PRELIMINARY COPY

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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<td>Hydraulic System, Power Plant - Diagram</td>
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<tr>
<td>9</td>
<td>225-lb. Air System - Diagram</td>
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<tr>
<td>10a</td>
<td>Ship's Ventilation System, Internal -</td>
</tr>
<tr>
<td></td>
<td>Diagram</td>
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<td>10b</td>
<td>Ship's Ventilation System, External -</td>
</tr>
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<td>Diagram</td>
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<td>11</td>
<td>Fresh Water and Plumbing System - Diagram</td>
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<td>12</td>
<td>Fuel Oil System - Diagram</td>
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<td>13</td>
<td>H.P. Air System - Diagram</td>
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<td>14</td>
<td>Lube Oil System - Diagram</td>
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<tr>
<td>16</td>
<td>Trimming and Drainage System - Diagram</td>
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<td>17</td>
<td>Hydraulic System - Diagram</td>
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<td>18</td>
<td>Air Flask - Stowage</td>
</tr>
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<td>19</td>
<td>M.B.T. &amp; F.B.T. - Vent Valve - Arrgt.</td>
</tr>
<tr>
<td>20</td>
<td>Torpedo handling</td>
</tr>
<tr>
<td>21</td>
<td>Air Salvage System - Diagram</td>
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<tr>
<td>22</td>
<td>Magazine Flooding - Diagram</td>
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<td>23</td>
<td>Battery Ventilation - Details</td>
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<td>24</td>
<td>Escape Arrangement</td>
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<td>25</td>
<td>Midship Section</td>
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**SET NUMBER FOR PLATES**

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<tr>
<td>SS381</td>
<td>SS381-50107-68119</td>
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<td>SS382</td>
<td>SS382-50107-68139</td>
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<td>SS383</td>
<td>SS383-50107-68159</td>
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# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AER</td>
<td>After Engine Room</td>
</tr>
<tr>
<td>Aft.</td>
<td>After</td>
</tr>
<tr>
<td>ATR</td>
<td>After Torpedo Room</td>
</tr>
<tr>
<td>B</td>
<td>Bow Planes, on Ind. Light</td>
</tr>
<tr>
<td>B/P</td>
<td>Bow Plane</td>
</tr>
<tr>
<td>B&amp;S</td>
<td>Bow &amp; Stern</td>
</tr>
<tr>
<td>C.J.</td>
<td>Cone Joint</td>
</tr>
<tr>
<td>C/L</td>
<td>Center Line</td>
</tr>
<tr>
<td>COC</td>
<td>Obsolete term for CR</td>
</tr>
<tr>
<td>Comp.</td>
<td>Compressor</td>
</tr>
<tr>
<td>Conn.</td>
<td>Connection</td>
</tr>
<tr>
<td>Cont.</td>
<td>Control</td>
</tr>
<tr>
<td>C/R</td>
<td>Control Room</td>
</tr>
<tr>
<td>C/T</td>
<td>Conning Tower</td>
</tr>
<tr>
<td>Cyl.</td>
<td>Cylinder</td>
</tr>
<tr>
<td>D.P.</td>
<td>Driproof</td>
</tr>
<tr>
<td>Emerg.</td>
<td>Emergency</td>
</tr>
<tr>
<td>Eng. Air Int.</td>
<td>Engine Air Intake</td>
</tr>
<tr>
<td>FBT</td>
<td>Fuel Ballast Tank</td>
</tr>
<tr>
<td>FER</td>
<td>Forward Engine Room</td>
</tr>
<tr>
<td>F.O.</td>
<td>Fuel Oil</td>
</tr>
<tr>
<td>FTR</td>
<td>Forward Torpedo Room</td>
</tr>
<tr>
<td>Fwd.</td>
<td>Forward</td>
</tr>
<tr>
<td>H/P</td>
<td>High Pressure</td>
</tr>
</tbody>
</table>
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, by means, up to the instant of firing. Range limits are from 300 to 3000 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 reticles 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. 1 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 system problem solving circuit makes a mathematical analysis of the factors involved in the approach and applies to the torpedo gyro pot (by means), 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 (G/A) 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 resolver 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 Living Station in the control room. The ship is designed for service operation at 430 axial, or 412 feet depth range.

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.T. Air
- Pump, Hydraulic and Motor, Steering
- Training Gear, JK and 42
- 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 consistent 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 flt.
(c) The inner surface of the pressure hull, in storerooms.
(d) Magazine.

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-storare 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 Faintiny 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 LOC. The rod meter of the pitometer log is so located (See Section A-I 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 Storeroom.

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.

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

CONSTRUCTURAL 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, WARFARE AND MOUNTING. 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 CHECK, 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.

LIQUID METERS. Balanced hydraulic type gages are installed in the variable ballast tanks (including the auxiliary, trim tanks and W.R.T. tanks), the negative tank, the fuel oil collection and expansion tank, the auxfuel oil tank, and the lube oil sump tanks. The indicators for the auxfuel trimmings 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 Far. Station
5° Control Room Far. Station
15° Control Room After Station
5° Control Room After Station

Clinometers, Itemized:

Type and Location

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

Reference Plans:

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<tr>
<th>Port No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<tr>
<td>201-285</td>
<td>490769</td>
<td>Main Ballast Tanks - Lead Ballast Stowage</td>
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<tr>
<td>305-285</td>
<td>544522</td>
<td>Chart Cable and Stowage of Chronometers in Conning Tower</td>
</tr>
<tr>
<td>651-228</td>
<td>380541</td>
<td>Displacement and other Curves</td>
</tr>
<tr>
<td>652-228</td>
<td>380562</td>
<td>Cross Curves of Stability</td>
</tr>
<tr>
<td>653-228</td>
<td>380543</td>
<td>Curves of Capacity Center of Gravity - Moments Inertia - Main Ballast and Safety Tank</td>
</tr>
<tr>
<td>655-228</td>
<td>380545</td>
<td>Curves of Capacity - Center of Gravity - Moments of Inertia - Fuel Oil Tanks</td>
</tr>
<tr>
<td>656-285</td>
<td>490430</td>
<td>Curves of Capacity - Center of Gravity - Moments of Inertia - Lube Oil Tanks</td>
</tr>
<tr>
<td>658-285</td>
<td></td>
<td>Moment Diagram</td>
</tr>
</tbody>
</table>
**FLEET SUBMARINE**

**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
- **Aft Perpendicular**: 6" Aft. Frame 13
- **Middle Perpendicular**: 12" Aft. Frame 59
- **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 3½ inches normal diving trim.

**PROJECTIONS BELOW KEEL**

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

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<tr>
<th>Length Overall</th>
<th>Feet</th>
<th>Inches</th>
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<tr>
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<td>317</td>
<td>5</td>
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<th>Length between perpendiculars</th>
<th>Feet</th>
<th>Inches</th>
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<tr>
<td>Extension of vessel beyond F.P.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extension of vessel beyond A.P.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length on L.W.L.</td>
<td>307</td>
<td>0</td>
</tr>
<tr>
<td>Beam, extreme, 12 feet above base</td>
<td>27</td>
<td>3½</td>
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<tr>
<td>Beam, molded, 12 feet A.B.</td>
<td>27</td>
<td>1½</td>
</tr>
<tr>
<td>Depth, molded amidships, Fr. 53</td>
<td>22</td>
<td>1½-3½/8</td>
</tr>
<tr>
<td>Midship section is forward of Fr. 69 inches</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Freeboard at bow 27½ A.B. (10½-75&quot;)</td>
<td>6</td>
<td>8½-5½/8</td>
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<tr>
<td>Freeboard at stern 22-3½/8 A.B. (15½-7&quot;)</td>
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<td>47, 13, 3</td>
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<td>0 to 35</td>
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<td>42 to 62</td>
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<td>62 to 69</td>
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<td>69 to 103</td>
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<td>103 to 106</td>
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<td>106 to 138</td>
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<th>Keel, Bottom of, below the base line inches</th>
<th>Feet</th>
<th>Inches</th>
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<tr>
<td>1&quot;</td>
<td>55,556</td>
<td>55-105</td>
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<tr>
<td>Fuel Oil, fuel capacity (normal) gals.</td>
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<tr>
<td>Fuel Oil, reserve, capacity</td>
<td>94,110</td>
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<tr>
<td>Fuel oil, total capacity - max.</td>
<td>5,787</td>
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</tr>
<tr>
<td>Lube Oil, capacity (tanks 95%, sumps 75%) max.</td>
<td>4,059</td>
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</tr>
<tr>
<td>Potable water tanks</td>
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<tr>
<td>Battery water tanks</td>
<td>1,197</td>
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</tr>
<tr>
<td>Shafts, Incidence, down and aft</td>
<td>5-30/16</td>
<td></td>
</tr>
<tr>
<td>Shafts, divergence of, from C.L.</td>
<td>1½-39/16</td>
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</tr>
<tr>
<td>Rudder, area of - sq. ft.</td>
<td>98.22</td>
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<tr>
<td>Mast, after stub from A.P., ft. in.</td>
<td>79½-0&quot;</td>
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<tr>
<td>Ballast tanks, main, capacity, tons</td>
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<tr>
<td>Ballast tanks, variable, capacity, tons</td>
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<tr>
<td>Negative tank, tons</td>
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<th>Heights: above base line</th>
<th>Feet</th>
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<tr>
<td>D.W.L. normal forward</td>
<td>14</td>
<td>8-3/8</td>
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<tr>
<td>D.W.L. normal aft</td>
<td>15</td>
<td>8-1/8</td>
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<tr>
<td>D.W.L. amidships</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Mast, vertical antenna, up</td>
<td>56</td>
<td>73</td>
</tr>
<tr>
<td>Mast, vertical antenna, down</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Gun, &quot;A&quot; axis</td>
<td>27</td>
<td>11-7/8</td>
</tr>
<tr>
<td>Guns (2) 20 H.M. AA - Frs. 48 &amp; 59</td>
<td>33</td>
<td>78</td>
</tr>
<tr>
<td>Masthead light, high, center of</td>
<td>44</td>
<td>2-5/8</td>
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Heights: above base line (continued)

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<tr>
<th>Height Description</th>
<th>Feet</th>
<th>Inches</th>
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<tr>
<td>Highest Point, fixed part of ship, periscope support</td>
<td>47</td>
<td>5½</td>
</tr>
<tr>
<td>Anchor light, stern Fr. 122</td>
<td>25</td>
<td>10½/8</td>
</tr>
<tr>
<td>Bow Anchor Light, Fr. 10½</td>
<td>34</td>
<td>4½/8</td>
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<tr>
<td>Deck, platform, control room</td>
<td>11</td>
<td>5½/16</td>
</tr>
<tr>
<td>Deck, conning tower, (C.L. of C.T.)</td>
<td>24</td>
<td>3½</td>
</tr>
<tr>
<td>Deck, Bridge Forward</td>
<td>29</td>
<td>3½</td>
</tr>
<tr>
<td>Deck, Bridge aft</td>
<td>29</td>
<td>3½</td>
</tr>
<tr>
<td>Periscope Nos. 1 &amp; 2 - up, top</td>
<td>66</td>
<td>8½/16</td>
</tr>
<tr>
<td>Periscope Nos. 1 &amp; 2 - up, Optical Center</td>
<td>66</td>
<td>5½</td>
</tr>
<tr>
<td>Periscope Nos. 1 &amp; 2 - down, top</td>
<td>47</td>
<td>2½</td>
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Calculated data, from displacement curves:

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<tr>
<th>Description</th>
<th>Normal</th>
<th>Emergency</th>
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<tbody>
<tr>
<td>Draft, mean, feet, inches</td>
<td>15½ - 2½</td>
<td>17 - 2½</td>
</tr>
<tr>
<td>Draft, forward, feet, inches</td>
<td>14½-10½</td>
<td>16½ - 11½</td>
</tr>
<tr>
<td>Draft, Aft.</td>
<td>15½-7½</td>
<td>16½-5½</td>
</tr>
<tr>
<td>Immersion tons per inch</td>
<td>12.45</td>
<td>11.82</td>
</tr>
<tr>
<td>Waterplane area, sq. ft.</td>
<td>5860</td>
<td>4980</td>
</tr>
<tr>
<td>Moment to alter trim 1°, ft. tons</td>
<td>210</td>
<td>205</td>
</tr>
<tr>
<td>C.B. above base line, feet</td>
<td>9.18</td>
<td>9.70</td>
</tr>
<tr>
<td>Waterplane, C.G. aft of Fr. 69</td>
<td>5.30</td>
<td>6.50</td>
</tr>
</tbody>
</table>

Displacement:

Submerged Ship, displacement tons                   | 2419   | 2419     |

Main Ballast & Safety Tanks corrected for lead Ballast

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement tons</td>
<td>612.80</td>
<td>456.31</td>
</tr>
<tr>
<td>C.G. from Fr. 69 ft. Aft.</td>
<td>1.38</td>
<td>1.04</td>
</tr>
<tr>
<td>Moment about Fr. 69 ft. tons</td>
<td>845 Aft</td>
<td>755 Aft</td>
</tr>
<tr>
<td>(a) Surface, diving trim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displacement tons</td>
<td>1205.20</td>
<td>1952.69</td>
</tr>
<tr>
<td>C.G. from Fr. 69 ft.</td>
<td>2.22 Aft</td>
<td>2.09 Aft</td>
</tr>
<tr>
<td>Moment about Fr. 69</td>
<td>4099 Aft</td>
<td>4095 Aft</td>
</tr>
<tr>
<td>Center of buoyancy, Fr. 69</td>
<td>1.12 Aft</td>
<td>1.46 Aft</td>
</tr>
<tr>
<td>(b) Trimming lever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trimming moment, by stern ft. tons (axb)</td>
<td>2027</td>
<td>1230</td>
</tr>
</tbody>
</table>

*Metacentric height -- transverse

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface, normal diving trim</td>
<td>1.49 ft.</td>
<td></td>
</tr>
<tr>
<td>Surface, emergency diving trim</td>
<td>1.47 ft.</td>
<td></td>
</tr>
<tr>
<td>Submerged, normal diving trim</td>
<td>0.9 ft.</td>
<td></td>
</tr>
<tr>
<td>Submerged, emergency diving trim</td>
<td>0.9 ft.</td>
<td></td>
</tr>
<tr>
<td>Submerging and emerging (min.)</td>
<td>0.87 ft.</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacenter, transverse, above C.G. (1905.20)</td>
<td>3.22 ft.</td>
<td></td>
</tr>
<tr>
<td>Metacenter, longitudinal above C.G. (1905.20)</td>
<td>371.00</td>
<td></td>
</tr>
<tr>
<td>Metacentric height, longitudinal, above base</td>
<td>380.16</td>
<td></td>
</tr>
<tr>
<td>Midship section, immersed area, NDT sq. ft.</td>
<td>340</td>
<td></td>
</tr>
<tr>
<td>Wetted surface NDT sq. ft.</td>
<td>11643</td>
<td></td>
</tr>
<tr>
<td>Ratio, length between perpendiculars and beam, molded</td>
<td>11.37</td>
<td></td>
</tr>
</tbody>
</table>

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:

Diesel Engines, Main
Auxiliary Engine
Scavenger Blower
Main Motors
Main Controls (1)
Reduction Gears
Shafting (finished work)
Propellers
Main Storage Batteries

Manufacturer
Fairbanks, Morse & Company
Fairbanks, Morse & Company
Fairbanks, Morse & Company
Elliot Company & General Electric Co.
Westinghouse Co.
Navy Yard, Portsmouth, New Hampshire
Navy Yard, Mare Island, California
(1) Electric Storage Battery Company & (Exide)
(2) National Battery Co. (Gould)

Diesel Engine Data:

<table>
<thead>
<tr>
<th>Type</th>
<th>Main Model 38D8-1/8</th>
<th>Auxilary 300 KW Model 38E5½</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>BHP</td>
<td>1600</td>
<td>440</td>
</tr>
<tr>
<td>RPM</td>
<td>720</td>
<td>1200</td>
</tr>
<tr>
<td>No. Cyl.</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Dia. Cyl. Inches</td>
<td>8-1/8&quot;</td>
<td>5½&quot;</td>
</tr>
<tr>
<td>Stroke Inches</td>
<td>10</td>
<td>7 4&quot;</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>14,23:1</td>
<td>15,3:1</td>
</tr>
<tr>
<td>Scavenging blower</td>
<td>Gear driven</td>
<td>Gear driven</td>
</tr>
<tr>
<td>Impellers</td>
<td></td>
<td>Impellers</td>
</tr>
</tbody>
</table>

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 cooled.

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):

<table>
<thead>
<tr>
<th>Gear</th>
<th>Pinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.8996</td>
<td>9.3244</td>
</tr>
<tr>
<td>4.2790</td>
<td>1</td>
</tr>
<tr>
<td>184</td>
<td>43</td>
</tr>
<tr>
<td>280</td>
<td>1189.1</td>
</tr>
<tr>
<td>2700</td>
<td>2700 (two)</td>
</tr>
</tbody>
</table>

Shafting:
Crankshaft, main engine
Crank pin, main engine
Line Shafting, 1 section
Axial holes
Vulcanized rubber covering on shaft between stern tube bearing sleeves.
### SECTION II DATA

#### Specifications and Ratings

<table>
<thead>
<tr>
<th></th>
<th>9-cylinder</th>
<th>10-cylinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model number</td>
<td>38DB4%</td>
<td>38DB4%</td>
</tr>
<tr>
<td>Type</td>
<td>Opposed Piston</td>
<td>Opposed piston</td>
</tr>
<tr>
<td>Cycle</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Bore and stroke</td>
<td>8 1/8&quot; x 10&quot;</td>
<td>8 1/8&quot; x 10&quot;</td>
</tr>
<tr>
<td>Number of cylinders</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Rated speed</td>
<td>720 r.p.m.</td>
<td>720 r.p.m.</td>
</tr>
<tr>
<td>Displacement per minute</td>
<td>3883 cu. ft</td>
<td>4321 cu. ft</td>
</tr>
<tr>
<td>Total piston displacement</td>
<td>9333 cu. in</td>
<td>10370 cu. in</td>
</tr>
<tr>
<td>Piston speed per minute</td>
<td>1200 ft.</td>
<td>1200 ft.</td>
</tr>
<tr>
<td>Speed factor</td>
<td>7.60</td>
<td>8.60</td>
</tr>
<tr>
<td>Output at rated speed</td>
<td>1600 hp.</td>
<td>1600 hp.</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>12.6 - 14.9 to 1</td>
<td>12.6 - 14.9 to 1</td>
</tr>
<tr>
<td>Brake mean effective pressure at rated load and speed</td>
<td>94.3 p.s.i.</td>
<td>84.9 p.s.i.</td>
</tr>
<tr>
<td>Rating order</td>
<td>L.H. rotation engine</td>
<td>R.H. rotation engine</td>
</tr>
<tr>
<td>Weight (dry) of engine only</td>
<td>30500 lbs.</td>
<td>33200 lbs.</td>
</tr>
<tr>
<td>Weight (wet) of engine only</td>
<td>30770 lbs.</td>
<td>33600 lbs.</td>
</tr>
<tr>
<td>Weight of lubricating oil in engine passages</td>
<td>350 lbs.</td>
<td>350 lbs.</td>
</tr>
<tr>
<td>Cylinder relief valve setting</td>
<td>2000 p.s.i.</td>
<td>2000 p.s.i.</td>
</tr>
<tr>
<td>Lubricating oil filter relief valve set for differential of</td>
<td>10 p.s.i.</td>
<td>10 p.s.i.</td>
</tr>
</tbody>
</table>

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

#### Blower

<table>
<thead>
<tr>
<th></th>
<th>Positive displacement</th>
<th>Positive displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Gear</td>
<td>Gear</td>
</tr>
<tr>
<td>Capacity per minute</td>
<td>5500 cu. ft.</td>
<td>6000 cu. ft.</td>
</tr>
<tr>
<td>Speed</td>
<td>1320 r.p.m.</td>
<td>1450 r.p.m.</td>
</tr>
<tr>
<td>Power required to drive at rated load and speed</td>
<td>118 hp.</td>
<td>127 hp.</td>
</tr>
<tr>
<td>Displacement per revolution of impellers</td>
<td>4.20 cu. ft.</td>
<td>4.80 cu. ft.</td>
</tr>
<tr>
<td>Scavenging pressure</td>
<td>3.6 to 6 p.s.i.</td>
<td>3.8 to 6 p.s.i.</td>
</tr>
</tbody>
</table>

#### Fuel Oil Pump

<table>
<thead>
<tr>
<th></th>
<th>Gear</th>
<th>Gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>8 g.p.m.</td>
<td>8 g.p.m.</td>
</tr>
<tr>
<td>Speed</td>
<td>1200 r.p.m.</td>
<td>1200 r.p.m.</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>25 p.s.i.</td>
<td>25 p.s.i.</td>
</tr>
<tr>
<td>Power required to drive at rated load and speed</td>
<td>35 hp.</td>
<td>35 hp.</td>
</tr>
<tr>
<td>Suction lift</td>
<td>15° Hg</td>
<td>15° Hg</td>
</tr>
<tr>
<td>Hydrostatic test pressure</td>
<td>200 p.s.i.</td>
<td>290 p.s.i.</td>
</tr>
<tr>
<td>Approx mechanical efficiency</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Temperature range</td>
<td>35° to 100° F</td>
<td>35° to 100° F</td>
</tr>
<tr>
<td>Viscosity range</td>
<td>35 to 100 S.S.U.</td>
<td>35 to 100 S.S.U.</td>
</tr>
</tbody>
</table>

#### Injection Nozzle

<table>
<thead>
<tr>
<th></th>
<th>.0225&quot;</th>
<th>.0225&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three tip holes at 15° angles. Diameter</td>
<td>.0225&quot;</td>
<td>.0225&quot;</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>3000 p.s.i.</td>
<td>3000 p.s.i.</td>
</tr>
</tbody>
</table>

#### Jacket Water Pump

<table>
<thead>
<tr>
<th></th>
<th>Centrifugal</th>
<th>Centrifugal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Centrifugal</td>
<td>Centrifugal</td>
</tr>
<tr>
<td>Capacity</td>
<td>500 g.p.m.</td>
<td>555 g.p.m.</td>
</tr>
<tr>
<td>Speed (at engine speed of 720 r.p.m.)</td>
<td>1745 r.p.m.</td>
<td>1745 r.p.m.</td>
</tr>
<tr>
<td>Power required to drive at rated load and speed</td>
<td>7.75 hp.</td>
<td>18.2 hp.</td>
</tr>
<tr>
<td>Head including 61/2-ft. suction lift</td>
<td>45 ft.</td>
<td>45 ft.</td>
</tr>
<tr>
<td>Test pressure</td>
<td>200 p.s.i.</td>
<td>100 p.s.i.</td>
</tr>
<tr>
<td>Efficiency at 100° F</td>
<td>74.5%</td>
<td>46%</td>
</tr>
</tbody>
</table>
### Lubricating Oil Pump

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
<th>Speed (at engine speed of 720 r.p.m.)</th>
<th>Power required to drive at rated load and speed</th>
<th>Relief valve setting</th>
<th>Suction lift</th>
<th>Temperature range</th>
<th>Viscosity range</th>
<th>Approximate mechanical efficiency</th>
<th>Approximate volume efficiency</th>
<th>Hydrostatic test pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-Cylinder</td>
<td>215 g.p.m.</td>
<td>1280 r.p.m.</td>
<td>14 hp.</td>
<td>60 p.s.i.</td>
<td>10&quot; Hg.</td>
<td>100°F to 150°F</td>
<td>400 to 130 S.S.U.</td>
<td>80%</td>
<td>60 p.s.i.</td>
<td></td>
</tr>
<tr>
<td>10-Cylinder</td>
<td>260 g.p.m.</td>
<td>1280 r.p.m.</td>
<td>18.5 hp.</td>
<td>60 p.s.i.</td>
<td>10&quot; Hg.</td>
<td>100°F to 150°F</td>
<td>400 to 130 S.S.U.</td>
<td>80%</td>
<td>60 p.s.i.</td>
<td></td>
</tr>
</tbody>
</table>

### Sea Water Pump

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
<th>Speed (at engine speed of 720 r.p.m.)</th>
<th>Power required to drive at rated load and speed</th>
<th>Head including 8½-ft. suction lift</th>
<th>Test pressure</th>
<th>Efficiency at 85°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal</td>
<td>500 g.p.m.</td>
<td>1745 r.p.m.</td>
<td>7.9 hp.</td>
<td>45 ft.</td>
<td>200 p.s.i.</td>
<td>74.5%</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>525 g.p.m.</td>
<td>1745 r.p.m.</td>
<td>16.5 hp.</td>
<td>45 ft.</td>
<td>100 p.s.i.</td>
<td>48%</td>
</tr>
</tbody>
</table>

### Dimensions of Principal Parts

#### Camshaft Bearings

<table>
<thead>
<tr>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>2.500&quot; - .001&quot;</td>
</tr>
<tr>
<td>Camshaft diameter</td>
<td>2.4955&quot; - .001&quot;</td>
</tr>
</tbody>
</table>

#### Connecting Rod Bearings, crank end

<table>
<thead>
<tr>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>6.752&quot; - .001&quot;</td>
</tr>
<tr>
<td>Crankshaft diameter</td>
<td>6.746&quot; - .001&quot;</td>
</tr>
</tbody>
</table>

#### Connecting Rod Bearing Diameter, piston end, needle bearing type

<table>
<thead>
<tr>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushing diameter</td>
<td>3.6945&quot; - .0005&quot;</td>
</tr>
<tr>
<td>Roller diameter</td>
<td>2.204&quot; - .0002&quot;</td>
</tr>
<tr>
<td>Piston pin diameter</td>
<td>3.1925&quot; - .0005&quot;</td>
</tr>
</tbody>
</table>

#### Connecting Rod Bearing Diameter, piston end, lined bushing type

<table>
<thead>
<tr>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushing diameter</td>
<td>3.198&quot; - .0005&quot;</td>
</tr>
<tr>
<td>Piston pin diameter</td>
<td>3.1925&quot; - .0005&quot;</td>
</tr>
</tbody>
</table>

#### Connecting Rod Bearing Length, piston end

<table>
<thead>
<tr>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot in bracket</td>
<td>3.625&quot; ± .004&quot;</td>
</tr>
<tr>
<td>Retaining ring thickness</td>
<td>2.100&quot; - .002&quot;</td>
</tr>
<tr>
<td>Piston pin bushing length</td>
<td>3.187&quot; + .005&quot;</td>
</tr>
</tbody>
</table>

Connecting rod bore tolerances added.
## Main and Thrust Bearing Diameter

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>8.005&quot;</td>
<td>+ .005&quot;</td>
</tr>
<tr>
<td>Crankshaft diameter</td>
<td>7.995&quot;</td>
<td>+ .001&quot;</td>
</tr>
</tbody>
</table>

## Thrust Bearing Width

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft width</td>
<td>4.000&quot;</td>
<td>+ .003&quot;</td>
</tr>
<tr>
<td>Bearing width</td>
<td>3.995&quot;</td>
<td>+ .002&quot;</td>
</tr>
</tbody>
</table>

## Blower

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Impellers</td>
<td></td>
<td>.002&quot; to .008&quot;</td>
<td>.002&quot; to .008&quot;</td>
</tr>
<tr>
<td>Timing Gear</td>
<td></td>
<td>.002&quot; to .008&quot;</td>
<td>.002&quot; to .008&quot;</td>
</tr>
<tr>
<td>Impeller to housing</td>
<td></td>
<td>.002&quot; to .008&quot;</td>
<td>.002&quot; to .008&quot;</td>
</tr>
<tr>
<td>Impeller to bearing plate</td>
<td></td>
<td>.002&quot; to .008&quot;</td>
<td>.002&quot; to .008&quot;</td>
</tr>
<tr>
<td>Impeller to outer bearing plate</td>
<td></td>
<td>.002&quot; to .008&quot;</td>
<td>.002&quot; to .008&quot;</td>
</tr>
</tbody>
</table>

## Blower Flexible Drive

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive gear to pinion</td>
<td></td>
<td>.003&quot; to .009&quot;</td>
<td>.003&quot; to .009&quot;</td>
</tr>
<tr>
<td>Inside diameter of drive gear wearing ring</td>
<td>8.500&quot;</td>
<td>+ .001&quot;</td>
<td>.0045&quot; to .0065&quot;</td>
</tr>
<tr>
<td>Drive hub outside diameter</td>
<td></td>
<td>+ .0005&quot;</td>
<td>.0045&quot; to .0065&quot;</td>
</tr>
<tr>
<td>Inside diameter of end plate wearing ring</td>
<td>10.000&quot;</td>
<td>- .000&quot;</td>
<td>.0045&quot; to .0065&quot;</td>
</tr>
<tr>
<td>Drive hub outside diameter</td>
<td></td>
<td>+ .0005&quot;</td>
<td>.0045&quot; to .0065&quot;</td>
</tr>
</tbody>
</table>

## Crankshaft Vertical Drive

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Nozzle</td>
<td></td>
<td>.012&quot; to .016&quot;</td>
<td>.012&quot; to .016&quot;</td>
</tr>
<tr>
<td>Needle diameter</td>
<td>.281&quot;</td>
<td>+ .000&quot;</td>
<td>.003&quot; to .0045&quot;</td>
</tr>
<tr>
<td>Sleeve diameter</td>
<td>.281&quot;</td>
<td>+ .000&quot;</td>
<td>.003&quot; to .0045&quot;</td>
</tr>
<tr>
<td>Body diameter</td>
<td>.5625&quot;</td>
<td>+ .0005&quot;</td>
<td>.003&quot; to .0045&quot;</td>
</tr>
<tr>
<td>Filter diameter at longitudinal grooves</td>
<td>.559&quot;</td>
<td>- .0005&quot;</td>
<td>.003&quot; to .0045&quot;</td>
</tr>
</tbody>
</table>

## Injection Pump

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plunger barrel diameter</td>
<td>.5000&quot;</td>
</tr>
<tr>
<td>Plunger diameter</td>
<td>.5000&quot;</td>
</tr>
</tbody>
</table>

## Jacket Water and Sea Water Pumps for 9-cylinder engine

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve wearing ring inside diameter</td>
<td>5.000&quot;</td>
<td>+ .0008&quot;</td>
</tr>
<tr>
<td>Impeller wearing ring outside diameter</td>
<td>4.968&quot;</td>
<td>- .003&quot;</td>
</tr>
</tbody>
</table>

## Jacket Water and Sea Water Pumps for 10-cylinder engine

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve wearing ring inside diameter</td>
<td>5.500&quot;</td>
<td>+ .000&quot;</td>
</tr>
<tr>
<td>Impeller wearing ring outside diameter</td>
<td>5.468&quot;</td>
<td>- .003&quot;</td>
</tr>
</tbody>
</table>

*Block bore tolerance added*
Lubricating Oil Pump

<table>
<thead>
<tr>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impellers</td>
<td>.0005&quot; to .003&quot;</td>
<td>.002&quot; to .004&quot;</td>
</tr>
<tr>
<td>Impeller to inner or outer wearing plate</td>
<td>.003&quot; to .005&quot;</td>
<td></td>
</tr>
<tr>
<td>Impeller to pump body</td>
<td></td>
<td>.003&quot; to .005&quot;</td>
</tr>
<tr>
<td>Timing Gears</td>
<td>.0005&quot; to .002&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Piston

<table>
<thead>
<tr>
<th>Liner diameter</th>
<th>.002&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston diameter (with tin plate)</td>
<td>.0085&quot; to .0135&quot;</td>
</tr>
</tbody>
</table>

Piston Rings

<table>
<thead>
<tr>
<th>Number of Compression Rings</th>
<th>Side</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 and 2</td>
<td>.008&quot; to .010&quot;</td>
<td></td>
</tr>
<tr>
<td>No. 3 and 4</td>
<td>.005&quot; to .0080&quot;</td>
<td></td>
</tr>
<tr>
<td>Oil ring</td>
<td>.0015&quot; to .0045&quot;</td>
<td></td>
</tr>
<tr>
<td>Oil drain rings</td>
<td>.0015&quot; to .0045&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Pump Flexible Drive

| Gear bushing diameter      | .002" to .006" |
| Drive hub diameter         | .002" to .006" |

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

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Read at:</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firing pressure</td>
<td>Portable instrument</td>
<td>Max, 11,250 p.s.i.</td>
</tr>
<tr>
<td>Fuel oil at injection pump inlet</td>
<td>Gauge board</td>
<td>5 to 20 p.s.i.</td>
</tr>
<tr>
<td>Hot engine compression at half speed</td>
<td>Portable instrument</td>
<td>*440 to 560 p.s.i.</td>
</tr>
<tr>
<td>Hot engine compression at full speed</td>
<td>Portable instrument</td>
<td>*Max, 750 p.s.i.</td>
</tr>
<tr>
<td>Jacket water at pump discharge</td>
<td>Gauge board</td>
<td>18 to 29 p.s.i.</td>
</tr>
<tr>
<td>Lubricating oil at engine upper header</td>
<td>Gauge board</td>
<td>17 to 32 p.s.i.</td>
</tr>
<tr>
<td>Pressure drop across fuel oil filter</td>
<td>Gauge board</td>
<td>2 p.s.i.</td>
</tr>
<tr>
<td>Pressure drop across lubricating oil filter</td>
<td>Gauge board</td>
<td>8 p.s.i.</td>
</tr>
<tr>
<td>Sea water at pump discharge</td>
<td>Gauge board</td>
<td>18 to 35 p.s.i.</td>
</tr>
<tr>
<td>Starting air at法兰 or header</td>
<td>Gauge board</td>
<td>3500 p.s.i.</td>
</tr>
<tr>
<td>Starting air at reducing valve outlet</td>
<td>Gauge board</td>
<td>250 p.s.i.</td>
</tr>
</tbody>
</table>

† 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

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Read at:</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust, combined, at nozzle</td>
<td>Pyrometer</td>
<td>430° to 770° F.</td>
</tr>
<tr>
<td>Exhaust, individual cylinder</td>
<td>Pyrometer</td>
<td>*Max, 770° F.</td>
</tr>
<tr>
<td>Jacket water outlet</td>
<td>Piping</td>
<td>140° to 170° F.</td>
</tr>
<tr>
<td>Jacket water outlet preferred range</td>
<td>Piping</td>
<td>Max, 30° F.</td>
</tr>
<tr>
<td>Jacket water differential inlet to outlet</td>
<td>Piping</td>
<td>Max, 10° F.</td>
</tr>
<tr>
<td>Lubricating oil outlet</td>
<td>Piping</td>
<td>140° to 180° F.</td>
</tr>
<tr>
<td>Lubricating oil outlet preferred range</td>
<td>Piping</td>
<td>Max, 40° F.</td>
</tr>
<tr>
<td>Lubricating oil differential, inlet to outlet</td>
<td>Piping</td>
<td>Max, 30° F.</td>
</tr>
</tbody>
</table>

† 100° F. maximum variation between cylinders on any one engine.
### Fuel Consumption at Various Loads and Speeds

| B.H.P. | R.P.M. | *Generator 1133 Kw. | **Generator 1125 Kw. | Fuel (Average) per Brake H.P.-Hr.  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>720</td>
<td></td>
<td></td>
<td>9-Cylinder 375 lbs.</td>
<td>10-Cylinder 375 lbs.</td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td>720</td>
<td>847 Kw.</td>
<td>847 Kw.</td>
<td>380 lbs.</td>
<td>381 lbs.</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>720</td>
<td>560 Kw.</td>
<td>563 Kw.</td>
<td>418 lbs.</td>
<td>419 lbs.</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>720</td>
<td>289 Kw.</td>
<td>287 Kw.</td>
<td>555 lbs.</td>
<td>555 lbs.</td>
<td></td>
</tr>
<tr>
<td>1280</td>
<td>648</td>
<td>906 Kw.</td>
<td>903 Kw.</td>
<td>365 lbs.</td>
<td>364 lbs.</td>
<td></td>
</tr>
<tr>
<td>960</td>
<td>648</td>
<td>677 Kw.</td>
<td>878 Kw.</td>
<td>376 lbs.</td>
<td>366 lbs.</td>
<td></td>
</tr>
<tr>
<td>720</td>
<td>648</td>
<td>506 Kw.</td>
<td>506 Kw.</td>
<td>403 lbs.</td>
<td>405 lbs.</td>
<td></td>
</tr>
<tr>
<td>360</td>
<td>648</td>
<td>246 Kw.</td>
<td>245 Kw.</td>
<td>530 lbs.</td>
<td>529 lbs.</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>376</td>
<td>564 Kw.</td>
<td>564 Kw.</td>
<td>373 lbs.</td>
<td>371 lbs.</td>
<td></td>
</tr>
</tbody>
</table>

* Elliott  
† General Electric

### Miscellaneous

- **Blower suction, vacuum**: .75" to 5.6" water
- **Exhaust gas volume per minute at 570°F**: 11,700 cu. ft
- **Exhaust line back-pressure at engine nozzle**: 40" water
- **Overspeed governor trips at**: 800 r.p.m.
- **Ratio of air to fuel**: 42 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.
**ENGINE DATA**

### B. DATA

#### 1. Engine Data

**a. Specifications and Ratings**

- **Output at Rated R.P.M.** 300 K.W.
- **Model No.** 28721/4
- **Type** Opposed Piston
- **Cycle** Two

**Rating**

- **Bore and Stroke—Inches** 5 1/4 x 7 1/4
- **Number of Cylinders** 7
- **Rated R.P.M.** 1200
- **Displacement—Cu. Ft. Per Min.** 1738
- **Total Piston Displacement—Cu. In.** 2197
- **Piston Speed—Ft. Per Min.** 1450
- **Speed Factor** 1.74
- **Compression Ratio** 13.2 to 15.3 to 1
- **B.M.E.P. at Rated Load and Speed—Lbs. Per Sq. In.** 64.5

**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.** 1.1
- **Scavenging Pressure—Lbs. Per Sq. In.** 3

**Injection Nozzle Tip Hole**

- **Number at 15° angle .018” Dia.** 3

**Fuel Oil**

- **Type** Gear
- **Capacity—Gals. per Min.** 2
- **R.P.M.** 1600
- **Horse Power to Drive (At Rated Load and Speed)** 90
- **Discharge Pressure—Lbs. per Sq. In.** 25
- **Suction—Inches Mercury** 15
- **Fuel Temp. Range—Fahrenheit** 35°-100°
- **Fuel Viscosity Range—S.S.U** 100-130
- **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)** 90
- **Discharge Pressure—Lbs. per Sq. In.** 25
- **Suction—Inches Mercury** 10
- **Oil Temp. Range—Fahrenheit** 60°-180°
- **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)** 340
- **Suction Pressure—Lbs. per Sq. In.** 1.7
- **Total Head—Ft.** 49
- **Test Pressure—Lbs. per Sq. In.** 200

**Pump—Lubricating Oil**

- **Type** Gear
- **Capacity—Gals. per Min.** 24
- **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%
### Engine Data (Continued)

