for Automatic By-Pass Valve - Details
777-285	490276	Hydraulic System - Accumulator - Capacity 1000 cu.in. - Arrangement
778-201	312265	Hydraulic System - Details Sheet #1
779-285	490277	Hydraulic System - Details Sheet #2
780-275	386907	Hydraulic System - Flanges & Special Fittings - Sheet #1
781-275	386908	Hydraulic System - Flanges & Special Fittings - Sheet #2
782-228	386695	Hydraulic System - Main Mainfold - Details - Sheet #3
818-201	312305	Steering Gear - Hydraulic System - Bow & Stern Diving Gears - Windlass & Capstan & Bow (Plane) Tilting - Vent and Surge Tanks - Arrangement and Details
878-285	490287	Steering Gear and Hydraulic System - Emergency Steering Gear Control Valve - Arrangement
879-285	490288	Steering Gear and Hydraulic System - Emergency Steering Gear Control Valve - Details - Sheet #1
880-285	490289	Steering Gear and Hydraulic System - Emergency Stee .ng Gear Control Valve - Details - Sheet #2
881-285	490290	Ditto - Details - Sheet #3
898-275	386894	Hydraulic System - Oil Supply Tank and Details
899-228	386697	Hydraulic System - Air Tank and Oil Supply Tank Strainer - Details
911-381	490294	Steering Gear - Hydraulic System - Instruction Plates and Name Plates
948-381	386973	Stuffing Box Data for Hydraulic Packing
1111-285	490278	Hydraulic System - Accumulator - Capacity 1000 cu.in. - Details Sh.#3
1148-275	387474	Bow and Stern Diving Gear - Hydraulic System - Flanges & Special Fittings
35961	386945	Shock Absorber for Hydraulic Air and Water Systems
35278	490406	Hydraulic Piping System - Bossed Sleeve Fittings for
35760	490407	Hydraulic System - Fill and Vent Manifold
	490459	1/8" Hydraulic Valve with Silbraz Union
	490460	¼" Hydraulic Valve with Silbraz Union
	490461	½" Hydraulic Valve with Silbraz Union
	490463	1" Hydraulic Valve with Silbraz Union
864-285	490566	Reserve Oil Tank Arrangement

NOTE: The Bureau of Ordnance has made a very comprehensive investigation of hydraulic oils. Results are contained in Specifications O.S. 1113.

Section V-5

LUBRICATION

For a complete recapitulation of all oil and grease connections by individual fittings, by pieces of machinery, and by compartments, see Lubrication Chart (Ref. 1523-381). If not on board this pamphlet should be requested from Navy Yard, Portsmouth, New Hampshire.

Threaded connections on bearings and other parts of auxiliary machinery to which grease is supplied under pressure through leads of cone-joint piping are in no case less than ¼ inch, I.P.S., unless special conditions prevent.

On large parts of important machinery, especially if subject to repeated or continuous movement or vibration, the threaded connections for grease lubrication are ⅜ inch I.P.S.

Fittings are in accordance with plan, Bu. No. 148662.

Piping for greasing connections are copper tubing. Piping and fittings are capable of withstanding a pressure of 3,000 pounds per square inch.

Grease lines where led through the pressure hull are fitted with valves inside of the hull.

Grease fitting springs are made of spring wire conforming to Table III of Navy Department Specification 4165, dated 15 September, 1942. The balls are made of nickel-copper-aluminum alloy conforming to Table II of Spec. 4165, dated 15 September 1942.

Two high pressure air driven grease guns, of two pounds capacity each with necessary adapters, two small hand grease guns, two hand loaders suitable for 10 pound grease can, and six 50-foot lengths of hose are furnished on the allowance list.

Sheet steel drip pans are provided as necessary under overhead machinery.

All ball bearings and their mountings are in accordance with latest revision of Navy Department Specification 4285.

Welded-steel stuffing boxes of approved design are used for shafts passing through structural boundaries.

For convenience of handling and use as check off list, a lubrication chart (Ports.Plan No. 1523-381, Bu.No.544641) has been prepared. This chart lists all gear under the cognizance of the Bureaus of Ships and Ordnance in convenient groups with instructions as to the kind of lubricant and frequency of application.

For use as a reference for lubricants used with Hull Machinery, the following data are furnished:

Description of Unit	Lube Oil Symbol	Viscosity	Grease	Alternative
H.P. Air Compressor Circ. Water Pump Bearings			Grade I Soft L.S. 14G1	Grade B
H.P. Air Compressor, Bearings	2190	185-205 sec: at 130°F.		Eng. Lub. Oil
H.P. Air Compressor. Cylinders	1150	140-160 sec: at 210°F.		Eng. Lub. Oil
H.P. Air Compressor, Motor Bearings			Ball Brg.Lub.: L.S., 14L3, Gr.A	Grade B
Refrigeration, Compressor	2135	120-145 130		2190
Refrigeration, Compressor Motor			Ball Brg.Lub.: L.S., 14L3	Grade I
Air Conditioning Compressor	2135	120-145 130		2110
Air Conditioning Motor Gear	2135	120-145 130		2110
Air Conditioning Motor Bearing			Ball Brg.Lub.: L.S., 14L3	Grade I
Trimming Pump	Eng.			
(Bearings	L.O.	180-220 210		3065
(Worm	5190		Ball Brg.Lub.:	
(Motor Bearings			L.S. 14L3, Gr.A: Gr.II, Medium:	Grade B
(Plunger packing			L.S. 14G1	Grade I

For use as a reference for lubricants used with Hull Machinery, the following data are furnished: (Continued:)

Description of Unit	Lube Oil Symbol	Viscosity	Grease	Alternative
L.P. Air Compressor	2110	120-145 130		2075
Windlass Chain Compressor Screws	2110	110-115 130		2075
Windlass, Bearings (Grease)			Gr. II, Med.	Grade I
Steer. Gear Bearings (Grease)			Gr. II, Med.	Grade I
Diving Gear, Bearings (Grease)			Gr. II, Med.	Grade I
Hydraulic System	2075	70-90 130		2110
Hydraulic Speed Gears	2075	70-90 130		2110
Periscope Hoists	2110	110-115 130		2075
Herringbone Speed Reducers	2075	70-90 130		2110

Reference Plans:

Ports.No.	BuShips No.	Title
1523-381	544641	Lubrication Chart
974-381	544630	Bow Torpedo Tubes - Greasing Arrangement
975-308	544598	Stern Torpedo Tubes & Steering Gear - Greasing Arrangement
975-382	544546	Stern Torpedo Tubes & Steering Gear - Greasing Arrangement
1181-381	544625	Bow Torpedo Tubes - Bulkhead grease manifold & Greasing Details
1182-308	544600	Stern Torpedo Tubes & Steering Gear - Greasing Details
1182-382	544639	Stern Torpedo Tubes & Steering Gear - Greasing Details

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GENERAL NOTES

1. This chart contains a record of parts and mechanisms to be lubricated, their location, method, and type of lubrication. Exceptions are main and auxiliary engines and related equipment, propeller shaft bearings, guns, radio apparatus, and all electrical equipment including electric motors and generators

2. Any change in individual lubrication should be noted with affected item.

3. "* - Self lub" refers to bearings that may be lubricated by replacing plug with grease fitting in case N-R bushings are substituted for self lub.

4. Medium grease, "Med.Gr.," must conform with navy spec.14G1h, Grade II.

SUPERSTRUCTURE

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Bow Buoyancy Vent Valves						
Forward Valve Linkage	2	C/L	1	F	Med. Gr.	704-275
Aft Valve Linkage	8	S	1	F	Med. Gr.	704-275
Greasing Station (4 Plates)	11	C/L	1 Ea.	F	Med. Gr.	704-275
Greasing Station (2 Plates)	20	C/L	1 Ea.	F	Med. Gr.	704-275
Bell Crank (Plate)	25	C/L	1	F	Med. Gr.	704-275
Windlass & Capstan						
Anchor Chain Indicator Gear Case	10½	S	1	P	Oil 2110	1030-308
Chain Compressor Gear Case	10½	P	1	P	Oil 2110	1030-308
Universal Joint	10½	P	4	F	Med. Gr.	1030-308
Band Brake Gear Case	11½	P	1	P	Oil 2110	1030-308
Universal Joint	12½	C/L	4	F	Med. Gr.	1010-275
Universal Joint	15	C/L	4	F	Med. Gr.	1010-275
Universal Joint (2)	15	C/L	4 Ea.	F	Med. Gr.	1010-275
Capstan Head	16	S	1	F	Med. Gr.	1031-308
Main Drive Bevel Gear Case	16	C/L	1	P	Oil 2110	1037-308
Capstan Gear Case	16½	P	1	P	Oil 2110	1031-308
Greasing Station	12	S	14	F	Med. Gr.	1018-271
Universal Joint (Hyd.Emerg.Control)	21½	S	4	F	Med. Gr.	1011-381
Universal Joint (Hyd.Power Control)	22½	S	4	F	Med. Gr.	1011-381
Bow Diving Gear						
Plane Stock Hinge Pin (2)	17-18	P&S	2 Ea.	F	Med. Gr.	713-201
Connecting Rod	18	P&S	2 Ea.	F	Med. Gr.	713-201
Universal Joint	19	C/L	4	F	Med. Gr.	713-201
Universal Joint	23	C/L	4	F	Med. Gr.	713-201
Rigging Gear Bevel Gear Case	24	C/L	1	P	Oil 2110	713-201
Marker Buoy - Forward						
Releasing Mechanism	22	P	1	F	Med. Gr.	256-228
Marker Buoy - Aft						
Releasing Mechanism						
Bearing (3)	105½	P	[illegible] Ea.	F	Med. Gr.	256-228
Stuffing Box	107	P	[illegible]	F	Med. Gr.	256-228
Roller Chocks						
Forward Chocks (2)	14	P&S	1 Ea.	F	Oil	251-381
Aft Chocks (2)	112½	P&S	1 Ea.	F	Oil	251-381

F - Grease Fitting C - Grease Cup P - Oil Hole P.P. - Pipe Plug * - Self Lub.
S - Grease Stick

OIB - 384-396-V-5 Date 27 October 1943 1523-8 U. S. Navy Yard, Portsmouth, N. H. - 1943

LUBRICATION CHART

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SUPERSTRUCTURE (Cont.)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Forward Torpedo Derrick						
Boom End Sheave	39	C/L	1	F	Med. Gr.	187-275
Boom Base Sheave (2)	39	C/L	1 Ea.	F	Med. Gr.	187-275
Hatches						
Forward Escape Trunk						
Watertight Door	28½	P	9	F	Med. Gr.	35954
Arm for Contact Maker	28½	P	1	F	Med. Gr.	1060-381
Upper Hatch	27½	C/L	3	F	Med. Gr.	35977
Arm for Contact Maker	27½	C/L	1	F	Med. Gr.	1061-381
Lower Hatch	27½	C/L	2	F	Med. Gr.	35746
Forward Torpedo Loading	34	C/L	3	F	Med. Gr.	35977
Gun Access Trunk						
Watertight Door	48	P	9	F	Med. Gr.	35954
Arm for Contact Maker	48	P	1	F	Med. Gr.	1060-381
Upper Hatch	48	P	3	F	Med. Gr.	35977
Arm for Contact Maker	48	P	1	F	Med. Gr.	1061-381
Lower Hatch	48	P	2	F	Med. Gr.	35746
Galley & Mess Room	64½	S	3	F	Med. Gr.	35977
Forward Engine Room	85½	F	3	F	Med. Gr.	35977
After Engine Room	94½	C/L	3	F	Med. Gr.	35977
After Torpedo Loading	109	C/L	3	F	Med. Gr.	35977
After Torpedo Room	115½	C/L	3	F	Med. Gr.	35977
Main Vent Valves						
M.B. #1	32	S	1	F	Med. Gr.	1099-381
M.B. #2A & 2B	49	S	2	F	Med. Gr.	985-381
M.B. #2C & 2D	61	S	2	F	Med. Gr.	985-381
F.B. #3A & 3B	61½	S	2	F	Med. Gr.	985-381
M.B. #4A & 4B	74½	C/L	2	F	Med. Gr.	985-381
F.B. #5A & 5B	79	P	2	F	Med. Gr.	985-381
M.B. #6A & 6B	84	P	2	F	Med. Gr.	985-381
M.B. #6C & 6D	90	P	2	F	Med. Gr.	985-381
M.B. #7	119	S	1	F	Med. Gr.	985-381
Safety Tank	63½	S	1	F	Med. Gr.	990-308
Stern Capstan						
Capstan Head	118½	S	1	F	Med. Gr.	914-381
Switch Operating Mechanism						
Deck Bearing	109	P	1	F	Med. Gr.	1167-228
Stuffing Box	109	P	1	F	Med. Gr.	1167-228
Forward Escape Trunk Inboard Closing Device						
Universal Joint (2)	28	P	4 Ea.	F	Med. Gr.	742-285
Forward Escape Trunk Flood Valve						
Shaft Bracket	27	C/L	2	F	Med. Gr.	531-285
Emergency Identification Signal Ejector						
Muzzle Valve Body	48	P	2	F	Med. Gr.	842-308
After Torpedo Derrick						
Boom End Sheave	100	S	1	F	Med. Gr.	187-275
Boom Base Sheave	100	S	1	F	Med. Gr.	187-275
Ship's Ventilation System						
36" Supply, Exhaust & Induction Valve						
Valve Seat	58	C/L	1	*		1319-308
Yoke Guides	58	C/L	Swab with Grease each Month			
Hydrophone for 'J.P.' Sound Apparatus						
Upper Bearing	32	S	1	F	Med. Gr.	1200-287

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

SUPERSTRUCTURE (Continued)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Main Engine Exhaust System						
15" Outside Exhaust Valves						
Gagging Device Gear Case (2)	78½	P&S	1 Ea.	F	Med. Gr.	5110-381
Gagging Device Gear Case (2)	89	P&S	1 Ea.	F	Med. Gr.	5110-381
Gagging Socket (2)	78½	P&S	1 Ea.	F	Med. Gr.	5110-381
Gagging Socket (2)	89	P&S	1 Ea.	F	Med. Gr.	5110-381
Bushing (14)	78-79	P	1 Ea.	*		5110-381
Bushing (14)	78-79	S	1 Ea.	*		5110-381
Bushing (4)	80-90	P	1 Ea.	*		5110-381
Bushing (4)	80-90	S	1 Ea.	*		5110-381
Bushing (10)	80½ 90½	- P	1 Ea.	*		5110-381
Bushing (10)	80½ 90½	- S	1 Ea.	*		5110-381
Bushing (6)	81 - 91	P	1 Ea.	*		5110-381
Bushing (6)	81 - 91	S	1 Ea.	*		5110-381
Circulating Water Muffler By-Pass						
Universal Joint (4)	81½	P&S	1 Ea.	H	Oil	5106-381
Universal Joint (4)	91½	P&S	1 Ea.	H	Oil	5106-381
BRIDGE & CONNING TOWER						
Steering Gear						
Drive Shaft Universal Joint (2)	48½	P	4 Ea.	F	Med. Gr.	870-285
Drive Shaft Gear Case	49½	P	2	F	Med. Gr.	885-285
Drive Shaft Stuffing Box	49	P	1	F	Med. Gr.	870-285
Periscopes						
No. 1 Periscope						
Hoist Winch	53	S	1	P	Oil 2110	827-381
Hull Casting	53	C/L	2	F	Med. Gr.	828-381
Sheave Bracket (2)	53	S	2 Ea.	F	Med. Gr.	827-381
Sheave (2)	53	C/L	1 Ea.	F	Med. Gr.	827-381
Sheave (2)	53	S	1 Ea.	F	Med. Gr.	827-381
Wire Ropes	53	S			Graphite Wheel Rope Grease	827-381
No. 2 Periscope						
Hoist Winch	54	S	1	P	Oil 2110	827-381
Hull Casting	54	C/L	2	F	Med. Gr.	828-381
Sheave Bracket	54	S	2 Ea.	F	Med. Gr.	827-381
Sheave (2)	54	C/L	1 Ea.	F	Med. Gr.	827-381
Sheave (2)	54	S	1 Ea.	F	Med. Gr.	827-381
Wire Ropes	54	S			Graphite Wheel Rope Grease	827-381
Hatches						
Upper Hatch	50½	S	3	F	Med. Gr.	35750
Lower Hatch	52	P	2	F	Med. Gr.	35746
Model "SJ" Radar Equipment Training Mechanism						
Upper Bearing	54½	C/L	1	F	Med. Gr.	944-285
Middle Bearing	54½	C/L	1	F	Med. Gr.	944-285
Lower Bearing	54½	C/L	1	F	Med. Gr.	944-285
Hull Casting	54½	C/L	1	F	Med. Gr.	944-285
Upper Bevel Gear Case	54	P	1	P	Oil 2190	944-285
Lower Bevel Gear Case	53½	P	1	P	Oil 2190	944-285
Universal Joint (2)	54	P	2 Ea.	F	Med. Gr.	944-285
Universal Joint (2)	53	P	2 Ea.	H	Oil	944-285
Clutch						
Gear Case	53	P	3	F	Med. Gr.	1024-285
Gear Case	53	P	1	H	Oil	1024-285
Bearing Cover	53	P	1	F	Med. Gr.	1024-285
Bearing Indicator	53	P	2	F	Med. Gr.	944-285

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

LUBRICATION CHART

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SS381-434

FORWARD TORPEDO ROOM

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Torpedo Tubes (Fittings per tube)						
Greasing Station on Bulkhead (For Nest)	16	P&S	54	F	Med. Gr.	974-381
Breech Door Mechanism	20	P&S	9	F	Med. Gr.	224940
Speed Setting Mech. (R.H. Tubes)	17	S	6	F	Med. Gr.	261127
Speed Setting Mech. (L.H. Tubes)	17	P	7	F	Med. Gr.	261124
Depth Setting Mechanism	18	P&S	6	F	Med. Gr.	261141
Tripping Latch Mechanism						
Shaft Bearing (2)	18-20	P&S	1 Ea.	F	Med. Gr.	290742
Greasing Station (2 Panels for Nest)	17	S	13 Ea.	F	Med. Gr.	290777
Greasing Station (3 Panels for Nest)	17	P	9 Ea.	F	Med. Gr.	290777
Poppet Valve						
Vent Valve Gag	18	P&S	4	H	Oil	261156
Discharge Angle Valve						
Bearing (Four Upper Tubes)	20	P&S	1 Ea.	F	Med. Gr.	290757
Socket (Two Lower Tubes)	19	P&S	1 Ea.	F	Med. Gr.	261223
Gear Case (Two Lower Tubes)	21	P&S	2 Ea.	F	Med. Gr.	261223
Gyro Setting Mechanism						
Spindle Drive Housing	18	P&S	1	P	Oil 3050	290617
Spindle Drive Housing Cover	18	P&S	4	F	Med. Gr.	290617
Spindle Retraction Mechanism	18	P&S	5	F	Med. Gr.	290627
Cross Shaft Drive Housing (For Nest)	18	P&S	6	F	Med. Gr.	261200
Coupling (7 for Nest)	16	P&S	1 Ea.	H	Oil	261180
Universal Joint (2 for Nest)	18	P&S	1 Ea.	H	Oil	261180
Roller (4)	11-20	P&S	1 Ea.	H	Oil	290775
Muzzle Door Mechanism						
Sleeve Oper. Gear, Upper Bracket	18½	P&S	1	F	Med. Gr.	290638
Sleeve Oper. Gear, Lower Bracket	19	P&S	1	F	Med. Gr.	290638
Thrust Block (2)	18	P&S	1 Ea.	F	Med. Gr.	290649
Hand Operating Gear						
Clamp Bearing	20	P&S	2	F	Med. Gr.	290649
Universal Joint (2)	18-20	P&S	1 Ea.	H	Oil	290649
Interlocking Mechanism						
Breech Bracket	20	P&S	2	F	Med. Gr.	290725
Breech & Muzzle Door Int. Crank	20	P&S	1	F	Med. Gr.	290725
Muzzle Door Indicator Plate	20	P&S	1	F	Med. Gr.	290725
Drain Valve Interlock Lever	19½	P&S	1	F	Med. Gr.	290725
Firing Interlock Shaft	19½	P&S	1	F	Med. Gr.	290725
Firing Interlock Clutch Shaft	19	P&S	1	F	Med. Gr.	290725
Sleeve Head	19	P&S	1	F	Med. Gr.	290725
Control Valve Handle	20	P&S	2	H	Oil	290725
Drain Valve Interlock						
Bearing (8 for Nest)	20	P&S	1 Ea.	F	Med. Gr.	290731
Torpedo Stop Mechanism						
Stuffing Box	10	P&S	1	F	Med. Gr.	81-285
Drain Valve (For Nest)						
Operating Gear Bearing (2)	20	P&S	2 Ea.	H	Oil	492-275
Bearing (4)	20	P&S	1 Ea.	H	Oil	498-275
Bonnet (6)	20	P&S	2 Ea.	H	Oil	498-275
Shaft (4)	20	P&S	1 Ea.	H	Oil	498-275
Bow Diving Gear						
Plane Stock Bearing (2 Grease Panels)	17	P&S	2 Ea.	F	Med. Gr.	725-381
Flexible Coupling	23	P	1	F	Med. Gr.	713-381
Rigging Shaft Hull Fitting	23½	S	1	F	Med. Gr.	713-381
Rigging Indicator						
Gear Case	23½	C/L	3	F	Med. Gr.	719-381
Gear Case (Note Sight Glass)	23½	C/L	1	P	Oil 2110	719-381
Pump Control Shaft	22½	P	2	F	Med. Gr.	713-381
Control Piston Lever	22½	P	2	F	Med. Gr.	713-381
Pump Spindle Lever	22½	P	2	F	Med. Gr.	713-381
Tilting Block Centering Device	22½	P	6	H	Oil 2110	713-381

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

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FORWARD TORPEDO ROOM (Continued)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Torpedo Handling (Fittings per cradle)						
Cradle Roller (8)	23-32	P&S	1 Ea.	H	Oil	963-275
Flat Roller (2)	24&31	P&S	1 Ea.	H	Oil	963-275
Track Roller (4)	24&31	P&S	1 Ea.	*		963-275
Forward Escape Trunk Inboard Closing Device						
Gear Case	28	P	3	F	Med. Gr.	742-285
Gear Case	28	P	1	P	Oil 2110	742-285
Hull Stuffing Box	28	P	1	F	Med. Gr.	742-285
Forward Escape Trunk Flood Valve						
Hull Stuffing Box	27	C/L	1	F	Med. Gr.	531-285
Bow Buoyancy Vent Valves						
Operating Gear	25½	P	6	F	Med. Gr.	711-381
Stuffing Box	25½	P	1	F	Med. Gr.	704-275
Hydrophone for 'J.P.' Sound Apparatus						
Stuffing Box	32	S	2	F	Med. Gr.	1200-287
Gear Case	32	S	1	P	Oil 2190	1200-287
Watertight Door (381-410 & 417-434)	35	S	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	34	P	2	H	Oil	745-381
Watertight Door (411-416)	35	S	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	34	P	2	H	Oil	745-381
Main Vent Valves						
M.B. #1						
Operating Gear	32	S	9	F	Med. Gr.	1099-381
Hull Stuffing Box	32	S	1	F	Med. Gr.	1099-381
Echo Ranging & Detection Equipment						
Sea Valve Bracket (Grease Header)(2)	34	P&S	5 Ea.	F	Med. Gr.	186-285
Sea Valve Stuffing Box (2)	34	P&S	1 Ea.	P	Med. Gr.	186-285
Lower Contact Maker (2)	34	P&S	1 Ea.	Wick	Oil	6215-228
Upper Drift Stop Shaft (2)	34	P&S	1 Ea.	F	Med. Gr.	6215-228
Lower Drift Stop Lever (2)	34	P&S	1 Ea.	F	Med. Gr.	6215-228
Greasing Header (2)	35	P&S	5 Ea.	F	Med. Gr.	6215-228
Power Training Unit						
Reduction Gear (2)	34	P&S	1 Ea.	P	Oil 2110	6215-228
Projector Tube Head (2)	34	P&S	2 Ea.	H	Oil	6215-228
Emergency Hand Training Gear						
Clutch Spider	34	P	2	F	Med. Gr.	6215-228
Stop Cylinder	34	P	1	F	Med. Gr.	6215-228
Bearing	34	P	1	F	Med. Gr.	6215-228
Underwater Log						
Gear Case	33	P	1	P	Oil 2110	6399-283
Worm Shaft Bearing	33½	P	1	F	Med. Gr.	6399-283
Crank Handle	33½	P	2	H	Oil	6399-283
Upper Bearing	33	P	1	F	Med. Gr.	6399-283
Sea Valve Handwheel Shaft Bearing	34	P	1	F	Med. Gr.	6399-283
Forward W.R.T. Tank Overflow Valve						
Bearing (2)	20½	P	1 Ea.	F	Med. Gr.	522-285
Bearing	20½	P	1	H	Oil	522-285
Bonnet	22½	P	2	F	Med. Gr.	521-285
Forward W.R.T. Tank Flood & Drain Valve						
Universal Joint (2)	21	P	1 Ea.	H	Oil	545-275
Plumbing Drain Valve (2)	35	P&S	1 Ea.	S		472-285
Air Valves						
Compartment Air Valve	35	S	1	H	Oil	405-381
Salvage Air Valve	21	P	1	F	Med. Gr.	405-381
Salvage Air Valve	31	S	1	F	Med. Gr.	405-381

