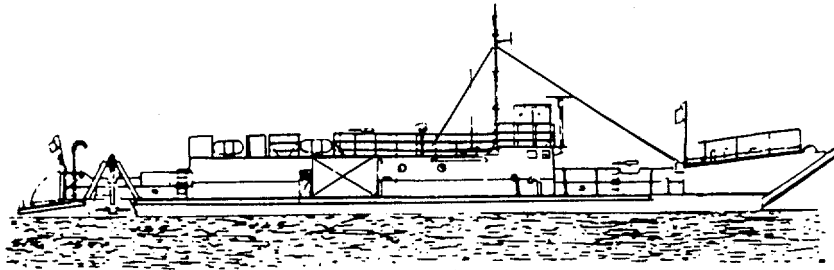


**TECHNICAL MANUAL  
OPERATOR'S, ORGANIZATIONAL,  
AND DIRECT SUPPORT  
MAINTENANCE MANUAL**

**LANDING CRAFT UTILITY  
LCU 1671-1679  
NSN 1905-01-009-1056**

**OPERATOR/CREW  
ELECTRIC POWER  
GENERATION AND  
DISTRIBUTION  
MAINTENANCE INSTRUCTIONS**



**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**11 OCTOBER 1983**

CHANGE  
NO. 2

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 27 APRIL 1992

Operator's, Organizational,  
Direct Support and General Support  
Maintenance Manual

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

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CHANGE



NO. 1

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 27 June 1984

Operator's, Organizational,  
Direct Support, and General Support  
Maintenance Manual

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## **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.
- 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.



**WARNING (Cont)**

- 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 Fire 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.

**b**

**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.

**Change 1 c**

**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.

**Change 1 d**

Technical Manual  
No. 55-1905-220-14-5

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 11 October 1983

OPERATORS, ORGANIZATIONAL, DIRECT SUPPORT, AND  
GENERAL SUPPORT MAINTENANCE MANUAL

LANDING CRAFT UTILITY

LCU 1671-1679 NSN 1905-01-009-1056

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.

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\*This manual supersedes TM 55-1905-220-14-5, 11 July 1980.

## CHAPTER 3 (CONTINUED)

## SECTION V. MAINTENANCE PROCEDURES (CONTINUED).

## 3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION.

The electric power generation and distribution maintenance procedures are as follows:

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**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
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## a. General Description

(1) The Generator engine covered in this manual is a 3 cylinder Detroit Diesel. The engine is equipped with an oil cooler, lubricating oil filter, fuel oil strainer, fuel oil filter, air cleaner, governor, heat exchanger, raw water pump, and a starting motor.

(2) Fuel is drawn from the supply tank through a strainer by a gear - type fuel pump, and then forced through the filter and fuel inlet gallery in the cylinder head and to the injectors. Excess fuel is returned to the supply tank via the fuel outlet gallery 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 a blower which pumps air into the engine cylinders via the air box and cylinder liner ports. All air entering the blower first passes through an air cleaner.

(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 and then to the oil cooler. From the oil cooler, the oil enters a longitudinal oil

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

gallery in the cylinder block where the supply divides; a portion entering the by-pass filter and then draining back into the oil pan, part going to the cam and balance shaft end bearings and cylinder head, with the remainder going to the main bearings and connecting rod bearings via the drilled crankshaft.

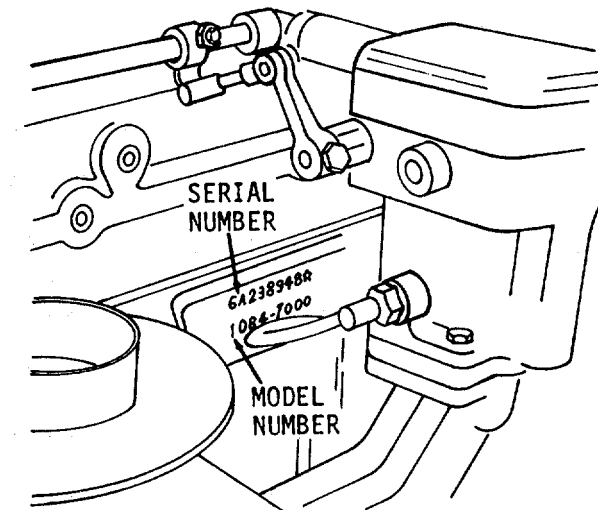
(5) Coolant is circulated through the engine by a centrifugal- type water pump. Heat is removed from the coolant, which circulates in a closed system, by a heat exchanger. Control of the engine temperature is accomplished by thermostats that regulate the flow of the coolant within the cooling system.

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

(7) Engine speed is controlled by an hydraulic type engine governor.

**b. Engine Model and Serial Number Designation**

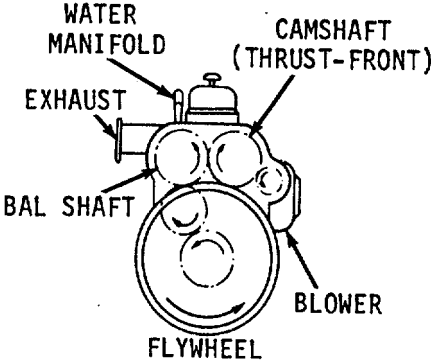
The engine serial number and model number are stamped on the cylinder block. The engine and model numbers are also stamped on the Option Plate attached to the valve rocker cover.



*Engine Serial Number and Model Number as Stamped on Cylinder Block*

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

c. Engine Rotation and Firing Order



Rotation Viewed from Rear of Engine

GENERAL SPECIFICATIONS

3-71

---

Number of Cylinders .....	3
Bore.....	4 1/4 in.(10.8 cm)
Stroke .....	5 in. (12.7 cm)
Compression Ratio .....	18.7 to 1
Total Displacement - Cubic Inches .....	213
Firing Order - R.H. Rotation.....	1-3-2
Number of Main Bearings .....	4

3-1018



**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

## d. General Information - Detroit Diesel N-71

(1) In many cases, the maintenance technician is justified in replacing parts with new material rather than attempting repair. However, there are times when 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 and blowers are also desirable service items.

(2) 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.

(3) 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.

## e. Disassembly

(1) 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.

**NOTE**

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

(2) 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.

## f. Cleaning

(1) Before removing any of the subassemblies 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.

(2) If parts are not to be used immediately after cleaning, dip them in a rust preventive compound. The rust preventive compound should be removed before installing the parts in an engine.

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

## g. Inspection

(1) 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 judgement must be exercised.

(2) 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.

(3) 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.

(4) 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.

(5) In addition to measuring the used parts after cleaning, the parts should be carefully inspected for cracks, scoring, chipping and other defects.

## h. Assembly

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

(2) 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.

(3) 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.

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

(4) Particular attention should be paid to storing of parts and sub-assemblies, 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.

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

**i. Work Safety**

(1) A maintenance technician 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.

(2) 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.

**j. 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 device 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 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.

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

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

- (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.

**k. 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 judgement 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.

3-58. ELECTRIC POWER AND DISTRIBUTION (Cont).

Table of Specifications, NEW CLEARANCES AND WEAR LIMITS

These limits also apply to oversize and undersize parts.

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<u>CYLINDER BLOCK</u>						
Block bore:						
Diameter .....	4.6260	11.7500	4.6270	11.7526		
Out-of-round.....			.0010	.0025	.0020	.0051
Taper .....			.0010	.0025	.0020	.0051
Cylinder liner counterbore:						
Diameter .....	5.0460	12.8168	5.0485	12.8000		
Depth .....	.4770	1.2116	.4795	1.2179		
Main bearing bore:						
Inside diameter (vertical axis) .....	3.8120	9.6700	3.8130	9.6700		
Top surface of block:						
Centerline of main bearing bore to top of block .....	16.1840	41.1074	16.1890	41.1201	16.176 min.	41.0870 min.
Flatness-transverse .....					.0030	.0076
Flatness-longitudinal .....					.0060	.0152
Depth of counterbores (top surface):						
Cylinder head seal strip groove .....	.0920	.2337	.1070	.2718		
Large water holes (between cylinders).....	.1090	.2769	.1200	.3048		
Small water holes (at ends) .....	.0870	.2210	.0980	.2489		
Combination water and oil holes .....	.0870	.2210	.0980	.2489		
<u>CYLINDER LINER</u>						
Outside diameter .....	4.6250	11.7475	4.6260	11.7500		
Inside diameter .....	4.2495	10.7937	4.2511	10.7978		
Clearance-liner-to-block: Cast iron block .....	.0000	.0000	.0020	.0051	.0025	.0064
	.0000	.0000	.0020	.0051	.0025	.0064

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
Out-of-round-inside diameter .....			.0020	.0051	.0025	.0064
Taper-inside diameter.....			.0010	.0025	.0020	.0051
Depth of flange.....	.0450	.1143	.0500	.1270	.0500	.1270
Variation in depth between adjacent liners .....			.0020	.0051	.0020	.0051
Insert thickness.....	.1795	.4559	.1800	.4572		
<b>PISTON</b>						
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			
Clearance-piston skirt-to-liner .....	.0045	.0114	.0083	.0211	.0120	.0305
Out-of-round .....			.0005	.0013		
Taper .....			.0005	.0013		
<b>COMPRESSION RINGS</b>						
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	.0060	.0152	.0100	.0254
No. 2 .....	.0100	.0254	.0130	.0330	.0220	.0559
No. 3 and 4 .....	.0040	.0102	.0070	.0178	.0130	.0330
<b>OIL CONTROL RINGS</b>						
Gap .....	.0080	.0203	.0230	.0584	.0430	.1092
Clearance.....	.0015	.0038	.0055	.0140	.0080	.0203
<b>PISTON PINS (Trunk Pistons)</b>						
Length .....	3.6050	9.1570	3.6200	9.1950		
Diameter .....	1.4996	3.8090	1.5000	3.8100	1.4980	3.8050
Clearance-pin to piston bearing.....	.0025	.0064	.0034	.0086	.0100	.0254
Clearance-pin to conn. rod bushing .....	.0015	.0038	.0024	.0061	.0100	.0254

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
Clearance-end (pin-to-retainer-retainer with lock ring .....	.0160	.0406	.0640	.1626	.0640	.1626
Piston bushing-inside diameter .....	1.5025	3.8164	1.5030	3.8176	1.5050	3.8227
<u>CONNECTING ROD</u>						
Length-center-to-center of upper and lower bores.....	10.1240	25.7150	10.1260	25.7200		
Inside diameter (upper bushing) .....	1.5025	3.8164	1.5030	3.8176	1.5080	3.8303
Normal side clearance .....	.0060	.0152	.0120	.0305		
<u>CRANKSHAFT</u>						
Journal diameter-main bearing .....	3.4990	8.8875	3.5000	8.8900		
Journal diameter-conn. rod bearing.....	2.7490	6.9825	2.7500	6.9850		
Journal out-of-round .....			.00025	.00064	.0010	.0025
Journal taper .....			.0005	.0013	.0015	.0038
*Runout on journals-total indicator reading:						
3 cylinder (mounted on No.1 and No. 4 journals):						
At No. 2 and No. 3 journals .....			.0020	.0051		
Thrust washer thickness .....	.1190	.3023	.1220	.3099		
End play (end thrust clearance) .....	.0040	.0102	.0140	.0356	.0180	.0457

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
*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.						
<u>CONNECTING ROD BEARINGS</u>						
Inside diameter (vertical axis).....	2.7514	6.9886	2.7534	6.9936		
Bearing-to-journal clearance .....	.0014	.0036	.0044	.0112	.0060	.0152
Bearing thickness 90° from parting line .....	.1548	.3932	.1553	.3945	.153 min	.388 min
<u>MAIN BEARINGS</u>						
Inside diameter (vertical axis).....	3.5014	8.8936	3.5034	8.8986		
Bearing-to-journal clearance .....	.0014	.0036	.0044	.0112	.0060	.0152
Bearing thickness 90° from parting line .....	.1548	.3932	.1553	.3945	.153 min	.389 min
<u>CAMSHAFT</u>						
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		
Shaft diameter at gear .....	1.1875	3.0162	1.1880	3.0175		
Length-thrust bearing end journal .....	2.8740	7.3000	2.8760	7.3050		
End thrust .....	.0040	.0102	.0120	.0305	.0180	.0457
Thrust washer thickness .....	.1190	.3023	.1220	.3099		



3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<u>CAMSHAFT BEARINGS</u>						
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		
Diameter of cylinder block bore .....	2.1875	5.5563	2.1885	5.5588		
Clearance-bearings- to-block:						
Front and rear .....	.001	.0025	.0005	.0013		
	press	press	loose	loose		
Intermediate (extruded) .....	.0015	.0038	.0065	.0165		
Intermediate (die cast).....	.0015	.0038	.0105	.0267		
<u>CAMSHAFT and BALANCE SHAFT GEARS</u>						
Inside diameter.....	1.1865	3.0137	1.1875	3.0163		
Clearance-gear-to-shaft .....	.0015	.0038	.0000	.0000		
	press	press				
Backlash.....	.0030	.0076	.0080	.0203	.0100	.0254
<u>IDLER GEAR</u>						
Backlash.....	.0030	.0076	.0080	.0203	.0100	.0254
Pre-load-variation on pull 2 lbs. 11 oz .....	1.2500	.5675	6.7500	3.0645		
(1.219 kg)						
<u>CRANKSHAFT TIMING GEAR</u>						
Inside diameter.....	4.7490	12.0625	4.7500	12.0650		
Clearance-gear-to-shaft .....	.001	.0025	.001	.0025		
	press	press	loose	loose		
Backlash.....	.0030	.0076	.0080	.0203	.0100	.0254

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<u>BLOWER DRIVE GEAR</u>						
Backlash.....	.0030	.0076	.0080	.0203	.0100	.0254
Gear-to-hub fit .....	.0005	.0013	.001	.0025		
	press	press	loose	loose		
Support-to-end plate.....	.0005	.0013	.0025	.0064		
	press	press	loose	loose		
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
Hub-to-cam clearance .....	.0020	.0051	.0070	.0178		
End thrust (current bearing).....	.0060	.0152	.0140	.0356		
<u>CYLINDER HEAD</u>						
Flatness-transverse .....					.0040	.0102
Flatness-longitudinal.....					.0055	.0140
Distance between top deck and fire deck .....	3.5560	9.0322	3.5680	9.0627	3.5360	8.9814
Water nozzle .....	.0312	.0335	Flush	Flush		
	Recess	Recess				
Cam follower bores .....	1.0620	2.6975	1.0630	2.7000	1.0650	2.7051
<u>EXHAUST VALVE SEAT INSERTS</u>						
Seat width-30° (4-valve) .....	.0468	.1189	.0937	.2380	.0937	.2380
Valve seat runout.....			.0020	.0051		
<u>EXHAUST VALVES</u>						
Stem diameter.....	.3100	.7874	.3105	.7887	.3090	.7849
Valve head-to-cylinder head:						
30° .....	.023	.0584	.006	.0152		
	Recess	Recess	protr	protr		

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS (Cont)

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<u>VALVE GUIDES</u>						
Height above cylinder head.						
4-Valve (chamfered guide) .....	.8800	2.2352	.8800	2.235	.3140	.7976
4-Valve (machined guide) .....	.6900	1.7526	.6900	1.7526		
Diameter-inside .....	.3125	.7938	.3135	.7963	.3140	.7976
Clearance-valve-to-guide .....	.0020	.0051	.0036	.0089	.0050	.0127
<u>VALVE BRIDGE GUIDES</u>						
Height above cylinder head .....	2.0400	.1816	2.0400	5.1816		
<u>ROCKER ARMS and SHAFTS</u>						
Diameter-rocker shaft .....	.8735	2.2187	.8740	2.2200		
Diameter-inside (rocker arm bushing) .....	.8750	2.2225	.8760	2.2250		
Clearance-shaft-to-bushing .....	.0010	.0025	.0025	.0064	.0040	.0102
<u>CAM FOLLOWERS</u>						
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

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

AIR INTAKE SYSTEM SPECIFICATIONS

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS

ENGINE PARTS (Standard Size, New)	MINIMUM		MAXIMUM		LIMITS	
	(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<u>BLOWER</u>						
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	.965299				
Dowel pin (projection beyond inside face 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				

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

**HYDROSTARTER SYSTEM SPECIFICATIONS**

<u>HYDROSTARTER MOTOR</u>		ENGLISH	METRIC
Type .....	Swash plate		
Number of pistons .....	Seven		
Displacement per revolution (20 Series).....		1.35 cu.in.	22.1 cm <sup>2</sup>
Maximum torque at 3000 psi (206.85 kPa).....		45 lb.ft.	61.0 nm
Drive .....	Overrunning clutch		
 <u>ENGINE-DRIVEN PUMP</u>			
Type .....	Positive displacement		
Number of pistons .....	One		
Displacement per revolution .....		0.0208 cu.in.	13.3 mm <sup>2</sup>
Maximum discharge pressure .....		3250 psi	22409 kPa
Maximum continuous speed .....	2500 rpm		
 <u>MANUAL PUMP</u>			
Type .....	Positive displacement		
Number of pistons .....	One		
Displacement per stroke .....		0.773 cu.in.	498.7 mm <sup>2</sup>
 <u>ACCUMULATOR</u>			
Type .....	Piston		
Capacity .....		200 or 300 cu.in.	1290 or 1935 cm <sup>2</sup>
Precharge (nitrogen).....		1250 psi	8618.8 kPa
Operating pressure .....		900-3000psi	19996-20685 kPa

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

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

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

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.

Thread Size	TORQUE			
	Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (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

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

FUEL SYSTEM AND GOVERNOR  
EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	SIZE NUT or BOLT	TORQUE			
		Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	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
Air inlet housing adaptor- to blower housing bolt ..	3/8-16	16	21.6960	20	27.1200
Air inlet housing-to- adaptor bolts .....	3/8-16	16	21.6960	20	27.1200
Fuel pipe nut.....	3/8-24	12	16.2720	15	20.3400
Blower end plate-to-cyl- inder block bolts .....	7/16-14	40	54.2400	45	61.0200
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



3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

**AIR INTAKE SYSTEM  
EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS**

Application	SIZE NUT or BOLT	TORQUE			
		(lb ft)	Minimum (Nm)	Maximum (lb ft)	(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.....	3/8-16	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

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

LUBRICATION SYSTEM SPECIFICATIONS  
EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

Application	SIZE NUT or BOLT	TORQUE			
		(lb ft)	Minimum (Nm)	Maximum (lb ft)	(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

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3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

**ENGINE BLOCK AND CYLINDER HEAD  
EXCEPTIONS 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

**ENGINE BLOCK AND CYLINDER HEAD  
EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS (Cont).**

Application	Thread Size	TORQUE			
		Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (Nm)
Balance weight-to-cam-shaft gear slotted nut....	3/8-24	28	37.9680	32	43.3920
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
#Threaded exhaust valve bridge guide (Nylon insert)	7/16-14	46	62.3760	50	67.8000
Rear accessory drive pulley bolt .....	7/16-14	35	47.4600		
Generator drive bearing retaining bolt .....	7/16-14	30	40.6800	35	47.4600
Generator drive oil seal retaining bolt .....	7/16-14	30	40.6800	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
Flywheel housing bolts.....	1/2-13	90	122.0400	100	135.6000
Generator drive bearing retaining bolts.....	1/2-13	30	40.6800	35	47.4600
Generator drive oil seal retaining bolt .....	1/2-13	30	40.6800	35	47.4600

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

ENGINE BLOCK AND CYLINDER HEAD  
EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS (Cont).

Application	Thread Size	TORQUE			
		Minimum (lb ft)	Minimum (Nm)	Maximum (lb ft)	Maximum (Nm)
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
**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
**Cylinder head nuts.....	5/8-18	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
Blower drive gear hub nut.....	1 7/16-16	50	67.8000	60	81.3600

\$ Stake nut after tightening.

# Lubricate before assembling to cylinder head.

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

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).****ENGINE BLOCK AND CYLINDER HEAD  
SPECIAL PIPE PLUG TORQUE SPECIFICATIONS**

Application	Plug	Assembly	TORQUE			
			MINIMUM (lb ft)	(Nm)	MAXIMUM (lb ft)	(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.

**3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).**

**CYLINDER HEAD  
STUD TORQUE SPECIFICATIONS**

APPLICATION	MINIMUM		MAXIMUM		HEIGHT
	(lb ft)	(Nm)	(lb ft)	(Nm)	
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

3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

**ENGINE OPERATING CONDITIONS  
71 N ENGINES (English)**

	1200 rpm	1800 rpm	2100 rpm
<b><u>LUBRICATING SYSTEM</u></b>			
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
<b><u>AIR SYSTEM</u></b>			
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.....	10	2.1	3.0
<b><u>FUEL SYSTEM</u></b>			
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 pump suction at pump inlet (inches mercury) - max.:			
Clean system .....	6.0	6.0	6.0
Dirty system .....	12.0	12.0	12.0
<b><u>COOLING SYSTEM</u></b>			
Coolant temperature (degrees F.) - normal .....	160-185	160-185	160-185
<b><u>COMPRESSION</u></b>			
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.



3-58. ELECTRIC POWER GENERATION AND DISTRIBUTION (Cont).

**ENGINE OPERATING CONDITIONS  
71 N ENGINES (English)**

	1200 rpm	1800 rpm	2100 rpm
<b><u>LUBRICATING SYSTEM</u></b>			
Lubricating oil pressure (kPa):			
Normal .....	241-379	344.8-482.7	344.8-482.7
Minimum for safe operation .....	172.4	193.1	206.9
* Lubricating oil temperature (degrees C.):			
Normal .....	93-113	93-113	93-113
<b><u>AIR SYSTEM</u></b>			
Air box pressure (kPa) - minimum 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) - maximum:.....	0.2	0.5	0.7
Exhaust back pressure (kPa) - maximum:			
Full load .....	5.1	11.1	14.9
No load.....	3.4	7.1	10.1
<b><u>FUEL SYSTEM</u></b>			
Fuel pressure at inlet manifold (kPa):			
Normal (.080" orifice) .....	310-483	310-483	310-483
Minimum. 207 .....	207	207	
Fuel spill (1pm) - minimum at no load:.....	1.9	2.1	2.1
Fuel pump suction at pump inlet (kPa) -maximum:			
Clean system .....	20.3	20.3	20.3
Dirty system .....	40.5	40.5	40.5
<b><u>COOLING SYSTEM</u></b>			
Coolant temperature (degrees C.) - normal.....	71-85	71-85	71-85
<b><u>COMPRESSION</u></b>			
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 lower (5.5°C).

**3-59. SHIPS' SERVICE MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS**

This task covers:

**a. Inspection**

**b. Repair**

**INITIAL SETUP:**

**Test Equipment**

Volt - Ohmmeter

**References**

NONE

**Special Tools**

NONE

Equipment

**Condition Condition Description**

Para

NONE

**Material/Parts**

NONE

**Special Environmental Conditions**

NONE

**Personnel Required**

1

**General Safety Instructions**

OBSERVE WARNINGS

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Main switch-board (Engine access room)	a. lamps	Inspect for burned out lamps.	
	b. Fuses	Inspect for broken or blown fuses.	
	c. Identification plates	Inspect for broken or damaged identification plates.	
	d. Panel	Inspect for visible water damage.	
	e. Dials and gages	Inspect for dirt on dial glass or broken dial glass.	
	f. Switches	Inspect for loose handles or knobs.	

**3-59. SHIPS' SERVICE MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**WARNING**

ALL SOURCES OF POWER MUST BE TURNED OFF BEFORE PERFORMING ANY MAINTENANCE PROCEDURES ON THE MAIN SWITCHBOARD. Failure to do so will result in severe injury or loss of life.

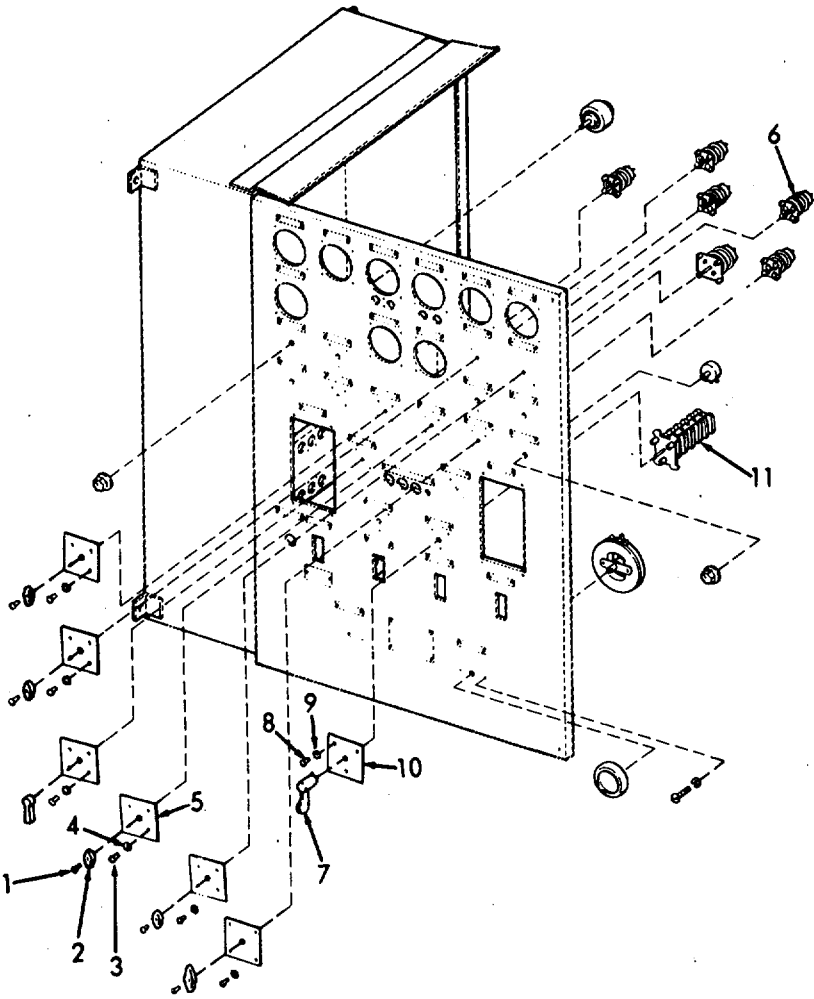
**REPAIR.**

2. Main switch-board	a. Identification plates with oval knobs	<ol style="list-style-type: none"> <li>1. Remove screw (1).</li> <li>2. Remove knob (2).</li> <li>3. Remove screws (3) and lockwashers (4) from Identification plate (5).</li> <li>4. Remove Identification plate (5).</li> <li>5. Install switch (6).</li> <li>6. Install new Identification plate, and secure with lockwashers (4) and screws (3).</li> <li>7. Replace knob (2).</li> <li>8. Install screw (1).</li> </ol>	<p>Switch (6) will be loose and must be supported.</p> <p>Align holes of switch with front panel.</p>
	b. Identification plates with pistol-grip knobs	<ol style="list-style-type: none"> <li>1. Remove pistol-grip knob (7), by gently pulling it off Identification plate (10).</li> <li>2. Remove screws (8) and lockwashers (9).</li> </ol>	<p>Switch (11) will be loose and must be supported.</p>

**3-59. SHIPS' SERVICE MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



*Ships Service Main Switchboard*

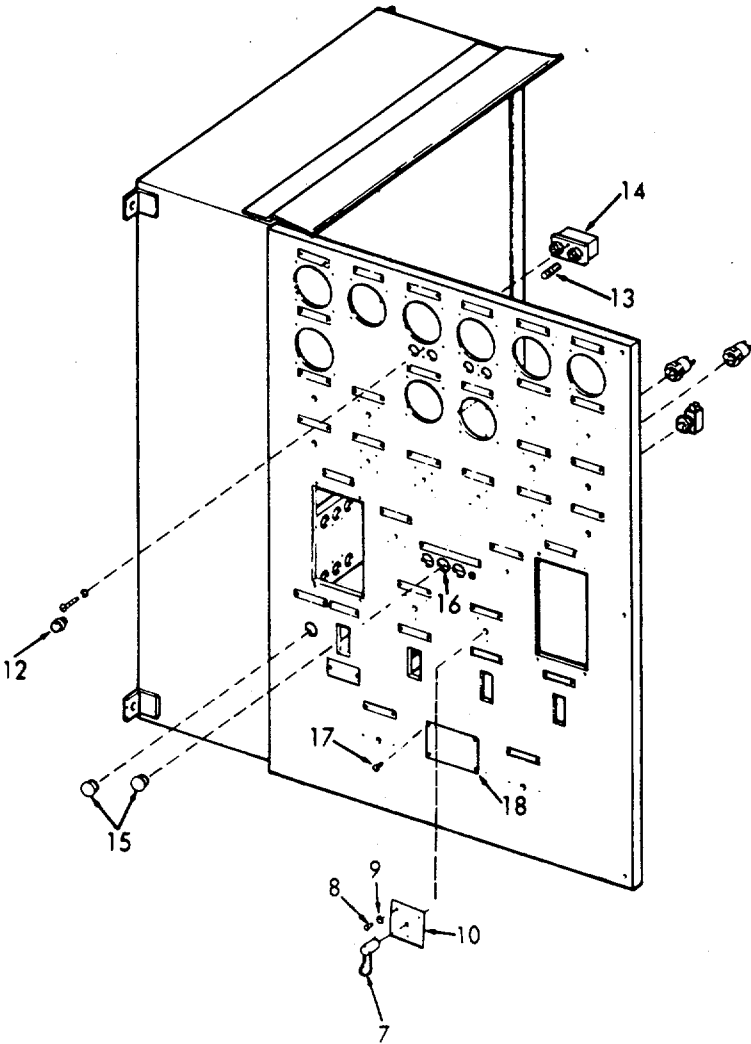
**3-59. SHIPS' SERVICE MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		<ol style="list-style-type: none"> <li>3. Remove Identification plate (10).</li> <li>4. Install new Identification plate (10).</li> <li>5. Secure, using lockwashers (9) and screws (8).</li> <li>6. Replace pistol-grip knob (7) by gently pushing it back into place.</li> </ol>	
	c. Fuse	<ol style="list-style-type: none"> <li>1. Remove fuse cap (12) and fuse (13).</li> <li>2. Remove fuse (13) from fuse holder (14).</li> <li>3. Install new fuse (13) into fuse cap (12).</li> <li>4. Replace fuse cap (12) into fuse holder (14).</li> </ol>	<p>Retain fuse cap.</p> <p>Check fuse with volt-ohmmeter. Discard if burned out or damaged.</p>
	d. Lamps	<ol style="list-style-type: none"> <li>1. Remove lamps (15) from lamp sockets (16) or damaged.</li> <li>2. Install new lamps (15) into lamp sockets (16).</li> </ol>	Discard lamps if burned out
	e. Identification Plates	<ol style="list-style-type: none"> <li>1. Remove screws (17) from Identification plate (18).</li> <li>2. Remove Identification plate (18).</li> </ol>	Discard if damaged.

3-59. SHIPS' SERVICE MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS  
(Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)
---------------



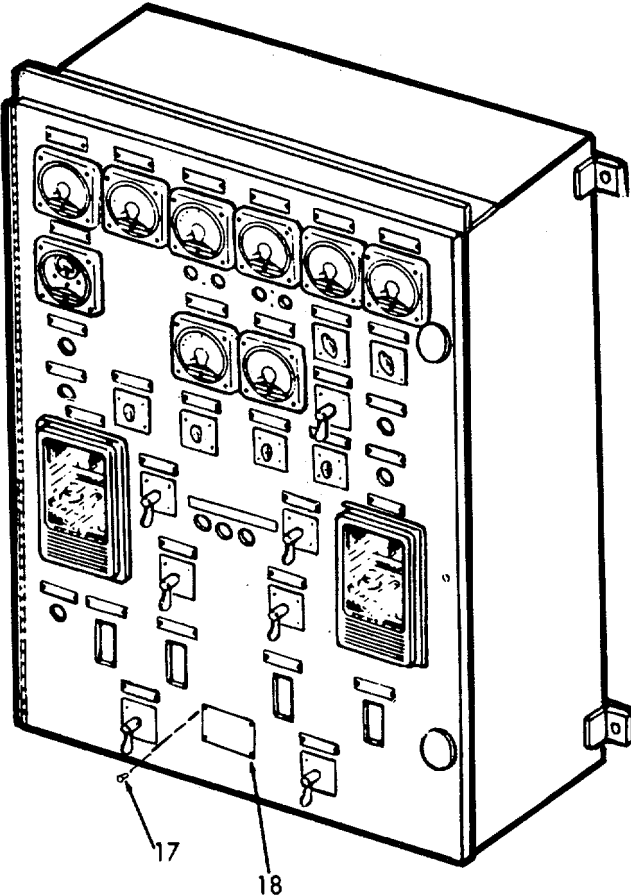
3-1049

**3-59. SHIPS' SERVICE MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS.**  
**(Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

- 3. Install new Identification plate (18).
- 4. Secure, using screws (17).



**3-60. TRANSFORMER-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**Inspection**

**INITIAL SETUP:**

**Test Equipment**  
NONE

**References**  
NONE

**Special Tools**  
NONE

**Equipment**  
**Condition Condition Description**

Para

NONE

**Material/Parts**  
NONE

**Special Environmental Conditions**  
NONE

**Personnel Required**  
1

**General Safety Instructions**  
NONE

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION
------------

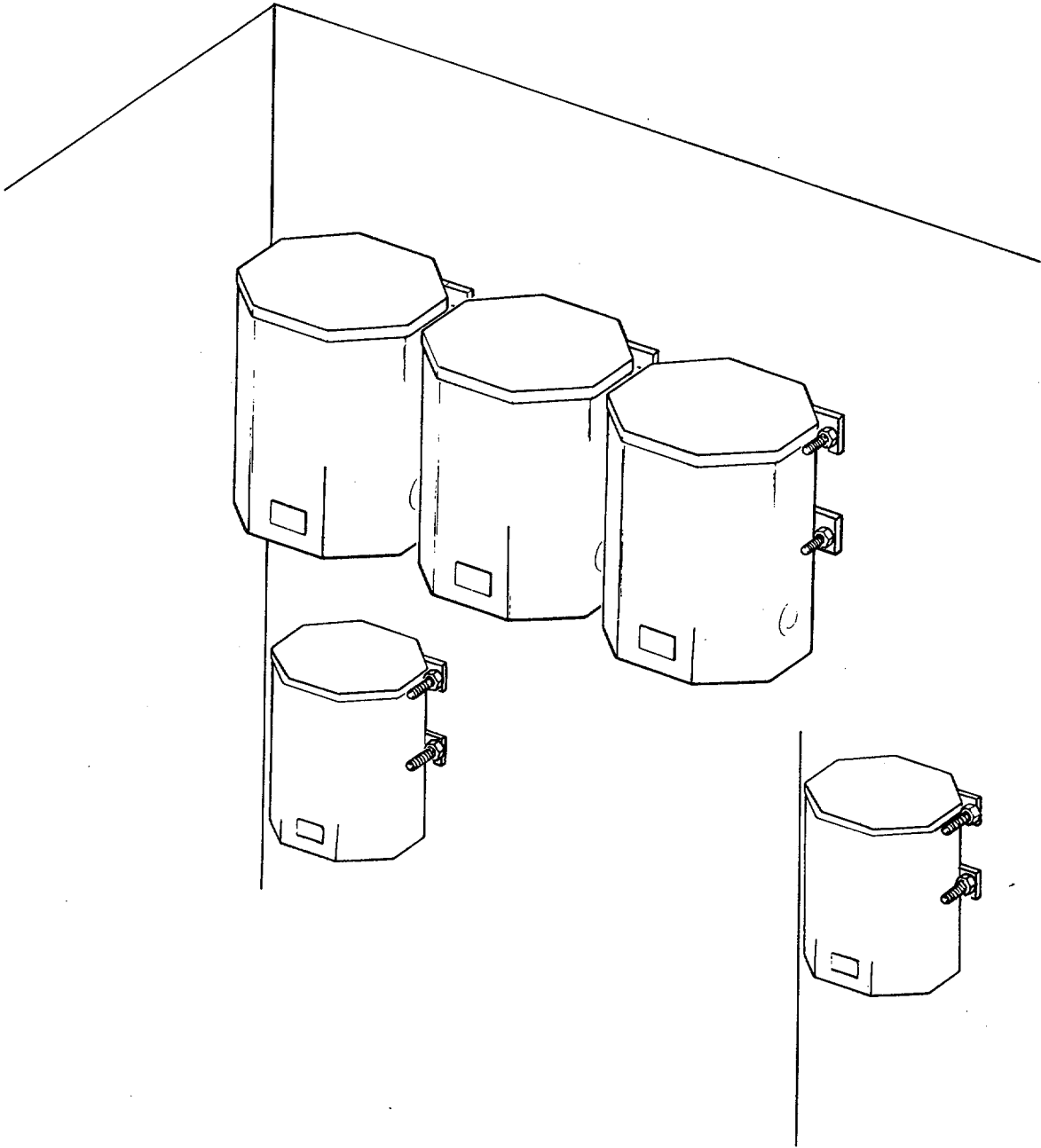
1. Engine Access Room	Transformers	1. Inspect for damage.  2. Inspect for frayed, worn, loose or damaged wiring.  3. Inspect for signs of overheating.	Refer to Direct Support Maintenance for all repairs.
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3-60. TRANSFORMER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)



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**3-61. POWER DISTRIBUTION PANEL BOARDS-MAINTENANCE INSTRUCTIONS.**

---

a. The maintenance instructions for the Power Distribution Panel boards and the Shore Power Distribution Box are contained in this paragraph. The Power Distribution Panels are designated in P400 series.

b. Refer to the following paragraphs for maintenance instructions.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Power Distribution Panel	3-61.1
Shore Power Distribution Box	3-61.2

**3-1054**

**3-61.1. POWER DISTRIBUTION PANEL-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**a. Inspection**

**b. Repair**

**INITIAL SETUP:**

**Test Equipment**  
NONE

**Reference**  
NONE

**Special Tools**  
NONE

**Equipment Condition Condition Description**  
Para

NONE

**Material/Parts**  
NONE

**Special Environmental Conditions**  
NONE

**Personnel Required**  
1

**General Safety Instructions**  
OBSERVE WARNINGS

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**WARNING**

- MAKE SURE ALL INCOMING POWER IS SHUT OFF. Tag circuit breakers to prevent accidental turn on.
- Voltage in panel is lethal and can cause death.

**INSPECTION**

1.	Panels designated P4-	Power Distribution Panel	a. Operate circuit breakers to see if functioning properly.  b. Check exterior wires and cables for signs of fraying or deterioration.	If defects are found, refer to Direct Support Maintenance.
----	-----------------------	--------------------------	--	--

3-61.1. POWER DISTRIBUTION PANEL- MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION (Cont)

- c. Check to see that interior wiring and cable connections are tight.



ALL SOURCES OF POWER MUST BE TURNED OFF before performing any maintenance procedures. Failure to do so will result in severe injury or loss of life, and major damage to the landing craft.

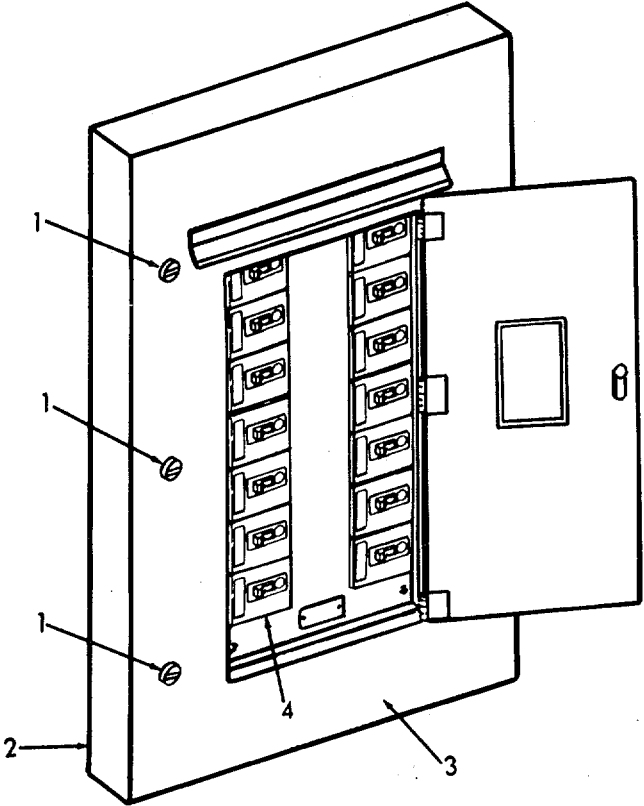
REPAIR

2.	Circuit breakers	<ul style="list-style-type: none"> <li>a. Remove screws (1) from Power Distribution Box (2).</li> <li>b. Remove front panel (3).</li> <li>c. Tag and disconnect all wiring.</li> <li>d. Remove circuit breakers (4).</li> <li>e. Install new circuit breakers (4) and secure.</li> <li>f. Attach all wiring and remove tags.</li> <li>g. Install front panel (3) on Power Distribution Box (2).</li> <li>h. Secure with screws (1).</li> <li>i. Turn on all sources of power.</li> </ul>	Discard.
----	------------------	--	----------

3-61.1. POWER DISTRIBUTION PANEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)



3-1057

**3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS.**

The Shore Power Distribution Box is used to connect the shore power from the pier to the internal wiring of the landing craft. The Shore Power Distribution Box is also used to electrically connect one landing craft to another, and then to the pier.

**This task covers:**

- a. Inspection**
- b. Repair**

**INITIAL SETUP:**

**Test Equipment**  
NONE

**Reference**  
NONE

**Special Tools**  
NONE

**Equipment**  
**Condition Condition Description**  
Para  
NONE

**Material/Parts**  
NONE

**Special Environmental Conditions**  
NONE

**Personnel Required**  
1

**General Safety Instructions**  
OBSERVE WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

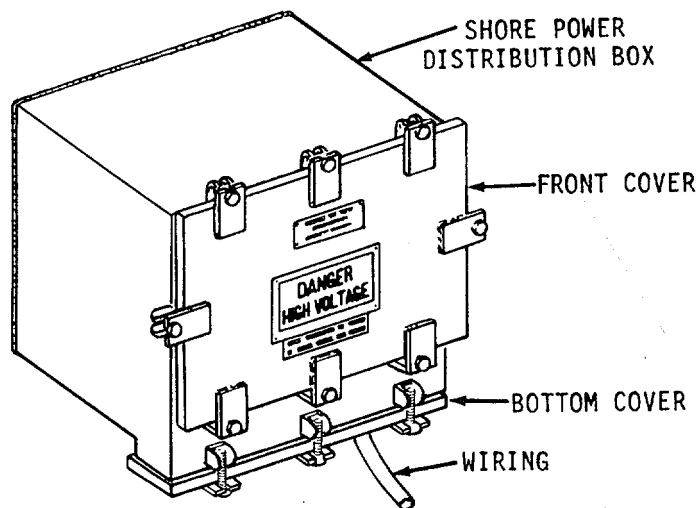


**DANGER - HIGH VOLTAGE.**

The voltage inside this Distribution box is lethal. Failure in observing this warning could result in DEATH or severe injury. Disconnect all wiring on the pier before opening.

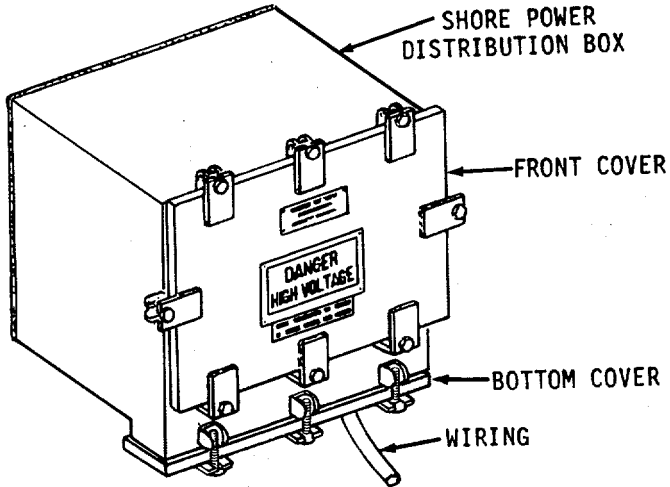
**INSPECTION**

- |    |                              |                                   |   |
|----|------------------------------|-----------------------------------|---|
| 1. | Shore Power Distribution Box | a. Front cover assembly hardware. | <ol style="list-style-type: none"> <li>1. Inspect for damage.</li> <li>2. Inspect for loose</li> <li>3. Inspect for signs of leaking gasket.</li> </ol>           |
|    |                              | b. Bottom cover assembly          | <ol style="list-style-type: none"> <li>1. Inspect for damage.</li> <li>2. Inspect for loose hardware.</li> <li>3. Inspect for signs of leaking gasket.</li> </ol> |



**3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Wiring	Inspect for frayed, broken, worn, or damaged wiring.	
	d. Distribution Box	<ol style="list-style-type: none"> <li>1. Inspect for damage, dents, or breaks.</li> <li>2. Inspect for broken welds on the bulk-head or hinges.</li> </ol>	If welding is required, refer to Direct Support Maintenance.



**WARNING**

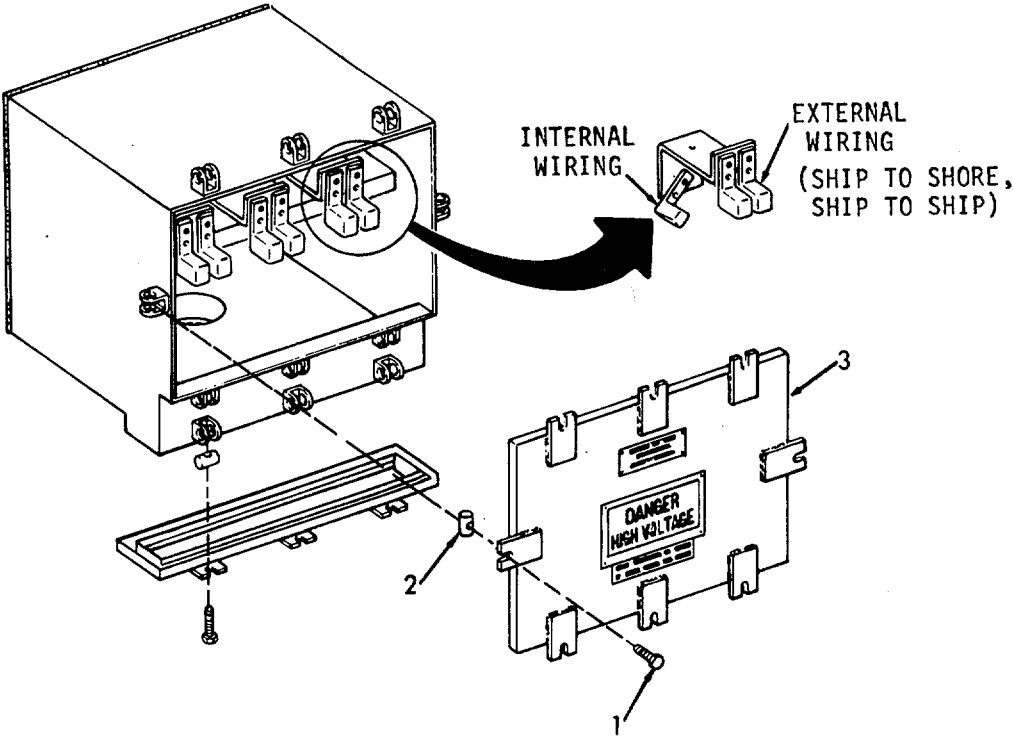
**DANGER - HIGH VOLTAGE.**

The voltage inside this Distribution Box is lethal. Failure in observing this warning could result in DEATH or severe injury. Disconnect all wiring on the pier before opening.



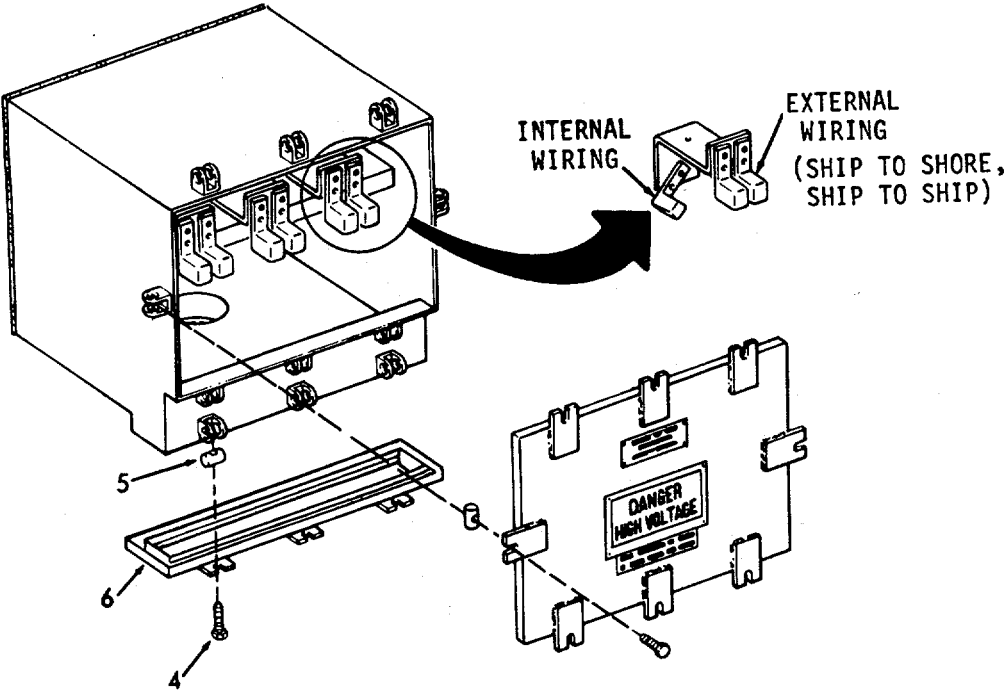
**3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
2. Front cover	a. Screws (1)	Loosen screw and swing hinge pin (2) out of the way.	
	b. Front cover (3)	Remove.	
	c. Hinge pin (2)	Remove and replace	If necessary.
	d. Front cover (3)	Replace.	
	e. Screws (1)	Swing screws to secure cover and tighten.	



**3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Bottom cover	a. Screws (4)	Loosen screw and swing hinge pin (5) out of the way.	
	b. Bottom cover (6)	Remove.	
	c. Hinge pin (5)	Remove and replace -	If necessary.
	d. Bottom cover (6)	Replace.	
	e. Screws (4)	Swing screws to secure cover and tighten.	

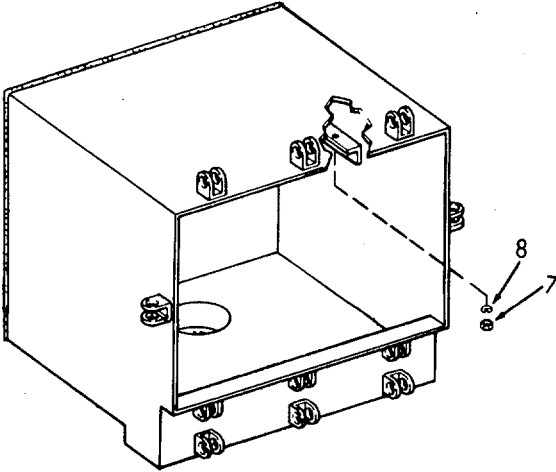


3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS (Cont.)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

- |                       |                                  |                     |
|-----------------------|----------------------------------|---------------------|
| 4. Wiring terminators | a. External wiring               | Tag and disconnect. |
|                       | b. Internal wiring               | Tag and disconnect. |
|                       | c. Nuts (7) and lock-washers (8) | Remove.             |



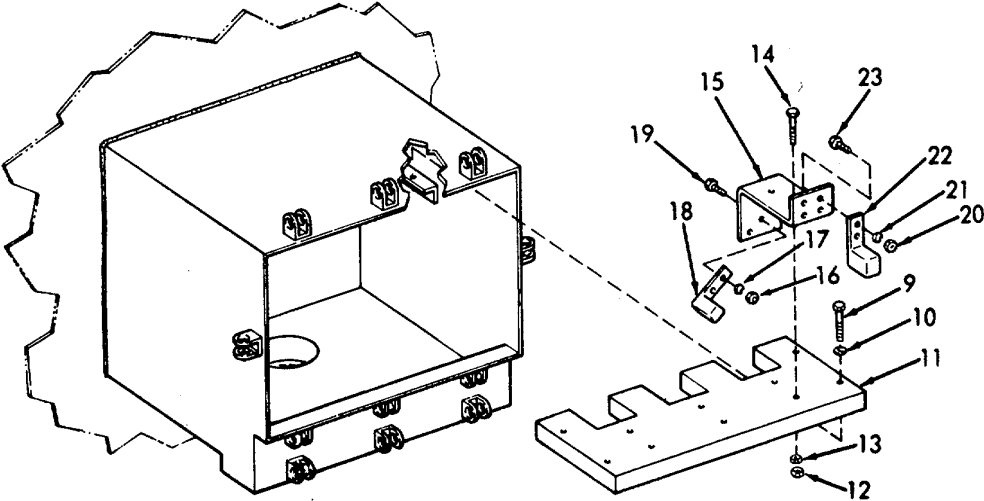
3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS (Cont.)

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	d. Screws (9), and flat- washers (10)	Remove.	
	e. Insul- ator (11)	Remove.	
	f. Nuts (12) and lock- washers (13)	Remove.	
	g. Screw (14)	Remove.	
	h. Copper bus (15)	Remove.	
	i. Nuts (16), lock- washers (17), lug (18) and screws (19)	Remove.	
	j. Nuts (20), lock- washers (21) lugs (22) and screws (23)	Remove.	

3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS (Cont.)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)



- k. Screws (23), lugs (22), lock-washers (21) and nuts (20)

Reassemble on copper bus.

- I. Screws (19), lug (18), lock-washers (17) and nuts (16)

Reassemble on copper bus.

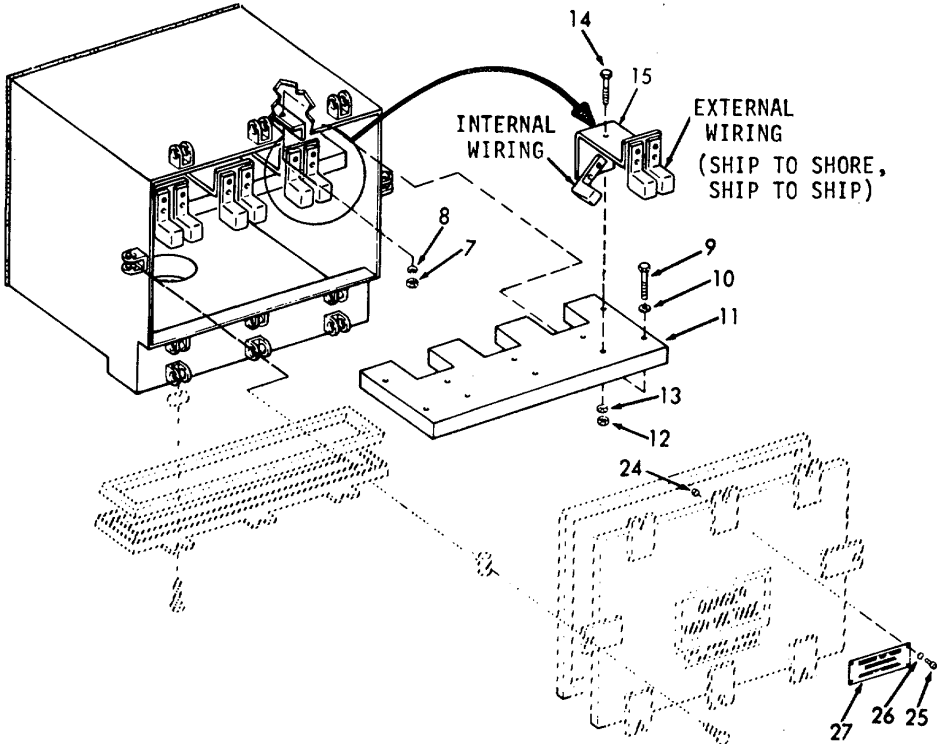
3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS (Cont.)

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	m. Copper bus (15), screws (14), lock-washers (13) and nuts (12)	Reassemble on insulator.	
	n. Insulator (11), flat-washers (10), screws (9), lock-washers (8), and nuts (7)	Install.	
	o. Internal Wiring	Reconnect.	
	p. External wiring	Reconnect.	
5. Identification plate	a. Nuts (24), screws (25), lock-washers (26) and plate (27)	Remove and replace	If necessary.

3-61.2. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS (Cont.)

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



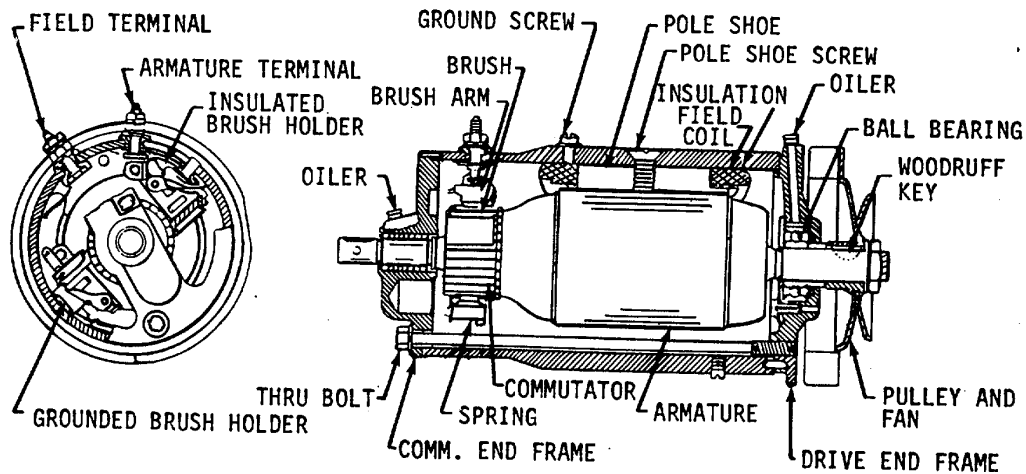
**3-62. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS.**

- a. The generator circuit on the generator engine consists of a generator and voltage regulator. The generator provides power to the various components of the alarm system. Refer to paragraph 3-65.
- b. Refer to the following paragraphs for maintenance instructions.

<u>DESCRIPTION</u>	<u>PARAGRAPHS</u>
Generator (12VDC)	3-62.1
Voltage Regulator	3-62.2

**3-62.1. SHORE POWER DISTRIBUTION BOX-MAINTENANCE INSTRUCTIONS.**

The generator provides a source of electrical current for maintaining the alarm system. The generator is of the direct current (DC) type. The generator is belt driven by the engine.





3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

- |               |            |                |
|---------------|------------|----------------|
| a. Inspection | c. Test    | e. Disassembly |
| b. Service    | d. Removal | f. Reassembly  |

INITIAL SETUP:

Test Equipment

- Ammeter
- Battery
- Clips
- Test lamp

References

NONE

Special Tools

NONE

Equipment  
Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions  
NONE

Personnel Required

1

General Safety Instructions

OBSERVE WARNINGS

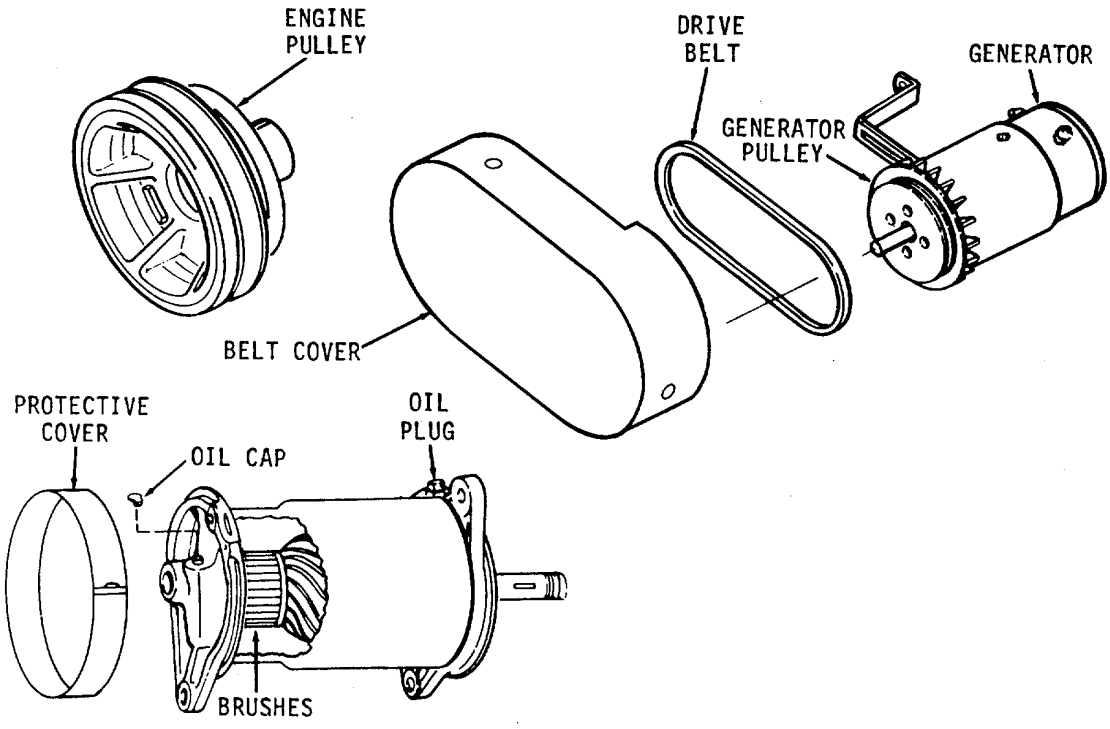
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |              |               |   |                                 |
|--------------|---------------|---|---------------------------------|
| 1. Generator | a. Drive belt | <ol style="list-style-type: none"> <li>1. With the engine off, check the belt tension.</li> <li>2. With the engine off, check for wear or fraying.</li> </ol>         | Refer to Step 3 for tightening. |
|              | b. Bearings   | <ol style="list-style-type: none"> <li>1. With the engine running, listen for noisy bearings.</li> <li>2. Check that oil cap and oil plug have been oiled.</li> </ol> |                                 |

3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	c. Wiring	<ol style="list-style-type: none"><li>1. Inspect external wiring for wear, breaks or fraying.</li><li>2. Check for tight, external electrical connections.</li></ol>	
	d. Brushes	<ol style="list-style-type: none"><li>1. Remove protective cover and inspect for wear and broken brushes or springs.</li><li>2. With the engine running, inspect for excessive sparking.</li></ol>	



**3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).**

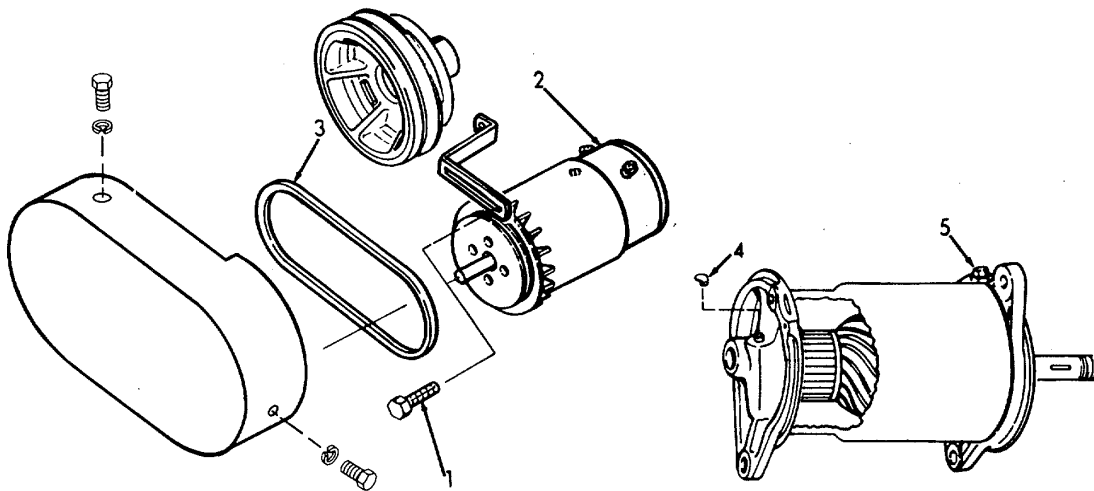
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION (Cont)**

2.	Engine	Ammeter	<ol style="list-style-type: none"> <li>1. Inspect for damaged or broken glass.</li> <li>2. With the engine running, the meter should show a slight charge.</li> </ol>	Refer to paragraph 3-99 for maintenance.
----	--------	---------	---	--

**SERVICE**

3.	Drive Belt	a. Screw (1)	Loosen.	Use a pry bar.
		b. Generator (2)	Move to increase tension of drive belt (3).	
		c. Screw (1)	Tighten.	
4.	Bearing oil	a. Oiler (4)	Lift to lubricate.	Use oil type OE/HDO.
		b. Oiler (5)	Remove to lubricate.	Use oil type OE/HDO.



3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**TEST**

5. Generator

**NOTE**

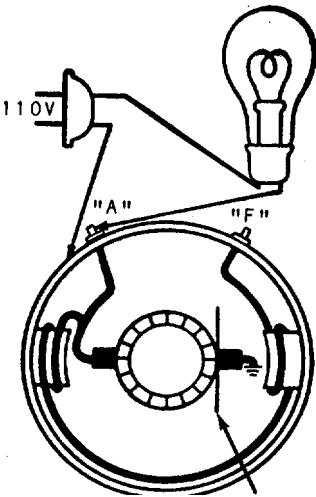
In the tests that follow, all that is needed is a set of test points or clips and a 110-volt test lamp.

**WARNING**

When performing the following tests-110 Volts is present. Exercise extreme caution. Failure to do so will result in severe injury or loss of life.

- |                  |  |
|------------------|--|
| a. Short circuit | <ol style="list-style-type: none"> <li>1. Raise the grounded brush and insulate it from the commutator with a piece of cardboard.</li> <li>2. Using the test points, check for a ground from the "A" terminal to the generator frame.</li> </ol> |
|------------------|--|

If the bulb lights, the short is in the field coils, armature, or brush holder.



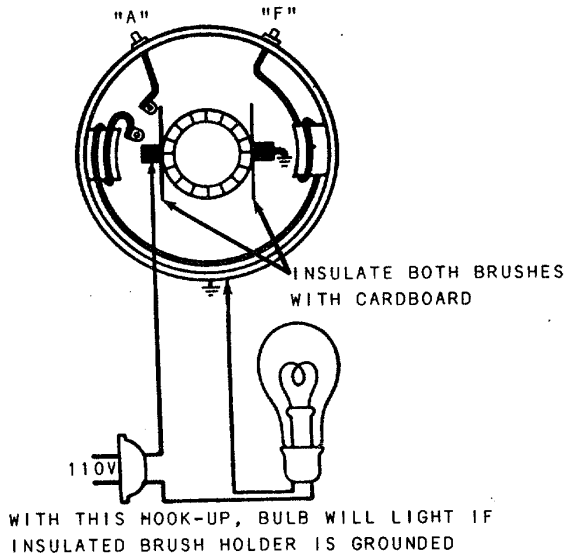
INSULATE WITH CARDBOARD TESTING FOR SHORT CIRCUIT IN GENERATOR. IF BULB LIGHTS, SHORT IS IN FIELD COILS, ARMATURE OR BRUSH HOLDER.

3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TEST (Cont)**

- |                                      |  |  |
|--------------------------------------|--|--|
| b. Insulated brush holder (grounded) | <ol style="list-style-type: none"><li>1. Disconnect all wiring to the insulated brush holder and field coil.</li><li>2. Insulate both brushes with cardboard.</li><li>3. Using the test points, check for a ground from the insulated brush holder to the generator frame.</li></ol> | Light bulb will light if insulator brush holder is grounded. |
|--------------------------------------|--|--|



- |                        |  |
|------------------------|--|
| c. Armature (grounded) | <ol style="list-style-type: none"><li>1. Disconnect all wiring to the insulated brush holder and field coil.</li></ol> |
|------------------------|--|

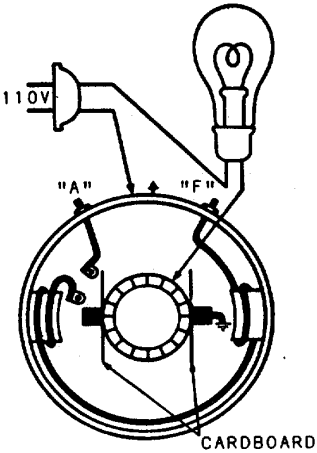
3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TEST (Cont)**

2. Insulate both brushes with cardboard.
3. Using the test points, check for a ground from the armature segments to the generator frame.
4. Rotate armature slowly to check each segment.

Light bulb will light if armature is grounded.



WITH THIS HOOKUP, BULB WILL LIGHT IF ARMATURE IS GROUNDED

- |                                      |  |
|--------------------------------------|--|
| d. Field coil or terminal (grounded) | <ol style="list-style-type: none"> <li>1. Disconnect all wiring to the insulated brush holder and field coil.</li> <li>2. Insulate the grounded brush with cardboard.</li> </ol> |
|--------------------------------------|--|

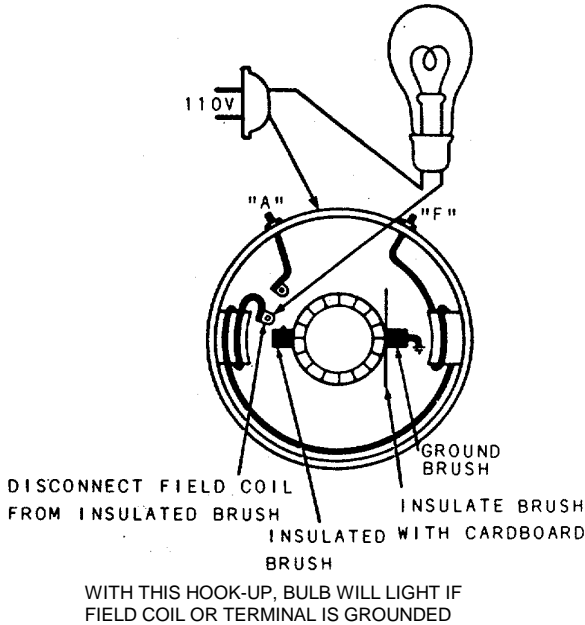
3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TEST (Cont)**

3. Using the test points, check for a ground from the field coil to the generator frame.

Light bulb will light if field coil or terminal is grounded.



e. Field circuit (open)

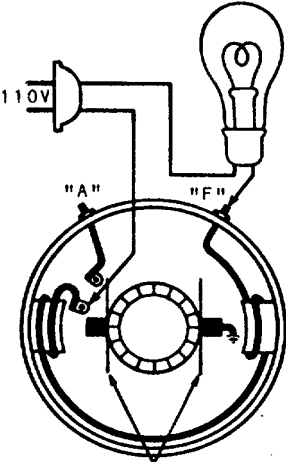
1. Disconnect all wiring to the insulated brush holder and field coil.
2. Insulate both brushes with cardboard.
3. Using the test points, check for an open circuit between the "F" terminal and the field coil.

