HEADQUARTERS, ARMY AIR FORCES
WASHINGTON 25, D. C.

TECHNICAL ORDER NO. 19-85A-10

GROUND SERVICING, SPECIAL VEHICLE AND MARINE EQUIPMENT

17 May 1945

BOATS GENERAL—INSTALLATION OF THE TYPE E-2A LIFE RAFTS

NOTE The work directed herein will be accomplished as soon as practicable by service activities with the aid of the base maintenance facilities, if necessary.

1. To assure that satisfactory life rafts are provided in AAF Sea Rescue Boats, the type E-2A pneumatic life raft, Specification No. 94-40618, complete with accessories, will be installed, located, and present equipment replaced, in the quantities indicated under each type of boat in accordance with the following chart:

INSTALLATION OF RAFT, PNEUMATIC, TYPE E-2A

BOAT TYPE	TOTAL QUANTITY OF E-2A RAFTS TO BE INSTALLED	TOTAL QUANTITY OF OLD TYPE TO BE REMOVED	LOCATION OF E-2A RAFT ON BOARD BOAT
42 ft	1	0	Dispensary
45 ft	1	1	Dispensary
63 ft	2	2	a. One in lazaret b. One in bridge locker
83 ft	2	2	One each in port and starboard stowage boxes on after deck
85 ft	3	2	a. One in dispensary b. Two in bridge lockers
104 ft	3	2	a. One in dispensary b. Two in pilot house lockers

NOTE When the rafts are stowed in lockers or boxes the words "Life Raft" will be stenciled on the lockers or boxes.

2. a. Prior to installation each type E-2A life raft will be inspected to assure serviceability and completeness.

b. Periodic inspections will be performed as outlined in applicable instructions pertaining to life rafts (T. O. No. 04-15-1) except as follows:

(1) When a boat is ordered on a trip exceeding 500 miles, each raft installed will be removed, fully inflated and tested prior to departure if more than 60 days has elapsed since last inspection.

3. a. The following rafts are required per boat to accomplish this change:

QTY	STOCK NO.	NOMENCLATURE	CLASS	SOURCE
As req	6600-663560	Raft - Pneumatic, type E-2A, Specification No. 94-40618, complete with accessories	04-B	AF Stock

b. The life rafts removed will be returned to AF Stock if serviceable or reparable.

BY COMMAND OF GENERAL ARNOLD:

Prepared by Vehicles and Miscellaneous Equipment Section, Maintenance Div, Rq, ATSC.

B. E. MEYERS
Major General, U. S. A.
Acting Director
Air Technical Service Command

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RESTRICTED
SEP 12 1945
INSPECTOR

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON 25, D. C.

TECHNICAL ORDER
NO. 19-85A-12

20 June 1945

GROUND SERVICING, SPECIAL VEHICLE AND MARINE EQUIPMENT

BOATS AND MARINE ENGINES—TECHNICAL INSTRUCTIONS FOR RESCUE BOATS

1. The purpose of this Technical Order is to establish the type of Technical Orders and other data to be maintained aboard sea rescue boats and made available at all times to master, crews, and service maintenance personnel.

2. RESPONSIBILITY.

a. AAF Representatives assigned to or located at shipyards will take such steps as are necessary to insure that applicable technical instructions are included in each new rescue boat delivered to the Army Air Forces in accordance with the instructions contained in this Technical Order. Applicable technical instructions will not be omitted from any vessel unless specifically authorized in each instance by the Director, Air Technical Service Command, Wright Field, Dayton, Ohio.

b. Commanding Generals of District Air Technical Service Commands will be responsible for seeing that the affected AAF Representatives within the district fully comply with the provisions of this Technical Order at all times.

c. Base Air Inspectors will be responsible to see that required current technical instructions are located and maintained in the delivered rescue boats at all times in accordance with the instructions contained in this Technical Order.

3. LOCATION AND MAINTENANCE.

a. All rescue boats will maintain one copy of each of the following Technical Orders, as applicable to that particular type of boat or equipment maintained thereon:

(1) Log Book

(2) Handbook of Operating Instructions

(3) Service Instructions

(4) Overhaul Manual

(5) Short Technical Orders

b. Rescue boats not covered by specific Technical Orders will maintain a file of applicable Technical Orders at the discretion of the Master.

c. The afore-mentioned outline is not to be construed as setting a limit for the number of copies of on-board instructions. Additional Technical Orders may be obtained and kept aboard at the discretion of the Master.

4. SUPPLY INFORMATION.

Requisitions for additional copies of Technical Orders will be submitted in accordance with instructions contained in T. O. No. 00-5-2. Boats in general will be covered in the 19-85 series Technical Orders.

BY COMMAND OF GENERAL ARNOLD:

Prepared by Vehicles and
Miscellaneous Equipment Section,
Maintenance Div,
Hq, ATSC.

L. T. MILLER
Major General, U.S.A.
Acting Director
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T. O. NO. 19-85AB-1

HANDBOOK OF INSTRUCTIONS

FOR

85-FOOT AAF RESCUE BOATS

Published by authority of the Commanding General, Army Air Forces.

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FEBRUARY, 1945 -8200

1 FEBRUARY 1945

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Instructions Applicable to AAF Personnel.

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"*(c) Restricted* matter may be disclosed, under special circumstances, to persons not in the Government service when it appears to be in the public interest."

The Bureau of Aeronautics Circular Letter No. 12-43 further states:

"Therefore, it is requested that all naval activities check their own local regulations and procedures to make sure that handbooks, service instructions and other *restricted* technical publications are actually being made available to both civilian and enlisted personnel who have use for them."

General.

These instructions permit the issue of restricted publications to civilian contract and other accredited schools engaged in training personnel for Government work, to civilian concerns contracting for overhaul and repair of aircraft or aircraft accessories, and to similar commercial organizations.

LIST OF REVISED PAGES ISSUED

NOTE: A heavy black vertical line, to the left of the text on revised pages, indicates the extent of the revision. This line is omitted where more than 50 percent of the page is revised.

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AAF ACTIVITIES.—Submit requisitions through the Air Inspector, Technical, whenever practicable, in accordance with T. O. No. 00-25-3 to the Commanding General, Fairfield Air Service Command, Patterson Field, Ohio. Attn: Publications Distribution Branch, as outlined in AAF Regulation 5-9. For details of Technical Order distribution, see T. O. No. 00-25-3.

NAVY ACTIVITIES.—Submit requests to the Chief, Bureau of Aeronautics, Navy Department, Washington, D. C. Also, see NavAer 00-500 for details on distribution of technical publications.

BRITISH ACTIVITIES.—Submit requirements on Form 294A, in duplicate, to the Air Publications and Forms Store, New College, Leadhall Lane, Harrogate, Yorkshire, England.

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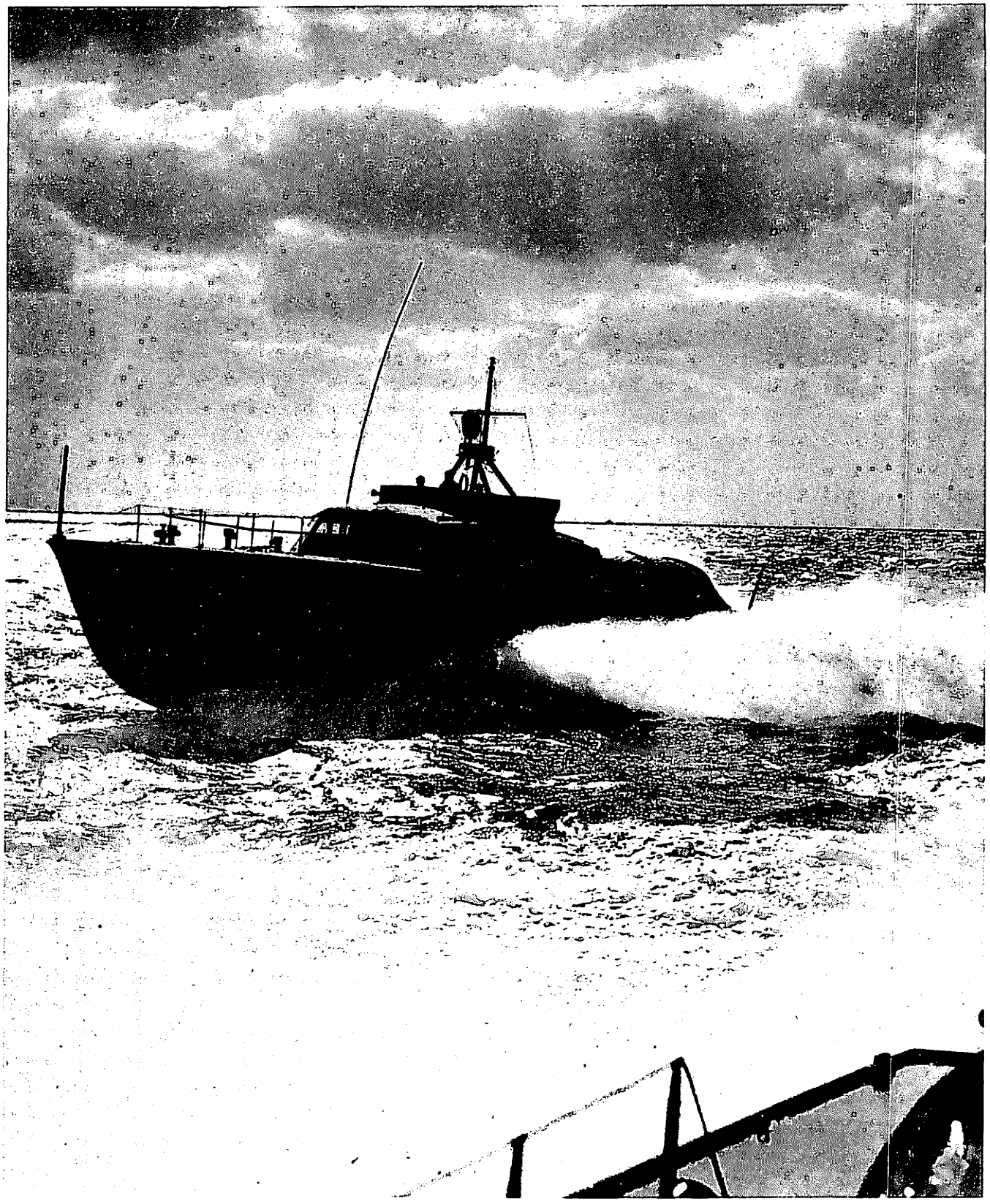
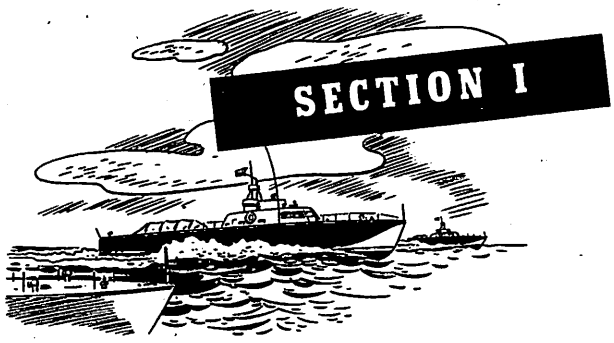


Figure 1—85-Foot Rescue Boat, Design No. 379



Description

1. INTRODUCTION.

This Handbook covers the operation, service, and maintenance of the 85-foot Army Rescue Boat, design 379 (figure 1). The text and illustrations were prepared from approved plans made by the design agent and from data obtained on boat number P-559, built by Dooley's Basin and Drydock Co., Ft. Lauderdale, Fla.

Because of successive alteration of plans, changes made at various yards for local reasons, and authorized modifications after the boats have been in operation, not all the data in this Handbook will apply to every 85-foot boat of this design. For this reason, it is important that operating personnel become familiar with wiring, piping and equipment installed on individual boats, and compare the actual installations with the text and diagrams.

Reference is made in this Handbook to T. O. No. 31-10A-1 for Operation, Service, and Maintenance Instructions on the main engines, Packard 4M-2500, and to Technical Order AN 19-45-11 for data on the auxiliary power plant, type HRU-28.

2. GENERAL DESCRIPTION.

a. TYPE.—The 85-foot Army rescue boat, design 379, is intended for offshore, long-range operations. It can be driven at high speeds under severe weather conditions without excessive pounding and yet remain dry. The construction is of ample strength to withstand the severe operation anticipated. It is powered by two Packard marine engines, model 4M-2500, type W-16, capable of producing 1250 hp each at 2400 rpm.

b. ARRANGEMENT BELOW DECKS. *(See figure 2.)*—Amidships a stateroom is provided for the master and chief engineer. On the port and starboard side of the radio room accommodations are provided for four junior officers. Quarters are provided forward for eight men. The dispensary, located aft, is equipped with eight litters, one lavatory, medical cabinets, and lockers. The engine room, forward of the dispensary and abaft the galley, is equipped with two main propelling engines, an auxiliary generator, and a fire pump unit. The galley, with electric range, refrigerator and mess room, is provided amidships. The pilot house is fitted with chart table and chart lockers. Directly below it is the radio room.

c. ENGINE ROOM MACHINERY ARRANGEMENT.

(1) The main engines, located one port and one starboard of the centerline, have a clutch and reverse gear, and are equipped for 24-volt starting.

(2) A main engine control pedestal is located on the port side of the high floor between the main engines. This stand is located between frames 53 and 54 on the port side of which are mounted oil and water temperature and pressure gages, switches, push-buttons, etc.

(3) On the low floor between the main engines, two Harrison coolant heat exchangers are installed between frames 54 and 56, port and starboard, and two Harrison lubricating oil heat exchangers are installed between frames 56 and 58, port and starboard.

(4) A gasoline-engine-driven combined generator and pump unit is located on the starboard side between frames 47 and 52. The generator unit is a Kermath 5 kw, 2600 rpm, 40 amperes, 140-volt type to charge the 110-volt service batteries located under engine room floor. The pump unit is a GF-250K Barton American geared-type fire pump, capable of handling 250 gpm of salt water against a discharge head of 100 psi and a maximum suction lift of 15 feet.

(5) A Westco fresh-water pump unit is provided for distributing fresh water under pressure.

(6) A Stewart-Warner Model 792-E, internal-combustion gasoline heater, rated at 20,000 Btu per hour, is mounted on bulkhead 42, port side.

(7) Five carbon dioxide tanks are located on the port side, forward of bulkhead 60, for use in conjunction with a remote-control system for fire extinguishing.

(8) For the purpose of fire fighting, an American-LaFrance Model 11C foamite generator unit is located on the starboard side in the engine room. Eight foam powder cans are located on the starboard side, forward of bulkhead 60.

(9) On the port and starboard sides are two engine coolant expansion tanks, two lubricating oil storage tanks, and two lubricating oil service tanks for the main engines.

(10) Fuel and water gage panels are mounted on the starboard side of the forward engine room bulkhead and on the forward side of the after bulkhead.

Instruments are mounted on these panels to indicate the amount of gasoline and water contained in the storage tanks.

(11) The main 110-volt switchboard is located on the forward bulkhead.

3. LEADING PARTICULARS.

a. DIMENSIONS. *(See figure 2.)*

Length, overall	85 ft 0 in.
Length, designed water line	78 ft 10 in.
Maximum beam (moulded)	20 ft 3 in.
Beam, designed water line	18 ft 8 in.
Maximum draft (propeller tips)	4 ft 8 in.
Depth, amidships at centerline to main deck	11 ft 2 in.
Freeboard forward	8 ft 7¾ in.
Freeboard aft to center of deck	5 ft 11¾ in.

b. DISPLACEMENT.

Full load displacement (including ordnance) (46.38 long tons)	103,700 lbs
Mean trial displacement (fuel, oil, and fresh water tanks half full)	89,200 lbs

c. TANK CAPACITIES.

Fuel gasoline capacity	3,840 U. S. gals.
Lubricating oil capacity	120 U. S. gals.
Fresh water capacity	500 U. S. gals.

d. RANGE AND SPEED.

Range, at 24.3 knots	644 stat miles
Speed, trial trip	34.75 knots
Speed, continuous	24.3 knots

4. CONSTRUCTION.

The hull is a twin-screw V-bottom stepless hydroplane and is of continuous longitudinal and transverse framing and double planking. It is divided into six compartments by plywood water-tight bulkheads of the stressed-skin type, with water-tight doors where passage is necessary between compartments. Engine beds are trussed box girders with steel facing angles in the engine compartment. Construction materials are as follows:

a. BOTTOM FRAMING.—Longitudinal spruce stringers with transverse frames of bent oak.

b. SIDE FRAMES.—Sawn mahogany, connected to bottom frames by plywood gussets.

c. PLANKING.—Double, white cedar inside, laid diagonally, and mahogany outside, laid horizontally.

d. DECK.—Transversely framed and planked with 1-inch plywood, canvas covered.

e. SUPERSTRUCTURE.—Plywood with mahogany trim.

5. DECK STRUCTURES.

a. Pilot house trunk, forward.

b. Bridge, located amidships just aft of pilot house trunk.

c. Steering station, located on bridge.

d. Twin 50-cal air-cooled machine guns, mounted port and starboard on bridge.

e. Ammunition lockers, located on bridge.

f. Mast on a four stanchion mounted with searchlight mounted on the crow's nest.

g. 20mm AA gun, located on centerline in cockpit aft.

h. Life lines, extending from bow to 20mm AA gun position.

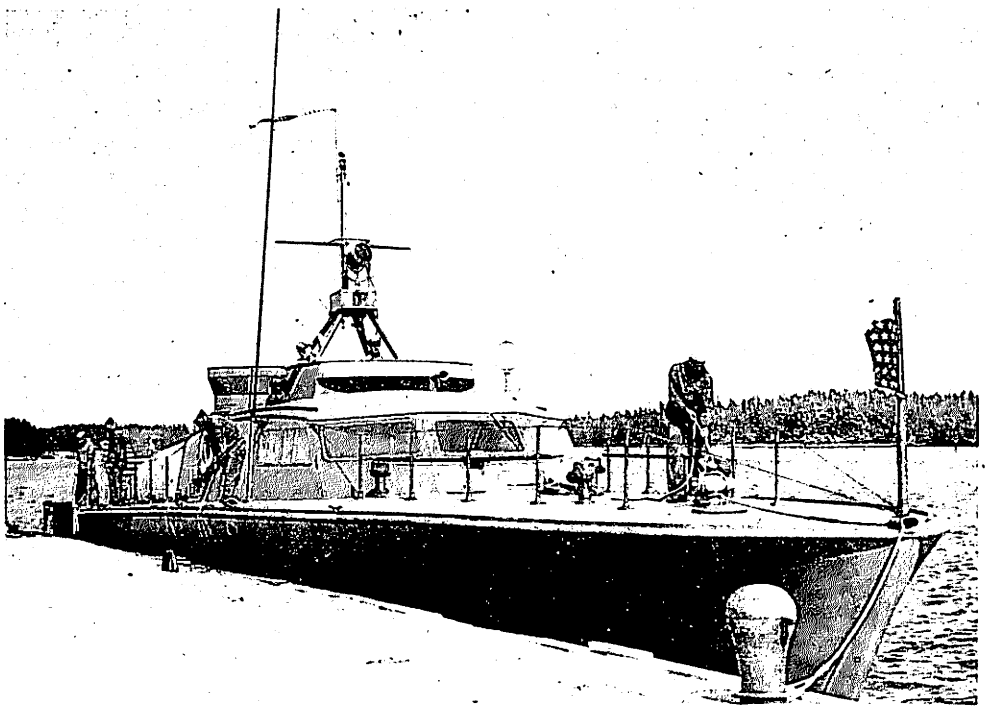


Figure 2—INBOARD PLAN AND PROFILE

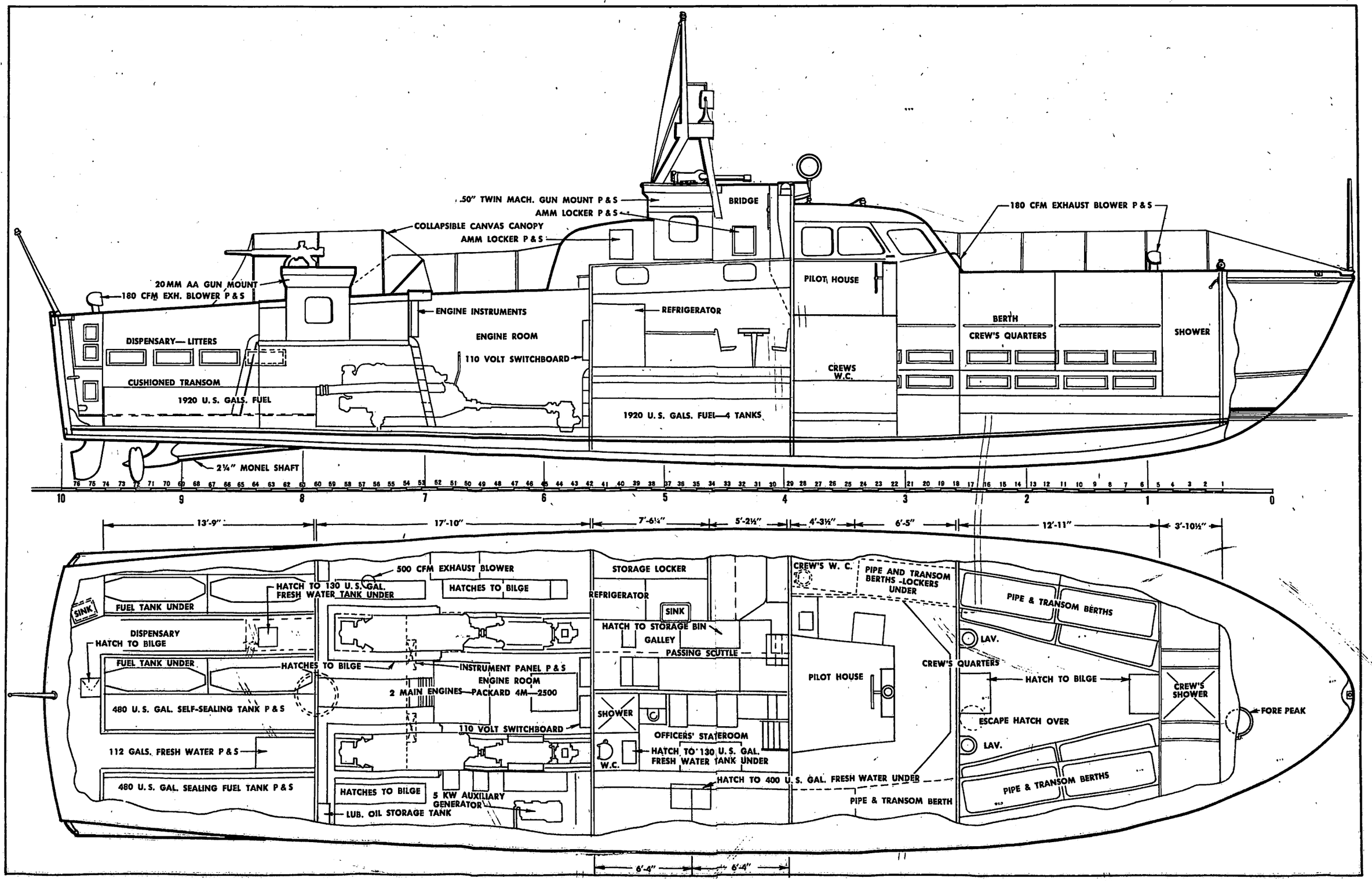
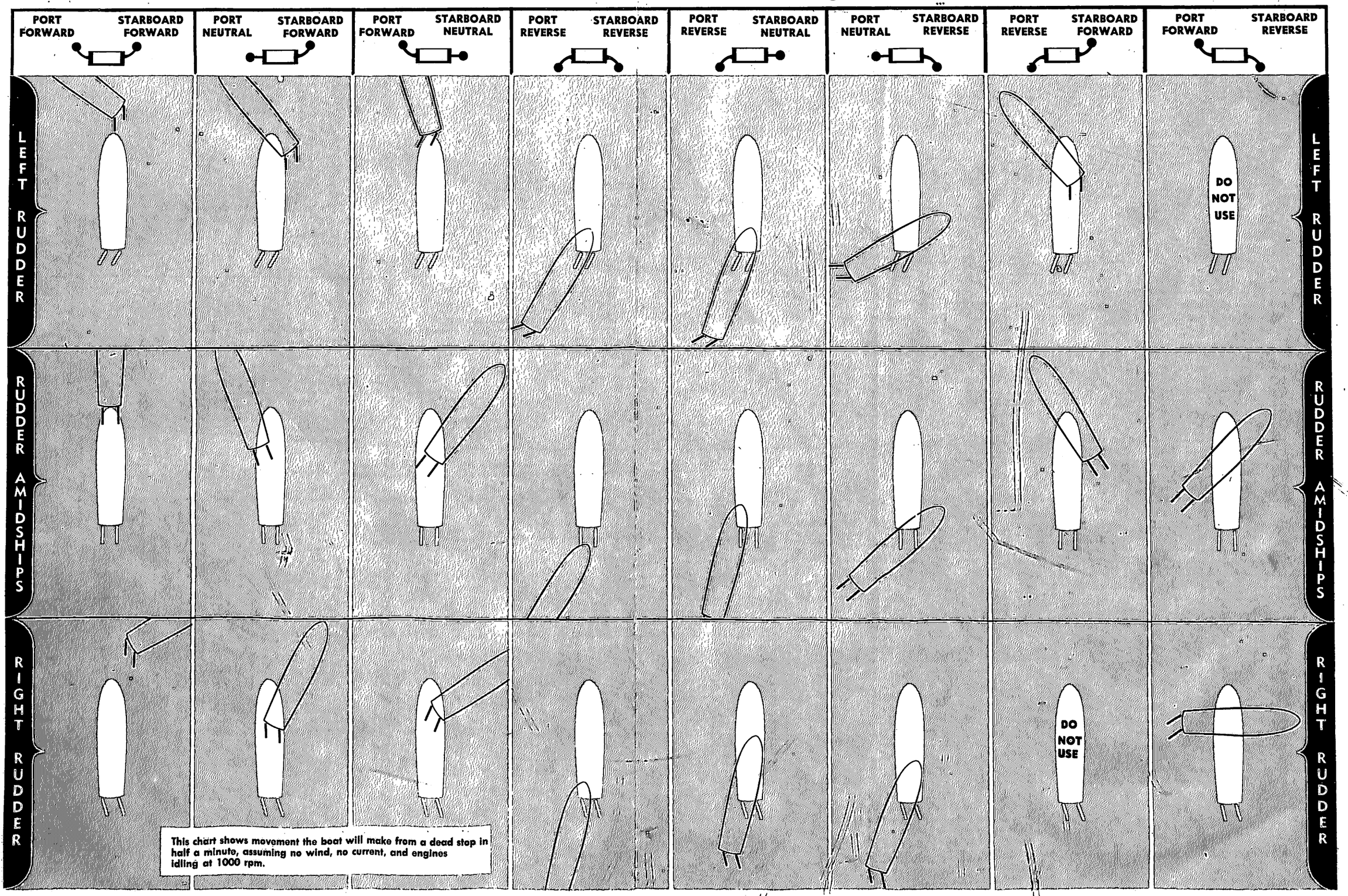
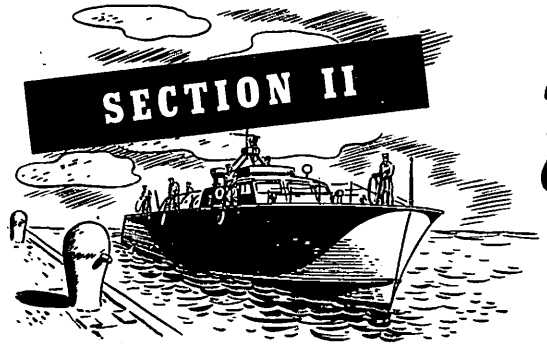


Figure 3 — MANEUVERING CHART





Boat Operation Instructions

1. MANEUVERING INSTRUCTIONS.

a. GENERAL.—The 85-foot rescue boats with two right-hand propellers respond to controls differently from those with one right- and one left-hand. Two right-hand propellers tend to swing the boat to port when backing, regardless of rudder position. Because boats with conventional right- and left-hand propellers do not have this peculiarity and maneuver as readily to one side as the other, the instructions given in this section cover only boats with two right-hand propellers.

b. MANEUVERING CHARACTERISTICS. — The maneuvering chart (figure 3) shows the approximate movement the boat will make in half a minute from a dead stop with various combinations of rudder and clutch controls. In this chart it is assumed there is no wind, current, or headway, and that both engines are idling at 1000 rpm. Some of the maneuvering characteristics shown in the chart are as follows:

(1) With rudders amidships, the boat swings to starboard on the port engine more sharply than it swings to port on the starboard engine.

(2) With both propellers in reverse, the ship's stern will veer to port regardless of the rudders. With hard right rudder this tendency will be reduced but not overcome.

(3) The tendency to veer to port when underway astern can be minimized by reversing the port propeller only with hard right rudder.

c. MOORING.—Proper stations for crew members before mooring are shown in figure 4.

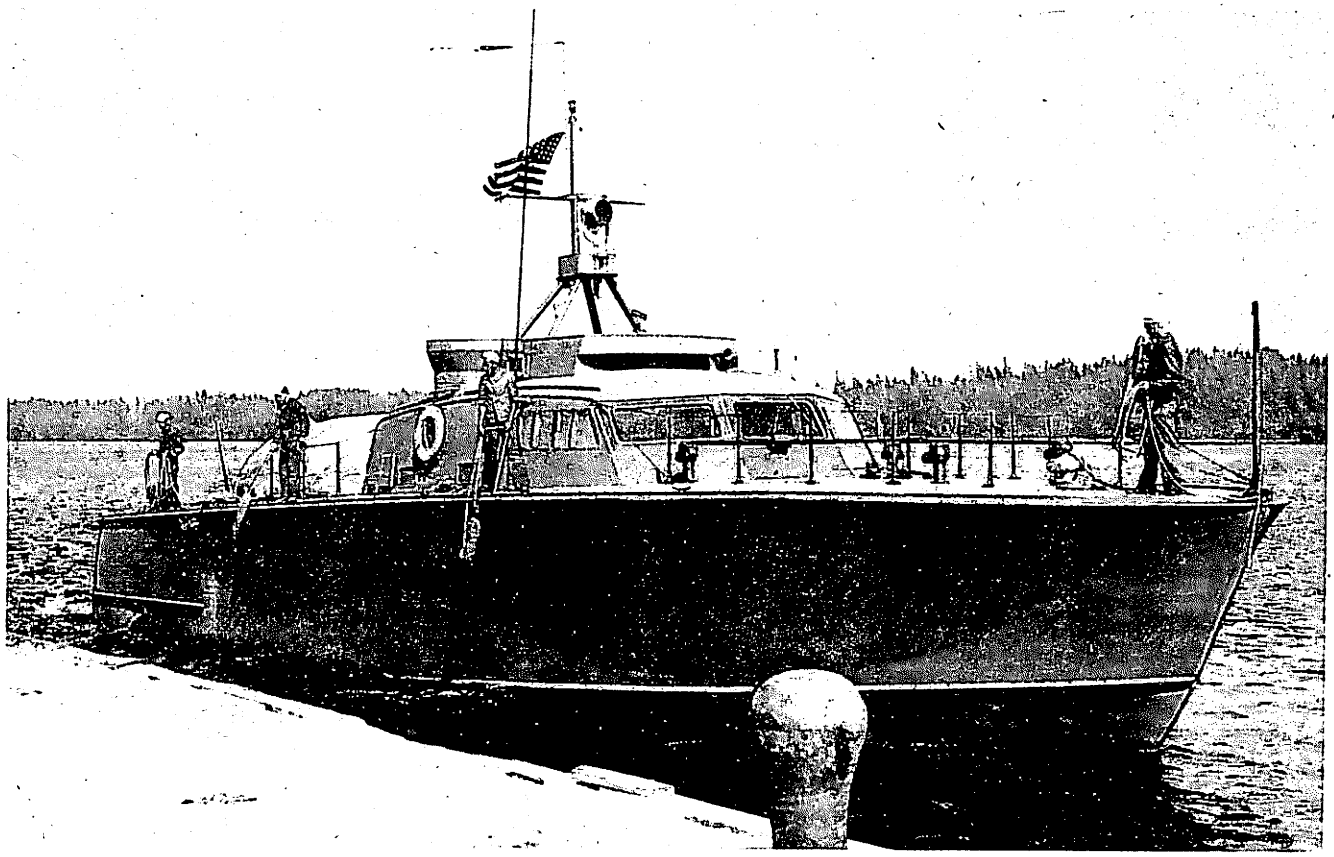


Figure 4—Crew Stations Prior to Mooring

2. ENGINE OPERATION.

a. GENERAL.—Continued operation of the engines on retarded spark at less than 1200 rpm will cause fouling of the spark plugs. Therefore, when slow speed is desired for any great length of time during a cruise, it is better to shut off one engine and operate on only one engine, between 1300 and 1350 rpm. This will give the boat the same speed as both engines will give at 1000 to 1100 rpm, and will avoid hours of retarded spark operation. Use the engines alternately. For instance, if 6 hours of slow cruising is necessary, run the port engine for 3 hours and then the starboard engine for 3 hours. The alternate engine should be started by engaging the clutch while under way on the other engine.

Note

The preceding instructions apply only to cruising in open water. For maneuvering at the dock, both engines must be operated. As a precaution, at least two extra sets of serviceable spark plugs for each engine should be carried on the boat at all times.

b. STEPS PRELIMINARY TO STARTING.

CAUTION

The engines should never be started while there is a strong odor of gasoline in the engine room. *This is a fire precaution which must be observed.* If fumes are present in the engine room, do not start the blowers until the hatches are opened and the room ventilated. Determine the source of fumes.

(1) Check to make sure that the two emergency ignition switches at the bridge are pushed to the "ON" position. (See figures 5 and 6.)

(2) Go down to the engine room and give the engine a general visual inspection. The engine room temperature should not be below 13°C (55°F).

(3) At the 110-volt switch board, turn on the generator or battery main switch and the engine room blower switches. (See figures 7 and 8.)

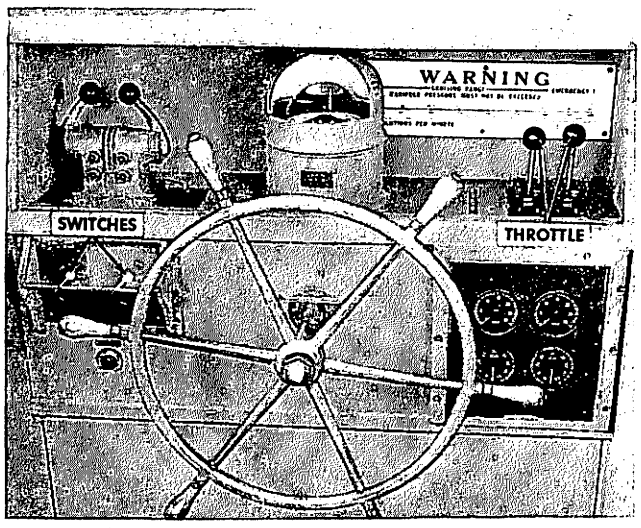


Figure 5—Emergency Ignition Switches at the Bridge

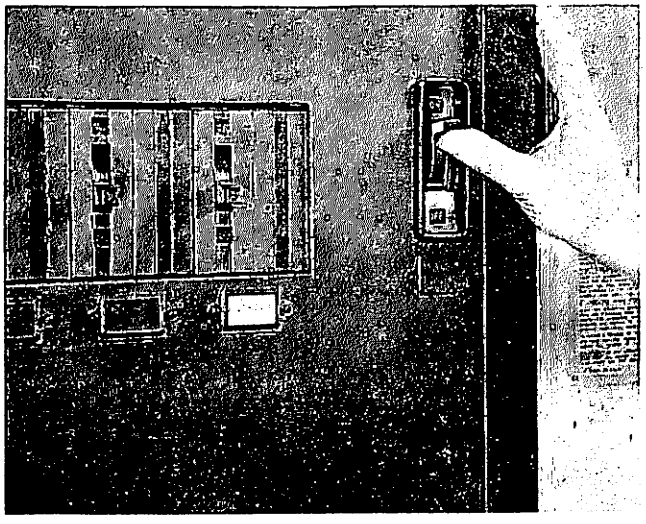


Figure 7—Turning on Main 110-Volt Switch

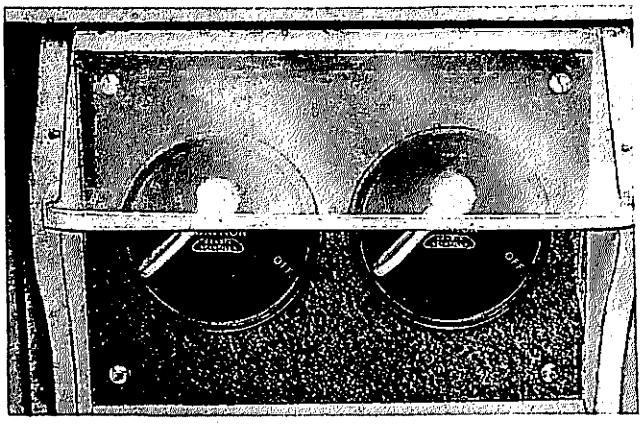


Figure 6—Ignition Switches in "ON" Position

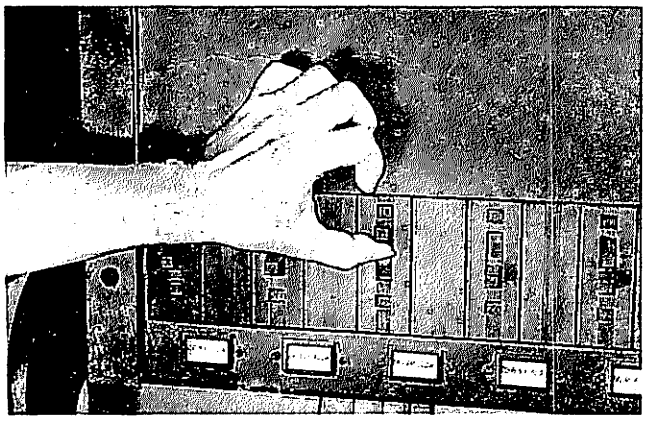


Figure 8—Closing Circuit to Engine Room Blower Switch

(4) Turn on the engine room blower switches on the instrument panel. (See figure 9.) Let the blowers run for at least 5 minutes before starting the engines.

(5) Check the amount of fuel in the fuel tanks. (See figure 10.)

(6) Turn on the main switch of the 24-volt system. (See figure 11.)

(7) Open the valve at the fuel manifold for the tanks desired. (See figure 12.) The other valves should be closed.

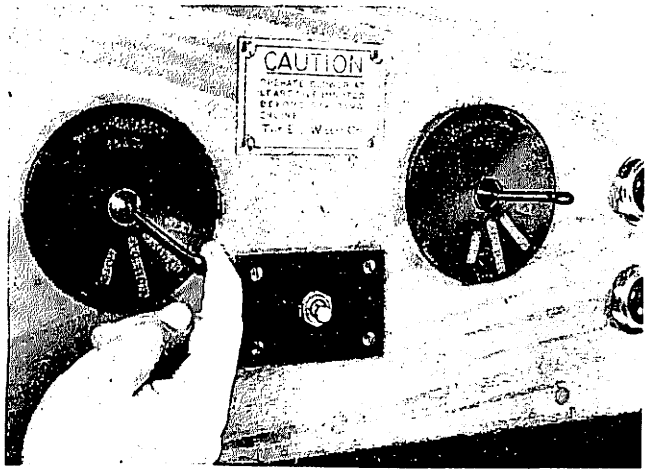


Figure 9—Turning on Blowers

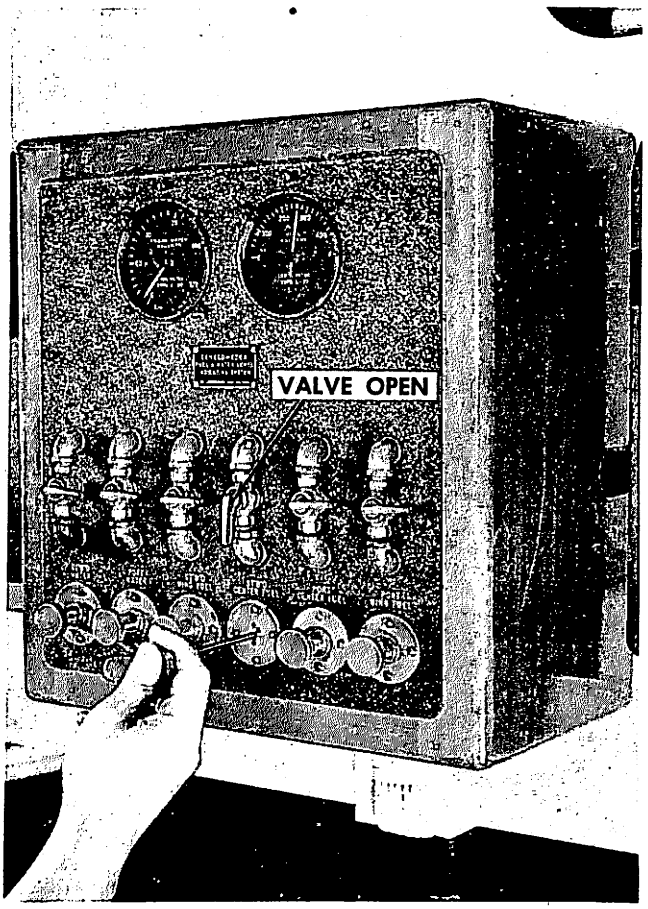


Figure 10—Checking Fuel Tanks

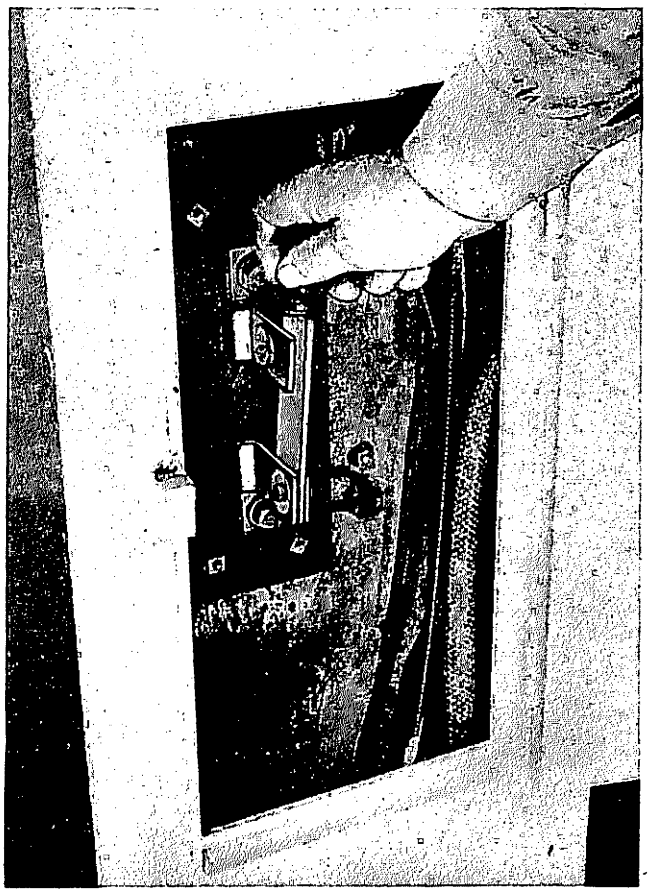


Figure 11—Closing Main 24-Volt Switch

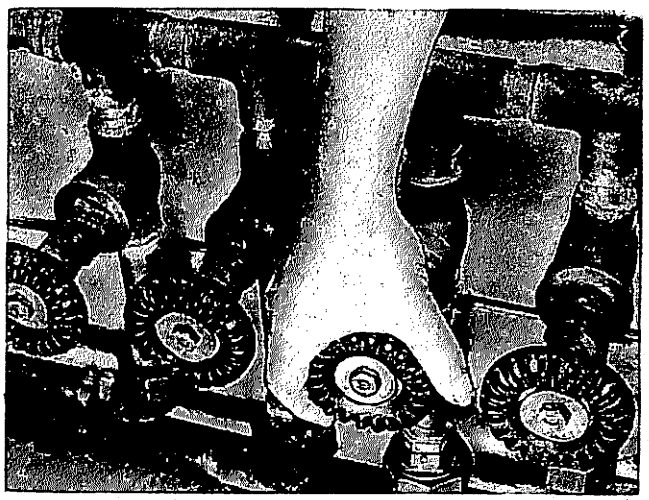


Figure 12—Turning on Center Aft Tanks at Fuel Manifold

(8) Open valves to supply fuel to the two engines. (See figure 13.)