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

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SS381-434

FORWARD TORPEDO ROOM (Cont.)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Bulkhead Ventilation Valves						
Bushing (6)	35	P&S	1 Ea.	*		1261-381
Windlass & Capstan						
Flexible Coupling	24½	S	1	F	Med. Gr.	713-381
Control Shaft Hull Stuffing Box	25	S	1	E	Med. Gr.	713-381
Main Drive Bulkhead 16, Gear Case	16	S	1	P	Oil 2110	1037-308
Universal Joint	17	S	4	F	Med. Gr.	1037-308
Universal Joint	22½	S	4	F	Med. Gr.	1011-381
OFFICERS' QUARTERS						
Main Battery Disconn. Switch (381-384)						
Operating Gear (2)	47	P&S	1 Ea.	Fitting to be inserted for Greasing	Med. Gr.	6242-289
Plumbing Drain Valve (2)	35	P&S	1 Ea.	S		454-285
Watertight Door (381-410 & 417-434)	47	S	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	47	S	2	H	Oil	745-381
Watertight Door (411-416)	47	S	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	47	S	2	H	Oil	745-381
Air Valves						
Compartment Air Valve	35	S	1	H	Oil	405-381
Compartment Air Valve	47	S	1	H	Oil	408-381
Salvage Air Valve	38	S	1	F	Med. Gr.	406-381
Salvage Air Valve	43	S	1	F	Med. Gr.	406-381
Bulkhead Ventilation Valves						
Stuffing Box (2)	35	P&S	1 Ea.	*		1261-381
Bushing (6)	35	P&S	1 Ea.	*		1261-381
Bearing	47	S	1	*		1262-285
Bushing (6)	47	P&S	1 Ea.	*		1262-285
Main Battery Disconn. Switch						
Operating Gear (2)			1 Ea.	F	Med. Gr.	
CONTROL ROOM						
Steering Gear						
Control Valve						
Gear Bracket	48½	P	2	F	Med. Gr.	878-285
Gear Case	48½	P	1	P	Oil 2110	871-285
Handwheel	49	P	1	F	Med. Gr.	871-285
Drive Shaft Universal Joint (2)	48½	P	4 Ea.	F	Med. Gr.	870-285
Drive Shaft Stuffing Box	48½	P	1	F	Med. Gr.	870-285
Clutch	48½	P	1	F	Med. Gr.	870-285
Bow Diving Gear						
Change Valve Operating Shaft	51½	P	2	F	Med. Gr.	716-381
Pump Lever Bracket	52½	P	1	H	Oil	716-381
Emergency Handwheel Handle	50½	P	1	H	Oil	716-381
Emergency Handwheel Bearing	50½	P	1	F	Med. Gr.	716-381
Stern Diving Gear						
Change Valve Operating Shaft	52½	P	2	F	Med. Gr.	716-381
Pump Lever Bracket	52½	P	1	H	Oil	716-381
Emergency Handwheel Handle	53½	P	1	H	Oil	716-381
Emergency Handwheel Bearing	53½	P	1	F	Med. Gr.	716-381
Emergency Identification Signal Ejector						
Barrel	48	P	1	F	Med. Gr.	842-308
Shaft	48	P	1	F	Med. Gr.	842-308
Hull Stuffing Box	48	P	1	F	Med. Gr.	846-381
Breech	48	P	1	F	Med. Gr.	842-308

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

CONTROL ROOM (Cont.)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Mast for Vertical Antenna						
Greasing Station	55	S	4	F	Med. Gr.	823-285
Upper Limit Switch Lever	55	S	1	H	Oil	823-285
Flood Valves						
Negative Tank Operating Gear	51	S	1	F	Med. Gr.	1121-285
Negative Tank Handle	51	S	1	F	Med. Gr.	1121-285
Negative Tank Stuffing Box	51	S	1	F	Med. Gr.	1121-285
Main Vent Valves						
M.B. #2A & 2B						
Operating Gear	49	S	9	F	Med. Gr.	978-308
Hull Stuffing Box	49	S	1	F	Med. Gr.	978-308
Emergency Vent Valves						
M.B. #2A	51½	S	5	F	Med. Gr.	978-308
M.B. #2B (Greasing Manifold)	51½	P	5	F	Med. Gr.	978-308
M.B. #2C	56	S	5	F	Med. Gr.	978-308
M.B. #2D	56	P	5	F	Med. Gr.	978-308
List Control Manifold (2)	55	S	1 Ea.	F	Med. Gr.	408-381
Air Valves						
Compartment Air Valve	47	S	1	H	Oil	408-381
Compartment Air Valve	58	S	1	H	Oil	411-381
Salvage Air Valve	48	S	1	F	Med. Gr.	408-381
Salvage Air Valve	58	S	1	F	Med. Gr.	408-381
Bulkhead Ventilation Valves						
Stuffing Box (2)	47	P&S	1 Ea.	*		1262-285
Bushing (6)	47	P&S	1 Ea.	*		1262-285
Bushing (5)	58	P&S	1 Ea.	*		1263-281
Bushing	58	P&S	1 Ea.	*		1263-281

PUMP ROOM

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Mast for Vertical Antenna						
Hoist Winch	54½	C/L	1	P	Oil 5190	819-285
Ship's Hydraulic Power Plant						
Flexible Coupling	49½	P	1	F	Med. Gr.	773-285
Accumulator						
Lubricator	48	P	Funnel		Oil 2075	777-285
Air Cylinder	48	P	2 Aut.Cup		Med. Gr.	777-285
Air Plunger Casing	48	P	Open Basin		Oil 2075	777-285
Trim Pump						
*Multiple Oiler (6 Feeds)	55	P	1	P	Oil 9250	25936
Worm Drive (Sight Glass)	55	P	1 Fill Cap		Oil 5190	25936
Plunger Packing (2)	55	P	1 Ea.	C	Med. Gr.	25936
Discharge Indicator	55	P	2	F	Med. Gr.	35116
Flexible Coupling (To Motor)	55	P	1	F	Med. Gr.	25936
Drain Pump						
*Multiple Oiler (6 Feeds)	54	P	1	P	Oil 9250	25947
Worm Drive (Sight Glass)	54	P	1 Fill Cap		Oil 5190	25947
Plunger Packing (2)	54	P	1 Ea.	C	Med. Gr.	25947
Flexible Coupling (To Motor)	54	P	1	F	Med. Gr.	25947

* Oilers to be shut off when machinery is not in use.

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
H.P. Air Compressor (2)						
Air Cylinder (Pressure Lubricator)	49	P&S	4 Ea.	Force Feed	Oil 1150	470-381
Crankcase	49	P&S	1 Ea.	P	Oil 2190	470-381
L.P. Air Compressor (2) 10# Blow	54-55	S	1 Ea.	P	Oil 3080	470-381
Refrigeration Compressor	51-52	S	1 Fill Val.		Oil 2135	470-381
Air Cond. Compressor (2)	52	P&S	1 Ea.	Fill Valve	Oil 2135	470-381
200# Air Compressor	50	S	1	P	Oil 2110	470-381

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

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SS381-434

CREW'S QUARTERS

MECHANISM	LOCATION FR.	P-S	FITTING NO.	TYPE	LUBRICANT	PLAN NO.
Flood Valves						
F.B. #3A Operating Gear (2)	59	S	2 Ea.	F	Med. Gr.	1104-285
F.B. #3B Operating Gear (2)	59-60	P	3 Ea.	F	Med. Gr.	977-275
F.B. #3B Universal Joint (2)	59-60	P	4 Ea.	F	Med. Gr.	977-275
M.B. #4A Operating Gear	70	S	2	F	Med. Gr.	1104-285
M.B. #4A Operating Gear	72	S	2	F	Med. Gr.	1104-285
M.B. #4A Operating Gear	74	S	2	F	Med. Gr.	1104-285
M.B. #4B Operating Gear	70	P	2	F	Med. Gr.	977-275
M.B. #4B Operating Gear	72	P	2	F	Med. Gr.	977-275
M.B. #4B Operating Gear	74	P	2	F	Med. Gr.	977-275
Safety Tank Operating Gear	62½	P	3	F	Med. Gr.	795-285
Safety Tank Operating Gear	62½	S	4	F	Med. Gr.	795-285
Safety Tank Handle (2)	62½	P&S	1 Ea.	F	Med. Gr.	795-285
Main Vent Valves						
M.B. #2C & 2D						
Operating Gear	60½	S	9	F	Med. Gr.	978-308
Hull Stuffing Box	60½	S	1	F	Med. Gr.	978-308
F.B. #3A & 3B						
Operating Gear	61½	C/L	9	F	Med. Gr.	985-381
Hull Stuffing Box	61½	C/L	1	F	Med. Gr.	985-381
M.B. #4A						
Operating Gear	74½	S	9	F	Med. Gr.	979-381
Hull Stuffing Box	74½	S	1	F	Med. Gr.	979-381
M.B. #4B						
Operating Gear	74½	P	9	F	Med. Gr.	979-381
Hull Stuffing Box	74½	P	1	F	Med. Gr.	979-381
Safety Tank						
Operating Gear	63½	S	9	F	Med. Gr.	990-308
Hull Stuffing Box	63½	S	1	F	Med. Gr.	990-308
F.B. #5A & 5B						
Operating Gear	75	C/L	9	F	Med. Gr.	980-381
Hull Stuffing Box	75	C/L	1	F	Med. Gr.	980-381
Emergency Vent Valves						
F.B. #3A	62	S	5	F	Med. Gr.	979-381
F.B. #3B	62	P	5	F	Med. Gr.	979-381
M.B. #4A	74½	S	5	F	Med. Gr.	979-381
M.B. #4B	74½	P	5	F	Med. Gr.	979-381
Safety Tank (2)	63½	P&S	2 Ea.	F	Med. Gr.	990-308
Ship's Ventilation System						
36" Supply, Exhaust & Induction Valve						
Operating Gear	59-60	C/L	8	F	Med. Gr.	1346-308
Operating Gear Worm Gear Case	60	C/L	1	P	Oil 5190	1346-308
Hull Casting	59½	C/L	1	*		1346-308
Watertight Door (SS381-410 & 417-434)	58	S	5	F	Med. Gr.	35829
Watertight Door Catch (381-410 & 417-434)	59	S	2	H	Oil	745-381
Watertight Door (SS411-416)	58	S	5	F	Med. Gr.	35080
Watertight Door Catch (SS411-416	59	S	2	H	Oil	745-381
Plumbing Drain Valve (2)	77	S	1 Ea.	S		457-285
Main Battery Disconn. Switch (381-384)						
Operating Gear (2)	76	P&S	1 Ea.		Med. Gr.	6242-289
			Ftg. to be inserted for greasing			
Air Valves						
Compartment Air Valve	58	S	1	H	Oil	411-381
Compartment Air Valve	77	S	1	H	Oil	412-381
Salvage Air Valve	58½	S	1	F	Med. Gr.	411-381
Salvage Air Valve	77	S	1	F	Med. Gr.	412-381

F - Grease Fitting C - Grease Cup. H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

CREW'S QUARTERS (Continued)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Bulkhead Ventilation Valves						
Bearing	58	P	1	*		1263-381
Stuffing Box (2)	58	P&S	1 Ea.	*		1263-381
Bushing (6)	58	P&S	1 Ea.	*		1263-381
Stuffing Box	77	P&S	1 Ea.	*		1263-381
Bushing (6)	77	P&S	1 Ea.	*		1263-381
Main Battery Disconn. Switch						
Operating Gear (2)			1 Ea.	F	Med. Gr.	

ENGINE ROOMS

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Ship's Ventilation System (SS381-424)						
22" Hull Valves (Forward Engine Room)						
Lever	84	P	1	F	Med. Gr.	1291-381
Bearing Bracket (2)	84	P	1 Ea.	F	Med. Gr.	1291-381
Pin	84	P	1	F	Med. Gr.	1291-381
Pin (2)	81	P	1 Ea.	F	Med. Gr.	1291-381
Double Lever	81	P	1	F	Med. Gr.	1291-381
Pin	78	P	1	F	Med. Gr.	1291-381
Bearing Bracket	79	P	1	F	Med. Gr.	1291-381
Bushing (2)	79	P	1 Ea.	*		1291-381
22" Hull Valves (After Engine Room)						
Lever	96	P	1	F	Med. Gr.	1290-381
Bearing Bracket (2)	96	P	1 Ea.	F	Med. Gr.	1290-381
Pin	97	P	1	F	Med. Gr.	1290-381
Pin	93	P	1	F	Med. Gr.	1290-381
Bearing Bracket	93	P	1	F	Med. Gr.	1290-381
Bushing (2)	93	P	1 Ea.	*		
15½" Ship's Supply Hull Valve						
Pin	80½	S	1	F	Med. Gr.	1306-381
Bushing (5)	80½	S	1 Ea.	*		1306-381
Bevel Gear Box	80	S	3	F	Med. Gr.	1306-381
Bevel Gear Box	80	S	1	P	Oil 5190	1306-381
Spur Gear Box	80½	S	2	F	Med. Gr.	1306-381
Spur Gear Box	80½	S	1	P	Oil 5190	1306-381
Lever	84	S	1	F	Med. Gr.	1306-381
Bearing Bracket	84	S	1	F	Med. Gr.	1306-381
Flood Valves						
F.B. #5A Operating Gear (2)	78	S	2 Ea.	F	Med. Gr.	789-275
F.B. #5B Operating Gear (2)	78	P	2 Ea.	F	Med. Gr.	789-275
Main Vent Valves						
F.B. #5A&5B						
Operating Gear	80	P	9	F	Med. Gr.	980-381
Hull Stuffing Box	80	P.	1	F	Med. Gr.	980-381
M.B. #6A &6B						
Operating Gear	86	P	9	F	Med. Gr.	980-381
Hull Stuffing Box	86	P	1	F	Med. Gr.	980-381
M.B. #6C & 6D						
Operating Gear	88	P	9	F	Med. Gr.	980-381
Hull Stuffing Box	88	P	1	F	Med. Gr.	988-381
Emergency Vent Valves						
F.B. #5A	79	S	5	F	Med. Gr.	980-381
F.B. #5B	79	P	5	F	Med. Gr.	980-381
M.B. #6A	84½	S	5	F	Med. Gr.	980-381
M.B. #6B	84½	P	5	F	Med. Gr.	980-381
M.B. #6C	90	S	5	F	Med. Gr.	980-381
M.B. #6D	90	P	5	F	Med. Gr.	980-381

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

ENGINE ROOMS (Cont.)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Watertight Door (381-410 & 417-434)	77	S	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	78	S	2	H	Oil	745-381
Watertight Door (411-416)	77	S	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	78	S	2	H	Oil	745-381
Watertight Door (381-410 & 417-434)	88	S	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	87	P	2	H	Oil	745-381
Watertight Door (411-416)	88	S	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	87	P	2	H	Oil	745-381
Watertight Door (381-410 & 417-434)	98½	P	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	97½	P	2	H	Oil	745-381
Watertight Door (411-416)	98½	P	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	97½	P	2	H	Oil	745-381
Main Engine Exhaust System						
15" Inside Exhaust Valves						
Bracket (2)	81	P&S	1 Ea.	F	Med. Gr.	5107-381
Stuffing Box (2)	80½	P&S	1 Ea.	F	Med. Gr.	5107-381
Bonnet (2)	80½	P&S	1 Ea.	F	Med. Gr.	5107-381
Bracket (2)	91	P&S	1 Ea.	F	Med. Gr.	5107-381
Stuffing Box (2)	90½	P&S	1 Ea.	F	Med. Gr.	5107-381
Bonnet (2)	90½	P&S	1 Ea.	F	Med. Gr.	5107-381
15" Outside Exhaust Valves						
Hydraulic Operating Gear (2)	78-79	P&S	8 Ea.	F	Med. Gr.	42038
Worm Gear Case (2)	79	P&S	1 Ea.	H	Oil 5190	42038
Worm Gear Housing Cover Bushing	79	P&S	1 Ea.	*		5110-381
Hull Casting	86	P&S	1 Ea.	*		5110-381
Hydraulic Operating Gear (2)	88-89	P&S	8 Ea.	F	Med. Gr.	42038
Worm Gear Case (2)	89	P&S	1 Ea.	H	Oil 5190	42038
Worm Gear Housing Cover Bushing	89	P&S	1 Ea.	*		5110-381
Hull Casting	91	P&S	1 Ea.	*		5110-381
Auxiliary Engine Exhaust System						
8" Inside Exhaust Valve						
Stuffing Box	90	P	1	F	Med. Gr.	5133-381
Bonnet	90	P	1	F	Med. Gr.	5133-381
Air Valves						
Compartment Air Valve	77	S	1	H	Oil	412-381
Compartment Air Valve	88	S	1	H	Oil	414-381
Compartment Air Valve	99	C/L	1	H	Oil	510-381
Salvage Air Valve	77½	P	1	F	Med. Gr.	413-381
Salvage Air Valve	87	S	1	F	Med. Gr.	413-381
Salvage Air Valve	88½	P	1	F	Med. Gr.	414-381
Salvage Air Valve	98½	P	1	F	Med. Gr.	414-381
Bulkhead Ventilation Valves						
Bushing (6)	77	P&S	1 Ea.	*		1253-381
Stuffing Box	88	P&S	1 Ea.	*		1264-381
Bushing (12)	88	P&S	1 Ea.	*		1264-381
Bushing (6)	99	P&S	1 Ea.	*		1265-381
Circulating Water Muffler By-Pass						
Hull Stuffing Box (2)	81½	P&S	1 Ea.	F	Med. Gr.	5106-381
Hull Stuffing Box (2)	91½	P&S	1 Ea.	F	Med. Gr.	5106-381

MANEUVERING ROOM

Ship's Ventilation System (381-424)						
15½" Engine Air Supply Hull Valve						
Bearing Bracket	106	P	1	F	Med. Gr.	1306-381
Lever	106	P	1	F	Med. Gr.	1306-381
Bevel Gear Box	105	S	2	F	Med. Gr.	1306-381
Bevel Gear Box	105	S	1	P	Oil 5190	1306-381
Pin	105	S	1	F	Med. Gr.	1306-381
Spiral Gear Box	105	S	4	F	Med. Gr.	1306-381
Spiral Gear Box	105	S	1	P	Oil 5190	1306-381

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F - Grease Fitting C - Grease Cut H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

MANEUVERING ROOM (Continued)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Watertight Door (381-410 & 417-434)	107	P	5	F	Med. Gr.	42070
Watertight Door Catch (381-410 & 417-434)	106	P	2	H	Oil	745-381
Watertight Door (411-416)	107	P	5	F	Med. Gr.	35829
Watertight Door Catch (411-416)	106	P	2	H	Oil	745-381
Water Closet						
Plug Cock	105½	P	1	S		520-228
Air Valves						
Compartment Air Valve	99	C/L	1	H	Oil	510-381
Compartment Air Valve	107	C/L	1	H	Oil	510-381
Salvage Air Valve	99	S	1	F	Med. Gr.	510-381
Salvage Air Valve	106	P	1	F	Med. Gr.	510-381
Bulkhead Ventilation Valves						
Stuffing Box (2)	99	P&S	1 Ea.	*		1265-381
Bushing (6)	99	P&S	1 Ea.	*		1265-381
Bushing (6)	107	P&S	1 Ea.	*		1266-381
Gear Oil Sump Tank (381-409)						
Sluice Valve Stuffing Box	103½	S	1	F	Med. Gr.	5074-381
Gear Oil Sump Tank (411-424)						
Sluice Valve Stuffing Box	103½	S	1	F	Med. Gr.	5074-411

AFTER TORPEDO ROOM

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Torpedo Tubes (Fittings per tube)						
Greasing Sta. on Bulkhead (For Nest)	125	S	42	F	Med. Gr.	975-382
Breech Door Mechanism	121	P&S	8	F	Med. Gr.	224940
Speed Setting Mechanism (R.H. Tubes)	124	P	6	F	Med. Gr.	261127
Speed Setting Mechanism (L.H. Tubes)	124	S	6	F	Med. Gr.	261124
Depth Setting Mechanism	123	P&S	6	F	Med. Gr.	261141
Tripping Latch Mechanism						
Shaft Bearing (2)	121-123	P&S	1 Ea.	F	Med. Gr.	290762
Greasing Station (2 Panels for Nest)	124	P	13 Ea.	F	Med. Gr.	290777
Greasing Station (2 Panels for Nest)	124	S	9 Ea.	F	Med. Gr.	290777
Poppet Valve						
Vent Valve Gag	123	P&S	4	H	Oil	261156
Discharge Angle Valve Bearing	121	P&S	1	F	Med. Gr.	290757
Gyro Setting Mechanism						
Spindle Drive Housing	123	P&S	1	P	Oil 3050	290618
Spindle Drive Housing Cover	123	P&S	4	F	Med. Gr.	290618
Spindle Retraction Mechanism	123	P&S	5	F	Med. Gr.	290627
Cross Shaft Drive Housing (For Nest)	123	P&S	5	F	Med. Gr.	261201
Coupling (9 for Nest)	123	P&S	1 Ea.	H	Oil	261181
Roller (4)	121-130	P&S	1 Ea.	H	Oil	290775
Muzzle Door Mechanism						
Sleeve Oper. Gear, Upper Bracket	122½	P&S	1	F	Med. Gr.	290638
Sleeve Oper. Gear, Lower Bracket	122	P&S	1	F	Med. Gr.	290638
Thrust Block (2)	123	P&S	1 Ea.	F	Med. Gr.	290649
Hand Operating Gear						
Clamp Bearing	121	P&S	2	F	Med Gr.	290649
Universal Joint	121-123	P&S	1 Ea.	H	Oil	290649
Interlocking Mechanism						
Breech Bracket	121-122	P&S	2	F	Med. Gr.	290725
Breech & Muzzle Door Int. Crank	121	P&S	1	F	Med. Gr.	290725
Muzzle Door Indicator Plate	121	P&S	1	F	Med. Gr.	290725
Drain Valve Interlock Lever	121½	P&S	1	F	Med. Gr.	290725
Firing Interlock Shaft	121½	P&S	1	F	Med. Gr.	290725
Firing Interlock Clutch Shaft	122	P&S	1	F	Med. Gr.	290725
Sleeve Head	122	P&S	1	F	Med. Gr.	290725
Control Valve Handle	121	P&S	2	H	Oil	290725
Drain Valve Interlock						
Bearing (4 for Nest)	121	P&S	1 Ea.	F	Med. Gr.	290733
Interlock Pedestal (2 for Nest)	121	P&S	1 Ea.	F	Med. Gr.	290733
Torpedo Stop Mechanism						
Stuffing Box	125	P&S	1	F	Med. Gr.	89-285

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

AFTER TORPEDO ROOM (Continued)

MECHANISM	LOCATION FR.	LOCATION P-S	FITTING NO.	FITTING TYPE	LUBRICANT	PLAN NO.
Torpedo Tubes (Fittings per Tube)(Continued)						
Drain Valve (For Nest)						
Bearing (2)	121	P&S	1 Ea.	H	Oil	500-275
Bonnet (4)	121	P&S	2 Ea.	H	Oil	500-275
Shaft (2)	121	P&S	2 Ea.	H	Oil	500-275
Stern Diving Gear						
Pump Control Shaft	119	P	2	F	Med. Gr.	913-275
Control Piston Lever	119	P	2	F	Med. Gr.	913-275
Pump Spindle Lever	119	P	2	F	Med. Gr.	913-275
Tilting Block Centering Device	119	P	6	H	Oil 2110	913-275
Mechanical Indicator & Linkage	124	P	6	F	Med. Gr.	915-275
Greasing Station	124	C/L	2	F	Med. Gr.	915-275
Flexible Coupling	118½	P	1	F	Med. Gr.	913-275
Bearing	118	P	1	F	Med. Gr.	913-275
Stern Capstan						
Worm Shaft Bearing	118	S	1	F	Med. Gr.	914-381
Worm Gear Case	118½	S	1	P	Oil 5190	914-381
Hydraulic Pump Centering Device	118½	S	1	H	Oil	914-381
Torpedo Handling (Fittings per Cradle)						
Cradle Roller (8)	109-118	P&S	1 Ea.	H	Oil	963-275
Flat Roller (2)	110&117	P&S	1 Ea.	H	Oil	963-275
Track Roller (4)	110&117	P&S	1 Ea.	*		963-275
Aft W.R.T. Tank Overflow Valve						
Bonnet	120½	S	2	F	Med. Gr.	524-275
Lever	121	S	1	H	Oil	524-275
Bearing	120½	S	1	H	Oil	524-275
Universal Joint (2)	120½	S	2 Ea.	H	Oil	524-275
Main Vent Valves						
M.B. #7						
Operating Gear	119	S	9	F	Med. Gr.	810-228
Hull Stuffing Box	119	S	1	F	Med. Gr.	810-228
Air Valves						
Compartment Air Valve	107	C/L	1	H	Oil	510-381
Salvage Air Valve	109½	S	1	F	Med. Gr.	415-381
Salvage Air Valve	114	S	1	F	Med. Gr.	415-381
Bulkhead Ventilation Valves						
Stuffing Box (2)	107	P&S	1 Ea.	*		1266-381
Bushing (6)	107	P&S	1 Ea.	*		1266-381
Steering Gear						
Greasing Station on Bulkhead	125	S	9	F	Med. Gr.	975-382
Bulkhead Stuffing Box (2)	125	P&S	1 Ea.	F	Med. Gr.	812-308
Cylinder Housing (2)	120	P&S	2 Ea.	F	Med. Gr.	812-308
Cylinder Housing (2)	123	P&S	2 Ea.	F	Med. Gr.	812-308
Plunger (2)	121	P&S	1 Ea.	F	Med. Gr.	812-308
Plunger (2)	121	P&S	1 Ea.	C	Med. Gr.	812-308
Rudder Angle Transmitter	121	P	1	F	Med. Gr.	867-381
Rudder Angle Transmitter	123½	P	2	F	Med. Gr.	867-381
Flexible Coupling	122½	P	1	F	Med. Gr.	909-381
Control Cylinder & Pump Control	123-124	P	7	F	Med. Gr.	856-381

F - Grease Fitting C - Grease Cup H - Oil Hole P - Fill Plug * - Self Lub.
S - Grease Stick

Section Z-1 PROVISION STORE ROOMS

NAME	DAYS	LBS.	CU.FT.	FRAMES	P&S	UNDER
Frozen Storage	60	4100	152	61½-64	P	Crew's Mess
Chilled Storage						
(1) Butter & Eggs	60)					
(2) Vegetables	30)	5300	180	61-64	S	Crew's Mess
Dry Provisions						
(1) Cases, Bags, Kegs	75	19,100	500	55½-57½	P&S	Radio Room
(2) Same				58-61S	S	

Two storerooms for the stowage of dry provision, one located in crew's mess room starboard and the other under radio room beneath platform deck, and a meat room and cool room for the stowage of meats and fresh provisions are provided under the crew's mess room beneath the platform deck.

