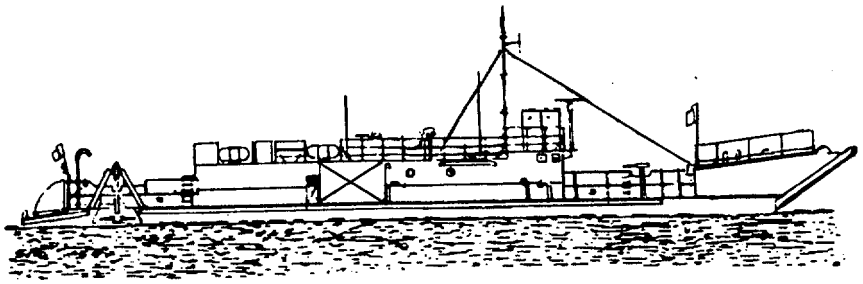
TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

LANDING CRAFT UTILITY
LCU 1671-1679
(1905-01-009-1056)

OPERATOR/CREW PROPULSION ENGINE MAINTENANCE INSTRUCTIONS



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CHANGE

NO. 3

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Operator's, Organizational,
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Maintenance Manual

LANDING CRAFT UTILITY
LCU 1671-1679
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URGENT

WARNING

DEATH

OR SEVERE INJURY MAY RESULT IF PERSONNEL FAIL TO OBSERVE THE GENERAL SAFETY PRECAUTIONS BELOW, AND THE SPECIFIC PRECAUTIONS CONTAINED IN THE TEXT.

- Wear safety glasses, safety shoes, and a hard hat to provide adequate protection.
- Death or severe injury may result if personnel fail to use a lifting device that is adequate for the item to be lifted.
- Ear protection must be worn when engines or machinery is in operation.
- Use care when using power tools.
- If cleaning agents are used, be sure area is adequately ventilated, and use protective gloves and goggles, or face shield and apron.
- Avoid excessive injection of ether into an engine during starting attempts. Follow the instructions on the container or by the manufacturer of the starting aid.
- Use the recommended air pressure when using compressed air to clean components. Too much air pressure can rupture or in some way damage a component and create a hazardous situation that can lead to personal injury.
- When working on an engine that is running, accidental contact with the hot exhaust manifold can cause severe burns.

WARNING **(Cont)**

- Use extreme care when near rotating fans, belts and pulleys.
- Avoid making contact across the terminals of the batteries and do not spill the contents of the battery.
- Keep clear of the Anchor Winch or Bow Ramp Winch while it is in operation.
- During any removal, disassembly, assembly, or installation of an electrical device, make sure all electrical power is disconnected, and tagged. (Circuit breaker in the OFF position and tagged).
- Improper functioning of Engine Exhaust System can cause injury or death.
- Personnel should know the location and operation of all equipment for emergency use.
- Before attempting to operate any equipment, read the instructions completely. Then, return to the appropriate section and follow the instructions.
- Do not enter a Winch Compartment alone.
- If the Halon System is activated (horn sounds), leave the compartment immediately. Check that no one is left, and then close and dog the hatch.
- Use extreme care when handling gasoline for the Salvage Pump.
- Store all flammable material in the Flammable Storage Compartment.

WARNING **(Cont)**

- When cutting with a torch, or when welding, always station fire watches, ready with fire extinguishers, in the vicinity on both sides of the plate that is being cut or welded.

- Prior to cutting or welding on the ramp, remove drain plugs on both sides of the ramp and check if ramp interior is primer coated. If primer coated, flush thoroughly with steam, carbon dioxide, or water. Do not reinstall drain plugs until the cutting and/or welding operation is completed. Failure to take this precaution may result in explosion of accumulated primer vapors.

- When refueling, shut down the electrical system. Observe the no smoking rule. Do not permit anyone to operate tools or equipment which may produce sparks near the refueling operation. Sparks or fire may ignite the diesel fuel and produce an explosion.

- Fuel oil and other petroleum products are highly volatile in extreme heat. To minimize the possibility of explosion, wipe up all spills at once, see that fuel lines and valves are not leaking and pump bilges regularly.

- Before attempting to remove any compressed air system lines or components, relieve air pressure from system. Failure to do so may result in injury or possible death to maintenance personnel.

- Before disconnecting a line in the hydraulic system, bleed the pressure from that portion of the line. Failure to do so may result in injury or possible death to maintenance personnel.

- When working inside the hydraulic oil supply tank, a portable-type circulating blower should be used to prevent vapor accumulation. For extended work periods inside the tank, an air line tube respirator should be worn. Station an observer outside tank in case worker is overcome by fumes.

- Acids can cause serious burns or blindness. Avoid contact with eyes, skin, or clothing. Do not breathe vapors. Wear rubber gloves, goggles, and a rubber apron when handling them. When diluting acids, do not add water to acid; the acid must be added to the mixture slowly and with constant mixing. In case of contact with acid, flush the affected area with plenty of water and obtain medical aid immediately.

WARNING (Cont)

- Ramp hinge pins must be replaced one at a time, allowing three remaining pins to support ramp. Removal of two or more hinge pins may result in the weight of the ramp misaligning the remaining hinges, resulting in damage to ramp and possible injury or death to maintenance personnel.

TECHNICAL MANUAL

NO. 55-1905-220-14-4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON D.C., 10 August1983

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

LANDING CRAFT UTILITY
LCU 1671-1679
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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MPSD, 4300 Goodfellow Blvd., St. Louis, Mo 63120. A reply will be furnished directly to you.

TABLE OF CONTENTS

*This manual supersedes TM 55-1905-220-14-4, dated 29 August 1980.

CHAPTER 3 (CONTINUED)

SECTION V. MAINTENANCE PROCEDURES.

3-6. PROPULSION SYSTEM.

The propulsion system maintenance instructions are as follows:

3-6. PROPULSION SYSTEM (Cont).

a. General Description.

(1) The main propulsion engine is a 12 cylinder Detroit Diesel. The engine is equipped with an oil cooler, lubricating oil filter, fuel oil strainer, fuel oil filter, air silencer, governor, heat exchanger, raw water pump and a starter.

(2) Fuel is drawn from the supply tank and through a strainer by a gear-type fuel pump, then forced through the filter and fuel inlet manifolds in the cylinder heads to the injectors. Excess fuel is returned to the supply tank via the return fuel manifolds and connecting lines. Since fuel is constantly circulating through the injectors, it serves to cool the injectors and carry off any air in the fuel system.

(3) Air for scavenging and combustion is supplied by blower(s) which pumps air into the engine cylinders via the air box and cylinder liner ports. All air entering the blower(s) first passes through an air silencer.

(4) Full pressure lubrication is supplied to all main connecting rod and camshaft bearings, and to other moving parts of the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filter(s) and then to the oil cooler(s). From the oil cooler(s) the oil flows through passages that connect with the oil galleries in the cylinder block and cylinder heads for distribution to the bearings, rocker arm mechanism and other functional parts.

(5) Coolant is circulated through the engine by a centrifugal type water pump. Heat is removed from the coolant, which circulates in a closed system, by a heat exchanger. Control of the engine temperature is accomplished by thermostats that regulate the flow of the coolant within the cooling system.

3-6. PROPULSION SYSTEM (Cont).

(6) Engine starting is provided by a hydraulic starting system.

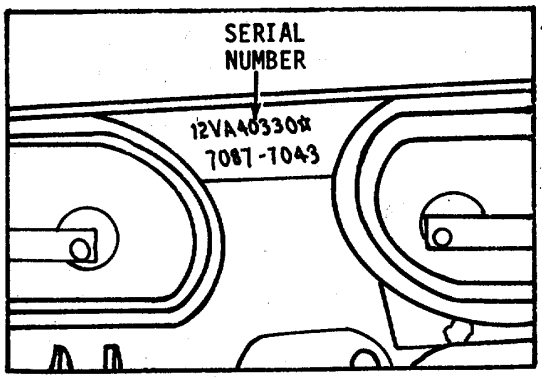
(7) Engine speed is controlled by a variable speed hydraulic governor.

b. Engine Model and Serial Number Designation.

(1) The engine serial number and model number are stamped on the right-side of the cylinder block.

(2) Engines with optional equipment have an option plate attached to one of the valve rocker covers. The engine serial number and model number are also stamped on this plate.

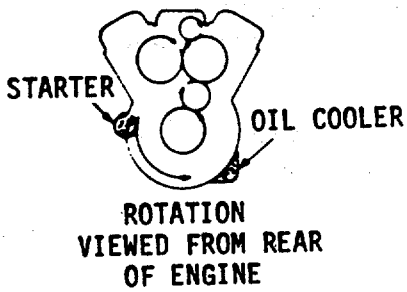
(3) Hydraulic marine gears also carry name plates pertaining to the particular assembly to which they are attached.

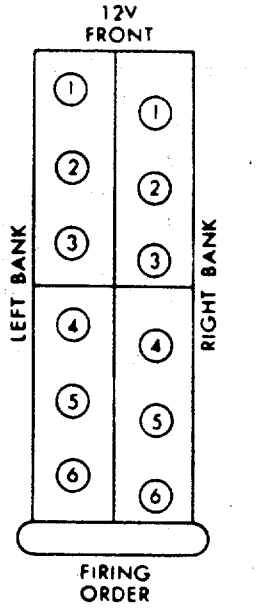


3-249

3-6. PROPULSION SYSTEM (Cont).

ENGINE ROTATION AND FIRING ORDER





GENERAL SPECIFICATIONS

	12V
Type	2 Cycle
Number of Cylinders	12
Bore	4/ 1/4 in.(10.8 cm)
Stroke	5 in. (12.7 cm)
Compression Ratio	18.7 to 1
Total Displacement - Cubic Inches	852 (13.97 liters)
Number of Main Bearings	7

3-6. PROPULSION SYSTEM (Cont).

c. General Information - DETROIT DIESEL V-71

(1) General Procedures.

(a) In many cases, the maintenance man is justified in replacing parts with new material rather than attempting repair. However, there are times where a slight amount of reworking or reconditioning may save time. Crankshafts, cylinder liners and other parts are in this category. For example, if a cylinder liner is only slightly worn and within usable limits, a honing operation to remove the glaze may make it suitable for reuse. Exchange assemblies such as injectors, fuel pumps, water pumps and blowers are also desirable service items.

(b) Various factors such as the type of operation of the engine, hours in service and next overhaul period must be considered when determining whether new parts are installed or used parts are reconditioned to provide trouble-free operation.

(c) For convenience and logical order in disassembly and assembly, the various sub-assemblies and other related parts mounted on the cylinder block will be treated as separate items in the various sections.

(2) Disassembly.

(a) Before any major disassembly, the engine must be drained of lubricating oil, water and fuel. On engines cooled by a heat exchanger, the fresh water system must be drained. Lubricating oil should also be drained from the marine gear.

NOTE

Do not drain oil into bilges. Use the oil separation system to collect drained oil.

(b) Parts removed from an individual engine should be kept together so they will be available for inspection and assembly. Those items having machined faces, which might be easily damaged by steel should be stored on suitable wooden racks or blocks.

(3) Cleaning.

Before removing any of the sub-assemblies from the engine (but after removal of the electrical equipment), the exterior of the engine should be thoroughly cleaned. Then, after each subassembly is removed and disassembled, the individual parts should be cleaned. Thorough cleaning of each part is absolutely necessary before it can be satisfactorily inspected.

3-6. PROPULSION SYSTEM (Cont).

(4) Rust preventive.

If parts are not to be used immediately after cleaning, dip them in a rust preventive compound (P/N 6850-00-753-4967). The rust preventive compound should be removed before installing the parts in an engine.

(5) Inspection.

(a) The purpose of parts inspection is to determine which parts can be used and which must be replaced. Although the engine overhaul specifications given throughout the text will aid in determining which parts should be replaced, considerable judgment must be exercised.

(b) The guiding factors in determining the usability of worn parts, which are otherwise in good condition, is the clearance between the mating parts and the rate of wear on each of the parts. If it is determined that the rate of wear will maintain the clearances within the specified maximum allowable until the next overhaul period, the reinstallation of used parts may be justified. Rate of wear of a part is determined by dividing the amount the part has worn by the hours it has operated.

(c) Many service replacement parts are available in various undersize and/or oversize as well as standard sizes. Also, service kits for reconditioning certain parts and service sets which include all of the parts necessary to complete a particular repair job are available.

(d) A complete discussion of the proper methods of precision measuring and inspection are outside the scope of this manual. However, every shop kit should be equipped with standard gages, such as dial bore gages, dial indicators, and inside and outside micrometers.

(6) Assembly.

(a) Following cleaning and inspection, the engine should be assembled using new parts as determined by the inspection.

(b) Use of the proper equipment and tools makes the job progress faster and produces better results. Likewise, a suitable working space with proper lighting must be provided.

(c) Keep the working space, the equipment, tools and engine assemblies and parts clean at all times. The area where assembly operations take place should, if possible, be located away from the disassembly and cleaning operation. Also, any machining operations should be removed as far as possible from the assembly area.

3-6. PROPULSION SYSTEM (Cont).

(d) Particular attention should be paid to storing of parts and subassemblies, after removal and cleaning and prior to assembly, in such a place or manner as to keep them clean. If there is any doubt as to the cleanliness of such parts, they should be recleaned.

(e) When assembling an engine or any part thereof, refer to the table of torque specifications for proper bolt, nut and stud torques.

(7) Work Safety.

(a) A maintenance person can be severely injured if caught in the pulley or belts of an engine that is accidentally started. To avoid such a misfortune, take these precautions before starting to work on an engine: Tag all electrical switches so that the electrical circuit is disrupted. Accidental contact with the starter button will not produce an engine start.

(b) Make sure the mechanism provided at the governor for stopping the engine is in the stop position. This will mean the governor is in the no-fuel position. The possibility of the engine firing by accident is minimized.

(c) Some Safety Precautions to Observe When Working On The Engine:

1. Consider the hazards of the job and wear protective gear such as safety glasses, safety shoes, hard hat, etc., to provide adequate protection.

2. When lifting an engine component, make sure the lifting de- vice is fastened securely. Be sure the item to be lifted does not exceed the capacity of the lifting device.

3. Always use caution when using power tools.

4. When using compressed air to clean a component such as cleaning an air silencer, use a safe amount of air. Recommendations regarding the use of air are indicated throughout the manual. Too much air can rupture or in some other way damage a component and create a hazardous situation that can lead to personal injury.

5. Avoid the use of carbon tetrachloride as a cleaning agent because of the harmful vapors that it releases. Use perchlorethylene or trichlorethylene. However, while less toxic than other chlorinated solvents, use these cleaning agents with caution. Be sure the work area is adequately ventilated and use protective gloves, goggles or face shield and apron.

3-6. PROPULSION SYSTEM (Cont).

WARNING

Exercise caution against burns when using oxalic acid to clean the cooling passages of the engine.

6. Avoid excessive injection of ether into the engine during start attempts. Follow the instructions on the container of the starting aid.

7. When working on an engine that is running, accidental contact with the hot exhaust manifold can cause severe burns. Remain alert to the location of the rotating pulleys and belts.

8. Engine Specifications.

(Less Major Assemblies)

Specifications, clearances and wear limits are listed below. It should be specifically noted that the clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled "Limits" in this chart lists the amount of wear or increase in clearance which can be tolerated in used engine parts and still ensure satisfactory performance. It should be emphasized that the figures given as "Limits" must be qualified by the judgment of the personnel responsible for installing new parts. These wear limits are, in general, listed only for the parts more frequently replaced in engine overhaul work. For additional information, refer to the text.

ENGINE BLOCK AND CYLINDER HEAD

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS

These limits also apply to oversize and undersize parts.

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Cylinder Block						
Block bore:						
Diameter	4.6260	11.7500	4.6270	11.7526		
Out-of-round			0010	.0025	.0020	.0051
Taper			.0010	.0025	.0020	.0051
Cylinder line counterbore:						
Diameter	5.0460	12.8168	5.0510	12.8295		
Depth.	4770	1.2116	.4795	1.2179		
Main bearing bore:						
Inside diameter (vertical axis)	4.8120	12.2225	4.8130	12.2250		
Top surface of block:						
Centerline of main bearing bore to top of block	6.1840	41.1074	16.1890	41.1201	16.176 min.	41.0870 min.
Flatness-transverse (all)					.0030	.0076
Flatness-longitudinal (all)					.0050	.0127
Depth of counterbores (top surface):						
Cylinder head seal strip groove	.0970	.2464	.1070	.2718		
Water holes (between cylinders)	.1140	.2896	.1200	.3048		
Combination water and oil holes	.0920	.2337	.0980	.2489		
Cylinder Liner						
Outside diameter	4.6250	11.7475	4.6260	11.7500		
Inside diameter	4.2495	10.7937	4.2511	10.7978		
Clearance-liner-to-block	.0000	.0000	.0020	.0051	.0025	.0064
Out-of-round-inside diameter			.0020	.0051	.0025	.0064
Taper-inside diameter			.0010	.0025	.0020	.0051
Depth of flange BELOW block	.0450	.1143	.0500	.1270	.0500	.1270
Variation in depth between adjacent liners			.0020	.0051	.0020	.0051
Flange thickness	.2500	.6350	.2520	.6401		
Insert thickness	.1795	.4559	.1800	.4572		

Table Of Specifications. (continued)

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Piston:						
Height (centerline of bushing to top)	3.5430	8.9992	3.5480	9.0119		
Diameter (above compression rings)	4.2225	10.7252	4.2255	10.7328		
Diameter (at skirt)	4.2428	10.7767	4.2450	10.7823		
Clearance-piston skirt-to-liner	.0045	.0114	.0083	.0211	.0120	0305
Out-of-round			.0005	.0013		
Taper			.0005	.0013		
Compression rings:						
Gap (top-fire ring)	.0230	.0584	.0380	.0965	.0600	.1524
Gap (No. 2, 3 and 4)	.0180	.0457	.0430	.1092	.0600	.1524
Clearance-ring-to-groove:						
No. 1 (top-fire ring)	.0040	.0102	.0070	.0178	.0180	.0457
No. 2	.0100	.0254	.0130	.0330	.0220	.0559
No. 3 and 4	.0040	.0102	.0070	.0178	.0130	.0330
Oil control rings:						
Gap	.0080	.0203	.0230	.0584	.0430	.1092
Clearance	.0015	.0038	.0055	.0140	.0080	.0203
Crankshaft						
Journal diameter-main bearing	4.4990	11.4275	4.5000	11.4300		
Journal diameter-conn. rod bearing	2.9990	7.6175	3.0000	7.6200		
Journal out-of-round			.00025	.00064	.0010	.0025
Journal taper			.0005	.0013	.0015	.0038
*Runout on journals-total indicator reading:						
Crankshaft (mounted on No. 1 and No.7 journals):						
At No. 2 and No. 6 journals			.0020	.0051		
At No. 3 and No. 5 journals			.0040	.0102		
At No. 4 journal			.0060	.0152		
Thrust washer thickness	.1190	.3023	.1220	.3099		
End play (end thrust clearance)	.0040	.0102	.0140	.0356	.0180	.0457

* Runout tolerance given for guidance when regrinding crankshaft. When the runout on adjacent journals is in the opposite direction, the sum must not exceed .003 inches (.008 cm) total indicator reading. When the runout on adjacent journals is in the same direction, the difference must not exceed .003 inch (.008 cm) total indicator reading. When high spots of the runout on adjacent journals are at right angles to each other, the sum must not exceed .004 inches (.010 cm) total indicator reading or .002 inches (.005 cm) on each journal.

Table Of Specifications. (continued)

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Connecting Rod Bearing						
Inside diameter (vertical axis)	3.0014	7.6236	3.0034	7.6286		
Bearing-to-journal clearance	.0014	.0036	.0044	.0112	.0060	.0152
Bearing thickness 90° from parting line	.1238	.3145	.1243	.3157	.1230 min.	.3124 min.
Main Bearings						
Inside diameter (vertical axis)	4.5016	11.4341	4.5040	11.4402		
Bearing-to-journal clearance	.0016	.0041	.0050	.0127	.0060	.0152
Bearing thickness 90°. from parting line	.1545	.3924	.1552	.3942	.1540 min.	.3912 min.
Camshaft						
Diameter (at bearing journals):						
Front and rear	1.4970	3.8024	1.4975	3.8037		
Center and intermediate	1.4980	3.8049	1.4985	3.8062		
Runout at center bearing (when mounted on end bearings)			.0020	.0051		
End thrust	.0040	.0102	.0120	.0305	.0180	.0457
Thrust washer thickness	.1190	.3023	.1220	.3099		
Camshaft Bearings						
Inside diameter:						
Front and rear	1.5000	3.8100	1.5010	3.8125		
Center and intermediate	1.5010	3.8125	1.5030	3.8176		
Clearance-bearing-to-shaft:						
Front and rear	.0025	.0064	.0040	.0102	.0060	.0152
Center and intermediate	.0025	.0064	.0050	.0127	.0090	.0229
Outside diameter:						
Front and rear	2.1880	5.5575	2.1885	5.5588		
Center and intermediate	2.1840	5.5474	2.1860	5.5524		

Table Of Specifications. (continued)

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Diameter of cylinder block bore	2.1875	5.5563	2.1885	5.5588		
Clearance-bearings-to-block:						
Front and rear	.0010 press	.0025 press	.0005 loose	.0013 loose		
Intermediate	.0015	.0038	.0045	.0114		
Camshaft Gears						
Inside diameter	1.1865	3.0137	1.1875	3.0163		
Clearance-gear-to-shaft	.0015	.0038	.0000	.0000		
Backlash	.0030	.0076	.0080	.0203	.0100	.0254
Idler Gear						
Backlash	.0030	.0076	.0080	.0203	.0100	.0254
Pre-load-Variation on pull 2 lbs. 11 oz	1.2500	.5675	6.7500	3.0645		
Crankshaft Timing Gear						
Inside diameter	4.7490	12.0625	4.7500	12.0650		
Clearance-gear-to-shaft.	.001 press	.0025 press	.001 loose	.0025 loose		
Backlash	.0030	.0076	.0080	.0203	.0100	.0254
Blower Drive Gear (and Left Bank Accessory Drive Gear)						
Backlash	.0030	.0076	.0080	.0203	.0100	.0254
Inside diameter (support bushing)	1.6260	4.1300	1.6265	4.1313		
Hub diameter (at bearing)	1.6240	4.1250	1.6250	4.1275		
Hub-to-support bushing clearance	.0010	.0025	.0025	.0064	.0050	.0127
Thrust washer thickness	.2350	.5969	.2450	.6223		
Thrust bearing thickness	.0590	.1499	.0610	.1549		
End thrust	.0050	.0127	.0100	.0254		
Cylinder Head						
Flatness-transverse					..0040	.0102
Flatness-longitudinal					.0100	.0254
Distance between top deck and fire deck	3.5560	9.0322	3.5680	9.0627	3.5360	8.9814
Water nozzles	.0132 Recess	.0335 Recess	Flush	Flush		
Cam follower bores	1.0620	2.6975	1.0630	2.7000	1.0650	2.7051

Table Of Specifications. (continued)

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Exhaust Valve Insert Counterbore:						
Diameter	1.2600	3.2004	1.2610	3.2029		
Depth	.3380	.8585	.3520	.8941		
Exhaust Valve Seat Inserts						
Outside diameter	1.2615	3.2042	1.2625	3.2068		
Seat width	.0469	.1191	.0938	.2383	.0938	.2383
Valve seat runout			.0020	.0051	.0020	.0051
Exhaust Valves						
Stem diameter	.3100	.7874	.3105	.7887	.3090	.7849
Valve head-to-cylinder head:						
30°	.023 recess	.0584 recess	.006 protr.	.0152 protr.		
Valve Guides						
Height above cylinder head	.8800	2.2352	.8800	2.2352		
Diameter-inside	.3125	.7938	.3135	.7963	.3140	.7976
Clearance-valve-to-guide	.0020	.0051	.0035	.0089	.0050	.0127
Valve Bridge Guides						
Height above cylinder head		2.0400	5.1816	2.0400	5.1816	
Rocker Arms and Shafts						
Diameter-rocker shaft	.8735	2.2187	.8740	2.2200		
Diameter-inside (rocker arm bushing)	.8750	2.2225	.8760	2.2225		
Clearance-shaft-to-bushing	.0010	.0025	.0025	.0064	.0040	.0102
Cam Followers						
Diameter	1.0600	2.6924	1.0610	2.6949		
Clearance-follower-to-head	.0010	.0025	.0030	.0076	.0060	.0152
Rollers and pins:						
Clearance-pin-to-bushing	.0013	.0033	.0021	.0053	.010 Horiz	.0254 Horiz
Side clearance-roller to follower	.0150	.0381	.0230	.0584	.0230	.0584

AIR INTAKE SPECIFICATIONS

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
BLOWER						
Backlash (timing gears)	.0005	.001270	.0025	.006350	.0040	.010160
Oil Seal (below end plate surface	.0020	.005080	.0080	.020320		
Oil Strainer (below end plate surface).	.0000	.000000	.0150	.038100		
Dowel Pin (projection beyond inside face of front end plate)	.3800	.965200				
Dowel Pin (projection beyond inside face of rear end plate)	.2700	.685800				
Clearances:						
Rotor to end plate (gear end).....	.0070	.017780				
Rotor to end plate (front end).....	.0120	.030480				
Rotor to housing (inlet side).....	.0160	.040640				
Rotor to housing (outlet side).....	.0040	.010160				
Trailing edge of R.H. helix rotor to leading edge of L.H. helix rotor.	.0020	.005080	.0060	.015240	.0060	.015240
Leading edge of R.H. helix rotor to trailing edge of L.H. helix rotor..	.0120	.030480				

HYDROSTARTER SYSTEM SPECIFICATIONS

	English	Metric
HYDROSTARTER MOTOR		
Number of pistons	Seven	
Displacement per revolution	2 cu. in.	37.8 cm^2
Maximum torque at 3000 psi (206.85 kPa) (20 Series)	73 lb. ft.	99.1 nm^2
Drive	Overrunning clutch	
ENGINE-DRIVEN PUMP		
Type	Positive displacement	
Number of pistons	One	
Displacement per revolution	0.0208 cu. in.	13.3 mm^2
Maximum discharge pressure	3250 psi	22409 kPa
Maximum continuous speed	2500 rpm	
MANUAL PUMP		
Type	Positive displacement	
Number of pistons	One	
Displacement per stroke	0.773 cu. in.	498.7 mm^2
ACCUMULATOR		
Type	Piston	
Capacity	200 or 300 cu. in.	1290 or 1935 cm^2
Precharge (nitrogen)	1250 psi	8618.8 kPa
Operating pressure	900-3000 psi	19996-20685 kPa

STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Thread Size	TORQUE Minimum (lb ft)	(nm)	Maximum (lb ft)	(nm)
1/4 -20	7	9.4920	9	12.2040
1/4 -28	8	10.8480	10	13.5600
5/16 -18	13	17.6280	17	23.0520
5/16 -24	15	20.3400	19	25.7640
3/8 -16	30	40.6800	35	47.4600
3/8 -24	35	47.4600	39	52.8840
7/16 -14	46	62.3760	50	67.8000
7/16 -20	57	77.2920	61	82.7160
1/2 -13	71	96.2760	75	101.7000
1/2 -20	83	112.5480	93	126.1080
9/16 -12	90	122.0400	100	135.6000
9/16 -18	107	145.0920	117	158.6520
5/8 -11	137	185.7720	147	199.3320
5/8 -18	168	227.8080	178	241.3680
3/4 -10	240	325.4400	250	339.0000
3/4 -16	290	393.2400	300	406.8000
7/8 -9	410	555.9600	420	569.5200
7/8 -14	475	644.1000	485	657.6600
1 -8	580	786.4800	590	800.0400
1 -14	685	928.8600	695	942.4200

BOLT IDENTIFICATION CHART

Grade identification markings are normally stamped on the heads of the bolts. To aid identification of the various bolts used in Detroit Diesel engines, refer to the following chart.

Grade Identification Marking on Bolt Head	GM Number	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None	GM 255-M	1	No. 6 thru 1-1/2	60,000
None	GM 260-M	2	No. 6 thru ¾ over 3/4 to 1-1/2	74,000
Bolts and Screws	GM 280-M	5	No. 6 thru 1 over 1 to 1-1/12	120,000 105,000
Hex Head Sems Only	GM 275-M	5.1	No. 6 thru 3/8	120,000
Bolts and Screws	GM 290-M	7	¼ thru 1-1/2	133,000
Bolts and Screws	GM 300-M	8	¼ thru 1-1/2	150,000
Bolts and Screws	GM 455-M	None	No. 6 thru 1-1/2	55,000

STANDARD PIPE PLUG TORQUE SPECIFICATIONS

Use sealing compound on plugs without gaskets or Teflon. These specifications apply to plugs installed below the surface of the part of which they are a component.

	TORQUE			
Thread size	Minimum (lb ft)	(nm)	Maximum (lb ft)	(nm)
1/8.....	10	13.5600	12	16.2720
1/4.....	14	18.9840	16	21.6960
3/8.....	18	24.4080	22	29.8320
1/2.....	23	31.1880	27	36.6120
3/4.....	33	44.7480	37	50.1720
1.....	75	101.7000	85	115.2600
1-1/4.....	95	128.8200	105	142.3800
1-1/2.....	110	149.1600	130	176.2800

ENGINE BLOCK AND CYLINDER HEAD

EXECPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	Thread Size	TORQUE Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (Nm)
Cam follower guide bolt.....	1/4-20	12	16.2720	15	20.3400
Injector control shaft bracket bolt.....	1/4-20	10	13.5600	12	16.2720
Air box cover bolt.....	5/16-18	8	10.8480	12	16.2720
Oil pan bolts (lower pan).....	5/16-18	10	13.5600	12	16.2720
Exhaust valve bridge adjusting screw lock nut..	5/16-24	20	27.1200	25	33.9000
Idler gear bearing retainer bolts.....	5/16-24	24	32.5440	29	39.3240
Injector clamp bolts.....	3/8-16	20	27.1200	25	33.9000
Front end plate bolt (two bolts into water jacket plug)	3/8-16	20	27.1200	25	33.9000
Flywheel housing bolts.....	3/8-16	25	33.9000	30	40.6800
Oil pan bolts (upper).....	3/8-16	15	20.3400	20	27.1200
Idler gear hub and spacer bolts.....	3/8-16	40	54.2400	45	61.0200
Front accessory drive pulley bolt.....	3/8-16	25	33.9000		
Camshaft end bearing bolts.....	3/8-16	35	47.4600	40	54.2400
Flywheel housing bolts (threaded into plug nuts).....	3/8-24	25	33.9000	30	40.6800
Camshaft intermediate bearing lock screw.....	3/8-24	15	20.3400	20	27.1200
Balance weight-to-camshaft gear plain nut.....	3/8-24	18	24.4080	22	29.8320
Balance weight-to-camshaft gear lock nut.....	3/8-24	25	33.9000	30	40.6800
Blower drive support bolts and nuts.....	3/8-24	25	33.9000	30	40.6800
Balance weight-to-camshaft gear bolt.....	3/8-24	15	20.3400	18	24.4080

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS (continued)

Application	Thread Size	TORQUE Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (Nm)
Balance weight-to-camshaft gear slotted nut.....	3/8 -24	28	37.9680	32	43.3920
Left bank accessory drive support bolts and nuts..... .	3/8 -24	25	33.9000	30	40.6800
Accessory drive hub to camshaft gear bolt.....	3/8 -24	45	61.0200	50	67.8000
Accessory drive disc to camshaft gear bolt.....	3/8 -24	45	61.0200	50	67.8000
Injector clamp nut.....	3/8 -24	20	27.1200	25	33.9000
Exhaust manifold outlet flange nuts (brass).....	3/8 -24	20	27.1200	25	33.9000
Water manifold cover nuts.....	3/8 -24	20	27.1200	25	33.9000
Fuel pipe nuts.....	3/8 -24	12	16.2720	15	20.3400
Rear accessory drive pulley bolt.....	7/16 -14	35	47.4600		
Connecting rod nut (Lubrite)	7/16 -20	60	81.3600	70	94.9200
Connecting rod nut (castellated)	7/16 -20	65	88.1400	75	101.7000

EXECPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	Thread Size	TORQUE Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (Nm)
Flywheel housing bolts.....	1/2 -13	90	122.0400	100	135.6000
Rocker shaft bolts.....	1/2 -13	90	122.0400	100	135.6000
Idler gear hub and dummy hub bolt.....	1/2 -13	80	108.4800	90	122.0400
** Flywheel bolts..... .	9/16 -18	180	244.0800	190	257.6400
** Camshaft gear bolt (right bank-300M).....	9/16 -18	180	244.0800	190	257.6400
** Main bearing bolts (assembly).....	5/8 -11	180	244.0800	190	257.6400
** Main bearing bolts (boring).....	5/8 -11	165	223.7400	175	237.3000
** Cylinder head bolts.....	5/8 -11	175	237.3000	185	250.8600
Accessory drive pulley nut	3/4 -16	80	108.4800	100	135.6000
Crankshaft end bolt.....	1 -14	290	393.2400	310	420.3600
Camshaft nut.....	1 1/8 -18	300	406.8000	325	440.7000
Exhaust manifold nuts.....	7/16 -20	30	40.68	35	47.4600
Fuel manifold connectors (steel washer)	7/16 -20	40	54.24	45	61.0200
#Fuel manifold connectors (Nylon insert)	7/16 -20	30	40.68	35	47.4600
Fuel manifold connector nuts	7/16 -20	30	40.68	35	47.4600
Crankshaft front cover bolts	1/2 -13	80	108.48	90	122.0400
Left bank accessory drive gear nut	1 7/16-16	50	67.8000	60	81.3600
Blower drive gear hub nut.....	1 7/16-16	50	67.8000	60	81.3600

** Lubricate at assembly with International Compound No. 2, or equivalent.

STUD TORQUE SPECIFICATIONS

APPLICATION	TORQUE MINIMUM (lb ft)	TORQUE MINIMUM (Nm)	TORQUE MAXIMUM (lb ft)	TORQUE MAXIMUM (Nm)	HEIGHT
Cylinder head stud.....	75	101.7000			4.3750±0.0312 (11.1125±0.0792 cm)
Injector clamp stud.....	10	13.5600	25	33.9000	
Water hole cover stud.....	10	13.5600	25	33.9000	
Exhaust manifold stud.....	25	33.9000	40	54.2400	

SPRING SPECIFICATIONS

SPRING	REPLACE WHEN LOAD IS LESS THAN: (ENGLISH)	(METRIC)
Cam follower (11 coils - .177” wire).....	172 lbs @ 2.1250"	78.09 kg @ 5.3975 cm
Cam follower (11 1/2 coils - .162” wire).....	133 lbs @ 2.1094"	60.38 kg @ 5.3579 cm
Exhaust valve and bridge guide (9 3/4 coils-.135" wire)....	79 lbs @ 1/4160"	35.87 kg @ 3.5966 cm
Exhaust valve (8 3/4 coils - .148" wire).....	100 lbs @ 1.3970"	45.40 kg @ 3.5484 cm

ENGINE BLOCK AND CYLINDER HEAD
SPECIAL PIPE PLUG TORQUE SPECIFICATIONS

Application	Plug	Assembly	TORQUE MINIMUM (lb ft)	TORQUE MINIMUM (Nm)	TORQUE MAXIMUM (lb ft)	TORQUE MAXIMUM (Nm)
Oil gallery plug.....	3/8" Dryseal	+ Assemble with max. 1/16" PT thread protrusion from surface				
Cylinder head (side).....	3/8-16"	Assemble flush to 1/16" protrusion from surface				
Cylinder head (end).....	3/4" Dryseal PTF-SAE	Flush to 1/8" recessed.				
Core hole plug (air box floor)...	1 3/4" -16		150	203.4000	180	244.0800
Core hole plug (air box floor)...	2 1/2" -16		230	311.8800	270	366.1200
Oil drain plug (Nylon washer)....	18mm		25	33.9000	35	47.4600

*Apply sealing compound to plugs used without gaskets.

+After installation, a 7/32" rod inserted in oil line must pass inner face of plug.

LUBRICATION SYSTEM SPECIFICATIONS

EXECPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	SIZE NUT or BOLT	TORQUE Minimum (lb ft)	TORQUE Minimum (Nm)	TORQUE Maximum (lb ft)	TORQUE Maximum (Nm)
Oil Pan Bolts.....	5/16-18	10	13.5600	12	16.2720
Oil Pan Bolts.....	3/8-16	15	20.3400	20	27.1200
Lubricating Oil Filter Center Stud.....	5/8-18	40	54.2400	50	67.8000
Oil Pan Drain Plug (Nylon Washer)	18MM	25	33.9000	35	47.4600

AIR INTAKE SYSTEM
EXECPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	THREAD SIZE	TORQUE Minimum (lb ft)	TORQUE Minimum (Nm)	TORQUE Maximum (lb ft)	TORQUE Maximum (Nm)
Blower drive coupling-to rotor gear bolt.....	5/16-24	20	27.1200	25	33.9000
Air inlet housing adaptor-to-blower housing bolt.....	3/8 -16	16	21.6960	20	27.1200
Air inlet housing-to-adaptor bolt.....	3/R -16	16	21.6960	20	27.1200
Blower end plate-to-cyl-inder block bolt	7/16 -14	40	54.2400	45	61.0200.
Blower rotor gear retainer bolt (Allen head).....	1/2 -20	55	74.5800	65	88.1400
Fuel pump drive disc bolt.....	1/2 -20	55	74.5800	65	88.1400
Blower rotor gear retainer bolt (large bearing blower).....	1/2 -20	100	135.6000	110	149.1600

AIR INTAKE SYSTEM
EXECPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	SIZE NUT or BOLT	TORQUE Minimum (lb ft)	TORQUE Minimum (Nm)	TORQUE Maximum (lb ft)	TORQUE Maximum (Nm)
Variable Speed Spring Lever Set Screw.....	5/16-24	12	16.2720	15	20.3400
Governor Weight Shaft, Bearing Retaining Bolt.....	5/16-24	15	20.3400	19	25.7640
Injector Clamp Bolt	3/8-16	20	27.1200	20	27.1200
Fuel Pipe Nut.....	3/8-24	12	16.2720	15	20.3400
Rocker Arm Bracket Bolts.....	1/2-13	90	122.0400	100	135.6000
Injector Filter Caps.....	5/8-24	65	88.1400	75	101.7000
Injector Nut.....	15/16-24	75	101.7000	85	115.2600

ENGINE OPERATING CONDITIONS
V-71 ENGINES (English)

	1200 rpm	1800 rpm	2100 rpm
LUBRICATING SYSTEM			
Lubricating oil pressure (psi):			
Normal	35-55	50-70	50-70
Min. for safe operation	25	28	30
* Lubricating oil temperature (degrees F.):			
Normal	200-235	200-235	200-235
AIR SYSTEM			
Air box pressure (inches mercury)-min. at full load:			
At zero exhaust back pressure:	1.1	3.8	5.0
At maximum full-load exhaust back pressure:	2.3	6.4	8.2
Air inlet restriction (inches water)-full-load speed, max.:			
Dirty air cleaner	12.4	25.0	25.0
Clean air cleaner	5.2	9.1	11.5
Crankcase pressure (inches water)-max:	1.0	2.2	3.0
Exhaust back pressure (inches mercury) - max.:			
Full load	1.5	3.3	4.4
No load	1.0	2.1	3.0
FUEL SYSTEM			
Fuel pressure at inlet manifold (psi):			
Normal (.080" orifice)	45-70	45-70	45-70
Minimum.	30	30	30
Fuel spill (gpm)-min. at no load:	0.8	0.9	0.9
Fuel pum suction at pump inlet (inches mercury) - max.:			
Clean system	6.0	6.0	6.0
Dirty system	12.0	12.0	12.0
COOLING SYSTEM			
Coolant temperature (degrees F.)-normal	160-185	160-185	160-185
COMPRESSION			
Compression pressure (psi)			
Average-new engine at 600 rpm	565		
Minimum at 600 rpm	515		

* The lubricating oil temperature range is based on the temperature measurement in the oil pan at the oil pump inlet.

When measuring the oil temperature at the cylinder block oil gallery, it will be approximately 10°F lower.

ENGINE OPERATING CONDITIONS
V-71 ENGINES (Metric)

	1200 rpm	1800 rpm	2100 rpm
LUBRICATING SYSTEM			
LUBRICATING SYSTEM			
Lubricating oil pressure (kPa):			
Normal	241-379	344.8-482.7	344.8-482.7
Min. for safe operation	172.4	193.1	206.9
* Lubricating oil temperature (degrees C.):			
Normal	93-113	93-113	93-113
AIR SYSTEM			
Air box pressure (kPa)-min. at full load:			
At zero exhaust back pressure:	3.7	12.8	16.9
At maximum full-load exhaust back pressure:	7.8	21.6	27.7
Air inlet restriction (kPa)-full-load speed, max:			
Dirty air cleaner	3.9	6.2	6.2
Clean air cleaner	1.3	2.3	2.9
Crankcase pressure (kPa)-max	0.2	0.5	0.7
Exhaust back pressure (kPa)-max:			
Full load	5.1	11.1	14.9
No load	3.4	7.1	10.1
FUEL SYSTEM			
Fuel pressure at inlet manifold (kPa):			
Normal (.080" orifice)	310-483	310-483	310-483
Minimum	207	207	207
Fuel spill (1pm)-min. at no load:	1.9	2.1	2.1
Fuel pump suction at pump inlet (kPa) -max:			
Clean system	20.3	20.3	20.3
Dirty system	40.5	40.5	40.5
COOLING SYSTEM			
Coolant temperature (degrees C.)-normal	71-85	71-85	71-85
COMPRESSION			
Compression pressure (kPa)			
Average-new engine at 600 rpm	3895		
Minimum at 600 rpm	3551		

*The lubricating oil temperature range is based on the temperature measurement in the oil pan at the oil pump inlet.

When measuring the oil temperature at the cylinder block oil gallery, it will be approximately 5.5° C lower.

3-7. ENGINE-MAINTENANCE

The maintenance instructions for the main propulsion engine are those functions that can be performed without any removal of components. These functions require servicing, testing and inspection of the overall engine.

This task covers:

a. Inspection **c. Service**
b. Test **d. Repair**

INITIAL SETUP:

Test Equipment
None

References
None

Special Tools
None

Equipment Condition: Condition Description
None

Material/Parts
None

Special Environmental Conditions
None

Personnel Required
1

General Safety Instructions
None

LOCATION	ITEM	ACTION	REMARKS
Inspection			
1. Marine gear	Case, bases, and fittings	Inspect.	Refer to paragraph 3-8.
2. Engine transmission controls	Control station, control unit, and linkage	Inspect.	Refer to paragraph 3-9.

3-7. ENGINE-MAINTENANC E INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
Inspections (Cont)			
3. Emergency shutdown	Cable, control head, linkage	Inspect.	Refer to paragraph 3-9.
4. Alarm system	Alarm switches	Inspect.	Refer to paragraph 3-9.
5. Governor	Housing, linkage	Inspect.	Refer to paragraph 3-10.
6. Air intake	Silencers, housing	Inspect.	Refer to paragraph 3-11.
7. Blower	Housing, oil seals	Inspect.	Refer to paragraph 3-12.
8. Fuel pump fittings	Housing, hoses and	Inspect.	Refer to paragraph 3-13.
9. Fuel filter and fuel lines	Housing, shell, hoses and fittings	Inspect.	Refer to paragraph 3-14.
10. Lube oil filters fittings	Housing, shell, hoses,	Inspect.	Refer to paragraph 3-16.
11. Oil cooler	Housing, gaskets	Inspect.	Refer to paragraph 3-17.
12. Fresh water pump	Inspect.		Refer to paragraph 3-18.

3-7. ENGINE-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
Inspections (Cont)			
13. Expansion tank	Inspect.		Refer to paragraph 3-19.
14. Water connections	Inspect.		Refer to paragraph 3-20.
15. Water manifold	Inspect.		Refer to paragraph 3-21.
16. Thermostat and housing	Inspect.		Refer to paragraph 3-22.
17. Tachometer drive	Inspect.		Refer to paragraph 3-23.
18. Instrument panel	Inspect.		Refer to paragraph 3-24.
19. Crankshaft pulley and vibration dampener	Inspect.		Refer to paragraph 3-25.
20. Balance weight cover and accessory drive	Inspect.		Refer to paragraph 3-26.
21. Engine supports, lift brackets, and crankshaft front cover	Inspect.		Refer to paragraph 3-27.

3-7. ENGINE-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
Inspections (Cont)			
22. Exhaust manifold	Inspect.		Refer to paragraph 3-28.
23. Muffler	Inspect.		Refer to paragraph 3-29.
24. Rocker arm cover	Inspect.		Refer to paragraph 3-30.
25. Flywheel housing	Inspect.		Refer to paragraph 3-32.
26. Valve operating mechanism	Inspect.		Refer to paragraph 3-33.
27. Cylinder head	Inspect.		Refer to paragraph 3-34.
28. Oil pan and dip-	Inspect.		Refer to paragraph 3-35.
29. Lube oil distribution	Inspect.		Refer to paragraph 3-39.
30. Cylinder block	Inspect.		Refer to paragraph 3-44.
31. Starting aid	Inspect.		Refer to paragraph 3-45.
32. Hydrastarter	Inspect.		Refer to paragraph 3-46.
33. Accumulator	Inspect.		Refer to paragraph 3-47.
34. Hydrostarter pump (engine driven)	Inspect.		Refer to paragraph 3-48.

3-7. ENGINE-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
Inspections (Cont)			
35. Hydro-starter pump (hand)		Inspect.	Refer to paragraph 3-49.
36. Hydro-starter piping (fwd eng rm)	Hoses, lines, and fittings	Inspect.	Refer to paragraph 3-50.
37. Hydro-start piping (aft eng rm)	Hoses, lines and fittings	Inspect.	Refer to paragraph 3-51.
38. Reservoir, filters and solenoids	Hoses, filters, fittings and wiring	Inspect.	Refer to paragraph 3-52.
Test			
39. Engine panel	a. Control until warm.	Start engine and run	Check all gages for proper readings.
	b. Engine	While running-	Check for vibrations and uneven operation.
	c. Engine	Stop and let cool.	Proceed with service checks.
40. Engine oil	Dipstick (1)	Remove and check oil level.	Add oil if necessary:Type OE/HDO.

NOTE

o FULL Engine has 34 quarts (32.2 liters)

o LOW Engine has 26 quarts (24.6 liters)

3-7. ENGINE-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
Service			
41. Tachometer drive	Grease fitting (2)	Lubricate.	Use grease (Mil-G-10924 Symbol GAA).
42. Throttle controls	Linkage (3)	Lubricate.	Use oil (MIL-L-2104 type OE/HDO).
43. Emergency stop control	Linkage (4)	Lubricate.	Use oil (MIL-L-2104 type OE/HDO).
44. Expansion tank	Cap (5)	Remove and check coolant level.	Add coolant.
45. Hydrostarter reservoir	Cap (6)	Remove and check level.	Add mineral oil MIL-L-17672, type 2135TH.
Repair			
46. Engine	Engine	Perform maintenance on any component that may or is producing a problem.	

3-8. MARINE GEAR- MAINTENANCE INSTRUCTIONS.

a. General.

(1) The Model MG-514 Marine Gear is a marine reverse and reduction gear. The marine gear may be operated continuously in either the forward or reverse position. Identical ratios in forward and reverse permit the type of installation known as "twinning"; that is, mounting two gears on right-hand rotation engines and running one gear in forward and the other gear in reverse to obtain opposite rotation of the propellers.

(2) This marine gear is completely hydraulic in all phases-all bearings are oil lubricated, both clutches are engaged by high pressure oil, and both clutches are cooled and lubricated by low pressure oil. Refer to paragraph 3-8.1 for oil base maintenance instructions.

(3) A mechanical lock-up, or come-home, feature is provided for clutch engagement in the event emergency operations are necessary.

(4) The forward clutch shaft and the reverse driving gear always rotate in engine direction. The reverse clutch shaft and the reverse driven gear always rotate in anti-engine direction. When the forward clutch is engaged, the output shaft gear will rotate in an anti-engine direction due to the gear meshing with the forward pinion. When the reverse clutch is engaged, the output shaft gear will rotate in anti-engine direction due to the gear meshing with the reverse pinion.

b. Hydraulic System.

NOTE

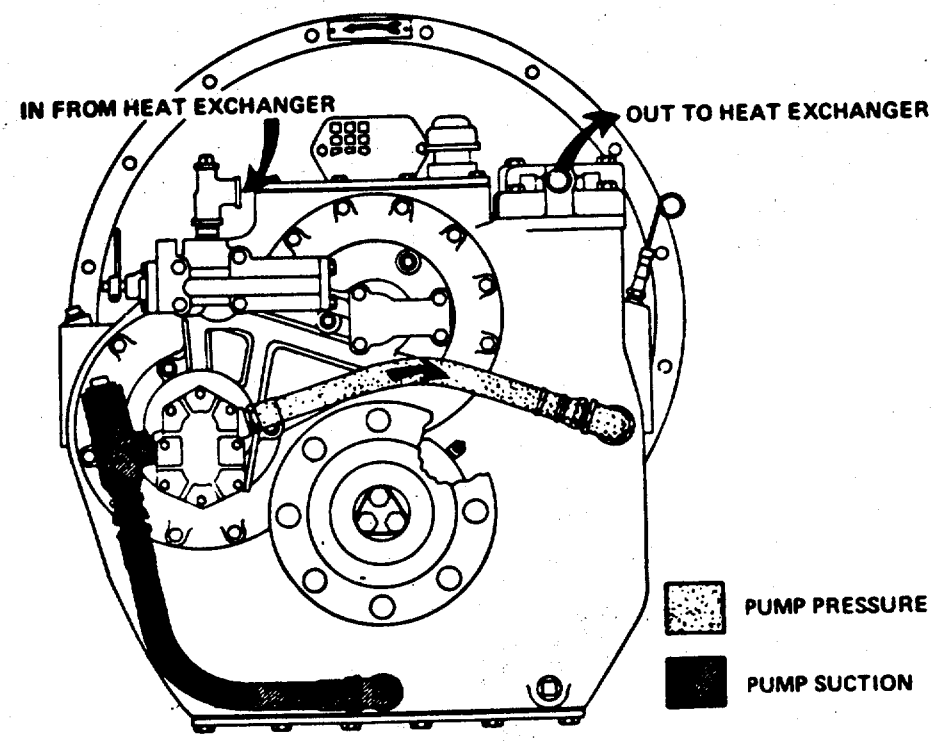
All pressures given in this section are under the following conditions only: An engine speed of 1800rpm with a recommended oil in the gear sump and a sump or heat exchanger inlet temperature of 180 degrees F (82° C). Pressure readings taken under other conditions will vary.

(1) Description. The hydraulic system in the Model MG-514 Marine Gear distributes both high and low pressure oil for clutch engagement, cooling, and lubrication functions. The sump, which is located in the bottom of the main housing, contains an adequate amount of oil for all functions of the system. The oil pump assembly pressurizes the oil for both high and low pressure requirements. The selector valve assembly is both a pressure regulator and distributor for the hydraulic system: The manifold is not only a protective cover for the clutches, but also a distribution component since it contains passageways for high and low pressure oil distribution.

3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

(2) Metal piston rings, which function as oil seals, are used in the clutches. The metal rings prove superior to other types of seals normally used in marine gear clutches. All oil that passes through the hydraulic system is subjected to two full-flow type filters. The oil return pipe assembly regulates the low pressure oil supply and also distributes oil for lubrication purposes. A heat exchanger is installed in the hydraulic system to maintain the oil within the marine gear at the recommended temperature.

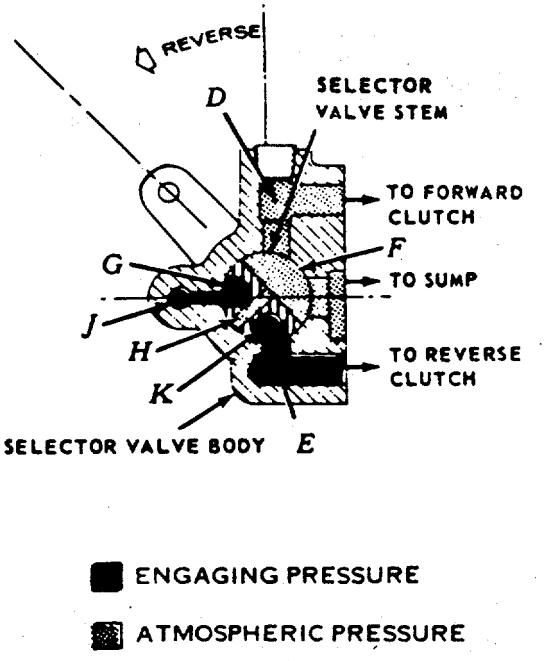
(3) External Oil Circuit. Oil is drawn from the sump through the oil strainer to the oil pump assembly. From the oil pump assembly, the oil is conveyed by a flexible hose to the oil filter. The filtered oil is routed from the filter to a remote-mounted heat exchanger. The cooled oil from the heat exchanger is routed to a reduction "tee" fitting on the selector valve. The "tee" fitting on the selector valve has a pipe plug which should be removed and replaced by a pressure gage or connecting line to a pressure gage. Pressure reading at this point will be "clutch-apply pressure" oil.



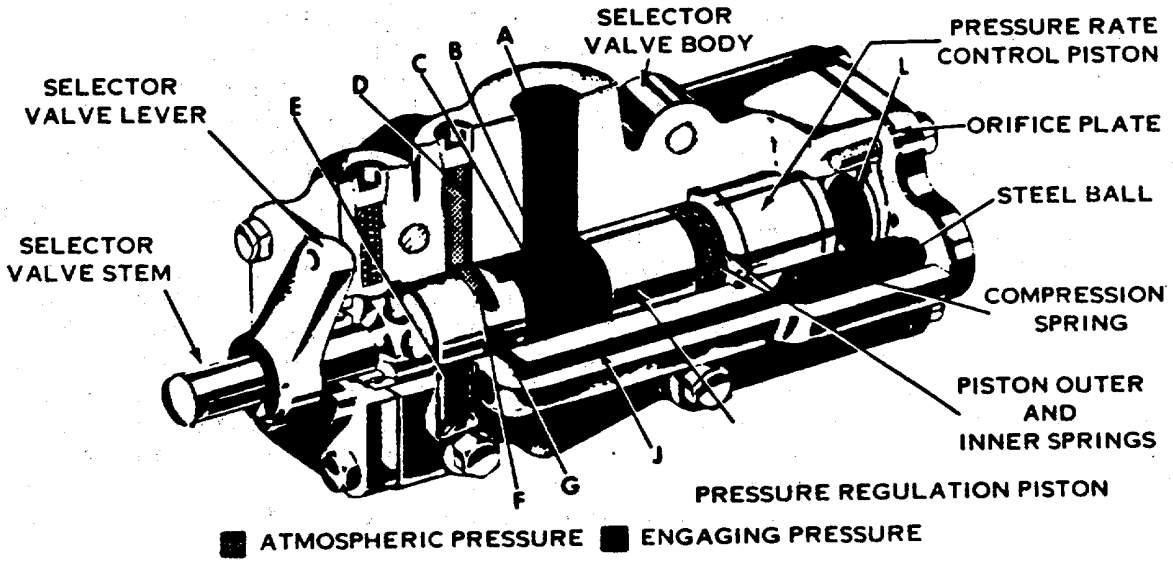
3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

(1) General. The selector valve assembly contains passages and ports for the transmission and direction of pressurized oil within the hydraulic system. It is the function of the pressure rate control piston within the selector valve assembly to provide a rapid, yet smooth, pressure rise for the hydraulic system when required.

(2) Selector Valve-Neutral. Oil enters the selector valve body through passage A and fills chamber B. The oil causes the pressure regulation piston to partially compress the piston outer and inner springs against the pressure rate control piston. This results in an oil pressure of 60-65 psi (414-448 kpa) in chamber B. The movement of the pressure regulation piston against the springs exposes port C in the valve body. Port C directs the pressurized oil to the oil return pipe cavity in the front face of the selector valve body. The piston and spring in the oil return pipe regulate the cooling and lubricating oil supply to a pressure of 18-20 psi (124-138 kpa). Passage D (which is the engaging outlet to the forward clutch) and passage E (which is the engaging outlet to the reverse clutch) are interconnected by slot F in the selector valve stem when in the neutral position. The slot is aligned with a drilled hole and cored cavity in the front face of the valve body. The drilled hole and cored cavity are aligned with drilled holes that pass through the manifold and the main housing to atmosphere. Therefore, passages D and E are at atmospheric pressure at this time. Also, passage J is at atmospheric pressure since port H interconnects with slot F. The area between the pistons and around the springs is vented to the sump through drilled holes in the front face of the valve body, the manifold, and the main housing. This area is at atmospheric pressure at all positions of the valve which permits the return to sump of any leakage oil past the pistons.

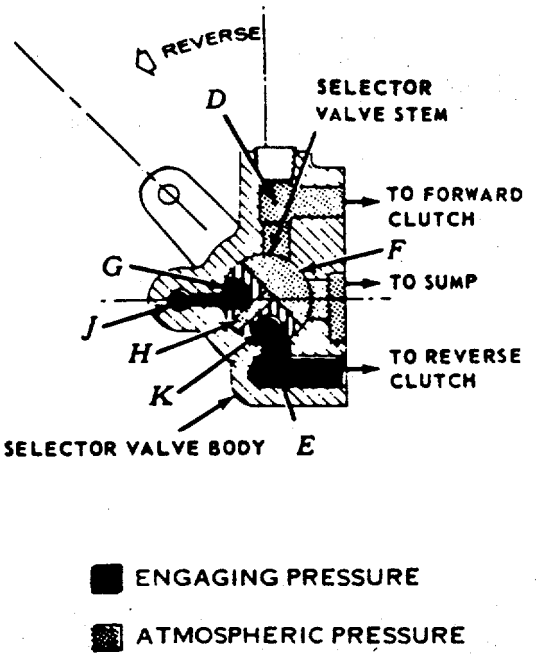


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

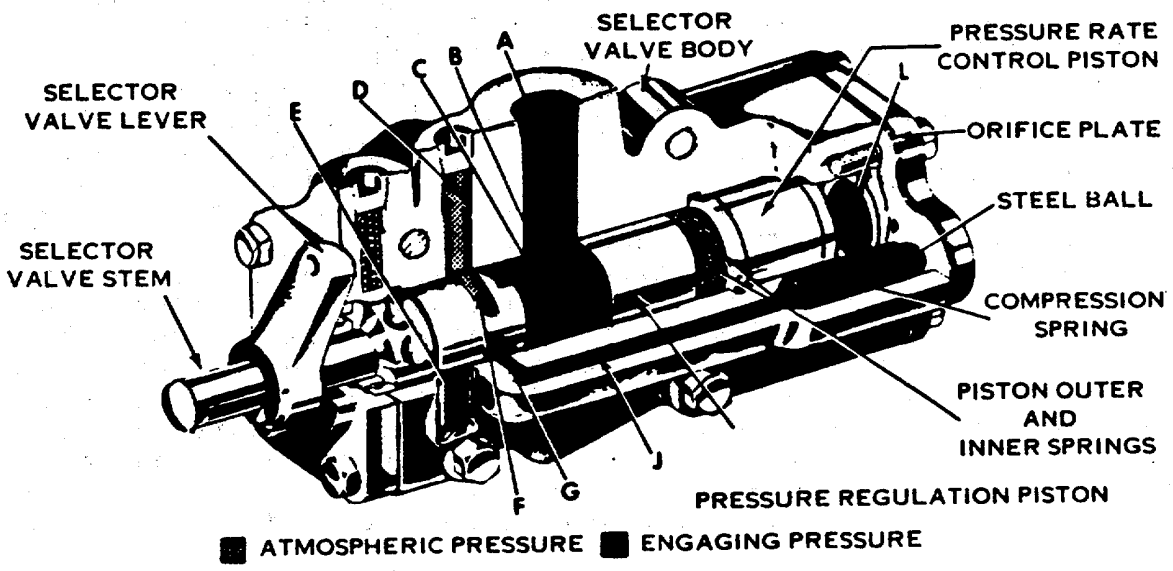


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

(3) Selector Valve-Forward. When a shift to the forward position is desired, the selector valve lever is moved towards the engine. The shift causes the selector valve stem to rotate and assume the position indicated. The 60-65 psi (414-448 kpa) oil in chamber B is directed through ports G and K to passages D and J. Passage D is aligned with a drilled hole and channel X in the manifold. Pressurized oil from port K travels through passage J and enters chamber L through an orifice in the orifice plate. The orifice in the plate meters the oil for a steady, smooth pressure rise in chamber L. As chamber L fills with oil, the pressure rate control piston moves against the springs until the piston is stopped by a shoulder in the valve body. This causes the pressure in chamber B to rise from 60-65 psi (414-448 kpa) to an engaging pressure of 185-215 psi (1276-1482 kpa). The time required to accomplish all the above action is a very short 1-1/2 seconds. When in forward, passage E (and channel W) remain at atmospheric pressure since slot F remains open to sump. When a shift is made from forward to neutral, the valve stem is rotated to the position illustrated. Under these conditions, passage D is connected to sump by slot F. Passage J also is connected to sump by port H in the valve stem. Since passage D is connected to slot F this permits a rapid drain of oil from the forward clutch to the sump. Since passage J is now at atmospheric pressure, the pressure in chamber L unseats the steel ball against the compression spring permitting a rapid oil drain of chamber L to sump. When the pressure rate control piston is against the orifice plate, the neutral position is attained again.

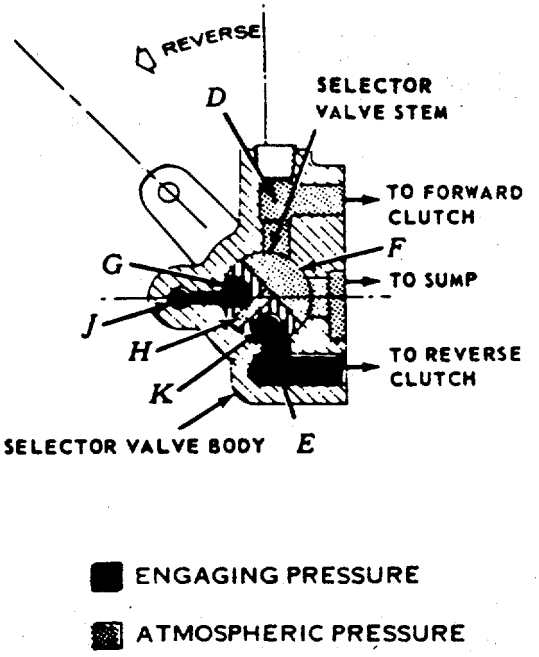


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

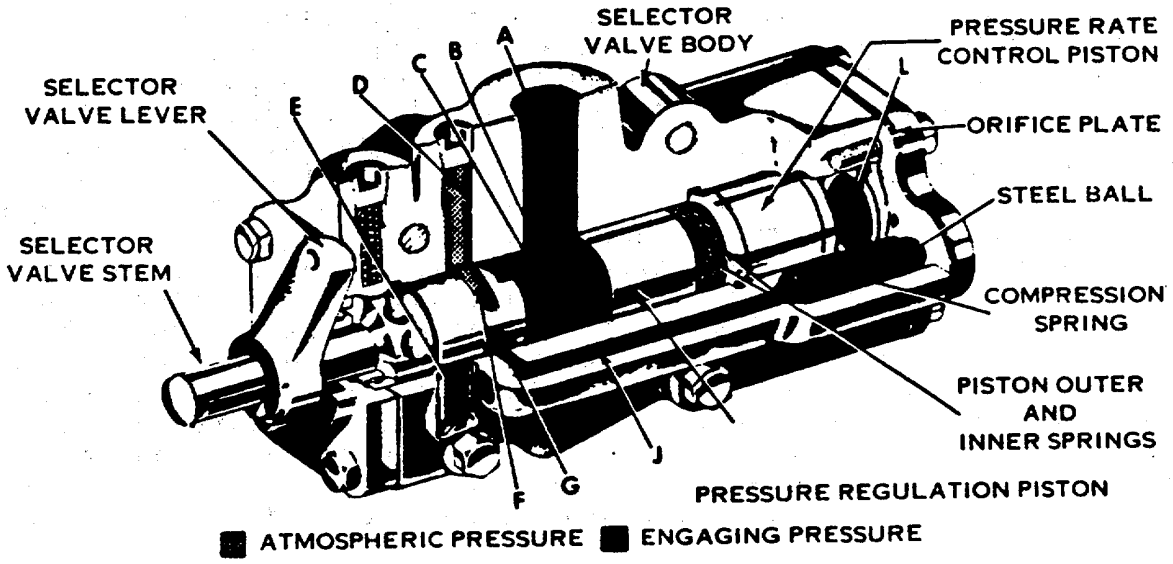


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

(4) Selector Valve-Reverse. When a shift to the reverse position is desired, the selector valve lever is moved away from the engine. The shift causes the selector valve stem to rotate and assume the position indicated. The 60-65 psi (414-448 kpa) oil in chamber B is directed through ports G and K to passages E and J. Passage E is aligned with a drilled hole and channel W in the manifold. Pressurized oil from port G travels through passage J, and enters chamber L through an orifice in the orifice plate. The orifice in the plate meters the oil for a steady, smooth pressure rise in chamber L. As chamber L fills with oil, the pressure rate control piston moves against the springs until the piston is stopped by a shoulder in the valve body. This causes the pressure in chamber B to rise from 60-65 psi (414-448 kpa) to an engageing pressure of 185-215 psi (1276-1482 kpa). The time required to accomplish all the above action is a very short 1-1/2 seconds. When in reverse, passage D (and channel X) remains at atmospheric pressure since slot F remains open to sump. When a shift is made from reverse to neutral, the valve stem is rotated to the position illustrated. Under these conditions, passage E is connected to sump by slot F. Passage J also is connected to sump by port H in the valve stem. Since passage E is connected to slot F, this permits a rapid drain of oil from the reverse clutch to the sump. Since passage J is now at atmospheric pressure, the pressure in chamber L unseats the steel ball against the compression spring permitting a rapid oil drain of chamber L to sump. When the pressure rate control piston is against the orifice plate, the neutral position is attained again.



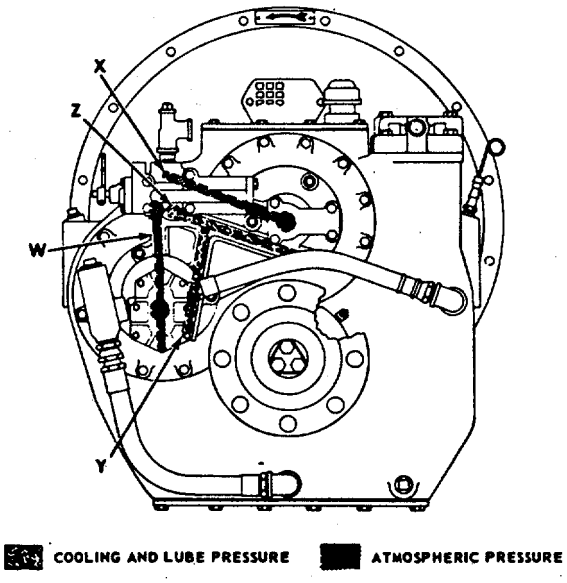
3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)



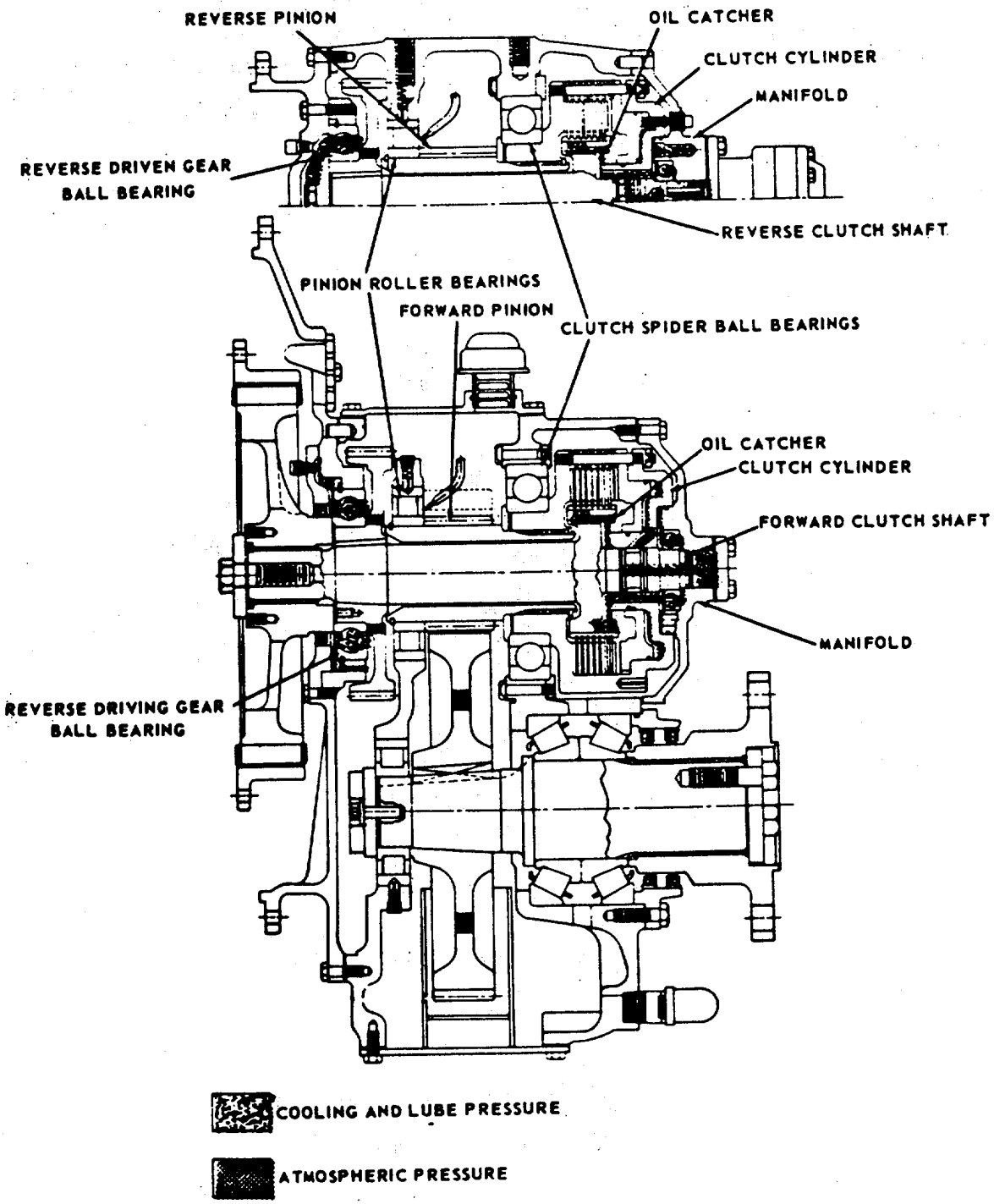
3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

d. Oil Flow.

(1) Oil Flow-Neutral. Some of the 18-20 psi (124-140 kpa) oil in the oil return pipe cavity of the selector valve body is metered through the orifice in the return pipe piston. This oil lubricates the forward and reverse pinions, the forward and reverse pinion roller bearings, the clutch spider ball bearings and the reverse and driving and driven gear ball bearings in all positions of the selector valve. The remainder of the 18-20 psi (124-140 kpa) oil in the return pipe cavity is distributed by channel Z in the manifold which directs cooling oil to the forward clutch through an orifice plug installed in the manifold. Branch channel Y in the manifold is interconnected with channel Z and directs cooling oil to the reverse clutch through another orifice plug if located in the-manifold. The pressurized oil which is metered through the orifice plugs is directed to an area between the front face of the manifold and the rear face of the clutch cylinders. From this area the oil passes through drilled holes in the hub of each cylinder- to the oil catcher area of each clutch shaft. Due to centrifugal force in the oil catcher area, the oil passes out through drilled holes in the hub portion of each clutch shaft, through the clutch plates, and returns to the sump. Cooling oil is supplied to the clutch plates in all positions of the selector valve. A drilled port in passage D and a drilled port in passage E of the selector valve are aligned with similar holes in the manifold. The port in passage D aligns with channel X in the manifold that extends to a chamber at the clutch end of the forward clutch shaft. The port in passage E aligns with channel W in the manifold that extends to a chamber at the clutch end of the reverse clutch shaft. A center-drilled hole and a cross-drilled hole in each clutch shaft connects each chamber to an area between each clutch piston and cylinder through an angular-drilled hole in the cylinder. Since passage D and passage E are at atmospheric pressure when in the neutral position, then the area between each clutch piston and cylinder also is at atmospheric pressure.

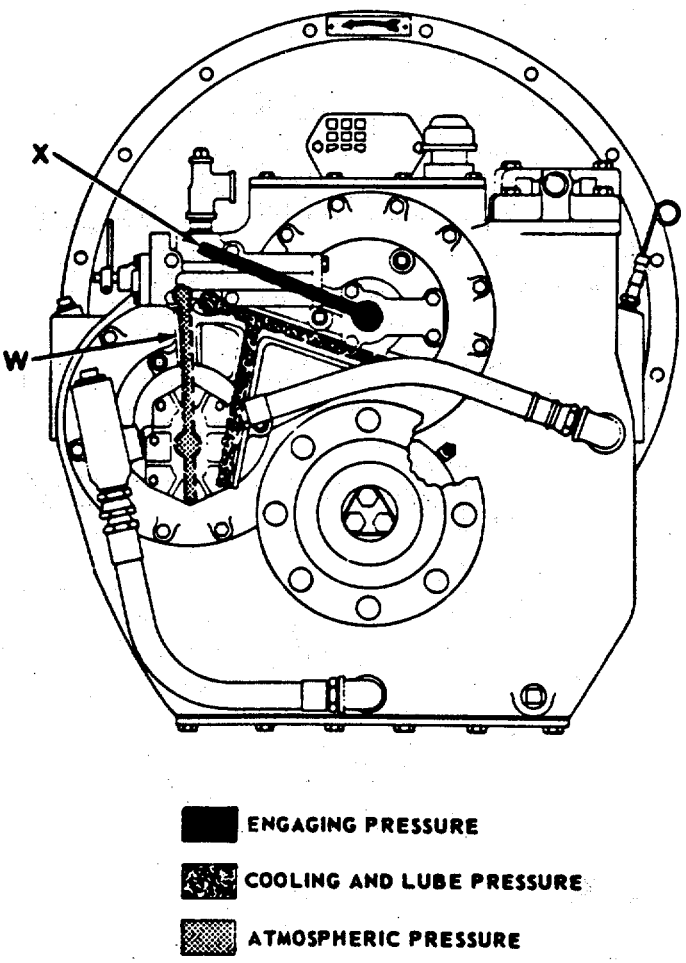


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

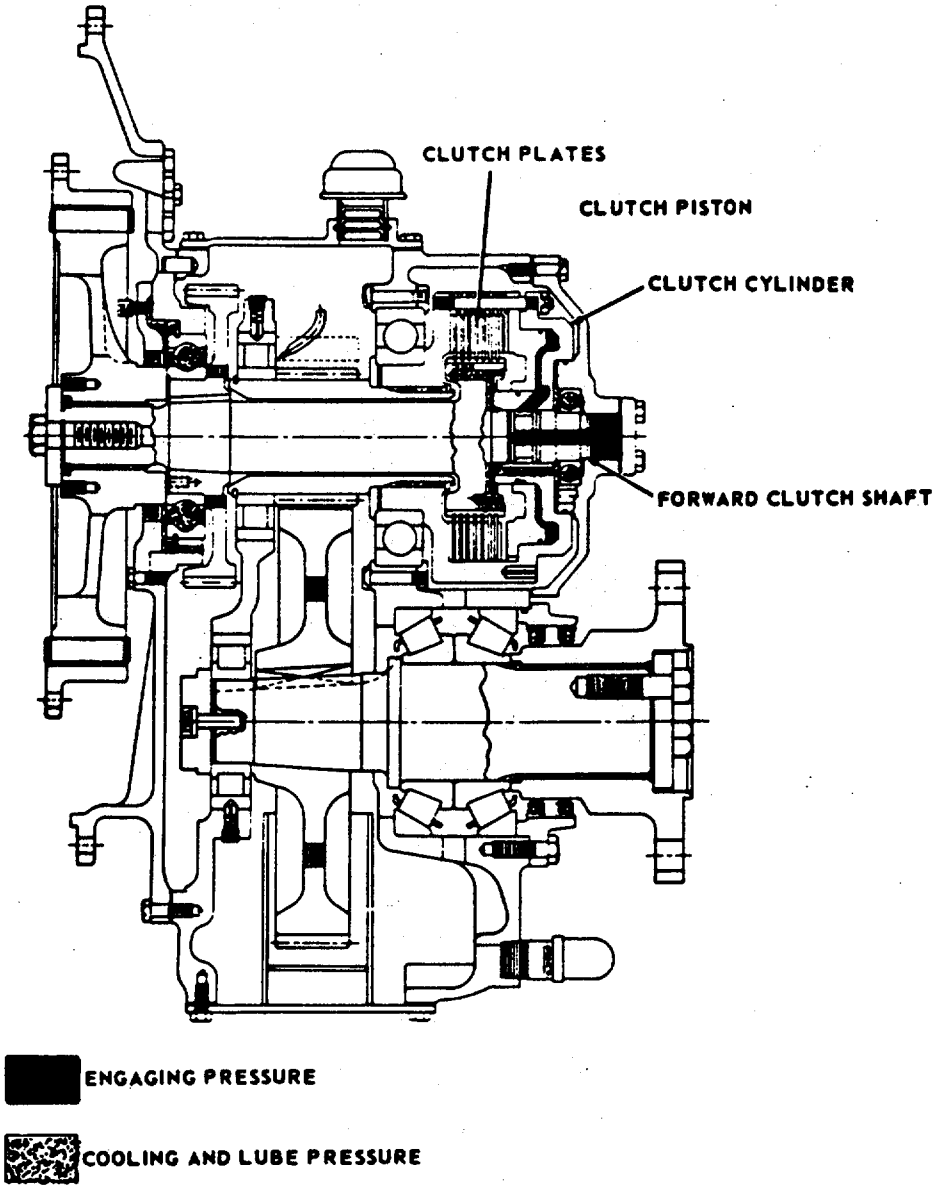


3-8. MARINE GEAR- MAINTENANCE INSTRUCTION (Cont.)

(2) Oil Flow-Forward. The port in passage D is aligned with a drilled hole and channel X in the manifold. Therefore, high pressure oil is supplied to channel X when a shift to forward is made. This oil flows through channel X to the area at the clutch end of the forward clutch shaft. The 185-215 psi (1276-1482 kpa) oil then passes through the center-drilled and crossed-drilled hole in the clutch shaft to the area between the clutch piston and the clutch cylinder through an angular hole in the cylinder. This moves the piston forward to compress and engage the clutch plate stack. The area between the reverse clutch piston and reverse clutch cylinder remains at atmospheric pressure as described in Neutral.

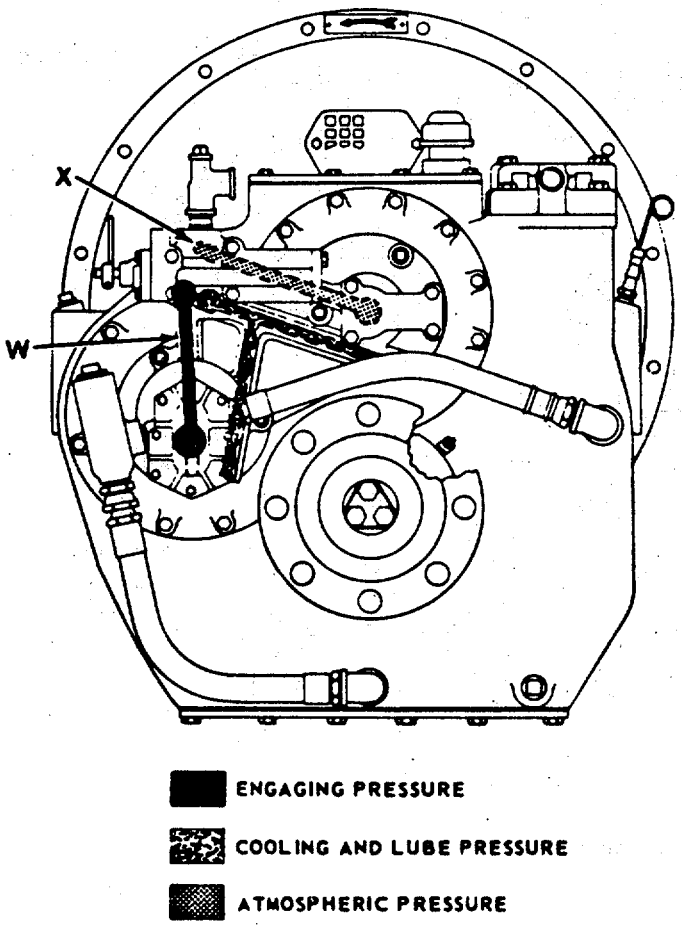


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

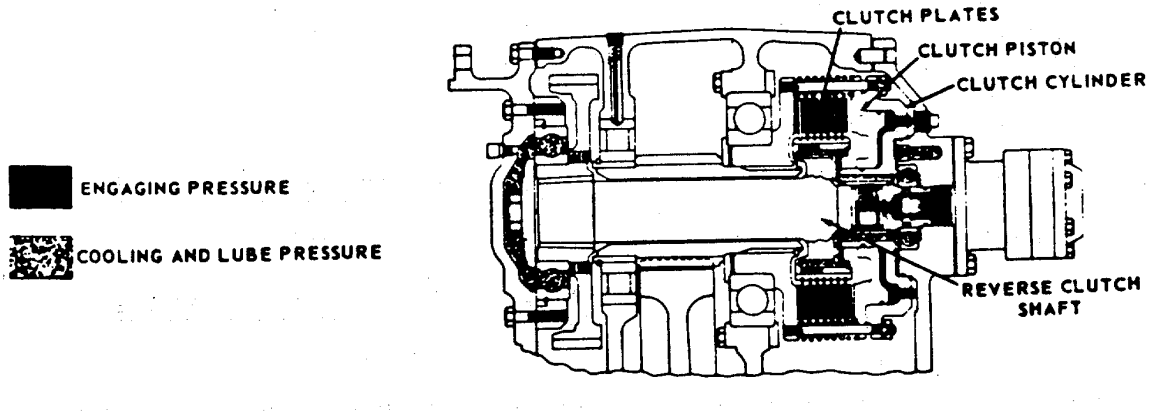


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

(3) Oil Flow-Reverse. The port in passage E is aligned with a drilled hole and channel W in the manifold. Therefore, high pressure oil is supplied to channel W when a shift to reverse is made. This oil flows through channed W to the area at the clutch end of the reverse clutch shaft and around the flats of the oil pump drive sleeve. The 185-215 psi (1276-1482 kpa) oil then passes through the center drilled and cross-drilled hole in the clutch shaft to the area between the clutch piston and the clutch cylinder through an angular hole in the cylinder. This moves the piston forward to compress and engage the clutch plate stack. The area between the forward clutch piston and cylinder remains at atmospheric pressure as described in Neutral.



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).



3-293

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **c. Service**
b. Test **d. Repair**

INITIAL SETUP:

Test Equipment

NONE

Special Tools
Gear puller with 3/8-16 screws
Torque wrench
Porto power or equivalent

Material/Parts

NONE

Personnel Required
1

References
Paragraph 3-39
Lube Oil Distribution System

Equipment

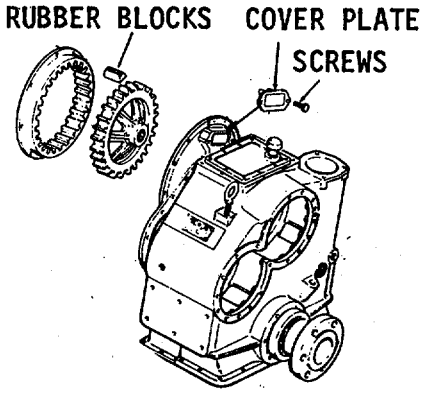
Condition	Condition Description
	NONE

Special Environmental Conditions

NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
Inspection			
1. Marine gear	a. Hoses	Inspect.	Refer to paragraph 3-8 .
	b. Housing	Inspect.	
	c. Rubber blocks	Remove screws, and access cover.	Inspect for rubber blocks with wear or damage.



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Service			
2. Marine gear	a. Oil level gage	Check level daily with engine running at idle speed in neutral.	The marine gear has a capacity of 9 gallons (136.3 liters)
	b. Oil strainers	Clean.	Refer to PMCS.
	c. Oil breather	Clean.	Refer to PMCS.
Test			
3. Engine - Start main propulsion engine - when warm, proceed as follows:			
	a. Clutch	Place in forward.	Check if propeller shaft rotates.
		Place in neutral.	Check if propeller shaft stops rotation.
		Place in reverse.	Check if propeller shaft rotates in opposite direction.
	b. Oil pressure gage	Observe pressure.	Pressure should be:

Oil Pressure at 1800 RPM

	PSI/KPA	°F / °C
Neutral	60-65/413.7-448.2	180°/82°
Engaged	185-215/1275.6-1482.4	180°/82°

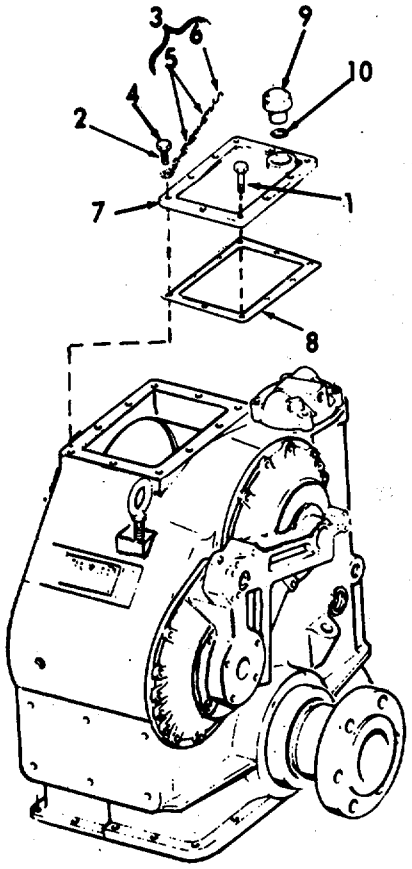
	c. Marine gear	Check for vibration, noise.	

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair			
4. Top cover plate	a. Screws (1)	Remove.	
	b. Screws (2), breather chain (3)	Remove.	Breather chain consists of retainer (4), chain (5), and link (6).
	c. Top cover plate (7)	Remove.	
	d. Gasket (8)	Remove.	Discard.
	e. Oil breather assembly (9)	Remove.	
	f. Preformed packing (10)	Remove.	Discard.
	g. Preformed packing (10)	Replace.	Use new gasket.
	h. Oil breather assembly (9)	Replace.	
	i. Gasket (8)	Replace.	Use new gasket.
	j. Top cover plate (7)	Replace.	

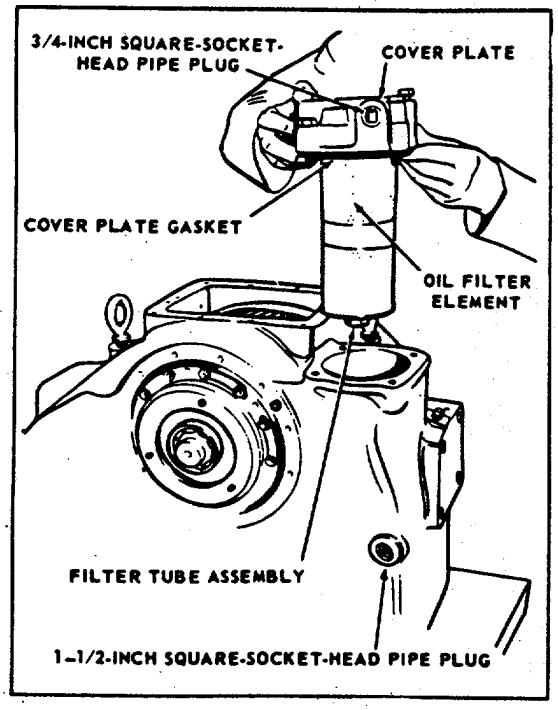
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

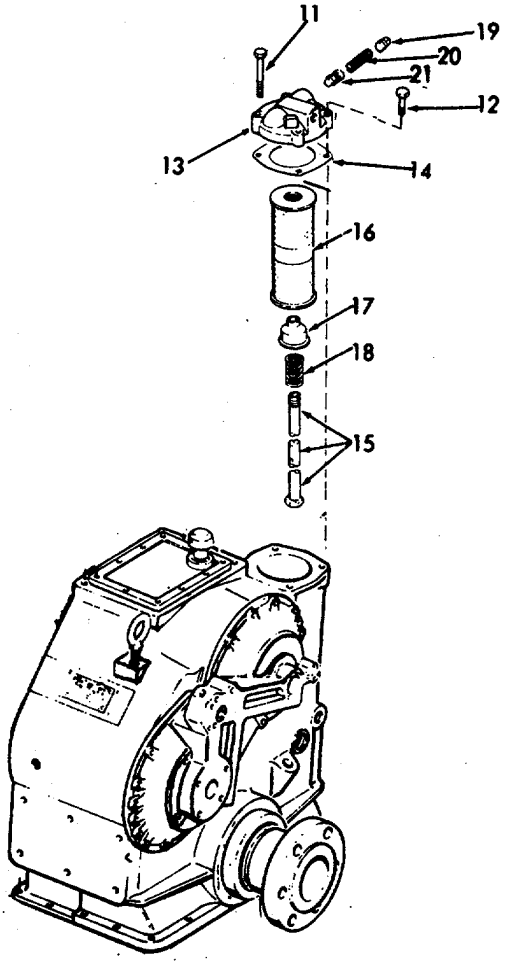
LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	k. Screw (2), breather chain (3)	Replace.	
	l. Screws (1)	Replace.	



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
5. Oil Filter Element Assembly	a. Cap screws (11 and 12)	Remove.	
	b. Cover plate (13)	Remove.	With attached parts
	c. Gasket (14)	Remove.	Discard.





3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

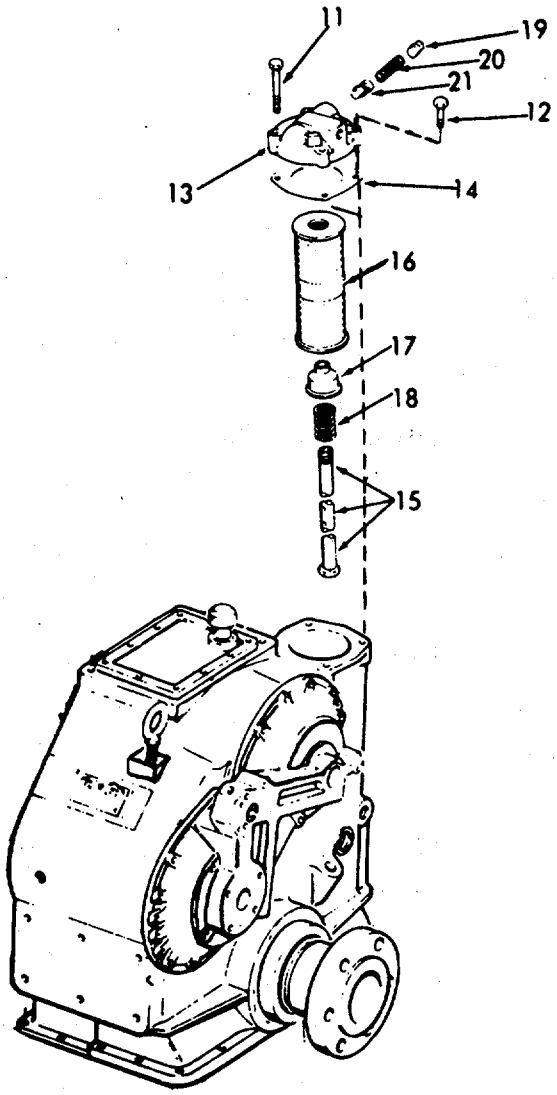
LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	d. Oil filter tube assembly (15)	Unscrew.	Hold cover plate.
	e. Filter element (16)	Remove.	Discard.
	f. Filter seat (17)	Remove.	
	g. Filter spring (18)	Remove.	
	h. Square socket-head pipe plug (19)	Remove.	
	i. Oil by-pass piston spring (20)	Remove.	
	j. Oil by-pass piston (21)	Remove.	Clean all parts.
	k. Oil by-pass piston (21)	Insert in cover plate.	

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	l. Oil by-pass piston spring (20)	Insert in cover plate.	
	m. Square-socket-head pipe plug (19)	Replace.	
	n. Filter spring (18)	Insert on oil filter tube assembly.	
	o. Filter seat (17)	Insert on oil filter tube assembly.	
	p. Filter element (16)	Insert.	Use new filter element.
	q. Oil filter tube assembly (15)	Install in cover plate.	
	r. Gasket (14)	Align with holes in housing.	Use new gasket.
	s. Cover plate (13)	Align with holes in gasket.	The tapped hole must face forward.
	t. Screws (11 and 12)	Install.	Torque to 75-85 lb-ft (236.7-268.3 Nm)

3-8 MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			

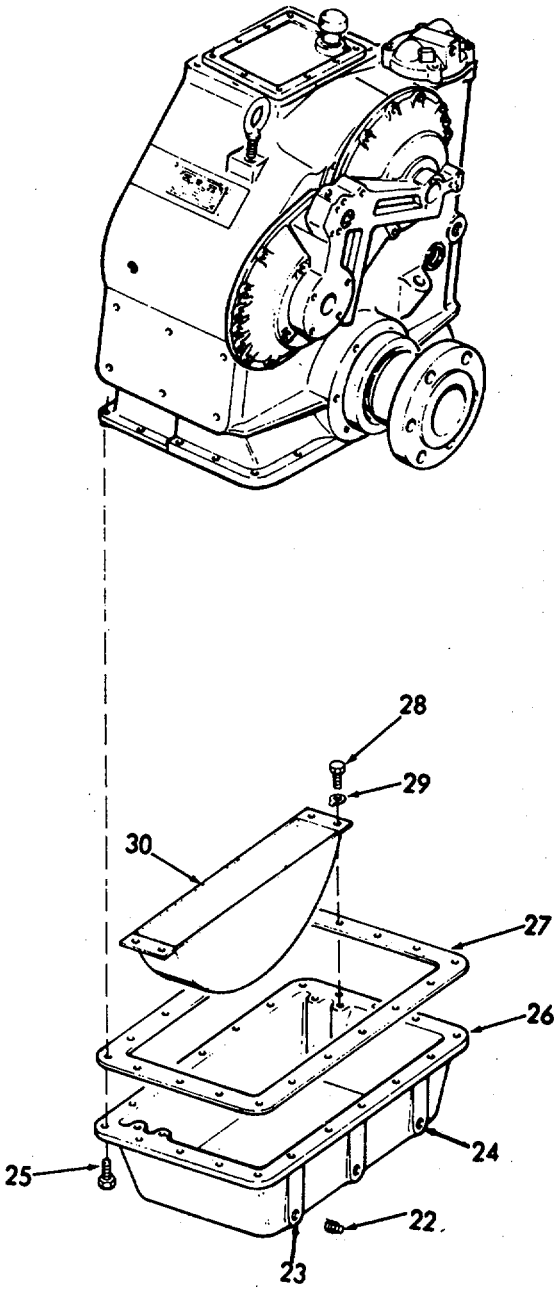


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
6. Sump-cover-and-gear-pan	a. Pipe plug (22)	Remove.	Drain oil into suitable container.
	b. Hoses (23 and 24)	Disconnect at pan.	Drain oil into suitable container.
	c. 14 special zinc-plated hex-head cap screws (25)	Remove.	
	d. Sump-cover-and-gear-pan assembly (26)	Remove.	
	e. Gasket (27)	Remove.	Discard.
	f. Screws (28) and screw locks (29)	Remove.	
	g. Gear pan (30)	Remove.	Clean all parts.

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			

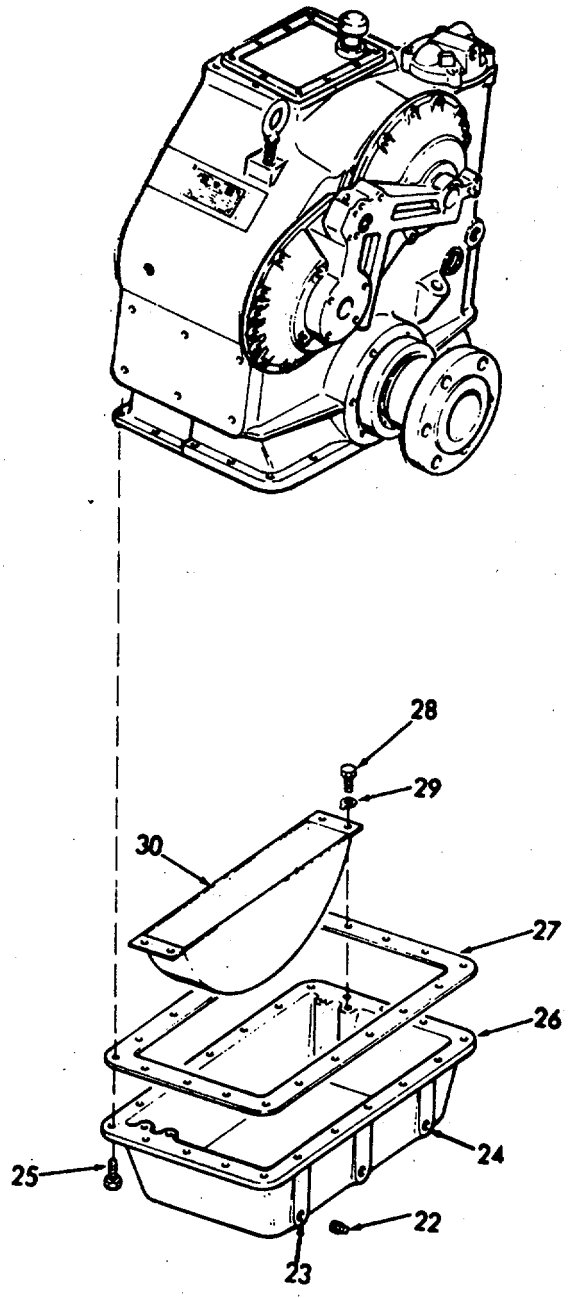


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	h. Gear pan (30), screws (28), and screw locks (29)	Replace.	
	i. Gasket (27)	Install.	Use new gasket.
	j. Sump-cover-and-gear-pan assembly (26), cap screws 25)	Install.	
	k. Hoses (23 and 24)	Replace.	
	l. Pipe plug (22)	Install.	
	m. Oil	Add oil.	

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
7.	Drive spider		

NOTE

This procedure requires either of the following:

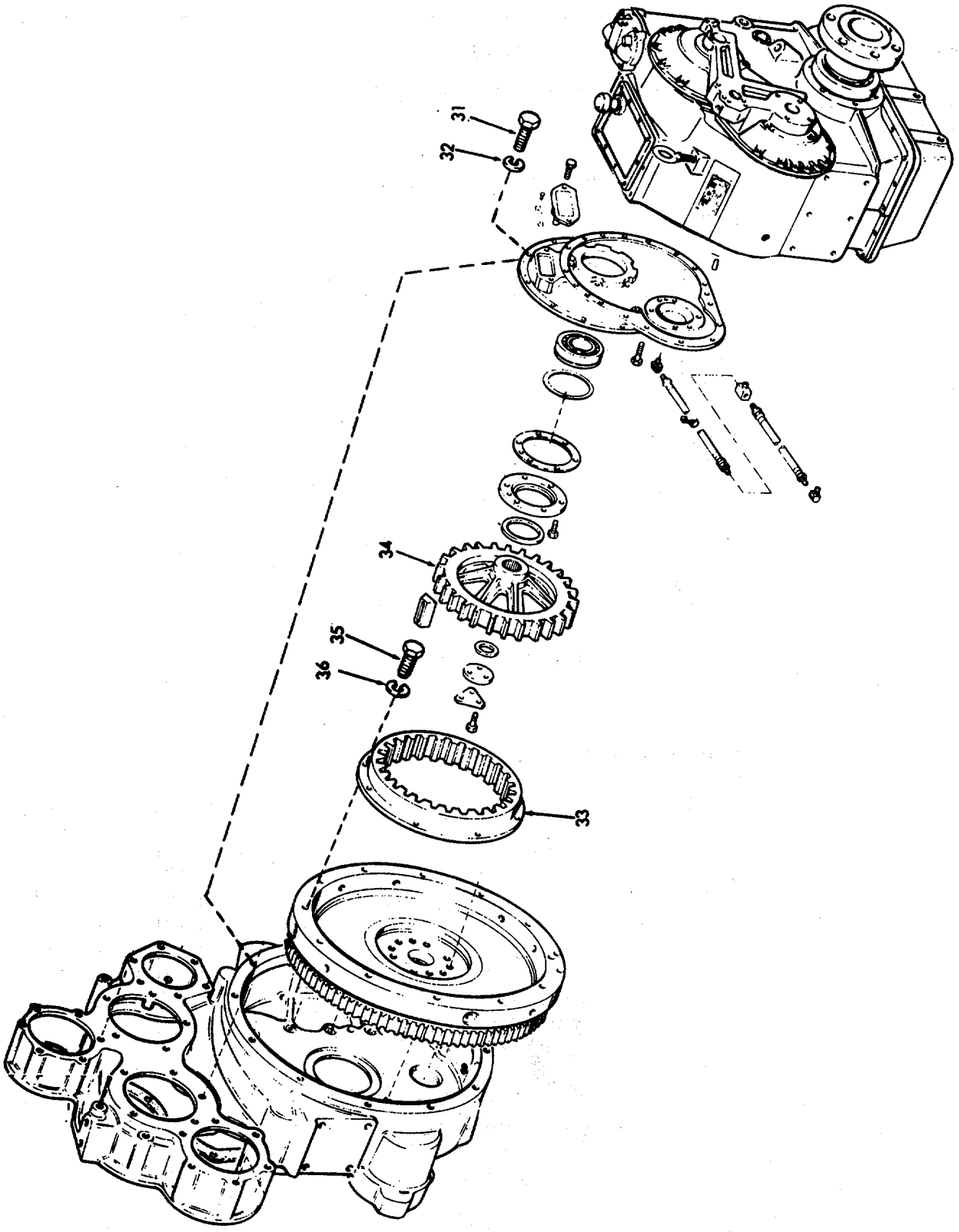
- Movement of the propulsion engine forward or
- Movement of the propeller shaft aft

This procedure also requires disconnection of the marine gear so that access can be obtained to the drive spider (forward) components.

CAUTION

The marine gear weighs 1358 lb (616 kg) without oil. The engine weighs approximately 4500 lb (2043 kg).

a. Bolts (31), and lock-washers (32)	Remove.	
b. Marine gear	Move so that the drive ring (33) and drive spider (34) disengage.	
c. Bolts (35), and lock-washers (36)	Remove.	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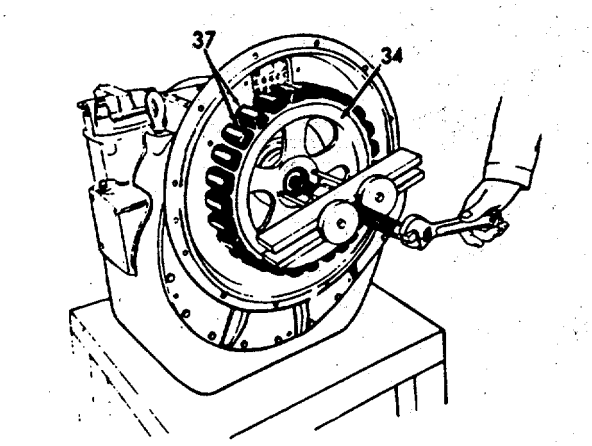
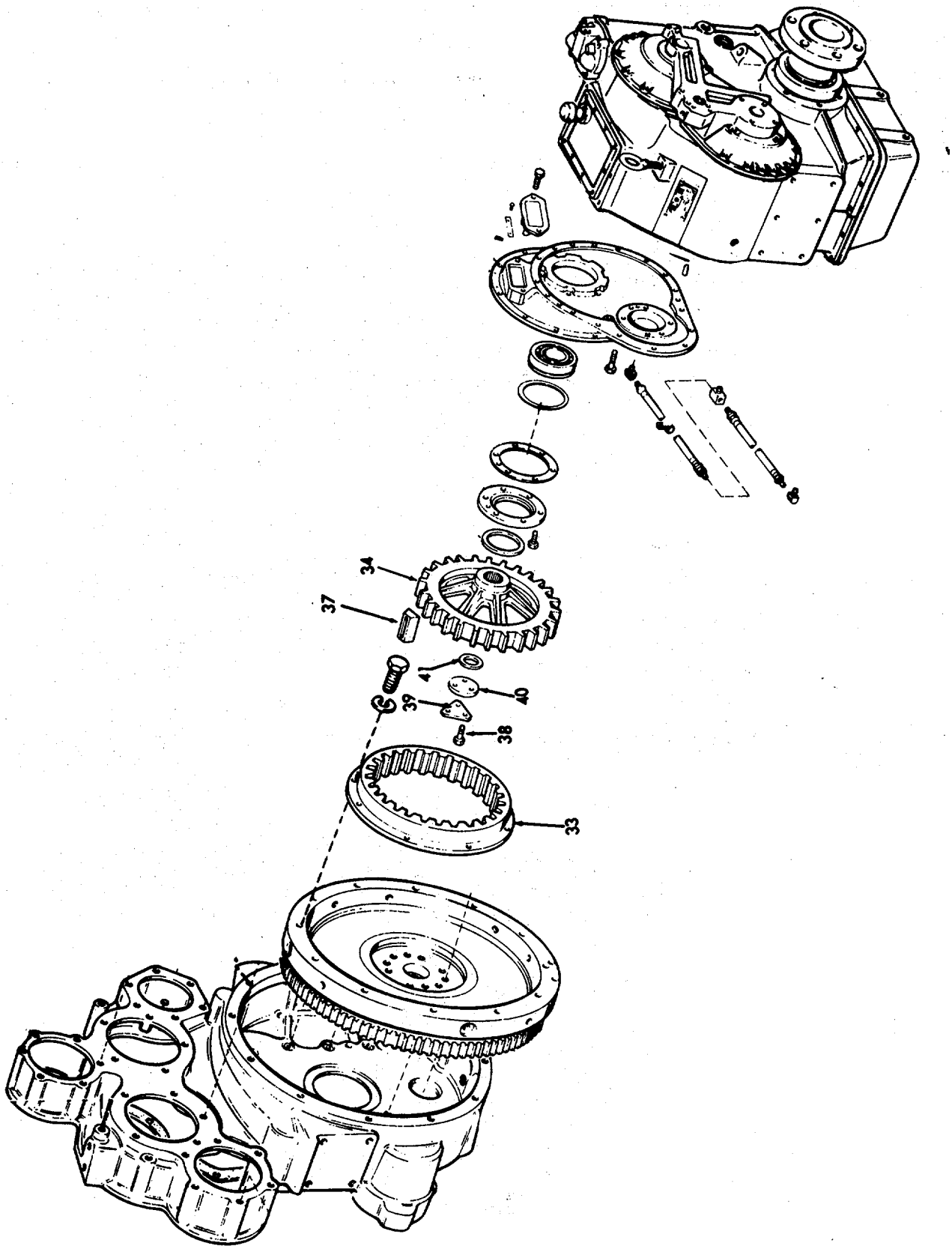
33

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	d. Driving ring (33)	Remove.	
	e. Rubber driving ring coupling blocks (37)	Remove.	Remove only the blocks requiring replacements.
	f. Hex-head cap screws (38)	Remove.	
	g. Lock plate (39)	Remove.	
	h. Retainer washer (40)	Remove.	
	i. Preformed packing (41)	Remove.	
	j. Drive spider (34)	Remove.	Install a puller in the two 3/8-16 UNC tapped holes in the drive spider.

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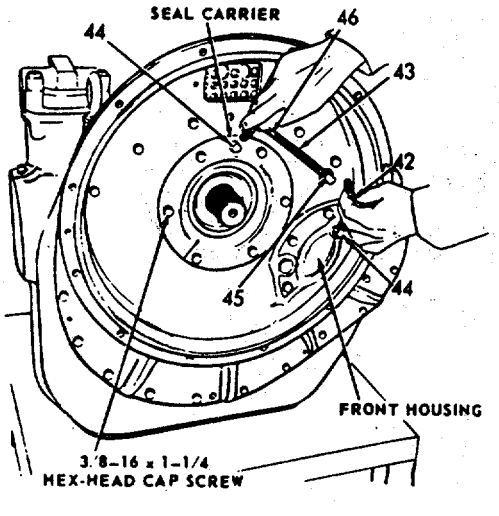
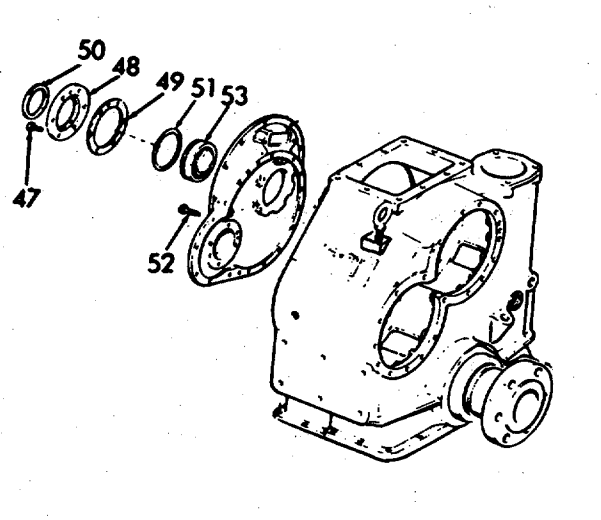
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	k. Short flexible hose (42), and long flexible hose (43)	Disconnect from inverted elbow fittings (44)	Disconnect at unions.
	l. Flexible hoses (42 and 43)	Unscrew from inverted tee fitting (45)	
	m. Hose clamp and washer (46)	Remove.	Only if re-placement is required.
	n. Inverted elbow fittings (44)	Remove.	Only if re-placement is required.
	o. Inverted tee fitting (45)	Remove.	Only if re-placement is required.



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	p. Hex-head cap screws (47)	Remove.	
	q. Seal carrier (48)	Remove.	
	r. Seal carrier gasket (49)	Remove.	Discard.
	s. Drive spider oil seal (50)	Remove from seal carrier (48).	Discard.
	t. Snap ring (51)	Remove.	
	u. Hex-head cap screws (52)	Remove.	
	v. Reverse driving gear ball bearing (53)	Remove.	

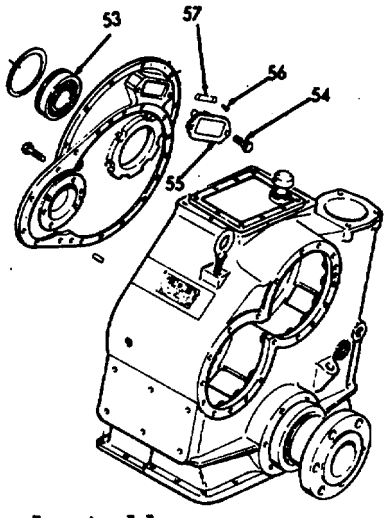


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

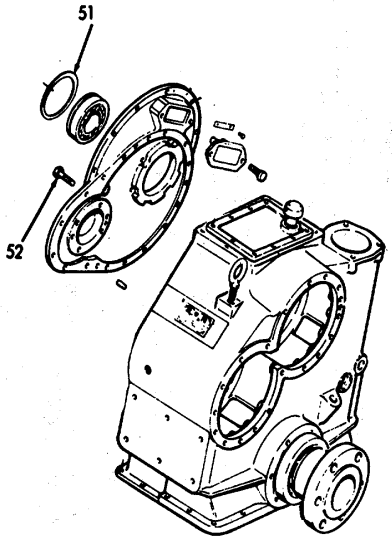
LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	w. Screws (54)	Remove.	Only if replacement is required.
	x. Front housing cover plate (55)	Remove.	
	y. Drive pins (56)	Remove.	Only if replacement is required.
	z. Rotation indicator plate (57)	Remove.	
	aa. Rotation indicator plate (57), and drive pins (56)	Replace.	
	ab. Front housing cover plate (55), and screws (54)	Replace.	Screws 3/8-16 x 7/8 torque to 34-38 lb-ft (46-51.5 Nm).
	ac. Reverse driving gear ball bearing (53)	Install.	Press on.

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			

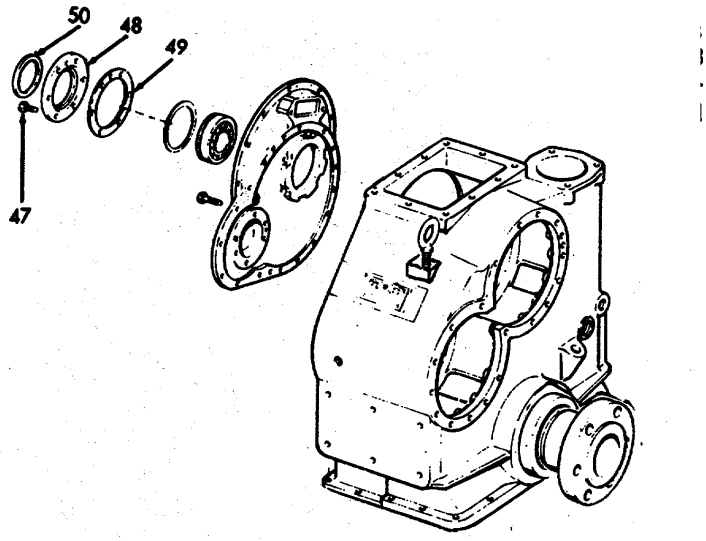


ad.	Hex-head cap screws (52)	Install.	Screws are 3/8-16 x 1-1/4. Alternately tighten to 34-38 lb-ft (46-51.5 Nm) torque.
ae.	Snap-ring (51)	Install.	In groove of the reverse driving ball bearing (53).



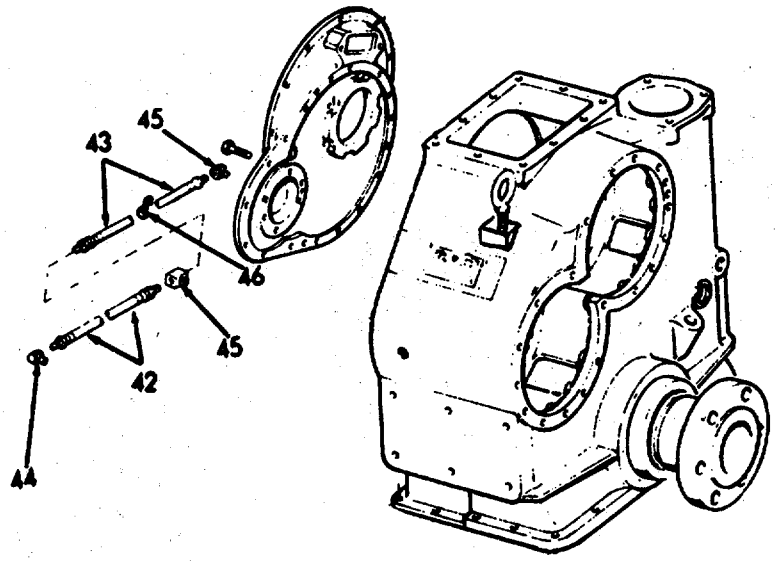
3-8 MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
af.	Drive spider oil seal (50)	Install in seal carrier (48).	Lip of seal must point to the machined face of the carrier. Front side of seal must be flush with the carrier bore.
ag.	Seal carrier (48), seal carrier gasket (49)	Install.	Use new gasket.
ah.	Hex-head cap screws (47)	Install	Screws are 3/8-16 x 1-1/4. The tapped hole in the carrier must be in the top center position. Tighten screws to 34-38 lb-ft (46-51.5 Nm) torque.



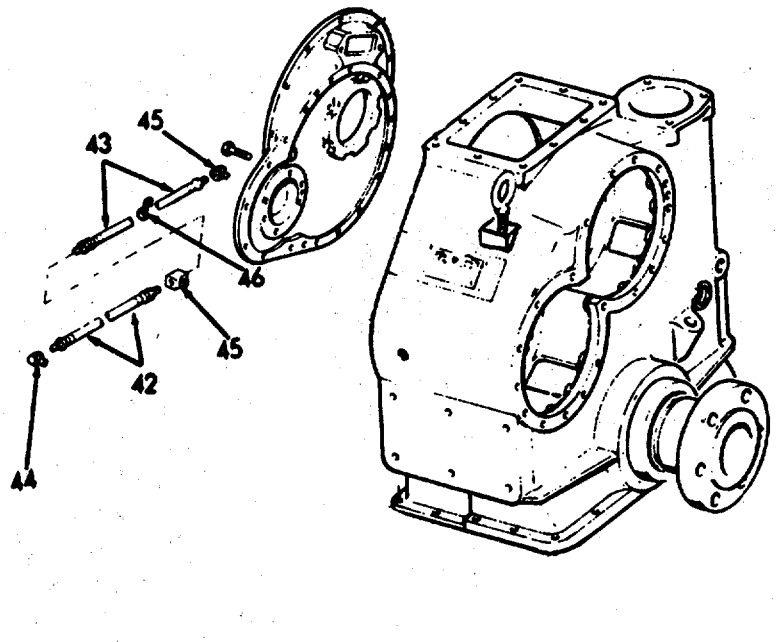
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
ai.	Inverted tee fitting (45)	Install.	If removed
aj.	Inverted elbow fittings (44)	Install.	If removed
ak.	Hose clamp and washer (46)	Install on 9 inch (22.9 cm) hose.	Remove a screw from the front housing.
al.	Flexible hoses (42 and 43)	Install in inverted tee fitting (45).	



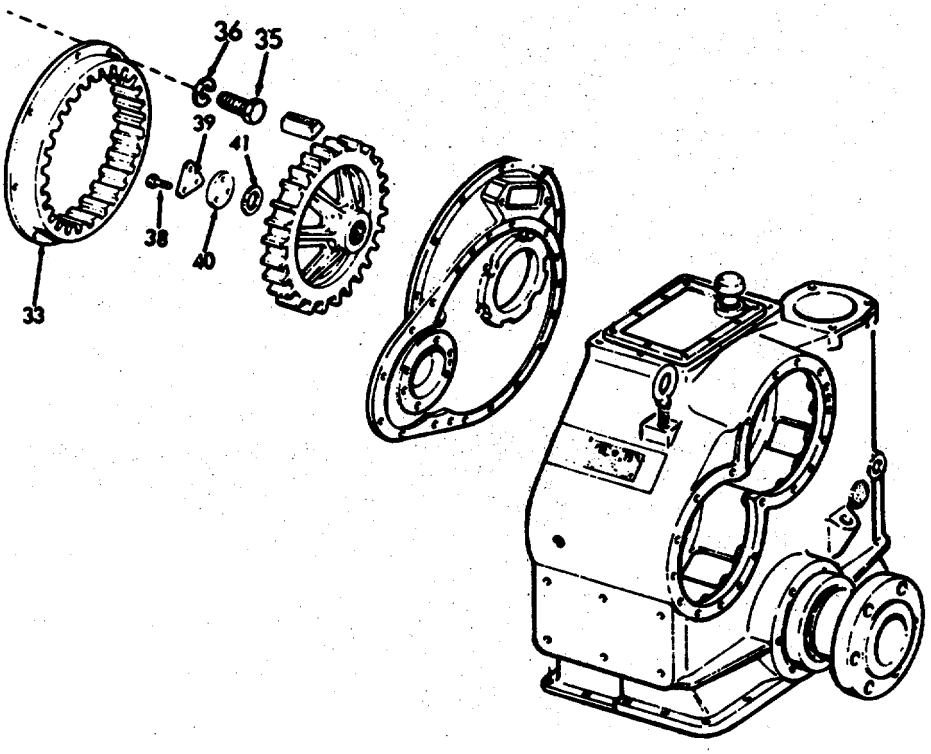
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
am.	Long flexible hose (43), and short flexible hose (42)	Reconnect to inverted elbow fittings (44). Install on lugs on drive spider (34).	Requires 26 blocks.
an.	Rubber driving ring coupling blocks (37)	Install replacement blocks.	
ao.	Drive spider (34)	Install on shaft.	Make certain to align splines on spider and shaft. Press on shaft with a hollow ram porto-power or equivalent.



3-8 MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
ap.	Preformed packing (41), retaining washer (40), lock plate (39), and screws (38)	Install.	Torque dry to 405-550 lb-ft (549-746 Nm).
aq.	Driving ring (33), screws (35), and lock-washer (36)	Install	Screws are 1/2-13 x 1-1/4 torque to 71 to 75 lb-ft 96.276 to 101.700 Nm).



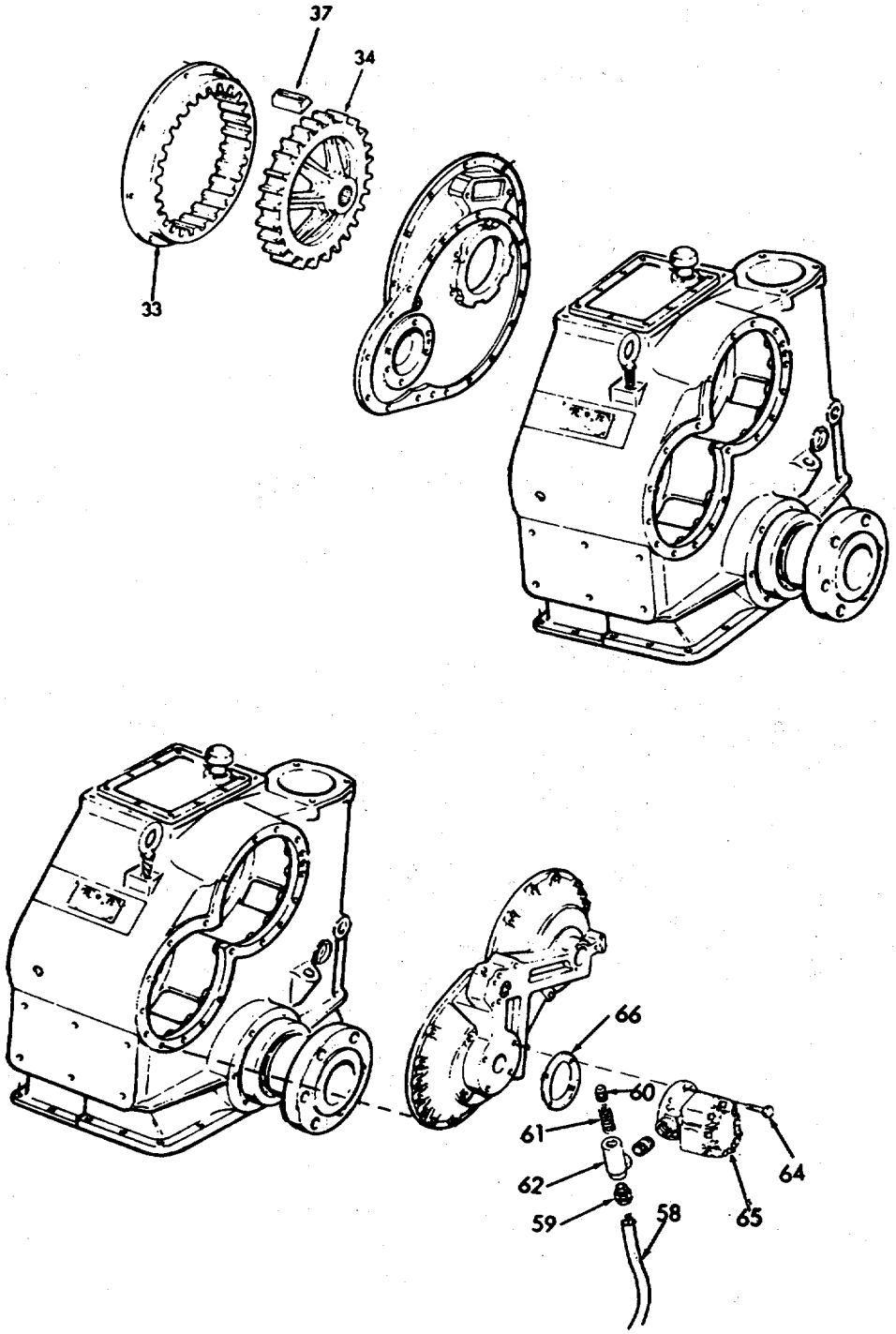
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	ar. Marine gear	Move so that the drive ring (33) and drive spider (34) [with rubber driving ring coupling blocks (37)] engage.	
	as. Engine or propeller shaft	Reconnect.	
8. Oil pump assembly	a. Hose (58)	Disconnect at union (59).	
	b. Pipe plug (60)	Remove.	
	c. Strainer (61)	Remove.	
	d. Oil strainer housing (62)	Remove.	
	f. Screws (64)	Remove.	
	g. Oil pump (65) and gasket (66)	Remove.	Discard gasket.
	h. Gasket (66), oil pump (65), and screws (64)	Install.	Use new gasket.

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

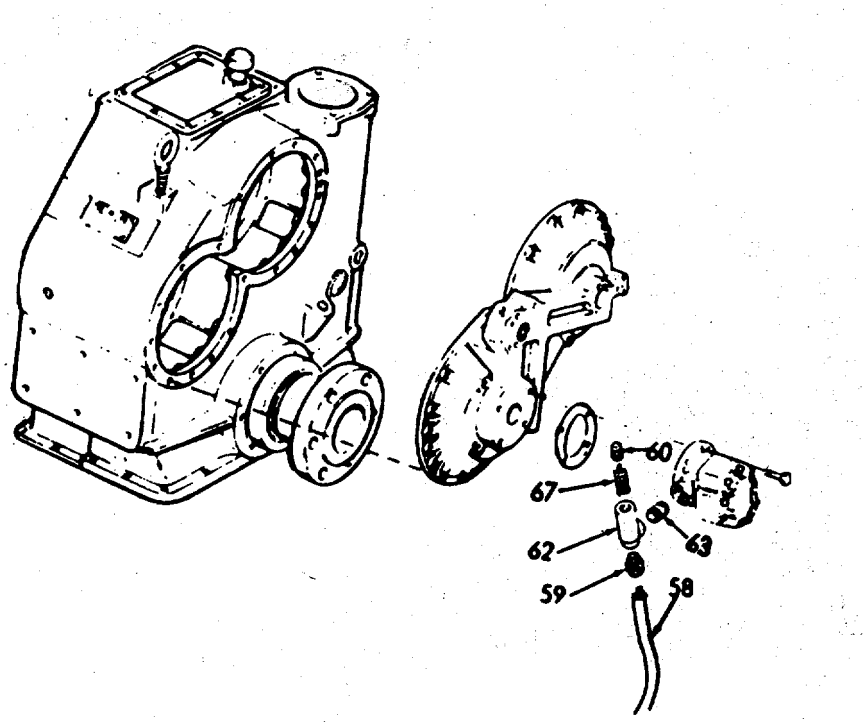
LOCATION	ITEM	ACTION	REMARKS

Repair Cont)



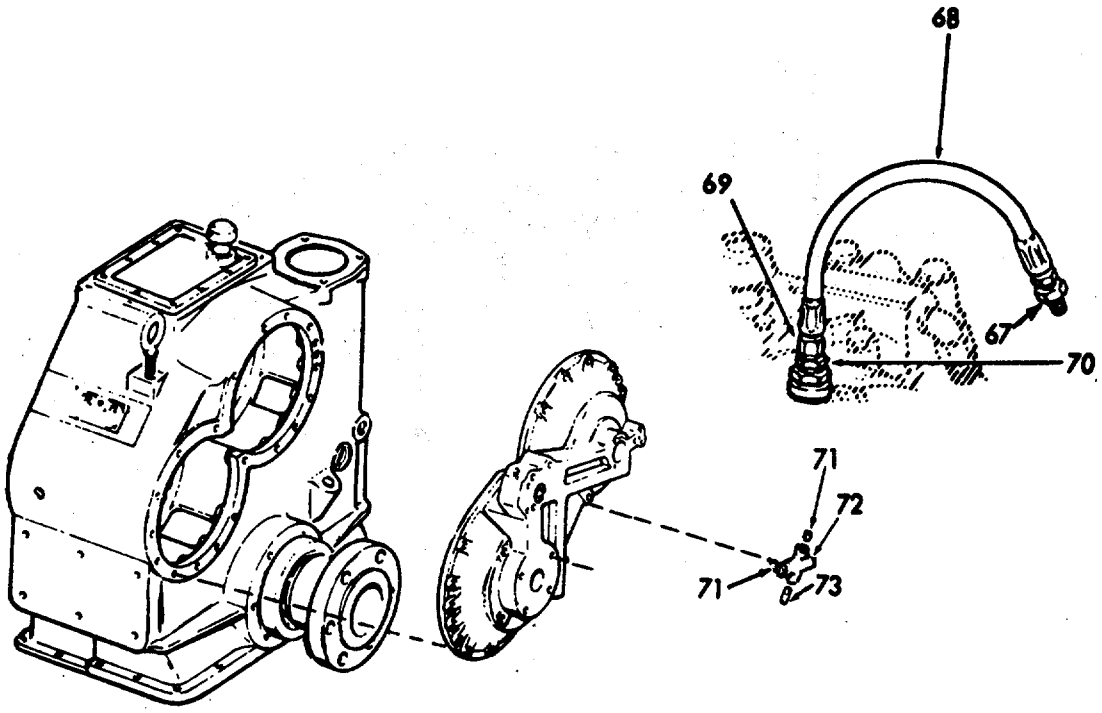
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair Cont)			
	i. Pipe nipple (63)	Install.	
	j. Oil strainer housing (62)	Install.	
	k. Strainer (67)	Install.	
	m. Pipe plug (60)	Install.	
	n. Hose (58)	Install at union (59).	



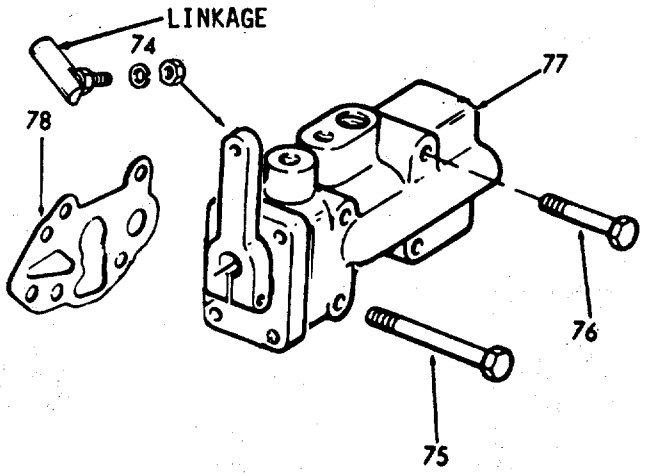
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
9. Selector valve	a. Connector tube (67)	Remove.	At standby lube oil pump
	b. Hose (68)	Remove.	
	c. Restriction fitting (69)	Remove.	
	d. Pipe reducer (70)	Remove.	
	e. Pipe plug (71)	Remove.	
	f. Pipe tie (72)	Remove.	
	g. Pipe nipple (73)	Remove.	



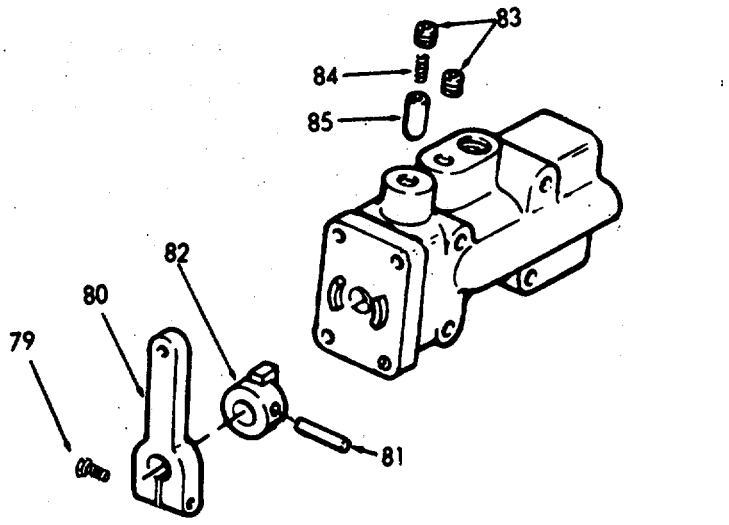
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
h.	Linkage (74)	Disconnect.	
i.	Cap screws (75 and 76)	Remove.	
j.	Selector valve assembly (77)	Remove.	
k.	Gasket (78)	Remove.	Discard.



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
l.	Cap screw (79)	Remove.	
m.	Selector valve lever (80)	Remove.	
n.	Roll pin (81)	Remove.	
o.	Stop collar (82)	Remove.	
p.	Pipe plug (83)	Remove both.	
q.	Indexing detent spring (84)	Remove.	
r.	Indexing detent (85)	Remove.	

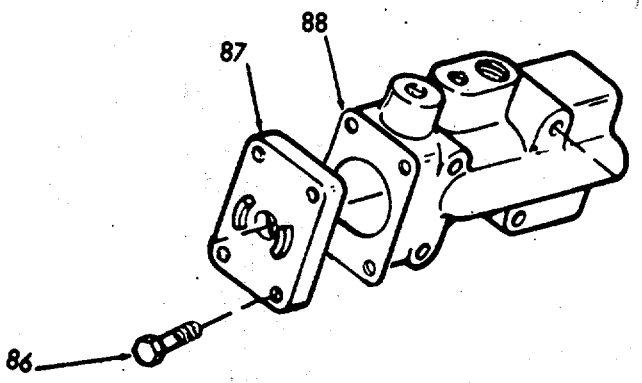


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
s.	Hex-head cap screws (86)	Remove.	
t.	Selector valve stem cover (87)	Remove.	
u.	Gasket (88)	Remove.	Discard.

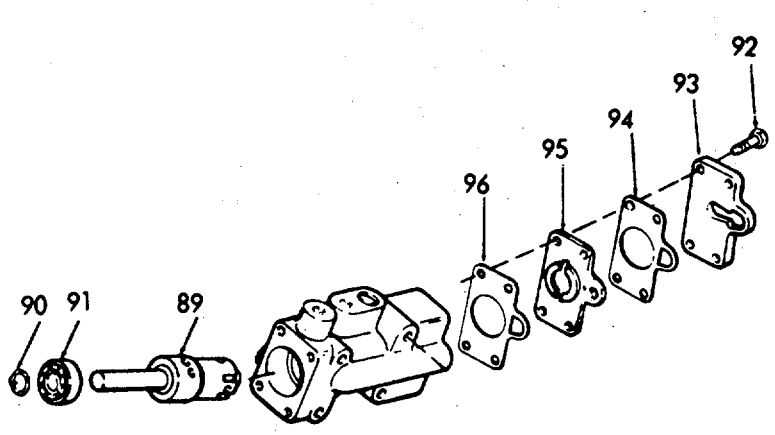
CAUTION

Exercise care in handling the selector valve stem, this port is ground accurately to fit in the body.



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
v.	Selector valve stem (89)	Remove.	Includes "O" ring seal and ball bearing.
w.	"O" ring seal (90)	Remove.	Discard.
x.	Ball bearing (91)	Remove.	
y.	Hex-head cap screws (92)	Remove.	
z.	Orifice plate cover (93)	Remove.	
aa.	Orifice plate gasket (94)	Remove.	Discard.
ab.	Orifice plate (95)	Remove.	Discard.
ac.	Gasket (96)	Remove.	Discard.

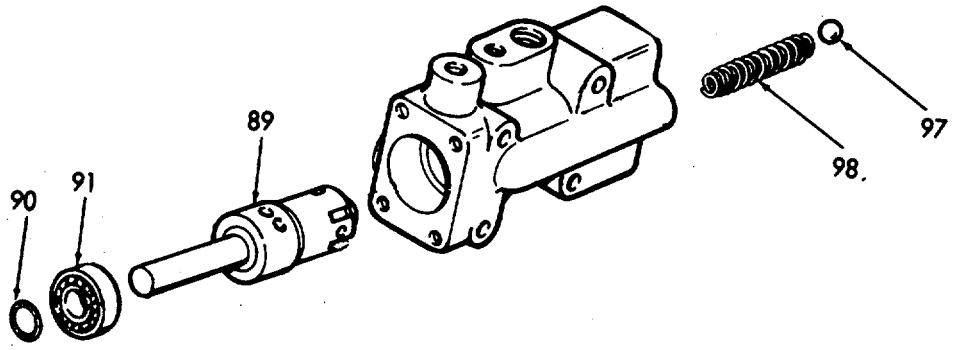


3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

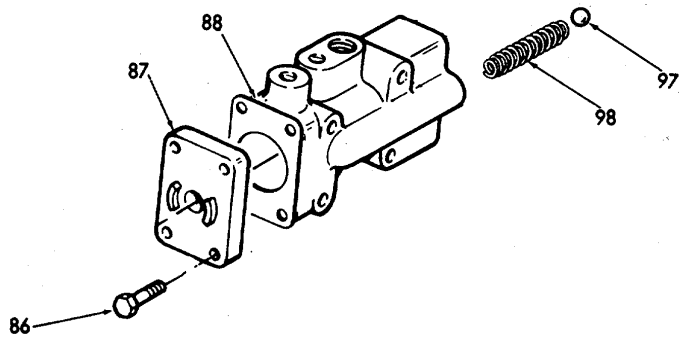
LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
		NOTE When removing cover and plate the steel ball (97) will pop out.	
ad.	Steel ball (97)	Remove.	
ae.	Compression spring (98)	Remove.	
		CAUTION • Do not remove the pistons, these parts are ground accurately to fit in the body. • Exercise care in handling the selector valve stem, this part is ground accurately to fit in the body.	
af.	Ball bearing (91)	Install.	Use an arbor press to press ball bearing on selector valve stem (89).
ag.	Selector valve stem (89)	Install in body.	
ah.	"O" ring seal (90)	Install in selector valve stem cover (87).	

3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			

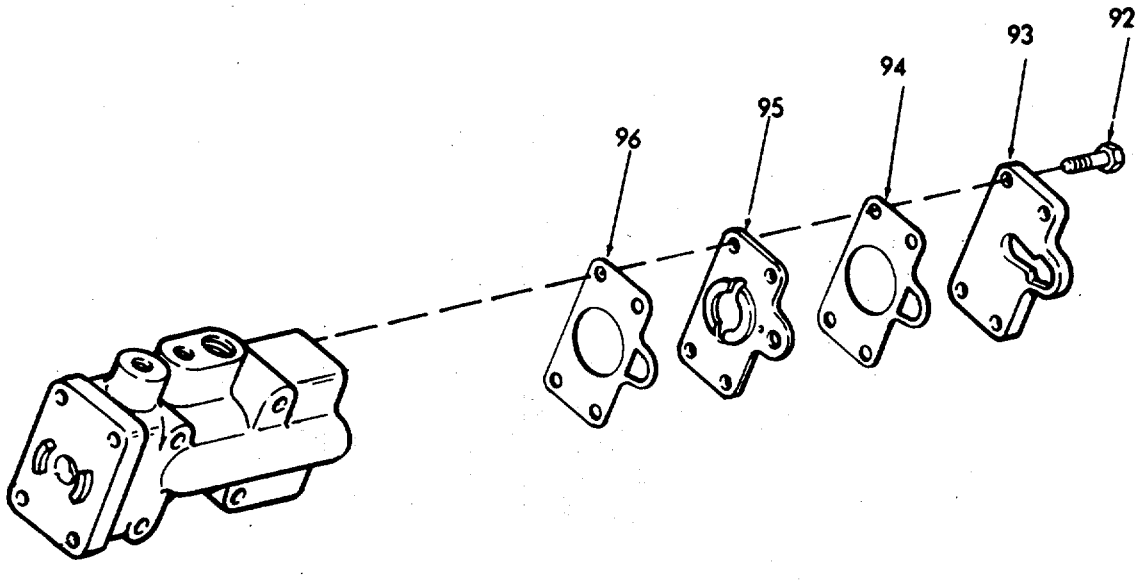


ai.	Gasket (88), selector valve stem cover (87)	Position over selector valve stem (89).	
aj.	Hex-head cap screws (86)	Install.	Screws are 5/16-18 x 1 inch. Torque to 19-21 lb-ft (25.8 - 28.5 Nm).
ak.	Compression spring (98), and steel ball (97)	Install.	



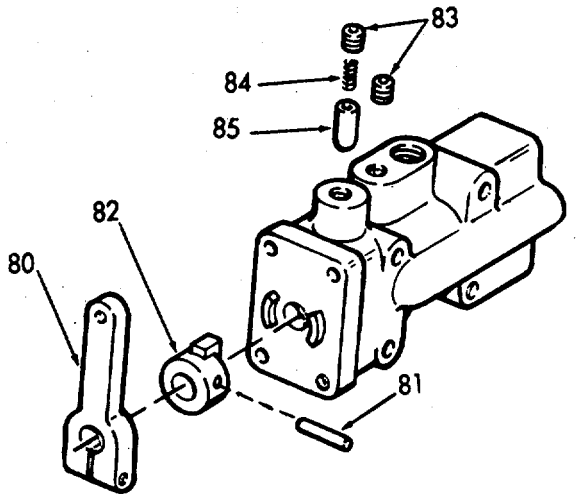
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
al.	Gasket (96) and orifice plate (95)	Install.	Use new gasket.
am.	Orifice plate cover gasket (94), orifice plate cover (93), and hex-head cap screws (92)	Install.	Screws are 5/16-18 x 1 inch. Torque to 19-21 lb-ft (25.8 - 28.5 Nm).



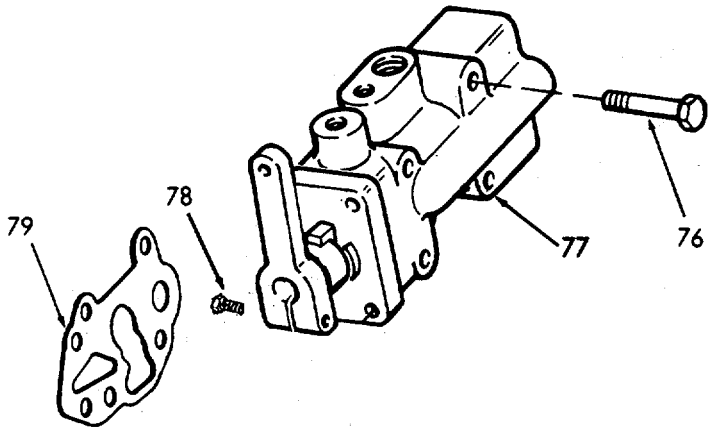
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
an.	Indexing detent (85), indexing detent spring (84), and pipe plug (83)	Install.	Install in hole nearest the protruding end of the selector valve stem. Make certain the detent indexes one of the bores in the stem.
ao.	Pipe plug (83)	Install.	Install in the next hole.
ap.	Stop collar (82), and roll pin (81)	Install.	
aq.	Selector valve lever (80)	Install.	



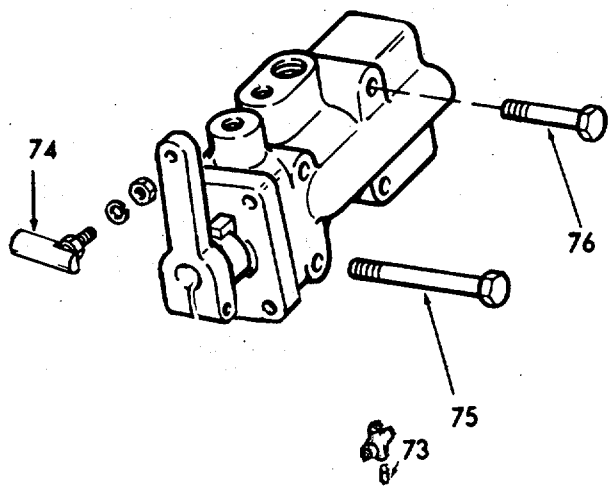
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
ar.	Cap screw (79)	Install.	Screw is 5/16-18 x 1. Torque to 19-21 lb-ft (25.8 to 28.5 Nm)
as.	Selector Valve assembly (77), gasket (78)	Align with holes in manifold.	Use new gasket.
at.	Screws	Install.	Screws are 3/8-16 x 2-3/4.



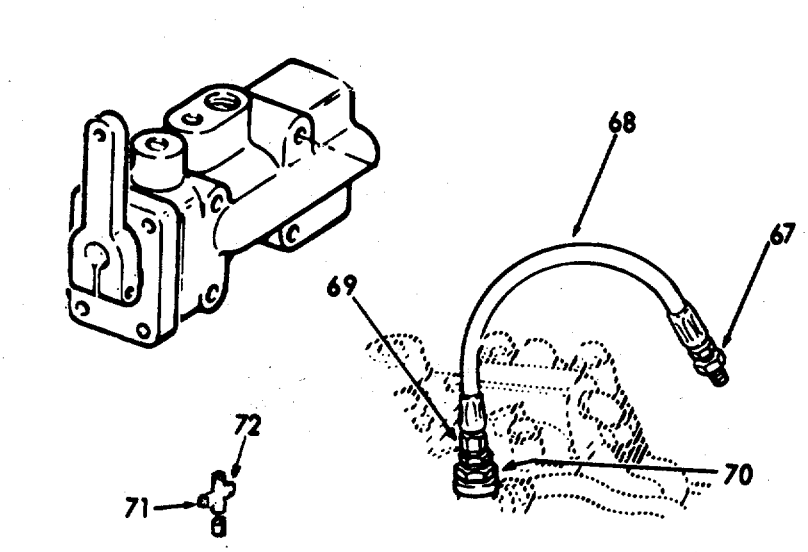
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
au.	Screws (75)	Install.	Screws are 3/8-16 x 5-3/8.
av.	Screws (75 and 76)	Tighten.	Tighten in a criss-cross sequence to 17-25 lb-ft (23.1-33.9 Nm). Check the freeness of valve stem. If stem binds, loosen screws and retorque in a criss-cross sequence. Repeat until valve stem moves freely.
aw.	Linkage (74)	Reconnect.	
ax.	Pipe nipple (73)	Install.	Use pipe thread compound.



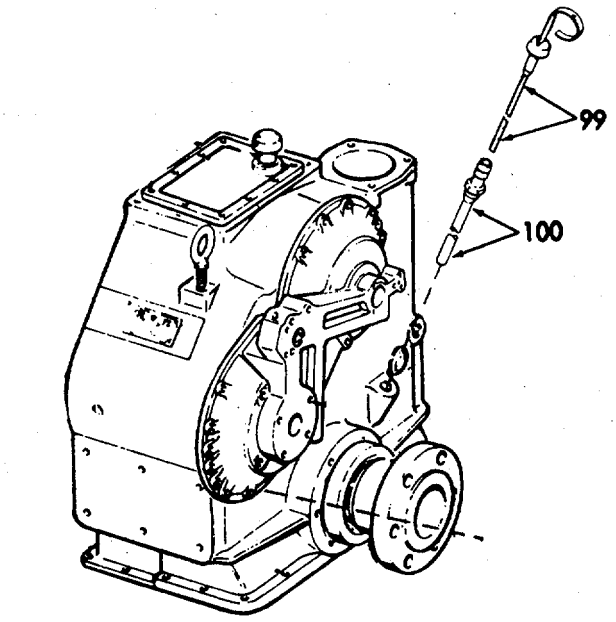
3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
ay.	Pipe tee (72)	Install.	Use pipe thread compound.
az.	Pipe plug (71)	Install.	Use pipe thread compound.
ba.	Pipe reducer (70)	Install.	Use pipe thread compound.
bb.	Restric-tion fitting (69)	Install.	Use pipe thread compound.
bc.	Connector tube (67)	Install.	
bd.	Hose (68)	Install.	



3-8. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
10. Oil level gage (99)	a. Oil level gage	Remove.	
	b. Tube (100)	Remove.	
	c. Tube (100)	Replace.	
	d. Oil level gage (99)	Replace.	



3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
NONE

Condition Description

Materials/Parts
Hoses as required

Special Environmental Conditions
Do not drain oil into bilges.
Use oil separation method to collect oil.

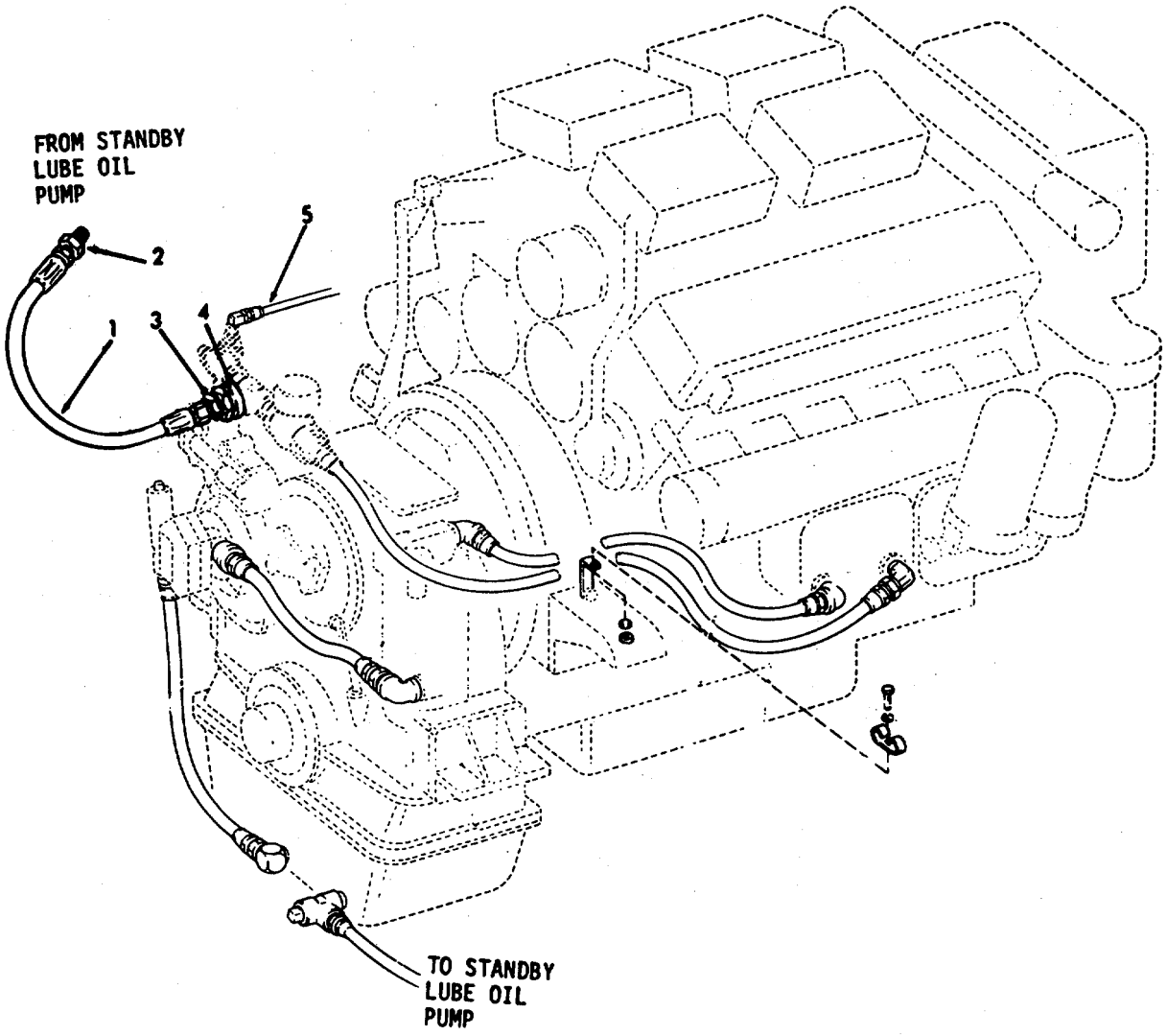
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
Inspection			
1. Oil lines	Hoses and fittings	Inspect for leaks, breaks, cracks, wear and signs of possible failure.	
Removal			
2. Hose-from stand by lube oil Pump	a. Hose (1)	Remove.	
	b. Connector tube (2)	Remove.	
	c. Restric-tion fitting (3)	Remove.	

3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	d. Pipe reducer (4)	Remove.	
3. Hose-oil pressure gage	Hose (5)	Remove.	



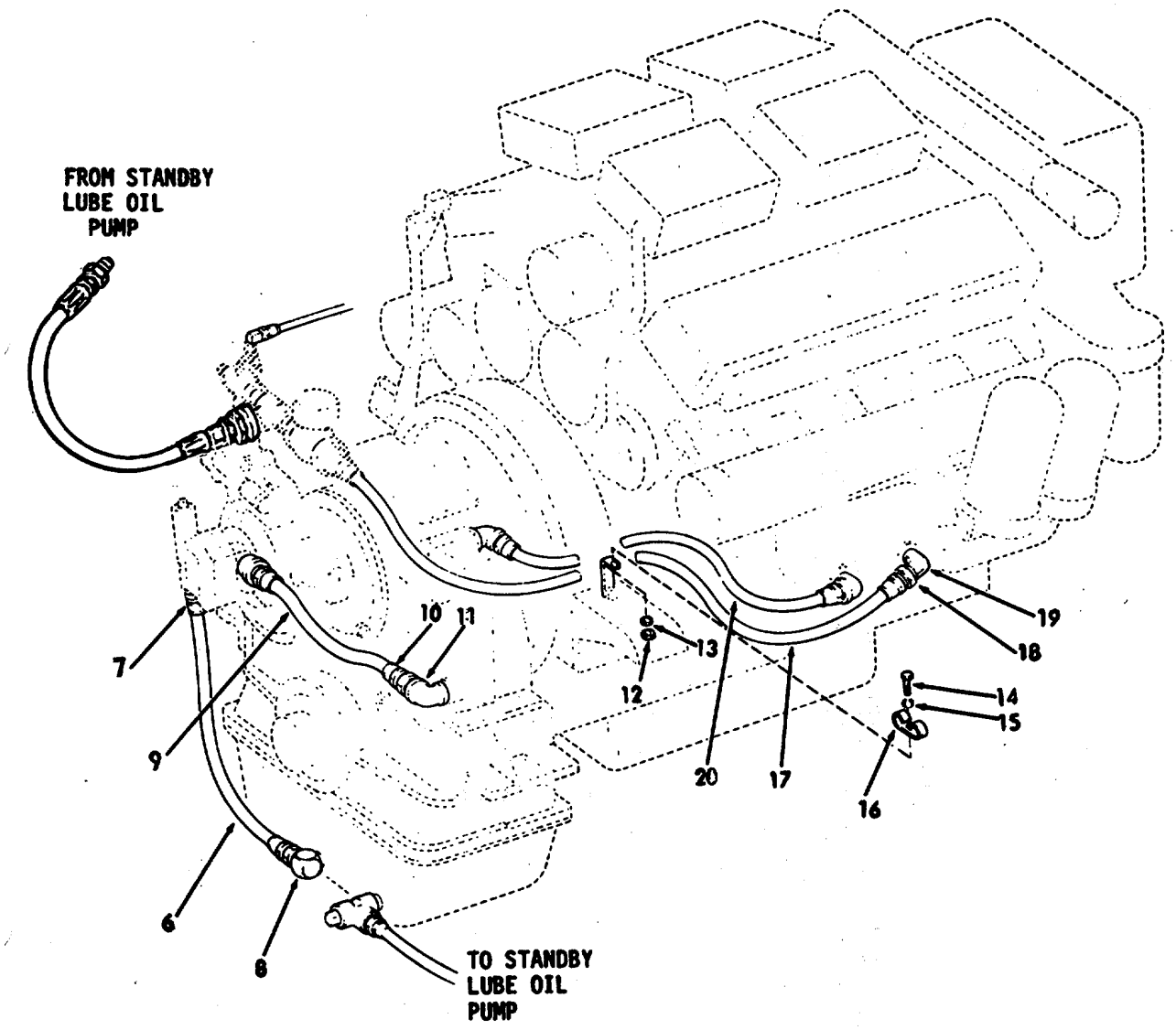
3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
4. Hose-marine gear to oil pump	a. Hose (6)	Remove.	
	b. Elbow (7)	Remove.	
	c. Elbow (8)	Remove.	
5. Hose-oil pump to oil filter	a. Hose (9)	Remove.	
	b. Pipe adaptor (10)	Remove.	
	c. Elbow (11)	Remove.	
6. Hose-clip	a. Nut (12), and flat-washer (13)	Remove.	
	b. Screw (14), lock-washer (15), and hose clip (16)	Remove.	
7. Hose-oil outlet to	a. Hose (17) oil cooler	Remove.	Remove from clip.
	b. Adaptor (18)	Remove.	
	c. Elbow (19)	Remove.	
8. Hose-oil cooler to oil filter	a. Hose (20)	Remove.	Remove from clip.