(9) Check the fuel tank outlet valves to make sure that they are open. (See figure 14.)

(10) Check the supply of coolant in the expansion tanks. (See figure 15.) There should be 5 gallons of coolant in each 7-gallon tank.

(11) Check the supply of oil in the service tanks. (See figure 16.)

(12) See that the spark is retarded. (See figure 17.)

(13) See that the mixture control is set in the "PUMP LOCK" position. (See figure 18.)

(14) Open and close the throttles to check operation of the hydraulic throttle control. (See figure 19.)

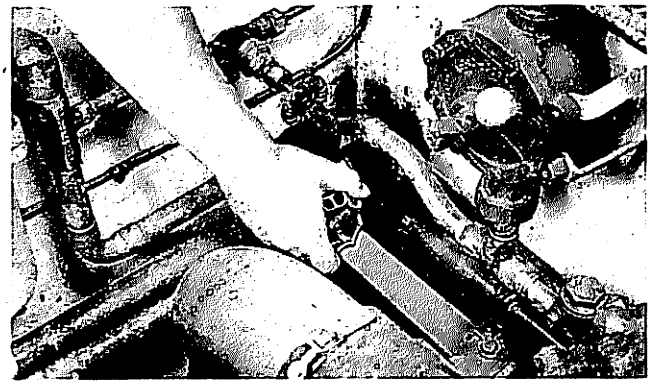


Figure 13—Opening Valve Supplying Fuel to Engine

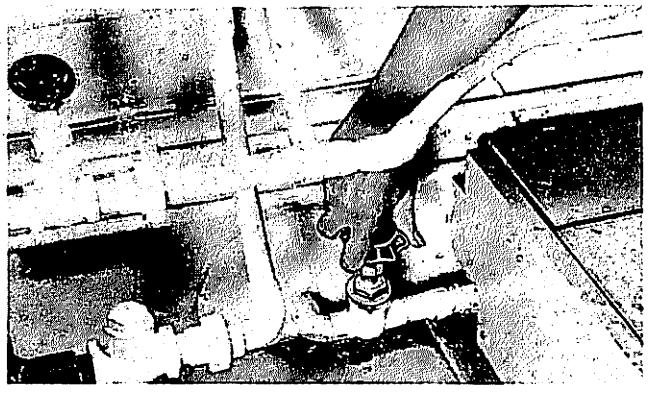


Figure 14—Checking Fuel Tank Outlet Valve

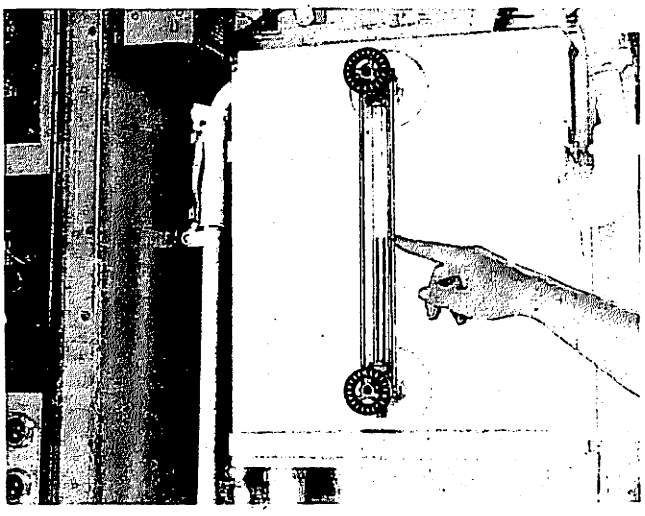


Figure 15—Checking Coolant in Expansion Tank

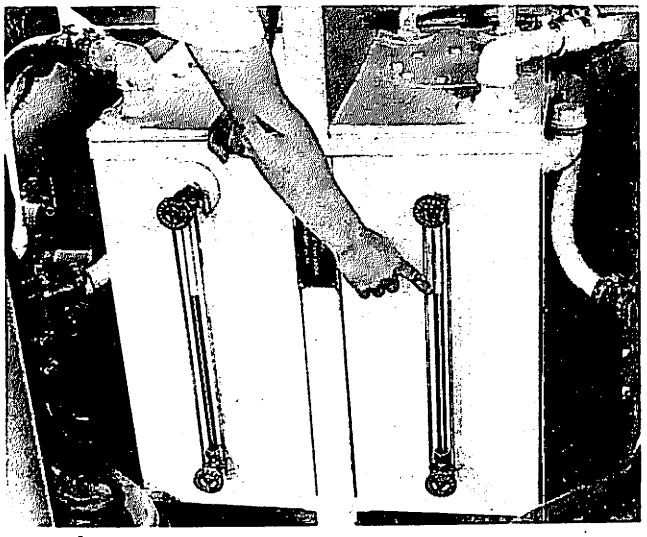


Figure 16—Checking Oil In Service Tank

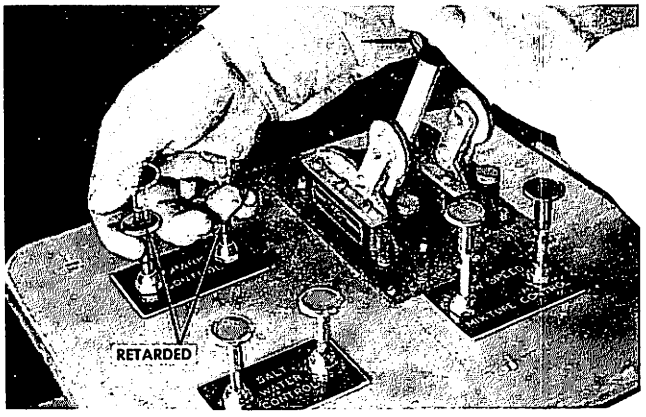


Figure 17—Pulling Spark Controls Up to Retarded Position

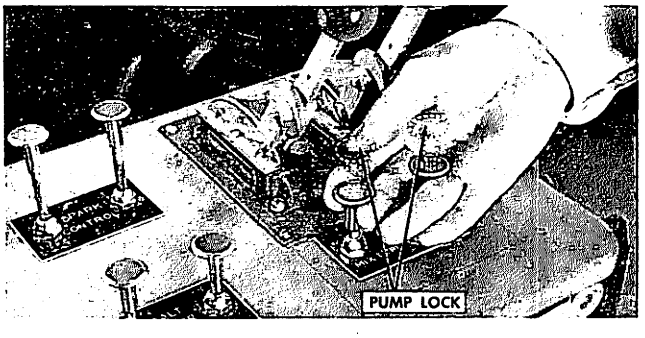


Figure 18—Pulling Mixture Controls up to "Pump Lock" Position

(15) Remove the covers from the air cleaners on the carburetors. (See figure 20.)

(16) Close the drain cocks at the end of each of the four exhaust manifolds. (See figure 21.) Use an $1\frac{1}{16}$-inch open-end wrench.

(17) Check to see that the clutch control is in neutral and turn on (up) the clutch control switch. (See figure 22.)

(18) Operate the wobble pumps until the gage for each engine shows at least 6 pounds fuel pressure. (See figure 23.) Check for fuel leaks.

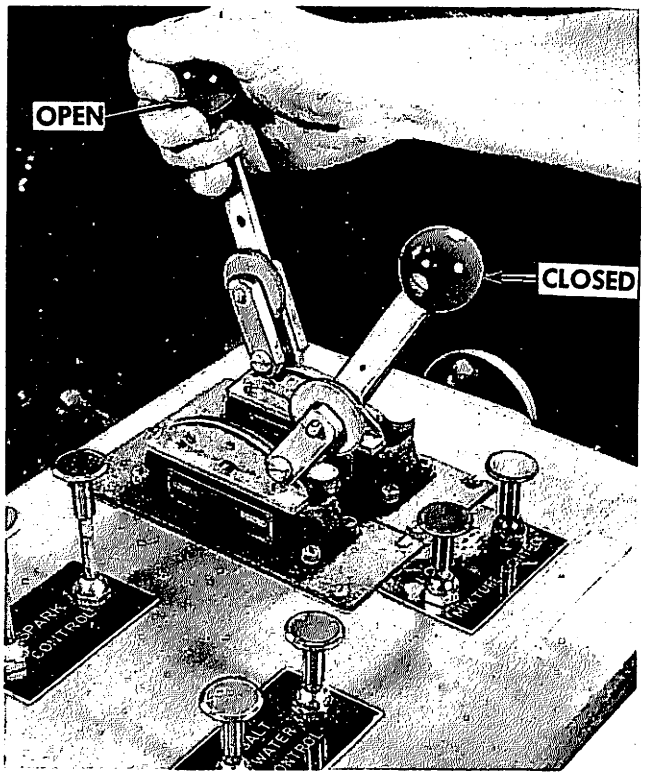


Figure 19—Checking Operation of Throttles

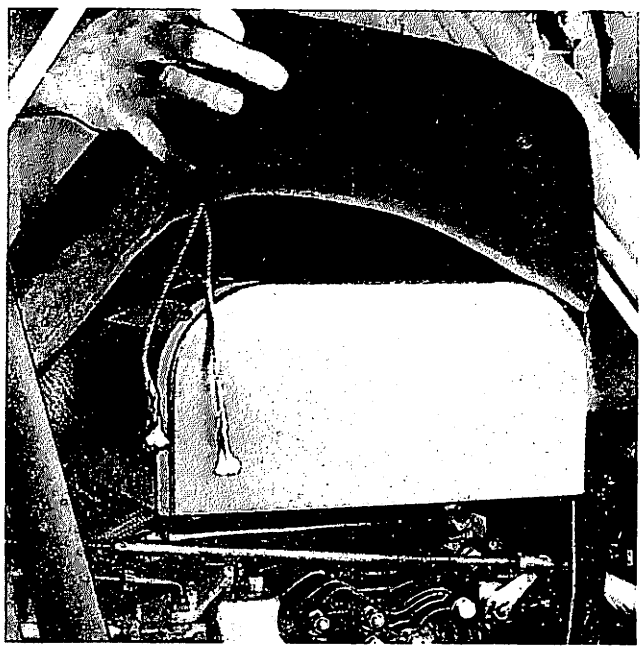


Figure 20—Removing Cover From Carburetor Air Cleaners

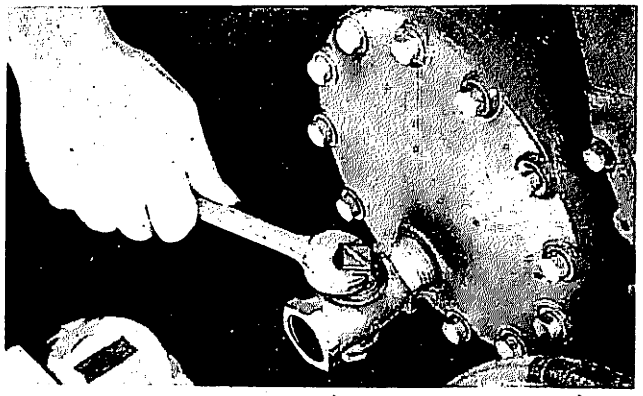


Figure 21—Closing Exhaust Manifold Drain Cock

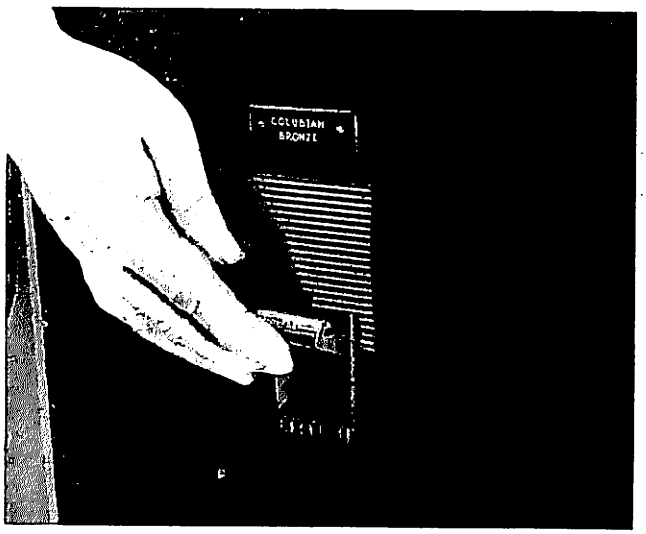


Figure 22—Turning on Clutch Control Switch

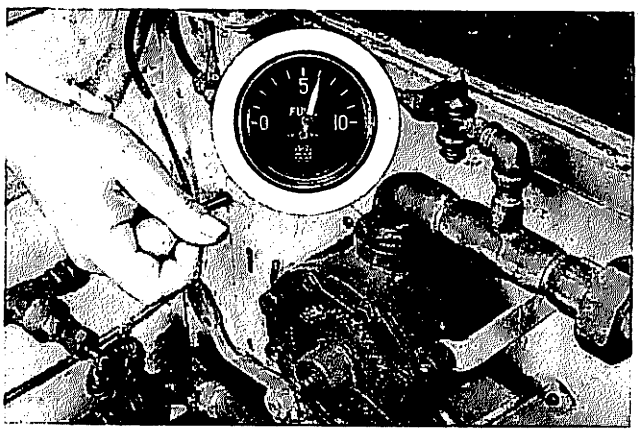


Figure 23—Operating Wobble Pump

(19) Turn both blower switches to "BLO-IGN." (See figure 24.)

(20) Turn on the instrument panel toggle switch (figure 25) and see that all instruments are operating.

(21) Push the starter buttons and turn the engines over a few revolutions, with the ignition switch off, to check the engines for free turning (without the jack-shaft turning). This operation will provide a suitable fuel mixture in the cylinders for immediate starting and will minimize possible backfiring. (See figure 26.)

c. STARTING THE ENGINES.

(1) Set the mixture control in the "RICH" position. (See figure 27.)

(2) If the engine is cold, operate the primer pump from two to six strokes. (See figure 28.) Do not overprime, and never prime a hot engine.

CAUTION

Never use the primer unless the engines are *extremely* cold, as the rich mixture will usually result in hard starting. If the primer must be used, first make sure that the throttles are closed. Then give the primer several strokes to clear it of air and use two to six priming strokes after the pump takes hold.

(3) Turn the ignition switch of the first engine to be started to "BOTH." (See figure 29.) In cold weather, turn first to "START," then to "BOTH" after starting.

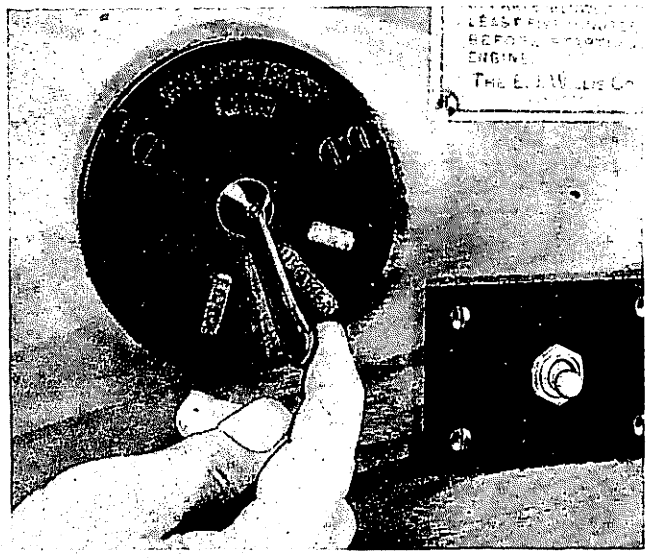


Figure 24—Turning Switch to "BLO-IGN"

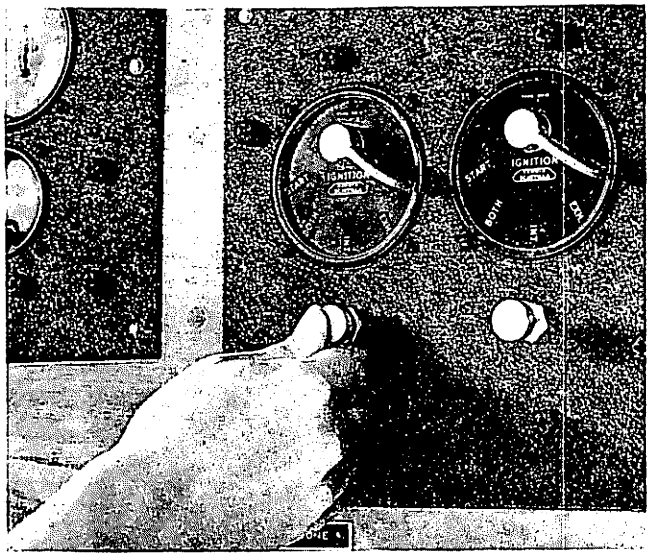


Figure 26—Testing Operation of Starter

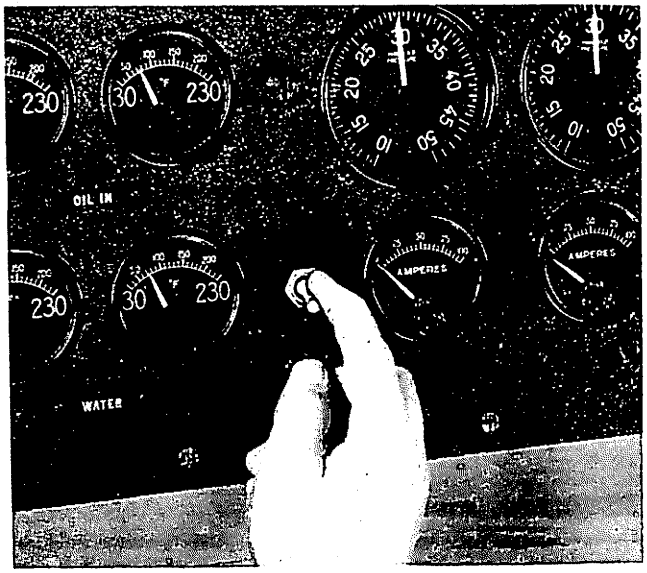


Figure 25—Turning on Instrument Panel Toggle Switch

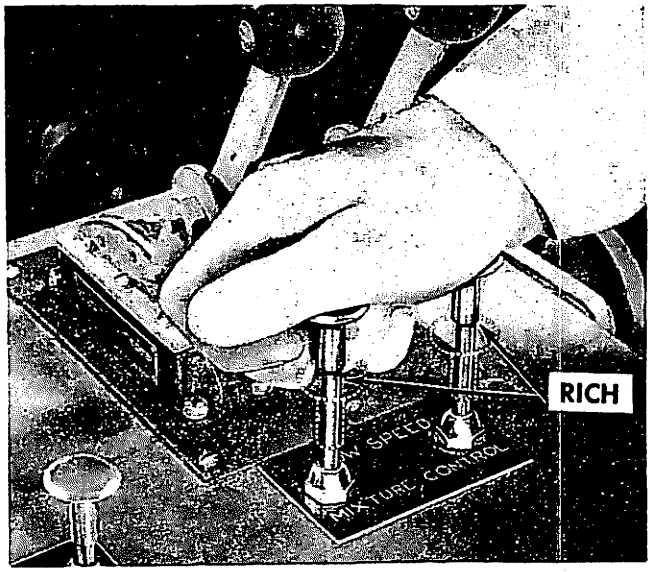


Figure 27—Pushing Mixture Controls Down to Rich Position

Note

If necessary to use the booster coil, have the engine turning over by the starter before turning the switch to "START." Never leave switch on "START" while running.

(4) Crack the throttle open and press the starter button. (See figure 30.)

(5) Maintain 6 pounds of fuel pressure with the wobble pump to help the engine get started. (See figure 31.)

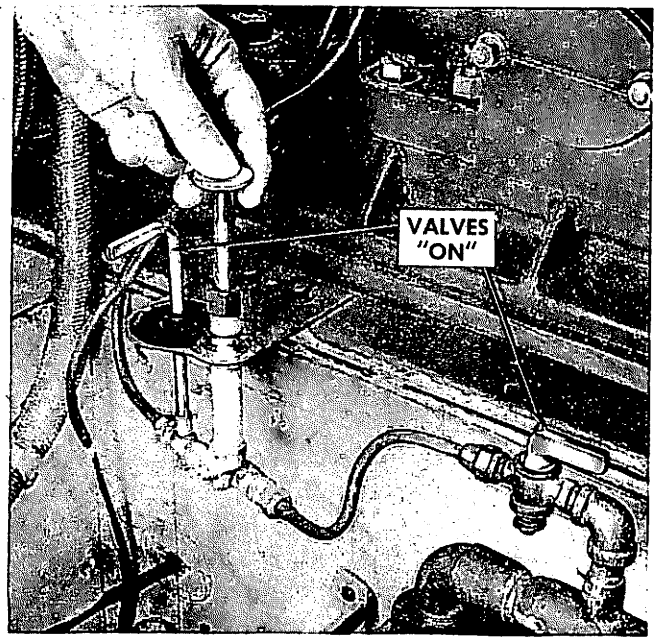


Figure 28—Operating Primer Pump

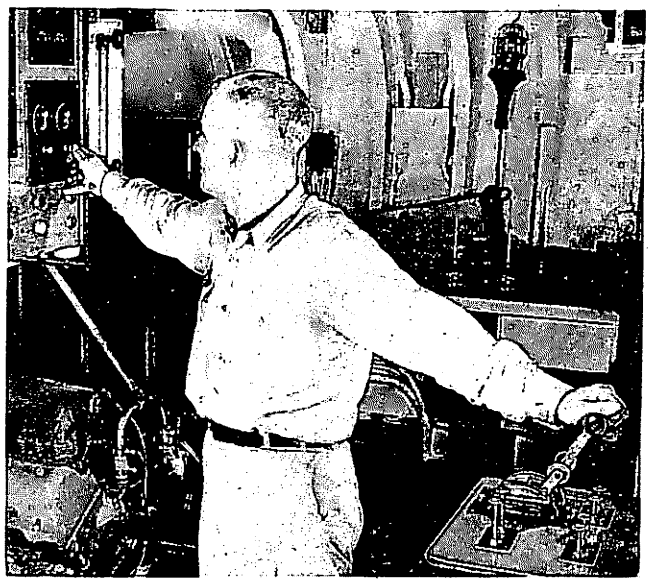


Figure 30—Starting Port Engine

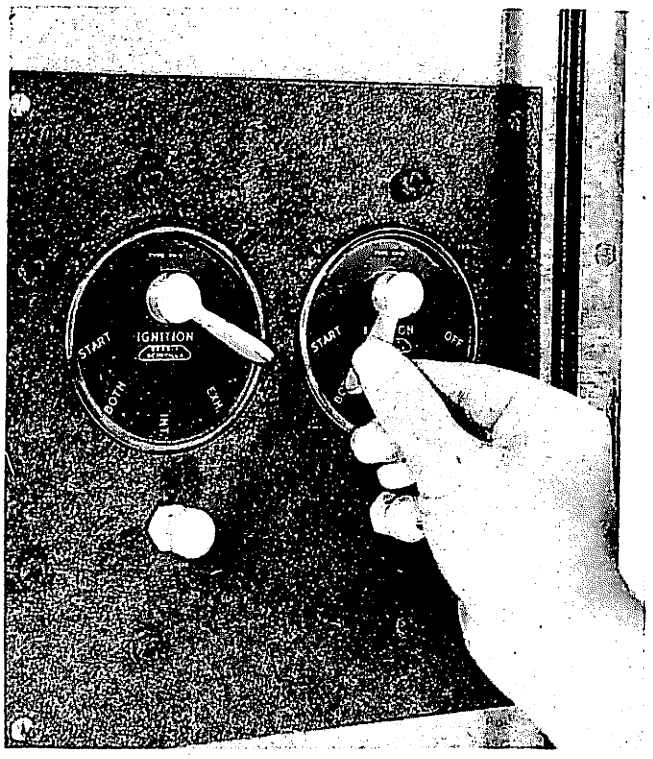


Figure 29—Turning Ignition Switch to "BOTH"

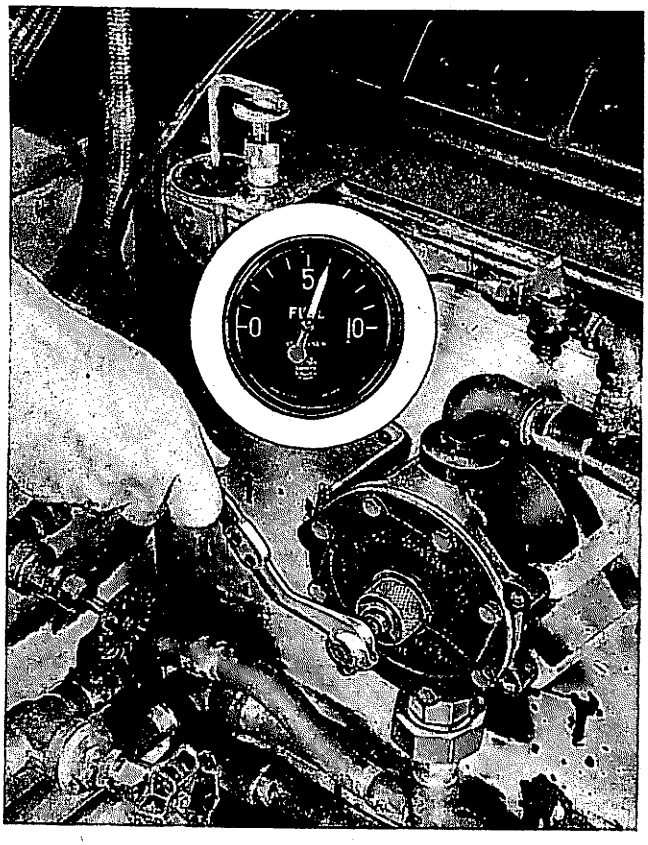


Figure 31—Maintaining Pressure with Wobble Pump

(6) As soon as the engine starts, check for oil pressure. The gage (figure 32) should show pressure within 5 seconds.

CAUTION

If oil pressure does not register after 10 seconds of operation, shut the engine down and determine the cause of lack of pressure. Oil pressure should not be allowed to exceed 150 pounds per square inch. This maximum pressure should only be reached when the oil is cold.

(7) Feel the exhaust manifold water pipe to see if the salt water is circulating properly.

(8) Start the second engine by repeating steps (1) to (7), inclusive.

d. WARM-UP AT THE DOCK.

(1) Idle at 850 rpm with manifold pressure at 10 to 12 inches of mercury. (See figure 33.)

(2) Do not get under way until oil-in and water-out temperatures reach 43°C (110°F). (See figure 34.)

Note

To warm up the engines more quickly at the dock, open the salt water outlet valve, and allow the salt water pump to pull the water directly through the outlet scoop instead of through the heat exchangers. Close the outlet valve before getting under way.

e. WARM-UP UNDER WAY.

Note

The engine should be warmed up under way whenever possible to shorten the warm-up time and reduce the possibility of spark plug fouling.

(1) Immediately after the boat gets under way, open the salt water outlet scoops slightly. (See figure 35.)

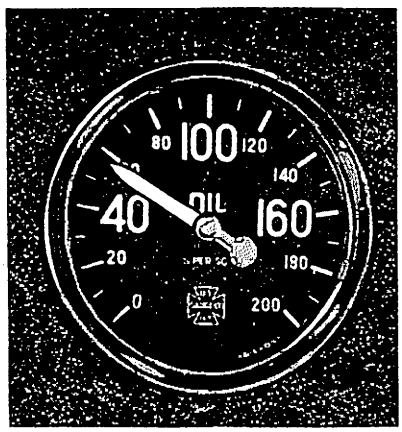


Figure 32—Oil Pressure Gage

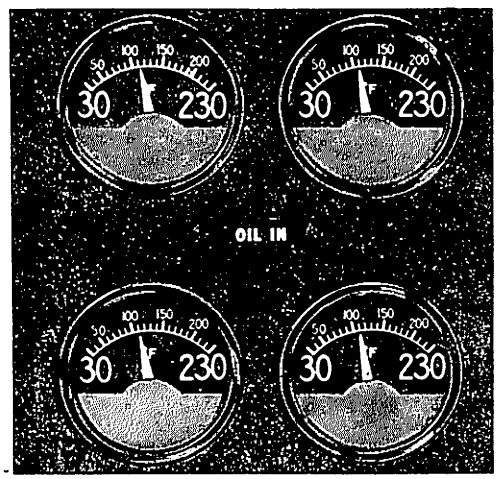


Figure 34—Oil-In and Water Temperatures 110°F

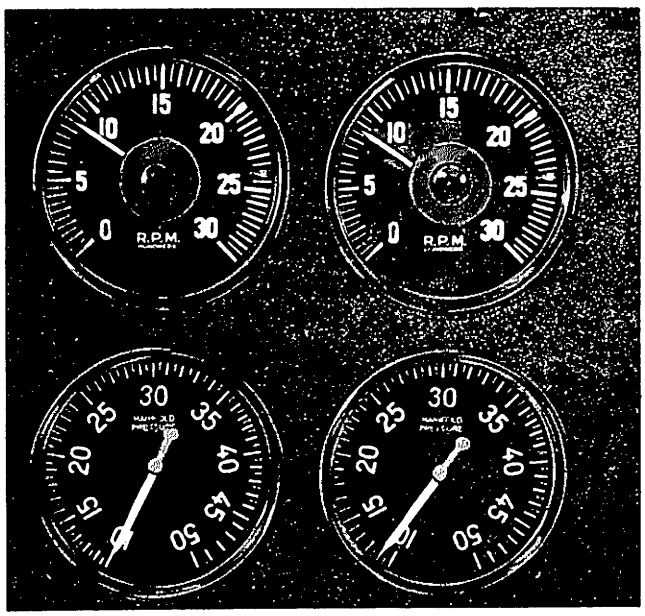


Figure 33—Tachometers and Manifold Pressure Gages

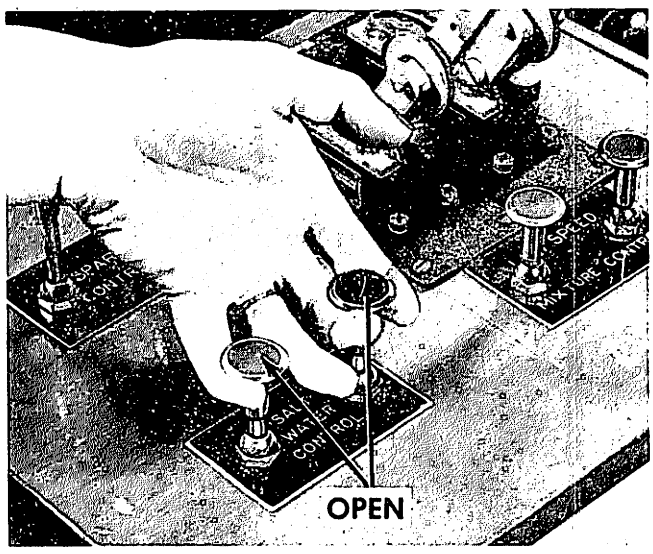


Figure 35—Opening Salt Water Control Valve

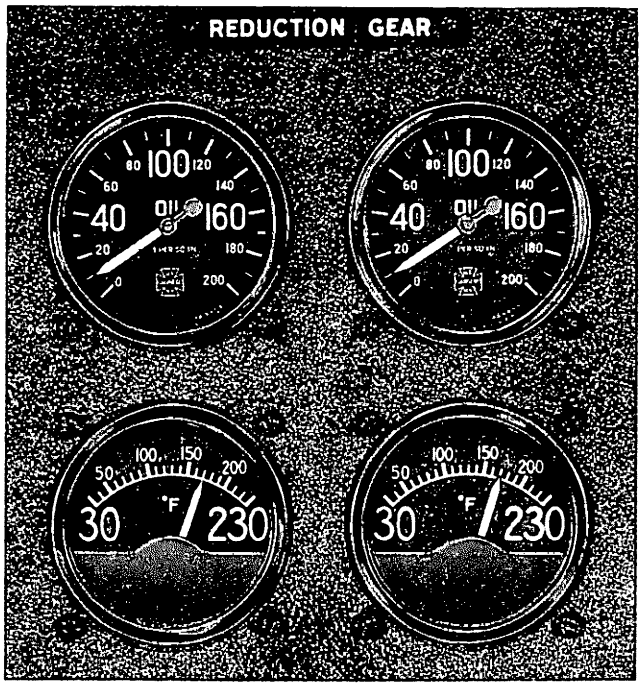


Figure 36—Gages for Angle Drive Oil Pressure and Temperature

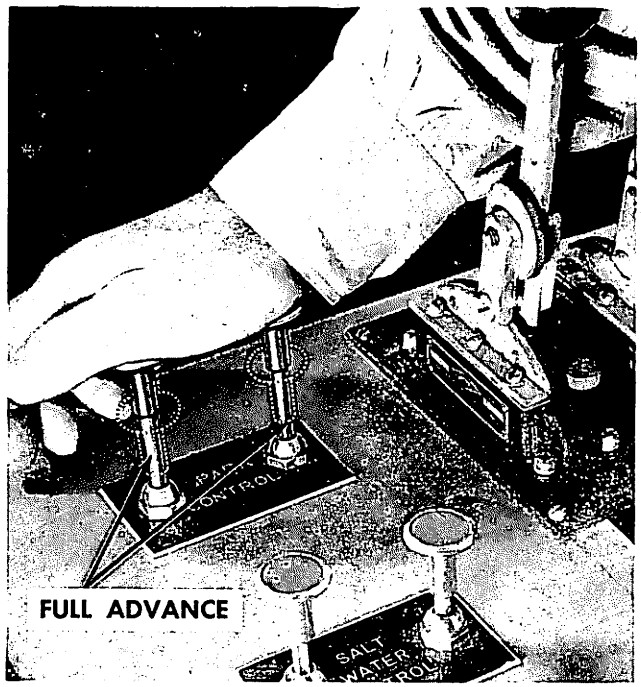


Figure 37—Advancing Spark

(2) Check the angle drive oil pressure and temperature on the gages marked "REDUCTION GEAR." (See figure 36.) The pressure should be between 2 and 18 pounds, and the temperature should be between 66° and 82°C (150° and 180°F), with a maximum of 104°C (220°F). At high speeds, the angle drive will heat up if the oil pressure is not at least 18 pounds.

f. UNDER WAY AT FULL RPM.—When the water-out temperature reaches 66°C (150°F) and the oil-in temperature is 54°C (130°F) the engines are ready to be run at full rpm.

(1) Move the spark controls to the "FULL ADVANCE" position as soon as the engine speed reaches 1200 rpm. (See figure 37.)

(2) Carefully watch all gages and instruments while the boat is under way. Any change from normal should be investigated immediately.

(a) Oil pressure should be 90 to 105 pounds at all speeds. Any sudden or considerable variation above or below these limits should be investigated immediately. However, oil pressure may drop to as low as 60 pounds when the throttles are closed quickly.

CAUTION

A sudden increase or decrease in engine speed places extremely heavy loads on all moving engine parts. This is a form of abuse which might cause serious damage to an engine. *Do not jerk throttles open or closed.* Instead, change throttle positions slowly and smoothly to increase or decrease engine speeds.

(b) Watch oil temperatures constantly while the boat is under way. Normally, the oil-in temperature will be held between 54° and 66°C (130° and 150°F) by the thermostat.

(c) Oil-out temperatures will go up as the engine speed increases and will range from 48° to 93°C (140° to 200°F). However, an oil-out temperature of around 93°C (200°F) should not be reached except when the engines are running at 2400 to 2500 rpm.

(d) Any sudden or unusual change in oil temperature is an indication of trouble. The engine involved should be stopped immediately and should not be restarted until the trouble has been corrected.

(e) Manifold pressures and engine speeds should also be watched constantly while under way. A manifold pressure table above the instrument panel (figure 38) shows the maximum allowable pressures at which the engines are to be operated. These manifold pressures should not be exceeded.

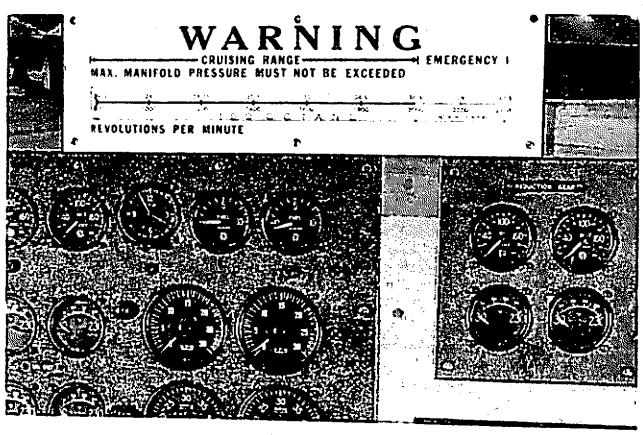


Figure 38—Manifold Pressure Table

g. STOPPING THE BOAT AND SECURING THE ENGINES. — As the boat's master brings the boat in and gets ready to dock, he will close the throttles gradually and come in at idle speed. When the boat loses way, close the salt water outlet valves. When the clutch levers have been placed in the "NEUTRAL" position, stand by with the engines running until the signal to stop the engines is received. Then proceed as follows:

Note

After a hard run, idle the engines for a few minutes before stopping them.

(1) Place the mixture controls in the "PUMP LOCK" position. (See figure 39.)

(2) Close the fuel supply valves (figure 40) and allow the engines to idle until the fuel in the carburetors is nearly exhausted and the fuel pressure drops to approximately 3 pounds.

(3) When the engines begin to run roughly because of lack of fuel, turn the ignition switches to the "OFF" position. (See figure 41.)

(4) Turn off the clutch switch. (Push DOWN the handle shown in figure 22.)

(5) Turn off the instrument panel toggle switch. (See figure 42.)

(6) Open the drains on the exhaust manifolds. (See figure 43.) To make sure that the drains are not clogged, insert a short length of stiff wire entirely through the valve openings.