**App. Vol. Eff.**
Hydrostatic Test Pressure—Lbs. per Sq. In.
Relief Valve Set at Lbs. per Sq. In.

**Pump—Sea Water**

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity—Gals. per Min.</th>
<th>R.P.M.</th>
<th>Suction Pressure—Lbs per Sq. In.</th>
<th>Horse Power to Drive (At Rated Load and Speed)</th>
<th>Total Head—Ft.</th>
<th>Test Pressure—Lbs per Sq. In.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal</td>
<td>100</td>
<td>2571</td>
<td>6.7</td>
<td>315</td>
<td>48</td>
<td>200</td>
</tr>
</tbody>
</table>

**b. Dimensions and Clearances of Principal Engine Parts**

<table>
<thead>
<tr>
<th>Bearing—Camshaft</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>2.0615&quot; to 2.0613&quot;</td>
<td>0.0015&quot; to 0.004&quot;</td>
<td></td>
</tr>
<tr>
<td>Camshaft diameter</td>
<td>2.059&quot; to 2.060&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bearings—Connecting Rod—Crank End</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter crank end</td>
<td>4.251&quot; to 4.2525&quot;</td>
<td>0.003&quot; to 0.0055&quot;</td>
<td></td>
</tr>
<tr>
<td>Crankshaft diameter</td>
<td>4.247&quot; to 4.248&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bearings—Connecting Rod—Piston End</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushing diameter</td>
<td>2.4075&quot; to 2.4085&quot;</td>
<td>0.0015&quot; to 0.0029&quot;</td>
<td></td>
</tr>
<tr>
<td>Roller diameter</td>
<td>1.248&quot; to 1.255&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piston pin diameter</td>
<td>1.1555&quot; to 1.1565&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bearings—Connecting Rod—Piston End—Side</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot in Bracket</td>
<td>2.059&quot; to 2.065&quot;</td>
<td>0.006&quot; to 0.018&quot;</td>
<td></td>
</tr>
<tr>
<td>Retaining ring—thickness</td>
<td>1.875&quot; to 1.875&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bushing—length</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bearings—Main—Diameter</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>5.004&quot; to 5.0055&quot;</td>
<td>0.007&quot; to 0.0095&quot;</td>
<td></td>
</tr>
<tr>
<td>Crankshaft diameter</td>
<td>4.996&quot; to 4.997&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bearings—Main—Thrust</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft width</td>
<td>2.3125&quot; to 2.3155&quot;</td>
<td>0.005&quot; to 0.011&quot;</td>
<td></td>
</tr>
<tr>
<td>Bearing width</td>
<td>2.3045&quot; to 2.3075&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Bearing Thickness Shell and Liner</td>
<td>4.0775&quot; to 4.0825&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Blower**

| Between impellers | 0.001" to 0.002" | 0.014" to 0.018" |
| Timing gears | 0.002" to 0.008" | 0.012" to 0.016" |
| Drive gear to pinion | 0.018" to 0.022" |
| Impeller to housing | |
| Impeller to inner bearing plate | 0.010" to 0.014" |
| Impeller to outer bearing plate | |

**Blower Drive—Flexible**

| Wearing ring diameter | 5.75" to 5.751" | 0.0045" to 0.0065" |
| Drive hub diameter | 5.7445" to 5.755" |

**Crankshaft Drive—Vertical Gear**

| .003" to .010" |

**Flexible Pump Drive—Attached—Governor and Pumps**

| All gears | 0.002" to 0.006" | 0.006" to 0.008" |

| Gear bushing | 4.625" to 4.626" |
| Drive hub diameter | 4.618" to 4.619" |
### Engine Data (Continued)

<table>
<thead>
<tr>
<th>Injection Needle</th>
<th>Size</th>
<th>Backlash</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle diameter (lapped with sleeve)</td>
<td>.281&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeve diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body diameter</td>
<td>542&quot; to 543&quot;</td>
<td>.003&quot; to .0045&quot;</td>
<td></td>
</tr>
<tr>
<td>Filter diameter</td>
<td>5585&quot; to 559&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Injection Pump**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel diameter (lapped with plunger)</td>
<td>11 m/m</td>
<td>.005&quot; to 0.02&quot;</td>
<td>.003&quot; to .005&quot;</td>
</tr>
<tr>
<td>Plunger diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lubricating Oil Pump**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Impellers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impellers bearing to wear plate</td>
<td>.005&quot; to .003&quot;</td>
<td>.003&quot; to .005&quot;</td>
<td>.002&quot; to .004&quot;</td>
</tr>
<tr>
<td>Impellers to bearing plate/inner</td>
<td>.002&quot; to .005&quot;</td>
<td>.003&quot; to .005&quot;</td>
<td>.0015&quot; to .003&quot;</td>
</tr>
<tr>
<td>Impellers to bearing plate/outer &amp; Impeller housing</td>
<td>.0015&quot; to .003&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing gears</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Piston**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Liner diameter</td>
<td>52495&quot; to 52505&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piston diameter open end (with tin plate)</td>
<td>52405&quot; to 52415&quot;</td>
<td>.006&quot; to .010&quot;</td>
<td>.008&quot; to .012&quot;</td>
</tr>
</tbody>
</table>

**Piston**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Liner diameter</td>
<td>52495&quot; to 52505&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piston diameter closed end</td>
<td>5197&quot; to 5202&quot;</td>
<td>.0475&quot; to .0535&quot;</td>
<td>.0475&quot; to .0535&quot;</td>
</tr>
</tbody>
</table>

**Piston Rings**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring #1 compression, side</td>
<td>.009&quot; to .011&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring #1 compression, end</td>
<td>.020&quot; to .030&quot;</td>
<td>.007&quot; to .008&quot;</td>
<td>.007&quot; to .008&quot;</td>
</tr>
<tr>
<td>Rings #2, #3, #4, compression, side</td>
<td>.020&quot; to .030&quot;</td>
<td>.007&quot; to .008&quot;</td>
<td>.007&quot; to .008&quot;</td>
</tr>
<tr>
<td>Ring oil cooler, side</td>
<td>.0055&quot; to .0025&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring oil cooler, end</td>
<td>.025&quot; to .030&quot;</td>
<td>.005&quot; to .006&quot;</td>
<td>.005&quot; to .006&quot;</td>
</tr>
<tr>
<td>Ring oil drain, side</td>
<td>.005&quot; to .006&quot;</td>
<td>.015&quot; to .025&quot;</td>
<td>.015&quot; to .025&quot;</td>
</tr>
<tr>
<td>Ring oil drain, end</td>
<td>.015&quot; to .025&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring oil scraper, side</td>
<td>.003&quot; to .005&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring oil scraper, end</td>
<td>.003&quot; to .005&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Water Pump**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volute ring diameter</td>
<td>3.996&quot; to 4.0005&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller ring diameter</td>
<td>3.966&quot; to 3.968&quot;</td>
<td>.030&quot; to .0345&quot;</td>
<td>.030&quot; to .0345&quot;</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th></th>
<th>Read At</th>
<th>Lbs. Per Sq. In. Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Water at Pump Discharge to Engine Inlet</td>
<td>Gauge Board</td>
<td>13 to 25</td>
</tr>
<tr>
<td>Sea Water at Pump Discharge</td>
<td>Gauge Board</td>
<td>14 to 25</td>
</tr>
<tr>
<td>Fuel Oil at Injection Pump Inlet</td>
<td>Gauge Board</td>
<td>7 to 21</td>
</tr>
<tr>
<td>Scavenging Air</td>
<td>Gauge Board</td>
<td>22 to 5.0</td>
</tr>
<tr>
<td>Hot Engine Compression—500 ft/sec</td>
<td>Gauge Board</td>
<td>470 to 580</td>
</tr>
<tr>
<td>Maximum Variation on any one engine &amp; Maximum Variation on any one engine</td>
<td>Gauge Board</td>
<td>580</td>
</tr>
<tr>
<td>Lubricating Oil at Engine upper header</td>
<td>Gauge Board</td>
<td>30</td>
</tr>
<tr>
<td>Lubricating Oil Outlet to Cooler</td>
<td>Gauge Board</td>
<td>1225</td>
</tr>
<tr>
<td>Lubricating Oil Outlet—Preferred</td>
<td>Gauge Board</td>
<td>60</td>
</tr>
</tbody>
</table>

**b. Temperatures**

<table>
<thead>
<tr>
<th></th>
<th>Read At</th>
<th>Degrees Fahrenheit Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricating Oil Outlet to Cooler</td>
<td>Gauge Board</td>
<td>140 to 100</td>
</tr>
<tr>
<td>Lubricating Oil Outlet—Preferred</td>
<td>Gauge Board</td>
<td>105</td>
</tr>
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</table>
Engine Data (Continued)

<table>
<thead>
<tr>
<th>Read At</th>
<th>Degrees Fahrenheit Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricating Oil Differential—In-Out</td>
<td>Gauge Board 40 Max.</td>
</tr>
<tr>
<td>Lubricating Oil Differential—In-Out—Preferred</td>
<td>Gauge Board 25</td>
</tr>
<tr>
<td>Fresh Water Outlet to Cooler—Preferred</td>
<td>Gauge Board 160</td>
</tr>
<tr>
<td>Fresh Water Differential—In-Out</td>
<td>Gauge Board 20 Max.</td>
</tr>
<tr>
<td>Fresh Water Differential—In-Out—Preferred</td>
<td>Gauge Board 10</td>
</tr>
<tr>
<td>Exhaust (Combined at Exhaust Nozzle or Nozzles)</td>
<td>Gauge Board 360 to 590</td>
</tr>
<tr>
<td>Exhaust Variation at Any One Engine</td>
<td>Gauge Board 100 Max.</td>
</tr>
<tr>
<td>Exhaust Maximum</td>
<td>Gauge Board 590</td>
</tr>
</tbody>
</table>

c. Miscellaneous

| Overspeed Governor Trips at R.P.M. | 1200 - 1370 |
| Blower Suction—Vacuum—Inches of Water | 5 to 4.3 |
| Rack 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 | 0.122 to 0.157 |
| Piston Head Clearance Max. variation any one Engine | 0.15 |

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 32N3800E54.

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 CY77—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. 11½"

### Storage Batteries:

- **Type**: Gould or Exide.
- **Number of Cells - 2 Groups - 126 cells**: 262
- **Voltage, Max. Sp.gr. at 120° F - 1.250**: 262.5 V
- **Hours**: 1/2, 1, 3, 5, 10, 20, 30, 40, 50, 60
- **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'-5.121"
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'-2-1/2"
Lowest Point of Keel to Top of Vertical Antenna Mast Support - - - - - - - - - - - - - - - - - - 42'-10-1/2"

HOSE CONNECTIONS (AIR)

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>No.</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease Gun Connection</td>
<td>For'd. Torpedo Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Officers Quarters</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Control Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Crew's Mess</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Crew's quarters</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>For'd. Engine Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Aft. Engine Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>Maneuvering Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Grease Gun Connection</td>
<td>After Torpedo Room</td>
<td>1</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Pneumatic Air</td>
<td>For'd Engine Room</td>
<td>1</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>Pneumatic Air</td>
<td>After Engine Room</td>
<td>1</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>Pneumatic Air</td>
<td>Maneuvering and Motor Room</td>
<td>1</td>
<td>1/2&quot;</td>
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</table>

HOSE CONNECTIONS (WATER)

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>No.</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compt. Hose Connection</td>
<td>For'd. Torpedo Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>Officer's Quarters</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>Control Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>Crew's Quarters</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>For'd. Engine Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>After Engine Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>Maneuvering Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compt. Hose Connection</td>
<td>After Torpedo Room</td>
<td>1</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Description</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21&quot; Mk. XXXI - Mod. 3 - Bow Torpedo Tubes</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21&quot; Mk. XXXI - Mod. 3 - Stern Torpedo Tubes</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4&quot; /50 Cal. Gun Mount - Mk. 12 - Mods. 38 to 41</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 MM. Anti-Aircraft Machine Gun Mounts Mk. 10</td>
<td>2</td>
<td></td>
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</tbody>
</table>

### TORPEDOES, ETC.

<table>
<thead>
<tr>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>21&quot; Torpedo, Mk. 14-1 or 3</td>
<td>24</td>
</tr>
<tr>
<td>War Heads, Mark 16</td>
<td>24</td>
</tr>
<tr>
<td>Exploder Mech., Mark 6-1</td>
<td>24</td>
</tr>
<tr>
<td>Warhead Ext., Mk. A</td>
<td>24</td>
</tr>
<tr>
<td>Torp. Igniter, Mark 6-2</td>
<td>24</td>
</tr>
<tr>
<td>Detonator, Mark 7</td>
<td>24</td>
</tr>
<tr>
<td>Booster Charges</td>
<td>24</td>
</tr>
</tbody>
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### SMALL ARMS

<table>
<thead>
<tr>
<th>Description</th>
<th>Stowage Provided For</th>
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<tbody>
<tr>
<td>Rifles, .30 Cal. Model 1903</td>
<td>6</td>
</tr>
<tr>
<td>Pistols, .45 Cal. Colt Automatic</td>
<td>12</td>
</tr>
<tr>
<td>Machine Guns, .30 Cal. Browning M1917</td>
<td>2</td>
</tr>
<tr>
<td>Automatic Rifles, .30 Cal. Browning M1919</td>
<td>2</td>
</tr>
<tr>
<td>Submachine Gun, .45 Cal. Thompson M1928</td>
<td>2</td>
</tr>
<tr>
<td>Pistol, .22 Cal. Gallery Target</td>
<td>1</td>
</tr>
<tr>
<td>Shotgun, Riot, 12-gauge, M1897</td>
<td>2</td>
</tr>
</tbody>
</table>

### LINE THROWSING EQUIPMENT

<table>
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</thead>
<tbody>
<tr>
<td>Rifle, .45 Cal. Line Throwing</td>
<td>1</td>
</tr>
<tr>
<td>Projectiles, Cal. .45 Line Throwing</td>
<td>10</td>
</tr>
<tr>
<td>Blank Cartridges for .45 Cal. Line Throwing Rifle</td>
<td>50</td>
</tr>
</tbody>
</table>

### ALLOWANCE OF AMMUNITION

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; /50 Cal. Cartridges in Tanks, Mk. 4</td>
<td>100</td>
</tr>
<tr>
<td>4&quot; /50 Cal. Short Cartridge Cases in Modified Tanks</td>
<td>2</td>
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</tbody>
</table>

### SMALL ARMS AMMUNITION - SERVICE

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>.45 Cal. Cartridge, Ball, for Colt Automatic Pistol</td>
<td>2000</td>
</tr>
<tr>
<td>.30 Cal. Cartridge, Ball</td>
<td>19,500</td>
</tr>
<tr>
<td>20 MM. Cartridges - Consisting of 1/3 A.P.T., &amp; 1/3 H.E.T., and 1/3 H.E.I.</td>
<td>3,960</td>
</tr>
<tr>
<td>12 Gauge Shells (No. 00 Buckshot)</td>
<td>50</td>
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</tbody>
</table>

### TRAINING

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>4&quot; /50 Cal. Dummy Drill Cartridges, Mk. 3, in Mk. 4 Tanks</td>
<td>4</td>
</tr>
<tr>
<td>4&quot; /50 Cal. Test Cartridge Cases, Mk. 2, in Mk. 4 Tanks</td>
<td>2</td>
</tr>
<tr>
<td>Primers, Lock, Drill (Annual Allowance)</td>
<td>20</td>
</tr>
<tr>
<td>20 MM. Cartridges, Dummy Drill, in Mk. 3 Boxes</td>
<td>2</td>
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### PYROTECHNICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Submarine Identification Signals, Mark 2, Mod. 2 with Grenades, Mk. 5</td>
<td>36</td>
</tr>
<tr>
<td>Flare Signals - Mk. 10 &amp; Mods. (10 each red, green and yellow)</td>
<td>30</td>
</tr>
<tr>
<td>Rocket Signals - 12 each red, green and yellow</td>
<td>36</td>
</tr>
<tr>
<td>Rocket Pistols</td>
<td>2</td>
</tr>
<tr>
<td>Very's Night Signalling Apparatus (Complete)</td>
<td>1 Box</td>
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</tbody>
</table>

**Date:** 6 SEPT 43
## COMPLEMENT

<table>
<thead>
<tr>
<th>Position</th>
<th>No.</th>
<th>Total</th>
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<tbody>
<tr>
<td>Commanding Officer</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Wardroom Officers</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Gunners Mate 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Torpedoman Mate - Chief</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Torpedoman Mate - 1st Class</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Torpedoman Mate - 2nd Class</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Torpedoman Mate - 3rd Class</td>
<td>4</td>
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</tr>
<tr>
<td>Quartermaster - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Quartermaster - 2nd Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Quartermaster - 3rd Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Signalman - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fire Control Man - (Material) 1st Class</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Seaman - 1st Class</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Electricians Mate - Chief</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Electricians Mate - 1st Class</td>
<td>2</td>
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</tr>
<tr>
<td>Electricians Mate - 2nd Class</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Electricians Mate - 3rd Class</td>
<td>3</td>
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<tr>
<td>Radioman - Chief</td>
<td>1</td>
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<tr>
<td>Radioman - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Radioman - 2nd Class</td>
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<td></td>
</tr>
<tr>
<td>Radioman - 3rd Class</td>
<td>1</td>
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<tr>
<td>Radio Technician - 1st Class</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Radio Technician - 2nd Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Motor Machinists Mate - Chief</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Motor Machinists Mate - 1st Class</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Motor Machinists Mate - 2nd Class</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Fireman - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yeoman - 1st Class</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pharmacists Mate - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Baker - 1st Class</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ships Cook - 1st Class</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ships Cook - 3rd Class</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Stewards Mate - 1st Class</td>
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<tr>
<td>Stewards Mate - 2nd Class</td>
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Total Ship's Officers: 7
Total Ship's Crew: 69
Total Ship's Complement: 76
### VARIABLE TANKS

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<tr>
<th>Tanks</th>
<th>Cu.Ft.</th>
<th>Lbs.</th>
<th>Tons S.W.</th>
<th>Tons F.W.</th>
<th>Bot. Keel</th>
<th>Fwd.</th>
<th>Aft</th>
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<td>860</td>
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<tr>
<td>Aux. No. 1</td>
<td>1094</td>
<td>70016</td>
<td>31.26</td>
<td>9.12</td>
<td>-</td>
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<tr>
<td>Aux. No. 2</td>
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<td>70016</td>
<td>31.26</td>
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<td>139.11</td>
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| 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| 60.80 | 24.41 |

### 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.N. | 206 | 13184 | 5.89 | 12.08 | 117.06 |
| 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.H. | 157 | 10048 | 4.49 | 14.83 | 139.03 |

### MAIN BALLAST TANKS INCLUDING VENT PIPING

| H.B.T. No. 1 | 1700 | 48.58 | 6.85 | 85.84 |
| H.B.T. No. 2A | 1128 | 32.22 | 9.92 | 41.26 |
| H.B.T. No. 2B | 1128 | 32.22 | 9.92 | 41.26 |
| H.B.T. No. 2C | 1166 | 33.31 | 9.24 | 27.61 |
| H.B.T. No. 2D | 1166 | 33.31 | 9.24 | 27.61 |
| F.B.T. No. 3A | 1310 | 37.42 | 9.14 | 15.19 |
| F.B.T. No. 3B | 1310 | 37.42 | 9.14 | 15.19 |
| H.B.T. No. 4A | 1586 | 45.31 | 9.17 | 12.48 |
| H.B.T. No. 4B | 1586 | 45.31 | 9.17 | 12.48 |
| 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 | 39.19 | 9.21 | 30.98 |
| M.B.T. No. 6B | 1197 | 39.19 | 9.21 | 30.98 |
| M.B.T. No. 6C | 1260 | 36.00 | 9.05 | 30.98 |
| M.B.T. No. 6D | 1260 | 36.00 | 9.05 | 30.98 |
| H.B.T. No. 7 | 1430 | 40.85 | 8.80 | 108.90 |
| Safety        | 847  | 24.19 | 9.34 | 7.00  |
| Total M.B. & S.| 21909 | 625.88 |  |  | 222.26 | 6.37 |

### LEAD DEDUCTION

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<th>Cu.Ft.</th>
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From Ports.No, 658-308 - Subject to correction for SS381-404.
### Normal Fuel Oil Tanks

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<th>Tank</th>
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<th>Tons Oil</th>
<th>Tons S.W.</th>
<th>C.G. Above</th>
<th>C.G. From Fr. 66½</th>
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<tr>
<td>M.F.O. No. 1</td>
<td>1524</td>
<td>11400</td>
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<td>43.54</td>
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<td>M.F.O. No. 2</td>
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<td>49.86</td>
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<td>M.F.O. No. 6</td>
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<td>M.F.O. No. 7</td>
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<tr>
<td>Expansion</td>
<td>398</td>
<td>2980</td>
<td>9.48</td>
<td>11.37</td>
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<tr>
<td>C.F.O. No. 1 95%</td>
<td>64</td>
<td>475</td>
<td>1.52</td>
<td>1.83</td>
<td>5.27</td>
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<tr>
<td>C.F.O. No. 2 95%</td>
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<td>475</td>
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</table>

### 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             | 38550| 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 | 3.94     | 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  | 0.64     | 3.20      | 91.79      |
| M. & R.G. Sump 2  | 25               | 184  | 0.64     | 3.20      | 91.79      |
| TOTAL Sump        | 266              | 1372 | 6.84     |           |            |
| Maximum L.O.      | 777              | 5787 | 19.98    |           |            |

### Compartment Capacities Aft Fr. 66½ (Floodable Volume)

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### Compartment Capacities Fwd. Fr. 66½ (Floodable Volume)

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<td>Conning Tower</td>
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From Ports No. 658-308 - Subject to correction for - SS381-404
<table>
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<tr>
<th>COMP. TANK</th>
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<th>FLOOD ED TOTAL</th>
<th>EFFECT LIST DEG</th>
<th>DRAFT MEAN FT.-IN</th>
<th>RESERVE BUCYANCY AFTERS TONS</th>
<th>VOLUME GROSS</th>
<th>FLOOD ED TOTAL</th>
<th>EFFECT LIST DEG</th>
<th>DRAFT MEAN FT.-IN</th>
<th>RESERVE BUCYANCY AFTERS TONS</th>
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<tr>
<td>Ford. Tr.</td>
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<td>116 LIST DEG</td>
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<td>12-3</td>
<td>155 LIST DEG</td>
<td>127</td>
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<td>12-3</td>
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**Typical Ship (SS285)**

**Flooding Effects**

**From Floodable Effects Diagram - Ports No. 661-285.**
Section A-1-a

GENERAL - WEIGHTS

Tabulation of Weights in Ship:

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<th>Item</th>
<th>Surface</th>
<th>Emergency</th>
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<td>Air, Oil, Water in System</td>
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Variable Ballast, estimated

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<td>F.W.R.T. Tank</td>
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<td>A.W.R.T. Tank</td>
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<td>Forward Trim</td>
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<td>Auxiliary</td>
<td>16.4</td>
<td>38.4</td>
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<td>A.T.</td>
<td>11.1</td>
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Variable Ballast, Total (designed) 41.00 57.00

Main Ballast

<table>
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<tr>
<th>Item</th>
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<th>Emergency</th>
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<tr>
<td>Mos. 1, 2, 3, 4, 5, 6 &amp; 7</td>
<td>612.80</td>
<td>466.31</td>
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<td>Safety</td>
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<td></td>
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<tr>
<td>Negative</td>
<td>0</td>
<td>0</td>
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</table>
BOARD OF INSPECTION AND SURVEY
NAVY DEPARTMENT
TACTICAL DIAMETERS
OF THE
USS BATFISH
27 SEPTEMBER 1943
SCALE: 1" = 100 FT
DRAWN BY: USS B
APPROVED: W. N. O.
November 1943
REPRODUCED BY: CAPTAIN J. S. M.

32.1
DOCKING

Reference (a) Docking Plan for the individual Ship.
(b) Appendix 5, General Specification for Building Vessels of the Navy. (Nov. 1942 or later edition)
(c) Painting Schedule S3381-404 (Pt. 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.

<table>
<thead>
<tr>
<th>Blocks</th>
<th>No.</th>
<th>Ft. Spaced</th>
<th>Location (Position No.1)</th>
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<tr>
<td>Keel Blocks</td>
<td>23</td>
<td>6</td>
<td>Fr. 38 to 99½</td>
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<tr>
<td>Pier Blocks</td>
<td>6</td>
<td>Fwd. 18'</td>
<td>Fr. 19½ to 24</td>
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<td></td>
<td></td>
<td>Aft. 24&quot; &amp; 6'</td>
<td>Fr. 99½ to 115</td>
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<td>Bilge Blocks</td>
<td>5</td>
<td>16</td>
<td>Fr. 54 to 81, P &amp; S</td>
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<tr>
<td>or 7</td>
<td></td>
<td>12</td>
<td>Fr. 52½ to 82½&quot; P &amp; S</td>
</tr>
</tbody>
</table>

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) Barnacles, 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:

<table>
<thead>
<tr>
<th>Ports. No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<td>544532</td>
<td>Bilge Keels &amp; Stringers</td>
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<tr>
<td>110-285</td>
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<td>Painting Schedule</td>
</tr>
<tr>
<td>308-381</td>
<td></td>
<td>Docking Plan, (Each ship has individual docking plan S3381-404)</td>
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Date: 21 July 1943
<table>
<thead>
<tr>
<th>Item</th>
<th>Service</th>
<th>Size of Hole</th>
<th>Location</th>
<th>Aft Fr.No.</th>
<th>Athwart Ships</th>
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<td>1</td>
<td>Torp. Tube Outboard Vent</td>
<td>2&quot; D.</td>
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<td>2</td>
<td>For'd. Torp. Rm. Sea Press. Gauge</td>
<td>1-9/12&quot; D</td>
<td>10&quot;</td>
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<tr>
<td>3</td>
<td>Submerged Log</td>
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<td>6-9/16&quot;</td>
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<td>#1 Sanitary Tank Disch.</td>
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<td>6-7/8&quot;</td>
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<td>7&quot;</td>
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<td>Sea Press. Gauge</td>
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<td>Comb. Refrig. Air Cond. &amp; H.P. Air Comp.</td>
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<td>52</td>
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<td>2½-2¾&quot; x</td>
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<td>89</td>
<td>7½-1½&quot;</td>
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<td>53</td>
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<td>89</td>
<td>7½-1½&quot;</td>
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Reference Plans:

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<td>544532</td>
<td>Bilge Keels &amp; Stringers</td>
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<td>S3404-50700-68100</td>
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Date: 21 July 1943
Section A-5
TORPEDO CONTROL SYSTEM

Ref: Section S71-I 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 0 to 25 kts.
- Target Speed 0 to 8000 yds.
- Present Range (for Generation of Bearing) 300 to 8000 yds.
- Gyro Angle 210° - 30° - 150°
- Torpedo Gyro Angle Order 210° - 30° - 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 (Nos. 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, 7C, 7K and 95.
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.

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 light 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. lba.
2. Torque, output shaft - starting - Max. 14 ft. lba.
3. Torque, output shaft - Min. 1.0 ft. lba.
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 10° gyro angle per second allowed - 12 Min.
9. Error, at 15° gyro angle per second allowed - 9 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.

The Gyro Setter line switch controls the power supply to the driving motor. Overload protection is also provided. Slow over 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 both 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 for 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 speed 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, synchronous 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.
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).
15. Depth settings.
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 axes). 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:

<table>
<thead>
<tr>
<th>Elements</th>
<th>Units</th>
<th>Operational Limits</th>
<th>Least Graduations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own course</td>
<td>Degr &amp; Mins.</td>
<td>0-360</td>
<td>10'</td>
</tr>
<tr>
<td>Enemy course</td>
<td>Degrees</td>
<td>0-360</td>
<td>2°</td>
</tr>
<tr>
<td>True bearings</td>
<td>Degrees</td>
<td>0-360</td>
<td>10°</td>
</tr>
<tr>
<td>Enemy speed</td>
<td>Knots</td>
<td>0-40</td>
<td></td>
</tr>
<tr>
<td>Own speed</td>
<td>Knots</td>
<td>0-22</td>
<td></td>
</tr>
<tr>
<td>Depth speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variation</td>
<td>Knots</td>
<td>0-4</td>
<td></td>
</tr>
<tr>
<td>Depth Variation</td>
<td>Feet</td>
<td>10-50</td>
<td>1</td>
</tr>
<tr>
<td>Present range</td>
<td>Yards</td>
<td>0-8000</td>
<td>(Counters)</td>
</tr>
<tr>
<td>Predicted run</td>
<td>Yards</td>
<td>300-4500</td>
<td>100</td>
</tr>
<tr>
<td>Relative bearing sound</td>
<td>Degrees</td>
<td>0-360</td>
<td>2°</td>
</tr>
<tr>
<td>Relative bearing</td>
<td>Degr &amp; Mins.</td>
<td>0-360</td>
<td>10°</td>
</tr>
<tr>
<td>Angle on Row</td>
<td>Degrees</td>
<td>0-180</td>
<td>2°</td>
</tr>
<tr>
<td>Track angle</td>
<td>Degrees</td>
<td>0-180</td>
<td>2°</td>
</tr>
<tr>
<td>*Gyro Angle</td>
<td>Degr &amp; Mins.</td>
<td>210-0-150</td>
<td>1°</td>
</tr>
<tr>
<td>Time</td>
<td>Mins &amp; Sec.</td>
<td>0-60</td>
<td>1 sec, 5 min.</td>
</tr>
<tr>
<td>Target length</td>
<td>Feet</td>
<td>300-1000</td>
<td>10</td>
</tr>
</tbody>
</table>

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.
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
MK 15 MOD 7 - STERN

ELECTRO MECHANICAL TRANSMISSION
DIAGRAM OF

SHIPS DATA - AUTO

GYRO COMPASS L.C.
COURSE

PITOMETER
SPEED

HAND - DEPTH GAUGE READING

ELECTRONIC DATA COMPUTER

OBSERVATION -
- HAND SET
- ENEMY DATA

- COURSE
- SPEED
- RANGE
- BEARING
- LENGTH

METHODS OF OBS -
(1) PERISCOPE
(2) PELUCHE
(3) SOUND - ECHO
- LISTENING

1 3 5
2 4 6
7 9
8 10
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) C.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 by the remaining sections. (If the "Recordar" 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 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 2" to 30 diameters. However, for a 8" x 13" 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 No. (1st block Number)
   (2) by Filing Manual Classification (2nd block Number)
   (3) by numeric order in class (3rd block Number)

The Navy 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 20") 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 filling 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

**Hull (Mechanical)**
(1) Periscopes
(2) H.P. Air Compressor
(3) L.P. Air Compressor
(4) Air Compressor 225 lb.
(5) Trim Pump
(6) Drain Pump
(7) Reduction Valves
(8) 21" S/H T/T Mk. 34 & 35, Description of.
(9) Airflow Heter

**Hull (Electrical)**
(10) Electric Range
(11) Electric Coffee Urn
(12) Electric Refrigerator (WR)
(13) Electric H.W. Heaters

**Machinery**

Main Engines
Electrical Propulsion
Auxiliary Engine
L.P. Purifiers
Refrigeration (cold storage)
Refrigeration (Air Cond.)
Kleinschmidt Still
**Motor Boat Engine**
**Lathe 14"**

Contractor
Polimorgen
Hardie-Tynes
Roots-Connersville
Ingersoll-Rand
Gardner-Denver
Gardner-Denver
Grove
PHY No. 5-3149
Republic Flowmeter Co.

Edison G.F. Co.
Flickman
York
Automatic Elec. Heater

Fairbanks, Morse
Elliott Co.
Fairbanks, Morse
Sharples
York
York
E.M. Badger
NY Mor., Va.
Stokes Industries
MACHINERY (Electrical)

Electric Plant Data - S/H - MBS 605
*Motor Generator, A.C.
*Speed and Voltage Reg. A.C.H.G.
Circuit Breakers - Type AL - 24

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

Hydrogen Detector
General Announcing
Telephone, Sound Powered
Electric Telegraph
Shaft Rev. Ind.
Searchlight
Underwater Log
Gyro Compass
Radar Equipment SD
Radar Equipment SJ
Radio Trans., TBL 7
Radio Rec’g, RAK/RAI 6
Radio Direction Finder
Calibrated Freq. Indicator Mod. LH-11
Sound Echo Ranging & Listening WCA & WCA-1
Machinery History Binder
Shipboard Tests - Machinery
Radio Broadcast Receiving, Model RRO
Loop Switching Adapter, Loop Coupling
Unit for use with RAK equipment
**Submarine Bathyskymograph

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

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

3. Allowance List, Hull (Ex-S and A).
4. Allowance List, Hull (Ex-Mav).
5. Allowance List, Machinery.
6. Allowance List, Ordnance.
8. Auxiliaries (Record of Electrical) Volume I - Description.
10. Inclining Experiment Booklet.
11. Flooding Efficiency - Diagram.
**Furnished with Equipment.

BOOKS ISSUED BY THE NAVY YARD.

1. Instructions for Painting & Cementing Vessels, Appendix 6.
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 Terms, Labelling.
8. Specifications 17H10, 17C10, 17M17, and 17C17.
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. 108-381
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.

<table>
<thead>
<tr>
<th>Tank</th>
<th>Testing Medium</th>
<th>Test Feet</th>
<th>Head Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary ballast, individually</td>
<td>Water</td>
<td>412</td>
<td>30</td>
</tr>
<tr>
<td>Fresh Water, Ship's</td>
<td>Air</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Fresh Water, Battery</td>
<td>Air</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Fuel oil, fuel-ballast, collecting, expansion, individually</td>
<td>Water</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>Fuel oil, clean, individually</td>
<td>Water</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Motor &amp; Red. gear sumps</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>Main engine sumps</td>
<td>Water</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Engine lube oil stow. Nos. 1, 2, 3, 4</td>
<td>Water</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Main Ballast, individually</td>
<td>Air</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>Sanitary, including gages and fittings</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>Trimming</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>W.R.T.</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>Motor &amp; Red. gear L.O. Stowage</td>
<td>Water</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td>(1) Miscellaneous Auxiliaries</td>
<td>Hydostatic Pressure</td>
<td>Pounds per sq. inch</td>
<td></td>
</tr>
<tr>
<td>** Doors, W.T. (External) 30&quot; Dia.</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>*** Covers, hatch, W.T.</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>* Doors, W.T.</td>
<td></td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>Water closets, waste receivers</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Water jackets, H.P. air compressor</td>
<td></td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>Signal ejector, hull casting</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Tubes, torpedo, parts prior to assembly (Shop test).</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Tubes, torpedo, after installation</td>
<td>20# Air</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Tubes, radio entering, external</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Valves, outboard and hull, ship's ventilation, with trunks</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Valves, safety tank and variable ballast tank, flood and vent (Inboard)</td>
<td></td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>Valves, (including safety Tk.) main ballast tank, main vent</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Valves, safety tank emergency vent</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>(2) Compartments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual compartments (Allowable drop 4 oz. in 10 min.)</td>
<td></td>
<td>15 lbs.</td>
<td></td>
</tr>
</tbody>
</table>

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.

* 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.

GIB 381-404 D-1 20 September 1943

U.S. NAVY YARD, PORTSMOUTH, N.H.
<table>
<thead>
<tr>
<th>System</th>
<th>S</th>
<th>T</th>
<th>S</th>
<th>T</th>
<th>S</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Piping Misc.</td>
<td></td>
<td></td>
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<td>Air, M.P.</td>
<td>4500</td>
<td>4500</td>
<td></td>
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<tr>
<td>Air Banks</td>
<td>3000</td>
<td>3000</td>
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<tr>
<td>Air L.P. blow from hull valves out</td>
<td>300</td>
<td>300</td>
<td></td>
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<tr>
<td>Air L.P. blow from hull valve to manifold</td>
<td>300</td>
<td>300</td>
<td></td>
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<tr>
<td>Air, 225 lb.</td>
<td>338</td>
<td>338</td>
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<td>Air, 225 lbs. volume tanks</td>
<td>676</td>
<td>676</td>
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<td>Air, salvage</td>
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<tr>
<td>Air, M.B. blow, incl. stop check and regulator valves</td>
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<td>Air, M.E. Starting</td>
<td></td>
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<td>(1) Complete to eng. red. valves</td>
<td>4500</td>
<td>4500</td>
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<td>(2) Red. Valve to starting valve</td>
<td>450</td>
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<td></td>
<td></td>
<td>300</td>
<td>300</td>
<td></td>
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<tr>
<td>Circ. Water, sea, Main Motors</td>
<td></td>
<td></td>
<td>300</td>
<td>300</td>
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<td></td>
<td>75</td>
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<tr>
<td>Drainage suction lines between sea &amp; pump</td>
<td></td>
<td></td>
<td>300</td>
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<tr>
<td>Fuel oil lines</td>
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<td>Lube oil Sys., filling &amp; distributing</td>
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<td></td>
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<td>Lube oil Sys., M.E. to &amp; incl. checks in sump tanks</td>
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<td>Oxygen System, each comp.</td>
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<td>Refrigerating FL2 piping</td>
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<td>Pressure side</td>
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<td>Suction side</td>
<td>225</td>
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<tr>
<td>Torpedo impulse piping &amp; tanks</td>
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<td></td>
<td>900</td>
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<td>Ventilation, shipb outside pressure hull, valves gagged</td>
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<td>200</td>
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<td>Ventilation, shipb, piping &amp; hull valves</td>
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<td>18</td>
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<td>(2) Hydraulic</td>
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<td>Accumulator, air side</td>
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<td></td>
<td>2900</td>
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<tr>
<td>Accumulator, oil side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1200</td>
<td>1200</td>
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<tr>
<td>Main pressure</td>
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<td>1200</td>
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<tr>
<td>Mains, working side</td>
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<td></td>
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<td>1200</td>
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<tr>
<td>Replenishing line, not incl.supply tank</td>
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<td>(3) Steering Gear</td>
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<tr>
<td>Control Cyl. &amp; Lines to change valve</td>
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<td></td>
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<td>900</td>
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<tr>
<td>Ram Cyl., piping, manifolds, &amp; valves</td>
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<td></td>
<td></td>
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<td>1800</td>
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<td>Replenishing &amp; vent lines, Valves &amp; fittings:</td>
<td></td>
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<td>150</td>
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<tr>
<td>3(a) Bow Diving - Same</td>
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</tr>
<tr>
<td>3(b) Stern Diving - Same</td>
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<td></td>
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</tr>
<tr>
<td>3(c) Windlass &amp; Capstan - Same</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
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 DD 717 T/T testing sets, Mark 1, Mod. 1, 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.
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 1\(\frac{1}{2}\)" 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 3\(\frac{1}{2}\)" 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" athwartships, with 3' R. on corners. In way of frame 39, the portable plate is secured with 4 - 1" x 3/4" Ni-Cu tap bolts. There is a 1/8" thick m.s. 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. (Forward Room). Clear Opening 2' 2-7/8" x 3' 4" with corners on a 6" R. The inboard run of the hole stands 13\(\frac{1}{2}\)" of ship's centerline to starboard. Forward edge of the hole stands 6" abait frame 56 and the after edge stands 2'-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. (At battery space). Clear opening 17\(\frac{1}{2}\)" x 27" (13\(\frac{1}{2}\)" 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 5'-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'-0" athwartships. Forward edge 9" abait 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:

<table>
<thead>
<tr>
<th>Port No.</th>
<th>Pu Ships No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>56-381</td>
<td>490920</td>
<td>Portable Plates - Frames 84 to 87 - 93 to 96 - 103 to 106.</td>
</tr>
<tr>
<td>57-308</td>
<td>490880</td>
<td>Portable Plates - Frames 38 to 40 - 56 to 56 - 69(\frac{1}{2}).</td>
</tr>
<tr>
<td>58-381</td>
<td>387252</td>
<td>Access Hatches at Frames 76(\frac{1}{2}) and 94(\frac{1}{2}).</td>
</tr>
<tr>
<td>72-285</td>
<td>387252</td>
<td>Torpedo Loading Matches.</td>
</tr>
<tr>
<td>161-381</td>
<td>544567</td>
<td>Access Hatch &amp; Cover to Cool Room.</td>
</tr>
<tr>
<td>288-381</td>
<td>544568</td>
<td>Hatch Davit (Portable) Location, Details and Installation.</td>
</tr>
</tbody>
</table>
Rudder

See section on steering.