Light bulb will not light if field circuit is open.

3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TEST (Cont)**



INSULATE BOTH BRUSHES WITH CARDBOARD  
WITH THIS HOOK-UP, BULB WILL NOT LIGHT IF FIELD CIRCUIT IS OPEN

- |                               |   |
|-------------------------------|---|
| f. Field coil internal shorts | <ol style="list-style-type: none"><li>1. Disconnect all wiring to the insulated brush holder and field coil.</li><li>2. Insulate both brushes with cardboard.</li></ol> |
|-------------------------------|---|

**WARNING**

Proceed with care in this test, since a shorted field may draw an excessively high current.



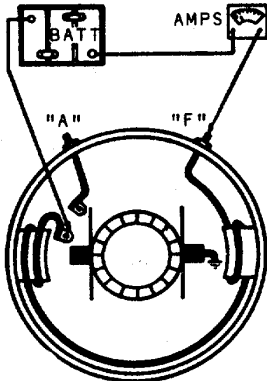
3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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TEST (Cont)

3. Use a battery and an ammeter and check as shown.

If the field coils have an internal short, ampere draw will be excessive.



WITH THIS HOOK-UP, IF THE FIELD COILS HAVE AN INTERNAL SHORT, AMPERE DRAW WILL EXCEED SPECIFICATIONS

g. Armature open circuit

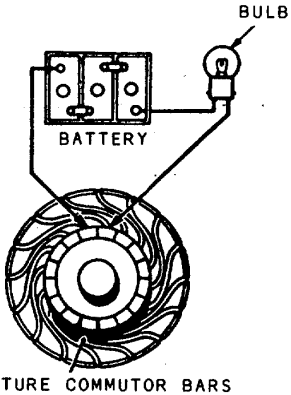
1. Remove the armature from the generator.
2. Rotate the armature slowly, checking between adjacent bars with test points and a light in series with a battery.

Refer to disassembly, step 6-11. Any open circuited coils will prevent the lamp from lighting.

3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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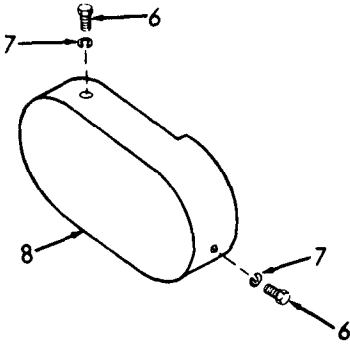
**TEST (Cont)**



HOOK-UP FOR TESTING ARMATURE FOR OPEN CIRCUIT. WHEN CHECKING AGAINST COMMUTATOR BARS, NO LIGHT WILL INDICATE OPEN-CIRCUITED ARMATURE COILS.

**REMOVAL**

- 6. Generator
  - a. Screws (6) and lock-washers (7) Remove.
  - b. Belt cover (8) Remove.



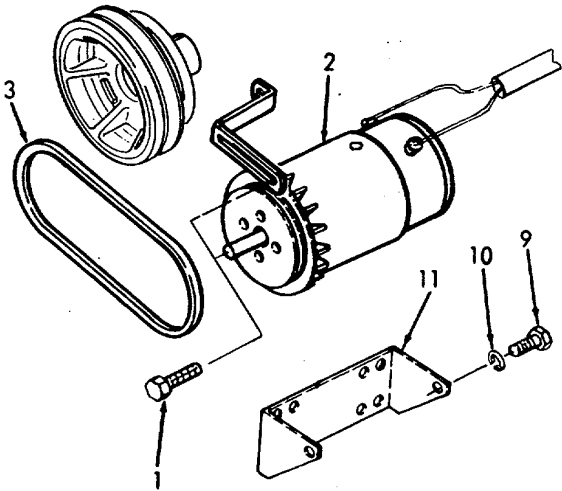
3-1079

3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- c. Wiring Tag and disconnect.
- d. Screw (1) Loosen.
- e. Generator (2) Move to loosen drive belt.
- f. Drive belt (3) Remove.
- g. Screws (9), and lock-washers (10) Remove.
- h. Screw (1) Remove.
- i. Generator (2) Remove from bracket (11).

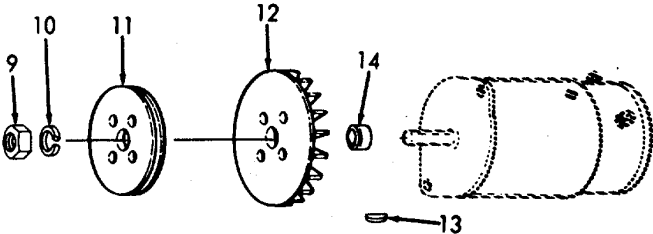


3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

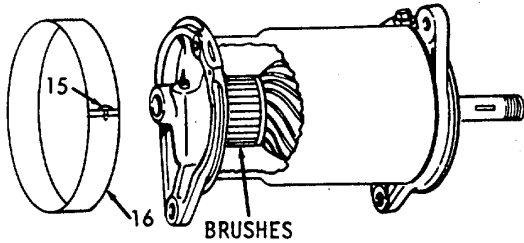
LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY**

- 7. Drive pulley
  - a. Nut (9) and fan and lock-washer (10) Remove.
  - b. Drive pulley (11), fan (12) and key (13) Remove.
  - c. Collar (14) Remove.



- 8. Brush protective cover
  - a. Screw (15) Loosen.
  - b. Cover (16) Remove from generator.

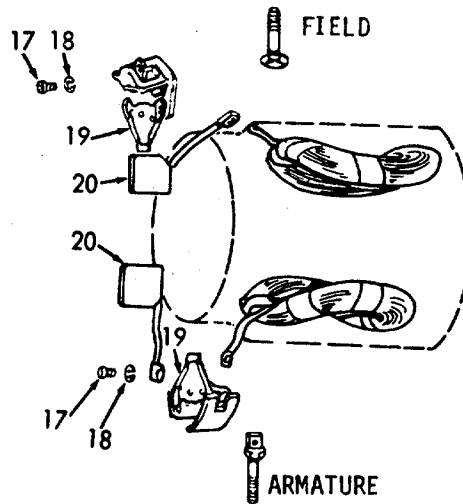


3-62.1. GENERATOR (12VDC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY (Cont)**

- |            |                                      |                   |                     |
|------------|--------------------------------------|-------------------|---------------------|
| 9. Brushes | a. Screws (17) and lock-washers (18) | Remove all wires. |                     |
|            | b. Brush arms (19)                   | Lift.             |                     |
|            | c. Brushes (20)                      | Remove.           | Discard if damaged. |

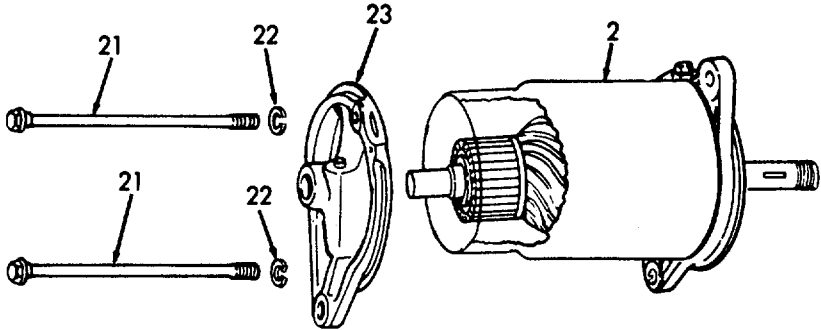


- |                          |   |         |  |
|--------------------------|---|---------|--|
| 10. Commutator end frame | a. Through bolts (21) and lock-washers (22) | Remove. |  |
|                          | b. Commutator end frame (23)                | Remove. |  |

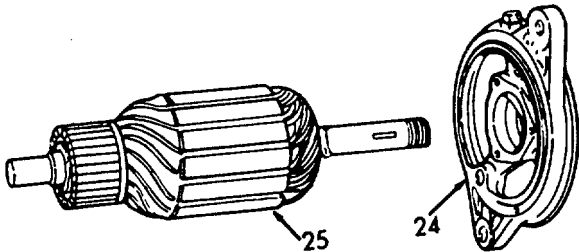
3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

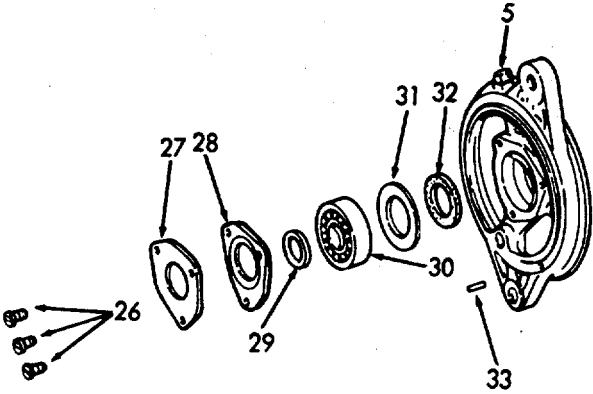


- 11. Drive end frame (24) and armature (25)
  - a. Drive end frame (24) and armature (25) Remove as one assembly.
  - b. Armature (25) Remove from drive end frame (24).



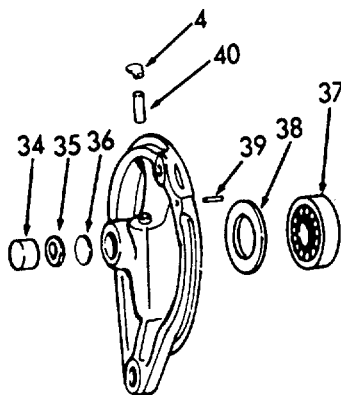
3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
12. Drive end frame	a. Screws (26)	Remove.	
	b. Retaining plate (27) and gasket (28)	Remove.	
	c. Washer (29), bearing (30), felt retainer (31) and felt (32)	Remove.	
	d. Oiler (5)	Remove.	
	e. Dowel Pin (33)	Remove.	If necessary



3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

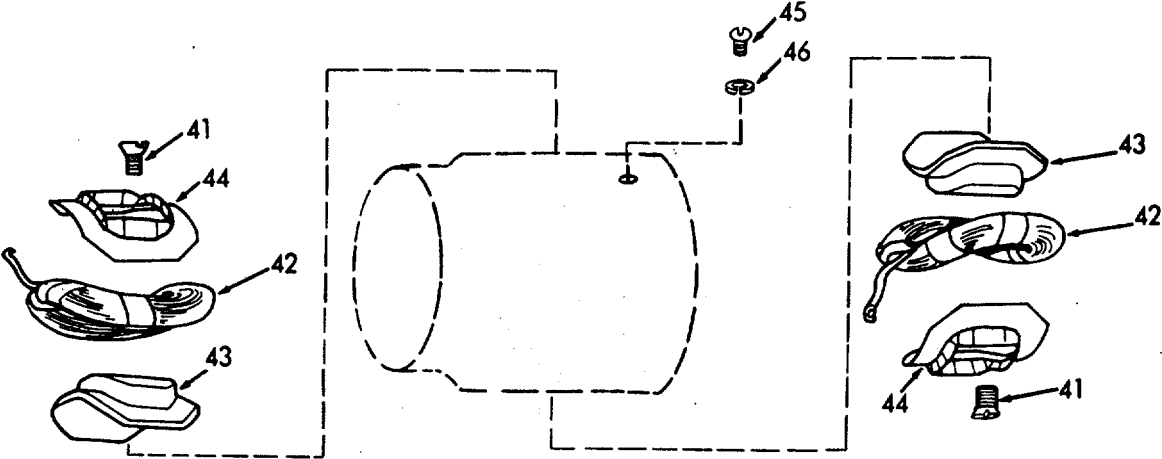
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
13. Commuta- tor end frame	a. Felt retain- ing cup (34), felt washer (35) and expan- sion plug (36)	Remove.	
	b. Bear- ing (37) and bear- ing ring (38)	Remove.	
	c. Dowel pin (39)	Remove.	If necessary
	d. Oiler (4) and felt plug (40)	Remove.	If necessary





3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
14. Field frame	a. Pole shoe screws (41)	Remove.	
	b. Field coils (42), pole shoes (43) and field coil insulators (44)	Remove as one part. Then disassemble.	The two field coils are wired together.
	c. Ground screw (45), lock-washer (46)	Replace.	If necessary.

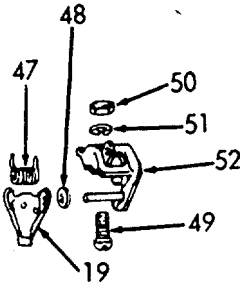


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

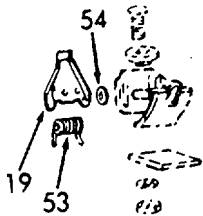
LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- |     |                         |   |                   |
|-----|-------------------------|---|-------------------|
| 15. | Brush holder (grounded) | a. Brush arm (19), spring (47) and washer (48)                    | Slide off holder. |
|     |                         | b. Screw (49), nut (50), lockwasher (51) and grounded holder (52) | Remove.           |



- |     |                          |  |                   |
|-----|--------------------------|--|-------------------|
| 16. | Brush holder (insulated) | a. Brush arm (19), spring (53) and washer (54) | Slide off holder. |
|-----|--------------------------|--|-------------------|

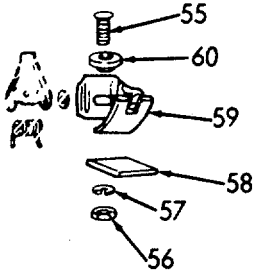


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- b. Screw (55), nut (56), lock washer (57), insulator (58), insulated brush holder (59), and insulated bushing (60)
- Remove.



- 17. Field terminal stud
- a. Nuts (61), lock-washers (62), plain washers (63) and insulated washer (64)

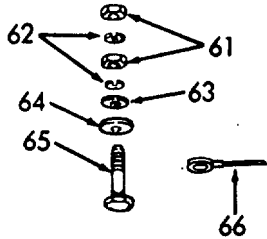
Disassembly

3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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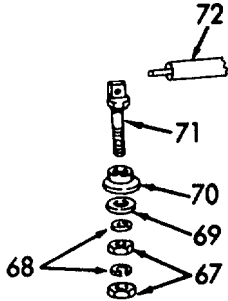
DISASSEMBLY (Cont)

- b. Stud (65) and wiring (66) Remove from field frame.



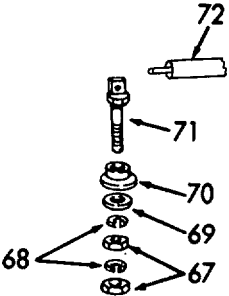
18. Armature terminal stud

- a. Nuts (67), lockwashers (68), plain washer (69) and insulated bushing (70) Remove.
- b. Stud (71) and wiring (72) Remove from field frame.



3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
19. Armature terminal stud	a. Insulated bushing (70)	Insert in outside of field frame.	
	b. Stud (71) and wiring (72)	Insert in field frame.	
	c. Plain washer (69), lock-washers (68) and nuts (67)	Install.	



20. Field terminal stud	a. Stud (65) and wiring (66)	Insert in field frame.	
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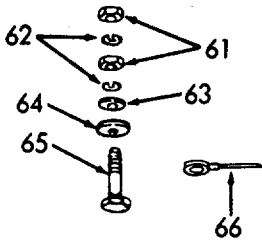
3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- b. Insulated washer (64), plain washer (63), lock-washers (62) and nuts (61)

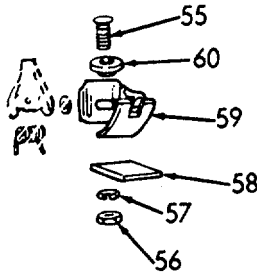
Install.



21. Brush holder (insulated)

- a. Insulated brush holder (59), insulated bushing (60), insulator (58), lock-washers (57), nut (56), and screw (55)

Assemble.

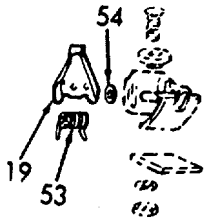


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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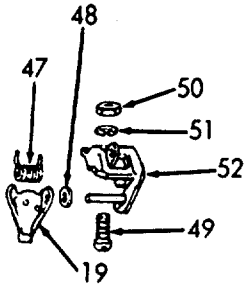
REASSEMBLY (Cont)

- b. Brush arm (19), spring (53) and washer (54)



22. Brush holder (grounded)

- a. Grounded holder (52), lock-washer (51), screw (49), and nut (50)
- b. Brush arm (19), spring (47), and washer (48)

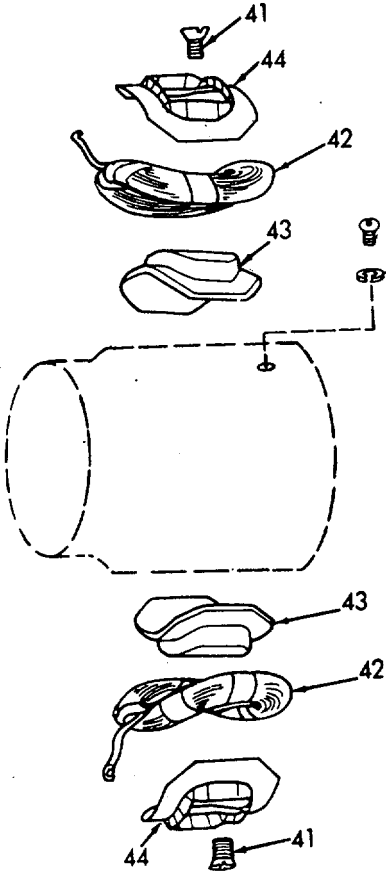


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

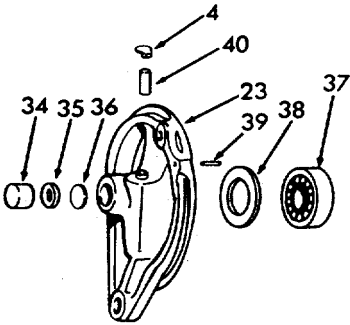
23. Field frame	a. Field coil shoes (43), field coil (42), and field coil insulator (44)	Assemble and place in field frame.	
	b. Pole shoe screws (41)	Install.	





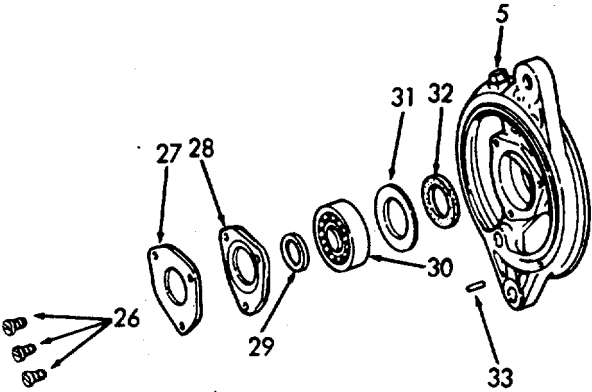
3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
24. Commu- tator end frame	a. Felt plug (40), and oiler (4)	Install.	Lubricate felt plug with oil after install- ation.
	b. Dowel pin (39)	Install,	If removed.
	c. Bear- ing ring (38) and bear- ing (37)	Install.	
	d. Expan- sion plug (36), felt washer (35) and felt retain- ing cup (34)	Install.	



3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
25. Drive end frame	a. Dowel pin (33)	Install.	If removed.
	b. Oiler (5)	Install.	
	c. Felt (32), felt retain-er (31), bear- ing (30), and washer (29)	Install.	
	d. Gasket (28), retain- ing plate (27) and screws (26)	Install.	

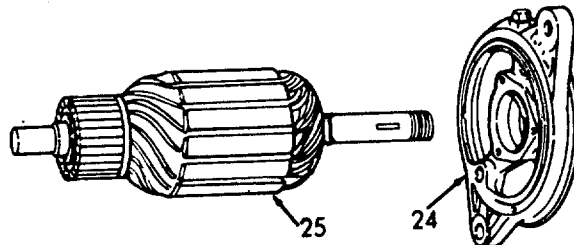
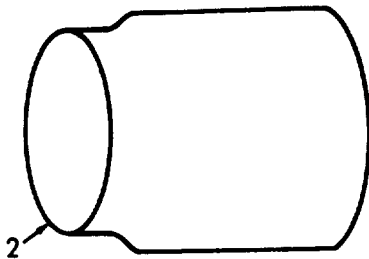


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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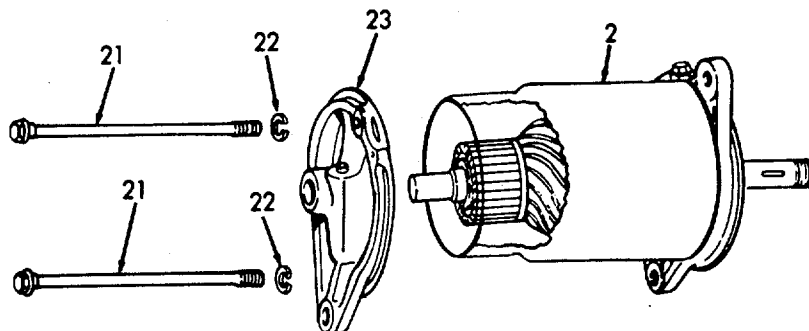
REASSEMBLY (Cont)

26. Drive end	Drive end frame (24) and armature (25)	Reassemble into field frame (2) on dowel pins.	
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27. Commutator end frame	a. Commutator end frame (23)	Assemble into field frame (2) on dowel pins.	
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Raise the brushes in the brush holders so that the commutator will slide in. Failure to do this will result in damage to the brushes and the brush holder.

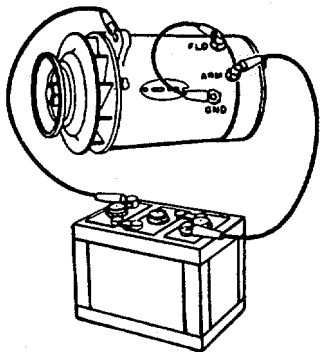


3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Through bolts (21) and lockwashers (22)	Insert through field frame.	Tighten.
<b>NOTE</b>			
Make sure the armature is free to rotate before the brushes are placed against the commutator.			
28. Brushes	a. Brushes (20) and brush arms (19)	Lift arm and insert brushes.	<ol style="list-style-type: none"> <li>1. If new brushes are too long, the commutator ends should be sanded until each is, shortened enough for the spring tension arm to be properly located on top of the brushes. Do not file or notch the top of the brushes.</li> <li>2. Be sure the brush leads are bent so that they will follow the brushes as they wear shorter.</li> <li>3. Be sure they do not rub against any part of the armature.</li> </ol>
<p>The diagram illustrates the brush assembly of a generator. It shows two brush arms (19) mounted on a brush holder. Each arm holds a brush (20). The brush holder is attached to a field frame (FIELD) and an armature (ARMATURE). Screws (17) and lockwashers (18) are used to secure the brush holder to the field frame. The brush leads are shown bent to follow the brushes. The commutator is visible on the armature.</p>			
	b. Screws (17) and lockwashers (18)	Install wiring.	

3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
29. Generator	Generator assembly and a battery	<ol style="list-style-type: none"><li>1. Run the generator as a motor by connecting it as shown. When the jumper wire from the field is grounded the armature should "motor" or rotate slowly. If it does not, locate and correct fault.</li><li>2. After running the generator for a few minutes, stop it and lift the brushes to examine the contact surfaces. If the brush shows that it is wearing in on one side only, slightly twist the brush tension arm to equalize the pressure on the brush to obtain uniform wear.</li></ol>	



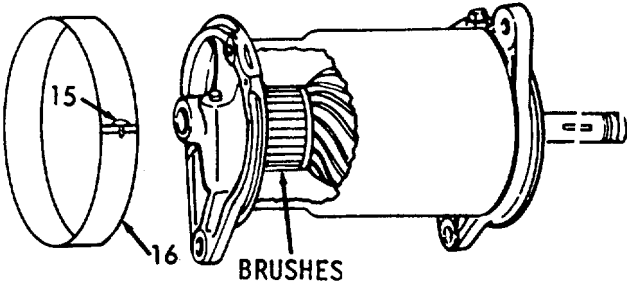
CONNECTIONS FOR RUNNING GENERATOR AS A MOTOR. BE SURE TO CONNECT THE GENERATOR WITH THE SAME POLARITY THAT IT WILL HAVE WHEN IT IS INSTALLED.

3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont.).

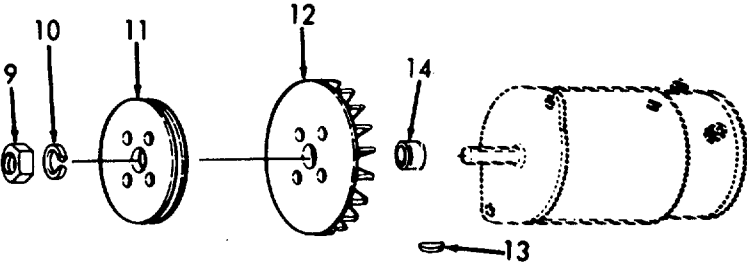
LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

30.	Brush protective cover	Screw (15) and cover (16)	Reinstall.
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31.	Drive Pulley and fan	a. Collar (14)	Slide on shaft.
		b. Key (13), fan (12) and drive pulley (11)	Install on shaft.
		c. Lock-washer (10) and nut (9)	Install.



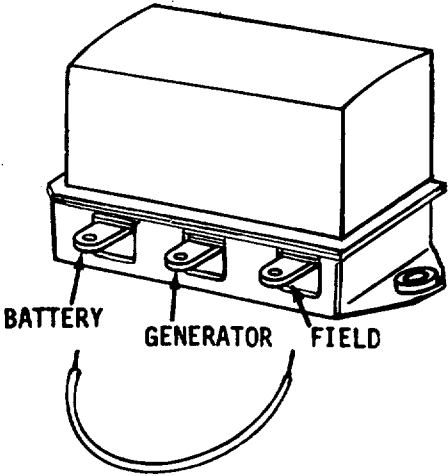
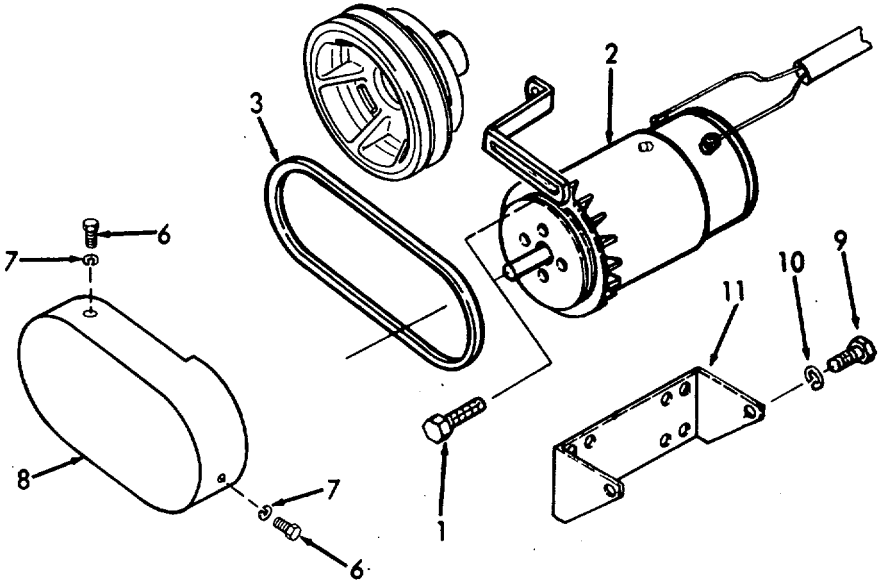
3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Con t)			
32. Gener- ator	a. (Genera- tor (2), bracket (11), screws (9), lock- washers (10) and screw (1)	Align holes in generator with bracket. Insert screws and lockwashers.	Tighten finger tight.
	b. Drive belt (3)	Place on generator and engine pulley.	
	c. Gener- ator (2), drive belt (3) and screw (1)	Move generator to tighten drive belt. Then, tighten screw.	
	d. Belt cover (8), screws (6) and lock.- washers (7)	Reassemble.	
	e. Voltage regular- tor	Using a jumper wire, momentarily touch the BAT to the F ter- minal.	A spark will occur. This will polarize the generator to the voltage regulator.

3-62.1. GENERATOR (12VDC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

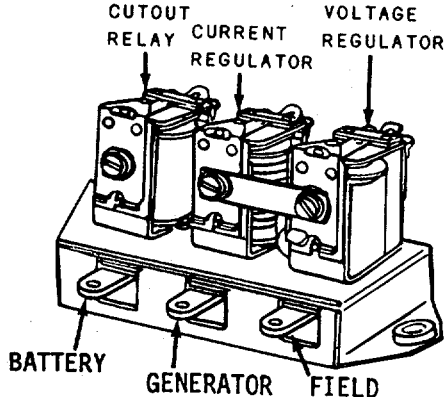




3-62.2. VOLTAGE REGULATOR - MAINTENANCE INSTRUCTIONS.

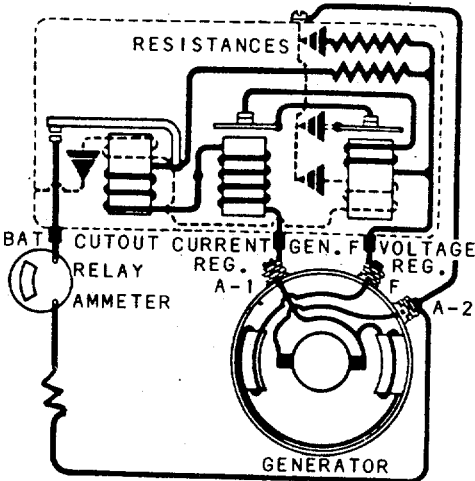
LOCATION	ITEM	ACTION	REMARKS
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a. A voltage regulator is used to regulate the voltage and current output of the generator. The regulator consists of a cutout relay, a voltage regulator and a current regulator mounted in a single assembly.



b. Cutout Relay.

(1) The cutout relay has two windings assembled on one core; a series winding of a few turns of heavy wire, and a shunt winding of many turns of fine wire. The relay core and windings are assembled into a frame. A flat steel armature is attached to the frame by a hinge so it is centered just above the center of the core. The armature has two or more contact points which are located just above a similar number of stationary contact points.



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**3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).**

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## (2) Operation.

(a) When the engine is not running, the armature contact points of the relay are held away from the stationary points by tension of a leaf spring.

(b) As the engine starts and the generator speed increases, the current flowing through the shunt winding builds up until it reaches the value for which the relay has been set. At this point, sufficient magnetism overcomes the armature spring tension, the contact points close and the current flows to the battery. Then the current which flows through the series winding is in the right direction to add to the magnetic force holding the armature down and the points closed.

(c) When the engine is slowed down or stopped, the magnetic field is not strong enough to hold the armature down. The leaf spring pulls the armature away from the core and the points separate, opening the circuit.

<b>CAUTION</b>
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The regulator cutout relay contact points must never be closed by hand with the battery connected. This would cause a high current flow through the units and damage them.

## c. Voltage Regulator.

(1) The voltage regulator has two windings on a single core. One is a shunt winding consisting of many turns of fine wire which, in series with a resistor, is shunted across the generator at all times. The second winding is a field current winding which is connected between the generator field circuit and ground whenever the regulator contact points are closed. In addition to the core frame, armature and contact points, the unit has a spiral spring which holds the armature away from the core so the contact points are touching when the voltage regulator is not operating.

## (2) Operation.

When the generator voltage reaches the value-for which the voltage regulator is adjusted, the combined magnetic field produced by the shunt winding and the field current winding overcomes the armature spring tension, pulls the armature down, and separates the voltage regulator contact points. This introduces resistance into the generator field circuit so the generator field current and

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**3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).**

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generator voltage are reduced. The lowering of the output of the generator causes the points to close again, thereby removing the resistance and increasing the generator output. The complete cycle of opening and closing the points and the alternate inserting and removing of the resistance in the generator field circuit is done rapidly, thus limiting the generator voltage to a predetermined maximum value. With the generator voltage limited, the generator supplies varying amounts of current to meet the requirements of varying electrical loads.

d. Current Regulator.

(1) The current regulator contains two windings assembled on one core: a series winding and a field current winding. The series winding, consisting of a few turns of heavy wire, is connected into the charging circuit so that the full output of the generator passes through it. The field current winding is connected in series with the generator field circuit so that the field current flows through the field winding when the regulator contact points are closed.

(2) The outward appearance of the current regulator is similar to that of the voltage regulator.

(3) Operation.

(a) The magnetism produced by current flowing through the series winding overcomes the armature spring tension, and the contact points open when the current reaches the value for which the current regulator is adjusted. This inserts a resistance into the generator field circuit, resulting in a drop in generator output. Immediately, the magnetic field of the series winding is weakened, the contact points close, the generator output starts to increase and the cycle is repeated. This action prevents the generator from exceeding its rated output.

(b) Therefore, when the load demand is heavy, generator output will increase until it reaches the current value for which the current regulator is set; then the current regulator will begin to operate and pre-regulate the current output from the generator.

(c) After any check or adjustment of the voltage regulator, it is necessary to polarize the generator before starting the engine to assure correct polarity.

**3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Removal                      b. Test                              c. Installation

**INITIAL SETUP:**

Test Equipment

- Battery
- Jumper wire
- Test lamp

References

NONE

Special Tools

NONE

Equipment Condition    Condition Description

Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

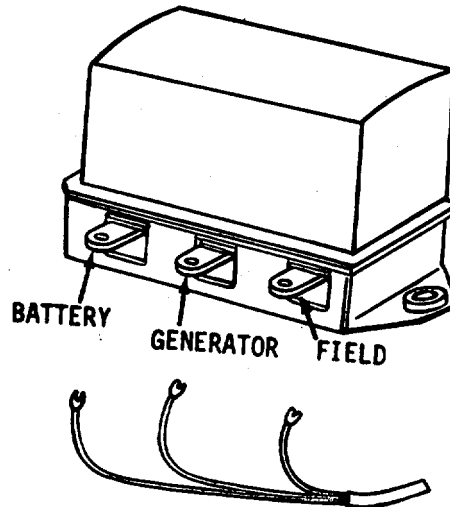
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |                      |           |                     |  |
|----------------------|-----------|---------------------|--|
| 1. Voltage regulator | a. Wiring | Tag and disconnect. | Wires to BAT., GEN., F., and a ground strap. |
|----------------------|-----------|---------------------|--|

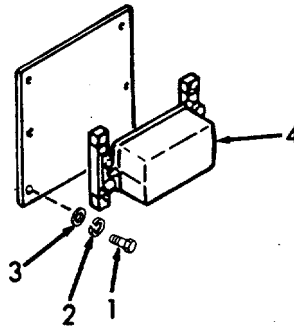


3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- b. Screws (1), lock-washers (2), and flat-washers (3)
- c. Voltage regulator (4)



**NOTE**

The following tests require a battery (12V) and a lamp (12V).

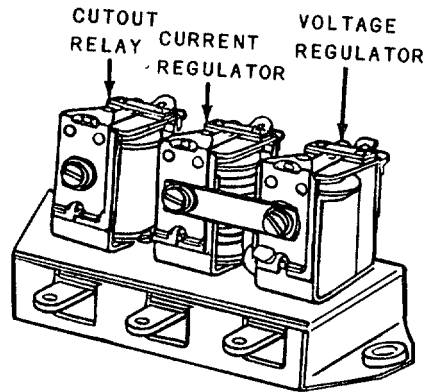
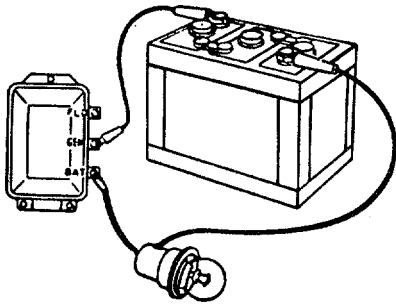
**TEST**

- 2.
    - a. Continuity of series winding
      - 1. Clip one lead to the GEN. terminal.
      - 2. Clip the other lead to the BAT. terminal.
      - 3. Close the cutout relay contacts by hand.
- The lamp should not light.
- The lamp should light. If it does not, replace regulator.

3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

TEST (Cont)

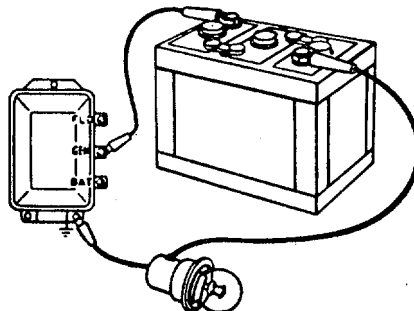


HOOK-UP FOR CHECKING CONTINUITY OF SERIES WINDING. BULB SHOULD NOT LIGHT. BULB SHOULD LIGHT WHEN CUTOUT RELAY CONTACTS ARE CLOSED BY HAND. IF IT DOESN'T REPLACE REGULATOR.

b. Continuity of voltage regulator shunt

1. Clip one lead to the GEN. terminal.
2. Clip one lead to the regulator base (ground)

The voltage regulator contacts should move. If they do not, replace the regulator.



HOOK-UP FOR CHECKING CONTINUITY OF VOLTAGE REGULATOR SHUNT WINDING. VOLTAGE REGULATOR CONTACTS SHOULD MOVE. IF THEY DO NOT, REPLACE THE REGULATOR.

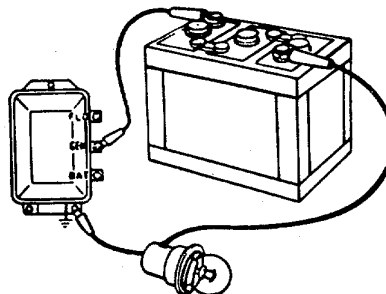
3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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TEST (Cont)
-------------

		3. Lightly touch the cut-out relay.	The assist of closing the cut out relay closes the contacts. The shunt winding of the circuit breaker is continuous. If the contacts do not close, replace the regulator.
--	--	-------------------------------------	---

c. Efficiency of the insulators on the strap which connects the voltage regulator to the current regulator		1. Clip one lead to the F terminal.	
		2. Clip one lead to the regulator base (ground).	The lamp should light.
		3. Open the voltage regulator contacts by hand.	The lamp should go out.
		4. Close the current regulator contacts.	The lamp should go dim. If not, replace the regulator.



HOOK-UP FOR CHECKING EFFICIENCY OF INSULATORS ON STRAP WHICH CONNECTS CURRENT AND VOLTAGE REGULATOR UNITS. BULB SHOULD LIGHT. WHEN THE VOLTAGE REGULATOR CONTACTS ARE OPENED (BY HAND) LIGHT SHOULD GO OUT., CLOSING CURRENT REGULATOR CONTACTS SHOULD CAUSE LIGHT TO GO OUT OR DIM.

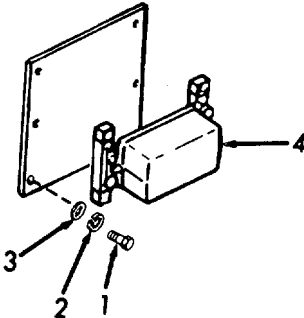
3-62.2. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

- 3. a. Voltage regulator (4), screws (1), lock-washers (2) and flat-washers (3)

Install.

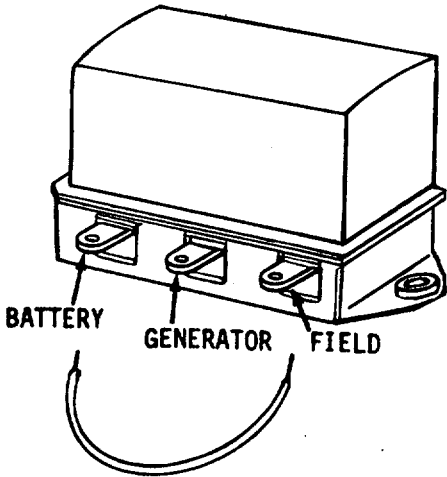


- b. Wiring
- c. Polarizing

Reconnect.

Using a jumper wire, momentarily touch the BAT to F terminals.

A spark will occur.





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**3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS**

---

- a. The generator is an alternating current (AC) brushless type. The generator produces 450/VAC, 3 phase, 60 hertz, 40 kilowatts at 1800 revolutions per minute (RPM).
- b. The generator consists of two major components: The alternator, and a direct-connected exciter.
- c. The alternator is made up of a rotating coil assembly, or rotor, and a fixed stator-coil assembly, or stator. The rotor consists of four coil and pole piece assemblies bolted to a shaft. These coils are connected in series with leads brought out to the rotating rectifier assembly. The stator consists of coil groups placed in slots in a laminated steel cove. The stator and coils are mounted in the frame. The rotating rotor is energized by exciter armature. The output of the exciter armature is converted to direct current (DC) by the rotating rectifier assembly.
- d. The rotating rectifier assembly and the exciter armature are mounted on the shaft. The exciter armature rotates inside the exciter field assembly. The exciter field assembly consists of twelve coils connected in series and is attached to the frame. The exciter armature is of the twelve pole type. It is connected in a three-phase, three wire, wye coil group. These groups are mounted on the shaft. The output of the armature is rectified by the rotating rectifier assembly.
- e. The rotating rectifier assembly is a bridge rectifier with surge protection and control components.

**3-1110**

**3-63. GENERATOR-MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Inspection
- c. Removal
- e. Installation
- b. Service
- d. Repair

**INITIAL SETUP:**

Test Equipment

Volt Ohmmeter

References

NONE

Special Tools

Chain hoist  
Torque wrench

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions  
Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

<b>INSPECTION</b>
-------------------

1. Generator	a. Mounting to engine frame	Inspect for loose or worn mounting hardware.
	b. Wiring-internal and External	1. Inspect for frayed, worn, broken or damaged wiring. 2. Inspect internally for loose connections.
	c. Oil leaks plugs.	Inspect for broken, loose, or leaking oil gage and
	d. Mounting to engine	Inspect for loose or worn mounting hardware.

**3-1111**

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

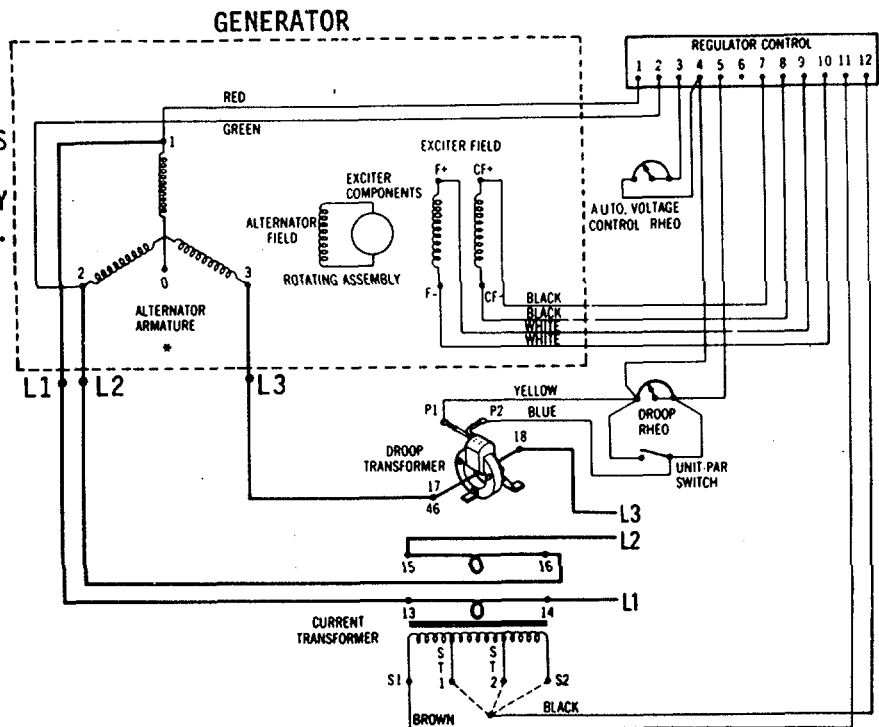
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	e. Bearings	Inspect for noise or vibration when engine is running.	Refer to Direct Support Maintenance.
	f. Generator	With engine running, feel for signs of overheating due to overloading.	Refer to Direct Support Maintenance.
	g. Fan	Inspect for dirt.	

**WARNING**

When the generator is operating, a high voltage is present. Exercise EXTREME CAUTION while performing the next step. Failure to do so will result in severe injury or loss of life.

h. Generator	Check the voltages on L1, L2 and L3.	Use a volt-meter.
--------------	--------------------------------------	-------------------

NOTE:  
THERE ARE 8 EXTERNAL WIRES TO GENERATOR.  
\* THE NEUTRAL LEAD MAY BE GROUNDED OR UNGROUNDED.

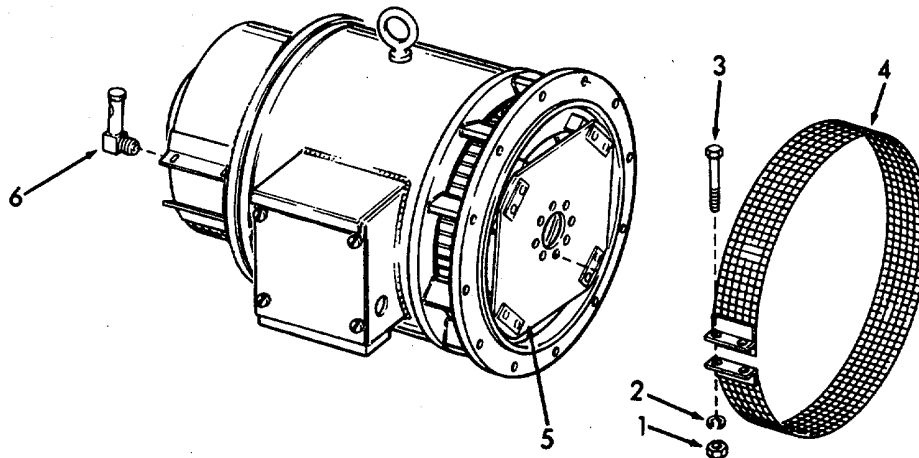


3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**SERVICE**

- |                 |  |                  |                                    |
|-----------------|--|------------------|------------------------------------|
| 2. Fan assembly | a. Nuts (1), lock-washers (2) and screws (3) | Remove.          |                                    |
|                 | b. Fan cover (4)                             | Remove.          |                                    |
|                 | c. Fan (5)                                   | Clean.           | Use compressed air.                |
| 3. Oil level    | Oil level sight (6)                          | Check oil level. | Add oil if necessary; type OE/HDO. |



**REMOVAL**

4. Main switch-board (engine access room)

**WARNING**

Tag the Main Switchboard START switch to prevent accidental turn on of the generator. Failure to do so can result in severe injury or loss of life.

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL(Cont)

**WARNING**

Support rear of engine prior to removing generator.

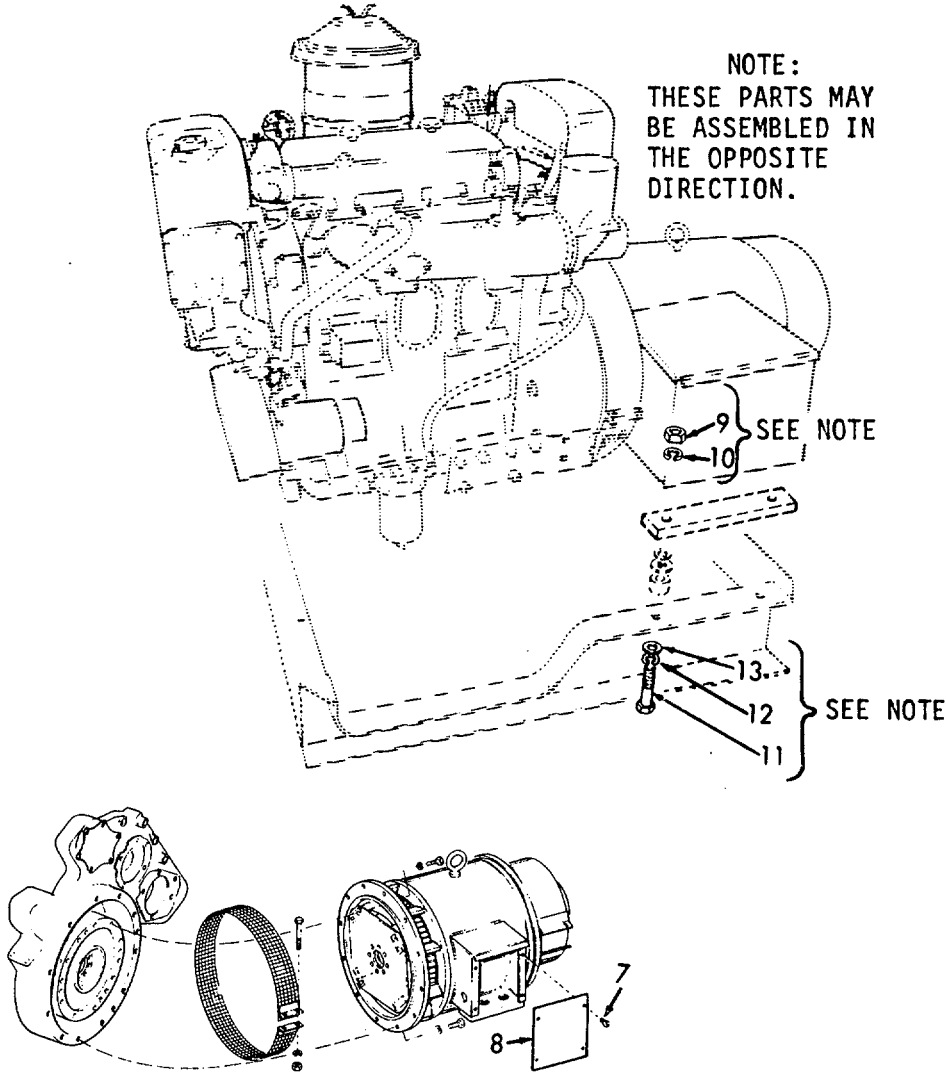
5. Terminal Box (right side) cover	a. Screws (7) and terminal box (8)	Remove.	
	b. Wiring	Tag and disconnect.	Depending on the installation, there might be either a terminal board or wiring tied together and taped.
	c. Nuts (9), lock-washers (10), bolts (11), lockwashers (12), and flat-washers (13)	Remove.	
6. Terminal box (left side)	a. Screws (7) and terminal box cover (8)	Remove.	

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- b. Nuts (9), lock-washers bolts (11), lock-washers (12), and flat-washers
- Remove.



## 3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

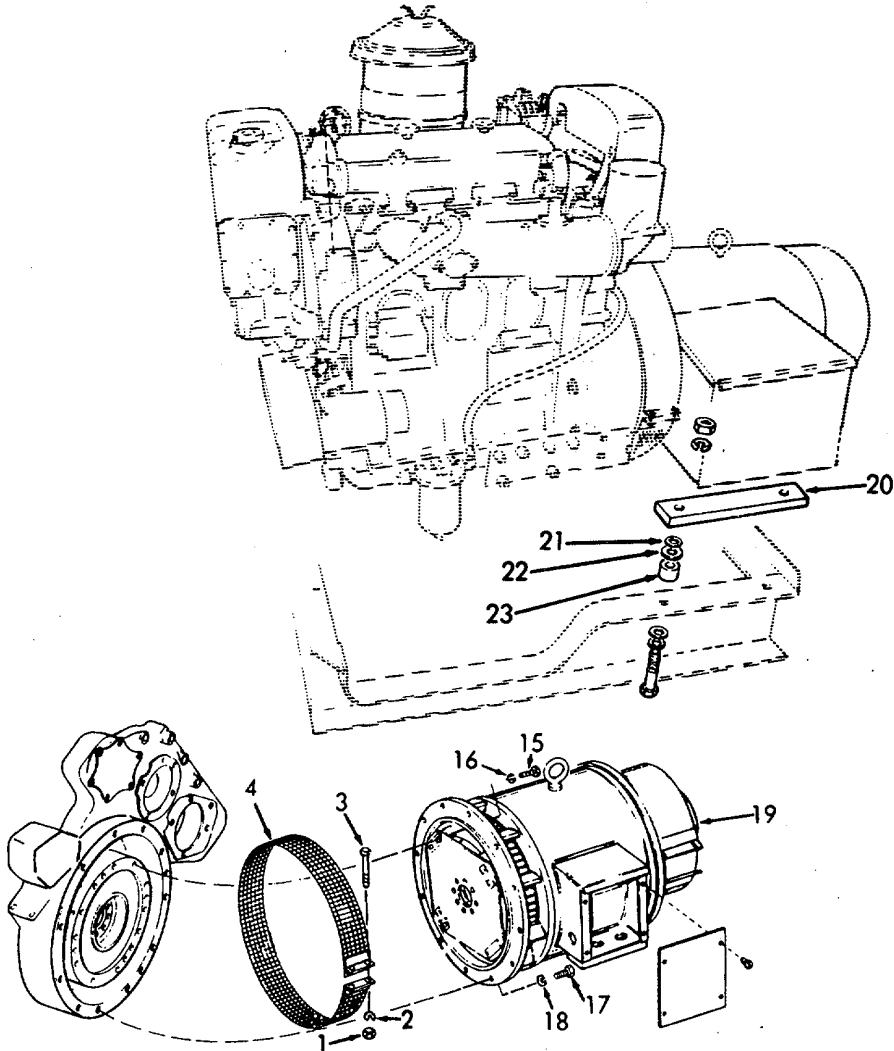
LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
7. Generator	a. Lifting eye bolt (14)	Attach a chain hoist.	Take up slack.
	b. Nuts (1), lock-washers (2), bolts (3) and fan cover (4)	Remove.	Do not lift generator.
	c. Screws (15) and lock-washers (16)	Remove in eight places.	Disconnects fan and driving disc from flywheel.
	d. Screws (17) and lock-washers (18)	Remove twelve places.	Disconnects generator from flywheel housing.
	e. Generator (19)	Using a chain hoist, slide generator away from engine.	Use a pry bar if necessary.
	f. Generator (19)	Lift and remove.	

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- g. Rubber mounting insulators (20), washers (21), spacers (22) and bushings (23)
- Remove.





## 3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

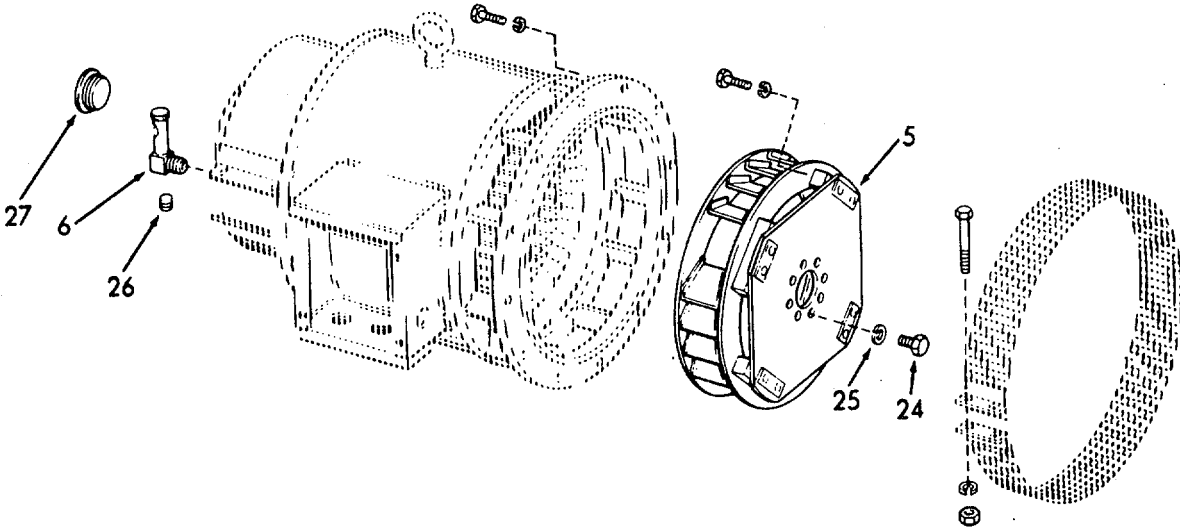
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
8.	Fan and drive disc	a. Screws (24) and lock-washers (25)	Remove eight places.
		b. Fan and drive disc (5)	Remove.
		c. Fan and drive disc screws (24) and lock-washers (25)	Reinstall.
9.	Oil level sight gage	a. Oil plug (26)	Remove. Drain oil into a suitable container.
		b. Oil level sight gage (6)	Remove.
		c. Oil level sight gage (6)	Replace.
		d. Oil plug (26)	Replace.
		e. Oil level	Refill with oil. Use type OE/HDO.

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

- |     |            |           |                      |
|-----|------------|-----------|----------------------|
| 10. | Frame plug | Plug (27) | Remove if necessary. |
|-----|------------|-----------|----------------------|



## 3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

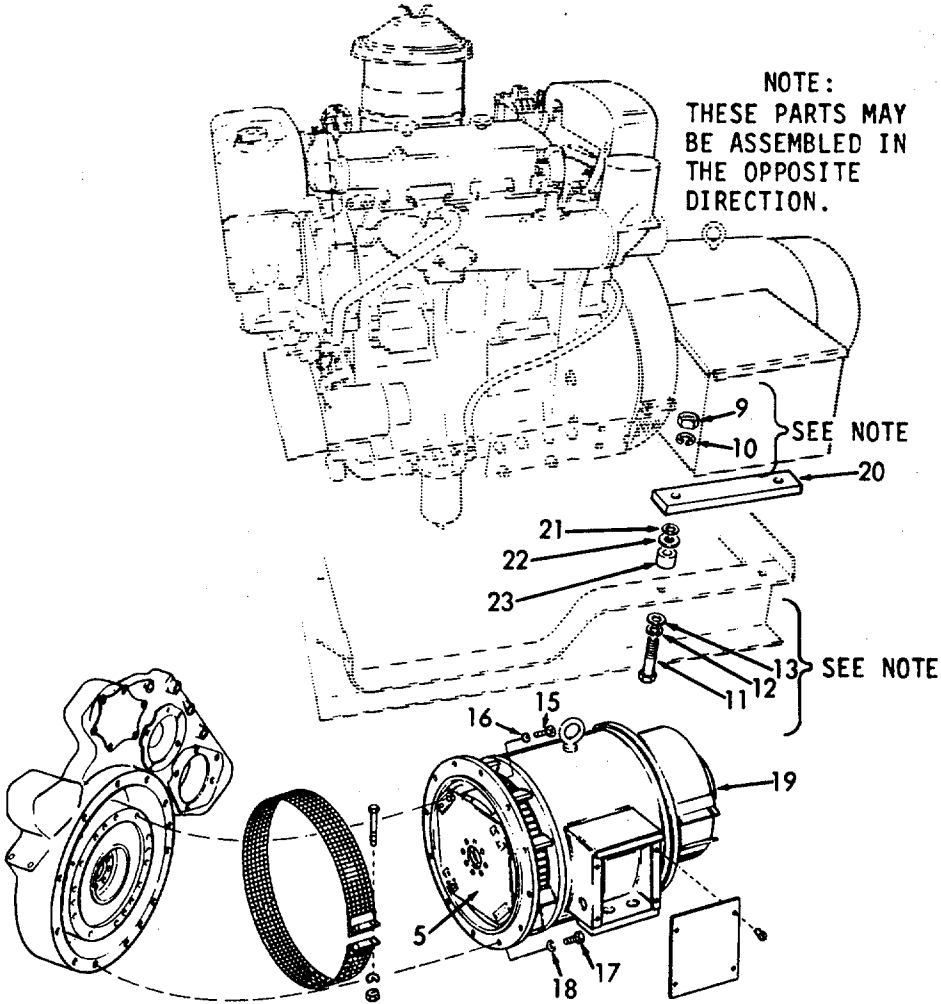
11. Gener- ator	a. Gener- ator (19)	Using a chain hoist, slide straight into the engine flywheel.	
	b. Bolts (11), lock- washers (12), flat- washers (13), bush- ings (23) spacers (22), washers (21), rubber mount- ing in- sulators (20), lock- washers (10) and nuts (9)	Align parts and assemble. Adjust position using chain hoist and pry bar.	Tighten to finger tight.
	c. Screws (17) and lock- washers (18)	Align holes in generator and flywheel housing.	Tighten to finger tight.
	d. Screws (15) and lock- washers (16)	Align holes in fan drive disc (5) with flywheel.	

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- e. Fan drive disc and fly-wheel, generator and fly-wheel housing
- When aligned, tighten screws (17) and (15).



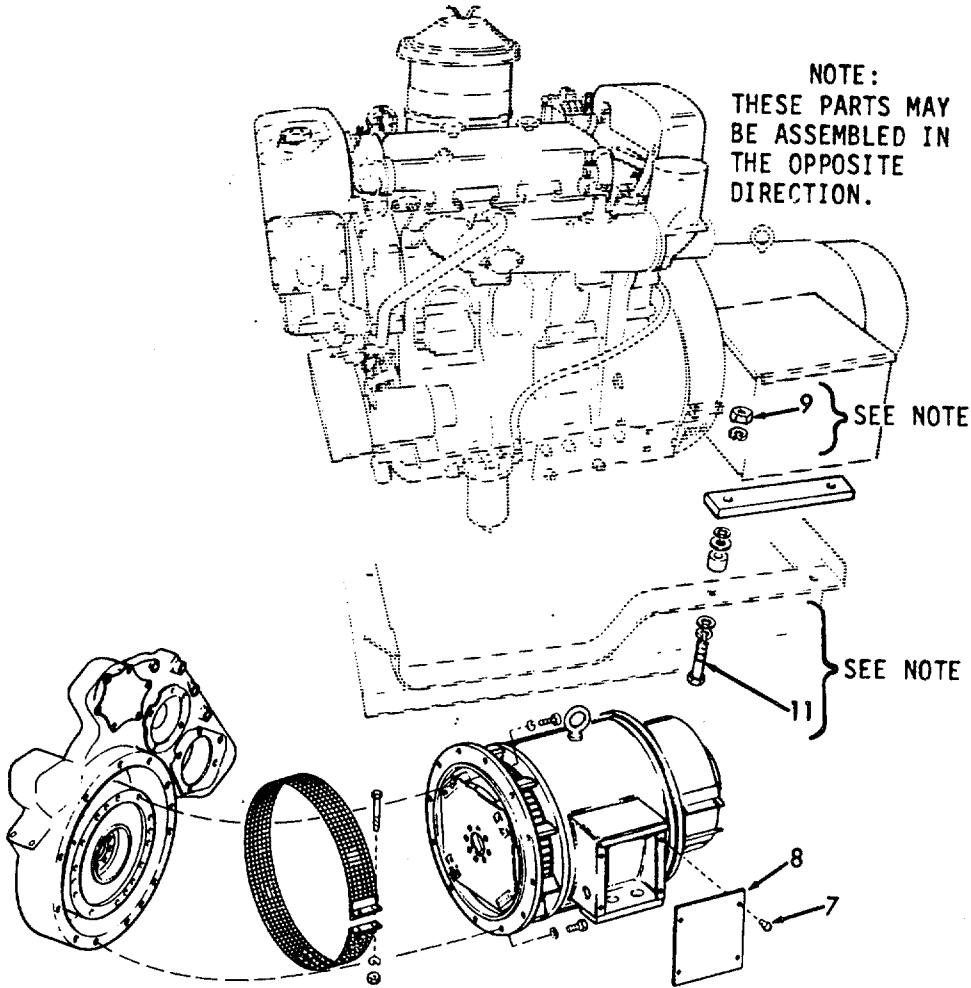
## 3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	f. Mounting nuts (9) and bolts (11)	Tighten.	
	g. Chain hoist	Remove.	
12. Terminal box (Left side)	Screws (7), and terminal box cover (8)	Replace.	
13. Terminal box (Right side)	a. Wiring	Reconnect and remove tags.	
	b. Screws (7) and terminal box cover (8)	Replace.	
14. Generator engine		Start engine and check out all functions.	
15. Main switch-board (Engine Access Room)		a. Observe gages and meters to verify correct operation.	
		b. Remove warning tags.	

3-63. GENERATOR. (40 KW)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



**3-64. ENGINE-MAINTENANCE INSTRUCTIONS**

This task covers:

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

**INITIAL SETUP:**

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

Grease, MIL-G-10924 Type GAA    NONE  
Oil, MIL-L-17672 Type 213STH  
Oil, MIL-L-2104 Type OE/HDO

Special Environmental Conditions

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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<b>INSPECTION</b>
-------------------

1.	Generator	Generator cables and fittings	Inspect.	Refer to paragraph 3-63.
2.	Emergency shut-down system	Cable, control head, linkage	Inspect.	Refer to paragraph 3-65.
3.	Alarm system	Alarm switches	Inspect.	Refer to paragraph 3-65.
4.	Governor (hydraulic)	Housing, linkage	Inspect.	Refer to paragraph 3-66.

**3-1124**

**3-64. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>INSPECTION (Cont)</b>				
5.	Air intake	Silencers, Housing	Inspect.	Refer to paragraph 3-67
6.	Blower	Housing, oil seals	Inspect.	Refer to paragraph 3-68
7.	Fuel pump	Housing, hoses and fittings	Inspect.	Refer to paragraph 3-69
8.	Fuel filter and strainer, fuel lines	Housing, shell, hoses and fittings	Inspect.	Refer to paragraph 3-70
9.	Lube oil filters	Housing, shell, hoses, and fittings	Inspect.	Refer to paragraph 3-73
10.	Oil cooler	Housing, gaskets	Inspect.	Refer to paragraph 3-74
11.	Fresh water Pump		Inspect.	Refer to paragraph 3-75
12.	Expansion tank		Inspect.	Refer to paragraph 3-76
13.	Water manifold		Inspect.	Refer to paragraph 3-77
14.	Thermostat and housing		Inspect.	Refer to paragraph 3-78



**3-64. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
15.	Over-speed governor	Inspect.	Refer to paragraph 3-79
16.	Tachometer drive	Inspect.	Refer to paragraph 3-80
17.	Air cleaner	Inspect.	Refer to paragraph 3-81
18.	Crankshaft pulley	Inspect.	Refer to paragraph 3-82
19.	Balance weight Cover	Inspect.	Refer to paragraph 3-83
20.	Engine supports and lift brackets	Inspect.	Refer to paragraph 3-84
21.	Exhaust manifold	Inspect.	Refer to paragraph 3-85
22.	Rocker arm cover	Inspect.	Refer to paragraph 3-86
23.	Oil pan and dip-Stick	Inspect.	Refer to paragraph 3-88
24.	Cylinder head	Inspect.	Refer to paragraph 3-89
25.	Valve operating mechanism	Inspect.	Refer to paragraph 3-90

**3-64. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
26.	Fly-wheel housing	Inspect.	Refer to paragraph 3-92
27.	Lube oil distribution	Inspect.	Refer to paragraph 3-95
28.	Cylinder Block	Inspect.	Refer to paragraph 3-98
29.	Instrument Panel	Inspect.	Refer to paragraph 3-99
30.	Starting Aid	Inspect.	Refer to paragraph 3-100
31.	Hydrostarter	Inspect.	Refer to paragraph 3-101
32.	Accumulator	Inspect.	Refer to paragraph 3-102
33.	Hydrostarter pump (engine driven)	Inspect.	Refer to paragraph 3-102
34.	Hydrostarter pump (hand)	Inspect.	Refer to paragraph 3-104
35.	Hydrostarter piping (fwd eng rm)	Hoses, lines and fittings Inspect.	Refer to paragraph 3-105

**3-64. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>INSPECTION (Cont)</b>				
36.	Hydro-starter piping (aft eng rm)	Hoses, lines and fittings	Inspect.	Refer to paragraph 3-106
37.	Reservoir, filters and solenoids	Hoses, filter, fittings and wiring	Inspect.	Refer to paragraph 3-107
<b>TEST</b>				
38.	Engine	a. Control panel	Start engine and run until warm.	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.
<b>SERVICE</b>				
39.	Engine oil	Dip-stick	Remove and check oil level.	Add oil if necessary: Type OE/HDO.
<b>NOTE</b>				
FULL engine has 15 quarts (14.19 liters)				
LOW engine has 11 quarts (10.41 liters)				
40.	Tachometer drive	Grease fitting	Lubricate.	Use grease (MIL-G-10924 Symbol GAA).

**3-64. ENGINE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>SERVICE (Cont)</b>				
41.	Emergency stop control	Linkage	Lubricate.	Use oil (MIL-L-2104 type OE/HDO).
42.	Expansion Tank	Cap	Remove and check coolant level.	Add coolant.
43.	Hydro-starter reservoir	Cap	Remove and check level.	Add mineral oil (MIL-L-17672, type 2135TH).
<b>REPAIR</b>				
44.	Engine	Engine	Perform maintenance on any component that may, or is producing a problem.	

**3-1129**

**3-65. ENGINE CONTROLS-MAINTENANCE INSTRUCTIONS**

This paragraph contains the maintenance procedures for the following components that affect the operation of the generator engine.

DESCRIPTION	PARAGRAPH
Emergency Shut-down-Head and Linkage	3-65.1
Shut-down Solenoid	3-65.2
Automatic Electrical Shut-down System	3-65.3

**3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE INSTRUCTIONS**

A manually operated emergency engine shut-down 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 overspeeding of the engine, the shut-down device will prevent damage to the engine by cutting off the air supply and thus stopping the engine. The shut-down device consists of a flap valve mounted in the air inlet housing and a suitable operating mechanism.

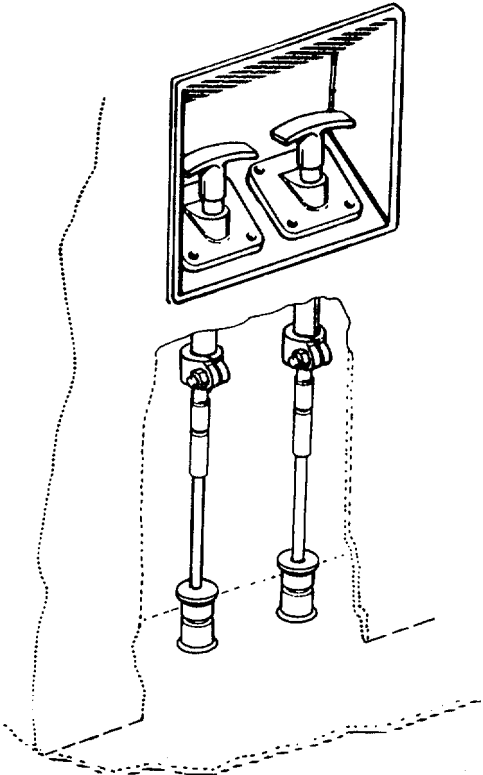
This task covers:

- |               |                 |
|---------------|-----------------|
| a. Inspection | c. Removal      |
| b. Service    | d. Installation |

**INITIAL SETUP:**

<u>Test Equipment</u>	<u>References</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition</u> <u>Condition Description</u>
NONE	<u>Para</u>
	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
2	NONE

3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Emergency shut-down linkage	a. Cables	Inspect for binding, damage and loose components.	Lubricate if binding; tighten if loose; replace if required.
 <p>The diagram illustrates the emergency shut-down linkage mechanism. At the top, a rectangular control panel is shown with two levers. Below the panel, two vertical cables are connected to the levers. Each cable has a ball joint at its upper end where it meets the lever and a threaded end at its lower end. The cables are shown in a slightly curved position, indicating their range of motion. Dotted lines represent the boundaries of the mechanism.</p>			
	b. Ball joint	Inspect for binding, damage and loose components.	Lubricate if binding; tighten if loose; replace if required.
<b>SERVICE</b>			
2. Emergency shut-down Linkage	a. Cables	Lubricate.	Use oil type OE/HDO-10.
	b. Ball joint	Lubricate.	Use oil type OE/HDO-10.

