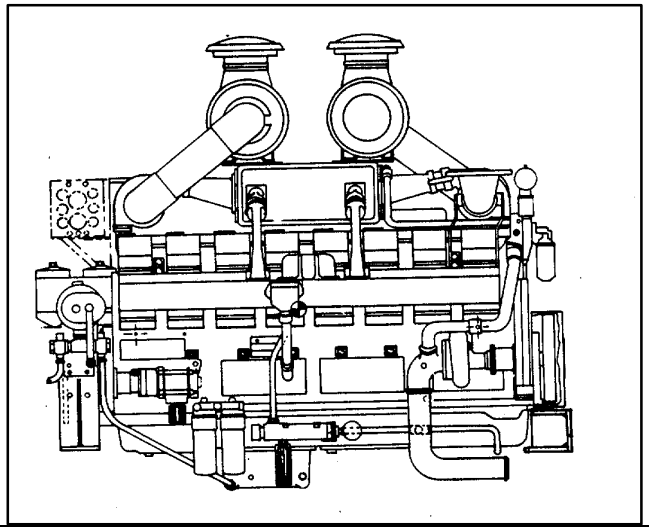
TECHNICAL MANUAL
UNIT, INTERMEDIATE DIRECT SUPPORT
AND INTERMEDIATE GENERAL SUPPORT
MAINTENANCE INSTRUCTIONS

MAIN PROPULSION ENGINE
FOR
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191

STARBOARD (RIGHT SIDE)



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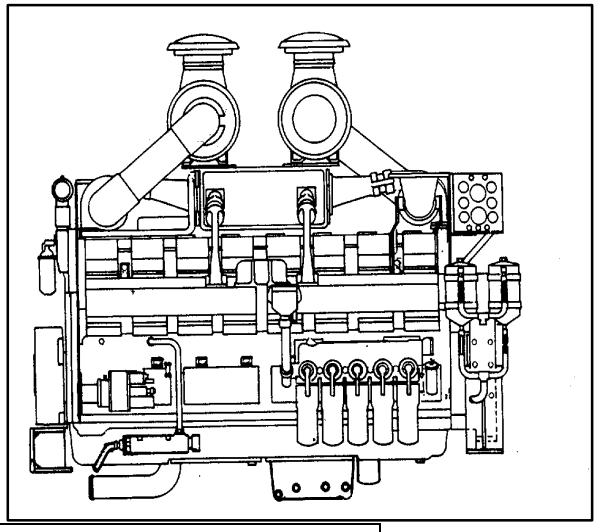

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CHANGE

NO. 4

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Unit, Intermediate Direct Support and
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MAIN PROPULSION ENGINE
for
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191

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B-17 and B-18	B-17 and B-18

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Unit, Intermediate Direct Support and Intermediate
General Support Maintenance Instructions

MAIN PROPULSION ENGINE
FOR LANDING CRAFT UTILITY (LCU)
(NSN 1905-01-154-1191)
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UNIT, INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

MAIN PROPULSION ENGINE
FOR LANDING CRAFT UTILITY (LCU)
(NSN 1905-01-154-1191)

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Unit, Intermediate Direct Support and
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Maintenance Instructions
MAIN PROPULSION ENGINE
for
LANDING CRAFT UTILITY
(NSN 1905-01-154-1191)
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2-35 through 2-38	2-35 through 2-38
2-45 and 2-46	2-45 and 2-46
2-49 and 2-50	2-49 and 2-50
2-121 and 2-122	2-121 and 2-122
2-129 through 2-132	2-129 through 2-132
2-139 and 2-140	2-139 and 2-140
3-9 and 3-10	3-9 and 3-10
3-21 and 3-22	3-21 and 3-22
3-25 and 3-26	3-25 and 3-26
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3-99 and 3-100	3-99 and 3-100
4-5 through 4-8	4-5 through 4-8
4-29 and 4-30	4-29 and 4-30
4-37 and 4-38	4-37 and 4-38
4-43 and 4-44	4-43 and 4-44
4-59 and 4-60	4-59 and 4-60
4-69 and 4-70	4-69 and 4-70
4-75 and 4-76	4-75 and 4-76
4-83 and 4-84	4-83 and 4-84
B-5 through B-18	B-5 through B-18

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DISTRIBUTION:
To be distributed in accordance with DA Form 12-25E, Unit, Intermediate Direct Support and Intermediate General Support Maintenance requirements for Landing Craft, Utility, LUC-1466, Type III

WARNING

MODIFICATION HAZARD

Unauthorized modifications, alterations or installations of or to this equipment are prohibited and are in violation of AR 750-10. Any such unauthorized modifications, alterations or installations could result in death, injury or damage to the equipment.

HIGH PRESSURE
HYDRAULIC SYSTEM HAZARDS

Hydraulic systems can cause serious injuries if high pressure lines or equipment fail.

Never work on hydraulic systems or equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who can give first aid. A second person should stand by controls to turn off hydraulic pumps in an emergency. When the technicians are aided by the operators, the operators must be warned about dangerous areas.

MOVING MACHINERY HAZARDS

Be very careful when operating or working near moving machinery.

Running engines, rotating shafts, and other moving machinery parts could cause personal injury or death.

ELECTRICAL HAZARDS

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Do not be misled by the term "low voltage." Potentials as low as 50 volts may cause death under adverse conditions.

Be careful not to contact 115-Vac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

For Artificial Respiration, refer to FM 21-11.

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TECHNICAL MANUAL

No.55-1905-223-24-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 17 January1989

UNIT, INTERMEDIATE DIRECT SUPPORT, AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

MAIN PROPULSION ENGINE
For
Landing Craft Utility (LCU)
NSN 1905-01-154-1191

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of Changes to Publications and Blank Forms), or DA Form 20282 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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CHAPTER 1

INTRODUCTION

SECTION I. GENERAL INFORMATION

1-1. Scope. The scope of this manual is as follows:

a. Type of Manual. Unit, intermediate direct support, and intermediate general support maintenance manual.

b. Model Number and Equipment Name. Main Propulsion Engine, Model KTA50-M.

c. Purpose of Equipment. Provides drive power to the marine gear to propel the craft.

1-2. Maintenance Forms, Records, and Reports. Department of the Army forms and procedures used for equipment maintenance are those prescribed by DA Pam 738-750, the Army Maintenance Management System.

1-3. Destruction of Army Materiel. Refer to TM 750-244-3 for instructions covering the destruction of Army materiel to prevent enemy use.

1-4. Reporting Equipment Improvement Recommendations (EIR). If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, U.S. Army Troop Support Command; ATTN: AMSTR-QX; 4300 Goodfellow Blvd.; St. Louis, Missouri 63120-1798. We'll send you a reply.

1-5. Preparation for Storage or Shipment. Administrative storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the Preventive Maintenance Checks and Services (PMCS) charts before storing. When removing the equipment from administrative storage, the PMCS should be performed to assure operational readiness. Repacking of equipment for shipment or short term storage is covered in paragraph 2-38.

SECTION II. EQUIPMENT DESCRIPTION AND DATA

1-6. General Description. The KTA50-M is a 1250 hp, 16 cylinder, water-cooled diesel engine designed for marine use. The main propulsion engines furnish drive power to the marine gear. The main propulsion engines are equipped with remote and local control stations.

1-7. Characteristics, Capabilities, and Features. A very broad view of the main propulsion engines is as follows:

a. Characteristics.

(1) Turbocharger allows more horsepower to be developed.

(2) Fuel injectors deliver atomized fuel into combustion chambers for ignition by heat of compressed air.

(3) Four stroke cycle, in order, is: intake stroke, compression stroke, power stroke, and exhaust stroke.

(4) Cooling as follows:

(a) Engine operating heat is controlled by coolant.

(b) Lube oil is controlled by lube oil cooler.

(c) Air is cooled or heated as necessary by an aftercooler.

b. Capabilities and Features.

(1) Furnishes 1250 hp to drive the marine propellers.

(2) Can put out 2100 rpm (maximum).

(3) Engine idle speed is 725-775 rpm.

(4) Has both remote and local controls.

1-8. Location and Description of Major Components. FIG. 1-1 shows views of each side of the engine with the locations of major components indicated. Refer to FIG. 1-1 and the reference number key below for the description of these components.

a. Turbocharger Group (1). Two turbine wheels, one located on the exhaust manifold on each side of the engine.

b. Air Cleaner Group (2). Two filter canister and cover assemblies, located on the top of the engine.

c. Air Intake Manifold Group (3). Intake air distribution piping, located on both sides of the engine.

d. Thermostat Housing/Water Transfer Tube Group (4). Thermostat and water distribution piping, located on the front of the engine behind the water filters.

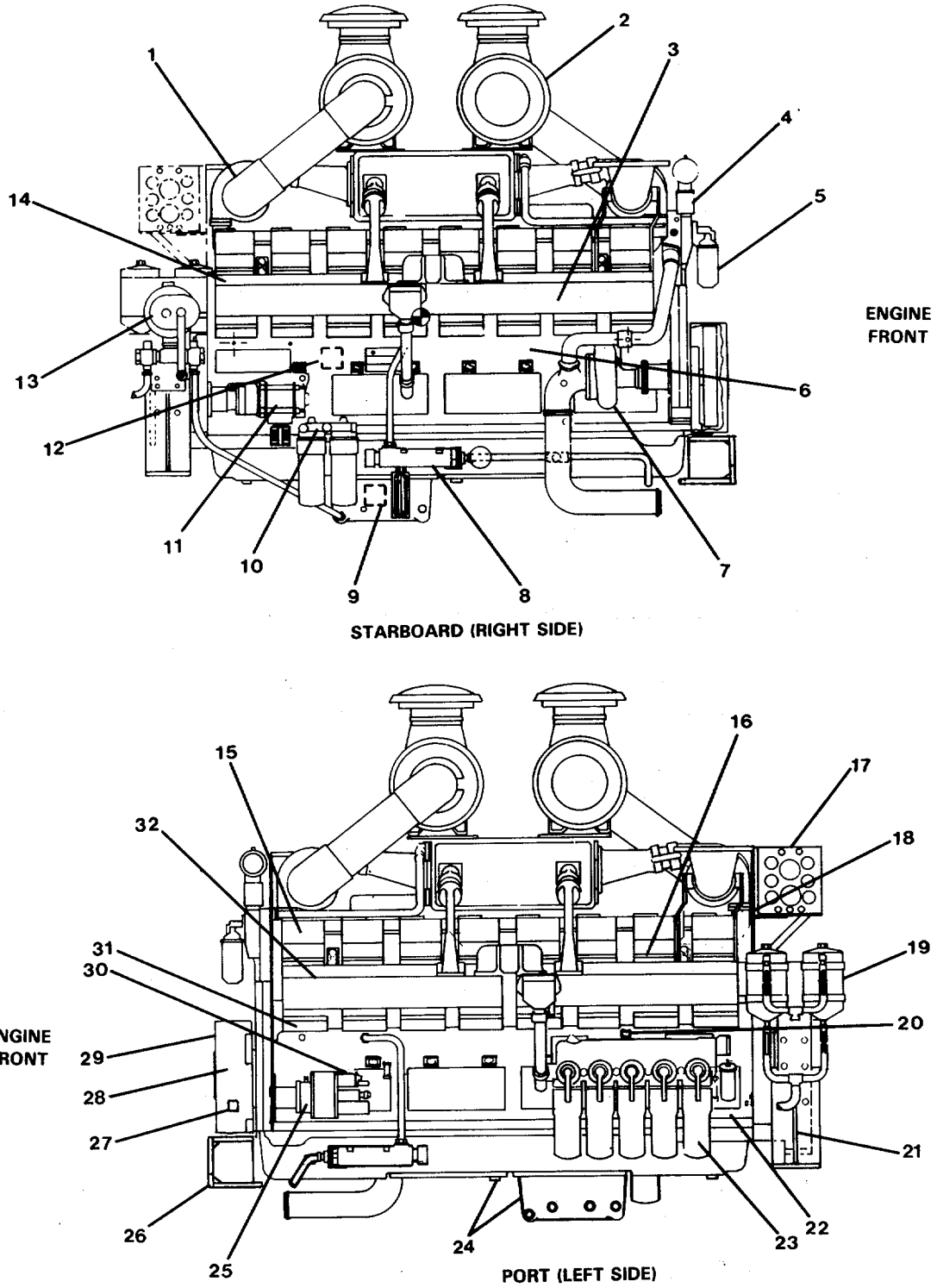


FIGURE 1-1. Location of Major Components.

e. Water Filter Group (5). Four spin-on filters and head assembly, located on the front of the engine.

f. Cylinder Block assembly (6). The engine block, which supports the assemblies necessary for engine operation.

g. Water Pump Group (7). Centrifugal water pump, located on the right side near the front of the engine.

h. Cold Starting Aid Group (8). Two thermostatically controlled coolant heaters, located on the deck on either side of the engine.

i. Lubricating Oil Pump Group (9). Gear driven lube oil pump, located in the cylinder block directed below the crankshaft.

j. Lube Oil Bypass Filter Group (10). Two spin-on filters and head assembly, located on the lower right rear corner of the engine.

k. Engine Air Starter (11). Turbine driven starter, located on the right side near the rear of the engine.

l. Lubricating Oil Cooler Group (12). Plate type heat exchangers, located in the main water passage in the center of the "V" of the cylinder block.

m. Sump Pump Group (13). Manually operated lube oil pump, located at the right rear of the engine.

n. Fuel Manifold Group (14). Fuel distribution piping assembly, located on the rocker lever housing on both sides of the engine.

o. Rocker Housing Cover, Rocker Lever Housing Group (15). Sixteen rocker lever assemblies, located on the top of the cylinder heads.

p. Cylinder Head Group (16). Sixteen cylinder head assemblies, located on the top of the cylinder block.

q. Instrument Panel Group (17). Electrical panel, located at the top rear of the engine, that contains gauges and switches for local control of the engine.

r. Exhaust Manifold Group (18). Exhaust air assembly, located on the top of both sides of the engine.

s. Fuel Filter Group (19). Two filter canister assemblies, located on the rear of the engine near the top.

t. Connecting Rod and Piston Group (Internal. 20). Sixteen sets of pistons and connecting rods, located in the cylinder block.

u. Flywheel Housing Group (21). The flywheel, ring gear, and barring mechanism assemblies, located at the lower rear of the engine.

v. Handhole Cover Group (22). Eight access covers, located on each side of the cylinder block.

w. Lube Oil Filter Assembly (23). Five spin-on filters and head assembly, located on left side of engine near the rear.

x. Oil Pan and Adapter Group (24). Lube oil pan, located under the engine.

y. Fuel Pump Group (25). Gear-driven pump and throttle assembly, located on the left side near the front of the engine.

z. Engine Support Group (26). Engine mounting support assembly, located below the front and rear of the engine.

aa. Camshaft and Gear Group (27). Two camshafts and gears, located in the cylinder block.

ab. Vibration Damper/Bearings/Crankshaft Group (28). Vibration damper and crankshaft, located in the cylinder block.

ac. Pulley Shield/Front Gear Housing Group (29). Housing assembly, located on the front of the engine.

ad. Shutdown Valve Group (30). Solenoid-operated shutdown valve assembly,

ae. Cam Follower and Housing Group (31). Sixteen cam follower assemblies located in the cylinder block.

af. Injector Group (32). Sixteen fuel injectors, one in each cylinder head.

1-9. Equipment Data. Characteristics and reference data are provided in Table 1-1. Also see the equipment data given in the operator's manual, TM 55-1905-223-10.

Table 1-1. Equipment Data

Characteristics	Reference Data
GENERAL ENGINE DATA	
Horsepower	1250 hp
Engine Speed @ Maximum Output	2100 rpm
Bore and Stroke	6.25 in (159 mm) x 6.25 in (159 mm)
Displacement	3067 in^3 (50.3 litres)
Compression Ratio	14.5:1 to 15.5:1
Firing Order	1R-1L-3R-3L-7R-7L-5R-5L-8R-8L-6R-6L-2R-2L-4R-4L
Engine Weight	
Dry Weight	11,000 lb (4950 kg)
Wet Weight	12,000 lb (5400 kg)
Dimensions (overall)	
Length	98.8 in (251.0 cm)
Width	55.3 in (105.5 cm)
Height	91.0 in (231.0 cm)
AIR INDUCTION SYSTEM	
Maximum allowable turbocharged intake restriction	25 in H_20 (63.5 cm H_20)
LUBRICATION SYSTEM	
Oil pressure at idle	20 psi (138 kPa) minimum idle 45 psi (310 kPa) minimum rated rpm 70 psi (483 kPa) maximum rated rpm
Oil capacity of engine:	
Bypass filter	0.75 U.S. gl (2.8 litres)
Full flow filter	0.93 U.S. gl (3.5 litres)
Oil pan capacity (low-high)	32 to 55 U.S. gl (121-208.5 litres)
Maximum oil temperature	250°F (120°C)
COOLING SYSTEM	
Coolant capacity (engine only)	40.5 U.S. gallons (153 litres)
Standard thermostat modulating range	175-195°F (80°-90°C)
Maximum allowable top tank temperature	203°F (95°C)
Minimum recommended top rank temperature	160°F (70°C)
Minimum recommended pressure cap	7 psi (48 kPa)

Table 1-1. Equipment Data-CONT

Characteristics	Reference Data
EXHAUST SYSTEM	
Maximum allowable back pressure imposed by piping and silencer	3 in Hg (75 mm Hg)
Exhaust pipe size (normally acceptable inside diameter	6 in (152 mm)
FUEL SYSTEM	
Engine idle speed	725 to 775 rpm
Maximum allowable restriction to pump:	
With clean filter	4 in Hg (100 mm Hg)
With dirty filter	8 in Hg (200 mm Hg)
Maximum allowable fuel return line restriction	2.5 in Hg (63 mm Hg)

1-10. **Safety, Care, and Handling**. Safety precautions must be observed at all times while performing maintenance. General WARNINGS and first-aid data appear in the front of this manual. Review all safety information before starting any task. Carefully read through an entire maintenance procedure before performing any maintenance function. Make sure the task can be done safely. All WARNINGS, CAUTIONS, and NOTES are of great importance to your safety and the safety of the equipment.

SECTION III. PRINCIPLES OF OPERATION

1-11. **Diesel Engine Operation**. Diesel engine operation is different from spark-ignited engine operation. Compression ratios are higher and the charge taken into the combustion chamber during the intake stroke consists of air only, with no fuel mixture. Injectors receive low-pressure fuel from the fuel system and deliver it into individual combustion chambers at the proper time, and in the right quantity and atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber.

a. Diesel Engine Cycles. The diesel engine four stroke combustion cycle consists of four piston strokes. The four strokes happen in this order: intake stroke, compression stroke, power stroke, and exhaust stroke (FIG. 1-2). In order for the four strokes to function properly, valves and injectors must act in direct relation to each of the four strokes of the piston. The intake valves, exhaust valves, and injectors are camshaft actuated, linked by tappets or cam followers, push rods, rocker levers, and valve crossheads. The camshaft is driven by the crankshaft gear, and that means rotation of the crankshaft drives the camshaft, which then controls the opening and closing sequence of the valves and injection timing (fuel delivery).

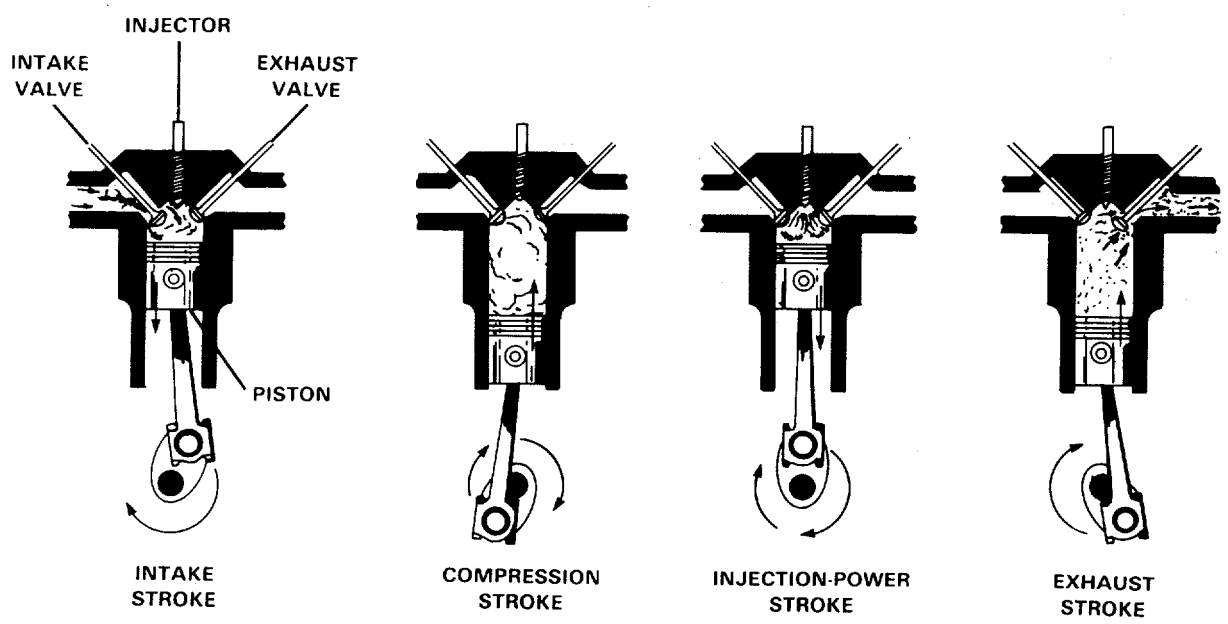


FIGURE 1-2. Diesel Engine.

(1) Intake Stroke. During the intake stroke, the piston travels downward, the intake valve is open, and the exhaust valve is closed. The downward travel of the piston allows air from the intake manifold to enter the cylinder. The intake manifold is pressurized with air from the turbocharger.

(2) Compression Stroke. At the end of the intake stroke, the intake valve closes and the piston starts upward on compression stroke (exhaust valve remains closed). At end of compression stroke, air in combustion chamber is compressed into a small space, causing the air temperature to rise to a point high enough for ignition of fuel. During the last part of compression stroke and early part of power stroke, a small metered charge of fuel is injected into combustion chamber. The fuel is then ignited by the hot compressed air.

(3) Power Stroke. During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases (intake and exhaust valves are still closed). As more fuel is added and burns, gases get hotter and expand to further force the piston downward to deliver driving force to crankshaft rotation.

(4) Exhaust Stroke. During the exhaust stroke, the intake valve is closed, exhaust valve is open, and the piston is on the upstroke. Upward travel of the piston forces burned gases out of combustion chamber through the open exhaust valve port and into the exhaust manifold.

b. Cooling System. The coolant system removes heat created during engine operation. Coolant is circulated by a centrifugal water pump with mounted thermostats to control engine operating temperature. Coolant temperature is reduced in a keel cooler (heat exchanger), and circulated through a water filter which passes a small amount of coolant from the system through a filtering and treating element. The engine is also equipped with two (one on each side of the block) coolant heaters which are thermostatically controlled to aid in cold weather operation. The system is treated with antifreeze to afford protection.

c. Lubrication System. The engine is pressure lubricated by a gear-type lube oil pump mounted to the block directly below the crankshaft and driven from the rear crankshaft gear. An external electric motor driven pump provides prelube pressure for starting.

(1) Filtering. Lube oil is filtered by five spin-on lube filters mounted to a common filter head. In the event of filter blockage, a bypass valve on the filter head routes the lube oil directly to the main oil galleries providing uninterrupted lube oil flow until the main filters are changed.

(2) Cooling. Lube oil is routed from the lube oil pump to lube oil cooler elements located in the block "V" between the cylinder banks and under the aftercooler. The coolers are finned heat exchangers which give off heat to the engine coolant which is circulated around them.

(3) Turbocharger Lubrication. Lube oil is routed from block drillings to the turbocharger supply line. The return line runs from the turbocharger to a block drilling where it is then routed back to the oil pan.

d. Air System. For the engine to operate efficiently, intake and exhaust systems must not be restricted. Intake air is routed through an air cleaner directly to the turbocharger and then to the aftercooler.

(1) Aftercooler. The aftercooler reduces or increases intake air temperature. It consists of a housing which is part of the engine intake air manifold, with an internal core made of tubes through which coolant circulates. Air is cooled or heated by passing over the core prior to entry into the engine combustion chambers, thereby improving combustion through better control of intake air temperature.

(2) Turbocharger. The turbocharger forces additional air into combustion chambers so the engine can burn more fuel and develop more horsepower than if it were naturally aspirated. The turbocharger consists of a turbine wheel and a centrifugal blower (compressor wheel), separately encased but mounted on and rotating with a common shaft. Power to drive the turbine wheel, which in turn drives the compressor, is obtained from the energy of engine exhaust gases. Rotating speed of the turbine changes as the energy level of exhaust gas changes, providing the engine with additional air to meet increased load requirements.

e. Fuel System. Filtered diesel fuel is supplied to the injectors via the fuel filters, fuel manifold and cylinder head drillings, from a fuel pump that is driven by the front camshaft (geared to the crankshaft).

CHAPTER 2

UNIT MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

2-1. **Common Tools and Equipment**. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

2-2. **Special Tools, TMDE, and Support Equipment**. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

2-3. **Repair Parts**. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

SECTION II. SERVICE UPON RECEIPT

2-4. **Checking Unpacked Equipment**.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

d. Remove protective caps, plugs, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective films at time of installation.

e. Remove chocks from resilient mounted components.

2-5. Preliminary Servicing, Adjustment and Operation of Newly Installed Equipment.

a. New and Rebuilt Engine Break-In. The way a new engine is operated during the first 100 hours of service will have an important effect on the life of the engine and its parts. Even though all engines are run on a dynamometer for several hours before they leave the factory, an additional period of careful operation is required.

(1) Perform pre-starting procedures (paragraph 2-5(b)).

(2) Avoid operation for long periods at engine idle speeds, or at maximum horsepower levels in excess of 5 minutes.

(3) Develop the habit of watching engine instruments closely during operation and reduce speed if oil temperature reaches 250°F (121°C) or coolant temperature exceeds 190°F (88°C).

(4) Check oil level each 10 hours during break-in period.

b. Pre-Starting Procedures. Follow these procedures when starting a new or rebuilt engine for the first time:

(1) Prime the Fuel System.

(a) Fill fuel filter with clean diesel fuel oil.

(b) Remove suction line from fuel pump and prelubricate gear pump with 2 to 3 oz (50 to 60 cc) of clean lubricating oil.

(c) Check fuel tanks. There must be an adequate supply of clean diesel fuel in the tanks.

(d) If injector and valve or other adjustments have been disturbed by any maintenance work, check to be sure they have been properly adjusted before starting the engine.

CAUTION

Do not attempt to prime engine lubricating system from bypass filter.

(2) Priming the Lubricating System. The engine is primed automatically by an external electrically driven pump. However, in the event of problems in the self priming system, the following procedures should be performed before starting the engine:

(a) Remove oil inlet line from the turbocharger and prelubricate bearing with 2 to 3 oz (50 to 60 cc) of clean lubricating oil. Reconnect oil supply line.

(b) Fill crankcase until oil on dipstick (2, FIG. 2-1) or in liquid level gauge (FIG. 2-2) reaches the "H" (High) mark.

(c) Remove plug (1, FIG. 2-1) from lubricating oil filter head and use this opening as the priming point.

(d) Connect a hand or motor-driven priming pump hose from source of clean lubricating'oil to priming point.

(e) Prime until a 30 psi (207 kPa) pressure is obtained.

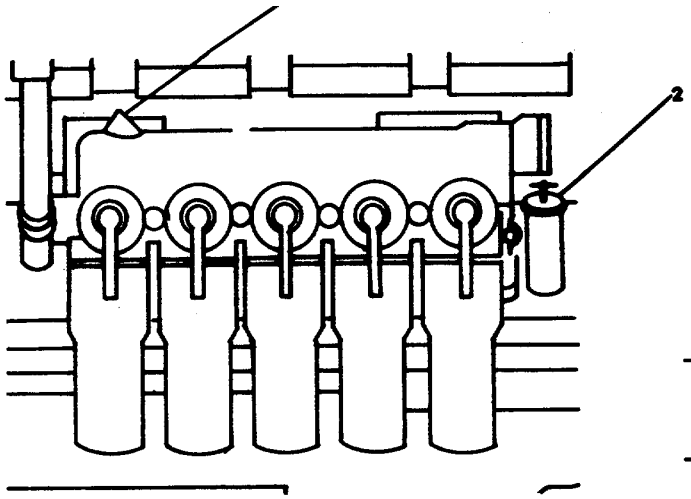


FIGURE 2-1. Lube Oil Priming Point and Oil Fill/Dipstick Arrangement.

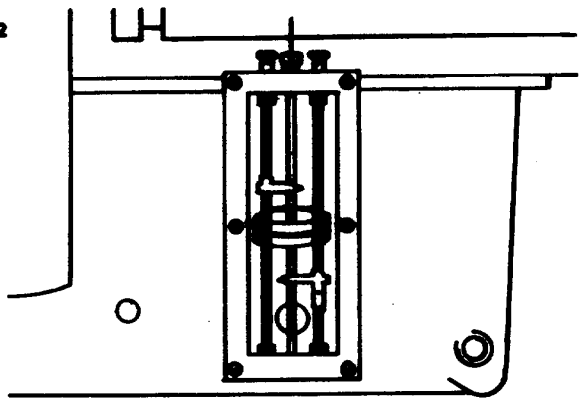


FIGURE 2-2. Oil Level Sight Glass.

(f) Crank engine at least 15 seconds (with fuel shutoff valve closed or disconnected to prevent starting), while maintaining external oil pressure at a minimum of 15 psi (103 kPa).

(g) Remove priming hose and replace the plug removed in step (c).

(3) Lubricating Oil Dipstick Gauge Marking. All marine engines are shipped with unmarked lubricating oil dipstick gauges. The reason for this is the engine mounting angle which is determined at installation. Even though a given amount of oil is required, the dipstick must be marked so the oil level is correct at the engine mounting angle. If marking has not been previously accomplished or the dipstick is lost, the following procedures apply:

(a) With engine in the installed position and the boat in the water, use the sump pump to completely drain the engine.

CAUTION

Any oil left in oil pan will cause error in marking. Oil sometimes accumulates as the oil drains from upper portions and oil passages within the engine; therefore, it is necessary to wait 15 minutes after the sump pump has emptied the oil pan initially to pump out the remaining oil, ensuring complete evacuation of oil from the engine.

(b) A tag is attached to new engines indicating high and low capacities of the oil pan. The capacity of the KTA50-M engine is 32 gallons (low) to 55 gallons (high).

NOTE

The above figures do not include amount required to fill oil lines and oil purifier.

(c) Fill engine with amount of oil listed as low-level oil pan capacity (32 gallons).

(d) Allow 5 minutes or more for oil to drain to the oil pan. If engine and/or oil temperature is below 40°F (4°C), a longer period may be required.

(e) Insert dipstick (2, FIG. 2-1) into gauge tube until fully seated; hold for 5 to 10 seconds, then ` withdraw slowly.

(f) Mark oil level indicated on dipstick with an electric etch. Depth of mark must not exceed 0.010 inch (0.24 mm). Etch "L" above mark.

(g) Add enough additional oil to fill engine to listed high-level capacity (55 gallons).

(h) Repeat steps (d), (e), and (f). Etch letter "H" directly above the second or "high" level mark.

(i) Start engine (TM 55-1905-223-10) and operate at idle for 3 minutes. Stop engine and fill to high mark. Additional oil may be required to fill oil filters and lines.

NOTE

The above procedure determines dipstick gauge marking for oil pan capacity only. Do not confuse with complete oil system capacity which also includes drilled passages, lines, and filters.

(4) Check Air Connections. Check for loose clamps or connections; cracks, punctures, or tears in hoses or tubing; collapsing hose; or other damage. Tighten clamps or replace parts as necessary to ensure an airtight air intake system. Make sure that all air goes through the air cleaner.

(5) Check Engine Coolant.

(a) Observe the sight level gauge on the expansion tank located on top of EOS to check engine coolant supply.

CAUTION

Do not, under any circumstances, add a large amount of cold water to a hot engine suddenly. The rapid cooling may crack the cylinder liner and head or seize the piston.

(b) If coolant level is low, check for evidence of coolant leakage around tubing, hose connections, etc.; correct as necessary. Inspect water pump bleed hole for leakage; leakage indicates a worn or damaged seal. Fill the expansion tank to the proper level as indicated in the sight glass on the coolant expansion/fill tank.

(6) Check Fuel Supply and Connections. Visually check for evidence of external fuel leakage at fuel connections and tighten as necessary. Inspect hoses and tubing for damage and replace as necessary.

c. Starting the Engine. After the above actions are taken, the engine is ready to start.

WARNING

Ensure that all personnel are clear of the engine, the marine gear is disengaged, and appropriate operations personnel are notified before starting the engine.

CAUTION

Protect the engine and engine components during start-up by idling until normal idle oil pressure (20 psi minimum) is obtained. Do not prolong idling unnecessarily. Operation at low temperatures can result in serious damage.

(1) Place marine gear in neutral.

(2) Place engine ON/OFF switch to the ON position. This activates the fuel solenoid.

NOTE

A manual override knob provided on the forward end of the electric shutdown valve allows the valve to be opened in case of electric power failure. To use, open by turning fully in a clockwise direction.

CAUTION

To prevent permanent starter motor damage, do not crank engine for more than 30 seconds continuously. If engine does not start within first 30 seconds, wait 1 to 2 minutes before recranking. Damage to starter motor will occur if pushbutton is pressed before starter motor stops rotation.

(3) Press starter button and hold till the engine starts.

(4) After engine has run for a few minutes, shut downand wait 5 minutes for oil to drain back into pan. Check engine oil level again; add oil as necessary to bring oil level to "H" mark on dipstick. The drop in oil level is due to absorption by the oil filter and filling of the oil cooler.

CAUTION

Never operate the engine with oil level below the low level mark (L), or above the high level mark (H).

(5) Check for evidence of external oil leakage. Secure capscrews, fittings, connections, or replace gaskets, and O-rings as necessary to correct. Check oil dipstick and filler tube caps to see that they are secure.

2-6. Normal Startup. Refer to the operator's manual, TM 55-1905-223-10.

2-7. Shutdown Procedure (Usual or Unusual). Refer to the operator's manual, TM 55-1905-223-10.

SECTION III. UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-8. Explanation of PMCS Table. PMCS is designed to keep the equipment in good working condition. This is accomplished by performing certain tests, inspections, and services. Table 2-1 lists items to be serviced and the procedures needed to accomplish the PMCS. The "Interval" column tells you when to perform a check or service. If needed, PMCS may be performed more frequently than the indicated interval. The "Procedures" column tells you how to perform the required checks and services. If your equipment does not perform as required, see Table 2-2, Troubleshooting. Report any malfunctions or failures on DA Form 2404. In the "TM" Number column on DA Form 2404, record the appropriate Item Number from the PMCS table.

CAUTION

Never operate the engine with oil level below the low level mark or above the high level mark.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
1	*				Lube Oil Level	Check oil level at the sight level gauge (FIG. 2-2) or with the dipstick (2, FIG. 2-1). For accurate readings, oil level should not be checked until oil has settled into the pan after engine shutdown (approximately 15 minutes). Keep oil level as near the "H" mark as possible. **CAUTION** Do not, under any circumstances, add a large amount of cold water to a hot engine suddenly. The rapid cooling may crack the cylinder liners and heads or seize the pistons.
2	*				Coolant Level	Keep cooling system filled to operating level on the expansion tank sight gauge. Investigate for causes of coolant loss. Check coolant level when system is cool. Whenever coolant is added, check the corrosion inhibitor and antifreeze concentration by using DCA coolant checking kit, Item 14, Appendix C.
3	*				Intake Air System	Check air connections for loose clamps or connections, cracks, punctures, or tears in hose or tubing, collapsing hose, or other damage. Secure clamps or replace parts as necessary to make sure that the air intake is airtight. Make sure that all air goes through the air cleaner.
4	*				Throttle Linkage	Look for evidence of binding, loose fittings, obstructions, etc., that affect the smooth operation of the throttle throughout its range.
5	*				Engine	Give the engine a thorough visual inspection. Look for anything that appears to be damaged, leaking, broken, torn, missing, or out of the ordinary. Be sure that exhaust system and hoses are checked as follows:

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
5	*				Exhaust System	Check exhaust manifold for exhaust leaks, water leaks, and corrosion. Check insulation blankets (turbocharger also) to make sure that all hot surfaces are properly covered to prevent any possibility of oil spraying on the hot surfaces.
	*				Fuel, Lube and Coolant Hoses	Make sure there are no signs of abrasion. Make sure all hoses are properly connected. Make sure there is no seepage or leaks of hoses or fittings. Make sure clamps are tightened properly. **NOTE** Inspect under operating conditions with engine running. No twisting or bending force should be applied during inspection, since flexible hose may "take a set" after being in service.
	*				Fuel Pump	Check for misadjustment, evidence of tampering, and leakage.
6		*			Lube Oil (or at every 250 operating hours)	Change lube oil. The engine is provided with a manually operated sump pump located at the right rear of the engine, mounted to the flywheel housing The output side of the pump is connected to the "Dirty Lube Oil" tank. To change oil, proceed as follows. Bring engine to operating temperature (175° to 195°), then shut down. Wait 15 minutes, then open the valve between the engine sump and sump pump. Be sure the valve to the marine gear is closed. Turn the handle until all oil has been pumped from the oil pan. Close valve when all oil has been removed. Fill the crankcase to the "H" mark on the dipstick or on the sight gauge. Start engine and check for leaks. Shut down engine; allow 15 minutes for oil to drain back into pan; recheck oil level. Add oil as required.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

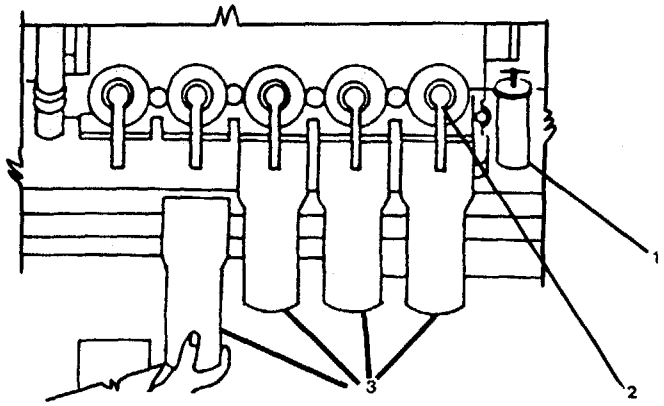
Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
7		*			Lube Oil Filters	Change lube oil filters. Unscrew all filter elements (3, FIG. 2-3). **CAUTION** Only one valve at a time should be in OFF position. All other valves should be in ON position. **NOTE** If necessary, as dictated by mission requirements, main oil filters may be changed (one at a time) while the engine is running by turning the valve for each filter to the OFF position. Be sure to turn the valve ON before proceeding to the next filter.  *FIGURE 2-3. Lube Oil Filter Change*

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
7		*			Lube Oil Filters-continued	**NOTE** Bypass filters are changed in the same manner as main filters. Fill replacement filters with lube oil. **CAUTION** Mechanical tightening may distort threads or damage filter element seal. Position oil filter element (3, FIGURE 2-3) to filter head. Secure by hand until seal touches filter head. Make additional one-half to three-fourths turn. Run engine, check for leaks, recheck oil level; add oil as necessary to bring oil level to "H" mark on dipstick or sight gauge. **NOTE** Always allow oil to drain back to oil pan before checking level. This may require 15 minutes.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

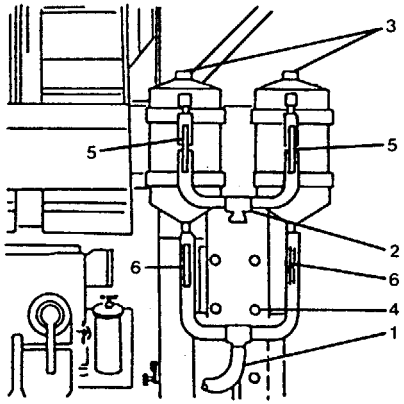
Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
8		*			Fuel Filters	**WARNING** Remove the fuel filters slowly and very carefully. Allow as much of the fuel to run out into the canister case as soon as possible before removing. Have a bucket available to place the filters in when removed. Wipe up all spills immediately. Make sure the fuel supply is turned off. Remove canister tops and remove old filters. (FIGURE 2-4)  LEGEND 1. FUEL OUTPUT 2. FUEL IN 3. CANNISTER TOPS 4. MOUNTING BOLTS 5. FUEL INPUT CUTOFF VALVES 6. FUEL OUTPUT CUTOFF VALVES *FIGURE 2-4. Fuel Filter.*

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
8		*			Fuel Filters- continued	Clean and inspect sealing ring. Replace if necessary. Clean out the canister cases thoroughly with a clean rag. Install new fuel filters. Fill canisters with clean fuel oil. Replace canister tops. Tighten the hold-down bolt to 20 to 25 ft-lb (27 to 34 Nm) torque. Turn the fuel supply on and check for leaks.
9		*			Coolant Filter	turn the water cutoff valve on the filter head (1, FIG. 2-5) to the OFF position. Unscrew filters (2) and discard.

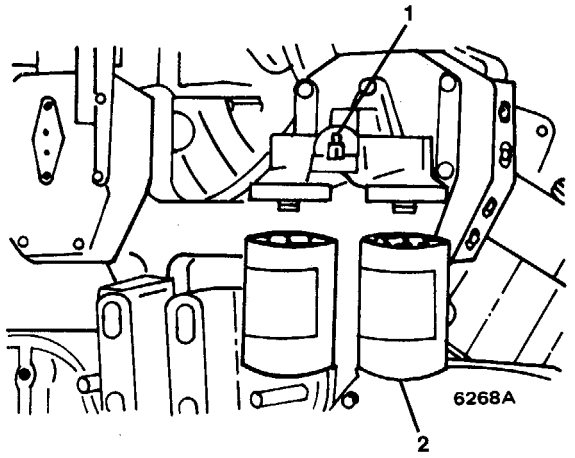


FIGURE 2-5. Coolant Filters.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

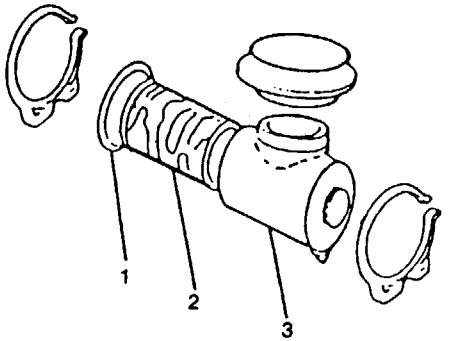
Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
9		*			Coolant Filter-continued	**CAUTION** Mechanical tightening may distort threads or damage filter element seals. Install new service filters (2). Secure by hand until seal touches filter head (1). Secure an additional one-half to three-fourths turn. Turn water cutoff to the ON position. **NOTE** Precharge filters are used only when the system has been drained.
10			*		Air Cleaner	Remove end cap (1, FIG. 2-6) from body (3). Remove element (2) and discard. Insert new element and replace end cap.  *FIGURE 2-6. Air Cleaner.*

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
11		*			Coolant	Check corrosion inhibitor and antifreeze concentration. Use the DCA check kit, Item 14, Appendix C. The system is treated with corrosion inhibitor and antifreeze (to -20°F) at delivery.
12			*			Clean the engine by performing the following steps. **CAUTION** Be sure that all access covers, filters, oil dipstick, and filler caps are in place before cleaning engine. Protect electrical connections by covering with plastic or similar waterproof material and securing with tape. Protect surrounding areas with tarpaulins, plastic sheeting, or similar material before cleaning the engine. Use steam or high pressure hot water to remove all dirt and grease from engine exterior. Be sure to clean areas hidden by external components, such as behind filter assemblies, starter, etc.
13			*		Engine Mountings	Check for and replace any broken or missing bolts, nuts, and washers. Check mountings for cracks and corrosion. Tighten bolts to 230 ft-lb.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

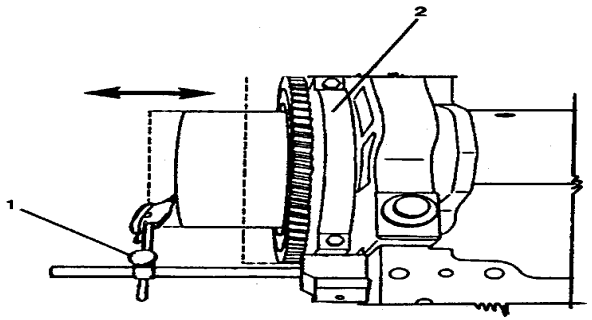
Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
14			*		Crankshaft End	This check is made by attaching a dial indicator (1, FIG. 2-7) to rest against the vibration damper while prying against the front cover (2) and back side of the vibration damper hub. End clearance must be as stated below with engine mounted in the craft and assembled to marine gear. Crankshaft end clearance (new) minimum: 0.005 in (0.13 mm) Crankshaft end clearance (new) maximum: 0.015 in (0.38 mm) Crankshaft end clearance (operating) worn limit: 0.020 in (0.51 mm) If measurement does not meet these criteria, notify your supervisor. New thrust rings are required to be installed by intermediate direct support maintenance.  6269B *FIGURE 2-7. Crankshaft End Clearance Check.*

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
15			●		Safety Controls	Check high temperature water control (TM 55-1905-223-10): a. Remove sensing unit from water passage. b. The opening of the circuit can be checked against a thermometer, while immersed in water, as the water is heated to activate temperature control. c. The warning horn should sound at about 200°F (93ºC). Check low lube oil pressure protective device (TM 55-1905-223-10): a. With engine shut down, remove protective device from engine block and reconnect the wire. b. With shutoff valve in oil pressure line open and bleed valve closed, operate engine at rated speed and no load. c. Open bleed valve and purge air from system. d. Close bleed valve and record oil pressure on instrument panel oil pressure gauge. Close shutoff valve. e. Observe the instrument panel oil pressure gauge and slowly open bleed valve until protective device sounds the warning horn. f. Sensing unit should activate when pressure is lowered below operating level.
16				●	Water Pump	Replace water pump every 24 months or every 2000 hours, whichever comes first.

Table 2-1. Preventive Maintenance Checks and Services

D-Daily Q-Quarterly A-Annually B-Biennially

Item No.	Intervals D	Q	A	B	Items To Be Inspected/Serviced	Procedures
17	·			●	Vibration Damper	Visually inspect the damper front cover plate for signs of raising or deforming. If variations are noted or suspected, proceed as follows: a. Remove the paint and accumulated dirt and grime from both the front and rear surfaces of the damper in four equally-spaced areas (avoid the area with stamped lettering); use only a good paint solvent. This will allow for precise measurement of the damper's thickness. b. Measure and record the thickness of these four areas approximately 0.125 inch (3.17mm) from the outside edge of the front cover plate. c. Replace the damper if variations of 0.010 inch (0.25 mm) or more are found or if the thickness exceeds 2.574 inches (65.38 mm) (paragraph 4-12). Evacuate to general support maintenance.
18			●		Valves and Injectors	Adjust valves and injectors every 1500 hours or annually, whichever occurs first. Refer to page 2-108, para. 1.

SECTION IV. UNIT MAINTENANCE TROUBLESHOOTING

2-9. General. A thorough analysis of the problem is the key to successful troubleshooting. The more information known about a problem, the faster and easier it can be solved. Most troubles are simple and easily corrected, such as: low power, caused by loose throttle linkage or dirty fuel filters; and excessive lube oil consumption, caused by leaking gaskets or connections. Always check the simplest, most obvious things first. More often than not, the source of the problem will be found and fixed quickly that way.

2-10. Troubleshooting Steps. The following steps make up the troubleshooting process.

a. Determine all the facts by asking the following basic questions:

(1) What were the warning signs preceding the troubleshooting?

(2) What previous repair and maintenance work has been done?

(3) Has similar trouble occurred before?

(4) If the engine still runs, is it safe to continue running it to make further checks.

b. Relate the symptoms to the basic engine systems and components.

c. Consult the troubleshooting table (see paragraph 2-12).

d. Double-check your findings before starting any disassembly. Too often, engines are disassembled in search of the cause of a certain complaint and all evidence is destroyed during disassembly operations. Check again to be sure an easy solution to the problem has not been overlooked.

e. After all the above considerations have been weighed and the problem has been identified, repair thoroughly ensuring that the basic cause of the malfunctions has been corrected so that the same failure will not reoccur. For example, the mechanical malfunction of "sticking in injector plungers" is corrected by replacing the faulty injectors, but something caused the plungers to stick. The cause may be improper injector adjustment, or more often, water in the fuel.

f. Once repairs have been made, check engine operation thoroughly to be sure all aspects of the malfunction have been cleared and the engine is operating normally.

2-11. General Symptoms.

a. White Smoke. White smoke is the result of incomplete combustion and is generally associated with engine startup. At low outside temperature, misfiring cylinders or incomplete combustion causes fuel to be exhausted which condenses upon contact with the cold outside air causing this condition. As the engine warms, the misfiring cylinders begin to sustain combustion and the level of white smoke decreases.

NOTE

Since white smoke is a normal characteristic during startup at low outside temperature, it is extremely important to determine if the level is significantly higher than normal before attempting to correct a problem which may not exist. Compare the level of white smoke from one engine to the other. If there is a significant difference under the same operating conditions, refer to Table 2-2.

b. General Engine Noise. Engine noises heard at the crankshaft speed (rated engine rpm) are related to the crankshaft, rods, pistons and piston pins. Those heard at the camshaft speed (one-half engine rpm) are related to the valve train. There is no definite rule which will positively determine the source of a noise; however, it can sometimes be isolated by holding the injector plungers down one at a time and listening for a reduction in the noise level.

NOTE

The use of a stethoscope is helpful in isolating noise. A handheld digital tachometer will help to determine whether the noise is camshaft or crankshaft related.

(1) Connecting Rod Bearing Noise. Connecting rods with excessive clearance knock at all engine speeds and under both idle and load conditions. When the bearings begin to become loose, the noise can be confused with piston slap or loose piston pins. The noise increases in volume with engine speed. Low oil pressure can also accompany this condition.

(2) Piston Noise. It is difficult to tell the difference between piston pin, connecting rod, and piston noise. A loose piston pin causes a loud double knock which is usually heard when the engine is idling. When the injector to this cylinder is held down, a noticeable change will be heard in the sound of the knocking noise. However, sometimes the knock becomes more noticeable when the engine is operated at a steady speed condition.

(3) Main Bearing Noise. A loose main bearing produces a dull knock heard every other revolution when the engine is under heavy load. If all main bearings are loose, a loud clatter will be heard. Low oil pressure can also accompany this condition. Causes that can produce a knock in tight bearings are oil that is too thin, or no oil at the bearing.

(4) Crankshaft End Clearance Excessive. This condition is accompanied by a sharp intermittent knock. Changes in engine speed and/or load will cause the noise to change.

(5) Other Possible Causes of Engine Noise.

(a) Gear train whine.

1 Excessive gear backlash.

2 Insufficient oil supply.

3 Worn gears.

(b) Bearing failure in the turbocharger, water pump, or fuel pump.

(c) Loose or damaged engine mounts.

(d) Vibrating tubing or hoses due to loose, damaged or missing mounting hardware.

2-12. Troubleshooting. Both a symptom index and a troubleshooting table are provided. The symptom index will help you locate the information you need for troubleshooting.

SYMPTOM INDEX

SYMPTOM INDEX-CONT

	Troubleshooting Procedure (Table 2-2)
EXHAUST	
Excessive Black Smoke	Item 23
IDLE	
Rough	Item 16
White Smoke	Item 22
LUBE OIL	
Contains Coolant	Item 10
Contains Fuel	Item 11
Pressure Too Low	Item 6
Sludge in Crankcase	Item 8
Temperature Too High	Item 7
NOISE	
Connecting Rod Bearing	Item 27
Engine	Item 25
Main Bearing	Item 26
Piston	Item 28
Turbocharger	Item 29
OIL	
Consumption Excessive	Item 9
POWER	
Excessive Smoke	Item 19
Low	Item 18
TURBOCHARGER	
Leaks	Item 30

Table 2-2 lists the common fault conditions that may be found during operation or maintenance of the equipment. Look for causes and do corrective actions in the order listed. This manual cannot list every symptom that may show up, and it cannot list all of the possible causes and corrective actions. If a symptom is not listed, or if it keeps up after you have performed the corrective actions, notify your supervisor.

Table 2-2. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Coolant Temperature Above Normal.

   STEP 1. Check for low coolant level.
   Add coolant. Check for leaks. (Refer to PMCS, Table 2-1, Item 2.)

   STEP 2. Check for air in the cooling system.
   Bleed off air from system.

   STEP 3. Check for incorrect or malfunctioning pressure cap.
   Change pressure cap.

   STEP 4. Check for overconcentration of antifreeze and/or supplemental coolant additives.
   Check concentration. Use DCA coolant checking kit, Item 14, Appendix C.

   STEP 5. Check if water pump malfunctioning.
   Replace water pump. Refer to para. 2-23.

   STEP 6. Check if temperature gauge/sensor malfunctioning.
   Test against units of known accuracy. Replace if necessary. Refer to para. 2-15.

2. Coolant Temperature Below Normal.

   STEP 1. Check for incorrect or malfunctioning thermostat.
   Change thermostat. Refer to para. 2-17.

   STEP 2. Check for temperature gauge/sensor malfunctioning.
   Test gauge against a unit of known accuracy. Replace if necessary. Refer to para. 2-15.

3. Coolant Loss (Overflow).

   STEP 1. Inspect for dirt, scale, or sludge in the system.
   Clean cooling system. Refer to TB 55-1900-207-24.

   STEP 2. Check for coolant frozen due to incorrect antifreeze concentration.
   Check coolant antifreeze concentration. (See Item 1, Step 4).

   STEP 3. Check if engine overheating.
   Refer to "Coolant Temperature Above Normal," Malfunction 1.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 4. Check if combustion gases or intake manifold pressure entering the cooling system.
Check the cylinder head (para. 2-34), gasket (para. 2-34), and aftercooler (para. 2-32) for leaks. Replace as necessary.

4. Coolant Loss (External).

STEP 1. Check if hose clamps loose.
Inspect hose clamps. Tighten to 40 in-lb (5 N•m) torque.

STEP 2. Check for leaking hoses.
Inspect hoses. Replace if necessary.

STEP 3. Check if coolant draincocks leaking.
Tighten or replace as necessary.

STEP 4. Check coolant expansion plugs, pipe plugs, or fittings for leakage.
Tighten or replace as necessary.

STEP 5. Check water pump seal for leaking.
Replace the water pump. Refer to para. 2-23.

STEP 6. Check for incorrect or malfunctioning pressure cap.
Change the pressure cap.

STEP 7. Check for leaking gaskets.
Inspect gasket sealing surfaces, and install new gaskets if leakage is detected.

STEP 8. Check if cylinder head gasket leaking.
Replace gasket. Refer to para. 2-34.

5. Coolant Loss (Internal).

STEP 1. Pressure test coolant system (para. 2-13).
Check for leaks.

STEP 2. Inspect aftercooler radiator core for leakage.
Replace radiator core. Refer to para. 2-32.

STEP 3. Remove cylinder head (para. 2-34).
Evacuate to general support maintenance procedures to test cylinder head for leakage.

6. Lube Oil Pressure Too Low.

STEP 1. Check if oil level low.
Check for oil leaks. Add engine oil as necessary.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 2. Check if oil pressure gauge malfunctioning.
Check oil pressure gauge against one of known accuracy. Replace if faulty.

STEP 3. Check if oil temperature above normal [250ºF (120ºC)].
Refer to "Lube Oil Temperature Too High," Malfunction 7.

STEP 4. Check if oil transfer or suction tube broken.
Remove oil pan and inspect. Refer to para. 2-36.

7. Lube Oil Temperature Too High.

STEP 1. Check for incorrect oil level.
Add or drain engine oil.

STEP 2. Check for high engine coolant temperature [above 212ºF (100ºC)].
Check "Coolant Temperature Above Normal," Malfunction 1.

STEP 3. Check if oil temperature gauge malfunctioning.
Check gauge against one of known accuracy. Replace if faulty.

8. Lube Oil Sludge in the Crankcase Excessive.

STEP 1. Inspect if oil filter(s) is dirty.
Replace oil filters. Refer to PMCS, Table 2-1, Item 7.

STEP 2. Check if engine coolant temperature too low [below 140ºF (60ºC)].
Check "Coolant Temperature Below Normal," Malfunction 2.

STEP 3. Inspect for internal coolant leaks.
Pressure test the cooling system. Refer to para. 2-13.

9. Oil Consumption Excessive.

STEP 1. Check for external oil leaks.
Tighten capscrews, pipe plugs, and fittings.

STEP 2. Check for blowby restriction causing external oil leaks.
Check crankcase breather and tube.

STEP 3. Inspect for incorrect dipstick calibration.
Check dipstick calibration. Refer to PMCS Table 2-1, Item 1.

STEP 4. Inspect for oil contaminated fuel.
Refer to "Fuel in the Lubricating Oil," Malfunction 11.

STEP 5. Check for high oil temperature [above 250ºF (120ºC)1.
Check engine oil and coolant levels. Refer to PMCS Table 2-1, Items 1 and 2.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 6. Check for turbocharger seal malfunctioning.
Replace turbocharger. Refer to para. 2-19.

10. Lube Oil in Coolant or Coolant in Lube Oil.

STEP 1. Inspect cylinder head cracked/porous or cylinder head gasket for leaking.
Replace head or gasket. Refer to para. 2-34.

11. Fuel in Lube Oil.

STEP 1. Check if top injector O-ring damaged.
Check injectors. Replace preformed packings if necessary. Refer to para.2-31.

STEP 2. Check for damaged injector plunger.
Replace the injector. Refer to para. 2-31.

STEP 3. Check for damaged injector cup.
Replace injector. Refer to para. 2-31.

STEP 4. Check if cylinder head cracked or porous.
Replace cylinder head. Refer to para 2-34.

12. Engine Cranking, But Will Not Start (No Exhaust Smoke).

STEP 1. Check for fuel in tank and proper alignment of values. Refer to TM 55-1905-223-10.
Add fuel, align valves.

STEP 2. Check if fuel filter plugged or suction line restricted.
Replace fuel filter elements (PMCS Table 2-1, Item 8). Inspect fuel hose for restrictions.

STEP 3. Check if fuel in pump.
Prime fuel pump. Refer to para. 2-5.

STEP 4. Check for fuel to injectors.
Loosen fuel pump output while cranking engine. If no fuel output, replace the pump. Refer to para. 2-29.

STEP 5. Check if fuel connections loose on suction side of fuel pump.
Tighten all fuel filter fittings and connections from fuel tank to fuel pump.

STEP 6. Inspect for intake or exhaust system restricted.
Check intake and exhaust system for restrictions.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

13. Engine Hard to Start or Will Not Start (Exhaust Smoke Present).

STEP 1. Check if engine cranking speed low (below 150 rpm).
Check air pressure to cranking motor.

STEP 2. Check if starting motor speed too low with air pressure okay.
Replace starting motor. Refer to para. 2-14.

STEP 3. Inspect for plugged fuel filter.
Replace fuel filter elements (PMCS Table 2-1, Item 8).

STEP 4. Check for air in the fuel system.
Check for air in fuel, tighten filter.

STEP 5. Check for restricted fuel suction line.
Inspect fuel lines.

STEP 6. Check for intake air system restriction.
Correct restriction.

14. Engine starts but will not keep running.

STEP 1. Check for air in the fuel system.
Bleed fuel lines, tighten fuel connections, tighten filter.

STEP 2. Check if marine gear engaged.
Disengage marine gear.

STEP 3. Check for plugged fuel filter.
Replace fuel filter elements (PMCS Table 2-1, Item 8).

STEP 4. Check for restricted fuel suction line.
Inspect fuel lines.

STEP 5. Inspect for contaminated fuel.
Drain and clean fuel tank. Replenish fuel.

STEP 6. Check if idle speed is low.
Adjust engine idle speed.

STEP 7. Check if injector cup spray holes plugged.
Replace injectors. Refer to para. 2-31.

STEP 8. Check that injection timing is set incorrectly.
Adjust injection timing. Refer to para. 2-31.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

15. Engine Surges.

STEP 1. Check for air in fuel system.
Bleed fuel lines, tighten fuel connections, tighten filter.

STEP 2. Check if engine idle speed set low.
Adjust low idle screw.

STEP 3. Check for fuel drain line restriction.
Check lines and tank vents.

STEP 4. Check if throttle linkage set incorrectly.
Set linkage to proper position.

STEP 5. Fuel pump calibrated incorrectly.
Replace fuel pump. Refer to para. 2-29.

STEP 6. Check if injector levers out of adjustment.
Adjust injector levers. Refer to para. 2-30.

16. Idle-Rough.

STEP 1. Check for low idle speed on tachometer.

STEP 2. Check for air in fuel.
Bleed fuel lines, tighten lines, fittings, and filter.

STEP 3. Check if injector lever adjustment incorrect.
Adjust injector lever. Refer to para. 2-30.

STEP 4. Check for defective injectors.
Replace injectors. Refer to para. 2-31.

STEP 5. Check for loose engine mounts.
Tighten to 270 ft-lb (365 N•m).

17. Engine runs rough or misfires in operating range (warm engine).

STEP 1. Check for air in fuel.
Bleed air from fuel lines, tighten fuel connections, tighten filter.

STEP 2. Check for poor fuel quality. Take fuel sample if necessary.
Drain and clean fuel tanks. Replenish fuel.

STEP 3. Check if valve or injectors rockers adjusted incorrectly.
Check valve and injector settings. Refer to para. 2-30.

STEP 4. Inspect if rocker lever broken.
Replace rocker levers. Refer to para 2-30.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 5. Check if injectors defective.
Replace defective injector. Refer to para. 2-31.

18. Low Power.

STEP 1. Inspect for foreign object fouling propeller.
Check propeller, remove foreign object, reference TM 55-1905-223-24-18.

STEP 2. Check if fuel suction line or fuel filter is restricted.
Check fuel inlet restriction. Replace fuel filter elements if necessary.
Refer to PMCS Table 2-1, Item 8.

STEP 3. Check if lubricating oil level is too high.
Drain to "H" mark on dipstick or sight glass.

STEP 4. Check if throttle linkage adjustment incorrect.
Check throttle linkage adjustment for full opening of throttle lever.

STEP 5. Check if intake or exhaust system restricted.
Check intake and exhaust system for restrictions while engine is running using a manometer
Remove restriction.

STEP 6. Check for air in fuel.
Bleed air from fuel lines, tighten fuel connections, tighten filter.

STEP 7. Check for poor fuel quality. Take fuel sample if necessary.
Drain and clean fuel tanks. Replenish fuel.

STEP 8. Check for air or exhaust leaks between turbocharger and engine.
Tighten all connections.

STEP 9. Check fuel rate using fuel flow measuring instrument (P/N 3376375).
Refer to manufacturer's instruction and testing procedures.
Check fuel pressure by attaching a gauge with minimum capacity of 300 psi (2070 kPa) at the fitting on the fuel pump outlet.
Check air manifold (turbocharger) by attaching a gauge with a minimum capacity of 90 in.-Hg (2286 mm-Hg) to one of the plugs in the air crossover.

a. If fuel rate ok, fuel pressure high, and turbocharger pressure okay, replace injectors. Refer to para. 2-31.
b. If fuel rate ok, fuel pressure high, and turbocharger pressure okay or low, replace injectors. Refer to para. 2-31.
c. If fuel rate low, fuel pressure ok, and turbocharger pressure low, replace injectors. Refer to para. 2-31.
d. If fuel rate ok, fuel pressure ok, and turbocharger pressure low, check intake air restriction. Replace turbocharger if necessary. Refer to para. 2-19.
e. If fuel rate ok, fuel pressure high, and turbocharger pressure ok, check for restrictions in fuel lines.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 10. Check for carboned injectors.
Replace injectors. Refer to para. 2-31.

STEP 11. Check if injectors are not seated.
Secure holddown capscrews. Refer to para. 2-31.

STEP 12. Check if injectors stuck.
Check rocker lever, injector link action. Replace if necessary. Refer to paras. 2-30, 2-31.

19. Low Power or Excessive Smoke (Low Turbocharger Boost Pressure).

STEP 1. Check for dirty air filter element.
Check air filter element. Refer to para. 2-18.

STEP 2. Check for intake or exhaust air leaks.
Secure or replace damaged air piping.

STEP 3. Check for excessive intake air restriction by connecting manometer between air filter and turbocharger. Verify maximum air inlet restriction of 15 in. (380 mm-H_20) with clean filter elements.
Remove restriction.

STEP 4. Check for excessive exhaust restriction by connecting manometer toto exhaust pipe fitting. Verify maximum restriction of 3 in.--Hg (75 mm-Hg).
Remove restriction.

STEP 5. Check for turbocharger bearing damage.
Replace turbocharger. Refer to para. 2-19.

STEP 6. Check for fuel system malfunctioning.
Refer to "Exhaust Smoke Excessive Under Load," Malfunction 23.

STEP 7. Check if fuel pump manual override open.
Make sure manual control knob is in the fully clockwise position.

STEP 8. Check if fuel tank vents plugged.
Remove, clean, replace.

STEP 9. Fuel line restricted.
Check lines from head to tank.

STEP 10. Check if engine running on fumes drawn into air intake.
Close off air intake, locate and isolate the source of fumes.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

20. Engine Will Not Shut Down.

STEP 1. Check if fuel pump manual override is open.
Make sure manual control knob is in the fully counterclockwise position.

STEP 2. Check if fuel pump shutoff valve is stuck.
Replace shutoff valve. Refer to para. 2-28.

STEP 3. Check if fuel tank vents are plugged.
Remove, clean, replace tank vents.

STEP 4. Check if engine is running on fumes drawn into air intake.
Close off air intake, locate and isolate the source of fumes.

21. Engine Will Not Reach Rated Speed Under Load.

STEP 1. Check for fuel suction line restriction.
Check for fuel inlet restriction. Replace fuel filter elements if necessary. Refer to PMCS Table 2-1, Item 8.

STEP 2. Check if throttle linkage adjustment wrong.
Check for full throttle travel. Adjust linkage if necessary.

STEP 3. Check for fuel pump malfunctioning. Test by using substitute pump temporarily.
Replace fuel pump, if necessary. Refer to para. 2-29.

STEP 4. Check if tachometer has a malfunction.
Replace tachometer. Refer to para. 2-15.

STEP 5. Inspect for foreign object fouling propeller.
Check Propeller, remove foreign object (TM 55-1905-223-24-18).

22. White Smoke at Idle, Excessive.

STEP 1. Check for low coolant temperature.
Refer to "Coolant Temperature Below Normal," Malfunction 2.

STEP 2. Check for poor quality fuel. Take sample, if necessary.
Drain and clean fuel tank. Replenish fuel.

23. Exhaust Smoke (Black) Excessive Under Load.

STEP 1. Check for overloaded engine.
Check for proper operation of reduction gear (TM 55-1905-223-24-2).

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

STEP 2. Inspect if intake air system restricted.
Check air restriction indicators on air intake tubes. Replace tubes if necessary.

STEP 3. Check if turbocharger wheel rubbing.
Replace turbocharger. Refer to para. 2-19.

STEP 4. Check for intake air leaks between turbocharger and air cleaner.
Tighten all connections.

STEP 5. Check if fuel return line restricted.
Replace stuck valve (TM 55-1905-223-10).

STEP 6. Check if injector loose or valve adjusted incorrectly.
Adjust valves and injectors. Refer to para. 2-31.

STEP 7. Check if turbocharger turbine seal leakage.
Replace turbocharger. Refer to para. 2-19.

STEP 8. Check if injector cups damaged.
Hold down injectors one at a time at idle. Observe change in smoke level.
Replace injector. Refer to para. 2-31.

24. Engine Crankcase Gases (Blowby), Excessive.

STEP 1. Check for restricted crankcase breather vent tube.
Check breather tube restriction. Replace as necessary.

STEP 2. Check for turbocharger seals leaking.
Replace turbocharger. Refer to para. 2-19.

STEP 3. Cylinder head valve guide wear.
Evacuate to general support maintenance procedures to check cylinder head valve guide.

25. Engine Noise, excessive.

STEP 1. Check for excessive valve or injector clearance.
Adjust valve and injector. Refer to para. 2-30.

STEP 2. Check for damaged push rod or cam follower.
Check push rods and cam followers. The roller must rotate easily. If it doesn't, evacuate to general support.

STEP 3. Check if main or connecting rod bearings loose or damaged.
Refer to "Connecting Rod Noise" or "Main Bearing Noise," Malfunctions 26 or 27.

STEP 4. Piston rings broken or worn.
Refer to direct support for corrective action.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

26. Main Bearing Noise.

STEP 1. Check for insufficient oil supply or low oil pressure.
Check oil level. Refer to "Lubricating Oil Pressure Low," Malfunction 6.

STEP 2. Check for thin or diluted lubricating oil.
Refer to "Coolant in the Lube Oil" and "Fuel in the Lubricating Oil" Malfunctions 10 and 11.

27. Connecting Rod Bearing Noise.

STEP 1. Check for insufficient oil supply or low oil pressure.
Check oil level. Add oil. Refer to "Lube Oil Pressure too Low," Malfunction 6.

STEP 2. Check for thin or diluted lubricating oil.
Refer to "Coolant in the Lube Oil" and "Fuel in the Lube Oil," Malfunctions 10 and 11.

28. Piston Noise.

STEP 1. Check for contaminated or poor quality fuel. Test fuel.
Drain and clean fuel tank. Replenish fuel.

STEP 2. Check for carbon deposits on the top of the piston contacting the cylinder head.
Remove the cylinder head and remove carbon from the pistons. Refer topara. 2-34.

29. Turbocharger Noise Excessive.

STEP 1. Check if intake or exhaust air leaks piping.
Check for loose or damaged piping. Tighten or replace as necessary.

STEP 2. Check for excessive intake air restriction by connecting manometer between air filter and turbocharger. Verify maximum air inlet restriction of 15 in.-H_20 (380 mm-H_20) with clean filter elements.
Remove restriction.

STEP 3. Check for excessive exhaust restriction by connecting manometer to exhaust pipe fitting. Verify maximum restriction of 3 in.-Hg (75 mm-Hg).
Remove restriction.

STEP 4. Check turbocharger turbine and compressor wheels for fretting and broken vanes.
Replace turbocharger. Refer to para. 2-19.

Table 2-2. Troubleshooting-CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

30. Turbocharger Leaks (Engine Oil in Fuel).

STEP 1. Turbocharger turbine seal leak.
Replace turbocharger. Refer to para. 2-19.

31. Engine Vibration, Excessive.

STEP 1. Check for loose mounting bolts.
Tighten mounting bolts.

STEP 2. Check if engine idle speed too low.
Increase engine idle speed.

STEP 3. Check alignment with marine gear.
Refer to TM 55-1905-223-24-2.

STEP 4. Bent propeller shaft.
Refer to TM 55-1905-223-24-18.

SECTION V. UNIT MAINTENANCE PROCEDURES

MAINTENANCE OF MAIN PROPULSION ENGINE

2-13. Repair Main Propulsion Engine.

This task covers:
a. Inspection **b. Test** **c. Adjust**
d. Repair

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Strap wrench P/N 3376807
Filter cutter P/N 3376579
Oil filter wrench P/N 3375049
Pressure manometer P/N PVS-2

Equipment Condition

Engine shutdown. TM 55-1905-223-10

INSPECTION

a. Visually inspect hoses and metallic lines for leaks, cracks, kinks, abrasions, corrosion and loose or damaged clamps and fittings.

b. Check insulation blankets to make certain that all surfaces that get hot during operation are covered.

c. Operate engine and inspect for leaks in all hoses and metallic hoses.

d. With engine operating, check for exhaust leaks.

e. Listen for unusual engine noises (knocks, rattles and taps).

f. Shut down engine. Refer to TM 55-1905-223-10.

g. Perform checks and inspections outlined in paragraph 2-5.

TEST

a. Pressure test coolant system.

WARNING

Ensure engine is cooled to below 120ºF (50ºC) to avoid burn injury.

(1) Remove oil pan and adapter group (para. 2-36).

(2) Ensure coolant is at proper level.

(3) Remove and plug expansion tank overflow tube (3, FIG. 2-7a).

CAUTION

Do not apply more than 20 psi air pressure. Over-pressure could cause damage to the cooling system.

(4) Install pressure manometer (1) in the fill neck (4) of the expansion tank (2).

(5) Apply 20 psi maximum air pressure to the tester.

(6) Inspect engine thoroughly for coolant leaks.

(7) Remove pressure manometer (1).

(8) Install overflow tube (3) and pressure cap in expansion tank.

ADJUST

The adjustment to the main engine is done to the injectors and valves upon replacement of rocker levers (refer to para. 2-30).

REPAIR

Engine repair consists of individual component and assembly replacement and repair. The replacement and repair procedures are provided in the remainder of this manual.

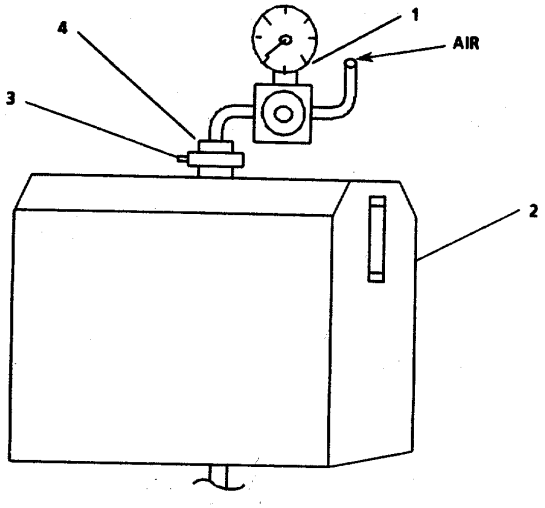


FIGURE 2-7a. Pressure Test Cooling System.

2-14. Replace Engine Air Starter. (FIGURE 2-8)

This task covers:

a. Removal **b. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Lifting sling P/N 3375958
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. Tagged Out of Service. TM 55-1905-223-10. Air supply to starter-off/secured.

Materials/Parts

Air starting engine P/N 5244i-12
Out of Service tags, Item 7, Appendix C

WARNING

- Do not attempt to adjust the automatic trip valve (ATV) in the starter inlet or remove the lower plate protecting the ATV mechanism.
- The starting motor is very heavy. Be sure it is rigged properly to the lift sling before any attempt is made to remove it.

REMOVAL

a. Attach lifting sling to the starter motor (3) and take up slack.

b. Remove air supply connection (7) slowly, allowing air pressure to bleed off.

c. Remove air lines (6) from starter to solenoid (5).

d. Remove two bolts (4) and remove solenoid (5) from starter motor (3).

e. Remove three capscrews and washers (2), securing the starter to the flywheel cover (1).

f. Pull starter (3) straight away from the flywheel cover (1). Lift away with the sling.

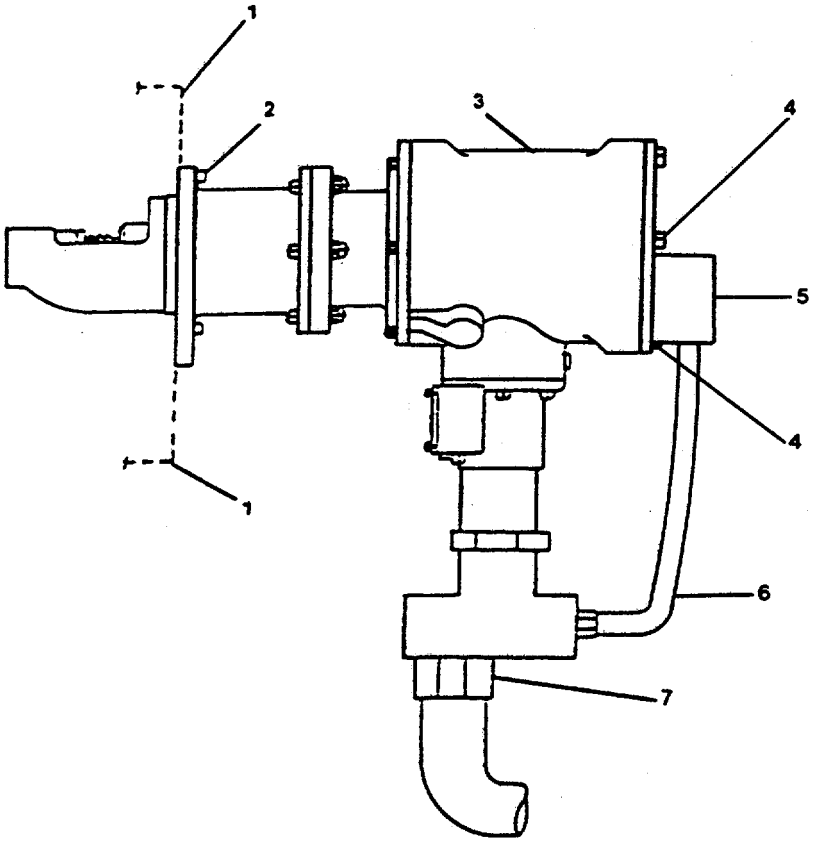


FIGURE 2-8. Engine Air Starter Detail.

REPLACEMENT

WARNING

Failure to properly install the starter or operate it according to TM 55-1905-223-10, could result in damage to the starter, engine or personal injury.

a. Attach lifting sling to the starter (3) and position it to the flywheel cover (1) opening.

b. Secure with three capscrews and washers (2) and torque to 180 - 200 ft-lb (244 to 271 N-m).

c. Position solenoid (5) to starter motor (3). Secure with two bolts (4). Hand tighten bolts (4).

d. Connect the air supply line (7) and air lines (6) from starter to solenoid (5).

e. Turn on air supply to starter. Check for leaks.

2-15. Replace/Repair Instrument Panel. (FIG. 2-9)

This task covers:

a. Inspection **b. Removal** **c. Repair**
d. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783

Materials/Parts

Electrical coil P/N 3034571
Thermocouple P/N 3036575
Pressure switches P/N 3057448, 3010649, 3010647, 3038248, 3038249
Air control valve P/N 154706
Toggle switches P/N 113527, MS35058-22
Pyrometer P/N 3036577
Tachometer/Hourmeter P/N 3049555
Temperature switch P/N 3010653
Indicator light P/N 3022279
Dial indicating pressure gauge P/N 3057440
Circuit breaker P/N 3034953
Wiring harness P/N 3035718, 3035719, 3035727
Out of Service tags, Item 7, Appendix C

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Air supply secured.
Air supply removed from panel TM 55-1905-223-24-18.
Electrical supply secured. TM 55-1905-223-10.
Electrical supply removed from panel TM 55-1905-223-10. Tagged "Out of Service."

INSPECTION

a. Visually inspect the instrument panel for broken gauges, lenses, frayed wires, or damage to the panel face or cabinet.

b. Visually inspect wiring from instrument panel to engine for damaged, cracked, or torn sections. Ensure all visible connections are solidly attached.