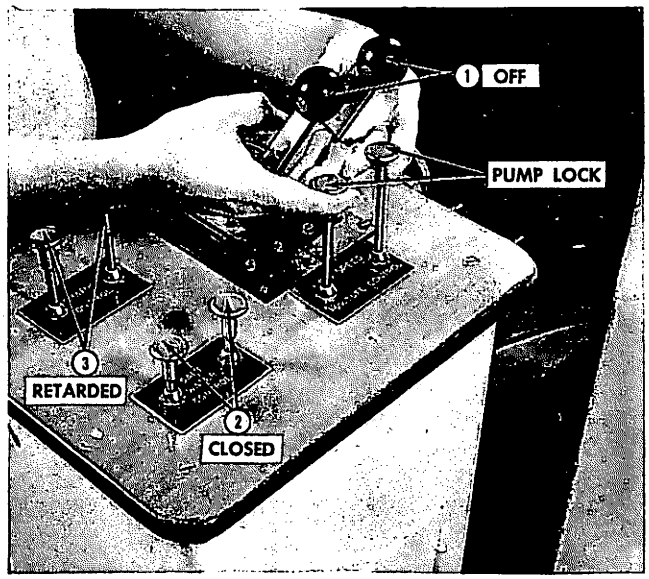


Figure 39—Pulling Handles of Mixture Controls to "Pump Lock"

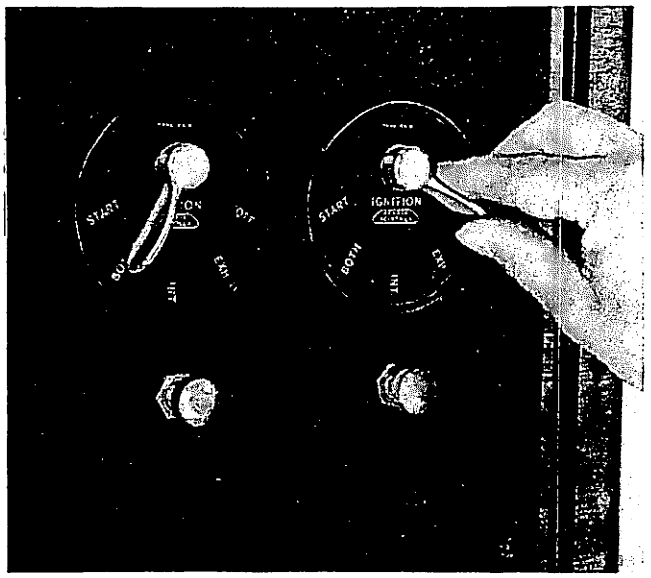


Figure 41—Turning Off Ignition

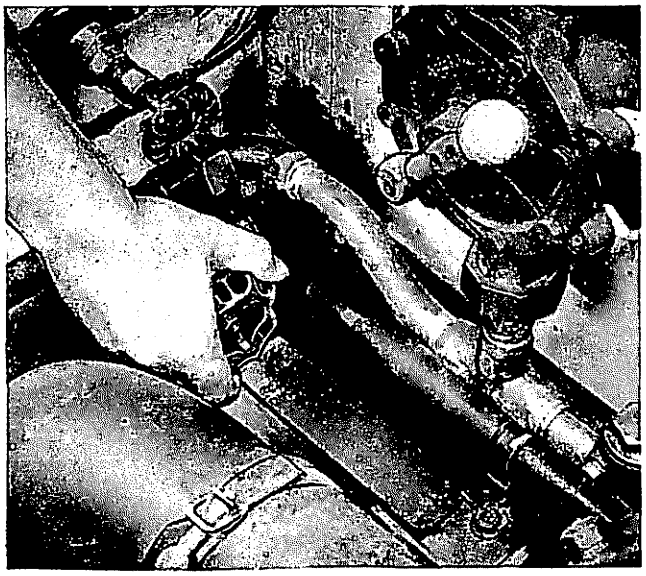


Figure 40—Closing Fuel Supply Valve

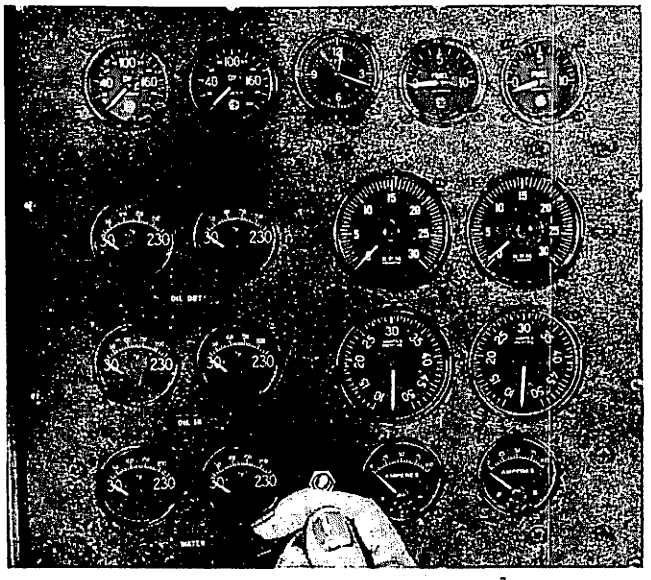


Figure 42—Turning Off Instrument Panel Toggle Switch

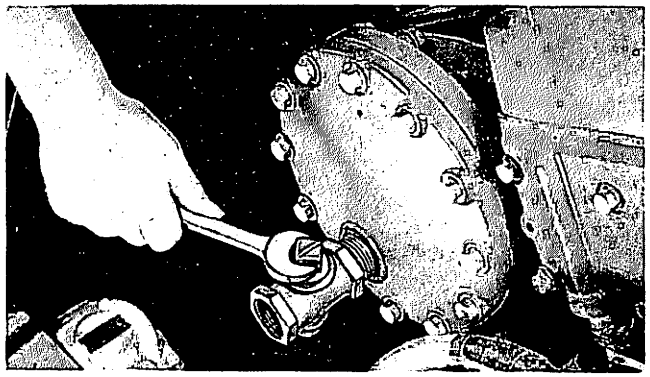


Figure 43—Opening Drains in Exhaust Manifold

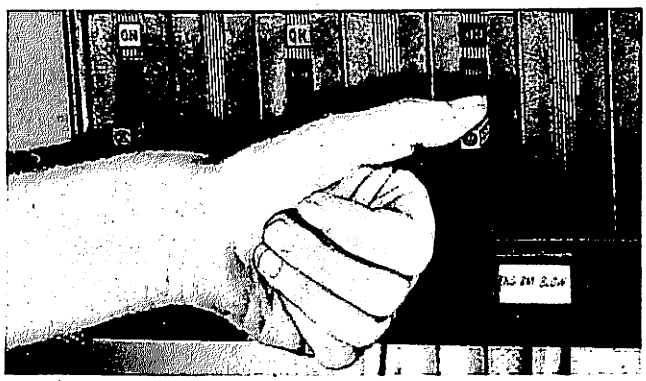


Figure 46—Turning Off Blower Circuit

Figure 44—Turning Off Blower



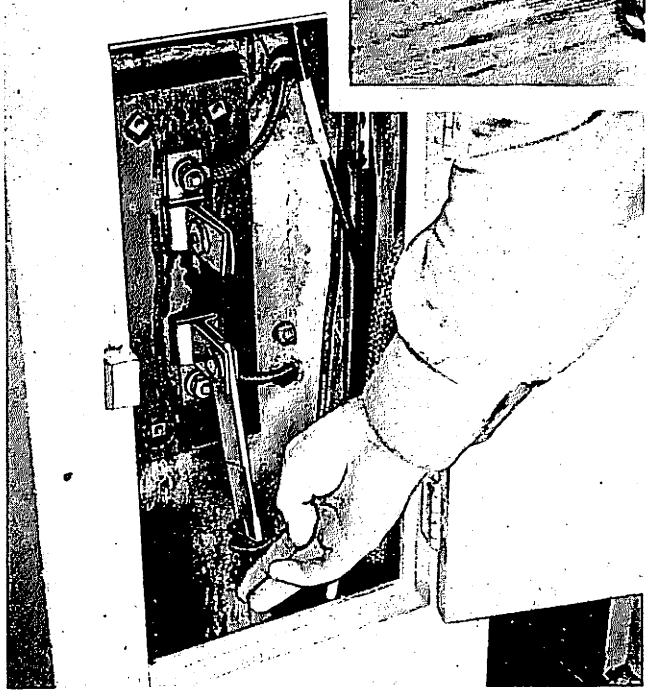


Figure 45—Opening 24-Volt Switch

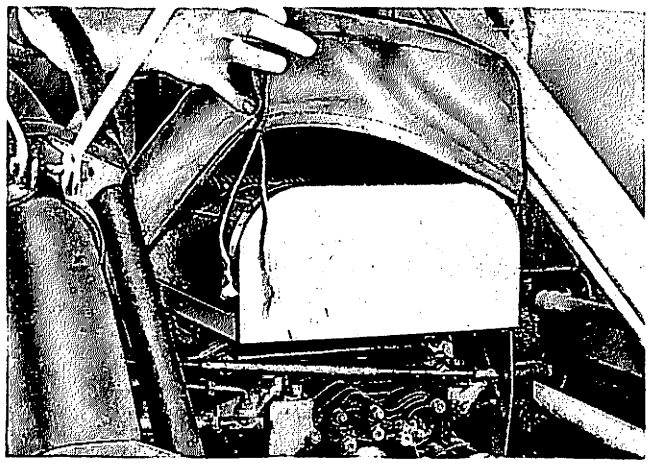


Figure 47—Covering Carburetor Air Cleaner

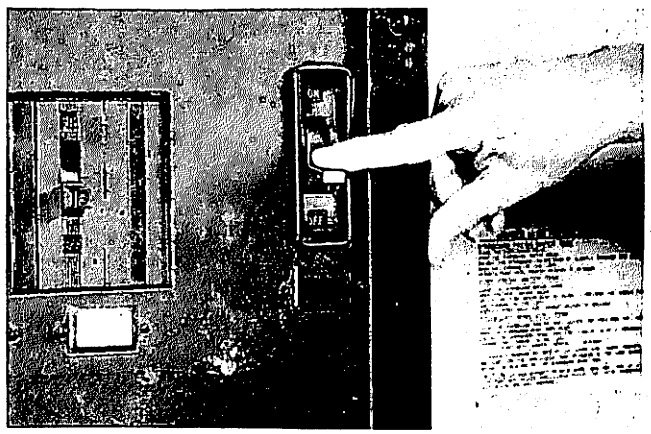


Figure 48—Turning Off Main 110-Volt Switch

(7) Turn the blower switches to the "OFF" position. (See figure 44.)

(8) Open the 24-volt knife switch in the control pedestal. (See figure 45.)

(9) Turn off the blower switches on the main switchboard. (See figure 46.)

(10) Place the covers on the carburetor air cleaners. (See figure 47.)

(11) Wipe the engines clean while they are still warm.

(12) Make needed minor repairs and adjustments.

(13) Turn the handles of the oil-out strainers two revolutions.

(14) When leaving the boat, turn off both generator and battery main switches on the 110-volt switchboard. (See figure 48.)

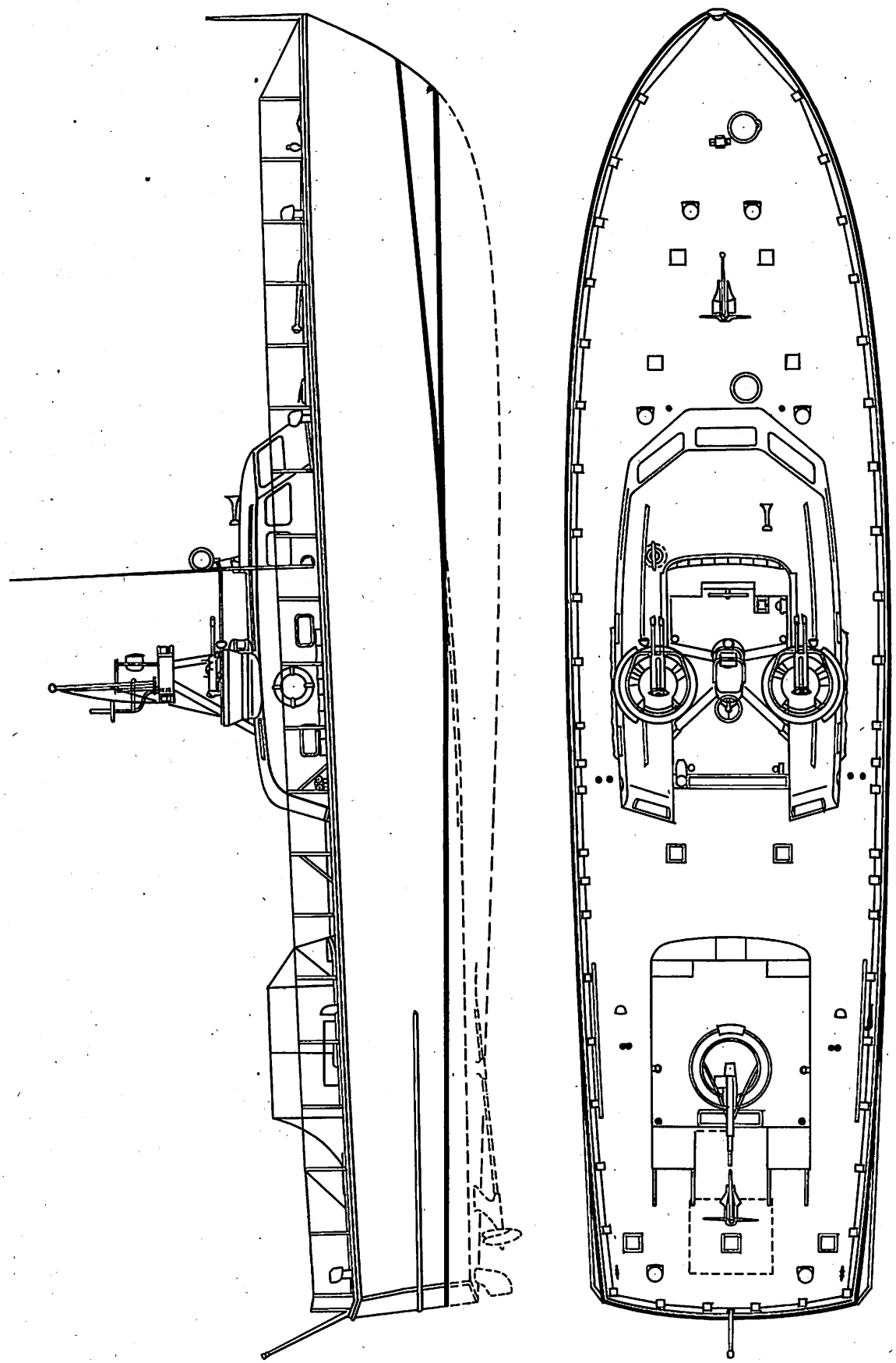
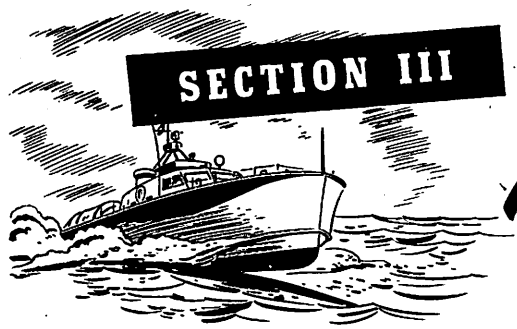


Figure 49—Outboard Plan and Profile



Hull and Deck

1. GENERAL.

a. Proper stowage of equipment on board a boat is important not only for the sake of appearance, but because it increases the efficiency of the boat and crew. "The right thing in the right place at the right time" should be the guiding principle behind any stowage plan. Gear and equipment lying haphazardly around throughout a boat gets lost, damaged, damages other equipment at sea, interferes with the free movement of the crew about the boat, and decreases the boat's speed.

b. Preparation of a stowage plan and the discipline of the crew in observing it is the responsibility of the master of the boat.

c. The maintenance periods given in this section may vary with climate, operational conditions, and general care. The periods may be changed to fit local conditions at the discretion of the commanding officer.

d. The overhaul time of a boat is determined by the condition of the bottom. The entire boat should be inspected and overhauled if necessary when the bottom is to be painted. (Refer to paragraph 4.*a.*, this section.)

e. Refer to the overhaul instructions for each system in the following sections. Most overhaul work, such as topsides and interior painting and machinery repair, should be made while the boat is in the water. Haul the boat only for bottom painting and repairs that cannot be made afloat.

2. DESCRIPTION.

(See figure 49.)

a. HULL FRAMING.

(1) The keel, forefoot knee, stem knee, and stem are made of mahogany in nine sections. The sections are scarfed, glued, and bolted. The keel is double rabbetted to take the inner and outer planking. White pine water stops are fitted through the outer planking back rabbet at each scarf.

(2) The keelson is spruce or Douglas fir with its sections scarfed. It is fastened to the keel by the keel bolts.

(3) The chines are mahogany, made up of six sections, scarfed and double rabbetted in the same manner as the keel. The breast hook is mahogany also, fastened to the stem and to the chines with carriage bolts.

(4) Longitudinal stringers on the bottom only are spruce or Douglas fir, tapered fore and aft and spaced on 12-inch centers. They are glued up with scarfs and are gusseted to the transom stiffeners with 3/8-inch plywood on both sides.

(5) Transverse frames in the bottom are double. An oak outer strap frame is steam bent from chine to chine from frame No. 19 to frame No. 59. The other outer frames notch into the keel. The inner frames are also steam bent and fit inside the longitudinals. A white oak floor filler is fitted between the center longitudinals and spruce filler flocks. Floor fillers are fitted between all the other longitudinals. The top side frames are mahogany sawed to shape. The transverse frames are spaced on 12-inch centers. They are fastened with plywood gussets on both sides of every frame at the chines and at the shear. The bent oak frames are fastened through the longitudinals with bolts and into the fillers with screws. The keelson, bent oak frames, floor fillers, and keel are through-bolted at each frame with a single carriage bolt. The frames are bolted to the chines in the same manner.

(6) The horizontal transom frame is mahogany sawed to shape and steam bent. Vertical frames are mahogany also, spaced on 12-inch centers lining up with the longitudinal stringers. The stem post is spruce or Douglas fir, gusseted to the keel and keelson with 3/4-inch plywood on both sides.

(7) The clamp and shelf are spruce or Douglas fir with glued scarfs. The clamp and shelf are glued and bolted together between the frames every 6 inches and bolted to each frame. The transom shelf is spruce or Douglas fir sawed to the transom crown and steam bent to the deck crown. It is bolted to each vertical frame.

(8) The engine beds are each built up of two long leaf yellow pine stringers spaced by spruce vertical and diagonal stiffeners and faced with 3/8-inch plywood, glued and screwed on both sides. The lower stringers are bolted through each frame. In the engine room compartment only, the engine beds are faced with steel angles fastened through the beds with steel bolts.

(9) The deck beams are spruce, tapered and sawed to shape. They are spaced on 12-inch centers to meet each frame, and are gusseted to the frames.

(10) The deck headers are spruce or Douglas fir, with glued scarfs, and run the full length of the boat. They are bolted to the breast hook, each beam, and the transom shelf.

(11) Shear and quarter fender guards are shaped from oak or yellow pine faced with galvanized steel, half oval. The half oval is screwed to the guards and the guards are screwed to the hull.

(12) Spray strips are shaped from mahogany and faced with brass half oval. They are screwed to the hull from the stern to station 6.

b. PLANKING.

(1) Inner planking is full length without butts. It is laid diagonally at approximately 45 degrees. The planking is screwed to the keel and chine rabbets and the shear clamp and is nailed to the frames.

(2) The outer planking is mahogany run longitudinally. The butts are staggered and made on butt blocks between frames. The planking is made up as tightly as possible with no caulking seam except at the garboard seam. This seam is caulked lightly with cotton and filled with surfacing putty. "Stealers" in the planking are let in forward where the edge set becomes excessive. The outer planking is screwed with three screws in each plank at each frame. The screws are set below the surface of the planks only far enough for planing and sanding the hull and are covered with a hard surfacing putty. The inner and outer planking is fastened together with screws from the inside. These screws are spaced 2 inches apart and there are two rows between each frame.

(3) The transom planking is the same as the other planking. The transom corners are protected with brass angles let in flush at the bottom and extending up to the quarter guards on the top sides.

(4) Six-ounce cotton duck is laid in marine glue between the inner and outer planking.

(5) The main deck planking is 1-inch plywood. It is fastened to the clamp shelf and the deck beams with screws. Removable sections are provided over the engine room for removing the engines and over the tank compartments for removing the tanks.

(6) The deck is covered with No. 12 cotton duck laid in marine glue. The removable sections of the deck are made watertight by gluing and painting down a 3-inch wide strip of duck over the seams.

c. BULKHEADS.

(1) Watertight bulkheads are of the stressed skin type with spruce boundary frames and vertical stiffeners spaced on 12-inch centers. Spruce blocking is used at the points where tubes, pipes, and wires pass through. The bulkheads are faced on both sides with 3/8-inch plywood glued and screwed to the stiffeners. They are clipped to the keel and chines with galvanized angles bolted in place.

(2) The longitudinal bulkheads are built up of spruce stringers spaced on 12-inch centers and faced with 14-inch plywood on both sides.

d. PILOT HOUSE.

(1) The pilot house is built on a rabbetted mahogany sill which is bolted through the main deck and headers with carriage bolts spaced 6 inches apart.

(2) Rabbetted mahogany mullions are used as corner posts for the octagonal pilot house front. The pilot house beams are sawed from 1 1/4-inch plywood, moulded 3 inches deep. The sides and front panels are 3/4-inch plywood and the top is 3/8-inch plywood with the compound curvature at the front stripped with white cedar.

e. BRIDGE.

(1) The bridge deck beams are gusseted to vertical stiffeners. The outer side pieces are a continuation of the 3/4-inch plywood pilot house side panels. The inner pieces are also 3/4-inch plywood and the top is 1/2-inch plywood. The bridge deck is 3/4-inch plywood screwed to the deck beams and covered with canvas.

(2) The wind deflector on the forward side of the bridge is made with 3/8-inch plywood baffles and 1/2-inch plywood facing.

(3) The two machine gun barbettes are built up of spruce horizontal and vertical stiffeners faced inside and out with 1/4-inch plywood.

f. COCKPIT.

(1) The cockpit deck is reinforced and planked in the same manner as the bridge deck.

(2) The deck is reinforced to take the gun mounting. The gun foundation is a 3/4-inch thick square steel plate through which the gun base is bolted to the beams and steel angles below.

g. INTERIOR FLOORS.—Interior floors are 1/2-inch plywood supported by spruce beams on 12-inch centers. Removable sections with flush lifting handles are provided for access to valves, bilges, etc.

h. WINDOWS.

(1) The pilot house windows are glazed with 1/2-inch Plexiglas. They are laid in hard seam composition in babbets and held by brass finishing strips screwed to the plastic. The side windows are movable.

(2) The two galley and two officers' quarters windows are marine type glass units. They are watertight closing and are equipped with screens.

(3) Deadlights are set flush in the deck, two in the dispensary, two in the engine room, and four in the forward crew's quarters. They are made of 3/8-inch Plexiglas in a steel frame and are watertight. They are equipped with sliding wooden covers on the under side.

i. HATCHES AND DOORS.

(1) Sliding weather tight hatches on the engine room companionway and the two dispensary companionways are made of 1/2-inch plywood on oak slides. A wooden strip on the under side slides into a notched block to lock the hatch closed.

(2) The manholes in the forward crew's quarters and the forepeak can be closed from either side

by the handles. The handle of each has a grease gun fitting for periodic lubrication. (See figure 50.)

(3) The watertight bulkhead doors in the forward crew's quarters, galley forward bulkhead, and the galley after bulkhead operate similar to the manhole covers.

(4) A key locker containing the keys to all locking doors and lockers is located in the officers' quarters.

j. COMPANIONWAYS AND LADDERS.—Companionways and ladders throughout the boat are made of mahogany with the stair treads mortised into the side stringers. Steps are provided with antiskid treads.

k. RAILINGS.—The life line consists of $\frac{5}{16}$-inch, 8x9 flexible galvanized plow steel wire rope fitted with turnbuckles and other gear. It runs through steel tubing stanchions bolted to the deck.

l. DECK GEAR AND FITTINGS.

(1) Deck cleats are galvanized malleable iron, 10 inches long. They are bolted through the deck to braces below.

(2) The six chocks are similarly mounted on the deck.

(3) The bow plate is a casting of manganese bronze with a closed fair-lead for two ropes and an end socket for the jackstaff.

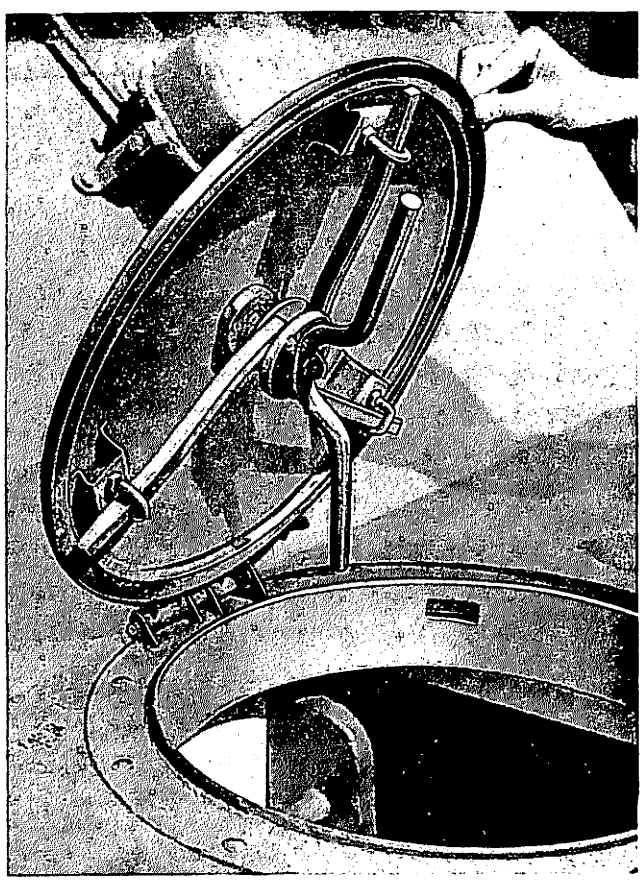


Figure 50—Forward Crew's Quarters Manhole

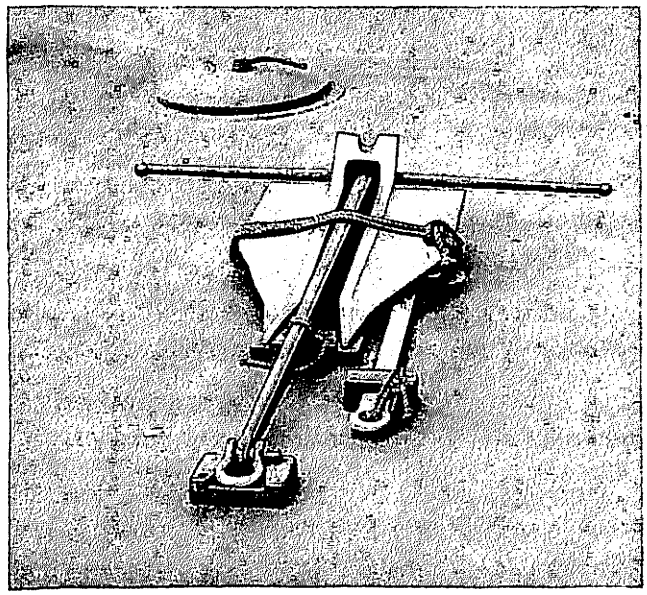


Figure 51—Forward Anchor Stowed

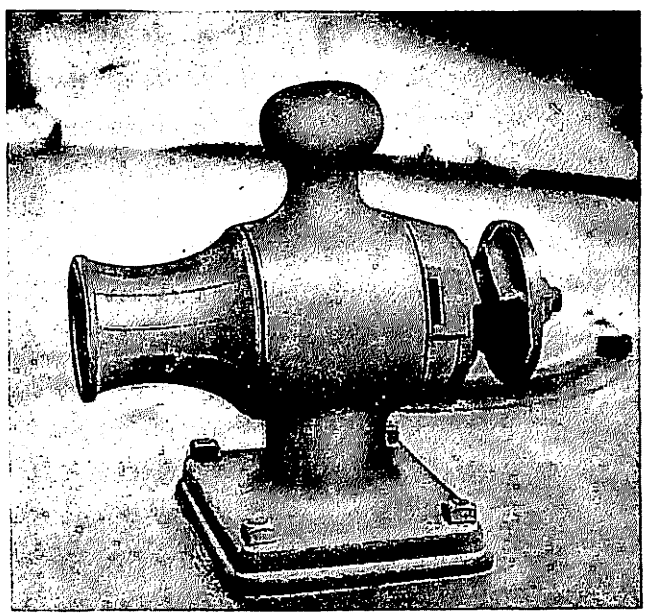


Figure 52—Anchor Winch

m. ANCHORS AND WINCH.

(1) Two 100-pound galvanized heat treated steel anchors with stock balance lifting shackles are stowed on suitable blocks on deck, one forward and one aft. (See figure 51.)

(2) The hand-operated anchor winch is bolted on the fore deck and blocked underneath the deck beams. (See figure 52.) The winch handle is stowed by the forward anchor. The winch is operated by inserting the handle in the slot on the side and pushing it back and forth. The winch works only in one direction and is used for raising the anchor. The post on the top can be used for securing lines.

n. LIFE SAVING EQUIPMENT.

(1) The two ring life buoys are stowed on the outboard sides of the bridge. They are equipped with 15 fathoms of 3/8-inch sisal line each.

(2) The 22 adult size, vest type, reversible, canvas covered life preservers should be stowed in racks in each compartment and in the deck lockers for quick accessibility.

(3) The two life rafts are seven-man aircraft type with carbon dioxide filling bottles and collapsible oars. They should be stored conveniently in the dispensary.

(4) The two rescue ("scramble") nets are fastened with snap hooks to eyes on the outboard sides of the bridge trunk. Each net is 8 feet wide and 14 feet long, made of 5/8-inch sisal rope woven in 1-foot squares, the intersections seized with marline. ~~(See figures 53 and 54.)~~

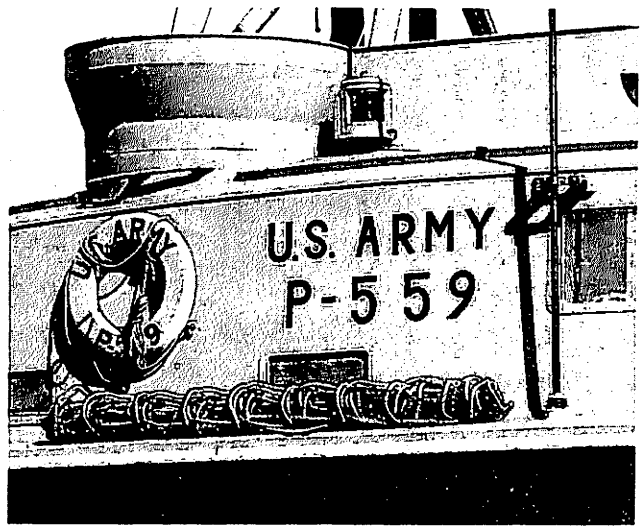


Figure 53—Starboard Life Ring Buoy and Rescue Net Stowed

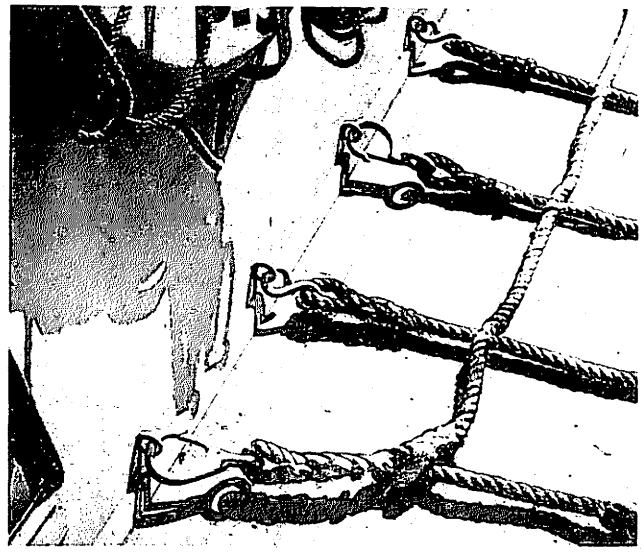


Figure 54—Rescue Net Fastenings

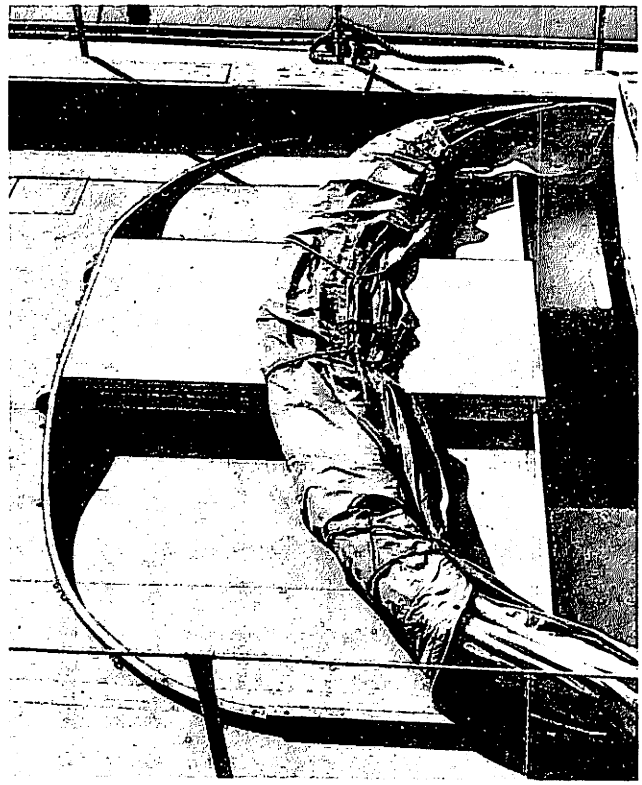


Figure 55—Cockpit Canopy Stowed

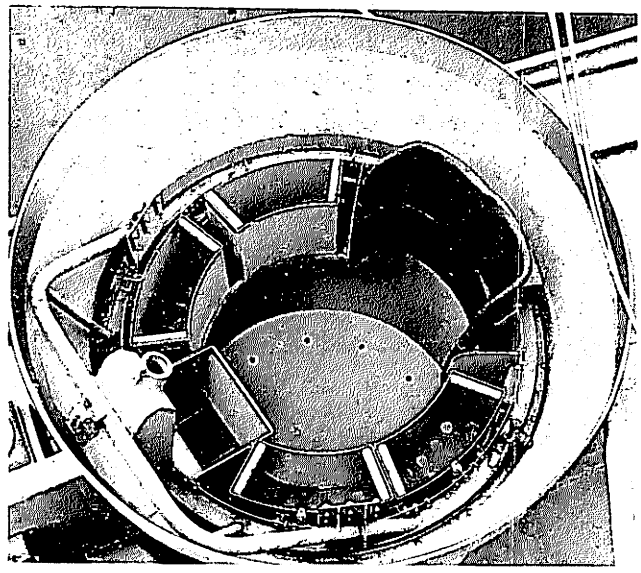


Figure 56—Machine Gun Mount

o. CANVAS WORK.

(1) All covers are fire, water, and weather resistant cotton duck conforming to *Federal Specification No. CC-D-746.* Covers should be made, if they are not provided, for the searchlight, the bridge wheel, the deck stowed fire hoses, and the armament.

(2) The canopy is of 10-ounce cotton duck mounted on steel tubing frames bent to shape. The frames are

mounted on hinged slides which move on sail track fastened to the deck outside the cockpit coaming. (See figure 55.)

p. ORDNANCE.

(1) ANMK-17 Model I mount for twin .50-caliber machine guns, M2 (aircooled) H. B., is installed in each bridge barbette. (See figure 56.)

(2) An MK-12 (Navy) mount for one 20-mm Oerlikon gun is installed in the cockpit.

(3) The two ammunition lockers in the cockpit each carry two 20-mm magazines.

(4) The watertight bridge lockers carry .50-caliber machine gun ammunition.

3. CARE, MAINTENANCE, AND STOWAGE.

a. AT DOCK.

(1) Keep fiber mats or strips of canvas laid down on the principal walking surfaces of the deck and below decks to catch dirt and save the paint work.

(2) Wash down the deck daily with fresh water and a hose, if available. Swab the decks clean and dry.

(3) Surround deck filler connections with rags when filling oil or fuel tanks, to catch any spills or drips which would stain the paint.

(4) Sweep interior floors daily. Swab them with fresh water twice a week.

(5) Wash interior surfaces and fittings as required. Use soap or cleaning powder for interior walls. Use a piece of chamois for windows and glass surfaces.

(6) Polish brass daily.

(7) Keep bright work covered with a light oil.

(8) Keep canvas covers installed and lashed on armament, the searchlight, the bridge wheel, and the fire hoses.

(9) Keep the cockpit canopy tracks lubricated with light engine oil. If the canopy is kept folded, open it so it can air out every three days. Open it to dry after a rain or if it gets wet while hosing the deck.

(10) Keep lines and fenders stowed neatly when not in use. Make sure they are dry before stowing them in the forepeak or closed lockers. Air and dry stowed lines once a week.

(11) Air life jackets in the sun once a week.

(12) Air bedding above decks once a week. Every 3 months, or as necessary, close up the sleeping quarters and spray, gas, or fumigate the compartments with a suitable insecticide.

(13) Keep the galley scrupulously clean. Do not leave food exposed without reason; remove all food from the refrigerator when it is not operating. Clean the refrigerator with hot water and soda every week. Wash all mess gear and silver after use. Operate the galley blower while cooking to keep the other compartments free of cooking odors.

(14) Keep living quarters clean and orderly. Bunks should be made up and clothes, toilet articles, and personal belongings should be stowed away when not in use. Clean toilets and lavatories as often as necessary.

b. AT SEA.

(1) All loose deck gear should be stowed away or lashed in place. This includes such things as the anchor, lines, and fenders not in use, hoses, life rings, and pennants, or flags.

(2) Keep the canvas covers installed on such items as the searchlight and the armament when the use of such equipment is not anticipated during the trip.

(3) The cockpit canopy should be either lashed open, or folded and lashed to the deck. Do not leave it untied.

(4) Stow away below deck gear and equipment—galley equipment, tools, charts, and papers, navigation equipment, clothes and bedding, etc.—when not in actual use.

(5) Fasten bulkhead doors and manhole covers shut to prevent them from swinging and to maintain watertight integrity.

c. AFTER MOORING.

(1) Wash down the decks and all exterior surfaces with fresh water, if available, to remove salt water deposits. Use a hose, if possible, and swab the decks dry and clean.

(2) Wash interior surfaces which have been wet by salt water. Use a piece of chamois and fresh water.

(3) Wash windows with fresh water and a chamois.

(4) Dry all lines and fenders thoroughly before stowing them.

(5) Wash the cockpit canopy with fresh water. If it was folded while at sea, raise it and wash it. Allow it to dry thoroughly before folding and lashing it down.

(6) Polish all brass.

(7) Wash oilskins with fresh water and dry them before stowing them away.

d. AT HAULING.

(1) When the boat is taken out of the water, clean the marine growth off the bottom immediately. Use a long handled scraper to remove the barnacles and seaweed. Finish the cleaning with fresh water and a stiff brush. Sand down any rough spots that still remain before repainting the bottom.

(2) Inspect and clean all the below water line through hull fittings. Remove and clean sea chest strainers.

4. PAINTING.

a. GENERAL.

(1) The painting period of a boat varies with the climate in which it is operated. In tropical climates, the hull and exterior surfaces should be painted every 3 months. In colder latitudes the period between painting can extend up to 5 or 6 months. If a boat is regularly moored in fresh water it can go longer between paintings than one moored in salt water. Different localities have different types of marine growth which may necessitate longer or shorter periods between painting the bottom. Interior painting times vary with the use and

care a boat gets. The average period is between 8 months and 1 year.

(2) When successive coats of paint become too thick, burn and scrape off all the old paint down to the bare wood and repaint. On exterior surfaces prime the prepared surfaces with aluminum paint; fill any cracks or exposed seams with plastic wood or seam compound; apply a first coat of hull or deck paint thinned down with 1½ quarts of linseed oil to 1 gallon of paint; and apply a regular coat of the proper paint. This should be done about every six coats of paint (every 1½ years for exterior surfaces).

(3) Whenever metal surfaces such as through-hull connections and deck fittings are cleaned down to the bare metal, prime the surface with red lead, Federal Specification No. TT-R-191a, grade B or C, before repainting.

(4) The following rules and precautions should be observed in painting:

(a) Never paint over a wet, dirty, or greasy surface. Make sure the sections to be painted have been cleaned and are dry.

(b) Do not paint in wet weather or in bright sunlight. Too much heat may blister the paint.

(c) Do not apply the paint too heavily. Thick, uneven coats will crack and peel.

(d) Do not let dirt or water fall on fresh paint until it is thoroughly dry.

(5) The following order of painting the various sections of the boat is most convenient.

(a) Interiors, including bilge, if they are to be painted.

(b) Pilot house exterior, bridge, cockpit, and decks.

(c) Deck gear.

(d) Hull topsides.

(e) Bottom.

b. BOTTOM.

(1) The bottom should be scraped clean and dry (paragraph 3.*d.*, this section) before painting.

(2) Use a good antifouling, non-corrosive marine bottom paint, preferably copperoid.

(3) Boot topping has been discarded on the 85-foot rescue boat. Carry the bottom paint up to the former top line of the boat topping, 4 inches at the stem and 3 inches at the stern above the designed water line.

(4) If the bottom has been scraped down to the wood, prime the surface as described in paragraph 4.*a.*(2), this section, and apply two coats of copper bronze bottom paint.

(5) The boat, of course, must be hauled out of the water for bottom painting. It can be put back in the water as soon as the paint has been applied, since it is slow drying and will not be affected by water.

c. TOPSIDES.

(1) Paint all exterior vertical surfaces above the top line of the bottom paint with sea blue paint conforming to Formula No. 5S, Marine Design Construction and Procurement Specification No. 1-MDCP-2 (TEN.).

(2) This includes hull topsides, pilot house and bridge sides, cockpit sides, mast, radio mast, direction finder loop, life ring buoys, and similar surfaces or items fastened to vertical surfaces. *However, clear lacquer only should be applied to the black ring at the top of the loop.*

d. DECKS.

(1) Paint all horizontal exterior surfaces above the water line with deck blue paint conforming to Formula No. 20B, Marine Design Construction and Procurement Specification No. 1-MDCP-1.

(2) This includes the main deck, bridge deck, cockpit deck, all steps, and deck gear and fittings such as the anchor and anchor winch, hand rail, bitts and cleats, and deck plates.

(3) If the old paint is to be scraped off, as described in paragraph 4.*a.*(2), this section, be careful not to scrape through or tear the canvas deck covering.

e. INTERIOR (EXCEPT BILGES).

(1) When interior surfaces except bright work are scraped down to the bare wood, prime them with flat white paint, Navy Formula No. 27. Then apply two coats of the proper finish paint.

(2) Paint all interior walls and ceilings except in the pilot house with cream or white enamel gloss, Navy Formula No. 30. This includes the forepeak and all lockers, bunks, and fittings except those to be finished bright.

(3) Paint interior walls and ceiling of the pilot house with the same sea blue paint used on vertical exterior surfaces. This includes the chart tables.

(4) Woodwork to be finished bright should first have the old varnish sanded down. If the coloring is worn off, apply a coat of filler tinted to the color required. Apply two coats of spar varnish, Navy Formula No. 80.

(5) Paint interior walking surfaces with light grey deck paint, Navy Formula No. 80.

f. BILGES.

(1) If the bilges are not painted when the boat is received, it is recommended that they be thoroughly cleaned and dried and painted to make their upkeep easier.

(2) Use the deck paint used for horizontal exterior surfaces, thinned down with 1½ quarts of linseed oil to 1 gallon of paint.

(3) The painting period of the bilges varies with their condition, care, and the amount of water seepage. It is usually not necessary to repaint them as often as exterior surfaces, but sometimes their condition requires painting more frequently than interior walls and floors.

g. SPECIAL.

(1) Paint exterior canvas covers and the canopy at the time the other exterior surfaces are painted. Use

a special flexible canvas paint of the same sea blue color as the exterior vertical surfaces.

(2) Paint the engines and other units machinery at the same time the interior of the boat is painted. Use grey synthetic enamel, Navy Formula No. 30L.

(3) Paint battery boxes and covers whenever the interior is painted. Use black acid resisting paint, Navy Formula No. 28.

(4) Table tops in the galley, officers' quarters, crew's quarters, and radio room may be painted with blue enamel.

(5) Paint the words "U. S. ARMY" and the boat's number on either side of the bridge aft of the pilot house aft windows. Use flat black exterior paint.

(6) Paint the same designation on the ring life buoys. Use the same flat black enamel.

(7) On the forward deck about midway between the bow and the pilot house paint the U. S. Army Air Force insignia. Paint it as large as is practicable, with the bars on either side of the star running athwartships. Where the anchor or other deck gear comes over the insignia, paint it to match so the insignia will be clearly visible from the air. Use white and blue flat exterior enamel.

(8) When the interior has been painted, mark exposed tanks, doorways and lockers, and units of machinery as necessary for quick identification. Use stencils and black paint.