STOWAGE, LIQUID, MISCELLANEOUS, List of:

NAME	CAPACITY	FR. NO.	SIDE	PURPOSE
E.F.W. E.F.W. E.F.W.	45 52 52	24 - 25 25 - 26 26 - 27	P P P	3 Tanks, FTR piped as a unit, filling funnel (#36 mesh strainer) at Fr. 25, C/L. Carries tethered cover. ½" filling valve of F.W. system over. Delivery valve and padlock at Fr. 32. Tank Test p.s.i. 3.
E.F.W. E.F.W.	80 76	111 - 112 112 - 113	S S	2 Tanks ATR - Connected for filling and delivery locally, as a unit. Filling Valve at Fr. 111, Delivery at Fr. 109.
Alcohol	45	25 - 26	S	Filled through portable funnel and lead through T/ loading hatch. Padlocked outlet at Fr. 32
Alcohol Spirits (Turp. for cleaning)	12.8	23 - 24	S	Filling funnel Fr. 23, Outlet Fr. 22
H.R.T. Oil Tank	45	29 - 30	S	Portable filling funnel with lead through torpedo loading hatch. Outlet Fr. 32
Tectyl	45	28 - 29	P	Fills through funnel & lead through T/loading hatch. Outlet Fr. 32
Hyd. Oil	135	26 - 30	S	Reserve Oil for Hyd. System for details see Section U-27
Oil Lub. H.P. Air Compressors	6.23 GALS.	50	C/L	Between Air Compressors in Pump Room Service Tank: filling conn. in top, 1" pipe plug & 3/8" I.P.S. Service Conn. Valve at bottom
Oil, light, Torpedo	13 GALS.	18 - 19	P	Tank with short ¾" filling pipe conn. air cock & ¾" Ser. Valve at bottom

STOWAGE, MISCELLANEOUS

NAME	Fr. No.	Side	Remarks
Emergency Rations	34-35	S	Over Officer's W.C. Glass Dr. Over Torp.
	117-18	P	Stowage Glass Dr. in same Group as Crew's Lkrs.
S/M Lungs	23-31	P&S	Between Frs. Overhead, supported by trays,
	109-116		Slats & Hydraulic Piping
Bread	59-60	S	Crew's Mess Room; Locker just above flat
Electrical Spares	22-23	S	Under Crew's Lockers, between
	24-25	S)	Frames
	99 BHD.	P&S	Lockers between Bhd.-Stiff'rs
	13½		Maneuvering Room
	Ford.Fr.		
	99		
F.C. Spares	51½	P	Binoculars in Racks on Conning Tower Shell.
	51-52	S	Chart Table Upper Drawer in Conning Tower
General Stowage	22-24	P	Between Frs. Under Crew's Lkrs.
	32-33	P	Over Toilet Gear Locker
	34-35	P	On Flat (Outboard of
	109-116	S	Under Crew's Lkrs. (Torp. Stowage
	109-115	P	" " " "
	107-110	P	F.W.C. in Aft. Torp. Com't.
Medical	66	P	Special Locker & Drawers (in Crew's Qtrs.)
	69-70	P	Locker over Pea Coat Locker
Paint	22-25	P	Stowage Space, Below Flat, Expanded
	22-24	S	Metal Sides for Paint, Rope & Misc.
	107-110	S	Stowage - in Strm. Mis. Stwg.
Signal Outfit	50-52	P	Blinker Gun & Pistols in Racks on Conning
			Tower Shell
	50	S	Small Lockers on Bhd. in Conning Tower
	54	S	Fwd. of Ord. Locker in Control Rm.
Clothes	69-70	P&S	Pea Coat Lockers, in Crews Qtrs.
	56-58	S	Wet Clothes locker - C/R
Chronometer	40-41	P	Wardroom, Under Chart Table
Gyro Compass Spares	23-24	P	Cork Lined with Light Over Torp. Stowage
	107-109	S	Cork Lined with Light in Top of Storeroom
Torpedo Igniters	30-31	P&S	In special moisture-proof lkr.
	109-110	P&S	" " " " "

BATTERY CELL HANDLING GEAR

The tracks, trolley, crane, cell lifting pads and chain hoists are identical for SS191, 192, 193, 196, 197, 201, 202, 203, 209, 210, 211, 212 to 434. One complete unit of this equipment includes the track, weight pieces marked A, B, C, D, E, F, the crane, weight piece marked G, the trucks, pieces A, B, A3, B3, C3, D3, E3, F3, G3, H3, all on Bureau of Ships Plan 386061, the chain hoist, piece L3, on Bureau of Ships Plan 386061, and the cell lifting device shown on Electric Storage Battery Co. Plan DD-28292. This, with the requisite bolts, brackets and jacking lever, is the equipment necessary for installing the battery in one compartment and is interchangeable between the forward and after compartments.

None of this equipment, with the exception of cell lifting device, is carried on board the submarine but there is one complete set at each of the following locations:

SM Tender - AS-11
do. - AS-12
do. - AS-15
do. - AS-16
do. - AS-17
do. - AS-18
do. - AS-19

Navy Yard, Portsmouth, N.H.
Navy Yard, Mare Island
Submarine Base, New London
Submarine Base, Pearl Harbor

Reference Plans:

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210-228	386061	Battery Cell - Handling Gear - Forward and Aft

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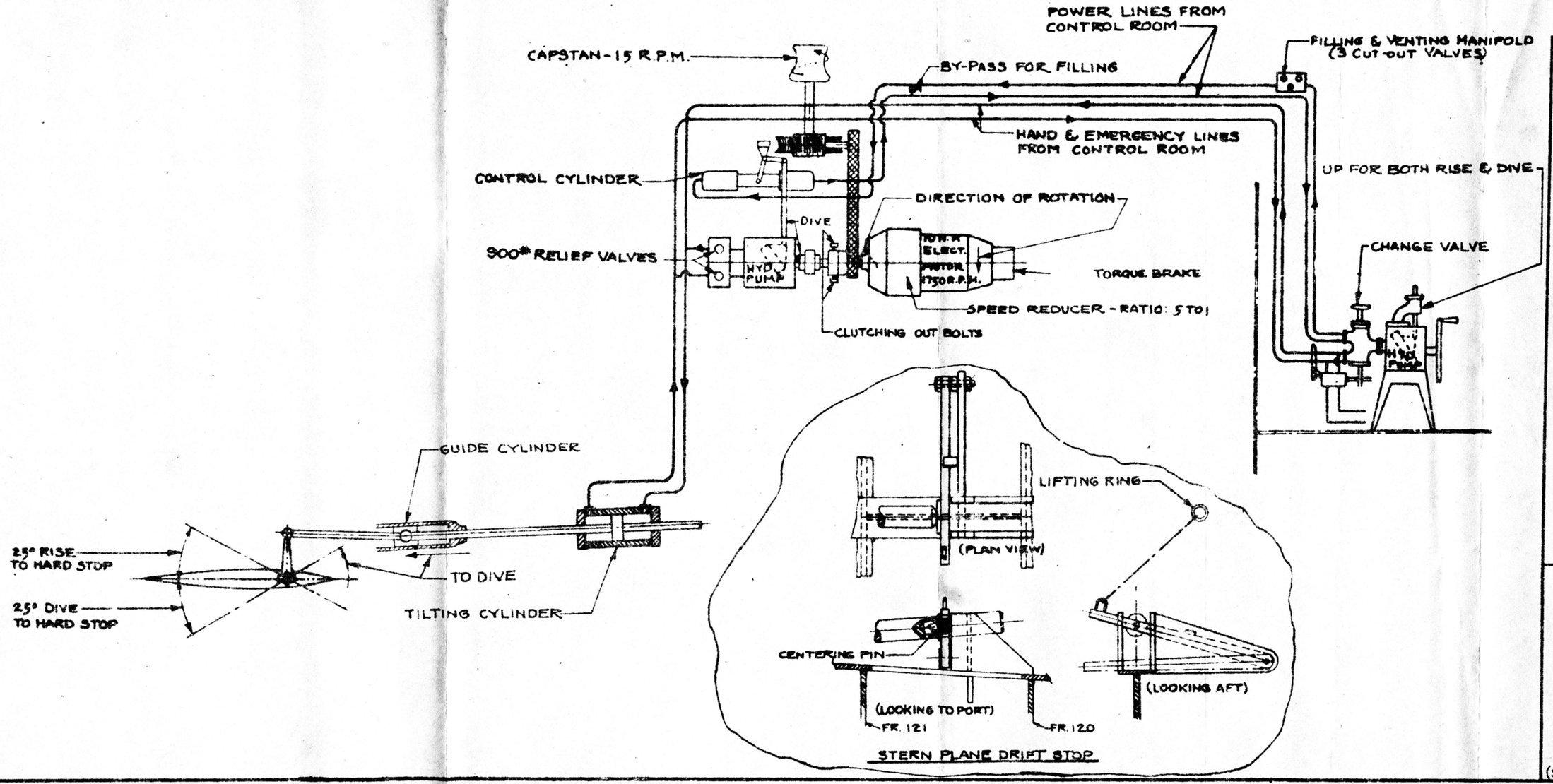

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
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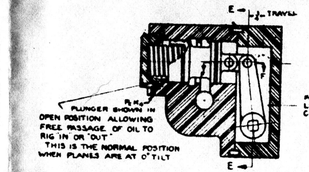
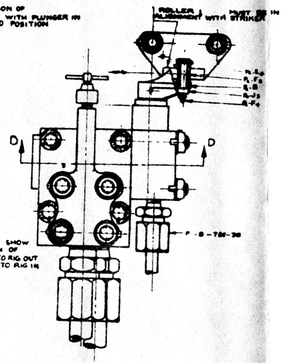
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

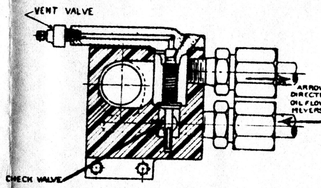
AFTER CAPSTAN & STERN PLANE GEAR DIAGRAM

(SECT. U-26) PLATE I



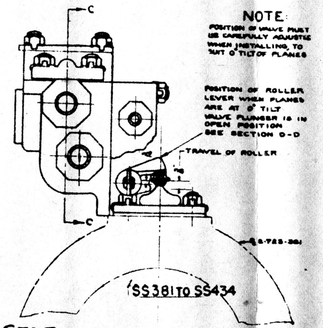
SECTION D-D





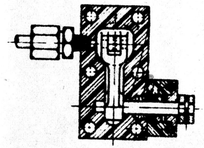
SECTION C-C

WHEN PLANES ARE AT 0° TILT.
VALVE PLUNGER CLOSES
AND CHECK VALVE FUNCTIONS AS FOLLOWS -
1. WHEN RIGGING PLANES OUT CHECK VALVE SEALS, ALLOWING OIL TO BY PASS PLUNGER
2. CHECK VALVE PREVENTS RIGGING IN BY REMAINING CLOSED AGAINST OIL FLOW



NOTE.
POSITION OF VALVE MUST BE CAREFULLY ADJUSTED WHEN INSTALLING, TO SUIT 0° TILT OF PLANES

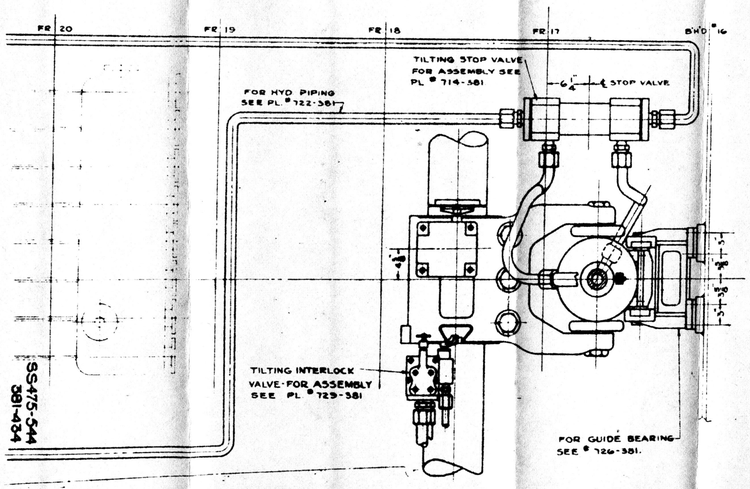
POSITION OF ROLLER LEVER WHEN PLANES ARE AT 0° TILT
VALVE PLUNGER IS IN OPEN POSITION
SEE SECTION D-D



SECTION E-E

BOW DIVING GEAR
TILTING INTERLOCK VALVE

PC NO.	POS	NAME	MATL
A	2	STOP FOR B_3 & C_3	BRONZE
B	2	BUSHING FOR A_3	CR. & STEEL
A_3	1	VALVE BODY	CR. & STEEL
D_3	1	PISTON FOR B	CR. & STEEL
C_3	1	PISTON FOR B	CR. & STEEL
E_3	2	COVER FOR A_3	CR. & STEEL
F_3	4	STUD FOR A_3: 0.25 N.F.	STEEL
G	16	⅛ LOCKING PCS FOR F_3 & J_3	STEEL
H_3	2	SHIM 1½ × 4⅛ × 1/16	CR. & STEEL
J_3	12	STUD FOR A_3 & E_3	CR. & STEEL
K_3	2	VENT VALVE FOR A_3	
L_3	2	GASKET 3 11/16 × 3 9/16 × 1/32 THK	COPPER ASBESTOS
M_3	1	SPRING	STEEL
N_3	1	BRACKET FOR A_3	CR. & STEEL
O_3	1	BRACKET FOR A_3	CR. & STEEL
P_3	2	RETAINER FOR B	CR. & STEEL



BOW DIVING GEAR

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
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SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

DIVING GEAR, BOW & STERN

(SECT. U-26)

(SHEET 1 OF 3) PLATE 2

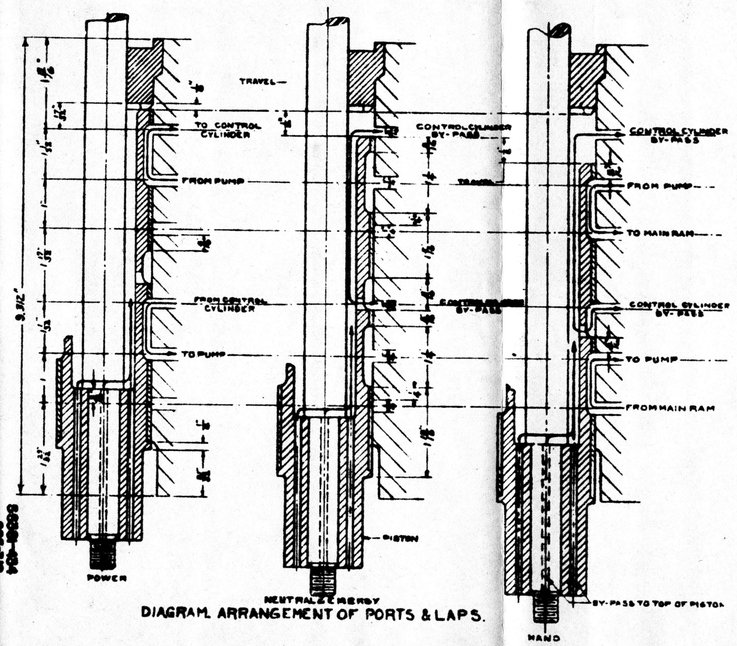


DIAGRAM. ARRANGEMENT OF PORTS & LAPS.

Bow & Stern Diving Gear - Hydraulic Change Valve

SECTION

THE PISTON IS SHOWN IN NEUTRAL.

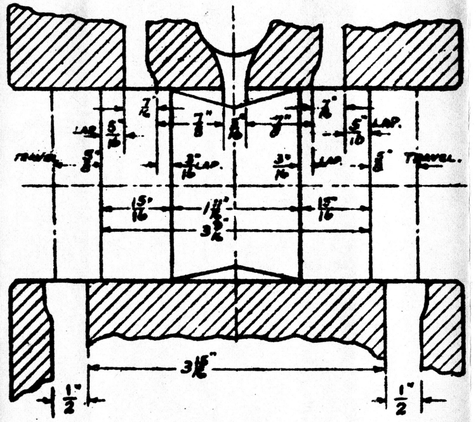
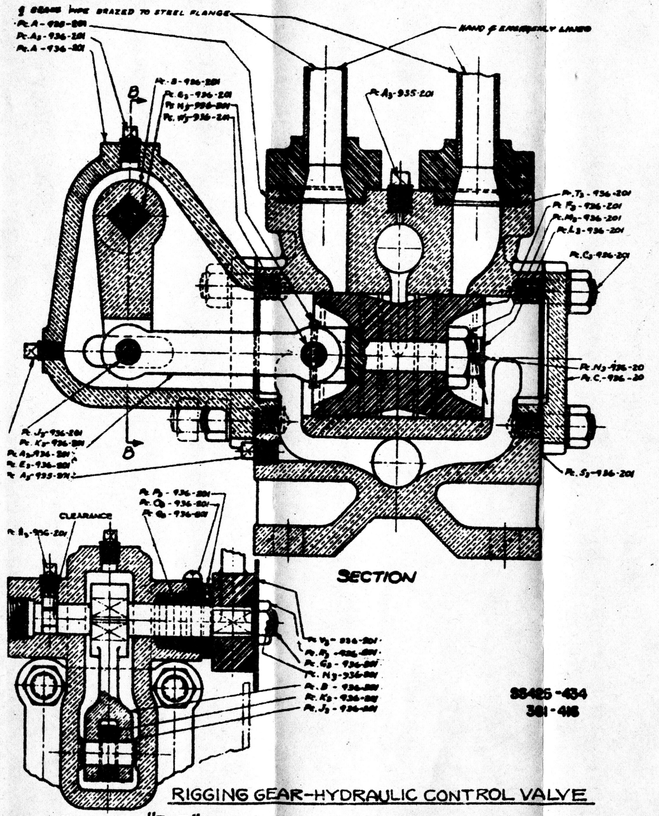


DIAGRAM. SECTION SHOWING PORTS & LAPS.

SS425-434
381-416



SECTION

SECTION "B-B"

SS425-434
381-416

RIGGING GEAR-HYDRAULIC CONTROL VALVE

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
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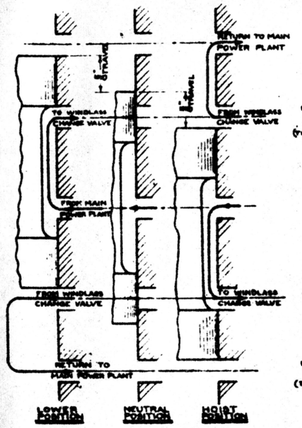
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

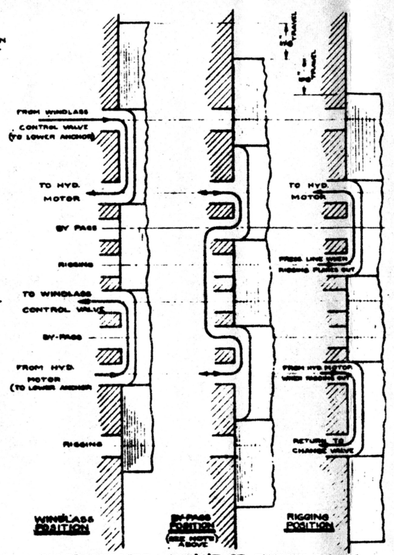
DIVING GEAR, BOW & STERN

(SECT. U-26)

(SHEET 2 OF 3) PLATE 2



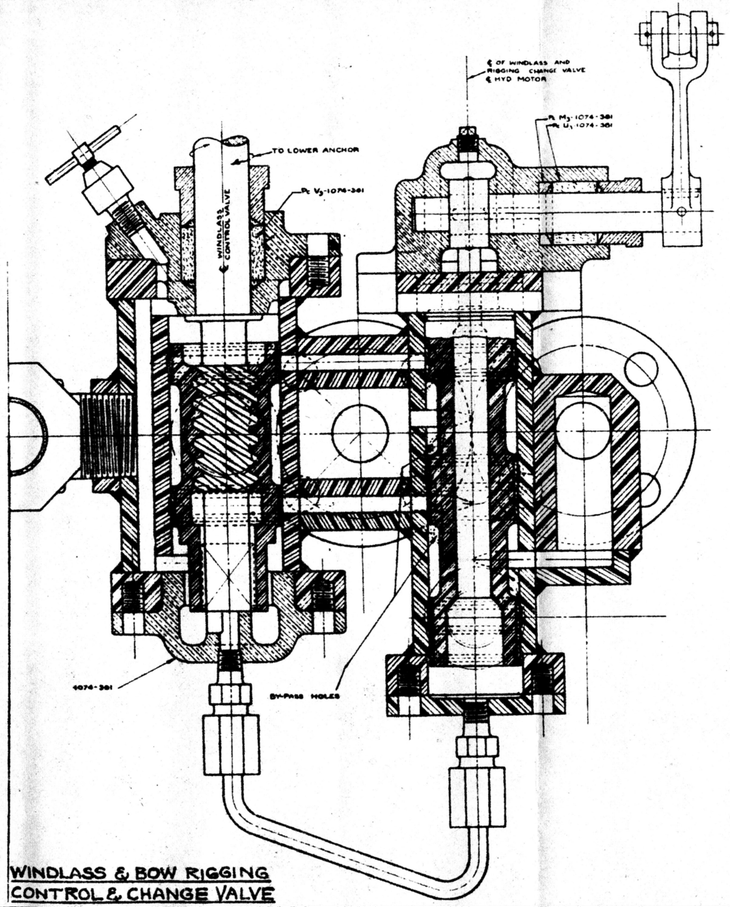
DIAGRAMMATIC ARR'G'T OF WINDLASS CONTROL VALVE



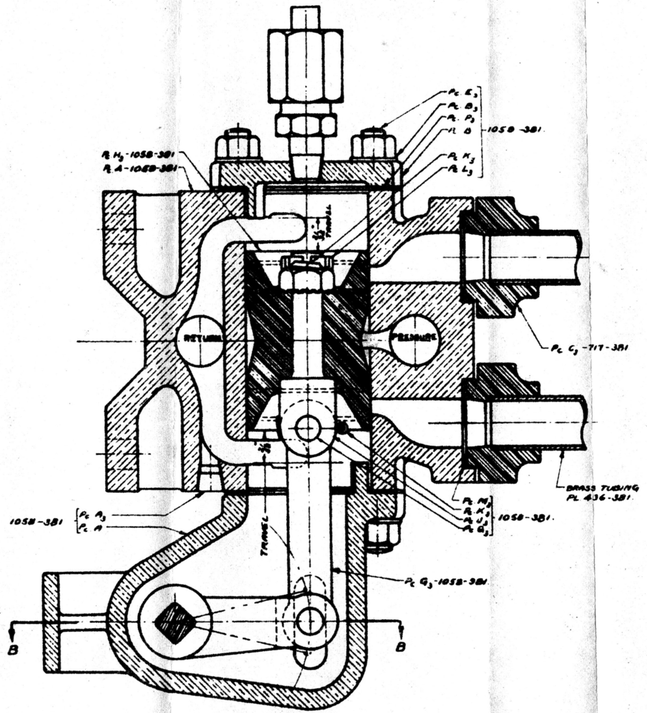
DIAGRAMMATIC ARR'G'T OF CHANGE VALVE

NOTE:-

BY PASS POSITION OF CHANGE VALVE USED WHEN SELECTIVE CLUTCH FOR WINDLASS AND BOW RIGGING IS IN NEUTRAL POSITION. ROTATE HYD. MOTOR SHAFT TO BY-PASS HYD. MOTOR BY HANDWHEEL ON COUPLING TO ALLOW ENGAGING OF SELECTIVE CLUTCH.



WINDLASS & BOW RIGGING CONTROL & CHANGE VALVE



BOW DIVING GEAR
RIGGING GEAR-HYDRAULIC CONTROL VALVE

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
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SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

DIVING GEAR, BOW & STERN

BOW DIVING GEAR
DATA FOR RIGGING AND TILTING.

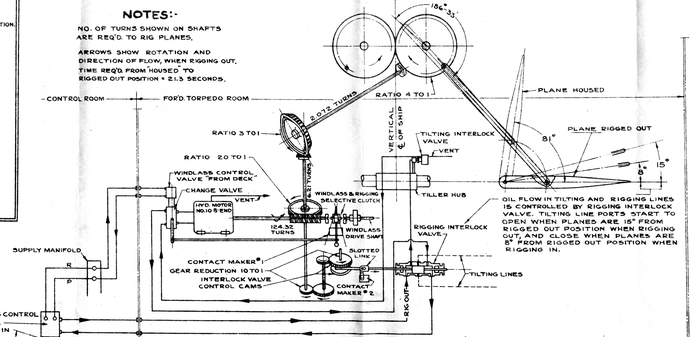
1. WHEN TILTING BY "EMERGENCY" CONTROL FROM MAIN MANIFOLD, "CHANGE VALVE" MUST BE IN "EMERGENCY" POSITION.
2. INTERLOCK "C" PREVENTS OPERATION OF CONTROL VALVE "D" WHEN CHANGE VALVE IS IN "HAND OR POWER" POSITION
3. INTERLOCK SWITCH "B" ALLOWS OPERATION OF TILTING GEAR BY POWER, ONLY WHEN CHANGE VALVE IS IN POWER POSITION.
4. "CONTACT MAKER #1" OPERATES INDICATOR LIGHT AT DIVING STATION IN CONTROL ROOM, SHOWING POSITION OF THE CLUTCH FOR "WINDLASS OR RIGGING."
5. CONTACT MAKER #2 OPERATES INDICATOR LIGHT AT DIVING STATION IN CONTROL ROOM SHOWING WHETHER PLANES ARE FULLY "RIGGED IN" OR "RIGGED OUT."
6. CONTROL OF HYDRAULIC MOTOR IS TRANSFERRED TO "RIGGING" FROM "WINDLASS" BY MEANS OF THE CHANGE VALVE WHICH IS OPERATED BY THE "WINDLASS & RIGGING" SELECTIVE CLUTCH.
7. BOW PLANE TILTING AND RIGGING GEARS ARE SO INTERLOCKED, THAT BOW PLANES CAN BE RIGGED "IN" ONLY WHEN THEY ARE AT 0° TILT AND BE TILTED ONLY WHEN RIGGED "OUT" FOR DIVING.
8. RIGGING INTERLOCK VALVE PREVENTS TILTING OF PLANES UNLESS THEY ARE RIGGED OUT." IT ALSO CUTS OUT HYDRAULIC RIGGING MOTOR AT "RIGGED IN" AND "RIGGED OUT" POSITIONS.
9. TILTING INTERLOCK VALVE PREVENTS RIGGING PLANES "IN" UNLESS THEY ARE AT 0° TILT."
10. HARD STOPS IN CYLINDER, LIMIT TILT OF PLANE TO 25° RISE AND 25° DIVE. RELIEF VALVE PREVENTS DAMAGE TO GEAR WHEN CYLINDER COMES AGAINST HARD STOP.
11. SELECTIVE CLUTCH FOR "WINDLASS AND RIGGING" IS CONTROLLED FROM FOR'D TORPEDO ROOM ONLY.
12. TILTING STOP VALVE TRAPS OIL IN TILTING CYLINDER, WHEN TILTING CONTROL IS AT NEUTRAL AND PROTECTS PIPE LINES FROM EXCESSIVE BACK PRESS CAUSED BY SEA SLAP ON PLANES.