3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)



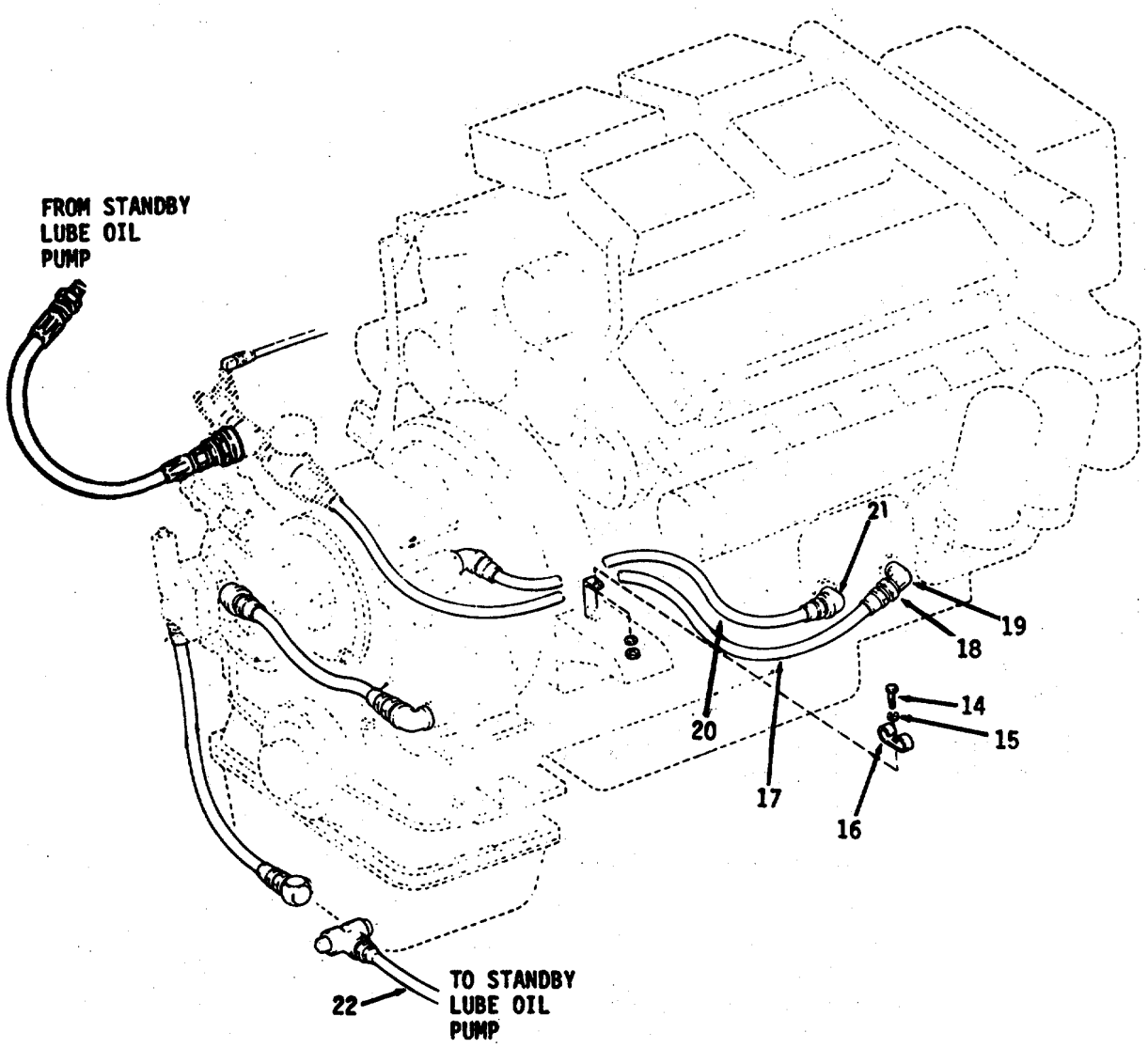
3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	b. Elbow (21)	Remove.	
9. Hose-marine gear to stand by lube oil pump Installation	Hose (22)	Remove.	
10. Hose-marine gear to stand by lube oil pump	Hose (22)	Install.	
11. Hose-oil Cooler to oil filter	a. Elbow (21)	Install.	
	b. Hose (20)	Install.	
12. Hose-oil Outlet to oil cooler	a. Elbow (19)	Install.	
	b. Adaptor (18)	Install.	
	c. Hose (17)	Install.	
13. Hose-Clip	a. Hose clip (16), screw (14), and lock-washer (15)	Place in bracket.	

3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

Installation (Cont)

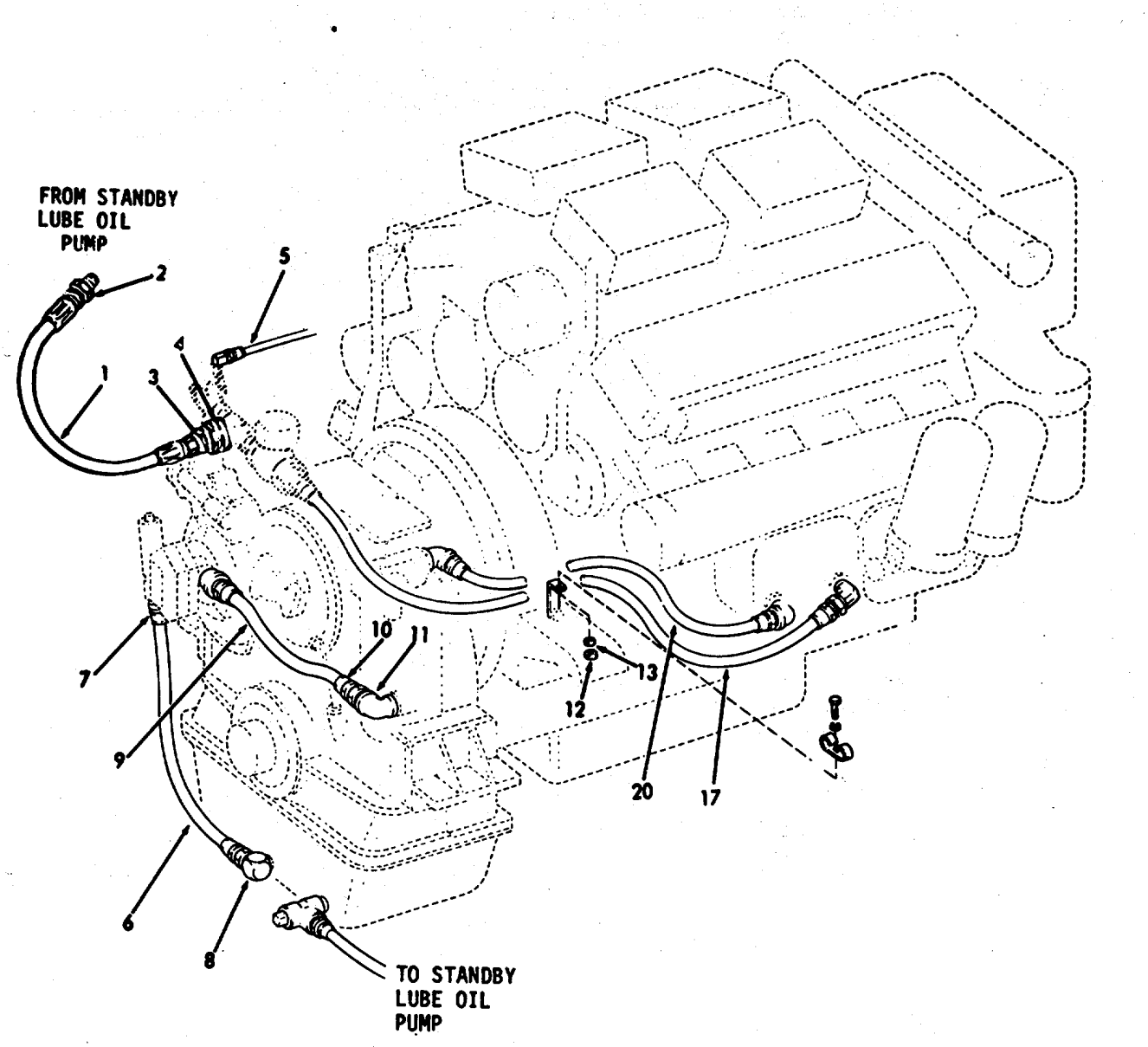


3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	b. Flat-washer (13), and nut (12)	Install.	Torque to 35 to 39 lb-ft (47.460 to 52.884 Nm).
	c. Hoses (17 and 20)	Place in clip.	
14. Hose-oil pump to oil filter	a. Elbow (11)	Install.	
	b. Pipe adaptor (10)	Install.	
	c. Hose (9)	Install.	
15. Hose-marine gear to oil pump	a. Elbow (8)	Install.	
	b. Elbow (7)	Install.	
	c. Hose (6)	Install.	
16. Hose-oil pressure gage	Hose (5)	Install.	
17. Hose-from stand by lube oil pump	a. Pipe reducer (4)	Install.	
	b. Restriction fitting (3)	Install.	
	c. Connector tube (2)	Install.	
	d. Hose (1)	Install.	

3-8.1. MARINE GEAR OIL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			



3-9. ENGINE/TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS.

This paragraph contains the maintenance instructions for the following:

3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS.

a. General.

(1) The control station provides remote control for the propulsion engine clutch and throttle.

(2) One handle (red knob) operates the clutch and reverse gear. The other handle (black knob) operates the throttle.

(3) The transmission of the operating force from the control station to the engine room is by means of two mechanical push-pull cables, one for the reverse gear and one for the throttle.

b. Operation of the reverse gear.

The engagement of the clutch into the AHEAD position is accom- plished by moving the reverse gear operating handle (red knob) 45 degrees in AHEAD direction. The opposite procedure is followed in REVERSE. To put the reverse gear into NEUTRAL, the lever is brought to the vertical position. A spring-loaded plunger detent is provided for readily locating the neutral position by feel, without having to rely on sight or guess work.

c. Operation of throttle.

(1) The opening of the throttle is accomplished by moving the throttle (black knob) from the AFT position (maneuvering speed) to the FORWARD position (full speed).

(2) The total stroke of the clutch or throttle operating cable is three (3) inches. The cable connection on the control may be arranged so that the cable either pulls or pushes the engine lever.

(3) The control unit contains an electrical interlock switch to prevent energizing the starter when the clutch is in the AHEAD or ASTERN positions.

3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection **c. Installation**
b. Repair **d. Adjustment**

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

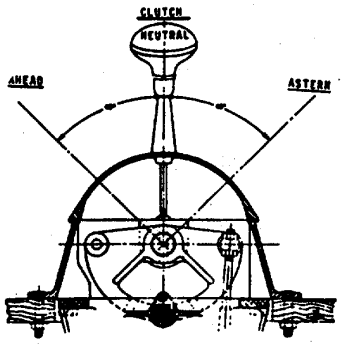
Personnel Required
2

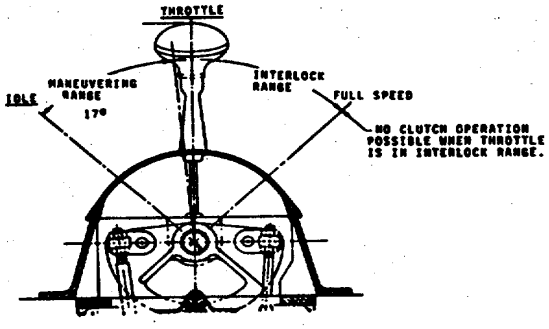
General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Pilot house	a. Clutch	Place in ahead and astern positions.	Check for ease of operation, broken, frayed coverings, and damaged control cables.
	b. Throttle	Place in idle and full speed positions.	Check for ease of operation, broken, frayed coverings, and damaged control cables.

3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Inspection (Cont)			
2. Engine room (fwd or aft)	a. Clutch	Ahead and astern position.	Check for ease of operation, broken, frayed coverings, and damaged control cables.
	b. Throttle	Idle and full speed positions	Check for ease of operation, broken, frayed coverings, and damaged control cables.
Test			
3. Pilot house	a. Clutch	Check angle from neutral to AHEAD and neutral to ASTERN.	Angle should be 45°. Refer to adjustment procedures.
	b. Throttle	Check angle of maneuvering range.	Angle should be 17°. The clutch should move only in the maneuvering range. Refer to adjustment procedure.





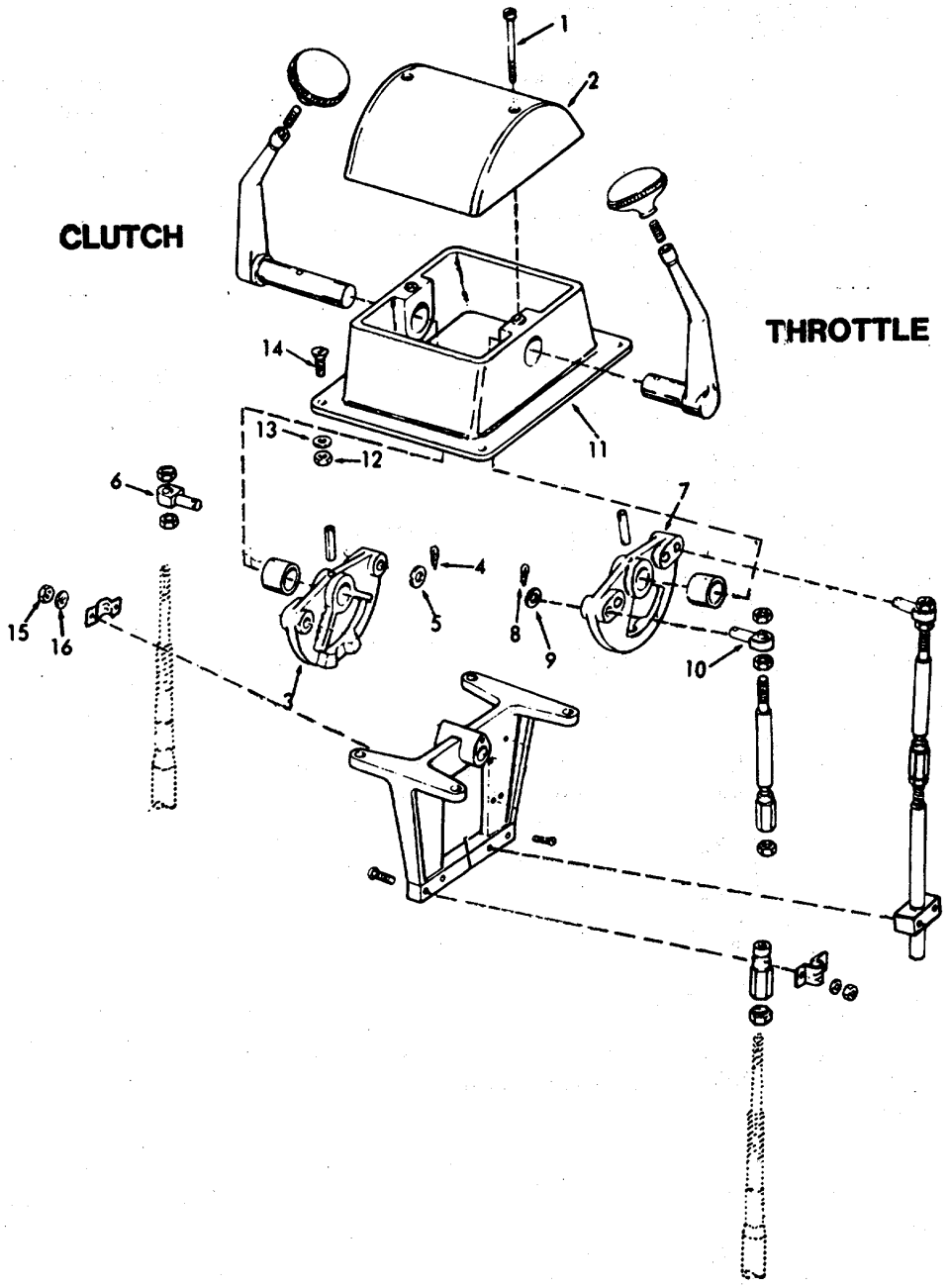
3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Removal - Control Station			
4. Control Station	a. Screws (1)	Remove.	
	b. Cover (2)	Remove.	
5. Clutch Quadrant (3)	a. Cotter pin (4)	Remove.	
	b. Washer (5)	Remove.	
	c. Joint (6)	Remove from quadrant.	
6. Throttle Quadrant (7)	a. Cotter pin (8)	Remove.	
	b. Washer (9)	Remove.	
	c. Joint (10)	Remove from quadrant.	
7. Control station housing (11)	a. Nuts (12), and washers (13)	Remove.	
	b. Screws (14)	Remove.	
	c. Housing (11)	Lift to gain access to cables.	
	d. Nuts (15), lock-washers (16)	Remove.	

3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

Removal - Control Station



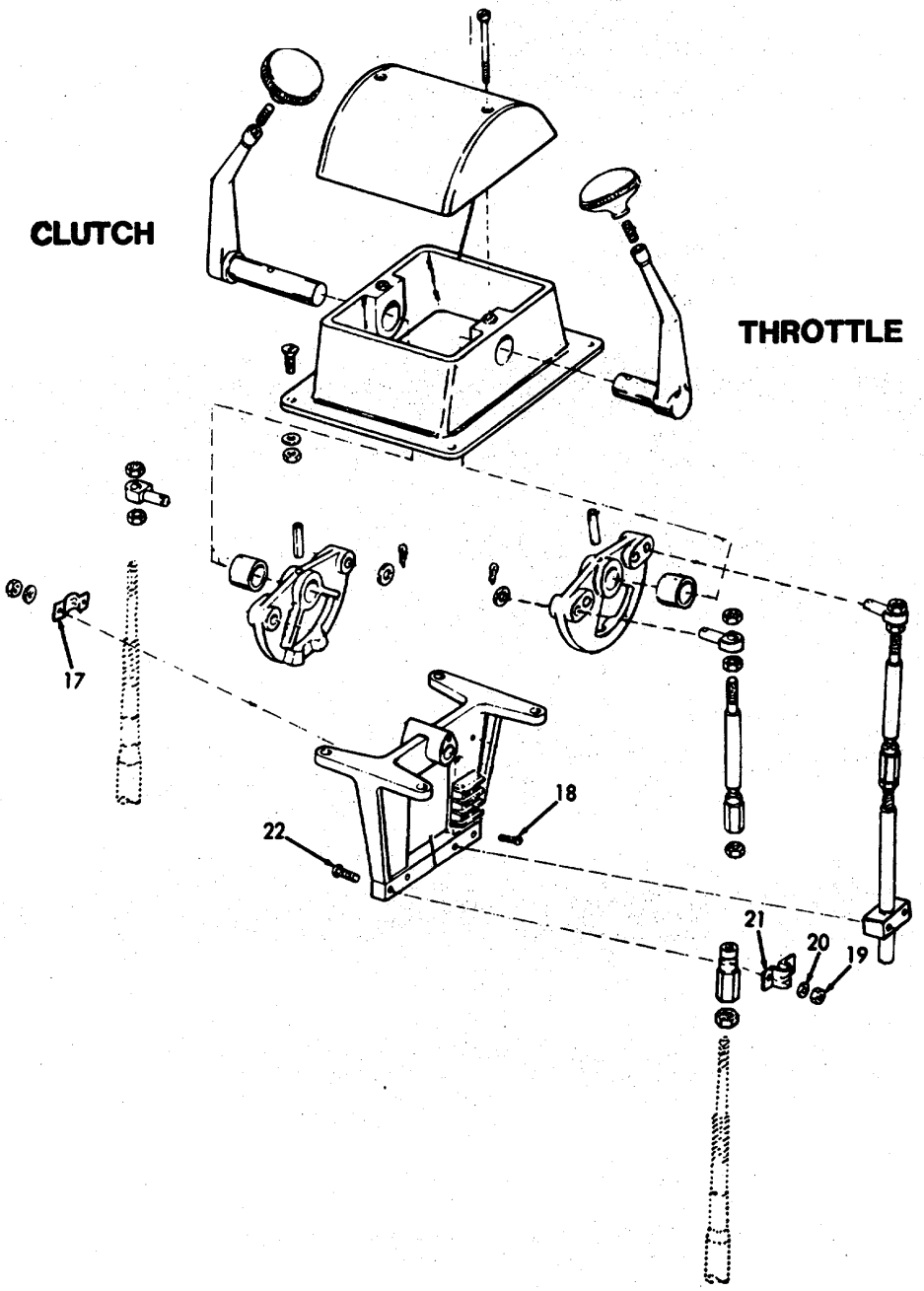
3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Removal - Control Station			
	e. Cable clamp (17), and screws (18)	Remove.	Clutch cable is loose.
	f. Nuts (19) and lock-washers (20)	Remove.	
	g. Cable clamp (21), and screws (22)	Remove.	Throttle cable is loose.
	h. Wiring	Tag and disconnect.	
	i. Control station	Remove.	
Installation - Control Station			
8. Control station housing	a. Wiring	Reconnect.	
	b. Cable clamp (21), screws (22), lock-washers (20), and nuts (19)	Install around detent on throttle cable.	
	c. Cable clamp (17), screws (18), lock-washers (16), and nuts (15)	Install around detent in clutch cable.	

3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

Installation - Control Station



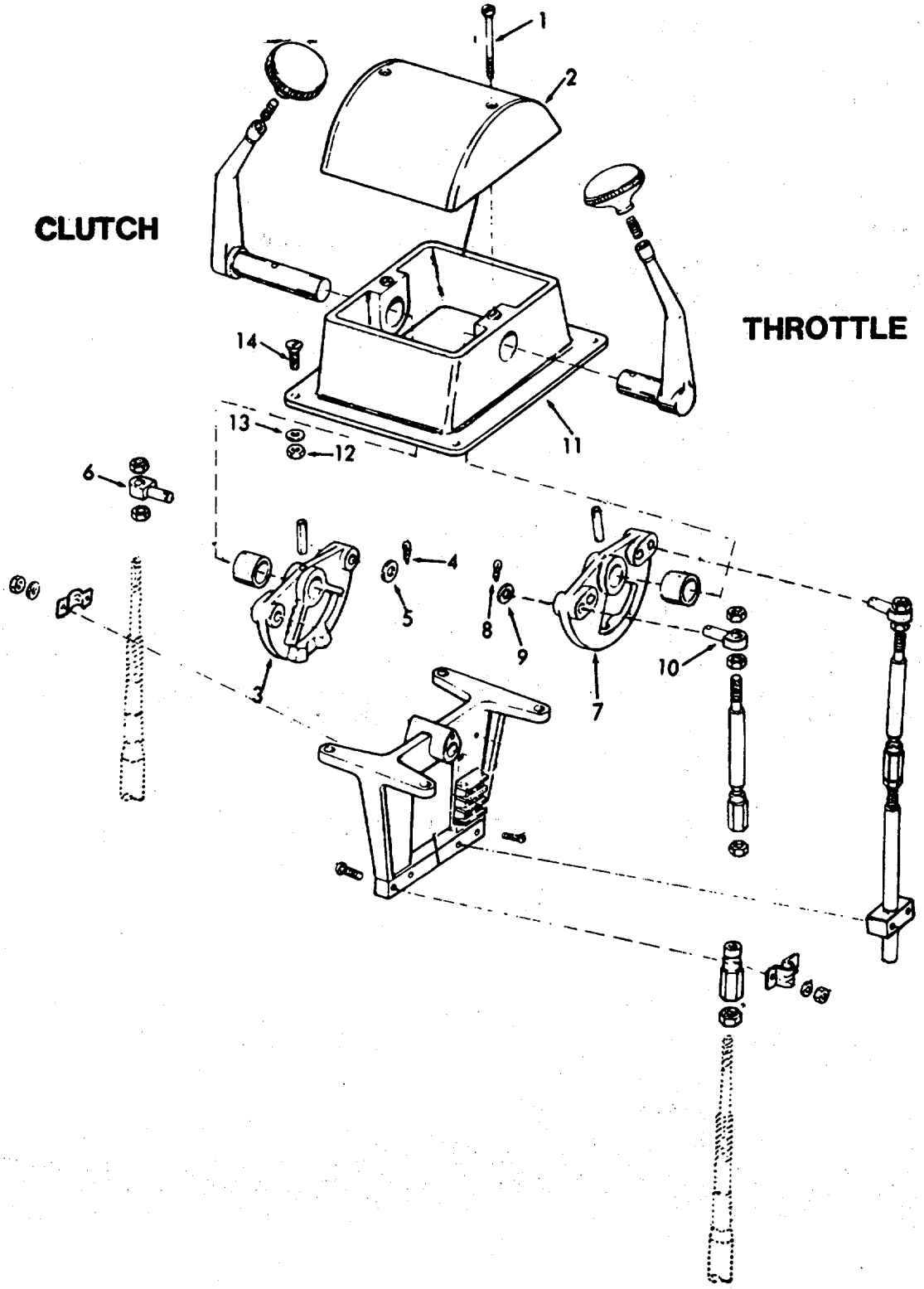
3-9.1. CONTROL STATION - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation - Control Station			
	d. Housing (11)	Align holes in steering console.	
	e. Screws (14), washers (13), and nuts (12)	Install.	
9. Throttle Quadrant (7)	a. Joint (10)	Place in quadrant.	
	b. Washer (9), and cotter pin (8)	Install.	
10. Clutch Quadrant	a. Joint (6) (3)	Place in quadrant.	
	b. Washer (5), and cotter pin (4)	Install.	
11. Control Station	a. Lubricate bearings through hole for screw (1)	Use engine oil Type OE/HDO-10.	
	b. Cover (2)	Install.	
	c. Screws (1)	Install.	
	d. Adjustment	Refer to adjustments.	

3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Installation-Control Station (Cont)



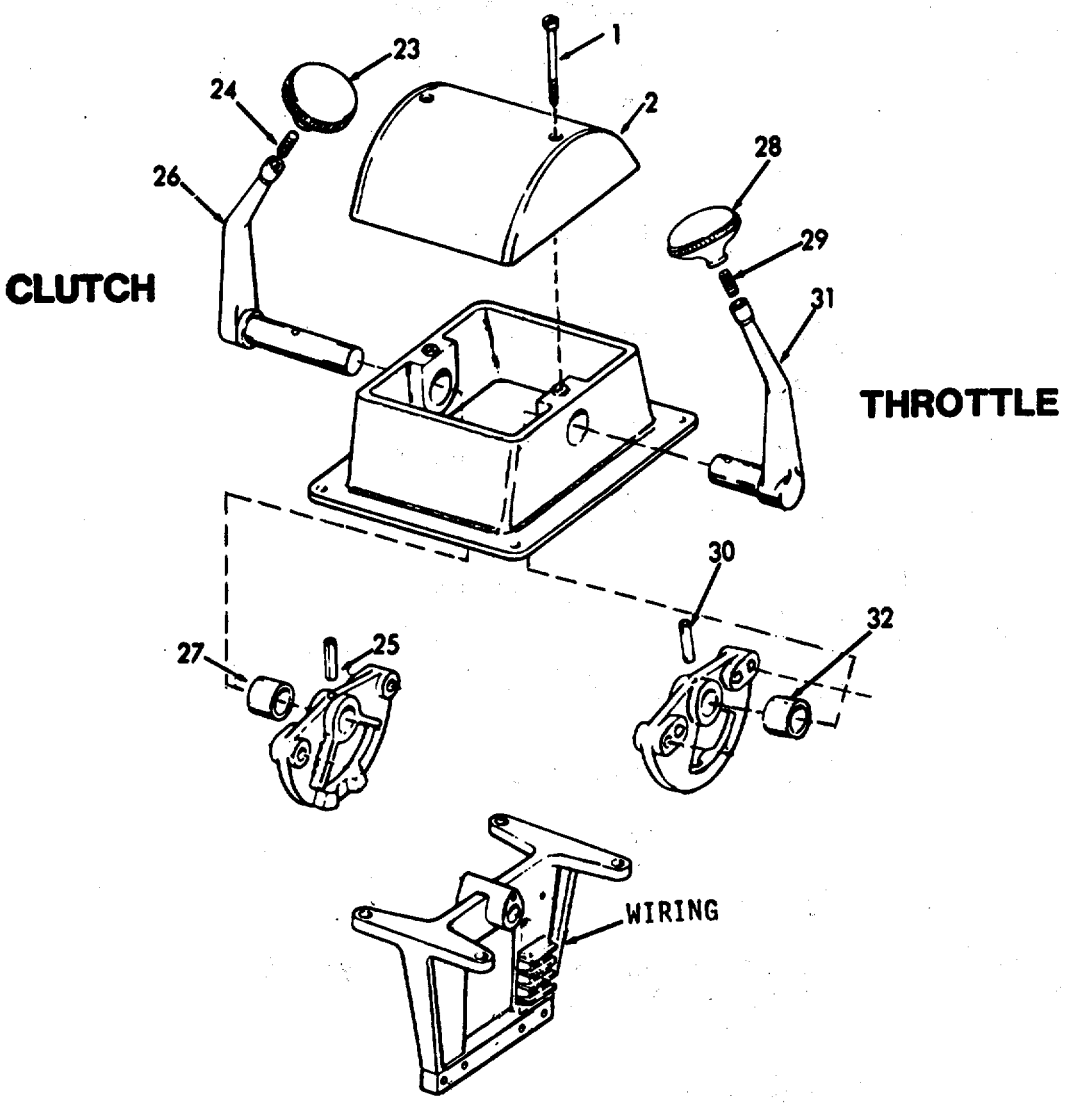
3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Repair-Control Station			
12. Control station	a. Screw (1)	Remove.	
	b. Cover (2)	Remove.	
13. Clutch	a. Knob (red) (23)	Remove if required.	
	b. Stud (24)	Remove if required.	
	c. Roll pin (25)	Remove.	
	d. Handle (26)	Remove.	
	e. Handle bearing (27)	Remove.	
14. Throttle	a. Knob (black) (28)	Remove if required.	
	b. Stud (29)	Remove if required.	
	c. Roll pin (30)	Remove.	
	d. Handle (31)	Remove.	
	e. Handle bearing (32)	Remove.	

3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Repair-Control Station (Cont)



3-353

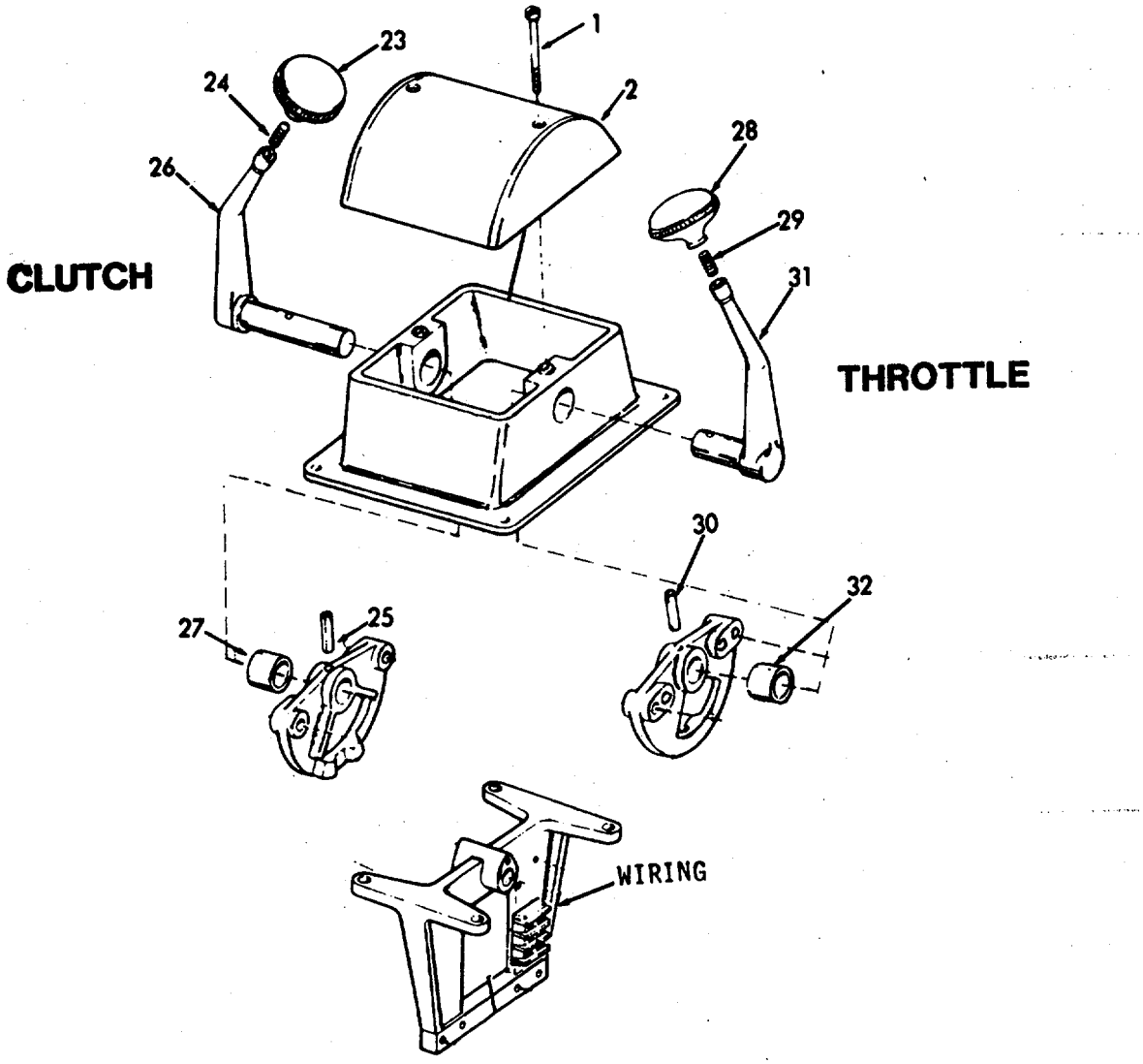
3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Reassembly-Control Station (Cont)			
15. Throttle	a. Handle bearing (32)	Insert in housing.	
	b. Handle (31)	Insert in bearing.	
	c. Roll pin (30)	Install.	
	d. Stud (29)	Install.	
	e. Knob (black) (28)	Install.	
16. Clutch	a. Handle bearing (27)	Insert in housing.	
	b. Handle (26)	Insert in housing.	
	c. Roll pin (25)	Install.	
	d. Stud (24)	Install.	
	e. Knob (red) (23)	Install.	
17. Control station	a. Lubricate bearings through hole for screw (1)	Use engine oil type OE/ HDO-10.	
	b. Cover (2)	Install.	
	c. Screws (1)	Install.	

3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

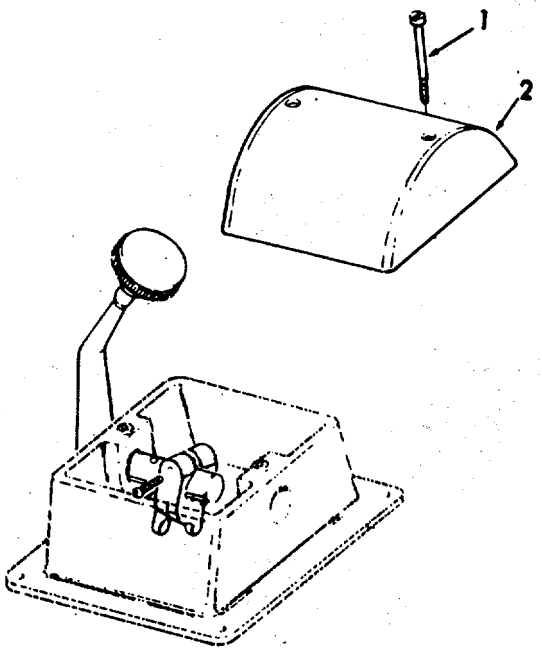
LOCATION	ITEM	ACTION	REMARKS

Reassembly-Control Station (Cont)



3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

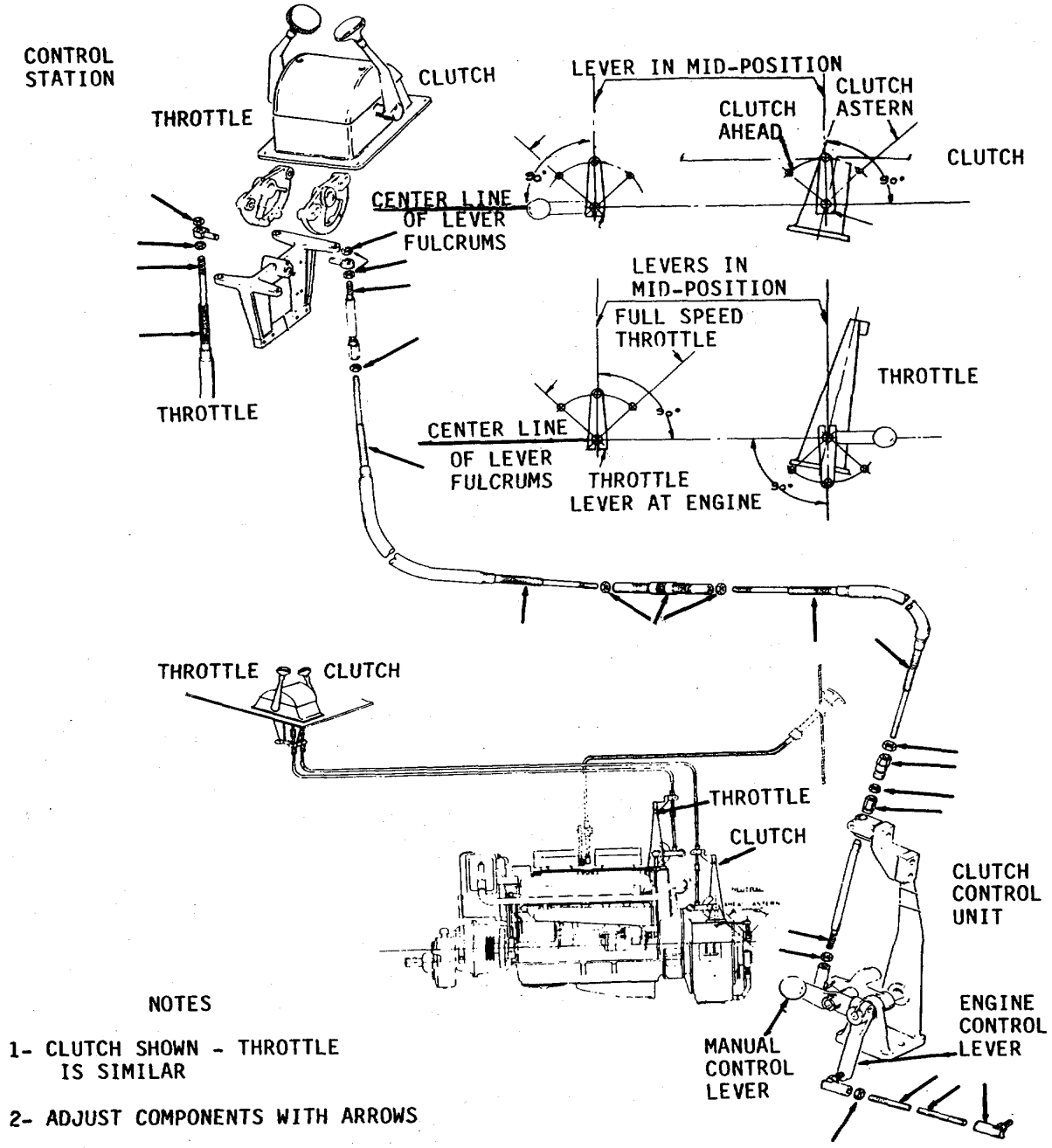
LOCATION	ITEM	ACTION	REMARKS
Adjustments (Cont)			
		NOTE These adjustments to the control station, cables, and control unit must be done when any of these components are repaired.	
18. Control station throttle brake	a. Screws (1)	Remove.	
	b. Cover (2)	Remove.	



3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Adjustments (Cont)



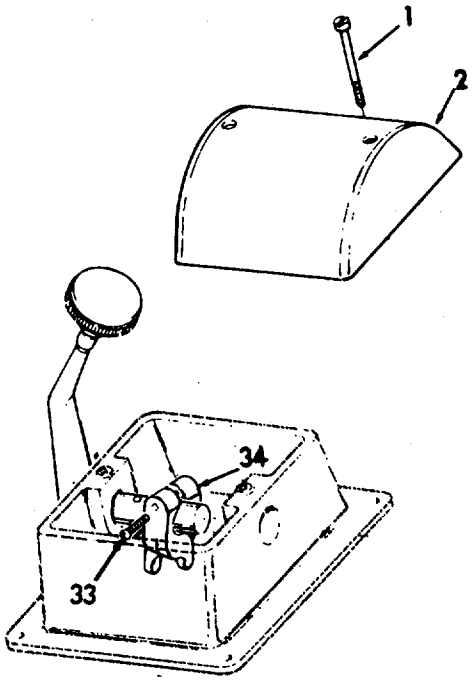
3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Adjustments (Cont)			
	c. Brake shoe (33)	Adjust screw (34) to increase or decrease tension.	The throttle brake is used to maintain desired engine speed regardless of vibration or governor return spring loads.
	d. Cover (2)	Replace.	
	e. Screws (1)	Replace.	
19. Throttle and clutch	a. Screws (1)	Remove.	
a. Control station (2) pilothouse	b. Cover	Remove.	
	c. Clutch and throttle levers	Place in mid-position.	
b. Engine room (fwd or aft)	a. Control unit (clutch and throttle)	a. Observe position of manual control lever.	Should be on center line of lever fulcrums.
		b. Adjust as required between control station and control unit.	This is the clutch neutral position, and the 1/2 speed throttle position.
		c. Observe the position of the engine control lever.	Should be at 90° to center line of lever fulcrum.
		d. Adjust position of engine control lever on control unit shaft.	

3-9.1. CONTROL STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Adjustments



		e. Observe the position of the engine control lever to lever on engine.	Should be at 90° to center line of lever fulcrum.

NOTE

At the mid-position of the cable stroke both levers at the control station, the clutch and throttle levers on the engine, and the manual control lever on the control unit must be in the mid-position.

3-9.2. CONTROL UNIT AND LINKAGE - MAINTENANCE INSTRUCTIONS.

a. The engine control unit serves three functions. The first and main function is to provide a disconnect at the engine so that the throttle or clutch may be operated from the engine room independently of the control in the pilothouse. Operation from the engine room is accomplished by pulling out the manual disconnect pin and twisting it 90 degrees. The engine may then be operated by the manual control knob provided for this purpose.

b. The second function of the unit is to provide a means of varying the stroke of the control cable to suit the stroke requirements of the lever being operated. This is accomplished by changing the length of the engine control lever. This lever is connected to the throttle lever or clutch lever on the engine by means of a connecting rod and ball joints.

c. The third function of the unit is to provide vertical entry and a fastening point for the PUSH-PULL control cable.

NOTE

If a control cable is to be replaced, order by stock number and cable length.

3-9.2. CONTROL UNIT AND LINKAGE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **c. Inspection** **e. Installation**
b. Test and Adjustment **d. Repair**

INITIAL SETUP

Test Equipment
NONE

References
3-9.1 Control Station Adjustments.

Special Tools
NONE

Equipment Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKSS
Inspection			
1. Control unit (fwd or Aft eng room)	a. Clutch	Place in ahead and astern positions.	Check for ease of operation, broken, frayed coverings, and damaged control cables or control unit.
	b. Throttle	Place in idle and full speed positions.	
Test and Adjustment			
		NOTE Refer to paragraph 3-9.1 for test and adjustment procedures.	

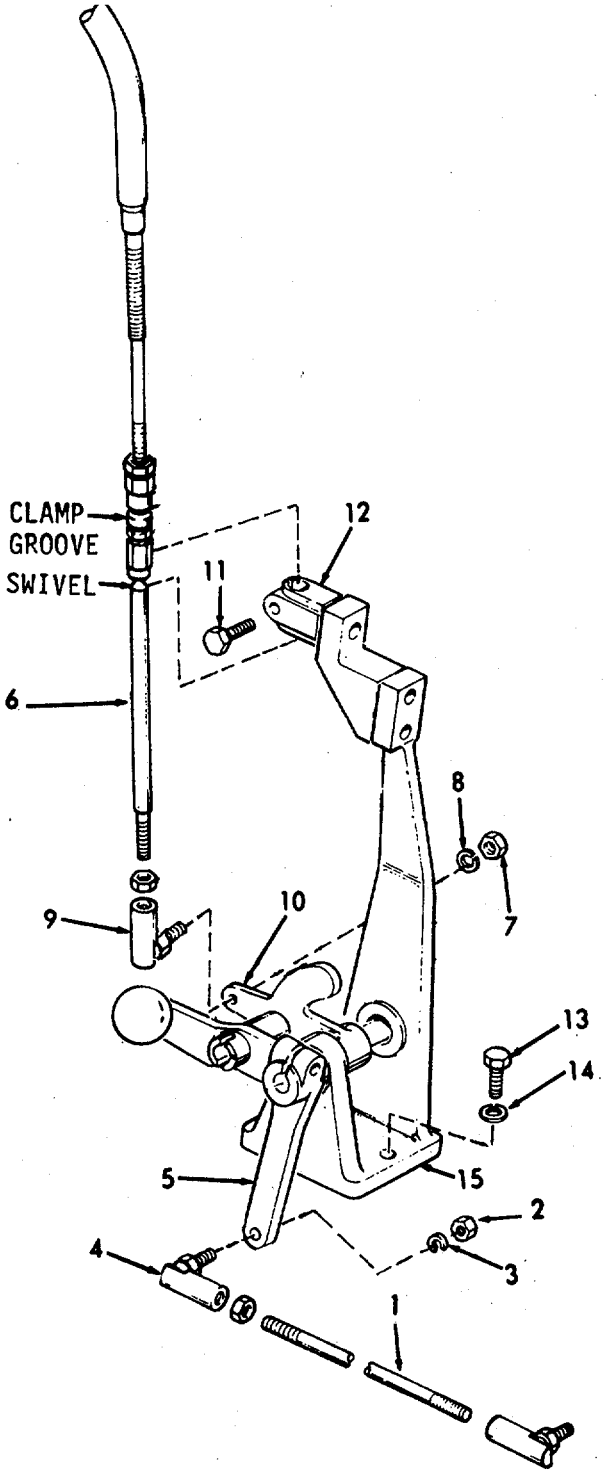
3-9.2. CONTROL UNIT AND LINKAGE MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Removal-Control Unit			
2. Connecting rod assembly (1)	a. Nut (2), and lockwasher (3)	Remove.	
	b. Ball joint (4)	Remove from engine control lever (5).	
3. Articulator assembly (6)	a. Nut (7), and lockwasher (8)	Remove.	
	b. Ball joint (9)	Remove from remote control lever (10).	
	c. Bolt (11)	Remove.	
	d. Articulator assembly (6)	Remove from cable clamp (12).	
4. Control unit	a. Bolts (13) and lockwashers (14)	Remove.	
	b. Control unit (15)	Remove.	
Installation-Control Unit			
5. Control Unit	Control unit (15), lockwashers (14), and bolts (13)	Install.	

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Installation-Control Unit (Cont)



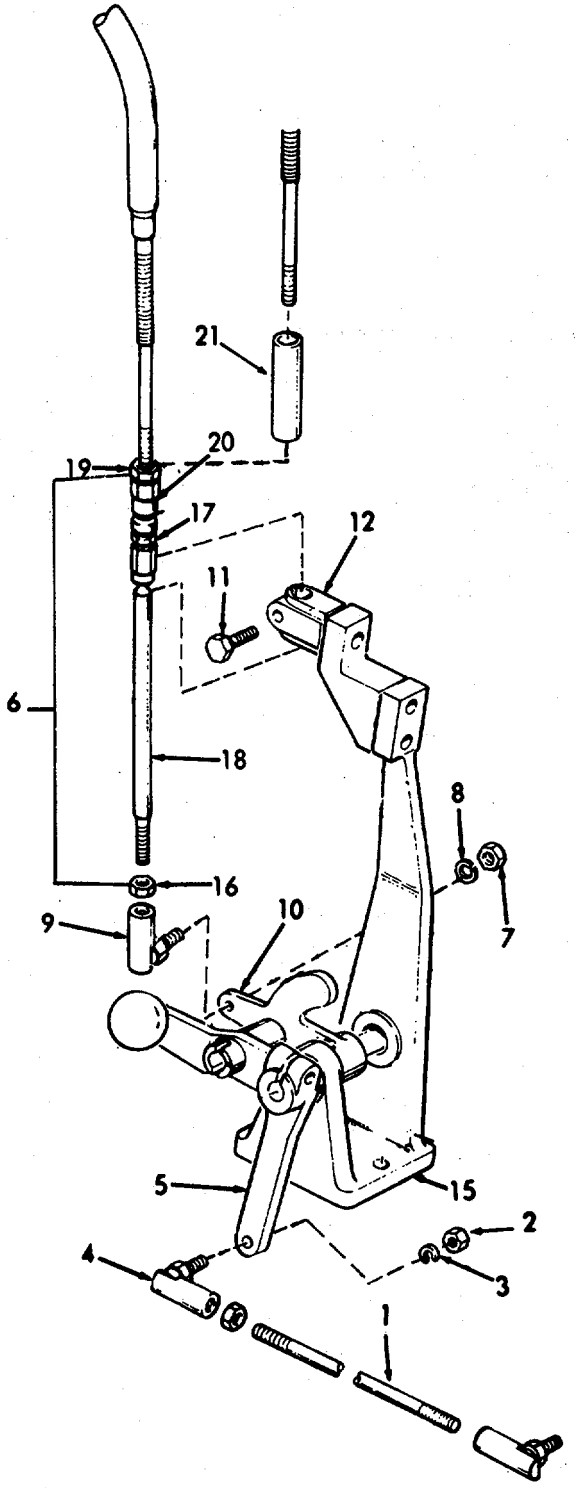
3-9.2. CONTROL UNIT AND LINKAGE MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Installation-Control Unit (Cont)			
6. Articulator assembly	a. Articulator assembly (6)	Place in cable clamp (12).	
	b. Bolt (11)	Install.	
	c. Ball joint (9)	Place in remote control lever (10).	
	d. Lockwasher (8), and nut (7)	Install.	
7. Connecting rod assembly (1)	a. Ball joint (4)	Place in engine control lever (5).	
	b. Lockwasher (3) and nut (2)	Install.	
Removal-Control Cable			
8. Control unit	a. Nut (7), and lockwasher (8)	Remove.	
	b. Bolt (11)	Loosen.	
	c. Articulator (6)	Remove from cable clamp (12).	
	d. Nut (16)	Loosen.	
	e. Ball joint (9)	Remove.	
	f. Nut (17)	Loosen.	
	g. Rod and socket assembly (18)	Remove.	

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

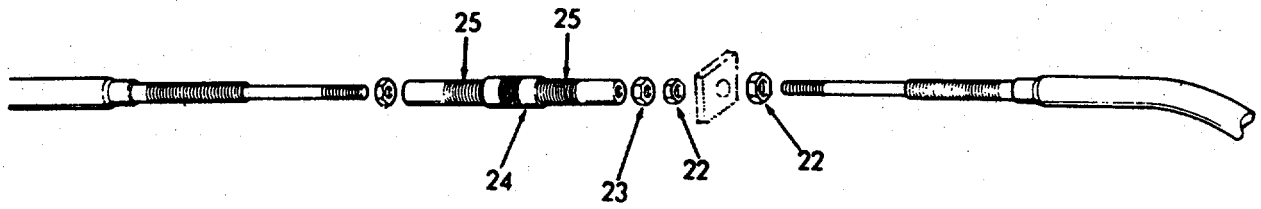
LOCATION	ITEM	ACTION	REMARKS

Removal-Control Cable



3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

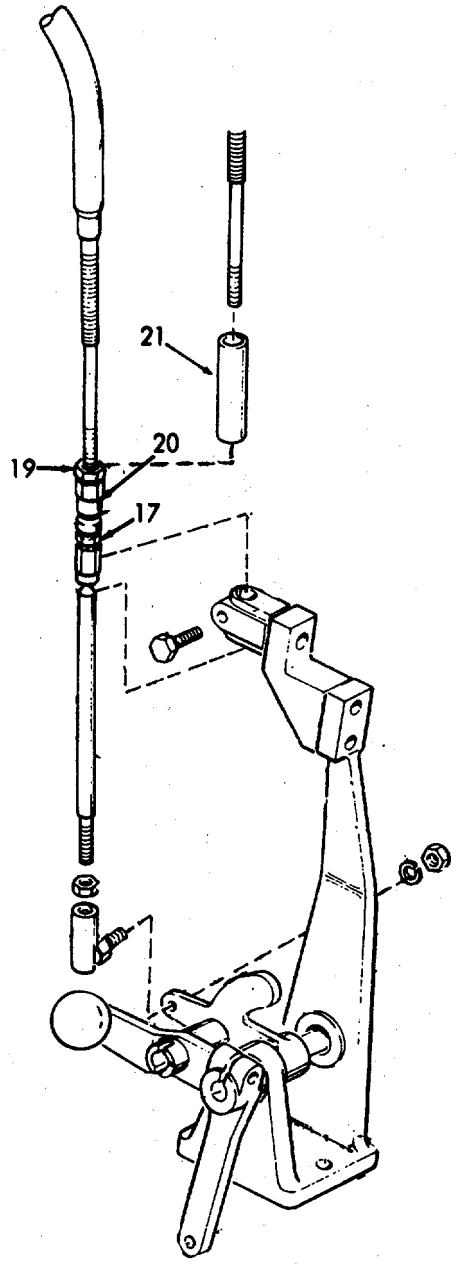
LOCATION	ITEM	ACTION	REMARKS
Removal-Control Cable			
	h. Nut (17)	Remove.	From end of cable
	i. Nut (19)	Loosen.	
	j. Cable adaptor bushing (20)	Remove.	
	k. Nut (19)	Remove	From end of cable
	l. Cable support bushing (21)	Remove.	
9. Cable coupling	a. Nuts (22)	Loosen.	
	b. Nut (23)	Loosen.	
	c. Coupling (24) sleeve (25).	Rotate to release inner	
	d. Sleeve (25)	Remove.	
	e. Nuts (23), and nuts (22)	Remove.	
f.	f. Cable	Remove.	

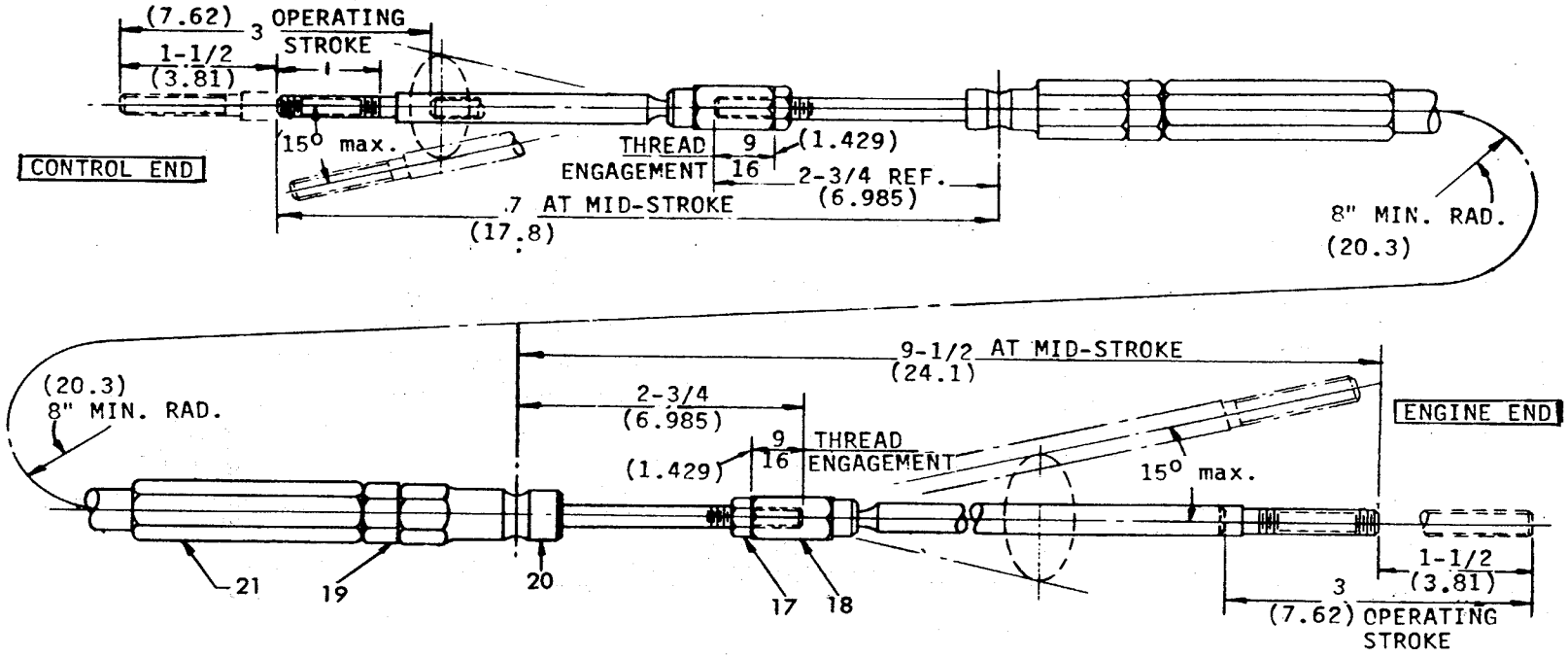


3-9.2. CONTROL UNIT AND LINKAGE STATION-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

Removal-Control Cable





NOTE:

1- CONTROL CABLE SHOWN AT MID-STROKE POSITION.

2- ALL DIMENSIONS IN INCHES.

3- DIMENSIONS IN ( ) ARE CENTIMETERS.

3-9.2. CONTROL UNIT AND LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

Installation-Control Cable (Cont)

NOTE

Control cables are precision equipment and should be handled with care. They should not be bent sharply, twisted, or forced into position. They should be allowed to adjust themselves to a given installation and worked into position rather than forced.

UNPACKING INSTRUCTIONS

The control cable is shipped in a figure 8 shape with sufficient number of layers to take care of its length. The whole package should be lifted out and laid on a smooth open surface. Cut the restraining ropes and - holding the top end - walk away from the package until the cable is straightened out. The cable should unfold smoothly and evenly. However, if a kink or loop develops, stop and uncoil this section. When the control is out straight, lift one end up about 4 feet and walk along handing the cable through your hands, keeping it about 4 feet off the deck, until the other end is reached. This removes internal twists and gives the cable full flexibility.

INSTALLATION INSTRUCTIONS

Never force cable into any position. Let it take its natural shape by shaking it gently before and during operation. Be sure not to bend flexible parts of cable where it joins the rigid end fitting. Allow an inch or more to remain straight before starting bend. When installing articulator fittings, DO NOT twist end rod.

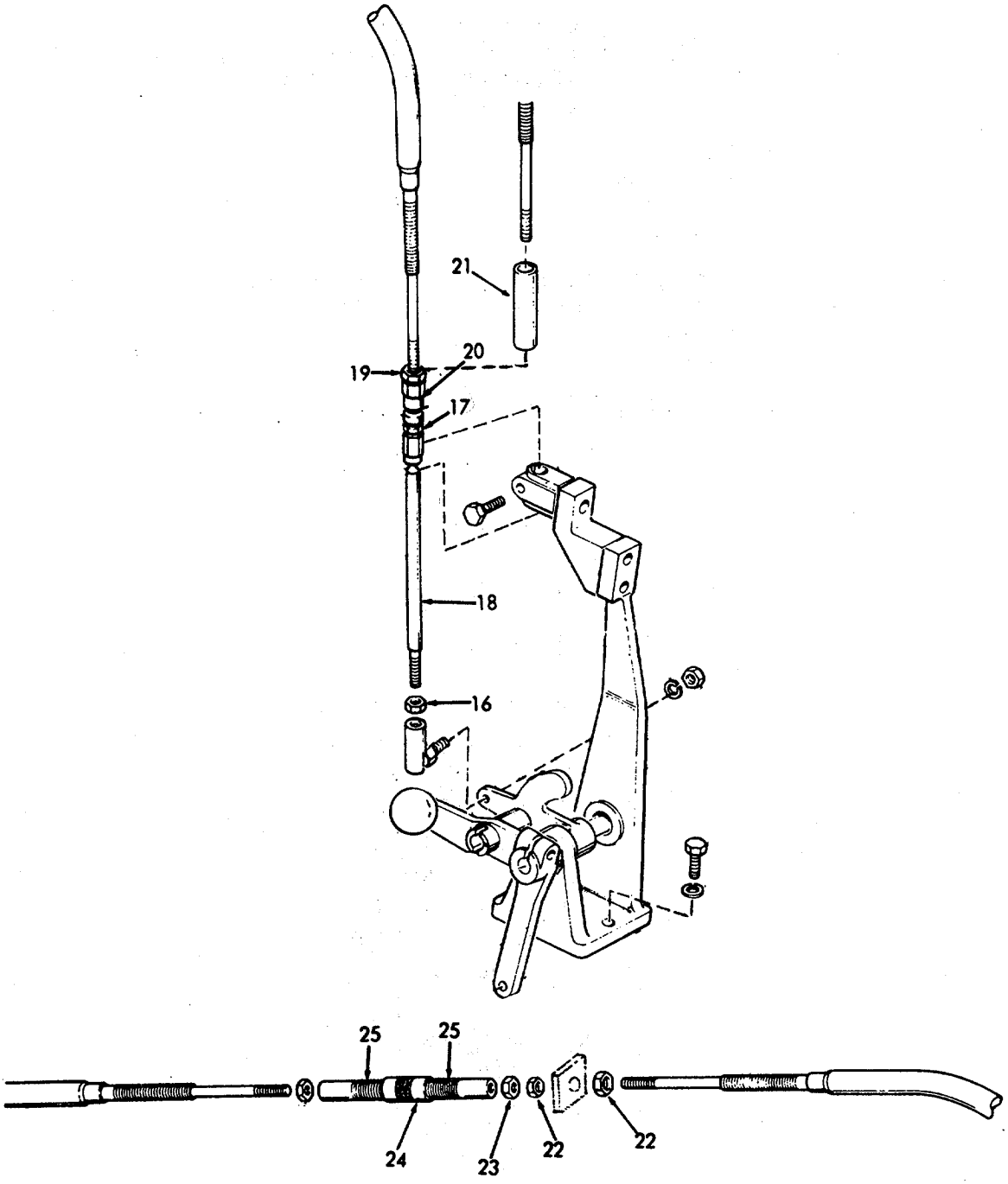
3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Installation-Control Cable (Cont)			
		CONTROL CABLE LENGTHS	
	Stbd Clutch	32 feet 6 inches	(9.91 meters
	Stbd Throttle	30 feet 6 inches	(9.30 meters)
	Port Clutch	27 feet 6 inches	(8.39 meters)
	Port Throttle	25 feet 6 inches	(7.78 meters)
	Common	40 feet	(12.2 meters)
10. Cable coupling	a. Nut (22)	Install on each side of bracket.	Do not tighten nuts.
	b. Nut (23)	Install	Do not tighten.
	c. Sleeve (25)	Install.	
	d. Coupling (24)	Install.	Place sleeves flush with coupling. Rotate coupling so that each is drawn in evenly.
11. Control Unit	a. Cable support bushing (21)	Install.	
	b. Nut (19)	Install.	Do not tighten.
	c. Cable adaptor bushing (20)	Install.	
	d. Nut (17)	Install.	Do not tighten.
	e. Rod and socket assembly (18)		
	f. Nut (16)	Install.	Do not tighten.

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS

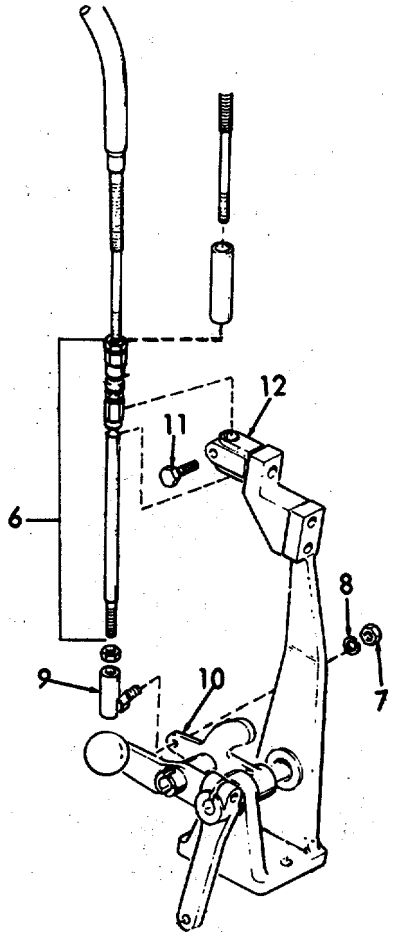
Installation-Control Cable (Cont)



3-371

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Installation-Control Cable (Cont)			
	g. Ball joint	(9) Install on cable. Then, place in remote control lever (10).	Do not tighten.
	h. Nuts (7) and lock-washers (8)	Install.	
12. Articulator assembly (6)	a. Articulator assembly	Adjust-then install in cable clamp (12).	Tighten nuts when adjusted.
	b. Nut (11)	Tighten.	

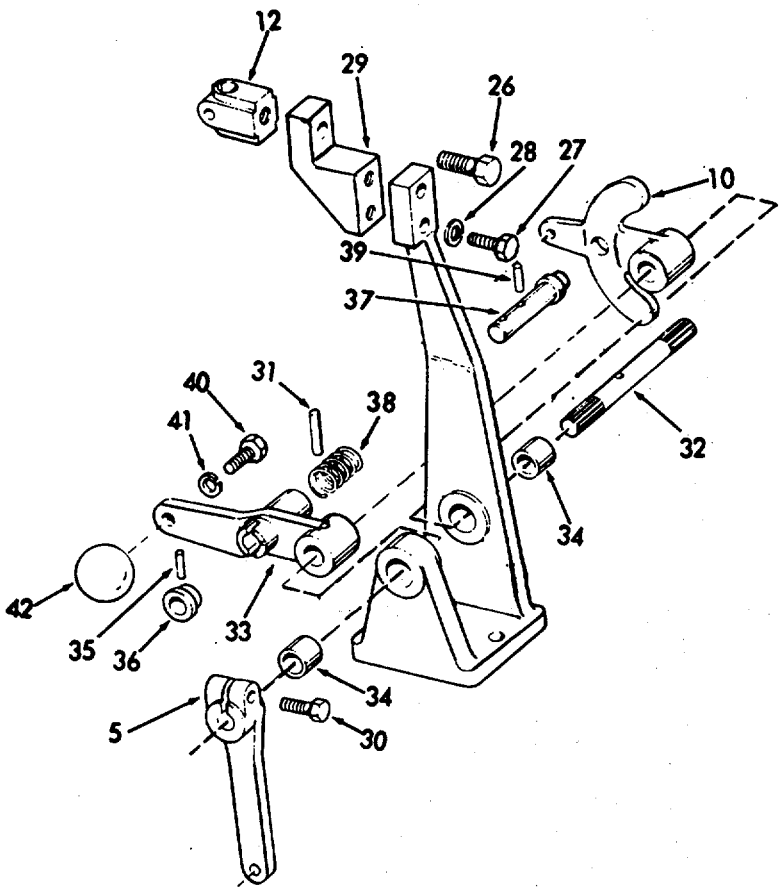


3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Installation-Control Cable (Cont)			
	NOTE Adjust control cables as per paragraph 3-9.1 and tighten all connections.		
Disassembly			
13. Control unit	a. Control unit	Perform the removal procedure.	
	b. Screw (26)	Remove.	Cable clamp (12) is removed.
	c. Screws (27), and lockwashers (28)	Remove.	Cable clamp bracket (29) is removed.
	d. Screw (30)	Loosen.	
	e. Engine control lever (5)	Remove.	
	f. Pin shaft (31)	Remove.	Use drift pin and hammer.
	g. Control unit shaft (32)	Remove.	Use drift pin and hammer. Remote control lever (10) and manual control lever (33) will come apart.
	h. Bushings (34)	Remove.	
14. Manual control lever (33)	a. Pin knob (35)	Remove.	Use drift pin and hammer.
	b. Lock pin knob (36)	Remove.	

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Disassembly (Cont)			
	c. Cross pin (37)	Remove.	
	d. Spring (38)	Remove.	
	e. Pin lock (39)	Remove.	Use drift pin and hammer.
	f. Screw (40), lockwasher (41), and knob (42)	Remove.	

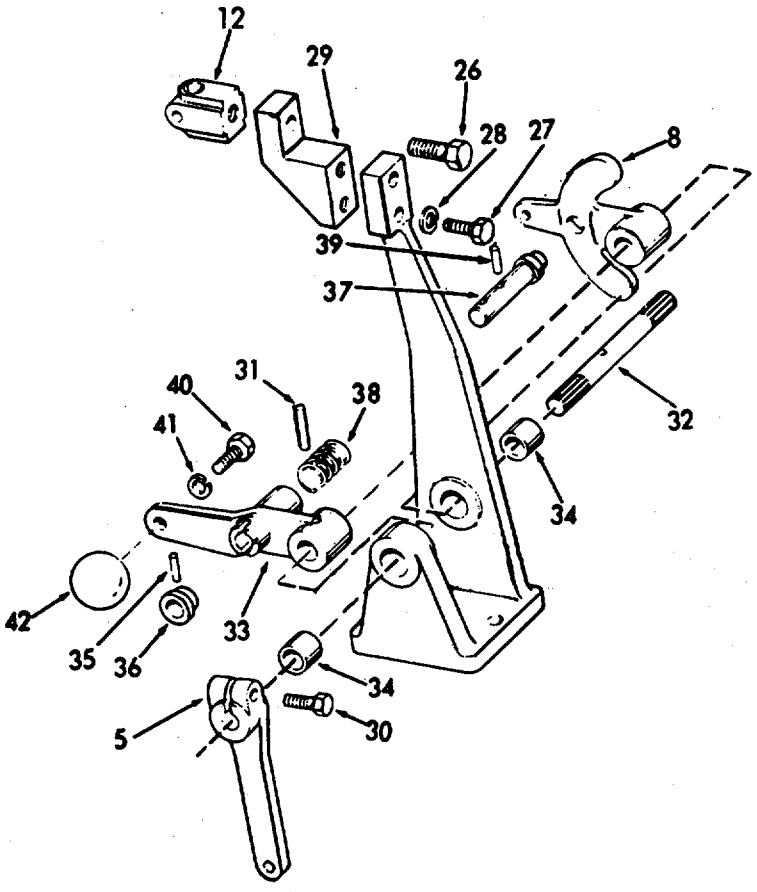


3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Reassembly			
15. Manual control lever (33)	a. Knob (42), lock-washer (41), and screw (40)	Install.	
	b. Pin lock (39)	Install in cross pin (37).	
	c. Cross pin (37), spring (38), and pin knob (35).	Install, then insert lock pin knob (36).	
16. Control Unit	a. Bushings (34)	Install.	
	b. Remote control lever (8), manual control lever (33), and control unit shaft (32)	Install.	
	c. Pin shaft (31)	Align holes and install.	
	d. Screws (27), lockwash-ers (28), and cable clamp bracket (29)	Install.	

3-9.2. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Reassembly (Cont)			
e.	Screw (26) and cable clamp (12)	Install.	
f.	Control unit	Perform the installation procedure.	
g.	Engine control lever (5)	Install.	
h.	Screw (30)	Tighten.	
i.	Alignment	Perform alignment procedure.	



3-377

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS .

a. A manually operated emergency engine shutdown device enables the engine operator to stop the engine in the event an abnormal condition should arise. If the engine continues to run after the engine throttle is placed in the NO FUEL position, or if combustible liquids or gases are accidentally introduced into the combustion chamber causing over spending of the engine, the shutdown device will prevent damage to the engine by cutting off the air supply and thus stopping the engine. The shutdown device consists of a flap valve mounted in the air inlet housing and a suitable operating mechanism.

b. When the handle is pulled sufficiently to stop the engine, a spring-loaded plunger prevents the handle from being returned to the RUN position. It is necessary to pull the plunger manually before the shutdown control can be returned to the RUN position.

NOTE

If a control cable is to be replaced, order by stock number and cable length.

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **c. Removal**

b. Service **d. Installation**

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
2

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

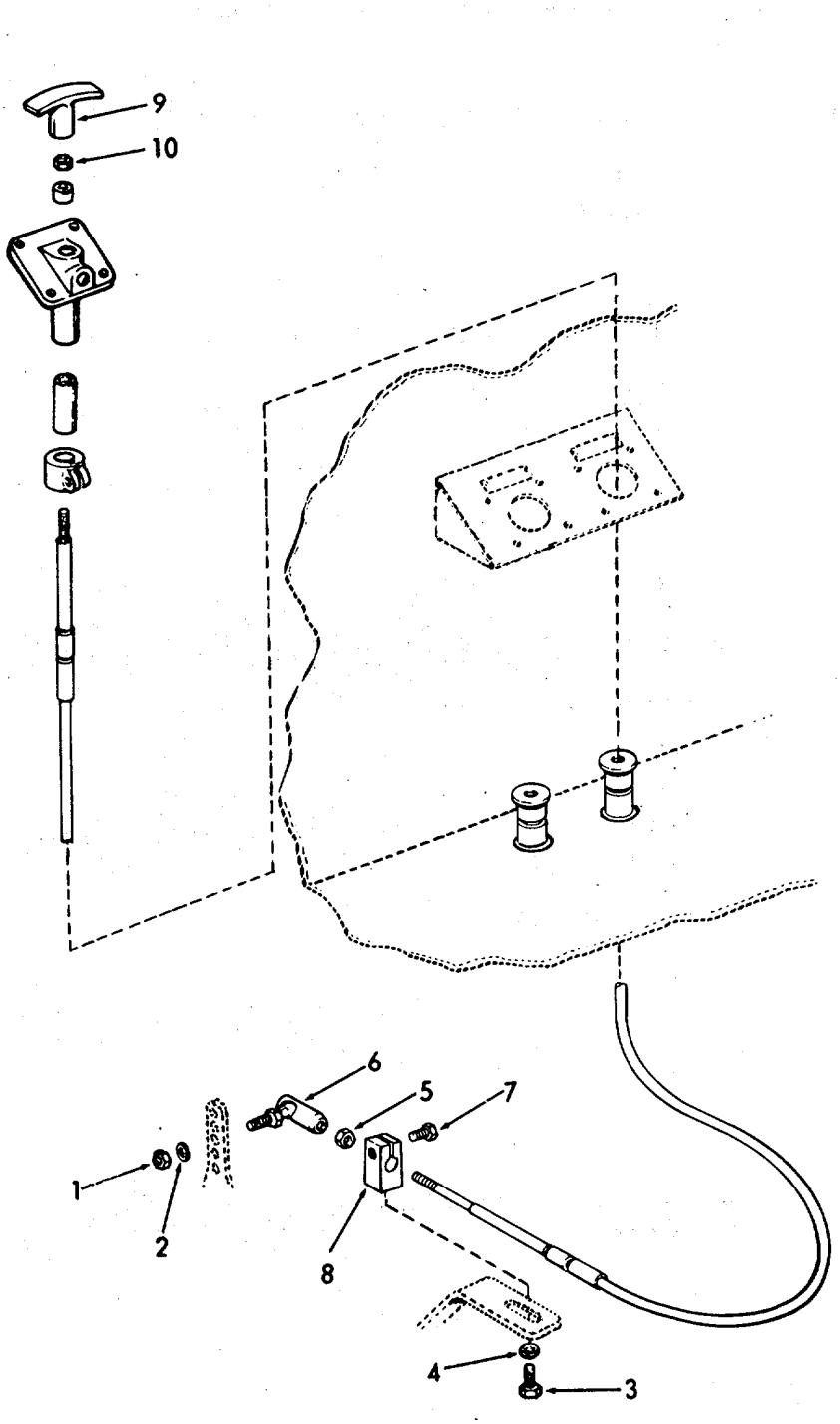
3-9.3. CONTROL UNIT AND LINKAGE-MAINTENANCE INSTRUCTIONS (CONT).

LOCATION	ITEM	ACTION	REMARKS
Inspect			
1. Emergency shutdown linkage	Cables	Inspect for binding, damage, and loose components.	Lubricate if binding, tighten if loose, or replace if required.
	b. Ball joints	Inspect for binding, damage, and loose connections.	Tighten if loose, or replace if required.
Service			
2. Emergency shutdown linkage	a. Cables	Lubricate.	Use oil type OE/HDO-10.
	b. Ball	Lubricate. joint	Use oil type OE/HDO-l0.
Removal			
3. Emergency shutdown linkage and cable	a. Nut (1) and lockwasher (2)	Remove.	
	b. Cap screw (3) and lockwasher (4)	Remove.	
	c. Nut (5)	Loosen.	
	d. Ball joint (6)	Remove.	
	e. Nut (5)	Remove.	
	f. Cap screw (7)	Remove.	
	g. Cable clamp (8)	Remove.	
	h. Handle (9)	Unscrew to remove.	Do not remove nut (10).

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)

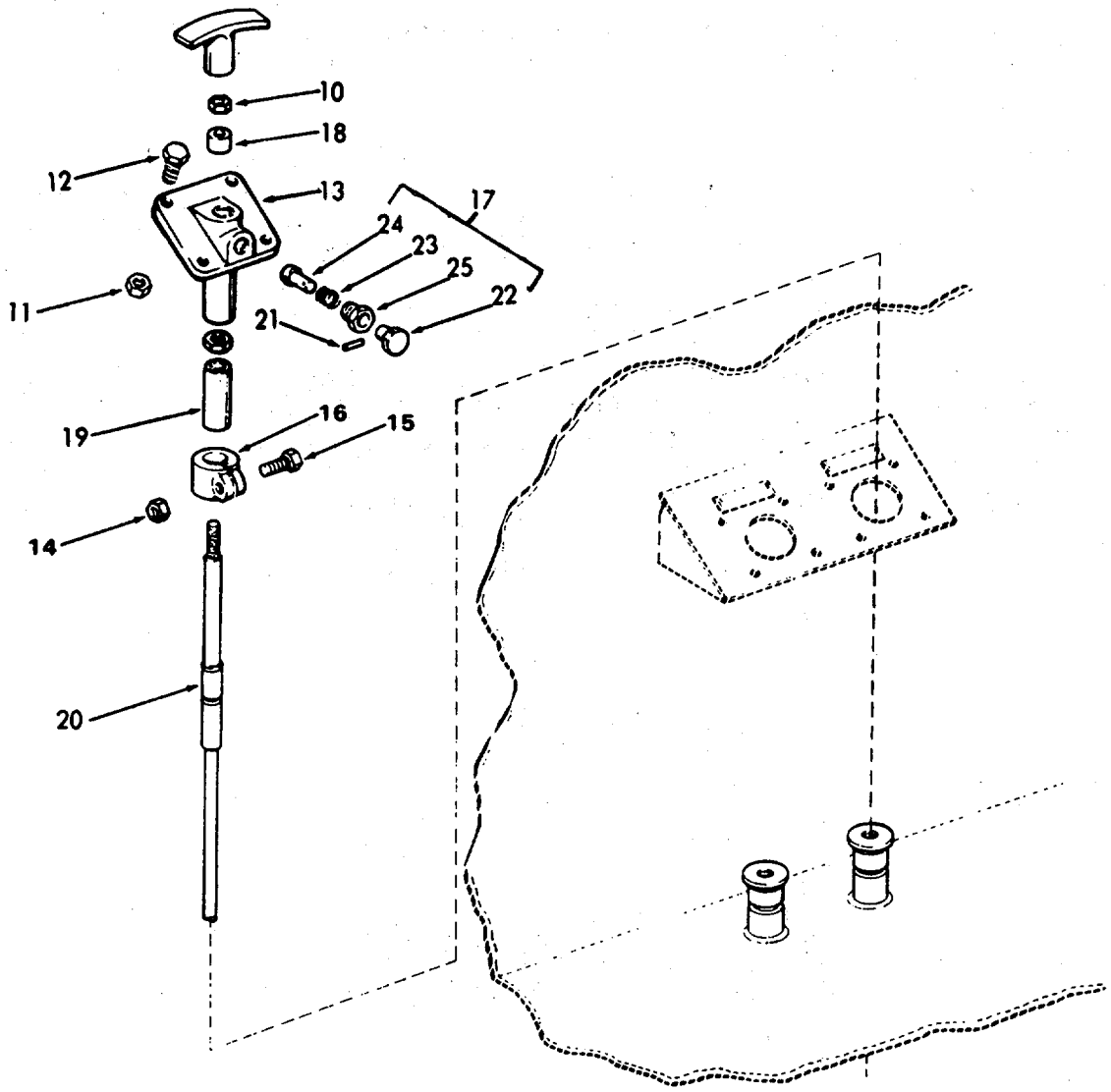


3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	i. Nuts (11), and screws (12)	Remove.	Raise tube and bracket assembly (13) up to gain access to continue disassembly.
	j. Nut (14)	Remove.	
	k. Cap screw (15)	Remove.	Cable clamp (16) will be loose, causing able to drop down.
	l. Nut (10)	Remove.	
	m. Locking pin assembly (17)	Remove.	
	n. Guide bushing (18) and shutdown tube (19)	Remove.	Push tube and bracket assembly (13) down while holding cable. Guide bushing (18) and shutdown tube (19) will come out top of tube and bracket assembly.
	o. Cable clamp (16)	Remove.	
	p. Cable (20)	Remove.	Pull cable up to remove.

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
4. Locking pin assembly	a. Roll pin (21)	Remove.	Use drift pin and hammer.
	b. Knob (22), spring (23), and locking pin (24)	Disassemble from lock pin bushing (25)	



3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

Control cables are precision equipment and should be handled with care. They should not be bent sharply, twisted, or forced into position. They should be allowed to adjust themselves to a given installation and worked into position rather than forced.

UNPACKING INSTRUCTIONS

The control cable is shipped in a figure 8 shape with sufficient number of layers to take care of its length. The whole package should be lifted out and laid on a smooth open surface. Cut the restraining ropes and - holding the top end - walk away from the package until the cable is straightened out. The cable should unfold smoothly and evenly. However, if a kink or loop develops, stop and uncoil this section.

When the control is out straight, lift one end up about 4 feet and walk along handing the cable through your hands, keeping it about 4 feet off the deck, until the other end is reached. This removes internal twists and gives the cable full flexibility.

INSTALLATION INSTRUCTIONS

Never force cable into any position. Let it take its natural shape by shaking it gently before and during operation. Be sure not to bend flexible parts of cable where it joins the rigid end fitting. Allow an inch or more to remain straight before starting bend. When installing articulator fittings, DO NOT twist end rod.

CABLE LENGTHS

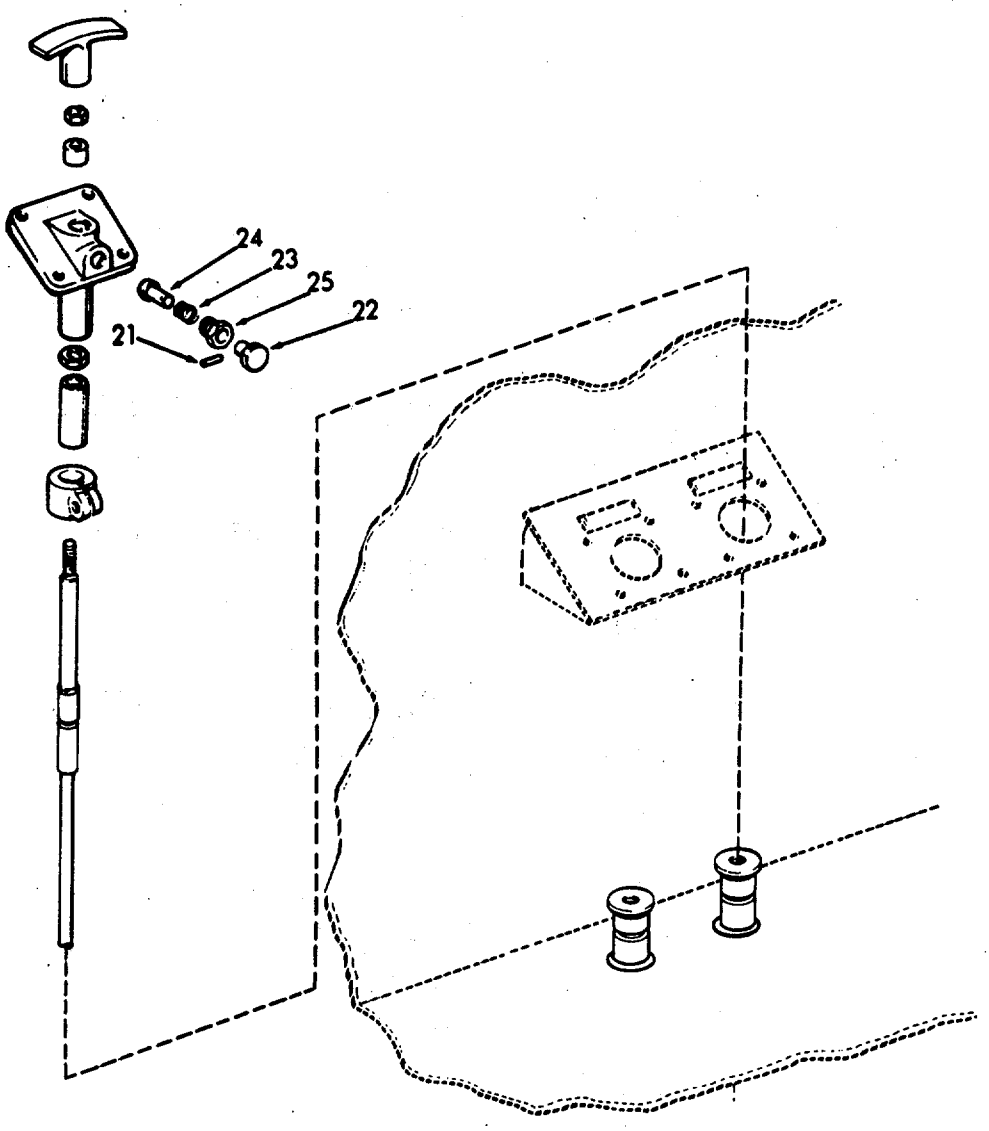
Port Engine	24 feet	(7.3 meters)
Starboard Engine	16 feet	(4.9 meters)

5. Emergency Shutdown cable and linkage	a. Locking pin (24), spring (23), lock pin bushing (25), knob (22), and roll pin (21)	Assemble.	

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Installation (Cont)

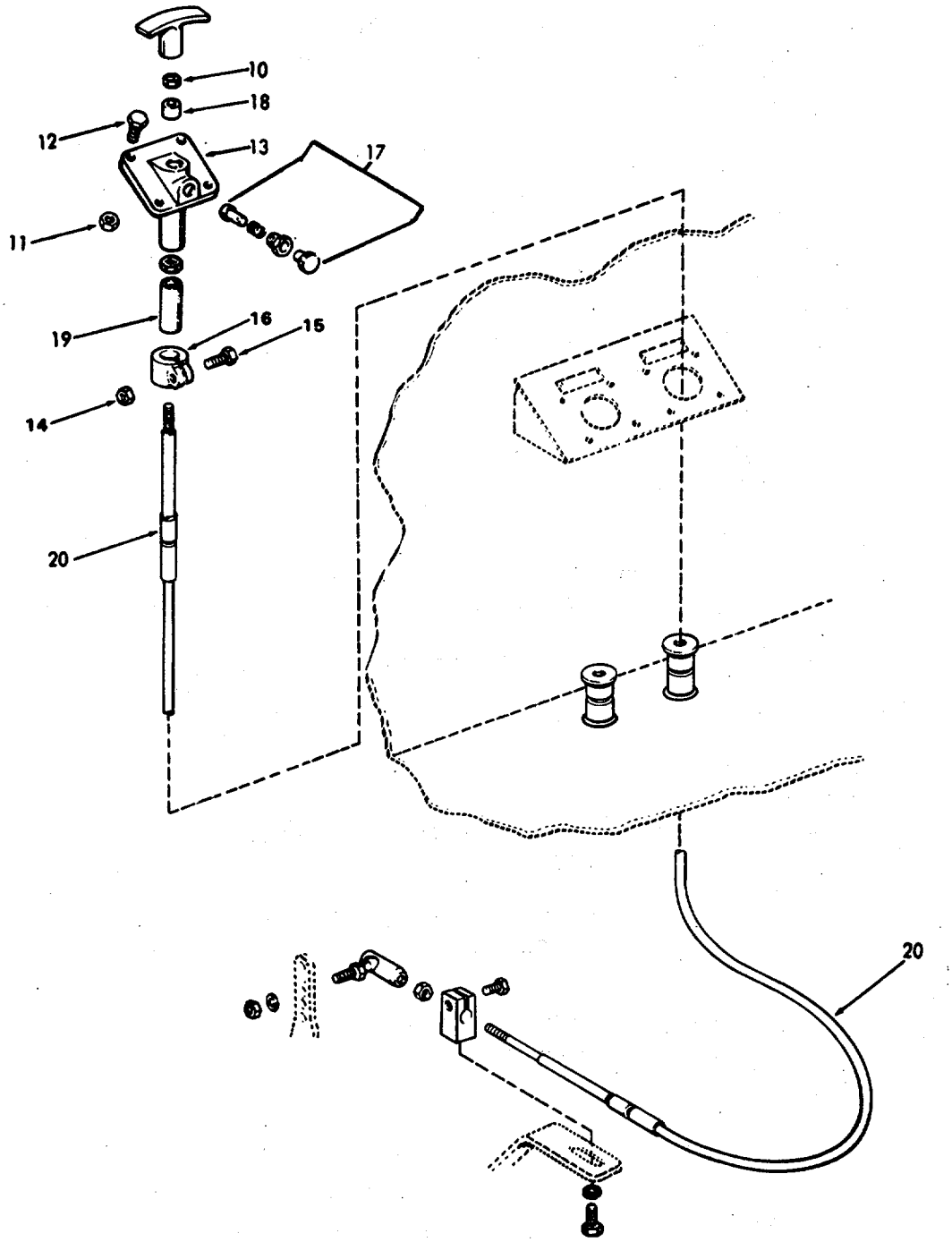


3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	b. Shutdown tube (19)	Install.	Check that hole in tube (19) and tube and bracket assembly (13) are aligned.
	c. Guide bushing (18)	Install.	
	d. Cable (20)	Install.	
	e. Cable clamp (16)	Slide over end of cable.	
	f. Screw (15), and nut (14)	Insert in cable clamp (16).	Tighten nut (14) finger tight.
	g. Tube and bracket assembly (13)	Slide over end of cable.	
	h. Nut (10)	Install.	
	i. Locking pin assembly (17)	Install.	
	j. Cap screw (12) and nut (11)	Install tube and bracket assembly (13).	

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			

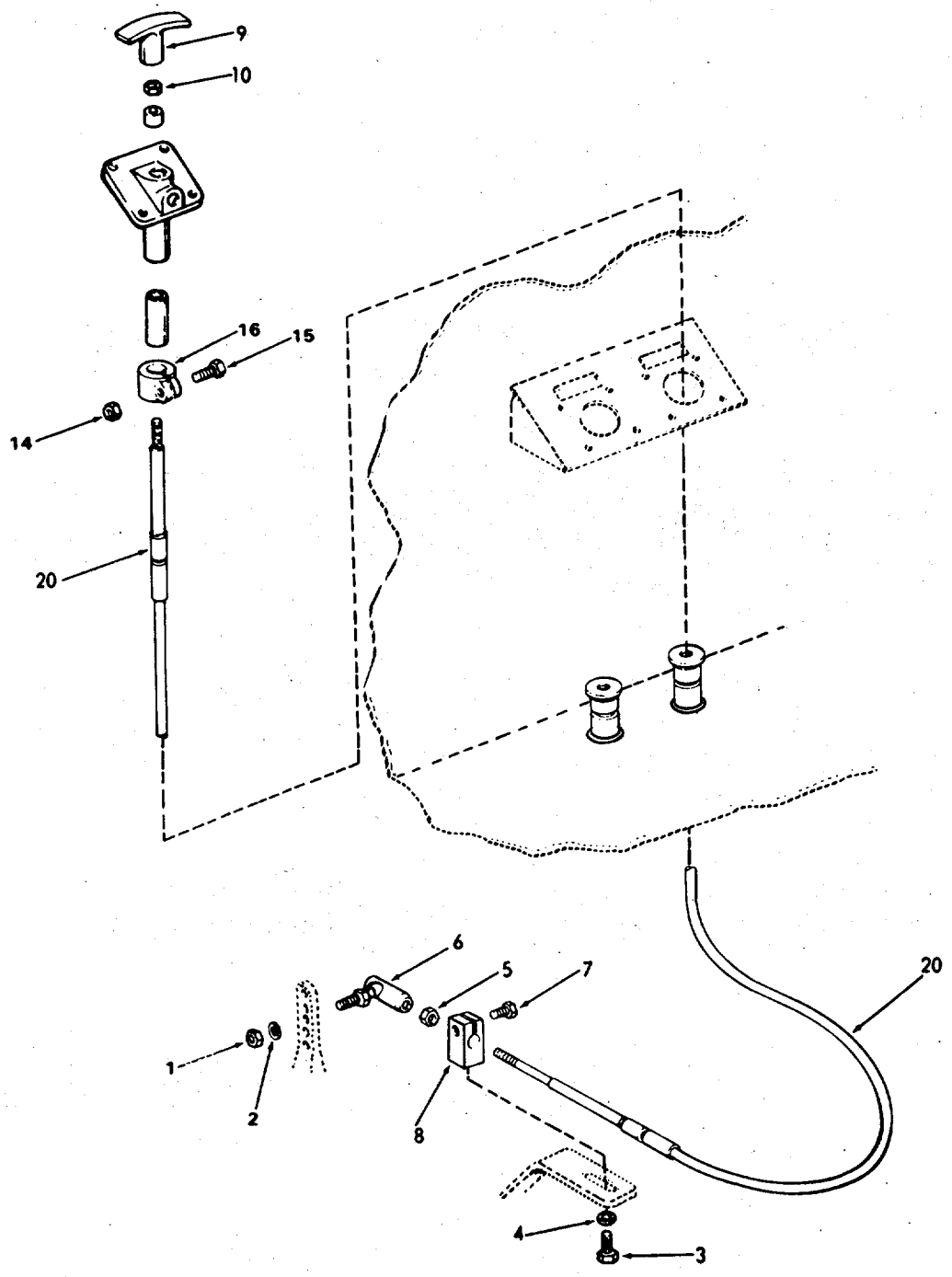


3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	k. Cable clamp (16)	Position so that notch on cable is in clamp.	
	l. Cap screw (15) and nut (14)	Tighten.	
	m. Handle (9)	Install.	
	n. Nut (10) and handle (9)	Secure.	
	o. Cable clamp (8)	Install on cable (20).	
	p. Cap screw (7)	Install in cable clamp (8) and secure.	
	q. Nut (5)	Install on cable (20).	
	r. Ball joint (6)	Install on cable (20).	
	s. Nut (5)	Jam against ball joint (6).	
	t. Ball joint (6)	Install in air intake latch.	
	u. Lockwasher (4), cable clamp (8), screw (3)	Secure cable clamp to bracket	
	v. Lockwasher (2) and nut (1)	Secure ball joint (6).	

3-9.3. EMERGENCY SHUTDOWN HEAD & LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			



3-9.4. WATER TEMPERATURE SWITCH - MAINTENANCE INSTRUCTIONS

a. The terminals of the water temperature switch are connected into the alarm system, andwhen the engine circulating water temperature reaches 205° ± 5°F (96° ± 2.9°C), the switch closes and turns on the alarm system.

b. As the water temperature increases, a plunger rises and contacts a wheel which is attached to the switch actuating lever. A further increase in water temperature forces the contact end of the actuating lever upwards. When the water temperature reaches 205° ± 5°F (96° ± 2.9°C); this lever forces the switch button upwards into the switch block, thus closing the switch. Since this lever is spring loaded, the contact end of the lever moves away from the switch button as the water temperature decreases.

NOTE

An alarm will sound in the pilothouse.

This task covers:

a. Testing
b. Adjustment
c. Removal
d. Installation

INITIAL SETUP:

Test Equipment

Thermometer

References

NONE

Special Tools

NONE

Equipment Condition: NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

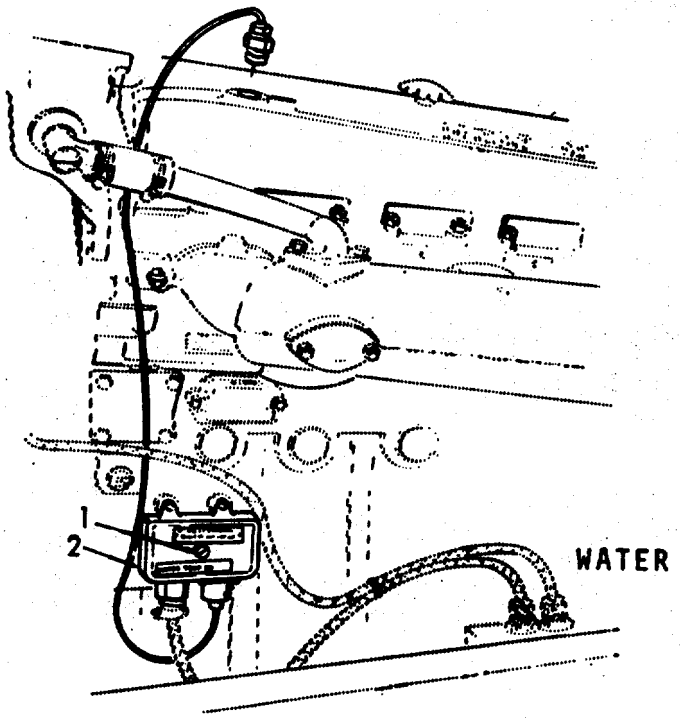
General Safety Instructions

NONE

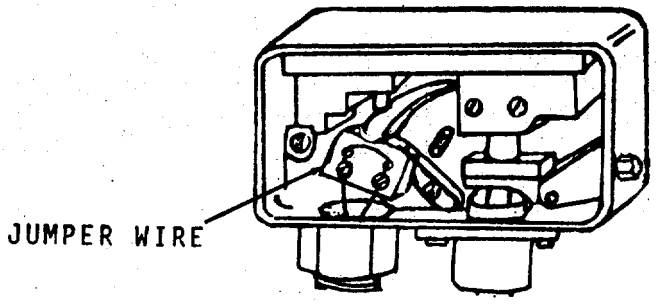
LOCATION	ITEM	ACTION	REMARKS
Testing			
1. Engine	Instrument panel	Start engine and operate at idle speed.	

3-9.4. WATER TEMPERATURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Testing (Cont)			
2. Water temperature alarm switch	a. Screw (1)	Loosen.	
	b. Cover (2)	Remove.	

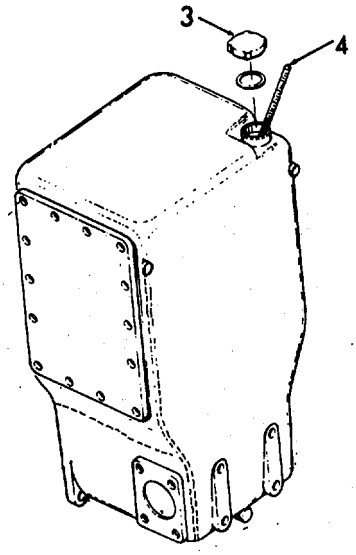


	c. Jumper wire	Install.	



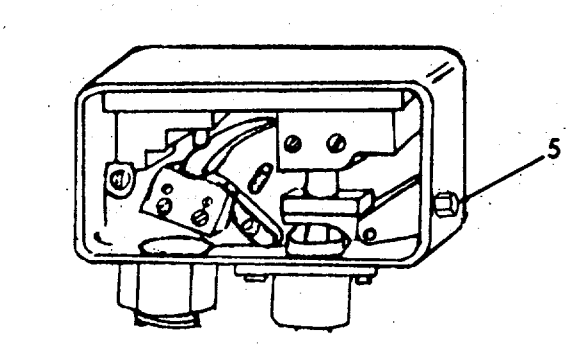
3-9.4. WATER TEMPERATURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Testing (Cont)			
3. Heat exchanger	a. Cap (3)	Remove.	
	b. Thermometer (4)	Insert in heat exchanger.	
4. Engine	a. Thermometer (4)	a. Operate at rated speed and under enough load to raise the water temperature gradually until the thermometer reads 205 ± 5°F (96.1 ± 2.7°C).	
	b. Engine temperature gage.	b. Record the temperature.	
	c. Water temperature alarm switch	c. Check that switch is activated.	
5. Engine	a. Thermometer (4)	Remove.	
	b. Cap (3)	Replace.	



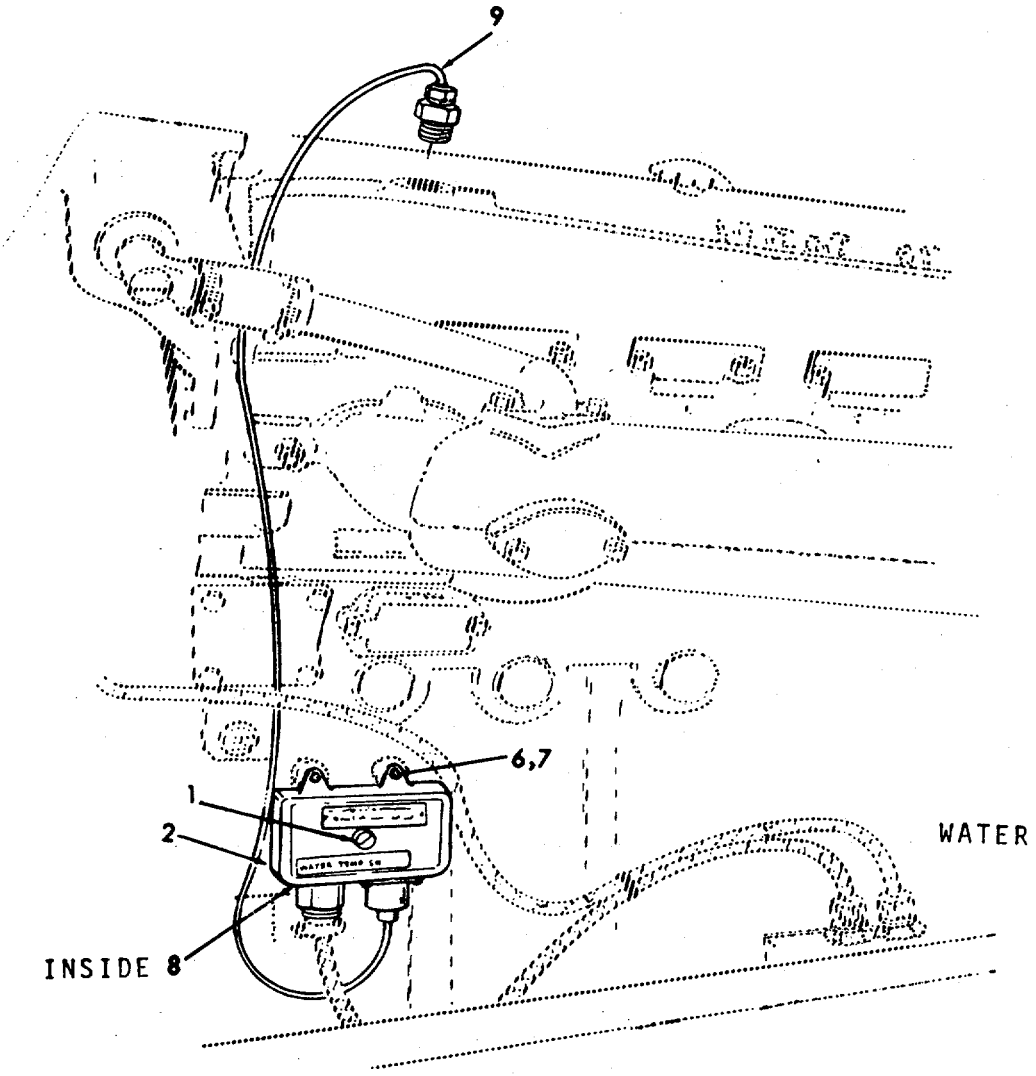
3-9.4. WATER TEMPERATURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Adjustment			
6. Water temperature alarm switch	a. Adjusting screw (5)	a. Adjust.	Adjust so that the points close at 205 ± 5° F (96.1 ± 2.7°C).
	b. Jumper wire	b. Remove.	
	c. Cover (2), and screw (1)	c. Replace.	
Removal			
7. Water temperature alarm switch	a. Screw (1)	Remove.	
	b. Cover (2)	Remove.	
	c. Wiring	Disconnect.	
	d. Screws (6) and lockwashers (7)	Remove.	
	e. Switch (8)	Remove.	
	f. Capillary tube (9)	Remove.	



3-9.4. WATER TEMPERATURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation			
8. Water temperature arm	a. Capillary tube (9)	Install.	
	b. Switch (8), screws (6), and lockwashers (7)	Install.	
	c. Wiring	Install.	
	d. Cover (2) and screw (1)	Install.	



3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS.

a. The lubricating oil pressure switch is of the "break" type. The lubricating oil pressure switch is calibrated to break contact when the lubricating oil pressure increases to 10 psi (7.03 gm cm^2). The phrase "10-BREAK" is stamped on the switch cover.

b. As the lubricating oil pressure increases when the engine starts, the diaphragm in the switch body expands and forces the plunger upwards. Since the bottom of the adjusting screw bears against the plunger and the adjusting screw is attached to the bracket which controls the upper breaker point arm, 'the arm is also forced upwards. When the lubricating oil pressure increases to 10 psi (7.03 gm cm^2), the points separate. If the lubricating oil pressure decreases to 10 psi (7.03 gm cm^2) during operation, the breaker point will close and the alarm will sound.

NOTE

An alarm will sound in the pilothouse.

This task covers:

a. Testing **c. Removal**
b. Adjustment **d. Installation**

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition: NONE — Condition Description: NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

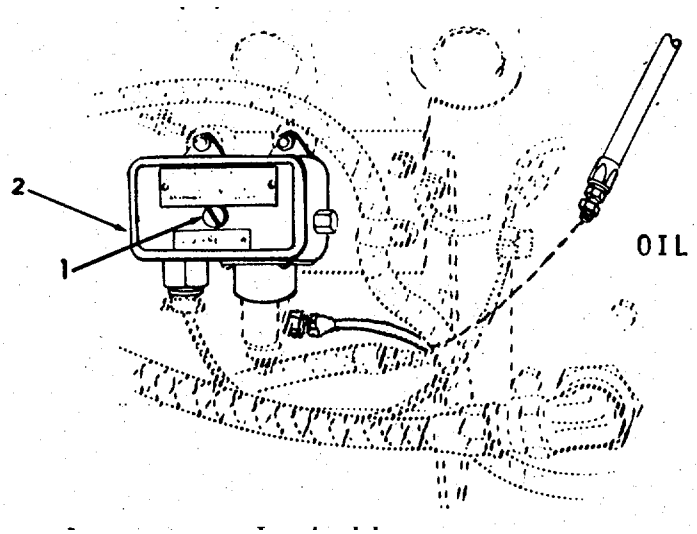
General Safety Instructions

NONE

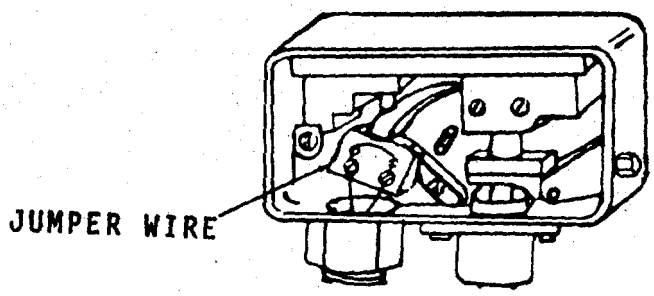
LOCATION	ITEM	ACTION	REMARKS
Testing			
1. Engine	Instrument panel	Start engine and operate at idle speed.	

3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Testing (Cont)			
2. Lube oil alarm switch	a. Screw (1)	Loosen.	
	b. Cover (2)	Remove.	



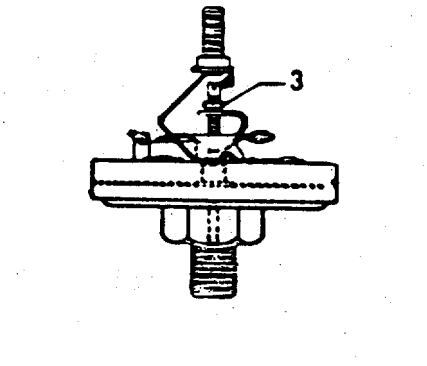
	c. Jumper wire	Install.	



3. Engine	Instrument panel	a.	Slow the engine down towards the no-fuel position while watching the oil pressure gage.	The alarm will not sound in pilothouse.
		b.	Observe lube oil alarm switch. When the switch actuates, observe the oil pressure gage.	

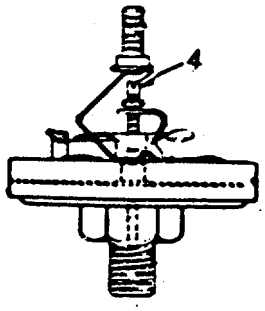
3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Testing (Cont)			
		c. Note the oil pressure at which the engine shuts down.	If the pressure is not 10 psi (7.03 gm cm^2) adjust the lube oil pressure switch. Adjust the lube oil alarm switch if it does not actuate at the proper pressure.
Adjustment Lube Oil Pressure Switch			
4. Lube oil pressure switch	a. Brass cap in center of switch	Remove.	Use a small screw driver.
		CAUTION Do not damage the brass cap or gasket.	
	b. Locknut (3)	Loosen.	Secures adjusting screw.

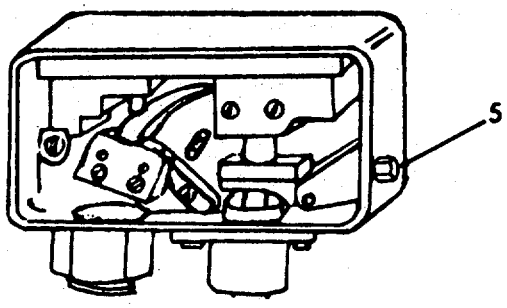


3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Adjustment Lube Oil Pressure Switch (Cont)			
	c. Adjusting screw (4)	Adjust.	With the locknut backed off, turn the adjusting screw clockwise to decrease the pressure at which the switch will make contact. Turn the adjusting screw counter-clockwise to increase the pressure at which the switch will make contact.

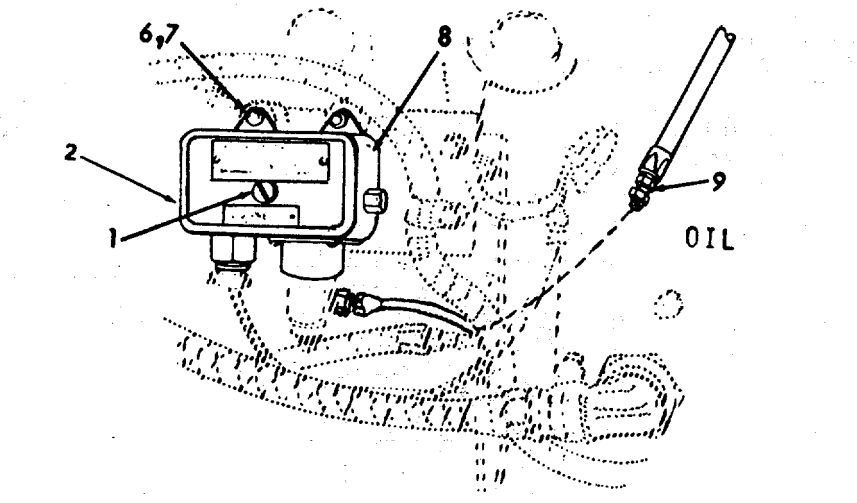


Adjustment Lube Oil Alarm Switch			
5. Lube oil alarm switch	a. Adjusting screw (5)	Adjust.	Adjust so that the points open at 10 psi (7.03 gm cm^2).

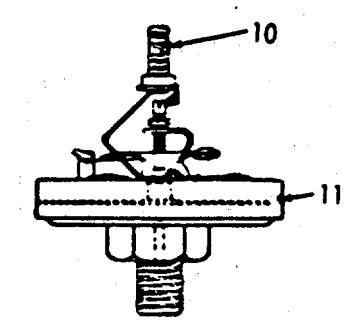


3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Adjustment Lube Oil Alarm Switch (Cont)			
	b. Jumper wire	Remove.	
	c. Cover (2) and screw (1)	Replace.	
Removal			
6. Lube oil alarm switch	a. Screw (1)	Remove.	
	b. Cover (2)	Remove.	
	c. Wiring	Disconnect.	
	d. Screws (6) and lockwash-ers (7)	Remove.	
	e. Switch (8)	Remove.	
	f. Capil-lary tube (9)	Remove.	



3-9.5. LUBRICATING OIL PRESSURE SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
7. Lube oil pressure switch	a. Terminal (10)	Remove wires.	
	b. Switch (11)	Unscrew.	
			
Installation			
8. Lube oil alarm switch	a. Capillary tube (9)	Install.	
	b. Switch (8), screws (6) and lockwash-ers (7)	Install.	
	c. Wiring	Install.	
	d. Cover (2) and screw (1)	Install.	
9. Lube oil pressure switch	a. Switch (11)	Install.	
	b. Terminals (10)	Reconnect wires.	
	c. Brass cap	Replace.	Do not damage gasket or cap.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS.

a. General.

(1) The variable speed mechanical governor performs the following three functions:

(a) Controls the engine idle speed.

(b) Limits the maximum no-load speed..

(c) Holds the engine at any constant speed, between idle and maximum.

(2) The mechanical engine governor is identified by a name plate attached to the governor housing. The letters S-W.-V.S. stamped on the name plate denote a single-weight variable speed governor.

(3) The governor is mounted on the front end of the blower, and is driven by a blower rotor. The governor assembly consists of three subassemblies:

(a) Control Housing Cover.

(b) Variable Speed Spring Housing and Shaft.

(c) Control and Weight Housing.

b. Operation.

(1) Two manual controls are provided on the variable speed governor; a governor stop lever and a speed control lever. For starting, the governor stop lever is moved to the RUN position; this moves the injector control racks to the FULL FUEL position. Upon starting, the governor moves the injector racks out to the position required for idling. The engine speed is then controlled manually by movement of the speed control lever.

(2) The centrifugal force of the revolving governor weights is converted into linear motion, which is transmitted through the riser and operating shaft to the operating shaft lever. One end of the operating shaft lever bears against the variable speed spring plunger, while the other end provides a changing fulcrum on which the differential lever pivots.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

(3) The centrifugal force of the governor weights is opposed by the variable speed spring. Load changes or movement of the speed control lever create an unbalanced force between the revolving governor weights and tension on the variable speed spring. When the two forces are equal, the engine speed stabilizes for a setting of the speed control lever.

(4) Fuel rods connected to the injector control tube levers and the control link operating lever assembly are operated by the differential lever, through the operating lever connecting link. This allows the governor to change the fuel settings of the injector rack control levers.

(5) The engine idle speed is determined by the centrifugal force required to balance out the tension on the variable speed spring in the low speed range.

(6) To adjust the engine idle speed, change the tension on the variable speed spring by adjusting the idle speed screws. Adjustment of the maximum no-load speed is done by varying the tension on the variable speed spring by installing or removing stops and shims.

c. Lubrication.

The governor is lubricated by a spray of lubricating oil from the blower end plate. The governor weights distribute this oil to all parts of the governor assembly requiring lubrication. Oil returning from the governor goes through passages in the blower end plate and cylinder block to the engine oil pan.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **c. Installation** **e. Adjustment**
b. Removal **d. Repair**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Plastic hammer
Torque wrench

Material/Parts

Gasket kit P/N 5196375

Personnel Required

1

References

NONE

Equipment

Condition	Condition Description
3-30	Rocker Arm Covers
3-13	Fuel Pump

Special Environmental Conditions

NONE

General Safety Instructions

NONE

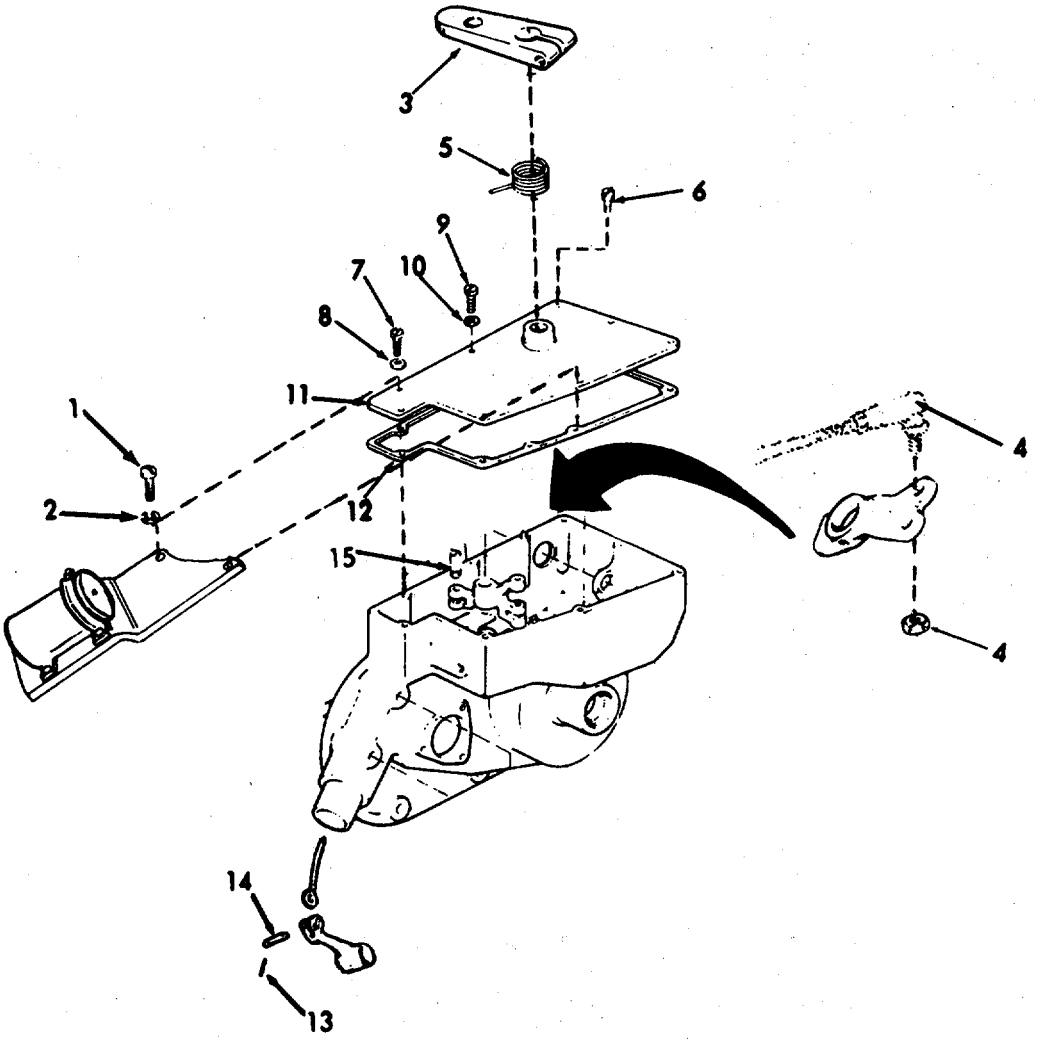
LOCATION	ITEM	ACTION	REMARKS
Inspection			
1. Governor	a. Linkage	Inspect for wear, damage, or loose components.	
	b. Hoses	Inspect for leaks, cracks, and loose hose clamps.	
	c. Housing	Inspect for leaks, or external damage.	
	d. Solenoid	Inspect for defective wiring, wear, or damage.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal			
2. Stop solenoid	a. Wiring	Tag and disconnect wires.	
	b. Screws (1) and lock-washers (2)	Remove.	
	c. Stop solenoid assembly	Lift from stop lever (3) and remove.	
3. Speed control	Nut on speed control rod (4)	Remove nut to remove rod.	
4. Governor	a. Stop lever return spring (5)	Remove end from behind the head of special screw (6).	
	b. Special screw (6)	Remove.	
	c. Screw (7), and lock-washer (8)	Remove.	
	d. Screws (9), and lock-washers (10)	Remove 4 screws.	
	e. Cover (11) and gasket (12)	Remove.	Discard gasket if damaged.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
5. Right bank	a. Cotter pin (13)	Remove.	Discard if damaged.
	b. Pin (14)	Remove.	
6. Governor	a. Governor control link operating pin (15)	Unscrew and remove.	Pin is 5/16 x 1 inch.



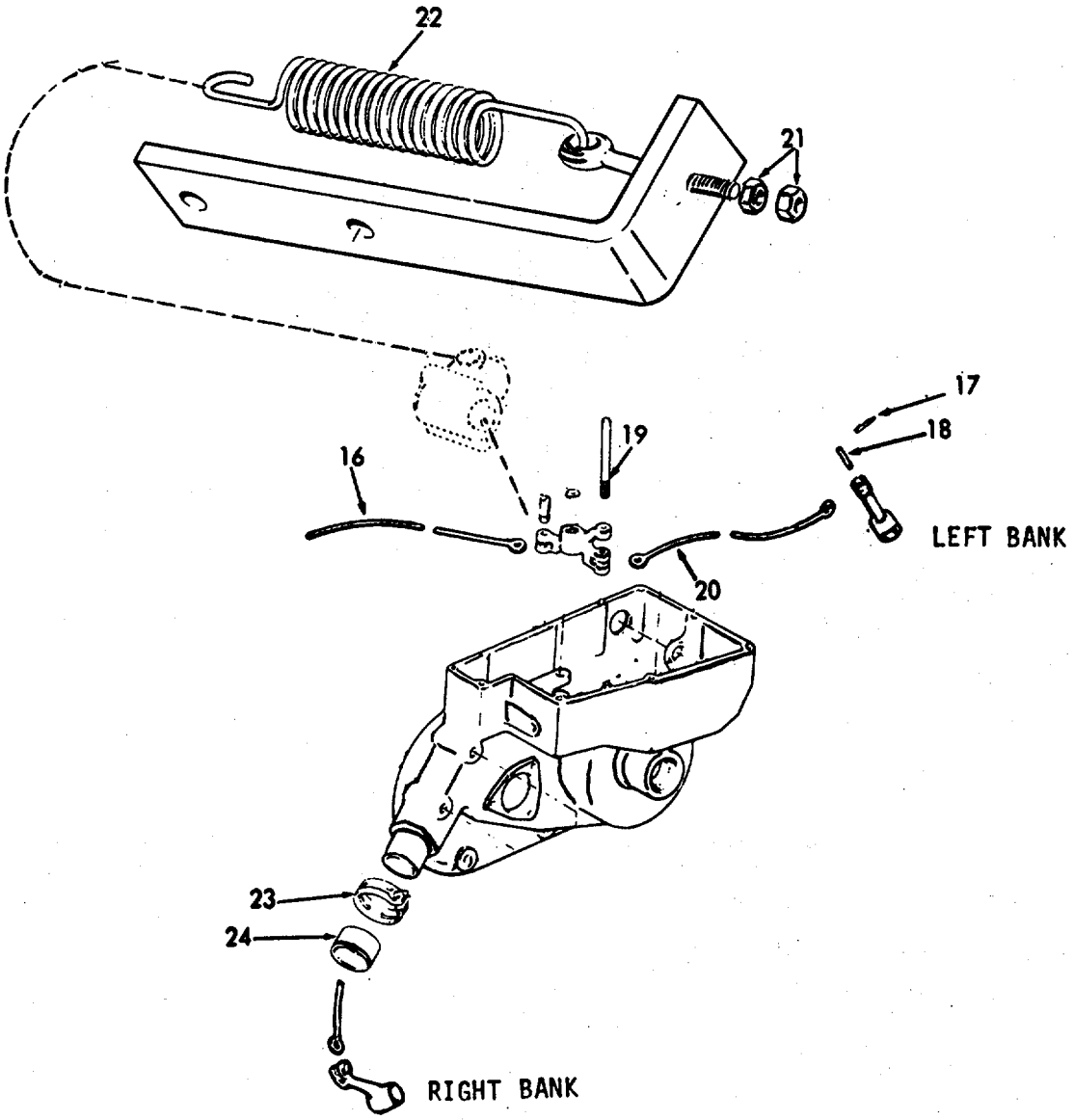
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	b. Fuel rod (long) (16)	Remove.	Withdraw from governor.
7. Left bank	a. Cotter pin (17)	Remove.	Discard if damaged.
	b. Pin (18)	Remove.	
8. Governor	a. Governor control link operating pin (19)	Unscrew and remove.	Pin is 3/8 x 2 inches.
	b. Fuel rod (short) (20)	Remove.	Withdraw from governor.
9. Fuel pump	Hoses	Remove.	Refer to paragraph 3-14.
10. Speed control	a. Booster spring adjusting nuts (21)	Loosen.	
	b. Booster spring (22)	Remove.	
11. Governor	a. Hose clamps (23)	Loosen.	
	b. Hoses (24) and clamps (23)	Slide up tube on governor housing.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

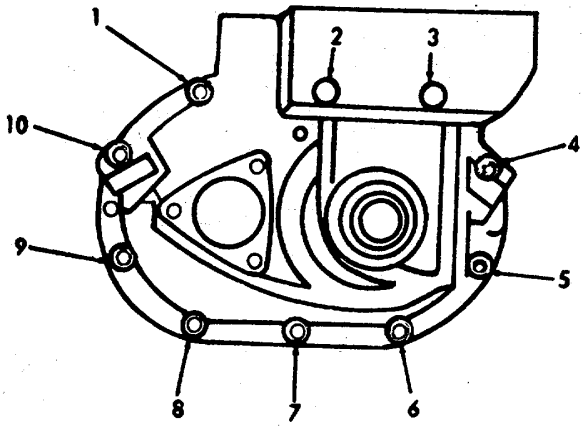
LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	c. Governor mounting bolts.	Remove as shown below.	Bolts in positions 2 and 3 are inside governor.

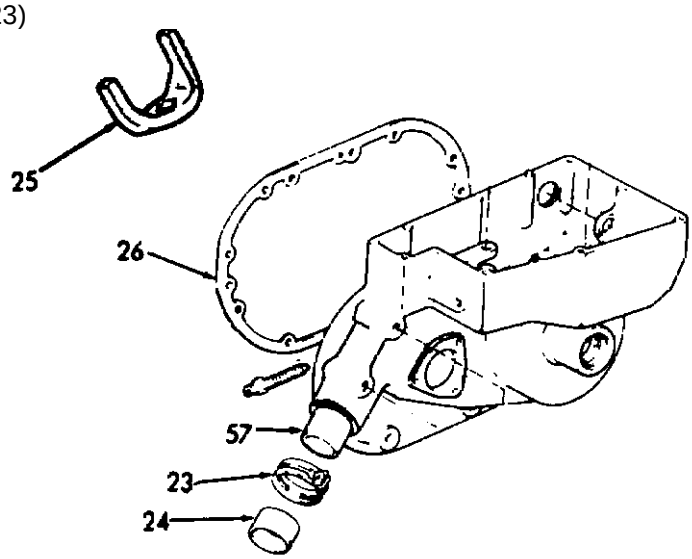


BOLT SIZE	WASHER	POSITION
5/16"-18x5-1/4"	Copper	4
5/16"-18x4"	Copper	10
5/16"-18x3-3/4"	Lock and Plain	1
5/16"-18x2-1/4"	Lock	2-3-5-6-7-8-9

	d. Governor housing and fuel pump assembly	Remove.	Tap the sides of the governor housing slightly with plastic hammer to loosen governor from blower. Pull the governor and fuel pump assembly straighten out from the dowels in the blower end plate.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
		NOTE The fuel pump drive coupling fork may stay on either the fuel pump or the blower rotor shaft.	
	e. Fuel pump drive coupling fork (25)	Remove.	
	f. Governor to blower gasket (26)	Remove.	Discard.
12. Fuel pump	Fuel pump	Remove.	Refer to paragraph 3-13.
Installation			
13. Fuel pump	Fuel pump	Replace if removed.	Refer to paragraph 3-13.
14. Governor	a. Hoses (24) and clamps (23)	Slide up fuel rod cover tube (57)	On each side of governor

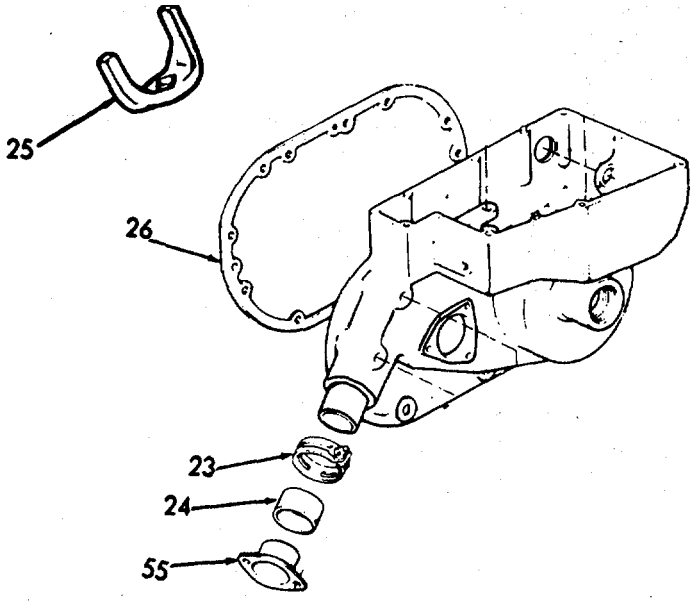


3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Cont).

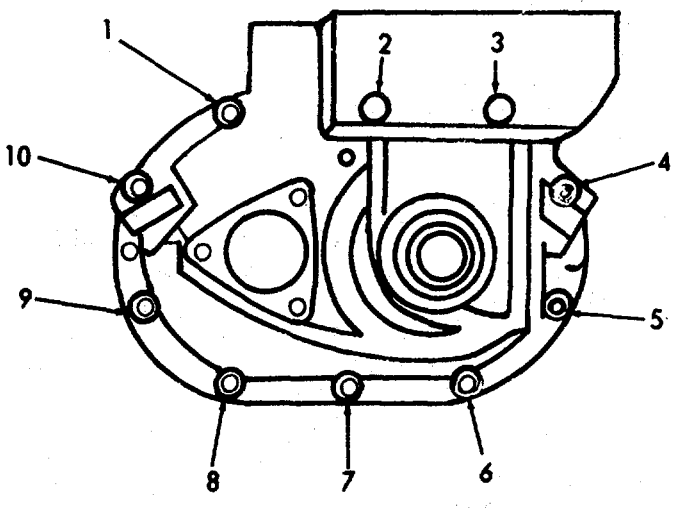
LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	b. Gasket (26)	Affix to forward face of blower end plate	Use a new gasket.
	c. Fuel pump drive fork (25)	Install.	On fuel pump shaft
	d. Governor and fuel pump assembly	Position in front of blower.	1- Rotate fuel pump fork until the prongs of the fork align with the slots in the drive disc. 2- Rotate the weight shaft and align the splines on the shaft with the splines in the blower.
	e. Governor and fuel pump assembly	Push straight back over dowels in the blower end plate and gasket (26)	
	f. Bolts, lock-washers, copper washers, and washer	Install as shown below.	Torque to 13-17 lb-ft (17.6 - 23.1 Nm) torque.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



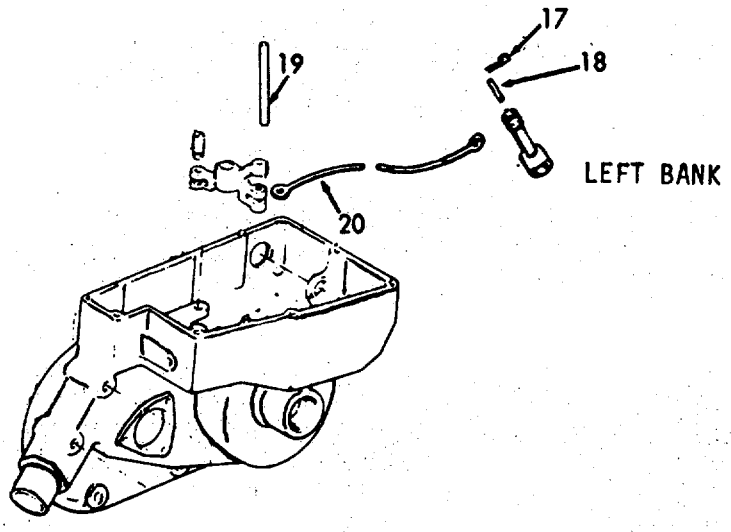
g.	Hoses (24) and clamps (23)	Slide over fuel rod cover tube (55)	Tighten hose clamps.
15. Fuel pump	Fuel hoses and lines	Attach.	Refer to paragraph 3-14.



BOLT SIZE	WASHER	POSITION
5/16"-18x5-1/4"	Copper	4
5/16"-18x4"	Copper	10
5/16"-18x3-3/4"	Lock and Plain	1
5/16"-18x2-1/4"	Lock	2-3-5-6-7-8-9

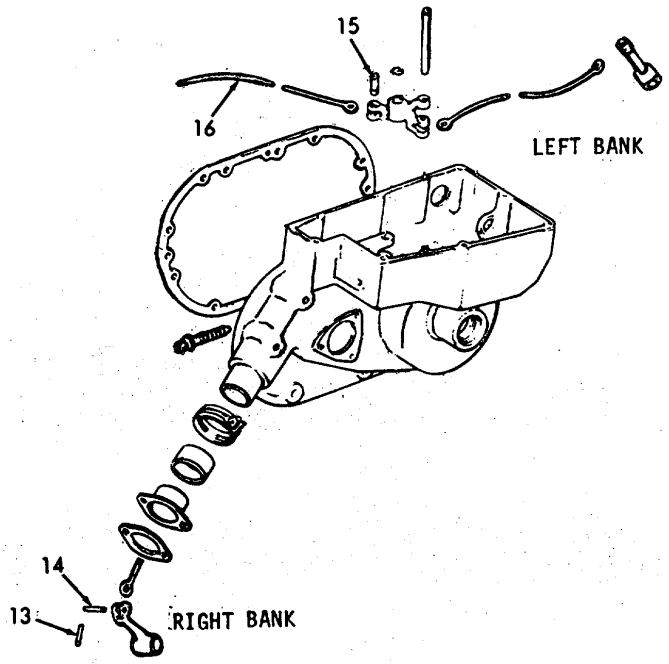
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
16. Governor	a. Left bank fuel rod (short) (20)	Insert.	Insert the lower end of the left-bank fuel rod down through the top of the governor housing and through the fuel rod cover tubes to the injector control tube lever.
	b. Governor control link operating pin (19)	Insert rod (20) between bosses on lever. Insert pin (19)	
17. Left bank	a. Left bank fuel rod (20)	Insert in lever.	
	b. Pin (18), Install. and cotter pin (17)		



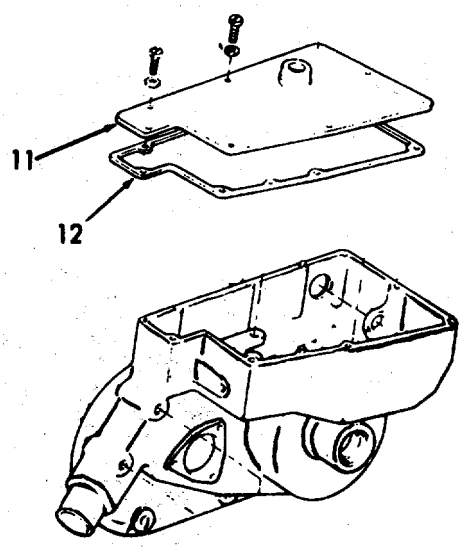
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
18. Governor	a. Right bank fuel rod (long) (16)	Insert.	Insert the lower end of the right-bank fuel rod down through the top of the governor housing and through the fuel rod cover tubes to the injector control tube lever.
	b. Governor control link operating pin (15)	Insert rod (16) between bosses on lever. Insert pin (15).	
19. Right Bank	a. Right bank fuel rod (16)	Insert in lever.	
	b. Pin (14), Install. And cotter pin (13)		



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
20. Governor	a. Gasket (12) b. Governor Install. cover assembly (11)	Affix to governor housing	Use a new gasket. Place the governor cover assembly on the governor housing with the pin in the stop control shaft assembly in the slot of the differential lever, and the dowel pins in the housing in the dowel pin holes in the cover.



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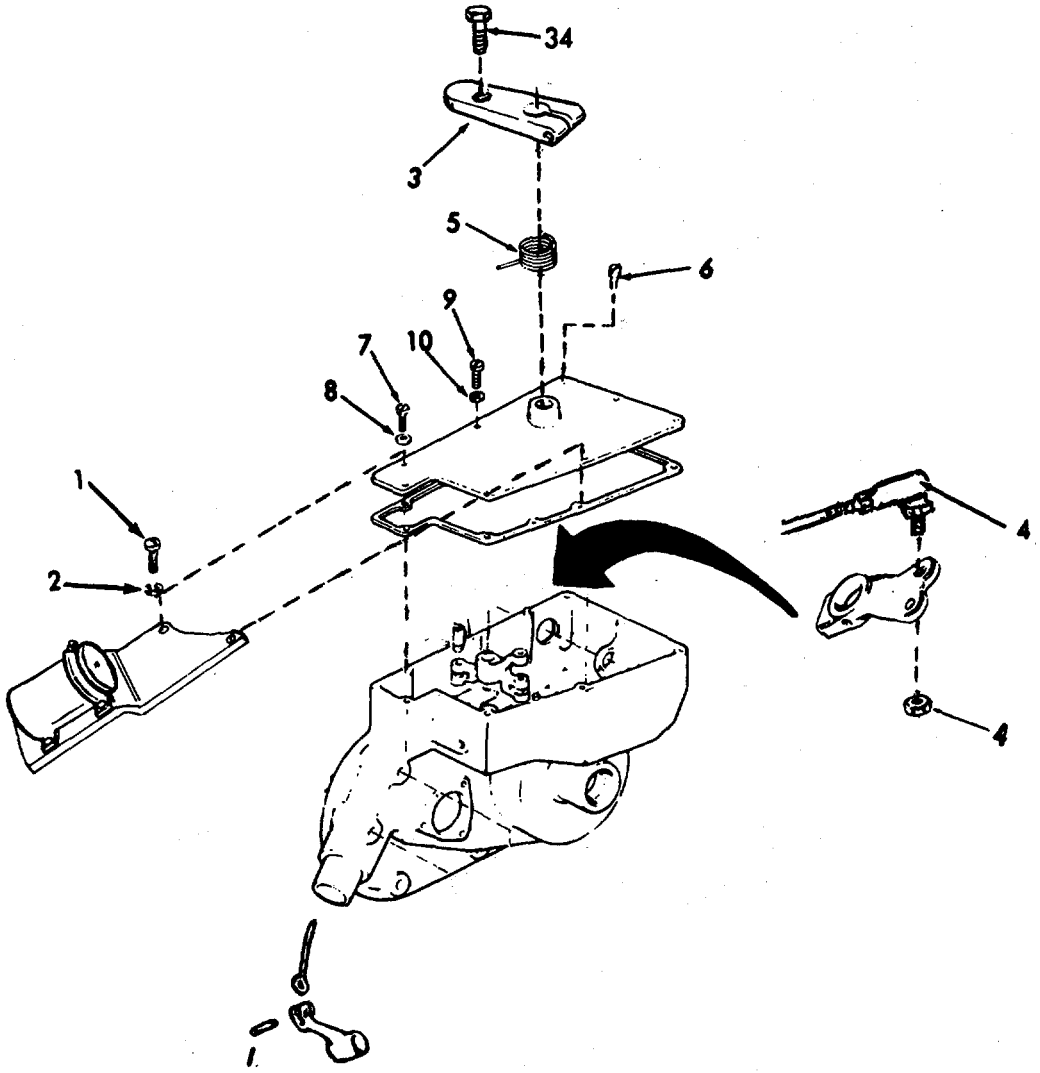
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Screws (9), and lock-washer (10)	Install.	
	d. Screw (7), and lock-washer (8)	Install.	
	e. Special screw (6)	Install.	
	f. Screws (6), (7), and (9)	Tighten.	
	g. Stop lever return spring (5)	Install.	Place one end behind special screw (6).
21. Speed control	Nut on speed control rod (4)	Install.	
22. Stop solenoid	a. Stop solenoid assembly	Insert bolt (34) through stop lever (3).	
	b. Screws (1), and lock-washers (2)	Install.	Tighten securely.
	c. Wiring	Install.	
	d. Stop solenoid assembly	Adjust.	Refer to adjustment procedure.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



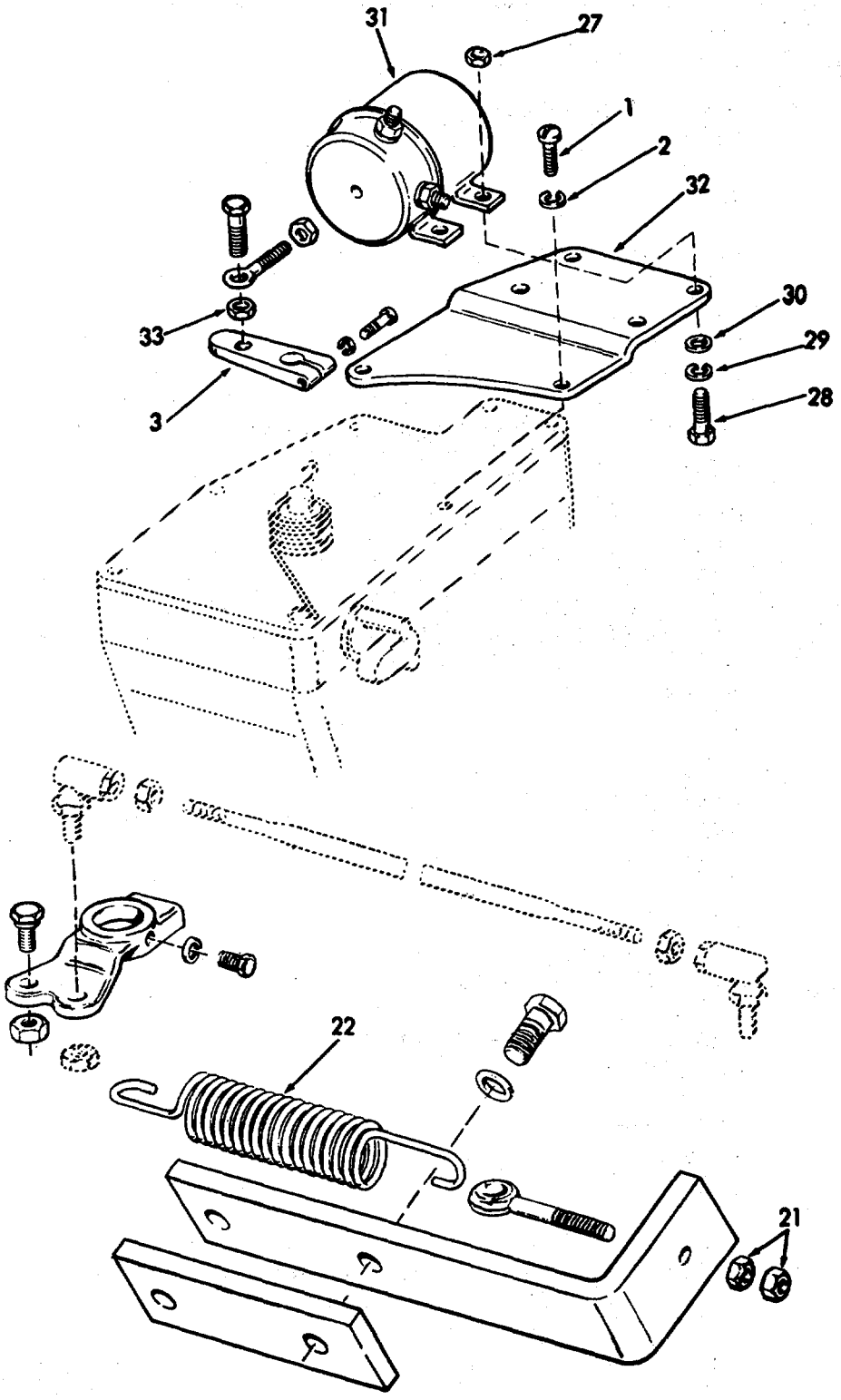
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
23. Booster spring	a. Booster spring (22)	Install.	
	b. Nuts (21).	Install.	
24. Governor	Idle speed, buffer screw, and booster spring.	Adjust.	Refer to adjustment procedure.
Repair			
25. Stop solenoid	a. Wiring	Tag and disconnect wires.	
	b. Screws (1) and lockwashers (2)	Remove.	
	c. Stop solenoid assembly	Lift from stop lever (3) and remove.	
	d. Nuts (27)	Remove.	
	e. Screws (28), lockwashers (29), and washers (30)	Remove.	
	f. Solenoid (31)	Remove from bracket (32).	
	g. Nut (33)	Remove.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



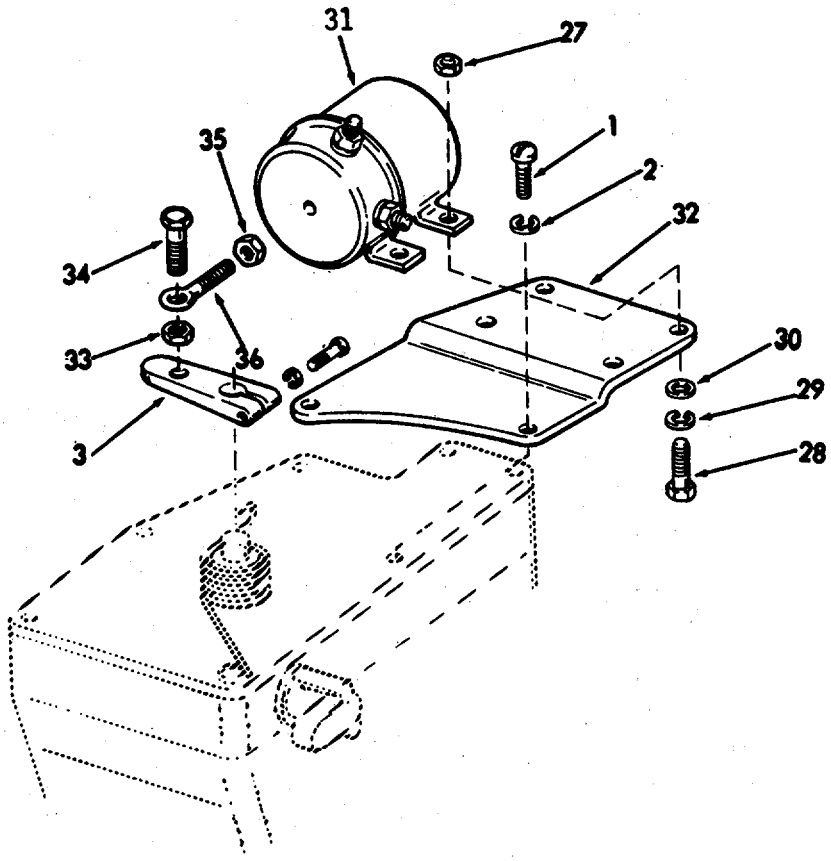
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Bolt (34)	Remove.	
	i. Nut (35)	Loosen.	
	j. Control link adjusting rod eye (36)	Unscrew from solenoid (31).	
	k. Control link adjusting rod eye (36), and nut (35)	Screw into solenoid (31).	Do not tighten.
	l. Solenoid (31), and bracket (32)	Align holes.	
	m. Screws (28), lock-washers (29), washers (30), and nuts (27)	Install.	
	n. Solenoid assembly, screws (1), and lock-washers (2)	Install on governor.	
	o. Bolt (34)	Place through rod end eye (36), and stop lever (3).	
	p. Nut (33)	Install.	Proceed to adjustment.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



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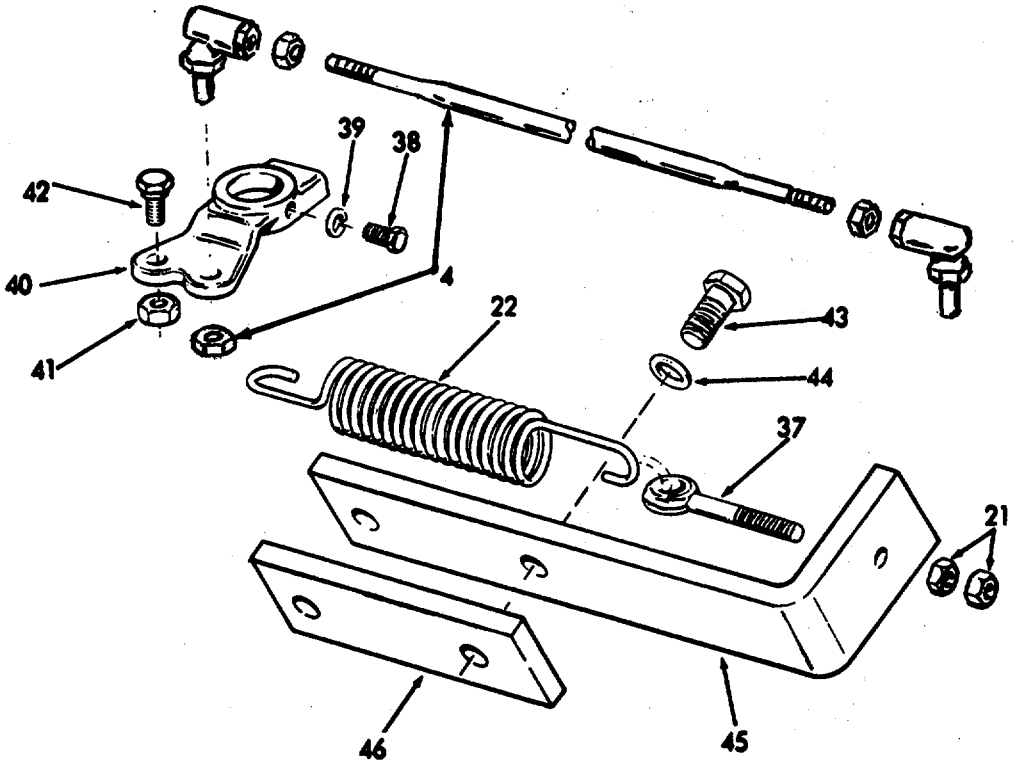
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
26. Engine throttle linkage	a. Nut on speed control rod (4)	Remove.	
	b. Booster spring adjusting nuts (21)	Loosen.	
	c. Booster spring (22)	Remove.	
	d. Nuts (21)	Remove.	
	e. Throttle booster adjusting eye (37)	Remove.	
	f. Screw (38), and lock-washer (39)	Remove.	
	g. Speed control lever (40)	Remove.	
	h. Nut (41), and screw (42)	Remove.	
	i. Screws (43), and lock-washers (44)	Remove.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Booster spring bracket (45)	Remove.	
	k. Spacer (46)	Remove.	

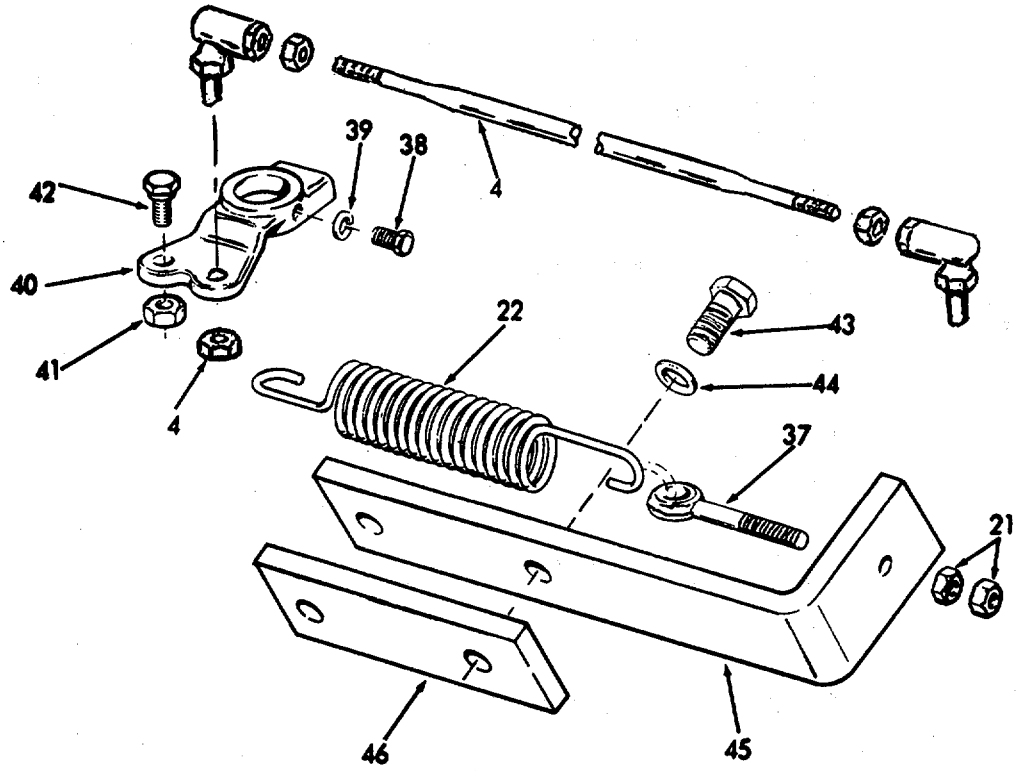


3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	1. Spacer (46), booster spring bracket (45), screws (43), and lock-washers (44)	Install.	
	m. Screw (42), nut (41), and speed control lever (40)	Assemble.	
	n. Speed control lever (40)	Place on governor.	
	o. Screw (38), and lock-washer (39)	Install.	
	p. Throttle booster adjusting eye (37), and nuts (21)	Install.	Do not tighten.
	q. Booster spring (22)	Install.	
	r. Nuts (21)	Adjust.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	s. Speed control rod (4)	Install.	