The rudder is 10'-8" high D.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 hydrodynamic balance viz. 20 K. ahead, 13° rudder. (BuShips 312983)

Table of Transfer of Stress - Rudder to Snip

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Pressure</td>
<td>Rudder</td>
<td>100 sq. ft.</td>
</tr>
<tr>
<td>Rudder</td>
<td>Key (tip of stock)</td>
<td>1-1/8 x 1 x 18(\frac{1}{2})</td>
</tr>
<tr>
<td>Key (tip of stock)</td>
<td>Rudder Stock Taper</td>
<td>8.98 D x 19-5/8</td>
</tr>
<tr>
<td>Taper (tip)</td>
<td>Stock (head)</td>
<td>9.0 x 7(\frac{1}{2}) - 8-1/8</td>
</tr>
<tr>
<td>Stock</td>
<td>Stern Post:</td>
<td></td>
</tr>
<tr>
<td>Stock (tip)</td>
<td>Lower Bearing (wood)</td>
<td>9.78 D x 19-5/8</td>
</tr>
<tr>
<td>Key (head)</td>
<td>Upper Bearing (wood)</td>
<td>9.78 D x 12</td>
</tr>
<tr>
<td>Cross Head</td>
<td>Pintle Bearing (wood)</td>
<td>7.14 x 15(\frac{1}{2})</td>
</tr>
<tr>
<td>Rudder Wgt. (11,000 lb.)</td>
<td>Key (at head)</td>
<td>1-1/8 x 1 x 20-3/8</td>
</tr>
<tr>
<td></td>
<td>Cross Head</td>
<td>9.0 D x 21 high</td>
</tr>
<tr>
<td></td>
<td>Conn. Rod Pins (2)</td>
<td>2.375 D x 9</td>
</tr>
<tr>
<td></td>
<td>Stern Post Casting Thrust Ball Race</td>
<td>16 Balls, (\frac{1}{2}) D x 12(\frac{1}{8}) PD</td>
</tr>
</tbody>
</table>

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 (2\(\frac{1}{2}\)" 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 eight inch.

Reference plans:

<table>
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<tr>
<th>Port</th>
<th>BuShips No.</th>
<th>Title</th>
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<tr>
<td>645-201</td>
<td>312983</td>
<td>Steering Gear Rudder - Calculations and Curves</td>
</tr>
<tr>
<td>848-201</td>
<td>312335</td>
<td>Steering Gear - Rudder and Rudder Stock - Details</td>
</tr>
<tr>
<td>849-201</td>
<td>312336</td>
<td>Steering Gear - Rudder Stock Crosshead and Details</td>
</tr>
</tbody>
</table>
Section H-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 hydrofoil of built-up bat wing, construction - cast steel hub and web, fabricated area finished all over with 10.29 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:

<table>
<thead>
<tr>
<th>Misc.</th>
<th>Ft.</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bow Plane Area, sq. ft. each</td>
<td>62</td>
<td>-</td>
</tr>
<tr>
<td>Bow Plane, each max. torque (24°) in lbs., 9K</td>
<td>95,000</td>
<td>-</td>
</tr>
<tr>
<td>Bow Planes, each min. torque (12°) in lbs., 9K</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Bow Planes, each negative torque (5°) in lbs., 9K</td>
<td>16,000</td>
<td>-</td>
</tr>
<tr>
<td>Bow Planes, each max. sea slap torque in lbs.</td>
<td>1,926,000</td>
<td>- (design fig.)</td>
</tr>
<tr>
<td>Bow Plane Wgt. complete, lbs.</td>
<td>5,000</td>
<td>-</td>
</tr>
<tr>
<td>Bow Plane Stock, C.L. Position - Fwd. of Fr. 18</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Bow Plane Hinge Pin, A.B.</td>
<td>-</td>
<td>17 0</td>
</tr>
<tr>
<td>Bow Plane, length O.A.</td>
<td>-</td>
<td>10 4</td>
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<tr>
<td>Bow Plane Stock, length to outer edge</td>
<td>-</td>
<td>9 1</td>
</tr>
<tr>
<td>Bow Plane Stock (each) length to C.L. hinge pin</td>
<td>Port</td>
<td>5 5 2 7/8</td>
</tr>
<tr>
<td>Bow Plane Stock (each) length to C.L. hinge pin</td>
<td>Std.</td>
<td>5 5 2 7/8</td>
</tr>
<tr>
<td>Bow Plane Stock dia., effective</td>
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<td>8.750</td>
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<tr>
<td>Bow Plane Hinge Pin - length</td>
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<td>7 1/8</td>
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<tr>
<td>Bow Plane Hinge Pin - dia. (effective)</td>
<td>-</td>
<td>5.718</td>
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</table>

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, hydrofoil, 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 (shaft 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 10.29 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 3") 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:

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Plane, area (std.) sq.ft.</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Plane, length, O.A.</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Plane, width, O.A.</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Stock, length, O.A.</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Stock, dia. O.A.</td>
<td>8.5</td>
<td>4</td>
</tr>
<tr>
<td>Stock, axis, (fwd. of frame 13)</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Stock, axis A.B. (also propeller hub)</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Plane, width extreme, off ship's CL</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Propeller, hub tip, off ship's CL</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Plane, torque, max. (sea slap) in lbs. (designed)</td>
<td>1,200,000</td>
<td>-</td>
</tr>
<tr>
<td>Plane, torque, max. positive 25°, 9K</td>
<td>60,000</td>
<td>-</td>
</tr>
<tr>
<td>Plane, torque, zero, angle of, 9K</td>
<td>12.5°</td>
<td>-</td>
</tr>
<tr>
<td>Plane, torque, max. negative 5°, 9K</td>
<td>10,000</td>
<td>-</td>
</tr>
<tr>
<td>Plane, counter-balance, leading edge lead approx. lbs.</td>
<td>1,500</td>
<td>-</td>
</tr>
<tr>
<td>Plane, pressure, max. 25°, 9K lbs.</td>
<td>12,500</td>
<td>-</td>
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### Reference Plans: (Bow Planes)

<table>
<thead>
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<th>Ports No.</th>
<th>BuShips No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>713-381</td>
<td>312200</td>
<td>Bow Diving Gear - Arrgt. Forward.</td>
</tr>
<tr>
<td>723-381</td>
<td>312210</td>
<td>Ditto-Tiller &amp; Plane Stock - Details.</td>
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<td>724-201</td>
<td>312211</td>
<td>Ditto-Sector Gears &amp; Connecting Rod Details.</td>
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<td>725-201</td>
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<td>Ditto-Bearings for Plane Stocks.</td>
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### Reference Plans: (Stern Planes)

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<td>386746</td>
<td>Stern Diving Gear - Plane Details.</td>
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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:

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

Sight Approach (surface) (low visibility) is based on the target designation system (circuit 07) 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 #3 equipment (built into remote control unit)
Range indicator "J-B" - "Q-C"
Receiver amplifier "J-B"
Receiver amplifier, JK-QC
Remote control unit "Q-B"
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 2 1/2
  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 22.

TORPEDO ATTACK - TORPEDO CONTROL (CT)
  Gyro compass input
  Torpedo data computer
  Target bearing indicator
  Motor selson 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
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 — tower 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
- CO₂ absorbent container
- Light, emergency, p.p. (2)
- Light fixture — Red
- Misc. electrical fittings, conn. and junction boxes

Reference Plans:

<table>
<thead>
<tr>
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<th>BuShips No.</th>
<th>Title</th>
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<td>Chart Table.</td>
</tr>
<tr>
<td>409–381</td>
<td>490205</td>
<td>Air system — Piping Arrangement in Conning Tower.</td>
</tr>
</tbody>
</table>
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 Compartment under submerged abandon ship conditions.
(d) BuShips Pamphlet - Submarine Safety Respiration and Rescue Devices - 1938.

Design and equipment provide 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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Ship</th>
<th>F.T.R.</th>
<th>A.T.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For collective rescue:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Flange, 63&quot;, on hatch</td>
<td>1</td>
<td>fr. 27-1/2</td>
<td>1</td>
</tr>
<tr>
<td>(2) Submarine Rescue Chamber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For individual escape:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special escape trunk</td>
<td>1</td>
<td>fr. 27-1/2</td>
<td></td>
</tr>
<tr>
<td>(3) Skirt, on hatch</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>(4) Escape Buoy, balsa wood</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(5) Ascending line</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(6) Oxygen Manifold</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(8) Oxygen, Cyl. 200 cu.ft.</td>
<td>11</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(9) Oxygen, Cyl. 200 cu.ft.</td>
<td>11</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(10) Lungs, per man</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(11) Goggles, per man</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(12) Divers' knife</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(13) Portable lantern</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(14) Oxygen, Cyl. 200 cu.ft.</td>
<td>11</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(15) CO₂ Absorbent, per man (lbs.)</td>
<td>7.2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(16) Oxygen Manifolds</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(17) Regulators, Oxygen, with attached gages</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(18) Lung Repair Kit</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(19) CO₂ Testing Outfit</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Communications:

Signal Ejector
QB & QC Projectors

1
1
NOTE: Weigh CO₂ absorbent containers semi-annually for moisture content. Do not paint CO₂ absorbent container.

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

- Limitation of CO₂ 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 CO₂, 18.2 hours.

Notes on CO₂ absorbent:

- Size of absorbent container 6 x 12 x 12 inches - 15 lbs. Amount
- Amount required to absorb one man hour of CO₂ - 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) CO₂ 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 CO₂ from compartment prior to flooding.
- (2) Distribute CO₂ 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 CO₂ 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.
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. 526266, 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 brought 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 CO₂.
- 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 CO₂ is determined by color comparison with set of standard tubes.

Directions for use of CO₂ 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 1/2 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 CO₂ 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 60-65 degrees F. gives readings about 10% too high and a temperature of 85 degrees F. gives readings about 10% too low. A temperature of from 68 to 76 degrees F. 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:

\[
\text{Barometer reading} \times \frac{\% \text{ CO}_2 \text{ read}}{750} = \text{correct percentage}
\]
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.
The vertical antenna mast is mechanically similar in design and operation to a 6"-0.0 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 brakes, worm drive to double winch drums, grooved. The electric circuit carries also an upper limit switch, lower limit switch, slack wire switch, 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 floor, and thence to the winch drums. Limits of travel are regulated by suitably mounted switches.

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) 9' - 5½" above 15' - 2½" mean WL.
- Top of antenna section (lowered position) 29' - 4" above 15' - 2½" mean WL.

Reference Plans:

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<td>312308</td>
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<td>825-285</td>
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<td>Mast for Vertical Antenna - Spring Buffer Details</td>
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</tbody>
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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).

<table>
<thead>
<tr>
<th>Item</th>
<th>Frame</th>
<th>Hoisting Speed</th>
<th>Max. Wkg. Load, Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Forward Socket</td>
<td>40</td>
<td>12 Ft./Min.</td>
<td>3185 (Torpedo)</td>
</tr>
<tr>
<td>In Forward Socket</td>
<td>40</td>
<td>12 Ft./Min.</td>
<td>4550 (Boat)</td>
</tr>
<tr>
<td>In After Socket</td>
<td>100</td>
<td>12 Ft./Min.</td>
<td>3185 (Torpedo)</td>
</tr>
</tbody>
</table>

Reference Plans:

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<th>BuShips No.</th>
<th>Title</th>
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<td>490949</td>
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<td>544533</td>
<td>Boat &amp; Torpedo Derrick - Details</td>
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<td>53275-37523-67544</td>
<td>Torpedo Derrick - Aft Stress - Diagram &amp; Data</td>
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<td>387033</td>
<td>Stowage for 20 Ft. Motor Boat</td>
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<td>Boat &amp; Forward Torpedo Handling Derrick - Stress</td>
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<td>Boat &amp; Torpedo Handling - Metal Blocks</td>
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<td>544704</td>
<td>Torpedo Handling &amp; Stowage - Forward Deck Skid</td>
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<td>Boat &amp; Torpedo Derrick - Rigging</td>
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<td>219-275</td>
<td>490924</td>
<td>Boat &amp; Torpedo Derrick - Kingpost Foundations</td>
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<td>347-275</td>
<td>490913</td>
<td>Stowage in Superstructure for Boat &amp; Torpedo Derrick</td>
</tr>
</tbody>
</table>
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)

<table>
<thead>
<tr>
<th>Location</th>
<th>Hand</th>
<th>Right of Frame</th>
<th>Pressure p.s.i.</th>
<th>No. of Dogs</th>
<th>With or Without</th>
</tr>
</thead>
<tbody>
<tr>
<td>For’ld Escape Trunk</td>
<td>LH</td>
<td>curved 30° D.</td>
<td>0 (a) 300</td>
<td>4</td>
<td>W.O.</td>
</tr>
<tr>
<td>Gun Access Trunk</td>
<td>RH</td>
<td>(cyl.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulkhead at</td>
<td>35</td>
<td>RH flat</td>
<td>30° D (b) 198:</td>
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<td>Bulkhead 9&quot; Aft.</td>
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<td>LH</td>
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<td>Bulkhead 3&quot; Aft.</td>
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<td>Bulkhead 71/2&quot; Aft.</td>
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<td>Bulkhead at</td>
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<td>RH</td>
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<td>W.</td>
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</table>

(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. Wat. seal is by (7/8" B. x 3/8" x 11/16" deep) rubber gasket (8° - 78° 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 88 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. 3-4795.

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 jaw 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-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 (1/8" x 2" 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 system. 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 hand sawing 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 miter gears leading to an operating lever (4'-0 long x 24" 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 not fitted with inboard closing device, nor with an Outside Operating Crank Handle.

Reference Plans:

<table>
<thead>
<tr>
<th>Ports. No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>741-285</td>
<td>490427</td>
<td>W.T. Door - Forward Escape Trunk - Door Frame Details</td>
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<td>743-201</td>
<td>312230</td>
<td>W.T. Door - Conning Tower &amp; Escape Trunk - Inboard Closing Device - Gear Case Details</td>
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<td>744-275</td>
<td>386915</td>
<td>W.T. Door - Conning Tower &amp; Escape Trunk - Inboard Closing Device - Lever &amp; Indicator Details</td>
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<td>745-381</td>
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<td>W.T. Doors - Stops &amp; Catches for Wide Open Position</td>
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<td>746-381</td>
<td>491105</td>
<td>W.T. Doors - List of</td>
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<td>747-285</td>
<td>490439</td>
<td>W.T. Doors - Forward Escape Trunk - Inboard Closing Device - Shaft &amp; Universal Joint Details</td>
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<td>490387</td>
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<td>35955</td>
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<td>W.T. Doors - Door Frame Details</td>
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<td>42076</td>
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<td>W.T. Doors - Gear Details</td>
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<td>42072</td>
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<td>W.T. Doors - Latch Details</td>
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<td>35080</td>
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<td>W.T. Doors - Stop, Latch &amp; Buffer - Arrgt. and Details</td>
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<td>42077</td>
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<td>W.T. Doors - Fixed Deadlight</td>
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Section R-3

HATCHES

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

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>Escape Trunk Forward Upper Hatch</td>
<td>300</td>
<td>25°: Circular: Dished</td>
<td>3</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Escape Trunk Fwd. Lower Hatch</td>
<td>300</td>
<td>21°: oval: Dished</td>
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<td>No</td>
<td>Yes</td>
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<td>Torpedo Loading Hatch - Fwd.</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>Galley &amp; Mess Room Hatch</td>
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<td>Gun Access Trunk - Lower Hatch</td>
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<td>21°: oval: Dished</td>
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<td>No</td>
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<td>35746: 466331</td>
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<td>After Engine Room Hatch</td>
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<td>25°: Circular: Dished</td>
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<td>No</td>
<td>No</td>
<td>35973: 490414</td>
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<tr>
<td>Torpedo Loading Hatch - Aft</td>
<td>300</td>
<td>25°: Circular: Dished</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td>35973: 490414</td>
<td></td>
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</tr>
<tr>
<td>Torpedo Room Hatch - Aft</td>
<td>300</td>
<td>25°: Circular: Dished</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td>35973: 490414</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gun Access Trunk - Upper Hatch</td>
<td>300</td>
<td>25°: Circular: Dished</td>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>35977: 490418</td>
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</tr>
</tbody>
</table>

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, splicer 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, 2" 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.

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. 504 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 is equipped 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 against the line passing through.

Reference Plans:

<table>
<thead>
<tr>
<th>Porta.No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>35875</td>
<td>490416</td>
<td>Hatch Cover - 25&quot; Dia. Dished Plate - Misc. Details</td>
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<td>35876</td>
<td>490417</td>
<td>Hatch Cover - Standard, Escape &amp; Torpedo Loading, Springs &amp; Misc. Details</td>
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<td>35796</td>
<td>466331</td>
<td>Hatch Cover, 21&quot; x 27&quot; Oval - General Arrangement</td>
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<tr>
<td>35797</td>
<td>466332</td>
<td>Hatch Cover - Cover Details</td>
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<td>35798</td>
<td>466333</td>
<td>Hatch Cover - Miscellaneous Details</td>
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<td>466334</td>
<td>Hatch Cover - Latch Details</td>
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<td>Hatch Cover - 25&quot; Diameter Dished Plate for C.T. &amp; G.A. Trunk - General Arrangement</td>
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<td>35878</td>
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<td>Ditto - Cover Details</td>
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<td>35132</td>
<td>390466</td>
<td>Access Hatch 15&quot; x 23&quot; - Flush Type - Welded</td>
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<td>554-201</td>
<td>312141</td>
<td>1&quot; Manifold - Divers Connections - Escape Trunk</td>
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<tr>
<td>1077-285</td>
<td>490481</td>
<td>Hatch Cover - 21&quot; x 27&quot; Oval - Location Stop for Dog Handle in Wide Open Position</td>
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<td>35873</td>
<td>35794</td>
<td>Hatch Cover - 25&quot; Dia. Dished Plate-General Arrgt.</td>
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<td>Ditto - Cover, Spider &amp; Toggle Details</td>
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<td>490449</td>
<td>Hatches - Frames &amp; Covers List</td>
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</table>

GIB 35381-404  R-3  DATE: 12 August 1943  64
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

<table>
<thead>
<tr>
<th>No.</th>
<th>Tank</th>
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<tbody>
<tr>
<td>1</td>
<td>Forward Trim</td>
<td>Forward Torpedo Tank Top</td>
</tr>
<tr>
<td>2</td>
<td>Forward W.R.T. or W.R.M.</td>
<td>Forward Torpedo Tank Top</td>
</tr>
<tr>
<td>3</td>
<td>Sanitary No. 1</td>
<td>Forward Torpedo Tank Top</td>
</tr>
<tr>
<td>4</td>
<td>Aft. W.R.T. or W.R.M.</td>
<td>After Torpedo Tank Top</td>
</tr>
<tr>
<td>5</td>
<td>Sanitary No. 2</td>
<td>Bulkhead 74° Aft Fr. 77</td>
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### DISHED PLATE MANHOLES

<table>
<thead>
<tr>
<th>No.</th>
<th>Tank</th>
<th>Located</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Forward Trim</td>
<td>Outer Hull (Top)</td>
</tr>
<tr>
<td>2</td>
<td>Fresh Water No. 1</td>
<td>Bulkhead 35 (Starboard)</td>
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<tr>
<td>3</td>
<td>Fresh Water No. 2</td>
<td>Bulkhead 35 (Port)</td>
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<tr>
<td>4</td>
<td>Negative</td>
<td>Frames 51-52-53 (Long. Bhd.)</td>
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<tr>
<td>5</td>
<td>Negative</td>
<td>Frames 51-52-53 (Long. R.HD.)</td>
</tr>
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<td>6</td>
<td>Fresh Water No. 3</td>
<td>Bulkhead 92° Forward Frame 57</td>
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<tr>
<td>7</td>
<td>Fresh Water No. 4</td>
<td>Bulkhead 92° Forward Frame 57</td>
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<td>8</td>
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<td>Outer Hull (Port)</td>
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<td>9</td>
<td>Auxiliary No. 2</td>
<td>Outer Hull (Starboard)</td>
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<tr>
<td>10</td>
<td>Mot. &amp; Red. Gear L.O.</td>
<td>Inner Hull</td>
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<tr>
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<tr>
<td>12</td>
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<tr>
<td>13</td>
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<tr>
<td>14</td>
<td>Eng. L.O. Stowage No. 4</td>
<td>Bulkhead 107 (Tank Top)</td>
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<td>15</td>
<td>Aft Trim Tank</td>
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<td>Outer Hull</td>
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<tr>
<td>17</td>
<td>: Access to W.C. Drain</td>
<td>Bsd. 74° Aft Fr. 77</td>
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### FLAT PLATE MANHOLES

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<td>Bow Buoyancy</td>
<td>Main Deck</td>
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<tr>
<td>2</td>
<td>Bilge for Torp. Tube</td>
<td>Forward Torpedo Tank Top</td>
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<td>3</td>
<td>Main Ballast No. 44</td>
<td>Outer Hull (Tank Top) (Starboard)</td>
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<td>4</td>
<td>Main Ballast No. 48</td>
<td>Outer Hull (Tank Top) (Port)</td>
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<td>5</td>
<td>Clean Fuel Oil</td>
<td>Engine Foundation (Forward Engine Room)</td>
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<td>6</td>
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<td>Engine Foundation (Forward Eng. Rm. Std. Fr. 80)</td>
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<td>7</td>
<td>Lub. Oil Sump No. 1</td>
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<td>Engine Foundation (For'ld Eng. Room-Port Fr. 80)</td>
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<td>9</td>
<td>Lub. Oil Sump No. 2</td>
<td>Engine Foundation (For'ld Eng. Room-Port Fr. 83)</td>
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### FLAT PLATE MANHOLES

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<td>Engine Foundation (After Eng. Rm.- Std. Fr. 91)</td>
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<td>12</td>
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<td>Engine Foundation (After Eng. Rm.- Std. Fr. 99)</td>
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<td>13</td>
<td>Lub. Oil Sump No. 4</td>
<td>Engine Foundation (After Eng. Rm.- Port Fr. 91)</td>
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<td>Lub. Oil Sump No. 4</td>
<td>Engine Foundation (After Eng. Rm.- Port Fr. 94)</td>
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<td>Engine Foundation (Forward Engine Room)</td>
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<td>Engine Lub. Oil Stow. No. 3</td>
<td>Bhd. 13° Forward Fr. 99 (Tank Top) Starboard</td>
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### FLUSH TYPE MANHOLES

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<td>Normal Fuel Oil No. 1</td>
<td>Outer Hull (Bottom Starboard)</td>
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<td>2</td>
<td>Normal Fuel Oil No. 2</td>
<td>Outer Hull (Bottom Port)</td>
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<tr>
<td>3</td>
<td>Fuel Oil Expansion</td>
<td>Outer Hull (Bottom Starboard)</td>
</tr>
<tr>
<td>4</td>
<td>Fuel Oil Collection</td>
<td>Outer Hull (Bottom Port)</td>
</tr>
<tr>
<td>5</td>
<td>Normal Fuel Oil No. 6</td>
<td>Outer Hull (Bottom Starboard)</td>
</tr>
<tr>
<td>6</td>
<td>Normal Fuel Oil No. 7</td>
<td>Outer Hull (Bottom Port)</td>
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**Reference Plans:**

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<th>Ports No.</th>
<th>BuShips No.</th>
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<tr>
<td>61-381</td>
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<td>Manhole List - Boiler Type - Flat Plate - Dished Plate &amp; Flush Type</td>
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<td>Compartment &amp; Access</td>
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<td>92-381</td>
<td>490900</td>
<td>Foundation &amp; Tanks for Main &amp; Aux. Generating Sets</td>
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<tr>
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<td>50-285</td>
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<tr>
<td>97-285</td>
<td>490820</td>
<td>Flush Type Manhole</td>
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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 Y-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.

<table>
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<tr>
<th>Mark</th>
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<th>Mark 14-3</th>
<th>Mark 10-3</th>
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<td>Ordnance pamphlet</td>
<td>617</td>
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<tr>
<td>Length</td>
<td>20'-00</td>
<td>20'-06&quot;</td>
<td>161'-03&quot;</td>
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<tr>
<td>WEIGHTS, IN LBS.</td>
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<tr>
<td>Explosive Charge</td>
<td>496</td>
<td>497.35</td>
<td></td>
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<tr>
<td>Torpedo, ready for war shot</td>
<td>3048</td>
<td>3185</td>
<td>2215</td>
<td></td>
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<tr>
<td>Torpedo, ready for exercise shot</td>
<td>3012</td>
<td>-</td>
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<tr>
<td>Torpedo, buoyancy, max. end of exercise run</td>
<td>2875</td>
<td>3071</td>
<td>2060</td>
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<tr>
<td>Torpedo, buoyancy, end of exercise run, normal</td>
<td>293</td>
<td>-</td>
<td>255</td>
<td></td>
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<td>Torpedo, negative buoyancy, end of exercise run, head not blown</td>
<td>250</td>
<td>-</td>
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Characteristics of tubes

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<tr>
<th>Number in Nest</th>
<th>Bow</th>
<th>Stern</th>
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<tr>
<td>Mark 34-Mod.3</td>
<td>6</td>
<td>4</td>
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<tr>
<td>Mark 35-Mod.3</td>
<td>3225</td>
<td>3530</td>
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<tr>
<td>Capacity - lbs. SW.</td>
<td>20'-10&quot;</td>
<td>22'-10&quot;</td>
</tr>
<tr>
<td>Capacity - length - max.</td>
<td>6</td>
<td>4</td>
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<tr>
<td>Stowage, torpedoes</td>
<td>795</td>
<td>1100</td>
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<tr>
<td>W.R.T., Mark 14, war shot, Mark 14, Head 14</td>
<td>709</td>
<td>1014</td>
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</tbody>
</table>

For complete description of:
21-inch 3/N T/T Marks 34 and 35, Moda. 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 - 33285-312.

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. (RuShips Standard Receptacle Plug 9-R-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
PERISOCES

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

Principal measurements, feet and inches:

<table>
<thead>
<tr>
<th>Position</th>
<th>No. 1</th>
<th>No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>0-9-3/16 Fwd. Fr. 53</td>
<td>0-4-11/16 Fwd. Fr. 54</td>
</tr>
<tr>
<td>Diameter</td>
<td>0-7½&quot;</td>
<td>0-7½&quot;</td>
</tr>
<tr>
<td>Length, optical</td>
<td>40-00</td>
<td>40-00</td>
</tr>
<tr>
<td>Eyepiece, above deck (designed)</td>
<td>5 - 3</td>
<td>5 - 3</td>
</tr>
<tr>
<td>Eyepiece, above base line</td>
<td>26' - 54&quot;</td>
<td>26' - 54&quot;</td>
</tr>
<tr>
<td>C.T. flat, A.B.</td>
<td>21 - 2½&quot;</td>
<td>21-2½&quot;</td>
</tr>
<tr>
<td>Top raised, A.B.</td>
<td>66' - 8-1/16&quot;</td>
<td>66' - 8-1/16&quot;</td>
</tr>
<tr>
<td>Top lowereded, A.B.</td>
<td>47 - 2</td>
<td>47 - 2</td>
</tr>
<tr>
<td>Bottom lowered, A.B.</td>
<td>5 - 6-3/16</td>
<td>5 - 6-3/16</td>
</tr>
<tr>
<td>Fairwater, A.B.</td>
<td>47 - 2½&quot;</td>
<td>47 - 2½&quot;</td>
</tr>
<tr>
<td>Antenna Mast Raised A.B.</td>
<td>56 - 78&quot;</td>
<td>-</td>
</tr>
</tbody>
</table>

Characteristics of Periscope:

- Optical length: 40' - 00 |
- Diameter of head section: 1.99 |
- Magnification, low power (× field): 1.5 x 32° |
- Magnification, high power (× field): 6.0 x 8° |
- Line of sight, max elevation & depression: 45° - 0° |
- Ray Filters: Clear, red, green, yellow, polarizing, dark neutral |
- Material of main body & reduced section - C.R.S.

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 8 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 8 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 unreeel 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 out 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, 6 1/4" effective diameter, with a 1" greased grooved hole. The sheave 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 (1/4") 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., 7 1/2 H.P. shock proof class 50 (not damageable by class 180 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 15° between "closed" and "open", but can rotate without damage through 30°. This switch is drip-proof, 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 stop 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, 50 coils, 8¼" 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 goes 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 83/4", and three 71/2". Resistance to shock progresses from (4 3/4" x 1 1/2") cushion rubber pad (4 3/4" D x 1 1/2" 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 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. 1948)

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. 02-C 7 long.0075
2. Ring Bronze 8 long 1/64
3. Flax - 5/8" long 1 turn
4. Ring Bronze 3/4" long 1/64 turn and 1/4" grease
5. Flax - 5/8" long 1 turn
6. Gland Bronze 13/8" 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 (16-11/16" 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 lubrication adjustments. 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 manufacturer's 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 stadiometer 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 stadiometer scales. The surplus grease will emerge between the scales and should be wiped off. No polish or other abrasive should be used on the stadiometer 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 111-3-11/16". (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 dioptric scale before starting observation. The dioptric scale is located on the hub of the focusing knob. The stadiometer 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 STADIOMETER

The principle of the stadiometer 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 stadiometer 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 stadiometer 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 stadiometer, 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:

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<th>BuShips No.</th>
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<td>C.T. Structural Details.</td>
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<tr>
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<td></td>
<td>No. 1 &amp; No. 2 Periscopes - General Arrangement.</td>
</tr>
<tr>
<td>828-381</td>
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<td>No. 1 &amp; No. 2 Periscopes - Arrgt. - Lower End.</td>
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<tr>
<td>829-285</td>
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<td>No. 1 &amp; No. 2 Periscopes - Stuffing Box and Misc. Details.</td>
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<td>No. 1 &amp; 2 Periscopes - Azimuth Circle - Arrgt. and Details.</td>
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<td>No. 1 &amp; 2 Periscopes - Sheave &amp; Bracket - Details.</td>
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<td>840-381</td>
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<td>1622-201</td>
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<td>Pushbutton - Portable - W.T. - 2 Gang - for Periscope Hoist Motors.</td>
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<tr>
<td>1625-226</td>
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<td>Upper Limit Switch - Quick Break Double Pole for Periscope Hoists - Assembly &amp; Details.</td>
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<td>Periscope Hoist - Motor Control - Elementary Wiring Diagram.</td>
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<td>No. 1 &amp; 2 Periscopes Lower Limit Switch - Details.</td>
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<td>Limit Switch - Quick Break.</td>
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<td>Kollmorgen pamphlet - Submarine Periscope - Bureau of Ships Manual ( Hull) - Section XII.</td>
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<td>480445</td>
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<td>No. 1 &amp; No. 2 Periscope - Azimuth Circle - Support &amp; Extension Ring Details.</td>
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MAGAZINES

For specific quantities of ammunition see BuOrd Allowance Lists.
For Instructions, handling of explosives, see BuOrd Manual.
For Stowage Arrt., 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 NM 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, CQC (fr. 54-55 port) is a steel inclosure (.4-2½ W.
× 18" deep × 6½ " high). The design stowage allows for:

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

The Ordnance Ready Service Locker - Officers' Quarters - (frs. 45½ to 46½ C/L of Ship) is a steel inclosure (17" W. x 9½" deep x 5½" high). The stowage allows for:

(1) 20 .45 AA Machine Gun, Mk. IV (complete)  
(2) 20 .45 Spare Barrels  
(3) 12 Gauge Riot Shotgun M1897  

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:

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<td>154-275</td>
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<td>Ordnance Ready Service Lockers - Control Room &amp; Officers' Quarters.</td>
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<tr>
<td>505-308</td>
<td>490969</td>
<td>Magazine Sprinkling System - Piping Arrangement.</td>
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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 P-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 for 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-
inches by 16 1/2 ft. torpedoes, with or without heads attached. The facilities in both torpedo
rooms are suitable for handling 20'-13/16" D x 9'-10 1/2" mines (Mk. 10) (contact) and 20'-13/16" D x 7'
10 1/2" mines (Mk. 12) (magnetic). The latter includes taking the mines onboard, 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 crane 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. 1, mine, see Ordnance Pamphlet.
For Mark 12 mine, see Ordnance Pamphlet.

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

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<tr>
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<th>Mark 10-1</th>
<th>Mark 12</th>
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<tbody>
<tr>
<td>Length overall - inches</td>
<td>118-5</td>
<td>94.25</td>
</tr>
<tr>
<td>Diameter, inches</td>
<td>20-13/16</td>
<td>20.812</td>
</tr>
<tr>
<td>Weight, lbs.</td>
<td>1760</td>
<td>1500</td>
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<tr>
<td>Displacement, sea water</td>
<td>1150</td>
<td>1080</td>
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<tr>
<td>Weight, Overboard</td>
<td>610</td>
<td>420</td>
</tr>
<tr>
<td>Center of gravity, inches, from base and explosive charge, lbs., TNT cast</td>
<td>301/2&quot;</td>
<td>543</td>
</tr>
<tr>
<td>Incendiary charge, Ib., TNT cast</td>
<td>300</td>
<td>1130</td>
</tr>
<tr>
<td>Detonator</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Arming period, minutes</td>
<td>Mk. 1, Mod. 1</td>
<td>50</td>
</tr>
</tbody>
</table>

Date: 31 July 1943
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 carried 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 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 3% 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, 90 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 unreele first 24 ft. cable - 5 minutes.
   Speed of unreele 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 - 4".
(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) Eye bolts - 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) Contours - for roller trip, two on anchor.
(9) Starting lever - anchor release mechanism.
(10) Adapter plug (Ports. Plan No. 1143-201) for use with double assembly in a tube; fits over
anchor eye bolt, bulbs 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 bend on the breech end of T.T.

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

(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
the 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 200f 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. 1193-201) - insert this in mine two.
4. The tube tail stop handwheel - back this full out.
5. The mine gauge (Ports. Plan No. 1193-201) - 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 40754.
   c. The tripping latch (52375 from breach end) engages mine starting lever (3244 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 and drift 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:

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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 154" in diameter for a rope speed of 80 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 11.

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 snubbing 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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<td>Windlass &amp; Capstan - Wildcat Frame Details</td>
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<td>1017-275</td>
<td>387283</td>
<td>Windlass &amp; Capstan - Wildcat &amp; Spur Gear - Details</td>
</tr>
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<td>Windlass &amp; Capstan - Chain Compressor - Arrgt. and Details</td>
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<td>387288</td>
<td>Windlass &amp; Capstan - Chain Compressor - Frame Details</td>
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<td>Windlass &amp; Capstan - Band Brake Gear Case Details</td>
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<td>Windlass &amp; Capstan - Band Brake &amp; Gear Details</td>
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<td>Windlass &amp; Capstan - Wildcat &amp; Band Brake - Arrgt.</td>
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<td>Windlass &amp; Capstan - Capstan Gear Case - Arrangement</td>
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<td>Windlass &amp; Capstan - Capstan Gear Case - Details</td>
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<td>Windlass &amp; Capstan - Capstan Shaft &amp; Gear Details</td>
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<td>Windlass &amp; Capstan - Capstan Head Details</td>
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<td>491049</td>
<td>Windlass &amp; Capstan - Main Drive - Bevel Gear Case - Details</td>
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<td>1037-308</td>
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<td>Windlass &amp; Capstan - Main Drive - Bevel Gear Cases - Arrgt.</td>
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<td>491051</td>
<td>Windlass &amp; Capstan - Main Drive - Bulkhead #16 - Gear Case Details</td>
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<td>491052</td>
<td>Windlass &amp; Capstan - Anchor Chain ind. Gear Case Details</td>
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<td>491093</td>
<td>Windlass &amp; Capstan - Chain Compressor - Gear Case Details</td>
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<td>Windlass &amp; Capstan - Chain Compressor - Deck Indicator Details</td>
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<td>387306</td>
<td>Windlass &amp; Capstan - Chain Slip - Arrangement</td>
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<td>387307</td>
<td>Windlass &amp; Capstan - Chain Slip - Details</td>
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<tr>
<td>1055-285</td>
<td>490257</td>
<td>Windlass &amp; Capstan - Hydraulic Power Plant - Planetary Gear Case - Details</td>
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<td>387309</td>
<td>Windlass &amp; Capstan - Hydraulic Power Plant - Windlass &amp; Bow Rigging - Details</td>
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<td>Windlass &amp; Capstan - Windlass &amp; Bow Rigging - Clutch Details</td>
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<td>Windlass &amp; Capstan - Hydraulic Power Plant - Clutch Shaft &amp; Coupling Details</td>
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<td>Windlass &amp; Capstan - Hydraulic Power Plant - Pressure Regulator Details</td>
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<td>Windlass &amp; Capstan - Hydraulic Power Plant - Main Manifold Body Details</td>
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<td>Windlass &amp; Capstan - Hydraulic Power Plant-Control Valve Body Details - Emergency</td>
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<td>Windlass &amp; Capstan - Hydraulic Power Plant - Cont. Valve Cover Details - Emergency</td>
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<td>387323</td>
<td>Windlass &amp; Capstan - Hydraulic Power Plant - Control Valve Shaft Details - Emergency</td>
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<td>1076-275</td>
<td>387324</td>
<td>Windlass &amp; Capstan - Hydraulic Power Plant - Flanges &amp; Special Fittings - Details</td>
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<td>Windlass &amp; Capstan - Main Drive - Bevel Gear Details</td>
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<td>1152-201</td>
<td>312639</td>
<td>Stern Capstan - Worm Gear - Arrgt. &amp; Details</td>
</tr>
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<td>1153-201</td>
<td>312640</td>
<td>Stern Capstan - Worm Gear Case - Details</td>
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<td>1154-201</td>
<td>312641</td>
<td>Stern Capstan - Head Shaft and Shaft Bearing Details</td>
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<td>1167-228</td>
<td>386762</td>
<td>Stern Capstan - Control Switch Operating Mechanism - Arrgt.</td>
</tr>
<tr>
<td>1168-228</td>
<td>386763</td>
<td>Stern Capstan - Control Switch Operating Mechanism - Details</td>
</tr>
</tbody>
</table>
Section U-8

STEERING GEAR - GENERAL

See Section U-27, Hydraulic System.
See Plate A - Steering Gear.
See Plate 5 - Steering Gear in After Torpedo Room.
See Plate 5a - Steering Gear - Wiring Diagram.
See Engraved C.S.S. Plates, Control Room, and After Torpedo Room (Ports. No. 911-361 - BuShips No. 493294).
See Shipboard Tests (SS22B-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 A.T.R. 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 36° rudder 1977) 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 has 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 834).