NOTES:-

NO. OF TURNS SHOWN ON SHAFTS ARE REQ'D TO RIG PLANES.

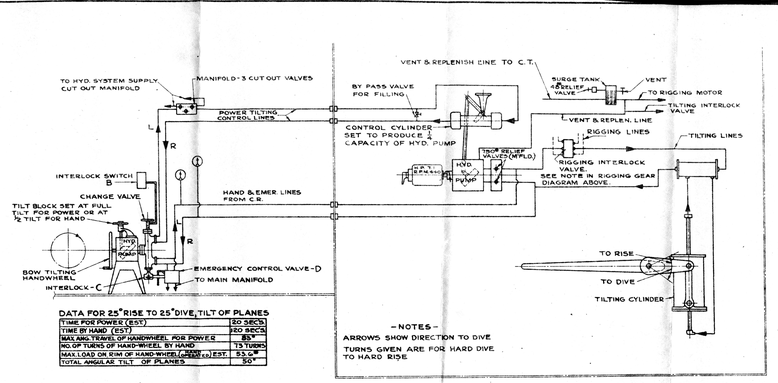
ARROWS SHOW ROTATION AND DIRECTION OF FLOW, WHEN RIGGING OUT.

TIME REQ'D FROM HOUSED TO RIGGED OUT POSITION = 21.5 SECONDS.



OIL FLOW IN TILTING AND RIGGING LINES IS CONTROLLED BY RIGGING INTERLOCK VALVE. TILTING LINE PORTS START TO OPEN WHEN PLANES ARE 15° FROM RIGGED OUT POSITION WHEN RIGGING OUT, AND CLOSE WHEN PLANES ARE 8° FROM RIGGED OUT POSITION WHEN RIGGING IN.

BOW PLANE RIGGING GEAR AND PIPING DIAGRAM



DATA FOR 25° RISE TO 25° DIVE, TILT OF PLANES

TIME FOR POWER (EST)	20 SECS.
TIME BY HAND (EST)	220 SECS.
MAX. ARC TRAVEL OF HANDWHEEL FOR POWER	83°
NO. OF TURNS OF HAND-WHEEL BY HAND	1.75 TURNS
MAX. LOAD ON RIM OF HAND-WHEEL (MAN POWER)	EST. 53.0#
TOTAL ANGULAR TILT OF PLANES	50°

-NOTES-

ARROWS SHOW DIRECTION TO DIVE

TURNS GIVEN ARE FOR HARD DIVE TO HARD RISE

BOW PLANE TILTING GEAR AND PIPING DIAGRAM

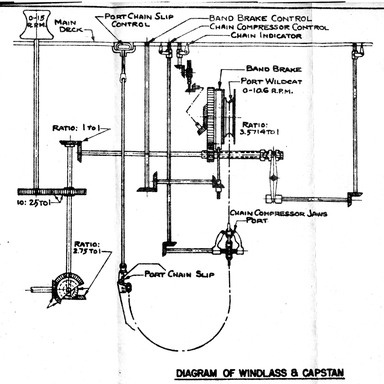


DIAGRAM OF WINDLASS & CAPSTAN

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
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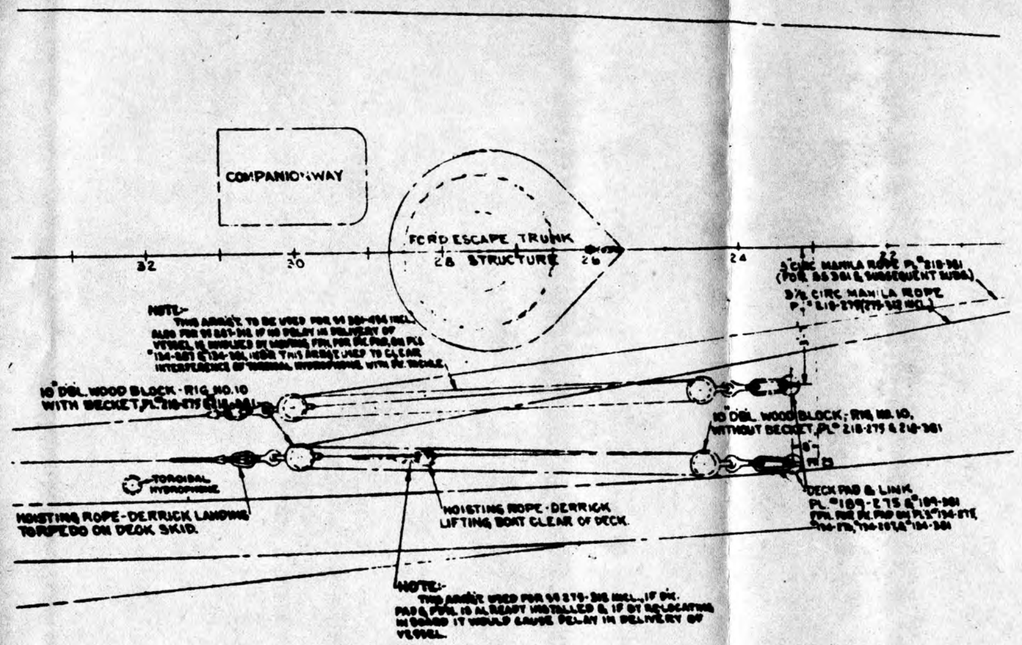
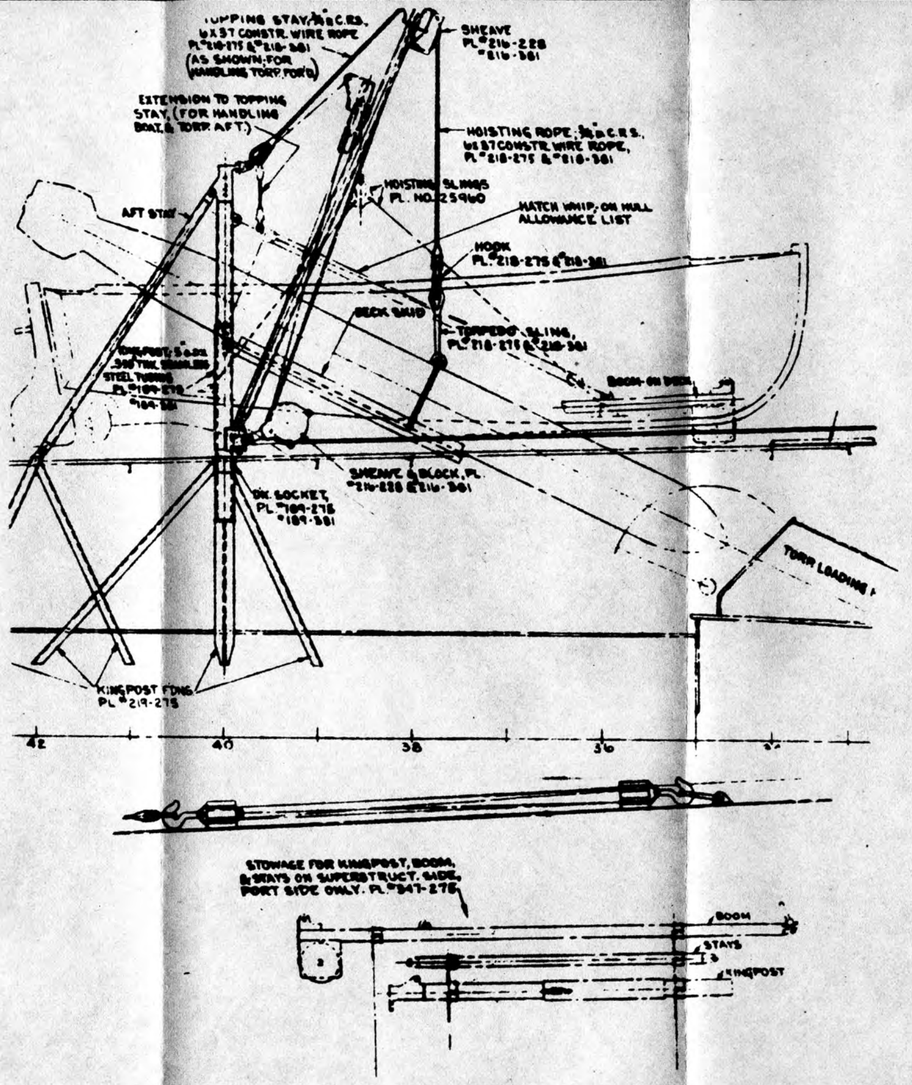
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

WINDLASS, CAPSTAN & BOW DIVING PLANE GEAR DIAGRAM

(REF. PL. 713-381) (SHEET 1 OF 6) PLATE 3.





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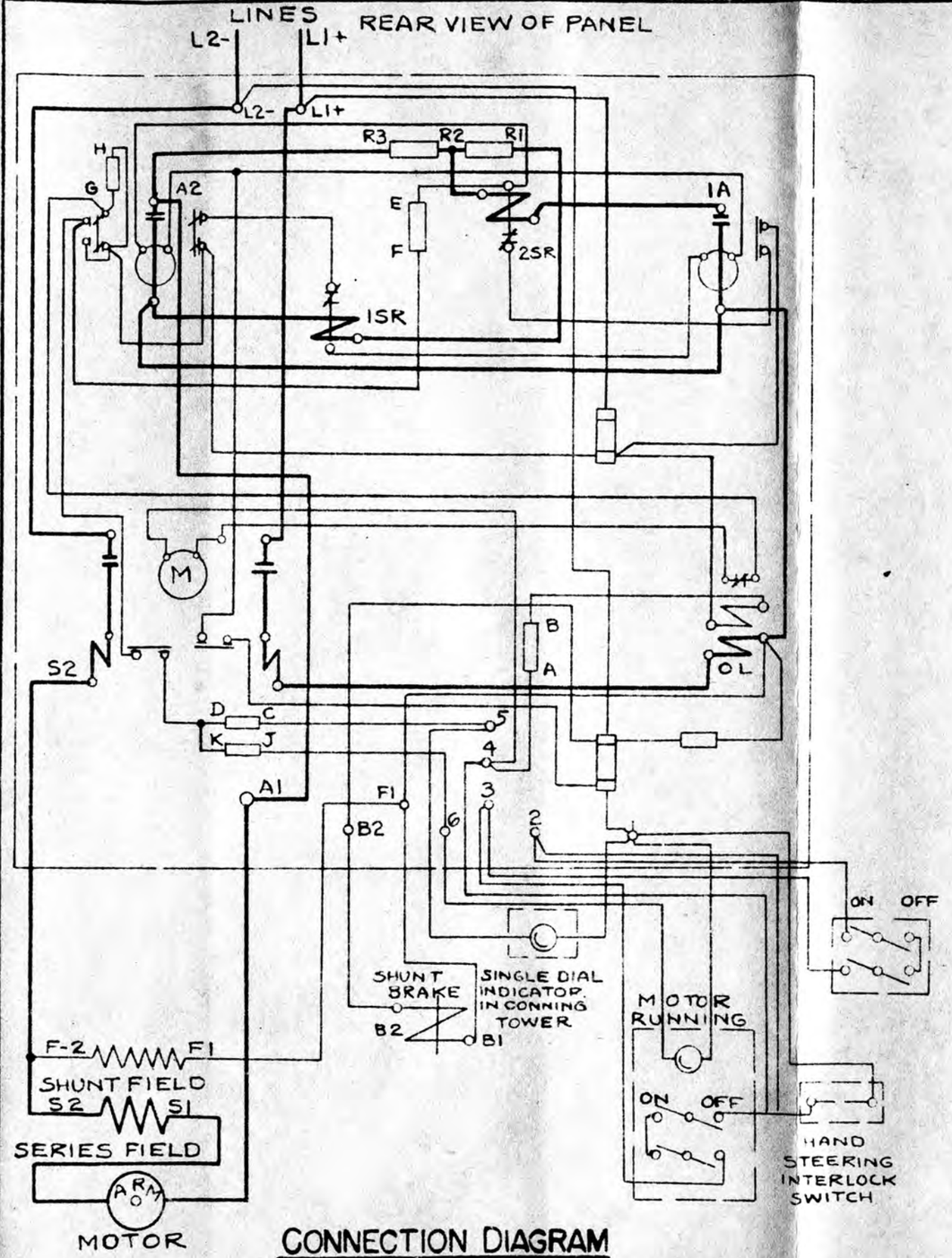
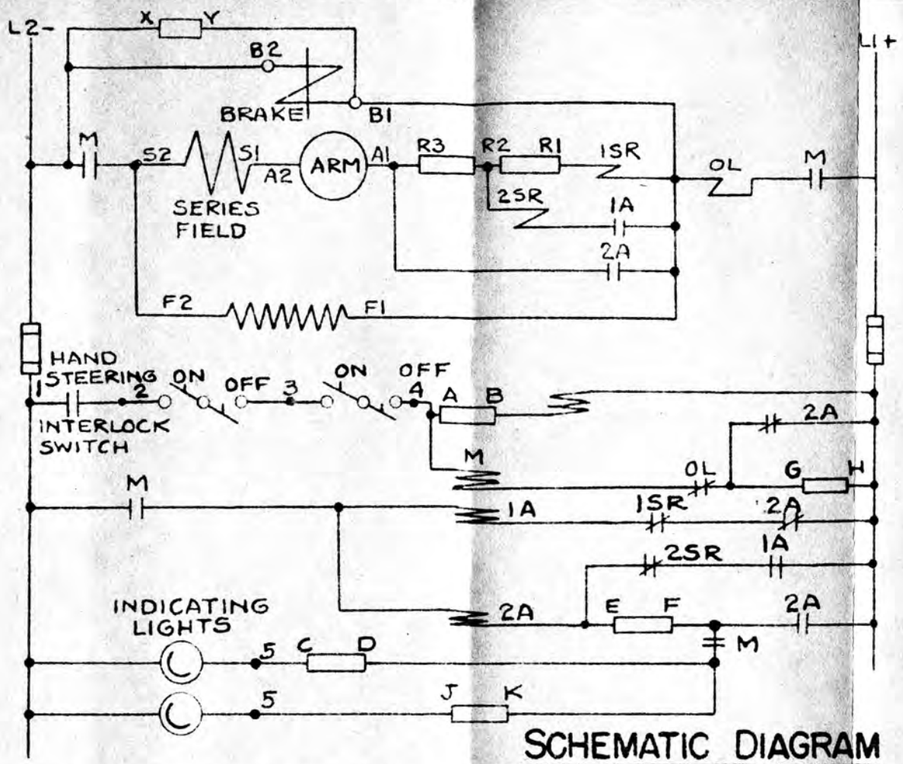
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

BOAT & TORPEDO DERRICK

(REF. 187-275) (SECT. P-2) PLATE 4



CONNECTION DIAGRAM



SCHEMATIC DIAGRAM

DESCRIPTION OF OPERATION

TO START, PRESS THE "ON" BUTTON OF THE PUSHBUTTON MASTER, THIS ENERGIZES THE COIL OF THE MAIN CONTACTOR (M) WHICH CLOSES & CONNECTS THE MOTOR TO THE LINE THROUGH TWO STEPS OF STARTING RESISTOR. THE MAGNETIC BRAKE IS ALSO ENERGIZED & RELEASES AT THIS TIME. ACCELERATION IS CONTROLLED BY THE ACTION OF SERIES RELAYS. WHEN THE INRUSH CURRENT DECREASES TO 62 AMPERES THE CONTACTS OF THE FIRST SERIES RELAY (1SR) CLOSE & ENERGIZE THE COIL OF THE FIRST ACCELERATING CONTACTOR (1A). THIS CONTACTOR CLOSES & SHORTS OUT RESISTOR STEP R1-R2. WHEN SECOND INRUSH DECREASES TO 62 AMPS. THE CONTACTS OF THE LAST SERIES RELAY (2SR) CLOSE. THE LAST ACCELERATING CONTACTOR (2A) THEN CLOSES & SHORTS OUT RESISTOR STEP R2-R3 & PLACES MOTOR ACROSS THE LINE.

TO STOP MOTOR, PRESS THE "OFF" PUSHBUTTON. THIS DEENERGIZES BRAKE WHICH APPLIES. LOW VOLTAGE RELEASE IS PROVIDED &, IN EVENT OF VOLTAGE FAILURE, EQUIPMENT WILL RESTART WHEN VOLTAGE HAS BEEN RESTORED TO LINE. OPERATION OF CONTROLLER IS SUBJECT AT ALL TIMES TO OPERATION OF OVERLOAD RELAY (OL) WHICH OPENS CIRCUIT TO MAIN CONTACTOR (M) ON EXCESSIVE OVERLOADS. AFTER OVERLOAD RELAY HAS TRIPPED IT IS NECESSARY TO PRESS THE "OFF" PUSHBUTTON TO RESET OVERLOAD RELAY, & RESTART MOTOR BY PRESSING THE "ON" PUSHBUTTON. AN AUXILIARY CONTACT ON MAIN CONTACTOR PROVIDES A CIRCUIT TO INDICATING LIGHT IN MASTER SWITCH FOR INDICATION TO OPERATOR THAT MOTOR IS RUNNING.

A MAGNETIC BRAKE (NOT SUPPLIED BY C-H) IS CONNECTED IN THE MOTOR CIRCUIT TO RELEASE SIMELTANEOUSLY WITH STARTING OF MOTOR.

BU. SHIPS NO
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
SS 390 - S 0107 - 68299
SS 391 - S 0107 - 68319
SS 392 - S 0107 - 68339
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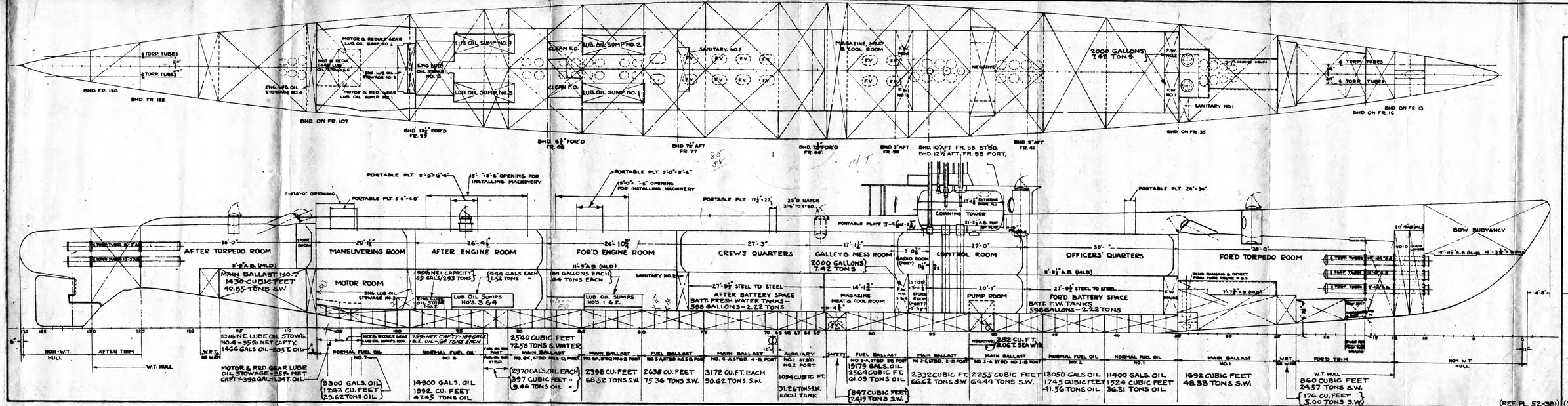
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

STEERING GEAR WIRING DIAG.



BU SHIPS NO.
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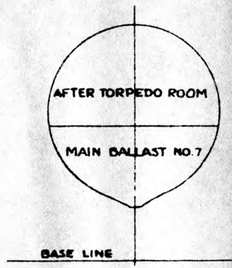
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

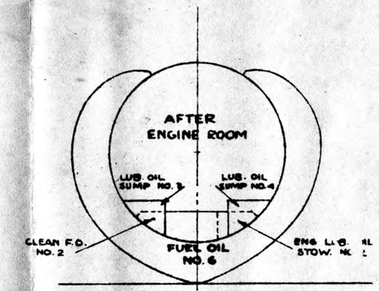
COMPARTMENTS & TANKS
PART I

(REF. PL. 52-381) (SECT. A-1)

PLATE 6(A)



SECTION AT FR. 113
LOOKING AFT.



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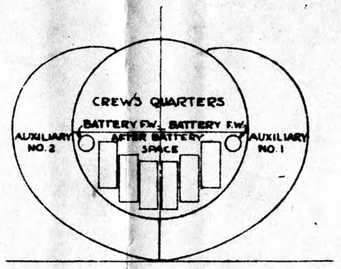

SECTION AT FR. 67
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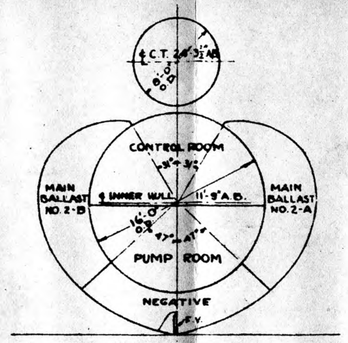

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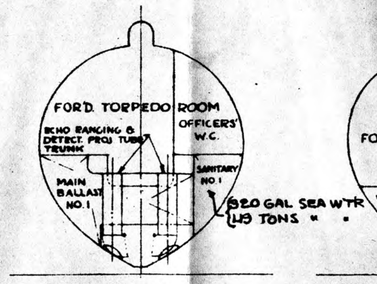

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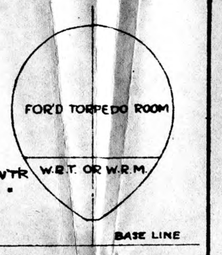

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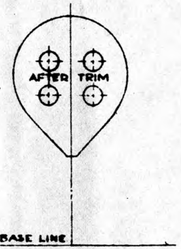

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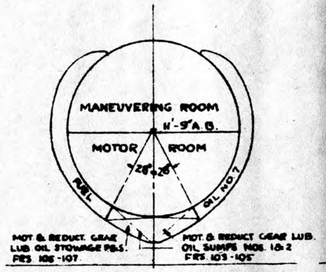

SECTION AT FR. 105
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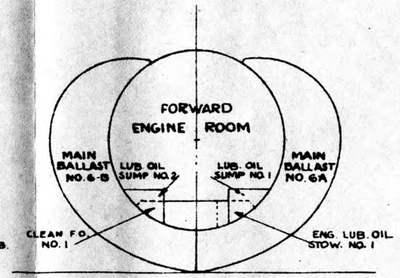

SECTION AT FR. 81
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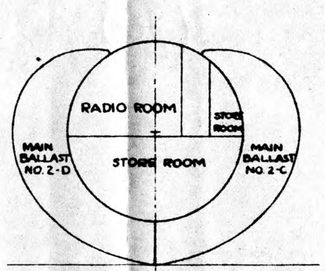

SECTION AT FR. 56½
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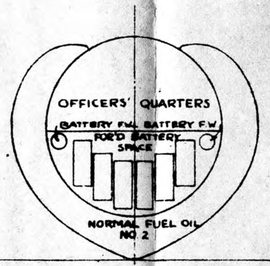

SECTION AT FR. 43
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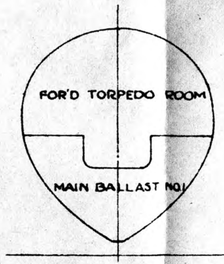

SECTION AT FR. 30
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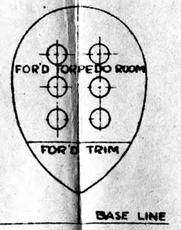

SECTION AT FR. 19
LOOKING FOR'D

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
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SS 384 - S 0107 - 68179
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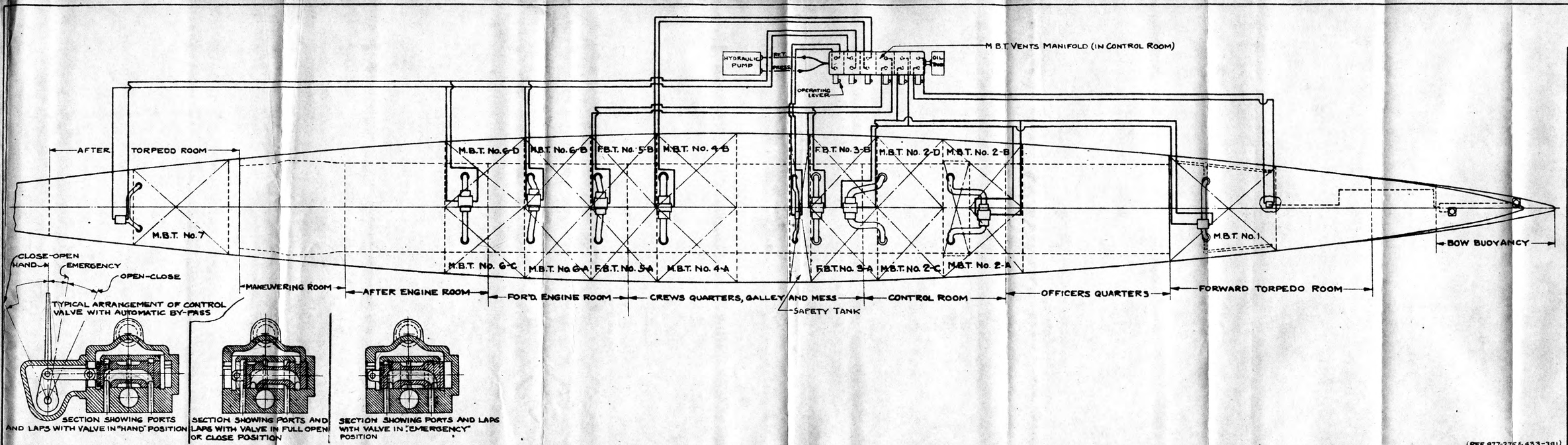
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