5. HAULING.

a. The boat must be hauled out of the water for bottom painting, below water line exterior maintenance, and structural repairs which cannot be made afloat.

b. Because of the construction of the boat, it cannot be rested on its keel alone. It must be supported equally at the keel and chines at least at every watertight bulkhead. The docking plan (figures 57 and 58) should be used to carefully place keel timbers and chocks.

c. If a marine railway is not available, but a crane with sufficient tonnage is, the shipping cradle may be used to lift the boat onto land. Attach a yoke sling to the cradle frame at the four corners and two or four other places. The sling should be large enough to fit around the boat in the frame and should be braced so the lines will clear the topsides. Lift the cradle frame with a crane and swing it under the boat in the water so it fits the hull properly. Protect any places where the sling rubs the sides of the boat with fenders or similar padding. Lift the boat in the cradle frame from the water and place it on level ground or a cradle bed.

d. If neither a crane or a marine railway is available, the boat may be hauled in a locality with sufficient rise and fall of tide. Place the cradle in shallow water at

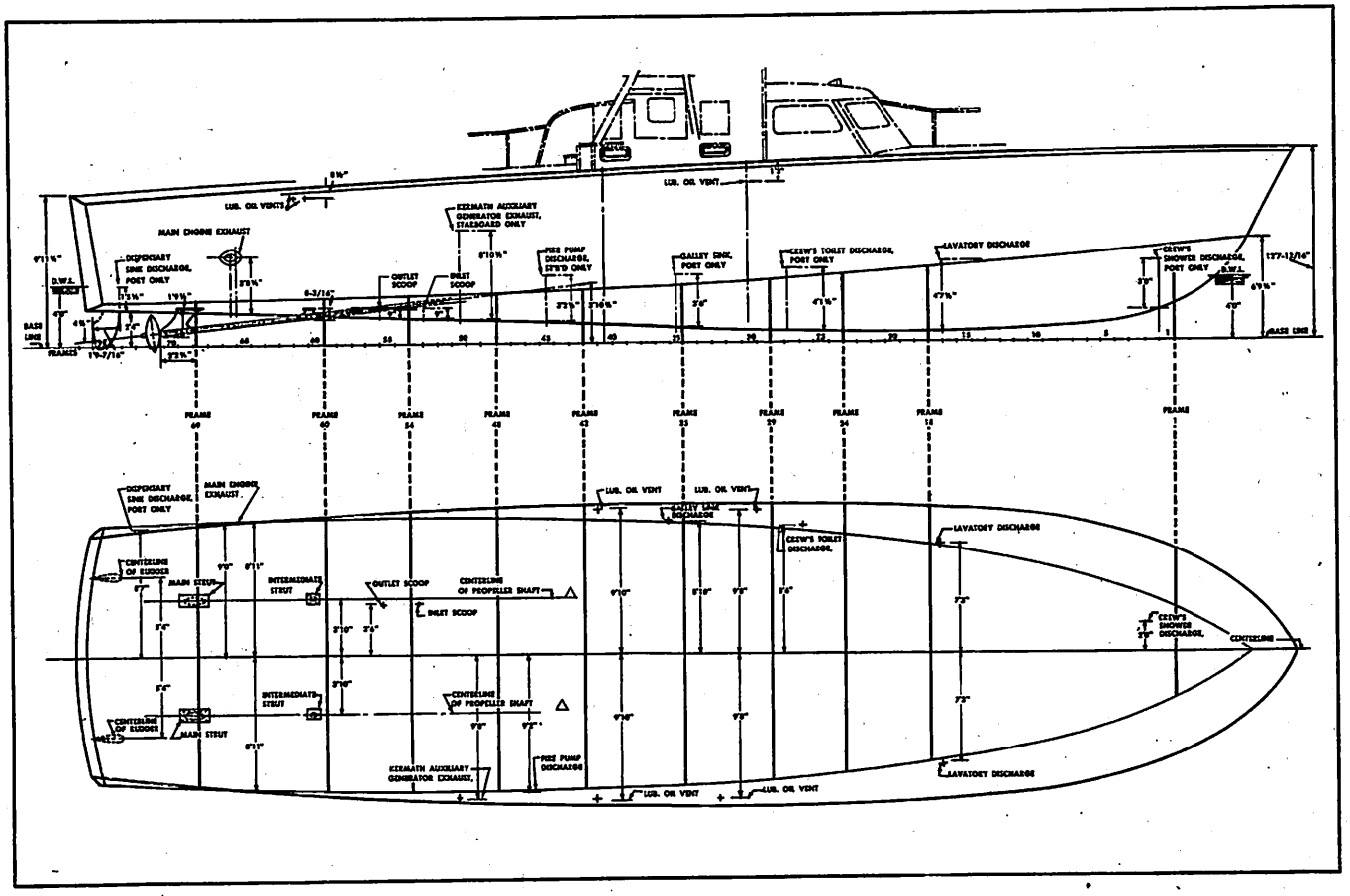


Figure 57—Docking Plan

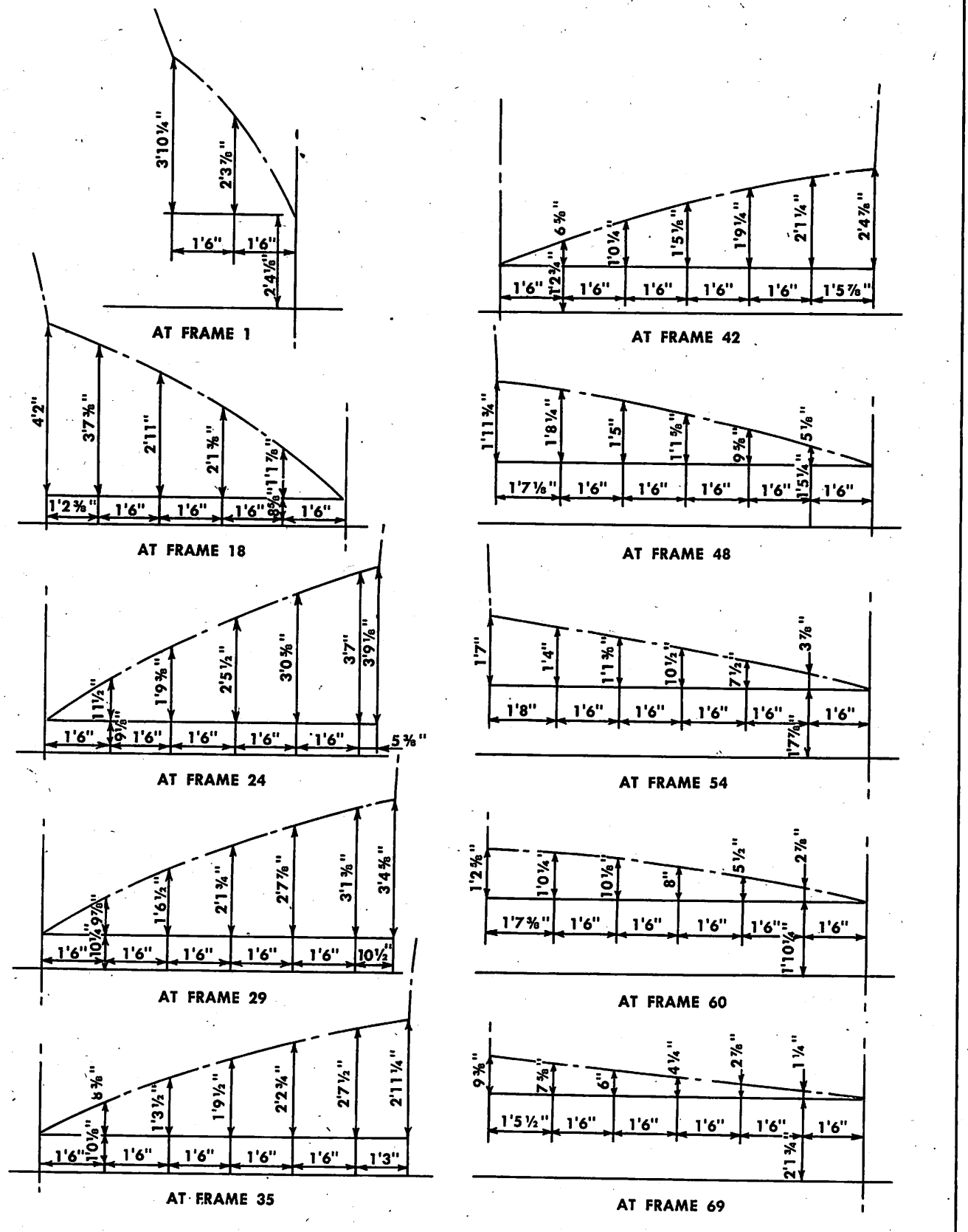


Figure 58—Docking Plan Dimensions

high tide so that just enough water is over it to float the boat onto the cradle.

CAUTION

Support the cradle firmly.

When the tide recedes, the bottom may be painted. The boat can be floated off the cradle at the next high tide.

e. In placing the cradles under the hull, care should be taken not to place them so the boat will rest on a through-hull connection, a strut, or a propeller shaft. Avoid such places, marked in figure 57, by bridging the cradles over them.

f. When the boat is resting on shores or chocks, one shore or chock at a time may be removed or shifted to provide access for painting all parts of the bottom. Be sure not to remove more than one shore at a time and to replace it before taking out the next one. When the boat is hauled in a cradle, keep record of hauling so that the boat may be hauled on a different supporting area every other time.

6. MAJOR REPAIRS.

a. PLANKING.

(1) Repair small gouges in the hull, if they are not through the outer planking, with several thin layers of plastic wood and sand it off flush with the planking.

(2) Repair more serious cuts or cracks by replacing the damaged planks. Usually it is necessary to replace only the outer layer.

(3) It is generally advisable to replace entire planks, but when the damage is slight, the affected sections of planks can be cut out and replaced. When only sections of planks are installed, stagger the seams where the new patches butt against the old planks so they are not in a straight line. (See figure 59.)

(4) Be careful when removing planks from the hull to damage as little as possible the fabric between the two layers of planking. If the fabric is not seriously damaged, apply a coat of marine glue and install the new plank over the old fabric. If it is badly damaged, replace the fabric with a new section. Coat the inside plank with marine glue, lay the new section of fabric in place smoothly, coat the outside of the fabric with glue, and install the new outside plank.

(5) When a new plank is installed, plug the old screw holes with wooden pegs and duplicate the fastenings of the old plank as closely as possible.

(6) New planks should fit as snugly as possible. Where a slightly open seam is unavoidable, fill the crack with plastic wood.

(7) When the new plank is installed, sand it down to a very smooth finish matching the surrounding planks. Prime and paint it as described in paragraph 4.*a.*(2), this section.

b. FRAME MEMBERS.

(1) Broken main frames are almost impossible to remove and must be repaired in the boat. Cut two "sister frames" out of heavy plywood to fit both sides of the broken frame and extend as far as possible above and below the break. Place the plywood pieces on both sides of the frame and through-bolt them with brass or galvanized bolts. Use fairly large bolts and as few of them as practical, since many holes in the frame will weaken it. (See figure 60.)

(2) Cracked battens do not weaken the structure of the boat materially unless several of them in the same area are cracked. Cut a new batten to fit between the frames over the damaged one. Fasten the new piece to the frames at either end with metal angles, and to the cracked batten with screws. (See figure 61.)

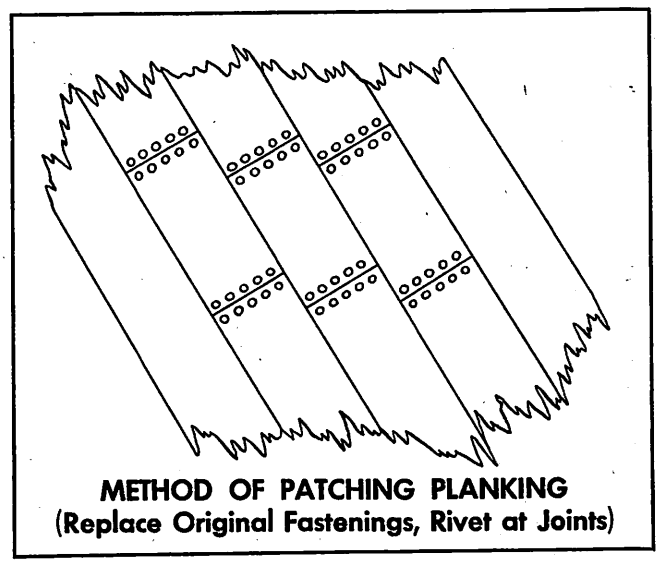


Figure 59—Patching Planks

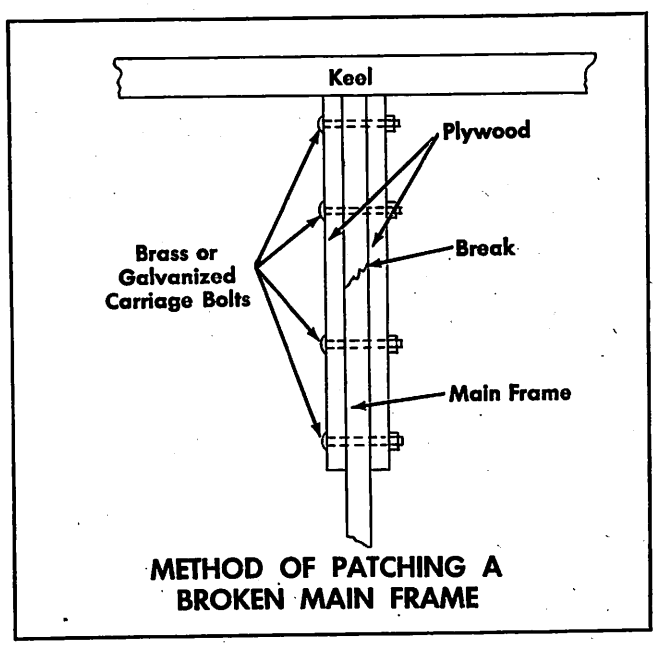


Figure 60—Main Frame Repair

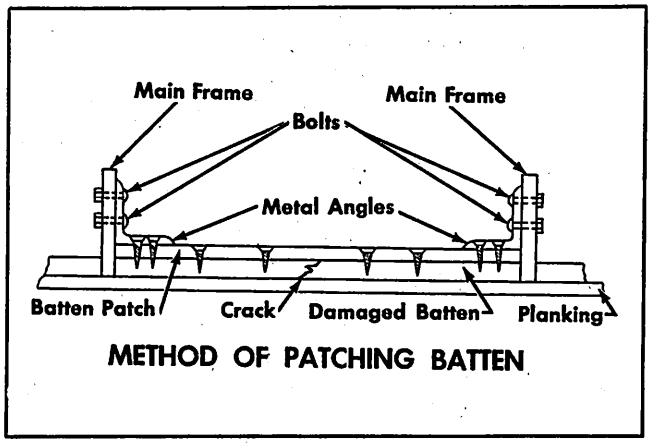


Figure 61—Batten Repair

(3) The rub strake and chine cap are designed to prevent damage to more vital parts of the boat when it comes in contact with the dock or floating objects and as such they must be replaced fairly often. Remove the damaged pieces in entire sections as they were built on the boat. Plug the old screw holes, and install new sections. When a new chine cap is shaped and installed, do not let it overlap or come flush with the bottom of the chine; the bottom of the chine should extend at least 1/8 inch below the bottom of the cap so the force of the water will not rip the cap off.

c. PROPELLERS.

(1) REMOVAL OF PROPELLER.

(a) Remove the propeller nut fairing.

(b) Remove the cotter pin from the propeller nut.

(c) Unscrew the propeller nut about 1/2 inch.

(d) Fasten a propeller puller to the propeller and tighten it until it puts a strain on the propeller, but not tight enough to damage the propeller.

(e) Strike the propeller hub sharply with a hammer to break it loose from the shaft.

(f) Remove the propeller nut, the propeller, and the propeller key.

(2) INSTALLATION OF PROPELLER.

(a) Make sure the shaft and the inside of the propeller hub are clean and free of dirt and grit.

(b) With the propeller key removed from the shaft, push the propeller over the tapered end of the shaft as far as it will go.

(c) Mark the position of the forward end of the propeller hub on the shaft and remove the propeller.

(d) Insert the key in the shaft and push the propeller back on the shaft, lining up the key with the keyway in the propeller hub.

(e) The propeller hub should come up to its previous position on the shaft. If it does not, the propeller is riding on the key which will unbalance it or shear off the key. Trim down the key enough to fit.

(f) Install the propeller nut, the cotter pin, and the propeller nut fairing.

d. SHAFTS.

(1) A bent shaft must be replaced. Each 85-foot rescue boat carries a spare shaft loaded on deck. This spare shaft should not be removed until the boat reaches its permanent installation.

(2) REMOVAL OF SHAFT.

(a) Remove the nuts and bolts fastening the shaft coupling flange to the angle drive flange.

(b) Slide the shaft out of the boat a few inches to provide access to the inboard end.

(c) Loosen the coupling nut locking plate, remove the coupling nut, tap the angle drive coupling from the shaft, and remove the coupling key.

(d) Remove the shaft from the boat.

(3) INSTALLATION OF SHAFT.

(a) Push the shaft up through the struts and shaft log to the angle drive. If it is difficult to push the shaft through the rubber strut bearings, lubricate them with water. Do not use oil or grease.

(b) Check the relationship of the key and the coupling as the propeller key was checked. (Refer to paragraph 6.*c.*(2), this section.)

(c) Install the coupling key, the coupling, and the coupling nut, and tighten the locking plate.

(d) Push the shaft further into the boat until the coupling is flush with the angle drive coupling and fasten the two together with the nuts and bolts.

e. INSTALLATION OF STRUT.

(1) Install the propeller shaft through the new or repaired strut and through the hull to the angle drive. Do not fasten the shaft to the angle drive yet. Support the strut so its weight is not on the shaft.

(2) Since the shaft is slightly flexible, it will sag slightly at the after end. Block up this end until the shaft is perfectly straight as tested with a dial indicator.

(3) Move the strut into position on the hull. Check the location of the shaft in the strut bearing. The bearing should have the same pinch all around. Adjust it, if necessary, by planing down or building up the section of the hull on which the strut is fastened.

(4) Bolt the strut in place.

(5) Fasten the shaft to the angle drive.

f. STRUT BEARINGS.

(1) Examine the condition of the one intermediate strut bearing and the two main strut bearings on each shaft as a regular part of overhaul.

(2) To make this inspection, block up the propeller end of the shaft until it is true. Check this with a dial

indicator. Examine the bearings. The rubber bearing liner should pinch the shaft slightly all around. If it does not, replace the bearing.

(3) To remove a bearing, first remove the shaft. Loosen the setscrews on either side of the strut (four for each bearing) and drive the bearing from the strut.

(4) Install a new bearing of the proper diameter and fasten it in place with the setscrews. Do not drive the setscrews in too far as they may cause high spots in the bearing, resulting in too rapid wear. Stake the screw heads. Reinstall the shaft.

Note

Make sure the shaft is free of oil or grease when it is passed through the bearings as oil will deteriorate the rubber bearing liner. If a lubricant is needed for easy installation, use only water.

g. METAL TANKS.

(1) TEMPORARY PATCH.

(a) Bend down jagged edges of the hole so that the outside surface of the tank will be smooth.

(b) Clean oil from the surface of the tank around the hole.

(c) Cut a cloth patch large enough to extend 4 inches away from the hole in all directions.

(d) Coat one side of the patch with No. 1 Permatex and center the patch over the hole in the tank, pressing it firmly into place.

(e) If possible, place a flat piece of wood over the patch and brace it in place.

(f) Let the Permatex harden before filling the tank above the break.

(2) PERMANENT PATCH.—As soon as convenient and the proper tools and materials are available, replace temporary patches with permanent ones as follows:

(a) Pound the edges of the hole flush with the metal of the tank or trim the edges of the hole.

(b) Cut a patch of sheet metal large enough to extend at least 1 inch beyond any part of the break.

(c) Drill matching holes around the edges of both the patch and the break.

(d) Tap the drilled holes to fit the threads of available screws.

(e) Cut a gasket to fit under the patch, and coat both sides with shellac or No. 1 Permatex. Be sure to cut screw holes in the gasket.

(f) Install the gasket and patch over the break, and fasten securely with screws.

h. PLUMBING.

(1) When replacing any unit of plumbing, duplicate the original fittings as closely as possible. Make sure the pipe lines are securely bracketed. Make sure the bonding system is not broken.

(2) Temporary repairs of pipes can be made with rubber hose of the proper diameter to fit around the pipe. Cut out the broken or leaking section of pipe. Drain the pipe and dry the ends. Connect the two open ends with a section of hose, allowing a liberal overlap on the pipe. Fasten the hose with hose clamps. Install bonding clamps and cable to bridge the hose and keep the bonding system intact.

(3) For permanent repairs, replace the entire section of pipe at the nearest connections.

(4) Coat the threads of mating units of plumbing with litharge and glycerine, white lead, red lead, or Permatex.

(5) Paint new units of pipe, valves, or fittings to match the color of the rest of the system.

(6) Through-hull and through-bulkhead fittings should be watertight. If a fitting is replaced, insert cotton wick and white lead caulking around the fitting between it and the bulkhead. Paint the bulkhead where the flange will fit with white lead and screw the flange securely to the bulkhead.

(7) VALVES.

(a) Valves should maintain their open or closed positions. If a valve slips open when left closed, or works closed when left open, the stem is worn and the valve should be replaced.

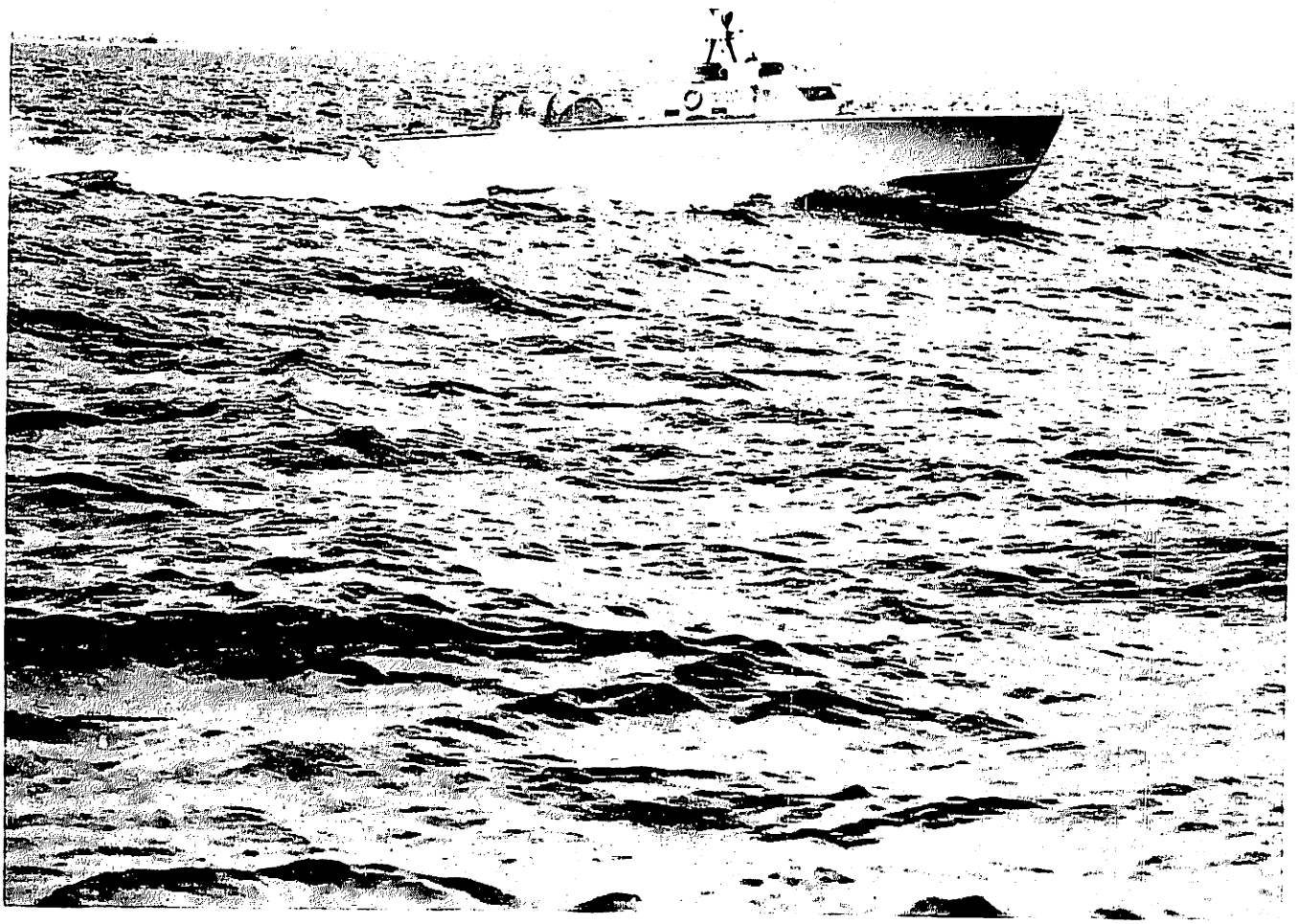
(b) If fluid flows through a line when the valve controlling that line is closed, the valve is leaking. Some valves can have the valve seat reground or the washer replaced to stop the leak.

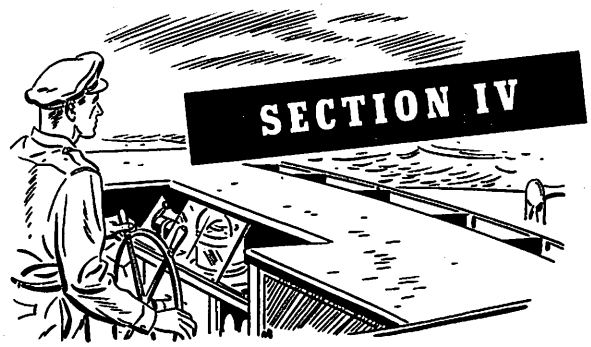
(c) Leaks around valve stems can be fixed by tightening the gland nut. If this does not stop the leak, unscrew the gland nut and insert more packing around the valve stem. Ordinary cotton twine is suitable for packing in most cases.

Note

If it is necessary to repack a gate valve gland while the system is being used, open the valve fully and then the gland nut can be removed without leakage.

(d) If a check valve does not stop the back flow of fluid in a line, remove the plug in the top of the valve and clean out the valve chamber. If the valve flap does not fit closely against its seat, replace the valve. When installing a new check valve, be sure it permits free flow in the proper direction. The arrow cast on the side of the valve indicates the direction of free flow.





Steering Gear

1. DESCRIPTION.

(See figure 62.)

a. MAIN STEERING GEAR ASSEMBLY.

(1) The steering gear assembly is arranged for the simultaneous actuation of port and starboard rudders by either the steering wheel on the bridge or in the pilot house. The two steering wheels are permanently chain-connected to a tubular jack shaft located on the starboard side of the radio room. Thirty-tooth sprockets on the wheel shafts and 15-tooth sprockets on the jack shaft effect a torque reduction of two to one and thus reduce the stresses in the torque tube assembly while maintaining a practical number of hardover to hardover turns on the steering wheel.

(2) The jack shaft is connected by chain over a pair of 30-tooth sprockets to the torque tube located on the starboard side of the boat.

(3) The torque tube assembly is supported by ball bearings of the flanged cartridge type at bulkheads Nos. 29, 42, and 60, and at frames Nos. 74 and 75, and by a ball-bearing pillow block at frame No. 51. The pillow block carries a splined expansion joint assembly which compensates for fore and aft displacement of the end bearings when the boat is working in a seaway. The intermediate bearings provide free longitudinal movement of the torque tube. Further flexibility is provided by universal joints near frames Nos. 30, 41, 61, and 73.

b. REDUCTION GEAR ASSEMBLY.

(See figure 62A.)

(1) The reduction gear, located on the starboard rudder support shelf, is of the automobile steering gear type. It has an hourglass worm which engages a convex roller supported on a yoke. The worm shaft is supported at each end by a thrust and radial bearing of the tapered roller type. Wear takeup is provided at the forward bearing by means of a shim-seated retaining plate. The yoke shaft rotates in a needle bearing at the upper end and in an oil-sealing sleeve-bearing in the housing tube at the lower end. A 30-tooth sprocket on the reduction gear is chain-connected to a 15-tooth sprocket on the torque tube, aft of frame No. 74. The gear reduces rotational motion in the ratio of 24.4 to 1 and increases torque in a corresponding ratio.

(2) The take-off arm on the reduction gear and the two rudder tiller arms are connected by tubular tie-rods with clevis ends. The tie-rod from the reduction gear to the starboard tiller arm is attached to the serrated end of the yoke shaft. The position of the reduction gear take-off arm is adjustable in steps through a complete circle. Normally, this adjustment is made only at the time of installation, the take-off arm being positioned so that it is in a fore and aft line when the roller is in midposition on the worm.

c. RUDDER ASSEMBLY. *(Figure 62B.)*—The rudders are carried by the upper bearings, located on the rudder support shelves. The lower bearings for the rudders are combined with stuffing boxes, packed with 1/4-inch square flax packing. The rudders are set at the building yards for proper fore and aft alignment.

d. EMERGENCY TILLER.—The emergency tiller consists of a tiller arm, emergency tiller shaft, and an adapter. The adapter is provided to connect the emergency tiller shaft to the square end of the starboard rudder shaft.

2. OPERATION.

a. NORMAL.—Seven full turns of the wheel are required to turn the rudders from hardover to hardover. To locate the rudders amidships, turn the wheel hardover and then make three and one-half turns in the opposite direction.

b. EMERGENCY.—If the bridge steering wheel fails to actuate the rudders, the wheel in the pilot house may still function. If neither wheel operates, use the emergency tiller, as follows:

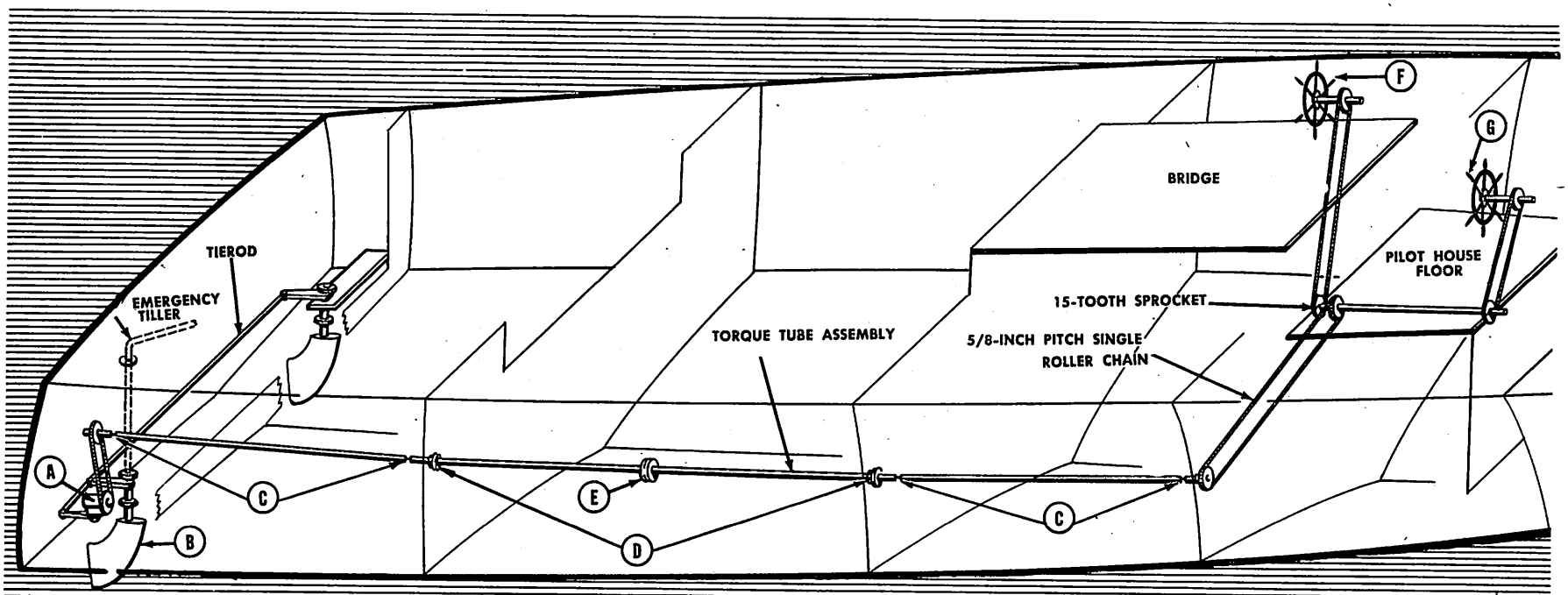
(1) Disconnect the tie rod which joins the reduction gear take-off arm to the starboard tiller arm.

(2) Remove the deck plate on the starboard quarter.

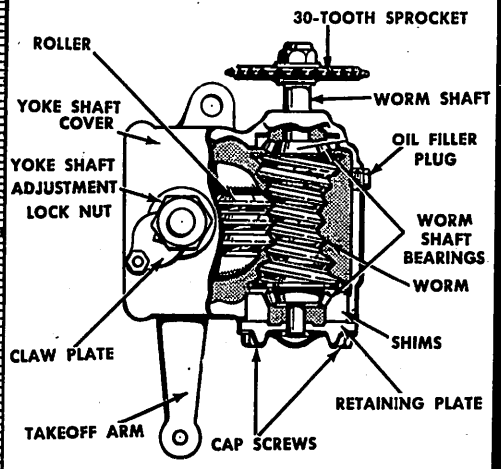
(3) Insert the emergency tiller shaft and connect it to the starboard rudder shaft with adapter sleeve.

(4) Connect the emergency tiller arm (above deck) to the tiller shaft.

Figure 62 — STEERING GEAR

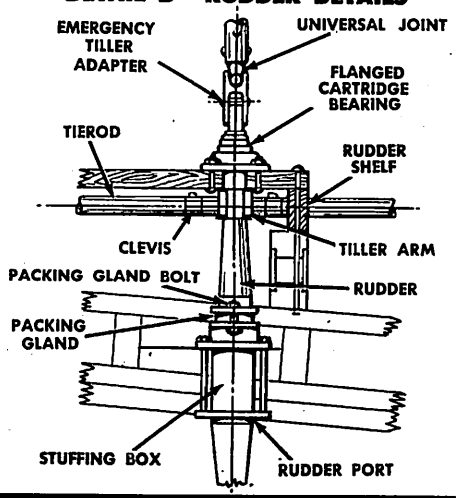


DETAIL A — REDUCTION GEAR



- A Reduction Gear
- B Rudder Details
- C Universal Joint
- D Flange Bearing Cartridge
- E Ball Bearing Pillow Block and Splined Connecting Sleeve
- F Steering Assembly in Pilot House
- G Steering Assembly on Bridge

DETAIL B — RUDDER DETAILS



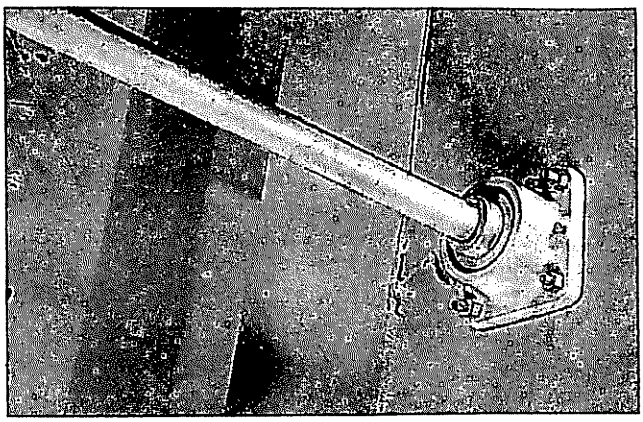


Figure 62C—Flange Cartridge Bearing

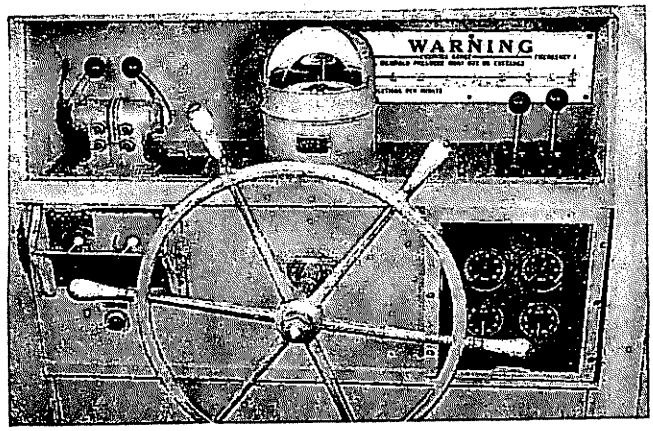


Figure 62E—Steering Assembly in Pilot House

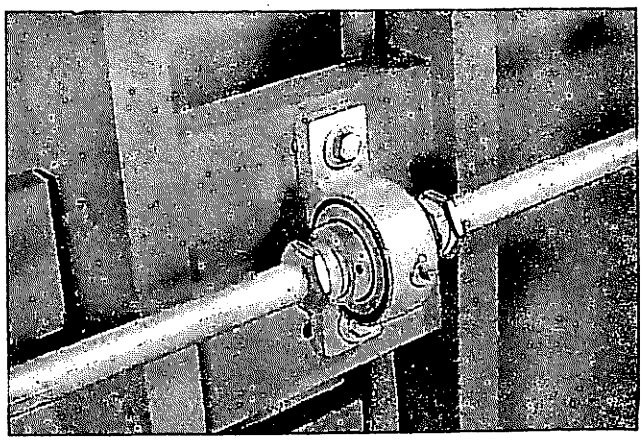


Figure 62D—Ball Bearing Pillow Block and Splined Connecting Sleeve

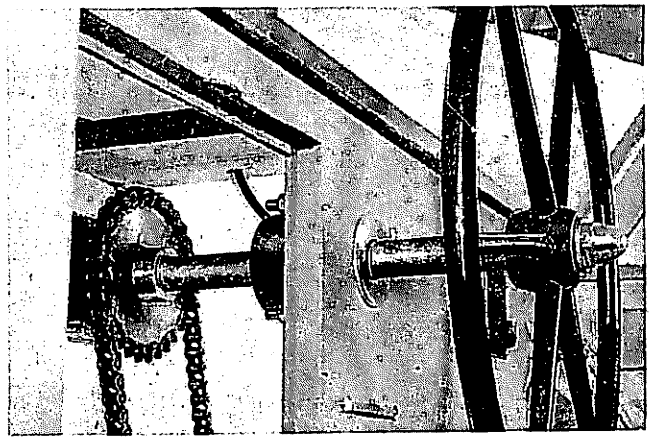


Figure 62F—Steering Assembly on Bridge

3. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
WHEELS TURN BUT DO NOT ACTUATE RUDDERS	Key lost from sprocket wheel assembly.	Replace key or install a bolt through the shaft. (See paragraph 4.*b*.)
	Sprocket chain broken.	Replace.
	Failure of expansion joint assembly.	Repair or replace.
STIFFNESS OF CONTROLS	Faulty lubrication in cartridge bearing.	Lubricate.
	Reduction gear worm shaft bearings adjusted too tightly.	Readjust. (See paragraph 5.*b*.)
	Reduction gear yoke shaft adjusted too tightly.	Readjust. (See paragraph 5.*d*.)
	Rudder stuffing box packed too tightly.	Loosen or repack. (See paragraph 5.*e*.)
EXCESSIVE VIBRATION	Rudders improperly aligned.	Readjust.

4. SERVICE, INSPECTION, MAINTENANCE, AND LUBRICATION.

a. GENERAL.—Maintenance of the steering gear is of utmost importance. The entire assembly should be inspected periodically to check for wear, misalignment, and binding or looseness in the component parts. The marked midship positions of the steering wheels should coincide with each other and with the midship position of both rudders. With the rudders in this position, the reduction gear should provide equal travel to port and starboard.

b. SPROCKET WHEELS.—In normal service the set screws which hold the sprocket wheel keys in place can easily become loosened by vibration, permitting the keys to fall out. This can be prevented by one of the following methods:

(1) Use a longer setscrew with a locking nut.

(2) Replace the original setscrew with a square-head screw, the head of which has been drilled to permit safety-wiring.

(3) Drill a 1/4-inch hole through the shaft and both sides of the sprocket wheel. Insert a bolt through the sprocket wheel and shaft, tighten the nut, and peen the bolt end to prevent the nut from working loose.

c. BEARINGS.—All cartridge-type ball bearings, pillow-block bearings, splined connecting sleeve and rudder bearings are equipped with "Alemite" type fittings. These should be greased with a light grease every 100 hours of operation.

d. REDUCTION GEAR.—If the reduction gear is kept properly lubricated, it is unlikely that any repair or adjustment will become necessary. To lubricate, proceed as follows:

(1) Remove oil filler plug and vent hole cover.

(2) Fill with SAE 50 lubricating oil until oil comes out of the oil vent. (In cold weather SAE 30 oil can be used.)

(3) Replace oil filler plug and vent hole cover to prevent dirt from entering housing.

CAUTION

Do not use graphite or heavy solidified oil in the reduction gear.

e. TIE ROD ASSEMBLY.—The adjustment of the tie rod connecting the two tillers is not to be changed unless the assembly should in some way become damaged. When making adjustments, make sure enough thread remains engaged in the clevises to allow fastening them by means of the setscrews.

f. HANGER AND LOCK NUT.—Proper adjustment of the hanger nut and tightening of the lock nut are required so that adequate clearance for the tiller arm is provided below the support shelf when the tie rods are in horizontal alignment.

g. STUFFING BOX.—Adjustment of the packing glands is accomplished by tightening up the bolts located forward and aft of the rudder stocks. Moderate wrench pressure should be sufficient to obtain proper water tightness in the packing. If considerable wrench pressure is required, need for renewal of the packing is indicated. In no case should packing be compressed to the point where the rudder cannot be rotated freely by hand, by means of the tiller arm disconnected from the tie rods.

5. MAJOR REPAIRS.

a. PROCEDURE FOR CHECKING REDUCTION GEAR.—If the steering gear assembly should develop excessive looseness or tightness, and the causes are not traceable to faults in the other parts of the assembly, check action of the reduction gear as follows:

(1) Disconnect the tie rod from the take-off arm.

Note

If it becomes necessary to remove the take-off arm, use puller only. Do not pry, wedge or drive.

(2) Rotate the steering wheel right or left about two turns from midships position.

(3) Fasten chain which connects the end of torque tube to the worm shaft in such a way that worm shaft cannot rotate.

(4) Rock take-off arm back and forth as hard as possible while lightly holding finger on worm shaft and against the gear housing. If, under these conditions, longitudinal motion is felt in the shaft, end play is indicated and the worm shaft bearings require adjustment.

b. PROCEDURE FOR ADJUSTING WORM SHAFT BEARINGS.—The worm shaft is held in place by a retaining plate fastened by four cap screws. Proceed as follows:

(1) Loosen the cap screws about 1/8-inch.

(2) With a knife loosen the outermost shim, being careful to pass the blade all the way around between surfaces so as not to injure the remaining shims.

(3) Remove loosened shim, and replace the retaining plate. Reinspect for end play as described in paragraph 5.*a.* and, if necessary, remove another shim and replace the plate. *Take care not to set up stiffness in the worm shaft by removing too many shims. With the chain disconnected, it should be possible to rotate the sprocket easily by hand.*

c. PROCEDURE FOR CHECKING ADJUSTMENT OF ROLLER IN RELATION TO WORM.—After having made worm shaft bearing adjustment, the reduction gear should be checked for proper mesh between worm and roller. Proceed as follows:

(1) Move wheel to midships position.

(2) Fasten chain and rock take-off arm to determine the amount of play, if any. If play exceeds 1/32-inch at the end of the take-off arm, the yoke shaft should be adjusted.

d. PROCEDURE FOR ADJUSTING YOKE SHAFT.

(1) Remove the claw plate on the nut at the top end of the yoke shaft.

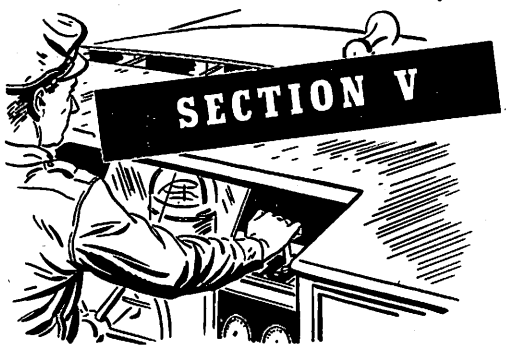
(2) Remove nut and slip off U-shaped thrust washer and one shim. Note that two thicknesses of shims are provided.

(3) Remove shims as necessary to take up wear. Do not remove so many shims that it appreciably increases the effort required to rotate the worm shaft. It is better to leave a slight amount of play between roller and worm than to remove too many shims so that a tight set-up results.

(4) Replace the thrust washer, nut, and claw plate. The lock nut must be tightened securely to prevent rotation of shims and thrust washer. Four different locking positions are obtainable by turning the claw plate over. Select the position that will leave the lock nut tightened securely.

(5) Reconnect the tie rod.

e. REPLACEMENT OF PACKING IN STUFFING BOXES.—At the time of handling, the rudder stuffing boxes should be checked and repacked if necessary with 1/4-inch square flax packing. Insert each length of packing so that the ends will join on the opposite side from that of the previous piece.