## 3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL</b>			
3. Emergency shut-down linkage and cable	a. Nut (1) and lock-washer (2)	Remove.	
	b. Lock-washer (2)	Discard.	Lockwasher will be fatigued and cannot be re-used.
	c. Cap-screw (3) and lock-washer (4)	Remove.	
	d. Lock-washers (4)	Discard.	Lockwasher will be fatigued and cannot be re-used.
	e. Nut (5)		Loosen.
	f. Ball joint (6)	Remove.	
	g. Nut (5)	Remove.	
	h. Cap-screw (7)	Remove.	
	i. Cable clamp (8)	Remove.	
	j. Handle (9)	Unscrew to remove.	Do not remove nut (10).

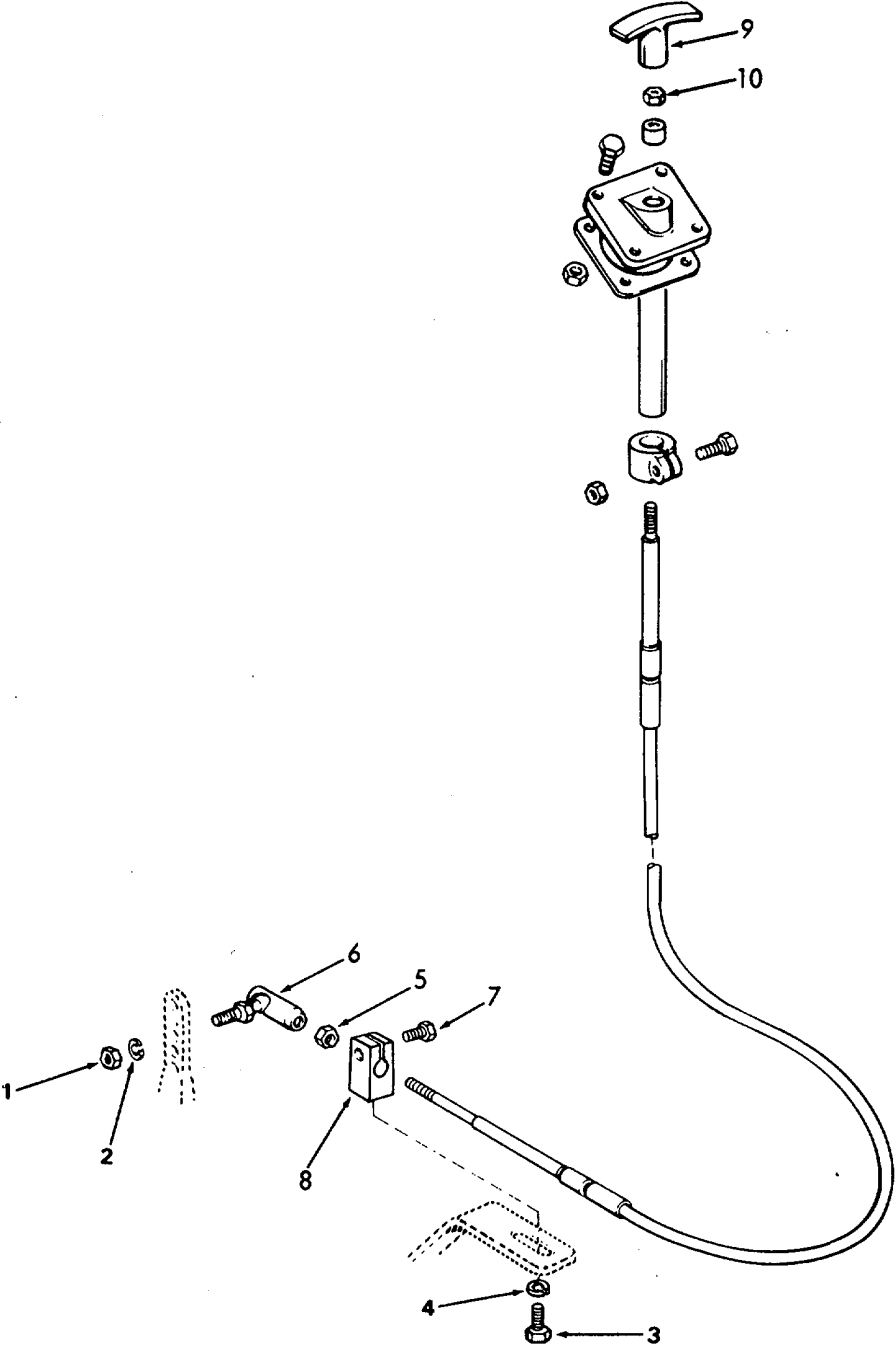
**3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE INSTRUCTIONS (Cont).**

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LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)





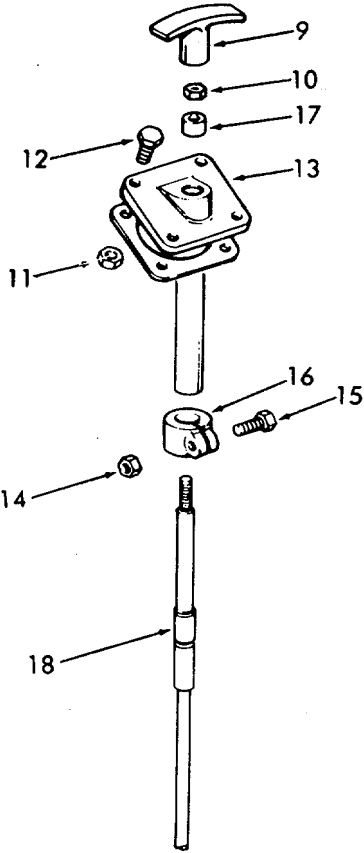
**3-65.1. EMERGENCY SHUT-DOWN - HEAD AND LINKAGE - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<div style="border: 1px solid black; padding: 2px; display: inline-block;">REMOVAL (Cont)</div>	k. Nut (11) and screw (12)	Remove.	Raise tube and bracket assembly (13) up to gain access to continue dis-assembly.
	l. Nut (14)	Remove.	
	m. Cap-screw (15)	Remove.	Cable clamp (16) will be loose causing cable to drop down.
	n. Nut (10)	Remove.	
	o. Guide bushing (17)	Remove.	
	p. Cable clamp (16)	Remove.	
	q. Cable (18)	Remove.	Pull cable up to remove.

**3-65.1. EMERGENCY SHUT-DOWN - HEAD AND LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**



**INSTALLATION**

4. Emergency shut-down cable and linkage.	a. Replacement cable (18)	Install.	Replacement cable is as follows: Star-board Generator 14 feet (4.3 m), Port Generator 20 feet (6.1 m). Route cable from emergency shut-down station to engine room.
---	---------------------------	----------	---

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**3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE  
INSTRUCTIONS (Cont).**


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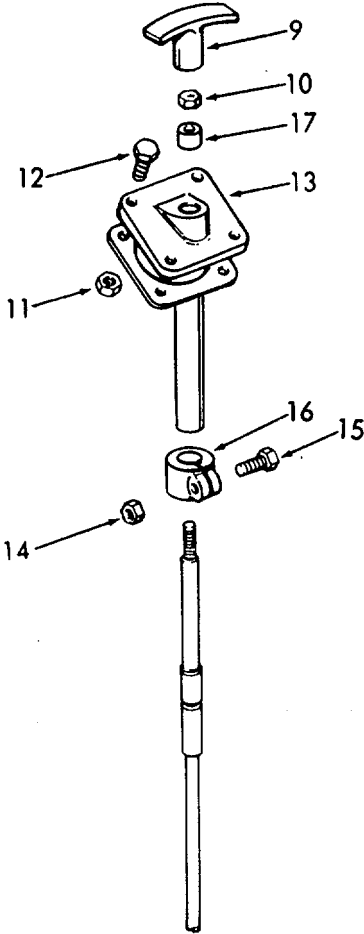
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	b. Cable clamp (16)	Slide over end of cable.	Do not let it drop.
	c. Screw (15) and nut (14)	Insert in cable clamp (16).	Tighten nut (14), finger tight.
	d. Tube and bracket assembly (13)	Slide over end of cable.	
	e. Guide bushing (17)	Install.	
	f. Nut (10)	Install.	
	g. Cap-screw (12) and nut (11)	Secure tube and bracket assembly to panel (13).	
	h. Cable clamp (16)	Position on tube and bracket assembly (17).	
	i. Cap-screw (15) and nut (14)	Tighten.	
	j. Handle (9)	Install.	

**3-65.1. EMERGENCY SHUT-DOWN-HEAD AND LINKAGE-MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

- k. Nut (10) and handle (9) Secure.



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**3-65.1. EMERGENCY SHUT-DOWN - HEAD AND LINKAGE - MAINTENANCE  
INSTRUCTIONS (Cont).**

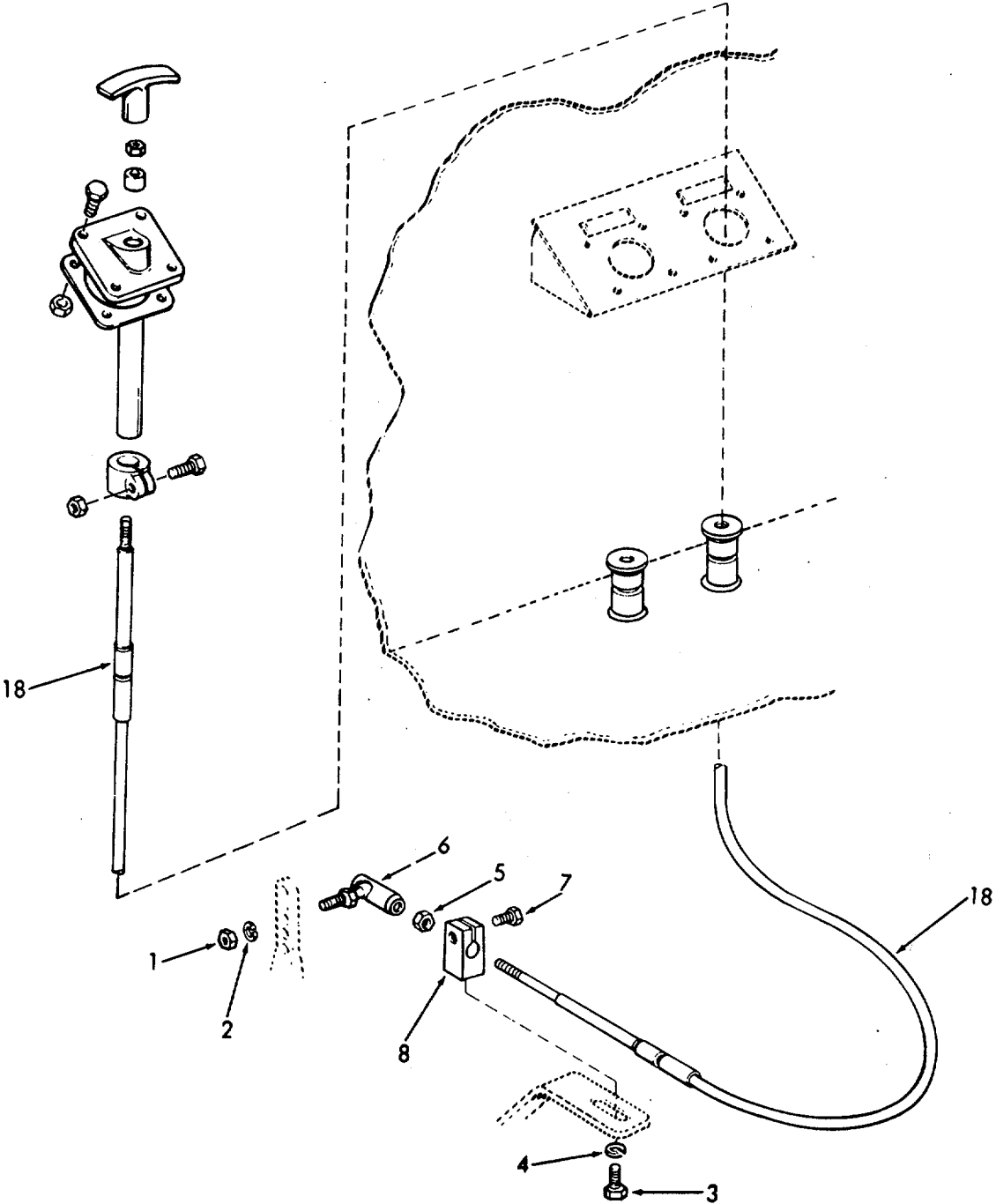

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LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	l. Cable clamp (8)	Install on cable (18).	
	m. Cap-screw (7)	Install in cable clamp (8) and secure.	
	n. Nut (5)	Install on cable (18).	
	o. Ball joint (6)	Install on cable (18).	
	p. Nut (5)	Jam against ball joint (6).	
	q. Ball joint (6)	Install in air intake latch.	
	r. Lock-washer (4) and cap-screw (3)	Secure cable clamp (8) to bracket.	
	s. Lock-washer (2) and nut (1)	Secure ball joint (6).	

3-65.1. EMERGENCY SHUT-DOWN - HEAD AND LINKAGE - MAINTENANCE  
INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



**3-65.2. SHUT-DOWN SOLENOID - MAINTENANCE INSTRUCTIONS.**

Refer to paragraph 3-65.4 for the operation of the shut-down solenoid.

**This task covers:**

- |    |            |    |             |    |            |
|----|------------|----|-------------|----|------------|
| a. | Inspection | c. | Disassembly | e. | Adjustment |
| b. | Removal    | d. | Reassembly  |    |            |

**INITIAL SETUP:**

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment  
Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

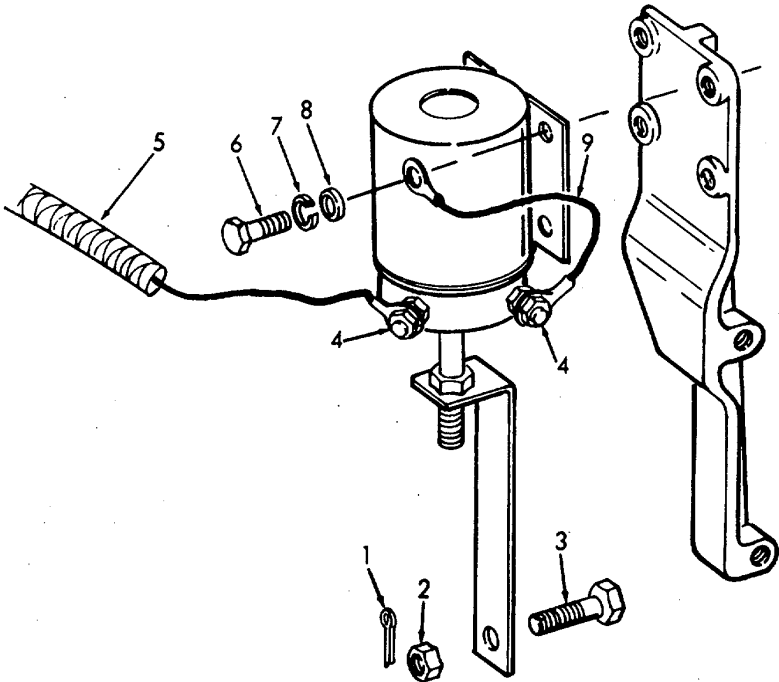
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |    |                    |    |          |  |                                 |
|----|--------------------|----|----------|--|---------------------------------|
| 1. | Shut-down solenoid | a. | Wiring   | Inspect for loose or broken wires.   | Tighten or replace if required. |
|    |                    | b. | Mounting | Inspect for looseness, cracks and damage.                                  | Tighten or replace if required  |
|    |                    | c. | Plunger  | Inspect for freedom of movement.   | Replace if required.            |
|    |                    | d. | Link     | Inspect for looseness and freedom of movement. Check for damage or cracks. | Tighten or replace if required. |

3-65.2. SHUT-DOWN SOLENOID - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
2. Shut-down solenoid	a. Cotter pin (1)	Remove.	Discard if damaged.
	b. Nut (2) and bolt (3)	Remove.	
	c. Nuts (4)	Remove.	
	d. Wire (5)	Remove.	
	e. Screws (6), lock-washers (7) and washers (8)	Remove.	
	f. Wire (9)	Remove.	
	g. Solenoid and link	Remove.	



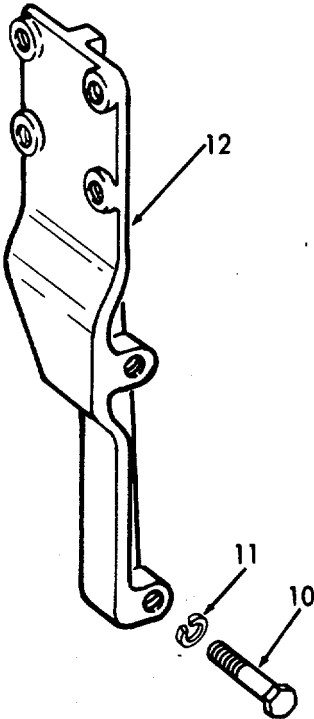


3-65.2. SHUT-DOWN SOLENOID-MAINTENANCE INSTRUCTIONS (Cont).

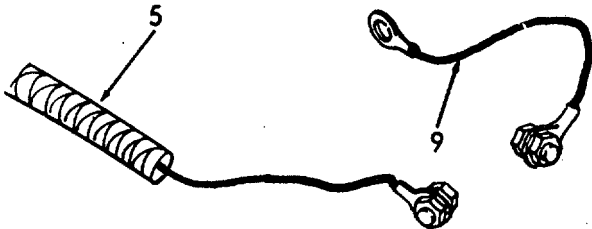
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

3. Bracket	a. Screws (10) and washers (11)	Remove.	Attaches bracket to air inlet housing.
	b. Bracket (12)	Remove.	Inspect for damage. Repair.



4. Wiring	Wires (5 and 9)	Repair.	Use wire and lugs of the same size.
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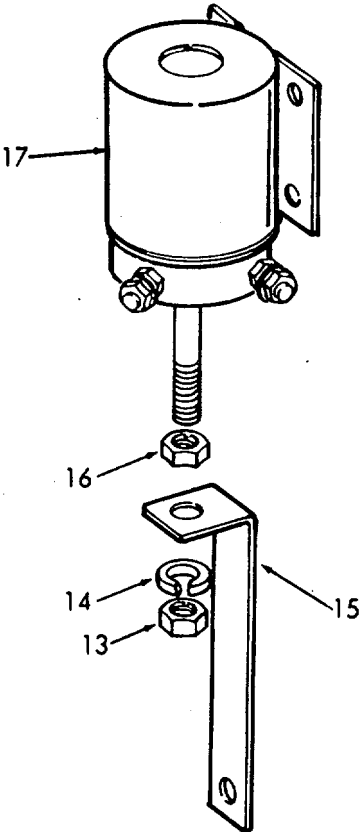


3-65.2. SHUT-DOWN SOLENOID - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**DISASSEMBLY**

- 5. Link
  - a. Nut (13) and lock-washer (14) Remove.
  - b. Link (15) Remove.
  - c. Nut (16) Remove.
  - d. Solenoid (17) Remove.



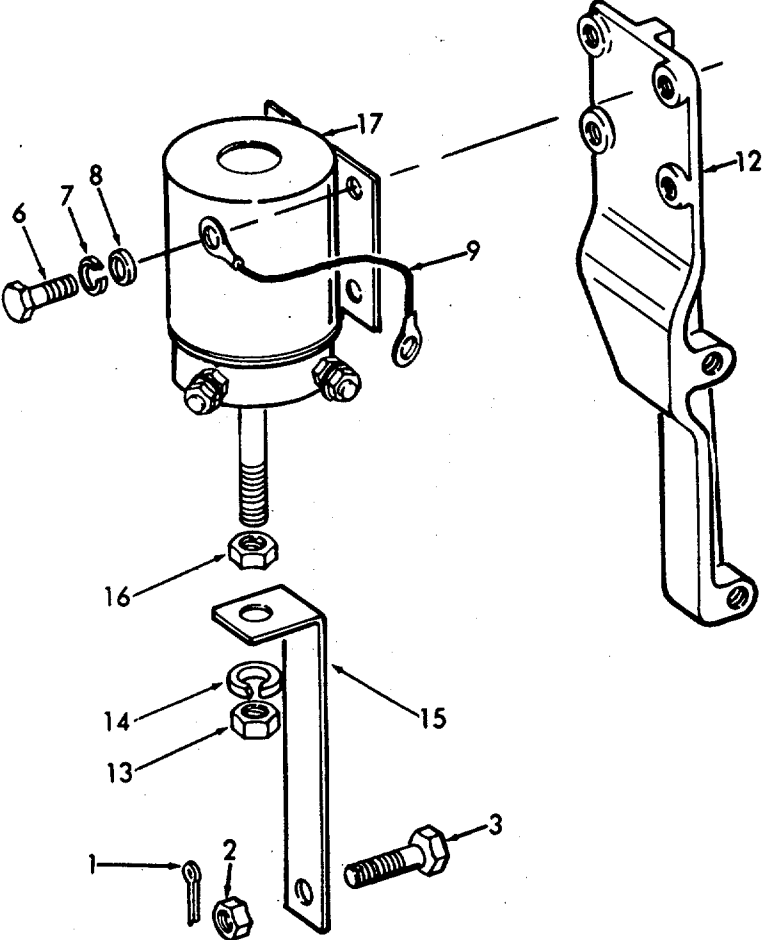
**3-65.2. SHUT-DOWN SOLENOID - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REASSEMBLY</b>			
6. Shut-down solenoid	a. Solenoid (17)	Place on bracket (12).	
	b. Screws (6), lock-washers (7) and washers (8)	Install.	Wire (9) is installed under one screw.
	c. Nut (16)	Install.	
	d. Link (15)	Install.	
	e. Lock-washer (14) and nut (13)	Install on solenoid rod.	Tighten to finger tight.
	f. Bolt (3) and nut (2)	Install.	
	g. Cotter pin (1)	Install.	

3-65.2. SHUT-DOWN SOLENOID-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION                      ITEM                      ACTION                      REMARKS

REASSEMBLY (Cont)

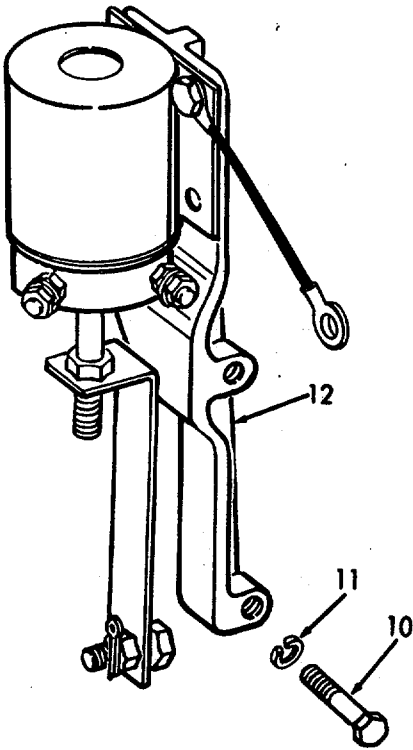


3-65.2. SHUT-DOWN SOLENOID-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REASSEMBLY (Cont)**

7. Bracket (12)	Lockwasher (11) and screws (10)	Install.	Torque cap screws evenly to 16 to 20 ft.lbs. (21.8 to 27.3 Nm).
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NOTE

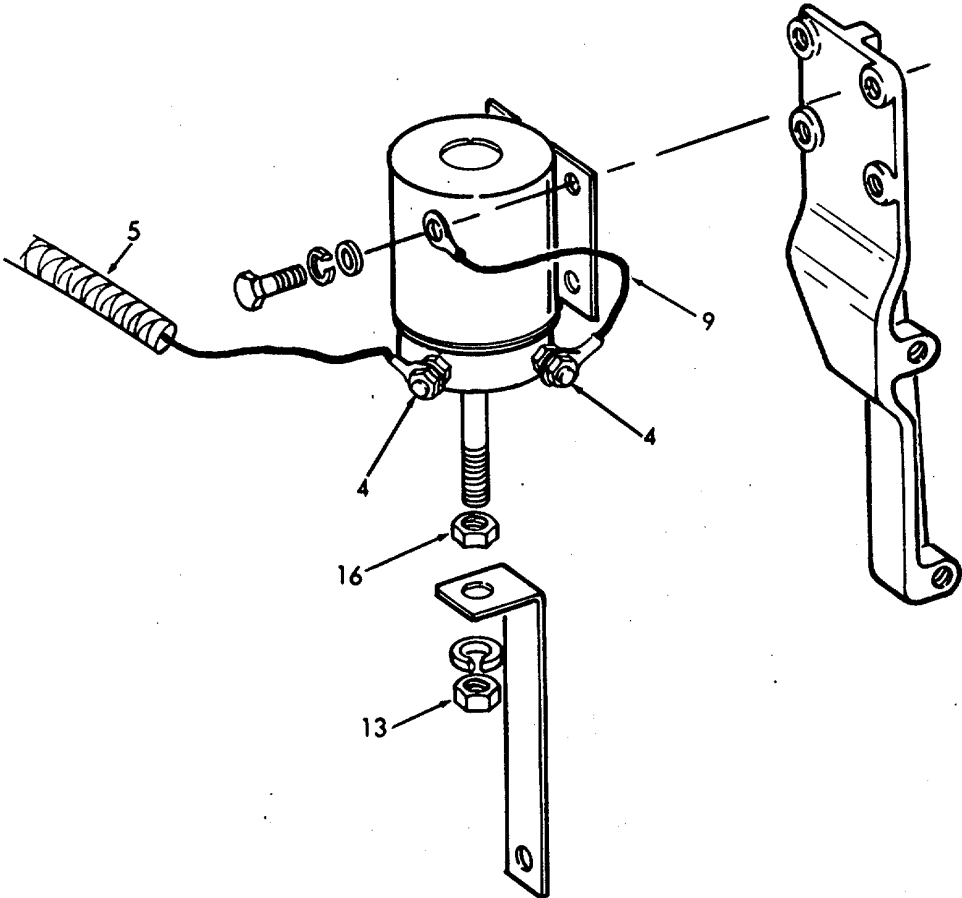
Re-torque all screws in the air inlet housing.

8. Shut-down solenoid	a. Wires (5 and 9)	Install.
	b. Nuts (4)	Install.

3-65.2. SHUT-DOWN SOLENOID - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION                      ITEM                      ACTION                      REMARKS

REASSEMBLY (Cont)

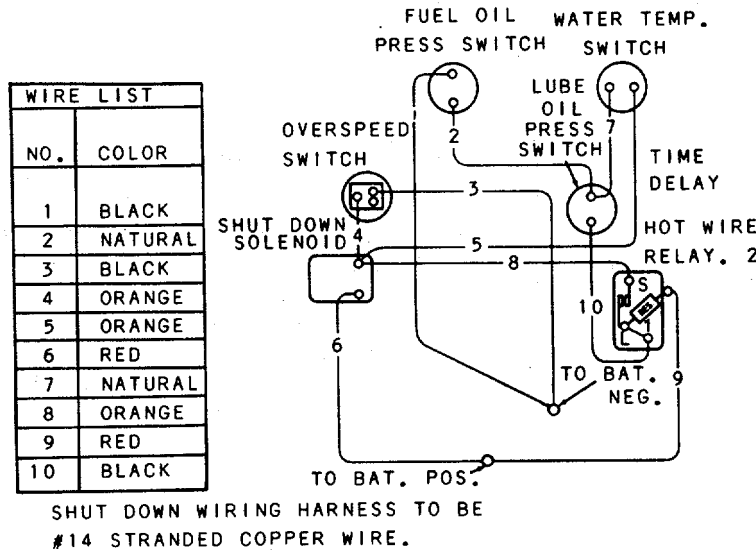


ADJUSTMENT

9.	Shut-down solenoid	Link	Adjust nuts (13 and 16) on solenoid rod.	When the solenoid is activated, the shut-down valve in the air inlet housing should seal tightly.
10.	Emergency shut-down	Linkage	Check that it functions properly.	

3-65.3. AUTOMATIC ELECTRICAL SHUT-DOWN SYSTEM (Cont).

a. The electrically operated automatic shut-down includes a lubricating oil pressure switch, a water temperature switch and a shut-down solenoid.



*Automatic Shut-Down Wiring Diagram*

b. There is an overspeed governor switch in conjunction with the above electrical shut-down system. See paragraph 3-79.

c. A time-delay hot wire relay is introduced into the electrical shut-down system to prevent the fuel oil pressure switch from closing before the lubricating oil pressure switch opens, which would cause a shut-down of the engine.

d. When the engine is not running, the fuel oil pressure switch is open, the lubricating oil pressure switch is closed and the water temperature switch is open.

e. After starting the engine, the lubricating oil pressure switch contacts are open when the oil pressure is 10 psi (68.95 kPa) or higher (approximately 700 rpm), and the fuel oil pressure switch contacts are closed when the fuel oil pressure is 20 psi (137.90 kPa) or greater, (approximately 800 rpm). The electrical circuit of this system is so arranged that the closing of the fuel pressure switch energizes the entire system and at any time thereafter, the closing of either the lubricating oil pressure switch, or water temperature switch, will cause the shut-down to operate. When the engine starts, the fuel pressure increases so rapidly that the fuel pressure switch

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**3-65.3. AUTOMATIC ELECTRICAL SHUT-DOWN SYSTEM (Cont).**

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contacts close before the lubricating oil pressure reaches 10 psi (68.95 kPa). This condition normally would cause the engine to shutdown, except for the introduction of a time delay relay into the circuit. This relay delays the energizing of the shut-down solenoid by 3 to 10 seconds, enabling the lubricating oil pressure to exceed 10 psi (68.95 kPa) thereby opening the lubricating oil pressure switch and preventing the energizing of the circuit. When the engine has reached normal operating speed, the lubricating oil pressure switch is open.

f. When the lubricating oil pressure falls below  $10 \pm 2$  psi ( $68.95 \pm 13.8$  kPa), the oil pressure switch closes and the current flows to the time delay relay which must be heated by the current to complete the circuit to the solenoid. The few seconds required to heat the time delay relay provides sufficient delay to avoid engine shut-down when low oil pressure is caused by a passing condition such as an air bubble or by the temporary overlap in the operation of the lubricating oil pressure switch and fuel pressure switch during starting and stopping of the engine.

**NOTE**

An alarm will sound in the pilothouse.

g. The high water temperature switch is connected in parallel with the lubricating oil pressure switch and normally remains open, closing only when the engine coolant temperature exceeds  $200 \pm 5^\circ\text{F}$  ( $93.3 \pm 2.8^\circ\text{C}$ ), thus energizing the shut-down solenoid.

**NOTE**

An alarm will sound in the pilothouse.

h. The overspeed governor is driven by the blower drive shaft. If the engine speed exceeds the speed which has been established by the engine governor, the overspeed governor switch is actuated, causing the shut-down solenoid to close the shut-down valve.

i. When the engine is shut-down, as described above, the fuel oil pressure switch opens, thus breaking the circuit and eliminating the possibility of damage due to continued exposure to current.

j. Fuel Oil Pressure Switch.

(1) The fuel oil pressure switch is the controlling switch of the system, since this switch controls the flow of current to the other two switches. The fuel oil pressure switch is set to make contact when the fuel pressure reaches 20 psi (137.90 kPa) and the phrase "20-MAKE" is stamped on the switch cover.



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**3-65.3. AUTOMATIC ELECTRICAL SHUT-DOWN SYSTEM (Cont).**

---

(2) As the fuel pressure increases upon starting, a diaphragm in the switch body is expanded and forces the plunger upwards. Since the bottom of the adjusting screw bears against this plunger, the adjusting screw and the lower breaker point are also forced upwards. When the fuel pressure reaches 20 psi (137.90 kPa) the breaker points close and the current flows to the terminal of the lubricating oil pressure switch and the water temperature switch.

(3) When the engine is stopped, the fuel pressure decreases, and the diaphragm in the switch body contracts. This action causes the plunger to lower and when the fuel oil pressure decreases to 20 psi (137.90 kPa) permits the lower breaker point arm to lower, thus breaking the electrical circuit. The bracket to which the lower breaker point arm and the adjusting screw are attached is spring loaded which provides for positive breaking of the points when the fuel pressure decreases sufficiently.

**k. Lubricating Oil Pressure Switch.**

(1) The lubricating oil pressure switch is similar to the fuel oil pressure switch, except that the fuel oil pressure switch is of the "make" type while the lubricating oil pressure switch is of the "break" type. In other words, the lubricating oil pressure switch is calibrated to break contact when the lubricating oil pressure increases to 10 psi (68.95 kPa). The phrase "10-BREAK" is stamped on the switch cover.

(2) 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 (68.95 kPa), the points separate. However, as previously described, current flows to the lubricating oil pressure switch only after the fuel oil pressure switch closes. At this time the points of the lubricating oil pressure switch opens. If the lubricating oil pressure decreases to 10 psi (68.95 kPa) during operation, the breaker point will close and either the alarm bell or the shut-down solenoid will be energized.

**l. Water Temperature Switch.**

(1) The terminals of the water temperature switch are connected into the shutdown system and when the engine circulating water temperature reaches  $205 \pm 5^\circ\text{F}$  ( $96 \pm 2.9^\circ\text{C}$ ), the switch closes and completes the shut-down or alarm system.

---

**3-65.3. AUTOMATIC ELECTRICAL SHUT-DOWN SYSTEM (Cont).**

---

(2) 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  $205\pm 5^{\circ}\text{F}$  ( $96 \pm 2.9^{\circ}\text{C}$ ), 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.

(3) If the engine has been stopped by any of the above mentioned switches, the shut-down valve must be re-set in the OPEN position before the engine can be started.

(4) For maintenance instructions, refer to the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Time Delay Relay	3-65.3.1.
Water Temperature Alarm Switch	3-65.3.2.
Fuel Oil Pressure Alarm Switch	3-65.3.3.
Lubricating Oil Pressure Alarm Switch	3-65.3.4.

**3-65.3.1. TIME DELAY RELAY - MAINTENANCE INSTRUCTIONS**

This task covers:

- a. Testing
- b. Removal
- c. Installation

**INITIAL SETUP:**

Test Equipment

NONE

References

NONE

Special Tools

Stop watch

<u>Equipment Condition</u>	<u>Condition Description</u>
<u>Para</u>	

Engine running at idle speed.

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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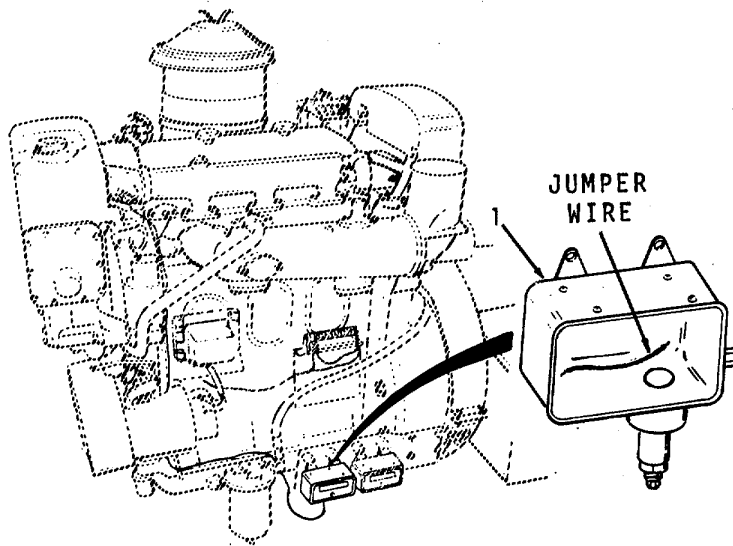
**TESTING**

1. Lube oil pressure switch (1)	a. Screw and cover	Remove.	
	b. Jumper wire	Place across switch terminals.	Start the stop watch. Engine air shut-down valve should close in not more than 3 to 10 seconds. If not, replace time delay relay.

3-65.2. SHUT-DOWN SOLENOID-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TESTING (Cont)**



**NOTE**

When the engine is operating at idle speed or above, the air shut-down valve will completely close off the air from the engine, causing it to stop. However, when the engine is operating at the very low speeds that are necessary when performing the test on the fuel shut-down switch and the lubricating oil shutdown switch, the air shut-down solenoid will close the valve, but the engine may continue to run very slowly. This may be due to insufficient force exerted on the back of the valve by the low air flow needed to completely close the shut-down valve.

- |                    |          |
|--------------------|----------|
| c. Jumper wire     | Remove.  |
| d. Cover and screw | Replace. |

---

**3-65.3.1. TIME DELAY RELAY - MAINTENANCE INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

---

<b>REMOVAL</b>
----------------

- |                         |   |         |
|-------------------------|---|---------|
| 2. Time delay relay (2) | a. Screws (3), washers (4) and lock-washers (5) | Remove. |
|                         | b. Cover (6)                                    | Remove. |
|                         | c. Wires  | Remove. |
|                         | d. Screws (7)                                   | Remove. |
|                         | e. Mounting plate (8)                           | Remove. |
|                         | f. Nuts (9), lock-washers (10) and screws (11)  | Remove. |
|                         | g. Relay (2)                                    | Remove. |

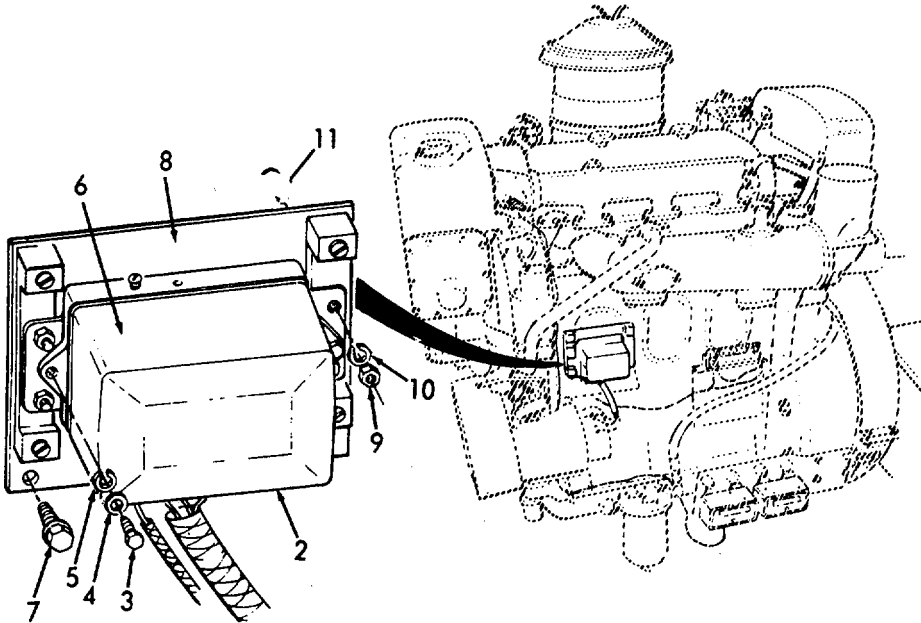
<b>INSTALLATION</b>
---------------------

- |                     |  |                                 |
|---------------------|--|---------------------------------|
| 3. Time delay relay | a. Relay (2)                                   | Position on mounting plate (8). |
|                     | b. Screws (11), lock-washers (10) and nuts (9) | Install.                        |

3-65.3.1. TIME DELAY RELAY-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



- c. Screws (7)                      Install mounting plate (8)
- d. Wiring                              Install.
- e. Cover (6)                              Position on relay.
- f. Screws (3), washers (4) and lock-washers (5)                      Install.

**3-65.3.2. WATER TEMPERATURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Testing                      b. Removal                      c. Installation

**INITIAL SETUP:**

Test Equipment

Thermometer

References

NONE

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

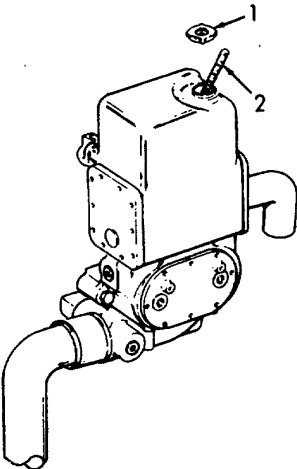
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TESTING**

- |                   |                    |                           |
|-------------------|--------------------|---------------------------|
| 1. Heat exchanger | a. Cap (1)         | Remove.                   |
|                   | b. Thermometer (2) | Insert in heat exchanger. |



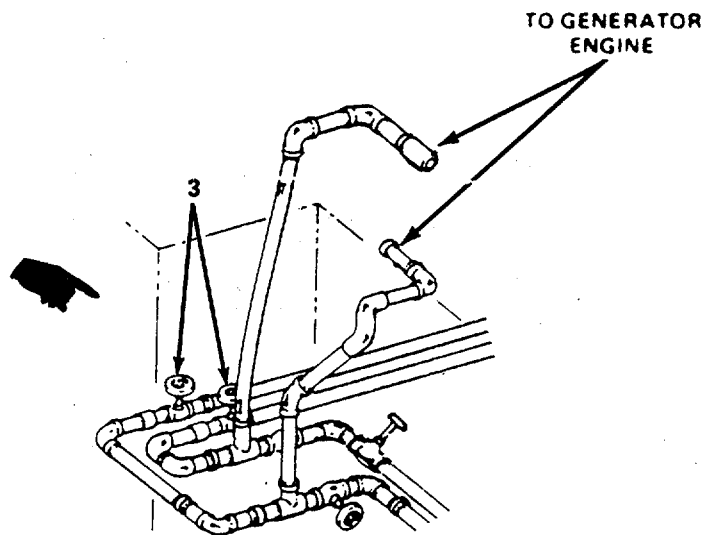
**3-65.3.2. WATER TEMPERATURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>TESTING (Cont)</b>			
2. Engine Cooling water lines	a. Gate Valves (3)	1. Close valves.	

**NOTE**

An alarm will sound in the pilothouse.

2. Start and operate at rated speed and under enough load to raise the water temperature gradually until the air shut-down valve closes. The shut-down should occur at  $205 \pm 50F$  ( $96.1 \pm 2.7^{\circ}C$ ). If the engine does not shut-down, replace the alarm switch.
3. Note the temperature at which the air shut down valve closed.



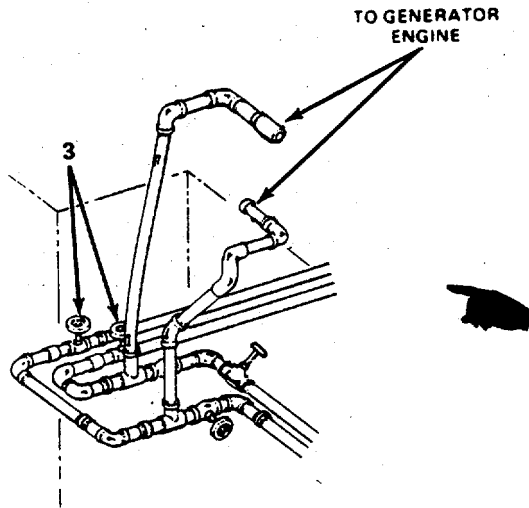


**3-65.3.2. WATER TEMPERATURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TESTING (Cont)**

- |                |  |
|----------------|--|
| b. Gate Valves | <ol style="list-style-type: none"> <li>1. Open valves.</li> <li>2. Restart the engine immediately without load. Run the engine until the engine cools down.</li> </ol> |
|----------------|--|



4955-123

**REMOVAL**

- |                 |  |
|-----------------|--|
| 3. Alarm switch | <ol style="list-style-type: none"> <li>a. Screw (4) Remove.</li> <li>b. Cover (5) Remove.</li> <li>c. Wiring Disconnect.</li> <li>d. Screws (6) and lock-washers (7) Remove.</li> <li>e. Switch (8) Remove.</li> </ol> |
|-----------------|--|

3-1158

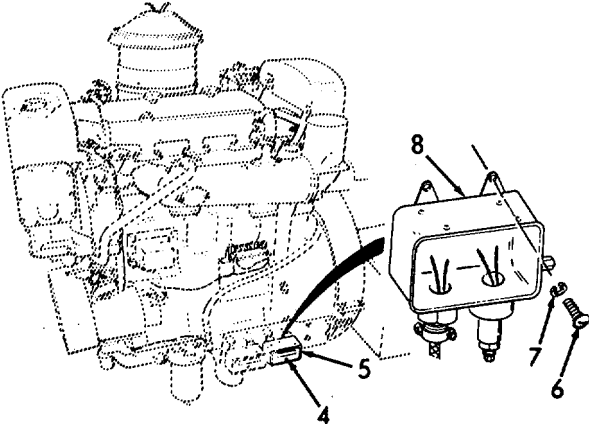
**3-65.3.2. WATER TEMPERATURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

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LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

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**REMOVAL (Cont)**



**INSTALLATION**

- |                 |                                    |                             |
|-----------------|------------------------------------|-----------------------------|
| 4. Alarm Switch | a. Switch (8)                      | Align with holes on engine. |
|                 | b. Lock-washers (7) and screws (6) | Install.                    |
|                 | c. Wiring                          | Connect.                    |
|                 | d. Cover (5) and screw (4)         | Install.                    |

**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS.**

This task covers:

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

**INITIAL SETUP**

Test Equipment  
Jumper wire

References  
NONE

Special Tools  
Fuel oil pressure gage

Equipment Condition      Condition Description  
Para

NONE

Material/Parts  
NONE

Special Environmental Conditions  
NONE

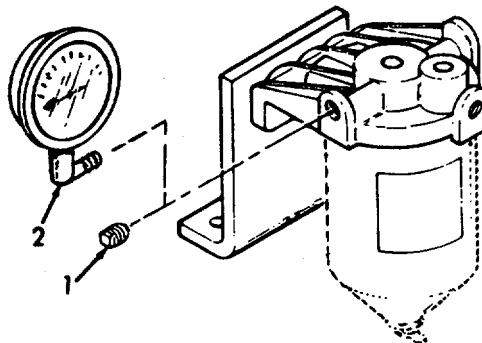
Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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**TESTING**

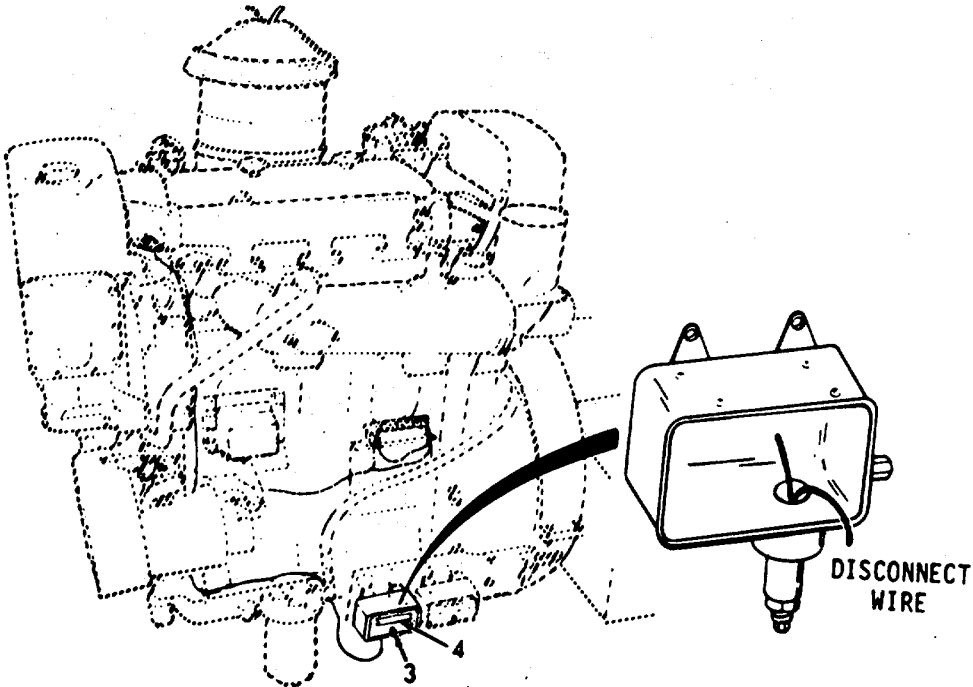
- |                       |                      |          |
|-----------------------|----------------------|----------|
| 1. Fuel filter outlet | a. Pipe plug (1)     | Remove.  |
|                       | b. Pressure gage (2) | Install. |



3-1160

**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

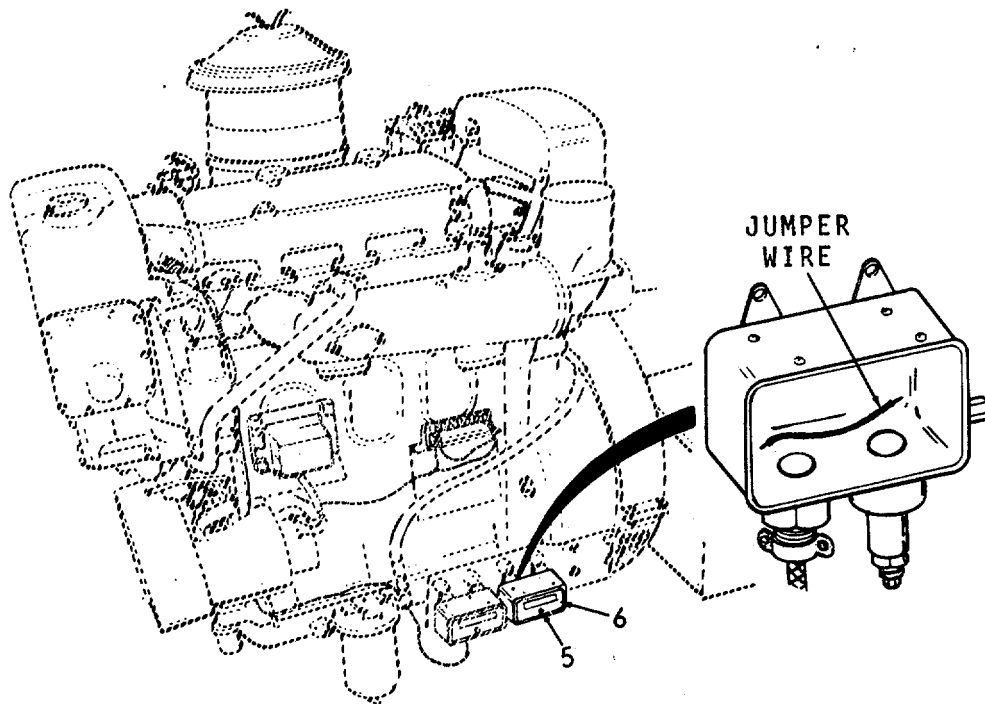
LOCATION	ITEM	ACTION	REMARKS
<b>TESTING (Cont)</b>			
2. Fuel oil pressure alarm switch	a. Screw (3)	Remove.	
	b. Cover (4)	Remove.	
	c. Wiring	Disconnect one wire.	This will prevent shutdown of the engine by low lube oil pressure.
3. Engine		a. Start engine and operate at idle speed.	
		b. Slow the engine down until the fuel pressure is approximately 15 psi (103.4 kPa) and the engine is barely turning over.	



3-1161

**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>TESTING (Cont)</b>			
4. Water temperature alarm switch	a. Screw (5)	Remove.	
	b. Cover (6)	Remove.	
	c. Jumper wire	Place across terminals.	



- |           |   |
|-----------|---|
| 5. Engine | <ul style="list-style-type: none"> <li>a. Raise the engine speed slowly and watch the fuel oil pressure gage until the air shutdown valve closes.</li> <li>b. Note the pressure on the gage.</li> </ul> |
|-----------|---|

**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**TESTING (Cont)**

c. If the gage reads 20 psi (137.9 kPa), the fuel oil pressure switch is good.

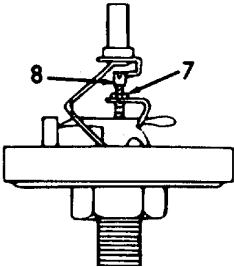
**ADJUSTMENTS**

6. Fuel 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 (7)	Loosen.	Secure adjusting screw.
c. Adjusting screw (8)	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.



3-1163

**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>ADJUSTMENTS (Cont)</b>			
7. Water temperature alarm Switch	a. Jumper wire	Remove.	
	b. Cover (6) and screw (5)	Install.	
8. Fuel oil pressure alarm switch	a. Wire	Reconnect.	
	b. Cover (4) and screw (3)	Install.	
<b>REMOVAL</b>			
9. Fuel oil pressure alarm switch	a. Screw (3)	Remove.	
	b. Cover (4)	Remove.	
	c. Wiring	Disconnect.	
	d. Screws (9) and lock-washers (10)	Remove.	
	e. Switch (11)	Remove.	
10. Fuel oil Pressure switch	a. Terminals (12)	Remove wires.	
	b. Switch (13)	Unscrew.	





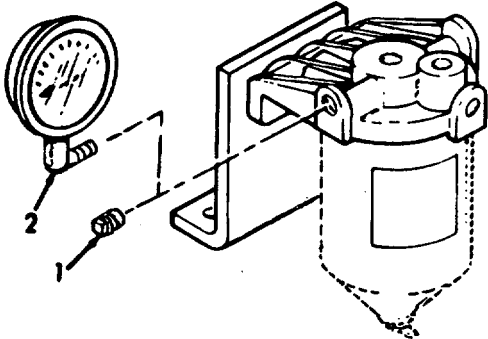
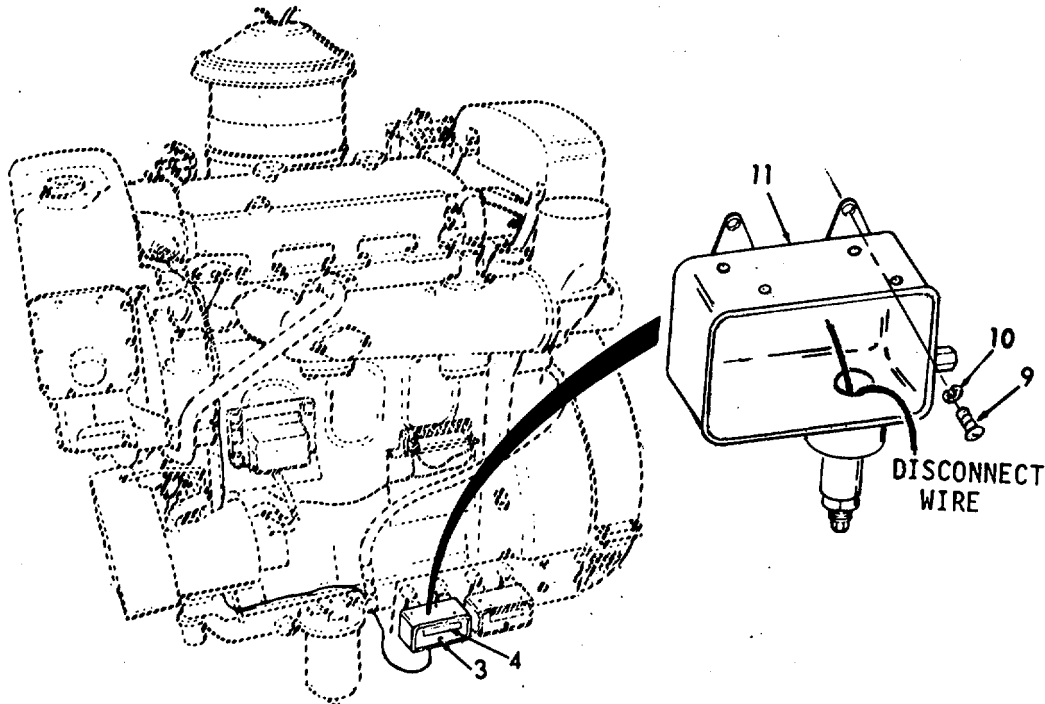
**3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
11. Fuel oil Pressure switch	a. Switch (13)	Install.	
	b. Wiring (12).	Reconnect to terminals	
12. Fuel oil-pressure alarm switch	a. Switch (11), screws (9), and lock-washers (10)	Install.	
	b. Wiring	Reconnect.	
	c. Cover (4) and screws (3)	Install.	
13. Fuel filter	a. Pressure gage (2)	Remove.	
	b. Pipe plug (1)	Replace.	

3-65.3.3. FUEL OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS  
(Cont).

LOCATION                      ITEM                      ACTION                      REMARKS

INSTALLATION (Cont)



**3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

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

**INITIAL SETUP**

Test Equipment  
Jumper wire

References  
NONE

Special Tools  
NONE

Equipment Condition      Condition Description  
Para  
  
NONE

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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**TESTING**

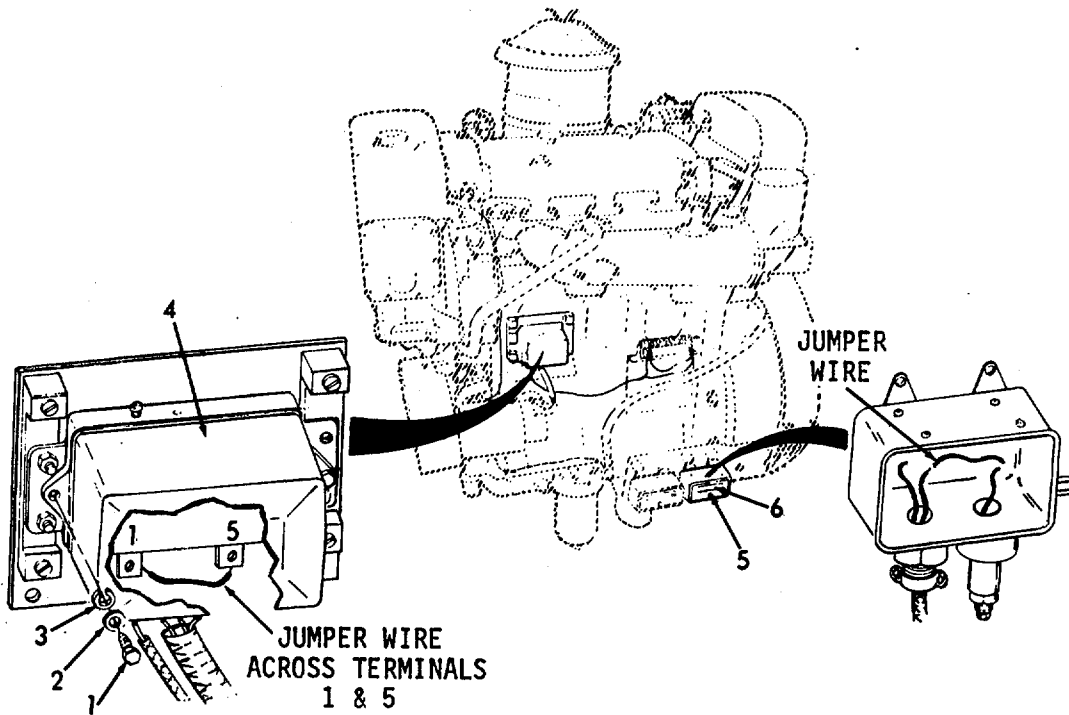
- |    |                  |  |   |
|----|------------------|--|---|
| 1. | Engine           |  | Start the engine and operate at idle speed. |
| 2. | Time delay relay | a. Screws (1), washers (2), and lock-washers (3) | Remove.                                     |
|    |                  | b. Cover (4)                                     | Remove.                                     |
|    |                  | c. Jumper  | Install across terminals 1 and 5.           |

**3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**TESTING (Cont)**

3. Fuel Oil pressure switch	a. Screw (5)	Loosen.	
	b. Cover (6)	Remove.	
	c. Jumper wire	Install.	



4. Engine	a.	Slow the engine down towards the no-fuel position while watching the oil pressure gage.	
	b.	Note the oil pressure at which the engine shuts down.	

**3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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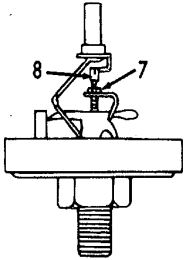
**ADJUSTMENT**

5.	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.	Lock-nut (7)	Loosen.	Secures adjusting screw.
c.	Adjusting screw (8)	Adjust.	With the lock-nut 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.



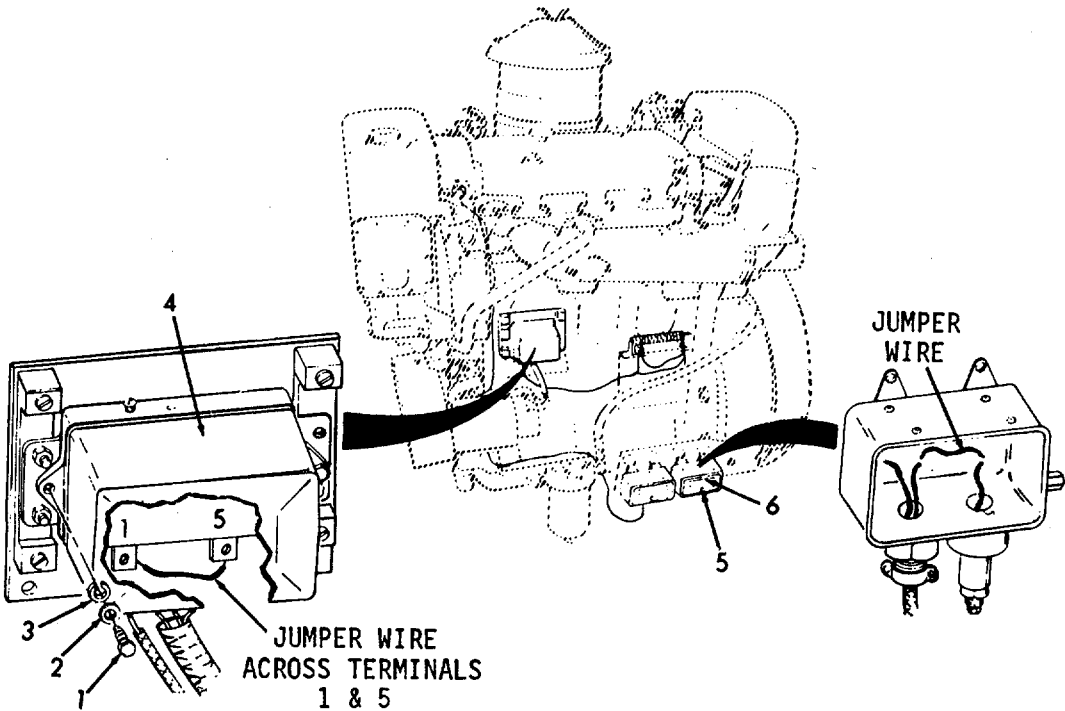
6.	Fuel oil pressure switch	a. Jumper wire	Remove.
		b. Cover (6) and screw (5)	Install.

3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

ADJUSTMENT

- |                     |  |          |
|---------------------|--|----------|
| 7. Time delay relay | a. Jumper  | Remove.  |
|                     | b. Cover (4)   | Install. |
|                     | c. Screws (1)<br>washers (2)<br>and lock-washers (3) | Install. |



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**3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE  
INSTRUCTIONS (Cont).**

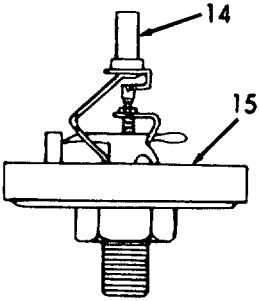
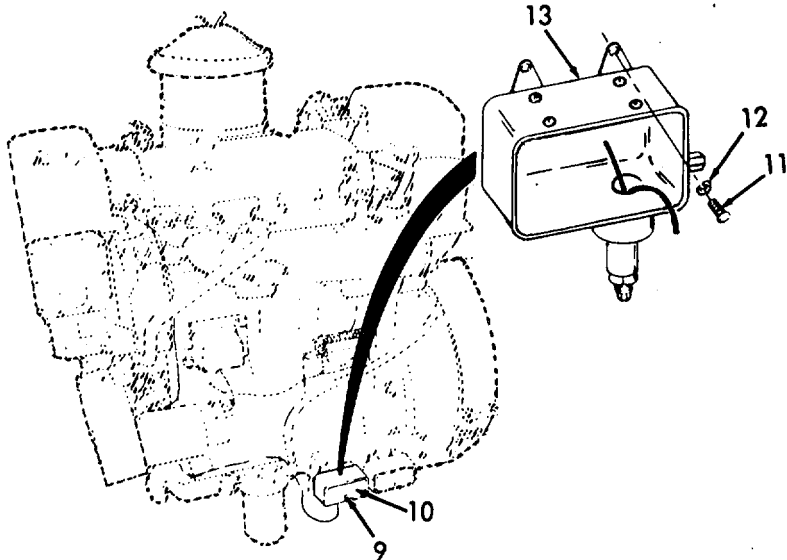

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LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL</b>			
8. Lube oil alarm switch	a. Screw (9)	Remove.	
	b. Cover (10)	Remove.	
	c. Wiring	Disconnect.	
	d. Screws (11) and lock- washers (12)	Remove.	
	e. Switch (13)	Remove.	
9. Lube Oil pressure switch	a. Terminal (14)	Remove wires.	
	b. Switch (15)	Unscrew.	
<b>INSTALLATION</b>			
10. Lube oil alarm switch	a. Switch (13), screws (11), and lock- washer (12)	Install.	
	b. Wiring	Install.	
	c. Cover (10) and screws (9)	Install.	

3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE  
INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

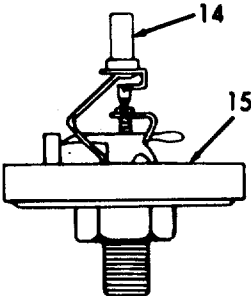


3-1173



**3-65.3.4. LUBRICATING OIL PRESSURE ALARM SWITCH - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
11. Lube oil pressure switch	a. Switch (15)	Install.	
	b. Terminals (14)	Reconnect wires.	



3-1174

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**3-66. GOVERNOR HYDRAULIC - MAINTENANCE INSTRUCTIONS.**

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- a. The governor is the isochronous hydraulic type with speed droop stabilization. Hydraulic action is transmitted by oil which is admitted under pressure from the engine lubricating system to an auxiliary oil pump in the governor. The pump then develops the oil pressure necessary to actuate the governor mechanism.
- b. The isochronous feature of this governor is its ability, at zero droop, to hold the engine at a constant speed regardless of the load, providing the load is within the rated capacity of the power generator.
- c. The mechanical connection of the governor to the fuel injectors is by means of a fuel rod attached to a lever on the injector control tube.
- d. The governor operates in such a manner that fuel supplied to the injectors is decreased by action of a fuel rod spring and increased by the opposing action of the hydraulic operated power piston. Admission of oil under the power piston is controlled by the vertical movement of the pilot valve plunger. This plunger is, in turn, controlled by the flyweights. The flyweight ball head is mounted on the pilot valve bushing.
- e. Rotation of the governor is accomplished by the upper blower rotor through an integral horizontal drive shaft and bevel gear and an integral vertical driven shaft and bevel gear both mounted on ball bearings and retained in a drive housing.
- f. In starting a cold engine, considerable time is required for the lubricating oil pressure to become sufficient to operate the governor and thus move the injector control racks to the full fuel position so the engine can start. Since this delay in starting is considered objectionable, the starting time can be shortened by pressing in on the knob which is threaded on the fuel rod and projects from the side of the governor subcap. The inward movement of this knob takes the control of the injector fuel racks away from the governor.
- g. The engine can be stopped in a similar manner, regardless of the governor, by pulling out on the fuel rod knob.

**3-66. GOVERNOR HYDRAULIC - MAINTENANCE INSTRUCTIONS (Cont).**

h. In addition to its function of holding the engine speed constant under varying load conditions, the hydraulic governor acts as an automatic shut-down device in the event of lubricating oil pressure failure. Should the engine fail to supply oil to the governor, the power piston will drop, thus allowing the fuel rod to return to the no-fuel position.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Governor (Hydraulic)	3-66.1
Governor Oil Filter	3-66.2
Synchronizing Motor	3-66.3

**3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS.**

This task covers:

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

**INITIAL SETUP**

Test Equipment  
NONE

References  
NONE

Special Tools  
Wrench J4242

<u>Equipment</u>	<u>Condition</u>	<u>Condition Description</u>
	Para	
	3-86	Rocker Arm Cover Removed

Material/Parts  
Gasket P/N 5193113

Special Environmental Conditions  
NONE

Personnel Required  
1

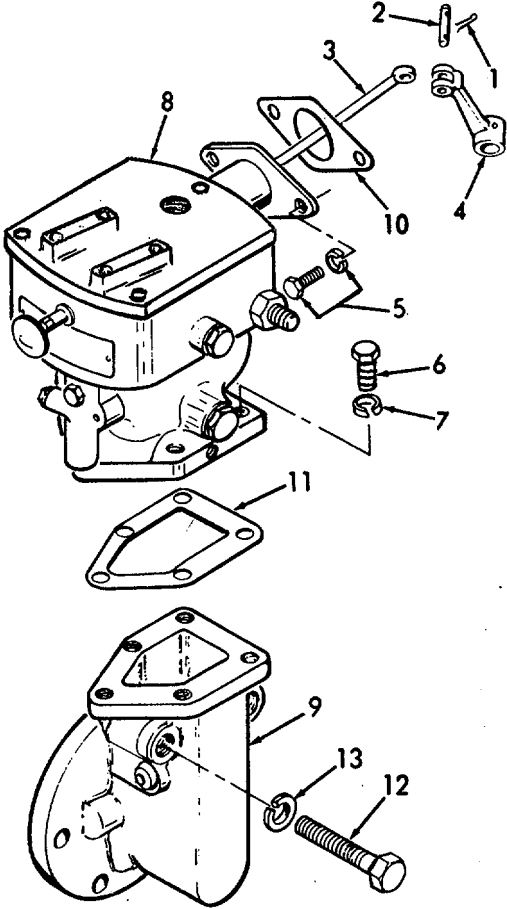
General Safety Instructions  
None

**3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Synchronizing motor	a. Wiring	Check for breaks, wear and bad connections.	Refer to paragraph 3-66.3.
	b. Mounting	Check for loose motor mounting.	Refer to paragraph 3-66.3.
	c. Motor	Check for damage.	Refer to paragraph 3-66.3.
<b>REMOVAL</b>			
2. Rocker arm Cover	a. Cover	Remove.	Refer to paragraph 3-86.
	b. Cotter pins (1) and link pins (2)	Remove.	
	c. Fuel rod (3) and control tube lever (4)	Disassemble.	
3. Synchronizing motor	Motor	Remove.	Refer to paragraph 3-66.3.
4. Governor	a. Tube governor oil filter to governor	Remove.	Refer to paragraph 3-66.2.
	b. Bolt assemblies (5)	Remove.	
	c. Screws (6) and lock-washers (7)	Remove.	