COMPARTMENTS & TANKS
PART 2

(REF. PL. 52-381) (SECT. A-1)

PLATE 6(B)



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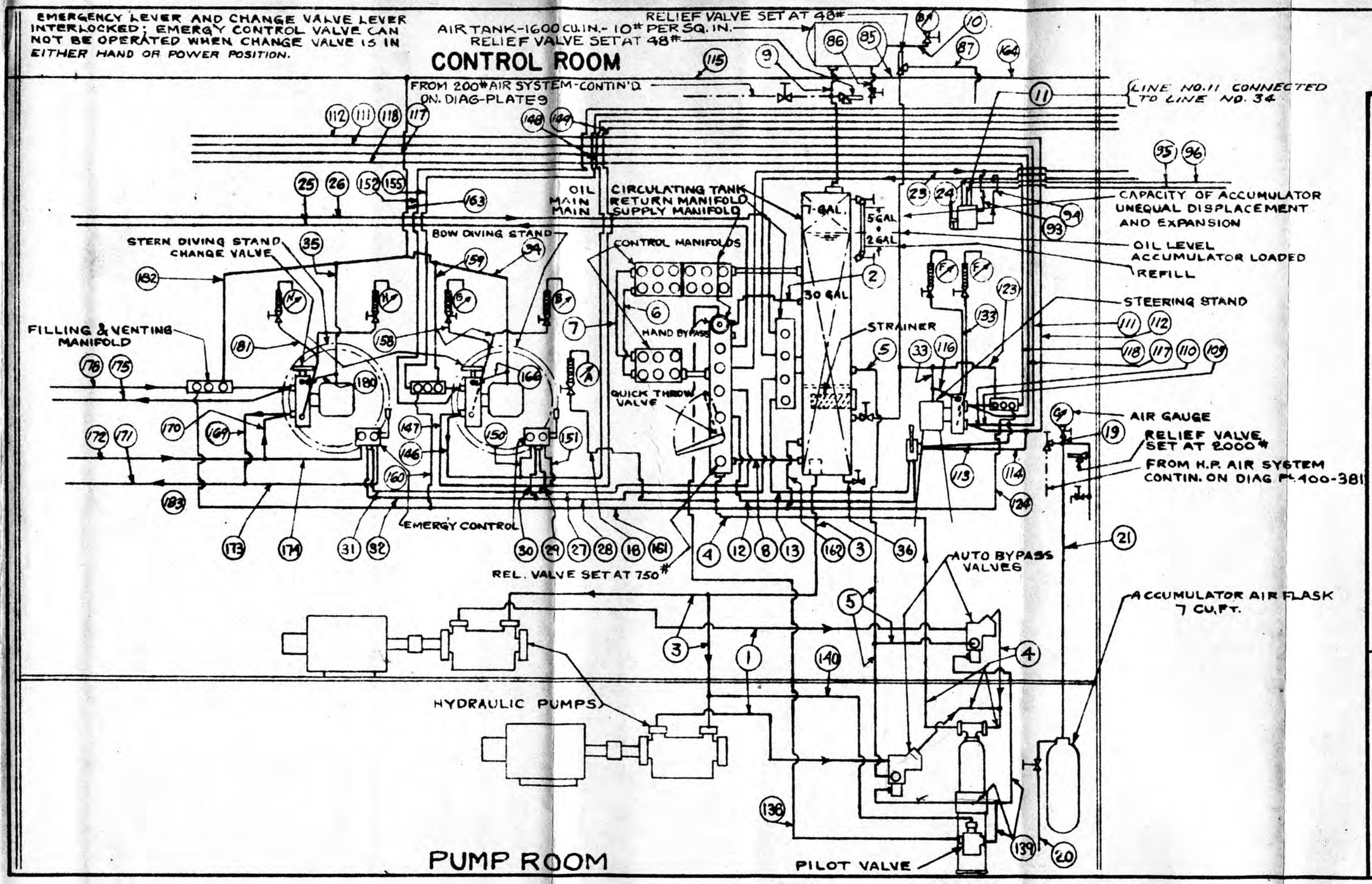
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

HYDRAULIC SYSTEM M. B. T. VENTS DIAGRAM

(REF 977-275 & 433-381) (SECT. U-27) PLATE 7



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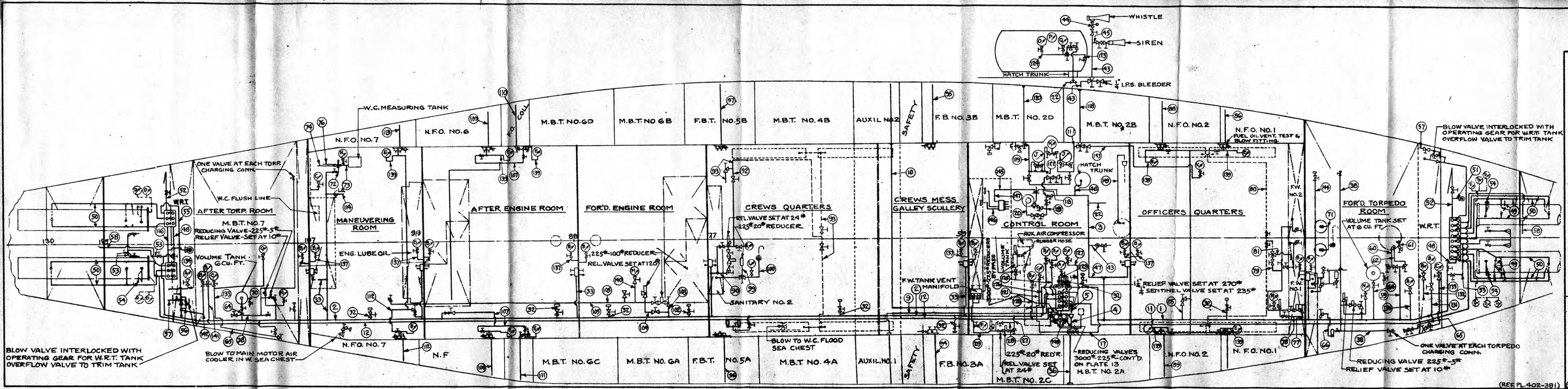
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

HYDRAULIC SYSTEM
POWER PLANT DIAGRAM



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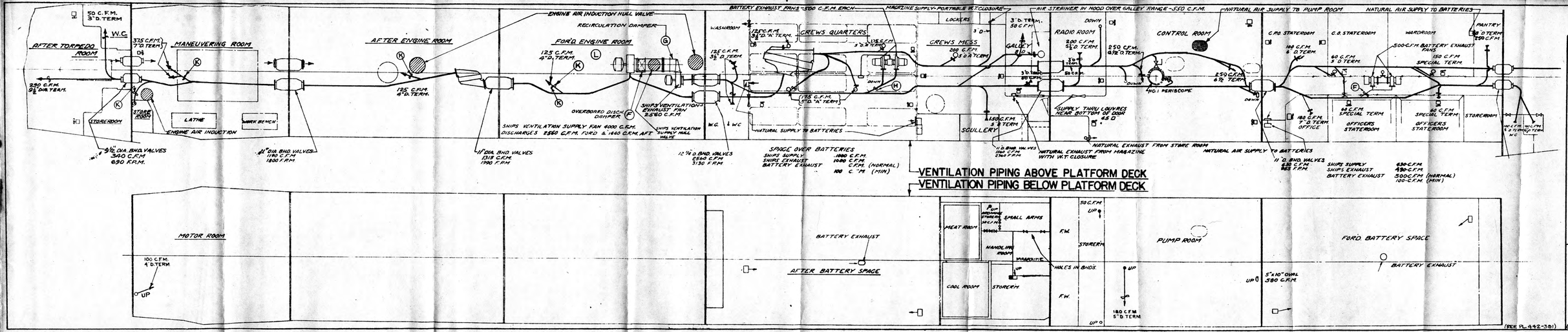
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

225# AIR SYSTEM DIAGRAM

(REF. PL. 402-381) SECT. U-19-W

PLATE 9



BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
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SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

SHIPS VENTILATION SYSTEM INTERNAL DIAGRAM

(REF. PL. 442-381) (SECT. U-19-C) PLATE 10(A)

VALVE & DAMPER OPERATION

CONDITION OF VESSEL	RECIRCULATE	A	D	E	F	G	J	K	(H) DAMPER	VENT SETS SUPPLY	VENT SETS EXHAUST
SURFACE-ENGINES-STOPPED	NONE	O	O	O	C	O	C	O	M	R	R
" " "	ALL	O	O	C	P	C	O	O	X	R	R
" ENGINES STOPPED BATTERIES CHARGING	1/3	O	O	C	O	C	O	O	O	R	R
" ENGINES STOPPED BATTERIES CHARGING											
SURFACE-ENGINES RUNNING	NONE	O	O	O	C	O	C	C	X	R	R
	2560 C.F.M.	O	O	O	C	C	O	C	X		
SUBMERGED	ALL	C	C	C	C	C	O	O	C	R	R

RECIRCULATE
1. COLD WEATHER TO REDUCE HEATING LOAD
2. WARM WEATHER TO REDUCE COOLING LOAD

C = CLOSED O = OPEN X = EITHER P = PART OPEN
PP = CLOSED AS MUCH STOP PERMITS

M = MAY BE EITHER, EXCEPT HATCH IN AFT. ENGINE ROOM WHICH SHOULD BE OPEN

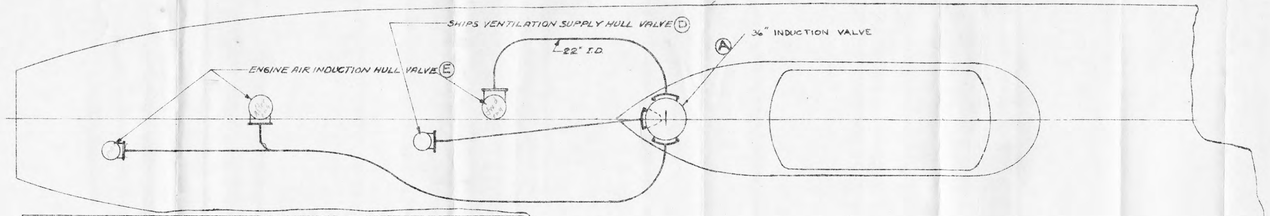
(H) THIS DAMPER IS FITTED TO THROTTLE BATTERY VENTILATION. IN FULL CLOSED POSITION AIR WILL STILL PASS DAMPER

FAN DATA

NO.	SYSTEM	TYPE	CAP. C.F.M.	STATIC PRESSURE	LOCATION	REMARKS
1	SHIP	SUPPLY	4000	3	FOOD ENG. RM	
2	"	EXHAUST	2560	3	" "	
3	BATTERY	"	375 300	6" 2.66"	OFFICERS QTRS	
4	"	"	375 500	6" 2.66"	" "	
5	"	"	375 500	6" 2.66"	CREWS QTRS	
6	"	"	375 500	6" 2.66"	" "	

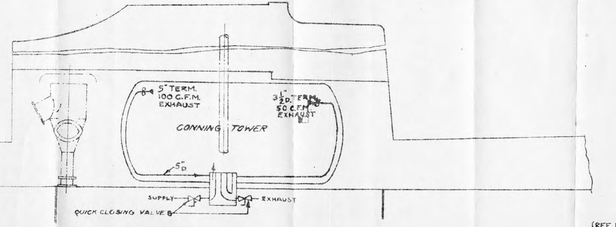
COMPARTMENT VENTILATION

	MECHANICAL VENTILATION SUPPLY	MECHANICAL VENTILATION EXHAUST	NATURAL VENTILATION SUPPLY	NATURAL VENTILATION EXHAUST	NET VOL. CU. FT.	AIR CHANGE MINUTES	BRACKETS FANS
FORD TORPEDO ROOM	200			200	5036	25	4
OFFICERS W.C		100	100		72	.72	
OFFICERS SHOWER		100	100		60	.60	
OFFICERS PANTRY		250	300	50	92	.31	
WARDROOM	150			150	295	2	1
WARDROOM STATE ROOM	60			60	170	2.8	1
WARDROOM STATE ROOM	60			60	170	2.8	1
CAPTAINS STATE ROOM	60			60	170	2.8	1
SHIPS OFFICE		180	180		63	.35	1
C.P.O QUARTERS	100			100	178	1.7	2
CONNING TOWER	150	150			483	3.25	2
CONTROL ROOM	500			500	1917	3.5	4
RADIO ROOM	50	200	150		456	2.26	1
PUMP ROOM	180	580	400		1620	2.82	
DRY STORES	50			50	298	6	
GALLEY	50	600	550		182	.30	1
CREWS MESS ROOM	200		450	650	1155	1.84	2
SCULLERY		150	150		103	.69	
MAGAZINE	50			50	332	6.6	
CREWS QUARTERS	100			750	1820	2.74	4
CREWS W.C		125	125		181	1.45	
CREWS WASHROOM		125	125		278	2.22	
FORD MACHY COMPT	125			125	4380	35	
AFTER MACHY COMPT	125			125	4480	36	
MANEUVERING ROOM	750			750	1672	2.2	2
CREWS W.C	50			50	70	1.4	
MOTOR ROOM	100			100	1672	16.7	
AFTER TORPEDO ROOM	290			290	4350	14.0	4
CREWS W.C	50			50	300	6	
TOTAL	4000	2560					31



MATERIAL SCHEDULE

SYMBOL	DESCRIPTION	SIZE	THICK	MATERIAL	SPEC	PLAN NO	TEST PRESSURE	REMARKS
	SUPPLY TERMINAL			BRASS	4783 g			
	EXHAUST TERMINAL			BRASS	4782 g			
	AIR TIGHT DAMPER			CU. SI	4674 g			
	DIFFUSING TERMINAL TYPE A			BLACK STEEL	4731 d			
	VENTILATION MAINS SECTION		061	BLACK STEEL	4731 d			
	CONNECTED TO END VALVE FOR 1.5" DIAMETER							
	ALL OTHER DUCT WORK OVER 9" D		089	BLACK STEEL	4731 d			
	ALL OTHER DUCT WORK UNDER 9" D		031	BLACK STEEL	4731 d			
	BATTERY VENTILN. EXHAUST	1 1/2	049	BLACK STEEL	4731 d			
	BATTERY VENTILN. INTAKES	1 1/2	064	AL. ALLOY				
	SHIPS VENTILN. SUPPLY OUTBOARD	8 x 10		STEEL	4855		300 "	
	MAIN ENGINE AIR INTAKE	22 I.D		STEEL	4855		300 "	
	FLANGES OUTBOARD			3/8" CLR	4855			
	FLANGES INBOARD	1 1/2		STEEL	4851			
	BOLTS & NUTS			STEEL 3/4"	4381			
	GASKETS	1/16		RUBBER				



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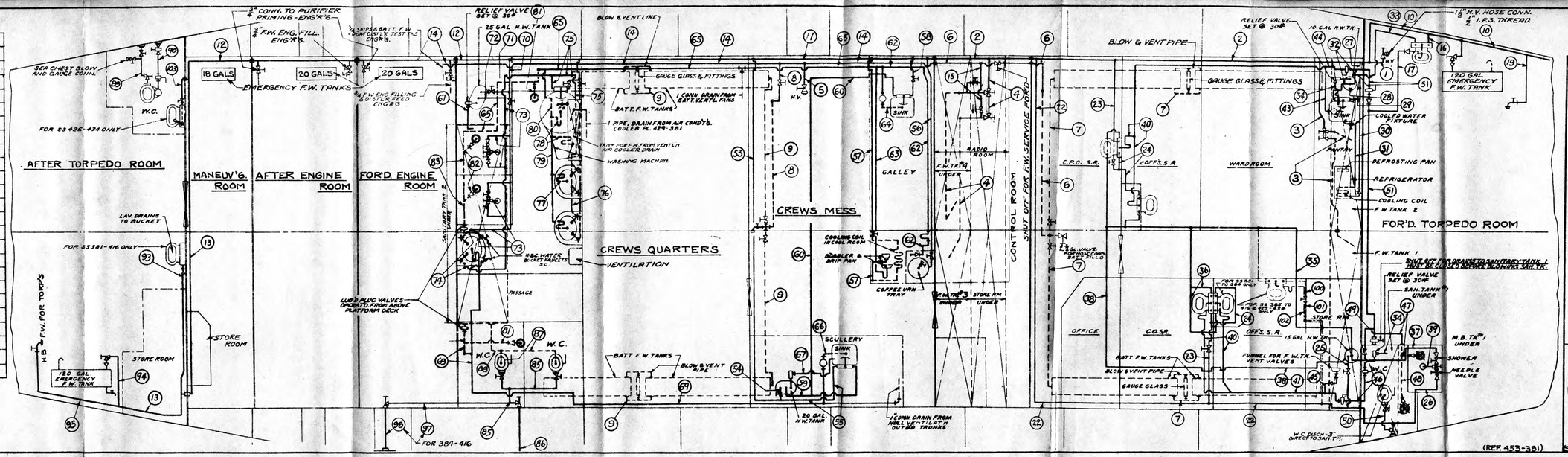
SS 404 - S 0107 - 68579

SHIPS VENTILATION SYSTEM
EXTERNAL DIAGRAM

(REF. PL. 442-38) (SECT U-19-C) PLATE 10(9)

SYMBOL	DESCRIPTION
	GLOBE & CROSS VALVE
	ANGLE VALVE
	GATE VALVE
	STOP CHECK VALVE
H.V.	HOSE VALVE GLOBE
	CHECK VALVE
	RELIEF VALVE
	PLUG VALVE (MUST BE PROPERLY LUBRICATED TYPE)
S.C.B.	SELF CLOSING BIBB
H.B.	HOSE BIBB
	SELF CLOSING BASIN FAUCET
	FOLDING LAVATORY
	WATER CLOSET (AIR EXPULSION TYPE)
	FLOOR DRAIN VALVE & W. SEAL
	SHOWER HEAD
	POT TRAP
	"S" TRAP
	"P" TRAP
	RUNNING TRAP
H.V.	HOSE VALVE ANGLE
	SINK FAUCET SET (SWING TYPE)
	FLOOR DRAIN TRAP
	WATER CLOSET (SPECIAL TYPE)
P.B.	PLAIN BIBB



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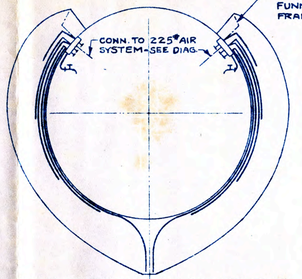
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

FRESH WATER & PLUMBING SYSTEM DIAGRAM

(REF. 453-381) SECT. U-15 PLATE 11

PIPE LIST

MARK	SERVICE
1	FUEL OIL FILLING MANIFOLD
2	" " " -AFT
3	" " " AND TRANSFER MAIN
4	" " TRANSFER NOS. 1 & 2 FUEL OIL TANKS
5	" " " " 3B " " "
6	" " -NORMAL FUEL OIL TANK NO. 1
7	" " " " " " " 2
8	" " " " " " " "
9	" " FILLING TEST
10	" " NO. 3A FUEL BALLAST TANK
11	" " " " " " "
12	
13	FUEL OIL NO. 3B FUEL BALLAST TANK
14	" " " 5A " " "
15	" " " " " " "
16	" " " 5B " " "
17	" " " " " " "
18	" " " 6 FUEL OIL TANK
19	" " " " " " "
20	" " " 7 " " "
21	" " " " " " "
22	" " " 6 & 7 " " "
23	" " TO COLLECTING TANK
24	" " " " "
25	" " PUMPS SUCTION COLLECTING TANK
26	
27	F.O. PUMPS SUCTION FR. F.O. TRANSFER LINE
28	
29	
30	COMP. WATER STANDPIPE DRAIN
31	" " " " VENT & OVERFLOW
32	" " TO FUEL OIL EXPANSION TANK
33	" " " " " " "
34	" " FUEL OIL EXP. TANK BYPASS
35	" " " " " " "
36	" " DISCHARGE
37	
38	COMP. WATER FROM EXPANSION TANK
39	" " " TO MAIN
40	" " " "
41	
42	COMP. WATER, NORMAL FUEL OIL TANK NO. 1
43	" " " " " " " " 2
44	" " " " " " " "
45	" " TO FUEL BAL. TANKS NOS. 3A & 3B
46	" " " " " " " " "
47	" " " " " " " 5A " 5B
48	" " " " " " " " "
49	" " " NORMAL FUEL OIL TANK NO. 6
50	" " " " " " " "
51	" " " " " " " " 7
52	" " " " " " " " "
53	FUEL OIL TEST PIPING
54	
55	COMP. WATER, VENT & OVERFLOW



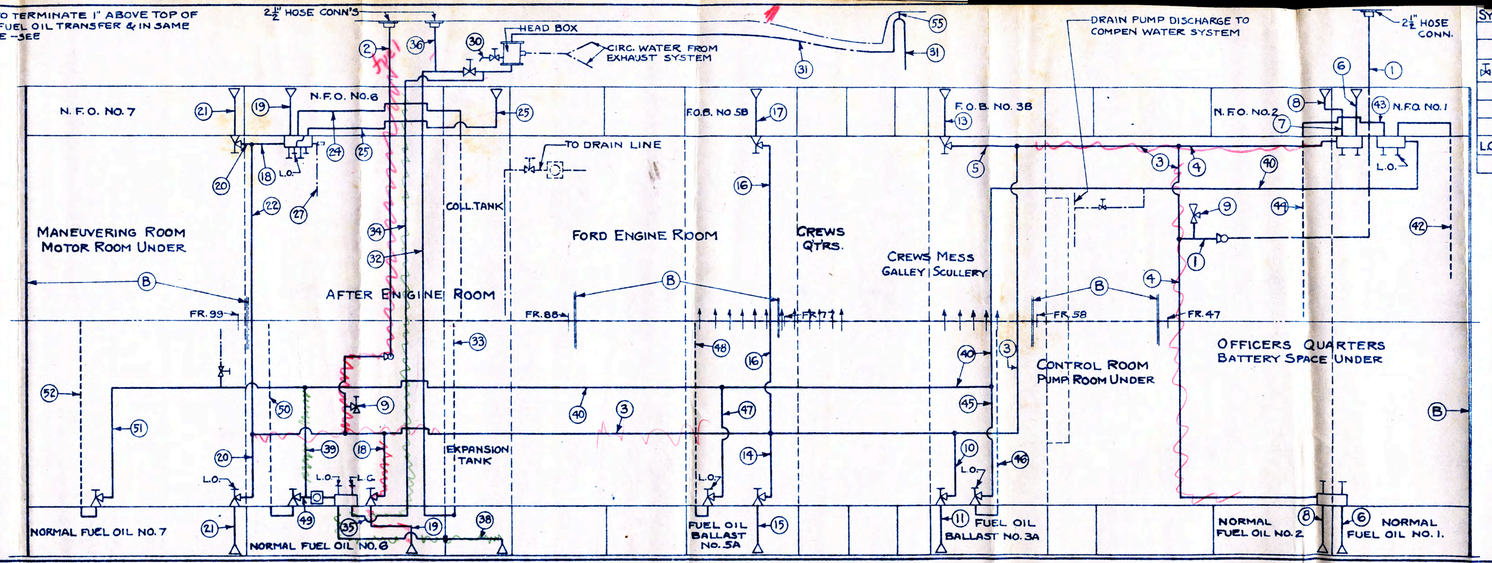
TYPICAL SECTION SHOWING BLOW, VENT AND TEST MANIFOLD AND PIPING IN FUEL OIL & FUEL BALLAST TANKS TO TAKE SAMPLES OF OIL AT INTERVALS OF 5000 GALLONS.

CAUTION

ONE FUEL OIL TANK MUST BE OPEN TO TRANSFER LINE AT ALL TIMES, OTHERWISE COLL. TANK WILL BE COLLAPSED ON A DIVE.