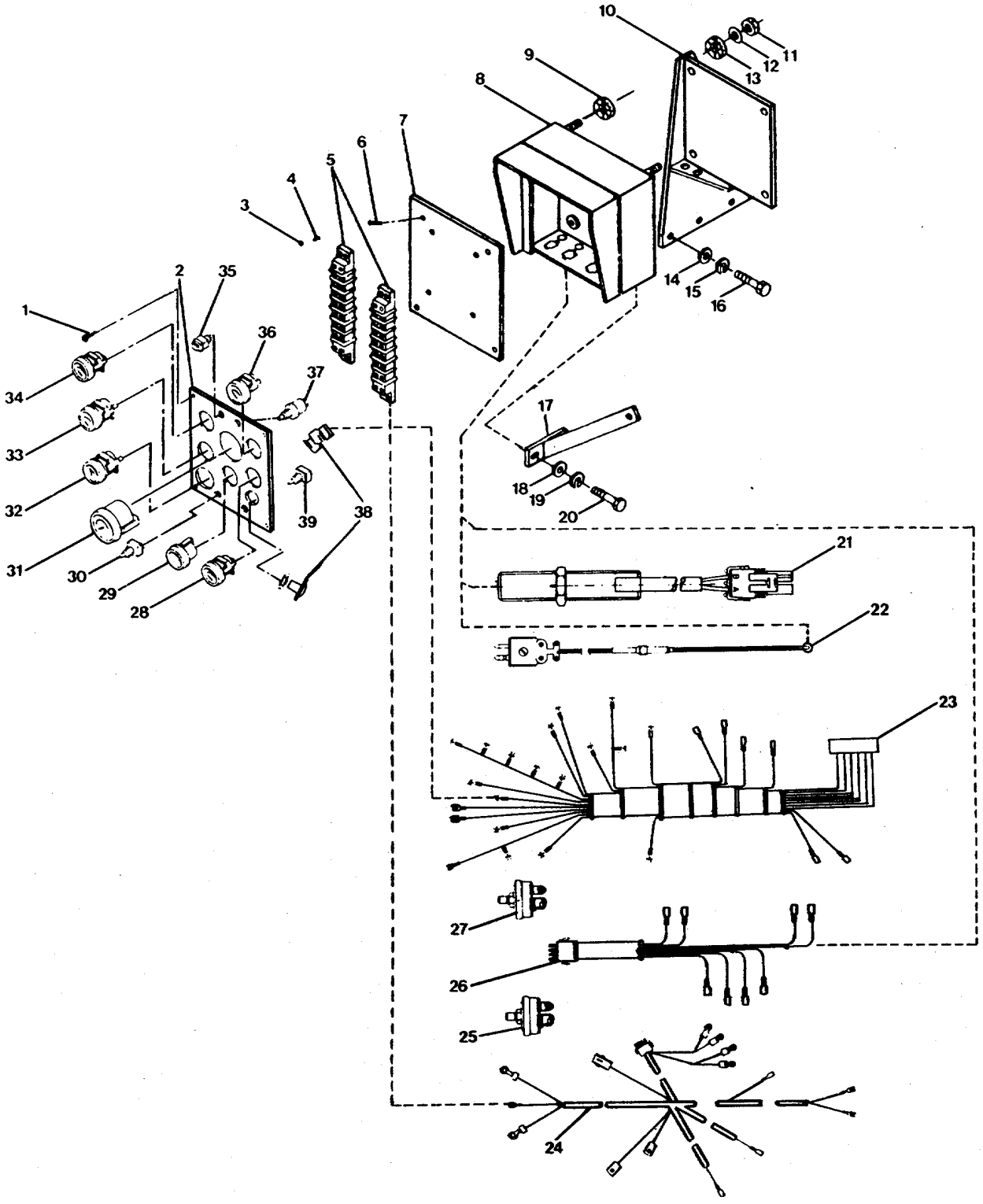


FIGURE 2-9. Instrument Panel Group.

REMOVAL

NOTE

If only defective gauges, meters, switches, circuit breaker, wiring harnesses, or indicator light are being replaced, follow the repair procedures of this procedure.

a. Make sure all electrical circuits to the engine are OFF.

b. Loosen the two pinhead screws (1) in the upper corners of the front panel (2) and swing the panel down for access to inside wiring connections. Tag and disconnect all wiring harness connections to the instrument panel.

c. Remove four self-locking nuts (11) and washers (12) attached to the instrument cabinet (8) studs.

d. Remove four outer resilient mounts (13).

e. Remove instrument cabinet (8) from instrument panel bracket (10).

f. Remove four inner resilient mounts (9).

g. To remove back panel (7), perform the following:

(1) Tag and disconnect all wiring harness connections to the terminal block (5).

(2) Remove four machine screws (6) attaching back panel (7) to instrument cabinet (8).

(3) Remove back panel (7).

h. To remove terminal blocks (5), perform the following:

(1) Tag and disconnect all wiring harness connections to the terminal block (5).

(2) Remove four hexagon capscrews (4-) and hexagon nuts (3) securing terminal blocks (5) to the back panel (7).

(3) Remove terminal blocks (5).

i. To remove the instrument panel brace (17) perform the following:

(1) Remove two hexagon head capscrews (20), lockwashers (19), and washers (18).

(2) Remove instrument panel brace (17).

j. To remove the instrument panel bracket (10), perform the following:

(1) Remove two hexagon head capscrews (16), lockwashers (15), and washers (14).

(2) Remove the instrument panel bracket (10).

REPAIR

NOTE

Repair to the instrument panel assembly will be only the replacement of defective gauges, meters, switches, circuit breaker, wiring harness, and light. Replace components which are defective or not working. Replace damaged or frayed wiring harnesses.

a. Loosen the two pinhead screws (1) in the upper corners of the front panel (2) and swing the panel down.

b. Disconnect and remove wiring harnesses (23, 24, 26).

c. Disconnect and remove electrical coil (21).

d. Disconnect and remove thermocoupler (22).

e. Remove circuit breaker (37).

f. Remove air control valves (38).

g. Remove power toggle switch (39).

h. Remove pressure switches (25, 27).

i. Remove remote start toggle switch (30).

j. Remove pyrometer (29).

k. Remove lube filter gauge (36).

l. Remove tachometer/hourmeter (31).

m. Remove engine water gauge (32).

n. Remove engine oil pressure gauge (33).

o. Remove engine oil temperature gauge (34).

p. Remove indicator light (35).

q. Remove start air gauge (28).

REPLACEMENT

a. If a repair component is being replaced, perform the following:

(1) Position the new part in the panel and install the mounting hardware.

(2) Attach electrical connections.

(3) Close front panel (2) and secure with two pinhead screws (1).

b. To replace the instrument panel bracket (10), perform the following:

(1) Position instrument panel bracket (10) to mounting.

(2) Secure with two washers (14), lockwashers (15) and hexagon head capscrews (16).

c. To replace the instrument panel brace (17) perform the following:

(1) Position instrument panel brace (17) to instrument cabinet (8).

(2) Secure with two washers (18), lockwashers (19), and hexagon head capscrews (20).

d. To replace terminal blocks (5), perform the following:

(1) Position terminal blocks (5) on back panel (7).

(2) Secure with four hexagon nuts (3) and hexagon capscrews (4).

(3) Connect all electrical harness connections to the terminal block (5).

e. To replace the back panel (7), perform the following:

(1) Position back panel (7) in the instrument cabinet (8).

(2) Secure with four machine screws (6).

(3) Connect all electrical harness connections to the terminal block (5).

f. To replace the instrument cabinet (8) perform the following:

(1) Position four inner resilient mounts (9) on instrument cabinet (8) studs.

(2) Position instrument cabinet (8) to instrument cabinet bracket (10).

(3) Position four outer resilient mounts (13) on instrument cabinet (8) studs.

(4) Attach and secure four self-locking washers (12) and nuts (11) to the instrument cabinet (8) studs.

(5) Connect all wiring harness connections to the instrument panel. Remove tags.

(6) Close front panel (2) and secure with two pinhead screws (1).

g. Turn electrical power and the air supply on.

2-16. Replace/Repair Water Filter Group. (FIG. 2-10)

This task covers:

a. Inspection **b. Removal** **c. Repair**
d. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Strap wrench P/N 3376807
Filter cutter P/N 3376579

Equipment Condition

Engine shutdown and cooled to 120ºF (50ºC). TM 55-1905-223-10.

Materials/Parts

Water filter head P/N 3175453
Water filter element P/N 3318318
Sandpaper, Item 1, Appendix C
Preformed packing P/N 145528, 70415
Engine lube oil, Item 2, Appendix C
Out of Service tags, Item 7, Appendix C

NOTE

This procedure also covers repair and replacement of the water filter head assembly.

INSPECTION

WARNING

Be sure coolant is below 120ºF (50ºC) before removing filters or replacing parts and fittings.

a. Visually inspect the filter (5) and head assembly (4) for signs of leakage and corrosion.

b. If the filter is leaking around the gasket sealing surface, do the following:

(1) Close the water shutoff valve (8).

(2) Using the filter wrench, unscrew and remove the filter (5).

(3) Clean the gasket sealing surfaces of the filter (5) and head (4) with a lint-free cloth.

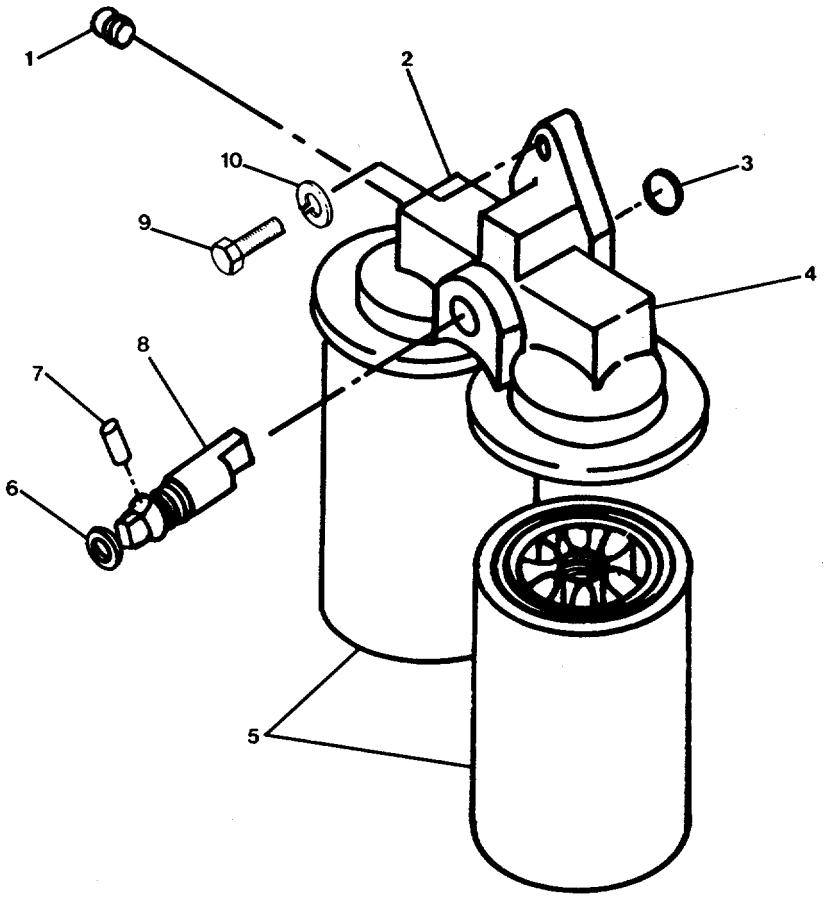


FIGURE 2-10. Water Filter Group.

(4) Apply a light coat of clean lube oil on the filter gasket. Install the filter (5) and hand-tighten.

(5) Open the water shutoff valve (8) and check for leaks.

(6) If leakage is still present, install a new filter element (5) and recheck.

(7) If the new filter element still leaks, replace the head assembly (4). Refer to removal and replacement steps of this procedure.

NOTE

For coolant inspection and test procedures, refer to TB 55-1900-207-24.

REMOVAL

NOTE

Refer to Table 2-1, Item 9, for removal of water filter elements only.

a. Drain cooling system (TM 55-1905-223-10).

b. Remove water filter elements (5) by unscrewing using the filter wrench. Discard filter elements.

c. Remove water filter head assembly (4) by removing two hexagon head capscrews (9), lockwashers (10), and preformed packing (3) from counterbores.

d. Remove pipe plug (1) from water filter head assembly (4).

e. Remove spring pin (7) and shutoff valve shaft (8) from water filter head assembly (4).

f. Remove preformed packing (6) from shutoff valve shaft (8). Discard preformed packing.

REPAIR

a. Remove any corrosion found on the surfaces of the water filter head (2) where the head mates to the water filter gaskets, and where the head mates to the thermostat housing gasket.

b. Smooth out by using sand paper any pits, nicks or other surface irregularities found on the gasket mating surfaces. Any flaw that cannot be readily removed will require the replacement of the water filter head assembly (4).

c. Inspect the water filter head assembly (4) body counterbores to make sure fluid has a clear passage. Clean openings as required.

d. Replace any component that shows signs of excess wear. Be sure the shutoff valve shaft turns freely in the water filter head body.

e. Inspect the preformed packing (3, 6) for nicks, cuts, or deformity. Replace if necessary.

REPLACEMENT

a. Assemble preformed packing (6) to shutoff valve shaft (8) and replace spring pin (7).

b. Replace shutoff valve shaft (8) on water filter head assembly (4).

c. Position pipe plug (1) on water filter head assembly (4) counterbores.

d. Position water filter head assembly (4). Install two lockwashers (10) and hexagon head capscrews (9). Tighten to 30 ft-lb (40 N•m).

CAUTION

Mechanical tightening may distort threads or damage filter element seals. Tighten by hand only.

e. Position new filter elements (5) on water filter head assembly (4) and secure by threading filter elements clockwise, by hand, until element seal touches filter head. Tighten and additional one-half to three-quarters turn.

f. Turn water filter shutoff valves to the ON position.

g. Refill cooling system with coolant which was drained, or from pre-mixed supply.

h. Start engine (TM 55-1905-223-10).

i. Observe coolant level and temperature.

j. Check for leaks, repair as necessary.

2-17. Replace/Repair Thermostat Housing/Water Transfer Tube Group.

This task covers:

a. Removal **b. Inspection** **c. Repair**
d. Replacement

INITIAL SETUP:

Tool

Thermostat seal mandrel P/N 3375411
Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Water tube driver P/N ST-1319
Lifting sling P/N 3375958

Equipment Condition

Engine shutdown and cooled to 120°F (50ºC). TM 55-1905-223-10.
Water filter heads removed (paragraph 2-16).
Guards supporting water lines removed.

Materials/Parts

Thermostat P/N 3022299
Gasket P/N 206460, 207515, 206443, 206556
Preformed packing P/N 3042759, 70861, 3028291, 3008710
Coolant, Item 3, Appendix C
Thermometer, Item 13, Appendix C

REMOVAL

a. Drain cooling system to a level just below the thermostat housing coolant inlet (TM 55-1905-223-10).

b. Remove clamp (10, FIG. 2-11) retaining the coolant nonmetallic outlet hose (9) to thermostat housing (17). Remove clamp (8) to water transfer connection piping (7). Remove the outlet nonmetallic hose (9).

c. To remove the thermostat only, perform the following steps.

(1) Remove six hexagon head capscrews (15, FIG. 2-11) and lockwashers (14) retaining thermostat housing (17) to housing support (18).

(2) Remove thermostat housing (17) and thermostat housing gasket (11). Discard gasket.

(3) Remove thermostat (12) and thermostat seal (13). Discard seal.

(4) Remove pipe plug (16).

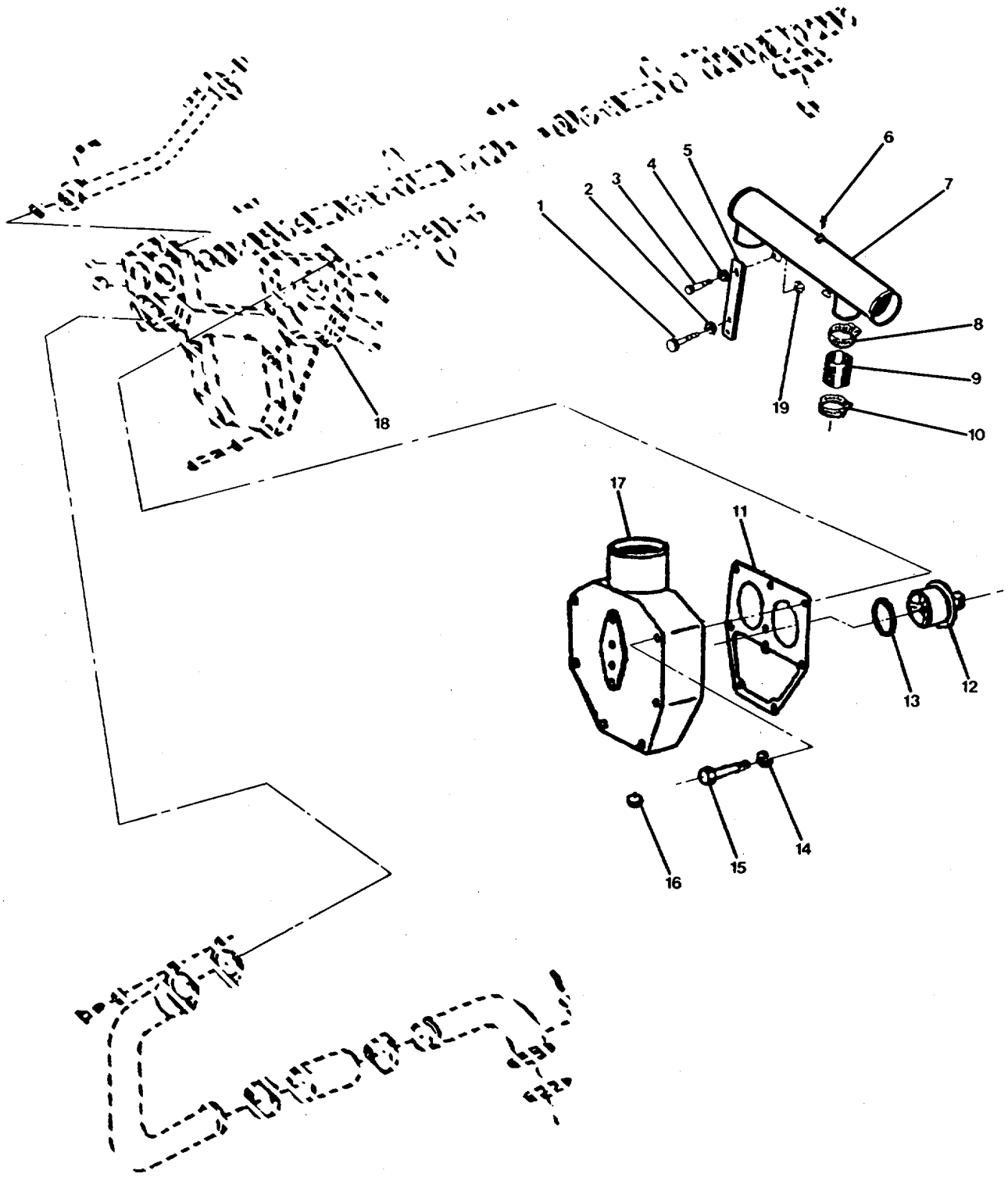


FIGURE 2-11. Thermostat Housing/Water Transfer Coupling

d. To remove bypass tube assembly, perform the following steps.

(1) Remove two hexagon head capscrews (49, FIG. 2-12) and lockwashers (50) retaining metal bypass tube assembly (58) to the housing (44).

(2) Remove gasket (51) and discard.

(3) Remove two hose clamps (52) retaining metal bypass tube assembly (58) to nonmetallic hose (57). Remove bypass metal tube assembly (58) and non-metallic hose (57).

(4) Remove two hexagon head capscrews (54) and lockwashers (55) retaining the opposite end of metal bypass tube assembly (53).

(5) Remove metal bypass tube (53) and gasket (56). Discard gasket.

e. To remove the water transfer connection piping, perform the following steps.

(1) Remove pipe plug (6, FIG. 2-11).

(2) Remove four hexagon head capscrews (1 and 3), lockwashers (2 and 4), and nuts (19).

(3) Remove tube braces (5).

(4) Remove the water transfer connection (7).

f. To remove water transfer metal tube assembly, perform the following steps:

(1) Remove two hexagon head capscrews (5, FIG. 2-12) and lockwashers (6) retaining water transfer tube (4) to the after cooler.

(2) Remove preformed packing (7) and discard.

(3) Remove two hexagon head capscrews (3) and lockwashers (2) retaining water transfer tube (4) to thermostat housing support (44).

(4) Remove preformed packing (1) and discard.

(5) Remove water transfer metal tube assembly (4).

g. To remove the water inlet transfer tube assembly, perform the following steps.

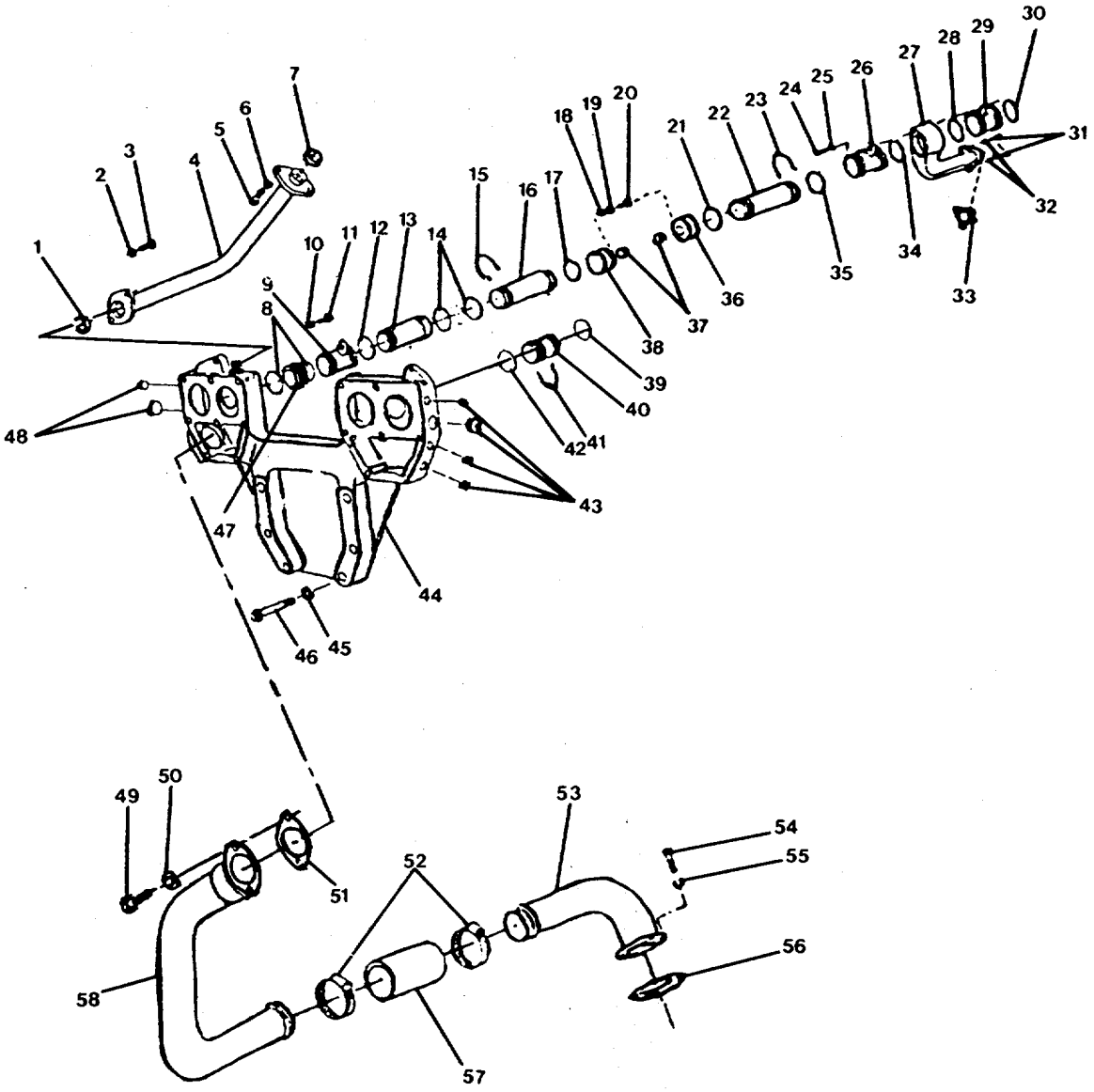


FIGURE 2-12. Thermostat Housing Support/Water Transfer Tube Group.

NOTE

Do not reuse the internal preformed packings in the inlet water transfer tubes.

(1) Remove retaining ring (41, FIGURE 2-12) from side of thermostat housing (44) opposite water pump.

(2) Remove section of transfer tube (40) retained by retaining ring (41).

(3) Remove two preformed packings (39 and 42).

(4) Remove machine bolts (11) and lockwashers (10) from opposite side of the thermostat housing (44).

(a) Use a water tube driver (1, FIGURE 2-13) and a hammer to push the tubes (2) until the tubes clear the rocker lever housing (3).

(b) Push the water transfer on the right bank toward the front of the engine. Push the water tubes on the left bank toward the rear of the engine.

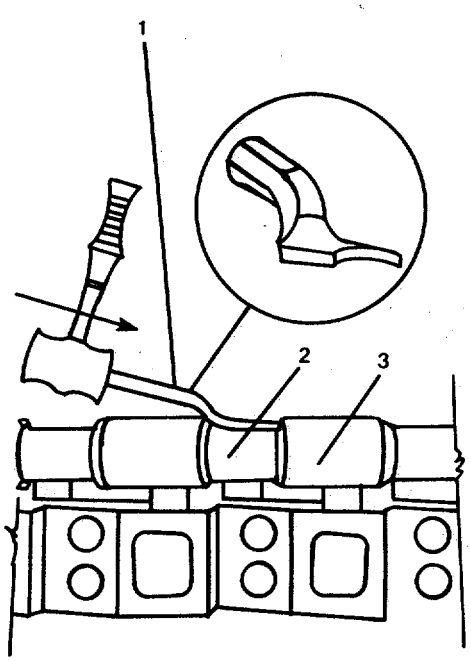


FIGURE 2-13. Water Transfer Tube Positioning for Removal

(5) Remove nearest portion of inlet water transfer metal tube assembly (47, FIGURE 2-12), and two preformed packings (8).

(6) Remove the next two segments of the inlet water transfer metal tube assembly (9 and 13), and three preformed packings (12 and 14).

(7) Remove retainer ring (15) retaining the next segment of tube (16).

(8) Remove the next segment of inlet water metal transfer tube assembly (16) and preformed packing (17).

(9) Remove hexagon head capscrews (20), lockwashers (19) and ring spacers (18) from water transfer expansion plugs (36 and 38). Remove two pipe plugs(37).

(10) Remove retaining ring (23) from the next segment of inlet transfer metal tube assembly (22).

(11) Remove next segment of inlet transfer metal tube assembly (22) and two preformed packings (21 and 35).

(12) Remove machine bolts (24) and lockwashers (25) retaining metal tube assembly (26).

(13) Remove metal tube assembly (26) and preformed packing (34) from water connection (27).

(14) Remove hexagon head capscrews (31) and lockwashers (32). Remove water connection (27) and gasket (33). Discard gasket.

(15) Remove preformed packing (28,30) from water transfer assembly (29).

h. To remove the thermostat housing support, perform the following steps.

WARNING

The thermostat housing support is heavy. Attach a lifting device to prevent personnel injury or equipment damage.

(1) Remove pipe plugs (43 and 48, FIGURE 2-12) from both sides of thermostat housing support (44).

(2) Remove six hexagon head capscrews (46) and lockwashers (45) retaining support (44) to the engine block.

(3) Remove thermostat housing support (44).

INSPECTION

a. Test the performance of the thermostats with a thermometer and container of heating water. Thermostats should be fully open between 170F (-9°C) and 22°F (-60C) and should be closed at 1650F (760°C). Replace any thermostat that fails to function freely.

b. Check the mating surfaces of the thermostat housing that come in contact with gaskets for corrosion, nicks, dents, or other physical defects severe enough to cause a leak. Repair or replace as required.

c. Check all passages and orifices in the thermostat housing and support for cleanliness. Clean as required.

d. Inspect the water transfer tubes (right and left bank) for evidence of physical damage or corrosion. Clean or replace as required.

REPAIR

Repair consists of replacement of defective parts.

REPLACEMENT

a. To replace the thermostat housing support, perform the following steps.

WARNING

The thermostat housing support is heavy. Attach a lifting device to prevent personnel injury or equipment damage.

(1) Position thermostat housing support (44, FIGURE 2-12) to the engine block.

(2) Install six lockwashers (45) and hexagon head capscrews (46). Tighten the capscrews to 270 ft-lb (365 N-m).

(3) Install pipe plugs (43 and 48) in both sides of thermostat housing support (44).

b. To replace the water inlet transfer tube assembly, perform the following steps.

NOTE

Do not reuse the internal preformed packings in the inlet transfer water tubes.

(1) Lubricate new preformed packings with clean engine lube oil before installing.

(2) Position two preformed packings (28 and 30, FIGURE 2-12) on last portion of water inlet transfer tube (29). Install tube (29).

(3) Position gasket (33) on water connection (27) and install water connection. Secure water connection (27) with lockwashers (32) and hexagon head capscrews (31). Tighten capscrews to 30 ft-lb (40 N-m).

NOTE

For the left bank housing the end of the tubes with two grooves must be installed in the bore that is positioned toward the front of the engine. For the right bank housing the end of the tube with two grooves must be installed in the bore that is positioned toward the rear of the engine.

(4) Use a water tube driver (1, FIG. 2-13) and a hammer to push the water tube into the adjacent housing until the groove is visible.

(5) Position preformed packing (34, FIG. 2-12) and install metal /tube assembly (26) on water connection (27).

(6) Secure metal tube assembly (26) with lockwashers (25) and machine bolts (24). Tighten bolts to 15 ft-lb (20 N•m).

(7) Position two preformed packings (21 and 35) and install next segment of tube assembly (22).

(8) Install retaining ring (23).

(9) Position two pipe plugs (37) in water transfer expansion plugs (36 and 38). Attach water transfer expansion plugs with ring spacers (18), lockwashers (19) and hexagon head capscrews (20). Tighten capscrews to 15 ft-lb (20 N•m).

(10) Position preformed packing (17) and install next segment of tube assembly (16).

(11) Install retaining ring (15).

(12) Position three preformed packings (12 and 14). Install the next two segments of tube assembly (9 and 13).

(13) Position two preformed packings (8). Install last segment of tube assembly (47).

(14) Install water inlet transfer tube assembly (47) to thermostat housing (44). Secure with lockwashers (10) and machine bolts (11). Tighten bolts to 30 ft-lb (40 N•m).

(15) Position two preformed packings (39 and 42).

(16) Install transfer tube (40).

(17) Install retaining ring (41).

c. To replace water transfer metal tube assembly, perform the following steps:

(1) Position preformed packing (1, FIG. 2-12).

(2) Position water transfer metal tube assembly (4) on thermostat housing support (44).

(3) Secure with two lockwashers (2) and hexagon head capscrews (3). Tighten capscrews to 30 ft-lb (40 N•m).

(4) Position preformed packing (7).

(5) Position water transfer metal tube assembly (4) on the after cooler.

(6) Secure with two lockwashers (6) and hexagon head capscrews (5). Tighten capscrews to 30 ft-lb (40 N•m).

d. To replace the water transfer connection piping, perform the following steps.

(1) Position water transfer connection piping (7, FIG. 2-11).

(2) Position tube braces (5). Secure with nuts (19), lockwashers (2 and 4), and hexagon head capscrews (1 and 3).

(3) Install pipe plug (6).

e. To replace bypass tube assembly, perform the following steps.

(1) Position gasket (56, FIG. 2-12) and the lower end of metal bypass tube (53) to water pump inlet housing.

(2) Install two lockwashers (55) and hexagon head capscrews (54). Tighten capscrews to 30 ft-lb (40 N•m).

(3) Install nonmetallic hose (57) and two hose clamps (52) on lower end of metal bypass tube (53).

(4) Install the lower end of metal bypass tube (58) to nonmetallic hose (57).

(5) Position upper end of metal bypass tube (58) to thermostat support housing (44).

(6) Install two lockwashers (50) and hexagon head capscrews (49). Tighten capscrews to 30 ft-lb (40 N•m).

(7) Tighten hose clamps (52) to 50 in-lb (5 N•m).

f. To replace thermostats, perform the following steps.

NOTE

Seals must be installed with the part number, or metal flange of the seal up (toward the seal mandrel) during installation to ensure proper operation.

(1) Install new seal (2, FIG. 2-14) using a seal mandrel (1). Install the seal even with but to no more than 0.020 inch (0.51 mm) below the top of the cast edge.

(2) Install thermostat (12, FIG. 2-11) into thermostat housing (17) with the vent hole at the top.

(3) Position thermostat gasket (11) and thermostat housing (17) to thermostat housing support (18).

(4) Install six lockwashers (14) and hexagon head capscrews (15). Tighten capscrews to 30-35 ft-lb (41-47 N•m) alternately and evenly.

g. Refill coolant system (TM 55-1905-223-10).

h. Start engine (TM 55-1905-223-10). Check for leaks.

i. Shut down engine after it reaches operating temperature. Check coolant level. Add coolant as necessary.

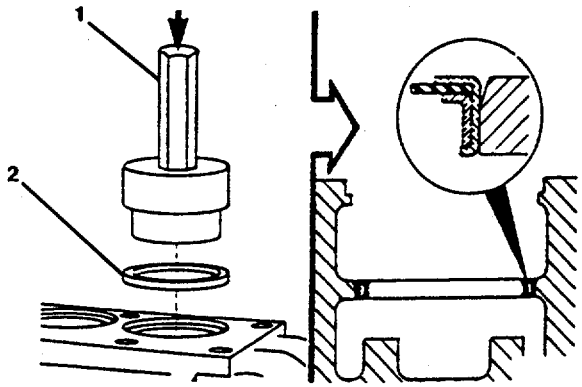


FIGURE 2-14. Thermostat Seal Replacement.

2-18. Replace/Repair Air Cleaner. (FIGURE 2-15)

This task covers:
a. Inspection b. Removal c. Repair d. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Tagged "Out of Service."

Materials/Parts

Filter warning indicator P/N 178957
Air cleaner intake element P/N 3018042
Wiping rags, Item 4, Appendix C
Out of Service tags, Item 7, Appendix C

INSPECTION

CAUTION

Holes, loose end seals, dented sealing surfaces, and other forms of damage render cleaner inoperative and require immediate element replacement.

NOTE

Wipe dirt from cap and upper portion of air cleaner with wiping rags before removing cap and filter.

a. Visually check the air cleaner housing (16), cap (2) and elbow tubes (7 and 10) for cracks and other damage.

b. Check retaining straps (1) for bending, distortion or other defects.

c. Air Cleaner Element Inspection and Replacement:

(1) Check the filter warning indicator (9) for intake air restriction. The indicator will change from green to red when restricted.

(2) Remove the hexagon head capscrew (3), lockwasher (4), hexagon nut (5), and retaining strap (1). Remove retaining strap.

(3) Remove bolts on element cover; remove the cleaner element (15). Check the accumulation of dirt and debris on the element. Replace as necessary.

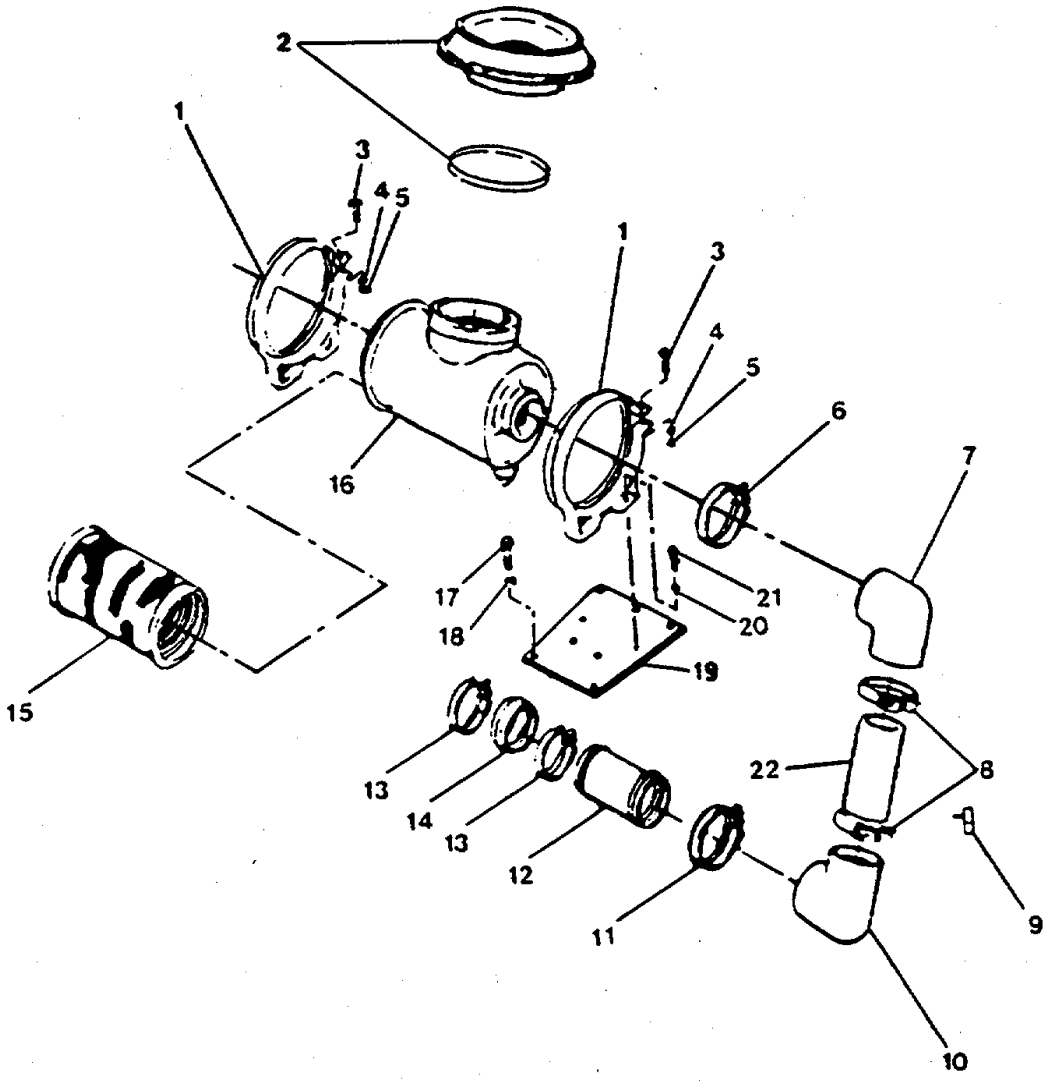


FIGURE 2-15. Air Cleaner Group.

WARNING

High pressure compressed air tanks, piping systems and air-operated devices possess potential for serious injury to eyes and exposed areas of skin due to escaping air pressure.

c. Replace or clean the air cleaner element (15), using compressed air.

d. Inspect piping between air element and turbocharger for cracks or breaks.

REMOVAL

a. Remove two hose clamps (13) from preformed hose (14). Remove preformed hose.

b. Remove hose clamp (11) retaining metal tube assembly (12). Remove metal tube assembly.

c. Remove two clamps (8), tube elbow (10), metal tube assembly (22) and filter warning indicator (9).

d. Remove clamp (6) and tube elbow (7).

e. Remove hexagon head capscrews (3), lockwashers (4), and hexagon nuts (5). Remove two retaining straps (1). Remove air cleaner housing (16).

f. Remove five hexagon head capscrews (17), and lockwashers (18).

g. Remove four hexagon head capscrews (21), and lockwashers (20). Remove bracket (19).

h. Remove air cleaner element (15) from air cleaner housing.

i. Remove cap with clamp assembly (2).

REPAIR

Repair consists of replacement of defective parts.

REPLACEMENT

a. Install cap with clamp assembly (2) on air cleaner housing (16).

b. Insert clean or new air cleaner element (15) into the air cleaner housing (16).

c. Install two retaining straps (1) to air cleaner housing (16). Secure with hexagon nuts (5), lockwashers (4), and hexagon head capscrews (3).

d. Position retaining strap (1) on bracket (19). Secure with four lockwashers (20) and hexagon head capscrews (21).

e. Position bracket (19) on engine block. Secure with five lockwashers (18) and hexagon head capscrews (17).

f. Install clamp (6) and tube elbow (7) on air cleaner housing (16).

g. Install filter warning indicator (9), metal tube assembly (22), tube elbow (10) and clamps (8).

h. Install clamp (11) to tube elbow (10) and retaining metal tube assembly (12).

i. Install two clamps (13) to metal tube assembly (12) and preformed hose (14).

2-19. Replace Turbocharger Group. (FIGURE 2-16)

This task covers:

a. Removal **b. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Flex socket P/N 3375300

Equipment Condition

Engine shutdown and cooled to 120°F (50°C). TM 55-1905-223-10.

Materials/Parts

Turbocharger P/N 3524648
Hi-Temperature anti-seize compound, Item 5, Appendix C
Turbocharger blanket P/N 30063697
Gasket P/N 3033784, 201048
Nonmetallic hose assembly P/N 3019035
Preformed packing P/N 216187
Turbocharger gasket P/N 206576
Engine lube oil, Item 2, Appendix C

REMOVAL

CAUTION

Upon removal and installation of this item, blank, cover or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

a. To remove the turbocharger (16), perform the following steps.

(1) Remove turbocharger blanket (25). Inspect blanket for damage (tears or splits). Discard blanket if damaged.

(2) Loosen loop clamp (26) on hose (27) between air cleaner and turbocharger (16). Disconnect hose (27) from turbocharger (16).

(3) Loosen loop clamp (13) on exhaust connection (12). Disconnect exhaust connection (12) from turbocharger (16).

(4) Remove hexagon head capscrew (19), lockwasher (20) and ring spacer (21) from metallic (oil drain) hose assembly (18).

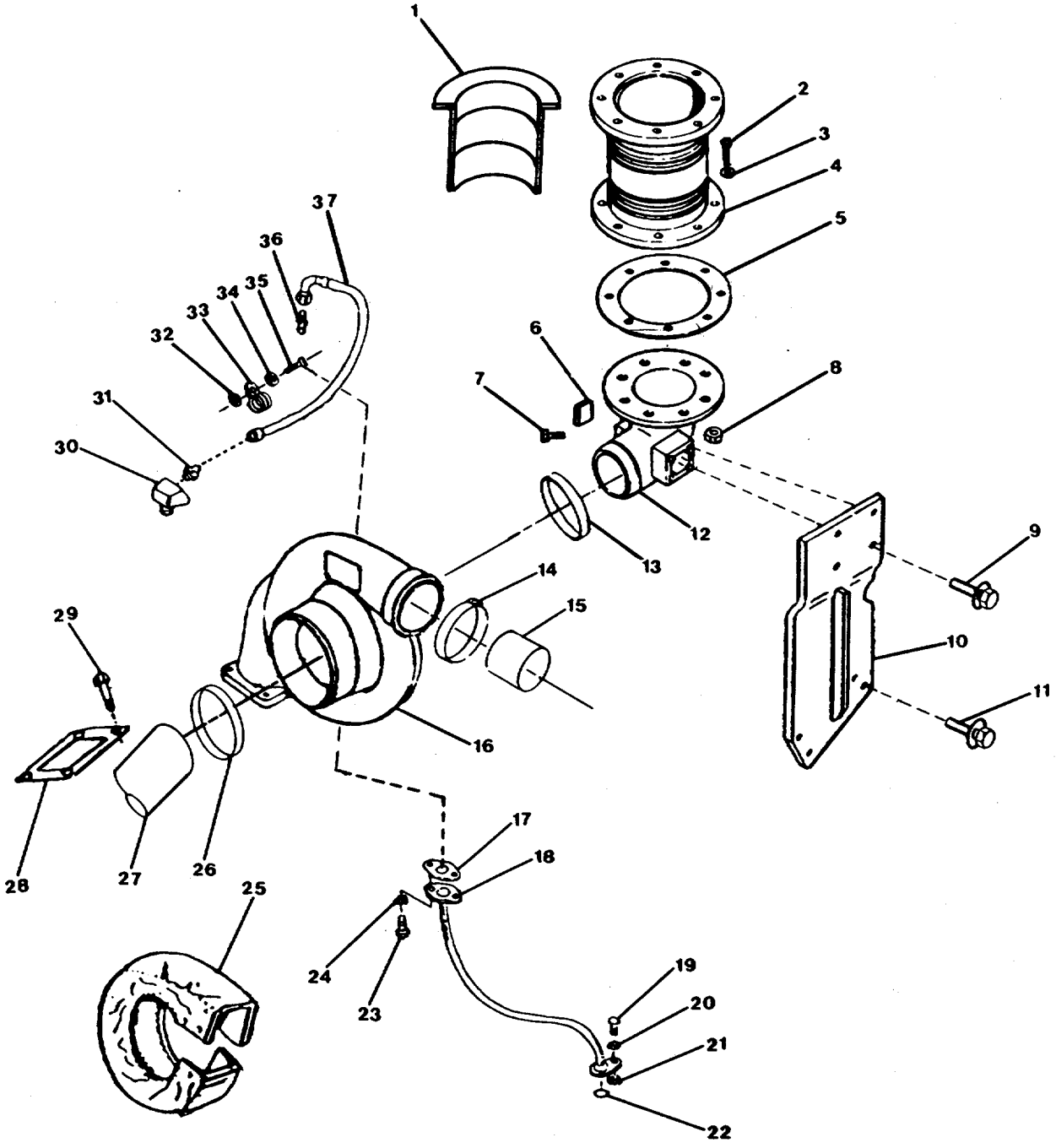


FIGURE 2-16. Turbocharger Group.

(5) Detach metallic hose assembly (18) from cylinder block. Remove and discard preformed packing (22).

(6) Remove two hexagon head capscrews (23) and lockwashers (24) attaching metallic hose assembly (18) to turbocharger (16).

(7) Remove metallic hose assembly (18) and gasket (17). Discard gasket (17).

(8) Disconnect nonmetallic (oil inlet) hose assembly (37) and straight adapter (36) from turbocharger (16).

(9) Remove hexagon head capscrew (35), lockwasher (34) and flat washer (32) securing nonmetallic hose loop clamp (33). Remove loop clamp.

(10) Disconnect pipe-to-tube adapter (31) from pipe bushing (30). Remove pipe-to-tube adapter (31), pipe bushing (30) and nonmetallic hose (37).

(11) Loosen hose-clamp (14) to after cooler air hose (15). Disconnect hose (15) from turbocharger (16).

(12) Remove four hexagon head capscrews (29) securing turbocharger (16) to manifold.

WARNING

The turbocharger weighs 50 lb (23 kg) or more. To avoid personnel injury, two soldiers are required to lift the turbocharger.

(13) Remove turbocharger (16) and turbocharger gasket (28). Discard gasket.

b. To remove exhaust connections perform the following steps.

(1) Remove exhaust connection blanket (1).

(2) Remove thermocoupler (6) in accordance with TM 55-1905-223-24-18.

(3) Loosen loop clamp (13) on exhaust connection (12). Disconnect exhaust connection (12) from turbocharger (16).

(4) Remove 16 hexagon head capscrews (2), lockwashers (3) and plain hexagon nuts (8).

(5) Remove exhaust connection (4) and gasket (5). Discard gasket.

(6) Remove pipe plug (7) from exhaust connection (12).

(7) Remove four machine screws (9) securing exhaust connection (12) to exhaust connection bracket (10). Remove exhaust connection (12) and loop clamp (13).

(8) Remove four machine screws (11) from exhaust connection bracket (10). Remove exhaust connection bracket.

REPLACEMENT

a. To replace exhaust connections perform the following steps.

(1) Position exhaust connection bracket (10). Install four machine screws (11). Tighten screws to 70 ft-lb (90 N•m).

(2) Position exhaust connection (12) to exhaust connection bracket (10). Install four machine screws (9). Tighten screws to 70 ft-lb (90 N•m).

(3) Install loop clamp (13) on exhaust connection (12). If turbocharger (16) is installed, attach exhaust connection (12) to turbocharger (16). Tighten loop clamp (13) to 60 in-lb (7 N•m)

(4) Install pipe plug (7).

(5) Install gasket (5) and exhaust connection (4).

(6) Install 16 lockwashers (3), hexagon head capscrews (2) and plain hexagon nuts (8). Secure capscrews to 70 ft-lb (90 N•m).

(7) Install thermocoupler (6) in accordance with TM 55-1905-223-24-18.

(8) Install exhaust connection blanket (1).

b. To replace turbocharger perform the following steps.

WARNING

The turbocharger weighs 50 lb (23 kg) or more. To avoid personnel injury, two soldiers are required to lift the turbocharger.

(1) Install turbocharger gasket (28) and turbocharger (16).

(2) Connect after cooler air hose (15) to turbocharger (16). Do not tighten hose clamp (14).

(3) Connect hose (27) between air cleaner and turbocharger (16). Do not tighten loop clamp (26).

(4) Connect exhaust connection (12) to turbocharger (16). Do not tighten loop clamp (13).

(5) Coat four hexagon head capscrews (29) with high temperature anti-seize compound. Install hexagon head capscrews (29). Tighten capscrews to 30 ft-lb (40 N•m).

NOTE

The centerline of the turbocharger oil drain connection must be within 35 degrees of vertical when the turbocharger is installed on the engine.

(6) Tighten hose clamp (14) to 140 in-lb (15 N•m). Tighten loop clamps (26 and 13) to 60 in-lb (7 N•m).

(7) Install pipe brushing (30). Connect pipe-to-tube adapter (31) to pipe brushing (30) and nonmetallic hose assembly (37).

(8) Attach loop clamp (33) to nonmetallic hose assembly (37). Secure loop clamp (33) to engine block with flat washer (32), lockwasher (34) and hexagon head capscrew (35). Hand tighten capscrew (35).

(9) Connect straight adapter (36) to turbocharger (16). Tighten straight adapter (36) to 25 ft-lb (35 N•m). Connect nonmetallic hose assembly (37) to straight adapter (30) and to turbocharger (16).

(10) Position gasket (17) and metallic hose assembly (18) to turbocharger (16). Install two lockwashers (24) and hexagon head capscrews (23). Tighten capscrews to 30 ft-lb (40 N•m).

(11) Lubricate preformed packing (22) with clean engine lube oil. Install preformed packing (22), ring spacer (21) and metallic hose assembly (18) in engine block.

(12) Install lockwasher (20) and hexagon head capscrew (19). Tighten capscrew to 30 ft-lb (40 N•m).

(13) Install turbocharger blanket (25) to turbocharger (16).

2-20. Replace/Repair Fuel Filter Group. (FIGURE 2-17)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine
5180-00-629-9783

Equipment Condition

Engine shutdown. Fuel valve to filter OFF. TM 22-1905-223-10.

Materials/Parts

Nonmetallic hose assembly P/N AM 1208455
Gasket P/N 252598
Fluid filter element P/N 256835
Diesel fuel, Item 6, Appendix C

REMOVAL

WARNING

Be sure to catch fuel in a container when removing the filter elements and lines. Wipe up all spills immediately. Fuel is extremely volatile and could cause a fire.

a. Turn input and output shutoff valves (6) to OFF position.

b. Loosen bolt (1) and remove fluid filter body top (2) and gasket (3) from fluid filer body (5). Remove and discard fluid filter element (4).

c. Remove fuel input and output nonmetallic hoses (8 and 10) from pipe unions (7 and 9) and position out of way.

d. Remove fuel filter assembly (17) from filter bracket (18) by removing eight hexagon head capscrews (12), lockwashers (13), and flat washers (14).

e. Remove filter bracket (18) by removing four hexagon head capscrews (15) and lockwashers (16).

f. Remove nonmetallic hose assembly (10) from elbow adapter (11).

g. Remove elbow adapter (11).

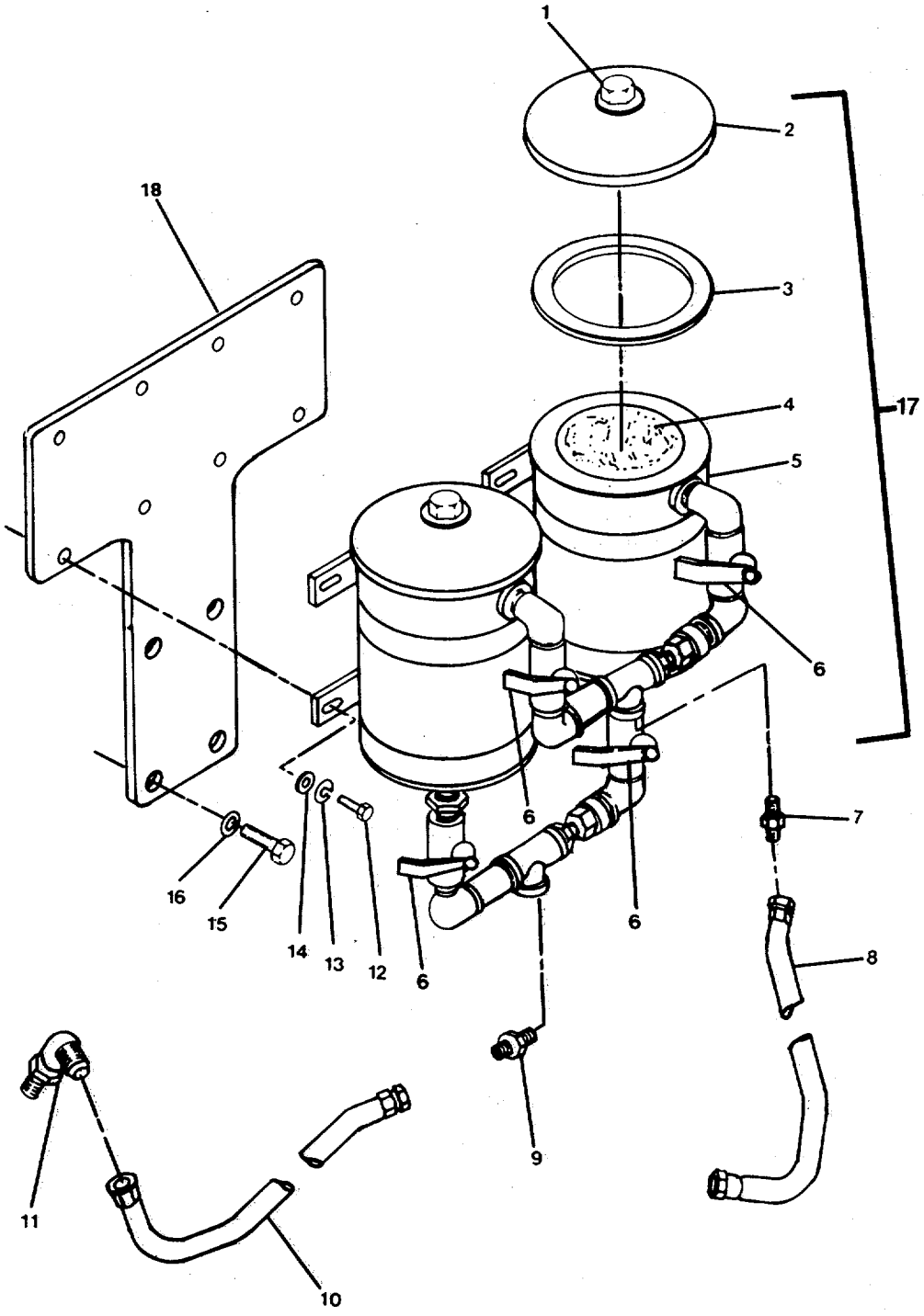


FIGURE 2-17. Fuel Filter Group and Assembly.

REPAIR

Repair of fuel filter group consists of replacement of defective parts.

REPLACEMENT

a. Position filter bracket (18), and secure with four lockwashers (16) and hexagon head capscrews (15).

b. Position fuel filter assembly (17) on filter bracket (18) and secure with eight flat washers (14), lockwashers (13), and hexagon head capscrews (12).

c. Install pipe unions (7 and 9) and fuel input and output nonmetallic hose assemblies (8 and 10).

d. Install elbow adapter (11). Connect nonmetallic hose assembly (10) to elbow adapter (11).

e. Insert new fluid filter elements (4) in fluid filter body (5) and fill with clean diesel fuel.

f. Position new gasket (3) on fluid filter body (5).

g. Position fluid filter body top (2). Hand tighten hold-down bolt (1).

h. Turn input and output shutoff valves (6) to ON position.

2-21. Repair Fuel Filter Assembly. (FIGURE 2-18)

This task covers:

a. Disassembly **b. Repair** **c. Assembly**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine
5180-00-629-9783

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Fuel filter assembly removed, para. 2-20.

Materials/Parts

Gasket P/N 252598
Fluid filter element P/N 256835

DISASSEMBLY

a. To remove the components of bottom section of the fuel filter assembly perform the following steps.

(1) Remove pipe nipple (12) and pipe adapter (11).

(2) Remove pipe tee (13).

(3) Remove pipe nipple (14).

(4) Remove two pipe elbows (15).

(5) Remove two shutoff valves (16) from two reducing pipe nipples (17).

b. To remove components of top section of fluid filter assembly perform the following steps.

(1) Remove pipe nipple (7) and pipe adapter (8).

(2) Remove pipe tee (9).

(3) Remove pipe nipple (10).

(4) Remove two pipe elbows (6).

(5) Remove two shutoff valves (5) and two reducing pipe elbows (4).

c. To remove fluid filter body (18) perform the following steps.

(1) Loosen bolt (19) and remove fluid filter body top (1). Remove and discard gasket (2) and fluid filter element (3).

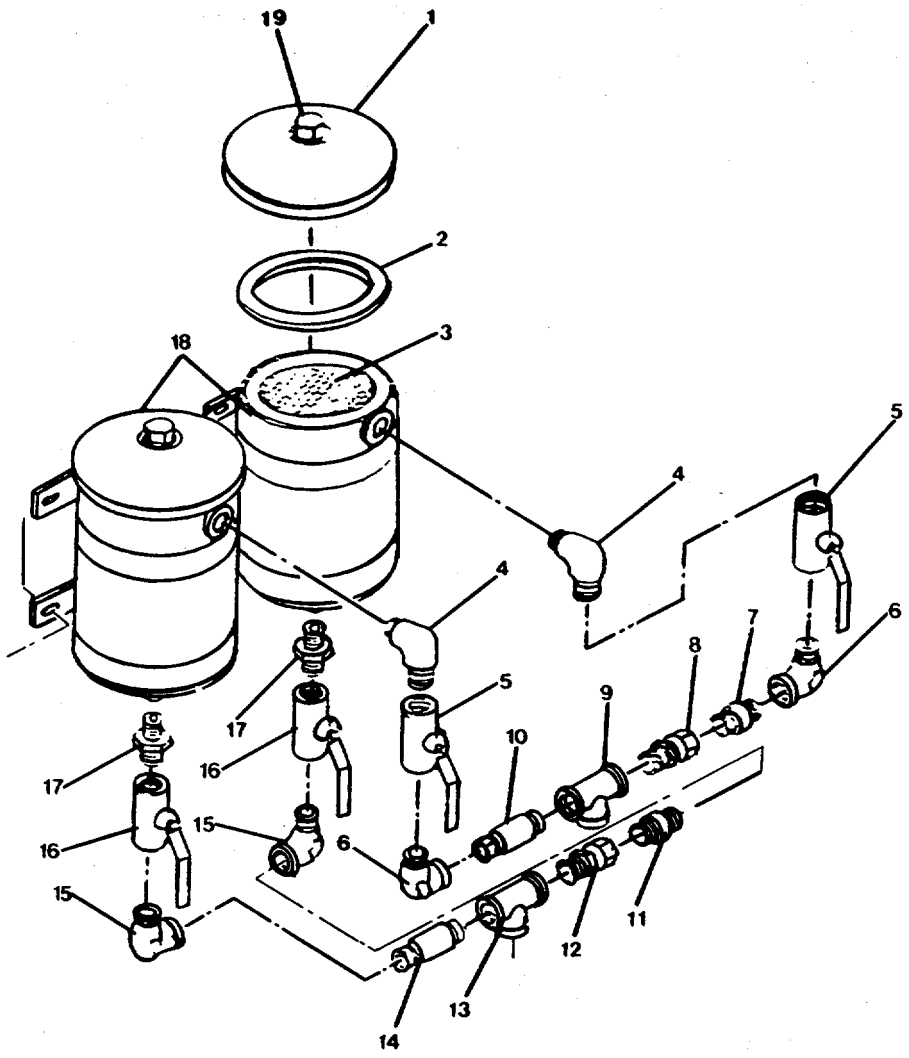


FIGURE 2-18. Fuel Filter Assembly.

(2) Remove two reducing pipe elbows (4) from fluid filter body (18).

(3) Remove fluid filter body (18) from two reducing pipe nipples (17).

REPAIR

Repair consists of replacement of defective parts.

ASSEMBLY

a. To replace fluid filter body (18) perform the following steps.

(1) Connect two reducing pipe nipples (17) to fluid filter body (18).

(2) Connect two reducing pipe elbows (4) to fluid filter body (18).

(3) Insert new fluid filter element (3).

(4) Install gasket (2).

(5) Install fluid filter body top (1). Hand tighten holddown bolt (19).

b. To replace components of top section of fluid filter assembly, perform the following steps.

(1) Connect two reducing pipe elbows (4) and two shutoff valves (5).

(2) Connect two pipe elbows (6).

(3) Connect pipe nipple (10).

(4) Connect pipe tee (9).

(5) Connect pipe adapter (8) and pipe nipple (7) to pipe tee (9) and pipe elbow (6).

c. To replace components of bottom section of fluid filter assembly, perform the followingsteps.

(1) Connect two reducing pipe nipples (17) to two shutoff valves (16).

(2) Connect two pipe elbows (15).

(3) Connect pipe nipple (14) to pipe elbow (15) and pipe tee (13).

(4) Connect pipe adapter (11) to pipe elbow (15) and pipe nipple (12).

(5) Connect pipe nipple (12) to pipe tee (13).

d. Replace fuel filter assembly, paragraph 2-20.

e. Start engine (TM 55-1905-223-10), check for leaks, correct as required.

2-22. Replace/Repair Sump Pump Group. (FIGURE 2-19)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine
5180-00-629-9783

Equipment Condition

Engine shutdown. TM 55-1905-223-10.

Materials/Parts

Rotary pump P/N 3032869

REMOVAL

a. Close engine oil sump stop-check valve (11) and reduction gear stop-check valve (15).

b. Remove outlet line and pipe nipple (1) from top of sump pump (18).

c. Disconnect nonmetallic hose (16) from reduction gear end.

d. Disconnect nonmetallic hose (9) from pipe elbow (10).

e. Remove two machine bolts (19), lockwashers (3) and plain hexagon nuts (2). Remove sump pump (18) from bracket (4).

f. Remove nonmetallic hose (9) from pipe elbow (8).

g. Remove nonmetallic hose (16) from pipe elbow (17).

h. Remove two pipe elbows (8 and 17).

i. Remove two stop-check valves (11 and 15) and pipe nipples (12 and 14). Remove pipe tee (13).

j. Remove pipe nipple (5) from sump pump (18).

k. Remove four hexagon head capscrews (7) and lockwashers (6) from bracket (4). Remove bracket (4).

REPAIR

Repair of the sump pump group consists of replacement of defective parts.

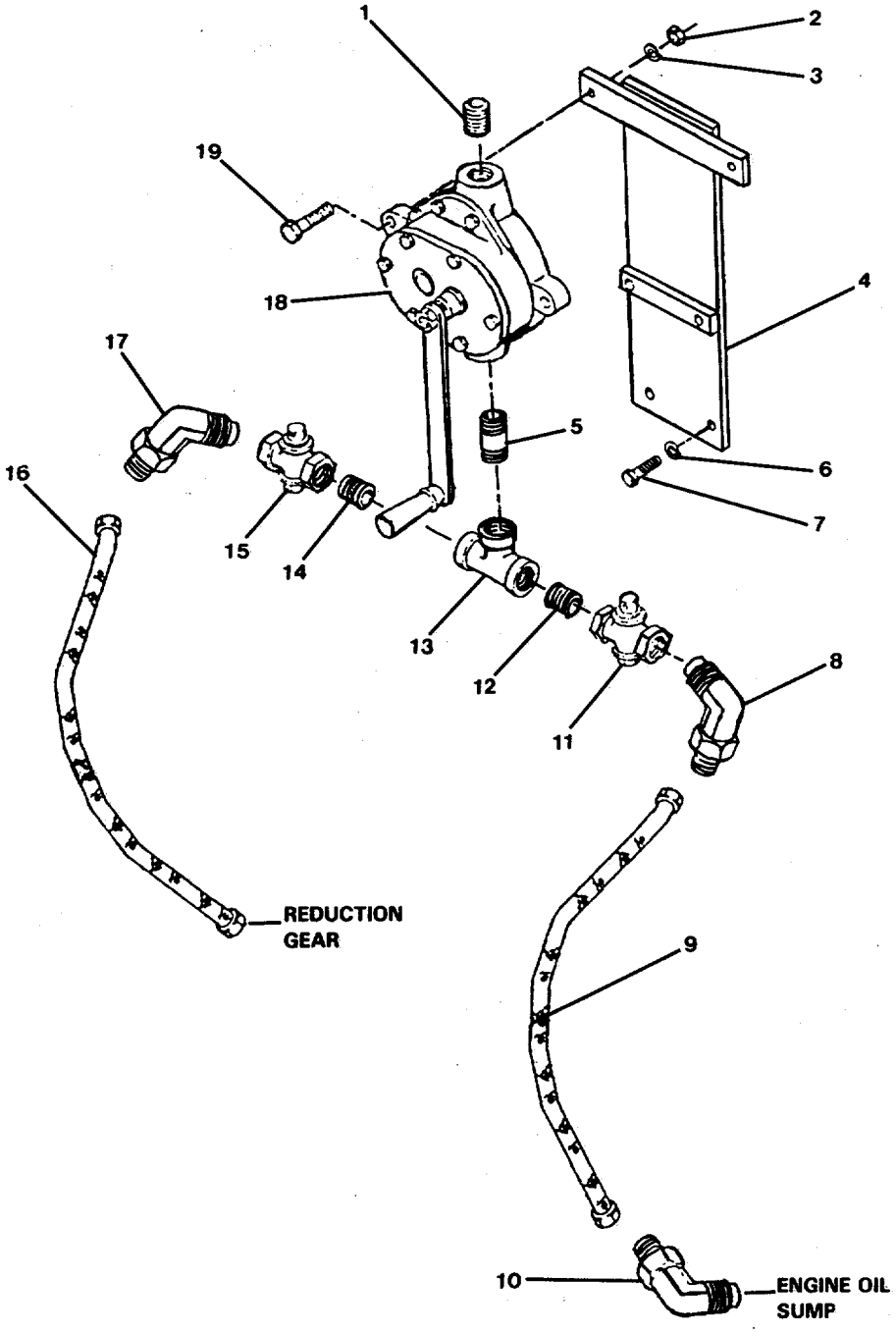


FIGURE 2-19. Sump Pump Group.

REPLACEMENT

a. Position bracket (4). Secure with four lockwashers (6) and hexagon head capscrews (7).

b. Connect pipe nipple (5) and sump pump (18) to pipe tee (13).

c. Connect two pipe nipples (12 and 14) and two stop-check valves (11 and 15) to pipe tee (13).

d. Connect two pipe elbows (8 and 17) to stop-check valves (11 and 15).

e. Position sump pump (18) on bracket (4). Secure with two machine bolts (19), lockwashers (3), and plain hexagon nuts (2).

f. Install pipe nipple (1) in top of sump pump (18). Connect outlet hose to pipe nipple (1).

g. Connect nonmetallic hoses (9 and 16) to pipe elbows (8 and 17).

h. Connect nonmetallic hoses (9) to pipe elbow (10).

i. Connect nonmetallic hose (16) to reduction gearend.

2-23. Replace/Repair Water Pump Group. (FIG. 2-20)

This task covers: **a. Removal,** **b. Repair,** **c. Replacement.**

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown, and secured, coolant drained. TM 55-1905-223-10.

Materials/Parts

Engine cooling system pump P/N 3050447
Engine lube oil, Item 2, Appendix C
Anti-Seize compound, Item 5, Appendix C
Gasket P/N 207540,
Preformed packing P/N 206457, 3007512
Water inlet connection P/N 207539
Water pump gasket P/N 206193
Water pump adapter gasket P/N 206455

NOTE

Replacement of the engine cooling system pump and engine accessory bracket are included in this procedure.

REMOVAL

WARNING

The engine cooling system pump is very heavy. To avoid personal injury, two soldiers are required to lift the engine cooling system pump.

a. Remove two machine bolts (11) and lockwashers (12) that hold water pump support (16) to engine block.

b. Remove four machine bolts (9) and lockwashers (10) from water pump inlet connection (8).

c. Remove four machine bolts (14), lockwashers (15), and flat washers (13) that hold water pump inlet connection (8) to engine system cooling pump (4).

d. Remove water pump support (16).

e. Remove water inlet connection (21) from water pump inlet connection (8).

f. Remove water pump inlet connection (8) and gasket (22). Discard gasket.

g. Remove two pipe plugs (6 and 7) from water pump inlet connection (8).

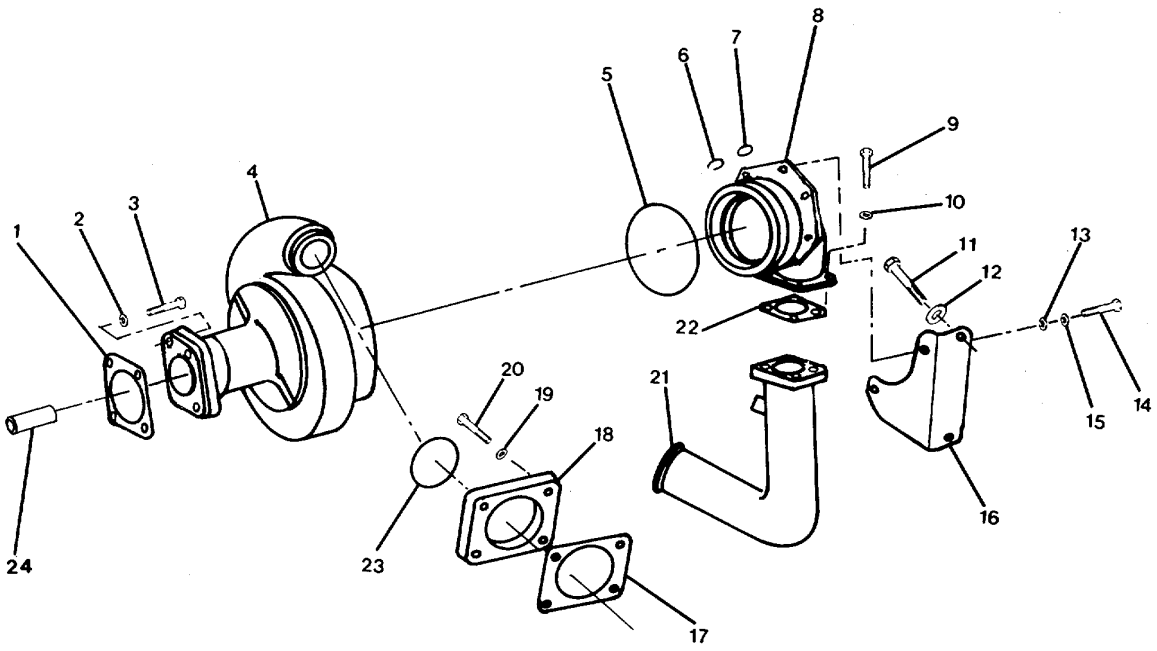


FIGURE 2-20. Water Pump Group.

h. Remove and discard preformed packing (5).

i. Remove four machine bolts (20) and lockwashers (19).

j. Remove four hexagon head capscrews (3) and lockwashers (2).

k. Remove engine cooling system pump (4) by pulling straight away from the drive.

NOTE

Pump spline coupling (24) may come out with pump.

l. Remove and discard water pump gasket (1).

m. Remove water pump adapter plate (18).

n. Remove and discard water pump adapter gasket (17) and preformed packing (23).

REPAIR

Repair of the water pump group consists of replacement of defective parts. Repair of the engine cooling system pump is covered by intermediate direct support maintenance procedures (Chapter 3).

REPLACEMENT

a. Lubricate preformed packing (23) with clean engine lube oil. Install preformed packing (23) in the water pump adapter plate (18) groove.

b. Install water pump adapter plate (18) on engine system cooling pump (4) with grooved side of plate nearest to the pump.

NOTE

If the spline coupling (24) came out when the engine system cooling pump (4) was removed, install spline coupling on pump shaft before installing water pump gasket (1).

c. Install water pump gasket (1) on engine system cooling pump (4).

WARNING

The engine cooling system pump is very heavy. To avoid personal injury, two soldiers are required to lift the engine cooling system pump.

d. Position engine cooling system pump (4). Rotate the pump to align the spline coupling (24) with the splines on the engine cooling system pump drive shaft. Install four lockwashers (2) and hexagon head capscrews (3). Tighten capscrews only enough to hold the parts together.

e. Install water pump adapter gasket (17).

f. Install four lockwashers (19) and machine bolts (20). Do not tighten.

g. Rotate the engine cooling system pump (4) as required until the pump outlet and water pump adapter plate (18) are as near to the cylinder block as required.

h. Tighten four hexagon head capscrews (3) to 45 ft-lb (60 N•m). Tighten four machine bolts (20) to 30 ft-lb (40 N•m).

i. Install preformed packing (5) in water pump inlet connection (8) groove. Lubricate preformed packing with clean engine lube oil.

j. Install two pipe plugs (6 and 7) in water pump inlet connection (8).

k. Install gasket (22).

l. Position water pump support (16) to cylinder block. Install two lockwashers (12) and machine bolts (11). Tighten bolts only enough to hold the parts together.

m. Position water inlet connection (8) to bore of engine system cooling pump (4). Align holes.

n. Install four washers (13), lockwashers (15) and machine bolts (14).

o. Position water inlet connection (21) to water inlet connection (8).

p. Install four lockwashers (10) and machine bolts (9).

CAUTION

Be sure the water pump support remains flat against the cylinder block and the water inlet connection while tightening bolts. If the support does not remain flat stress will cause the support to fail.

q. Tighten machine bolts (9 and 14) to 30 ft-lb (40 N•m). Tighten machine bolts (11) to 45 ft-lb (60 N•m).

2-24. Replace Lube Oil Filter Assembly. (FIG. 2-21)

This task covers:

a. Inspection and Servicing
b. Removal
c. Repair
d. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Filter cutter P/N 3376579
Oil filter wrench P/N 3375049

Equipment Condition

Engine Shutdown. TM 55-1905-223-10.

Materials/Parts

Fluid filter elements P/N 3313282
Engine lube oil, Item 2, Appendix C
Filter head gasket P/N 3177108
Lube oil filter head gasket P/N 3011650

INSPECTION AND SERVICING

Inspection and servicing of lube oil filter assembly is covered in Table 2-1.

REMOVAL

CAUTION

Upon removal and replacement of this unit, cover, blank, or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

a. Remove lube oil filter assembly.

(1) Disconnect and remove pre-lube oil line (4).

(2) Remove five fluid filter elements (6) by unscrewing with filter wrench.

(3) Use filter cutter to cut open the fluid filter elements. Check inside fluid filter elements for metal particles. Determine cause of problem if metal particles are found. Discard fluid filter elements.

(4) Turn adaptor counterclockwise to disconnect the instrument panel oil line from its port (2), located near the rear of the lube oil filter assembly (5).

WARNING

The lube oil filter assembly is very heavy. To prevent injury to personnel or property damage, have another soldier support the assembly while removing the last two machine bolts.

(5) Remove 12 machine bolts (7) and lockwashers (8) retaining the lube oil filter assembly (5).

(6) Remove the lube oil filter assembly (5) from the engine block.

(7) Remove and discard filter head gasket (1) and lube oil filter head gasket (3).

REPAIR

Repair of lube oil filter assembly is by replacement of fluid filter elements and the head gasket.

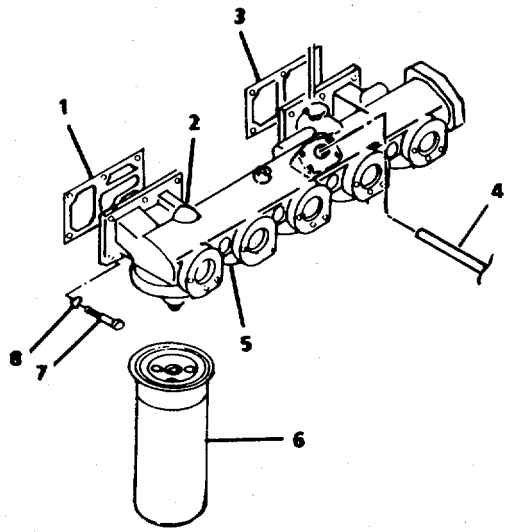


FIGURE 2-21. Lube Oil Filter Assembly.

REPLACEMENT

a. Install lube oil filter assembly.

WARNING

The lube oil filter assembly is very heavy. To avoid personal injury, two soldiers are required to lift the lube oil filter assembly.

CAUTION

The lube oil filter assembly must be installed opposite the engine bank to where the oil transfer tube is connected. If the oil filter assembly is installed on the wrong bank, the engine will be damaged severely because of the lack of lubrication.

NOTE

The lube oil filter assembly contains the pressure regulator, piston cooling and filter bypass valves. Make sure these valves are installed by intermediate direct support maintenance prior to mounting the new lube oil filter assembly to the block.

(1) Install guide studs in the upper corners of the filter head mounting flanges.

CAUTION

The lube oil filter head gasket (3) has a rib down the center. This gasket must be installed on the right end of the lube oil filter assembly. If installed incorrectly, the engine will be damaged due to loss of lubrication.

(2) Install filter head gasket (1) and lube oil filter head gasket(3) over the guide studs.

(3) Position the lube oil filter assembly (5) over the guides.

(4) Install ten lockwashers (8) and machine bolts (4) finger tight.

CAUTION

It is extremely important that machine bolts be tightened to the proper torque value; otherwise, leakage could occur causing severe damage to the engine.

(5) Remove guide studs and install the remaining two lockwashers (8) and machine bolts (7). Tighten machine bolts (7) alternately and evenly to 30 ft-lb (40 N-m).

(6) Fill replacement fluid filter elements (6) with clean engine lube oil.

CAUTION

Mechanical tightening may distort threats or damage fluid filter element seals.

(7) Install five fluid filter elements (6). Tighten by hand until the fluid filter element seal touches the lube oil filter assembly (5). Tighten an additional one-half to three-quarters turn.

(8) Attach pre-lube oil line (4) to filter assembly (5).

b. Add engine lube oil.

(1) Fill the crankcase to the "H" mark on the dipstick or on the sight gauge.

(2) Start engine (TM 55-1905-223-10) and check for leaks. Correct any leaks found.

(3) Shut down engine (TM 55-1905-223-10) and allow 15 minutes for lube oil to drain back into engine oil pan.

(4) Recheck oil level. Add lube oil, if necessary.

2-25. Replace/Repair Lube Oil Bypass Filter Group. (FIG. 2-22)

This task covers:

a. Inspection and Servicing
b. Removal
c. Repair
d. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Oil filter wrench P/N 3375049
Filter cutter P/N 3376579

Equipment Condition

Engine operating, lube oil temperature normal.

Materials/Parts

Nonmetallic hose assembly P/N AM06018SS
Fluid filter elements P/N 3313282
Lube oil bypass filter assembly P/N 3176127
Engine lube oil, Item 2, Appendix C

INSPECTION AND SERVICING

Inspection and servicing of lube oil bypass filter group is covered in Table 2-1.

REMOVAL

a. Drain engine lube oil.

(1) Shut down engine. TM 55-1905-223-10.

2) Wait 15 minutes, then open the valve between the engine oil pan and sump pump. Be sure the valve to the marine gear is closed.

(3) Turn sump pump handle until all oil has been pumped from oil pan.

(4) Close valve.

b. Remove oil bypass filter group.