Engine Controls

Note

As there are two engines for propelling the boat, all engine controls are arranged in pairs —one for each engine.

1. MIXTURE CONTROLS.

a. DESCRIPTION.—*(See figure 63.)*

(1) Located on the engine control pedestal is a pair of push-pull handles which operate, by remote control, levers which adjust the two engines' gasoline mixture. The handles are attached to a cable which slides back and forth through a flexible conduit when the handles are manipulated. A bronze ferrule, rigidly supported by a bronze housing and brackets, is attached to the aft end of the cable so that a positive push will be maintained beyond the end of the conduit. (See A, figure 63.)

(2) The ferrules of the mixture controls are connected to the mixture control arm of the carburetor on each engine. (See A, figure 63.)

b. OPERATION.—Two types of mixture control handles are shown in figures 63C and 64. They are attached to the same kind of cable, and are operated in the same way. The new type (figure 64) has a lock which must be released by depressing the button at the top before its position can be changed.

(1) "PUMP LOCK."—When the handle of the mixture control is pulled upward as far as it will go, it is in the "PUMP LOCK" position. This locks the mechanical accelerator pump on the carburetor. Both controls are pulled up to this position just before the engine is to be stopped.

(2) "RICH."—When the handle is pushed down as far as it will go, the mixture control is in the "RICH" position.

(3) "LEAN."—On the new type of control handle (figure 64) the "LEAN" position has been located when the groove in the rod engages with the spring-ball locating device. The older type is in the "LEAN" position when the handle is halfway between the "RICH" and "PUMP LOCK" positions.

c. TROUBLE SHOOTING.—See table below.

d. SERVICING.—As the mixture controls, like the spark and salt water controls, are direct remote-control devices for setting levers in the desired position, they should require little servicing and will need only simple repairs.

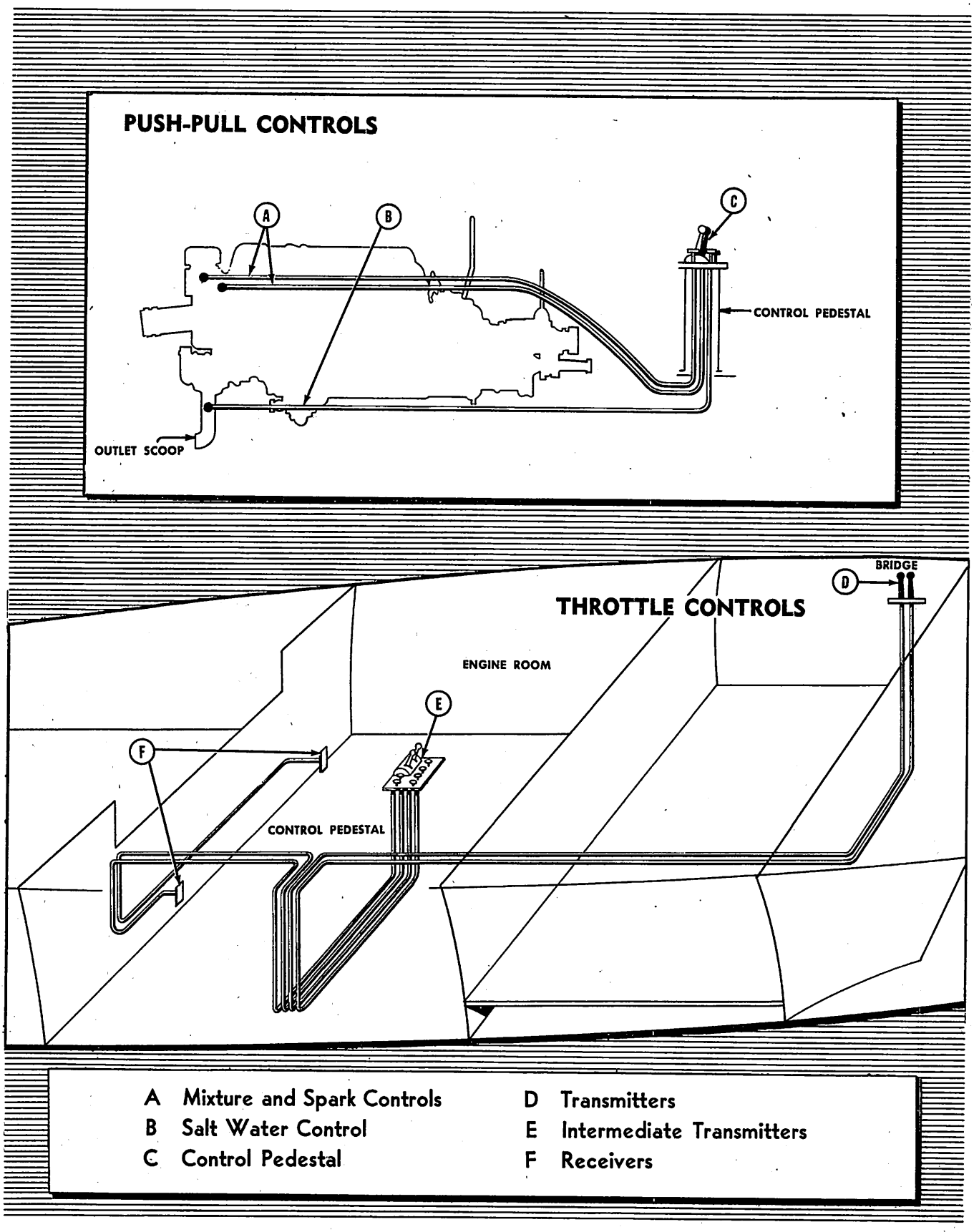
(1) If the twisted wire core of the push-pull cable breaks, the coiled spring will still allow the device to be pushed, but there will be no response when the handle is pulled. In that event, a new cable should be installed. For emergency in event no cable is available, the break can be located and soldered.

(2) If the cable conduit or ferrule housing is not securely fastened, allowing the cable to bend when the handle is pushed instead of moving the lever to which the aft end of the cable is attached, the handle will spring back upwards. To correct this condition, tighten the loosened brackets, or, if no brackets are loose, install additional brackets.

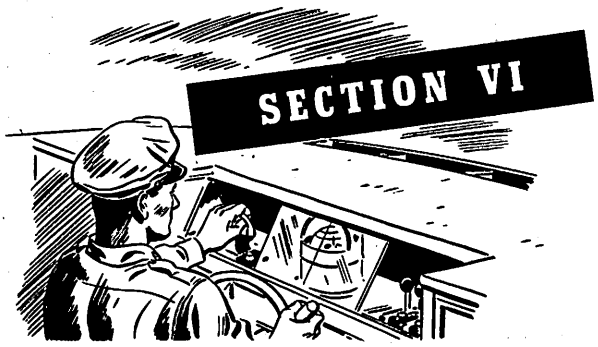
c. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
PULLING UP ON MIXTURE CONTROL HANDLE FAILS TO OPERATE ARM ON CARBURETOR	Broken cable core.	Solder wire. Refer to paragraph 1.*d.*(1), this section.
PUSHING DOWN ON MIXTURE CONTROL HANDLE FAILS TO OPERATE ARM ON CARBURETOR	Conduit or bronze housing loose in brackets.	Secure brackets. Refer to paragraph 1.*d.*(2), this section.

Figure 63 — ENGINE CONTROLS



A	Mixture and Spark Controls	D	Transmitters
B	Salt Water Control	E	Intermediate Transmitters
C	Control Pedestal	F	Receivers



Clutch Control SYSTEM

1. DESCRIPTION.

(See figure 70.)

The electric-hydraulic clutch control system consists of the following equipment:

a. A control pedestal, located on the bridge, containing two triple-throw rotary switches and four indicator lights to show clutch operation. (Some boats are equipped with two control pedestals, one on the bridge and one in the pilot house.)

b. A group of indicator lights on the engine instrument panel to show clutch operation.

c. A limit switch box for each engine, containing four cams on a shaft which is linked by a lever and tie rod to the clutch lever.

d. A solenoid-operated four-way valve for each engine. These valves direct the flow of oil to the actuating cylinders.

e. A master switch on the engine control pedestal, which supplies 12-volt current to the solenoids.

f. A spur-geared high-pressure oil pump for each engine, direct driven from the engine camshaft.

g. A pressure-type strainer on the delivery side of each pump. (On some boats, a suction-type strainer is located on the supply side of the pump.)

h. A ball check type relief valve for each engine, set to open at a pressure approximately 20 percent greater than that required for clutch operation.

i. A double-acting hydraulic actuating cylinder for each engine to operate the clutch levers.

2. PRINCIPLES OF OPERATION.

a. While the main engines are running, the gear pump delivers oil under pressure to the relief valve. While the clutch controls are not in use the relief valve returns the oil to the reservoir. While the clutch is in use oil is delivered through the relief valve to a four-way valve which has three positions.

b. In the extreme left and right positions of the valve stem, the valve is open and oil flows into one or the other end of the actuating cylinder. In the center position the four-way valve is closed, and oil returns to the reservoir.

c. The valve stem is actuated by a transfer lever connected to a pair of solenoids. One solenoid controls forward action of the clutch lever and the other controls reverse action.

d. Each of the solenoids is connected to a 12-volt dc source through switches in the control pedestal. When a control handle is moved from neutral to *forward,* for example, the solenoid which causes *forward* movement is energized, the valve stem is pulled to one of its extreme positions, oil flows into one end of the actuating cylinder and causes the clutch lever to move toward its *forward* position. This movement continues until the solenoid circuit is broken.

e. It is the function of the limit switch box to break the circuit at the point where the clutch lever has moved to the desired position. The limit switch box contains four switches operated by cams on a shaft linked to the clutch lever itself. Two switches control forward movement and two control reverse movement. The setting of the cams determines the positions to which the clutch lever will move before the limit switches open.

3. OPERATION INSTRUCTIONS.

a. NORMAL OPERATION.—In normal operation, movement of the levers on the control pedestal is all that is necessary for proper clutch control. While the solenoid which controls *forward* movement of the clutch lever is energized, the *green* light (on both the control pedestal and on the engine instrument panel) will light and remain on. While the solenoid which controls *reverse* movement of the clutch lever is energized, the *red* lights will remain on. Four seconds is the normal time required to complete one operation.

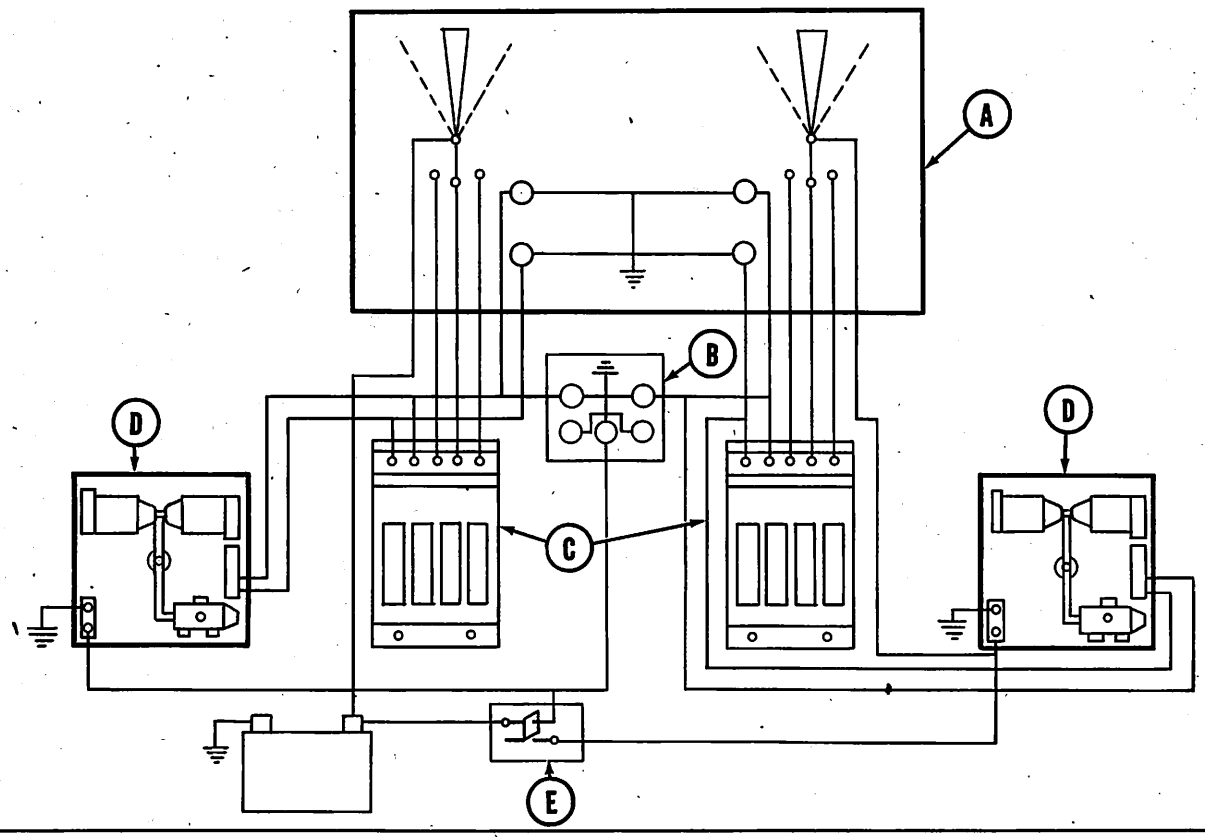
The handles on the control pedestal have three definite positions: neutral, forward, and reverse. Intermediate positions will *not* cause the solenoids to operate. The operator should observe the length of time the indicator lights stay on. Failure of an indicator light to go out within a few seconds shows that one of the solenoids has remained on.

Note

The solenoids are not designed for continuous operation, and will be burned out in less than 10 minutes if the control circuit is not opened. This can be done either by moving the control lever to a new position, or opening the master switch on the engine control pedestal. Before resuming normal operation, stop the main engines and make any necessary adjustments of the cams in the limit switch box.

Figure 70 — CLUTCH CONTROL SYSTEM

ELECTRICAL SYSTEM



HYDRAULIC SYSTEM

A Control Pedestal on Bridge

B Indicator Lights on Engine Instrument Panel

C Limit Switch Boxes

D Four-Way Valve Assemblies

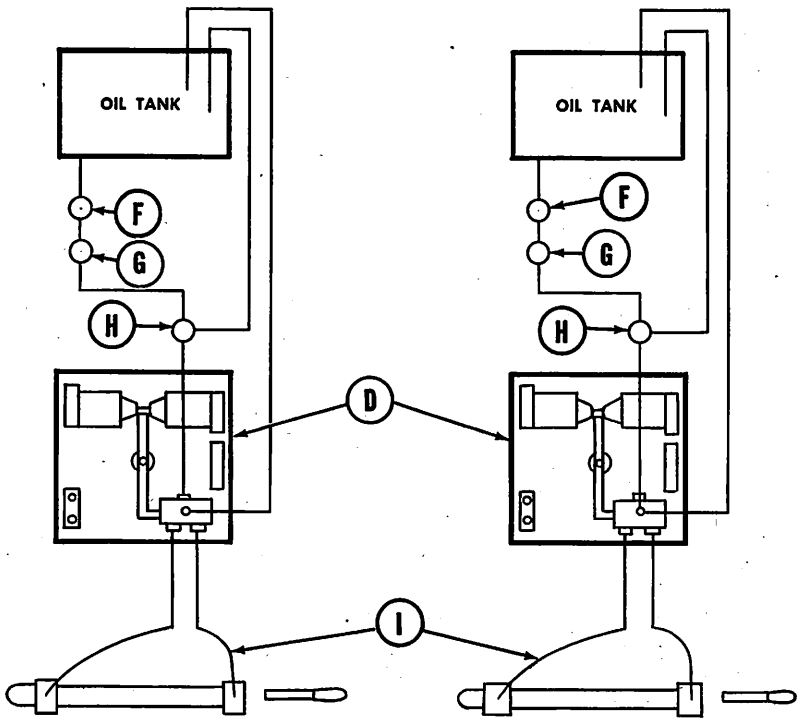
E Main Switch

F Pressure Pumps

G Strainers

H Relief Valves

I Actuating Cylinders



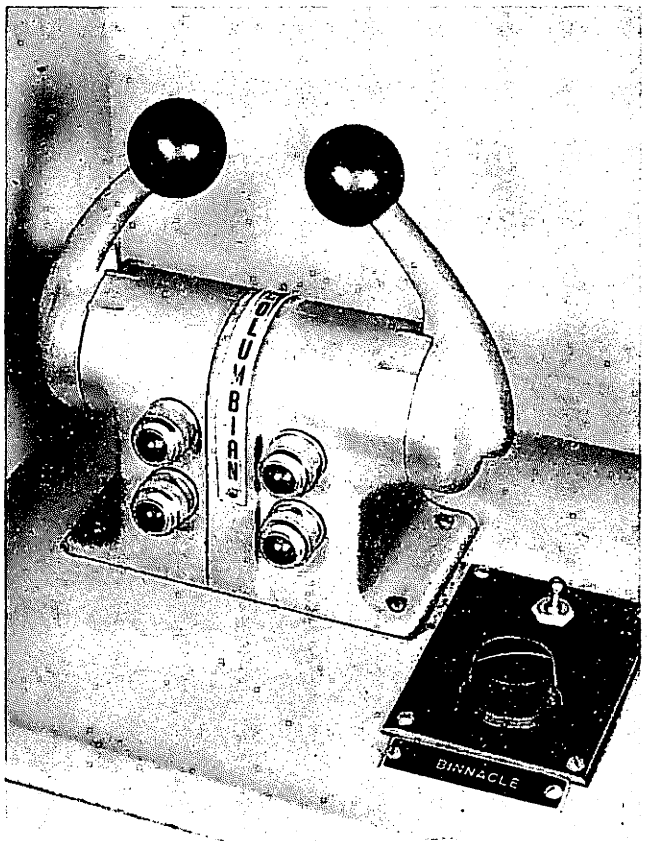


Figure 70A—Clutch Control Pedestal

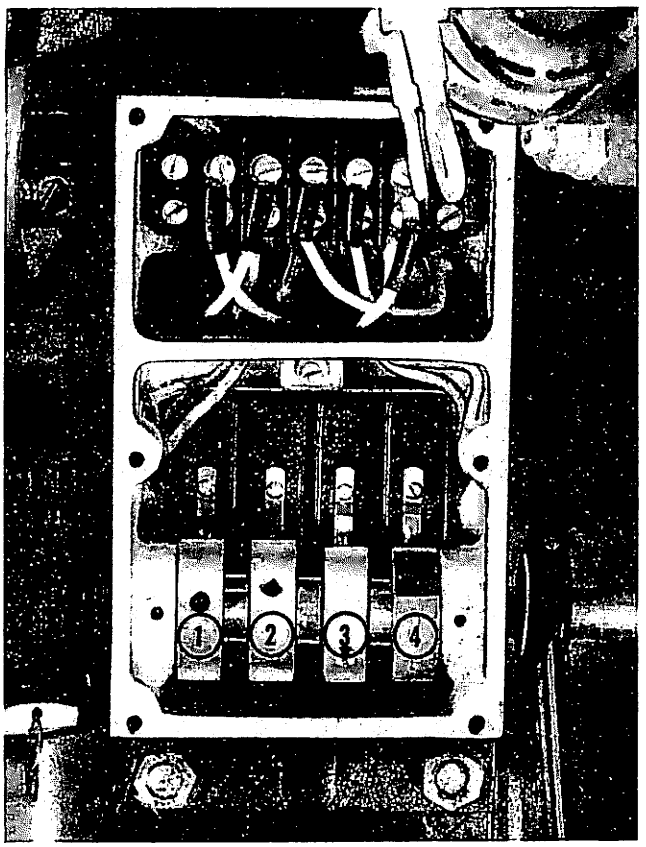


Figure 70C—Limit Switch Box

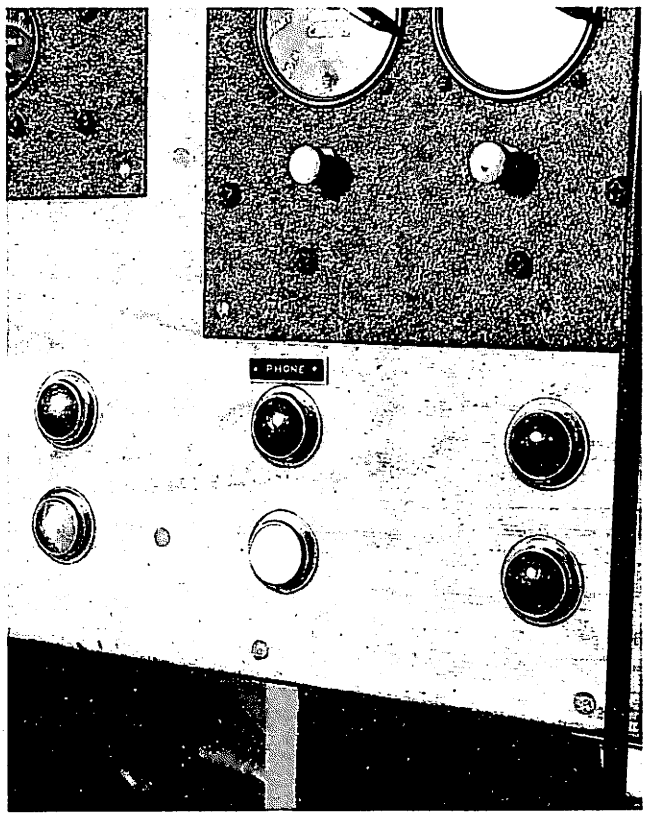


Figure 70B—Clutch Control Indicator Lights on Engine Instrument Panel

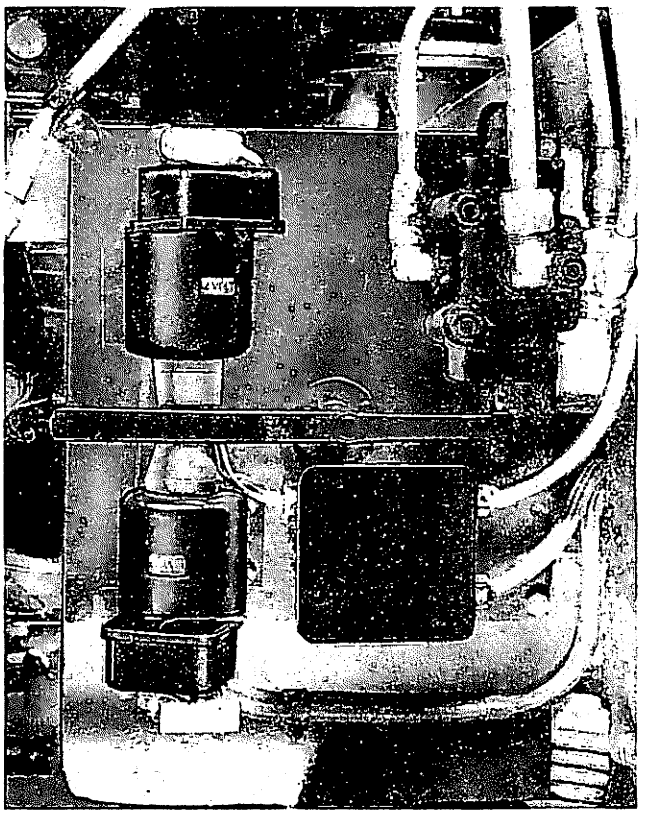


Figure 70D—Four-Way Valve Assembly

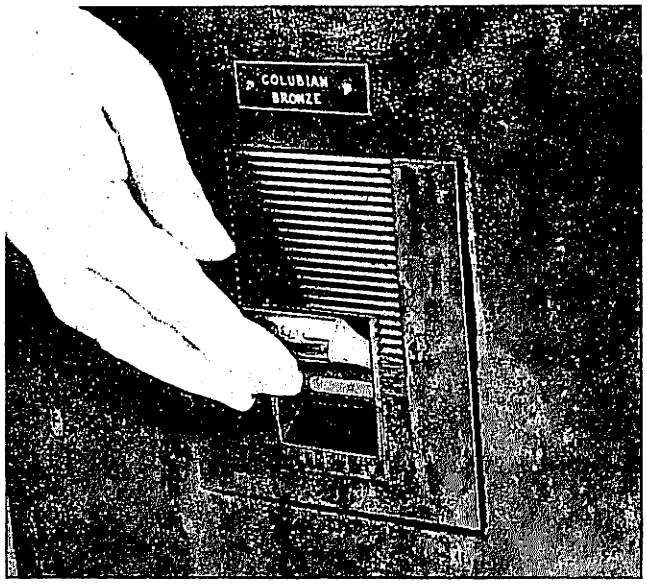


Figure 70E—Clutch Control Master Switch

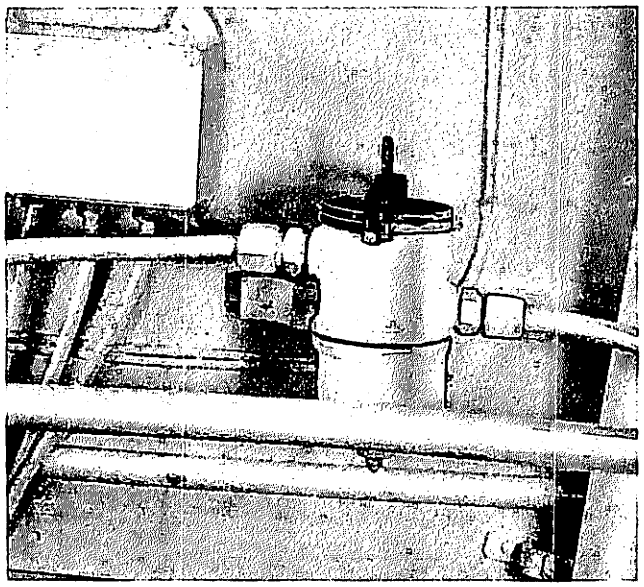


Figure 70G—Clutch System Oil Strainer

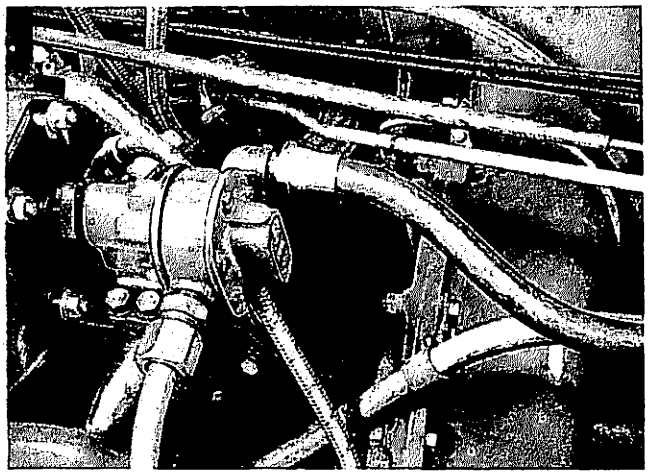


Figure 70F—Clutch System Oil Pump

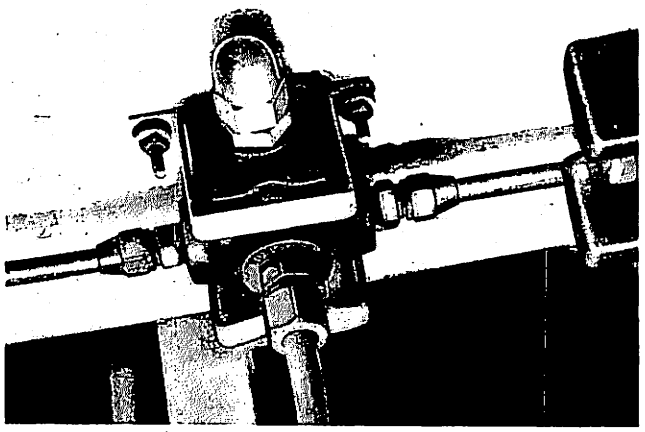


Figure 70H—Clutch System Relief Valve

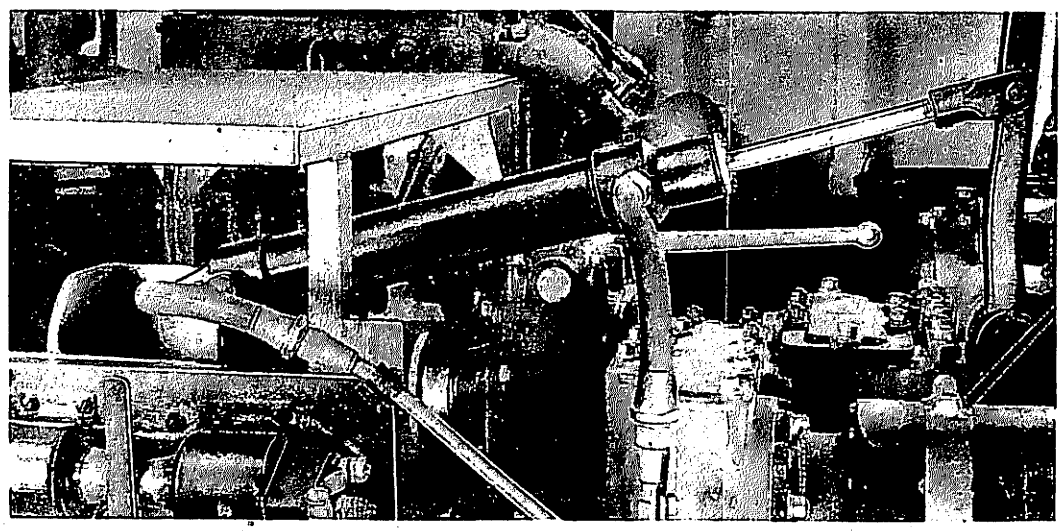


Figure 70I—Clutch Lever Actuating Cylinder

b. EMERGENCY OPERATION.—If any electrical component of the clutch control system fails but the hydraulic part of the system is still functioning, the engineer can (with instructions or signals from the bridge) manually move the transfer lever on the four-way valve assembly (figure 70D) and thus, with little effort, cause the clutch lever to move to the desired positions. For this operation, the master switch on the engine control pedestal should be turned off.

Note

It is recommended that the four-way valve plate be marked or painted to show which movements of the transfer lever will cause forward and reverse action of the clutch lever.

If any part of the hydraulic system fails, it is necessary to move the clutch lever by hand.

c. FOR BOATS EQUIPPED WITH TWO CONTROL PEDESTALS.—Some boats are equipped with clutch control pedestal in the bridge and in the pilot house. A selector switch is provided to connect one or the other pedestal to the system. On such installations, do not turn the selector switch before making sure that the control handles on each control pedestal are in similar positions.

4. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
CONTROL FAILS TO OPERATE ELECTRICALLY	Handles loose on shaft at control pedestal.	Adjust and tighten.
	Handles not properly adjusted on shaft at control pedestal.	Readjust.
	Defective rotary switch.	Replace.
	Defective solenoid.	Replace.
	Low batteries.	Recharge.
	Inaccurate adjustment of cams in limit switch box.	Readjust cams.
	Loose or broken connections at master switch, in control pedestal, on four-way valve assembly, in limit switch box, or in terminal block.	Repair.
	Failure or improper operation of transfer lever.	Check and repair.
SLUGGISH OPERATION, "SNAP-ACTION" OF CONTROLS, OR FAILURE OF HYDRAULIC PART OF SYSTEM	Pump not operating.	Repair or replace.
	Pump air-bound.	Put oil in pump inlet.
	Air trapped in actuating cylinder.	Loosen 1/8-inch pipe plug and let air escape (while pump is operating).
	Incorrect setting of relief valve.	Check setting; adjust to open at 300 psi.
	Dirty strainer.	Clean.
	Block or leak in suction line, or pressure line.	Locate and repair.
	Four-way valve fails to operate.	Repair.
OSCILLATION AROUND NEUTRAL, FORWARD, OR REVERSE, OR FAILURE TO REACH FORWARD OR REVERSE	Cams in limit switch box out of adjustment.	Readjust.

5. SERVICE, INSPECTION, AND MAINTENANCE.

a. CONTROL PEDESTAL.—If the indicator lights on the control pedestal do not light during clutch operation, or if they remain on continuously, it is possible that the control handles are loose on the shaft, or are not adjusted properly in relation to the rotary switch shaft. To readjust a handle proceed as follows:

(1) Loosen the Allen setscrew and take off the handle.

(2) Turn the rotary switch shaft by hand to determine its neutral position (intermediate position between forward and reverse positions).

(3) Locate the shaft in this position, then replace the handle in the exact neutral position, and tighten the setscrew.

(4) Move the handle to the forward and reverse positions to check the adjustment.

b. LIMIT SWITCH BOX.—Normally the limit switch box requires no attention unless improper operation of the system reveals that one or more of the cams are out of adjustment. Procedures for adjusting cams are given in paragraph 6 of this section. It is important that the tie rod which connects the limit switch box lever to the clutch lever be free of any play. Personnel in the engine room should never step on the limit switch box, in order to avoid bending or damaging the tie rod.

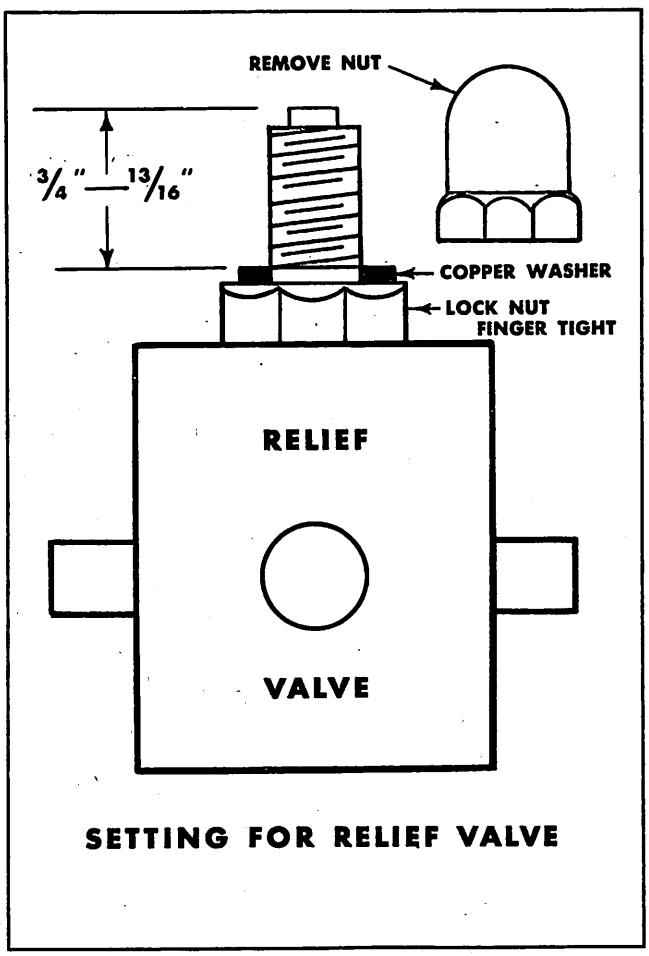


Figure 71—Adjustment of Relief Valve

c. RELIEF VALVE.—Slow operation of the clutch indicates that there is inadequate oil pressure at the actuating cylinder. If this is not caused by restrictions in the lines, dirty filter, or failure of the pump, the relief valve may require adjustment to raise the pressure at which oil is bypassed. To readjust the relief valve, remove the nut, loosen the lock nut on the adjusting screw, and turn the adjusting screw clockwise. When the valve is set properly, about 3/4 to 13/16 inch of thread is left exposed, and oil will be bypassed at about 300 psi. (See figure 71.)

6. CAM ADJUSTMENT.

Note

Personnel not familiar with cam adjustments should not attempt to change them.

a. GENERAL. — The arrangement of the limit switches in relation to the cams is not the same on all boats. The following text applies to boats in which the standard arrangement recommended by the manufacturer is used. As you look at the cam box with the terminal strip away from you, the cams function as follows (figure 70C):

(1) The left-hand cam (1) controls motion from neutral to reverse.

(2) The second cam from the left (2) controls motion from forward to neutral.

(3) The third cam from the left (3) controls motion from reverse to neutral.

(4) The right-hand cam (4) controls motion from neutral to forward.

It will be noted that clutch return to neutral from forward or reverse position depends on the two center cams; proper action from neutral to reverse depends on the left-hand cam, and proper action from neutral to forward depends on the right-hand cam.

b. HOW TO ADJUST CAM CONTROLLING ACTION FROM NEUTRAL TO FORWARD.

(1) Stop the engines, turn the master switch off, and remove limit switch box cover.

(2) Loosen setscrew in the cam which controls action from neutral to forward position.

(3) Move clutch lever into full forward position, determine the amount of play of the lever in this position, then hold lever at midpoint of this play.

(4) Adjust the cam so that its switch has just opened, and so that further movement of the clutch lever will result in the switch remaining open.

(5) Secure the cam on the shaft very tightly.

(6) Start engine.

(7) Turn on master switch.

(8) Move handle on control pedestal from neutral to forward and observe clutch action in engine room.

Green indicator light should be on while clutch lever is in motion, and go off when the lever has reached the forward position. The action should not take more than 4 seconds.

c. HOW TO ADJUST CAM CONTROLLING ACTION FROM NEUTRAL TO REVERSE.—Procedure is the same as that for adjusting cam controlling forward action except that clutch lever should be moved to reverse.

d. HOW TO ADJUST CAM CONTROLLING ACTION FROM FORWARD TO NEUTRAL. *(See figure 72.)*

(1) Stop the engines, turn the master switch off, and remove limit switch box cover.

(2) Loosen setscrew in cam controlling action from forward to neutral.

(3) Move clutch lever to its definite neutral position, then move it forward to position 1 shown in figure 72.

(4) Adjust the cam so that its switch has just opened and that any movement of the clutch lever toward neutral will result in the switch remaining open.

(5) Secure the cam on the shaft very tightly.

(6) Locate the clutch lever in its definite neutral.

(7) Locate the handles on the control pedestal in neutral.

(8) Turn on the master switch.

(9) Move the clutch lever forward until the red indicator light goes on, then move it back toward neutral, and note the position of the lever when the red light goes out. It should go out at position 1 shown in figure 72.

e. HOW TO ADJUST CAM CONTROLLING ACTION FROM REVERSE TO NEUTRAL. *(See figure 72.)*—Procedure is the same as that for adjusting cam controlling action from forward to neutral except that the clutch lever should be moved toward reverse.

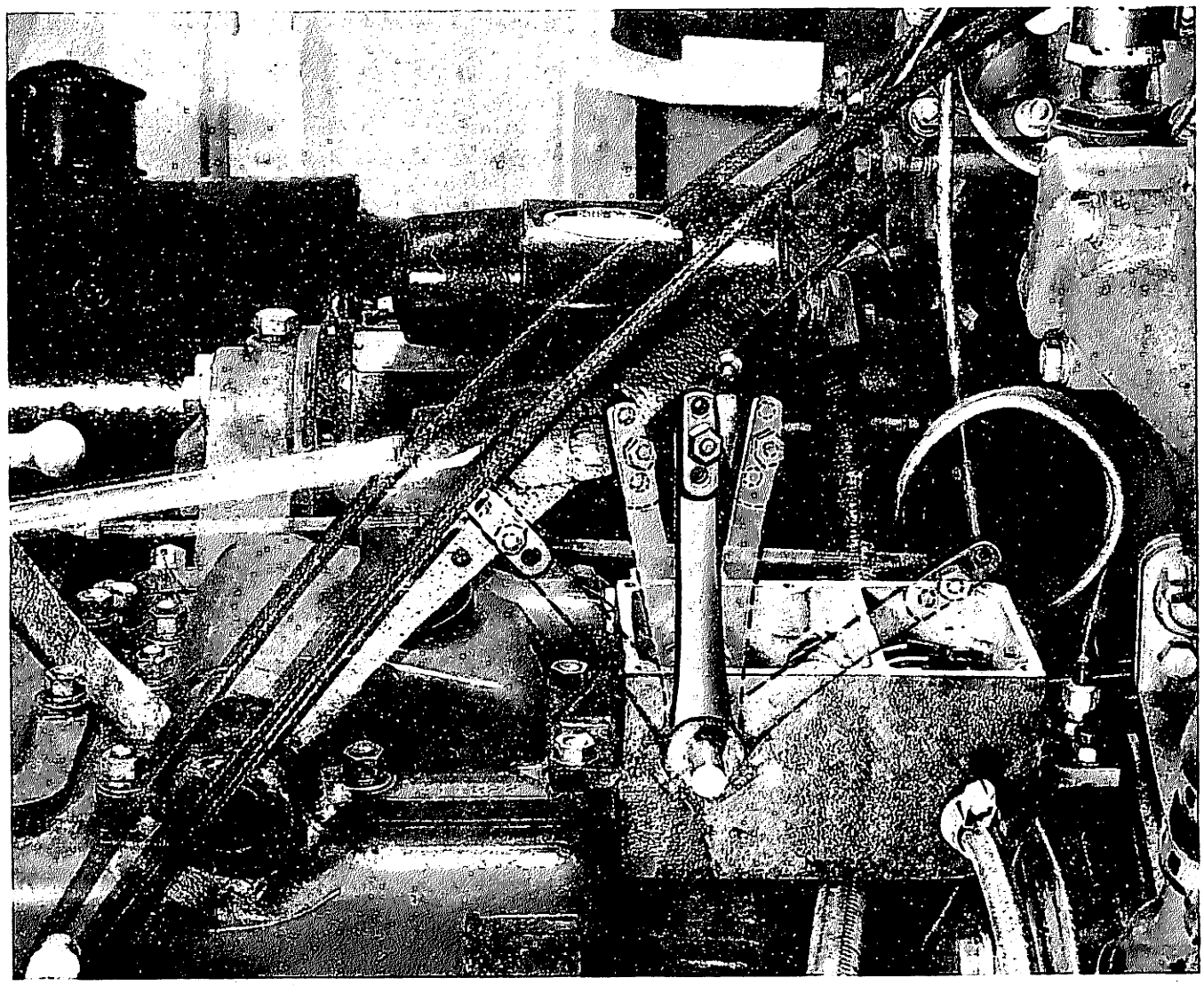


Figure 72—Positions of Clutch Lever at Various Cam Adjustments

f. HOW TO ADJUST ALL CAMS AT TIME OF NEW INSTALLATION.

(1) Remove limit switch box cover.

(2) Loosen setscrews and rotate all cams so that switches are in released ("OFF") position.

(3) Put handles on control pedestal in neutral and turn the master switch on.

(4) Depress the spring leaf on one of the center switches and note which solenoid operates. Determine whether this solenoid controls forward or reverse movement of the clutch lever. To do this, note which end of the actuating cylinder oil is directed into when the solenoid is energized. If the valve stem is moved into the valve, the flow is into the actuating cylinder from the stem end of the valve. If the valve stem is moved out of the valve, the flow is from the valve outlet opposite the stem end.

(5) Turn the master switch off.

(6) If the switch tested in paragraph 6.*f.*(4) controls action from reverse to neutral, the remaining *center* switch will control action from forward to neutral.

(7) Move the clutch lever forward to position 1 shown in figure 72.

(8) Adjust the center cam which controls action from forward to neutral so that its switch has just opened, and that further movement of the clutch lever toward neutral will result in the switch *remaining* open.

(9) Move the clutch lever to position 2 shown in figure 72.

(10) Adjust the center cam controlling action from reverse to neutral, so that its switch has just opened, and so that further motion of the clutch lever toward neutral will result in the switch *remaining* open.