3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	d. Governor (8)	Lift from drive housing (9) and slide, so that fuel rod (3) disengages.	
	e. Gasket (10)	Remove.	Discard.
	f. Gasket (11)	Remove.	Discard.
5. Governor drive housing	a. Screws (12) and lockwashers (13)	Remove.	

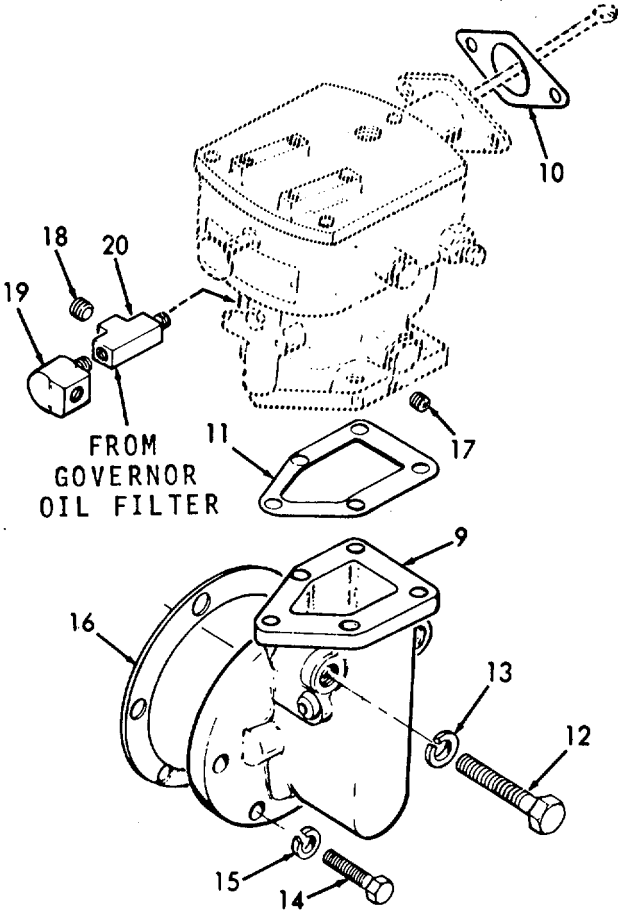


**3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	b. Screws (14) and lockwashers (15)	Remove.	
	c. Junction box	Swing out of way.	
	d. Drive housing (9)	Remove.	
	e. Gasket (16)	Remove.	Discard.
<b>REPAIR</b>			
6. Governor	a. Pipe plugs (17 and 18)	Remove and replace	If necessary.
	b. Elbow (19) and tee (20)	Remove and replace -	If necessary.
<b>INSTALLATION</b>			
7. Governor drive housing	a. Gasket (16), drive housing (9) and junction box	Align holes with holes in blower housing.	1. Also align shaft. 2. Use new gasket.
	b. Screws (14) and lockwashers (15)	Install.	

3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	c. Screws (12) and lockwashers (13)	Install.	
8. Governor	a. Gasket (11)	Place on drive housing (9).	Use new gasket.
	b. Gasket (10)	Place on governor.	Use new gasket.



**3-66.1. GOVERNOR (HYDRAULIC) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	c. Governor (8)	1. Slide fuel rod (3) into rocker arm assembly.  2. Then, place governor on drive housing.	Align drive shaft.
	d. Screws (6) and lock-washers (7)	Install.	
	e. Bolt assemblies (5)	Install.	
	f. Tube governor to oil filter	Reinstall.	Refer to paragraph 3-66.2.
9. Synchronizing motor	Motor	Reinstall.	Refer to paragraph 3-66.3.
10. Rocker arm cover	a. Fuel rod (3) and control tube lever (4)	Insert rod in lever.	
	b. Cotter pins (1) and link pin (2)	Reassemble.	

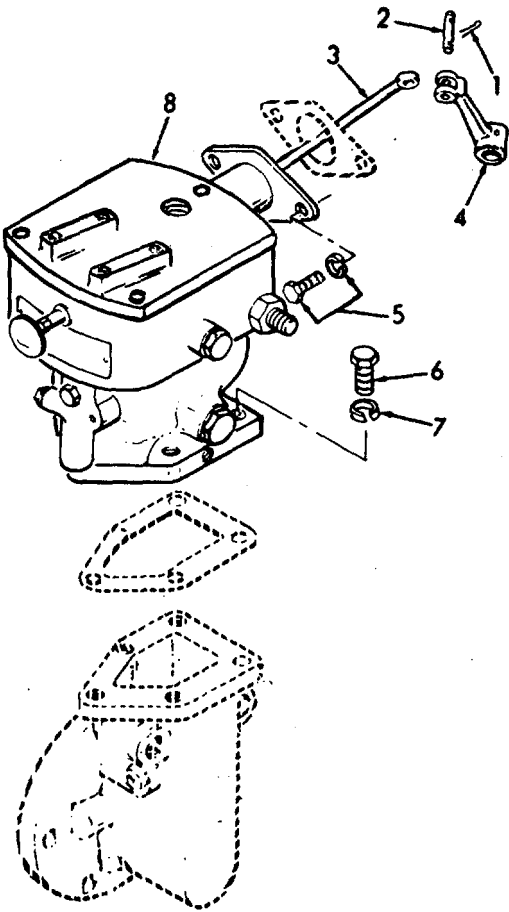


3-66.1. GOVERNOR (HYDRAULIC)-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

c.	Rocker arm cover	Install.	Refer to paragraph 3-86.
----	------------------	----------	--------------------------



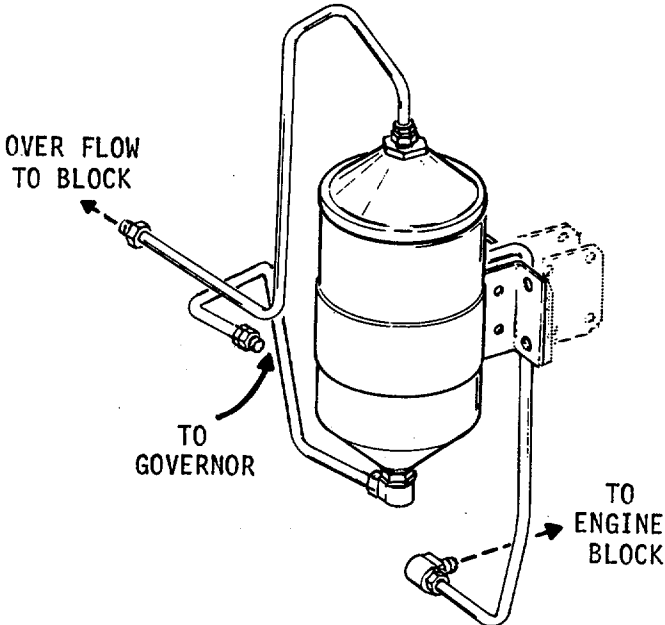


3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION (Cont)

- |  |                  |   |  |
|--|------------------|---|--|
|  | c. Governor tube | 1. Check for leaks.<br>2. Check for loose and leaking fittings.<br>3. Check for dents, cracks and breaks. |  |
|  | d. Block tube    | 1. Check for leaks.<br>2. Check for loose and leaking fittings.<br>3. Check for dents, cracks and breaks. |  |

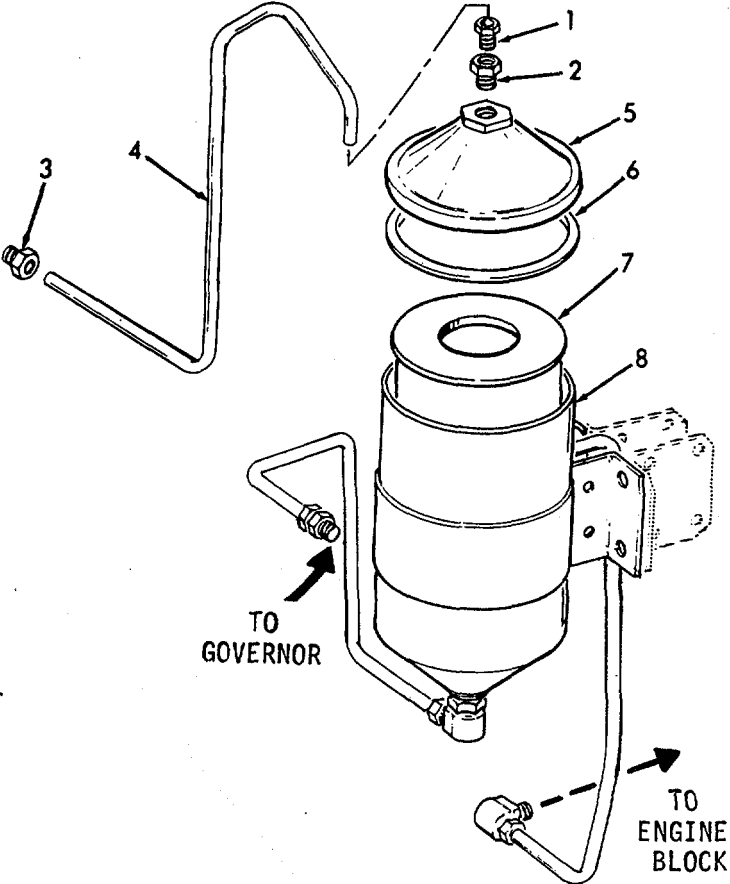


3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2. Governor oil filter	a. Straight adapter (1) and pipe reducer (2)	Unscrew adapter (1) from reducer (2).	Use two wrenches.
	b. Straight adapter (3)	Unscrew from block.	
	c. Overflow tube (4)	Remove.	
	d. Pipe reducer (2)	Remove.	
	e. Filter cover (5)	Unscrew.	
	f. Gasket (6)	Remove	Discard.
	g. Filter element (7)	Remove	Discard.
	h. Filter Housing (8)	<ol style="list-style-type: none"> <li>1. Pump oil out of housing.</li> <li>2. Clean interior with clean engine oil.</li> <li>3. Wipe dry with a clean, lint free cloth.</li> </ol>	
	i. Filter element (7)	<ol style="list-style-type: none"> <li>1. Insert in housing (8). element.</li> <li>2. Fill housing with engine oil.</li> </ol>	<p>Use new filter</p> <p>Use type OE/HDO.</p>

3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)	j. Gasket (6)	1. Wipe with engine oil.  2. Place on filter housing (8).	
	k. Filter cover (5)	Screw onto filter housing (8).	Make sure gasket is properly seated.
	l. Pipe reducer (2)	Install.	



3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

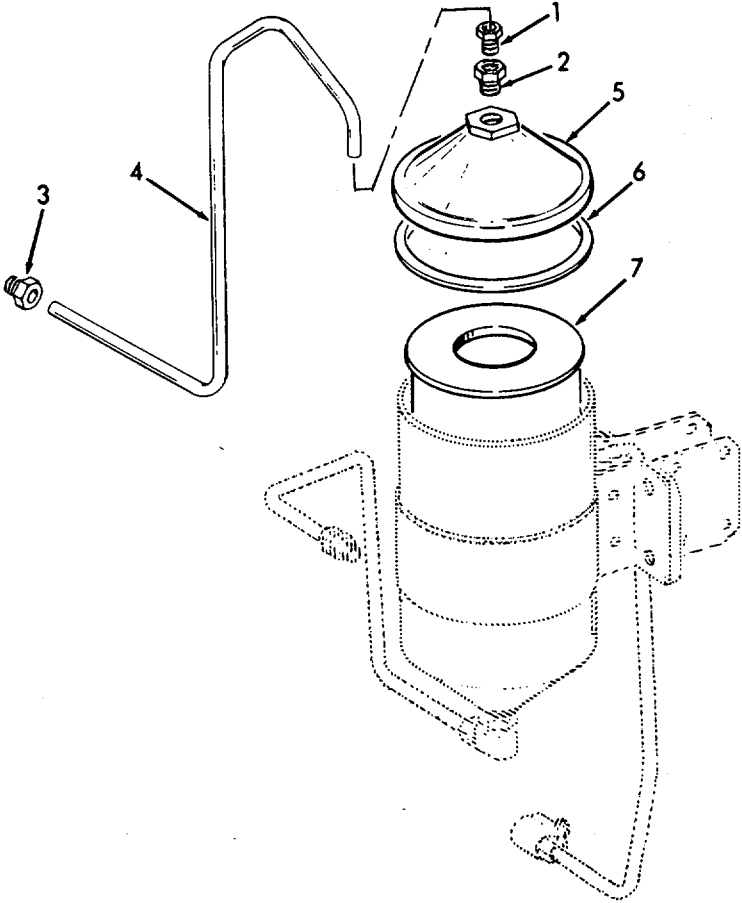
LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	m. Over-flow tube (4) and straight adapter (3)	Assemble.	
	n. Pipe reducer (2) and straight adapter (1)	Assemble.	Use two wrenches to assemble.
	o. Operate engine and check for leaks.	Tighten as needed.	
REMOVAL			
3. Governor oil filter	a. Straight adapter (1) and pipe reducer (2)	Unscrew adapter (1) from reducer (2).	Use two wrenches.
	b. Straight adapter (3)	Unscrew from block.	
	c. Over-flow tube (4)	Remove.	
	d. Pipe reducer (2)	Remove.	
	e. Filter Cover (5)	Unscrew.	

3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- f. Gasket (6) Remove. Discard.
- g. Filter element (7) Remove. Discard.



3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)	h. Filter housing (8)	1. Pump oil out of housing.	
	i. Tube connector (9) and pipe reducer (10)	Unscrew connector (9) from reducer (10).	Use two wrenches.
	j. Tube connector (11)	Unscrew.	
	k. Governor tube (12)	Remove.	
	l. Tube connector (13)	Unscrew.	
	m. Nuts (14), lock-washers (15), flat-washers (16) and screws (17)	Remove.	
	n. Housing (8) and attached bracket	Remove.	

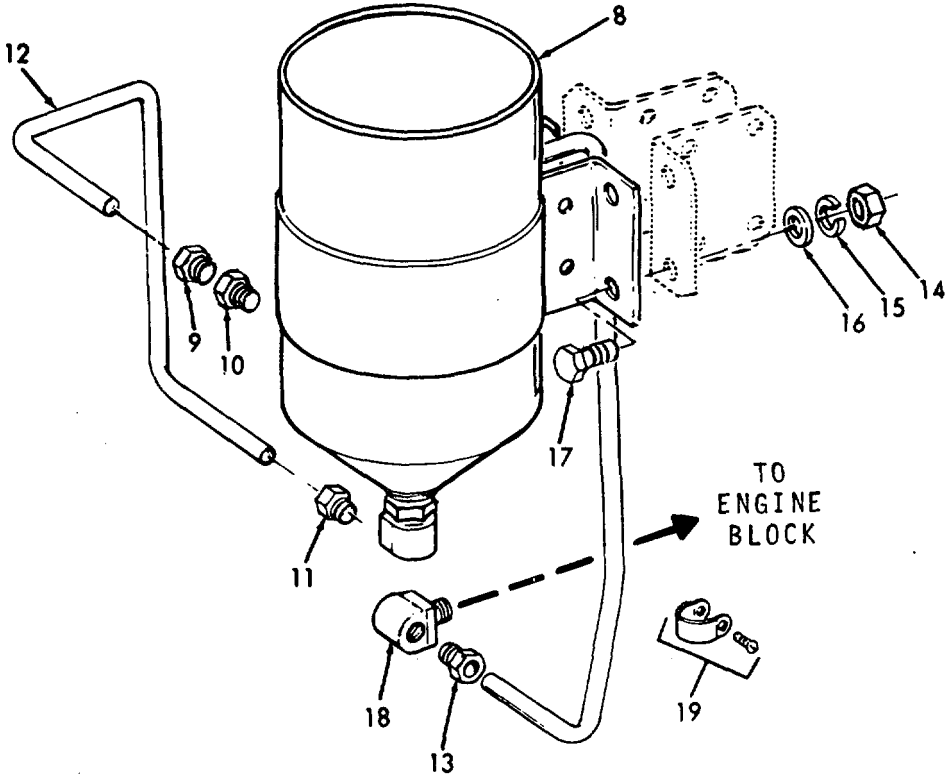


3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- o. Elbow (18) Remove from engine block,
- p. Clamp (19) Remove. If necessary.

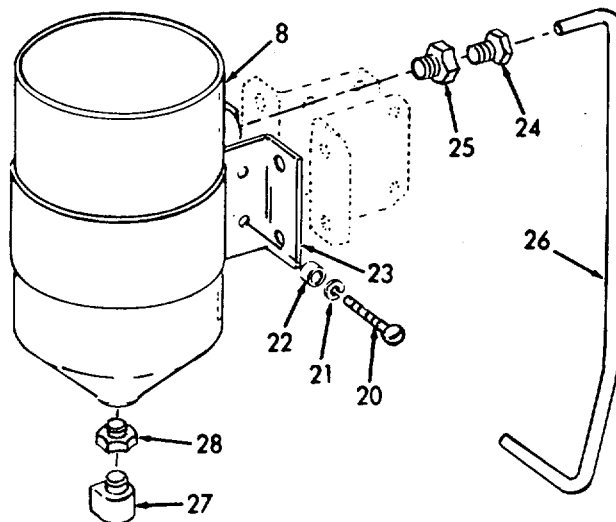


3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
4. Oil filter housing	a. Screws (20), lock-washers (2) and bracket spacers (22)	Remove.	
	b. Filter housing (8) and bracket (23)	Slide filter housing out of bracket.	
	c. Tube connector (24) and pipe reducer (25)	Unscrew.	Use two wrenches.
	d. Block tube (26)	Remove	
	e. Elbow (27) and pipe reducer (28)	Remove.	
REASSEMBLY			
5. Oil filter housing	a. Elbow (27) and pipe reducer (28)	Assemble.	

3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
b.	Block tube (26) and tube connector (24)	Assemble.	Use two wrenches.
c.	Filter housing (8) and bracket (23)	Assemble.	
d.	Spacers (22), lock-washers (21) and screws (20)	Reassemble in bracket (23).	



3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

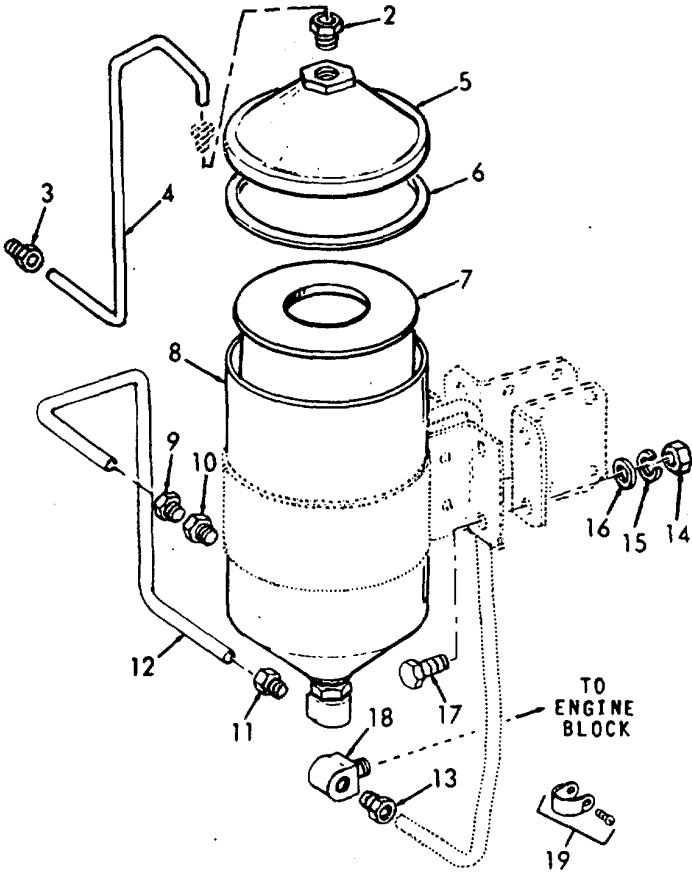
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Governor oil Filter	a. Elbow (18)	Install on engine block.	
	b. Housing (8) and attached bracket, screws (17), flat-washers (16), lock-washers (15) and nuts (14)	Reassemble.	
	c. Tube connector (13)	Install.	
	d. Governor tube (12), tube connector (11), tube connector (9), and pipe reducer (10)	Reassemble.	
	e. Filter element (7)	<ol style="list-style-type: none"> <li>1. Insert in housing (8).</li> <li>2. Fill housing with engine oil.</li> </ol>	<p>Use new filter element.</p> <p>Use type OE/HDO-.</p>
	f. Gasket (6)	<ol style="list-style-type: none"> <li>1. Wipe with engine oil.</li> <li>2. Place on filter housing (8).</li> </ol>	

3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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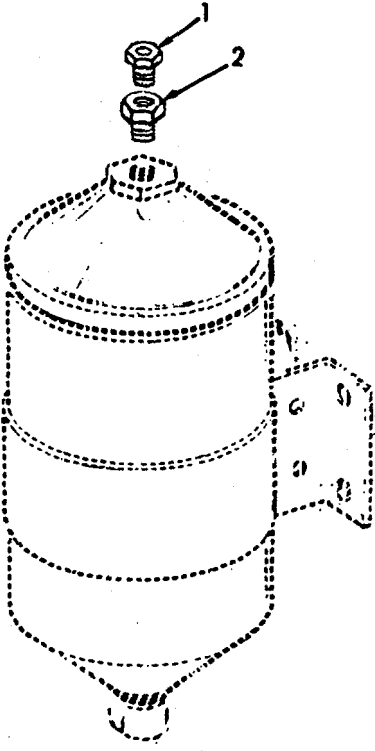
INSTALLATION (Cont)

- g. Filter cover (5)                      Screw onto filter housing (8).                      Make sure gasket is properly seated.
- h. Pipe reducer (2)                      Install.
- i. Over-flow tube (4) and straight adapter (3)                      Assemble.



3-66.2. GOVERNOR OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

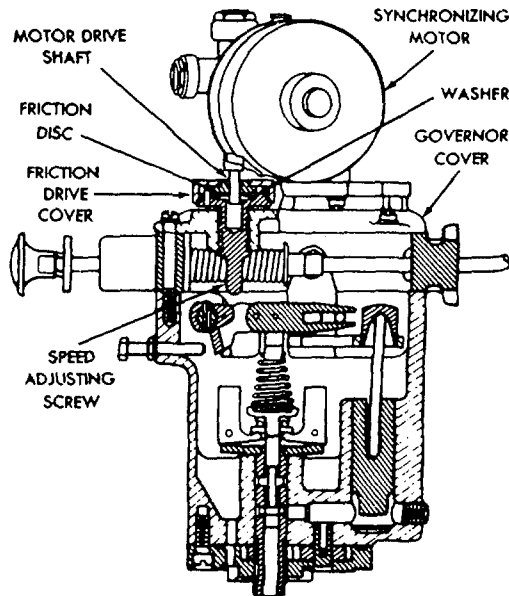
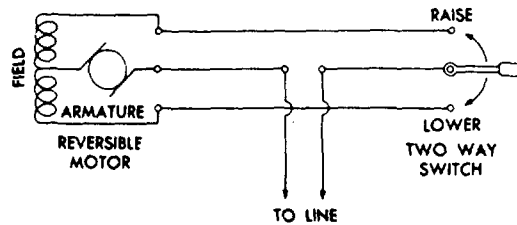
LOCATION	ITEM	ACTION	REMARKS
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">INSTALLATION (Cont)</div>		
	j. Pipe reducer (2) and straight adapter (1)	Assemble.	Use two wrenches to tighten.
	k. Operate engine and check for leaks.	Tighten as needed.	



**3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS.**

a. The hydraulic governor is equipped with a reversible electric synchronizing motor mounted on the governor cover. This motor permits close adjustment of the engine speed from a remote control point. This feature is especially valuable when synchronizing two generators from a central control panel.

b. The motor is connected to the source of electrical supply through a two-way switch located on the Main Switchboard. The friction drive components are assembled to the drive shaft of the synchronizing motor and extend down through the governor cover. The speed adjusting screw of the friction drive is threaded into the governor cover and bears directly on the speed adjust lever.



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**3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS (Cont).**

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**c. OPERATION.**

(1) The synchronizing motor is used to change the engine speed when the unit is running alone, or to adjust the load when the unit is operating in parallel with other units.

(2) When the two-way control switch on the Main Switchboard is closed, the motor shaft turns the governor speed adjusting shaft by means of the reduction gear and friction drive. The direction of rotation (clockwise or counter-clockwise) is dependent upon the position of the switch. When the desired engine speed is indicated on a tachometer or frequency meter on the switchboard, the switch is returned to the OFF position by the operator.

(3) If the switch is held in the LOWER speed position too long, the synchronizing motor will continue to lower the engine speed until it ultimately shuts the engine down. If the switch is held too long in the RAISE speed position, the motor will turn the governor speed adjusting shaft until it strikes the maximum speed adjusting screw, after which the friction drive will slip and the motor will continue to run at a slightly reduced speed without further effect.

**d. SERVICE.**

(1) The synchronizing motor is constructed to render long satisfactory service. However, if the motor is damaged or fails to operate, replace the entire motor as an assembly.

(2) The spring washer of the friction drive or slip-clutch must be strong enough to permit the motor to carry the speed adjusting lever up against the maximum speed adjusting screw without slipping, yet it must be loose enough to slip after the lever contacts the screw.



**3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. Inspection**
- b. Repair**

INITIAL SETUP:

Test Equipment  
NONE

References  
NONE

Special Tools  
  
NONE

Equipment  
Condition   Condition Description  
Para

3-66.1   Governor (Hydraulic)

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION
------------

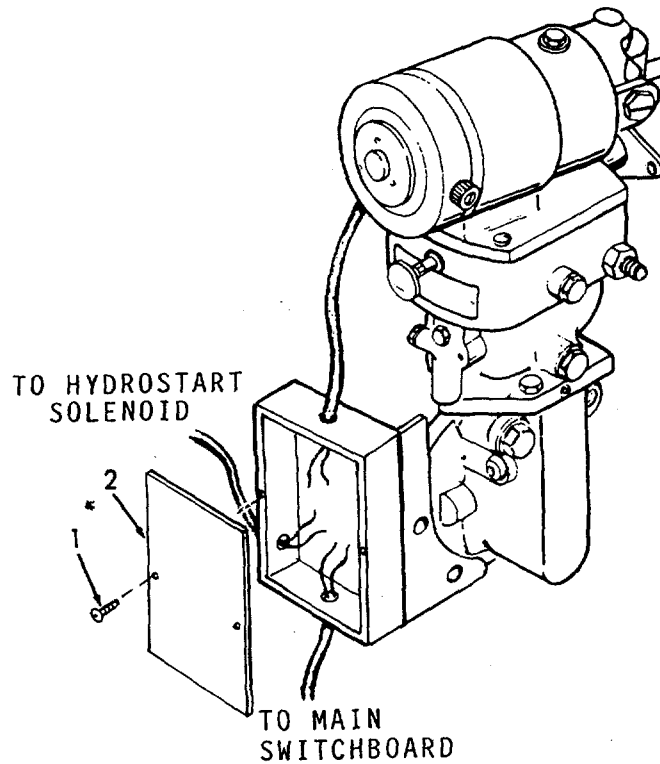
1.	Synchronizing Motor	a. Wiring	Check for breaks, wear and bad connections.	
		b. Mounting	Check for loose motor mounting.	
		c. Motor	Check for damage.	Refer to Direct Support.

3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR

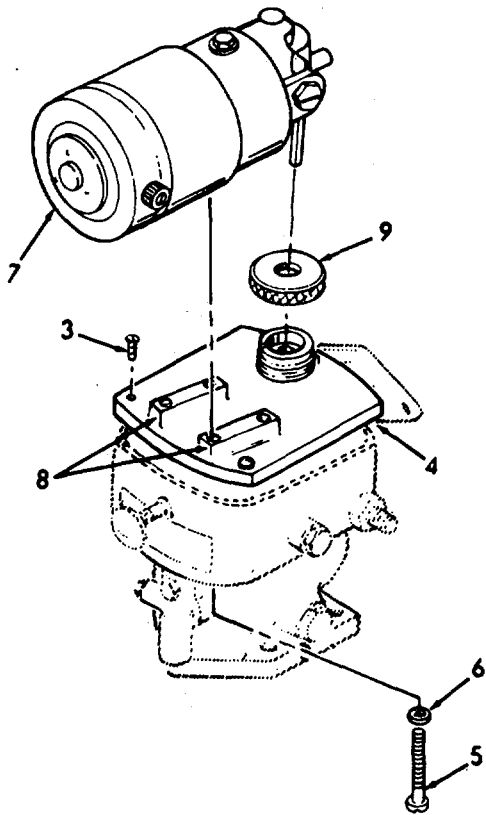
- |                        |                             |  |  |
|------------------------|-----------------------------|--|--|
| 2. Wiring junction box | a. Screws (1) and cover (2) | Remove.                                  |  |
|                        | b. Wiring                   | Tag and disconnect three wires to motor. |  |



- |                   |                                  |                  |  |
|-------------------|----------------------------------|------------------|--|
| 3. Governor cover | a. Screws (3)                    | Remove.          |  |
|                   | b. Cover (4) with motor attached | Lift and remove. |  |

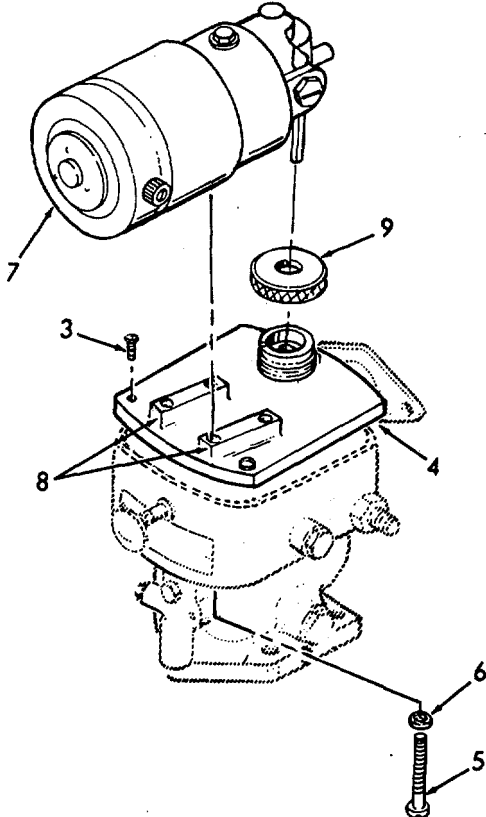
3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Screws (5) and flat-washers (6)	Remove.	
	d. Synchronizing motor (7) and mounting brackets (8)	Remove.	
4. Synchronizing motor	Friction disc cover (9)	Unscrew, remove and replace.	



3-66.3. SYNCHRONIZING MOTOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Governor cover	a. Synchronizing motor (7), mounting brackets (8), screws (5) and flatwashers (6)	Reassemble.	
	b. Cover (4) with motor attached	Replace.	
	c. Screws (3)	Reinstall.	

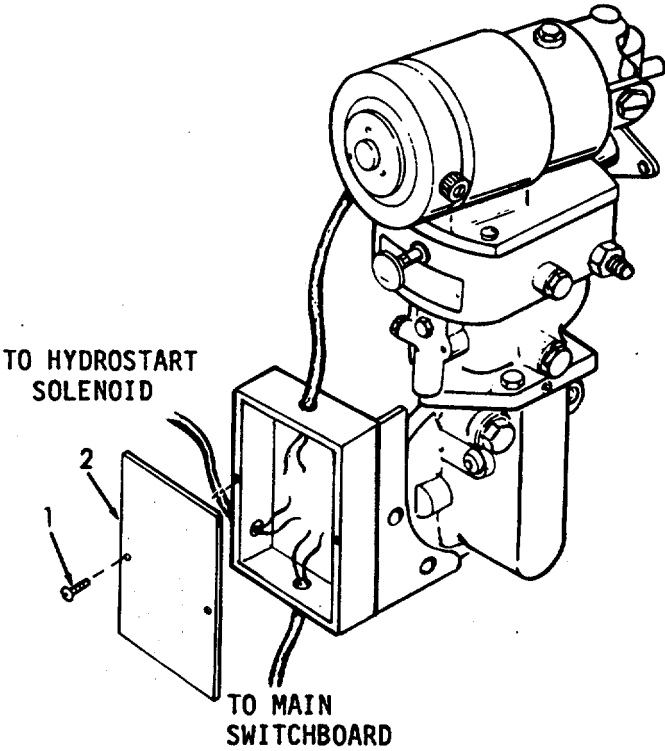


3-66.3. SYNCHRONIZING MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

6.	Wiring, junction box	a. Wiring	Reconnect and disconnect tags
		b. Cover (2) and screws (1)	Reinstall.



**3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS.**

The air intake shut-down housing, mounted on the side of the blower, serves as a mounting for the air cleaner. The air shut-down housing contains an air shut-down valve that shuts off the air supply and stops the engine whenever abnormal operating conditions require an emergency shut-down.

**This task covers:**

- |                      |                       |                        |
|----------------------|-----------------------|------------------------|
| <b>a. Inspection</b> | <b>c. Removal</b>     | <b>e. Repair</b>       |
| <b>b. Service</b>    | <b>d. Disassembly</b> | <b>f. Installation</b> |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Torque wrench 0-50 ft. lb.

Equipment Condition Description  
Para

- 3-71. Air Cleaner Removal
- 3-65.1. Disassembly Emergency Shutdown Linkage
- 3-65.2. Disassembly Shutdown Solenoid

Material/Parts

- Repair Kit P/N 5193113
- Oil MIL-L-2104 Type
- OE/HDO-10

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

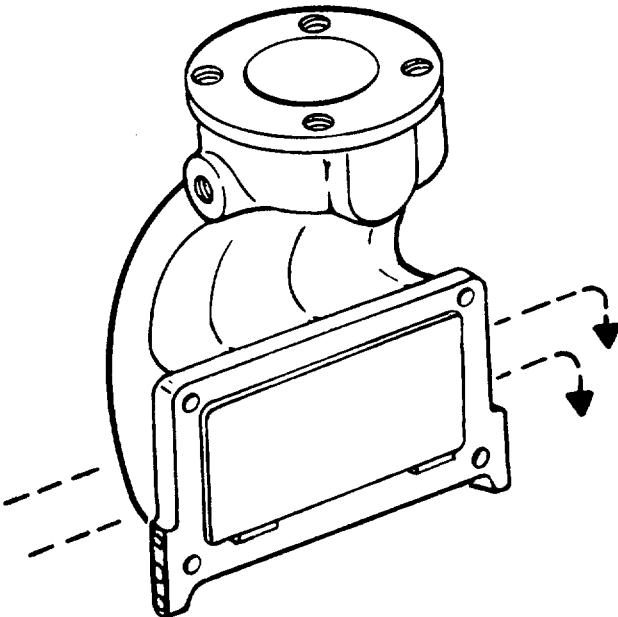
1.	Air intake	a. Shut-down valve shaft	Inspect for binding. Disconnect latch from ball joint and link. Move latch manually.	Lubricate if binding, or replace if required.
----	------------	--------------------------	--	---

3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	b. Air intake housing	Inspect for cracks, breaks or damage.	Replace if defective.
	c. Air intake housing-to-blower housing gaskets	Inspect for leaking.	Replace if defective.

**SERVICE**

2. Air intake	Shutdown valve Shaft	Lubricate.	Use oil type OE/HDO-10.
---------------	-------------------------	------------	-------------------------



**3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Air Intake	a. Air cleaner mounting tube (1)	Remove.	
	b. Cap-screws (2) and lock-washers (3)	Remove.	Screw 3/8 - 16 x 1-5/8 inch.
	c. Air intake housing (4)	Remove.	
	d. Air intake housing striker plate (5)	Remove.	
	e. Striker plate-to-air intake housing gasket (6)	Remove.	Discard.
	f. Mating surfaces blower housing-to striker plate (5)	Clean.	Remove gasket particles.

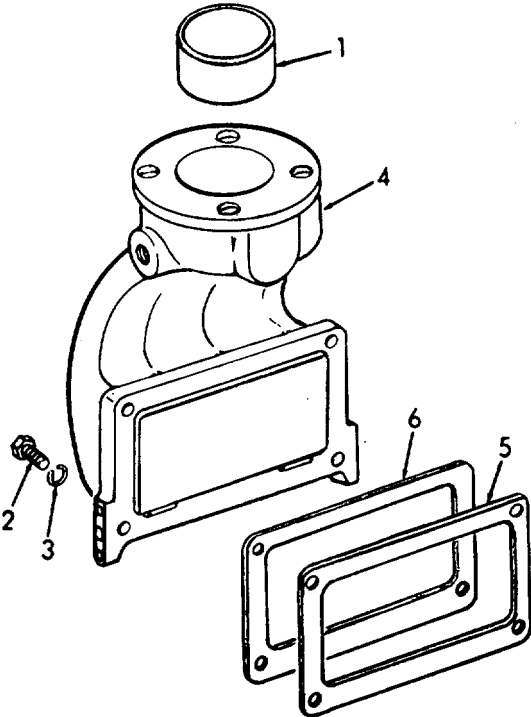


3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- |  |  |                   |               |
|--|--|-------------------|---------------|
|  | g. Mating surfaces intake housing-to-striker plate (5) | Clean. particles. | Remove gasket |
|--|--|-------------------|---------------|



DISASSEMBLY

**WARNING**

Wear eye protection when using compressed air.

**NOTE**

Clean all parts in fuel oil and dry with compressed air.

- |               |                           |  |
|---------------|---------------------------|--|
| 4. Air intake | a. Air intake housing (4) | Remove, clean and inspect for cracks or damaged threads. |
|---------------|---------------------------|--|

**3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).**

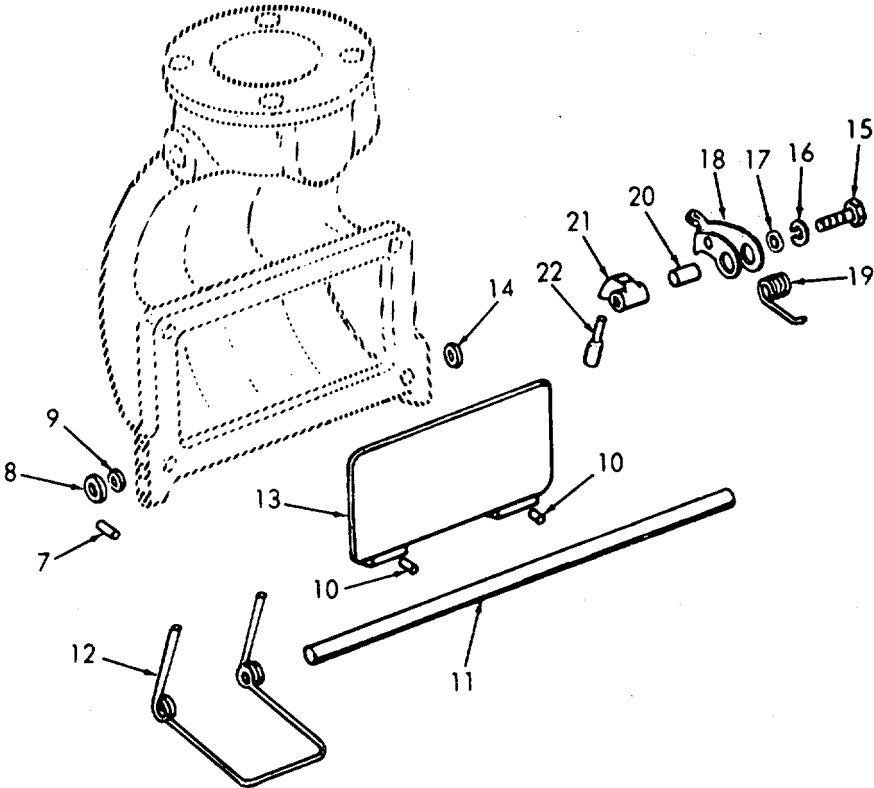
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	b. Roll pin (7)	Remove and inspect.	Use small punch to remove.
	c. Flat-washer (8)	Remove.	
	d. Seal ring (9)	Remove and discard.	
	e. 2 roll pins (10)	Remove and inspect.	
	f. Shut-down valve shaft (11)	Remove, clean and inspect for wear or damage.	Note position of shutdown valve spring (12) and shut-down valve (13) before withdrawing shaft.
	g. Shut-down valve (13)	Inspect for flatness.	
	h. Seal ring (14)	Remove and discard.	
	i. Cap-screw (15), lock-washer (16), and flat-washer (17)	Remove.	
	j. Latch (18)	Remove, clean and inspect for wear or damage.	

3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- k. Latch spring (19) Remove, clean and inspect for wear or damage.
- l. Latch spacer (20) Remove, clean and inspect for wear or damage.
- m. Cam (21) Clean and inspect for wear or damage.
- n. Handle (22) Clean and inspect for wear or damage.



**3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).**

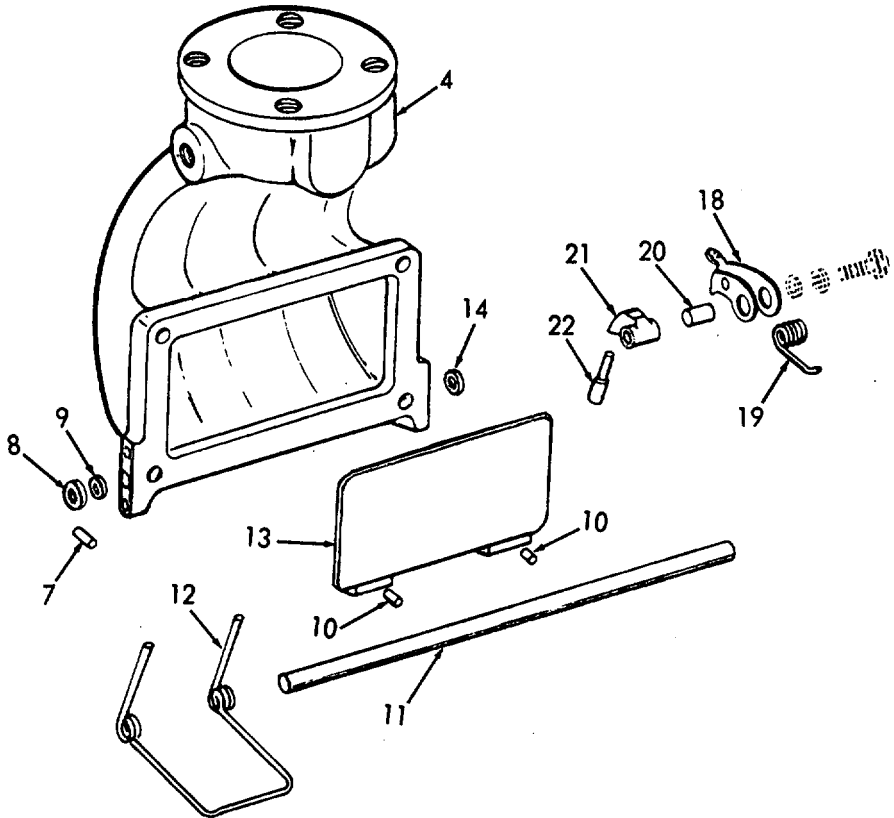
LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5. Air intake	a. Shut-down valve (13) and shut-down valve spring (12)	Place in position in air intake housing (4) before installing shutdown valve shaft (11).	Face of shut-down valve must be perfectly tight to assure a tight seal in the shut-down position.
	b. Shut-down valve shaft (11)	Install in air intake housing (4)	Shaft (11) must extend 0.76 inch (1.9 cm) from latch side of housing (4).
	c. 2 roll pins (10)	Install.	If new shutdown valve (13) or shaft (11) is installed, holes for roll pins (10) must be drilled.
	d. Seal rings (14) and (9)	Install.	
	e. Cam (21)	Install.	
	f. Handle (22)	Install.	If new shaft (11) is installed, hole for handle (22) pin must be drilled.

3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- |  |                      |                         |  |
|--|----------------------|-------------------------|--|
|  | g. Flat-washer (8)   | Install.                |  |
|  | h. Roll pin (7)      | Install.                | If new shaft (11) is installed, hole for roll pin (7) must be drilled. |
|  | i. Latch spacer (20) | Assemble on shaft (11). |  |
|  | j. Latch spring (19) | Assemble in latch (18)  |  |

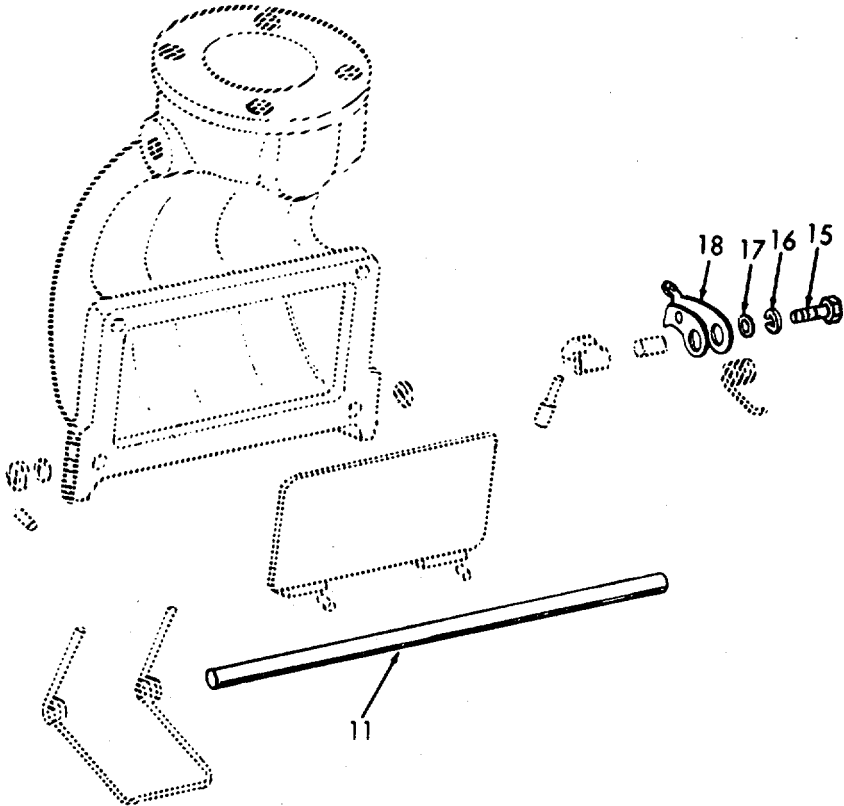


3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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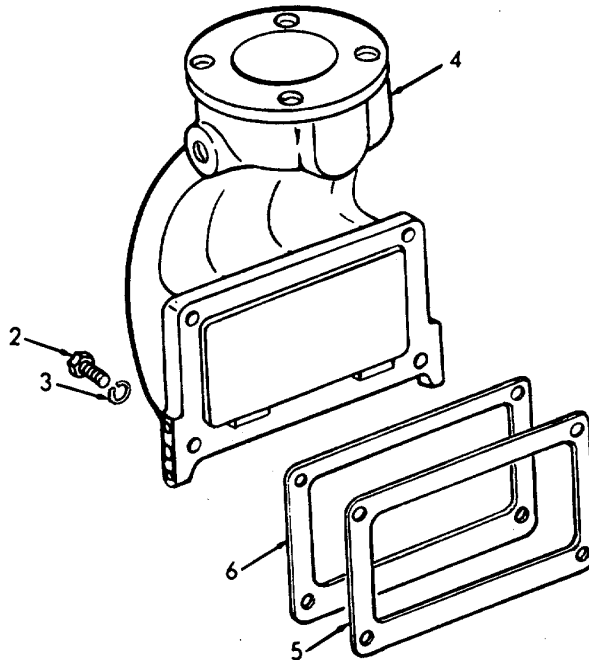
REPAIR (Cont)

- k. Flat-washer (17), lock-washer (16) and cap screw (15)  
Slip through latch (18), and secure to shaft (11).



3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
6. Air intake	a. Striker plate-to-air intake housing gasket (6)	Place against air intake housing (4).	
	b. Striker plate (5)	Place against striker plate-to-air intake housing gasket.	
	c. Air intake housing (4)	Position on blower housing.	
	d. Cap-screws (2) and lock-washer (3)	Install.	Screw 3/8-16 x 1-5/8 inch.



**3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).**

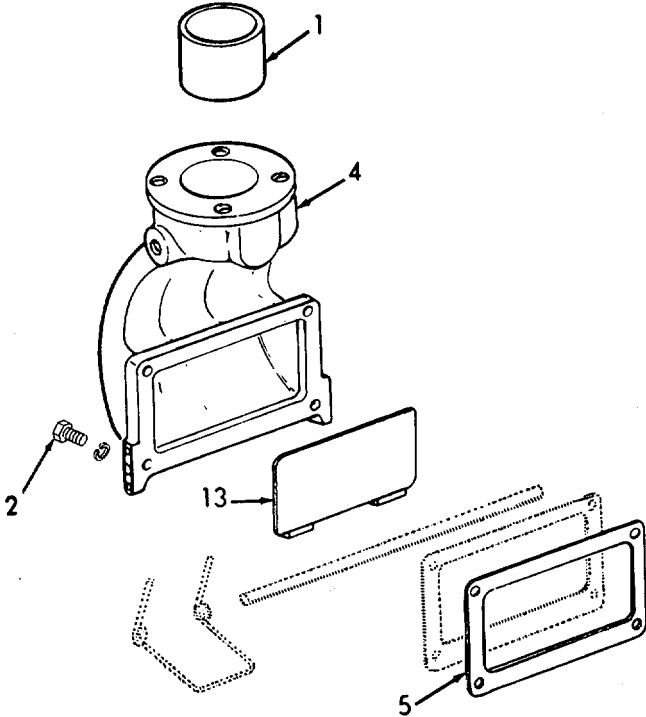
LOCATION	ITEM	ACTION	REMARKS	
<b>INSTALLATION (Cont)</b>				
7.	Emergency shut-down	Cable and linkage	Install.	Refer to paragraph 3-65.1.
8.	Shut-down solenoid	Linkage and bracket	Install.	Refer to paragraph 3-65.2.
9.	Air intake	a. Cap-screw (2) and those from paragraph 3-65.2.	Tighten.	Torque cap screws evenly to 16-20 lb. ft. (21.8 to 27.3 Nm).
		b. Air cleaner mounting tube (1)	Install.	
		c. Air intake housing (4)	Check by starting and running the generator engine at idle speed and no load. Trip the air shutdown. If the engine does not stop, check for air leakage between the shutdown valve (13) and the striker plate (5). Re-position valve as necessary.	
		d. Air cleaner	Install.	See paragraph 3-74.



3-67. AIR INTAKE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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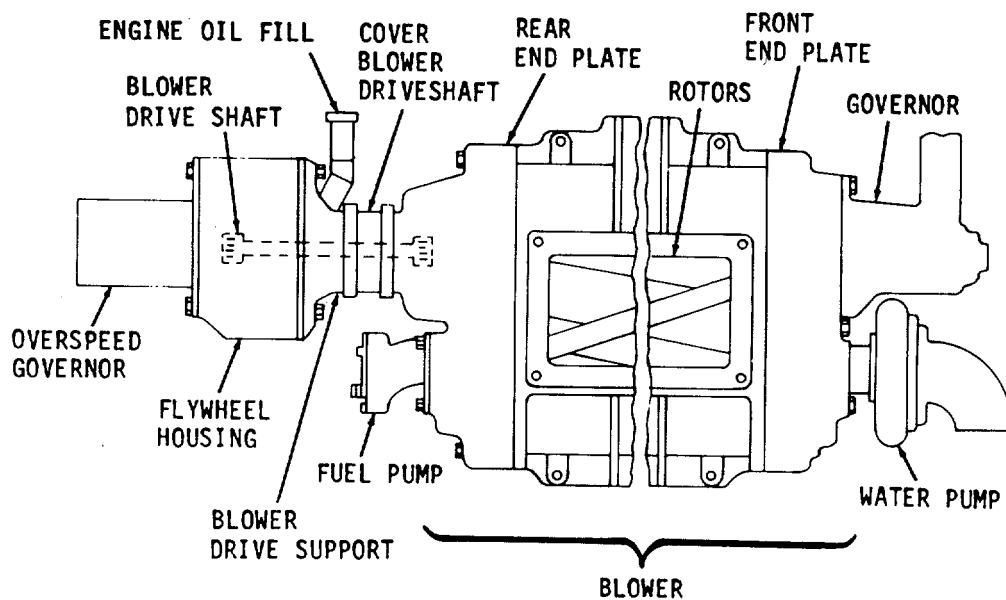
INSTALLATION (Cont)



3-1215

### 3-68. BLOWER - MAINTENANCE INSTRUCTIONS.

- a. The blower supplies the fresh air needed for combustion and scavenging. Its operation is similar to that of a gear-type oil pump. Two hollow three-lobe rotors revolve with very close clearances in a housing bolted to the cylinder block. To provide continuous and uniform displacement of air, the rotor lobes are made with a helical (spiral) form.
- b. Two timing gears, located in the rear end-plate of the rotor shafts, space the rotor lobes with a close tolerance; therefore, as the lobes of the upper and lower rotors do not touch at any time, no lubrication is required.
- c. Oil seals located in the front and rear blower end plates prevent air leakage and also keep the oil used for lubricating the timing gears and rotor shaft bearings from entering the rotor compartment.
- d. The blower upper rotor is driven by the blower drive shaft which is coupled to the upper rotor timing gear by means of a flexible drive hub located in the flywheel housing.
- e. A flexible coupling, formed by an elliptical cam, driven by two bundles of leaf springs which ride on four semi-cylindrical supports and spring seats is attached to the blower drive gear and prevents the transfer of torque fluctuations to the blower.
- f. The blower drive gear is mounted in the blower drive gear support and in addition to driving the blower, drives the governor, water pump and fuel pump.



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**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

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## g. LUBRICATION

(1) Oil drains from the valve operating mechanism on the cylinder head into the camshaft pocket in the cylinder block; then, when it reaches a certain level, the oil flows from the pocket into cavities at the upper corners of the blower and through passages in the blower and end plates to lubricate the bearings, governor and water pump drives at the front end, and bearings and gears at the rear end of the blower. A slinger attached to the front end of the lower rotor shaft throws oil onto the front roller bearings and governor weights. A dam in the blower end plates maintains oil at a level adequate to submerge the lower portion of the slinger and the driven gear.

(2) Surplus oil overflows the dams in the end plates and returns through two drilled holes in the cylinder block to the engine crankcase.

**3-1217**

**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. Inspection
- c. Removal
- e. Installation
- b. Repair`
- d. Service

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Torque wrench

Equipment Condition Condition Description  
Para

Material/Parts

Gasket kit - P/N 5193113  
Gasket kit - P/N 5192753

- 3-65. Emergency Shutdown Solenoid
- 3-66. Governor
- 3-67. Oil Intake Housing
- 3-69. Fuel Pump
- 3-74. Fresh Water Pump
- 3-81. Air Cleaner Removal
- 3-10. Hydrostarter Solenoid

Special Environmental Conditions

Do not drain oil or anti-freeze into bilge.

Personnel Required

2

General Safety Instructions

Observe CAUTION when operating engine.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

1. Blower (Engine not running)	a. Hoses	1. Inspect for breaks, wear or defects. 2. Inspect for leaks. 3. Inspect for loose hose clamps.	
	b. Housing	1. Inspect for oil leaks.	

**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Blower drive support	a. Oil fill pipe	2. Inspect for breaks, dents, cracks or damage.	
		3. Inspect for loose mounting hardware.	
		Inspect for leaks, breaks and damage.	
	b. Housing	1. Inspect for breaks, cracks and damage.	
2. Inspect for leaking oil.			
3. Inspect for tight hardware.			
3. Blower (Engine running)	c. Hoses	Inspect for wear, breaks, or defects.	
	d. Tubing	Inspect for breaks, bends, or damage.	

**NOTE**

The air intake (paragraph 3-67.) and the emergency shutdown solenoid (paragraph 3-65.) must be removed to perform the following inspections.



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

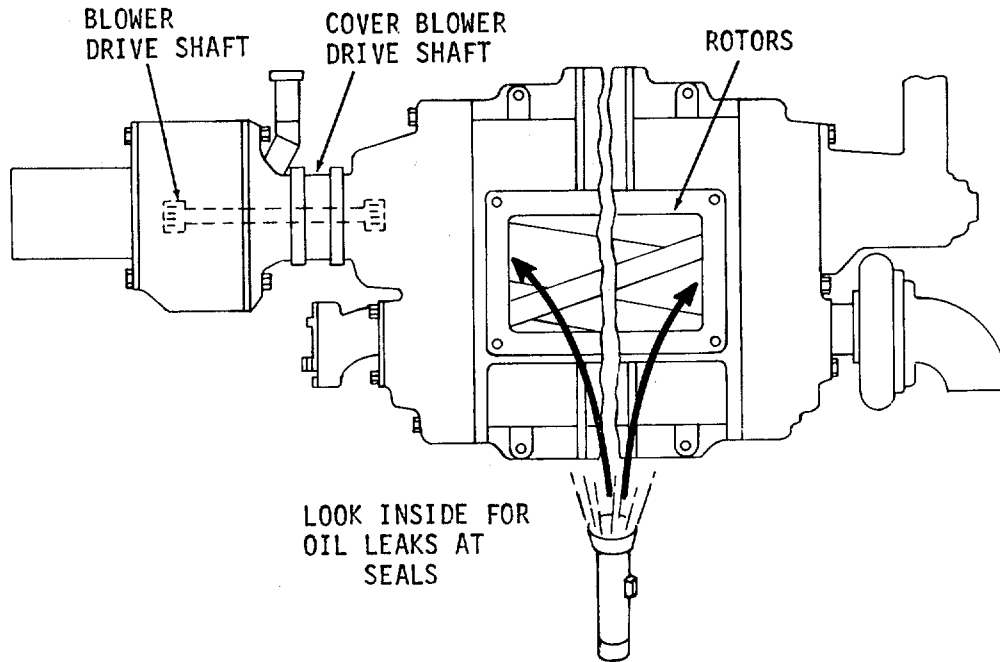
**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	a. Rotors	Dirt or chips drawn through 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 or between the rotors and the housing, remove the blower from the engine and dress the parts down to eliminate the interference, or replace the rotors if they are too badly scored.	
	b. Oil seals	Leaky oil seals are usually manifested by the presence of oil on the blower end plates and rotors or the 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 is indicative of an oil leak.	To correct any of the above conditions, remove the blower from the engine and replace it.

3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION (Cont)



c. Blower drive

A worn blower drive, resulting in a rattling noise inside the blower, may be detected by grasping the top rotor firmly and attempting to rotate it. Rotors may move from 3/8" to 5/8", measured at the lobe crown, with a springing action. When released, the rotors should move back at least 1/4". If the rotors cannot be moved as directed above, or if the rotors move too freely, inspect the flexible blower drive coupling and replace it if necessary.

To correct any of the above conditions, remove the blower from the engine and replace it.

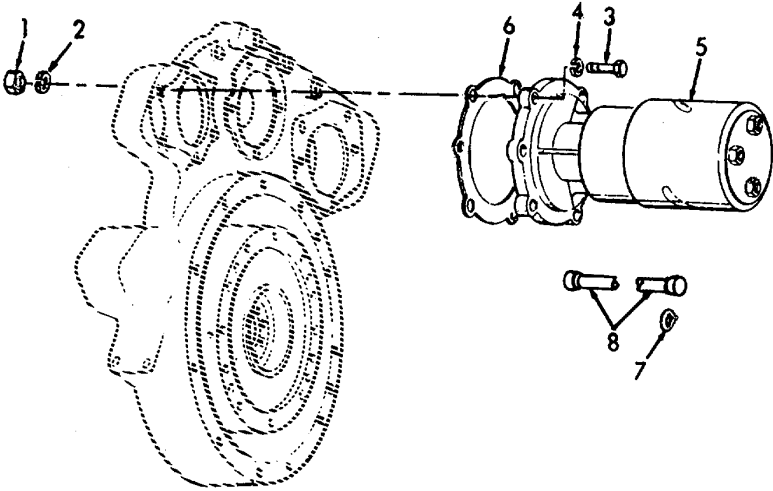
**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	d. Rotor shafts	<p>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. A loose shaft usually causes rubbing between the rotors and the end plates. Worn or damaged bearings will cause rubbing between the mating rotor lobes at some point or perhaps allow the rotor assemblies to rub the blower housing. This condition will usually show up at the end where the bearings have failed.</p> <p>Excessive back-lash between the blower timing gears usually results in the rotor lobes rubbing throughout their entire length.</p>	To correct any of the above conditions, remove the blower from the engine and replace it.
	e. Blower screen	Inspect the blower inlet screen periodically for an accumulation of dirt which, after prolonged operation, may affect the air flow.	To correct any of the above conditions, remove the blower from the engine and replace it.



3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Blower drive shaft	a. Nuts (1) lock-washers (2)	Remove four.	
	b. Screws (3) and flat-washers (4)	Remove four.	
	c. Over-speed governor (5) and gasket (6)	Remove.	Discard gasket.
	d. Snap ring (7)	Remove.	
	e. Blower drive shaft (8)	Pull drive shaft out of flywheel housing.	



3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

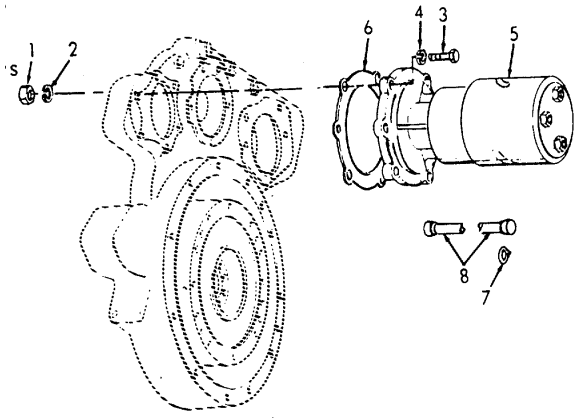
LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

NOTE

1. The blower drive shaft may have a hole tapped into the shaft end. This can be an aid in removing the shaft.
2. If the blower drive shaft is broken and it is not possible to remove all the pieces, the blower MUST be removed. Refer to step #5.

- |    |   |   |                |
|----|---|---|----------------|
| f. | Blower drive shaft (8)                                      | Install. Push the plain end, without the squared hole, through the blower drive coupling in the flywheel housing. |                |
| g. | Snap ring (7)   | Replace.  |                |
| h. | Gasket (6) and over-speed governor (5)                      | Replace.  | Use new gasket |
| i. | Screws (3), flat-washers (4), lock-washers (2) and nuts (1) | Replace.  |                |



**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
5. Engine	a. Air cleaner	Remove.	Refer to paragraph 3-81.
	b. Hydro-starter solenoid	Remove.	Refer to paragraph 3-107.
	c. Emergency shut-down solenoid	Remove.	Refer to paragraph 3-65.
	d. Governor	Remove.	Refer to paragraph 3-66.
	e. Fresh water pump	Remove.	Refer to paragraph 3-75.
	f. Fuel pump	Remove.	Refer to paragraph 3-69.
	g. Air intake housing	Remove.	Refer to paragraph 3-67.
	h. Blower drive shaft	Remove.	Refer to step 4.

**3-1225**

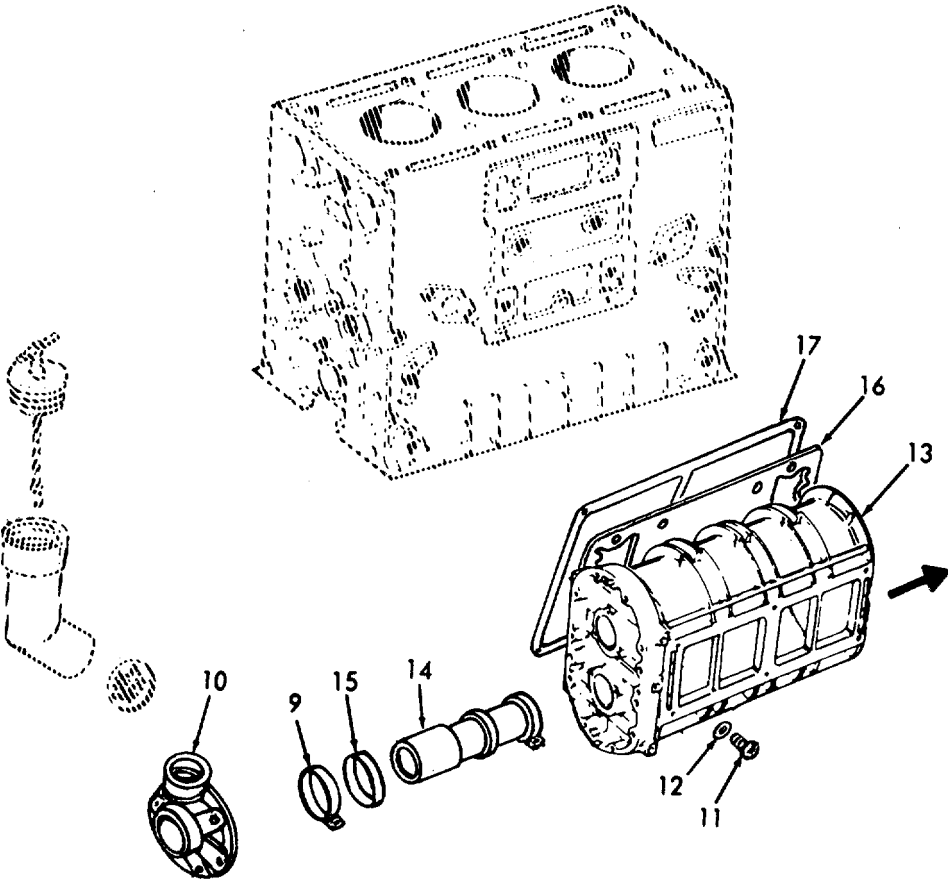
**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
6. Blower	a. Blower drive cover packing clamp (9)	Loosen at blower drive gear hub support (10).	
	b. Screws (11) and flat-washers (12)	Remove.	
	c. Blower (13)	Slide forward slightly.	
	d. Blower drive shaft cover (14) and seal (15)	Withdraw cover from seal.	
	e. Blower (13)	Lift blower from cylinder block.	
	f. Gasket (16)	Remove.	Discard gasket.
	g. Screen (17)	Remove.	Discard screen.

3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



SERVICE

7. Blower screen

The blower screen can be washed in fuel oil and cleaned with a stiff brush until the screen is free of all dirt deposits.

**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION
--------------

**NOTE**

The fuel pump and fresh water pump can be installed on the blower prior to reassembly.

8. Blower

**NOTE**

Before attaching the blower to the engine, check the inside of the blower for any foreign material and revolve the rotors by hand to be sure they turn freely.

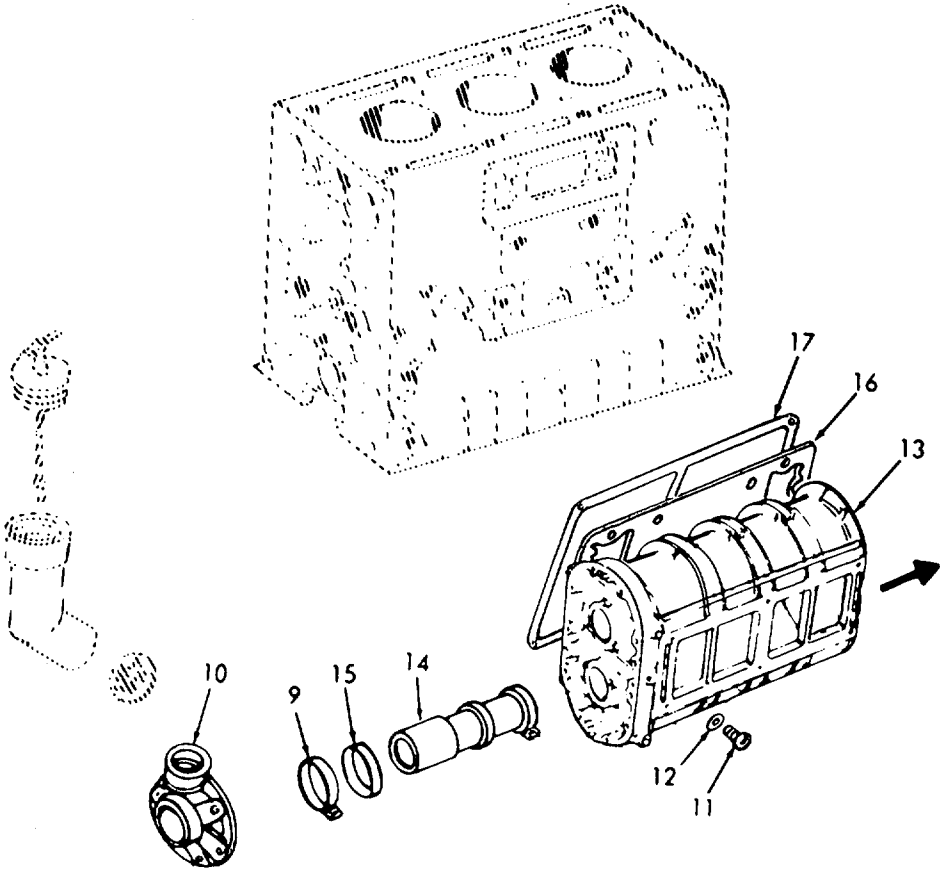
- |   |   |   |
|---|---|---|
| a. Screen (17) and gasket (16)                  | Affix to engine block.                      | Use a new gasket. Affix with Scotch Grip Rubber Adhesive #4300 or equivalent. |
| b. Blower drive seal (15) and packing clamp (9) | Place on drive shaft cover (14)             | Use a new seal and clamp.   |
| c. Fresh water pump                             | Install on blower.                          | Refer to paragraph 3-75.  |
| d. Fuel pump                                    | Install on blower.                          | Refer to paragraph 3-69.  |
| e. Blower (13)                                  | Place into position against cylinder block. | Be careful not to move blower gasket.   |
| f. Screws (11) and flat-washers (12)            | Install.                                    | Torque to 55-60 lb. ft. (74.58-81.36 Nm)                                      |

3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- g. Blower drive shaft seal (15)  
Slide seal into position against the blower drive gear hub support (10).
- h. Packing clamp (9)  
Tighten.