CAUTION

Upon removal and replacement of this unit, cover, blank, or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

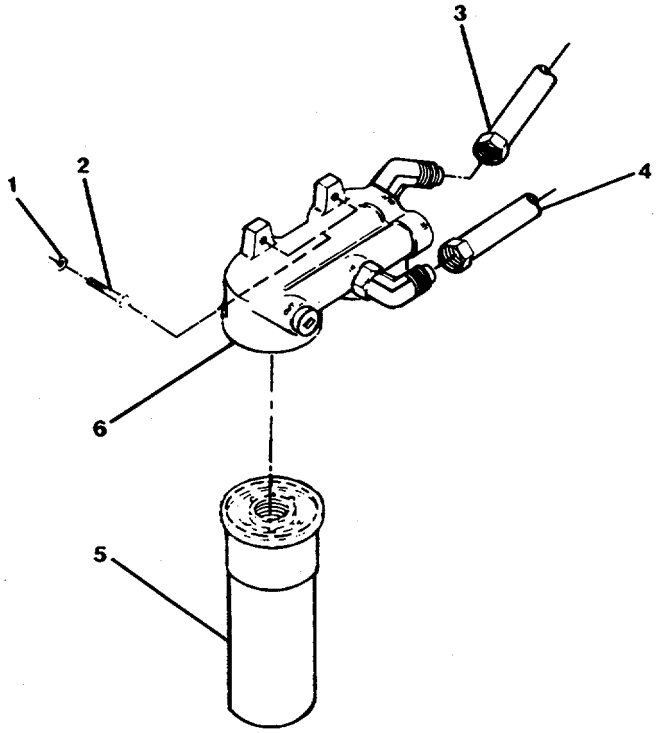


FIGURE 2-22. Lube Oil Bypass Filter Group.

(1) Remove two fluid filter elements (5) by unscrewing with oil filter wrench.

(2) Use filter cutter to cut open the fluid filter elements. Check inside fluid filter elements for metal particles. Determine cause of problem if metal particles are found. Discard fluid filter elements.

(3) Disconnect and remove two nonmetallic hose assemblies (3 and 4).

(4) Remove two hexagon head capscrews (2) and lockwashers (1).

(5) Remove lube oil bypass filter assembly (6).

REPAIR

Repair of the lube oil bypass filter group is accomplished by replacing defective parts. Repair of the lube oil bypass filter assembly is covered in paragraph 2-26.

REPLACEMENT

a. Install lube oil bypass filter group.

(1) Position lube oil bypass filter assembly (6) to cylinder block. Install two lockwashers(1) and hexagon head capscrews (2). Tighten capscrews to 35 to 40 ft-lb (47 to 54 Nm).

(2) Connect two nonmetallic hose assemblies (3 and 4).

CAUTION

Mechanical tightening may distort threads or damage fluid filter element seals.

(3) Fill two fluid filter elements (5) with clean engine lube oil.

(4) Install fluid filter elements (5). Tighten by hand until the fluid filter element seal touches the lube oil bypass filter assembly (6). Tighten an additional one-half to three-quarters turn.

b. Add engine lube oil.

(1) Fill the crankcase to the "H" mark on the dipstick or on the sight gauge.

(2) Start engine (TM 55-1905-223-10) and check for leaks. Correct any leaks found.

(3) Shut down engine (TM 55-1905-223-10) and allow 15 minutes for lube oil to drain back into engine oil pan.

(4) Recheck oil level. Add lube oil, if necessary.

2-26. Replace/Repair Lube Oil Bypass Fluid Filter Head. (FIG. 2-23)

This task covers:

a. Inspection and Servicing
b. Removal
c. Repair
d. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Oil filter wrench P/N 3375049

Equipment Condition

Engine Shutdown. TM 55-1905-223-10.
Lube oil bypass filter assembly removed, para. 2-25.

Materials/Parts

Performed packing P/N MS9021-116

INSPECTION AND SERVICING

Inspection and servicing of lube oil bypass filter assembly is covered in Table 2-1.

REMOVAL

CAUTION

Upon removal and replacement of this unit, cover, blank or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

a. Remove two pipe elbows (2) from fluid filter head (1).

b. Remove two machine thread plugs (3) from fluid filter head.(l).

c. Remove and discard preformed packing (4).

d. Remove filter head insert (5) and key washer (6).

REPAIR

Repair of the lube oil bypass filter head and the fluid filter head consists of replacement of defective parts.

REPLACEMENT

a. Install key washer (6) and filter head insert (5) in fluid filter head (1). Tighten to 150 ft-lb (200 N•m).

b. Install preformed packing (4).

c. Install two machine thread plugs (3). Tighten to 35 ft-lb (47 N•m).

d. Install two pipe elbows (2). Tighten to 35 ft-lb (47 N•m).

e. Install lube oil bypass filter assembly (paragraph 2-25).

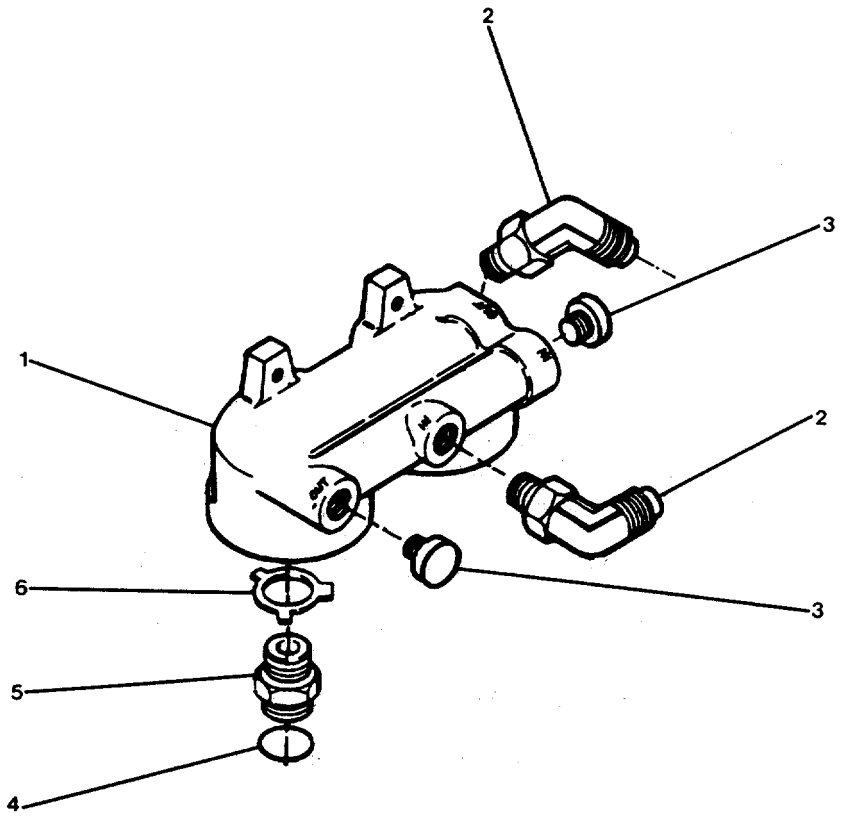


FIGURE 2-23. Lube Oil Bypass Filter Assembly.

2-27. Replace/Repair Cold Starting Aid Group. (FIG. 2-24)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783

Equipment Condition

Engine shutdown, electrical power to engine coolant heater OFF at switch and circuit breaker. TM 55-1905-223-10.

Materials/Parts

Engine coolant heater P/N 212024
Nonmetallic hose P/N 3027706
Nonmetallic hose P/N 155789
Nonmetallic hose P/N AS04030SS
Nonmetallic hose P/N AS04060SS
Pressure switch P/N 196074

REMOVAL

a. Remove supply and return hoses.

(1) Loosen eight hose clamps (2, 53, 55, 60-left bank or 16, 19, 46, 48-right bank) from associated bank.

(2) Remove four nonmetallic hoses (1, 50, 52, 59-left blank or 17, 20, 45, 57-right bank) and two metallic bent tubes (54 and 61-left blank or 18 and 47-right bank).

(3) Remove associated pipe-to-hose straight adapters (3, 21, 43, 51, 56, 58), hose elbows (15 and 49), tube-to-hose tee (12) and pipe nipples (13 and 14) as required.

(4) Remove hexagon head capscrew (9), lockwasher (8), flat washer (5) and hexagon nut (4) to remove loop clamp (6).

(5) Remove hexagon head capscrew (11) and lockwasher (10) to remove corner brace (7).

b. Remove engine coolant heater (44).

(1) Tag and disconnect electrical wiring.

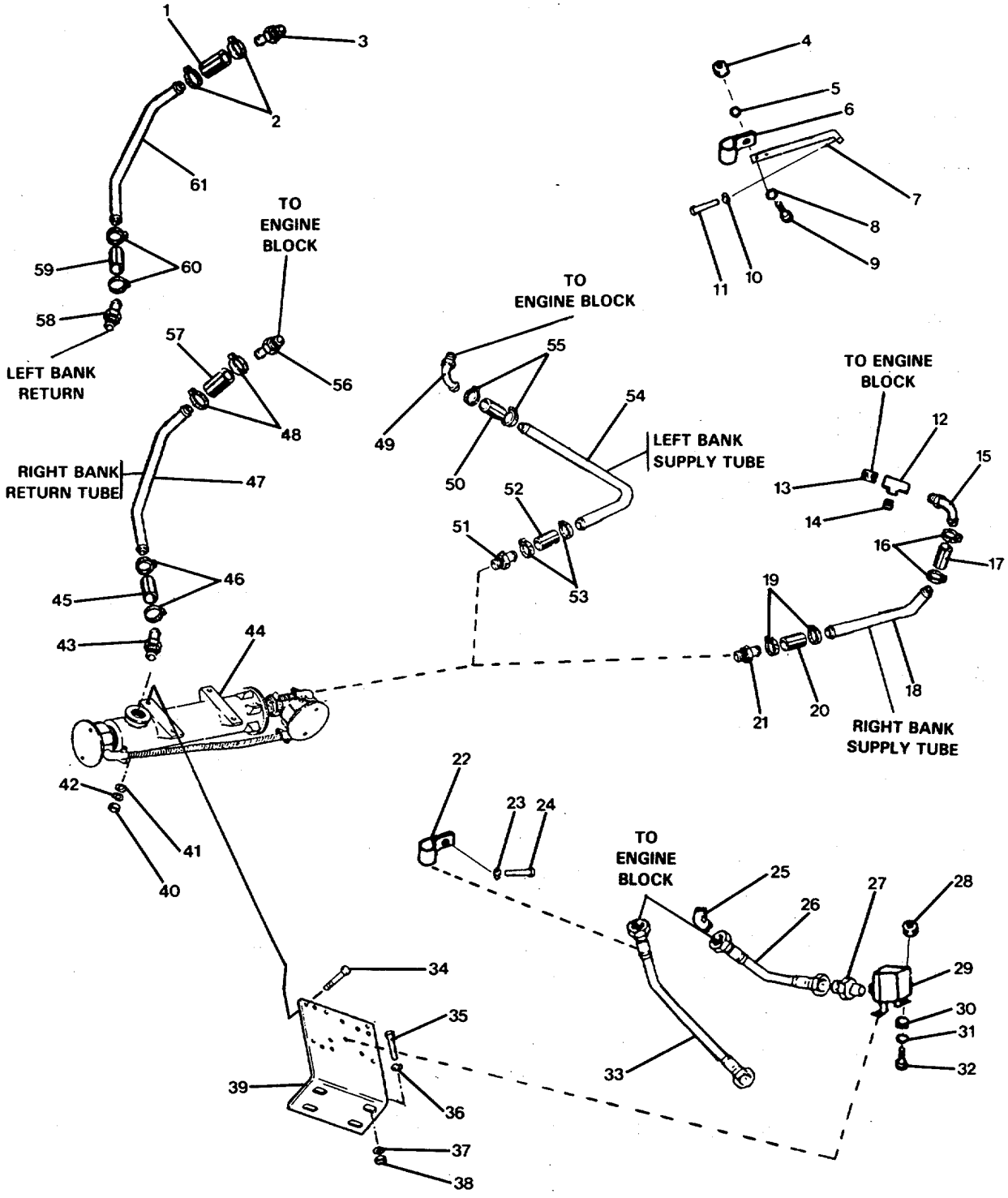


FIGURE 2-24. Cold Starting Aid Group.

(2) Remove four machine bolts (34), washers (41), lockwashers (42), and hexagon nuts (40).

(3) Lift engine coolant heater (44) from engine heater bracket (39).

c. Remove pressure switch (29).

(1) Tag and disconnect electrical wiring.

(2) Remove nonmetallic hose (26 or 33). Remove hexagon head capscrew (24) and lockwasher (23) to remove loop clamp (22).

(3) Remove pipe reducer (27) and tube-to-hose elbow (25).

(4) Remove four hexagon head capscrews (32), lockwashers (31), special spacers (30) and hexagon nuts (28).

(5) Remove pressure switch (29).

d. Remove engine heater bracket (39).

(1) Remove four hexagon head capscrews (35), lockwashers (36), flat washers (37) and hexagon nuts (38).

(2) Remove engine heater bracket (39).

REPAIR

Repair consists of replacing damaged nonmetallic hoses.

REPLACEMENT

a. Replace engine heater bracket (39).

(1) Position engine heater bracket (39).

(2) Install four hexagon nuts (38), flat washers (37), lockwashers (36) and hexagon capscrews (35). Secure until tight.

b. Replace pressure switch (29).

(1) Position pressure switch (29) on engine heater bracket (39).

(2) Install four hexagon nuts (28), special spacers (30), lockwashers (31) and hexagon head capscrews (32). Secure until tight.

(3) Install pipe reducer (27) and tube-to-hose elbow (25).

(4) Install nonmetallic hose (26 or 33). Install loop clamp (22), lockwasher (23), and hexagon head capscrew (24).

(5) Connect electrical wiring. Remove tags.

c. Replace engine coolant heater (44).

(1) Position engine heater cooler (44) on engine heater bracket (39).

(2) Install four hexagon nuts (40), lockwashers (42), washers (41) and machine bolts (34). Secure until tight.

(3) Connect electrical wiring remove tags.

d. Replace supply and return lines.

(1) Position corner brace (7). Secure with lockwasher (10) and hexagon head capscrew (11).

(2) Position loop clamp (6). Secure with hexagon nut (4), flat washer (5), lockwasher (8), and hexagon head capscrew (9).

(3) Connect pipe nipples (13 and 14), tube-to-hose tee (12), hose elbows (15 and 49) and pipe-to-hose straight adapters (3, 21, 43, 51, 56, 58) as required.

(4) Install hose clamps (2, 53, 55, 60-left bank or 15, 19, 46, 48-right bank), nonmetallic hoses (1, 50, 52, 59-left bank or 17, 20 45, 57-right bank), and metallic bent tubes (54 and 61-left bank or 18 and 47-right bank).

(5) Secure hose clamps until tight.

2-28. Replace/Repair Shutdown Valve Group. (FIG. 2-25)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216

Materials/Parts

Shutdown valve assembly P/N 3053461
Gasket P/N 154087
Utility pail, Item 30, Appendix C
Wiping rag, Item 4, Appendix C
Electrical tag, Item 7, Appendix C

Equipment Condition

Engine shutdown. Power switch emergency stop to STOP position and tagged "Out of Service-Do Not Operate," TM 55-1905-223-10.
Fuel control shutoff valve manual knob counterdockwise to the OFF position.

REMOVAL

WARNING

- Before attempting any of the following actions turn the fuel control shutoff valve manual knob counterclockwise to the OFF position and the power switch emergency stop to the STOP position.
- Use extreme caution while disconnecting fuel lines. Place cans to catch fuel from disconnected lines. Wipe up all fuel spills immediately.

a. Disconnect the fuel line from the shutdown valve assembly (4).

b. Tag and disconnect electrical connections.

c. Remove socket head capscrew (1), lockwasher (2) and flat washer (3).

d. Remove shutdown valve assembly (4).

e. Remove gasket (5) and discard.

REPAIR

The only repair authorized at unit level is replacement of the gasket and the shutdown valve assembly. Repair of shutdown valve assembly is covered by intermediate direct support maintenance procedures (Chapter 3).

REPLACEMENT

a. Position gasket (5) in recess located around discharge port of fuel pump.

b. Position shutdown valve assembly (4) over fuel pump discharge port with bolthole in shutdown valve assembly (5) aligned with bolthole in fuel pump.

c. Install flat washer (3), lockwasher (2) and socket head capscrew (1). Tighten capscrew to 11 ft-lb (15 N•m).

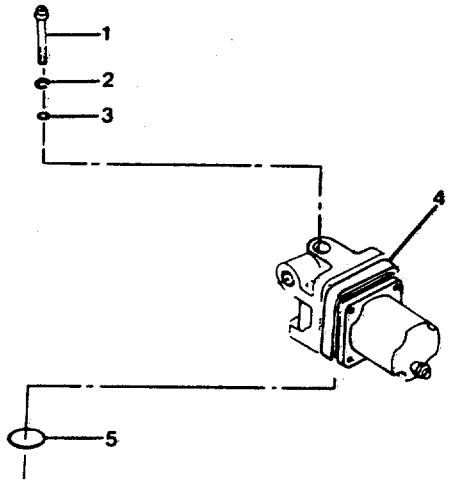


FIGURE 2-25. Shutdown Valve.

2-29. Replace/Repair Fuel Pump Group.

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216

Materials/Parts

Flex coupling insert P/N 3046200
Cam-actuated fuel pump P/N 3279570-B644
Gasket P/N 3035053
Utility pail, Item 30, Appendix C
Wiping rags, Item 4, Appendix C
Electrical tag, Item 7, Appendix C

Equipment Condition

Engine shutdown. Power switch emergency stop to STOP position and tagged "Out of Service-Do Not Operate." TM 55-1905-223-10.
Fuel control shutoff valve manual knob counterclockwise to the OFF position.

REMOVAL

WARNING

Use extreme caution while disconnecting fuel lines. Cans should be used to catch fuel from disconnected lines. All fuel spills should be wiped up immediately.

a. Remove fuel input and output lines (2 and 1, FIG. 2-26) attached to the cam-actuated fuel pump (3, FIG. 2-27).

b. Tag and disconnect electrical connections.

c. Remove linkage from throttle lever (2).

d. Remove four hexagon head capscrews (4), lockwashers (5) and flat washers (6) retaining cam-actuated fuel pump (3) to the engine block (8).

e. Remove cam-actuated fuel pump (3) and gasket (7). Discard gasket.

f. Remove flexible coupling insert (1).

g. Loosen throttle level capscrew and remove throttle lever (2).

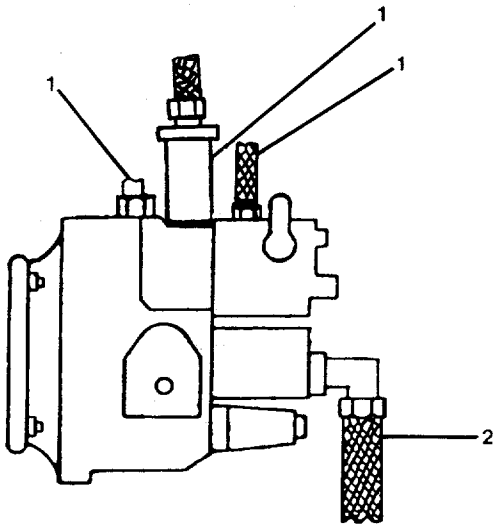


FIGURE 2-26. Fuel Pump External Components.

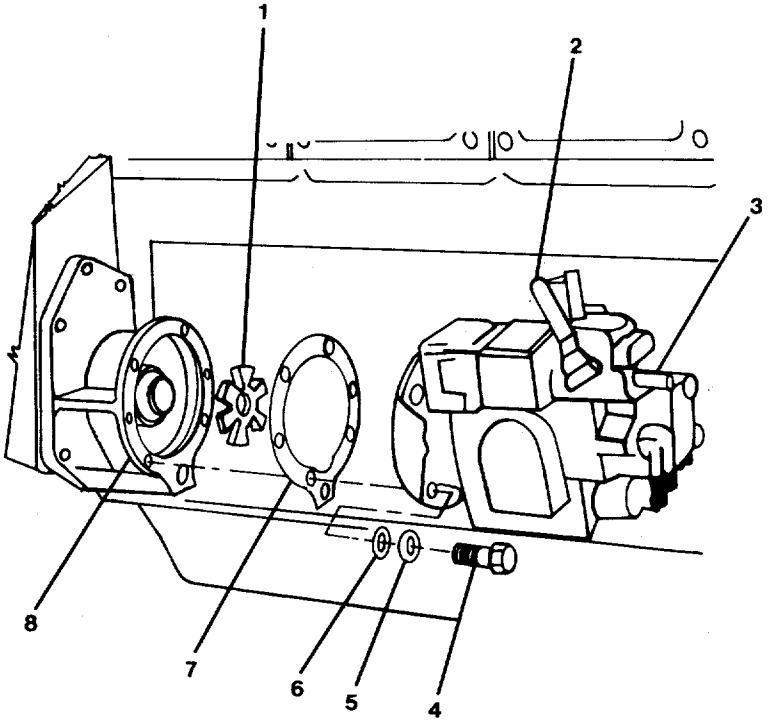


FIGURE 2-27. Fuel Pump External Throttle Components.

REPAIR

Repair of the fuel pump group is by replacement of the fuel pump. Repair of the fuel pump is covered by intermediate direct support maintenance procedures (Chapter 3).

REPLACEMENT

NOTE

All KTA 50 engines must have a white or light green flexible coupling insert.

a. Position flexible coupling insert (1, FIG. 2-27) on pump shaft.

b. Position lockwasher (5) and washer (6) on each hexagon head capscrew (4).

c. Insert hexagon head capscrews (4) through boltholes in fuel pump mounting flange.

d. Position gasket (7) on pump mounting flange with hexagon head capscrews (4) through boltholes of gasket (7).

e. Align flexible coupling insert (1) with drive coupling shaft in engine (8).

f. Install cam-actuated fuel pump (3) with hexagon capscrews (4) aligned with boltholes in engine (8). Tighten hexagon head capscrews (4) to 35 ft-lb (47 Nm).

g. Install throttle lever (2) and tighten capscrew until hand tight. Connect linkage to throttle lever (2).

h. Connect input and output fuel lines (2 and 1, FIG. 2-26).

i. Connect electrical connections. Remove tags.

2-30. Replace/Repair Rocker Lever Housing Group/Cover Group.

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Water tube driver P/N ST-1319
Rocker lever actuator P/N 3375539

Equipment Condition

Engine shutdown and secured. TM 55-1905-223-10.
Coolant drained. TM 55-1905-223-10.
Air intake group removed (para. 2-32).

Materials/Parts

Valve cover gasket P/N 3040720
Exhaust rocker lever P/N 304-7599
Injector rocker lever P/N 3013300
Plain hexagon nut P/N MS51968-14
Setscrew P/N 168306
Engine poppet valve rocker arm P/N 205138
Rocker lever housing gasket P/N 3201517
Emery cloth, Item 18, Appendix C
Cleaning solvent, Item 15, Appendix C

REMOVAL

NOTE

Each main propulsion engine contains sixteen rocker lever housing/cover groups. This procedure covers the removal, repair, and replacement of one only. It is typical of all sixteen.

a. Remove engine poppet valve rocker arm cover.

(1) Remove the assembled washer bolt (1, FIG. 2-28) and flat washer (34).

(2) Remove two hexagon head capscrews (2), lockwashers (3) and flat washers (4).

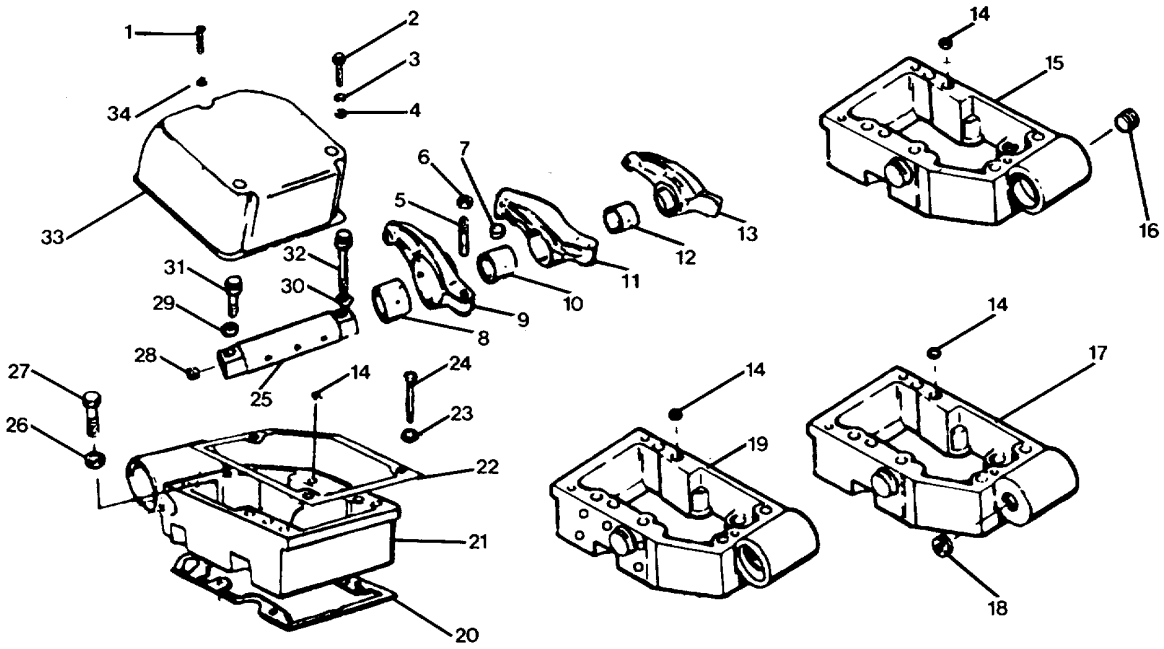


FIGURE 2-28. Rocker Lever Housing Group/Rocker Housing Cover.

(3) Remove engine poppet valve rocker arm cover (33).

(4) Remove and discard valve cover gasket (22).

b. Remove rocker levers.

(1) Loosen three plain hexagon nuts (6).

(2) Loosen three setscrews (5).

CAUTION

Do not allow rocker levers to fall from the shaft or they will be damaged.

(3) Remove two hexagon head capscrews (31 and 32) and flat washers (29 and 30).

NOTE

The rocker lever shafts are mounted on top of the housing (21) and have a ring dowel (14) under one hexagon head capscrew. When removing rocker levers, lift straight up to clear the ring dowel.

(4) Remove straight shaft (25) a with their position as removed. More accurate adjustments will result due to the wear pattern established if the parts are installed in the same position during reassembly.

(5) Remove injector links (3, FIG. 2-49).

c. Remove housing.

NOTE

Water passages are cast into the housing. Water transfer tubes are held in position with retaining rings to make up the water manifold.

(1) Remove associated water transfer tube retaining rings (1, FIG. 2-29).

(2) Use a water tube driver (1, FIG. 2-30) and a hammer to push the tubes (2) until the tubes clear the housing (3) tube on the left bank toward the rear of the engine.

(3) Remove dowel ring (14, FIG. 2-28) and pipe plugs (16 and 18) where installed.

(4) Remove six hexagon head capscrews (24 and 27) and flat washers (26).

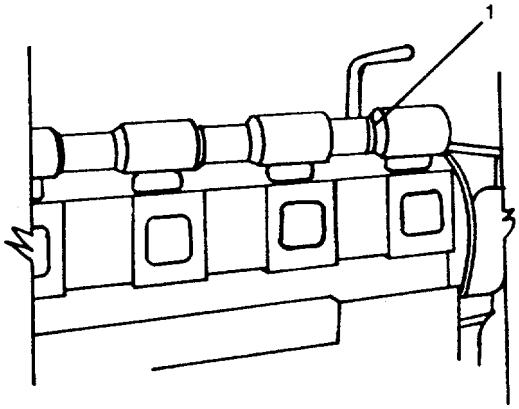


FIGURE 2-29. Water Transfer Retaining Ring Removal.

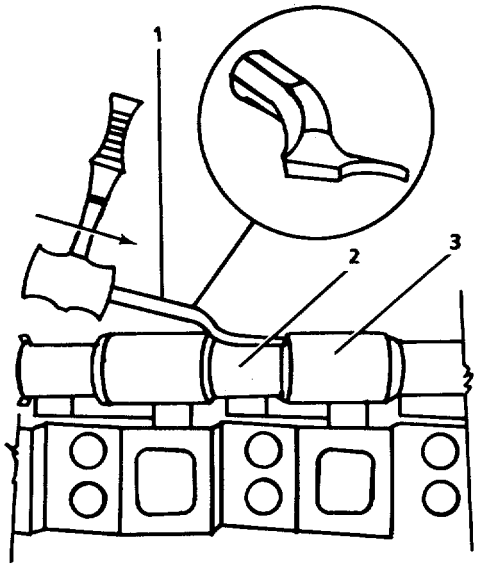


FIGURE 2-30. Water Transfer Tube Positioning for Removal.

(5) Remove housing (15, 17, 19 or 21). Mark housing with cylinder location for reassembly.

(6) Remove and discard rocker lever housing gasket (20).

REPAIR

Repair of the rocker lever housing/cover group consists of cleaning, and replacement of valve cover gaskets, rocker levers, plain hexagon nuts, setscrews, and rocker lever housing gaskets.

a. Clean the rocker lever housing (33, FIG. 2-28) and inspect as follows:

(1) Visually inspect the housing for cracks or damage, and replace if necessary.

(2) Visually inspect the capscrew holes in the housing for damaged threads.

(3) Visually inspect the rocker lever shaft bore. Remove any burns or sharp edges with emery cloth.

b. Clean the rocker lever shafts (25) and inspect as follows:

(1) Use solvent to clean the rocker lever shaft. Use compressed air to clean out oil holes. Ensure holes are not blocked.

(2) Clean the shaft bore.

(3) Visually inspect the shaft for cracks or damages.

(4) Visually inspect the thread conditions of the shafts with internal threads.

(5) Measure the rocker lever shaft outside diameter in the center and both ends of the shaft. The measurement should be between 1.3710 inch (34.823 mm) and 1.3725 inch (34.862 mm).

(6) Replace the rocker lever shaft as necessary.

c. Clean the rocker levers [engine poppet valve rocker arms (13), exhaust levers (9) and injector levers (11)] with solvent and inspect as follows:

(1) Use compressed air to clean out oil holes. Ensure holes are not blocked.

(2) Visually check the rocker levers for cracks. Special attention should be given to the areas indicated in FIG. 2-31.

(3) Check the ball end of rocker lever adjusting screw (5, FIG. 2-28) for damage.

(4) Replace the adjusting screw if the ball end is out of round or flat at the bottom.

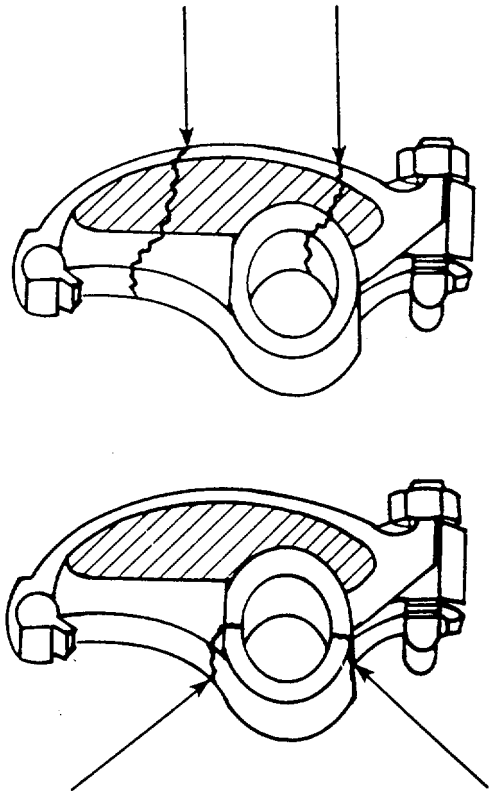


FIGURE 2-31. Crack Inspection Areas on Rocker Levers.

(5) Check the thread condition on all adjusting screws and in the levers.

(6) Check carefully for threaded distortion at the assembly position of the locknut. Screws must move freely through the levers.

(7) Visually inspect the sockets on the end of each lever for damage. Replace the lever assembly if damaged.

(8) Visually check the rocker bushing for damage. Replace thelever assembly if damaged.

(9) Measure the inside diameter of the rocker lever bushing. The measurement must be between 1.3776 inches (34.991 mm) and 1.3735 inches (34.887 mm). If these limits are exceeded, replace the lever assembly.

REPLACEMENT

a. Replace housing.

(1) Install rocker lever housing gasket (20, FIG. 2-28) on cylinder head.

(2) Position housing (15, 17, 19 or 21) on cylinder head.

NOTE

The gasket and housing must be aligned correctly with the dowel pins that are in the cylinder head.

(3) Install six flat washers (26) and hexagon head capscrews (24 and 27). Tighten to 65 ft-lb. (88 Nm) using the sequence shown in FIG. 2-32.

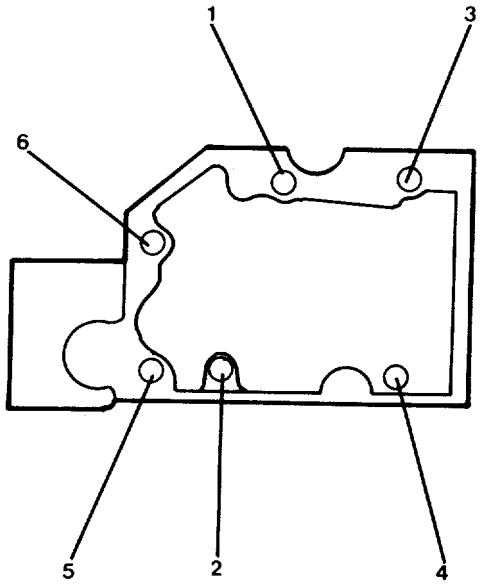


FIGURE 2-32. Rocker Lever Housing Tightening Sequence.

(4) Install dowel ring (14, FIG. 2-28) and pipe plugs (16 and 18) if required.

NOTE

For the left bank housing the end of the tubes with two grooves must be installed in the bore that is positioned toward the front of the engine. For the right bank housing the end of the tube with two grooves must be installed in the bore that is positioned toward the rear of the engine.

(5) Use a water tube driver (1, FIG. 2-30) and a hammer to push the water tube into the adjacent housing until the groove is visible.

b. Install rocker levers.

(1) Install injector links (3, FIG. 2-49).

CAUTION

The engine intake poppet valve rocker arm (13, FIG. 2-28) must have a blind rivet installed in the oil drilling. The exhaust lever (9) must not have a blind rivet in the oil drilling. The three oil drillings on the shaft (25) that have the same centerline must be toward the end of the rocker lever that contains the adjusting screw. The plug in the shaft main oil drilling must be nearest to the exhaust lever.

NOTE

Ensure that the adjusting screws (5) are loose and that the ring dowel (14) is installed in the housing.

(2) Position straight shaft (25, FIG. 2-28) and rocker levers (9, 11 and 13) with sleeve bushings (8, 10 and 12) on housing (21).

(3) Install two flat washers (29 and 30) and hexagon head capscrews (31 and 32). Do not tighten.

CAUTION

The shaft (25) must fit correctly down and over the ring dowel (14).

(4) Align push rod sockets with setscrews (5). Align injector links with rocker lever sockets.

(5) Tighten hexagon head capscrews (31 and 32) to 65 ft-lb (88 Nm).

c. Injector and valve adjustment general information.

(1) Two crankshaft revolutions are required to adjust all of the valves and injectors.

NOTE

One pair of valves and one injector are adjusted at each index mark before rotating the crankshaft to the next mark.

(2) Reference FIG. 2-33 for how cylinders are numbered. Reference FIG. 2-34 for location of intake and exhaust valves.

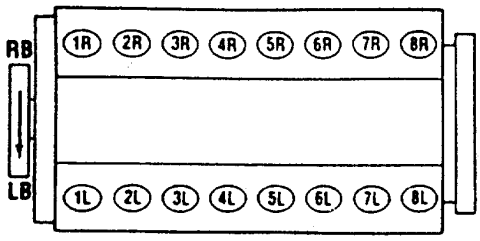


FIGURE 2-33. Cylinder Number.

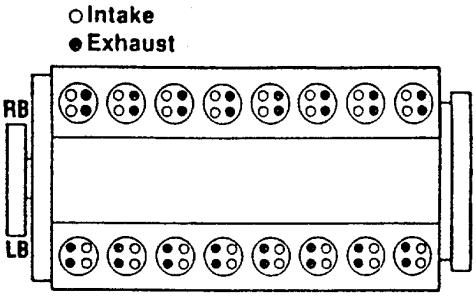


FIGURE 2-34. Intake and Exhaust Valve Location.

(3) The KTA50 engine has valve and injector adjustment marks in three locations.

(a) Adjustment marks are on the vibration damper (FIG. 2-35). The marks must be aligned with pointer.

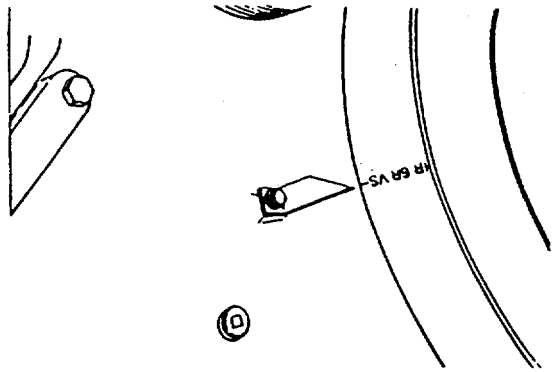


FIGURE 2-35. Intake and Exhaust Valve Location.

CAUTION

When using this index mark, the marks on the flywheel that begin with an "A" must be used or the valves and injectors will not be adjusted correctly, causing damage to the push rods.

(b) To locate adjustment marks on the flywheel (FIG. 2-36), with the engine barring device located on the right bank, remove bore cover to see marks.

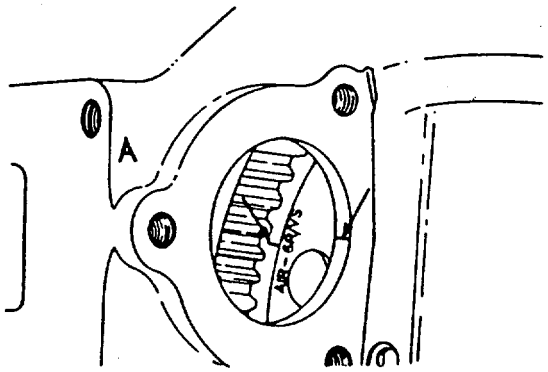


FIGURE 2-36. Flywheel/Adjustment Marks (Barring Device-Right Bank).

CAUTION

When using this index mark, the marks on the flywheel that begin with an "C" must be used or the valves and injectors will not be adjusted correctly, causing damage to the push rods.

(c) To locate adjustment marks on the flywheel (FIG. 2-37), with the engine barring device located on the left bank, the starter bore cover must be removed.

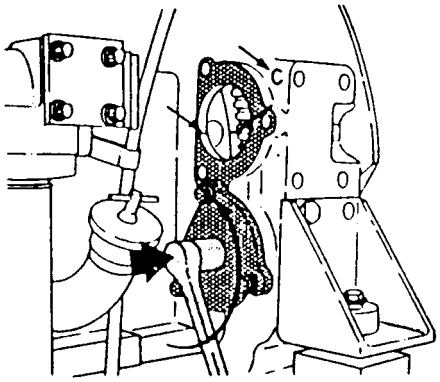


FIGURE 2-37. Flywheel/Adjustment Marks (Barring Device-Left Bank).

(4) Reference FIG. 2-38 for firing order.

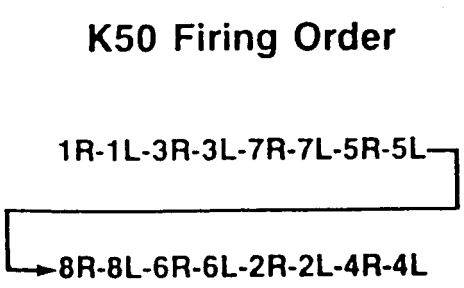


FIGURE 2-38. Firing Order.

(5) Adjust the valves.

NOTES

o "VS" represents the valve set. Ignore any "TC" (top center) marks while setting the valves and injectors.

O Barring device must be rotated counterclockwise to turn the flywheel in the direction of normal engine rotation.

(a) Use the barring device or a tool installed with the crankshaft adapter capscrews to rotate the engine until the "VS" mark for "lR" (Number 1 Right Bank cylinder) is aligned with the pointer or the index mark in the starter bore (FIG. 2-39).

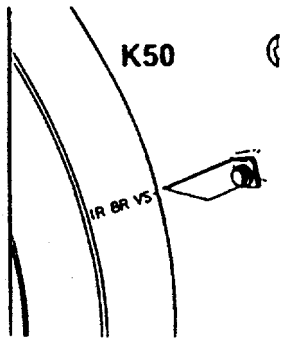


FIGURE 2-39. Starter Bore Index Mark.

(b) Determine the cylinder in position for valve set. The valves are ready to be adjusted on the cylinder that has all the valves closed.

CAUTION

- All adjusting screws must be loose on all cylinders.
- The push rod must remain in alignment.

NOTE

Perform this step on both cylinders to be checked.

(c) Hold both rocker levers against the crossheads. Turn the adjusting screws until they touch the push rods.

(d) Turn the lock nuts until they touch the levers. Compare the height of the adjusting screws above the lock nut (FIG. 2-40).

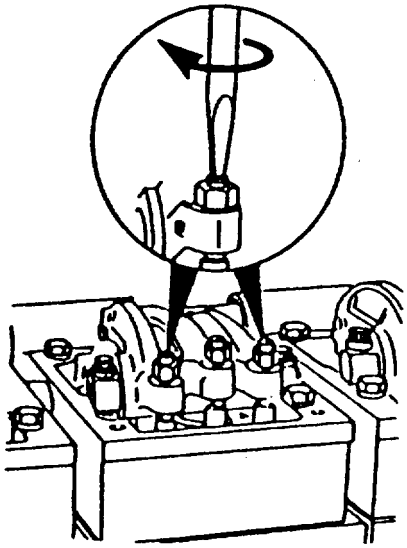


FIGURE 2-40. Adjusting Screws.

(e) The cylinder that has the adjusting screws that are the same height is ready for valve adjustment.

NOTE

The push rods will be the same height above the top of the rocker lever housing on the cylinder ready for valve adjustment.

(f) After identifying the cylinder with the valves ready to be adjusted, use the following chart for sequence. Adjust valves to the initial set shown in FIG. 2-41.

Valve and Injector Adjustment Chart

VS MARK		VALVES CLOSED ON CYLINDER NUMBER		ADJUST VALVES AND INJECTORS ON CYLINDER NUMBER	
1R-8R	VS	1	RB	1	RB
1L-8L	VS	1	LB	1	LB
3R-6R	VS	3	RB	3	RB
3L-6L	VS	3	LB	3	LB
2R-7R	VS	7	RB	7	RB
2L-7L	VS	7	LB	7	LB
4R-5R	VS	5	RB	5	RB
4L-5L	VS	5	LB	5	LB
1R-8R	VS	8	RB	8	RB
1L-8L	VS	8	LB	8	LB
3R-6R	VS	6	RB	6	RB
3L-6L	VS	6	LB	6	LB
2R-7R	VS	2	RB	2	RB
2L-7L	VS	2	LB	2	LB
4R-5R	VS	4	RB	4	RB
4L-5L	VS	4	LB	4	LB

(g) Select a feeler gauge for the correct valve lash specification. Insert the gauge (1, FIG. 2-42) between the rocker lever and the crosshead.

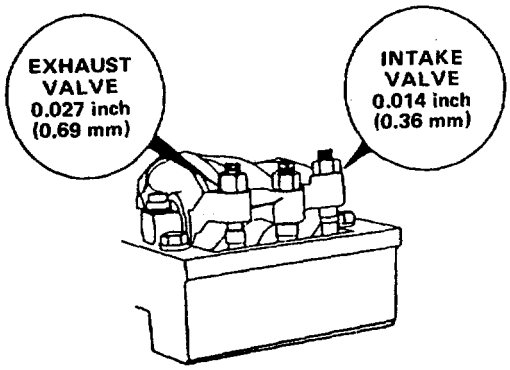


FIGURE 2-41. Valve Adjustment Initial Set.

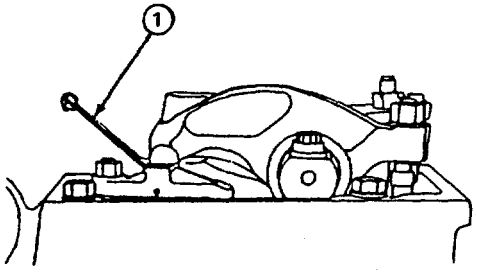


FIGURE 2-42. Feeler Gauge Position.

(h) To establish valve lash clearance, use inch-pound torque wrench and tighten the adjusting screw (FIG. 2-43) to 6 in-lb (0.68 N•m).

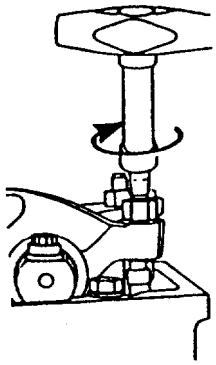


FIGURE 2-43. Adjusting Screw Tightening.

CAUTION

The adjusting screw must not turn when the lock nut is tightened.

(i) Tighten lock nut (FIG. 2-44). Torque 45 ft-lb (60 N•m).

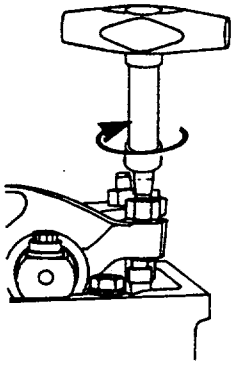


FIGURE 2-44. Lock Nut Tightening.

NOTE

The feeler gauge must slide backward and forward with only a slight drag.

(j) Attempt to insert a feeler gauge that is 0.001 inch (0.03 mm) thicker. The valve lash is not correct when the thicker feeler gauge will fit.

(k) Repeat the adjustment process until the clearance is correct on both the intake and exhaust valves for the cylinder being adjusted.

(6) Adjust the injector.

(a) Assemble the parts of the injector adjustment kit.

(b) Install the adjustment kit on the cylinder to be adjusted as shown (1, FIG. 2-45).

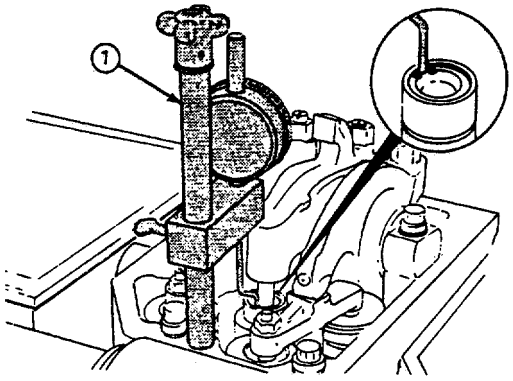


FIGURE 2-45. Adjusting Kit Installation.

(c) Adjust the indicator so that the top is touching the top of the injector plunger.

CAUTION

The tip must not touch the rocker lever.

(d) Lower the indicator 0.500 inch (12.7 mm) to allow for travel. Lock the indicator support to the post.

WARNING

The injector plunger is under spring tension. Do not allow tool to slip. Personal injury can result.

(e) With rocker lever actuator, depress the lever until the injector bottoms 2 or 3 times. This will remove fuel from the cup (FIG. 2-46).

(f) Tighten the adjusting screw until the injector plunger is bottomed to the cup.

(g) Set the indicator to "O". Turn the adjusting screw backward and forward 2 or 3 times to confirm "O" setting (FIG. 2-47).

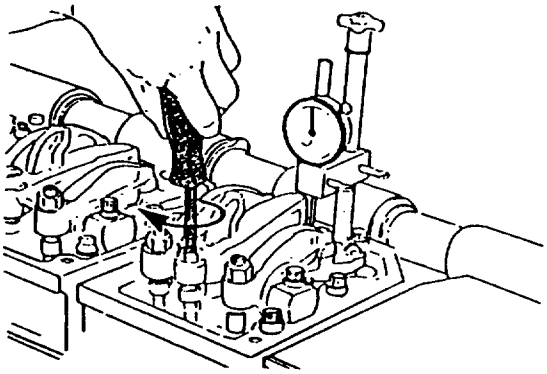


FIGURE 2-46. Rocker Lever Actuator.

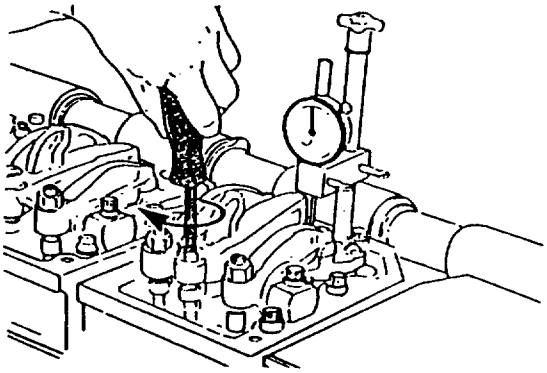


FIGURE 2-47. Confirming "O" Setting.

(h) Loosen the adjusting screw until the indicator reads 0.3075 inch (7.811 mm) travel (FIGURE 2-48).

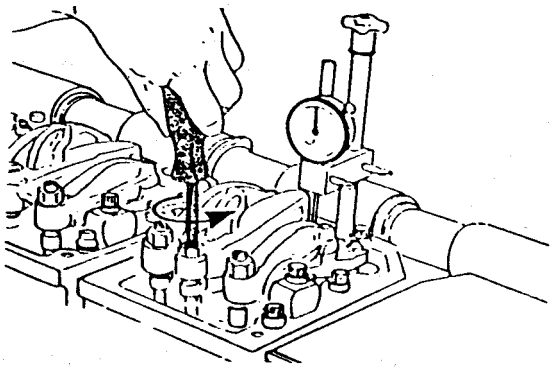


FIGURE 2-48. Adjusting Screw Loosening.

CAUTION

The adjusting screw must not turn when the lock nut is tightened.

(i) Tighten the lock nut. Torque 45 lb (61 N•m).

WARNING

The injector plunger is under spring tension. Do not allow the tool to slip. Personal injury can result.

CAUTION

Prevent damage to the indicator by allowing the lever to return slowly.

(j) To check adjustment; use rocker lever actuator. Bottom the injector plunger. Confirm the "0" on the indicator setting.

(k) Allow the rocker lever to return slowly. Check the injector setting. Repeat the adjustment process if not within specification: minimum 0.307 inch (7.80 mm); maximum 0.308 inch (7.82 mm).

(l) Rotate the engine. Align the next mark. Adjust appropriate valves and injectors. Repeat process to adjust all of the valves and injectors correctly.

NOTE

If barring device was used, allow the spring to push the shaft and clear the ring gear. Install clip.

d. Install engine poppet valve rocker arm cover.

CAUTION

Do not use gasket sealant. The gaskets are manufactured from a material that becomes larger when it contacts engine oil. The use of gasket sealant will cause an oil leak.

(1) Position valve cover gasket (22, FIG. 2-28) on housing (21).

(2) Position engine poppet valve rocker arm cover (33).

(3) Install two flat washers (4), lockwashers (3) and hexagon head capscrews (2). Do not tighten.

(4) Install the flat washer (34) and assembled washer bolt (1).

(5) Tighten assembled washer bolt (1) and two hexagon head capscrews (2) to 30 ft-lb (40 N•m) starting with assembled washer bolt (1).

2-31. Repair Injector Group

This task covers:

a. Removal **b. Inspection** **c. Replacement**

INITIAL SETUP:

Tools:

Tool kit, general mechanic's rail and marine diesel engine NSN 5180-00 629-9783
Torque wrench kit P/N 3377216
Injector puller P/N 3376000
Injector adjustment kit P/N 3822575

Equipment Condition:

Engine shutdown. TM 55-1905-223-10.
Rocker lever housing group removed, para. 2-30.

Materials/Parts:

Fuel injector assembly P/N 3053124
Injector plunger link P/N 205462
Injector ring P/N 207244
Lube oil, Item 2, Appendix C
Preformed packing P/N 193736

REMOVAL

CAUTION

- To avoid getting dirt in the injector barrel and cup, causing damage, do not remove the plunger and spring.
- Upon removal reinstallation of this piece of equipment, blank cover or otherwise protect all openings to prevent foreign matter from entering and damaging this system.

NOTE

There is one injector for each cylinder.

a. Remove two hexagon head capscrews (1, FIG. 2-49).

b. Remove injector damp (2).

c. Remove injector plunger link (3).

d. Use injector puller (1, FIG. 2-50) to remove injector (2).

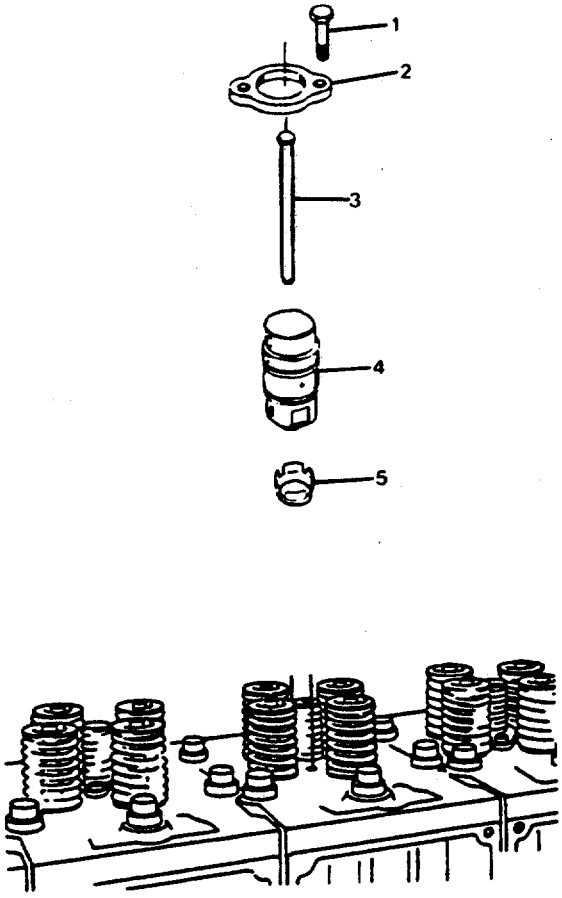


FIGURE 2-49. Injector Removal.

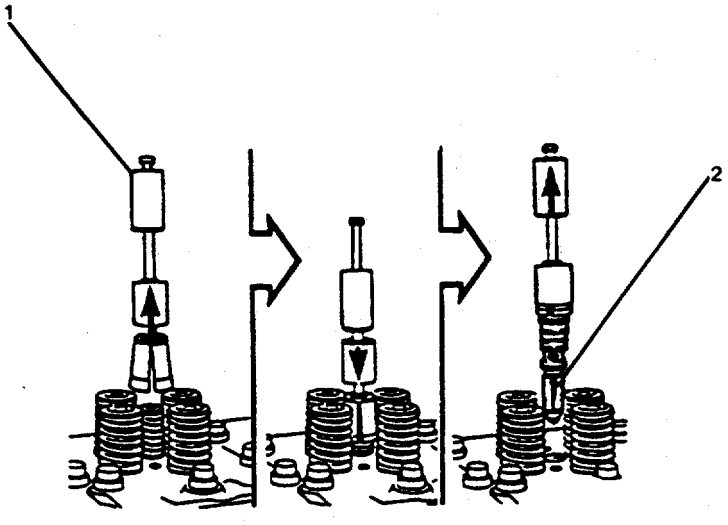


FIGURE 2-50. Injector Removal Tool.

NOTE

The injector ring can be oversize. Tag the ring with the cylinder number. Mark the cylinder head so the seal and the head can be kept together.

e. Remove injector ring (5, FIG. 2-49).

INSPECTION

CAUTION

Injector plungers and barrels have a very precise fit (match fit) and are damaged easily. Untrained personnel should not remove plungers. Do not allow the plungers to fall out.

a. Remove O-rings (1, 2, and 3, FIG. 2-51).

b. Remove sealing ring (4).

c. Use a clean cloth that does not have any lint. Clean the exterior of the injector. Closely check the area where the sealing ring (4) contacts the injector.

d. Check the orifice screen (5) for cleanliness. If any debris is found on the screen, remove the retaining clip and the screen, clean the screen, install the screen and the retaining clip.

CAUTION

Do not lubricate O-rings until installation in the engine.

e. Install O-rings (1, 2, and 3). Each O-ring is color-coded for installation in the proper groove as follows:

(1) Red dot or stripe.

(2) No dot or stripe.

(3) Green dot or stripe.

f. Install the sealing ring (4).

REPLACEMENT

a. Replace the injector ring (5, FIG. 2-49).

b. Lubricate the injector bore with clean engine lubricating oil. Position the seal seat on the injector cup.

c. Lubricate the injector body preformed packings with alight coat of clean engine lubricating oil.

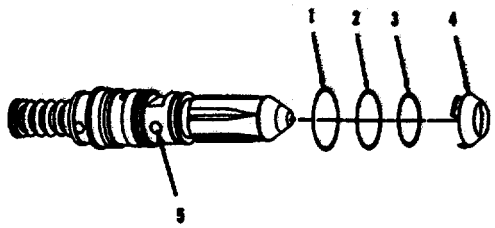


FIGURE 2-51. Injector Inspection.

CAUTION

Do not use a wooden tool to push the injector on the seat. Failure can result due to splinters falling into the tappet.

d. Start the injector (4) into the bore by hand and seat it with a quick, hard push.

NOTE

Remove the injector and inspect the preformed packings and seal seat if the injector fails to seat properly.

e. Place the hold-down clamp (2) over the injector body. Install two hexagon head capscrews (1). Do not tighten.

f. Carefully insert the injector plunger link (3). Tighten the holddown capscrews alternately and evenly to 144 in.-lb (16 N•m).

g. Install rocker levers (paragraph 2-30).

h. Adjust injectors and valves (paragraph 2-30).

2-32. Replace/Repair Air Intake Manifold Group

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958
Pressure manometer P/N PVS-2

Equipment Condition

Engine shutdown.	TM 55-1905-223-10.
Coolant drained.	TM 55-1905-223-10.

Materials/Parts

Air intake manifold P/N 3027574, 3027575
Gaskets P/N 3028123, 3016122
Preformed packings P/N 3026421, 3175545, 206435, 3014449, 3008710, 3016631
Nonmetallic hose P/N 3016142, 3018060
Gasket adhesive, Item 8, Appendix C
Plain seal P/N 3023130
Intake manifold gasket P/N 206277
Rubber bushing P/N 3014304
Aftercooler gasket P/N 3011580
Radiator core P/N 3032030
Air crossover connection P/N 3176834
Water outlet connection P/N 3019620

WARNING

Due to the weight of the air intake manifold, a lifting sling should be used to prevent personal injury or equipment damage.

REMOVAL

a. Remove air intake manifold.

(1) Remove four machine bolts (28, FIG. 2-52), lockwashers (27), and flat washers (26) from each of four air crossover connections (17).

(2) Remove air crossover connection (17), pipe plug (16) and gasket (18) from intake air manifold (19). Discard gasket.

(3) Remove metallic tube (15) from plain seal (13) and air crossover connection (17). Remove and discard two preformed packings (14).

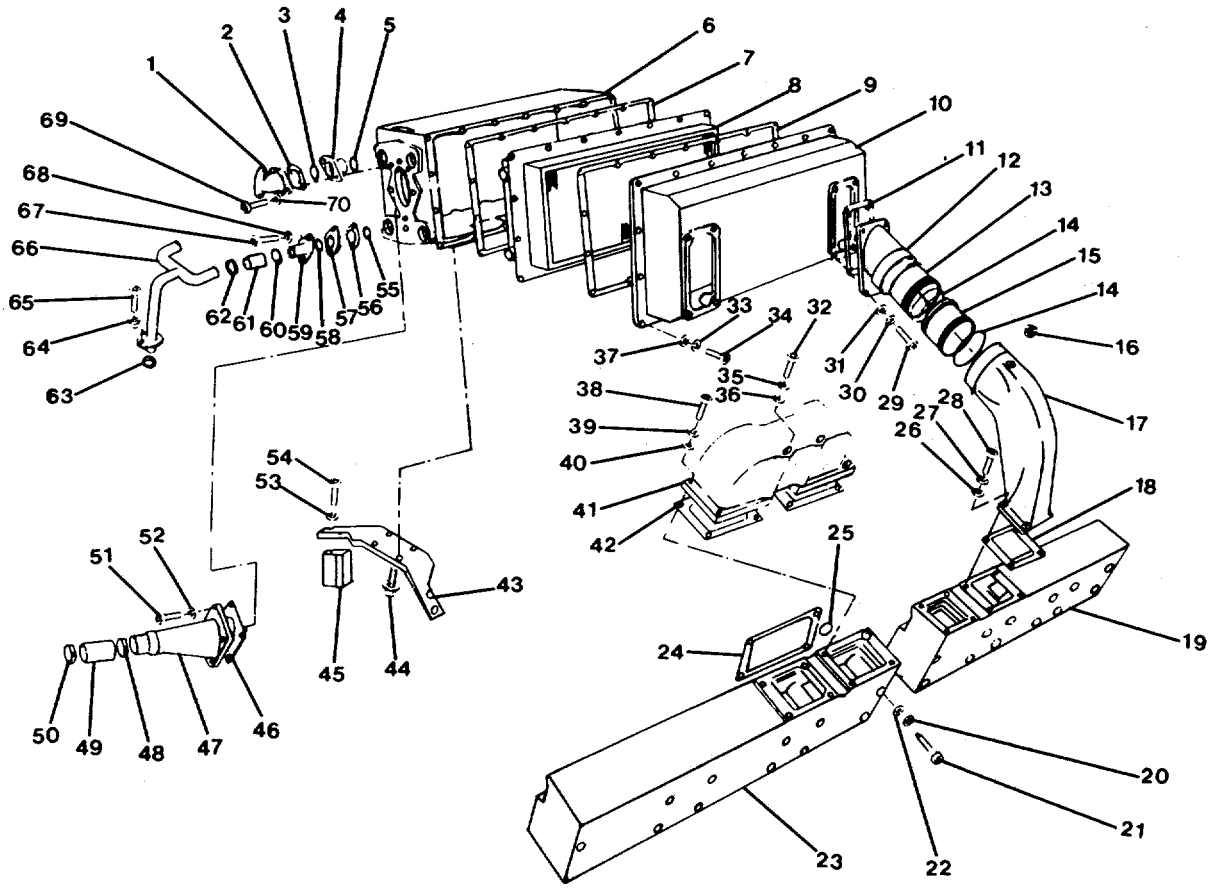


FIGURE 2-52. Air Intake Manifold Group.

(4) Remove plain seal (13) from air crossover connection (12). Discard seal.

(5) Remove six hexagon head capscrews (38), lockwashers (39) and flat washers (40) and two hexagon head capscrews (32), lockwashers (35) and flat washers (36) from each of two air intake connections (41).

(6) Remove air intake connection (41) and gaskets (42). Discard gaskets.

NOTE

Perform steps 7 through 9 if removing the right front or left rear intake air manifold.

(7) Loosen two hose clamps (5, FIG. 2-53) on crankcase breather hose (6). Remove hose.

(8) Remove four capscrews (4), lockwashers (3), and flat washers (2).

(9) Remove crankcase breather (1).

WARNING

To prevent personal injury or equipment damage. Do not remove two hexagon head capscrews in the upper corners of the intake air manifold until the lifting sling is attached to the manifold.

(10) Remove 12 hexagon head capscrews (21, FIG. 2-52), lockwashers (20),and flat washers (22).

(11) Remove intake air manifold (19 or 23), rubber bushing (25), andintake manifold gasket (24). Discard bushing and gasket.

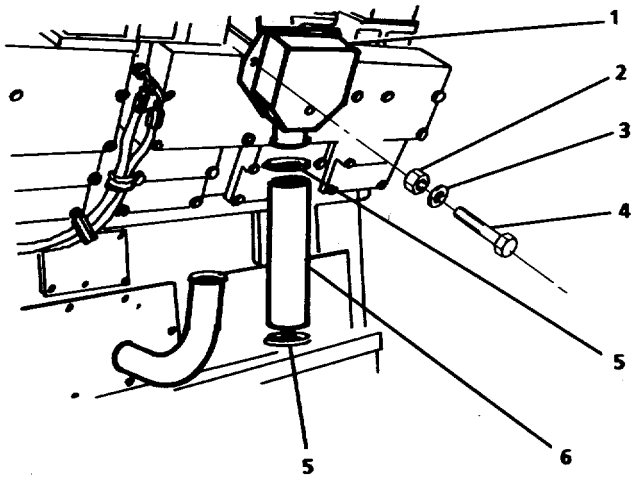


FIGURE 2-53. Crankcase Breather.

b. Remove aftercooler.

(1) Remove air cleaner group (paragraph 2-18).

(2) Remove four machine bolts (29, FIG. 2-52), lockwashers (30), and flat washers (31).

(3) Remove air crossover connection (12) and preformed packing (11). Discard preformed packing.

(4) Loosen retaining clips (48 and 50) on nonmetallic hose (49) connecting aftercooler to turbocharger. Remove hose.

(5) Remove two hexagon head capscrews (65), lockwashers (64), four machine bolts (67), and lockwashers (68) from the water transfer housing (66).

(6) Remove water transfer housing (66) and preformed packing (63). Discard preformed packing.

(7) Loosen hose clamps (60 and 62). Remove nonmetallic hose (61), water transfer connection (59), preformed packing (58), adapter connector (57),and preformed packing (56 and 55). Discard preformed packings.

(8) Remove hexagon head capscrews (51) and flat washers (52). Remove air crossover connection (47) and gasket (46). Discard gasket.

(9) Remove four hexagon head capscrews (69) and lockwashers (70).

(10) Remove water outlet connection (1), preformed packings (2 and 3), adapter connection (4), and preformed packing (5). Discard preformed packings.

(11) Remove 18 hexagon head capscrews (34), lockwashers (33), and flat washers (37) from each aftercooler housing cover (10). Remove aftercooler housing cover (10) and aftercooler gasket (9). Discard gasket.

(12) Remove radiator core (8) and aftercooler gasket (7). Discard gasket.

(13) Remove eight assembled washer screws (44). Remove aftercooling housing (6).

(14) Remove eight hexagon head capscrews (54) and lockwashers (53). Remove aftercooler brackets (43) and mounting spacers (45).

REPAIR

a. Pressure test radiator core (8).

(1) Use a hose plugged with a pipe plug. Plug one of the radiator core nipples.

(2) Attach air line and gauge to the remaining nipple.

(3) Submerge core in a container of water.

(4) Apply 65 psi (448 kPa) of air pressure to the core.

(5) Check for bubbles in the water. Bubbles indicate a leak in the core.

(6) Replace core if leaks are found.

b. Repair of the air intake manifold group consists of replacement of defective parts.

REPLACEMENT

a. Replace aftercooler.

(1) Position mounting spacers (45, FIG. 2-52) and aftercooler brackets (43). Install eight lockwashers (53) and hexagon head capscrews (54). Tighten to 70 ft-lb (95 N•m).

(2) Position aftercooler housing (6) on aftercooler brackets (43). Install eight assembled washer screws (44). Tighten to 45 ft-lb (60 N•m).

(3) Install aftercooler gasket (7), radiator core (8), aftercooler gasket (9) and aftercooler housing cover (10).

(4) Install 18 flat washers (37), lockwashers (33) and hexagon head capscrews (34) in each aftercooler housing cover (10). Tighten capscrews to 20 ft- lb (25 N•m).

CAUTION

- The adapter connection (4) must be installed so that the water leakage hole is toward the bottom of the aftercooler housing. This prevents water from entering the aftercooler housing.

- Ensure that the correct seal (2) is installed for the water connection (1). A rectangular seal is used with the connection that does not have a step at the end of the chamber. An O-ring seal is used with the connection that has a step at the end of the chamber. Using the wrong seal can cause a leak.

(5) Install preformed packing (5), adapter connection (4), preformed packings (2 and 3) and water outlet connection (1).

(6) Install four lockwashers (70) and hexagon head capscrews (69). Tighten to 20 ft-lb (25 N•m).

(7) Position gasket (46) and air crossover connection (47). Install flat washers (52) and hexagon head capscrews (51). Tighten to 20 ft-lb (25 N•m).

(8) Install preformed packings (55 and 56), adapter connector (57), preformed packing (58), water transfer connection (59), hose clamps (60 and 62) and non-metallic hose (61).

(9) Position preformed packing (63) and water transfer housing (66). Install four lockwashers (68) and machine bolts (67). Tighten to 20 ft-lb (25 N•m).

(10) Install two lockwashers (64) and hexagon head capscrews (65). Tighten to 30 ft-lb (40 Nm).

(11) Tighten hose clamps (60 and 62) to 140 in-lb (15 N•m).

(12) Install retaining clips (48 and 50) and nonmetallic hose (49). Connect nonmetallic hose (49) between aftercooler and turbocharger. Tighten retaining clips (48 and 50) to 140 in-lb (15 Nm).

(13) Install preformed packing (11) and air crossover connection (12).

(14) Install four flat washers (31), lockwashers (30), and machine bolts (29). Tighten to 20 ft-lb (25 N•m).

(15) Install air cleaner group (paragraph 2-18).

b. Install air intake manifold.

WARNING

Due to the weight of the air intake manifold, a lifting sling should be used to prevent personal injury or equipment damage.

NOTE

- The intake manifold for the "LB" front and "RB" rear are the same. The intake manifold for the "LB" rear and "RB" front are the same.
- The use of guide bolts installed in the row of capscrew holes at the bottom of the cylinder heads will aid the replacement procedure.
- The raised bead of the intake manifold gasket must be toward the cylinder head.

(1) Position intake manifold gasket (24, FIG. 2-52), rubber bushing (25), and intake air manifold (19 or 23).

(2) Install twelve flat washers (22), lockwashers (20), and hexagon head capscrews (21). Hand tighten capscrews.

NOTE

The raised bead of the gasket must be toward the air intake connection.

(3) Install gasket (42) and air intake connection (41).

(4) Install two flat washers (36), lockwashers (35), hexagon head capscrews (32), six flat washers (40), lockwashers (39), and hexagon head capscrews (38). Hand tighten capscrews.

(5) Tighten intake air manifold capscrews (21) to 20 ft-lb (25 N•m) in the sequence shown in FIG. 2-54. When complete, use the same sequence to retighten capscrews to 35 ft-lb (45 N•m).

(6) Tighten air intake connection capscrews (32 and 38) to 125 in-lb (15 N•m) using the sequence shown in FIG. 2-54. When complete use the same sequence to retighten capscrews to 20 ft-lb (25 N•m).

(7) Position two preformed packings (14, FIG. 2-52) and plain seal (13) on metallic tube (15). Lubricate seal with clean engine lube oil. Install tube (15) on air crossover connection (12).

(8) Install air crossover connection (17) non-metallic tube (15). Push connection on tube as far as possible. Install pipe plug (16).

NOTE

The raised bead of the gasket must be toward the crossover connection.

(9) Install gasket (18) and air crossover connection (17) on intake air manifold (19).

(10) Install four flat washers (26), lockwashers (27) and machine bolts (28). Tighten to 20 ft-lb (25 N•m).

NOTE

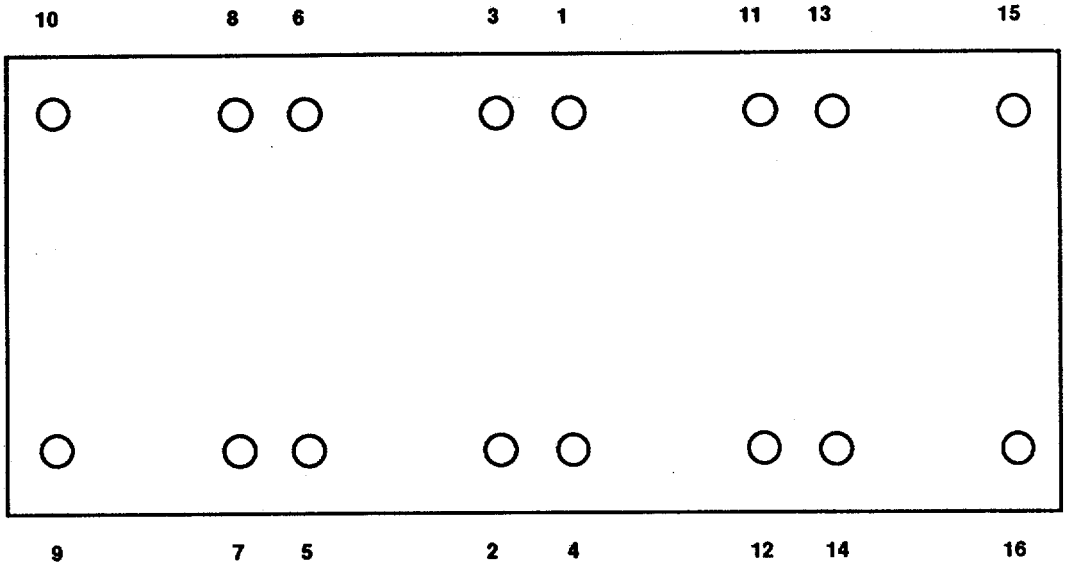
Perform the following steps if replacing the right front or left rear intake air manifold.

(11) Position crankcase breather (1, FIG. 2-53). Install two flat washers (2), lockwashers (3) and capscrews (4). Tighten to 30 ft-lb (40 N•m).

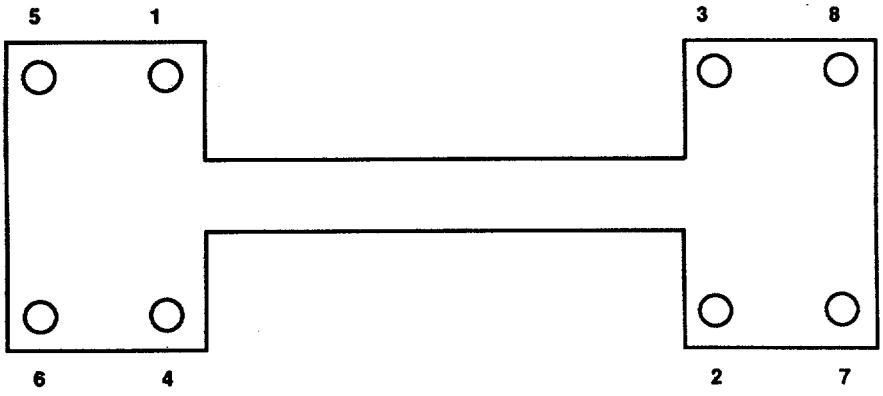
NOTE

Ensure hose is positioned so there is enough length for the clamp to fasten the hose above or below the head on the tubes.

(12) Install hose clamps (5) and crankcase breather hose (6). Tighten hose clamps to 50 in-lb (6 N•m).



INTAKE MANIFOLD



AIR CROSSOVER CONNECTION

FIGURE 2-54. Capscrew Tightening Sequence.

2-33. Replace/Repair Exhaust Manifold Group. (FIG. 2-55)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Lifting sling P/N 3375958
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown and cooled to 120°F (50°C), coolant drained; (TM 55-1905-223-10).
Intake manifold group removed, para. 2-32.
Turbocharger group removed, para. 2-19.

Materials/Parts

Anti-seize compound, Item 5, Appendix C
Gasket P/N 3037821

REMOVAL

a. Remove exhaust manifold group.

WARNING

Due to the weight of the exhaust manifold, a lifting sling should be used to prevent personal injury or equipment damage.

b. Attach lifting sling to manifold assembly (1) so that the cable/chain is just barely taut.

c. Remove the thirty two hexagon head capscrews (4) and flat washers (3) attaching exhaust manifold group (1) to the cylinder heads.

CAUTION

- The gaskets between block and heads may stick. To prevent damage to the manifolds or head, apply a slight prying pressure between head and manifold until manifold is free of block.
- Upon removal and replacement of this component, block, cover, or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

d. Lift the exhaust manifold group clear of the engine.

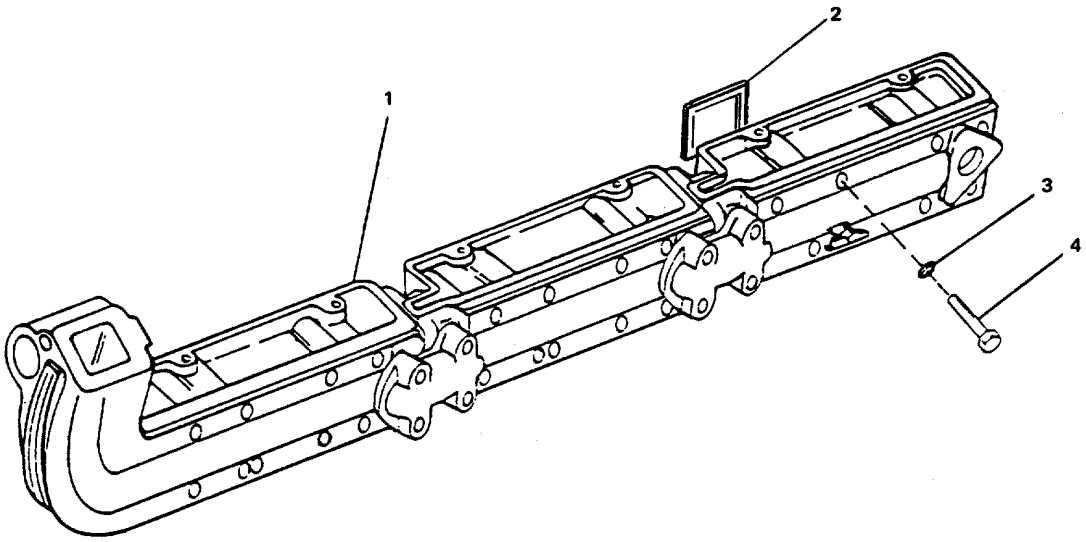


FIGURE 2-55. Exhaust Manifold Group.

e. Remove gasket (2).

REPAIR

Repair of the exhaust manifold group is by replacement of the gasket (2). Repair of the exhaust manifold is covered by intermediate direct support maintenance instructions (Chapter 3).

REPLACEMENT

WARNING

Due to the weight of the exhaust manifold, a lifting sling should be used to prevent personal injury or equipment damage.

a. Install gasket (2).

b. Position exhaust manifold (1) on the cylinder head.

c. Apply anti-seize compound on the hexagon head capscrew (4) threads.

NOTE

Use a screwdriver or a prybar. Pry the manifold up so it is not touching the cylinder block or water header plates when tightening the capscrews.

d. Install 32 flat washers (3) and hexagon head capscrews (4). Tighten capscrews to 45 ft-lb (60 Nm).

e. Reinstall the intake manifold group (paragraph 2-32) and turbocharger group (paragraph 2-19).

f. Replace coolant, start engine (TM 55-1905-223-10) and check for coolant and exhaust leaks.

2-34. Replace/Repair Cylinder Head Group.

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engines 5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958

Equipment Condition

Engine shutdown and cooled to 120°F (50°C). TM 55-1905-223-10.
Coolant drained. TM 55-1905-223-10.
Rocker lever cover and assembly removed, para. 2-30.
Air intake manifold group removed, para. 2-32.
Fuel manifold loosened, para. 3-20.
Exhaust manifold loosened, para. 2-33.

Materials/Parts

Cylinder head gasket P/N 3022340
Preformed packing P/N 207448, 205852, 205855, 205858
Rust preventive lubricant, Item 9, Appendix C
Diesel engine cylinder head P/N 3021692

REMOVAL

CAUTION

The cylinder head capscrews and washers are special parts. Do not damage parts by throwing them against each other or in a container. Damage to the parts could result in engine failure.

a. Remove six hexagon head capscrews (2, FIG. 2-56), and flat washers (1).