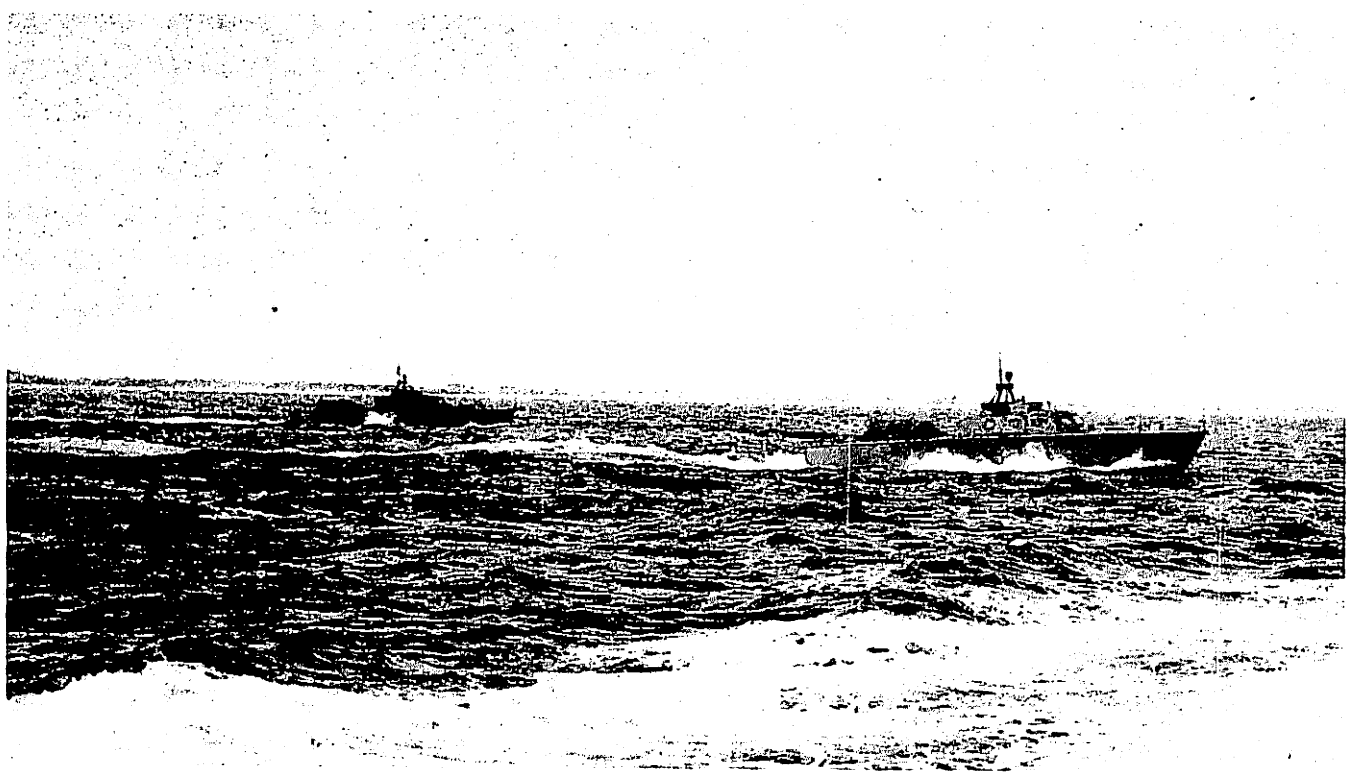
(11) Set the clutch lever in forward, locating it in the center of the slack, if any.

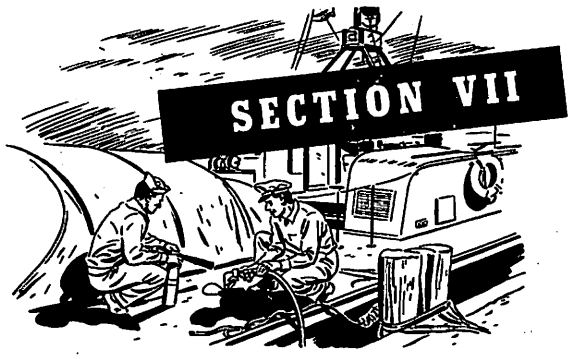
(12) Locate the outside cam furthest away from the center cam which controls action from reverse to neutral. It will be this cam which controls the forward position of the clutch lever. Adjust this cam so that its switch has just opened, and so that further movement of the clutch lever toward *forward* will result in the switch *remaining open.*

(13) The remaining outside cam controls the reverse position of the clutch lever. Move the clutch lever to reverse and locate it in the middle of the slack, if any.

(14) Adjust this cam so that its switch has just opened, and that further movement of the clutch lever towards *reverse* will result in the switch *remaining open.*

(15) Start the engine, turn on the master switch and test operation of the control from the pedestal. The green indicator lamp should light only while the clutch is moving toward forward (from reverse to neutral or from neutral to forward); the red lamp should light only while the clutch is moving toward reverse (from forward to neutral or from neutral to reverse). Be sure all lights are out whenever the control is not actually moving. Check to see that the forward and reverse clutch positions are correct and that no pressure is brought to bear on the clutch lever when engaged in forward or reverse. If positions of the clutch lever are not correct, further adjustments of the corresponding cams must be made, as described in paragraphs 6.*b., c., d.,* and *e.*





Fuel System

1. DESCRIPTION.

(See figure 73.)

a. FUEL TANKS AND CONNECTIONS.

(1) FUEL TANKS. *(See figure 73B.)*—Eight self-sealing fuel tanks of aircraft type are provided for furnishing fuel to the engines, the generator engine, and the heating system. The tanks are identical and have a capacity of 480 gallons each. Four tanks are located on the forward side of bulkhead 42, the center tanks under the floor of the officers' stateroom and galley and the wing tanks under the officers' berths and the port side of the galley. The four after tanks are under berths in the dispensary and are enclosed by removable paneling.

(2) FILLER PIPES AND CAPS.—The tanks are connected to the filler caps on the deck (figure 73A) by individual 2½-inch filler pipes with flexible connections. These pipes extend from the deck to the forward tanks on the after side of bulkhead 42 and to the aft tanks on the fore side of bulkhead 60. The filler caps on the deck are marked "GAS" and are a different size so that they will not be confused with the filler caps for the lubricating oil tanks.

(3) FUEL MAINS.—The tanks are connected to the full manifold by four 1-inch fuel mains. The tanks are connected in pairs by ¾-inch pipe to each main: fore center tanks, fore wing tanks, aft center tanks, and aft wing tanks. The lines have flexible connections. Each tank may be cut off from its main by a gate valve located on the engine room side of the bulkheads. (See figure 74.) Ordinarily, however, the tank outlet valves remain open and are closed only in the event that a tank is damaged or a break occurs in a line.

(4) VENT LINES.—Each of the tanks is vented through two ¾-inch vent lines which pass through the hull just below the deck. (See figure 73F.) Four tanks have one common vent with two outlets. This permits an overfilled tank to drain into another.

b. FUEL DISTRIBUTING MANIFOLD.—Each fuel main carries fuel from its pair of tanks to a valve on the fuel distributing manifold. (See figure 73C.) These valves are labeled to indicate the pair of tanks that they control. Other valves on the outboard sides of the fuel strainers control the flow of fuel to the engines, the generator engine, and the heating system. (See figure 73C.)

c. FUEL STRAINERS.—On each side of the fuel distributing manifold is a fuel strainer of conventional type. (See figure 73C.) Each strainer has a filtering element of closely spaced, spiral-wound wire. The spacing between the turns is .0015 inch, so close that dirt and water are effectively strained out.

d. WOBBLE PUMP. — A hand-operated wobble pump is mounted in the ¾-inch line between the fuel manifold and each engine. (See figure 73D.) Each wobble pump has a relief valve set at 9 to 11 pounds per square inch to prevent putting excessive pressure on the carburetor diaphragm.

e. ENGINE PRIMER.—A ¼-inch line leading to the engine primer (figure 75) takes fuel from the ¾-inch line on the engine side of the wobble pump. Two quick-acting valves, one of which is incorporated in the pump, are in the ¼-inch primer line. There is a primer for each engine.

f. LIQUID LEVEL GAGES.—Separate liquid level gage panels for the forward fuel tanks and for the aft tanks are mounted on bulkhead 42 and bulkhead 60, respectively. Each tank is connected to the panel by a ¼-inch line, which passes vertically from near the bottom of the tank up through the top of the tank. Gages for the fresh water tanks are on the left of each panel. (See figure 73E.)

2. OPERATION.

a. FILLING TANKS.—As high octane fuels are very volatile and may cause an explosion at some distance from the fuel itself, the following precautions should be taken whenever refueling:

(1) Hoist "Baker."

(2) Only the personnel engaged in the actual refueling operation should remain aboard the boat.

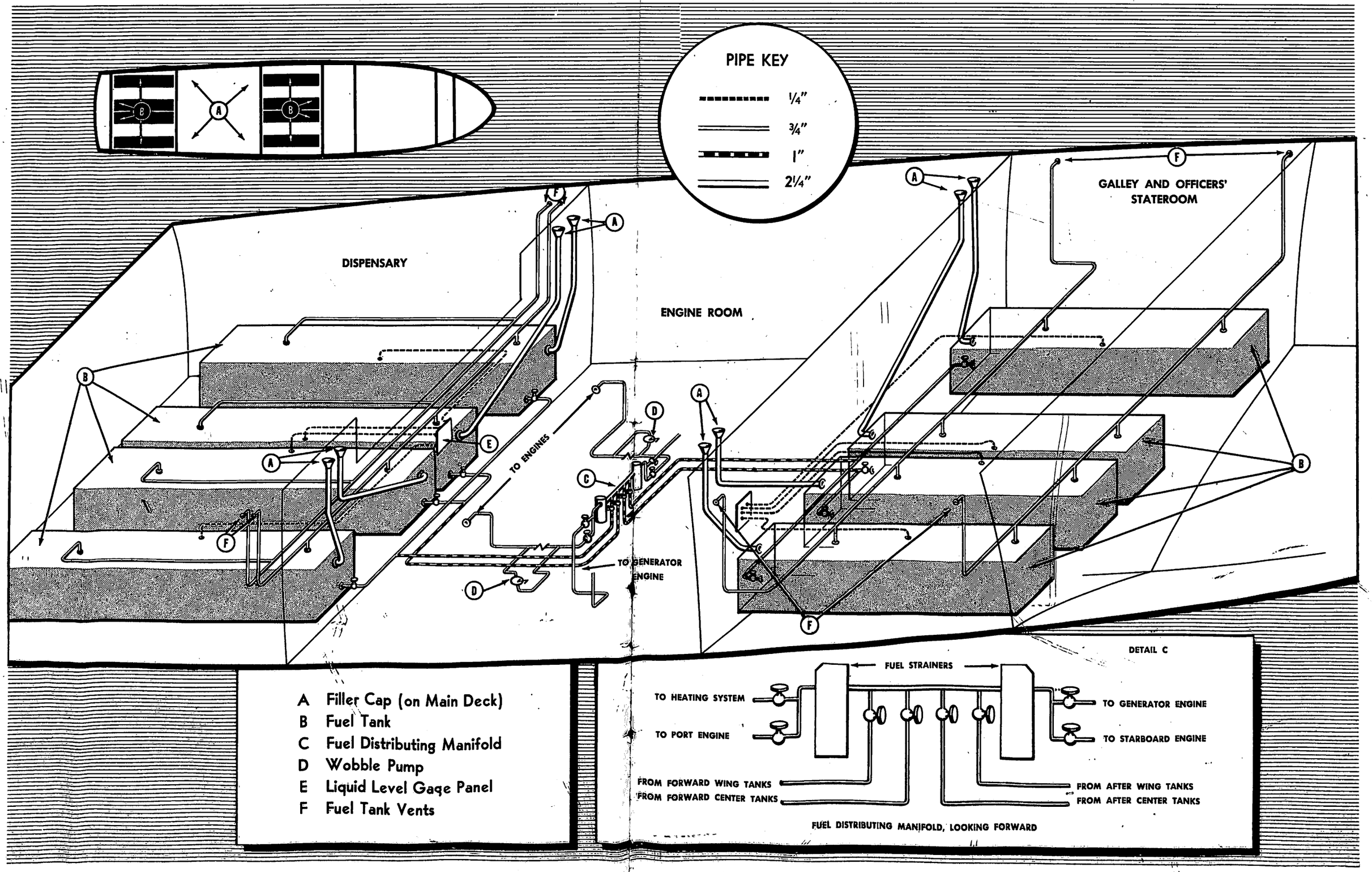
(3) The built-in fire extinguisher system is a very important factor in fire control during refueling. The controls for the system should be ready for instant use.

(4) Portable CO_2 fire extinguishers must be held in readiness on the deck alongside each fuel hose. (See figure 76.)

(5) The main battery switches should be in the "OFF" position.

(6) No smoking should be permitted within 100 feet of a boat engaged in fueling. The deck should be swabbed around the filler cap.

Figure 73 — FUEL SYSTEM



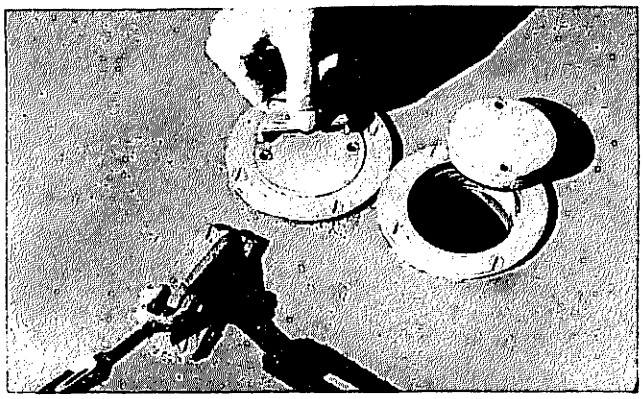


Figure 73A—Filler Cap (On Main Deck)

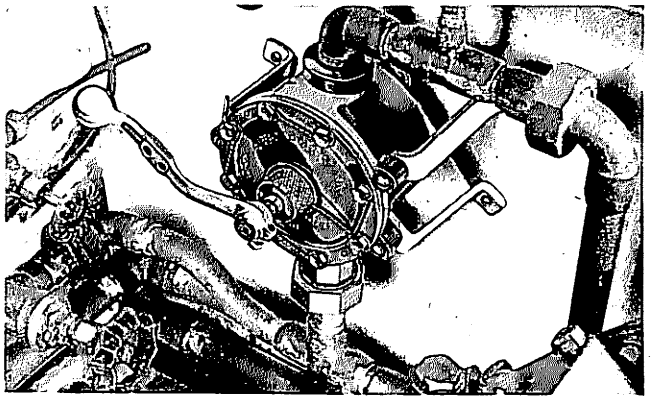


Figure 73D—Wobble Pump

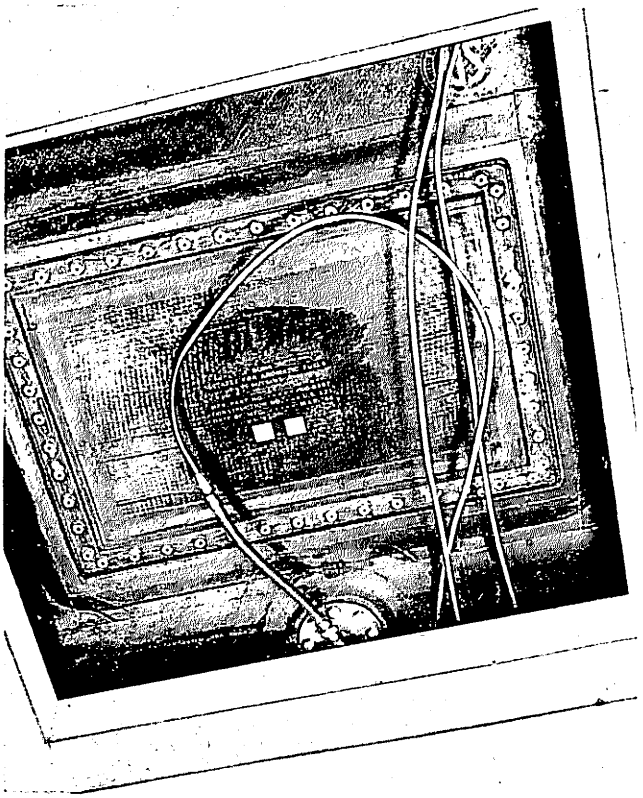


Figure 73B—Fuel Tank

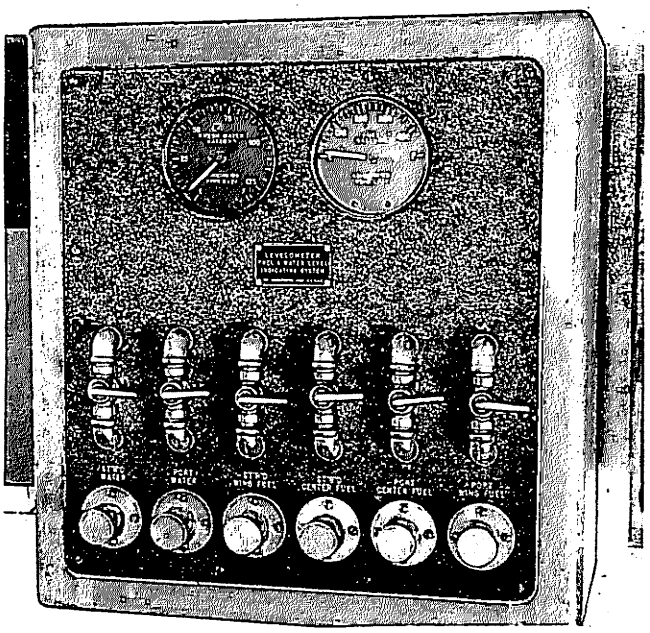


Figure 73E—Liquid Level Gage Panel

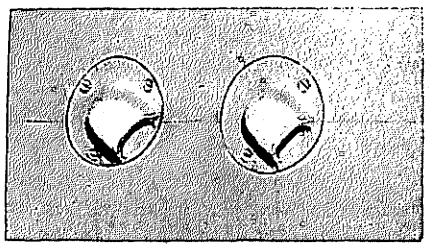


Figure 73F—Fuel Tank Vents

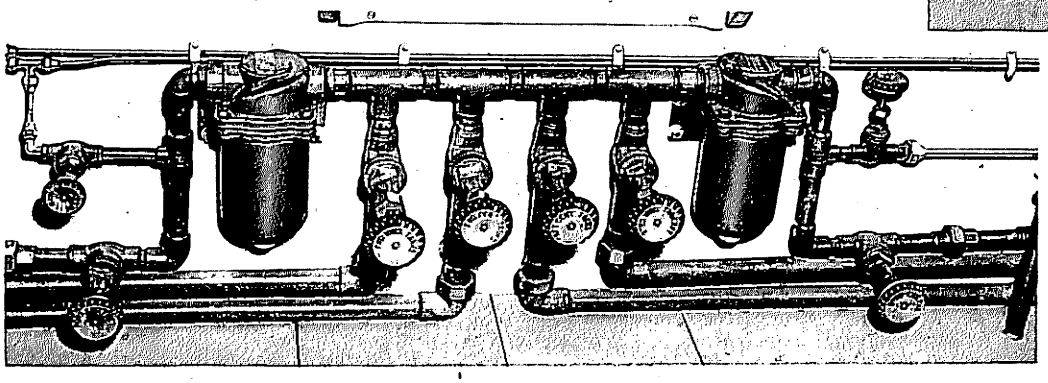


Figure 73C—Fuel Distributing Manifold

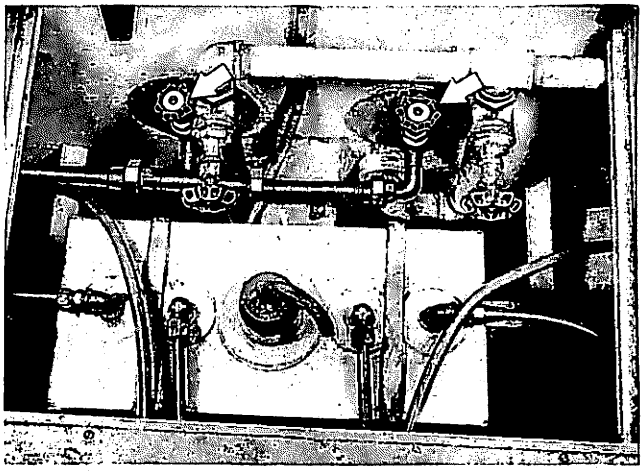


Figure 74—Outlet Valves for Foward Center Tank

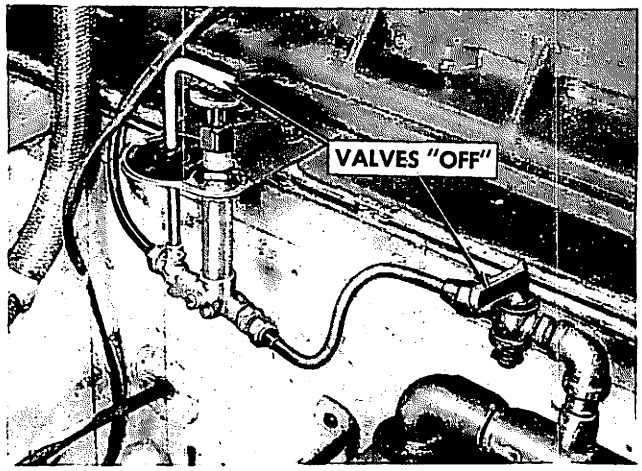


Figure 75—Engine Primer

(7) While one man stands by the nozzle, another should remove the filler cap just before fueling is to be started. Immediately after fueling is completed, the filler cap must be put back.

(8) A ground wire should be attached to the nozzle of the supply hose and to the fuel tank filler neck, and all component parts of the filtering system must be grounded. This means that, before refueling, the funnels, drums, shore tanks, hose, hose nozzles, and boat's tanks—or any combination of them—must be interconnected to a grounded metal surface. Stranded copper wire and spring grips are suggested for this purpose. (See figure 76.)

Note

Gasoline should not be filtered through chamois because of the great amount of static electricity produced in that way. If, however, it is necessary to filter the fuel, as at an advanced base, the chamois should be well grounded by laying it on fine wire screen across the funnel. The funnel should be carefully grounded.

(9) Except in emergencies, boats should not be fueled at night or while close to one another.

(10) Remove the filler cap only when ready to fill immediately and AFTER grounding the hose nozzle to the filler neck.

(11) When the tank is nearly full, pour in fuel more slowly to avoid "blow-back" resulting from an air-lock.

(12) Remember this: Gasoline fumes in the boat are always a fire hazard. MAKE IT AN ABSOLUTE RULE NEVER TO START AN ENGINE WHILE THERE IS A STRONG ODOR OF GASOLINE IN THE ENGINE ROOM.

b. SELECTING FUEL TANKS.—Because the outlets of the fuel tanks are at the ends of the tanks nearest the engine room bulkheads, approximately 150 gallons in each aft tank will not feed into the lines leading to the fuel mains when the boat is planing at high speed. Therefore, it is recommended that the aft tanks be used first when the boat is proceeding at cruising speed and that the forward tanks be reserved for emergency high speed running. Selection of tanks is made at the fuel distributing manifold described in paragraph 1.*b.*, this section.

c. BUILDING FUEL PRESSURE FOR STARTING. —Operation of the wobble pumps by hand to build up pressure for starting the engines is described in section II, paragraph 2. After the engines are started and the engine-driven fuel pumps are operating, the fuel is bypassed around the wobble pumps instead of passing through them.

d. PRIMING THE ENGINE.

(1) Each engine has a hand-operated primer pump to supply the engine by injecting fuel into the side induction manifolds. When the valve handle points in the "OFF" position, it covers the pump handle so that

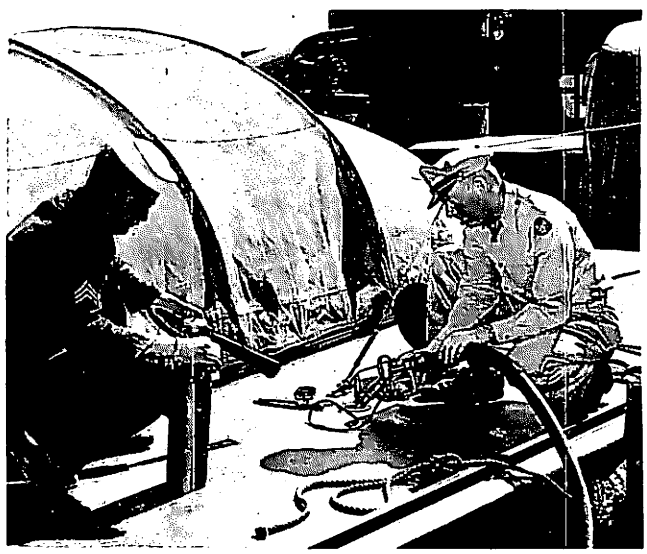


Figure 76—Filling Aft Tanks

the primer pump cannot be operated. The handle of a second valve (figure 75) must be turned parallel with the pipe before fuel will reach the primer.

Note

The primer pumps are intended only for use in starting an extremely cold engine. Priming a warm engine will make it very difficult to start.

(2) If the primer is to be used, first make sure that the throttle is closed. Then give the primer several strokes to clear it of air, and use two to six priming strokes after the pump takes hold.

e. MEASURING FUEL.—To ascertain the amount of fuel remaining in a fuel tank, operate the liquid level gage as follows:

Note

The starboard center fuel tank is used as an example.

(1) Open the starboard center fuel tank valve on the gage panel. Make sure that all the other valves are closed. (See figure 77.)

(2) Unlock the starboard center tank fuel pump by pressing in on the handle and by turning it to the left.

(3) Operate the pump (figure 77) until the highest reading is obtained on the dial. The quantity of gasoline in the starboard center tank will be registered.

(4) Bleed the air from the gage by pulling outward on the valve handle. (See figure 78.)

CAUTION

Do not attempt to gage more than one tank at a time. Be sure that all valves are closed except the valve connected to the tank being gaged.

(5) Repeat steps (1) through (4) to measure the quantity of fuel in the other three fuel tanks connected to the panel.

Note

The liquid level gage panel for the forward tanks is identical with that for the aft tanks. Both are operated in the same way.

3. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
VENTS OBSTRUCTED	Frozen spray or vapor.	Thaw out.
STRONG ODOR OF GASOLINE IN BOAT	Leak in fuel tank.	Locate and repair.
	Leak in fuel lines.	Locate and repair.
DIRT IN FUEL	Damaged screen in fuel strainer.	Replace.

4. SERVICING AND MAINTENANCE.

a. FUEL TANKS AND LINES.

(1) Fuel tank filler caps should be checked to see that they fit properly and are securely fastened.

(2) Be sure that fuel tank air vents are unobstructed. Although these vents are of ample size, they sometimes freeze shut when spray and vapor hits them when boats are operating in cold climates.

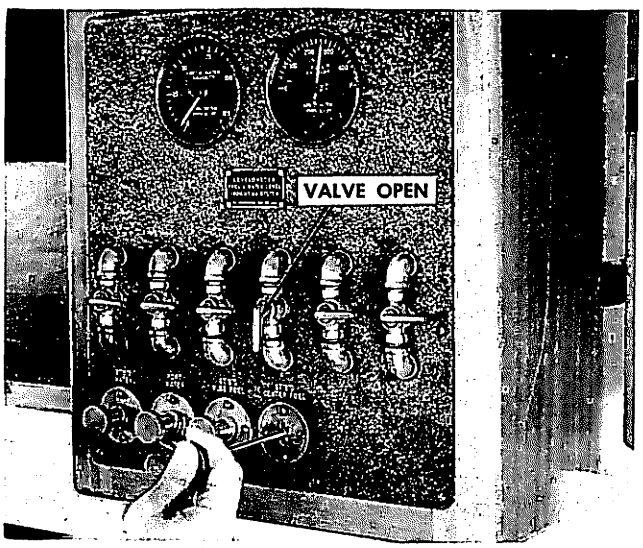


Figure 77—Pumping Air Into Line

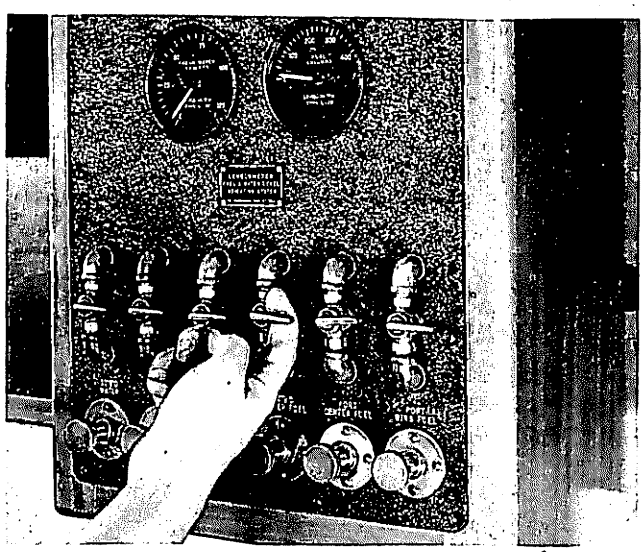


Figure 78—Bleeding Air From Line

(3) If a fuel main or tank leaks, a strong odor of gasoline will be noted. Check the lines and connections to discover the leak.

(4) Fuel tanks will not have to be cleaned if the fuel is properly strained when the tanks are filled. However, if a supply of dirty fuel, through error, is placed in the tanks, remove the manhole covers (figure 73B) and pump the tanks dry. Air them out for 24 hours. *Do not* use steam—it would ruin the rubber tanks. Then, clean the tanks out with long-handled clean swabs or clean rags. When reinstalling the manhole covers, torque the screws to 8 inch-pounds, and safety wire them.

b. WOBBLE PUMP.

(1) The wobble pump should be operated briefly, to make sure that it is in working order. Operate the pump slowly, as rapid operation may cause the compensator to open momentarily, discharging a spurt of fuel, which is sometimes confused with flooding.

(2) After building up fuel pressure to the required 6 to 7 pounds, check the fuel system for leaks, paying particular attention to all valve packing nuts and strainers.

c. PRIMER PUMP.

(1) Operate the primer pump sufficiently to force fuel through the primer lines.

(2) Inspect all the primer lines and connections for leaks, particularly the small tubing in the vee of the engine.

d. FUEL STRAINERS.

(1) The fuel strainers should be drained and cleaned at the specified intervals.

(2) To drain the strainer, remove the drain plug from the bottom of the case, using a socket wrench.

(3) To clean the strainer, remove the four stud nuts from the case clamping ring bolts, being very careful to loosen them evenly so that the ring will not be distorted. Pull the strainer case and clamping ring assembly out of the head and unscrew the strainer element from the head by hand.

(4) Wash the element and the inside of the case and head with cleaning fluid, using a clean soft paint brush. Never use a wire brush or scraper, for either will damage the fine element or screen. This would allow dirt and other foreign matter to enter the fuel system.

(5) When reassembling the strainer, run down the four nuts evenly. Tighten each nut a little at a time until all the nuts have been uniformly tightened. Always use a new gasket when reinstalling the strainer.

5. EMERGENCY REPAIRS.

a. REPAIRING TANKS.—Repair of the self-sealing fuel tanks may be made with the repair kit included in the equipment of the boat. A manual giving detailed instructions is in the kit.

Note

Whenever a tank is damaged, close the outlet valve at the tank and plug up the hole if possible.

b. REPAIRING PIPES. — Emergency repair of a break in the fuel mains may be made by slipping a length of neoprene hose over the ends of the pipe and installing clamps. Valves to broken fuel lines should be closed as follows:

(1) If the break is between the fuel tanks and the fuel distributing manifold, close the outlet valves of the two tanks affected by the broken main. Close the corresponding valve at the manifold.

(2) If the break is between the fuel manifold and the engines, generator engine, or heating units, close the valve at the side of the manifold which controls the flow of fuel to the broken line. Shut down the engine, or the heater system, using fuel from that line.

CAUTION

As high-octane gasoline is extremely volatile, it is important that all engines, motor-driven equipment and any electrical apparatus that may cause sparks be IMMEDIATELY SHUT DOWN upon discovery of a leak or break in the fuel system. All valves at the tanks and pumps affected should then be closed.

6. REMOVING TANKS FROM BOAT.

a. FORWARD TANKS.—When removing the fuel tanks under the officers' stateroom or the galley, it is necessary first to remove the built-in fittings, such as tables, benches, and sink, and to remove accessories such as the refrigerator and stove before removing the paneling and disconnecting the tanks from the vent lines and fuel lines. (See figure 79.) Hoist the tanks through the hatch in the after part of the bridge deck. (See figure 80.)

CAUTION

When removing self-sealing tanks, take care not to bend or twist them more than necessary. Such treatment may cause serious damage.

b. AFT TANKS.—The aft tanks are inclosed by removable paneling which forms a base for the berths in the dispensary. After the panels have been removed and the lines disconnected, the tanks may be hoisted through the main deck hatch in the stern. (See figure 81.)

c. OPENING HATCHES.—To open either of the hatches for removing fuel tanks, proceed as follows:

(1) Remove the painted strip of canvas that is glued and tacked to the deck around the edge of the hatch.

(2) Remove the pieces of wood that wedge the hatch in place.

(3) From below, remove the bolts that fasten the hatch to the hatch coaming.

(4) Remove the hatch, using a suitable sling and hoist, if available.

Note

When replacing hatches, use a mixture of whiting and white lead paint for waterproofing.

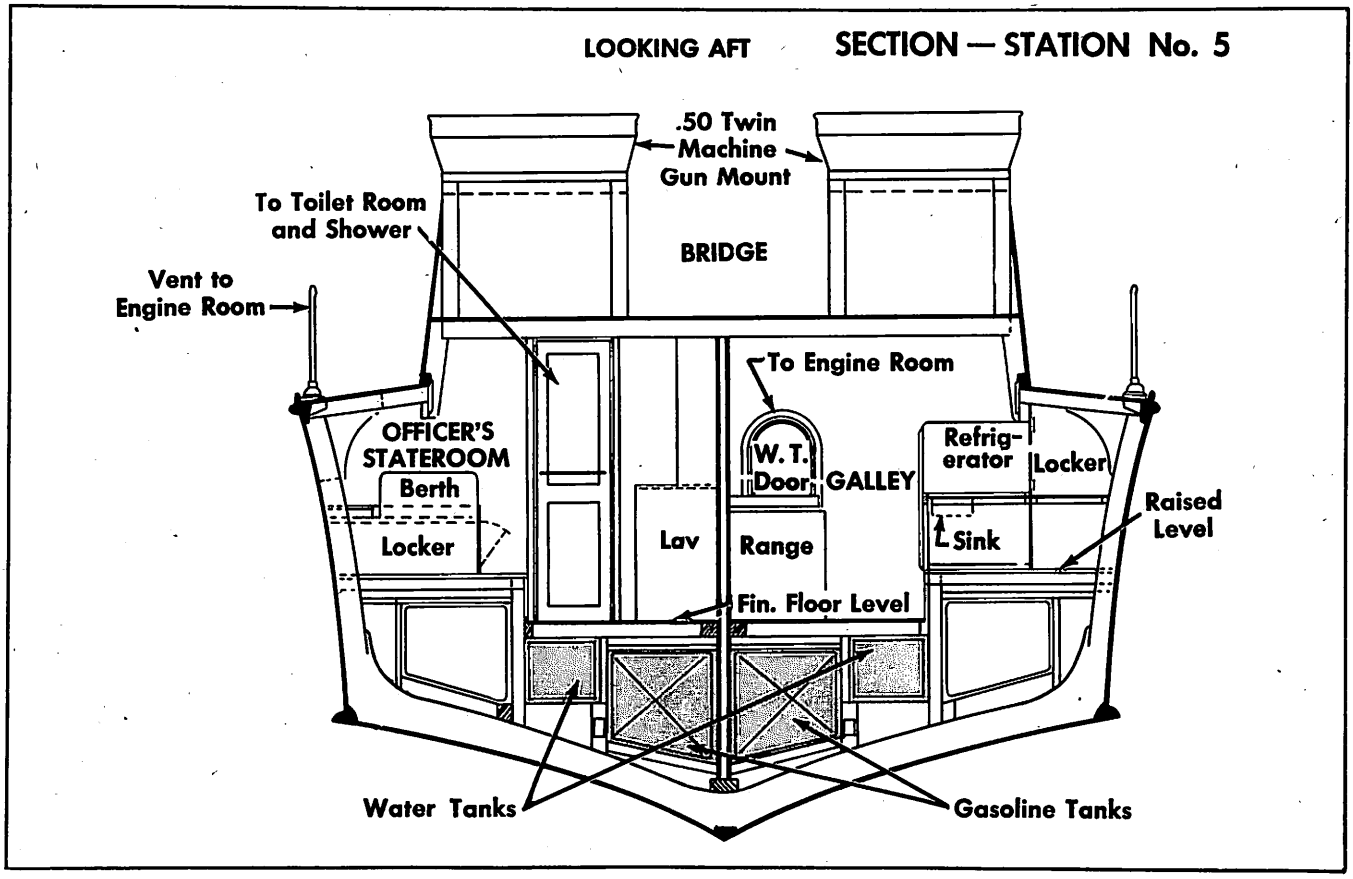


Figure 79—Location of Forward Tanks

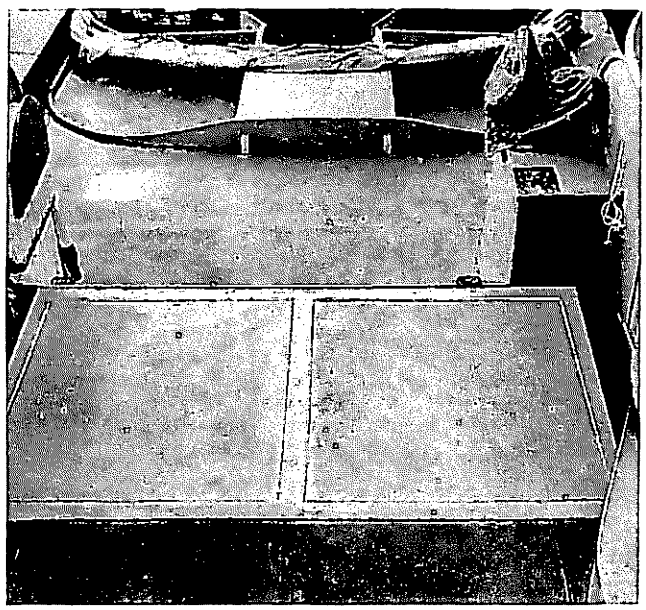


Figure 80—Hatch for Removing Forward Tanks

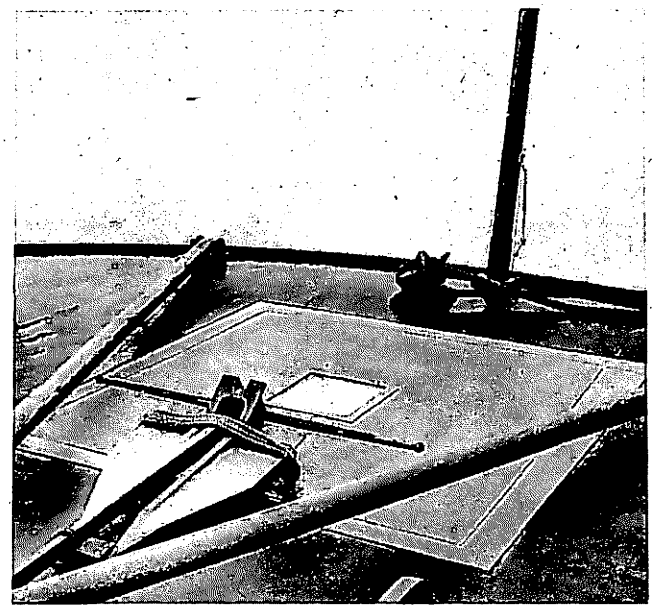
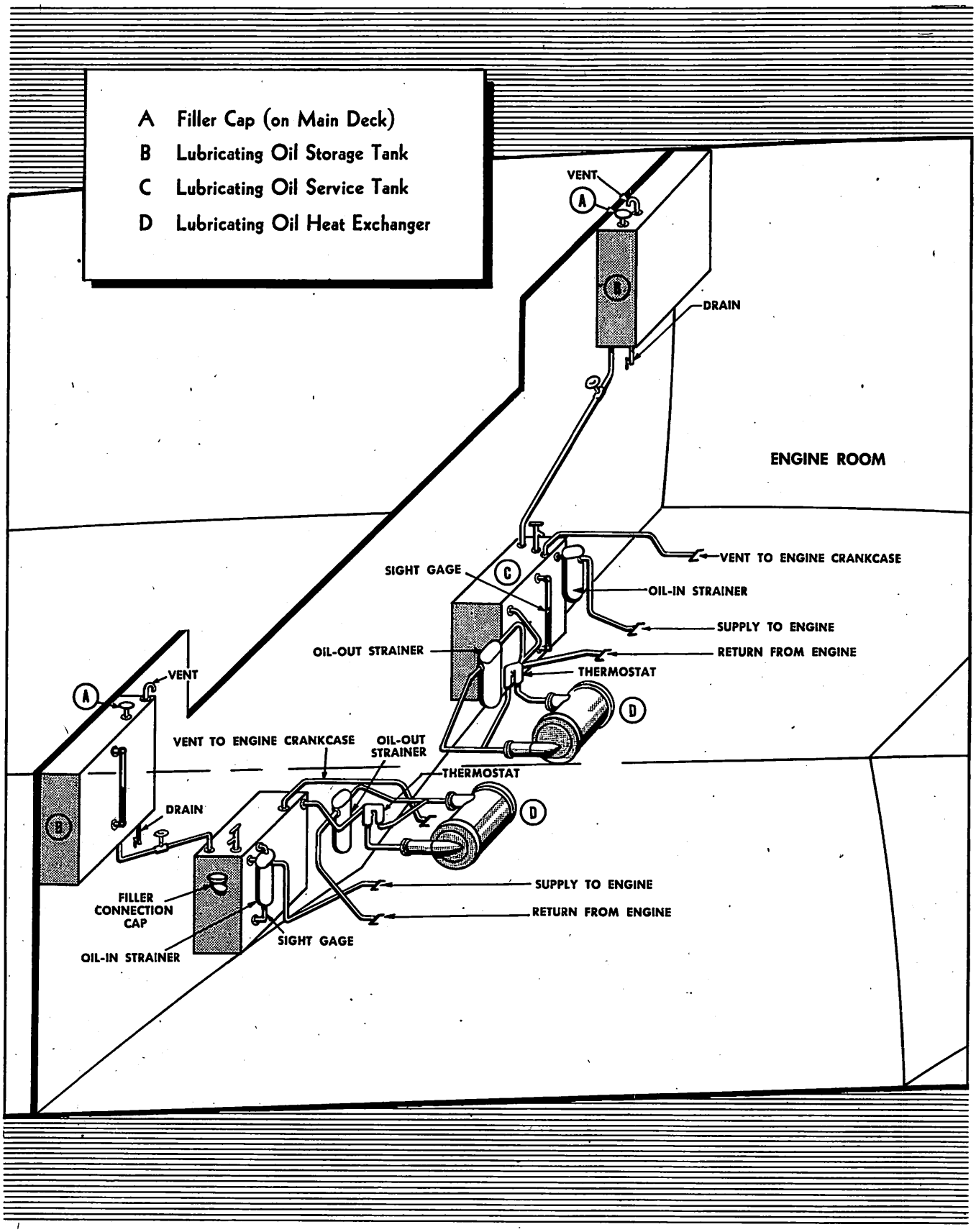


Figure 81—Hatch for Removing Aft Tanks

Figure 82 — ENGINE LUBRICATING OIL SYSTEM





Lubrication System

1. DESCRIPTION.

(See figure 82.)

a. STORAGE TANKS.—A surplus supply of lubricating oil for the engines is stored in two 30-gallon storage tanks. The tanks are attached to bulkhead 60 on the port and starboard sides of the engine room. (See figure 82B.) The tanks have separate 2-inch filling connections located on the main deck. (See figure 82A.) A 1-inch pipe with a gate valve (figure 82B) connects each storage tank with the oil service tank. Boats having hydraulic clutch controls take oil from the storage tanks for operation of the control system through the lines indicated in figure 82B. A drain valve is at the bottom of each storage tank.