CAPACITIES & VOLUMES OF TANKS

FUEL OIL TANKS	CU. FT.	TONS OIL	TONS SWATER
NO. 1 FUEL OIL TANK			
" 2 " " "			
" 6 " " "			
" 7 " " "			
COLLECTING			
EXPANSION			
CLEAN 95% NET CAPACITY			
TOTAL			

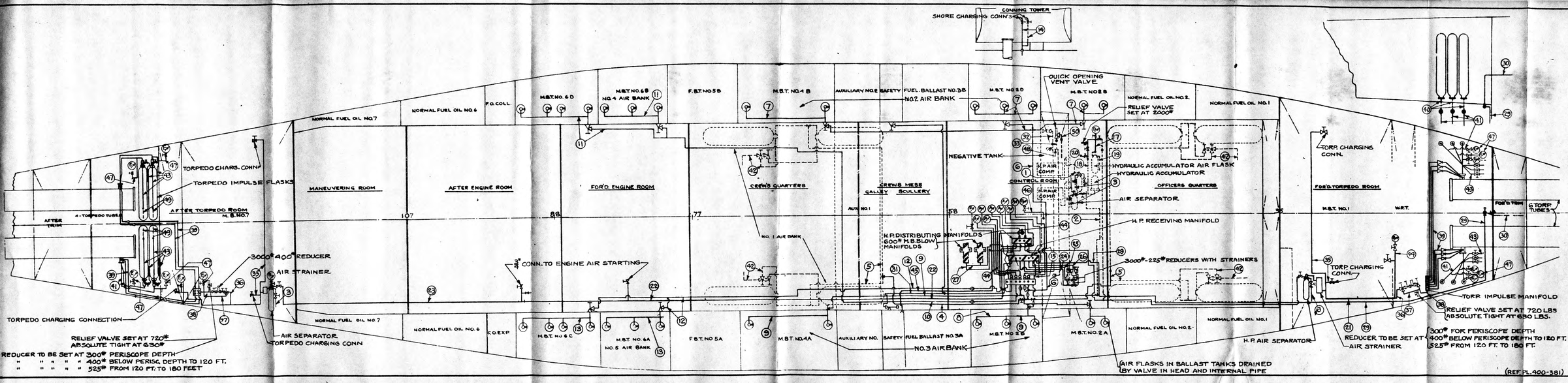


SYMBOLS	NAME
	SIGHT GLASS
	MANIFOLD
	GLOBE, ANGLE AND CROSS VALVES
	CHECK VALVE
	RELIEF VALVE
	TEST COCK
L.O., L.O.	LOCK'D CLOS'D OR OPEN
B	BULKHEAD

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
SS 390 - S 0107 - 68299
SS 391 - S 0107 - 68319
SS 392 - S 0107 - 68339
SS 393 - S 0107 - 68359
SS 394 - S 0107 - 68379
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

FUEL OIL SYSTEM DIAGRAM

(REF. PL. 423-381) (SECT. 1-10) PLATE 12



BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
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SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

H. P. AIR SYSTEM DIAGRAM

(REF. PL. 400-381) (SECT. U-19) PLATE 13

	DESIGNATE
A	PURIFIER
B	PUR. DISCH. PUMP
C	STRAINER
D	FLOW REG'L'T'G. VALVE
E	PURIFIER FEED PUMP
F	HEATER
G	RELIEF VALVE
H	ABSORBENT FILTERS
J	FUNNEL WASTE TO BILGE
K	FUNNEL WATER PRIMING
L	PRESSURE GAUGES
M	THERMOMETER

OPERATION	VALVE SETTINGS (C=VALVE CLOSED, O=VALVE OPEN)														
VALVE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SUMP TO FEED PUMP, HEATER, PUR. & FILTERS TO SUMP.	O	O	O	O	O	O	C	O	C	C	C				
	SUMP TANK FILLING & SUCTION VALVES OPEN (ONE TANK ONLY)														
SUMP TO FEED PUMP, HEATER, FILTERS TO SUMP.	O	O	O	O	C	O	O	C	C	C	C				
	AS ABOVE														
SUMP TO FEED PUMP, HEATER TO SUMP	O	O	O	O	C	C	O	C	O	C	C				
	AS ABOVE														
ENG. ATT. PUMP TO PURIFIER SYSTEM.	-	C	-	-	-	-	-	-	-	-	O				
	ENG. ATT. PUMP DISCH. AND SUMP FILLING VALVE OPEN														
FLUSHING ENG., SUMP TO FEED PUMP TO ENGINES	O	O	C	-	-	-	-	-	-	C	O				
	ENG. ATT. PUMP DISCH. AND SUMP SUCTION VALVE OPEN														
SUMP REPLENISHING FROM STOWAGE TANK	O	O	C	C	-	C	O	C	O	O	C				
	STOWAGE TANK SUCTION & SUMP FILLING VALVES OPEN														
TEMPERATURE REGULATION	-	-	-	-	-	-	O	-	-	-	-				
	OVER HEATING - SEE NOTE 5														

NOTES-PIPING SYSTEM

1-THE PURIFIER DISCH. PUMP "B" HAS A BUILT IN RELIEF VALVE SET AT 30 LBS. PER SQ. IN.

2-THE FEED PUMP "E" HAS A BUILT IN RELIEF VALVE SET AT 30 LBS. PER SQ. IN.

3-THE REGULATOR VALVE "D" SHOULD BE SET FOR 4 G.P.M. FLOW TO THE PURIFIER "A"

4-TEMPERATURE TO PURIFIER AT THERM. "M" FOR NAVY SYMBOL OIL NO. 9250 SHOULD BE 140°F & NO. 9370 SHOULD BE 158°F.

5-TO CONTROL OVER HEATING, BY-PASS A PORTION OF HOT OIL RETURN TO HEATER "F" THROUGH VALVE # 7 TO SUMP.

6-RELIEF VALVE "G" SET FOR 25 LBS. PER SQ. IN., RETURNS 11 G.P.M. TO HEATER FOR RE-CIRCULATION

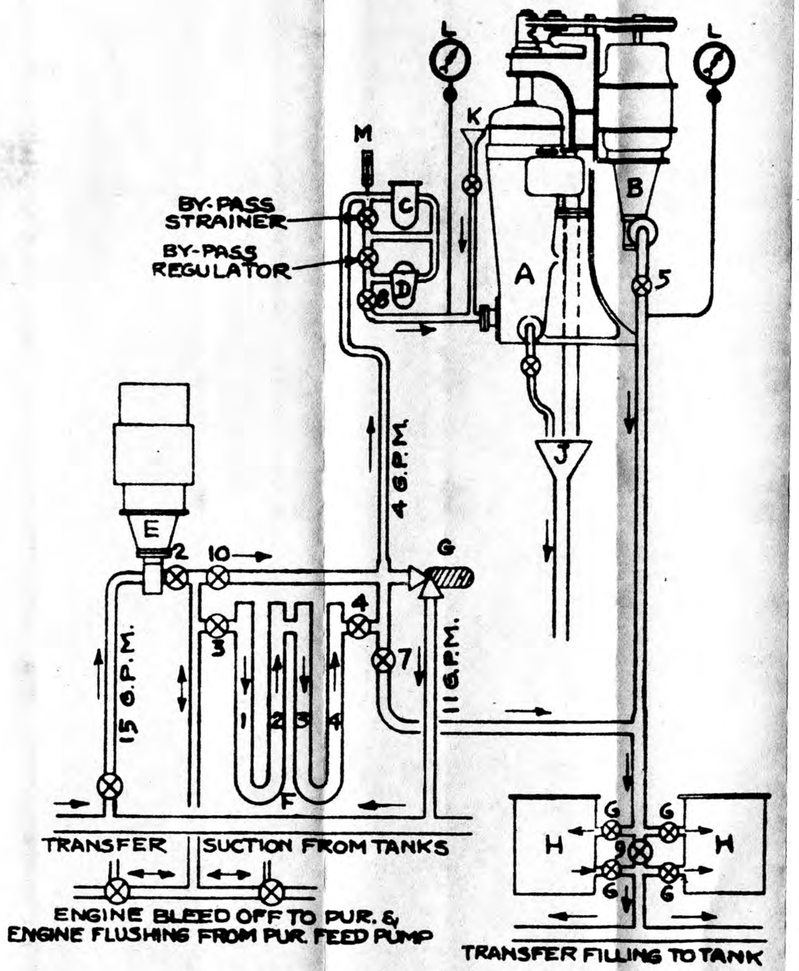
THIS IS IMPORTANT TO RELIEVE THE LOAD ON THE PUMP "E" AND PRODUCE HIGH VELOCITY THROUGH THE HEATER "F" THEREBY DECREASING THE POSSIBILITY OF BURNING THE OIL.

NOTES-ELECTRICAL CONTROL OF HEATERS

UNIT #1 & 2 FULL HEAT. 9.5 K.W. } COMBINED 19 TO 36 K.W., @ 250 TO 345 V.
UNIT #3 & 4 FULL HEAT. 9.5 K.W. }
ALL UNITS HALF HEAT 9.5 K.W. @ 250 V., 18 K.W. @ 345 V.
HEATER CAN NOT BE USED UNLESS FEED PUMP IS RUNNING (PUMP CONTROLLER CONTROLS HEATERS)

WARNING

DO NOT CLOSE VALVES #3 & #4 WHILE HEATERS ARE ON TO ELIMINATE A POSSIBLE EXPLOSION.



BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
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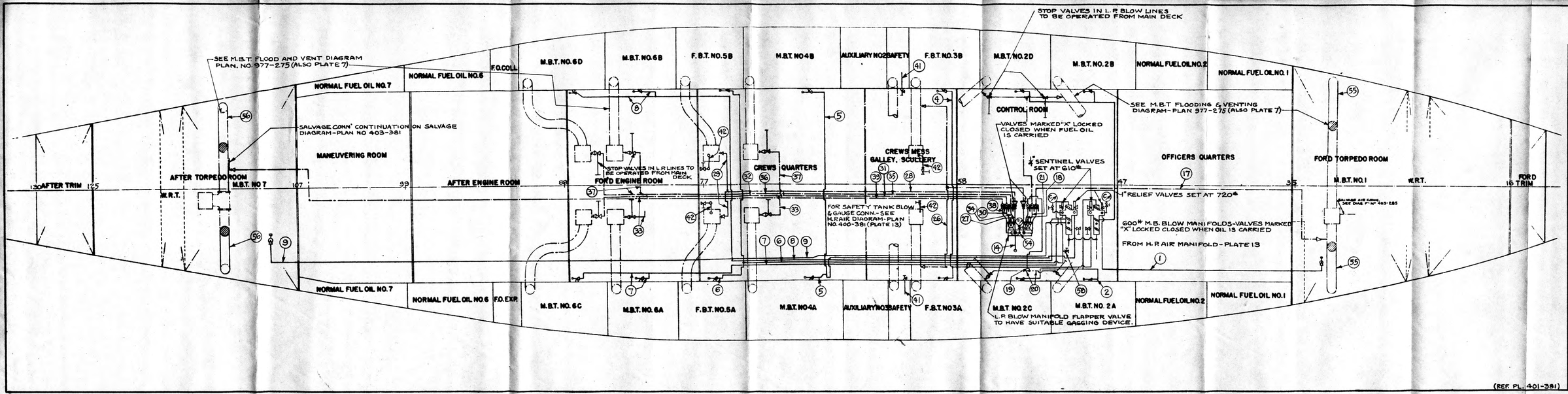
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

LUBE OIL SYSTEM DIAGRAM



BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
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SS 387 - S 0107 - 68239
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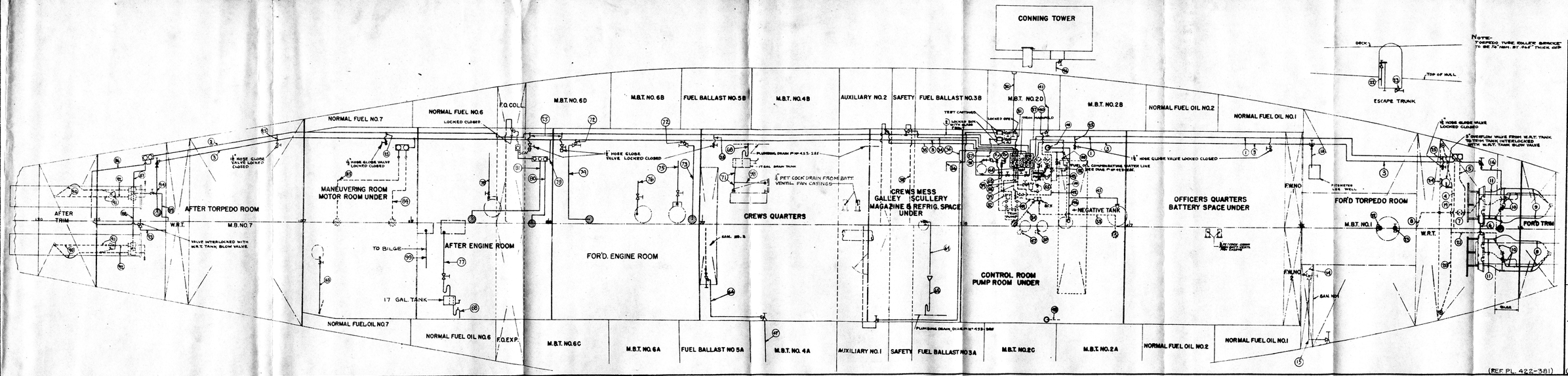
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

600" & 10" M.B.T. BLOW DIAGRAM

(REF. PL. 401-381) (SECT. U-19) PLATE 15



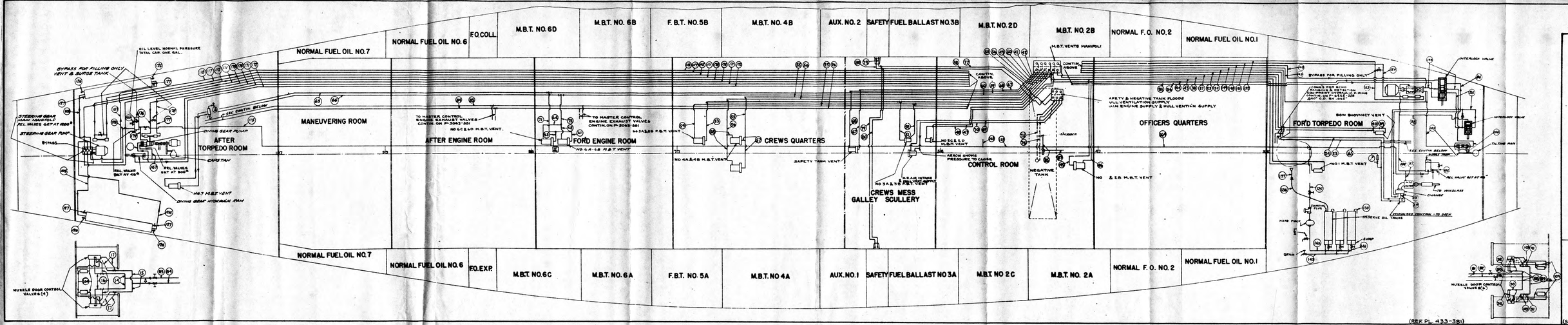
BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 396 - S 0107 - 68219
SS 397 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
SS 390 - S 0107 - 68299
SS 391 - S 0107 - 68319
SS 392 - S 0107 - 68339
SS 393 - S 0107 - 68359
SS 394 - S 0107 - 68379
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

TRIMMING & DRAINAGE SYSTEM DIAGRAM

(REF. PL. 422-381)

(SECT. U-11)

PLATE 16



(REF PL. 433-381)

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
SS 390 - S 0107 - 68299
SS 391 - S 0107 - 68319
SS 392 - S 0107 - 68339
SS 393 - S 0107 - 68359
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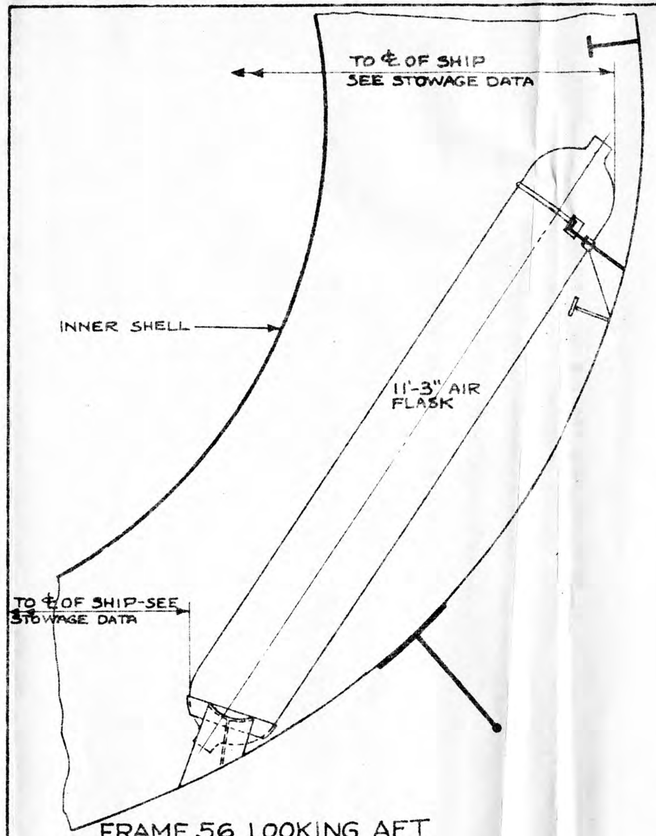
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

HYDRAULIC SYSTEM DIAGRAM

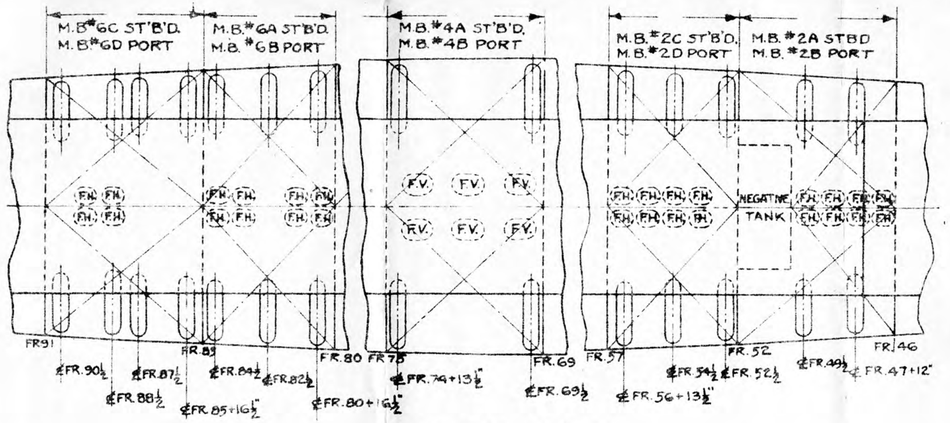
(SECT. U-27)

PLATE 17



FRAME 56 LOOKING AFT

FRS. 52½ & 54½ SIMILAR-P.&S.



PLAN VIEW

ARRANGEMENT OF AIR FLASKS IN TANKS

SCALE: ⅛"=1 FOOT

AIR FLASK STOWAGE DATA

MAIN BALLAST TANKS	No OF FLASKS	LENGTH OF FLASKS	CAP'TY OF FLASKS	TOTAL CAP'TY CU. FEET	HEIGHT OF BOTTM. OF FLASK	LOCAT'N. OF ℄ OF FLASK	DISTANCE OF FLASKS BOTTOM INBOARD	DISTANCE OF FLASKS OUTB'D. TOP OUTBOARD
2A&2B	2	11'-3"	15.65	31.3	2'-2"	FR.47+12"	4'-10⅜"	11'-7⅛"
2A&2B	2	11'-3"	15.65	31.3	2'-2"	FR.49½	5'-2⅛"	11'-10½"
2C&2D	2	11'-3"	15.65	31.3	2'-2"	FR.52½	5'-7 7/16"	12'-3 3/16"
2C&2D	2	11'-3"	15.65	31.3	2'-2"	FR.54½	5'-10 3/16"	12'-5½"
2C&2D	2	11'-3"	15.65	31.3	2'-2"	FR.56+13½"	6'-0¼"	12'-7"
4A&4B	2	11'-3"	15.65	31.3	2'-2"	FR.69½	6'-7¼"	13'-2⅜"
4A&4B	2	11'-3"	15.65	31.3	2'-2"	FR.74+13½"	6'-6¼"	13'-1¼"
6A&6B	2	11'-3"	15.65	31.3	2'-2"	FR.80+16½"	6'-2⅜"	12'-9⅛"
6A&6B	2	11'-3"	15.65	31.3	2'-2"	FR.82½	6'-1"	12'-8½"
6A&6B	2	11'-3"	15.65	31.3	2'-2"	FR.84½	6'-0⅞"	12'-5½"
6C&6D	2	11'-3"	15.65	31.3	2'-2"	FR.85+16½"	5'-11"	12'-3½"
6C&6D	2	11'-3"	15.65	31.3	2'-2"	FR.87½	5'-9"	12'-0½"
6C&6D	2	11'-3"	15.65	31.3	2'-2"	FR.88½	5'-7½"	11'-10"
6C&6D	2	11'-3"	15.65	31.3	2'-2"	FR.90½	5'-4½"	11'-7½"
	28	TOTAL CAP'TY.-438.2 CU.FT.						

FLASKS INSIDE OF INNER HULL

LOCAT'N.	NO.	SIZE	CAPACITY OF EACH FLASK	TOTAL CAP'TY.	PLAN NO.
FORD BATT. SPACE	4	11'-3" x 18" O.D.	15.65 CU. FT.	62.6 CU. FT.	76-285
AFT. BATT. SPACE	4	11'-3" x 18" O.D.	15.65 CU. FT.	62.6 CU. FT.	76-285
			TOTAL CAPACITY-125.2 CU.FT.		

TOTAL CAPACITY OF AIR FLASKS-563.4 CU. FT.

NOTE: FOR AIR FLASK STOWAGE INSIDE OF INNER HULL SEE PLAN 76-285.

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
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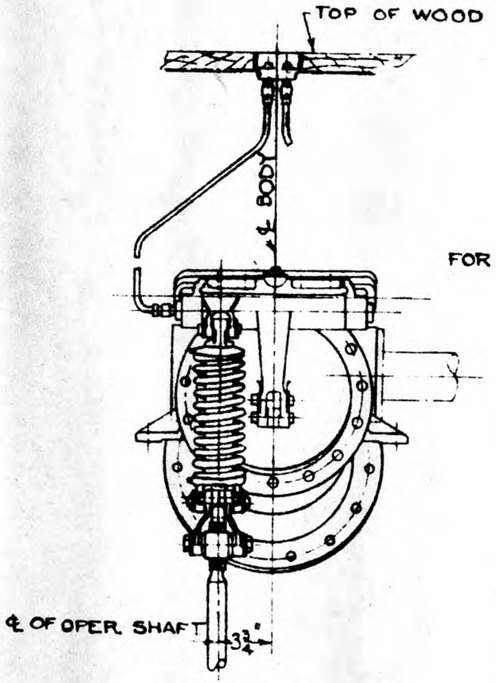
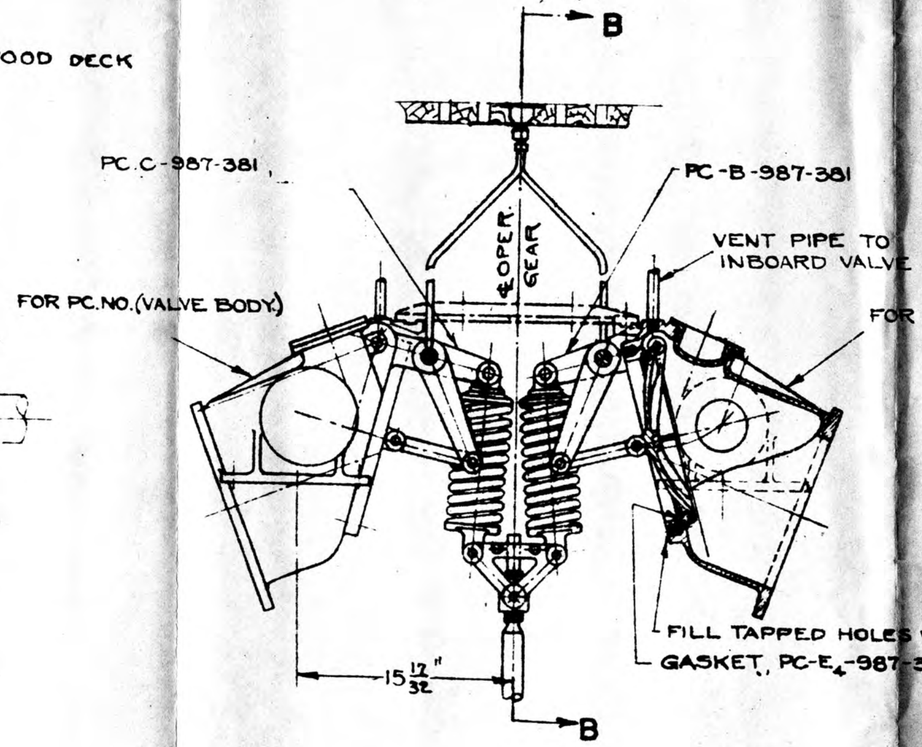
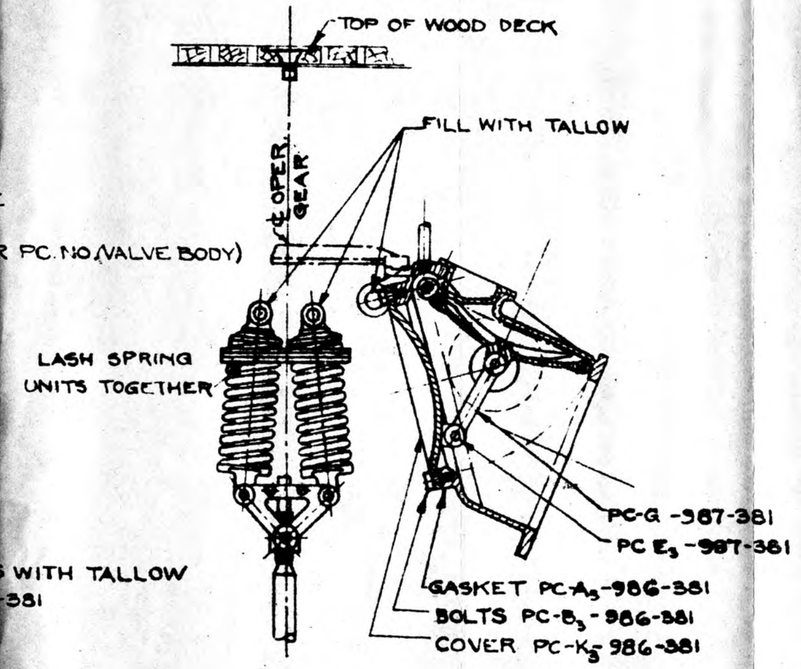
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