WARNING

The cylinder head is heavy and could easily be dropped causing injury to personnel or damage to equipment.

b. Attach a lifting sling to the cylinder head (FIG. 2-57).

c. Lift diesel engine cylinder head (3, FIG. 2-56) straight away from the block to clear the dowels.

d. Remove and discard gasket (7) and preformed packings (4, 5, 6 and 8).

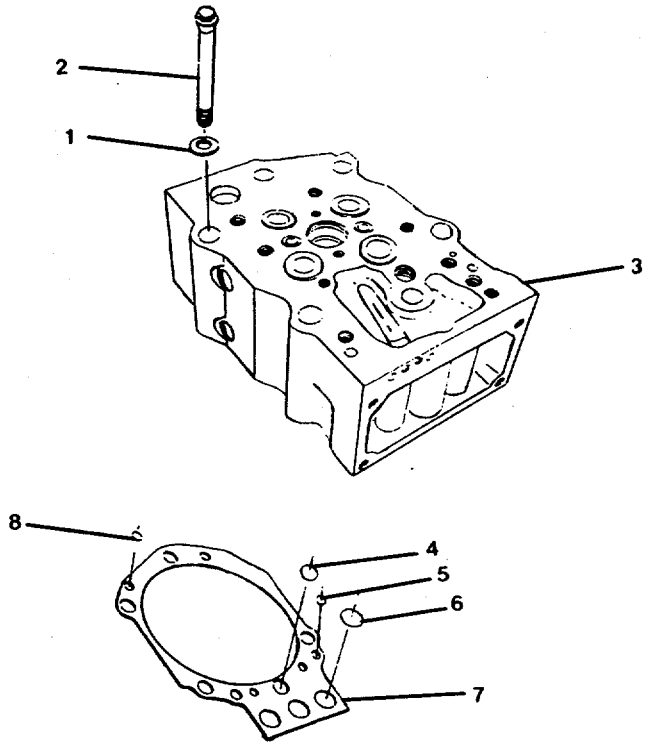


FIGURE 2-56. Cylinder Head Group, Cylinder Head Diesel Engine.

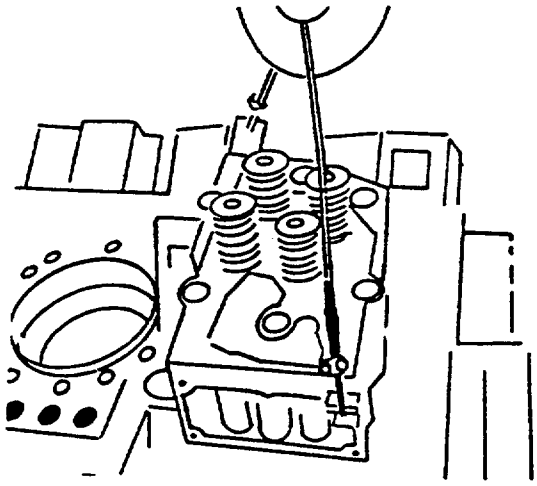


FIGURE 2-57. Lifting Sling.

REPAIR

Repair of the cylinder head group at the unit maintenance level consists of replacing the diesel engine cylinder head (3), the cylinder head gasket (7), and the preformed packings (4, 5, 6 and 8). Repair of the diesel engine cylinder.head is covered by intermediate general support maintenance procedure (Chapter 4).

REPLACEMENT

a. Be sure the orifice plug in the cylinder block is open. Place the cylinder head gasket (7, FIG. 2-56) over the dowels in the block. The word "TOP" on the gasket must be visible after the gasket is installed.

NOTE

The gasket must slide easily over the dowels. If it does not, check the dowels for damage.

b. Install water (8), oil (5), and push tube (6) preformed packings into position in each cylinder head gasket (7). Install capscrew preformed packing (4) on the camshaft side of the cylinder.

CAUTION

The preformed packings are a loose fit in the head gasket; care must be taken not to misalign the preformed packings prior to or during the cylinder head installation. Misaligned packings could result in engine failure.

c. Use the lifting sling (FIG. 2-57) to position to the cylinder head (3) over the dowels in the block.

d. Lubricate the head and threads of the hexagon head capscrews (2, FIG. 2-56) and the washer (1) with clean engine lube oil.

CAUTION

Allow excess engine lube oil to drip from the capscrews before installation in the block. Excess engine oil could damage the cylinder block.

NOTE

The washers must be positioned on the capscrews with the rounded edges toward the washer face of the capscrew head.

e. Install six flat washers (1) and hexagon head capscrews (2).

f. Start capscrews (2) through the cylinder heads into the block by hand, engaging two or more threads.

g. Tighten the capscrews (2) in the sequence as shown (FIG. 2-58) to the torque values as listed in Table 2-6.

h. Reinstall the following:

(1) Intake manifold, paragraph 2-32.

(2) Rocker lever housing assembly and cover, paragraph 2-30.

(3) Tighten fuel and exhaust manifolds, paragraphs 3-20 and 2-33.

i. Start engine, TM 55-1905-223-10. Observe performance and check for water and oil leaks.

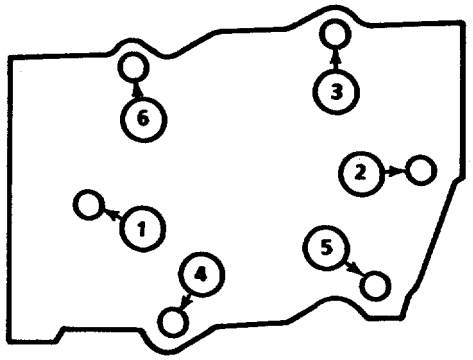


FIGURE 2-58. Cylinder Head Tightening Sequence.

Table 2-6. Cylinder Head Torquing Procedure

Step	Procedure	Torque
1.	Tighten to	50 ft-lb (65 N•m)
2.	Advance to	150 ft-lb-(200 N•m)
3.	Advance to	250 ft-lb (340 N•m)
4.	Advance to	360 ft-lb (490 N•m)
5.	Advance to	410 ft-lb (555 N•m)

2-35. Replace/Repair Handhole Cover Group. (FIG. 2-59)

This task covers:

a. Removal **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. TM 55-1905-223-10.

Materials/Parts

Handhole gaskets P/N 3175856
Preformed packing P/N 108172

NOTE

There are a total of eight handhole covers on the engine (four each side); each one exposes two connecting rod end caps. The left rear handhole cover contains the oil fill tube and dipstick. The two covers located second from the rear include the crankcase ventilation tubes. The remaining five handhole covers are blank access plates. All use the same type gasket.

REMOVAL

a. Remove blank handhole covers.

(1) Remove the water pump group (paragraph 2-23) and fuel pump group (paragraph 2-29). (Front covers only.)

(2) Remove eleven hexagon head capscrews (23), lockwashers (24), one hexagon head capscrew (19), and lockwasher (21).

(3) Remove handhole cover (20) and handhole gasket (22). Discard gasket.

b. Remove handhole cover with dipstick and oil filler tube (15).

(1) Remove lube oil filter assembly (paragraph 2-24).

(2) Remove liquid level gage rod (11). If required, remove filler opening cap (14).

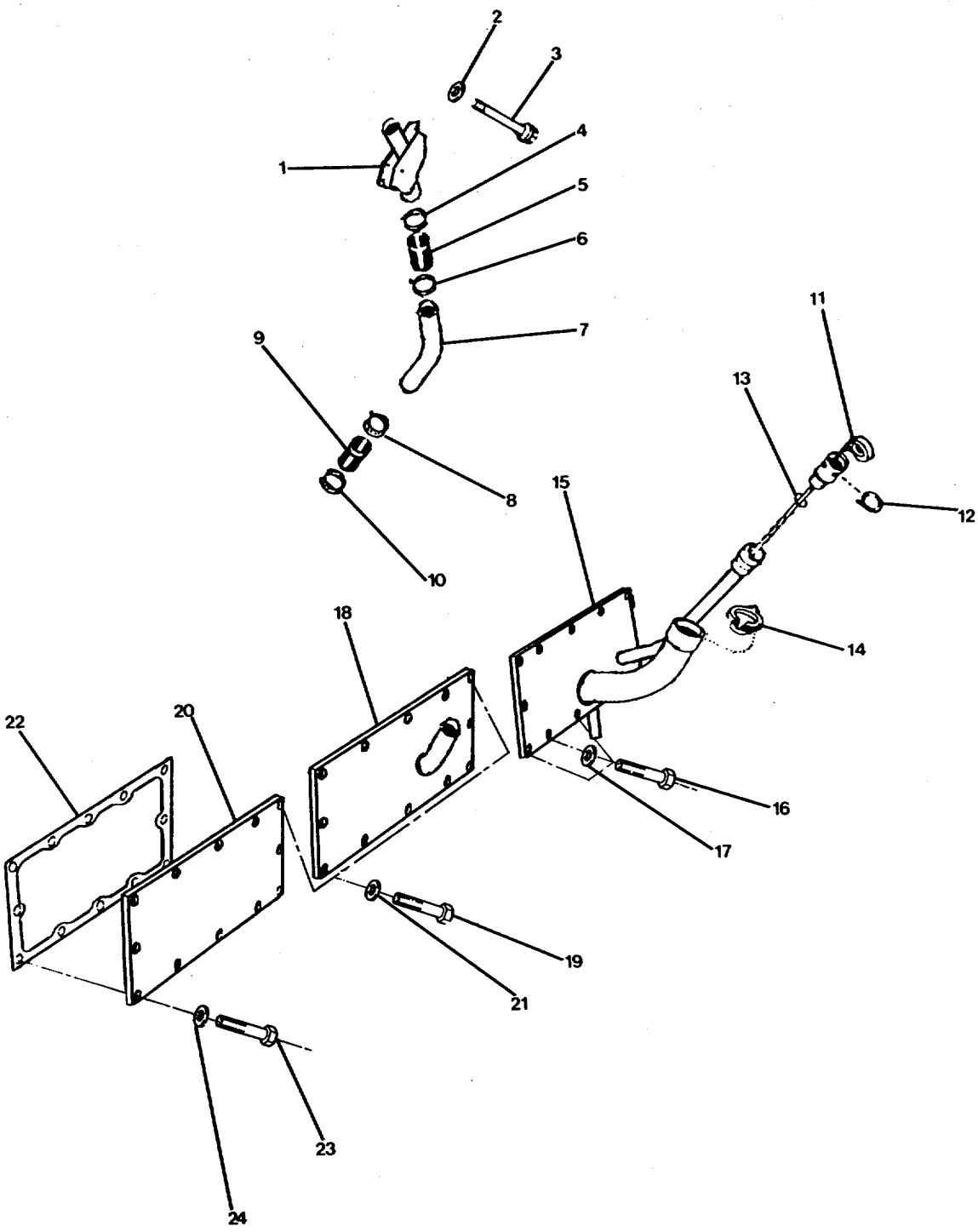


FIGURE 2-59. Handhole Cover Group.

(3) Remove retaining clip (12) and preformed packing (13) from liquid level gage rod (11). Discard preformed packing.

(4) Remove twelve hexagon head capscrews (16) and lockwashers (17).

(5) Remove handhole cover (15) and handhole gasket (22). Discard gasket.

c. Remove access cover with crankcase ventilation tube (18) (one each side).

(1) Remove lube oil filter assembly (paragraph 2-24). (Left side only.)

(2) Loosen four hose clamps (4, 6, 8 and 10). Remove two preformed hoses (5, 9) and one metallic bent tube (7).

(3) Remove four hexagon head capscrews (3) and lockwashers (2). Remove crankcase breather (1) from the air manifold.

(4) Remove twelve hexagon head capscrews (19) and lockwashers (21).

(5) Remove access cover (18) and handhole gasket (22). Discard gasket.

REPAIR

Repair of the handhole covers consists of replacement of defective components.

REPLACEMENT

NOTE

- A twelve point capscrew must be used in top right corner of all plain covers. Use a 7/8 inch capscrew on all plain covers unless a clamp or bracket is attached. (Use 1-inch for this). Use--a 1-inch twelve point capscrew in all holes on covers with liquid level gage rod or breather tube.
- Omit two capscrews from the right bank front cover. These capscrews secure the water pump mounting bracket.

a. Install handhole cover with crankcase ventilation tube (18).

(1) Position handhole gasket (22) and handhole cover (18) on engine.

(2) Install twelve lockwashers (21) and hexagon head capscrews (19). Tighten to 30 ft-lb (40 N•m).

(3) Position crankcase breather (1). Install four lockwashers (2) and hexagon head capscrews (3).Tighten to 30 ft-lb (40 N•m).

(4) Assemble metallic bent tube (7), two preformed hoses (5, 9) and four hose clamps (4, 6, 8, 10). Attach to crankcase breather (1) and handhole cover (18). Tighten hose clamps to 50 in-lb (6 N•m).

(5) Install lube oil filter assembly (paragraph 2-24) if removed.

b. Install handhole cover with liquid level gage rod and oil filter tube (15).

(1) Position handhole gasket (22) and handhole cover (15) on engine.

(2) Install twelve lockwashers (17) and hexagon head capscrews (16). Tighten to 30 ft-lb (40 N•m).

(3) Install preformed packing (13) and retaining clip (12) on dipstick (11).

(4) Install liquid level gage rod (11) and filler opening cap (14).

(5) Install lube oil filter assembly (paragraph 2-24).

c. Install blank handhole covers (20).

(1) Position handhole gasket (22) and handhole cover (20) on engine.

(2) Install one lockwasher (21) and twelve-point capscrew (19) intop right corner. Install eleven lockwashers (24) and hexagon head capscrews (23). Tighten to 30 ft-lb (40 N•m).

(3) Install water pump group (paragraph 2-23) and fuel pump group (paragraph 2-29) if removed.

2-36. Repair Oil Pan and Adapter Group.

This task covers:

a. Removal, b. Replacement.

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine 5180-00-629-8783
Lifting sling P/N 3375958

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Lube oil drained, PMCS Table 2-1, Item 6.

Materials/Parts

Gasket P/N 3043213

REMOVAL

a. Remove two pipe to tube elbows (5 and 9, FIG. 2-60). Remove nonmetallic hose (10) from oil pan. Remove electrical connections.

b. Remove fuel line elbow (6) and male adapter elbow (8). Remove metallic hose (7) from oil pan.

WARNING

The oil pan and adapter group is heavy. To avoid personal injury or equipment damage, use the lifting sling to lift the oil pan and adapter group.

c. Remove 56 hexagon head capscrews (11 and 4), lockwashers (3) and flat washers (2) that retain the oil pan and adapter group to the engine block.

d. Remove oil pan and adapter group from engine.

e. Remove gasket (1) and discard.

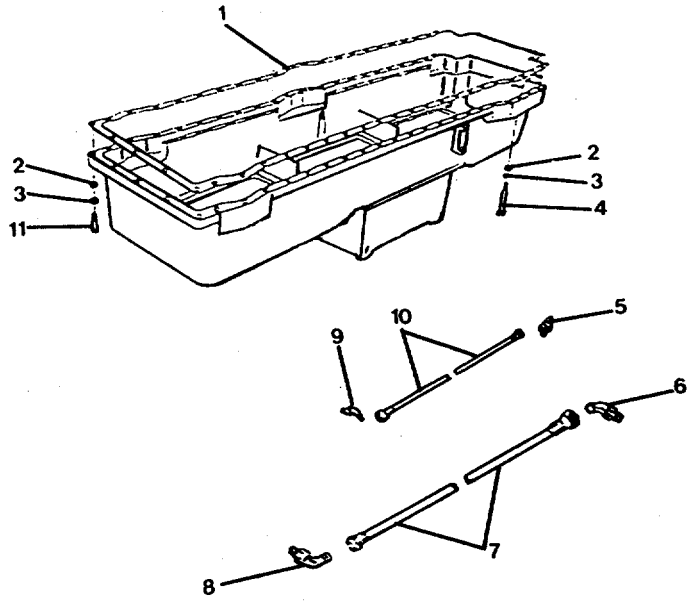


FIGURE 2-60. Oil Pan and Adapter Group.

REPLACEMENT

a. Install a new gasket (1).

WARNING

The oil pan and adapter group is heavy. To avoid personal injury or equipment damage, use the lifting sling to lift the oil pan and adapter group.

b. Position oil pan and adapter group on engine block with boltholes aligned.

CAUTION

Do not damage the oil suction tube when installing the adapter assembly. If the part is damaged, a major engine failure will result from lack of lubrication.

c. Install 56 flat washers (2), lockwashers (3), and hexagon head capscrews (11 and 4). Tighten to 45 ft-lb (60 N•m) following torque pattern (FIG. 2-61).

d. Install male adapter elbow (8, FIG. 2-60), metallic hose (7), and fuel line elbow (6).

e. Install pipe to tube elbow (9), nonmetallic hose (10), and pipe to tube elbow (5). Connect electrical connections.

f. Refill engine with lube oil (PMCS Table 2-1, Item 6), start engine (TM 55-1905-223-10), and check for leaks. Repair as required.

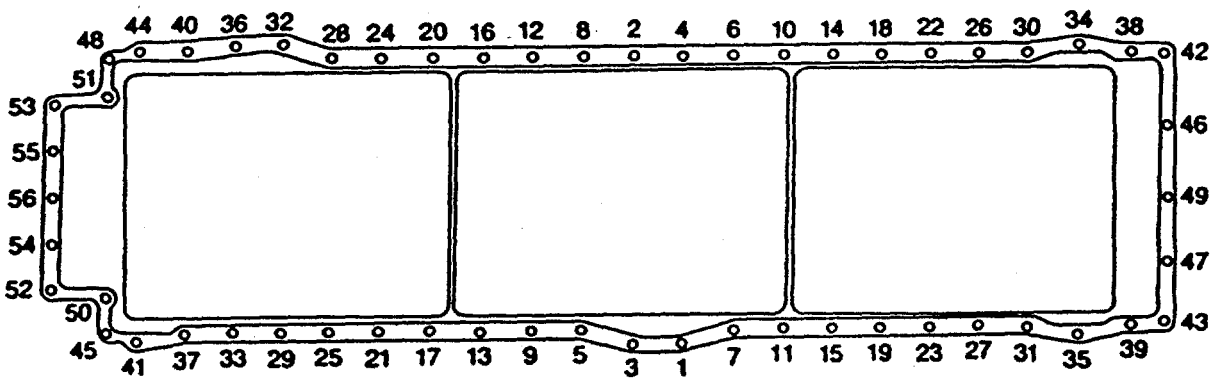


FIGURE 2-61. Oil Pan and Adapter Group Capscrew Torque Sequence.

2-37. Replace/Repair Expansion Tank Group. (FIG. 2-62)

This task covers:

a. Removal, b. Repair. c. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine
5180-00-629-9783

Equipment Condition

Engine shutdown, coolant drained.
TM 55-1905-223-10.

Materials/Parts

Liquid level gauge rod P/N 3057445
Pressure switch P/N 3057444
Coolant, Item 3, Appendix C

REMOVAL

A. Remove insulation blanket (10).

B. Remove piping connections from expansion tank.

C. Remove six machine bolts (3), lockwashers (4) and hexagon nuts (5) retaining the expansion tank (9). Remove expansion tank.

D. Remove filler opening cap (1).

E. Remove fill opening connection (2).

F. Remove liquid level gauge rod (6).

G. Remove pressure switch (8).

H. Remove water line (7) from bottom of tank (9).

REPAIR

Repair of the expansion tank group consists of a thorough inspection of all components for serviceability. Inspect all threaded components for clean, undamaged threads, check the gauge and switch for proper operation. Replace any component as required. Insulation blankets are to be procured/fabricated commercially from sources skilled in the art of manufacturing removable insulation from material meeting requirements of MIL-I-24244 and MIL-I- 16411, Type II.

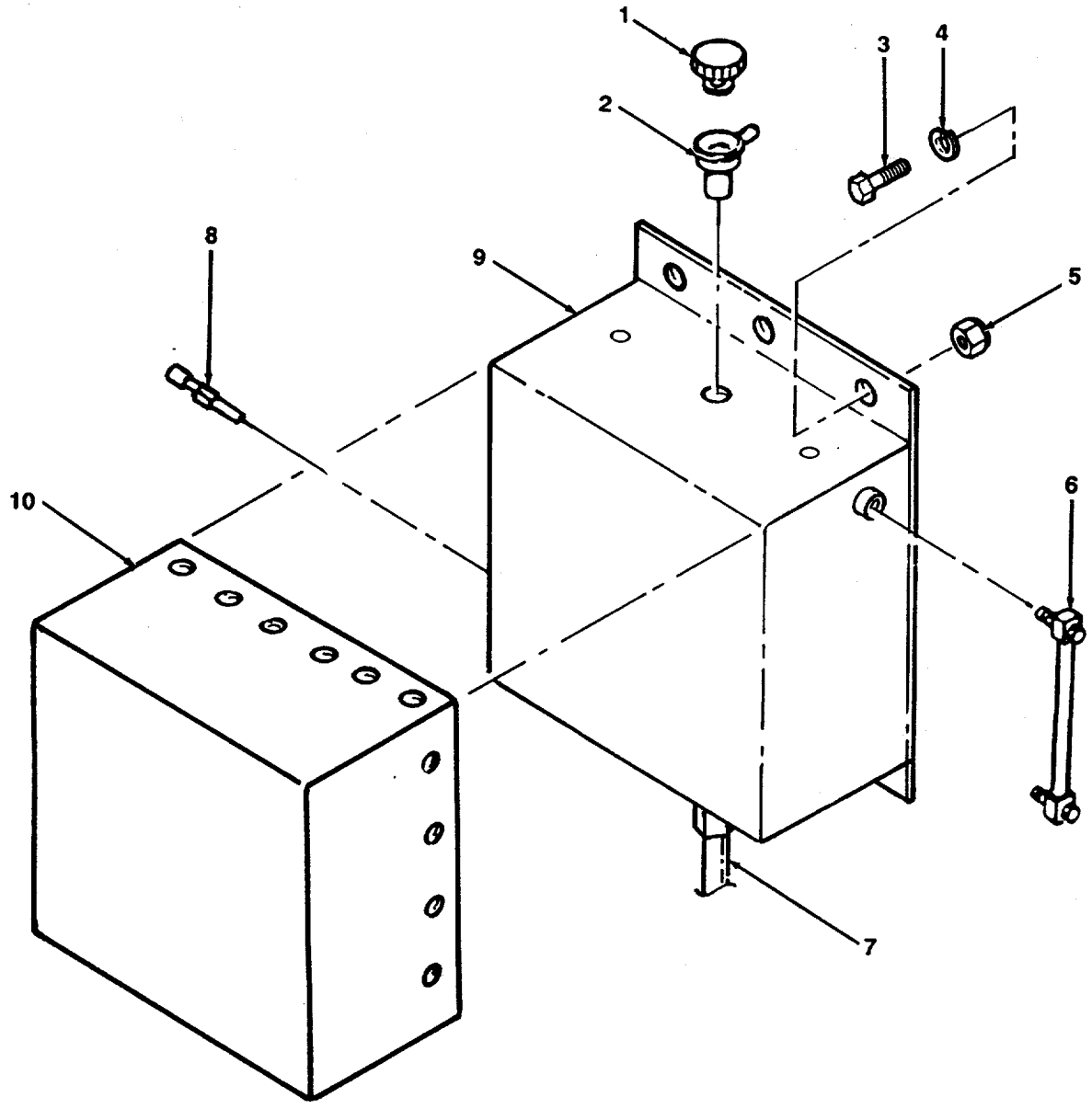


FIGURE 2-62. Expansion Tank Group.

REPLACEMENT

a. Install pressure switch (8).

b. Install liquid level gage rod (6).

c. Install filler opening connection (2).

d. Install filler opening cap (1).

e. Position expansion tank (9) with boltholes aligned.

f. Install six hexagon nuts (5), lockwashers (4) and machine bolts (3).Secure until tight.

g. Install piping connections.

h. Install water line (7).

i. Refill coolant and start engine (TM 55-1905-223-10).

j. Check for leaks. Repair as required.

SECTION VI. PREPARATION FOR STORAGE, RESHIPMENT, AND RETURN TO SERVICE

2-38. **General**. If an engine will be out of service for an extended period of time (3 weeks or longer), or reshipped to another location, certain actions must be taken to protect it against the corrosive effect of the elements. Further information can be found in Army Technical Bulletin TB 740-97-4.

a. Temporary Storage. If an engine is to remain out of service for a maximum of' 6 months, the procedures listed below are required to minimize or prevent damage:

(1) Start the engine and operate until thoroughly warm. Disconnect the fuel lines to the engine fuel filter and injector drain line (fuel return to tank). Fill two containers, one with diesel fuel and a second with preservative oil (MIL-L-644 Type P-9).

(2) Start the engine with the fuel line to the filter submerged in the container of diesel fuel. (The injector drain line should also flow into the container.) After the engine is running smoothly, switch the fuel line to the container with the preservative oil. Operate the engine for 5 to 10 minutes on preservative oil. Stop the engine and reconnect the fuel lines.

(3) Drain the oil sump and fuel filters and reinstall the drain plugs. The sump may remain empty until the engine is ready for use; tag the engine with a warning tag.

(4) Disconnect the electrical wiring and turn the fuel pump manual shut-off valve fully counterclockwise to off. Spray lubricating oil into the intake manifold while cranking the engine slowly.

(5) Cover all the openings with tape to prevent the entrance of dirt and moisture.

(6) Bar the engine crankshaft two or three revolutions each three to four weeks.

b. Permanent Storage. When an engine is to be stored 6 months or more, the following procedures must be performed:

(1) Start the engine and operate it at fast idle until the engine is thoroughly warm. Stop the engine and drain the old oil.

(2) Fill the crankcase to the full mark on the sight gauge or dipstick with preservative oil, U.S. Military Specification MIL-L-21260, Type P-10, Grade 2 SAE 30.

(3) Repeat steps a, (1), (2), and (3) above.

(4) Disconnect the electrical wiring and turn the fuel pump manual shutoff valve fully counterclockwise to off.

(5) Remove the intake and exhaust manifolds. Spray all the intake and exhaust ports with preservative oil. Replace the manifolds.

(6) Inspect the cooling system; if the coolant is contaminated, drain it and flush the system. Fill it with a rust preventive compound.

(7) Remove the exhaust plate from the starter and spray with preservative oil. Reinstall plate.

(8) Brush on or spray a film of rust preventive compound on all exposed, unpainted surfaces of the engine. Use a rust preventive conforming to Type P-l, Grade 1 or 2, U.S. Military Specification MIL-C-16173C. Remove the cylinder head covers and spray the rocker levers, valve stems, springs, guides, crosshead and push tubes. Replace the covers.

(9) Cover all the engine openings with heavy paper and tape. Tag the engine to indicate that it has been treated with preservatives and the crankshaft should not be barred over. The tag should indicate; if coolant has been removed, the date of treatment, and that the engine is not ready to run.

(10) Store the engine in an area where the air is dry and temperature uniform.

NOTE

- Engines in storage for more than 24 months should be flushed out with a suitable solvent or a light, hot oil, and then be reprocessed with rust preventive materials. Periodically inspect the engines for rust or corrosion. Take corrective action as necessary.

- Although the preservative materials may be added to and be used for the same purpose repeatedly, they must be kept clean; the accumulated deposits should be removed after being allowed to settle.

2-39. **Preparing a Stored Engine for Service**. When an engine is removed from storage and put into service, the following operations must be performed:

a. Clean Engine.

(1) Clean accumulated dirt from the exterior of the engine. Remove the covers, tape, and wrappings.

(2) Use a suitable cleaner to remove the rust preventive compound from the unpainted surfaces.

(3) If required, paint the engine in accordance with TM 43-0139, Painting Instructions for Field Use.

(4) Refill the crankcase with clean lubricating oil. Flush and fill the cooling system. Install DCS (Diesel Coolant Additives) precharge elements to the water filter heads. These will be exchanged with service elements at the first oil change.

b. Inspection.

(1) When an engine has been stored for 6 months or less, it is necessary to adjust the injectors, valves, tighten the cylinder head capscrews and connections, and replace the filters.

(2) When an engine has been stored for 6 months or more, the following procedures must be followed in addition to the above:

(a) Flush the fuel system with clean fuel oil until all preservative oil is removed.

(b) Remove a plug from the oil gallery and force hot, light mineral oil through the oil passages to flush away all preservative oil bar over the engine crankshaft three of four revolutions during the flushing operation.

(c) Actions stated in paragraph b. (1) above.

(d) After inspecting the engine and parts, make sure all the preservative oil and accumulated deposits have been flushed away. Start the engine as described in paragraph 2-5(b) and (c).

CHAPTER 3

INTERMEDIATE DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

3-1. **Common Tools and Equipment**. For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

3-2. **Special Tools, TMDE, and Support Equipment**. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

3-3. **Repair Parts**. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

SECTION II. SERVICE UPON RECEIPT

3-4. **Checking Unpacked Equipment.**

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

d. Remove protective caps, plugs, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease or protective films at time of installation.

e. Remove chocks from resilient mounted components.

3-5. Initial Setup Procedure. Includes operational checks and inspections that are not performed for a routine startup. Direct support maintenance personnel will perform initial setup in accordance with the operator's manual, TM 55-1905-223-10.

3-6. Normal Startup. Refer to the operator's manual, TM 55-1905-223-10.

3-7. Shutdown Procedure (Usual or Unusual). Refer to the operator's manual, TM 55-1905-223-10.

SECTION III. INTERMEDIATE DIRECT SUPPORT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

3-8. PMCS. There is no PMCS at the direct support level. See Chapter 2, Section III.

SECTION IV. INTERMEDIATE DIRECT SUPPORT TROUBLESHOOTING

3-9. **Troubleshooting**. Both a symptom index and a troubleshooting table are provided. The symptom index will help you locate the information you need for troubleshooting.

SYMPTOM INDEX

Table 3-1 lists the common fault conditions that may be found during the operation or maintenance of the equipment. Look for causes and do corrective actions in the order listed. This manual cannot list every symptom that may show up, and it cannot list all of the possible causes and corrective actions. If a symptom is not listed, or if it keeps up after you have performed the corrective actions, notify your supervisor.

Table 3-1. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Coolant loss (internal).

   STEP 1. Check if lubricating oil cooler is leaking.
   Isolate elements and pressure test for air leaks. Refer to para. 3-17.

2. Lube oil pressure too low.

   STEP 1. Check if main oil pressure regulator is malfunctioning.
   Repair main oil pressure regulator assembly. Refer to para. 3-15.

   STEP 2. Check if oil cooler bypass valve is malfunctioning.
   Repair oil cooler bypass valve assembly. Refer to para. 3-15.

   STEP 3. Check if oil cooler is plugged.
   Repair oil cooler elements. Refer to para. 3-17.

   STEP 4. Check if there is internal engine damaged.
   Analyze the lubricating oil. Refer to LO 55-1905-223-12.

   STEP 5. Check if lubricating oil pump is malfunctioning.
   Replace lubricating oil pump. Refer to para. 3-23.

   STEP 6. Check if oil pressure gauge is malfunctioning.
   Check gauge against one of known accuracy.

3. Lube oil temperature too high.

   STEP 1. Check if oil cooler by-pass valve is malfunctioning.
   Repair the oil cooler by-pass valve assembly. Refer to para. 3-15.

4. Lube oil in coolant or coolant in lube oil.

   STEP 1. Check if lubricating oil cooler is malfunctioning.
   Replace oil cooler. Refer to para. 3-17.

Table 3-1. Troubleshooting - CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

5. Rough idle.

   STEP 1. Check if injection timing is wrong.
   Correct engine timing. Refer to para. 3-24.

   STEP 2. Check for loose or broken engine mounts.
   Secure engine mounts. To replace broken engine mounts, refer to para.3-20.

6. Engine runs rough or misfires in operating range (warm engine).

   STEP 1. Check for damaged camshaft.
   Inspect camshaft and replace if required. Refer to para. 3-24.

   STEP 2. Check if injection timing is set incorrectly.
   Correct injection timing. Refer to para. 3-24.

7. White smoke at idle excessive.

   STEP 1. Check if injection timing is set wrong.
   Correct injection timing. Refer to para. 3-24.

8. Engine crankcase gases (blowby) excessive.

   STEP 1. Check for broken piston rings.
   Replace piston rings. Refer to para. 3-25.

9. Engine noise excessive.

   STEP 1. Check for excessive gear train backlash or damaged gear teeth.
   Correct gear backlash. Refer to para. 3-24.
   Replace gear teeth. Refer to para. 3-24.

10. Main bearing noise.

    STEP 1. Check for loose flywheel.
    Secure flywheel mounting capscrews. Refer to para. 3-26.

    STEP 2. Check if main bearing capscrews are loose, worn, or not secured.
    Secure capscrews. Refer to para. 3-24.

Table 3-1. Troubleshooting - CONT

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

11. Connecting rod bearing noise.

    STEP 1. Check if connecting rod capscrews are loose or not tightened correctly.
    Secure the connecting rod capscrews. Refer to para. 3-25.

    STEP 2. Connecting rod bearings are not assembled correctly, damaged, worn, or wrong bearings installed.
    Replace the connecting rod bearings. Refer to para. 3-25.

    STEP 3. Check if connecting rod(s) are bent.
    Replace connecting rod(s). Refer to para. 3-25.

2. Piston noise.

    STEP 1. Check for loose or worn piston pin or bushing.
    Replace piston. Refer to para. 3-25.

    STEP 2. Check for cracked or broken piston.
    Replace piston. Refer to para. 3-25.

    STEP 3. Connecting rod(s) are bent.
    Replace connecting rod(s). Refer to para. 3-25.

    STEP 4. Check for worn or broken piston rings.
    Determine faulty cylinder. Replace the piston rings. Refer to para. 3-25.

13. Engine vibration excessive.

    STEP 1. Check for loose or damaged engine mounts.
    Tighten and check engine mountings. Refer to para. 3-20.

    STEP 2. Check for loose or damaged flywheel.
    Secure or replace flywheel. Refer to para. 3-26.

SECTION V. INTERMEDIATE DIRECT SUPPORT MAINTENANCE PROCEDURES

3-10. **General**. Before beginning the disassembly of any engine component, a thorough inspection should be made to determine its overall condition and whether, in fact, repair is the best thing to do. Many times it is better to replace the component with a new one rather than spend the time and effort to repair it. When it is determined that repair is needed, the component should be disassembled carefully (see a, below) and all parts thoroughly cleaned.

a. Disassembly. Information noted during disassembly can save a lot of time during reassembly.

(1) Mark or identify mounting components, as removed, for location and position.

(2) Record capscrew type, length and location as they are removed, to make sure you replace the right ones when you reassemble.

(3) Tag things like electrical wiring, tubing, and bearing shell positions, to make sure of correct reassembly.

(4) Discard hoses, preformed packings, crevice seals, and gaskets when replacement items are authorized.

(5) Be sure to follow the equipment disassembly procedures. Be careful when removing attaching hardware, wiring, etc., so you do not break or strip capscrews, bend tubing, or break wiring terminals.

b. Assembly. Be sure to follow assembly procedures as outlined, paying particular attention to torque values and torquing procedures. If torque values are not specified in the procedure, follow the guidance found in Appendix D, "Torque Limits."

3-11. **Cleaning**. Proper cleaning is very important. If you do not clean correctly you could have inaccurate torque readings, reduced or restricted lubrication, scoring, fuel or lube oil contamination, and other problems.

a. Steam clean all disassembled units and parts (except for those that might be damaged by steam or moisture) with a steam jet and dry with compressed air. All units such as oil coolers, oil pan, etc., should be cleaned as quickly as possible to prevent hardening and drying of accumulated foreign substance.

CAUTION

Do not use glass bead cleaning on pistons. Small particles of glass will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, and other parts, can also be damaged. Follow the cleaning directions listed in the procedures.

b. Glass Bead Cleaning. This method can be used to remove carbon deposits from many engine components. The nature and degree of treatment is controlled by the size of glass beads used, operating pressure and exposure time.

(1) Bead Size. For general purpose cleaning use No. 60.

CAUTION

Do not expose the part being cleaned to the bead blast any longer than absolutely necessary. This is particularly true when cleaning soft material such as aluminum.

(2) Operating Pressure. Use 90 psi (5.4 kg/sq cm) for general cleaning.

(3) The only additional cleaning required is to wash with solvent and dry with compressed air. Be sure all foreign material has been removed from the parts before reassembling.

c. Solvent/Acid Cleaning.

WARNING

Wear gloves, goggles and aprons when using solvent solution.

CAUTION

- Solvent/acid cleaners may damage bearing shells and aluminum parts; check manufacturer's instructions before cleaning these parts in solvent.
- Do not damage gasket mating surfaces.

(a) Remove all gasket material and deposits of sludge, carbon, etc., with a wire brush or scraper from units such as cylinder heads, oil pan, rocker lever housing and cover, etc., before submerging them in wash tank.

(b) Solvent solution should be heated to approximately 180°F to 2-00°F (82°C to 93°C) and kept in constant agitation. With sufficient heat the agitation can be accomplished by built-in baffle plates.

(c) After unit disassembly, put all small parts in wire mesh baskets and steam clean; then, immerse them in cleaning tank for as long as necessary. Larger parts can be lowered directly by hoist into tank.

(d) Run rods with bristle brushes through oil passages. Scrape the liner counterbore lightly to remove scale; sand lower liner bore or use emery cloth to remove any nicks or burrs that might damage the packing rings as the liner is installed.

WARNING

The use of acid may be extremely dangerous to personnel and injurious to machinery. Always provide a tank of strong soda water as a neutralizing agent.

(e) To remove heavy deposits of lime, use circulated acid-type cleaner.

(f) Rinse all parts in hot water and dry with compressed air; blow water from the capscrew holes to prevent damage when capscrews are tightened.

(g) Replace all fittings, plugs, etc., that have been removed for cleaning.

NOTE

If machining is required, reclean the affected area and replace the pipe plugs after machining is completed.

(h) If the parts are not to be reused immediately after cleaning, dip them in a suitable rust proofing compound.

NOTE

Rustproofing compound must be removed before installing the parts in the engine.

3-12. Replace Main Propulsion Engine.

This task covers:

a. Removal **b. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's, rail and marine diesel engine, 5180-00-629-9783
Engine lifting fixture, P/N 3375109
Lifting sling, P/N 3375958

Materials/Parts

Main propulsion engine, starboard P/N S.O. 51165-KTA50M
Main propulsion engine, port P/N S.O. 51180-KTA50M

Equipment Condition

Engine secured. TM 55-1905-223-10.
Fuel supply valve shut off. TM 55-1905-223-10.
All overhead obstructions (such as piping and lighting fixtures) removed. TM 55-1905-223-24-18.

WARNING

The engine weights approximately 11,000 pounds (4950 kg). Use extreme care when lifting engine to prevent personal injury or equipment damage.

REMOVAL

Overview. This section is about actions necessary to prepare the engine for removal, and actions needed to install the repaired or new engine after it has been "shipped" and positioned to its operating location.

WARNING

Before attempting any of the following actions, turn the fuel control shutoff valve manual knob counterclockwise to the OFF position and the power switch emergency stop to the STOP position and tag controls "Out of Service Do Not Operate."

a. Disconnect reduction gear.

(1) Remove bolts securing the coupler to the flywheel.

(2) Remove the lube oil drain line where it connects to the sump pump. Plug or tape the hose and position out of the way so it does not impede removal of the engine.

b. Remove the capscrews securing the flexible outlets to the exhaust piping. Discard gaskets.

c. Drain and disconnect fuel system.

WARNING

Use extreme caution while disconnecting fuel lines. Place cans to catch fuel from disconnected lines. Wipe up all fuel spills immediately.

(1) Disconnect the fuel supply line at the fuel filter block.

(2) Disconnect the fuel tank return drain line located directly to the rear of the fuel pump.

(3) Drain fuel filters and discard elements.

d. Disconnect electrical wiring.

(1) Disconnect and tag all electrical connectors from the vessel to the engine.

NOTE

Be sure to tag all connectors and mounting hardware for reinstallation.

(2) Remove all retaining clips and supporting devices mounting the wiring to the engine.

(3) Move and secure all wiring clear of the engine so that it will not interfere with the engine during the removal process.

e. Drain and disconnect lubrication system.

(1) Drain the oil pan completely using the sump pump.

NOTE

Drain plugs in the adapter cover plates and sump must be removed to completely drain the engine.

(2) Disconnect oil supply line.

f. Drain and disconnect cooling system.

(1) Drain all coolant from the system.

(2) Remove water inlet connection from the pump.

(3) Remove water outlet connection at the thermostat housing.

(4) Remove the three expansion vent lines at the:

(a) Aftercooler

(b) Thermostat Housing

(c) Water Outlet Manifold.

g. Remove air cleaners and tubes and store in a safe place to prevent damage.

h. Attach two 3-ton monorail chain hoists to the lifting brackets (two-point lift) and remove bolts securing the engine mounts to the vessel support rails.

i. The engine is ready to be removed (unshipped) from the vessel.

REPLACEMENT

NOTE

The following procedures describe the actions required to complete engine installation once the engine has been placed into position in the vessel.

a. Perform engine alignment and mounting.

(1) With the engine still suspended slightly above the mounting position, align the engine so the front mounting holes line up.

(2) Install guide pins to keep the engine in alignment.

(3) Slowly lower the engine until the rear mounting holes line up. Insert capscrews finger tight.

(4) Install front engine mounting bolts finger tight. Remove guide pins and install remaining bolts.

(a) Keeping most of the engine weight on the overhead hoists, gently movethe engine to align the reduction gear coupler and engine flywheel.

(b) Install all coupling capscrews as the engine comes in alignment with the coupler.

NOTE

With the guide pins installed, very little engine movement is possible, but enough to allow proper alignment.

(5) Once alignment of the coupling has been accomplished, insert bolts finger tight.

(6) When the engine is properly aligned, that is,all coupling-and mounting bolts turn easily into their mating threads and the coupling is aligned flush with the flywheel, torque the mounting and coupling bolts to 230 ft-lb (310 N-m).

b. Connect cooling system.

(1) Reconnect the water inlet connection to the water pump.

(2) Reconnect the water outlet connection to the thermostat housing.

(3) Install four DCA (Diesel Cooling Additive) filter precharge water filter elements, paragraph 2-16.

(4) Fill the system with a 50-50 mixture of ethylene glycol antifreeze and fresh water or to the proportions dictated by local conditions. Also see TB 55-1900-207-24.

(5) Replace the fill cap.

(6) Pressure test cooling system (para. 2-13). Check for leaks.

c. Connect electrical wiring.

(1) Connect all electrical connectors to the shutdown valve, sensors, heaters, etc. Remove tags.

NOTE

Make sure all connections are free of dirt, grease or paint before tightening securely. Check wire routing to ensure that there is no binding, crimping or interference with other components.

(2) Install all clips and supporting devices used to secure/support the wiring to the engine.

d. Connect the flexible exhaust outlet connections to be exhaust uptakes. Use new gaskets and tighten capscrews equally and evenly.

e. Bar engine by hand over 360° to check for binding.

f. Start engine (TM 55-1905-223-10).

3-13 Repair Engine Cooling System Pump.

This task covers:

a. Disassembly
b. Repair
c. Assembly

INITIAL SETUP

Tools

Tool kit, general mechanic's, rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Mechanical puller, 5120-00-595-9304
Mandrel P/N ST-1285
Bearing driver P/N 3375318
Arbor press 4920-00-373-9376
Water pump seal driver P/N 3377260, 3375319
Hydraulic press P/N 2009-13
Machinist measuring tool set 5280-00-278-9919

Materials/Parts

Centrifugal impeller pump P/N 3050454
Seal P/N 206198
Retaining ring P/N 206196
Retaining ring P/N 3175573
Annular ball bearing P/N S-16054
.Annular ball bearing P/N S-16069
Loctite 601, Item 10, Appendix C
Engine lube oil, Item 2, Appendix C
Loctite 290, Item 12, Appendix C

Equipment Conditions

Engine shutdown. TM 55-1905-223-10.
Engine cooling system pump removed, para. 2-23.

DISASSEMBLY

CAUTION

The puller screw must pass easily through the impeller bore to prevent damage.

a. Install mechanical puller on centrifugal pump impeller (11, FIG. 3-1). Remove impeller (11).

b. Remove retaining ring (3) from groove located in drive port of pump housing (12).

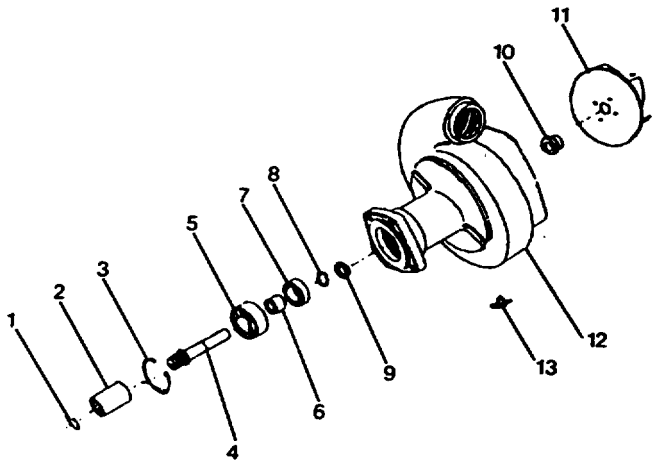


FIGURE 3-1. Engine Cooling System Pump.

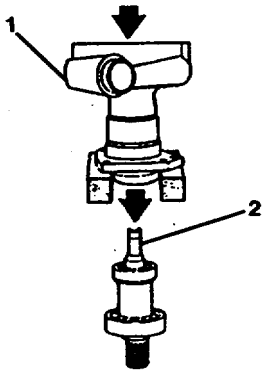


FIGURE 3-2. Shaft Removal From Pump.

c. Support water pump housing (12) in arbor press with drive port of housing down.

d. Using arbor press (1, FIG. 3-2), apply pressure to impeller end of straight shaft (2) to remove shaft from water pump housing (12, FIG. 3-1)

e. Remove seal (10).

f. Remove retaining ring (1).

g. Remove rigid shaft coupling (2).

h. Remove valve seat (9).

i. Remove retaining ring (8).

CAUTION

Do not damage the end of the shaft if it is to be installed again.

j. Using a hydraulic press (1, FIG. 3-3), support the large annular ball bearing (2) as shown.

k. Remove the small annular ball bearing (3), sleeve spacer (4) and the large annular ball bearing (2) from the shaft (5).

l. Remove drain cock (13, FIG. 3-1).

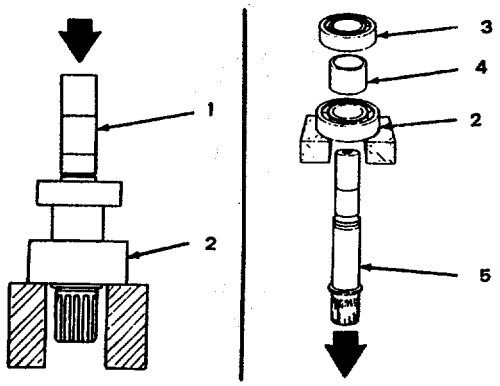


FIGURE 3-3. Shaft Removal.

REPAIR

a. Inspect centrifugal pump impeller (11, FIG. 3-1).

(1) Inspect impeller for nicks, cracks and obvious damage.

(2) Check for wear marks on outside diameter of impeller and on impeller vane edges.

(3) Check center (shaft) bore of impeller for wear.

(4) Measure inside diameter of impeller bore. Verify diameter is within specifications (Table 3-2).

(5) Replace impeller, if defective.

b. Inspect straight shaft (4).

(1) Check shaft for wear, damage and corrosion in impeller mounting area, bearing and seal mounting areas.

(2) Check for wear, obstructions, corrosion and damage in retaining ring groove.

(3) Measure outer diameter of shaft at impeller end. Verify outer diameter is within specifications (Table 3-2).

(4) Inspect straight shaft for damaged threads in impeller end and damaged spines in coupling end of shaft.

(5) Replace shaft, if defective.

c. Inspect rigid shaft coupling (2) for broken, worn or damaged splines and cracks, corrosion and damage to coupling body. Replace if defective.

d. Inspect annular ball bearings (5 and 7).

(1) Inspect bearings for pitting, corrosion and looseness.

(2) Hold bearing by inner race and spin outer race to check for binding.

(3) Inspect bearing center (shaft) bore and outside diameter for nicks, cracks and obvious damage.

(4) Replace any bearing that has pitting, corrosion, nicks, cracks or obvious damage. Replace any bearing that does not spin freely, when checked for binding.

e. Inspect seal (10) for tears, kinks, wear and obvious damage. Replace if defective.

f. Inspect bearing sleeve spacer (6) for wear and damage. Replace if defective.

g. Inspect retaining rings (1 and 8) for distortion and damage. Replace defective retaining rings.

h. Inspect drain cock (13) for corrosion and damage. Replace if defective.

i. Inspect water pump housing (12).

(1) Inspect exterior of water pump housing, including mounting surfaces, for cracks, corrosion and obvious damage.

(2) Inspect bearing mounting surfaces, seal surfaces and retaining ring grooves located inside housing, for nicks, pitting, corrosion and obvious damage.

(3) Inspect impeller cavity and straight (pump) shaft bore for internal cracks, pitting, corrosion, wear and obvious damage.

(4) Check inside diameters of outer bearing bore, inner bearing bore, oil seal bore and impeller bore to determine if bores are within specifications (Table 3-2).

(5) Replace water pump housing if defective.

ASSEMBLY

CAUTION

The mandrel must contact on the inner race of the bearing to prevent damage.

a. Use a hydraulic press to support the shaft (4, FIG. 3-1).

b. Push the large bearing (5) with a mandrel on the shaft (4) until it touches the shaft step.

c. Install sleeve spacer (6) on the shaft.

d. Push the small bearing (7) with a mandrel on the shaft until it touches the sleeve spacer.

e. Install the retaining ring (8).

f. Support-the water pump housing (12) in an arbor press with the impeller side down.

NOTE

The seal must be installed with the part number positioned down.

g. Use water pump seal driver to install valve seat (9). The valve seat must be even with or no more than 0.020 inch (0.51 mm) below the top of the step in the housing.

h. Use water pump bearing driver to install the shaft (4). Ensure the beveled edge of the shaft is positioned as shown in FIG. 3-4.

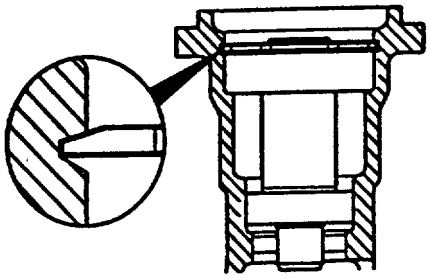


FIGURE 3-4. Shaft Beveled Edge Position.

i. Install retaining ring (3, FIG. 3-1).

CAUTION

Support the water pump body, not the shaft. This will prevent damage to the bearings.

j. Support the water pump housing (12) with the impeller end up. Use water pump seal driver (part number 3377260) to install the seat (10). Ensure that the seal touches the housing and that the installed height of the seal is 0.841 inch (21.36 mm) to 0.861 inch (21.87 mm).

CAUTION

The seal will fail if the spring tension is not correct. One drop of Loctite 290 must be applied on the joint between the seat and the shaft. More than one drop of Loctite 290 can cause the seal to fail.

k. Apply one drop of Loctite 290 to the seal (10) and the parting line of the shaft.

1. Apply thin coat of Loctite 601 to the impeller (11) bore. Supporting the drive end of the shaft, align the slot in the impeller (11) to the slot in the shaft and press the impeller on flush with end of the shaft.

m. Install engine cooling system pump (paragraph 2-23).

Table 3-2. Water Pump Specifications - Inch (mm)

Dimension Location	Minimum	Maximum
Housing Bore Outer Bearing	2.8345 (71.996)	2.8351 (72.012)
Housing Bore Inner Bearing	2.4408 (61.996)	2.4412 (62.009)
Housing Bore Oil Seal	1.498 (38.05)	1.500 (38.10)
Shaft Diameter Impeller End and Seat Location	0.9842 (24.999)	0.9846 (25.009)
Shaft Diameter Inner Bearing	1.1816 (30.010)	1.1820 (30.020)
Shaft Diameter Outer Bearing	1.1816 (30.010)	1.1820 (30.020)
Impeller Bore	0.9811 (24.919)	0.9821 (24.945)
Minimum Press-Fit Between Shaft and Impeller	0.001 (0.03)	

3-14. Replace/Repair Engine Accessory Bracket..

This task covers: **a. Removal** **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's, rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Dial indicator 5210-00-277-8840
Arbor press 4920-00-373-9376
Mandrel P/N ST-598
Machinist measuring tool set 5280-00-278-9919
Hydraulic press P/N 2009-13

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Water pump removed, para. 2-23.

Materials/Parts

Engine accessory bracket P/N 3024194
Gasket P/N 206416
Cleaning solvent, Item 15, Appendix C
Loctite 609, Item 35, Appendix C
Lubriplate No. 105, Item 16, Appendix C

REMOVAL

a. Remove four hexagon head capscrews (8 and 16, FIG. 3-5) and lockwashers (9 and 15).

b. Pull engine accessory bracket (1) from engine.

c. Remove and discard gasket (11).

REPAIR

a. Remove retaining ring (2).

b. Remove clamping washer (3) and thrust washer bearing (4) from the straight shaft (5).

c. Remove spur gear (12) and straight shaft (5). Remove thrust washer bearing (13) from the support (14).

d. Remove pipe plug (10) and expansion shield (7) from the support (14).

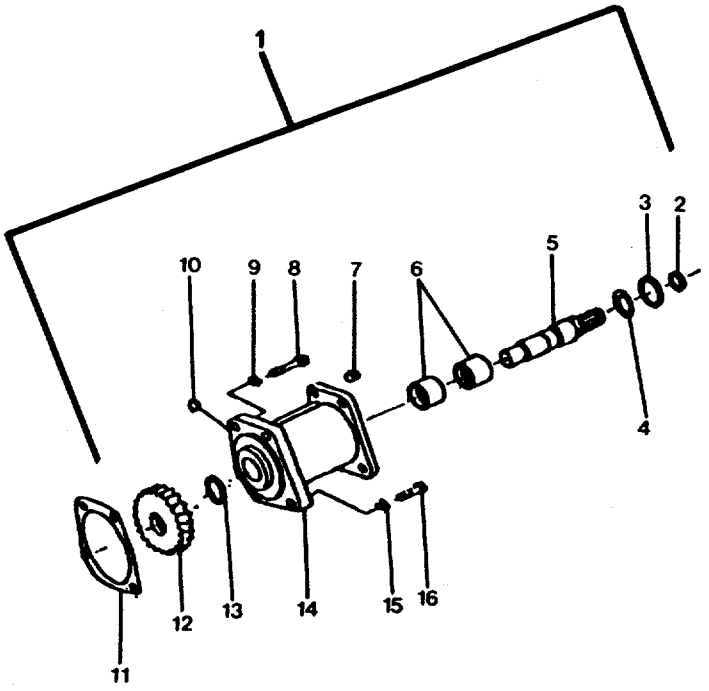


FIGURE 3-5. Engine Accessory Bracket.

e. Clean parts with solvent. Ensure all oil drillings are open and free from blockage.

f. Measure the inside diameter of the sleeve bushings (6). Ensure inside diameter is between 1.751 inch (44.48 mm) and 1.755 inch (44.58 mm). If the inside diameter of either bushing is not within specifications, replace both bushings as follows:

(1) Support the housing (14) with an arbor press.

(2) Use a mandrel to remove the bushings (6).

(3) Measure the inside diameter of the housing bore. Verify inside diameter is between 1.875 inch (47.63 mm) and 1.876 inch (47.65 mm). If the inside diameter is not to specification, replace the engine accessory bracket.

(4) Support the housing (14) with an arbor press.

(5) Use a mandrel to install the bushings (6). Ensure the bushings are even with or no more than 0.015 inch (0.38 mm) below the housing surface.

g. Check the shaft (5) for wear, chips or burrs. Measure the shaft outside diameter at the locations shown in FIG. 3-6. Verify measurements are within the following specifications:

Location	Min	Max
1	1.3810 in (35.077 mm)	1.3815 inch (35.090 mm)
2	1.5615 in (39.662 mm)	1.5620 inch (39.675 mm)
3	1.7480 in (44.399 mm)	1.7490 inch (44.425 mm)

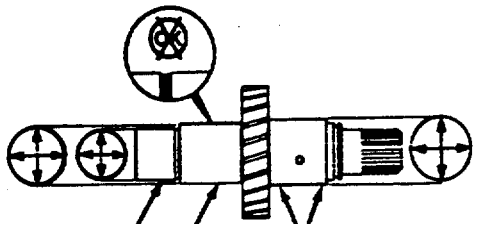


FIGURE 3-6. Straight Shaft Measurement Locations.

NOTE

Only remove the gear from the shaft when the gear or the shaft must be replaced.

h. If the shaft (5, FIG. 3-5) measurements are not in specification or the gear is damaged, replace as follows:

(1) Use an arbor press to support the gear (12) with the shaft oil hole down.

(2) Remove the gear by pressing on the shaft.

(3) Measure the shaft outside diameter at the gear location. Verify outside diameter is between 1.5660 inch (39.776 mm) and 1.5670 inch (39.802 mm). Replace shaft if outside diameter is not within specifications.

(4) Measure the inside diameter of the spur gear (12). Verify the inside diameter is between 1.5640 inch (39.726 mm) and 1.5650 inch (39.751 mm). Replace gear if inside diameter is not within specifications.

(5) Apply a smooth coating of Loctite 609 on the gear (12) bore. Use an arbor press to support the gear. Press in the shaft (5) until the gear touches the shoulder of the shaft.

REPLACEMENT

a. Install pipe plug (10, FIG. 3-5) in support (14). Tighten to 135 in-lb (15 N-m).

b. Use Lubriplate No. 105 to lubricate the grooved surface on the thrust washer bearing (13).

CAUTION

The thrust washer bearing (13) must be installed so that the side with the oil grooves is toward the gear. Failure will result if the bearing is installed incorrectly.

c. Install the thrust washer bearing (13) in the counterbore of the support (14).

d. Use Lubriplate No. 105 to lubricate the bores of the bushings (6) and to lubricate the shaft (5).

e. Install the shaft (5) and spur gear (12) in the support with the spline end of the shaft being inserted first.

f. Use Lubriplate No. 105 to lubricate the thrust washer bearing (4).

CAUTION

The thrust washer bearing (4) must be installed so that the side with the oil grooves is toward the clamping washer (3). Failure will result if the bearing is not installed correctly.

g. Install the thrust washer bearing (4) in the counter bore of the support (14).

CAUTION

The clamping washer (3) must be installed so that the chamfer on the inside diameter of the washer is toward the thrust bearing (4). Failure will result if the washer is not installed correctly.

h. Install the clamping washer (3).

CAUTION

The retaining ring (2) must be installed with the beveled side toward the spline end of the shaft (5). If the ring is not installed correctly, the end clearance will be wrong.

i. Install retaining ring (2).

j. Install expansion shield (7). Ensure shield is below the surface of the support (14).

k. Use a dial indicator to measure the water pump drive end clearance. Verify end clearance is between 0.009 inch (0.23 mm) and 0.13 inch (0.33 mm). If the end clearance is not within specifications, verify that thrust bearings (4 and 13) are completely in the counterbore of the support (14). If thrust bearings are in place, disassemble- engine accessory bracket (1) to find problem.

l. Install gasket (11) on support (14).

m. Position engine accessory bracket (1) to engine. Turn the shaft in the drive to engage the gears.

n. Install four lockwashers (9 and 15) and hexagon head capscrews (8 and 16). Tighten to 45 ft-lb (60 N•m).

o. Install water pump group (paragraph 2-23).

p. Start engine (TM 55-1905-223-10), check pump group, engine pump, and accessory bracket for leaks and proper operation. Correct as required.

3-15. Repair Lube Oil Filter Assembly. (FIG. 3-7).

This task covers: **a. Disassembly** **b. Repair** **c. Assembly**

INITIAL SETUP:

Tools

Tool Kit, General Mechanic's
Rail and Marine Diesel Engine,
5180-00-629-9783
Torque Wrench Kit P/N 3377216
Spring Tester P/N 3375182

Equipment Condition

Lube oil filter assembly removed,
para. 2-24.

Materials/Parts

Preformed packings P/N 3201125,
3026393,68910
Gaskets P/N 3015794, 3015029
Engine lube oil, Item 2, Appendix C
Plain seal P/N 145578
Valve piston P/N 205348
Loctite 601, Item 10, Appendix C

Materials/Parts - CONT

Plain encased seal P/N 145529
Compressed helical spring P/N 205659,
205349, 144195
Detent plunger P/N 3028888, 3021618
Lube oil filter cover gasket
P/N 3028890
Throttle stop pin P/N 148976
Crocus cloth, Item 11, Appendix C

DISASSEMBLY

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control the parts firmly.

CAUTION

Upon removal or replacement of this component, blank, cover, or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

a. Remove lube oil filter assembly (para 2-24).

b. Remove hexagon head capscrew (27), lockwasher (26), and flat washer (25) from the end of the lube oil filter head (54).

c. Remove access cover (24) and plain encased seal (23).

d. Remove compression helical spring (22) and detent plunger (21).

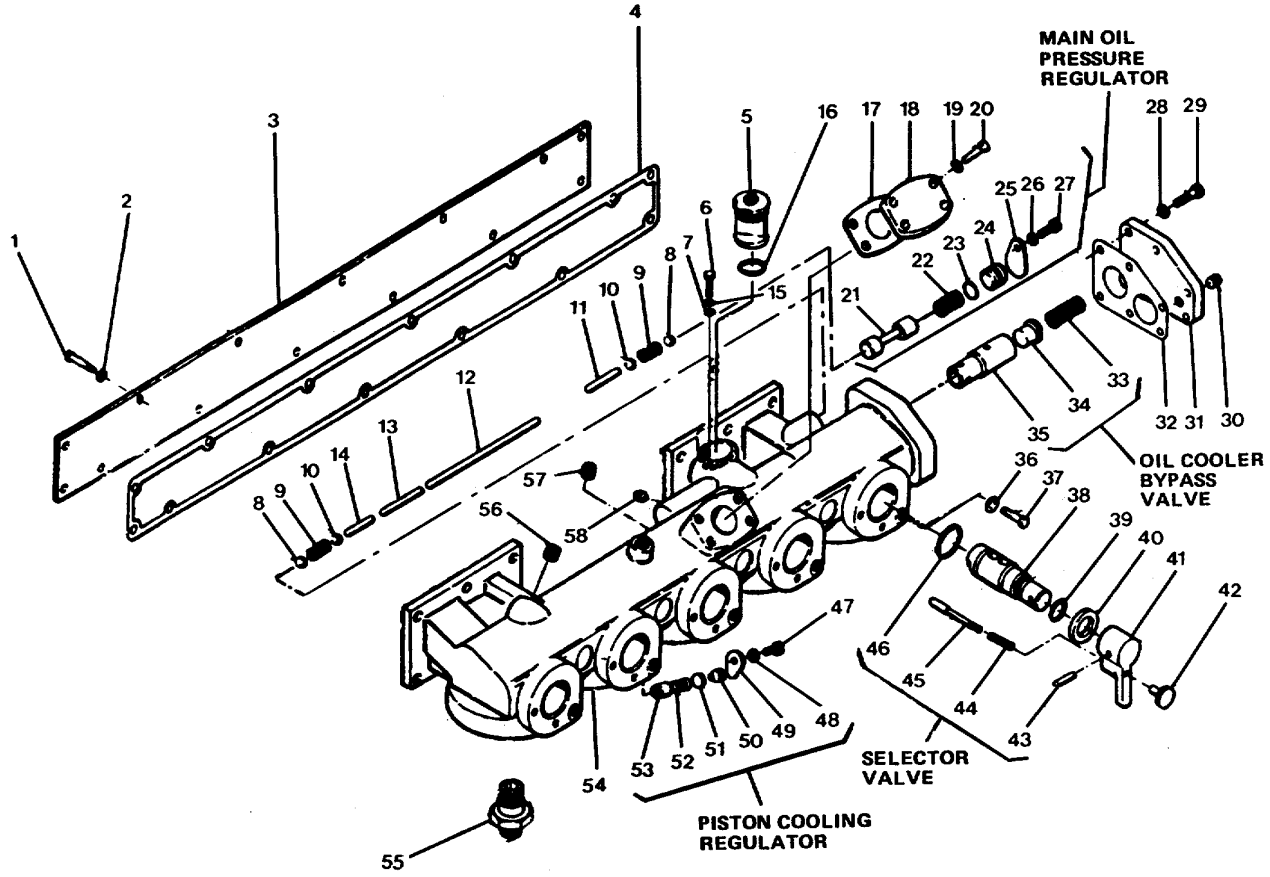


FIGURE 3-7. Lube Oil Filter Assembly.

e. Remove pipe plug (30), hexagon head capscrews (29), and lockwashers (28) retaining access cover (31).

f. Remove springs (9), ball bearings (8 and 10), and rigid connecting links (I 11, 12, 13, and 14) from lube oil filter head (54).

g. Remove access cover (31), lube oil filter cover gasket (32), compression helical spring (33), detent plunger (34) and valve (35). Keep the parts together to aid installation.

h. Remove hexagon head capscrew (47), lockwasher (48), and shouldered washer (49) retaining the fluid valve stem (50). Remove fluid valve stem (50), preformed packing (51), compression helical spring (52) and valve piston (53). Discard the preformed packing (51). Keep the parts together to aid installation.

i. Remove hexagon head capscrews (20) and lockwashers (19). Remove access cover (18) and gasket (17). Discard gasket.

j. Remove machine screws (37) and washers (36).

k. Remove throttle stop pin (43) from lever (41). Remove lever (41). Check spring action of detent rod (45). If necessary, disassemble detent assembly by removing knurled nut (42) from the detent rod (45). Remove spring (44).

1. Remove shaft retainer plate (40) and pull out detent plunger (38). Remove anddiscard preformed packings (39 and 46).

m. Remove hexagon head capscrew (6), lockwasher (15) and flat washer (7). Pull out shutoff valve rotor (5) and seal (16). Discard seal.

n. Remove pipe plugs (56, 57, and 58).

o. Remove hexagon head capscrews (l) and lockwashers (2) retaining access cover (3) to side of engine block. Remove cover (3) and gasket (4). Discard gasket.

p. Remove adapter bushing (55) only if it is damaged or loose.

REPAIR

a. Clean all parts with cleaning solvent and dry with compressed air.

b. Measure the free length of the springs. Ensure the bypass valve spring (33) and the pressure regulator spring (22) are between 4.03 inch (102 mm) and 4.18 inch (106 mm). Ensure the piston cooling regulator spring (52) is between 2.39 inch (60.7 mm) and 2.54 inch (64.5 mm).

c. Use a spring tester. Measure the force of the spring at the working height. Refer to Table 3-3. Replace springs that are not to specifications.

Table 3-3. Lube Oil Filter Springs

		BYPASS VALVE SPRING (33)	PRESSURE REGULATOR SPRING (22)	COOLING REGULATOR SPRING (52)
Working	Height:	2.50 in. (63.5 mm)	2.50 in. (63.5 mm)	1.75 in. (44.4 mm)
Load:	Min	56 lbf (249 N)	56 lbf (249 N)	11.5 lbf (51 N)
	Max	64.4 lbf (286 N)	64.4 lbf (286 N)	12.8 lbf (56 N)

d. Check the surfaces of the plungers and their mating bores. The part must be replaced if it is not possible to remove scratches or marks with a fine crocus cloth.

e. Replace defective parts.

ASSEMBLY

a. Position gasket (4) and access cover (3) on side of engine block. Install lockwashers (2) and hexagon head capscrews (1). Tighten to 20 ft-lb (25 N•m).

b. If adapter bushing (55) was removed, apply Loctite 601 to adapter bushing threads that touch filler head (1) threads. Install adapter bushing (55). Tighten to 150 ft-lb (200 N•m).

c. Install pipe plugs (56, 57, and 58). Tighten to 15 ft-lb (20 N•m).

d. Install seal (16) and shutoff valve rotor (5). Install flat washer (7), lockwasher (15) and hexagon head capscrew (6). Tighten to 7 ft-lb (9 N•m).

e. Lubricate preformed packings (39 and 46) with clean engine lube oil. Install preformed packings (39 and 46) on detent plunger (38).

f. Install detent plunger (38) and shaft retainer plate (40).

g. Install spring (44) on detent rod (45). Position detent rod (45) on lever (41). Install knurled knob (42).

h. Install lever (41). Secure with throttle stop pin (43).

i. Install washers (36) and machine screws (37).

j. Install gasket (17) and access cover (18). Secure with lockwashers (19) and hexagon head capscrews (20).

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control the parts firmly.

NOTE

Ensure the plunger moves freely in the housing. If the plunger does not move freely, check again for debris or burrs on the part and assembly.

k. Lubricate preformed packing (51) and valve piston (53) with clean engine lube oil. Install valve piston (53), spring (52), preformed packing (51) and fluid valve stem (50).

1. Install shouldered washer (49), lockwasher (48) and hexagon head capscrew (47). Tighten to 35 ft-lb (40 N•m).

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control the parts firmly.

NOTE

Ensure the plunger moves freely in the housing. If the plunger does not move freely, check again for debris or burrs on the part and assembly.

m. Lubricate detent plunger (34) with clean engine lube oil. Install valve (35), detent plunger (34), spring (33), lube oil filter cover gasket (32) and access cover (31).

n. Install lockwashers (28) and hexagon head capscrews (29). Tighten to 30 ft-lb (40 Nm).

O. Install pipe plug (30).

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control the parts firmly.

NOTE

Ensure the plunger (21) moves freely in the housing. If the plunger does not move freely, check again for debris or burrs on the part and assembly.

p. Install rigid connecting links (11, 12, 13 and 14), springs (9) and ball bearings (8 and 10) in lube oil filter head (54).

q. Lubricate detent plunger (21) and plain encased seal (23) with clean engine lube oil. Install detent plunger (21), spring (22), seal (23) and access cover (24).

r. Install flat washer (25), lockwasher (26) and hexagon head capscrew (27). Tighten to 35 ft-lb (40 N•m).

s. Install lube oil filter assembly (para. 2-24).

3.16. Repair Shutdown Valve Assembly. (FIG. 3-8)

This task covers:

a. Pre-Inspection **b. Repair** **c. Assembly**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Digital multimeter, 6625-01-139-2512

Materials/Parts

Shutdown valve assembly P/N 3053461
Preformed packings P/N 129888, 190876
Solenoid P/N 3026246

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Power switch emergency stop to STOP position and tagged "Out of Service - Do Not Operate."
Fuel control shutoff valve manual knob counterclockwise to the OFF position, Table 1-3.
Shutdown valve group and assembly removed, para. 2-28.

DISASSEMBLY

a. Remove four hexagon head capscrews (8) and lockwashers (7), retaining the solenoid (93 to the valve body (14). Remove solenoid.

b. Remove override knob (1) and pipe plug (2) (if installed) from the valve body (14).

c. Remove access cover (6) and preformed packing (10). Discard preformed packing.

d. Remove spring tension washer (5) and valve disk (11) from the actuator housing (4).

e. Remove actuator disk (12) from the housing (4). Remove straight shaft (13) and preformed packing (3). Discard preformed packing.

REPAIR

a. Use digital multimeter to check the continuity of the solenoid. If defective windings are found, replace the solenoid.

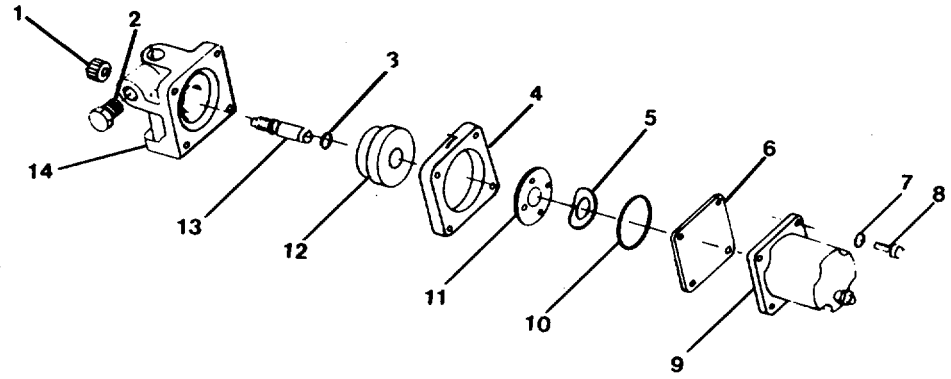


FIGURE 3-8. Shutdown Valve Assembly.

b. Inspect the actuator disk (12) for evidence of wear or other physical damage. Replace as required.

c. Inspect all other components for thread wear or other evidence of physical damage. Inspect the actuator housing (4) for scoring and check orifices for cleanliness and freedom of fluid passage. Replace any component found to be unserviceable.

ASSEMBLY

a. Lubricated preformed packing (3) with engine lube oil. Position preformed packing (3) on override shaft (13).

b. Install actuator disk (12) on override shaft (13).

c. Insert override shaft (13) into valve body (14) with override shaft (13) through opening in back of valve body.

d. Install override knob (1) on end of override shaft (13).

e. Position actuator housing (4) on valve body (14) with bolt holes aligned.

f. Insert valve disk (11) and spring tension washer (5) into bore of actuator housing (4).

g. Position preformed packing (10) on actuator housing (4).

h. Position access cover (6) on actuator housing (4) with bolt holes aligned.

i. Position solenoid (9) with bolt holes aligned with of access cover (6), bolt holes actuator housing (4) and valve body (14).

j. Install four lockwashers (7) and hexagon head capscrews (8). Tighten to 80 in-lb (9 Nm.).

k. Install pipe plug (2).

1. Install the shutdown valve group and assembly, paragraph 2-28 .

m. Restore the engine and fuel flow system to operating condition and start the engine. TM 55-1905-223-10.

n. Check for fuel leaks and proper valve operation. Correct any discrepancies.

3-17. Replace/Repair Lubricating Oil Cooler Group. (FIGURE 3-9)

This task covers:

a. Pre-Inspection **b. Repair,** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Turbocharger group removed, para. 2-19

Materials/Parts

Preformed packings P/N 212161, 206021
Water header cover gaskets P/N 3009323, 3009324
Lube oil cooler elements P/N 3177235
Engine lube oil, Item 2, Appendix C

REMOVAL

a. Remove two self-locking hexagon nuts (5).

b. Remove hexagon capscrews (1 and 4) and lockwashers (12 and 3).

NOTE

Removal of covers may be aided by using capscrews partially threaded into the covers as lifting handles.

c. Remove access cover (6) and water header cover gasket (7). Discard gasket.

d. Remove access cover (2) and water header cover gasket (11). Discard gasket.

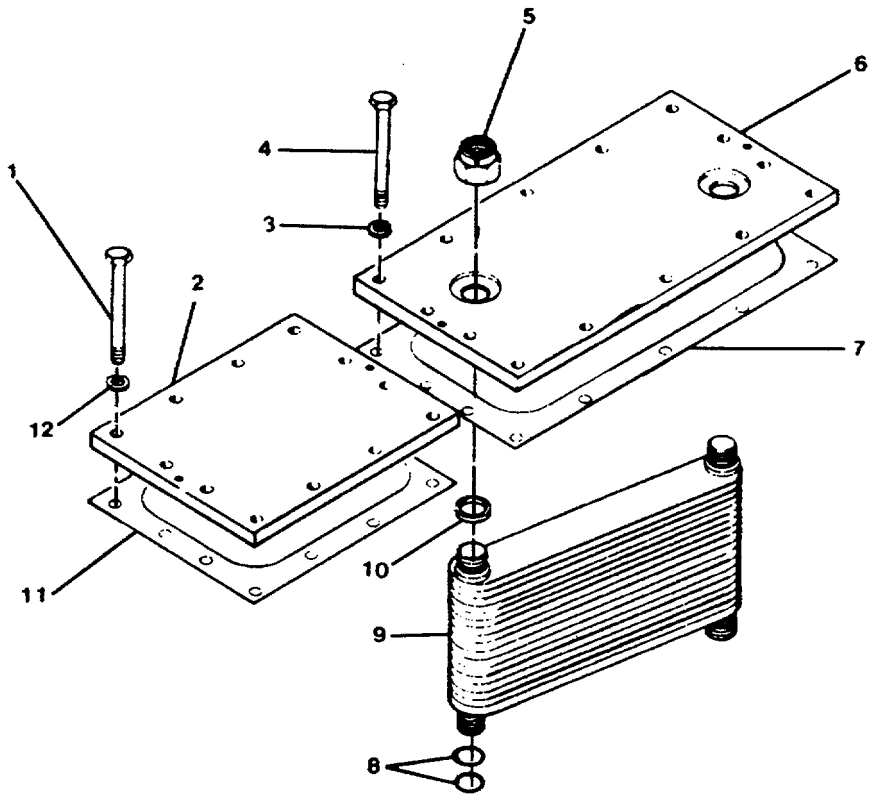


FIGURE 3-9. Lubricating Oil Cooler Group

CAUTION

o Upon removal and installation of this component, blank, cover, or otherwise protect all openings to prevent foreign matter from entering and damaging the system.

o Do not attempt to remove the elements by prying with sharp tools. Penetration of the element will cause a leak.

e. Remove the lube oil cooler element (9).

f. Remove the preformed packings (8 and 10) and discard.

REPAIR

a. Use steam or hot, high pressure water to thoroughly flush the interior and exterior of the lube oil cooler element (9).

b. Check the exterior of the lube oil cooler element (9) for water scale deposits or other corrosion. Clean all deposits off completely.

WARNING

High pressure compressed air tanks, piping systems, and air operated devices possess potential for serious injury to eyes and exposed areas of skin due to escaping air pressure.

c. Plug one end of the element (9), attach a high pressure air supply to the other, and submerge the finned portion of the element in a water tank.

d. Apply high pressure air, not to exceed 60 psi (415 kPa), and check for leaks. If leaks are detected, the element (9) must be replaced.

e. Inspect threaded pipes of element (9) for damaged threads.

f. Inspect capscrews (1 and 4) and nuts (5) for damaged threads.

REPLACEMENT

CAUTION

o All water must be thoroughly removed from element or oil contamination will result.

o Ensure all shipping plugs have been removed from element or the engine will be severely damaged due to lack of lubrication.

a. Lubricate preformed packings (8) with clean engine lube oil.

b. Install preformed packings (8) in grooves of element pipes.

c. Reach in through cooler access hole in engine block and lubricate seals and bore with clean engine lube oil.

d. Push lube oil cooler element (9) into engine block bore until all preformed packings (8) are in bore completely.

e. Position preformed packings (10) on each threaded pipe of element (9).

f. Position water header cover gaskets (7 and 11) on engine block with bolt holes aligned.

g. Position access cover (6) on gasket (7) with bolt holes aligned and threaded pipes of element (9) protruding through openings in cover (6).

h. Install self-locking nuts (5), capscrews (4) and lockwashers (3). Tighten capscrews (4) to 30 ft-lb (40 N m). Tighten self-locking nuts (5) to 45 ft-lb (60 N my.

i. Position access cover (2) on gasket (11) with bolt holes aligned.

j. Install hexagon head capscrews (1) and lockwashers (12). Tighten capscrews to 30 ft-lb (40 Nm).

3.18. Repair Exhaust Manifold Group. (FIG. 3-10)

This task covers:

a. Pre-Inspection **b. Repair** **c. Assembly**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Machinist measuring tool set 5280-00-278-9919

Equipment Condition

Exhaust manifold group removed, para. 2-33.