Relief valves are placed in both sides of the main manifold, set at 1200 psi.
There is also one in the pump casing, set at 68 pounds per square inch.

Extracts from Ship's Rudder Calculations

<table>
<thead>
<tr>
<th></th>
<th>Ahead, 20 Knots</th>
<th>Astern : 10 Knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, lbs.</td>
<td>5° (40000) 50000 10°</td>
<td>15° (120000) 30000 25° (45000)</td>
</tr>
<tr>
<td>C.P. from axis</td>
<td>5° (25000) 13&quot; 10°</td>
<td>15° (120000) 30000 25° (45000)</td>
</tr>
<tr>
<td>Torque, units</td>
<td>10° (110) 10&quot; 15°</td>
<td>10° (100) 15° (150)</td>
</tr>
<tr>
<td>(relative)</td>
<td>15° (90) 15&quot; 20°</td>
<td>22000 22000 40000</td>
</tr>
<tr>
<td>32° Tiller</td>
<td>-- 22000 22000 40000</td>
<td></td>
</tr>
<tr>
<td>Stress, Lbs.</td>
<td>* 100,000 inch pounds.</td>
<td></td>
</tr>
</tbody>
</table>

* 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 elements of the system. In principle, the steering wheel in HAND is a hydraulic jack applied to the rudder cross-head. 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 jacking 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 35° 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 steerman (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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ram (Diameter 6-1/2&quot;D.) displacement per inch</td>
<td>33.183 cu. in.</td>
</tr>
<tr>
<td>Stroke, 35° R. to 35° L.</td>
<td>36.67 in.</td>
</tr>
<tr>
<td>Stroke, 25° R. to 25° L.</td>
<td>27.00 in.</td>
</tr>
<tr>
<td>Displacement 35° R. to 35° L.</td>
<td>2410 cu. in.</td>
</tr>
<tr>
<td>Displacement 25° R. to 25° L.</td>
<td>1775 cu. in.</td>
</tr>
<tr>
<td>Displacement, pump, per turn</td>
<td>22.6 cu. in.</td>
</tr>
<tr>
<td>Displacement, rates of Ram to Pump</td>
<td>78.5</td>
</tr>
<tr>
<td>Efficiency - percent</td>
<td>85</td>
</tr>
<tr>
<td>Turns of wheel, 25° R. to 25° L.</td>
<td>95</td>
</tr>
<tr>
<td>Turns of wheel, rate, to meet Specified time of 120 seconds</td>
<td>47 R.P.M.</td>
</tr>
</tbody>
</table>

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. 128). 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.

Action, 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

<table>
<thead>
<tr>
<th>Part</th>
<th>Power CT/CP</th>
<th>Hand CT/CP</th>
<th>Energy CT/CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) WHEEL, Steering, Conning Tower</td>
<td>IN X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>OUT</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) WHEEL, Steering, Control Room</td>
<td>IN</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(a) CLUTCH, Locking Pin</td>
<td>OUT</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(b) ARM, Locking</td>
<td>LOCKED</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>UNLOCKED</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(c) HANDLE, Spinner</td>
<td>FOLDED</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>OUT</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(3) STEERING STAND OR.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Change Valve</td>
<td>POWER</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>HAND</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>ENERGY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) PUMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) LEVER, Tilling Box</td>
<td>HAND</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>POWER</td>
<td></td>
<td></td>
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<tr>
<td>(2) STROVE, Locking Wheel</td>
<td>HAND (adj)</td>
<td></td>
<td></td>
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<tr>
<td>(e) POWER, adj</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) CLUTCH, Lever, (CT Drive Shaft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Butterfly</td>
<td>LOCKED UP</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>LOCKED DOWN</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(2) Bolt, Locking</td>
<td>LOCKED UP</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>UNLOCKED</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(d) MOTOR SWITCH, Power</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Control Room Station</td>
<td>START</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>STOP</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(b) ATR Station</td>
<td>START</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>STOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Indicator Light C.R.</td>
<td>ON</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
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 far as 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)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Instruction of Valve</th>
<th>Service</th>
<th>Valve Positions for Pipe Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steering Stand</td>
<td>A : Change Valve</td>
<td>(1)</td>
<td>Hand</td>
</tr>
<tr>
<td></td>
<td>B : Control Valve, Emergency</td>
<td>(2)</td>
<td>Control: Emergency</td>
</tr>
<tr>
<td>Ship's Hyd. Manifold</td>
<td>C : Emergency Steering Supply</td>
<td>: Neutral, Rudder full</td>
<td></td>
</tr>
<tr>
<td>By-pass</td>
<td>D : Emergency Steering Return</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E : Stop across &quot;Rudder &quot;</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td>&quot;Manifold&quot;</td>
<td>F : Shunt from &quot;Rudder Right&quot;</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F : Shunt from &quot;Rudder Left&quot; to Tank</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F : Shunt from &quot;Rudder Left&quot; to Tank</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td>Main Manifold (Steering)</td>
<td>A : Main cut-out aft, Fore</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B : Main cut-out aft, Aft</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C : Main cut-out port Fore</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D : Main cut-out port Aft</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E : N.A. cut-out, Rudder right</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F : N.A. cut-out, Rudder left</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G : By-pass</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H : Relief, Rudder Right</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J : Relief, Rudder Left</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td>Control Cylinder</td>
<td>K :</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td>Oil Vent and Surge Tank</td>
<td>L : Cut-out, Replenishing</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L : Line</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L : Ship's Hydraulic System</td>
<td>: Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>: On</td>
<td></td>
</tr>
</tbody>
</table>
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 FLUNGERS, 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.
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 -

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>MARK</th>
<th>SERVICE</th>
<th>POSITION OF VALVES WHEN OPERATING BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUMP</td>
<td>A</td>
<td>CHANGE VALVE FOR POWER &amp; HAND</td>
<td>POWER: OPEN TO CONTROL LINES OPEN TO MAIN MANifold EMERGENCY LEFT-NEUT-RT.</td>
</tr>
<tr>
<td>STEERING STAND</td>
<td>B</td>
<td>CONTROL VALVE FOR EMERGENCY</td>
<td>RECORDED IN NEUTRAL OPEN OPEN OPEN</td>
</tr>
<tr>
<td>SHIPS HYD</td>
<td>C</td>
<td>EMERGENCY STEERING SUPPLY CUT-OUT</td>
<td>OPEN OPEN OPEN</td>
</tr>
<tr>
<td>MAIN MAN</td>
<td>D</td>
<td>EMERGENCY STEERING RETURN CUT-OUT</td>
<td>OPEN OPEN OPEN</td>
</tr>
<tr>
<td>BY-PASS MAN</td>
<td>E</td>
<td>FOR VENTING &amp; FILLING (ONLY)</td>
<td>CLOSED CLOSED CLOSED</td>
</tr>
<tr>
<td>CONT LINES</td>
<td>F</td>
<td>FOR VENTING &amp; FILLING (ONLY)</td>
<td>CLOSED CLOSED CLOSED</td>
</tr>
</tbody>
</table>
### CAUTION
Valve settings must be in accordance with tables in instructions 142 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mark</th>
<th>Service</th>
<th>Position</th>
<th>Operator</th>
<th>Location</th>
<th>Mark</th>
<th>Service</th>
<th>Position</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PUMP MANIFOLD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>FORD STBD RAM CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>REPORT</td>
<td>M</td>
<td>DRAIN</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>AFTER STBD RAM CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>CONTROL</td>
<td>N</td>
<td>VENT</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>FORD PORT RAM CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>MAN</td>
<td>O</td>
<td>DRAIN</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>AFTER PORT RAM CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>STEERING</td>
<td>P</td>
<td>VENT</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>K.E.R. RUDDER CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>SUBMERGE</td>
<td>Q</td>
<td>DRAIN</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>K.E.L. RUDDER CUT-OUT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td>FILL</td>
<td>R</td>
<td>VENT</td>
<td>CLOSED</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>BY-PASS</td>
<td>CLOSED</td>
<td></td>
<td></td>
<td>CONTROL</td>
<td>S</td>
<td>SPRING LOAD</td>
<td>CLOSERED</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>RELIEF R. RUDDER 1200</td>
<td>SPRING LOAD</td>
<td></td>
<td></td>
<td>REPORT</td>
<td>T</td>
<td>VENT</td>
<td>CLOSERED</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>RELIEF L. RUDDER 1200</td>
<td>SPRING LOAD</td>
<td></td>
<td></td>
<td>CONTROL</td>
<td>U</td>
<td>PUMP CUT-OUT</td>
<td>CLOSERED</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>MANIFOLD</td>
<td>V</td>
<td></td>
<td></td>
<td>MAN</td>
<td>V</td>
<td>PUMP CUT-OUT-L RUDDER</td>
<td>OPEN</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>FOR FILLING LINES</td>
<td>OPEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>NEAR VENT</td>
<td>OPEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **STEERING BY PORT RAM ONLY:**
   - Close pump manifold valves A & B and open drain valves 9 & 8.

2. **STEERING BY STBD. RAM ONLY:**
   - Close pump manifold valves C & D and open drain valves 9 & 8.

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SS425-434
381-416

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92 PORTS NO 811-31 U.S. NAVY YARD, PORTSMOUTH, N. H.
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" O. 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 480 rpm, max. working pressure, 1200 lbs. relief valve pressure. The full travel of the control shaft is 1.0.17, 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.P. 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 0/0 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 reamed and recessed 1/16" deep to supply grease to the slots and axial hole of the pin. This bearing can be ginned 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"1/4" x 8-7/8"T.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
**FLEET SUBMARINE GENERAL INFORMATION**

(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 flex, 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 cylinders and 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 tight only.

95
GIB 8381-404-U-8-a-10 26 August 1943
U.S.NAVY YARD, PORTSMOUTH, N.H.-1943
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 helmman 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 helmman's station, the spring cannot act. If helmman releases wheel, spring neutralizes pump control shaft. (Ref. 863). Notes as to adjustments - (Reference Ports. Plan NS-9641 and NS-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, (17498 D. x 7-7/8" L.) slotted center yoke, precision ground, billet. The yoke carries a steel grease-grooved sliding block (17499 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 (71/8 b.c. x 2" wide). The lever arm carries a boss (9999) 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 (2718875 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 slackening 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 (GR) 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. 861)

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)

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Approx. Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Horizontal miter gear</td>
<td>CT drive</td>
<td>5&quot; PD</td>
</tr>
<tr>
<td>2. Vertical miter gear</td>
<td>Steering wheel</td>
<td>5&quot; PD</td>
</tr>
<tr>
<td>3. Vertical gear</td>
<td>Pump drive</td>
<td>5&quot; PD</td>
</tr>
<tr>
<td>4. Gear Case cover</td>
<td>Shaft bearing</td>
<td>5&quot; PD</td>
</tr>
<tr>
<td>5. Control valve</td>
<td>Emerg. Strg.</td>
<td>7&quot; x 7&quot;</td>
</tr>
<tr>
<td>6. Foundation</td>
<td>Deck support</td>
<td>8 x 7</td>
</tr>
</tbody>
</table>

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 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, "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 semicircular 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 scene R.H. threads of 0.666" lead and assemblies 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.
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" O.A.). 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 similar 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 and 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)
<table>
<thead>
<tr>
<th>Ports No.</th>
<th>BuShips No.</th>
<th>Title Br.</th>
</tr>
</thead>
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<tr>
<td>812-308</td>
<td>386905</td>
<td>Steering Gear - Cylinder &amp; Plunger - Arrangement.</td>
</tr>
<tr>
<td>813-308</td>
<td>312300</td>
<td>Steering Gear - Connecting Rod &amp; Guide Details - Sheet #2.</td>
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<tr>
<td>815-381</td>
<td>386871</td>
<td>Steering Gear - Power Plant - Main Foundation.</td>
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<tr>
<td>847-201</td>
<td>312334</td>
<td>Stern Post Casting - Details.</td>
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<tr>
<td>848-201</td>
<td>312335</td>
<td>Steering Gear - Rudder and Rudder Stock - Details.</td>
</tr>
<tr>
<td>859-201</td>
<td>312336</td>
<td>Steering Gear - Rudder Stock Crosshead &amp; Details.</td>
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<td>850-381</td>
<td>386872</td>
<td>Steering Gear - Arrangement - Aft.</td>
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<td>851-275</td>
<td>386903</td>
<td>Steering Gear - Cylinder &amp; Plunger - Details - Sheet 1.</td>
</tr>
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<td>852-275</td>
<td>386906</td>
<td>Steering Gear - Cylinder Foundations - Details.</td>
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<td>490607</td>
<td>Steering Gear - Connecting Rods &amp; Guide Details - Sheet #1.</td>
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<td>854-381</td>
<td>490293</td>
<td>Steering Gear - General Arrangement and Dia. Arrangement of Piping.</td>
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<td>856-381</td>
<td>386863</td>
<td>Steering Gear - Control Cylinder and Pump Control Arrangement.</td>
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<td>857-275</td>
<td>386864</td>
<td>Steering Gear - Control Cylinder - Details - Sheet #1.</td>
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<td>Steering Gear - Control Cylinder - Details - Sheet #2.</td>
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<td>862-275</td>
<td>387397</td>
<td>Steering Gear - Pump Control - Details.</td>
</tr>
<tr>
<td>863-285</td>
<td>386921</td>
<td>Steering Gear - Control Cyl. - Details - Sheet #3.</td>
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<tr>
<td>865-285</td>
<td>490567</td>
<td>Steering Gear &amp; Hydraulic System - Reserve Oil Tank - Details.</td>
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<tr>
<td>868-381</td>
<td>386876</td>
<td>Steering Gear - Rudder Angle - Transmitter - Details.</td>
</tr>
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<td>869-381</td>
<td>386873</td>
<td>Steering Gear - Flanges &amp; Special Fittings - Details.</td>
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<td>870-285</td>
<td>490268</td>
<td>Steering Gear - Conning Tower and Control Room Steering Stand - Shafting Arrangement.</td>
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<td>871-285</td>
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<td>Steering Gear - Control Room Steering Stand - Arrangement.</td>
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<td>490270</td>
<td>Steering Gear - Control Room Steering Stand - Details Sheet #1.</td>
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<td>873-285</td>
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<td>Steering Gear - Control Room Steering Stand - Details Sheet #2.</td>
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<td>Steering Gear - Control Room Steering Stand - Details Sheet #3.</td>
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<td>490281</td>
<td>Steering Gear - Control Room Steering Stand - Details Sheet #4.</td>
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<td>876-285</td>
<td>490282</td>
<td>Steering Gear - Control Room Steering Stand - Details Sheet #5.</td>
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<td>877-285</td>
<td>490286</td>
<td>Steering Gear - Control Room Steering Stand - Details Sheet #6.</td>
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<tr>
<td>879-285</td>
<td>490288</td>
<td>Steering Gear &amp; Hydraulic System - Emergency Steering Gear Control Valve Details Sheet #1.</td>
</tr>
<tr>
<td>880-285</td>
<td>490289</td>
<td>Steering Gear &amp; Hydraulic System - Emergency Steering Gear Control Valve Details Sheet #2.</td>
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<td>882-285</td>
<td>490291</td>
<td>Steering Gear - Pump Control Lever - Arrangement.</td>
</tr>
<tr>
<td>883-285</td>
<td>490292</td>
<td>Steering Gear - Pump Control Lever - Details.</td>
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<td>885-285</td>
<td>490442</td>
<td>Steering Gear - Conning Tower Steering Stand - Arrangement.</td>
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<td>889-275</td>
<td>387442</td>
<td>Steering Gear - Change Valve - Arrangement.</td>
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<td>890-275</td>
<td>387743</td>
<td>Steering Gear - Change Valve Body.</td>
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<td>891-275</td>
<td>387744</td>
<td>Steering Gear - Change Valve - Details.</td>
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<tr>
<td>900-275</td>
<td>386857</td>
<td>Steering Gear - Drive Shaft - Details Sheet #2.</td>
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<td>905-275</td>
<td>387361</td>
<td>Steering Gear - Pump Manifold - Arrangement.</td>
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<td>906-275</td>
<td>387362</td>
<td>Steering Gear - Pump Manifold - Body Casting.</td>
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<tr>
<td>907-275</td>
<td>387363</td>
<td>Steering Gear - Pump Manifold Valve Details.</td>
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<td>909-381</td>
<td>386898</td>
<td>Steering Gear - Power Plant - Bed Plate.</td>
</tr>
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<td>911-381</td>
<td>386897</td>
<td>Steering Gear &amp; Hydraulic System Instruction Plates &amp; Name Plates.</td>
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<td>912-201</td>
<td>312399</td>
<td>Stern Diving Gear - General Arrangement.</td>
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<tr>
<td>949-275</td>
<td>386914</td>
<td>Steering Gear - Drive Shaft - Details Sheet #3.</td>
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<td>950-201</td>
<td>312437</td>
<td>Steering Gear - Connecting Rod &amp; Guide Details Sheet #3.</td>
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<td>951-201</td>
<td>312438</td>
<td>Steering Gear - Cylinder &amp; Plunger - Details Sheet #2.</td>
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<tr>
<td>42024</td>
<td>490274</td>
<td>Steering Gear - Handwheel &amp; Details.</td>
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</tbody>
</table>
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:
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

<table>
<thead>
<tr>
<th>Steering Station</th>
<th>Kind of Steering</th>
<th>Compasses</th>
<th>Rudder Indicator</th>
</tr>
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<tr>
<td>Bridge</td>
<td></td>
<td>1 Gyro Repeater</td>
<td>Electric</td>
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<tr>
<td></td>
<td></td>
<td>P.P. Pelorus, Portable</td>
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<tr>
<td>Conning Tower</td>
<td>Power, Hand &amp; Emergency</td>
<td>Gyro Repeater</td>
<td>Electric</td>
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<td>Control Room</td>
<td>Power, Hand &amp; Emergency</td>
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<tr>
<td>After Torpedo Room</td>
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<td>Mechanical</td>
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</table>

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).

<table>
<thead>
<tr>
<th>Descriptive Item</th>
<th>Trim Pump</th>
<th>Drain Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cylinders &amp; Single acting plun.</td>
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<td>2</td>
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<tr>
<td>Source</td>
<td>Gardner-Denver</td>
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</tr>
<tr>
<td>Capacity - gal. per min. - Max. at 176#</td>
<td>100</td>
<td>35</td>
</tr>
<tr>
<td>Discharge Head - feet</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Location</td>
<td>Pump Room: Pump Room</td>
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</tr>
<tr>
<td>Plan No., Portsmouth</td>
<td>1738-381: 1758-381</td>
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</tr>
<tr>
<td>Motor - rated speed r.p.m.</td>
<td>1500</td>
<td>1150</td>
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<tr>
<td>Motor - rated H.P.</td>
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<td>10</td>
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<tr>
<td>Rated working speed r.p.m.</td>
<td>94</td>
<td>81</td>
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<tr>
<td>Worm drive - Ratio</td>
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<td>14.25 to 1</td>
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<tr>
<td>Maximum working pressure</td>
<td>225</td>
<td>225</td>
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<tr>
<td>Bore - Inches</td>
<td>5 1/4</td>
<td>4 1/4</td>
</tr>
<tr>
<td>Stroke - Inches</td>
<td>5 1/4</td>
<td>4 7/8</td>
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<tr>
<td>Suction - Inches</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Discharge - Inches</td>
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<td>2</td>
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<tr>
<td>Clearance, Worm thrust - Inches</td>
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<td>.000</td>
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<tr>
<td>Main bearing - (total) inches</td>
<td>.003-.001</td>
<td>.0035 to .0025</td>
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<tr>
<td>Conn. Rod bearing - (total) inches</td>
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<td>.004 to .0025</td>
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<tr>
<td>Wrist pin - (total inches)</td>
<td>.0015 to .0005 to .0010</td>
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<td>Temperature, main bearing - °F (C.W. - 70°F)</td>
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<td>84</td>
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<td>Conn. rod bearing</td>
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<td>90</td>
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<tr>
<td>Worm</td>
<td>117</td>
<td>100</td>
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<tr>
<td>Room</td>
<td>66</td>
<td>64</td>
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<tr>
<td>Lube Oil Sump - °F (C.W. - 74°F)</td>
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<td>100</td>
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<td>Valves, Spring loaded, disc type</td>
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<td>Valves, lift - inches</td>
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<td>3/8</td>
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<tr>
<td>lift suction - inches</td>
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<tr>
<td>lift discharge - inches</td>
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<tr>
<td>Setting, Relief valve</td>
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<tr>
<td>Test Pressure (hydro) completed pump.</td>
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# TANKS

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

<table>
<thead>
<tr>
<th>Ports. No.</th>
<th>BuShips No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>52-381</td>
<td></td>
<td>Compartments and tanks</td>
</tr>
<tr>
<td>470-381</td>
<td></td>
<td>Pump Room - Arrangement</td>
</tr>
</tbody>
</table>
**LIQUIDOMETER**
**TANK CAPACITY GAUGES-BALANCED TYPE**

## GAUGE LIST

<table>
<thead>
<tr>
<th>Type</th>
<th>Test Pressure</th>
<th>Graduation</th>
<th>Name of Tank</th>
<th>Location of Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUND BALL</td>
<td>465 FT</td>
<td>1000 LBS</td>
<td>FOR' D. TRIM TANK</td>
<td>FOR' D. TORPEDO ROOM</td>
</tr>
<tr>
<td></td>
<td>490 FT</td>
<td>1000 LBS</td>
<td>AFTER TRIM TANK</td>
<td>CONTROL ROOM</td>
</tr>
<tr>
<td></td>
<td>450 FT</td>
<td></td>
<td>NO. 1 AUXILIARY TANK</td>
<td>AFT. TORPEDO ROOM</td>
</tr>
<tr>
<td></td>
<td>460 FT</td>
<td></td>
<td>NO. 2 AUXILIARY TANK</td>
<td>CONTROL ROOM</td>
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<tr>
<td></td>
<td>450 FT</td>
<td></td>
<td>SAFETY TANK</td>
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</tr>
<tr>
<td></td>
<td>450 FT</td>
<td>1000 LBS</td>
<td>W.R.T. TANK</td>
<td>CONTROL ROOM</td>
</tr>
<tr>
<td></td>
<td>450 FT</td>
<td></td>
<td>W.R.T. TANK</td>
<td>AFT. TORPEDO ROOM</td>
</tr>
<tr>
<td></td>
<td>450 FT</td>
<td></td>
<td>F.O. COLLECTING TANK</td>
<td>ENGINE ROOM-AFT.</td>
</tr>
<tr>
<td></td>
<td>450 FT</td>
<td></td>
<td>F.O. EXPANDING TANK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>CLEAN FUEL OIL TANK</td>
<td>FOR' D.</td>
</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>LUB. OIL SUMP TANK No. 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>LUB. OIL SUMP TANK No. 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>LUB. OIL SUMP TANK No. 3</td>
<td></td>
</tr>
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<td></td>
<td>18 LBS</td>
<td></td>
<td>LUB. OIL SUMP TANK No. 4</td>
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</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>MOT. &amp; RED. GEAR SUMP No. 1</td>
<td>MANEUVERING ROOM</td>
</tr>
<tr>
<td></td>
<td>18 LBS</td>
<td></td>
<td>MOT. &amp; RED. GEAR SUMP No. 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>450 FT</td>
<td>1000 LBS</td>
<td>NEGATIVE TANK</td>
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</tr>
<tr>
<td></td>
<td>15 LBS</td>
<td></td>
<td>CLEAN FUEL OIL TANK</td>
<td>ENGINE ROOM-AFT.</td>
</tr>
<tr>
<td></td>
<td>15 LBS</td>
<td></td>
<td>MAIN MOTOR SUMP No. 1</td>
<td>MANEUVERING ROOM</td>
</tr>
<tr>
<td></td>
<td>15 LBS</td>
<td></td>
<td>MAIN MOTOR SUMP No. 2</td>
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</tr>
<tr>
<td></td>
<td>15 LBS</td>
<td></td>
<td>MAIN MOTOR SUMP No. 3</td>
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</tr>
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</table>

For Subs 381 to 416 only.

Tank capacities and curves of capacities to be furnished contractor.
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.
(f) Section U-12-a - Flooding and Venting.

Fuel Oil Capacity of Ship, total, 1a 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:

<table>
<thead>
<tr>
<th>Fuel Oil Tanks (BuShips Plan 387234)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Fuel</td>
</tr>
<tr>
<td>No. 1</td>
</tr>
<tr>
<td>No. 2</td>
</tr>
<tr>
<td>No. 6</td>
</tr>
<tr>
<td>No. 7</td>
</tr>
<tr>
<td>Collecting</td>
</tr>
<tr>
<td>Expansion</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Clean Fuel Oil Tanks Nos. 1 &amp; 2</td>
</tr>
</tbody>
</table>

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:**

<table>
<thead>
<tr>
<th>Sea Pressure</th>
<th>Working</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Depth</td>
<td>Depth</td>
</tr>
<tr>
<td></td>
<td>Gage psi</td>
<td>Gage psi</td>
</tr>
<tr>
<td>Surface</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Deep Dive, working</td>
<td>416</td>
<td>183</td>
</tr>
<tr>
<td>Deep Dive, piping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tests, Max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cap. Max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cap. Cubical Expansion from 28°F to 85°F (Max.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cap. Max.(295°F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cap. Min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Weight of Ship</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date: 24 July 1943
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 (2,880 gal.) FR. 91-93 Port. Sea water on its way to the compensating water line is relayed through the expansion tank (2,880 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 line. 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 or 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. 3947) 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.

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, FR. 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 H.B. Tank No.2. 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.
The Compensating Water Line Hose Connection (2 1/2") main deck, R.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, heightened 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 (1") 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, R.B. 3A and 3B, 5A and 5B. All fuel tanks are cross connected through the vertical keel, including R.B. Tanks.

Fuel Ballast Tanks 3A and 3B (Fr. 57-62) carries 19,220 gallons of fuel (51.24 Tons) or 2,570 cubic feet. Description of this tank is given in Section 4-12-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 (200#) 1/2" 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 heightened 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 (2 1/2") 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 will 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 pocketed 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, S/Ship No. 388427, 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.
<table>
<thead>
<tr>
<th>Mx.</th>
<th>VALVE</th>
<th>POSITION</th>
<th>CRUISING</th>
<th>BIG FOR DIVING</th>
<th>FUELING</th>
<th>DISCHARGING</th>
<th>TANK BILGED</th>
<th>PUMPING BILGES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Exp. Tank, Stop Valve</td>
<td>Open</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Locked</td>
</tr>
<tr>
<td></td>
<td>(Deep Pipe)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
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<td>Open</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Locked</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Closed</td>
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<td>X</td>
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<td></td>
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<td></td>
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<td>Normal</td>
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<tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td>31</td>
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<td></td>
<td></td>
<td></td>
<td>In Fairwater</td>
</tr>
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<td></td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>55</td>
<td>Vent on Stand Pipe</td>
<td>Open</td>
<td>X</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>Drain Pump Discharge</td>
<td>Open</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Closed</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For Blowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tanks, Navy</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>(30°F)</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td>Pump Press.</td>
</tr>
<tr>
<td>36</td>
<td>Comp. Water 2-1/2</td>
<td>Dis. Hose</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Hose Conn.</td>
<td>On</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Navy Spec</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Closed</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>34°F</td>
</tr>
<tr>
<td>37</td>
<td>F.O. Tanks, Stop to</td>
<td>Open</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deep Pipe</td>
<td></td>
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<td>Drain Pump Conn</td>
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## VALVE AND MANIFOLD LIST - ( Hull )

**CONTROL ROOM - 426-285**  
**BuShips No. 386515**

<table>
<thead>
<tr>
<th>Service</th>
<th>Size</th>
<th>Type</th>
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<tbody>
<tr>
<td>Trim System</td>
<td>-</td>
<td>Manifold</td>
<td>53-55 P</td>
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<tr>
<td>Drain Pump Suction</td>
<td>3&quot;</td>
<td>Spec. Globe</td>
<td>54-55 P</td>
</tr>
<tr>
<td>Trim Pump Suct. &amp; Disch.</td>
<td>5&quot;</td>
<td>Spec. Sea</td>
<td>54-55 P</td>
</tr>
<tr>
<td>Magazine Sprinkler Supply</td>
<td>4&quot;</td>
<td>Gate</td>
<td>55 P</td>
</tr>
<tr>
<td>Pyrotechnic Locker Flood</td>
<td>1½</td>
<td>Gate</td>
<td>55 P</td>
</tr>
<tr>
<td>Drain Line Cutout</td>
<td>2-2&quot;</td>
<td>Gate Sld'd.</td>
<td>54-55 P</td>
</tr>
<tr>
<td>Hose Conn. (Locked closed)</td>
<td>1½</td>
<td>Globe Hose</td>
<td>50-51 P</td>
</tr>
<tr>
<td>Conning Tower Hatch Drain</td>
<td>1&quot;</td>
<td>Globe</td>
<td>51-52 P</td>
</tr>
<tr>
<td>Radio Entering Tube Drain</td>
<td>½&quot;</td>
<td>Globe</td>
<td>56-57 P</td>
</tr>
<tr>
<td>Trim Pump Gauge Lines</td>
<td>¼&quot;</td>
<td>Globe</td>
<td>55 P</td>
</tr>
<tr>
<td>Gun Access Trunk Drain</td>
<td>¼&quot;</td>
<td>Sea - Angle</td>
<td>47-48 P</td>
</tr>
<tr>
<td>Magazine &amp; Pyrotechnic Locker</td>
<td>4-3/8&quot;</td>
<td>Globe</td>
<td>55-56 P</td>
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<td>test casting drain</td>
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**AFTER BATTERY ROOM - 429-381**  
**BuShips No. 490751**

<table>
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<th>Service</th>
<th>Size</th>
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<tbody>
<tr>
<td>Sanitary Tk. #2 Disch. Over board</td>
<td>2&quot;</td>
<td>Angle Stop Chk.</td>
<td>77S</td>
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<tr>
<td>Sanitary Tk. #2 Disch. Over board</td>
<td>2&quot;</td>
<td>Angle-Sea</td>
<td>74-75S</td>
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<tr>
<td>Compt. Hose Trim Line</td>
<td>1½</td>
<td>Hose Globe(LC)</td>
<td>76-77P</td>
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**FORWARD ENGINE ROOM - 430-381**  
**BuShips No. 491055**

<table>
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<th>Service</th>
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<tbody>
<tr>
<td>F.O. Transfer #5B F.B. Tank</td>
<td>2&quot;</td>
<td>Sea Valve</td>
<td>78-79P</td>
</tr>
<tr>
<td>F.O. Transfer #5A F.B. Tank</td>
<td>2&quot;</td>
<td>Sea Valve</td>
<td>79-80S</td>
</tr>
<tr>
<td>Comp Water #5A &amp; 5B F.B. Tank</td>
<td>3&quot;</td>
<td>Sea Valve</td>
<td>78-79S</td>
</tr>
<tr>
<td>Trim Line Hose Conn.</td>
<td>1½</td>
<td>Globe Hose</td>
<td>86-87P</td>
</tr>
<tr>
<td>Drain Line Hull Vent.</td>
<td>¾&quot;</td>
<td>Globe</td>
<td>80-81S</td>
</tr>
<tr>
<td>Drain Line Air Induction</td>
<td>¾&quot;</td>
<td>Globe</td>
<td>82-83P</td>
</tr>
<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>86-87P</td>
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**AFTER ENGINE ROOM - 431-381**  
**BuShips No. 491056**

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<th>Service</th>
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<tbody>
<tr>
<td>F.O. Filling</td>
<td>2½&quot;</td>
<td>Angle Sea</td>
<td>98-99S</td>
</tr>
<tr>
<td>Comp. Water to F.O. Tank #6</td>
<td>3&quot;</td>
<td>Angle Sea (Locked Open)</td>
<td>97-98S</td>
</tr>
<tr>
<td>F.O. Transfer F.O. Tank #6</td>
<td>1-2&quot;</td>
<td>Angle Sea</td>
<td>97-98S</td>
</tr>
<tr>
<td>Test Valve F.O. Filling</td>
<td>¾&quot;</td>
<td>Angle</td>
<td>98-99S</td>
</tr>
<tr>
<td>Drain Pump from Coll. Tank</td>
<td>2&quot;</td>
<td>Spec. Angle Sea</td>
<td>91-92P</td>
</tr>
<tr>
<td>Coll. Tank Suction</td>
<td>1½</td>
<td>Angle Relief</td>
<td>97-98P</td>
</tr>
<tr>
<td>F.O. Transfer F.O. Tank #6</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>97-98P</td>
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<tr>
<td>Compensating Water</td>
<td>3&quot;</td>
<td>Manifold</td>
<td>97-98S</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>1½</td>
<td>Manifold</td>
<td>97-98P</td>
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<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>89P</td>
</tr>
<tr>
<td>Trim Line Hose Conn.</td>
<td>1½</td>
<td>Globe Hose (LC)</td>
<td>89-90P</td>
</tr>
<tr>
<td>Eng. Air Induction Valve Dr.</td>
<td>¾&quot;</td>
<td>Angle Screw</td>
<td>92-93P</td>
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**FORWARD BATTERY ROOM - 425-285**  
**BuShips No. 386514**

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<tr>
<td>Comp. Water Normal, F.O.</td>
<td>3&quot;</td>
<td>Manifold</td>
<td>40-41P</td>
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<tr>
<td>Tanks #1-2</td>
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<tr>
<td>F.O. Transfer</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>40-41P</td>
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<tr>
<td>F.O. Transfer</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>41S</td>
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<tr>
<td>Trim Line Comp. Hose</td>
<td>1½&quot;</td>
<td>Flg. Ang. Hose</td>
<td>47-48S</td>
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<td>Test F.O. Fill</td>
<td>¼&quot;</td>
<td>Scr. Ang. St.</td>
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**CREW'S MESS, GALLEY & SCULLERY - 426-310**  
**BuShips No. 54488K**

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<tr>
<td>Comp. Water Fuel Bal. Tank #3A-3B</td>
<td>3&quot;</td>
<td>Spec. Angle (LO)</td>
<td>60-61S</td>
</tr>
<tr>
<td>Fl. &amp; Dr. Aux. Tank #2</td>
<td>3&quot;</td>
<td>Spec. Angle (LO)</td>
<td>64-65P</td>
</tr>
<tr>
<td>Fl. &amp; Dr. Safety Tank #2</td>
<td>3&quot;</td>
<td>Angle Sea</td>
<td>62-63P</td>
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<td>Type</td>
<td>Location</td>
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<tr>
<td>Fl. &amp; Dr. Aux. Tank #1</td>
<td>3&quot;</td>
<td>Spec. Angle (LO)</td>
<td>64-65S</td>
</tr>
<tr>
<td>Vent Trunk Drain</td>
<td>1&quot;</td>
<td>Screw Gl. Check</td>
<td>59-60S</td>
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<tr>
<td>Vent Trunk Drain</td>
<td>8&quot;</td>
<td>Screw Globe</td>
<td>59-60S C/L</td>
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<td>Comp. Water to F.O. Tk. #7</td>
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<td>Ang. Sea Valve</td>
<td>99-100S</td>
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<td>(Locked Open)</td>
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<td>F.O. Trans. to F.O. Tk. #7</td>
<td>2-2&quot;</td>
<td>Ang. Sea Valve</td>
<td>99-100 P&amp;S</td>
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<td>Wash Deck</td>
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<td>Globe Hose Fig. L.C.</td>
<td>100-101P</td>
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<td>Sea Water to Comp. Water</td>
<td>1&quot;</td>
<td>Globe Valve</td>
<td>99-100S</td>
</tr>
<tr>
<td>Dr. from Eng. Air. Ind. Valve</td>
<td>2&quot;</td>
<td>Globe Valve</td>
<td>105-106S</td>
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<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>99-100P</td>
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<td><strong>FORWARD TORPEDO ROOM - 424-285</strong></td>
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<tr>
<td>Trim Lines</td>
<td>3&quot;</td>
<td>Manifold</td>
<td>21-22P</td>
</tr>
<tr>
<td>Port Torp. Tube Drains</td>
<td>5&quot;</td>
<td>L.H. Manifold</td>
<td>19-20P</td>
</tr>
<tr>
<td>Std. Torp. Tube Drains</td>
<td>5&quot;</td>
<td>R.H. Manifold</td>
<td>19-20S</td>
</tr>
<tr>
<td>Torp. Tubes Dr. to W.R.T. Tank</td>
<td>5&quot;</td>
<td>L.P. Globe</td>
<td>21-22P</td>
</tr>
<tr>
<td>W.R.T. Tk. Overflow</td>
<td>5&quot;</td>
<td>Special Angle</td>
<td>22-23P</td>
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<td>Escape Trunk Fl.</td>
<td>3&quot;</td>
<td>L.P. Ang. Spec.</td>
<td>26-27 C/L</td>
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<tr>
<td>Escape Trunk Dr.</td>
<td>3&quot;</td>
<td>L.P. Angle</td>
<td>28-29S</td>
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<tr>
<td>No. 1 Sept. Tk. Disch. Overboard</td>
<td>2&quot;</td>
<td>Angle Sea</td>
<td>34-35S</td>
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<tr>
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<td>2&quot;</td>
<td>L.P. Ang. Stop Chk.</td>
<td>34-35S</td>
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<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>L.P. Cross Stop Chk.</td>
<td>33-34P</td>
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<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>L.P. Ang. Stop Chk.</td>
<td>19-20P</td>
</tr>
<tr>
<td>Trim Line Hose Conn.</td>
<td>1½&quot;</td>
<td>Globe Hose (LC)</td>
<td>21-22P</td>
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<td><strong>PUMP ROOM - 427-381</strong></td>
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<tr>
<td>Trim Suction</td>
<td>2&quot;</td>
<td>Manifold</td>
<td>55P</td>
</tr>
<tr>
<td>Conning Tower Drain</td>
<td>3&quot;</td>
<td>Flg. Ang. St.</td>
<td>53-54S</td>
</tr>
<tr>
<td>Trim Pump Discharge</td>
<td>3&quot;</td>
<td>Globe Silver Solder</td>
<td>54-55P</td>
</tr>
<tr>
<td>Dr. Pump Suct.</td>
<td>3&quot;</td>
<td>Flg. Globe St.</td>
<td>54-55P</td>
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<td>Dr. Pump Disch. Overbd.</td>
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<td>Flg. Ang. St.</td>
<td>54-55P</td>
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<td>Globe St. Silver Solder</td>
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<td>Dr. Pump Disch. to Comp. Water</td>
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<td>Sold'd Globe St.</td>
<td>53-54P</td>
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<td>54-55P</td>
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<td>No. 1 Periscope Well Drain</td>
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<td>53-54C/L</td>
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<td>2-2&quot;</td>
<td>Globe Screw</td>
<td>55-56P</td>
</tr>
<tr>
<td>Negative Tank Flood &amp; Drain</td>
<td>3&quot;</td>
<td>Angle - Sea</td>
<td>51-52P</td>
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<td><strong>AFTER TORPEDO ROOM - 432-285</strong></td>
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<td>Std. Torp. Tube Drains</td>
<td>5&quot;</td>
<td>L.H. Manifold</td>
<td>121-122S</td>
</tr>
<tr>
<td>Port. Torp. Tube Drains</td>
<td>5&quot;</td>
<td>R.H. Manifold</td>
<td>121-122P</td>
</tr>
<tr>
<td>Torp. Tubes Dr. to W.R.T. Tk.</td>
<td>5&quot;</td>
<td>L.P. Globe</td>
<td>120-121P</td>
</tr>
<tr>
<td>W.R.T. Tk. Overflow</td>
<td>5&quot;</td>
<td>Spec. Angle</td>
<td>120-121S</td>
</tr>
<tr>
<td>Bilge Suction</td>
<td>2&quot;</td>
<td>L.P. Ang. Stop Chk.</td>
<td>119-120P</td>
</tr>
<tr>
<td>Trim Line Hose Conn. to Compt. (LC)</td>
<td>1½&quot;</td>
<td>Globe Hose</td>
<td>109-110P</td>
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Reference Plans:

<table>
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<tr>
<th>Ports No.</th>
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<tr>
<td>147-275</td>
<td>387388</td>
<td>Stowage of Fuel Oil Filling Hose</td>
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<tr>
<td>423-381</td>
<td>490240</td>
<td>Fuel Oil System - Diagram (Piping)</td>
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<tr>
<td>425-285</td>
<td>386514</td>
<td>Fuel Oil, Water &amp; Drainage - Piping Arrgt, Officers' Quarters</td>
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<tr>
<td>426-285</td>
<td>385515</td>
<td>Fuel Oil, Water &amp; Drainage - Piping Arrgt, - Control Room</td>
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<tr>
<td>429-310</td>
<td>544888</td>
<td>Fuel Oil, Water &amp; Drainage - Piping Arrgt, - Crew's Mess, Galley &amp; Scullery</td>
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<tr>
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<td>490751</td>
<td>Fuel Oil, Water &amp; Drainage - Piping Arrgt, - Aft Battery Room</td>
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<td>430-381</td>
<td>491055</td>
<td>Fuel Oil, Water &amp; Drainage - Piping Arrgt, - Fwd. Eng. Room</td>
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<tr>
<td>431-381</td>
<td>491056</td>
<td>Fuel Oil, Water &amp; Drainage - After Engine Rm. (Piping Arrgt.)</td>
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<tr>
<td>495-381</td>
<td>544884</td>
<td>Fuel Oil, Water &amp; Drainage System - Special Fittings - Sheet #1</td>
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<tr>
<td>496-228</td>
<td>386472</td>
<td>Fuel Oil, Compensating System Manifolds</td>
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<td>508-292</td>
<td>490183</td>
<td>Manifold - 3&quot; - Fuel Oil System</td>
</tr>
<tr>
<td>35177</td>
<td>448713</td>
<td>Fuel Oil Tanks - Blow, Vent &amp; Test Manifold</td>
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<tr>
<td>35681</td>
<td>490400</td>
<td>2&quot; Gooseneck Valve - Fuel Oil System Drainage System</td>
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</tbody>
</table>

Section U-10-b

FUELLING 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, Oilling 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 streams 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: 3/4" manila hauling line, 2 1/2" oil hose, (4" may be used) 1 1/2" fresh water hose, 2" battery water hose, (2") 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 (2") 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.
# FLEET SUBMARINE
## GENERAL INFORMATION
### FUEL OIL SYSTEM

#### PIPE LIST

<table>
<thead>
<tr>
<th>MARK</th>
<th>Size</th>
<th>Service</th>
<th>LBS. TEST PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2½&quot;</td>
<td>Fuel Oil Filling - Forward</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>2½&quot;</td>
<td>Fuel Oil Filling - Aft</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>3&quot;</td>
<td>Fuel Oil Filling and Transfer Main</td>
<td>300</td>
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<tr>
<td>4</td>
<td>2½&quot;</td>
<td>Fuel Oil Transfer Nos. 1 &amp; 2 Fuel Oil Tanks</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>2&quot;</td>
<td>Fuel Oil Transfer Nos. 3A &amp; 3B Fuel Oil Tanks</td>
<td>300</td>
</tr>
<tr>
<td>6</td>
<td>2&quot;</td>
<td>Fuel Oil - Normal Fuel Oil Tank #1</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>2&quot;</td>
<td>Fuel Oil - Normal Fuel Oil Tank #2</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>2&quot;</td>
<td>Fuel Oil - Normal Fuel Oil Tank #2</td>
<td>-</td>
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<tr>
<td>9</td>
<td>1½&quot;</td>
<td>Fuel Oil - Filling Test</td>
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<tr>
<td>10</td>
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<td>Fuel Oil No. 3A Fuel Ballast Tank</td>
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<tr>
<td>11</td>
<td>2&quot;</td>
<td>Fuel Oil No. 3A Fuel Ballast Tank</td>
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<tr>
<td>12</td>
<td>2&quot;</td>
<td>Fuel Oil No. 3B Fuel Ballast Tank</td>
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<tr>
<td>13</td>
<td>2&quot;</td>
<td>Fuel Oil No. 5A Fuel Ballast Tank</td>
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<td>14</td>
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<td>Fuel Oil No. 5A Fuel Ballast Tank</td>
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<td>15</td>
<td>2&quot;</td>
<td>Fuel Oil No. 5B Fuel Ballast Tank</td>
<td>300</td>
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<tr>
<td>16</td>
<td>2&quot;</td>
<td>Fuel Oil No. 5B Fuel Ballast Tank</td>
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<tr>
<td>17</td>
<td>2&quot;</td>
<td>Fuel Oil No. 6 Fuel Oil Tank</td>
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<tr>
<td>18</td>
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<tr>
<td>19</td>
<td>2&quot;</td>
<td>Fuel Oil No. 7 Fuel Oil Tank</td>
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<td>20</td>
<td>2&quot;</td>
<td>Fuel Oil No. 7 Fuel Oil Tank</td>
<td>300</td>
</tr>
<tr>
<td>21</td>
<td>2½&quot;</td>
<td>Fuel Oil No. 6 &amp; 7 Fuel Oil Tanks</td>
<td>300</td>
</tr>
<tr>
<td>22</td>
<td>1½&quot;</td>
<td>Fuel Oil to Collecting Tank</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>1½&quot;</td>
<td>Fuel Oil Pumps Suction Collecting Tank</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>1½&quot;</td>
<td>F.O. Pumps Suction Fr. F.O. Transfer Line</td>
<td>300</td>
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<tr>
<td>25</td>
<td>½&quot;</td>
<td>Comp. Water Standpipe Drain</td>
<td>-</td>
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<tr>
<td>26</td>
<td>½&quot;</td>
<td>Comp. Water Standpipe Vent &amp; Overflow</td>
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</tr>
<tr>
<td>27</td>
<td>½&quot;</td>
<td>Comp. Water to Fuel Oil Expansion Tank</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>½&quot;</td>
<td>Comp. Water to Fuel Oil Expansion Tank</td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>½&quot;</td>
<td>Comp. Water Fuel Oil Exp. Tank By-pass</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>½&quot;</td>
<td>Comp. Water Fuel Oil Exp. Tank By-pass</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>2&quot;</td>
<td>Comp. Water Discharge</td>
<td>-</td>
</tr>
<tr>
<td>32</td>
<td>3&quot;</td>
<td>Comp. Water from Expansion Tank</td>
<td>300</td>
</tr>
<tr>
<td>33</td>
<td>3&quot;</td>
<td>Comp. Water to Main</td>
<td>300</td>
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<tr>
<td>34</td>
<td>3&quot;</td>
<td>Comp. Water Normal Fuel Oil Tank #1</td>
<td>-</td>
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<tr>
<td>35</td>
<td>3&quot;</td>
<td>Comp. Water Normal Fuel Oil Tank #2</td>
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<tr>
<td>36</td>
<td>3&quot;</td>
<td>Comp. Water Normal Fuel Oil Tank #2</td>
<td>-</td>
</tr>
<tr>
<td>37</td>
<td>3&quot;</td>
<td>Comp. Water to Fuel Ballast Tanks Nos. 3A &amp; 3B</td>
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<td>38</td>
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<td>Comp. Water to Fuel Ballast Tanks Nos. 3A &amp; 3B</td>
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<td>39</td>
<td>3&quot;</td>
<td>Comp. Water to Fuel Ballast Tanks Nos. 5A &amp; 5B</td>
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<td>40</td>
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<td>Comp. Water to Fuel Ballast Tanks Nos. 5A &amp; 5B</td>
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<td>41</td>
<td>3&quot;</td>
<td>Comp. Water to Normal Fuel Oil Tank No. 6</td>
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<tr>
<td>42</td>
<td>3&quot;</td>
<td>Comp. Water to Normal Fuel Oil Tank No. 6</td>
<td>300</td>
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<tr>
<td>43</td>
<td>3&quot;</td>
<td>Comp. Water to Normal Fuel Oil Tank No. 7</td>
<td>300</td>
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<tr>
<td>44</td>
<td>3&quot;</td>
<td>Comp. Water to Normal Fuel Oil Tank No. 7</td>
<td>300</td>
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<tr>
<td>45</td>
<td>3&quot;</td>
<td>Fuel Oil Test Piping</td>
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<tr>
<td>46</td>
<td>3&quot;</td>
<td>Comp. Water Vent &amp; Overflow</td>
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</table>

#### CAPACITIES & VOLUMES OF TANKS

<table>
<thead>
<tr>
<th>Fuel Oil Tanks</th>
<th>Cu.Ft.</th>
<th>tons Oil</th>
<th>tons S.Water</th>
</tr>
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<tbody>
<tr>
<td>No. 1 Fuel Oil Tank</td>
<td>1525</td>
<td>36.31</td>
<td>1.00</td>
</tr>
<tr>
<td>No. 2 Fuel Oil Tank</td>
<td>1744</td>
<td>41.56</td>
<td>1.00</td>
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<td>No. 6 Fuel Oil Tank</td>
<td>1992</td>
<td>47.45</td>
<td>2.00</td>
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<td>No. 7 Fuel Oil Tank</td>
<td>243</td>
<td>29.62</td>
<td>1.00</td>
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<tr>
<td>Collecting</td>
<td>398</td>
<td>9.48</td>
<td>1.00</td>
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<tr>
<td>Expansion</td>
<td>398</td>
<td>9.48</td>
<td>1.00</td>
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<tr>
<td>Clean B5% Net Cap.</td>
<td>398</td>
<td>9.48</td>
<td>1.00</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
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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 Red. Gear & Main Motors (Std. NM 1 & 3 Red. Gear #1) (Port NM 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 (NM & 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).

<table>
<thead>
<tr>
<th>Main Generator Engines (F.M.C. 10 Cyl. Mod. 3808-1/8) (1600 BHP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>Forward E.R. :</td>
</tr>
<tr>
<td>WE #1</td>
</tr>
<tr>
<td>WE #2</td>
</tr>
<tr>
<td>Aft E. R.</td>
</tr>
<tr>
<td>WE #3</td>
</tr>
<tr>
<td>WE #4</td>
</tr>
<tr>
<td>300 KW</td>
</tr>
<tr>
<td>Crankcase</td>
</tr>
</tbody>
</table>

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 valves
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 (X section
of the double bottom under) carries its own attached pump and lube oil service equipment.
(Technical duplicate Reduction Gear #2 and NM 2 & 4).

Reduction Gears Thrusts & Main Motors - L.O. System Parts

| Designate        | Cal. Cap. | Attached | Strainer | Absorbent | Cooler |
|                 | Sump Under | Pump | (Cotton) Filter | |
| Red. Gear #1     | 184       | X    | X        | X    | X    |
| Main Motor #3    |           | X    | X        | X    | X    |
| Main Motor #1    |           | X    | X        | X    | X    |
| Red. Gear #2     | 184       | X    | X        | X    | X    |
| Main Motor #2    |           | X    | X        | X    | X    |
| Main Motor #4    |           | X    | X        | X    | X    |
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.)

<table>
<thead>
<tr>
<th>Designate</th>
<th>Location</th>
<th>Purifier Pumps</th>
<th>Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purifier #1</td>
<td>FER</td>
<td>Built in</td>
<td>Supply &amp; Disch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Purifier #2</td>
<td>AER</td>
<td>X</td>
<td>15 gpm</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Designate</th>
<th>Location</th>
<th>Capacity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME Stowage #1</td>
<td>86-88</td>
<td>479 Gals</td>
<td>1.65 Tons</td>
</tr>
<tr>
<td>ME Stowage #2</td>
<td>95-99</td>
<td>814 Gals</td>
<td>2.70 Tons</td>
</tr>
<tr>
<td>ME Stowage #3</td>
<td>99-100</td>
<td>990 Gals</td>
<td>3.40 Tons</td>
</tr>
<tr>
<td>ME Stowage #4</td>
<td>100-107</td>
<td>1465 Gals</td>
<td>5.05 Tons</td>
</tr>
<tr>
<td>M.E. &amp; Red. Gear</td>
<td>105-107</td>
<td>390 Gals</td>
<td>1.34 Tons</td>
</tr>
<tr>
<td>General Service</td>
<td>M.R.</td>
<td>Standby Pump substitutes for any attached pump</td>
<td></td>
</tr>
<tr>
<td>Pump Standby and Transfer</td>
<td>IMO Pump</td>
<td>for distribution of reserve oil and general utility purpose</td>
<td></td>
</tr>
<tr>
<td>Strainer, Macomb</td>
<td>M.R.</td>
<td></td>
<td>Stand between outboard filling connection &amp; the stand-by pump carries By-Pass</td>
</tr>
<tr>
<td>Pump, Hand</td>
<td>M.R.</td>
<td></td>
<td>Sampling pump (both sumps for removing water)</td>
</tr>
<tr>
<td>Filling Conn. (and Disch.)</td>
<td>Main Deck</td>
<td>Takes a 1½ Standard hose connection (M.E. Specs. (and Disch.)</td>
<td>Fr. 107</td>
</tr>
<tr>
<td>Filling Valve</td>
<td>Fr. 107</td>
<td>19° Fwd.</td>
<td>A 2° sw angle valve, 2 ft. to port C/L Upper</td>
</tr>
<tr>
<td>Soundings</td>
<td>Sump Tank</td>
<td>Liquidometer gauge for engine sumps</td>
<td></td>
</tr>
<tr>
<td>Soundings</td>
<td>Sump &amp; Tank</td>
<td>Each tank carries a ½ sounding tube and rod calibrated in gals</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>In</th>
<th>Out</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Engines</td>
<td>138</td>
<td>166</td>
<td>28</td>
</tr>
<tr>
<td>Aux. Engines</td>
<td>138</td>
<td>160</td>
<td>24</td>
</tr>
<tr>
<td>Main Motor</td>
<td>120</td>
<td>126</td>
<td>6</td>
</tr>
</tbody>
</table>

Lube Oil Consumption - Pounds per BHP per hr: 0.0021

Reserve Oil Tanks

- M.E. Sumps (4) Total, 75° net cap: 1776 Gallons
- M.E. Reserve Tanks, 95% net cap: 3749 Gallons
- M.E. & Red. Gear Sumps, 75% net cap: 368 Gallons
- M.E. & Red. Gear Reserve, 95% net cap: 380 Gallons
- M.E. & M.E. Sump & Reserve, total (21.50 tons): 8263 Gallons
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 assure 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.
<table>
<thead>
<tr>
<th>Ports. No.</th>
<th>BuShips No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>52-381</td>
<td>490889</td>
<td>Compartments &amp; Tanks</td>
</tr>
<tr>
<td>533-208</td>
<td>312432</td>
<td>Lube Oil System - 2&quot; Wacomb Strainer</td>
</tr>
<tr>
<td>5053-381</td>
<td>5381-64501-12235</td>
<td>Piping Diagram - Lube Oil System, Machinery Spaces.</td>
</tr>
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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 tanks, 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 leads 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

<table>
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<tr>
<th>Compartment &amp; Description</th>
<th>Frame : Side</th>
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## List of Bilge Suctions and Cut-out Valves

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SS425-434 incl.
SS381-416 Incl.

13 October 1943
### PIPE LIST (Continued)

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<td>Brass</td>
<td>Drain from Radio Entering Tube</td>
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<td>Drain Line Suction from Motor Room</td>
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* - Pipes subject to external pressure.

### MATERIAL SCHEDULE

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**SS425-434 Incl.**

**SS381-416 Incl.**
### MATERIAL SCHEDULE (Continued)

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<td>Compressed Asbestos</td>
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<td>Cu Si Hard</td>
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### TRIM PUMP DATA

Type - Vertical - Duplex Single Acting Worm Drive

- No. of Cyl.: 2
- Bore: 4.375
- Stroke: 4.3 in.
- Suction: 2" NOM.
- Discharge: 2" NOM.
- 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: 4.375
- Stroke: 4.7/8 in.
- Suction: 3" NOM.
- Discharge: 2" NOM.
- 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.
**GAUGE LIST**

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<th>DIA.</th>
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<th>ENGRAVING</th>
<th>READING</th>
<th>RED HAND SETTING</th>
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<td>220#</td>
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<td>220#</td>
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**CAPACITIES & VOLUMES OF TANKS**

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<th>CUBIC FEET</th>
<th>OIL TONS</th>
<th>SEA WATER TONS</th>
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<td>After W.R.T.</td>
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# 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

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<thead>
<tr>
<th>Tank</th>
<th>M.B. No.</th>
<th>F.B.No.</th>
<th>Size</th>
<th>Operation Units</th>
<th>Main Units</th>
<th>Valve Power</th>
<th>Control Cap.</th>
<th>Power Trolley</th>
<th>Vents - Unit</th>
<th>Flood- Type</th>
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<td>11½</td>
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**(plus reliefs):**
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.

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<th>VENTS</th>
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<td>POWER - VENT VALVES</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.B.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Main Ballast Indicator System (Circuit TP) Control Room Indicator:

X Indicates Contactor Type P.
Intermediate position for Vents shows RED, for Flood Valves DARK.

<table>
<thead>
<tr>
<th>Designate</th>
<th>Tank Extent</th>
<th>Emergy Vents</th>
<th>VENTS Hydraulic Circuit</th>
<th>FLOOD VALVES Hand</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.B.</td>
<td>0-10</td>
<td>None</td>
<td>25: X</td>
<td>Free</td>
<td>13</td>
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<tr>
<td>M.B. 1</td>
<td>25-35</td>
<td>None</td>
<td>32: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 2A</td>
<td>46-52S</td>
<td>52S</td>
<td>49: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 2B</td>
<td>P</td>
<td>P</td>
<td>Hand: 51S: 51P:</td>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>50-52</td>
<td>51S</td>
<td>Hand: 51P:</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>M.B. 2C</td>
<td>52-57S</td>
<td>56S</td>
<td>61: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 2D</td>
<td>P</td>
<td>P</td>
<td>Hand: 60-60S:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.B. 3A</td>
<td>57-62S</td>
<td>62S</td>
<td>62: X</td>
<td>58-60S:</td>
<td></td>
</tr>
<tr>
<td>F.B. 3B</td>
<td>P</td>
<td>P</td>
<td>Hand: 58-60S:</td>
<td>Neoprene gaskets</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>62-64</td>
<td>64</td>
<td>64: X</td>
<td>63 P &amp; S: X</td>
<td></td>
</tr>
<tr>
<td>M.B. 4A</td>
<td>69-75S</td>
<td>75S</td>
<td>75S: X</td>
<td>70-72-74S:</td>
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</tr>
<tr>
<td>M.B. 4B</td>
<td>P</td>
<td>P</td>
<td>P: X</td>
<td>Extra Flg. Capacity</td>
<td></td>
</tr>
<tr>
<td>F.B. 5A</td>
<td>75-80S</td>
<td>79</td>
<td>76: X</td>
<td>76-79S: Fdg. Neoprene</td>
<td></td>
</tr>
<tr>
<td>F.B. 5B</td>
<td>P</td>
<td>P</td>
<td>76: X</td>
<td>76-79P: Neoprene Gaskets</td>
<td></td>
</tr>
<tr>
<td>M.B. 6A</td>
<td>80-85S</td>
<td>84</td>
<td>86: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 6B</td>
<td>P</td>
<td>P</td>
<td>84: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 6C</td>
<td>85-91S</td>
<td>90</td>
<td>87: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 6D</td>
<td>P</td>
<td>P</td>
<td>90: X</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>M.B. 7</td>
<td>108-117</td>
<td>None</td>
<td>119: X</td>
<td>Free</td>
<td></td>
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</table>
### Hull Opening Indicator System (Circuit TR) Showing units on the circuit and indicators itemized according to location:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatches &amp; Doors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escape Trunk Door</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fwd. Torpedo Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escape Trunk Hatch</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fwd. Torpedo Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gun Trunk Hatch</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gun Trunk Door</td>
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<td></td>
</tr>
<tr>
<td>Crew's Space Hatch</td>
<td>X</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Aft E.R. Hatch</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aft T.R. Hatch</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dive</td>
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<td></td>
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<tr>
<td>Conning Tower Upper Hatch</td>
<td>X</td>
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<td></td>
<td></td>
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<tr>
<td>Eng. Air Ind. Vent (Exhaust &amp; Hull (Supply Outboard ))</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>Main &amp; Aux. Exhs.</td>
<td>No. 1 M.E.</td>
<td>X</td>
<td>X</td>
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<tr>
<td>No. 2 M.E.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No. 3 M.E.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 4 M.E.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aux.</td>
<td>X</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Inboard Valves</td>
<td>Hull Supply Inboard</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Induction,</td>
<td>Fwd. E.R. Inboard</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aft E.R. Inboard</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Induction,</td>
<td>Manvgr. Rm. Inboard</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

129
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

<table>
<thead>
<tr>
<th>No.</th>
<th>Frames</th>
<th>Area Sq. Ft.</th>
<th>Cap. Tons</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT No. 1</td>
<td>8</td>
<td>29-33</td>
<td>16.59</td>
<td>45.34</td>
</tr>
<tr>
<td>MBT No. 2A &amp; 2B</td>
<td>8</td>
<td>46-50</td>
<td>12.08</td>
<td>31.90</td>
</tr>
<tr>
<td>MBT No. 2C &amp; 2D</td>
<td>8</td>
<td>53-57</td>
<td>12.08</td>
<td>33.03</td>
</tr>
<tr>
<td>After Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6A &amp; 6B</td>
<td>6</td>
<td>80 &amp; 81</td>
<td>10.56</td>
<td>34.09</td>
</tr>
<tr>
<td>6C &amp; 6D</td>
<td>6</td>
<td>85 &amp; 86</td>
<td>10.56</td>
<td>36.15</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>108 &amp; 111</td>
<td>11.32</td>
<td>40.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>181.14</td>
</tr>
</tbody>
</table>

The vents of each of the above groups are thrown from a single lever at the ship's hydraulic manifold. Harvest security is provided in the hand vents.

M.B. Tank No. 4A and 4B stands at the ship's center of buoyancy (11.1 ft. abaft of Frame 59). This tank carries 150% of normal venting capacity, with consequent speed in flooding. For adverse purposes it concentrates a rapid negative effect at the center of buoyancy. Six flapper flooded valves, hand operated, (pressure sealed) 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. Padlocks 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 lever. 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:

(1) Vent - B.B. Tank.
(2) Vents - M.B. Tanks Nos. 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 Nos. 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 (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.

**GI 981-900-U-12-2-1** DATE: 19 August 1943

**130** U.S. NAVY YARD, PORTSMOUTH, N.H. 1943
FLEET SUBMARINE
GENERAL INFORMATION

Flooding and Venting

U-12-a
SS381-504

Venting inboard (only) at blow manifolds is provided for:

1. Variable ballast tanks.
2. Auxiliary tanks.

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 88 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 (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)

W.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 1/2 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 11/2" ID and its center is 1112" 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 (eliptated hole for flexibility), and gasketed 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 (4" x 1/4" 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°C 0.D. x 2-7/8" L) is H.C alloy and the worm wheel (83° 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 H.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 75 revolutions on the handwheel to open. The toggle has a positive stop to prevent the joint from moving beyond a point 1" 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 143/4" in diameter. There are 14 emergency vent valves in the ship, total.

Main Ballast Tank No. 2C - Master Vent Valve stands 12" to Starboard of Ship's C.L. above the pressure hull (21'-3" A9, C.L. of Hull at this point is 11'-9" A5). (Ref. 978)

Main Ballast Tank No. 2C Vent Valve Cover is circular Comp. G disc (12-17/32" O.D.) dishes against sea pressure, webbed, loose (double) hinged from top. It carries a molded rubber "T" shaped gasket (3" face) with a retainer ring. The valve cover in the closed position hangs 6 ½" above an angle of 15° from vertical, the bottom edge outboard. When open it swings outward through 90°, and recesses clear of the air stream. (Ref. 987)


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 (111/8" ID) to the pipe leading to the emergency vent valve. It supports the valve cover, the bell crank mechanism which operates the valve, has a flat chamfered 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 (3/4" 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 (143/8" x 3" 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 13-2" 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 (1.439" 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 (31/8" L.) connection to a slotted link (71/8" B.C.). The slotted case hardened rollers (1.625" 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 (31/8" D. x 3/4" stroke) mounted at 30° from level on the frame. When operating on POWER, a HAND lever (2-7/8") rests horizontal in its fulcrum pin and a tethered locking pin (.785" D. x 5-9/16" L). The lower arm 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 (1" 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, P.O. 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 ½" 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 Compartments 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 8 1/2" assembled Mt.) (1600 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. H, 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 5" 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 (1.689" x 2") 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 ½" 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, N.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 290 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 17°. The mechanism is bell crank. (Ref. 1122)
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 ¾” 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 then connected to the H.P. air manifold, CR.

The Negative Tank Inboard Vent Valve (1¼” 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-acting blow through a small pipe 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 (1¼” 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 with a toggle joint, the stop lugs of which are set short of 1/3” from dead center. The valve seats are at Frame 0½ port (11¼” off C.L.) and Frame 8½, 75” 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 Operating Gear stands overhead in T.R. Frame 25½ (18¼-6¼” A.B.). The POWER is hydraulic and the alternative is HAND. The principle and design is the same as 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:

<table>
<thead>
<tr>
<th>Name and Number</th>
<th>Extent Fr.</th>
<th>Side</th>
<th>Manifold from which flooded &amp; pumped</th>
<th>Size</th>
</tr>
</thead>
</table>
| 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. | 3"-5"
| Forward W.R.T.   | 23-25      | P&S  | Trim manifold in COC & drain manifold| 3"-5"
| Aft Trim         | 125-130    | P&S  | Trim manifold in COC and Overflow   | 3"-5"

Variable Ballast Tanks - Blow and Vent Connections:

<table>
<thead>
<tr>
<th>Name and Number</th>
<th>Extent Fr.</th>
<th>Side</th>
<th>Manifold from which blown and vented</th>
<th>Size</th>
</tr>
</thead>
</table>
| Aux. No. 1       | 64-69      | S    | 225-1b, Service manifold in COC     | 1"
| Aux. No. 2       | 64-69      | P    | 225-1b, Service manifold in COC     | 1"
| Forward Trim     | 13-23      | P&S  | 225-1b, Service manifold in COC     | 1"
| Aft. Trim        | 125-130    | P&S  | 225-1b, Service manifold in A.T.R.  | 1/2" Vent
|                  |            |      |                                     | 1/2" Vent
### MAIN BALLAST TANKS

<table>
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<tr>
<th>MBT No.</th>
<th>Frames</th>
<th>Side</th>
<th>Frames</th>
<th>Side</th>
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<th>Flood Valve Area, each tank, (Sq.Ft.)</th>
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<td>P</td>
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<td>P</td>
<td>58 &amp; 60</td>
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### Bow Buoyancy: Free Flooding From Sea

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### Vent Valves

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## Moulded Gaskets for One Vessel

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<td>M.B. Tank #1 Vent Valve Cover</td>
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<td>M.B. Tank #2 &amp; #4 Vent Valve Cover</td>
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1. All Eng. Exh. & Fuel Ballast Gaskets made with special oil resisting compound, similar to "Neoprene" packing O.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 K.B. Rubber Cement furnished by LaFavorite Rubber Mfg. Co. of Patterson, N.J.
2. All vent valve gaskets for tubes S5205 to S5206 are to be furnished with 100% spare.
3. Where gaskets are moulded or purchased in strip form additional allowance must be made for tabulated developed length for overlap of vulcanized ends.
4. Pcs. 89, 89, 89, & 89 may be moulded in continuous rings of a diameter to fit properly in gasket groove assembly.
5. Pcs. 89, 89, 89, & 89 may be moulded in continuous rings of a diameter to fit properly in gasket groove assembly.
6. Where gaskets are moulded or purchased in strip form additional allowance must be made for tabulated developed length for overlap of vulcanized ends.
7. Moulded Gaskets for One Vessel.
MOLDED RUBBER GASKETS
SPECIAL
TEE & ANGLE

HULL STOP VALVE QUICK OPERATE
L. P. BLOM

FOR SHIPS: SEE TABLE
MOULDED RUBBER GASKETS U-12-A
SPECIAL
TEE & ANGLE

FOR SHIPS: SEE TABLE
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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 (Nul) - Art. 636.
(c) BuOrd Manual - Art. 1499, 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.

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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.

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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 II.
Fresh water tanks are listed, with capacities, on Plate II.

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 and 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 1/2" std. relief valve adjustable from 10 pounds to 30 pounds pressure, 1/4" 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 180 degrees Fahrenheit.

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.


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 1/4" 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 2” 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 2” 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.
                                             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.
                                             Connection to F.W. tanks.
                                             Cold water supply to galley, scullery, hot water tank, drinking water cooling coils, and coffee urn.
                                             Cold water to hot water tank, showers, bucket faucet, washing machine, and lavatories in Crew’s Wash Room.
                                             Connections for F.W. feed to distillers.
                                             Connections for Engine cooling & Lub. Oil Purifier priming.
                                             Connections for engine cooling system and sub-aid purifier priming.
                                             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 2” 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 ship’s 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 225 lbs. - 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. 490452**
F.W. to Emergency F.W. Tanks | * | Angle Scr. | 25-26P
F.W. to Torpedoes | * | Hose Bibb Scr. | 22P
Hot & Cold Water to Off. Showers | * | Horz. Chk. Scr. | 32-33 S
Hot & Cold Water to Off. Showers | * | Globe Needle Scr. | 32-33 S
Hot & Cold Water to Off. Shower Head | * | Cross Scr. | 32-33 S
F.W. Filling | * | Ang. Hose Scr. | 34-35 P
Hot Water Tk. Set @ 30 | * | Relief Scr. | 33-34 S

**Forward Battery Compartment - Ports. No. 454-285, BuShips No. 490217**
F.W. Tank #2 Filling | 1½" | Cross Scr. | 36 P
F.W. Tank #1 Filling | 1½" | Angle Scr. | 36 P
Cold Water to Sink | 1½" | Globe Scr. | 36 P
Cold Water to Lavs. | 3/8" | Globe Scr. | 44 P
Supply to Port Hot Water Tank | * | Globe Chk. Scr. | 40-41 S
Supply to Stbd. Hot Water Tank | * | Angle Scr. | 35-36 S
Supply to Stbd. H.W. Tank | * | Horz. Chk. | 35-36 S
Supply to Refrig. Cool Coil | * | Angle Scr. | 35-36 P
Port Hot Water Tank Set @ 30 | * | Relief Scr. | 35-36 P
Batt. F.W. Tk. Fill Below Deck | * | Globe Scr. | 45-46 C
Batt. Tank Fill Conn. | * | Globe Valve | 45-46 C
Pantry Sink H & C water | * | Sw. Type Faucet Set. Scr. | 36-37 P
Pantry Sink | * | Drink. Fix. Scr. | 35-36 P
Drain from H.W. Tanks | * | Globe Scr. | 35-36 P & S

**Control Room - Ports. No. 455-381, BuShips No. 431059**
F.W. Fill F.W. Tank #1 | 1½" | Ang. Stop Scr. | 57-58 P
F.W. Fill F.W. Tank #4 | 1½" | Cross Scr. | 57-58 P
Distilled Water to F.W. Tank #3 | 1½" | Ang. Stop Chk. Scr. | 57-58 P
Distilled Water to F.W. Tank #4 | 1½" | Ang. Stop Chk. Scr. | 57-58 P
Distilled Water to For'd Battery | 1½" | Globe Scr. | 56-57 P
F.W. Tanks | * | Globe Scr. | 52 P
Shut-off, F.W. Fwd. | 1½" | Globe Scr. | 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.
<table>
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<th>Size</th>
<th>Type</th>
<th>Location</th>
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<td>Globe Chk. Scrd.</td>
<td>65 S</td>
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<tr>
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<td>1/2&quot;</td>
<td>Globe Hose Scrd.</td>
<td>62-63 P</td>
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<tr>
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<tr>
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<tr>
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<td>1&quot;</td>
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<td>64-65 S</td>
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<td>Globe Stop Chk. Scrd.</td>
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<tr>
<td>Hot &amp; Cold Water to Shower</td>
<td>1/2&quot;</td>
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<td>77 P</td>
</tr>
<tr>
<td>Hot &amp; Cold Water to Shower</td>
<td>1/2&quot;</td>
<td>Horz. Chk. Scrd.</td>
<td>77 P</td>
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<tr>
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<td>Globe Scrd.</td>
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<tr>
<td>Cold Water to Showers</td>
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<td>Globe Scrd.</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>1/2&quot;</td>
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<td>75-76 P</td>
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<tr>
<td>Cold Water to Wash. Mach.</td>
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<td>Globe Scrd.</td>
<td>75-76 P</td>
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<tr>
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<td>75-76 P</td>
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<tr>
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<td>75-76 P</td>
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<td>1/2&quot;</td>
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<td>75-76 P</td>
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<tr>
<td>Batt. F.W. Tank Fill P&amp;S</td>
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<td>Globe Scrd.</td>
<td>64-65 P-S</td>
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<tr>
<td>Batt. Fill Conn.</td>
<td>1/2&quot;</td>
<td>Globe Valve</td>
<td>64-65 C</td>
</tr>
<tr>
<td>Hot &amp; Cold Water to Shower Head</td>
<td>3/8&quot;</td>
<td>Cross Scrd.</td>
<td>77 P</td>
</tr>
<tr>
<td>Drain from H.W. Tank</td>
<td>1&quot;</td>
<td>Globe Scrd.</td>
<td>77-76 P</td>
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<tr>
<td>F.W. Fill. Engines &amp; Dist'l' Er Feed</td>
<td>2&quot;</td>
<td>Globe Scrd. (L.C.)</td>
<td>87-88 P</td>
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<tr>
<td>F.W. for Oil Purifier Priming</td>
<td>1/2&quot;</td>
<td>Globe Scrd.</td>
<td>77-78 P</td>
</tr>
<tr>
<td>F.W. from air conditioning Cooler Drain Tk.</td>
<td>1&quot;</td>
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<td>F.W. Fill. Engines</td>
<td>2&quot;</td>
<td>Globe Scrd. (L.C.)</td>
<td>89-90 P</td>
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<td>F.W. Purifier Priming</td>
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<td>98-99 P</td>
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<td>111-112 S</td>
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<td>Hose Bibb</td>
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<td>MARK</td>
<td>SIZE</td>
<td>SERVICE</td>
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<td>------------------------------------------------------------------------</td>
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<td>1</td>
<td>1/2&quot;</td>
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<td>1/2&quot;</td>
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<td>Filling &amp; Service Conn. to &amp; From Aft F.W. Tanks</td>
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<td></td>
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<td></td>
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<td>8</td>
<td>1/2&quot;</td>
<td></td>
<td>Filling Line to Aft Battery F.W. Tanks</td>
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<td>9</td>
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<td></td>
<td>Aft Battery F.W. Tank Piping (Below flat)</td>
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<td></td>
<td>F.W. Service Line - Aft</td>
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<td></td>
<td>W.C. Floor Drain</td>
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<tr>
<td>48</td>
<td>1/2&quot;</td>
<td></td>
<td>Sanitary Tank Drain Conn.</td>
</tr>
<tr>
<td>49</td>
<td>1/2&quot;</td>
<td></td>
<td>W.C. Flush - Forward Torpedo Room</td>
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<tr>
<td>50</td>
<td>2&quot;</td>
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<td>Main Drain Port Side to F.T.R. &amp; San. Tank</td>
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<tr>
<td>51</td>
<td>2&quot;</td>
<td></td>
<td>Cold Water to H.W. Tank &amp; Scullery Sink</td>
</tr>
<tr>
<td>52</td>
<td>2&quot;</td>
<td></td>
<td>Cold Water to H.W. Tank</td>
</tr>
<tr>
<td>53</td>
<td>2&quot;</td>
<td></td>
<td>Cold Water to Scullery Sink</td>
</tr>
<tr>
<td>54</td>
<td>2&quot;</td>
<td></td>
<td>F.W. to Coffee Urn - Galley</td>
</tr>
<tr>
<td>55</td>
<td>2&quot;</td>
<td></td>
<td>F.W. to Coffee Urn - Galley</td>
</tr>
<tr>
<td>56</td>
<td>1/2&quot;</td>
<td></td>
<td>F.W. to Coffee Urn - Galley</td>
</tr>
<tr>
<td>57</td>
<td>1/2&quot;</td>
<td></td>
<td>F.W. to Coffee Urn - Galley</td>
</tr>
<tr>
<td>58</td>
<td>1/2&quot;</td>
<td></td>
<td>F.W. to Coffee Urn - Galley</td>
</tr>
<tr>
<td>59</td>
<td>1/2&quot;</td>
<td></td>
<td>Hot Water to Galley Sink</td>
</tr>
<tr>
<td>60</td>
<td>1/2&quot;</td>
<td></td>
<td>Hot Water to Galley &amp; Scullery Sinks</td>
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### PIPE LIST (Continued)