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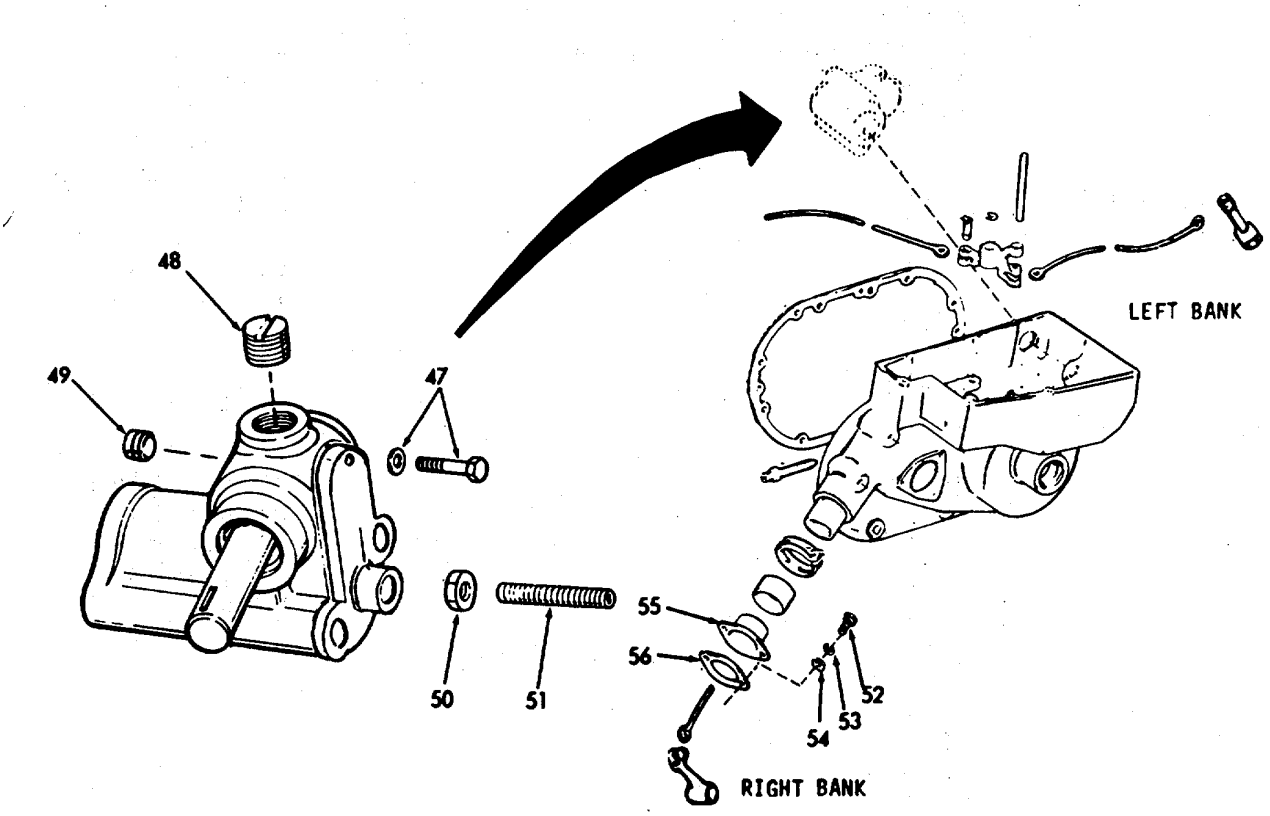
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
27. Variable speed spring housing assembly (47)	a. Screw assembly	Replace if damaged.	
	b. Expansion plug .(48)	Replace if damaged.	
	c. Pipe plug (49)	Replace if damaged.	
	d. Idle speed adjusting screw (51), and nut (50)	Replace if damaged.	Adjust as per adjustment procedure.
28. Governor fuel rod cover	a. Screw (52), lock-washer (53), and washer (54)	Remove.	
	b. Governor fuel rod cover (55)	Remove.	
	c. Gasket (56)	Remove.	Discard.
	d. Gasket (56), governor fuel rod cover (55), screw (52),	Assemble.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	lock-washer (53), and washer (54)		



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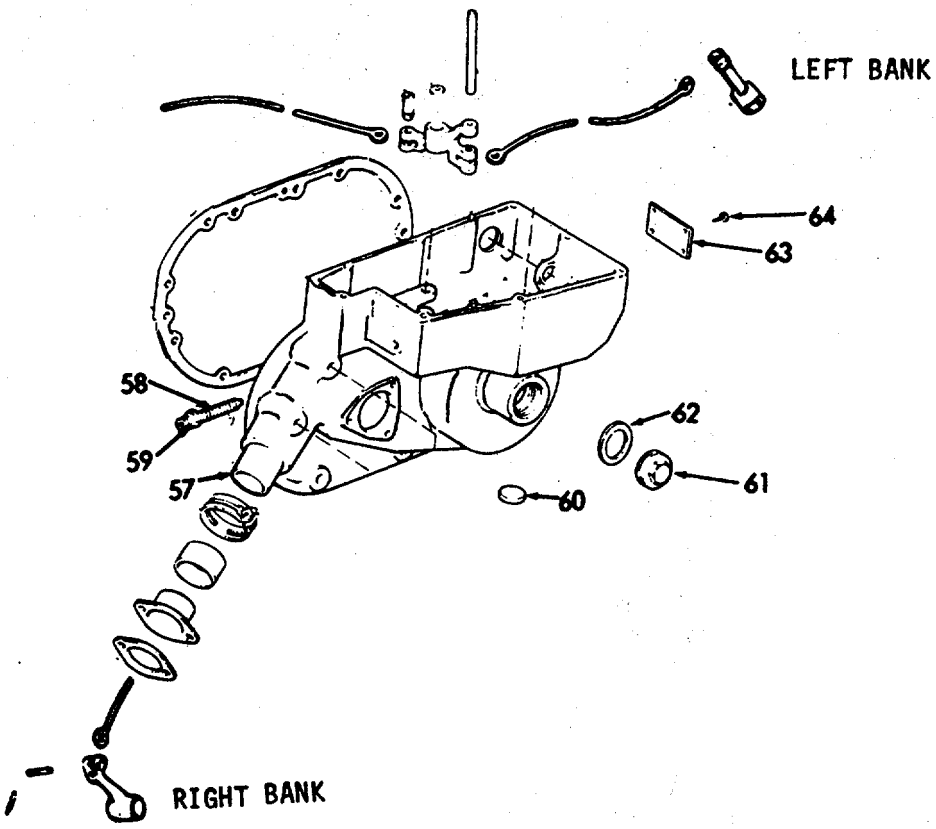
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
29. Governor housing	a. Fuel rod cover tube (57)	Replace if damaged.	
	b. Governor buffer screw assembly (58) and nut (59)	Replace if damaged.	
	c. Expansion plug (60)	Replace if damaged.	Apply a thin coat of good quality sealant around the edge of a new expansion plug. Place the plug,' concave side up, in the opening in-the housing next to the lower operating shaft bearing. Tap the center of the plug with a hammer to secure the plug in the housing.
	d. Governor weight housing cap (61) and gasket (62)	Replace if damaged	Use new gasket.
	e. Identification plate (63) and drive screw (64)	Replace if damaged.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-431

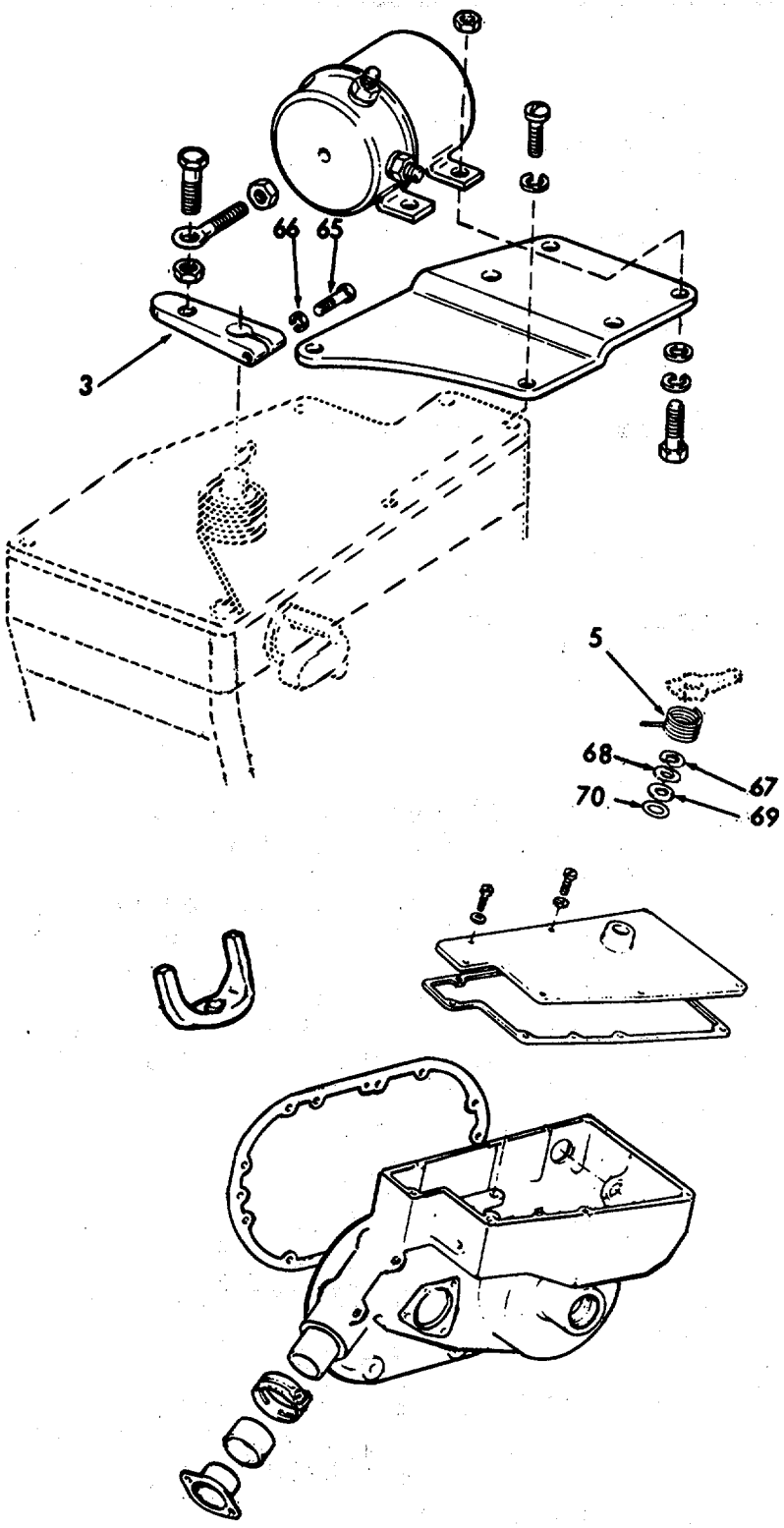
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
30. Governor cover assembly	a. Stop solenoid	Remove.	
	b. Screw (65), and lock-washer (66)	Loosen.	
	c. Stop lever (3)	Remove.	
	d. Governor lever retract-ing spring (5)	Remove.	
	e. Snap ring (67), retainer (68), backup washer (69), and seal ring (70)		
	f. Seal ring (70), backup washer (69), retainer (68), and snap ring (67)	Install.	

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

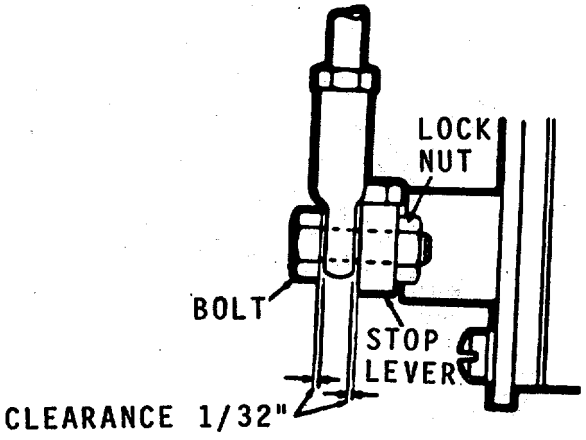
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Governor lever retracting spring (5)	Install	One end of spring is behind screw (6)
	h. Stop lever (3), screw (65), and lockwasher (66)	Install.	Do not tighten.
	i. Stop solenoid	Install.	Refer to adjustment procedure.

ADJUSTMENTS

31. Stop solenoid

The solenoid plunger can be properly aligned to the governor stop lever as follows:

a. The bolt through the rod end eye should be locked to the stop lever and adjusted to a height that will permit the eye or clip to float vertically. The clearance above and below the eye or clip and the bolt head should be approximately 1/32" (0.079 cm) minimum.



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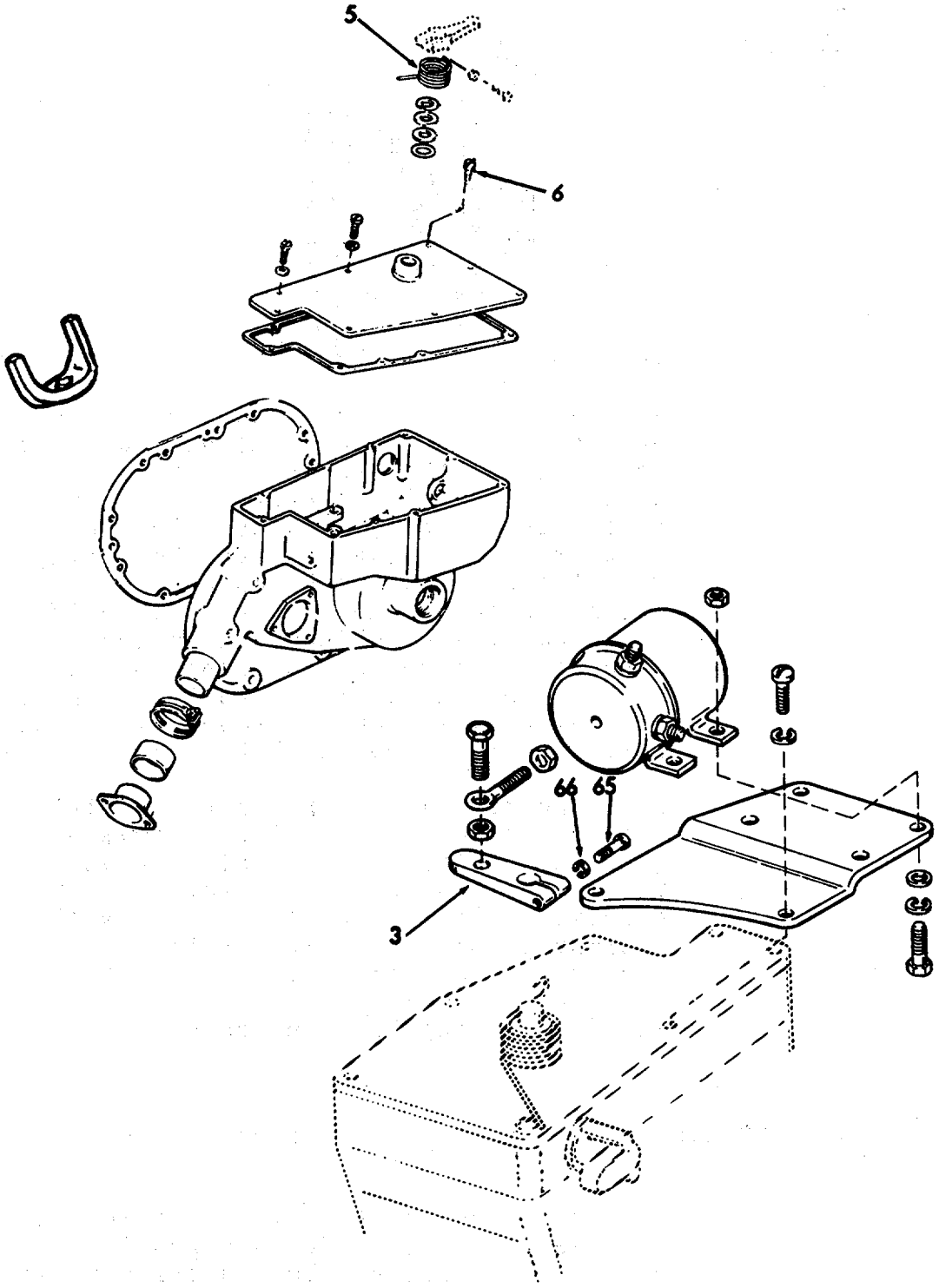
3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

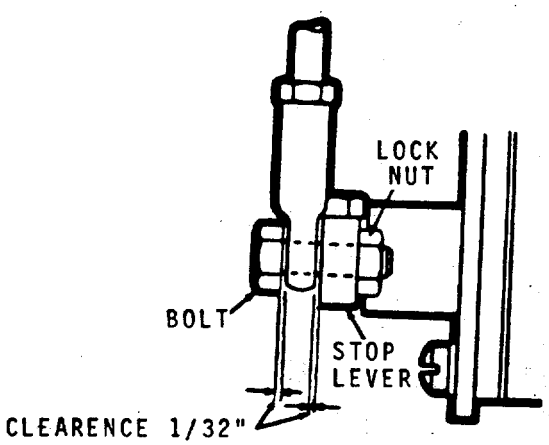
ADJUSTMENTS (Cont)



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)



b. Remove the bolt connecting the rod and eye to the stop lever. Align and clamp the lever to the shutdown shaft in such a way that, at its mid-travel position, it is perpendicular to the solenoid plunger. This assures that the linkage will travel as straight as possible. The solenoid plunger has available 1/2" (1.27 cm) travel which is more than adequate to move the injector control racks from the full-fuel to the complete no-fuel position and shutdown will occur prior to attaining complete travel.

c. With the stop lever in the run position, adjust the rod end eye for minimum engagement on the solenoid plunger when the connecting bolt is installed. The oversize hole in the eye or clip will thereby permit the solenoid to start closing the air gap, with a resultant build-up of pull-in force prior to initiating stop lever movement.

NOTE

The lock nut can be either on top of or below the stop lever.

d. Move the lever to the stop position and observe the plunger for any possible bind. If necessary, loosen the mounting bolts and realign the solenoid to provide free plunger motion.

3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

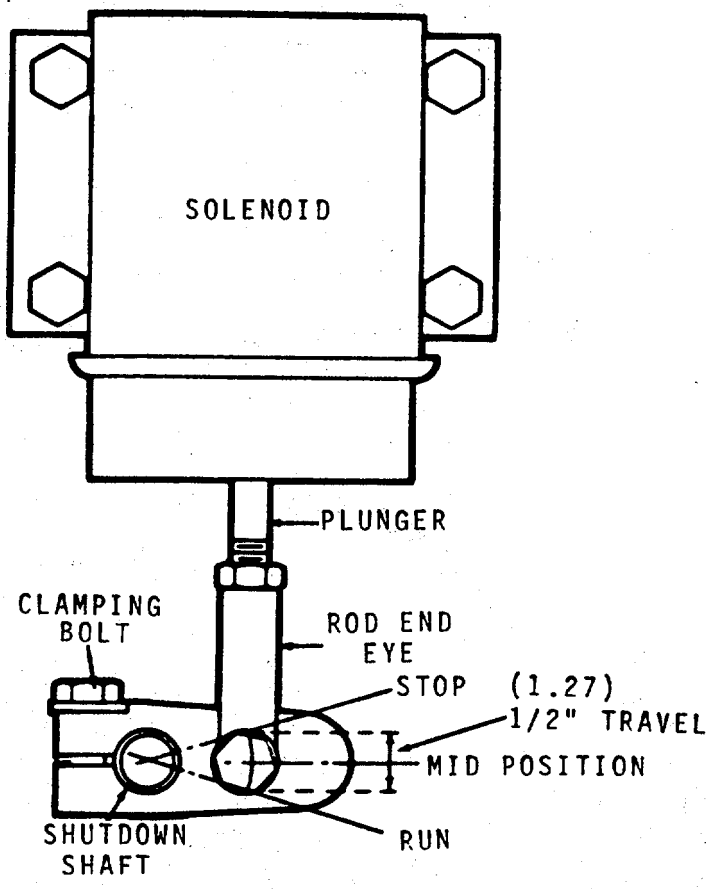
LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

32. Idle speed

Adjust the idle speed as follows:

a. Place the stop lever in the "run position and the speed control lever in the "idle" position.



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

b. With the engine operating, loosen the lock nut (50) and turn the idle speed adjusting screw (51) until the engine idles at the recommended idle speed.

c. Hold the idle speed adjusting screw and tighten the lock nut.

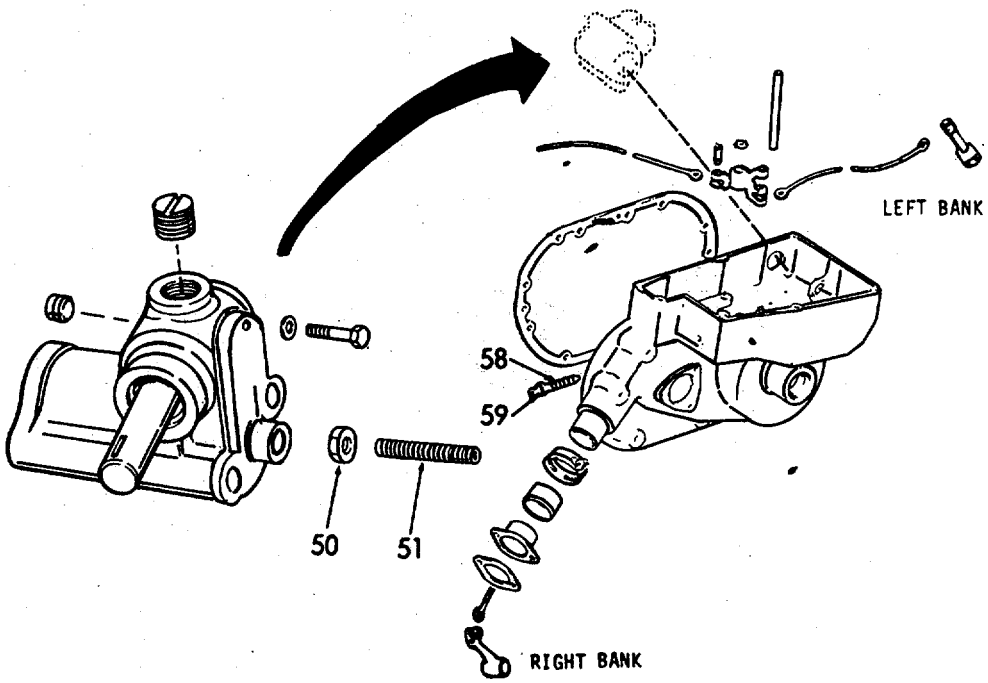
33. Buffer screw — With the idle speed properly set, adjust the buffer screw (58) as follows:

a. With the engine at idle speed, turn the buffer screw "in" so that it contacts the differential lever as lightly as possible and still eliminates the engine roll.

NOTE

Do not raise the engine idle speed more than 15 rpm with the buffer screw.

b. Hold the buffer screw (58) and tighten the lock nut (59).



3-10. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS - (Cont).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

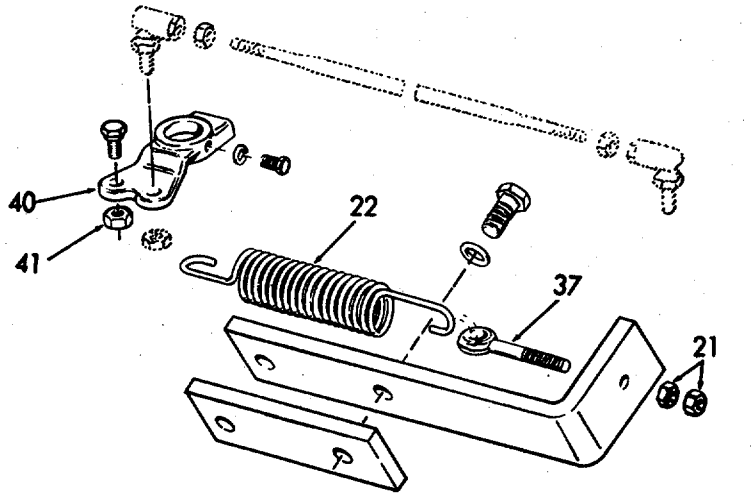
34. Booster spring

With the idle speed set, adjust the booster spring as follows:

a. Refer to and loosen the booster spring retaining nut (41) on the speed control lever (40). Loosen lock nuts (21) on the eye bolt (37) at the opposite end of the spring (22).

b. With the speed control lever in the idle position, move the bolt in the slot of the speed control lever until the center of the bolt is on an imaginary line through the center of the bolt, lever shaft, and eye bolt. Hold the bolt and tighten the lock nut.

c. Start the engine and move the speed control lever to the maximum speed position and release. The speed control lever should return to the idle position. If it does not, reduce the booster spring tension; if it does, continue to increase the spring tension until the point is reached that will not return to idle. Then, reduce the tension until it does return to idle and tighten the lock nut on the eye bolt. This setting will result in the minimum force required to operate the speed control lever.



3-11. AIR INTAKE - MAINTENANCE INSTRUCTIONS.

a. The air intake shutdown housing, mounted on the top of the blower, serves as a mounting for the air silencers. The air shutdown housing contains an air shutdown valve that shuts off the air supply ¾ and stops the engine whenever abnormal operating conditions require an emergency shutdown.

b. This paragraph contains the following procedures:

3-11.1. AIR SILENCER - MAINTENANCE INSTRUCTIONS.

a. Two air silencers are mounted on the air inlet housing which is attached to the intake side of the blower housing to reduce the sound level of the air entering the blower. The two silencers are mounted side by side and form a shallow inverted vee atop the blower. A pair of silencers is used with each blower.

b. Each silencer has a perforated steel partition welded into place parallel with the outside faces, dividing the entire silencer into two sections. The engine side of this partition together with the outer shell forms an air duct the entire length of the silencer. Air enters the silencer at both ends and flows through this duct to the blower intake opening at the center portion. The other portion of the silencer - between the perforated partition and the unbroken outer wall - is filled with sound absorbent, flame proof, felted cotton waste.

3-11.1. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition: Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

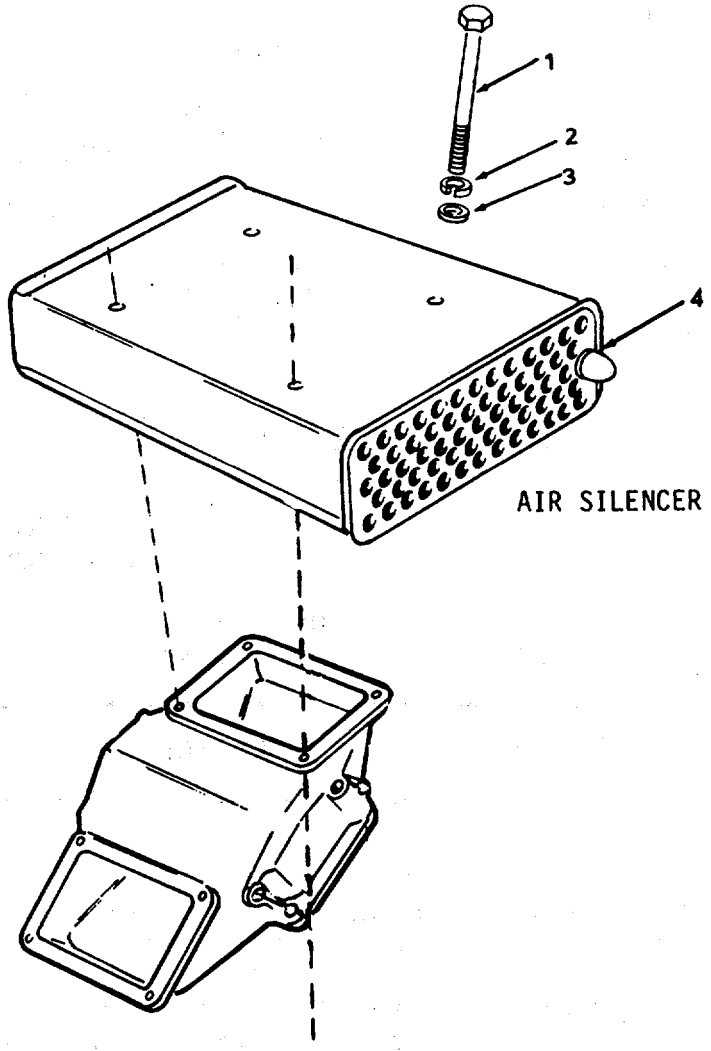
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM		ACTION	REMARK
INSPECTION				
1. Air silencer(s)	Air silencer		Inspect for damage, and dirt.	
REMOVAL				
2. Air silencer(s)	a. Screws (1), lockwashers (2), and washer (3)		Remove.	Typical four silencers.
	b. Air silencer (4)		Remove.	

3-11.1. AIR SILENCER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation			
3. Air silencer(s)	a. Air silencer (4), screws (1), lockwashers (2), and washers (3)	Install.	



3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS.

An air intake housing is mounted on each blower. Each housing contains a shutdown valve. The shutdown valve shuts off the air supply and stops the engine when abnormal operating conditions require an emergency shutdown. The two air intake housings are connected together and to the emergency shutdown station. After an emergency shutdown, the shutdown valves must be reset.

This task covers:

a. Inspection **c. Repair** **e. Adjustment**
b. Removal **d. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Torque Wrench

Material/Parts
Gasket kit P/N 5196375
Gasket kit P/N 5196386

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
3-11.1 Air silencer removed

Special Environmental Conditions
NONE

General Safety Instructions

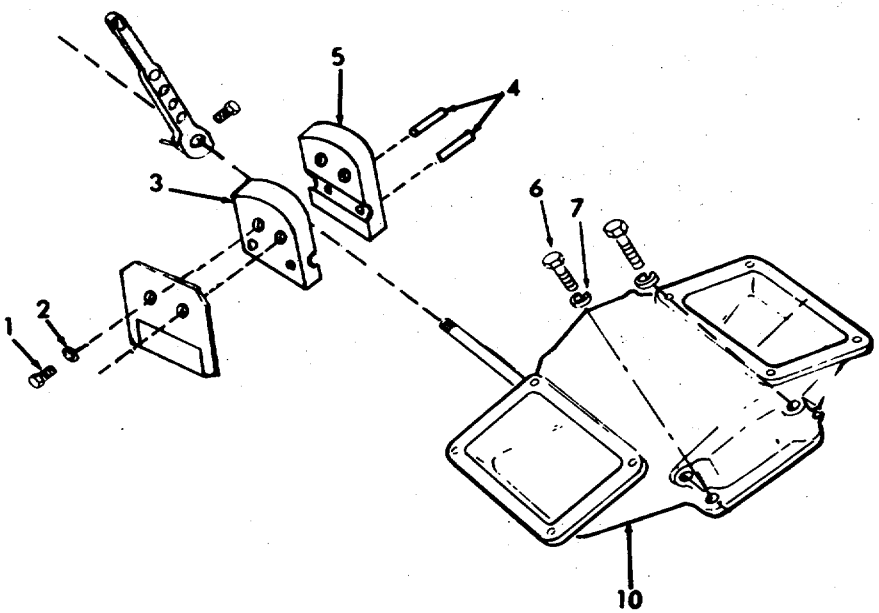
WARNING

Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
Inspection			
1.	Air intake	a. Housing Inspect for cracks, breaks and damage.	
		b. Linkage Inspect for binding, defective parts, damage and loose parts.	

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Inspection (Cont)			
	c. Shutdown valves	Inspect for proper operation.	
Removal			
2. Forward air intake	a. Screws (1), and lock-washers (2)	Remove.	
	b. Coupling cover (3)	Remove.	
	c. Roll pins (4)	Remove.	Use center punch to remove pins that attach coupling back (5) to rods.
	d. Screws (6), and lock-washers (7)	Remove.	



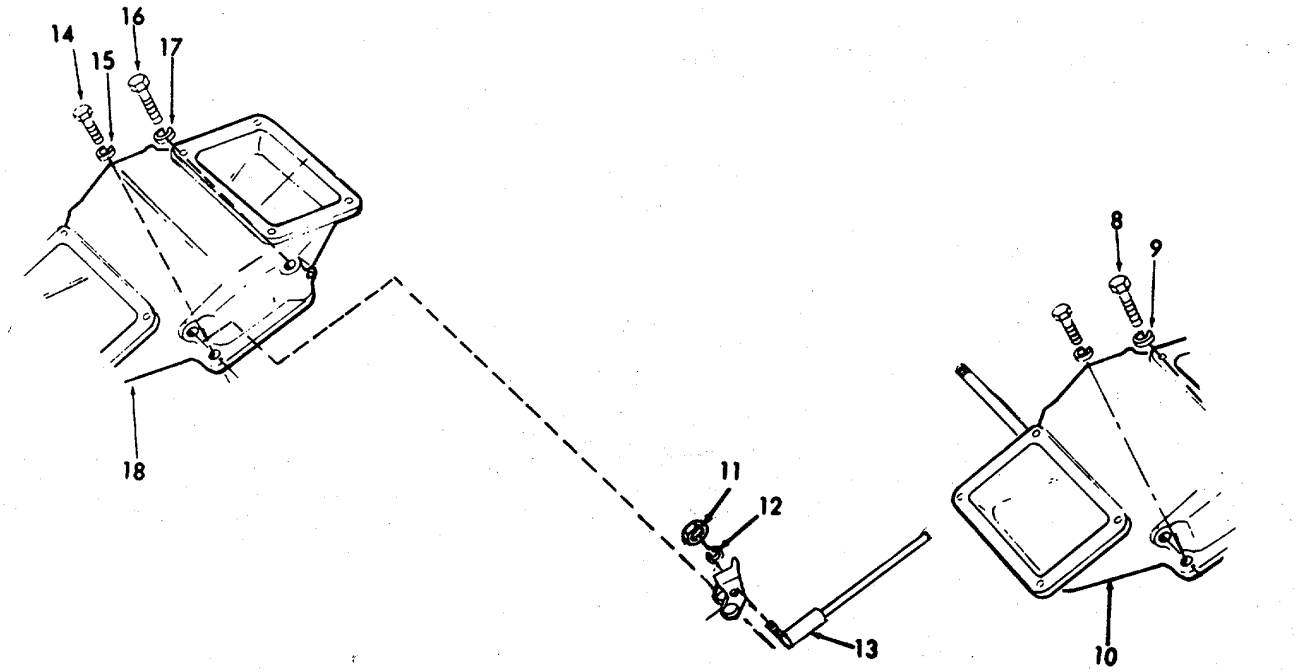
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	e. Screws (8), and lock-washers (9)	Remove.	
	f. Air in-take (10)	Remove.	
3. Aft air intake	a. Nut (11), and lock-washer (12)	Remove.	
	b. Ball joint (13)		
	c. Screws (14), and lock-washers (15)	Remove.	
	d. Screw (16), and lock-washers (17)	Remove.	
	e. Air intake (18)	Remove.	

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)



3-447

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
4. Striker plate (forward and/or aft)	a. Screws (19), lock-washers (20), and flat-washers (21)	Remove.	
	b. Striker plate (22)	Remove.	
	c. Gasket (23)	Remove.	Discard.
	d. Blower screen (24)	Remove.	Clean or discard.

WARNING

Use eye protection when using compressed air.

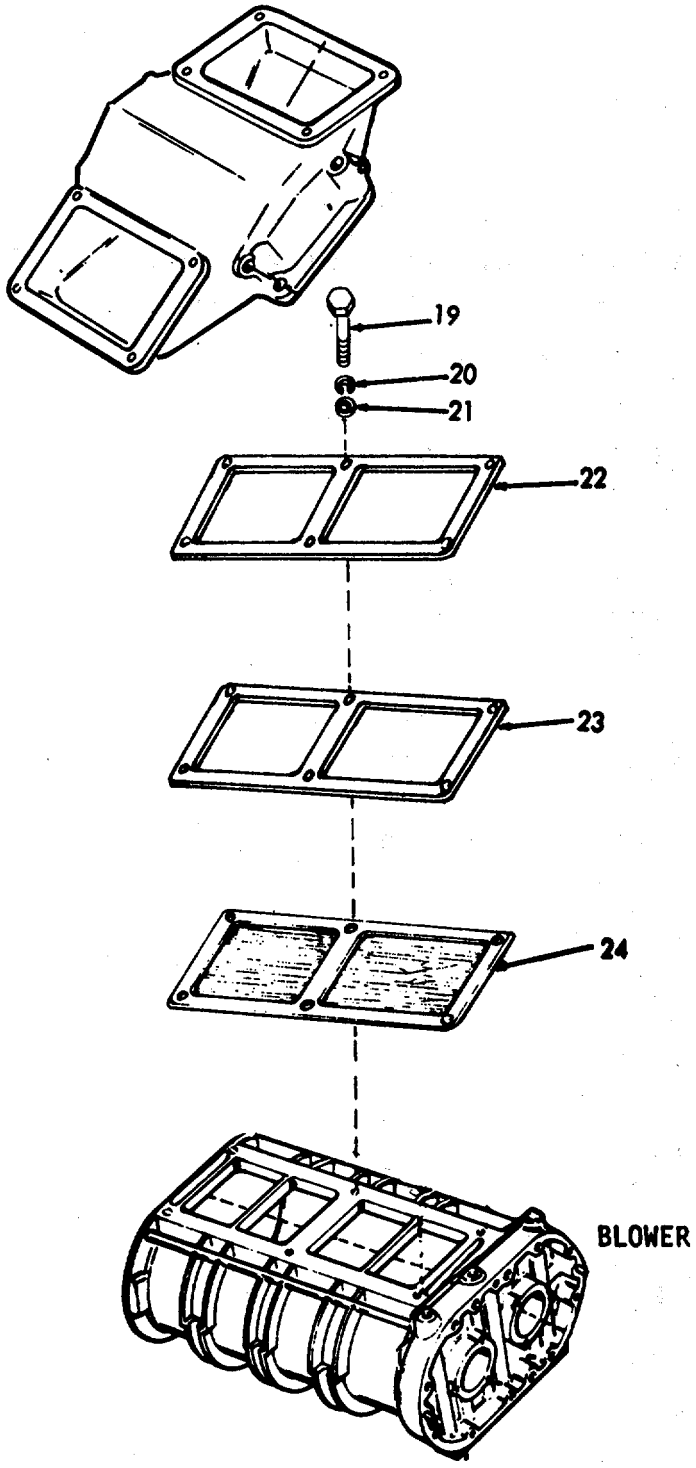
NOTE

Clean all of the parts thoroughly, including the blower screen, with fuel oil and dry them with compressed air. Inspect the parts for wear or damage. The face of the shutdown valve must be perfectly flat to assure a tight seal when it is in the shutdown position.

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)

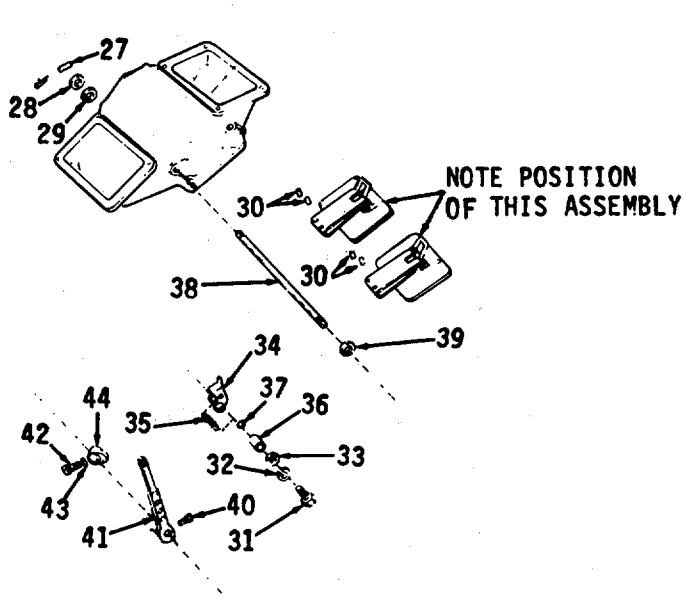


3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair			
5. Air intake housing			
		NOTE Repair is to the aft air intake housing. The forward air intake housing is similar.	
	a. Roll pin (27)	Remove.	
	b. Flat-washer (28)	Remove.	
	c. Seal ring (29)	Remove.	
	d. Hinge pins (30)	Remove.	
	e. Screw (31), lock-washer (32), and flat-washer (33)	Remove.	Components attach latch to housing.
	f. Latch (34), spring (35), spacer (36), and flat-washer (37)	Remove.	

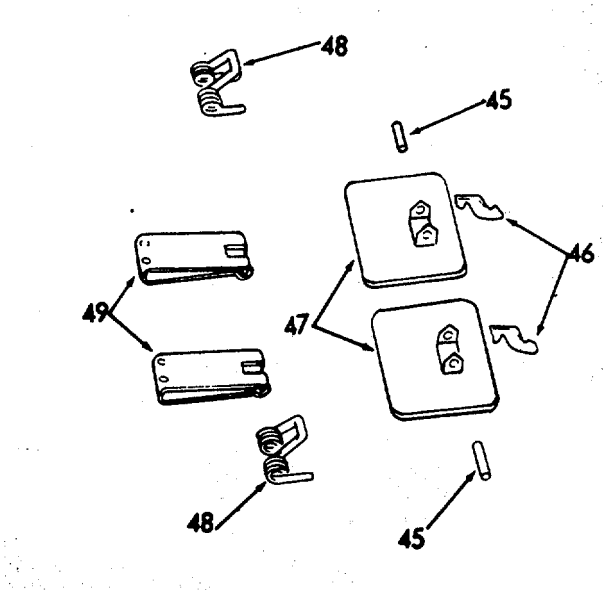
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
	g. Shaft (38), and seal ring (39)	Remove.	Before removing, note the position of the air shutdown valve spring and valve. The hinge, spring, and valve will be released as an assembly.
	h. Screw (40)	Remove.	
	i. Reset lever (41)	Remove from shaft.	
	j. Screw (42), and lock-washer (43)	Remove.	
	k. Cam (44)	Remove from shaft.	



3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

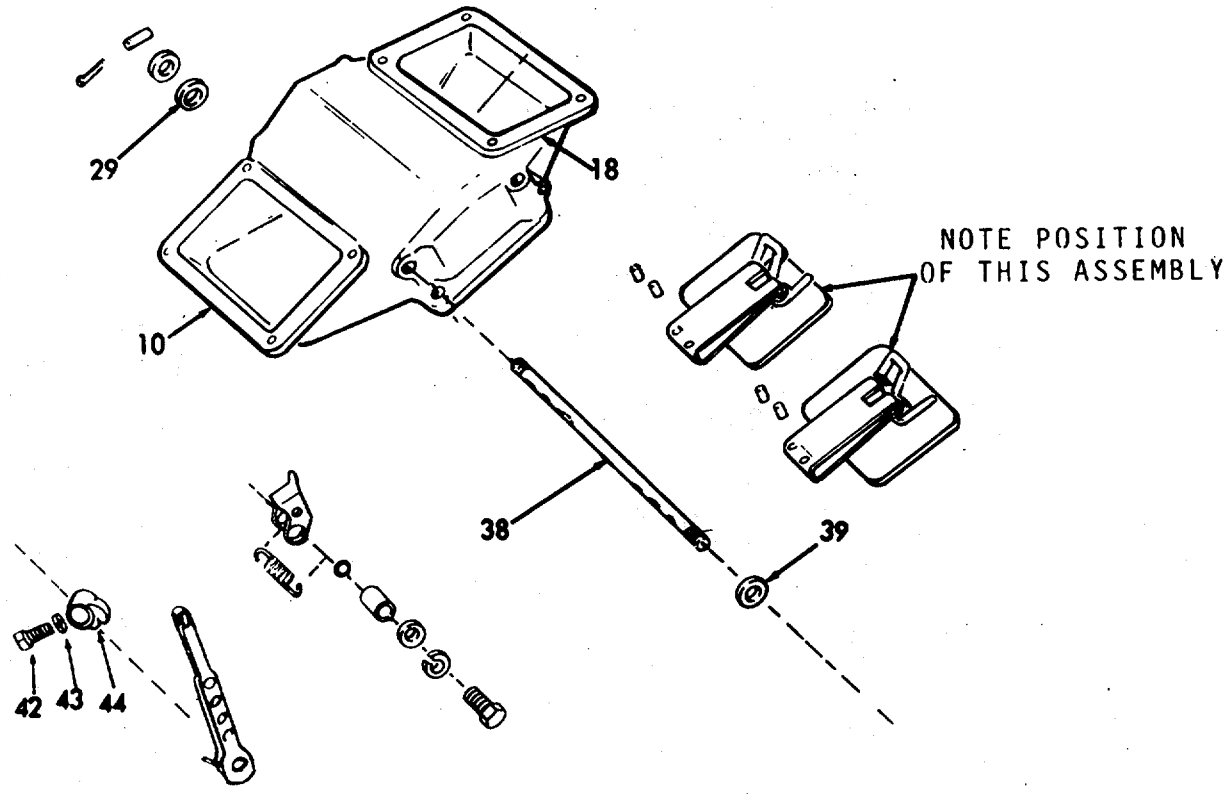
LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
6. Air shutdown valve	a. Pin (45), valve spring hinge (46), and shutdown valve (47)	Disassemble.	Check for damaged shutdown valves.
	b. Spring (48), and valve hinge (49)	Disassemble.	



	c. Spring (48), and valve hinge (49)	Assemble.	
	d. Shutdown valve (47), spring hinge (46) and pin (45)	Assemble.	

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
7. Air intake housing	a. Shutdown valve assembly and shaft (38)	Assemble in housing (10 or 18)	Shaft must extend .7 inch (1.8 cm) toward shutdown latch.
	b. Seal rings (29 and 39)	Slide on shaft. Be sure seal is seated in counterbore of housing.	Lubricate and use new seal rings.
	c. Cam (44), screw (42), and lockwasher (43)	Assemble.	Do not tighten.



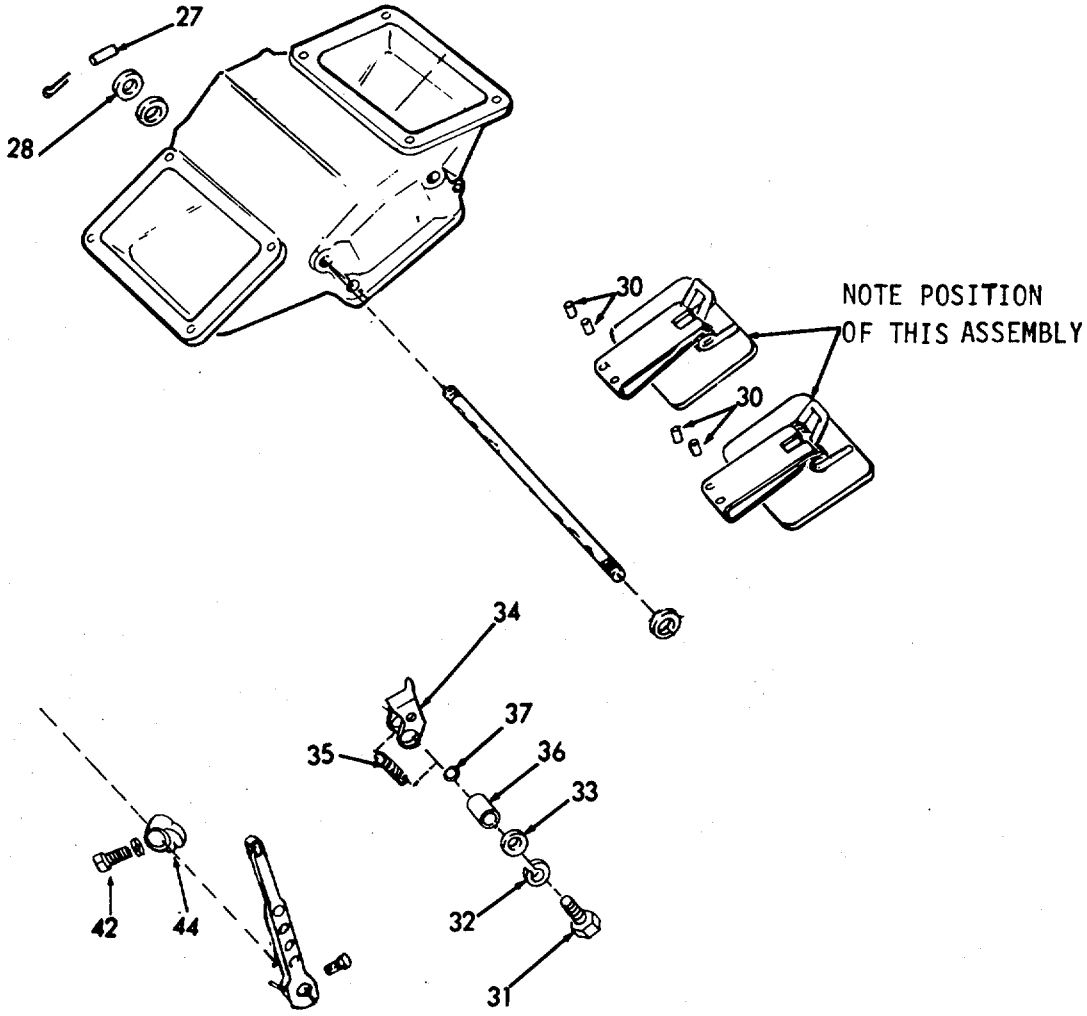
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
	d. Flat-washer (28), and roll pin (27)	Install on shaft.	On opposite ends of housings.
	e. Latch (34), spring (35), flat-washer (37), spacer (36), flat-washer (33), lock-washer (32), and screw (31)	Assemble to housing.	Screw is 1/4-20.
	f. Cam (44), and latch (34)	Align.	Align notch on cam with the notch on the latch and lock the cam in this position with lock screw (42).
	g. Pins (30)	Install.	Install the pins in the valve(s) to retain it to the shaft with the cam release latch set and the valve(s) in the run position.

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Repair (Cont)



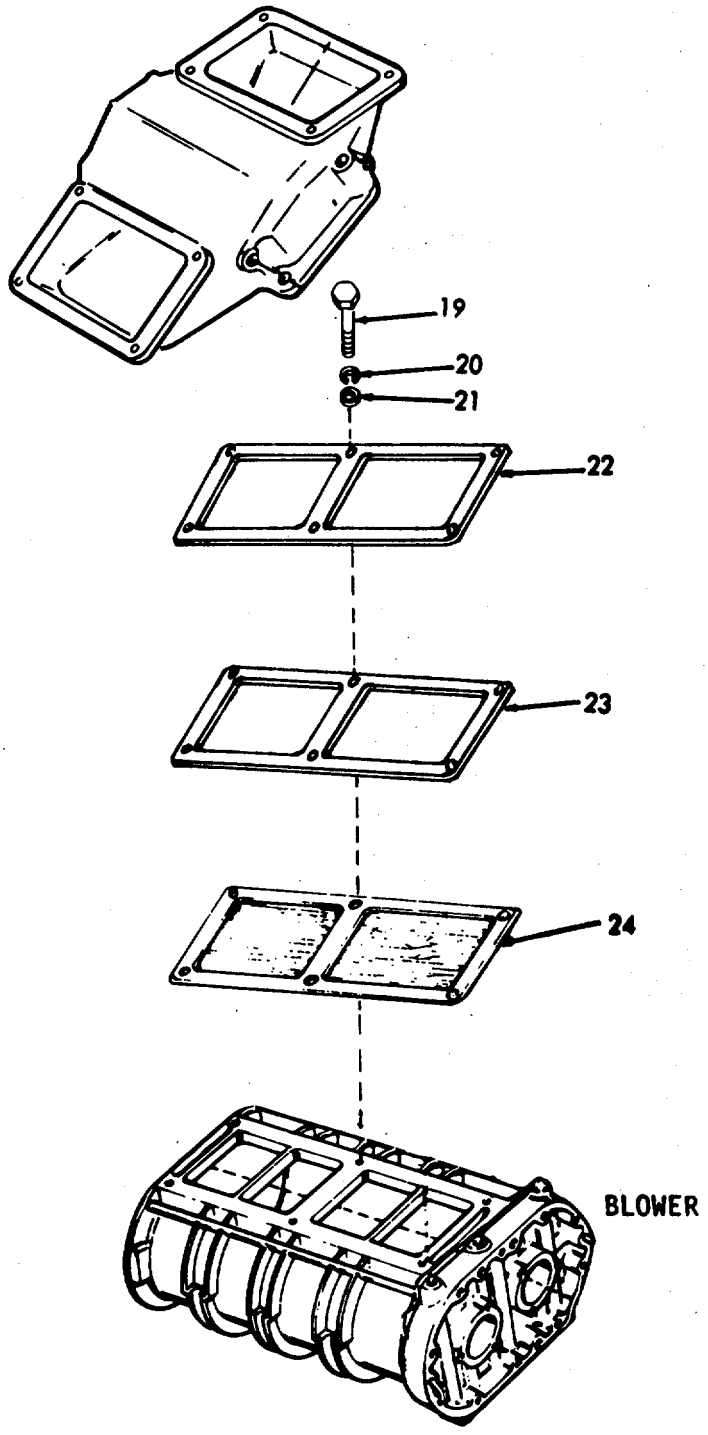
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
	h. Valves	Level the valves in the shutdown position.	
	i. Cam	Adjust.	1. Adjust the cam so the valve(s) contact the housing when the cam release latch is set. 2. After assembly check for .015"-.040" (0.038 - 0.102 cm) shaft end play.
Installation			
8. Striker plate (forward and aft)	a. Blower screen (24), gasket (23), and striker plate (22)	Align with holes in blower.	Use new gasket and blower screen.
	b. Screws (19), lock-washers (20), and flat-washers (21)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7-27.1 Nm).
9. Aft air intake	a. Air in-take (18)	Align with holes in striker plate.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7-27.1 Nm).

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Installation (Cont)



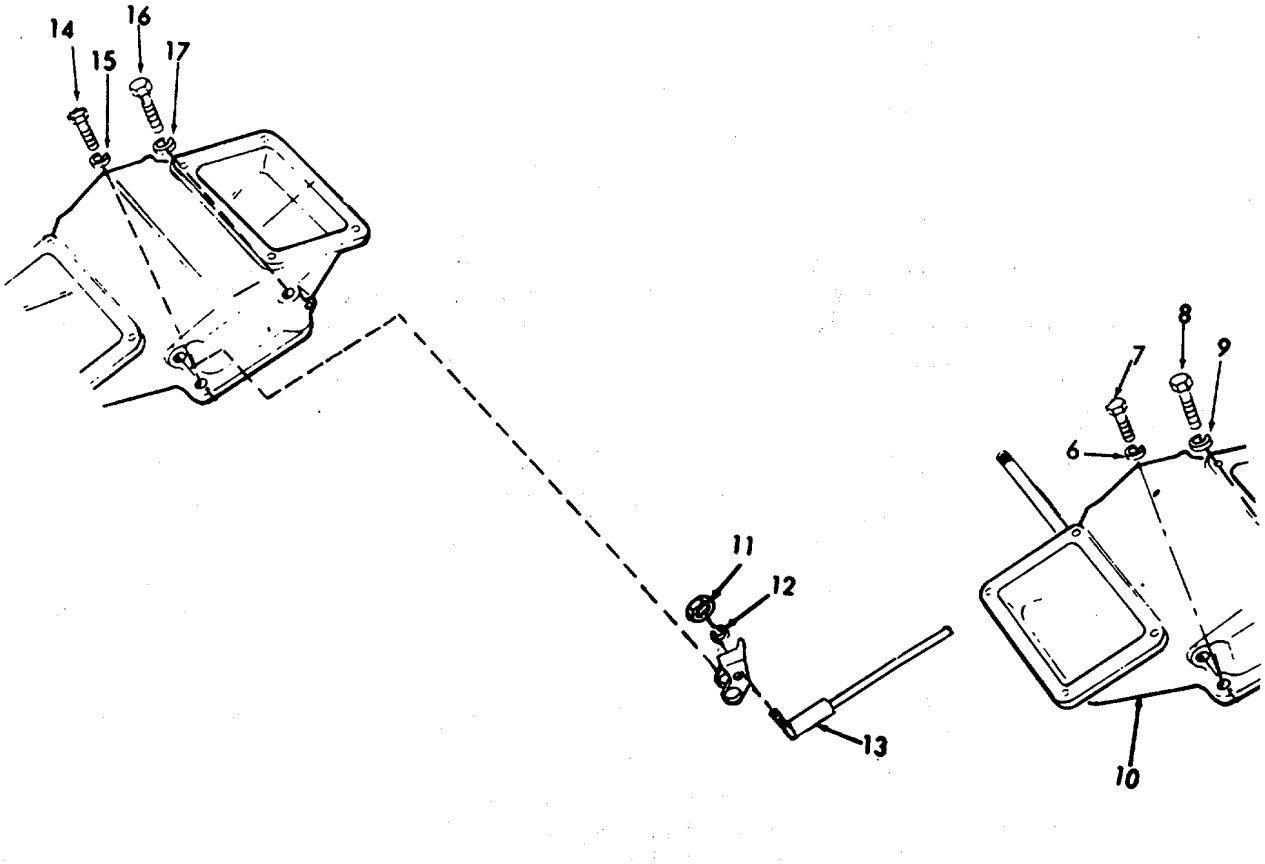
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	b. Screws (16), and lock-washers (17)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7-27.1 Nm).
	c. Screws (14), and lock-washers (15)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7 - 27.1 Nm).
	d. Ball joint (13)	Install.	
	e. Nut (11), and lock-washer (12)	Install.	
10. Forward air in-take	a. Air in-take (10)	Align with holes in striker plate.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7 - 27.1 Nm).
	b. Screws (8), and lock-washers (9)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7 - 27.1 Nm).
	c. Screws (6), and lock-washers (7)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7 - 27.1 Nm).

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Installation (Cont)



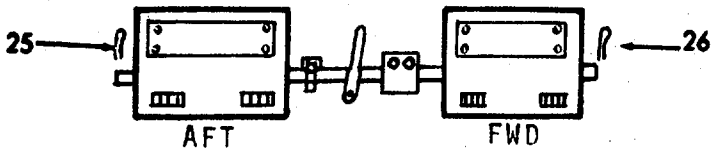
3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

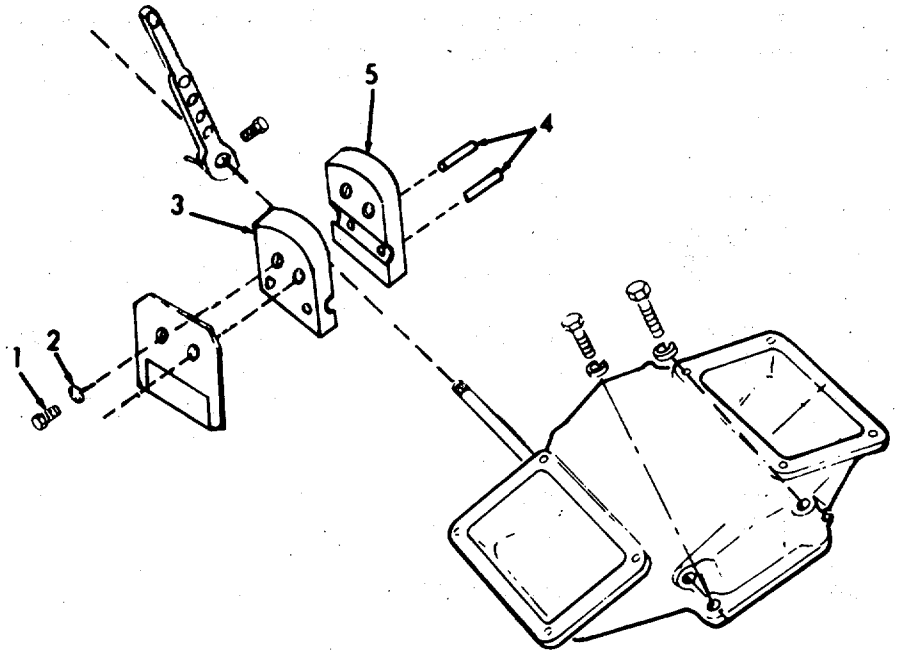
LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	d. Coupling back (5), coupling cover (3), screws (1), and lock-washers (2)	Install.	Screws 3/8-16. Torque to 16-20 lb-ft (21.7 - 27.1 Nm).
		CAUTION	
	Before securing the couplings, close the valves in both of the shutdowns and center the couplings on both housing shafts with the aid of new cotter pins.		
Adjustment			
11. Engine	a. Cotter pins (25 and 26)	Install and adjust. Refer to caution above.	Use new cotter pins.
	b. Screws (1)	Tighten.	Tighten to 21-26 lb-ft (28.5-35.3 Nm)
	c. Air shut-down	1. Reset to run position.	Valves in open position.
		2. Start and run the engine at idle speed and no load. Trip the air shutdown. If the engine does not stop, check it for air leakage between valves and the strike plates. If neces-sary, reposition the valves.	
		3. After this test has been satisfactorily performed, pin the couplings to the shafts with roll pins (4).	

3-11.2. AIR INTAKE HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Adjustment (Cont)





3-12. BLOWER - MAINTENANCE INSTRUCTIONS.

a. General.

(1) The blower supplies fresh air for combustion and scavenging to the diesel engine. Two hollow three-lobe rotors revolve with very close clearances in a housing bolted to the top deck of the cylinder block, between two banks of cylinders. The rotor lobes are made with a helical (spiral) form to provide continuous and uniform displacement of air.

(2) The blower has a 2.05:1 ratio blbwer-to-engine speed. Two timing gears on the drive end of the rotor shafts space the rotor lobes with a close tolerance. As the lobes of the two rotors do not touch at any time, no lubrication is required.

(3) Lip type oil seals are installed in the blower end plates. Each rotor is supported in the doweled end. plates of the blower housing by a roller bearing at the front end and a two row pre-loaded radial and thrust ball bearing at the gear end. The right-hand helix rotor of the blower is driven at approximately twice engine speed by the blower drive shaft. The blower drive shaft is splined at one end to a flexible drive hub attached to the blower drive gear and at the other end to a flexible coupling attached to the right-hand helix blower timing gear. The mating left-hand helix timing gear drives the left-hand helix rotor.

(4) The flexible coupling, formed by an eliptical cam driven by two bundles of leaf springs which ride on four semi-cylindrical supports, is attached to the blower right-hand helix timing gear and prevents the transfer of torque fluctuations to the blower.

(5) The blower rotors are timed by two rotor gears at the rear end of the rotor shafts. This timing must be correct, or the required clearance, obtained by the use of shims behind the gears, and between the rotor lobes will not be maintained.

(6) Normal gear wear causes a decrease of rotor-to-rotor clearance between the leading edge of the right-hand helix (drive) rotor and the trailing edge of the left-hand helix (driven) rotor. Clearance between the opposite sides of the rotor lobes is increased correspondingly.

(7) While the rotor lobe clearance may be corrected by adjustment, gear backlash cannot be corrected. When gears have worn to the point where the backlash exceeds .004 inch (0.01 cm), replace the gears. Refer to DIRECT SUPPORT MAINTENANCE.

3-12. BLOWER - MAINTENANCE INSTRUCTIONS.

b. Lubrication.

(1) The blower bearings, timing gears, governor drive and fuel pump drive are pressure lubricated by oil passages in the top deck of the cylinder block which lead from the main oil galleries to an oil passage in each blower end plate.

(2) A cup shaped oil strainer in the vertical oil passage at the bottom of each blower end plate removes any foreign material in the lubricating oil. The oil flows upward in the end plate and leaves through a small orifice just above the centerline of the end plate. The oil is ejected from this orifice against the timing gears at the rear and the governor weights at the front of the blower and is then carried by splash to the bearings. Oil which collects at the bottom of each end plate overflows into two drain passages which lead back to the crankcase via oil passages in the cylinder block.

(3) The blower drive support bearings receive oil under pressure from a tube which connects the oil passage in the rear end plate to passages in the blower drive support. Excess oil drains back to the crankcase by way of the gear train.

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection
b. Removal
c. Installation
d. Repair

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Torque Wrench

Material/Parts
Blower installation gasket kit P/N 5196386
Engine overhaul gasket kit P/N 5196375
Scotch grip rubber adhesive #9300 or equivalent

Personnel Required
2

References
NONE

Equipment Condition

Condition	Condition Description
3-9.3	Emergency Shut-off Disconnect
3-10	Governor Removal
3-11	Air Intake Removal
3-13	Fuel Pump Removal

Special Environmental Condition
NONE

General Safety Instructions

WARNING

When inspecting a blower on an engine while running, keep fingers and clothing away from moving parts and run engine at low speeds only.

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Inspection

The blower may be inspected for any of the following conditions without being removed from the engine. However, the air silencer and adaptor, or the air inlet housing, air shutdown housing and adaptor must first be removed.

WARNING

When inspecting a blower on an engine with the engine running, keep fingers and clothing away from moving parts and run the engine at low speeds only.

a. Dirt or chips, drawn thru the blower, will make deep scratches in the rotors and housing, and throw up burrs around such abrasions. If burrs cause interference between the rotors and the housing, replace the blower(s).

b. Leaky oil seals are usually manifest by the presence of oil on the blower rotors or inside surfaces of the housing. This condition may be checked by running the engine at low speed and directing a light into the rotor compartment at the end plates and the oil seals. A thin film of oil radiating away from the seals toward the inlet of the blower is indicative of leaking seals.

c. A worn blower drive, resulting in a rattling noise inside the blower, may bedetected by grasping the right-hand helix rotor firmly and attempting to rotate it. The rotors may move from 0.3750 inch (0.9525 cm) to 0.625 inch (1.588 cm), measured at the lobe crown, with a springing action. When released, the rotors should move back at least 0.250 inch (0.635 cm). If the rotors cannot be moved as directed above, or if the rotors move too freely, the flexible blower drive coupling should be inspected and replaced if necessary. The drive coupling is attached to the right-hand helix blower timing gear.

d. Loose rotor shafts or damaged bearings will cause rubbing and scoring between the crowns of the rotor lobes and the mating rotor roots, between the rotors and the end plates, or between the rotors and the housing. Generally, a combination of these conditions exists. Worn or damaged bearings will cause rubbing between mating rotor lobes at some point or perhaps allow the rotor assemblies to rub the blower housing or the end plates. This condition will usually show up at the end where the bearings have failed. Replace the blower(s).

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

Inspection (Cont)

e. Excessive backlash between the blower timing gears usually results in the rotor lobes rubbing throughout their entire length. This usually is on the trailing (close clearance) side. Replace the blower(s).

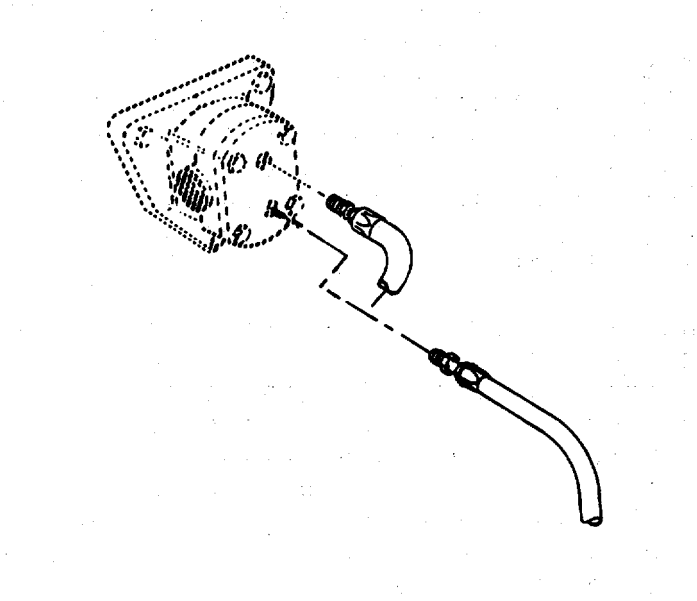
f. Inspect the blower inlet screen periodically, for an accumulation of dirt which, after polonged operation, may affect the air flow. Servicing of the screen consists of thoroughly washing it in fuel oil and cleaning with a stiff brush until the screen is free of all dirt deposits. If broken wires are found in the blower screen, replace the screen.

g. Check the lubricating oil connection between the blower and the blower drive support for excessive oil leakage. If oil leakage exists, retighten or replace the fittings.

To correct any of the conditions cited in Items 1 through 6,the blower must be removed from the engine and returned to Direct Support Maintenance.

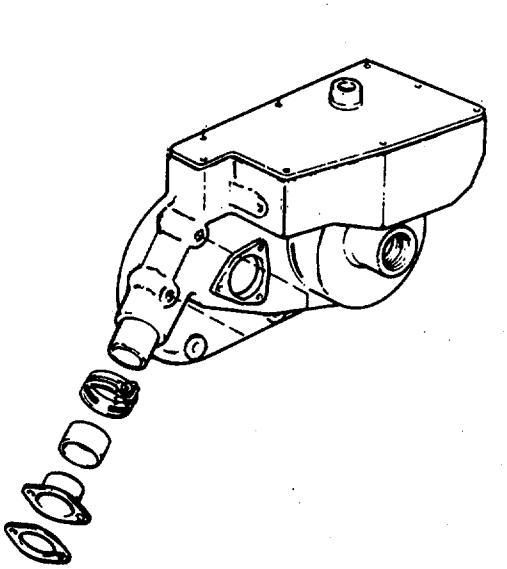
Removal

1.	Fuel pump	Fuel hoses	Remove.	Refer to paragraph 3-13. The fuel pump does not have to be removed.



3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
2. Governor	Injector control rods	Remove.	Refer to paragraph 3-10. The governor does not have to be removed.



NOTE

The engine governor components are assembled in a combination governor housing and blower front end plate cover. The fuel pump is also attached to the front end of the governor. Therefore, when removing the blower assembly from the engine, the fuel pump and governor will also be removed at the same time.

3. Air intake	a.	Air intake housing and silencers	Remove.	Refer to paragraph 3-11.

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	b. Blower screen (1)	Remove.	
4. Blower (Forward	a. Bolts 2) and special washers (3)	Remove.	
	b. Bolts (4) and retaining washers (5)	Remove.	
	c. Clamp (6)	Remove.	
	d. Seal (7)	Loosen.	
	e. Blower (8)	Remove.	Slide forward to disengage blower drive chain (9).

NOTE

The fuel pump, governor, and blower are removed as a unit. Refer to fuel pump and governor maintenance instructions for removal and maintenance procedures.

	f. Gasket (10)	Remove.	Discard.

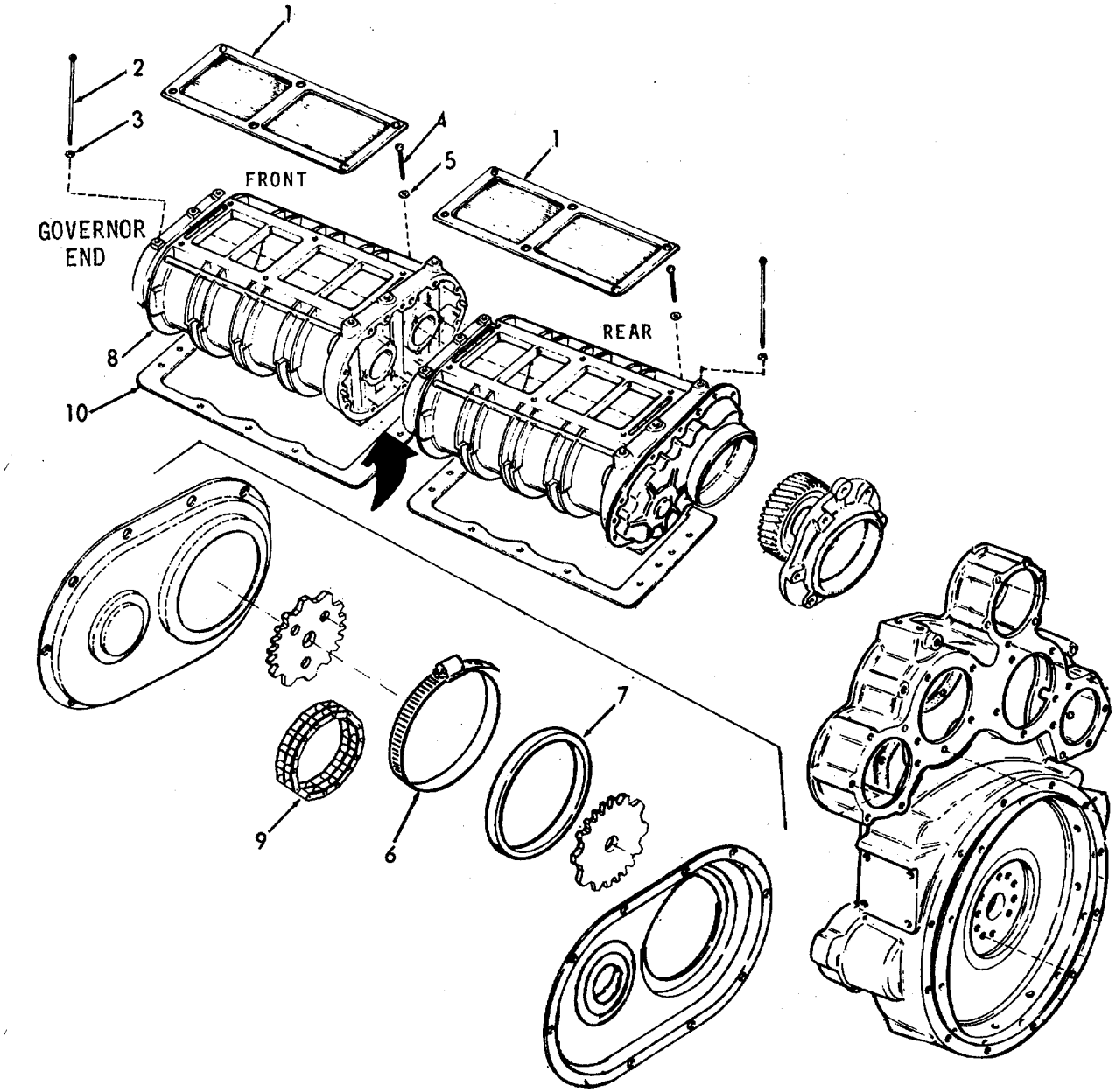
NOTE

If the rear blower is to be removed, proceed. If not, proceed to step 7.

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

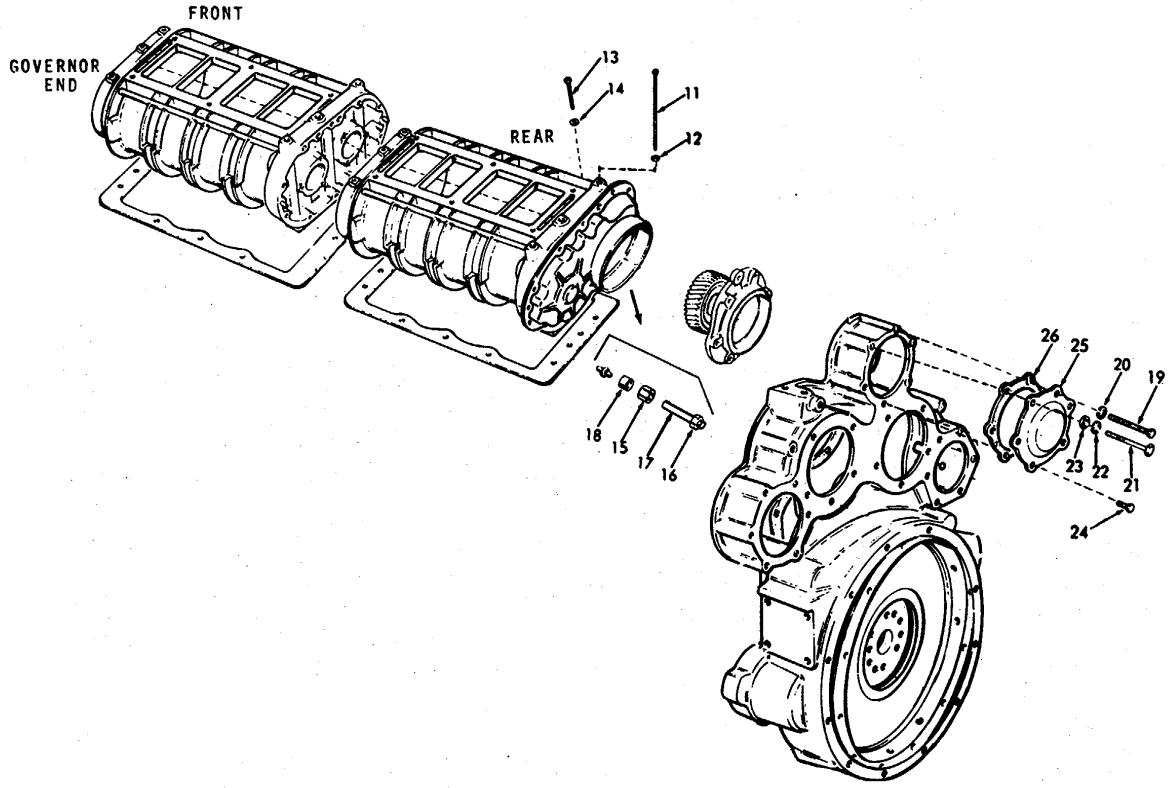
LOCATION	ITEM	ACTION	REMARKS

Removal (Cont)



3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
5. Blower (rear)	a. Bolts (11) and special washers (12).	Remove.	
	b. Bolts (13) and retaining washers (14)	Remove.	
	c. Tube nut (15)	Loosen.	
	d. Pipe to tube connector (16)	Remove.	
	e. Tube (17)	Remove.	
	f. Tube nut (15), and tube seal ring (18)	Remove.	
	g. Screw (19) and lockwasher (20)	Remove.	
	h. Screw (21), lockwasher (22), and flatwasher (23)	Remove.	
	i. Screw (24)	Remove.	


FRONT
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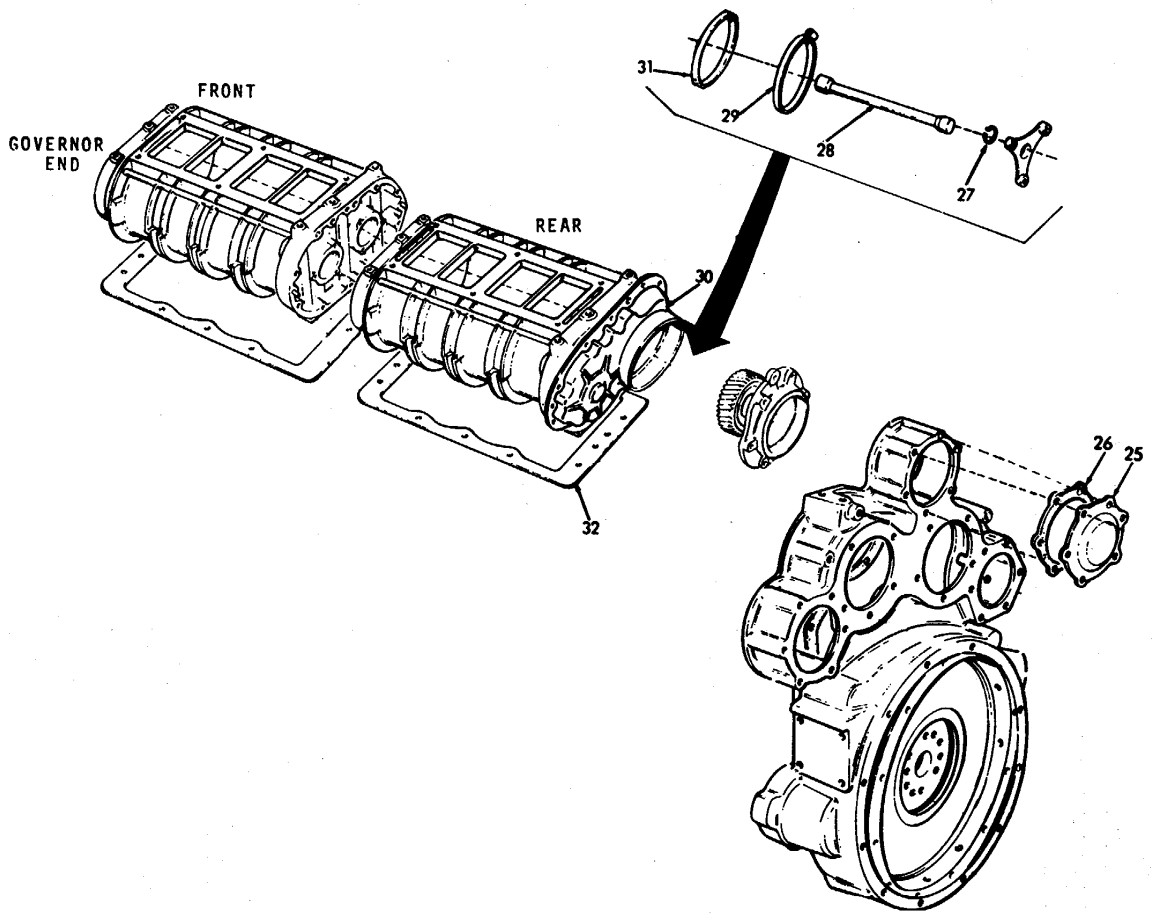
3-471

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	j. Cover (25)	Remove.	
	k. Gasket (26)	Remove.	Discard.
	l. Snap ring (27)	Remove.	
	m. Blower drive shaft (28)	Remove.	Remove through access in fly-wheel housing.
	n. Clamp (29)	Loosen.	
	o. Blower (30)	Move forward.	Slide forward to disengage blower drive cover seal (31).
	p. Blower (30)	Remove.	
	q. Gasket (32)	Remove.	Discard.
Installation			
6. Blower (rear)	a. Blower drive cover seal (31), and clamp (29)	Place on end of blower drive support.	
	b. Gasket (32)	Align with holes on en-gine.	Use scotch grip rubber adhesive No. 4300 or equivalent.



3-473

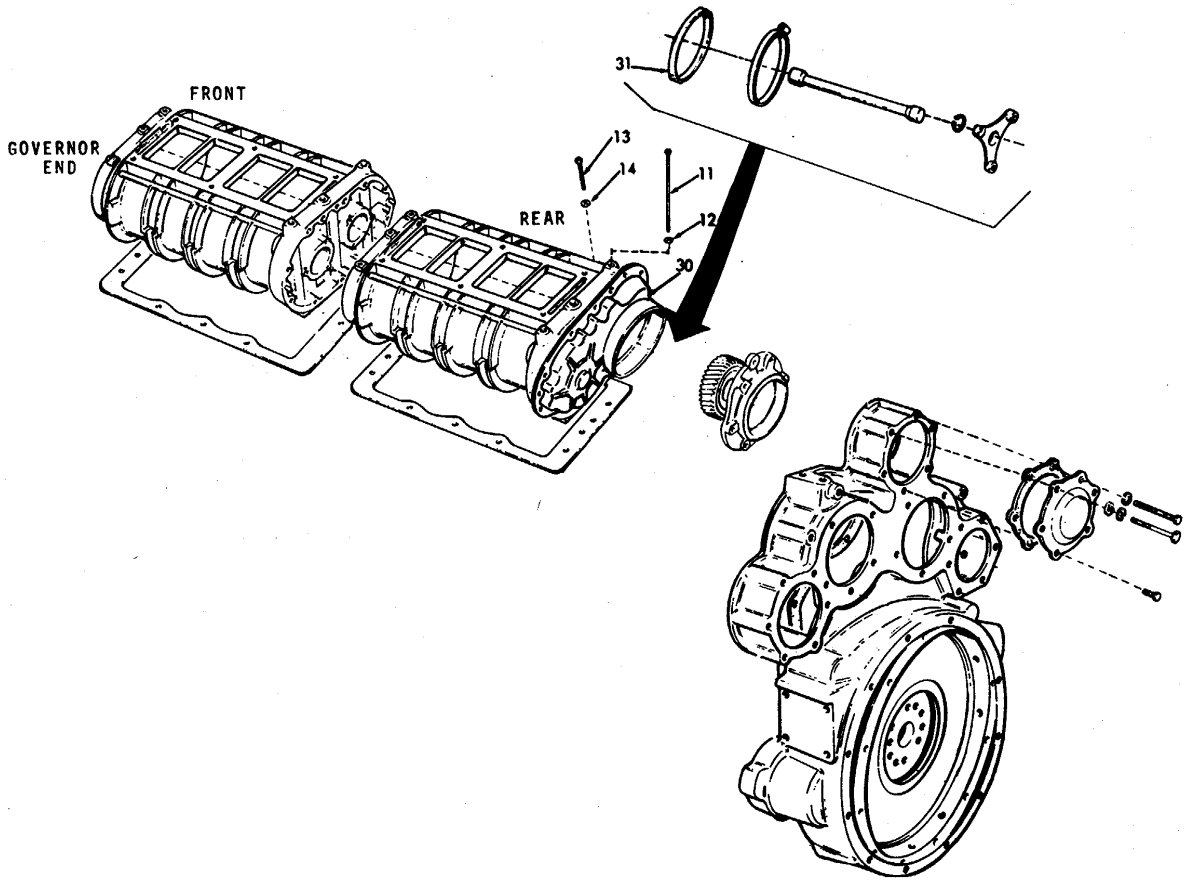
3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	c. Blower (30)	Install.	Lift at a slight angle and position it on the cylinder block, with the flange of the end plate inside the seal ring.
	d. Blower drive cover seal (31)	Install.	
	e. Bolts (11) and special washers (12)	Install.	Place bolts 7/16"-14 x 8 1/4" in center holes of blower end plates.
	f. Bolts (13) and retaining washers (14)	Install.	Use bolts 3/8"-16 x 5 1/2" and retaining washers. Tighten finger tight.

NOTE

The lip at the beveled end of the bolt retaining washer goes in the small recess in the housing just above the bolt hole.

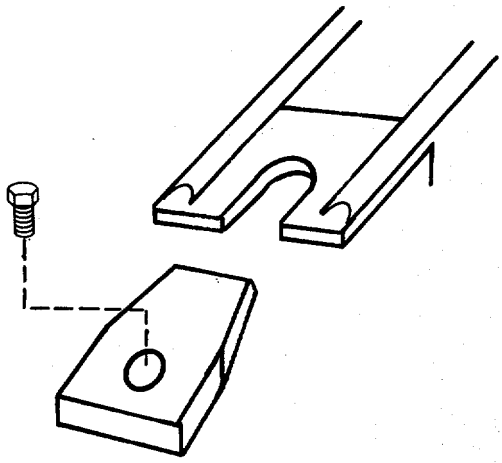
	g. Bolts (11)	Tighten.	Tighten to 40-45 lb-ft (54-61 Nm) torque.
	h. Bolts (13)	Tighten.	Tighten uniformly to 30-35 lb-ft (41-47 Nm) torque in 5 lb-ft (7 Nm) increments.
	i. Bolts (11)	Retighten.	



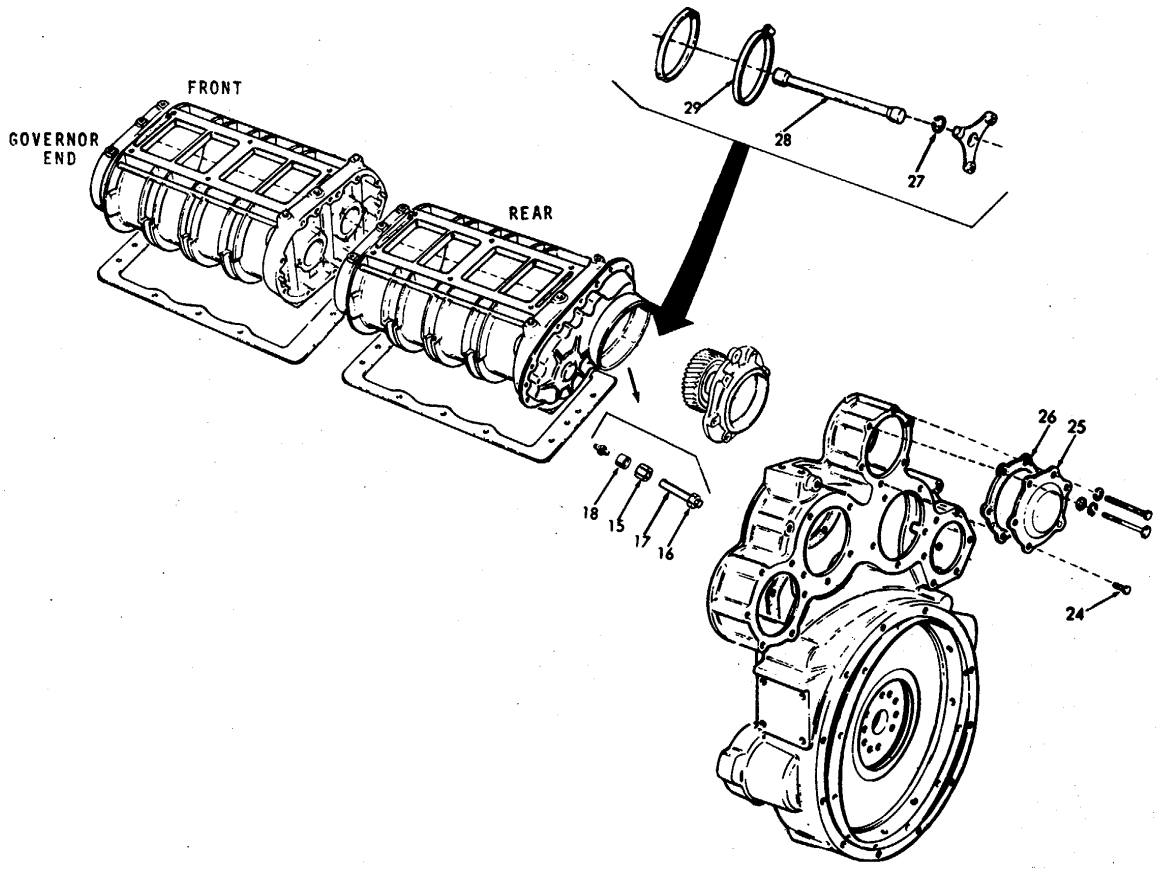
3-475

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	j. Clamp (29)	Tighten.	
	k. Tube (17), tube nut (15), tube seal ring (18), and pipe to tube connector (16)	Install.	
	l. Blower drive shaft (28)	Install.	Insert shaft through the blower, drive flexibe coupling and into the blower drive coupling.



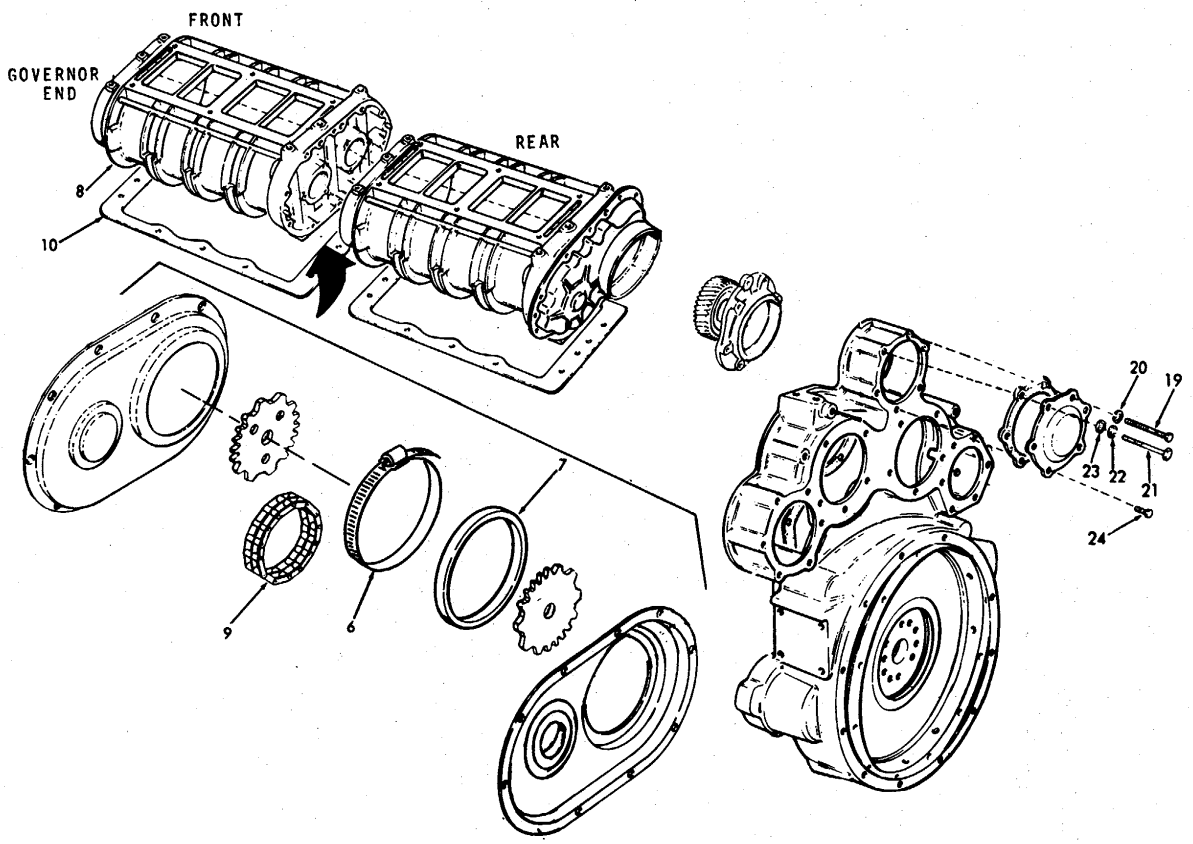
	m. Snap ring (27)	Install.	
	n. Cover (25) and gasket (26)	Align holes.	Use new gasket.
	o. Screw (24)	Install.	



3-477

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

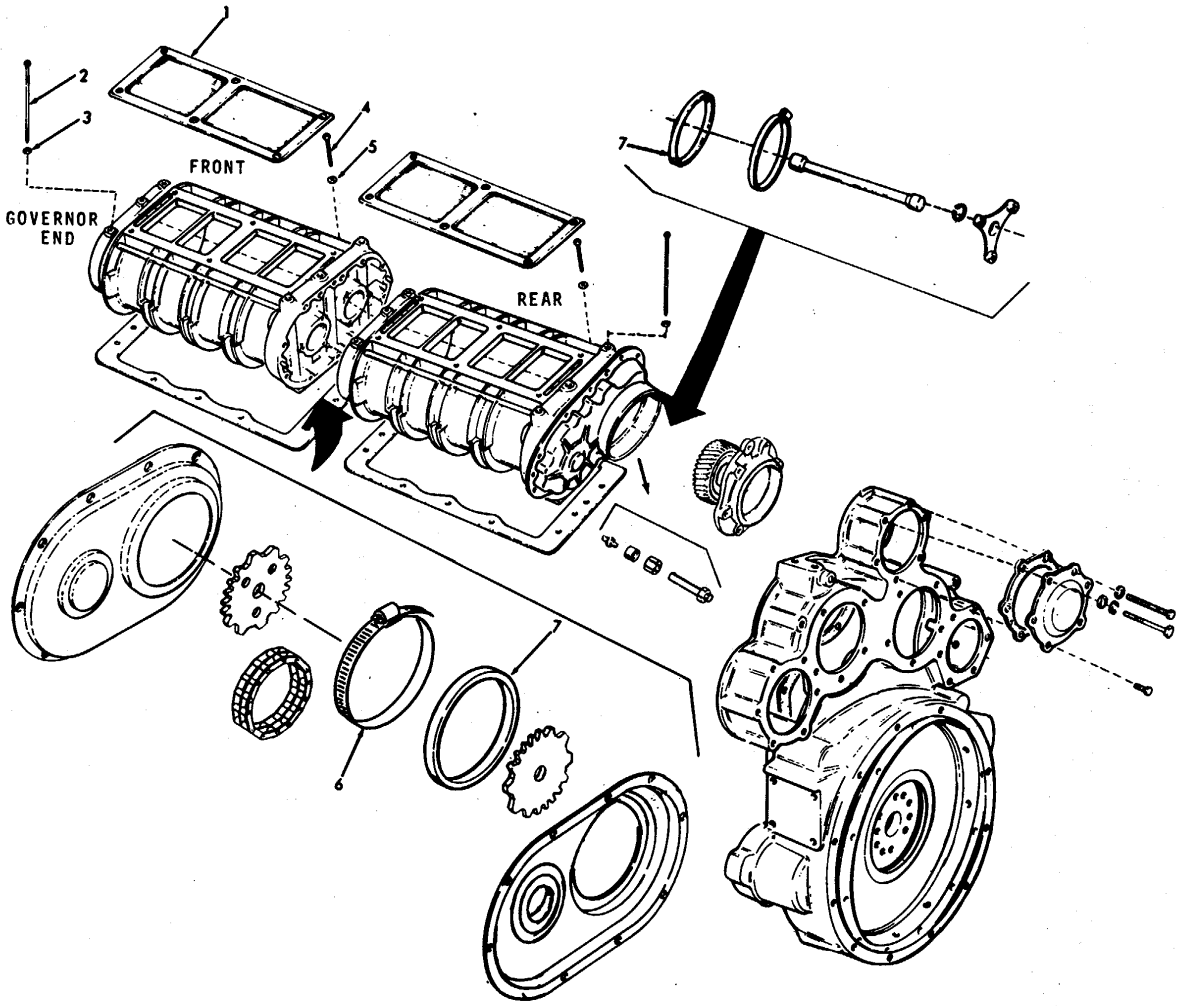
LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	p. Screw (21), lock-washer (22), and flat-washer (23)	Install.	
	q. Screw (19) and lockwash-er (20)	Install.	
	r. Drive chain (9), blower seal (7), and clamp (6)	Install.	Position on rear blower.
7. Blower (front)	a. Gasket (10)	Align with holes on engine.	Use Scotch Grip Rubber Adhesive No. 4300 or equivalent.
	b. Blower (8)	Install.	Place the front blower in posi-tion on the cyl-inder block with the drive chain over the drive sprocket on the front blower. Make sure the drive chain is in position on the drive and driven sprock-ets.



3-479

3-12. BLOWER MAINTENANCE INSTRUCTIONS (Cont).

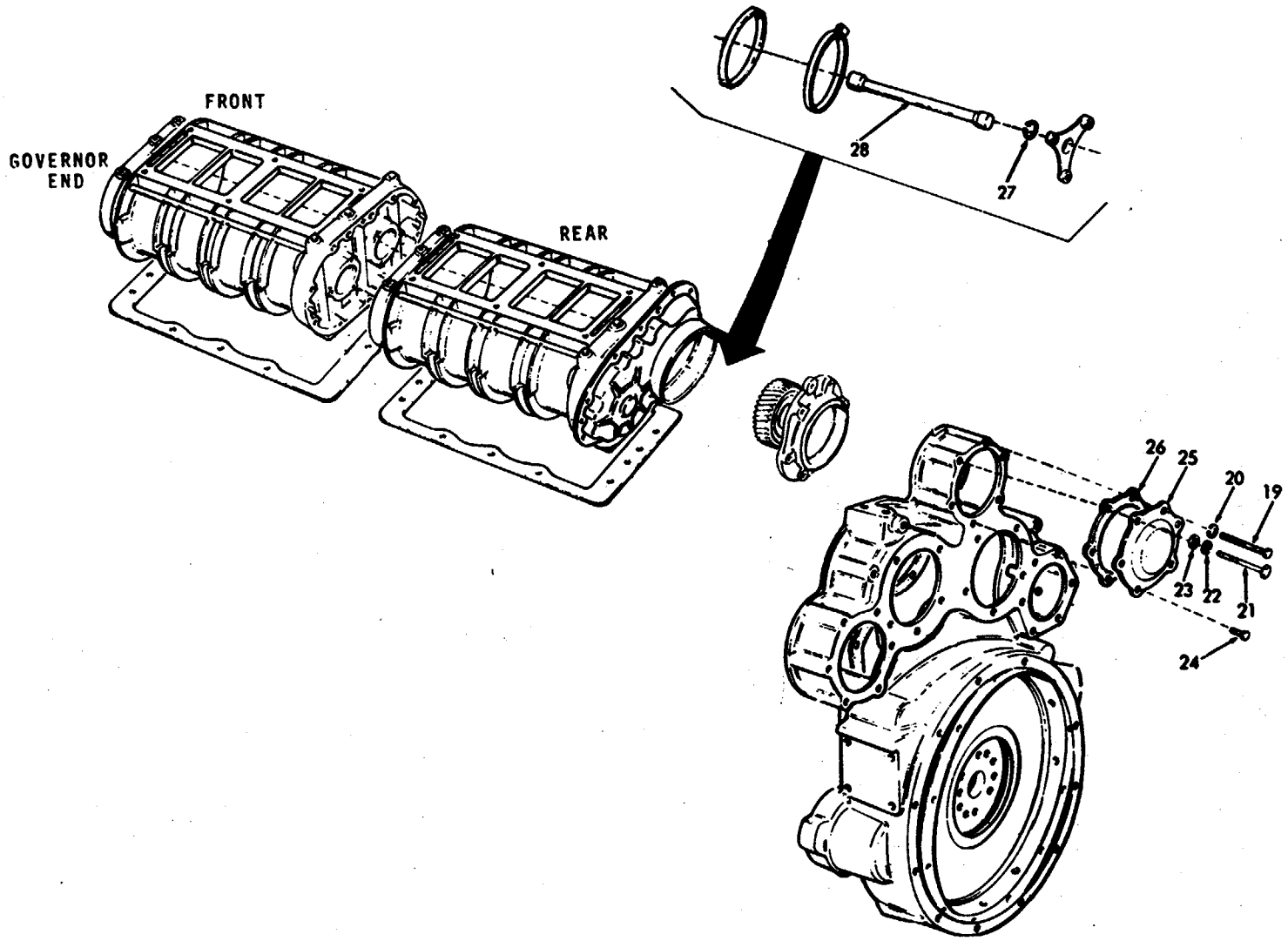
LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	c. Seal (7)	Slide into place.	
	d. Clamp (6)	Install and tighten.	
	e. Screw (2) and special washer (3)	Install.	Place bolts 7/16" - 14 x 8 1/4" in center holes of blower end plate.
	f. Bolts (4) and retaining washers (5)	Install.	Use bolts 3/8"-16 x 5 1/2" and retaining washers. Tighten finger tight.
		NOTE	
	The lip at the beveled end of the bolt retaining washer goes in the small recess in the housing just above the bolt hole.		
	g. Bolts (2)	Tighten.	Tighten to 40-45 lb-ft (54-61 Nm) torque.
	h. Bolts (4)	Tighten.	Tighten uniformly to 30-35 lb-ft (41-47 Nm) torque in 5 lb-ft (7 Nm) increments.
	i. Governor	Reconnect.	Refer to paragraph 3-10 .
	j. Fuel pump	Reconnect.	Refer to paragraph 3-13 .
	k. Air intake	Install.	Use new gaskets (1).



3-481

3-12. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	l. Emergency shutdown	Reconnect.	Refer to paragraph 3-9.3.
Repair			
8. Blower drive shaft	a. Bolts (19) and lockwashers (20)	Remove.	
	b. Bolt (24)	Remove.	
	c. Bolt (21), lockwasher (22), and flatwasher (23)	Remove.	
	d. Cover (25)	Remove.	
	e. Gasket (26)	Remove.	Discard.
	f.Slip ring (27)	Remove.	
	g. Blower drive shaft (28)	Remove.	
	h. Blower drive shaft (28)	Install.	Insert shaft through the blower drive flexible coupling and into the blower drive coupling.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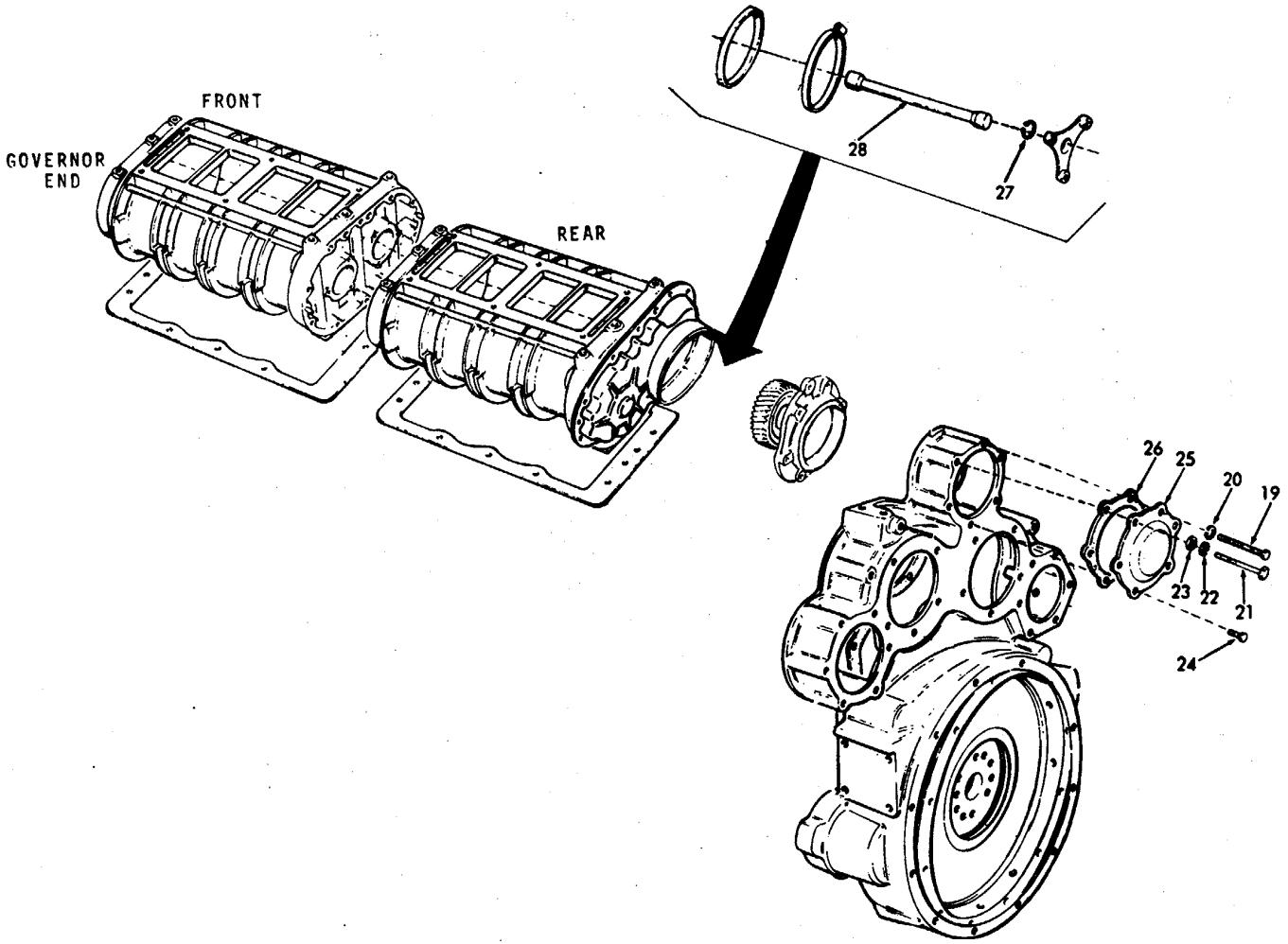
3-12. BLOWER MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			
	i. Slip ring (27)	Install.	
	j. Cover (25) and gasket (26)	Align holes.	
	k. Screw (24)	Install.	
	l. Screw (21), lock washer (22), and flat washer (23)	Install.	
	m. Screw (19) and lock washer (20)	Install.	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3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS.

a. The fuel pump is constructed to be basically trouble free. Clean, water-free fuel, and maintenance of the fuel filters, will give long, satisfactory service.

b. If the fuel pump fails to function satisfactorily:

- Check the level in the fuel tank.
- Make sure the fuel supply valve is open.
- Check for external fuel leaks at the fuel line connections, filter gaskets and air heater lines.
- Check for a broken pump drive shaft or drive coupling. Insert the end of a wire through one of the pump flange drain holes, and crank the engine momentarily. Note if the wire vibrates. Vibration will be felt if the pump shaft rotates.

c. All fuel pump failures result in no fuel or insufficient fuel being delivered to the fuel injectors and may be indicated by:

- Uneven running of the engine.
- Excessive vibration
- Stalling at idling speeds
- Loss of power.

d. The most common reason for a fuel pump to function improperly is a sticking relief valve. The relief valve, due to its close fit in the valve bore, may stick in a fully open, or partially open position. A small amount of grit or foreign material, lodged between the relief valve and its bore or seat will cause the fuel oil to circulate within the pump, rather than being forced through the fuel system.

e. After the relief valve has been checked, and the fuel pump reinstalled on the engine, start the engine. Check the fuel flow between the restricted fitting in the fuel return manifold at the cylinder head, and the fuel tank.

3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **c. Inspection/Cleaning** **e. Installation**
b. Disassembly/Inspection **d. Assembly**

INITIAL SETUP:

Test Equipment
NONE

Special Tools

Holding fixture 1508-10
Oil seal puller 1508-13
(Oil seal installer 1508-8 & 9)
Torque wrench

Material/Parts

Kit P/N 5196938
Vegetable shortening (Crisco)
Emery Cloth
Sealant

Personnel Required
1

References
NONE

Equipment

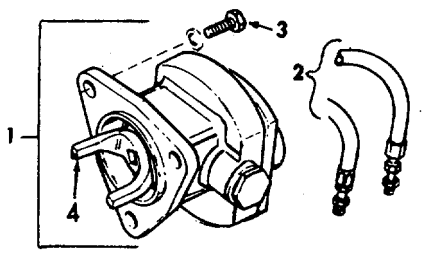
Condition	Condition Description
3-14.3	Fuel lines disconnected.

General Safety Instructions

WARNING

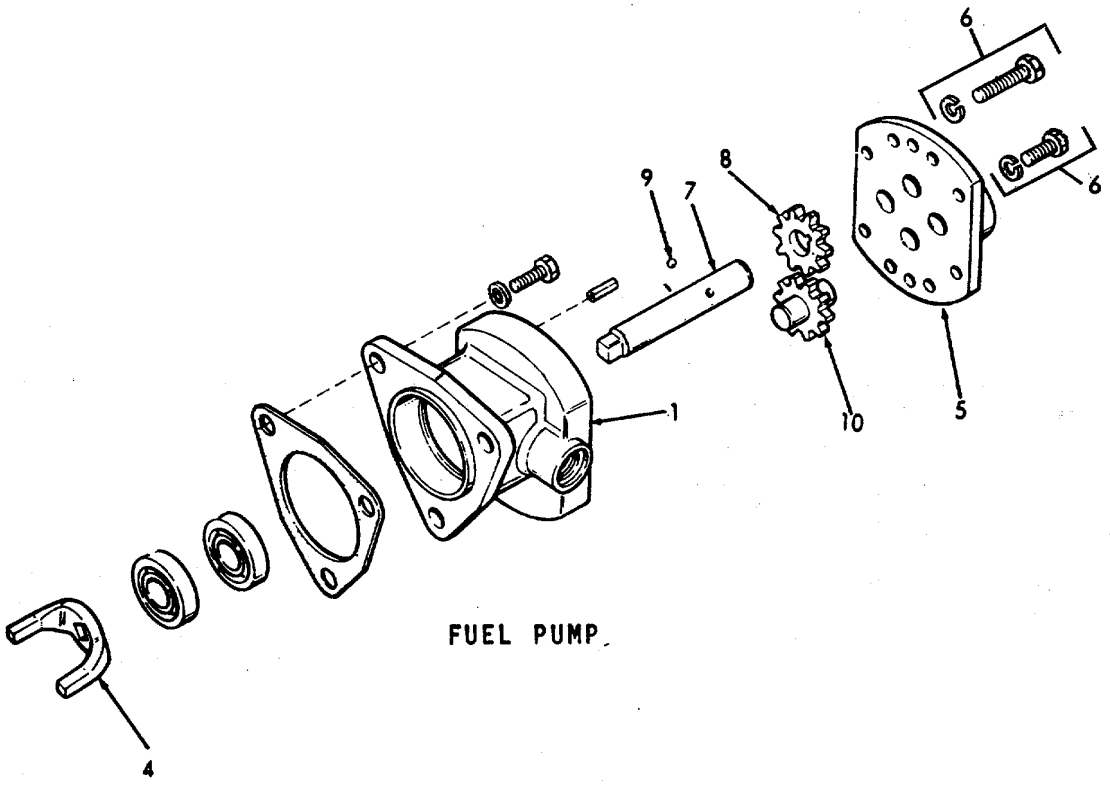
Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
Removal			
1. Fuel pump (1)	Fuel lines (2)	Disconnect.	
2. Governor housing	Fuel pump	Withdraw pump from housing.	Remove three bolts, washer and seal assemblies (3).



3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

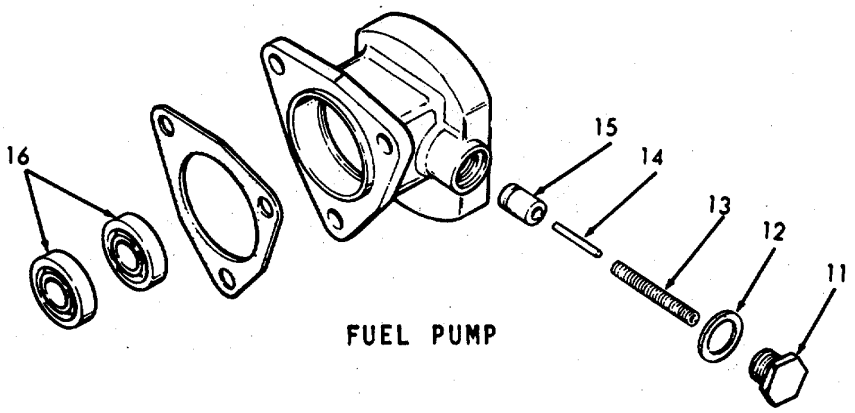
LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
3. End of fuel pump	Drive coupling fork (4)	Examine for damage or wear.	Replace if damaged or worn.
Disassembly and Inspection			
4.	Pump	Mount pump in holding fixture J1508-10 prior to disassembly.	
5. Pump body (1)	Pump cover (5)	Remove cover from body.	Remove right cover bolts and lockwashers (6).
6.	Drive shaft (7),drive gear (8), and gear retaining ball (9)	Withdraw as an assembly.	



FUEL PUMP

3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

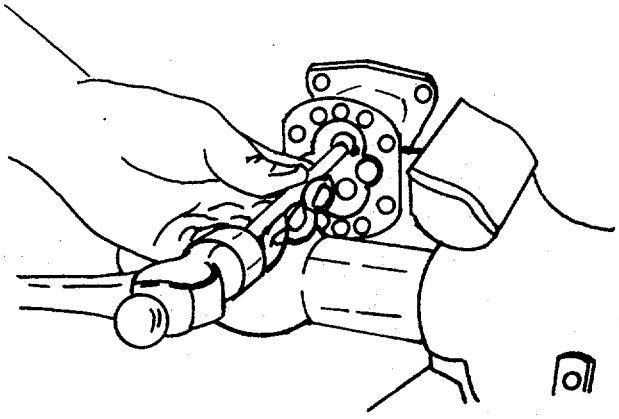
LOCATION	ITEM	ACTION	REMARKS
Disassembly and Inspection (Cont)			
7. Drive shaft	Gear retaining ball	Press drive shaft just enough to remove gear retaining ball; invert shaft, press shaft from gear.	Do not lose ball. Do not press squared end of shaft through gear as it will damage oil seal control surface.
8.	Driven gear and shaft assembly (10)	Remove from pump body as an assembly.	Do not separate gear and shaft.
9.	Relief valve plug (11) and copper gasket (12)	Unscrew and remove.	



FUEL PUMP

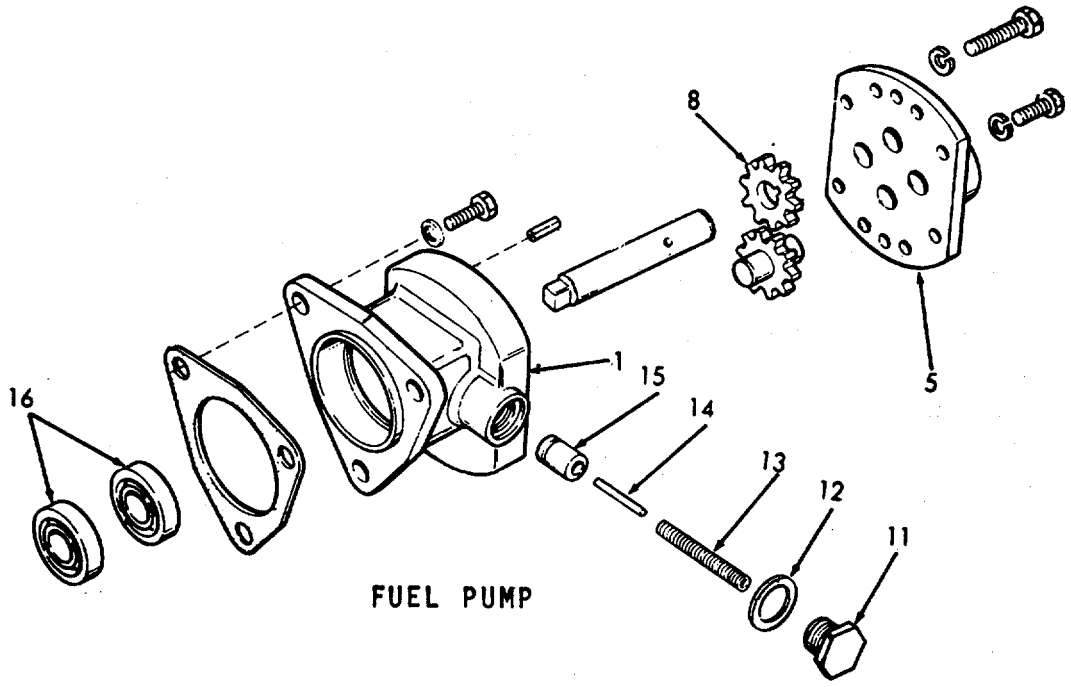
3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Disassembly and Inspection (Cont)			
10.	Valve spring (13), pin (14), and relief valve (15)	Remove from pump body.	
11.	Oil seals (16)	Inspect for damage, scores, and fit. To remove: Clamp pump body in bench vise. Tap end of tool with hammer.	Replace if necessary. Use tool J1508-13. Observe position of oil seal lips before removal so new seals can be replaced in same manner.



3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

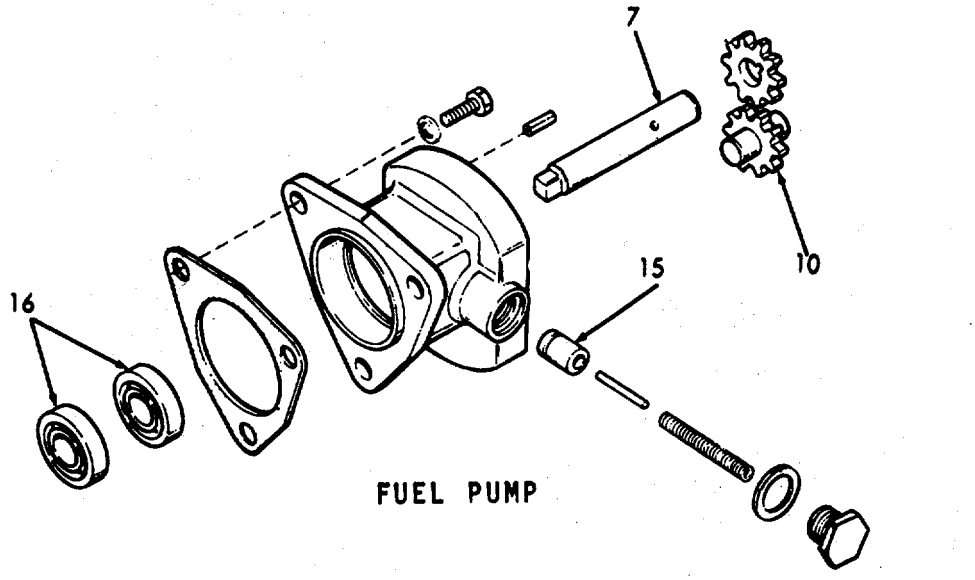
LOCATION	ITEM	ACTION	REMARKS
Inspection and Cleaning			
		WARNING Use eye protection when using compressed air.	
12.	All parts (not oil seals)	Clean all parts with clean fuel oil and dry with compressed air.	
13.	Pump body (1) and cover (5)	Check mating surfaces for scratches or other damage. Check for wear at areas contacted by gears and shafts. Replace if necessary.	Surface must fit flat and smooth.
14.	Gear (8)	Check gear teeth for chipping, scoring or wear. Check ball slot for wear.	Replace if necessary.



FUEL PUMP

3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

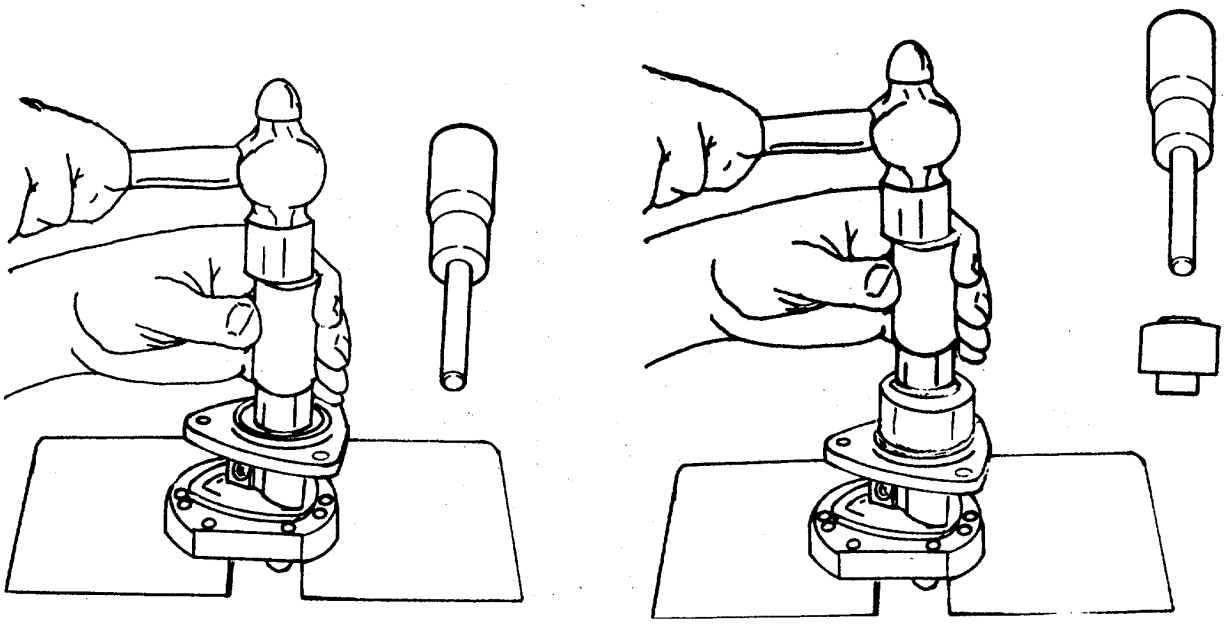
LOCATION	ITEM	ACTION	REMARKS
Inspection and Cleaning (Cont)			
15.	Drive shaft (7), driven gear and shaft assembly (10)	Check shafts for scoring or wear, and gear teeth (10) for scoring, chipping or wear.	Replace if necessary. Driven shaft and gear is serviced or replaced as an assembly only.
16.	Relief valve (15)	Make sure valve is free from burrs or scoring. Valve must fit its seat in body.	Clean scores or burrs with piece of emery cloth. Replace if valve cannot be cleaned.
17.	Oil seals (16)	If oil seals were removed from pump body, they must be replaced with new seals.	



FUEL PUMP

3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Assembly and Installation			
18.	Oil seals	Lubricate seals with thin coat of vegetable shortening.	
19. Pump	a. Inner oil seal	Place inner oil seal on pilot of installer handle J1508-8 so that lip of seal will face in same direction as original seal.	
	b. Inner oil seal	Insert installer handle into pump body so seal starts straight into pump flange. Drive seal in until it bottoms.	Support pump body on wood blocks.

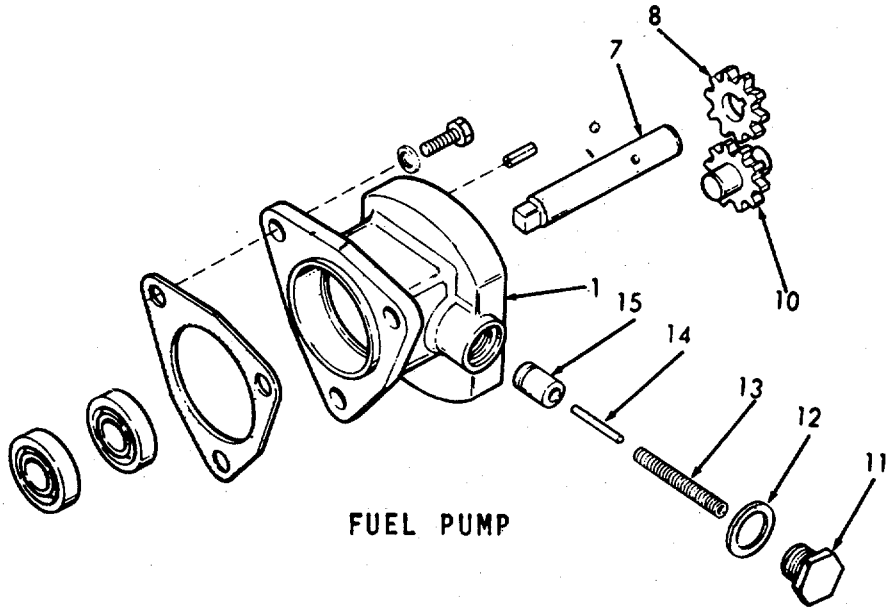


3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Assembly and Installation (Cont)			
	c. Outer oil seal	Place shorter end of adapter over pilot and against shoulder of installer handle. Place outer oil seal on pilot of installer handle with lip of seal facing adaptor. Insert pilot of installer handle into pump body and drive seal in until shoulder of adaptor contacts pump body.	Oil seals will be positioned so that the space between them will be the same as the drain holes located in bottom of pump body.
20.	Relief valve (15)	Lubricate outside of valve. Place in cavity with hollow end up.	Clamp pump body in vise with soft jaws, valve cavity up.
21.	Spring (13) and pin (14)	Insert spring into valve and pin into spring.	
22.	Gasket (12) and relief valve plug (11)	Place new gasket over plug. Thread plug into pump body.	Tighten to 18-24 lb-ft (24-33 Nm) torque.
23. Drive shaft (7)	Drive gear (8)	Place gear onto shaft over round end (not square end) of shaft. Press gear beyond gear retaining ball slot in shaft. Place ball in slot, press gear back until end of slot contacts the ball.	Square end of shaft can score gear.
24. Pump body, gear side	Drive shaft	Insert square end of shaft into opening of gear side of pump and through oil seals.	Lubricate shaft first with clean engine oil.

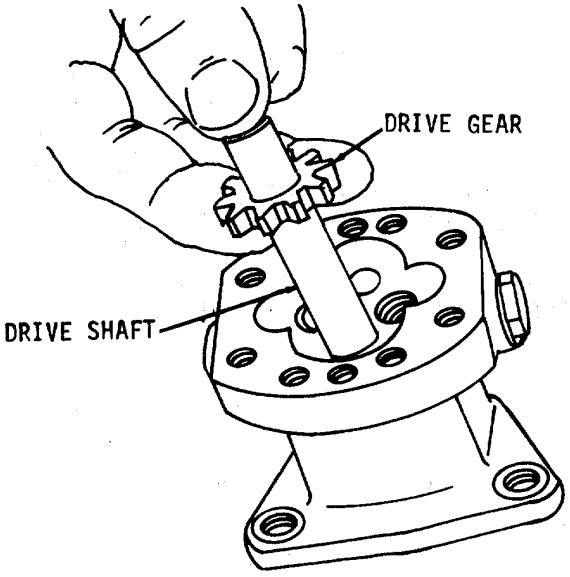
3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Assembly and Installation (Cont)			



FUEL PUMP

25.	Driven shaft and gear assembly (10)	Place assembly in pump body, having chamfered end of gear teeth facing pump body. If a replacement assembly with a slot is used, then the slot must face the pump cover.	Make certain that gear is centered on shaft.

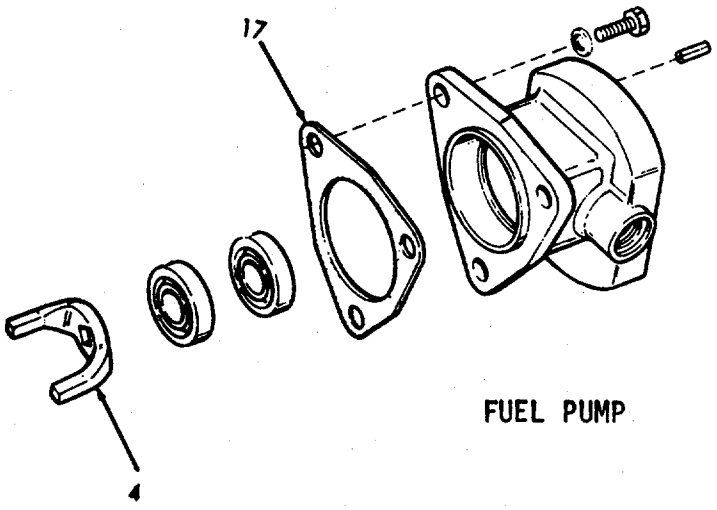


3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Assembly and Installation (Cont)			
26.	Gears and shafts	Lubricate, using clean engine oil.	
27. Pump cover face, not near gear area -	Sealant	Apply an especially thin coat of quality sealant to face of pump cover.	Sealant must be very thin. Do not squeeze sealant into gear compartment.
28. Pump body	Pump covers	Place cover against pump body, making sure two dowel pins in pump cover are located in holes in pump body.	Cover can be installed in only one position.
29.	Pump covers	Install bolts and lockwashers. Tighten alternately and evenly.	Eight bolts and lockwashers:
30.	Pump shaft	Rotate shaft by hand to insure that all parts rotate freely.	If shaft sticks, tap corner of pump. Try again.
31. Drain holes	Pipe plugs	Install.	
		NOTE Pump must always be installed with inlet opening in pump cover marked "L.H.IN" next to balance weight cover.	
32. Pump body Mounting flange	Gasket (17)	Affix new gasket to flange.	Remove all bits of old gasket.
33. Drive shaft, square end	Drive coupling fork (4)	Place fork on shaft.	

3-13. FUEL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Assembly and Installation (Cont)			



FUEL PUMP

34. Governor housing	Pump	Place pump against housing.	Make sure that coupling fork registers with slot in drive disc.
35. Pump		Attach pump to housing.	Secure three bolts and lock washers.
36. Pump cover	Fuel lines	Reconnect.	
37. Fuel system	Pump	Prime pump with fuel before starting engine.	

3-14. FUEL FILTER, STRAINER, AND FUEL LINES - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

The maintenance instructions contained in this paragraph are as follows:

DESCRIPTION	PARAGRAPH
Fuel Filter	3-14.1
Fuel Strainer	3-14.2
Fuel Lines	3-14.3

3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS.

a. A fuel filter (secondary), is used to remove impurities from the fuel. It is installed between the fuel pump and the fuel inlet manifold in the cylinder head. The replaceable paper-type element can remove particles as small as 10 microns.

b. The fuel filter operates under pressure. Fuel enters through the inlet passage in the cover and into the shell surrounding the filter element. Pump pressure causes the fuel to flow through the filter element where dirt particles are removed. Clean fuel flows to the interior of the filter element, up through the central passage in the cover, into the outlet passage, and then to the fuel inlet manifold in the cylinder head.

3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal
b. Inspection and Cleaning
c. Replacement

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

Do not drain fuel into bilges. Use oil separation and recovery system to collect used oil.

General Safety Instructions

Do not drain fuel into bilges.

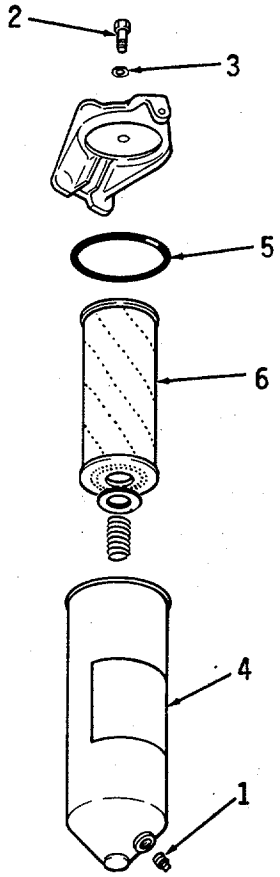
WARNING

Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
Removal			
1. Pipe plug	Container or pan	a. Place under pipe plug (1).	
		b. Remove pipe plug (1).	Allow fuel to drain into con-\ tainer.
		c. Replace pipe plug (1) when all fuel has drained out.	

3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

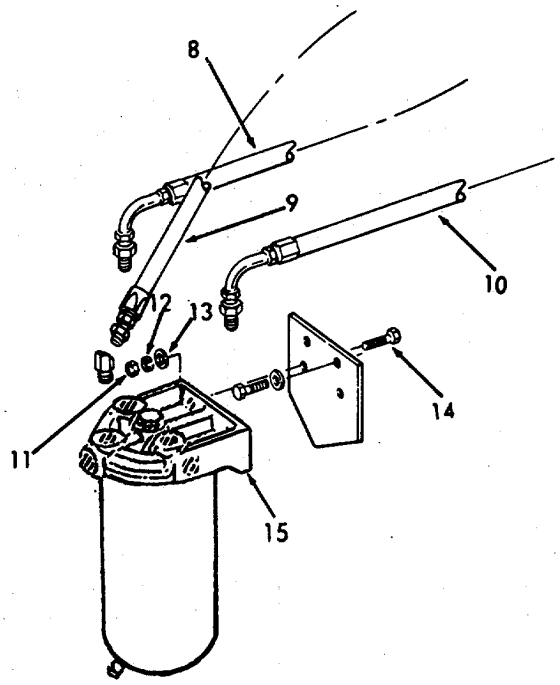
LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
2. Top of element	a. Fuel filter cover screw (2) and gasket (3)	Unscrew and remove.	Support fuel shell assembly while unscrewing.
	b. Fuel filter shell (4) and gasket (5)	Remove shell from cover; discard gasket.	Cover is to remain bolted to engine.
3. Fuel filter	Element (6)	Remove and discard.	



3-501

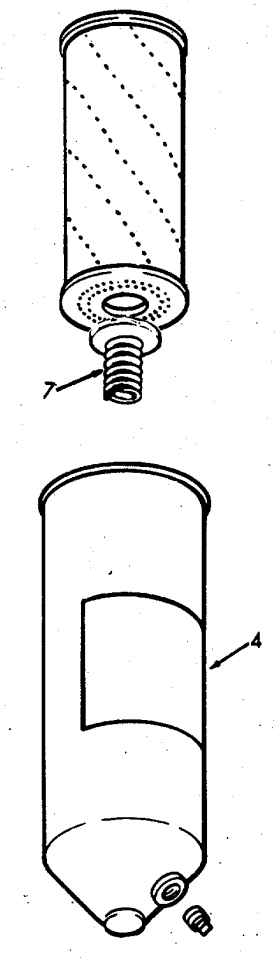
3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
4. Fuel filter cover	a. Hoses (8),(9) and (10)	Remove.	Replace if damaged.
	b. Nuts (11), lockwashers (12), washers (13) and bolts (14)		
	c. Fuel filter cover (15)	Remove from bracket.	



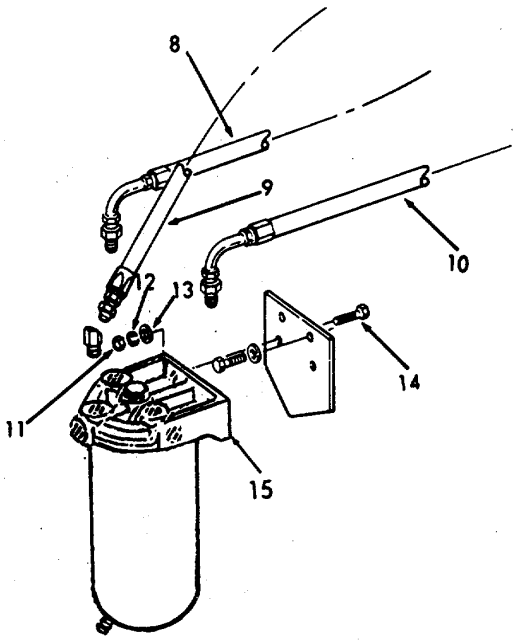
3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION/CLEANING			
		WARNING	
		Use eye protection when using compressed air.	
5.	Fuel Filter shell (4)	Clean with clean fuel oil. Dry with compressed air.	
6.	Element spring (7)	Examine for alignment. Check spring by pressing on element seat.	If seat is out of place or spring has lost tension, replace



3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

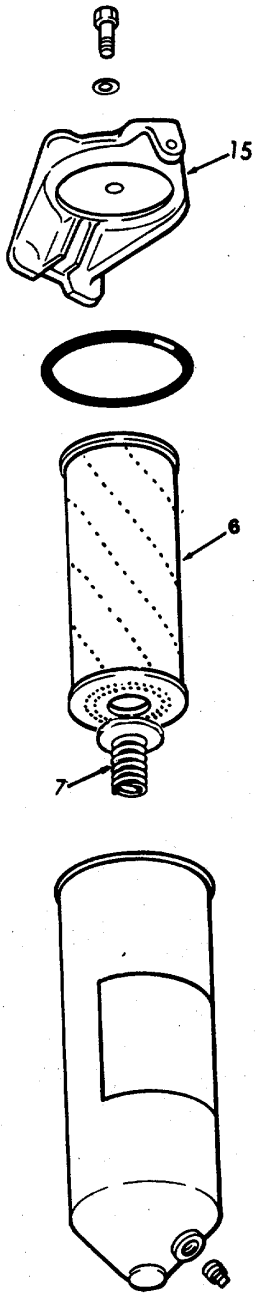
LOCATION	ITEM	ACTION	REMARKS
Replacement			
7. Fuel filter cover	a. Fuel filter cover (15), bolts (14), washers (13), lock-washers (12) nuts (11)	Reassemble.	
	b. Hoses (8,9 and 10)	Reinstall.	
8.	Fuel filter element (6)	Place new element over center stud; push it down against element seat (7). Fill shell about 2/3 full with clean fuel oil.	Make sure pipe plug is closed.



3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

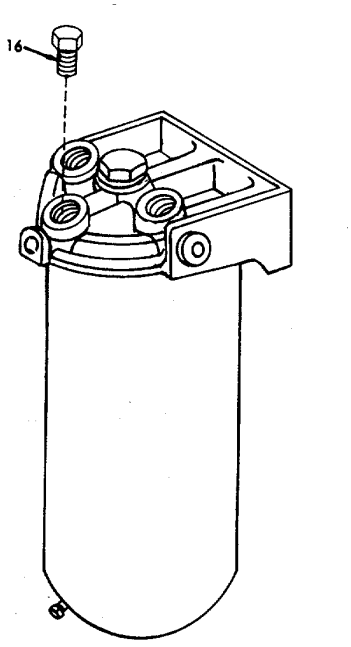
LOCATION	ITEM	ACTION	REMARKS

Replacement (Cont)



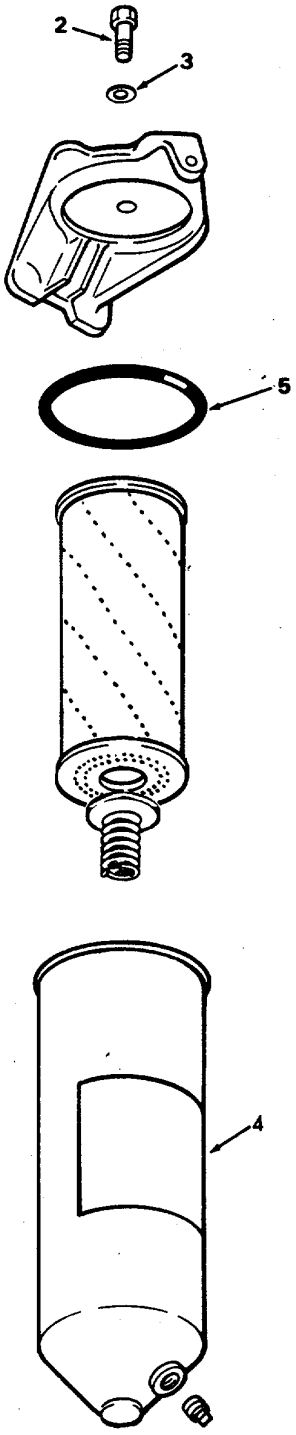
3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Replacement (Cont)			
9.	a. Fuel filter shell gasket (5)	Install new gasket in shell recess.	
	b. Cover gasket (3)	Replace.	
10.	Element and shell (4)	Position under cover. Thread cover bolt in center stud.	
11.	Cover screw (2) and gasket (3)	Tighten.	Tighten enough to prevent fuel leakage.
12. Top of filter	Access plug (16)	Remove and fill filter with fuel oil. Replace plug.	
13. Engine	Start engine.	Check for leaks.	



3-14.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Replacement (Cont)			



3-507

3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.

A fuel strainer (primary) is used to remove impurities from the fuel. It is located between the fuel supply tank and the fuel pump, and operates under suction. It consists of two strainer elements. Either element is selected by a lever located on the front. The selector allows a strainer to be removed and cleaned while the engine is in operation.

This task covers:

a. Removal
b. Cleaning and Inspection
c. Repair
d. Installation

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition / Condition Description

NONE

Special Environmental Conditions

Do not drain fuel into bilges.

General Safety Instructions

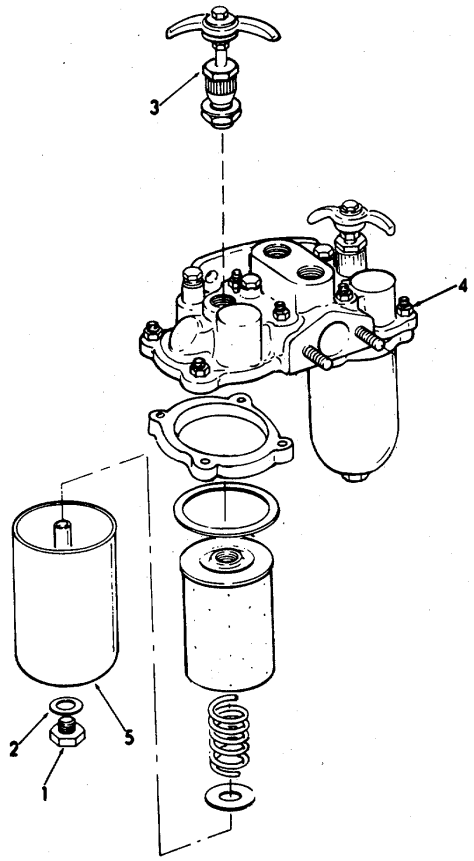
WARNING

Use eye protection when using compressed air

LOCATION	ITEM	ACTION	REMARKS
Removal			
1. Pipe plug and gasket	a. Container	a. Place under plug (1). b. Remove plug (1) and gasket (2). c. Replace plug and gasket when fuel has drained out.	Allow fuel to drain into container.

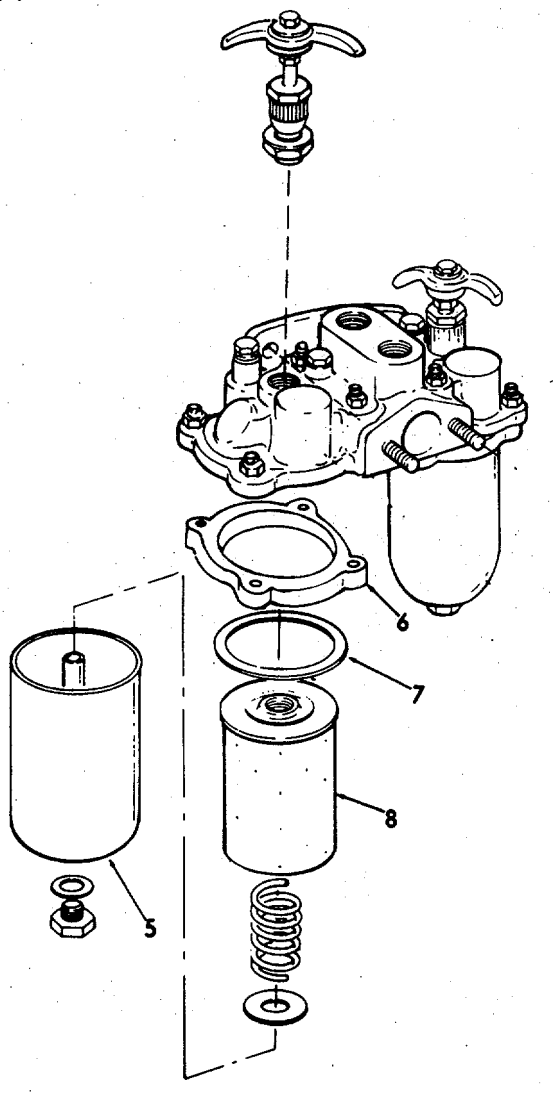
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
2. Top of cover	a. Fuel strainer	Unscrew knife handle control (3) and remove.	Support strainer shell (5) with hand while unscrewing.
	b. Nuts (4)	Unscrew and remove.	



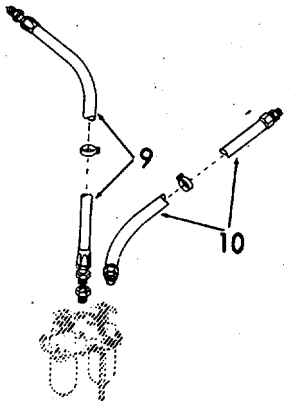
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
3. Under-side of cover	Fuel strainer shell (5) retaining ring (6) and cover gasket (7)	Remove ring and gasket. Discard gasket.	Shell is now free from cover; cover remains bolted to engine.
4. Fuel strainer shell (5)	Fuel strainer element (8)	Remove and discard.	

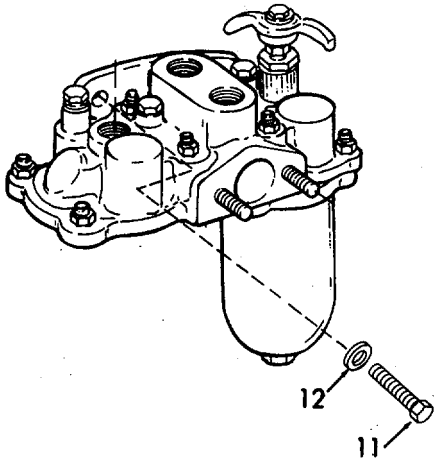


3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
5. Hoses	Hoses (9) and (10)	Remove.	

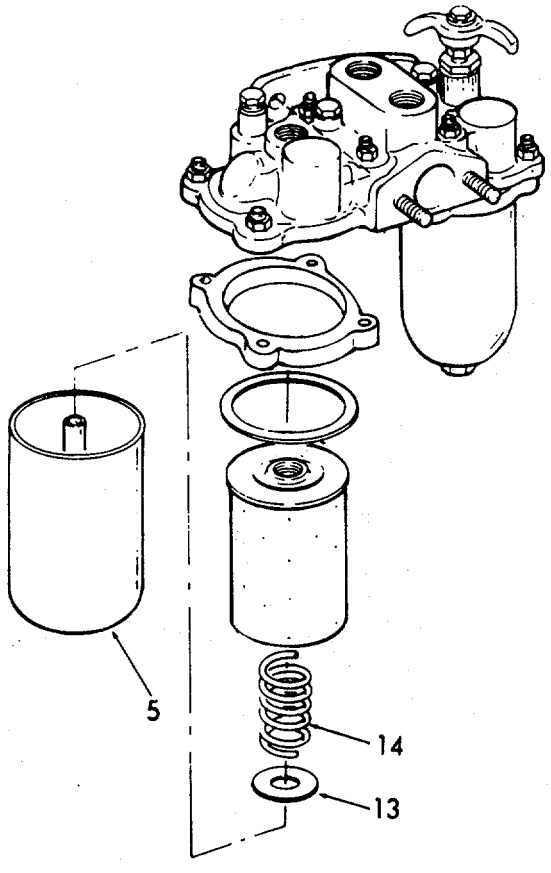


6. Cover	Bolts (11) and washers (12)	Remove.	Cover is now free from engine.



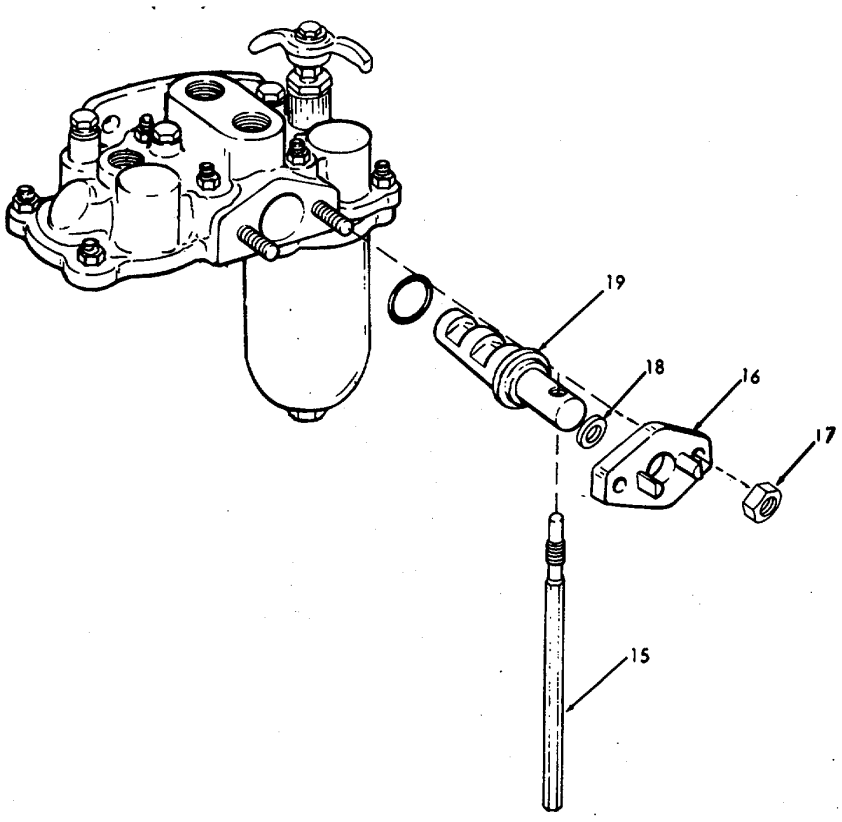
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
CLEANING AND INSPECTION			
		WARNING Use eye protection when using compressed air.	
7.	Fuel Strainer shell (5)	Clean with clean fuel oil. Dry with compressed air.	
8.	Element seat (13) and spring (14)	Examine for alignment. Check spring by pressing on element seat.	If seat is out of place or spring has lost tension, replace entire shell.



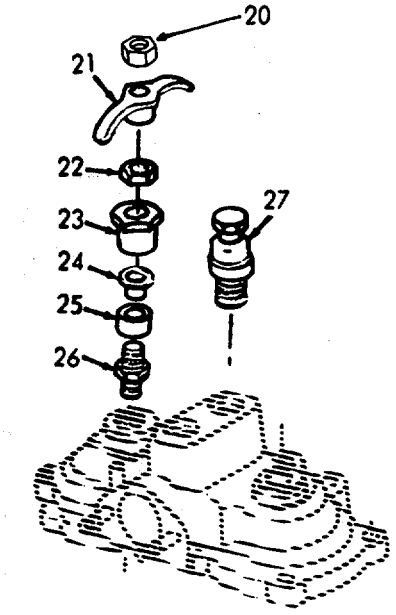
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
9. Cover	a. Handle (15) regulator valve Packing retainer (16)	Remove handle from regulator valve. Discard old packing and install a new packing. Replace regulator valve and handle.	
	b. Nuts (17)	Remove.	
	c. Regulator valve packing retainer (16) and preformed packing (18)	Remove.	
	d. Regulator valve (19)	Remove.	