**3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).**

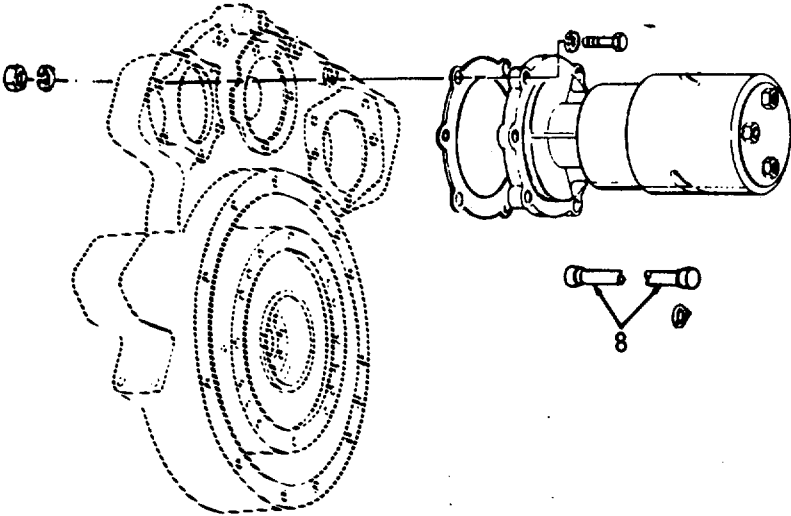
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	i. Blower drive shaft (8)	Install.	Refer to step 4. If necessary, rotate the blower rotors slightly to align the splines of the drive shaft with those in the gear hub.
	j. Fresh water pump	Complete installation.	Refer to paragraph 3-75.
	k. Fuel pump	Complete installation.	Refer to paragraph 3-69.
	l. Governor	Install.	Refer to paragraph 3-66.
	m. Air intake housing	Install.	Refer to paragraph 3-67.
	n. Emergency shut-down solenoid	Install.	Refer to paragraph 3-65.
	o. Hydro-starter solenoid	Install.	Refer to paragraph 3-107.
	p. Air cleaner	Install.	Refer to paragraph 3-81.



3-68. BLOWER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



3-1231

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**3-69. 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.

**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Removal
- b. Disassembly and Inspection
- c. Inspection and Cleaning
- d. Assembly and Installation

INITIAL SETUP:

Test Equipment  
NONE

References  
NONE

Special Tools

Holding fixture J1508-10  
Oil seal puller J1508-13  
(oil seal installer  
J1508-8 & 9)

Equipment  
Condition      Condition Description  
Para

3-72      Fuel lines disconnected

Material/Parts  
Kit P/N 5196938  
Vegetable shortening

Special Environmental Conditions  
NONE

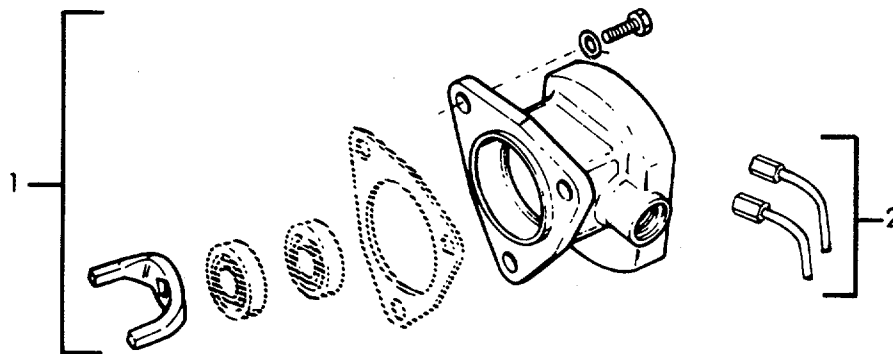
Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

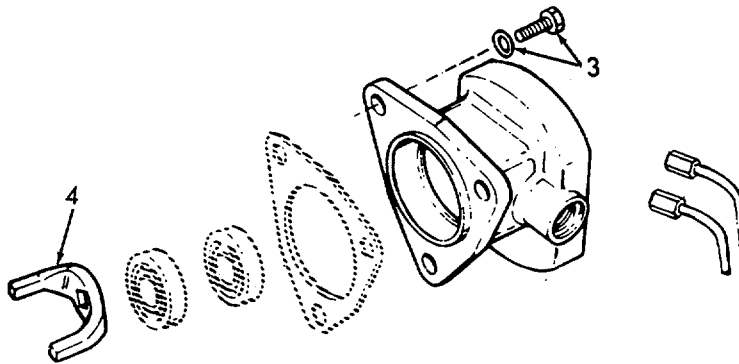
- |    |               |                |             |
|----|---------------|----------------|-------------|
| 1. | Fuel pump (1) | Fuel lines (2) | Disconnect. |
|----|---------------|----------------|-------------|



3-1233

**3-69. FUEL PUMP-MAINTENANCE INSPECTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
2. Governor housing	Fuel pump	Withdraw pump from housing.	Remove three bolts, washer and seal assemblies (3).
3. End of fuel pump	Drive coupling fork (4)	Examine for damage or wear.	Replace if damaged or worn.

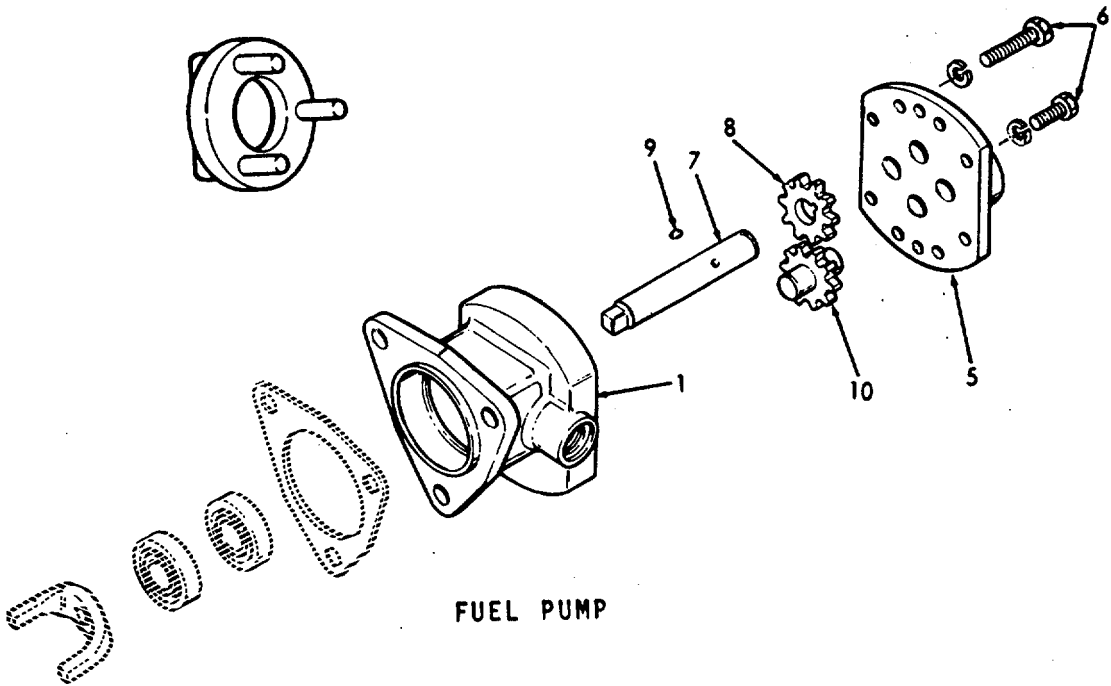


**DISASSEMBLY and INSPECTION I**

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 lock-washers (6).
6.	Drive shaft (7), drive gear (8) and gear retaining ball (9)	Withdraw as an assembly.	

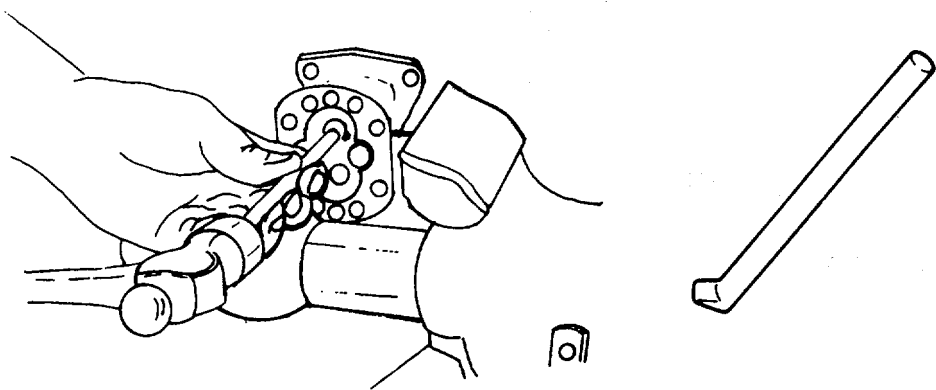
3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY AND INSEPECTION (Cont)			
7.	Drive shaft Gear retain- ing ball	Press drive shaft just enough to re- move 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 (1 0)	Remove from pump body as an assembly.	Do not separate gear and shaft.



**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

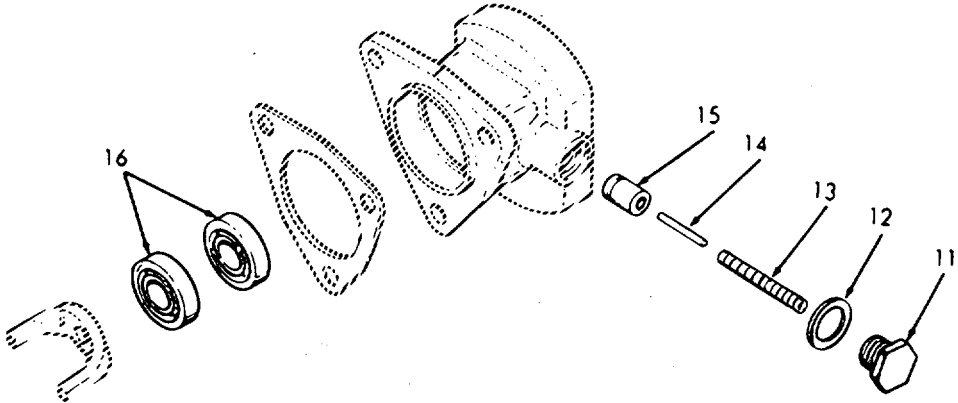
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY AND INSEPECTION (Cont)			
9.	Relief valve plug (11) and copper gasket (12)	Unscrew and remove.	
10.	Valve spring (13), pin (14) and re-lief valve (15)	Remove from pump body.	
11.	Oil seals (16)	Inspect for damage, scores, and fit. To remove: Clamp pump body in 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 the same manner.



3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

DISASSEMBLY AND INSEPECTION (Cont)



INSPECTION AND CLEANING

**WARNING**

Wear eye protection when using compressed air.

12.	All parts (notdry oil seals)	Clean all parts with clean fuel oil and with compressed air.
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**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

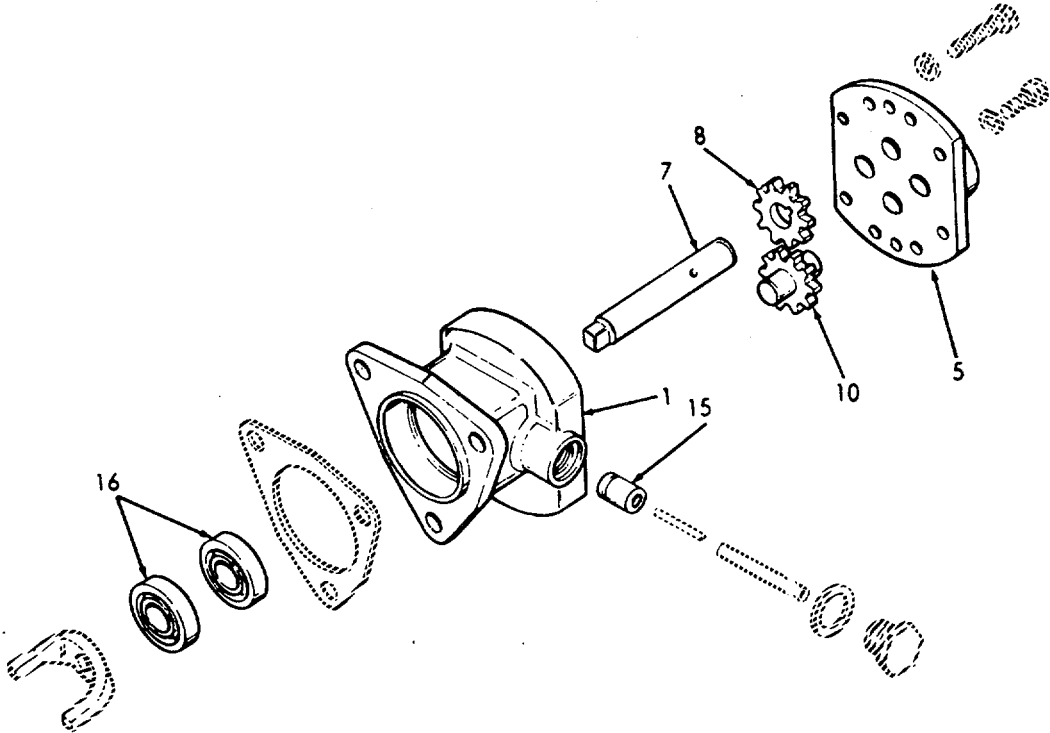
LOCATION	ITEM	ACTION	REMARKS
INSPECTION and CLEANING (Cont)J			
13.	Pump body (1) damage. And cover (5)	Check mating surfaces for scratches or other. Check for wear at areas contacted by gears and shafts. Replace if necessary.	Surface must fit flat and smooth.
14.	Gear (8)	Check gear teeth for chipping, scoring or wear. Check ball slot for wear.	Replace if necessary.
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.	



3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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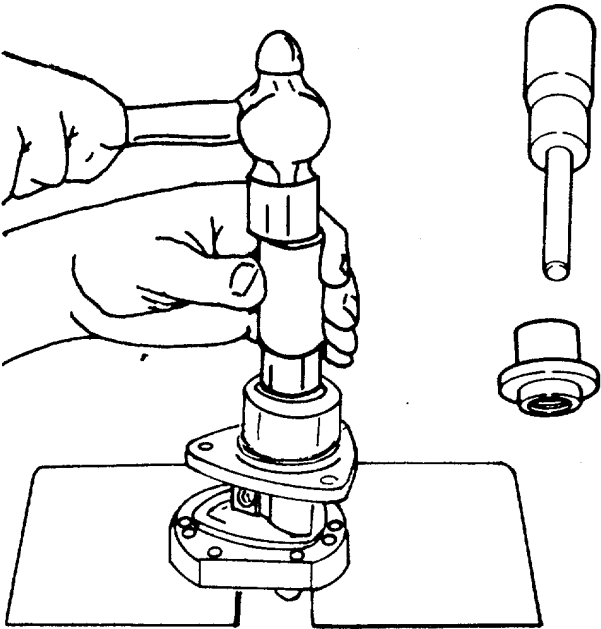
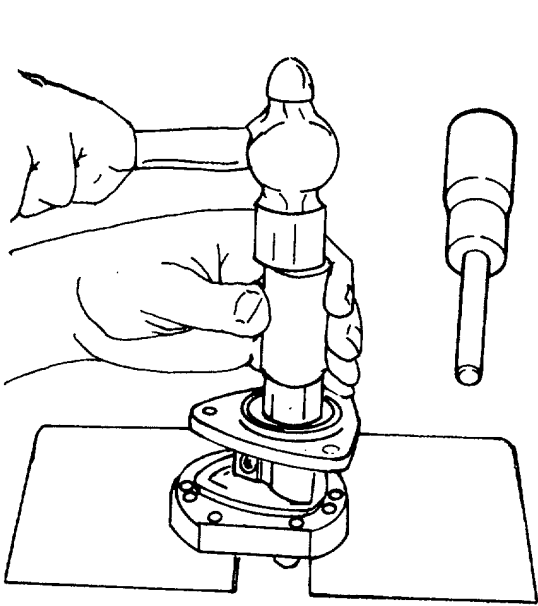
INSPECTION and CLEANING (Cont)
--------------------------------



3-1239

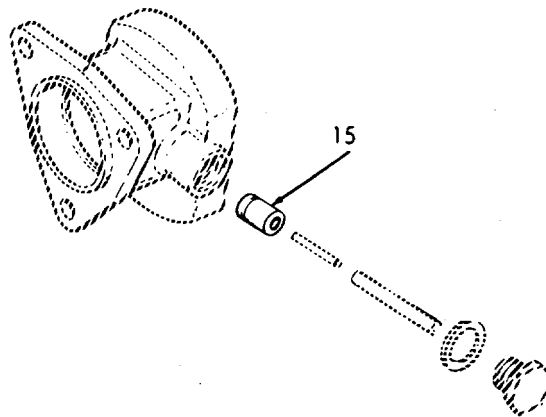
3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY AND INSTALLATION</b>			
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.



**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

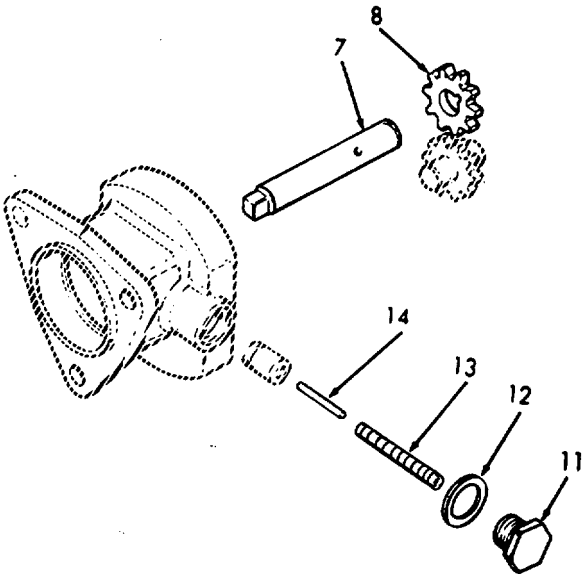
LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY AND INSTALLATION (Cont)			
	c. Outer oil seal	Place shorter end of adaptor over pilot and against shoulder of installer handle. Place outer oil seal on pilot of installer handle with lip of seal facing adaptor. Insert pilot of installer handle into pump body and 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.



3-1241

**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY AND INSTALLATION (Cont)</b>			
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.

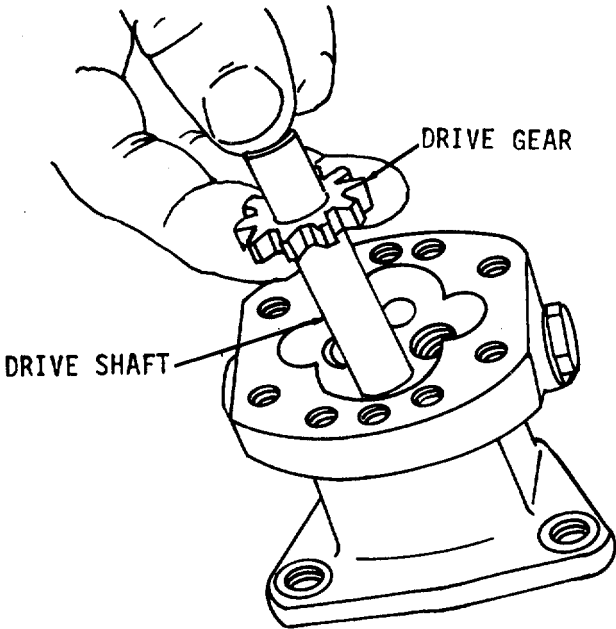


3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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ASSEMBLY AND INSTALLATION (Cont)

24. Pump body, gear side	Drive shaft	Insert square end of shaft into opening of gear side of pump body and through oil seals.	Lubricate shaft first with clean engine oil.
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3-1243

**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

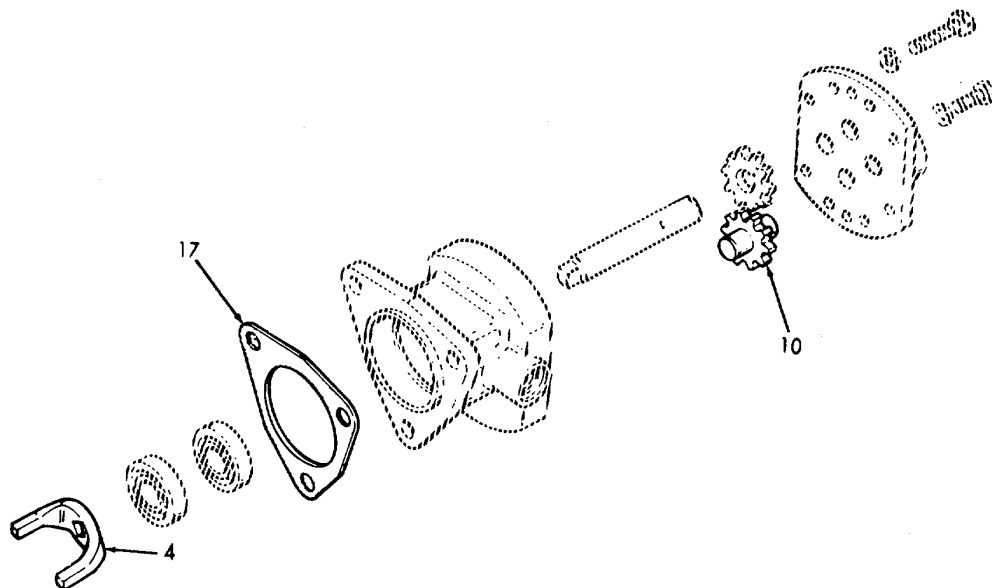
LOCATION	ITEM	ACTION	REMARKS	
<b>ASSEMBLY AND INSTALLATION (Cont)</b>				
25.	Driven shaft and gear assembly (10)	Place assembly in pump body, having chamfered end of gear teeth facing pump body. If a replacement assembly with a slot is used, then the slot must face the pump cover.	Make certain that gear is centered on shaft.	
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 lock-washers. Tighten alternately and evenly.	Eight bolts and lock-washers.
30.		Pump shaft	Rotate shaft by hand to insure that all parts rotate freely.	If shaft sticks, tap corner of pump and 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.

**3-69. FUEL PUMP-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY AND INSTALLATION (Cont)</b>			
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.	
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.	



**3-70. FUEL FILTER, FUEL STRAINER-MAINTENANCE INSTRUCTIONS.**

a. A fuel strainer (primary) and fuel filter (secondary), are used to remove impurities from the fuel. The fuel strainer is located between the fuel tank and the fuel pump. The replaceable density-type element is capable of filtering out particles of 30 microns (a micron is approximately .00004"). The fuel filter is installed between the fuel pump and the fuel inlet manifold. The replaceable paper-type element can remove particles as small as 10 microns.

b. The fuel strainer and fuel filter are essentially the same in construction and operation.

c. The filter and strainer consist basically of a shell, a cover and a replaceable filtering element. The assembly is made oil tight by a shell gasket, a cover nut or bolt, and a cover nut or bolt gasket.

d. The central stud is a permanent part of the shell and, when the unit is assembled, extends up through the cover where the nut or bolt holds the assembly together.

e. A filter element sets over the central stud inside the shell and is centered in the shell by the stud.

f. Operation

(1) Since the fuel strainer is between the fuel supply tank and the fuel pump, it functions under suction. The fuel filter, placed between the fuel pump and the fuel inlet manifold in the cylinder head, operates under pressure. Fuel enters through the inlet passage in the cover and into the shell surrounding the filter element. Pressure or suction created by the pump 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 and into the outlet passage, then to the fuel inlet manifold in the cylinder head.

(2) The following paragraphs contain the maintenance instructions:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Fuel Filter	3-70.1
Fuel Strainer	3-70.2



**3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS**

This task covers:

- a. Inspection
- b. Service
- c. Removal
- d. Installation
- e. Repair

INITIAL SETUP:

Test Equipment  
NONE

References  
NONE

Special Tools  
  
None

Equipment Condition      Condition Description  
Para

NONE

Material/Parts  
Filter element with gasket P/N 5573261

Special Environmental Conditions  
Do not drain fuel into bilges.

Personnel Required  
1

General Safety Instructions  
Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

<b>INSPECTION</b>
-------------------

1.	Fuel filter assembly	<ul style="list-style-type: none"> <li>a. Shell and cover</li> <li>b. Inlet and outlet tube connections</li> <li>c. Cover screw gasket</li> <li>d. Engine</li> </ul>	<ul style="list-style-type: none"> <li>Inspect shell-to-cover seals for leakage.</li> <li>Inspect for leakage.</li> <li>Check for leakage under screw head.</li> <li>Check for erratic operation caused by shortage of fuel or flow obstructions.</li> </ul>	<ul style="list-style-type: none"> <li>If fuel flow is restricted, replace filter element.</li> </ul>
----	----------------------	--	--	---

**3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>SERVICE</b>			
2. Fuel filter assembly	a. Engine	Shut down.	
	b. Drain-cock (1)	Rotate counter-clockwise.	Place a suitable container under the filter assembly to catch fuel oil. Loosen screw (2) just enough to allow fuel to drain freely. When fuel has drained out, close draincock.

**CAUTION**

The wiring harness or other electrical equipment must be shielded when draining the fuel, since fuel oil can permanently damage the electrical insulation.

c. Screw (2)	Remove supporting shell (3).	
d. Gasket (4)	Remove.	Discard gasket.
e. Gasket (5)	Remove.	Discard gasket.
f. Filter element (6)	Remove.	Discard filter element.
g. Filter element seat retainer (7) and seat (8)	Remove.	

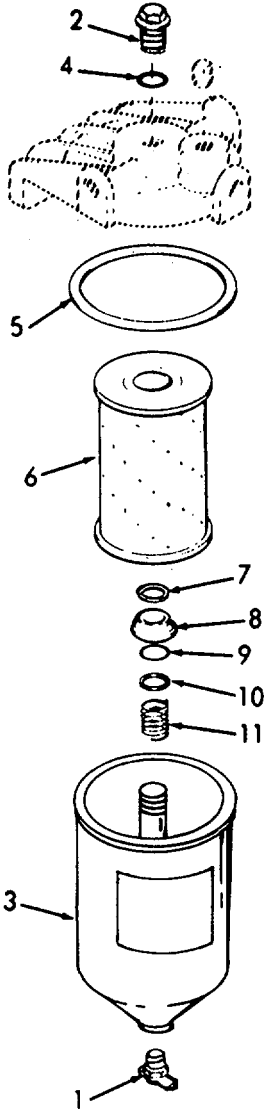
3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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SERVICE (Cont)

h. Seat seal (9), spring seat (10) and spring (11)

Remove.

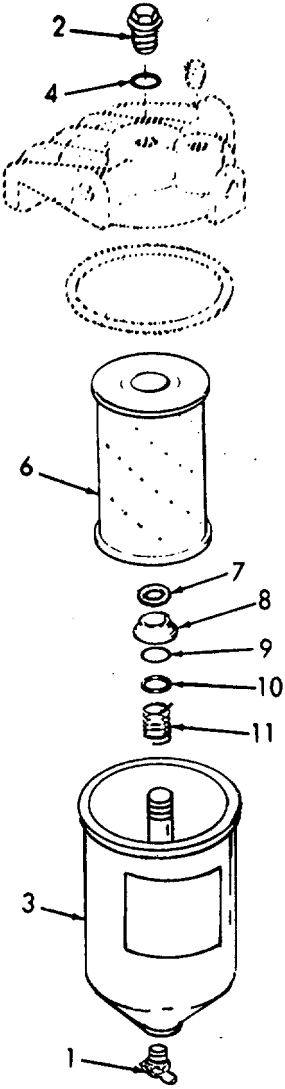


**3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
<div style="border: 2px solid black; padding: 5px; display: inline-block;"><b>WARNING</b></div>			
Wear eye protection when using compressed air.			
	i. Shell (3)	Clean all parts.	Wash thoroughly with clean fuel oil and dry with compressed air.
	j. Seat seal (9)	Inspect for hardening or cracks.	
	k. Spring (11), spring seat (10), seat seal (9), seat (8) and element seat retainer (7)	Install.	Check by pressing on element seat (8). When released, the spring must return against the retainer (7). If necessary, replace spring.
	l. Drain cock (1)	Rotate clockwise to close.	
	m. Replacement element (6)	Place over center stud of shell (3) and push it against the element seat (8).	

3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)	n. Shell (3)	Fill about two-thirds full with clean fuel oil.	
	o. Cover screw gasket (4)	Install on screw (2).	Use new gasket.



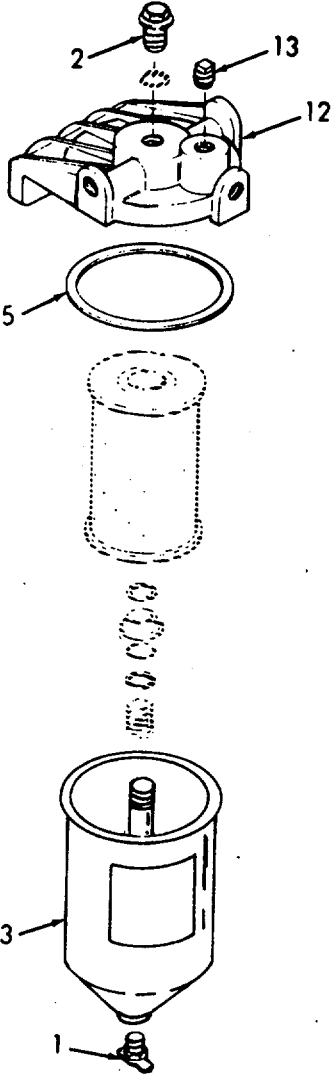
**3-70.1. FUEL FILTER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	p. Shell gasket (5)	Place in recess of shell (3).	Use new gasket.
	q. Shell (3) with filter element	Place under cover (12). Secure with screw (2).	Tighten screw just enough to prevent fuel leakage.
	r. Plug (13)	Remove.	Completely fill shell (3) with fuel oil.
	s. Plug (13)	Reinstall.	
	t. Engine	Start and check fuel system for leaks.	
REMOVAL			
3. Fuel filter assembly	a. Engine	Shut down.	
	b. Drain-cock (1)	Rotate counter-clockwise.	Open drain-cocks after placing a suitable container under the filter assembly to catch the fuel oil. Loosen screw (2) just enough to allow fuel to drain freely. When fuel has drained out, close the draincock.

3-70.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)



3-1253

**3-70.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)
----------------

CAUTION
---------

The wiring harness or other electrical equipment must be shielded when draining the fuel since fuel oil can permanently damage the electrical insulation.

- |    |                |                           |
|----|----------------|---------------------------|
| c. | Inlet<br>hose  | Disconnect at elbow (14). |
| d. | Outlet<br>hose | Disconnect at elbow (15). |

**NOTE**

Removal of the fuel filter assembly can be made easier if the filter element shell is removed. Refer to Service - Step 2.

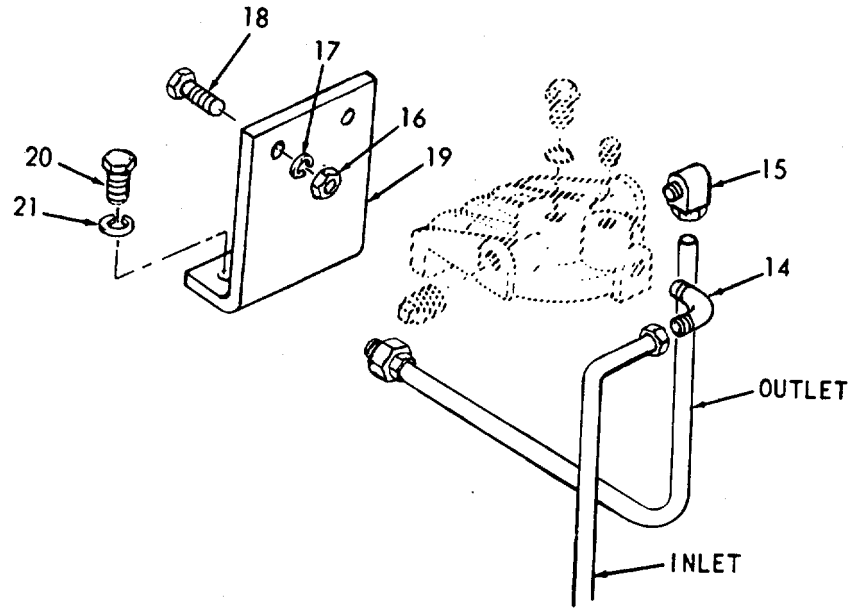
- |    |   |                                       |
|----|---|---------------------------------------|
| e. | Nuts<br>(16),<br>lock-<br>washers<br>(17),<br>cap<br>screws<br>(18),<br>and<br>filter<br>assembly | Remove from mounting<br>bracket (19). |
| f. | Screws<br>(20)<br>and<br>lock-<br>washers<br>(21)   | Remove.                               |
| g. | Bracket<br>(19)   | Remove.                               |



3-70.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)



INSTALLATION

- |                         |  |                             |
|-------------------------|--|-----------------------------|
| 4. Fuel Filter assembly | a. Bracket (19), screws (20) and lock-washers (21)               | Reassemble.                 |
|                         | b. Filter assembly, screws (18), lock-washers (17) and nuts (16) | Reassemble on bracket (19). |

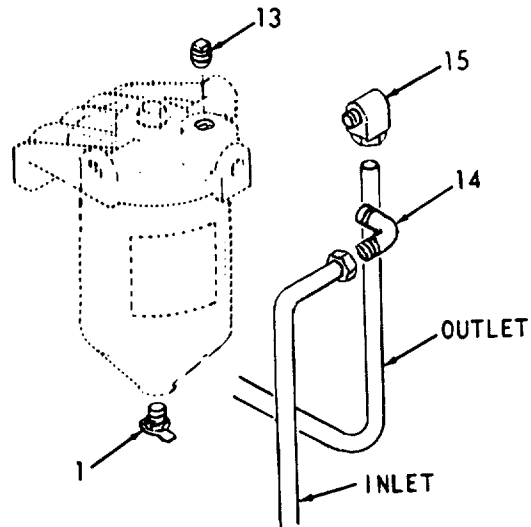
3-70.1. FUEL FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	c. Outlet line	Reconnect elbow (15).	
	d. Inlet line	Reconnect elbow (14).	
	e. Drain-cock (1)	Make sure it is closed.	
	f. Plug (13)	Remove completely. Fill shell with fuel oil. Reinstall plug (13).	
	g. Engine	Start and check fuel system for leaks.	

**REPAIR**

- 5. Fuel filter assembly

Repair fuel filter bracket and cap in accordance with standard procedures.



**3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- |                      |                        |                  |
|----------------------|------------------------|------------------|
| <b>a. Inspection</b> | <b>c. Removal</b>      | <b>e. Repair</b> |
| <b>b. Service</b>    | <b>d. Installation</b> |                  |

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment  
Condition Condition Description

Para  
NONE

Material/Parts

Strainer element with gasket P/N T553

Special Environmental Conditions

Do not drain fuel into bilges.

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

<b>LOCATION</b>	<b>ITEM</b>	<b>ACTION</b>	<b>REMARKS</b>
-----------------	-------------	---------------	----------------

<b>INSPECTION</b>
-------------------

1.	Fuel strainer assembly	<ul style="list-style-type: none"> <li>a. Shell and cover</li> <li>b. Inlet and outlet tube connection.</li> <li>c. Cover screw gasket</li> <li>d. Engine</li> </ul>	<ul style="list-style-type: none"> <li>Inspect shell-to-cover seal for leakage.</li> <li>Inspect for leakage.</li> <li>Check for leakage under screw head.</li> <li>Check for erratic operation caused by shortage of fuel or flow obstruction-</li> </ul>	<ul style="list-style-type: none"> <li>If fuel flow is restricted, replace strainer element.</li> </ul>
----	------------------------	--	--	---

**3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
<b>SERVICE</b>			
2. Fuel strainer assembly	a. Engine	Shut down.	
	b. Drain-cock (1)	Rotate counter-clockwise.	Open draincock after placing a suitable container under the strainer assembly to catch the fuel oil. Loosen screw (2) just enough to allow fuel to drain freely. When fuel has drained out, close the draincock.

**CAUTION**

The wiring harness or other electrical equipment must be shielded when draining the fuel since fuel oil can permanently damage the electrical insulation.

c. Screw (2)	Remove while supporting shell (3).	
d. Gasket (4)	Remove.	Discard gasket.
e. Gasket (5)	Remove.	Discard gasket.
f. Strainer element (6)	Remove.	Discard strainer element.
g. Strainer element seat retainer (7) and seat (8)	Remove.	



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**3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.**


---

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

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SERVICE (Cont)
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**WARNING**

Wear eye protection when using compressed air.

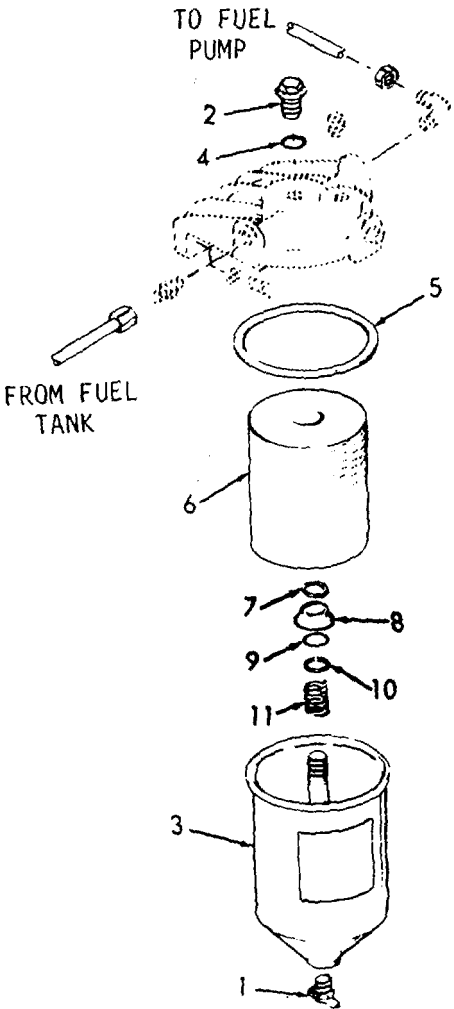
- |    |   |   |   |
|----|---|---|---|
| i. | Shell<br>(3)  | Clean all parts.  | Wash thoroughly with clean fuel oil and dry with compressed air.  |
| j. | Seat<br>seal<br>(9)   | Inspect for hardening or cracks.  |   |
| k. | Spring<br>(11),<br>spring<br>seat<br>(10),<br>seat<br>seal<br>(9),<br>seat<br>(8)<br>and<br>element<br>seat<br>retainer (7) | Install.  | Check by pressing on element seat (8). When released, the spring must return against the retainer (7). If necessary, replace. |
| l. | Drain-<br>cock<br>(1)   | Rotate clockwise to close.  |   |
| m. | Re-<br>placement<br>element<br>(6)  | Place over center stud of shell (3) and push it against the element seat (8). |   |
| n. | Shell<br>(3)  | Fill about two-thirds full with clean fuel oil.                               |   |

3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

SERVICE (Cont)

- o. Cover screw gasket (4)                      Install on screw (2).                      Use new gasket.
- p. Shell gasket (5)                      Place in recess of shell (3).                      Use new gasket.



**3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
<b>SERVICE (Cont)</b>			
	q. Shell (3) with strainer-element	Place under cover (12). Secure with screw (2).	Tighten screw just enough to prevent fuel leakage.
	r. Plug (13)	Remove.	Completely fill shell (3) with fuel oil.
	s. Plug (13)	Re-install plug	
	t. Engine	Start and check the fuel system for leaks.	
<b>REMOVAL</b>			
3. Fuel strainer assembly	a. Engine	Shut down.	
	b. Drain-cock (1)	Rotate counter-clockwise.	Open draincock after placing a suitable container under the strainer assembly to catch the fuel oil. Loosen screw (2) just enough to drain freely. When fuel has drained out, close the draincock.

**CAUTION**

The wiring harness or other electrical equipment must be shielded when draining the fuel since fuel oil can permanently damage the electrical insulation.

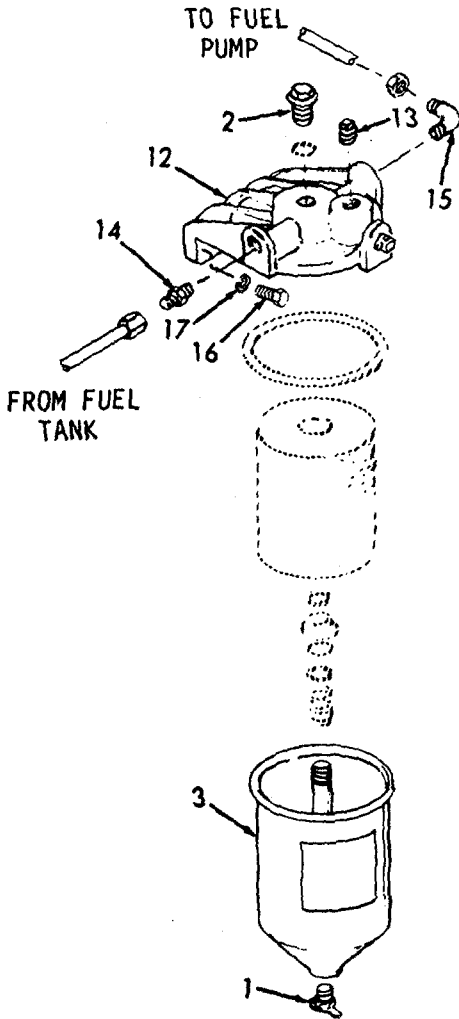


3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- c. Inlet hose  
Disconnect at fitting (14).
- d. Outlet hose  
Disconnect elbow (15).
- e. Screws (16) and lockwashers (17)



**3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- |    |  |         |  |
|----|--|---------|--|
| f. | Strainer cap (12) including strainer shell | Remove. |  |
|----|--|---------|--|

**NOTE**

Removal of the fuel strainer assembly can be made easier if the strainer element shell is removed. Refer to Service - Step 2.

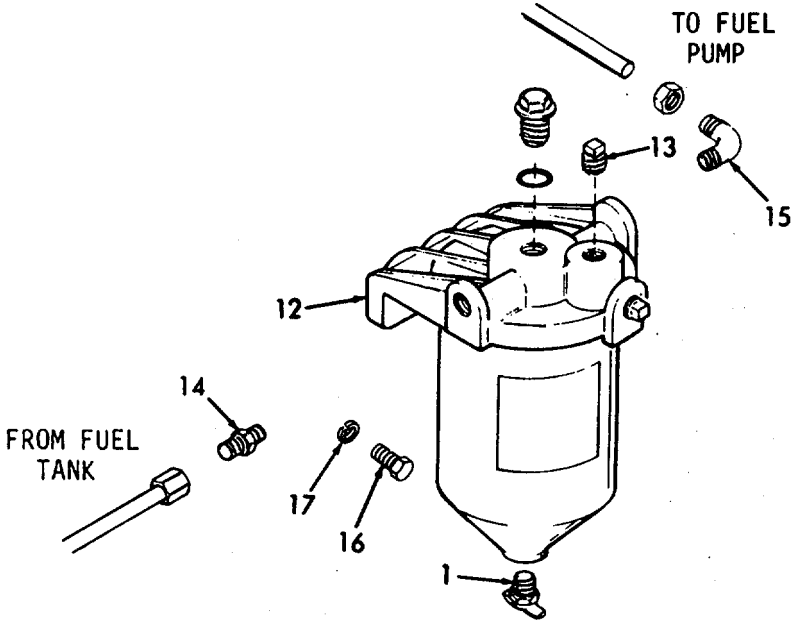
**INSTALLATION**

- |    |                        |   |   |
|----|------------------------|---|---|
| 4. | Fuel strainer assembly | a. Screws (16), lockwashers (17) and strainer cap (12) including strainer shell | Reassemble.   |
|    |                        | b. Outlet hose  | Reinstall at elbow (15).  |
|    |                        | c. Inlet hose   | Reinstall at fitting (14).  |
|    |                        | d. Draincock (1)  | Make sure it is closed.   |
|    |                        | e. Plug (13)  | Remove completely. Fill shell with fuel oil. Reinstall plug (13). |
|    |                        | f. Engine   | Start and check fuel system for leaks.                            |

3-70.2. FUEL STRAINER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



REPAIR

- 5. Fuel strainer assembly  
Repair fuel strainer bracket and cap in accordance with standard procedures.

---

**3-71. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS.**

---

a. The fuel injector is a light-weight, 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.

<b>CAUTION</b>
----------------

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

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 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.

**3-71. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS.**

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 of fuel filters and clean water-free fuel are the keys to trouble-free operation of the injectors.

This task covers:

- |                         |                     |
|-------------------------|---------------------|
| a. Removal and Cleaning | b. Install Injector |
|-------------------------|---------------------|

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Torque wrench

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment

Condition Condition Description

Para

3-86 Rocker Arm Cover

Special Environmental Conditions

Use lint-free cloths; not rags.

General Safety Instructions

Observe all WARNINGS.

**3-71. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Con't)**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL and CLEANING</b>			
1. Top of cylinder (2)	Fuel pipes (1 and 2)	Remove from injector (3) Protect fuel and fuel connectors (4).	pipes and fuel connectors from dirt or foreign particles.
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 and swing rocker arms away from injector and valves.	
5. Underneath rocker arm	Injector clamp (8)	Loosen and remove injector clamp bolt (9), washer (10) and clamp (8).	
6. Injector tube (11), (outer side of cylinder head)	Injector rack control lever (12)	Loosen two screws on lever. Slide lever away from injector.	
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:

**3-71. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont)**

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL and CLEANING (Cont)

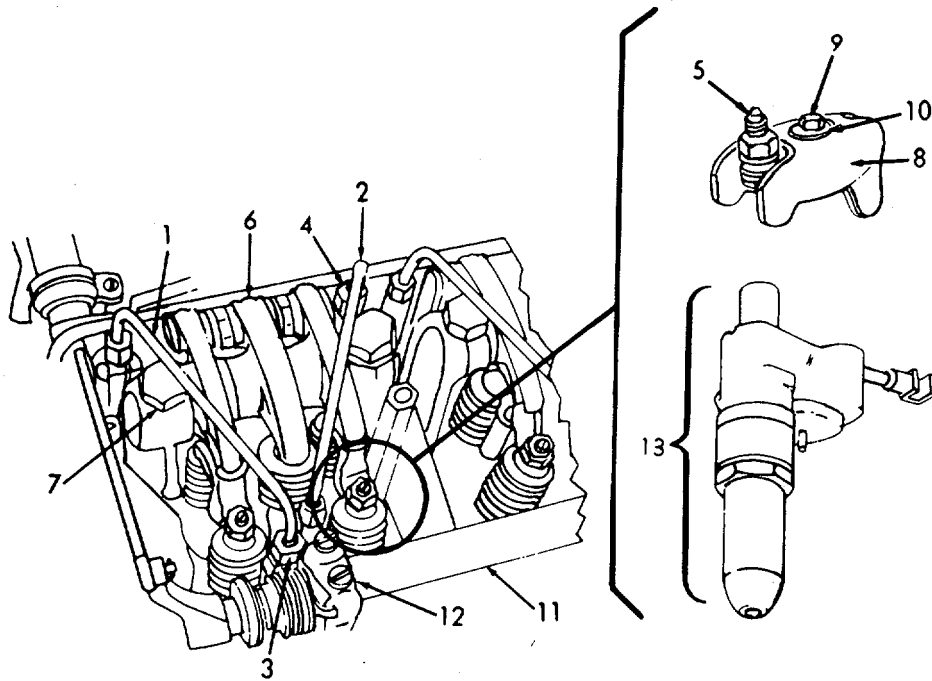
**WARNING**

Wear 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.

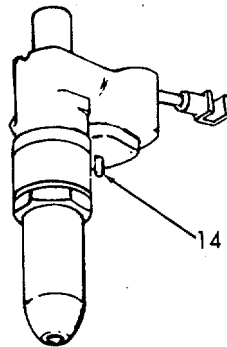


**3-71 FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont)**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALL INJECTOR**

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



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) and washer (10)	Install torque bolt to 20 to 25 lb. ft.(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 movement. (15)	Check rack for free	
-----	--	------------------------------	---------------------	--

13.	Top of injector	Rocker arm assembly (6)	Swing rocker arms into position. Secure brackets to cylinder head by tightening two bolts (7).	Torque bolts 90-to 100 lbs. ft. (130 to 145 kg/m).
-----	-----------------	-------------------------	--	--

**NOTE**

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

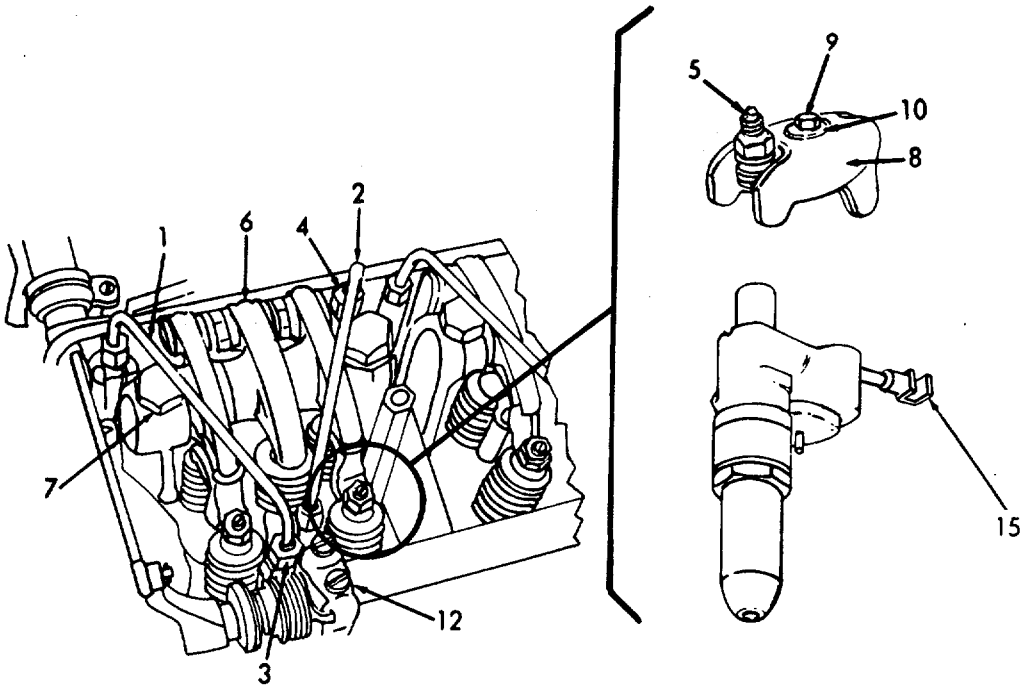


3-71 FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALL INJECTOR (Cont)

- |     |                                      |                      |   |   |
|-----|--------------------------------------|----------------------|---|---|
| 14. | Filter cap (5)                       | Shipping caps        | Remove.   |   |
| 15. | Injector (3) and fuel Connectors (4) | Fuel pipes (1 and 2) | Use torque connections. Do not bend fuel pipes. | wrench and tighten to 12-15 lb. ft. (17.9 to 22.3 kg/m). Do not over-tighten since leaks or damage can occur. |



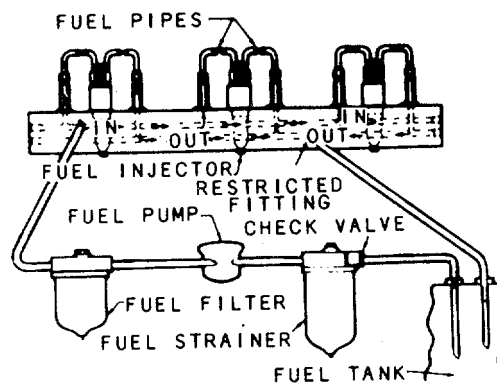
**3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS.**

a. The fuel system includes the following which are integral to the engine fuel injectors, fuel pipes and a fuel manifold. The external components of the fuel system are a fuel filter, a fuel strainer, a fuel pump and fuel lines.

b. Fuel is drawn from the supply tank through the fuel strainer, and enters the fuel pump at the inlet side. Leaving the pump under pressure, the fuel is forced through the fuel filter and into the inlet fuel manifold, then through the fuel pipes and into the inlet side of each fuel injector.

c. The fuel manifold is identified by the words IN (top passage) and OUT (bottom passage cast into the engine block).

d. Surplus fuel returns from the outlet side of the injectors to the fuel return manifold and then back to the supply tank.



3-1272

**3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Con't).**

This task covers:

- a. Removal and Cleaning      b. Install Injector

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

Para  
NONE

Material/Parts

NONE

Special Environmental Conditions

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

Personnel Required

1

General Safety Instructions

NONE.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |    |                              |                             |  |
|----|------------------------------|-----------------------------|--|
| 1. | Tube-filter to cylinder head | a. Tube                     | Inspect for cracks, breaks, dents and bends. |
|    |                              | b. Fittings                 | Inspect for leaking.                         |
| 2. | Tube-filter to fuel pump     | a. Tube                     | Inspect for cracks, breaks, dents and bends. |
|    |                              | b. Fittings                 | Inspect for leaking.                         |
| 3. | Tube-drain                   | a. Tube<br>dents and bends. | Inspect for cracks, breaks,                  |
|    |                              | b. Fittings                 | Inspect for leaking.                         |

**3-1273**

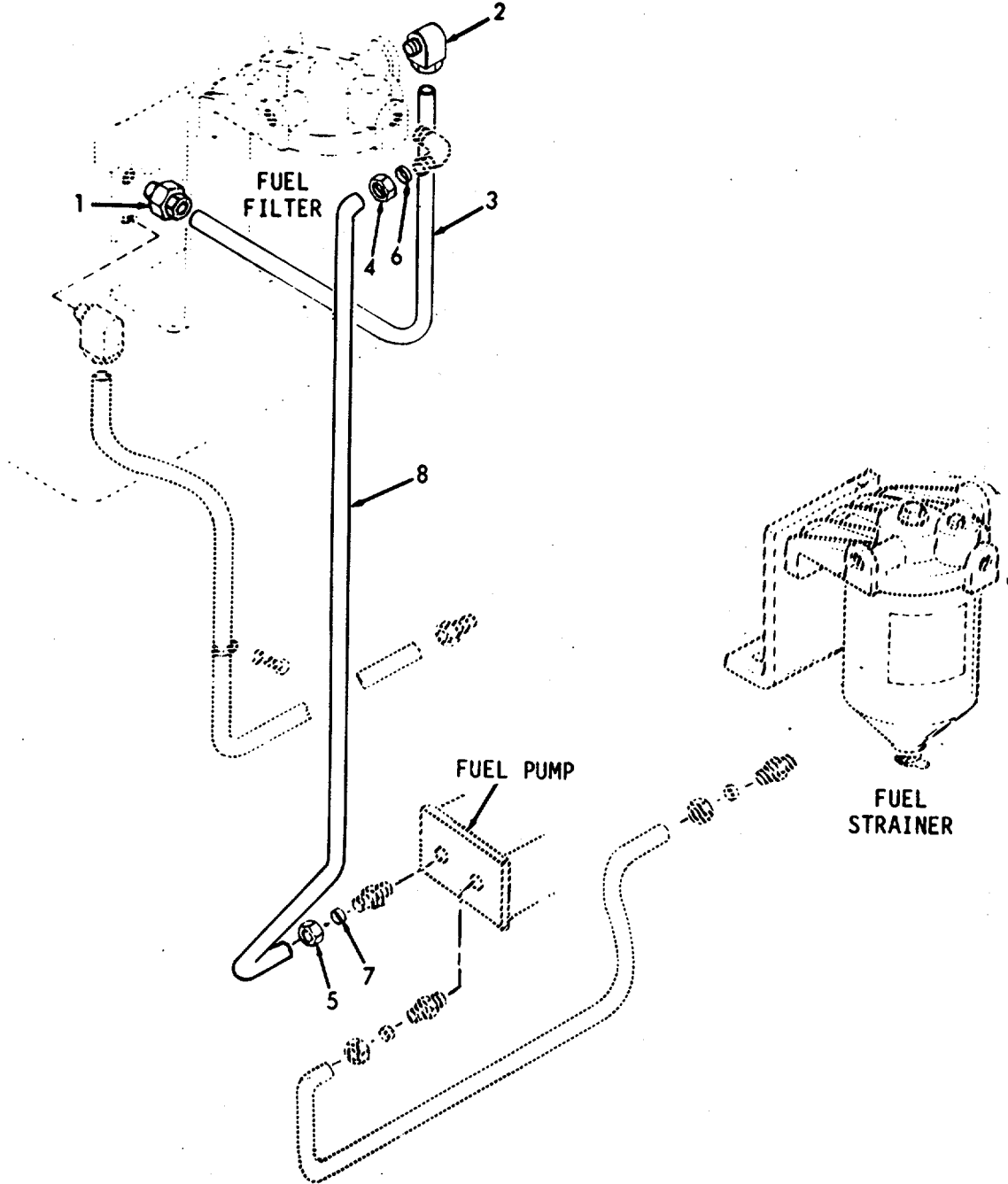
**3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
4. Tube-fuel pump-to-strainer	a. Tube dents and bends.	Inspect for cracks, breaks,	
	b. Fittings	Inspect for leaking.	
5. Tube-strainer	a. Tube dents and bends.	Inspect for cracks, breaks,	
	b. Fittings	Inspect for leaking.	
<b>REPLACE</b>			
6. Tube-filter-to cylinder head	a. Connector (1)	Loosen and remove.	
	b. Elbow (2)	Loosen and remove.	
	c. Tube (3)	Remove.	
	d. Tube (3)	Replace.	
	e. Elbow (2)	Install.	
	f. Connector (1)	Install.	
7. Tube-filter-to-fuel pump	a. Tube nuts (4 and 5)	Remove.	
	b. Ring seals (6 and 7)	Remove.	
	c. Tube (8)	Remove.	

3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPLACE (Cont)



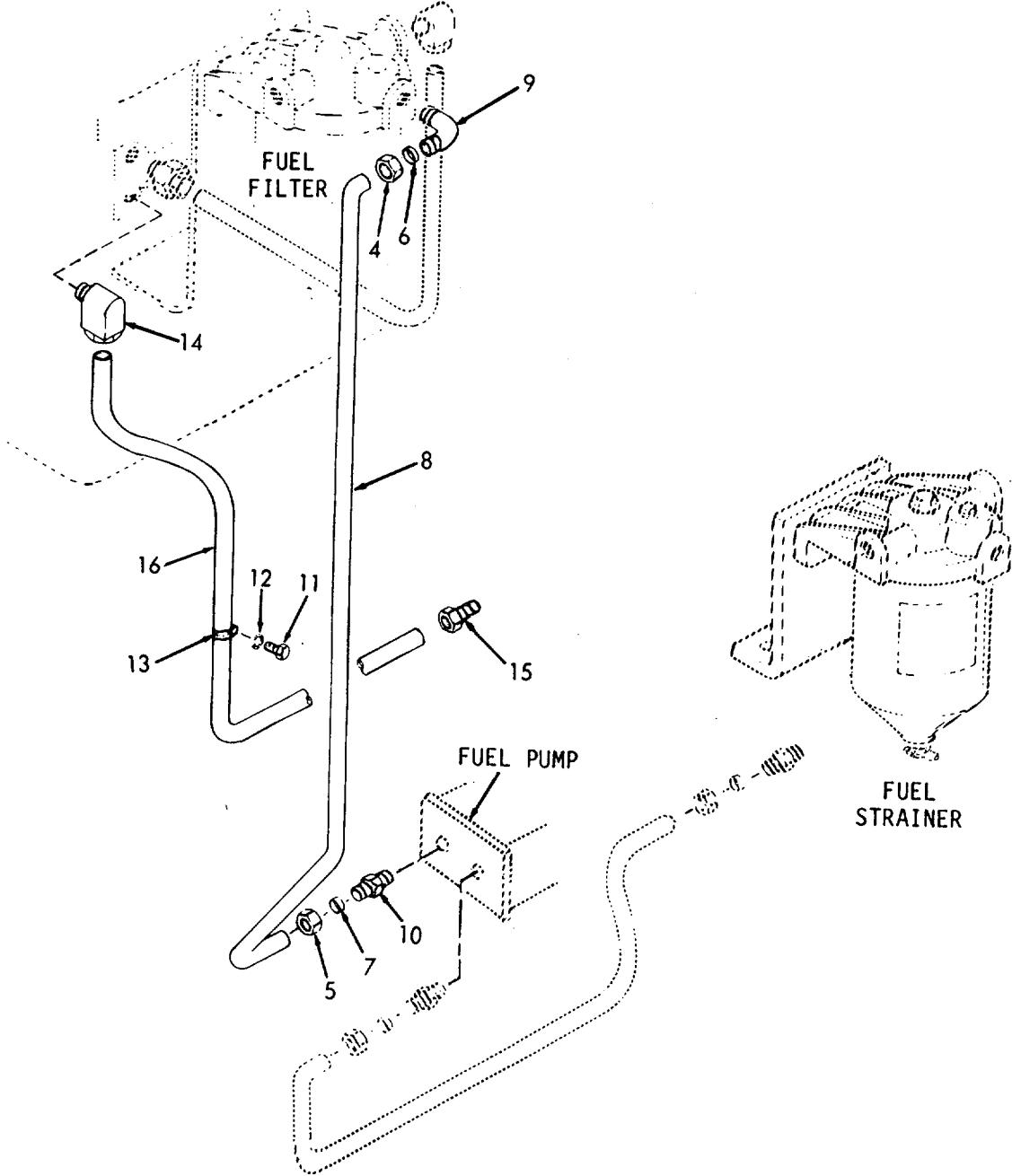
3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
	REPLACE (Cont)		
	d. Elbow (9)	Remove.	
	e. Connector (10)	Remove.	
	f. Connector (10)	Install.	
	g. Elbow (9)	Install.	
	h. Tube (8)	Install.	
	i. Ring seals (6 and 7)	Install.	
	j. Tube nuts (4 and 5)	Install.	
8. Tube- drain	a. Screw (11) and lockwasher (12)	Remove from clamp (13).	
	b. Elbow (14)	Remove.	
	c. Connector (15)	Remove.	
	d. Tube (16)	Remove.	

3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPLACE (Cont)



3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

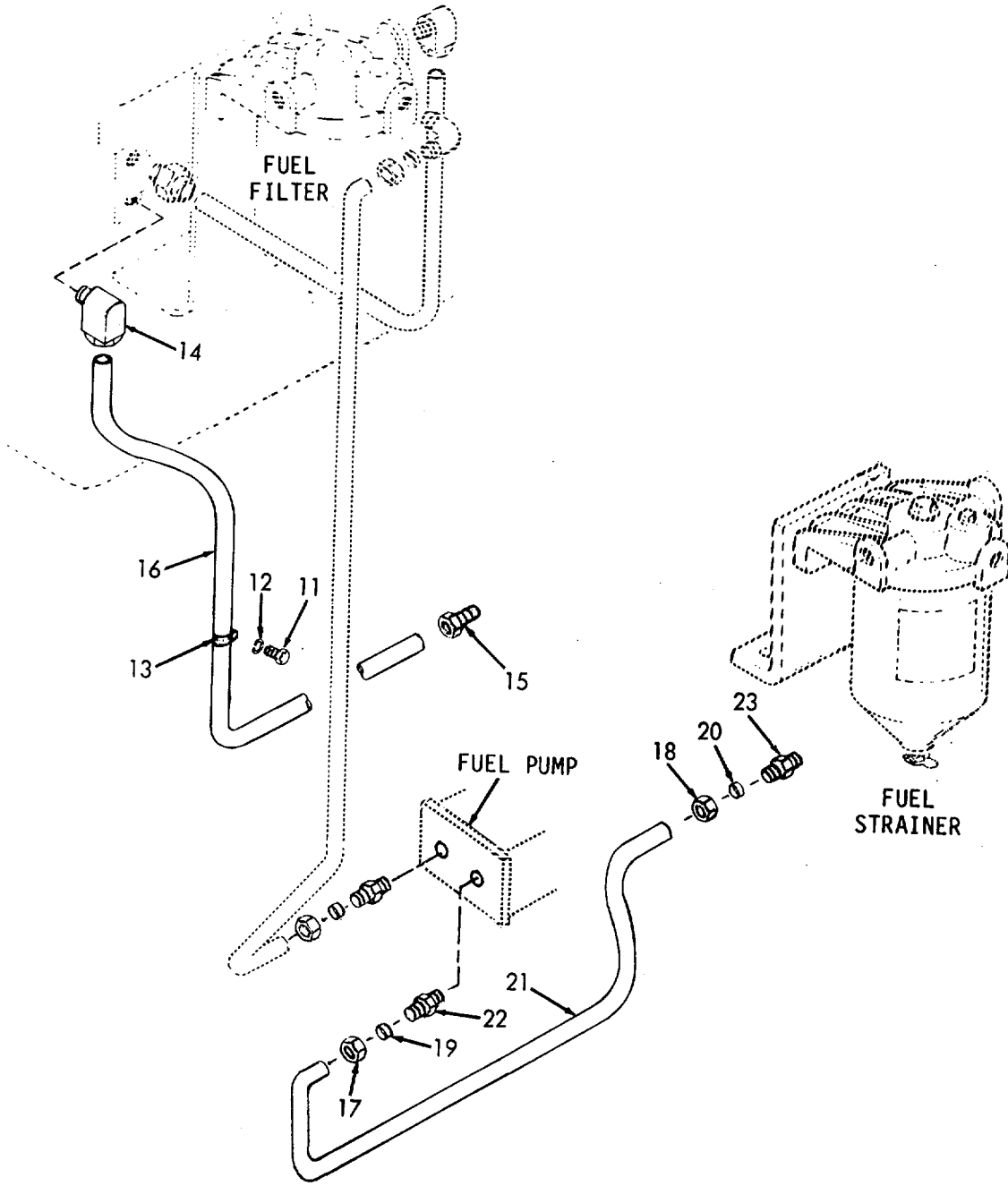
LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	e. Tube (16)	Install.	
	f. Connector (15)	Install.	
	g. Elbow (14)	Install.	
	h. Screw (11), and lock-washer (12)	Install in clamp (13).	
9. Tube-fuel pump-to-strainer	a. Tube nuts (17 and 18)	Remove.	
	b. Seal rings (19 and 20)	Remove.	
	c. Tube (21)	Remove.	
	d. Connectors (22 and 23)	Remove.	
	e. Connectors (22 and 23)	Install.	



3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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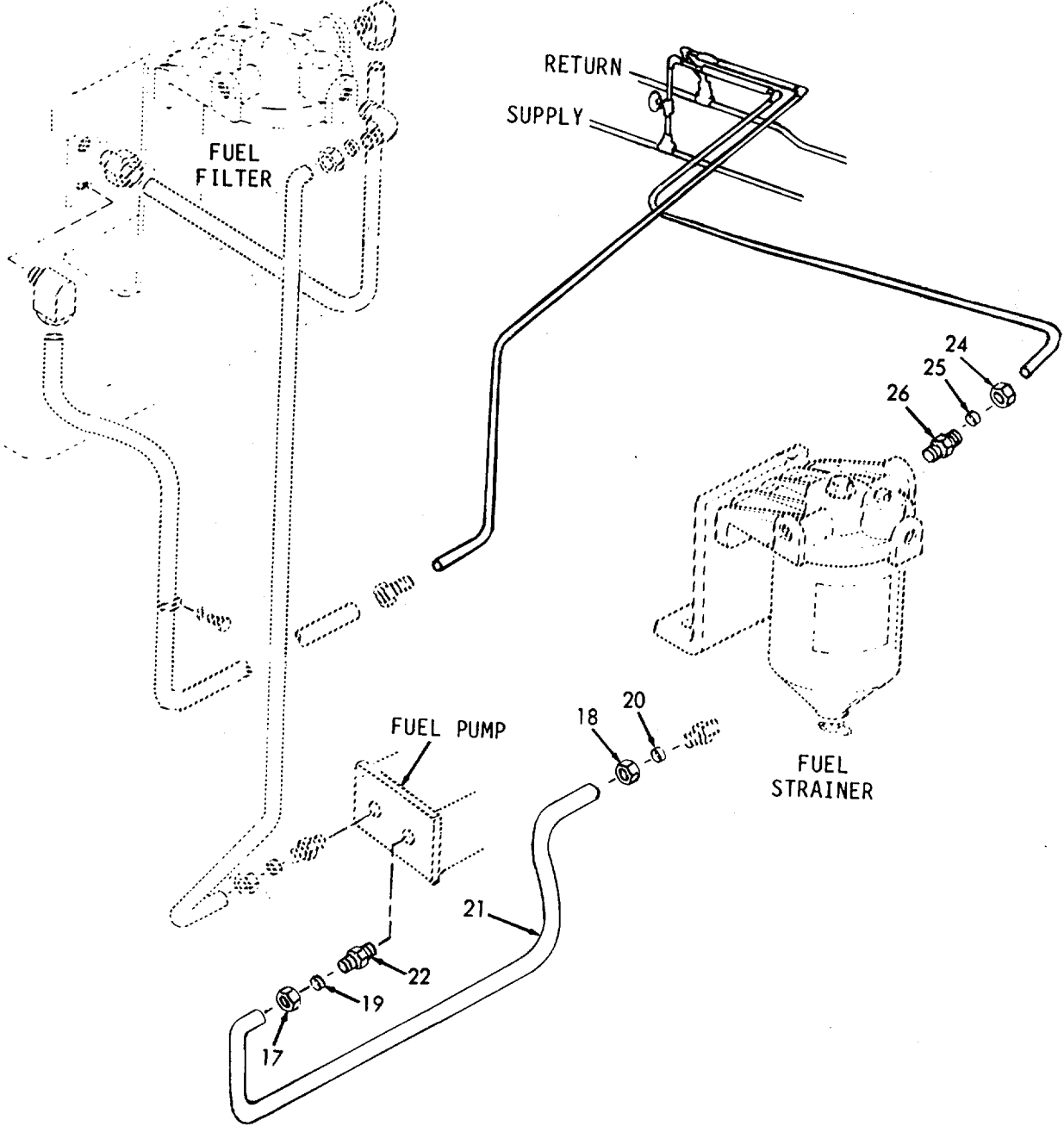
REPLACE (Cont)



**3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	f. Tube (21)	Install.	
	g. Seal rings (19 and 20)	Install.	
	h. Tube nuts (17 and 18)	Install.	
10. Tube-strainer	a. Tube nut (24)	Remove.	
	b. Seal ring (25)	Remove.	
	c. Connector (26)	Remove.	
	d. Connector (26)	Install.	
	e. Seal ring (25)	Install.	
	f. Tube nut (24)	Install.	

3-72. FUEL LINES AND MANIFOLD CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).



**3-73. LUBE OIL FILTER AND HOUSING/BREATHER - MAINTENANCE.  
INSTRUCTIONS**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACE (Cont)

The following is an index to the lube oil filter and housing/breather maintenance instructions.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Lube Oil Filter	3-73.1
Housing/Breather	3-73.2

**3-73.1. LUBE OIL FILTER - MAINTENANCE INSTRUCTIONS**

- a. The lube oil filter is a by-pass type oil filter. All oil passes through the filter, filtering out fine foreign particles that may be present.
- b. The by-pass filter consists of a replacable element (filter) contained in a shell mounted on a combination base and mounting bracket.
- c. A hollow center stud serves as the outlet passage from the filter as well as securing the lube oil filter in place on the engine.