AIR FLASK STOWAGE



SECTION B-B





RIGGED WHEN FUEL BALLAST IS CARRIED

BAG UP, LABEL, & STORE IN SHIP, PIECES SHOWN REMOVED

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
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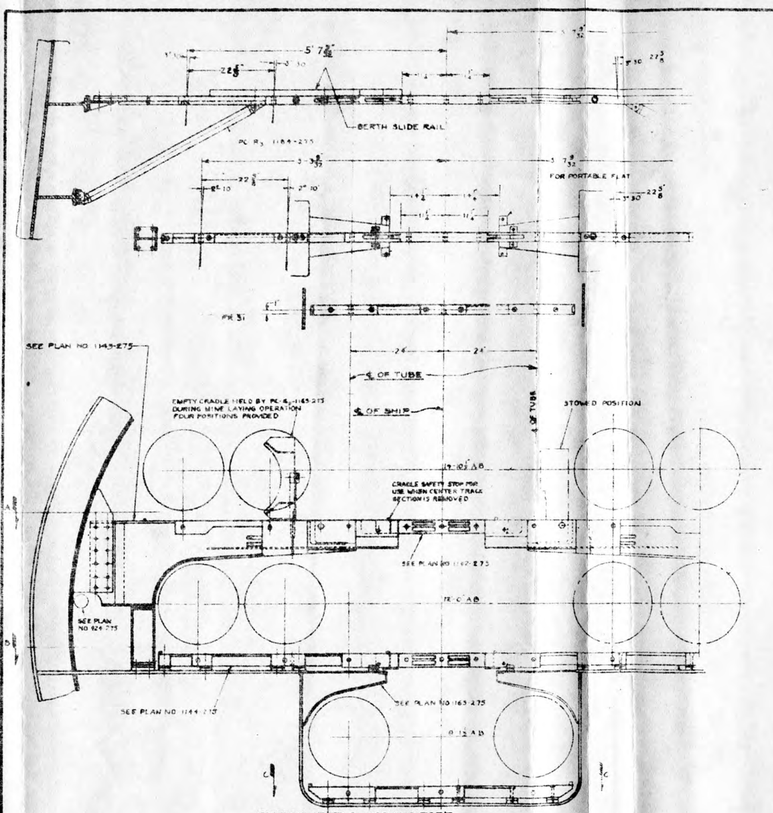
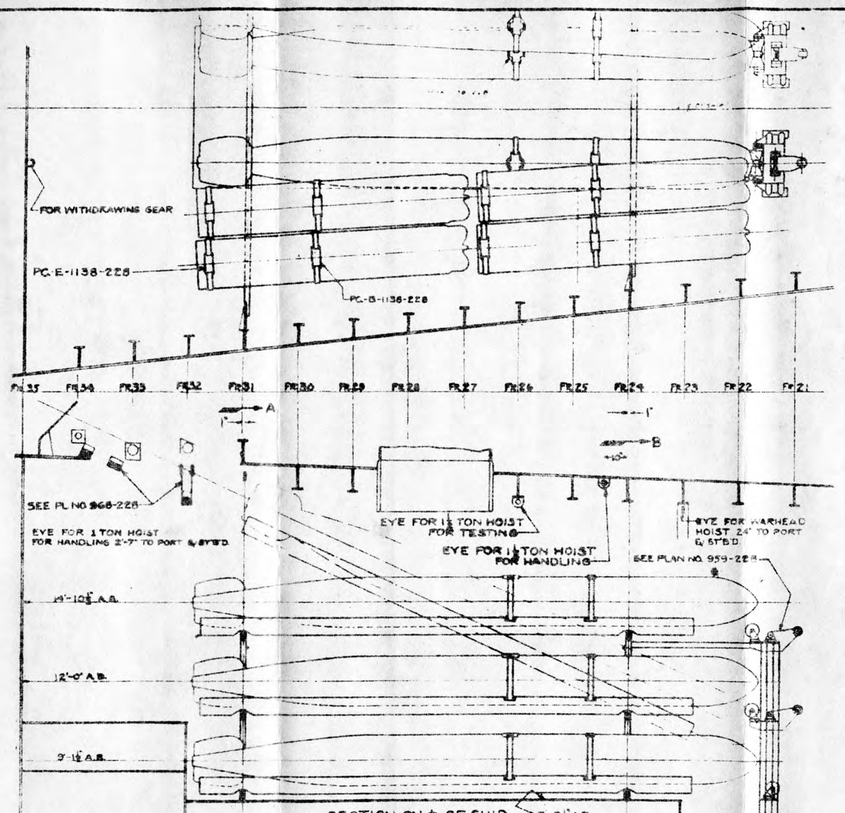
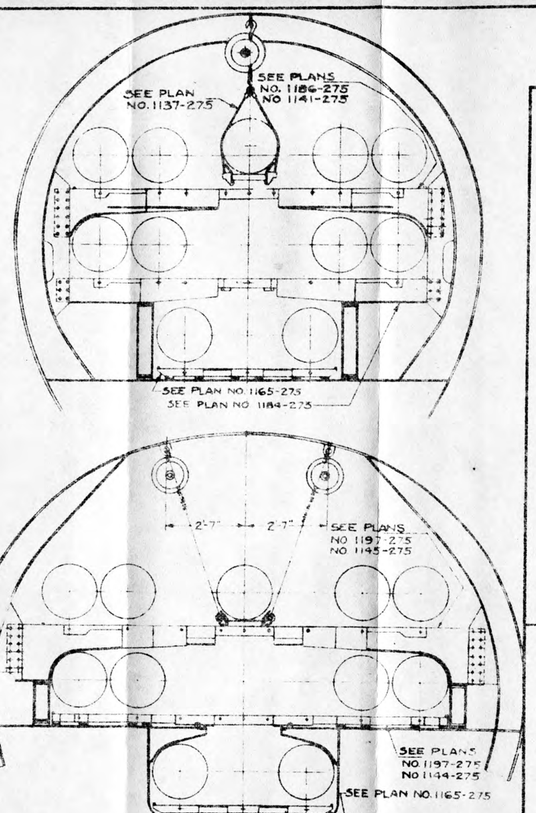
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

M.B.T. & F.B.T. VENT VALVE ARRANGEMENT







BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
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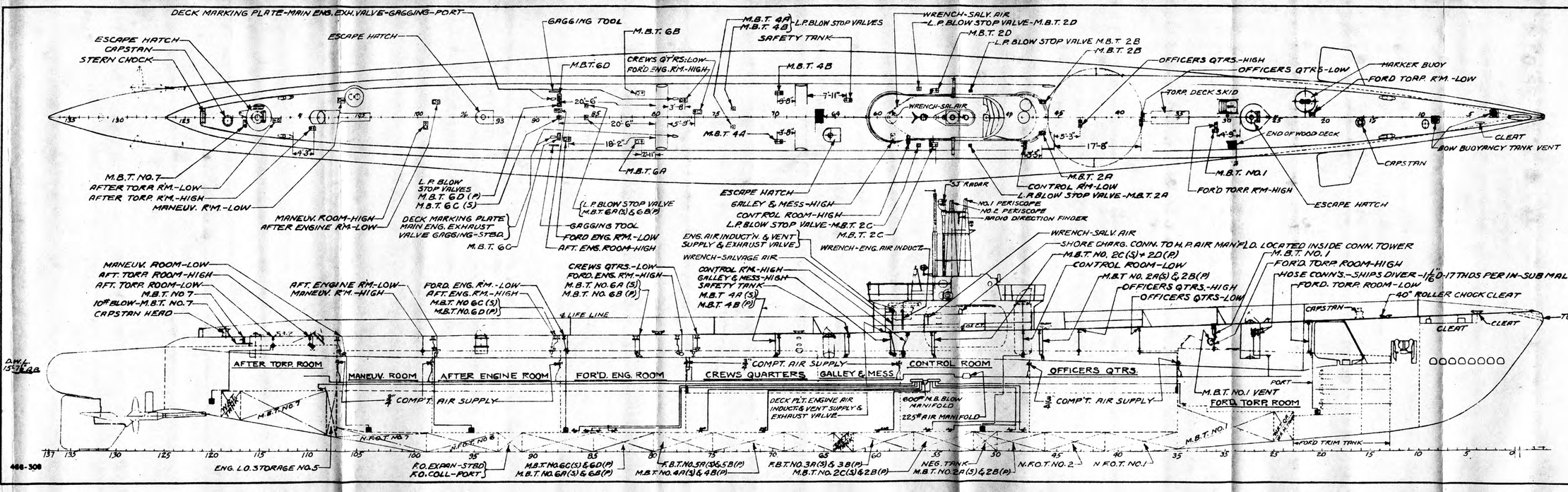
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

TORPEDO HANDLING

(REF. 956-275 & 1197-275) (SECT. T-3)

PLATE 20

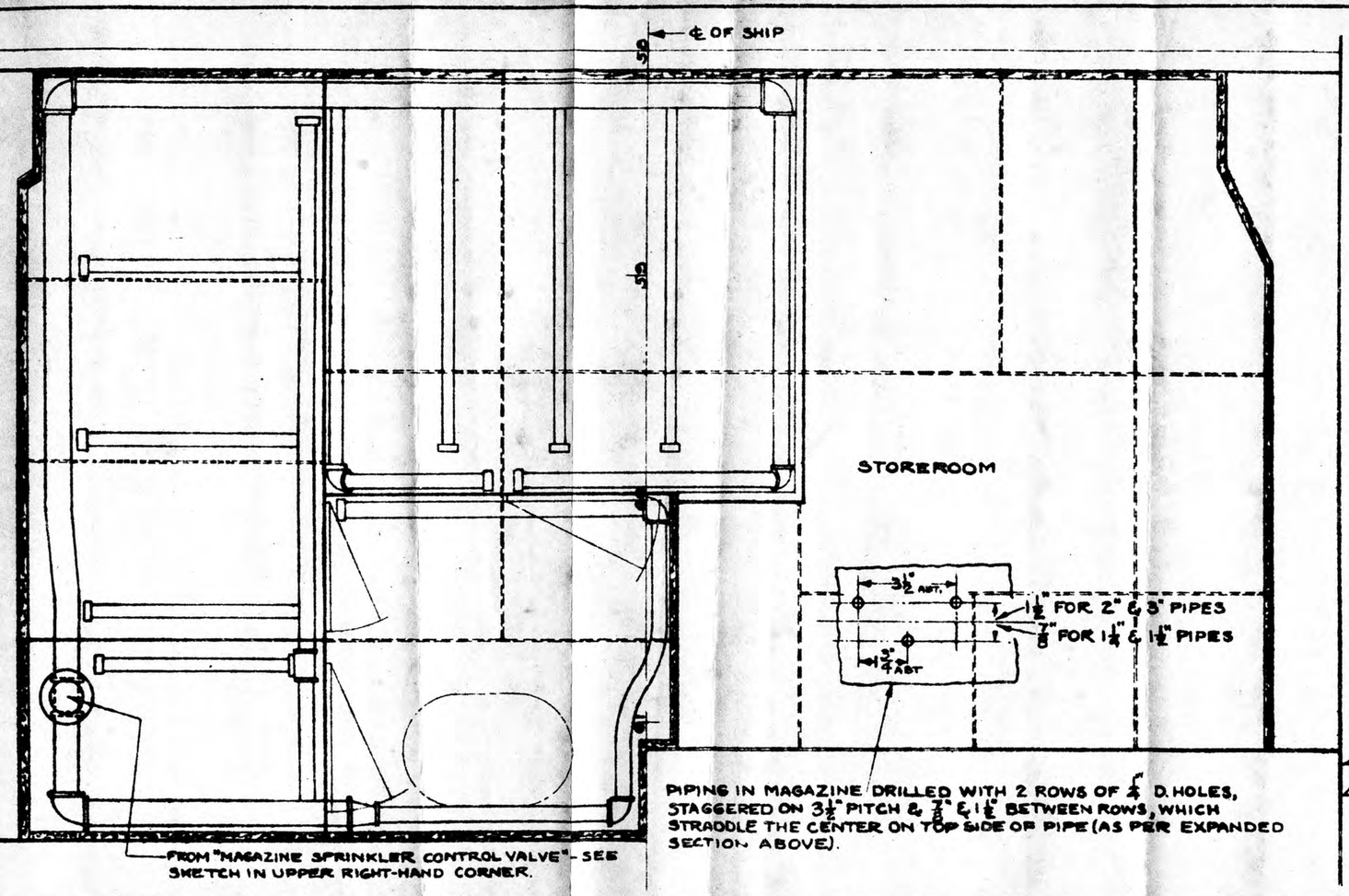


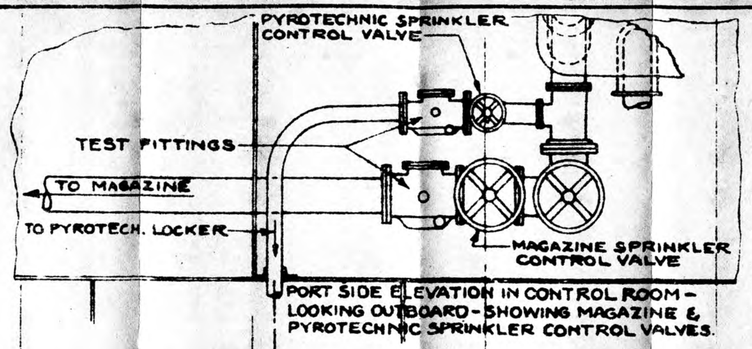
BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
SS 390 - S 0107 - 68299
SS 391 - S 0107 - 68319
SS 392 - S 0107 - 68339
SS 393 - S 0107 - 68359
SS 394 - S 0107 - 68379
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

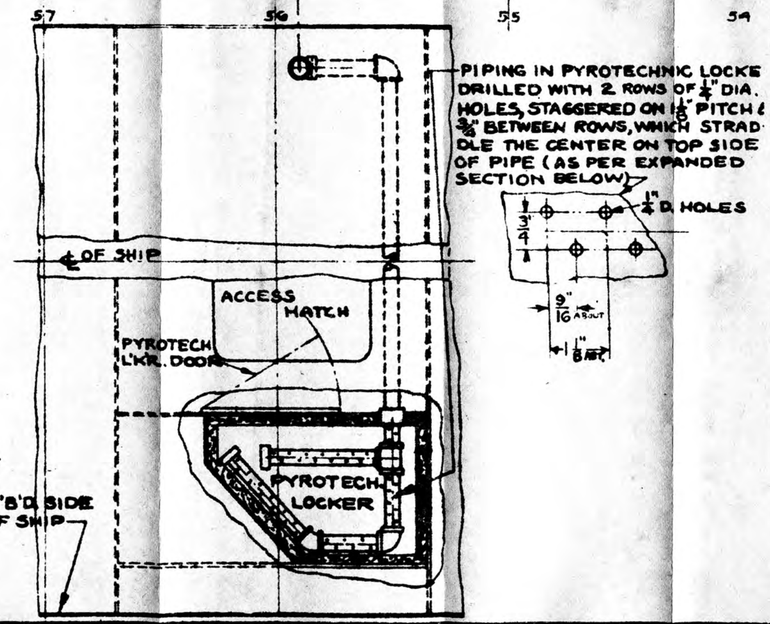
AIR SALVAGE SYSTEM DIAG.

(REF. PL. 466-381) (SECT. U-19-d)

PLATE 21







BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
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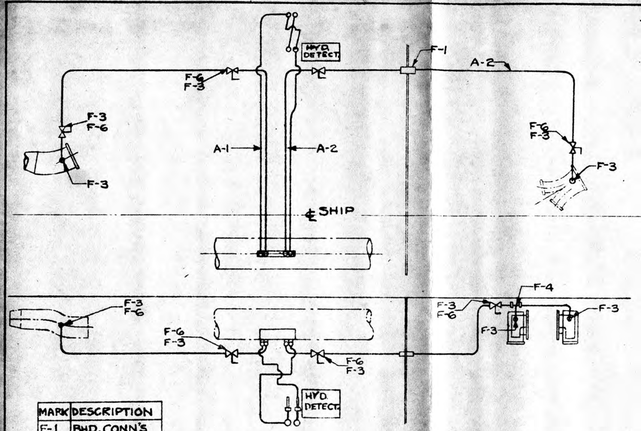
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

MAGAZINE FLOODING AND SPRINKLING SYSTEM DIAGRAM

(SECT. U-1)

PLATE 22



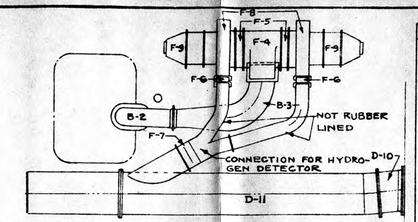
MARK	DESCRIPTION
F-1	BHD. CONN'S
F-2	TUBE UNION
F-3	MALE CONN'R.
F-4	TUBE TEE
F-5	DEHYDRATOR
F-6	GLOBE VALV. SCR
F-7	FILTER

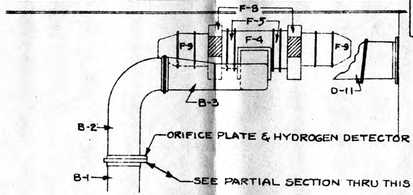
CONTINUOUS HYDROGEN DETECTOR

MINE SAFETY APPLIANCES COMPANY

DESCRIPTION: THE MSA CONTINUOUS HYDROGEN DETECTOR IS AN INSTRUMENT CAPABLE OF CONTINUOUSLY SAMPLING AND INDICATING THE CONCENTRATION OF HYDROGEN AT EACH OF TWO SEPARATE REMOTE POINTS AND OPERATING VISUAL ALARM SIGNALS WHEN THE CONCENTRATION OF HYDROGEN OF EITHER SAMPLE EXCEEDS THREE PER CENT BY VOLUME. THE INSTRUMENT IS PARTICULARLY INTENDED FOR SAMPLING THE EXHAUST AIR FROM BATTERY COMPARTMENTS OF SUBMARINES.

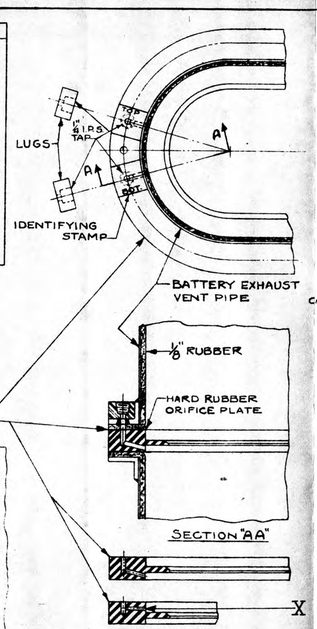
PRINCIPLE OF OPERATION: THE INSTRUMENT DEPENDS FOR ITS OPERATION, UPON THE ACTUAL COMBUSTION OF A FRACTION OF THE FLAMMABLE PORTION OF THE SAMPLED ATMOSPHERE. THE SAMPLE IS DRAWN THROUGH A COMBUSTION CHAMBER CONTAINING A HEATED DETECTOR FILAMENT WHICH FORMS A PORTION OF A BALANCED ELETRICAL CIRCUIT. HYDROGEN IS BURNED UPON COMING INTO CONTACT WITH THE HOT DETECTOR FILAMENT. THIS COMBUSTION INCREASES THE FILAMENT TEMPERATURE AND HENCE ITS ELECTRICAL RESISTANCE, RESULTING IN AN UNBALANCE OF THE BRIDGE CIRCUIT. THE BRIDGE UNBALANCE PRODUCES DEFLECTIONS OF THE POINTERS OF THE PANEL INDICATING METER AND AN INDICATING RELAY MOUNTED BACK OF THE PANEL. WHEN THE CONCENTRATION REACHES THREE PER CENT OF HYDROGEN, THE CONTACTS OF THE INDICATING RELAY CLOSE TO ACTUATE, THROUGH A SECONDARY POWER RELAY, AN ALARM SIGNAL LIGHT.

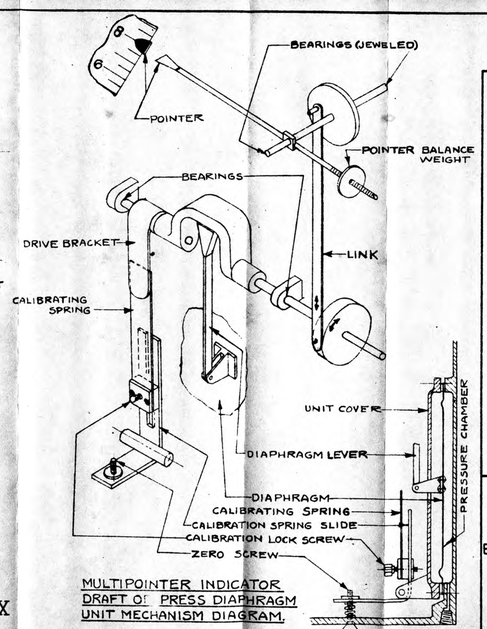




MARK	NAME
B-1, B-2, B-3, B-4, B-5	BATTERY EXHAUST
D-10, D-11	EXHAUST MAINS
F-4	TEE, COMPLETE-BATT. EXH.
F-5, F-6	RUBBER SPOOLS
F-7	THROTTLE DAMPER
F-8	BATT. EXH. BLOWER.
F-9	" " MOTOR

ABOVE "MARKS" IDENTICAL WITH THOSE ON PLAN 445-381.





MULTIPOINTER INDICATOR
DRAFT OF PRESS DIAPHRAGM
UNIT MECHANISM DIAGRAM.

BU SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
SS 386 - S 0107 - 68219
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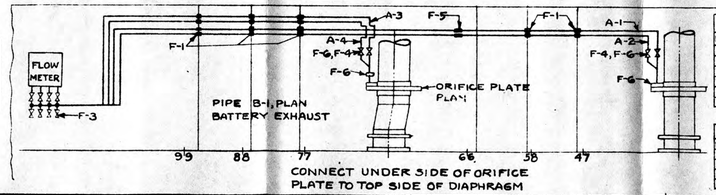
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

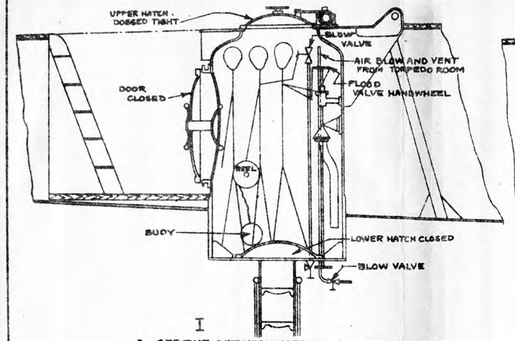
BATTERY VENTILATION DETAILS

PIPE LIST			
MARK	SERVICE		TEST
A-1	HYD. DETECTOR SAMPLING LINE-FOR'D. BATT. EXH.		300#
A-2	" " " " AFT. " "		"



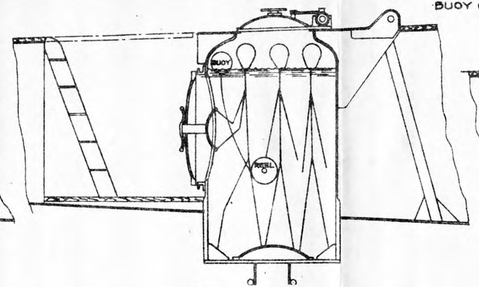
FITTING LIST			
MARK	SIZE	DESCRIPTION	SERVICE
			FLOWMETER PIPING
F-1	.375	BULKHEAD CONN.	" "
F-2	1/8"	TEE-SCREWED	" "
F-3	1/8"	GLOBE VALVE SCR.	" "
F-4	1/8"	" " "	" "
F-5	.375	TUBE UNION	" "
F-6	.375	MALE CONNECTOR	" "

PIPE LIST		
MARK	DIA	SERVICE
A-1	.375	FLOWMETER PIPING-FOR'D. BATTERY VENTILATION
A-2	"	" " " " " "
A-3	"	" " " AFTER " "
A-4	"	" " " " " "



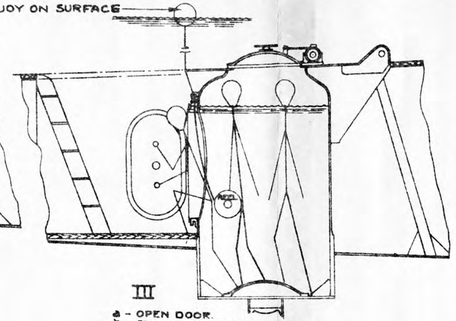
I

a - SEE THAT OVERHEAD HATCH IS SECURELY DOGGED. CHECK BLOW VALVE IN FOR'D. TORP. ROOM & VENT VALVE IN ESCAPE TRUNK WHICH ARE NORMALLY CLOSED.
b - MEN ENTER ESCAPE TRUNK WITH ESCAPE APPLIANCES ADJUSTED TO BODY (FIRST GROUP TO ENTER TAKE ASCENDING LINE, BUOY AND SUITABLE METAL OBJECT TO SIGNAL EVACUATION OF TRUNK).
C - CLOSE LOWER HATCH.
d - FLOOD TRUNK AS RAPIDLY AS POSSIBLE THROUGH FLOOD VALVE WITHOUT EXCESSIVE DISCOMFORT TO OCCUPANTS.
e - SEE II (d) FOR ADJUSTMENT OF AIR BUBBLE.
f - IF THERE IS ANY PHYSICAL EVIDENCE OF EXCESS CO_2 DURING FLOODING, ADJUST MOUTHPIECE & NOSE CLIP OF ESCAPE APPLIANCE, CHARGE IT EVERY FOUR OR FIVE MINUTES WITH OXYGEN & BREATHE THROUGH APPLIANCE.



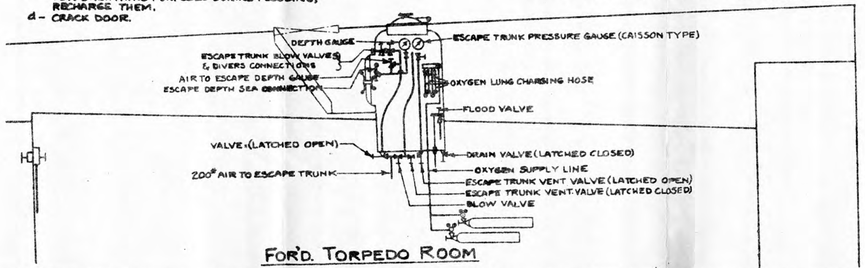
II

a - FLOOD TRUNK UNTIL WATER REACHES TOP OF DOOR. EQUALIZE INSIDE AND OUTSIDE PRESSURES BY ADMITTING AIR THROUGH ESCAPE TRUNK BLOW VALVE (DIVERS CONNECTIONS), OR, BY CRACKING DOOR, DEPENDING ON DEPTH.
b - ADJUST MOUTHPIECES AND NOSE CLIPS.
C - CHARGE ESCAPE APPLIANCES. IF THEY WERE USED FOR BREATHING PURPOSES DURING FLOODING, RECHARGE THEM.
d - CRACK DOOR.