Note

There are no cross-connections between the lubricating systems of the two engines. Each engine has a complete lubricating system.

b. SERVICE TANKS.—Oil that circulates through the engines is contained in two service tanks located on the aft side of the engine room between the two engines. (See figure 82C.) Each tank has a capacity of 30 gallons. Oil inlet and outlet lines, 1 inch in diameter, are located in such a manner that short-circuiting of oil through the tanks is prevented. Each service tank is vented through a 1-inch pipe that connects to the breather of the engine served by the tank. Sight gages indicate the amount of lubricating oil in each tank. There are filler connections on the outboard sides of each service tank so that the supply of oil can be replenished when the storage tanks are empty.

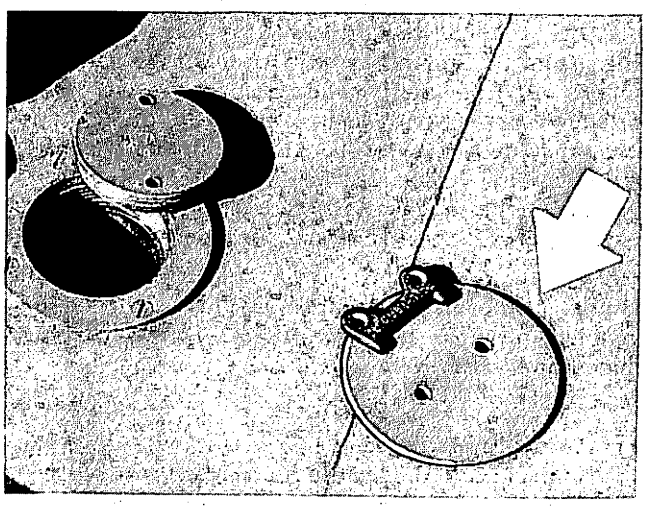


Figure 82A—Oil Filler Cap

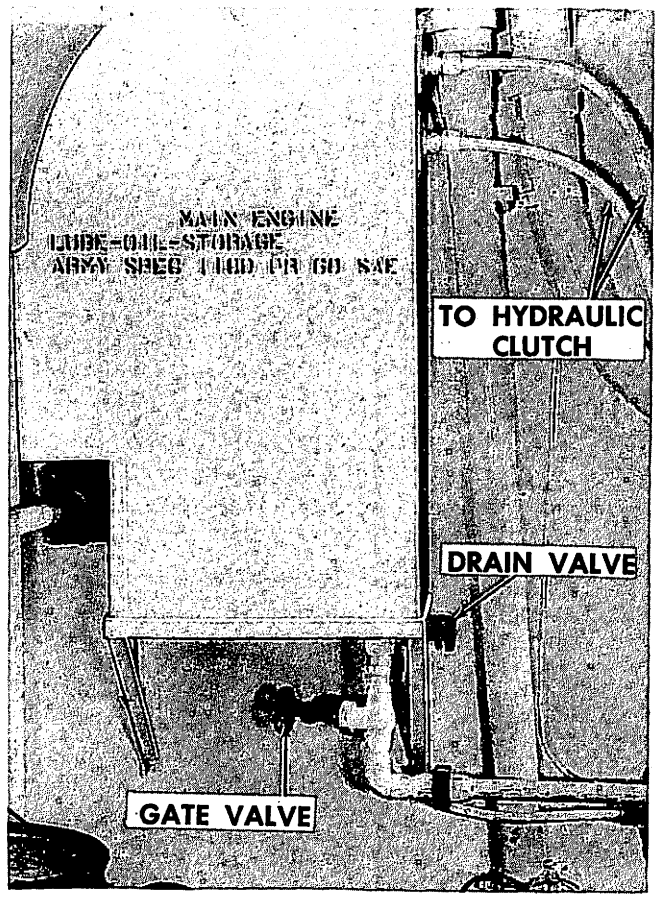


Figure 82B—Main Engine Oil Storage Tank

c. OIL STRAINERS.—Two oil strainers are located between each service tank and its engine.

Note

The strainers derive their names from the direction the oil is flowing in reference to the engine. For example, the oil-in strainer strains the oil going into the engine, not into the tank.

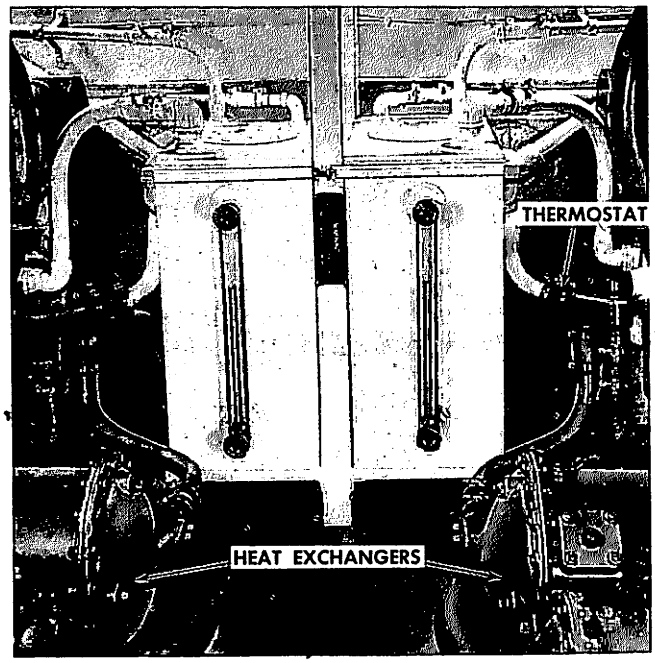


Figure 82C—Service Tanks

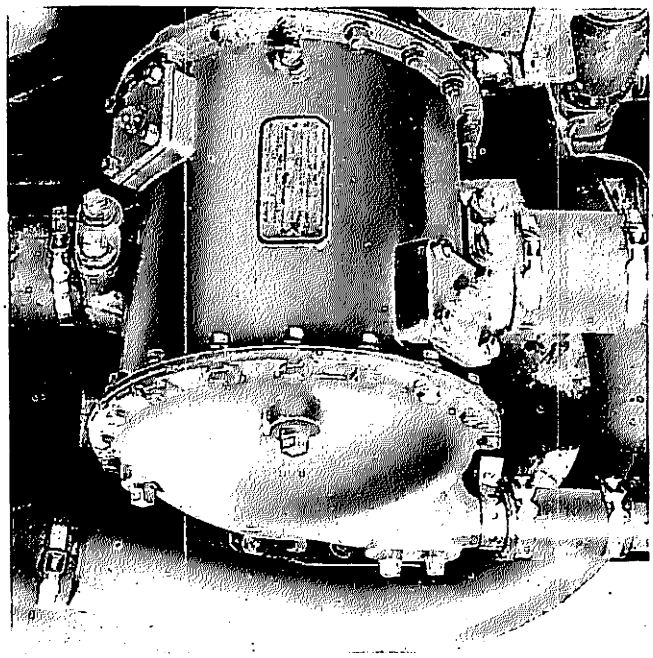


Figure 82D—Oil Heat Exchanger

(1) OIL-IN STRAINER.—This strainer (figure 83) is located in the line that transfers oil from the service tank to the inlet of the engine-driven oil pump. It contains a screen element of 14-mesh .020-inch brass wire.

(2) OIL-OUT STRAINER.—This is an edge-type strainer, with .003-inch gap, located on the discharge side of the oil pump between the oil pump and the oil heat exchanger. Its handle (figure 83) distinguishes it from the oil-in strainer.

d. OIL HEAT EXCHANGERS.—To cool the oil heated by the engine before it is returned to the service tank, the oil is circulated through the tubes of the oil heat exchanger. (See figure 82D.) There the salt water flowing around the tubes cools the oil. A thermostat bypasses the oil around the heat exchanger if the oil is not hot enough to require cooling. The oil heat exchangers for both engines are shown in figure 82C.

e. OIL PIPES. — All pipes of the lubricating oil system are of seamless copper tubing. Connections are made with synthetic rubber hose and hose clamps.

f. BONDING. — All parts of the lubricating oil system are electrically bonded together.

g. AUXILIARY STORAGE TANK.—An auxiliary tank for storing lubricating oil is located on the port side of the engine room forward of the work bench. It is filled through a deck filler connection. This tank has an oil level sight gage and a spigot for filling oil cans. (See figure 84.)

2. OPERATION.

a. FILLING STORAGE TANKS.—The storage tanks should be filled with lubricating oil whenever the boat is being fueled. Oil remaining in the storage tanks should be used to fill the service tanks to the proper level before the storage tanks are filled.

CAUTION

Storage tank filling connections are flush with the deck, and care should be exercised to prevent dirt from falling into the opening after the filler cap is removed. Note that the filler connection is marked "LUBE OIL" to prevent its being confused with the fuel filler connections nearby.

b. FILLING SERVICE TANKS.—Service tanks are filled from the storage tanks by opening the gate valve (figure 82B) in the pipe connecting the two tanks. Although the service tanks have a capacity of 30 gallons each, they should never be filled with more than 25 gallons of oil. Red marks on the oil level sight gages indicate the height to which the tanks may be filled and leave adequate space for expansion and air separation.

c. OPERATING OIL-OUT STRAINER. — The handle of the oil-out strainer should be rotated two complete turns to clean the filter before starting the engine and after every 2 hours of operation.

CAUTION

Always turn the handle in a clockwise direction. Turning the handle counterclockwise will damage the cleaning knives and cause the filter to be inoperative.

3. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
DIRTY OIL REACHING ENGINE	Damaged element in oil-in strainer.	Replace element.
METAL PARTICLES IN OIL FROM OIL-OUT STRAINER	Trouble inside the engine.	Notify officer in command.
ENGINE OIL PUMP LOSES PRIME	Air leak in oil-in line or strainer.	Stop engine and repair leak.
OIL SLICK AROUND BOAT WHEN IDLING AT DOCK	Leak inside heat exchanger.	Stop engine; repair or bypass heat exchanger.

4. SERVICING AND MAINTENANCE.

a. GENERAL.

(1) The aim of inspection and servicing of the lubricating oil system is to maintain a clean oiling system and to guard against oil leaks.

(2) Always be on the lookout for any abnormal condition, and either stop the engine or correct the trouble before any damage can be done.

Note

Proper operation of the lubricating system is necessary to keep the engines in good condition, for this system not only lubricates all moving parts but it helps to maintain proper engine temperatures.

b. CLEANING THE OIL-OUT STRAINERS.—At specified intervals, the strainer should be disassembled and flushed with kerosene, as follows:

(1) Remove the drain plug and drain the strainer case, catching the drainings in a clean container. The drained oil should be strained through a cloth or filter and carefully checked for metal particles which would indicate trouble inside the engine.

Note

Any indication of metal particles in the engine oil should be called to the attention of the officer in command of the boat. It might indicate abnormal wear on the bearings of the engine.

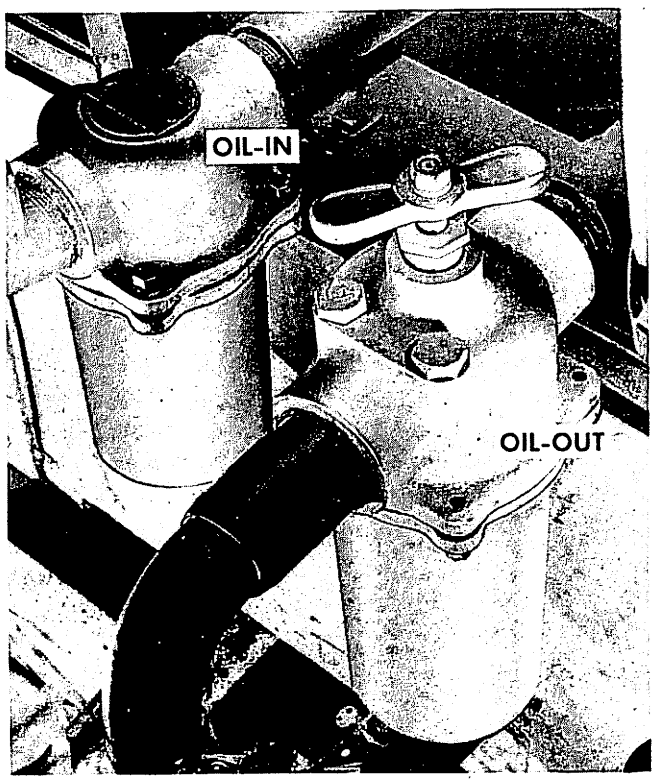


Figure 83—Oil Strainers

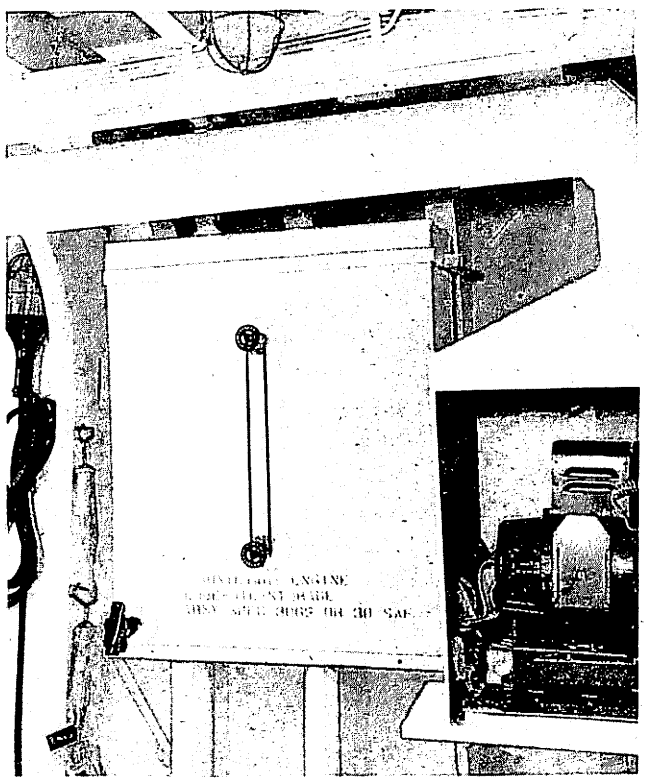


Figure 84—Auxiliary Oil Storage Tank

(2) Unscrew the four clamping ring nuts. These nuts should be unscrewed evenly to avoid distorting the ring.

(3) Unscrew the three fillister-head screws on the cleaning knife frame—one from the bottom spider and two from the head.

(4) Remove the three screws holding the bottom spider to the strainer element support rods.

(5) Pull the element out of the head, being extremely careful not to damage the delicate strainer element.

Note

The strainer element is composed of a series of finely wound wires. If it is damaged in any way, it should be discarded and replaced with a new one.

(6) Wash the element in kerosene, being careful that no dirt gets inside the element. Use a soft, lint-free cloth for cleaning the element—never use a scraper or wire brush. A scraper or wire brush will damage the element.

(7) When reinstalling the element, be sure to tighten the screws uniformly and turn the cleaning handle clockwise, before reassembling the case, to make sure that the element is properly lined up.

(8) Carefully position the new gasket when installing the case, and tighten the four clamping ring nuts, a little at a time, to avoid distorting the ring. Tighten securely enough to prevent leaks.

Note

In tightening the nuts, start with two that are diametrically opposite before tightening the other two.

(9) The cleaning handle stuffing box may occasionally require repacking. Repack as follows:

(a) Remove the handle.

(b) Remove the stuffing box lock nut and spanner gland nut.

(c) Pull out the old packing.

(d) Repack the gland with new packing and reinstall the handle, the spanner gland nut, and lock nut.

(e) Tighten the gland only enough to prevent leaks. If it is too tight, the packing may score the shaft.

c. CLEANING THE OIL-IN STRAINERS.—The oil-in strainer must be cleaned every 50 hours. To do this, proceed as follows:

(1) Drain the oil by removing the bottom plug and remove the case and clamping ring, as with the oil-out strainer.

(2) Unscrew the strainer element by hand and wash the element, the case, and the inside of the head with kerosene. Use a soft, lint-free cloth for cleaning the element. Never use a scraper or wire brush which would damage the element.

(3) Use a new gasket when reassembling the strainer, and tighten the clamping ring nuts evenly and uniformly, in the same order as described for the oil-out strainer.

CAUTION

These clamping ring nuts must be tightened securely, paying particular attention to preventing leaks. On the suction side of the oil pump a slight air leak might cause the pump to lose its prime.

d. OIL LINES AND CONNECTIONS.—All of the oil line connections must be checked for leaks, and repairs must be made immediately if leaks are found.

(1) Pay particular attention to the oil-in line, and see that the hose are in good condition and all hose clamps are tight.

(2) Especially check the hard-to-get-at section of the line in the bilge, as even a slight leak would result in failure of the oil pump to prime and cause loss of oil pressure.

e. CHANGING OIL.—Oil should be changed at 50-hour intervals. Proceed as follows:

(1) Remove the old oil from the tank with a suction pump.

(2) Clean the oil strainers.

(3) Clean the oil tanks by removing the cover from each tank and washing out the inside of the tank with kerosene.

(4) Refill the system with clean oil. Use only oil that meets the current specifications.

5. REPAIR.

a. REPAIRING PIPES.—Broken oil lines may be temporarily repaired by cutting out the damaged portion of the pipe and connecting the ends with a rubber hose held by clamps. In the event that a line breaks, shut off the oil supply as follows:

(1) If the broken line is between the storage tank and the service tank, shut off the valve in the oil transfer pipe just below the storage tank. (See figure 82B.)

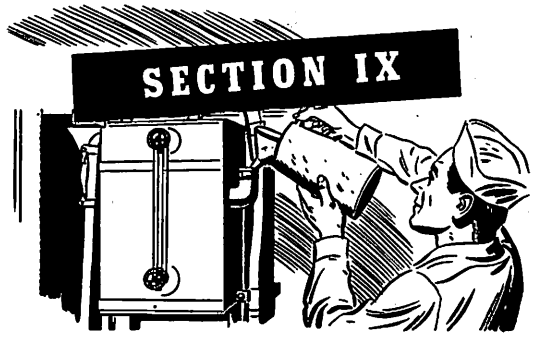
(2) If the broken line is between the service tank and the engine, shut down the engine at once.

CAUTION

Do not start the engine unless oil can be fully circulated between the service tank and the engine and unless the service tank contains a suitable quantity of oil.

b. REPAIRING TANKS.—Refer to section III, paragraph 6.*g.*

c. OVERHAULING HEAT EXCHANGER.—Overhaul of the heat exchanger is explained in section X, paragraph 5.



Engine Coolant SYSTEM

1. DESCRIPTION.

(See figure 85.)

a. EXPANSION TANK.—A metal expansion tank having a capacity of 5 gallons with an additional expansion space of 2 gallons is a part of each engine's coolant system. This tank is suspended above the engine. (See figure 85A.) The coolant is not circulated through the tank, which is connected to the engine by vent pipes only. The tank is fitted with a sight gage and a vent pipe that drains into the bilge. A filler connection on the side of the tank is so located that the tank cannot be filled with more than 5 gallons of coolant.

b. HEAT EXCHANGER. *(See figure 85B.)*—Coolant that has been heated by being circulated around the cylinders of the engine is cooled in tubes of the heat exchanger before being drawn into the engine again by the fresh water pump. Salt water passing around the heat exchanger tubes takes heat away from the coolant at a rate of 32,000 Btu per minute at maximum speed, when the flow of coolant is approximately 200 to 250 gallons per minute.

c. THERMOSTAT.—A thermostat (figure 86) which will maintain the water outlet temperature between 66° to 77°C (150° to 170°F) is installed so that it will bypass the coolant around the heat exchanger if the liquid is not hot enough to require cooling by the salt water system.

d. PIPES.—The pipes of the coolant system are soft copper tubing, connected by rubber hose and clamps. All the parts are electrically bonded together.

2. OPERATION PRINCIPLES.

a. COOLANT CIRCULATION.—The engine coolant, either fresh water or an antifreeze solution, is circulated through jackets around the engine's cylinders by the fresh water pump on the engine. (See figure 87.) The heated coolant leaves the engine and passes through a pipe to the thermostat, which either routes the coolant to the heat exchanger or bypasses it back into the engine again. The cylinder jackets are vented fore and aft to the expansion tank above the engine. (See figure 86.)

b. THERMOSTAT OPERATION.—The engine temperature is controlled by an automatic bypass thermostat (figure 87A) located in the line that transfers the heated coolant from the engine to the heat exchanger.

(1) In the thermostat, a bellows which is sensitive to temperature changes is attached to a valve. As long as the engine and coolant remain cool, the thermostat valve remains closed and the coolant flows around the bellows, down through the holes in the valve and out through the bypass outlet to the coolant (fresh water) pump on the engine. The coolant is thus bypassed around the heat exchanger until the coolant gets warm enough to open the thermostat valve. (See figure 87B.)

(2) As the coolant gets warmer, it expands the bellows and the valve is partly opened. Part of the coolant then will go through the heat exchanger and the rest through the bypass outlet.

(3) Finally, when the thermostat valve is wide open, it seats on the base of the thermostat housing. (See figure 87C.) Thus the flow of coolant through the bypass outlet is cut off, and all of the coolant from the engine passes through the heat exchanger to be cooled.

3. SERVICE AND MAINTENANCE.

a. FILLING THE SYSTEM.

(1) FILLING WITH WATER. — Fresh water, mixed with a water soluble oil to prevent rust, is poured into the system through the filler opening of the expansion tank. Use a 1-gallon oil can. Filling is continued until the sight gage indicates that the system is full and the tank contains 5 gallons.

Note

Whenever the water standing in the sight gage begins to show indications of rust, the system should be flushed and refilled.

(2) FILLING WITH ANTIFREEZE.—An antifreeze solution, such as ethylene glycol, should be used in the engine coolant system when the boat is operated in temperatures below freezing. To fill with this solution, proceed as follows:

Note

New hose and hose clamps should be installed when necessary. This is very important because ethylene glycol solutions will leak through openings that water will not penetrate. The fresh water pump should be checked for leaks and a new seal installed if necessary.

Figure 85—ENGINE COOLANT SYSTEM

A Coolant Expansion Tanks
B Coolant Heat Exchangers

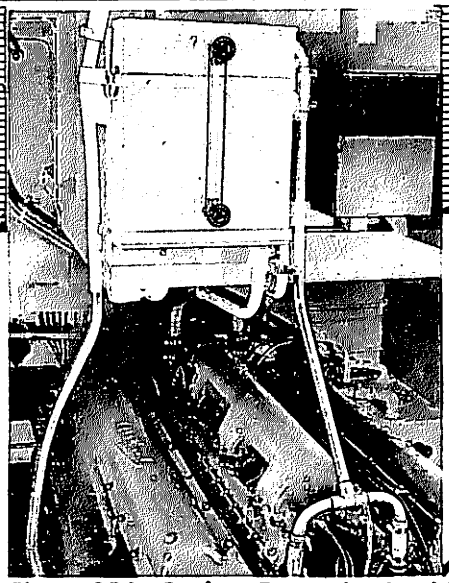


Figure 85A—Coolant Expansion Tank

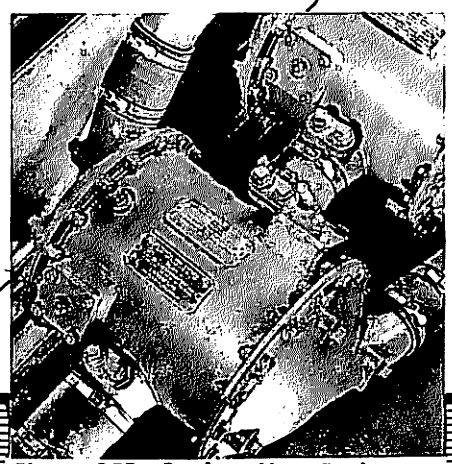


Figure 85B—Coolant Heat Exchanger

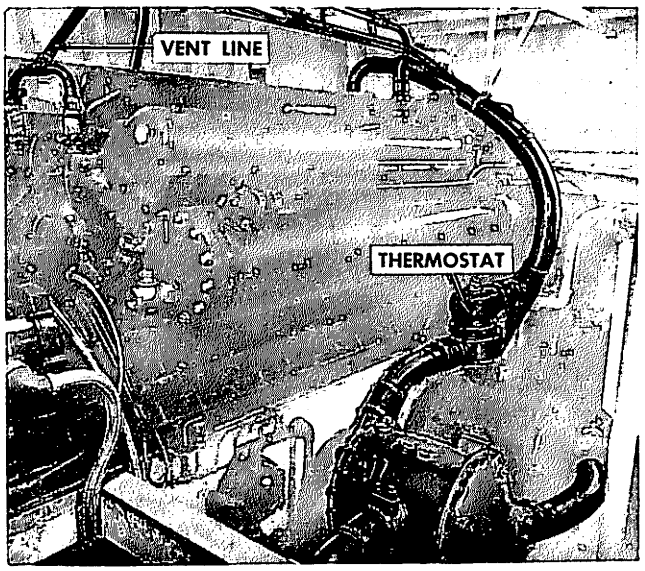


Figure 86—Heat Exchanger Thermostat

(a) Drain the entire fresh water system first, disconnect the make-up line at its lowest point and remove both plugs on the underside of each valve housing. These plugs are located at the outside corners and are for the purpose of completely draining fresh water from the engine.

(b) THE AMOUNT OF ANTIFREEZE REQUIRED.

For Protection at	*Use Ethylene Glycol*
− 9°C (+16°F)	20%
−12°C (+10°F)	25%
−15°C (+ 4°F)	30%
−18°C (0°F)	33%
−25°C (−12°F)	40%
−37°C (−34°F)	50%

(c) Replace all the drain plugs and pour enough fresh water into the tank to fill the system about one-

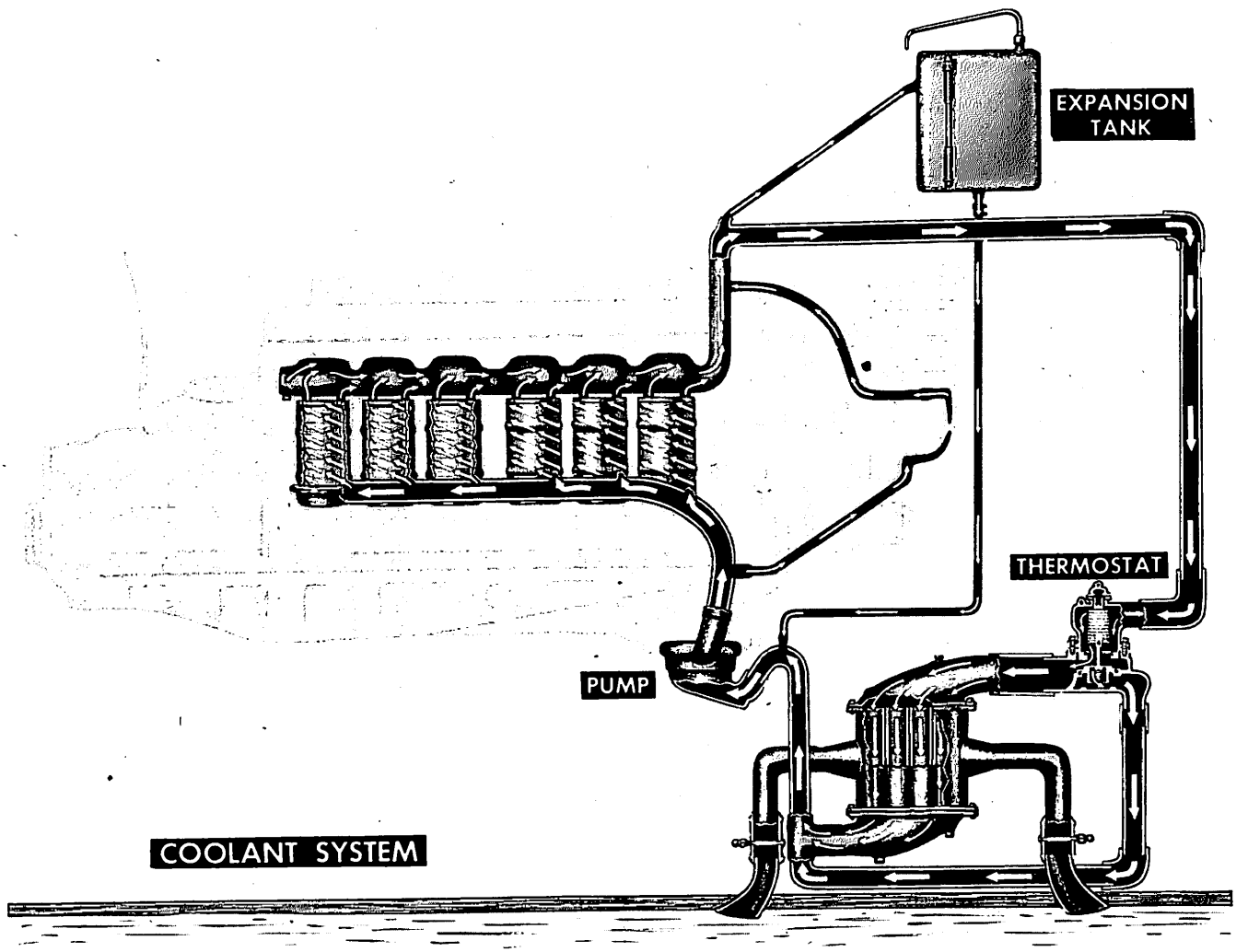


Figure 87—Engine Coolant Schematic

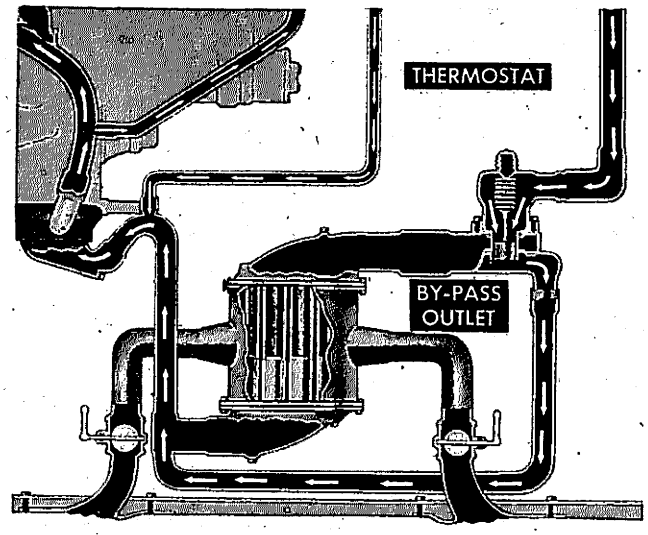


Figure 87A—Location of Thermostat in System

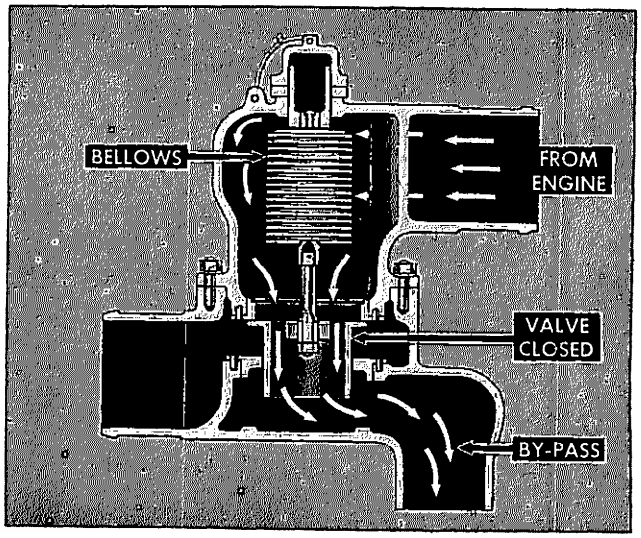


Figure 87B—Coolant Bypassed

quarter full. Add the antifreeze and then add more fresh water to bring the coolant level up to the required point in the expansion tank.

Note

If the antifreeze preparation already contains a rust inhibitor, a water soluble oil should not be added, as it would cause foaming in the system.

(d) Run the engine sufficiently to warm up the entire system and to open the thermostat, thus insuring complete mixing of the water and antifreeze. The level in the tank will drop somewhat as the solution circulates and the trapped air is expelled through the tank vent. Add fresh water, a little at a time, until the level remains constant at the full mark.

(3) REPLENISHING WITH ANTIFREEZE. — After a cooling system containing antifreeze has been properly filled, do not add make-up water to the system until the solution has been checked with the proper antifreeze tester. To check the antifreeze:

(a) Start the engine and run it long enough to circulate and warm the cooling solution thoroughly.

(b) Fill and empty the tester several times to warm it and remove air bubbles, and read the protective strength of the solution following the directions on the tester.

(c) If the strength of the solution is not sufficient to protect the system for the lowest expected temperature, add more antifreeze. If the system simply needs more liquid, then antifreeze and water should be added in the same proportion as the mixture in the tank.

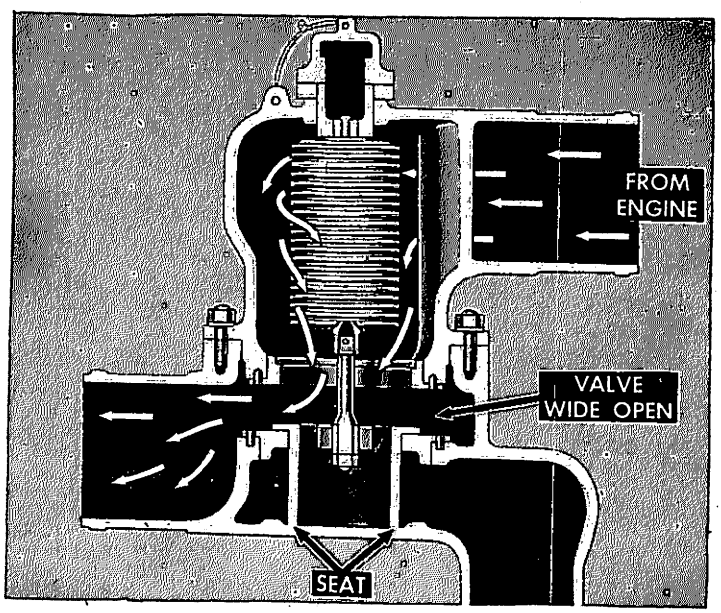
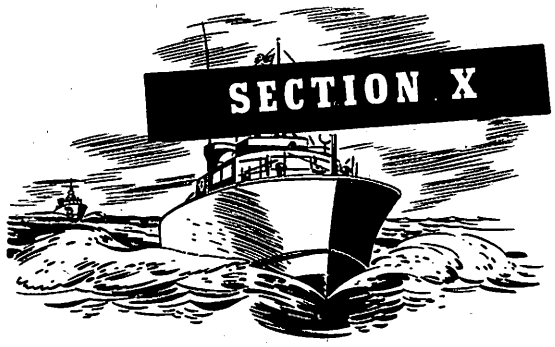


Figure 87C—Coolant Going to Heat Exchanger



Salt Water
COOLING SYSTEM

1. DESCRIPTION.

(See figure 88.)

a. HEAT EXCHANGERS.—Each engine has two separate heat exchangers for cooling oil and coolant. (See figure 88A.) Salt water is circulated around tubes carrying the oil and the coolant. Each heat exchanger is provided with two zinc plugs and two pairs of zinc disks which prevent electrolysis of the sea water from corroding the metal of the exchangers. Salt water attacks these zinc electrodes first, so that the greater part of its corrosive action is spent on them and its action on the steel and aluminum parts of the salt water cooling system is reduced to a minimum.

b. SCOOPS AND VALVES.—The salt water that passes through the heat exchangers is picked up by a scoop through the hull. A pipe leads the sea water from the scoop to the heat exchangers, and another pipe takes the water back through the hull to the outlet scoop. Valves control the flow of water into the inlet scoop and out of the outlet scoop. (See figures 88B and 88C.) A screen over the intake scoop prevents fouling of the salt water compartment in the heat exchangers.

c. EXHAUST MANIFOLD COOLING.—A salt water pump on the engine takes water from the main salt water pipe and circulates it through jackets that cool the exhaust manifolds. (See figure 89.) After cooling the manifolds, the salt water passes overboard through the exhaust pipes.

2. OPERATION.

Water is circulated through the salt water system in two different ways: by action of the salt water pump and by the forward movement of the boat.

a. IDLING AT DOCK.—When the boat is at the dock with the engines idling, the salt water pump will draw water through the heat exchangers if the inlet scoop valve is open and the outlet scoop valve is closed. Warm-up of lubricating oil and coolant to operating temperatures may be speeded up by opening the outlet valve. The salt water then will follow the shorter course and enter the system through the outlet scoop without passing through the heat exchangers.

Note

In warm climates, the inlet scoop valve is always left open. Where the water is colder, the inlet scoop valve is clamped in a position to allow only the right amount of cold water to reach the heat exchangers. The outlet scoop is opened and closed by operating the push-pull handles on the engine control pedestal. (Refer to section V, paragraph 3.)

b. UNDER WAY.—When the boat is under way and the outlet valve is open, suction is formed at the outlet scoop. This force, combined with the pressure exerted at the inlet scoop, circulates the salt water through the system from fore to aft. Closing or partially closing the outlet valve reduces the suction and stops or restricts the outflow of water, thereby regulating the intake of water by the intake scoop.

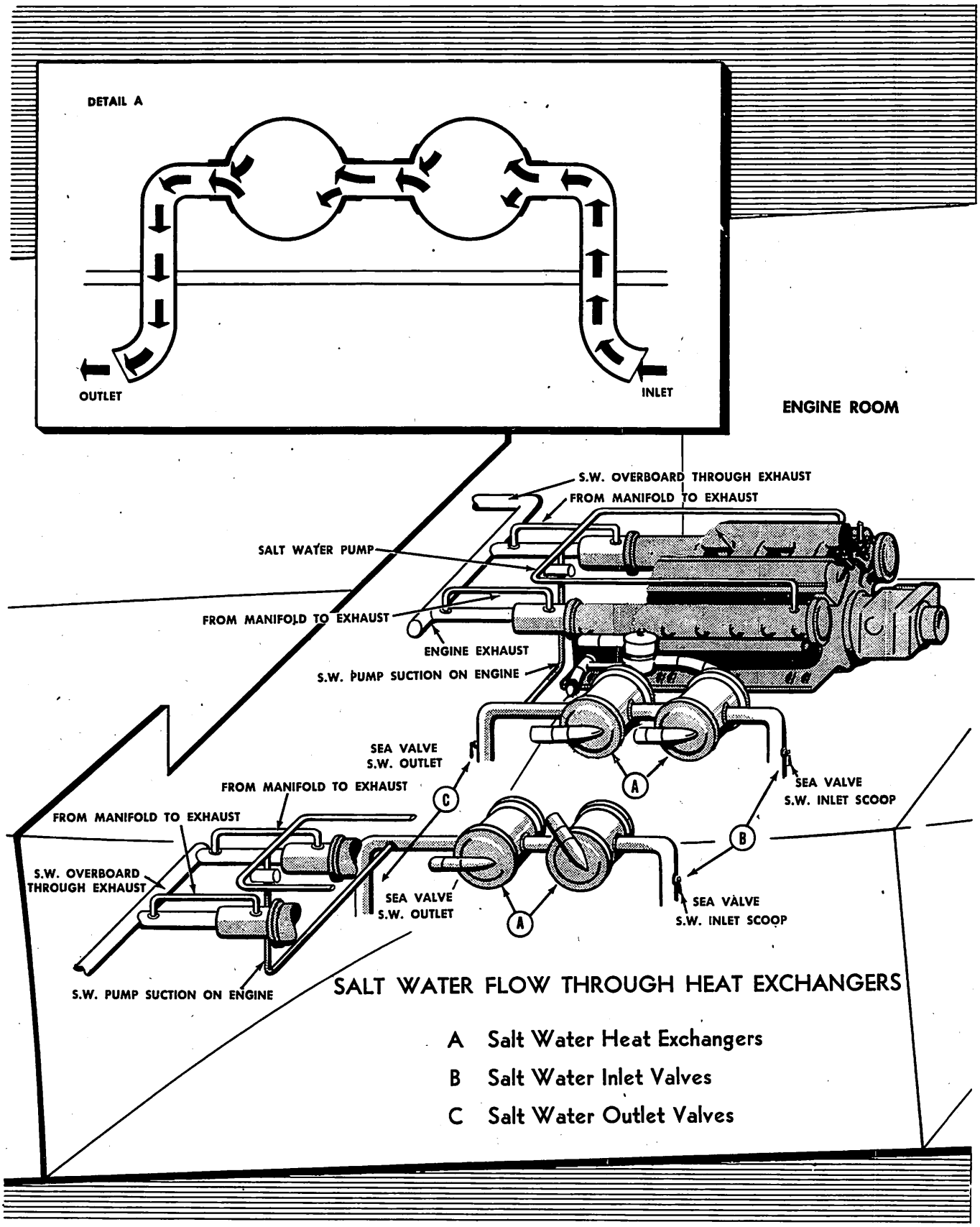
Note

Directions for adjusting the outlet valve are given in section II, paragraph 3.*b.*

3. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
SALT WATER DOES NOT FLOW THROUGH SYSTEM THOUGH VALVES ARE OPEN	Intake scoop screen covered with seaweed or other matter.	Operate boat in reverse to reverse flow of salt water through system.
OIL SLICK APPEARS AROUND BOAT WHEN IDLING AT DOCK	Broken tubes in oil heat exchanger.	Repair heat exchanger. Refer to paragraph 5.*b.*, this section.