**3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Inspection
- b. Service

- c. Disassembly
- d. Reassembly

- e. Installation

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

None

**Equipment**

**Condition      Condition Description**

Paragraph 3-74      Lube Oil Cooler removed

**Material/Parts**

Gasket, Kit P/N 5192637  
Gasket, Kit P/N 5193113

**Special Environmental Conditions**

Do not drain oil in bilges, use the oil separator recovery system to dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

Observe all WARNINGS.

LOCATION

ITEM

ACTION

REMARKS

**INSPECTION**

- |               |                |  |
|---------------|----------------|--|
| 1. Oil filter | a. Shell       | 1. Check for cracks, dents, or wear.<br>2. Check for leaks.  |
|               | b. Center stud | 1. Check for leaks.<br>2. Check tightness of center stud.  |
|               | c. Oil cooler  | 1. Check for cracks, dents, or wear. adaptor<br>2. Check for leaks.<br>3. Check shell's fitting to oil cooler adaptor. |

**3-1283**

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

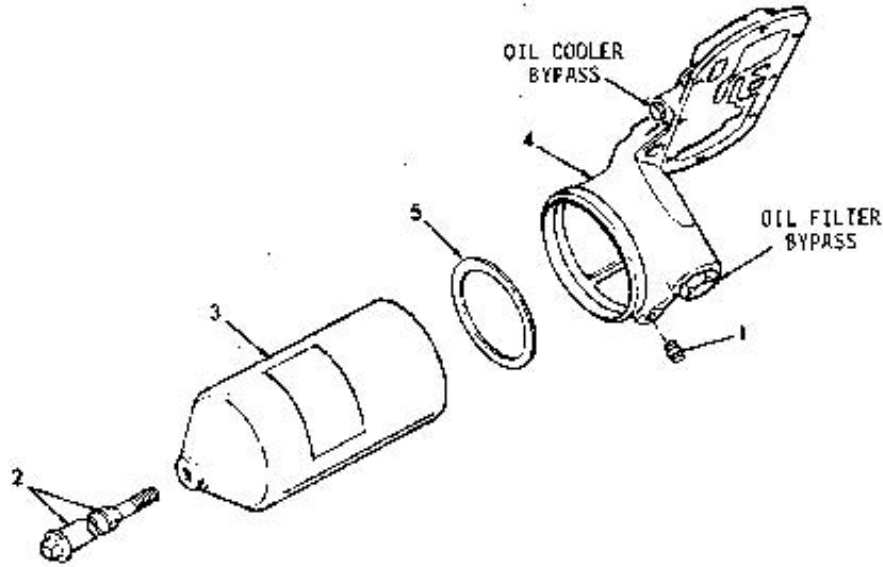
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	d. Pipe plug	<ol style="list-style-type: none"> <li>1. Check tightness.</li> <li>2. Check for wear.</li> <li>3. Check for leaks.</li> </ol>	
	e. Oil filter by-pass plug	<ol style="list-style-type: none"> <li>1. Check tightness.</li> <li>2. Check for wear.</li> <li>3. Check for leaks.</li> </ol>	
	f. Oil cooler by-pass plug	<ol style="list-style-type: none"> <li>1. Check tightness.</li> <li>2. Check for wear. plug</li> <li>3. Check for leaks.</li> </ol>	
<b>SERVICE</b>			
2. Oil filter	a. Pipe plug (1)	Remove.	Drain oil into a suitable container. Do not drain into bilges, use the oil water separator recovery system.
	b. Shell	<ol style="list-style-type: none"> <li>1. Unscrew center stud (2).</li> <li>2. Withdraw the shell (3) from the oil cooler adaptor (4).</li> <li>3. Remove cover gasket (5).</li> </ol>	<p>Leave filter element and center stud intact.</p> <p>Discard. Check gasket surfaces of shell (3) and oil cooler adaptor (4) for nicks, burrs, or other damage.</p>
<b>3-1284</b>			

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

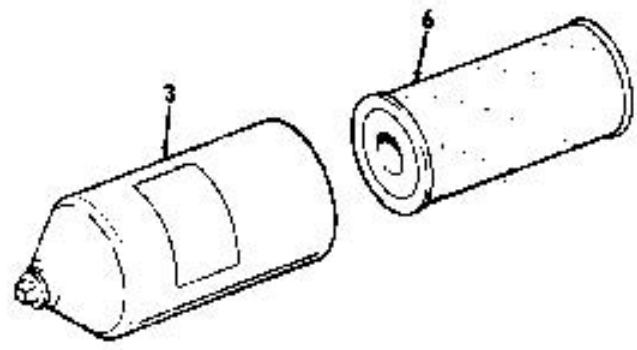
If nicks, burrs or damage is found the oil filter and oil cooler adaptor has to be replaced.



c. Filter element (6)

Remove from shell (3).

Discard and dispose of properly.



3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

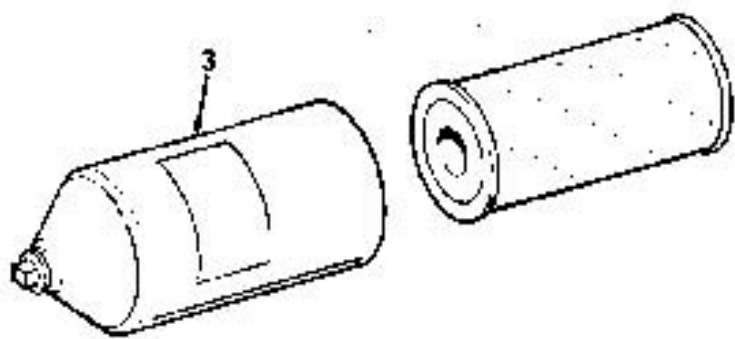
LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

**WARNING**

Wear eye protection when using compressed air.

d.	Shell (3)	Clean.	Use clean fuel oil and dry with compressed air.
----	-----------	--------	---



**DISASSEMBLY**

3.	Oil filter	a.	Pipe plug (1)	Remove.	Drain oil into a suitable container.
		b.	Shell	<ol style="list-style-type: none"> <li>1. Unscrew center stud (2).</li> <li>2. Withdraw the shell (3) from oil cooler adaptor (4).</li> <li>3. Remove cover gasket (5).</li> </ol>	<p>Leave filter element and center stud intact.</p> <p>Discard. Check gasket surfaces of shell (3) and oil cooler adaptor (4) for nicks, burrs, or other damage.</p>



3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

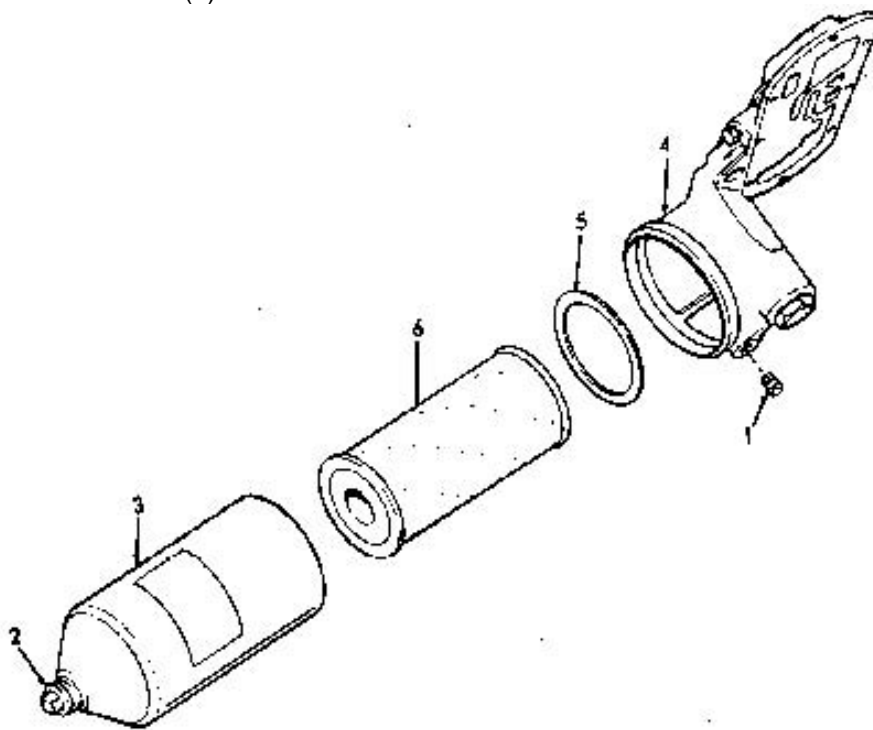
LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY (Cont)**

c. Filter element (6)

Remove from shell (3).

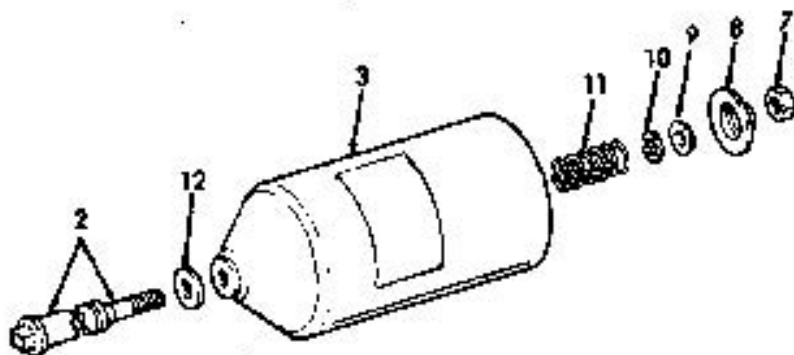
Discard and dispose of properly.



3-1287

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

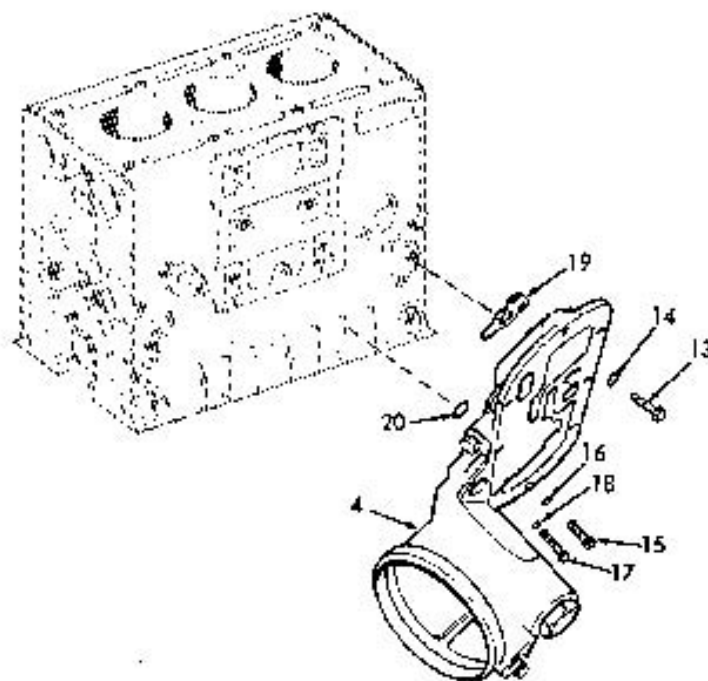
LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
4. Shell	Center stud	<ol style="list-style-type: none"> <li>1. Remove hex nut (7).</li> <li>2. Remove spring retainer (8).</li> <li>3. Remove retainer gasket (9).</li> <li>4. Remove washer (10).</li> <li>5. Remove spring (11).</li> <li>6. Remove center stud (2) from shell (3).</li> <li>7. Remove gasket (12).</li> </ol>	<p>Inspect for hardening or cracks. Replace, if necessary.</p> <p>Inspect for wear.</p> <p>Replace, if damaged or leaks occurs.</p>



3-1288

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
5. Generator engine block	Oil cooler adaptor	<ol style="list-style-type: none"> <li>1. Remove capscrews (13) and washers (14).</li> <li>2. Remove capscrews (15) and lockwashers (16).</li> <li>3. Remove capscrews (17) and lockwashers (18).</li> <li>4. Remove oil cooler adaptor (4) from generator engine block.</li> <li>5. Remove gaskets (19). Discard.</li> <li>6. Remove gasket (20). Discard.</li> </ol>	



**3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
6. Oil Cooler adaptor	a. Oil filter bypass	1. Remove bypass plug (21).	Inspect for wear, replace if necessary.
		2. Remove bypass gasket (22).	Inspect for wear, replace if necessary.
		3. Remove bypass spring (23).	Inspect for wear, replace if necessary.
		4. Remove bypass valve (24).	Inspect for wear, replace if necessary.

**NOTE**

Clean the above parts in clean fuel oil and dry with compressed air.

**WARNING**

Wear eye protection when using compressed air.

b. Oil cooler bypass	1. Remove bypass plug (25).	Inspect for wear, replace if necessary.
	2. Remove bypass gasket (26).	Discard.
	3. Remove bypass valve spring (27).	Inspect for wear, replace if necessary.
	4. Remove bypass valve (28).	Inspect for wear, replace if necessary.

**NOTE**

Clean the above parts in clean fuel oil and dry with compressed air.

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

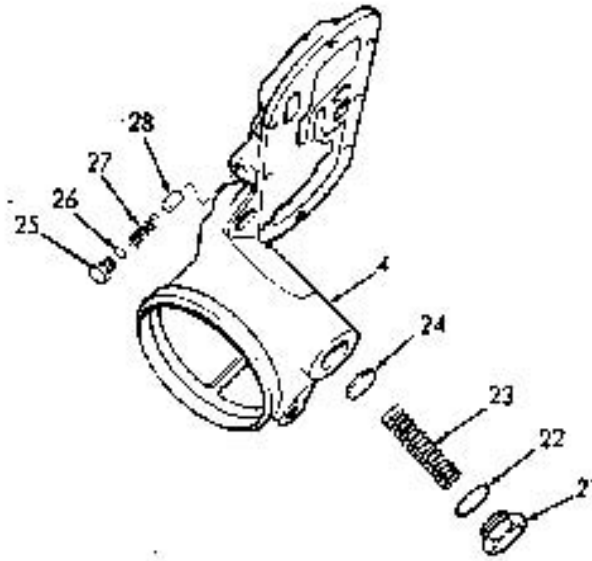
LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY (Cont)**

**WARNING**

**Wear eye protection when using compressed air.**

- |    |                    |  |
|----|--------------------|--|
| c. | Oil cooler adaptor | Clean with clean fuel oil and dry with compressed air. |
|----|--------------------|--|



**REASSEMBLY**

- |    |                    |                      |   |
|----|--------------------|----------------------|---|
| 7. | Oil cooler adaptor | a. Oil cooler bypass | <ol style="list-style-type: none"> <li>1. Install bypass valve (28).</li> <li>2. Install bypass valve spring (27).</li> <li>3. Install bypass gasket (26).</li> <li>4. Install bypass plug (25).</li> </ol> |
|----|--------------------|----------------------|---|

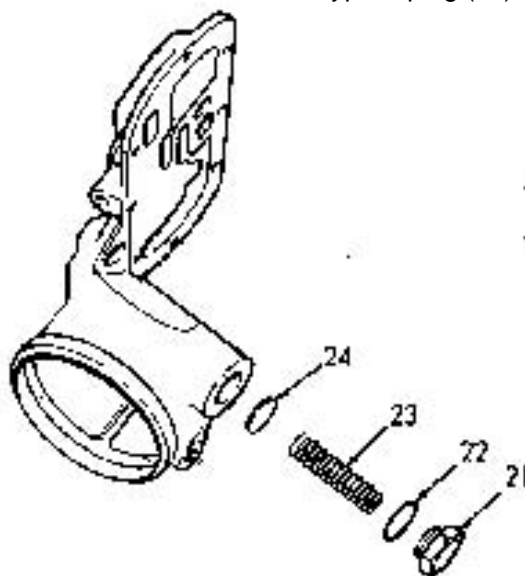
Use repair kit P/N 5192637.

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY (Cont)**

- |                       |   |  |  |
|-----------------------|---|--|--|
| b. Oil filter by-pass | <ol style="list-style-type: none"> <li>1. Install bypass valve (24).</li> <li>2. Install bypass spring (23).</li> <li>3. Install bypass gasket (22).</li> <li>4. Install bypass plug (21).</li> </ol> |  |  |
|-----------------------|---|--|--|



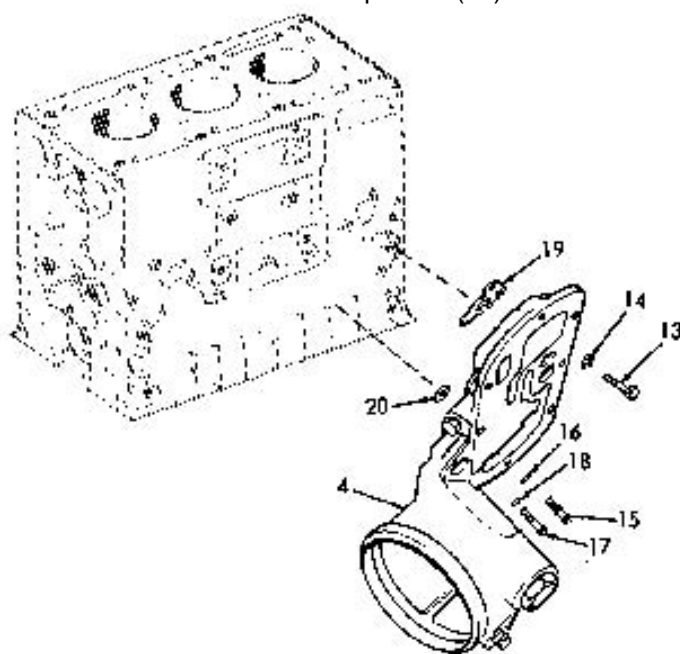
- |                           |                    |   |   |
|---------------------------|--------------------|---|---|
| 8. Generator engine block | Oil cooler adaptor | <ol style="list-style-type: none"> <li>1. Install gasket (20).</li> <li>2. Install gaskets (19).</li> <li>3. Mount oil cooler adaptor (4) onto generator engine block.</li> </ol> | <p>Use repair kit P/N 5193113.</p> <p>Use repair kit P/N 5193113.</p> |
|---------------------------|--------------------|---|---|

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REASSEMBLY (Cont)**

4. Install lockwashers (18) and capscrews (17).
5. Install lockwashers (16) and capscrews (15).
6. Install washer (14) and capscrew (13).



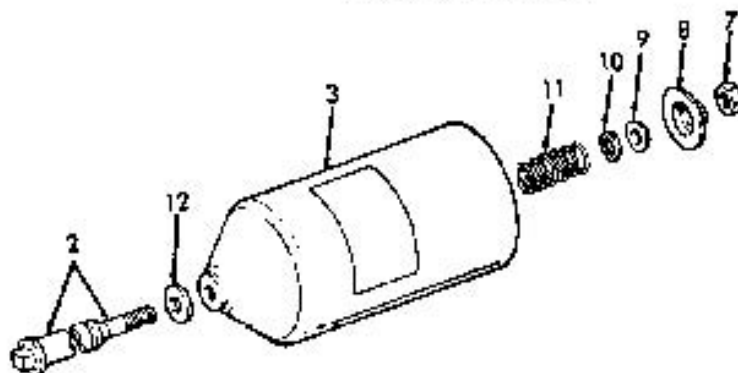
3-1293

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REASSEMBLY (Cont)**

- |          |             |  |  |
|----------|-------------|--|--|
| 9. Shell | Center stud | <ol style="list-style-type: none"> <li>1. Install gasket (12) onto center stud (2).</li> <li>2. Insert center stud (2) into shell (3).</li> <li>3. Install spring (11).</li> <li>4. Install washer (10).</li> <li>5. Install retainer gasket (9).</li> <li>6. Install spring retainer (8).</li> <li>7. Install hex nut (7).</li> </ol> |  |
|----------|-------------|--|--|



3-1294

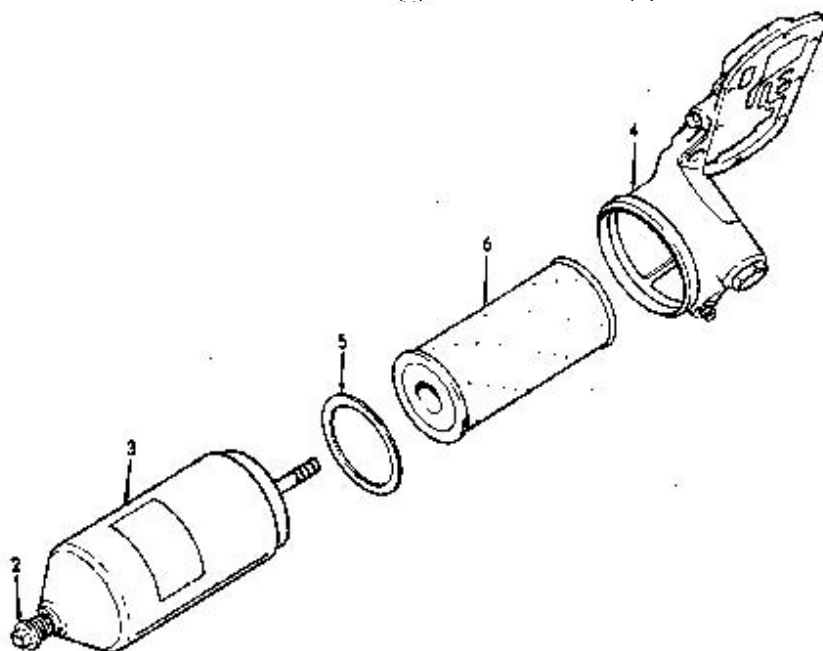


3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION (Cont)**

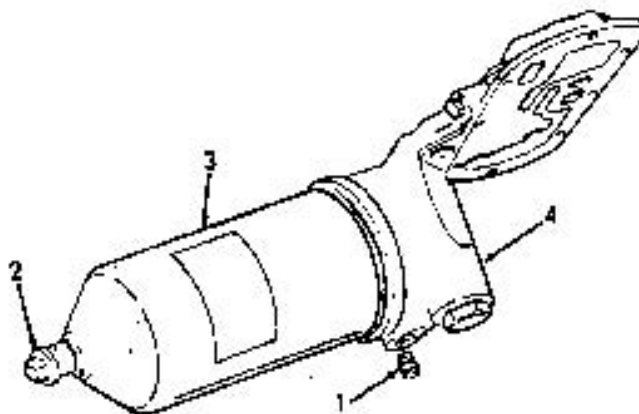
10. Oil filter	a. Shell	Install cover gasket (5).	Use new cover gasket. Make sure the gasket surfaces of the shell (3) and oil cooler adaptor (4) have no nicks, burrs or other damage.
	b. Filter element	Carefully position filter element (6) over center stud (2) and within shell (3).	



3-1295

3-73.1. LUBE OIL FILTER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
c. Oil cooler	<ol style="list-style-type: none"> <li>1. Insert shell (3) onto oil cooler adapter (4). adaptor</li> <li>2. Tighten center stud (2).</li> </ol>	Torque to 50 60 ft. lb. (67.881.3 Nm).	
d. Oil filter	Install pipe plug (1).	Start and run engine for a short period of time. Check for oil leaks. Stop engine for 10 minutes and check oil level. Add sufficient oil to bring level up to full on dipstick.	



3-1296

**3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .**

1. The breather/housing is part of the engine ventilating system. It helps in moving harmful vapors from the engine and exhausting them to the atmosphere. Minute particles of lubricating oil, carried along with the moving vapors, are trapped in an oil separator within the breather and the trapped oil is eventually returned to the crankcase.

This task covers:

- a. Inspection
- b. Removal
- c. Service
- d. Installation

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

Paragraph. 3-73.1 Lube Oil Filter

**Special Tools**

NONE

**Equipment**

**Condition      Condition Description**

**Para**

3-80      Tachometer Drive removed.

**Material/Parts**

Gasket, Kit P/N 5193116  
Gasket, Kit P/N 5193113

**Special Environmental Conditions**

NONE

**Personnel Required**

1

**General Safety Instructions**

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

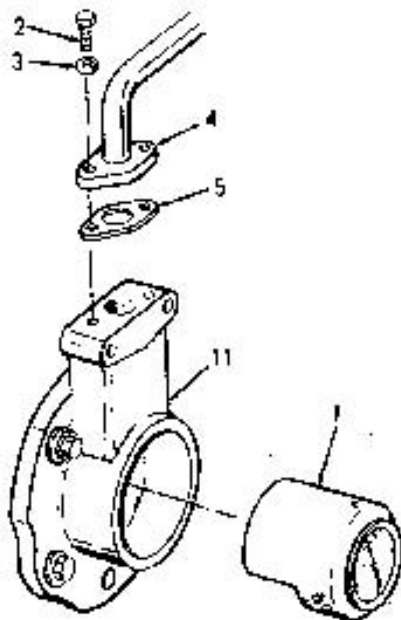
**INSPECTION**

1.	Oil breather separator	Check for dents and cracks.	
----	------------------------	-----------------------------	--

**3-1297**

3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .(Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL</b>			
2. Oil breather separator	a. Tacho meter (1)	Remove	Refer to paragraph 3-80.
	b. Breather pipe	<ol style="list-style-type: none"> <li>1. Remove capscrews (2) and lockwashers (3).</li> <li>2. Lift breather pipe (4) out of the way.</li> <li>3. Remove gasket (5).</li> </ol>	Discard.
	c. Oil breather separator	<ol style="list-style-type: none"> <li>1. Remove capscrews (6), lockwashers (7), and copper washers (8).</li> <li>2. Remove capscrew (9) and special washer (10).</li> </ol>	

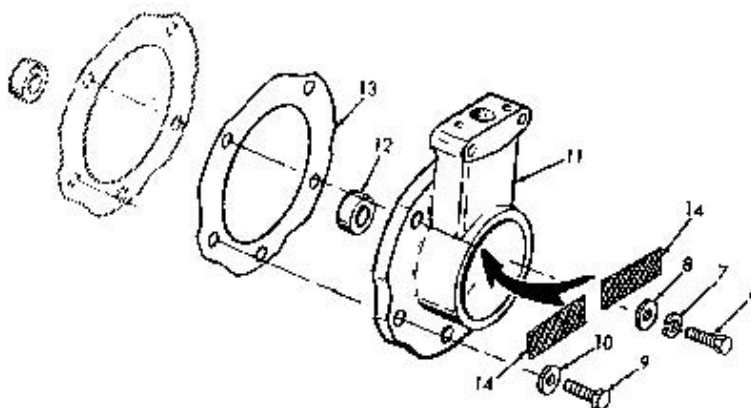


3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

- |    |                                     |  |                        |
|----|-------------------------------------|--|------------------------|
| 3. | Remove oil breather separator (11). |  |                        |
| 4. | Remove seal (12).                   |  |                        |
| 5. | Remove gasket (13).                 |  | Discard.               |
| 6. | Remove filters (14).                |  | Replace, if necessary. |



3-1299

**3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**SERVICE**

**WARNING**

**Wear eye protection when using compressed air.**

3.	Oil breather separator	Wash thoroughly with clean fuel oil and dry with compressed air.	
4.	Filters	Clean with clean fuel oil and dry with compressed air.	

**INSTALLATION**

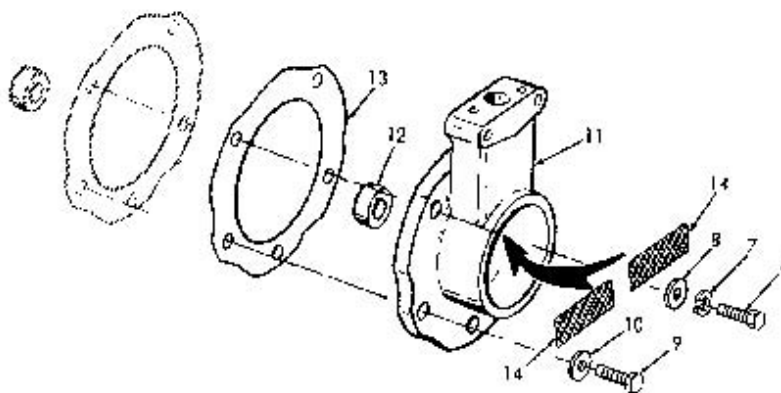
5. Oil breather separator	a. Oil breather separator	<ol style="list-style-type: none"> <li>1. Install filters (14).</li> <li>2. Install gasket (13).</li> <li>3. Install seal (12).</li> <li>4. Install oil breather separator (11).</li> <li>5. Install special washer (10) and capscrew (9).</li> <li>6. Install copper washers (8), lockwashers (7), and capscrews (6).</li> </ol>	Use repair kit P/N 5193113.
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**3-1300**

3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



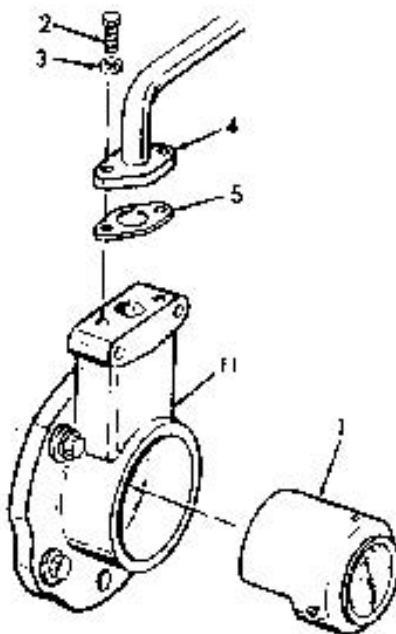
3-1301

3-73.2. BREATHER/HOUSING-MAINTENANCE INSTRUCTIONS .

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

b.	Breather pipe	<ol style="list-style-type: none"> <li>1. Install breather pipe (4) on oil breather separator (11).</li> <li>2. Insert gasket (5).</li> <li>3. Install lockwashers (3) and capscrews (2).</li> </ol>	Use repair kit P/N 5193116 or 5193113.
c.	Tachometer (1)	Install.	Refer to paragraph 3-80.



3-1302



**3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS .**

a. In order 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.

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. To assure engine lubrication, if the oil cooler becomes clogged, a by-pass valve located at the oil inlet to the oil cooler by-passes oil around the oil cooler directly to the oil gallery in the cylinder block.

d. The oil cooler core is sealed to prevent the coolant from getting into the oil.

This task covers:

- |               |                     |                 |
|---------------|---------------------|-----------------|
| a. Inspection | c. Cleaning         | e. Repair       |
| b. Removal    | d. Testing-Pressure | f. Installation |

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

Paragraph 3-73 Lube Oil Filter

**Special Tools**

NONE

**Equipment**

<b><u>Condition</u></b>	<b><u>Condition Description</u></b>
-------------------------	-------------------------------------

**Para**

NONE

**Material/Parts**

Gasket, Kit P/N 5192637  
Gasket, Kit P/N 5193113

**Special Environmental Conditions**

Do not drain into bilges,  
dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

Observe all CAUTIONS and WARNINGS.

**3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>INSPECTION</b>				
1.	Generator engine	Dipstick	Remove dipstick and check for presence of water in engine oil.	Engine oil will be creamy tan if water is present.
2.	Oil Cooler	a. Drain cock	1. Check for leaks. 2. Check tightness.	Water only.
		b. Water hole flange cover	1. Check fitting. 2. Check for leaks.	Oil and water.
		c. Oil cover housing	1. Check for dents or cracks.  2. Check for leaks. Oil and water.	
<b>REMOVAL</b>				
3.	Oil filter	Drain plug	Remove.	Refer to paragraph 3-73.1. Drain into a suitable container. Do not dump into bilges, use oil water separator recovery system.
4.	Oil cooler housing	a. Drain cock (1)	Turn counter-clockwise to open.	Drain into a suitable container. Do not dump into bilges, dispose of properly.
		b. Water pump seal	1. Remove screw (2) and nut (3). 2. Remove clamp (4). 3. Remove water pump seal (5).	

**3-1304**

3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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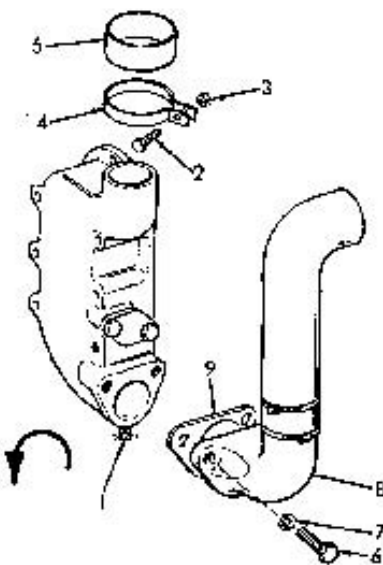
**REMOVAL**

c. Oil cooler water inlet connection

1. Remove capscrews (6) and lockwashers (7).
2. Swing oil cooler water inlet connection (8) out of the way.

3. Remove gasket (9).

Discard.



3-1305

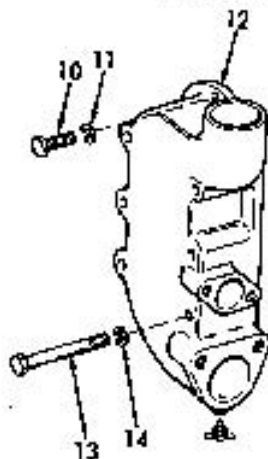
3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

d. Oil cooler housing

1. Remove capscrews (10) and lockwashers (11).
2. Remove oil cooler housing (12) from the oil cooler adaptor.
3. Remove capscrews (13) and lockwashers (14).



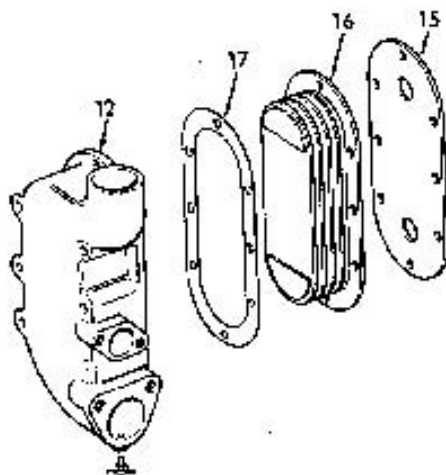
4. Remove outer gasket (15). Discard.
5. Remove oil cooler core (16) from oil cooler housing (12).
6. Remove inner gasket (17) from oil cooler core (16). Discard.

3-1306

3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

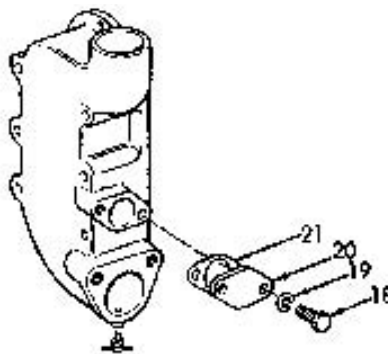


7. Remove capscrews (18) and lockwashers (19).

8. Remove oil cooler water hole cover (20).

9. Remove gasket (21).

Discard.



3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>CLEANING</b>			
5. Oil cooler	a. Oil cooler (oil side)	1. Circulate a solution of trichloroethylene through the core passages	Use a force pump to remove carbon and sludge.

**WARNING**

Cleaning solvent, trichloroethylene, used to clean parts is potentially dangerous to personnel and property. Use in the open or a well ventilated room to prevent toxic fumes from building up.

2. Clean the oil cooler core before the sludge hardens.
3. If oil passages are badly clogged, circulate an Oakite or alkaline solution through the oil cooler core. Flush thoroughly with clean hot water.

b. Oil cooler (water side)

1. Immerse oil cooler core (water side) in the following solution:  
  
1/2 lb. (0.227 kg) of oxlic acid to each 2-1/2 gals. (9.46 l) solution. Composed of 1/3 muriatic acid and 2/3 water.

Clean oil cooler (oil side) first.

Cleaning action evidenced by bubbling and foaming.

2. Carefully watch process and when bubbling stops remove oil cooler core.

30 to 60 seconds after oil cooler core is immersed.

3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**CLEANING (Cont)**

3. Thoroughly flush with clean hot water.
4. After cleaning, dip oil cooler core in light oil.

**NOTE**

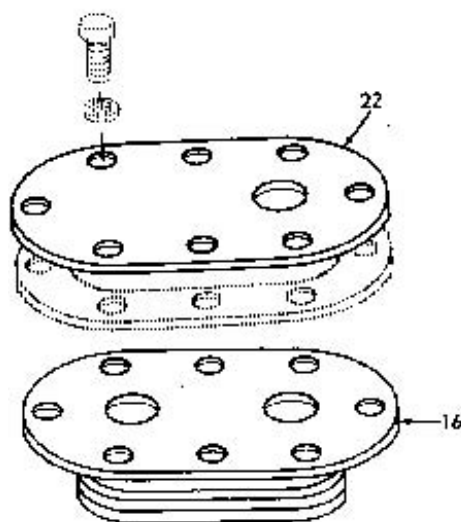
Do not attempt to clean an oil cooler core when engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil. In this instance, replacement of the oil cooler core is recommended.

**TESTING-PRESSURE**

- |               |          |
|---------------|----------|
| 6. Oil cooler | a. Plate |
|---------------|----------|

1. Make a suitable plate (22) to attach to the oil cooler core (16).

Use a suitable rubber gasket to ensure a tight seal.

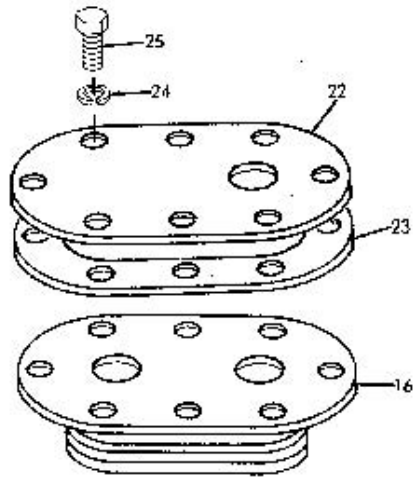


3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**TESTING-PRESSURE (Cont)**

		2. Drill and tap plate (22) on inlet side of the oil cooler core (16).	To attach an air hose fitting.
b.	Oil cooler core	1. Install rubber gasket (23).	
		2. Install plate (22).	
		3. Install lockwashers (24) and screws (25).	Tighten plate to oil cooler core securely.



**WARNING**  
Wear eye protection when using compressed air.



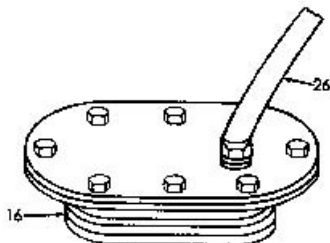
3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**TESTING-PRESSURE (Cont)**

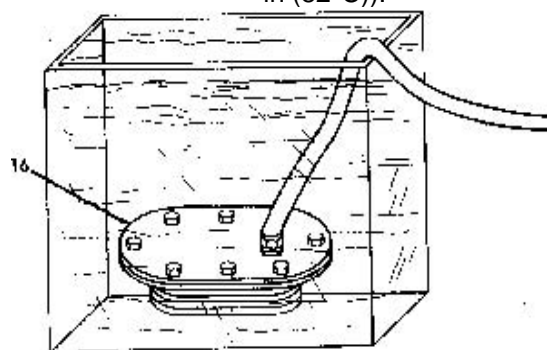
4. Attach air hose (26) to oil cooler core (16).

Apply 75-150 psi (517-1034 kPa) air pressure.



5. Submerge oil cooler core in a tank of heated water (180°F in (82°C)).

Any leaks will be indicated by air bubbles the water.



3-1311

**3-74. LUBE OIL COOLER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**TESTING-PRESSURE (Cont)**

**CAUTION**

**When making the pressure test be sure that personnel are adequately protected against any stream of pressurized water from a leak or rupture of a fitting, hose or the oil cooler core.**

- |   |  |
|---|--|
| 6. Pressure test completed.                     | Indication of leaks in oil cooler core, replace. |
| a. Remove oil cooler core (16) from water tank. |  |
| b. Remove air hose (26).                        |  |
| c. Remove screw (25) and lock-washers (24).     |  |
| d. Remove plate (22) and gasket (23).           |  |

**NOTE**

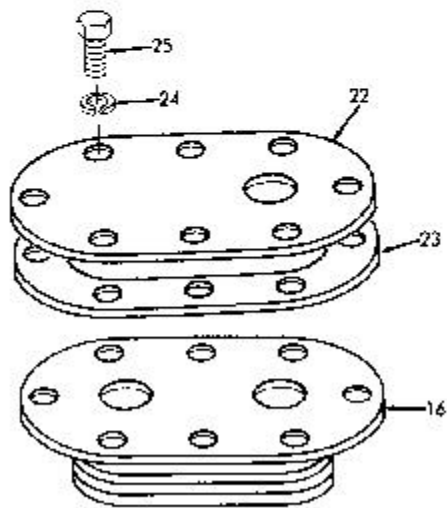
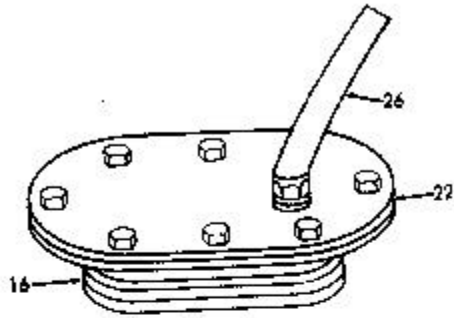
**In cases where leaking oil cooler core has caused contamination of the engine, the engine must be flushed immediately to prevent serious damage.**

**REPAIR**

Repair according to standard practices and procedures.

3-74. LUBE OIL COOLER - MAINTENANCE INSTRUCTIONS ( Cont).

LOCATION	ITEM	ACTION	REMARKS
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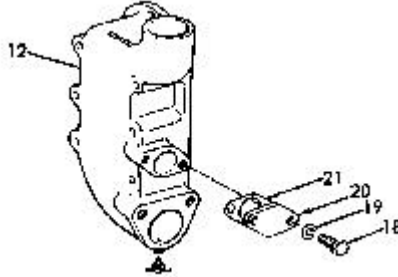
3-1313

**3-74. LUBE OIL COOLER - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

7. Oil cooler	a. Oil cooler	<ol style="list-style-type: none"> <li>1. Install gasket (21).</li> <li>2. Install oil cooler water hole cover (20).</li> <li>3. Install lockwashers (19) and capscrews (18).</li> </ol>	Use repair kit, P/N 5193113. housing
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		<ol style="list-style-type: none"> <li>4. Install inner gasket (17) on oil cooler</li> <li>5. Install oil cooler core (16) into oil cooler housing (12).</li> </ol>	Use repair kit, P/N 5193113. core (16).
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**NOTE**

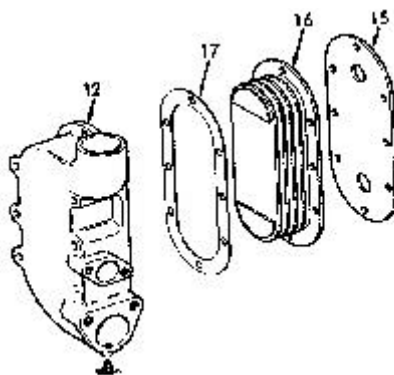
The inlet and outlet openings in the oil cooler core are marked **IN** and **OUT**. Make sure the oil cooler core is reinstalled in its original position, otherwise the oil flow will be reversed and could result in foreign particles that may not have been removed to be loosened and circulated through the engine.

		<ol style="list-style-type: none"> <li>6. Install outer gasket (15).</li> </ol>	Use repair kit, P/N 5193113.
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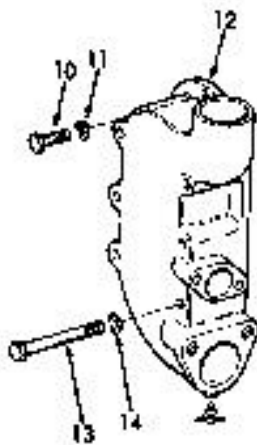
**3-1314**

**3-74. LUBE OIL COOLER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION ( Cont)**

7. Install lockwashers (14) and cap screws (13).
8. Install oil cooler housing (12) onto the oil cooler adaptor.
9. Install lockwashers (11) and cap screws (10).



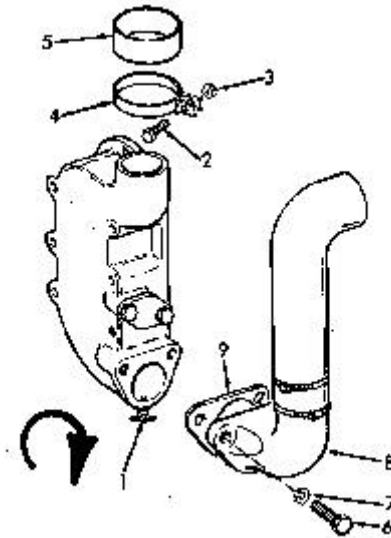
3-1315

**3-74. LUBE OIL COOLER - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont.)**

- |    |                                   |  |                              |
|----|-----------------------------------|--|------------------------------|
| b. | Oil cooler water inlet connection | <ol style="list-style-type: none"> <li>1. Install gasket (9).</li> <li>2. Swing oil cooler water inlet connection (8) back into place.</li> <li>3. Install lockwashers (7) and capscrews (6).</li> </ol> | Use repair kit, P/N 5193113. |
| c. | Water pump Seal                   | <ol style="list-style-type: none"> <li>1. Install water pump seal (5).</li> <li>2. Install clamp (4).</li> <li>3. Install screw (2) and nut (3).</li> </ol>  | Tighten.                     |
| d. | Drain cock (1)                    | Turn clockwise to close.   |                              |



8. Fill heat exchanger with antifreeze.

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS**

The fresh water pump circulates the engine coolant through the cylinder block, cylinder head, heat exchanger and the oil cooler.

**This task covers:**

- a. Inspection                      b. Replacement                      c. Installation**

**INITIAL SETUP:**

**Test Equipment**

NONE

**References**

Paragraph 3-74 lube Oil Cooler  
Equipment

**Special Tools**

Wrench, J4242

**Condition                      Condition Description**

**Para**

NONE

**Material/Parts**

Seal, Kit P/N 5193605

**Special Environmental Conditions**

Do not drain into bilges, dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
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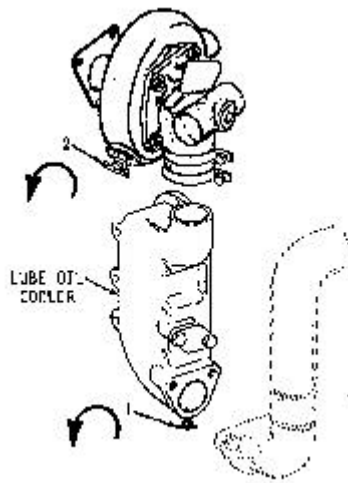
**INSPECTION**

1. Fresh water Pump	a. Hose	1. Check for cracks, breaks, or wear.
		2. Check for leaks.
		3. Check fittings tightness.
	b. Water	1. Check for cracks or pump dents.
		2. Check for leaks.
	c. Outlet	1. Check for leaks. Flange
	2. Check for cracks.	

**3-1317**

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

LOCATION	ITEM	ACTION	REMARKS	
<b>REPLACEMENT</b>				
2.	Lube oil cooler	Drain cock (1)	Turn counter-clockwise to open.	Drain into a suitable container. Do not drain into bilges, dispose of properly.
3.	Fresh water pump	a. Drain cock (2)	Turn counter-clockwise to open.	Drain into a suitable container. Do not drain into bilges, dispose of properly.



- b. Hose
  1. Loosen hose clamps (3 and 4).
  2. Slide hose clamp (4) down onto lube oil cooler.

**3-1318**

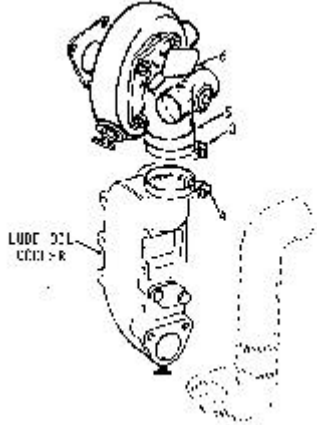


**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPLACEMENT (Cont)**

- Slide seal (5) back against pump cover (6) from lube oil cooler.



c. Outlet flange

- Remove capscrews (7) and lockwashers (8).
- Remove outlet packing (9).
- Remove outlet flange (10) from fresh water pump outlet (11).

Discard.



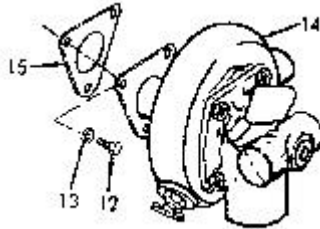
**3-1319**

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPLACEMENT Cont.**

- |                     |  |                                      |
|---------------------|--|--------------------------------------|
| d. Fresh water pump | 1. Remove bolts (12) and seal washers (13).  | Use J 4242, wrench, to loosen bolts. |
|                     | 2. Remove fresh water pump (14) from blower. |                                      |
|                     | 3. Remove gasket (15).                       | Discard.                             |



**INSPECTION**

- |                     |                     |  |   |
|---------------------|---------------------|--|---|
| 4. Fresh water pump | a. Outlet flange    | 1. Place the outlet flange (10) on fresh water pump outlet (11). |   |
|                     |                     | 2. Slip outlet packing (9) over fresh water pump outlet (11).    | Use repair kit, P/N 5193605.  |
|                     | b. Fresh water Pump | 1. Install gasket (15).  | Use repair kit, P/N 5193605.  |
|                     |                     | 2. Place fresh water pump (14) against the blower end plate.     | Align and mesh lugs on the drive coupling with the lugs on the intermediate shaft coupling. |
|                     |                     | 3. Install seal washers (13) and bolts (12).                     | Tighten, secure to the blower.  |

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

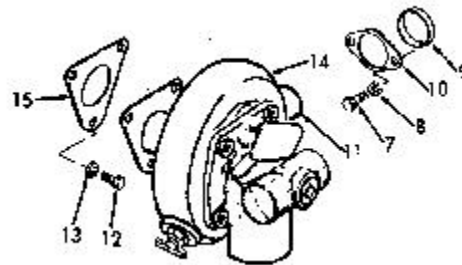
LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION Cont.**

c. Outlet flange

1. Slide outlet packing (9) and outlet flange (10) against the cylinder block.
2. Install lockwashers (8) and capscrews (7).

Tighten.



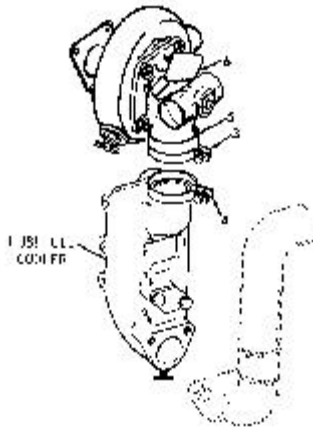
3-1321

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION Cont.**

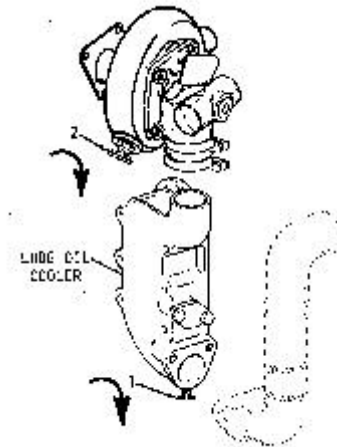
- |    |      |  |   |
|----|------|--|---|
| d. | Hose | <ol style="list-style-type: none"> <li>Slide seal (5) down from pump cover (6) to lube oil cooler.</li> <li>Slide hose clamp (4) up from lube oil cooler.</li> <li>Tighten hose clamps (3 and 4).</li> </ol> | Securing fresh water pump to lube oil cooler. |
|----|------|--|---|



- |    |    |                                   |                          |  |
|----|----|-----------------------------------|--------------------------|--|
|    | e. | Drain cock (2)                    | Turn clockwise to close. |  |
| 5. |    | Lube oil cooler<br>Drain cock (1) | Turn clockwise to close. |  |

**3-75. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS Cont.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION Cont.**

6. Fill the engine cooling system with antifreeze.

**NOTE**

When filling the cooling system of certain models, it is necessary to open the vent valve at the top of the thermostat housing.

3-1323

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS.**

a. The expansion tank (heat exchanger) provides a means of filling the engine cooling system as well as space for expansion of the coolant as its temperature rises. An over flow pipe, attached near the top of the tank, provides a vent to the atmosphere.

b. In this system the hot coolant flows from the water manifold to the expansion tank (heat exchanger) and down through the vertical cells of the heat exchanger core. While raw water flows horizontally between the cells and lowers the temperature of the coolant. The coolant is then circulated through the cylinder block and head by the fresh water pump.

c. The engine coolant level should be maintained near the top of the expansion tank (heat exchanger).

d. The expansion tank (heat exchanger) receives coolant from the water manifold, exhaust manifold and raw water pump. The expansion tank (heat exchanger) returns coolant to the system thru the fresh water pump and lube oil cooler.

**This task covers:**

- a. Inspection                      c. Cleaning                      b. Removal                      d. Installation**

**INITIAL SETUP:**

**Test Equipment**

NONE

**References**

- Para 3-74 Lube Oil Cooler
- Para 3-75 Fresh Water Pump
- Para 3-77 Water Manifold
- Para 3-78 Thermostat and Housing Equipment

**Special Tools**

NONE

**Condition                      Condition Description**

**Para**

NONE

**Material/Parts**

- Gasket, Kit P/N 5192637
- Gasket, Kit P/N 5193113

**Special Environmental Conditions**

Do not drain into bilges, dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

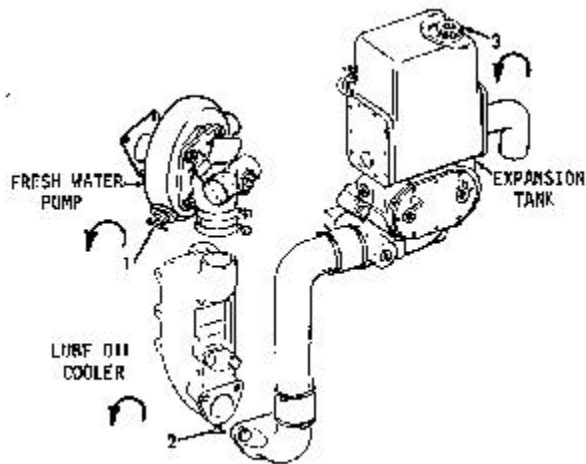
NONE

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>INSPECTION</b>				
1. Expansion tank	a. Pressure cap	1. Check for cracks.	If any of these conditions exists replace with new pressure cap.	
		2. Check for leaks.		
		3. Check tightness of pressure cap.		
	b. Overflow	1. Check for leaks. elbow	2. Check for cracks.	
	c. Expansion or dents. tank	1. Check for cracks,		
		2. Check for leaks.		
		3. Check tightness of hose connections.		
	d. Hoses	1. Check for cracks or breaks.		
		2. Check for leaks.		
	e. Outlet connection	1. Check for cracks or dents.		
		2. Check for leaks.		
	<b>3-1325</b>			

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>REMOVAL</b>				
2.	Lube oil cooler	Drain cock (1)	Turn counter-clockwise to open.	Drain into a suitable container. Do not drain into bilges, dispose of properly.
3.	Fresh water pump	Drain cock (2)	Turn counter-clockwise to open.	Drain into a suitable container. Do not drain into bilges, dispose of properly.
4.	Expansion tank	a. Pressure cap (3)	1. Loosen, turn counter-clockwise.	Aids in the draining of cooling system.



3-1326

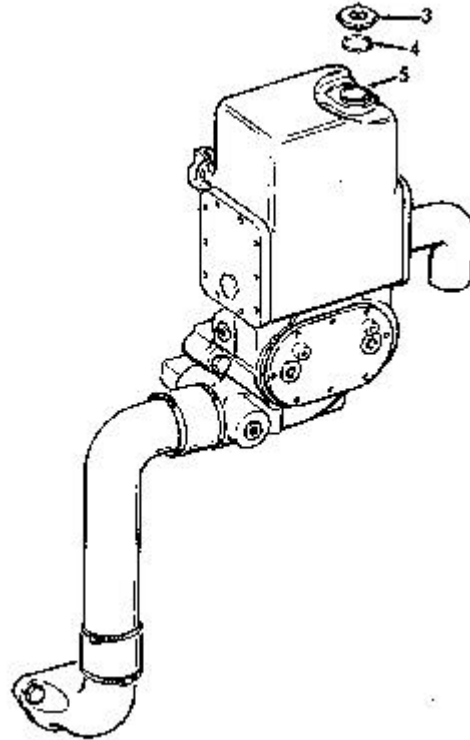


**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

2. Remove pressure cap (3).
  3. Remove neck gasket (4) from expansion tank neck (5).
- Discard.



3-1327

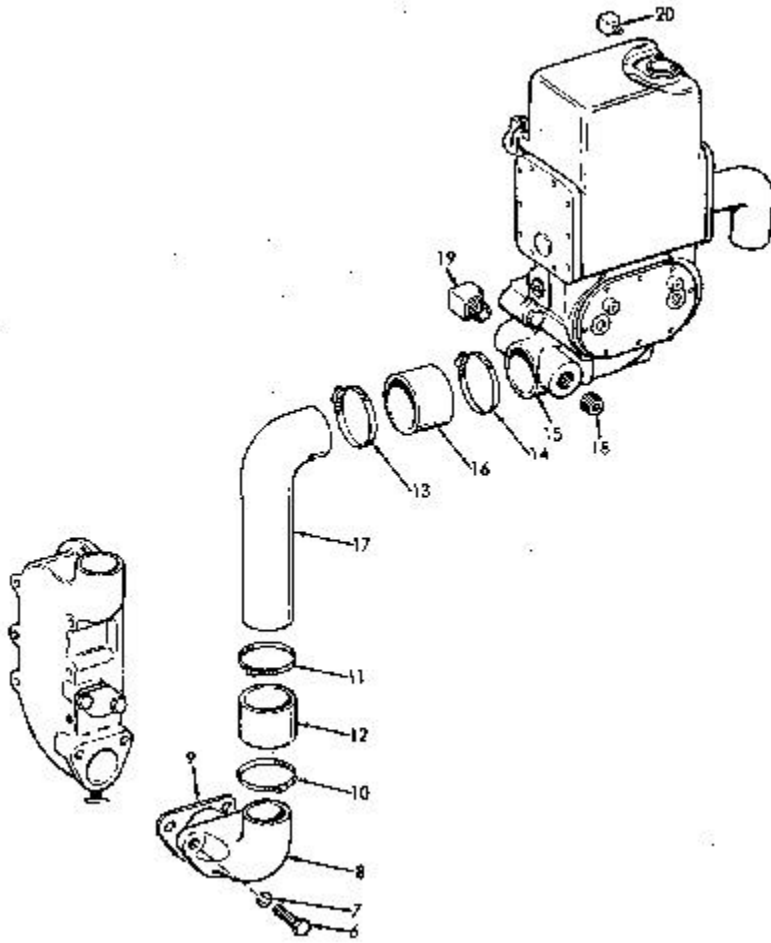
**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	b. Oil cooler inlet water connector and hose	<ol style="list-style-type: none"> <li>1. Remove capscrews (6) and lockwashers (7).</li> <li>2. Remove oil cooler inlet water connector (8).</li> <li>3. Remove gasket (9) from oil cooler housing.</li> <li>4. Loosen and remove hose clamps (10 and 11) from oil cooler inlet water connector (8).</li> <li>5. Remove hose (12).</li> <li>6. Loosen and remove hose clamps (13 and 14) from outlet water connection (15).</li> <li>7. Remove hose (16).</li> <li>8. Remove inlet water tube (17).</li> </ol>	Discard.
	c. Inlet water connection (15)	<ol style="list-style-type: none"> <li>1. Remove headless pipe plug (18). connec-</li> <li>2. Remove outlet elbow (19).</li> </ol>	
	d. Overflow elbow (20)	Remove	
<b>3-1328</b>			

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**



3-1329

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

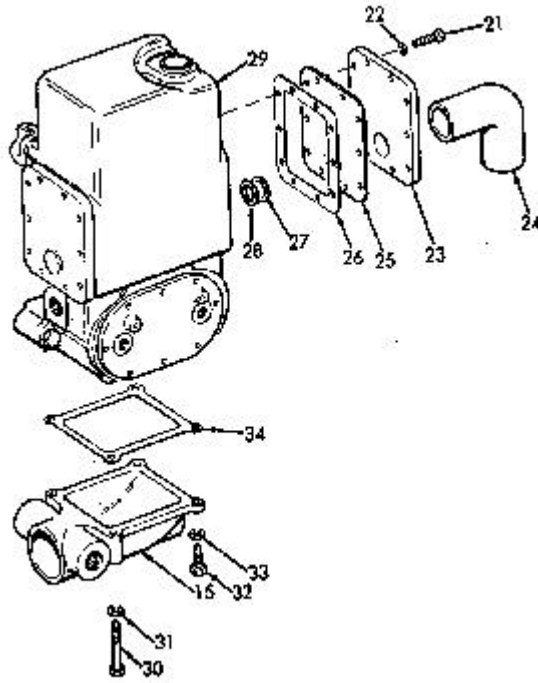
LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	e. Outlet cover and inlet water	<ol style="list-style-type: none"> <li>1. Remove capscrews (21) and lockwashers (22).</li> <li>2. Remove outlet cover tube (23) and inlet water tube (24).</li> <li>3. Remove seal retainer (25).</li> <li>4. Remove gasket (26).</li> <li>5. Remove seals (27 and 28) from expansion tank (29) (heat exchanger).</li> </ol>	<p>Discard.</p> <p>Discard.</p>
5.	Outlet water connection	<ol style="list-style-type: none"> <li>a. Cap screws (30) and lock-washers (31)</li> <li>b. Cap screws (32) and lock-washers (33)</li> <li>c. Outlet water connection</li> </ol> <ol style="list-style-type: none"> <li>1. Remove outlet water connection (15) from expansion tank (29) (heat exchanger).</li> <li>2. Remove outlet gasket (34).</li> </ol>	<p>Remove.</p> <p>Remove.</p> <p>Discard.</p>

**3-1330**

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



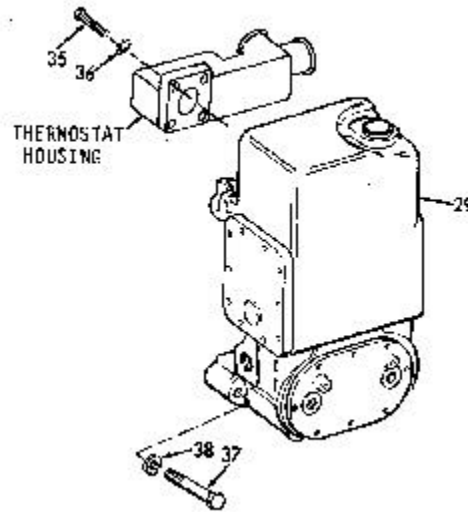
3-1331

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS ( Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

6. Expansion tank	a. Cap screws (35) and lockwashers (36)	Remove thermostat housing from expansion tank (29) (heat exchanger).	Refer to paragraph 3-78.
	b. Expansion tank	<ol style="list-style-type: none"> <li>1. Remove capscrews (37) and lockwashers (38).</li> <li>2. Remove expansion tank (29) from cylinder block.</li> </ol>	



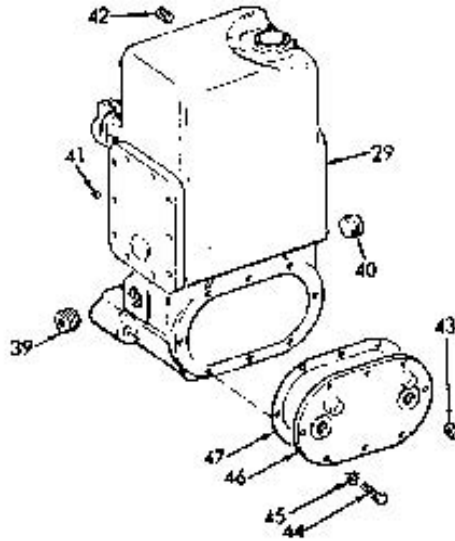
3-1332

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

- |    |                                |   |          |
|----|--------------------------------|---|----------|
|    | c. Plugs<br>(39, 40 and 41)    | Remove.   |          |
|    | d. Pipe<br>plug (42)           | Remove.   |          |
| 7. | Oil cooler<br>housing<br>Cover | <p>a. Remove headless pipe<br/>plug (43).</p> <p>b. Remove capscrews (44)<br/>and lockwashers (45).</p> <p>c. Remove oil cooler<br/>housing cover (46)<br/>from expansion tank (29)<br/>(heat exchanger).</p> <p>d. Remove cover gasket<br/>(47).</p> | Discard. |



3-1333

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

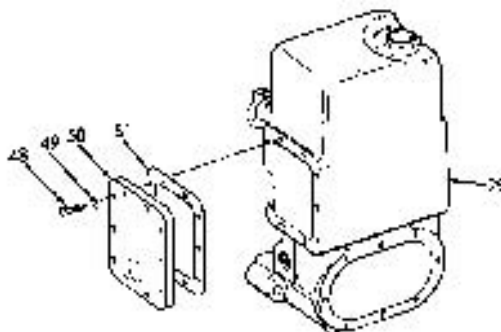
LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

8.	Expansion tank	<ul style="list-style-type: none"> <li>a. Remove capscrews (48) and lockwashers (49).</li> <li>b. Remove blank cover (50).</li> <li>c. Remove gasket (51) from expansion tank (29) (heat exchanger).</li> </ul>	Discard.
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**CLEANING**

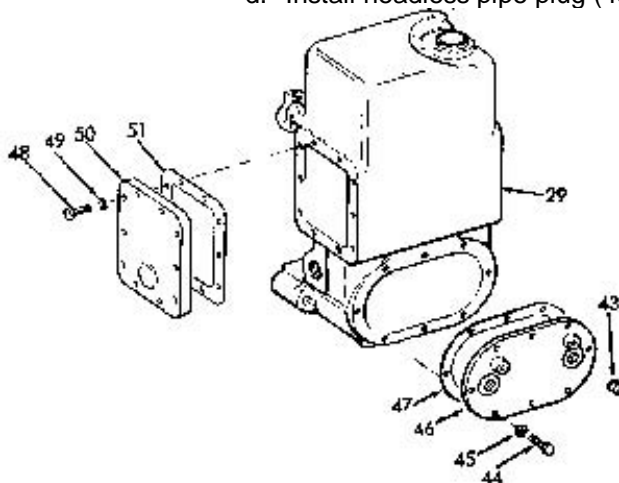
9.	Expansion tank	<ul style="list-style-type: none"> <li>a. Immerse the heat exchanger (29) (expansion tank) in a scale solution.</li> <li>b. Remove heat exchanger (29) (expansion tank) when foaming and bubbling stops.</li> <li>c. Flush thoroughly with clean hot water under pressure.</li> </ul>	<p>To prevent drying and hardening of accumulated foreign substances, the heat exchanger must be cleaned as soon as possible after removing it from service. Use a solvent consisting of 1/3 muriatic acid and 2/3 water to which 1/2 lb (0.226 kg) of oxalic acid has been added to each 2-1/2 gals. (9.46 l) of solution.</p> <p>30 to 60 seconds.</p>
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3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
10.	Expansion tank	a. Install gasket (51). b. Install blank cover (50). c. Install lockwashers (49) and capscrews (48).	Use repair kit, P/N 5192637 and 5193113.  Tighten.
11.	Oil cooler housing cover	a. Install cover gasket (47). b. Install oil cooler housing (46) onto heat exchanger (29) (expansion tank). c. Install lockwashers (45) and capscrews (44). d. Install headless pipe plug (43)	Use repair kit, P/N 5193113.