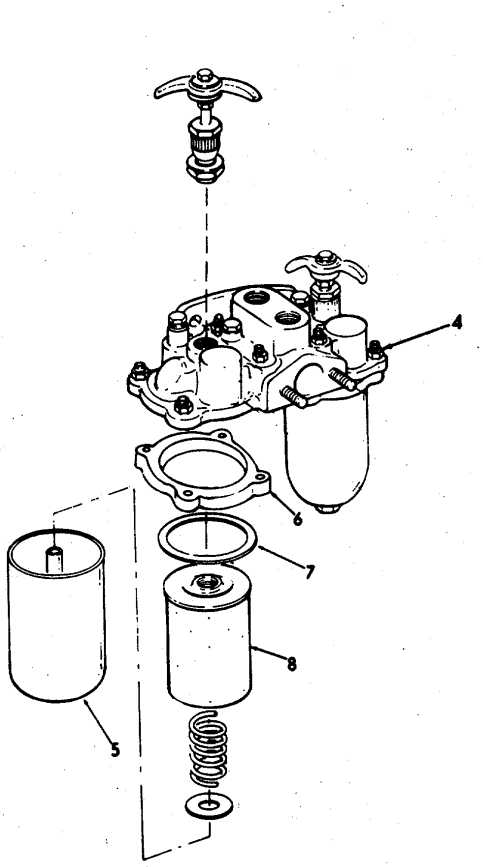
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
10. Knife control handle	a. Jam nut (20) and handle (21)	Remove.	
	b. Jam nut (22)	Remove.	
	c. Packing nut (23)	Remove.	
	d. Packing gland (24), packing (25), and packing gland adapter (26)	Reassemble.	
11. Vent valve	Valve (27)	Remove.	If necessary,



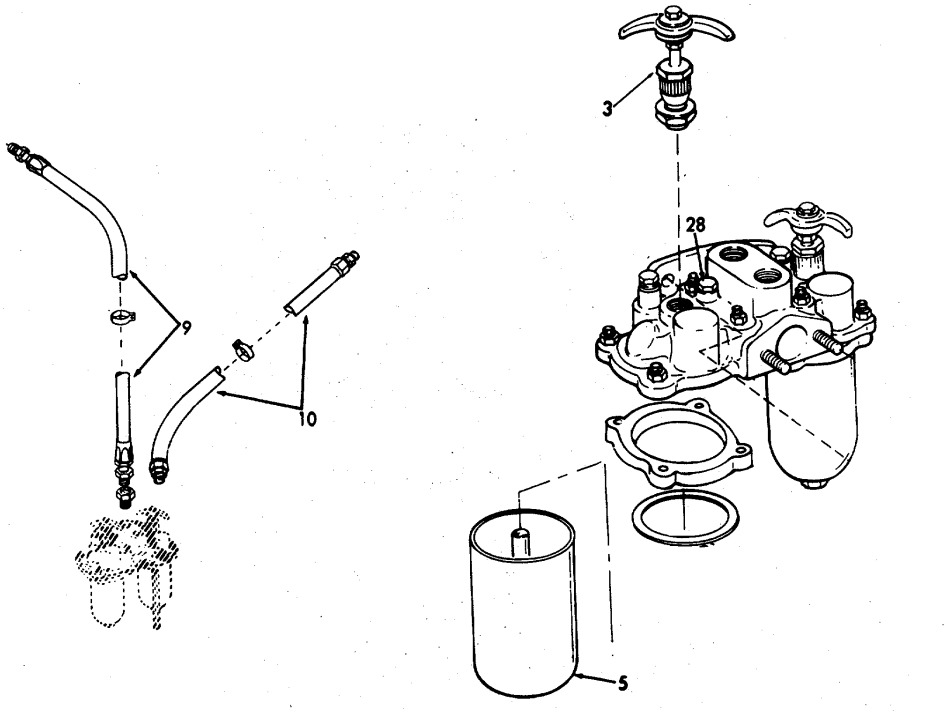
3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
12.	a. Fuel strainer element (8)	Place new element over center stud. Push down against element seat. Fill shell 2/3 full with clean fuel oil.	Make sure pipe plug is closed.
	b. Cover gasket (7) and fuel strainer retaining ring (6) and nuts (4)	Install new gasket in shell recess (5). Replace retaining ring.	



3-14.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION Cont			
	c. Shell (5)	Realign under cover; thread knife control handle (3) onto center stud tighten.	Tighten to prevent fuel leakage.
	d. Top of cover	1. Access plug (28). Remove. Fill strainer with fuel and replace.	
		2. Engine. Start and check for leaks.	
		NOTE Procedure is the same for either strainer shell assembly.	
	e. Hoses (9) and (10)	Replace.	



3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS.

Flexible fuel lines are used to facilitate connection of lines, and to minimize the effects of vibration in the installation.

This task covers:

a. Inspection
b. Test
c. Installation
d. Removal

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment
Condition — Condition Description
NONE

Special Environmental Conditions
Drain fuel lines as needed into a suitable container.

General Safety Instructions
NONE

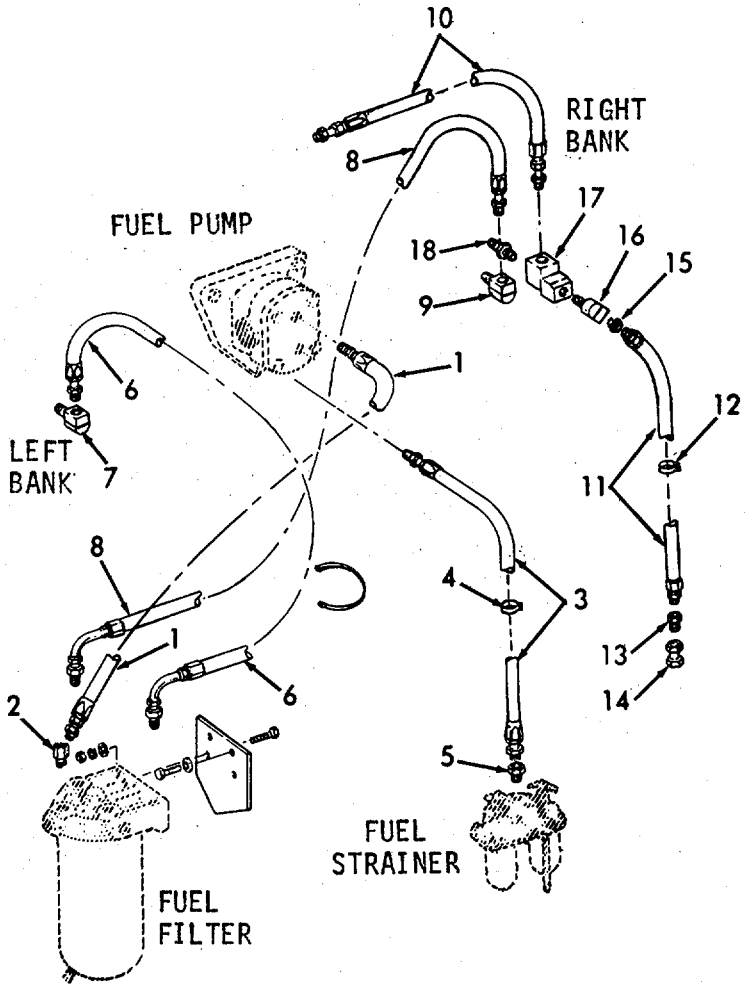
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Fuel line	Hoses, fittings	Inspect for kinks, twists, breaks, wear, and leaks.	

3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2. Hose-fuel pump to fuel filter	a. Hose (1)	Unscrew then remove.	Unscrew at fuel pump, then at fuel strainer fitting.
	b. Inverted elbow (2)	Remove.	
3. Hose-fuel pump to fuel strainer	a. Hose (3)	Unscrew.	Unscrew at fuel pump, then at fuel filter fitting.
	b. Hose clips (4)	Remove hose.	
	c. Inverted connector (5)	Remove.	
4. Hose-fuel filter to left bank	a. Hose (6)	Unscrew, then remove.	Unscrew at left bank then at filter.
	b. Fuel restrictor elbow (7)	Remove.	
5. Hose-fuel filter to right bank	a. Hose (8)	Unscrew, then remove.	Unscrew at right bank then at filter.
	b. Fuel restrictor elbow (9)	Remove.	
6. Hose-crossover	Hose (10)	Unscrew, then remove.	
7. Hose-fuel Drain	a. Hose (11)	Unscrew.	
	b. Clip (12)	Remove hose.	

3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Coupling (13)	Remove.	
	d. Adaptor (14)	Remove.	
	e. Pipe reducer (15)	Remove.	
	f. Fuel restric-tor (16)	Remove.	
	g. Tee (17)	Remove.	
	h. Pipe reducer (18)	Remove.	



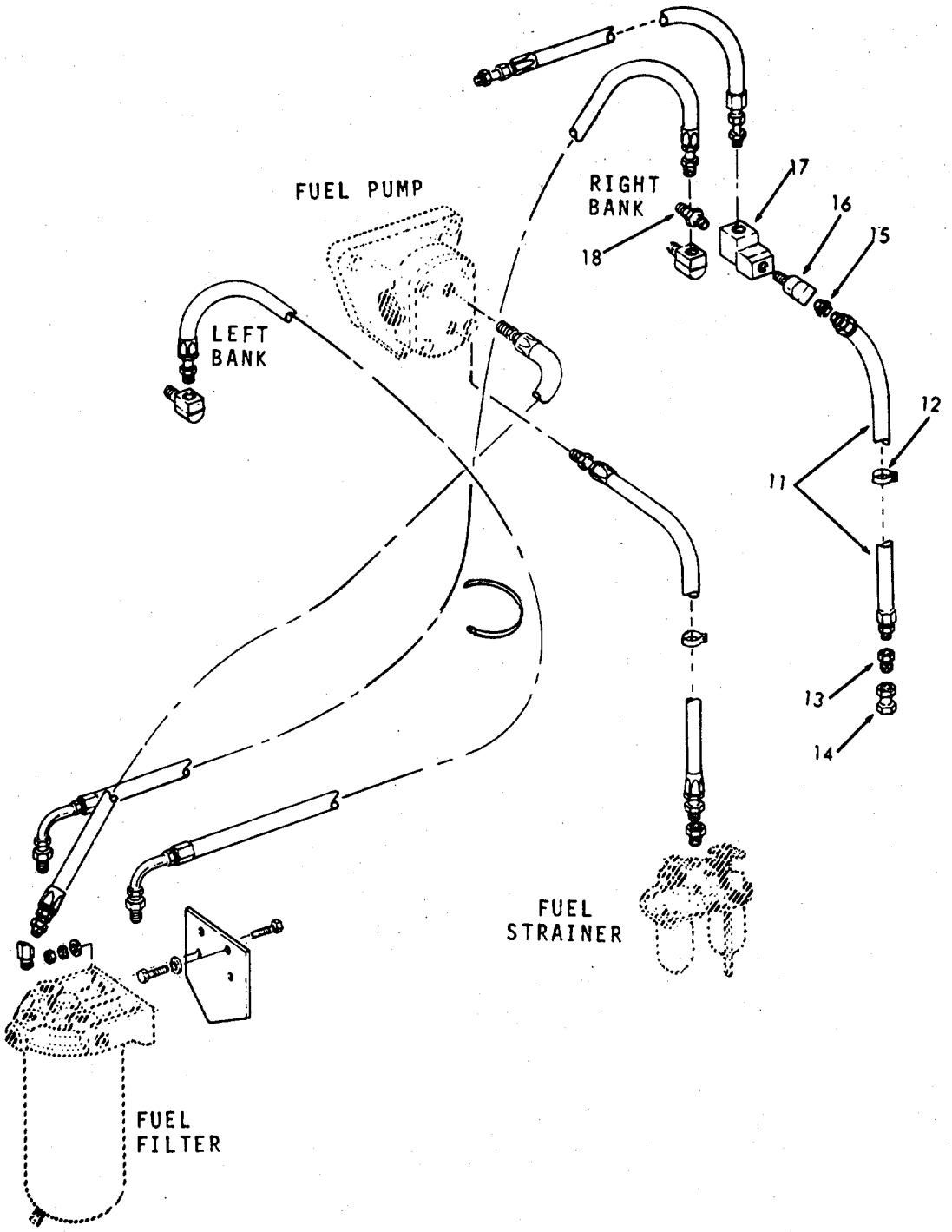
3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
		NOTE When installing fuel lines, it is recommended that connections be tightened only sufficiently to prevent leakage of fuel; thus flared ends of the fuel lines will not become twisted or fractured because of excessive tightening. After all fuel lines are installed, run the engine long enough to determine whether or not all connections are sufficiently tight. If any leaks occur, tighten the connections only enough to stop the leak. Also check the filter cover bolts for tightness.	
8. Hose-fuel drain	a. Pipe reducer (18)	Install.	
	b. Tee (17)	Install.	
	c. Fuel restrictor (16)	Install.	
	d. Pipe reducer (15)	Install.	
	e. Adaptor (14)	Install.	
	f. Coupling (13)	Install.	
	g. Hose (11)	Install.	Hose must be fabricated.
	h. Clip (12)	Insert hose.	

3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
9. Hose-crossover	Hose (10)	Install.	Hose must be fabricated.
10. Hose-fuel filter to right bank	a. Fuel restrictor elbow (9)	Install.	
	b. Hose (8)	Install.	
11. Hose-fuel filter to left bank	a. Fuel restrictor elbow (7)	Install.	
	b. Hose (6)		
12. Hose-fuel pump to fuel strainer	a. Inverted connector (5)	Install.	
	b. Hose (3)	Install.	
	c. Hose clip (4)	Insert hose.	
13. Hose-fuel pump to fuel filter	a. Inverted elbow (2)	Install.	
	b. Hose (1)	Install.	

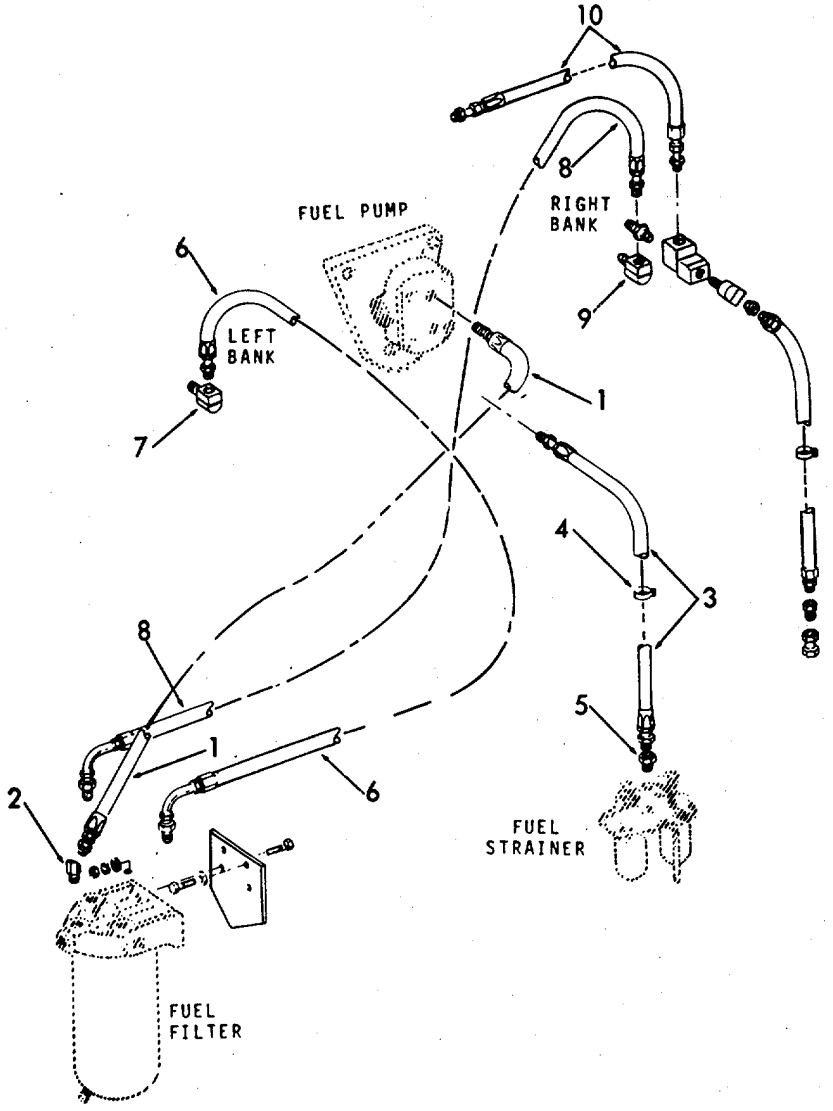
SERVICE

Air drawn into the fuel system may result in uneven running of the engine, stalling when idling, or a loss of power. Poor engine operation is particularly noticeable at the lower engine speeds. An opening in the fuel suction lines may be too small for fuel to pass through but may allow appreciable quantities of air to enter.

3-14.3. FUEL LINES - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



SERVICE (Cont)

Check for loose or faulty connections. Also check for improper fuel line connections such as a fuel pump suction line connected to the short fuel return line in the fuel tank which would cause the pump to draw air.

Presence of an air leak may be detected by observing the fuel filter contents after the filter is bled and the engine is operated for 15 to 20 minutes at a fairly high speed. No leak is indicated if the filter shell is full when loosened from its cover. If the filter shell is only partly full, an air leak is indicated.

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

a. The fuel injector is a lightweight compact unit which enables quick, easy starting directly on diesel fuel and permits the use of a simple open type combustion chamber. The simplicity of design and operation provides for simplified controls and easy adjustment.

b. The fuel injector performs four functions:

1. Creates the high fuel pressure required for efficient injection.
2. Meters and injects the exact amount of fuel required to handle the load.
3. Atomizes the fuel for mixing with the air in the combustion chamber.
4. Permits continuous fuel flow.

c. Combustion required for satisfactory engine operation is obtained by injecting, under pressure, a small quantity of accurately metered and finely atomized fuel oil into the cylinder.

d. The continuous fuel flow through the injector:

- Prevents air pockets in the fuel system.
- Provides a coolant for those injector parts subjected to high combustion temperatures.

CAUTION

Do not intermix the needle valve injectors with the other types of injectors in an engine.

e. Each fuel injector has a circular disc pressed into a recess at the front side of the injector body for identification purposes. The identification tag indicates the nominal output of the injector in cubic millimeters.

f. Fuel under pressure enters the injector from a fuel manifold. Motion of the rocker arm allows the injector to release a spray of fuel into a cylinder. A control rack on the side of the injector controls the amount of fuel being dispensed, and the speed of the

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

engine. The injector control rack is actuated by a lever on the injector control tube which, in turn, is connected to the governor by means of a fuel rod. These levers can be adjusted independently on the control tube, thus permitting a uniform setting of all injector racks. Excess fuel exits the injector and is returned to a fuel manifold. The fuel then returns to the fuel tank.

g. The fuel injector is one of the most important and precisely built parts of the engine. The injection of the correct amount of fuel into the combustion chamber at exactly the right time depends upon this unit. Because the injector operates against high compression pressure in the combustion chamber, efficient operation demands that the injector assembly is maintained in first-class condition at all times. Proper maintenance of the fuel system and the use of the recommended type fuel filters and clean water-free fuel are the keys to trouble-free operation of the injectors.

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal/Cleaning
b. Installation

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Torque wrench

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition: 3-29 — Condition Description: Rocker arm cover

Special Environmental Condition

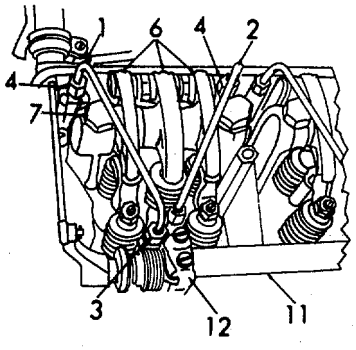
Use lint-free cloth, not rags.

General Safety Instructions

WARNING

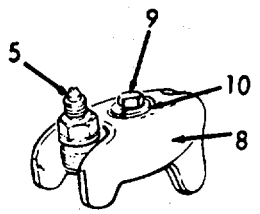
Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL AND CLEANING			
1. Top of cylinder	Fuel pipes (1,2)	Remove from injector (3) and fuel connectors (4).	Protect fuel pipes and fuel connectors from dirt or foreign particles.

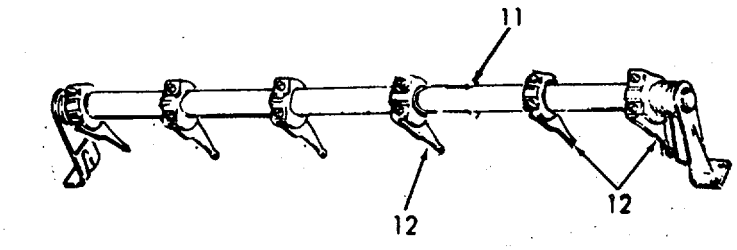


3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL AND CLEANING (Cont)			
2. Top of injector	Filter cap (5)	Cover filter cap with shipping cap.	Do immediately after fuel pipes are removed.
3. Start switch	Engine	Crank engine to bring outer ends of injector push rods and rocker arms in line horizontally.	
4. Rocker arms (6)	Two rocker shaft bracket bolts (7)	Remove bolts, swing rocker arms away from injector and valves.	
5. Underneath rocker arm	Injector clamp (8)	Loosen injector clamp bolt,(9), remove bolt, washer (10) and clamp.	

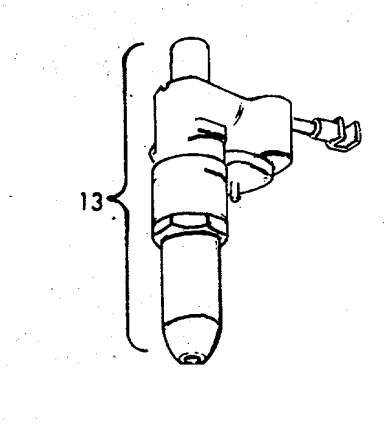


6. Injector tube (11) (outer side of cylinder head)	Injector rack control lever (12)	Loosen two screws on lever. Slide lever away from injector.	Refer to first figure.



3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL AND CLEANING (Cont)			
7. Cylinder head	Injector (13)	Lift injector out of cylinder head.	Immediately after removal of injector, cover injector hole to keep out dirt or foreign particles.



WARNING

Use eye protection when using compressed air.

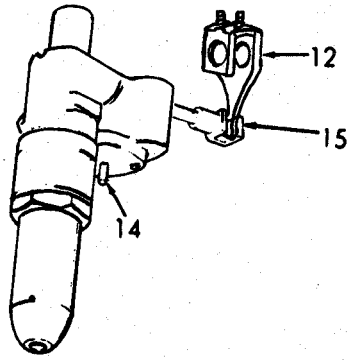
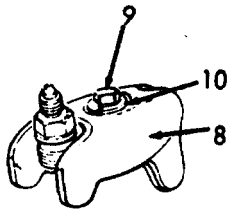
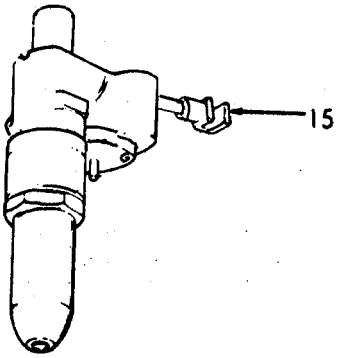
8.	Injector	Clean exterior with fuel oil and dry with compressed air.	

NOTE

Perform a complete engine tune-up. However, if only one injector was replaced and the other injectors and governor adjustments were not disturbed, it is necessary to adjust valve clearance and time the injector for that cylinder, and to position the injector rack control lever.

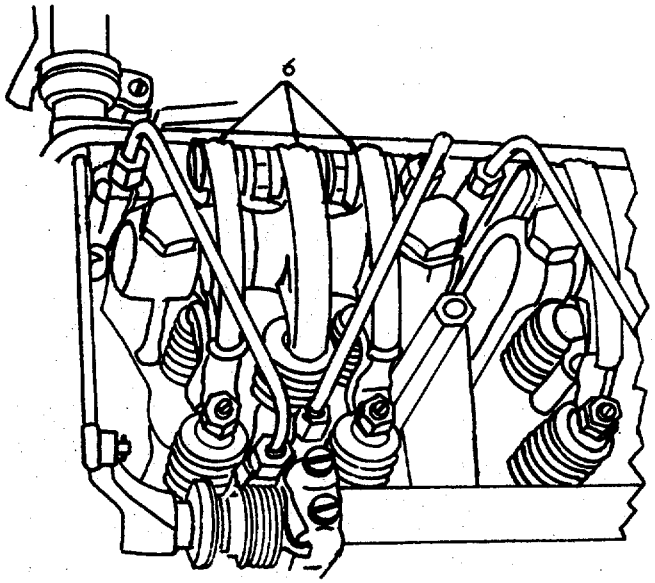
INSTALLATION OF INJECTOR			
9. Injector tube	Injector	Insert into tube.	Make sure dowel pin (14) in injector body registers with locating hole in cylinder head.

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION OF INJECTOR (Cont)			
10. Injector rack (15)	Injector rack control lever (12)	Slide lever so it registers with injector rack.	Tighten two bolts.
			
11.	Injector clamp, (8), bolt (9), washer, (10)	Install. Torque bolt to (29.8 to 37 kg/m).Make sure that clamp does not interfere with injector follower spring or exhaust valves.	Curved side of washer must face injector clamp.
			
12.	Injector rack (15)	Check rack for free movement.	
			

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION OF INJECTOR (Cont)			
13. Top of injector	Rocker arm assembly (6)	Swing rocker arms into position. Secure brackets to cylinder head by tightening two bolts.	Torque bolts 90- to 100 lbs. ft.(130 to 145 kg/m).



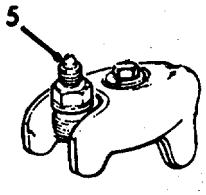
3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

INSTALLATION OF INJECTOR (Cont)

NOTE

Exhaust valve bridge must rest on exhaust valves before, during and after tightening rocker shaft bolts. If not, exhaust valves can be damaged. Make sure exhaust valve bridge is resting on ends of exhaust valves when tightening rocker shaft bracket bolts.

14.	Filter cap (5)	Shipping caps	Remove.

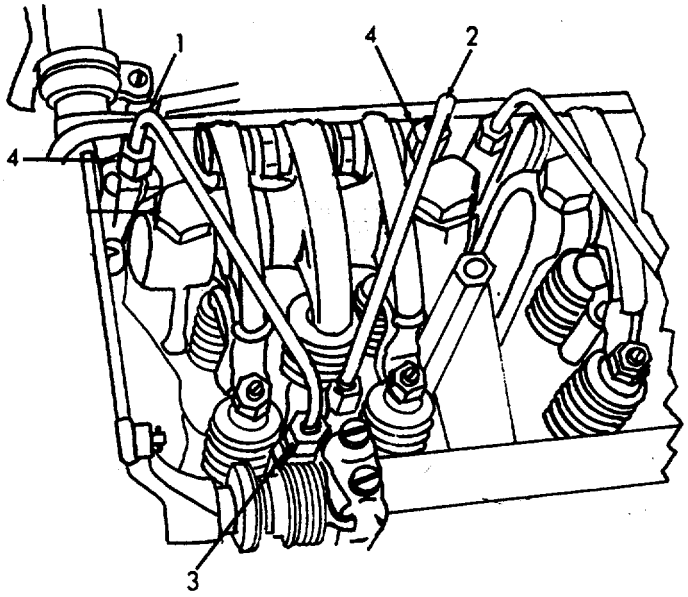


3-531

3-15. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont).

INSTALLATION OF INJECTOR (Cont)

15. Injector (3) and fuel connectors (4)	Fuel pipes (1 and 2)	Replace and tighten connections. Do not bend fuel pipes.	Use torque wrench, and tighten to 12-15 lb. ft. (17.9 to 22.3 kg/m). Do not overtighten since leaks or damage can occur.



3-532

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS.

a. The full-flow dual type lubricating oil filter is installed ahead of the oil cooler in the lubrication system.

b. The filter assembly consists of a replaceable element enclosed within a shell which is mounted on an adaptor or base. When the filter shell is in place, the element is restrained from movement by a coil spring.

c. All oil supplied to the engine passes through the filter before reaching the various moving parts of the engine. Pump pressure forces the oil through a passage in the filter adaptor or base to the space surrounding the filter element. The filtered oil is forced through the element to a central passage surrounding the center stud and out through another passage in the filter adaptor or base and then to the oil cooler.

d. A valve, opening at approximately 18-21 psi (124-145 kpa), is located in the filter adaptor, or, on a remote mounted filter, in the filter junction. This will by-pass the oil directly to the oil cooler should the filter become clogged.

e. With the use of detergent lubricating oils, the color of the lubricant has lost value as an indicator of oil cleanliness or proper filter action. Due to the ability of the detergent compounds to hold minute carbon particles in suspension, heavy duty oils will always appear dark colored on the oil level dipstick.

f. Heavy sludge deposits on the filter elements at the time of an oil change indicates that the detergency of the oil has been exhausted, and the oil drain interval should be shortened. The removal of abrasive dust, metal particles and carbon must be ensured by replacement of the oil filter elements at the time the engine oil is changed.

3-16. LUBRICATING OIL FILERS - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **b. Replace** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description

Material/Parts

Special Environmental Conditions
Do not dump oil in bilges

Gasket kit P/N 5196375
Filter element P/N 5573014

Personnel Required
1

General Safety Instructions

WARNING

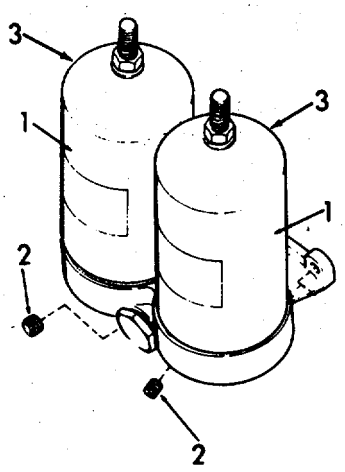
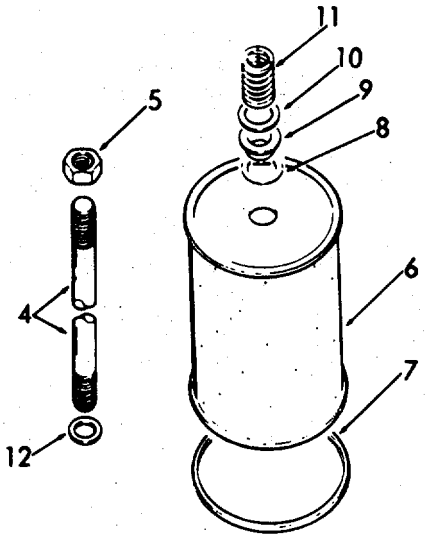
Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Cylinder block (right side)	Dual oil filter (1) and drain plug (2)	Remove two drain plugs.	Drain oil Into container.

NOTE

Do not drain oil into bilges. Use oil separation and recovery system to collect used oil.

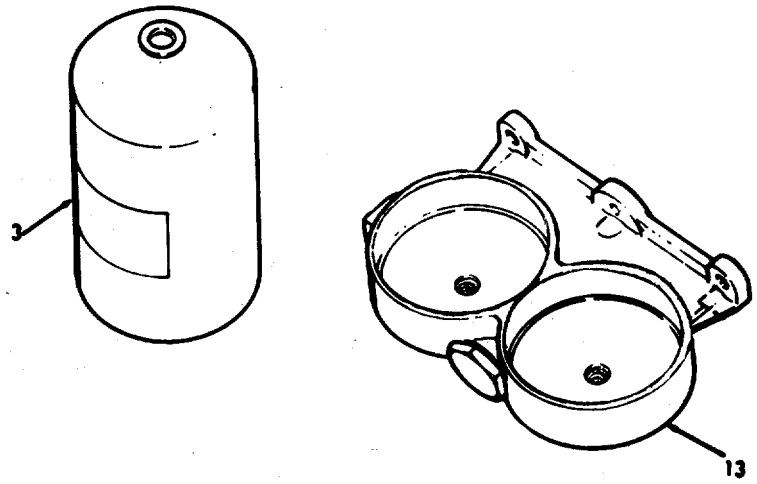
3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
			
2. Top of each filter shell(s) (3)	a. Center stud (4)	Unscrew nut (5). Do not remove from stud.	Shell, element, and stud will remove as an assembly.
	b. Element (6) and shell gasket (7)	Discard.	
3. Shell assembly	Center stud (4)	Remove gasket (8), spring retainer (9), spacer (10), spring (11) and gasket (12).	Discard gaskets (8). and (12).
4. Center stud (4)	Nut (5)	Remove.	
			

3-535

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

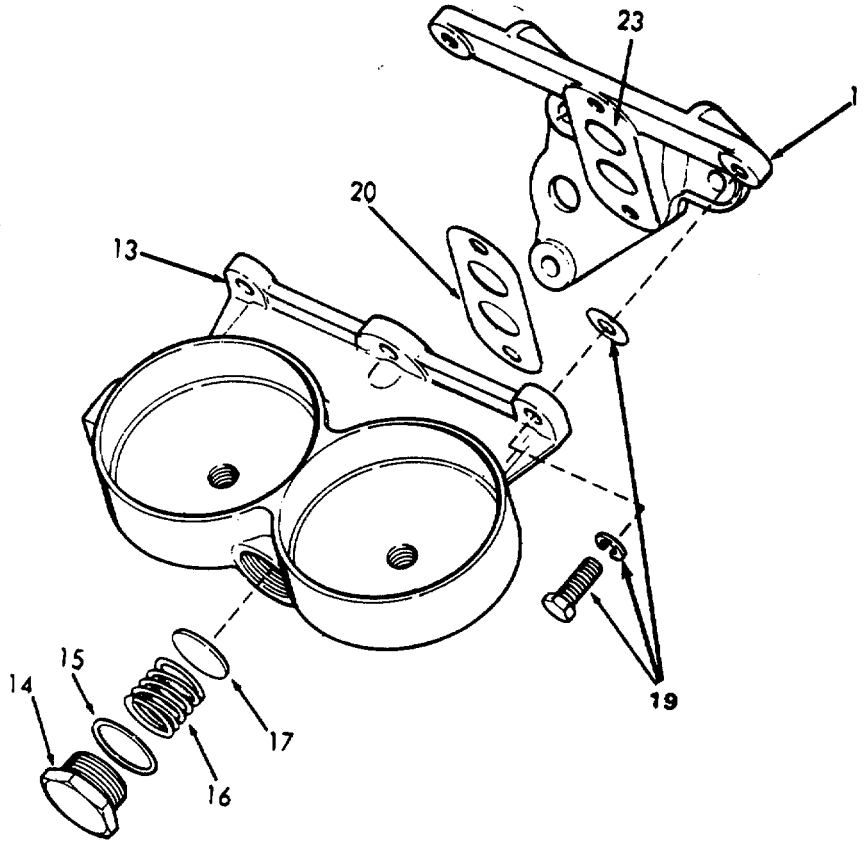
LOCATION	ITEM	ACTION	REMARK
		WARNING	
		Use eye protection when using compressed air.	
CLEANING			
5.	Shell (3) and base (13)	Clean.	Use clean fuel oil. Dry with compressed air.



REMOVAL OF BY-PASS VALVE				
6.	Oil filter base (13)	a. Drain plug (14) and gasket (15)	Remove. Withdraw spring (16) and by-pass valve (17).	Drain oil into container.
			WARNING	
			Use eye protection when using compressed air.	
		b. All parts	Wash in clean fuel oil, and dry with compressed air. Inspect for wear or damage.	Replace parts if worn or damaged.

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

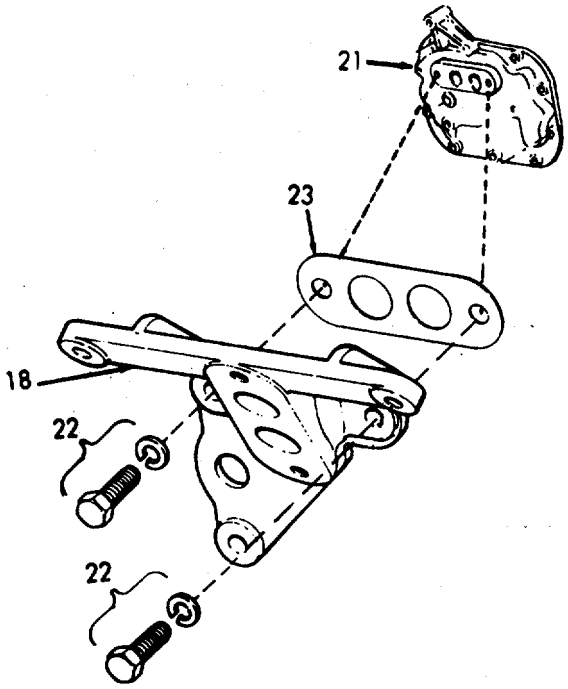
LOCATION	ITEM	ACTION	REMARK
REMOVAL OF BY-PASS VALVE			
7.	By-pass valve	Insert valve (17), spring (16), gasket (15) and plug (14).	Tighten plug to 110-130 lb-ft (150-177 Nm) torque.



REMOVAL OF UNIT FROM OIL COOLER-				
8.	Rear of oil filter base (13)	a. Oil filter cover adaptor (18)	Remove from oil filter base (13).	Loosen and remove 4 bolts, spacers and lockwashers (19).
		b. Gasket (20)	Discard and replace with new gasket.	

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

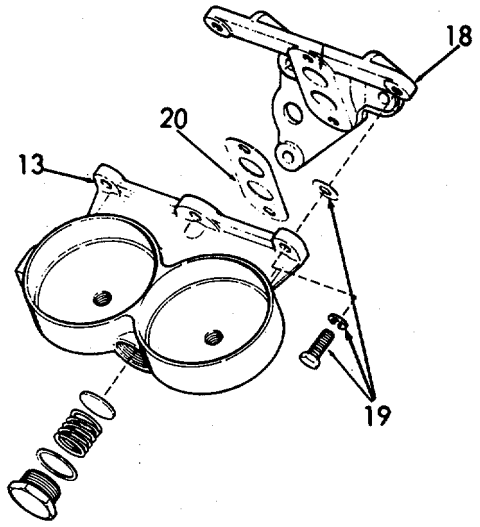
LOCATION	ITEM	ACTION	REMARK
REMOVAL OF UNIT FROM OIL COOLER (Cont)			
9.	a. Oil filter cover adaptor (18)	Remove from oil cooler (21).	Loosen and remove 3 bolts and lockwashers (22).
	b. Gasket (23)	Discard and replace with new gasket.	



REPLACE OIL FILTER BASE TO OIL COOLER			
10. Oil cooler (21)	Oil filter cover gasket (23)	Replace gasket.	
11.	Oil filter cover adapter (18)	Place adaptor against oil cooler cover gasket.	Secure cover with two bolts and lockwashers (22).

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPLACE OIL FILTER BASE TO OIL COOLER (Cont)			
12.	Gasket (20)	Replace gasket.	
13.	Rear of oil filter base (13)	Place base against oil filter cover adaptor (18) and against gasket.	Secure with three bolts, washers, and lockwashers (19)



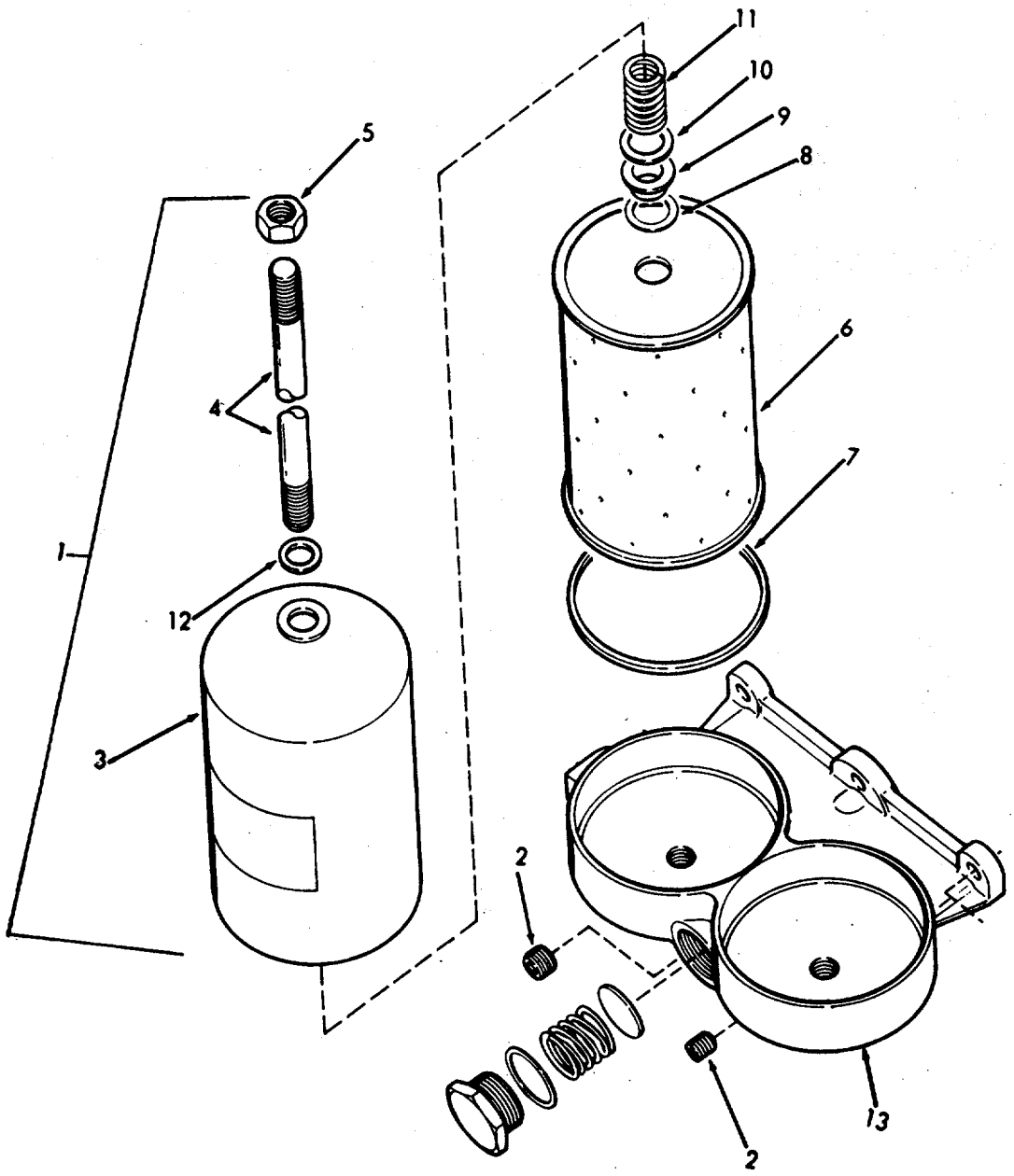
3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPLACING OIL FILTER ELEMENT ASSEMBLY (Cont)			
14. Center stud (4)	a. Nut (5)	Thread onto stud.	
	b. Gasket (12)		
	c. Shell (3)	Slide onto stud.	
	d. Spring (11), spacer (10), spring retainer (9) and spring retainer gasket (8)	Slide onto stud. Return in order.	
15. Oil filter base (13)	Gasket (7)	Install new gasket.	Remove all pieces of old gasket from base and filter' shell; make sure all surfaces are free from nicks or burrs.
16. Stud assembly	Element (6)	Position new element on stud within shell.	
17. Oil filter base (13)	Stud assembly with element (1)	Place assembly over gasket (7) and tighten stud (4) and nut nut (5).	Tighten to 50-60 lb-ft (68-81 Nm) torque.
18. Bottom of base	Drain plugs (2)	Reinstall.	
19.		Start engine and run for short period. Shut off. Check oil level in crankcase after 20 minutes. Add oil.	
20. Rocker covers	Oil inlet	Add oil.	

3-16. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK

REPLACING OIL FILTER ELEMENT ASSEMBLY (Cont)



3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTR UCTIONS.

a. To perform its functions satisfactorily, the lubricating oil must be kept within the proper temperature limits. If the oil is too cold, it will not flow freely. If the oil is too hot, it cannot support the bearing loads, it cannot carry away enough heat, and it may result in too great an oil flow. As a consequence, oil pressure may drop below acceptable limits and oil consumption may become excessive.

b. In performing its lubricating and cooling functions, the oil absorbs a considerable amount of heat and this heat must be dissipated by an oil cooler.

c. The engine is provided with an oil cooler mounted on the side of the cylinder block at the lower front corner. To cool the lubricating oil used in marine gear, a separate oil cooler core is mounted adjacent to the engine oil cooler.

d. Oil from the lubricating oil pump flows through a passage in the oil cooler adaptor to the oil filter, through the oil cooler, and finally through the outlet passage in the cooler adaptor which leads to the cylinder block oil galleries. The engine coolant is pumped through the oil cooler and completely surrounds the oil cooler core.

e. To ensure continuing engine lubrication should the oil cooler become plugged, a by-pass valve is installed in the oil cooler adaptor

3-17. LUBRICATING OIL FILERS - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **b. Cleaning** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Cleaning Solutions
(1) Trichloroethylene
(2) Oakite or alkaline solution
(3) Oxalic acid
(4) Muriatic acid
Gasket kit P/N 5196375
Anti freeze (MIL-A-46153

Personnel Required
3

References
NONE

Equipment

Condition	Condition Description
Para 3-16	Remove oil filer
Para 3-14	Remove oil lines

Special Environmental Conditions
Do not dump used cleaning solutions into the ocean.

General Safety Instructions

WARNING

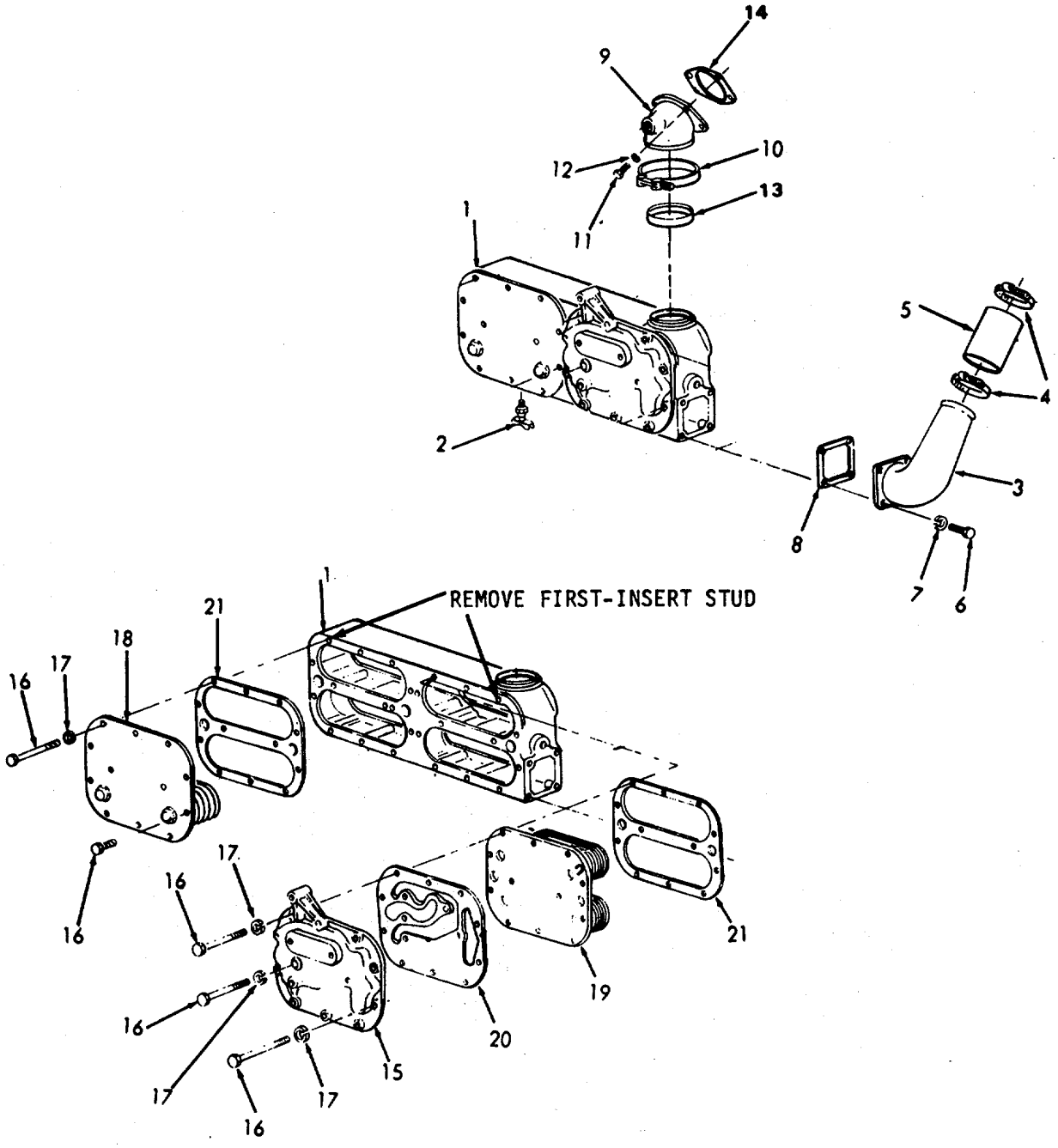
Perform all cleansing operations in well-ventilated rooms.
Avoid breathing fumes of chemicals or contact with skin or eyes.

3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Bottom of oil cooler housing (1)	Drain-cock (2)	Open.	Drain cooling system.
2. Water inlet elbow (3)	Hose clamps (4)	Loosen clamps. Slide hose (5) down onto elbow (3).	
3.	Bolts (6) and lock-washers (7)	Loosen and remove. Remove elbow (3) and gasket (8).	
4. Water outlet elbow (9)	a. Seal clamp (10)	Loosen.	
	b. Bolts (11) and lock-washers (12)	Loosen and remove.	
	c. Elbow (9) seal (13), and gasket (14)	Withdraw.	
5. Oil cooler cover (15, 18)	a. Two outer bolts (16) and lock-washers (17)	Remove.	
	b. Two studs	Install to support housing.	Studs must measure 8-1/2" (21.59 cm) long with 5/16"(8.13 cm)-18 thread at one end.
	c. Bolts (16) lock-washers (17)	Remove.	

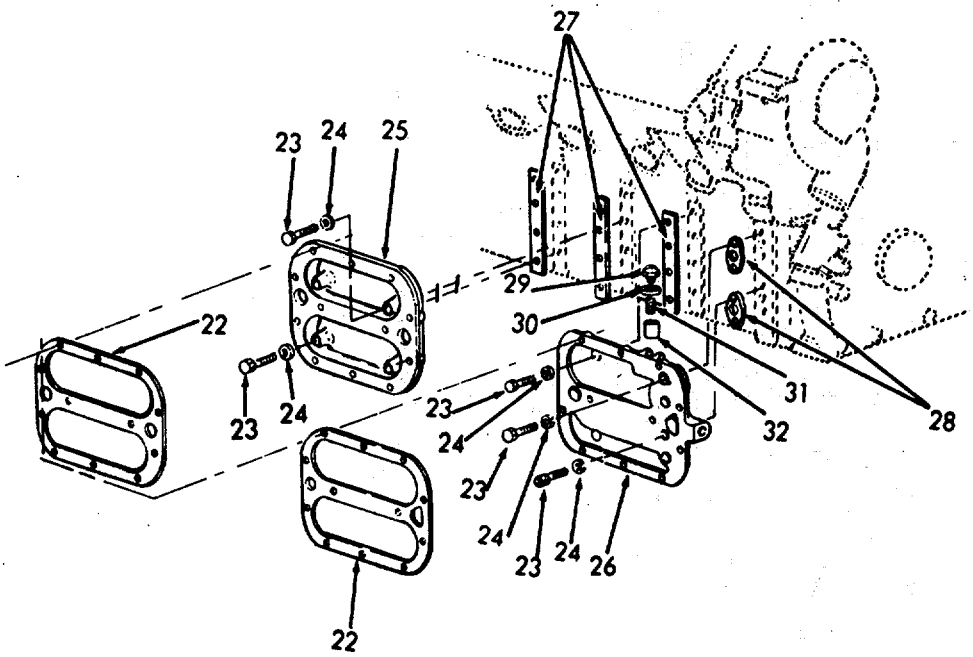
3-17. LUBRICATING OIL FILTERS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
	d. Covers (15 and 18), oil cooler (19), gasket (20), gaskets (21), and housing (1)	Remove.	



3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
6. Oil cooler adaptor	a. Gaskets (22)	Remove.	
	b. Bolts (23), and lockwashers (24)	Remove.	
	c. Adaptor oil coolers (25 and 26)	Remove.	
7. Cylinder block.	a. Spacers (27), gasket (28)	Remove.	
	b. Verticle passage	Inspect for plug (29), gasket (30), spring (31) and valve (32).	Plug must be present for cooling system to function properly.



3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).

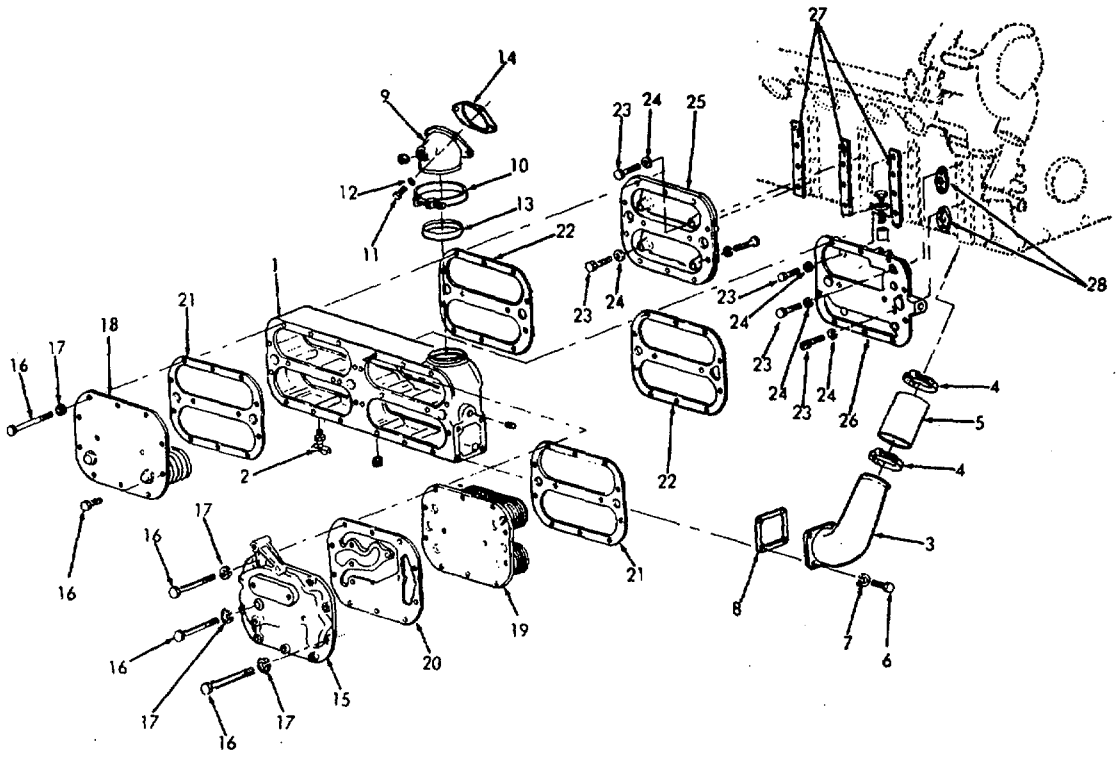
LOCATION	ITEM	ACTION	REMARK
CLEANING			
8. Cylinder block	Gasket	Remove all traces of gasket from block and cooler parts.	
		WARNING	
Perform this operation in an open or well-ventilated room. Avoid breathing fumes or direct contact of chemicals with your skin.			
9. Oil cleaner core.	a. Oil passages.	Force a solution of trichloroethylene thru passages. Clean out loosened sludge from passages. If passages are badly clogged, circulate an Oakite or Alkaline solution thru core and flush thoroughly with clean, hot water.	Use a force pump.
		CAUTION	
If engine failure has occured, where metal particles from worn or broken parts have been released into the lubricating oil, do not clean oil cooler core. The core must be replaced.			
		WARNING	
Perform this operation in an open or well-ventilated room. Avoid breathing fumes or direct contact of acid with skin.			
	b. Water side of cooler core.	a. Immerse in cleaning solution. Bubbles and foaming indicate cleaning action.	Make solution by adding 1/2 pound (0.227 kg), oxalic acid to 2 1/2 gallons of a solution of 1/3 muriatic acid and 2/3 water.

3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
CLEANING			
	b. Remove when bubbling stops.		Approximately 30-60 seconds.
	c. Flush thoroughly with clean, hot water. Dip core into light oil.		
INSTALLATION			
10. Cylinder block	Adaptor	Install adaptors (25 and 26) onto cylinder block with spacers (27), gaskets (28), using bolts (23) and lockwashers (24).	Use new gaskets (28).
11. Oil filter, oil line	Filters	Re-install per paragraph 3-16. .	
12. Oil pan	Dipstick	Remove, check oil level. If necessary, add oil.	
13. Engine		Start engine. Run for five minutes. Check for oil or water leaks. Stop engine. Wait twenty minutes for oil to drain into crankcase. Re-check oil level with dipstick and if low, add oil.	
14. Oil cooler housing	Housing (1), and gaskets (22)	Place housing (1) and gaskets (22) onto studs.	a. Use new gaskets. b. Studs installed in step (7).
15. Oil coolers	Coolers (18 and 19), gaskets (20 and 21), oil cooler covers (15 and 18)	Install using bolts (16) and washers (17).	Remove studs and install bolts (16) and washers (17).

3-17. LUBRICATING OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION (Cont)			
16. Water outlet	a. Elbow (9), seal (13), gasket (14)	Install using bolts (11) and washers (12).	Use new gasket.
	b. Seal clamp (10)	Install.	
17. Water inlet	a. Elbow (3),gas-ket (8)	Install using bolts (6), and washers (7).	Use new gasket.
	b. Hose (5),hose clamp (4)	Install.	
18. Oil cooler housing	Drain-cock (2)	Close.	
19. Expansion tank		Fill cooling system to proper level.	Use anti-freeze (MIL-A-46153).



3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS.

a. The centrifugal-type water pump circulates the engine coolant thru the cylinder block, cylinder heads, heat exchanger and oil cooler. The pump is mounted on the engine front cover and is driven by the front camshaft gear.

b. An oil seal is located in front of the smaller bearing and a spring-loaded face type water seal is used behind the impeller.

c. The pump ball bearings are lubricated with oil splashed by the water pump gear.

This task covers:

a. Inspection
b. Removal
c. Installation
d. Repair

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Impeller puller J22143
Wrench J4242
Installer water pump oil seal J22150
Remover water pump coupling and oil seal J1930
Installer water pump seal J8501
Installer water pump seal J21971
Feeler gage

Material/Parts
Compound P/N 5198653
Reconditioning kit P/N 5198576
Permatex - Non-hardening

Personnel Required
1

References
NONE

Equipment Condition
Para 3-19

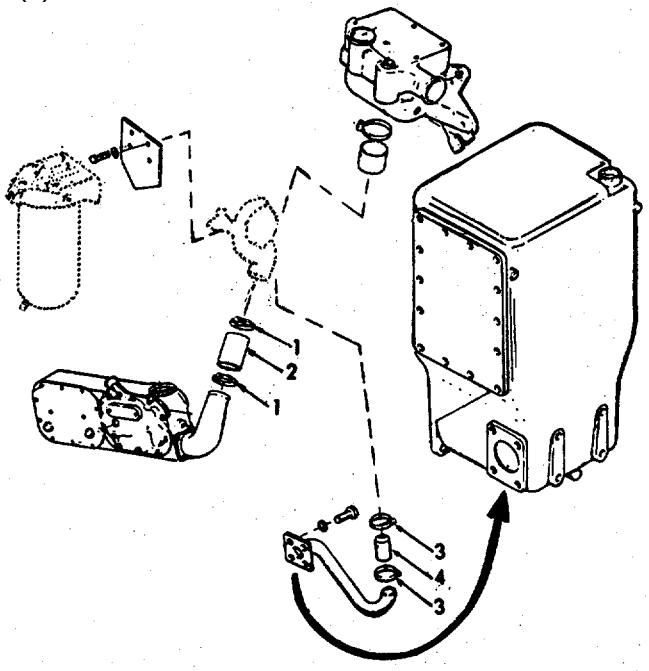
Condition Description
Heat Exchanger Removal

Special Environmental Conditions
None

General Safety Instructions
None

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

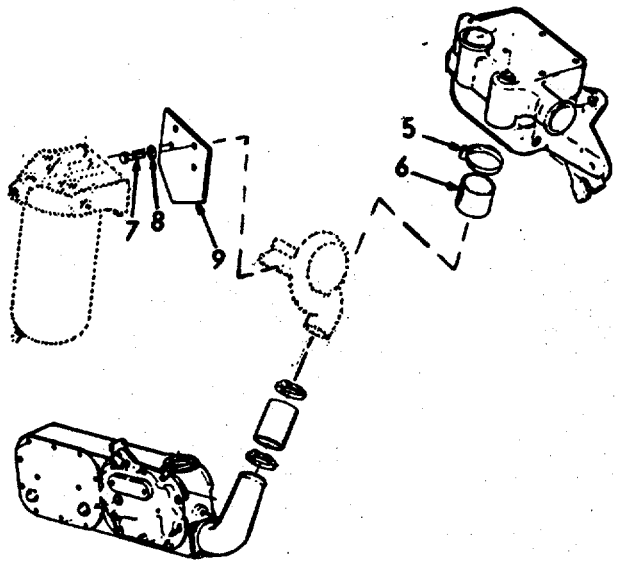
LOCATION	ITEM	ACTION	REMARK
INSPECTION			
1. Water pump	a. Hoses	Inspect for leaks, breaks, and worn hoses.	
	b. Water pump	Inspect for cracks, leaks, excessive noise, and damage.	
REMOVAL			
2. Hose-water pump to oil cooler	a. Hoses clamps (1)	Loosen.	
	b. Hose (2)	Remove.	
3. Hose-water pump to heat exchanger	a. Hose clamp (3)	Loosen.	
	b. Hose (4)	Remove.	



3-551

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
4. Hose-water pump to thermostat	a. Hose clamp (5)	Loosen.	
	b. Hose (6)	Remove.	
5. Fuel filter	a. Screws (7) and flat-washers (8)	Remove.	
	b. Bracket with fuel filter attached (9)	Remove.	Move fuel filter out of way.



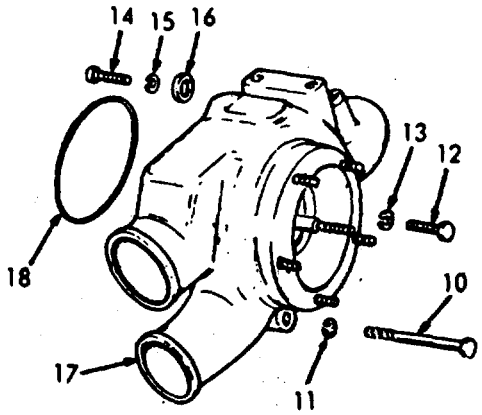
3-552

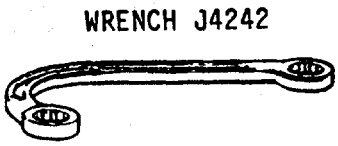
3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
6. Water pump	a. Bolt (10) and lock-washer (11)	Remove.	
	b. Bolt (12) and lock-washer (13)	Remove.	
	c. Bolt (14) lock-washer (15) and flatwasher (16)	Remove.	Use wrench J4242.
	d. Water pump (17)	Remove.	
	e. Seal ring (18)	Remove.	Discard.

CAUTION

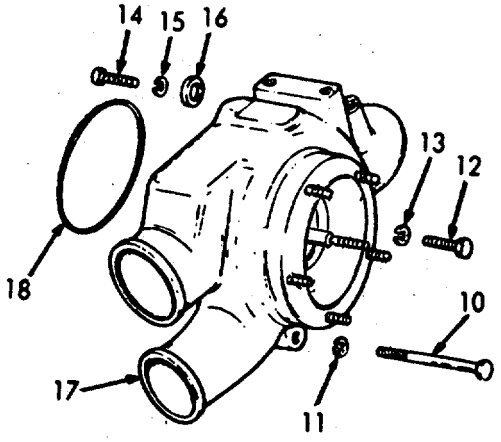
Use care to prevent damage to gear teeth when disengaging pump gear from front camshaft gear (water pump drive gear).

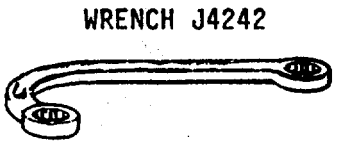




3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

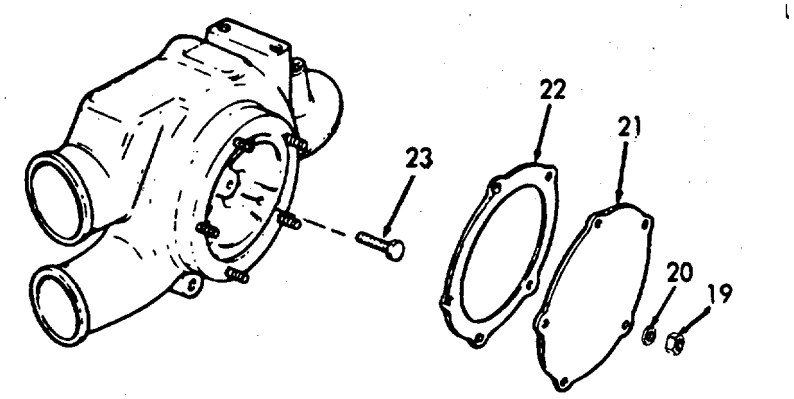
LOCATION	ITEM	ACTION	REMARK
INSTALLATION			
		CAUTION	
Use care to prevent damage to gear teeth when engaging the pump gear to the front camshaft gear (water pump drive gear).			
7. Water pump	a. Seal ring (18)	Install.	Use new ring.
	b. Water pump (17)	Align holes.	Observe caution.
	c. Bolt (14) lockwasher (15) and flatwasher (16)	Install.	Use wrench J4242.
	d. Bolt (10) and lock-washer (11)	Install.	
	e. Bolt (12) and lock-washer (13)	Install.	Tighten bolts (14, 10 and 12).





3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION (Cont)			
	f. Nuts (19) and lock-washer (20)		
	g. Fresh water pump body cover (21)	Remove.	
	h. Gasket (22)	Remove.	
	i. Bolt (23)	Install.	In impeller puller holes.

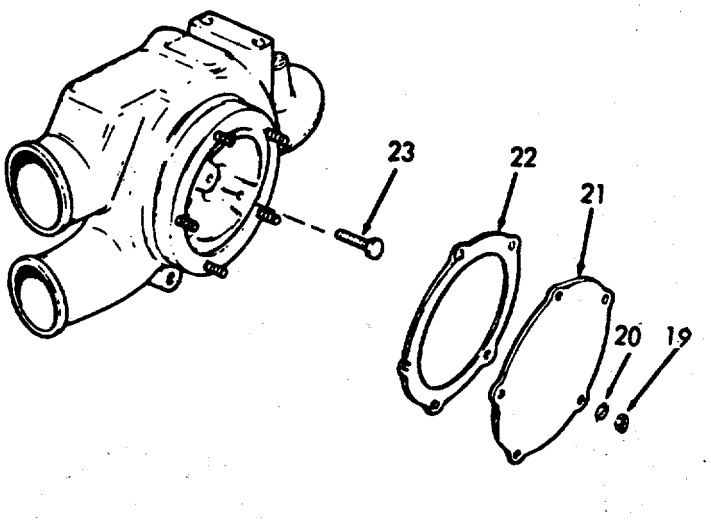


NOTE

Check the gear lash by installing a bolt, or equivalent, in the impeller puller holes. Measure the lash with an indicator at that point. The gear lash setting should be .0015 inch to .0045 inch (0.0038 to 0.0114 cm). When the specified lash cannot be obtained, loosen the pump attaching bolts and move the pump up as required to obtain the correct gear lash. Retighten the mounting bolts. A .0015 inch (0.0038 cm) movement of the pump directly away from the camshaft will increase the lash .001 inch (0.0025 cm). Likewise, moving the pump toward the camshaft .0015 inch (0.0038 cm) will decrease the lash .001 inch (0.0025 cm).

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION (Cont)			
	j. Bolt (23)	Remove.	
	k. Cover (21) and gasket (22)	Align holes.	Use new gasket.
	l. Nuts (19) and lockwashers (20)	Install.	



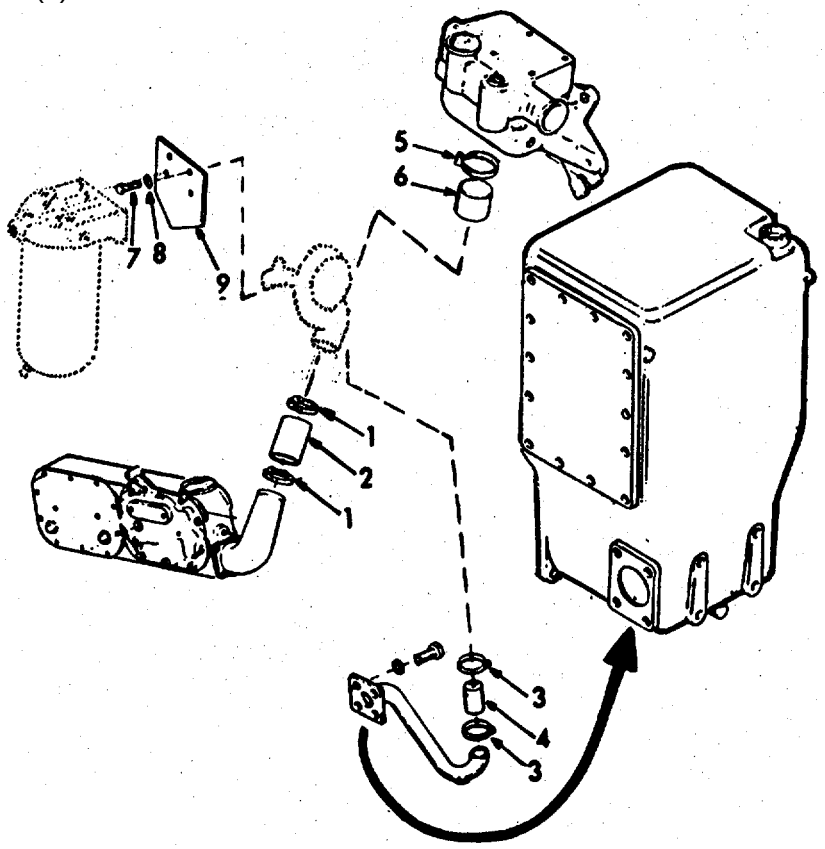
NOTE

When the cover is secured by cadmium plated bolts with nylon inserts, inspect the bolts carefully to make sure the nylon inserts are in place and protrude sufficiently beyond the threads to prevent leakage. Under no circumstances should a standard bolt be used.

8. Fuel filter	a. Bracket with fuel filter attached (9)	Align holes.	
	b. Screws (7), and flatwashers (8)	Install.	

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

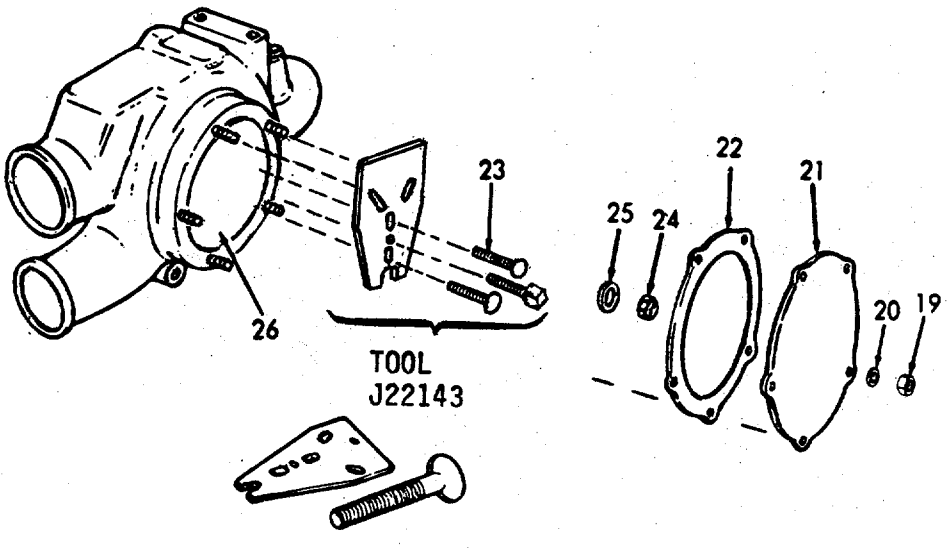
LOCATION	ITEM	ACTION	REMARK
INSTALLATION			
9. Hose-water pump to thermostat	a. Hose (6)	Install.	
	b. Hose clamp (5)	Install and tighten.	
10. Hose water pump to heat exchanger	a. Hose (4)	Install.	
	b. Hose clamp (3)	Install and tighten.	
11. Hose-water pump to oil cooler	a. Hose (2)	Install.	
	b. Hose clamp (1)	Install and tighten.	



3-557

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR			
12. Water pump water seal	a. Nuts (19), and lock-washers (20)	Remove.	
	b. Cover (21), and gasket (22)	Remove.	Discard gasket.
	c. Bolt (23), self-locking nut (24)	Remove.	Discard.
	d. Flat washer (25)	Remove.	
	e. Impeller (26)	Install water pump impeller remover.	Tool J22143



3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

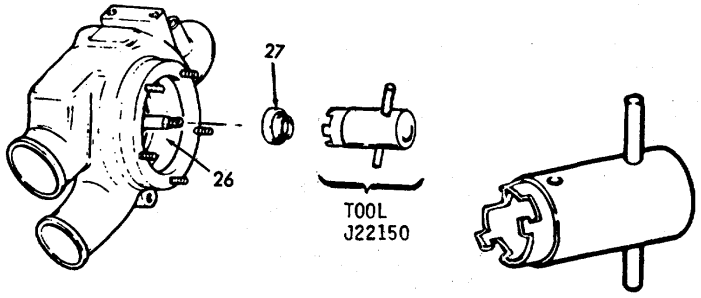
LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

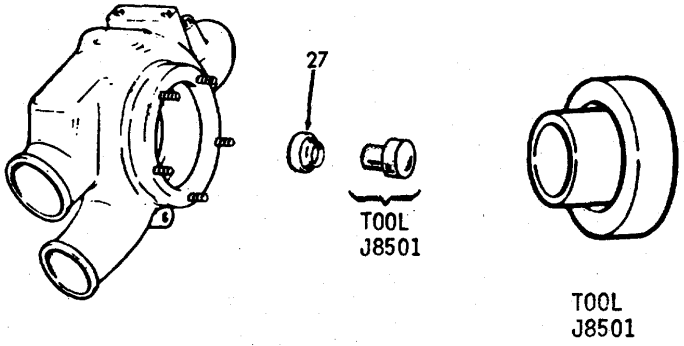
CAUTION

Use care to prevent damage to the-ceramic impeller insert. Place the impeller on the bench with the insert up.

f.	Impeller (26)	Remove.	Discard.
g.	Seal (27)	Remove.	Use tool J22150. Place seal puller over seal and into two slots in the pump body. Remove by turning in a clockwise direction.



h.	Seal (27)	Install.	To reduce possible coolant leakage, apply a light coat of non-hardening Permatex to a new water seal. Tap the seal into seal cavity with tool J8501.

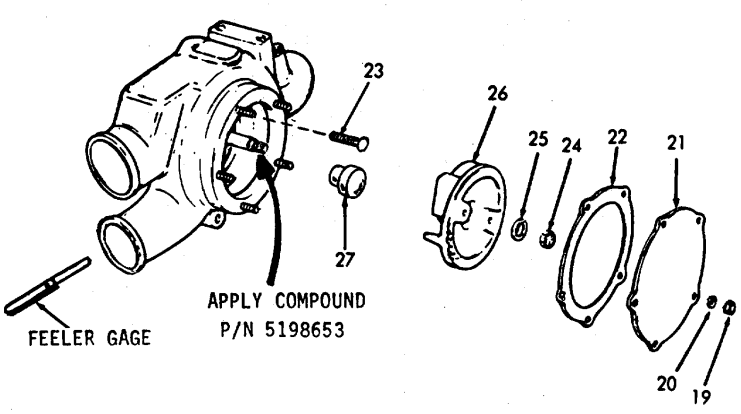


3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Impeller (26)	Inspect the ceramic insert for cracks, scratches, and bond to the impeller.	If the insert is damaged, refer to step 13.
	j. Seal (27) and impeller (26)	Clean the mating surfaces of the seal and the ceramic insert in the impellor.	Remove all dirt, metal particles and oil film.
	k. Pump shaft	Apply a small quantity of compound P/N5198653	Apply to threads of pump shaft. Use International Compound #2, or equivalent.
	l. Impeller (26), and washer (25)	Place on shaft.	
	m. Locknut (24), bolt (23)	Start on shaft. Hold the pump gear while drawing the impeller down on the tapered shaft.	Use new locknut. Tighten nut to 45-50 lb-ft (61-68 Nm) torque.
	n. Water outlet opening	Insert a feeler gage.	Minimum clearance between impeller and pump body must be .015 inch (.038 cm).
	o. Water pump cover (21), and gasket (22)	Align holes on pump.	Use new gasket.

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
p.	Lock-washers (20), and nuts (19)	Install.	Tighten securely.



NOTE

When the water pump cover is secured by cadmium plated bolts with nylon inserts, inspect them care- fully to make sure the nylon inserts are in place and protrude sufficiently beyond the threads to prevent leakage. Under no circumstances should a standard bolt be used.

q.	Hoses	Replace as needed.	

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

13. Impeller ceramic insert

If the impeller ceramic insert has cracks or scratches, and is not bonded to the impeller, proceed as follows:

a. Bake the insert and impeller assembly at 500°F (260°C) for one hour. The insert can be removed easily while the adhesive is hot. After removing the insert, clean the insert area of the impeller with sandpaper, wire brush or a buffing wheel to remove the old adhesive, oxide, scale, etc.

b. Wet a clean cloth with a suitable solvent such as alcohol and thoroughly clean the impeller insert area and the grooved side of a new ceramic insert. Then wipe the parts with a clean, dry cloth.

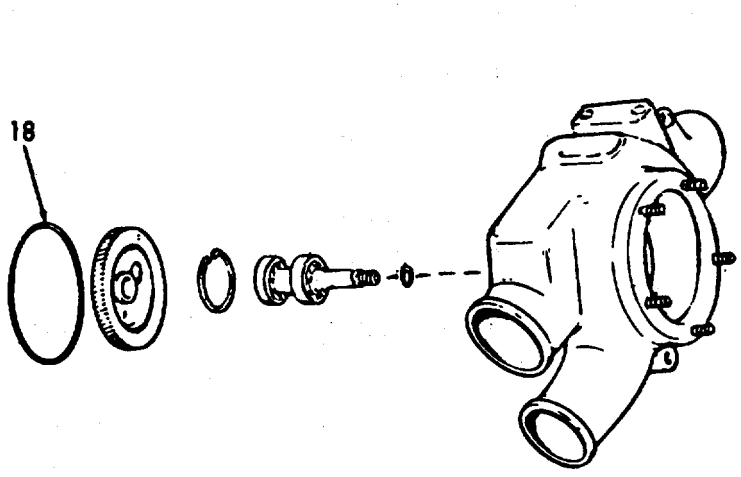
c. Place the adhesive washer in the impeller bond area with the ceramic insert on top. The polished face of the ceramic insert should be visible to the assembler. Clamp the ceramic insert and impeller together with a 3/8 inch (6.774 cm) bolt and nut and two smooth .125 inch (0.318 cm) thick washers. Tighten the bolt to 10 lb-ft (14 Nm) torque.

CAUTION

Do not mar the polished surface of the ceramic insert.

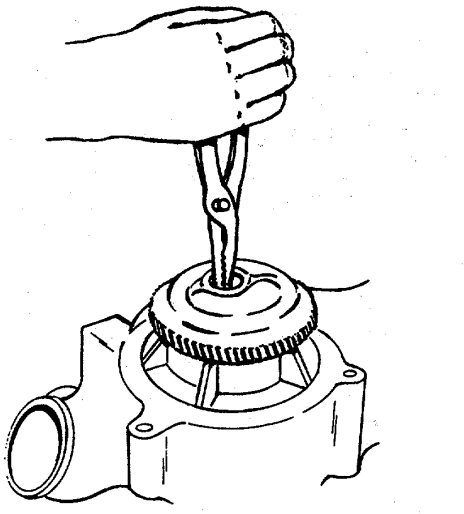
3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		NOTE The face of the ceramic insert must be square with the axis of the tapered bore 4ithin .004 inch (.0102 cm). The pump shaft may be used as a mandrel for this inspection.	
		d. Place the impeller assembly in a level position, with the ceramic insert up, in' an oven preheated to 350°F (1770C) for one hour to cure the adhesive.	
		e. Remove the impeller from the oven and, after it has cooled to room temperature, install it in the pump. Do not loosen or remove the clamping bolt and washers until the assembly cools.	
14. Water pump shaft, bearings, and gear	a. Seal ring (18)	Remove.	Discard.



3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Retaining ring (28)	Remove.	Insert pliers into slot, and using a small screw driver, remove ring. Discard ring.



	c. Impeller (26)	Remove.	Refer to step 12.
	d. Shaft, bearings, and gear assembly (29)	Remove.	Press the assembly out of pump body
	e. Assembly (29)	Discard.	
	f. Bearing oil seal (30)	Remove.	Use tool J1930

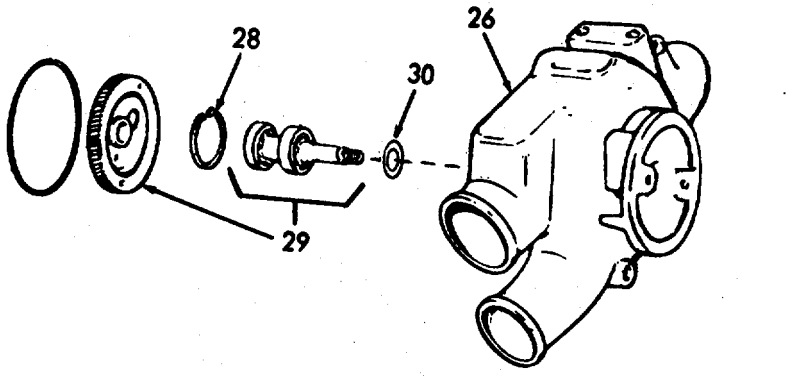
CAUTION

Apply pressure to the inner races of the bearings only during assembly on the shaft.

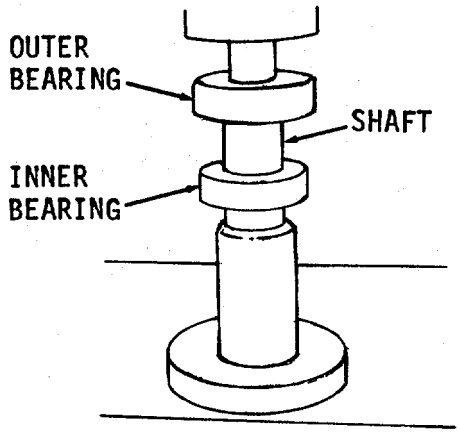
3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



g.	Bearing (31) and shaft (32)	Install.	Use new bearing and shaft. Lubricate bearing bore and shaft bearing surface. Use arbor press.
h.	Bearing (33), and shaft (32)	Install.	Use new bearing. Lubricate from above.



3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
i.	Pump body (17) and bearing and shaft assembly	Install.	Support the pump body on the bed of an arbor press with the cover side down. Then press the shaft and bearing assembly in place by applying pressure on the outer race of the large bearing.

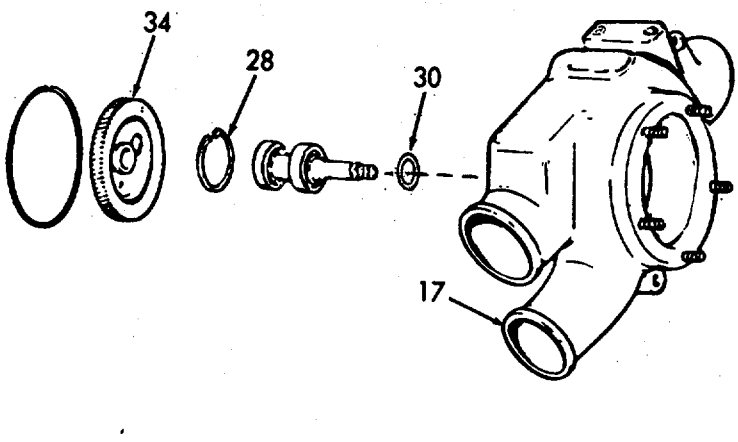
CAUTION

Support the pump body so the studs (if used) do not rest on the bed of the arbor press.

j.	Lock-ring (28)	Install.	Use new part.
k.	Gear (34)	Install.	Use new gear with gear installer positioned on the impeller end of shaft, place gear between the shaft and the ram of the press. Press the gear on the shaft so it is flush with end of shaft.

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	l. Bearing oil seal (30)	Install.	Use new seal. Apply a film of engine oil to sealing lip of oil seal and lip contact surface of shaft. Then insert seal into pump body. Using tool J21971, tap the seal into place.

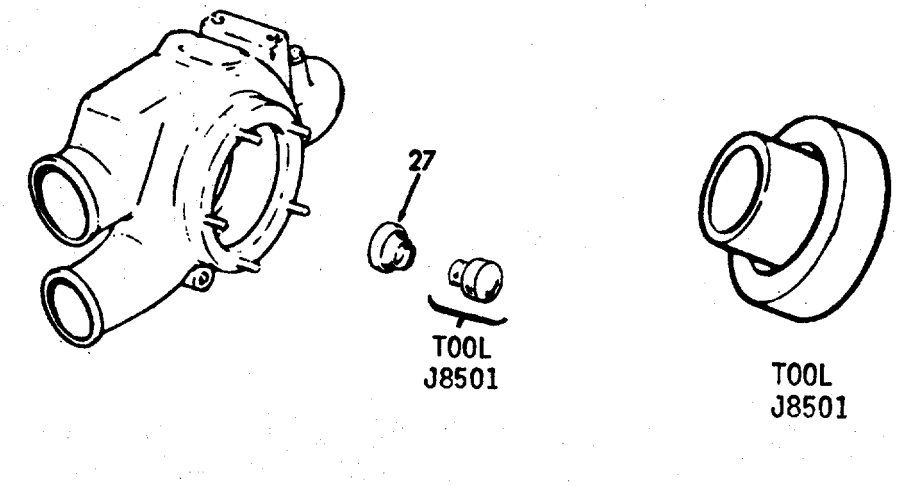


CAUTION

The oil seal must be flush with the water seal counterbore in the pump body.

3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	m. Water pump seal (27)	Install.	Place the pump body on the bed of an arbor press. To reduce possible coolant leakage, apply a light coat of non-hardening sealant on the outside diameter of a new water seal. Then insert the seal in the cavity in the pump body and, with tool J8501 resting on 'the brass cartridge lip, press the seal into place.
	n. Water Pump seal (27)	Clean.	Make sure the mating surfaces of the water seal and the ceramic insert are free of dirt, metal particles and oil film.
	o. Shaft, bearings, and gear assembly (29)	Apply a small quantity of compound P/N 5198653.	Apply to threads of pump shaft. Use International Compound #2, or equivalent.



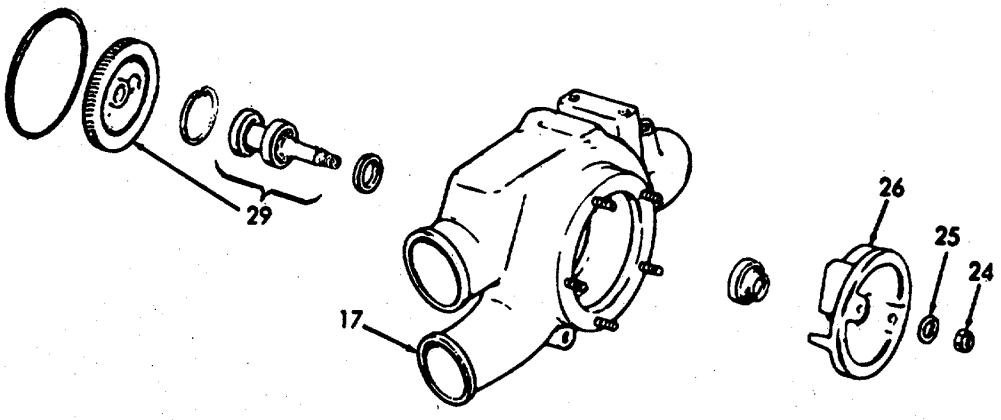
3-18. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	p. Impeller (26), washer (25), and locknut (24)	Install.	Use new impeller and locknut. Hold the pump gear securely while drawing the impeller down on the tapered shaft with the locknut. Tighten the nut to 45-50 lb-ft (61-68 Nm) torque.

CAUTION

Do not damage the gear teeth while holding the gear.

	q. Pump assembly (17)	Install on engine.	Refer to step 7 installation.



3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS.

a. In the expansion tank and keel cooling systems, the coolant is drawn by the raw water pump from the expansion tank and keel cooler, and is forced through the engine oil cooler, cylinder block, cylinder heads, exhaust manifolds and finally to the thermostat housings. A by-pass from the thermostat housings to the inlet. side of the water pump permits circulation of coolant through the engine while the thermostats are closed.

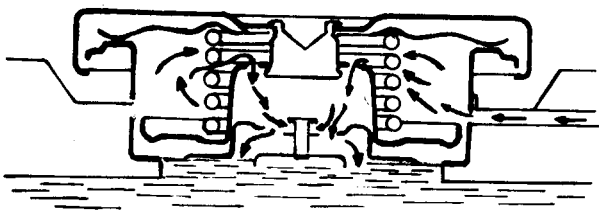
b. In the keel cooling system, coolant flows through the keel cooling coils and then to the suction side of the raw water pump for recirculation. The heat of the engine coolant is passed through the keel cooler coils and out to the sea water.

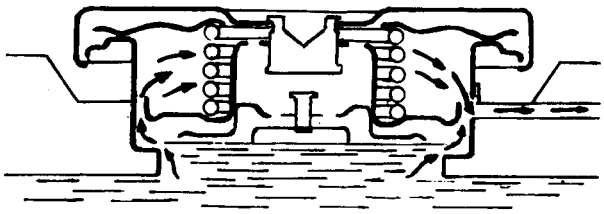
c. The expansion tank has a pressure control cap with a normally closed valve. The cap with a number 7 stamped on its top, is designed to permit a pressure of approximately seven pounds in the system before the valve opens. This pressure raises the boiling point of the cooling liquid and permits somewhat higher engine operating temperatures without loss of any coolant from boiling. To prevent the collapse of hoses and other parts which are not internally supported, a second valve in the pressure cap opens under vacuum when the system cools.

WARNING

Always remove the expansion tank cap slowly and carefully to avoid possible flash of hot cooling liquid.

d. To ensure against possible damage to the cooling system from either excessive pressure or vacuum, check both valves periodically for proper opening and closing pressures. If the pressure valve does not open between 6-1/4 and 7-1/2 psi (43.1 and 51.7 kpa) or vacuum valve does not open at 5 to 8 Hg (34.5 to 55.2 kpa) replace cap.





3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont)

This task covers:

a. Inspection **c. Removal** **e. Installation**
b. Service **d. Repair** **f. Test**

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Gasket kit P/N 5196378
Gasket kit P/N 5196375
Anti-freeze (MIL-A-46153)

Personnel Required
2

References
Para 3-22 Thermostat testing

Equipment Condition: NONE — Condition Description

Special Environmental Conditions
Do not drain oil into bilges. Use the oil/water separation system and drain into suitable containers.

General Safety Instructions
NONE

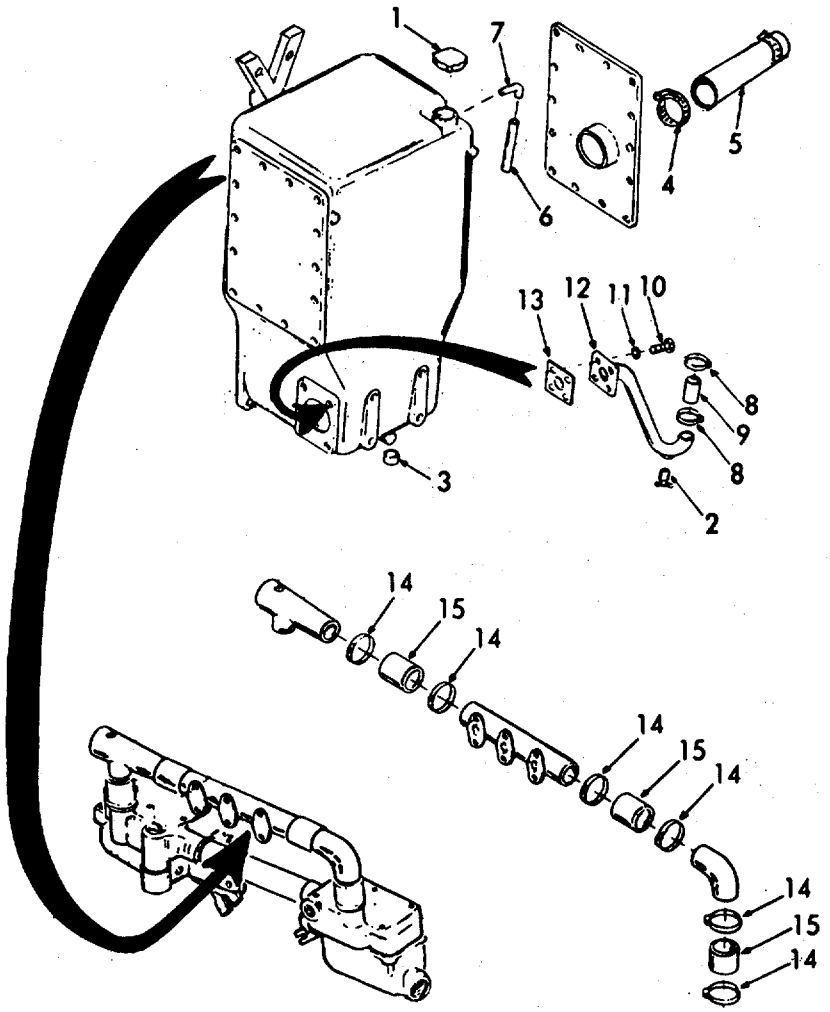
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Expansion tank	a. Hoses, gaskets	Inspect for cracks, breaks, leaks, and deterioration.	
	b. Expansion tank	Inspect for cracks, damage, loose mounting bolts and leaks.	
SERVICE			
2. Expansion tank	Coolant level	Add coolant as required.	Use anti-freeze MIL-A-46153, ethylene glycol, inhibited, heavy duty.

3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
3. Pressure cap	All engine coolant hoses	With engine running, check for collapsed hoses.	If hoses are collapsed, the pressure cap may be defective.
REMOVAL			
4. Pressure cap	Cap (1)	Remove.	
5. Expansion tank	a. Drain cock (2)	Open.	Drain anti-freeze into a suitable container.
	b. Plug (3)	Remove.	If necessary to drain tank.
6. Inlet Hose	a. Hose clamp (4)	Loosen.	
	b. Hose (5)	Remove.	
7. Overflow tube	a. Tube (6)	Remove.	
	b. Elbow (7)	Remove.	
8. Outlet Hose	a. Hose clamps (8)	Loosen.	
	b. Hose (9)	Remove.	
9. Outlet Elbow	a. Screws (10), and lock-washers (11)	Remove.	
	b. Elbow (12)	Remove.	

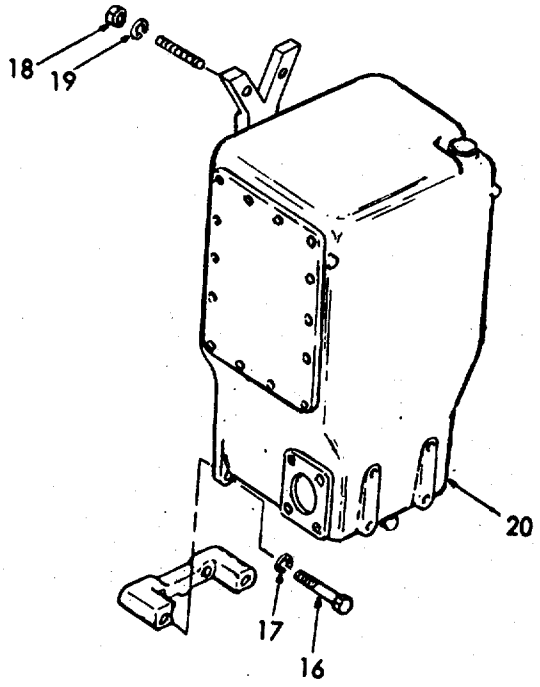
3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Gasket (13)	Remove.	Discard.
10. Heat exchanger/ thermostat hoses	a. Hose clamps (14)	Loosen.	Loosen one set on each side.
	b. Hoses (15)	Remove.	Remove 1 hose on each side.



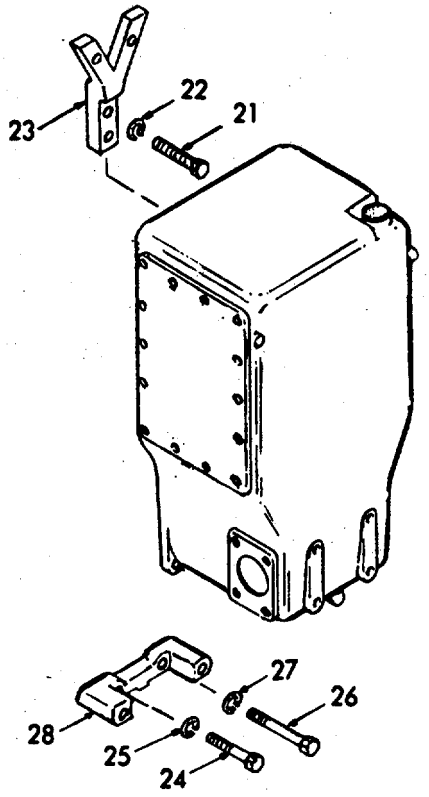
3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
11. Lower Mounting bracket	Screws (16), and lock-washers (17)	Remove.	
12. Upper mounting Bracket	Nuts (18) and lock-washers (19)	Remove.	Support the expansion tank.
13. Expansion tank	Tank (20)		Slide forward off of studs and remove.
14. Upper Mounting bracket	a. Screws (21), and lock-washers (22)	Remove.	
	b. Bracket (23)	Remove.	



3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
15. Lower Mounting bracket	a. Screw (24), and lock-washer (25)	Remove.	
	b. Screw (26), and lock-washer (27)	Remove.	
	c. Bracket (28)	Remove.	

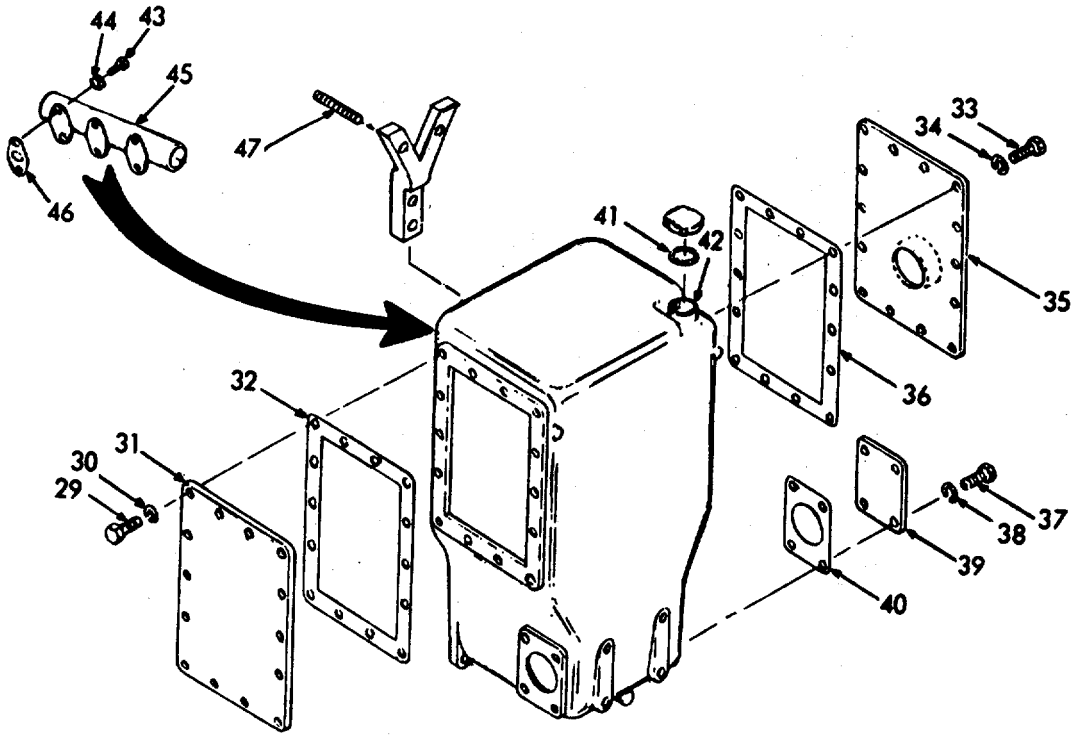


3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
16. Expansion tank	a. Screws (29), and lockwashers (30)	Remove.	
	b. Cover (31)	Remove.	
	c Gasket (32)	Remove.	Discard gasket.
	d. Screws (33), and lockwashers (34)	Remove.	
	e. Inlet cover (35)	Remove.	
	f. Gasket (36)	Remove.	Discard gasket.
	g. Screws (37), and lockwashers (38)	Remove.	
	h. Cover (39)	Remove.	
	i. Gasket (40)	Remove.	Discard gasket.
	j. Filler neck gasket (41)	Remove.	Discard gasket.

3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
k.	Filler neck (42)	Remove.	
l.	Screws (43), and lock-washers (44)	Remove.	
m.	Heat ex-changer (45)	Remove.	
n.	Gaskets (46)	Remove.	Discard gaskets.
o.	Studs (47)	Remove.	If damaged.

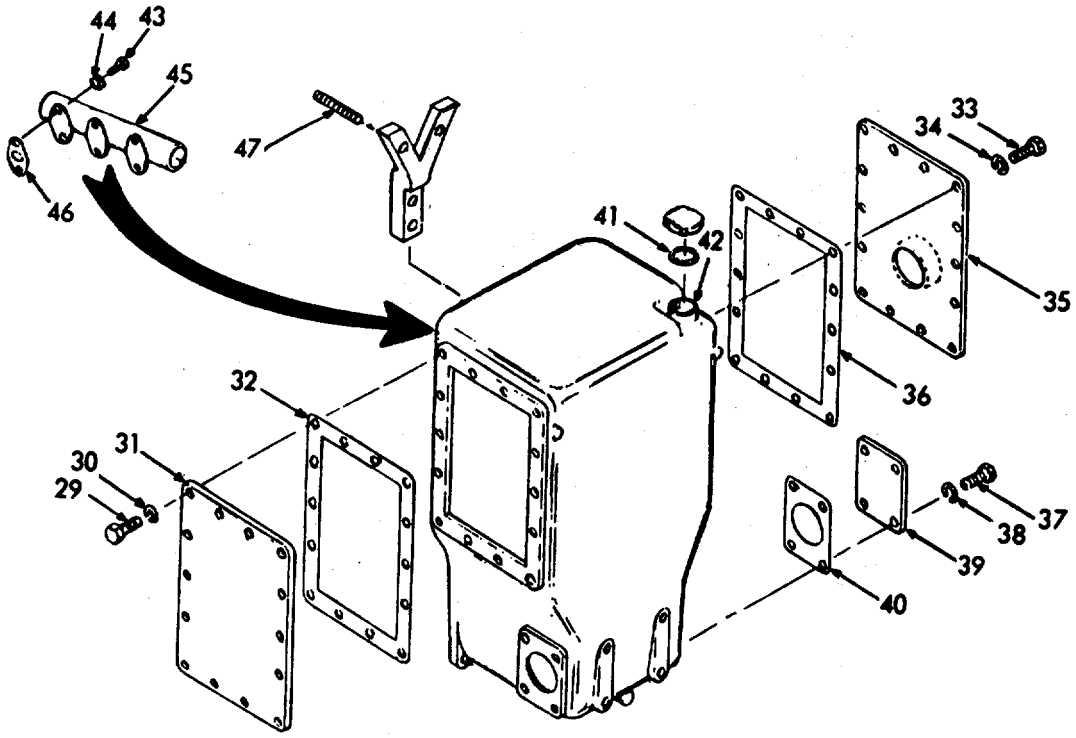


3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
	p. Studs (47)	Replace.	If removed.
	q. Gaskets (46) and heat exchanger (45)	Align with holes on expansion tank.	
	r. Screws (43), and lockwashers (44)	Install.	
	s. Filler neck (42)	Install.	
	t. Filler neck gasket (41)	Replace.	Use new gasket.
	u. Cover (39), and gasket (40)	Align hoses on tank.	Use new gasket.
	v. Screws (37), and lockwashers (38)	Install.	
	w. Inlet cover (35), and gasket (36)	Align holes on tank.	Use new gasket.

3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (CONT)			
	x. Screws (33), and lock-washers (34)	Install.	
	y. Cover (31), and gasket (32)	Align holes on tank.	Use new gasket.
	z. Screws (29), and lock-washers (30)	Install.	

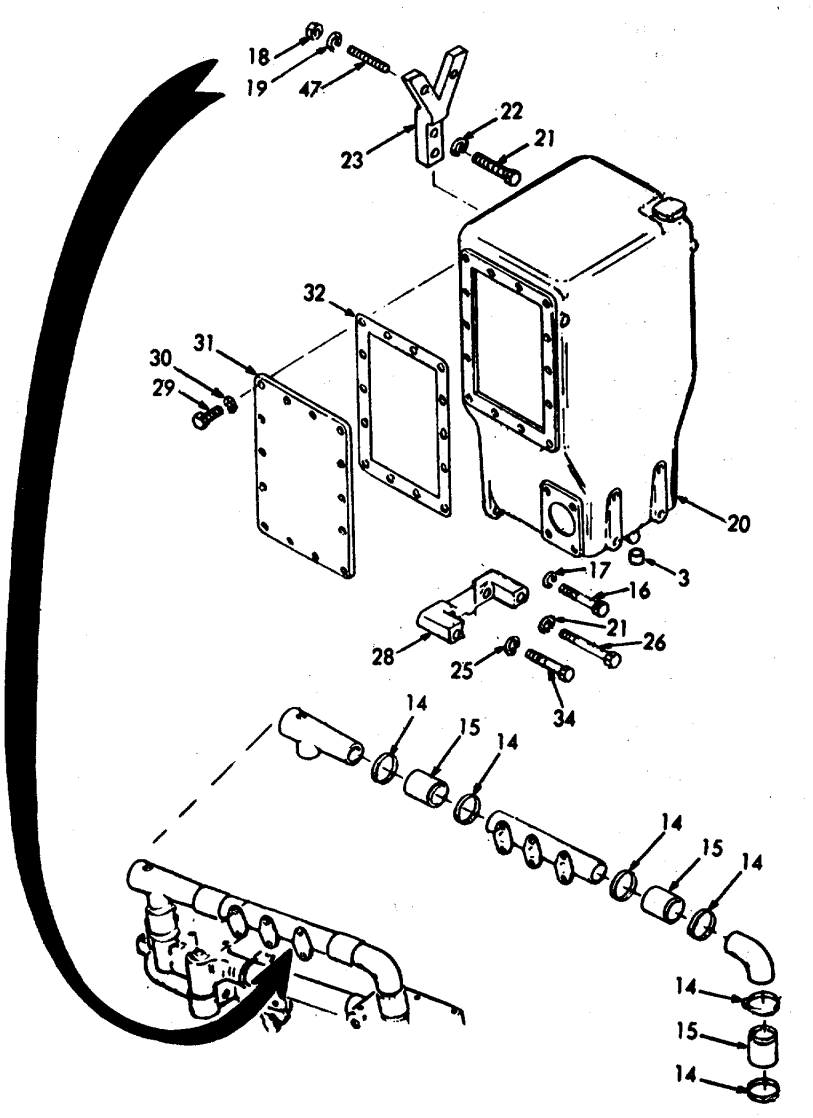


3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
17. Lower mounting bracket	a. Bracket (28)	Align holes on engine.	
	b. Screws (26), and lock-washer (27)	Install.	
	c. Screw (24), and lock-washer (25)	Install.	
18. Upper Mounting bracket	a. Bracket (23)	Align holes on engine.	
	b. Screws (21), and lock-washers (22)	Install.	
19. Expan-sion tank	a. Tank (20)	Position tank on bracket (23).	
	b. Nuts (18), and lock-washers (19)	Install.	
	c. Screws (16), and lock-washers (17)	Install.	

3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
20. Heat exchanger/ thermostat hoses	Hoses (15), and hose clamps (14)	Install.	Replace hoses and clamps that were removed.

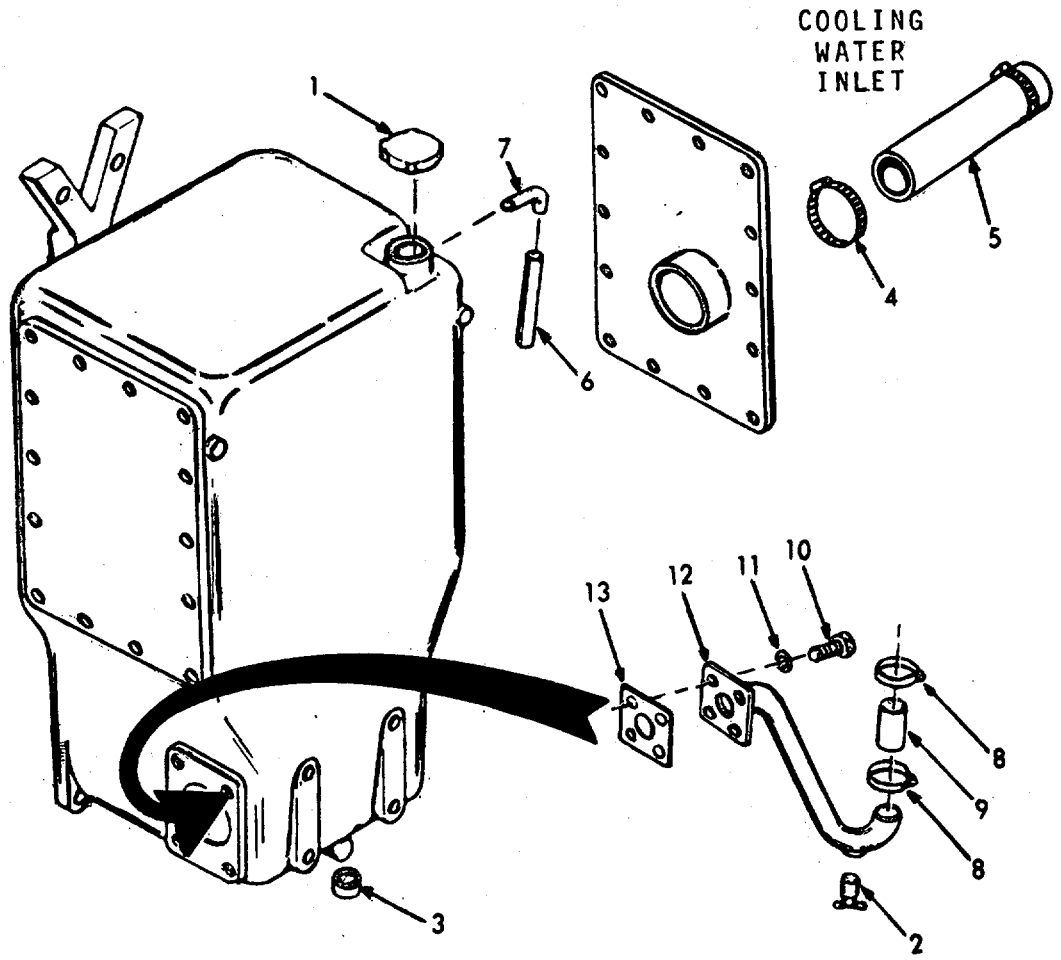


3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
21. Outlet elbow	a. Elbow (12), and gasket (13)	Align holes on tank.	Use new gasket.
	b. Screws (10), and lock-washers (11)	Install.	
	c. Hose (9), and clamps (8)	Install.	Use new hose as required.
	d. Drain cock (2)	Close.	
22. Overflow tube	a. Elbow (7)	Install.	
	b. Tube (6)	Install.	
23. Inlet hose	Hose (5), and clamp (4)	Install.	
24. Expan-sion tank	a. Pipe plug (3)	Install.	
	b. Pressure cap (1)	Place on tank.	Fill expansion tank with anti-freeze MIL-A-46153 ethylene glycol, inhibi-ted, heavy duty. Operate engine and check for leaks.
25. Thermostat	Refer to paragraph 3-22.		

3-19. EXPANSION TANK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (CONT)			



3-20. WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS.

The water connections are the water inlet and outlet hoses and fittings to the right and left exhaust manifolds.

This task covers:
a. Inspection **b. Repair**

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition: NONE
Condition Description

Material/Parts
Gasket kit P/N 5196375

Special Environmental Conditions
NONE

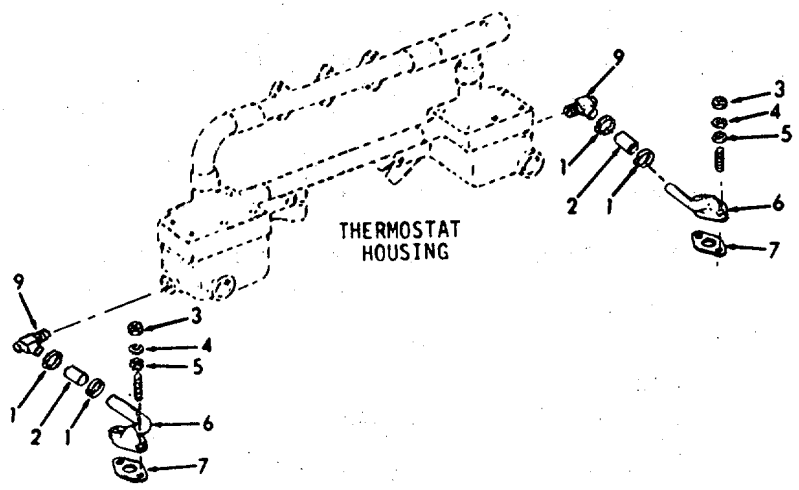
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION,			
1. Left side of engine	a. Hoses, and fittings	Inspect for worn, or deteriorated parts.	
	b. Hose clamps	Inspect for loose clamps.	
	c. Draincocks	Inspect for leaking or corrosion.	
2. Right side of engine	a. Hoses, and fittings	Inspect for worn, or deteriorated parts.	
	b. Hose clamps	Inspect for loose clamps.	
	c. Draincocks	Inspect for leaking or corrosion.	

3-20. WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
		NOTE Open drain-cocks to drain anti-freeze from system. Drain into a suitable container.	
3. Right or left side of engine	a. Hose clamps (1)	Loosen.	
	b. Hose (2)	Remove.	
	c. Nuts (3), lock washers (4), and flat-washer (5)	Remove.	
	d. Tube assembly (6)	Remove.	
	e. Gasket (7)	Remove.	Discard.
	f. Studs (8)	Remove.	If necessary
	g. Water outlet elbow (9)	Remove.	

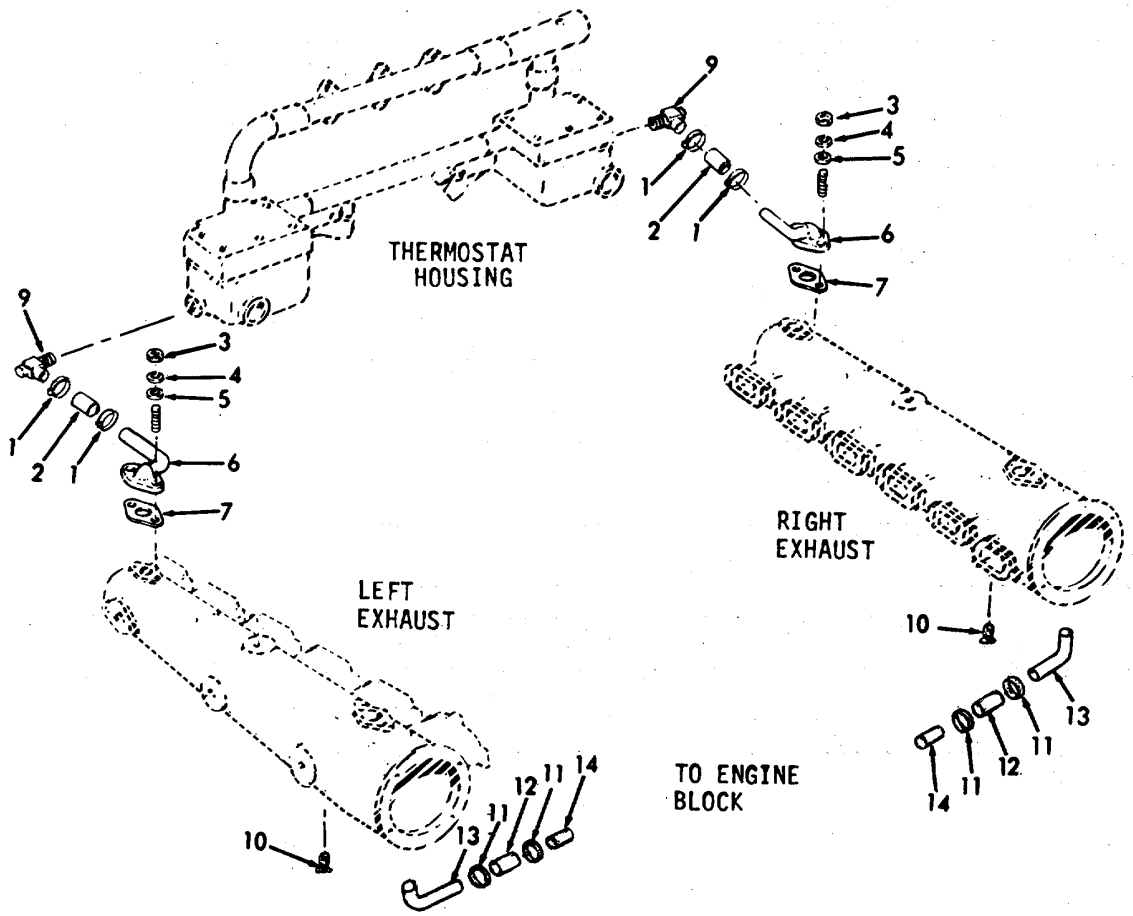


3-20. WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Drain-cock (10)	Remove.	
	i. Hose clamps (11)	Remove.	
	j. Hose (12)		
	k. Elbow (13)	Remove.	
	l. Pipe connector (14)	Remove.	
	m. Pipe connec-tor (14)	Install.	
	n. Elbow (13)	Install.	
	o. Hose (12) and hose clamps (11)	Install.	
	p. Drain-cock (10)	Install.	Close.
	q. Water outlet elbow (9)	Install.	
	r. Tube assembly (6), and gasket (7)	Assemble on studs.	Use new gasket.

3-20. WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	s. Nuts (3), lock-washers (4), and flat-washers (5)	Install.	
	t. Hose (2), and hose clamps (1)	Install.	



3-21. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS.

a. The engine is equipped with external water manifolds (one per cylinder head).
b. Coolant leaving the cylinder head through an opening directly over each exhaust port, enters the water manifold which is attached to the cylinder head.

This task covers:
a. Inspection **b. Removal** **c. Replacement**

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Part of gasket kit 5196375
Anti-freeze (MIL-A-46153

Personnel Required
1

References
NONE

Equipment
Condition — Condition Description
Draw cooling system to below manifold level.

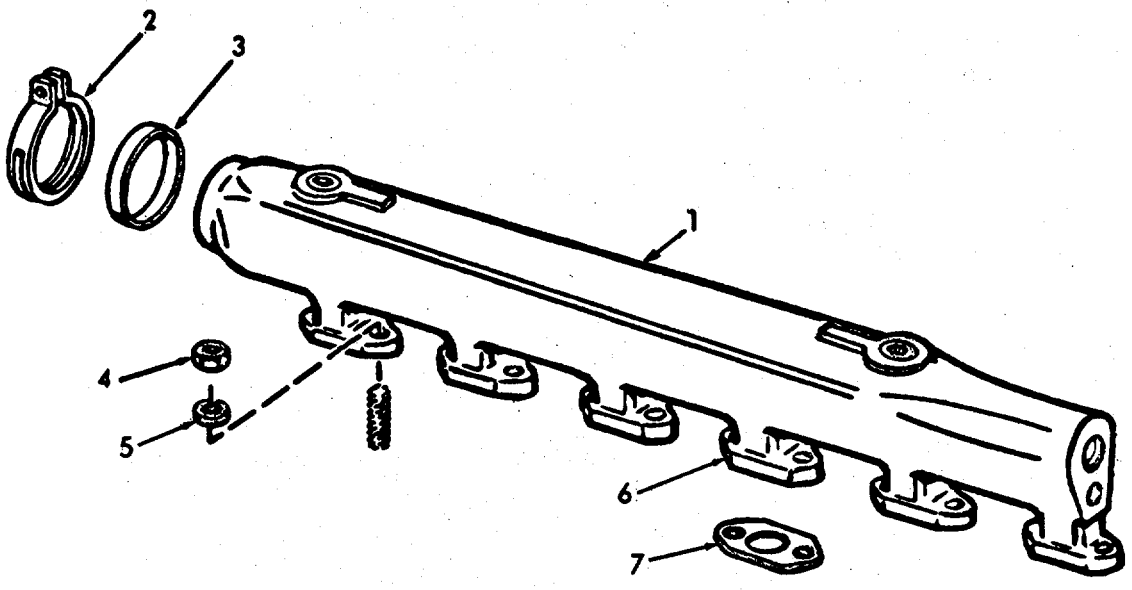
Special Environmental Conditions
NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Water manifold	Water manifold	a. Inspect for cracks, leaks and bad gaskets.	
		b. Inspect for loose mounting bolts.	

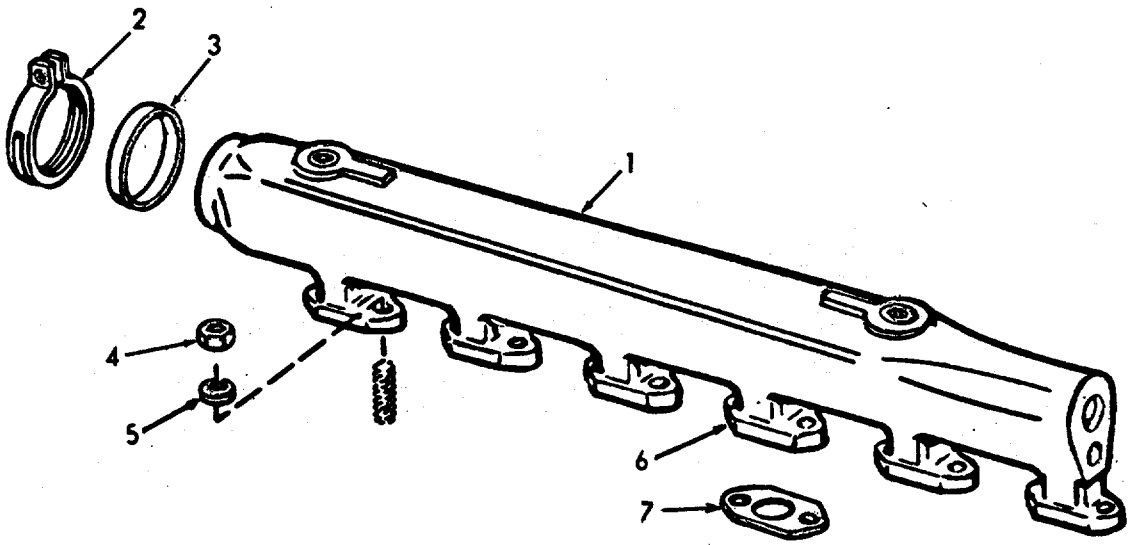
3-21. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Front of water manifold (1)	Hose clamp (2)	Loosen and remove.	
2.	Seal (3)	Slide seal off neck of manifold.	
3.	Manifold	Lift off of studs.	Remove stud nuts (4) and lockwashers (5).
4.	Ports (6)	Remove gaskets (7).	



3-21. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
5. Each port (6)	Gaskets (7)	Install a new gasket at each port.	
6. Cylinder head	Manifold (1)	Place manifold on studs and secure with nuts (4) and lockwashers (5).	
7. Front of manifold (1)	Seal (3) and hose clamp (2)	Replace seal on front of manifold, secure seal with clamp.	Examine seal for signs of deterioration Replace with new seal if necessary.
8. Cooling system	Coolant	Restore coolant to proper operating level.	Use anti-freeze MIL-A-46153 ethylene glycol inhibited, heavy-duty.



3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS.

a. The temperature of the engine coolant is automatically controlled by a thermostat located in a housing attached to the water outlet end of each cylinder head. Blocking type thermostats are used with a standard cooling system, and there are four thermostats.

b. At coolant temperatures below approximately 1700F (76.60C), the thermostat valves remain closed and block the flow of coolant to the heat exchanger. During this period, all of the coolant in the standard system is circulated through the engine and is directed back to the suction side of the water pump via the by-pass tube. As the coolant temperature rises above 1700F (76.60C), the thermostat valves start to open, restricting the by-pass system, and permit a portion of the coolant to circulate through the heat exchanger. When the coolant temperature reaches approximately 1850 F (850C), the thermostat valves are fully open, the by-pass system is completely blocked off, and all of the coolant is directed through the heat exchanger.

c. A defective thermostat which remains closed, or only partially open, will restrict the flow of coolant and cause the engine to over-heat. A thermostat which is stuck in a full open position may not permit the engine to reach its normal operating temperature. The incomplete combustion of fuel due to cold engine operation will result in excessive carbon deposits on the pistons, rings, and valves.

3-22. THERMOSTAT - MAINTENANCE IN STRUCTIONS (Cont).

This task covers:

a. Inspection **c. Repair** **e. Test**
b. Removal **d. Installation**

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket kit P/N 5196375

Personnel Required
1

References

NONE

Equipment Condition: Condition Description

3-20: Water Connections

Special Environmental Conditions

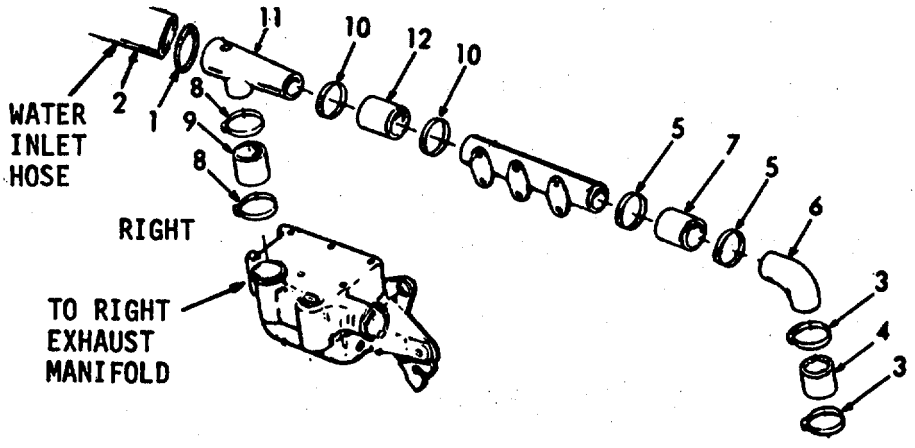
Drain the cooling system into a suitable container.

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Thermostat housing	a. Hose clamps, and Fitting	Inspect for leaks, cracks, looseness, and signs of wear.	
	b. Housing	Inspect for leaks, cracks, damage, and broken or loose hardware.	
REMOVAL			
		NOTE Drain the cooling system.	
2. Water Inlet Hose	a. Hose clamp (1)	Loosen.	

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Hose (2)	Remove.	
3. Left Side	a. Hose clamps (3)	Loosen.	
	b. Hose (4)	Remove.	
	c. Hose clamps (5)	Loosen.	
	d. Outlet elbow (6)	Remove.	
	e. Hose (7)	Remove.	
4. Right Side	a. Hose clamps (8)	Loosen.	
	b. Hose (9)	Remove.	
	c. Hose clamp (10)	Loosen.	
	d. Outlet tee elbow (11)	Remove.	
	e. Hose (12)	Remove.	



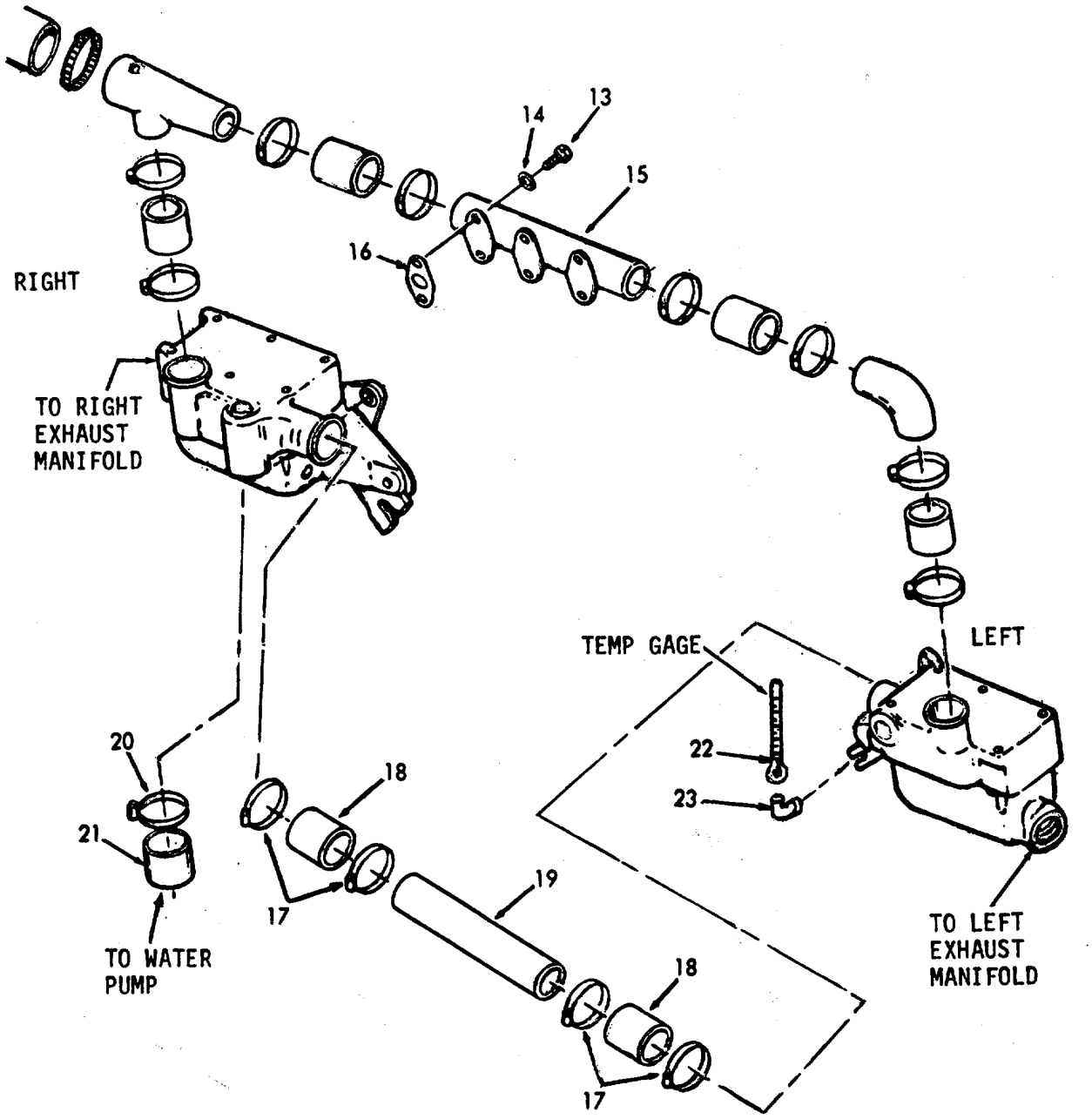
3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
5. Heat exchanger	a. Screws (13) and lockwashers (14)	Remove.	
	b. Heat exchanger (15)	Remove.	
	c. Gaskets (16)	Remove.	Discard gaskets.
6. Water by-pass tube	a. Hose clamps (17)	Loosen.	
	b. Hoses (18) and by-pass tube (19)	Remove.	
7. Water pump hose	a. Hose clamp (20)	Loosen.	
	b. Hose (21)	Remove.	
8. Temperature gage capillary tube	a. Tube nut (22)	Loosen.	
	b. Elbow (23)	Remove.	

3-22. THERMOSTAT - MAINTENANCE INS TRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



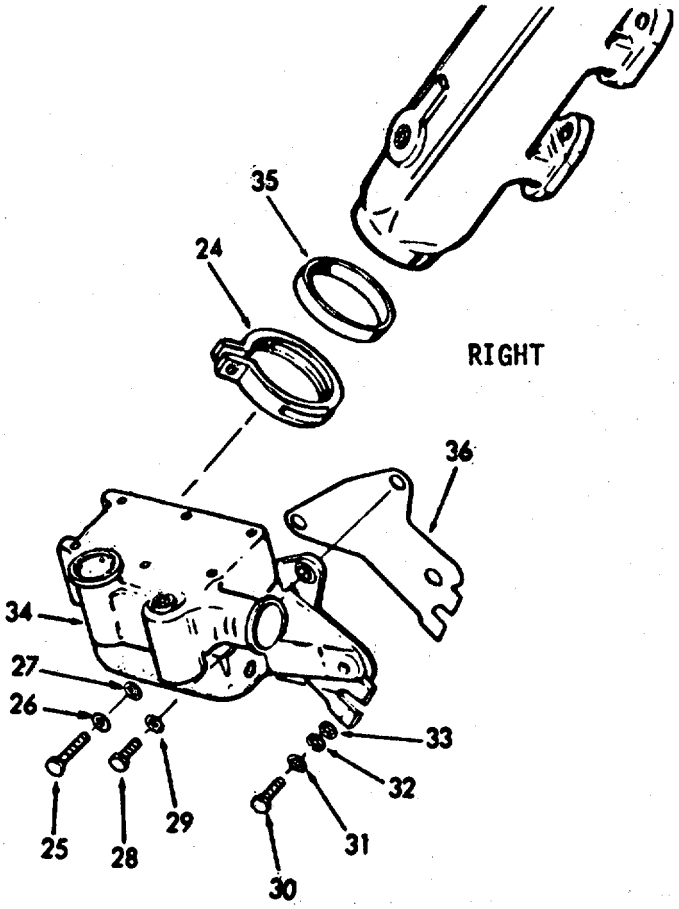
3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
9. Right Side	a. Hose clamp (24)	Loosen.	
	b. Screw (25), lock-washer (26), and flat-washer (27)	Remove.	
	c. Screw (28), and flat-washer (29)	Remove.	
	d. Screw (30), lock-washer (31), and flat-washers (32 and 33)	Remove.	
	e. Right thermo-stat assem-bly (34)	Remove.	Slide assembly off of hose (35). Remove hose clamp (24).
	f. Gasket (36)	Remove.	Discard gasket.¾'j

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



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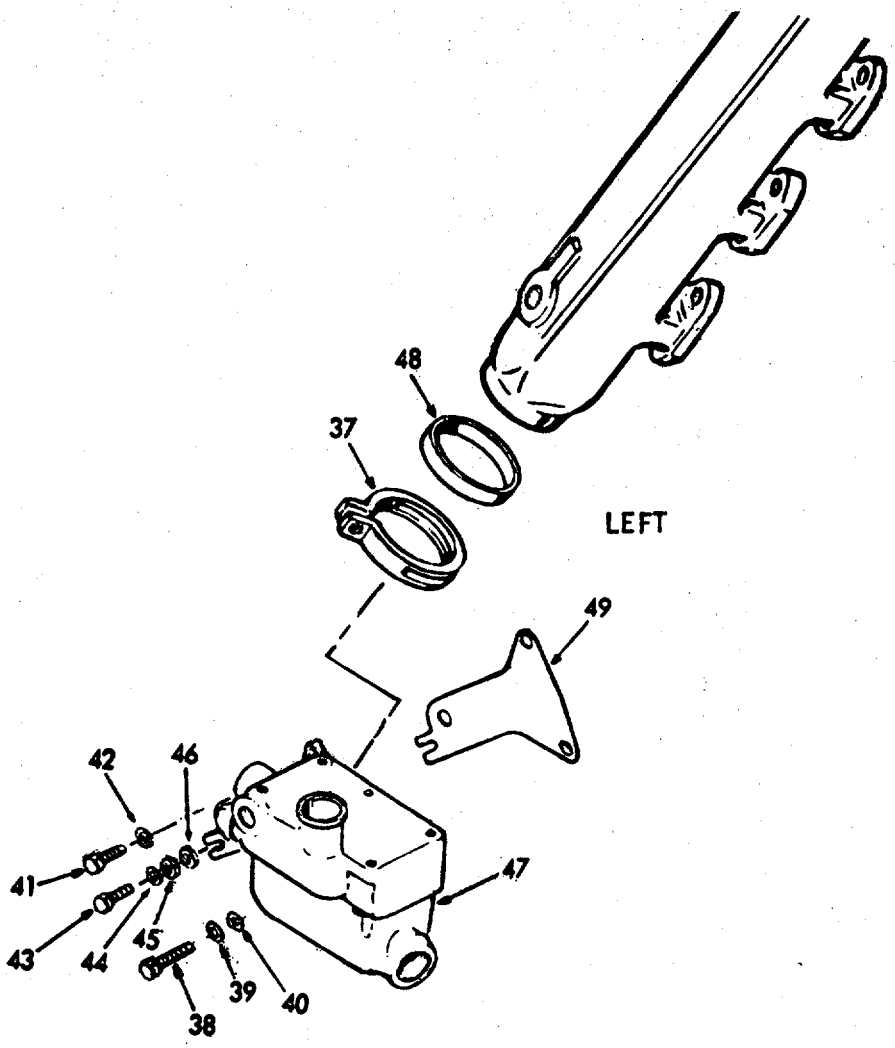
3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
10. Left Side	a. Hose clamp (37)	Loosen.	
	b. Screw (38), lock-washer (39), and flat-washer (40)	Remove.	
	c. Screw (41), and flat-washer (42)	Remove.	
	d. Screw (43), lock-washer (44), and flat-washers (45 and 46)	Remove.	
	e. Left thermo-stat assem-bly (47)	Remove.	Slide assembly off of hose (48). Remove. hose clamp (37).
	f. Gasket (49)	Remove.	Discard gasket.

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

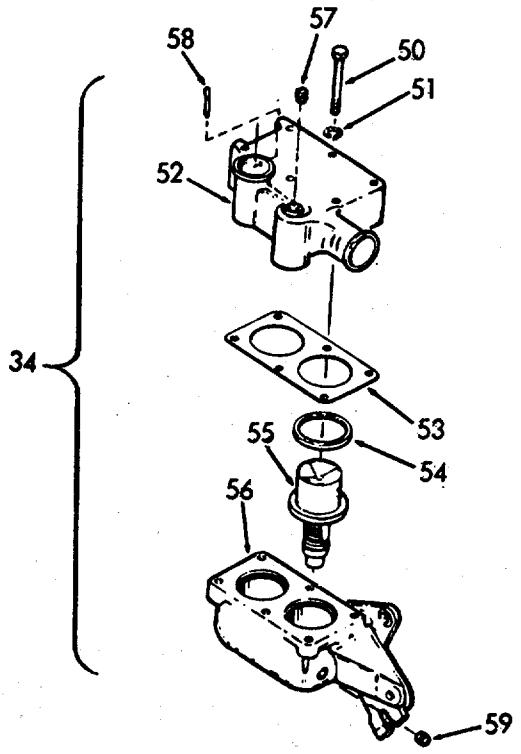


3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
11. Right thermostat assembly (34)	a. Screws (50) and lockwashers (51)	Remove.	
	b. Cover (52)	Remove.	
	c. Gasket (53)	Remove.	Discard gasket.
	d. Thermostat seals (54)	Remove from cover.	
	e. Thermostats (55)	Remove from housing (56).	
	f. Pipe plug (57)	Remove.	If necessary.
	g. Housing cover pin (58)	Remove.	If necessary.
	h. Pipe plug (59)	Remove.	If necessary.
	i. Pipe plug (59)	Install.	If necessary.
	j. Housing cover pin (58)	Install.	If necessary.
	k. Pipe plug (57)	Install.	If necessary.
	l. Thermostats (55)	Install in housing (56).	Inspect - see step 13.
	m. Thermostat seals (54)	Install. Position the seal so that the lips of the seal faces up (away from the thermostat) when the cover is installed on	

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		the thermostat housing. Seal is positioned the correct distance from the bottom face of the cover and parallel with the cover face.	
	n. Cover (52), and gasket (53)	Align holes in housing.	Use new gasket.
	o. Screws (50), lock-washers (51)	Install.	Screws are 3/8-16. Torque to 30-35 lb-ft (40.7 - 47.5 Nm).

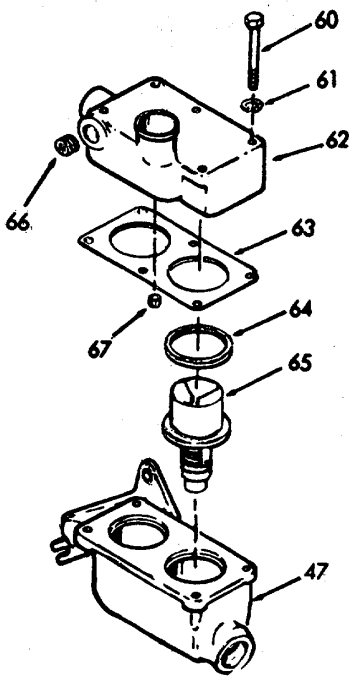


3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
12. Left thermostat assembly (47)	a. Screws (60), and lockwashers (61)	Remove.	
	b. Cover (62)	Remove.	
	c. Gasket (63)	Remove	Discard gasket.
	d. Thermostat seals (64)	Remove from cover.	
	e. Thermostat (65)	Remove from housing (66).	
	f. Pipe plug (66)	Remove.	If necessary.
	g. Pipe reducer (67)	Remove.	If necessary.
	h. Pipe reducer (67)	Install.	If necessary.
	i. Pipe plug (66)	Install.	If necessary.
	j. Thermostats (65)	Install.	Inspect - see step 13.
	k. Thermostat seals (64)	Install. Position the seal so that the lip of the seal faces up (away from the thermostat)when the	

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		cover is installed on the thermostat housing. Seal is positioned the correct distance from the bottom face of the cover and parallel with the cover face.	
	1. Cover (62), and gasket (63)	Align holes in housing. Use new gasket.	
m.	Screws (60), and lock-washers (61)	Install.	Screws are 3/8-16. Torque to 30-35 lb-ft (40.7-47.5 Nm)

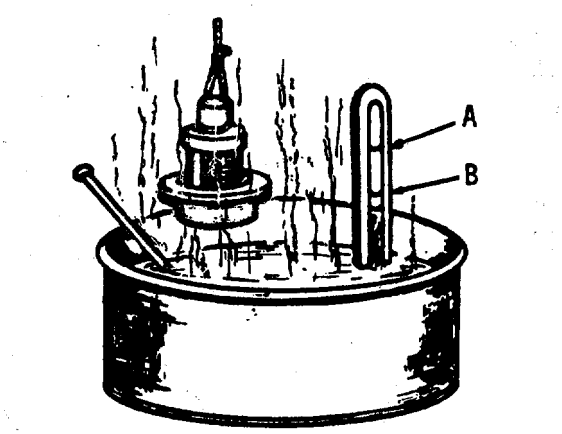


3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

TEST

13. Thermostats — Check the operation of a thermostat by immersing it in a container of hot water. Place a thermometer in container, but do not allow it to touch the bottom of the container. Agitate the water to maintain an even temperature throughout the container. As the water is heated, the thermostat should begin to open when water temperature is approximately 165° or 170°F (73.8 or 76.60C). (The opening temperature is usually stamped on the thermostat). The thermostat should be fully open at approximately 1850F (850C)



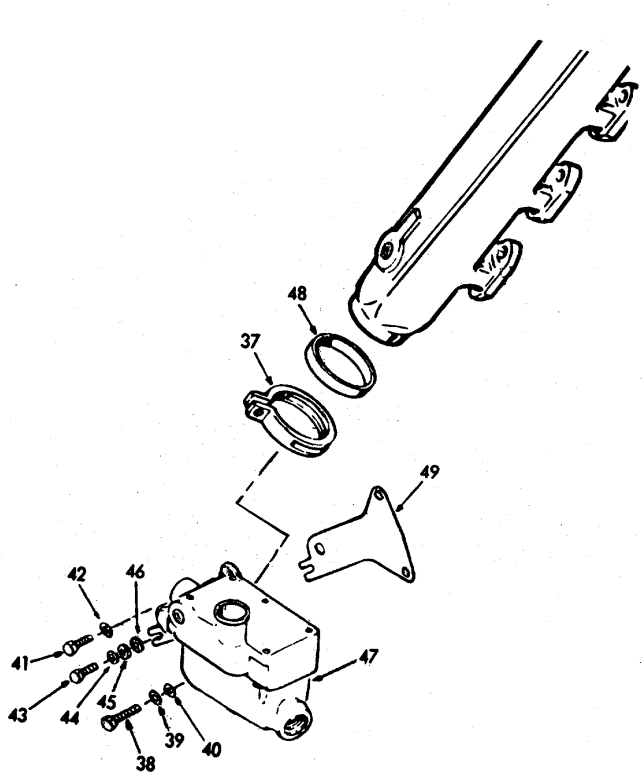
A - STARTS TO OPEN
B - FULLY OPEN

INSTALLATION

14. Left side	a.	Hose (48), and hose clamp (37)	Place on water manifold.	
	b.	Left thermostat assembly (47), gasket (49)	Align with holes on engine, and hose (48).	Use new gasket.
	c.	Screw (43), lockwasher (44), and flatwashers (45 and 46)	Install.	

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Screw (41), and flat-washers 42)	Install.	
	e. Screw (38), lock-washer (39), and flat-washer (40)	Install.	
	f. Hose clamp (37)	Tighten.	

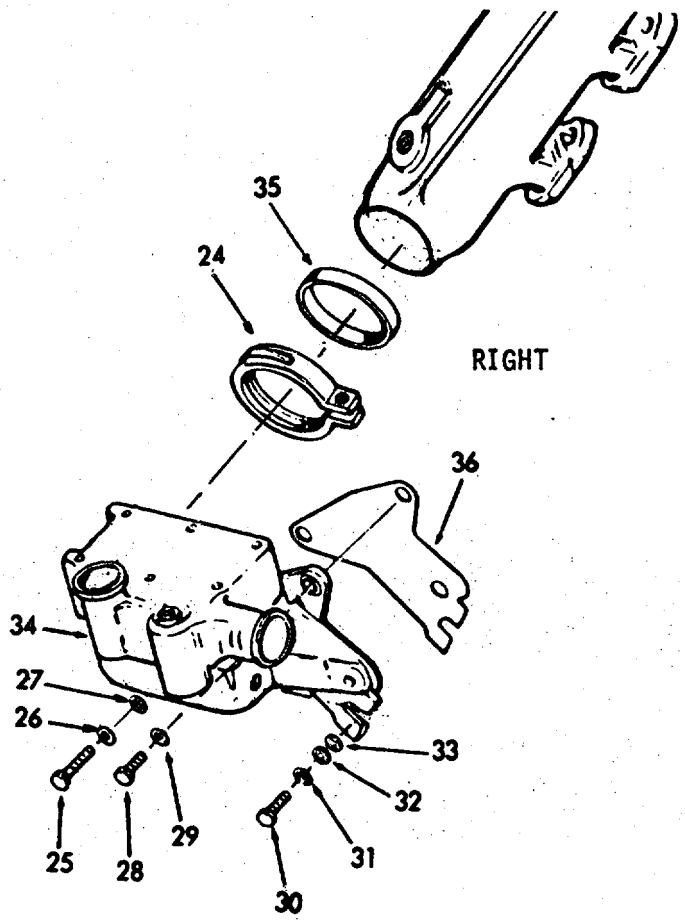


3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
15. Right Side	a. Hose (35), and hose clamp (24)	Place on water manifold.	
	b. Right thermostat assembly (34), and gasket (36)	Align with holes on engine and hose (35).	Use new gasket.
	c. Screw (30), lockwasher (31), and flatwashers (32 and 33)	Install.	
	d. Screw (28), and flatwasher (29)	Install.	

3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	e. Screw (25), lock-washer (26), and flat-washer (27)	Install.	
	f. Hose clamp (24)	Tighten.	

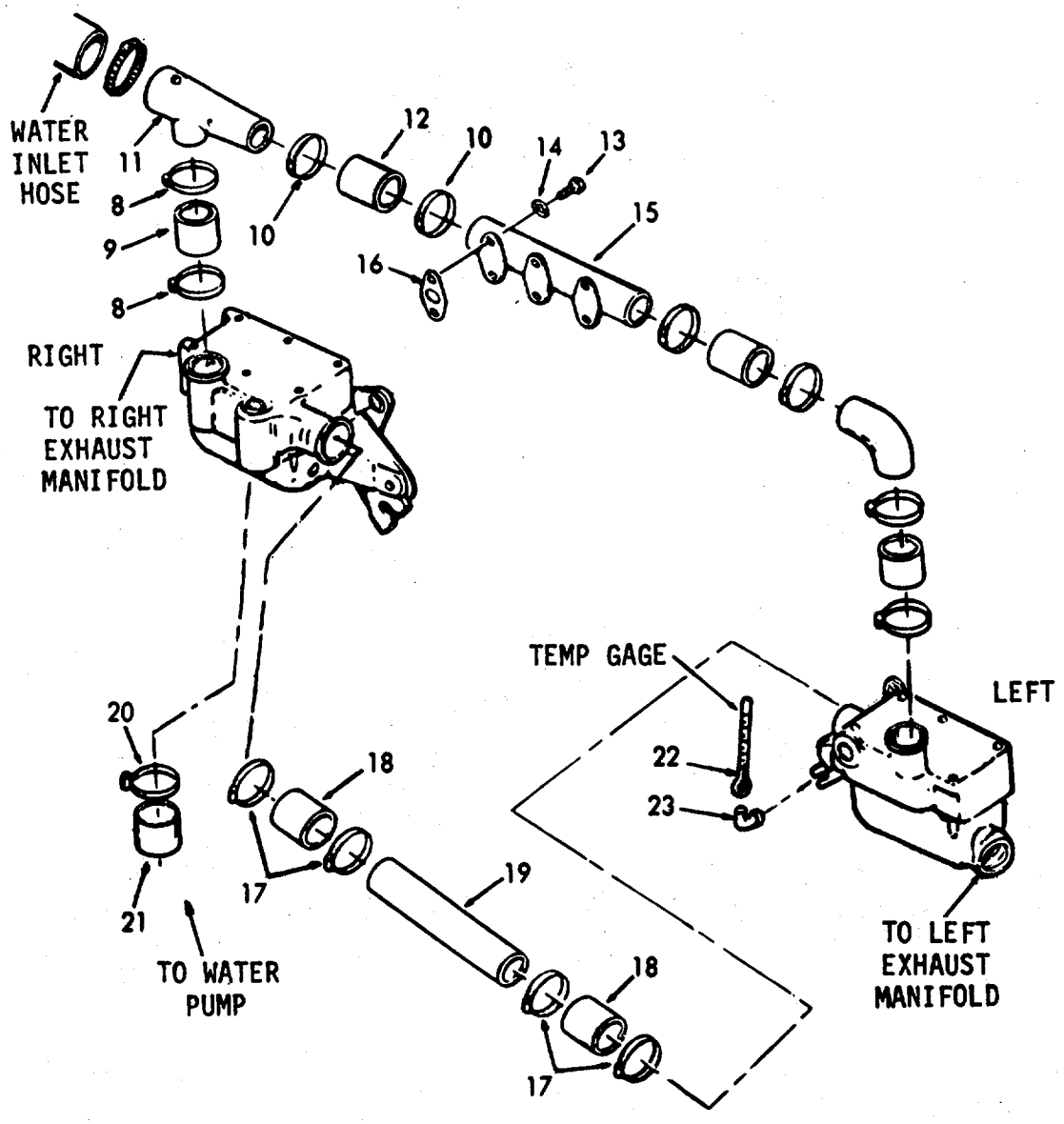


3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
16. Temperature gage capillary tube	a. Elbow (23)	Install.	
	b. Tube nut (22)	Install.	
17. Water pump hose hose clamp (20)	Hose (21) and	Install and tighten clamp.	
18. Water by-pass tube	By-pass tube (19), hose clamps (17), and hoses (18)	Reassemble and tighten clamp.	
19. Heat exchanger	a. Heat exchanger (15) and gaskets (16)	Align with holes in expansion tank.	Use new gaskets.
	b. Screws (13), and lock-washers (14)	Install.	
20. Right Side	a. Outlet tee elbow (11), hose clamps (10), and hose (12)	Assemble to heat exchanger.	

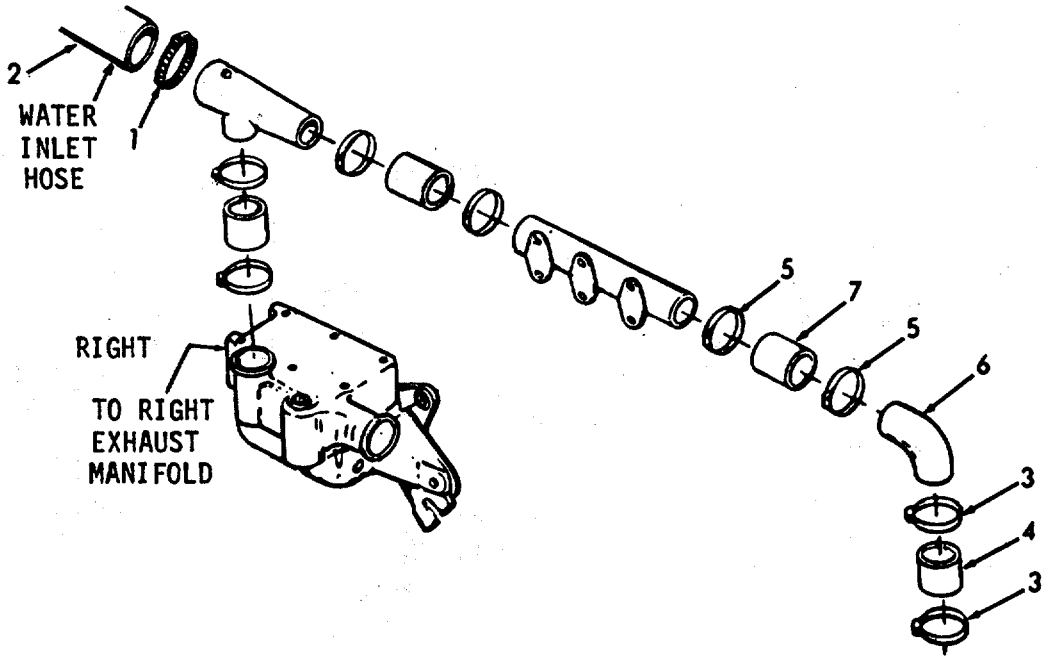
3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	b. Hose (9) and hose clamps (8)	Assemble.	Tighten hose clamps (8 and 10).



3-22. THERMOSTAT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
21. Left side	a. Outlet elbow (6), hose clamps (5), and hose (7)	Assemble to heat exchanger.	
	b. Hose clamps (3), and hose (4)	Assemble.	Tighten hose clamps (3 and (5).
22. Water inlet hose	Hose (2) and hose clamp (1)	Reassemble.	