Materials/Parts

Wood block, Item 17, Appendix C
Solvent, Item 15, Appendix C
Anti-seize compound, Item 5, Appendix C
Gaskets P/N 3015545, 3175908, 3037821
Coolant, Item 3, Appendix C

DISASSEMBLY

a. Remove hexagon head capscrews (8) and lockwashers (7).

b. Remove water transfer connections (6) from manifolds. Remove and discard gaskets (5).

c. Remove hexagon capscrews (3) and lockwashers (4).

d. Separate exhaust manifolds (1, 9, and 10) and remove gaskets (11). A mallet with a soft nose can be used to separate the sections.

e. Remove sleeve bushings (12) only if they are loose.

f. Remove drain cocks (2) from manifolds (1, 9 and 10).

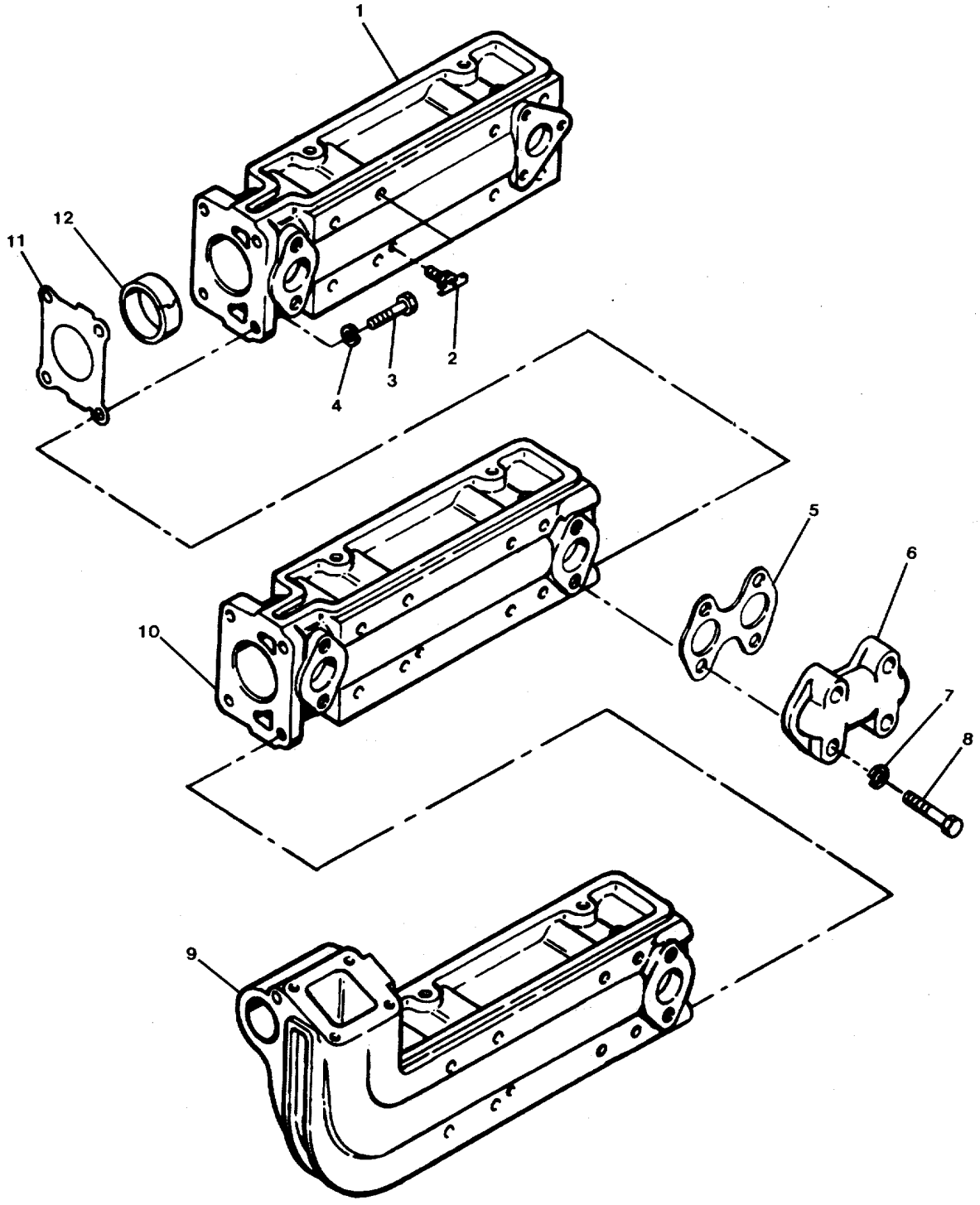


FIGURE 3-10. Exhaust Manifold Group.

REPAIR

a. Clean parts, using steam or solvent.

b. If sleeve bushing were removed, check sleeve bushings-(12) and sleeve bushing bores in manifolds (1, 9, and 10) for wear or damage. The outside diameter of the sleeve bushing (12) must be between 0.010 inch (0.25mm) and 0.070 inch (1.78mm) larger than the inside diameter of the bore into which it is installed.

c. Inspect manifolds (1, 9, and 10) for cracks, distortion or evidence of leaking.

WARNING

High pressure compressed air tanks, piping systems, and air operated devices possess potential for serious injury to eyes and exposed areas of skin due to escaping air pressure.

d. Plug manifold ports and apply compressed air at 20 psi (138 kPa).

e. Check for leaks. Replace manifold if leak is found in exhaust passage.

f. Inspect drain cocks (2) for signs of leakage, corrosion and damaged threads. Replace, if defective.

g. Inspect capscrews (3 and 8) for damaged threads, rounded heads and excessive corrosion.

h. Inspect water transfer connections (6) for cracks, corrosion and obvious damage. Replace, if defective.

ASSEMBLY

a. Install drain cocks (2) to manifolds (1, 9, and 10)

b. Coat the outside of the sleeve bushing (12) with antiseize compound.

CAUTION

Do not strike the sleeve bushing face with any tool, including the soft-head mallet, or misalignment and exhaust leaks may occur.

c. Using a wood block to the face of sleeve bushing (12), drive sleeve bushing (12) into the manifolds (1, 9, and 10) bore by gently striking the wood block with a soft-head mallet.

d. Position gaskets (11) on each manifold end, with bolt holes aligned and sleeve bushing (12) through center hole of gasket (11).

e. Use a mallet to connect manifolds (1, 9, and 10).

CAUTION

The manifold sections must be on a level surface when tightening the capscrews. If the portion of the manifold that touches the cylinder heads is not in alignment, exhaust leaks will result.

f. Put manifold on a level surface. Ensure that the portion of the manifold that touches the cylinders (exhaust ports) is touching the level surface. Use a mallet to turn the manifold sections until all of the exhaust ports are in alignment.

g. Install lockwashers (4) and hexagon head capscrews (3). Tighten capscrews to 35 ft-lb (45 Nm)

h. Position gaskets (5) with bolt holes aligned.

i. Position water transfer connections (6), on gaskets (5), with bolt holes aligned.

j. Install hexagon head capscrews (8) and lockwashers (7). Tighten to 35 ft-lb (45 Nm).

k. Replace the exhaust manifold group, paragraph 2-33 .

3.19 Remove/Repair Fuel Manifold Group. (FIG. 3-11)

This task covers:

a. Pre-Inspection **b. Repair** **c. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Power switch emergency stop to STOP position and tagged "Out of Service - Do Not Operate." TM 55-1905-223-10.
Fuel control shutdown valve manual knob turned counterclockwise to the OFF position.

Materials/Parts

Nonmetallic hose assembly P/N AS06034SL, AS06032SL
Preformed packing P/N 131026, 3001340
Electrical tag, Item 7, Appendix C
Cleaning solvent, Item 15, Appendix C
Wiping rags, Item 4, Appendix C
Utility pail, Item 30, Appendix C
Lubriplate, Item 16, Appendix C

REMOVAL

WARNING

Use extreme care when disconnecting fuel lines. Pails should be used to catch fuel from disconnected lines. All fuel spills should be wiped up immediately.

a. Remove fuel blocks (33).

(1) Tag nonmetallic hoses (26 and 31) and disconnect-from fuel pump.

(2) Remove pipe tee (29) from outlet port of fuel pump. Remove pipe to tube adapter (30) from pipe tee (29).

(3) Remove pipe plug (28) from side port of pipe tee (29).

(4) Remove pipe to tube adapter (27) from inlet port of fuel pump

(5) Remove hoses (26 and 31) from fuel block (33).

(6) Remove pipe to tube elbow (25) from pipe to hose elbow (36).

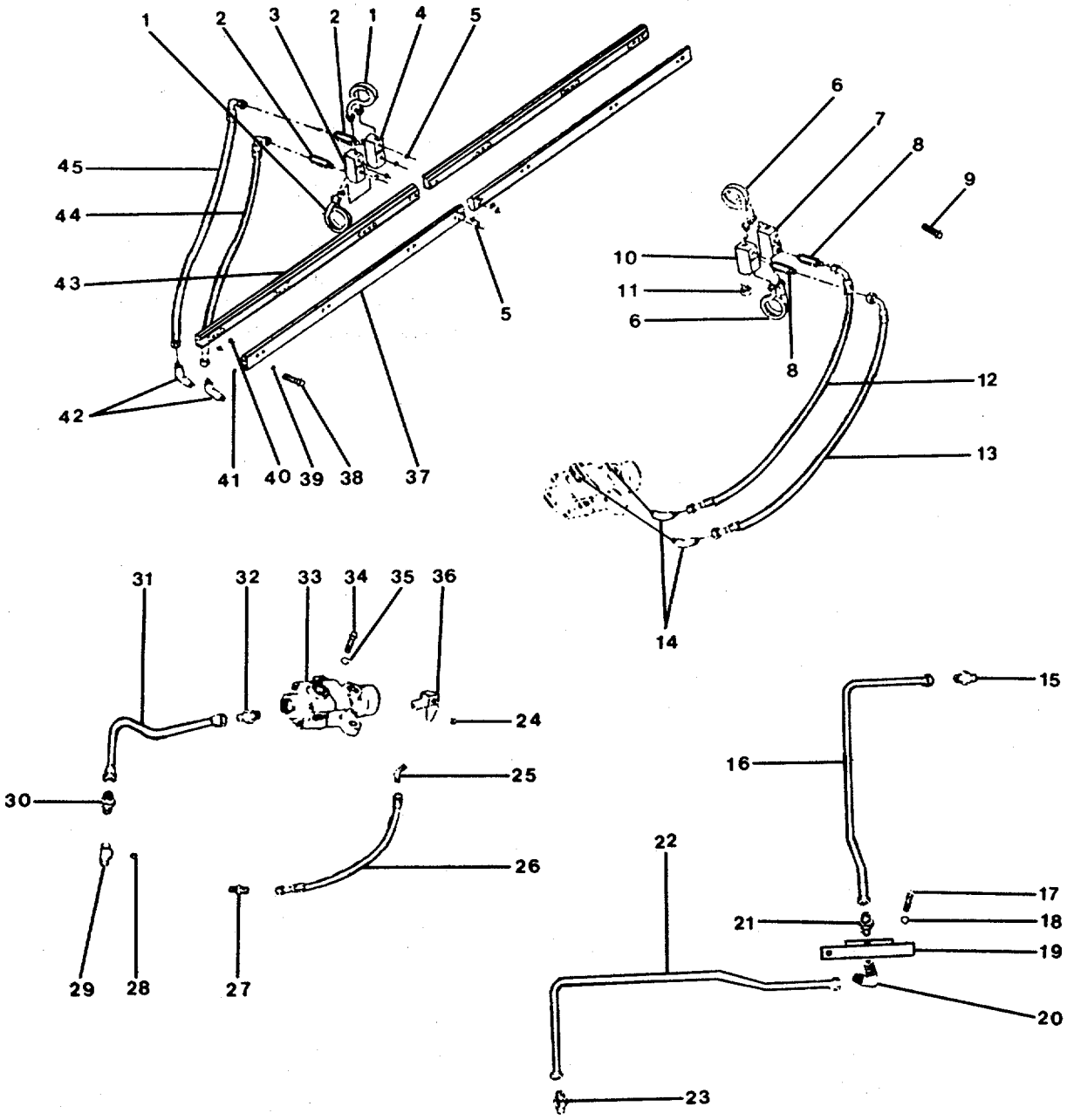


FIGURE 3-11. Fuel Manifold Group.

(7) Remove pipe plug (24) from elbow (36).

(8) Remove elbow (36) from fuel block (33).

(9) Remove pipe to tube adapter (32) from fuel block (33).

(10) Tag and remove nonmetallic hoses (12 and 13 or 44 and 45) from fuel block (33).

(11) Remove fuel fittings (14 and 42) from fuel blocks (33).

(12) Remove machine bolts (34) and lockwashers (35).

(13) Remove fuel blocks (33).

b. Remove fuel blocks assembly.

(1) Remove nonmetallic hoses (12, 13, 44 and 45) from fuel blocks (3, 4, 7 and 10).

(2) Remove fuel fittings (2 or 8) from fuel blocks (3, 4, 7 and 10)

(3) Remove socket head capscrews (9).

(4) Remove fuel blocks (3, 4, 7 and 10) from fuel manifolds (37 and 43).

(5) Remove and discard preformed packing (5).

(6) Remove tube coupling (11) from fuel blocks (3, 4, 7 and 10).

(7) Remove metal tube assembly (1 and 6).

c. Remove fuel manifold.

(1) Remove socket head capscrews (38) and washers (39).

(2) Remove fuel manifolds (37 and 43).

(3) Remove and discard preformed packings (40).

(4) Remove machine thread plug (41).

d. Remove air tube components.

(1) Tag and disconnect metal tube assembly (22) from pipe to tube adapter (23) and tube connector elbow (20).

(2) Remove pipe to tube adapter (23) from air port of fuel pump.

(3) Tag and disconnect metal tube assembly (16) from pipe to tube adapters (15 and 21).

(4) Remove pipe to tube adapter (21) from fuel block connection (19) and intake manifold.

(5) Remove hexagon head capscrews (17) and lockwashers (18).

(6) Remove fuel block connection (19).

(7) Remove tube connector elbow (20) from fuel block connection (19)

REPAIR

a. Clean all parts with solvent, dry with compressed air.

b. Inspect all hoses for tears, frayed or worn areas, kinks, or other evidence of leaks or physical damage. Replace as required.

c. Inspect all metallic tubing for kinks, bends, abrasions, or other evidence of physical damage.

d. Inspect all threaded components for damage or excess wear on the threads.

e. Inspect all components for freedom of fluid flow. Clean or replace as required.

f. Inspect tube connector elbow (20) and fuel block (33) for freedom of fluid flow. Check all orifices for deposits of foreign matter contamination. Clean thoroughly or replace as required.

g. Inspect the manifolds for cracks. Replace as required.

REPLACEMENT

a. Install air tube components.

(1) Install tube connector elbow (20) and pipe to tube adapter (21) in fuel block connection (19).

(2) Position fuel block connection (19) on engine with bolt holes aligned.

(3) Install lockwashers (18) and hexagon capscrews (17). Tighten capscrews (17) to 60 in-lb (7 Nm).

(4) Install pipe to tube adapters (23) in air port of fuel pump and in intake manifold.

(5) Install metal tube assembly (16) to pipe to tube adapters (15 and 21).

(6) Install metal tube assembly (22) between tube connector elbow (20), V located at fuel block connection (19) and pipe to tube adapter (23), located in air port of fuel pump.

b. Install fuel manifolds.

NOTE

The engine has two different manifolds. The left bank front and right bank rear are the same. The left bank rear and right bank front are the same.

(1) Position preformed packings (40) on fuel manifolds (37 and 43). Use Lubriplate to hold the preformed packing in the manifold counterbore.

(2) Position fuel manifolds (37 and 43) on engine with bolt holes aligned.

CAUTION

Ensure preformed packing (40) stays in place. If the packing falls out, a high pressure fuel leak can result, creating a fire hazard.

(3) Install socket head capscrews (38) and washers (39). Tighten socket head capscrews to 85 in-lb (10 N•m).

(4) Install machine thread plug (41).

c. Install fuel blocks assembly.

CAUTION

The fuel fittings (24) must be installed on the metal tube assemblies (1 and 6) before the assemblies are installed in the fuel blocks (3, 4, 7 and 10). A fitting could be damaged if installed first.

(1) Install fuel fittings (24) on metal tube assemblies (1 and 6).

(2) Install metal tube assemblies (1 and 6) in fuel blocks (3, 4, 7 and 10). Do not tighten.

(3) Install fuel fittings (2 and 8) in fuel block (3, 4, 7 and 10).

(4) Install preformed packings (5) in fuel block (3, 4, 7 and 10). Use Lubriplate to hold preformed packings in fuel block counterbores.

(5) Position fuel block (3, 4, 7 and 10) on fuel manifold (37 and 43). Install socket head capscrews (9). Tighten to 45 in-lb (5 N•m).

(6) Tighten metal tube assembly (1 and 6) nuts by hand until the nut touches the fuel fitting (24) and the fuel fitting (24) touches the counterbore in the fuel block (3, 4, 7 and 10). Use an 11/16-inch wrench to tighten the nut until the bottom of the hex touches the fuel block.

(7) Install nonmetallic hoses (12, 13, 44 and 45) to fuel fittings (2 and 8). Tighten hose fittings to 20 ft-lb (25 N•m).

d. Install fuel blocks.

(1) Position fuel blocks (33) with bolt holes aligned.

(2) Install machine bolts (34) and lockwashers (35). Tighten to 30 ft-lb (40 N•m).

(3) Install fuel fittings (14 and 42).

(4) Install nonmetallic hoses (12, 13, 44 and 45).

(5) Install pipe to tube adapter (32).

(6) Install pipe plug (24) in elbow (36).

(7) Install elbow (36).

(8) Install pipe to tube elbow (25) in pipe to hose elbow (36).

(9) Install nonmetallic hose (26) on pipe to tube elbow (25).

(10) Install nonmetallic hose (31) on pipe to tube adapter (32).

(11) Install pipe to tube adapter (27) into inlet port of fuel pump.

(12) Connect free end of nonmetallic hose (26) to pipe to tube adapter (27).

(13) Install pipe to tube adapter (32) into outlet port of fuel pump.

(14) Connect free end of hose (31) to pipe to tube adapter (30).

(15) install pipe plug (28) in side port of pipe tee (29).

(16) Install pipe tee (29) in outlet port of fuel pump.

(17) Install tube coupling (11).

3-20. Replace/Repair Engine Support Group. (FIG. 3-12)

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine removed. Para 3-12.

Materials/Parts

Solvent, Item 15, Appendix C

REMOVAL

a. Remove hexagon head capscrews (2 and 13), hex nuts (10), and lockwashers (1 and 12).

b. Remove front engine support (11).

c. Remove hexagon head capscrews (4 and 7), lockwashers (5, 8) and flat washers (6, 9) from both sides of engine.

d. Remove rear engine supports (3).

REPAIR

a. Clean all engine oil and other residue from the components. If solvent is used, make sure all solvent is thoroughly removed.

b. Inspect the front and rear support (3 and 11) for cracks or enlarged mounting holes. Replace if required.

c. Inspect hexagon head capscrews for thread damage, head rounding, or other physical damage. Replace as required.

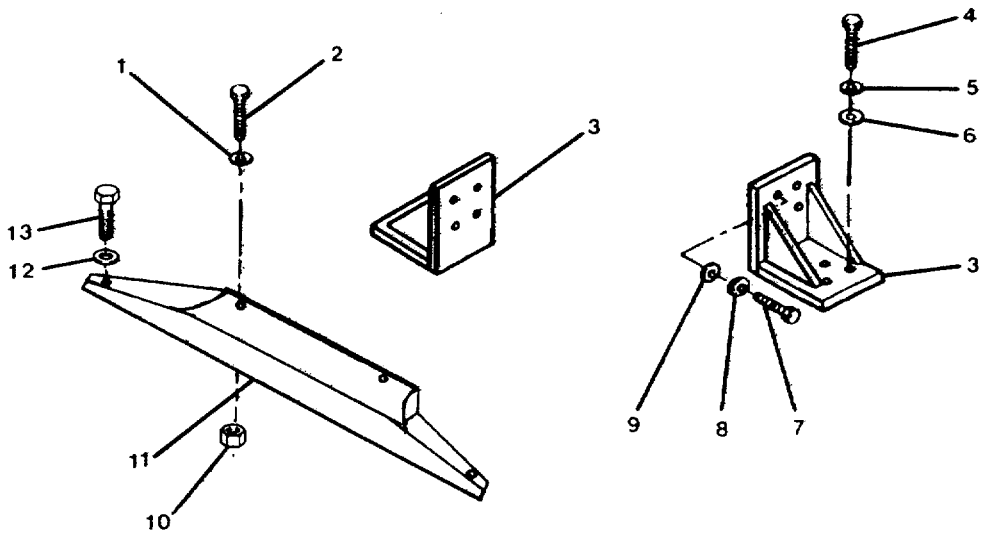


FIGURE 3-12. Engine Support Group.

REPLACEMENT

a. Position front engine mount (11) on engine frame with bolt holes aligned.

b. Loosely install hexagon head capscrews (13) with lockwashers (12).

c. Position rear engine supports (3) on engine with bolt holes aligned.

d. Loosely install hexagon head capscrews (7), with lockwashers (8) and flat washers (9).

e. Lower engine into position with front bolt holes aligned with bolt holes of front engine mount (11).

f. Loosely install hexagon head capscrews (2), lockwashers (1) and hex nuts (10).

g. Align bolt holes in rear engine supports (3) with bolt holes in engine frame.

h. Loosely install hexagon head capscrews (4), lockwashers (5) and flat washers (6).

i. After all hexagon head capscrews are installed, tighten to 270 ft-lb (365 Nm).

3-21. Replace Pulley Shield and Front Gear Housing Group.

This task covers:

a. Removal, b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Engine lifting fixture P/N 3375109
Lifting sling P/N 3375958
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. TM 55-1905-223-10.

Materials/Parts

Gasket P/N 3016792, 3007402, 3007404, 206407
Preformed packing P/N 145600, 70861
Lubriplate, Item 16, Appendix C
Lube oil, Item 20, Appendix C

REMOVAL

WARNING

Due to the weight and size of the cover and gear housing, care must be taken during removal to avoid personal injury or equipment damage.

a. Remove damper screen guard (37, FIG. 3-13).

(1) Remove four hexagon head capscrews (35) and lockwashers (36).

(2) Separate damper screen guard (37) from damper guard (38).

b. Remove damper guard (29).

(1) Remove two hexagon head capscrews (26), lockwashers (27) and flat washers (28), located on backside of gear housing (15).

(2) Remove two hexagon head capscrews (30), lockwashers (31) and flat washers (32).

(3) Remove damper guard (29).

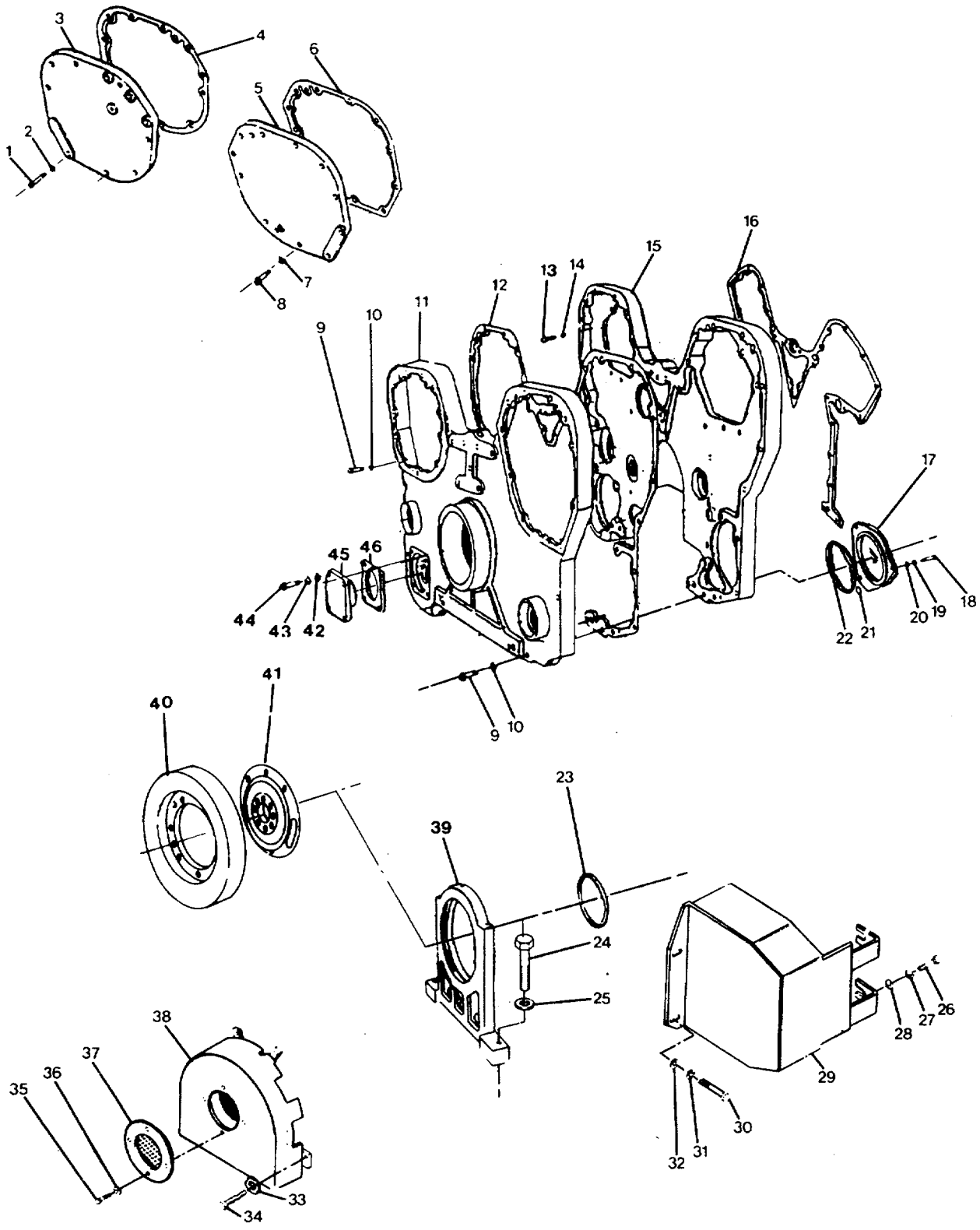


FIGURE 3-13. Pulley Shields and Front Gear Housing Group.

c. Remove damper guard (38).

(1) Remove eight hexagon head capscrews (34) and lockwashers (33).

(2) Remove damper guard (38).

d. Remove engine vibration damper (40) (para. 4-12).

e. Remove crankshaft adapter (41) (para. 4-12).

f. Remove engine mount bracket (39).

(1) Remove two hexagon head capscrews (24) and lockwashers (25).

(2) Pull engine mount bracket (39) from engine.

(3) Remove and discard gasket (23).

g. Remove access covers (3 and 5)

(1) Remove hexagon head capscrews (1) and lockwashers (2) from access cover (3).

(2) Remove hexagon head capscrews (7) and lockwashers (8) from access cover (5).

(3) Remove access covers (3 and 5). Remove and discard gaskets (4 and 6).

h. Remove access cover (45).

(1) Remove four hexagon head capscrews (44), lockwashers (43), and flat washers (42).

(2) Remove access cover (45) and gasket (46). Discard gasket.

i. Remove access cover (11).

WARNING

The access cover is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the access cover.

(1) Remove 24 hexagon head capscrews (9) and lockwashers (10).

(2) Remove access cover (11) and gasket (12). Discard gasket.

j. Remove camshaft and gear group (para. 3-24).

k. Remove front gear housing (15).

WARNING

The front gear housing is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the front gear housing.

(1) Remove 15 hexagon head capscrews (13) and lockwashers (14).

(2) Remove front gear housing (15) and gasket (16). Discard gasket.

1. Remove access plate (17).

(1) Remove three hexagon head capscrews (18), lockwashers (19) and flat washers (20).

(2) Remove access cover (17) and preformed packings (21 and 22). Discard preformed packing.

REPLACEMENT

a. Replace access plate (17, FIG. 3-13).

(1) Position small preformed packing (21) in counterbore located around oil bore in backside of font gear housing (15). Use Lubriplate to hold packing in position.

(2) Install large preformed packing (22) in groove of access cover (17). Lubricate packing with clean engine lube oil.

(3) Position access cover (17) on front gear housing (15) with bolt holes aligned.

(4) Install short hexagon head capscrews (18) with lockwashers (19) and flat washers (20) in bolt hole located farthest from engine block.

(5) Install hexagon head capscrews (18)with lockwashers (19) and washers (20).

(6) Torque capscrews (18) to 40 ft-lb (54 N•m).

b. Replace front gear housing (15).

WARNING

The front gear housing is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the front gear housing.

(1) Position gasket (16) on front gear housing (15) with bolt holes aligned.

(2) Position front gear housing (15) on engine with bolt holes aligned.

(3) Install fifteen lockwashers (14) and hexagon head capscrews (13).

(4) Tighten capscrews (13) to 45 ft-lb (60 N•m) using the sequence shown in FIG. 3-14.

c. Install camshaft and gear group (para. 3-24).

d. Replace access cover (11, FIG. 3-13).

WARNING

The cover access is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the access cover.

(1) Position gasket (12) on access cover (11) with bolt holes aligned.

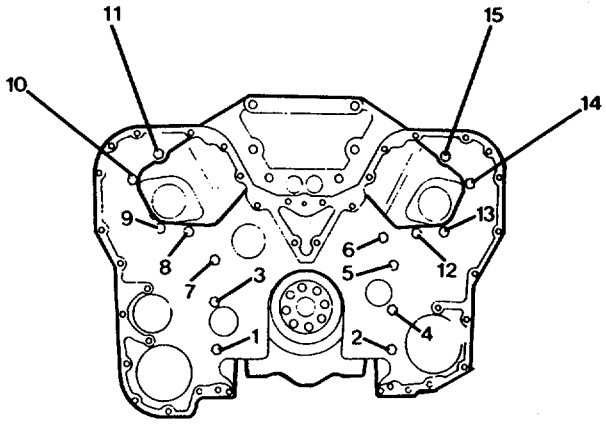


FIGURE 3-14. Front Gear Cover Torquing Sequence.

(2) Position access cover (11) on front gear housing (15) with bolt holes aligned. Use a mallet to tap the cover over the dowel pins until the cover is touching the housing (15).

(3) Install 24 lockwashers (10) and hexagon head capscrews (9). Tighten to 40 ft-lb (54 N•m).

e. Replace access cover (45).

(1) Position gasket (46) on access cover (45) with bolt holes aligned.

(2) Position access cover (45) on access cover (11) with bolt holes aligned.

(3) Install four flat washers (42), lockwashers (43), and hexagon head capscrews (44). Tighten to 40 ft-lb (54 N•m).

f. Replace access covers (3 and 5).

(1) Position gasket (6) on access cover (11).

(2) Position access cover (5) on access cover (11) with bolt holes aligned.

(3) Position gasket (4) on access cover (11) with bolt holes aligned.

(4) Position access cover (3) on access cover (11) with bolt holes aligned.

(5) Install lockwashers (2 and 7) and hexagon head capscrews (1 and 8) in each access cover (3 and 5). Tighten hexagon head capscrews to 45 ft-lb (60 N•m).

g. Replace engine mount bracket (39).

(1) Install gasket (23) in engine mounting bracket (39). Lubricate mount bore and trunnion sleeve with grease.

(2) Install engine mount bracket (39) on access cover (11).

(3) Install two lockwashers (25) and hexagon head capscrews (24). Tighten to 270 ft-lb (365 N•m).

h. Replace crankshaft adapter (41) (para. 4-12).

i. Replace engine vibration damper (40) (para. 4-12).

j. Replace damper guard (38).

(1) Position damper guard (38) against access cover (11) with bolt holes aligned.

(2) Install eight lockwashers (33) and hexagon head capscrews (34) and tighten.

k. Replace damper guard (29).

(1) Position dumper guard (29) against damper guard (38) with mounting tabs behind front gear housing (15).'

(2) Install two flat washers (32), lockwashers (31), and hexagonhead capscrews (30).

(3) Install two flat washers (28), lockwashers (27), and hexagon head capscrews (26).

(4) Tighten hexagon head capscrews (26 and 30) until tight.

1. Replace damper guard (38).

(1) Position damper guard screen (37) on damper guard (38).

(2) Install four lockwashers (36) and hexagon head capscrews (35). Tighten hexagon head capscrews until tight.

3-22. Repair Oil Pan and Adapter Group. (FIG. 3-15)

This task covers: a. Removal, b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's
rail and marine diesel engine,
5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Engine shutdown. TM 55-1905-223-10.

Materials/Parts

Gasket P/N 3043213
Nonmetallic hose assembly
P/N AS04024SS, AS10009SS
Liquid level float switch
P/N 3057439
Oil pan gasket P/N 3043211
Wiping rags, Item 4, Appendix C

DISASSEMBLY

WARNING

Wipe up all spills immediately to prevent the possibility of personnel slipping and falling into surrounding equipment. The equipment area is very congested and any slip could cause serious injury or even death.

a. Disassemble oil pan (19).

(1) Remove pipe plugs (28 and 29).

(2) Remove machine thread plug (16), screw thread insert (17), and ring spacer (18).

(3) Remove 22 machine bolts (8), lockwashers (7), and flat washers (6).

(4) Remove oil pan (19), cover (4), and gasket (3). Discard gasket.

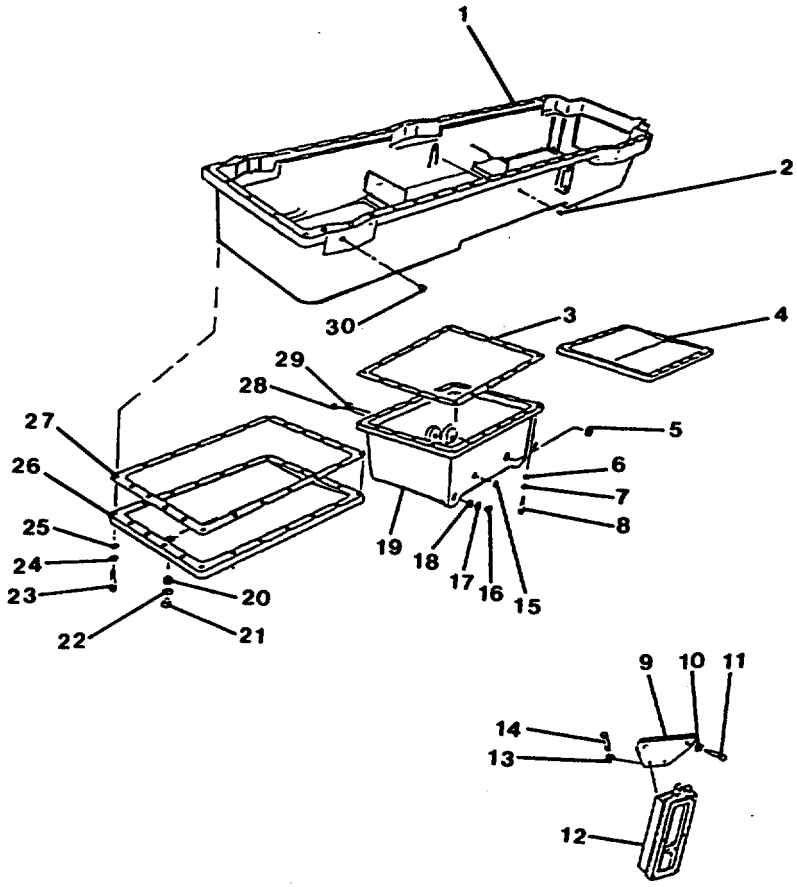


FIGURE 3-15. Oil Pan and Adapter Group.

b. Disassemble oil pan adapter (1).

(1) Remove machine bolts (14) and lockwashers (13) retaining the liquid level float switch (12) to the switch bracket (9). Remove the switch (12).

(2) Remove two hexagon head capscrews (11) and lockwashers (10) retaining bracket (9). Remove bracket.

(3) Remove pipe plugs (2 and 30) and oil drain plug (21), insert (20), andgasket (22).

(4) Remove machine bolts (23), lockwashers (24), and flat washers (25) retaining the cover (26). Remove the cover (26), and gasket (27), from the oil pan adapter (1).

REPAIR

a. Using a scraper, remove all gasket material on the gasket surfaces of the covers (4 and 26), oil pan (19), and adapter (1).

b. Steam clean the oil pan (19) and adapter (1). Clean up other components thoroughly.

WARNING

High pressure compressed air tanks, piping systems, and air operated devices possess potential for serious injury to eyes and exposed areas of skin due to escaping air pressure.

c. Use compressed air to completely remove all water, and solvent if used.

d. Inspect the cover (4 and 26), oil pan (19), and adapter (1) for cracks or warping. Replace as required.

e. Inspect all threaded components for thread wear or damage, or rounded heads. Replace as required.

f. Inspect all gaskets for tears, warping, or other physical damage. Replace as required.

g. Check the magnets on the drain plugs and make sure they are thoroughly clean. Replace if magnetic force appears weak.

ASSEMBLY

a. Assemble oil pan adapter (1).'

CAUTION

Gaskets enlarge when in contact with engine oil. Do not use gasket shellac or cement to install the gaskets or a leak will result.

(1) Install gaskets (3 and 27) on the oil pan adapter (1).

(2) Position covers (4 and 26) on oil pan adapter (1) with bolt holes aligned.

(3) Install machine bolts (23) with lockwashers (24) and flat washers (25). Tighten bolts to 35 ft-lb (45 N•m).

(4) Install pipe plugs (2 and 30) in adapter (1).

(5) Install oil drain plug (21) with insert (20) and gasket (22).

(6) Position switch bracket (9) on adapter (1) with bolt holes aligned.

(7) Install hexagon head capscrews (11) with lockwashers (10). Secure until snug.

(8) Position liquid level float switch (12) on switch bracket (9), with bolt holes aligned.

(9) Install machine bolts (14) with lockwashers (13). Tighten machine bolts.

b. Assemble oil pan (19).

(1) Position oil pan (19) on oil pan adapter (1) with bolt holes aligned.

(2) Install machine bolts (8), lockwashers (7), and washers (6). Tighten to 35 ft-lb (45 N•m).

(3) Install screw thread insert (17) into oil pan drain port. Tighten to 100 ft-lb (135 N•m).

(4) Install machine thread plug (16), with ring spacer (18), into screw thread insert (17). Tighten to 100 ft-lb (135 N•m).

(5) Install pipe plugs (28 and 29) in oil pan (19). Tighten to 100 ft-lb (135 N•m).

3-23. Replace/Repair Lubricating Oil Pump Group. (FIG. 3-16)

This task covers:
a. Removal b. Disassembly c. Repair
d. Assembly e. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's
rail and marine diesel engine,
5180-00-629-9783
Torque wrench kit P/N 3377216
Hydraulic press P/N 2009-13
Mandrel P/N ST-598
Valve spring compression tester
P/N 3375182
Dial indicator,
P/N 5210-00-277-8840
Machinist measuring tool set
5280-00-278-9919

Equipment Condition

Engine shutdown and cooled to 120°F
(500C). TM 55-11905-223-10.
Oil pan and adapter group removed,
para. 2-36.

Materials/Parts

Engine lube oil, Item 2, Appendix C
Engine oil pump assembly P/N 3038725
Oil connection gasket P/N 3000632
Gasket adhesive, Item 8, Appendix C
Packing assembly P/N 3028392, 3031544
Compression helical spring P/N 3026926
Plunger P/N 3026927
Solvent, Item 15, Appendix C
Crocus cloth, Item 11, Appendix C

REMOVAL

a. Remove suction tube (46).

(1) Remove loop clamps (45).

(2) Bend tabs of nut and bolt lockplates (43) away from heads of hexagon head capscrews (44).

(3) Remove hexagon head capscrews (44) and nut and bolt lockplates (43).

(4) Remove hexagon head capscrews (47) and nut and bolt lockplates (48).

(5) Remove brackets (40, 49, and 50).

(6) Pull suction tube (46) and packing assembly (42) from oil pump.

b. Remove transfer tube (41).

(1) Bend tabs of nut and bolt lockplates (38) away from heads of hexagon head capscrews (39).

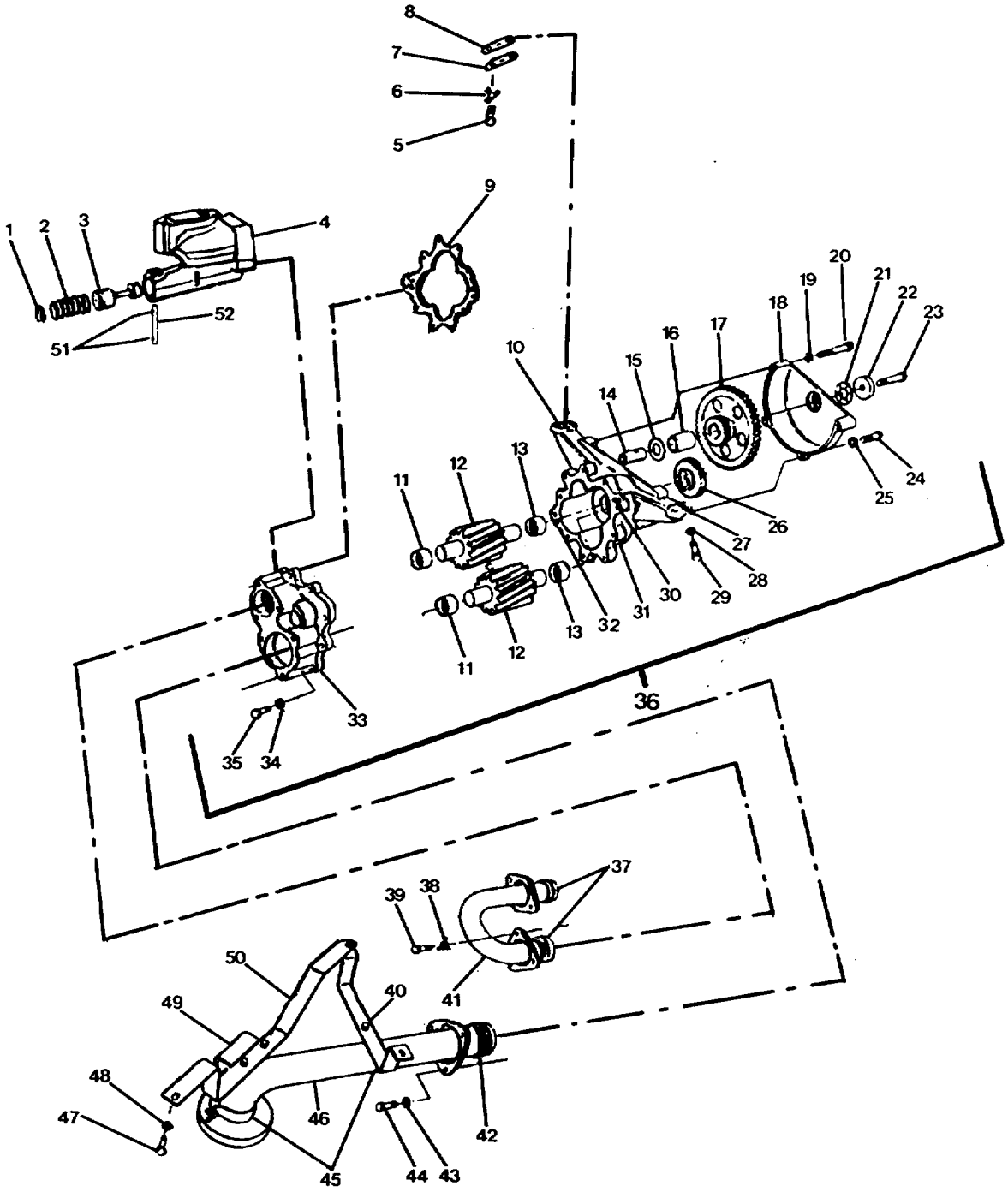


FIGURE 3-16. Lubricating Oil Pump Group.

(2) Remove hexagon head capscrews (39) and nut and bolt lockplates (38) from each mounting flange of transfer tube (41).

(3) Remove transfer tube (41) and packing assemblies (37).

c. Remove oil pressure relief valve (4) and gasket (9).

(1) Remove relief valve retaining capscrews.

(2) Remove relief valve (4).

d. Remove oil pump (36).

WARNING

The oil pump is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the oil pump.

NOTE

Measure oil pump to crankshaft gear lash before removing pump. Acceptable backlash is between 0.0003 in (0.08 mm) and 0.012 in (0.30 mm). If backlash is less than specifications, remove the pump and install shims of equal thickness between each of the mounting legs and the cylinder block. Shims are available in 0.005 in. (0.13 mm) (P/N 3026312) and 0.0010 in. (0.25 mm) (P/N 3026313). If the backlash is greater than specifications, remove any shims and check again. If no shims were used, the pump drive gear or the rear crankcase gear is worn and must be replaced.

(1) Bend nut and bolt locking plates (6 and 28) away from heads of oil pump mounting hexagon head capscrews (5 and 29).

(2) Remove hexagon head capscrews (5 and 29), nut and bolt locking plates (6 and 28) and shims (7 and 8).

(3) Remove oil pump (36).

DISASSEMBLY

a. Disassemble safety relief valve (4).

WARNING

Internal parts of the safety relief valve are spring loaded. Exercise caution during disassembly to avoid personal injury.

(1) Use a small hammer and a drift. Remove straight headed pin rollers (51) from retaining pin (52).

WARNING

Parts are under spring tension. When the retaining pin is removed, the spring can move with enough force to cause personal injury.

(2) Position safety relief valve (4) in vise to control tension of compression spring (2). Push on recessed washer (1) until it does not touch the retaining pin (52).

(3) Using hammer and drift pin, drive retaining pin (52) out of safety relief valve (4).

(4) Slowly open vise until all tension of compression spring (2) is relieved.

(5) Remove recessed washer (1), compression spring (2), and plunger (3) from valve (4).

b. Perform pre-disassembly checks to oil pump (36).

(1) Flush interior and exterior of pump with solvent. Dry with compressed air.

(2) Rotate large (compound) gear (17). Acceptable clearance between large gear (17) and smaller gear (26) is between 0.008 in (0.20 mm) and 0.032 in (0.81 mm).

CAUTION

Do not use excessive force while turning gears in following steps or gear damage will result.

(3) Wedge piece of wood or hammer handle between gears (17 and 26) of pump to prevent movement.

(4) Gently turn gear (26) by hand to check backlash. Acceptable backlash is between 0.0006 inch (0.15 mm) and 0.0010 inch (0.25 mm).

(5) Remove wood wedge from internal gears.

(6) Measure oil pump idler shaft (14) end clearance. Acceptable clearance is 0.0045 inch (0.114 mm) to 0.0085 inch (0.216 mm).

c. Disassemble oil pump.

CAUTION

Oil pump is heavy. To prevent personal injury or equipment damage obtain assistance when lifting or moving oil pump.

(1) Remove machine bolts (20 and 24) and lockwashers (19 and 25).

NOTE

The clearance between the bore in the cover and the compound gear is small. There will be some resistance until the retainer moves from the bore.

(2) Pull access cover (18) straight away from oil pump body (31).

(3) Remove hexagon head capscrew (23), shaft retainer (22) and thrust bearing (21) from center of large gear (17).

(4) Pull large gear (17) and thrust bearing (15) from idler shaft (14).

NOTE

If idler shaft does not lift from bore in pump body and shaft is within specifications, it is not necessary to remove idler shaft.

(5) Remove hexagon head capscrews (35) and lockwashers (34) from oil pump cover (33).

(6) Separate pump cover (33) from pump body (31).

(7) Remove gear and shaft (12) and bushing (11 and 13) from pump body (31).

(8) Using hydraulic press with a mandrel that is smaller than the bore in the drive gear (26), press gear and shaft (12) out of drive gear (26) and pump body (31).

REPAIR

a. Use solvent to clean all parts. Inspect all parts for evidence of wear or other damage, and make sure the housing and cover oil passages are free of obstructions.

b. Check the body (31) and covers (18 and 33) for scratch or abrasion damage. If the marks on either part may be felt with a finger nail, replace the part.

c. Measure the inside diameter of the bushings (11 and 13). The minimum is:1.5025 inch (38.164 mm), and the maximum is: 1.5050 inch (38.227 mm). If the bushings fail to meet the specifications, replace the body or cover.

d. Measure the inner diameter of the idler shaft (14) bore in the body (31). The minimum is: 0.999 inch (25.37 mm), and the maximum is: 1.001 inch (25.43 mm). If the bore fails to meet the specifications the body must be replaced.

e. Measure the inner diameter of the large (compound) gear bushing (16). The minimum is: 1.0005 inch (25.413 mm), and the maximum is: 1.0025 inch (25.464 mm). If the bushing fails to meet specifications, the large gear must be replaced.

f. Check the gear teeth on the large gear (17) for wear or other evidence of physical damage. Replace gear if required.

g. Measure the outer diameter of the idler shaft (14). The minimum is: 0.9985 inch (25.362 mm), and the maximum is: 0.9990 inch (25.375 mm). Replace the shaft if it fails to meet the specifications.

NOTE

An outer diameter of 0.9980 inch (25.349 mm) is acceptable in the portion of the shaft that fits in the bushing of the compound (16).

h. Measure the thickness of the thrust bearings (15 and 21). The minimum is: 0.110 inch (2.79 mm), and the maximum is: 0.113 inch (2.87 mm). Replace if not meeting specifications.

i. Check the thrust bearings (15 and 21) for wear or other physical damage. Replace as required.

j. Measure the drive gear (26) bore inner diameter. The minimum is: 1.4973 inch (38.031 mm), and the maximum is: 1.4983 inch (38.057 mm). Replace gear if it fails to meet specifications.

k. Measure the pump shaft (12) outer diameter. The minimum is: 1.4993 inch (38.082 mm), and the maximum is: 1.5000 inch (38.100 mm). Replace shaft if it fails to meet specifications.

1. Measure the pump cover (33) bore inner diameter. The minimum is: 2.000 inch (50.80 mm), and the maximum is: 2.002 inch (50.85 mm). Replace cover if it fails to meet specifications.

m. Measure the shaft retainer (22) outer diameter. The minimum is: 1.998 inch (50.75 mm), and the maximum is: 2.000 inch (50.80 mm). Replace retainer if it fails to meet specifications.

n. Inspect relief valve components.

(1) Inspect bore of relief valve (4) and plunger (3) for scoring and damage. If damage cannot be removed using fine grit crocus cloth, replace part.

(2) Check spring (2) length and tension. Replace spring (2) if it does not meet specifications. Table 3-4 .

(3) Check washer (1) for wear. If worn, replace.

Table 3-4. Safety Relief Valve Spring

		inch	mm
Free length	MIN	3.63	92.2
	MAX	3.73	94.7
Working height:		1.94	49.3
Load:	MIN	88 lbf	391N
	MAX	104 lbf	463N

If the part is not within specifications, it must be replaced.

o. Repair consists of replacement of defective parts.

ASSEMBLY

CAUTION

The raised portion of the gear on the drive gear and shaft must be placed nearest the body of the pump or the pump will fail.

NOTE

Coat all components with clean engine lube oil prior to replacement.

a. Install the gear and shaft (12) bushing (11 and 13) to the body (31).

NOTE

If the shaft was removed from the gear, the gear must be pressed on the shaft with a hydraulic press.

b. Install the pump gear and shaft (12) to the body (31). Ensure the shaft will turn.

c. Lubricate bushings (11) in front cover (33). Install front cover (33) on dowel pins (30 and 32) in body (31). If necessary use hammer with a soft nose to push cover on dowel pins until cover touches body.

CAUTION

Capscrews (35) are SAE grade 8. If any capscrew must be replaced, use SAE grade 8 only.

d. Install lockwashers (34) and hex head capscrews (35) to oil pump cover (33). Tighten to 70 ft-lb (95 N·m).

e. Check the pump gear shaft (12) end clearances with a dial indicator. The minimum is: 0.0045 inch (0.114 mm), and the maximum is: 0.0085 inch (0.216 mm). If specifications are not met, check for dirt or debris in the gears.

CAUTION

The idler shaft must be installed so that the oil hole in the shaft is farthest from the pump body to permit lubrication of the large (compound) gear bushing.

f. Install idler shaft (14) in housing (31).

CAUTION

The side of the thrust bearings with the oil grooves must touch the large (compound) gear for proper lubrication.

g. Install thrust bearing (15) and large (compound) gear (17) on to shaft (14).

CAUTION

The flat side of the retainer must be nearest the rear thrust bearing for proper operation.

h. Install access cover (18), thrust bearing (21), and retainer (22).

CAUTION

The capscrew (23) is a special fatigue related capscrew. Install the proper capscrew or the pump will fail.

i. Install capscrew (23). Tighten to 125 ft-lb (170 N·m).

j. Measure the large (compound) gear (17) to drive gear (26) backlash by holding one gear firm and moving the other gear. The minimum is: 0.006 inch (0.15 mm), and the maximum is: 0.010 inch (0.25 mm). If backlash is not to specifications one or both of the gears must be replaced.

k. Measure the large (compound) gear end (17) clearance. The minimum is: 0.008 inch (0.20 mm). The maximum is 0.032 inch (0.81 mm). If clearance is not within specifications, check for dirt or debris in the gears.

CAUTION

Do not use a hammer to push the access cover (18) over the retainer (22). Damage to parts will result.

NOTE

The clearance between the access cover (18) and the gear retainer (22) is small. Ensure the cover and retainer are aligned properly so that the cover will touch the body (31).

l. Install lockwashers (19 and 25) and machine bolts (20 and 24). Tighten machine bolts to 35 ft-lb (45 Nm).

m. While turning compound gear (17), lubricate all gears and thrust bearings with clean engine lube oil. Cover pump until installation to prevent the entry of dirt.

n. Assemble safety relief valve (4).

(1) Lubricate plunger (3) and bore of valve (4) with clean engine lube oil. Insert plunger in bore.

(2) Insert compression spring (2) in bore.

CAUTION

Parts are under spring pressure. The spring can move with enough force to cause personal injury. Use a tool that will control the parts firmly.

(3) Position washer (1) on end of spring (2).

(4) Push the parts into bore until washer (1) is beyond retaining pin (52) holes.

(5) Hold parts in position and install retaining pin (52). Use a small hammer and a drift to move the pin through the hole in the body.

6) Use a small hammer. Install pin rollers (51) in retaining pin (52).

REPLACEMENT

NOTE

The lubricating oil pump is dowel fit to the cylinder block on both sides.

a. Install oil pump (36).

(1) Position shims (7 and 8) in original location on engine block.

CAUTION

The oil pump is heavy. To avoid personal injury or equipment damage, use a hoist or get assistance when lifting the oil pump.

(2) Position oil pump (36) on engine with gear (17) meshed with crankshaft gear and bolt holes aligned. Ensure dowels (10 and 27) are in place.

(3) Install capscrews (5 and 29) with nut and bolt lockplates (6 and 28). Tighten capscrews (5 and 29) to 70 ft-lb (90 N·m). Bend lockplate over the heads of the capscrews and feet of the pump.

b. Install oil pressure relief valve (4).

(1) Position relief valve (4) and gasket (9) on engine block with bolt holes aligned.

(2) Install relief valve retaining capscrews. Tighten to 45 ft-lb (60 N·m).

c. Install transfer tube (41).

(1) Lubricate packing assemblies (37) with clean engine lube oil.

(2) Position packing (37) on end of transfer tube (41).

(3) Position transfer tube (41) with one end in port of relief valve (4) and one end in port of oil pump (36).

(4) Install capscrews (39) with nut and bolt lockplates (38). Torque capscrews at oil pump to 45ft-lb (60 N·m) and capscrews at relief valve to 30 ft-lb (40 N·m). Bend lockplates over capscrew heads and connecting parts.

d. Install suction tube (46).

(1) Lubricate packing (42) with clean engine lube oil.

(2) Position packing (42) on end of suction tube (46).

(3) Insert suction tube (46) end with packing (42), into port of oil pump (36).

(4) Align bolt holes.

(5) Install capscrews (44) with nut and bolt lockplates (43). Rotate tube until screen is parallel to the bottom of the cylinder block. Tighten capscrews (44) to 45 ft-lb (60 N·m).

(6) Install loop clamps (45) and tighten to 30 ft-lb (40 N·m).

(7) Install brackets (40, 49, and 50), nut and bolt lockplates (48) and hexagon head capscrews (47).

(8) Tighten capscrews (47) to 30 ft-lb (40N·m). Bend lockplates (48).

e. Replace oil pan and adapter group, paragraph 2-36.

3-24. Replace/Repair Camshaft and Gear Group.

This task covers: a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's
rail and marine diesel engine,
5180-00-629-9783
Torque wrench kit P/N 3377216
Timing fixture P/N 3375522
Camshaft installation pilots
P/N 3376280
Dial indicator 5120-00-277-8840
Machinist measuring tool set
5280-00-228-9919

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Rocker covers and assemblies, pushrods and tubes removed, paras. 2-30 and 3-25.
Engine/reduction gear coupler removed TM 55-1905-223-24-2.
Rear engine cover, flywheel housing group removed, para. 3-26.
Front gear cover removed, para. 3-21.
Cam follower removed, para. 4-11.

Materials/Parts

Camshaft P/N 3006299
Rear camshaft cover plate gasket
P/N 3040722
High pressure lubricant, Item 19, Appendix C
Oil SAE 30W, Item 20, Appendix C
Lubriplate, Item 16, Appendix C
Cleaning solvent, Item 15, Appendix C

REMOVAL

a. Remove rear access cover (7, FIG. 3-17).

(1) Remove three hexagon head capscrews (6) and lockwashers (5) from each rear access cover (7).

(2) Remove access covers (7) and gaskets (8). Discard gaskets.

b. Remove idler gears (2).

CAUTION

Do not allow the gears or shaft to fall or the parts will be damaged.

(1) Remove capscrews, retainers, and thrust washer bearings (1).

(2) Remove idler gears (2).

(3) Remove inner thrust washers (4).

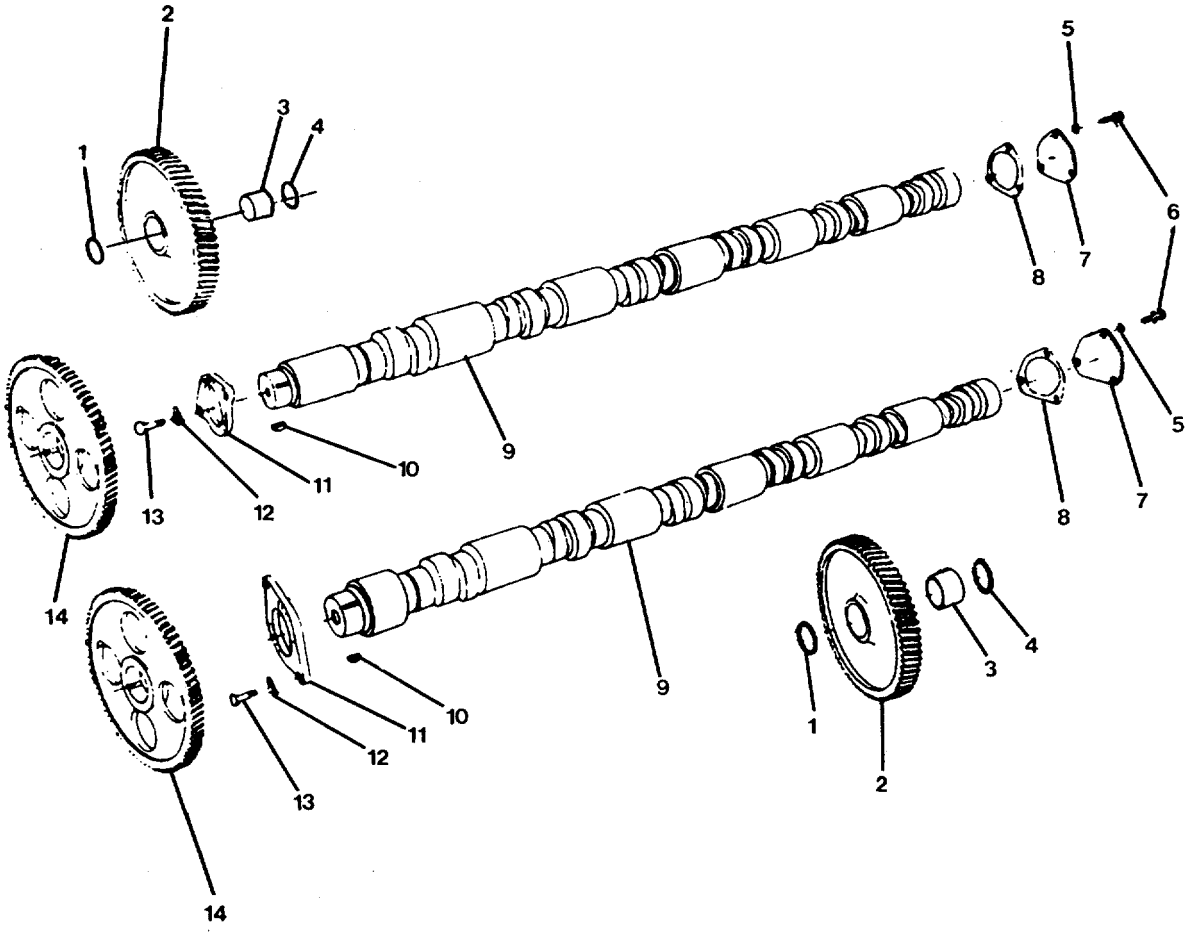


FIGURE 3-17. Camshaft Gear Group.

c. Remove camshaft (9).

NOTE

The camshafts are different for the right and left bank. Tag the parts for future assembly.

(1) Use a dial indictor to measure camshaft end clearance (FIG. 3-18).

(2) Use a hammer and a drift to bend the lockplates (12, FIG. 3-17) from the heads of the hexagon head capscrews (13).

(3) Remove hexagon head capscrews (13) and lockplates (12) from shaft retaining plate (11).

CAUTION

Two soldiers are required when removing the camshaft to prevent damage to the camshafts and bushings. Turn the camshaft gently clockwise and counterclockwise while pulling camshaft out.

(4) Rotate and slightly lift camshaft gear (14) while removing camshaft (9) from block.

CAUTION

Do not touch the machined surface with bare hands after the camshaft has been cleaned. This will cause rust to form.

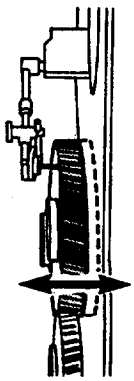


FIGURE 3-18. Camshaft End Clearance Measurement.

(1) Clean camshaft assembly with solvent.

NOTE

Marks on the lobes and journals that cannot be felt with fingernail are acceptable.

(2) Visually inspect camshaft (9) for scuffed, scored or cracked lobes. Discard camshaft if any of these conditions exist.

(3) Measure bushing journals' outside diameter. Replace camshaft if journals are not between 2.995 inch (76.07 mm) and 2.997 inch (76.12 mm).

(4) Visually inspect camshaft gear (14). If the gear is visibly chipped, cracked or worn, it must be replaced. Evacuate to intermediate general support maintenance.

(5) Use a feeler gauge to measure camshaft thrust clearance. If clearance is not between 0.006 inch (0.15 mm) and 0.013 inch (0.33 mm) the gear must be removed. Evacuate to intermediate general support maintenance.

REPAIR

Repair of camshaft and gear group is by replacement of defective parts.

REPLACEMENT

a. Replace camshaft (9, FIG. 3-17).

CAUTION

The camshafts are different for each bank. Ensure the correct camshaft is installed in the correct bank. If camshafts are not installed correctly, the engine will be seriously damaged.

(1) Install camshaft pilot to the rear of camshaft (9, FIG. 3-19).

(2) Lubricate the camshaft and bushings with lubriplate.

CAUTION

Two soldiers are required when installing camshafts to avoid possible damage to the camshafts and bushings. Do not damage the camshaft bushings or the bushing will fail.

(3) Install camshaft (9, FIG. 3-17) in the correct bank of the cylinder block. Using the pilot as a guide, rotate the camshaft clockwise and counterclockwise to assist in installation.

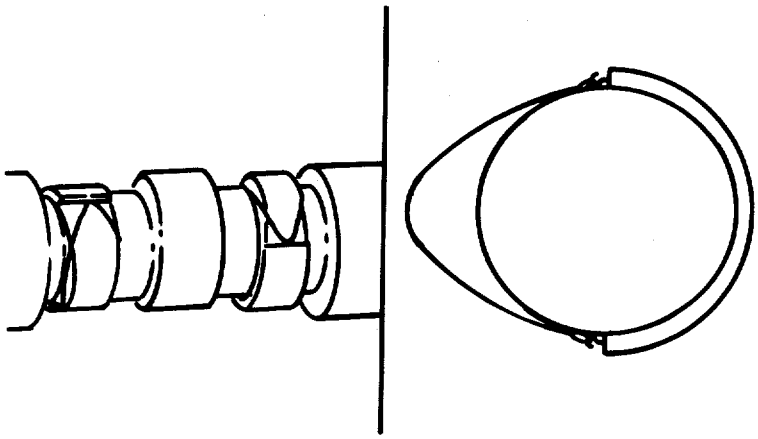


FIGURE 3-19. Camshaft Pilots.

(4) If necessary, rotate camshaft (9) until holes in gear (14) allow access to holes in retaining plate.

(5) Install lockplates (12) and hexagon head capscrews (13). Tighten capscrews (13) to 35 ft-lb (45 N·m). Bend lockplates (12).

(6) Remove camshaft pilot from the rear of camshaft (9). Install gasket (8) and camshaft rear cover (7). Install lockwashers (5) and hexagon head capscrews (6). Tighten to 30 ft-lb (40 Nm).

(7) Repeat steps (1) through (6) for remaining camshaft if required.

(8) Attach a dial indicator gauge to the housing and check the camshaft end clearance (FIG. 3-18). Verify end clearance is between 0.006 to 0.013 inch (0.15 to 0.33 mm) on both camshafts. If the end clearance is not within the limits, check for foreign material or a piece of gasket material between the shaft retaining plate (11, FIG. 3-17) and the block. If measurement is still out of tolerance, evacuate to intermediate general support and check shaft retaining plate thickness.

(9) Replace front and rear camshaft covers using new gaskets. Tighten capscrews alternately and evenly to 30 ft lb (40 N·m).

b. Replace idler gears (2, FIG. 3-17).

CAUTION

The grooves in the thrust washers must be toward the idler gears. Failure will result if the thrust washers are installed wrong.

(1) Lubricate thrust washers (4) and install on idler shaft.

CAUTION

The idler gears (2) have index marks that must be aligned with index marks on the crankshaft and camshaft gears. If the marks are not aligned the engine timing will not be correct and the engine will be damaged (FIG. 3-20).

(2) Lubricate bushings (3, FIG. 3-17) and idler shafts with Lubriplate.

(3) Install gears (2). Align the timing marks.

CAUTION

The grooves in the thrust washers (1) must be toward the idler gears. Failure will result if the thrust washers are installed wrong.

(4) Lubricate thrust washers (1) and install on idler shafts. Install retainer and capscrew on idler shaft. If capscrew has a flange head, tighten to 215 ft-lb (290 N·m). If capscrew does not have a flange head, tighten to 185 ft-lb (250 N·m).

c. Measure front gear train backlash.

(1) Position dial indicator on a gear as shown in FIG. 3-21.

NOTE

The adjacent (engaging) gear must not turn.

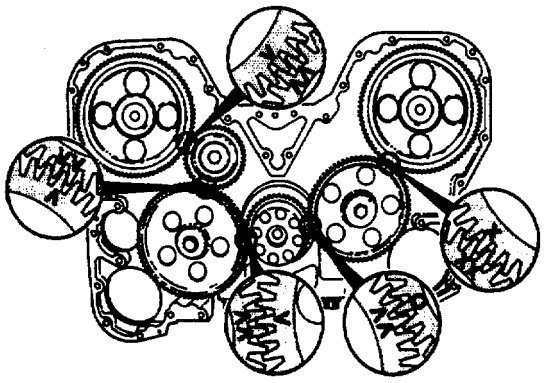


FIGURE 3-20. Idler Gear Timing Marks.

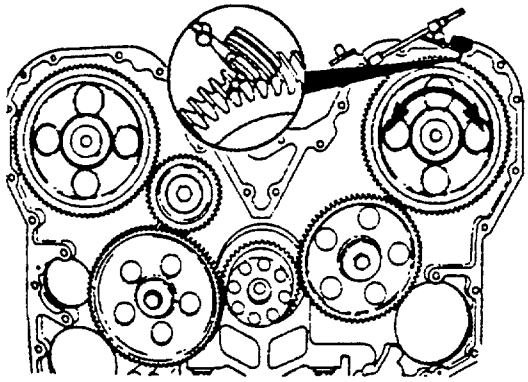


FIGURE 3-21. Front Gear Train Backlash Measurement.

(2) Rotate gear clockwise. Position indicator to "0".

(3) Rotate gear counterclockwise. Verify indicator reading is between 0.003 inch (0.07 mm) and 0.020 inch (0.51 mm).

NOTE

If backlash is not within specifications, be sure the adjacent (engaging) gear is not moving during the measurement.

(4) If reading is not within specification, the gear must be replaced.

(5) Repeat procedure for all gears except the crankshaft gear.

d. Restore the engine to operating condition and check for normal operation.

3-25. Replace/Repair Connecting Rod and Piston Group.

This task covers: a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools
Tool kit, general mechanic's
rail and marine diesel engine,
5180-00-629-9783
Torque wrench kit P/N 3377216
Connecting rod guide pins
P/N 3375098
Piston ring compressor P/N 3375342
Rod bolt checking fixture
P/N 3376846
Piston ring expander P/N ST-1269

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Handhole cover removed, para. 2-35.
Cylinder head removed, para. 2-34.

Materials/Parts

Connecting rod assembly
P/N 3043910
Piston P/N 3801436
Engine lube oil, Item 2, Appendix C

REMOVAL

a. Remove connecting rod and piston.

WARNING

To prevent injury, wear eye protection when using a wire brush. Ensure the wire brush is rated for the rpm being used if the brush is motor driven. Remove any broken wire bristles from the engine.

CAUTION

Do not use aluminum oxide cloth to remove the carbon ring. Remove any broken wire bristles from the engine. Small particles of abrasives or debris can cause damage to the engine.

(1) Using wire brush, remove the carbon ring from the top of the cylinder lining as necessary to allow the removal of the pistons.

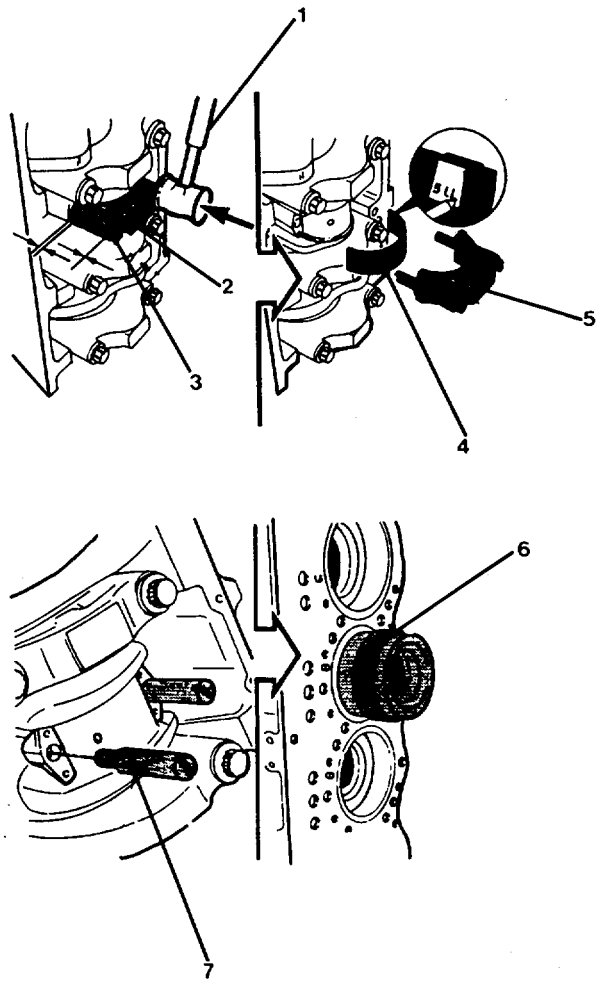


FIGURE 3-22. Connecting Rod and Piston Assembly Removal.

NOTE

The connecting rod journals in FIG. 3-22 are shown positioned at BDC. If the connecting rod is adjacent to a crankshaft counterweight, the rod journal must be at TDC to remove the rod.

(2) Loosen machine bolts (3, FIG. 3-22) until there is 1/4 inch (6 mm) clearance between the connecting rod (2) and the bolt heads.

NOTE

Identify and tag attaching hardware. Connecting rods must have the cylinder number marked on both the rod and the cap.

(3) Tap the machine bolts (3) with a mallet (1) until the connecting rod cap (5) slides from the dowel pins in the rod. Remove and tag connector bearing (4).

(4) Install connecting rod guide pins (7).

(5) Push the piston and connecting rod until the piston rings (6) are above the cylinder lining.

CAUTION

Put piston and rod assembly in a rack after removal to prevent damage.

NOTE

Care must be taken not to knock the upper bearing loose from the connecting rod while removing the assembly.

(6) Remove the connecting rod and piston assembly.

(7) Remove connecting rod guide pins (7) and upper rod bearings (4, FIG. 3-25).

b. Remove piston from connecting rod.

(1) Remove one retaining ring (1, FIG. 3-23).

WARNING

Wear protective gloves to prevent injury when handling hot parts.

CAUTION

Do not attempt to remove piston pin without applying heat. Damage to the piston will result.

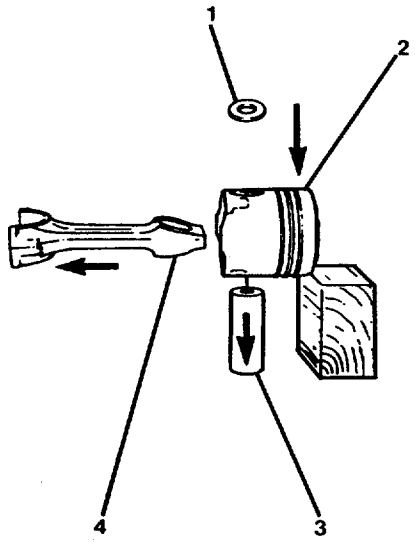


FIGURE 3-23. Removal of Piston from Connecting Rod.

(2) Place assembly in water heated to 180°F-212°F (82°C-100°C). Leave assembly in water for 3 to 5 minutes.

(3) Remove assembly from water. Turn piston (2) so remaining retaining ring (1) is positioned up.

NOTE

A brass drift and hammer can be used to remove a scuffed pin. Use caution to avoid damage to the connecting rod bushing.

(4) Tap the piston on a block of wood until the piston pin (3) slides out.

(5) Remove connecting rod (4) and retaining ring (1).

REPAIR

Repair of the connecting rod and piston group is by replacement of the piston and the connecting rod assembly.

REPLACEMENT

a. Install piston on connecting rod.

(1) Install one retaining ring (6, FIG. 3-25).

WARNING

Wear protective gloves to prevent injury when handling hot parts.

(2) Heat piston (2) in an oven at 200°F (93°C) for 15 minutes or in boiling water for 5 minutes.

(3) Lubricate connecting rod (3) bushing and piston pin (5) with clean engine lube oil.

(4) Install connecting rod (3) in piston (2).

CAUTION

Do not attempt to install piston pin without applying heat. Damage to the piston will result.

(5) Install piston pin (5). If force is required, check the temperature of the piston and check the pin for burrs.

CAUTION

Ensure both retaining rings are in the groove. A retaining ring not in the groove could fall out causing severe engine damage.

(6) Install other retaining ring (6).

(7) Place piston and rod assembly carefully aside to allow time to cool naturally. Do not attempt to reduce cooling time.

b. Replace connecting rod and piston.

(1) Clean connecting rod with a clean lint-free cloth.

CAUTION

The bearings in the connecting rod must have the same part number. If part numbers are different, the bearings can fail and cause severe engine damage. The old bearings must be installed in their original location if new bearings are not installed. Do not lubricate the back of the connector shell.

(2) Install bearings (4) in connecting rod (3). Align bearing oil hole with rod oil hole. Lubricate bearing with clean engine lube oil.

(3) Install connecting rod guide pins (5).

CAUTION

- The connecting rods and caps are not interchangeable. Failure will result if they are mixed.
- The bearings in the same rod and cap must have the same part number. If the part numbers are not the same, the bearings will fail and cause severe engine damage.

(4) Install bearing (4, FIG. 3-22) in connecting rod cap (5). Align bearing oil hole with cap oil hole. Lubricate bearing with clean engine lube oil.

(5) Lubricate the connecting rod machine bolt threads and beneath the bolt head with clean engine lube oil.

(6) Lubricate the entire cylinder liner with clean engine lube oil.

(7) Immerse the piston in lube oil until the rings are covered. Allow excess oil to drip from pistons.

CAUTION

Ring damage may result from improper use of the ring compressor. If a band-type compressor is used, be sure the inner band does not slip and bind the piston. The rings should pass into the liner smoothly. Ensure rings are staggered.

NOTE

The ring compressor has a tapered bore. The small end of the taper must be toward the piston skirt.

(8) Install piston ring compressor on piston.

CAUTION

The connecting rod must be installed so that the chamfer on the rod is toward the fillet radius on the crankshaft rod journal. If the rod is reversed, the crankshaft will be damaged (FIG. 3-24).

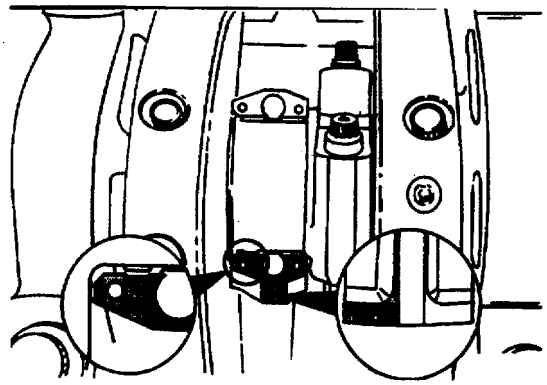


FIGURE 3-24. Crankshaft Rod Journal.

NOTE

- Check to be sure the number on the rod is the same as the number of the cylinder. Newer connecting rods have a painted number.
- The crankshaft rod journal must be at TDC for the piston and rod assembly being installed. The connecting rod will not move past the crankshaft counterweights during assembly.
- The cylinder numbers stamped on the pistons and connecting rods should be toward the camshafts or to the outside away from the "V" on both left and right banks after installation.

(9) Insert connecting rod and piston into cylinder liner. Use the handle of a wooden hammer to push the piston into the liner (FIG. 3-26).

(10) Push piston into liner until the connecting rod touches the crank shaft journal. Remove the connecting rod guide pins (5, FIG. 3-25).

CAUTION

- Do not rotate the crankshaft. The upper rod bearing can fall out and cause damage.
- The cylinder number on the rod and cap must be the same. If the numbers are different, the parts will fail and cause severe engine damage.
- The side of the cap with the chamfer must be toward the fillet radius of the crankshaft journal. The bearing tang on the rod and cap must be positioned together.

(11) Install connecting rod cap (5, FIG. 3-22) and machine bolts (3). Tighten the machine bolts (3) alternately and evenly to pull the cap over the pin dowels.