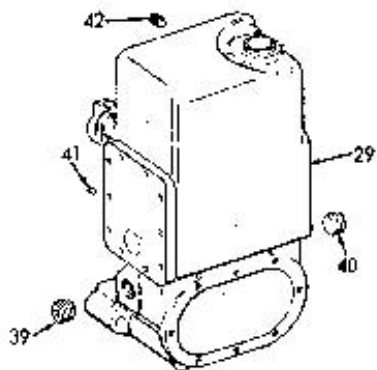
3-1335

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |                    |                          |          |  |
|--------------------|--------------------------|----------|--|
| 12. Expansion tank | a. Pipe plug (42)        | Install. |  |
|                    | b. Plugs (39, 40 and 41) | Install. |  |

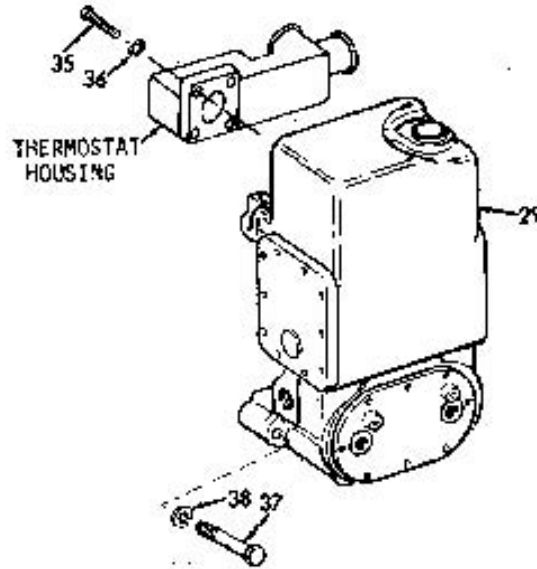


- |  |  |  |  |
|--|--|--|--|
| c. Expansion tank                      | 1. Install expansion tank (29) (heat exchanger) onto cylinder block. |  |  |
|  | 2. Install lockwashers (38) and capscrews (37).                      |  | Tighten, torque to 25-30 ft. lb. (33.9-40.7 Nm). |
| d. Capscrews (35) and lockwashers (36) | Install thermostat housing on expansion tank (29).                   |  | Refer to paragraph 3-78.                         |

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



3-1337

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).**

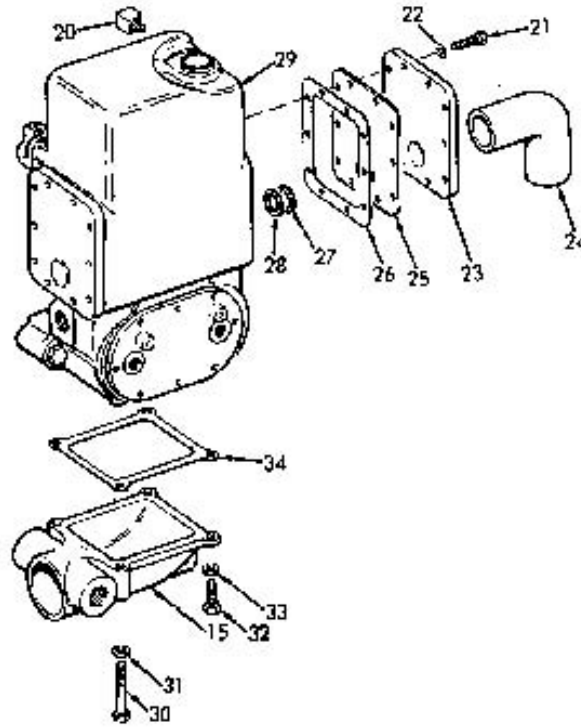
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
13. Outlet water connection	a. Outlet water connection	<ol style="list-style-type: none"> <li>1. Install outlet gasket (34).</li> <li>2. Install outlet water connection (15) onto the expansion tank (29).</li> </ol>	Use repair kit, P/N 5193113.
	b. Cap-screw (32) and lockwasher (33)	Install.	Tighten.
	c. Cap-screw (30) and lockwashers (31)	Install.	Tighten.
14. Expansion tank	a. Outlet cover and inlet water tube	<ol style="list-style-type: none"> <li>1. Install seals (27 and 28) into expansion tank (29).</li> <li>2. Install gasket (26).</li> <li>3. Install seal retainer (25).</li> <li>4. Install outlet cover (23) and inlet water tube (24).</li> <li>5. Install lockwashers (22) and capscrews (21).</li> </ol>	Use repair kit, P/N 5192637.  Use repair kit, P/N 5192637 and 5193113.
		Install	Tighten.
	b. Overflow elbow (20)	Install	

**3-1338**

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



3-1339

**3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).**

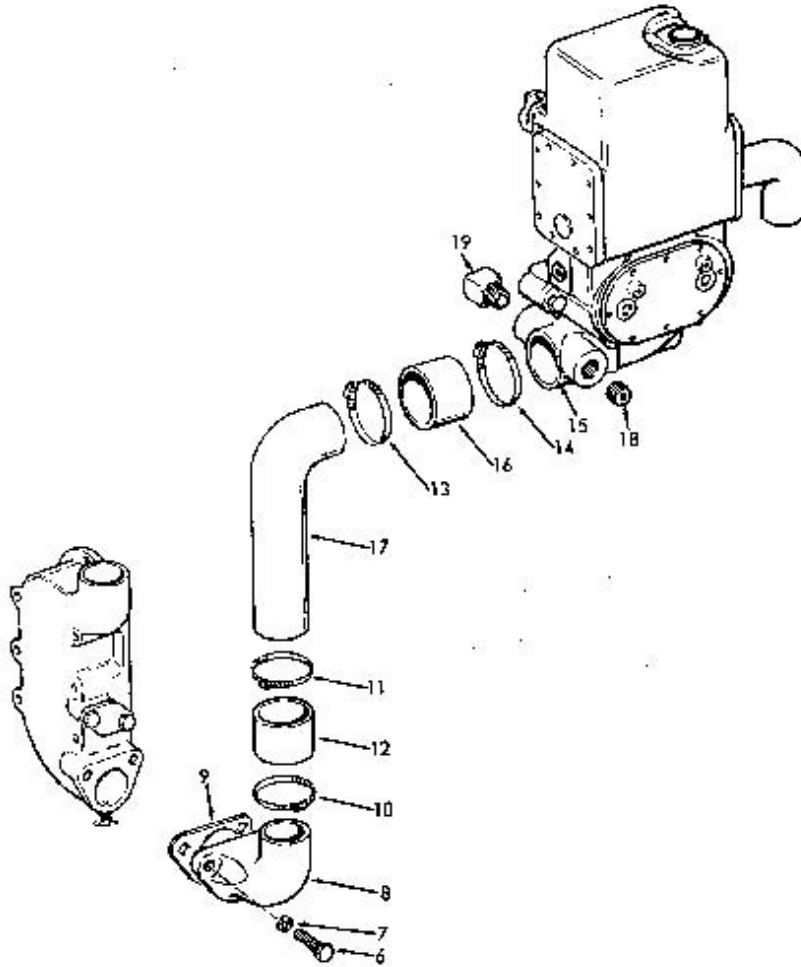
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	c. Outlet water connection (15)	<ol style="list-style-type: none"> <li>1. Install outlet elbow (19).</li> <li>2. Install headless pipe plug (18) onto inlet water connection (15).</li> </ol>	
	d. Oil cooler inlet water connection	<ol style="list-style-type: none"> <li>1. Install inlet water tube (17).</li> <li>2. Install hose (16).</li> <li>3. Install and tighten hose clamps (13 and 14) onto outlet water connection (15).</li> <li>4. Install hose (12).</li> <li>5. Install and tighten hose clamps (10 and 11) on oil cooler inlet water connector (8).</li> <li>6. Install gasket (9).</li> <li>7. Install oil cooler inlet water connector (8).</li> <li>8. Install lockwashers (7) and capscrews (6).</li> </ol>	<p>Use repair kit, P/N 5193113.</p> <p>Use repair kit, P/N 5193113.</p> <p>Tighten.</p>

**3-1340**

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



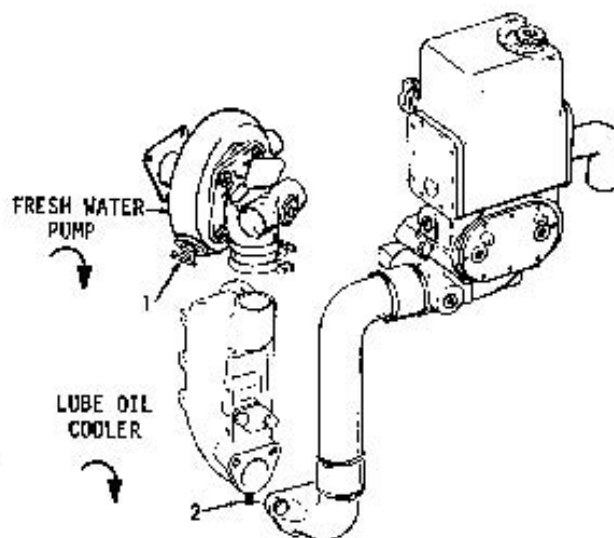
3-1341

3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |     |                  |                |                          |
|-----|------------------|----------------|--------------------------|
| 15. | Fresh water pump | Drain cock (2) | Turn clockwise to close. |
| 16. | Lube oil cooler  | Drain cock (1) | Turn clockwise to close. |



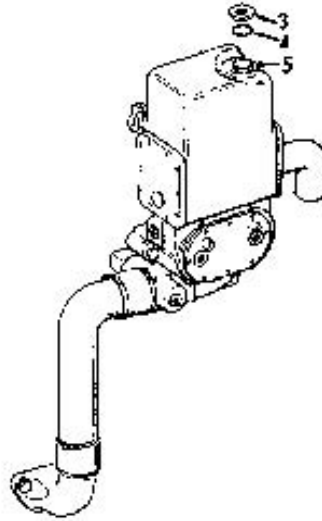
- |     |                |    |                |  |                              |
|-----|----------------|----|----------------|--|------------------------------|
| 17. | Expansion Tank | a. | Expansion tank | Fill the engine cooling system with antifreeze.  |                              |
|     |                | b. | Pressure cap   | <ol style="list-style-type: none"> <li>1. Install neck gasket (4) onto expansion tank neck (5).</li> <li>2. Install pressure cap (3).</li> </ol> | Use repair kit, P/N 5193113. |



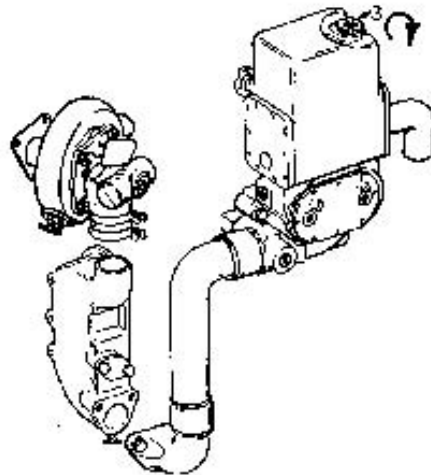
3-76. EXPANSION TANK AND WATER CONNECTIONS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



3. Turn pressure cap (3) clockwise to tighten.



3-1343

**3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS**

Cooling water, leaving the cylinder head through an opening over each exhaust port, enters the water manifold. The front section of the water manifold is connected to the thermostat housing. The aft section of the water manifold contains a flexible by-pass hose to the exhaust manifold, where it will leave the exhaust manifold and flows to the oil cooler.

This task covers:

- a. Inspection
- b. Removal
- c. Installation

**INITIAL SETUP:**

**Test Equipment**

NONE

**References**

- Para 7-75 Fresh Water Pump
- Para 7-76 Expansion Tank and Water Connection
- Para 7-77 Thermostat and Housing

**Special Tools**

NONE

**Equipment**

**Condition      Condition Description**

**Para**

NONE

**Material/Parts**

- Gasket, Kit P/N 5193113
- Gasket, Kit P/N 5193116

**Special Environmental Conditions**

Do not drain oil in bilges, dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |                   |                               |   |  |
|-------------------|-------------------------------|---|--|
| 1. Water manifold | a. Water manifold outlet seal | 1. Check for leaks.<br>2. Check for wear.<br>3. Check for cracks or breaks. |  |
|-------------------|-------------------------------|---|--|

**3-1344**

**3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).**

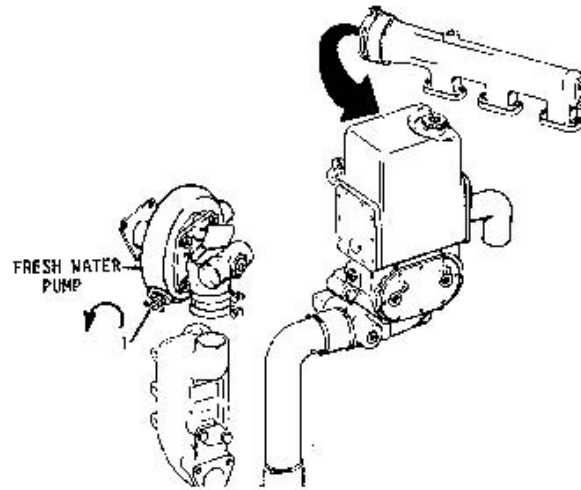
LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION (Cont)**

- |                   |  |
|-------------------|--|
| b. Water manifold | <ol style="list-style-type: none"> <li>1. Check for leaks.</li> <li>2. Check for cracks or dents.</li> <li>3. Check for wear.</li> <li>4. Check tightness of fitting to cylinder block.</li> </ol> |
|-------------------|--|

**REMOVAL**

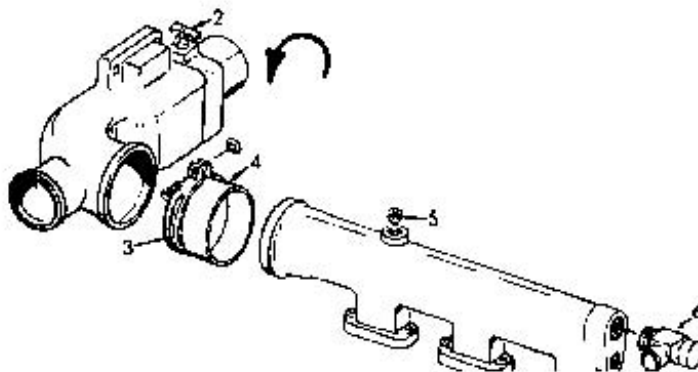
- |                     |                |                                 |   |
|---------------------|----------------|---------------------------------|---|
| 2. Fresh water pump | Drain cock (1) | Turn counter-clockwise to open. | Drain into a suitable container. Drain to necessary level to repair water manifold. |
|---------------------|----------------|---------------------------------|---|



3-1345

3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS	
<b>REMOVAL (Cont)</b>				
3.	Thermostat housing	Drain cock (2)	Turn counter-clockwise to open.	Drain into a suitable container. Drain to necessary level to repair water manifold.
4.	Water manifold	a.	Water manifold outlet seal (3)	1. Loosen hose clamp (3). 2. Slip water outlet manifold seal (4) over the neck of the thermostat housing.
		b.	Headless pipe plug (5)	Remove.
		c.	Water Manifold outlet to exhaust manifold	Remove 90° elbow (6).
		d.	Water temperature gage (7)	Remove.

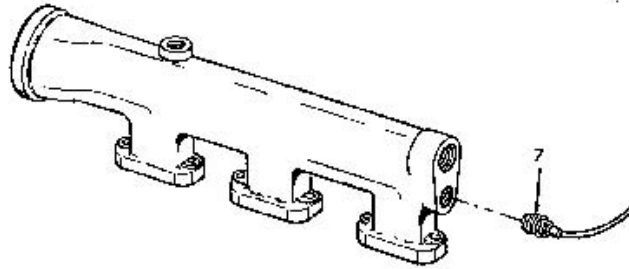


3-1346

3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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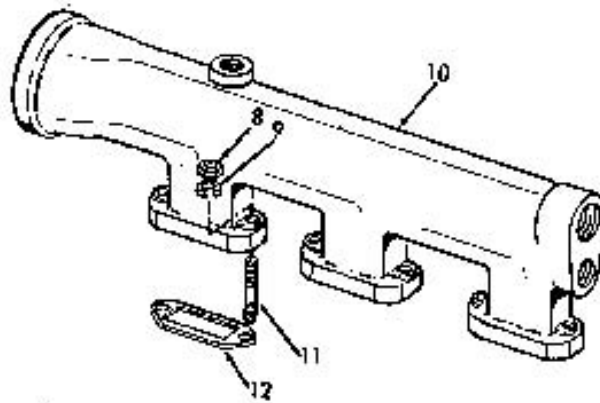
**REMOVAL (Cont)**



e. Water manifold

1. Remove stud nuts (8) and lockwashers (9).
2. Lift water manifold (10) straight up off studs (11).
3. Remove studs (11).
4. Remove gaskets (12).

Discard.



3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

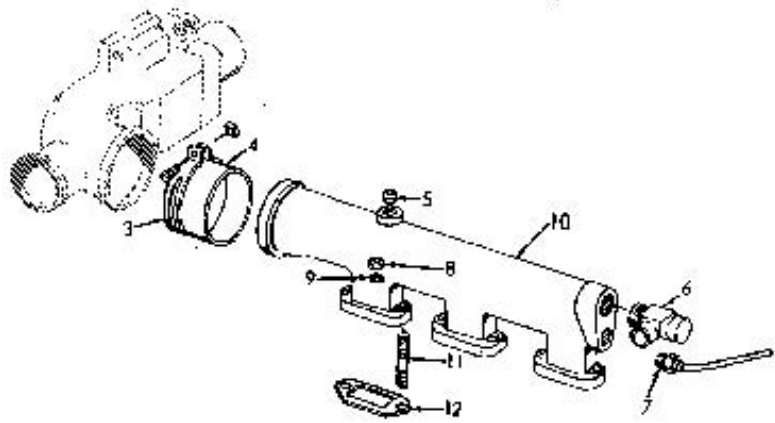
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
5. Water manifold	a. Water manifold	<ol style="list-style-type: none"> <li>1. Install gasket (12).</li> <li>2. Install studs (11).</li> <li>3. Install water manifold (10) on studs (11).</li> <li>4. Install lockwashers (9) and stud nuts (8).</li> </ol>	<p>Use repair kit, P/N 5193113 and 5193116.</p> <p>Tighten, securing the water manifold (10) to the cylinder block.</p>
	b. Water temperature gage (7)	Install.	
	c. Water manifold outlet to exhaust manifold	Install 90° elbow (6).	
	d. Headless pipe plug (5)	Install.	
	e. Water manifold output seal	<ol style="list-style-type: none"> <li>1. Slide down water manifold outlet seal (4) onto the water manifold neck.</li> <li>2. Tighten hose clamp (3) on water manifold outlet seal (4) and water manifold (10).</li> </ol>	

3-1348

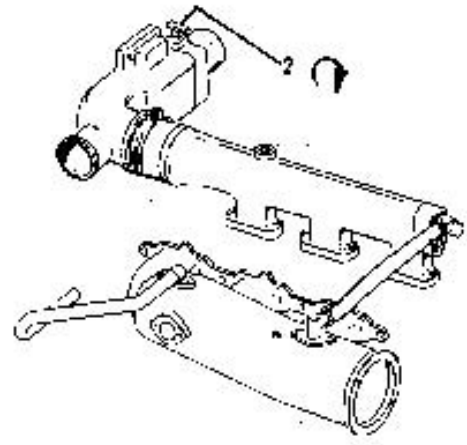
3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



- |                               |                   |                          |  |
|-------------------------------|-------------------|--------------------------|--|
| 6. Thermo-<br>stat<br>housing | Drain cock<br>(2) | Turn clockwise to close. |  |
|-------------------------------|-------------------|--------------------------|--|



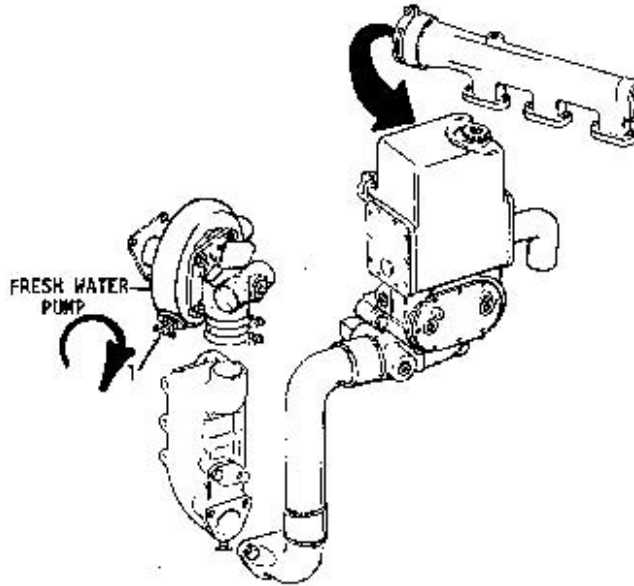
3-1349

**3-77. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |                     |                |                          |  |
|---------------------|----------------|--------------------------|--|
| 7. Fresh water pump | Drain cock (1) | Turn clockwise to close. |  |
|---------------------|----------------|--------------------------|--|



- |    |  |                                      |  |
|----|--|--------------------------------------|--|
| 8. |  | Fill cooling system to proper level. |  |
|----|--|--------------------------------------|--|

**NOTE**

When filling cooling system on certain models, it is necessary to open the vent valve at the top of the thermostat housing.

3-1350/(3-1351 blank)



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**3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTION.**

---

a. The temperature of the engine coolant is automatically controlled by a thermostat located in the housing connected to the outlet end of the water manifold and to the heat exchanger (expansion tank).

b. At coolant temperatures below approximately 170°F (76.7°C), the thermostat valves remain closed and block the flow of coolant to the heat exchanger (expansion tank). During this period, all of the coolant 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 170°F (76.7°C), the thermostat valves start to open, restricting the by-pass system, and permit a portion of the coolant to circulate through the heat exchanger (expansion tank). When the coolant temperature reaches approximately 185°F (85°C), the thermostat valves are fully open, the by-pass system is partially blocked off, and most of the coolant is directed through the heat exchanger (expansion tank).

c. A properly operating thermostat is essential for efficient operation of the engine. If the engine operating temperature deviates from the normal range of 160° to 185°F (71° to 85°C) remove the thermostat and check it.

d. The by-pass hoses and tubes of the water and exhaust manifold help to by-pass the thermostat while the engine is warming up.

**3-1352**

**3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTION (Cont).**

This task covers:

- |               |                 |
|---------------|-----------------|
| a. Inspection | c. Testing      |
| b. Removal    | d. Installation |

**INITIAL SETUP:**

**Test Equipment**

NONE

**References**

Para 3-74 Lube Oil Cooler  
 Para 3-75 Fresh Water Pump  
 Para 3-76 Expansion Tank and Water Connections  
 Para 3-77 Water Manifold  
 Para 3-85 Exhaust Manifold

**Special Tools**

Thermostat Seal Replacer,  
 J8499

**Equipment**

**Condition      Condition Description**

**Para**

3-76 Expansion Tank and Water Connections, removed.  
 3-77 Water Manifold, removed.  
 3-85 Exhaust Manifold, removed.

**Material/Parts**

Gasket, Kit P/N 5193113

**Special Environmental Conditions**

Do not drain in bilges, dispose of properly.

**Personnel Required**

1

**General Safety Instructions**

Observe all CAUTIONS and WARNINGS

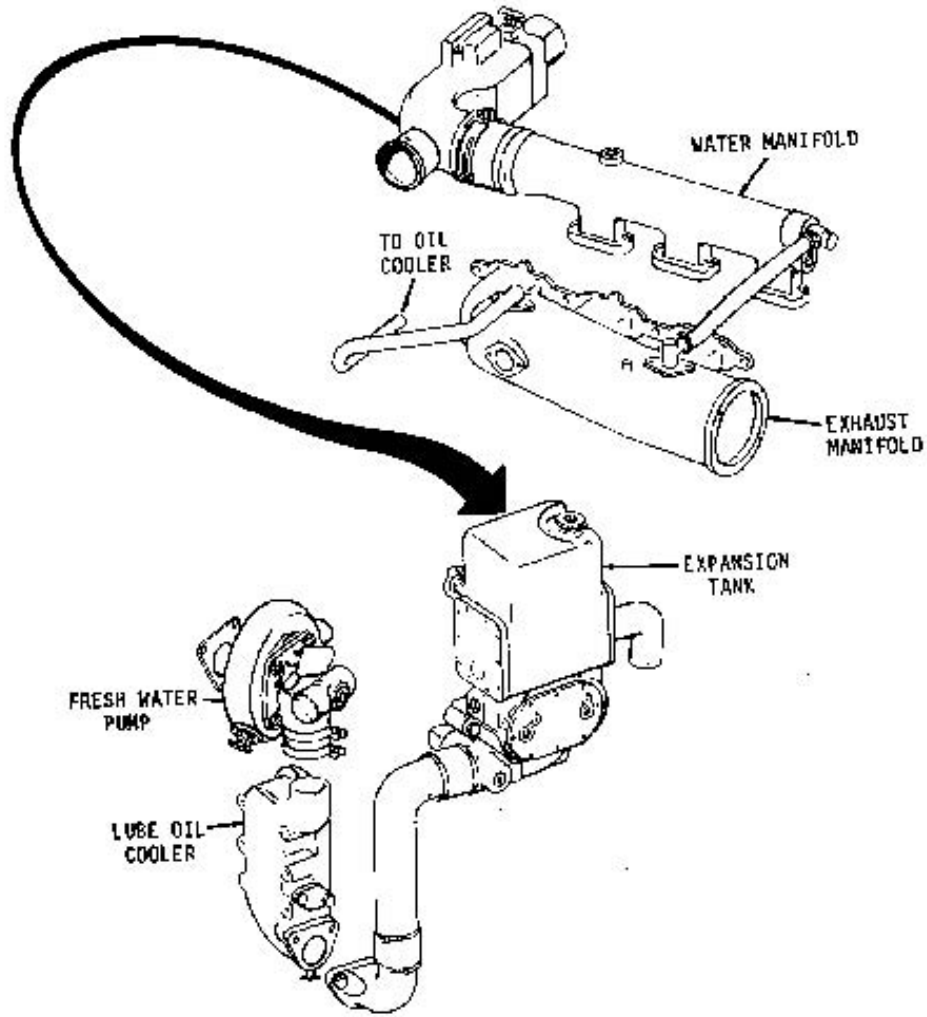
**3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1.	Thermostat housing	a. Check for cracks or dents. b. Check for leaks. c. Check connections from thermostat housing to expansion tank and water manifold.	
2.	Water manifold to exhaust manifold	a. 90° elbows 1. Check for cracks or dents. 2. Check for leaks.	
	b. By-pass hose	1. Check for cracks or breaks. 2. Check for wear. 3. Check for leaks. 4. Check tightness of hose clamps and fittings.	
3.	Exhaust Manifold to oil cooler	a. By-pass tube 1. Check for cracks. 2. Check for wear. 3. Check for leaks. 4. Check tightness of hose clamps and fittings.	
	b. Flexible hose	1. Check for cracks or breaks. 2. Check for wear. 3. Check for leaks. 4. Check tightness of hose clamps and fittings.	

3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION (Cont)**



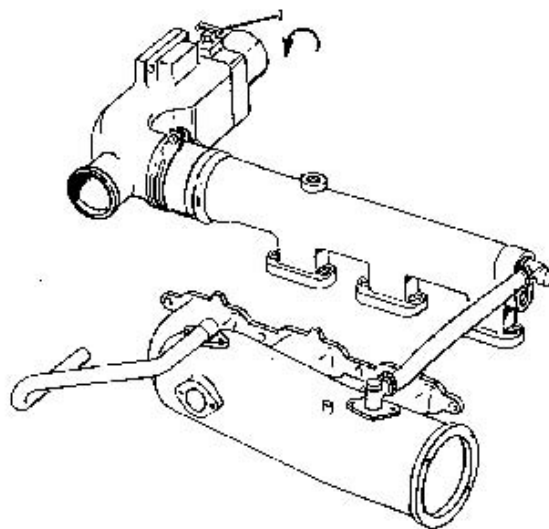
3-1355

3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

4. Thermostat housing	Drain cock (1)	Turn counter-clockwise to open.	Drain the cooling system to the necessary level to repair the thermostat and housing. Drain into a suitable container, do not use bilges and dispose of properly.
-----------------------	----------------	---------------------------------	---



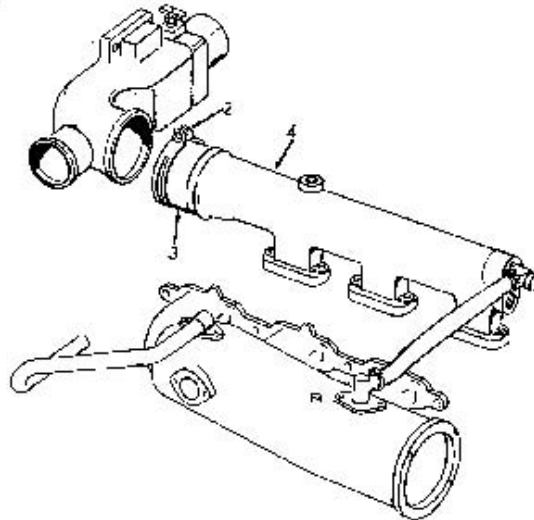
5. Water Manifold and thermostat housing	a. Water manifold outlet seal	<ol style="list-style-type: none"> <li>1. Loosen hose clamp (2).</li> <li>2. Slide water manifold outlet seal (3) down onto the water manifold (4).</li> </ol>
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3-1356

3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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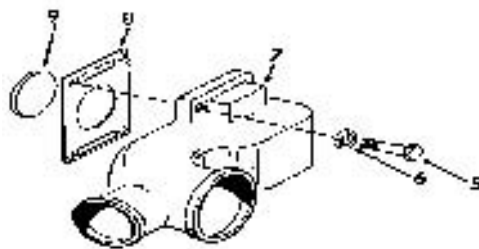
**REMOVAL (Cont)**



b. Thermostat housing

1. Remove cap screws (5) and lockwashers (6).
2. Remove thermostat housing (7) from heat expansion tank.
3. Remove gasket (8).
4. Remove expansion tank cover plate (9).

Discard.



3-1357

3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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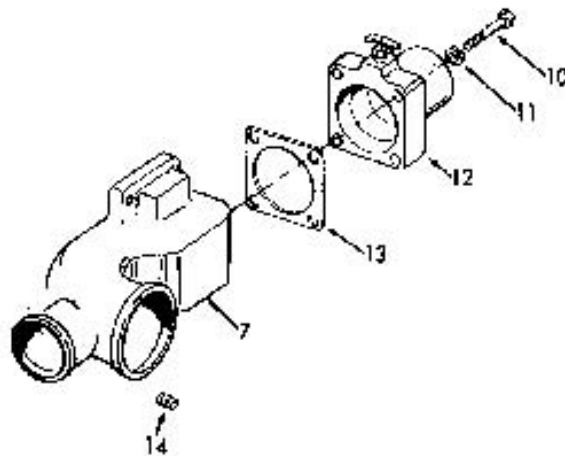
**REMOVAL (Cont)**

6. Thermostat Housing

a. Water outlet thermostat housing

1. Remove capscrews (10) and lockwashers (11).
2. Remove water outlet thermostat housing (12) exposing the thermostat.
3. Remove gasket (13).
4. Remove pipe plug (14).

Discard.



b. Thermostat

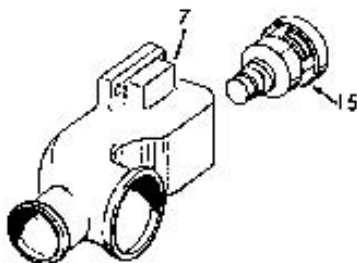
Carefully remove thermostat (15) from thermostat housing (7).

Clean the thermostat seat in the thermostat housing.

**3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**



**NOTE**

When working on the water manifold by-pass hose and exhaust manifold by-pass tube, it will be necessary to drain the cooling system further for maintenance. Refer to paragraphs 3-74 Lube Oil Cooler, 3-75 Fresh Water Pump and 3-76 Expansion Tank and Water Connection for draining the cooling system.

**CAUTION**

Completely drain cooling system before maintenance repairs to water manifold by-pass hose or exhaust manifold by-pass tube can be made. Do not drain into bilges.

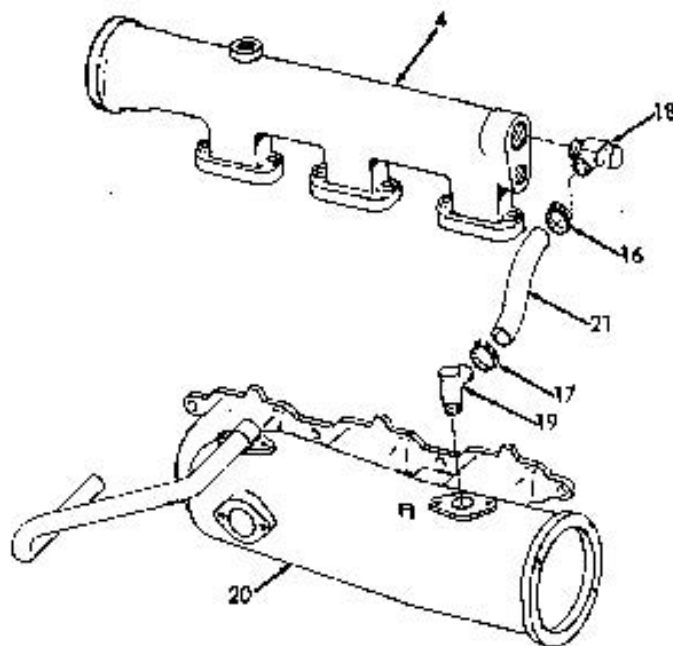


3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

7. Water manifold to exhaust manifold	By-pass hose	<ul style="list-style-type: none"> <li>a. Loosen hose clamps (16 and 17).</li> <li>b. Slide hose clamps (16) onto 90° elbow (18) at water manifold (4).</li> <li>c. Remove 90° elbow (18).</li> <li>d. Slide hose clamp (17) onto 90° elbow (19) at exhaust manifold (20).</li> <li>e. Remove by-pass hose (21).</li> <li>f. Remove 90° elbow (19) from exhaust manifold (20).</li> </ul>	Remove, if necessary.
---------------------------------------	--------------	---	-----------------------

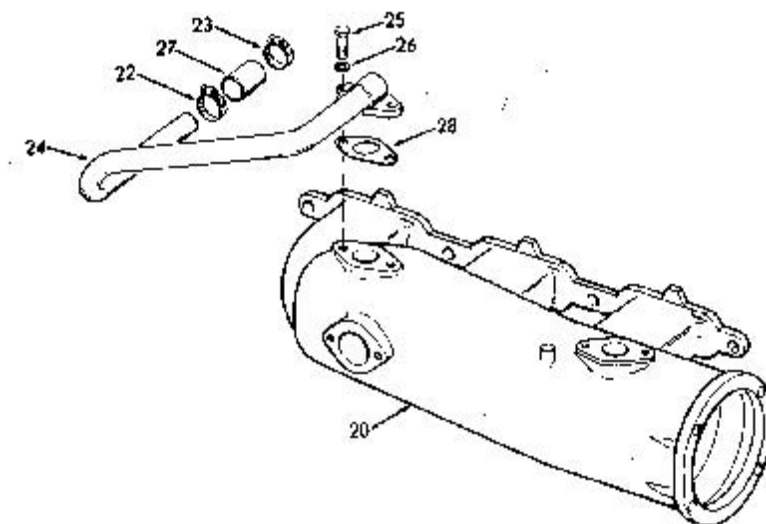


3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

8. Exhaust manifold to oil cooler	By-pass tube	<ul style="list-style-type: none"> <li>a. Loosen hose clamps (22 and 23).</li> <li>b. Slide hose clamp (22) down to the oil cooler.</li> <li>c. Slide hose clamp (23) up the by-pass tube (24).</li> <li>d. Remove capscrews (25) and lockwashers (26).</li> <li>e. Remove by-pass tube (24).</li> <li>f. Remove flexible hose (27).</li> <li>g. Remove gasket (28).</li> </ul>	<ul style="list-style-type: none"> <li>Remove, if necessary.</li> <li>Discard.</li> </ul>
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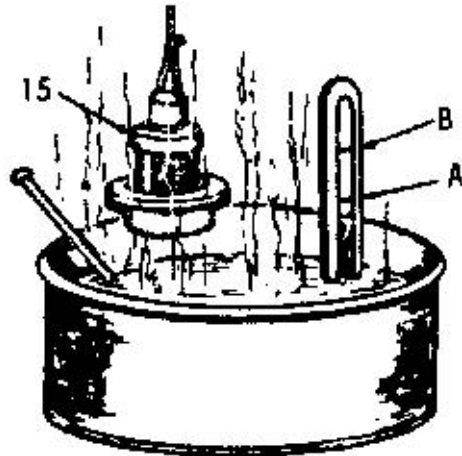
## 3-78. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>TESTING</b>			
9.	Thermostat (15)	<ol style="list-style-type: none"> <li>a. Check for accumulation of rust and corrosion from the engine coolant, if present, can restrict the flow of water causing engine overheating.</li> <li>b. Thermostat (15) stuck in wide open position will not allow engine to reach normal operating temperature.</li> <li>c. Check thermostat (15) operation by immersing it in a container of hot water. <ol style="list-style-type: none"> <li>1. Place thermometer in the container, do not let it touch the bottom of the container.</li> <li>2. Agitate water to maintain an even temperature.</li> <li>3. As the water is heated, the thermostat (15) should begin to open.</li> <li>4. Thermostat (15) should be fully open by 185°F (85°C).</li> </ol> </li> </ol>	<p>Allows incomplete combustion of fuel and build-up of carbon deposit on pistons, rings and valves.</p> <p>Water temperature at 170°F (76.7°C).</p> <p>Few types fully open at 195°F (90.6°C).</p>
<b>3-1362</b>			

3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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TESTING (Cont)



A - STARTS TO OPEN  
 B - FULLY OPEN

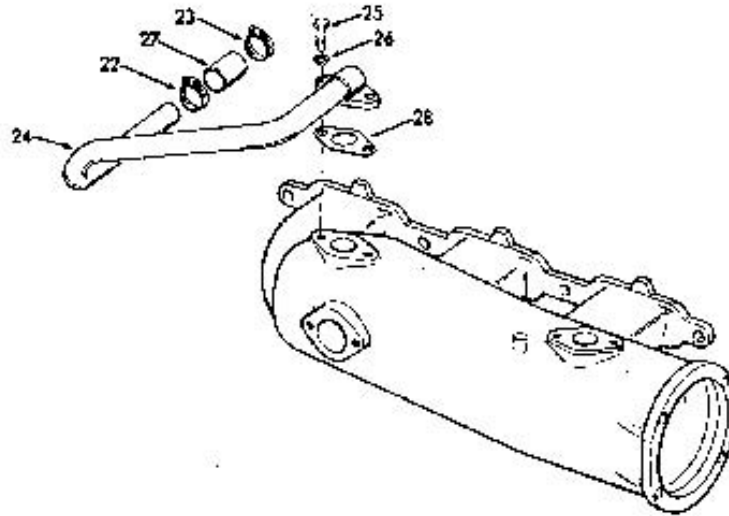
3-1363

3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION**

10. Exhaust manifold to oil cooler	By-pass tube	<p>a. Slide hose clamp (23) down by-pass tube (24), attach flexible hose (27) and tighten hose clamp (23).</p> <p>b. Slide hose clamp (22) up from oil cooler, attach flexible hose (27) and tighten hose clamp (22).</p> <p>c. Install gasket (28).</p> <p>d. Install by-pass tube (24).</p> <p>e. Install lockwashers (25) and capscrews (26).</p>	<p>Use repair kit, P/N 5193113.</p> <p>Tighten.</p>
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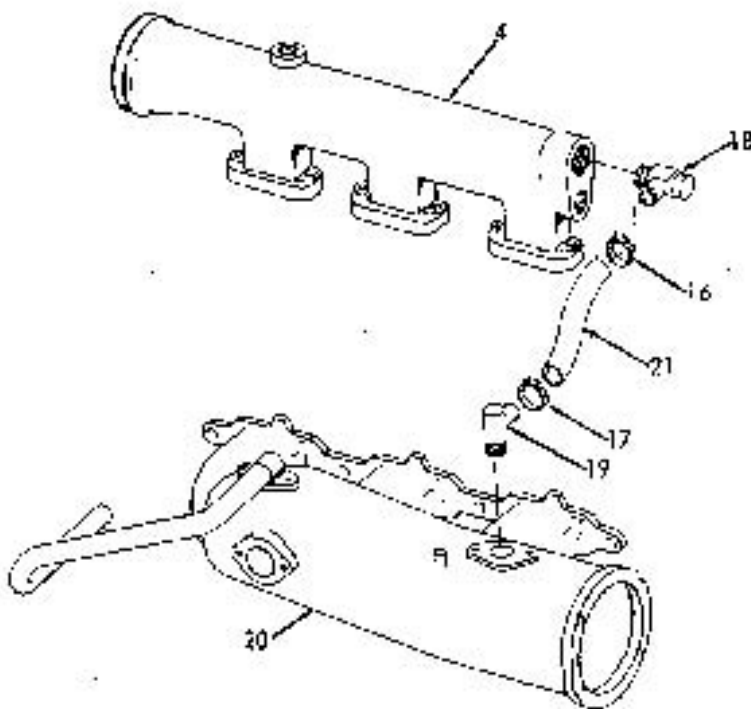


3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION(Cont)**

- |  |              |   |
|--|--------------|---|
| 11. Water manifold to exhaust manifold | By-pass hose | <ul style="list-style-type: none"> <li>a. Install 90° elbow (19) onto exhaust manifold (20).</li> <li>b. Slide hose clamp (17) up from 90° elbow (19), attach by-pass hose (21) and tighten hose clamp (17).</li> <li>c. Install 90° elbow (18) onto water manifold (4).</li> <li>d. Slide hose clamp (16) down from 90° elbow (18), attach by-pass hose (21) and tighten hose clamp (16).</li> </ul> |
|--|--------------|---|

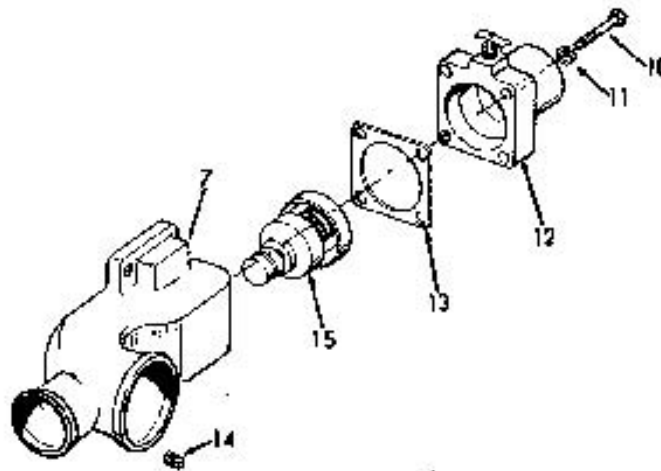


3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

- |                        |   |   |                              |
|------------------------|---|---|------------------------------|
| 12. Thermostat housing | a. Thermostat                                   | Install thermostat (15) into thermostat housing (7).                            |                              |
|                        | b. Water outlet thermostat housing              | 1. Install pipe plug (14).  |                              |
|                        |   | 2. Install gasket (13).   | Use repair kit, P/N 5193113. |
|                        |   | 3. Install water outlet thermostat housing (12) carefully over thermostat (15). |                              |
|                        | 4. Install lockwashers (11) and capscrews (10). | Tighten.  |                              |



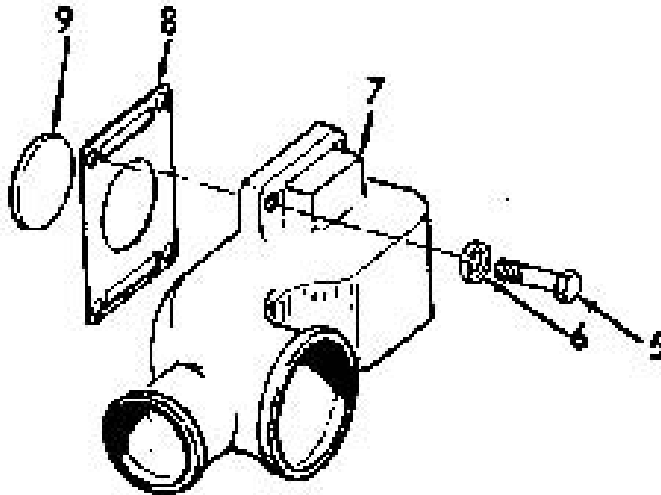
3-1366

3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

13. Water manifold and thermostat housing	a. Thermostat housing	<ol style="list-style-type: none"> <li>1. Install expansion tank cover (9).</li> <li>2. Install gasket (8).</li> <li>3. Install thermostat housing (7) onto heat expansion tank.</li> <li>4. Install lockwashers (6) and capscrews (5).</li> </ol>	Use repair kit, P/N 5193113.
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3-1367

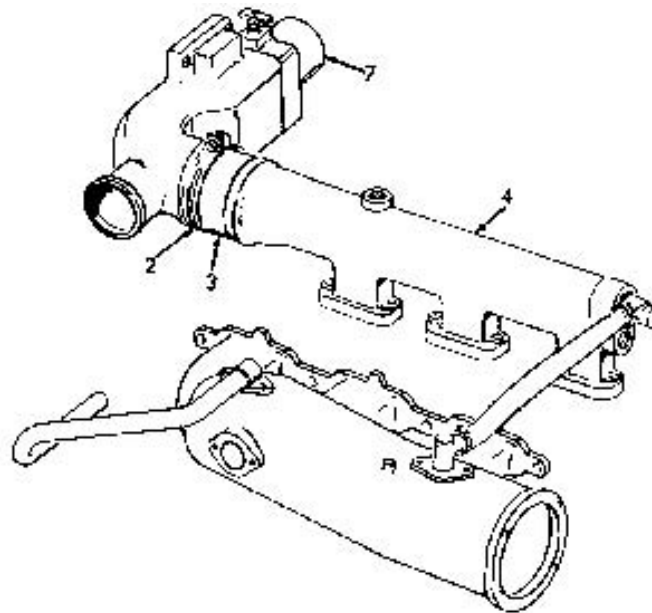


3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION(Cont)**

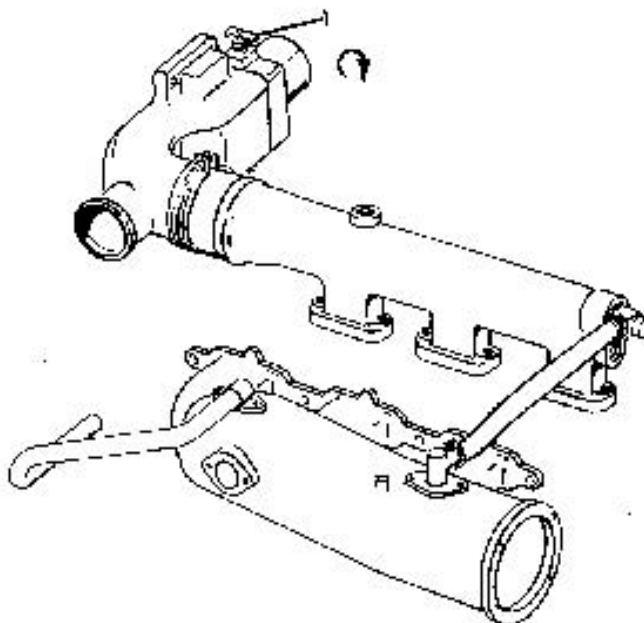
	<p>b. Water manifold outlet seal</p>	<p>1. Slide water manifold outlet seal (3) and hose clamp (2) down from water manifold (4) onto thermostat housing (7).</p> <p>2. Tighten hose clamp (2) around thermostat housing (7) and water manifold (4).</p>	
<p>14. Thermo stat housing</p>	<p>Drain cock (1)</p>	<p>Turn clockwise to close.</p>	



**3-78. THERMOSTAT AND HOUSING-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**



- |     |  |  |  |
|-----|--|--|--|
| 15. |  | Fill the cooling system to proper level. | Refer to paragraph 3-74, 3-75 and 3-76 on closing drain cocks, if opened for maintenance of water manifold by-pass hose and exhaust manifold by-pass tube. |
|-----|--|--|--|

**NOTE**

When filling cooling system on certain models, it is necessary to open the vent valve at the top of the thermostat housing.

**3-1369**

**3-79. OVERSPEED GOVERNOR-MAINTENANCE INSTRUCTIONS.**

The overspeed governor is connected electrically to a solenoid which actuates the shut-down mechanism on the air inlet housing. The governor is actuated when the engine speed exceeds a preset limit.

This task covers:

- |                |               |                 |               |
|----------------|---------------|-----------------|---------------|
| a. Removal     | c. Repair     | e. Reassembly   | g. Adjustment |
| b. Disassembly | d. Reassembly | f. Installation |               |

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Sharp pointed instrument  
Arbor press  
Rod 9/16 inch diameter

Material/Parts

Gasket, Kit P/N 5193113  
Grease (MIL-G-18709)

Personnel Required

1

References

NONE

<u>Equipment</u>	<u>Condition</u>	<u>Condition Description</u>
	<u>Para</u>	

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

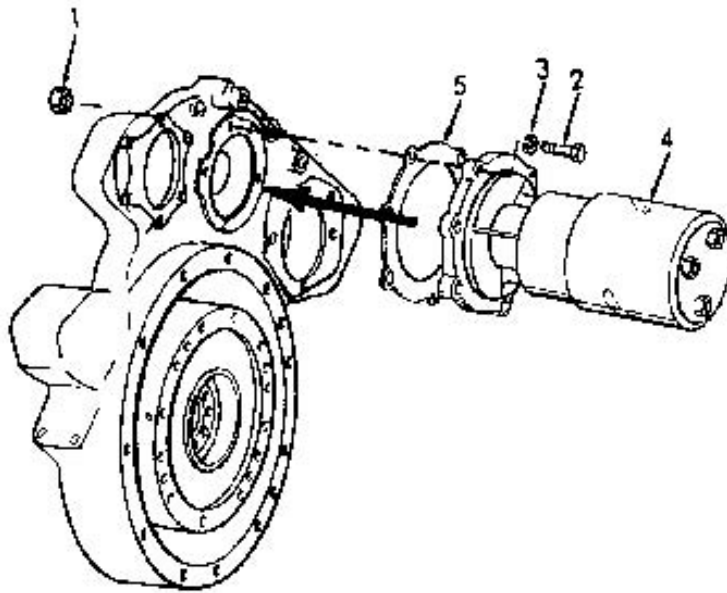
- |                     |  |                    |
|---------------------|--|--------------------|
| 1. Flywheel housing | a. Wiring                                    | Tag and disconnect |
|                     | b. Nuts (1), screws (2) and lock-washers (3) | Remove four sets.  |

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- |    |                                       |                            |  |
|----|---------------------------------------|----------------------------|--|
| c. | Overspeed Governor (4) and gasket (5) | Remove and discard gasket. |  |
|----|---------------------------------------|----------------------------|--|



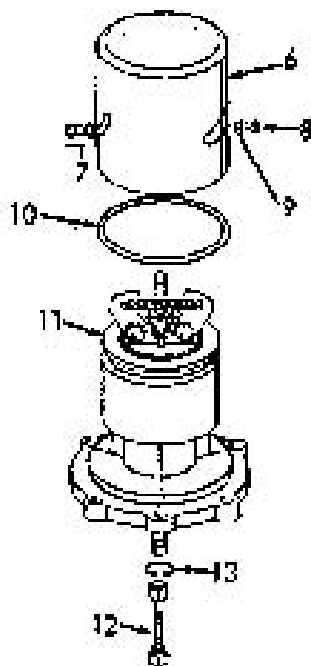
3-1371

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY**

- |                               |                                   |  |  |
|-------------------------------|-----------------------------------|--|--|
| 2. Overspeed Governor cap (6) | a. Screw and washer assembly (7)  | Remove.  |  |
|                               | b. Adjusting stud (8) and nut (9) | Remove.  |  |
|                               | c. Cap (6)                        | Remove.  |  |
|                               | d. Seal ring (10)                 | Remove from body (11).   |  |
| 3. Flexible shaft (12)        | a. Spring clip (13)               | Insert a sharp pointed instrument in the loop of the spring clip (13) and pull the clip from the flexible shaft (12) as far as possible. |  |
|                               | b. Flexible shaft assembly (12)   | Remove.  |  |

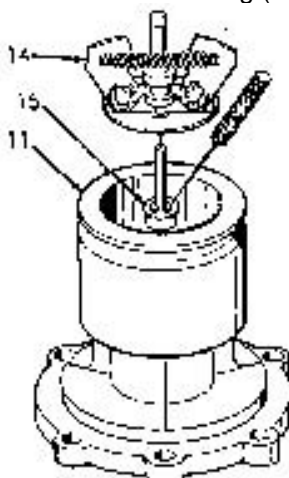


3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

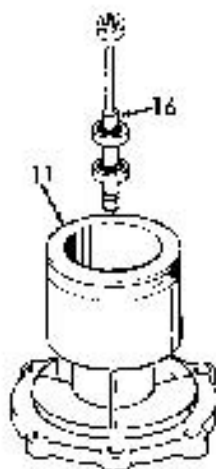
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**DISASSEMBLY (Cont)**

- |                         |                          |  |  |
|-------------------------|--------------------------|--|--|
| 4. Weight assembly (14) | a. Weight assembly (14)  | Remove.  |  |
|                         | b. Bearing retainer (15) | Insert a sharp pointed instrument in the bearing retainer (15) and remove from housing (11). |  |



- |                              |                                    |                        |  |
|------------------------------|------------------------------------|------------------------|--|
| 5. Shaft and Weight assembly | a. Shaft and bearing assembly (16) | Remove from body (11). |  |
|------------------------------|------------------------------------|------------------------|--|



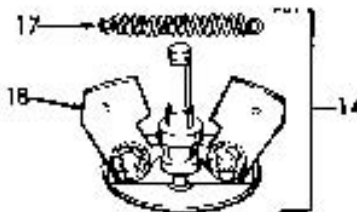
3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**DISASSEMBLY (Cont)**

b. Springs (17)

Remove from posts on weight assembly (18).

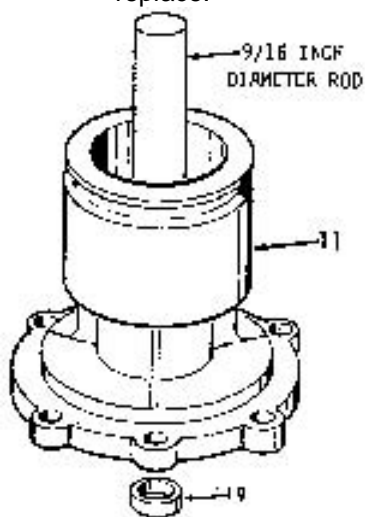


**INSPECTION**

6. Body (11)

Seal (19)

Inspect the oil seal, if damaged, or leaking replace.



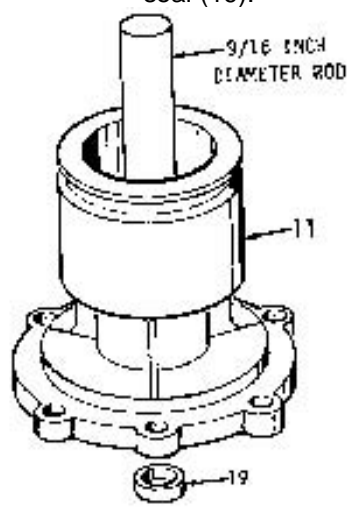
3-1374

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

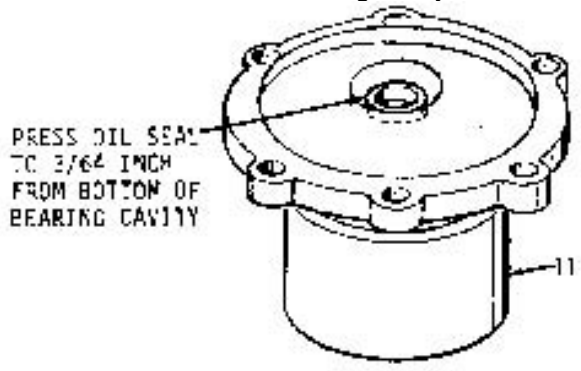
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR**

- |    |          |           |  |
|----|----------|-----------|--|
| 7. | Oil seal | Body (11) | <p>a. Place body in arbor press with the mounting flange facing down. Use a 9/16 inch diameter rod to press out the oil seal (19).</p> |
|----|----------|-----------|--|



- b. Turn body (11) over and press in new oil seal. Seal must be 3/64 inch (0.119 cm) from bottom of bearing cavity.



3-1375



**3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

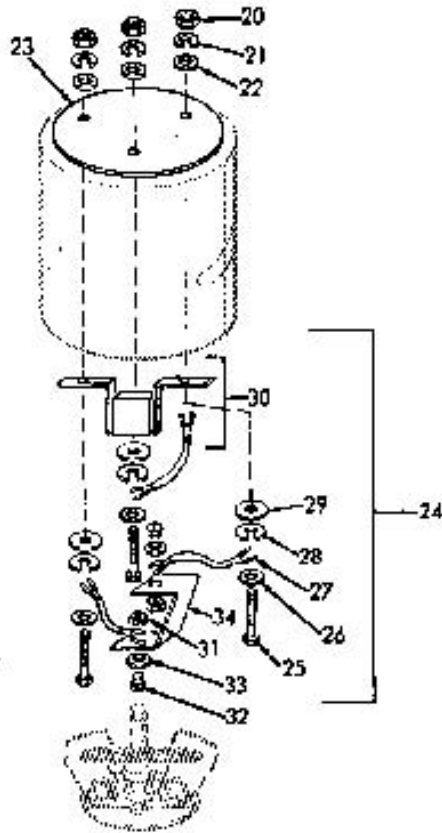
8.	Cap	a. Nuts (20) lockwash- ers (21), insula- ting washers (22), and insulator (23)	Remove.
		b. Switch and wir- ing (24)	Remove from cap.
		c. Screws (25), flat washers (26), wires (27), lockwash- ers (28), bushings (29), and switch assembly (30)	Remove.
		d. Nuts (31), screws (32), flat- washers (33), and con- nector (34)	Disassemble

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

- |    |  |             |  |
|----|--|-------------|--|
| e. | Conne-<br>tor (34),<br>screws<br>(32),<br>flat-<br>washers<br>(33), and<br>nuts (31) | Reassemble. |  |
|----|--|-------------|--|



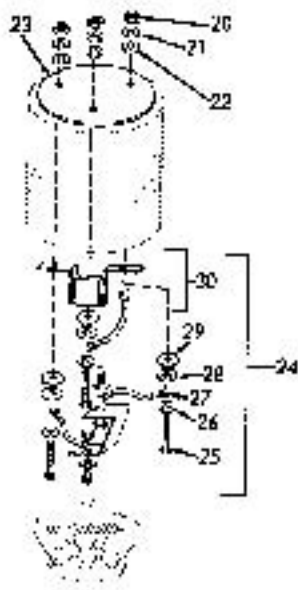
3-1377

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

- |    |  |                    |  |
|----|--|--------------------|--|
| f. | Switch Assembly (30), bushings (29), lockwashers (28), wires (27), flatwashers (26), and screws (25) | Reassemble.        |  |
| g. | Switch and wiring (24)   | Insert in cap.     |  |
| h. | Insulator (23), insulating washers (22), lockwashers (21), and nuts (20)                             | Reassemble on cap. |  |

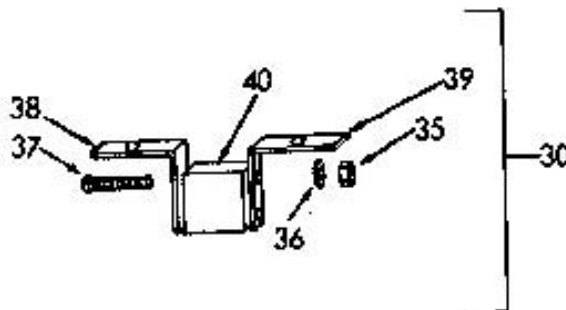


3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

- |                         |  |             |  |
|-------------------------|--|-------------|--|
| 9. Switch assembly (30) | a. Nuts (35), lockwashers (36), and screws (37)  | Remove.     |  |
|                         | b. Bracket (left) (38), bracket (right) (39) and switch (40)   |             |  |
|                         | c. Bracket (right) (39), bracket (left) (38), switch (40), screws (37), lockwashers (36) and nuts (35) | Reassemble. |  |

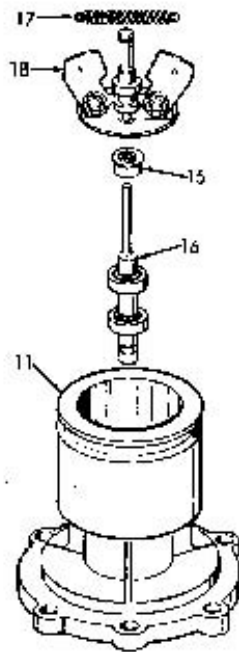


**3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REASSEMBLY**

- |                               |                                    |                                    |
|-------------------------------|------------------------------------|------------------------------------|
| 10. Shaft and weight assembly | a. Springs (17)                    | Reassemble on weight assembly (18) |
|                               | b. Shaft and bearing assembly (16) | Insert in body (11).               |
|                               | c. Bearing Retainer (15)           | Install.                           |



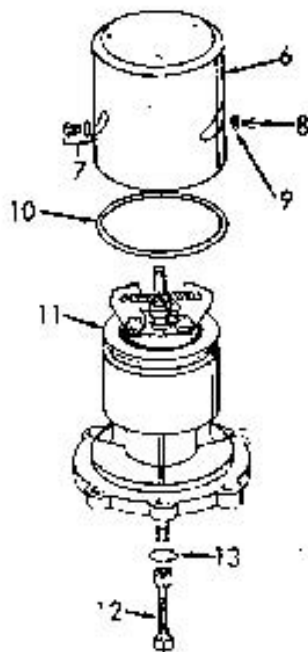
**3-1380**

3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REASSEMBLY (Cont)**

- |     |                |  |  |
|-----|----------------|--|--|
| 11. | Flexible Shaft | Flexible shaft (12) and spring clip (13) | Install.   |
| 12. | Cap            | a. Seal ring (10)                        | Install on body (11).                            |
|     |                | b. Cap (6)                               | Place over seal ring and align holes for screws. |
|     |                | c. Adjusting stud (8) and nut (9)        | Install.   |
|     |                | d. Screw and washer assembly (7)         | Install.   |



3-1381

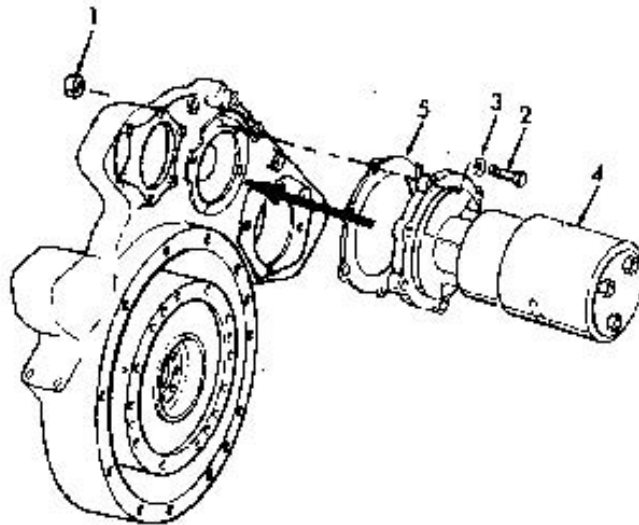
3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION**

13. Governor Assembly	a. Governor (4), gasket (5), screws (2), lockwashers (3), and nuts (1)	Reassemble.	Use new gasket.
-----------------------	--	-------------	-----------------

b. Wiring Reinstall.



3-1382

**3-79. OVERSPEED GOVERNOR-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

<b>ADJUSTMENT</b>
-------------------

14. Overspeed Governor	a. Cap adjusting lock	<ol style="list-style-type: none"> <li>1. Loosen.</li> <li>2. Rotate cap clockwise screw to lower the trip speed.</li> <li>3. Rotate cap counter clockwise to raise the trip speed.</li> <li>4. Tighten screw when the adjustment is complete.</li> </ol>	<p>The total range of adjustment is shown on the name plate on the governor. The governor should not be adjusted to trip below 100 RPM above the normal running speed of the engine.</p>
------------------------	-----------------------	---	--

**CAUTION**

Under no circumstances should the governor switch be by-passed to prevent engine shut-down in the event of overspeed, otherwise serious damage to not only the engine, but also to the governor may be incurred since the governor is not designed to operate above its tripping speed.



**3-80. TACHOMETER DRIVE-MAINTENANCE INSTRUCTIONS.**

The tachometer and drive are mounted on the oil breather housing.

This task covers:

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

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition

Condition Description

Para 3-73.2 Breather housing -removed

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

1. Tachometer	a. Glass	Inspect for broken glass.	Replace if defective.
	b. Needle	Inspect for damage.	Replace if defective.
	c. Tachometer	Does not indicate engine speed.	Replace tachometer or drive.

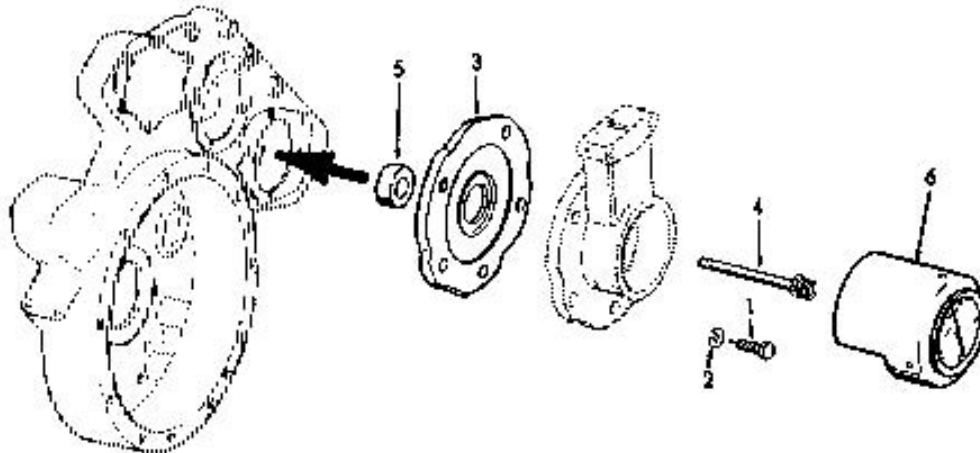
**3-1384**

3-80. TACHOMETER DRIVE-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

2. Breather housing	a. Screws (1), lock-washers (2)	Remove.	Refer to para 3-73.2 for breather housing removed.
	b. Tachometer drive cover assembly (3)	Remove.	
	c. Drive cover adapter (4)	Remove from flywheel housing.	
	d. Seal (5)	Remove.	
	e. Tachometer mounting adapter (6)	Remove from breather housing.	



**3-80. TACHOMETER DRIVE-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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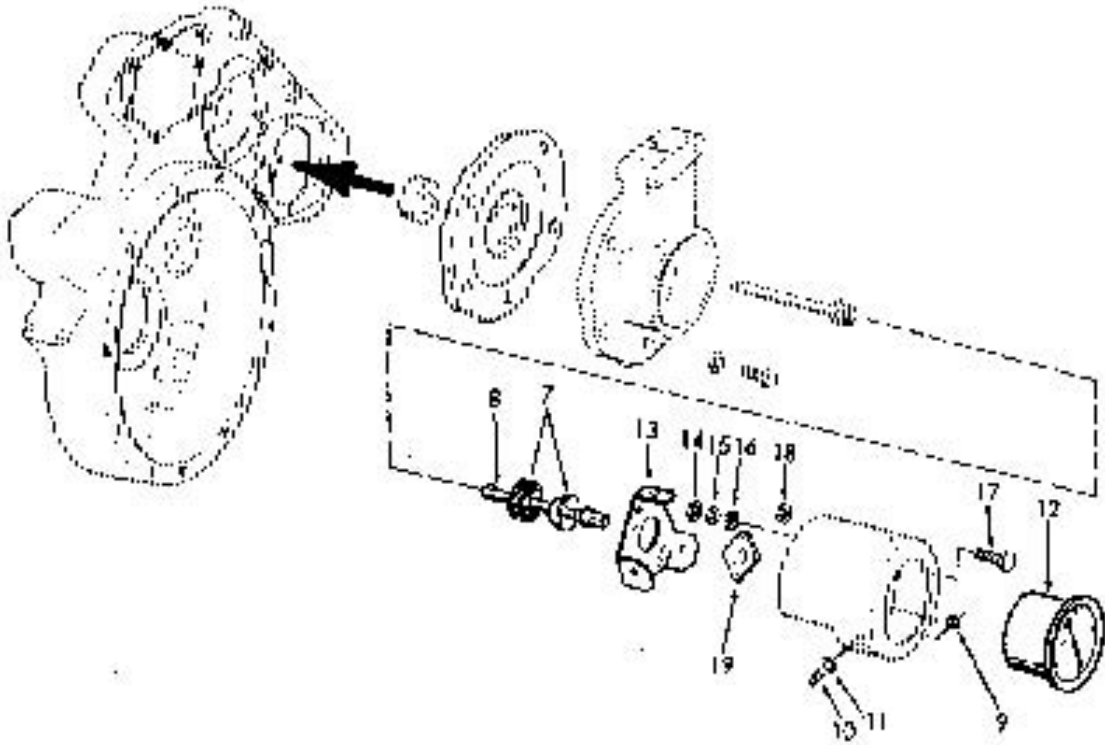
**REPAIR**

- |    |            |   |                           |
|----|------------|---|---------------------------|
| 3. | Tachometer | a. Shaft Assembly ferrule and nut assembly (7), and flexible drive shaft (8)  | Remove if necessary.      |
|    |            | b. Nuts (9), Screws (10), lockwashers (11), tachometer (12) and retainer (13) | Disassemble if necessary. |
|    |            | c. Nuts (14), lockwashers (15), flatwashers (16) and screw (17)               | Remove if necessary.      |
|    |            | d. Lockwasher (18) and vibration mount (19)                                   | Remove if necessary.      |

3-80. TACHOMETER DRIVE-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



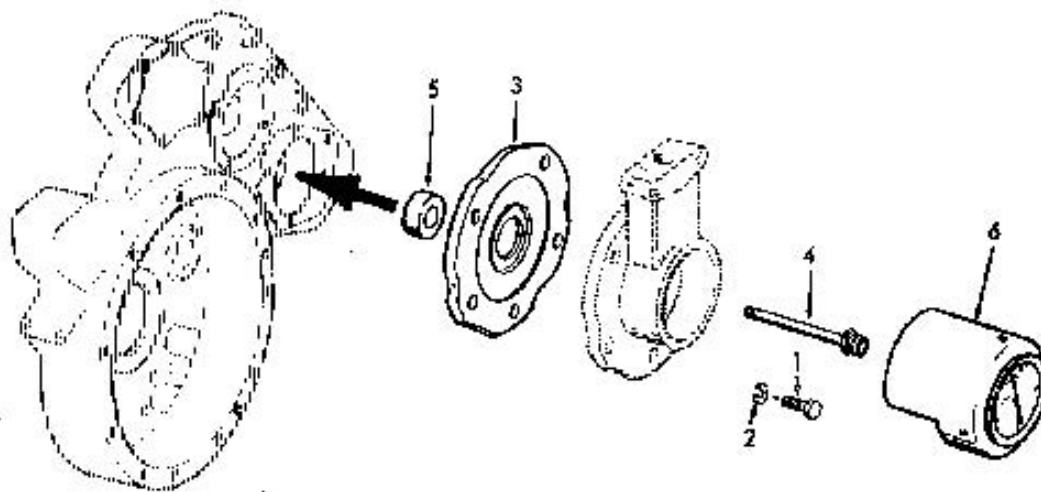
3-1387

3-80. TACHOMETER DRIVE-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

- |               |  |   |  |
|---------------|--|---|--|
| 4. Tachometer | a. Tachometer Mounting adapter (6), seal (5) and drive cover adapter (4) | Install. Make sure the drive sections mate. |  |
|               | b. Tachometer drive cover (3), screws (1) and lockwashers (2)            | Install.                                    |  |



---

**3-81. AIR CLEANER.**

---

a. The air cleaner is designed to remove foreign matter from the air, pass the required volume of air for proper combustion and maintain their efficiency for a reasonable period of time before requiring service.

b. The importance of keeping dirt and grit laden air out of an engine cannot be overemphasized since clean air is so essential to satisfactory engine operation and long engine life. The air cleaner must be able to remove fine materials such as dust as well as coarse materials as lint from the air. It must also have a reservoir capacity large enough to retain the material separated from the air to permit operation for a reasonable period before cleaning and servicing are required.

c. The light duty, oil bath type air cleaner, consists essentially of a wire screen element supported inside a cylindrical housing which contains an oil bath directly below the element. Air drawn through the cleaner passes over the top of the oil bath. The air stream direction reverses when the air impinges on the oil in the sump and is then directed upwards by baffles. During this change in the direction of air flow, much of the foreign matter is trapped by the oil and is carried to the sump where it settles out. The air passes upward through the metal-wool elements where more dust and the entrained oil are removed. A second change of air direction at the top of the cleaner directs the air downward through the center tube and into the blower inlet housing.

**3-1389**

**3-81. AIR CLEANER (Cont)**

This task covers:

- a. Inspection
- c. Service
- e. Repair
- b. Removal
- d. Installation

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition      Condition Description  
Para

NONE

Special Environmental Conditions

Do not dump oil into the water.