3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

A tachometer drive shaft is installed at the rear of the engine, in the end of a camshaft. A tachometer drive shaft adaptor is attached to the flywheel housing cover. A special key is used to connect the drive shaft to the tachometer drive cable adaptor.

This task covers:

a. Inspection **c. Repair** **e. Alignment**
b. Removal **d. Installation**

INITIAL SETUP

Test Equipment

NONE

References

Para 3-24 Instrument Panel Maintenance Instructions.

Special Tools

NONE

Equipment Condition: NONE

Condition Description

Material/Parts

Gasket kit P/N 5196375

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Flywheel Housing	a. Tachometer drive	Inspect for gasket leaks.	
	b. Electric tachometer transmitter	Inspect for broken or frayed wiring. Inspect for damage and wear to couplings.	
2. Engine	Instrument panel	Start engine and observe tachometer. If not functioning, refer to paragraph 3-24 for replacement of tachometer.	

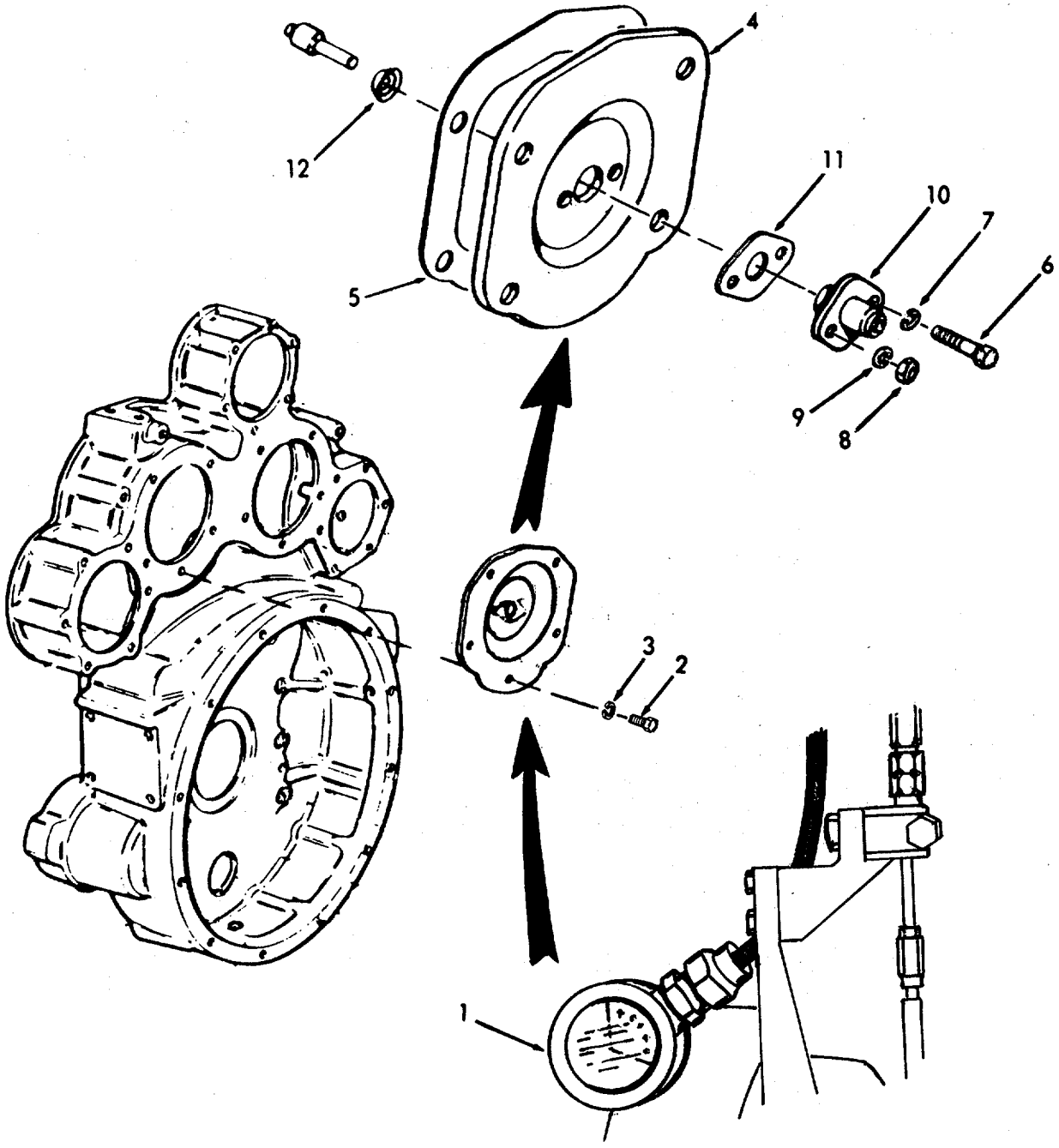
3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Electric-Tachometer transmitter	a. Mounting hardware	Remove.	
	b. Transmitter (1)	Remove, and move out of the way.	The output cable is connected in the instrument panel. For removal refer to paragraph 3-24
4. Tachometer drive cover (3)	a. Screws (2) and lockwashers	Remove.	
	b. Tachometer drive cover (4)	Remove.	The tachometer drive adaptor is attached to cover.
	c. Gasket (5)	Remove.	Discard gasket.
5. Tachometer drive adaptor	a. Screw (6) and lockwasher (7)	Remove.	
	b .Nut (8) and lockwasher (9)	Remove.	
	c. Adaptor cover (10), and gasket (11)	Remove.	Discard gasket.
	d. Oil slinger (12)	Remove.	

3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
6. Tachometer drive shaft	Shaft (13)	Remove.	1. If the tachometer drive shaft is pressed into end of camshaft, it cannot be turned since the end is either square or knurled. If threads (5/16 inch - 24 or 3/8 inch - 24) are provided on the outer end of the tachometer drive shaft to accomodate a removing tool, thread remover onto the shaft. Then, attach a slide hammer to the remover. A few sharp blows of the weight against the slide hammer rod will remove the tachometer drive shaft. 2- If threads are not provided on the outer end of the tachometer drive shaft, or if the end of the shaft is broken off, drill and tap the shaft. Then thread a stud into the shaft and remove shaft with remover and slide hammer.

3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

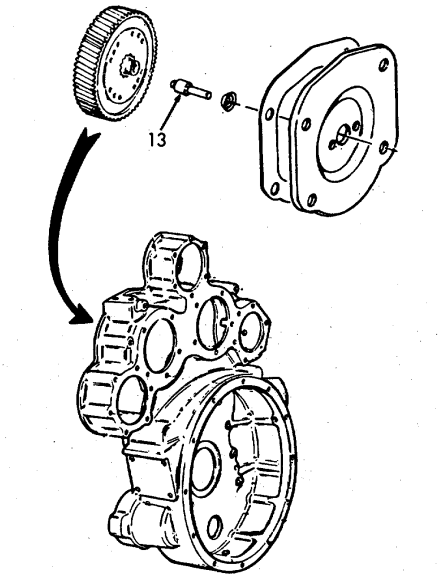
REPAIR (Cont)

CAUTION

Use adequate protective measures to prevent metal particles from falling into the gear train and oil pan.

INSTALLATION

7.	Tachometer drive shaft	Shaft (13)	Install.	Start the tachometer drive shaft in the end of camshaft. Using a suitable sleeve, tap or press against the shoulder on the tachometer driveshaft until shoulder contacts the camshaft.



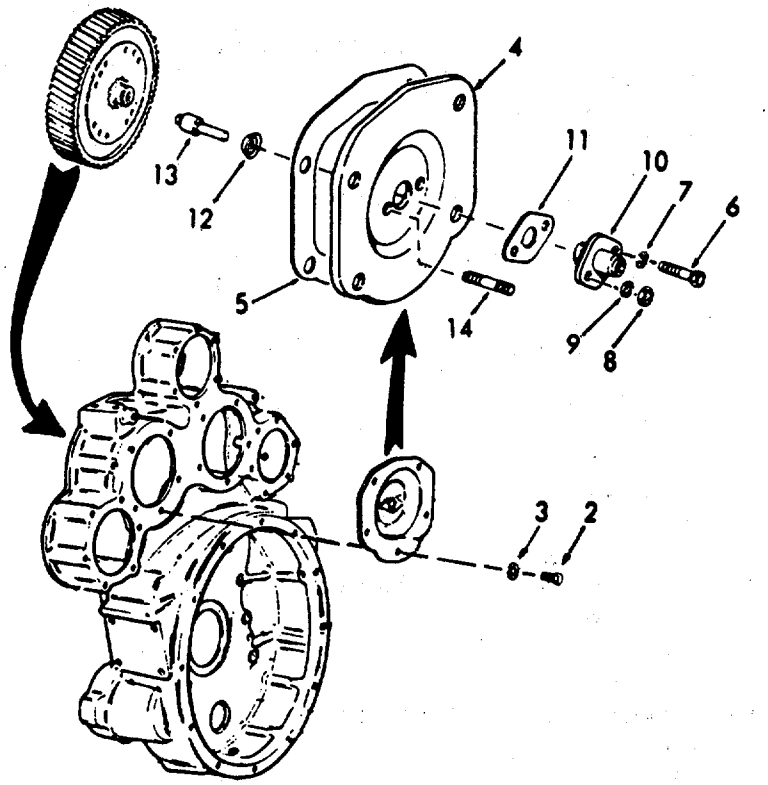
3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Tachometer drive adapter	a. Stud (14)	Replace.	If removed.
	b. Adaptor cover (10), and gasket (11)	Place on stud.	Use new gasket.
	c. Nut (8) and lockwasher (9)	Install.	
	d. Adaptor cover (10)	Lubricate.	Use grease.
	e. Screw (6), and lockwasher (7)	Install.	
9. Tachometer drive cover	a. Oil slinger (12)	Install on tachometer drive shaft.	
	b. Cover (4) and gasket (5)	Install.	Use new gasket.
	c. Screws (2), and lockwashers (3)	Install.	
	d. Tachometer drive shaft (13)	Align.	Refer to alignment step 11.
10. Electric tachometer transmitter	Transmitter, and mounting hardware.	Reassemble.	

3-23. TACHOMETER DRIVE - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



ALIGNMENT

11. Tachometer drive	Whenever a tachometer drive cover assembly or a tachometer drive adaptor is installed on an engine, it is important that the cover assembly or adaptor be aligned properly with the tachometer drive shaft. Misalignment of a tachometer drive shaft can impose a side load on a tachometer drive cable adaptor resulting in possible gear seizure and damage to other related components. Correct alignment is established when there is no tachometer drive shaft bind on the inside diameter of the tool when one complete hand rotation of engine is made.	

3-24. INSTRUMENT PANEL - MAINTENANCE.INSTRUCTIONS

The instrument panel consist of an engine oil pressure gage, a marine gear oil pressure gage, water temperature gage, and an electrical tachometer. The throttle control and engine starting and stopping controls are mounted in various locations.

a. Engine Oil Pressure Gage.

The oil pressure gage registers the pressure of the lubricating oil in the engine. As soon as the engine is started, the oil pressure gage should start to register. If not, the engine should be stopped and the cause of the low oil pressure determined and corrected before the engine is started again.

b. Marine Gear Oil Pressure Gage.

The oil pressure gage registers the pressure of the lubricating oil in the engine (marine gear). As soon as the engine is started, the oil pressure gage should start to register. If not, the engine should be stopped and the cause of the low oil pressure determined and corrected before the engine is started again.

c. Water Temperature Gage.

The engine coolant temperature is registered on the water temperature gage.

d. Tachometer.

The tachometer receives an electrical signal from a transmitter on the engine, and registers the speed of the engine in revolutions per minute (rpm).

e. Engine Starting Motor Switch

The engine starting motor switch is used to energize the starting motor. As soon as the engine starts, the switch is released. The starting switch is mounted on the instrument panel with the contact button extending through the front face of the panel.

3-24. INSTRUMENT PANEL-MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Inspection **b. Repair** **c. Replace**

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
NONE

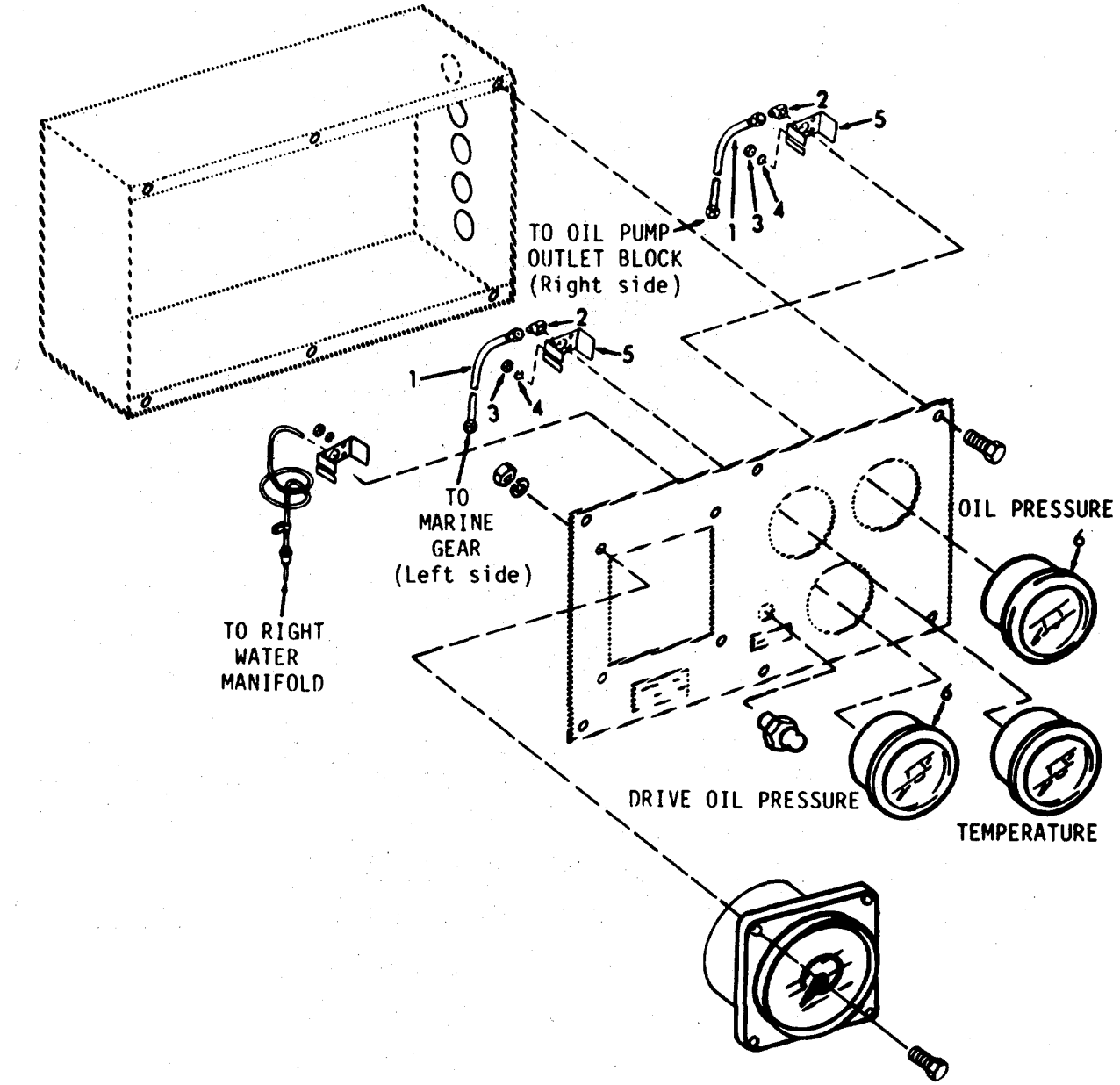
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Instrument panel	a. Oil pressure gages	1. Inspect for broken glass, bent pointer, and other signs of damage.	
		2. Presence of oil in gage.	
		3. With engine running, does gage function and indicate properly?	Defective gage or tubing.
	b. Water pressure gage	1. Inspect for broken glass, bent pointer, and other signs of damage.	
		2. Presence of water in gage.	
		3. With engine running, does gage function and indicate properly?	Defective gage or tubing.

3-24. INSTRUMENT PANEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Tachometer	1 Inspect for broken glass, bent pointer, and other signs of damage.	
		2. With engine running, does tachometer function and indicate properly.	Defective tachometer or wiring.
	d. Start switch	Inspect for proper operation.	
REPAIR			
2. Oil Pressure gages	a. Flexible hose (1)	Loosen at hose nuts.	Remove hose.
	b. Elbow (2)	Remove.	
	c. Nuts (3), and lockwashers (4)	Remove.	
	d. Gage clamp (5)	Remove.	
	e. Gage (6)	Remove.	
	f. Gage (6)	Install.	
	g. Gage clamp (5)	Install.	
	h. Nuts (3), and lockwashers (4) elbow (2)	Install.	
	i. Flexible hose (1)	Install.	

3-24. INSTRUMENT PANEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			

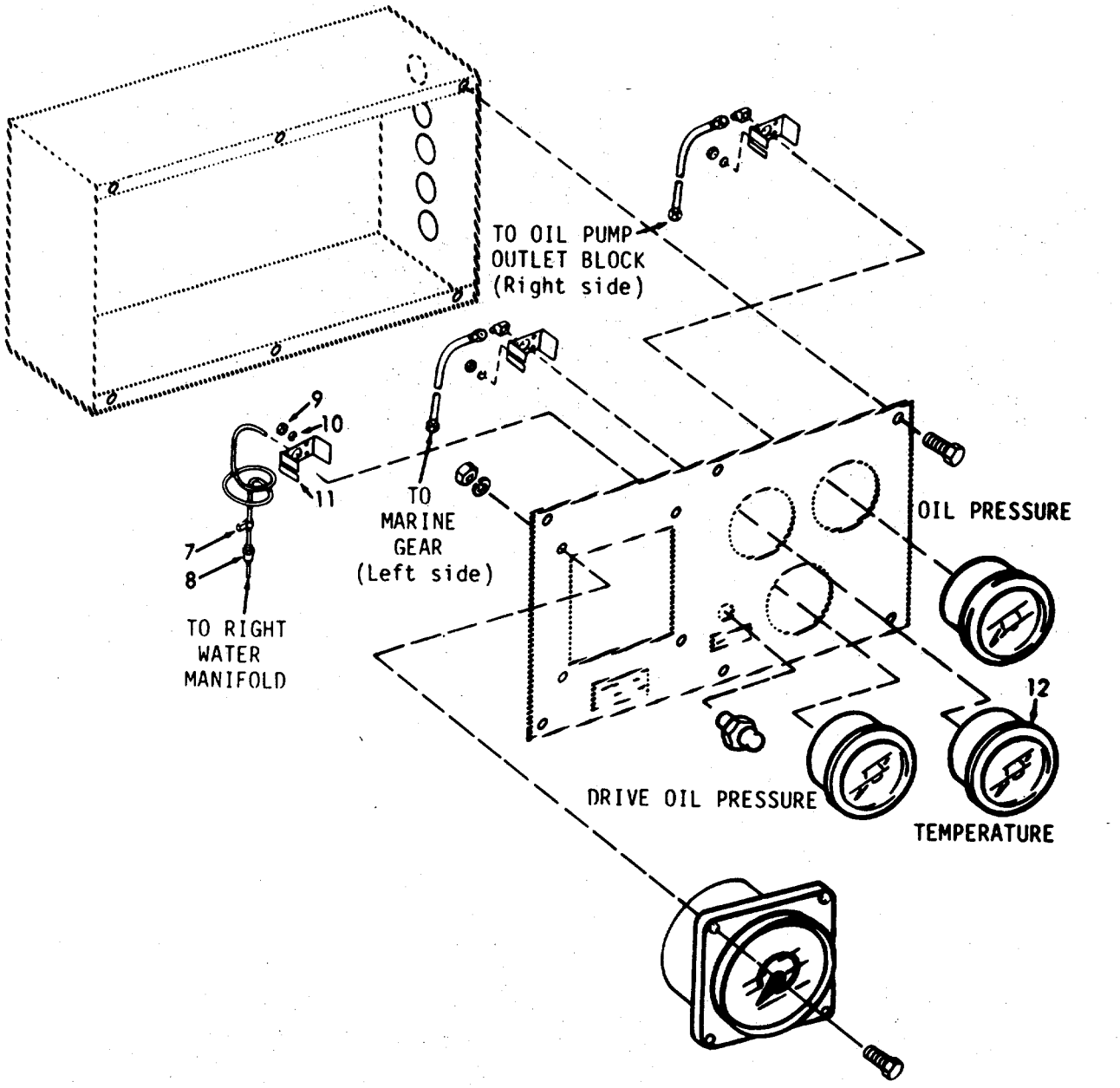


3-24. INSTRUMENT PANEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Water temperature gage	a. Clip (7)	Remove.	
	b. Adaptor (8)	Remove.	
	c. Nuts (9), lockwashers (10) and gage clamp (11)	Disassemble.	
	d. Gage (12)	Remove.	
	e. Gage (12)	Install.	
	f. Gage clamp (11), nuts (9) and lockwashers (10)	Assemble.	Incorrect coolant temperature readings will be registered if the gage assembly is incorrectly installed or the capillary tube is damaged.
	g. Clip (7)	Install.	To prevent damage to the gage assembly from vibration, the capillary tube must be securely fastened to engine the full length with suitable clips at intervals of ten inches or less. Sharp bends in tube must be avoided, particularly at gage or bulb connection areas.. Where tube must be.

3-24. INSTRUMENT PANEL--MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair			

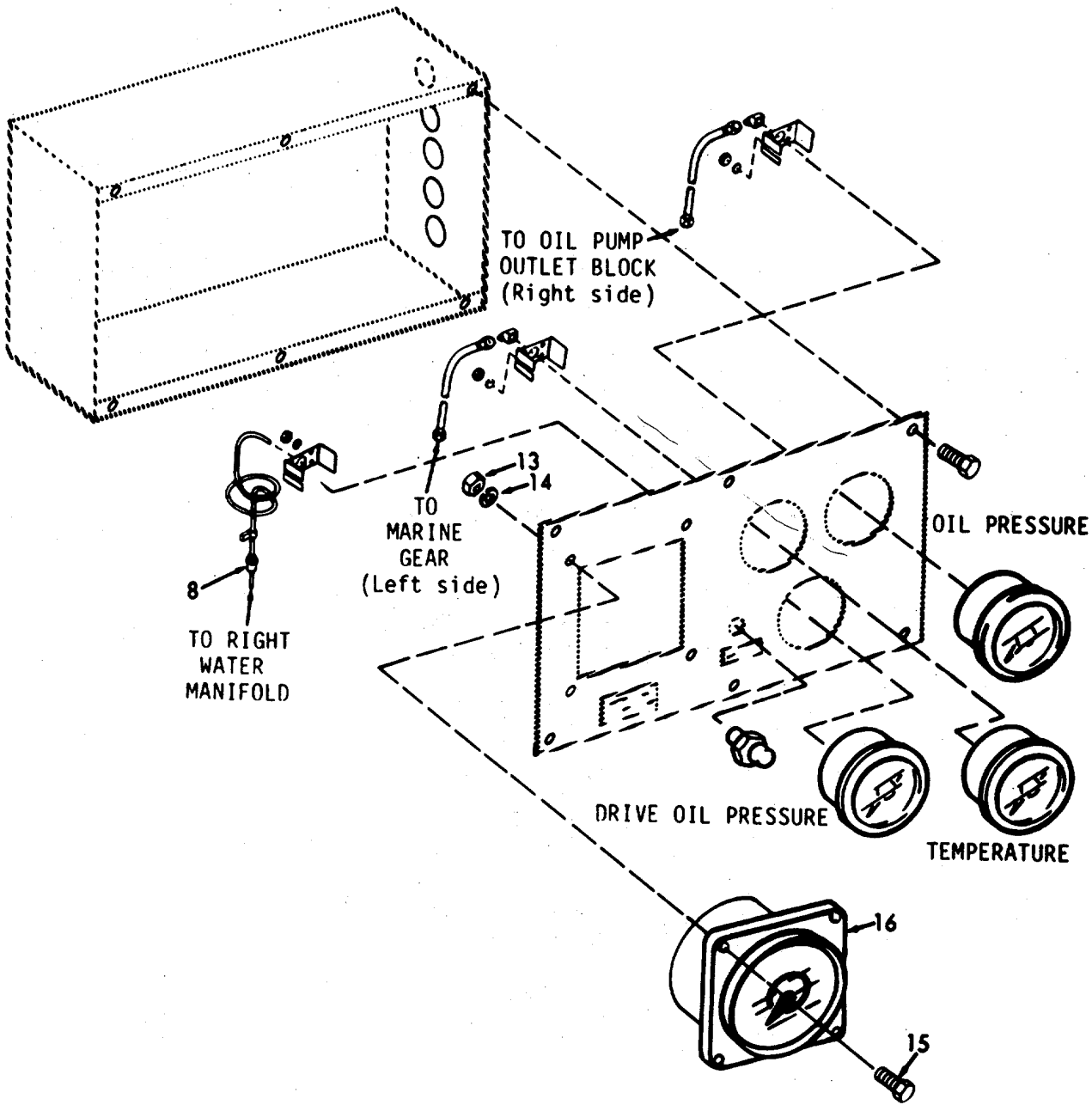


3-24. INSTRUMENT PANEL--MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			bent around any object, the bend must not be less than one inch in radius. Any extra length can be taken up by coiling, the diameter of which should not be less than two inches. The coils must be located so that they may be securely fastened to prevent vibration.
	h. Adaptor(8)	Install.	
4. Tachometer	a. Wiring wires.	Tag and disconnect	Refer to schematic for wiring.
	b. Nuts (13.), and lockwashers (14)	Remove.	
	c. Screws (15)	Remove.	
	d. Tachometer (16)	Remove.	
	e. Tachometer (16)	Install.	
	f. Screw (15)	Install.	
	g. Nuts (13), lockwashers (14)	Install.	
	h. Wiring	Reconnect	Refer to schematic for wiring.

3-24. INSTRUMENT PANEL--MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			

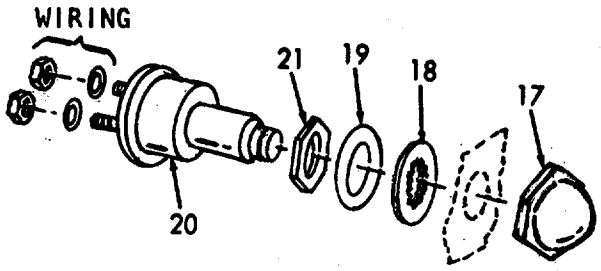


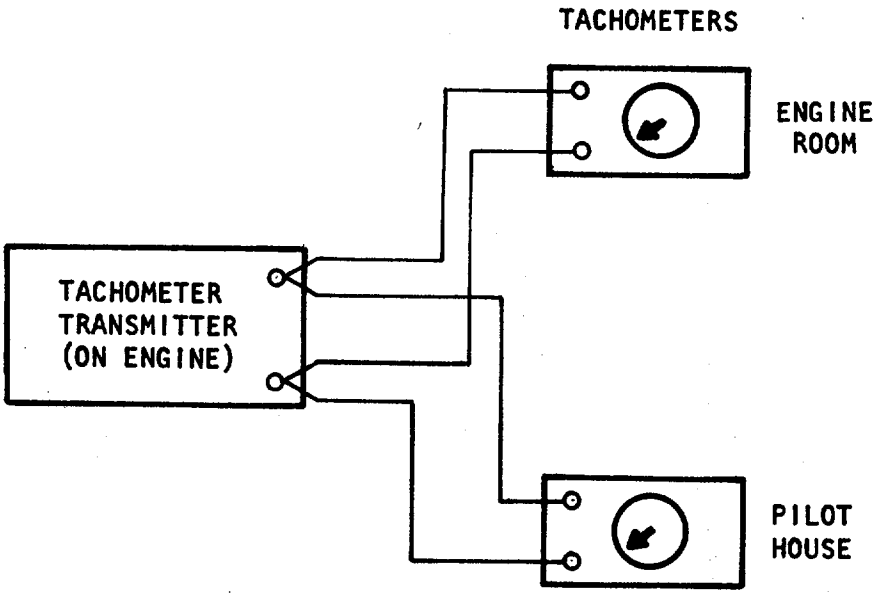
3-24. INSTRUMENT PALEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Start Switch	a. Wiring	Tag and disconnect.	
	b. Nut (17)	Remove.	On front of panel.
	c. Lock-washer (18), flatwash-er (19), and switch (20)	Remove.	
	d. Switch (20), nut (21), flat-washer (19) and lockwash-er (18)	Assemble.	Position assem-bled switch in panel. Adjust nut (21) as required.
	e. Nut (17)	Install.	Torque to 36-48 inch-lbs (4.07-5.42 Nm).
	f. Wiring	Reinstall.	
6. Instru-ment Panel	a. Wiring	Tag and disconnect wiring at instrument panel.	
	b. Oil pressure hoses	Disconnect at engine.	
	c. Water tempera-ture tube	Disconnect at engine.	
	d. Remove panel	Disconnect all mounting hardware.	
	e. Panel, hoses, tubing, and wiring	Reinstall.	

3-24. INSTRUMENT PALEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Repair (Cont)			





3-25. CRANKSHAFT PULLEY AND VIBRATION DAMPER - MAINTENANCE INSTRUCTIONS.

a. The engine is equipped with either rigid or rubber mounted type pulleys. Rubber mounted pulleys have a rubber insulator between the pulley and the pulley hub for vibration dampening.

b. The crankshaft pulley is keyed to the crankshaft and secured with a special washer and bolt.

c. A viscous type vibration damper is mounted on the front end of the crankshaft to reduce crankshaft stresses to a safe value. The vibration damper is bolted to a hub which is on the front end of the crankshaft.

d. A viscous type vibration damper consists of an inertia mass (flywheel) enclosed in a fluid-tight outer case but separated by a thin wall of viscous liquid not responsive to temperature changes. Any movement of the inertia mass, is resisted by the friction of the fluid, which tends to dampen excessive torsion vibrations in the crankshaft. The vibration damper must be removed whenever the crank-shaft, crankshaft front oil seal, and crankshaft front cover is removed.

3-25. CRANKSHAFT PULLEY AND VIBRATION DAMPER - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP

Test Equipment
NONE

Special Tools
Crankshaft pulley Puller-J4558-01
Torque wrench 3/4 inch drive 0-600 Ft.Lbs.

Material/Parts
Emery Cloth

Personnel Required
1

References
NONE

Equipment Condition Condition Description
Remove drive belts to bilge pump if necessary.

Special Environmental Conditions
NONE

General Safety Instructions

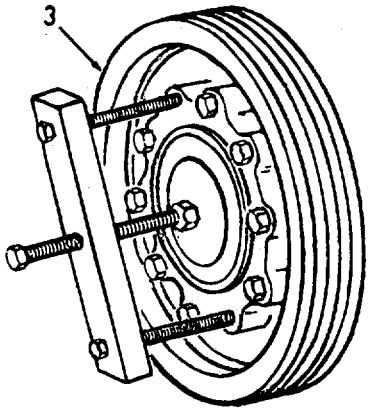
WARNING

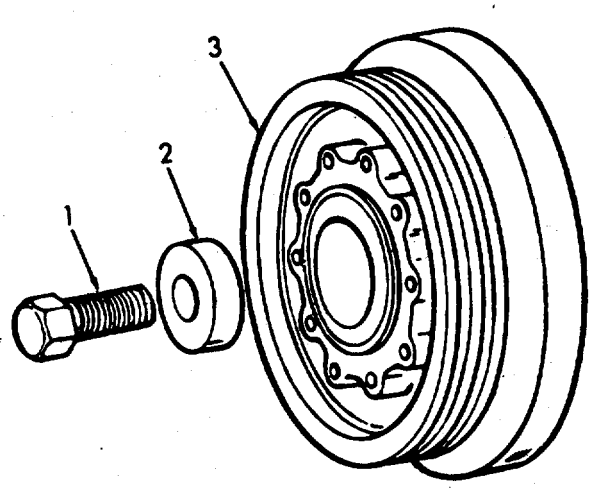
Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Crankshaft hub end	a. Crankshaft pulley retaining bolt (1) and washer (2)	Remove.	

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

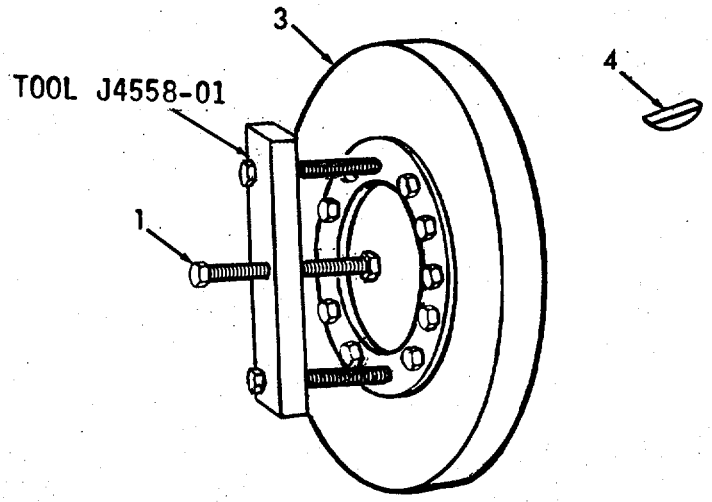
LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
	b. Crankshaft pulley retaining bolt (1)	Re-Install in end of crankshaft.	
2. Pulley	a. Puller J4558-01	Attach puller to pulley (3)with two long bolts	Bolts are size 7/16 inch -20.
	b. Pulley (3), key (4)	Remove	
	c. Puller J4558-01	Remove from pulley	





3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

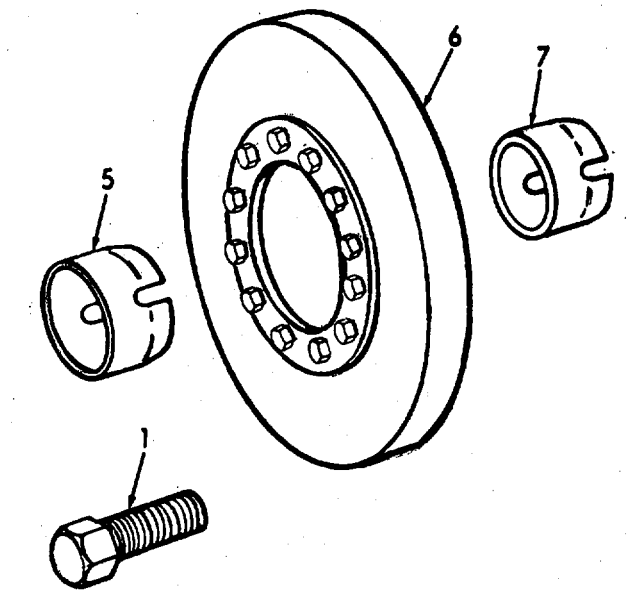
LOCATION	ITEM	ACTION	REMARKS
Removal (Cont)			
3. Vibration damper hub	a. Puller J4558-01	Attach puller to damper with two long bolts.	Bolts are size 7/16 inch-20.
	b. Puller	Remove from damper hub.	



	c. Crank-shaft pulley retain-ing bolt (1)	Remove.	
4. Crank-Shaft	a. Outer cone (5)	Pull cone off crankshaft.	

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

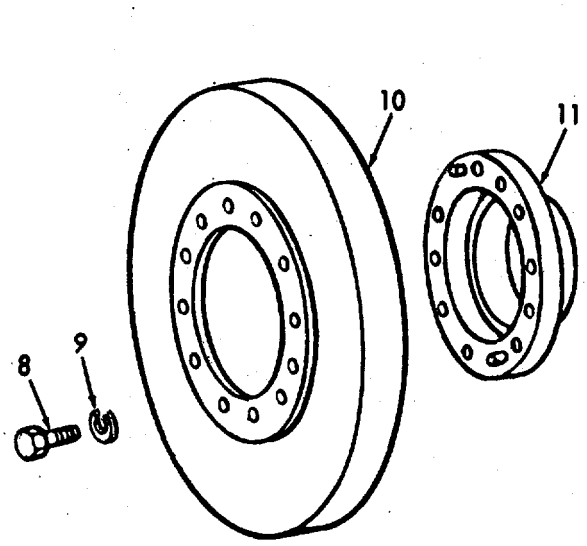
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		NOTE Do not attempt to remove viscous type damper by pounding with hammer or prying with other tools. Dents in damper's outer case will render damper useless. Damper cannot be repaired.	
b.	Vibration damper and damper hub (6)	Slide off end of crankshaft.	Use hands. Remove as an assembly.
c.	Inner cone (7)	Remove from crankshaft.	If required.



d.	Crankshaft retaining bolt (1)	Remove.	

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
5. Vibration damper and damper hub	a. Vibration damper and damper hub retaining bolts (8) and washers (9)	Remove.	
	b. Vibration damper (10) and damper hub (11)	Disassemble.	



Use eye protection when using compressed air.

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

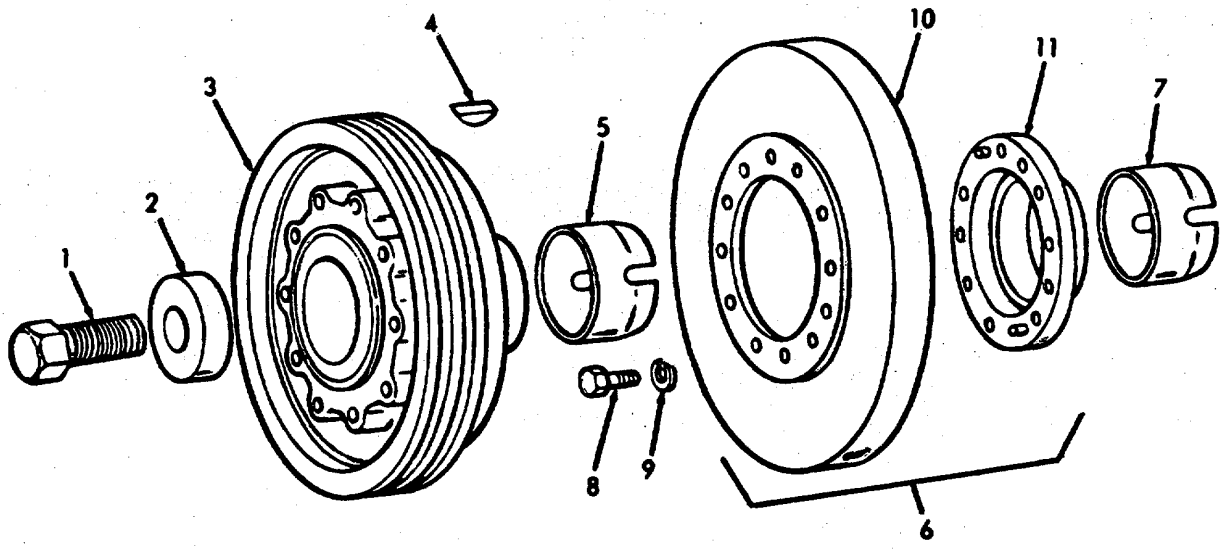
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
6. Vibration damper	a. Rubber area	Clean with fuel oil. Dry immediately with compressed air.	
		CAUTION Do not let fuel oil remain on damper. Blow dry. Damper can be damaged.	
	b. Rubber area	Make sure that rubber is firmly bonded to metal parts and that metal discs are not bent.	Discard if rubber has separated from metal or if discs are bent.
7. Inner and outer cones	Cones	Inspect for galling or burrs. Clean with emery cloth.	Replace if seriously damaged.
8. Inner cone	Outside diameter	Check for wear.	Replace crankshaft front oil seal and cone if worn. Refer to Direct Support Maintenance.
9. Pulley	Overall	Check for damage.	

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
10. Vibration damper, damper hub,and pulley	Damper hub (11), vibration damper (10), retaining bolts (8) and washers (9)	Assemble.	
11. End of crankshaft	a. Damper inner cone (7) (if removed)	Place over end of crankshaft, through oil seal, up against oil slinger.	Tapered end of cone points toward front end of crankshaft.
	b. Damper and hub as a unit (6)	Slide over end of crankshaft, up against inner cone.	Long end of hub faces inner cone. Do not hit with hammer.
	c. Damper outer cone (5)	Slide over end of crankshaft and against damper hub.	Tapered end of cone points toward hub.
	d. Pulley (3), key (4)	Re-assemble.	
	e. Crankshaft end bolt (1) and washer (2)	Thread into end of crankshaft.	Tighten bolt to 180 lb.ft. (267.9 kg/m) torque. Strike once with 2-3 lb. hammer. Tighten to 300 lb. ft. (446.45 kg/m) torque. Strike once again. Tighten to 290-310 lb. ft. (431-461.36 kg/m

3-25. CRANKSHAFT PULLY AND VIBRATION DAMPER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



3-637

3-26. BALENCE WEIGHT COVER -MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

a. The balance weight cover encloses the combination balance weight and water pump drive gear on the front end of the right cylinder bank camshaft. This cover also serves as a support for the fresh water pump.

b. The balance weight cover requires no servicing. When an engine is being completely reconditioned or when the right bank camshaft, camshaft bearings or water pump drive gear need replacing, the balance weight cover must be removed.

This task covers:

a. Inspection

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

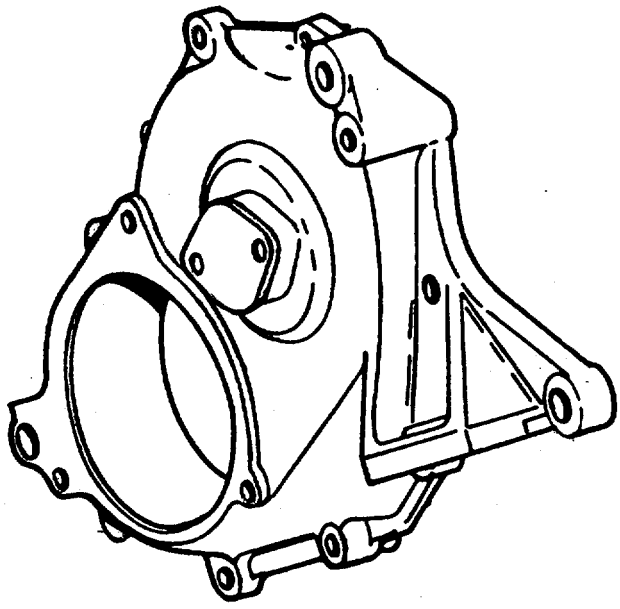
Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

3-26. BALENCE WEIGHT COVER -MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Front of engine	Balance weight cover	Inspect for cracks, leaks, breaks, and damage.	Refer to Direct Support Maintenance for all repairs.



3-27. ENGINE SUPPORTS, LIFT BRACKETS AND CRANKSHAFT FRONT COVER

LOCATION	ITEM	ACTION	REMARKS

a. The engine and marine gear are supported in three places on each side. The front engine support is attached to the crankshaft front cover, which is attached to the engine.

b. The engine also has front and rear lift eye pads.

This task covers:

a. Inspection **b. Replacement**

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
NONE

Condition Description

Material/Parts
NONE

Special Environmental Conditions
NONE

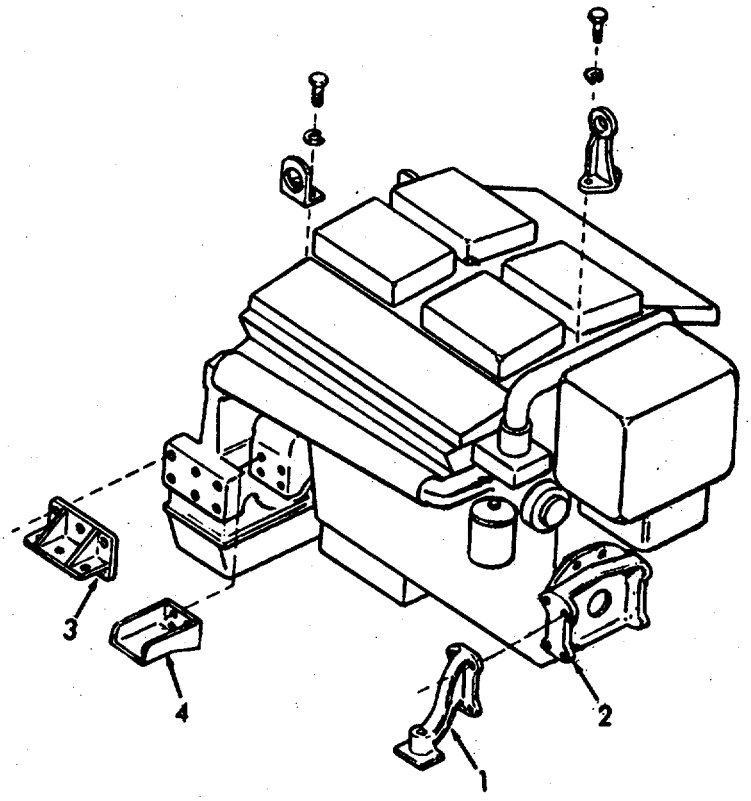
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Engine supports	a. Engine front support brackets (1)	Inspect for breaks, cracks, and loose hardware.	
	b. Crankshaft front cover (2)	Inspect for breaks, cracks, and loose hardware.	

3-27. ENGINE SUPPORTS, LIFT BRACKETS AND CRANKSHAFT FRONT COVER (Cont)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Marine gear supports (3)	Inspect for breaks, cracks, and loose hardware.	
	d. Engine rear support brackets (4)	Inspect for breaks, cracks, and loose hardware.	
2. Lift brackets	Brackets	Inspect for breaks, cracks, and loose hardware.	



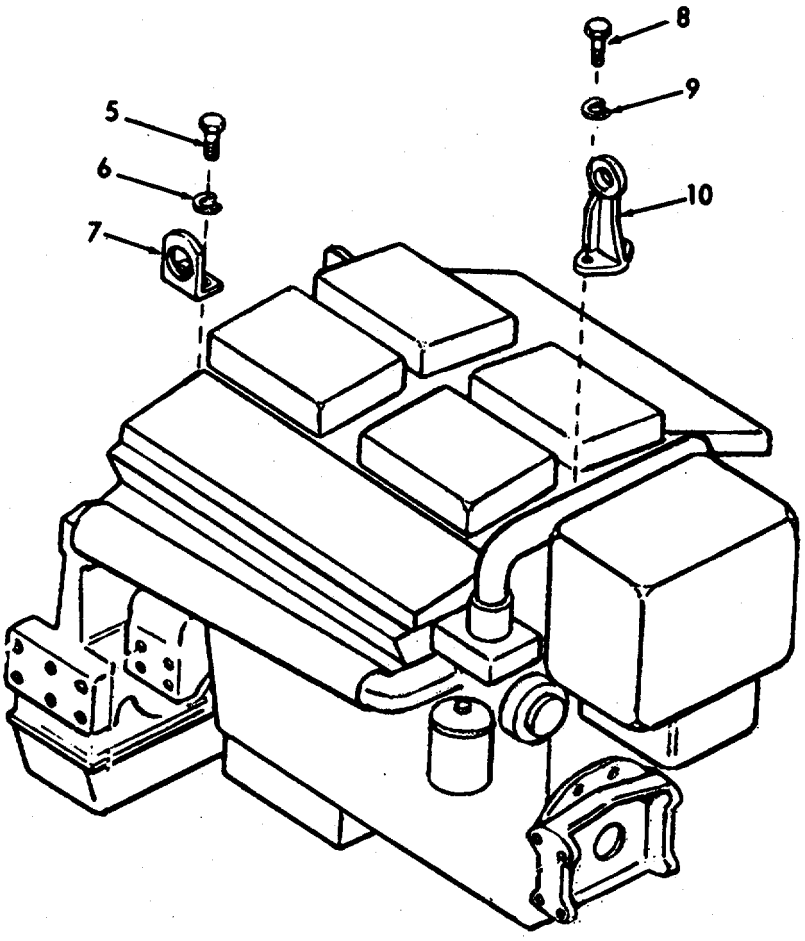
3-27. ENGINE SUPPORTS, LIFT BRACKETS AND CRANKSHAFT FRONT COVER (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPLACEMEN			
3. Lift brackets rear	a. Screw (5), and lock-washer (6)	Remove.	
	b. Bracket (7)	Remove.	
	c. Bracket (7)	Replace.	
	d. Screw (5) and lock-washer (6)	Install.	
4. Lift bracket front	a. Screw (8), and lock-washer (9)	Remove.	
	b. Bracket (10)	Remove.	
	c. Bracket (10)	Replace.	
	d. Screw (8), and lockwash-er (9)	Install.	

3-27. ENGINE SUPPORTS, LIFT BRACKETS AND CRANKSHAFT FRONT COVER (Cont)

LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)



3-643

3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS.

The one-piece water-cooled exhaust manifold is cast with an integral water jacket surrounding the exhaust chamber. The diameter of the exhaust chamber increases uniformly from one end to the other where it terminates in a flange to which an elbow and flexible exhaust connection is attached. A portion of the engine coolant is by-passed from the rear of the cylinder block into the rear end of the jacket surrounding the exhaust manifold and discharged from the forward end through a tube into the thermostat housing. A draincock is installed in the bottom of the manifold for draining the water jacket.

This task covers:

a. Inspection
b. Removal
c. Repair
d. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
Torque wrench
Lifting tool

Equipment Condition: Condition Description

Material/Parts
Gasket kit-
P/N 5196375

Special Environmental Conditions
NONE

Personnel Required
2

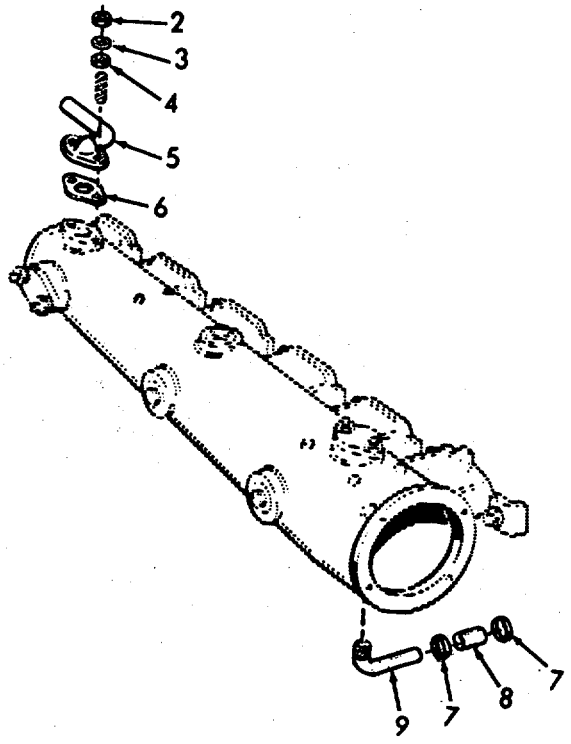
General Safety Instructions
NONE

3-28. ENGINE SUPPORTS, LIFT BRACKETS AND CRANKSHAFT FRONT COVER (Cont)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Exhaust manifold	a. Hoses and fittings	Inspect for any leakage, and loose clamps.	
	b. Tubes and hardware	Inspect tubes for cracks, and loose hardware.	
	c. Exhaust manifold	Inspect for cracks, leaking water, and exhaust gases.	
REMOVAL			
2. Exhaust manifold (Right or left)	a. Draincock (1)	Open draincock and drain the cooling system.	

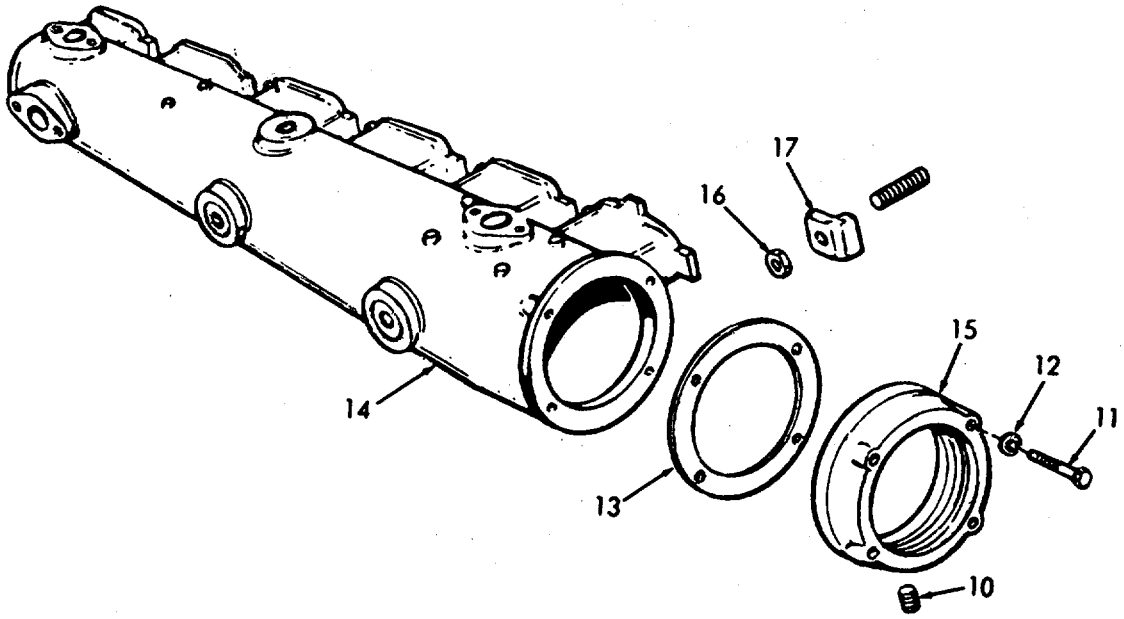
3-28. ENGINE MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Nuts (2), lockwashers (3), flatwashers (4), water outlet tube (5), and gasket (6)	Remove clamps and hose from the water outlet tube if necessary.	Repeat this procedure on the opposite exhaust manifold for water outlet tube. Discard gasket.
	c. Clamps (7), hose (8) and water inlet tube (9)	Remove clamps, hose and water inlet tube. Then unscrew water inlet tube from the exhaust manifold.	



3-28. ENGINE MANIFOLD-MAINTENA NCE INSTRUCTIONS (Cont)

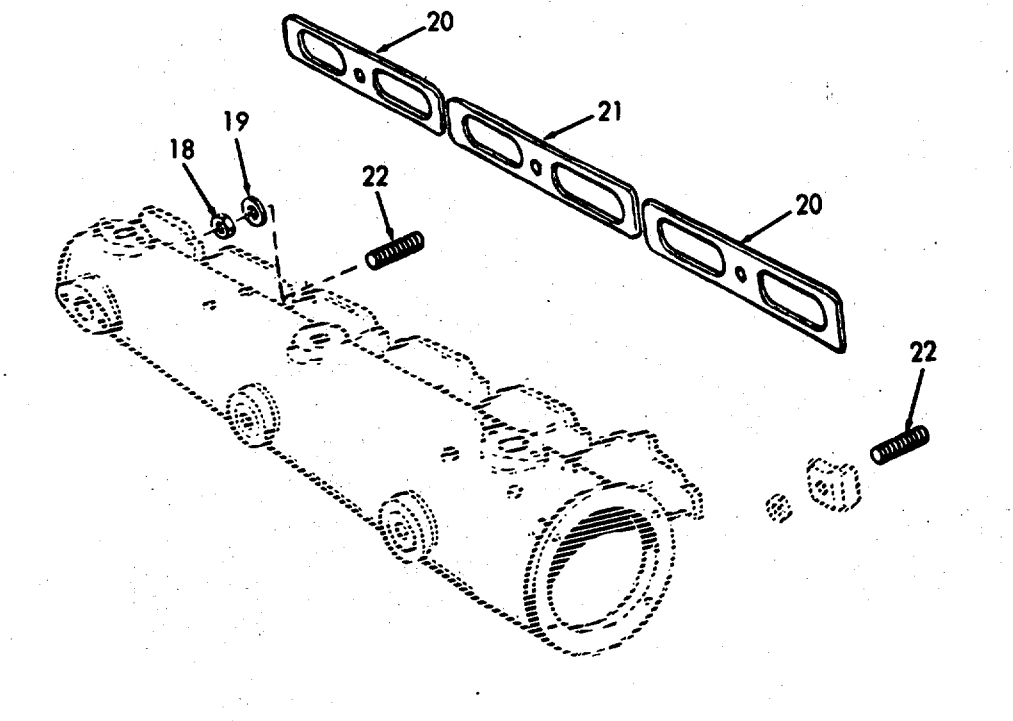
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Pipe plug (10)	Remove. flange.	Drain exhaust
	e. Screws (11) and lock-washers (12)	Remove.	
	f. Gasket (13)	Remove.	Pull exhaust manifold (14) and flange (15) apart. Discard gasket.
	g. Nuts (16) and grabs (17)	Remove.	Both ends of exhaust mani-fold.



3-647

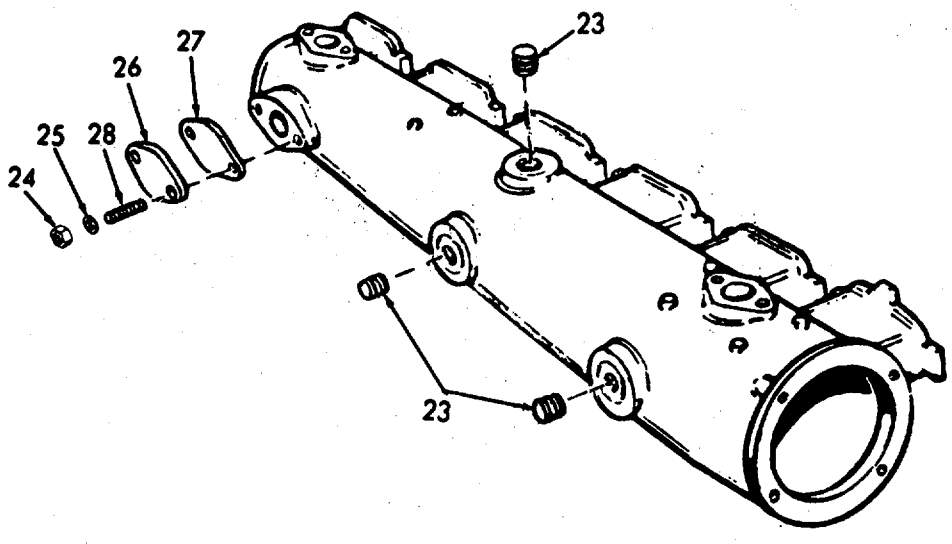
3-28. ENGINE MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Nuts (18) and bevel washers (19)	Loosen all, and remove all except one on each end of exhaust manifold.	Attach lifting device to manifold. Slide manifold off of studs to remove.
	i. Gaskets (20 and 21)	Remove.	Discard gasket.
	j. Studs (22)	Remove.	Remove if damaged.



3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Exhaust manifold	a. Pipe plugs (23)	Remove.	Remove if damaged.
	b. Nuts (24) and flatwashers (25)	Remove.	
	c. Cover plate (26) and gasket (27)	Remove.	Discard gasket.
	d. Studs (28)	Remove.	Remove if damaged.

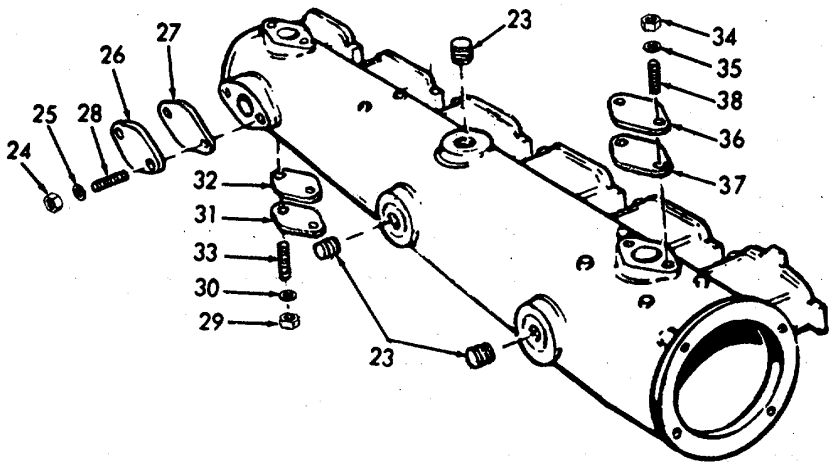


3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Nuts (29) and flat-washers (30)	Remove.	
	f. Cover plate (31) and gas-ket (32)	Remove.	Discard gasket.
	g. Studs (33)	Remove.	Remove if dam-aged.
	h. Nuts (34) and flat-washers (35)	Remove.	
	i. Cover plate (36) and gas-ket (37)	Remove.	Discard gasket.
	j. Studs (38)	Remove.	Remove. if dam-aged.
	k. Studs (28, 33 and 38)	Remove.	Replace if dam-aged.
	l. Cover plate (36), gasket (37), nuts (34) and flat-washers (35)	Install.	Use new gasket.

3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	m. Cover plate (31), gasket (32), nuts (29) and flat-washers (30)	Install.	Use new gasket.
	n. Cover plate (26), gasket (27), nuts (24) and flat-washers (25)	Install.	Use new gaskets.
	o. Pipe plugs (23)	Replace.	Replace if removed.

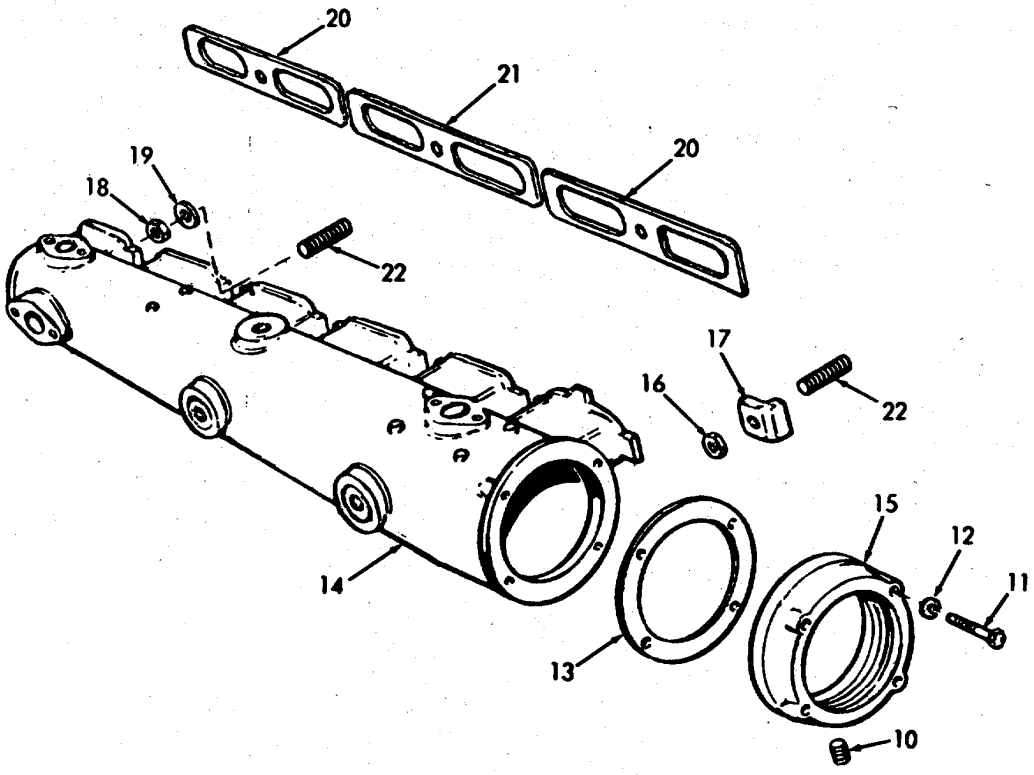


3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
4. Exhaust manifold (Right or left)		**NOTE** All traces of the old gaskets must be removed from the exhaust manifold and cylinder head.	
	a. Studs (22)	Replace.	If necessary.
	b. Gaskets (20 and 21)	Place on studs in cylinder head.	Use new gasket.
	c. Exhaust manifold (14)	Place on studs, up against gaskets.	
	d. Bevel washers (19) and nuts (18)	Install.	Draw manifold up to gaskets.
		NOTE Bevel washers should be set in position so that the outer diameter will rest on the manifold and the crown at the center is next to the nut.	
	e. Grabs (17) and nuts (16)	Install.	
	f. Nuts (16 and 18)	Tighten.	Torque to 30-35 lb-ft (40.7-47.5 Nm).
		NOTE The exhaust manifold stud nuts should be tightened from the center of the exhaust manifold outward, alternating towards either end.	

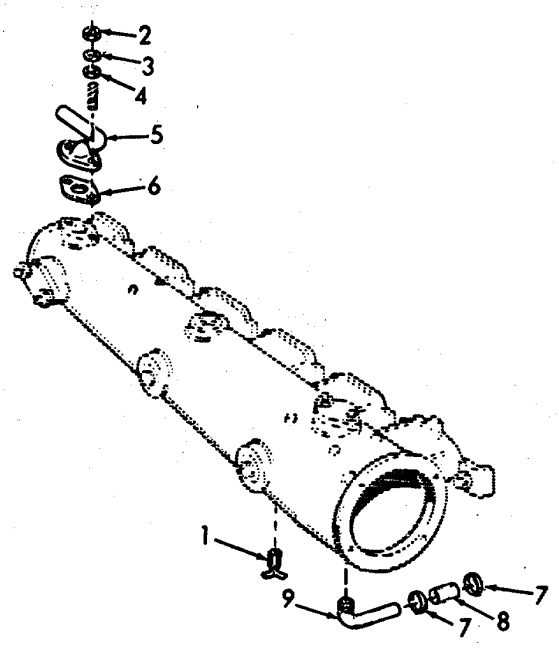
3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Gasket (13)	Place between exhaust manifold (14) and flange (15)	Use new gasket.
	h. Screws (11) and lock-washers (12)	Install.	
	i. Pipe plug (10)	Install.	



3-28. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	j. Water inlet tube (9)	Screw into manifold.	
	k. Hose (8) and clamp (7)	Install.	
	l. Water outlet tube (5) and gasket (6)	Align holes in manifold.	Use new gasket.
	m. Nuts (2) lockwashers (3) and flatwashers (4)	Install.	Replace hose and hose clamps if removed.
	n. Drain cock (1)	Close.	



3-29. MUFFLER.

The mufflers for a propulsion engine are attached to the exhaust manifold by a flexible coupling. The entire muffler system is covered with insulation to prevent radiation of heat.

This task covers:

a. Inspection **b. Service** **c. Repair**

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket kit-P/N 5196375
Gasket-Asbestos

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

WARNING

Do not perform work on the exhaust system until the exhaust manifold is cool to the touch.

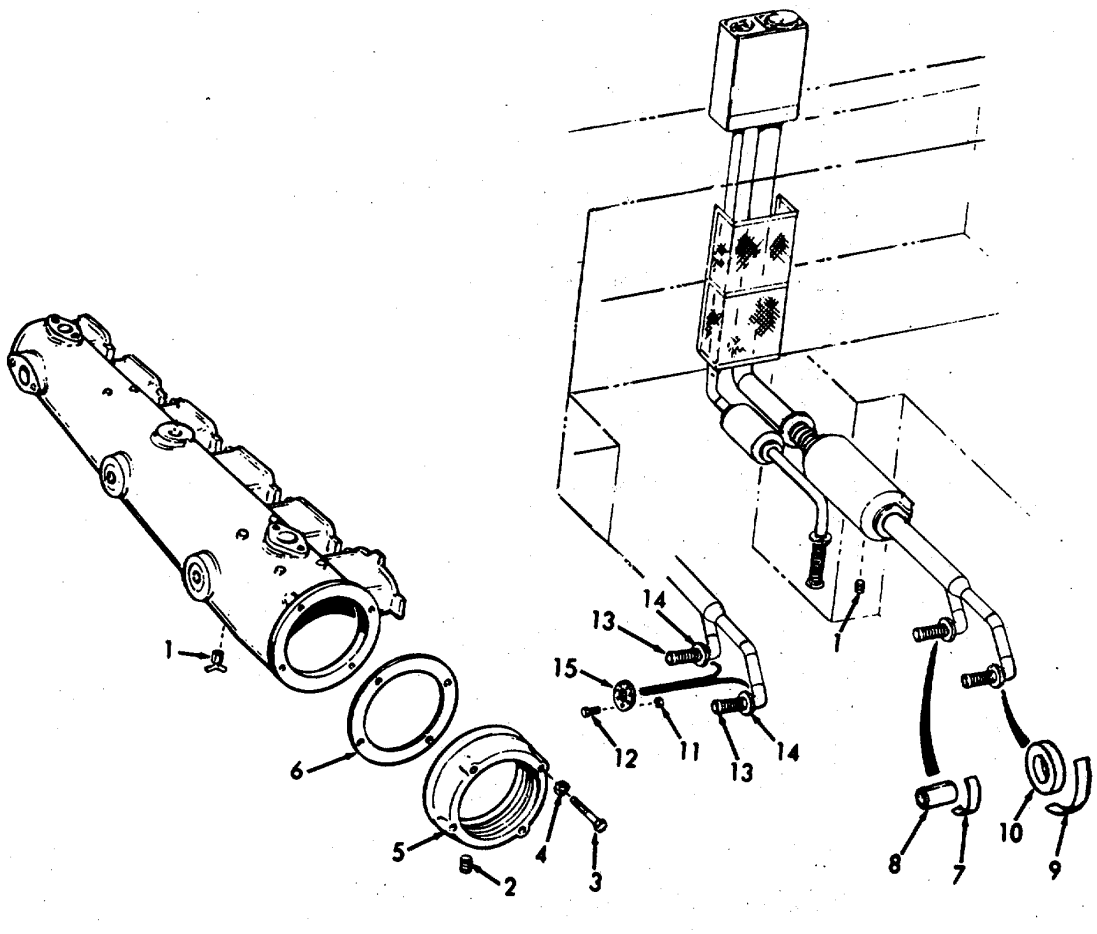
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Exhaust system	a. Flexible coupling	Inspect for exhaust leaks and wear or signs of damage.	
	b. Muffler and piping	Inspect for exhaust leaks, and wear, or signs of damage.	Refer to Direct Support Maintenance for repair.

3-29. MUFFLER (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2. Exhaust muffler	Drain plugs (1)	Remove and replace.	Drain any accumulated water from muffler periodically.
REPAIR			
3. Flexible Coupling	a. Drain plug (2)	Remove.	
	b. Screws (3) and lock-washers (4)	Remove.	
	c. Flange (5)	Slide up flexible coupling.	
	d. Gasket (6)	Remove.	Discard.
	e. Glass tape (7)	Remove.	
	f. Pipe insulation (8)	Remove.	
	g. Glass tape (9)	Remove.	
	h. Pipe insulation (10)	Remove.	
	i. Nuts (11) screws (12)	Remove.	

3-29. MUFFLER (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Flexible coupling (13) and gasket (14)	Remove.	Discard gasket.
	k. Coupling (13)	Slide out of flange.	
	1. Flange (15)	Slide off of coupling.	



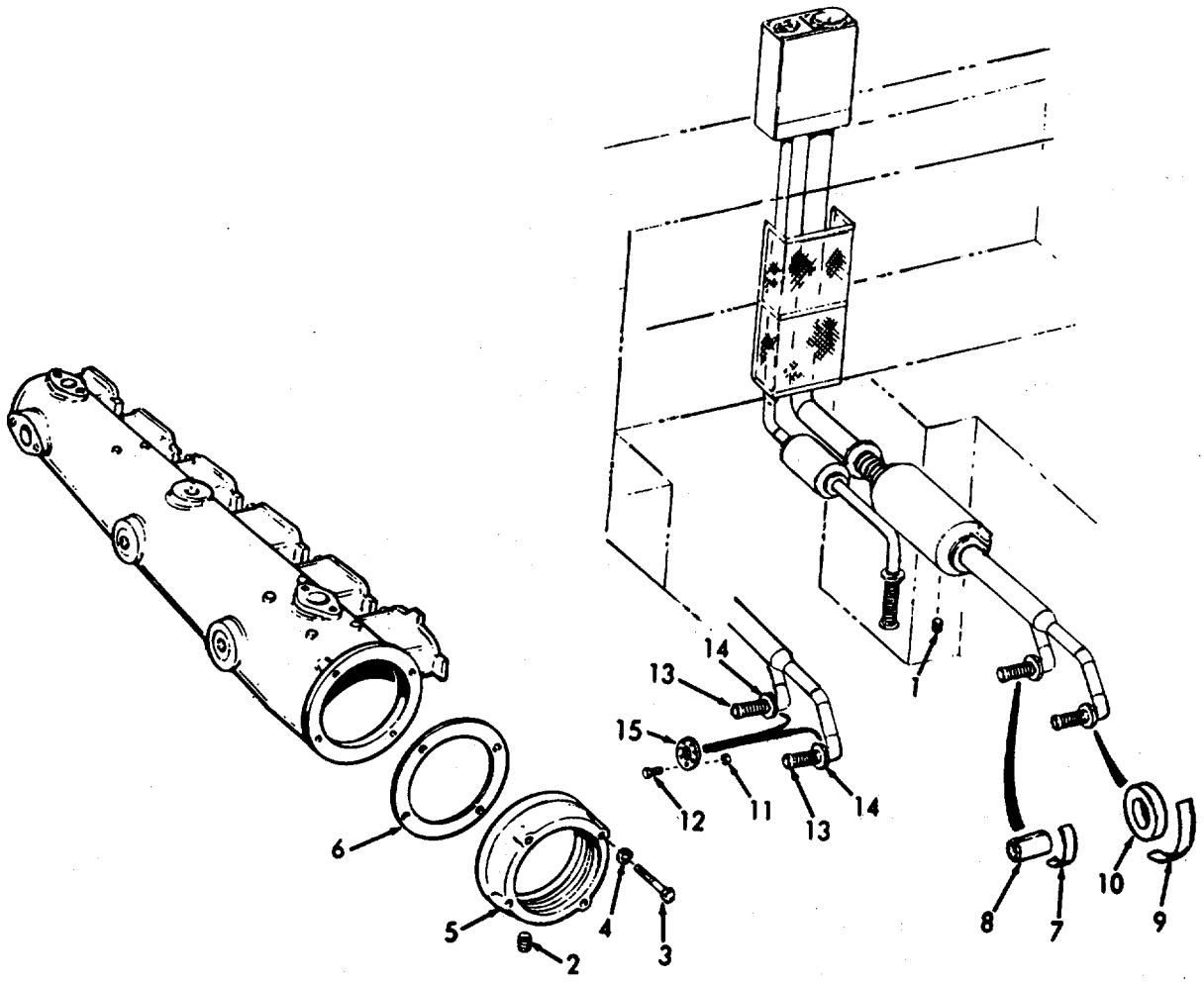
3-29. MUFFLER (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	m. Flange (15)	Slide onto coupling.	
	n. Coupling (13)	Slide into flange.	
	o. Flexible coupling (13) and gasket (14)	Align holes in exhaust pipe.	Use new gasket.
	p. Nuts (11) and screws (12)	Install.	
	q. Flange (5) and gasket (6)	Align holes in exhaust manifold.	Use new gasket.
	r. Screws (3) and lockwasher (4)	Install.	
	s. Drain plugs (2)	Install.	
	t. Flexible coupling	Operate engine. for leaks.	Check
	u. Pipe insulation (8) and glass tape (7)	Wrap on flexible coupling.	
	v. Pipe insulation (10) and glass tape (9)	Wrap on flexible coupling.	

3-29. MUFFLER (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-30. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS.

a. The valve rocker cover assembly completely encloses the valve and injector rocker arm compartment at the top of the cylinder head. The top of the cylinder head is sealed against oil leakage buy a gasket located in the flanged edge of the cover.

b. The valve rocker cover assembly includes an oil filler.

This task covers:

a. Cleaning
b. Removal
c. Installation
d. Repair

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket part of kit P/N 196375
Clean Rags

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

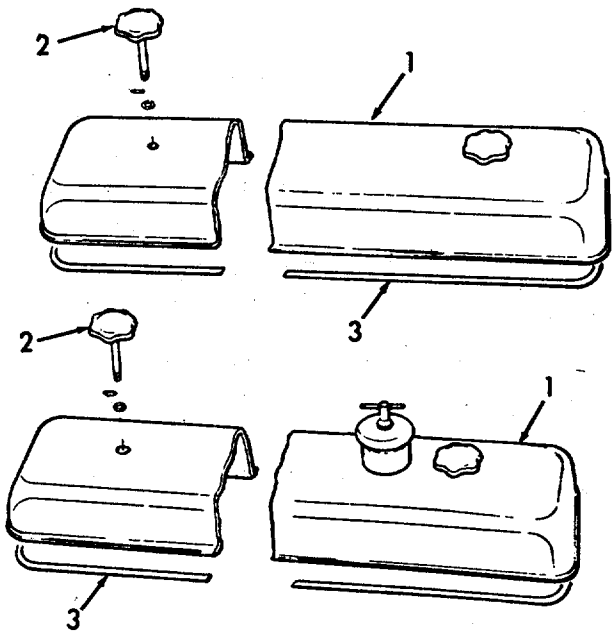
WARNING

Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
1. Rocker arm cover	Cover (1)	Clean before removal.	Use clean rags.

3-30. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
Rocker arm cover (1)	a. Knobs (2)	Loosen.	
	b. Cover (1)	Lift cover from cylinder head.	
	c. Gasket (3)	Remove.	Discard gasket. Clean inside of cover.
INSTALLATION			
3. Rocker Arm cover	a. Gasket (3)	Place on cylinder head.	Use new gasket.
	b. Cover (1)	Replace on cylinder head.	
	c. Knobs (2)	Tighten.	

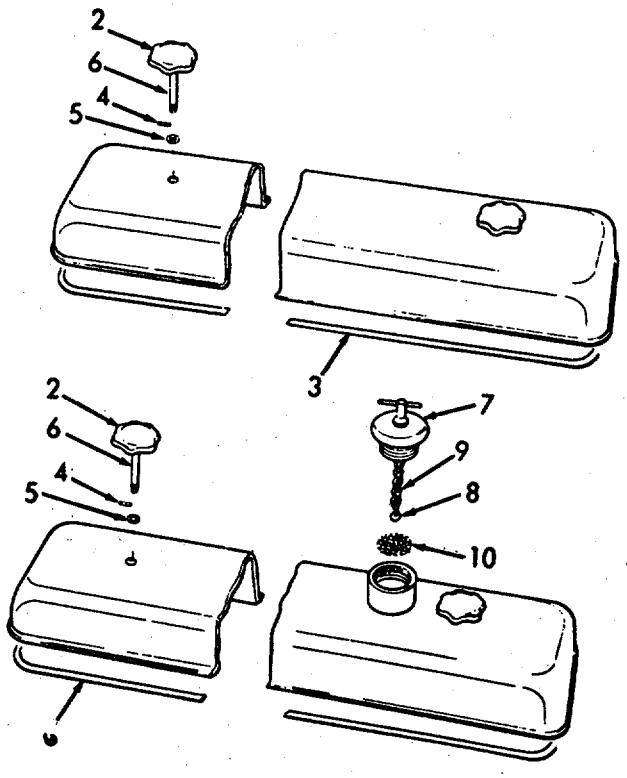


3-30. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Knobs	a. Roll pin (4)	Remove.	
	b. Washer (5)	Remove.	
	c. Knob (2) and screw (6)	Disassemble.	
	d. Knob (2) and screw (6)	Assemble.	
	e. Washer (5), roll pin (4) and knob (2)	Reassemble in cover.	
5. Oil filler cap	a. Cap (7)	Unscrew.	
	b. Hook (8)	Disconnect.	
	c. Chain (9)	Remove.	If necessary.
		WARNING Use eye protection when using compressed air.	
	d. Strainer (10)	Remove from neck.	Clean in fuel oil and blow dry with compressed air.

3-30. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Strainer (10)	Reinsert into neck.	
	f. Chain (9), cap (7) and hook (8)	Reassemble.	
	g. Hook (8)	Attach to neck.	
	h. Cap (7)	Screw into fill neck.	



3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS.

a. The fuel injector control tube assemblies are mounted on the left and right bank cylinder heads and consist of a control tube, injector rack control levers, a return spring and injector control tube lever mounted in two bracket and bearing assemblies attached to each cylinder head.

b. The injector rack control levers connect with the fuel injector control racks and are held in position on the control tube with two adjusting screws. The return spring enables the rack levers to return to the no-fuel position. The injector control tube lever is pinned to the end of the control tube and connects with the fuel rod which connects with the engine governor.

c. An emergency engine shutdown is accomplished by tripping the air shut-off valve in the air inlet housing.

This task covers:

a. Inspection **c. Disassembly**
b. Removal **d. Reassembly** **e. Installation**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

Para 3-10	Removal of Control Tube Links

Equipment Condition	Condition Description
Para 3-10	Governor Maintenance Instructions
Para 3-30	Rocker Arm Cover Removal

Special Environmental Conditions

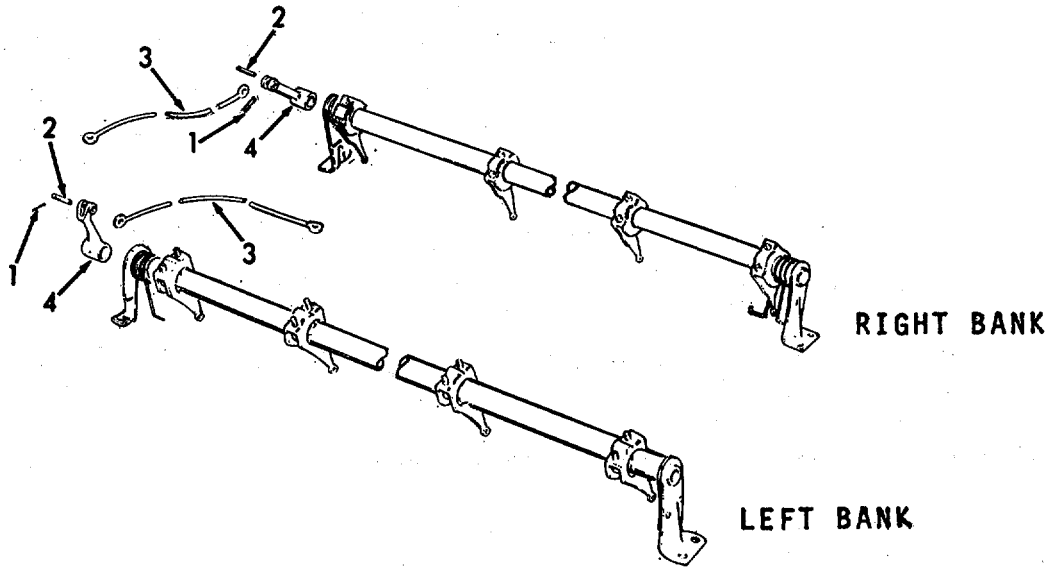
NONE

General Safety Instructions

NONE

3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION.			
1. Rocker arm covers	a. Covers	Remove.	Refer to paragraph 3-30.
	b. Control tubes	Inspect for broken springs, loose levers and bent or damaged control tubes.	
	c. Fuel rods	Inspect for wear or damage.	Refer to paragraph 3-10 for replacement.
REMOVAL			
2. Control Tubes (right or left)	a. Cotter pins (1), and link pins (2)	Remove.	
	b. Fuel rods (3)	Remove from control lever (4).	One end of fuel rod will remain connected inside the governor. Refer to paragraph 3-10 for removal.

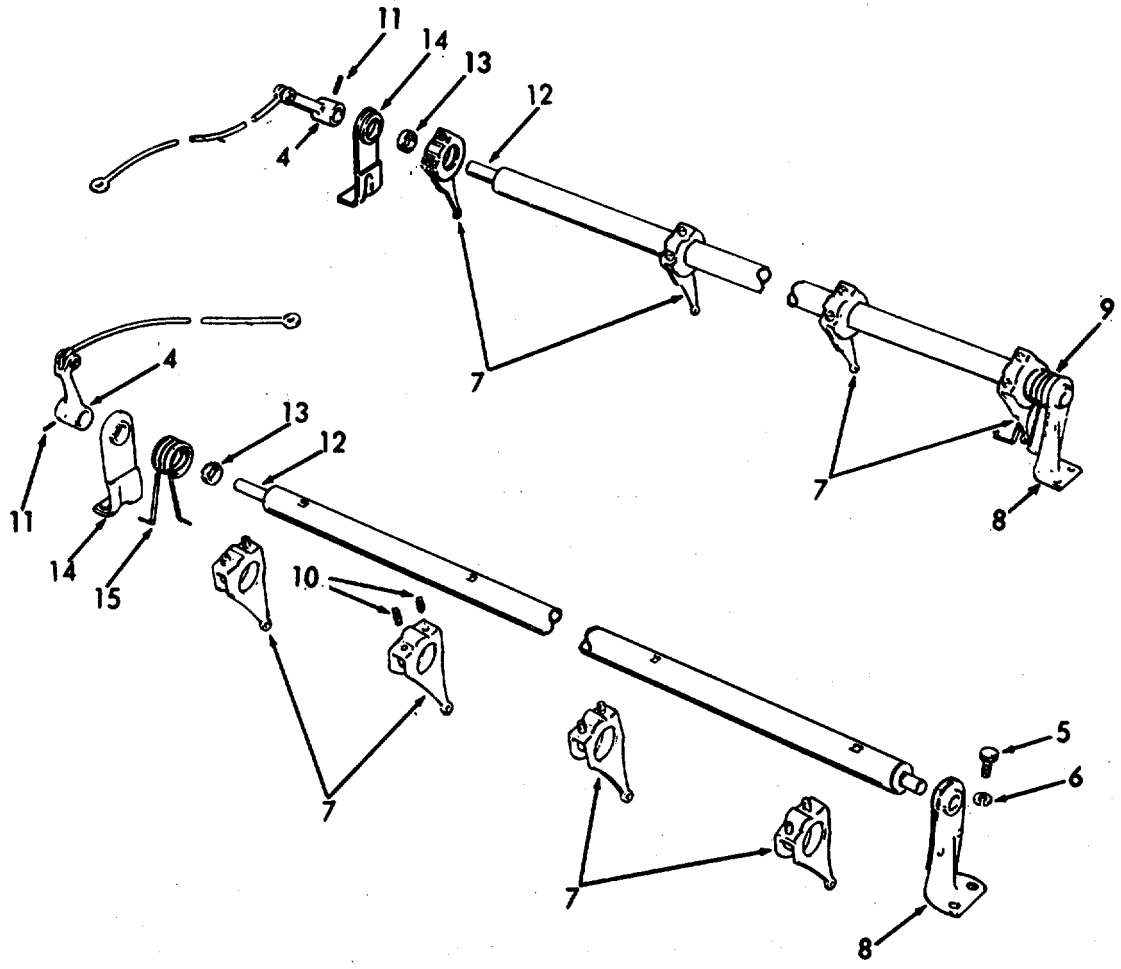


3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Screws (5) and lock-washers (6)	Remove.	
	d. Rack levers (7)	Disengage from injector control tubes.	Lift the control tube assembly from the cylinder head.
DISASSEMBLY			
	NOTE The injector control tube, one mounting bracket, a spacer and injector control tube lever, are available as a service assembly. When any part of this assembly needs replacing, it is recommended the complete service assembly be replaced. The following procedure includes complete disassembly and reassembly.		
3. Control tubes (right or left)	a. Bracket (8)	Remove.	
	b. Spring (9)	Remove.	
	c. Adjusting screws (10)	Remove.	
	d. Levers (7)	Remove.	
	e. Pin (11)	Remove.	
	f. Control lever (4)	Remove.	
	g. Control tube (12)	Remove.	

3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	h. Spacer (13)	Remove from bracket (14).	
	i. Spring (15)	Remove from bracket (14).	

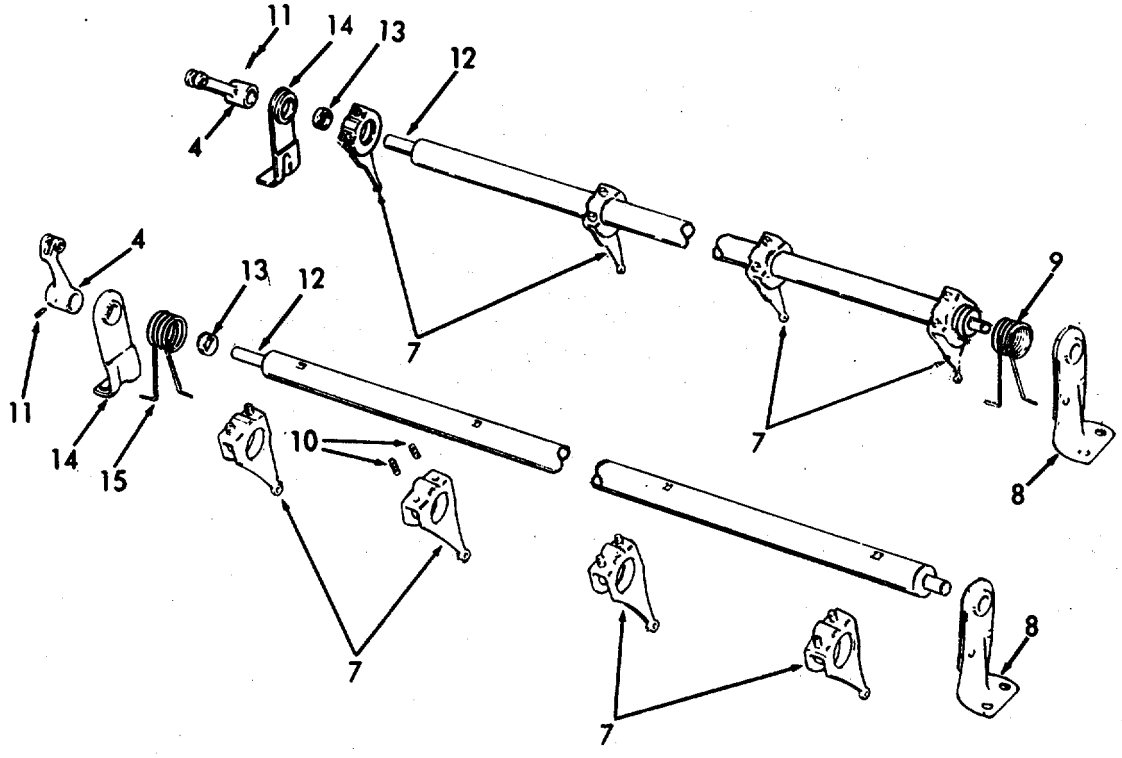


3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
4. Control tube (Left side)	a. Spring (15), bracket (14), spacer (13) and control tube (12)	Reassemble.	Spring (15) is on the right bank only.
	b. Control lever (4) and pin (11)	Install on control tube.	
	c. Levers (7) and adjust-Ing screws (10)	Assemble on control tube.	Levers to face the rear bracket position. Turn adjusting screws in far enough to position the levers on the control tube.
	d. Spring (15)	Attach the curled end of the spring to the lever, and the extended end of the spring behind the front bracket.	
	e. Bracket (8)	Install.	
5. Control tube (right side)	a. Control lever (4) and pin (11)	Install on control tube.	

3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Levers (7) and adjusting screws (10)	Assemble on control tube.	Levers to face the front brackets position. Turn adjusting screws in far enough to position the levers on the control tube.
	c. Spring (9)	Attach the curled end of the spring to the lever and the extended end of the spring behind the rear bracket.	
	d. Bracket (8)	Install.	



3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Control tubes (Right and left)	a. Levers (7)	Engage in injector control racks.	
	b. Bracket (8)	Align holes in cylinder head.	
	c. Screws (5) and lock-washers (6)	Install.	Screws are 1/4-20 x 5/8. Torque to 10-12 lb. ft. (14-16 Nm).
	d. Control tube	Check to be sure that it is free in the brackets.	Tap the control lightly to align the bear-ings in the brackets.
	e. Fuel rods (3), link pins (2) and cotter pins (1)	Install.	

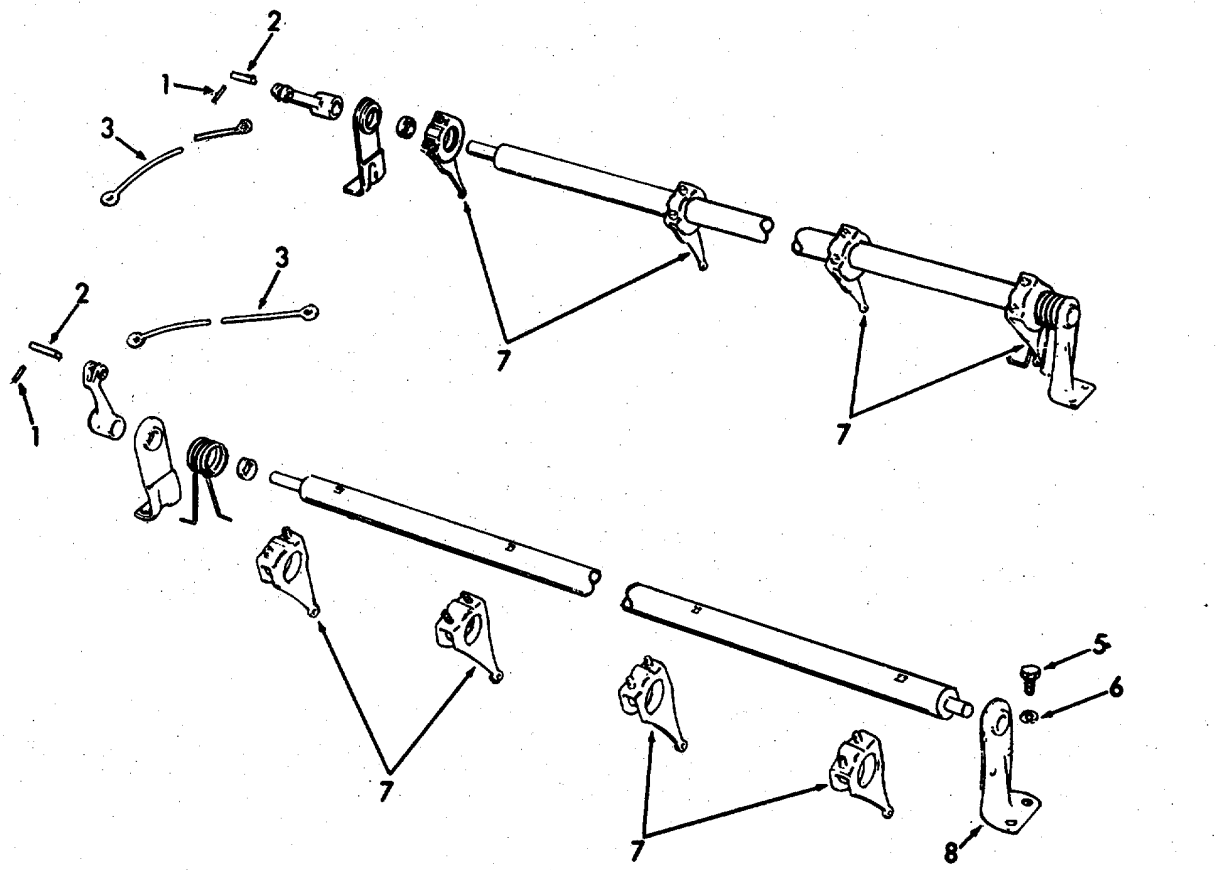
CAUTION

Be sure the injector rack control levers can be placed in a no-fuel position before re-starting the engine.

3-31. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-671

3-32. FLYWHEEL AND HOUSING AND OIL BREATHER - MAINTENANCE INSTRUCTIONS.

The maintenance instructions for the flywheel, flywheel housing, and oil breather (ventilation) are contained in the following paragraphs:

DESCRIPTION	PARAGRAPH
Flywheel and Housing	3-32.1
Oil Breather	3-32.2

3-32.1. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS.

a. The flywheel housing is a one-piece casting, mounted against the rear cylinder block end plate, which provides a cover for the gear train and flywheel. It also serves as a support for the starting motor and the Marine Gear. The torquemeter device and ventilation (oil breather) are also mounted on the flywheel housing.

b. The maintenance instructions in this paragraph are for the covers on the flywheel housing. All other maintenance on the flywheel or housing is to be performed by Direct Support Maintenance personnel.

3-32.1. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **b. Repair**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Torque Converter

Material/Parts

Gasket kit P/N 5196375

Personnel Required

1

References

NONE

Equipment Condition — Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Flywheel housing	a. Covers	Inspect for leaking gaskets and loose screws.	
	b. Housing	Inspect for leaking gaskets and seals.	If leaking is observed, refer to Direct Support Maintenance.

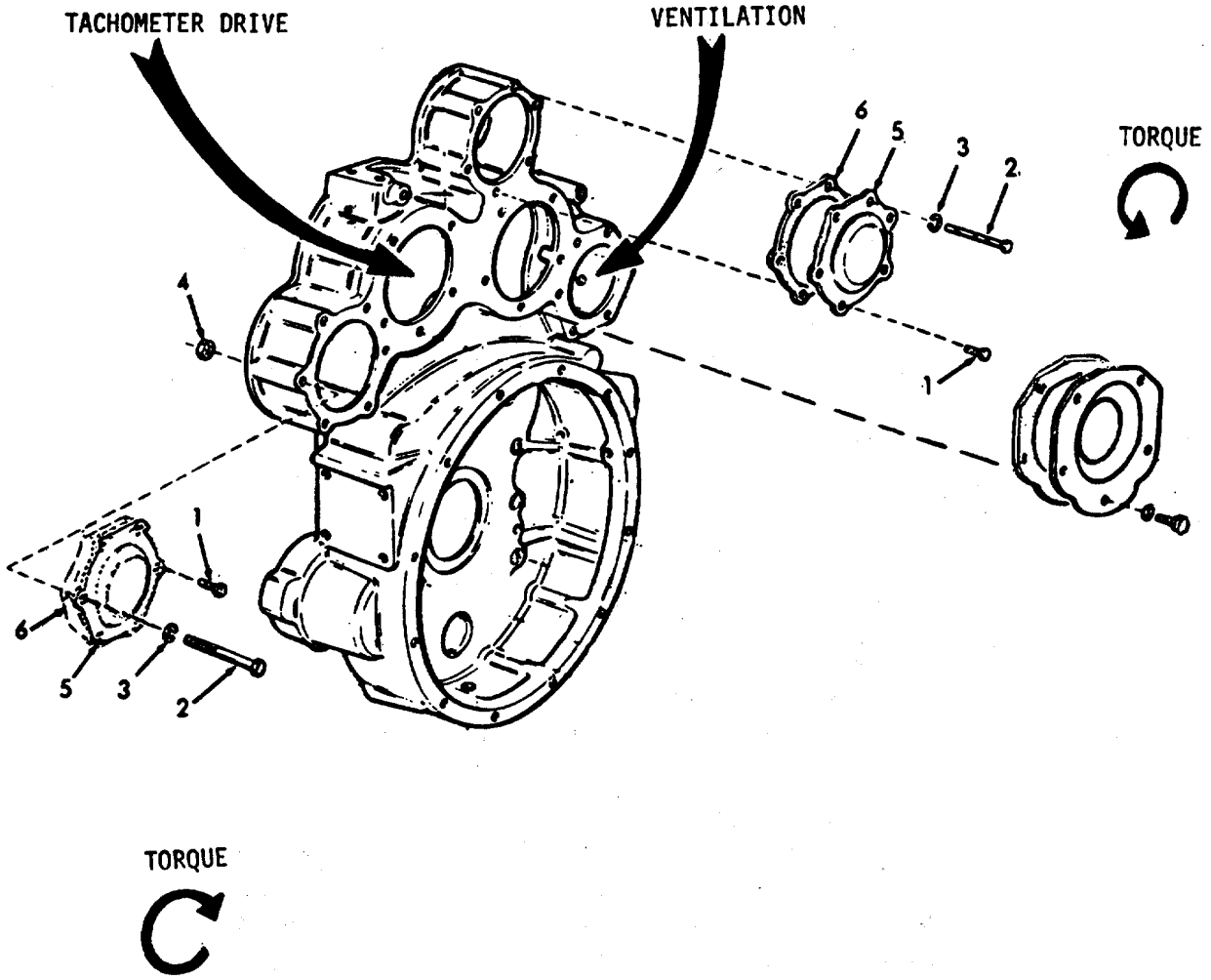
3-32.1. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2. Cover (Small)	a. Screws (1)	Remove.	
	b. Screws (2), lock-washers (3) and nuts (4)	Remove.	
	c. Cover (5)	Remove.	
	d. Gasket (6)	Remove.	Discard gasket.
	e. Gasket (6) and cover (5)	Align with holes in housing.	Use new gasket.
	f. Screws (1)	Install.	
	g. Screws (2), lock-washers (3) and nuts (4)	Install.	Torque to 30-35 lb-ft (41-47 Nm) torque in direction as shown.

3-32.1. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

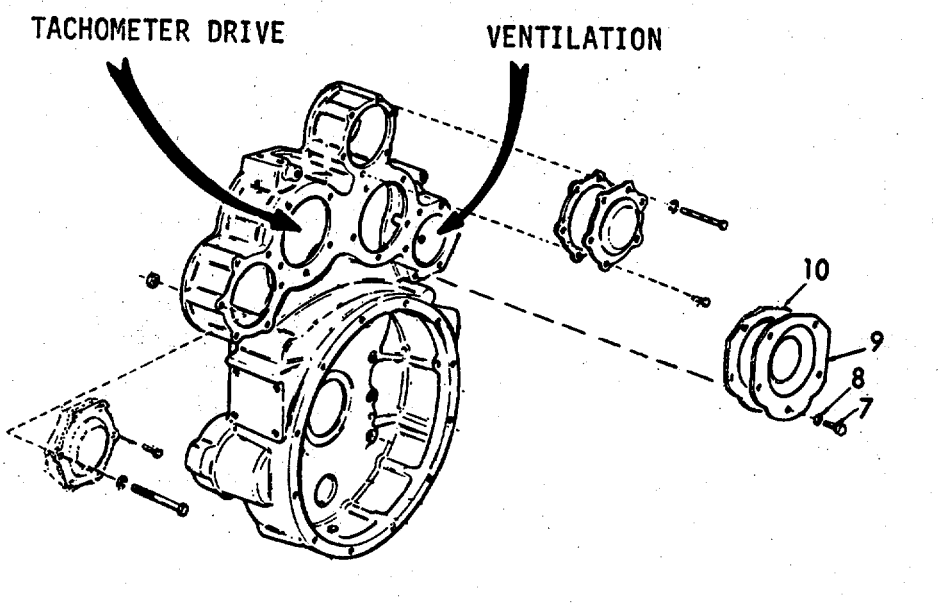
LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-32.1. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Cover (Large)	a. Screws (7) and flat-washers (8)	Remove.	
	b. Cover (9)	Remove.	
	c. Gasket (10)	Remove.	Discard gasket.
	d. Gasket (10) and cover (9)	Align with holes in housing.	Use new gasket.
	e. Screws (7) and flat-washers (8)	Install.	



3-32.2. OIL BREATHER - MAINTENANCE INSTRUCTIONS.

NOTE

Harmful vapors which may be formed within the engine are removed from the crankcase, gear train, and valve compartment by a continuous pressurized ventilation system.

An oil breather is mounted on the flywheel housing. The breather contains a filter element which traps oil particles. The oil drains back into the crankcase. The vapor is pulled into the engine air intake through the air silencers.

This task covers:

a. Inspection **b. Repair**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket kit P/N 5196375

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

Do not drain oil into bilges. Use oil/water separation system to drain bilges.

General Safety Instructions

WARNING

Use eye protection when using compressed air.

3-32.2. OIL BREATHER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Oil breather	a. Gaskets	Inspect for leaks.	
	b. Breather body	Inspect for cracks, breaks, bent tube, and loose hardware.	
	c. Breather tube	With engine running, see if vapor comes from tube.	
REPAIR			
2. Oil breather	a. Pipe plug (1)	Drain any accumulated oil into a suitable container.	
	b. Screw (2) and lockwasher (3)	Remove one screw.	
	c. Screws (4) and lockwashers (5)	Remove three screws.	
	d. Screws (6) and lockwashers (7)	Remove two screws.	
	e. Breather body (8) (with breather tube attached)	Remove.	
	f. Gasket (9)	Remove.	Discard gasket.

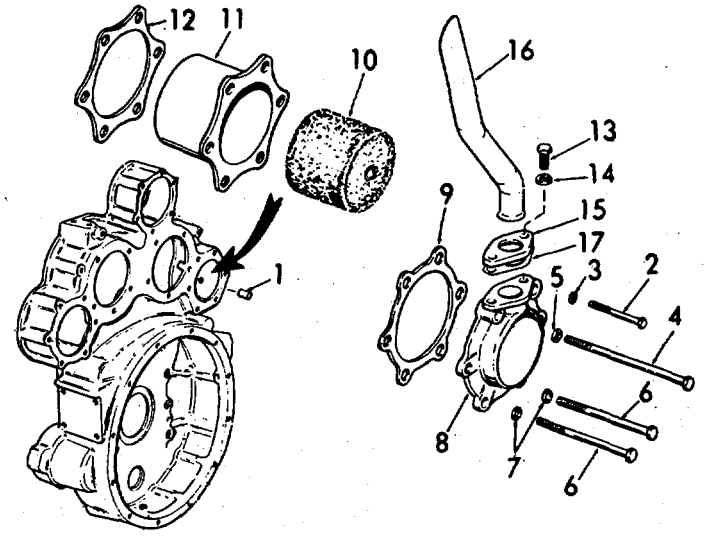
3-32.2. OIL BREATHER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

WARNING

Use eye protection when using compressed air.

g.	Filter element (10)	Remove and clean.	Clean in fuel oil and dry with compressed air.
h.	Breather shell (11)	Remove.	Repeat above.
i.	Gasket (12)	Remove.	Discard.
j.	Screws (13) and lockwashers (14)	Remove.	
k.	Flange (15)	Lift off tube (16).	
l.	Gasket (17)	Remove.	Discard.

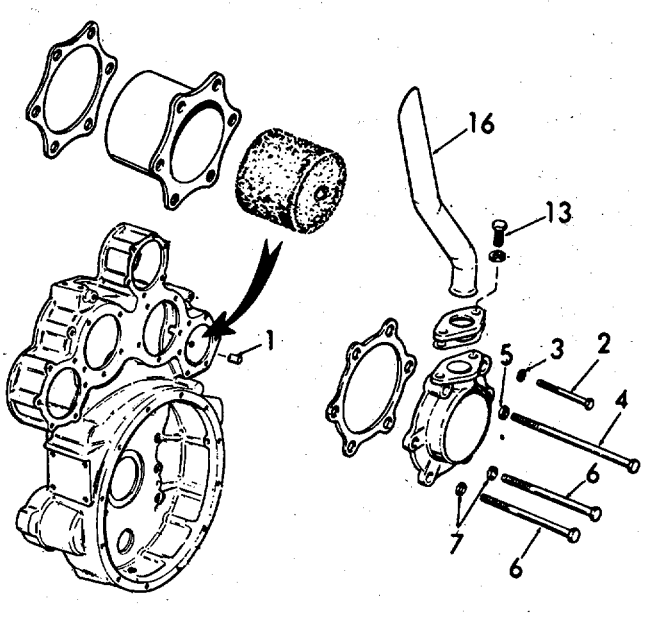


3-32.2. OIL BREATHER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	WARNING		
	Use eye protection when using compressed air.		
m.	Breather body (8) and tube (16)	Clean.	Clean in fuel oil and dry with compressed air.
n.	Flange (15)	Slide over tube (16).	
o.	Flange (15) and gasket (17)	Align with holes in breather body.	Use new gasket.
p.	Screws (13) and lock-washers (14)	Install.	Do not tighten.
q.	Filter element (10)	Place in breather shell (11).	
r.	Gasket (12), breather shell (11), gasket (9) and breather body (8)	Align holes in flywheel housing.	Slot in shell should be at the bottom and with approxi-mately 9/16 inch space be-tween element and back of breather body.
	NOTE		
	Be sure that the element covers the slot in the shell.		

3-32.2. OIL BREATHER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	s. Screws (6) and lock-washers (7)	Install.	
	t. Screws (4) and lockwash-ers (5)	Install.	
	u. Screw (2) and lock-washer (3)	Install.	
	v. Pipe plug (1)	Install.	
	w. Tube (16) and screws (13)	Position tube so that output is close to air silencer. Tighten screws.	



3-33. VALVE AND INJECTOR OPERATING MECHANISM - EXHAUST VALVES MAINTENANCE INSTRUCTIONS.

a. The valve and injector operating mechanism is located on the cylinder head.

b. Several operations may be performed on the valve and injector operating mechanism without removing the cylinder head from the block. These operations are:

(1) Rocker arm removal and installation. (Refer to paragraph 3-33.1).

(2) Rocker arm shaft or shaft bracket removal and installation. (Refer to paragraph 3-33.1).

(3) Fuel injector removal and installation. (Refer to paragraph 3-15).

c. It is also possible to remove or replace a push rod, push rod spring, spring seats or cam follower without removing the cylinder head. However, these parts are more easily changed from the lower side of the cylinder head when the head is off the engine. (Refer to paragraph 3-33.1).

d. Several operations may.be performed on the exhaust valve mechanism without removing the cylinder head from the block. These operations are:

(1) Valve clearance adjustment. (Refer to paragraph 3-33.2).

(2) Exhaust valve bridge adjustment. (Refer to paragraph 3-33.2).

(3) Valve spring removal and installation. (Refer to paragraph 3-33.2).

(4) Exhaust valve bridge or bridge guide removal and installation. (Refer to paragraph 3-33.2).

e. In addition, the following operations require removal of the cylinder head. These operations are:

(1) Remove and install exhaust valves. (Refer to paragraph 3-33.2).

(2) Remove and install exhaust valve guides. (Refer to paragraph 3-33.2).

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS.

a. Three rocker arms are provided for each cylinder; the two outer arms operate the exhaust valves. and the center arm operates the fuel injector.

b. Each set of three rocker arm assemblies pivot on a shaft supported by two brackets. A single bolt secures each bracket to the top of the cylinder head. The removal of the two bracket bolts permit the rocker arm assembly for one cylinder to be raised, providing easy access to the fuel injector and the exhaust valve springs.

c. The rocker arms are operated by a camshaft through cam followers and short push rods, extending through each cylinder head.

d. Contact between each cam follower and the camshaft is done by a hardened roller having a pressed-in bushing which runs on a pin in the lower end of the cam follower. Each cam follower operates in a bore in the cylinder head. A guide for each set of three cam followers is attached to the bottom of the cylinder head to keep the cam follower rollers in line with the cams and to serve as a retainer during assembly and disassembly of the cylinder head.

e. A coil spring inside each cam follower is held in place in the cylinder head by a spring seat and spring seat retainer.

f. The valve and injector operating mechanism is lubricated by oil from a longitudinal oil passage on the camshaft side of the cylinder head, which connects with the main oil gallery in the cylinder block. Oil from this passage flows through drilled passages in the rocker shaft bracket bolts, to the passages in the rocker arm shaft to lubricate the rocker arms.

g. Overflow oil from the rocker arms lubricate the exhaust valves, valve bridges and cam followers. The oil drains from the top deck of the cylinder head through oil holes in the cam followers, into the camshaft pockets in the cylinder block and back to the oil pan.

h. The cam follower rollers are lubricated with oil from the cam followers; oil picked up by the camshaft lobes and by oil emitted under pressure from milled slots in the camshaft intermediate bearings.

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **c. Repair**
b. Cleaning/ Inspection **d. Installation**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Service fixture cam follower J5840-01
Remover set pushrod J3092-01
Torque wrench
Fuel pipenut wrench J1928-01

References

NONE

Equipment Condition	Condition Description
Para 3-30	Rocker Arm Cover Removed
Para 3-34	Cylinder Head Maintenance Instructions

Material/Parts

Cindol 1705

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Rocker shaft assembly	a. Fuel pipes (1)	Remove from injector and connectors.	Use tool J1928-01.

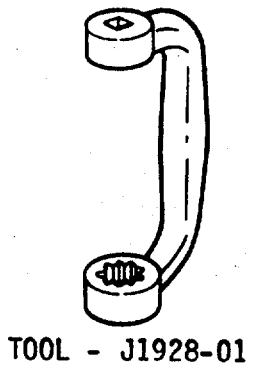
CAUTION

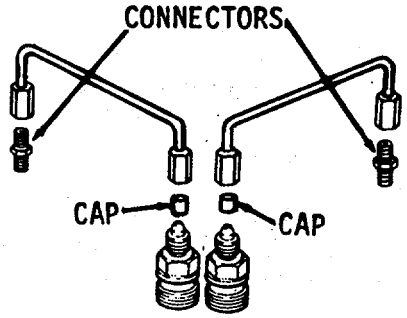
Immediately after removing the fuel pipes, cover the injector fuel inlet and outlet openings with shipping caps to prevent dirt or foreign material from entering the injector.

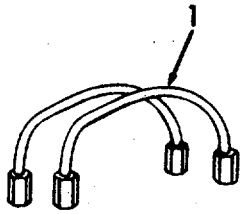
3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)







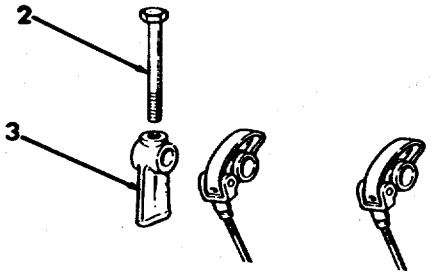
b. Engine — Turn the crankshaft, or crank the engine with the starting motor, to bring the injector and valve rocker arms in line horizontally.

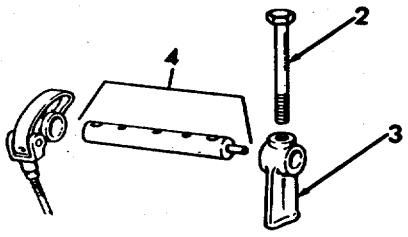
CAUTION

Do not.bar the crankshaft in a left-hand direction of rotation with a wrench or barring tool on the crankshaft bolt, or the bolt may be loosened.

c. Bolts (2) — Remove.

d. Rocker shaft brackets (3) and shaft (4) — Remove.





3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

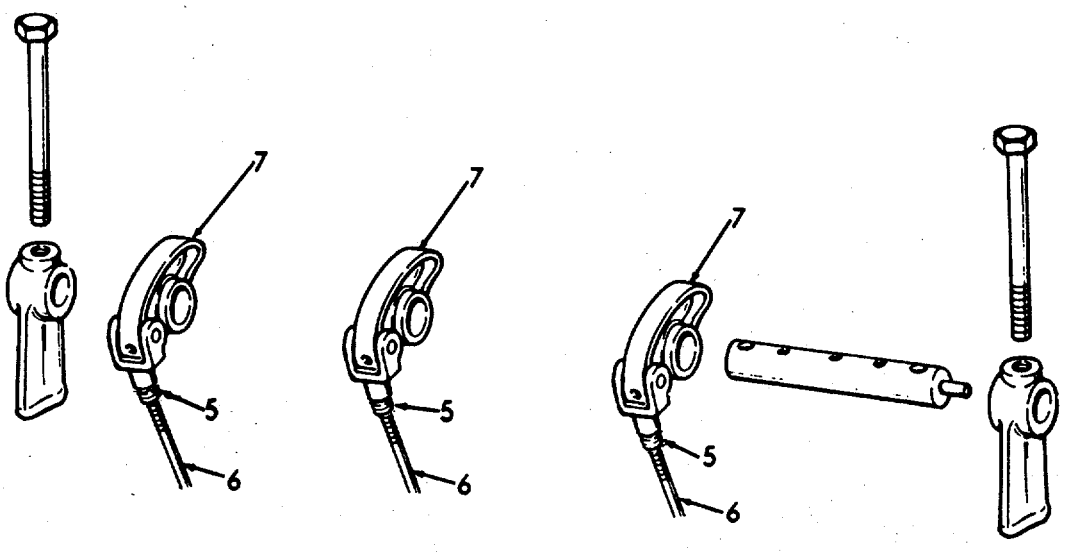
CAUTION

When removing the rocker arm shaft, fold the three rocker arms back just far enough so the shaft can be removed. Do not force the rocker arms all the way,back with the shaft in place as this may impose a load that could bend the push rods.

e.	Lock nuts (5)	Loosen.	
f.	Push rods (6)	Unscrew from rocker arms (7).	

NOTE

If the rocker arms and shafts from two or more cylinders are to be removed, tag them so they may be reinstalled in their original positions.



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD ON ENGINE

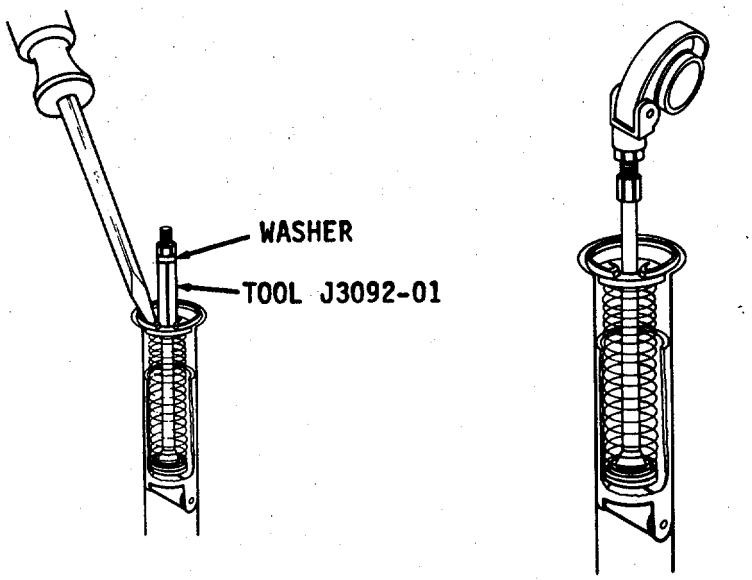
2. Cam follower and push rods

NOTE

When removing the cam followers and associated parts, tag them so they may be reinstalled in their original location.

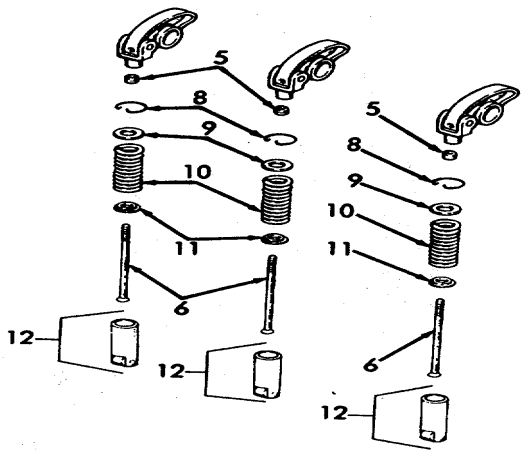
a. Lock nut (5) — Remove.

b Push rob (6) — Install remover J3092-01, a flat washer and the locknut on the push rod with the lower end of the tool resting on the upper spring seat.



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD ON ENGINE (Cont)			
c.	Push.rod (6), and lock nut (5)	Screw nut down to compress spring.	The push rod has milled flat sides, for ease of tightening.
d.	Push rod retainer (8)	Remove.	Use a screwdriver to release retainer from cylinder head.
e.	Lock nut (5)	Remove.	Disassemble tool J3092-01, and flat washer. Remove.
f.	Push rod (6), upper spring seat (9), spring (10), lower spring seat (11) and cam follower (12)	Pull out of cylinder head.	



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD REMOVED

3. Cam follower and push rod

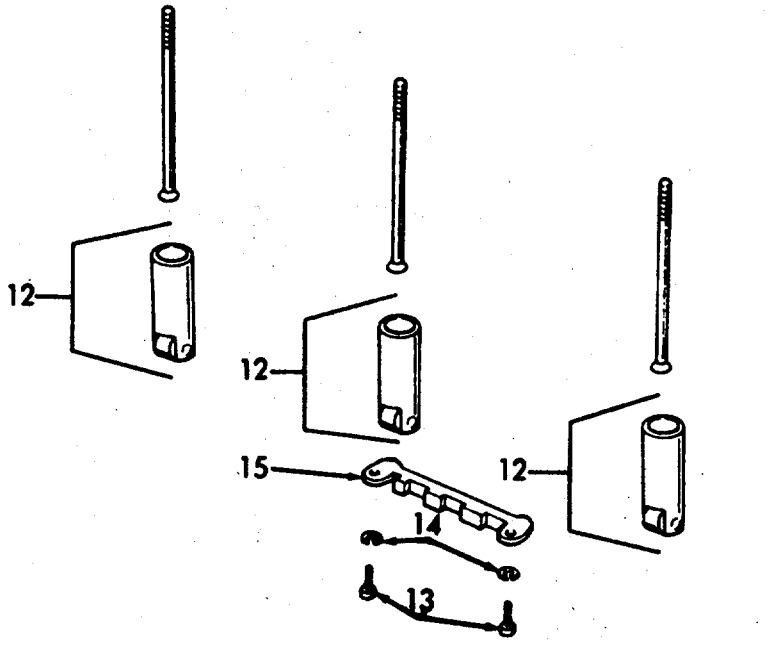
NOTE

When removing the cam followers and associated parts, tag them so they may be reinstalled in their original location.

a. Screws (13), and lockwashers (14) — Remove. — Rest cylinder head on its side.

b. Cam follower guide (15) — Remove.

c. Cam follower (12) — Pull out of cylinder head.



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

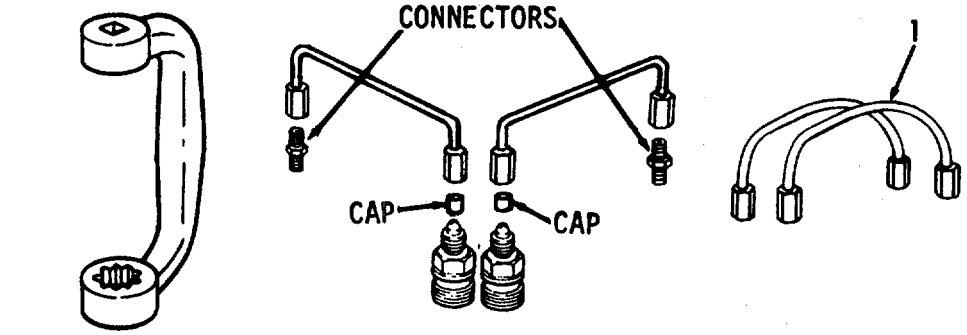
LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD REMOVED (Cont)

d.	Fuel pipes (1)	Remove from injector and connectors.	

CAUTION

Immediately after removing the fuel pipes, cover the injector fuel inlet and outlet openings with shipping caps to prevent dirt or foreign material from entering.



TOOL - J1928-01

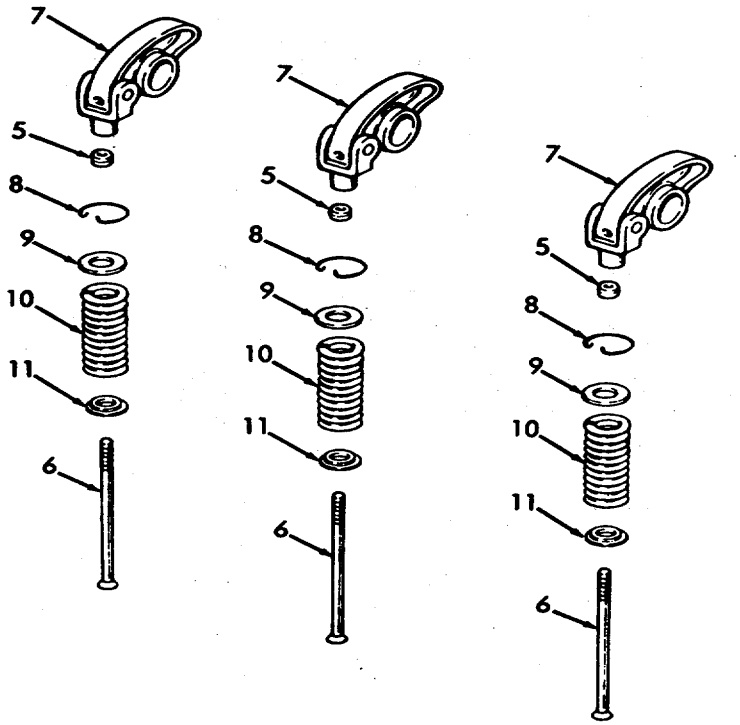
e.	Lock nut (5)	Loosen.	
f.	Push rod (6)	Unscrew from rocker arm (7).	
g.	Push rod (6) upper spring seat (9), spring (10), and lower spring seat (11)	Pull from bottom of cylinder head.	

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD REMOVED (Cont)			
h.	Lock nut (5), push rod (6), upper spring seat (9), spring (10), and lower spring seat.	Disassemble.	

NOTE

If the cylinder head is to be replaced, remove the spring retainers (8) and install them in the new head.



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

CLEANING AND INSPECTION.

WARNING

Use eye protection when using compressed air.

4. Rocker shaft assembly

Wash the rocker arms, shaft, brackets and bolts with clean fuel oil. Use a small wire to clean out the drilled oil passages in the rocker arms and rocker shaft bolts. Dry the parts with compressed air.

Inspect the rocker arm shaft and rocker arm bushings for wear. A maximum shaft to bushing clearance of .004 inch (0.010 cm) is allowable with used parts. Service replacement bushings must be reamed to size after installation.

Inspect the rocker arms for galling or wear on the pallets (valve or injector contact surfaces). If worn, the surface may be refaced up to a maximum of .010 inch (0.025 cm). However, proceed with caution when surface grinding to avoid overheating the rocker arm. Maintain the radius and finish as close to the original surface as possible. Also inspect the valve bridges for wear.

5. Cam follower

Proper inspection and service of the cam follower is very necessary to obtain continued efficient engine performance. When any appreciable change in injector timing or exhaust valve clearance occurs during engine operation, remove the cam followers and their related parts and inspect them for excessive wear. This change in injector timing or valve clearance can usually be detected by excessive noise at idle speed.

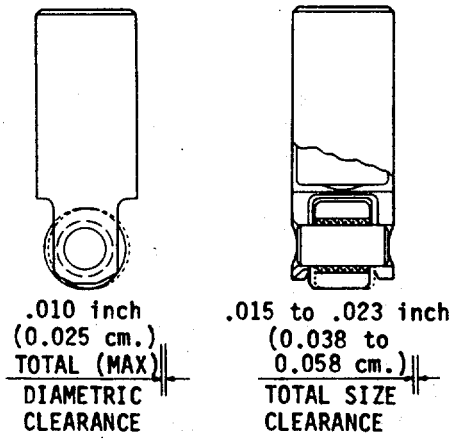
Wash the cam followers with lubricating oil or Cindol 1705 and wipe dry. Do not use fuel oil. Fuel oil working its way in between the cam roller bushing and pin may cause scoring on initial start-up of the engine since fuel oil does not provide adequate lubrication. The push rods, springs and spring seats may be washed with clean fuel oil and dried with compressed air.

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

CLEANING AND INSPECTION (Cont)

Examine the cam follower rollers for scoring, pitting or flat spots. The rollers must turn freely on their pins. Measure the total diametric clearance and side clearance. Install a new roller and pin if the clearances exceed those shown below. Cam followers stamped with the letter "S" on the pin, roller and follower body are equipped with an oversize pin and roller. The same clearances apply to either a standard or oversize cam follower assembly.



Examine the camshaft lobes for scoring, pitting or flat spots. Replace the camshaft if necessary. (Refer to Direct Support Maintenance).

Check the cam follower-to-cylinder head clearance. The clearance must not exceed .006 inch (0.015 cm) with used parts.

Examine the cam follower bores in the cylinder head to make sure they are clean, smooth and free of score marks. If necessary, clean up the bores.

6. Push rods and spring seats. — Inspect for wear.

7. Cam follower springs — Examine the cam follower springs for wear or damage. Check the spring load. Replace a spring when a load of less than 172 lbs (765 N) will compress it to a length of 2.125 inch (5.398 cm).

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR

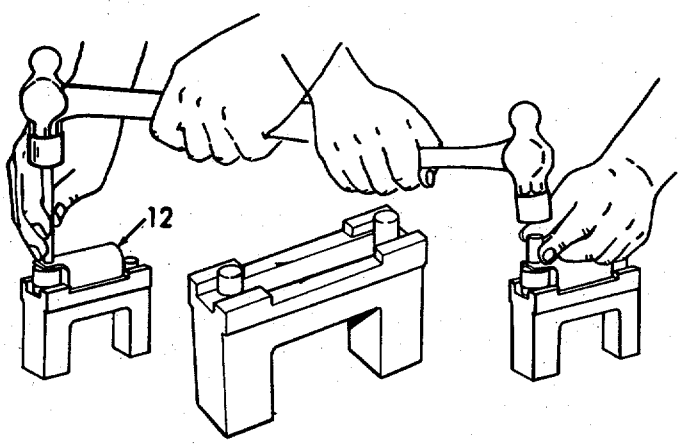
8. Cam follower

CAUTION

Do not attempt to bore out the legs of a standard cam follower for an oversize pin.

a. Cam follower (12)

1. Clamp fixture J5840-01 securely in a vise. Place cam follower in groove on top of fixture, with the follower pin resting on top of corresponding size plunger in the fixture.



2. Drive pin from roller with a suitable drift. Exercise caution in removing the cam follower body and roller from fixture as roller pin is seated on a spring-loaded plunger in the fixture.

3. Before installing the new roller pin, remove the preservative by washing parts with clean lubricating oil or Cindol 1705 and wipe dry. Do not use fuel oil. After washing the parts, lubricate the roller and pin with Cindol 1705.

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

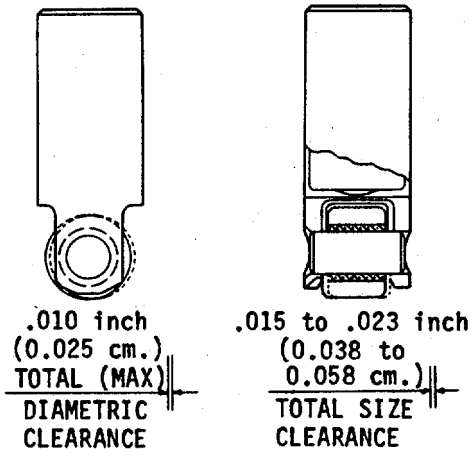
REPAIR (Cont)

4. Position the cam follower body in the groove of the fixture with a small plunger extending through the roller pin hole in the lower leg of the follower body.

5. Position new cam roller in the cam follower body. When released, the plunger will extend into the roller bushing and align the roller with the cam follower body.

6. Start the new pin in the cam follower body. Then carefully tap it in until it is centered in the cam follower body.

7. Remove the cam follower from the fixture and check the side clearance. The clearance must be .015 to .023 inch (0.038 to 0.058 cm).



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

NOTE

If new cam follower assemblies are to be installed, remove the preservative by washihg with Cindol 1705 and wipe dry. Do not use fuel oil.

Before cam followers are installed, immerse them in clean Cindol 1705 (heated to 100-125°F (38-52°C) for at least one hour to ensure initial lubrication of the cam roller pins and bushings. Rotate the cam rollers during the soaking period to purge any air from the bushing-roller area. The heated Cindol oil results in better penetration as it is less viscous than engine oil and flows more easily between the cam roller bushing and pin. After the cam followers are removed from the heated Cindol 1705, the cooling action of any air trapped in the bushing and pin area will tend to pull the lubricant into the cavity.

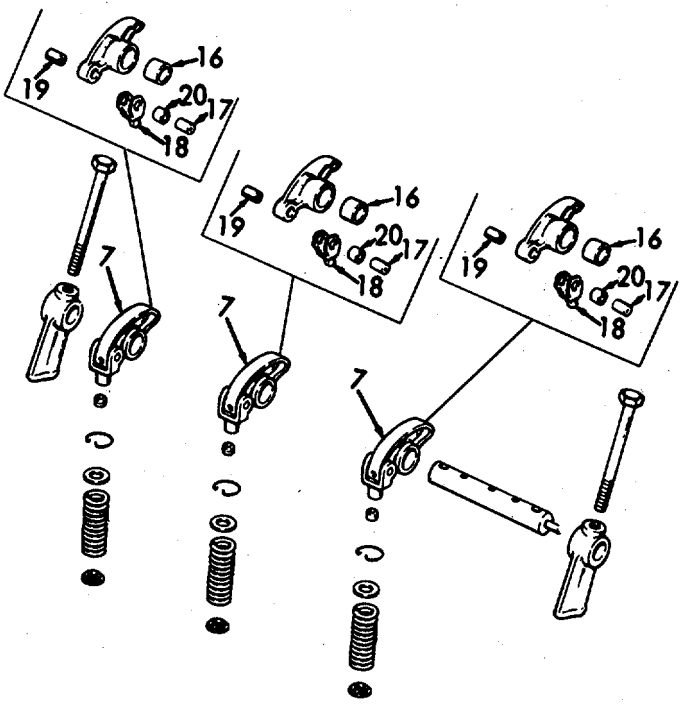
NOTE

Heat the Cindol 1705 in a small pail with a screen insert. The screen will prevent the cam followers from touching the bottom of the pail and avoid the possibility of contamination.

9.	Rocker Arm assembly (7)	a.	Rocker arm large bushing (16)	Press out of rocker arm.
		b.	Clevis pin (17)	Press out of rocker arm.
		c.	Clevis (18)	Remove.
		d.	Rocker arm small bushing (19)	Press out of rocker arm.

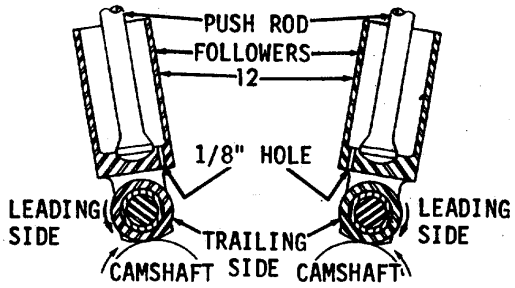
3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Clevis bushing (20)	Press out of clevis.	
	f. Clevis bushing (20)	Press into clevis.	
	g. Rocker arm small bushing (19)	Press into rocker arm.	
	h. Clevis (18)	Assemble.	
	i. Clevis pin (17)	Press into clevis and rocker arm.	
	j. Rocker arm large bushing (16)	Press into rocker arm.	



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

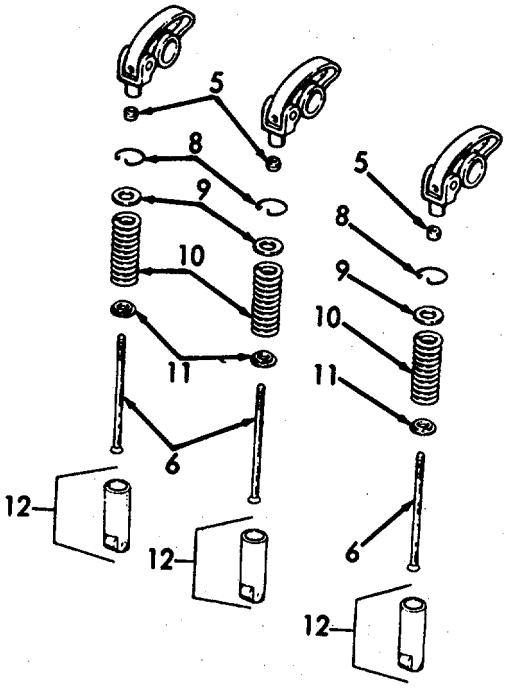
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD ON ENGINE			
10. Cam follower and push rod	a. Cam follower (12)	Slide into cylinder head.	Note the oil hole in the bottom of the cam follower. The oil hole should be directed away from the exhaust valve.



	b. Lower spring seat (11), spring (10), upper spring seat (9), and push rod (6)	Assemble.	Lower spring seat is serrated.
	c. Flat washer, and lock nut (5)	Place a flat washer over the upper spring seat and start the lock nut on the push rod. Place tool J3092-01 on the push rod between the washer and the upper spring seat and place the push rod assem-	

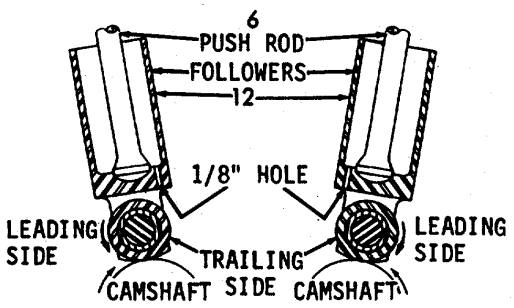
3-33.1. VALVE AND INJECTOR OPERATING MECHANISM -MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)			
		bly in the cam follower. Then thread the lock nut on the push rod until the spring is compressed sufficiently to permit the spring retainer to be installed.	
d.	Retainer (8)	Install with tangs facing the notch in the cylinder head.	
e.	Lock nut (5), and flat-washer	Remove.	Remove tool J3092-01.
f.	Lock nut (5)	Reinstall.	Thread it as far as possible on the push rod.



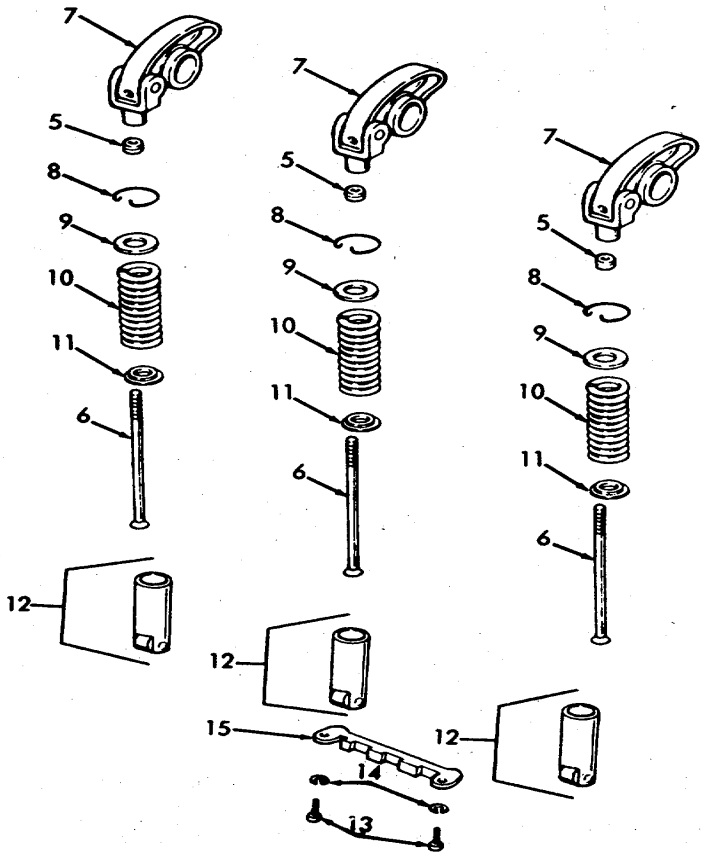
3-33.1. VALVE AND INJECTOR OPERATING MECHANISM -MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD REMOVED FROM ENGINE			
11. Cam follower and push Rod	a. Lower spring seat (11), spring (10), upper spring seat (9), push rod (6), and lock nut (5)	Assemble.	Lower spring seat is serrated.
	b. Retainer (8)	Install with tangs facing notch in cylinder head.	
	c. Push rod assembly	Slide in position from bottom of the head.	
	d. Cam follower (12)	Slide into cylinder head from bottom of head.	Note the oil hole in bottom of the cam follower. The oil hole should be directed away from the exhaust valve.



3-33.1. VALVE AND INJECTOR OPERATING MECHANISM -MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALATION - CYLINDER HEAD REMOVED FROM ENGINE (Cont)			
e.	Screws (13), lock-washers (14), and cam follower guide (15)	Reassemble.	Guide holds the group of three cam followers in place. Check to make sure there is clear-ance between cam followers and the lower guide. Tighten the guide bolts to 12-15 lb-ft (16-20 Nm) torque.



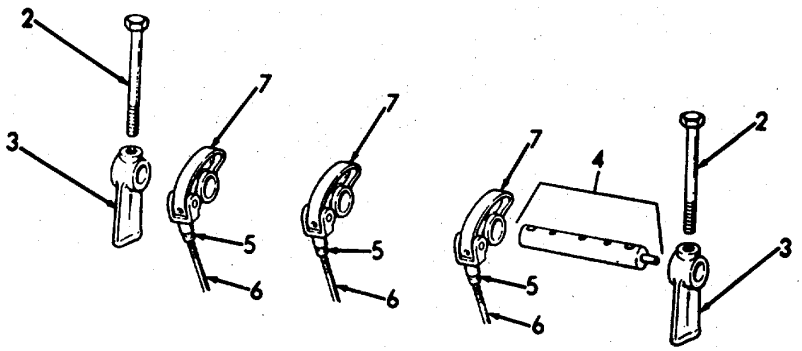
3-33.1. VALVE AND INJECTOR OPERATING MECHANISM -MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
12. Rocker shaft assembly			
		NOTE	
		The injector rocker arm (center arm of the group) is slightly different from the exhaust valve rocker arms; the boss for the shaft on the left and right-hand valve rocker arms is longer on one side. The extended boss of each valve rocker arm must face toward the injector rocker arm.	
	a. Rocker arm (7), and push rod (6)	Thread each rocker arm on its push rod until end of push rod is flush with or above the inner side of the clevis yoke.	Provide sufficient initial clearance between exhaust valve and piston when crankshaft is turned during valve clearance adjustment procedure.
	b. Rocker arm shaft (4) and rocker arm (7)	Assemble.	Apply clean engine oil to the rocker arm shaft and slide the shaft through the rocker arms.
	c. Bracket (3)	Assemble on shaft.	Finished face of bracket next to rocker arm.
	d. Bracket bolts (2)	Install.	Torque to 90-100 ft-lb (122-' 136 Nm) torque.
		NOTE	
		Bracket bolts go through the bracket and the shaft.	

3-33.1. VALVE AND INJECTOR OPERATING MECHANISM -MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

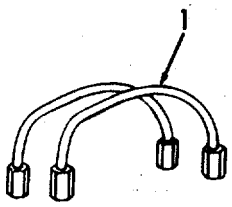


e.	Caps on injectors and connectors	Remove.	

CAUITION

Immediately after removing the caps, install the fuel pipes. This prevents dirt and foreign material from entering the injector.

f.	Fuel pipes (1)	Align and install.	Torque fuel pipe nuts (5) to 12-15 lb-ft (16-20 Nm) torque.



WARNING

Do not bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared ends of the fuel pipes and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS.

a. General.

(1) Four exhaust valves are provided for each cylinder. The valve heads are heat treated and ground to the proper seat angle and diameter, and the valve stems are ground to size and hardened at the end which contacts the rocker arm or exhaust valve bridge.

(2) Pre-finished replaceable valve guides are pressed into the cylinder head. Reaming of these guides is unnecessary.

(3) Exhaust valve seat inserts pressed into the cylinder head permit accurate seating of the exhaust valves under varying conditions of temperature and materially prolongs the life of the cylinder head. The inserts are ground to very close limits and the freedom from warpage, under ordinary conditions, reduces valve reconditioning to a minimum. The exhaust valves and valve seat inserts are ground to a 30 seating angle.

(4) The exhaust valve springs are held in place by the valve spring caps and tapered two-piece valve locks.

(5) Excess oil from the rocker arms lubricates the exhaust valve stems. The valves are cooled by the flow of air from the blower past the valves each time the air inlet ports are uncovered.

b. Exhaust Valve Clearance Adjustment.

Correct valve clearance adjustment is important for proper operation of the engine. Too little clearance between the exhaust valve stem and the rocker arm causes a loss of compression, misfiring cylinder, and eventual burning of the valves and valve seat inserts. Too much clearance results in noisy operation of the engine, especially in the idling speed range.

c. Exhaust Valve Maintenance.

(1) Efficient combustion in the engine requires that the exhaust valves be maintained in good operating condition. Valve seats must be true and unpitted to assure leakproof seating, valve stems must work freely and smoothly within the valve guides, and the correct valve clearance must be provided.

(2) Proper maintenance and operation of the engine is important to long valve life. Engine operating temperature should be maintained between 160°F and 185°F (71°C to 85°C). Low operating temperatures, usually due to extended periods of idling or light engine loads, result in incomplete combustion, formation of excessive carbon deposits and fuel lacquers on valves and related parts, and a greater tendency for lubricating oil to sludge.

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

(3) Lubricating oil and oil filters should be changed periodically to avoid the accumulation of sludge. Use only good quality oil as specified for the engine.

(4) Unsuitable fuels may also cause formation of deposits on the valves, especially when operating at low temperatures.

(5) When carbon deposits, due to partially burned fuel, build up around the valve stems and extend to that portion of the stem which operates in the valve guide, sticking valves will result. The valves cannot seat properly, and pitted and burned valves and valve seats and loss of compression will result.

(6) Valve sticking may also result from valve stems which have been scored due to foreign matter in the lubricating oil, leakage of anti-freeze (glycol) into the lubricating oil which forms a soft, sticky carbon and gums the valve stems, and bent or worn valve guides. Sticking valves may eventually result in valves being held in the open position, being struck by the piston, or becoming bent or broken.

(7) It is highly important that injector timing and valve clearance be accurately adjusted and inspected periodically. Improperly timed injectors will have adverse effects upon combustion. Tightly adjusted valves will cause rapid pitting of the valve seats and a hotter running condition on the valve stems.

(8) The cylinder head must first be removed before the exhaust valves, valve seat inserts, or valve guides can be removed for replacement or reconditioning. However, the valve springs may be removed without removing the cylinder head, if necessary.

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **c. Installation**
b. Inspection **d. Adjustment**

INITIAL SETUP:

Test Equipment

Micrometers and Gages
Feeler Gage

Special Tools

Compressor Valve Springs J7455-7
Installer Valve Seat Insert J6568
Remover Valve Seat Insert J6567-02

References

NONE

Equipment Condition — Condition Description

Para 3-15 — Fuel Injector Removal
Para 3-30 — Rocker Arm Cover Removal
Para 3-33.1 — Valve and Injector Operating
Para 3-34 — Cylinder Head Maintenance Instructions

Material/Parts

Gasket kit P/N 5196382
Gasket kit P/N 5196375

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD ON ENGINE			
1. Exhaust valve Spring	a. Rocker arm cover	Remove.	Refer to paragraph 3-30.
	b. Valve and injector operating mechanism	Remove.	Refer to paragraph 3-33.1.

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

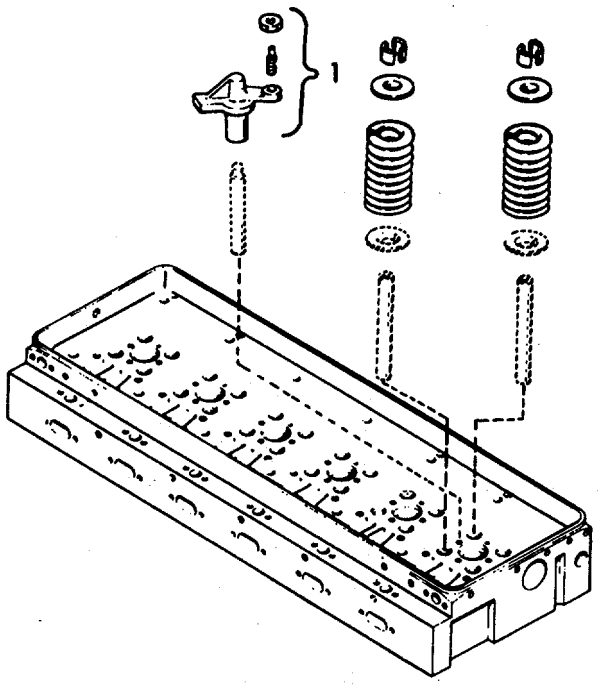
LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD ON ENGINE (Cont)

CAUTION

Immediately after removing the fuel pipes, cover each injector opening with a shipping cap to prevent dirt or other foreign matter from entering the injector.

c.	Exhaust valve bridges (1)	Remove	Lift up to remove.

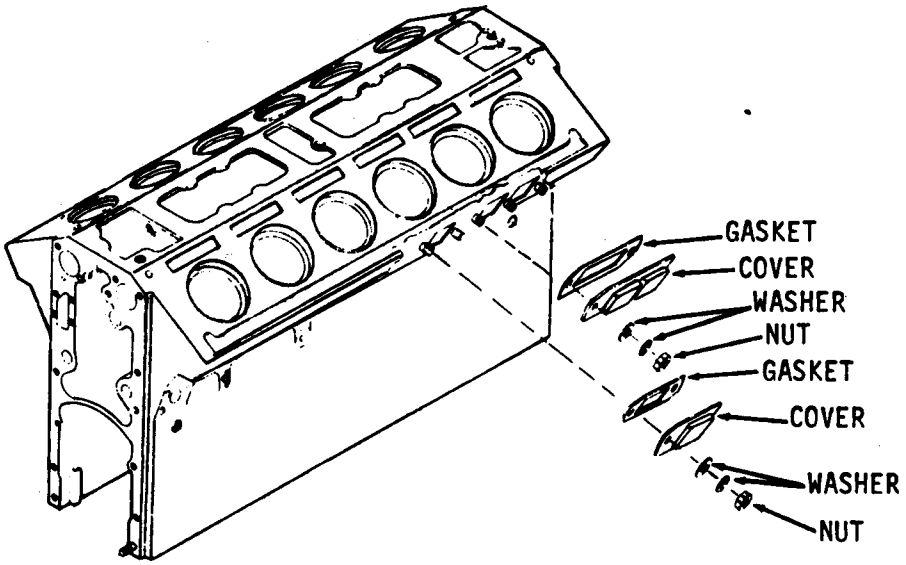


3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD ON ENGINE (Cont)

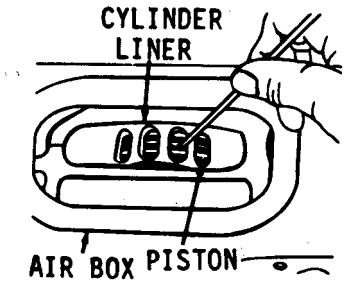
d.	Air box Cover	Remove nuts, lockwashers, flat washers, cover and gasket.	Discard gasket.



e.	Piston	Observe piston while turning crankshaft.	Piston should be at top of its' stroke.

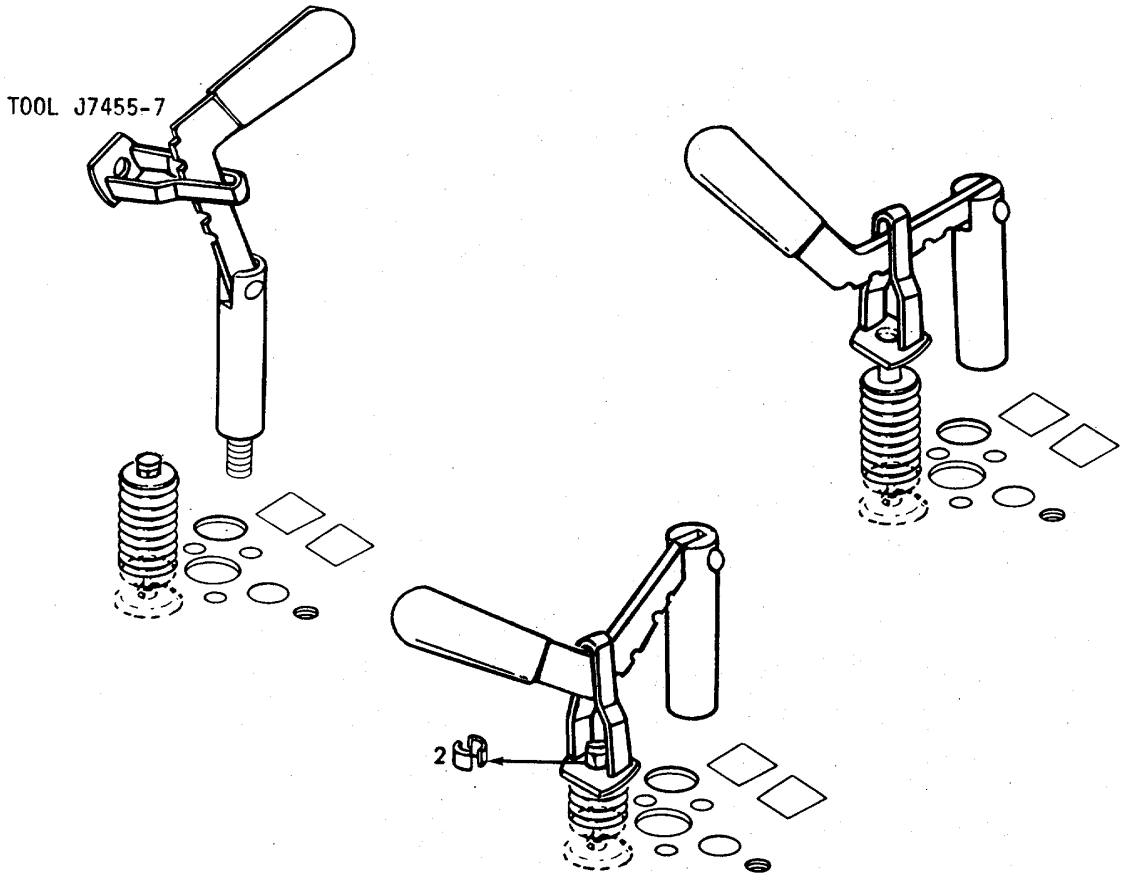
NOTE

When using a wrench on the crankshaft bolt and at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation or the bolt will be loosened.



3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

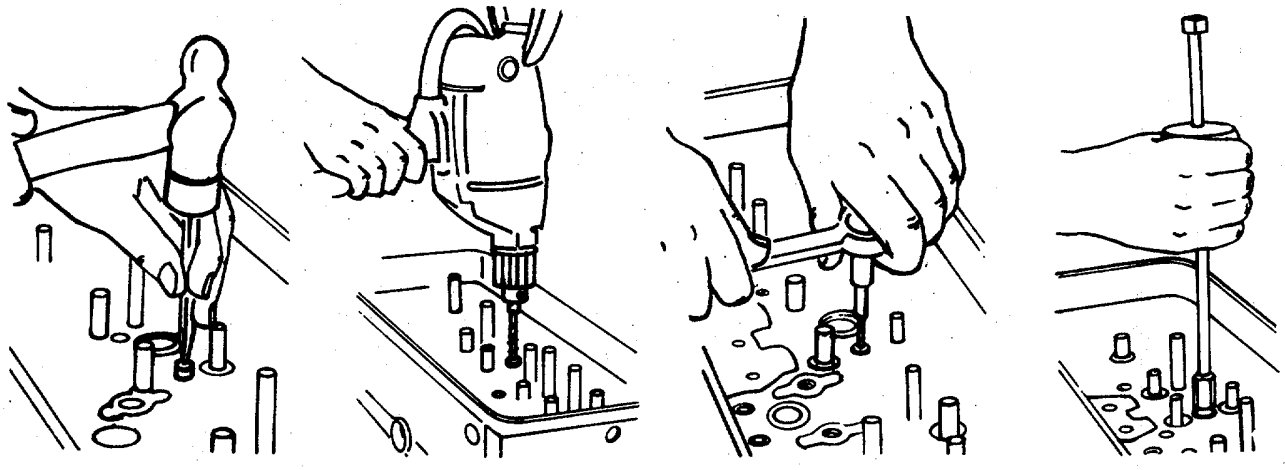
LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD ON ENGINE (Cont)			
	f. Valve spring compressor	Thread the valve spring compressor into the rocker shaft bolt hole in the cylinder head. Apply pressure to the end of the valve spring. Remove the two-piece tapered valve lock (2).	Use tool J 7455-7.



	g. Valve spring compressor	Raise slowly, then unscrew.	