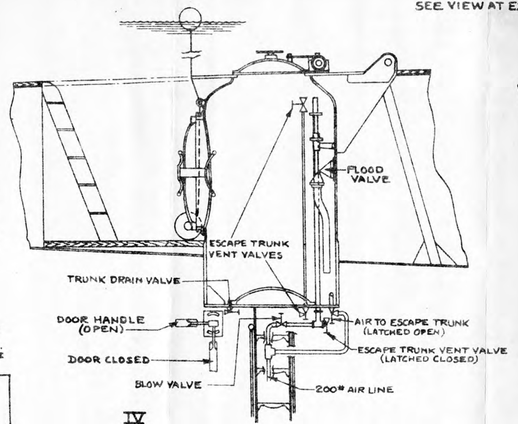


III

a - OPEN DOOR.
b - STREAM THE ESCAPE BUOY.
c - WHEN BUOY IS WATERBORNE, MAKE ASCENDING LINE FAST TO PADEYE ON OUTSIDE OF ESCAPE TRUNK. CUT THE INBOARD END SHORT SO THAT IT WILL BE ENTIRELY CLEAR OF THE DOOR.
d - STOW REEL AND ALL REMAINING LINE WELL OUTSIDE ESCAPE TRUNK TO PREVENT FOULING WATERTIGHT DOOR.



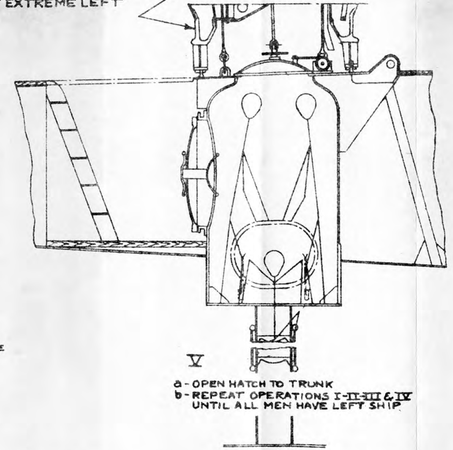
FOR'D. TORPEDO ROOM



IV

a - MEN LEAVE TRUNK ONE AT A TIME; LAST MAN TO LEAVE TRUNK RAP ON DOOR FRAME WITH METAL OBJECT TO SIGNAL THAT ESCAPE TRUNK IS CLEARED.
* b - LAST MAN TO LEAVE TRUNK CLOSE & DOG DOOR IF PRACTICABLE.
C - IF DOOR WAS NOT CLOSED BY LAST MAN, CLOSE TRUNK DOOR WITH INBOARD CLOSING DEVICE IN TORPEDO ROOM.
* d - BLOW WATER OVERBOARD THRU FLOOD VALVE IF POSSIBLE. CLOSE VALVE, OPEN DRAIN VALVE TO BLOW REMAINING WATER TO BILGE.
e - IF IMPRACTICABLE TO BLOW TRUNK OVERBOARD THRU FLOOD VALVE, DRAIN ALL WATER TO BILGE BY CLOSING FLOOD VALVE & OPENING DRAIN VALVE IN TORPEDO ROOM. OPEN INBOARD VENT ONLY IF WATER FLOW SLOWS DOWN, INDICATING TRUNK PRESSURE LOST.
f - CLOSE DRAIN VALVE & VENT & BLOW VALVES IN TORPEDO ROOM.
* NOTE: TRUNK CANNOT BE BLOWN OUTBOARD UNLESS DOOR HAS BEEN DOGGED - OPERATION "D".

SUBMARINE RESCUE CHAMBER
SEE VIEW AT EXTREME LEFT



V

a - OPEN HATCH TO TRUNK
b - REPEAT OPERATIONS I-II-III & IV UNTIL ALL MEN HAVE LEFT SHIP.

SPECIAL PRECAUTIONS

(a) SEE THAT UPPER HATCHES OF FORD ESCAPE TRUNK AND CONNING TOWER ARE DOGGED TIGHTLY.
(b) STRIKE DOWN ANY FLOATABLE MATERIAL THAT MIGHT FOUL DOOR CLOSINGS.
(c) SET OXYGEN REGULATOR TO 60 POUNDS ABOVE SEA PRESSURE AS REGISTERED ON GAUGES (IN FOR'D. TORP. ROOM AND CONTROL ROOM) BEFORE FLOODING TRUNK OR CONNING TOWER.
(d) WHEN BUOY HAS BEEN STREAMED AND SECURED, BE SURE THAT NEITHER THE STREAMED LINE NOR THE INBOARD CUT END CAN IN ANY WAY FOUL THE DOOR GEAR OR KNIFE EDGE.

BU. SHIPS NO.
SS 381 - S 0107 - 68119
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SS 386 - S 0107 - 68219
SS 387 - S 0107 - 68239
SS 388 - S 0107 - 68259
SS 389 - S 0107 - 68279
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SS 392 - S 0107 - 68339
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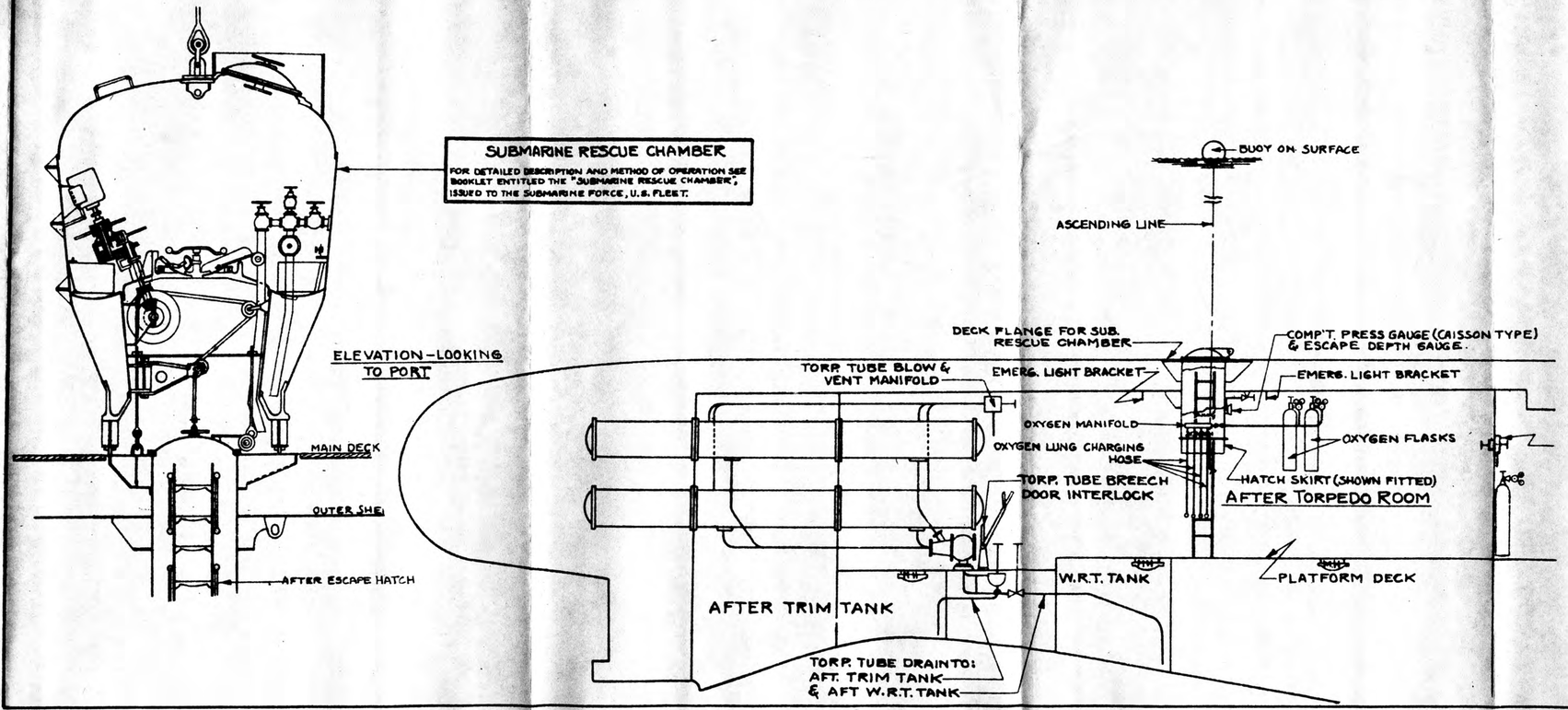
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

ESCAPE ARR'GT. DIAGRAM FOR'D.

(REF. PL.) (SECT A-1) PLATE 24(A)



METHOD OF ESCAPE FROM AFT TORPEDO ROOM

1 – CLOSE WATERTIGHT DOOR ON TORPEDO ROOM BULKHEAD. SEE THAT OVERHEAD ESCAPE HATCH & TORP. TRUNK HATCH ARE SECURELY DOGGED; FIT HATCH SKIRT.
2 – TURN OFF ALL EXCEPT PRESSURE PROOF ELECTRIC LIGHT FIXTURE. IF SHIPS CURRENT IS DEAD, LIGHT EMERGENCY LIGHT OVERHEAD NEAR TRUNK.
3 – PASS OUT LUNG TO EACH MAN.
4 – FLOOD COMPARTMENT AS QUICKLY AS POSSIBLE, REMOVE BONNETS FROM TRIM & W.R.T. TANK DRAIN VALVES. REMOVE MANHOLE COVER FROM W.R.T. TANK, EQUALIZE PRESSURE IN TORPEDO TUBES; OPEN TORPEDO TUBE MUZZLE DOORS; BREAK INTERLOCKS ON TORP. TUBE DRAIN VALVES; OPEN TORP. TUBE DRAIN VALVES; OPEN TORPEDO TUBE INBOARD VENTS.
5 – WHEN PRESSURE HAS RISEN TO THAT CORRESPONDING TO DEPTH OF SUBMERGENCE, AS INDICATED BY CAISSON GAUGE AND BY CESSATION OF UPWARD MOVEMENT OF WATER LEVEL IN COMPARTMENT, OPEN HATCH.
6 – STREAM ASCENDING LINE UNTIL BUOY WATCHES AND THEN SECURE LINE INSIDE THE COMPARTMENT.
7 – MEN ESCAPE ONE AT A TIME UP THE ASCENDING LINE, PROCEEDING UPWARD AT A STEADY HAND OVER HAND PACE.

IN FLOODING THE COMPARTMENT IT SHOULD BE NOTED THAT THE HEIGHT OF THE WATER IN THE COMPARTMENT UPON EQUALIZATION WILL DEPEND UPON THE DEPTH OF SUBMERGENCE. AT SHALLOW DEPTHS THE WATER WILL CEASE TO RISE WHEN IT IS STILL CLEAR OF THE TRUNK, AND THIS EXCESS "BUBBLE" WILL VENT OUT AND BE REPLACED BY WATER WHEN THE HATCH IS OPENED. AT DEEP DEPTHS, MAINTAIN BUBBLE, IF PRACTICABLE, BY BLEEDING AIR INTO COMPARTMENT

BU. SHIPS NO.
SS 381 - S 0107 - 68119
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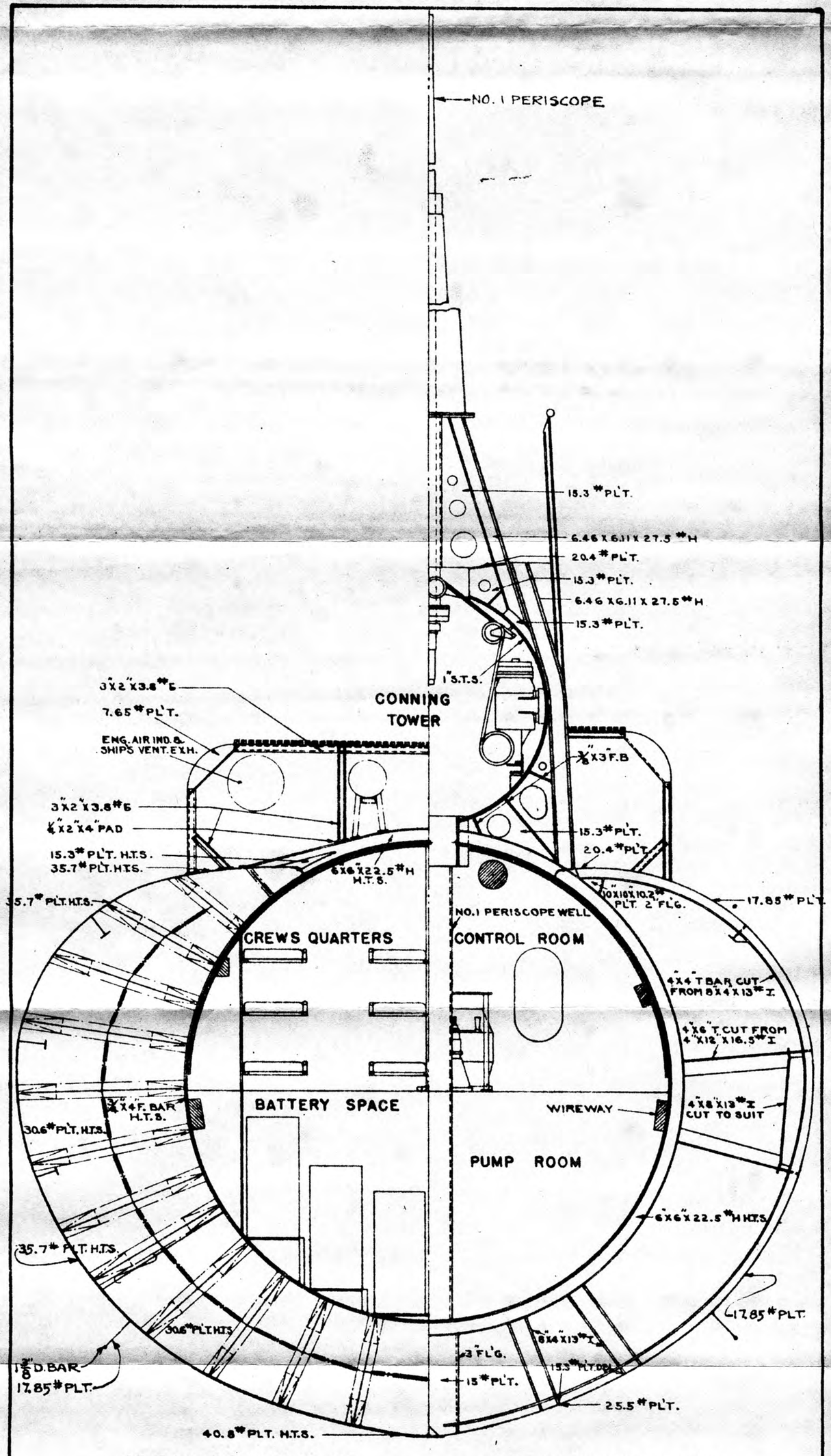
SS 392 - S 0107 - 68339
SS 393 - S 0107 - 68359
SS 394 - S 0107 - 68379
SS 395 - S 0107 - 68399
SS 396 - S 0107 - 68419
SS 397 - S 0107 - 68439
SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

ESCAPE ARR'G'T. DIAGRAM
AFT

(REF. PL. (SECT A-1) PLATE 24(B)



SECTION AT ABOUT FR. 69
LOOKING AFT.

SECTION AT ABOUT FR. 53
LOOKING FORWARD

BU. SHIPS NO.
SS 381 - S 0107 - 68119
SS 382 - S 0107 - 68139
SS 383 - S 0107 - 68159
SS 384 - S 0107 - 68179
SS 385 - S 0107 - 68199
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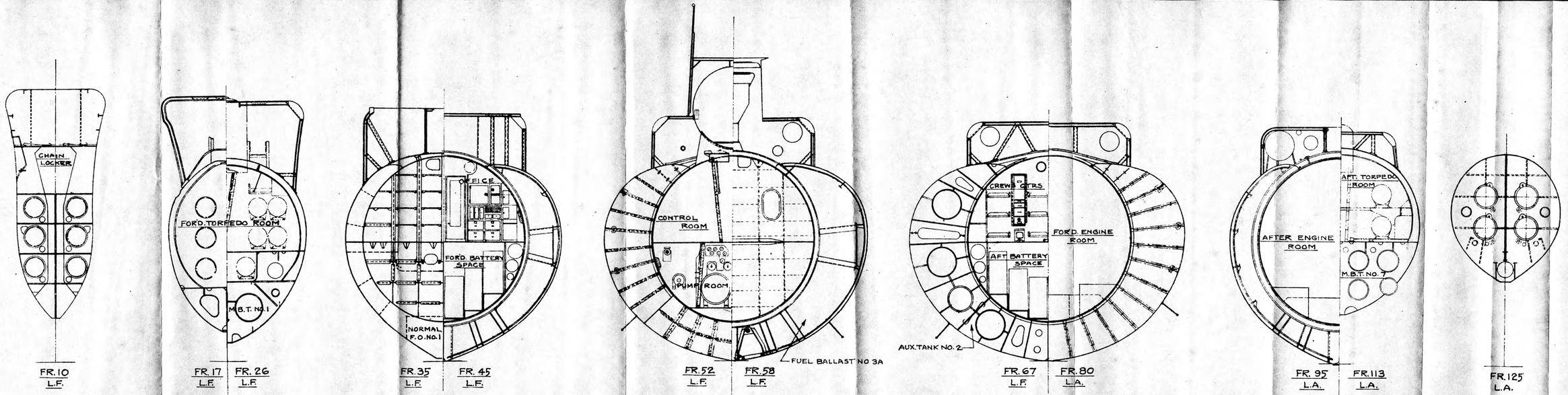
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

MIDSHIP SECTION

(SECT. A-1)

PLATE 25



BU. SHIPS NO.
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SS 398 - S 0107 - 68459
SS 399 - S 0107 - 68479
SS 400 - S 0107 - 68499
SS 401 - S 0107 - 68519
SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

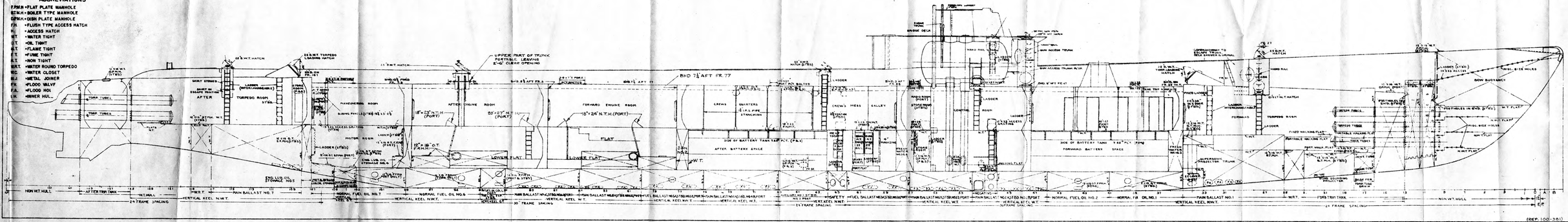
SECTIONS

(SECT. A-1)

PLATE 26

ABBREVIATIONS

- FPM.H. = FLAT PLATE MANHOLE
- BTM.H. = BOILER TYPE MANHOLE
- DPM.H. = DEEP PLATE MANHOLE
- F.A. = FLUSH TYPE ACCESS HATCH
- H. = ACCESS HATCH
- W.T. = WATER TIGHT
- O.T. = OIL TIGHT
- F.T. = FLAME TIGHT
- F.T. = FUME TIGHT
- N.T. = NON TIGHT
- W.R.T. = WATER ROUND TORPEDO
- W.C. = WATER CLOSET
- M.J. = METAL JOINER
- F.V. = FLOOD VALVE
- F.A. = FLOOD HOL
- I.H. = INNER HULL



BU. SHIPS NO.
SS 381 - S 0107 - 68119
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SS 402 - S 0107 - 68539
SS 403 - S 0107 - 68559
SS 404 - S 0107 - 68579

COMPARTMENT & ACCESS

(REF. 100-381) SECT. K-4

Sea Cat
for Inc. Sub. Folder

INFORMATION BULLENTIN

FOR SHIPS ENTERING DRYDOCK

U. S. S. ARD TWENTY-FOUR

I. PREPARATION FOR DOCKING:

All projecting devices such as oscillators, mushroom anchors, logs, etc., should be secured in a housed position.

For submarines a maximum draft of sixteen (16) feet is requested. In emergencies, drafts up to seventeen (17) feet can be handled.

Submarines shall be trimmed for a minimum drag and no list.

The dock shall be notified, prior to entering, of the draft of the vessel.

II. APPROACH AND ENTERING BASIN:

Dock is moored bow and stern. On approach to dock the after periscope will be raised approximately six (6) feet.

Approach fair into dock, crossing sill at one (1) to one and a half ($1\frac{1}{2}$) knots. (It is extremely important that the entering vessel be fair with the basin to prevent damage to gate chains which project aft of sill). Dock will pass heaving lines for number one brest line, port and starboard to be put aboard first, immediately followed by the bow line if necessary. After crossing the sill no oil or waste shall be discharged or any change of weights made without permission of the Docking Officer.

PREPARATORY: "Baker" will be two-blocked while dock is being flooded. "Affirm" at dip.

READINESS: "Baker" at dip and "Affirm" two blocked, vessel enter basin.

III. UNDOCKING:

Flooding will commence only after the hull of the vessel has been reported tight. The dock will be flooded to within approximately two feet

of lifting. Flooding will then cease until all openings have been checked for tightness and so reported to the Docking Officer. As flooding continues above sixteen (16) feet the word will be passed to the submarine to blow main ballast tanks. When the dock draft is sufficient the vessel will be lead out. When the screws are well clear of the sill and the vessel is heading fair, the commanding officer will be requested to take over.

IV. FACILITIES FURNISHED TO SHIPS IN DOCK:
(SHIP SERVICE CONNECTIONS)

A-POWER:

440 A.C., 110-115 A.C., 220 D.C., (300 Amps.), 110 D.C., (300 Amps), can be furnished upon request to ships entering dry dock for extensive repairs. Electric welding leads are also available.

B-AIR:

One hundred (100) pounds air pressure can be furnished upon request.

C-SEWAGE DISPOSAL:

As many as four sewage outlets can be furnished to ships entering dock for a period of more than twenty-four hours.

D-SALT WATER:

One two and one half (2½) inch salt water connection for flusing purposes will be placed aboard. Necessary fire protection will also be furnished to ships. (100 lb. pressure).

E-STEAM:

No steam will be available to ships in dry dock.

F-FRESH WATER:

No fresh water will be available to ships in dock.

V. SERVICES RENDERED:

A-STAGING:

Necessary staging and adequate lighting will be furnished for ships in dock to perform all necessary work.

B-PAINTING:

Ships forces will be charged with the responsibility of properly preparing the surface for painting. Upon entering dock, approximately eight (8) hands will be needed for side scraping. (The scraping to be performed on platforms suspended from dock wall cranes). All others should be detailed to the basin for scraping the bottom, as soon as the basin is dry. Necessary scrappers wire brushes, stages, etc., will be found in the basin. The preparing of the surface will be done immediately after entering dock, to leave as much time as possible for actual painting. Spray painting will be done by the dry dock force assisted by working hands (approximately eight (8) from the ships force. Painting will be in accordance with "Painting and Cementing Specifications of the U. S. Navy," Appendix 6, General Specifications.

C-CLEARANCES:

All routine shaft, rudder, and torpedo shutter clearances will be taken by dry dock forces, and submitted to the vessel in dock.

D-MACHINE SHOP:

The machine shop and technicans of the dry dock are available upon request.

E-REPAIR WORK:

The dry dock has available a crew of qualified shipfitters to do cutting, welding, pipe fitting, etc., upon request. A limited supply of materials is available to cover most repair jobs.

F-ELECTRICAL REPAIRS:

A repair crew of technicans is available but no supply of materials for repair work is carried aboard.

G-WOODWORKING SHOP:

Hull repairs to ships with wooden hulls, (AN's, YMS's, SC's, and sub chasers) can be accomplished upon request. The dry dock has a limited supply of planing and structural members aboard for this purpose.

H-ZINCS:

Zincs requiring renewal will be renewed by the drydock as necessary.

I-HEAD FACILITIES:

Head facilities can be arranged for aboard the dry dock by contacting the First Lieutenant. A compartment cleaner will be requested of the vessel in dock. Only designated places below deck are available to the crews of the vessels in dock. STRICT COMPLIANCE IS REQUESTED.

VI. GENERAL INFORMATION:

BASIN:

Ships upon preparing to leave will furnish adequate working parties to satisfactorily clean the dock basin.

SAFETY:

All hands working over the side of vessels in dock are required to wear safety belts. (Belts furnished by dry dock). This is particularly important to men working on moveable staging, stern planes, shafts, and around shutters.

Ships force (relief crews from tenders) shall notify the dry dock of all intended cutting and welding the scope and location of same aboard the vessel. This is necessary so that the dry dock forces can make adequate safety precautions for same. The dry dock will furnished skilled crane operators and riggers to make all necessary lifts with the cranes. No lifts are to be made without dry dock riggers present.

MISCELLANEOUS:

Division Engineers administering refit of submarine to be docked will deliver personally to the Docking Officer the submarine's docking plan and previous docking report if available. At that time the Docking Officer will be informed of any work required beyond the routines previously mentioned.

Information on any fuel tanks to be entered should be given to the dock in advance if possible in order to keep blocks clear of the manholes.

As soon as possible after docking the ship will furnish the dock a list of tank readings and a second set of readings just prior to undocking in order that comparison can be made for checking list, etc.

It is requested that all officers and chief petty officers of the vessel in dock make every effort to observe normal safety precautions to protect the personnel of both vessel in dock and the dry dock.

The dry dock is available for either docking or undocking both day and night, weather and alert conditions permitting.

Finally, it is requested that dry dock facilities and personnel be utilized to capacity by the vessels in drydock.