Table 3-5. Connecting Rod Bolt Tightening

Step		Torque Reading	
1.	Tighten to	80 ft-lb	(110 N·m)
2.	Advance to	160 ft-lb	(215 N·m)
3.	Advance to	240 ft-lb	(325 N·m)

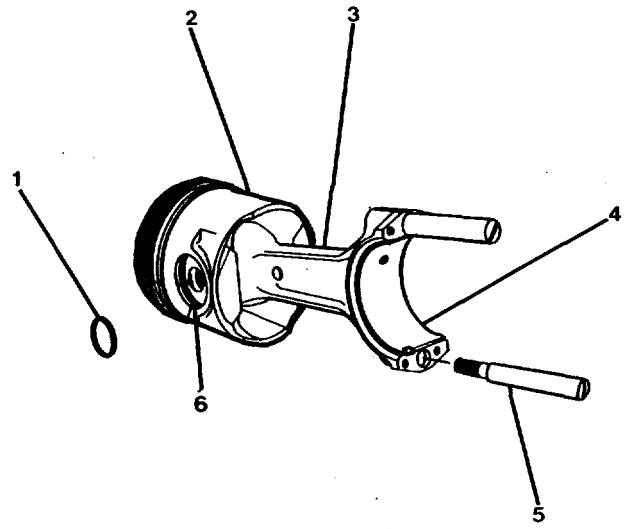


FIGURE 3-25. Piston and Connecting Rod Assembly.

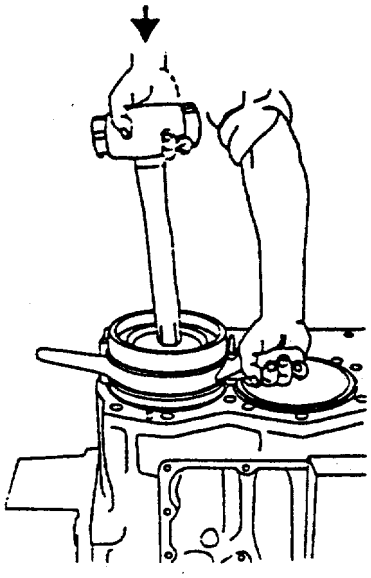


FIGURE 3-26. Piston and Connecting Rod Installation.

NOTE

After the piston and rod assemblies that share a crankshaft journal are installed and the caps are pulled to the rods, the crankshaft can be rotated. Rotating the crankshaft so that the installed rods are on the bottom will aid reaching the machine bolts. It is recommended that the four rods that are connected to the two crankshaft rod journals that have the same centerline be installed, then the crankshaft rotated to the bottom.

c. Measure connecting rod bolt stretch.

(1) Tighten connecting rod bolts (3, FIG. 3-22) using the procedure in Table 3-5. Apply torque to both bolts.

(2) Loosen both bolts (3).

(3) Position rod bolt checking fixture on rod bolt (FIG. 3-27). Ensure the fixture anvil is centered in hole of the rod bolt and the figure contacts the head of the bolt as shown in FIG. 3-27.

(4) Adjust the fixture indicator to the 0.050 inch mark. Ensure that there is a minimum of 0.030 travel remaining.

(5) Tighten indicator lock to maintain reading. Record reading as "First Bolt Zero."

CAUTION

Do not adjust indicator.

(6) Move fixture to second bolt. Record reading as "Second Bolt Zero." Remove fixture.

(7) Tighten both bolts using the procedure in Table 3-5 .

(8) Install fixture on first bolt. Record reading as "First Bolt Tight."

(9) Install fixture on second bolt. Record reading as "Second Bolt Tight." Remove fixture.

(10) Compute bolt stretch for each bolt by subtracting "Bolt Zero" reading from "Bolt Tight" reading. Ensure bolt stretch is between 0.0135 inch (0.343 mm) and 0.0185 inch (0.470 mm).

(11) If bolt stretch is greater than specification, replace bolt and repeat procedure.

(12) If bolt stretch is less than specification, perform the following:

(a) Loosen both bolts.

CAUTION

Tightening a bolt that was within specification to a greater torque value can result in bolt failure and engine damage.

(b) Tighten bolts using the procedure in Table 3-4, except that in Step 3 advance the bolt that was less than specification to 270 ft-lb (365 N•m).

(c) Repeat the "Bolt Tight" measurement and compute bolt stretch.

(d) If bolt stretch is still less than specified, the connecting rod and the bolt must be replaced.

(13) Check the connecting rod to crankshaft side clearance. The tightened connecting rods should be free tomove sideways on the crank shaft journal. Side clearance on a pair of connecting rods is 0.012 to 0.020 inch (0.30 to 0.51 mm) between rods or between the rods and the crankshaft (FIG. 3-28).

(14) Replace cylinder head, paragraph 2-34.

(15) Replace the handhole cover, paragraph 2-35.

(16) Check engine for normal operation.

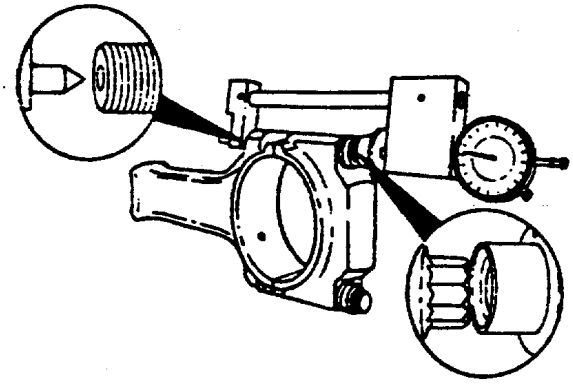


FIGURE 3-27. Rod Bolt Checking Fixture.

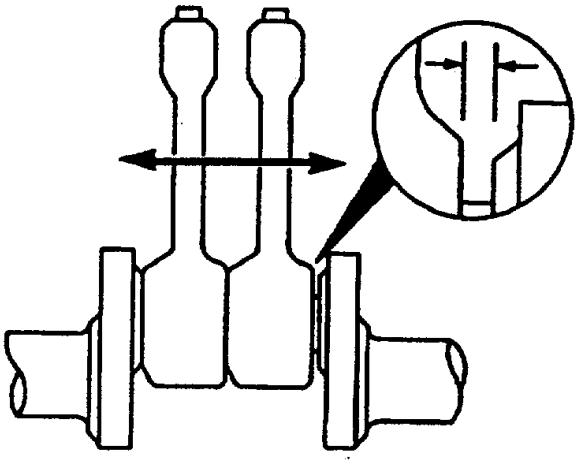


FIGURE 3-28. Connecting Rod Side Clearance Measurement.

3-26. Replace/Repair Flywheel Housing Group.

This task covers:

a. Removal, b. Repair c. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanic's
rail and marine diesel engine,
5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958
Dial Indicator 5210-00-277-8840

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Reduction gear uncoupled.
TM 55-1905-223-24-2.

Materials/Parts

SAE 140W lubricant, Item 27, Appendix C

REMOVAL

a. Remove barring mechanism assembly (10, FIG. 3-29).

(1) Remove three hexagon head capscrews (12) and lockwashers (11).

(2) Remove barring mechanism assembly (10).

b. Remove starter flange cover (13).

(1) Remove three machine bolts (15) and lockwashers (14).

(2) Remove starter flange cover (13).

c. Remove flywheel and ring gear assembly (7).

WARNING

The part is heavy. To avoid personal injury or equipment damage, use a lifting sling when lifting the part.

NOTE

The use of guide bolts will aid the removal procedure.

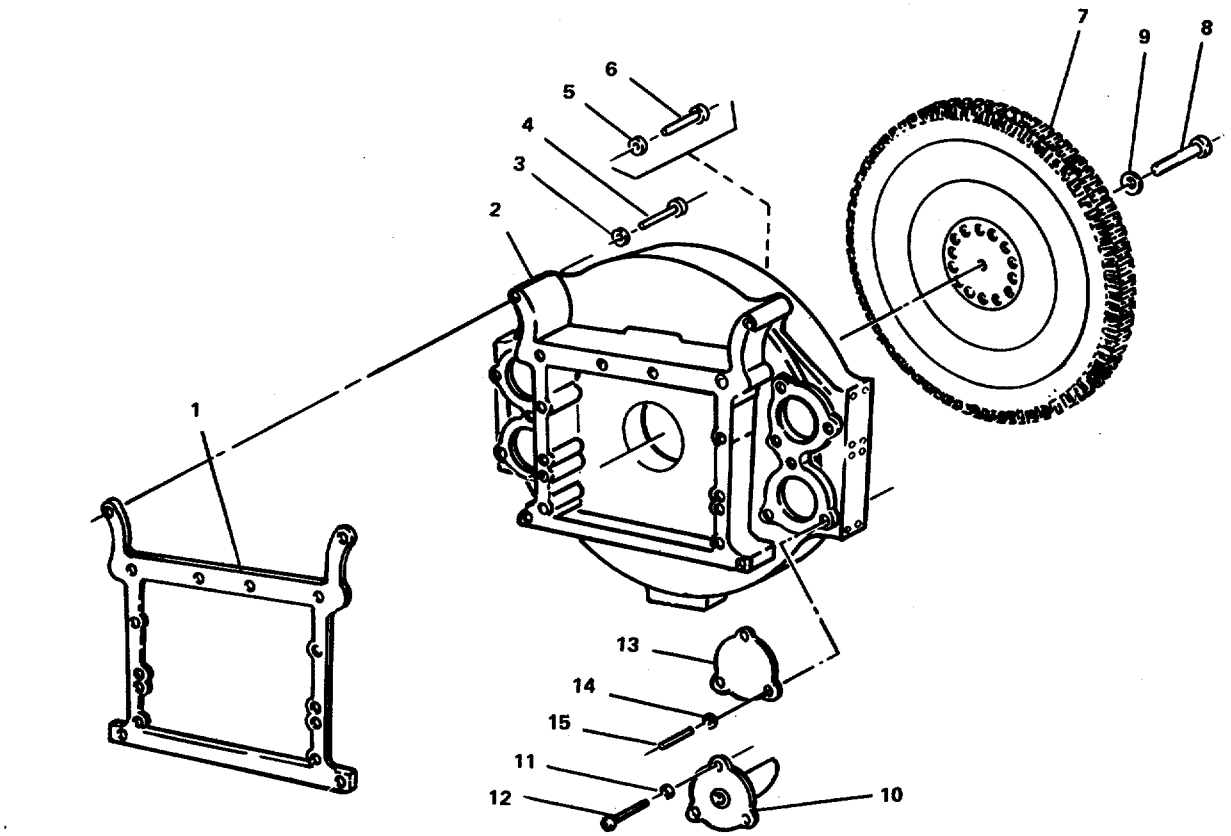


FIGURE 3-29. Flywheel Housing Group.

(1) Removal machine bolts (8) and washers (9).

(2) Remove flywheel and ring gear assembly (7).

d. Remove flywheel housing (2).

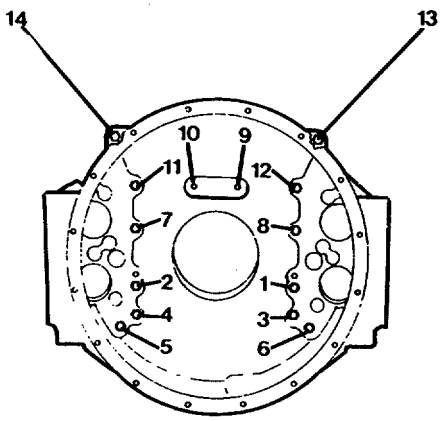


FIGURE 3-30. Flywheel Housing Bolt Tightening Sequence.

e. Housing Bore Check.

(1) Attach dial gauge attachment with a dial indicator to the crankshaft; position the indicator button on the clutch bore (FIG. 3-31).

NOTE

The indicator arm must be rigid.

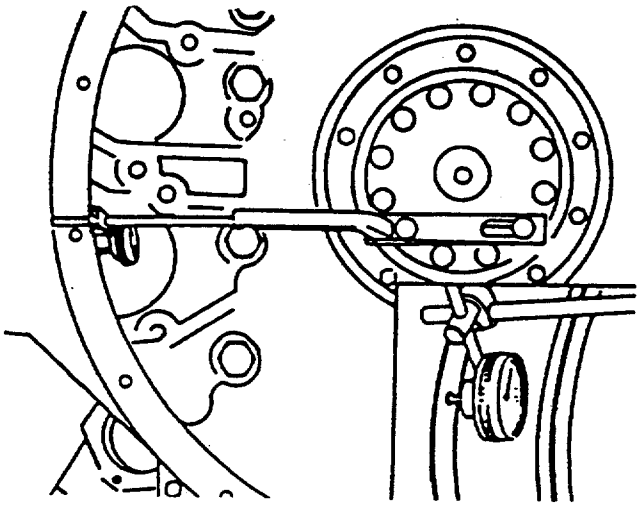


FIGURE 3-31. Flywheel Housing Bore Measurement.

(2) Draw chalk marks on the flywheel housing at 12, 3, 6, and 9 o'clock positions. Position indicator at 12 o'clock position and set dialto "0" (FIG. 3-32).

NOTE

If the alignment is not within specification, and the housing is round, the housing can be shifted. If the alignment is not within specification and the housing is not round, the housing must be replaced.

(3) Rotate crankshaft one complete revolution (360 degrees). Record total indicator run out (TIR). Determine if alignment is within the following specification:

NOTE

Specification depends on the diameter of the housing bore.

Housing Bore Diameter	Maximum TIR
31.00 to 31.91 inch (787.4 to 810.5 mm)	0.012 inch (0.30 mm)
25.50 to 25.51 inch (647.7 to 648.0 mm)	0.010 inch (0.25 mm)

CAUTION

The crankshaft end clearance must be pushed or pulled in the same direction each time it is measured.

(4) Position the indicator at the 12 o'clock position. Adjust the dial to "0" (FIG. 3-32a).

(5) Record readings at 3, 6 and 9 o'clock positions. Return to 12 o'clock position, ensure dial points to "0" (FIG. 3-32b).

(6) Compute TIR as shown in the example below. Verify TIR is within specification above. If not within specification, check for nicks, burrs, or foreign material between the housing and block. If none exist and the alignment is still out of specification, the block or housing is not machined correctly.

Example		Inch	mm
12 o'clock	0.00	0.00	
3 o'clock	+0.003	+0.08	
6 o'clock	-0.002	-0.05	
9 o'clock	+0.003	+0.08	
Equal TIR	0.005	0.13	

f. Using a lifting sling, install the flywheel and gear ring assembly (7, FIG. 3-29) over the guide studs previously installed, aligning the dowel in the crankshaft with the dowel hole in the flywheel (FIG. 3-33).

WARNING

The flywheel bolts must be SAE grade 8 (minimum) with rolled threads. The flywheel washers are special hardened. Do not substitute parts or a failure could result that would cause personal injury.

g. Lubricate machine bolt (8, FIG. 3-29) threads with clean engine lubricating oil. Lubricate hardened washer (9) faces with SAE 140W lubricant.

h. Replace ten of twelve machine bolts (8) and lockwashers (9); tighten by hand, one and one-half turns.

i. Remove the guide studs; install the remaining two bolts (8) and washers (7), and tighten one and one-half turns by hand.

j. Tighten all of the bolts in the sequence as shown in FIG. 3-34. First tighten to 110 ft-lb (150 N•m), then advance to 210 ft-lb (285 N•m), and then apply final torque of 380 ft-lb (515 N•m).

k. Place starter flange cover (13, FIG. 3-29) and retain with machine bolts (15) and lockwashers (14). Tighten to 45 ft-lb (60 N•m).

l. Position barring mechanism (10) to the left side flywheel housing lower mounting pad.

m. Install hexagon head capscrews (12) and lockwashers (11). Tighten to 135 ft-lb (185 N•m).

n. Replace the engine to reduction gear coupling (see TM 55-1905-223-24-2).

o. Start the engine and check for normal operation (TM 55-1905-223-10).

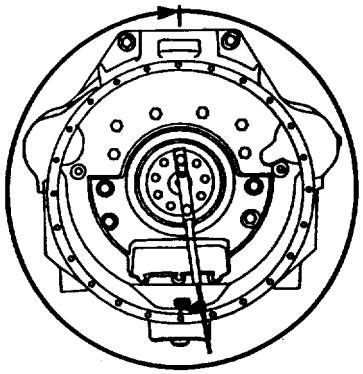


FIGURE 3-32. Flywheel Housing Alignment Measurement.

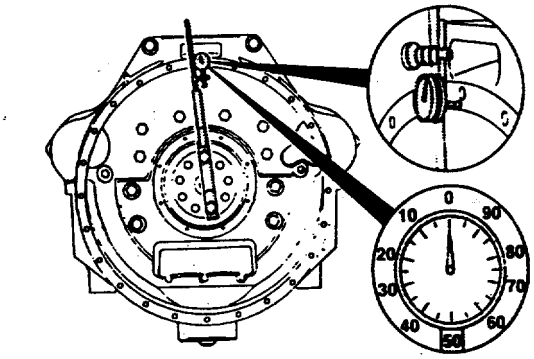


FIGURE 3-32a. Flywheel Housing End Clearance Measurement.

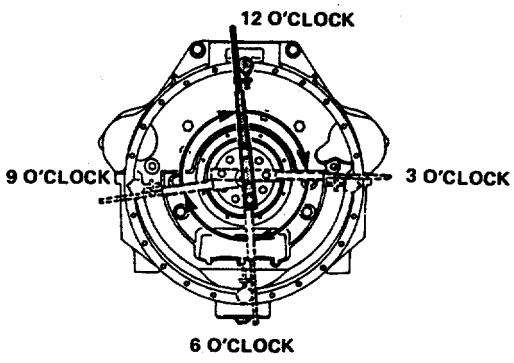


FIGURE 3-32b. Flywheel Housing End Clearance TIR.

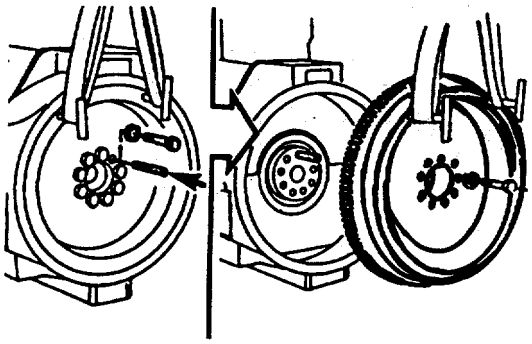


FIGURE 3-33. Flywheel Removal/Replacement.

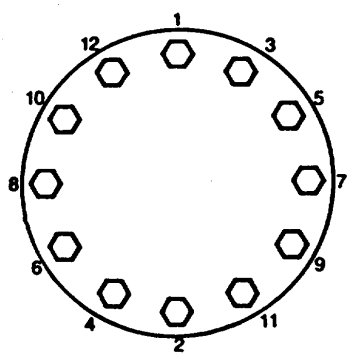


FIGURE 3-34. Flywheel Bolt Tightening Sequence.

3-27. Repair Engine Air Starter. (FIG. 3-35)

This task covers:
a. Disassembly, b. Repair, c. Assembly

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958
Bearing driver P/N 3375318
Arbor press 4920-00-373-9376

Equipment Condition

Engine air starter removed, para. 2-14.

Materials/Parts

Starter rebuild kit P/N 52-029

DISASSEMBLY

CAUTION

Do not attempt to adjust the automatic trip valve (ATV) in the starter's inlet or remove the cover plate protecting the ATV mechanism.

NOTE

Identify and tag attaching hardware.

a. Remove screws (57) and nuts (42) retaining drive assembly housing (58). Remove housing (58) from gearbox housing (35).

b. Remove lip seals (60) and bearing (59) from drive assembly housing (58).

c. Slide engine drive assembly (56) (Bendix gear) off carrier shaft (34).

d. Remove set screw (55) and key and spring assembly (54) from Bendix gear (56).

e. Remove retainer nut (40) and lockwasher (41) from carrier shaft (34).

f. Remove screws (39) holding retainer plate (38) to gearbox housing (35). Remove retainer plate (38), bearing (37), and bushing (36).

g. Remove screws (43) retaining gearbox housing (35) to turbine housing (25).

h. Slide gearbox housing (35) off the sungear/shaft (28).

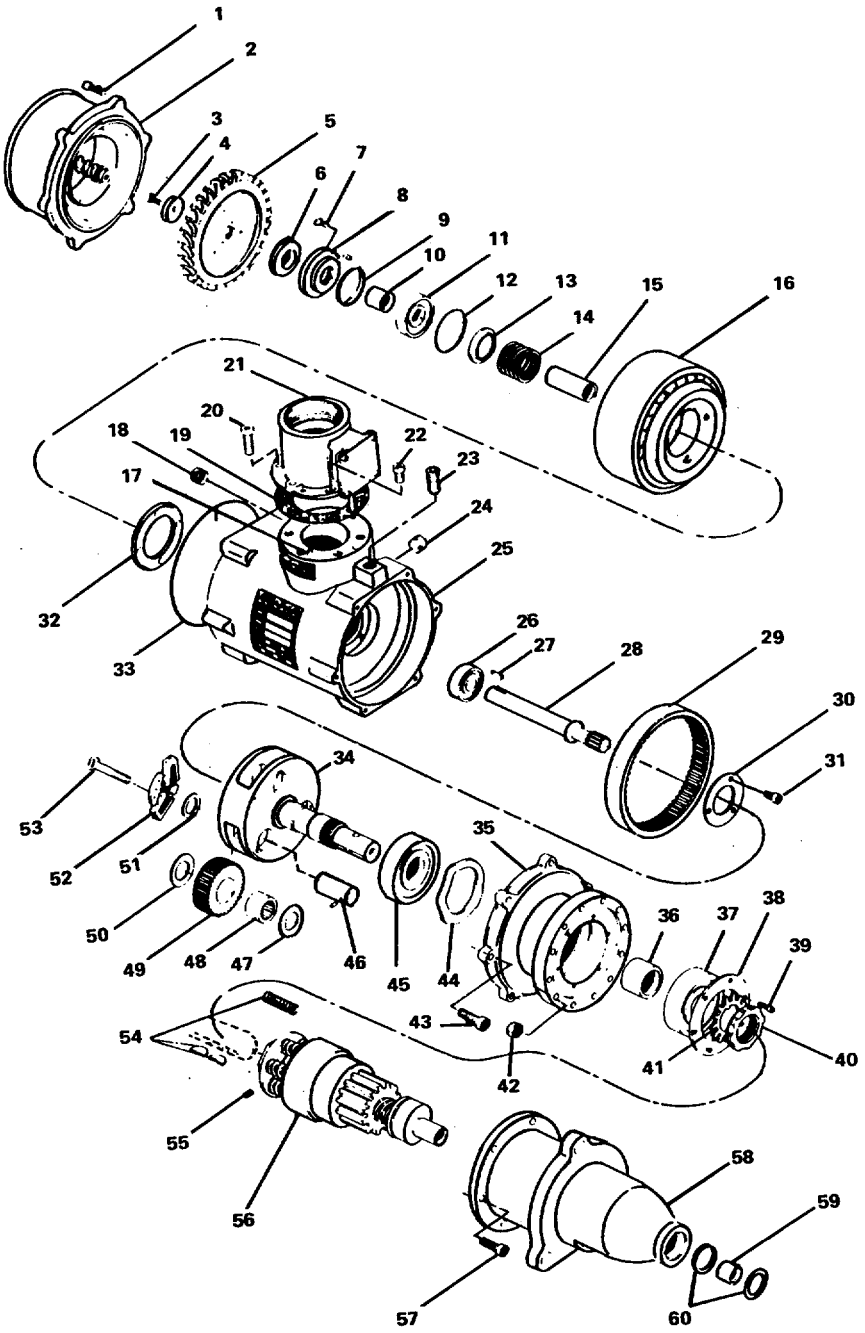


FIGURE 3-35. Engine Air Starter.

i. Remove bearing (45) and spring washer (44) from housing (35).

j. Remove screws (53) and hammer assemblies (52) from the carrier shaft (34).

k. Remove retaining rings (51) and planet shafts (46). Remove washers (47 and 50) planet gears (49), and bearings (48).

1. Remove ring gear (29).

m. Remove screws (31) and retainer plate (30).

n. Remove press bearing (26) and woodruff key (27) from sungear/shaft (28). Remove sungear/shaft (28).

o. Remove screws (1) retaining plate assembly (2) to turbine housing (25). Remove plate assembly (2).

p. Remove screw (3) and washer (4). Remove turbine wheel (5).

q. Remove screws (7) retaining lip seal (6). Remove seal (6) from the seal housing (8). Remove seal housing (8).

r. Remove performed packing (9), spacer (10), bearing (11), performed packing (12), spring seat (13), spring (14), and spacer (15) from nozzle/liner (16).

s. Remove nozzle/liner (16), nozzle gasket (32), and performed packing (33).

t. Remove screws (20 and 22), retaining ATV (21). Remove the ATV (21).

u. Remove ATV gasket (19) and straight headless (dowel) pins (17).

v. Remove set screw (23), vent plug (24), and pressure plug (18) from turbine housing (25).

REPAIR

Repair of the engine air starter is by replacement of defective parts.

ASSEMBLY

a. Install vent plug (24), set screw (23), and pressure plug (18) in turbine housing (25).

b. Install ATV gasket (19) and straight headless (dowel) pins (17) on turbine housing (25).

c. Position ATV (21) on turbine housing (25). Secure ATV with screws (20 and 22).

d. Install performed packing (33), nozzle gasket (32), and nozzle liner (16) on turbine housing (25).

e. Install spacer (15), spring (14), spring seat (13), performed packing (12), bearing (11), bearing (10), and performed packing (9) in nozzle/liner (16).

f. Install seal (6) in seal housing (8). Install housing (8) in nozzle/liner (16). Secure with screws (7).

g. Install turbine wheel (5) in nozzle/liner (16). Secure with washer (4) and screw (3).

h. Install plate assembly (2) on turbine housing (25). Secure with screws (1).

i. Install bearing (26) and woodruff key (27) on sungear/shaft (28). Install sungear shaft (28).

j. Install retaining plate (30). Secure with screws (31).

k. Install ring gear (29) on turbine housing (25).

l. Install planet shafts (46) and retaining rings (51). Install washers (50), planet gears (49), bearings (48), and washers (47) on planet shafts (46).

m. Install hammer assemblies (52). Secure with screws (53).

n. Install spring washer (44) and bearing (45) in gearbox housing (35).

o. Slide gearbox housing (35) on sungear/shaft (28).

p. Secure gearbox housing (35) with screws (43).

q. Install bushing (36), bearing (37), and retainer plate (38) to gearbox housing (35). Secure with screws (39).

r. Install lockwasher (41) and retainer nut (40).

s. Install spring assembly (54) and set screw (55) in Bendix gear (56).

t. Slide Bendix gear (56) on carrier shaft (34).

u. Install lip seals (60) and bearing (59) in drive assembly housing (58).

v. Install drive assembly housing (58) on gearbox housing (35). Secure with screws (57) and nuts (42).

w. Install engine air starter (paragraph 2-14).

3-28. Repair Fuel Pump (FIG. 3-36)

This task covers: Repair

INITIAL SETUP:

Tools

Tool kit, general mechanic's
rail and marine diesel engine
5180-00-629-9783
Torque wrench kit P/N 3377216

Equipment Condition

Fuel pump removed, para. 2-29.

Materials/Parts

Cleaning solvent, Item 15, Appendix C

REPAIR

CAUTION

Put plastic cap plugs or tape on all fuel pump openings to prevent dirt from entering the fuel pump. Use a cleaning solvent that will not harm aluminum.

NOTE

K50 engine must have the white or light green nylon coupling spider.

a. Use a brush and solvent to clean pump exterior.

b. Use clean engine lube oil to lubricate pump drive gear.

c. Rotate the fuel pump shaft by hand. Verify the shaft rotates easily.

d. Ensure tamper proof seals are in place. If tamper-proof seals are missing, the fuel pump calibration may not be according to specification.

e. Check fuel pump assembly for damaged capscrews or loose fittings.

f. Check fuel pump drive lugs for damage.

g. Check the shutoff valve for damage and for loose or damaged electrical terminals.

h. Check the drive coupling spider for excessive wear or cracks.

i. Replace fuel pump if any damage is discovered.

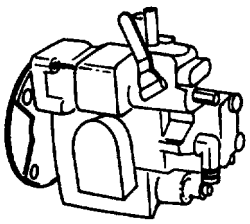


FIGURE 3-36. Fuel Pump.

SECTION VI. PREPARATION FOR STORAGE OR SHIPMENT

Refer to Chapter 2, Section VI.

CHAPTER 4

INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

4-1. Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

4-2. Special Tools, TMDE, and Support Equipment. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

4-3. Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

SECTION II. SERVICE UPON RECEIPT

4-4. Checking Unpacked Equipment.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

d. Remove protective caps, plugs, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective films at time of installation.

e. Remove chocks from resilient mounted components.

4-5. Initial Setup Procedure. Includes operational checks and inspections that are not performed for a routine startup. Direct support maintenance personnel will perform initial setup in accordance with the operator's manual, TM 55-1905-223-10. Also refer to Chapter 2, Section II .

4-6. Normal Startup. Refer to the operator's manual, TM 55-1905-223-10.

4-7. Shutdown Procedure (Usual or Unusual). Refer to the operator's manual, TM 55-1905-223-10.

SECTION III. INTERMEDIATE GENERAL SUPPORT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

4-8. PMCS. There is no PMCS at the general support level. See Chapter 2, Section III .

SECTION IV. INTERMEDIATE GENERAL SUPPORT TROUBLESHOOTING

4-9. Troubleshooting. Both a symptom index and a troubleshooting table are provided. The symptom index will help you locate the information you need for troubleshooting.

SYMPTOM INDEX

Table 4-1 lists the common fault conditions that may be found during the operation or maintenance of the equipment. Look for causes and do corrective actions in the order listed. This manual cannot list every symptom that may show up, and it cannot list all of the possible causes and corrective actions. If a symptom is not listed, or if it keeps up after you have performed the corrective actions, notify your supervisor.

Table 4-1. Troubleshooting

Malfunction
Test or Inspection
Corrective Action

1. Coolant loss (internal).

STEP 1. Check if cylinder liner is cracked/porous or if crevice seals are leaking. Check for cylinder liner and crevice seal damage. Refer to para. 4-10.

2. Oil consumption excessive.

STEP 1. Check for worn or broken piston rings. Check blowby. Inspect and replace piston rings if necessary. Refer to para. 4-16.

STEP 2. Check if piston ring grooves worn. Check blowby. Inspect and replace pistons if necessary. Refer to para. 4-16.

STEP 3. Check for scored or damaged cylinder liners. Check blowby. Replace liners if necessary. Refer to para. 4-19.

3. Lube oil in coolant or coolant in lube oil.

STEP 1. Check for cracked or porous cylinder block. Inspect cylinder block. Refer to para. 4-18.

STEP 2. Check cylinder liner for cracked/porous or crevice seals leaking. Replace cylinder liner. Refer to para. 4-19.

4. Exhaust smoke excessive under load.

STEP 1. Check if piston rings not sealing (blue smoke). Replace pistons and rings. Refer to para. 4-16.

5. Engine crankcase gases (blowby) excessive.

STEP 1. Check for broken cylinder liners. Replace cylinder liners. Refer to para. 4-19.

6. Main bearing noise.

STEP 1. Check for damaged or worn main bearings. Inspect main bearings and crankshaft journals. Refer to para. 4-13.

STEP 2. Check for damaged or out-of-round crankshaft journals. Inspect the crankshaft journals. Refer to para. 4-13.

Table 4-1. Troubleshooting

Malfunction Test or Inspection Corrective Action CONT.
7. Connecting rod bearing noise.
STEP 1. Check for damaged or out-of-round crankshaft rod journals. Inspect the crankshaft rod journals. Refer to para. 4-13.
8. Piston noise.
STEP 1. Check for worn or out-of-round cylinder liners. Determine faulty cylinder. Replace the cylinder liner. Refer to para. 4-19.
9. Engine vibration excessive.
STEP 1. Check for loose or damaged vibration damper. Check vibration damper. Refer to para. 4-12.

SECTION V. INTERMEDIATE GENERAL SUPPORT MAINTENANCE PROCEDURES

MAINTENANCE OF CYLINDER HEAD GROUP

4-10. Repair Cylinder Head Group.

This task covers: Repair.

INITIAL SETUP

Tool

Tool kit, general mechanics rail and marine diesel engine, 5180-00-629-9783
Torque wrench kit P/N 3377216
Valve spring compression tester P/N 3375182
Valve vacuum tester P/N ST-1257
Adapter plate P/N 3376687
Valve spring compressor P/N ST-448
Valve seat extractor P/N 3376799
Valve guide mandrel P/N ST-1284
Valve guide arbor P/N 3375946
Valve seat insert tool driver P/N ST-257
Valve seat insert cutter P/N ST-1310
Insert staking tool P/N ST-1288
Magnaglo tester P/N H620
Dowel puller P/N ST-1134
Crosshead guide mandrel P/N ST-1264
Hydrostatic tester P/N ST-1012
Lifting sling P/N 3375958
Valve facing machine P/N 3376256
Light duty puller kit P/N 3375784
Gauge block P/N 3376220
Water test adapter P/N 3375070
Valve seat grinding machine P/N ST-685
Valve guide driver P/N 3376779
Expansion plug driver P/N 3376813, 3376814
Extractor knocker P/N 3376617
Cutter plate P/N 3375908
Counterbore drive unit P/N 3376855
Valve head checking tool P/N 3375939, 3375940
Crack detector kit P/N 3375432
Eccentrimeter P/N ST-685-4
Driver handle P/N 3376795
Machinist measuring tool set 5280-00-278-9919
Magnetic Crack Detector P/N ST-1166
Lifting fixture P/N 3822512

Equipment Condition

Cylinder head group removed from engine, para. 2-34.

INITIAL SETUP (Continued)

Valve guide reamer ST-646
Grooving kit P/N 3376405
Drill 5130-00-293-1949
Lapping Tool 5120-00-289-5027
Ball Gauge P/N 3469

Materials/Parts

Cup plug loctite, Item 37, Appendix C
Solvent, Item 15, Appendix C
Prussian blue compound, Item 23, Appendix C
Crocus cloth, Item 11, Appendix C
Valve lapping paste, Item 36, Appendix C

REPAIR

a. Clean and check the cylinder head.

(1) Use solvent. Clean the parts.

(2) Check for broken springs, bent crosshead guides or other damage. If damage is found, rebuild the cylinder head (step b of this procedure).

CAUTION

Both ends of a crack between the valves must be visible. If one end of a crack extends into the valve seat insert bore behind the valve seat insert, the condition of the cylinder head is questionable. To be sure the cylinder head is in good condition, remove the valve and the valve seat insert.

(3) Visually inspect for cracks on the combustion surface (FIG. 4-1). If any cracks around the injector bore are longer than 0.25 inch (6 mm), discard the cylinder head.

(4) Use gauge block to measure the valve depth (FIG. 4-2). If valve depth exceeds 0.020 inch (0.51 mm), replace the cylinder head. FIG. 4-1. Crack Inspection.

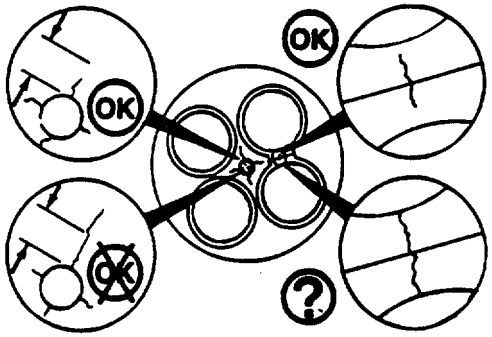


FIGURE 4-1. Crack Inspection.

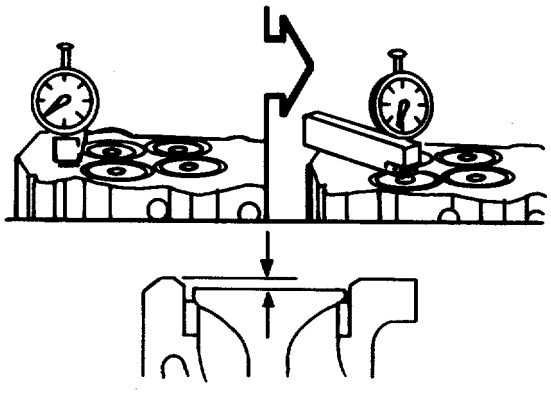


FIGURE 4-2. Valve Depth Measurement.

b. Rebuild cylinder head.

WARNING

The valve springs are under compression. Use care when using the valve spring compressor. Personnel injury can result if the tool slips.

(1) Use valve spring compressor (1, FIG. 4-3) compress spring (5).

CAUTION

The collet groove in the valve stem can cut the valve stem seals when the valve is removed. Pull the seal off of the guide and carefully move it past the groove in the stem. If the seal is cut, it must be replaced.

NOTE

Mark valves for location prior to removal. The intake and exhaust valves are different. Marking valves will aid the assembly procedure.

(2) Remove valve collets (2), spring retainer (4), spring (5), spring guide (3), and valve (8).

(3) Repeat procedure for each of four valves.

(4) Clean parts and check for broken springs, bent crosshead guides or other damage (refer to step a of this procedure).

(5) Use a drill, a sheet metal screw and a slide hammer and hook from the light duty puller kit to remove 10 cup plugs (FIG. 4-4).

(6) Measure free length of valve spring (5, FIG. 4-3). Verify spring length is approximately 3.35 inch (85.1 mm).

(7) Use a valve spring tester (1, FIG. 4-5). Measure spring (4) at working height (2) of 1.98 inch (50.3 mm). Verify spring force (3) is between 253 lb (1125 N-m) and 294 lb (1308 N-m).

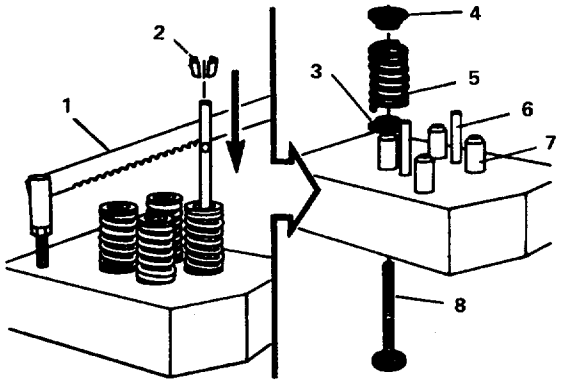


FIGURE 4-3. Valve Removal.

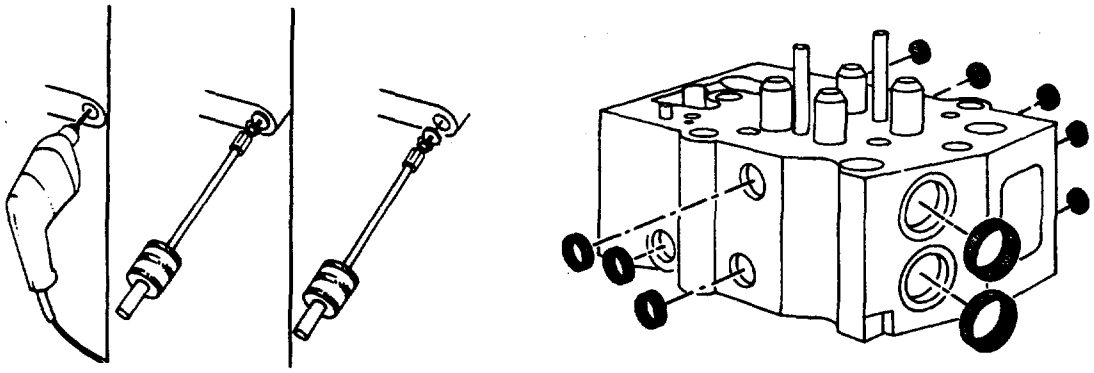


FIGURE 4-4. Cup Plug Removal.

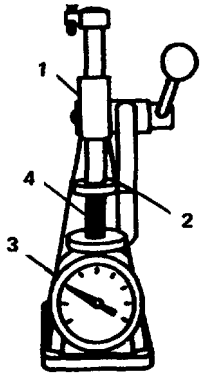


FIGURE 4-5. Spring Tester.

(8) Use crocus cloth to polish the valve stems.

CAUTION

Valves can be cleaned by the bead blasting method in the head area only. Do not allow glass bead blast to contact the stem valve. Glass bead blast will damage the surface finish of the stem.

(9) Check collet grooves for wear. If collet grooves show wear, as indicated in FIG. 4-6, discard the valve.

(10) Measure valve stem outside diameter with micrometer. Verify diameter is between 0.4935 inch (12.535 mm) and 0.4951 inch (12.576 mm).

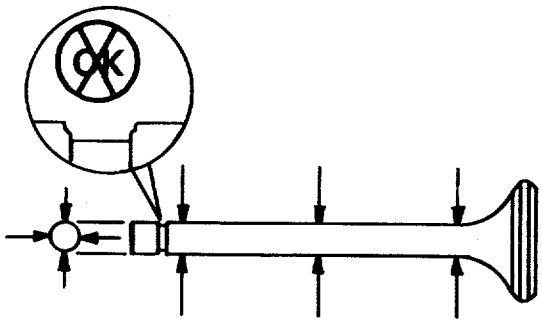


FIGURE 4-6. Valve Stem Inspection.

(11) Position valve on valve head checking tool so that the valve head touches the tool as shown in FIG. 4-7.

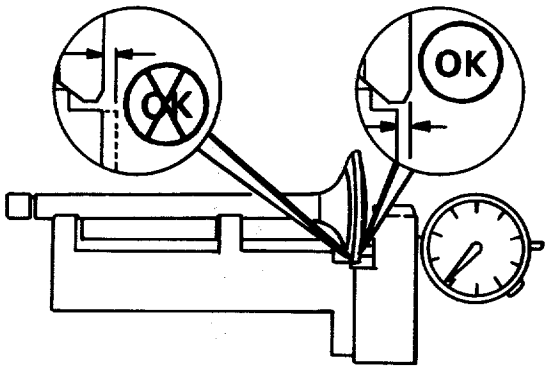


FIGURE 4-7. Valve Head Thickness Check.

NOTE

If the valve head is even with the end of the tool before grinding, the valve will not be thick enough for a second grinding.

(12) Use a gauge block to measure the distance between the tool and the valve head. The valve head thickness is acceptable when the head is even with or above the end of the tool.

NOTE

The following check is not as accurate as the previous check. Perform this check only if valve head checking tools are not available.

(13) Place valve on a flat surface. Check the height of the valve head at the outside diameter (FIG. 4-8). Verify height is at least 0.120 inch (3.05 mm) for exhaust valve and 0.085 inch (2.16 mm) for intake valve. FIG. 4-8. Valve Head Height Measurement.

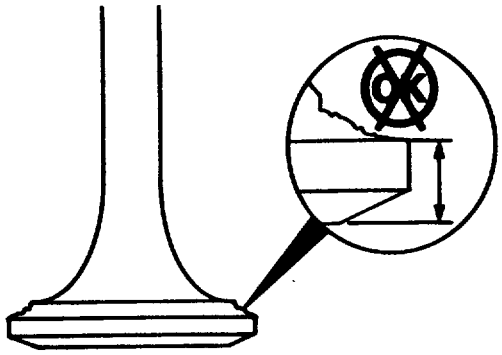


FIGURE 4-8. Valve Head Height Measurement.

(14) Use the dye penetrant method or magnetic crack detector to check for cracks on the combustion surface of the cylinder head.

(a) Dye penetrant method.

NOTE

Porosity usually appears as dots in local areas. Cracks usually appear as solid or dotted lines. A wider spread indicates a larger defect.

1 Apply dye penetrant to combustion surface of cylinder head.

2 Allow 15 minutes for dye to dry. Do not force dry.

3 Remove excess dye penetrant.

4 Apply developer.

CAUTION

If magnetic crack detector is used, the head must be demagnetized and cleaned thoroughly. Powdered fragments can damage the internal engine components.

(b) Magnetic crack detector.

1 Remove keeper bar from magnet poles and place magnet on area to be inspected.

2 Spray powder on area to be inspected with powder bulb. Remove excess powder with low pressure air.

3 Inspect for cracks. Cracks will show as white lines.

CAUTION

Both ends of a crack between the valves must be visible. If one end of a crack extends into the valve seat insert bore behind the valve seat insert, the condition of the cylinder head is questionable. To be sure the cylinder head is in good condition, remove the valve and the valve seat insert.

(15) Inspect for cracks on the combustion surface (FIG. 4-1). If any cracks around the injector bore are longer than 0.25 inch (6 mm) discard the cylinder head.

CAUTION

The upper (rocker lever housing) surface and the lower (cylinder block) surface of the cylinder head must be parallel within 0.005 inch (0.13 mm). If these surfaces are not square, the cylinder liner bore can be distorted.

NOTES

- The head can be resurfaced as long as the thickness (1, FIG. 4-9) is at least 4.715 inch (119.76 mm) after the head is resurfaced.
- If the head is resurfaced, be sure that the injector protrusion and the valve depth in the head are adjusted properly.

(16) Use a straight edge and a feeler gauge to measure the flatness of the head gasket surface (FIG. 4-9). The head must be resurfaced if a feeler gauge larger than 0.003 inch (0.08 mm) will fit between the straight edge and the cylinder head.

(17) Check the valve guides (7, FIG. 4-3) for chips or cracks. Replace the guide if it is chipped or cracked.

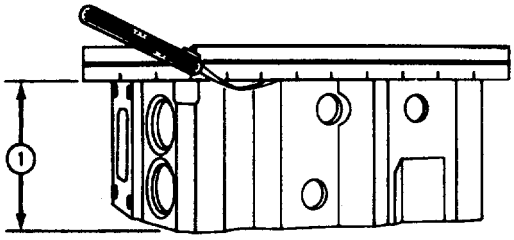


FIGURE 4-9. Head Gasket Surface Measurement.

NOTE

The valve guide can be used again if measurements performed near the top and bottom are greater than 0.4987 inch (12.667 mm).

(18) Use a ball gauge or dial bore indicator. Measure the inside diameter of the valve guides 0.5 inch (13 mm) from the top and bottom and in the center (FIG. 4-10). Verify inside diameter is between 0.4961 inch (12.601 mm) and 0.4987 inch (12.667 mm).

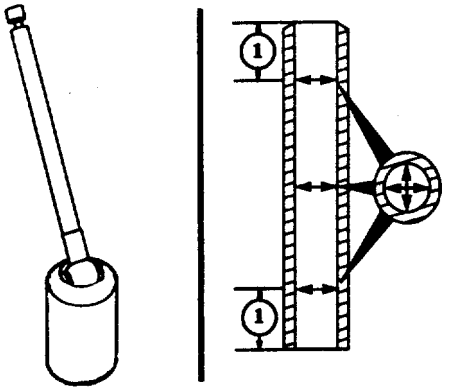


FIGURE 4-10. Valve Guide Measurement.

(19) Verify crosshead guide (6, FIG. 4-3) is straight. Use micrometer to verify outside diameter is between 0.4320 inch (10.973 mm) and 0.4335 inch (11.011 mm).

(20) Magnetic crack check valves.

CAUTION

Always demagnetize and clean parts thoroughly after a magnetic particle inspection. The iron fragments can damage the internal engine components. A demagnetizing coil is supplied with the magnaglo tester.

(a) Use magnaglo tester to check the valves (8, FIG. 4-3) for cracks. Check the exhaust valves with the coil shot method. Check the intake valves with the coil shot and head shot methods (coil shot first).

(b) Set up magnaglo tester for each method using instructions provided on tester.

(c) Apply wet bath solution to area being checked. Continually wet the area while applying voltage from the magnaglo tester.

NOTE

An ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

(d) Use the 12 inch (305 mm) diameter coil (FIG. 4-11) supplied with the magnaglo tester for coil shot method.

Coil Shot Amperage (Ampere Turns)	
MIN	400 dc or rectified ac
MAX	800 dc or rectified ac
Head Shot Amperage (Ampere)	
MIN	500 dc or rectified ac
MAX	700 dc or rectified ac

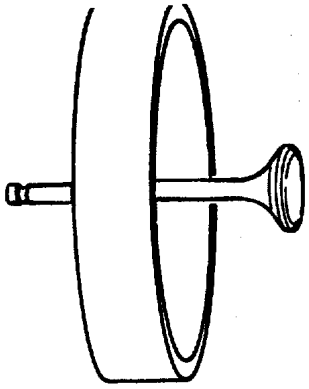


FIGURE 4-11. Valve Magnetic Crack Check.

(e) Use black light supplied with the tester to crack check valve. Verify valves meet the acceptance criteria shown in FIG. 4-12.

NOTE

A broad fuzzy pattern will appear at the welded joint on the exhaust valves. This is normal. If there is a distinct line in the broad fuzzy pattern, the valve must be replaced.

Acceptance Criteria (Intake and Exhaust Valves)

(1) Indications less than 38.1 mm [1-1/2 inch] in length are acceptable. More than five indications, spaced closer than 3 mm [1/8-inch], are not acceptable.
(2) No indications are acceptable.
(3) and (4) ONLY longitudinal indications are acceptable.
(5) No indications are acceptable.

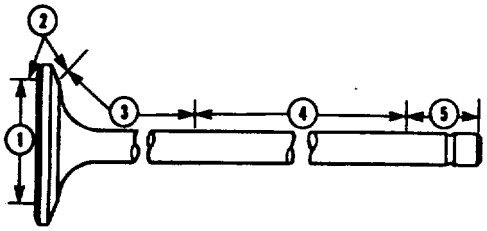


FIGURE 4-12. Valve Acceptance Criteria.

(21) Grind the Valve Seat.

(a) Use valve seat grinding machine and valve guide arbor set to grind the valve seat insert to the angle shown in FIG. 4-13.

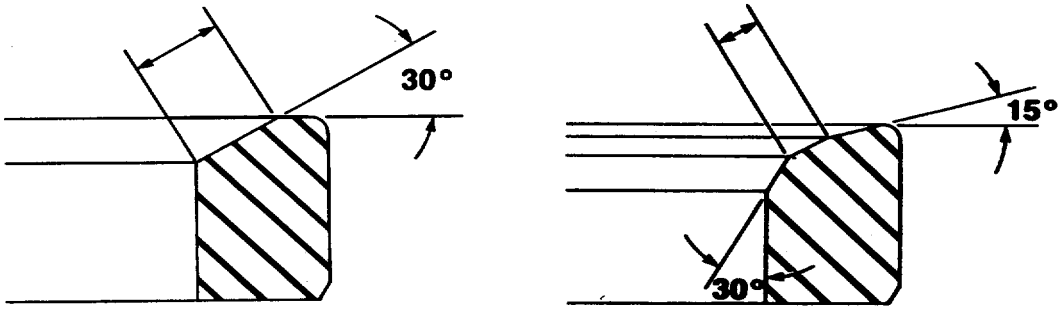


FIGURE 4-13. Valve Seat Grinding Angles.

(b) Measure the valve seat width. Verify width is between 0.120 inch (3.05 mm) and 0.140 inch (3.56 mm) (intake valve) or 0.060 inch (1.52 mm) and 0.100 inch (2.54 mm) (exhaust valve).

(c) If the width is not within specifications, remove some of the surface material on the inside diameter and outside diameter to decrease the width of the seat. If valve seat specifications cannot be obtained by grinding, replace the valve seat insert.

(d) Use eccentrimeter and an arbor to measure valve seat to valve guide concentricity (FIG. 4-14).

(e) Verify concentricity is within 0.002 inch (0.05 mm). If concentricity is not within specifications, grind the valve seat again.

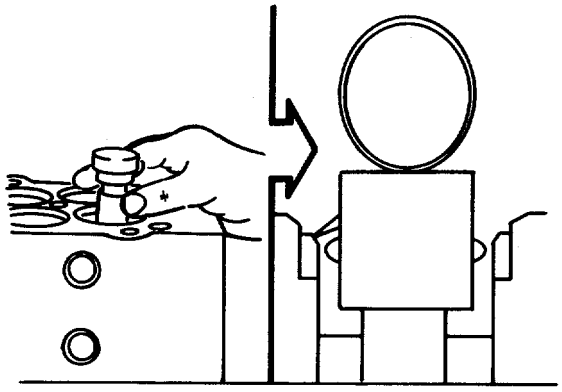


FIGURE 4-14. Valve Seat Concentricity Measurement.

(22) Check the injector bore (FIG. 4-15).

(a) Inspect injector bore for cracks or damage.

(b) Use a discarded (dummy) injector without injector 0-rings. Install sealing ring on the injector.

(c) Apply a thing coating of Prussian Blue on the injector sealing ring (FIG. 4-16).

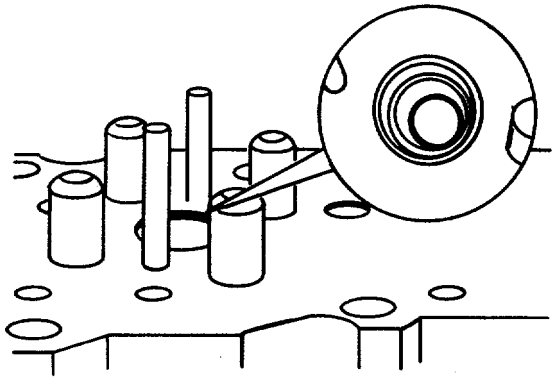


FIGURE 4-15. Injector Bore.

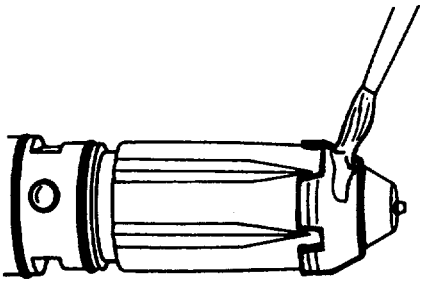


FIGURE 4-16. Dummy Injector.

CAUTION

Support the cylinder head to prevent damage to the injector tip that protrudes from the combustion face, and to allow the injector to touch the seat correctly.

(d) Install the injector (3, FIG. 4-17) in the cylinder head (4).

(e) Install injector holddown clamp (2).

(f) Install capscrews (1). Tighten screws to 145 in-lb (16 N-m).

(g) Turn cylinder head (4) over. Use a gauge block to measure injector protrusion (FIG. 4-18). Verify injector protrusion is between 0.090 inch (2.29 mm) and 0.110 inch (2.79 mm).

(h) If protrusion is not within specifications, use an oversized sealing ring. Sealing rings are available in various sizes as shown below.

NOTE

The 0.0135 to 0.0165 inch (0.343 to 0.419 mm) is the standard sealing ring.

Wall Thickness (Min/Max)		Protrusion Change	
Inch	mm	Inch	mm
0.0135/0.0165	0.343/0.419	0.000	0.000
0.0185/0.0215	0.470/0.546	0.010	0.25
0.0235/0.0265	0.597/0.673	0.020	0.51
0.0285/0.0315	0.724/0.800	0.030	0.76

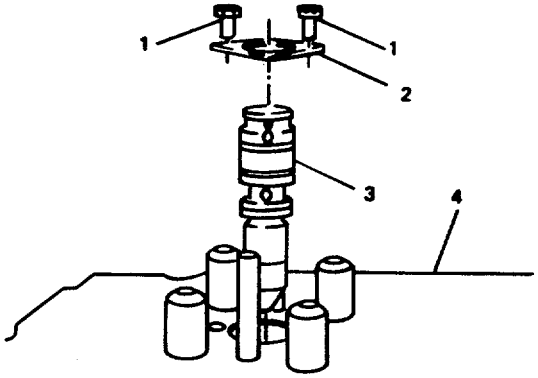


FIGURE 4-17. Injector Removal/Replacement.

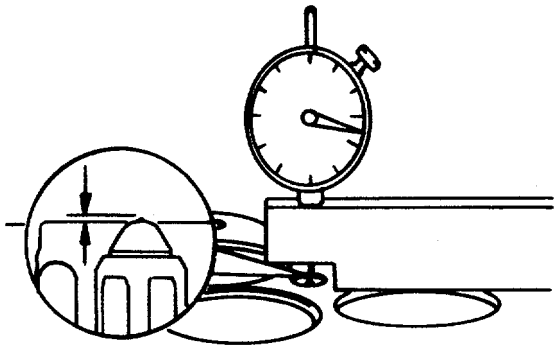


FIGURE 4-18. Injector Protrusion Measurement.

(i) Return cylinder head (4, FIG. 4-17) to original position. Remove capscrews (1), hold down clamp (2), and injector (3).

(j) Check the contact pattern in the injector bore (FIG. 4-19). A blue band at least 0.060 inch (1.52 mm) wide and 360 degrees full circumference must be visible. If pattern is not to specifications, clean bore with a tapered brush and recheck. If the pattern is still not to specifications, replace the cylinder head.

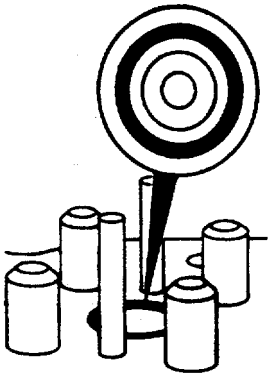


FIGURE 4-19. Prussian Blue Pattern.

(23) Install cup plugs (FIG. 4-4).

(a) Apply cup plug loctite to the outside of the cup plug.

(b) Use expansion plug drivers and driver handle to install cup plugs.

(24) Pressure test cylinder head.

(a) Attach cylinder head to hydrostatic tester with water test adapter plate FIG. 4-20.

(b) Apply 80 psi (552 kPa) air pressure. Check for cracks in the head and leaks at the cup plugs.

(c) Immerse the cylinder head in water. Apply 80 psi (552 kPa) air pressure. Check for leaks (bubbles) in the head and at the cup plugs.

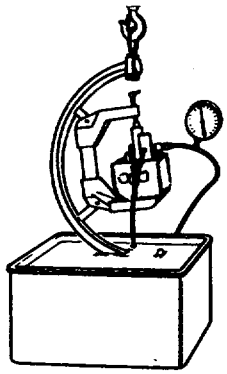


FIGURE 4-20. Hydrostatic Tester.

(d) If there is evidence of leaks at the cup plugs, remove the plug, clean the bore, and install a new plug (refer to step b of this procedure).

(e) If there is evidence of leaks in the casting, discard the cylinder head.

NOTE

Check the marking on the center of the valve head to identify the correct valve. Intake valves have no mark. Exhaust valves are marked "(E)" or "' (S)".

25 Measure valve depth.

(a) Install valve in valve guide.

(b) Use gauge block to measure the depth of the valve (FIG. 4-21). Verify the valve depth is even with no more than 0.020 inch (0.51 mm) below the surface of the head. If the valve depth is not within specifications, replace the valve seat insert (FIG. 4-25).

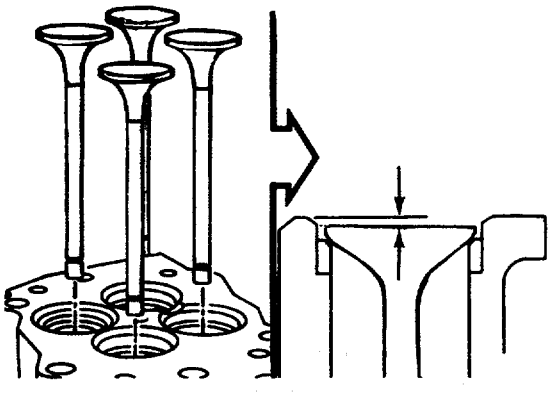


FIGURE 4-21. Valve Depth Measurement.

WARNING

The valve springs are under compression. Use care when using the valve spring compressor. Personnel injury can result if the tool slips.

(26) Use valve spring compressor (1, FIG. 4-3). Install spring guide (3), spring (5), spring retainer (4), and valve collets (2).

(27) Vacuum Test cylinder head.

(a) Install vacuum tester to valve seating area (FIG. 4-22).

(b) Apply vacuum. Measure time required for vacuum to decrease from 18 in-Hg (457 mm-Hg) to 8 in-Hg (203 mm-Hg).

(c) If elapsed time is less than 10 seconds, perform the following:

- Repeat the test to verify equipment operation.
- Hit valve stem lightly with a mallet to be sure valve is sealed. Repeat test.

(d) If elapsed time is still less than 10 seconds, apply a thin coating of grease to the outside diameter of the insert and valve head. The grease will show the point of leakage. Repeat test.

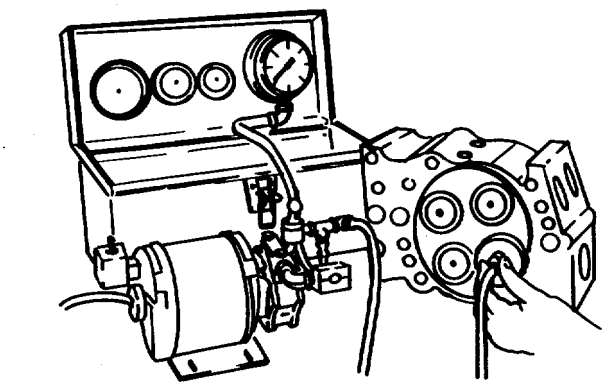


FIGURE 4-22. Vacuum Test.

(e) If leakage is between the valve seat insert and the cylinder head, replace the valve seat insert (FIG. 4-25).

CAUTION

The cylinder head must be disassembled and cleaned thoroughly after any grinding or cutting procedures. The metal fragments can damage the internal engine components.

(f) If leakage is between the valve and the insert, either lap valves to seat, grind valves or grind the valve seat.

c. Lap valves to seat.

WARNING

The valve springs are under compression. Use care when using the valve spring compressor. Personnel injury can result if the tool slips.

(1) Use valve spring compressor (1, FIG. 4-3) compress spring (5).

CAUTION

The collet groove in the valve stem can cut the valve stem seals when the valve is removed. Pull the seal off of the guide and carefully move it past the groove in the stem. If the seal is cut, it must be replaced.

NOTE

Mark valves for location prior to removal. The intake and exhaust valves are different. Marking valves will aid the assembly procedures.

(2) Remove valve collets (2), spring retainer (4), spring (5), spring guide (3), and valve (6).

(3) Repeat procedure for each of four valves.

(4) Apply a thin and even coating of lapping paste on the valve.

(5) Use lapping tool. Provide pressure in the center of the valve. Turn the valve backward and forward until the paste shows a continuous pattern on both the valve seat insert and the valve (FIG. 4-23).

CAUTION

Lapping paste is an abrasive material. Failure of the internal engine components will result if the cylinder head, the valves, and the valve seats are not cleaned thoroughly.

(6) Clean the lapping paste from the parts.

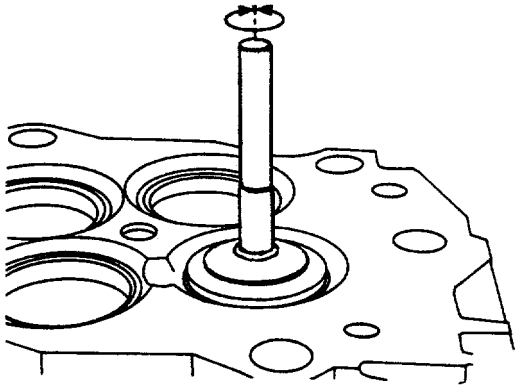


FIGURE 4-23. Valve Lapping.

WARNING

The valve springs are under compression. Use care when using the valve spring compressor. Personnel injury can result if the tool slips.

(7) Use valve spring compressor (1, FIG. 4-3). Install valve (8), spring guide (3), spring (5), spring retainer (4), and valve collets (2).

(8) Vacuum test cylinder head (step b-27).

d. Replace cylinder head valve guide.

CAUTION

If a valve guide is replaced, the valve seat insert for the valve guide must be ground. The inside diameter of the guide establishes the centerline of the valve location. The bore center in the new guide can be slightly different from the old guide.

NOTE

Only replace valve guide if it is not to specification.

(1) Use a valve guide mandrel (1, FIG. 4-24) and a valve guide arbor press to remove the valve guide (2).

(2) Measure inside diameter of guide bore. Verify inside diameter is between 0.8435 inch (21.425 mm) and 0.8445 (21.450 mm).

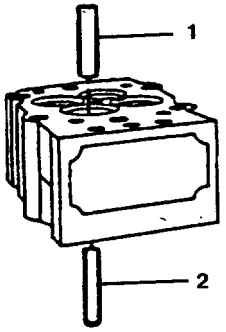


FIGURE 4-24. Valve Guide Removal.

NOTE

Valve guides are available in 0.010 inch (0.25 mm) and 0.015 inch (0.38 mm) oversizes.

(3) If the bore is not within specifications, use reamer to enlarge the bore for oversize valve guides. Ream the bore to maintain a press fit within 0.0011 to 0.0026 inch (0.028 mm to 0.067 mm) between the valve guide and the valve guide bore.

(4) Use valve guide driver to install valve guide. Verify valve guide installed height of 1.375 inch (34.93 mm) by using machinist rule.

e. Replace valve seat insert.

NOTE

Only replace the valve seat insert if it is not within specifications (refer to steps b (25) and (27) of this procedure).

(1) Use valve seat insert cutter to cut groove (2, FIG. 4-25). Machine a groove in the seat as close to the bottom of the bore as possible.

(2) Use valve seat extractor (exhaust seat or intake seat) (1, FIG. 4-25). Use extractor knocker assembly. Remove seat insert.

(3) Remove air flow deflectors from intake ports.

(4) Clean the valve seat insert bore. Inspect for cracks extending into the bore. Replace the cylinder head if a crack extends into the bottom of the bore (FIG. 4-26).

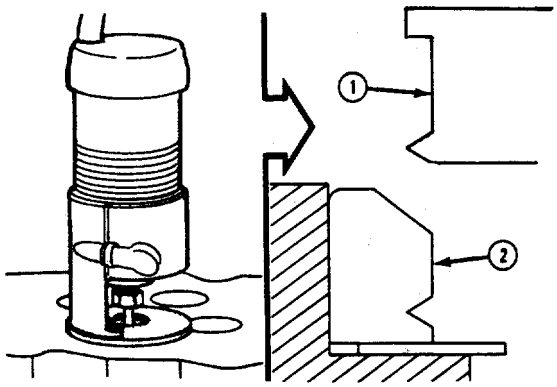


FIGURE 4-25. Valve Seat Insert Removal.

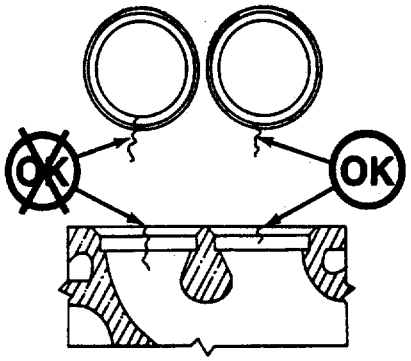


FIGURE 4-26. Valve Seat Insert Bore Inspection.

(5) Measure the inside diameter and the depth of the insert bore (FIG. 4-27). Verify bore meets following specifications.

	Diameter (6)	Depth (7) and (8)
Intake bore:	3.377 to 2.378 inch (60.38 to 60.40 mm)	0.512 to 0.517 inch (13.00 to 13.13 mm)
Exhaust bore:	2.377 to 2.378 inch (60.38 to 60.40 mm)	0.492 to 0.497 inch (12.50 to 12.62 mm)

NOTE

Oversize valve seat inserts are available in the following sizes.

Outside Diameter	Depth (Thickness)
0.010 inch (0.25 mm)	Standard
0.020 inch (0.51 mm)	0.005 inch (0.13 mm)
0.030 inch (0.76 mm)	0.010 inch (0.25 mm)
0.040 inch (1.02 mm)	0.015 inch (0.38 mm)

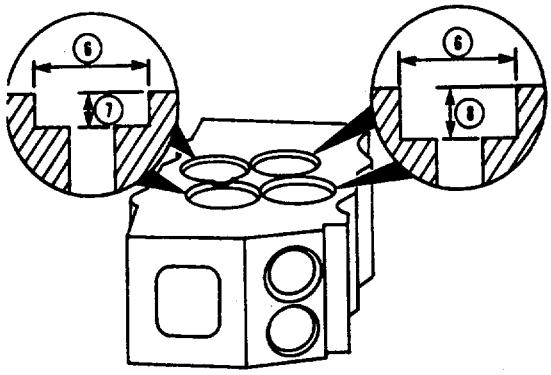


FIGURE 4-27. Valve Seat Insert Bore Measurement.

(6) If inside diameter is not within specification, machine the valve seat insert bore for an oversize seat. A press fit within 0.0025 to 0.0045 inch (0.064 to 0.114 mm) between the valve seat insert and the bore must be maintained.

(7) Install air flow deflectors in intake ports. Ensure tang on the deflector is in alignment with the hole on the notch in the head FIG. 4-28.

(8) Identify the correct valve seat insert (FIG. 4-29).

NOTE

Install insert with 30 degree angle pictured as shown.

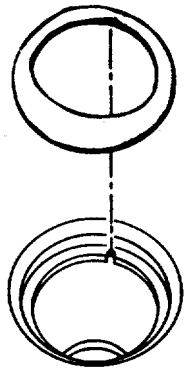


FIGURE 4-28. Air Deflector Replacement.

Intake Port
Diameter (1): 1.920 to 1.936 inch (48.77 to 49.14 mm)

Exhaust Port
Diameter (1); 2.025 to 2.040 inch (51.44 to 51.82 mm)

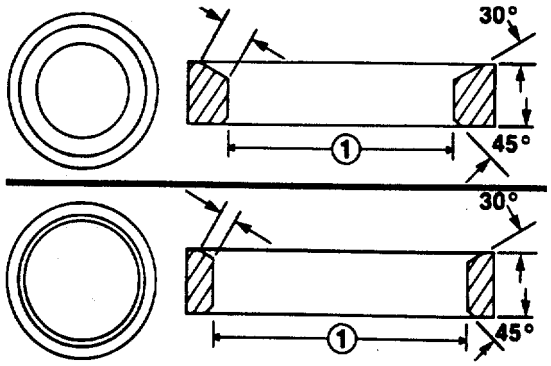


FIGURE 4-29. Valve Seat Insert Identification.

(9) Use an arbor press and a mandrel (1, FIG. 4-30) to install the insert (2) in the head (3).

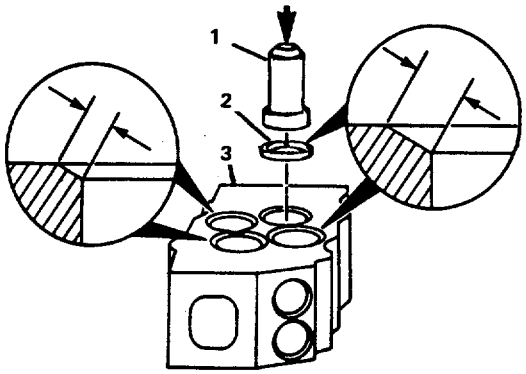


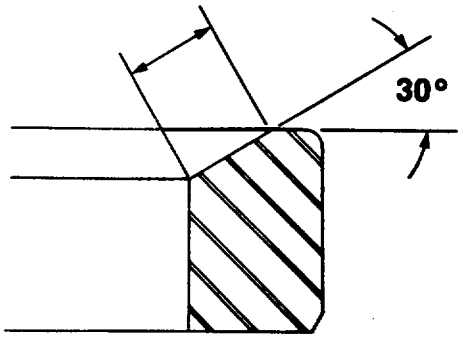
FIGURE 4-30. Valve Seat Insert Replacement.

(10) Use valve seat grinding machine and valve guide arbor set to grind the insert to the angle and width shown in FIG. 4-31.

f. Replace crosshead guide.

NOTE

Only remove the crosshead guide if it is bent or is not to specifications (refer to step b (19)).



Intake Valve Seat Width:
0.120 to 0.140 inch (3.05 to 3.56 mm)

Exhaust Valve Seat Width:
0.060 to 0.100 inch (1.52 to 2.54 mm)

FIGURE 4-31. Valve Seat Angle and Width

(1) Remove crosshead guide with a dowel pin extractor (P/N ST-1134) FIG. 4-32.

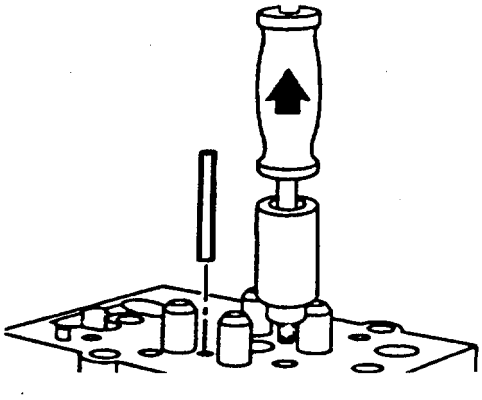


FIGURE 4-32. Crosshead Guide Removal.

NOTE

Crosshead guides are available with an oversize outside diameter. The bore in the head must be 0.0050 to 0.0021 inch (0.013 to 0.053 mm) smaller than the outside diameter of the guide.

(2) Use inside micrometer to measure the inside diameter of the crosshead guide bore in the cylinder head (FIG. 4-33). Verify diameter is between 0.4314 and 0.4325 inch (10.958 and 10.986 mm).

CAUTION

Do not use a hammer to install the crosshead guide.

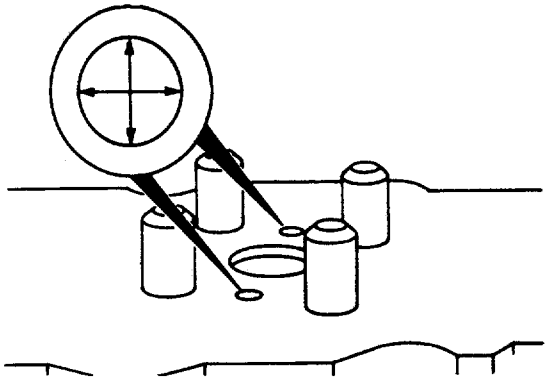


FIGURE 4-33. Crosshead Guide Bore Measurement.

(3) Install crosshead guide using crosshead guide mandrel. Verify guide is straight. Verify installed height of guide is between 2.350 and 2.370 inch (59.69 and 60.20 mm).

g. Grind valves.

(1) Clean valve with solvent.

(2) Use valve facing machine to grind valve to angle shown in FIG. 4-34.

(3) Ensure intake and exhaust valves are machined to the same angle.

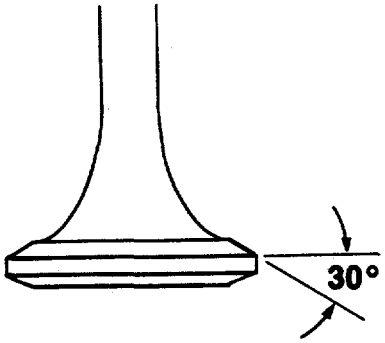


FIGURE 4-34. Valve Grinding Angle.

h. Inspect crossheads.

(1) Remove the nut (1, FIG. 4-35) and the adjusting screw (3) from the crosshead (2).

(2) Use solvent to clean the parts.

(3) Inspect the threads of the nut (1), adjusting screw (3), and crosshead (2) for damage. Check the largest end of the adjusting screw (3) for wear.

(4) Check the contact pad (4) for cracks (shaded area in FIG. 4-35).

(5) Measure the valve stem contact area for wear or damage (FIG. 4-36). Measure the inside diameter of the crosshead guide bore. Verify diameter is between 0.434 to 0.440 inch (11.02 to 11.18 mm).

NOTE

Do not tighten the nut until the crosshead has been installed and adjusted (para. 2-30).

(6) Install adjusting screw (3, FIG. 4-35) and nut (1) on crosshead (2).

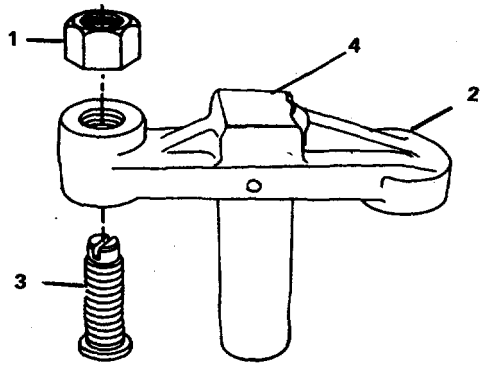


FIGURE 4-35. Crosshead Disassembly/Assembly.

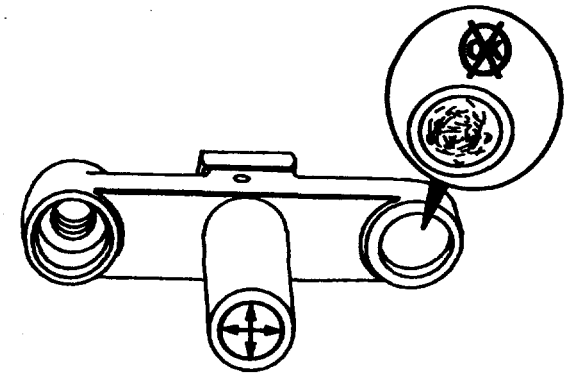


FIGURE 4-36. Crosshead Inspection.

4-11. Replace/Repair Cam Follower and Housing Group.

This task covers:

a. Removal, b. Disassembly, c. Repair, d. Assembly, e. Replacement.

INITIAL SETUP:

Tools

Tool kit, general mechanics rail and marine diesel engines, 5180-00-629-9783 Rocker lever
Torque wrench kit P/N 3377216
Magnaglo tester P/N H620
Arbor press, 4920-00-373-9376
Roller pin block P/N ST-1283
Machinist measuring tool set, 5280-00-278-9919

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Air intake manifold removed, para 2-32
Rocker lever housing group, rocker lever housing cover removed, para. 2-30.

Materials/Parts

Sand paper 240 grit, Item 21, Appendix C
Gasket P/N 3040721
Solvent, Item 15, Appendix C

REMOVAL

a. Remove push rods (3 and 4, FIG. 4-39) after removing rocker levers (para. 2-30). Lift push rods straight up to remove.

b. Remove capscrews (3, FIG. 4-37), lockwashers (5), washers (4), cam follower covers (2), and gaskets (1). Discard gasket.

c. Remove capscrews (1, FIG. 4-38) and lockwashers (2) securing the cam followers (3) to the cylinder block.

d. Remove cam follower assembly (3, FIG. 4-38).

e. Clean the cam follower assembly (3) and capscrews (1) with solvent. Check the assembly for obvious damage. Verify the shaft (10, FIG. 4-39) rotates easily.

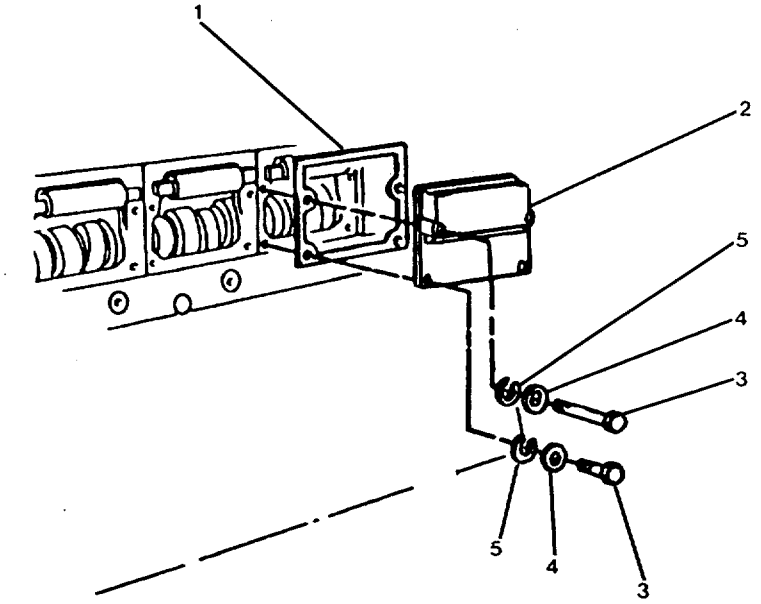


FIGURE. 4-37. Cam Follower Cover Removal/Installation.