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<tr>
<th>MARK</th>
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<th>TEST</th>
<th>LOCATION</th>
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<tr>
<td>61</td>
<td>1&quot; Hot Water to Scullery Sink</td>
<td>50$</td>
<td>C.W.</td>
</tr>
<tr>
<td>62</td>
<td>1&quot; Drain from Coffee Urn &amp; Tray</td>
<td>-</td>
<td>C.N.</td>
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<tr>
<td>63</td>
<td>1&quot; Drain from Drinking Fountain</td>
<td>-</td>
<td>C.M.</td>
</tr>
<tr>
<td>64</td>
<td>1&quot; Drain from Galley Sink</td>
<td>-</td>
<td>C.M.</td>
</tr>
<tr>
<td>65</td>
<td>1/2&quot; Drain - Port Side</td>
<td>-</td>
<td>C.M., C.O.</td>
</tr>
<tr>
<td>66</td>
<td>1/2&quot; Drain from Scullery Sink</td>
<td>-</td>
<td>C.N.</td>
</tr>
<tr>
<td>67</td>
<td>1/2&quot; H.W. Tank Relief Valve Diach.</td>
<td>-</td>
<td>C.M., C.O.</td>
</tr>
<tr>
<td>68</td>
<td>1/2&quot; Drain from Hull Ventilation Outboard Valve Trunk</td>
<td>-</td>
<td>C.M.</td>
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<tr>
<td>69</td>
<td>1/2&quot; Drain - Starboard Side</td>
<td>-</td>
<td>C.Q.</td>
</tr>
<tr>
<td>70</td>
<td>3/8&quot; Cold Water to Hot Water Tank &amp; Showers</td>
<td>50$</td>
<td>C.Q.</td>
</tr>
<tr>
<td>71</td>
<td>1/2&quot; Cold Water to Hot Water Tank</td>
<td>50$</td>
<td>C.Q.</td>
</tr>
<tr>
<td>72</td>
<td>1/2&quot; Hot Water Supply to Wash Room</td>
<td>50$</td>
<td>C.Q.</td>
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<tr>
<td>73</td>
<td>1/2&quot; H &amp; C. Water to Showers, Lev. &amp; Bucket Faucets</td>
<td>50$</td>
<td>C.Q.</td>
</tr>
<tr>
<td>74</td>
<td>1/2&quot; H &amp; C. Water to Lavatory</td>
<td>50$</td>
<td>C.Q.</td>
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<tr>
<td>75</td>
<td>1/2&quot; H &amp; C. Water to Washing Mach. &amp; Leafs.</td>
<td>50$</td>
<td>C.Q.</td>
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<td>76</td>
<td>3/8&quot; H &amp; C. Water to Leaves</td>
<td>50$</td>
<td>C.Q.</td>
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<tr>
<td>77</td>
<td>1&quot; Drain from Leafs.</td>
<td>-</td>
<td>C.Q.</td>
</tr>
<tr>
<td>78</td>
<td>1/2&quot; Drain from Wash. Mach. &amp; Overflow from F.W. Tank</td>
<td>-</td>
<td>C.O.</td>
</tr>
<tr>
<td>79</td>
<td>1/2&quot; Drain from Leafs.</td>
<td>-</td>
<td>C.O.</td>
</tr>
<tr>
<td>80</td>
<td>1/2&quot; Drain from Leafs. &amp; Wash. Mach.</td>
<td>-</td>
<td>C.O.</td>
</tr>
<tr>
<td>81</td>
<td>1/2&quot; Drain from Wash Room &amp; W.C. Floors</td>
<td>-</td>
<td>C.Q.</td>
</tr>
<tr>
<td>82</td>
<td>1/2&quot; Drain from Shower Floors</td>
<td>-</td>
<td>C.O.</td>
</tr>
<tr>
<td>83</td>
<td>2&quot; Port Drain to San Tank</td>
<td>-</td>
<td>C.Q.</td>
</tr>
<tr>
<td>84</td>
<td>2&quot; Starboard Drain to San Tank</td>
<td>-</td>
<td>C.Q.</td>
</tr>
<tr>
<td>85</td>
<td>1&quot; W.C. Flush - Crew's Space</td>
<td>300$</td>
<td>C.O.</td>
</tr>
<tr>
<td>86</td>
<td>1&quot; W.C. Flush - Crew's Space</td>
<td>-</td>
<td>M.B.T.</td>
</tr>
<tr>
<td>87</td>
<td>3/8&quot; W.C. Diach - Crew's Space</td>
<td>300$</td>
<td>C.O.</td>
</tr>
<tr>
<td>88</td>
<td>3/8&quot; W.C. Diach - Crew's Space</td>
<td>300$</td>
<td>C.O.</td>
</tr>
<tr>
<td>89</td>
<td>1/2&quot; W.C. Flush - After Torpedo Room</td>
<td>300$</td>
<td>A.T.R.</td>
</tr>
<tr>
<td>90</td>
<td>1/2&quot; W.C. Diach - After Torpedo Room</td>
<td>300$</td>
<td>A.T.R.</td>
</tr>
<tr>
<td>93</td>
<td>3/8&quot; Cold Water to Lev. - Aft Torp. Room</td>
<td>50$</td>
<td>A.T.R.</td>
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<tr>
<td>94</td>
<td>1/2&quot; F.W. To Emergency F.W. Tank</td>
<td>50$</td>
<td>A.T.R.</td>
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<tr>
<td>95</td>
<td>1/2&quot; F.W. To Torpedoes</td>
<td>50$</td>
<td>A.T.R.</td>
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<tr>
<td>96</td>
<td>1/2&quot; Overflow from F.W. Tank - Ventilation Air Cooler Drain</td>
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<td>A.E.R.</td>
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<tr>
<td>97</td>
<td>1&quot; Water Closet Flush</td>
<td>-</td>
<td>C.Q. &amp; F.E.R.</td>
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<tr>
<td>98</td>
<td>1&quot; Water Closet Flush</td>
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<td>M.B.T.No.6A</td>
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<tr>
<td>99</td>
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<td>50$</td>
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<td>100</td>
<td>3/8&quot; Cold Water Conn. to Lavatory</td>
<td>50$</td>
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<td>101</td>
<td>3/8&quot; Cold Water Conn. to Lavatory</td>
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<tr>
<td>102</td>
<td>3/8&quot; Drain from Lavatory - Starboard</td>
<td>50$</td>
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<tr>
<td>103</td>
<td>3/8&quot; Cold Water to Lavatory</td>
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### CAPACITIES OF TANKS-FRESH WATER & PLUMBING SYSTEM

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<thead>
<tr>
<th></th>
<th>Cu.Ft.</th>
<th>Gals</th>
<th>Tons</th>
<th>Test</th>
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<tbody>
<tr>
<td>Fresh Water Tank #1 &amp; #2</td>
<td>2000</td>
<td>7.42</td>
<td>30$</td>
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<tr>
<td>Fresh Water Tank #3 &amp; #4</td>
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<td>7.42</td>
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<tr>
<td><strong>Total</strong></td>
<td>4000</td>
<td>14.84</td>
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### Battery Fresh Water

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<tr>
<th></th>
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<tbody>
<tr>
<td>Battery F.W. Tanks - Forward</td>
<td>2.22</td>
<td>30$</td>
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<td>Battery F.W. Tanks - Aft</td>
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<td>30$</td>
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### Emergency Fresh Water

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<tr>
<td>Forward Torpedo Room</td>
<td>120</td>
<td></td>
<td></td>
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<tr>
<td>After Engine Room</td>
<td>20</td>
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<tr>
<td>Maneuvering Room</td>
<td>18</td>
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<tr>
<td>After Torpedo Room</td>
<td>120</td>
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8 October 1943
### Capacities of Tanks - Fresh Water & Plumbing System (Continued)

<table>
<thead>
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<th>Sanitary Tanks</th>
<th>Gals.</th>
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<td>No.1 Sanitary Tank - Forward</td>
<td>320</td>
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<tr>
<td>No.2 Sanitary Tank - Midship</td>
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<td><strong>Total</strong></td>
<td><strong>1420</strong></td>
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Auxiliary Fresh Water from Air Conditioning Cooler Drain

Crew's Quarters - Wash Room

Aft. Engine Room

20

---

### Material Schedule

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<th></th>
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<tbody>
<tr>
<td>Globe &amp; Cross Valve</td>
<td>Comp. H</td>
<td></td>
<td>Flanged&lt;sup&gt;Pr&lt;/sup&gt;</td>
<td>150#</td>
</tr>
<tr>
<td>Angle Valve</td>
<td>Comp. H</td>
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<tr>
<td>Gate Valve</td>
<td>Comp. H</td>
<td></td>
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<td>300#</td>
</tr>
<tr>
<td>Stop Check Valve</td>
<td>Comp. H</td>
<td></td>
<td></td>
<td>150#</td>
</tr>
<tr>
<td>Hose Valve Globe</td>
<td>Comp. H</td>
<td></td>
<td>Screwed</td>
<td>150#</td>
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<tr>
<td>Check Valve</td>
<td>Comp. H</td>
<td></td>
<td></td>
<td>150#</td>
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<td>Relief Valve</td>
<td>Comp. H</td>
<td></td>
<td></td>
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<tr>
<td>Plug Valve - Easy Operated Lubricated Type</td>
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<td>Flanged&lt;sup&gt;Pr&lt;/sup&gt;</td>
<td>300#</td>
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<tr>
<td>Self Closing Bibb</td>
<td>Comp. H</td>
<td></td>
<td>Screwed</td>
<td>50#</td>
</tr>
<tr>
<td>Hose Bibb</td>
<td>Comp. H</td>
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<td>Self Closing Basin Faucet</td>
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<td>Folding Lavatory</td>
<td>C.R.S.</td>
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<td>Water Closet (Air Expulsion Type)</td>
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<tr>
<td>Floor Drain Valve &amp; W. Seal</td>
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<td></td>
<td>Screwed</td>
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<tr>
<td>Shower Head</td>
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<td>Pot Trap</td>
<td>Comp. H Cus.</td>
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<td>44P12</td>
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<tr>
<td>&quot;S&quot; Trap</td>
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<td></td>
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<tr>
<td>&quot;P&quot; Trap</td>
<td>Brass</td>
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<tr>
<td>Running Trap</td>
<td>Brass</td>
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<tr>
<td>Hose Valve Angle</td>
<td>Comp. H</td>
<td></td>
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<tr>
<td>Sink Faucet Set (Swing Type)</td>
<td>Comp. H</td>
<td></td>
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<td>50#</td>
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<td>Floor Drain Trap</td>
<td>Comp. H</td>
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<td>48#</td>
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<td>Water Closet (Special Type)</td>
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<td>Screwed</td>
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<td>Plain Bibb</td>
<td>Comp. H</td>
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<td>SanTank Drach.</td>
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### Piping

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<tbody>
<tr>
<td>Battery Fresh Water</td>
<td>Brass</td>
<td>Screwed</td>
<td>30#</td>
<td>44P12</td>
<td>20#</td>
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<tr>
<td>Fresh Water Service</td>
<td>Brass</td>
<td>Screwed</td>
<td>30#</td>
<td>44P12</td>
<td>20#</td>
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<tr>
<td>Water Closet Flush</td>
<td>Cu.Ni.</td>
<td>311Brazed</td>
<td>300#</td>
<td>44T40</td>
<td>200#</td>
</tr>
<tr>
<td>Water Closet Disch.</td>
<td>Cu.Ni.</td>
<td>Figd.311</td>
<td>200#</td>
<td>44T40</td>
<td>200#</td>
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<tr>
<td>Drains to Sanitary Tanks</td>
<td>Brass</td>
<td>Screwed</td>
<td>200#</td>
<td>44P12</td>
<td>200#</td>
</tr>
</tbody>
</table>

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**Notes:**

- Flanged<sup>Pr</sup>: Flanged with a collar
- Screwed: Screwed in place
- 44P12: Working Pressure specification
- 33425-43# incl.: Maximum limits
- 33381-416 incl.: Minimum limits
<table>
<thead>
<tr>
<th>Ports No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>102-228</td>
<td>386135</td>
<td>Battery Fresh Water Tanks</td>
</tr>
<tr>
<td>453-381</td>
<td>491057</td>
<td>Fresh Water and Plumbing Systems - Diagram</td>
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<tr>
<td>454-285</td>
<td>490217</td>
<td>Fresh Water and Plumbing System - Piping Arrgt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Officers' Quarters &amp; Forward Battery Compt.</td>
</tr>
<tr>
<td>455-381</td>
<td>491059</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. - Control Room</td>
</tr>
<tr>
<td>457-381</td>
<td>491064</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. Crew's Quarters &amp; Aft Battery Compartment</td>
</tr>
<tr>
<td>458-381</td>
<td>491065</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. Forward Engine Room</td>
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<td>459-381</td>
<td>491066</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. After Engine Room</td>
</tr>
<tr>
<td>463-285</td>
<td>386537</td>
<td>Gauge List for C&amp;R Piping System</td>
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<tr>
<td>472-285</td>
<td>490152</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. - Forward Torpedo Room</td>
</tr>
<tr>
<td>473-425</td>
<td>490153</td>
<td>Fresh Water &amp; Plumbing - Piping Arrgt. - After Torpedo Room</td>
</tr>
<tr>
<td>488-228</td>
<td>386464</td>
<td>Fresh Water Tanks - Try Cock System</td>
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<tr>
<td>514-228</td>
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<td>Fresh Water &amp; Plumbing - Piping Arrgt. Maneuvering Room</td>
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<tr>
<td>561-381</td>
<td>491073</td>
<td>Fresh Water &amp; Plumbing System - Special Fittings</td>
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<tr>
<td>558-201</td>
<td>312145</td>
<td>Fresh Water Tank - Blow &amp; Vent Manifold</td>
</tr>
<tr>
<td>35919</td>
<td>386951</td>
<td>Fresh Water Tanks - Test Manifold</td>
</tr>
</tbody>
</table>
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 in the base of these closets acts as stop valve when sanitary tank is under pressure. Air expulsion Water Closet located in after Torpedo Room discharges to the sea.

<table>
<thead>
<tr>
<th>Service &amp; Compartment</th>
<th>Size</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Officers Shower &amp; Port Drain</td>
<td>2&quot;</td>
<td>Horiz. Chk Scr.</td>
<td>33-34-35 P&amp;S</td>
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<tr>
<td>Drain - Port Side</td>
<td>2&quot;</td>
<td>Plug Valve Scr. Lub Type</td>
<td>34-35 P</td>
</tr>
<tr>
<td>Drain Std. Side</td>
<td>1½&quot;</td>
<td>Plug Valve Scr. Lub Type</td>
<td>34-35 S</td>
</tr>
<tr>
<td>Drain at Sanitary Tank</td>
<td>2&quot;</td>
<td>Gate Flg.</td>
<td>34-35 S</td>
</tr>
<tr>
<td>Drain from Lav.</td>
<td>1&quot;</td>
<td>Horiz. Chk Scr.</td>
<td>33-34 P</td>
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<tr>
<td>Sanitary Tank Sound Tube</td>
<td>1&quot;</td>
<td>Gate Sld.</td>
<td>34-35 S</td>
</tr>
<tr>
<td>W.C. Flush Valve</td>
<td>1&quot;</td>
<td>Angle Sld.</td>
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</tr>
<tr>
<td>W.C. Flush (Sea)</td>
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<td>34-35 S</td>
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Forward Torpedo Room - Ports. No. 472-285, BuShips No. 490152.

<table>
<thead>
<tr>
<th>Service &amp; Compartment</th>
<th>Size</th>
<th>Type</th>
<th>Location</th>
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<tr>
<td>Drain from Refrig.</td>
<td>3&quot;</td>
<td>Globe Scr.</td>
<td>35-36 P</td>
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<td>Crew's Mess, Galley, Scullery</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Drain from Coffee Urn</td>
<td>3&quot;</td>
<td>Globe Scr.</td>
<td>58-59 C</td>
</tr>
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<tr>
<td>Drain from Shower Floor</td>
<td>1½&quot;</td>
<td>Horiz. Chk Scr.</td>
<td>77 P</td>
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<tr>
<td>Drains to Sanitary Tank</td>
<td>2&quot;</td>
<td>Horiz. Chk Scr.</td>
<td>77 S</td>
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<tr>
<td>Drains from W.C. and Wash. Room Floor</td>
<td>1½&quot;</td>
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<td>75-76 P&amp;S</td>
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<td>Drains to Sanitary Tank</td>
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<td>W.C. Flush (Sea)</td>
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<td>W.C. Flush Valve</td>
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<td>75-77 S</td>
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<tr>
<td>Sanitary Tank Sound Tube</td>
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<td>76-77 S</td>
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<tr>
<td>Service &amp; Compartment</td>
<td>Size</td>
<td>Type</td>
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<tr>
<td>-----------------------------------------------</td>
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<tr>
<td>After Torpedo Room W.C. - Ports. No. 520-381, BuShips No. SS381-53601-67928</td>
<td></td>
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</tr>
<tr>
<td>W.C. Discharge</td>
<td>2&quot;</td>
<td>Plug Valve Flgd. Lub Type</td>
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<tr>
<td>W.C. Flush Valve</td>
<td>1&quot;</td>
<td>Angle Sold.</td>
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</tr>
<tr>
<td>Stop in Flush. Line</td>
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<td>W.C. Disch. - Vent</td>
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<td>Globe Scrd.</td>
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</tr>
<tr>
<td>W.C. - Air Tank Drain</td>
<td>1&quot;</td>
<td>Globe Scrd.</td>
<td>108-109 P</td>
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<tr>
<td>W.C. - Air to Rocker Valve</td>
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<td>Globe Scrd.</td>
<td>108-109 P</td>
</tr>
<tr>
<td>W.C.-Gauges</td>
<td>1&quot;</td>
<td>Rocker Valve</td>
<td>108-109 P</td>
</tr>
<tr>
<td>W.C.-Air</td>
<td>1&quot;</td>
<td>Gate Flgd.</td>
<td>107-108 P</td>
</tr>
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<td>W.C. Discharge (Sea)</td>
<td>2&quot;</td>
<td>Globe Scrd.</td>
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</tr>
<tr>
<td>Sea Chest Blow &amp; Gauge Conn.</td>
<td>4&quot;</td>
<td>Globe Scrd.</td>
<td>108-109 P</td>
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Reference Plans:

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<th>Ports. No.</th>
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<td>453-381</td>
<td>491057</td>
<td>Diagram</td>
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<td>472-285</td>
<td>490152</td>
<td>Forward Torpedo Room</td>
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<tr>
<td>454-285</td>
<td>490217</td>
<td>Forward Battery Space</td>
</tr>
<tr>
<td>455-381</td>
<td>491059</td>
<td>Control Room and Conning Tower</td>
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<td>456-381</td>
<td>491074</td>
<td>Crew’s Mess, Galley &amp; Scullery</td>
</tr>
<tr>
<td>457-381</td>
<td>491068</td>
<td>After Battery Space</td>
</tr>
<tr>
<td>458-381</td>
<td>386434</td>
<td>Forward Engine Room</td>
</tr>
<tr>
<td>459-381</td>
<td>386435</td>
<td>After Engine Room</td>
</tr>
<tr>
<td>514-228</td>
<td>386490</td>
<td>Maneuvering Room</td>
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<td>473-425</td>
<td>490153</td>
<td>After Torpedo Room</td>
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<tr>
<td>35118</td>
<td>390454</td>
<td>Hot Water Tanks, Elec. Heated</td>
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<tr>
<td>520-381</td>
<td>SS381-53601-67929</td>
<td>Crew’s Aft Water Closet</td>
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<tr>
<td>462-285</td>
<td>490207</td>
<td>Y.C. Clapper Valve Box</td>
</tr>
</tbody>
</table>
Section U-19

3000 LB. AIR

          (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 Std.
  same Pump Room Forward End Port
L.P. Air Compressor Pump Room After End Std.

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 3000-4000# 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 installa-
tion. 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.
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 1½, stroke 4½ inches.

### AIR SYSTEMS 3000 LB

#### CAPACITY OF AIR BANKS

<table>
<thead>
<tr>
<th>Bank No.</th>
<th>Cubic Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>125.20</td>
</tr>
<tr>
<td>2</td>
<td>109.55</td>
</tr>
<tr>
<td>3</td>
<td>109.55</td>
</tr>
<tr>
<td>4</td>
<td>109.55</td>
</tr>
<tr>
<td>5</td>
<td>109.55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>563.40</strong></td>
</tr>
</tbody>
</table>

#### AIR FLASK DATA

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Flasks</th>
<th>Outside Dia.</th>
<th>Cap. each</th>
<th>Total Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.B.T. No. 0A</td>
<td>2</td>
<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>31.30</td>
</tr>
<tr>
<td>M.B.T. No. 9A</td>
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<td>15.05 Cu.Ft.</td>
<td>31.30</td>
</tr>
<tr>
<td>H.B.T. No. 2A</td>
<td>3</td>
<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>46.45</td>
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<td>M.B.T. No. 21</td>
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<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>46.45</td>
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<td>M.B.T. No. 4A</td>
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<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>31.30</td>
</tr>
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<td>M.B.T. No. 6A</td>
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<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>46.45</td>
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<tr>
<td>H.B.T. No. 6A</td>
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<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
<td>62.60</td>
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<tr>
<td>M.B.T. No. 7A</td>
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<td>11 Ft., 3 In., 18 Inches</td>
<td>15.05 Cu.Ft.</td>
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<td>Fwd. Battery Space</td>
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<td>62.60</td>
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<td>After Battery Space</td>
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<td>62.60</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>563.40</strong></td>
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#### IMPULSE AIR FLASKS

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<tr>
<th>Location</th>
<th>No.: Length</th>
<th>Outside Dia.</th>
<th>Cap. Each</th>
<th>Total Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superstructure - Forward</td>
<td>6 : 5&quot; - 3&quot;</td>
<td>18&quot;</td>
<td>.7 Cu. Ft.</td>
<td>.42 Cu. Ft.</td>
</tr>
<tr>
<td>After Torpedo Room</td>
<td>4 : 5&quot; - 3&quot;</td>
<td>18&quot;</td>
<td>.7 Cu. Ft.</td>
<td>.28 Cu. Ft.</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>70 Cu. Ft.</strong></td>
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#### HYDRAULIC ACCUMULATOR

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<th>No.: Length</th>
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<th>Capacity</th>
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<td>Pump Room</td>
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#### AIR SEPARATORS

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<th>Capacity</th>
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<tr>
<td>H.P. Air Compressors</td>
<td>2 : 3'-7½&quot;</td>
<td>5½&quot; I.D.</td>
<td>.994 Cu. Ft.</td>
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<td>Pump Room</td>
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<tr>
<td>Torpedo Rooms</td>
<td>2 : 3'-7½&quot;</td>
<td>5½&quot; I.D.</td>
<td>.994 Cu. Ft.</td>
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<td><strong>TOTAL</strong></td>
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### Relief Valve List

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<td>2</td>
<td>3/4&quot;</td>
<td>Male</td>
<td>Fem. Side</td>
<td>5/8&quot; Side</td>
<td>720#</td>
<td>630#</td>
<td>Air Flask Torpedo Impulse Air</td>
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### Air Flask Data

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<th>Total Capacity Cu. Ft.</th>
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<tr>
<td>M.B.T. No. 2A</td>
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<td>111 3/4&quot;</td>
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<td>15.65 Cu.Ft.</td>
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<tr>
<td>2B</td>
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<tr>
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### Impulse Air Flasks

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<tbody>
<tr>
<td>Superstructure - Forward</td>
<td>6</td>
<td>5'-10&quot;</td>
<td>16&quot;I.D.</td>
<td>7 Cu.Ft.</td>
<td>42 Cu.Ft.</td>
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<tr>
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<td>5'-3&quot;</td>
<td>18&quot;O.D.</td>
<td>7 Cu.Ft.</td>
<td>28 Cu.Ft.</td>
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<tr>
<td>Total</td>
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### Hydraulic Accumulator

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### Air Separators

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<tbody>
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<td>3'-7½&quot;</td>
<td>5½&quot;I.D.</td>
<td>994 Cu.Ft.</td>
</tr>
<tr>
<td>Pump Room</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Torpedo Rooms</td>
<td>2</td>
<td>3'-7½&quot;</td>
<td>5½&quot;I.D.</td>
<td>994 Cu.Ft.</td>
</tr>
<tr>
<td>Total</td>
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<td>1,988 Cu.Ft.</td>
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### Capacity of Air Banks

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<th>Cubic Feet</th>
</tr>
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<td>125.20</td>
</tr>
<tr>
<td>2</td>
<td>109.55</td>
</tr>
<tr>
<td>3</td>
<td>109.55</td>
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<td>4</td>
<td>109.55</td>
</tr>
<tr>
<td>5</td>
<td>109.55</td>
</tr>
<tr>
<td>Total</td>
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**CONFIDENTIAL**

**FLEET SUBMARINE GENERAL INFORMATION**

**3000# AIR SYSTEM**

*See Diagram U-19-a*

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**GIB SS361-404 U-19-a-1 28 September 1943**

155 400-381 U.S. NAVY YARD, PORTSMOUTH, N.H. 1943
### GAUGE LIST

<table>
<thead>
<tr>
<th>MARK</th>
<th>NO.</th>
<th>Dia.</th>
<th>Service</th>
<th>Red Hand Setting</th>
<th>Reading Setting</th>
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<tbody>
<tr>
<td>A</td>
<td>8</td>
<td>4½</td>
<td>H.P. Air Banks, Service Fwd. &amp; Aft, Dist. Manifold</td>
<td>0-4000#</td>
<td>3000#</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>4½</td>
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### REDUCING VALVES

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### CAPACITIES & VOLUMES OF TANKS

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### MATERIAL SCHEDULE

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*Note: *All items indicated with an asterisk (*) are for use in the U-19-a model of the submarine.*
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<td>Negative Tank Drain to Bilge</td>
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500 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 2B M.B.
3. 3B 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 60 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


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
Intake Silencer
Pump Room
L.P. Cut-out - flap valve
On Intake
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, 4A, 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 gaging 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 "Y", 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 465-381, 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 identification 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 stowages shown) for use as follows:


See "Hull Valves and number of turns necessary to secure", reference plan.

Diver's connections for salvage system are fitted for 1½ 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.
## Gauge List

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<tr>
<th>MARK</th>
<th>Req.</th>
<th>Dia.</th>
<th>DIAL</th>
<th>SERVICE</th>
<th>READING</th>
<th>RED HAND SETTING</th>
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### Capacities & Volumes of Tanks

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<td>Safety Tank</td>
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Total: 21,931 - 626.60

---

L. P. BLOWER

Rotary Type - Capacity 1600 Cu.Ft. per min. - 1750 R.P.M. - 10# psi pressure

## Pipe List

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<tr>
<th>MARK</th>
<th>SIZE</th>
<th>PIPE LIST</th>
<th>PRESSURE</th>
<th>WORK</th>
<th>TEST</th>
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<td>Vents - 600# Blow F.B.T.'s 3, 4, &amp; 5</td>
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<td>900</td>
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Section U-19

225 LB. AIR


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\(\frac{1}{2}\)" x 2\(\frac{1}{2}\)" - 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

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<tr>
<th>Variable Ballast Tanks</th>
<th>Cubic Feet</th>
<th>Tons S.W.</th>
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<td>31.26</td>
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<td>Forward Trim Tank</td>
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<td>Forward W.R.T.</td>
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<td>5.00</td>
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<td>After Trim Tank</td>
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<td>20.94</td>
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<td>After W.R.T.</td>
<td>185</td>
<td>9.28</td>
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### Normal Fuel Oil
- No. 1: 1525 Cu.Ft., 1400 Gals., 36.31 Tons
- No. 2: 1744 Cu.Ft., 13050 Gals., 41.56 Tons
- No. 6: 1992 Cu.Ft., 14900 Gals., 47.45 Tons
- No. 7: 1243 Cu.Ft., 9300 Gals., 28.62 Tons
- Collecting: 398 Cu.Ft., 2980 Gals., 9.49 Tons
- Expansion: 398 Cu.Ft., 2980 Gals., 9.49 Tons

### Fuel Ballast
- No. 3A & 3B: 2619 Cu.Ft., 19550 Gals., 62.26 Tons
- No. 5A & 5B: 2638 Cu.Ft., 19680 Gals., 62.68 Tons

### Fresh Water Tanks
- No. 1 & 2: 2000 Gals., 7.44 Tons
- No. 3 & 4: 2450 Gals., 9.12 Tons
- Forward Battery: 600 Gals., 2.22 Tons
- After Battery: 600 Gals., 2.22 Tons
- Sanitary Tanks: 320 Gals., 1.19 Tons
- No. 2: 1100 Gals., 4.09 Tons

## Material Schedule

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<tr>
<th>Material</th>
<th>Material</th>
<th>Conn.</th>
<th>USN Spec.</th>
<th>PLAN No.</th>
<th>Test</th>
<th>Remarks</th>
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<td>Globe, Angle &amp; Cross Valves</td>
<td>Comp.M</td>
<td>Flanged</td>
<td>45V9</td>
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<td>Relief Valve</td>
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<td>or Scwd.</td>
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<td>Quick Opening Gate</td>
<td>Bronze</td>
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<td>45V10</td>
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<td>Drina</td>
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<td>450#</td>
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**Remarks:**
- Signal Ejector Drain
- Signal Ejector Blow
- F.O. Tanks Test Manifold
- San. Tank Vent

**Incl.:** SS425-434 SS381-416
### Gauge List

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<th>Service</th>
<th>Reading</th>
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<td>A</td>
<td>3</td>
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<td>Air Service</td>
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<td>Air Compartment &amp; Variable Tanks</td>
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<td>C</td>
<td>4</td>
<td>4½&quot;</td>
<td>Air Sea Pressure</td>
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<td>Air Torpedo Tubes</td>
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<td>Air W.C. Measuring &amp; Tank</td>
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<td>J</td>
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<td>Air Depth Gauge (Control Room)</td>
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<td>K</td>
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<td>Air Torpedo Ventilating</td>
<td>0-600 ft.</td>
<td>-</td>
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<tr>
<td>O</td>
<td>3</td>
<td>3½&quot;</td>
<td>Air Escape Depth Gauge</td>
<td>0-600 ft.</td>
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<tr>
<td>P</td>
<td>3</td>
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<td>Air Caisson Type</td>
<td>0-600 ft.</td>
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<tr>
<td>Q</td>
<td>1</td>
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<td>Air Depth Gauge (Dolling Tower)</td>
<td>25-176 ft.</td>
<td>-</td>
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<tr>
<td>R</td>
<td>1</td>
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<td>Air Fresh Water &amp; Battery F.W.</td>
<td>0-60$</td>
<td>20$</td>
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### Reducing Valves

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<tr>
<th>INLET</th>
<th>OUTLET</th>
<th>SUPPLY PRESS</th>
<th>DELIV R'D PRESS</th>
<th>C.F.M.</th>
<th>DEL'R'D</th>
<th>SERVICE</th>
<th>NO. REJ.</th>
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<td>½&quot; I.P.S.</td>
<td>¼&quot; I.P.S.</td>
<td>225</td>
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<td>6</td>
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<tr>
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<td>¼&quot; I.P.S.</td>
<td>225</td>
<td>20$</td>
<td>5</td>
<td>5</td>
<td>Battery Fresh Water</td>
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<tr>
<td>¼&quot; I.P.S.</td>
<td>¼&quot; I.P.S.</td>
<td>225</td>
<td>20$</td>
<td>5</td>
<td>5</td>
<td>Fresh Water</td>
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<tr>
<td>⅜&quot; I.P.S.</td>
<td>⅜&quot; I.P.S.</td>
<td>225</td>
<td>5$</td>
<td>5</td>
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### Relief Valves

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<th>No.</th>
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<td>2</td>
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<td>240$</td>
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<td>Fem-side</td>
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<td>225$</td>
<td>Sentinel</td>
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<td>2</td>
<td>3/8&quot; I.P.S.</td>
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<td>Fem-side</td>
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<td>6$</td>
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<tr>
<td>1</td>
<td>⅛&quot; I.P.S.</td>
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<td>Fem-side</td>
<td>120$</td>
<td>105$</td>
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<td>Hale</td>
<td>Fem-side</td>
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<td>240$</td>
<td>225$ Aux. Air Comp.</td>
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<tr>
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<td>21$</td>
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SS425-434 incl.
SS381-416 incl.
**PIPE LIST**

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<td>225# Air Service Forward</td>
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<td>225# Air Service After</td>
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<td>225# Blow &amp; Vent No.1 Auxiliary Tank</td>
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<td>225# Blow &amp; Vent Forward Trim Tank</td>
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<td>225# Blow &amp; Vent After Trim Tank</td>
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<td>225# Blow Depth Gauge Sea Connection</td>
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<td>225# Blow - Depth Gauge Sea Connection</td>
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<td>225# Air to Signal Ejector - Impulse</td>
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<td>15</td>
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<td>225# Air to Signal Ejector - Blow Down</td>
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<td>16</td>
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<td>225# Air to Hydraulic Pressure Tank Cut-Out Valve</td>
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<td>225# Air Service Main</td>
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<td>225# Air Aux. Air Comp. Diach. to Volume Tank</td>
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<td>22</td>
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<td>225# - 20# Reducer By-pas</td>
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<td>26</td>
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<td>Grease Gun Conn.</td>
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<td>Gauge Line - Sea Pressure Conn.</td>
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<td>225# Air to Siren</td>
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<td>225# Air to Torpedo Tubes Blow &amp; Vent Manifold</td>
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<td>Torpedo Tubes Muzzle Vent</td>
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<td>43</td>
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<td>225# Air to Torpedo Tube Stop Cylinders</td>
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<td>225# Blow &amp; Vent W.R.T. Tanks</td>
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<td>51</td>
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<td>225# Air to Escape Trunk</td>
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<td>225# Blow, Escape Depth Gauge Sea Conn.</td>
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<td>54</td>
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<td>225# Air to Volume Tanks Forward &amp; Aft</td>
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<td>55</td>
<td>1/2&quot;</td>
<td>225# Blow Sea Pressure Gauges Forward &amp; Aft</td>
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SS425-434 incl.
SS381-416 incl.

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<td>225# Air to Fuel Oil Tanks Nos. 1 &amp; 2</td>
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<td>100# Air to Pneumatic Motors for Engine Jacking Gear Motor Reduction Gear, Propeller Shaft Turning Gear</td>
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<td>200</td>
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<td>Gauge Line, Sea Pressure Gauge</td>
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<td>Gauge Line, Sea Depth Gauge</td>
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<td>Gauge Line, 8&quot; Depth Gauge</td>
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<td>Gauge Line, 8&quot; Depth Gauge Conning Tower</td>
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<td>Gauge Line, Escape Depth Gauge - C.T.</td>
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### PIPE LIST (Continued)

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<td>Gauge Line, Forward Trim Tank</td>
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<td>128</td>
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<td>Gauge Line, After Trim Tank</td>
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<tr>
<td>129</td>
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<td>Gauge Line, 225# Air Manifold</td>
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<tr>
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<td>Gauge Line, Sea Pressure Gauges, W.C.</td>
<td>338</td>
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<td>Gauge Line, Forward Trim Tank</td>
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<td>132</td>
<td>1/8&quot;</td>
<td>Gauge Line, W.R.T. Tank</td>
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<td>Gauge Line, 225# Air Service Forward &amp; Aft</td>
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<td>Gauge Line, Sanitary Tanks</td>
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<td>Gauge Line, Fuel Oil Tanks</td>
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<td>Gauge Line, Pneumatic Tools</td>
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<td>Gauge Line, After Trim Tank</td>
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<td>Gauge Line, W.R.T. Tank</td>
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<td>144</td>
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<td>225# Blow Pitometer Log &amp; Grease Gun Connection</td>
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<td>145</td>
<td>1/8&quot;</td>
<td>225# Air to Trim and Drain Pump Air Chambers</td>
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<td>146</td>
<td>1/8&quot;</td>
<td>Blow &amp; Vent - Drain Pump Air Chamber</td>
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<td>147</td>
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<td>Blow &amp; Vent - Trim Pump Air Chamber</td>
<td>338</td>
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<tr>
<td>148</td>
<td>1/2&quot;</td>
<td>Pressure Equalization (Compartment)</td>
<td>-</td>
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<tr>
<td>149</td>
<td>3/8&quot;</td>
<td>Gun Access Trunk Drain</td>
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</table>

### 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
Platen Dia's. & Stroke - 3" & 1 1/8" x 24"
Capacity - 9 CU. Ft. Per Min. (PD)
Discharge Pressure - 175-225#
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<thead>
<tr>
<th>Ports.No.</th>
<th>BuShips No.</th>
<th>Title</th>
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<tr>
<td>60-285</td>
<td>387241</td>
<td>Ship's Air Flasks - Stowage in Main Ballast Tanks.</td>
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<tr>
<td>420-82</td>
<td>387261</td>
<td>18&quot; Air Flasks - Plug &amp; Drain Pipe.</td>
</tr>
<tr>
<td>94-285</td>
<td>387251</td>
<td>L.P. Air Compressor - Foundation.</td>
</tr>
<tr>
<td>400-381</td>
<td></td>
<td>3000# Air System - Diagram (Piping).</td>
</tr>
<tr>
<td>401-381</td>
<td></td>
<td>600# and 100# Main Ballast Tank Blow System - Diagram (Piping).</td>
</tr>
<tr>
<td>402-381</td>
<td></td>
<td>200# Air System - Diagram (Piping).</td>
</tr>
<tr>
<td>403-381</td>
<td></td>
<td>Salvage Air System - Diagram (Piping).</td>
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<tr>
<td>404-381</td>
<td></td>
<td>Torpedo Firing System - Impulse Air Piping Arrangement - Fwd. Torpedo Rm.</td>
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<tr>
<td>405-381</td>
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<td>Air System - Piping Arrangement - Forward Torpedo Room.</td>
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<tr>
<td>406-381</td>
<td></td>
<td>Air Piping Arrangement - Officers' Quarters and Forward Battery Space. (Piping)</td>
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<tr>
<td>407-381</td>
<td></td>
<td>600#, 3000# and Oxygen Air - Piping Arrangement - Control Room.</td>
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<tr>
<td>408-381</td>
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<td>100# and 200# Air Piping Arrangement - Control Room.</td>
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<tr>
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<td>Air System - Piping Arrangement - Conning Tower.</td>
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<td>410-381</td>
<td></td>
<td>Air System - Piping Arrangement - Pump Room.</td>
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<tr>
<td>412-381</td>
<td></td>
<td>Air - Piping Arrangement - Crew's Space &amp; After Battery Space.</td>
</tr>
<tr>
<td>412-381</td>
<td></td>
<td>After Battery Space.</td>
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<tr>
<td>413-381</td>
<td></td>
<td>Air Piping Arrangement - Forward Engine Room.</td>
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<tr>
<td>414-381</td>
<td></td>
<td>Air System - Piping Arrangement After Engine Room.</td>
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<tr>
<td>415-381</td>
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<td>Air System - Piping Arrangement After Torpedo Room.</td>
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<tr>
<td>416-381</td>
<td></td>
<td>Torpedo Firing System - Impulse Air Piping arrangement - After Torpedo Rm.</td>
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<tr>
<td>417-381</td>
<td></td>
<td>Air, Oil, Water and Vent Systems - Piping in Superstructure - Forward of Frame 70.</td>
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<tr>
<td>418-381</td>
<td></td>
<td>Air, Oil, Water and Vent Systems - Piping in Superstructure - After of Frame 69.</td>
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<tr>
<td>419-381</td>
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<td>Piping in Outside Tanks - Forward.</td>
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<td>420-381</td>
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<td>Piping in Outside Tanks - Aft.</td>
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<td>477-381</td>
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<td>3000 lb. High Pressure Air Distributing Manifold Body - Sheet #1.</td>
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<tr>
<td>479-201</td>
<td>312066</td>
<td>Manifold - Forward Torpedo Room - Torpedo Tube Blow &amp; Vent - Assembly &amp; Details.</td>
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<tr>
<td>480-201</td>
<td>312067</td>
<td>Manifold - Forward &amp; Aft Torpedo Rooms - Torpedo Tube Blow &amp; Vent Details.</td>
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<td>481-285</td>
<td>490157</td>
<td>Gauge Boards - Control Room.</td>
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<td>482-381</td>
<td>386460</td>
<td>600 lb. Air System - Main Ballast Tank Group Manifolds - Bodies.</td>
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<td>484-228</td>
<td>386460</td>
<td>Manifold - 200# Air Service - Sheet #1.</td>
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<td>485-228</td>
<td>386461</td>
<td>Manifold - 200# Air Service - Sheet #2.</td>
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<td>486-228</td>
<td>386462</td>
<td>Inboard Vent Valve - Negative Tank.</td>
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<tr>
<td>502-381</td>
<td></td>
<td>3000# Air System - H.P. Air Manifolds - Details.</td>
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</table>
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 just 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 Induction - 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**

<table>
<thead>
<tr>
<th>Name</th>
<th>Takes from</th>
<th>Discharge to</th>
<th>Capacity: Static</th>
<th>Reference Plan</th>
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<tr>
<td>Ship's Supply</td>
<td>Atmosphere</td>
<td>Ship's Compartment</td>
<td>C.F.M.</td>
<td>4000</td>
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<tr>
<td></td>
<td>exhaust</td>
<td>Line</td>
<td>Pressure:</td>
<td></td>
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<tr>
<td></td>
<td>Exhaust</td>
<td>Line</td>
<td>Pressure:</td>
<td></td>
</tr>
<tr>
<td>Battery Exhaust</td>
<td>Battery</td>
<td>Ship's</td>
<td>C.F.M.</td>
<td>175 Min.</td>
</tr>
<tr>
<td></td>
<td>Cells</td>
<td>Exhaust</td>
<td>Pressure:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Line</td>
<td>Pressure:</td>
<td></td>
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</table>

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.,
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.