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

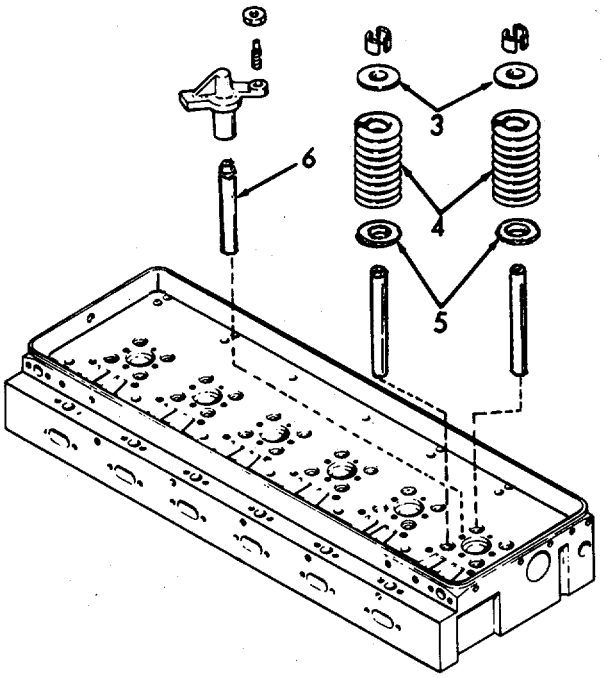
LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD ON ENGINE (Cont)			
	h. Spring cap (3), spring (4), and spring seat (5)	Remove.	
2. Exhaust valve bridge guide (6)	Fuel injector	1. Remove.	Refer to paragraph 3-15.
		2. Drill a hole approx-. imately 1/2 inch deep in the end of the guide with a No. 3 (.2130 inch) drill.	
		3. Tap the guide with a 1/4 inch -28 bottoming tap.	
		4. Thread remover into the guide and attach slide hammer to the remover tool.	
		5. One or two sharp blows with the puller weight will remove the broken guide.	



3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL - CYLINDER HEAD ON ENGINE (Cont)



INSPECTION

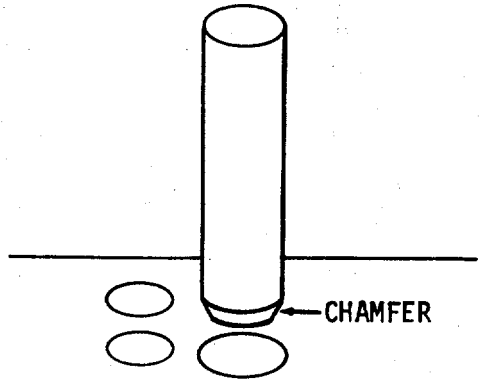
WARNING

Use eye protection when using compressed air.

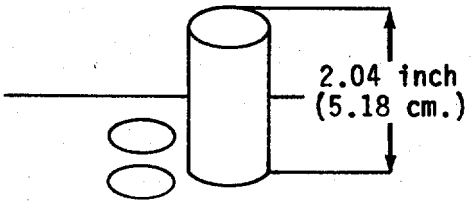
3.	Exhaust valve spring (4)	Clean the spring with fuel oil and dry it with compressed air. Then, inspect the spring for pitted or fractured coils. Use spring tester and an accurate torque wrench to check the spring load. The exhaust valve spring has an outside diameter of approximately 61/64 inch (2.4209 cm). Replace this spring when a load of less than 25 pounds (11.35 kg) will compress it to 1.80 inch (4.57 cm) (installed length). Inspect the valve spring seats and caps for wear. If worn, replace.

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
4. Exhaust valve bridge (1) and guide (6)		Inspect the valve bridge guide, valve bridge, and adjusting screw for wear. Replace excessively worn parts.	
INSTALLATION - CYLINDER HEAD ON ENGINE			
5. Exhaust valve bridge guide	Guide (6)	a. Start guide straight into the cylinder head.	Chamfer end first.

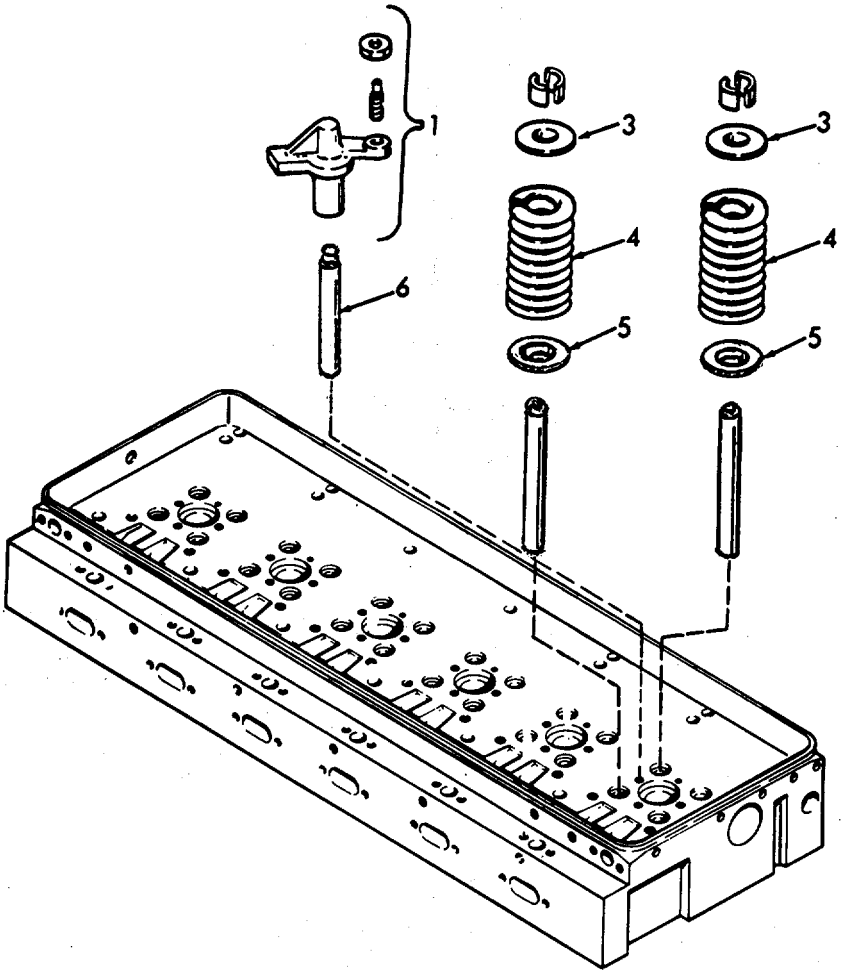


b. Drive into place. — Height of guide shall be 2.04 inch (5.18 cm).



3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)			
6. Exhaust valve spring	a. Spring seat (5), spring (4), and spring cap (3)	Place over valve stem.	



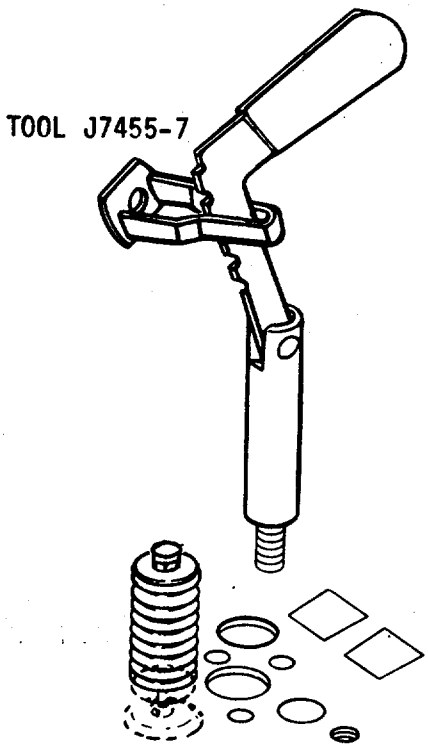
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

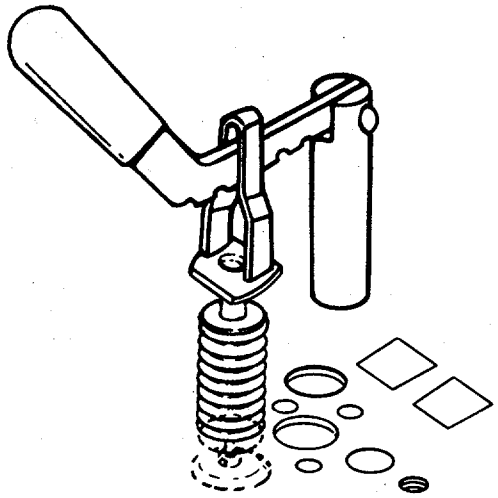
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)			
	b. Valve spring compressor	Thread the valve spring compressor into one of the rocker shaft bolt holes in the cylinder head.	Use tool J 7455-7.
		Apply pressure to the free end of the tool to compress the valve spring and install the two-piece tapered valve lock (2).	Exercise care to avoid scoring the valve stem with the valve cap when compressing the spring.
	c. Air box covers	Install gasket, cover, lockwashers, nuts, and flatwashers.	Use new gasket.
	d. Exhaust valve bridges (1)	Place on exhaust valve bridge guides.	Adjust, refer to step 7.
	e. Valve and injector operating mechanism	Install.	Refer to paragraph 3-33.1.
	f. Injector	Install.	Refer to paragraph 3-15.
	g. Rocker arm cover	Install.	Refer to paragraph 3-30.

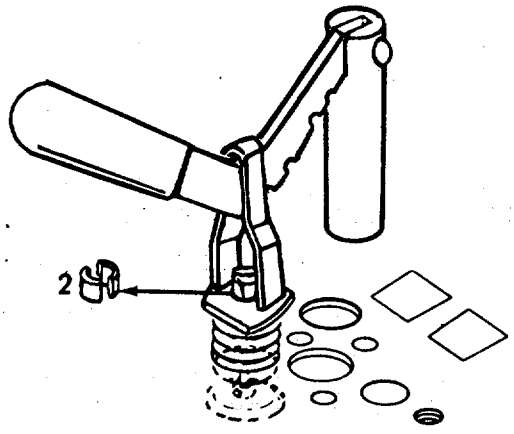
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)







3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS			
7.	Exhaust valve bridge	The exhaust valve bridge assembly (1) is adjusted and the adjustment screw (7) is locked securely after the cylinder head is installed on the engine. Until wear occurs, or the cylinder head is reconditioned, no further adjustment is required on the valve bridge. A complete valve bridge adjustment is performed as follows:	
		a. Place the valve bridge (8) in a vise and loosen the lock nut (9) on the bridge adjusting screw (7).	
		CAUTION Loosening or tightening the lock nut with the bridge in place may result in a bent bridge guide or bent rear valve stem.	
		b. Install the valve bridge (1) on the valve bridge guide (6).	
		c. While firmly pressing straight down on the pallet surface of the valve bridge (8) turn the adjusting screw (7) clockwise until it just touches the valve stem. Then, turn the screw an additional 1/8 to 1/4 turn clockwise and tighten the lock nut (9) finger tight.	
		d. Remove the valve bridge (1) and place it in a vise. Use a screw driver to hold the adjustment screw (7), from turning and tighten the lock nut (9), to 20-25 lb-ft (27-34 Nm) torque.	

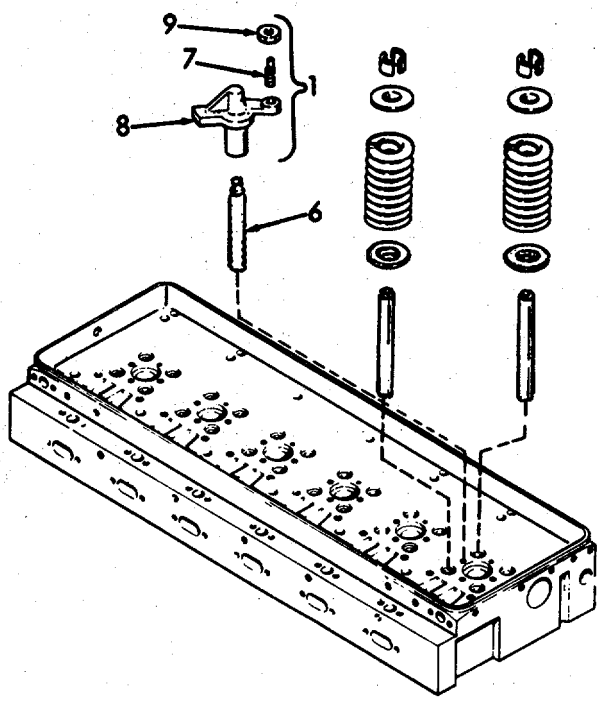
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS

e. Lubricate the valve bridge guide (6) and the valve bridge (1) with engine oil.

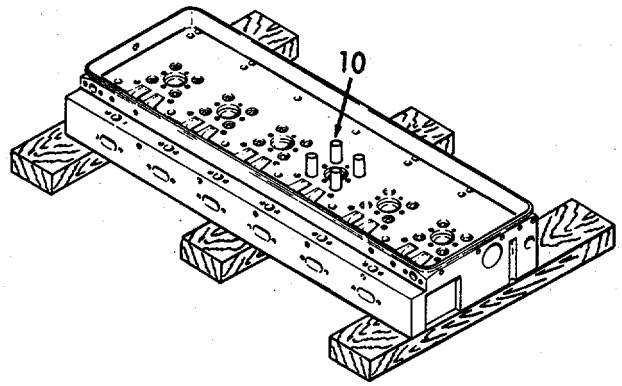
f. Reinstall the valve bridge (1) in its ORIGINAL position.



g. Place a .0015 inch feeler gage under each end of the valve bridge or use a narrow strip cut from .0015 inch feeler stock to fit in the bridge locating groove over the inner exhaust valve. While pressing down on the pallet surface of the valve bridge, both feeler gages must be tight. If both of the feeler gages are not tight, readjust the adjusting screw as outlined in steps C and D.

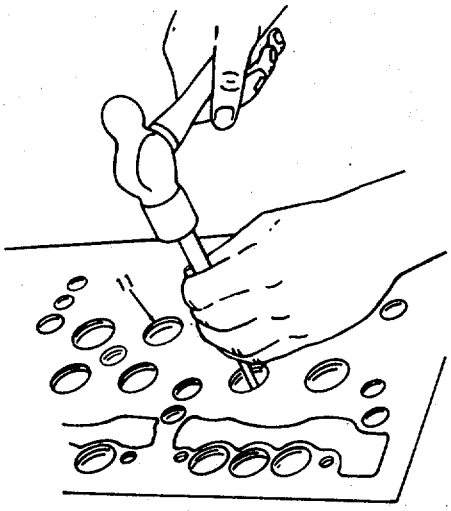
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

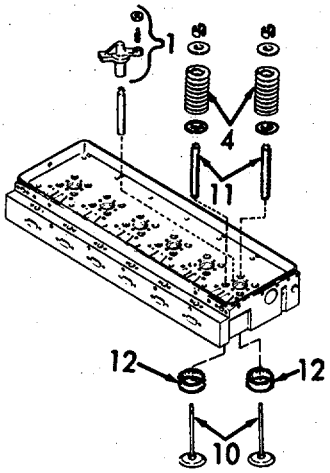
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			
		h. Remove the valve bridge and reinstall it in its ORIGINAL position.	
		i. Adjust the remaining valve bridges in the same manner.	
		j. Swing the rocker arm assembly into position, making sure the valve bridges are properly positioned on the rear valve stems. This precaution is necessary to prevent valve damage due to mislocated valve bridges. Tighten the rocker arm shaft bracket bolts. Torque to 90-100 ft-lb (122-136 Nm) torque.	
REMOVAL - CYLINDER HEAD OFF ENGINE			
8. Exhaust valve springs (4)	a. Cylinder head workbench.	Place on 2 inch wood blocks.	Keeps cam followers clear of
	b. Exhaust valves (10)	Place a 2 inch wood block under valves.	



3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD OFF ENGINE (Cont)			
	c. Exhaust valve bridge (1) and springs (4)	Refer to step 1.	
9. Exhaust valves	a. Cylinder head	Turn on its side.	Do not let the valves drop out.
	b. Valves (10)	Number and remove.	The valves must go back into their original locations.
10. Exhaust valve guides (11)	Cylinder head	a. Place on 2 inch wood blocks, bottom side up. b. Drive the valve guide (11) out from the bottom of the cylinder head.	





11. Exhaust valve seat insert (12)	a. Cylinder head	Place on side.	

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

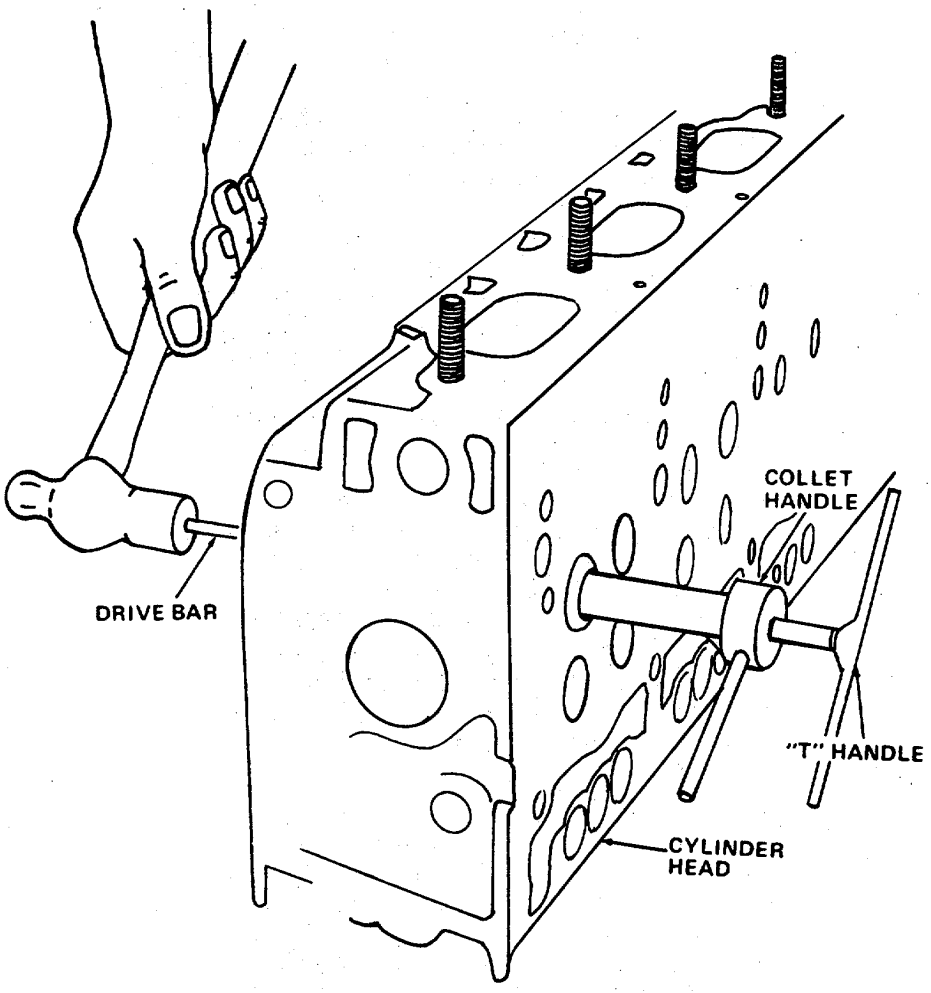
LOCATION	ITEM	ACTION	REMARKS
REMOVAL - CYLINDER HEAD OFF ENGINE (Cont)			
	b. Remove valve seat insert (12)	1. Place the collet of tool J 6567 inside the valve seat insert so the bottom of the collet is flush with the bottom of the insert. 2. Hold the collet handle and turn the T handle to expand the collet cone until the insert is held securely by the tool. 3. Insert the drive bar of the tool through the valve guide, and tap the drive bar once or twice to move the insert about 1/16 inch (1.588 cm). 4. Turn the T handle to loosen the collet cone and move the tool into the insert slightly so the narrow flange at the bottom of the collet is below the valve seat insert.	

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL-CYLINDER HEAD OFF ENGINE (Cont)

5. Tighten the collet cone and continue to drive the insert out of the cylinder head.



3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

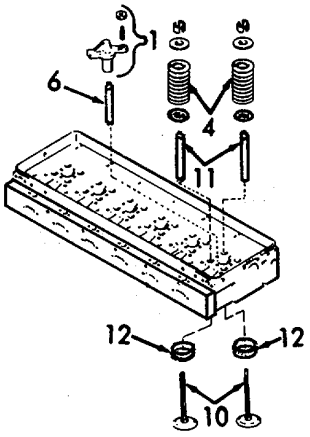
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
12. Exhaust valve springs (4)	Springs	Inspect.	Refer to step 3.
13. Exhaust valve bridge (1) and guide (6)	Bridge and guide	Inspect.	Refer to step 4.
14. Exhaust valves (10)	Carbon on the face of a valve indicates blow-by due to a faulty seat. Black carbon deposits extending from the valve guides may result from cold operation due to light loads or the use of too light a grade of fuel. Rusty brown valve heads with carbon deposits forming narrow collars near the valve guides evidence hot operation due to overloads, inadequate cooling, or improper timing which results in carbonization of the lubricating oil. Clean the carbon from the valve stems and wash the valves with fuel oil. The valve stems must be free from scratches or scruff marks and the valve faces must be free from ridges, cracks, or pitting. If necessary, reface the valves or install new valves. If the valve heads are warped, replace the valves. If there is evidence of engine oil running down the exhaust valve stem into the exhaust chamber, creating a high oil consumption condition because of excessive idling and resultant low engine exhaust back pressures, install valve guide oil seals.		

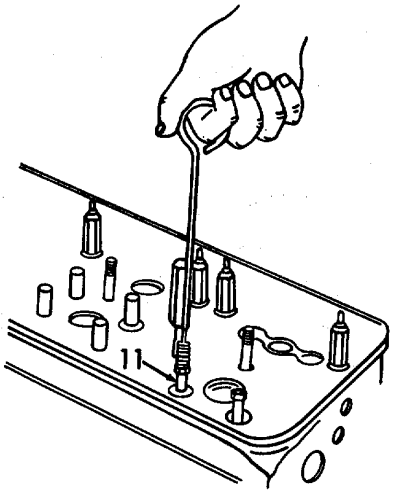
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

15.	Exhaust valve guides (11)	Remove and discard the valve guide oil seals if used. Clean the inside diameter of the valve guides with a brush. This brush will remove all gum or carbon deposits from the guides, including the spiral grooves. Inspect the valve guides for fractures, chipping, scoring, or excessive wear. Check the valve-to-guide clearance, since worn valve guides may eventually result in improper valve seat contact. If the clearance exceeds .005 inch (0.0127 cm), replace the valve guides.
16.	Exhaust valve seat insert (12)	Inspect the valve seat inserts for excessive wear, pitting, cracking or an improper seat angle. The proper angle for the seating face of both the valve and insert is 30°. When a valve seat insert has been ground to such an extent that the 30° angle will contact the cylinder head, install a new insert.



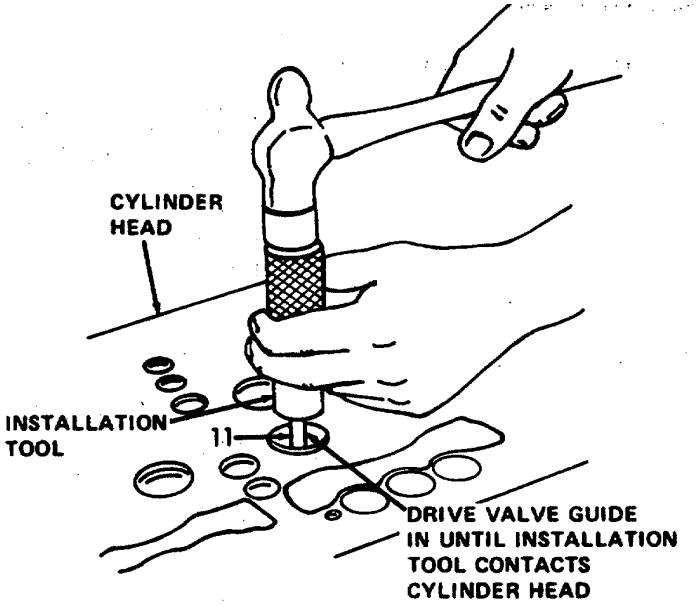


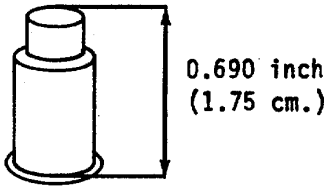
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE			
17. Exhaust valve guide	a. Cylinder head	Place cylinder head right side up on an arbor press.	
	b. Valve guide (11)	Position valve guide squarely in the bore of the cylinder head. Press into the head.	Height of valve guide above cylinder head shall be 0.690 inch (1.75 cm).

CAUTION

Do not use the valve guides as a means of turning the cylinder head over or in handling the cylinder head.





3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

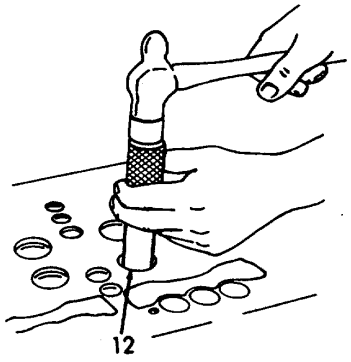
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
18. Exhaust valve seat insert			
		CAUTION	
		Great care must be used during the installation of a valve seat insert since this part is a press fit in the cylinder head.	
	a. Cylinder head	Clean.	Wash with fuel oil and dry with compressed air.
		WARNING	
		Use eye protection when using compressed air.	
	b. Valve insert	Clean.	Wash the valve insert counterbore and valve insert with a good solvent. Dry with compressed air.
	c. Valve insert counterbore	Inspect.	Inspect the valve seat insert counterbore in the cylinder head for cleanliness, concentricity, flatness and cracks. The counterbores in a four valve cylinder head have a

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

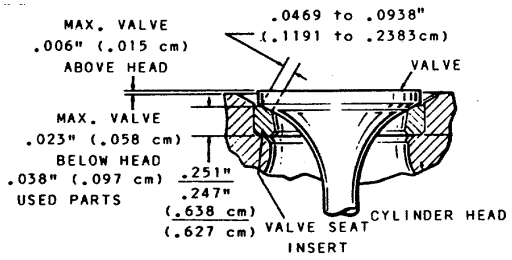
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
			diameter of 1.260 inch to 1.261 inch- (3,200 to 3,203 cm), and a depth of .338 inch to .352 inch (0.859 to 0.894 cm). The counter-bores must be concentric with the valve guides within .003 inch (0.0076 cm) total indicator reading. If required, use a valve seat insert which is .010 inch (0.025 cm) oversize on the outside diameter.
d.	Cylinder head	Heat.	Immerse the cylinder head for at least 30 minutes in water heated to 180°F to 200°F (82° to 93°C).
e.	Cylinder head and valve seat insert	Rest the cylinder head, bottom side up, on a work bench and locate the insert squarely in the counterbore, seating face up. Install the insert in the cylinder head while the head is still hot and the insert	

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
		is at room temperature; otherwise installation will be difficult and the parts may be damaged.	
	f. Valve Seat insert (12)	Drive insert in place until it seats solidly in cylinder head.	Use tool J6568.



19. Exhaust	a. Valve	Insert new valve into cylinder head.	The angle of the valve seat insert must be exactly the same as the angle of the valve face to provide proper seating of the valve. The proper angle for the seating face of the valve is 30°. The proper angle for the valve seat insert is 31°.



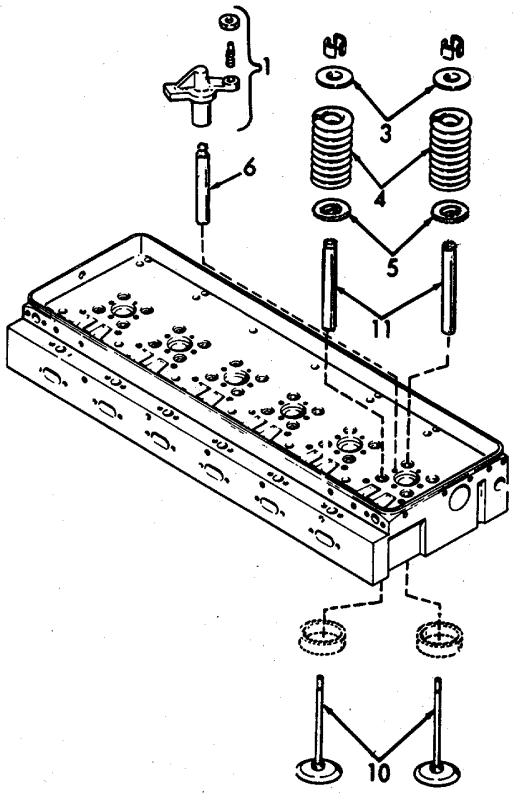
3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
b.	Valve guides (11)	Clean	
c.	Valves stems (10)	Lubricate.	Slide valves all the way into the guides.
		NOTE	
		If reconditioned valves are used,, install them in the same relative location from which they were removed.	
			Hold the valves in place with a strip of masking tape and turn the cylinder head right side up on the workbench. Place a board under the head to support the valves and to provide clearance between the cam followers and the bench.
d.	Valve seat (5), spring (4) and spring cap (3)	Install.	Refer to step 6.
e.	Exhaust valve bridges (1)	Place on exhaust valve bridge guides (6).	Adjust. Refer to step 7.

U.S. GOVERNMENT PRINTING OFFICE: 1986 - 652-02/40355
PIN 046744-002

3-33.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION-	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
f.	Valve and injector operating mechanism	Install.	Refer to paragraph 3-33.1.
g.	Injector	Install.	Refer to paragraph 3-15.
h.	Rocker arm cover	Install.	Refer to paragraph 3-30.



3-729

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS.

a. General.

(1) The cylinder head, one on each cylinder bank, is a one-piececasting securely held to the cylinder block by special bolts. The exhaust valves, fuel injectors and the valve and injector operating mechanism are located in the cylinder head.

(2) Four exhaust valves are provided for each cylinder. Exhaust valve seat inserts, pressed into the cylinder head, permit accurate seating of valves under varying conditions of temperature and prolong the life of the cylinder head.

(3) To ensure efficient cooling, each fuel injector is inserted into a thin-walled tube, which passes through the water space in the cylinder head. The lower end of the injector tube is pressed into the cylinder head and flared over; the upper end is flanged and sealed with a neoprene seal. The sealed upper end and flared lower end of the injector tube prevent water and compression leaks.

(4) The exhaust passages from the exhaust valves of each cylinder lead through a single port to the exhaust manifold. The exhaust passages and the injector tubes are surrounded by engine coolant. Cooling is further ensured by the use of water nozzles pressed into the water inlet ports in the cylinder head. The nozzles direct the comparatively cool engine coolant at high velocity toward the sections of the cylinder head which are subjected to the greatest heat.

(5) The fuel inlet and outlet manifolds are cast as an integral part of the cylinder heads. Tapped holes are provided for connection of the fuel lines at various points along each manifold.

(6) To seal compressions between the cylinder head and the cylinder liner, separate laminated metal gaskets are provided at each cylinder. Water and oil passages between the cylinder head and cylinder block are sealed with synthetic rubber seal rings which fit into counter-bored holes in the block. A synthetic rubber seal fits into a milled groove near the perimeter of the block. When the cylinder head is drawn down, a positive leakproof metal-to-metal contact is assured between the head and the block.

b. Cylinder Head Maintenance.

(1) The engine operating temperature should be maintained between 160°-185°F (71 to 85°C), and the cooling system should be inspected daily and kept full at all times. The cylinder head fire deck will overheat and crack in a short time if the coolant does not cover the fire deck surface. When necessary, add water very slowly to a hot engine to avoid rapid cooling which can result in distortion and cracking of the cylinder head and block.

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

(2) Abnormal operating conditions or neglect of certain maintenance items may cause cracks to develop in the cylinder head. A careful inspection should be made to find the cause and avoid a recurrence of the failure.

(3) Unsuitable water in the cooling system may result in lime and scale formation and prevent proper cooling. The cylinder head should be inspected around the exhaust valve water jackets. This can be done by removing an injector tube. Remove such deposits from the cooling system of the engine by using a reliable non-corrosive scale remover. A similar condition can exist in the cylinder block and other components of the engine.

(4) Loose or improperly seated injector tubes may result in compression leaks into the cooling system and in loss of engine coolant. The tubes must be tight to be properly seated.

(5) Both excessive fuel in the cylinders and overtightened injector clamp bolts can cause cracks in the cylinder head. Always use a torque wrench to tighten the bolts to the specified torque.

(6) Certain service operations on the engine require removal of the cylinder head:

(a) Remove and install pistons. (Refer to paragraph 3-40).

(b) Remove and install cylinder liners. (Refer to paragraph 3-40).

(c) Remove and install exhaust valves. (Refer to paragraph 3-33.2).

(d) Remove and install exhaust valve guides. (Refer to paragraph 3-33.2).

(e) Replace fuel injector tubes. (Refer to paragraph 3-34.1).

(f) Install new cylinder head gaskets and seals.

(g) Remove and install camshaft. (Refer to Direct Support Maintenance).

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal
b. Disassembly
c. Cleaning
d. Inspection
e. Repair
f. Reassembly
g. Pre-installation inspection
h. Installation

INITIAL SETUP:

Test Equipment
- Straight edge
- Feeler gage

Special Tools
- Torque Wrench
- Guide Stud Set J-9665
- Electric Drill and Bit

Material/Parts
- Gasket Kit P/N 5196382 or 5196375
- Lintless cloth
- Sealant
- Scrap or dummy injectors
- Crocus Cloth
- Water tank

Personnel Required
- 2

References

NONE

Equipment Condition — Condition Description Paragraph

3-10	Governor
3-14	Fuel Lines
3-15	Fuel Injectors
3-20	Water Connections
3-21	Water Manifold
3-22	Thermostat and Housing
3-28	Exhaust Manifold
3-30	Rocker Arm Cover
3-31	Injector Controls
3-33	Valve and Injector Operating Mechanism

Special Environmental Conditions

Do not dump oil into bilges. Use oil/water separation and recovery system to collect oil.

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Exhaust manifold	Exhaust piping	Disconnect.	Refer to paragraph 3-28.
2. Cylinder head	Fuel lines	Disconnect.	Refer to paragraph 3-14.
3. Thermostat Housing cover	Hose	a. Loosen hose clamps. b. Remove hose.	Refer to paragraph 3-22.
4. Water bypass tube	Water bypass tube	a. Loosen hose clamps b. Remove tube.	
5. Thermostat housing assembly	Thermostat housing assembly	Remove.	Refer to paragraph 3-22.
6. Cylinder head cover	Valve rocker	Remove.	Clean before removal. Refer to paragraph 3-30 .
7. Cylinder head	Governor cover	Remove.	Refer to paragraph 3-10.
8. Injector control tube lever and governor	Fuel rod	Disconnect and remove.	Refer to paragraph 3-31.
9. Fuel rod cover	Hose clamps	Loosen and slide hose up on fuel rod cover toward governor.	
10. Cylinder head	a. Exhaust manifold	Remove.	Refer to paragraph 3-28.

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Water manifold	Remove.	Refer to paragraph 3-21.
11. Injector control tube and brackets	Injector control tube and brackets	Remove.	Remove as an assembly. Refer to paragraph 3-31.

NOTE

If the cylinder head is to be disassembled for reconditioning of the exhaust valves and valve seat inserts or for a complete overhaul, remove fuel pipes and injectors at this time. See paragraph 3-15 for removal of the injectors.

NOTE

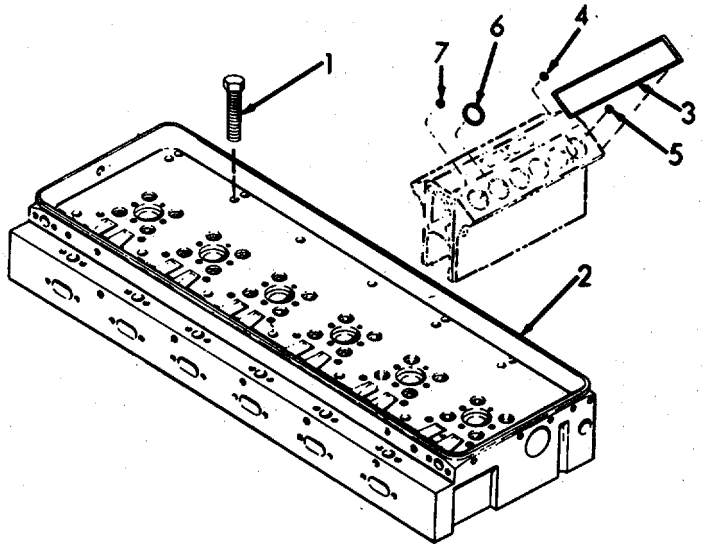
Check the torque on the cylinder head bolts and stud nuts (if used) before removing the head. Then remove the bolts and nuts and lift the cylinder head from the cylinder block. If interference is encountered between the rear end of the right-bank cylinder head and any of the flywheel attaching bolts, loosen the bolts. Checking the torque before removing the head bolts and examining the condition of the compression gaskets and seals after the head is removed may reveal the causes of any cylinder head problems.

CAUTION

When placing the cylinder head assembly on a bench, protect the cam followers and injector spray tips, if the injectors were not removed, by resting the valve side of the head on 2 inch (5.08 cm) wood blocks.

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
12. Cylinder Head	a. Bolts (1)	Remove fourteen bolts.	
	b. Head (2)	Remove.	Requires two persons.
	c. Oil seal ring (3)	Remove.	Discard.
	d. Seal rings (water hole) (4)	Remove ten rings.	Discard.
	e. Seal ring (end water hole) (5)	Remove.	Discard.
	f. Compression gaskets (6)	Remove six gaskets.	Discard.
	g. Oil and water gaskets (7)	Remove.	Discard.

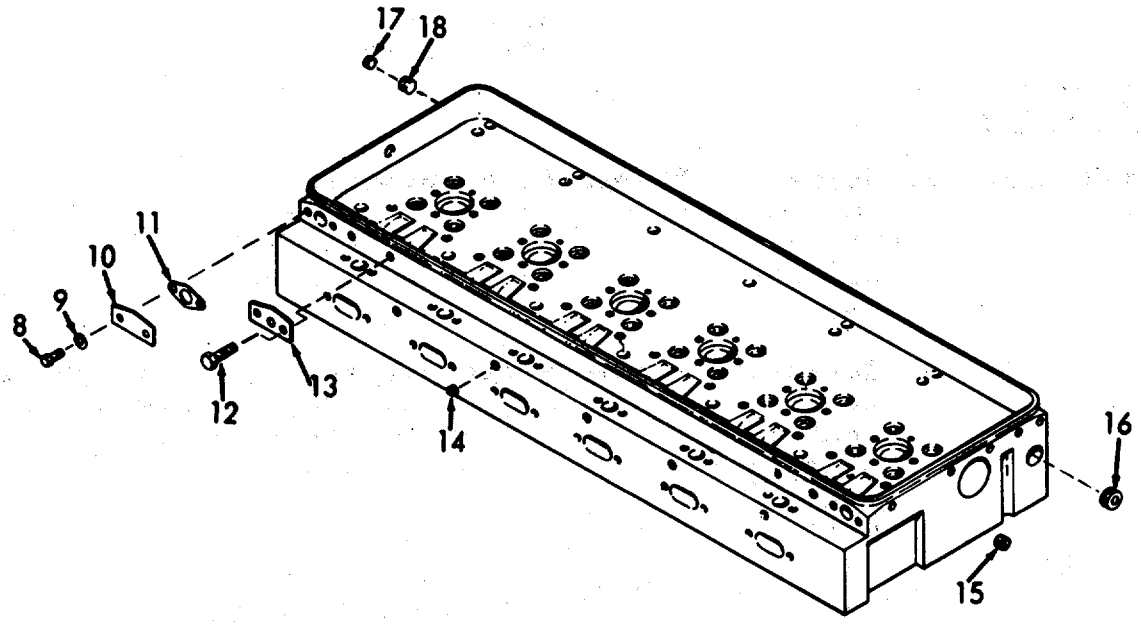


3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Exhaust valves	Remove.	Refer to paragraph 3-31.2.
	i. Valve and injector operating mechanism	Remove.	Refer to paragraph 3-33.1.
13. Engine	Engine oil	Remove oil.	Pump oil into a suitable container. Removing the oil will remove any coolant that may have worked; its way to the oil pan when the head was removed.
		NOTE Do not drain oil into bilges. Use oil separation and recovery system to collect used oil.	
DISASSEMBLY			
14. Cylinder Head	a. Screws (8), and flat washers (9)	Remove three places.	
	b. Governor hole covers (10), and gaskets (11)	Remove three places.	Discard gaskets.

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
c.	Screws (12), and governor tapped hole cover (13)	Remove.	
d.	Pipe plugs (14)	Remove thirteen plugs.	Plug is a 1/4 inch raised square drive.
e.	Oil gallery plugs (15)	Remove twelve plugs.	Plug is a special 3/8-16.
f.	Fuse plug (16)	Remove.	
g.	Plugs (17)	Remove twelve plugs.	Plug is a special 7/16-14.
h.	Pipe plugs (18)	Remove four plugs.	Plug is a 3/4 inch square drive.



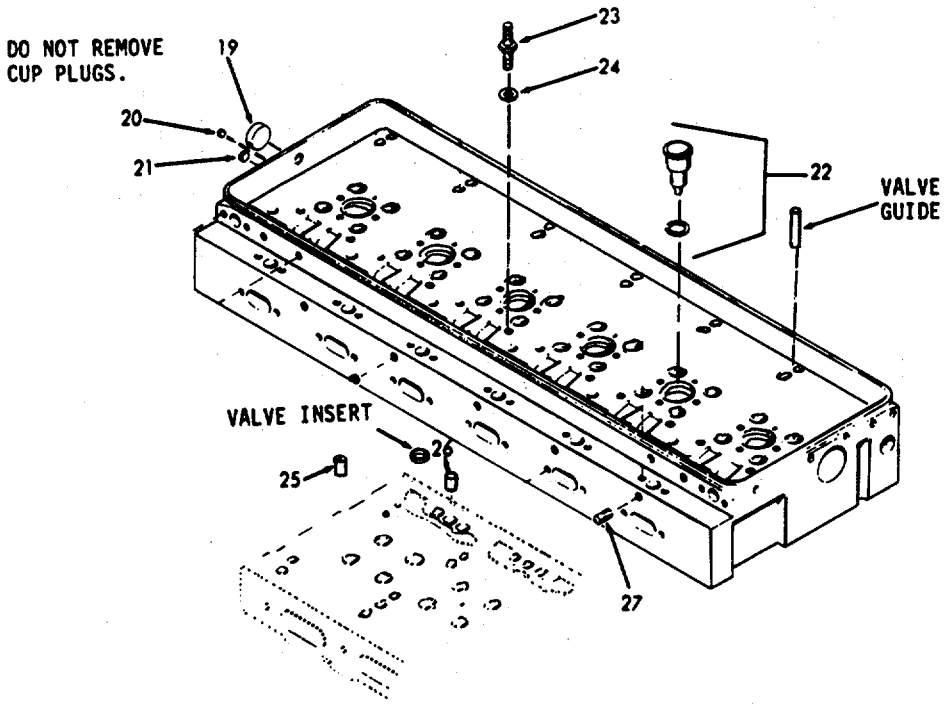
3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	i. Cup plugs (19)	DO NOT REMOVE, unless damaged. Cup plugs are located in six places.	
	j. Pipe plugs (20)	Remove seven plugs.	Plug is a 1/4-18 .
	k. Pipe plugs (21)	Remove seven plugs.	Plug is a 3/8-18 .
	l. Valve insert	Remove.	Refer to paragraph 3-33.2.
	m. Valve guide	Remove.	Refer to paragraph 3-33.2.
	n. Fuel injector tube (22)	Remove if heavily coated with scale.	Refer to step 15 .
	o. Fuel pipe connectors (23), and washer (24)	Remove twelve.	
	p. Water nozzle (single outlet) (25)	Remove if heavily coated with scale. The water nozzle (single outlet) is located in four places.	
	q. Water nozzle (double outlet) (26)	Remove if heavily coated with scale. The water nozzle (double outlet) is located in ten places.	
	r. Restriction connector (27)	Remove.	

3-34. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



15. Fuel injector tubes	Tubes	Remove.	Refer to paragraph 3-34.1.

CLEANING

16. Cylinder) head

After the cylinder head has been disassembled and all of the plugs (except cup plugs) have been removed, thoroughly clean the head. If the water passages are heavily coated with scale, remove the injector tubes and water nozzles (Refer to step.

WARNING

Use eye protection when using compressed air.

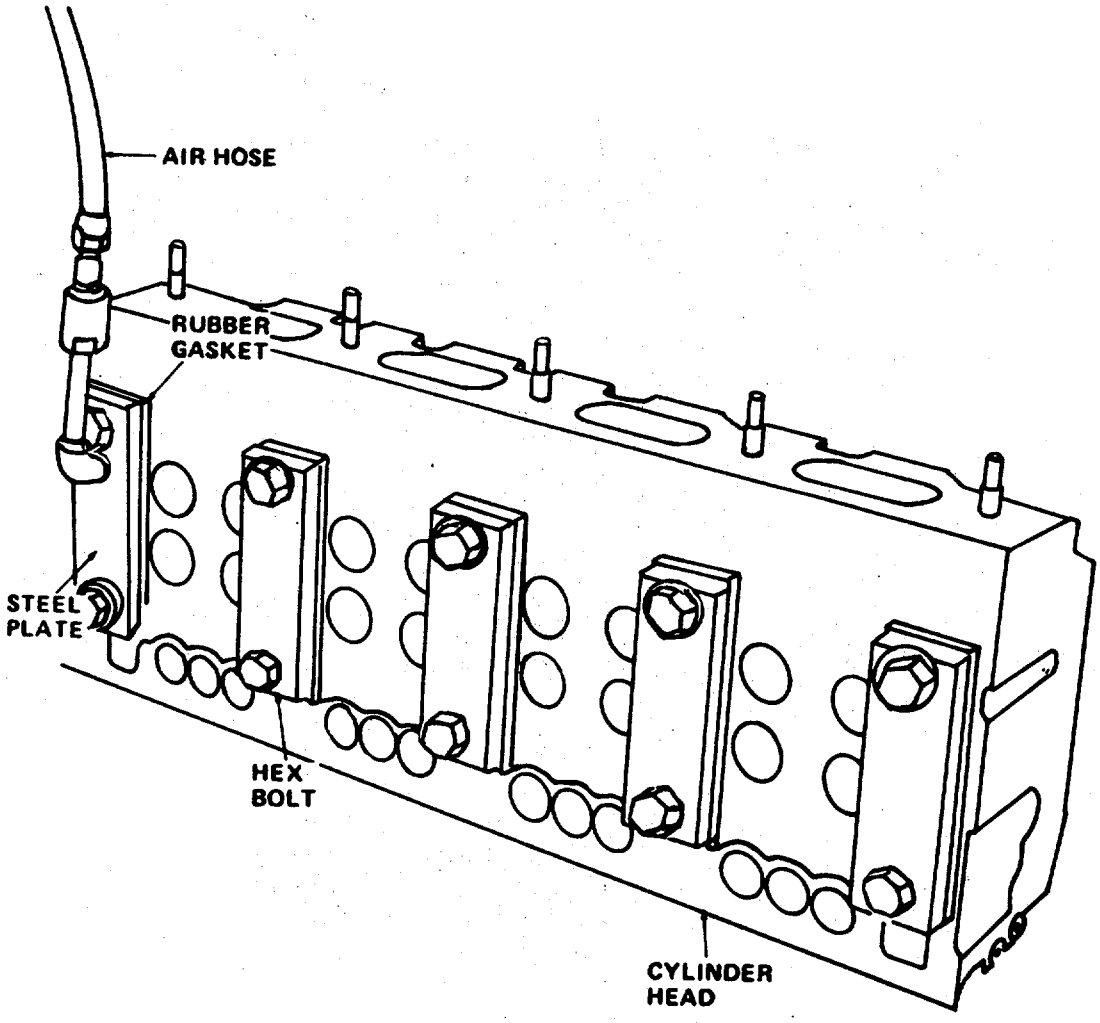
Clean all of the cylinder head components with fuel oil and dry them with compressed air.

3-34. CYLINDER HEAD-MAINTENA NCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION AND REPAIR			
17. Cylinder head	1. Pressure check cylinder head.	a. Seal off water holes in the head with steel plates and suitable rubber gaskets secured in place with bolts and washers. Drill and tap one of the cover plates for an air hose connection.	
		b. Install scrap or dummy injectors to ensure proper seating of the injector tubes. Dummy injectors may be made from old injector nuts and bodies (the injector spray tips are not necessary). Then tighten-the injector clamp bolts to 20-25 lb-ft (27-34 Nm) torque.	
		c. Apply 80-100 psi (552-689 kpa) air pressure to the water jacket. Then immerse the cylinder head in a tank of water, previously heated to 180°- 200°F (82°- 93°C), for about twenty minutes to thoroughly heat the head. Observe the water in the tank for bubbles which indicate a leak or crack. Check for leaks at the top and bottom'of the injector tubes, oil gallery, exhaust ports, fuel manifolds and at the top and bottom of the cylinder head.	

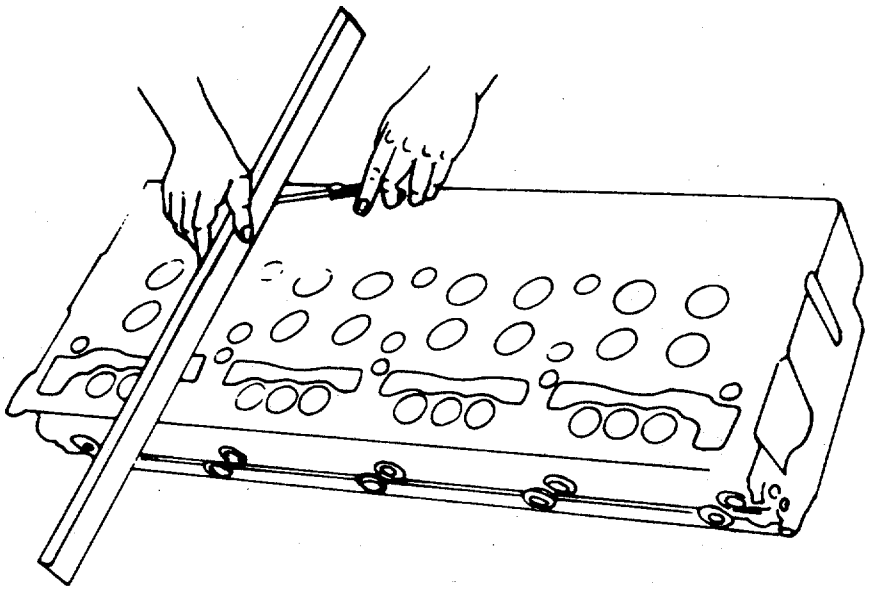
3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

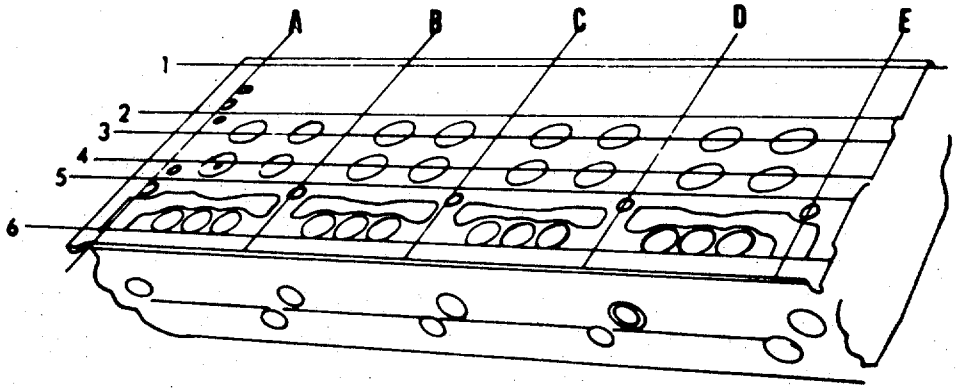
LOCATION	ITEM	ACTION	REMARKS
INSPECTION AND REPAIR (Cont)			
		d. Relieve the air pressure and remove the cylinder head from the water tank. Then remove the plates, gaskets and injectors and dry the head with compressed air. e. If the pressure check revealed any cracks, install a new cylinder head.	



3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION AND REPAIR (Cont)l			
	2. Check the bottom (fire deck) of the cylin-Der head for flat-ness.	a. Use a heavy, accurate straight-edge and feeler gages, to check for trans-verse warpage at each end and between all cylinders. Also check for longitudi-nal warpage in six places. Refer to table for maxi-maximum allowable warpage.	





3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION AND REPAIR (Cont)

Maximum Longitudinal Warpage		Maximum Transverse Warpage	
INCHES	CENTIMETER	INCHES	CENTIMETER
.010	.025	.004	.010

b. Use measurements obtained and limits given in the table as a guide to determine the adviseability of reinstalling the head on the engine or of refacing it. The number of times a cylinder head may be refaced will depend upon the amount of stock previously removed.

c. If the cylinder head is to be refaced, refer to Direct Support Maintenance.

NOTE

Resurface both heads together.

NOTE

If one head is refaced, the other head should be resurfaced.

CAUTION

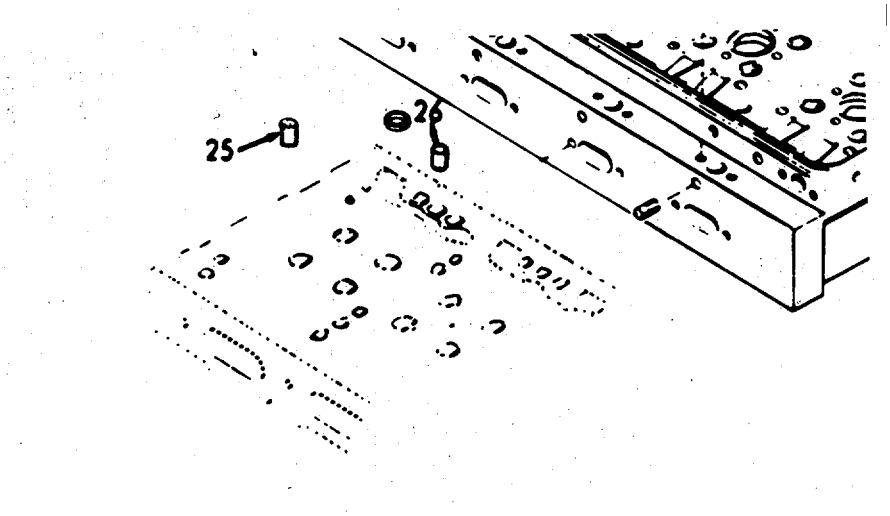
When a cylinder head has been refaced, critical dimensions such as the protrusion of valve seat inserts, exhaust valves, injector tubes and injector spray tips must be checked and corrected. The push rods must also be adjusted to prevent the exhaust valves from striking the pistons after the cylinder head is reinstalled into the engine.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION AND REPAIR (Cont)			
18. Exhaust valve areas	Exhaust valve seat inserts and valve guides	Inspect.	Refer to paragraph 3-33.2 .
REPAIR			
19. Cam follower	Camfollower bores	Inspect for scoring or wear.	Light score marks may be cleaned up with crocus cloth wet with fuel oil. Measure the bore diameter. The cam follower-to-cylinder head clearance must not exceed .006 inch (.015 cm) with used parts (refer to specifications). If the bores are excessively scored or worn, replace the cylinder head.
20. Water holes	Water hole nozzles (single outlet) (25), and (double outlet) (26)	Check that they are not loose.	Replace if necessary, as follows: a. Remove the old nozzles. b. Make sure the water inlet ports in the cylinder head are clean and free of scale.

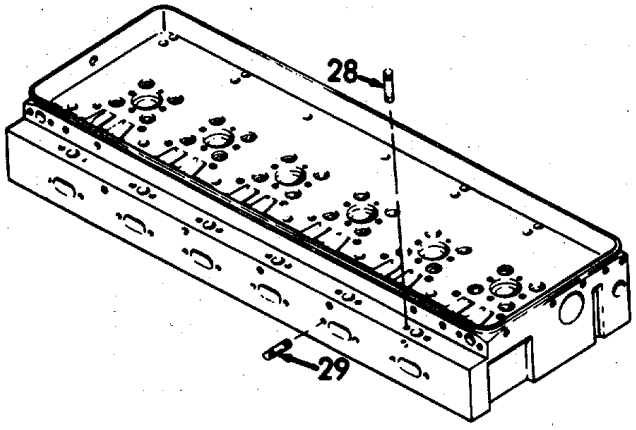
3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
			The water holes at each end of the head may be cleaned up with a 1/2 inch drill and the intermediate holes may be cleaned up with a 13/16 inch drill. Break the edges of the holes slightly.
		c. Press the nozzles in place with the nozzle openings parallel to the longitudinal centerline.	
			Press the nozzles flush to .0312 inch (.0792 cm) recessed below the surface of the cylinder head.



3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
			d. Check to make sure the nozzles fit tightly. If necessary, use a wood plug or other suitable tool to expand the nozzles, or line the outside diameter with solder to provide a tight fit. If solder is used, make sure the orifices in the nozzles are not closed with solder.
21. Studs	Water manifold studs (28) and exhaust manifold studs (29)	Replace broken or damaged studs.	Apply sealant to the threads of new studs and drive them to 10-25 lb-ft (14-34 Nm) torque (water manif'old cover studs) (28) or to 25-40 lb-ft (34-54 Nm). Torque exhaust manifold studs (29).



3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
22. Pilot sleeve	Pilot sleeves (30)	Pilot sleeves have been added to the head mounting bolt holes at each end of the cylinder heads. Make sure the sleeves are flush or recessed below the fire deck of the cylinder head. Replace damaged sleeves.	The sleeves, which act as a hollow dowel to provide a closer fit between the mounting bolts and the cylinder head, help to guide the head in place without disturbing the seals and gaskets.
23. Overall		Inspect all other components removed from the cylinder head.	
ASSEMBLY			

NOTE

If a service replacement cylinder head is to be installed, it must be thoroughly cleaned of all rust preventive compound, particularly inside the integral fuel manifolds, before installing the plugs. A simple method of removing the rust preventive compound is to immerse the head in solvent, oleum or fuel oil, then scrub the head and go through all of the openings with a soft bristle brush. A suitable brush for cleaning the various passages in the head can be made by

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

ASSEMBLY (Cont.)

NOTE (Cont.)

attaching a 1/8" (.3175 cm) diameter brass rod to a brush. After cleaning, dry the cylinder head with compressed air.

WARNING

Use eye protection when using compressed air.

CAUTION

Apply a small amount of "dual purpose" sealer to the threads of the plugs only. Work the sealant into the threads and wipe the excess with a clean lintless cloth so that sealant will not be washed into the fuel and oil passages.

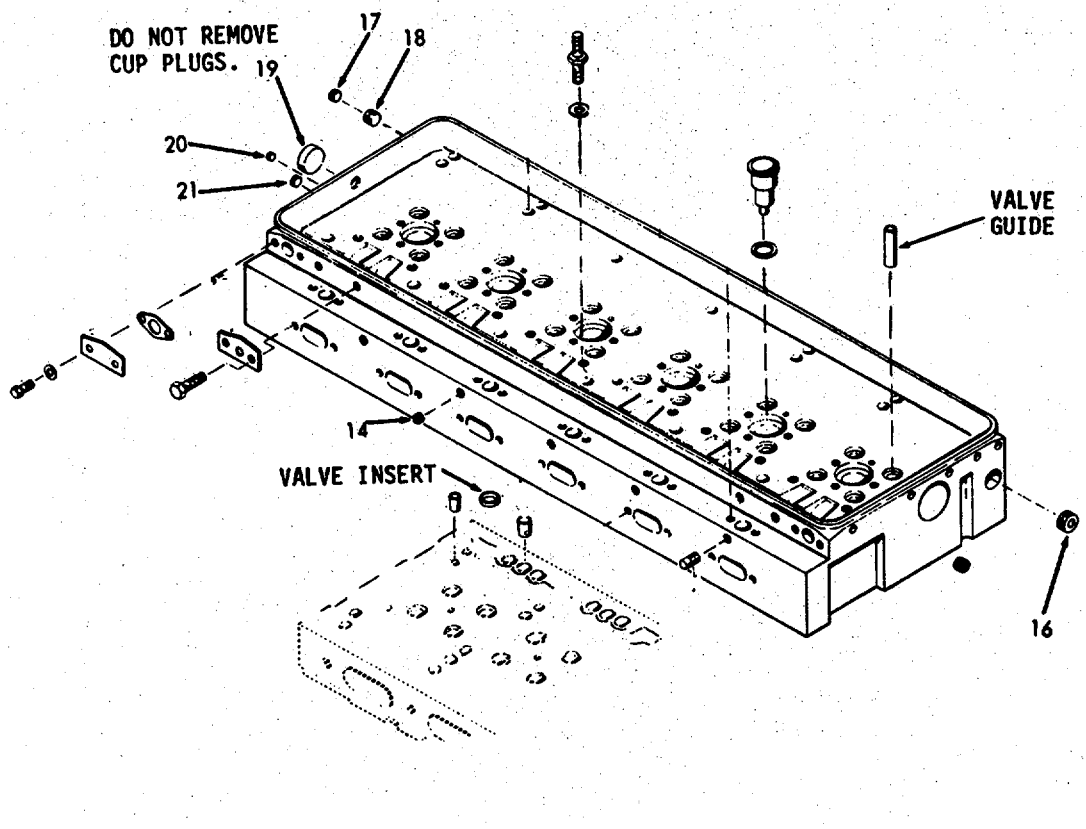
NOTE

Apply sealant to threads of pipe plugs 14, 20 and 21.

24.	Cylinder head	a. Pipe plugs (21)	Install seven plugs.	Tighten to (18-22 lb-ft), (24.4-29.8 Nm).
		b. Pipe plugs (20)	Install seven plugs.	Tighten to (14-16 lb-ft), (18.9-21.7 Nm).
		c. Pipe plugs (18)	Install four plugs.	Tighten to flush or 1/8 inch recessed.
		d. Pipe plugs (14)	Install thirteen plugs.	Tighten to (14-16 lb-ft), 18.9-21.7 Nm).

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
e.	Plugs (17)	Install twelve plugs.	Tighten.
f.	Fuse plug (16)	Install.	Tighten.
		NOTE Apply sealant to threads of pipe plugs 14, 20 and 21.	
g.	Cup plugs (19)	Drive into head.	Flush to .0625 inch (.1588 cm) below the surface of the cylinder head.

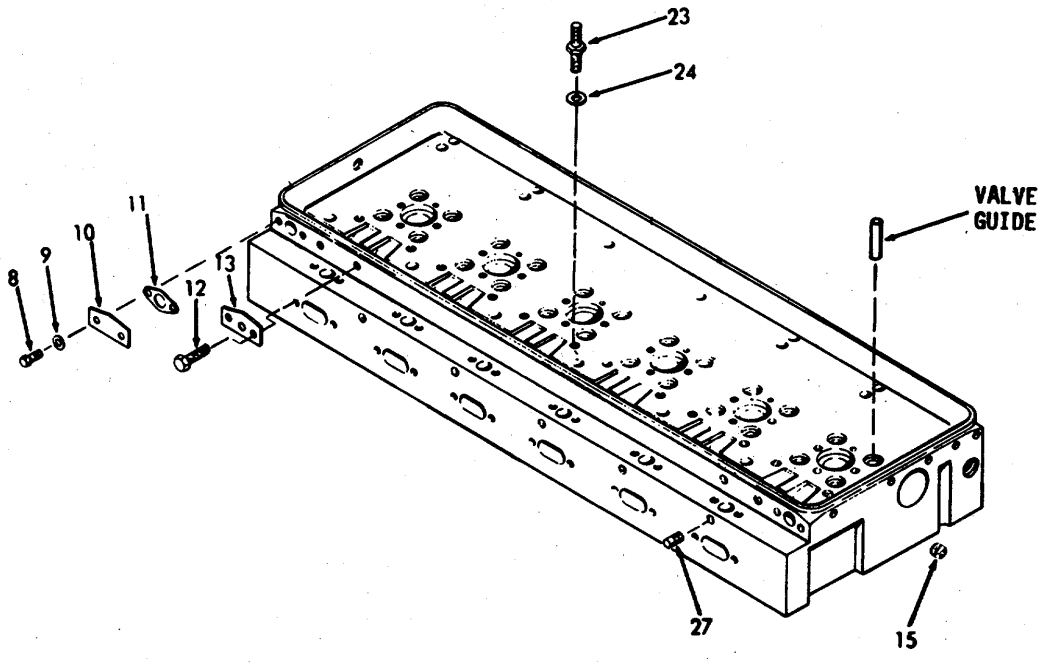


3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	h. Oil gallery plug (15)	Install twelve plugs.	Must not protrude, more than .0625 inch (.1588 cm), and a .2187 inch (.5555 cm) diameter rod placed in the vertical oil feed hole must pass the inner face of the plug.
	i. Fuel pipe connectors (23), and washers (24)	Install twelve.	Use new washers. Tighten to 40 - 45 6 lb.ft, (59-61--Nm), torque.
	j. Screws (12), and governor tapped hole cover (13)	Install.	
	k. Governor hole cover (10), gasket (11), screws (8), and flat washers (9)	Install three covers.	Use new gaskets.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM		ACTION	REMARKS
ASSEMBLY (Cont.)				
	1. Restriction connector (27)	a	Install. 23	



25. Fuel injector tube		Tubes	Install 1.	Refer to paragraph 3-34.1.
26. Cylinder head	a.	Exhaust valve	Replace.	Refer to paragraph 3-33.2. guides
	b.	Cam followers	Replace.	Refer to paragraph 3-33.1.
	c.	Exhaust valves	Replace.	Refer to paragraph 3-33.2.
	d.	Rocker arm assemblies	Replace.	Refer to paragraph 3-33.1.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
		NOTE The fuel injectors, fuel pipes, injector control tube assembly and water manifold, can be installed at this time or after the cylinder head is installed.	
PRE-INSTALLATION INSPECTION			
27. Engine		Make the following inspections Just prior to installing the cylinder head whether the head was removed to service only the head or to facilitate other repairs to the engine.	
		1. Check the cylinder liner flange heights with relationship to the cylinder block.	Refer to paragraph 3-40.
		2. Make sure the piston crowns are clean and free of foreign material.	
		3. Make sure that each push rod is threaded into its clevis until the end of the push rod projects thru the clevis.	This is important since serious engine damage will be prevented when the crankshaft is rotated during engine tune up.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

PRE-INSTALLATION INSPECTION (Cont)

4. Check the cylinder block and cylinder head gasket surfaces, counterbores and seal grooves to be sure they are clean and free of foreign material. Also check to ensure that there . are no burrs or sharp edges in the counterbores.

5. Inspect the cylinder head bolt holes in the block for accumulation of water, oil or any foreign material. Clean the bolt holes thoroughly and check for damaged threads.

NOTE

The 3/4" (1.,905 cm) diameter cup pipe plug at the front end of the head must be removed prior to in- stallation to prevent blocking the coolant flow out of the head.

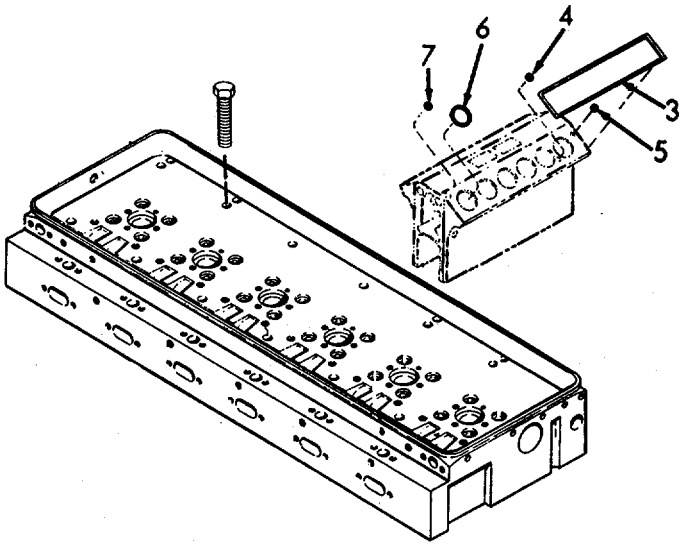
3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
		NOTE Never install used compression gaskets or seals.	
28. Engine block	a. Compression gaskets (6) water hole	Place on top of each cylinder liner.	Use new gasket.
	b. Waterhole seal rings (4)	Place in counterbore of the water holes.	Use ten new rings.
	c. End water hole seal ring (5)	Place in counterbore of the water holes.	Use three new rings.
	d. Oil and water gasket (7)	Install.	Use new gasket.
	e. Oil seal ring (3)	a. Place in groove at the perimeter of the block.	Use new seal.
		b. The seal must lay flat in the groove.	Do not stretch the seal and do not use any adhesive or other material to secure it in the groove.

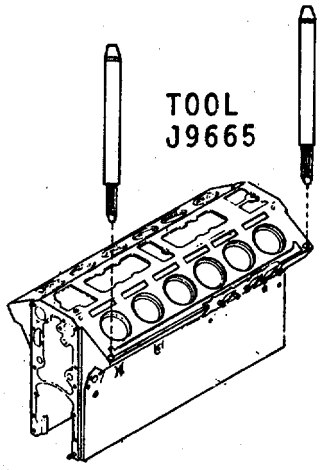
3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont.)



f.	Guide studs J9665	Install in two corner bolt holes.	Use tool J-9665.



NOTE

Cylinder heads have piloting sleeves installed in the corner bolt holes on the camshaft side of the head. The sleeves provide more accurate alignment of the cylinder head with the block bores. Do not install the guide studs in the bolt holes which lineup with the piloting sleeves in the head.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
29. Cylinder head			

NOTE

Make a final visual check of the compression gaskets and seals to ensure that they are in place before the cylinder head is lowered. This is a very impor- tant check. Gaskets and seals which are not seated properly will cause leaks and "blow-by" and result in poor engine performance and damage to the engine.

1. Apply a small amount of International compound No. 2, or equivalent, to the threads and under-side of the head of all cylinder head attaching bolts (1).

2. Wipe the bottom of the cylinder head clean. Then lower the head over the guide studs.

3. Then install a bolt through each piloting sleeve at the corners of the head and thread them finger tight into the cylinder block. Continue to tighten these bolts (finger tight) as the head is lowered into position on the cyliUnder block.

NOTE

Cylinder head bolts are especially designed for this purpose and must not be replaced by ordinary bolts.

3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

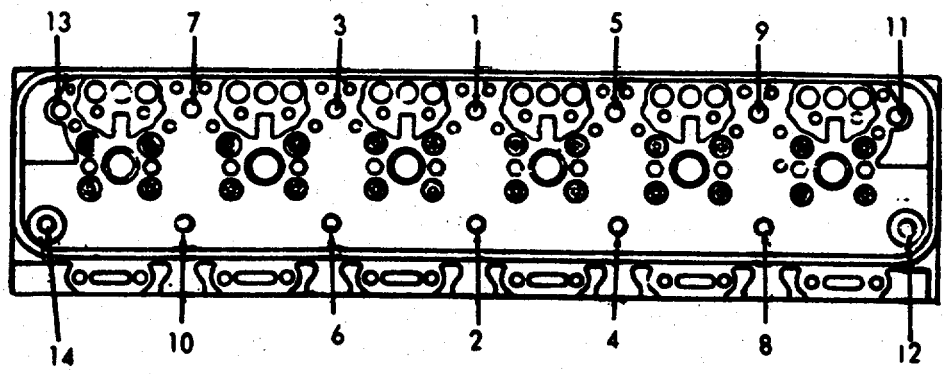
INSTALLATION (Cont)

4. After the head is in place, remove the guide studs and install the remaining bolts.

5. Tighten the bolts to 175-185 lb-ft (238-251 Nm) torque, one-half turn at a time, in the sequence shown. Begin on the cam follower side of the head to take up tension in the push rods springs. Tighten the bolts to the high side of the torque specification, but do not exceed the limit or the bolts may stretch beyond their elastic limits. Attempting to tighten the bolts in one step may result in trouble and consequent loss of time in diagnosis and correction of difficulties, such as compression leaks, when the engine is put into operation.

NOTE

Tightening the cylinder head bolts will not correct a leaking compression gasket or seal. The head must be removed and the damaged gasket or seal replaced.



3-34. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
a.	Fuel injectors	Install.	Refer to paragraph 3-15.
b.	Exhaust valve bridges	Adjust.	Refer to paragraph 3-33.2.
c.	Rocker arm bracket bolts	Install.	Refer to paragraph 3-33.1.
d.	Fuel pipes	Align and connect them to the fuel injectors and fuel connectors.	Tighten to 12-15 lb-ft (16-20 Nm) torque.
		CAUTION	
		Do not. bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared ends of the fuel pipes and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine	
e.	Injector control tube assembly	1. Set the injector control tube assembly in place on the cylinder head and install the attaching bolts finger tight. When positioning the control tube, be sure the ball end of each injector rack control lever engages the slot in the corresponding injector control rack. With one end of the control tube, return the spring hooked around an injector rack control lever and the other end hooked around a control tube	

3-4. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		bracket. Tighten the bracket. Tighten the bracket bolts to 10-12 lb-ft (14-16 Nm) torque.	
		2. After tightening the bolts, revolve the injector control tube to be sure the return spring pulls the injector racks out (no-fuel position) after they have been moved all the way in (full-fuel position), since the injector control tube is mounted in self-aligning bearings. Tapping the tube liqhtly will remove any bind that may exist. The injector racks must return to the no-fuel position freely by aid of the return spring only. Do not bend the spring. If necessary, replace the spring.	
	f. Fuel rods	Install.	Refer to paragraph 3-10.
	g. Fuel lines	Connect.	
	h. Thermostat and housing	Install.	Refer to paragraph 3-22.
	i. Water manifold	Install.	Refer to paragraph 3-21.

3-4. CYLINDER HEAD-MAINTENANCE INSTRUCTION S (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
j.	Water by-pass tube, hoses, and clamps	Install.	
k.	Exhaust manifold	Install.	Refer to paragraph 3-28.
		NOTE	
		Fill lubrication system and cooling system. Start engine and perform necessary adjustments.	

3-34.1. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS.

The bore in the cylinder head for the fuel injector is directly through the cylinder head water jacket. To prevent coolant from contacting the injector and still maintain maximum cooling of the injector, a tube is pressed into the injector bore. This tube is sealed at the top with a neoprene ring and upset into a flare on the lower side of the cylinder head to create water-tight and gas-tight joints at the top and bottom.

This task covers:

a. Removal **b. Cleaning** **c. Installation**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Injector tube service tool kit J 22525 (Consisting of tools J5286-) Torque wrench

Material/Parts

Trichloroethylene cutting oil

Personnel Required

1

References

NONE

Equipment Condition	Condition Description
3-34	Cylinder head removed.

Special Environmental Conditions

NONE

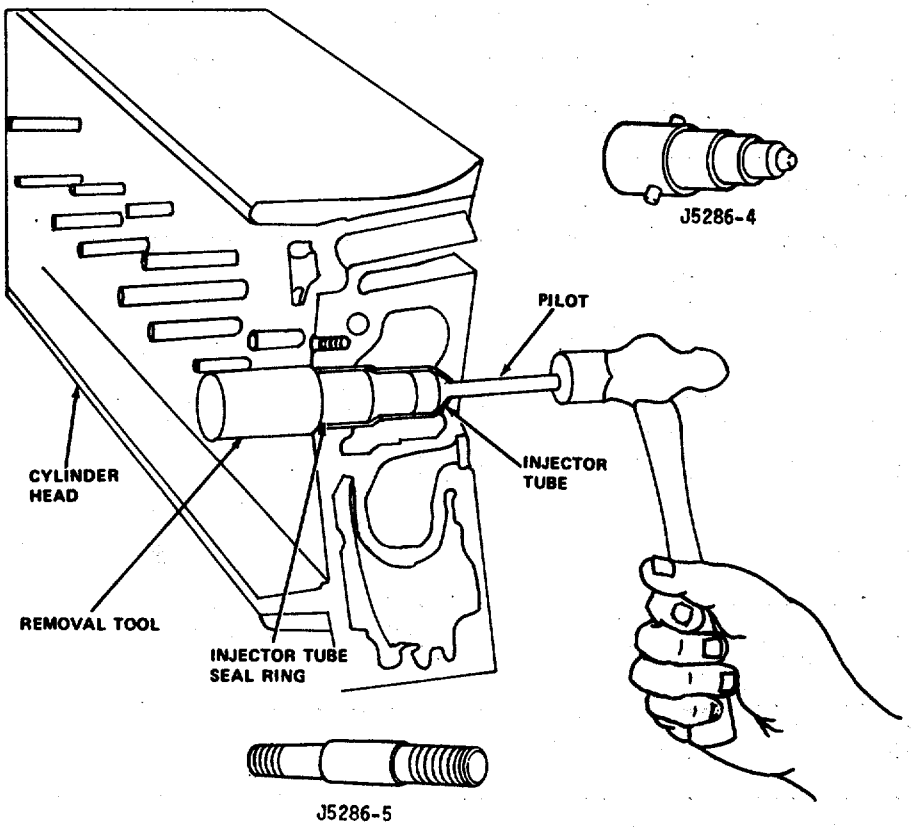
General Safety Instructions

WARNING

Wear eye protection when using compressed air.

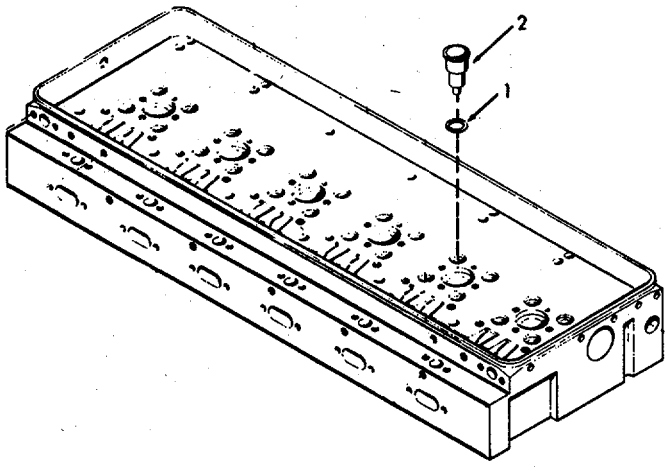
3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Cylinder head	Head	Remove, disassemble, and clean.	Refer to Paragraph 3-34.
2. Injector tube	a. Instal-ler	Place in injector tube.	Use tool J-5286-4.
	b. Pilot	Insert through small opening of the injector tube and screw the pilot into 'the tapped hole in the end of the installer.	Use tool J-5286-5.



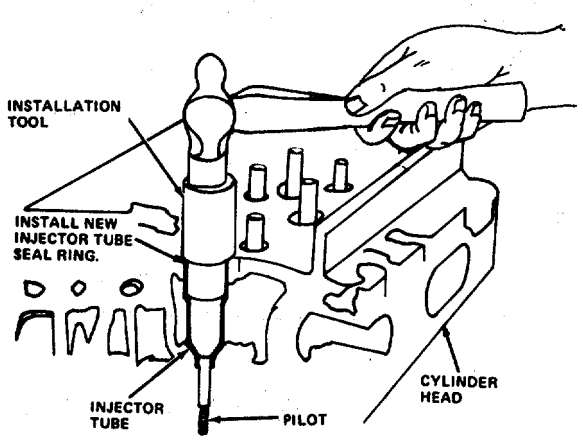
3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Pilot loosen	Tap on end of pilot to the injector tube.	
	d. Injector tube, instal - ler, and pilot	Remove from cylinder head.	
CLEANING			
3. Injector tube hole (in cyl- inder head		Thoroughly clean the hole to remove dirt, burrs, or foreign material that may prevent injector tube from seating at the upper end.	
INSTALLATION			
4. Injector tube seal ring (1)	a. Injector tube	Place in counterbore in cylinder head.	
	b. Instal- ler	Place in injector tube (2).	Use tool J5286-4.



3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
c.	Pilot	Insert in small opening of injector tube and screw into the tapped end of the installer.	Use tool J5286-5.
d.	Injector tube, pilot, and installer	Place in injector bore and drive it in place.	Sealing is accomplished between the head counterbore (inside diameter) and outside diameter of the injector tube. The tube flange is used to retain the seal ring.

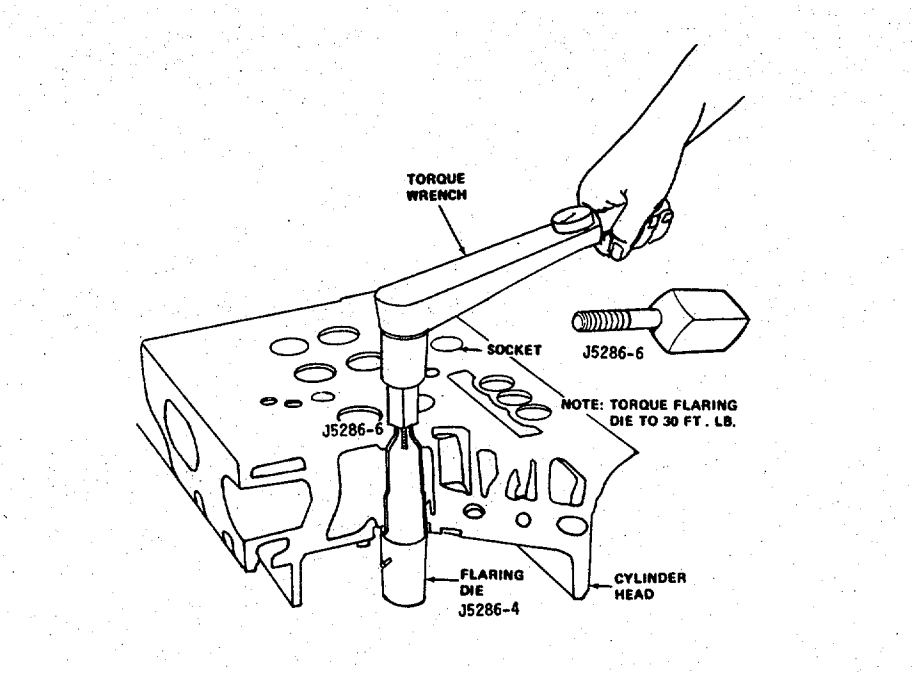


NOTE

With the injector tube properly positioned in the cylinder head, upset (flare) the lower end of the injector tube.

e.	Cylinder head	Turn bottom side up.	
f.	Pilot (J5286-5)	Remove.	

3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Upsetting die	1. Screw into tapped end of installer.	Use tool J5286-6.
			
		2. Using a socket and torque wrench (40.7 Nm)	Apply approximately 30 lb-ft
		3. Remove installing tools.	
5. Injector tube (reaming)	After an injector tube has been installed in a cylinder head, it must be finished in three operations: First, hand reamed, to receive the injector body nut and spray tip; second, spot-faced to remove excess stock at the lower end of the injector tube; and third, hand reamed to provide a good seating surface for the bevel or the lower end of the injector nut. Reaming must be done carefully and without undue force or speed so as to avoid cutting through the thin wall of the injector tube.		

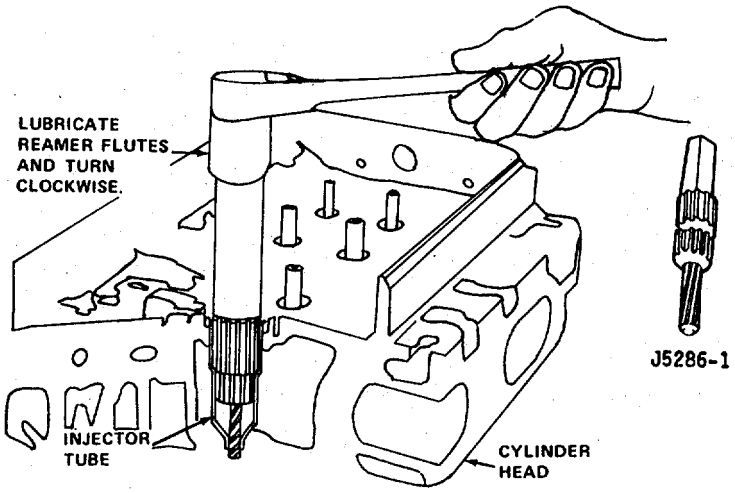
3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont			
		NOTE The reamer should be turned in a clockwise direction only, both when inserting and when withdrawing the reamer, because movement in the opposite direction will dull the cutting edges of the flutes.	
	a. Hand reaming	Ream the injector tube for the injector nut and spray tip. With the cylinder head right side up and the injector tube free from dirt, proceed with the first reaming operation as follows:	
		1. Place a few drops of light cutting oil on the reamer flutes, then carefully position the reamer in the injector tube.	Use tool J-5286-1.
		2. Turn the reamer in a clockwise direction (withdrawing the reamer frequently for removal of chips) until the lower shoulder of the reamer contacts the injector tube. Clean out all of the chips.	
	b. Spot facing	Remove excess stock:	
		1. With the cylinder head bottom side up, insert the pilot of cutting tool into the small hole of the injector tube.	Use tool J-5286-8.

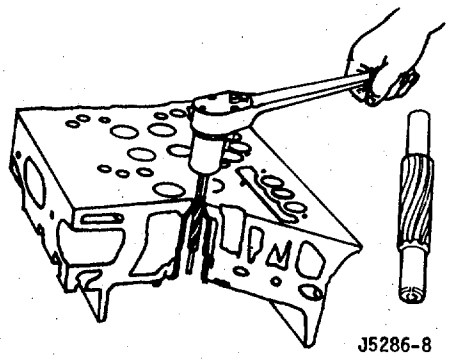
3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRU CTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

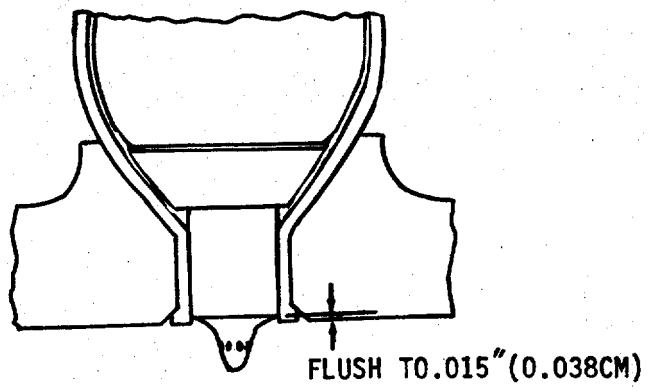


2. Place a few drops of cutting oil on the tool. Then, using a socket and a speed handle, remove the excess stock so that the lower end of the injector tube is from flush to .005 inch (0.0127 cm) below the finished surface of cylinder head.



3-34.1. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont.).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Hand reaming	Ream the bevel seat in the injector tube: The tapered lower end of the injector tube must provide a smooth and true seat for the lower end of the injector nut to effectively seal the cylinder pressures and properly position the injector tip in the combustion chamber. Therefore, to determine the amount of stock that must be reamed from the bevel seat of the tube, the injector assembly should be installed in the tube and the relationship between the numbered surface of the spray tip to the fire deck of the cylinder head noted.	



3-34.1. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

WARNING

Use eye protection when using compressed air.

With the first reaming operation completed and the injector tube spot- faced, wash the interior of the injector tube with trichloroethylene or clean fuel oil and dry it with compressed air. Then perform the second reaming operation as follows:

1. Place a few drops of cutting oil on the bevel seat of the tube. Carefully lower the reamer into the injector tube until it contacts the bevel seat. — Use tool J-5286-9.

2. Make a trial cut by turning the reamer steadily without applying any downward force on the reamer. Remove the reamer, blow out the chips and look at the bevel seat to see what portion of the seat has been cut.

3. Proceed carefully with the reaming operation, withdrawing the reamer occasionally to observe the reaming progress.

3-34.1. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

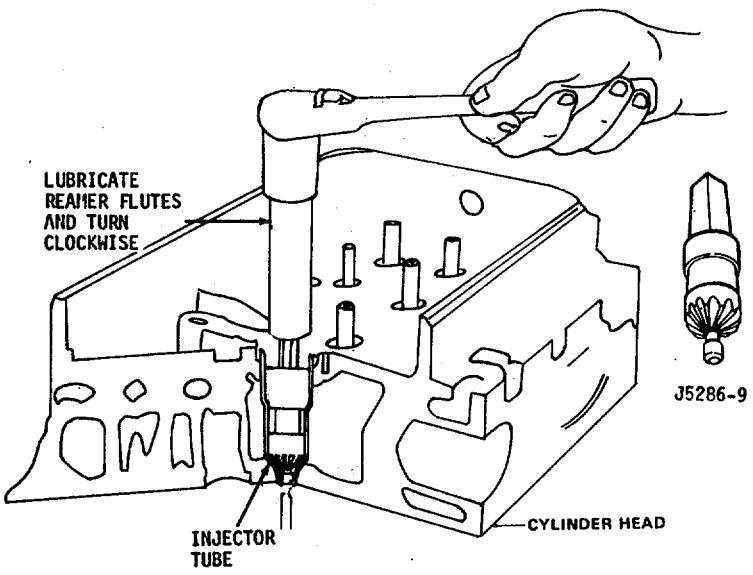
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

WARNING

Use eye protection when using compressed air.

4. Remove the chips from the injector tube and using an injector as a gage, continue the remaining operation until the shoulder of the spray tip is within the limits specified. Then wash the interior of the injector tube with trichloroethylene or clean fuel oil and dry it with compressed air.



NOTE

To sharpen any reamers, use lapping block.

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

a. A ribbon type oil level dipstick is used to determine the quantity of oil in the engine oil pan. The dipstick is located in an adaptor attached by a guide, to an opening in the cylinder block which leads to the oil pan.

b. The oil should never be allowed to drop below the LOW mark; nor is anything gained by having it above the FULL mark. The oil level should be checked in the engine crankcase with the engine stopped a minimum of ten (10) minutes to permit oil in various parts of the engine to drain back into the crankcase.

This task covers:

a. Removal **c. Cleaning** **e. Reassembly**
b. Disassembly **d. Inspection** **f. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Torque wrench
Pump, Hand NSN-
4930-00-263-9886

Material/Parts
Gasket kit
P/N 5196375

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
Do not drain oil into bilges. Use oil separation/recovery system to collect drained oil.

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

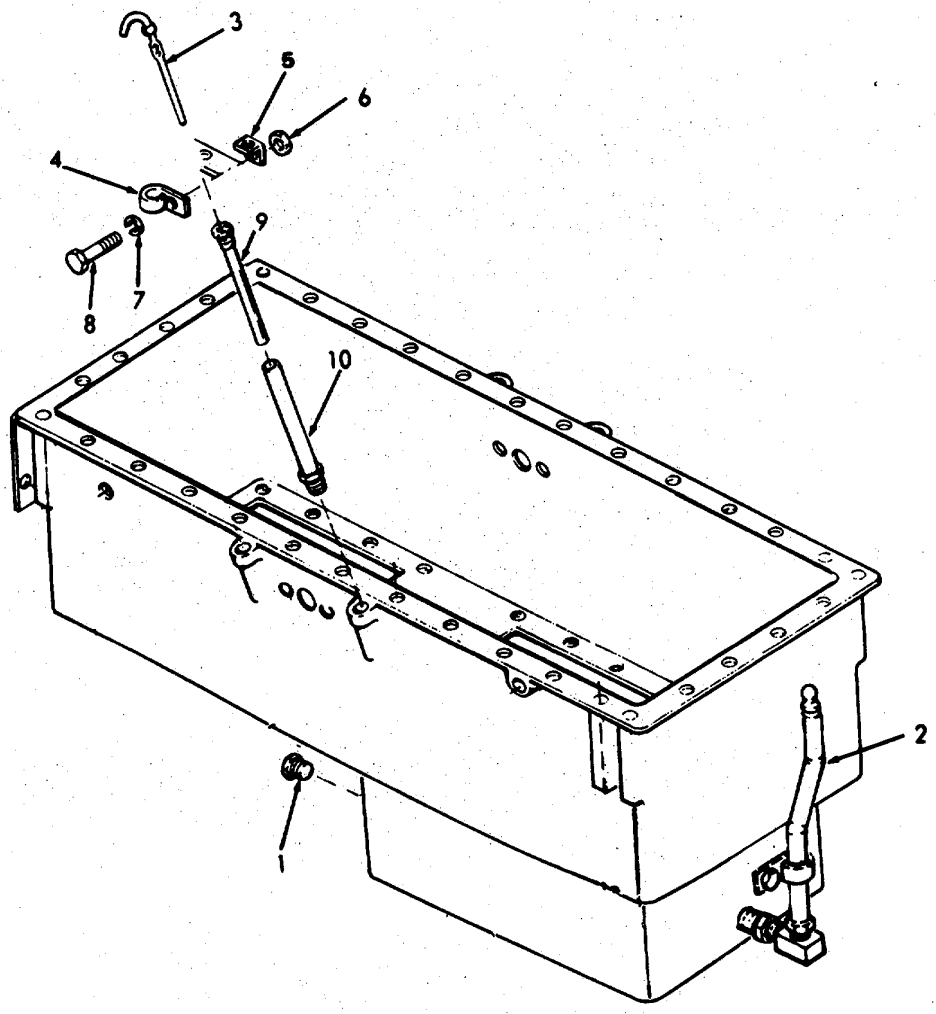
3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Oil pan	a. Drain plug (1)	Remove to drain oil.	Do not drain oil into bilge.
	b. Drain tube (2)	Insert pump into drain tube.	Pump oil into suitable container.
		NOTE	
		Engine contains 34 quarts (32.2 liters of oil).	
2. Side of cylinder block	a. Oil dipstick (3)	Remove.	
	b. Clamp (4), bracket (5), nut (6), washer (7), bolt (8)	Remove.	
	c. Dipstick adaptor (9)	Remove.	
	d. Dipstick tube (10)	Unscrew.	

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



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3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
3. Lower oil pan	a. Nut (11), screw (12), lock-washer (13) and drain tube clip (14)	Remove from clip bracket (15).	
	b. Drain tube (2)	Unscrew.	
	c. Elbow (16) and re-ducing bushing (17)	Unscrew.	
	d. Screw (18), and flat-washer (copper) (19)	Remove.	Bracket (15) will come off.
	e. Screws (20), and lock-washer (21)	Remove.	
	f. Lower oil pan (22), and gasket (23)	Remove.	Discard gasket.

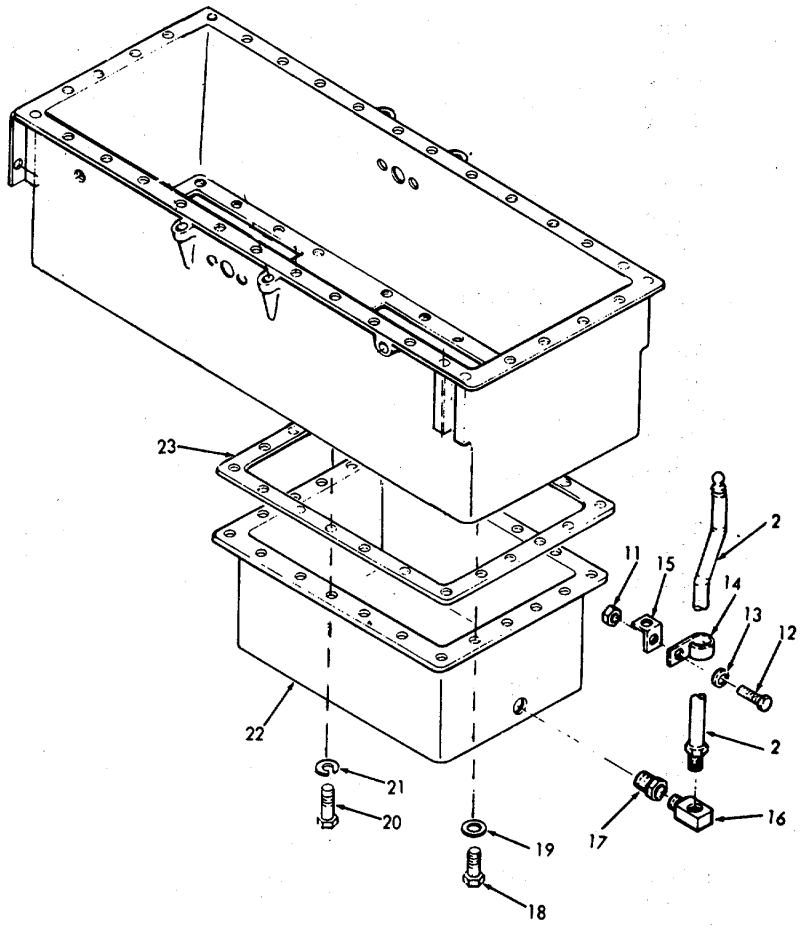
3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

CAUTION

Do not damage oil pump piping and inlet screen.



3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

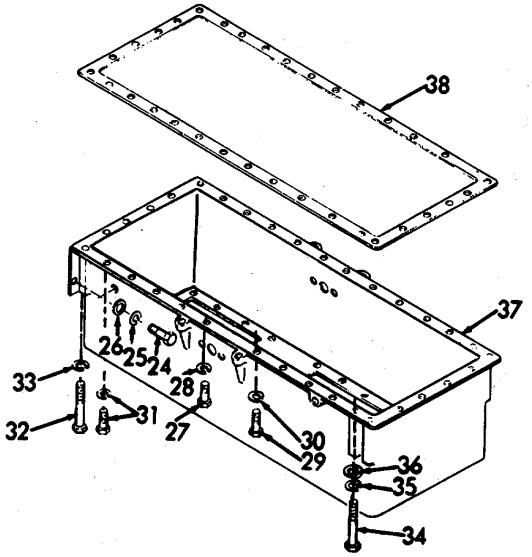
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Upper	a. Two oil pan (24), washers (25), and lock-washers (26)	Remove. bolts	
	b. Two bolts (27) and lock-washers (28)	Remove.	
	c. Two bolts (29) and lock-wash-ers (30)	Remove.	
	d. Twenty six bolt assemb-lies (31)	Remove.	
	e. Two bolts (32) and lock-washers (33)	Remove.	

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	f. Two bolts (34), lock-washers (35), and washers (36)	Remove.	
	g. Upper oil pan (37) and gasket (38)	Remove.	Discard gasket.

CAUTION

Do not damage oil pump piping and inlet screen.



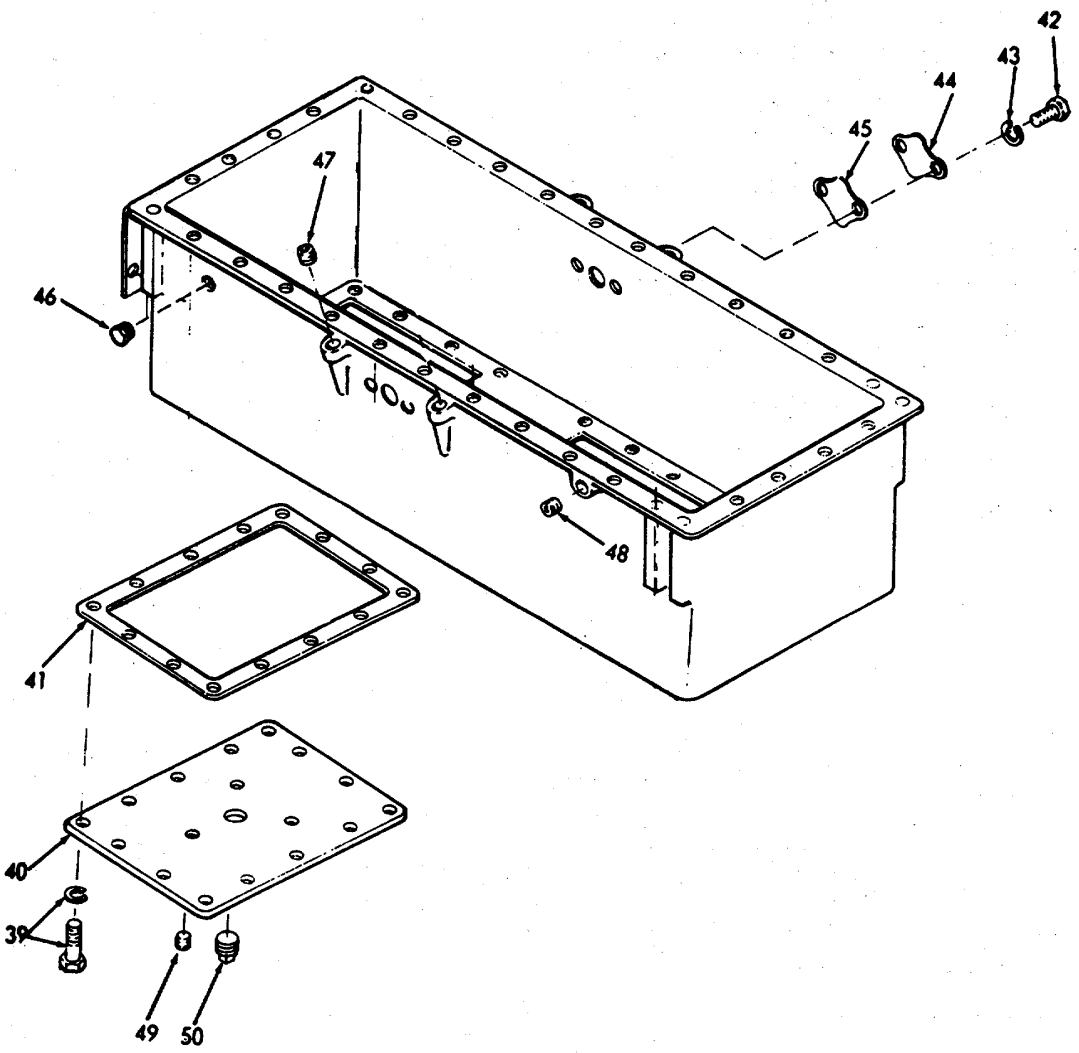
3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
5. Upper oil pan	a. Screws and lock-washers (39)	Remove.	
	b. Oil pan cover (40) and gasket (41)	Remove.	Discard gasket.
	c. Screws (42), and lock-washers (43)	Remove two places.	
	d. Covers (44), and gaskets (45)	Remove two places.	Discard gaskets.
	e. Plug (46)	Remove.	If necessary.
	f. Plugs (47)	Remove in three places.	If necessary.
	g. Plugs (48)	Remove in two places.	If necessary.
	h. Plugs (49)	Remove in three places.	If necessary.
	i. Plug (50)	Remove.	If necessary.

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

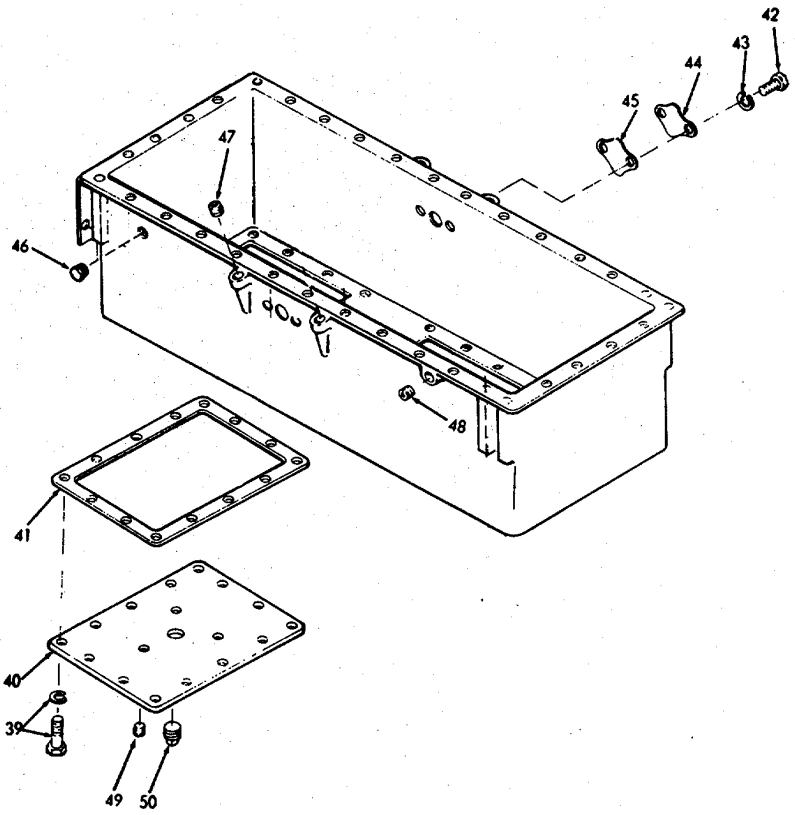


3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
		WARNING Use eye protection when using compressed air.	
6. Upper and lower oil pans	Gaskets	Remove old gasket from cylinder block and both oil pans. Clean oil pans, (interior) with fuel oil and dry thoroughly with compressed air.	Discard gaskets.
INSPECTION			
7.	Oil pans	Inspect for large dents, mis-aligned flanges or raised surfaces surrounding bolt holes. If either pan leaks through cracks, dents or other imperfections, replace pan.	Place on sur face plate or other large, flat surface to inspect.
REASSEMBLY			
8. Upper oil pan	a. Plugs (46, 47, 48, 49, 50)	Replace.	If removed.
	b. Covers (44) and gasket (45)	Replace two places.	Use new gasket.
	c. Screws (42) and lock-washers (43)	Replace.	

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
d.	Oil pan cover (40) and gasket (41)	Replace.	Use new gasket.
e.	Screws and lockwashers (39)	Replace.	

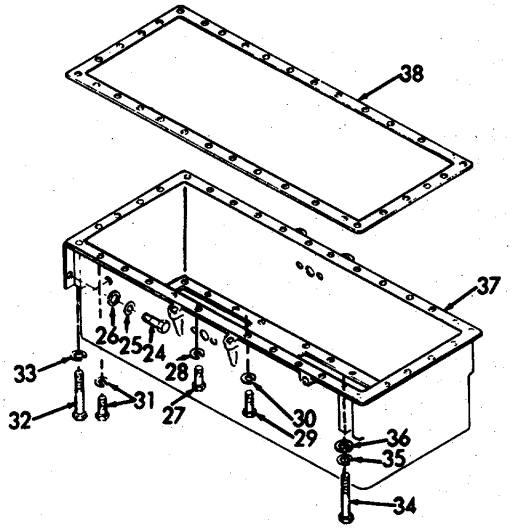


3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
9. Upper oil pan	a. Upper oil pan (37), and gasket (38)	Position pan and gasket on bottom of cylinder block.	Install new gasket in rim of pan.
		NOTE	
		Tighten center bolts on each side first; then work alternately toward each end of pan.	
	b. Bolt assembly (31)	Install in holes 1 and 2.	Tighten bolts to 15-20 lb-ft (20.34 -27.12 Nm) torque.
	c. Bolts (27) and lockwashers (28)	Install in holes 3 and 4.	
	d. Bolts (29) and lockwashers (30)	Install in holes 5 and 6.	
	e. Bolt assembly (31)	Install in holes 7 thru 20.	
	f. Bolts (32) and lockwashers (33)	Install in hole 21.	
	g. Bolts (34), lockwashers (35 and 36)	Install in holes 22 and 23.	

3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Bolt (32) and lock-washer (33)	Install in hole 24.	
	i. Bolt assem-blies (31)	Install in holes 25 through 34.	
	j. Bolt (24), lock-washer (25) and washer (26)	Install in holes 35 and 36.	

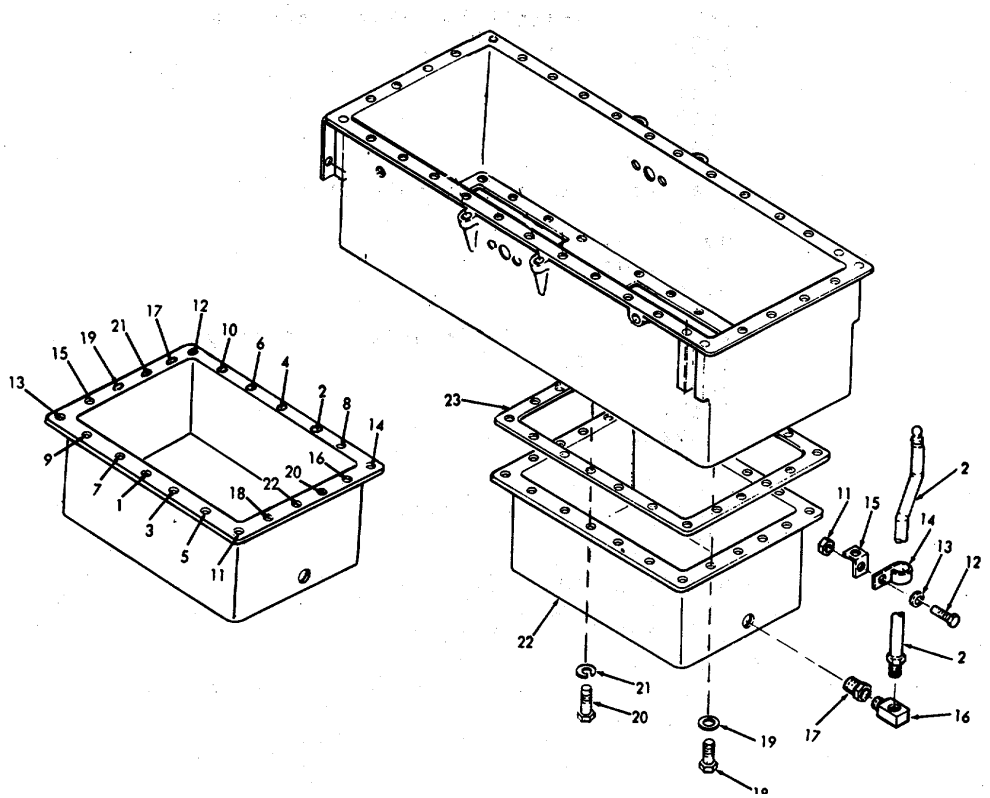


3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
10. Lower oil pan	a. Lower oil pan (22) and gasket (23)	Position pan and gasket on bottom of upper pan. rim of pan.	Install new gasket in
		NOTE	
		Tighten center bolts on each side first; then work alternately toward each end of pan.	
	b. Bolt (20), and lock-washer (21)	Install in holes 1 through 17.	
	c. Bracket (15), bolt (18) and copper washer(19)	Install in hole 18.	
	d. Bolts (20), and lock-washers (21)	Install in holes 19 through 22.	
	e. Drain plug	Install plug.	
	f. Reducing bushing (17) and elbow (16)	Install.	

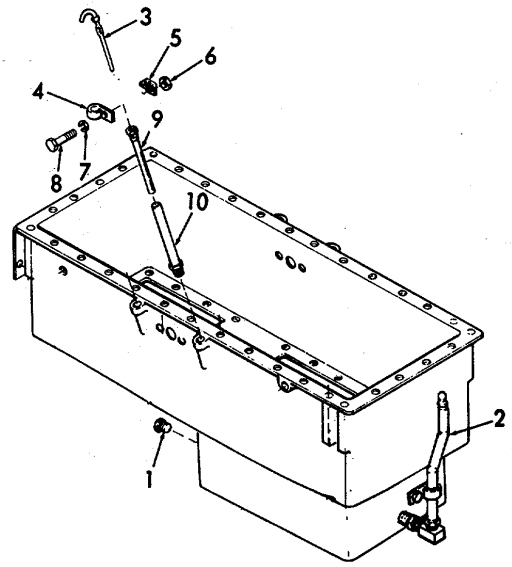
3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Drain tube (2)	Install.	
	h. Clip (14), screw (12), lock-washer (13) and nut (11)	Install in clip (15).	



3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
11. Side of Cylinder block	a. Adapter (9) and dip-stick tube (10)	Assemble.	
	b. Dip-stick tube (10)	Screw into place.	
	c. Clamp (4), bracket (5), nut (6), washer (7), bolt (8)	Install.	
	d. Dip-stick (3)	Insert.	



3-35. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
12. Rocker arm cover	Oil	Add oil as follows:	Engine contains 34 quarts (32.2 liters).

OIL TYPES

Above + 32°F Above 0°	+40°F to - 10°F +5°F to - 23°F	0°F to - 65°F -18°C to - 54°C
OE/HDO 30	OE/HDO 10	OES

13. Side of cylinder block	Oil dip-stick	Remove dipstick (3) and wipe with rag. Reinsert dipstick into tube (9), and remove. Read oil level and return dipstick. Add enough oil to bring level to full mark.	
14.	Start engine	Check for leaks around gaskets and see that oil pressure is normal.	Operate for at least 5 minutes.

3-36. LUBRICATING OIL PRESSURE RELIEF VALVE - MAINTENANCE INSTRUCTIONS.

a. Oil leaving the pump under pressure passes into the pressure relief valve housing. The spring-loaded valve opens when the pressure exceeds approximately 120 psi (827.4 kPa) and directs the excess oil to the oil pan. The pressure relief valve is located at the lower end of the vertical oil gallery near the front of the cylinder block on the oil cooler side.

b. The pressure relief valve consists of a valve body, a hollow piston-type valve, two springs (one located inside the other), a spring seat, and a pin to retain the valve assembly within the valve body.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Torque wrench
Pump, Hand NSN-
4930-00-263-9886

Material/Parts
Gasket kit
P/N 5196375

Personnel Required
1

References
NONE

Equipment

Condition	Condition Description
Para 3-35	Removing Oil Pan.

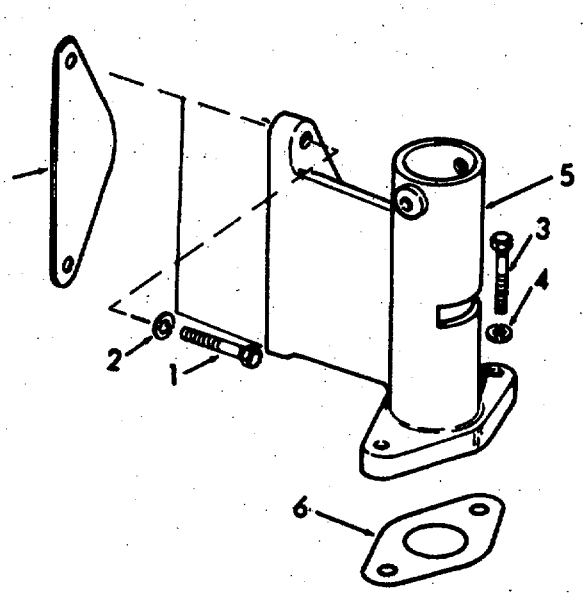
Special Environmental Conditions
Do not drain oil into bilges. Use oil/water separation system to collect drained oil.

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Relief valve	All parts	Inspect for scoring or pits on valve body and pits or fracture on springs.	Replace relief valve if damaged.

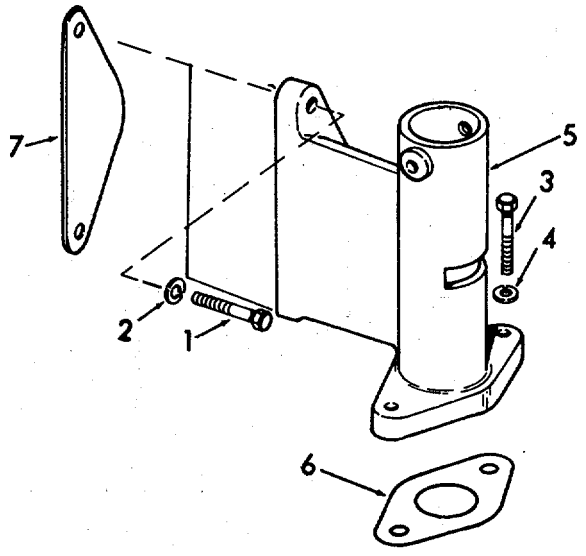
3-36. LUBRICATING OIL PRESSURE RELIEF VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2. Oil pump relief valve	a. Bolts (1) and lock-washers (2)	Remove.	
	b. Bolts (3) and lock-washers (4)	Remove.	
	c. Valve body (5)	Tap body lightly.	
	d. Valve body (5). gasket (6) and gasket (7)	Remove.	Discard gaskets.



3-36. LUBRICATING OIL PRESSURE RELIEF VALVE - MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3. Relief valve	a. Valve body (5), and gaskets (6 and 7)	Remove all traces of old gaskets. Affix new gaskets (6 and 7) to body.	Use new gaskets.
	b. Valve body (5)	Insert assembly into block.	
	c. Bolts (3) and lockwashers (4)	Install.	
	d. Bolts (1) and lockwashers (2)	Install.	



3-37. LUBRICATING OIL PRESSURE REGULATOR - MAINTENANCE INSTRUCTIONS.

a. Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of oil temperature, by means of a pressure regulator valve. The valve is installed at the end of the vertical oil gallery near the front of the cylinder block on the opposite side of the oil cooler.

b. The oil pressure regulator consists of a valve body, a hollow piston-type valve, a spring, a spring seat, and a pin to retain the valve assembly within the valve body.

c. The valve is held on its seat by the spring, which is compressed by the pin in back of the spring seat. The entire assembly is bolted to the lower flange of the cylinder block and sealed against leaks by a gasket between the block and the valve housing. When oil pressure at the valve exceeds 50 psi (344.8 kPa) the valve is forced from its seat and oil from the engine gallery is by-passed to the engine oil pan. This keeps oil pressure stabilized at all times.

d. Under normal conditions, the oil pressure regulator should require very little attention. If sludge has accumulated in the lubricating system, the valve may not work freely and may remain open, or fail to open at the normal operating pressure. Whenever the lubricating oil pump is removed for inspection, the regulator valve and spring should also be removed, inspected and cleaned in fuel oil.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Gasket kit P/N 5196375

Personnel Required
1

References
NONE

Equipment

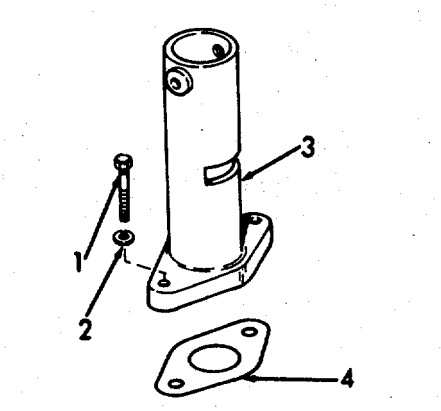
Description	Condition Description
Para 3-35	Oil Pan Removal

Special Environmental Conditions
NONE

General Safety Instructions
NONE

3-37. LUBRICATING OIL PRESSURE REGULATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Oil	All parts pressure regulator	Inspect for scores or pits on valve body and pits or fractures on spring.	Replace if damaged.
REMOVAL			
2. Oil pressure regulator	a. Bolts (1) and lock-washers (2)	Remove.	
	b. Regulator (3), and gasket (4)	Tap lightly and remove.	Discard gasket.
INSTALLATION			
3. Oil pressure regulator	a. Regulator (3) gasket (4)	Affix gasket to regulator body. Insert assembly into cylinder block.	Use new gasket.
	b. Screws (1), and lock-washers (2)	Install.	



3-38. LUBRICATING OIL PUMP - MAINTENANCE INSTRUCTIONS.

a. General.

(1) The gear-type lubricating oil pump is mounted on the number one and two main bearing caps at the front of the engine and is driven by a gear mounted on the crankshaft.

(2) An oil outlet opening is provided on each side of the pump housing to accommodate connections to the oil cooler and filter mounted on either side of the right front side of the cylinder block.

(3) The greatest amount of wear in the oil pump is on the internal drive and driven gears. This wear can be kept to a minimum by keeping the lubricating oil clean and acid-free. Do not allow dirt and sludge to accumulate in the lubricating system as wear may occur in a short period of time. Proper servicing of the oil filters will increase the life of the gears.

b.Operation.

(1) Oil is drawn by suction from the oil pan through the intake screen and pipe into the oil pump where it is pressurized. It passes from the pump through the block and out to the full-flow oil filters, through the oil cooler and into the oil galleries in the cylinder lock.

(2) An oil pump pressure relief valve is located between the oil pump outlet and the cylinder block vertical oil gallery leading to the oil filter and oil cooler. This valve opens at approximately 120 psi (827.4 kPa) and returns excess oil to the oil pan.

(3) Stabilized lubricating oil pressure is maintained in the engine at all speeds, regardless of the oil temperature, by means of a regulator valve mounted beneath the cylinder block at the lower end of the vertical oil gallery on the side opposite the oil cooler. This valve opens at approximately 50 psi (344.8 kPa) and returns excess oil directly into the oil pump.

3-38. LUBRICATING OIL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **b. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

References
NONE

Equipment

Condition	Condition Description
Para 3-35	Oil Pan Removal
Para 3-36	Removal of Oil Pressure Relief Valve
Para 3-39	Oil Distribution System (Inlet Pipe)

Material/Parts
NONE

Special Environmental Conditions
Do not drain oil into bilges.

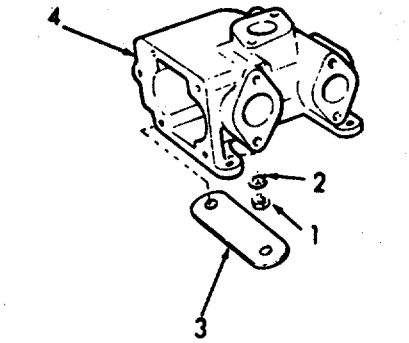
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
1. Oil pump and cylinder block	Oil pressure relief valve assembly	Remove.	Remove as per paragraph 3-36.
2. Oil pump inlet pipe	Support brackets and inlet pipe	Remove.	Refer to paragraph 3-39.
3. Oil pump assembly	Nuts (1), lockwashers (2) and shims (3)	Remove.	Note location of shims for reinstallation.

3-38. LUBRICATING OIL PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
4. Oil pump assembly	Oil pump (4), shims (3) lock-washers (2), and nuts (1)	Replace.	Put shims back in original location.
5. Oil pump inlet pipe	Inlet pipe	Install.	Refer to paragraph 3-39.
6. Oil pressure relief valve	Relief valve	Install.	Refer to paragraph 3-36.
7. Oil pan		Install.	Refer to paragraph 3-35.



3-795

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS.

The lube oil distribution system consists of two parts. The first part is the oil inlet pipe and screen for the lube oil pump. The second part is the oil pump outlet to the cylinder block and alarm systems.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Gasket kit P/N 5196375

Personnel Required
1

References
NONE

Equipment

Condition	Condition Description
Para 3-35	Oil Pan Removal
Para 3-38	Lube Oil Pump

Special Environmental Conditions
NONE

General Safety Instructions

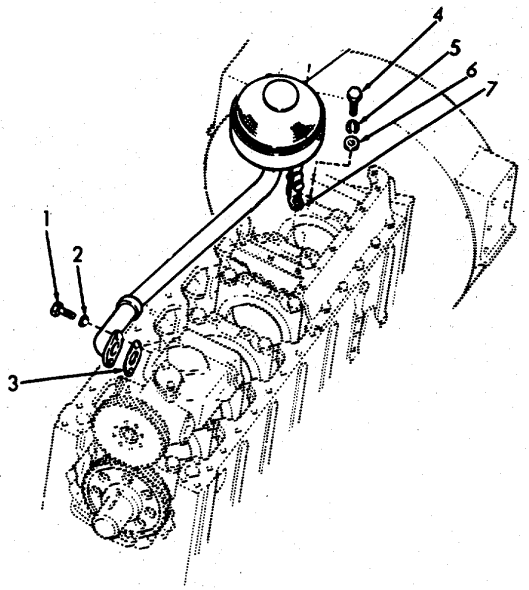
WARNING

Use eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Bottom of engine	Oil pan	a. Remove.	Refer to paragraph 3-35.
		b. Inspect for damage to inlet pipe.	Replace if damaged.
		c. Inspect for dirt and sludge in inlet screen.	Clean.

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Engine-right side	Oil pump outlet block	Inspect for leaks in fittings and damaged or bent tubes.	Replace if damaged.
REMOVAL			
3. Inlet pipe	a. Screws (1) and lock-washers (2)	Remove.	
	b. Gasket (3)	Remove.	Discard gasket.
	c. Screws (4), lock-washers (5) and flat-washers (6)	Remove from two brackets (7).	



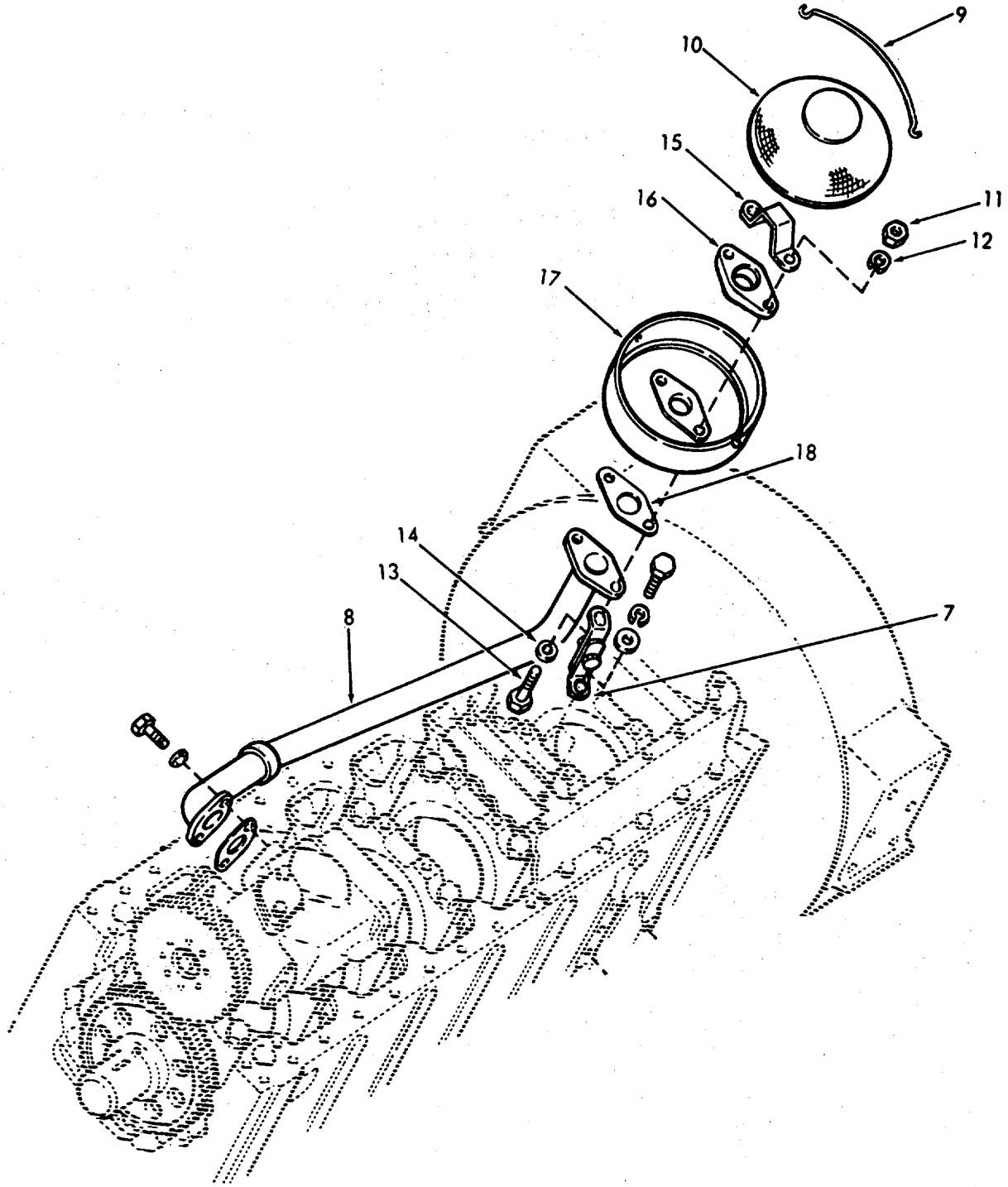
3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
d.	Inlet pipe (8)	Remove.	
e.	Retainer (9)	Remove.	
		WARNING Use eye protection when using compressed air.	
f.	Screen (10)	Remove.	Clean in fuel oil and dry with compressed air.
g.	Nuts (11), lock-washers, (12), screws (13) and flat-washers (14)	Remove.	
h.	Support brackets (7)	Remove two bolts.	
i.	Screen support (15), pipe flange (16), screen cover (17), and gasket (18)	Remove.	Discard gasket.

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL(Cont)



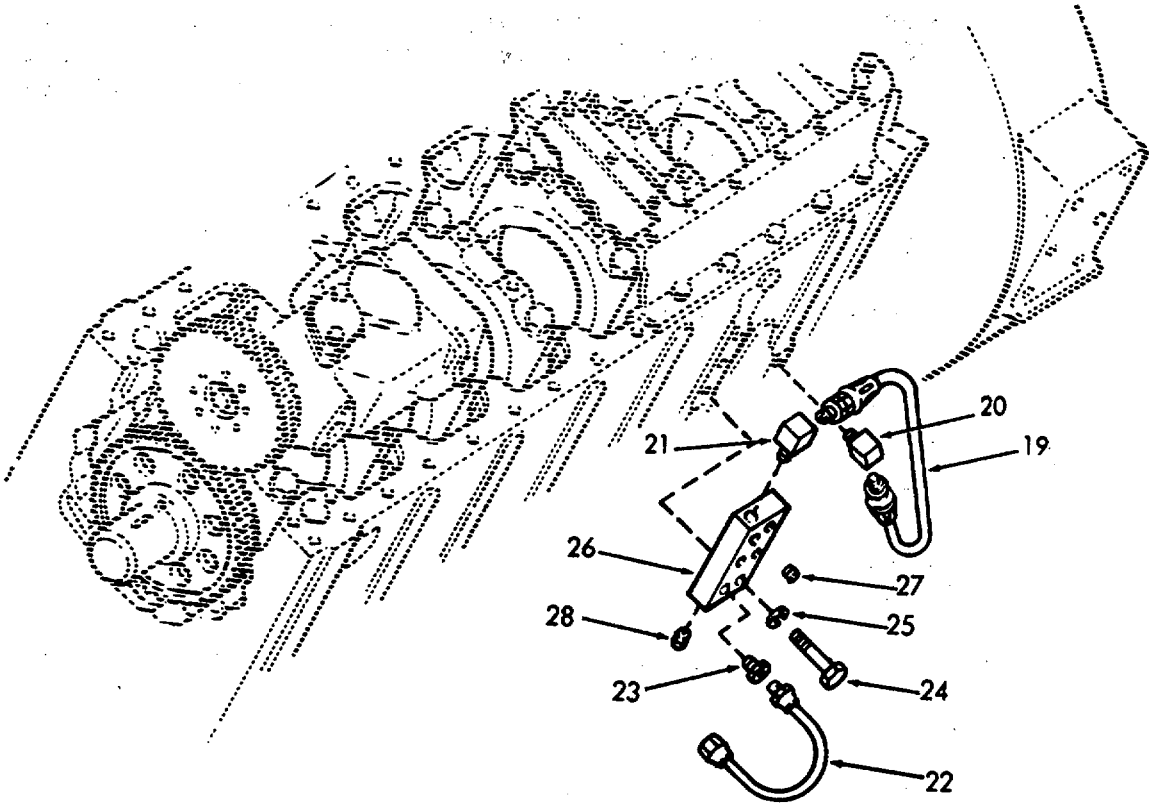
3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Oil pump outlet block	a. Tube (19)	Loosen tube nuts on ends and remove tube.	
	b. Elbow (20)	Remove.	Elbow is 45 degrees.
	c. Elbow (21)	Remove.	Elbow is 90 degrees.
	d. Tube (22)	Loosen tube nuts on both ends and remove tube.	Nuts are on oil pressure alarm system.
	e. Restriction fitting (23)	Remove.	
	f. Screws (24) and lockwashers (25)	Remove.	
	g. Block (26)	Remove	
	h. Plugs (27) and plug (28)	Remove.	If necessary.

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



3-801

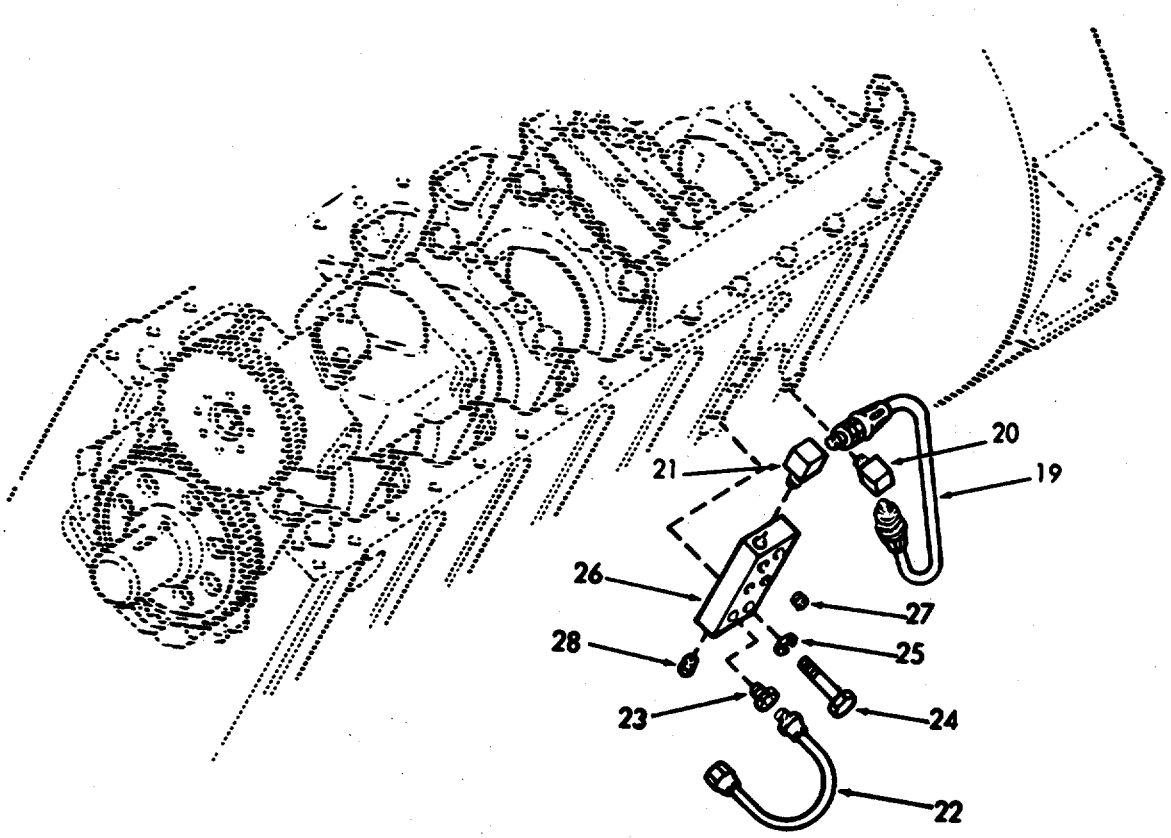
3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Oil pump outlet block	a. Plugs (27) and plug (28)	Replace.	If necessary
	b. Block (26), screws (24) and lock-washers (25)	Assemble to side of engine block.	
	c. Restriction fitting (23)	Install.	
	d. Tube (22)	Install.	
	e. Elbow (21)	Install.	90 degree elbow.
	f. Elbow (20)	Install.	45 degree elbow.
	g. Tube (19)	Install.	

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



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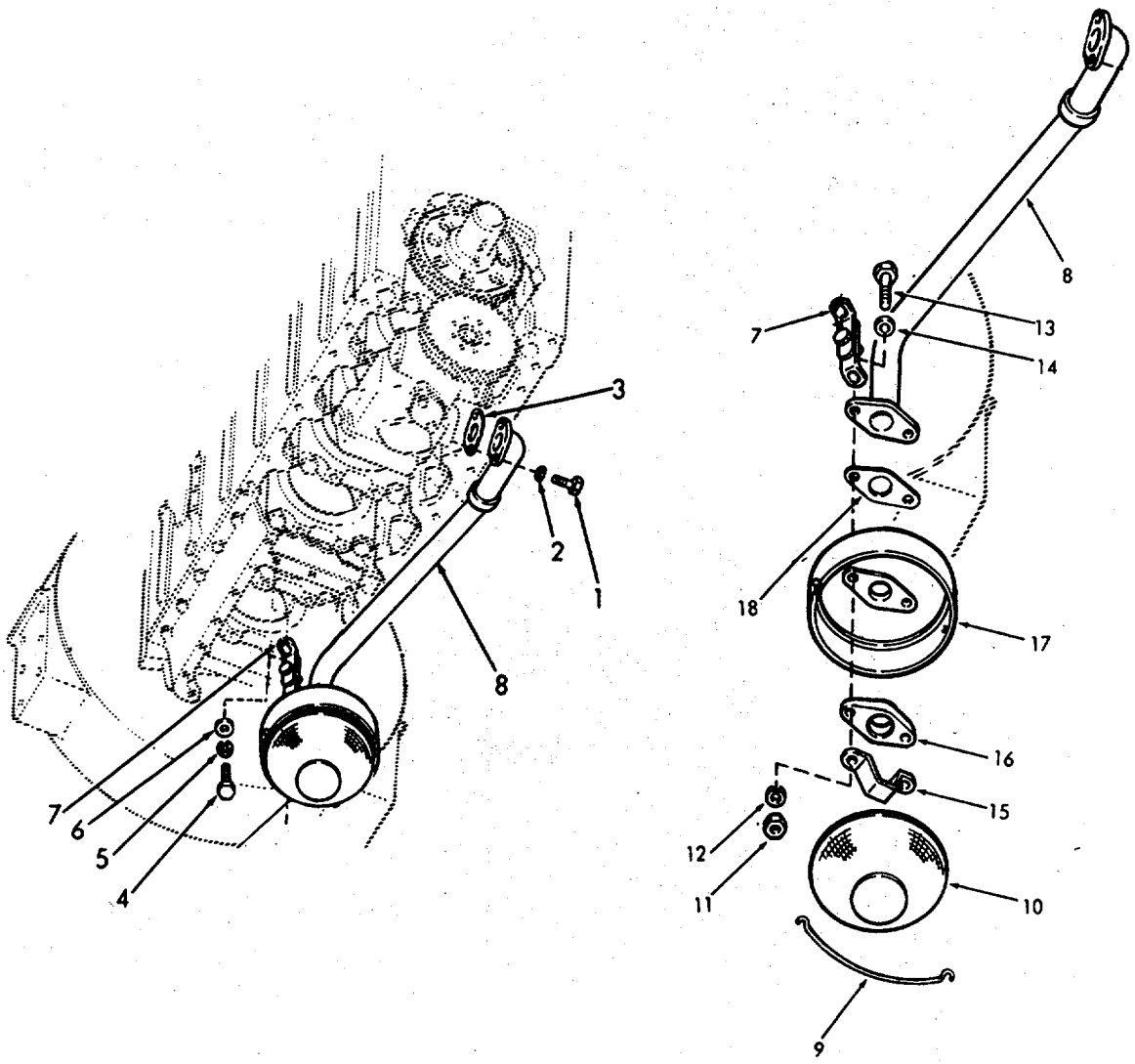
3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
6. Inlet pipe	a. Screws (13), flat-washers (14), inlet pipe (8), brackets (7), gasket (18), screen cover (17), pipe flange (16), screen support (15), lockwashers (12), and nuts (11)	Reassemble.	Use new gasket.
	b. Screen (10), and retainer (9)	Install.	
	c. Inlet pipe assembled, screws (4), lockwashers (5), and flatwashers (6)	Assemble.	

3-39. LUBE OIL DISTRIBUTION SYSTEM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
Reassembly (Cont)			
	d. Gasket (3)	Insert.	Use new gasket.
	e. Screws (1), and lock-washers (2)	Install.	



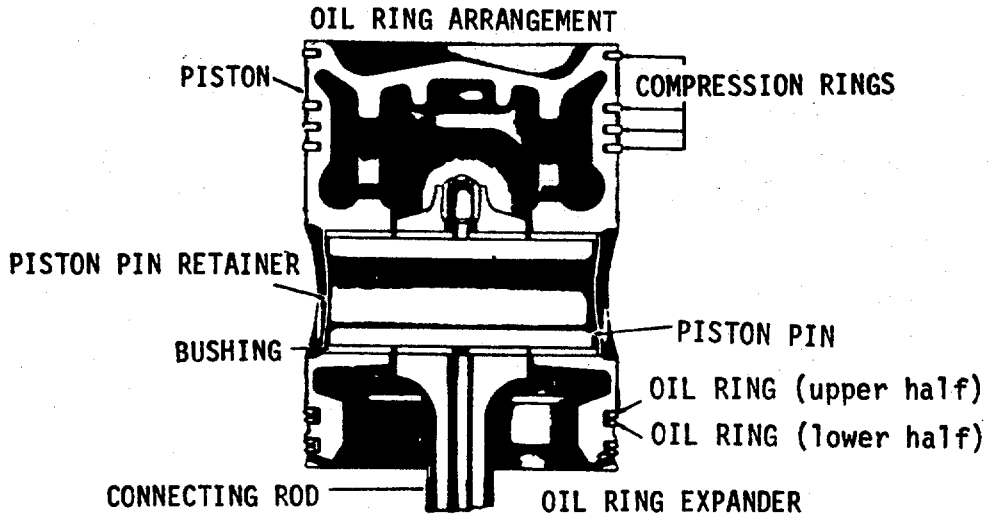
3-40. PISTONS, CONNECTING RODS AND LINERS.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS.

a. The trunk-type malleable iron piston is plated with a protective coating of tin which permits close fitting, reduces scuffing and prolongs piston life. The top of the piston forms the combustion chamber bowl and is designed to compress the air into the close proximity to the fuel spray.

b. Each piston is internally braced with fin-shaped ribs and circular struts, scientifically designed to draw heat rapidly from the piston crown and transfer it to the lubricating oil spray to ensure better control of piston ring temperature.

c. The piston is cooled by a spray of lubricating oil directed at the underside of the piston head from a nozzle in the top of the connecting rod, by fresh air from the blower to the top of the piston and indirectly by the water jacket around the cylinder.



d. Each piston is balanced to close limits by machining a balancing rib, provided on the inside at the bottom of the piston skirt.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

e. Two bushings, with helical grooved oil passages, are pressed into the piston to provide a bearing for the hardened, floating piston pin. After the piston pin has been installed, the hole in the piston at each end of the pin is sealed with a steel retainer. Thus lubricating oil returning from the sprayed underside of the piston head and working through the grooves in the piston pin bushings is prevented from reaching the cylinder walls.

f. Each piston is fitted with compression rings and oil control rings. Eight equally spaced drilled holes just below each oil control ring groove permit excess oil, scraped from the cylinder walls, to return to the crankcase.

g. When an engine is hard to start, runs rough or lacks power, worn or sticking compression rings may be the cause. Replacing the rings will aid the restoring engine operation to normal.

h. The compression rings may be inspected through the ports in the cylinder liners after the air box covers have been removed. If the rings are free and are not worn to the extent that the plating or grooves are gone, compression should be within operating specifications.

i. Excessively worn or scored pistons, rings or cylinder liners may be an indication of abnormal maintenance or operating conditions which should be corrected to avoid a recurrence of the failure. The use of the correct types and proper maintenance of the lubricating oil filters and air cleaners will reduce to a minimum the amount of abrasive dust and foreign material introduced into the cylinders and will reduce the rate of wear.

j. Long periods of operation at idle speed and the use of improper lubricating oil or fuel must be avoided, otherwise a heavy formation of carbon may result and cause the rings to stick.

k. Keep the lubricating oil and engine coolant at the proper levels to prevent overheating of the engine.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Pre-Inspection
b. Removal
c. Disassembly
d. Cleaning
e. Inspection
f. Reassembly
g. Installation

INITIAL SETUP:

Test Equipment

Feeler gage

Special Tools

Assembly tool piston ring J8128
Pump, hand NSN4930-00-263-9886

References

NONE

Equipment Condition — Condition Description

Paragraph

3-34 Cylinder Head Removal
3-35 Oil Pan Removal
3-38 Lube Oil Pump Removal
3-39 Oil Inlet Pipe Removal

Material/Parts

Cylinder Kit P/N 5149265

Special Environmental Conditions

Do not drain oil into bilges. Use oil/water separation system to collect drained oil.

Personnel Required

2

General Safety Instructions

WARNING

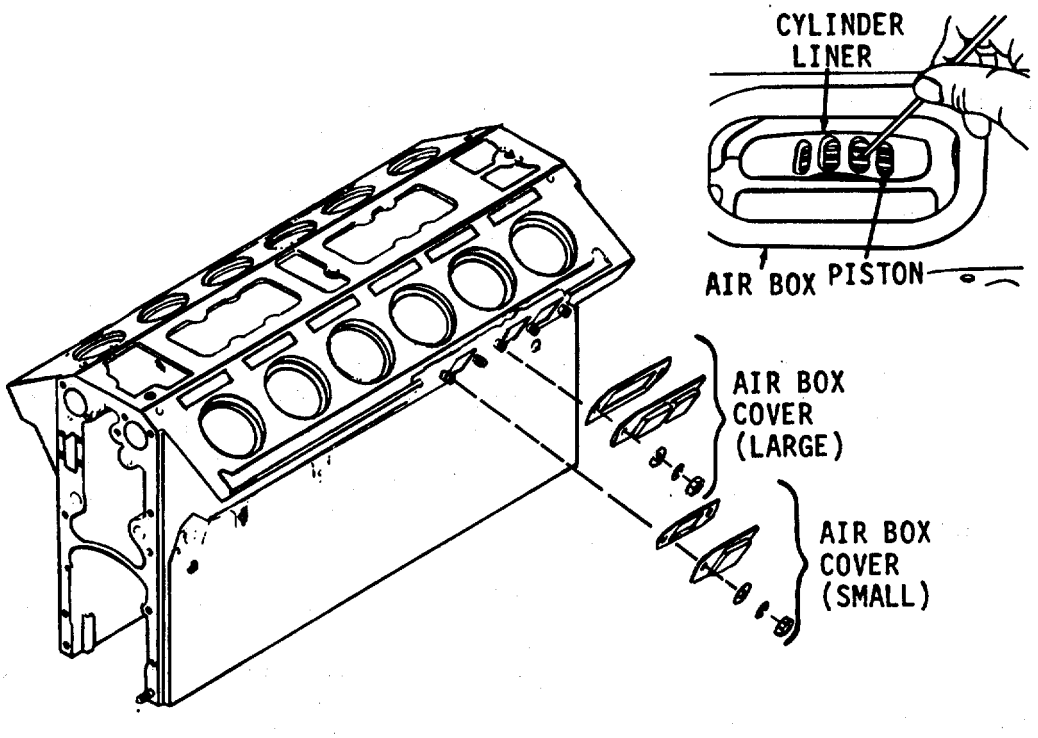
Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARK
PRE-INSPECTION			
1. Piston-compression rings	a. Air box covers gaskets.	Remove nuts, flatwashers, lockwashers, covers, and	Discard gaskets.
	b. Cylinder liners	Check that piston rings are free and are not worn to the extent that plating or grooves are gone.	

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

PRE-INSPECTION (Cont)



REMOVAL

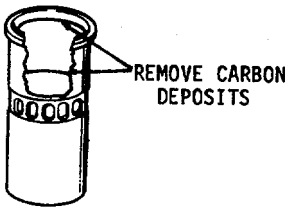
2. Piston and connecting rod	a. Cooling system		Drain.	
	b. Oil pan	1.	Remove oil.	Pump oil into a suitable container.
		2.	Remove.	Refer to paragraph 3-35.
	c. Oil inlet pipe		Remove.	Refer to paragraph 3-39.
	d. Lube oil pump		Remove.	Refer to paragraph 3-38.
	e. Cylinder head		Remove.	Refer to paragraph 3-34.
	f. Cylinder liner	1.	Remove the carbon deposits from the upper inner surface of the cylinder liner.	

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

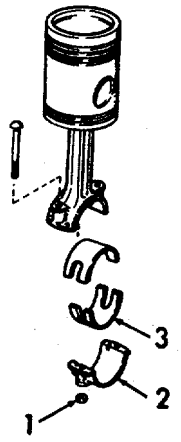
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		2. Use a ridge cutter to remove any ridge in the cylinder liner at the top of the piston ring travel.	

NOTE

Move the piston to the bottom of its travel and place a cloth over the top of the piston to collect the cuttings. After the ridge has been removed, turn the crankshaft to bring the piston to the top of its stroke and carefully remove the cloth with the cuttings.

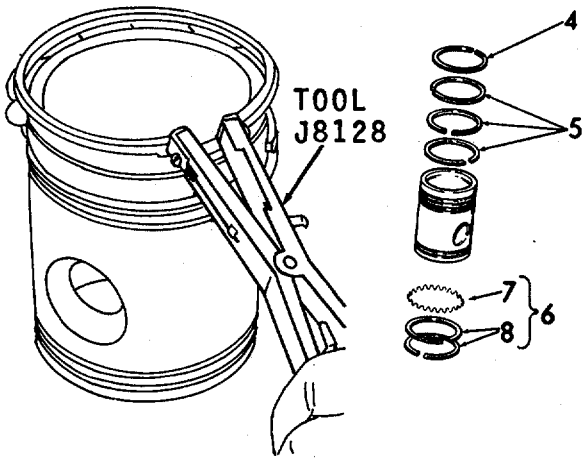


g.	Nut (1), bearing cap (2), and lower bearing shell (3)	Remove.	



3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

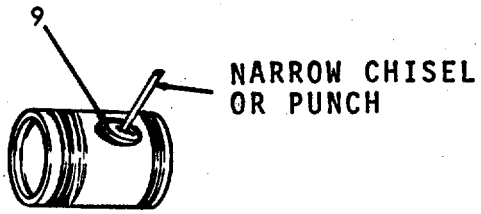
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Piston and connecting rod assembly	Push the piston and rod assembly out through the top of the cylinder block.	The piston cannot be removed from the bottom of the cylinder block.
	i. Lower bearing shell (3), bearing cap (2), and nuts (1)	Reassemble to connecting rod.	
DISASSEMBLY			
3. Piston and connecting rod	a. Piston and connecting rod assembly	Place connecting rod in a vise with soft jaws.	
	b. Ring (compression fire 4)	Remove.	Use tool J8128.
	c. Rings compression (5)	Remove three rings.	Use tool J8128.
	d. Oil rings 4 (6)	Remove rings (7 and 8).	Use tool J8128.



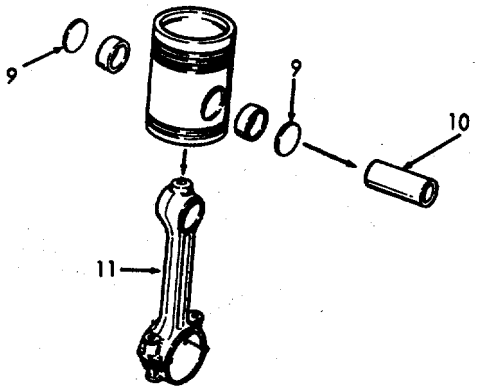
3-811

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
e.	Piston pin retainer (9)	Punch a hole through the center of one of the piston pin retainers with a narrow chisel or punch and pry the retainer from the piston.	Be careful not to damage the piston or bushings.



f.	Piston pin (10)	Remove.	
g.	Connecting rod (11)	Remove.	



h.	Piston pin retainer (9)	Drive out remaining retainer.	Use a brass rod or a suitable tool.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

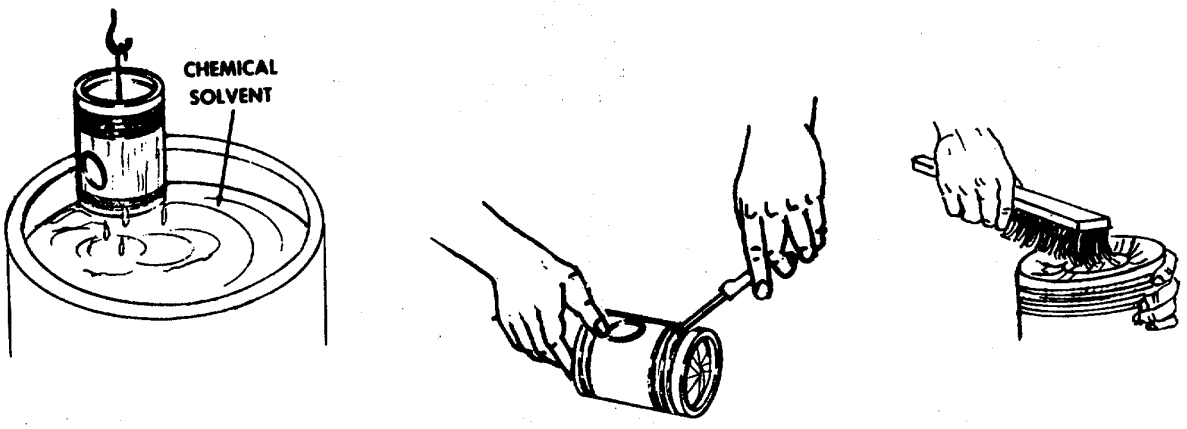
LOCATION	ITEM	ACTION	REMARKS

CLEANING

WARNING

Use eye protection when using compressed air.

4.	Piston components	Clean the piston components with fuel oil and dry them with compressed air. If fuel oil does not remove the carbon deposits, use a chemical solvent that will not harm the piston pin bushings or the tin-plate on the piston. The upper part of the piston, including the compression ring lands and grooves, is not tin-plated and may be wire-brushed to remove any hard carbon. However, use care to-avoid damage to the tin-plating on the piston skirt. Clean the ring grooves with a suitable tool or a piece of an old compression ring that has been ground to a bevel edge. Clean the inside surfaces of the piston and the oil drain holes in the piston skirt. Exercise care to avoid enlarging the holes while cleaning them.	