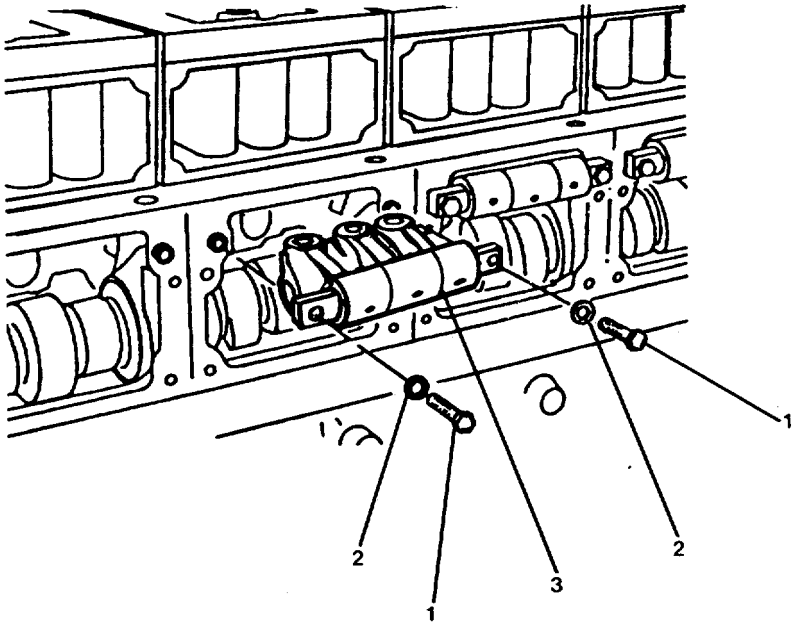


FIGURE 4-38. Cam Follower Removal/Installation.

DISASSEMBLY

a. Remove retaining rings (9, FIG. 4-39) that hold the cam followers (7) on the shaft (10).

b. Remove cam followers (7) and cup plugs (8) from the shaft (10). Clean the parts in solvent.

CAUTION

Use a shim or feeler gauge (the largest size that will fit) between the roller and the lever to prevent damage from bending or breaking.

c. Remove roll pins (1, FIG. 4-39) and position cam follower assembly (1, FIG. 4-40) on roller pin block (2). Press out the cam roller pin (2, FIG. 4-39). Remove rollers (5) from cam followers (7).

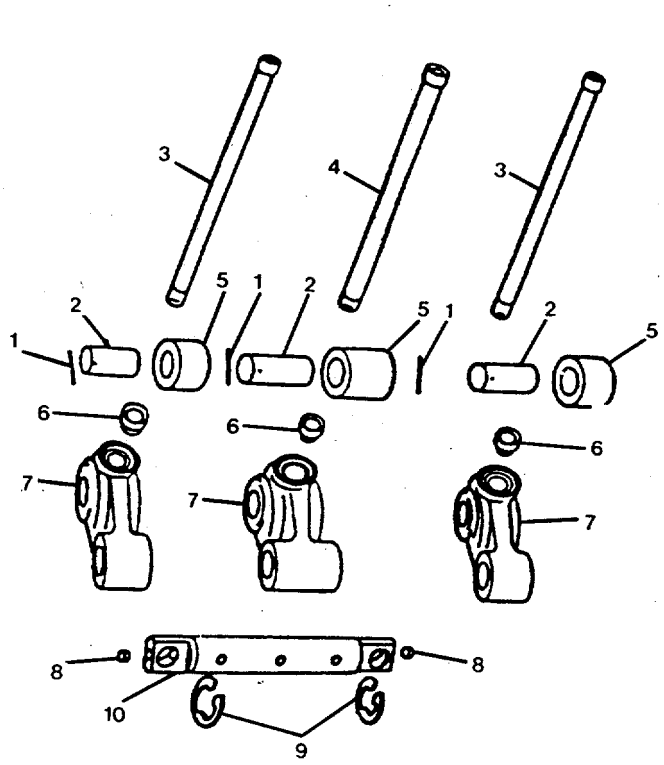


FIGURE 4-39. Cam Followers. Cover and Push Rods/Tube.

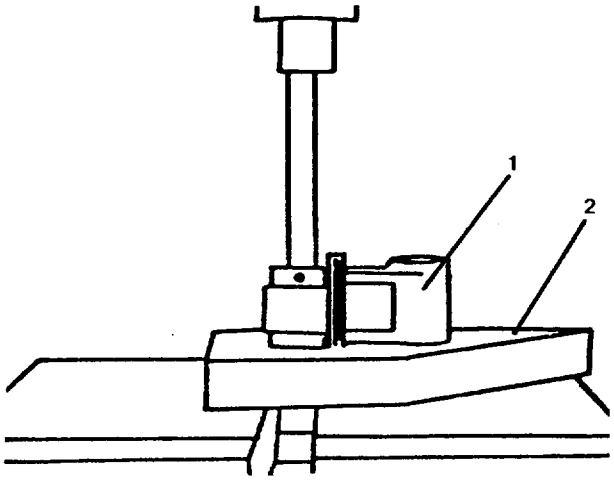


FIGURE 4-40. Cam Roller Pin Removal Socket.

REPAIR

a. Measure the outside diameter of the shaft (10, FIG. 4-39). If it is not between 0.8730 inch (22.174 mm) and 0.8740 inch (22.200 mm) or is scored or pitted, replace.

b. Check the inside diameter of the cam follower (7) for scratches, pitting, or scoring. Measure with an inside micrometer. If it is not between 0.8750 inch (22.225 mm) and 0.887 inch (22.276 mm), replace.

c. Use compressed air. Ensure cam follower (7) oil holes are not blocked.

d. Check socket (6) for damage. If the socket must be replaced, perform the following:

NOTE

The roller (5) must be removed to allow access to the socket removal hole.

(1) Use a brass drift to remove socket (6).

(2) Measure socket (6) outside diameter. Verify diameter is between 0.7505 inch (19.063 mm) and 0.7515 inch (19.088 mm).

(3) Measure cam follower (7) socket bore inside diameter. Verify diameter is between 0.7490 inch (19.025 mm) and 0.7500 inch (19.050 mm).

(4) Compute press fit by subtracting the measurement in step (3) from the measurement in step (2). Verify press fit is between 0.0005 inch (0.013 mm) and 0.0025 inch (0.064 mm).

CAUTION

Failure to use roller for support can cause cracks in the cam follower.

(5) Position roller (4, FIG. 4-41) in cam follower (3) when installing socket (2).

(6) Use a brass drift or used push rod (1) and an arbor press to install socket (2). Ensure socket touches the bottom of the bore in the cam follower (3).

e. Check for surface imperfections by magnetic inspection. Apply a coil magnetization amperage of 300 to 500 with residual Magnaglo. Demagnetize all serviceable parts after inspection. Remove any burrs from the bore of the lever with 240-grit sandpaper.

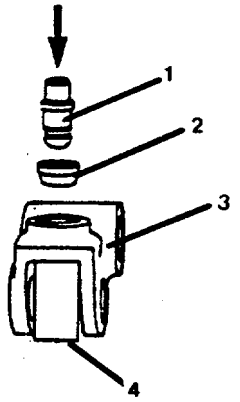


FIGURE 4-41. Cup Plug Installation in Cam Follower Shaft.

f. Check the cam roller (5, FIG. 4-39) width, outside diameter and bore inside diameter. Verify they are within the following specifications.

Width valve roller	0.672 inch (17.07 mm) maximum
Width injector roller	0.993 inch (25.22 mm) maximum
Outside diameter	1.625 inch (41.28 mm) maximum
Inside diameter	0.755 inch (19.18 mm) maximum

g. Roll pushrods (3 and 4, FIG. 4-39) across a level surface to check for straightness. Check both ends of rod for scratches and abrasions. Replace as required.

h. Replace defective parts as required.

ASSEMBLY

NOTE

If new parts are used, be sure all of the oil preservative has been removed.

a. Use a suitable arbor press and a roller pin block to assemble the rollers 2 (5, FIG. 4-39) and pin (2) as follows:

(1) Position the roller (5), pin (2), and cam follower (7) in the press.

(2) Align the oil passage and roll pin holes in the cam follower (7) and roller (5).

(3) Select the proper thickness feeler gauges (1, FIG. 4-42). Place the gauge (1) between the roller (5) and cam follower (4) for support while pressing the pin (2) into the lever.

NOTE

The roller (5) to cam follower (4) side clearance must be 0.009 to 0.024 inch (0.23 to 0.61 mm) after the pin (2) is pressed into place.

(4) Press the roller pin (2) into the cam follower (4) and roller (5)until it is flush.

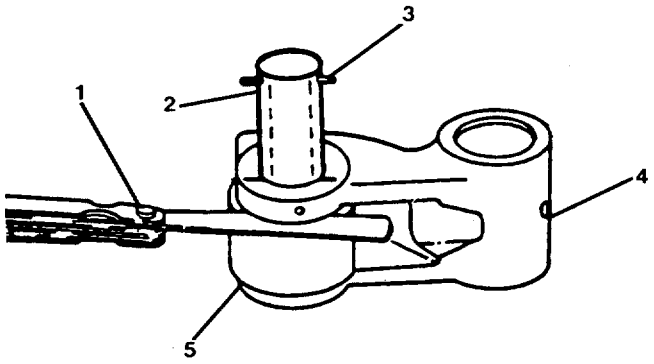


FIGURE 4-42. Cam Roller Pin Installation.

(5) Remove the feeler gauge (1). Recheck for side clearance. See the Note above.

(6) Use a mallet and tap the roll pin (3) into position if required. Verify roller rotates easily.

NOTE

The injector cam followers are in the center position on each shaft.

b. Assemble the cam followers (7, FIG. 4-39) onto the shaft (10). Secure the assembly with retainer rings (9).

REPLACEMENT

a. Lubricate camshaft and cam follower assemblies (3, FIG. 4-38) with clean engine lube oil.

CAUTION

- Service replacement cam followers are coated with a heavy preservative to prevent rust. This preservative must be completely removed with solvent before the parts are installed in the engine.

- The cam follower mounting capscrews have a special slot to allow the oil to flow to the cam follower assembly. The oil drilling intersects with the right capscrew hole. Failure will result if standard capscrews are used.

b. Position the cam follower assemblies (3, FIG. 4-38) over the ring dowels in the cylinder block. Install washers (2) and capscrews (1) finger tight. Ensure the shaft fits correctly on both ring dowels.

c. Torque the capscrew (1) alternately and evenly to 29 to 31 ft-lb (39 to 42 Nm).

d. Install gasket(s) (1, FIG. 4-37) and cam follower cover(s) (2).

e. Install washers (4), lockwashers (5) and capscrews (3). Torque to 30 ft-lb (40 Nm).

4-12. Replace/Repair Vibration Damper.

This task covers:

a. Removal, b. Repair, c. Replacement

INITIAL SETUP:

Tools

Tool kit, general mechanics rail and marine diesel engines, 5180-00-629-9783
Lifting sling P/N 3375958
Guide studs P/N 3376695
Torque wrench kit P/N 3377216
Crack detection kit P/N 3375432
Dial indicator 5120-00-277-8840

Materials/Parts

Paint solvent, Item 31, Appendix C
Engine lube oil, Item 2, Appendix C

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Front gear cover removed, para. 3-24.

REMOVAL

WARNING

The damper is very heavy. To avoid injury attach lifting sling gear before removing attaching bolts.

CAUTION

During removal, do not pry or pound on the damper. The damper may be extensively damaged.

NOTE

The use of a guide bolt will aid the removal process.

a. Remove bolts (3, FIG. 4-43) and washers (4), securing damper (6) to the crankshaft. Do not remove oil pin (5) unless it is damaged.

b. Lift damper (6) away from crankshaft.

c. Remove bolts (1) and spacer (2) from adapter (8). Remove adapter.

d. Install two 9/16-18 capscrews that have enough thread length to pass through the adapter (8) and touch the front mount with approximately 3/8 inch (9 mm) of thread protruding from the adapter. Turn the capscrews clockwise alternately and evenly to pull the adapter from the crankshaft.

e. Remove adapter (8). The roll pin (7) does not have to be removed unless it is damaged.

REPAIR

NOTE

Vibration damper must be replaced after 24,000 hours in service.

a. Check vibration damper for fluid leakage.

NOTE

The crack detection kit contains the necessary cleaner, penetrant and developer to check for cracks using the dye penetrant method.

(1) Spray rolled lip of vibration damper with crack detection developer.

(2) Preheat oven to 200°F (93°C).

WARNING

Wear protective clothing to prevent personal injury from burns.

(3) Place vibration damper in oven with rolled lip toward the bottom of the oven. Heat damper for 2 hours.

(4) Remove damper. Check for fluid leakage around the rolled lip. Replace damper if leakage is found.

b. Visually inspect the damper front cover plate for signs of raising or deforming. If variations are noted or suspected, proceed as follows:

(1) Using a paint solvent and fine emery cloth, remove the paint and accumulated dirt and grime from both the front and rear surfaces of the damper in four equally-spaced areas (avoid the area with stamped lettering). This will allow for precise measurement of the damper's thickness.

(2) Measure and record the thickness of these four areas approximately 1/8 inch from the outside edge of the front cover plate. Ensure the measurement is on a flat surface.

(3) Replace the damper if variations of 0.010 inch (0.25 mm) or more are found or if the thickness exceeds 2.574 inches (65.38 mm).

(4) Inspect all other mounting components for physical damage or wear. Replace as required.

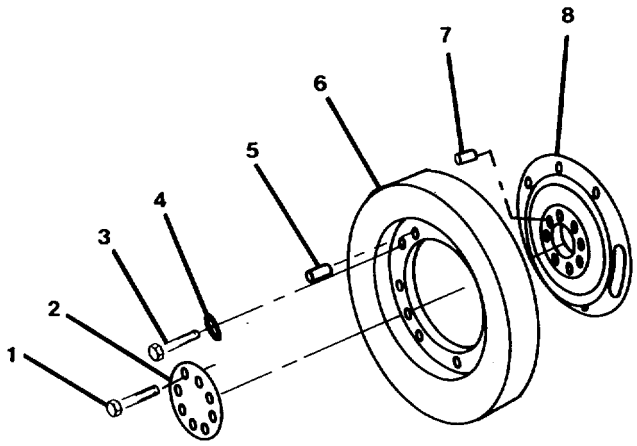


FIGURE 4-43. Vibration Damper Mounting Components.

c. Repair consists of replacement of defective parts.

REPLACEMENT

a. Wipe the crankshaft and damper mating surfaces with a clean dry cloth. Ensure surfaces are free of nicks and burrs.

b. Install roll pins in the front nose of the crankshaft and adapter face (7, FIG. 4-43), if they were removed.

c. Install two nine-inch guide studs 180 degrees apart in the capscrew holes of the crankshaft.

CAUTION

The crankshaft adapter must be aligned correctly with the crankshaft. Incorrect alignment will cause the valve and injector adjustment marks on the vibration damper to be in the wrong direction.

d. Align the roll pin with the receiving hole and position the adapter (8) over the guide studs to the crankshaft. Install spacer (2).

e. Lubricate threads and heads of bolts (1) with clean engine lube oil. Install four bolts (1) 90 degrees apart. Tighten bolts alternately and evenly to pull adapter (8) on the crankshaft. Ensure adapter is flat against crankshaft.

f. Install remaining bolts (1). Using the sequence in FIG. 4-44, torque bolts to 160 ft-lb (220 N•m). Advance bolts to 290 ft-lb (395 N•m). Apply final torque of 410 ft-lb (555 N•m).

CAUTION

- Dampers are available with standard and high viscosity fluid inside. If the damper has been replaced, verify the correct damper is installed.

- The vibration damper must be aligned correctly with the crankshaft adapter. Incorrect alignment will cause the valve and injector adjustment marks on the damper to be in the wrong position.

- The vibration damper is heavy. To avoid personal injury or equipment damage, use a lifting sling or get assistance when lifting the vibration damper.

g. Position the vibration damper (6) over the guide studs, engaging the adapter roll pin (7) and damper receiving hole.

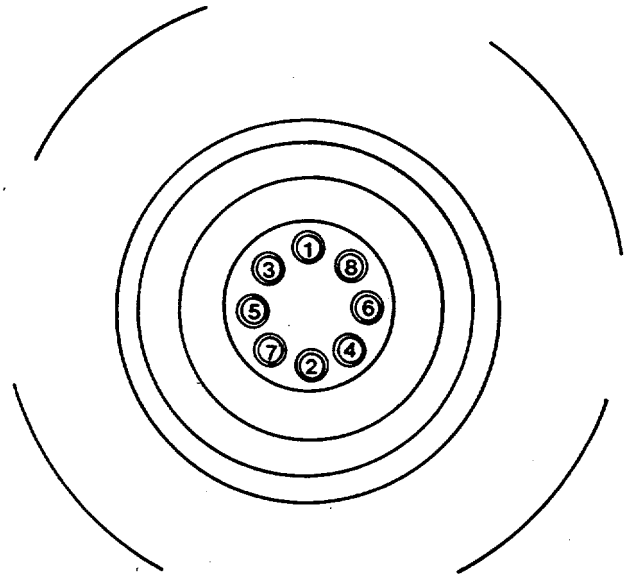


FIGURE 4-44. Tightening Sequence for Crankshaft Adapter.

WARNING

The capscrews (3) must be SAE grade 8. The washers (4) must be hardened. If the wrong parts are used, the capscrews could fail, allowing the damper to become loose and cause personal injury.

h. Lubricate the washer (4) faces and capscrews (3) threads with clean engine lubricating oil. Torque the capscrews (3) alternately and evenly to 155 ft-lb (210 N•m).

i. Check the vibration damper for eccentricity and wobble as follows.

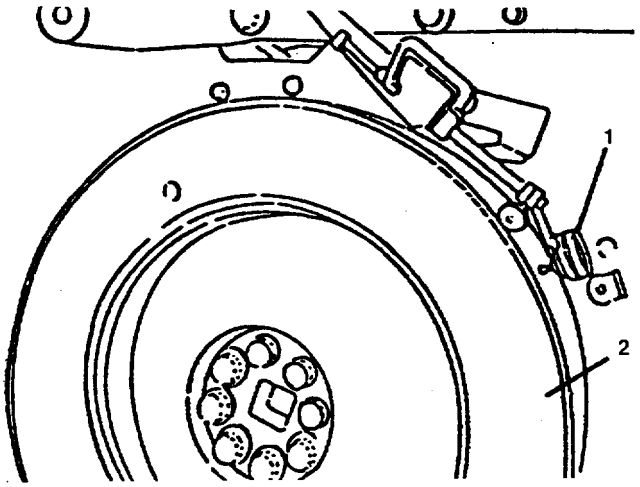


FIGURE 4-45. Vibration Damper Eccentricity Measurement.

NOTE

When adjusting the dial indicator, the indicator tip must not touch the valve and injector adjustment marks.

(1) Mount a dial indicator (1, FIG. 4-45) to the gear cover; position the indicator pointer on a machined surface of the outer member one-half inch back from the face of the damper (2).

(2) Rotate the engine crankshaft 360 degrees and record the total indicator runout. Verify eccentricity does not exceed 0.020 inch (0.51 mm).

(3) If the measurement is not within specifications, ensure that the roll pin is installed correctly. If it is still not within specifications, remove and inspect the damper.

NOTE

The crankshaft end clearance must be pushed or pulled in the same direction each time a measurement is taken during wobble measurement.

(4) Move the dial indicator (1) 0.50 inch (13.0 mm) from the outside diameter (FIG. 4-46).

NOTE

When dial indicator is not positioned 0.50 inch (13. mm) from the outside diameter, a new specification must be determined. To determine the new specification, measure the distance from the center of the crankshaft to the point the indicator tip touches the damper. Multiply distance by 0.0025 inch (0.064 mm) to obtain maximum total indicator runout (TIR) specification.

(5) Turn the crankshaft 360 degrees and record the total indicator runout. Verify wobble does not exceed 0.023 inch (0.58 mm).

(6) If the measurement is not within specifications, check for foreign matter between crankshaft, adapter and damper. If it is still not within specification, remove and inspect the damper.

j. Reinstall damper shield, paragraph 3-21.

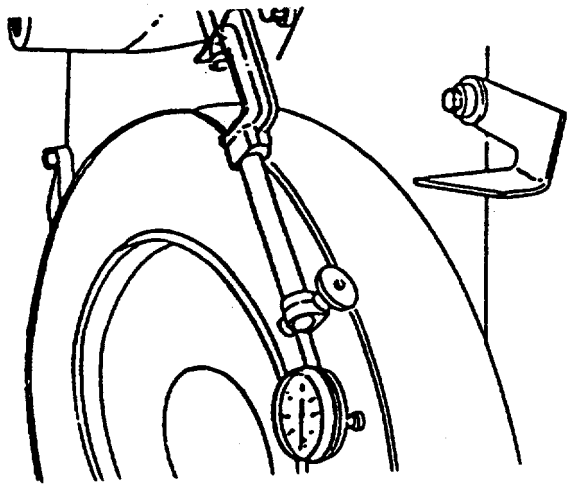


FIGURE 4-46. Vibration Damper Wobble Measurement.

4-13. Repair Crankshaft Assembly and Sleeve Bearings.

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP:

Tools

Tool kit, general mechanics rail and marine diesel engines, 5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958
Bearing cap puller P/N ST-1116
Crankshaft gear puller kit P/N 3375840
Machinist measuring tool set 5280-00-278-9919

Materials/Parts

Crankshaft assembly P/N 3040705
High pressure grease, Item 28, Appendix C
Engine lube oil, Item 2, Appendix C
Oil SAE 140W, Item 27, Appendix C

Equipment Condition

Engine removed from vessel, para. 3-12.
Turbocharger group removed, para. 2-19.
Water filters and thermostat housing assembly removed, paras. 2-16 and 2-17.
Instrument panel group removed, para. 2-15.
Fuel filters removed, para. 2-21.
Oil pan and adapter group removed, para. 2-36.
Oil pump removed, para. 3-23.
para. 2-34.
Cylinder head group removed, para. 2-34.
Piston and connecting rod removed, para. 2-25.

REMOVAL

NOTE

There are two side bolts for each main bearing cap.

a. Remove the main bearing cap side bolts (1, FIG. 4-47) and washers (2) from each side of the block.

NOTE

Ensure main bearing caps are identified correctly. The cylinder block has a number stamped at the bottom (oil pan flange) of the block at the left rear bank of the engine. Each main bearing cap contains the same number at the right bank top and front. The main bearing caps are also numbered 1 through 9. If the cap is not marked, mark the cap before removal.

b. Loosen the main bearing capscrews (3).

c. Use main bearing cap puller (1, FIG. 4-48) and remove the caps (2).

d. Remove the lower main bearing shells from the caps.

CAUTION

The main bearing cap capscrews are special high strength parts. Do not damage the capscrews by throwing them against each other or in a container. Damage to the parts will result in engine failure.

e. Remove capscrews (1, FIG. 4-49) lockwashers (2), and thrust bearing retainer plates (3).

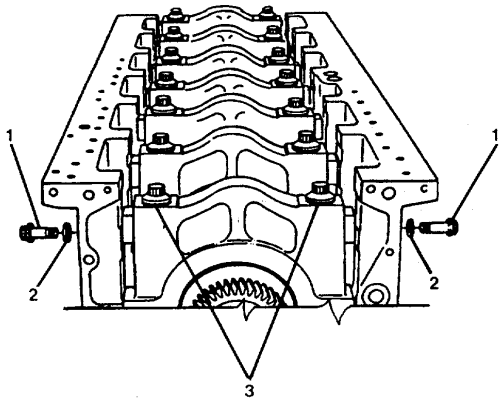


FIGURE 4-47. Main Bearing Side Bolt Removal.

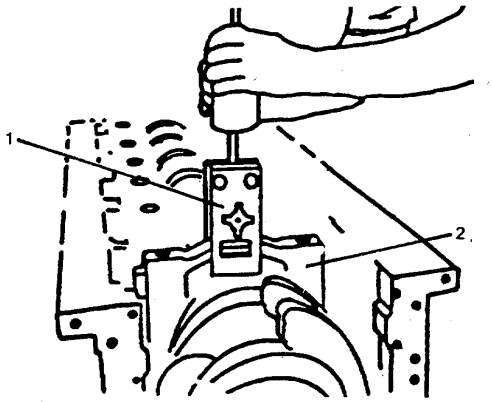


FIGURE 4-48. Main Bearing Removal/Installation.

f. Remove and mark thrust bearings (1, FIG. 4-57).

WARNING

The crankshaft is heavy. To avoid personal injury or equipment damage, use a lifting sling or get assistance when lifting the crankshaft.

g. Attach a sling (1, FIG. 4-50) to the crankshaft (2). Remove crankshaft using a suitable overhead lifting device.

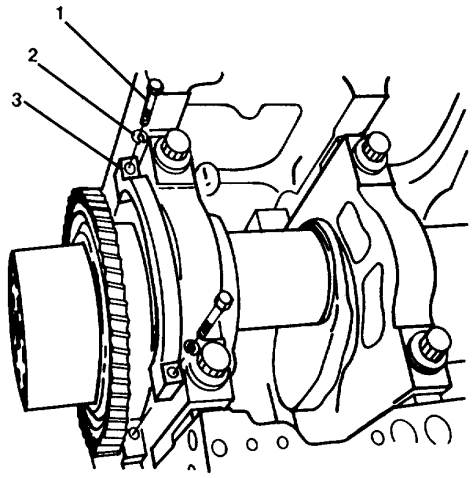


FIGURE 4-49. Main Bearing Cap Removal

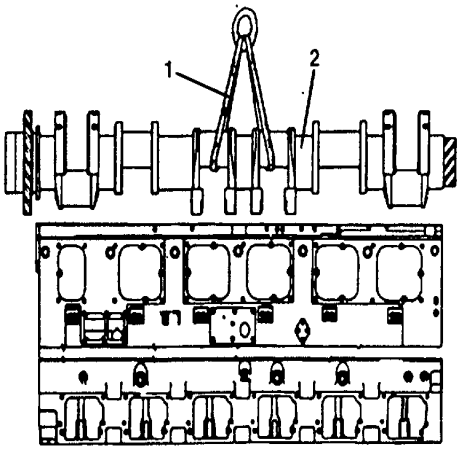


FIGURE 4-50. Crankshaft Removal/Installation

NOTE

Rotate the crankshaft, if necessary, to facilitate its removal.

h. Remove the upper main bearing shells and thrust rings. If bearing shell inspection is to be performed, tape the upper and lower shells together or otherwise identify them as removed.

REPAIR

a. Clean all drilled oil passages in the crankshaft with a bristle-brush and solvent (as if cleaning a rifle barrel).

b. If the crankshaft gear is chipped, cracked, broken or worn, replace the gear.

(1) Install puller jaw and bridge assembly on crankshaft (FIG. 4-51).

(2) Lubricate puller screw with clean engine lube oil.

CAUTION

Do not exceed 350 ft-lb (475 N•m) of torque when turning the puller screw on the puller jaw. The jaw will break.

(3) Hold pry bar steady while turning puller screw with torque wrench until gear is loose.

(4) Remove gear.

c. Inspect visually for scratches, nicks, cracks and obvious wear patterns and measure the crankshaft journals. See Table 4-4 .

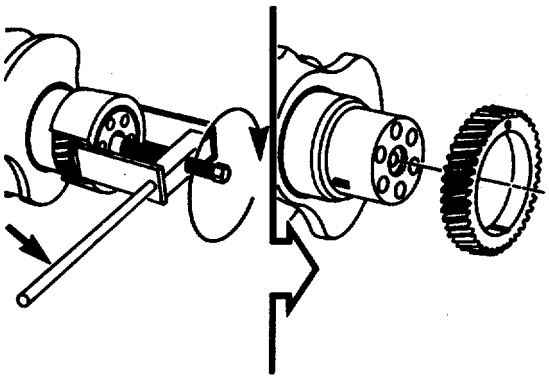


FIGURE 4-51. Crankshaft Gear Removal.

d. Check the journals for an out-of-round condition. Crankshafts should be reground if the main bearing or crankpin (connecting rod) journals are worn out-of-round more than 0.002 inch (0.05 mm).

CAUTION

If the counterweights have been removed for crank grinding or other reasons, do not intermix them. Upon assembly torque the capscrews for the counterweights to 200 to 210 ft-lb (271 to 285 N•m) and stake properly to prevent the capscrews from backing out.

e. Measure and carefully examine the crankshaft thrust flange (1, FIG. 4-52) at the No. 8 bearing. See Table 4-4 . If the surfaces are scored or scratched, the crankshaft should be reground and oversize thrust rings installed during reassembly.

f. Measure bearing shells (sleeves) (2, FIG. 4-53) with a ball point micrometer (1). See Table 4-4 for bearing thickness figures.

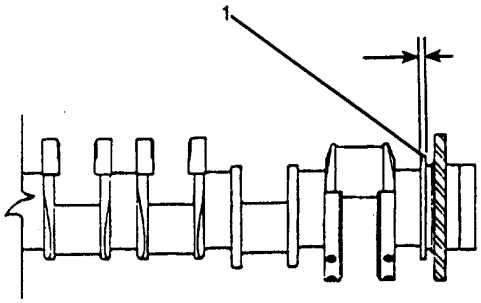


FIGURE 4-52. Crankshaft Thrust Flange Measurement.

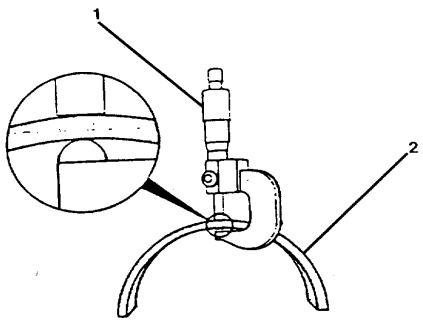


FIGURE 4-53. Bearing Shell (Sleeve) Measurement.

NOTE

- Do not scrape the bearing shells, or they will have to be lap filed, which increases the oil clearances. A properly fitted bearing will appear dull gray after a reasonable period of service, indicating it is running on an oil film. Bright spots indicate a metal-to-metal contact and black spots indicate an excessive clearance.

- Reground crankshafts or those used with undersize rod and main bearings and/or oversized thrust rings should be marked so the correct bearing shells and thrust rings can be installed in proper position. Markings (2, FIG. 4-54) for rod and main bearings are on the front counterweight (1). Thrust ring size (2, FIG. 4-55), and location are on the rear counterweight.

g. Install the crankshaft gear if removed.

(1) Install the key in the shaft.

(2) Heat the gear in a preheated oven at 400°F (205°C) for a minimum of one hour.

(3) Lubricate the flange with high pressure grease. Install the gear onto the shaft.

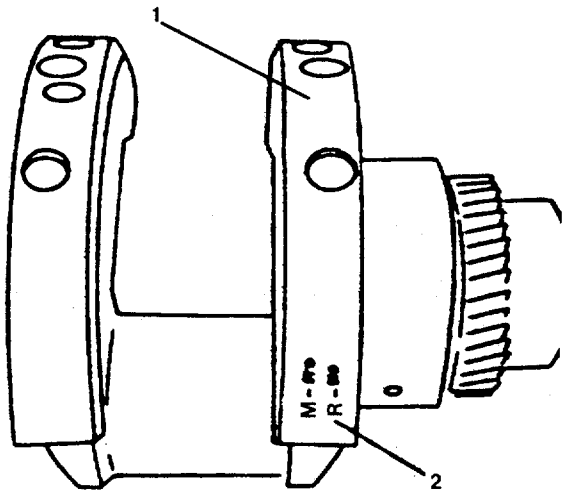


FIGURE 4-54. Markings on the Crankshaft for Undersize Main and Connecting Rod Journals.

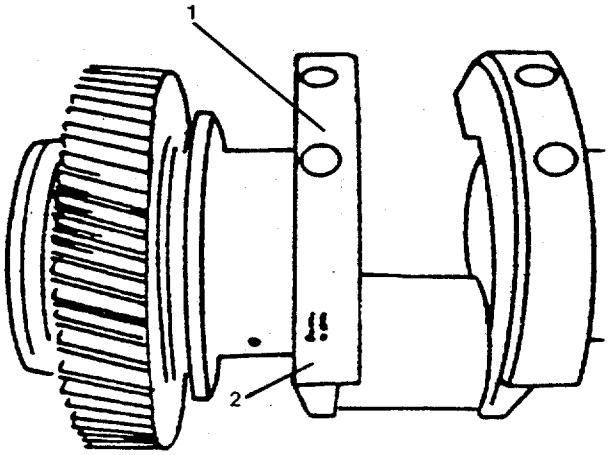


FIGURE 4-55. Marking on the Crankshaft for Oversize Thrust Bearing.

Table 4-4. Crankshaft Specifications Inch (mm)

Measurement	Minimum	Maximum
Connecting Rod Journal Outside Diameter	4.247 (107.87)	4.250 (107.95)
Main Bearing Journal Outside Diameter	6.498 (165.05)	6.500 (165.10)
Thrust Flange Width	0.493 (12.52)	0.502 (12.75)
Main Bearing Shell Thickness		
Standard	0.1685 (4.280)	0.1707 (4.336)
Oversize shells		
0.010	0.1735 (4.406)	0.1757 (4.463)
0.020	0.1785 (4.534)	0.1807 (4.590)
0.030	0.1835 (4.661)	0.1857 (4.717)
0.040	0.1885 (4.788)	0.1907 (4.844)
Thrust Ring Thickness		
Standard	0.1900 (4.826)	0.1945 (4.940)
Oversize		
0.010	0.2000 (5.080)	0.2045 (5.194)
0.020	0.2100 (5.334)	0.2145 (5.448)
0.030	0.2200 (5.588)	0.2245 (5.702)
0.040	0.2300 (5.842)	0.2345 (5.956)
End Clearance (Installed)	0.005 (0.13)	0.020 (0.51)

h. Repair consists of replacement of defective parts.

REPLACEMENT

NOTE

Before installation, check the bearing sizes (FIG. 4-54 and 4-55). Main bearings are two widths; the narrow bearings fit locations 1 and 9. The upper bearings contain an oil hole, the lower bearings do not. Both are marked on the back to indicate location.

a. Be sure the crankshaft, main bearing shells, thrust bearing retainer, and block main bearing bore are clean. Use a lint-free cloth to clean as necessary.

CAUTION

Prevent dirt from mixing with the lubricant. Dirty lubricant causes equipment failure.

b. Place the new upper main bearing shells (sleeves) (1, FIG. 4-56) in the block (2). Align the tang in the bearing with the slot in the block. The ends of the bearing shell (1) must be flush with the parting face of the block (2).

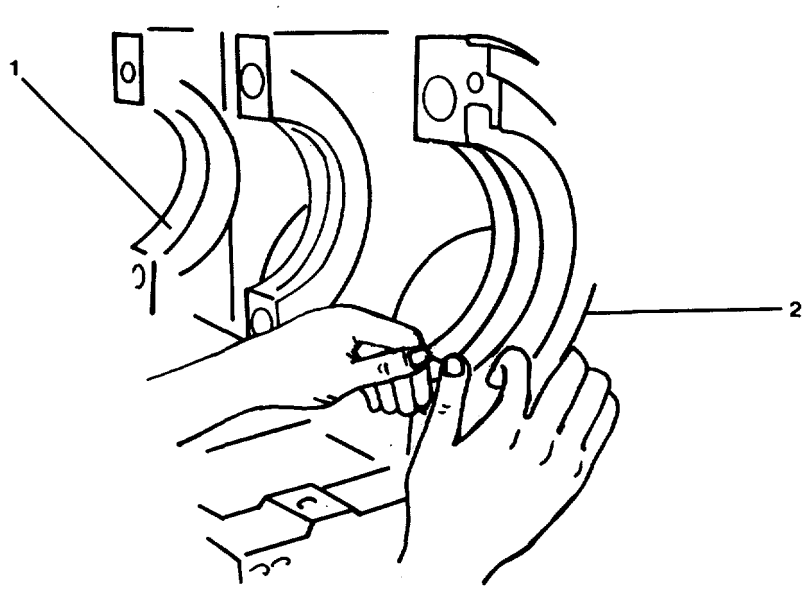


FIGURE 4-56. Main Bearing Shell (Sleeve) Installation.

NOTE

The upper main bearing shells are grooved and drilled for lubrication. No. 1 and 9 are 1/8 inch (3.17 mm) narrower than Nos. 2 through 8; locate them accordingly.

c. Lubricate the crankshaft journals and upper main bearing shells with a coat of clean engine lubricating oil.

WARNING

The crankshaft is heavy. To avoid personal injury or equipment damage, use a lifting sling or get assistance when lifting the crankshaft.

CAUTION

Do not cock the crankshaft during installation; damage to the bearing shells may result. If the crankshaft cocks, remove it and inspect the condition and location of the bearing shell and the condition of the thrust flange face.

d. Use a suitable hoist and lifting device to carefully lower the crankshaft into position (FIG. 4-50). Ensure the end of the crankshaft with the gear that has the smallest diameter points toward the front of the block.

CAUTION

The grooves in the thrust bearings must point toward the flange on the crankshaft or the engine will be damaged.

e. Lubricate the thrust bearings (1, FIG. 4-57); position with the grooved side of the face toward the crankshaft thrust flange (2) one on either side of flange and slide them into place in the thrust bearing retainer.

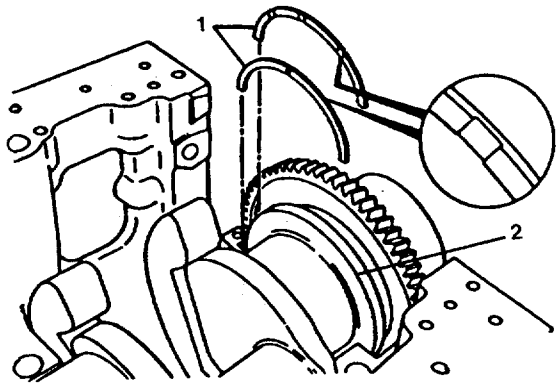


FIGURE 4-57. Crankshaft Thrust Bearing Removal/Installation.

NOTE

Move the crankshaft to the front or rear to install second thrust bearing.

NOTE

The cylinder block has a number to keep the block and main bearings together. The number is located on the bottom (oil pan flange) of the block at the left rear bank. The main bearing cap has the same number stamped at the lower bottom opposite the slot for the bearing tang. The bearings are numbered 1 through 9.

f. Use lint-free cloth to clean the lower bearings and the mounting surfaces of the cap.

CAUTION

Do not lubricate the back of the main bearings.

g. Position the lower half of the main bearing shells into the caps. Align the tang in the bearing with the slot in the cap. The end of the bearing must be even with the mounting surface of the main bearing cap.. Lubricate the bearing surfaces with clean engine lubricating oil.

h. Install main bearing caps as follows;

NOTE

Main bearing caps are numbered 1 through 9. Position caps (1, FIG. 4-58) to the block (2) carefully to avoid dislocation of bearing shell.

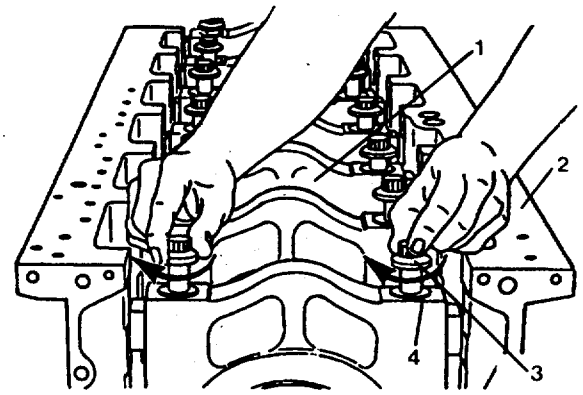


FIGURE 4-58. Main Bearing Cap Installation.

CAUTION

Allow excess oil to drip from the capscrews before installation in the block. Excess oil can result in hydraulic pressure causing the cylinder block to break.

(1) Lubricate the main bearing capscrew threads with clean engine lubricating oil; coat under the head of the capscrews (3) and hardened washers (4) with SAE 140W lubricant. Install washers and capscrews in main bearing cap (1).

CAUTION

- Ensure the side of the cap and bearing with the bearing locating tang is toward the tang in the block.
- Do not rotate the crankshaft until the caps are pulled to the block. Damage will result if the bearings move out of location.

NOTE

Keep the cap straight while moving it across the holes for the side bolts. There is little or no clearance between the parts.

(2) Install main bearing cap..

(3) Turn capscrews by hand until capscrews touch thewasher or the main bearing cap.

CAUTION

Do not use impact wrenches. The main bearing shells can fail.

(4) Use two wrenches. Tighten both capscrews at the same time to pull the main bearing cap into position. Ensure the cap is touching the block. If not, check for bearing out of location.

NOTE

The side of the thrust bearing retaining plate (3, FIG. 4-48) that is machined must be toward the main bearing cap.

i. Install thrust bearing retaining plate (3), lockwashers (2), and capscrews (1). Torque capscrews to 30 ft-lb (40 N•m).

CAUTION

Do not rotate the crankshaft until the main bearing caps are pulled to the block. Damage will result if the bearings move out of location.

j. Turn the crankshaft by hand to check ease of movement. If it does not turn, remove main bearing caps one at a time and recheck ease of movement. This will locate the out-of-alignment cap.

k. Lubricate washers (2, FIG. 4-47) and heads and threads of side bolts (1). Install washers and side bolts. Do not tighten.

l. Torque main bearing capscrews (3, FIG. 4-58) using the procedure in Table 4-5 and the sequence in FIG. 4-59.

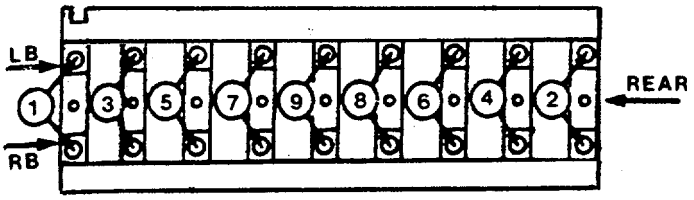


FIGURE 4-59. Main Bearing Capscrew Torquing.

m. Repeat step j.

n. Torque the side bolts (1, FIG. 4-47) using the procedure in Table 4-6 and the sequence in FIG. 4-60.

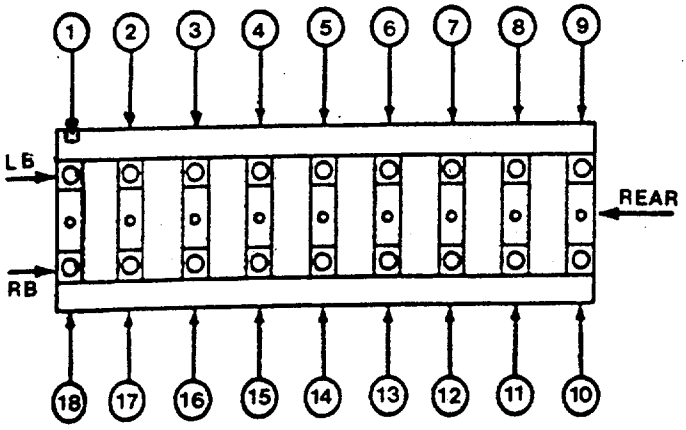


FIGURE 4-60. Side Bolt Torquing.

NOTE

It may be necessary to bring the crankshaft end clearance to specifications by installing oversize bearings. In extreme cases, a new or reconditioned crankshaft must be used.

o. Attach a dial indicator gauge (3, FIG. 4-61) to the cylinder block (2) with the contact point of the gauge resting on the crankshaft flange end-face. Measure end clearance. If end clearance is not between 0.005 inch (0.13 mm) and 0.020 inch (0.51 mm), check for foreign matter on thrust bearings and crankshaft flange.

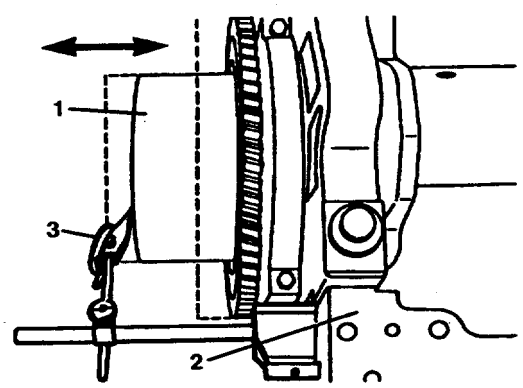


FIGURE 4-61. Crankshaft End Clearance Check.

Table 4-5. Main Bearing Capscrew Tightening

Capscrew Torque Value		
N•m	Step	ft-lb
175	1	130
285	2	210
610	3	450
Loosen	4	Loosen
175	5	130
285	6	210
610	7	450

Table 4-6. Main Bearing Cap Side Bolt Tightening

Capscrew Torque Value		
N•m	Step	ft-lb
65	1	50
215	2	160
455	3	335

4-14. Repair Pulley Shield Front Gear Housing Group.

This task covers:

Repair

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engines, 5180-00-629-9783

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Gear housing removed, para. 3-21.

Materials/Parts

Metal epoxy filler, Item 29, Appendix C
Gasket P/N 3178076
Repair sleeve P/N 132770
Crocus cloth, Item 11, Appendix C
Emery cloth, Item 18, Appendix C
Gasket adhesive, Item 8, Appendix C
Seal P/N 3016792
Engine lube oil, Item 2, Appendix C
Bushing sleeve P/N 4205683
Gasket P/N 43016792
Solvent, Item 15, Appendix C

REPAIR

a. Use solvent to clean the front gear housing. Inspect the gear cover seal bore for grooves and burrs. Remove all burrs which would damage the oil seal outside diameter and cause leakage.

b. Inspect the crankshaft oil seal wear surface for nicks, scratches, and sharp edges. Remove them by using 240 grit emery cloth dipped in clean lubricating oil. Use crocus cloth for a finalpolishing.

c. If the previous seal was operated with a wear sleeve, the sleeve must be removed and discarded. Oil seals are sized to operate directly on the shaft surface without a wear sleeve.

NOTE

Repair sleeves are available for crankshaft oil seal surfaces that are badly grooved or mutilated, where a renewed surface is desirable for the seal lip to seat.

d. Remove old wear sleeves by using a 3/4 inch (19 mm) chisel and a hammer. Grind a 1/16 inch (1.59 mm) radius on the cutting edge of the chisel. Using moderate blows with the hammer, strike the chisel against the wear sleeve at three to six equidistant points on the outside diameter of the wear sleeve. This will relieve the press-fit of the sleeve allowing it to be removed by hand.

e. After the old wear sleeve is removed, the surface should be cleaned and polished with crocus cloth. More advanced corrosion deposits may require the use of emery cloth.

f. Should a repair sleeve be required, select the proper repair sleeve and install using the installation tool provided with the sleeve.

g. Clean the old seal surface thoroughly. File down any burrs and clean up any rough spots.

h. Note the position of the repair sleeve required to cover the prior seal wear pattern. Ensure the disposable tool (2, FIG. 4-62) supplied with each repair sleeve will position the sleeve correctly. If a longer installation tool is required, see step (n).

i. Place the repair sleeve (1) over the worn or damaged area. If more clearance is required, the repair sleeve flange can be removed by sawing through the flange to the pre-cut groove (3).

j. If the crankshaft seal area is deeply scored, fill the groove with powdered metal epoxy type filler and install the repair sleeve before the filler hardens.

k. If the groove in the crankshaft does not require filling, apply a light coating of non-hardening sealant to the inner surface of the repair sleeve.

l. Place the repair sleeve into the end of the installation tool. Gently tap the center of the installation tool until the sleeve reaches a point on the crankshaft covering the wear pattern from the prior seal.

NOTE

Use a wood block or large-faced mallet to avoid caving in the back of the installation tool. Remove any excess filler or sealer.

m. Remove the repair sleeve flange by starting at the saw line (step i). Use side cut pliers to pull the flange away from the seal surface and twist into a coil. The flange will break loose along the pre-cut line.

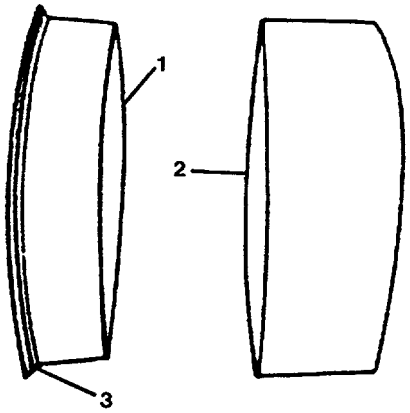


FIGURE 4-62. Installation Tool and Repair Sleeve.

CAUTION

The crankshaft and repair sleeve must be free of any burrs which might cut the seal lip.

n. If the installation tool supplied with the repair sleeve is too short to install the sleeve into the desired position, a length of tubing or pipe can be substituted as an installation tool. The tubing or pipe substituted for the installation tool should have an inside diameter larger than the crankshaft diameter.

NOTE

Pipe or tubing used as installation tool must be cut off squarely and all burrs which might damage the sleeve or crankshaft must be removed.

o. Inspect the trunnion sleeve for wear, scoring, or distortion; replace if damaged.

(1) Start the new sleeve (chamfer in) over the trunnion.

(2) Press the sleeve over the trunnion until it is flush with the trunnion face.

p. Drive Bore Bushings.

(1) Check the bore of the fuel and water pump drive bushings; replace if worn larger than 1.571 inch (39.9 mm).

(2) If either drive shaft is worn enough to allow use of an undersize bore bushing (maintain a minimum clearance of 0.003 inch (0.08 mm) between the shaft and bushing), use as listed in Table 4-7.

Table 4-7. Fuel and Water Pump Bore Bushing Specifications - Inch (mm)

Ref. No.	Dimension Location	Worn Limit	New Minimum	New Maximum
132770	(Standard) Inside Diameter	1.571 (39.90)	1.565 (39.75)	1.569 (39.85)
132771	0.010 (0.25) Undersize Inside Diameter	1.561 (39.65)	1.555 (39.50)	1.559 (39.60)
132772	0.020 (0.51) Undersize Inside Diameter	1.551 (39.40)	1.545 (39.24)	1.549 (39.34)

q. Idler Gear and Shafts.

(1) Check the bushing bore of the camshaft and water pump idler gears; replace if worn larger than 1.8785 inch (47.714 mm).

(2) Check the camshaft and water pump idler gear shafts; replace if smaller than 1.872 inch (47.55 mm).

(3) The cam and water pump idler gear end thrust must be less than 0.018 inch (0.46 mm).

r. Replace the gear housing (paragraph 3-21).

4-15. Repair Crankshaft and Gear Group.

This task covers:
Repair.

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engines, 5180-00-629-9783
Timing fixture P/N 3375522
Camshaft installation pilots P/N 3376280
Driver bushing kit P/N 3376633
Bearing and bushing inserter P/N 3376637
Torque wrench kit P/N 3377216
Machinist measuring tool set 5280-00-278-9919
Magnaglo tester P/N H620

Equipment Condition

Camshaft and gear group removed, para. 3-24.

Materials/Parts

High pressure lubricant, Item 19, Appendix C
Spur gear P/N 3004681, 3008970
Camshaft gear P/N 3008971
Helical gear P/N 3004683
Camshaft P/N 3006298, 3006299
Cleaning solvent, Item 15, Appendix C

REPAIR

CAUTION

Do not touch the machined surface with bare hands after the camshaft has been cleaned. This will cause rust to form.

a. Clean camshaft assembly with solvent.

NOTE
Marks on the lobes and journals that cannot be felt with fingernail are acceptable.

b. Visually inspect camshaft for scuffed, scored or cracked lobes. Discard camshaft if any of these conditions exist.

c. Measure bushing journals' outside diameter. Replace camshaft if journals are not between 2.995 inch (76.07 mm) and 2.997 inch (76.12 mm).

d. Check for possible cracks using magnaglo tester.

NOTE

The gear and shaft retaining plate must be removed before performing this check.

(1) Set up magnaglo tester for head shot method using instructions provided on tester. Adjust test to 2000 ampere dc or rectified ac (FIG. 4-62a).

(2) Apply wet bath solution to area being checked. Do not wet more than 1/3 of the camshaft at a time. Continually wet the area while applying voltage from the tester.

(3) Use black light supplied with tester to check camshaft for cracks.

(4) Set up magnaglo tester for coil shot method. Use the 12 inch (305 mm) coil supplied with the tester.

NOTE

An ampere turn is an electrical current of one ampere flowing through the coil multiplied by the number of turns in the coil.

(5) Apply coil shot of amperage (ampere turns) between 3600 and 4000 dc or rectified ac (FIG. 4-62b). Continuously wet area with solution.

(6) Check the camshaft for cracks using blacklight.

(7) Do not use camshaft if there is any of the following indications on the bearing journals:

- four open indications in an axial direction on one of the bearing journals,
- more than 1/2 of the open indications extend more than 1/2 the distance across the bearing journals,
- an open indication in a circumferential direction.

NOTE

An open indication is visible to the eye after the wetting operation has been completed. An indication below the surface is not visible to the eye after the wetting operation has been completed. An indication below the surface can be seen with the use of an ultraviolet light.

(8) Do not use the camshaft if there is any of the following open indications:

- indication in a circumferential direction,
- indication in the black or shaded areas shown in FIG. 4-63.
- indication longer than 1/4 inch (6 mm).

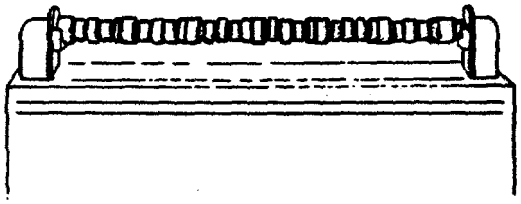


FIGURE 4-62a. Camshaft Head Shot Check.

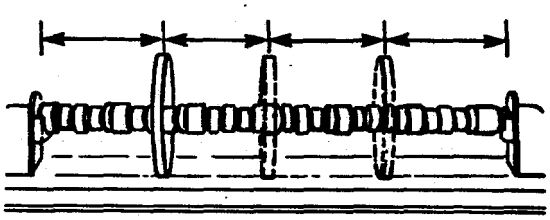


FIGURE 4-62b. Camshaft Coil Shot Check.

- indication that is closer than 3/16 inch (5 mm) from the edge,
- two or more indications on one lobe.

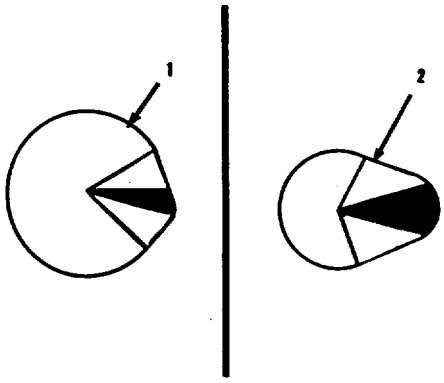


FIGURE 4-63. Camshaft Inspection Areas.

(9) Do not use camshaft if there is any of the following indications below the surface:

- two indications in shaded area (FIG. 4-63),
- indication in shaded area longer than 5/8 inch (16 mm),
- three indications in white area,
- indication in black area of injector lobe (1).
- more than two indications in black area of valve lobe (2),
- indication in black area of valve lobe (2) longer than 1/8 inch (3 mm).

CAUTION

The camshaft must be demagnetized completely and cleaned thoroughly. Small metal particles will cause engine damage.

(10) Demagnetize and clean the camshaft.

e. Inspect camshaft gear. If the gear is visibly chipped, cracked or worn, the gear must be replaced.

f. Use a feeler gauge to measure camshaft thrust clearance. If clearance is not between 0.006 inch (0.15 mm) and 0.013 inch (0.33 mm) the gear must be removed.

CAUTION

Do not use a heating torch when removing the camshaft gear. Damage to the camshaft could result.

g. Remove gear (1, FIG. 4-64) using a suitable hydraulic press. Remove shaft retaining plate (2) from the shaft (3).

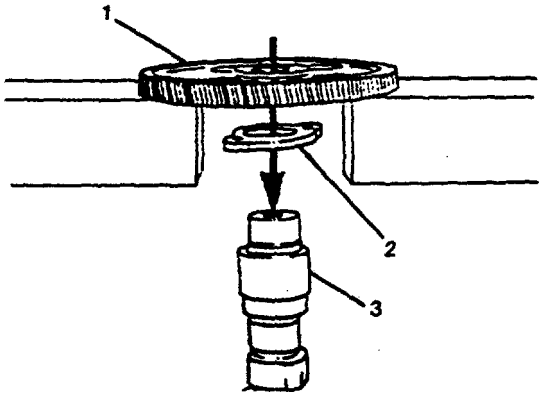


FIGURE 4-64. Camshaft Gear Removal.

NOTE

Camshaft keys are available in different sizes (amount of offset). The injection timing is controlled by the amount of offset and by the direction of offset when compared to the camshaft gear rotation. Check and record the direction of the key offset when compared to the camshaft gear rotation (same or opposite).

h. Remove the camshaft key (1, FIG. 4-65) from the shaft (2). Clean the parts.

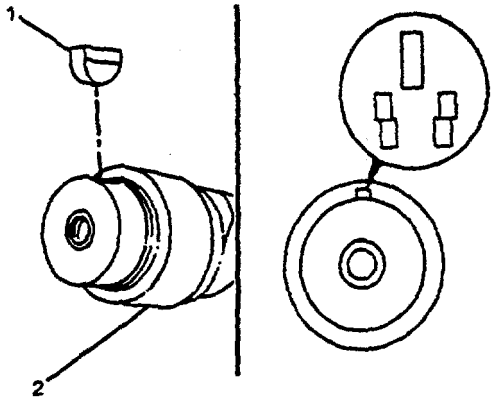


FIGURE 4-65. Camshaft Key Removal/Replacement.

i. Measure the shaft retaining plate with a micrometer. Replace if not between 0.360 to 0.372 inch (9.14 to 9.45 mm) thick or if it is scored.

CAUTION

If the area of fretting is longer than a 1/8-inch (3 mm) wide longitudinal band, replace the camshaft. Fretting or damage can cause camshaft failure.

j. Check the camshaft nose in the gear area for fretting or burrs. Remove fretting or burrs with a fine crocus cloth. If they cannot be removed, replace the camshaft.

k. Measure the outside diameter of the camshaft nose in the gear area. Replace the camshaft if the outside diameter is not between 2.2520 inch (57.201 mm) and 2.2524 inch (57.211 mm).

CAUTION

Do not use the gear if the bore is damaged or has fretting in excess of a 1/8 inch (3 mm) wide bank. Fretting or damage can result in gear movement causing camshaft failure.

1. Inspect camshaft gear for cracks, chipped or broken teeth. Inspect the bore for fretting or burrs. Inspect the keyway for burrs. Remove fretting, burrs, or raised material with a fine crocus cloth. If they cannot be removed, replace the gear.

m. Check camshaft gear for cracks using magnaglo tester.

CAUTION

Use the copper braid contact with neoprene covers supplied with the tester to avoid burning the teeth of the gear. Position the gear so that the keyway points toward one of the characters (FIG. 4-65a).

(1) Apply bath solution to area being checked.

(2) Set up magnaglo tester for head shot using instructions provided on tester. Apply head shot amperage. Adjust amperage to value specified below:

Gear Outside Diameter	Amperage dc
Less than 4 inch (101 mm)	1000
4 inch to 8 inch (101 mm to 203 mm)	1500
Greater than 8 inch (203 mm)	2000

(3) Use black light supplied with tester to checkgear for cracks.

CAUTION

Position gear so that keyway points toward the coil (FIG. 4-65b) 4-65

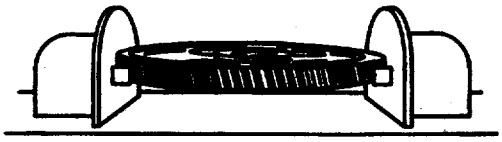


FIGURE 4-65a. Camshaft Gear Head Shot Check.

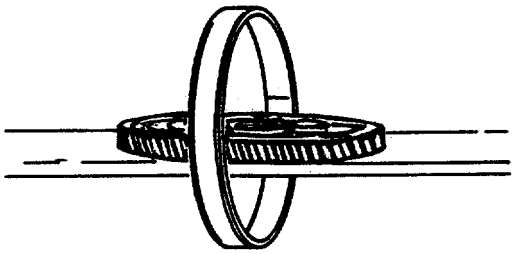


FIGURE 4-65b. Camshaft Gear Coil Shot Check.

(3) Set up magnaglo tester for coil shot method. Apply coil shot amperage. Adjust amperage to value specified below:

NOTE

Ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

Gear Outside Diameter	Amperage Turns
Less than 4 inch (101 mm)	4000
4 inch to 8 inch (101 mm to 203 mm)	6000
Greater than 8 inch (203 mm)	8000

(4) Check gear for cracks.

n. Measure the gear bore inside diameter. Replace the gear if the inside diameter is not between 2.2490 inch (57.125 mm) and 2.2500 inch (57.150 mm).

NOTE

The camshaft gear must be removed to adjust the injector timing. If the camshaft is replaced, do not install the camshaft gear until the injector timing has been adjusted using a slip-fit gear.

o. Install correct camshaft key (1, FIG. 4-65).

WARNING

Wear protective clothing to prevent personal injury from burns.

CAUTION

Do not attempt to install the gear without using heat. Do not exceed the specified time or temperature. Damage to the gear will result.

p. Heat the camshaft gear in a pre-heated oven at 450°F (235°C) for a minimum of 1 hour to a maximum of 6 hours.

q. Lubricate the camshaft at the gear location with lubricate.

r. Install the shaft retaining plate (2, FIG. 4-64). Ensure grooves on shaft retaining plate are toward the camshaft gear (1).

NOTE

The timing mark on the camshaft gear must be visible from the front of the camshaft after the gear is installed. The keyway must be aligned with the key in the gear.

s. Remove gear (1) from oven and install on camshaft (3).

CAUTION

Allow the gear to air cool. Do not use water or oil to reduce the cooling time. Forced cooling could cause the gear to crack.

t. Set camshaft and gear assembly aside to cool.

4-16. Repair Connecting Rod and Piston Group

This task covers: Repair

INITIAL SETUP:

Tools

Tool kit, general mechanics rail and marine diesel engines, 5180-00-629-9783
Piston ring expander P/N ST-1269
Dial indicator 5210-00-277-8840
Machinist measuring tool set 5280-00-278-9919
Magnaglo tester P/N H620

Equipment Condition

Rod/Piston assemblies removed from engine, pistons removed from rods, para. 3-25.

Materials/Parts

Connecting rod assembly P/N 3043910
Compression ring P/N 3046227
Piston P/N 3801436
Emery cloth, Item 18, Appendix C
Piston ring set P/N AR-10680
Cleaning solvent, Item 15, Appendix C

REPAIR

a. Connecting Rods.

CAUTION

The number on the connecting rod must be the same as the number on the rod cap. Never assemble a new cap to an old rod or an old cap to a new rod.

(1) Remove capscrews (3, FIG. 4-66), washers (4) and cap (2) from connecting rod (1).

(2) Use solvent to clean the parts.

(3) Inspect rod and cap for fretting damage. The rod and cap must be replaced as an assembly if fretting damage is visible on either piece.

(4) Check the threads of the connecting rod capscrews for damage. Check the capscrew head for ,cracks.

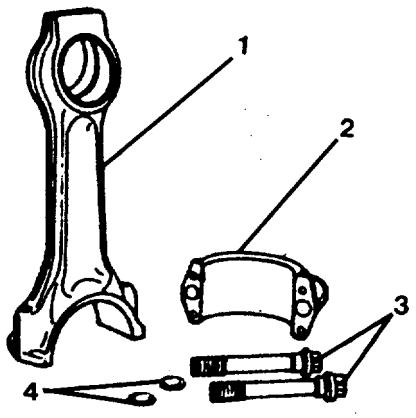


FIGURE 4-66. Connecting Rod Disassembly.

(5) Measure the connecting rod capscrew in the locations shown in FIG. 4-67. Replace the capscrew if it is not to the following specifications:

Length (1): 5.360 inch (136.14 mm) to 5.390 inch (136.91 mm)
Outside Diameter (2): 0.601 inch (15.26 mm) to 0.605 inch (15.37 mm)
Outside Diameter (3): 0.683 inch (17.35 mm) to 0.687 inch (17.45 mm)

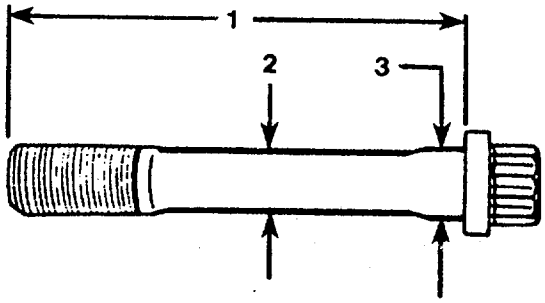


FIGURE 4-67. Capscrew Measurement.

(6) Measure the inside diameter of the connecting rod bushing. Replace the rod assembly if the diameter is not between 2.4010 inch (60.985 mm) and 2.4025 inch (61.024 mm).

CAUTION

- Use a vise with brass jaws to hold the rod. Notches, scratches, or dents in the rod will cause engine failure.
- The number on the connecting cap must be the same as the number on the rod cap. Never assemble a new cap to an old rod or an old cap to a new rod.

(7) Lubricate the connecting rod capscrews (3, FIG. 4-66) with clean engine lube oil.

(8) Assemble the rod (1), cap (2), washers (4) and capscrews (3). Tighten capscrews in the following sequence:

Step		Torque Value
1		80 ft-lb (108 N•m)
2		160 ft-lb (217 N•m)
3		240 ft-lb (326 N•m)
4	Loosen both capscrews	
5		80 ft-lb (108 N•m)
6		160 ft-lb (217 N•m)
7		240 ft-lb (326 N•m)

(9) Use a dial bore indicator. Measure the inner diameter of the connecting rod bearing bore. Measure at 90 degrees from the parting line and within a 20-degree arc from each side of the parting line (FIG. 4-68).

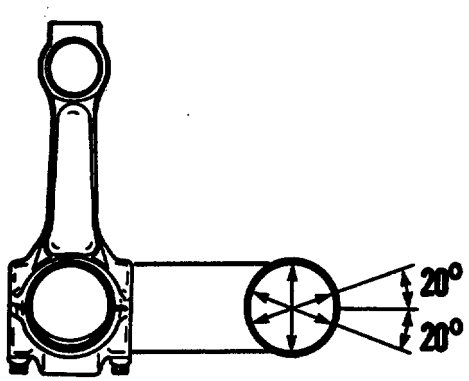


FIGURE 4-68. Connecting Rod Bore Measurement.

(10) Verify all three measurements are between 4.5017 inch (114.343 mm) and 4.5027 inch (114.369 mm). Replace rod if any measurement is not to specification.

(11) Set up magnaglo tester for head shot method using instructions provided on tester. Apply bath solution to area being checked. Apply head shot amperage of 1500 ampere dc or rectified ac. Check for cracks.

NOTE

Ampere turn is an electrical current of one ampere flowing through the coil, multiplied by the number of turns in the coil.

(12) Set up magnaglo tester for coil shot method. Apply coil shot amperage (ampere turns) between 2600 and 2800 dc or rectified ac (FIG. 4-68a).Check for cracks.

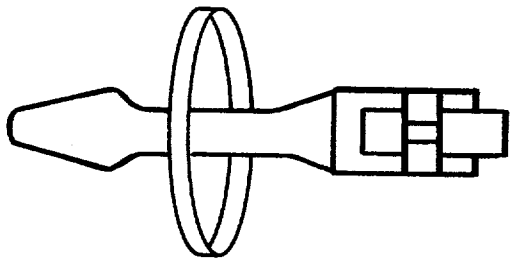


FIGURE 4-68a. Connecting Rod Magnetic Check.

(13) Replace connecting rod if any indications are visible in the shaded areas shown in FIG. 4-69.

CAUTION

The rod must be demagnetized completely and cleaned thoroughly. Any small particles will cause engine damage.

(14) Demagnetize connecting rod. Clean rod with steam or solvent.

b. Pistons.

(1) Use a piston ring expander to remove the piston rings.

WARNING

Wear protective clothing to prevent personal injuries from chemical or steam burns.

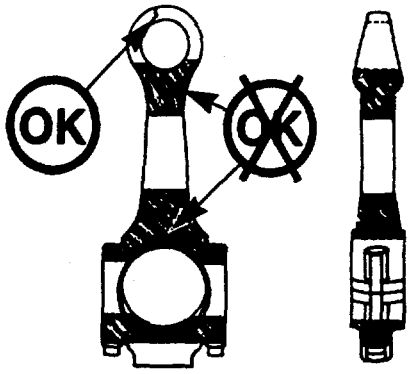


FIGURE 4-69. Connecting Rod Inspection.

CAUTION

Do not use the bead blast method to clean the piston. The piston will be damaged.

NOTE

Premium pistons have an anodized surface that is gray in appearance. Do not remove this surface when cleaning piston.

(2) Clean the outer layer of carbon from the piston with steam.

NOTE

- Do not use a solvent that is higher than 9.5 pH. Do not use a solvent that contains chlorinated hydrocarbons with cresols, phenols or cresylic compounds.
- For best results, soak the piston for several hours or overnight. Use a solvent that can be heated 180°F to 200°F (90°C to 95°C) and a cleaning tank that will constantly mix and filter the solution.

(3) Soak pistons in a kerosene emulsion based solvent for a minimum of 30 minutes.

CAUTION

Do not use a metal bristle brush to clean ring grooves. Exercise care if using a used piston ring to clean the grooves. Damage to the piston grooves can result in failure to piston and ring.

(4) Use a brush or the gap end of a used piston ring to clean the grooves on the piston.

(5) Repeat steps (3) and (4) until piston is thoroughly clean.

WARNING

Use protective clothing to prevent personal injury from steam burns.

(6) Use steam to rinse the solvent from the piston. Dry with compressed air.

(7) Check piston ring grooves. Replace piston if there is a visible ridge in the back of the groove or if a lip has formed on the outside diameter of the groove.

(8) Check piston for scratches, scuffing or other damage. Replace piston if damaged.

NOTE

Piston measurements must be done when the piston is a room temperature of approximately 70°F (21°C).

(9) Measure the inside diameter of the piston pin bore at several points. Replace piston if diameter is not between 2.3985 inch (60.922 mm) and 2.3989 inch (60.932 mm).

(10) Measure the outside diameter of the piston at the centerline of the pin bore (1, FIG. 4-70) and at 1 inch (25 mm) from the bottom (2). Replace piston if measurements are not as follows:

Location (1): 6.2380 inch (158.445 mm) to 6.2390 inch (158.471 mm)

Location (2): 6.2378 inch (158.440 mm) to 6.2402 inch (158501 mm)

(11) Use dye penetration method, check for cracks on the top of the piston and within the piston pin ring bore. Replace piston if cracks are found.

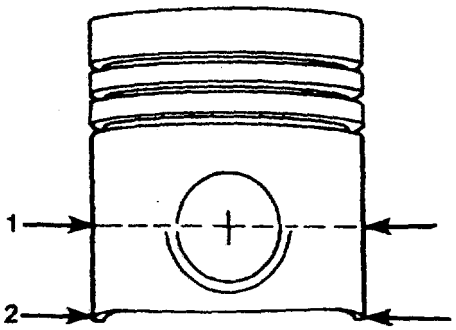


FIGURE 4-70. Piston Measurement.

CAUTION

- The gap in the oil ring expander (4, FIG. 4-71) must be turned 180 degrees opposite the gap on the oil ring (3) or the rings and piston will be damaged.
- Do not align the gap of a ring (1, 2, 3) with a piston pin bore (6) or the ring will break and damage the piston and cylinder liner.

NOTE

The piston rings are marked with the part number. The shipping package is marked with the location. The part number on the ring must be positioned toward the top of the piston.

(12) Use piston ring expander (7). Install rings (1, 2, 3, 4) on piston (5).

(13) Rotate rings so gaps are not aligned with an adjacent ring or the piston pin bore (6).

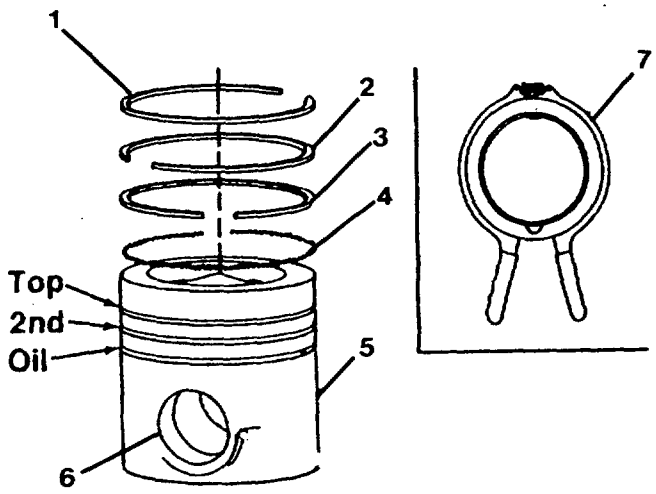


FIGURE 4-71. Oil Ring Expander.

4-17. Repair Flywheel Housing

This task covers: Repair

INITIAL SETUP:

Tools

Tool kit, general mechanic's rail and marine diesel engines, 5180-00-629-9783
Torque wrench kit P/N 3377216
Lifting sling P/N 3375958
Heating torch or oven
Dowel puller P/N ST-1134
Drill and ream fixture P/N ST-1232
Crack detector kit P/N 3375432
Arbor press 4920-00-373-9376

Equipment Condition

Engine shutdown. TM 55-1905-223-10.
Flywheel and housing group removed, para. 3-26.

Materials/Parts

Cleaning solvent, Item 15, Appendix C
Tempilstick crayon, 6000F (316°C), Item 32, Appendix C
Flywheel and ring gear assembly P/N 3017655
Ring gear P/N 124507
Gasket P/N 102827

REPAIR

a Flywheel and ring gear assembly (1, FIG. 4-72).

(1) Inspect the ring gear (2) for broken or cracked teeth.

(2) Inspect the flywheel (3) mounting area by the dye penetrant method. Check for cracks around the mounting holes of the pilot.

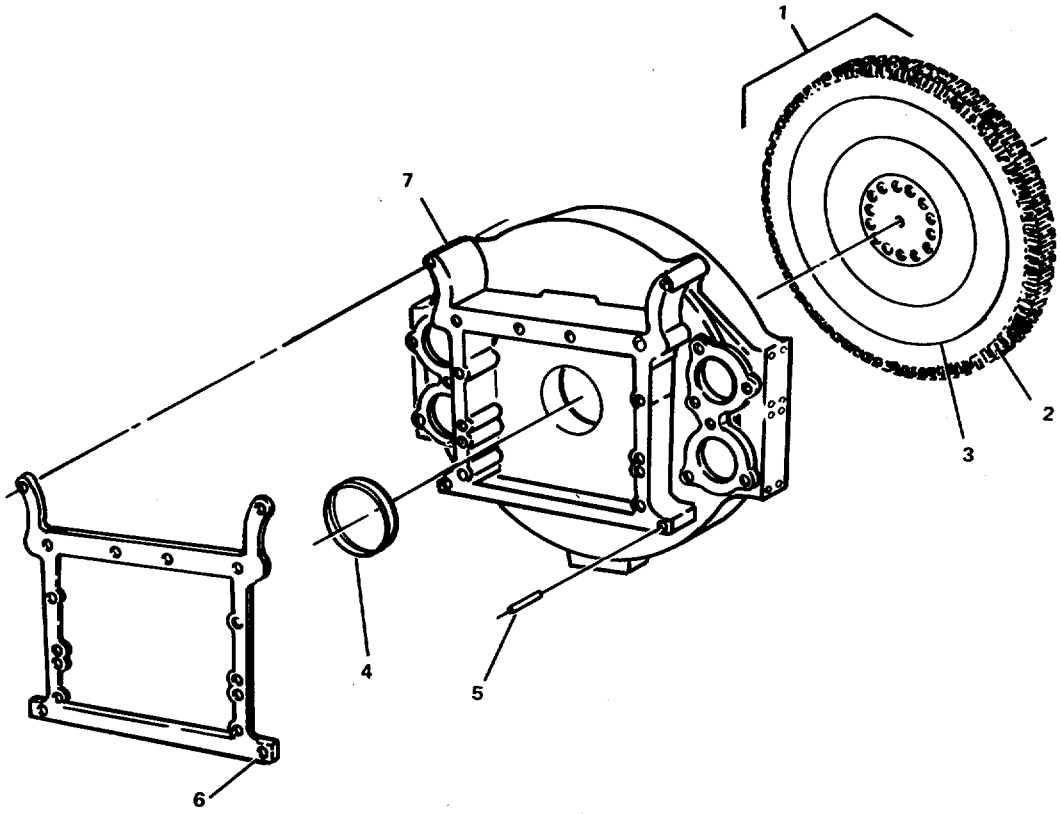


FIGURE 4-72. Flywheel Housing/Flywheel and Ring Gear Assembly.

(3) Replace a worn or broken ring gear (2) as follows:

WARNING

Wear protective clothing to prevent personal injury from burns.

CAUTION

Adjust the torch to a,good heating flame. Do not use a cutting flame (blue flame) to heat the ring gear. Damage to the flywheel can result.

(a) Use a torch to heat the ring gear (2).

NOTE

If a torch is not available, the ring gear can be removed with a brass drift and hammer. If this method is used, support the gear ring on a wooden block.

(b) Use a brass drift and hammer and drive the old gear (2) from the flywheel (3).

(c) Inspect the flywheel (3) (the ring gear seat area) for damage.

WARNING

Use protective clothing to prevent personal injury from burns.

CAUTION

Do not attempt to install the gear without using heat. Do not exceed the specified temperature. Damage to the gear will result.

(d) Heat the new ring gear (2) in an oven to 450°F (235°C) from 1 to 6 hours, or use a heating torch not a cutting torch -- from the inside diameter of the gear so the heat travels outward to the teeth.

(e) Stroke the gear while heating with a Tempilstick crayon, 600°F (316°C) several times to prevent overheating.

NOTE

The crayon will leave a chalk mark up to 6000F (316°C), then will leave a liquid smear.

CAUTION

Overheating the ring gear to 660°F (349°C) will soften the gear and make it useless.

NOTE

The part number is on the same side as the bevel.

(f) Place the ring gear (2) over the flywheel (3) while still hot. Install ring gear so the bevel is positioned toward the crankshaft edge of the flywheel.

CAUTION

Allow air to cool the gear. Do not use water or oil to reduce the cooling time. Damage to the gear can result.

(g) Place flywheel and ring gear assembly (1) aside to cool.

(4) If cracks or other defect are found in the flywheel (3), replace with a new component.

b. Barring mechanism (FIG. 4-73).

(1) Check the barring mechanism gear (2) for worn or broken teeth.

(2) Check the spring (1) for adequate tension.

(3) Check the shaft (5) for evidence of wear or other physical damage.

(4) Disassemble barring mechanism, if required.

(a) Remove retaining clip (6).

(b) Push shaft (5) in and remove gasket (4).

CAUTION

Do not attempt to push shaft out without spacers or supports between the gear and the housing. The woodruff key will damage the housing.

NOTE

1/8-inch steel pipe couplings may be used for the supports (3, FIG. 4-74).

(c) Place supports (3) between the gear (2) and the housing (4). The supports must be a minimum of 13/16 inch (21 mm) long to allow the key (5) to clear the gear (2) and not contact the housing (4).

(d) Use an arbor press and mandrel (1) to push the shaft until the key (5) is exposed. Remove the key (5) and the supports (3).

(e) Remove shaft (5, FIG. 4-73), spring (1), gear (2) and retaining ring (8).

(f) Clean the parts and inspect them for damage.