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 X. (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.
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 hand nut and screw operated from inside the ship is provided only for gagging these valves tight on the seat. When un gagging 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.
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:

<table>
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<th></th>
<th>Forward Coil</th>
<th>After Coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFM air</td>
<td>2560</td>
<td>1440</td>
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<tr>
<td>Face velocity fpm</td>
<td>488</td>
<td>468</td>
</tr>
<tr>
<td>Face area sq. ft.</td>
<td>5.25</td>
<td>3.10</td>
</tr>
<tr>
<td>Air, temp., entering °F</td>
<td>91.8° - 46%</td>
<td>91.8° - 46%</td>
</tr>
<tr>
<td>Air, temp., leaving °F</td>
<td>67° - 85%</td>
<td>67° - 85%</td>
</tr>
<tr>
<td>Refrigeration, moisture, tons</td>
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<td>.77</td>
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<tr>
<td>Refrigeration, sensible, tons</td>
<td>3.76</td>
<td>2.13</td>
</tr>
<tr>
<td>Refrigeration, total</td>
<td>5.10</td>
<td>2.90</td>
</tr>
<tr>
<td>Evaporating Temp., °F</td>
<td>5' - 9-1/2&quot;</td>
<td>3' - 5&quot;</td>
</tr>
</tbody>
</table>

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 aircraft) 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.
(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:

<table>
<thead>
<tr>
<th>Ports.No.</th>
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<th>Title</th>
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<tr>
<td>442-381</td>
<td>490239</td>
<td>Ventilation System Diagram.</td>
</tr>
<tr>
<td>1253-381</td>
<td>490591</td>
<td>Ship's Ventilation System - 12½&quot; Bulkhead Valves - Bulkhead 74'' Aft of Frame 77 - Arrangement.</td>
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<tr>
<td>1270-381</td>
<td>491040</td>
<td>Ventilation System - 9&quot; &amp; 9½&quot; Bulkhead Valves - Valve Disc and Valve Disc Arms.</td>
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<tr>
<td>1275-381</td>
<td>490596</td>
<td>Ventilation System - 12½&quot; Bulkhead Valves - Bulkhead 7¼&quot; Aft Frame 77 - Hoods (Forward).</td>
</tr>
<tr>
<td>1276-381</td>
<td>490597</td>
<td>Ventilation System - 12½&quot; Bulkhead Valves - Hoods (Aft.).</td>
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<tr>
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<td>BuShips No.</td>
<td>Title</td>
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<td>1300-381</td>
<td>491018</td>
<td>Ship's Ventilation System - 15½&quot; &amp; 22&quot; Hull Valves - Spring Detent - Arrangement &amp; Details.</td>
</tr>
<tr>
<td>1314-381</td>
<td>491030</td>
<td>Ship's Ventilation System - Hull Valves - Operating Gear - Positive Latch - Assembly &amp; Details.</td>
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<td>1343-308</td>
<td>491084</td>
<td>Ship's Ventilation System - 36&quot; Exhaust Valve (Outboard) - Hull Casting - Streamline Plate &amp; Yoke.</td>
</tr>
<tr>
<td>1345-308</td>
<td>491086</td>
<td>Ship's Ventilation System - 36&quot; Exhaust Valve (Outboard) - Deck Pad - Plug - Supporting Plates &amp; Spindle.</td>
</tr>
<tr>
<td>Part No.</td>
<td>BuShips No.</td>
<td>Title</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>6075-228</td>
<td>389907</td>
<td>Air Conditioning Plant - Fin Cooling Coil - Assembly &amp; Details.</td>
</tr>
<tr>
<td>506-381</td>
<td>491053</td>
<td>Ship's Ventilation System - Air Conditioning Coolers - Casing.</td>
</tr>
<tr>
<td>1261-381</td>
<td>491091</td>
<td>Ship's Ventilation System - 9&quot; Bulkhead Valves - Bulkhead 35 -</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arrangement.</td>
</tr>
<tr>
<td>25786</td>
<td></td>
<td>Ventilation Terminals - (Throttle Damper) (Cross Connection).</td>
</tr>
<tr>
<td>442-381</td>
<td>490239</td>
<td>Ventilation Diagram.</td>
</tr>
<tr>
<td>449-381</td>
<td>490991</td>
<td>Ventilation System - Aft Battery Room &amp; Crew's Quarters - Arrgt.</td>
</tr>
<tr>
<td>560-381</td>
<td>490975</td>
<td>Battery Ventilation System - Cross Connection.</td>
</tr>
<tr>
<td>1657-228</td>
<td>390060</td>
<td>Battery Ventilation Sets.</td>
</tr>
<tr>
<td>534-228</td>
<td>490182</td>
<td>Hydrogen Detector - Arrgt. of Piping</td>
</tr>
<tr>
<td>517-228</td>
<td>386493</td>
<td>Air-flow Meter Piping Arrangement.</td>
</tr>
</tbody>
</table>
Section U-21-b

OXYGEN SYSTEM

See Plate 24 - Escape Arrangement.
See Oxygen System - Diagram - Ports. No. 444-228, BuShips No. 386420.

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:

<table>
<thead>
<tr>
<th>Space</th>
<th>Frames</th>
<th>Flask &amp; Regulator</th>
<th>Manifold &amp; Needle Valves</th>
<th>4 Chucks &amp; Hoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fwd. Torpedo Room</td>
<td>32-33P</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fwd. Escape Trunk</td>
<td>27½</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Officers' Quarters</td>
<td>46-47S</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Room</td>
<td>47-48P</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conning Tower</td>
<td>49-56</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew's Quarters</td>
<td>73-755</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fwd. E. R.</td>
<td>81-82S</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aft. E. R.</td>
<td>95-97P</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maneuvering Room</td>
<td>108-107P</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aft. Torpedo Room</td>
<td>117-118S</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 located 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 stored 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.
Section U-21-d


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 HP, and controller.
- Capacity - 500 CFM - 6" static press. - 2900 rpm.
- 100 CFM - 24" static press. - 980 rpm.

The Battery Blower Set is the unit of ventilation service to the After Battery (technical duplicate - Fwd. 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.
- Lead-proofed wire - combines two fan discharges.
- Throttle Damper (Streamlined Cu351) and "ye forms cross connection.
- 7-1/2" x 13" "ye - into ship's exhaust main.
- Hydrogen detector connection.
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 valve combines the two fan discharges (3-3/4" x 1-1/16") into a throttle damper (7" D.) and thence through a valve to the ship's exhaust main (13" D.).

The ship's 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 (Perd. 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 edged orifice (1" restriction on diameter). The differential is of a low order (2" max.). Condensation at the orifice plate (point X - sketch shown) 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 valves (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.
Section U-26

BOW DIVING GEAR

Ref: (a) Section W-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 (8°) 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.16) 
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 ship's 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).
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. S/P hydraulic pump manifold & reliefs (750h)(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 RIS movements (for adjustments see Ref.719).

The Tilting Interlock Valve (Fr.18) prevents the operator from rigging IN unless the bow plane is on 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 0-15° zero TILT (11/2 tolerance). On zero TILT a cam on the bow plane tiller shaft (Fr.17) slides this mechanical check OPEH. 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).
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)**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Lines</th>
<th>HAND</th>
<th>EMERGENCY</th>
<th>POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>By-Pass</td>
<td>Open</td>
</tr>
<tr>
<td>Hand Pump (Fr. 52)</td>
<td>1</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Control Cyl. (Fr. 23)</td>
<td>Rise</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bow</td>
<td>Dive</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ram (Fr. 10)</td>
<td>Rise</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Dive</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
**BOW PLANE RIGGING - Component Parts & Setup Table**

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Rig</th>
<th>Rig</th>
<th>Wind</th>
<th>Position</th>
<th>Out</th>
<th>In</th>
<th>Neut.</th>
<th>Class</th>
<th>Capacity</th>
<th>Use</th>
<th>Frame</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supply Manifold Valve E</td>
<td></td>
<td></td>
<td></td>
<td>Open</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Distribution point from Accumulator</td>
<td></td>
<td>434</td>
</tr>
<tr>
<td>2</td>
<td>Change Valve</td>
<td>P:</td>
<td>B:</td>
<td>P</td>
<td>Rig:</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Switches control of 9, 7; from 9 through neut. to 7</td>
<td>25</td>
<td>1072</td>
</tr>
<tr>
<td>3</td>
<td>Clutch</td>
<td></td>
<td></td>
<td></td>
<td>B:</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Jaw Clutch (sliding)</td>
<td>23</td>
<td>720</td>
</tr>
<tr>
<td>4</td>
<td>Clutch Lever</td>
<td>Q:</td>
<td>R:</td>
<td>P</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Throws clutch &amp; change valve</td>
<td>23</td>
<td>720</td>
</tr>
<tr>
<td>5</td>
<td>Push Rod</td>
<td>Q:</td>
<td>B:</td>
<td>P</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Connects (2) &amp; (3) above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Contact Maker #1</td>
<td>R:</td>
<td>B:</td>
<td>P</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Works off &quot;5&quot;, &quot;lights&quot;7; 81° t 73° B: 39° t 75°</td>
<td>23</td>
<td>739</td>
</tr>
<tr>
<td>7</td>
<td>Pilot Light</td>
<td></td>
<td></td>
<td></td>
<td>B:</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Works off &quot;6&quot;</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Rigging Control Valve</td>
<td>J:</td>
<td>O:</td>
<td>Out</td>
<td>Neut.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>At operator's hand lever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Hydraulic Motor</td>
<td>CC:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>10 Cyl. Spins worm shaft</td>
<td>25</td>
<td>9382</td>
</tr>
<tr>
<td>10</td>
<td>Worm &amp; Pinion</td>
<td>CC:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>124 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Bevel Gears 3 to 1</td>
<td>CC:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>2 turns: Raises torque 3 to 1</td>
<td></td>
<td>732</td>
</tr>
<tr>
<td>12</td>
<td>Sector Gear</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>180° Drives connecting rod</td>
<td>18</td>
<td>724</td>
</tr>
<tr>
<td>13</td>
<td>Bow Plane</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>81° Rigs from 81° to 0°</td>
<td>18</td>
<td>721</td>
</tr>
<tr>
<td>14</td>
<td>Rigging Interlock Valve</td>
<td>M:</td>
<td>Out</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>6 leads: Controls at 0°, 8°, 16°, 24°</td>
<td>22</td>
<td>718</td>
</tr>
<tr>
<td>15</td>
<td>Contact Maker #2</td>
<td>S:</td>
<td>Out</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Makes pilot light (16°): 9° t 73°</td>
<td>23</td>
<td>739</td>
</tr>
<tr>
<td>16</td>
<td>Pilot Light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Works off &quot;15&quot;</td>
<td>52</td>
<td>735</td>
</tr>
<tr>
<td>17</td>
<td>Hard Stops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Port Sector gear carries &quot;IN&quot; &amp; &quot;OUT&quot; lugs</td>
<td>18</td>
<td>724</td>
</tr>
<tr>
<td>18</td>
<td>Rumpers, rubber</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0° Tack strike foundations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Windlass Control Valve</td>
<td></td>
<td></td>
<td></td>
<td>Hoist</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>2 per plane as superstructure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*CC Indicates counter clockwise
C Indicates clockwise
<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Setup for</th>
<th>Use</th>
<th>Capacity: Frame: Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Hand Pump Lever</td>
<td>Stroke: O</td>
<td>X</td>
<td>Adjusts rate of displacement of (1) 52: 716</td>
</tr>
<tr>
<td>3</td>
<td>Change Valve</td>
<td>HAND: X</td>
<td>X</td>
<td>Selection Unit for hand, Energy, &amp; Power 52: 716</td>
</tr>
<tr>
<td>4</td>
<td>Switch, R/P Motor</td>
<td>START: X</td>
<td>X</td>
<td>Closes contactors on panel 52: 716</td>
</tr>
<tr>
<td>5</td>
<td>Control Valve, Tilt</td>
<td>IN: X</td>
<td>X</td>
<td>Gives RISE &amp; DIYE on: Energy 52: 716</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>OUT: X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Interlock Lever &quot;C&quot;</td>
<td>Locked: X</td>
<td>X</td>
<td>Mechanical Lock on Lever of &quot;3&quot;: 52: 716</td>
</tr>
<tr>
<td></td>
<td>Unlocked: X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Interlock Switch &quot;B&quot;</td>
<td>ON: X</td>
<td>X</td>
<td>Switch in Motor Starting: Circuit (4) 52: 716</td>
</tr>
<tr>
<td>9</td>
<td>Rigging Interlock Valve</td>
<td>OFF: X</td>
<td>X</td>
<td>Automatic control over IN &amp; OUT 22: 714</td>
</tr>
<tr>
<td>10</td>
<td>Tilting Interlock Valve</td>
<td>ON: X</td>
<td>X</td>
<td>Prevents Rig IN except on: Zero tilt: 1/2 degrees 17: 729</td>
</tr>
<tr>
<td></td>
<td>OFF: X</td>
<td>X: X: X</td>
<td>Tolerance: Connect Change Valve to Ram (13) 52-17: 713</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Lines, Hand &amp; Energy Open</td>
<td>X: X: X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLOSED: X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Tilting Cylinder (Ram)</td>
<td>ON: X</td>
<td>X</td>
<td>10 Ton hydraulic ram: 16: 726</td>
</tr>
<tr>
<td>14</td>
<td>Positive Stops</td>
<td>ON: Y</td>
<td>X</td>
<td>Inside the ram at 250 &amp; 250°D: 16</td>
</tr>
<tr>
<td>15</td>
<td>Plane Angle Trans.</td>
<td>ON: X</td>
<td>X</td>
<td>Drives off quadrant on P Shaft: 17: 715</td>
</tr>
<tr>
<td>16</td>
<td>Lines, Power Tilting Open</td>
<td>X: X: X</td>
<td>X</td>
<td>Connects change valve to Control Cylinder</td>
</tr>
<tr>
<td></td>
<td>CLOSED: X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Manifold, Ship's Supply OPEN</td>
<td>X: X: X</td>
<td>X</td>
<td>Supplies Ship's Hydraulic: SVC Fwd, same for Return Lines: 16</td>
</tr>
<tr>
<td></td>
<td>RETURN CLOSED: X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>R/P Control Cylinder</td>
<td>ON: X</td>
<td>X</td>
<td>Throws Swash plate of Pump (19): 23: 726</td>
</tr>
<tr>
<td>19</td>
<td>R/P Hydraulic Pump</td>
<td>ON: X</td>
<td>X</td>
<td>Variable reversible Pressure to &quot;19&quot;: 23: 10932</td>
</tr>
<tr>
<td>20</td>
<td>R/P Hyd. Pump Motor</td>
<td>OFF: X</td>
<td>X</td>
<td>Direct drive to &quot;19&quot;: 7.17, 36, 23: 1705</td>
</tr>
<tr>
<td>21</td>
<td>Centering Device</td>
<td>ON: X</td>
<td>X</td>
<td>Spring-loaded Swash Plate: Neutralizer (19): 23: 35819</td>
</tr>
<tr>
<td>22</td>
<td>Relief Valve Manifold</td>
<td>OFF: X</td>
<td>X</td>
<td>Safety Valves: 22: 750 psi: 928</td>
</tr>
<tr>
<td>23</td>
<td>Vent &amp; Replenishing Lines</td>
<td>ON: X</td>
<td></td>
<td>Keeps pump (19) full of Oil: 23</td>
</tr>
<tr>
<td>24</td>
<td>By-pass Valve</td>
<td>OPEN: X</td>
<td></td>
<td>For filling &amp; venting Control Cyl: 23</td>
</tr>
<tr>
<td>25</td>
<td>Manifold, Fill &amp; Vent Open</td>
<td>CLOSED: X</td>
<td>X</td>
<td>For filling operation only: 23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X: X: X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BOW DIVING GEAR
RIGGING & TILTING

1. RIGGING INTERLOCK VALVE (D) 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.

2. TILTING INTERLOCK VALVE (L) PREVENTS RIGGING IN EXCEPT WHEN PLANES ARE AT 0° TILT (WITHIN 15° OF TILT) BUT TILTING INTERLOCK VALVE (L) DOES NOT PREVENT RIGGING OUT OF PLANES.

3. CHANGE VALVE (P) IS OPERATED BY CLUTCH LEVER (Q) AND PUSH ROD (R) WHEN SHIFTING TO WINDLASS OR RIGGING CONTACT MAKER (G) OPERATES INDICATOR LIGHTS IN CONTROL ROOM SHOWING CHANGE VALVE (P) CLUTCH LEVER (Q) AND PUSH ROD (R) EITHER IN WINDLASS OR RIGGING POSITION.

4. WINDLASS CONTROL VALVE (C) CONTROLS WINDLASS OPERATION ONLY WHEN CHANGE VALVE (P), CLUTCH LEVER (Q) AND PUSH ROD (R) ARE IN WINDLASS POSITION.

5. TILTING STOP VALVE (K) PREVENTS OVERHAULING OF TILTING CYLINDER (T) BY SEA SLAP OR PLANES.

6. RIGGED IN OR RIGGED OUT CONTACT MAKER (B) 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 PSI.

NOTE: ARROWS INDICATE MOTION TO DIVE AND TO RIG IN.
<table>
<thead>
<tr>
<th>Port No.</th>
<th>BuShips No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>713-38</td>
<td>544557</td>
<td>Bow Diving Gear - Arrangement Forward</td>
</tr>
<tr>
<td>714-38</td>
<td>544558</td>
<td>Bow Diving Gear - Tilting Stop Valve - Arrangement and Details</td>
</tr>
<tr>
<td>715-38</td>
<td>544561</td>
<td>Bow Diving Gear - Plane Angle Transmitters - Operating Gear Dts.</td>
</tr>
<tr>
<td>716-38</td>
<td>490747</td>
<td>Bow and Stern Diving Gear - Control and Indicating Mechanism In</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control Room - Arrangement</td>
</tr>
<tr>
<td>717-38</td>
<td>544559</td>
<td>Bow Diving Gear - Flanges &amp; Special Fittings</td>
</tr>
<tr>
<td>718-38</td>
<td>544560</td>
<td>Bow Diving Gear - Rigging Interlock Valve &amp; Bracket - Details</td>
</tr>
<tr>
<td>719-38</td>
<td>544561</td>
<td>Bow Diving Gear - Rigging Gear - Inboard Arrangement</td>
</tr>
<tr>
<td>720-38</td>
<td>544562</td>
<td>Bow Diving Gear - Rigging &amp; Windlass - Worm Gear &amp; Clutch Details</td>
</tr>
<tr>
<td>721-228</td>
<td>386624</td>
<td>Bow Diving Gear - Plane Details</td>
</tr>
<tr>
<td>722-38</td>
<td>544564</td>
<td>Bow Diving Gear - Hydraulic Piping - Arrangement - Forward</td>
</tr>
<tr>
<td>723-38</td>
<td>544565</td>
<td>Bow Diving Gear - Tiller, Links &amp; Plane Stock - Details</td>
</tr>
<tr>
<td>724-201</td>
<td>312211</td>
<td>Bow Diving Gear - Sector Gears &amp; Connecting Rod - Details</td>
</tr>
<tr>
<td>725-201</td>
<td>312212</td>
<td>Bow Diving Gear - Bearings for Plane Stocks</td>
</tr>
<tr>
<td>726-38</td>
<td>544568</td>
<td>Bow Diving Gear - Gudge Bearing &amp; Misc. Details</td>
</tr>
<tr>
<td>727-38</td>
<td>544569</td>
<td>Bow Diving Gear - Tilting Piston - Piston Rod, etc.</td>
</tr>
<tr>
<td>728-38</td>
<td>544570</td>
<td>Bow Diving Gear - Tilting Cylinder - Details</td>
</tr>
<tr>
<td>729-38</td>
<td></td>
<td>Bow Diving Gear - Arrangement of Tilting Gear in Forward Torpedo</td>
</tr>
<tr>
<td>730-38</td>
<td>544572</td>
<td>Compartment</td>
</tr>
<tr>
<td>731-38</td>
<td>544573</td>
<td>Bow Diving Gear - Tilting Indicator - Arrangement &amp; Details</td>
</tr>
<tr>
<td>732-201</td>
<td>312219</td>
<td>Bow Diving Gear - Bevel Gears - Shafts &amp; Bearing Casting for Rigging</td>
</tr>
<tr>
<td>733-201</td>
<td>312220</td>
<td>Bow Diving Gear - Rigging Gear - Bevel Gear Casing - Worm Gear, etc.</td>
</tr>
<tr>
<td>734-38</td>
<td>544576</td>
<td>Row Diving Gear - Rigging Gear - Shaft &amp; Hull Fitting - Details</td>
</tr>
<tr>
<td>735-38</td>
<td>544577</td>
<td>Row Diving Gear - Rigging Indicator &amp; Valve Operating Gear - Misc. Details</td>
</tr>
<tr>
<td>736-38</td>
<td>544578</td>
<td>Bow Diving Gear - Tilting Control Cylinders &amp; Power Plant - Assembly</td>
</tr>
<tr>
<td>737-228</td>
<td>386626</td>
<td>Location Table for Clinometer &amp; Trim Indicator Tubes</td>
</tr>
<tr>
<td>738-228</td>
<td>386625</td>
<td>Bow Diving Gear - Shear Pin Device for Horizontal Rigging Shaft</td>
</tr>
</tbody>
</table>
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. This piston is in accordance with delivery of a 55 A-end pump driven by a 7.1 horse power electric motor, with a 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#/sq.in.

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.

NOTE:
ARROWS INDICATE MOTION TO DIVE.

CUT-OUT SWITCH FOR C/O-O CIRCUIT TO TILTING & CAPSTAN MOTOR

HAND-BREMSZY TO CHANGE VALVE IN CONT. ROOM.

Elec. Motor.

COUNT COUNTERCLOCKWISE ROTATION.

WORM GEAR.

CAPSTAN HEAD.

CAPSTAN CLUTCHING-OUT BOLT.

PUMP CENT. SPRING.

CONT. CYCL.

VENT & SURGE TANK.

VENT & REP. LINE FOR'D. TO CONT.

ROOM.

CUT-OUT VALVE.

FILL & VENT BY-PASS VALVE.

CONT. TO CHANGE VALVE IN CONT. ROOM.

VENTS

PUMP VENT LINE TO TANK

REL. VALVE SET AT 45°

PUMP MAN.

PUMP MANIFOLD RELIEF VALVES SET AT 500°

VENTS

HAND-BREMSZY TO CHANGE VALVE IN CONT. ROOM.

FORD.

PLANE ANGLE TRANS.

GUIDE CYLINDER.

DIVING PLANE.

DIVE

ELECTRICAL SWITCH.

NOTE:
ARROWS INDICATE MOTION TO DIVE.

CUT-OUT Switch FOR C/O-O Circuit TO TILTING & CAPSTAN MOTOR

HAND-BREMSZY TO CHANGE VALVE IN CONT. ROOM.

Elec. Motor.
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:

<table>
<thead>
<tr>
<th>Kind</th>
<th>Displacement from:</th>
<th>Ft.</th>
<th>Drive from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAND</td>
<td>22.6 cu. in. A. end</td>
<td>52</td>
<td>manpower</td>
</tr>
<tr>
<td>EMERGENCY</td>
<td>1000 cu. in. Accumulator</td>
<td>52</td>
<td>IMO pump</td>
</tr>
<tr>
<td>POWER</td>
<td>22.8 cu. in. A. end</td>
<td>119</td>
<td>electric motor</td>
</tr>
</tbody>
</table>

The Stern Plane Diving Gear Change Valve (fr.52) is the selective unit for HAND, EMERGENCY and Power. This valve is a duplicate of the bow diving gear change valve, described under that subject.

The Stern Diving Gear Control Valve EMERGENCY 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-o 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.128) 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.
<table>
<thead>
<tr>
<th>Item Name</th>
<th>Aft.</th>
<th>Hand</th>
<th>Energy</th>
<th>Power</th>
<th>Filling</th>
<th>Purpose</th>
<th>Capacity</th>
<th>Fr. No.</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pump, Hyd. Hand</td>
<td>IN</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Drives off hand wheel (R3) per rev.</td>
<td>22.0 Cu.in.</td>
<td>53</td>
<td>716</td>
</tr>
<tr>
<td>2 Pump Stroke (variable)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Varies displacement of &quot; &quot;</td>
<td></td>
<td>53</td>
<td>716</td>
</tr>
<tr>
<td>3 Lever, Interlock (Neut.)</td>
<td>HAND</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Shifts Hand, Energy, Power (Mechanical)</td>
<td></td>
<td>53</td>
<td>716</td>
</tr>
<tr>
<td>4 Change Valve (Neut.)</td>
<td>HAND</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Shifts, Hand, Energy, Power (Hydraulic)</td>
<td></td>
<td>53</td>
<td>301</td>
</tr>
<tr>
<td>5 Tilting Cylinder</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Horizontal run to 15 ton tiller</td>
<td></td>
<td>122</td>
<td>915</td>
</tr>
<tr>
<td>6 Valve, Main Supply Man.</td>
<td>OPEN</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Throws diving gear on ships hydraulic system</td>
<td></td>
<td>52</td>
<td>750-295</td>
</tr>
<tr>
<td>Energy Bow &amp; Stern</td>
<td>CLOSED</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Throws diving gear on ships return lines &amp; supply tank</td>
<td></td>
<td>52</td>
<td>757-301</td>
</tr>
<tr>
<td>7 Valve, Main Return Man.</td>
<td>OPEN</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Gives RISE &amp; DIVE on ENERGY</td>
<td></td>
<td>52</td>
<td>854</td>
</tr>
<tr>
<td>Energy Bow &amp; Stern</td>
<td>CLOSED</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Drives off electric motor (11)</td>
<td>22.0 Cu.in.</td>
<td>110</td>
<td>912</td>
</tr>
<tr>
<td>8 Control Valve, Energy</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Overload protection 1200F</td>
<td></td>
<td>110</td>
<td>912</td>
</tr>
<tr>
<td>9 Pump, Hyd.</td>
<td>ON</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Drives pump (9) 7.1 HP, 540 RPM</td>
<td></td>
<td>117</td>
<td>912</td>
</tr>
<tr>
<td>10 Relief, Pump Manifold</td>
<td>IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shifts motor (11) to Capstan</td>
<td></td>
<td>118</td>
<td>913-306</td>
</tr>
<tr>
<td>11 Motor, Electric (CC)</td>
<td>OFF</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Hydraulic cushion relieves at $3.5</td>
<td></td>
<td>119</td>
<td>912</td>
</tr>
<tr>
<td>12 Clutch, Aft Capstan</td>
<td>OUT</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Neutralizes Sheathplates (9)</td>
<td></td>
<td>119</td>
<td>913-306</td>
</tr>
<tr>
<td></td>
<td>IN</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Hydraulic relay</td>
<td></td>
<td>119</td>
<td>736</td>
</tr>
<tr>
<td>13 Tank, Vent &amp; Surge</td>
<td>ON</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>For filling &amp; venting the system</td>
<td></td>
<td>118</td>
<td>912</td>
</tr>
<tr>
<td>14 Centering Spring</td>
<td>ON</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>For filling &amp; venting</td>
<td></td>
<td>912</td>
<td></td>
</tr>
<tr>
<td>15 Control Cylinder</td>
<td>IN</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Grease at zero tilt only</td>
<td></td>
<td>120</td>
<td>915</td>
</tr>
<tr>
<td></td>
<td>OUT</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Expansion &amp; seal water joints</td>
<td></td>
<td>125</td>
<td>105</td>
</tr>
<tr>
<td>16 By-Pass, Control Cyl</td>
<td>OPEN</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Secure for surface cruising</td>
<td></td>
<td>120</td>
<td>939-205</td>
</tr>
<tr>
<td></td>
<td>CLOSED</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Magnetic brake on (11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Manifold, Fill &amp; Vent</td>
<td>OPEN</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>27° rise &amp; dive</td>
<td></td>
<td>191</td>
<td>907</td>
</tr>
<tr>
<td>18 Guide Cylinder</td>
<td>CLOSED</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>42° stroke, 72 turn</td>
<td></td>
<td>53</td>
<td>716</td>
</tr>
<tr>
<td>19 Stuffing Box-Btd 125</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>1 min. equals 25° tilt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Drift Stop</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>24° radius</td>
<td></td>
<td>122</td>
<td>222-230</td>
</tr>
<tr>
<td>21 Brake, Motor, 19° Disc.</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Shows angle at Fr. 12</td>
<td></td>
<td>125</td>
<td>403-301</td>
</tr>
<tr>
<td>22 Hand Stops</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Shows angle at Fr. 82</td>
<td></td>
<td>125</td>
<td>403-301</td>
</tr>
<tr>
<td>23 Hand Wheel</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Tiller</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Plane, Stern</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 Indicator, Mechanical</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Transmitter, Angle</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PUMP CONTROL SHAFT (ALWAYS UP)
FULL STROKE FOR POWER OPERATION
1/4 STROKE FOR HAND (VARIABLE)

ARROWS SHOW FLOW FOR DIVE-

TO BOW DIVING BEAR.

INDICATOR PANEL SEE
PLAN NO 710-381

CLOCKWISE
ROTATION TO DIVE

TO MAIN POWER PLANT

CONT CONTROL ROOM

CHANGE VALVE LEVER

EMERGENCY CONT VALVE HAND WHEEL & INTER-LOCKING LEVERS FOR EMERGENCY DIVING FROM MAIN POWER PLANT

CONT SHAFT LEVER

DIVE

FOR MARKS - SEE PIPE LIST

U-26-B
CHANGE VALVE UP FOR POWER OPERATION
NEUTRAL FOR EMERGENCY OPERATION
DOWN FOR HAND OPERATION.

FOR POWER OPERATION
1/10 TURN (AT 100% EFF) OF
HAND WHEEL WILL
THROW CONTROL PISTON
FROM HARD OVER TO
HARD OVER FORCE ON
RIM OF HAND WHEEL
ASSUMED AT 23 POUNDS
(VARIABLE).

VARIABLE DISP. HYDRAULIC PUMP
MAX. CAP. 22.6 CU. IN. PER REV.
FULL STROKE FOR POWER
OPERATION 1/4 STROKE FOR HAND
FOR MARKS - SEE PIPE LIST

ARROWS SHOW FLOW FOR DIVE

FOR HAND OPERATION 72 TURNS (AT 1/4 STROKE OF PUMP AB'T)
OF HANDWHEEL (IN 1 MINUTE)
REQUIRED FOR 25° TILT OF PLANES.
FORCE ON RIM OF HANDWHEEL
ASSUMED AT 30 POUNDS.
CONFIDENTIAL FLEET SUBMARINE GENERAL INFORMATION

DIRECTION OF ROTATION CLOCKWISE

VENT & SURGE TANK SEE PLAN NO. 818-201

RELIEF VALVES SET AT 1200°

OPERATING MECHANISM SEE PLAN NO 913-381 (913-475)

ARROWS SHOW FLOW FOR DIVE

10.354' FOR 25° MOTION OF PLANES
11.123' FOR 27° MOTION OF PLANES (HARD STOP)
FOR MARKS SEE PIPE LIST

DRIFT STOP

WITH PLANES 4° ABOVE HORIZONTAL
B. PISTON IN NEUTRAL POSITION

SS 475-544
SS 381-434

190.6
1. Valve O prevents damage to gear by relieving pressure when gear strikes hard stop or oil pressure in line exceeds 1200 psi.

2. Clutching out bolt O 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 O to be broken when clutching out bolt O is being engaged or disengaged.

SS475-544
SS381-434
CONFIDENTIAL

FLEET SUBMARINE

GENERAL INFORMATION

STERN DIVING GEAR

GREASING DETAILS ORDERED
ON PLAN 925-201 (925-475)

GREASE ONLY WHEN PLANES
ARE AT ZERO TILT OR 1/2 DIVE

HARD STOP

SS 475 - 544
SS 381 - 434

25° DIVE

SE. RISE

190.9

NO 912 381
U. S. Navy Yard, Portsmouth, S. L. - 1943
**PIKE LIST - STERN DIVING GEAR - PORTS NO 912-381**

<table>
<thead>
<tr>
<th>MARK</th>
<th>NOM. SIZE</th>
<th>SERVICE OF LINES</th>
<th>TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1&quot;</td>
<td>PRESSURE RELIEF MANIFOLD TO RAM</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>2</td>
<td>1&quot;</td>
<td>RETURN RAM TO RELIEF MANIFOLD</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>3</td>
<td>3/4&quot;</td>
<td>PRESSURE-CHANGE VALVE TO RAM</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>4</td>
<td>3/4&quot;</td>
<td>RETURN RAM TO CHANGE VALVE</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>5</td>
<td>1&quot;</td>
<td>PRESSURE EMERGENCY CONTROL VALVE TO RAM</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>6</td>
<td>1&quot;</td>
<td>RETURN RAM TO EMERGENCY CONTROL VALVE</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>7</td>
<td>1/2&quot;</td>
<td>PRESSURE CHANGE VALVE TO CONTROL CYLINDER</td>
<td>900&quot;</td>
</tr>
<tr>
<td>8</td>
<td>1/2&quot;</td>
<td>RETURN CONTROL CYLINDER TO CHANGE VALVE</td>
<td>900&quot;</td>
</tr>
<tr>
<td>9</td>
<td>1/2&quot;</td>
<td>PRESSURE-MAIN MANIFOLD TO EMERGENCY CONTROL VALVE</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>10</td>
<td>1/2&quot;</td>
<td>RETURN EMERGENCY CONTROL VALVE TO MAIN MANIFOLD</td>
<td>150&quot;</td>
</tr>
<tr>
<td>11</td>
<td>1/2&quot;</td>
<td>VENT CHANGE VALVE TO REPLENISHING LINE</td>
<td>150&quot;</td>
</tr>
<tr>
<td>12</td>
<td>1/2&quot;</td>
<td>VENT PUMP TO REPLENISHING LINE</td>
<td>150&quot;</td>
</tr>
<tr>
<td>13</td>
<td>1/2&quot;</td>
<td>VENT &amp; REPLENISHING LINE</td>
<td>150&quot;</td>
</tr>
<tr>
<td>14</td>
<td>1/2&quot;</td>
<td>VENT - PUMP TO REPLENISHING TANK</td>
<td>150&quot;</td>
</tr>
<tr>
<td>15</td>
<td>1/2&quot;</td>
<td>CONTROL CYLINDER BY-PASS</td>
<td>900&quot;</td>
</tr>
<tr>
<td>16</td>
<td>1/2&quot;</td>
<td>PRESSURE-CHANGE VALVE TO GAUGE</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>17</td>
<td>1/2&quot;</td>
<td>PRESSURE-CHANGE VALVE TO GAUGE</td>
<td>1800&quot;</td>
</tr>
<tr>
<td>18</td>
<td>1/2&quot;</td>
<td>VENT &amp; FILL LINES</td>
<td>150&quot;</td>
</tr>
<tr>
<td>19</td>
<td>1/2&quot;</td>
<td>VENT &amp; FILL LINES</td>
<td>150&quot;</td>
</tr>
</tbody>
</table>

**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 20175
   FOR 50°F & ABOVE NAVY SYMBOL 2110
   SS475- 544
   SS381- 434
(a) Reference Plans

<table>
<thead>
<tr>
<th>Port No.</th>
<th>Ship No.</th>
<th>Title</th>
<th>Bow Plane</th>
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<tbody>
<tr>
<td>713-381</td>
<td>544557</td>
<td>Bow Diving Gear - Arrangement - Forward</td>
<td></td>
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<tr>
<td>722-381</td>
<td>544564</td>
<td>Bow Diving Gear - Hydraulic Piping Arrangement - Fwd.</td>
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<tr>
<td>716-381</td>
<td>490747</td>
<td>Bow and Stern Diving Gear - Control and Indicating Mechanism in Control Room - Arrangement.</td>
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<tr>
<td>730-381</td>
<td>544572</td>
<td>Bow Diving Gear - Arrangement of Tilting Gear - in Forward Torpedo Room.</td>
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</tr>
<tr>
<td>719-381</td>
<td>544561</td>
<td>Bow Diving Gear - Rigging Gear Inboard Arrangement</td>
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</tr>
<tr>
<td></td>
<td></td>
<td><strong>Stern Plane</strong></td>
<td></td>
</tr>
<tr>
<td>716-381</td>
<td>490747</td>
<td>Bow &amp; Stern Diving Gear - Control and Indicating Mechanism in Control Room - Arrangement.</td>
<td></td>
</tr>
<tr>
<td>912-381</td>
<td>490748</td>
<td>Stern Diving - General Arrangement</td>
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<tr>
<td>913-275</td>
<td>386390</td>
<td>Bow and Stern Diving Gear - Speed Reducer, Clutch &amp; Control Cylinders - Arrangement.</td>
<td></td>
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<tr>
<td>914-275</td>
<td>386391</td>
<td>Stern Diving Gear &amp; Capstan - Mechanism - arrangement.</td>
<td></td>
</tr>
<tr>
<td>915-275</td>
<td>387450</td>
<td>Stern Diving Gear - Tilting Gear - Arrangement.</td>
<td></td>
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<tr>
<td>928-201</td>
<td>312415</td>
<td>Bow &amp; Stern Diving Gear - Hydraulic Relief Valve Manifold - Arrangement.</td>
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<tr>
<td>934-381</td>
<td>490743</td>
<td>Bow &amp; Stern Diving Gear - Hydraulic Control Valve - Arrgt.</td>
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<tr>
<td>1149-381</td>
<td>491096</td>
<td>Stern Diving Gear - Hydraulic Piping Arrangement in After Torpedo Room.</td>
<td></td>
</tr>
</tbody>
</table>
HYDRAULIC SYSTEM

Ref: Plates 6, 7 and 8.
Hydraulic System Instruction Plate (CR).
Section U-12-a - Flooding and Venting.
Section U-6 - 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) NULL 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 A31H 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 resistant 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. 386294) consists of a (3/8" D. x 3-7/8" L.) bolt at each corner. Each bolt carries 9 nuts. When rubber mount is in operation this bolt is in a position of STMANGE 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).
   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).