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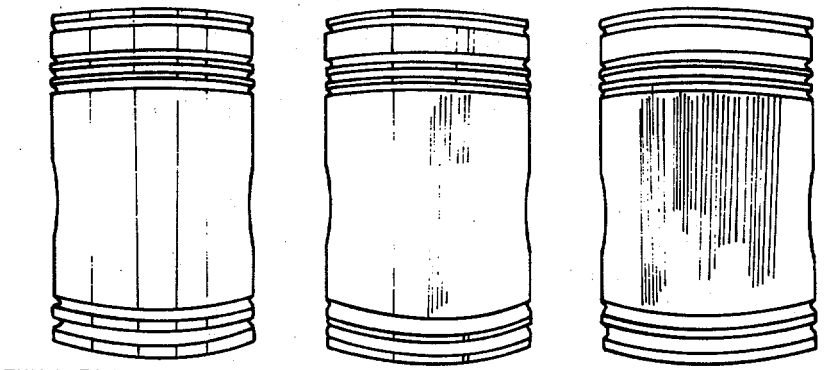
3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
5.	Piston	If the tin-plate on the piston and the original grooves in the piston rings are intact, it is an indication of very little wear. Examine the piston for score marks, cracks, damaged ring groove lands or indications of overheating. A piston with light score marks which can be cleaned up may be reused. Any piston that has been severely scored or overheated must be replaced. Indications of overheating or burned spots on the piston may be the result of an obstruction in the connecting rod oil passage. Replace the piston if cracks are found across the internal struts. Use the magnetic particle inspection method for locating cracks in the piston.	



THIS PISTON SUITABLE FOR INSTALLATION AS IS

SLIGHTLY SCORED, USE ONLY AFTER REMOVING SCORE MARKS BY POLISHING WITH CROCUS CLOTH OR HARD INDIA STONE

BADLY SCORED -UNFIT FOR USE

6.	Cylinder liner and block bore	Inspect.	Check the cylinder liner and block bore for excessive out-of-round, taper, or high spots which could cause failure of the piston.	Refer to paragraph 3-40.4.
7.	Connecting rod and piston pin	Inspect.		Refer to paragraph 3-40.2.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
8.	Piston pin bushing	Inspect and measure the piston pin bushings. The piston pin-to-bushing clearance with new parts is .0025 to .0034 inch (0.0064 to 0.0086 cm). A maximum clearance of .010 inch (0.0001 cm) is allowable with worn parts. The piston pin bushings in the connecting rod are covered in paragraph 3-40.2 .	
9.	Other	Other factors that may contribute to piston failure include oil leakage into the air box, oil pull-over from the air cleaner, dribbling injectors, combustion blow-by and low oil pressure (dilution of the lubricating oil).	
REASSEMBLY			
10.	Piston		

WARNING

Do not remove the bushings from the piston. They are not serviced separately.

a.	Piston and cylinder liner fitting	Measure the piston skirt diameter lengthwise and crosswise of the piston pin bore. Measurements should be taken at room temperature (70°F or 21°C). The taper and out-of-round must not exceed .0005 inch. Refer to Table for piston diameter specifications.	

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

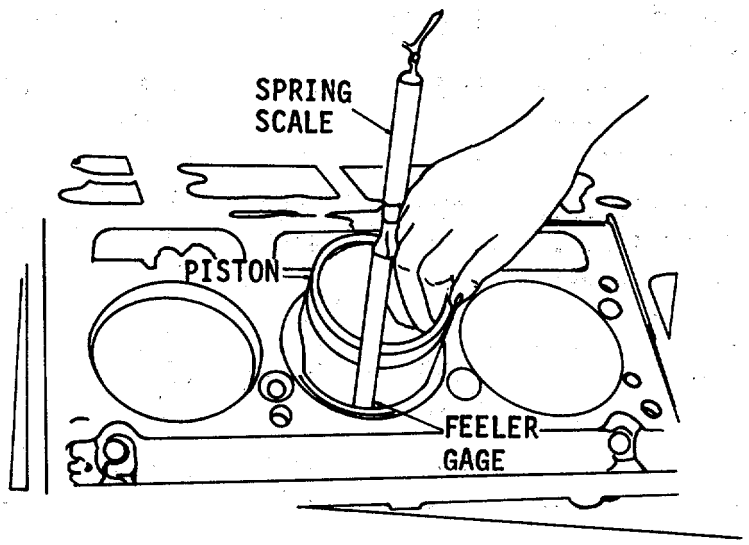
REASSEMBLY (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Piston:						
Height (centerline of bushing to top)	3.5430	8.9992	3.5480	9.0119		
Diameter (above compression rings)	4.2225	10.7252	4;2255	10.7328		
Diameter (at skirt)	4.2428	10.7767	4.2450	10.7823		
Clearance-piston skirt-to-liner	.0045	.0114	.0083	.0211	.0120	.0305
Out-of-round			.0005	.0013		
Taper			.0005	.0013		
Compression rings:						
Gap (top-fire ring)	.0230	.0584	.0380	.0965	.0600	.1524
Gap (No. 2, 3 and 4)	.0180	.0457	.0430	.1092	.0600	.1524
Clearance-ring-to-groove:						
No. 1 (top-fire ring)	.0040	.0102	.0070	.0178	.0180	.0457
No. 2	.0100	.0254	.0130	.0330	.0220	.0559
No. 3 and 4	.0040	.0102	.0070	.0178	.0130	.0330
Oil control rings:						
Gap	.0080	.0203	.0230	.0584	.0430	.1092
Clearance	.0015	.0038	.0055	.0140	.0080	.0203

A new cylinder liner has an inside diameter of 4.2495 to 4.2511 inch (10.7937 to 10.7978 cm). The piston-to-liner clearance, with new parts, will vary with the particular piston diameter. A maximum clearance of .012 inch (0.031 cm) is allowable with used parts. With the cylinder liner installed in the cylinder block, hold the piston

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

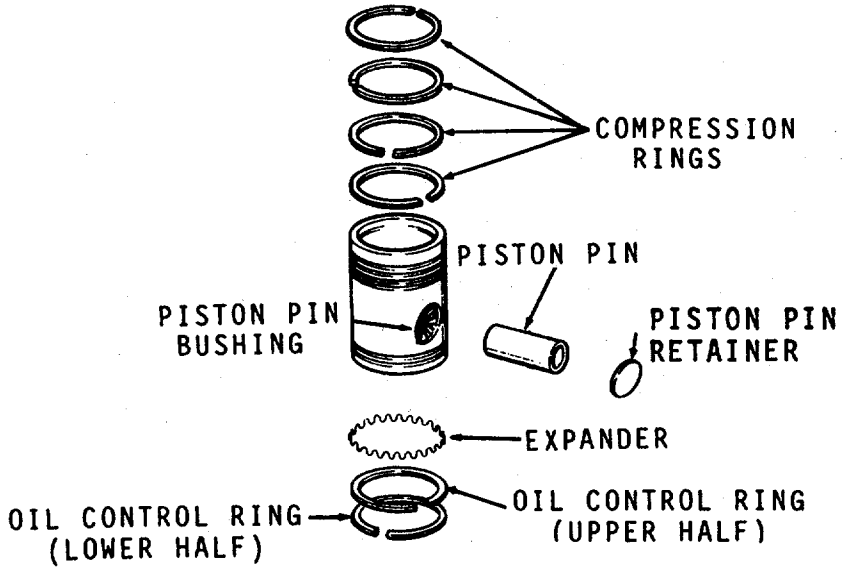
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		upside down in the liner and check the clearance in four places 900 apart. Use feeler gage to check the clearance. The spring scale, attached to the proper feeler gage, is used to measure the force in pounds required to withdraw the feeler gage.	



		Select a feeler gage with a thickness requiring a pull of six pounds (26.7 N) to remove. 'The clearance will be .001 inch (0.003 cm) greater than the thickness of the gage used, i.e., a .004 inch (0.010 cm) feeler gage will indicate a clearance of .005 inch (0.013 cm) when it is withdrawn with a pull of six pounds (26.7 N). The feeler gage must be perfectly flat and free of nicks and bends.	

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

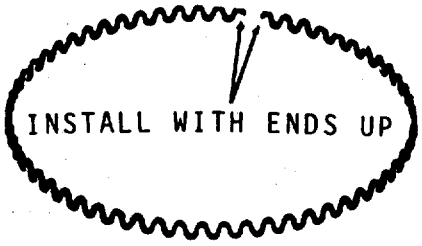
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		If any bind occurs between the piston and liner, examine piston and liner for burrs. Remove burrs with a fine hone (a flat one is preferable) and recheck the clearance.	
	b. Piston ring fitting	Each piston is fitted with a fire ring, three compression rings and two oil control rings.	



The top compression (fire) ring can be identified by the bright chrome on the bottom side and black oxide or copper color on the top. The prestressed fire ring is further identified by an oval mark.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		A pre-stressed compression ring is also used in the ring groove immediately below the fire ring. A two-piece oil control ring is used in both oil ring grooves in the piston and a peripheral abutment type oil ring expanders.	



PERIPHERAL ABUTMENT

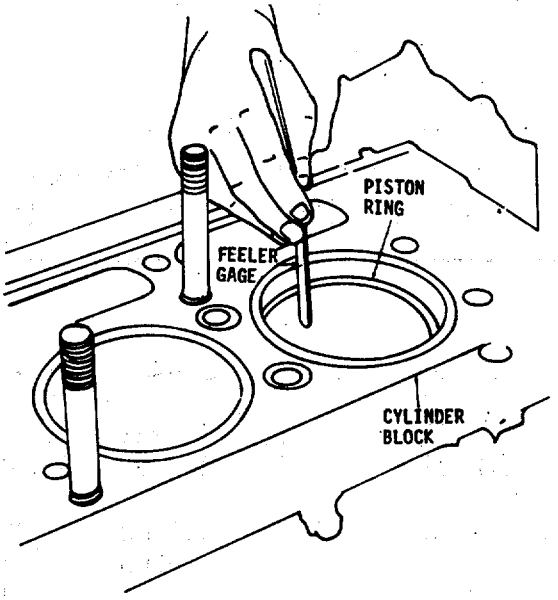
All new piston rings must be installed whenever a piston is removed regardless of whether a new or used piston or cylinder liner is installed.

Insert one ring at a time inside the cylinder liner and far down enough to be within the normal area of ring travel. Use a piston to push the ring down to be sure it is parallel with the top of the liner. Then measure the ring gap with a feeler gage. Refer to ring gap specifications.

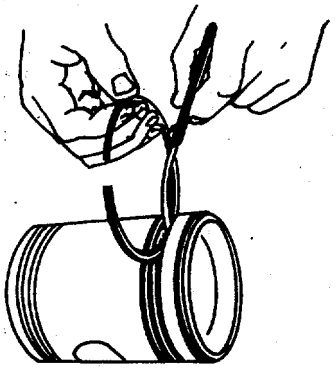
3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



If gap on a compression ring is insufficient, it may be increased by filing or stoning ends of ring. File or stone both ends of ring so the cutting action is from outer surface to inner surface. This will prevent chipping or peeling of chrome plates on ring. The ends of the ring must remain square and the chamfer on outer edge must be approximately .015 inch (0.038 cm). Check ring side clearances as shown. Refer to table of clearances.



3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	MINIMUM (cm)	MAXIMUM (inches)	MAXIMUM (cm)	LIMITS (inches)	LIMITS (cm)
Piston:						
Height (centerline of bushing to top)	3.5430	8.9992	3.5480	9.0119		
Diameter (above compression rings)	4.2225	10.7252	4.2255	10.7328		
Diameter (at skirt)	4.2428	10.7767	4.2450	10.7823		
Clearance-piston skirt-to- iner	.0045	.0114	.0083	.0211	.0120	.0305
Out-of-round			.0005	.0013		
Taper			.0005	.0013		
Compression rings:						
Gap (top-fire ring)	.0230	.0584	.0380	.0965	.0600	.1524
Gap (No. 2, 3 and 4)	.0180	.0457	.0430	.1092	.0600	.1524
Clearance-ring-to-groove:						
No. 1 (top-fire ring)	.0040	.0102	.0070	.0178	.0180	.0457
No. 2	.0100	.6254	.0130	.0330	.0220	.0559
No. 3 and 4	.0040	.0102	.0070	.0178	.0130	.0330
Oil control rings:						
Gap	.0080	.0203	.0230	.0584	.0430	.1092
Clearance	.0015	.0038	.0055	.0140	.0080	.0203

c.	Piston and connecting rod	Assemble.	Refer to paragraph 3-40.2.
d.	Piston and all piston rings	Lubricate for installation.	Use engine oil.

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
e.	Compression rings (5)	Install starting with the bottom ring.	Use tool J8128.

CAUTION

To avoid breaking or overstressing the rings, do not spread them any more than necessary to slip them over the piston.

f.	Compression fire rings (4)	Install.	Use tool J8128.

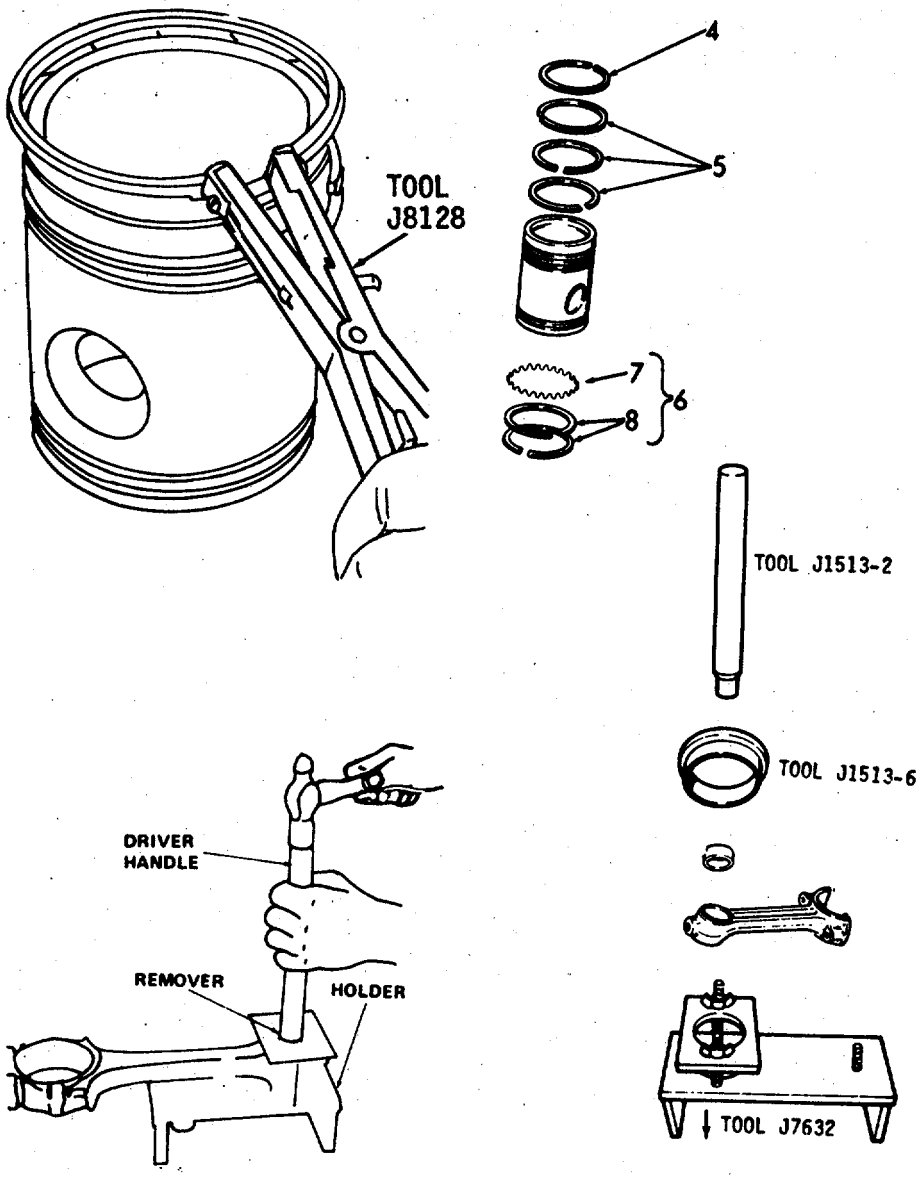
CAUTION

When installing the top compression (fire) ring, be sure the black oxide or copper color side (also identified by an oval mark) is toward the top of the piston.

g.	Compression rings (4 and 5)	Stagger ring gaps around the piston.	Rotate rings or piston.
h.	Ring expander (7)	Install in oil control ring groove.	Install with the legs of the free ends toward the top of the piston. With the free ends pointing up, a noticeable resistance will be encountered during installation of the piston

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
			if the ends of the expander are overlapped and corrective action can be taken before ring breakage occurs.



3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		CAUTION	
		When installing the oil control rings, use care to prevent overlapping the ends of the ring expanders. An overlapped expander will cause the oil ring to protrude beyond allowable limits and will result in breakage when the piston is inserted in the ring compressor during installation in the cylinder liner. Do not cut or grind the ends of the expanders to prevent overlapping. Cutting or grinding the ends will decrease the expanding force on the oil control rings and result in high lubricating oil consumption.	
	i. Oil control rings (8)	Install the upper and lower halves.	Install by hand Do not use tool. Install upper half with the gap 1800 from the gap in the expander. Then install the lower half with the gap 450 from the gap in the upper half of the ring. Make sure the scraper edges are facing down (toward bottom of the piston).
		NOTE	
		The face of the top half of the upper oil control ring used on V-71N engines is chrome-plated.	

3-40.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		NOTE The scraping edges of all oil control rings must face downward (toward the bottom of the piston) for proper oil control.	
		NOTE If there is a noticeable resistance during installation of the piston, check for an overlapped ring expander.	
INSTALLATION			
11.	Piston, connecting rod, and cylinder liner		For installation, refer to paragraph 3-40.4.

3-40.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS.

a. Each connecting rod (trunk-type piston) is forged to an "I" section with a closed hub at the upper end and a bearing cap at the lower end. The connecting rod is drilled to provide lubrication to the piston pin at the upper end and is equipped with a nozzle to spray cooling oil to the underside of the piston head. An orifice is pressed into a counterbore at the lower end of the oil passage to meter the flow of oil.

b. A helically-grooved bushing is pressed into each side of the connecting rod at the upper end. The cavity between the inner ends of these bushings registers with the drilled oil passage in the connecting rod and forms a duct around the piston pin. Oil entering this cavity lubricates the piston pin bushings and is forced out the spray nozzle to oil the piston. The piston pin floats in the bushings of both the piston and connecting rod.

c. This paragraph also includes assembly of the piston onto a connecting rod.

3-40.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **c. Inspection** **e. Reassembly**
b. Cleaning **d. Disassembly** **f. Assembly**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Remove; Connecting rod spray nozzle J8995
Reamer set, connecting rod bushing J1686-03
Installer and remover set piston and connecting rod J1513-02 (part J7032)
Pump, hand NSN 4930-00-263-9886

Material/Parts

Cylinder kit P/N 5149265
collect drained oil.

Personnel Required

1

References

NONE

Equipment Condition — Condition Description

Paragraph
3-34 Cylinder Head Removal
3-35 Oil Pan Removal
3-38 Lube Oil Pump Removal
3-39 Oil Inlet Pipe Removal
3-40.1 Piston Removal

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation/recovery system to

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Pump oil into a suitable container.
		2. Remove.	Refer to paragrap 3-35.

REMOVAL (Cont)

b.	Oil inlet pipe	Remove.	Refer to paragraph 3-39.
c.	Lube oil pump	Remove.	Refer to paragraph 3-38.
d.	Cylinder head	Remove.	Refer to paragraph 3-34.

NOTE

The connecting rod bearing caps are numbered 1L, IR, 2L, 2R, etc., with matching numbers and letters stamped on the connecting rods. When removed, each bearing cap and the bearing shells must always be reinstalled on the original connecting rod.

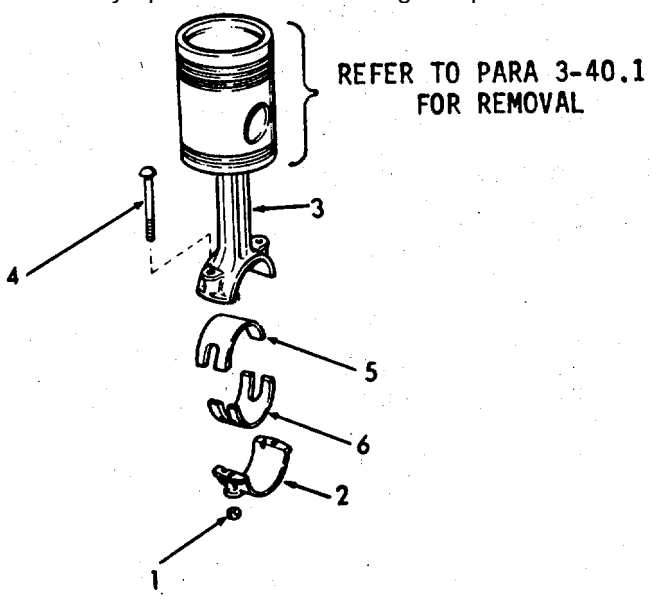
a.	Nuts (1)	Remove.	
b.	Bearing cap (2)	Remove.	
c.	Connecting rod (3)	Push connecting rod and piston assembly up into the cylinder liner.	
d.	Bolts (4)	Remove.	
e.	Upper bearing shell (5)	Remove from connecting rod.	Do not pound on edge of bearing shell with sharp tool.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	f. Lower bearing shell (6)	Remove if necessary.	Do not pound on edge of bearing shell with sharp tool.
	g. Piston	Disassemble.	Refer to paragraph 3-40.1.

WARNING

Use eye protection when using compressed air.



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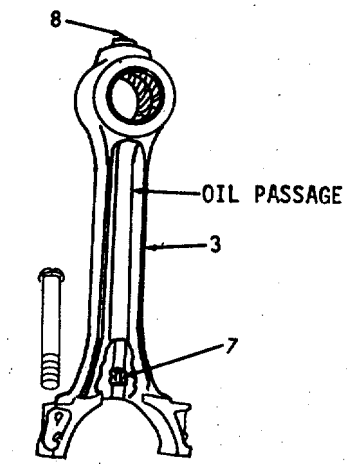
3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

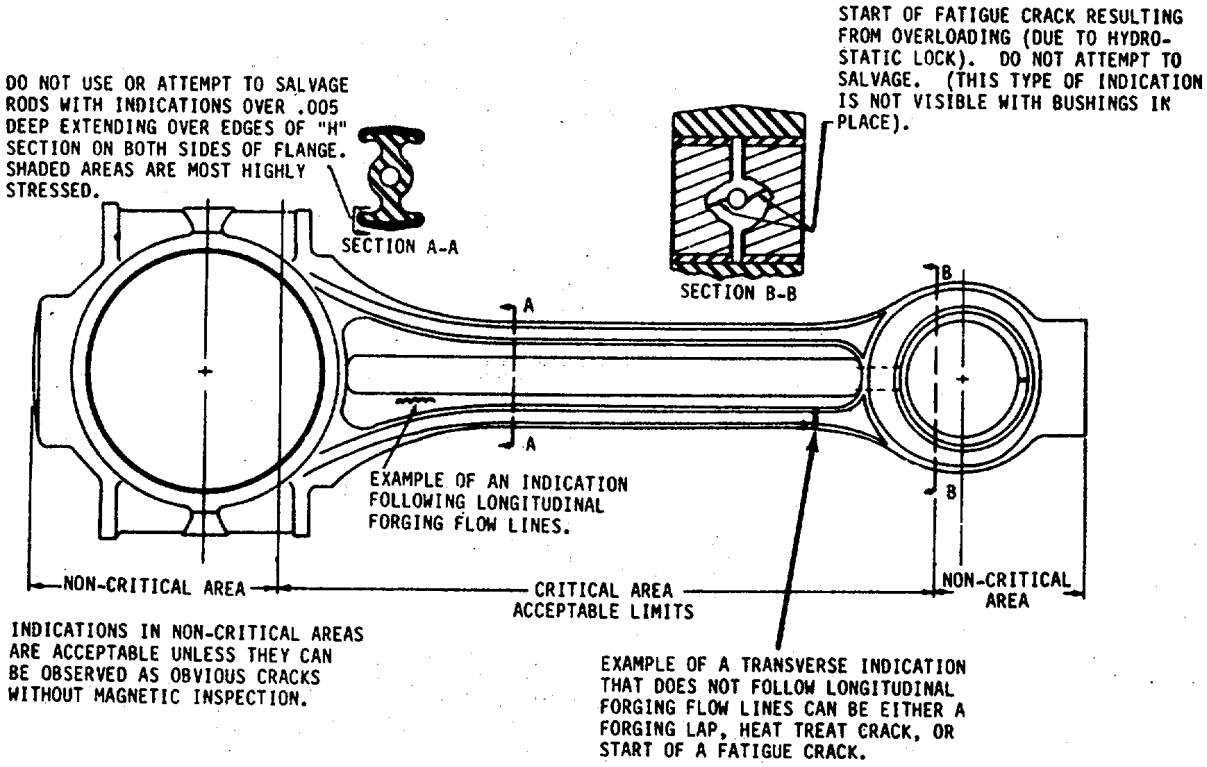
LOCATION	ITEM	ACTION	REMARKS
CLEANING			
3. Connecting rod	Connecting rod (3), orifice (7) and spray nozzle (8)	Clean the connecting rod and piston pin with fuel oil and dry them with compressed air. Blow compressed air through the drilled oil passage in the connecting rod to be sure the orifice, oils passage and spray nozzle are not clogged.	
INSPECTION			
4. Connecting rod	Connecting rod (3)	Inspect for cracks.	Magnetic particle is the preferred method.



3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE USUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 1/32 DEEP. DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

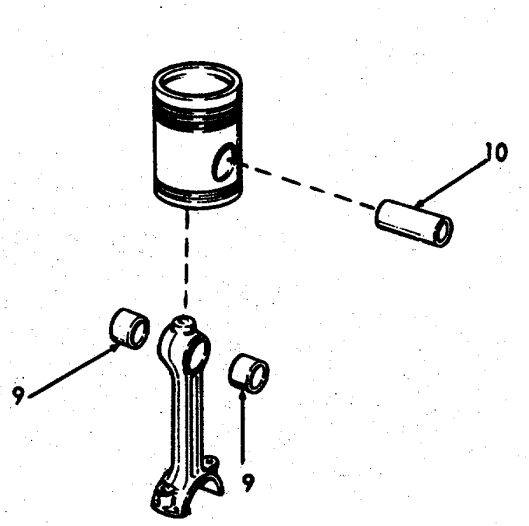
TRANSVERSE INDICATIONS (ACROSS FLOW LINES). HAVING A MAXIMUM LENGTH OF 1/2, WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 1/64 ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL. AN EXCEPTION TO THIS IS A ROD HAVING AN INDICATION WHICH EXTENDS OVER THE EDGE OF "H" SECTION AND IS PRESENT ON BOTH SIDES OF THE FLANGE. IN THIS CASE, MAXIMUM ALLOWABLE DEPTH IS .005 (SEE SECTION A-A).

GRINDING NOTES
CARE SHOULD BE TAKEN IN GRINDING OUT INDICATIONS TO ASSURE PROPER BLENDING OF GROUND AREA INTO UNGROUND SURFACE SO AS TO FORM A SMOOTH CONTOUR.

POOR PRACTICE GOOD PRACTIC

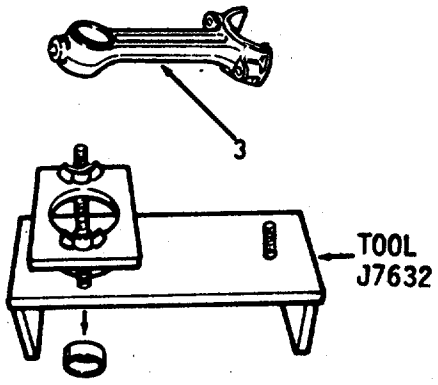
3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
5. Connecting rod bushings	Bushings (9)	Check the connecting rod bushings for indications of scoring, overheating or other damage.	Bushings that have overheated may Become loose and creep together, thus blocking off the supply of lubricating oil to the piston pin and spray nozzle.
6. Piston pin	Pin (10)	Inspect the piston pin for signs of fretting.	Bushings that have overheated may become loose Bushings that have overheated may become loose and creep together, thus blocking off the supply of lubricating oil to the piston pin and spray nozzle. When reusing a piston pin, the highly polished and lapped surface of the pin must not in any way be refinished. Polishing or refinishing the piston pin is not recommended as it could result' in very rapid bushing wear. Since it is subjected to downward load-



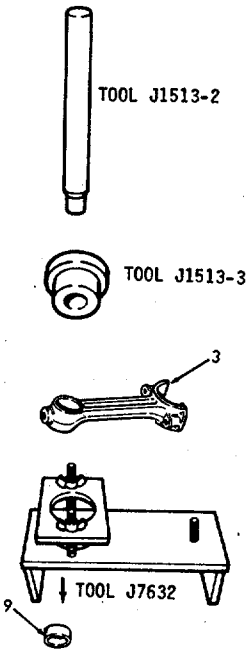
3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

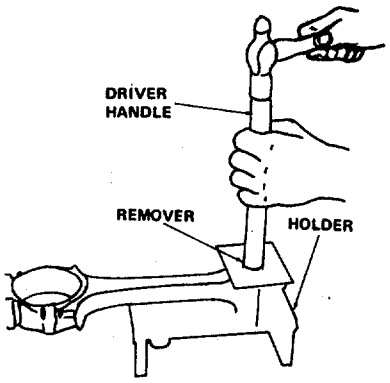
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			ing only, free movement of the piston pin is desired to secure perfect alignment and uniform wear. Therefore, the piston pin is assembled with a full floating fit in the connecting rod and piston bushings, with relatively large clearances. Worn piston pin clearances up to .010 inch (.025 cm) are satisfactory.
DISASSEMBLY			
7. Bushings	a. Connecting rod (3)	1. Clamp under end of rod in holder, so that bore in the bushings is aligned with the hole in the base of the holder.	Use tool J7632.



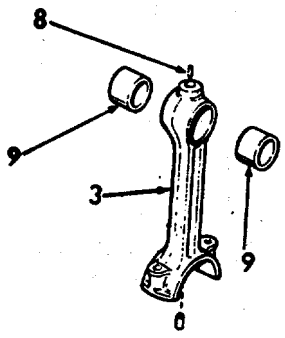
3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		2. Place bushing remover in the connecting rod bushing.	Use tool J1513-3.
		3. Insert handle in the remover and drive the bushings (9) from the rod (3).	Use tool J1513-2.



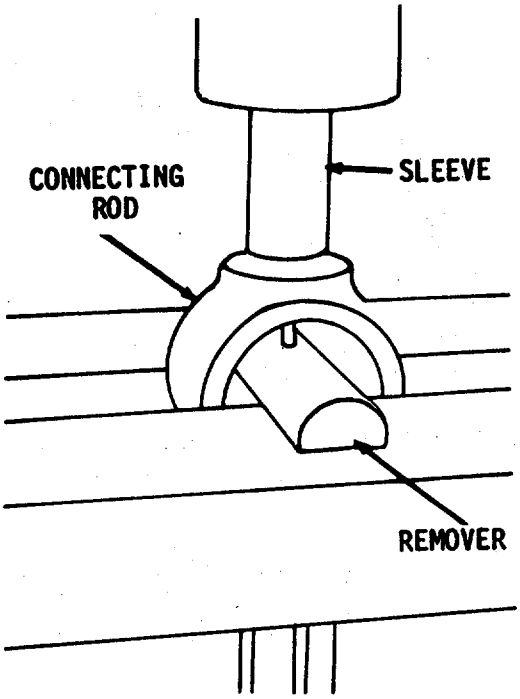


8.	Spray nozzle (8)	a. Connecting rod bushings (9)	Remove.	Refer to step 7.



3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	b. Spray nozzle (8)	1. Insert spray nozzle remover through the upper end of the connecting rod and insert the pin, in the curved side of the tool, in the opening in the bottom of the spray nozzle.	Use tool J8995.



TOOL J8995

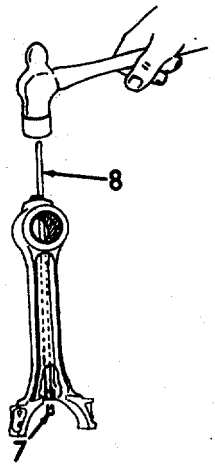
2. Support the connecting rod and tool in an arbor press.

3. Place a short sleeve directly over the spray nozzle. Then press the nozzle out of the connecting rod.

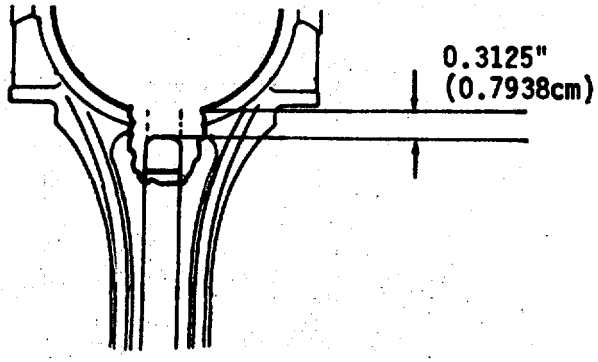
4. Remove the tool.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
9. Orifice (7)	a. Spray nozzle (8)	Remove.	
	b. Orifice (7)	Insert a rod in the oil passage and drive the orifice from the lower end of the connecting rod.	

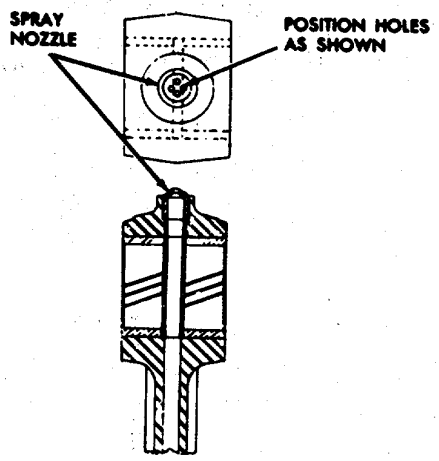


REASSEMBLY			
10. Orifice	Orifice (7)	Install from the upper bearing area.	Install orifice 0.3125 inch (0.7938 cm) from lower surface.

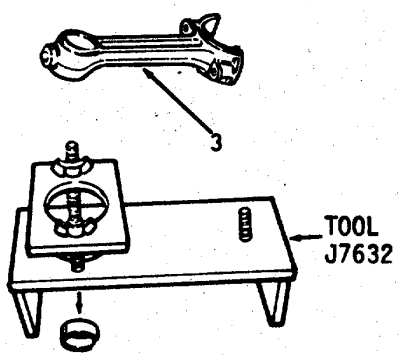


3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

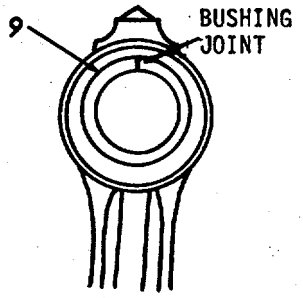
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
11. Spray nozzle	Spray nozzle (8) and connecting rod (3)	1. Insert nozzle straight into counterbore of connecting rod.	Align holes in spray nozzle as shown.



		2. Support the connecting rod in the arbor press place a short 3/8 inch I.D. sleeve on top of the nozzle and press the nozzle into the connecting rod until it bottoms in the counterbore.	
12. Bushings	a. Connecting rod (3)	Clamp upper end of connecting rod assembly in holder.	Use tool J7632. Align the bore of the bushing with the hole in the base of



3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Bushing (9)	1. Start a new bushing straight into the bore of the connecting rod, with the bushing joint at the top of the rod.	
			
		2. Insert installer in bushing, then insert handle in the installer.	Use installer tool J1513-6, and handle tool J1513-2.
		3. Drive the bushing in until the flange of the installer bottoms on the connecting rod.	
	c. Connecting rod (3)	Turn the connecting rod over in the holder and install the second bushing in the same manner.	

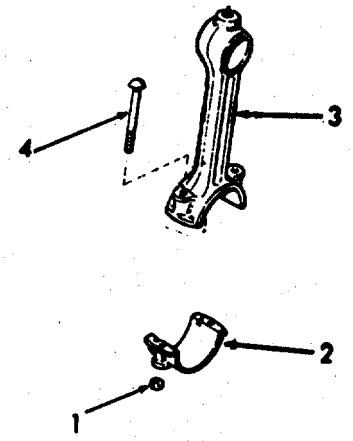
NOTE

The bushings must withstand an end load of 2000 pounds (907 kg) without moving after installation.

13. Bushing reaming	a. Connecting rod (3), bolts (4), bearing cap (2) and nuts (1)	Assemble.	

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



Ream the bushings to size, using tool set J1686-03, as follows:

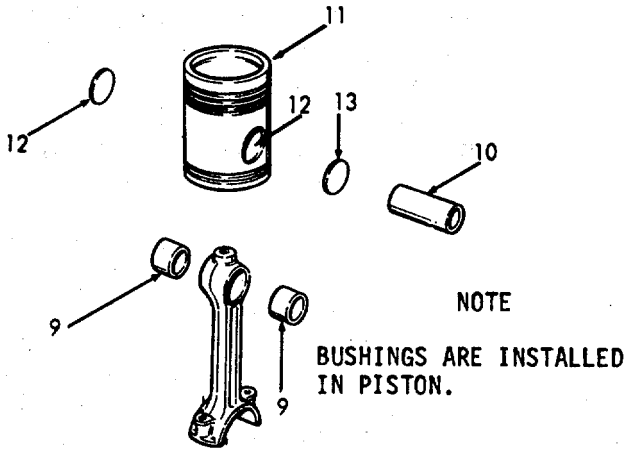
1. Clamp reaming fixture J1686-9 in a bench vise.
2. Position sleeve adaptor J1686-13 on the arbor of the fixture.
3. Place the crankshaft end of the connecting rod on the arbor of the fixture and tighten the connecting rod cap nuts to 60-70 lb-ft (81-95 Nm) torque for lubrite nut or 65-75 lb-ft (88-102 Nm) torque for the plain nut.
4. Slide the front guide bushing J1686-11 (with the pin end facing out in the fixture.
5. Align the upper end of the connecting rod with the hole in the reaming fixture.
6. Install the rear guide bushing J1686-5 on reamer J1686-20, then slide the reamer and bushing into the fixture.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

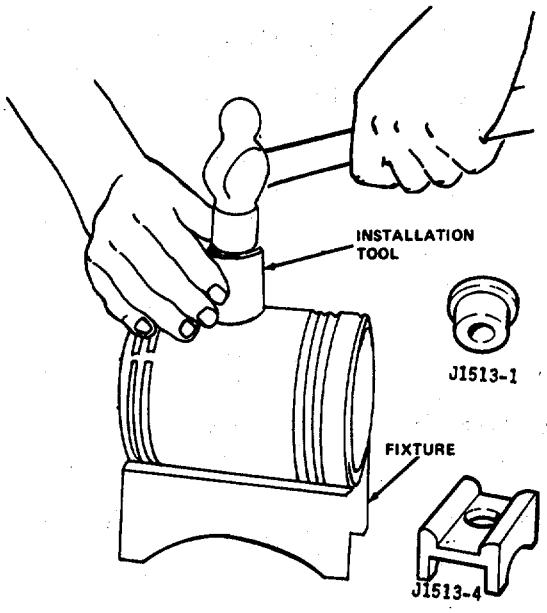
LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	7. Turn the reamer in a clockwise direction only, when reaming or withdrawing the reamer. For best results, use only moderate pressure on the reamer.		
	8. Remove the reamer and the connecting rod from the fixture, blow out the chips and measure the inside diameter of the bushings. The inside diameter of the bushings must be 1.5015 to 1.5020 inch (3.8138 to 3.8151 cm). This will provide a piston pin-to-bushing clearance of .0015 to .0024 inch (0.0038 to 0.0061 cm) with a new piston pin. A new piston pin has a diameter of 1.4996 to 1.5000 inch (3.8090 to 3.8100 cm).		
	NOTE Piston bushings are installed in piston (refer to paragraph 3-40.1).		
ASSEMBLY			
14. Connecting rod to piston	a. Piston pin (10), piston bushings (12), and connecting rod bushings (9)	Lubricate.	Use clean engine oil. Refer to paragraph 3-40.1.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			



b.	Piston (11)	Place in holding fixture.	Use tool J1513-1.



c.	Piston pin retainer (13)	1. Place on piston, then place crowned end of installer against the retainer.	Use tool J1513-4.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
		2. Place handle on installer.	Use tool J1513-2.
		3. Strike the handle enough to deflect the retainer and seat it evenly in the piston.	

CAUTION

Do not drive the retainer in too far or the piston bushing may be moved inward and result in reduced piston pin end clearance.

d.	Connecting rod (3)	Place the upper end of the connecting rod between the piston pin bosses and in line with the piston pin holes.	
e.	Piston pin (10)	Slide the piston pin in place. If the piston pin-to-bushing clearances are within the specified limits, the pin will slip into place without the use of force.	
f.	Piston pin retainer (13)	1. Place on piston; then place crowned end of installer against the retainer.	Use tool J1513-4.
		2. Place handle on installer.	Use tool J1513-2.
		3. Strike the handle just hard enough to deflect the retainer and seat it evenly in the piston.	

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			

CAUTION

Do not drive the retainer in too far or the piston bushing may be moved inward and result in reduced piston pin end clearance.

g. Piston pin (10) and connecting rod (3) assembled its bushings.

After the piston pin retainers have been installed, check for piston pin end clearance by cocking the connecting rod and shifting the pin in

h. Piston and connecting rod assembled

One important function of the piston pin retainer is to prevent the oil, which cools the underside of the piston and lubricates the piston pin bushings, from reaching the cylinder walls. Check the retainers for proper sealing as follows:

1. Place the piston and connecting rod assembly upside down on a bench.

2. Pour clean fuel oil in the piston to a level above the piston pin bosses.

3. Dry the external surfaces of the piston in the area around the retainers and allow the fuel oil to set for about fifteen minutes.

3-40.2. CONNECTOR ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
		4. Check for seepage of fuel oil around retainers. If it is leaking, install new retainers; In extreme cases, it may be necessary to replace the piston.	
		WARNING Use eye protection when using compressed air.	
		5. After the leakage test is completed, empty the fuel oil from the piston, dry the parts with compressed air and lubricate the piston pin with clean engine oil.	
i.	Piston and connecting rod assembly, and cylinder liner	Assembly.	Refer to paragraph 3-40.4.

3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS.

a. The connecting rod bearing shells are precision made and are replaceable with shim adjustments. They consist of an upper bearing shell seated in the connecting rod and a lower bearing shell seated in the connecting rod case. The bearing shells are prevented from end wise or radial movement by a tang at the parting line at one end of each bearing shell.

b. Multiple layer copper-lead coplated or aluminum triplated bearings are used. These bearings have an inner surface (matrix), of copper-lead or aluminum. A thin deposit of Babbitt is plated onto the matrix. This Babbitt overlay has excellent resistance to friction, corrosion and scoring tendencies which, combined with the material of the matrix, provides improved load carrying characteristics. These bearings are identified by the satin silver sheen of the babbitt when new and a dull gray after being in service.

c. The upper and lower connecting rod bearing shells are different and are not interchangeable. Both shells are notched midway between the bearing edges approximately 3/4 of an inch in from each parting line. The lower bearing shell has a circumferential oil groove that terminates at the notched ends. These notches maintain a continuous registry with the oil hole in the crankshaft connecting rod journal, and provide a constant supply of lubricating oil to the connecting rod bearings, piston pin bushings and spray nozzle through the oil passage in the connecting rod.

3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP

Test Equipment

Micrometer

Special Tools

Torque wrench
Pump, hand NSN 4930-00-263-9886
Soft plastic measuring strip

References

NONE

Equipment Condition

Condition Description

Paragraph:

3-35 0il Pan and Dipstick Removal
3-38 Lubricating Oil Pump Removal
3-39 Lube Oil Distribution System - Inlet Pipe Removal

Material/Parts

NONE

Special Environmental Conditions

Do not drain oil in bilges. Use oil/water separation and recovery system to collect drained oil.

Personnel Required

1

General Safety Instructions

WARNING
Wear eye protection when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Pump oil into suitable container.
		2. Remove oil pan.	Refer to paragraph 3-35.

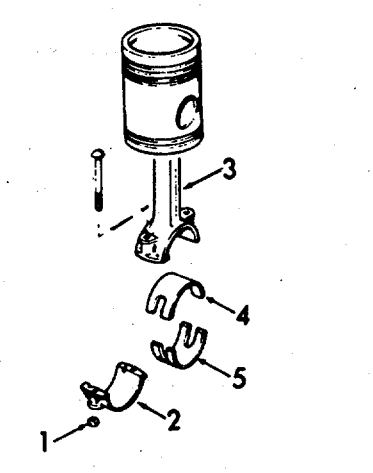
3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Lube oil pump	Remove	Refer to paragraph 3-38
2. Connecting rod(s)			

NOTE

The connecting rod bearing caps are numbered 1L,1R, AL, AIR, etc., with matching numbers and letters stamped on the-connecting rods. When removed, each bearing cap and the bearing shells must always be reinstalled on the original connecting rod.

a. Nuts (1)	Remove.	
b. Bearing cap (2)	Remove.	
c. Connecting rod (3)	Push connecting rod and piston assembly up into the cylinder liner.	Push far enough- to permit access to upper bearing shell.
d. Upper bearing shell (4)	Remove from connecting rod.	Do not pound on edge of bearing shell with sharp tool.
e. Lower bearing shell (5)	Remove from bearing cap (2).	Do not pound on edge of bearing shell with sharp tool.



3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		NOTE Do not remove another bearing cap or bearing shells.	
3.	Bearing shells	Bearing failures may result from deterioration (acid formation) or contamination of the oil or loss of oil An analysis of the lubricating oil may be required to determine if corrosive acid and sulphur are present which cause acid etching, flaking and pitting. Bear ing seizure may be due to low or no oil.	
	a. Upper and lower shells	1. Clean the bearings and inspect them for scor-ing, pitting, flaking, chipping, cracking, loss of Babbitt or signs of overheating.	If any of these defects are pre sent, the bear-ings must be discarded. how ever, Babbitt plated bearings may develop min ute cracks or small isolated cavities on the bearing surface during engine operation. These are char-acteristics of and are NOT de-trimental to this type of bearing. The bearings should not be replaced for these are minor surface imperfections. The upper bear ing shells, which carry loads will nor mally show signs of dis-tress before the lower bear-ing shells do.

3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION Cont)			
		2. Inspect the backs of the bearing shells for bright spots which indicate they have been shifting in their supports.	If such spots are present, discard the bearing shells.
		3. Measure the thickness of the bearing shells) using a micrometer and ball attachment.	The minimum thickness of a worn standard connecting rod bearing shell should not be ess than .1230 inch (0.3124 cm) and, if either bearing shell is thinner than this dimension, replace both bearing shells. A new standard bearing shell has a thickness of .1238 to .1243 inch (0.3145 to 0.3157 cm).
4. Connecting rod	Bearing bore	Inspect for burns, foreign particles and so forth.	
5. Crankshaft journal	Bearing shells	Check the clearance between the connecting rod bearing shells and the crankshaft journal.	This clearance may be checked by means of a soft plastic measuring strip which is squeezed between the journal and the bearing. The

3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

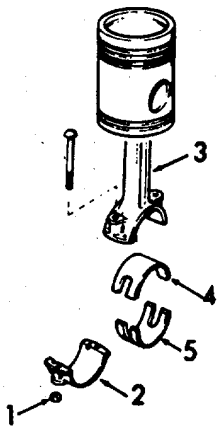
LOCATION	ITEM	ACTION	REMARKS
INSPECTION Cont)			
			maximum connecting rod bearing-to-journal clearance with used parts is .006 inch (0.015 cm).
INSTALLATION			
6.	Connecting rod(s)		

NOTE

Do not replace one connecting rod bearing shell alone. If one bearing shell requires replacement, install both new upper and lower bearing shells. Bearing shells are available in .010 inch, .020 inch and .030 inch undersize for service with reground crankshafts. Use these bearing shells on reground crankshafts only.

a.	Upper bearing shell (4)	Install the upper bearing shell-the one without the continuous oil groove-in the connecting rod.	Be sure the tang on the bearing shell fits in the groove in the connecting rod.
b.	Crank-shaft journal	Wipe clean and lubricate with clean engine oil.	
c.	Connec-ting rod and pis-ton as-sembly	Pull assembly down until the upper bearing seats firmly on the crankshaft journal.	

3-40.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION Cont)			
	d. Bearing cap (2) and lower bearing shell (5)	Assemble. 	Note the number and letter stamped on the connecting rod and the bearing cap and install the lower bearing shell-the one with the continuous oil groove-in the bearing cap, with the tang on the bearing shell in the groove in the bearing cap.
	e. Bearing cap (and lower bearing shell assembly) (2), and nuts (1)	Install.	Torque to 60-70 lb-ft (81-95 Nm) torque (lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (castel-lated nut).
	f. Lube oil pump	Install.	Refer to para-graph 3-38.
	g. Oil in-let pipe	Install.	Refer to para-graph 3-39.
	h. Oil pan	Install.	Refer to para-graph 3-35.
	i. Engine oil	Fill.	

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS.

a. The replaceable type cylinder liner is machined and heat treated to provide a long wearing scuff-resistant surface. The flange at the top fits into a counterbore in the cylinder block and rests on a replaceable cast iron insert which permits accurate alignment of he cylinder liner. Compression is sealed with an individual laminated i compression gasket for each cylinder.

b. The liner is cooled by a water jacket in the cylinder block and by the scavenging air introduced into the cylinder through the air inlet ports around the liner. These ports are machined at an angle to create a uniform swirling motion to the air as it enters the cylinder. This motion persists throughout the compression stroke and facilitates scavenging and combustion.

c. The wear on a liner and piston is directly related to the amount of abrasive dust and dirt introduced into the engine combustion chamber through the air intake. This dust; combined with lubricating oil on the cylinder wall, forms a lapping compound and will result in rapid wear. To avoid pulling contaminated air into the cylinder, the air silencer must be serviced regularly.

d. This paragraph also includes installation of the piston and connecting rod assembly into the cylinder liner. Next these components are installed in the engine.

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP

Test Equipment

Gage Cylinder Diameter Checking J5347-01
Gage Master Ring J8386-01

References

NONE

Special Tools

Remover Cylinder Liner J1918-02
Hold Down Clamp Cylinder Liner J21793-01 - Pump, hand NSN 4930-00-263-9886

Equipment Condition — Condition Description

Paragraph:

3-30	Rocker Arm Cover Removal
3-34	Cylinder Head Removal
3-35	Oil Pan Removal
3-38	Lube 0il Pump Removal
3-40.1	Piston Removal

Material/Parts

Cylinder Kit P/N 5149265
Cindol 1705

Special Environmental Conditions

Do not drain oil in bilges. Use -oil/water separation and recovery system-to collect drained oil.

Personnel Required

2

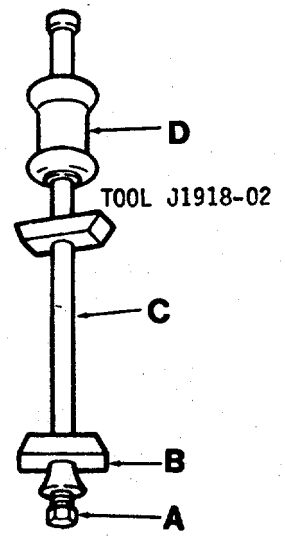
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Rocker arm cover	Remove.	Refer to paragraph 3-30.
	b. Oil pan	1. Remove oil.	Pump into suitable container.
		2. Remove.	Refer to paragraph 3-35.
	c. Lube oil pump	Remove.	Refer to paragraph 3-38.

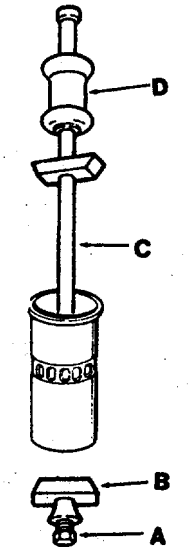
3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL Cont)			
	d. Cylinder head	Remove.	Refer to paragraph 3-34.
	e. Piston	Remove.	Refer to paragraph 3-40.1.
2. Cylinder liner			
	NOTE It is very important that the proper method is followed when removing a cylinder liner. Do not attempt to push the liner out by-inserting a bar in the liner ports and rotating the-crankshaft, otherwise the piston may be damaged or the upper ring groove may collapse.		
	a. Remover cylinder liner	1. Remove bolt (A), and lower shoe (B) from shaft (C).	Use tool J1918 02.
		2. Lower the lower shoe through the cylinder liner.	

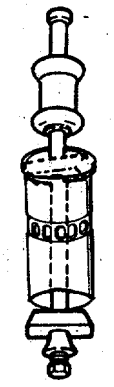


3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL Cont)			
		3. Lower the shaft (C) into the cylinder liner.	

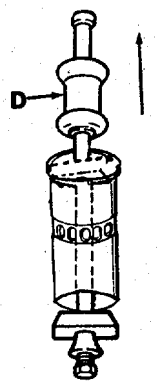


	4. Attach lower shoe (B) and bolt (A) to shaft (C).	Place the shoe on the bottom edge of the liner with the flat on the shoe parallel with the crank-shaft bore.

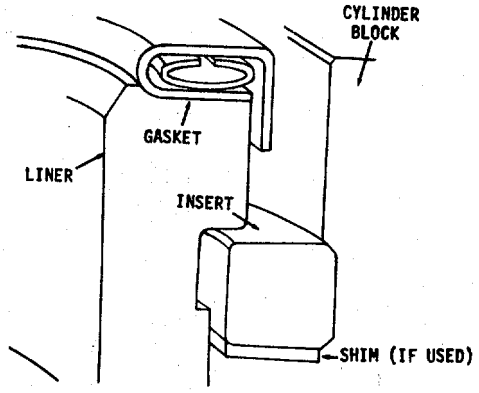


3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL Cont)			
		5. Hold the lower shoe and bolt assembly in the pulling position.	Place the upper shoe with the flat in the same position as the lower shoe. Adjust and tighten bolt(A).
		6. Grasp handle (D) and pull up sharply.	Pull up until cylinder liner is removed from cylinder.



		7. Disassemble tool from cylinder liner.	
3. Cylinder liner insert	Insert and shims (if used)	Remove and tag.	Remove from counterbore of engine block.

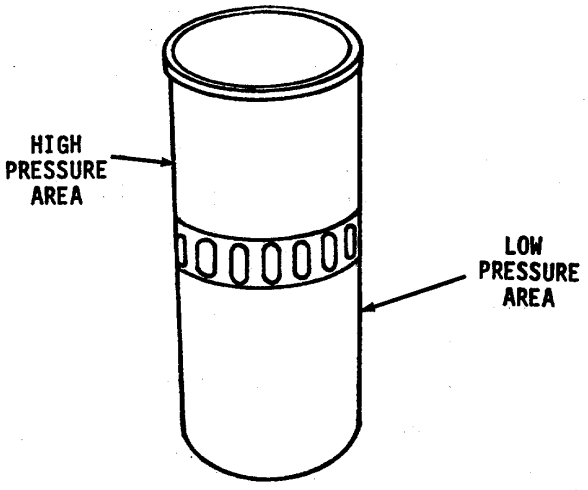


3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
4. Cylinder liner	a. Liner	1. Clean thoroughly.	
		2. Inspect for cracks or excessive scoring.	Discard. A slightly scored liner may be cleaned-up and reused.
		3. Inspect for excessive liner-to-block clearance or block bore distortion.	Excessive liner-to-block clearance or block bore distortion will reduce heat transfer from the liner to the block and to the engine coolant. Poor contact between the liner and the block bore may be indicated by stains or low pressure areas on the outer surface of the liner.
		4. Examine the outside diameter of the liner for fretting.	Fretting is the result of a slight movement of the liner in the block bore during engine operation, which causes material from the block to adhere to the liner. These metal particles may be removed from the surface of the

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIO NS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			liner with a coarse, flat stone.
		5. Inspect for cracks at the flange.	The liner flange must be smooth and flat on both the top and bottom surfaces. The liner insert must also be smooth and flat on the top and bottom surfaces. Replace the insert if there is any evidence of brinelling.



3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		6. Inspect the block bore and check the liner-to-block clearance whenever a liner is removed.	If the clearance exceeds zero to .002 inch (0.0051 cm), it will be necessary to bore the block for an oversize liner. Refer to Direct Support Maintenance.

NOTES

- Cylinder liners are available in .001, .005, .010, .020 and .030 inch oversize on the outside diameter. When an oversize liner is used, the amount of oversize is stamped on top of the cylinder block adjacent to the liner counterbore.
- New service liners, standard and oversize, have an inside diameter of 4.2495 to 4.2511 inch (10.7937 to 10.7978 cm).

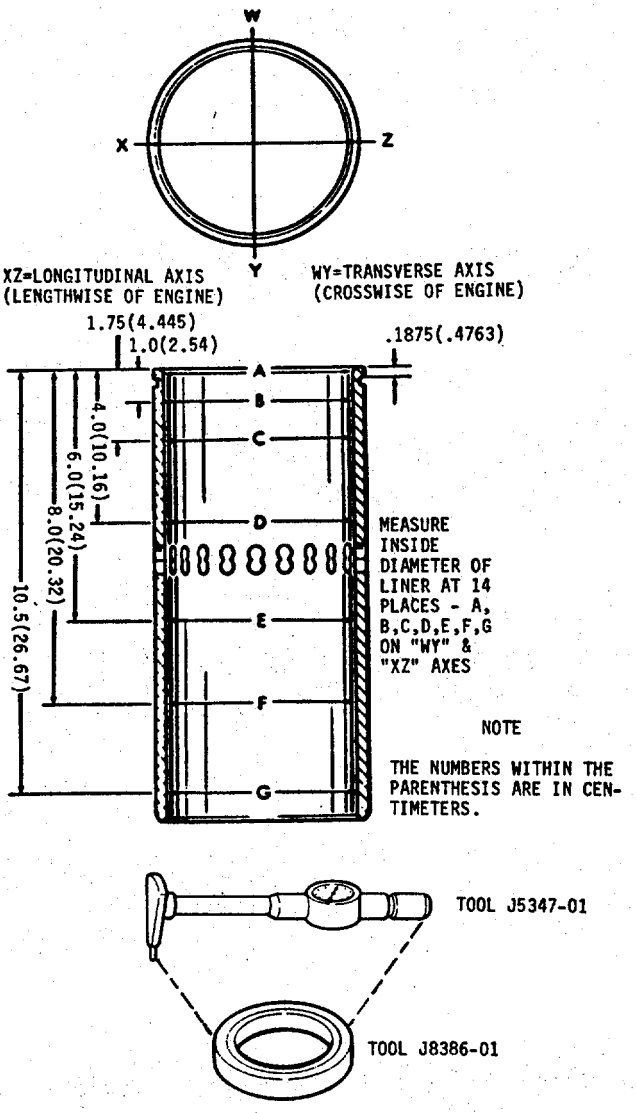
3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		NOTES (Cont)	
		• Do not modify the surface finish in a new service liner. Since the liner is properly finished at the factory, any change will adversely affect the seating of the piston rings.	
		7. Install the liner in the proper bore of the cylinder block and measure the inside diameter at the various points shown. Use cylinder bore gage J5347-01, which has a dial indicator calibrated in .0001 inch increments, as it is rather difficult to obtain an accurate measurement with a micrometer. Set the cylinder bore gage on zero in master ring gage J8386-01. Also check the liner for taper and out-of-round.	To reuse the liner, the taper must not exceed .002 inch and the out-of-round must not exceed .0025 inch. In addition, the ridge formed at the top of the ring travel must be removed. If the out-of-round exceeds .0025 inch rotate toe liner 90° in the block bore and recheck.

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

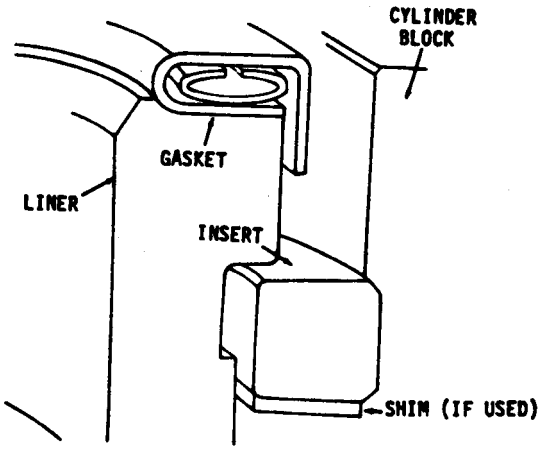
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Engine block	a. Engine block bore and counter-bore.	Wipe clean.	
	b. Cylinder liner insert	Insert in block counter-bore.	Use a standard size liner insert 0.1795 to 0.1800 inch (0.4559 to 0.4372 cm).



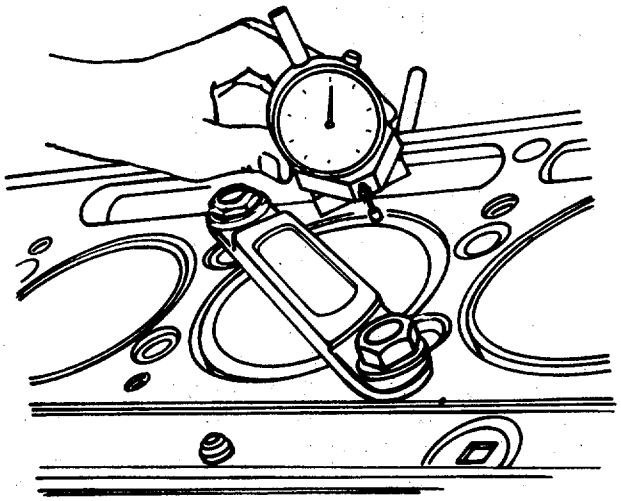
6. Cylinder liner	a. Liner	Push the cylinder into the cylinder block until the liner flange rests on the insert.	Do not use excessive force to install the liner. The liner should slide smoothly in place with thumb pressure. If a new liner cannot be pushed in place, light honing of the block bore may be necessary to obtain the desired

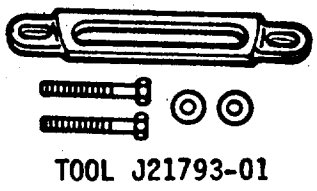
3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
			fit for best heat transfer liner-to-block clearance.

MINIMUM	MAXIMUM	LIMIT
.0000 (.0000 cm)	.0020 (.0051 cm)	.0025 (.0064 cm)

b.	Hold down clamp	Install.	Use tool J21793-01.





TOOL J21793-01

c.	Cylinder liner	1. Measure the distance from the top of the liner to the top of the block with a dial indicator. The liner flange must be .045 to .050 inch (.1143 to .1270 cm) below the surface of the block. However, even though	

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

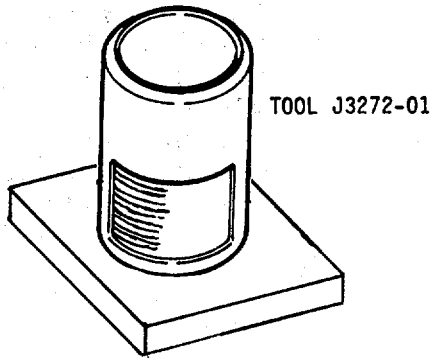
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		all of the liners are within these specifications, there must not be over .002 inch (.0051 cm) difference in depth between any two adjacent liners when measured along the cylinder longitudinal center line.	

NOTE

A .002 inch (.0051 cm) thick shim is available for adjusting the liner height. The shim must be in-stalled underneath the liner insert. Do not cut the shim for installation. Liner inserts which are .0015 inch (.0038 cm) thicker or thinner than standard are also available for service.

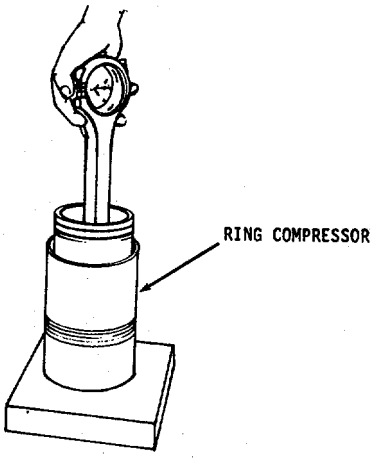
		2. Matchmark the liner and the cylinder block with chalk or paint so the liner may be reinstalled in the same position in the same block bore. The matchmarks should be on the side opposite the camshaft.	
d.	Hold down clamp and cylinder liner	Remove.	

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		NOTE Do not remove the liner insert.	
7. Piston and connecting rod assembly	a. Assembly and piston ring compressor	Lubricate piston, rings and inside surface of compressor.	Use tool J3272-01. Use lubricant Cindol 1705 oil.
		NOTE Inspect the ring compressor for nicks or burrs, especially at the non-tapered inside diameter end. Nicks or burrs on the inside diameter of the compressor will result in damage to the piston rings.	
	b. Compressor	Place on wood block with chamfered end up.  	
	c. Piston and connecting rod assembly	Position (stagger) the piston ring gaps properly on the piston.	Make sure the ends of the oil control ring expanders are not overlapped.

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Assembly and compressor	Start the top of the piston straight into the ring compressor. Then push the piston down until it contacts the wood block.	
	e. Cylinder liner	Note the position of the matchmark and place the liner, with the flange end down, on the wood block.	
	f. Compressor on piston and connecting rod assembly and cylinder liner	1. Place the ring compressor and the piston and connecting rod assembly on the liner so the numbers on the rod and cap are aligned with the matchmark on the liner.	



3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

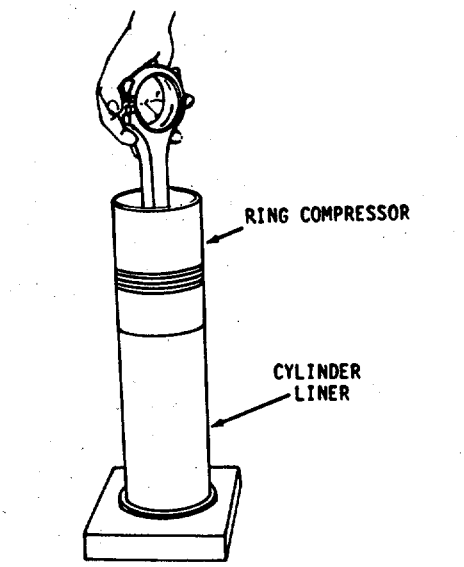
NOTE

The numbers on the side of the connecting rod and cap identify the rod with the cap and indicate the particular cylinder in which they are used. If a new ser- vice connecting rod is to be installed, the same identification numbers must be stamped in the same location as on the connecting rod that was replaced.

2. Push the piston and connecting rod assembly down into the liner until the piston is free of the ring compressor.

CAUTION

Do not force the piston into the liner. The peripheral abutment type expanders apply considerably more force on the oil ring than the standard expander.Therefore, extra care must be taken during the loading operation to prevent ring breakage.



3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Connecting rod cap and ring compressor	1. Remove. 2. Push piston down until the compression rings pass the cylinder liner ports.	
8. Cylinder liner, piston and connecting rod assembly			

NOTES

1. If any of the pistons and liners are already in the engine, use hold-down clamps to retain the liners in place when the crankshaft is rotated.

2. Rotate the crankshaft until the connecting rod journal of the particular cylinder being worked on is at the bottom of its travel. Wipe the journal clean and lubricate it with clean engine oil.

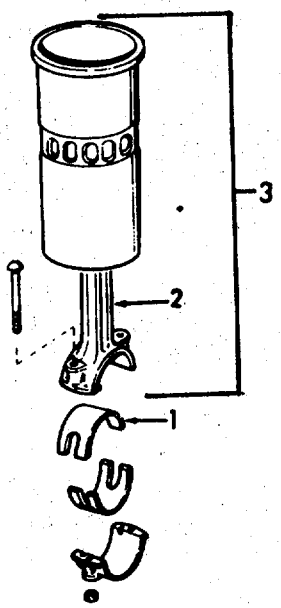
a. Upper bearing shell (1) groove.	Install in connecting rod (2). Lubricate.	The upper bearing shell does not have a continuous oil Lubricate the bearing shell with clean engine oil.

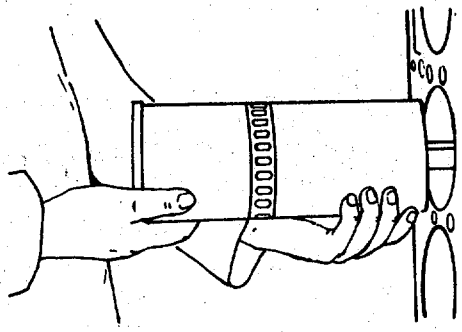
NOTE

Each connecting rod and its cap is numbered on one side - 1L, IR, 2L, 2R, etc. These numbers and letters identify the caps with the rods and indicate the particular cylinder in which they are used. Maintain these positions when assembling the engine.

3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	b. Piston, rod and liner assembly (3)	1. Position the piston, rod and liner assembly in front of the cylinder block bore so the identification number and letter on the rod face the outer edge of the cylinder block and the match-marks on the liner and the block are in alignment. 2. Guide the end of the connecting rod through the block bore carefully to avoid damaging or dislodging the bearing shell. 3. Slide the piston, rod and liner assembly straight into the block bore until the liner flange rests against the insert in the counterbore in the block.	





3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Piston and connecting rod (2)	Push or pull the piston and connecting rod into the liner until the upper bearing shell is firmly seated on the crankshaft journal.	

CAUTION

The distance from the vertical center line of the connecting rod bolts to the edges of the rod are not equal. Therefore, when installing the piston and connecting rod assembly, be sure that the narrow side of the two connecting rods on the crankshaft journal are together to avoid cocking of the rod.

d. Lower bearing shell (4) and bearing cap (5)	Assemble and lubricate.	The lower bearing shell has a continuous oil groove from one parting line to the other. Lubricate the bearing shell with clean engine oil.
e. Bearing cap with bearing shell, connecting rod (2) and nuts (6)	Install the bearing cap and the bearing shell on the connecting rod with the identification numbers on the cap and the rod adjacent to each other.	Tighten the connecting rod bolt nuts to 60-70 lb-ft (81-95 Nm) torque (notch or imbedded "O" lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (castellated nut).

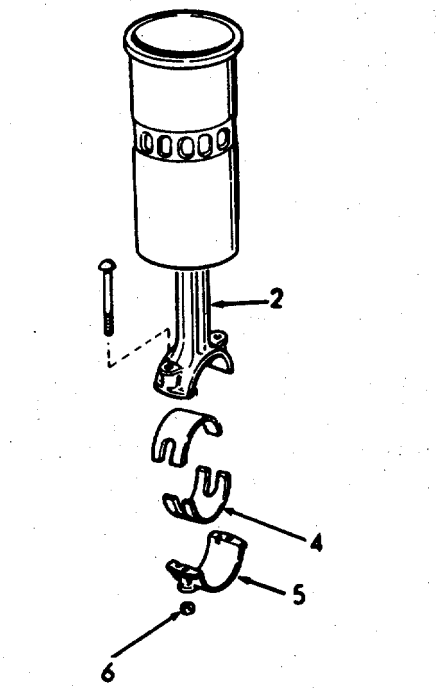
3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	f. Connecting rod (2)	Check the connecting rod side clearance.	The clearance between each pair of connecting rods should be .008 to .016 inch (0.020 to 0.041 cm) with new parts.

NOTES

1. Install the remaining liner, piston and rod assemblies in the same manner. Use hold-down clamps to hold each liner in place.

2. After all of the liners and pistons have been installed, remove the hold-down clamps.



3-40.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
g.	Cylinder head	Install.	Use new compression gaskets, water seals, and oil seals. Refer to paragraph 3-34.
h.	Lube oil pump	Install.	Refer to paragraph 3-38.
i.	Oil pan	Install.	Refer to paragraph 3-35.
j.	Rocker arm cover	Install.	Refer to paragraph 3-30.
k.	Engine	Add engine oil, and coolant.	

3-41. CRANKSHAFT BEARINGS.

a. The crankshaft main bearings shells are precision made and are replaceable without machining. They consist of an upper bearing shell seated in each cylinder block main bearing support and a lower bearing shell seated in each main bearing cap. The bearing shells are prevented from endwise or radial movement by a tang at the parting line at one end of each bearing shell. The tangs on the lower bearing shells are off-center and the tangs on the upper bearing shells are centered to aid correct installation.

b. The bearing caps are numbered 1,2,3, etc. indicating their respective positions and, when removed, must always be reinstalled in their original position.

c. An oil hole in the groove of each upper bearing shell, midway between the parting lines, registers with a vertical oil passage in the cylinder block. Lubricating oil, under pressure, passes from the cylinder block oil gallery by way of the bearing shells to the drilled passages in the crankshaft, then to the connecting rods and connecting rod bearings.

d. The lower main bearing shells have no oil grooves; therefore, the upper and lower bearing shells must not be interchanged.

e. Thrust washers on each side of the rear main bearing, absorb the crankshaft thrust. The lower halves of the two-piece washers are doweled to the bearing cap; the upper halves are not doweled.

f. Main bearing trouble is ordinarily indicated by low or no oil pressure. All of the main bearing load is carried on the lower bearings; therefore, wear will occur on the lower bearing shells first. The condition of the lower bearing shells may be observed by removing the main bearing caps.

g. Bearing failures may result from deterioration (acid formation) or contamination of the oil or loss of oil. An analysis of the lubricating oil may be required to determine if corrosive acid and sulphur are present which cause acid etching, flaking and pitting. Bearing seizure may be due to low oil or no oil.

h. Check the oil filter elements and replace them if necessary. Also check the oil by-pass valve to make sure it is operating freely.

3-41. CRANKSHAFT BEARINGS (Cont).

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP

Test Equipment

Cylinder diameter gage J5347-01
Micrometer - ball end

Special Tools

Torque wrench
Pump, hand NSN 4930-00-263-9886

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition | Condition Description

Para 3-35 | Oil Pan Removed
Para 3-38 | Lube Oil Pump Removed
Para 3-39 | Oil Inlet Pipe Removed

Special Environmental Conditions

Do not drain oil in bilges. Use oil/water separation and recovery system to collect drained oil.

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Pump into a suitable container.
		2. Remove.	Refer to paragraph 3-35.
	b. Oil inlet pipe	Remove.	Refer to paragraph 3-39.
	c. Lube oil pump	Remove.	Refer to paragraph 3-38.

3-41. CRANKSHAFT BEARINGS (Cont).

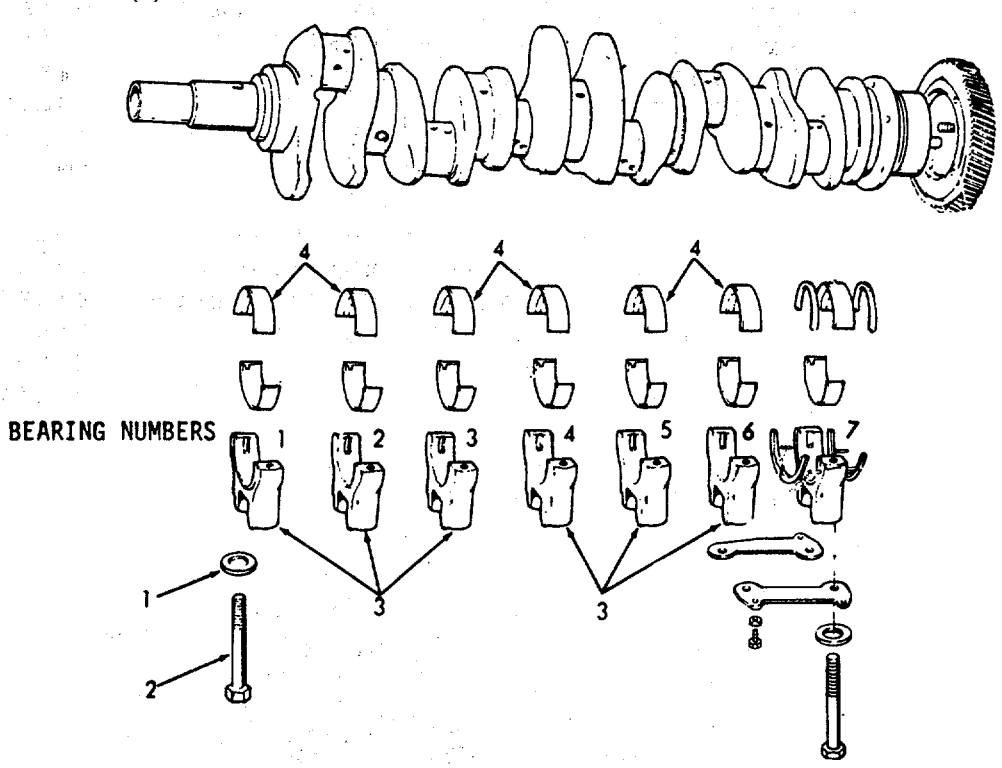
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2.	Main bearings, numbers 1, 2, 3, 4, 5 and 6.		

NOTES

- All crankshaft main bearing journals, except the rear journal, are drilled for an oil passage. Therefore, the procedure for removing the upper bearing shells with the crankshaft in place is somewhat different on the drilled journals than on the rear journal.
- If shims are used between the oil pump and the main bearing caps, save the shims so that they may be reinstalled in exactly the same location.
- Remove one main bearing cap at a time and inspect the bearing shells as outlined under inspection. Reinstall each bearing shell and bear- ing cap before removing another bearing cap.

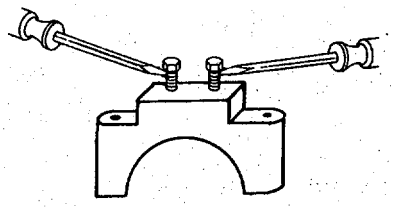
3-41. CRANKSHAFT BEARINGS (Cont).

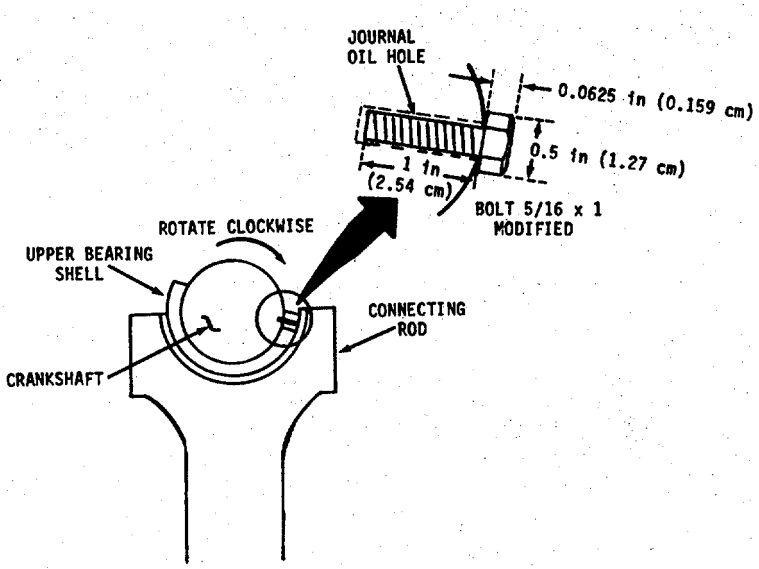
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	a. Bolts (1), and washers (2)	Remove.	



	b. Bearing cap (3)	1. Insert two bolts in bearing cap, leaving bottom of head accessible.	
		2. Pry bearing cap off.	
		3. Remove.	

3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
			
c.	Upper main bearing shell (4)	1. Insert bolt in crankshaft journal oil hole.	Make bolt from 5/16 x 1 (standard bolt). Modify head to 1/2 inch (1.27 cm).
		2. Rotate crankshaft to the right (clockwise), and roll bearing shell out of piston.	The head of bolt must not extend beyond the outside diameter of the bearing shell.
		3. Remove bolt.	



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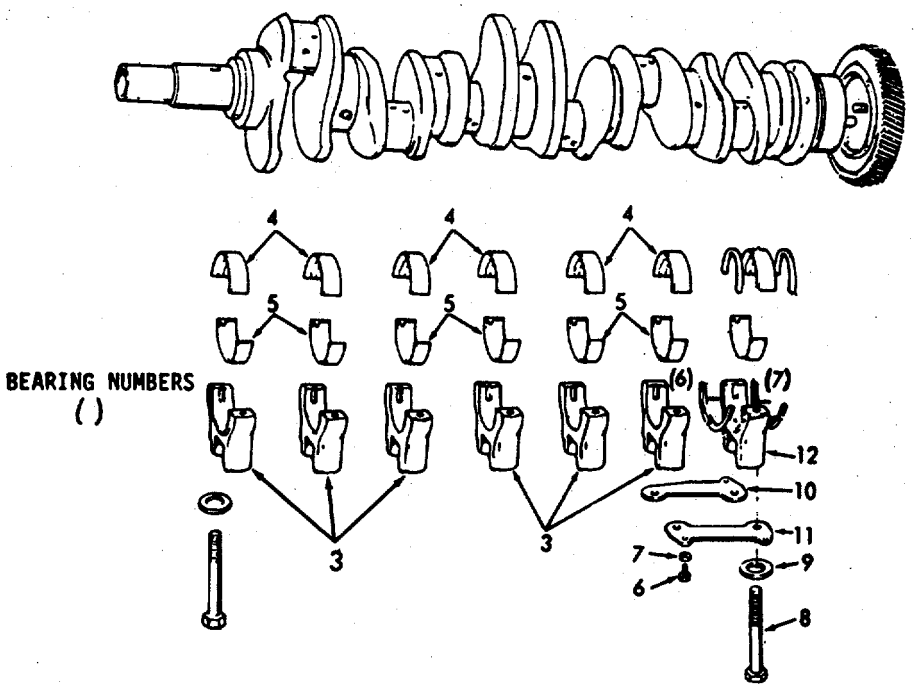
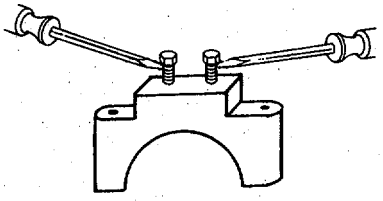
3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Lower housing. shell (5)	Remove from bearing cap (3).	
3. Main bearing, numbers 6 and 7	a. Lock bolts (6) and flat washers (7)	Remove.	



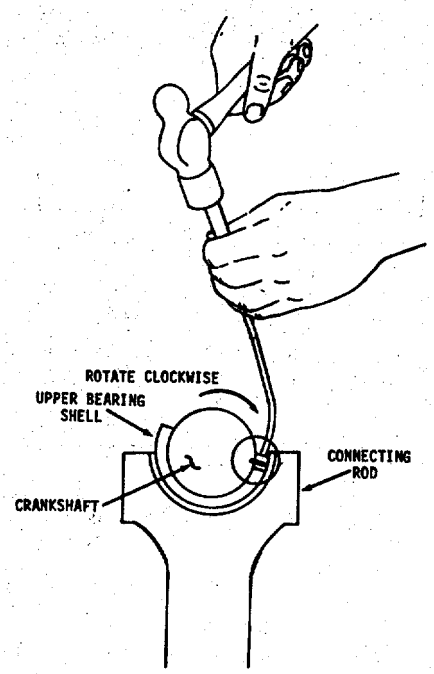
	b. Bolts (8) and washers (9)	Remove on one side only.
	c. Stabil-izer (10 or 11)	Remove one at a time.

3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
d.	Bolts (8), washers (9) and extra washers falling out.	Reinstall.	Add extra washer equal to thickness of stabilizer to prevent a bearing cap
e.	Stabilizer (10 or 11)	Remove the other stabilizer.	
f.	Bearing cap (3 or 12)	1. Insert two bolts in bearing cap, leaving bottom of head accessible. 2. Pry bearing cap off. 3. Remove. 	
g.	Upper main bearing (4)	Remove.	Refer to step 2c.

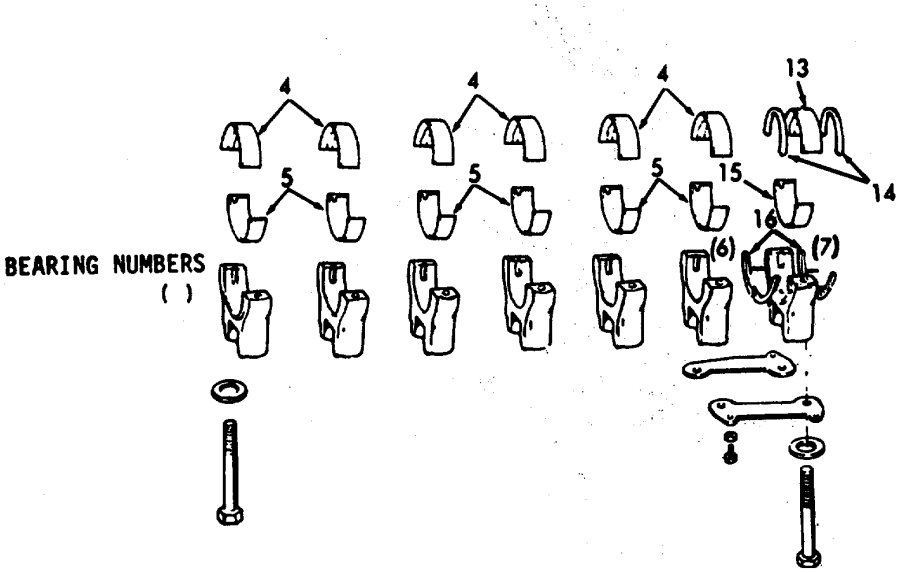
3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Upper main bearing shell (13)	Remove by tapping on the edge of the bearing with a small curved rod, revolving the crankshaft at the same time to roll the bearing shell out.	
	i. Upper thrust washers (14)	Remove by pushing on end of washers with a small rod. Force washers around and out.	
	j. Lower bearing shell (5)	Remove from bearing cap (3).	
	k. Lower bearing shell (15) and lower thrust washers (16)	Remove from bearing cap (12).	



3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
4. Upper and lower bearing shells	a. Bearing shells (4 and 13), (5 and (15)	1. Clean. 2. Inspect for scoring, pitting, flaking, etching, loss of babbitt, and signs of overheating.	The lower bearing shells, which carry the load, will normally show signs of distress before the upper bearing shells. However, babbitt plated bearings may develop minute cracks or small isolated cavities on the bearing surface during engine operation. These are characteristics of and are not detrimental to this type of bearing. They should not be replaced for these minor surface imperfections since function of the bearings is in no way impaired and they will give many additional hours of trouble-free operation.



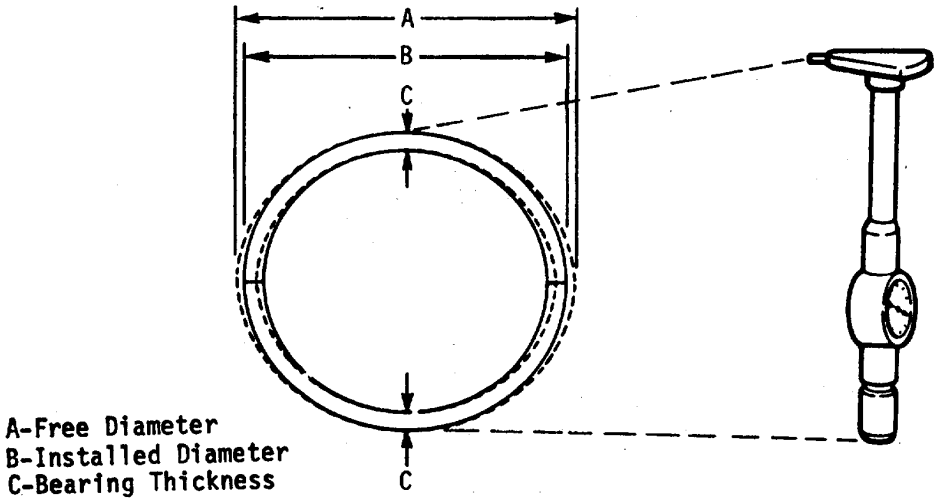
3-41. CRANKSHAFT BEARINGS (Cont).

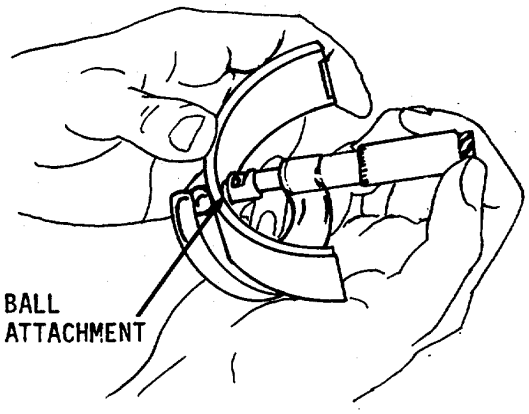
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		3. Inspect the backs of the bearing shells for bright spots which indicate they have been moving in the bearing caps or bearing supports.	If such spots are present, discard the bearing shells.
		4. Measure the thickness of the bearing shells at point "C", 90° from the parting line. Tool J5347-01, placed between the bearing shell and a micrometer, will give an accurate measurement. The bearing shell thickness will be the total thickness of the steel ball in the tool and the bearing shell, less the diameter of the ball. This is the only practical method for measuring the bearing thickness, unless a special micrometer is available for this purpose. The minimum thickness of a worn standard main bearing shell is .1540 inch (0.3912 cm) and, if any of the bearing shells are thinner than this dimension, replace all of the bearing shells. A new standard bearing shell has a thickness of .1545 to .1552 inch (0.3924 to 0.3942 cm).	

3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
	INSPECTION (Cont)		

Bearing Size	Bearing Thickness	Minimum Thickness
STANDARD	.1545"/.1552"	.154"
.002" Undersize	.1555"/.1562"	.155"
.010" Undersize	.1595"/.1602"	.159"
.020" Undersize	.1645"/.1652"	.164"
.030" Undersize	.1695"/.1702"	.169"





3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)		5. Check the clearance between the main bearings and the crankshaft journals. This clearance may be determined with the crankshaft in place by means of a soft plastic measuring strip which is squeezed between the journal and the bearing, measure the outside diameter of the crankshaft main bearing journals and the inside diameter of the main bearing shells when installed in place with the proper torque on the bearing cap bolts. When installed, the bearing shells are .001 inch (0.0025 cm) larger in diameter at the parting line than 90°from the parting line.	

The bearing shells do not form a true circle when not installed. When installed, the bearing shells have a squeeze fit in the main bearing bore and must be tight when the bearing cap is drawn down. The crush assures a tight, uniform contact between the bearing shell and bearing seat. Bearing shells that do not have sufficient crush will not have uniform contact, as shown by shiny spots on the-back, and must be replaced. If the clearance between any crankshaft journal and its bearing shells exceeds .0060 inch (0.0152 cm), all of the bearing shells must be discarded and replaced. This clearance is .0016 to .0050 inch (0.0041 to 0.0127 cm) with new parts.

3-41. CRANKSHAFT BEARINGS (Cont).

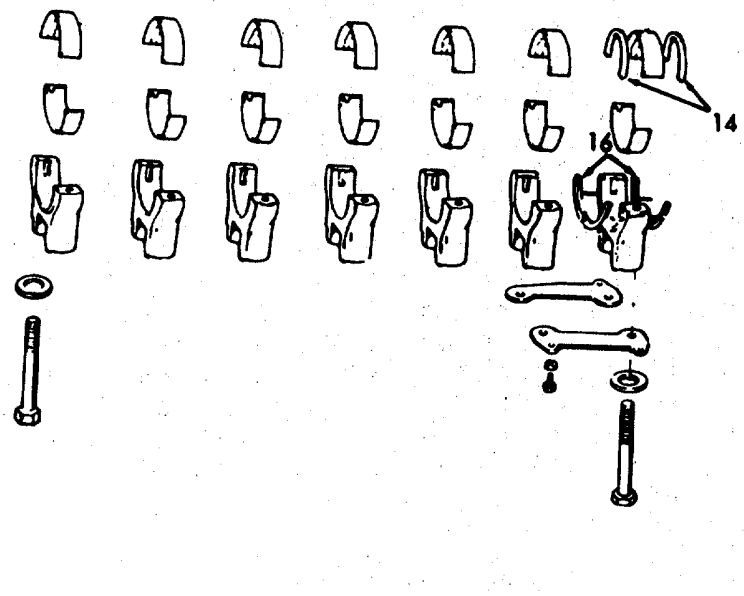
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

Before installing new replacement bearings, it is very important to thoroughly inspect the crankshaft journals. Very often, after prolonged engine operation, a ridge is formed on the crankshaft journals in line with the journal oil holes. If this ridge is not removed before the new bearings are installed, then, during engine operation, localized high unit pressures in the center area of the bearing shell will cause pitting of the bearing surface. Also, damaged bearings may cause bending fatigue and resultant cracks in the crankshaft. Refer to paragraph 3-42 under Crankshaft Inspection for removal of ridges and inspection of the crankshaft.

Do not replace one main bearing shell alone. If one bearing shell requires replacement, install both new upper and lower bearing shells. Also, if a new or reground crankshaft is to be used, install all new bearing shells.

5.	Upper and lower thrust washers	Thrust washers (14 and 16)	Inspect.	If the washers are scored or worn excessively or the crankshaft end play is excessive, they must be replaced. Improper clutch adjustment can contribute to excessive wear on the thrust washers. Inspect the crankshaft thrust surfaces. If, after dressing or regrinding the thrust surfaces, new standard size thrust washers do not hold the crankshaft end play within the specified limits, it may be necessary to in-



3-41. CRANKSHAFT BEARINGS (Cont).

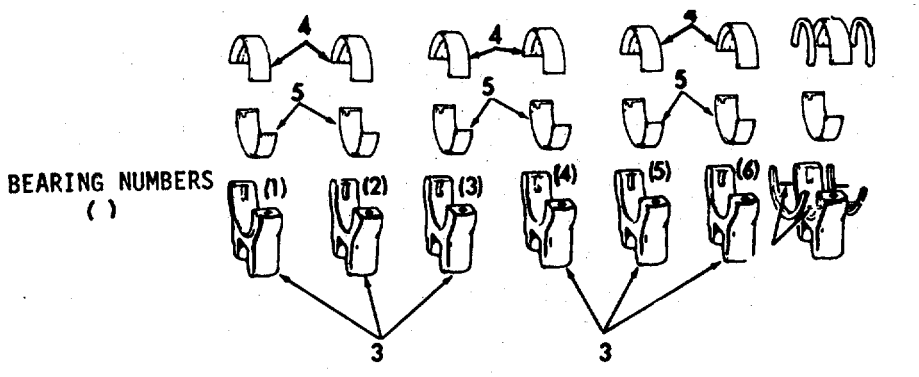
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			stall over-size thrust washer on one or both sides of the rear main bearing. A new standard size thrust washer is .1190 to .1220 inch (0.3023 to 0.3099 cm) thick. Thrust washers are available in .005 and .010 inch (0.0127 and 0.0254 cm) oversize.
INSTALLATION			
6. Upper bearing Numbers 1, 2, 3, 4, 5, 6	Upper bearing shells (4)	1. Clean. 2. Lubricate.	Use clean engine oil.

NOTE

The upper and lower main bearing shells are not alike: the upper bearing shell is grooved and drilled for lubrication - the lower bearing shell is not. Be sure to install the grooved and drilled bearing shells in the cylinder block and the plain bearing shells in the bearing caps, otherwise the oil

3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		NOTE flow to the bearings and to the upper end of the connecting rods will be blocked off. Used bearing shells must be rein- stalled on the same journal from which they were removed.	
		3. Install.	Start the plain end of the bearing shell around the crankshaft journal so that, when the bearing is in place, the tang will fit into the groove in the bearing support.
7. Lower Bearings numbers 1, 2, 3, 4, 5, 6	Lower bearing shells (5)	1. Clean. 2. Lubricate.	Use clean engine oil.
	3. Install so that the tang on the bearing fits into the groove in the bearing cap (3).		



3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Upper bearing number 7	Upper bearing shell (13) and thrust washers (14)	1. Clean.	
		2. Lubricate.	Use clean engine oil.
		3. Inspect for burrs.	Remove from washer seats- the slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.
		4. Slide the upper halves of thrust washers into place.	
		5. Install.	Remove from washer seats- the slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.
9. Lower bearing number 7	Lower bearing shell (15) and thrust washers (16)	1. Clean.	
		2. Lubricate.	Use clean engine oil.
		3. Inspect for burrs.	Remove from washer seats- the slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.

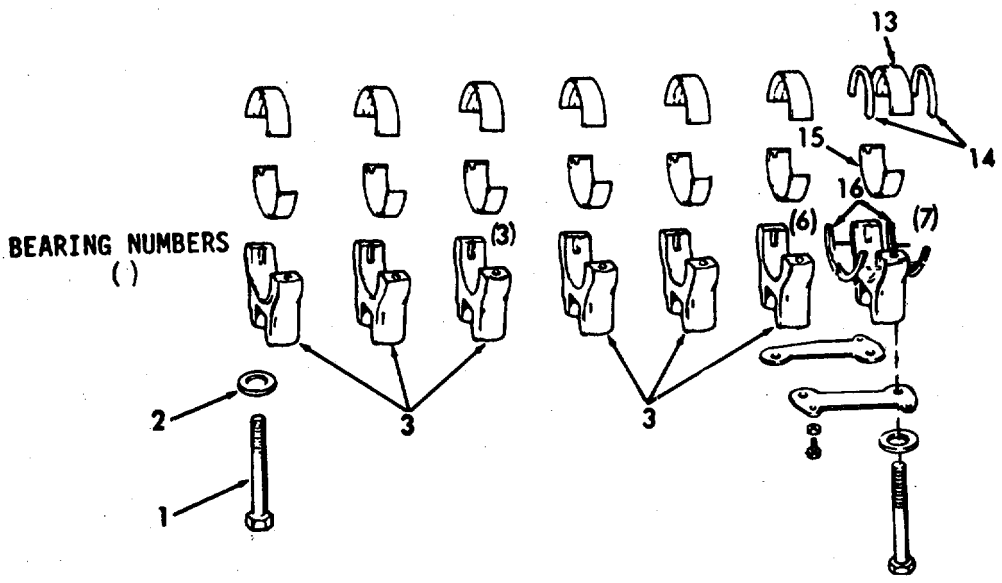
3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
10. Bearing caps numbers 1 thru 5	a. Bolts (1)	Place a small quantity of compound on threads and the bolt head contact area.	Use International Compound #2 or equivalent.
	b. Bearing caps (3)	Position on crankshaft.	

NOTE

The main bearing caps are bored in position and stamped 1,2,3, etc. They must be installed in their original positions in the cylinder block.

c. Bolts (1) and washers (2)	1.	Install and draw up tight.	
	2.	Rap the bearing cap sharply with a soft hammer.	To seat the bearing caps.
	3.	Tighten bolts uniformly.	Torque to 180-190 lb-ft (244.1-257.6 Nm).



3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM		ACTION	REMARKS
INSTALLATION (Cont)				
11. Bearing cap number 6	a. Bolts (1)		Place a small quantity of compound on threads and the bolt head contact area.	Use International Compound #2 or equivalent.
	b. Bearing caps (3)		Position on crankshaft.	
	c. Stabilizers (10 and 11), screws (6) and flat washers (7)		Install.	Torque to 70-75 lb-ft (94.9-101.7 Nm)
	d. Bolts (1) and washers (2)	1.	Install and draw up tight.	
		2.	Rap the bearing cap sharply with a soft hammer.	To seat the bearing caps.

NOTE

If the bearings have been installed properly, the crankshaft will turn freely with all of the main bearing cap bolts drawn to the specified torque.

12. Engine	a. Lube oil pump	Install.	Refer to paragraph 3-38.
	b. Oil inlet pipe	Install.	Refer to paragraph 3-39.

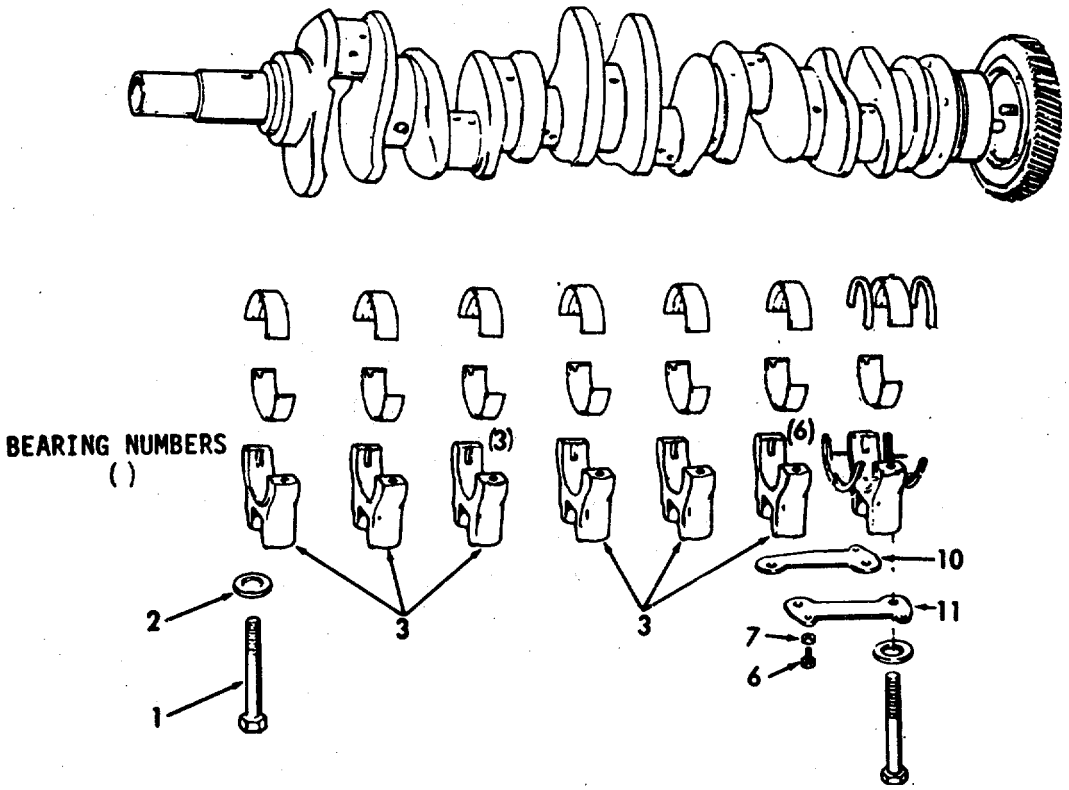
3-41. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

NOTE

If shims were used between the lube oil pump and the bearing caps, install them in their original positions.

c.	Oil pan	1. Install.	Refer to paragraph 3-35.
		2. Fill with oil.	



3-42. CRANKSHAFT - MAINTENANCE INSTRUCTIONS.

a. The crankshaft is a one-piece steel forging, heat-treated to ensure strength and durability. The main and connecting rod bearing journal surfaces and fillets on all crankshafts are induction hardener.

b. Complete static and dynamic balance of the crankshaft has been achieved by counterweights incorporated into the crankshaft.

c. The crankshaft end play is controlled by thrust washers located at the rear main bearing cap of the engine. Full pressure lubrication to all connecting rod and main bearings is provided by drilled passages within the crankshaft and cylinder block.

d. Two dowels and six tapped holes are provided in the rear end of the crankshaft for locating and attaching the flywheel. One hole is unequally spaced so that the flywheel can be attached in only one position.

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

References
NONE

Equipment

Condition	Condition Description
Para 3-35	Oil Pan Removed
Para 3-38	Lube Oil Pump Removed
Para 3-39	Oil Inlet Pipe Removed
Para 3-41	Crankshaft Bearings Removed

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
NONE

3-42. CRANKSHAFT BEARINGS (Cont).

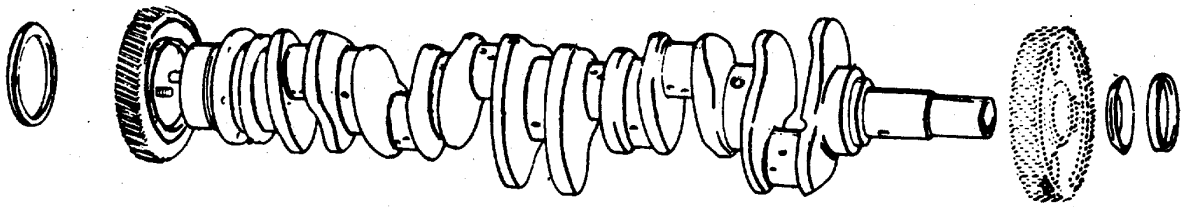
LOCATION	ITEM	ACTION	REMARKS

NOTE

Refer to Direct Support Maintenance for all repairs.

INSPECTION

1. Engine	Crankshaft	1. Inspect for cracks which start at an oil hole and follow the journal surface at an angle of 45 to the axis. 2. Inspect for crack's or wear around keyways. 3.Inspect for overheating. 4. Inspect the oil seal for roughness or grooves. 5. Check the gears for damage.	



3-893

3-43. CRANKSHAFT SEALS.

a. An oil seal is used at each end of the crankshaft to retain the lubricating oil in the crankcase. The sealing lips of the oil seals are held firmly, but not tight against the crankshaft sealing surfaces, by a coil spring.

b. The front oil seal is pressed into the crankshaft front cover. The lip of the seal bears against a removable spacer or vibration damper inner cone on the end of the crankshaft.

c. A double-lip oil seal is used in engines where there is oil on both sides of the oil seal; the lips of the seal face in opposite directions. The rear oil seal is pressed into the flywheel housing.

d. Oil leaks indicate worn or damaged oil seals. Oil seals may become worn or damaged due to improper installation, excessive main bearing clearances, excessive flywheel housing bore runout or grooved sealing surfaces on the crankshaft or oil seal spacers. To prevent a repetition of any oil seal leaks, these conditions must be checked and corrected.

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment

Condition	Condition Description
Para 3-35	Oil Pan Removed
Para 3-38	Lube Oil Pump Removed
Para 3-39	Oil Inlet Pipe Removed

Special Environmental Conditions
NONE

General Safety Instructions
NONE

3-43. CRANKSHAFT BEARINGS (Cont).

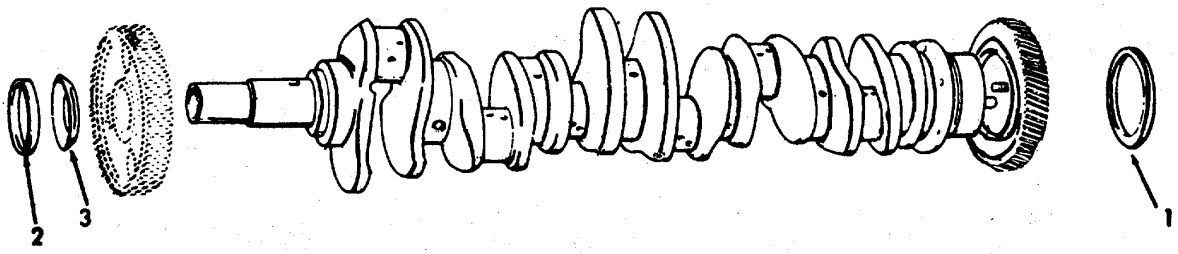
LOCATION	ITEM	ACTION	REMARKS

NOTE

Refer to Direct Support Maintenance for all repairs.

INSPECTION

1. Engine	a. Oil seals rear (1)	1. Inspect for wear due to the rubbing action of the oil seal. 2. Inspect for dirt build-up or fretting by the action of the flywheel. 3. Check for oil leaks.	
	b. Oil seal front (2) and spacer (3)	1. Inspect for wear, or dirt build-up. 2. Check for oil leaks.	



3-895

3-44. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS.

a. The cylinder block serves as the main structural part of the engine. Transverse webs provide rigidity and strength and ensure alignment of the block bores and bearings under load.

b. The block is bored to receive replaceable cylinder liners. The cylinder block is designed to provide water cooling below the air inlet port belt. An air box between the cylinder banks and extending around the cylinders at the air inlet port belt conducts the air from the blower to the cylinders. Air box openings on each side of the block permit inspection of the pistons and compression rings through the air inlet ports in the cylinder liners. The air box openings in the cylinder block assembly are about 1 7/8" x 3 1/8" (4.76 x 7.94 cm) and are covered with cast covers. The camshaft bores are located on the inner side of each cylinder bank near the top of the block.

c. The upper halves of the main bearing supports are cast intergral with the block. The main bearing bores are line-bored with the bearing caps in place to ensure longitudinal alignment. Drilled passages in the block carry the lubricating oil to all moving parts of the engine.

d. The top surface of each cylinder bank is grooved to accommodate a block-to-head oil seal ring. Each water or oil hole is counterbored to provide for individual seal rings.

e. Each cylinder liner is retained in the block by a flange at its upper end. The liner flange rests on an insert located in the counter- bore in the block bore. An individual compression gasket is used at each cylinder. When the cylinder heads are installed, the gaskets and seal rings compress to form a tight metal-to-metal contact between the heads and the block.

f. Cylinder block assemblies include the main bearing caps and bolts, dowels and the necessary plugs. Since the cylinder block is the main structural part of the engine, the various sub-assemblies must be removed from the cylinder block when an engine is overhauled.

3-44. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
NONE

Condition Description

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		Refer to Direct Support Maintenance for all repairs.	
1. Engine	a. Cylinder block	Inspect for cracks, and signs of damage.	Refer to Direct Support Maintenance.
	b. Air box covers	Inspect for leaking gaskets.	Replace.
	c. Air box drains	Inspect for bent or broken tubes.	Replace.
	d. Water holes	Inspect for leaking gaskets.	Replace.
	e. Pipe plugs	Inspect for leaking.	Replace.
	f. Drain cock	Inspect for proper operation.	Replace.

3-45 STARTING AID - MAINTENANCE INSTRUCTIONS.

a. When starting an internal combustion engine in cold weather, a large part of energy is absorbed by the pistons, cylinder walls, coolant and in overcoming friction.

b. Under extremely low temperatures the cold oil in the bearings and between pistons and cylinder walls creates high friction, thus engine starting is harder than when the engine is warm.

c. The normal diesel starting is to ignite the fuel sprayed into the combustion chamber by the heat of air compressed in the cylinder. This temperature is high enough for normal operating conditions, but at extremely low temperatures may not be high enough to ignite the injected fuel.

CAUTION

Do not actuate the starting aid more than once with the engine stopped. Over-loading the engine air box with this high volatile fluid could result in a minor explosion.

d. To assist engine starting in low temperatures use the cold weather starting device.

NOTE

The starting aid is not intended to correct deficiencies but for use when other conditions are normal and air temperature is too low for heat of compression to ignite the fuel-air mixture.

3-45. STARTING AID - MAINTENENCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **b. Replacement**
c. Service **d. Disassembly**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Cylinder Starting Aid LP-535
Valve repair kit LP-3250

Personnel Required
1

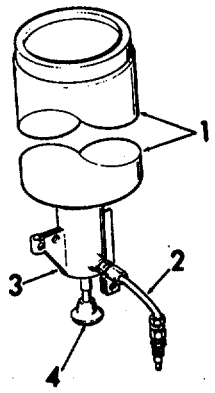
Reference
NONE

Equipment Condition
Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Starting aid	Cylinder (1)	a. Visually inspect for wear and cracks.	
		b. Check for fluid leakage.	



3-45. STARTING AID - MAINTENENCE INSTRUCTIONS (Cont).

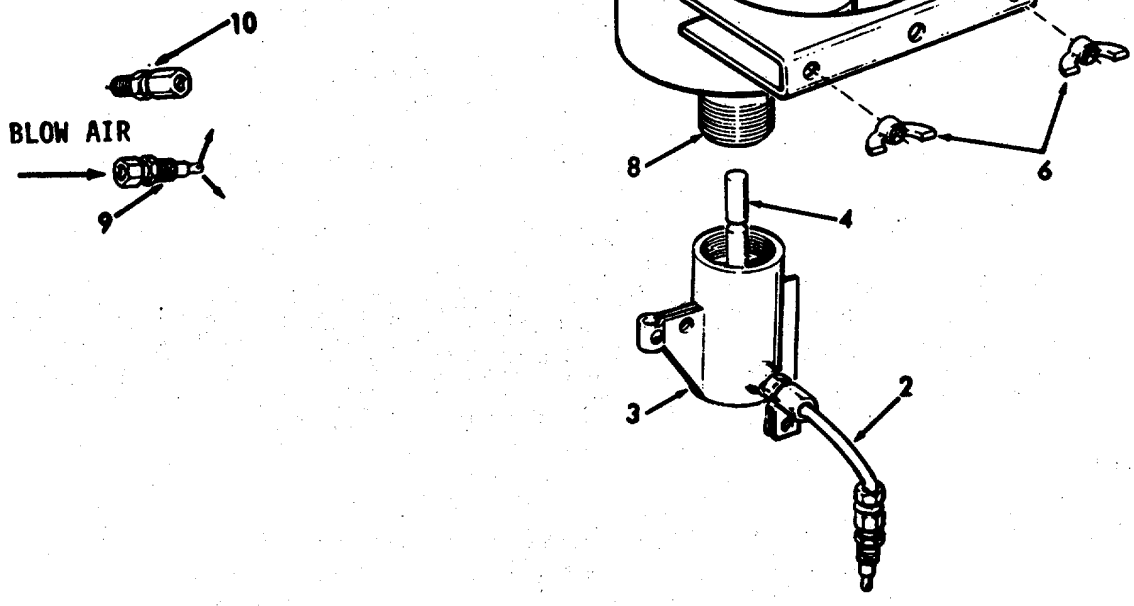
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Engine	Atomizer and filling valve assembly (2)	a. Visual. b. Check fitting valve for wear, cracks, and leakage. c. Check atomizer for wear, cracks and leakage.	
3. Starting aid	Body quick start (3)	a. Visually inspect for wear and cracks. b. Check for leakage.	
4.	Pin assembly (4)	Check for wear and cracks.	
SERVICE			
5. Starting aid	Clamp (5)	a. Remove wingnut (6) and U-bolt (7). b. Unscrew cylinder (1) from quick start body (3). c. Lubricate cylinder valve (8) and pin assembly (4). d. Replace cylinder (1).	Use light oil.
REPLACEMENT			
6. Engine	Atomizer and fitting valve assembly (2)	a. Remove atomizer (9) and fitting valve (10). b. Remove dirt from atomizer orifice (9) and screen.	

3-45. STARTING AID - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			

c. Blow air through orifice end only.

d. Replace atomizer (9) and fitting valve (10) to assembly (2).

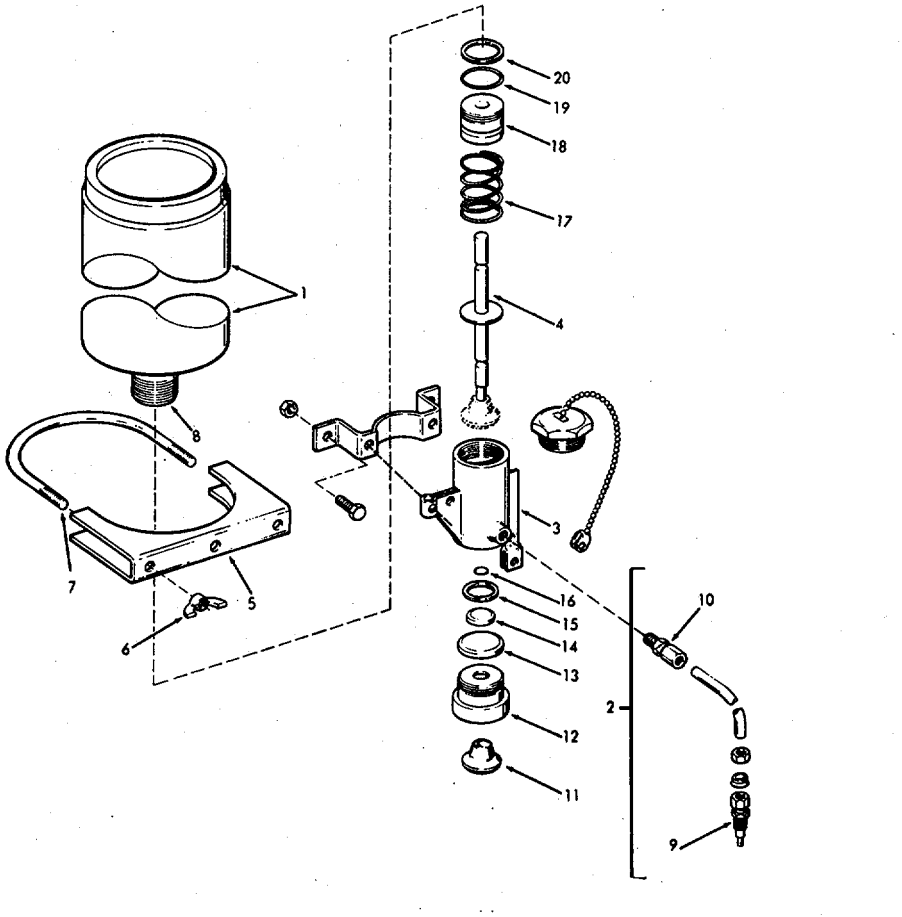


3-45. STARTING AID - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
7. Starting aid	Pin assembly (4)	a. Remove knob (11).	
		b. Remove bushing (12), preformed packing (13), preformed packing (14), nylon washer (15), pin assembly (4), preformed packing (16), spring (17), bushing (18), preformed packing (19) and gasket (20).	Discard.
8. Starting aid	Body quick start (3)	a. Install gasket (20), preformed packing (19), bushing (18), spring (17), preformed packing (16), pin assembly (4), nylon washer (15), preformed packing (14), preformed packing (13), and bushing (12).	Replace with new parts.
		b. Install knob (11).	
		c. Lubricate pin assembly (4) and gasket (20).	
9.	Cylinder (1)	a. Lubricate valve (8).	
		b. Screw cylinder (1) into body quick-start (3).	Hand tight.
		c. Install U-bolt (7) and wing nut (6) on clamp (5).	

3-45. STARTING AID - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
10.	Atomizer and fitting valve assembly (2)	a. Check for fluid leakage on engine air inlet housing.	If fluid occurs - disassemble and retighten air inlet housing fitting to housing.
		b. Actuate starting aid with engine stopped.	



3-46. HYDROSTARTER - MAINTENENCE INSTRUCTIONS.

a. The hydrostarter (starting) motor is mounted on the flywheel housing. The hydrostarter has a high rate of acceleration; therefore, the engine is cranked faster than other starting systems.

b. An overrunning clutch protects the starting motor at all times from being driven at high speeds by the engine before disengagement of the pinion.

This task covers:

a. Inspection
b. Replacement
c. Repair
d. Installation

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
Teflon Tape

Personnel Required
1

References
Para:
3-50 Forward Engine Room Piping.
3-51 Aft Engine Room Piping.

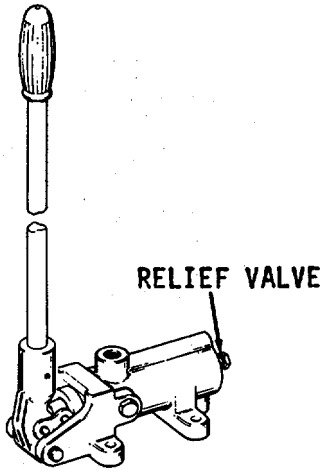
Equipment
Condition Condition Description.
None

Special Environmental Conditions
None

General Safety Instructions
Observe WARNINGS in this procedure.

3-46. HYDROSTARTER - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Hydro-starter	Hydro-starter	a. Check for leaks, cracks, dents or wear.	
		b. Check inlet and outlet connections for leaks.	
REPLACEMENT			
2. Hand pump	Bleeder screw	Release the oil pressure in the hoses and accumulator by opening the bleeder screw on the side of the hand pump approximately 1/2 turn.	



WARNING

The oil pressure in the system must be released prior to servicing the hydrostarter or any other components on the system to prevent possible injury to personnel or equipment.

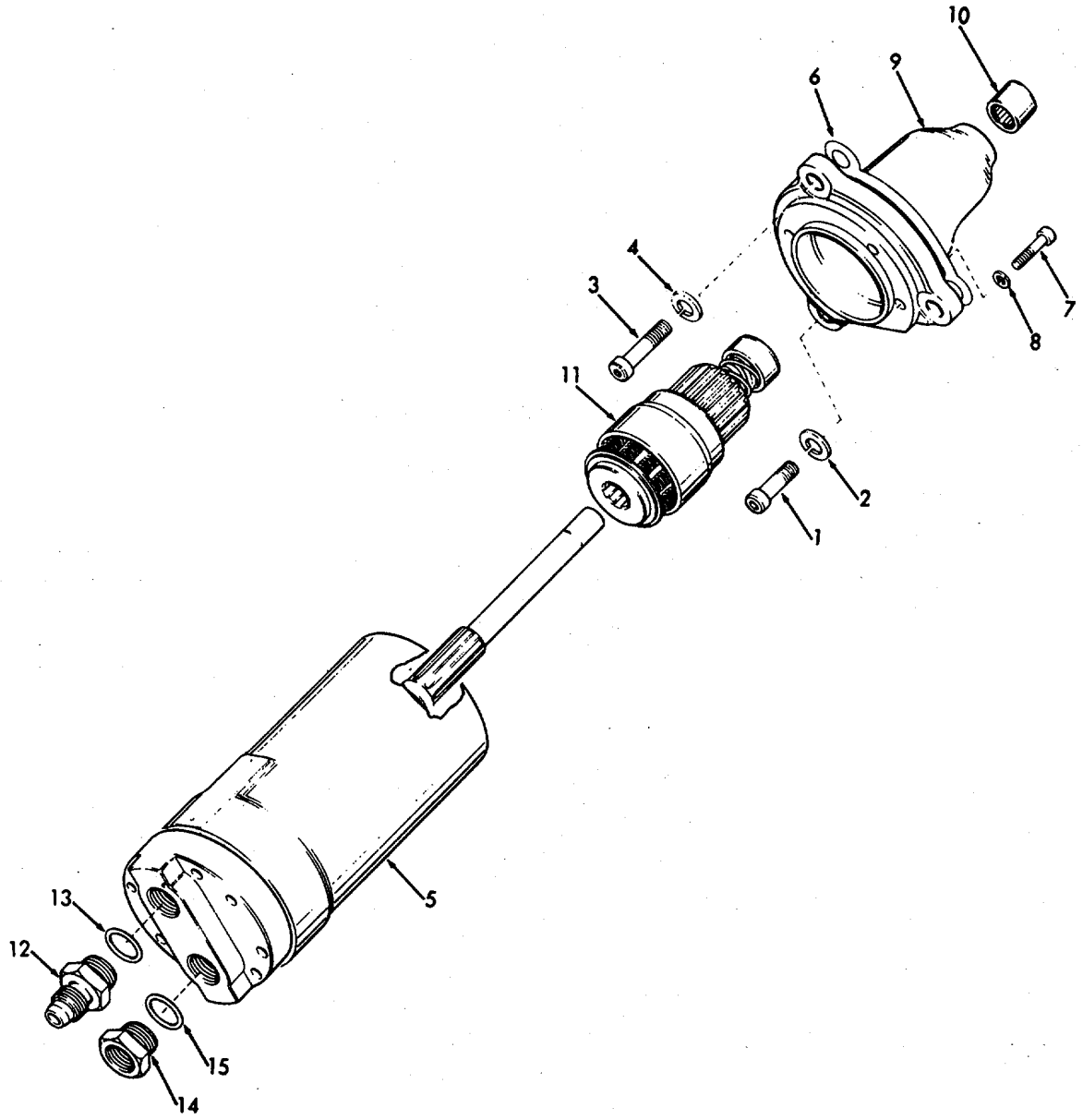
3. Hydraulic hoses	a. Inlet hoses	Disconnect from hydro-starter.	
	b. Outlet hose	Disconnect from hydro-starter.	

3-46. HYDROSTARTER - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
4. Hydro-starter	Hydro-starter	a. Remove two screws (1) and lockwashers (2).	
		b. Remove screw (3) and lockwasher (4).	
		c. Remove starter (5) from flywheel housing.	
		d. Remove gasket (6).	Discard gasket.
REPAIR			
5. Hydro-starter	Hydro-starter	a. Clamp motor in a vise.	
		b. Remove screws (7) and lockwashers (8).	
		c. Remove pinion gear housing (9).	Inspect for dams,. age.
		d. Remove needle bearing (10).	Inspect for damage and re-place if neces-sary.
		e. Slide bendix drive assembly (11) off shaft.	Inspect drive for worn, or chipped teeth. Inspect spring for damage or breaks. Replace defective bendix drive assembly.
		f. Remove hose adapter (12) and O-ring gasket (13).	Remove and dis-card only if damaged.
		g. Remove hose adapter (14) and O-ring gasket (15).	Remove and dis-card only if damaged.

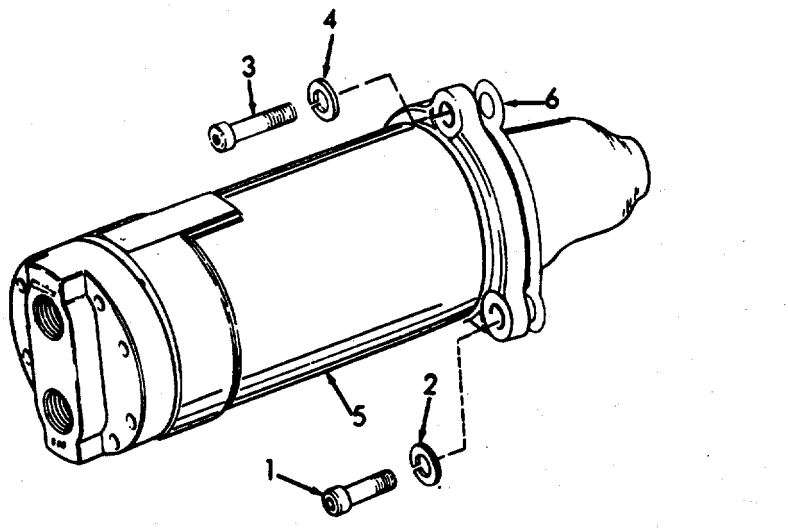
3-46. HYDROSTARTER - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



3-46. HYDROSTARTER - MAINTENENCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Hydro-starter	Hydro-starter	a. Install gasket (6).	
		b. Install starter (5) onto flywheel housing.	
		c. Install lockwasher (4) and screw (3).	
		d. Install two lockwashers (2) and screws (1).	
		e. Install inlet hose to IN.	
		f. Install outlet hose to OUT.	



7. Hand pump	Hand pump	Operate until all air- is purged from the system.	Refer to paragraph 3-49.

3-47. ACCUMULATOR - MAINTENENCE INSTRUCTIONS.

a. The accumulator is a heavy duty shell assembly and piston designed to hold nitrogen pressure-for an extended period of time.

b. The accumulator is pre-loaded with nitrogen through a small valve and sealed at the time of manufacture. A seal ring in the groove of the piston between two back-up rings prevents the nitrogen from entering the hydraulic system. The nitrogen is stored in the air valve end of the accumulator and the fluid is discharged at the opposite end.

c. A seal ring and back-up ring at each cap prevents escape of fluid and nitrogen from the shell. Nitrogen is an inert gas. Nitrogen will not rust or corrode the piston or accumulator.

d. Oil enters the accumulator under pressure from either the engine-driven pump or hand pump and forces the piston back, compress- ing the nitrogen and storing energy to operate the system.

e. Service replacement accumulators are supplied with a precharge of nitrogen [1250 + 50 psi (8619 + 345 kpa)].

This task covers:

a. Inspection **b. Replacement**

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

Reference
None

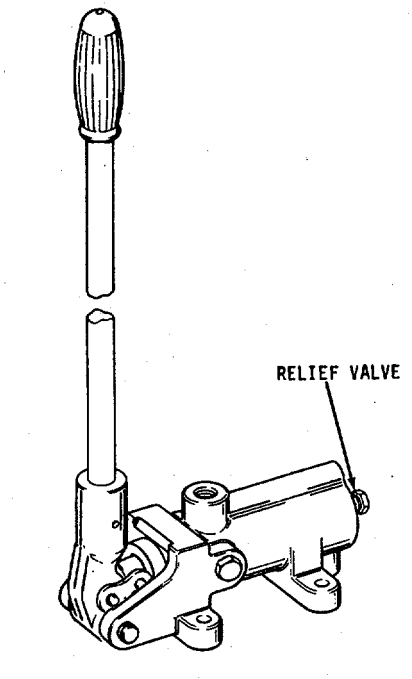
Equipment
Condition Condition Description
None

Special Environmental Conditions
None

General Safety Instructions
Observe WARNINGS in this procedure.

3-47. ACCUMULATOR - MAINTENENCE INSTRUCTIONS (continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Accumulator	Accumulator	a. Visually inspect accumulator cylinder for leakage.	
		b. Apply a light oil or soapy solution on the end of the accumulator.	If bubbles appear - replace.
2.	Valve caps	Check for leaks.	
3.	Accumulator	Apply a light oil or soapy solution on the accumulator valve (air check valve) to test for leakage.	If bubbles appear, replace.
REPLACEMENT			
4. Hand pump	Bleeder screw valve	Release the oil pressure in the hoses and accumulator by opening the bleeder screw valve on the side of the hand pump approximately 1/2 turn.	



3-47. ACCUMULATOR - MAINTENENCE INSTRUCTIONS (continued).

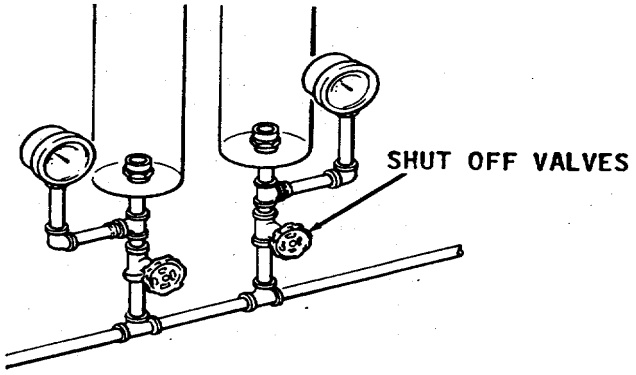
LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)

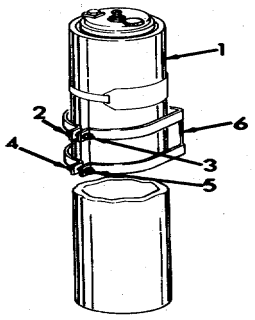
WARNING

The oil pressure in the system must be released prior to servicing the accumulator or any other components on the system to prevent possible in- jury to personnel or equipment.

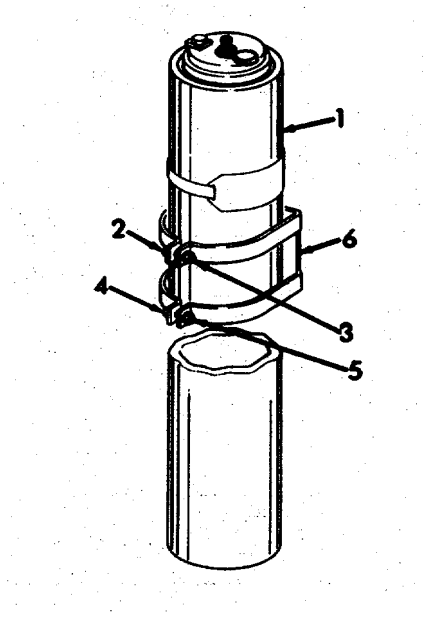
5.	Accumulator (1)	a. Turn shut off valve clockwise to close.	



b. Remove capscrews (2, 4) and nuts (3, 5) from bracket (6).



3-47. ACCUMULATOR - MAINTENENCE INSTRUCTIONS (continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
		c. Unscrew accumulator (1) from piping.	
		d. Replace accumulator (1) with a new cylinder supplied with a pre-charge of nitrogen [1250 ± 50 psi (8919 ± 345 1Pa)].	
		e. Install capscrews (2 and 4) and nuts (3 and 5) to bracket (6).	
		f. Open shut-off valve by rotating counterclockwise.	
			
6.	Hand pump	Operate to pressurize system.	

3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENENCE INSTRUCTIONS.

a. The hydrostarter charging pump maintains a pressure of approximately 2900-3300 psi (1996 22754 kPa) in the accumulator. Do not drive pump at a speed over 2500 RPMs. The pump body has an unloading valve which by-passes the pump discharge to the reservoir once operating pressure is reached. This allows the pump to work at a reduced load.

b. The hydrostarter charging pump is a single-piston positive displacement pump. The ball check valves and the unloading valve are controlled by the accumulator pressure. The pump shaft is supported on ball bearings and a seal. The pump is pressed into the bearing retainer to prevent leaks. The pump is attached to the flywheel housing and is driven by a drive plate bolted to the camshaft.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
Sealant (Permatex No. 2)
Masking Tape

Personnel Required
1

Reference
None

Equipment
Condition Condition Description
None

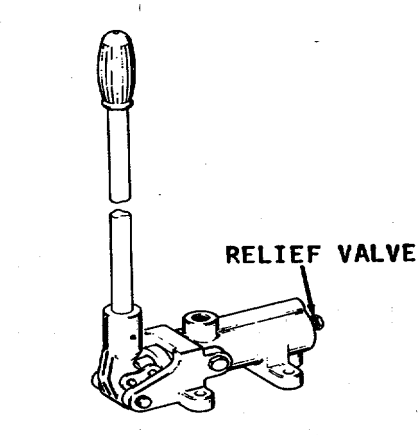
Special Environmental Conditions
None

General Safety Instructions
Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Engine	Charging pump assembly	a. Check for cracks, dents, and wear.	
		b. Check for leaks.	

3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENENCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Housing assembly		a. Check for cracks, dents, and wear.	
		b. Check for leaks.	
3. Supply hose		a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	
4.	Pressure hose	a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	
5.	Return hose	a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	



REMOVAL				
6. Hand pump	a.	Relief valve		Release oil pressure in system by opening relief valve on side of hand pump about 1/2 turn.

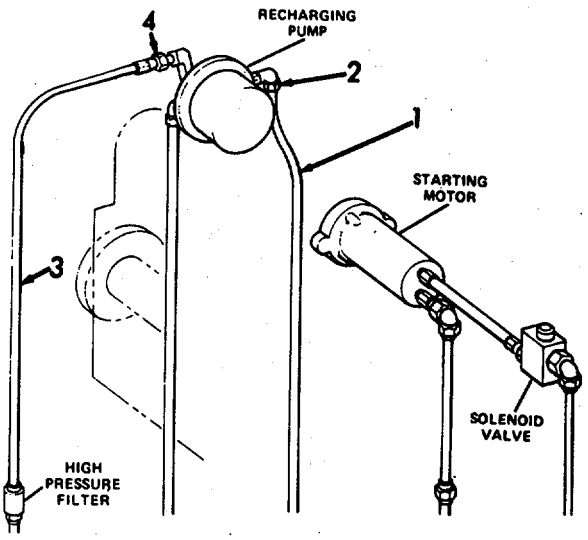
3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENENCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

WARNING

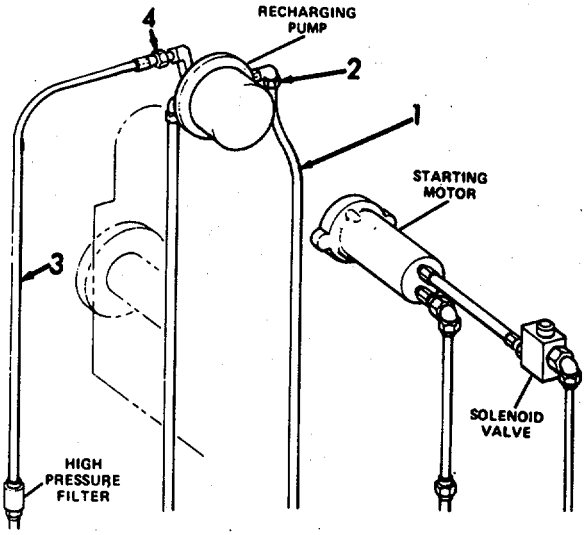
The oil pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or equipment.

7.	Supply hose	a. Clean exterior dirt off.	
		b. Disconnect supply hose (1) at swivel fitting (2).	
		c. Tape hose end to keep out dirt.	Use masking tape.
8.	Pressure hose	a. Clean exterior dirt off	
		b. Disconnect pressure hose (3) at swivel fitting (4).	
		c. Tape hose end to keep dirt out.	Use masking tape.



3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENENCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
9.	Return hose	a. Clean exterior dirt off.	
		b. Disconnect return hose (5) at swivel fitting (6).	
		c. Tape hose end to keep dirt out.	Use masking tape.

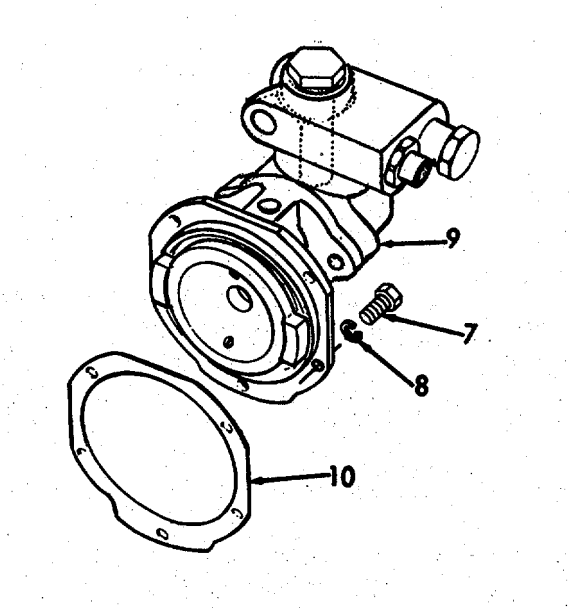


10.	Charging pump	a. Remove five capscrews (7) and lockwashers (8).	
		b. Remove charging pump (9) from flywheel housing.	
		c. Remove gasket (10).	

3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



INSTALLATION

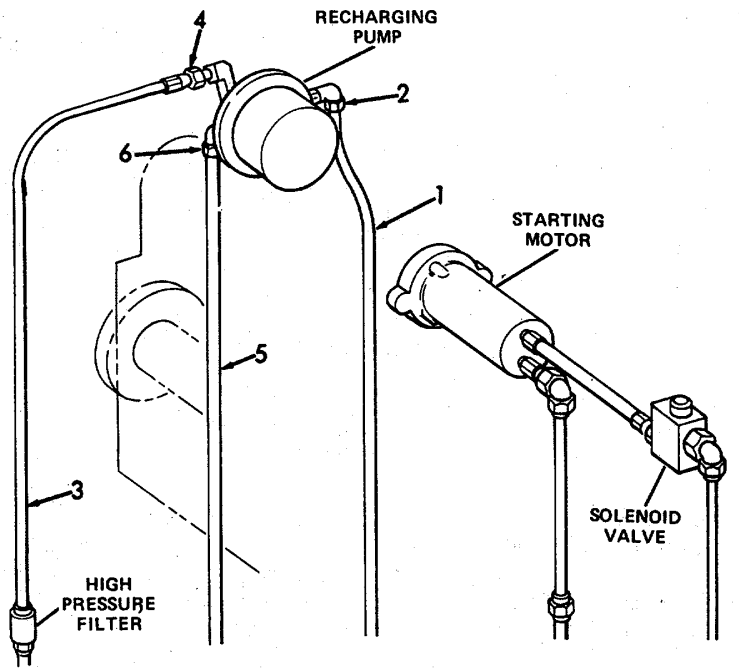
LOCATION	ITEM	ACTION	REMARKS
11. Engine driven pump	a. Charging pump	a. Install gasket (10) and charging pump (9).	Use a new gasket. Use Permatex #2 sealant on the flywheel side only.
		b. Align the tangs on the pump drive with the slots in the drive plate.	
		c. Install five lockwashers (8) and capscrews (7).	

CAUTION

Do not force the pump into place. Use of force, or tightening the bolts when the mounting flange is not against the flywheel housing, will force the drive arm against the pump body and result in damage to the pump when the engine is started.

3-48. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
12.	Return hose	a. Remove tape from hose. b. Connect return hose (5) at swivel fitting (6).	
13.	Pressure Hose	a. Remove tape from hose. b. Connect pressure hose (3) at swivel fitting (4).	
14.	Supply hose	a. Remove tape from hose. b. Connect inlet hose (1) at swivel fitting (2).	
15. Hand pump	Relief valve	Close and pressurize system.	



3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS.

a. The hand pump is a single position double-acting positive displacement pump. The pumping action is never in a vertical direction and the handle clears all obstructions throughout its stroke. Remove the handle and store when pump is not in use.

b. Use the hand pump to provide initial hydraulic pressure and to build up pressure if pressure was released from the hydrostarter.

c. A ball check valve controls the flow through the pump. A bleeder screw valve is manually operated to release the pressure before work can be done on the hydrostarter system at the hand pump.

This task covers:

a. Inspection **c. Repair** **e. Installation**
b. removal **d. Reassembly**

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
Repair kit KT202565

Personnel Required
1

References
None

Equipment
Condition Condition Description
None

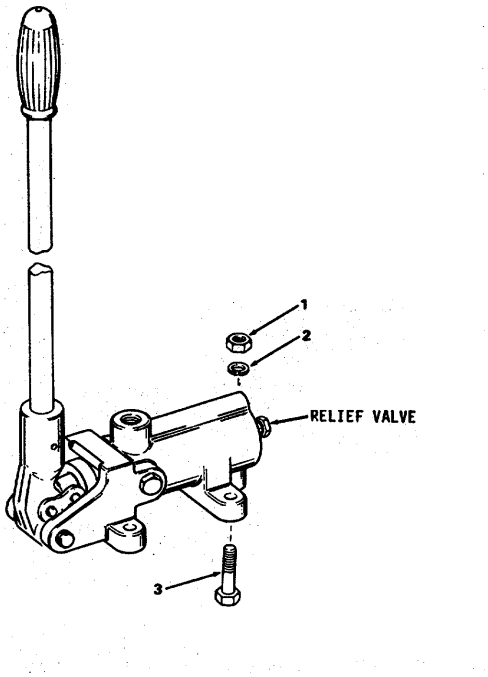
Special Environmental Conditions
None

General Safety Instructions
Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Hand pump	Hand pump assembly	Check for leaks, cracks and wear.	
2.	Pump lever handle	Check for cracks.	
3.	Inlet and outlet hoses	Check for leaks, cracks, wear and hoses are properly installed.	

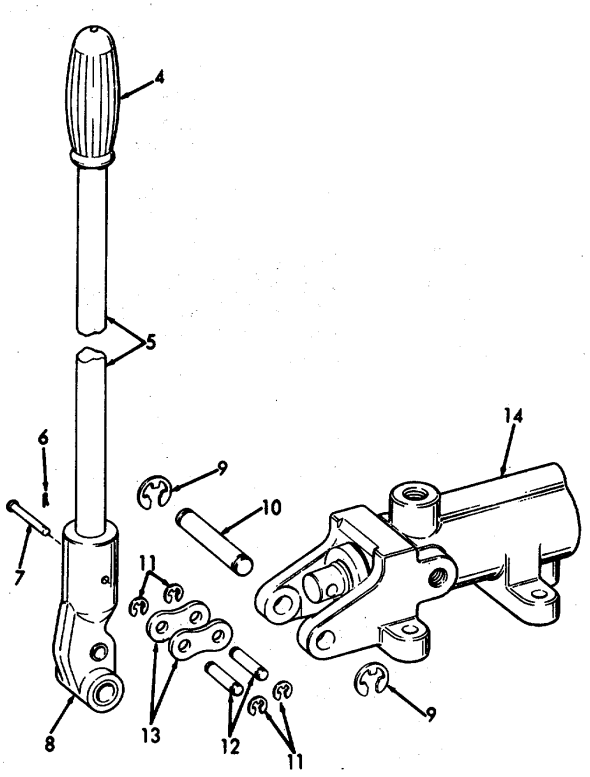
3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
4. Hand pump	a. Bleeder screw valve	Release the pressure in the hydraulic system by opening the bleeder screw on side of the pump approximately 1/2 turn.	
		WARNING The oil pressure in the system must be released prior to servicing the hand pump or any other components of the system to prevent possible injury to personnel or equipment.	
	b. Hand pump assembly	1. Clean exterior dirt from hand pump and hydraulic hoses.	
		2. Disconnect hydraulic hoses at the pump.	
		3. Remove nut (1), lockwasher (2), and capscrew (3) and lift pump from its mounting.	



3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5.	Pump handle	a. Pull pump handle grip (4) from hand pump operating handle (5).	Only if grip is damaged.
		b. Remove cotter pin (6), pin (7). Then lift handle (5) from operating lever (8).	
		c. Remove retaining rings (9) from clevis pin (10).	
		d. Remove retaining ring (11), clevis pin (12), links (13), to remove hand pump operating lever (8) from the pump body (14).	

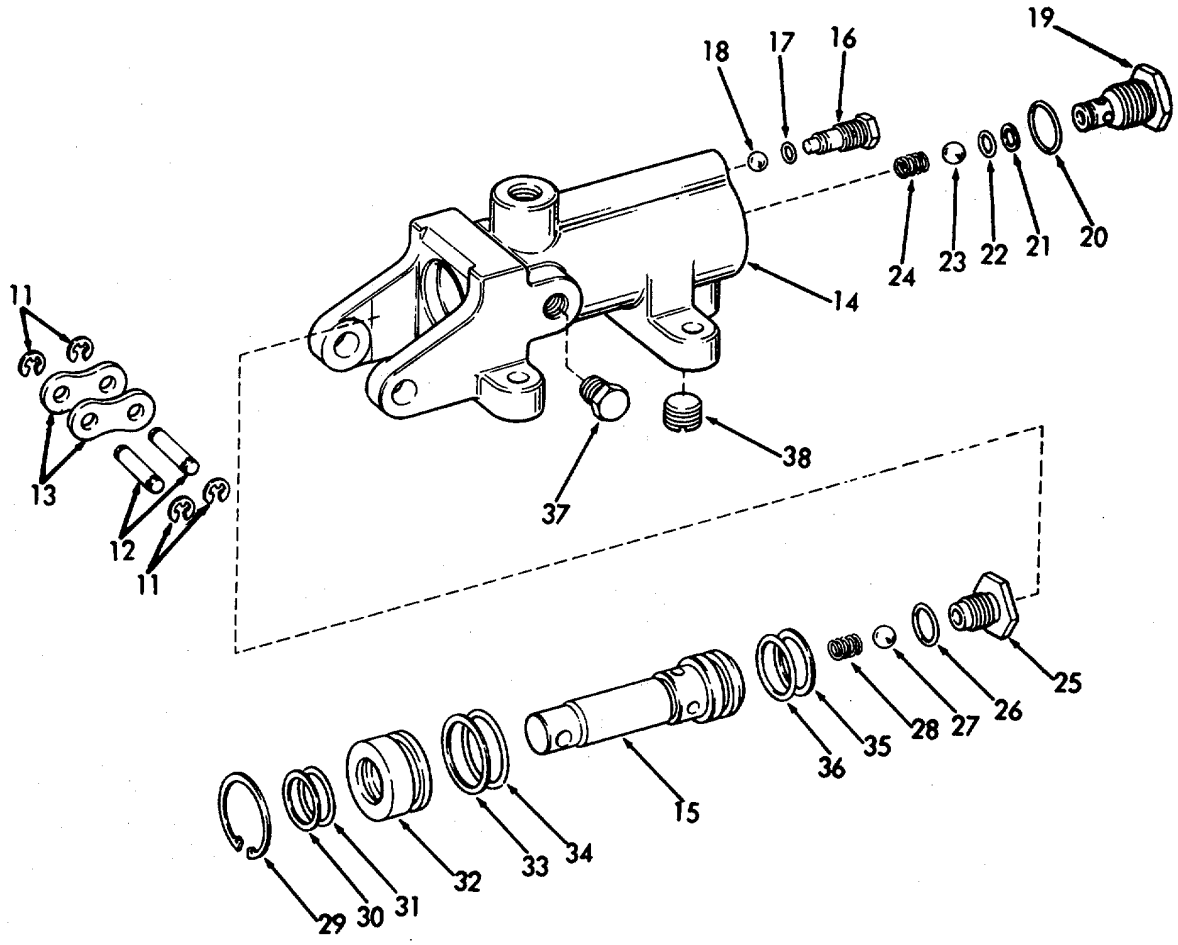


3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6.	Pump body	a. Remove retaining rings (11), clevis pin (12), links (13), from the plunger (15) after removing hand pump operating lever (8) from pump body (14).	
		b. Remove bleeder screw (16), O-ring gasket (17) and ball bleed valve (18) from pump body (14).	Discard O-ring gasket.
		c. Remove inlet oil fitting (19), O-ring gasket (20), back-up ring (21), O-ring gasket (22), ball check valve (23), spring (24), from plunger (15) and pump body (14).	Discard O-ring gasket (20), back-up ring (21), O-ring gasket (22) and spring (24).
		d. Remove seat check valve (25), O-ring gasket (26), ball check valve (27), spring check valve (28).	Discard O-ring gasket (26), and spring check valve (28).
		e. Remove retaining ring (29), back-up ring (30), O-ring gasket (31), plunger gland (32), back-up ring (33), O-ring gasket (34).	Discard back-up ring (30), O-ring gasket (31), back-up ring (33) and O-ring gasket (34).
		f. Remove back-up ring (35), o-ring gasket (36) and plunger (15).	Discard back-up ring and o-ring.
		g. Remove pipe plugs (37 and 38).	If necessary.

3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



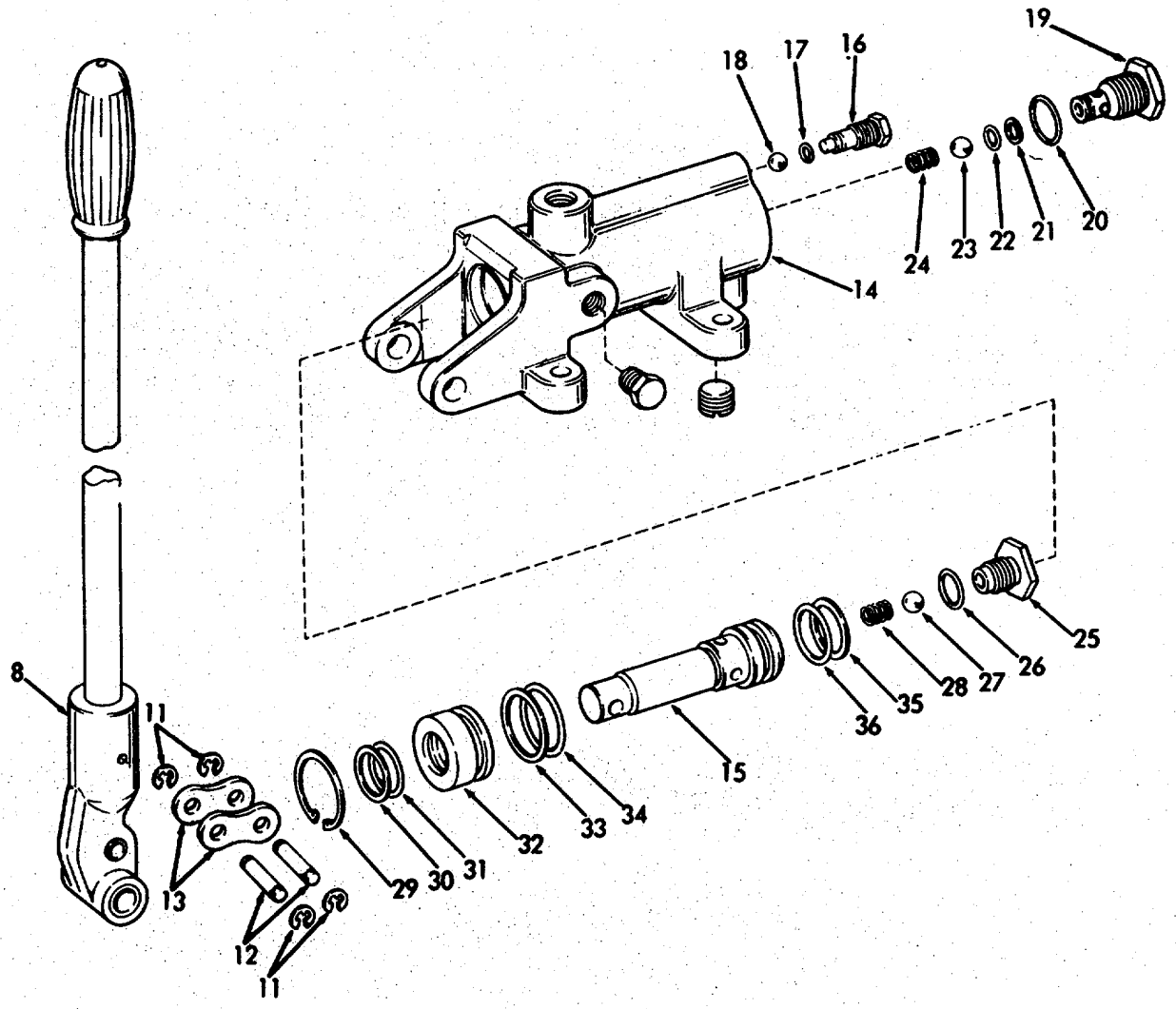
3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
7. Pump body	Plunger	a. Install O-ring gasket (34), back-up ring (33), plunger gland (32), O-ring gasket (31), back-up ring (30) and retaining ring (29).	Thoroughly soak new back-up rings (30, 33 35) in warm oil. Use repair kit for back-up ring (30), gasket (31), back-up ring (33) and gasket (34).
		b. Insert plunger (15).	
		c. Install O-ring gasket (35), back-up ring (36), spring (28), ball check valve (27), O-ring gasket (26) and seat check valve (25) on plunger.	Use repair kit for back-up ring (35), O-ring gasket (36) spring (28), O-ring gasket (26).
8.	Inlet oil fit. ting valve (19)	Install spring (24), ball valve (23), 0-ring gasket (22), back-up ring (21), O-ring gasket (20) and inlet oil fitting (19), in-to pump body (14).	Use repair kit for spring (24) O-ring gasket (20), back-up ring (21) and O-ring gasket (22).
9.	Bleeder screw valve	a. Install O-ring gasket (17) onto bleeder screw valve (16).	Use repair kit for O-ring gas-ket (17).
		b. Insert bleeder ball valve (18) in place.	
		c. Secure with bleeder screw valve (16).	
10.	Handle	a. Install retaining rings (11), clevis pin (12), links (13) to hand pump oper-ating lever (8) and piston (15).	