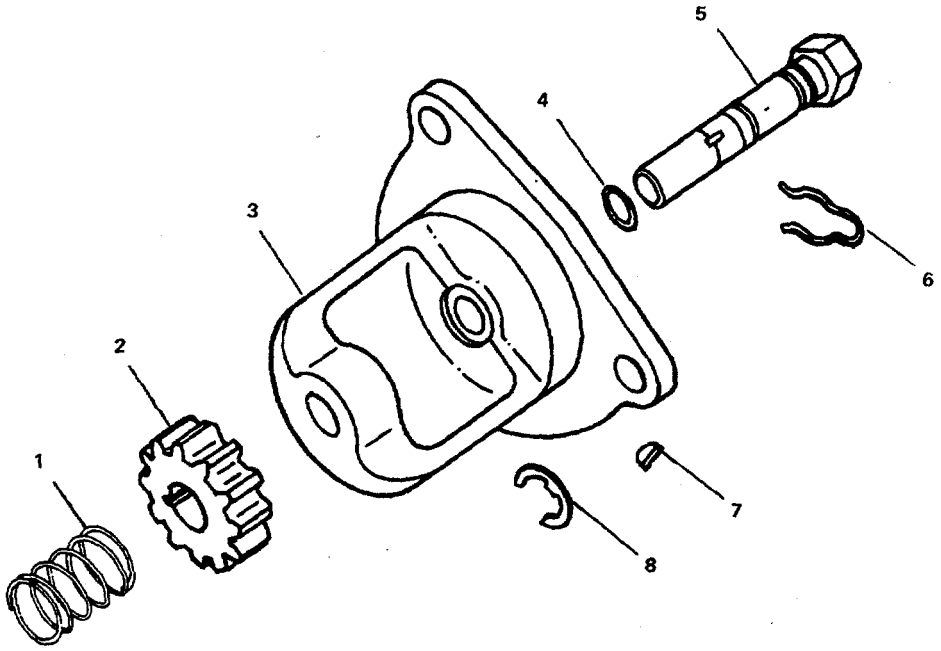


FIGURE 4-73. Barring Mechanism.

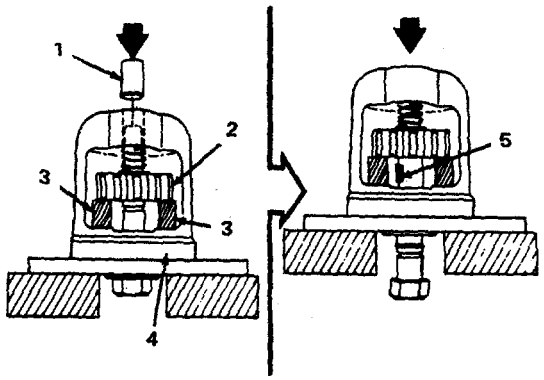


FIGURE 4-74. Barring Mechanism Shaft Removal.

(g) Measure gear (2) inside diameter. Verify diameter is between 0.739 inch (18.77 mm) and 0.740 (18.80 mm).

(h) Measure outside diameter of gear step of shaft (5). Verify diameter is between 0.7410 inch (18.821 mm) and 0.7415 inch (18.834 mm).

(i) Replace defective components.

(5) Assembly barring mechanism (FIG. 4-73).

(a) Install gasket (4) on shaft (5). Ensure gasket is in the second groove from the hex end of. shaft.

(b) Install spring (1) and gear (2) in housing (3).

(c) Lubricate gasket (4) and shaft (5) with clean engine lube oil. Install shaft (5) through housing (3) and in gear (2) until step in shaft touches gear.

NOTE

The supports used to remove the gear from the shaft can be used between the gear and the housing to allow the installation of the key (7).

(d) Push shaft (5) in until keyway is exposed. Install key (7). Align keyway in the gear with the gear.

CAUTION

Ensure key is aligned with keyway in the shaft before pushing the shaft in the gear or damage to the parts may result.

(e) Install supports (3, FIG. 4-74). Use an arbor press. Push shaft (5, FIG. 4-73) into the gear (2) until the end of the key (7) is even with the side of the gear.

(f) Remove supports (3, FIG. 4-74).

(g) Push shaft (5, FIG. 4-73) in until groove for retaining ring (8) is exposed. Install retaining ring (8).

(h) Push shaft (5) out until the retaining ring (8) touches housing (3). Install retaining clip (6).

c. Flywheel housing (7, FIG. 4-72).

(1) Check rear seal (4) and gasket (6) for wear or evidence of leaks. If rear seal (4) or gasket (6) are found to be unserviceable, replace (para. 3-26).

(2) Check dowels (5) for breaks or excessive wear. If defective dowels (9) are found, perform the following actions:

(a) Use a dowel pin extractor to remove the two dowels (5) and measure dowel pin so that oversize dowel pin can be determined.

(b) Install the flywheel housing, paragraph 3-26.

(c) Align the flywheel housing to the crankshaft, paragraph 3-26.

(d) Attach the plate in the drill ream fixture to the crankshaft, leaving the capscrews loose enough to allow plate movement.

(e) Use the locator pin in the drill ream fixture to align the plate to the hole for the dowel pin.

NOTE

The taper on the locator pin will engage and center in the dowel pin hole. The locator pin must rotate easily after the capscrews are tightened.

(f) Tighten the capscrews retaining the plate.

CAUTION

The crankshaft must be locked in position. It can turn during reaming.

(g) Lock the crankshaft to prevent turning.

(h) Select the new dowel pin. The dowel pin most protrude from the block one half of the flywheel housing thickness.

NOTE

There are three sizes of oversize dowel pins available from the engine manufacturer. They are: 0.015 [0.515 in (13.08 mm)], 0.030 [0.530 in (13.46 mm)], and 0.045 [0.545 in (13.84 mm)]. The reamer must be 0.0005 to 0.001 inch (0.013 to 0.02 mm) smaller than the dowel.

(i) Select the proper bushing, drill, and reamer for the size dowel pin.

CAUTION

Do not allow any metal chips to enter the engine or dowel hole or damage to the engine will occur.

(j) Drill and ream both dowel holes, drilling and reaming once, cleaning the holes, then ream again. The reamer must touch the bottom of the hole in the block.

(k) Remove the plate from the crankshaft.

(l) Using a square head drift, install the new dowels (9) until they touch the bottom of the hole in the block.

(3) Check the adapter plate mounting holes for cracks using the dye penetrant method.

NOTE

Do not attempt to disassemble the mounting plate.

4-18. Replace/Repair Cylinder Block

This task covers:

a. Removal **b. Disassembly** **c. Repair**
d. Assembly **e. Replacement**

INITIAL SETUP:

Tools

Tool kit, general mechanics rail and marine diesel engines, 5180-00-629-9783
Torque wrench kit P/N 3377216
Gauge block P/N 3376220
Driver bushing kit P/N 3376633
Dial indicator 5210-00-277-8840
Crack detector kit P/N 3375432
Dowell puller P/N ST-1134
Cutter plate P/N 3375908
Engine lifting fixture P/N 3375109
Cylinder liner puller P/N 3376015
Cylinder liner clamp set P/N 3822503
Cylinder line installation tool P/N 3375422
Light duty puller kit P/N 3375784
Machinist measuring tool set 5280-00-278-9919
Valve spring compression tester P/N 3375182
Lifting Fixture P/N 3822512

Equipment Condition

Engine shutdown. TM 55-1905-223-10.

Materials/Parts

Regulation fluid valve P/N AR-11509
Spring P/N 205349
Seal P/N 205115
Gasket P/N 3177108, 3011651
Preformed packing P/N 3201125, 3014668, 3011076
Emery cloth, Item 18, Appendix C
Cup plug loctite sealant, Item 37, Appendix C
Parts kit P/N 3007525
RTV sealant P/N 3377132

REMOVAL

a. Remove engine (para. 3-12).

b. Remove components from cylinder block (1, FIG. 4-75). Refer to procedures in chapters 2, 3, and 4.

DISASSEMBLY

a. Remove piston cooling regulator and oil jumper cover.

(1) Remove machine bolts (63, FIG. 4-75), lockwasher (64) and washer (65).

(2) Remove piston cooling regulator (66) and gasket (67). Discard gasket.

(3) Remove machine bolts (54), lockwasher (53), and washer (55).

(4) Remove oil jumper cover (52) and gasket (51). Discard gasket.

b. Remove piston cooling nozzles.

(1) Remove self locking screw (35), piston cooling nozzle (36), and preformed packing (37).

(2) Discard preformed packing.

c. Remove idler gear shafts.

NOTES

- Machine bolts (45 and 48) and washers (46 and 49) were removed to remove idler gears (para. 3-24).
- A slide hammer type tool that contains 3/4 x 16 inch threads can be used to remove the idler shafts.

(1) Remove camshaft idler shafts (47).

(2) Check shafts and cylinder block bore for any indication of movement from the shaft.

(3) Verify water pump shaft (50) has stayed in alignment as shown in FIG. 4-76. Carefully inspect parts if the shaft has moved.

(4) Remove water pump shaft (50, FIG. 4-75).

d. Remove thrust bearing support.

NOTE

The lower main bearings (21, 30, and 41), lower thrust bearing support (27) and associated hardware (20, 22, 23, 28, 29, 31, 32, 38, 39, 42, and 43) were removed to remove the crankshaft (para. 4-13).

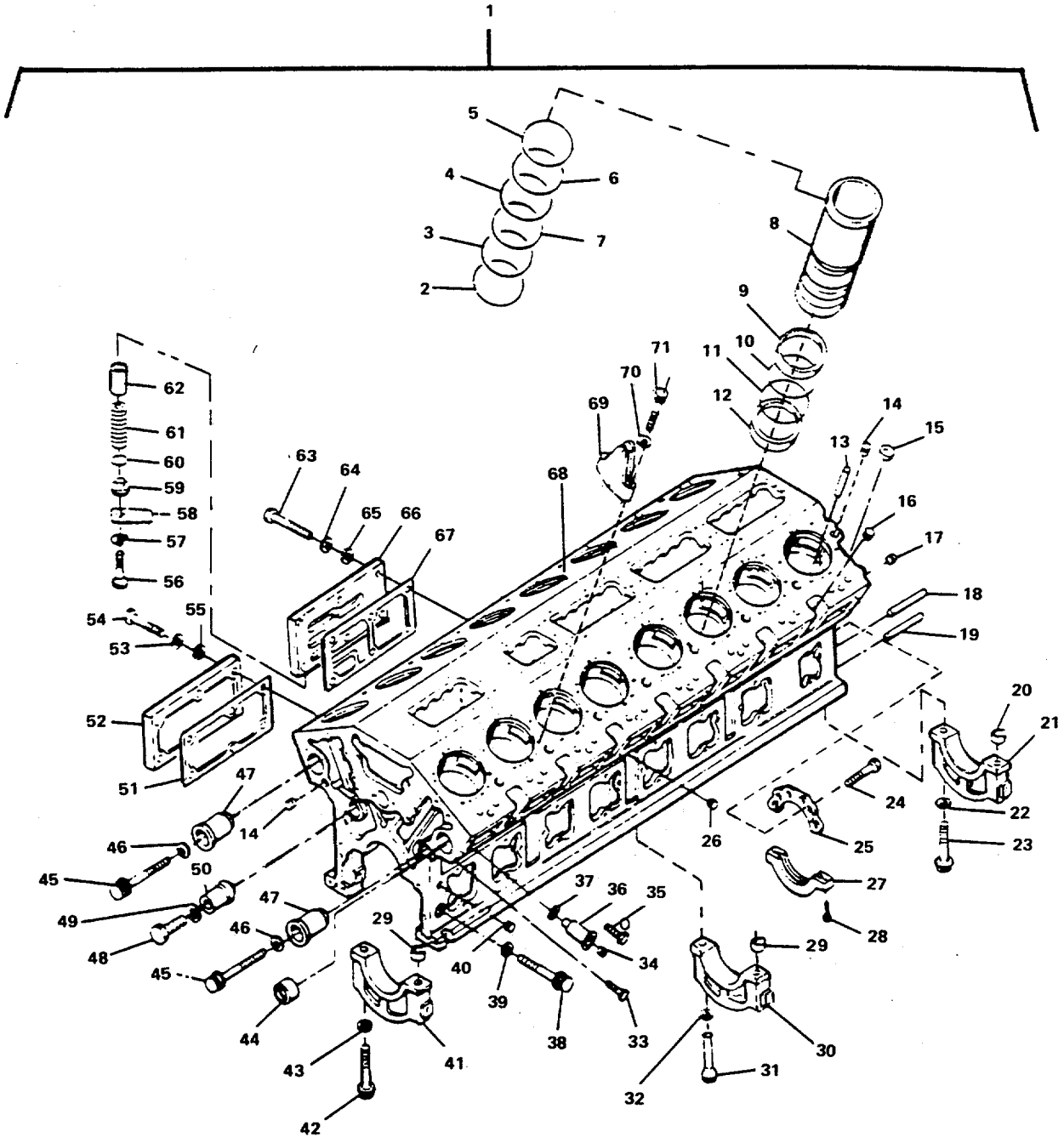


FIGURE 4-75. Cylinder Block Assembly.

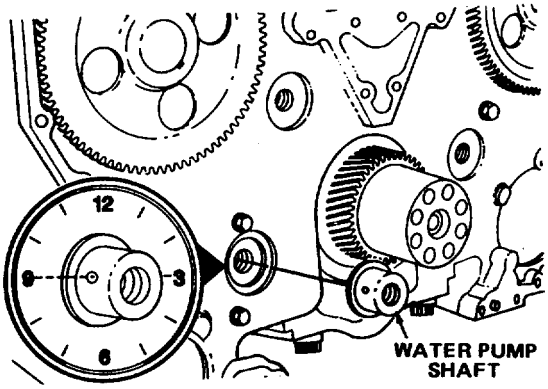


FIGURE 4-76. Water Pump Shaft Alignment.

(1) Remove six capscrews (24).

(2) Remove upper bearing retaining plate (25).

e. Remove engine lifting brackets.

(1) Remove machine bolts (71) and washers (70).

(2) Remove four engine lifting brackets (69).

f. Remove cylinder liner.

(1) Loosen set screws (1, FIG. 4-77) on cylinder liner puller.

(2) Turn feet (2) until the curved side is turned from the center.

(3) Move holding pins (3) to last hole.

NOTE

The puller feet must not touch the top of the liner. The puller arms must be positioned firmly on the bottom of the liner.

(4) Install puller in cylinder liner.

(5) Turn puller screw (4) until liner loosens in block. Remove tool and cylinder liner (8, FIG. 4-75).

(6) Remove shims (2 through 7), preformed packing (10 and 11), plain seal (12), and special ring (9).

g. Remove expansion plugs, expansion shields, pipe plugs and dowels.

(1) Use a drill, metal screw and slide hammer and hook from the light duty puller kit (FIG. 4-78) to remove expansion plug (15, FIG. 4-75) and expansion shields (14).

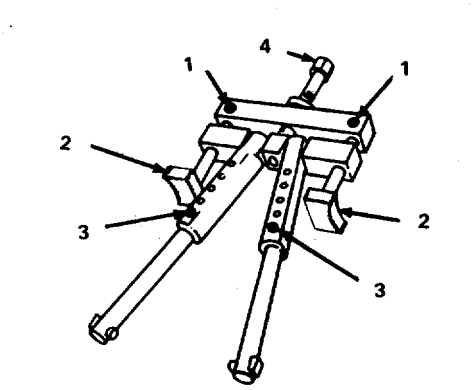


FIGURE 4-77. Cylinder Liner Puller.

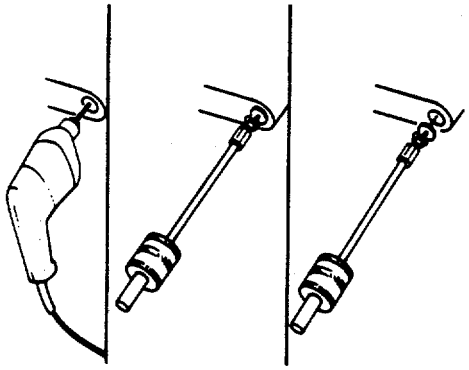


FIGURE 4-78. Expansion Plug/Shield Removal.

(2) Remove dowels (13, 18, and 19) (FIG. 4-75). ;-

(a) Put split collet (1, FIG. 4-79) of dowel pin extractor over dowel.

(b) Slide extractor collar (2) over split collar (1).

(c) Use slide hammer (3) to push extractor collar (2) tightly over split collar (1).

(d) Use slide hammer to remove dowel.

(3) Remove pipe plugs (16, 17, 26, FIG. 4-75) and drain cock (33).

h. Remove camshaft bushings.

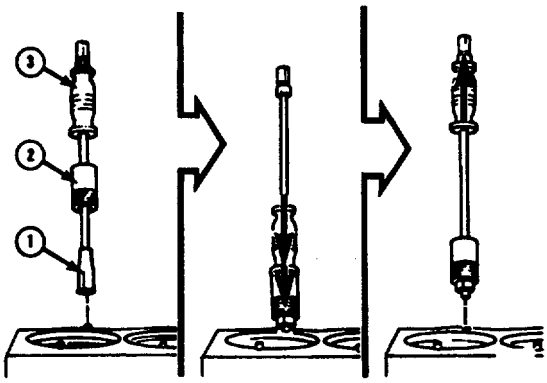


FIGURE 4-79. Dowel Removal.

NOTES

- The engine contains two camshaft bushings (44, FIG. 4-75) in each bore except in the LB front and RB rear bores. These bores contain one bushing only.
- If a bushing in a bore that contains two bushings is replaced, both bushings must be replaced. If a bushing in an engine bank is replaced, replace all bushings in that bank.

(1) Use the camshaft bushing driver (1, FIG. 4-80) to remove bushing (2) from the bore that contains one bushing.

(2) In a bore that contains two bushings, use driver (1) to push one bushing (2) until it touches the other one. Push both bushings out at the same time.

(3) Use an emery cloth to remove burrs and sharp edges from the bore.

(4) Measure inside diameter of bore. Verify it is between 3.1875 inch (80.963 mm) and 3.1885 inch (80.988).

REPAIR

CAUTION

Do not damage machined gasket surfaces or camshaft bushings.

a. Use scraper, wire brush and emery cloth to clean heavy dirt deposits from gasket surfaces, mounting surfaces, cylinder liner counter bore ledge and press fit areas, cylinder liner packing ring bore, top of block, main bearing saddles and caps, and plug bores.

b. Use bottle brush to clean all oil passages.

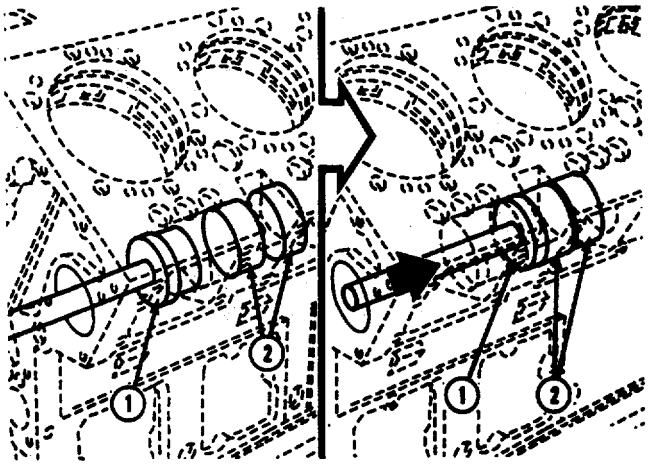


FIGURE 4-80. Camshaft Bushing Removal.

WARNING

Use protective measures to prevent personal injury.

c. Remove block from engine stand and place in cleaning tank.

CAUTION

Use a cleaning solution that will not damage the camshaft bushing.

NOTE

Follow instructions of the manufacturers of the cleaning tank and cleaning solution. Use a cleaning solution that can be heated to 180°F to 210°F (80°C to 95°C). Use a cleaning tank that will mix and filter the solution.

d. Clean block. Remove block from cleaning tank.

CAUTION

Ensure all water is removed from bolt holes and oil passages.

e. Steam clean block. Verify all oil passages are clean. Dry with compressed air.

f. If block is not going to be used immediately, apply a coating of preservation oil to prevent rust. Cover block to prevent dirt from accumulating.

CAUTION

All measurements must be performed with the block positioned on a flat surface. If the block is installed on an engine stand, distortion will cause the measurements to be wrong.

g. Measure cylinder block.

CAUTION

Ensure micrometer contacts flat surface of ledge. It must not touch the radius.

(1) Measure counterbore depth with a depth micrometer at the four locations shown in FIG. 4-81. Verify measurements are within 0.001 inch (0.25 mm) of each other and are within the specifications in Table 4-8 .

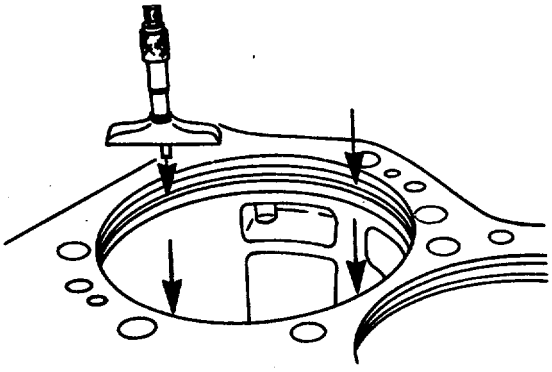


FIGURE 4-81. Counterbord Depth Measurement.

CAUTION

Ensure indicator does not contact counterbore radius on a block that does not have a double undercut.

(2) Use gauge block to measure the angle of the counterbore ledge at 4 places on the counterbore circumference (FIG. 4-82). Ensure measurement of ledge depth is as near to counterbore radius as possible and as near to counterbore edge as possible. Verify that the measurement near the counterbore edge is the same or no more than 0.0014 inch (0.036 mm) shorter than the measurement near the counterbore radius.

(3) Use crack detection kit to check the counterbore ledge for cracks. Circumferential cracks are acceptable if they do not extend more than ½ of the distance across the ledge. Cracks that extend into a water hole or capscrew hole are not acceptable.

(4) Measure inside diameter of upper counterbore (1, FIG. 4-83). The point of measurement must be within 0.100 inch (2.5 mm) from the top of the block. Verify measurement is within specifications in Table 4-8 . Verify upper counterbore is round within 0.001 inch (0.025 mm).

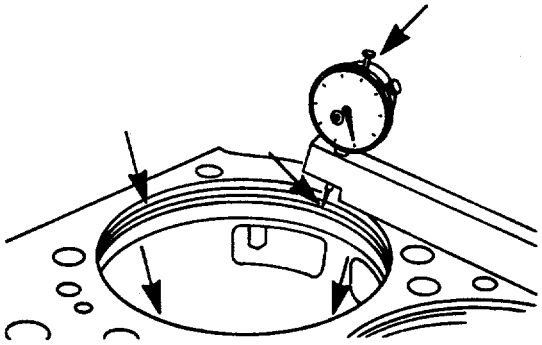


FIGURE 4-82. Counterbore Ledge Angle Measurement.

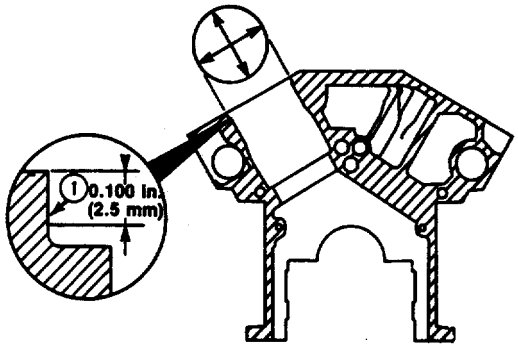


FIGURE 4-83. Upper Counterbore Measurement.

(5) Measure inside diameter of lower counterbore (3, FIG. 4-84). The point of measurement must be within 0.100 inch (2.5 mm) from the top of the counterbore ledge. Verify measurement is within specifications in Table 4-8 . Verify lower counterbore is round within 0.001 inch (0.025 mm).

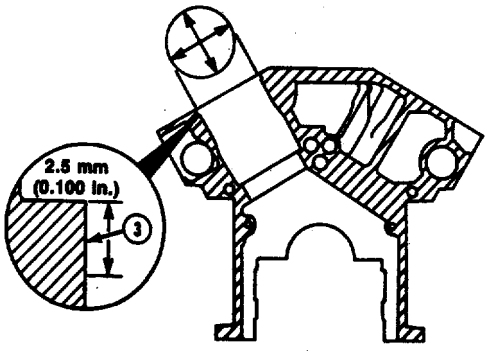


FIGURE 4-84. Lower Counterbore Measurement.

(6) Measure inside diameter of the packing ring bore (4, FIG. 4-85). Verify measurement is within specifications in Table 4-8 .

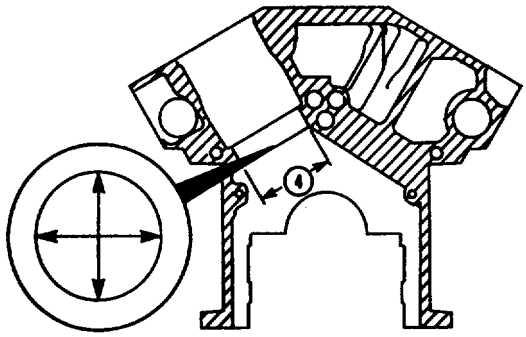


FIGURE 4-85. Packing Ring Bore Measurement.

CAUTION

The parting line of the main bearing cap is not the same height as the centerline of the main bearing bore.

NOTES

- If the block height is less than 18.994 inch (482.42 mm), a 0.020 inch (0.51 mm) oversize head gasket must be installed.
- If checking ring or centering ring is not available, block height can be measured from top of main bearing saddle (19, FIG. 4-86). If block height is less than 15.570 inch (395.48 mm), a 0.020 inch (0.51 mm) oversize head gasket must be installed.

(7) Measure height of cylinder block (18, FIG. 4-86). Verify height is within specifications in Table 4-8 . Verify height does not vary more than 0.003 inch (0.08 mm) from end-to-end of the block and more than 0.005 inch (0.13 mm) between the banks.

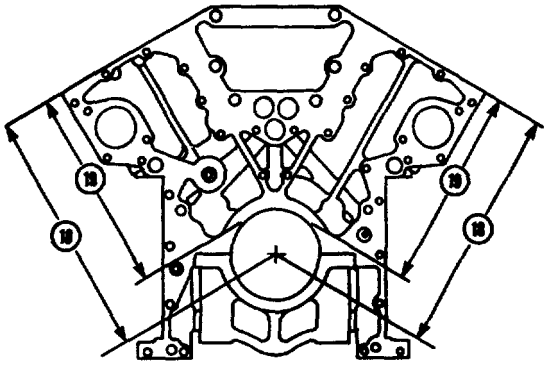


FIGURE 4-86. Block Height Measurements.

h. Check the head deck of the block (68, FIGURE 4-75) for wear using a precision straight edge. Verify no fretting is visible in areas when head gasket seal rings or grommets touch.

i. Clean and inspect cylinder liners.

WARNING

Wear eye protection. If motor driven, ensure wire brush is rated for correct rpm.

CAUTION

Do not use a home, aluminum oxide cloth, or sandpaper to clean cylinder liners. Abrasives can damage the finish and the pattern, and can contaminate the liner.

(1) Use high quality steel wire brush to clean the liner flange seating area and the secondary press fit below the liner flange.

(2) Use non-metallic brush, warm water, and detergent soap to clean the inside diameter.

(3) Clean liners with steam. Dry with compressed air.

(4) Inspect liners for cracks. Replace liner if any cracks are found.

NOTE

If liner with minimum pitting is re-installed, install so pitting is in line with longest centerline of crankshaft.

(5) Inspect outside of liner for pitting and corrosion. Replace liner if pitting exceeds 1/16 inch (1.6 mm) or if corrosion can not be removed with a fine emery cloth.

(6) Check the inside of liner for scratches, scuffing, and scoring. Replace liner that contains scuffs or scores or that contains scratches that can be felt with a fingernail.

(7) Check the inside diameter for liner bore polishing. A light finish produces a bright mirror finish in the worn area with traces of lubrite coating and the original hone marks remaining. A moderate polish produces a bright mirror finish in the worn area with very light traces of the original hone marks or an indication of an etch pattern. A heavy polish produces a bright mirror finish in the worn area with no traces of hone marks or an etch pattern.

(8) Replace liner if a heavy polish is present over 20 percent of the piston ring travel area or if 30 percent has both moderate and heavy polish with 15 percent being heavy polish.

NOTE

Reinstall liner so that polished area is in line with the longest centerline of the crankshaft.

(9) Inspect outside of liner flange for wear. Wear is indicated by small areas that are polished and by the absence of machining marks. Replace liner if an area over 0.5 inch (13 mm) in length does not have machining marks.

NOTE

Reinstall liner so that polished area is 90 degrees from the longest centerline of the crankshaft. An area that is not polished must be in line with the longest centerline of the crankshaft.

(10) Inspect bottom of flange for absence of machining marks in polished areas. Replace liner if an area over 0.5 inch (13 mm) does not have machining marks.

j. Measure cylinder liner.

NOTES

- Refer to Table 4-8 . for specifications.
- The inside diameter of a new cylinder liner can be 0.0006 inch (0.015 mm) smaller than specifications due to lubrite coating.

(1) Measure inside diameter of liner at top, middle, and bottom of piston ring travel area. Take two measurements, 90 degrees apart from each other, at each location.

(2) Measure thickness of liner flange.

(3) Measure outside diameter of liner flange.

(4) Measure outside diameter of liner set secondary press fit location.

CAUTION

Do not set liners in an area where dirty air flow can contaminate liners.

k. Apply thick film of clean 15W-40 oil to liner bores. After 5 to 10 minutes, wipe with clean lint-free paper towel until black and grey deposits are removed.

Table 4-8. Engine Measurements

NOTE

Some measurements may depend on whether standard or oversize liners were installed.

Measurement	Linear Size (inch)	Inch	mm
Counterbore Depth	Standard	0.718 to 0.720	18.26 to 18.31
	0.010	0.728 to 0.730	18.52 to 18.57
	0.020	0.738 to 0.740	18.77 to 18.82
	0.030	0.748 to 0.750	19.02 to 19.07
	0.040	0.758 to 0.760	19.28 to 19.33
Upper Counterbore I.D.	Standard	7.4915 to 7.4935	190.284 to 190.335
	0.010	7.5015 to 7.5035	190.538 to 190.589
	0.020	7.5115 to 7.5135	190.792 to 190.843
	0.030	7.5215 to 7.5235	191.046 to 191.097
	0.040	7.5315 to 7.5335	191.300 to 191.351
Lower Counterbore I.D.		7.155 to 7.157	181.74 to 181.79
Packing Ring Bore I.D.		6.982 to 6.984	177.34 to 177.39
Cylinder Block Height		18.974 to 19.007	481.94 to 482.75
Cylinder Block Height (from main bearing saddle)		15.551 to 15.583	395.00 to 395.81
Liner I.D.		6.2495 to 6.2550	158.737 to 158.877
Liner Flange Thickness	Standard	0.526 to 0.527	13.36 to 13.39
	0.010	0.536 to 0.537	13.61 to 13.64
	0.020	0.546 to 0.547	13.87 to 13.89
	0.030	0.556 to 0.557	14.12 to 14.15
	0.040	0.566 to 0.567	14.38 to 14.40
Linear Flange O.D.	Standard	7.4925 to 7.4945	190.309 to 190.360
	0.010	7.5025 to 7.5045	190.563 to 190.614
	0.020	7.5125 to 7.5145	190.817 to 190.868
	0.030	7.5225 to 7.5245	191.071 to 191.125
	0.040	7.5325 to 7.5345	191.325 to 191.376
Secondary Press Fit O.D.		7.158 to 7.160	181.81 to 182.04

l. Repair piston cooling valve (66, FIG. 4-75).

(1) Remove all gasket material from housing. Clean with solvent. Dry with compressed air.

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control parts firmly.

(2) Remove capscrew (56), lockwasher (57), shouldered washer(58), valve stem (59), preformed packing (60), spring (61) and valve piston (62).

(3) Clean parts. Dry with compressed air.

(4) Check piston (62) surface and housing (66) bore. Replace piston if unable to remove scratches and marks with a fine crocus cloth.

(5) Measure free length of spring (61). Verify length is between 2.39 and 2.54 inch (60.7 and 64.5 mm).

(6) Use spring tester, to measure force of spring at working height of 1.75 inch (44.4 mm). Verify spring force is between 11.5 and 12.8 1bf (51 and 57N). Replace spring if not to specification.

(7) Lubricate piston (62) with clean engine lube oil. Install piston (62) in body (66). Ensure plunger moves freely. If plunger does not move freely, disassembly, check for debris and burrs, and reassemble.

(8) Install preformed packing (60) on valve stem (59). Lubricate preformed packing with clean engine lube oil.

WARNING

Parts are under spring pressure. The parts can move suddenly with enough force to cause personal injury. Use a tool that will control the parts firmly.

(9) Install spring (61), valve stem (59), shouldered washer (58), lockwasher (57), and capscrew (58). Torque capscrew to 140 in-lb (16 N•m).

(10) Inspect oil jumper cover (52) for cracks. Replace if cracked.

m. Check piston cooling nozzle (36) for cracks, bends, and other damage. Check spray holes for burrs. Do not remove pipe plug (34). Replace nozzle if damaged.

n. Clean engine lifting fixture bracket (68), washer (69), and capscrew (70). Check for cracks, rust, and corrosion. Replace if damaged.

o. Inspect idler shafts (47 and 50).

(1) Check idler shafts for cracks, bends and other damage.

(2) Measure camshaft idler shaft (47) outside diameter.

(3) Verify outside diameter is between 0.9995 and 1.000 inch (25.397 and 25.400 mm) at location 1 in FIG. 4-86a. Verify outside diameter is between 1.8720 and 1.8740 inch (47.549 and 47.600 mm) at location 2.

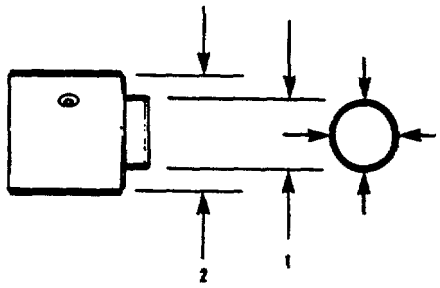


FIGURE 4-86a. Camshaft Idler Shaft Measurement.

(4) Measure water pump idler shaft (50, FIG. 4-75) outside diameter.

(5) Verify outside diameter is between 1.6995 and 1.7000 inch (43.167 and 43.180 mm) at location 1 in FIG. 4-86a. Verify outside diameter is between 1.8720 and 1.8740 inch (47.549 and 47.600 mm) at location 2.

(6) Replace idler shafts if damaged or not to specifications.

ASSEMBLY

a. Install camshaft bushing (44, FIG. 4-75).

NOTE

Steps (1), (2), and (3) are for installing bushings in bores that require two bushings. Steps (4), (5), and (6) are for installing single bushings in the LB Front and RB Rear bores.

(1) Position bushing (2, FIG. 4-87) so that clinch joint (3) is pointed toward the cylinder head surface of the block and the elongated hole (4) is on the side nearest to the use of the block.

(2) Use drive assembly to push bushing through the bore. Ensure bushing is even with or no more than 1/16 inch (1.6 mm) below the surface of the block web (5).

(3) Install second bushing using same procedure as above.

(4) Position bushing (2, FIG. 4-88) so that elongated hole in bushing (4) is in line with oil hole in block (6). Ensure oil holes in bushing are nearest to cylinder block and clinch join (3) is pointed toward outboard side of bore.

(5) Use drive assembly to push bearing in bore until it is even with or nomore than 1/16 inch (1.6 mm) below the surface of the block web (5).

(6) Ensure oil hole in block (6) is open and clean and aligned with elongated hole in bushing (4).

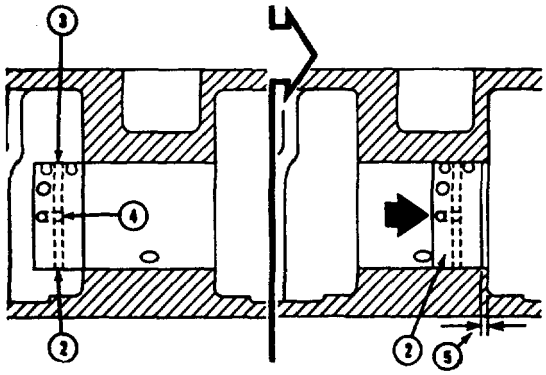


FIGURE 4-87. Two Bushing Installation.

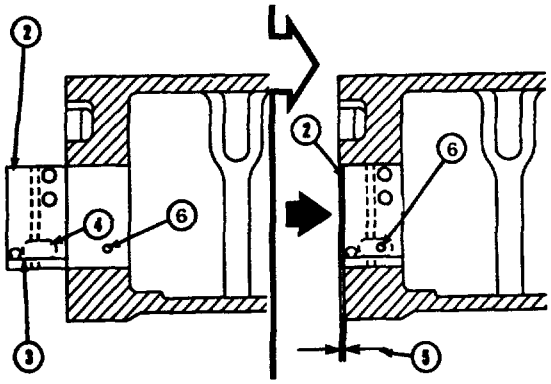


FIGURE 4-88. Single Bushing Installation.

b. Install expansion plugs, expansion shields, pipe plugs, and dowels.

(1) Apply sealant to outside of expansion plug, and expansion shields (15 and 14, FIG. 4-75). Use cup plug driver to install.

(2) Install pipe plugs (16, 17, and 26).

CAUTION

Do not use a hammer. Damage to dowels will result.

(3) Use mallet to install dowels (2, 8, 9).

c. Install cylinder liner (8).

(1) Lubricate packing ring bore of cylinder block with clean engine lube oil.

WARNING

Do not use starting fluid. Naphtha and methyl ethyl ketone are flammable. Use caution to prevent personal injury. Follow manufacturer instructions.

(2) Use hydrocarbon solvent (such as naphtha, methyl ethyl ketone, tricholoroethane 1,1,1 methyl chloroform or equivalent) to clean the counterbore and cylinder liner flange.

CAUTION

The counterbore ledge and cylinder liner flange must be dry. Sealant will not dry if parts contain oil,.

(3) Install shims (1, FIG. 4-89), if required.

NOTE

Do not lubricate plain seal (2) and preformed' packing (3 and 4). This prevents oil from contacting counterbore ledge.

(4) Lubricate packing ring bore in cylinder block.

(5) Install plain seal (2) with beveled edge as shown in FIG. 4-89.

NOTE

The preformed packings (3 and 4) have a d-shaped cross section. The packings must be installed with the flat side against the cylinder liner.

(6) Install black preformed packing (3) and red preformed packing (4). Use mold mark on preformed packings to check if packing is twisted.

CAUTION

The following parts must be installed within 10 minutes after applying the sealant. An excessive amount of sealant will cause engine damage.

(7) Use RTV sealant. Apply a bead of sealant to the bottom of the cylinder liner flange and the special ring (FIG. 4-90). Ensure sealant bead size is between 3/64 and 1/16 inch (1.1 and 1.6 mm).

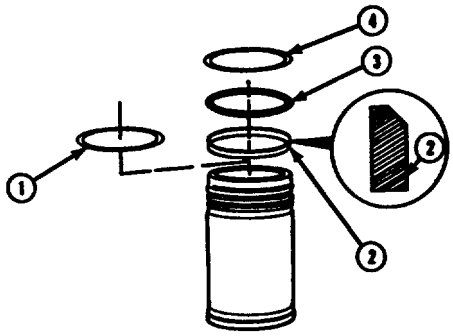


FIGURE 4-89. Cylinder Liner.

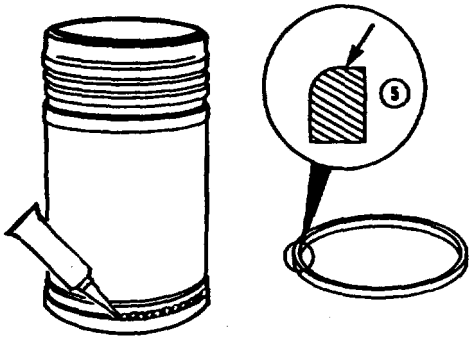


FIGURE 4-90. Liner Sealant.

NOTE

The special ring (12, FIG. 4-75) must be installed with the curved edge down.

(8) Install special ring (12). Push liner (8) in block by hand.

(9) Install liner installation tool bridge assembly. Install two cylinder head capscrews. Torque capscrews to 35 ft-lb (45 N-m).

(10) Install push plate. Ensure plate is aligned on the cylinder liner. Turn the push screw until it touches push plate.

CAUTION

Do not apply more than 50 ft-lb (65 N•m) of torque.

(11) Use a wrench to turn push screw until bottom of liner flange touches special ring. Remove installation tool.

NOTE

New cylinder liners can be 0.0002 to 0.0006 inch (0.005 to 0.015 mm) smaller than the minimum specification due to the lubrite coating.

(12) Use dial bore gauge to measure inside diameter at top, bottom, and middle of liner. Take two measurements 90 degrees apart at each location. Verify measurements are between 6.2495 and 6.2510 inch (158.737 and 158.775 mm). Also verify that two measurements at top are within 0.003 inch (0.076 mm) of each other and two measurements at bottom are within 0.002 inch (0.05 mm) of each other.

NOTE

A new bead of sealant must be applied if liner is removed and re-installed.

(13) If measurements are not within specification, remove liner, check for twisted preformed packing and out of round liner.

CAUTION

Clamps must touch the highest part of the liner.

(14) Install two cylinder liner clamps and capscrews. Torque capscrews to 50 ft-lb (65 N•m).

CAUTION

Parts must be clean and free of nicks and burrs to accurately measure the protrusion.

(15) Position gauge block so that indicator needle contacts liner flange on the outside of the sealing bead (FIG. 4-91).

(16) Gently push indicator needle down until it touches the liner. Turn gauge until the "O" is aligned with the indicator needle of the dial. Repeat step to ensure dial reads "O" when needle touches the liner.

(17) Raise indicator needle. Move gauge block until indicator needle is over the cylinder block. Gently push indicator needle until it touches the block. Verify dial reads between 0.006 and 0.008 inch (0.15 and 0.20 mm).

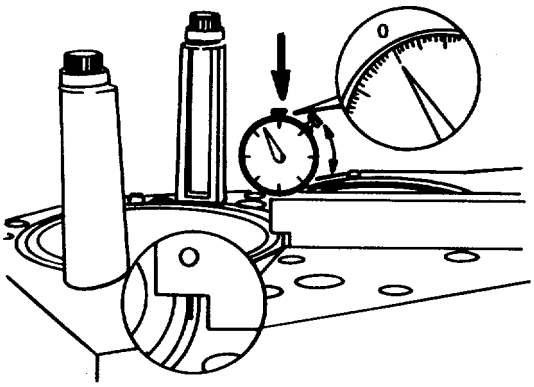


FIGURE 4-91. Liner Protrusion Measurement.

(18) Repeat steps (16) and (17) in four places equally spaced on the liner outside diameter. Ensure measurements do not differ more than 0.001 inch (0.03 mm).

NOTE

A new bead of sealant must be applied if the liner is removed and re-installed.

(19) If liner protrusion exceeds specifications, remove liner and check for burrs and dirt. If liner is less than specifications, use shims or an oversize ring to adjust the protrusion.

d. Install engine lifting brackets.

CAUTION

Sealant must be applied on lifting brackets to prevent corrosion of the bolts. Corroded bolts may break during engine lifting.

(1) Apply RTV sealant account the threaded holes in the block for the lifting fixture bolts (70, FIG. 4-75).

(2) Apply a bead of sealant to the bottom of the bolt head. Install washer (69) on bolt (70). Apply a bead of sealant to bottom of washer.

(3) Install lifting bracket (68). Secure with bolt (70). Torque bolt to 200 ft-lb (270 N•m).

e. Install appear thrust bearing support.

NOTE

The lower main bearings (21, 30, and 41), lower thrust bearing support (27) and associated hardware (20, 22, 23, 28, 29, 31, 32, 42, and 43) are installed when installing the crankshaft (para. 4-13.)

(1) Position upper bearing retaining plate (25).

(2) Install capscrews (24). Torque capscrews to 45 ft-lb (60 N•m).

f. Install idler gear shafts.

CAUTION

- Newer and older engines do not contain the same parts. If the correct parts are not installed, the engine will be seriously damaged.
- The water pump idler shaft (1, FIG. 4-92) must be installed so that the oil holes on the outside diameter of the shaft are at the 3 o'clock and 9 o'clock positions. If the oil holes are not in the correct position, failure will result due to lack of lubrication to the bushings. The two camshaft idler shafts (2) should be installed with the holes in the same position as the water pump idler shaft.

NOTE

Machine bolts (45 and 48) and washer (46 and 49) are installed when installing idler gears (para. 3-24).

(1) Install water pump idler shaft (1). Rotate shaft until holes are at 3 o'clock and 9 o'clock positions as shown in FIG. 4-92.

(2) Install two camshaft idler gear shafts (2). If a shaft does not stay within the block, verify parts are within specification. FIG. 4-92. Idler Shaft Installation.

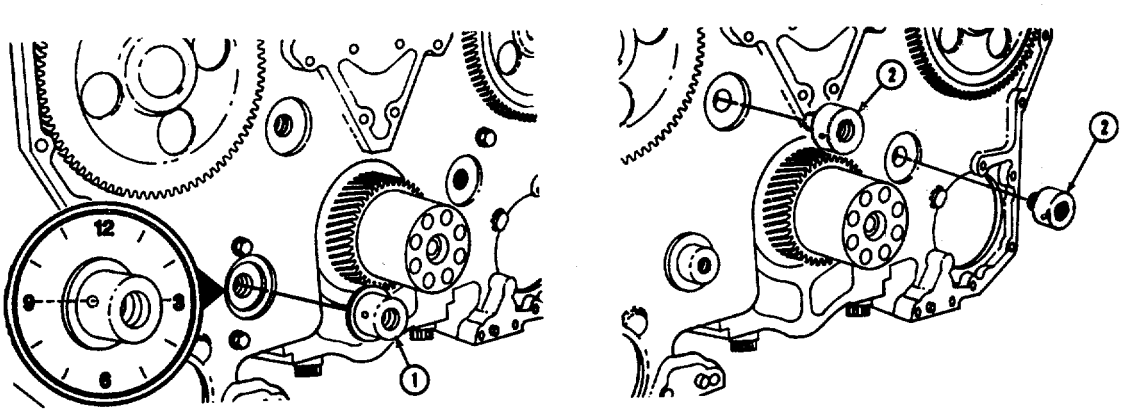


FIGURE 4-92. Idler Shaft Installation.

g. Install piston cooling nozzles (36, FIG. 4-75).

(1) Install preformed packing (37) on nozzle (36). Lubricate preformed packing with clean engine lube oil.

NOTE

The notch in the nozzle must be aligned so that the head of the self locking screw (35) will fit in the notch.

(2) Install nozzle (36) in block. Push nozzle in bore until the flange on the nozzle touches the block.

(3) Install self locking screw (35). Torque screw to 96 in-lb (10 N•m).

(4) Install pipe plug (34). Torque to 120 in-lb (15 N•m).

h. Install piston cooling regulator (65) and oil jumper cover (51).

CAUTION

The oil jumper cover gasket (50) does not have a rib in the center. The piston cooling regulator gasket (66) does have a rib in the center. The correct gasket must be installed with the proper part or the engine will fail due to lack of lubrication.

NOTE

The parts are installed on the engine bank opposite the oil filter head.

(1) Install oil jumper cover gasket (50), oil jumper cover (51), washers (54), lockwashers (52), and machine bolts (53). Torque machine bolts to 30 ft-lb (40 N•m).

(2) Install piston cooling regulator gasket (66), piston cooling regulator (65), washers (64), lockwashers (63), and machine bolts (62). Torque machine bolts to 30 ft-lb (40 N•m).

REPLACEMENT

a. Install components on cylinder block (1, FIG. 4-75). Refer to procedures in chapters 2, 3, and 4.

b. Install engine (para. 3-12).

SECTION VI. PREPARATION FOR STORAGE OR SHIPMENT

Refer to Chapter 2, Section VI.

APPENDIX A

REFERENCES

A-1. Scope. This paragraph lists the manuals, bulletins, specifications, and miscellaneous publications referenced in this manual or required for maintenance activities.

A-2. Field Manuals.

FM 21-11	First Aid for Soldiers
FM 31-70	Basic Cold Weather Manual
FM 55-501	Marine Crewman's Handbook

A-3. Technical Manuals.

TM 43-0139	Painting Instructions for Field Use
TM 55-1905-223-10	Operator's Manual for Landing Craft, Utility (LCU)
TM 55-1905-223-24-2	Main Reduction Gear
TM 55-1905-223-24-18	LCU 2000 Class Basic Craft Maintenance Manual
TM 55-1905-223-24P	Repair Parts and Special Tools List for the LCU 200 Class Watercraft
TM 750-244-3	Destruction of Army Materiel to Prevent Enemy Use

A-4. Technical Bulletins.

TB 43-0144	Painting of Vessels
TB 55-1900-207-24	Treatment of Cooling Water in Marine Diesel Engines
TB 740-97-4	Preservation of Vessels for Storage.

A-5. Military Specifications.

MIL-C-16173C	Rust Preventive, Type P-1
MIL-L-644	Preservative Oil, Type P-9
MIL-L-21260	Preservative Oil, Type P-10

A-6. Miscellaneous Publications.

DA Pam 738-750	The Army Maintenance Management System
LO 55-1905-223-12	Lubrication Order for the LCU 2000 Class Watercraft
✶AMC-R 750-11	Use of Lubricants, Fluids, and Associated Products

A-7. Forms.

DA Form 2028 and 2028-2	Recommended Changes to Publications and Blank Forms
DA Form 2404	Equipment Maintenance and Inspection Worksheet
DA Form 2408-16	Logsheet
DA Form 2410	Logsheet
SF Form 368	Quality Deficiency Report

✶ Supercedes Darcom-R 750-11

APPENDIX B

MAINTENANCE ALLOCATION CHART

SECTION I. INTRODUCTION

B-1. General.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories (levels).

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. Maintenance Functions. Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (for example, by sight, sound, or feel).

b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, that is, to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and is shown as the third position code of the SMR code.

i. Repair. The application of maintenance services[1], including fault, location/troubleshooting[2], removal/installation, and disassembly/assembly[3] procedures, and maintenance actions[4] to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., Depot Maintenance Work Requirements (DMWR)]. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

B-3. Explanation of Columns in the MAC, Section II.

a. Column 1. Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance-significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number
shall be "00."

b. Column 2. Component Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

---

[1]Services-inspect, test, service, adjust, align, calibrate, and/or replace.
[2]Fault locate/troubleshoot-The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).
[3]Disassemble/assemble-encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least componency identified as maintenance significant (that is, assigned an SMR code) for the category of maintenance under consideration.
[4]Actions-welding, grinding, riveting, straightening, facing, remachinery, and/or resurfacing.

c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2. (For detailed explanation of these functions, see paragraph B-2.)

d. Column 4. Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly-, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

UNIT	C-Operator or Crew O-Organizational Maintenance
INTERMEDIATE	F-Direct Support Maintenance H-General Support Maintenance
DEPOT	D-Depot

e. Column 5. Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. Column 6. Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

B-4. Explanation of Columns in Tool and Test Equipment Requirements, Section III.

a. Column 1. Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3. Nomenclature. Name or identification of the tool or test equipment.

d. Column 4, National Stock Number. The national stock number of the tool or test equipment.

e. Column 5, Tool Number. The manufacturer's part number.

B-5. Explanation of Columns in Remarks, Section IV.

a. Column 1. Reference code. This code recorded in Column 6, Section II.

b. Column 2. Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	INTERMED. F	INTERMED. H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
01	ENGINE, MAIN PROPULSION (STARBOARD)	INSPECT	0.8						
		TEST	0.8					31	
		SERVICE	1.2					1, 5, 6, 10	
		ADJUST	0.5						
		REPLACE			40.0			1, 2, 3	
		REPAIR	2.5	1.5	3.0	70.0		1-87	
		OVERHAUL					*	1-87	A
01	ENGINE, MAIN PROPULSION (PORT)	INSPECT	0.8						
		TEST	0.8					31	
		SERVICE	1.2					1, 5, 6, 10	
		ADJUST	0.5						
		REPLACE			40.0			1, 2, 3	
		REPAIR	2.5	1.5	3.0	70.0		1-87	
		OVERHAUL					*	1-87	A
0101	STARTER, ENGINE, AIR	REPLACE	1.2					1, 3, 4	B, C, D, E
		REPAIR			8.0			1, 3, 4, 43, 45	B, C, D, E
0102	INSTRUMENT PANEL GROUP	INSPECT	0.2						
		REPLACE		3.0				1	F
		REPAIR		1.5				1	F
0103	WATER FILTER GROUP	INSPECT	0.2						
		SERVICE	0.5					1, 4, 5, 6	
		REPLACE		1.0				1, 4, 5, 6	G
		REPAIR	0.5	1.0				1, 4, 5, 6	
010301	HEAD, WATER FILTER, ASSEMBLY	REPLACE			0.5			1, 4	G
		REPAIR		0.5				1, 4	
0104	THERMOSTAT HOUSING/WATER TRANSFER TUBE GROUP	INSPECT	0.2						
		REPLACE		1.5				1, 3, 4, 7, 8	H
		REPAIR		1.0				1, 4, 7, 8	H
0105	AIR CLEANER GROUP	INSPECT	0.1						
		SERVICE	0.2					1	
		REPLACE		0.5				1	
		REPAIR	0.5	0.5				1	

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT		INTERMED.		DEPOT		
			C	O	F	H	D		
0106	TURBOCHARGER GROUP	REPLACE	1.0					1, 4, 9	C, T
		REPAIR		4.0				1, 4, 9	
0107	FUEL FILTER GROUP	INSPECT	0.2						
		SERVICE	0.5						
		REPLACE		0.5				1	
		REPAIR		0.5				1	
010701	FILTER ASSEMBLY, FUEL	INSPECT	0.5						
		SERVICE	1.0						
		REPLACE		0.5				1	
		REPAIR	0.2	0.5				1	
0108	SUMP PUMP GROUP	REPLACE		0.5				1	
		REPAIR	0.5	0.5				1	
0109	WATER PUMP GROUP	REPLACE	1.5					1, 4	I
		REPAIR	1.5		2.0			1, 4	
010901	PUMP, COOLING SYSTEM, ENGINE	REPLACE	1.5					1, 4	I
		REPAIR		2.0				1, 4, 42-47, 50-51	
010902	BRACKET, ENGINE ACCESSORY	REPLACE			1.0			1, 4, 48, 50	I
		REPAIR			2.0			1, 4, 42, 45, 49, 50	I
0110	FILTER ASSEMBLY, LUBE OIL	INSPECT	0.2						
		SERVICE	0.5					1, 4, 6, 10	T
		REPLACE		0.5				1, 4, 6, 10	
		REPAIR	0.5	1.0				1, 4, 39	
0111	LUBE OIL BY-PASS FILTER GROUP	INSPECT	0.2						
		SERVICE	0.3						T
		REPLACE		0.5				1, 4, 6, 10	
		REPAIR	0.5	1.0				1, 4, 6, 10	
011101	FILTER ASSEMBLY, LUBE OIL BY-PASS	INSPECT	0.2						
		SERVICE	0.5						
		REPLACE		0.5				1, 4, 10	T
		REPAIR		1.0				1, 4	

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	INTERMED. F	INTERMED. H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
01110101	HEAD, FLUID FILTER	REPLACE		0.2				1, 4.10	
		REPAIR		1.0				1, 4	
0112	COLD STARTING AID GROUP	REPLACE		0.5				1	
		REPAIR		0.5				1	
0113	SHUTDOWN VALVE GROUP	REPLACE	1.0					1, 4	
		REPAIR	1.0		2.0			1, 4, 35	
011301	VALVE ASSEMBLY, SHUTDOWN	REPLACE	1.0					1, 4	
		REPAIR			2.0			1, 4, 35	
0114	FUEL PUMP GROUP	REPLACE	1.0					1, 4	C
		REPAIR	1.0		1.0			1, 4	C
011401	PUMP,FUEL,CAM ACTUATED	REPLACE	1.0					1, 4	C
		REPAIR			1.0			1, 4	C
0115	ROCKER LEVER HOUSING/ COVER GROUP	REPLACE	1.0					1, 4, 8, 66	J
		REPAIR	0.5	1.5				1, 4	
0116	INJECTOR GROUP	INSPECT	0.2						
		REPLACE	0.3					1, 4, 11 12	C, K, T, F
0117	AIR INTAKE MANIFOLD GROUP	REPLACE	2.0					1, 3, 4	L
		REPAIR	0.5	1.0				1, 3, 4, 37	
0118	LUBRICATING OIL COOLER GROUP	REPLACE			1.0			1, 4	M
		REPAIR			1.5			1, 4	T
0119	EXHAUST MANIFOLD GROUP	REPLACE	2.0					1, 3, 4	T
		REPAIR	0.5		1.0			1, 4, 42	
0120	CYLINDER HEAD GROUP	TEST	0.5						
		REPLACE	8.0					1, 3, 4	
		REPAIR	4.0			16.0		1, 3, 4, 13 -16, 28, 38, 39, 42 52-64, 68-79 83-87	

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT		INTERMED.		DEPOT		
			C	O	F	H	D		
012001	CYLINDER HEAD, DIESEL ENGINE	REPLACE REPAIR	4.0			 12.0		1, 3, 4 1, 3, 4 13-16, 28 38, 39, 42 52-64, 68-79, 83-87	J, T
0121	FUEL MANIFOLD GROUP	REPLACE REPAIR			2.5 1.0			1, 4 1, 4	
012101	FUEL BLOCK ASSEMBLY	REPLACE REPAIR			1.5 1.0			1, 4 1, 4	
012102	MANIFOLD, FUEL	REPLACE			1.5			1, 4	
0122	HANDHOLE COVER GROUP	REPLACE REPAIR	1.0	 1.5				1, 4 1, 4	N
0123	CAM FOLLOWER AND HOUSING GROUP	REPLACE REPAIR				1.0 1.0		1, 4 1, 4, 42, 45, 59, 65	
012301	CAM FOLLOWER, NEEDLE BEARING	REPLACE REPAIR				0.5 0.5		1, 4 1, 4	
012302	LEVER REMOTE CONTROL	REPLACE REPAIR				0.5 0.5		1, 4 1, 4	
012303	SHAFT, STRAIGHT	REPLACE REPAIR				0.5 0.5		1, 4 1, 4	
0124	VIBRATION DAMPER/BEARINGS GROUP	REPLACE REPAIR				1.0 0.5		1, 3, 4 1, 4, 48, 76, 82	Q, V
012401	CRANKSHAFT ASSEMBLY	REPLACE REPAIR			4.0 0.5			1, 3, 4 1, 4, 27, 42, 80	
0125	ENGINE SUPPORT GROUP	REPLACE REPAIR		0.5 0.5				1, 4 1, 4	

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT		INTERMED.		DEPOT		
			C	O	F	H	D		
0126	PULLEY SHIELD/FRONT GEAR HOUSING GROUP	REPLACE			1.0			1, 2, 3, 4	P
		REPAIR				1.5		1, 2, 3, 4	
0127	OIL PAN AND ADAPTER GROUP	REPLACE		1.0				1, 4	
		REPAIR			0.5			1, 4	
0128	LUBRICATING OIL PUMP GROUP	REPLACE			1.0			1, 4	R
		REPAIR			1.5			1, 4, 53, 56, 62-64	
012801	OIL PUMP ASSEMBLY, ENGINE	REPLACE			1.0			1, 4	R
		REPAIR			1.5			1, 4, 53, 56, 62-64	
0129	CAMSHAFT AND GEAR GROUP	REPLACE			3.5			1, 4, 17, 18, 56, 62	S
		REPAIR			1.0	3.5		1, 4, 17, 18, 19, 20, 56, 73	
0130	CONNECTING ROD AND PISTON GROUP	REPLACE			1.5			1, 4	J
		REPAIR			1.2	1.0		1, 4, 81	
013001	CONNECTING ROD ASSEMBLY	REPLACE			1.5			1, 4	B, U
		REPAIR				1.3		1, 4, 21, 56, 73	
013002	PISTON, INTERNAL COMBUS-TION ENGINE	REPLACE			1.0			1, 4, 23	
		REPAIR				0.5		1, 4, 22, 23, 56, 73	
0131	FLYWHEEL HOUSING GROUP	REPLACE			3.0			1, 3, 4, 62	
		REPAIR			2.0	1.5		1, 3, 4, 59, 74, 90	
013101	FLYWHEELAND RING GEAR ASSEMBLY	REPLACE			2.0			1, 4	
		REPAIR				1.5		1, 4	
013102	BARRING MECHANISM ASSEMBLY	REPLACE			2.0			1, 4	
		REPAIR			0.5	1.0		1, 4	

SECTION II. MAINTENANCE ALLOCATION CHART FOR MAIN PROPULSION ENGINE

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	INTERMED. F	INTERMED. H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0132	BLOCK ASSEMBLY, CYLINDER	REPLACE				35.0		1, 2, 4, 16 24, 25, 26	
		REPAIR				65.0		1, 2, 4, 14 16, 19, 24, 25, 26, 28, 39, 40, 42, 60, 63, 76	
013201	VALVE, REGULATING, FLUID PRESSURE	REPLACE				2.0		1, 4	
		REPAIR				1.5		1, 4	
0133	EXPANSION TANK GROUP	REPLACE		1.5				1	
		REPAIR		1.0				1	
013301	INSULATION BLANKETS	REPLACE		1.5					W
		REPAIR		1.5					

SECTION III. MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) TOOL OR TEST EQPT REF CODE	(2) MAINT. LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
1	C, O, F, H	Tool kit, general mechanic's: rail and marine diesel engine	5180-00-629-9783	(50980) SC-5180-CL -N55
2	F, H	Engine lifting fixture		(15434) 3375109
3	O, F, H	Lifting sling	3940-01-183-9412	(15434) 3375958
4	O, F, H	Torque wrench kit		(15434) 3377216
5	O	Strap wrench	5120-01-262-7306	(15434) 3376807
6	O	Fitter cutter	5120-01-262-7305	(15434) 3376579
7	O	Thermostat seal mandrel	5120-01-263-0138	(15434) 3375411
8	C, O	Water tube driver		(15434) ST-1319
9	O	Flex socket		(15434) 3375300
10	O	Oil filter wrench	5120-01-160-8863	(15434) 3375049
11	O	Injector puller	5120-00-116-7604	(15434) 3376000
12	C, O	Injector adjustment kit		(15434) 3822575
13	H	Adapter plate		(15434) 3376687
14	H	Cutter plate		(15434) 3375908
15	H	Counterbore, drive unit		(15434)

SECTION III. MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) TOOL OR TEST EQPT REF CODE	(2) MAINT. LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
				3376855
16	H	Gauge block	5120-01-157-3091	(15434) 3376220
17	F, H	Timing fixture	4910-00-999-1269	(15434) 3375522
18	F, H	Camshaft installation pilots		(15434) 3376280
19	H	Kit, driver bushing	5120-01-146-7131	(15434) 3376633
20	H	Bearing and bushing inserter		(15434) 3376637
21	F	Connection rod guide pins	5120-01-171-3914	(15434) 3375098
22	H	Piston ring expander	5120-01-171-3952	(15434) ST-1269
23	H	Piston ring compressor	5120-01-262-7315	(15434) 3375342
24	H	Cylinder Liner puller	5120-01-171-3915	(15434) 3376015
25	H	Cylinder Liner installation tool	4910-01-262-7309	(15434) 3375422
26	H	Cylinder liner clamp set	5120-01-262-7309	(15434) 3822503
27	H	Bearing cap putter	5120-01-171-3893	(15434) ST-1116
28	H	Lifting fixture		(15434) 3822512
29	O	Thermostat mandrel	5120-01-262-7304	(15434) ST-1226
30	O	Injector adjustment kit	4910-00-548-7984	(15434)

SECTION III. MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) TOOL OR TEST EQPT REF CODE	(2) MAINT. LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
				3375842
31	O	Fuel pump wrench		(15434) 3377198
32	O	Injector puller		(15434) 3382482
33	F	Barring tool	5120-01-262-7307	(15434) 3377321
34	F	Piston ring compressor	5120-00-116-7676	(15434) ST-755
35	F	Digital multimeter	6625-01-139-2512	(80058) AN/PSM-45
36	F	Ohmmeter	6625-00-141-3558	(80058) ZM73U
37	C, O	Pressure manometer	6685-01-107-6875	(23582) PVS-2
38	H	Valve vacuum tester	4910-01-141-8387	(15434) ST-1257
39	F, H	Valve spring compression tester	4910-01-142-4929	(15434) 3375182
40	O	Weighing scale	6670-01-184-0726	(03670) 53711
41	O	Electricians toot kit	5180-00-391-1087	(80064) 9000S6202-73125ALT2
42	F, H	Machinist measuring tool set	5280-00-278-9919	(50980) SC-5280-95-CL-A01-HR
43	F	Bearing driver		(15434) 3375318
44	F	Mechanical puller	5120-00-595-9304	
45	F, H	Arbor press	4920-00-373-9376	
46	F	Water pump seal driver		(15434)

SECTION III. MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) TOOL OR TEST EQPT REF CODE	(2) MAINT. LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
				3375319
47	F	Water pump seat driver		(15434) 3377260
48	F	Dial indicator	5210-00-277-8840	
49	F	Mandrel		(15434) ST-598
50	F	Hydraulic press		(68225) 2009-13
51	F	Mandrel		(15434) ST-1285
52	H	Valve spring compressor		(15434) ST-448
53	H	Valve seat extractor		(15434) 3376799
54	H	Valve guide mandrel		(15434) ST-1284
55	H	Valve guide arbor		(15434) 3375946
56	H	Valve seat insert toot driver		(15434) ST-257
57	H	Valve seat insert cutter		(15434) ST-1310
58	H	Insert staking toot		(15434) ST-1288
59	H	Magnaglo tester		(37676) H620
60	H	Dowel putter		(15434) ST-1134
61	H	Crosshead guide mandrel		(15434) ST-1264
62	H	Hydrostatic tester		(15434)

SECTION III MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) Tool Or Test Eqpt Ref Code	(2) Maintenance Level	(3) Nomenclature	(4) National/NATO Stock Number	(5) Tool Number
				ST-1012
63	H	Light duty puller kit		(15434) 3375784
64	H	Water test adapter		(15434) 3375070
65	H	Roller pin block		(15434) ST-1283
66	H	Rocker Lever actuator		(15434) 3375539
67	F	Rod bolt checking fixture		(15434) 3376846
68	H	Valve facing machine		(15434) 3376256
69	H	Valve seat grinding machine	5130-01-171-3909	(15434) ST-685
70	H	Valve guide driver		(15434) 3376779
71	H	Expansion plug Driver		(15434) 3376813
72	H	Expansion plug driver		(15434) 3376814
73	H	Extractor knocker		(15434) 3376617
74	H	Valve head checking tool		(15434) 3375939
75	H	Valve head checking tool		(15434) 3375940
76	H	Crack detector kit		(15434) 3375432
77	H	Eccentrimeter	5210-01-171-3910	(15434)

SECTION III MAINTENANCE ALLOCATION CHART FOR BASIC CRAFT

(1) Tool Or Test Eqpt Ref Code	(2) Maintenance Level	(3) Nomenclature	(4) National/NATO Stock Number	(5) Tool Number
				ST-685-4
78	H	Driver handle		(15434) 3376795
79	H	Magnetic crack detector	5120-01-128-2676	(15434) ST-1166
80	H	Crankshaft gear putter kit		(15434) 3375840
81	H	Drill and ream fixture		ST-1232
82	H	Guide studs		3376695
83	H	Valve guide reamer		ST-646
84	H	Grooving kit		3376405
85	H	Drill	5130-00-293-1949	
86	H	Lapping toot	5120-00-289-5027	
87	H	Ball gauge		3469

SECTION IV. REMARKS

MAIN PROPULSION ENGINE

REFERENCE CODE	REMARKS
A	Depot maintenance will be performed on a case by case basis subject to approval and funding by the National Maintenance Point (NMP).
B	Identify and tag attaching hardware.
C	This Item is a candidate for direct exchange with the vendor.
D	Failure to properly install the starter or operate it according to TM 55-1905-223-10 could result in damage to the starter, engine or in personal injury.
E	Do not attempt to adjust the automatic trip valve (ATV) in the starter's inlet or remove the cover plate protecting the ATV mechanism.
F	Item comes with attaching hardware.
G	Water filter mounting heads each have two mounting bolts that extend through the thermostat housing into the front water manifold connections.
H	Do not reuse the two internal O-rings in the water transfer tubes.
I	The water pump to block adapter plate and support bracket must be removed to allow the water pump to dear the splined coupling during removal.
J	Rocker lever housing and cylinder heads may be removed individually. Tag and identify upon removal for correct installation.
K	To avoid getting dirt in the injector barrel and cup, do not remove the plunger and spring.
L	Due to the weight of the complete aftercooler, a suitable lifting device should be used if the unit is removed as an assembly.
M	Replace the self-locking nuts and pry under the nuts with a pry bar until the O-ring sealing area at the base of the element is removed from the block.
N	A twelve point bolt must be used in top right comer of all plain covers. Use a 7/8-inch bolt on all plain covers unless a damp or bracket is attached. Use 1-inch for this. Use a 1-inch twelve point bolt in all holes on covers with oil fill dipstick on breather tube.
O	During removal, do not pry or pound on the damper. This may render the damper ineffective or crack the gear housing cover.

SECTION IV. REMARKS-Continued

MAIN PROPULSION ENGINE

REFERENCE CODE	REMARKS
P	Due to the weight and size of the cover and gear housing, care must be taken during removal to avoid damage to the cover and possible injury to personnel.
Q	CAUTION: Spring tension is released when removing pressure relief valve retaining pin.
R	The lubricating oil pump is dowel fit to the cylinder block on both sides.
S	Two men may be required when removing the camshafts to avoid possible damage to the camshaft and bushing.
T	Upon removal, reinstallation of this piece of equipment blank, cover, or otherwise protect all openings to prevent foreign matter from entering and damaging this system.
U	If the bearings are in satisfactory condition that will allow them to be used, be sure to mark them for location. Care must be taken not to knock the upper bearing loose from the connecting rod.
V	Rotate the crankshaft, if necessary, to facilitate its removal. If bearing shell inspection is to be performed, tape the upper and lower shells together or otherwise identify the shells as removed. Discard the bearing shells after inspection as required.
W	Insulation blankets are to be procured/fabricated commercially from sources skilled in the art of manufacturing removable insulation from material meeting requirements of MIL-1-24244 and MIL-1-16411, Type II.

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Section IV. REMARKS

MAIN PROPULSION ENGINE

REFERENCE CODE	REMARKS
M	Replace the self-locking nuts and pry under the nuts with a pry bar until theO-ring sealing area at the base of the element is removed from the block.
N	A twelve-point bolt must be used in top right corner of all plain covers. Use a 7/8-inch bolt on all plain covers unless a clamp or bracket is attached. Use 1-inch for this. Use a 1-inch twelve- point bolt in all holes on covers with oil fill dipstick on breather tube.
O	During removal, do not pry or pound on the damper. This may render the damper ineffective or crack the gear housing cover.
P	Due to the weight and size of the cover and gear housing, care must be taken during removal to avoid damage to the cover and possible injury to personnel.
Q	CAUTION: Spring tension is released when removing pressure relief valve retaining pin.
R	The lubricating oil pump is dowel fit to the cylinder block on both sides.
S	Two men may be required when removing the camshafts to avoid possible damage to the camshaft and bushing.
T	Upon removal, reinstallation of this piece of equipment, blank, cover, protect all openings to prevent foreign matter from entering this system.
U	If the bearings are in satisfactory condition that will allow them to be used, be sure to mark them for location. Care must be taken not to knock the upper bearing loose from the connecting rod.
V	Rotate the crankshaft, if necessary, to facilitate its removal, if bearing shell inspection is to be performed, tape the upper and lower shells together or otherwise identify the shells as removed. Discard the bearing shells after inspection as required.

APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

SECTION I. INTRODUCTION

C-1. **Scope**. This appendix lists expendable supplies and materials needed to operate and maintain the LCU 2000 Class Watercraft. These items are authorized by CTA 50-970, Expendable/Durable Items (except Medical, Class V, Repair Parts and Heraldic Items), or CTA 8-100, Army Medical Department Expendable Items.

C-2. **Explanation of Columns**.

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (for example, "Use cleaning compound, Item 5, App. C").

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item.

As applicable:

C - Operator/Crew
0 - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column (3) - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line of each item indicates the Federal Supply Code for Manufacturers (FSCM) in parentheses followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (for example, ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

ITEM NO.	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
1			Sandpaper	
2			Engine lube oil	
3			Coolant	
4			Wiping rags	
5			High temperature anti-seize compound	
6			Diesel fuel	
7			Electrical "Out of Service" tags	
8			Gasket adhesive	
9			Rust preventive lubricant	
10			Loctite 601	
11			Crocus cloth, fine	
12			Loctite 290	
13			Thermometer	
14			DCA coolant checking kit	
15			Cleaning solvent	
16			Lubriplate (or equivalent)	
17			Wood block	
18			Emery cloth	
19			High pressure lubricant	
20			Oil, SAE 30W	
21			Paper, abrasive 240 grit	

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

ITEM NO.	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
22			Alkaline solution	
23			Prussian blue compound	
24			Pipe sealant	
25			Teflon tape	
26			Grease	
27			Lubricant, SAE 140W	
28			High pressure grease	
29			Metal epoxy filler	
30			Utility pail	
31			Paint solvent	
32			Tempilstick crayon (600°F)	
33			White paper towels	
34			Bristle brush	
35			Loctite 609	
36			Valve Lapping Paste	
37			Cup Plug Loctite Sealant	

APPENDIX D

TORQUE VALUES

D-1. Scope. SAE capscrews are graded according to the strength of the capscrew. They are marked on the head so the correct strength and torque value are known. The tables in this appendix will list the capscrew markings with correct torque values as well as values for pipe plugs and metric bolts.

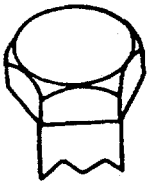
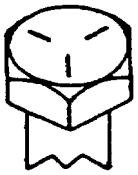
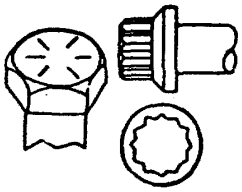
CAUTION

If replacement capscrews are of a higher grade than originally supplied, adhere to torque specifications for that placement.

NOTES

1. Always use the torque values listed when specific torque values are not available.
2. Do not use these listed values in place of those specified in other sections of this manual, special attention should be observed when using SAE Grade 6, 7 and 8 capscrews.
3. This listing is based on use of clean, dry threads.
4. Reduce torque by 10% when engine oil is used as a lubricant.
5. Reduce torque by 20% if new plated capscrews are used.
6. Capscrews threaded into aluminum may require reductions in torque of 30% or more of Grade 5 capscrews torque and must attain two capscrew diameters of thread engagement.

APPENDIX D

Quality of Material	Indeterminate	Minimum Commercial	Medium Commercial	Best Commercial
SAE Grade Number	1 or 2	5	6 or 7	B
Capscrew Head Marking Manufacturer's marks may vary These are all SAE Grade 5 (3 line) 				
Capscrew Body Size Inches - Thread	Torque Ft-Lb (N-m)	Torque Ft-Lb (N-m)	Torque Ft-Lb (N-m)	Torque Ft-Lb (N-m)
¼ -20	5 (7)	8 (11)	10 (14)	12 (16)
-28	6 (8)	10 (14)		14 (19)
5/16 -18	11 (15)	17 (23)	19 (26)	24 (33)
-24	13 (18)	19 (26)		27 (37)
3/8 -16	18 (24)	31 (42)	34 (46)	44 (60)
-24	20 (27)	35 (47)		49 (66)
7/16 -14	28 (38)	49 (66)	55 (75)	70 (95)
-20	30 (41)	55 (75)		78 (106)
½ -13	39 (53)	75 (102)	85 (115)	105 (142)
-20	41 (56)	85 (115)		120 (163)
9/16 -12	51 (69)	110 (149)	120 (163)	155 (210)
-18	55 (75)	120 (163)		170 (231)
5/8 -11	83 (113)	150 (203)	167 (226)	210 (285)
-18	95 (129)	170 (231)		240 (325)
¾ -10	105 (142)	270 (366)	280 (380)	375 (508)
-16	115 (156)	295 (400)		420 (569)
7/8 --9	160 (217)	395 (536)	440 (597)	605 (820)
-14	175 (237)	435 (590)		675 (915)
1 -8	235 (319)	590 (800)	660 (895)	910 (1234)
-14	250 (339)	660 (895)		990 (1342)

GENERAL CONVERSION TABLE

Multiply By	To Convert	To	-
	Length		
2.54	Inches	Centimeters	.3937
25.4	Inches	Millimeters	.03937
30.48	Feet	Centimeters	.0328
.304	Feet	Meters	3.28
.914	Yards	Meters	1.094
1.069	Miles	Kilometers	.621
	Volume		
.473	Pints	Liters	2.11
.946	Quarts	Liters	1.06
3.785	Gallons	Liters	.264
.016	Cubic Inches	Liters	61.02
16.39	Cubic Inches	Cubic cms	.061
28.3	Cubic Feet	Liters	.0353
	Mass (Weight)		
28.35	Ounces	Grams	.035
.4536	Pounds	Kilograms	2.20
	Area		
.645	Square Inches	Square cms	.155
.836	Square Yards	Square meters	1.196
	Force		
4.448	Pounds	Newtons	.225
.138	Ft-lbs	Kilogram-meters	7.23
1.36	Ft-lbs	Newton-meters	.737
.112	In-lbs	Newton-meters	8.844
	Pressure		
.068	Psi	Atmospheres	14.7
6.89	Psi	Kilopascals	.145
	Other		
1.104	Horsepower (DIN)	Horsepower (SAE)	.9861
.746	Horsepower (SAE)	Kilowatts (KW)	1.34
1.60	Mph	Km/h	.625
.425	Mpg	Km/1	2.35
-	To obtain	From	Multiply By

TAP DRILL SIZES

NATIONAL COARSE OR U.S.S.						NATIONAL FINE OR S.A.E.					
Screw & Tap Size	Thread Per Inch	Use Drill No.	Screw & Tap Size	Threads Per Inch	Use Drill No.	Screw & Tap Size	Threads Per Inch	Use Drill No.	Screw & Tap Size	Threads Per Inch	Use Drill No.
No. 5	40	39	1/2	13	27/64	No. 5	44	37	1/2	20	29/64
No. 6	32	36	9/16	12	31/64	No. 6	40	33	9/16	18	33/64
No. 8	32	29	5/8	11	17/32	No. 8	36	29	5/8	18	37/64
No. 10	24	25	3/4	10	21/32	No.10	32	21	3/4	16	11/16
No. 12	24	17	7/8	9	49/64	No. 12	28	15	7/8	14	13/16
1/4	20	8	1	8	7/8	1/4	28	3	1-1/8	12	1-3/64
5/16	18	F	1-1/8	7	63/64	5/16	24	1	1-1/4	12	1-11/64
3/8	16	5/16	1-1/4	7	1 and 7/64	3/8	24	Q	1-1/2	12	1-7/64
7/16	14	U	1-1/2	6	1 and 11/32	7/16	20	W			

GLOSSARY

Section I. ABBREVIATIONS

cm	Centimeter
gpd	Gallons per day
hrs	Hours
H.P.	High pressure
Hz	Hertz
id	Inside diameter
kg	Kilogram
kPa	Kilo Pascal
lb	Pound
MCHRY	Machinery
No	Number
Para	Paragraph
P/N	Part Number
ppm	Parts per million
psi	Pounds per square inch
qty	Quantity
RPM	Revolutions per minute
TDS	Total dissolved solids
V	Volts
Vac	Volts alternating current

ALPHABETICAL INDEX

Index (Continued)

Index (Continued)

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN, II
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25A, Unit and Direct Support and General Support Maintenance requirements for Landing Craft, Utility, LUC-1466, Type III.

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P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN : 065510 000