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.


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)

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Description or Purpose</th>
<th>Ports</th>
<th>Plan No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PUMP</td>
<td>15 H.P. 1750 r.p.m. mounted on same bed plate with pump, flexible cplg.</td>
<td>1703-381</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MOTOR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>MOUNTING, Rubber</td>
<td>For use with flexible hose connection only.</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>MOUNTING, Solid</td>
<td>Rigid pipe connection is an alternative with this mounting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RELIEF, Valve</td>
<td>Adjustable spring loaded ground seat valve, 750 p.s.i., main manifold.</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>VALVE, Cut-out #1</td>
<td>Segregates flexible hose No.1 in case of rupture.</td>
<td></td>
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<tr>
<td>7</td>
<td>VALVE, Cut-out #2</td>
<td>Segregates flexible hose No.2 in case of rupture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>HOSE, Flexible #1</td>
<td>Sound isolation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>HOSE, Flexible #2</td>
<td>Sound isolation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>RIGID, Pipe Connection</td>
<td>Standby hook-up, replaces 8 when rubber mounting is locked rigid.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>BY-PASS, AUTOMATIC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>PILOT VALVE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>ACCUMULATOR</td>
<td>1000 cu.in. 750 p.s.i.</td>
<td></td>
<td>407-275</td>
</tr>
<tr>
<td>14</td>
<td>AIR FLASK</td>
<td>7 cu. ft. 1750 p.s.i.</td>
<td></td>
<td>407-285</td>
</tr>
<tr>
<td>15</td>
<td>MANIFOLD, SUPPLY</td>
<td>EMERGENCY Steering supply to the Steering Gear Control Valve.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>VALVE, Steering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>VALVE, Diving, Bow &amp; Stern (Emergency)</td>
<td>EMERGENCY Diving Gear supply Bow &amp; Stern respectively.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>VALVE, SVC, Fwd.</td>
<td>Supply to service line forward.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>VALVE, SVC, Aft.</td>
<td>Supply to service line Aft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>VALVE, Main cut-out</td>
<td>A stop valve across supply from pump to the manifold.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>VALVE, By-pass</td>
<td>For shunting supply from Pump to supply tank.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>MANIFOLD, RETURN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>VALVE, Steering, Emergency</td>
<td>Return from Steering gear control valve, Emergency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>VALVE, Dividing, Bow &amp; Stern</td>
<td>Return from Diving gear, Bow &amp; Stern, respectively.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>VALVE, SVC, Fwd.</td>
<td>Return from service line forward.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>VALVE, SVC, Aft.</td>
<td>Return from service line aft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>TANK, Supply</td>
<td>Oil reservoir, Connection to auto by-pass is through a Check Valve.</td>
<td></td>
<td>898-275</td>
</tr>
<tr>
<td>28</td>
<td>TANK, Back pressure</td>
<td>Air cushion on Supply Tank.</td>
<td></td>
<td>899-228</td>
</tr>
</tbody>
</table>

### MANIFOLD, Control

<table>
<thead>
<tr>
<th>Handle, Vent Valve Group</th>
<th>Handle, Vent Valve Group</th>
<th>Handle, Vent Valve Group</th>
<th>Handle, Vent Valve Group</th>
<th>Handle, Vent Valve Group</th>
<th>Handle, Vent Valve Group</th>
<th>MANIFOLD, Control (Lower Section)</th>
<th>Handle &amp; latch CLOSED</th>
<th>Handle</th>
<th>Handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handle, Vent Valve Group</td>
<td>Straight</td>
<td>Toward</td>
<td>BB Tank</td>
<td>BB Tank</td>
<td>BB Tank</td>
<td>BB Tank</td>
<td>BB Tank</td>
<td>BB Tank</td>
<td>BB Tank</td>
</tr>
<tr>
<td>Handle, Vent Valve Group</td>
<td>Straight</td>
<td>Toward</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
<td>W B F 1, 2A &amp; 2B</td>
</tr>
<tr>
<td>Handle, Vent Valve Group</td>
<td>Straight</td>
<td>Toward</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
<td>Safety Tank</td>
</tr>
<tr>
<td>Handle, Vent Valve Group</td>
<td>Straight</td>
<td>Toward</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
<td>Main Induction Valve &amp; Ships, Sup.</td>
</tr>
<tr>
<td>Handle</td>
<td>Straight</td>
<td>Toward</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
<td>Flood Valve, Negative Tank</td>
</tr>
<tr>
<td>Handle</td>
<td>Straight</td>
<td>Toward</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
<td>Flood Valve, Safety Tank</td>
</tr>
</tbody>
</table>
Interrelation of Ship's Hydraulic System (CR) individual units in other parts of the ship are indicated by the following tabulation:

<table>
<thead>
<tr>
<th>System</th>
<th>Elec.</th>
<th>Hyd.</th>
<th>Remote Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Motor</td>
<td>Pump</td>
<td>Supply</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Speed</td>
<td>IMO: Water-</td>
</tr>
<tr>
<td>Hydraulic</td>
<td>15 HP</td>
<td>X</td>
<td>Local</td>
</tr>
<tr>
<td>System</td>
<td>1750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steering</td>
<td>15 HP</td>
<td>A-end</td>
<td>Ram</td>
</tr>
<tr>
<td>Bow Plane</td>
<td>10 HP</td>
<td>X</td>
<td>A-end</td>
</tr>
<tr>
<td>Tilt</td>
<td>1750</td>
<td></td>
<td>A-end</td>
</tr>
<tr>
<td>Stern Plane</td>
<td>10 HP</td>
<td>X</td>
<td>A-end</td>
</tr>
<tr>
<td>Capstan</td>
<td>1750</td>
<td>X</td>
<td>A-end</td>
</tr>
</tbody>
</table>

The Ship's Hydraulic Control Manifold (CR) is one of two principal diving stations of the boat. Certain prudent 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.D. Tanks 3A & 3B
   5A & 5B
4. Vents, (MB 4A & 4B (extra large vents on this tank)).
5. Vents, MR 5A & 5B, 6R & 7
6. Vent, Safety Tank

The Ship's Hydraulic Control Manifold (lower section) has 3 handles, right to left --

1. Hull ventilation valve
2. Engine air induction valve
3. Flood, negative tank
4. Flood, Safety tank
5. 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 = 32° max.
   for EMERGENCY = 7° max.
   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 (C9).

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 16" 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. 12" high x 10-7/8" OD of cylinder) is located in pump room. Principal parts are:

1) "He oil cylinder (9" ID). This takes the accumulator oil supply connection.
2) The plunger (9" 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 (7-1/2" ID). This is the inside dia. of the plunger.
5) Air plunger (5-3/4" OD). This takes the same type of packing as the plunger. The inside diameter is 1/8" and this leads air flash 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 (5-15") ID x 2-3/4" 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 2" 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 (12" 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.

<table>
<thead>
<tr>
<th>Pilot Valve Port</th>
<th>Loading</th>
<th>By-Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) To Piston Head, (auto. By-pass valve)</td>
<td>Open : Closed</td>
<td>Open : Closed</td>
</tr>
<tr>
<td>(2) To Working Pressure</td>
<td></td>
<td>X : X</td>
</tr>
<tr>
<td>(3) To Back Pressure</td>
<td>X :</td>
<td>X : X</td>
</tr>
</tbody>
</table>

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 OPER.
(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 (CR8) 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.
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. Washing 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 systems.

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 further use 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**

<table>
<thead>
<tr>
<th>Oil Symbol</th>
<th>Pour Point</th>
<th>Viscosity at 100°F</th>
<th>Viscosity at 210°F</th>
<th>S.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>(-40)</td>
<td>750</td>
<td>200</td>
<td>135; 50</td>
</tr>
<tr>
<td>2110</td>
<td>0</td>
<td>750</td>
<td>160</td>
<td>110; 45</td>
</tr>
<tr>
<td>1042</td>
<td>0</td>
<td>550</td>
<td>130</td>
<td>75; 42</td>
</tr>
<tr>
<td>2075</td>
<td>(-10)</td>
<td>750</td>
<td>160</td>
<td>75; 42</td>
</tr>
<tr>
<td>1047</td>
<td>0</td>
<td>1500</td>
<td>320</td>
<td>150; 47</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Shape</th>
<th>Material</th>
<th>Cap.</th>
<th>Fr. No.</th>
<th>Side</th>
<th>High</th>
<th>Suction</th>
<th>Conn.</th>
<th>Vent</th>
<th>Test P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Shell: Cu. 45</td>
<td>26-27</td>
<td>S</td>
<td>X</td>
<td>-</td>
<td>X</td>
<td>6 p.s.i.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>Shell: Cu. 45</td>
<td>28-29</td>
<td>S</td>
<td>X</td>
<td>X</td>
<td>6 p.s.i.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>Shell: W.S. 45</td>
<td>29-30</td>
<td>S</td>
<td>X</td>
<td>Fr. 33</td>
<td>6 p.s.i.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIXTURES COMMON TO HYD. OIL RESERVE TANKS (3)

<table>
<thead>
<tr>
<th>Name</th>
<th>Frame</th>
<th>Side</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Drain</td>
<td>32</td>
<td>S</td>
<td>For drawing off water &amp; sediment</td>
</tr>
<tr>
<td>(2) Hand Pump</td>
<td>32</td>
<td>S</td>
<td>Rotary Pump (Rumsey or equal) from high suction to replenishing line of Hydraulic System</td>
</tr>
<tr>
<td>(3) Strainer</td>
<td>32</td>
<td>S</td>
<td>Silbraz hyd. strainer 1&quot;, #36 mesh</td>
</tr>
<tr>
<td>(4) Stop Valve</td>
<td>32</td>
<td>S</td>
<td>1&quot; Hyd. valve, stop against the hyd. system replenishing line</td>
</tr>
<tr>
<td>(5) Filling Conn.</td>
<td>33</td>
<td>C/L</td>
<td>Adjacent to Torpedo Loading Hatch</td>
</tr>
<tr>
<td>(6) Funnel</td>
<td>Portable</td>
<td>C/L</td>
<td>With 3'8&quot; pipe to lead down the Torpedo Loading Hatch</td>
</tr>
<tr>
<td>(7) SAGE</td>
<td></td>
<td></td>
<td>Or Sounding Rod</td>
</tr>
</tbody>
</table>
The Ship's Hydraulic System is piped to distribute service according to the table below:

### Table of Hydraulic Service

<table>
<thead>
<tr>
<th>Type of Valve or Gear Served (Unit Served)</th>
<th>Type of (Valve: Control; Valve: Valves; Valve: Valves; Valve: Rigging; Door; Cation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VENTS</td>
<td></td>
</tr>
<tr>
<td>MBT 1</td>
<td></td>
</tr>
<tr>
<td>MBT 2A &amp; 2B</td>
<td></td>
</tr>
<tr>
<td>MBT 2C &amp; 2D</td>
<td></td>
</tr>
<tr>
<td>FGT 3A &amp; 3B</td>
<td></td>
</tr>
<tr>
<td>FGT 5A &amp; 5B</td>
<td></td>
</tr>
<tr>
<td>MBT 4A &amp; 4B</td>
<td></td>
</tr>
<tr>
<td>MBT 6A &amp; 6B</td>
<td></td>
</tr>
<tr>
<td>MBT 6B &amp; 6D</td>
<td></td>
</tr>
<tr>
<td>MBT 7</td>
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# ACCUMULATOR OPERATION - Tabulation of

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<th>Variation</th>
<th>Rotation</th>
<th>Both</th>
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<th>Unloaded &amp; Loading</th>
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INSTRUCTIONS

1. OIL PRESSURE SHOULD BE ABOUT 10% ABOVE MAX. OPERATING REQUIREMENTS. BACK PRESSURE IN PUMPS WITH ACCUMULATORS LOADED. AT RIS FOR DIVE CHECK BOTH PRESSURES.

2. FUNCTION AND SETTING OF VALVES:
   A. Bypass to Oil Tank. Closed except when warming up plant and testing pumps.
   B. Automatic by-pass for discharge from pump units 1 and 2 respectively.
   C. Non-return valves for pump discharge from pump units 1 and 2 respectively.
   D. Oil supply control for pump units 1 and 2 respectively. Open during operation.
   E. Pilot valve. Controls operation of valves A, B, C.
   F. Cut-out for pilot valve pressure to automatic by-pass valves on pump units 1 and 2 respectively.
   G. Latch open except when when working on line or by-pass valve.

3. Before starting pump units 1 and 2, completely open valves 1, 2, 3, 4, 5, 6, 7, 8.

4. In case of failure of flexible hose connections, stop pump and close valve for as appropriate.

5. To add oil to system, fully charge accumulator, close valve L, open all valves 1 and 2, try valve 3 and 4, drain out all water, manhole pump and opening valve. Open valve and pump oil. When finished close pump and reset oil level in surge tanks in each torpedoroom. 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 and strainer at regular Navy yard overhauls and whenever necessary.

10. Use oil symbol 210 for tropical use and oil symbol 2075 for cold weather use.
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<tr>
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<th>Material</th>
<th>Service</th>
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**Relief Valve List**

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*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 \( \frac{1}{8} \) 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 \( \frac{1}{4} \) 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.544841) 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:

<table>
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<tr>
<th>Description of Unit</th>
<th>Symbol</th>
<th>Viscosity</th>
<th>Grease</th>
<th>Alternative</th>
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<td>Ball Brg.Lub.: Grade B</td>
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For use as a reference for lubricants used with Hull Machinery, the following data are furnished:

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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 the bushings are substituted for self lub.

4. Medium grease, "Med. Gr..." must conform with navy spec. 14G14, Grade II.

### SUPERSTRUCTURE

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- Grease Cup
- Oil Hole
- Oil Filling
- Self Lub.
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**LEGEND**

- F - Grease Fitting
- C - Grease Cup
- H - Oil Hole
- P - Fill Plug

*Self Lub.*
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F - Grease Fitting  C - Grease Cup  H - Oil Hole  P - Fill Plug  * - Self Lub.  S - Grease Stick
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F - Grease Fitting  S - Grease Stick  C - Grease Cup  H - Oil Hole  P - Fill Plug  - Self Lub.
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F - Grease Fitting  C - Grease Cup  H - Oil Hole  P - Fill Plug
S - Grease Stick  * - Self Lub.
### CONFIDENTIAL

#### FLEET SUBMARINE

**GENERAL INFORMATION**

#### LUBRICATION CHART

<table>
<thead>
<tr>
<th>FORWARD TORPEDO ROOM (Cont.)</th>
<th>LOCATION</th>
<th>FITTING NO. TYPE</th>
<th>LUBRICANT</th>
<th>PLAN NO.</th>
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<tbody>
<tr>
<td><strong>MECHANISM</strong></td>
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<tr>
<td>Bulkhead Ventilation Valves</td>
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#### OFFICERS' QUARTERS

| Main Battery Disconn. Switch (381-384) Operating Gear (2) | 47 | P&S | 1 Ea. * | Med. Gr. | 6242-289 |

**Plumbing Drain Valve (2)**

<p>| | | | | |</p>
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<td>P&amp;S</td>
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<td>2 H</td>
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<tr>
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#### Air Valves

| Compartment Air Valve |          |                  |           |          |
| Compartment Air Valve | 47       | S                | 1 H      | Oil      | 406-381  |
|                      | 38       | S                | 1 F      | Med. Gr. | 406-381  |
|                      | 43       | S                | 1 F      | Med. Gr. | 406-381  |

### CONTROL ROOM

#### Steering Gear Control Valve

| Gear Bracket |          |                  |           |          |
| Gear Case    | 48½      | P                | 2 F      | Med. Gr. | 878-285  |
| Handwheel    | 49½      | P                | 1 H      | Oil      | 716-281  |
| 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  |

| Row Diving Gear Change Valve Operating Shaft |          |                  |           |          |
| Pump Lever Bracket | 51½ | P | 2 F | Med. Gr. | 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 |          |                  |           |          |
| Pump Lever Bracket | 52½ | P | 2 F | Med. Gr. | 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 |          |                  |           |          |
| Shaft | 48     | P                | 1 F      | Med. Gr. | 842-308  |
| Hull Stuffing Box | 48     | P                | 1 F      | Med. Gr. | 842-308  |
| Breech | 48    | P                | 1 F      | Med. Gr. | 842-308  |

**F - Grease Fitting**

**C - Grease Cup**

**H - Oil Hole**

**P - Fill Plug**

**- Self Lub.**

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**NOTE:** The document is confidential and contains specific information regarding the lubrication chart for various components of a fleet submarine. The table details the locations, fittings, types, lubricants, and plan numbers for different mechanisms and fittings. The page is marked as CONFIDENTIAL, indicating its sensitive nature.
## CONTROL ROOM (Cont.)

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<tr>
<th>MECHANISM</th>
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<th>LUBRICANT</th>
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## PUMP ROOM

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<tbody>
<tr>
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F - Grease Fitting  
C - Grease Cup  
H - Oil Hole  
P - Fill Plug  
S - Grease Stick

**210.7**
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F - Grease Fitting  C - Grease Cup  H - Oil Hole  P - Fill Plug  * - Self Lub.
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**ENGINE ROOMS**

**Ship’s Ventilation System (SS381-424)**

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| 15½" Ship’s Supply Hull Valve        |          |         |                    |
| Pin                                   | 80½      | S 1     | 300-381            |
| Bushing (5)                           | 80½      | S 1     | 300-381            |
| Bevel Gear Box                        | 80       | S 3     | 300-381            |
| Bevel Gear Box (2)                    | 80       | S 1     | 300-381            |
| Spur Gear Box                         | 80½      | S 2     | 300-381            |
| Spur Gear Box (2)                     | 80½      | S 1     | 300-381            |
| Lever                                 | 84       | S 1     | 300-381            |
| Bearing Bracket                       | 84       | S 1     | 300-381            |

**Flood Valves**

| F.R. #5A Operating Gear (2)   | 78       | S 2     | 789-275            |
| F.B. #5B Operating Gear (2)   | 78       | S 2     | 789-275            |

**Main Vent Valves**

| F.R. #5B & B |          |         |                    |
| Operating Gear                          | 80       | P 9     | 980-381            |
| Hull Stuffing Box (2)                   | 80       | P 1     | 980-381            |
| M.B. #5A & B   |          |         |                    |
| Operating Gear                          | 66       | P 9     | 980-381            |
| Hull Stuffing Box (2)                   | 66       | P 1     | 980-381            |
| M.B. #6C & 6D |          |         |                    |
| Operating Gear                          | 86       | P 9     | 980-381            |
| Hull Stuffing Box (2)                   | 86       | P 1     | 980-381            |

**Emergency Vent Valves**

| F.B. #5A      | 79       | S 5     | 980-381            |
| F.B. #5B      | 79       | S 5     | 980-381            |
| M.B. #5A      | 84½      | S 5     | 980-381            |
| M.B. #5B      | 84½      | S 5     | 980-381            |
| M.B. #6C      | 90       | S 5     | 980-381            |
| M.B. #6D      | 90       | S 5     | 980-381            |

F - Grease Fitting   C - Grease Cup   H - Oil Hole   P - Fill Plug   * - Self Lub.   S - Grease Stick
### ENGANCE ROOMS (Cont.)

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<th>LOCATION</th>
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<th>LUBRICANT</th>
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<td>Watertight Door Catch (381-410 &amp; 417-434)</td>
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<td>S</td>
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<tr>
<td>Watertight Door (411-416)</td>
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<td>5 F</td>
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<tr>
<td>Watertight Door Catch (411-416)</td>
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<td>2 H</td>
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<tr>
<td>Watertight Door (381-410 &amp; 417-434)</td>
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<td>2 H</td>
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<td>15&quot; Inside Exhaust Valves</td>
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### AUXILIARY ENGINE EXHAUST SYSTEM

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### BULKHEAD VENTILATION VALVES

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### CIRCULATING WATER HUFFLER BY-PASS

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### MANEUVERING ROOM

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**F - Grease Fitting  C - Grease Cut  H - Oil Hole  P - Fill Plug  " - Self Lub.**

**S - Grease Stick**

**Date:** 28 October 1943

**210.10**
### Maneuvering Room (Continued)

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### After Torpedo Room

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<td>124</td>
<td>P</td>
<td>9</td>
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<td>Poppet Valve Vent Valve Gag</td>
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<td>P&amp;S</td>
<td>4</td>
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<td>Discharge Angle Valve Bearing</td>
<td>121</td>
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<td>1</td>
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<td>Gyro Setting Mechanism</td>
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<td>P&amp;S</td>
<td>1</td>
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<tr>
<td>Spindle Drive Housing</td>
<td>123</td>
<td>P&amp;S</td>
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<td>Spindle Housing Cover</td>
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<td>P&amp;S</td>
<td>4</td>
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<td>Spindle Retraction Mechanism</td>
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<td>P&amp;S</td>
<td>5</td>
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<td>Cross Shaft Drive Housing (For Next)</td>
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<td>P&amp;S</td>
<td>5</td>
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<td>Coupling (9 for Next)</td>
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<td>P&amp;S</td>
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<tr>
<td>Roller (4)</td>
<td>121-130</td>
<td>P&amp;S</td>
<td>1</td>
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<tr>
<td>Huzzle Door Mechanism</td>
<td>122½</td>
<td>P&amp;S</td>
<td>1</td>
<td>F</td>
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</tr>
<tr>
<td>Sleeve Oper. Gear, Upper Bracket</td>
<td>122½</td>
<td>P&amp;S</td>
<td>1</td>
<td>F</td>
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<tr>
<td>Sleeve Oper. Gear, Lower Bracket</td>
<td>123</td>
<td>P&amp;S</td>
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<td>Thrust Block (2)</td>
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<td>Clamp Bearing</td>
<td>121</td>
<td>P&amp;S</td>
<td>2</td>
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<tr>
<td>Universal Joint</td>
<td>121-123</td>
<td>P&amp;S</td>
<td>1</td>
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<td>Interlocking Mechanism</td>
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<tr>
<td>Recess Bracket</td>
<td>121-122</td>
<td>P&amp;S</td>
<td>2</td>
<td>F</td>
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</tr>
<tr>
<td>Recess &amp; Huzzle Door Int. Crank</td>
<td>121</td>
<td>P&amp;S</td>
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<td>Huzzle Door Indicator Plate</td>
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<td>Drain Valve Interlock Lever</td>
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<tr>
<td>Firing Interlock Shaft</td>
<td>121½</td>
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<td>Firing Interlock Clutch Shaft</td>
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<td>Sleeve Head</td>
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<td>1</td>
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<tr>
<td>Control Valve Handle</td>
<td>122</td>
<td>P&amp;S</td>
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<tr>
<td>Drain Valve Interlock Rearing (4 for Next)</td>
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<td>P&amp;S</td>
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<td>Interlock Pedestal (2 for Next)</td>
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<td>P&amp;S</td>
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<td>Torpedo Stop Mechanism</td>
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<tr>
<td>Stuffing Box</td>
<td>125</td>
<td>P&amp;S</td>
<td>1</td>
<td>F</td>
<td>89-285</td>
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### After Torpedo Room (Continued)

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<tr>
<th>MECHANISM</th>
<th>LOCATION</th>
<th>FITTING</th>
<th>LUBRICANT</th>
<th>PLAN NO.</th>
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<tr>
<td><strong>Torpedo Tubes (Fittings per Tube)</strong></td>
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<tr>
<td>(Continued)</td>
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<td>Drain Valve (For Next)</td>
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<td>Bearing (2)</td>
<td>FR 121</td>
<td>P&amp;S 1 Ea.</td>
<td>H</td>
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<td>Bonnet (4)</td>
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<td>P&amp;S 2 Ea.</td>
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<td>Shaft (2)</td>
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<td>P&amp;S 2 Ea.</td>
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<td><strong>Stern Diving Gear</strong></td>
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<tr>
<td>Pump Control Shaft</td>
<td>FR 119</td>
<td>P 2</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Control Piston Lever</td>
<td>FR 119</td>
<td>P 2</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Spindle Lever</td>
<td>FR 119</td>
<td>P 2</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Tilting Block Centering Device</td>
<td>FR 119</td>
<td>P 6</td>
<td>H</td>
<td>Oil 2110</td>
</tr>
<tr>
<td>Mechanical Indicator &amp; Linkage</td>
<td>FR 124</td>
<td>P 6</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Greasing Station</td>
<td>FR 124</td>
<td>C/L 2</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Flexible Coupling</td>
<td>FR 118½</td>
<td>P 1</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Bearing</td>
<td>FR 118</td>
<td>P 1</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td><strong>Stern Capstan</strong></td>
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<td>Worm Shaft Bearing</td>
<td>FR 118</td>
<td>S 1</td>
<td>F</td>
<td>Med. Gr.</td>
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<td>Worm Gear Case</td>
<td>FR 118½</td>
<td>S 1</td>
<td>P</td>
<td>Oil 5190</td>
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<tr>
<td>Hydraulic Pump Centering Device</td>
<td>FR 118½</td>
<td>S 1</td>
<td>H</td>
<td>Oil</td>
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<td><strong>Torpedo Handling (Fittings per Cradle)</strong></td>
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<td>Cradle Roller (8)</td>
<td>FR 109-118</td>
<td>P&amp;S 1 Ea.</td>
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<td>Oil</td>
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<td>Flat Roller (2)</td>
<td>FR 110½-117</td>
<td>P&amp;S 1 Ea.</td>
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<td>Track Roller (4)</td>
<td>FR 110½-117</td>
<td>P&amp;S 1 Ea.</td>
<td>F</td>
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<td><strong>Aft W.R.T. Tank Overflow Valve</strong></td>
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<td>Bonnet</td>
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<td>S 2</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Lever</td>
<td>FR 121</td>
<td>S 1</td>
<td>H</td>
<td>Oil</td>
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<tr>
<td>Bearing</td>
<td>FR 120½</td>
<td>S 1</td>
<td>H</td>
<td>Oil</td>
</tr>
<tr>
<td>Universal Joint (2)</td>
<td>FR 120½</td>
<td>S 2</td>
<td>H</td>
<td>Oil</td>
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<td><strong>Main Vent Valves</strong></td>
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<td>W.B. #7</td>
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<td>Operating Gear</td>
<td>FR 119</td>
<td>S 9</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Hull Stuffing Box</td>
<td>FR 119</td>
<td>S 1</td>
<td>F</td>
<td>Med. Gr.</td>
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<td><strong>Air Valves</strong></td>
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<tr>
<td>Compartment Air Valve</td>
<td>FR 107</td>
<td>C/L 1</td>
<td>H</td>
<td>Oil</td>
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<tr>
<td>Salvage Air Valve</td>
<td>FR 107½</td>
<td>S 1</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Salvage Air Valve</td>
<td>FR 114</td>
<td>S 1</td>
<td>F</td>
<td>Med. Gr.</td>
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<td><strong>Bulkhead Ventilation Valves</strong></td>
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<tr>
<td>Stuffing Box (2)</td>
<td>FR 107</td>
<td>P&amp;S 1 Ea.</td>
<td>F</td>
<td>*</td>
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<tr>
<td>Bushing (6)</td>
<td>FR 107</td>
<td>P&amp;S 1 Ea.</td>
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<tr>
<td><strong>Steering Gear</strong></td>
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<tr>
<td>Greasing Station on Bulkhead</td>
<td>FR 125</td>
<td>S 9</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Bulkhead Stuffing Box (2)</td>
<td>FR 125</td>
<td>P&amp;S 1 Ea.</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Cylinder Housing (2)</td>
<td>FR 120</td>
<td>P&amp;S 2 Ea.</td>
<td>F</td>
<td>Med. Gr.</td>
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<td>Cylinder Housing (2)</td>
<td>FR 123</td>
<td>P&amp;S 2 Ea.</td>
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<td>Med. Gr.</td>
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<tr>
<td>Plunger (2)</td>
<td>FR 121</td>
<td>P&amp;S 1 Ea.</td>
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<td>Med. Gr.</td>
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<td>Plunger (2)</td>
<td>FR 121</td>
<td>P&amp;S 1 Ea.</td>
<td>C</td>
<td>Med. Gr.</td>
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<tr>
<td>Rudder Angle Transmitter</td>
<td>FR 121</td>
<td>P 1</td>
<td>F</td>
<td>Med. Gr.</td>
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<tr>
<td>Rudder Angle Transmitter</td>
<td>FR 123½</td>
<td>P 2</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Flexible Coupling</td>
<td>FR 122½</td>
<td>P 1</td>
<td>F</td>
<td>Med. Gr.</td>
</tr>
<tr>
<td>Control Cylinder &amp; Pump Control</td>
<td>FR 125-124</td>
<td>P 7</td>
<td>F</td>
<td>Med. Gr.</td>
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* - Self Lub.
Section Z-1

PROVISION STORE ROOMS

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<thead>
<tr>
<th>NAME</th>
<th>DAYS</th>
<th>LBS.</th>
<th>CU.FT.</th>
<th>FRAMES</th>
<th>P&amp;S</th>
<th>UNDER</th>
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<tbody>
<tr>
<td>Frozen Storage</td>
<td>60</td>
<td>4100</td>
<td>152</td>
<td>61½-64</td>
<td>P</td>
<td>Crew's Mess</td>
</tr>
<tr>
<td>Chilled Storage</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(1) Butter &amp; Eggs</td>
<td>50</td>
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<tr>
<td>(2) Vegetables</td>
<td>30</td>
<td>5300</td>
<td>180</td>
<td>61-64</td>
<td>S</td>
<td>Crew's Mess</td>
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<tr>
<td>Dry Provisions</td>
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<td></td>
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<tr>
<td>(1) Cases, Bags, Kgs</td>
<td>75</td>
<td>19,100</td>
<td>500</td>
<td>55½-57½</td>
<td>P&amp;S</td>
<td>Radio Room</td>
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<td>(2) Same</td>
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</table>

Two storerooms for the stowage of dry provisions, 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:

<table>
<thead>
<tr>
<th>NAME</th>
<th>CAPACITY</th>
<th>FR. NO.</th>
<th>SIDE</th>
<th>PURPOSE</th>
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<tbody>
<tr>
<td>E.F.W.</td>
<td>45</td>
<td>24 - 25</td>
<td>P</td>
<td>3 Tanks, FTR piped as a unit, filling</td>
</tr>
<tr>
<td>E.F.W.</td>
<td>52</td>
<td>25 - 26</td>
<td>P</td>
<td>funnel (36 mesh strainer) at Fr. 25, Carries tethered cover</td>
</tr>
<tr>
<td>E.F.W.</td>
<td>52</td>
<td>26 - 27</td>
<td>P</td>
<td>½&quot; filling valve of F.W. system over, Delivery valve and padlock at Fr. 32, Tank Test p.a.l. 3.</td>
</tr>
<tr>
<td>E.F.W.</td>
<td>80</td>
<td>111 - 112</td>
<td>S</td>
<td>2 Tanks ATR - Connected for filling and delivery locally, as a unit. Filling Valve at Fr. 111, Delivery at Fr. 109.</td>
</tr>
<tr>
<td>E.F.W.</td>
<td>76</td>
<td>112 - 113</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>45</td>
<td>25 - 26</td>
<td>S</td>
<td>Filled through portable funnel and lead through T/ loading hatch. Padlocked outlet at Fr. 32</td>
</tr>
<tr>
<td>Alcohol</td>
<td>12.8</td>
<td>23 - 24</td>
<td>S</td>
<td>Filling funnel Fr. 23, Outlet Fr. 22</td>
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<tr>
<td>Spirits (Turp. for cleaning)</td>
<td>45</td>
<td>29 - 30</td>
<td>S</td>
<td>Portable filling funnel with lead through torpedo loading hatch. Outlet Fr. 32</td>
</tr>
<tr>
<td>H.R.T. Oil Tank</td>
<td>45</td>
<td>28 - 29</td>
<td>P</td>
<td>Fills through funnel &amp; lead through T/loading hatch. Outlet Fr. 32</td>
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<tr>
<td>Tectyl</td>
<td>45</td>
<td>28 - 29</td>
<td>P</td>
<td></td>
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<tr>
<td>Hyd. Oil</td>
<td>135</td>
<td>26 - 30</td>
<td>S</td>
<td>Reserve Oil for Hyd. System for details see Section U-27</td>
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<tr>
<td>Oil Lub. H.P. Air Compressors</td>
<td>6.23</td>
<td>50</td>
<td>C/L</td>
<td>Between Air Compressors in Pump Room Service Tank: filling conn. in top, 1&quot; pipe plug &amp; 3/8&quot; I.P.S. Service Conn. Valve at bottom</td>
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<td>Air Compressors</td>
<td>GALS.</td>
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<tr>
<td>Oil, light, Torpedo</td>
<td>13</td>
<td>18 - 19</td>
<td>P</td>
<td>Tank with short 2&quot; filling pipe conn. air cock &amp; 2&quot; Ser. Valve at bottom</td>
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<tr>
<td>Name</td>
<td>Fr. No.</td>
<td>Side</td>
<td>Remarks</td>
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<td>--------------------------------------------------------------</td>
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<tr>
<td>Emergency Rations</td>
<td>34-35</td>
<td>S</td>
<td>Over Officer's W.C. Glass Dr. Over Torp.</td>
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<td></td>
<td>117-18</td>
<td>P</td>
<td>Stowage Glass Dr. in same Group as Crew's Lkrs.</td>
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<tr>
<td>S/M Lungs</td>
<td>23-21</td>
<td>P&amp;S</td>
<td>Between Fra. Overhead, supported by trays, Slats &amp; Hydraulic Piping</td>
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<tr>
<td></td>
<td>109-116</td>
<td>S</td>
<td></td>
<td></td>
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<tr>
<td>Bread</td>
<td>59-60</td>
<td>S</td>
<td>Crew's Mess Room; Locker just above flat</td>
<td></td>
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<tr>
<td>Electrical Spares</td>
<td>22-23</td>
<td>S</td>
<td>Under Crew's Lockers, Between</td>
<td></td>
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<tr>
<td></td>
<td>26-25</td>
<td>S</td>
<td>Frames</td>
<td></td>
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<td></td>
<td>99 BHD</td>
<td>P&amp;S</td>
<td>Lockers between Bhd.-Stiff's</td>
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<td></td>
<td>13½</td>
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<td>Maneuvering Room</td>
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<td>Ford, Fr.</td>
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BATTERY CELL HANDLING GEAR

The tracks, trolley, crane, cell lifting pads and chain hoists are identical for S5191, 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-28202. 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

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DESCRIPTION OF OPERATION


TO STOP MOTOR, PRESS THE "OFF" PUSHBUTTON. THE 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 OVERLOAD RELAY (OL) WHICH OPENS CIRCUIT TO MAIN CONTACTOR (M) ON EXCESSIVE OVERLOADS. AFTER OVERLOAD RELAY HAS TRIPPED IT IS NEEDED 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 SIMULTANEOUSLY WITH STARTING OF MOTOR.
NOTES - PIPING SYSTEM
1. The purifier discharge pump is a built in relief valve set at 30 lbs. per sq. in.
2. The feed pump is a built-in relief valve set at 30 lbs. per sq. in.
3. The regulator valve "O" should be set for a flow to the pump "A" of 0.65 GPM.
4. Temperature to the purifier should be set for a flow rate of 0.65 GPM.
5. Temperature to the purifier should be set for a flow rate of 0.65 GPM.
6. Relief valve "G" is set for 25 lbs. per sq. in. and returns 11.5% to heater for recirculation.

NOTES - ELECTRICAL CONTROL OF HEATERS
UNIT 15 K. Full heat, 3.5 Kw. Combined 90 to 36 Kw, 250 to 345. The control valves of heaters cannot be used unless feed pump is running.

WARNING
Do not close valves #3 & #4 while heaters are on to eliminate a possible explosion.
### AIR FLASK STOWAGE DATA

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<th>SIZE (IN CUBIC FEET)</th>
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#### PLAN VIEW

**ARRANGEMENT OF AIR FLASKS IN TANKS**

**SCALE: 1/1 FOOT**

**FLASKS INSIDE OF INNER HULL**

- LOCATION NO.
- SIZE (IN CUBIC FEET)
- CIRCUMFERENCE (IN INCHES)
- FLASKS PER TANK
- TOTAL FLASKS
- TANKS
- TOTAL CUBIC FEET
- TOTAL CIRCUIT

**NOTE:**
- AIR FLASK STOWAGE INSIDE OF INNER HULL.
- SEE PLAN 74-285.
SECTION B-B

RIGGED WHEN FUEL BALLAST IS CARRIED
BAG UP, LABEL, & STORE IN SHIP, PIECES SHOWN REMOVED

MBT & FBT VENT VALVE ARRANGEMENT

PLATE 19
INFORMATION BULLETIN
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 moused 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 (1½) 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 aback 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 flushing 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 scrapers, 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 technicians 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 technicians 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.