3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



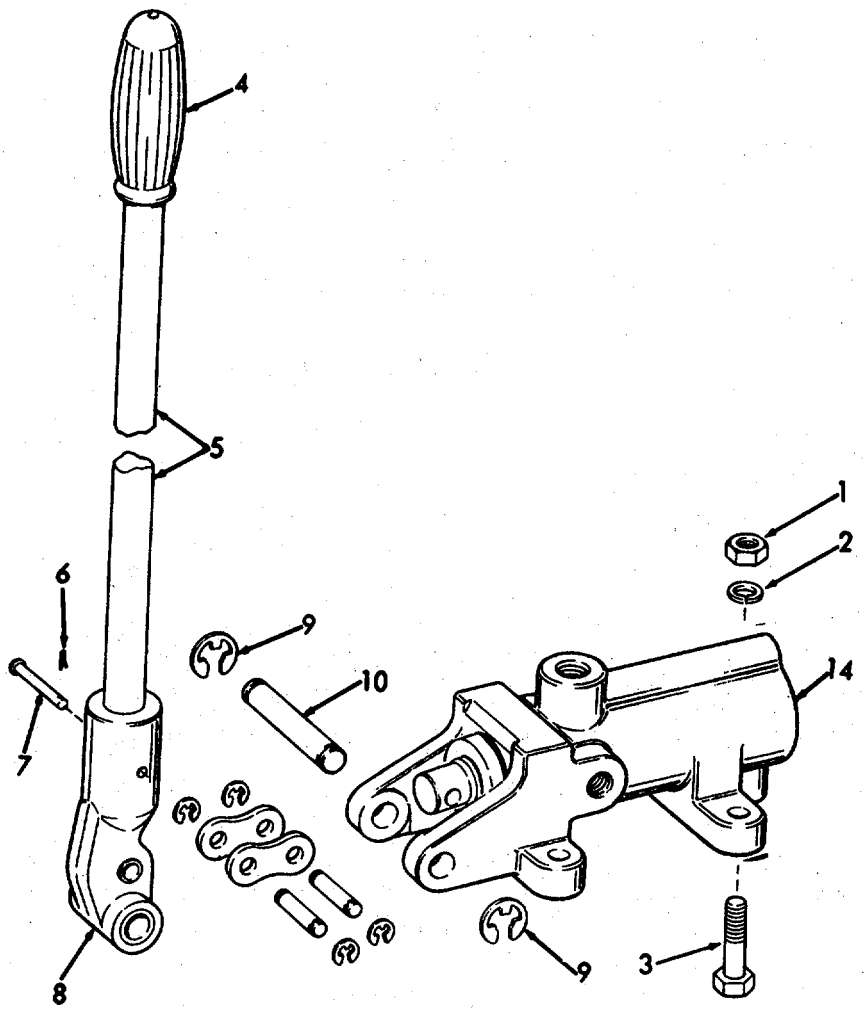
3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		b. Insert clevis pin (10) and retaining ring (9) into hand pump operating lever (8) and pump body (14).	
		c. Insert handle (5), pin (7) and cotter pin (6) into hand pump operating lever (8).	
		d. Install grip (4).	
INSTALLATION			
11.	Hand pump assembly	a. Place hand pump on its mounting.	
		b. Attach to mount with capscrews (3), lock-washers (2) and nuts (1).	
		c. Connect the hydraulic hoses to pump.	
		NOTE Make sure the hose and fittings are clean before any connections are made.	
		d. Check assemblies, make sure all fittings are tight and there are no leaks.	

3-49. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-50. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS.

a. The hydrostarter supply lines carry hydraulic fluid from the reservoir to the engine-driven pump or hand pump.

b. The hydrostarter return lines carry the hydraulic fluid from the engine-driven pump or the engine starter to the reservoir.

c. The hydrostarter pressure lines carry hydraulic fluid from the accumulator to the engine-driven pump, hand pump and starter.

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

Reference
None

Equipment
Condition Condition Description
None

Special Environmental Conditions
None

General Safety Instructions
None

LOCATION	ITEM	ACTION	REMARKS

NOTE

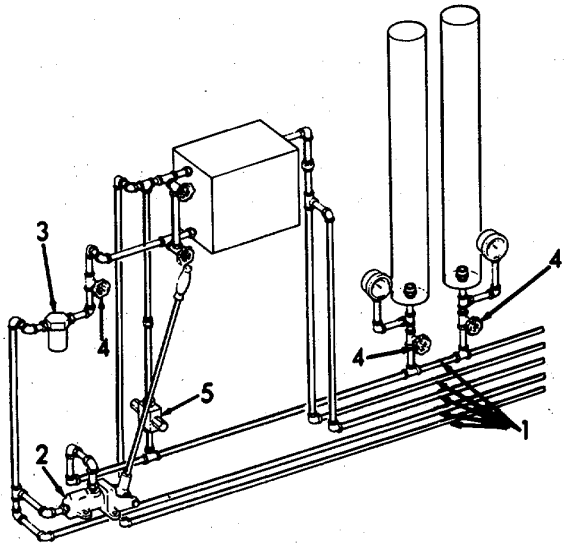
All maintenance to be performed by Direct Support Maintenance unless otherwise noted.

INSPECTION

1.	Hydro-starter piping (1)	a. Check all pipes for leaks, damage due to dents, cracks or breaks. b. Check all pipe fittings. Make sure they are tight and do not leak.	

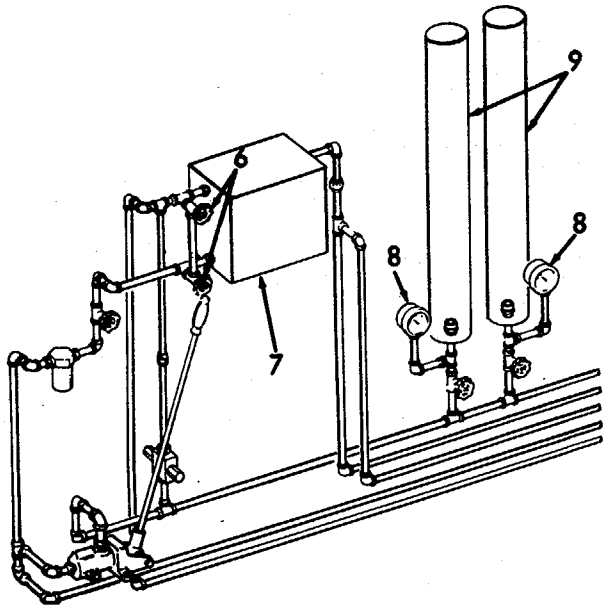
3-50. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

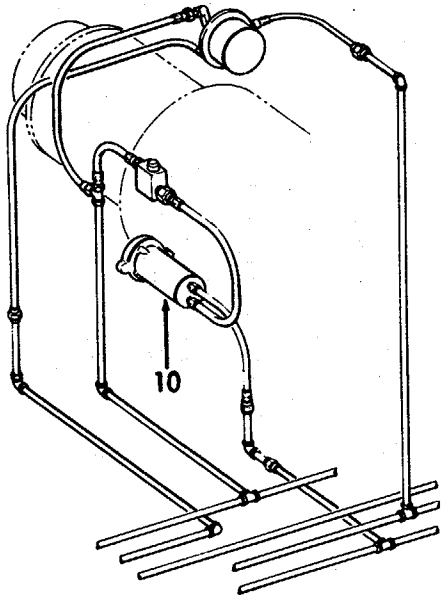
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		b. Check all pipe fittings. Make sure they are tight.	
2.	Hand pump (2)	Check for leaks. Refer to paragraph 3-49 for maintenance.	
3.	Suction filter (3)	a. Check for leaks. Refer to paragraph 3-52 for maintenance.	
		b. Checks fittings. Make sure they are tight.	
4.	Shut-off valves (4)	a. Check for leaks.	
		b. Check for cracks, or wear.	
		c. Check fitting for tightness.	
5.	Relief valve (5)	a. Check for leaks.	
		b. Check for cracks, wear or dents.	
		c. Check fittings for tightness.	



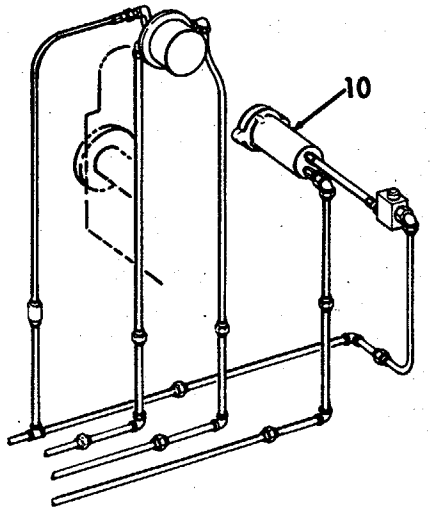
3-50. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
6.	Sight glass with valves (6)	a. Check for leaks. b. Check glass for cracks or breaks. c. Check valves for wear, cracks, or dents.	
7.	Reservoir (7)	a. Check for leaks, dents or cracks. b. Check pipe connections for leaks.	Refer to paragraph 3-52 for maintenance.
8.	Pressure gage (8)	a. Check gage glass for cracks or broken glass. b. Check fitting and connections for tightness and leaks.	
9.	Accumulators (9)	a. Check for leaks. b. Check for dents or cracks. c. Check pipe connections for leaks. d. Make sure all fittings are tight.	See paragraph 3-47 for replacement and Direct Support Maintenance.
10.	Hydrostarter (10)	a. Check for leaks. b. Check piping connections for leaks.	Refer to paragraph 3-46 for maintenance.





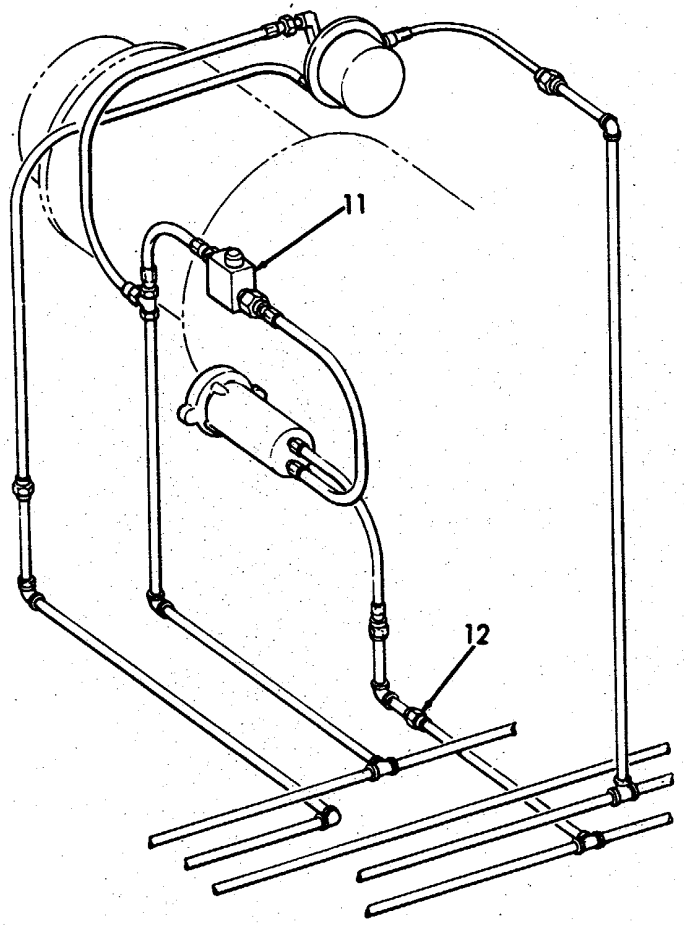
DIESEL GENERATOR
ENGINE CONNECTIONS



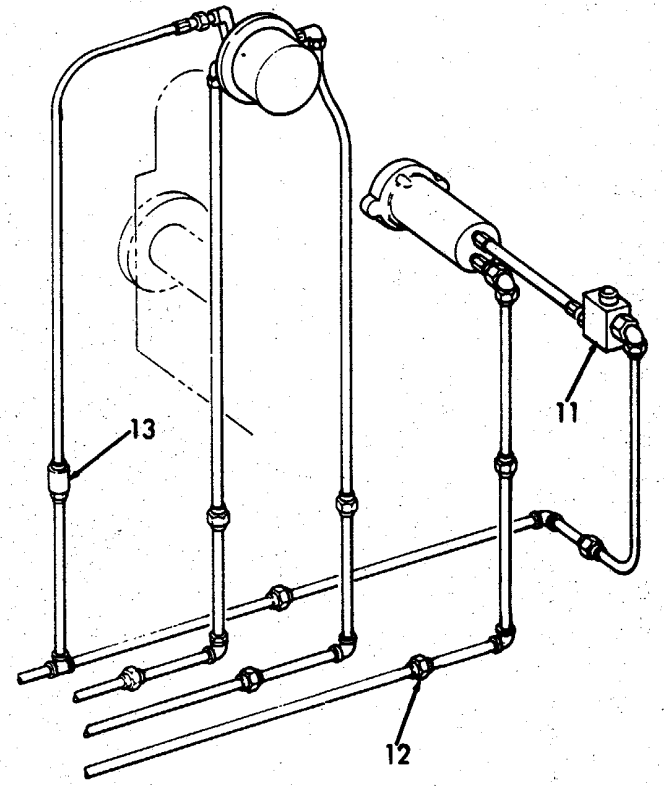
MAIN PROPULSION
ENGINE CONNECTIONS

3-50. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		c. Check to see if return, supply and accumulator (pressure) lines are tight.	
11.	Solenoid valve (11)	a. Check for leaks.	See paragraph 3-52 for maintenance.
		b. Check fittings, pipes, and wiring. Make sure they are tight.	
12.	Check valve (12)	a. Check for leaks.	
		b. Make sure all fittings are tight.	
13.	High pressure filter (13)	a. Check for leaks.	Refer to paragraph 3-52 for maintenance.
		b. Check for cracks, dents and wear.	
		c. Check fittings. Make sure they are tight.	



DIESEL GENERATOR ENGINE CONNECTIONS



MAIN PROPULSION ENGINE CONNECTIONS

3-51. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE INSTRUCTIONS.

a. The hydrostarter supply lines carry hydraulic fluid from the reservoir to the engine driven pump or the hand pump.

b. The hydrostarter return lines carry the hydraulic fluid from the engine-driven pump or the engine starter to the reservoir.

c. The hydrostarter pressure lines carry hydraulic fluid from the accumulator to the engine-driven pump, hand pump and the starter.

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

Reference
None

Equipment
Condition Condition Description
None

Special Environmental Conditions
None

General Safety Instructions
None

LOCATION	ITEM	ACTION	REMARKS

NOTE

All maintenance to be performed by Direct Support Maintenance unless otherwise noted.

INSPECTION

1.	Hydro-starter piping (1)	a. Check all pipes for leaks, damage do to dents, cracks or breaks.	

3-51. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

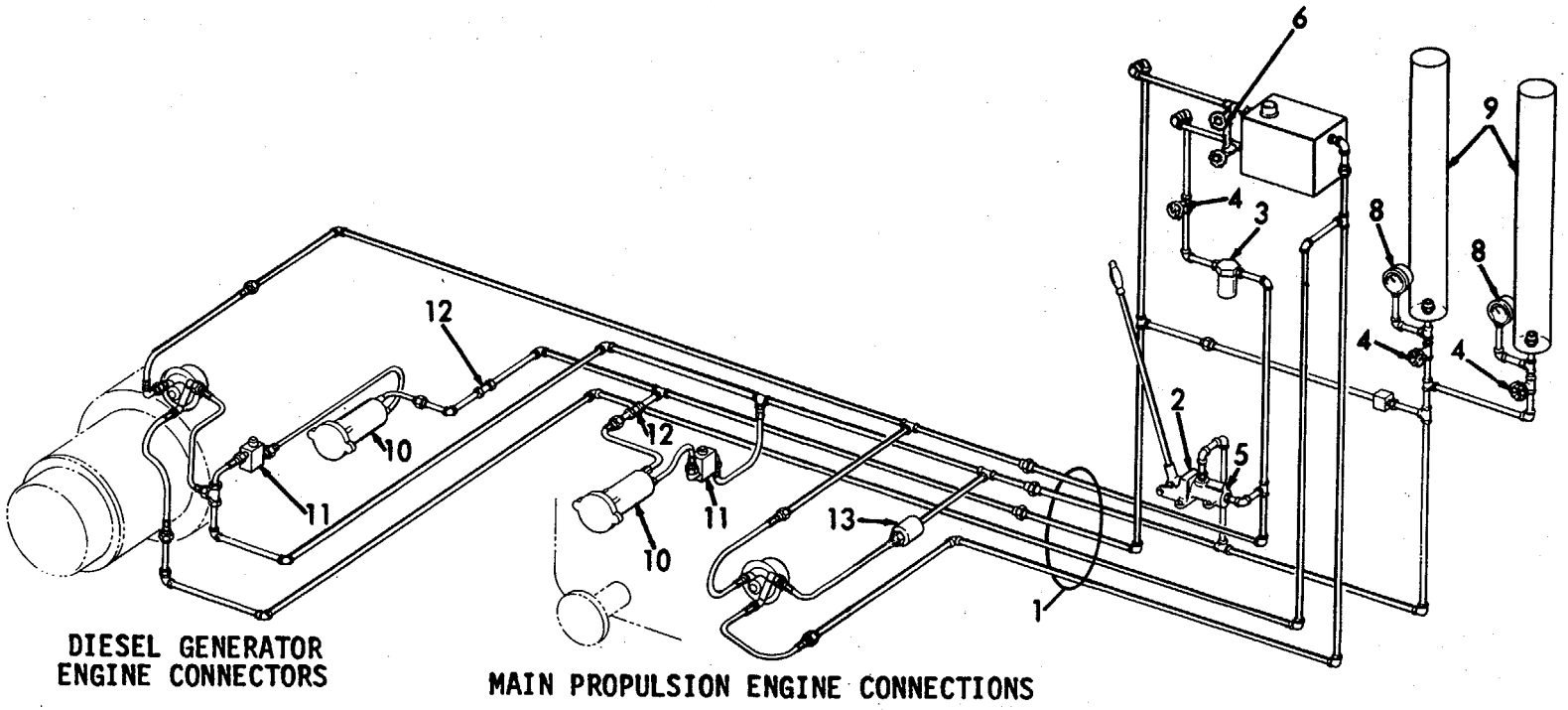
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		b. Check all pipe fittings make sure they are tight and do not leak.	
2.	Hand pump (2)	Check for leaks.	Refer to paragraph 3-49 for maintenance.
3.	Suction filter (3)	a. Check for leaks.	Refer to paragraph 3-52 for maintenance.
		b. Checks fittings, make sure they are tight	
4.	Shut-off	a. Check for leaks. valves (4)	
		b. Check for cracks, or wear.	
		c. Check fitting for tightness.	
5.	Relief valve (5)	a. Check for leaks.	
		b. Check for cracks, wear or dents.	
		c. Check fittings for tightness.	
6.	Sight glass with valves (6)	a. Check for leaks.	
		b. Check glass for cracks or breaks.	
		c. Check valves for wear, cracks, or dents.	

3-51. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
7.	Reservoir (7)	a. Check for leaks, dents or cracks.	Refer to paragraph 3-52 for maintenance.
		b. Check pipe connections or leaks.	
8.	Pressure gage (8)	a. Check gage glass for cracks or broken glass.	
		b. Check fitting and connections for tightness and leaks.	
9.	Accumulators (9)	a. Check for leaks.	Refer to paragraph 3-47 for replacement and to Direct Support Maintenance for repair.
		b. Check for dents or cracks.	
		c. Check pipe connections for leaks.	
		d. Make sure all fittings are tight.	
10.	Hydrostarter (10)	a. Check for leaks.	Refer to paragraph 3-46 for maintenance.
		b. Check piping connections for leaks.	
		c. Check return, supply and accumulator (pressure) lines are tight.	

3-51. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
11.	Solenoid valve (11)	a. Check for leaks.	Refer to paragraph 3-52 for maintenance.
		b. Check fittings, pipes, and wiring, make sure they are tight.	
12.	Check valve (12)	a. Check for leaks.	
		b. Make sure all fittings are tight.	
13.	High pressure filter (13)	a. Check for leaks.	Refer to paragraph 3-52 for maintenance.
		b. Check for cracks, dents and wear.	
		c. Check fittings, make sure they are tight.	


6
9
4
3
8
8
4
4
2
5
12
10
11
12
11
10
13
1
DIESEL GENERATOR
ENGINE CONNECTORS
MAIN PROPULSION ENGINE CONNECTIONS

3-52. HYDROSTARTER RESERVOIR, FILTER, AND SOLENOID - MAINTENANCE INSTRUCTIONS.

a. The reservoir is a rectangular steel tank. The reservoir will hold the entire oil supply for the hydrostarter system. A breather ventilator cap is at the top of the reservoir. A strainer screen on the inside of the reservoir filters the fluid flowing to the pump from the supply hose.

b. The supply hose connects at the reservoir bottom. The return hose connects at the top of the reservoir.

c. A suction filter is installed on the suction hose to provide a finer filtration that protects the pump mechanism. The filter is a stacked element that can be cleaned and reused.

d. A high pressure filter is installed in line with the outlet of the engine-driven charging pump.

3-52.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Replacement** **c. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Hydraulic fluid (MIL-L-17672 Type 2135TH),

Personnel Required
1

Reference
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Condition
Do not drain oil into bilges. Use the oil separation/recovery system to collect used oil.

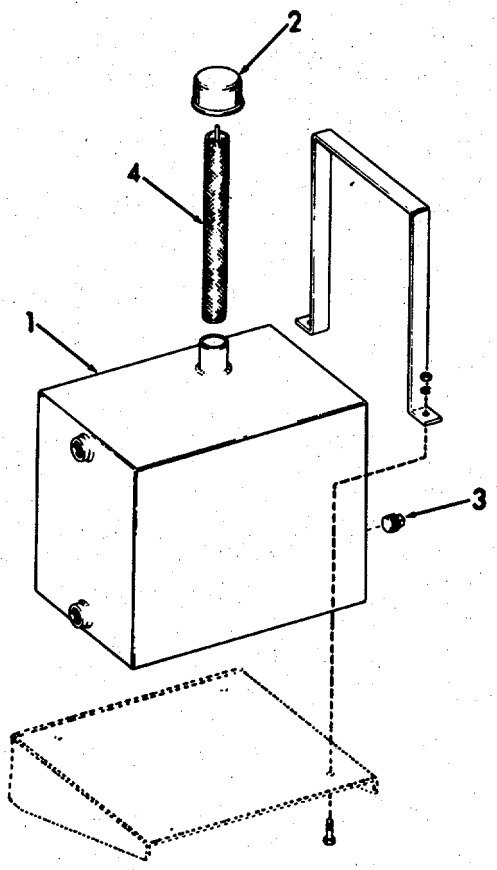
General Safety Instructions
Observe ALL WARNINGS.

3-52.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1.	Reservoir (1)	a. Check for dents, cracks and leaks.	
		b. Check return, relief, and supply pipes and fittings for leaks.	Refer to Direct Support Maintenance.
2.	Breather ventilator cap (2)	a. Check for dents, cracks, and leaks.	
		b. Check for tightness.	
		c. Check for clogging.	
3.	Drain plug (3)	a. Check fittings for tightness.	
		b. Check for leaks.	
4.	Drain plug (3)	a. Place suitable container under drain plug (3).	
		b. Turn drain plug (3) counter-clockwise to remove.	
		c. Drain reservoir.	Use oil separation and recovery system.
5.	Strainer screen (4)	a. Remove breather ventilator cap (2).	Replace, if necessary.
		b. Remove strainer screen (4).	

3-52.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		WARNING Use eye protection when using compressed air.	
		c. Clean strainer screen (4).	Clean in fuel oil and dry with compressed air.
		d. Clean reservoir (1) by flushing out the old hydraulic fluid.	

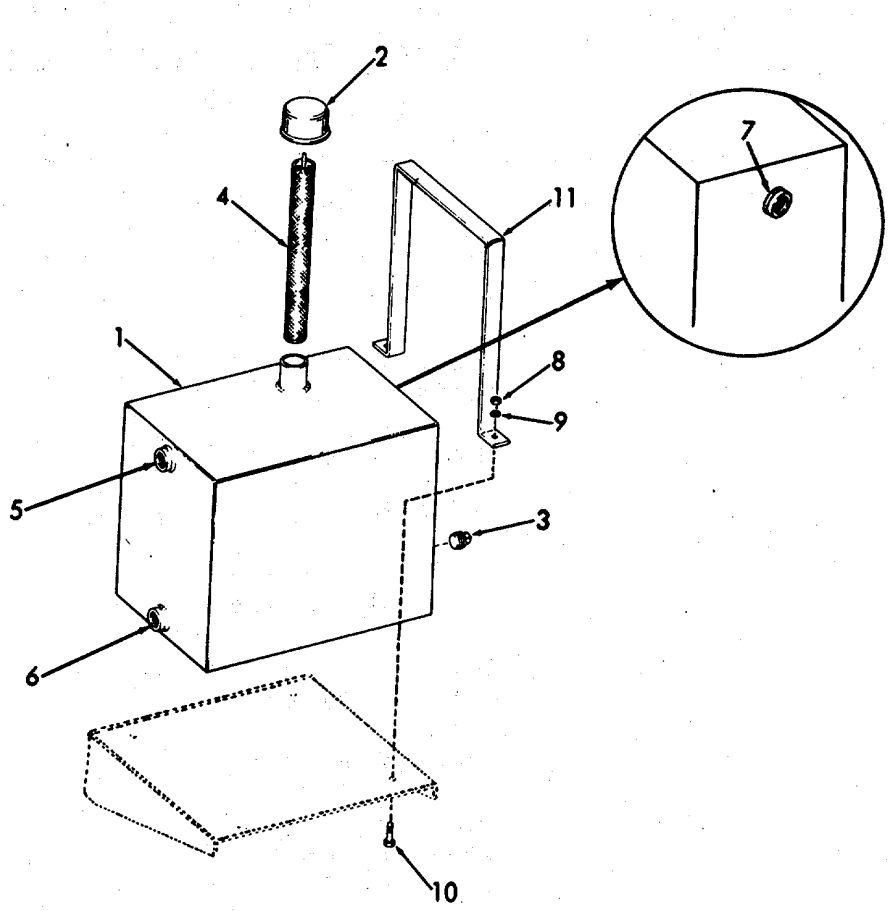


3-52.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
6.	Reservoir (1)	a. Place suitable container under drain plug (3).	
		b. Turn drain plug (3) counter-clockwise to remove.	
		c. Drain hydraulic oil into a suitable container.	
		d. Disconnect return piping (5).	
		e. Disconnect supply piping (6).	
i		f. Disconnect relief pipng (7).	
		g. Remove nuts (8), lockwashers (9) and capscrews (10) from brackets (11).	
		h. Remove reservoir (1) from its mountings.	
INSTALLATION			
7.	Reservoir (1)	a. Replace reservoir (1).	
		b. Install brackets (11), nuts (8), lockwashers (9), and capscrews (10).	
		c. Install strainer screen (4).	
		d. Install drain plug (3).	
		e. Connect supply piping (5).	
		f. Connect return piping (4).	

3-52.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		g. Connect relief piping (7).	
		h. Fill reservoir with hydraulic fluid (MIL-L-17672, Type 2135 TH).	Reservoir capacity is 7.5 gallons (28.4 liters).
		i. Replace and tighten breather ventilator cap (2).	
		j. Check all fittings and plugs for leaks.	



3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Service
c. Removal
d. Installation

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

Reference
None

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING in this procedure.

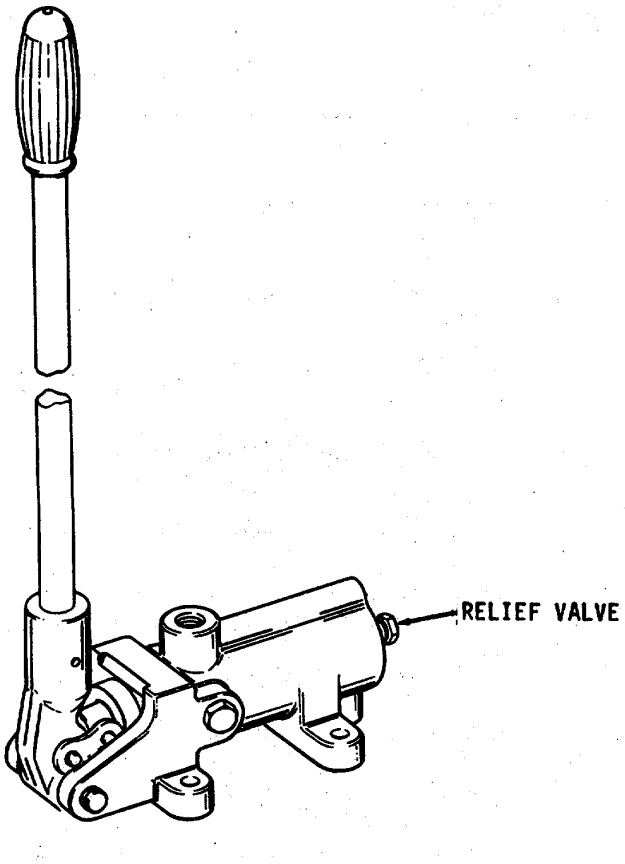
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Filter assembly	a. Cap	1. Check for leaks and dents.	
		2. Check for cracks.	
	b. Filter body	1. Check for leaks and dents.	
		2. Check for cracks.	
	c. Adapter	1. Check connections at cap for leaks.	
		2. Check for cracks.	
	d. Piping	1. Check connection at adapter and supply hose for leaks.	

3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2. Hand pump	Bleeder screw valve	Release the pressure in the hydrostarter system by opening the bleeder screw valve on side of pump approximately 1/2 turn.	

WARNING

The oil pressure in the system must be released prior to servicing the filter or any other components of the system to prevent possible injury to personnel or equipment.



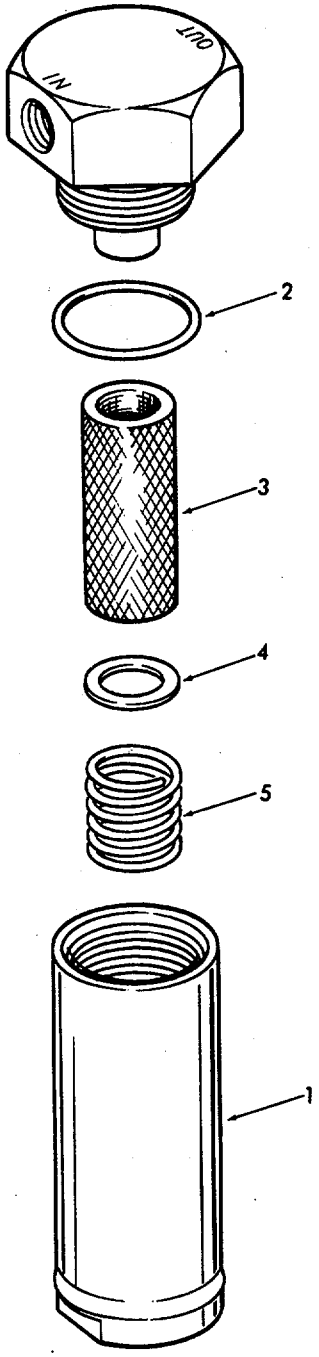
3-945

3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
3. Filter Assembly	a. Filter body (1)	Unscrew and remove.	
	b. Gasket (2)	Remove.	Discard.
	c. Filter element (3)	Remove.	Discard properly.
	d. Spring seat (4) and spring (5)	Remove.	
	e. Hydraulic fluid	Drain.	Dispose of used hydraulic fluid properly.
	f. All parts	Clean.	
	g. Filter body (1), spring (5) and spring seat (4)	Assemble.	
	h. Filter element (3), gasket (2) and filter body (1)	Install.	Use new filter and gasket.

3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



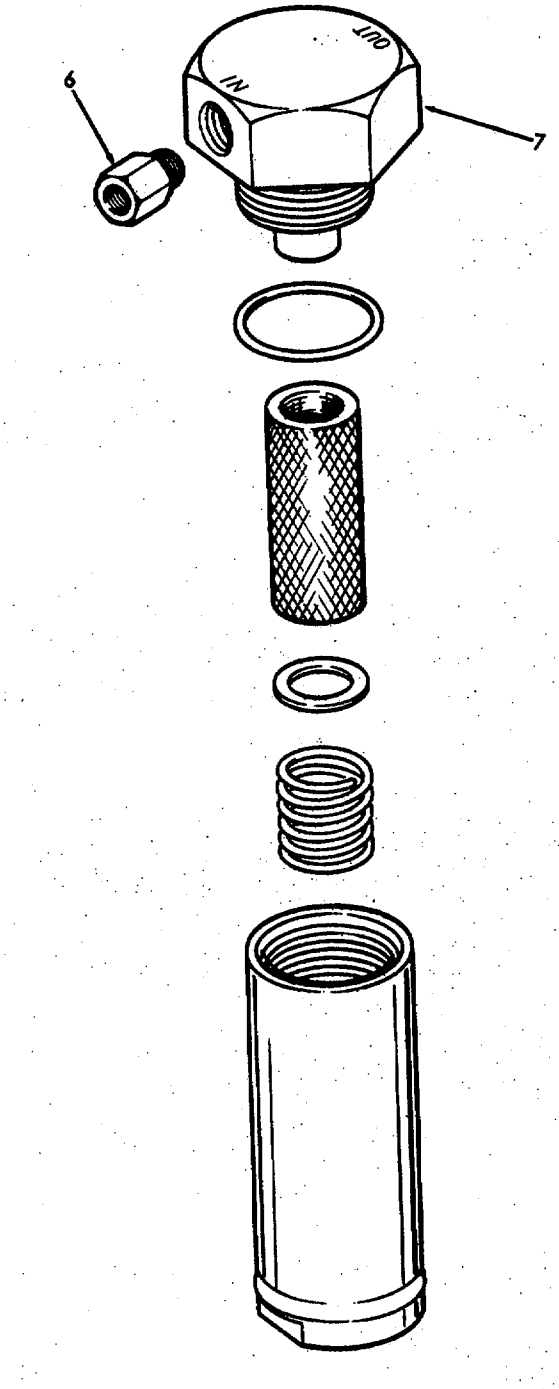
3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
4. Cap	a. Male connectors (6)	Loosen.	
	b. Cap (7)	Remove.	
INSTALLATION			
5. Cap	a. Cap (7) and male connectors (6)	Install.	
	b. Filter assembly if removed	Install.	Refer to step 3.
	c. System	Operate.	Make sure fittings are tight and leaks do not occur.

3-52.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-52.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Repair
d. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

Reference

None

Equipment Condition

None

Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in this procedure.

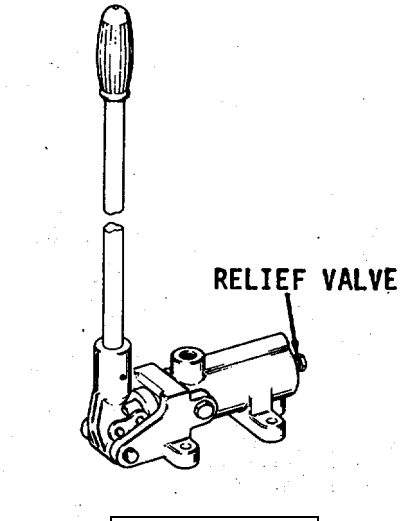
LOCATION	ITEM	ACTION	REMARK
INSPECTION			
1. Solenoid	Solenoid housing	a. Check for leaks.	
		b. Check for cracks, dents, and wear.	
		c. Check electrical connections.	
2.	Manual control valve	a. Check for leaks.	
		b. Check fittings.	
3.	Supply pipe	Check fittings for leaks.	
4.	Return pipe	Check fittings for leaks.	

3-52.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

5. Hand pump — Bleeder screw valve — Release pressure in the hydrostarter system by opening the bleeder screw valve on side of pump approximately 1/2 turn.



WARNING

The oil pressure in the system must be released prior to servicing the solenoid valve or any other components of the system to prevent possible injury to personnel or equipment.

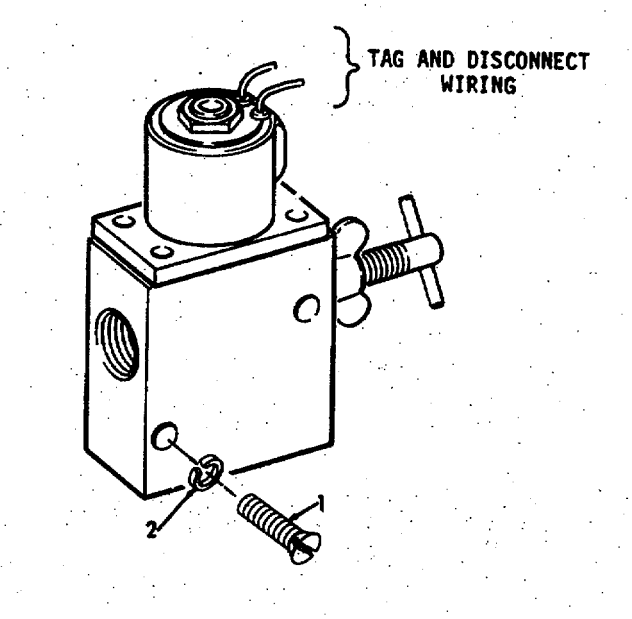
6. — Supply pipe — Disconnect supply pipe.

7. — Return pipe — Disconnect return pipe.

8. — Solenoid housing — a. Disconnect electrical connections.

3-52.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

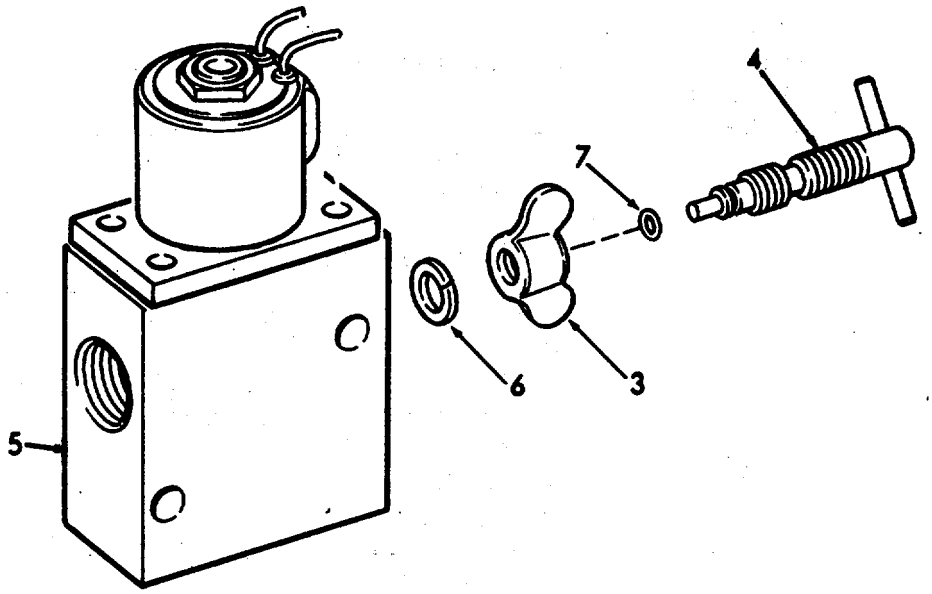
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		b. Remove screws (1) and lockwashers (2).	
		c. Remove housing from mount.	



REPAIR			
9.	Solenoid housing	Repair.	Refer to Direct Support Maintenance.
10.	Manual control screw	a. Loosen wing nut (3).	
		b. Unscrew manual control screw (4) from solenoid housing (5).	
		c. Remove lockwasher (6).	
		d. Remove wing nut (3).	
		e. Remove seal ring (7) from manual control screw (4).	Discard seal ring.

3-52.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11.	Manual control (7) screw (4)	a. Install new seal ring on manual control screw (4). b. Replace wing nut (3) on manual control screw (4). c. Install manual control screw (4) into solenoid housing (5) and lock-washer (6). d. Tighten wing nut (3).	
12.	Solenoid	a. Place on mounting. housing b. Install lockwashers (2) and screws (1). c. Connect electrical connections.	
13.	Return piping	Connect.	
14.	Supply Piping	Connect.	



3-52.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Service
d. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

Reference

None

Equipment Condition: None

Condition Description

None

Special Environmental Conditions

None

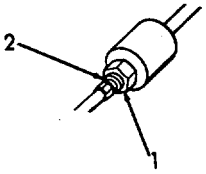
General Safety Instructions

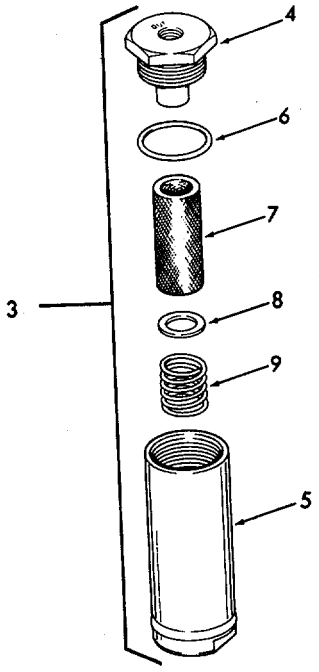
Observe ALL WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Filter Assembly	a. Filter	1. Check for leaks.	
		2. Check for dents and cracks.	
	b. Piping	1. Check for leaks.	
		2. Check for dents and cracks.	
REMOVAL			
2.	a. Connector (1) and adapters (2)	Loosen.	
	b. Filter (3)	Remove.	

3-52.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
3.	a. Cap (4) and filter body (5)	Unscrew.	
	b. Gasket (6)	Remove.	Discard.
	c. Filter (7)	Remove.	Discard properly.
	d. Spring seat (8) and spring (9)	Remove.	
	e. All Parts	Clean.	





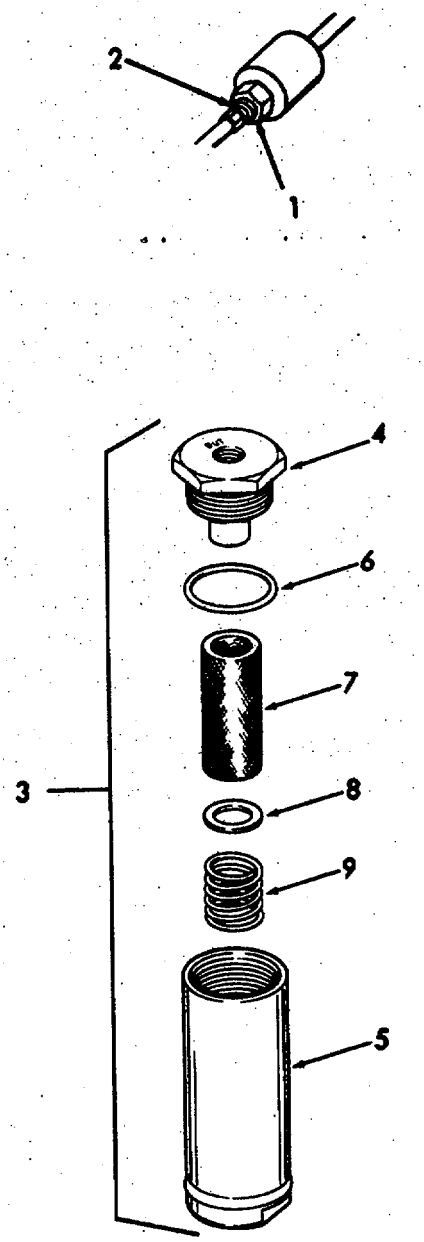
3-52.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	f. Filter body (5), Spring (9) and spring seat (8)	Assemble.	
	g. Filter (7), gasket (6), filter body (5) and cap (4)	Reassemble.	Use new filter and gasket.
INSTALLATION			
4.	a. Filter (3), adapters (2) and connec-tors (1)	Install.	
	b. System	Operate.	Make sure all fittings are tight and leaks do not occur.

3-52.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS.

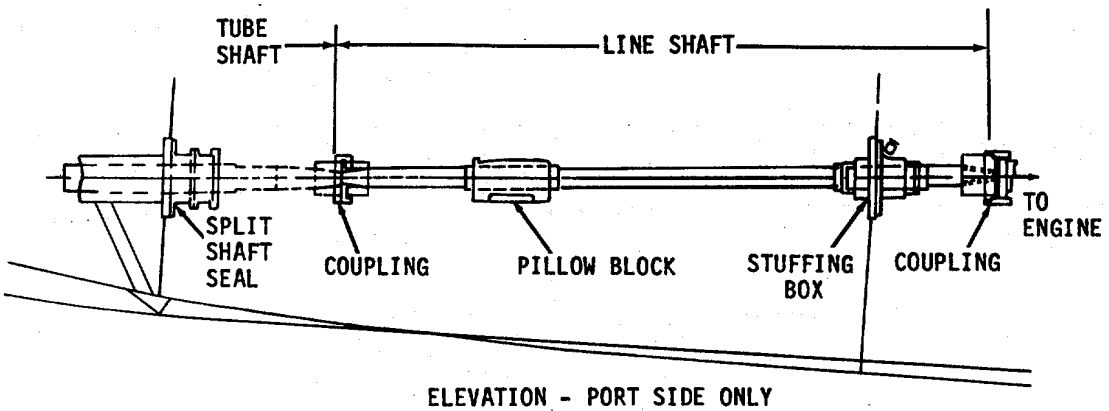
a. The propeller shafts are:

- Stub shaft (port and starboard)
- Outboard shaft (port and starboard)
- Line shaft (port only) (Refer to paragraph 3-54).
- Stern tube shaft (port and starboard)

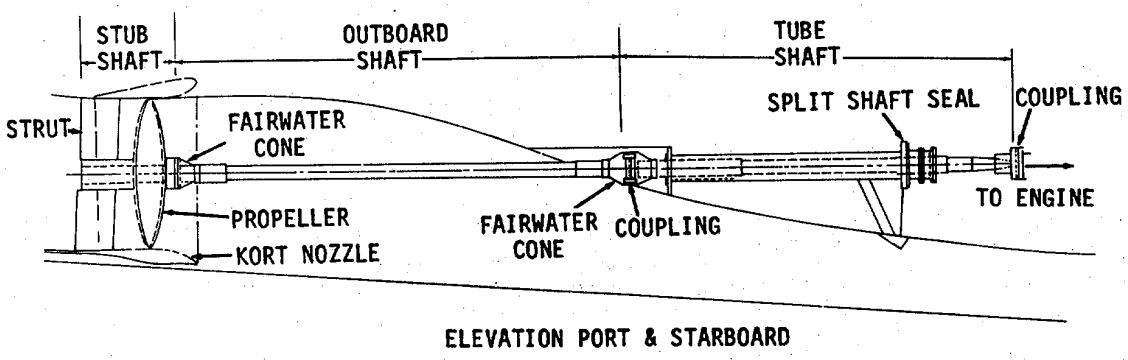
b. Each landing craft carries the following spare parts related to the propulsion shafting.

Item	Qty	Location
Line shaft	1	Bulwark, Port, Frame 41-48
Tube shaft	1	Bulwark, Port, Frame 41-48
Outboard shaft	1	Bulwark, Port, Frame 41-48
Stub Shaft	1	Aft engine room, Port Frame 62
Stub shaft sleeve	1	On spare shaft
Stub shaft cap	1	On spare shaft
Tube shaft sleeve (16 inches)	1	On spare shaft
Tube shaft sleeve (34 inches)	1	On spare shaft
Outboard shaft sleeves	2	On spare shaft

c. All maintenance is to be performed at the General Support Maintenance level, except for the line shaft. (Refer to paragraph 3-54).



ELEVATION - PORT SIDE ONLY



ELEVATION PORT & STARBOARD

3.53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Disassembly
c. Installation
d. Adjustment

INITIAL SETUP:

Test Equipment

Feeler gage 0.002 inch, straight edge
scribe

Special Tools

Chain hoist
Jacks

Material/Parts

Shims (metal or hardwood)

Personal Required

4

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

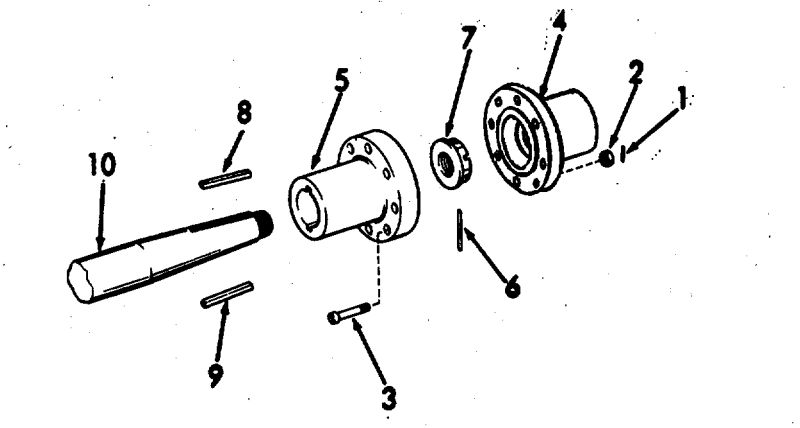
General Safety Instructions

The engine must be moved forward. Exercise caution when jacking or pulling engine.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Propeller shaft	a. Coupling half	1. Check for cracks.	
		2. Check nuts and bolts.	Make sure they are tight.
		3. Check cotter pins for wear, or breaks.	
		4. Check for wear.	
	b. Line shaft	1. Check for cracks.	
		2. Check for motion of coupling at shaft and indication of worn keys.	
		3. Check for wear.	

3-53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2. Propeller shaft	a. Coupling halves (4 and 5)	1. Punch mark both halves before disassembly.	Use scribe marks.
		2. Remove cotter pins (1).	
		3. Remove nuts (2) and capscrews (3).	
		4. Separate coupling half (4) from coupling half (5).	Engine must be moved forward.
	b. Shaft nut (7)	1. Remove cotter pin (6)	
		2. Remove shaft nut (7).	
	c. Line shaft (10)	1. Remove coupling half (5).	
		2. Remove shaft keys (8 and 9) from line shaft (10).	



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3-53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3. Propeller Shaft	a. Line shaft (10)	1. Install shaft keys (8 and 9) on line shaft (10).	
		2. Install coupling half (5).	
	b. Shaft nut (7)	Install shaft nut (7) and cotter pin (6).	
	c. Coupling halves (4 and 5)	1. Connect coupling halves (4 and 5).	Make sure the coupling halves are joined together at punch marks.
		2. Install capscrews (3), nuts (2) and cotter pins (1).	
ADJUSTMENT			
		NOTE	
4. Engine and marine gear alignment to propeller shafting		It is important to align the engine and gear only when the boat is afloat, and NOT in dry-dock. During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when boat is in service. With the engine and gear in position on the engine bed, arrangements must be made to have a controlled lift- or lowering of each of the four corners of the	

3-53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

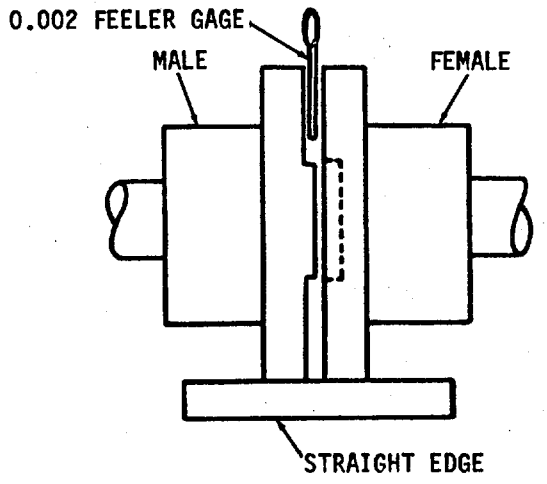
ADJUSTMENT (Cont)

NOTE (Cont)

engine. If threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the jacking screws will not damage the engine bed. Lifting can also be accomplished by the use of properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realignment.

(1) It will also be necessary to move the engine and gear from one side or the other on bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges.

(2) As the engine and marine gear then comes into its aligned position, it will be possible to match the male and female halves of the output flange and propeller coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. Place a 0.002 inch (0.005 cm) feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.



3-53. PROPELLER SHAFTS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT (Cont)

NOTE (Cont)

(3) Then the marine gear flange coupling is rotated 90, 180, and 270 degrees with the feeler blade being moved around the flange again in each successive position. If the alignment is correct, the feeler gauge will fit snugly, with the same tension, all around the flange coupling.

(4) If the alignment varies during rotation, then further alignment is necessary, or the marine gear and shaft couplings could be checked for improper face runout. Face runout on the marine gear output flange can usually be corrected by repositioning the coupling on its spline. Shaft coupling runout is usually due to an inaccuracy of taper fit or key interference.

(5) Some boats are not structurally rigid and some carry their load in such a way that they will "hog" or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine gear output flange and propeller coupling. This clearance might be 0.005 to 0.007 inch (0.013 to 0.018 cm) while the top would maintain the standard 0.002 inch (0.005 cm).

(6) During the process of securing final alignment, it may be necessary to shift the engine many times. When the final alignment is secured, the necessary steel or hardwood shims are made up and the engine and gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

(7) When a heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine gear coupling and prevent bending of the shaft.

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Disassembly
c. Installation
d. Adjustment

INITIAL SETUP:

Test Equipment

Feeler gage 0-002 inch, straight edge

Special Tools

Punch
Chain hoist

Material/Parts

None

Personnel Required

4

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Aft engine room, port side only	a. Shaft guard	1. Check for cracks, dents and wear.	
		2. Check mounting hardware to deck plates.	
	b. Pillow block	1. Check for leaking seals.	
		2. Check for wear.	
		3. Check mounting hardware for tightness.	
	c. Coupling	1. Check for cracks and wear.	
		2. Check attaching hardware for defective or broken cotter pins and looseness.	

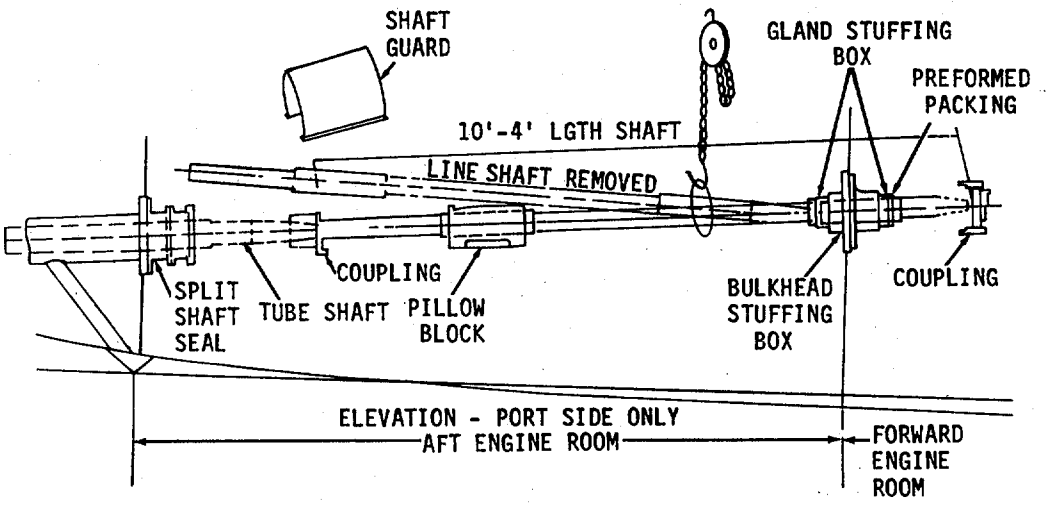
3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Gland stuffing box	1. Check for leaking.	
		2. Check for cracks, and wear.	
		3. Check mounting hardware for tightness.	
	e. Bulkhead stuffing box	1. Check for leaking.	
		2. Check for cracks, and wear.	
2.	Propeller line shaft	1. Check for cracks.	
		2. Check hardware for tightness.	
		3. Check shaft keys at couplings for looseness.	
		4. Check for wear.	
3. Forward engine room, port side only	a. Gland stuffing box	1. Check for leaking.	
		2. Check for cracks and wear.	
		3. Check mounting hardware for tightness.	
	b. Coupling	1. Check for cracks.	
		2. Check for wear.	
		3. Check hardware for tightness.	

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

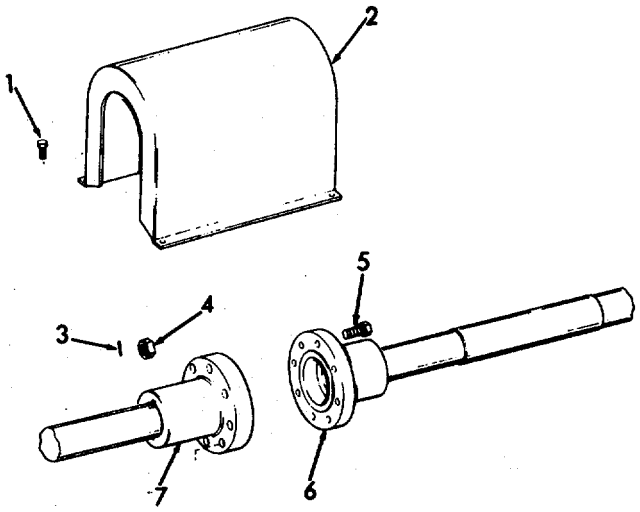
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



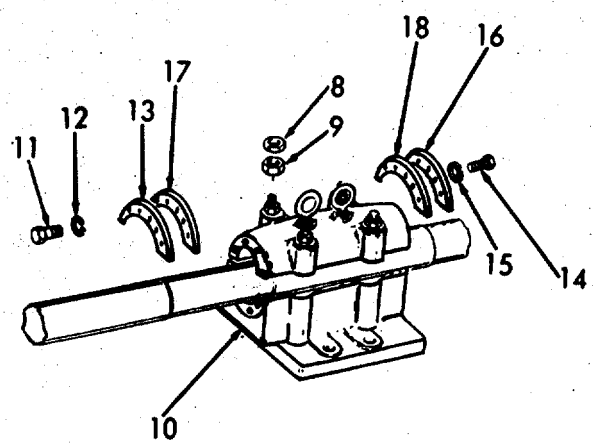
DISASSEMBLY

4.	Aft engine room, port side	a.	Shaft guard	1. Remove screws (1). 2. Remove shaft guard (2).	
		b.	Coupling halves	Remove slotted cotter pins (3), hex nuts (4) bolts (5) from coupling halves (6 and 7).	Punch-mark both halves before disassembly.



3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	c. Pillow block	1. Remove hex nuts (8) and lockwashers (9) from pillow block (10).	The pillow block may be double rutted.
		2. Remove bolts (11), lockwashers (12) and retaining half ring (13).	
		3. Remove bolts (14), lockwashers (15) and retaining half ring (16)	
		4. Remove top of pillow block (10).	
		5. Remove felt seals (17 and 18).	



5. Forward engine room, port side	a. Coupling halves	Remove cotter pins (19), slotted hex nuts (20) and bolts (21) from coupling halves (22 and 23).	Punch mark both halves before disassembly.
	b. Gland stuffing box	1. Remove jam hex nuts (24).	

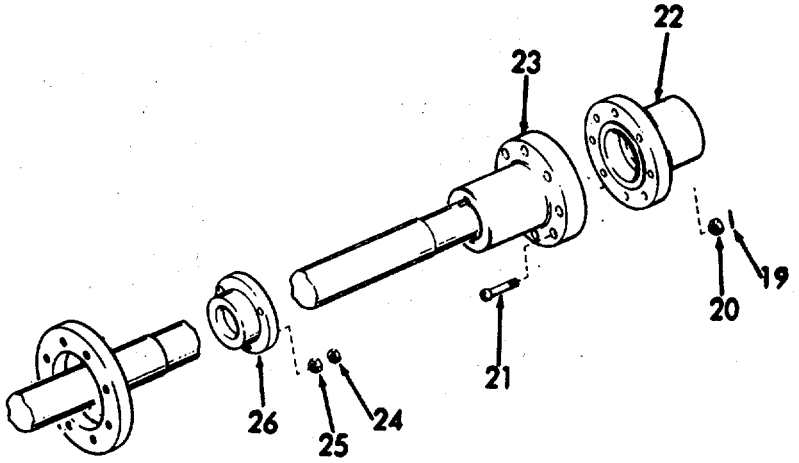
3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

2. Remove hex nuts (25).

3. Slide gland stuffing box (26) up shaft.



6. Aft engine room, port Side

a. Gland stuffing box

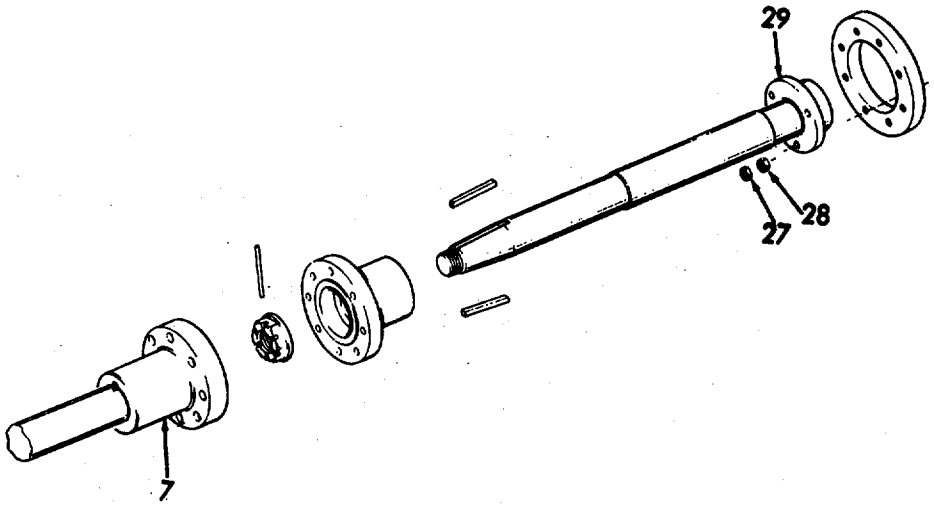
1. Remove jam hex nuts (27).

2. Remove hex nuts (28).

3. Slide gland stuffing box (29) down the shaft.

b. Tube shaft and coupling-half

1. Force coupling half (7), aft about 6 inches (15 cm).

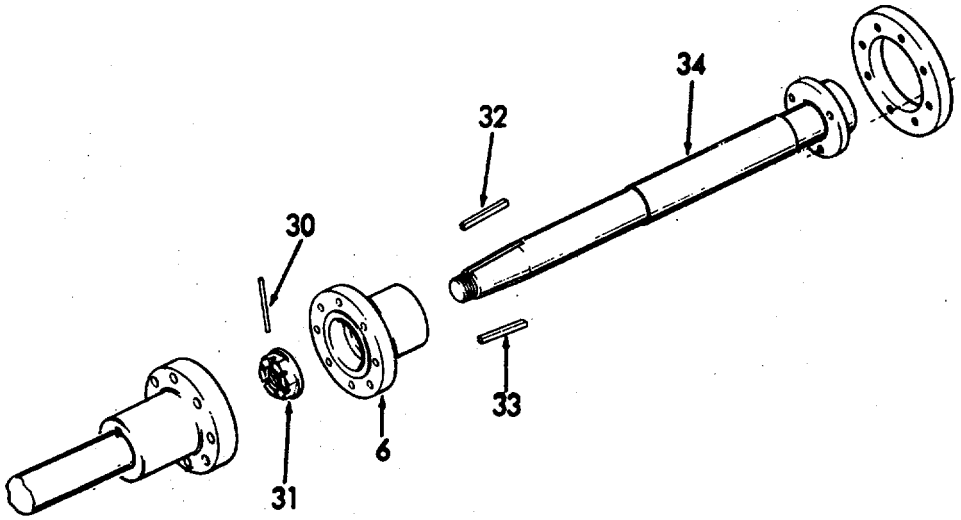


3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

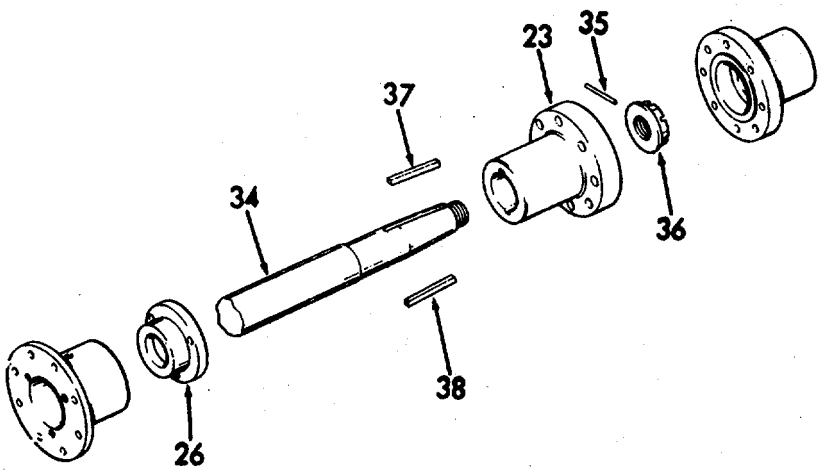
2. Remove cotter pin (30).
3. Remove shaft nut (31).
4. Remove coupling half (6).
5. Remove shaft keys (32 and 33) from propeller line shaft (34).



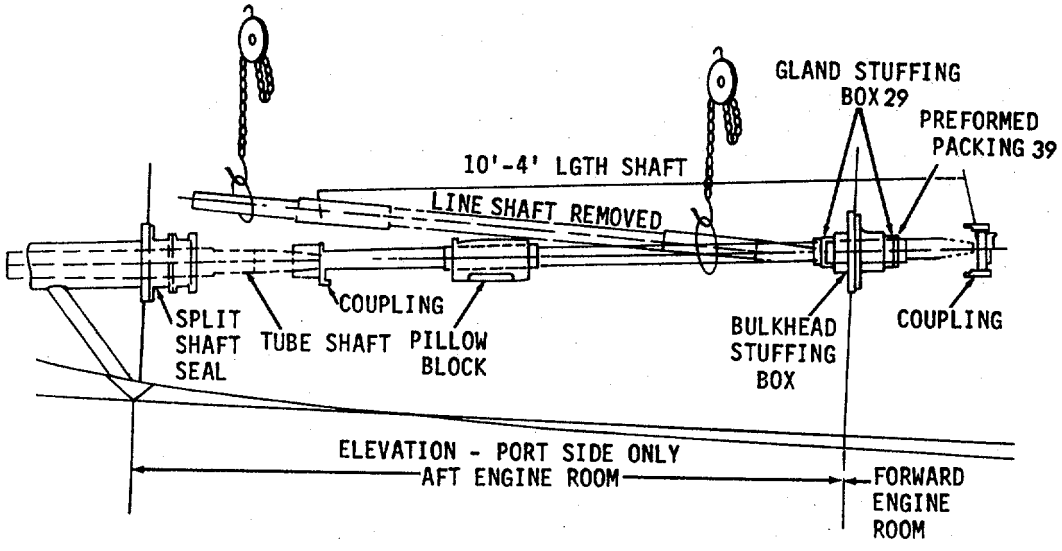
LOCATION	ITEM	ACTION	REMARKS
7. Forward engine room, port side	a. Coupling half	1. Slide coupling half (23) aft about 6 Inches (15 cm) 2. Remove cotter pin (35). 3. Remove shaft nut (36). 4. Remove coupling half (23). 5. Remove shaft keys (37 and 38) from propeller line shaft (34). 6. Slide gland stuffing box (26) off shaft.	

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

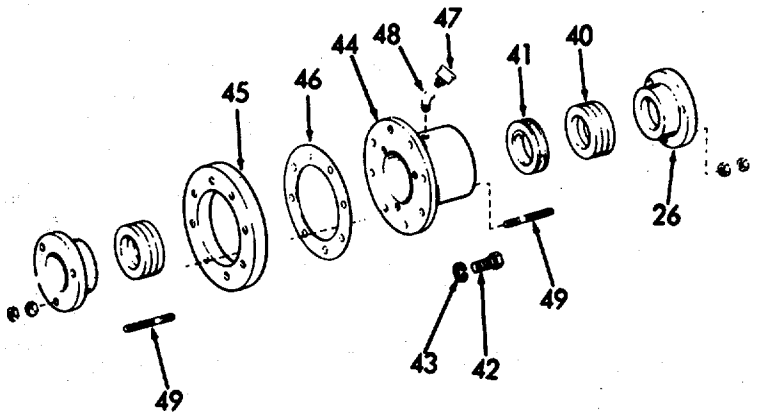


8.	Aft engine room, port side shaft	a.	Propeller line 388 lbs	1. Lift and slide the propeller line shaft (34) out of bulkhead. 2. Slide gland stuffing box (29) off the shaft. 3. Remove propeller line shaft (34).	Use chain hoists. The shaft weighs (176 kg).
		b.	Gland stuffing box	Remove preformed packing (39) from gland stuffing box (29).	



3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

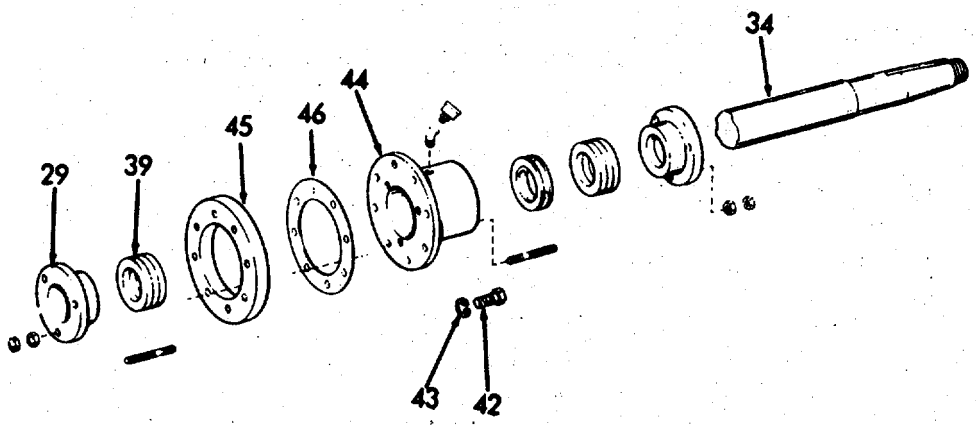
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
9. Forward engine room, port side	a. Gland stuffing box	1. Remove preformed packing (40) from stuffing box (26).	
		2. Remove lantern ring (41).	
	b. Bulkhead stuffing box	1. Remove capscrews (42) and lockwashers (43).	Do not let bulkhead plate insert (45) drop.
		2. Remove bulkhead stuffing box (44).	
		3. Remove seal gasket (46).	
		4. Remove grease cup (47) and elbow (48),	If necessary.
		5. Remove studs (49).	If necessary.



10. Aft engine room, port side	Bulkhead plate insert	Remove bulkhead plate insert (45) from bulkhead.	

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11. Aft engine room, port side	Bulkhead plate insert	Install bulkhead plate insert (45) onto bulkhead.	Hold into place until bulkhead stuffing box is bolted to the bulkhead and plate insert.
12. Forward engine room, port side	Bulkhead stuffing box	1. Install seal gasket (46). 2. Install bulkhead stuffing box (44) onto the bulkhead. 3. Install lockwashers (43) and capscrews (42).	
13. Aft engine room, port side	Propeller line shaft	1. Insert preformed packing (39) into gland stuffing box (29). 2. Slide gland stuffing box (29) on line propeller shaft (34). 3. Slide propeller line shaft (34) through bulkhead plate insert (45), seal gasket (46) and bulkhead stuffing box (44).	Use chain hoists.

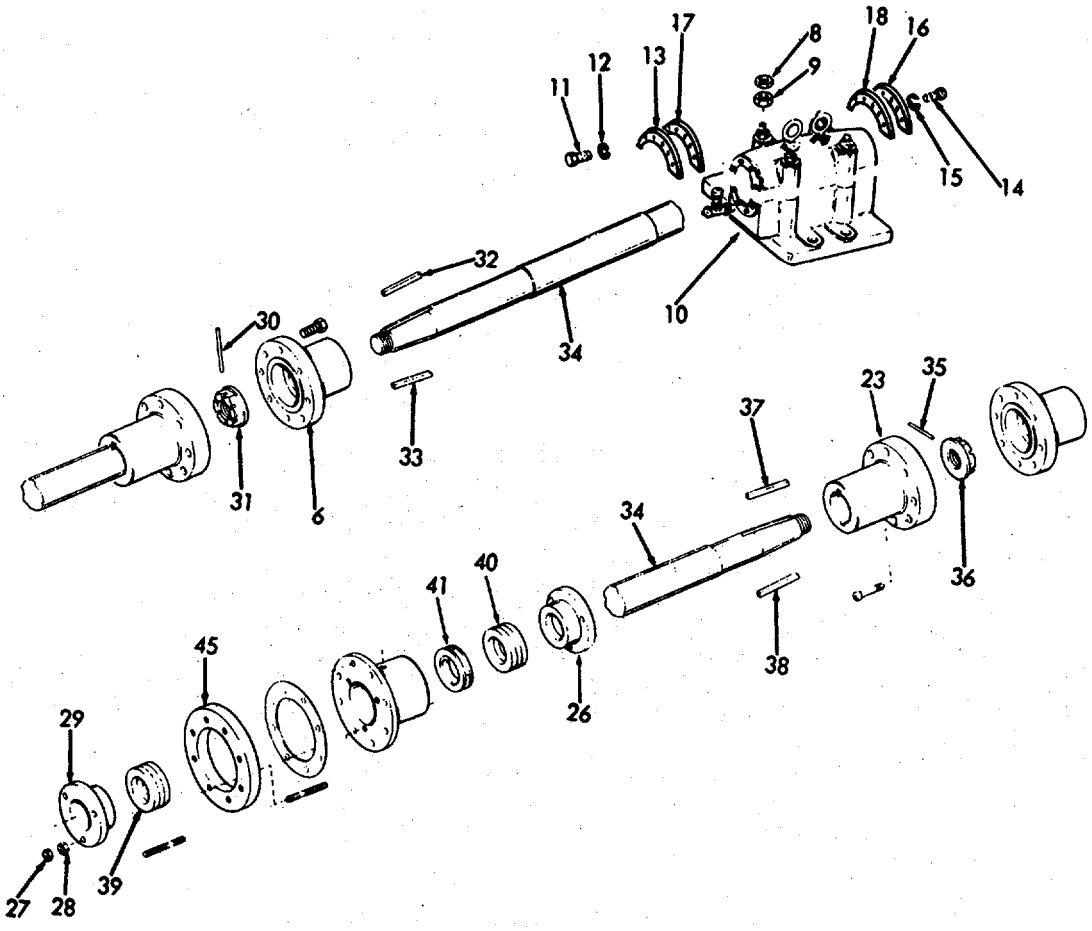


3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
14. Forward engine room, port side	a. Propeller line shaft	1. Install lantern ring (41), preformed packing (40) and gland stuffing box (26).	
		2. Slide gland stuffing box (26) onto propeller line shaft (34).	
	b. Coupling half	1. Install key shafts (37 and 38).	
		2. Install coupling-half (23) onto propeller line shaft (34).	
		3. Install shaft nut (36) and cotter pin (35).	
15. Aft engine room, port side	a. Coupling half (6)	1. Install key shafts (32 and 33).	
		2. Install coupling half (6).	
		3. Install shaft nut (31).	
		4. Install cotter pin (30).	
	b. Propeller line shaft	1. Lower, and slide propeller line shaft (34) forward.	
		2. Remove chain hoists.	
	c. Pillow block	1. Install felt seals (17), and (18).	
		2. Replace top of pillow block (10).	
		3. Install lockwashers (9), and hex nuts (8).	Hand tight.

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		4. Install retaining ring (16), lockwashers (15) and bolts (14).	
		5. Install retaining ring (13), using lockwashers (12) and bolts (11).	
	d. Gland stuffing box	1. Push gland stuffing box (29) and preformed packing (39) up tight against bulkhead plate insert (45).	
		2. Install hex nuts (28) and jam hex nuts (27).	



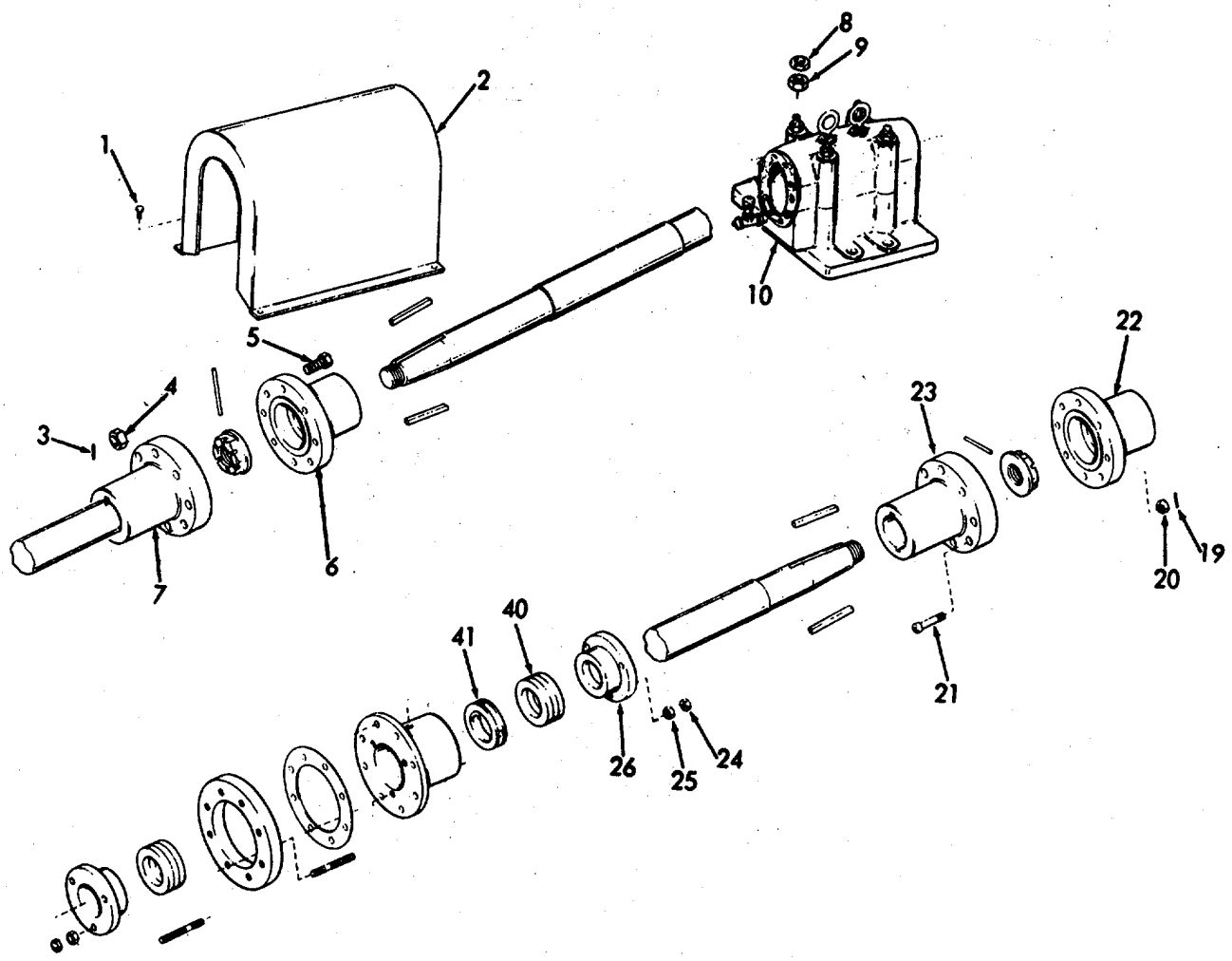
3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
16. Forward engine room, port side	a. Gland stuffing box	1. Install gland stuffing box (26), preformed packing (40), and lantern ring (41).	
		2. Install hex nuts (25) and jam hex nuts (24).	
	b. Coupling halves	1. Draw together coupling halves (22 and 23).	Align at punch marks.
		2. Install capscrews (21), and lockwashers (20).	Finger tight. Insert cotter pins (19) after alignment.
17. Aft engine room, port side	a. Coupling halves	1. Draw together coupling. halves (6 and 7).	Align at punch marks.
		2. Install capscrews (5) and lockwashers (4).	Finger tight only. Insert cotter pins (3) after alignment.
	b. Pillow block	Tighten hex nuts (8) and lockwashers (9), securing pillow block halves (10).	
	c. Shaft guard	1. Install shaft guard (2) over coupling halves (6 and 7).	After alignment is complete.
		2. Install screw (1), securing shaft guard to deck plate.	

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT

NOTE

18. Engine and marine gear alignment to propeller shaft

It is important to align the engine and gear only when the boat is afloat, and NOT in drydock. During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when the boat is in service. With the engine and gear in position on the engine bed, arrangements must be made to have a controlled lifting or lowering of each of the four corners of the engine. If threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the jacking screw will not damage the engine bed. Lifting can also be accomplished by the use of properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realignment.

(1) It will also be necessary to move the engine and gear from one side or the other on the bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges.

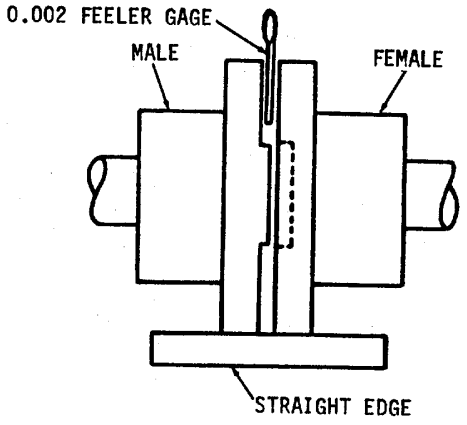
(2) As the engine and marine gear then comes into its aligned position, it will be possible to match the male and female halves of the output flange and propeller coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT (Cont)

critical. Place a 0.002 inch (0.005 cm) feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.



(3) Then the marine gear flange coupling is rotated 90, 180, and 270 degrees with the feeler blade being moved around the flange again in each successive position. If the alignment is correct, the feeler gauge will fit snugly, with the same tension, all around the flange coupling.

(4) If the alignment varies during rotation, then further alignment is necessary, or the marine gear and shaft couplings could be checked for improper face runout. Face runout on the marine gear output flange can usually be corrected by repositioning the coupling on its spline. Shaft coupling runout is usually due to an inaccuracy of taper fit or key interference.

3-54. LINE SHAFTING (PORT SIDE ONLY) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT (Cont)

(5) Some boats are not structurally rigid and some carry their load in such a way that they will "hog" or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine gear output flange and propeller coupling. This clearance might be 0.005 to 0.007 inch (0.013 to 0.018 cm) while the top would maintain the standard 0.002 inch (0.005 cm).

(6) During the process of securing final alignment, it may be necessary to shift the engine many times. When the final alignment is secured, the necessary steel or hardwood shims are made up and the engine and gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

(7) When a heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine gear coupling and prevent bending of the shaft.

3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS.

a. A feature of the marine split shaft seal is the split, inflatable sealing ring which is located in a recess in the seal housing; just off of the sealing element cavity. The inflatable sealing ring, when not in use, does not contact the shaft surface.

b. When it is necessary to interchange or replace the sealing element, the inflatable sealing ring is inflated with air from an appropriate source, and forms a restriction around the stationary shaft, restricting sea water ingress and permitting seal repair. After the interchange or replacement of the sealing elements is completed, the inflatable ring is deflated, receding back into its recess, loosing contact with the shaft.

This task covers:

a. Inspection **c. Service** **e. Inflation**
b. Removal **d. Installation** **f. Deflation**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Inflation kit B-108387

Personnel Required

1

References

None

Equipment Condition Condition Description

None

Special Environmental Conditions

None

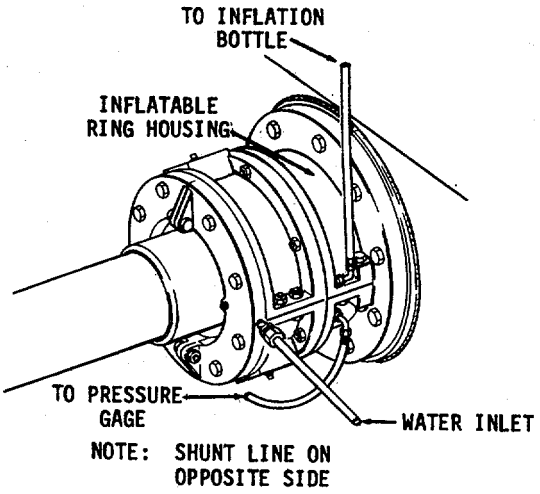
General Safety Instructions

WARNING

Observe all CAUTIONS and WARNINGS in this procedure. Failure to do so can result in loss of life and loss of the landing craft.

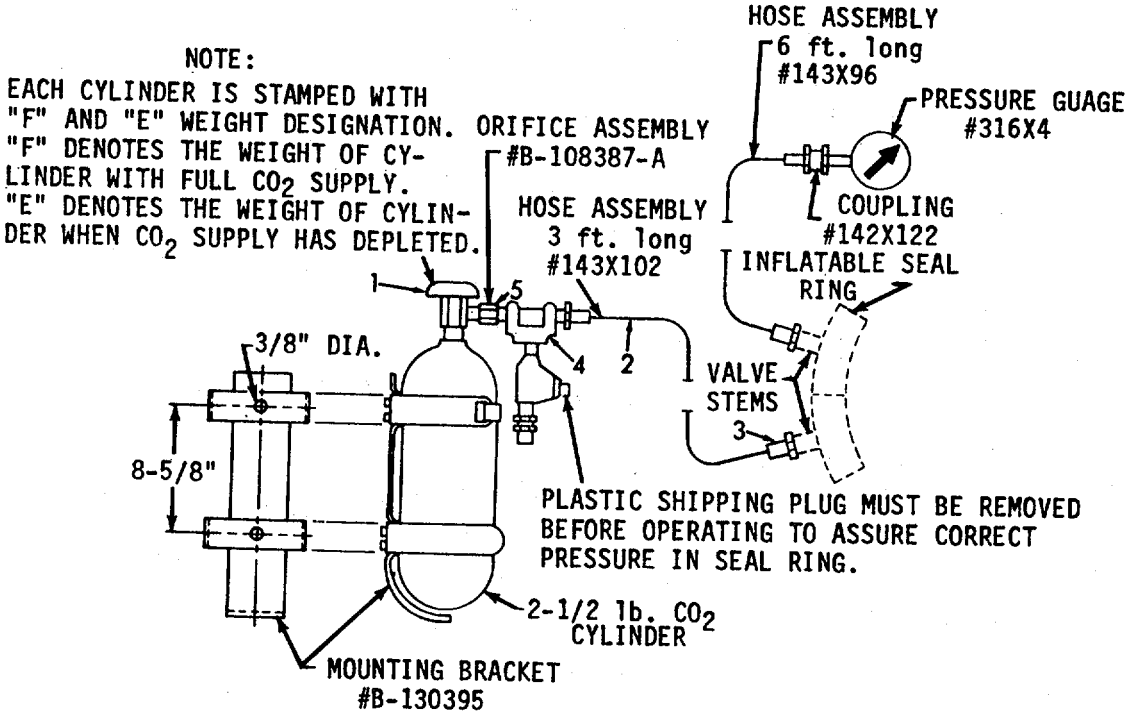
3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Shaft seal	Inflatable ring housing	a. Check for leaks. b. Check for cracks or signs of damage.	
2. Inflatable ring housing	a. Air hose	Check shunt line into both halves of housing.	
	b. Valve stems	Check fittings for wear or breaks.	
3. Inflation tank	Carbon dioxide tank (CO_2)	a. Check that $C0_2$ tank is full. b. Check valve on tank for leaks.	Full tank weighs 10 lbs (4.5 kg).
4. Hoses	Hoses	a. Check hose connections for leaks or cracks. b. Check hoses for leaks, cracks or breaks.	
5. Pressure gage	Gage	a. Check pressure gage for leaks. b. Check gage glass for breaks or cracks.	



3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
6. Inflation tank (1)	Carbon dioxide tank (CO_2)	a. Make sure tank is full.	
		b. Disconnect hose assembly (2) (#143x102) from inflatable sealing ring valve stem (3).	
		c. Disconnect hose assembly (2) from CO_2 valve stem (4) and orifice assembly (5) (# B-108387-A).	
		d. Disconnect tank (1) from orifice assembly (5).	
		e. Remove tank (1) from mounting brackets.	



3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
7. Pressure gage	Gage	a. Disconnect gage hose (6) (hose assembly #142x96) from inflatable sealing ring valve stem (7).	
		b. Remove coupling (8).	
		c. Remove pressure gage (9) from bulkhead.	
		d. Remove plastic shipping cap (10) before operation.	
SERVICE - RECHARGING THE CARBON DIOXIDE TANK (CO_2).			
		NOTE Recharging is not by pressure....psi (kpa) will vary with temperature and psi (kpa) in the recharging system.	
8. Inflation tank (1)	Carbon dioxide tank (CO_2)	a. Invert tank and chill.	
		b. Connect liquid CO_2 supply line to task valve (1).	
		c. Liquid CO_2 will now flow into tank.	
		d. Check by weight.	
		(1) Empty weight - 7.5 Lbs. (3.41 kg).	
		(2) Fully charged - 10 Lbs. (4.54 kg).	Means 2.5 Lbs. (1.14 kg) of liquid CO_2 into tank.
		(3) Variance - 2.5 Lbs. + 10% (1.14-kg + 10%).	

3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Cont).

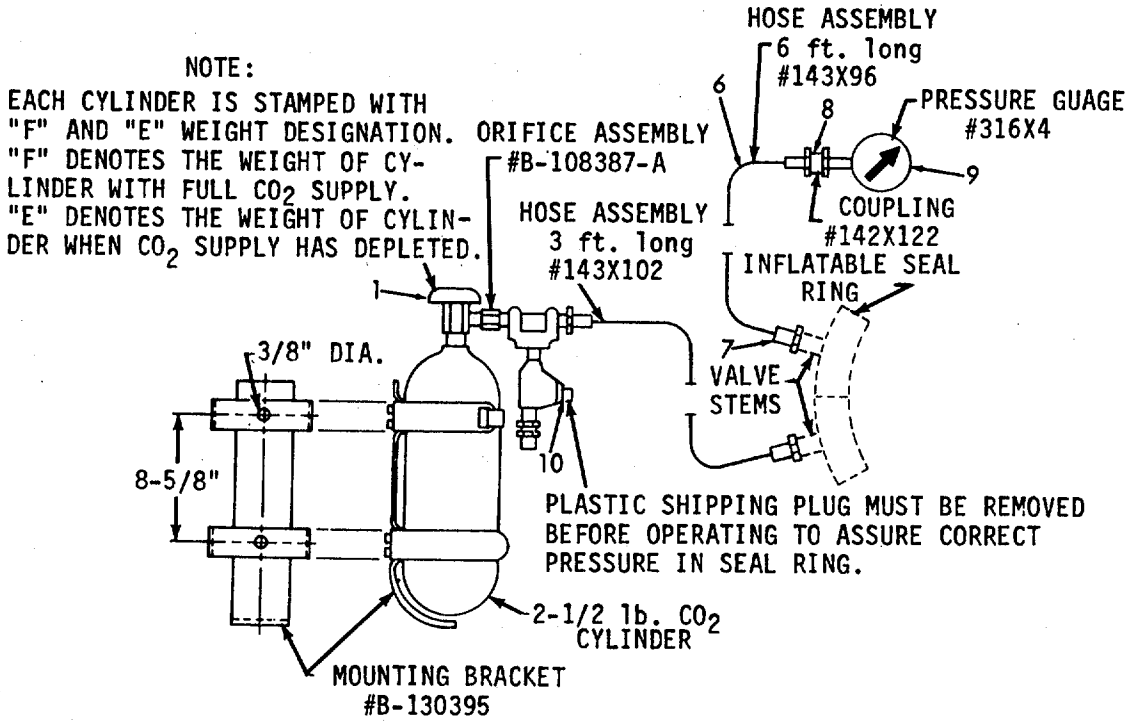
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

CAUTION

Do not exceed 2.5 pounds (1.14 kg). Bleed off excess.

9. Pressure gage	Gage	a. Attach pressure gage (9) to bulkhead. b. Attach coupling (8). c. Attach gage hose (6) to inflatable sealing ring stem (7).	



3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
10. Inflation tank (1)	Carbon dioxide tank (CO_2)	a. Install tank (1) in mounting bracket. b. Connect tank (1) to orifice assembly (5). c. Attach hose assembly (2) to CO_2 valve stem (4) and orifice assembly (5). d. Attach hose assembly (2) to inflatable sealing ring valve stem (3).	
		NOTE Plastic shipping plug (10) must be removed before operating to assure correct pressure.	
		CAUTION All connections must be firmly tightened to prevent CO_2 leakage.	
INFLATION			
11. Inflatable housing ring	a. Carbon dioxide tank (CO_2)	Open CO_2 valve (1) clockwise.	
	b. Pressure gage	Check pressure gage (9).	Inflation pressure is 125 to 175 psi (169.5 to 237.3 kpa). Not to exceed 200 psi (271.2 kps). Maintain pressure.

3-55. SHAFT INFLATABLE SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

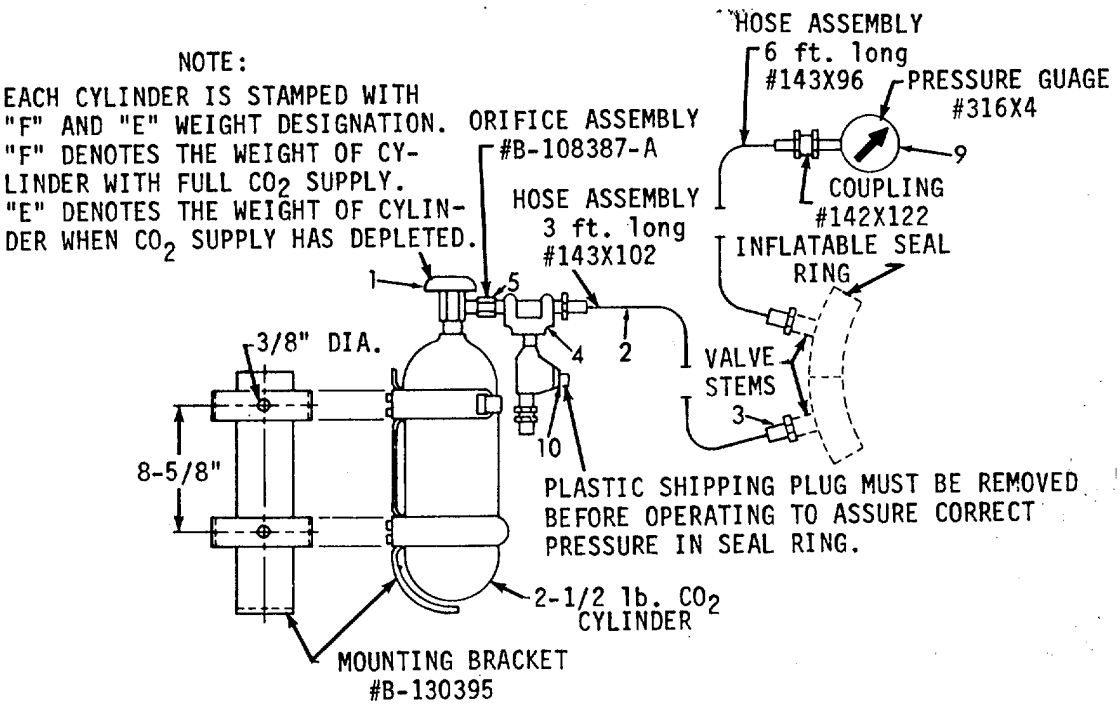
INFLATION (Cont)

WARNING

If inflatable sealing ring does not inflate STOP IMMEDIATELY. DO NOT PROCEED. Failure of inflatable sealing ring to inflate can cause loss of life and loss of the landing craft. Check carbon dioxide, (CO_2) tank is it full? Try CO_2 tank from aft or Forward engine room. If Inflatable sealing ring still does not inflate STOP - DO NOT PROCEED. Contact General Support Maintenance AT ONCE.

DEFLATION

12. Inflatable housing ring	a. Carbon dioxide tank (CO_2)	Close CO_2 valve (1). Turn counter-clockwise.	
	b. Pressure gage	Pressure will drop in pressure gage (9).	



3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS.

a. The Marine Split Shaft Seal is constructed of a sectional marine bronze housing casting which houses two flexible sealing elements and a split inflatable sealing ring. The housing is designed to facilitate installation and simplify maintenance and replacement of the sealing elements.

b. In the forward section of the assembly are installed two split sealing elements. The sealing elements are held in contact with the shaft by encircling garter springs. As a result of the contact, the sealing elements revolve with the shaft. However, actual sealing is accomplished only by the forward sealing element. The vertical surface contacts the lapped face of the seal gland ring. The aft sealing element acts as a spacer ring and is available as a replacement element when interchange is required.

c. The sealing contact is lubricated by a slight flow of clean water, which is injected through the gland ring, into a provided recess in the forward sealing element.

This task covers:

a. Inspection
b. Service
c. Disassembly
d. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

MEK (Methy-ethyl-ketone)
Goodyear Pliobond No.20
Cement or equivalent
Cup of grease

Personnel Required

1

References

Refer to paragraph 3-55 for inflation and deflation procedures

Equipment Condition — Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe all CAUTIONS AND WARNINGS in these procedures. Failure to do so can result in loss of life and loss of the Landing Craft.

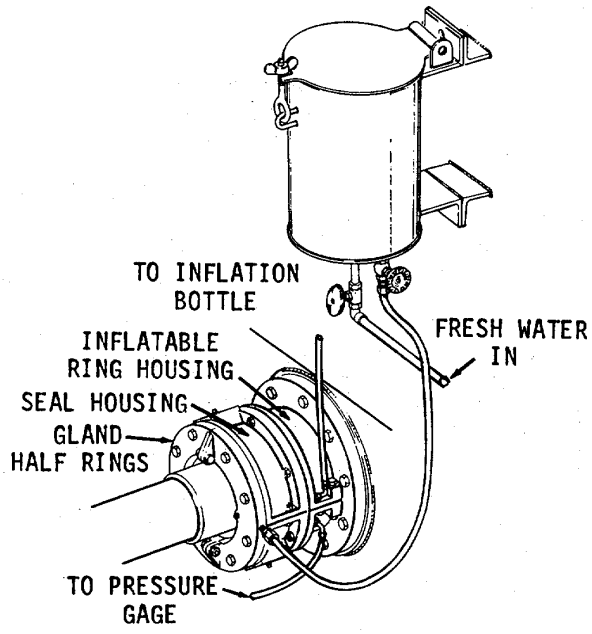
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Split shaft seal	a. Gland half ring	1. Check for leaks.	
		2. Check for breaks, cracks and loose hardware.	
		3. Check for broken lockwire.	
	b. Housing seal	1. Check for leaks.	
		2. Check for breaks, cracks and loose hardware.	
	c. Inflatable housing	1. Check for leaks.	
		2. Check for breaks, cracks and loose hardware.	
	d. Air hoses	Check for leaks, cracks and breaks.	
	e. Air hose shunt line	1. Check for leaks.	
		2. Check that connections are hand tight.	
	f. Water seal lines	1. Check for leaks.	
		2. Check for cracks and breaks.	
	g. Water seal connections	Check for leaks.	

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

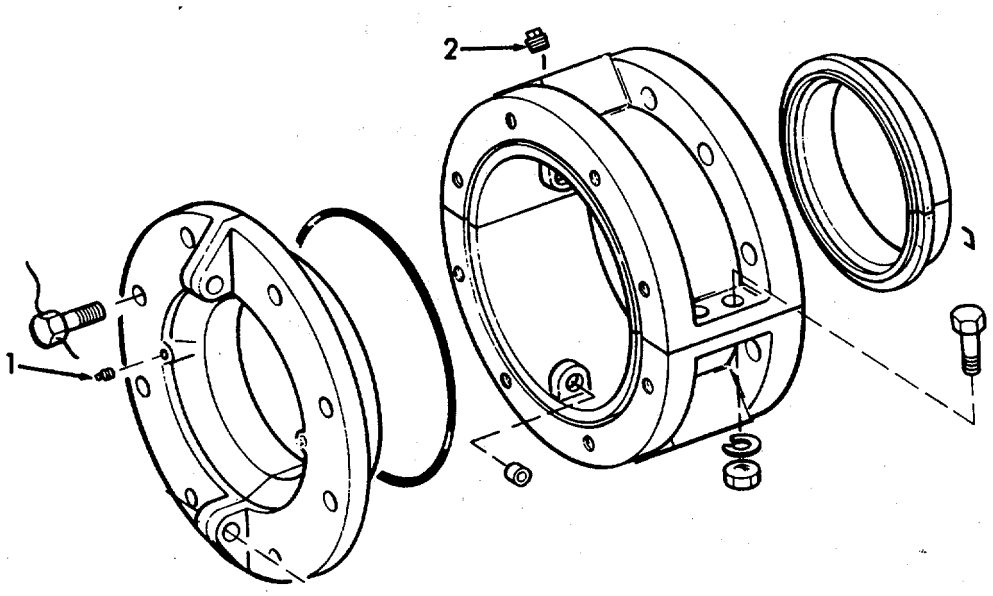
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



SERVICE

2.	Seal Housing	Drain plugs (1 and 2)	Remove drain plugs (1 and 2) monthly to drain water in the seal housing from shaft seal tank.

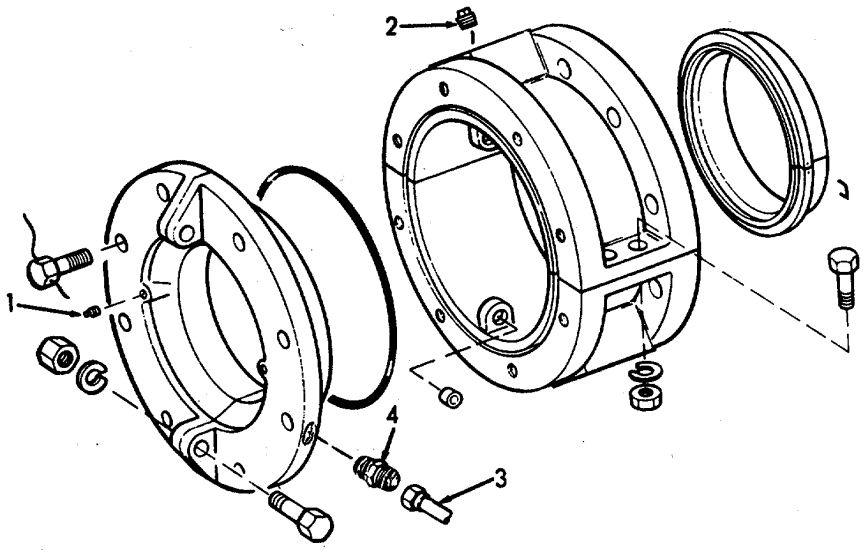


3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
		WARNING	
		Inflate the inflatable sealing ring BEFORE any work is performed on the split shaft seal. FAILURE TO DO SO CAN RESULT IN EXCESSIVE FLOODING WHICH CAN LEAD TO LOSS OF LIFE AND LOSS OF THE LANDING CRAFT.	
3. Inflatable housing ring	Carbon dioxide tank (CO_2)	a. Check that all hoses are connected.	Refer to paragraph 3-55 for inflation procedures.
		b. Open CO_2 tank valve to inflate the inflatable sealing ring.	
		c. Inflate ring with 125 to 175 psi (169.5 to 237.3 kpa) pressure from CO_2 tank.	Refer to paragraph 3-55. Maintain pressure.
		CAUTION	
		Do not exceed 200 psi (271.2 kpa) in inflatable sealing ring.	
		WARNING	
		If inflatable sealing ring fails to inflate: STOP IMMEDIATELY. DO NOT PROCEED.	
4. Shaft seal tank	a. Outlet gate valve	Turn clockwise to close.	
	b. Inlet valve	Turn counter-clockwise to close.	

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
5. Split shaft seal housing	a. Seal water lines	1. Disconnect pipe (3). 2. Remove fitting (4).	
	b. Pipe plugs	Remove pipe plugs (2) to drain seal housing.	Excessive leakage increases pressure in the inflatable sealing ring. Do not exceed 200 psi-(271.2). Leakage should stop or be reduced.
6. Gland ring	Pipe plugs	Remove pipe plugs (1) to drain gland ring.	Excessive leakage increases pressure in the inflatable sealing ring. Do not exceed 200 psi (271.2 kpa). Leakage should stop or be reduced.

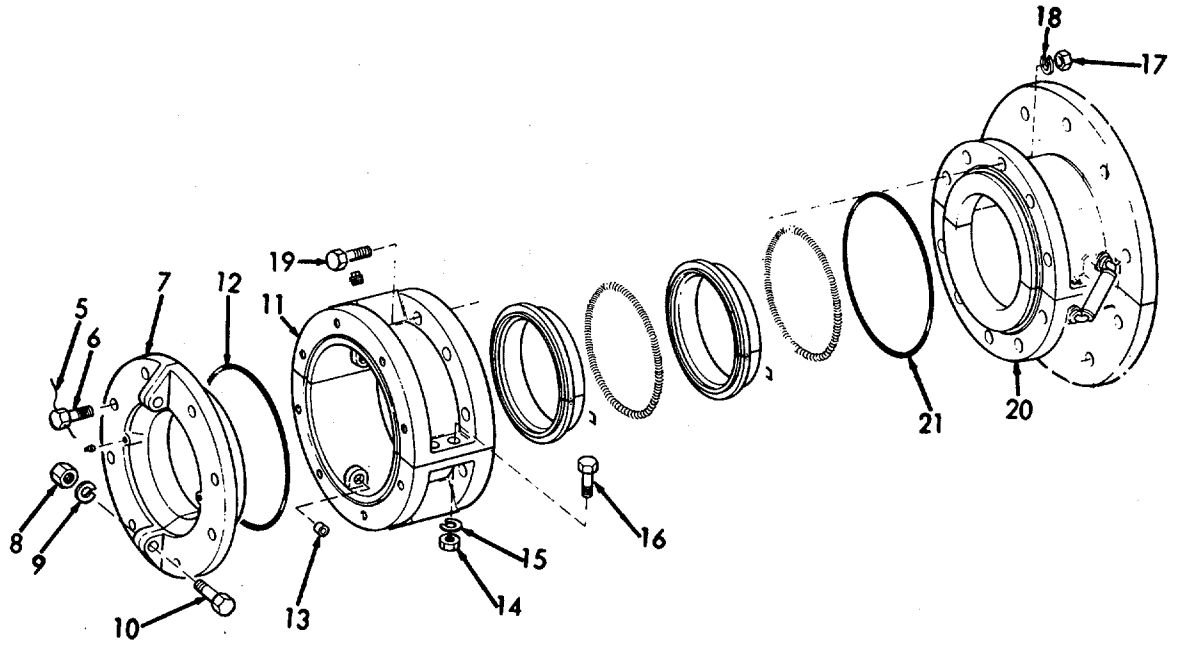


3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		WARNING If inflatable sealing ring fails to stem leakage or reduce the flow - STOP IMMEDIATELY. DO NOT PROCEED. Refer to General Support Maintenance.	
		NOTE Seal the lubricating system cavity drains, and if no excessive leakage occurs in the cavity or stern tube, proceed to the following steps.	
7. Split shaft seal	a. Gland ring	1. Remove lockwire (5) and capscrews (6) from gland half-rings (7).	
		2. Remove hex nuts (8), lockwashers (9) and bolts (10).	
		3. Carefully separate the gland half rings (7) from the seal housing (11).	
		4. Remove the cement attaching the pre-formed packing (12) to the gland half rings (7).	
		5. Remove bushings (13).	
		6. Carefully separate the 2 halves of the gland half rings (7). Take care not to damage surfaces.	
		7. Remove gland half ring (7) from propeller shaft.	Be careful not to damage the machined surfaces or mar the lapped face.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		8. Cut and remove preformed packing (12).	
	b. Seal housing	1. Remove hex nuts (14), lockwashers (15) and hex bolts (16).	
		2. Remove hex nuts (17), lockwashers (18), and hex bolts (19).	
		3. Carefully separate the seal housing from the inflatable ring housing (20).	
		4. Remove the cement attaching the preformed packing (21) to the seal housing.	
		5. Remove seal housing halves (11) from propeller shaft, to expose the sealing elements.	Take care not to damage the machined surfaces.
		6. Cut and remove preformed packing (21).	



3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

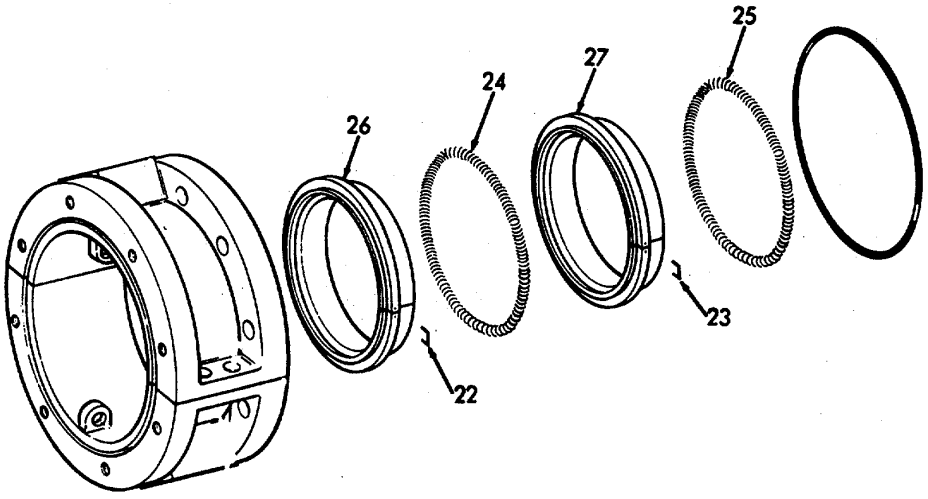
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
8. Propeller shaft	Sealing elements	1. Remove barbed staples (22 and 23).	
		2. Unhook the two ends of the garter springs (24 and 25).	
		3. Remove garter springs (24 and 25).	

WARNING

Methyl Ethyl Ketone (MEK) solvent is a highly volatile and flammable substance. DO NOT USE NEAR FIRE OR FLAME. Provide adequate ventilation. Avoid prolonged breathing of vapor. Avoid repeated contact with skin. Seal container when not in use.

4. Use Methyl Ethyl Ketone (MEK) solvent to dissolve the quick cemented bond, bonding the sealing element joint.

5. Remove sealing elements (26 and 27) from propeller shaft.



3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

9. Bonding Procedure - Quickset Adhesive.

NOTE

Use recommended quickset adhesive only: Eastman 910, Loctite 404, Alpha, Goodyear Pliobond, Perma-Grip, or equivalent.

WARNING

Quick-set adhesive used in maintaining equipment is basically. CYANOACRYLATE RESIN. It is a HAZARDOUS SUBSTANCE - an IRRITATING LIQUID and VAPOR. Use adequate ventilation. Avoid breathing vapor. Avoid skin contact. If skin contact occurs, wipe immediately and flush skin area with water. Eye or mouth contact requires medical attention.

- Quickset cement is a contact adhesive which means that as soon as surfaces make contact with each other a bond takes place.
- Since immediate bonding takes place upon contact, the mated surfaces cannot be pulled apart or adjusted. Therefore, it is important that extreme care be exercised to ensure that all surfaces and edges of the split joint be in alignment for perfect mating.
- Achieving alignment of the mating surfaces is facilitated if the aft edges of the element base can be set against a step in the shaft sleeve. This acts as a support and a guide to bring all edges in alignment.
- Clean the area where the rubber element will be seated during bonding. Any foreign matter on the mating surfaces will prevent bonding. Therefore, cleanliness is important.
- Use Methyl Ethyl Ketone (MEK) to clean split surfaces. Wipe lightly with a cloth moistened with MEK, if surface is soiled.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

WARNING

Methyl Ethyl Ketone (MEK) is a highly volatile and flammable substance. DO NOT USE NEAR FIRE OR FLAME. Provide adequate ventilation. Avoid prolonged breathing of vapor. Avoid repeated contact with skin. Seal container when not in use.

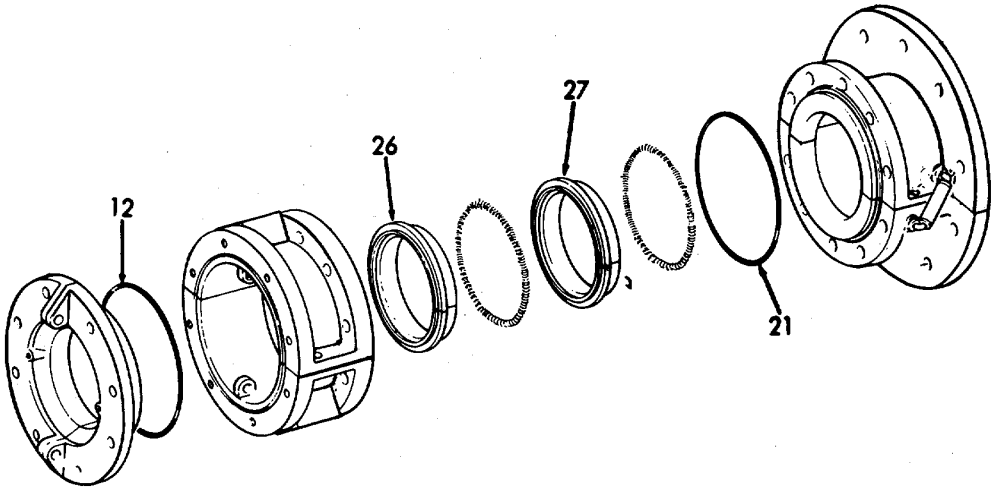
NOTE

Installation is very important and must be performed with care. It is suggested that these steps be per- formed using split sealing elements that have not had adhesive applied so that the person making installation will be familiar with the procedure. Do not use barbed staples until final assembly.

a. Preparation of sealing elements	1.	Clean both split surfaces of the two split sealing elements (26 and 27) thoroughly with Methyl Ethyl Ketone (MEK) solvent.	Let dry 5 to 10 minutes.
	2.	Wipe the bore of the sealing elements clean (26 and 27).	
	3.	Coat evenly, but not too heavily, both split surfaces of sealing elements (26 and 27) with quickset adhesive.	Goodyear Pliobond NO. 20 cement.
	(a)	Keep surfaces separated and let dry 24 to 48 hours at 70 to 72°F (21 to 22°C).	
	(b)	If temperature at cemented area can be raised to 100°F (38°C), drying time can be reduced to 3 hours.	Do not exceed 120° F(49° C). Use heat lamps.

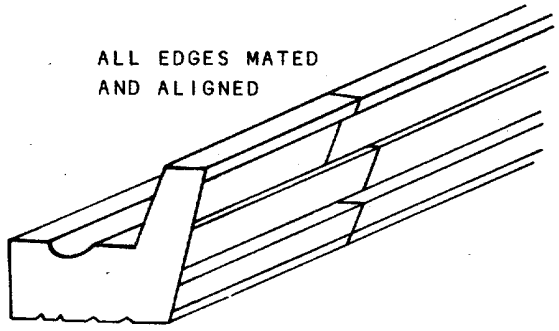
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	b. Preparation of preformed packing	1. Clean both split surfaces of the two preformed packing (12 and 21) thoroughly with Methyl Ethyl Ketone (MEK) solvent.	Let dry 5 to 10 minutes.
		2. Wipe the bore of the preformed packing (12 and 21) clean.	
		3. Coat evenly, but not too heavily, both split surfaces of the sealing elements (26 and 27) with quickset adhesive.	Goodyear Pliobond No. 20 cement.
		(a) Keep surfaces separated and let dry 24 to 48 hours at 70 to 72°F, (21 to 22°C).	
		(b) If temperature at cemented area can be raised to 100° F (38° C), drying time can be reduced to 3 hours.	Use heat lamps. Do not exceed 120°F (49°C).

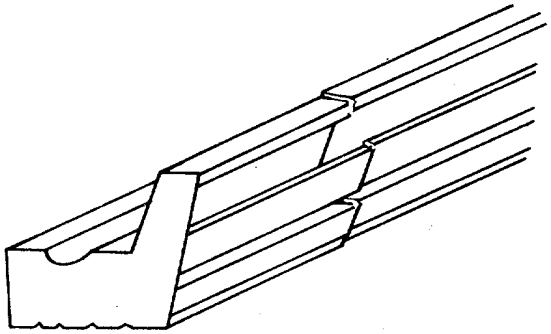


3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Sealing element	1. Wipe lightly one of the split surfaces of sealing element, (26) with Methyl Ethyl Ketone (MEK) solvent.	
		2. Wrap sealing element (26) around shaft with flanged end forward.	Be careful not to let split surfaces touch.
		3. With the bore of sealing element (26) pressed against the shaft, slide the split surfaces together. Be sure ALL surfaces are in perfect alignment. If not, completely separate and repeat the procedure.	This step is important, and must be done with care.



ALIGNMENT OF SEALING ELEMENT

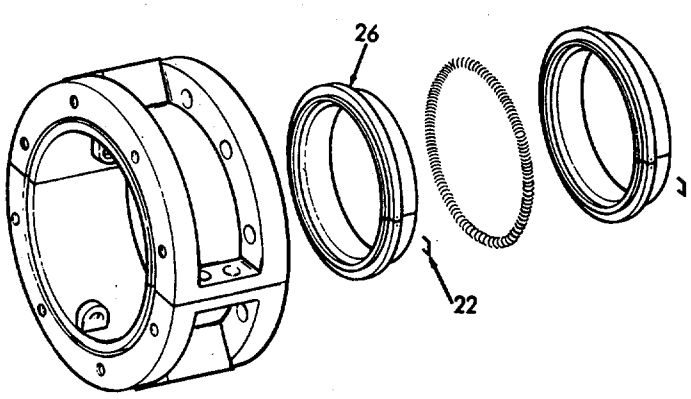


EDGES NOT MATED, COMPLETELY MIS-ALIGNED. WHEN THESE EDGES INTERFACE WITH HOUSING WALL, THE MIS-ALIGNED AREA, HOWEVER SLIGHT, FORMS A LEAK PATH.

IN LIKE MANNER, IF MIS-ALIGNMENT OCCURS WHEN THE HOUSING HALVES ARE PUT TOGETHER, LEAKAGE ALSO OCCURS.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		4. Hold sealing element (26) in shaft for 20 to 30 seconds to allow the cement to partially set up.	
		5. Still holding split sealing element (26) and keeping pressed against the shaft, drive the barbed staple (22) into the pre-drilled lead holes straddling the cemented joint.	Holes located on O.D. side of the sealing element. Use finger pressure only.
		6. The bridge of barbed staples (22) should contact the O.D. of the sealing element flanges.	
		7. Still holding the split surfaces in alignment, encircle the sealing element (26) in the spring garter recess with three turns of heavy cord or twine.	



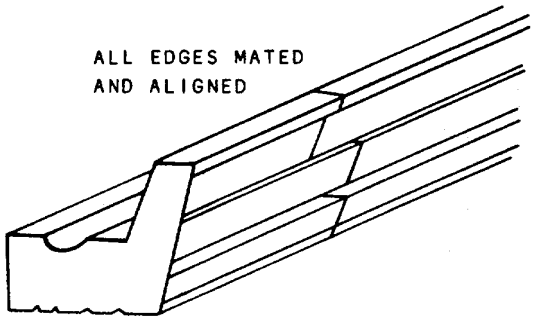
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

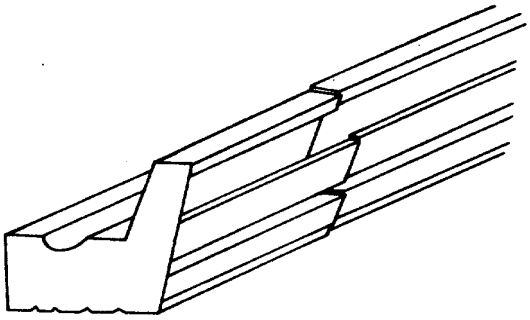
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		(a) Draw up cord until sealing element (26) is under a slight compression.	
		(b) Cord should be tight enough so that sealing element (26) remains in contact for drying period.	Sealing element need not be tight in shaft.
	d. Pre-formed packing	1. Lightly wipe one end of split preformed packing (12), and cement preformed packing around the shaft.	Sew preformed packing to-gether with care, using strong thin thread.
		2. Permit the sealing element (26) and pre-formed packing (12) to set up 24 to 36 hours at 75°F (24°C). Longer at lower temp-eratures.	Accelerate drying time to 3 hours by raising temperature to 100°F (38°C). Do not exceed 120°F (49°C).
	e. Sealing element	1. Wipe lightly on one of the split surfaces of sealing element (27) with Methyl Ethyl Ke-tone solvent.	
		2. Wrap sealing element (27) around shaft with flanged end forward.	Be careful not to let split surfaces touch.
		3. With the bore of the sealing element (27) pressed against the shaft, slide the split surfaces together.	This-step is important, and must be done with care.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

Installation (Cont)





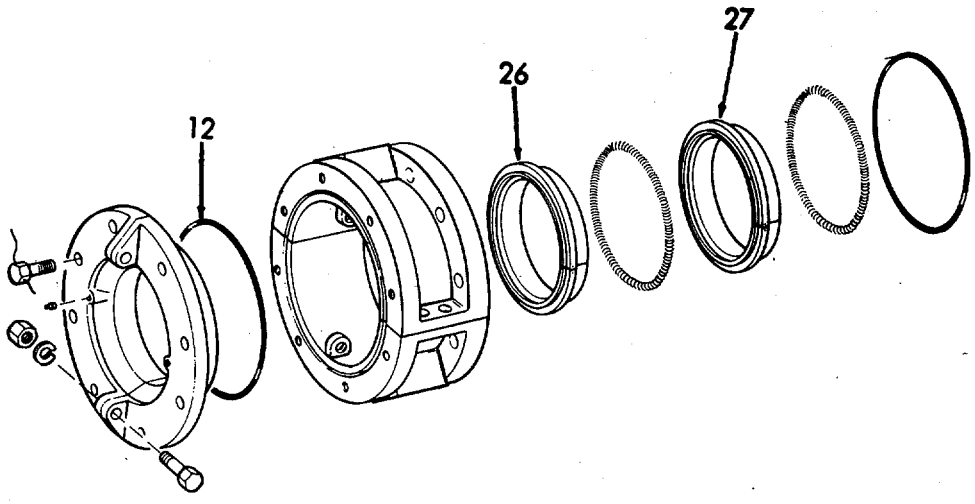
EDGES NOT MATED, COMPLETELY MIS-ALIGNED. WHEN THESE EDGES INTERFACE WITH HOUSING WALL, THE MIS-ALIGNED AREA, HOWEVER SLIGHT, FORMS A LEAK PATH.

ALIGNMENT OF SEALING ELEMENT

IN LIKE MANNER, IF MIS-ALIGNMENT OCCURS WHEN THE HOUSING HALVES ARE PUT TOGETHER, LEAKAGE ALSO OCCURS.

Be sure ALL surfaces are in perfect alignment. If not, completely separate and repeat procedures.

4. Hold sealing element (27) in shaft for 20 to 30 seconds to allow the cement to partially set up.

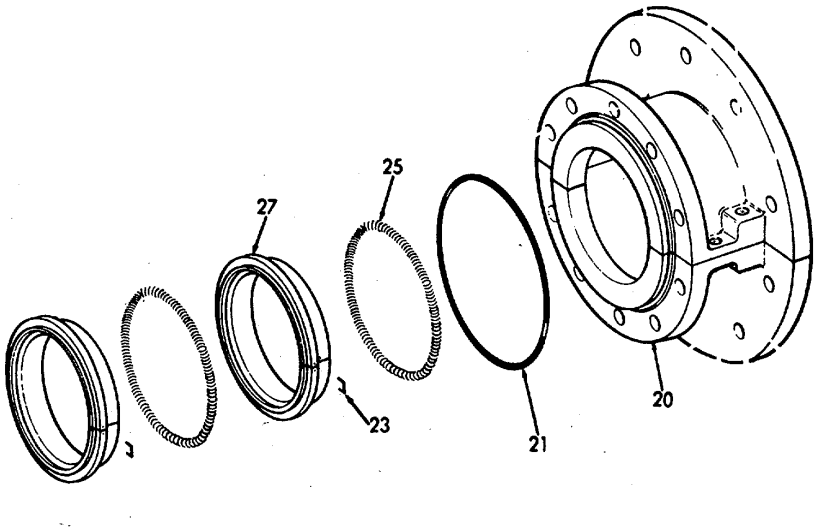


3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
		5. Still holding the split sealing element (27) and keeping it pressed against the shaft, drive barbed staple (23) into pre-drilled lead holes straddling cemented joint.	Holes are located on the O.D. side of the sealing element. Use finger pressure only.
		6. The bridge of barbed staple (23) should contact the O.D. of the sealing element flanges.	
		7. Still holding the split surfaces in alignment, encircle the sealing element (27.) in the spring garter recess with three turns of heavy cord or twine.	
		(a) Draw up cord until sealing element (27) is under a slight com- Preston.	
		(b) Cord should be tight enough so that sealing element (27) will remain in contact for the drying period.	Sealing element need not be tight in shaft.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
	f. Preformed packing	1. Lightly wipe one end of split preformed packing (21) and cement around the shaft.	Sew preformed packing together with care, using thin, strong, thread.
		2. Permit sealing elements (27) and preformed packing (21) to set up 24 to 36 hours at 75°F (24°C) Longer at lower temperatures.	Accelerate drying time to 3 hours by raising temperature to 100°F (38°C). Do not exceed 120°F (49°C).
10. Sealing element	Spring garter	1. Remove cord from sealing element (27), and carefully move it to approximately 1/8 inch (0.3175 cm) from the forward face .of the inflatable ring housing (20).	
		2. Using a strong cord, loop into each hook end of spring garter (25).	



3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
		3. Wrap spring garter (25) around sealing element (27). (a) By crossing and pulling cords manually, hook together the ends of the spring garter (25). (b) Ease spring garter (25) down onto the sealing element (27).	Do not disturb the cemented joint.
		(c) Remove the pulling cord.	
11. Sealing element	Spring garters	1. Remove cord from the sealing element (26), and carefully move it to approximately 1/8 inch (0.3175 cm) from the forward face of sealing element (27).	
		2. Using a strong cord, loop into each hook end of spring garter (24).	
		3. Wrap spring garter (24) around sealing element (26). (a) By crossing and pulling cords manually, hook together the ends of the spring garter (24).	
		(b) Ease spring garter (24) down onto the sealing element (26).	Do not disturb the cemented joint.
		(c) Remove pulling cord.	

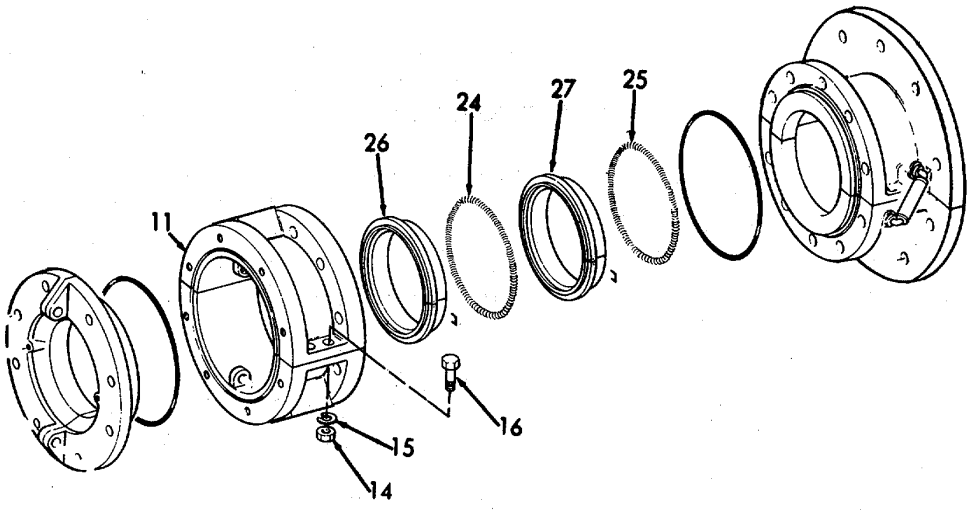
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
12. Seal housing	Seal housing	1. Wipe clean all machined surfaces of each seal housing (11).	Use MEK solvent.

WARNING

Methyl Ethyl Ketone (MEK) solvent is a highly volatile and flammable substance. DO NOT USE NEAR FIRE OR FLAME. Provide adequate ventilation. Avoid prolonged-breathing of vapor. Avoid repeated contact with skin. Seal container when not in use.

		2. Install hex bolts (16), lockwashers (15) and hex nuts (14), to secure seal housing (11) around shaft.	Be sure preformed packing grooves and bore surfaces are lined up.
		3. Apply a thin film of clean cup grease to one split surface section of seal housing (11).	



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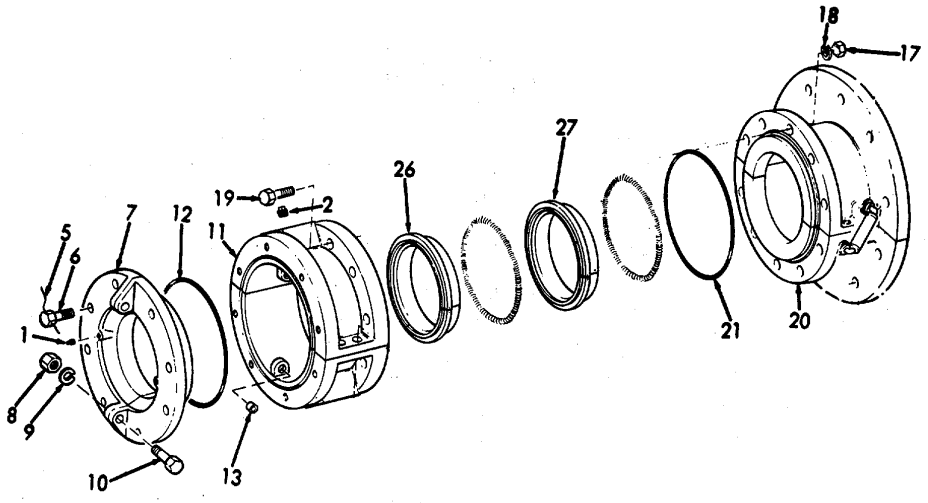
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
		4. Place cemented, preformed packing (12) onto seal housing (11).	
		5. Place cemented, preformed packing (21), onto seal housing (11).	
		6. Attach seal housing (11) to inflatable ring housing (20) with hex bolts (19), lockwashers (18), hex nuts (17).	Be sure surfaces to be joined are free of dirt, and metal chips, etc.
		CAUTION	
		Do not damage assembled sealing elements (26 and 27), during this operation.	
13. Gland ring	a. Gland half-ring (7)	1. Wipe clean all machined surfaces.	Use MEK solvent.
		2. Install bushings (13).	
		WARNING	
		Methyl Ethyl Ketone (MEK) solvent is a highly volatile and flammable substance. DO NOT USE NEAR FIRE OR FLAME. Provide adequate ventilation. Avoid prolonged breathing of vapor. Avoid repeated contact with skin. Seal container when not in use.	
		3. Apply a thin film of clean cup grease to one split surface section of gland ring (7).	
		4. Place gland ring (7) half around shaft.	Be sure all machined surfaces line up. This is obtained automatically unless damage has occured to the parts.

3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)		5. Install hex bolts (10), lockwashers (9) and hex nuts (8).	
		6. Use gland ring (7) to push sealing elements (26 and 27) to their final positions in seal housing (11).	
		7. Install capscrews (6).	Tighten capscrews evenly.
		8. Put lockwire (5), and capscrews (6) together.	
		9. Install pipe plugs (1).	
	b. Seal Housing	Install pipe plugs (2).	



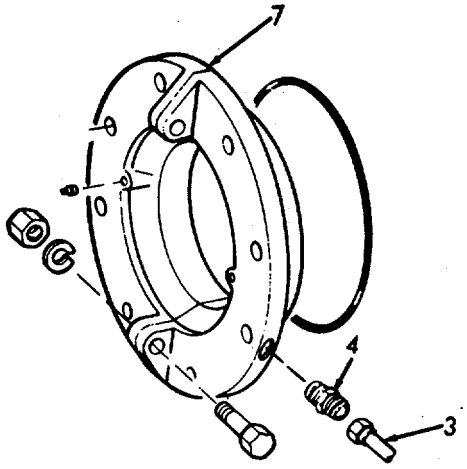
3-56. SHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			
14. Split shaft seal	a. Gland half ring (7)	1. Install adapter (4).	
		2. Reconnect fitting (3).	
	b. Shaft seal tank	1. Turn outlet valve clockwise to open.	
		2. Turn inlet valve clockwise to open.	

WARNING

Deflate inflatable sealing ring carefully. Make sure you have a full CO tank. Be ready to reinflate the inflatable sealing ring if excessive leakage occurs. FAILURE TO DO SO CAN RESULT IN LOSS OF LIFE AND LOSS OF THE LANDING CRAFT.

15. Inflation Device	a. Carbon dioxide bottle	Close valve on C02 bottle.	
	b. Inflatable ring	1. Disconnect one of the C02 hoses.	Refer to Paragraph 3-56.
	Housing	2. Inflatable sealing ring will deflate.	



3-57. SHAFT LOCK - MAINTENANCE INSTRUCTIONS.

a. A portable shaft locking device is provided for each of the propulsion shafts. Either shaft may be secured when vessel is under way on one propulsion unit. Shafts may be secured while being towed at a speed of 11 knots.

b. The locking plate is stowed in an inverted position on the propulsion unit foundation below the shaft coupling.

c. If the propeller shafts are allowed to turn while being towed, or when operating on one propulsion unit, the reduction gear standby lubricating oil pumps MUST be put into operation.

This task covers:

a. Inspection
b. Replacement
c. Repair
d. Installation

INITIAL SETUP

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

References
None

Equipment Condition: None

Special Environmental Conditions
None

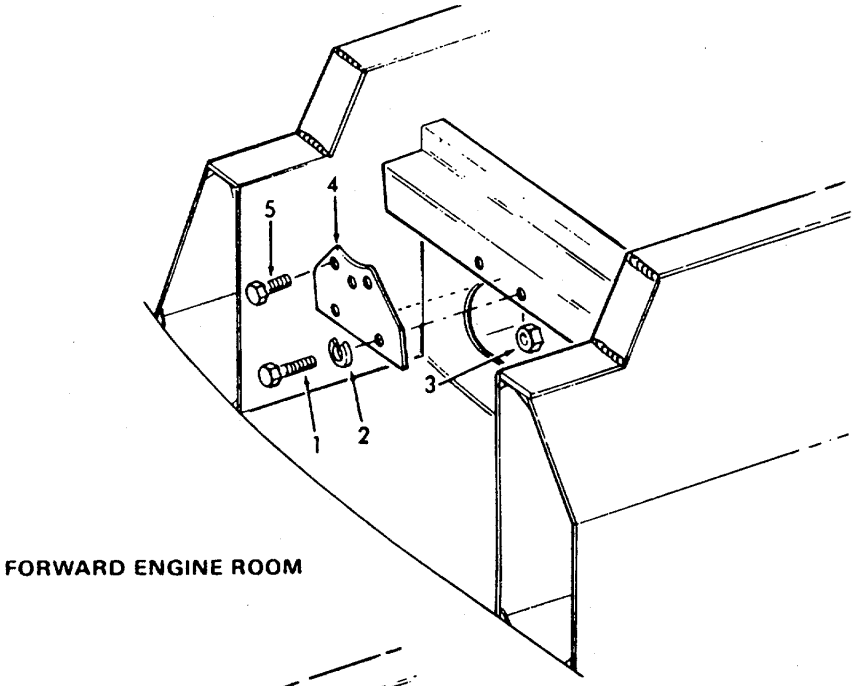
General Safety Instructions
None

3-57. SHAFT LOCK - MAINTENANCE INSTRUCTIONS (Continued).

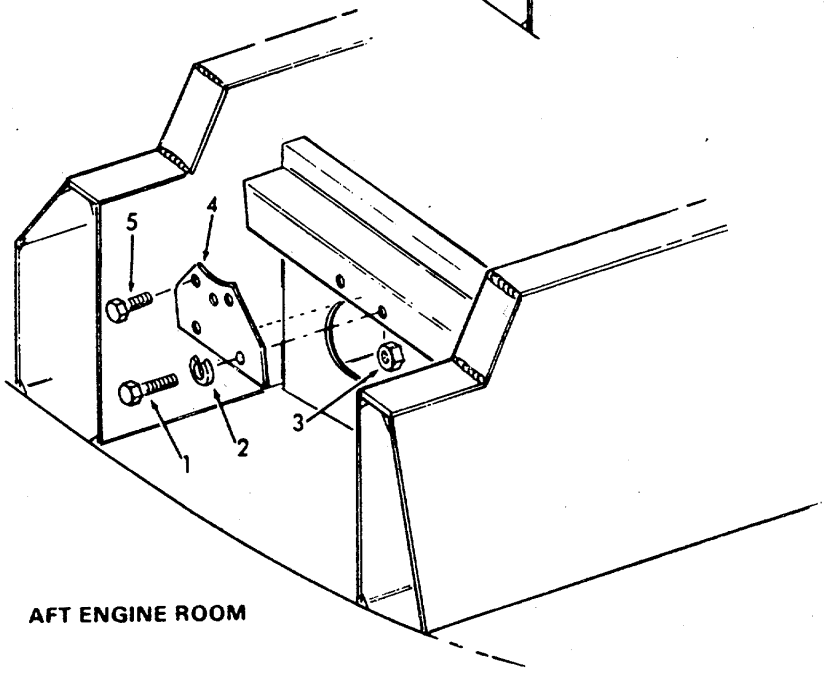
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1 Propulsion shafts - aft or forward engine room	a. Locking plate	1. Check for cracks or breaks.	
		2. Make sure locking plate is not bent.	
	b. Capscrews	Make sure threads are not stripped.	
REPLACEMENT			
2. Propulsion shaft - aft or forward engine room	a. Locking plate nuts (3).	1. Remove capscrews (1), lockwashers (2) and	
		2. Remove locking plate (4).	Screws (5) are for installation in coupling.
REPAIR			
3. Locking plate		Repair in accordance with standard procedures.	
INSTALLATION			
4. Propulsion shafts - aft or forward engine	a. Locking plate (4).	1. Install locking plate	
		2. Install capscrews (1), lockwashers (2) and nuts (3).	

3-57. SHAFT LOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Installation (Cont)			



FORWARD ENGINE ROOM



AFT ENGINE ROOM

3-57.1. AIR HORN - MAINTENANCE INSTRUCTIONS.

The airhorn should be inspected externally at regular intervals for loose bolts, loose cap screws, gasket leaks, etc. Internal inspection is not required unless the horn does not blow with its normal tone. In such case, determine which of the horns, if the horn is of the multiple type, is off tone, and remove the hexagon cap screws holding the cover on the back of the horn body or chamber. Carefully remove and inspect the bronze diaphragm, clean it off, and wipe out any water and dirt which may have accumulated in the horn chamber. Make sure the air passage hole, which is small in size and through when the air enters the horn chamber, is not blocked or partially blocked by dirt or chips. If necessary, check air passages through the bracket and other parts of the horn and blow them out with air.

If the diaphragm is bent, cracked, or otherwise damaged, it should be replaced with a new one. Inspect narrow sounding rim in the body against which the diaphragm presses for burrs or chips embedded on this narrow and important face. Avoid any damage to this face. Do not file or scrape this surface. Also inspect the wide seat in the body against which the rim of the diaphragm fits. See that it is clean, smooth, and free from dirt and embedded chips because the diaphragm must seat against this uniform and true. Likewise, inspect the seat in the cover which comes in contact with the diaphragm. To reassemble the horn, put the diaphragm back in carefully and then put cover on, inserting the series of cap screws around the rim of the cover and pulling these screws down carefully and evenly. Screws should be tightened firmly, but not overtightened.

Special attention is called to the following -- there is a small breathing hole provided in the outer rim of the cover. This hole also acts as a drain for water accumulating from condensation or sweating. The hole is drilled through the sloping part of the back of the cover at a point below and in line with the center of the circular Kahlenbert stainless steel name plate, which is located in the center of the back cover of each horn. Make sure this hole is open and clear and not clogged with dirt or paint. Putting the cover back on the airhorn body with the name plate reading horizontally, or as nearly horizontally as the bolt holes permit, automatically brings this vent-drain hole in the lower or proper gravity draining position. Occasionally check to see that the large gland nuts holding the projectors in the horn body are tight. Due to the big wrenches used in these nuts, they are frequently pulled too tight, which has a tendency to distort the horn body and may affect the tone of the horn.

If trouble is experienced with the tone of one of the horns on a multiple horn, and it cannot be remedied in the field by inspection of the interior of the horn and proceeding as described above, this projector and body should be removed and returned to the Kahlenberg factory, or the airhorn body assembly (body, cap and diaphragm) replaced with a new assembly. If necessary, the entire horn, less whistle valve, may be returned to the factory for repairs.

3-57.1. AIR HORN - MAINTENANCE INSTRUCTIONS (CONT'D).

This task covers:

a. Disassembly **b. Reassembly**

Initial Setup

Test Equipment

None

Special Tools

None

Material/Parts

Horn Diaphragm P/N P28-6
Air Strainer Gasket P/N D119-1
Air Strainer Element P/N 0175-1
Air Strainer Drain Cock P/N 0176-1
Whistle Valve Disc Holder Assy. P/N 187-7
Whistle Valve Spring P/N/P60-6

Reference

None

Equipment Condition | Condition Description

None

Special Environment Conditions

None

General Safety Instructions

WARNING

Wear eye protection when using compressed air.

3-57.1. AIR HORN - MAINTENANCE INSTRUCTIONS (CONT'D).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL - AIR HORN

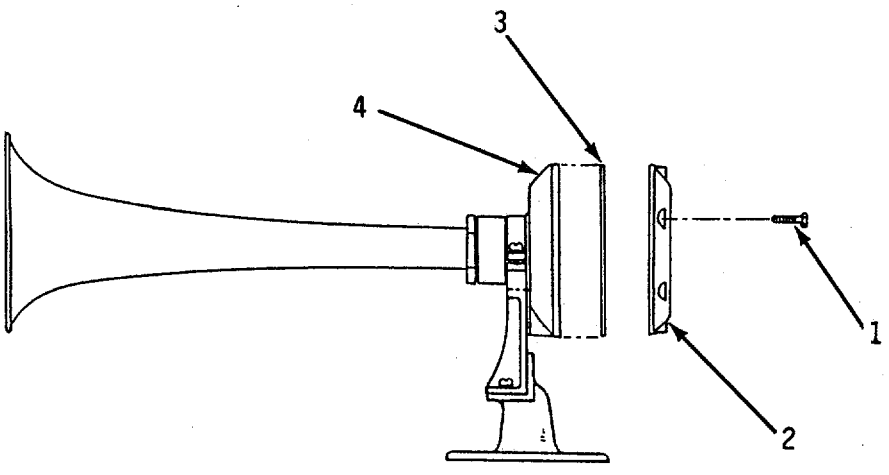
WARNING

Turn off all electric power to compressor and drain air system before attempting any work on air system.

1.	Air horn	a. Cover	Remove all hex screws (1) holding cover (2) on horn body (4).
		b. Air horn body	Remove old diaphragm (3) and clean surrounding area of any dirt and debris.

INSTALLATION

2.	Air horn	a. Air horn body	Replace diaphragm or, if necessary, replace with new diaphragm.
		b. Cover	Replace cover and check horn operation.



3-57.1. AIR HORN - MAINTENANCE INSTRUCTIONS (CONT'D).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL WHISTLE VALVE

WARNING

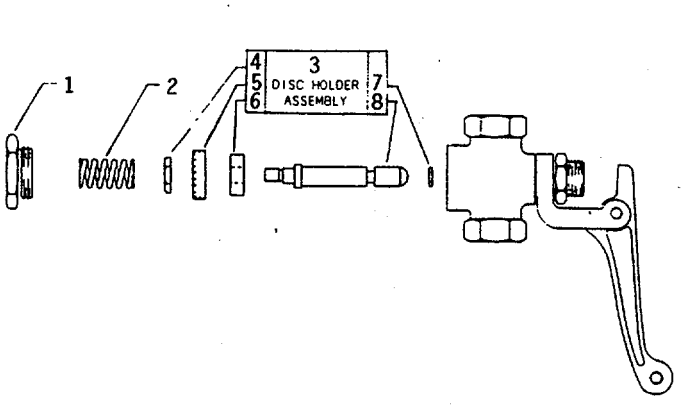
Turn off all electric power to compressor and drain air system before attempting any work on air system.

CAUTION

3.	Whistle valve	a. Valve cap (1)	Remove cap and spring (2).	Valve cap is under spring tension. Use caution while removing.
		b. Disc holder assembly (3)	Remove assembly as a unit. Clean area of exposed interior body.	Disc holder assembly (3) consists of nut, hex, i" NF (4), disc holder (5), disc (6), spindle (7), and O-ring (8).

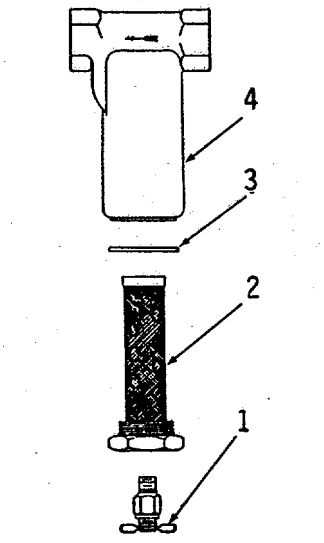
INSTALLATION

4.	Whistle valve	a. Disc holder assembly	Replace all elements of the disc holder assembly and insert into valve body.	
		b. Valve cap and spring	Install cap and spring onto valve body.	



3-57.1. AIR HORN - MAINTENANCE INSTRUCTIONS (CONT'D).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (cont'd)			
		Tighten and check operation.	
REMOVAL AIR STRAINER			
		WARNING Turn off all electric power to compressor and drain air system before attempting any work on air system.	
5. Air strainer (4)	a. Drain cock (1) if necessary.	Remove.	Inspect and replace
	b. Element (2)	Remove.	Inspect, clean or replace if necessary.
	c. Gasket (3)	Remove.	Inspect, and replace if necessary.
INSTALLATION			
6. Air strainer	a. Gasket, elements and drain cock	Replace, tighten, and check air system.	



APPENDIX A

REFERENCES

REFER TO VOLUME 10.

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 levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component and the work measurement time required to perform the functions by the designated maintenance level. The implementation of the maintenance functions upon the end item or components will be consistent with the assigned maintenance functions.

c. Section III lists the tools and test equipment required for each maintenance function as referenced from Section II.

d. Section IV lists the remarks referenced from Section II.

B-2. EXPLANATION OF COLUMNS IN S ection II.

a. Column (1), Group Number. Column 1 lists group numbers to identify related components, assemblies, subassemblies, and modules with their next higher assembly. The applicable groups are listed in the MAC in disassembly sequence beginning with the first group removed.

b. Column (2), Component/Assembly. This column contains the known names of components, assemblies, subassemblies and modules for which maintenance is authorized.

c. Column (3), Maintenance Functions. This column lists the functions to be performed on the item listed in Column 2. The maintenance functions are defined as follows:

(1) Inspect. To determine serviceability of an item by comparing its physical, mechanical, or electrical characteristics with established standards through examination.

(2) Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

(3) Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

(4) Adjust. To maintain within prescribed limits, by grinding into proper or exact position, or by setting the operating characteristics to specified parameters.

(5) Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

(6) 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 comparison 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.

(7) Install. The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of equipment or systems.

(8) Replace. The act of substituting a serviceable like type part, sub-assembly or module (component or assembly) for an unserviceable counterpart.

(9) Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, or replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, sub-assembly, module (component or assembly), end item, or system. (10) Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards in appropriate technical manuals. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to a like-new condition.

(10) Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards in appropriate technical manuals. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to a like new condition.

(11) Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with organizational manufacturing standards. Rebuild is the highest degree of material 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 equipment/components.

d. Column (4), Maintenance Level. This column is made up of sub- columns for each category of maintenance. Work time figures are listed in these subcolumns for the lowest level of maintenance authorized to perform the function listed in Column 3. These figures indicate the average active time required to perform the maintenance function at the indicated category of maintenance under typical field operating conditions.

e. Column (5), Tools and Equipment. This column is provided for referencing by code, the common tool sets (not individual tools), special tools, test and support equipment required to perform the designated functions.

f. Column (6), Remarks. This column is provided for referencing by code of the remarks pertaining to the designated functions.

B-3. EXPLANATION OF COLUMNS IN Section III.

a. Column (1), Reference Code. The tool and test equipment referenced code correlates with a maintenance function on the identified end item or component.

b. Column (2), Maintenance Level. The lowest level 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/NATO Stock Number. The National or NATO stock number of the tool or test equipment.

e. Column (5), Tool Number. The manufacturer's part number.

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0100	Propulsion Unit, (Engine/Marine Gear)								
0101	Engine	Inspect	.2						
		Test	1.0		8.0				
		Service	2.0						
		Replace			100.0				
		Repair	1.5		18.0				
		Overhaul			58.0			1,2	
0101A	Marine Gear	Inspect	.2						A
		Test	1.0		8.0				
		Service	2.0						
		Replace			100.0				
		Repair	1.5		18.0				
		Overhaul			58.0				
0102	Engine/Transmis-sion Controls	Inspect	.3						
		Test	.2						
		Service	.2						
		Adjust	1.0						
		Replace	10.0						
		Repair	1.0		10.0				
0102A	Emergency Shut-Down	Inspect	.3						
		Test	.2						
		Replace	10.0						
		Repair	1.0		10.0				
0102B	Alarm System	Inspect	.3						
		Test	.2						
		Replace	10.0						
		Repair	1.0		10.0				
0103	Governor	Inspect	.1						
		Test	1.0					3,4,5,6	
		Service	.2						
		Adjust	.2						
		Replace	.4						
		Repair	1.0						
		Overhaul			6.0				

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0104	Air Intake	Inspect	.2						
		Service	.2						
		Repair	1.5						
		Replace	3.5						
0105	Blower	Inspect	.2						
		Service	.2					8,9	
		Replace	1.5					7	
		Repair	1.0						
		Overhaul			8.0				
0106	Fuel Pump	Inspect	.2						
		Replace	1.0					10, 11	
		Repair	1.5						
0107	Fuel Filter,	Inspect	.1						
	Strainer and	Service	.5						
	Fuel Lines	Replace	2.0						
		Repair	1.5						
0108	Fuel Injector	Inspect	.1						
		Test	.3		.5				
		Service	.2						
		Replace	1.5					14	
		Repair	1.5					12,13,15	
		Overhaul			1.0				
0109	Lube Oil	Inspect	.2						
	Filters	Service	.4						
	And	Replace	1.5						
	Housing	Repair	1.4		1.5	(weld)			
0110	Oil Cooler	Inspect	.1						
		Replace	1.2						
		Repair	1.5		2.5				

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0111	Fresh Water Pump	Inspect	.2					11,23,24,	
		Replace	1.2					25,27	D
		Repair	2.5		3.0				
0112	Expansion Tank	Inspect	.1						
		Service	.2						
		Replace	2.5						
		Repair	1.7		2.5				
		Test	.5						
0113	Water Connections	Inspect	.2						
		Replace	2.0						
0114	Water Manifold	Inspect	.2						
		Replace	1.5						
		Repair			3.0 (weld)				
0116	Thermostat And Housing	Inspect	.2						
		Replace	.4						
		Repair	1.3		2.0 (weld)				
		Test	.5						
0118	Tachometer Drive	Inspect	.1						
		Replace	1.6						
		Repair	2.0						
0119	Instrument Panel	Inspect	.1						
		Replace	1.5						
		Repair	2.0						
0120	Crankshaft Pulley And Vibration Dampener	Inspect	.2						
		Replace	3.0					27,59	
		Repair			2.5				
0121	Balance Weight Cover And Accessory Drive	Inspect	.2					59	
		Replace			2.5				
		Repair			3.5				

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0122	Engine Supports, Lift Brackets & Crankshaft Front Cover	Inspect	.1						
		Replace	.5						
		Repair			1.5				
0123	Exhaust Manifold and Fittings	Inspect	.2					59	
		Replace	3.0						
		Repair	3.0		3.0				
0123A	Muffler	Inspect	1.0						
		Service	2.0						
		Replace			50.0				
		Repair			18.0				
0124	Rocker Arm Cover	Inspect	.1						
		Replace	.5						
0125	Injector Controls	Inspect	.1						
		Adjust	2.3						
		Replace	2.0						
		Repair	.7						
0126	Flywheel & Housing	Inspect	.2						
		Replace			4.0			28	
		Repair	2.0		2.0				
0127	Camshaft & Gear Train	Inspect			.9				
		Replace			4.5			29,30,31	
		Repair			4.0				
0128	Valve Operating Mechanism (per cylinder)	Inspect	.2					32	
		Adjust	.8						
		Replace	2.5						
		Repair	3.2						
0129	Cylinder Head	Inspect	.2						
		Replace	1.5					33,36,37 38,39,40	
		Repair	1.5		4.5	(weld)			
		Test			.5				

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0130	Oil Pan & Dipstick	Inspect	.2						
		Replace	2.5						
		Repair			2.5 (weld)				
0131	Lube Oil Relief Valve	Inspect	.1						
		Replace	1.0						
		Repair			1.5				
0131A	Lube Oil Regulator	Inspect	.1						
		Replace	1.0						
		Repair			1.5				
0132	Lube Oil Pump	Inspect	.2					41,42	
		Replace	1.4						
		Repair			2.0				
0133	Lube Oil Distribu-tion System	Inspect	.1						
		Replace	2.0						
0134	Pistons, Connect-ing Rods And Liners	Inspect	1.0					43,44,45, 46,47,48, 49,50,51, 52	
		Replace	4.5						
		Repair			5.5				
0135	Crankshaft Bearing	Inspect	1.0						
		Replace	6.5						
0135A	Crankshaft	Inspect	1.0						
		Replace			2.0				
0135B	Crankshaft Seals	Inspect	.1						
		Replace			1.0				
0136	Cylinder Block	Inspect	.3						
		Replace			12.0				
		Repair			8.5				

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0137	Starting Aid	Inspect	.1						
		Service	.2						
		Replace	1.5						
		Repair	2.0						
0138	Hydrostarter (hydrotor)	Inspect	.2					55	B
		Test			1.5				
		Replace	1.2						
		Repair	1.2						
		Overhaul			2.0				
0139	Accumulator	Inspect	.1						
		Service			1.0				
		Replace	1.4					20,21	
		Repair			1.0				
0140	Hydrostarter Pump (Engine Driven	Inspect	.1						
		Replace	.4						
		Repair			1.8				
		Overhaul			3.0				
0141	Hydrostarter Pump (Hand)	Inspect	.1						
		Replace	1.2						
		Repair	2.5						
0142	Hydrostarter Piping (Fwd Eng Rm)	Inspect	.2						
		Replace			2.7				
		Repair			1.5				
0143	Hydrostarter Piping (Aft Eng Rm)	Inspect	.2						
		Replace			2.7				
		Repair			1.5				
0144	Reservoirs, Filters and Solenoids	Inspect	.2						
		Replace	1.0						
		Repair			1.0				
		Service	2.0						
0150	Propeller Shaft And Bearings	Inspect	.5				5.5	54	E
		Adjust	.4						
		Replace	12.0				100.0		
		Repair					6.5		

SECTION II MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0150A	Port Line Shaft (from shaft seal to engine)	Inspect	.5						
		Repair	3.0						
		Adjust	1.0						
0150B	Shaft Inflatable Seals	Inspect	0.1						
		Service	4.0						
		Replace				15.0		54	
		Repair	2.0						
0150C	Shaft Seal Preformed	Inspect	.1						
		Replace	15.0						
		Service			2.0				
0151	Shaft Lock	Inspect	.3						
		Replace	4.5		4.0				

INDEX

INDEX (Cont)

INDEX (Cont)

PARAGRAPH
OR TABLE

P

INDEX (Cont)

PARAGRAPH
OR TABLE

P (Continued)

S

T

V

W

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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 milliters = .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: 046744