Figure 88 — SALT WATER COOLING SYSTEM



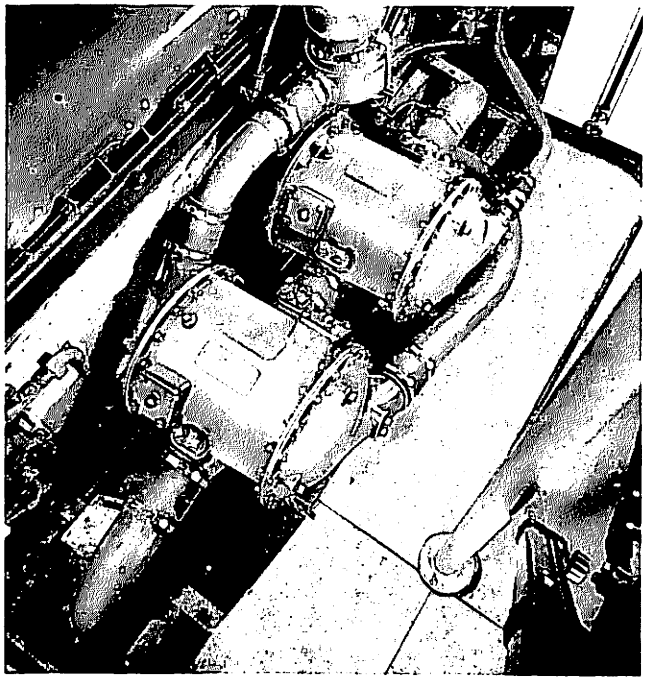


Figure 88A—Salt Water Heat Exchangers

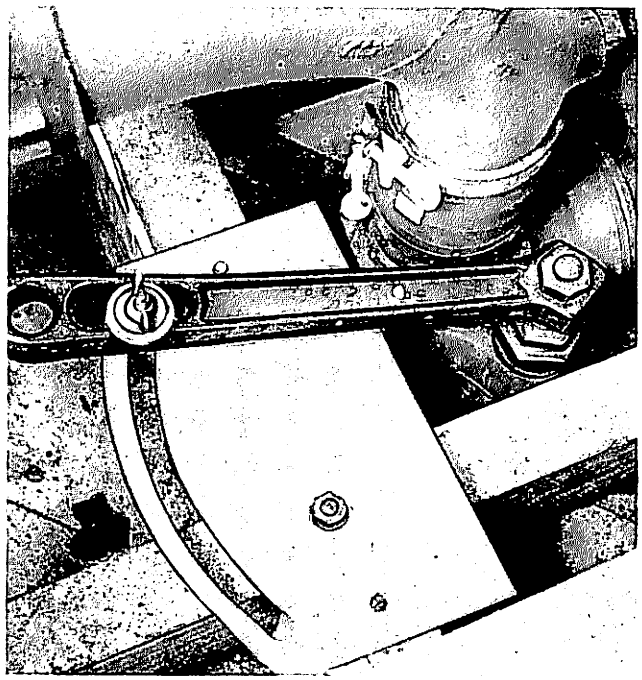


Figure 88B—Salt Water Inlet Valve

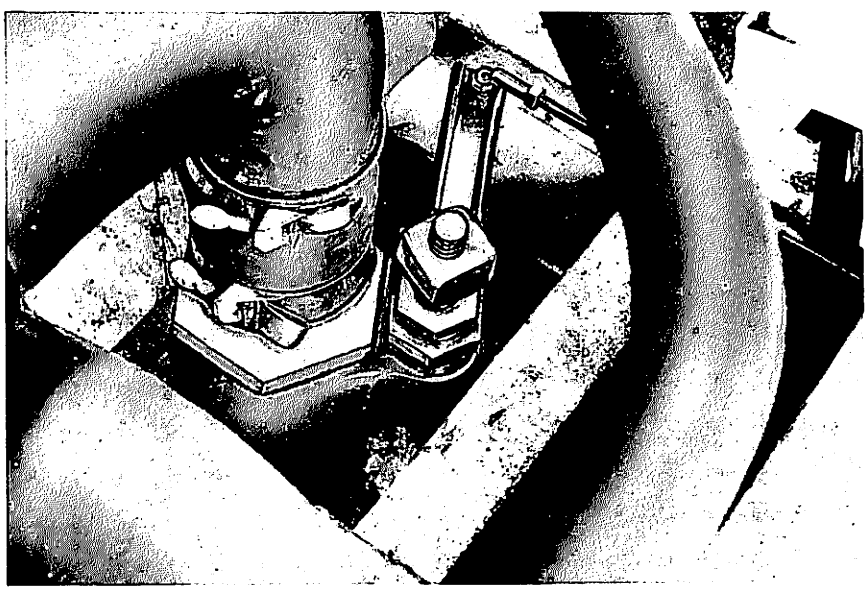


Figure 88C—Salt Water Outlet Valve

4. SERVICING AND MAINTENANCE.

a. REPLACING ZINC ELECTRODES.—There is one zinc plug, 3 inches long, fitted into a ¾-inch pipe plug on the inlet side and one on the outlet side of each heat exchanger. Two pairs of zinc disks are under the square plates on each heat exchanger. Both plugs and disks should be examined once a month, and, if they are eaten away as much as 50 percent, they must be replaced by new ones.

b. CLEARING CLOGGED SCREEN. — Operating the boat in reverse will reverse the salt water flow through the system and will clear away seaweed or other matter that may accumulate over the intake screen and interfere with the intake of salt water during normal operation.

5. CLEANING AND TESTING.

When the engines are removed from the boat for overhaul, heat exchangers should be removed for cleaning and testing, and for repair if needed.

a. CLEANING HEAT EXCHANGERS.—Clean heat exchangers every 6 months or after 1000 hours of oper-

ation. If oil and coolant are kept clean, a more frequent cleaning will be unnecessary. To clean a heat exchanger, after it has been removed from the boat, perform the following operations:

(1) Remove the covers.

(2) Thoroughly clean out the tubes forming the core, with white unleaded gasoline by submerging the heat exchanger in a tank of the cleaning fluid and by using a plumber's rubber suction pump to force the fluid back and forth through the tubes.

(3) Remove the heat exchanger from the tank and blow out the tubes with high-pressure air.

(4) Repeat steps (2) and (3) until visual inspection shows that the tubes are clean. A light held behind the core will aid in this inspection.

CAUTION

Never clean the core of the heat exchanger with wires or sharp instruments which might puncture the tubes.

(5) Clean the outside of the tubes in an agitated bath of an approved solution which will remove lime, rust, and other hard deposits.

(6) Flush the entire core with clean hot water to rinse off all traces of the cleaning solution.

(7) Coat the inside of the tubes with clean light oil.

(8) Thoroughly clean the inside surface of the covers and scrape the gasket surfaces of the case.

(9) Inspect the zinc electrodes and install new zinc disks and plugs if the old ones are more than half eaten away. If the zinc is only slightly eaten away, a disk or plug may be made serviceable by cleaning with a wire brush.

(10) Using new gaskets, reassemble the covers to the case.

b. TESTING FOR LEAKS.—To test the assembled heat exchanger for leaks:

(1) Plug one of the salt water openings.

(2) Fill the salt water compartment with water so that all air has been ejected.

(3) Apply water from a pressure hose, 40 to 50 pounds per square inch, to the opening.

(4) Note whether the water seeps through into the coolant or oil tubes. If it does, the tubes leak and should be replaced or repaired.

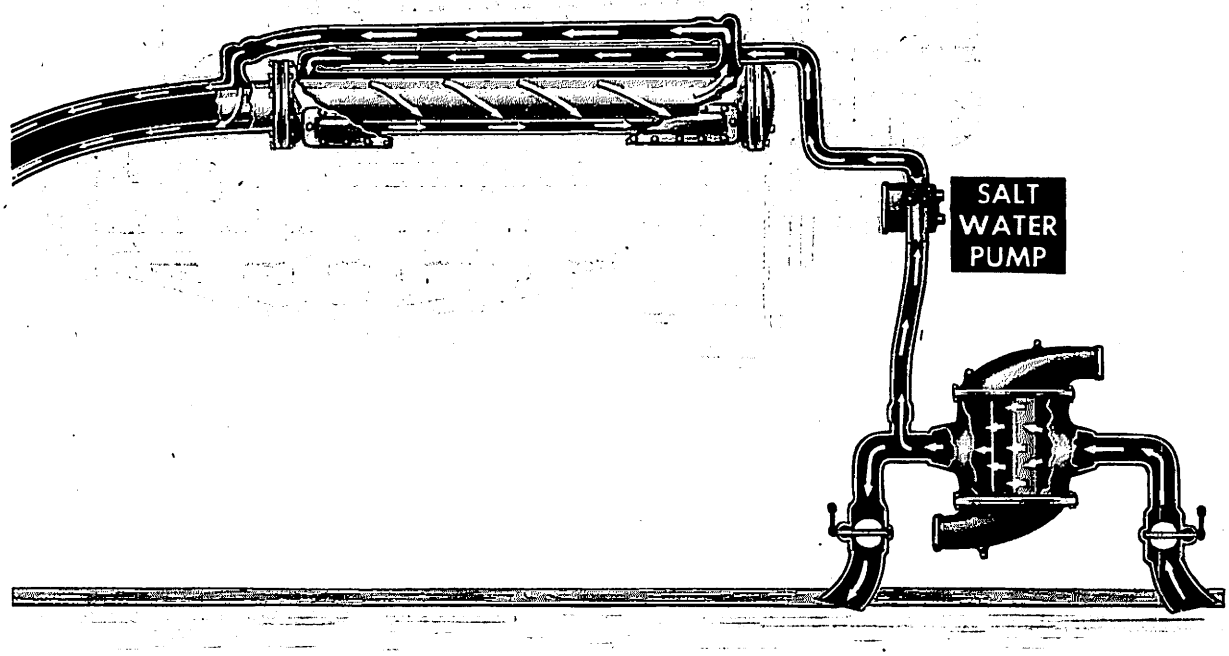
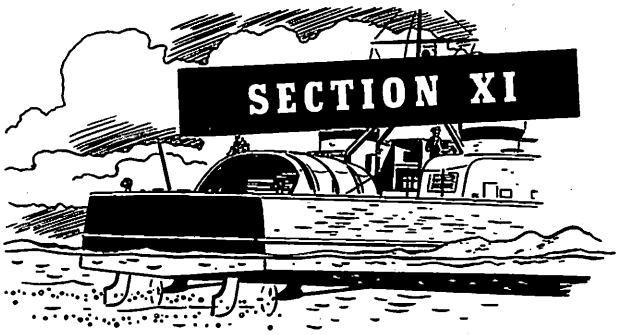


Figure 89—Exhaust Manifold Cooling



Angle Drive SYSTEM

1. DESCRIPTION.

(See figure 90.)

a. GENERAL.—The two engines propelling the 85-foot rescue boat are installed backwards. That is, the engine reverse coupling, to which the flange of the propeller shaft ordinarily is bolted, is turned toward the bow of the boat. Each engine is coupled to an angle drive—sometimes called a vee-drive or a reduction gear. The engine reverse coupling is connected to the angle drive by a shaft with universal joints on each end. The angle drive reduces the engine rotation by a 1.52:1 ratio, and thus serves as a reduction gear.

b. ANGLE DRIVE.—The angle drive is essentially an assembly of two bevel gears with short shafts and the necessary bearings and lubricating devices. (See figure 90A.) It is of the vee-type of transfer drives.

c. CONNECTING SHAFT.—The connecting shaft between the engine reverse coupling and the angle drive coupling is a double universal assembly with circular flange yokes. (See figure 91.)

d. OIL PUMP.—The gears of each angle drive are pressure lubricated by a duplex oil pump (figure 90A) mounted on the forward end of the angle drive housing. The pressure side of the oil pump supplies oil to the pinions and the scavenger side of the pump returns the oil to the lubricating oil tank.

e. LUBRICATING OIL TANK.—Lubricating oil for the angle drive is stored in a service tank below the engine room floor at bulkhead 4. (See figure 90B.) The tank has a capacity of 6 gallons and serves both the port and the starboard angle drives. It is filled by hand through a connection in the forward side of the tank. The filler connection is placed so that the tank will contain 4¾ gallons at filler level, leaving room in the top of the tank for expansion and air separation.

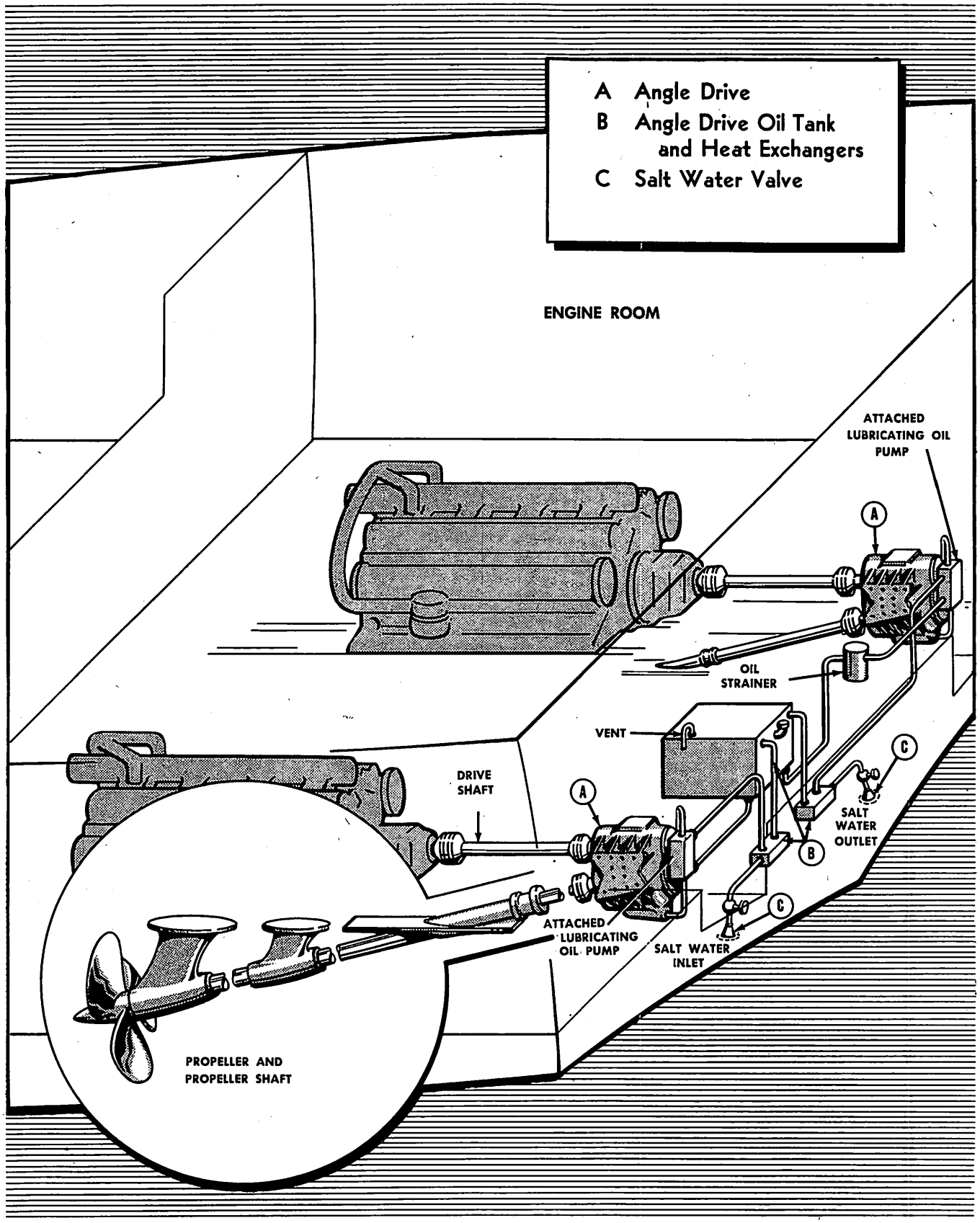
f. ANGLE DRIVE OIL HEAT EXCHANGERS.—Before the heated oil is returned to the tank, it passes through one of the two small heat exchangers located just aft of the tank. (See figures 90B and 90C.) Separate heat exchangers serve the port and the starboard angle drives. Salt water is circulated through the heat exchangers by means of pipes that pass through the hull to an intake scoop, turned forward, and an outlet scoop, turned aft. There are valves in the pipes just above the scoop. (See figure 90C.) As the angle drives operate only when the boat is under way, there is no need for a pump to circulate the salt water through the angle drive oil heat exchangers while the boat is idling at the dock.

g. OIL GAGES.—When the boat is under way and the angle drives are operating, the angle drive oil pressure and oil temperature are registered on gages on the instrument panel labeled "REDUCTION GEAR." (See figure 92.)

2. TROUBLE SHOOTING.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
EXCESSIVE OIL HEAT DEVELOPS SUDDENLY	Scavenger pump is not working.	Stop engine affected and repair pump.
EXCESSIVE OIL HEAT DEVELOPS SLOWLY	Oil bypass valve staying open.	Readjust bypass valve ball and spring.
OIL PRESSURE RISES SUDDENLY	Small holes in spray nozzle clogged up.	Remove and clean nozzle.
OIL PRESSURE DROPS SUDDENLY	Broken pump or broken oil line.	Stop engine or put in neutral. Check pump and oil lines.

Figure 90 — ANGLE DRIVE SYSTEM



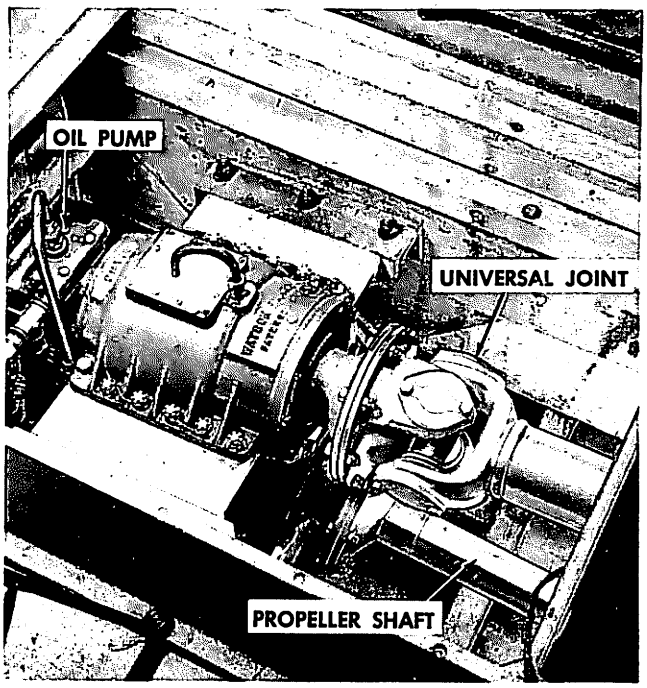


Figure 90A—Angle Drive

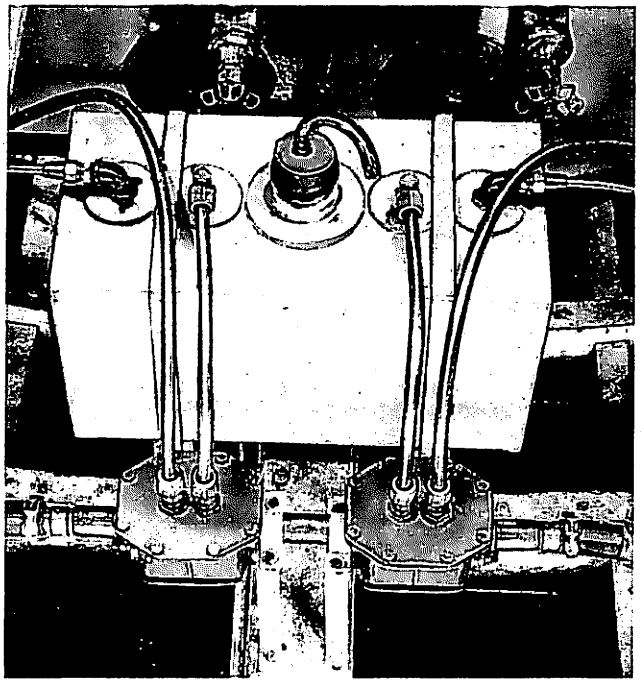


Figure 90B—Angle Drive Oil Tank and Heat Exchangers

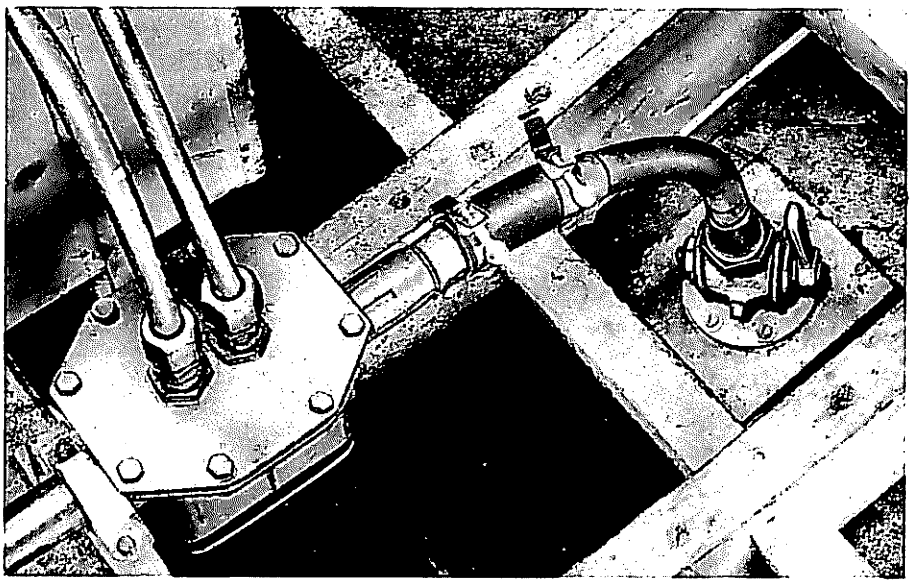


Figure 90C—Salt Water Valve

3. SERVICING AND MAINTENANCE.

a. ANGLE DRIVE LUBRICATING OIL.—The grade of oil SAE 30 with a paraffin base, Navy Symbol 1065, is recommended for lubricating the angle drive when the engine room temperature on the boat ranges from 10° to 48°C (50° to 120°F). When climatic temperatures are below 10°C (50°F), the main engines should be started at frequent intervals to maintain an engine room minimum temperature of 10°C (50°F).

(1) The normal operating oil temperature is 82°C (180°F), with 110°C (230°F) being the maximum safe temperature.

(2) The oil pressure for normal operation should range between 15 and 20 psi.

CAUTION

If the oil temperature is too high or oil pressure is abnormal, the oil-pressure relief valve should be checked for free movement. Any washers behind the oil relief spring should be replaced just as removed. The plunger should be inspected for imperfect seating. All oil lines should be free of obstructions.

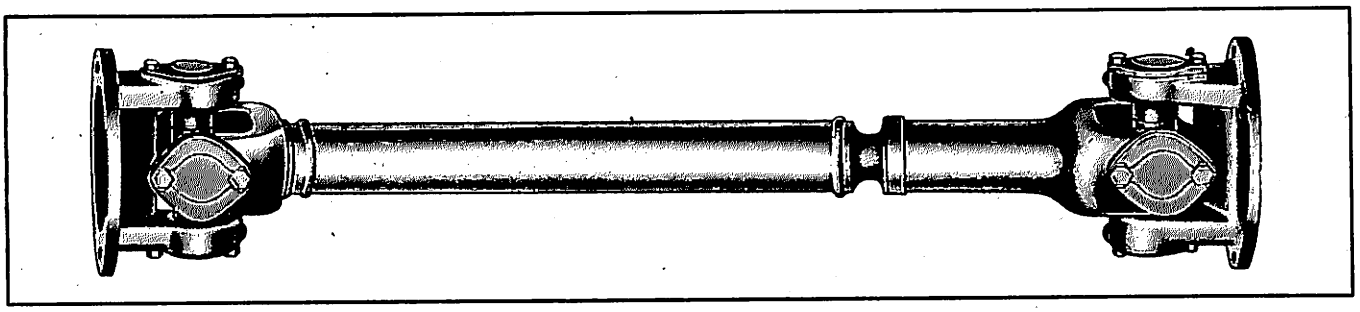


Figure 91—Connecting Shaft

(3) Any time oil leaks at the hub of the angle drive shaft flange, the oil seal should be replaced.

Note

If the boat has been idle for a long time, brush oil or a thin grease on the hub of the angle drive shaft flange as a protection to the oil seal before starting up the boat engines.

b. CHECKING ALIGNMENT.—Soon after a boat has been commissioned, and every 3 months thereafter, the alignment of the angle drive with the propeller shaft should be checked. The wooden hull swells after the boat is in the water, and this may result in improper alignment. Check and, if necessary, correct the alignment as follows:

(1) Remove the cotter pins, nuts, and bolts from the circular flanges which couple the gear shaft of the angle drive to the propeller shaft.

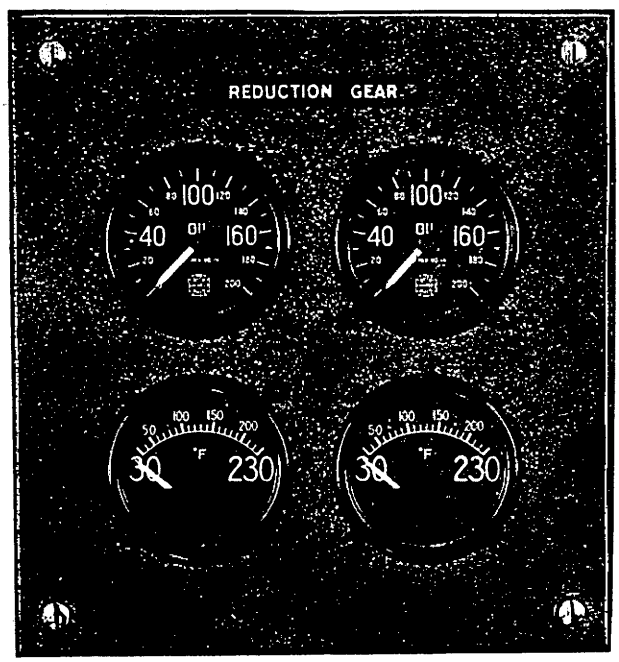


Figure 92—Gages for Angle Drive Oil

(2) Check the faces of the flanges for parallelism with a feeler gage. Turn one of the flanges 180 degrees and check again with the feeler gage.

(3) If the faces of the flanges are not parallel, shim up the angle drive on its mounting brackets until the feeler gage shows that the flanges and shafts are properly aligned.

(4) Reinstall and tighten the bolts and nuts holding the angle drive to its brackets.

(5) Check again with a feeler gage to make sure that the faces of the coupling flanges are parallel. If they are not, readjust the shims until the flanges and the shafts are properly aligned after the bolts have fastened the angle drive to its brackets.

(6) Reinstall the bolts and nuts that fasten the coupling flanges together. Tighten the nuts and install new cotter pins.

4. OVERHAULING THE ANGLE DRIVE.

Note

Parts mentioned in the following subparagraphs are keyed to figure 93.

a. DISASSEMBLING THE ANGLE DRIVE.—If the angle drive has failed or is in need of repair, disassemble it as follows:

(1) From the flanges (15) of the two main shafts (14 and 16), remove the flange hex nuts, fillister-head screws, locking plates, and counterweights.

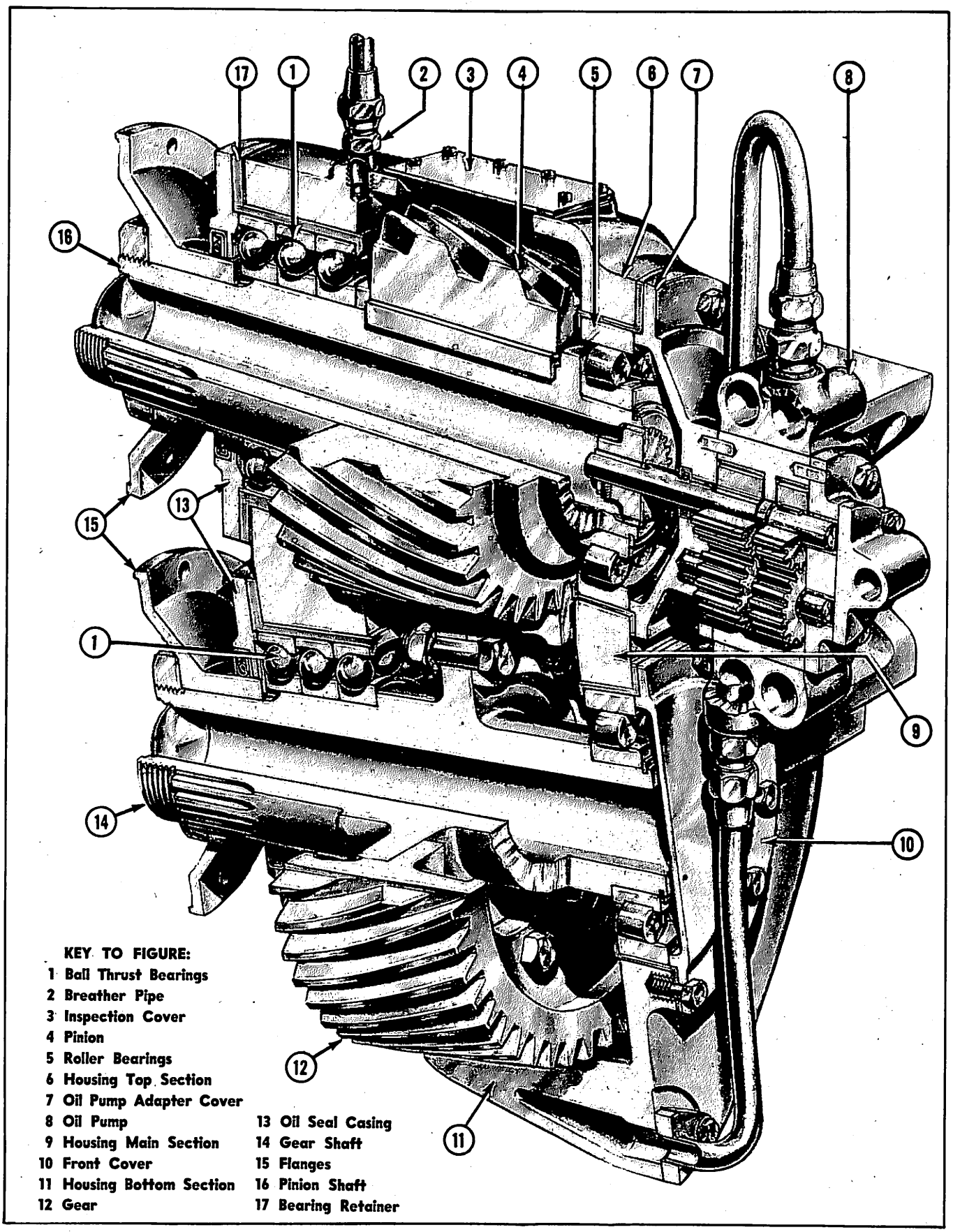
(2) Remove the two flanges.

(3) From the housing near the same end of the shafts, remove the bolts, washers, and oil-seal casings (13) that fit around both shafts. Mark the casings so that they can be installed around the same shaft from which they were removed.

(4) Remove and mark the oil slingers from each shaft.

(5) Use jackscrews to back the thrust bearing retainers (17) away from the aft end of the housing. Each retainer has two $\frac{3}{8}$-inch tapped holes for this purpose.

(6) Remove the shims from behind each retainer. Carefully mark the shims for each shaft, so that when the angle drive is reassembled the shims will be in the correct position and will insure the proper backlash of the main gears (4 and 12).



KEY TO FIGURE:

1 Ball Thrust Bearings
2 Breather Pipe
3 Inspection Cover
4 Pinion
5 Roller Bearings
6 Housing Top Section
7 Oil Pump Adapter Cover
8 Oil Pump
9 Housing Main Section
10 Front Cover
11 Housing Bottom Section
12 Gear
13 Oil Seal Casing
14 Gear Shaft
15 Flanges
16 Pinion Shaft
17 Bearing Retainer

Figure 93—Cross Sectional View of Angle Drive

(7) Remove the bolts and washers that hold the front cover (10) to the forward end of the angle drive housing, and remove the cover.

(8) Disconnect all oil pipe connections on the angle drive and the oil pump (8).

(9) Remove the bolts and washers that hold the oil pump adapter cover (7) to the forward end of the angle drive housing, and remove the oil pump and the adapter cover.

(10) Use jackscrews to back off the roller bearing retainers from the forward end of the housing.

(11) Remove the cotter pins, nuts, and bolts that hold the housing top, main, and bottom sections together.

(12) Remove the housing bottom section (11) from the main section, taking care not to drop the spiral bevel gear (12) and the gear shaft (14), which will come out with the bottom section.

(13) Remove the housing top section (6), and lift out the spiral bevel pinion (4) and the pinion shaft (16).

(14) Remove the remaining cotter pins, nuts, washers, and bolts from the top and bottom sections.

(15) Remove the breather pipe (2) and inspection cover from the housing top section.

(16) Remove the gears and bearings (1) and (5) from the main gear shafts.

(17) Remove the bearings from their retainers (17).

(18) Clean all parts.

b. ASSEMBLING THE ANGLE DRIVE. *(See figure 93.)*

Note

All parts must be thoroughly cleaned of all burs and foreign matter before they are assembled.

(1) ASSEMBLING THE MAIN GEARS AND SHAFTS.

(a) Press the 25-tooth spiral bevel pinion (4) on its shaft (16), taking care to have clearance from the top of the key to the root of the key slot in the gear so as to avoid the shearing of metal.

(b) Press the 38-tooth spiral bevel gear (12) on its shaft (14) and fasten it in place with the bolts, nuts, and cotter pins.

(c) Check both main gears and shafts for run-out, using a dial indicator. The run-out must not exceed .002 inch.

CAUTION

Main gear and shaft assemblies are lapped in pairs. Therefore, if it is necessary to replace one gear and shaft, a complete new set should be installed.

(2) ASSEMBLING BEARINGS AND OIL SEALS.

(a) BALL THRUST BEARINGS.—These bearings (1) are used in stacks of three in each retainer.

1. Thoroughly clean the retainers (17) of burs and all foreign matter.

Note

It is important that those bearings be located in the retainer correctly. A cone has been etched across the outer race of a set of bearings. To assure correct installation, the apex of the cone is to point toward the main gears.

2. Press the bearings into the retainers. Do not drive them into place by direct hammering on any part of the bearing, but press them into the retainers with an arbor press, using a piece of bronze bar stock sufficiently large to cover both the inner and outer races. No metal which is likely to chip under the pressure should be used for pressing the bearings into place.

3. Check the bearings for proper seating by measuring the distance at several points from the machined face of the retainer flange to the face of the outer race of the top bearing. It is important that the bearings be properly seated, so that the thrust from the main gears of the angle drive and the thrust from the engine and propeller shafts will be properly taken by the bearings.

(b) ROLLER BEARINGS.—These bearings (5) are used one in each retainer.

1. Thoroughly clean the retainers of all burs and foreign matter.

2. Press the outer race of the bearing into place, using an arbor press and a piece of bronze bar stock having a diameter sufficient to fit the outer race.

CAUTION

In cases where one or more bearings fail in the angle drive, all bearings on both main gear shafts must be replaced with new ones. Otherwise, excessive wear will be introduced to all moving parts of the angle drive.

(c) OIL SEAL AND OIL-SEAL CASING.—When the oil-seal casing (13) is drawn up to the ball thrust bearing retainer (17) flange face, the bearing (1) will be locked into position. To assure proper seating of the register lip of the oil-seal casing on the outer race of the bearing, measure the distance from the face of the top bearing outer race to the machined flange face of the retainer; then machine the register lip on the oil-seal casing, which presses against the top bearing, to a dimension which is .002 inch more than the measurement just taken.

1. Thoroughly clean the casing of all burs and foreign matter.

2. Apply a thin coating of sealing compound to the casing of the seal.

3. Press the seal into the seal casing with the seal lip pointing toward the main gears. Take care that no sealing compound comes in contact with the seal lip and that the seal is installed without distortion.

(d) INSTALLING BEARINGS ON MAIN GEAR SHAFTS.

1. Clean all burs from the bearing seats on the main shafts. Unless this is done, there is no assurance that the bearings will be seated properly on the shaft bearing seats.

2. Before pressing the ball thrust bearings (1) on the pinion shaft (16), press the bearing spacer into place. Then install the ball thrust bearings on the shaft, using a piece of tubing which has a diameter sufficient to fit the inner race. Do not use a metal which will chip easily under pressure.

3. Press the roller bearing inner race on each shaft by using a piece of metal tubing which has a sufficient diameter and which will not chip under pressure. Then insert the snap ring into the groove in the shaft.

(3) INSTALLING THE LUBRICATOR BLOCK AND LUBRICATOR TUBE.

(a) Install the lubricator block in the housing main section. Take care to mount the lubricator block with the openings in the lubricator tubes facing the ball thrust bearings. Bolt the lubricator block into place, and safety wire the Allen head cap screws.

Note

It is important that the tubes of the lubricator block clear the ends of the main gears and ball thrust bearings.

(b) The lubricator tube is silver soldered to the oil-pressure flange. Three holes have been drilled in the tube for the purpose of directing lubricating oil to the main gears and roller bearings. Install the lubricator tube in the housing, sliding the tube end through the hole in the housing center section into the hole in the lubricator block. Be sure that the holes in the lubricator tube always point toward the main gears. Bolt the tube flange and gasket into place, and safety wire the Allen head screws.

(4) INSTALLING THE MAIN GEAR AND SHAFT ASSEMBLIES IN THE HOUSING MAIN SECTION.—The top bore of the housing main section (9) may be located by matching the number stamped on the center section with the number stamped on the housing top section (6). Matching numbers also are stamped on the housing bottom section (11) and on the bottom bore of the main section.

(a) Install the 25-tooth pinion (4) and shaft (16) assembly in the top bore of the housing.

(b) Install the shims between the ball thrust bearing retainer (17) flange and the housing. A group of shims, averaging .060 inch in thickness, is used.

(c) Install the oil slingers on the spline end of the shaft, with the raised surface facing the inner race of the aft thrust bearing.

(d) Apply a thin coating of grease to the oil-seal lip of the oil-seal casing (13) and bolt the casing tight to the housing main section.

(e) Apply a thin coating of grease to the ground surface of the hub of the shaft flange (15), and bolt the flange tight on the shaft with the hexagon nut.

(f) Install the 38-tooth gear (12) and shaft (14) assembly in the bottom bore of the housing.

(g) Install the front cover (10) over the roller bearing end of the gear shaft. Bolt this cover tight to the housing main section.

(h) Install the shims between the ball thrust bearing retainer flange and the housing.

(i) Install the oil slinger on the spline end of the shaft, with the raised surface facing the inner race of the aft thrust bearing.

(j) Apply a thin coating of grease to the lip of the oil-seal casing (13) and bolt the casing tight to the housing main section.

(k) Apply a thin coating of grease to the ground surface of the shaft flange, and bolt the flange tight on the shaft with the hexagon nut.

(l) Bolt a spare front cover (10), or the oil pump (8) minus its gear, tight to the housing main section over the forward end of the pinion shaft. (This is a temporary installation for checking the backlash of the gears.)

(m) Check the backlash of the gear and pinion as follows:

1. Wedge the 25-tooth pinion (the upper gear) in a stopped position with a piece of fiber or green wood.

2. Mount a dial indicator in position so that the plunger presses against the meshing side of one of the teeth of the lower gear.

3. Rock the lower gear shaft clockwise and counterclockwise. Any movement of the gear will be shown on the dial indicator. The minimum amount of backlash has been marked on the face of the main gear. The backlash of the main gears may be +.004 inch more than the minimum backlash marked on the main gear face. If the minimum amount of backlash is not recorded on the dial indicator, then add more .060-inch shims to each shaft back of the ball thrust bearing retainer flange. These additional shims must be added equally, so that alignment of the main gear faces will be within .003 inch. After the backlash of the main gears has been established within the allowable limits by checking at several points around the circumference of the gear, remove the wedge holding the pinion. The backlash of the main gears must be within the range of .008 to .012 inch.

(5) INSTALLING THE HOUSING BOTTOM SECTION.

(a) Remove all bolts from the bottom oil-seal casing in the housing main section, and remove the casing, oil slinger, and shims.

(b) Remove the hexagon nut and the flange from the lower gear shaft.

(c) Back the bearing retainers away from the housing main section. Use jackscrews.

(d) Apply a thin coating of sealing compound on the housing mating surfaces of the main and bottom sections.

(e) Install the bottom section and the four bolts, washers, and nuts. Tighten the nuts only fingertight.

(f) Apply a thin coating of sealing compound to the housing face end of the bottom ball thrust bearing bore. Also coat very thinly all face surfaces of the shims, both flange face surfaces of the ball thrust bearing retainer, and the flange face surface of the oil-seal casing which mates with the bearing retainer.

(g) Install the shims between the housing and ball thrust bearing retainer.

(h) Place the oil slinger on the spline end of the lower gear shaft, with the raised surface toward the inner race of the ball thrust bearings.

(i) Bolt the oil-seal casing to the housing, but do not finally tighten.

(j) Apply a very thin coating of sealing compound to the mating face surfaces of the housing bore and the roller bearing retainer flange, and press the roller bearing retainer into the housing bore.

(k) Apply a thin coating of sealing compound to the face of the front cover which mates with the flange of the roller bearing retainer, and bolt the cover in place.

(l) Torque the four body bolt nuts.

(m) Install the body studs and tighten fully.

(n) Torque the cap screws in the oil-seal casing.

(6) INSTALLING HOUSING TOP SECTION.

(a) Remove all bolts from the spare front cover or oil pump adapter cover in the housing main section. If the oil pump has been bolted to the housing main section for checking the main gears' backlash, install the oil pump gear on the oil pump shaft.

(b) Remove all bolts from the top oil-seal casing in the housing main section. Remove the casing, oil slinger, and shims.

(c) Remove the hexagon nut and spline shaft flange from the pinion shaft.

(d) Back the bearing retainers away from the housing main section. Use jackscrews.

(e) Install the inspection cover (3) and breather pipe (2).

(f) Apply a thin coating of sealing compound on the housing mating surfaces of the main and top sections. Install the top section and the four body bolts, washers, and nuts. Tighten the nuts only fingertight.

(g) Apply a thin coating of sealing compound to the housing face end of the top ball thrust bearing bore. Also coat very thinly all face surfaces of the shims, both flange face surfaces of the ball thrust bearing retainer, and the flange face surface of the oil-seal casing which mates with the bearing retainer.

(h) Install the shims between the housing and ball thrust bearing retainer.

(i) Place the oil slinger on the splined end of the pinion shaft with the raised surface toward the ball thrust bearing inner race.

(j) Bolt the oil-seal casing to the housing, but do not finally tighten.

(k) Apply a very thin coating of sealing compound to the mating face surfaces of the housing bore and the roller bearing retainer flange, and press the roller bearing retainer into the housing bore.

(l) Torque the four body bolt nuts.

(m) Install the body studs and tighten fully.

(7) INSTALLING THE OIL PUMP.

(a) Measure the distance from the roller bearing retainer flange face to the bottom of the integral pump gear spline in the pinion shaft. After this distance has been determined, adjust the position of the pump gear on the pump shaft and then lock it in place with the setscrew.

(b) Apply a thin coating of sealing compound on the mating surfaces of the roller bearing retainer flange and the flange of the pump adapter cover (7), and bolt the oil pump (8) tightly in place.

(c) Tighten the cap screws in the oil-seal casing.

(d) Assemble the flange on the pinion shaft with the hub of the flange registering against the oil slinger. Care should be taken that a thin coating of grease is applied to the ground surface of the flange hub so that the oil-seal lip will not be damaged by scoring.

(e) Bolt the flange into place with the hexagon nut, and check for concentricity. This check is made by a dial indicator with the plunger pressing on the flange face and the inside surface of the flange register. A tolerance of .002 inch is allowable for the spline shaft flange run-out.

(f) Install the locking plates and counterweights.

(8) FINAL OPERATIONS.

(a) Make all oil pump pipe connections.

(b) Recheck all cap screws, studs, bolts, and nuts for tightness; then safety them with wire and cotter pins.