General Safety Instructions

Observe all CAUTIONS and WARNINGS

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |                |                        |   |
|----------------|------------------------|---|
| 1. Air cleaner | a. Air cleaner housing | <ul style="list-style-type: none"> <li>1. Check for dents and cracks.</li> <li>2. Check for oil leaks.</li> <li>3. Check air cleaner's tightness on air intake pipe.</li> <li>4. Make sure air cleaner's assembly is strictly oil and air tight.</li> </ul> |
|----------------|------------------------|---|

**REMOVAL**

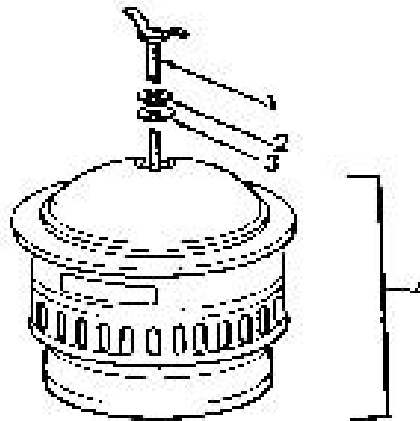
- |                |                  |                     |
|----------------|------------------|---------------------|
| 2. Air Cleaner | a. Wing bolt (1) | Unscrew and remove. |
|----------------|------------------|---------------------|

3-81. AIR CLEANER (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

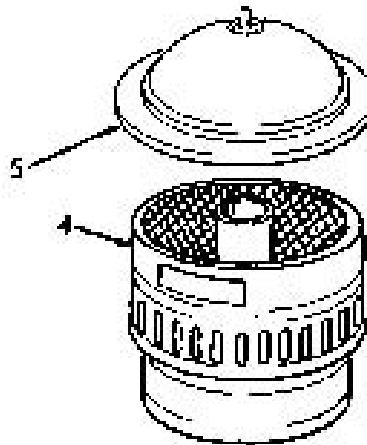
**REMOVAL (Cont)**

- b. Retainer seal (2) and gasket seal (3)
- Remove.
  
- c. Air cleaner housing (4)
- Remove from air inlet housing.



**SERVICE**

- 3. Air Cleaner
- a. Cover (5)
- Lift off.



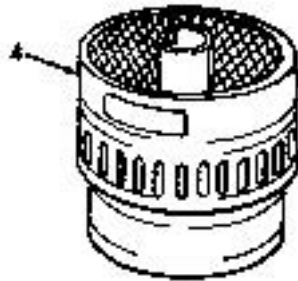


3-81. AIR CLEANER (Cont).

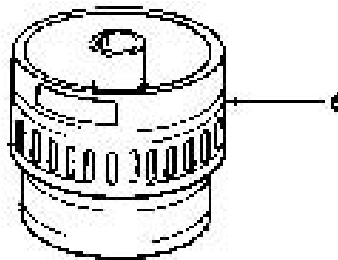
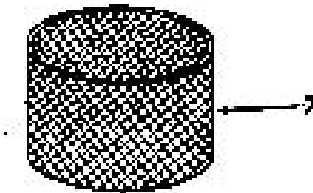
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**SERVICE (Cont)**

- |                |                             |   |
|----------------|-----------------------------|---|
| b. Housing (4) | Separate into two sections. | <ol style="list-style-type: none"> <li>Upper section housing (6), filter element (7)</li> <li>Lower section housing (8), oil cup (9)</li> </ol> |
|----------------|-----------------------------|---|



- |                              |                              |   |
|------------------------------|------------------------------|---|
| 4. Air cleaner upper section | a. Upper section housing (6) | <ol style="list-style-type: none"> <li>Remove filter element (7).</li> <li>Soak in fuel oil.</li> </ol> |
|------------------------------|------------------------------|---|



- |                       |                      |                                    |
|-----------------------|----------------------|------------------------------------|
| b. Filter element (7) | 1. Soak in fuel oil. | Use OE/HDO to loosen oil and dirt. |
|-----------------------|----------------------|------------------------------------|

3-81. AIR CLEANER (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

**WARNING**

**Wear eye protection when using compressed air.**

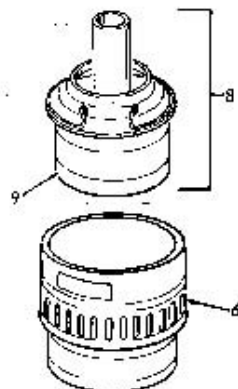
2. Flush out the dirt.

Thoroughly drain flushing fluid and dry with compressed air. Replace, if necessary.

5. Air cleaner  
Lower section housing

a. Lower section housing (8)

Lift out of upper section housing (6).



3-1393

3-81. AIR CLEANER (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

b. Oil cup  
(9)

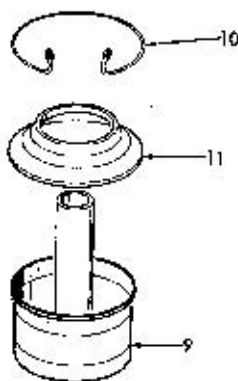
1. Remove snap ring (10).

**WARNING**

**Wear eye protection when using compressed air.**

2. Remove baffle (11).

Clean in fuel oil to remove sediment and dry with compressed air.



3-1394

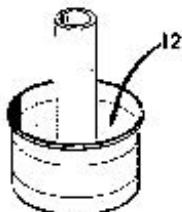
3-81. AIR CLEANER (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

**WARNING**

**Wear eye protection when using compressed air.**



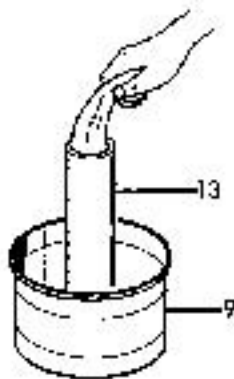
3. Drain oil and clean sump (12)

Use suitable container. Do not dump in bilges. Dispose of properly. Clean in fuel oil to remove sediment and dry with compressed air.

c. Oil cup center tube (13).

Clean.

Use lintless cloth pushed through center (13)



3-1395

3-81. AIR CLEANER (Cont).

LOCATION	ITEM	ACTION	REMARKS
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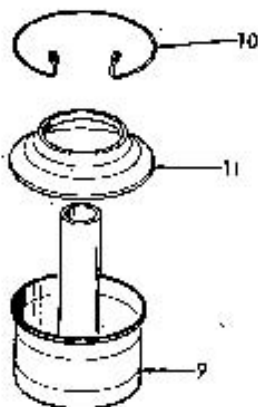
**SERVICE (Cont)**

6.	Air cleaner lower section housing	Oil cup (9)	<p>a. Refill to the oil level marked on oil cup (9).</p> <p>b. Install baffle (11).</p> <p>c. Install snap ring (10).</p>	Use engine oil OE/HDO. Check all gasket and seals to ensure air-tight seal.
----	-----------------------------------	-------------	---	---



b. Install baffle (11).

c. Install snap ring (10).



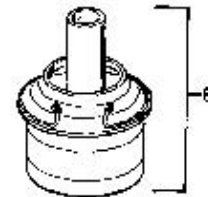
7.	Air cleaner housing	a. Air cleaner lower section housing (8)	Install into air cleaner upper section housing (6).	
----	---------------------	--	---	--

3-81. AIR CLEANER (Cont).

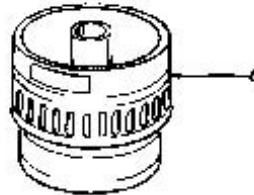
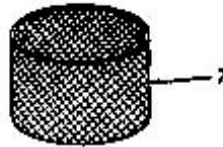
LOCATION	ITEM	ACTION	REMARKS
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**SERVICE (Cont)**

b. Filter element (7)



Install in air cleaner upper section housing (6).



3-1397

3-81. AIR CLEANER (Cont).

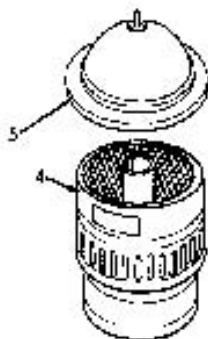
LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION**

8. Air cleaner Housing (4)

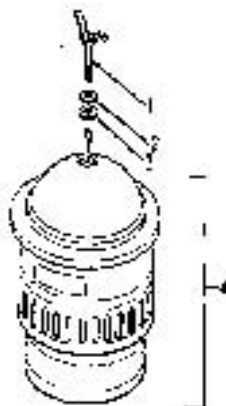
- a. Install cover (5).
- b. Install on air inlet housing.

Be sure housing (4) seats properly on air inlet housing.



- c. Install gasket seal (3).
- d. Install retainer seal (2).
- e. Install wing bolt (1)

Tighten until housing is rigidly mounted.



**REPAIR**

According to standard practices

3-1398/(3-1399 blank)

**3-82. CRANKSHAFT PULLEY-MAINTENANCE.**

The crankshaft pulley is used to drive the 12 VDC generator through drive belts.

This task covers:

- a. Inspection
- b. Removal
- c. Installation

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

Crankshaft Pulley Puller  
Tool J4558-01  
Hammer (Lead)  
Torque Wrench

**Equipment**

**Condition      Condition Description**

**Para**

3-62      Generator (12V)

**Material/Parts**

NONE

**Special Environmental Conditions**

NONE

**Personnel Required**

1

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

**NOTE**

The shroud over the generator drive belts might have to be removed. Refer to paragraph 3-62.

- |                 |                      |   |                         |
|-----------------|----------------------|---|-------------------------|
| 1. Engine-front | a. Crankshaft pulley | 1. Inspect for cracks and breaks.       |                         |
|                 |                      | 2. Inspect for slipping on crankshaft.  |                         |
|                 | b. Drive belts       | Inspect for looseness, wear and damage. | Refer to paragraph 3-62 |

**3-1400**

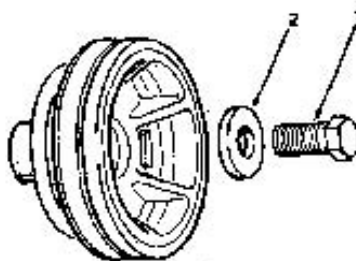


3-82. CRANKSHAFT PULLEY-MAINTENANCE (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

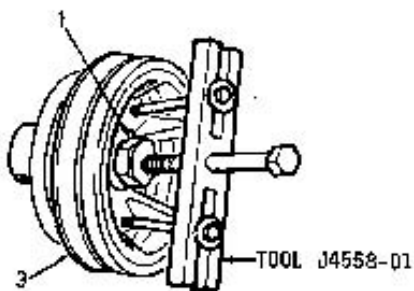
2. Crankshaft pulley	a. Shroud and drive belts	Remove.	Refer to paragraph 3-62
	b. Bolt (1) and washer (2)	Remove.	



c. Pulley (3)

1. Install bolt (1).
2. Install puller.
3. Remove pulley (3).
4. Remove puller.

Use tool J455801.



**3-82. CRANKSHAFT PULLEY-MAINTENANCE (Cont).**

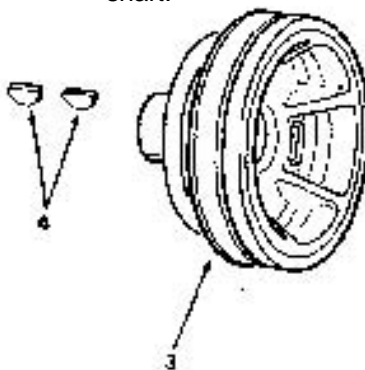
LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

- |  |                      |         |  |
|--|----------------------|---------|--|
|  | d. Woodruff keys (4) | Remove. |  |
|--|----------------------|---------|--|

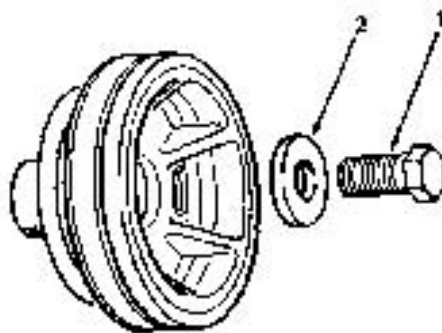
**INSTALLATION**

- |                      |                      |                             |  |
|----------------------|----------------------|-----------------------------|--|
| 3. Crankshaft Pulley | a. Woodruff keys (4) | Insert on crankshaft.       |  |
|                      | b. Pulley (3)        | Slide on end of crankshaft. |  |



- |  |                            |          |  |
|--|----------------------------|----------|--|
|  | c. Bolt (1) and washer (2) | Install. |  |
|--|----------------------------|----------|--|

Torque to 180 lb-ft (244 Nm) torque.

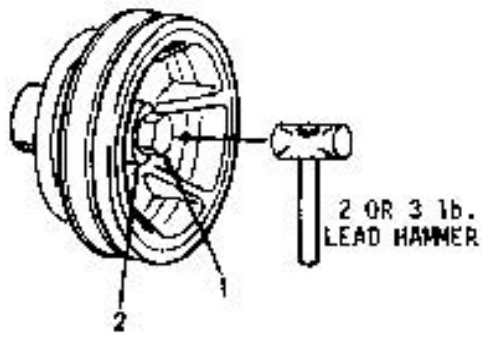


**3-82. CRANKSHAFT PULLEY-MAINTENANCE (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |    |               |  |                                      |
|----|---------------|--|--------------------------------------|
| d. | Pulley<br>(3) | 1. Strike the end of the bolt a sharp blow with a 2 or 3 lb lead hammer. |                                      |
|    |               | 2. Tighten bolt.   | Torque to 300 lb-ft (406 Nm) torque. |
|    |               | 3. Strike bolt again.  |                                      |
|    |               | 4. Tighten bolt.   | Torque to 300 lb-ft (406 Nm) torque. |



3-1403

**3-83. BALANCE WEIGHT COVER-MAINTENANCE INSTRUCTIONS.**

The balance weight cover covers the front engine balance weights and also is a support for the expansion tank.

This task covers:

- a. Inspection
- b. Removal
- c. Installation

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

Torque wrench

**Equipment**

<u>Condition</u>	<u>Condition Description</u>
<u>Para</u>	
3-76.	Expansion tank - Removed

**Material/Parts**

Gasket P/N 5193113 NONE

**Special Environmental Conditions**

**Personnel Required**

1

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

1.	Balance weight cover	a. Cover	Inspect for cracks and breaks.
----	----------------------	----------	--------------------------------

		b. Gaskets	Inspect for leaks.
--	--	------------	--------------------

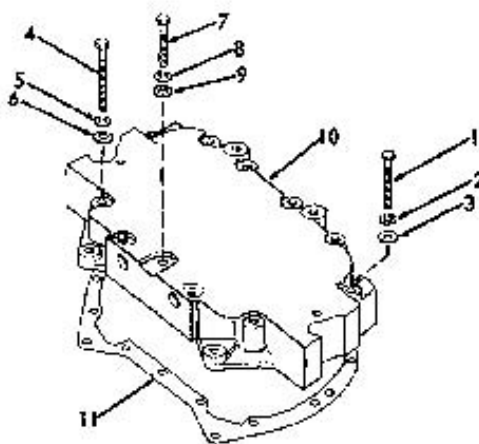
**REMOVAL**

2.		a. Expansion tank	Remove.	Refer to paragraph 3-76.
----	--	-------------------	---------	--------------------------

**3-1404**

3-83. BALANCE WEIGHT COVER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	b. Screws (1), lockwashers (2), and flat washers (3)	Remove two places.	Screws are 3/8-24 x 2 1/2 inch.
	c. Screws (4), lockwashers (5) and flatwashers (6)	Remove two places.	Screws are 3/8-16 x 3 1/2 inch.
	d. Screws (7), lockwashers (8) and flat-washers (9)	Remove nine places.	Screws are 3/8-24 x 2 3/8 inch.
	e. Cover (10)	Remove.	
	f. Gasket (11)	Remove.	Discard gasket.



3-1405

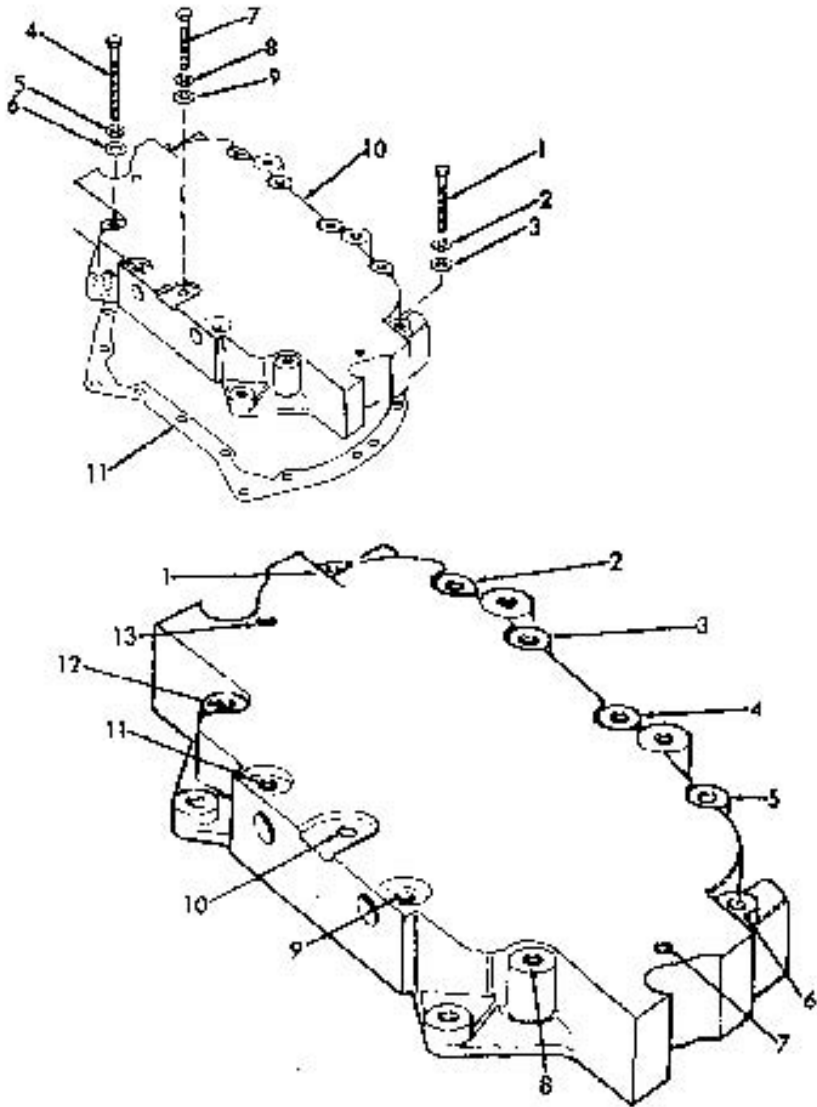
**3-83. BALANCE WEIGHT COVER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
3.	a. Gasket (11)	Attach to balance weight cover	Use Scotch Adhesive #4027.
	b. Cover (10)	Align holes with holes in engine.	
	c. Screws (7), lockwashers (8), and flat-washers (9)	Install in holes 2,3,4,5, 7,9,10,11 and 13.	Screws are 3/8-24 x 2 3/8 inch. Tighten finger tight.
	d. Screws (4), lockwashers (5) and flat-washers (6)	Install in holes 8 and 12.	Screws are 3/8-16 x 3 1/2 inch. Tighten finger tight.
	e. Screws (1), lockwashers (2) and flat-washers (3)	Install in holes 1 and 6.	Screws are 3/8-24 x 2 1/2 inch. Tighten finger tight
	f. Screws (1, 4 and 7)	Tighten in sequence shown	Tighten to 25-30 lb-ft (34-41 Nm) torque.

3-83. BALANCE WEIGHT COVER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**



TIGHTENING SEQUENCE  
Reinstall.

g. Expansion tank

Refer to paragraph 3-76.

**3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS.**

This task covers:

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

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

Chain hoist

**Equipment**

**Condition      Condition Description**

**Para**

NONE

**Material/Parts**

Gasket kit P/N 5193116 or  
5193113

**Special Environmental Conditions**

NONE

**Personnel Required**

2

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

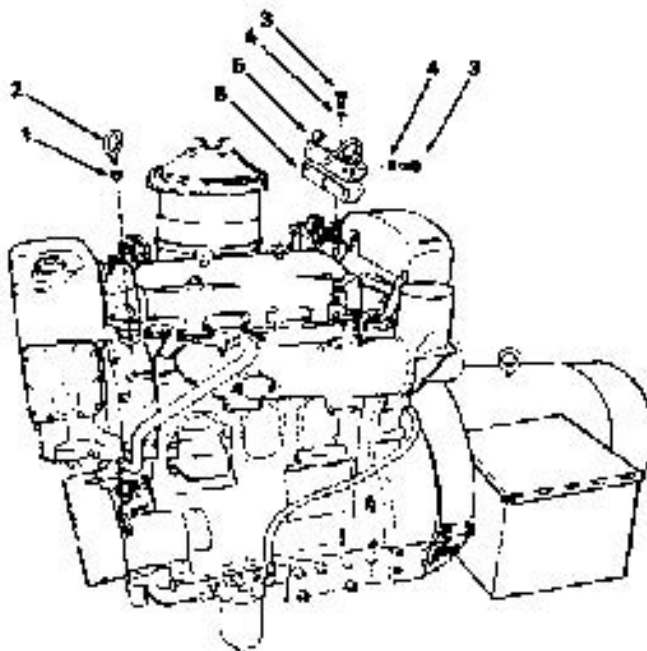
- |    |                 |    |                       |   |                       |
|----|-----------------|----|-----------------------|---|-----------------------|
| 1. | Lifter brackets | a. | Eye bolts             | Inspect for breaks, cracks and signs of wear.                     | Replace if defective. |
|    |                 | b. | Rear engine Bracket   | Inspect for breaks, cracks and signs of wear.                     | Replace if defective. |
| 2. | Supports        | a. | Front Engine supports | 1. Inspect for missing or damaged parts.                          | Replace.              |
|    |                 |    |                       | 2. Inspect for a spongy or defective spacer or mounting cushions. | Replace.              |

**3-1408**



3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	b. Generator Support	1. Inspect for missing or damaged parts.	Replace.
		2. Inspect for a spongy or defective mounting insulator.	Replace.
<b>REMOVAL</b>			
3. Eye bolts	a. Nut (1)	Loosen.	
	b. Eye bolt (2)	Unscrew.	
4. Rear Engine bracket	a. Screw (3) and lock-washers (4)	Remove.	
	b. Rear bracket (5) and gasket (6)	Remove.	Discard gasket.



**3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS (Cont).**

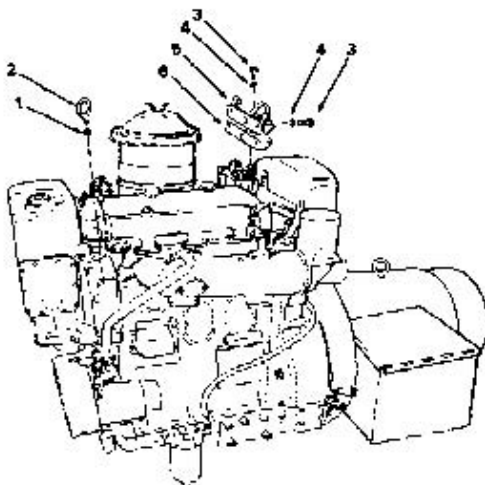
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
5. Rear Engine bracket	Bracket (5), gasket (6), screws (3) and lock-washers (4)	Install.	Use new gasket.
6. Eye bolts	Eye bolt (2) and nut (1)	Install.	

**REPAIR**

**NOTE**

**The following require the use of the chain hoist.**

- |                    |                                   |         |
|--------------------|-----------------------------------|---------|
| 7. Engine Supports | a. Cotter pin (7), castle nut (8) | Remove. |
|--------------------|-----------------------------------|---------|



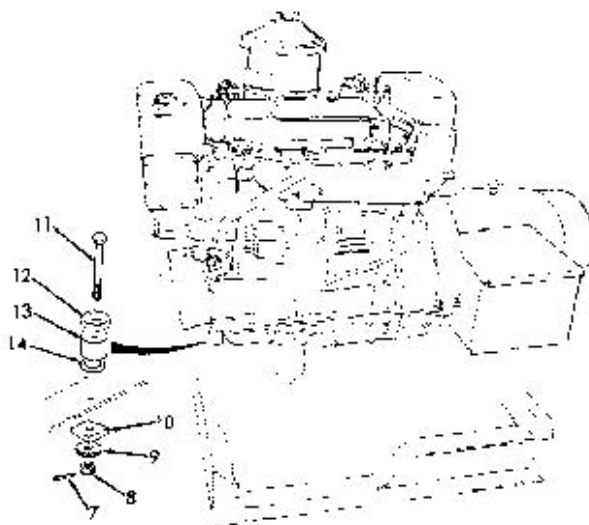
**3-1410**

3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

- b. Cushion (9) and bevel washer (10) Remove.
- c. Bolt (11), cushion washer (12), spacer (13) and shim (14) Remove.
- d. Shim (14), spacer (13), cushion washer (12) and bolt (11) Replace.



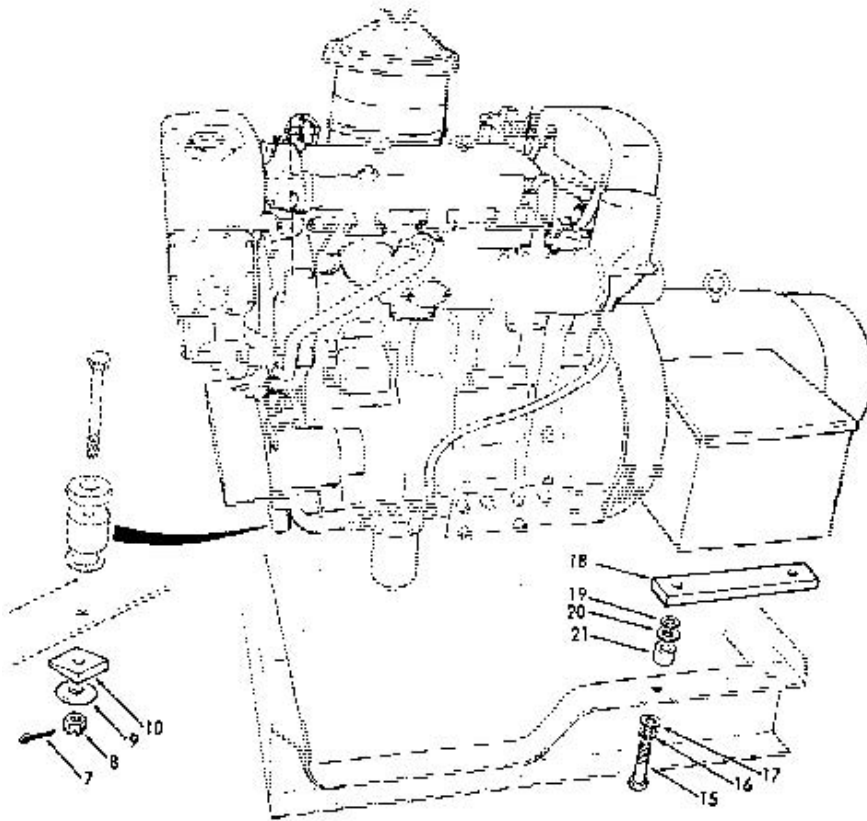
**3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
8. Generator Supports	e. Bevel washer (10), cushion (9), nut (8) and cotter pin (7)	Replace.	
	a. Screw (15), lockwasher (16) and flat-washer (17)	Remove.	
	b. Mounting insulator (18), insulator washer (19), insulator spacer (20) and bushing (21)	Remove.	
	c. Screw (15), lockwasher (16) and flat-washer (17)	Assemble and feed up through engine bed.	
	d. Bushing (21), spacer (20), washer (19) and insulator (18)	Place on screw and feed up to generator.	

3-84. LIFTER BRACKETS AND SUPPORTS-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**



3-1413

**3-85. 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 water manifold into the rear end of the jacket surrounding the exhaust manifold and is discharged from the forward end through a tube into the lower section of the expansion tank. A drain cock is installed in the bottom of the manifold for draining the water jacket. A plug is provided in the bottom of the exhaust outlet elbow for draining moisture condensed from the exhaust gases.

This task covers:

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

**INITIAL SETUP**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

Torque Wrench

**Equipment**

**Condition      Condition Description**

**Para**

NONE

**Material/Parts**

Gasket kit P/N 5193113 NONE

**Special Environmental Conditions**

**Personnel Required**

2

**General Safety Instructions**

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |    |                |                   |                        |
|----|----------------|-------------------|------------------------|
| 1. | Exhaust System | a. Drain cock (1) | Open to drain water.   |
|    |                | b. Pipe plug (2)  | Remove to drain water. |

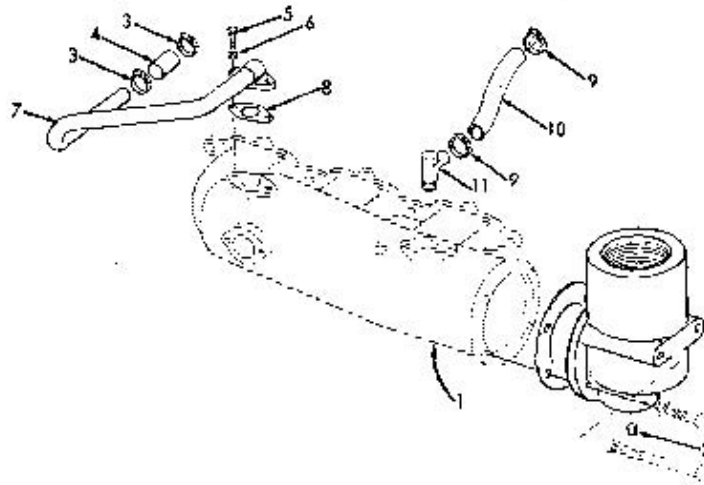
**3-1414**

**3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
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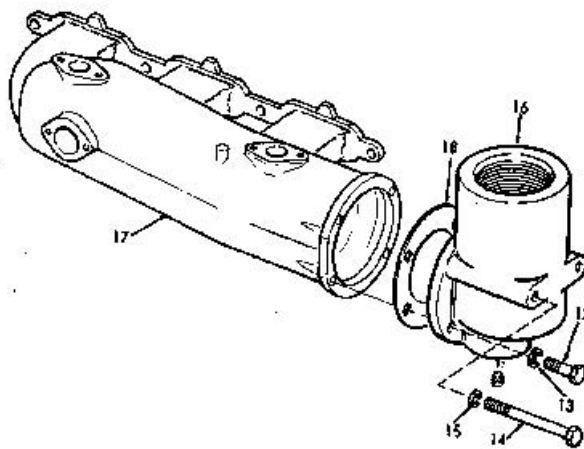
**REMOVAL (Cont)**

2. By-pass Hoses	a. Hose clamps (3)	Loosen.	
	b. Hose (4)	Remove.	
	c. Screws (5), lockwashers (6), tubing (7) and gasket (8)	Remove.	Discard gasket.
	d. Hose clamps (9)	Loosen.	
	e. Hose (10)	Remove.	
	f. Elbow (11)	Unscrew.	



3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
3. Elbow	a. Screws (12) and lockwashers (13)	Remove.	
	b. Screws (14) and lockwashers (15)	Remove.	
	c. Elbow (16) and exhaust manifold (17)	Separate.	
	d. Gasket (18)	Remove.	Discard.



3-1416

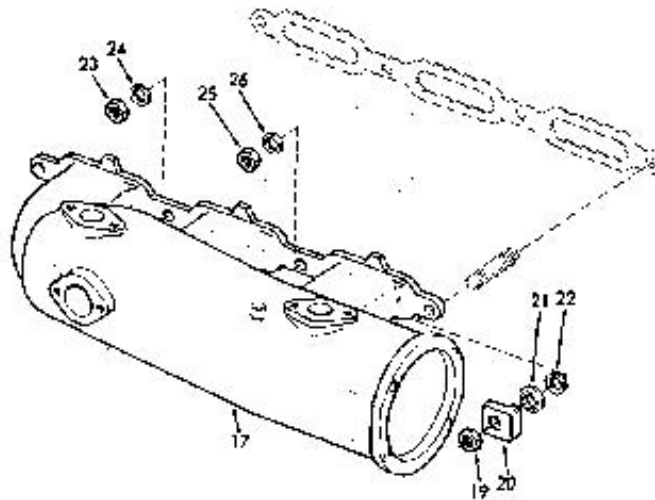


3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- |                     |  |   |  |
|---------------------|--|---|--|
| 4. Exhaust manifold | a. Nuts (19), crab washers (20), intermediate washers (21) and flat-washers (22) | Remove on both ends of manifold.          |  |
|                     | b. Nut (23) and flat-washer (24)   | Unscrew to end of stud.                   |  |
|                     | c. Nut (25) and flat washer (26)   | Remove.                                   |  |
|                     | d. Manifold (17)   | Pull away from engine as far as possible. |  |

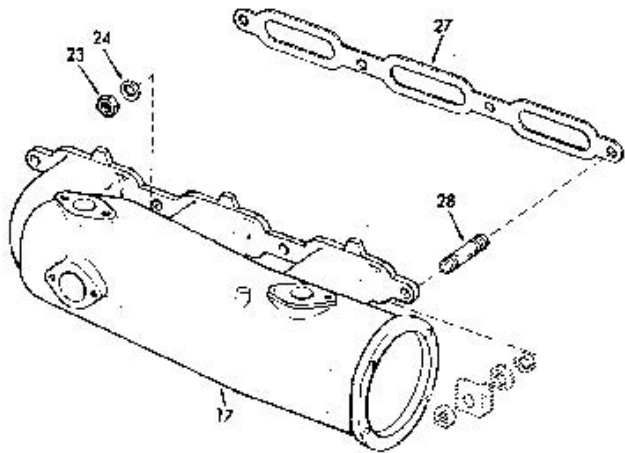


3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- e. Nut (23) and flat-washer (24) Remove.
- f. Manifold (17) and gasket (27) Remove. Discard gasket.
- g. Studs (28) Remove if necessary.



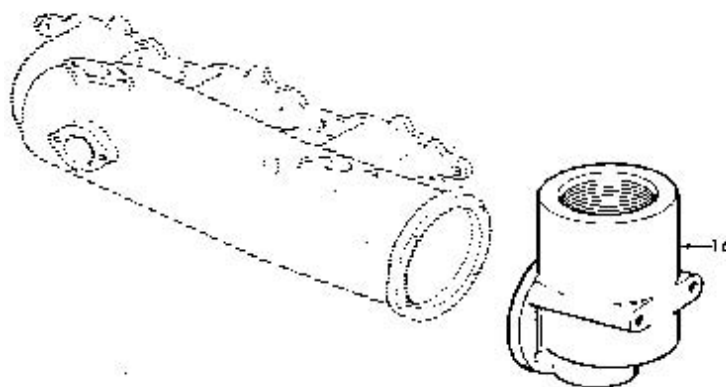
3-1418

**3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

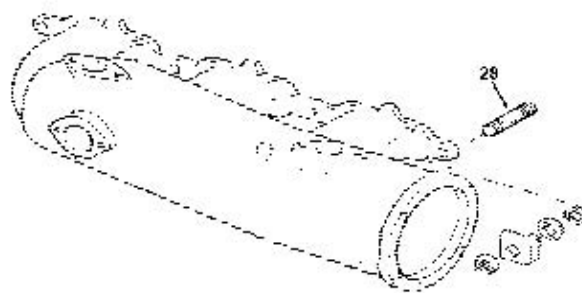
5. Elbow	Elbow (16)	Unscrew from exhaust pipes.	
----------	------------	-----------------------------	--



**INSPECTION**

6. Exhaust manifold and elbow		Remove the loose scale and carbon that may have accumulated on the internal walls of the manifold and elbow.	
-------------------------------	--	--	--

Studs (28)	Inspect for damage and stripped threads.	Replace if damaged.
------------	--	---------------------



**3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).**

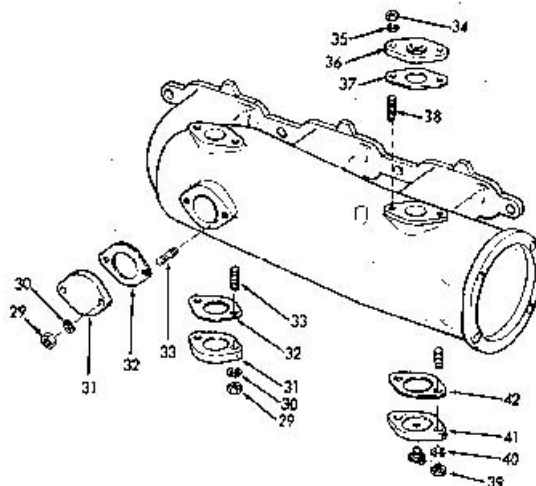
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
7. Cover Plate (plain)	a. Nuts (29), lockwashers (30), cover (31) and gasket (32)	Remove.	Discard gasket.
	b. Studs (33)	Remove if necessary.	
	c. Studs (33)	Install.	
	d. Gasket (32), cover (31), lockwashers (30) and nuts (29)	Reassemble.	Use new gasket.
8. Cover Plate (large tapped hole)	a. Nuts (34), lockwashers (35), cover plate (36) and gasket (37)	Remove.	Discard gasket.
	b. Studs (38)	Remove if necessary.	
	c. Studs (38)	Install.	

3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

	<p>d. Gasket (37), cover plate (36), lockwash-washers (35) and nuts (34)</p>	<p>Reassemble.</p>	<p>Use new gasket.</p>
<p>9. Cover Plate (small tapped hole)</p>	<p>a. Nuts (39), lockwash-ers (40), cover plate (41) and gasket (42)</p>	<p>Remove.</p>	<p>Discard gasket.</p>

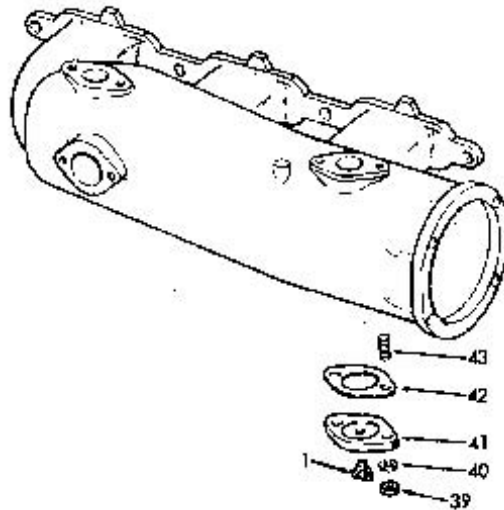


3-85. EXHAUST MANIFOLD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

- |    |   |                      |  |
|----|---|----------------------|--|
| b. | Drain cock (1)  | Remove.              |  |
| c. | Studs (43)  | Remove if necessary. |  |
| d. | Studs (43)  | Replace.             |  |
| e. | Drain cock (1)  | Install.             |  |
| f. | Gasket (42), cover plate (41), lockwashers (40) and nuts (39) | Reassemble.          |  |

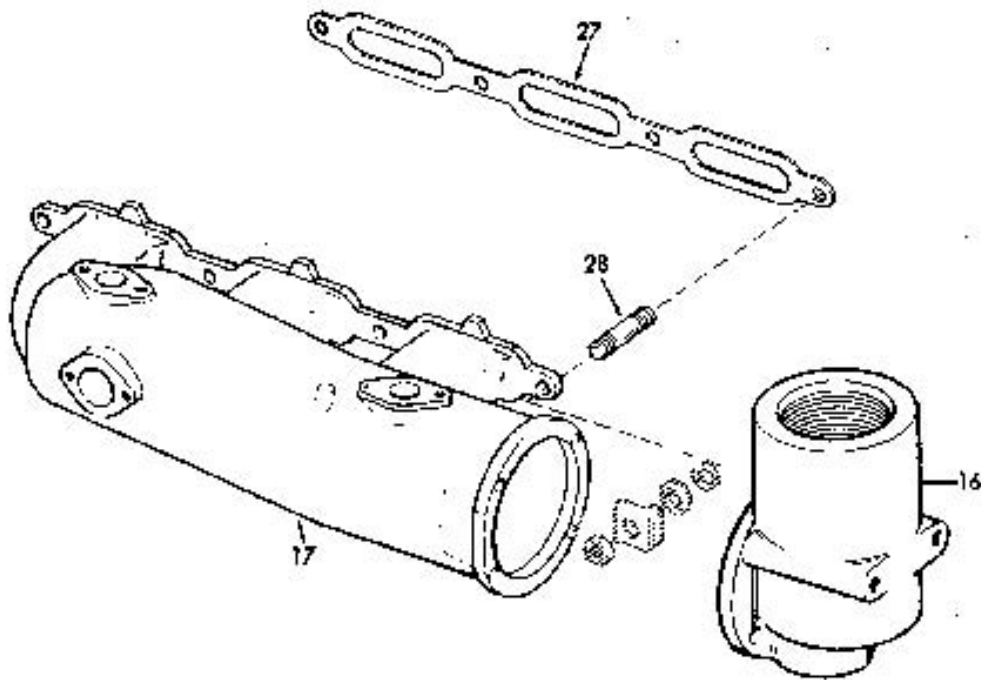


3-85. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

10. Studs	Studs (28)	Replace.	Drive in to 25-40 ft-lb (37.2-59.5 kg/m) torque.
11. Elbow	Elbow (16)	Reinstall on exhaust pipe.	
12. Exhaust manifold	a. Gasket (27)	Place over studs and against cylinder head.	Use new gasket.
	b. Exhaust manifold (17)	Position on studs (28) so that 1/2 inch (27 cm) of the stud threads extends beyond the mounting flanges of the manifold legs.	

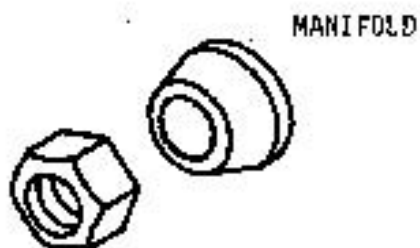


3-85. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |    |                                  |                           |  |
|----|----------------------------------|---------------------------|--|
| c. | Beveled washer (24) and nut (23) | Rotate nut several turns. |  |
|----|----------------------------------|---------------------------|--|



**NOTE**

The beveled washers are installed so that the outer diameter will rest against the manifold and the crown of the washer will be next to the nut.

- |    |                       |                                 |  |
|----|-----------------------|---------------------------------|--|
| d. | Exhaust manifold (17) | Slide up against cylinder head. |  |
|----|-----------------------|---------------------------------|--|

- |    |                                  |          |  |
|----|----------------------------------|----------|--|
| e. | Beveled washer (26) and nut (25) | Install. |  |
|----|----------------------------------|----------|--|

- |    |   |          |  |
|----|---|----------|--|
| f. | Flat washers (22), intermediate washers (21), crab washers (20) and nuts (19) | Install. |  |
|----|---|----------|--|

- |    |                      |  |   |
|----|----------------------|--|---|
| g. | Nuts (19, 23 and 25) | Tighten with the center nut and working alternately toward each end. | Torque nuts to 30-35 lb-ft (44.6 to 52.1 kg/m). |
|----|----------------------|--|---|



3-85. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

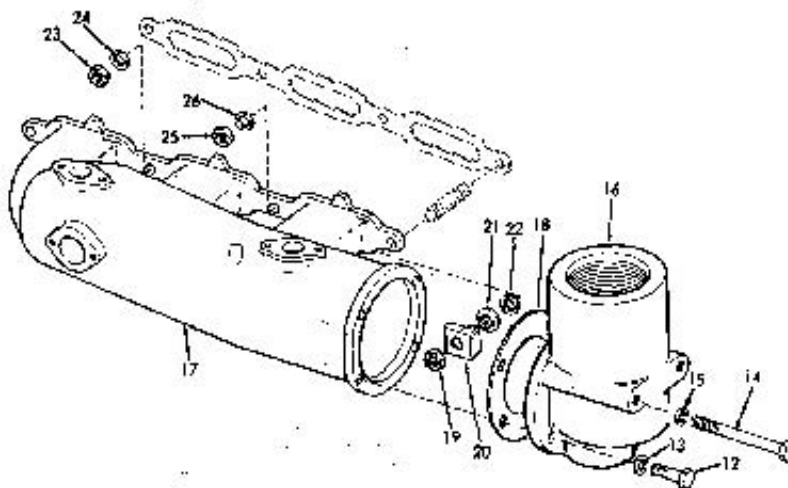
LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

**NOTE**

If the cylinder head was removed from the engine, do not tighten the manifold nuts until AFTER the head is reinstalled. Otherwise, interference may be encountered between the manifold and cylinder block bosses which serve as a support for the manifold when the cylinder head is installed.

- |    |   |                                       |                 |
|----|---|---------------------------------------|-----------------|
| h. | Elbow<br>(16) and<br>gasket<br>(18)         | Align holes with exhaust<br>manifold. | Use new gasket. |
| i. | Screws<br>(14) and<br>lockwash-<br>ers (15) | Install.                              |                 |
| j. | Screws<br>(12) and<br>lockwash-<br>ers (13) | Install.                              |                 |



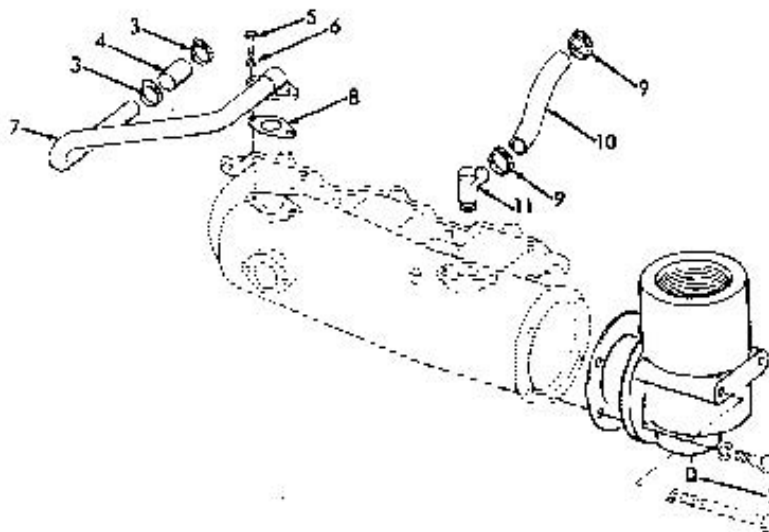
3-1425

3-85. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION (Cont)**

- |  |   |          |                 |
|--|---|----------|-----------------|
|  | k. Drain plug (2)   | Install. |                 |
|  | l. Tubing (7), gasket (8), screws (5) and lockwashers (6) | Install. | Use new gasket. |
|  | m. Hose (4) and clamps (3)                                | Install. | Install.        |
|  | n. Elbow (11)   | Install. |                 |
|  | o. Hose (10) and clamps (9)                               | Install. |                 |



3-1426/(3-1427 blank)

**3-86. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS.**

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 by a gasket located in the flanged edge of the cover.

This task covers:

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

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition      Condition Description  
Para

NONE

Material/Parts

Gasket part of kit  
P/N 5193116 and  
P/N 5193113

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**CLEANING**

1.	Rocker arm cover	Cover (1)	Clean before removal.	Use clean rag to wipe.
----	------------------	-----------	-----------------------	------------------------

**REMOVAL**

2.	Rocker arm cover	a. Knobs (2)	Loosen.	
		b. Cover (1)	Lift cover from cylinder head.	

**3-86. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

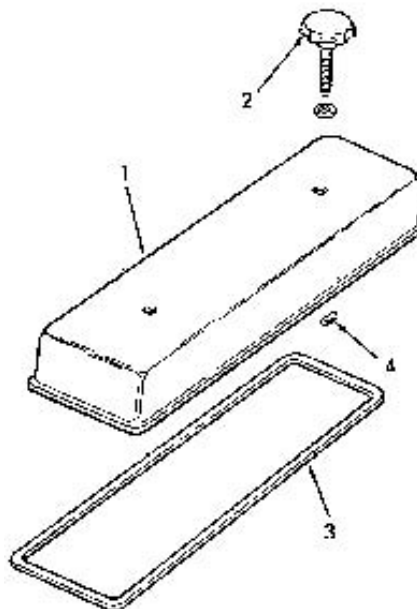
	c. Gasket (3)	Remove.	Discard gasket. Clean inside of cover.
--	---------------	---------	--

**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.	

**REPAIR**

4. Knobs	a. Slotted roll spring pin (4)	Remove.
----------	--------------------------------	---------



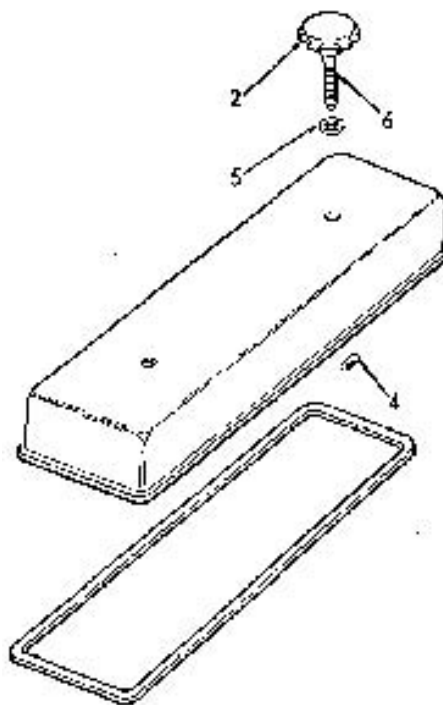
3-1429

3-86. VALVE ROCKER ARM COVER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR (Cont)**

- |    |  |                      |  |
|----|--|----------------------|--|
| b. | Washer (5)   | Remove.              |  |
| c. | Knob (2) and screw (6)                               | Disassemble.         |  |
| d. | Knob (2) and screw (6)                               | Assemble.            |  |
| e. | Washer (5), slotted roll spring pin (4) and knob (2) | Reassemble in cover. |  |



3-1430

**3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS.**

a. The fuel injector control tube assembly is mounted on the cylinder head and consists 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.

This task covers:

- |            |                 |                 |
|------------|-----------------|-----------------|
| a. Testing | c. Installation | e. Installation |
| b. Removal | d. Reassembly   |                 |

INITIAL SETUP:

Test Equipment

NONE

References

Refer to paragraph 3-66 for removal of control tube links.

Special Tools

NONE

Equipment

<u>Condition</u>	<u>Condition Description</u>
------------------	------------------------------

Para

3-66	Governor Maintenance Instructions
3-86	Rocker Arm Cover removal

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

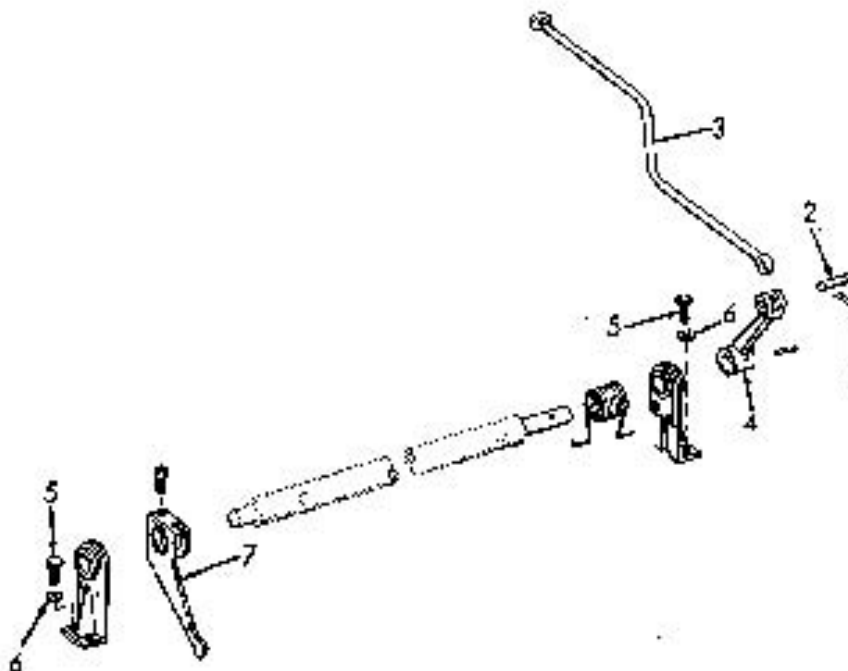
**3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Rocker arm cover	a. Cover	Remove.	Refer to paragraph 3-86.
	b. Control tube	Inspect for broken springs, loose levers and bent or damaged control tubes.	
	c. Fuel rod	Inspect for wear or damage.	Refer to paragraph 3-66 for replacement.
<b>REMOVAL</b>			
2. Control tube	a. Cotter pins (1), and link pin (2)	Remove.	
	b. Fuel rod (3)	Remove from control lever (4).	One end of fuel rod will remain connected inside the governor. Refer to paragraph 3-66 for removal.
	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.

3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**



**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.

3-1433



**3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
3. Control tube	a. Bracket (8)	Remove.	
	b. Spring (9)	Remove.	
	c. Adjusting screws (10)	Remove.	
	d. Levers (7)	Remove.	
	e. Bracket (11)	Remove.	
	f. Pin (12)	Remove.	
	g. Control lever (4)	Remove.	
	h. Control tube (13)	Remove.	

**REASSEMBLY**

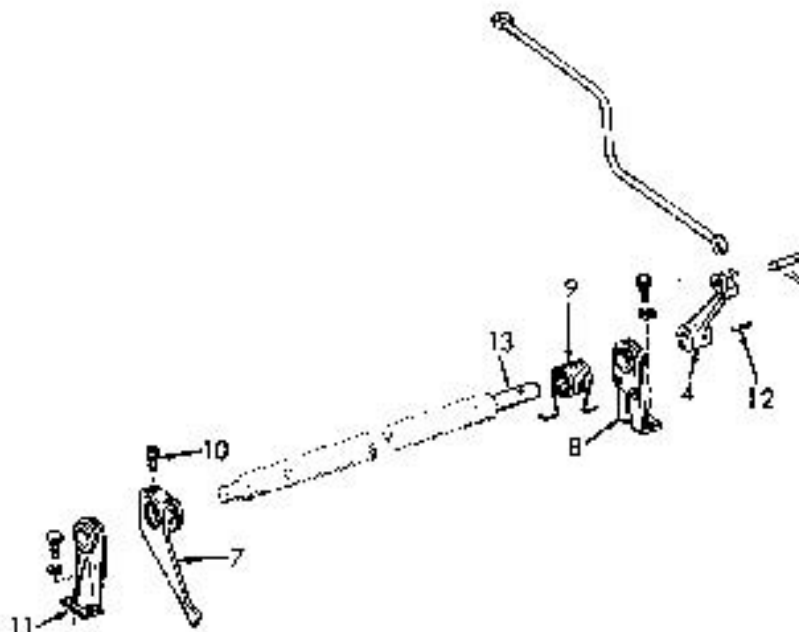
4. Control tube	a. Spring (9), bracket (8), control tube (13)	Reassemble.	
	b. Control Lever (4) and pin (12)	Install on control tube.	

3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REASSEMBLY**

- |    |                                      |  |   |
|----|--------------------------------------|--|---|
| c. | Levers (7) and adjusting 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. | Bracket (11)                         | Install.   |   |
| e. | Spring (9)                           | Attach the curled end of the spring to the lever, and the extended end of the spring behind the front bracket. |   |
| f. | Bracket (8)                          | Install.   |   |



**3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSTALLATION**

5. Control tube	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 ¼ 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 bearings in the brackets.
	e. Fuel rod (3), link pin (2) and cotter pins (1)	Install.	

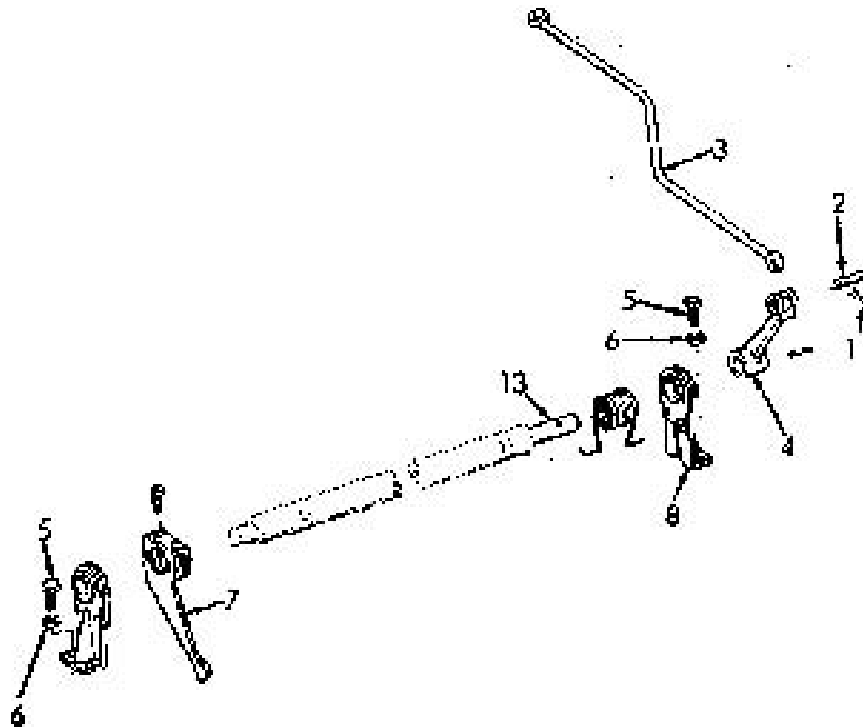
**CAUTION**

Be sure the injector rack control levers can be placed in a no-fuel position before re-starting the engine.

3-87. FUEL INJECTOR CONTROLS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



3-1437

**3-88. OIL PAN, DIPSTICK AND OIL FILLER - MAINTENANCE INSTRUCTIONS.**

The maintenance instructions for the oil pan, dipstick and oil filler are contained in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Oil Pan and Dipstick	3-88.1
Oil Filler	3-88.2

**3-88.1. OIL PAN, DIPSTICK AND OIL FILLER - MAINTENANCE INSTRUCTIONS.**

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 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
- b. Cleaning
- c. Inspection
- d. Installation

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

Torque wrench Pump,  
Hand NSN-  
4930-00-263-9886

Equipment

<u>Condition</u>	<u>Condition Description</u>
<u>Para</u>	

NONE

Material/Parts

Gasket kit P/N 5196375  
Oil, MIL-L-2104 Type OE/HDO

Special Environmental Conditions

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

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

3-88.1. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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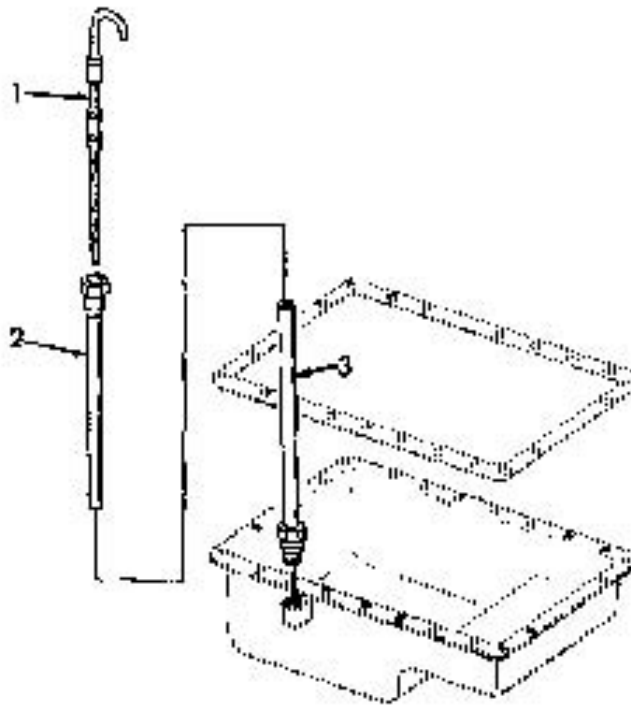
**REMOVAL**

1. Side of cylinder block

**NOTE**

Engine contains 12.7 quarts (12.02 liters) of oil.

- a. Oil dip stick (1) Remove.
- b. Dipstick guide (2) Remove.
- c. Dipstick adaptor (3) Remove.



3-1439

**3-88.1. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

**CAUTION**

Do not damage oil pump piping and inlet screen.

2.	Oil pan	a. Bolt set (4)	Remove.	
		b. Oil pan (5)	Remove.	
		c. Oil pan gasket (6)	Remove.	
		d. Drain plug (7)	Remove.	If necessary, due to leaks.

**CLEANING**

3.	Oil pan	Gasket (6)	Remove oil pan gasket from cylinder block and oil pan.	Discard gasket.
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**WARNING**

Wear eye protection when using compressed air.

Clean oil pan (interior) with fuel oil and dry thoroughly with compressed air.

3-88.1. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

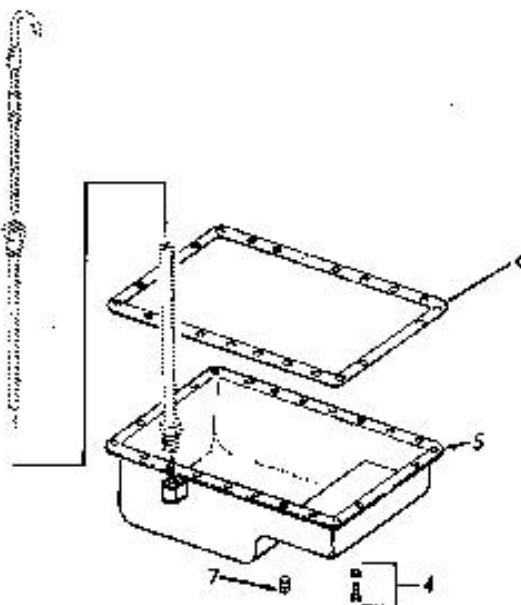
4.	Oil pan (5)	Inspect for large dents, mis-aligned flanges, or raised surfaces surrounding bolt holes. If either pan leaks through cracks, dents or other imperfections, replace pan.	Place on surface plate or other large flat surface to inspect.
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**INSTALLATION**

**CAUTION**

Do not damage oil pump piping and inlet screen.

5.	Oil pan	a. Oil pan gasket (6)	Install.
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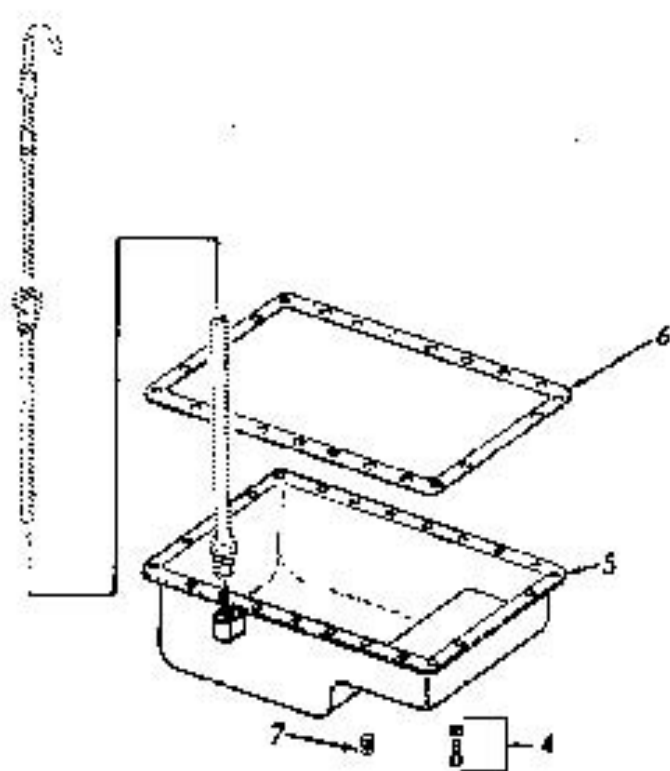


3-1441



3-88.1. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	b. Oil pan (5)	Install.	
	c. Bolt sets (4)	Install.	Tighten bolt sets to 10-12 lb. ft. (13.6 nm) torque.
6. Side of cylinder block	a. Dipstick adaptor (3)	Install.	
	b. Dipstick	Slide into dipstick adaptor (3). tube (2)	
	c. Dip-Stick (1)	Insert.	



**3-88.1. OIL PAN AND DIPSTICK - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

7.	Oil filler tube assembly	Oil	Refer to lube oil chart for oil types.	Engine contains 12.7 quarts (12.02 liters).
8.	Side of cylinder block	Oil dipstick	Remove dipstick (1) and wipe with rag. Re-insert dipstick into tube (2), and remove. Read oil level and return dipstick. Add enough oil to bring level to full mark.	
9.		Start engine.	Check for leaks around gasket and see that oil pressure is normal.	Operate for at least 5 minutes.

**3-1443**

**3-88.2. OIL FILLER - MAINTENANCE INSTRUCTIONS.**

This task covers:

a. Inspection

b. Replacement

INITIAL SETUP:

Test

NONE

Equipment References

NONE

Special Tools

NONE

Equipment

Condition      Condition Description

Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION

ITEM

ACTION

REMARKS

**INSPECTION**

- |    |                      |    |                      |  |
|----|----------------------|----|----------------------|--|
| 1. | Blower drive support | a. | Oil filler tube      | 1. Check for dents or cracks.<br>2. Check for leaks.                               |
|    |                      | b. | Oil filler cap       | 1. Check for dents or cracks.<br>2. Check for leaks.<br>3. Check tightness of cap. |
|    |                      | c. | Blower Drive support | 1. Check for leaks.<br>2. Check for dents or cracks.                               |

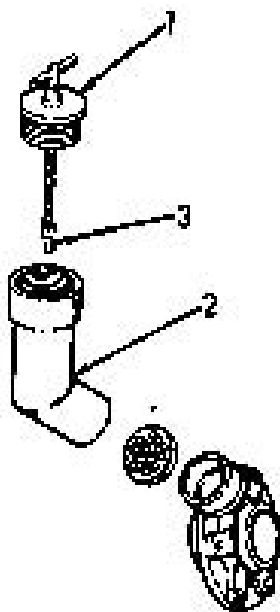
**3-1444**

3-88.2. OIL FILLER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPLACEMENT**

2.	Oil filler	<p>a. Turn counter-clockwise cap to remove.</p> <p>b. Lift off oil filler tube (2) and let it hang onto the tube side.</p>	<p>Oil filler cap (1) is attached to the oil filler tube (2) by the oil filler cap hook (3). Do not remove oil filler cap hook (3) unless replacing the oil filler cap (1).</p>
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3-1445

3-88.2. OIL FILLER - MAINTENANCE INSTRUCTIONS (Cont).

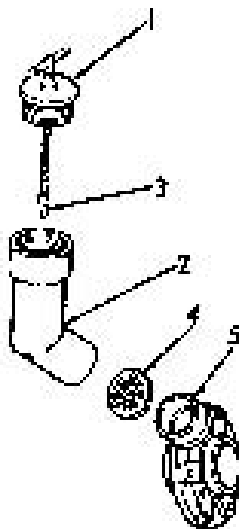
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPLACEMENT (Cont)**

**WARNING**

Wear eye protection when using compressed air.

3.	Oil filler tube	Oil filler tube strainer (4)	Remove from oil filler tube (2) and blower drive support (5).	Replace, if necessary. Clean thoroughly with clean fuel oil and dry with compressed air.
4.		Oil filler tube	<p>a. Install oil filler tube strainer (4) into oil filler tube (2) and blower drive support (5).</p> <p>b. Fill oil filler tube with oil.</p> <p>c. Replace oil filler cap (1) and turn clockwise to close.</p>	<p>Fill to proper level by checking the dipstick.</p> <p>Make sure oil filler cap hook (3) is on the inside of the oil filler tube (2).</p>



3-1446/(3-1447 blank)

**3-89. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

a. The cylinder head, one on each cylinder bank, is a one-piece casting 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.

b. 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.

c. 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.

d. 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.

e. 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.

f. 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.

g. Cylinder Head Maintenance

(1) The engine operating temperature should be maintained between 160°F - 185°F (71°C 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.

**3-89. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

(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 3-96).
- (b) Remove and install cylinder liners. (Refer to paragraph 3-96).
- (c) Remove and install exhaust valves. (Refer to paragraph 3-90.2).
- (d) Remove and install exhaust valve guides. (Refer to paragraph 3-90.2).
- (e) Replace fuel injector tubes. (Refer to paragraph 3-89.1).
- (f) Install new cylinder head gaskets and seals. (Refer to paragraph 3-89.1).
- (g) Remove and install camshaft. (Refer to paragraph 3-91).

**3-89.1. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS.**

This task covers:

- |                          |                                |
|--------------------------|--------------------------------|
| a. Removal               | e. Repair                      |
| b. Disassembly           | f. Assembly                    |
| c. Cleaning              | g. Pre-Installation Inspection |
| d. Inspection and Repair | h. Installation                |

INITIAL SETUP:

Test Equipment	References
Straight edge Feeler edge	NONE
Special Tools	Equipment Condition Para
Torque Wrench	3-66 Governor 3-72 Fuel Lines 3-71 Fuel Injectors 3-76 Water Connections 3-77 Water Manifold 3-78 Thermostat and Housing 3-85 Exhaust Manifold 3-86 Rocker Arm Cover 3-87 Injector Controls 3-90 Valve and Injector operating mechanism
Material/Parts	Special Environmental Conditions
Gasket Kit P/N 5193116 or 5193113	Do not dump oil in bilges. Use oil recovery system to collect oil.
Personnel Required	General Safety Instructions
2	Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |    |                  |                |             |                          |
|----|------------------|----------------|-------------|--------------------------|
| 1. | Exhaust manifold | Exhaust piping | Disconnect. | Refer to paragraph 3-85. |
| 2. | Cylinder head    | Fuel lines     | Disconnect. | Refer to paragraph 3-72. |



**3-89.1. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>REMOVAL (Cont)</b>				
3.	Thermostat housing cover	Hose	a. Loosen hose clamps. b. Remove hose.	Refer to paragraph 3-78.
4.	Water by-pass tube	Water by-pass tube	a. Loosen hose clamps b. Remove tube.	
5.	Thermostat housing assembly	Thermostat housing assembly	Remove.	Refer to paragraph 3-78.
6.	Cylinder head cover	Valve rocker	Remove.	Clean before removal.  Refer to paragraph 3-86.
7.	Cylinder head	Governor cover	Remove.	Refer to paragraph 3-66.
8.	Injector control tube lever and governor	Fuel rod	Disconnect and remove.	Refer to paragraph 3-87.
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 3-85.
		b. Water manifold	Remove.	Refer to paragraph 3-77.
11.	Injector control tube and brackets	Injector control tube and brackets	Remove.	Remove as an assembly. Refer to paragraph 3-87.

**3-89.1. CYLINDER HEAD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

**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 3-71 for removal of the injectors.
- 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.

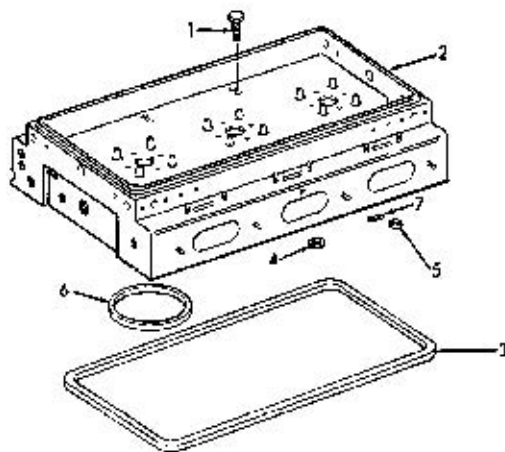
**CAUTION**

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.

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.

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	e. Seal ring (end water hole) (5)	Remove.	Discard.
	f. Compression gaskets (6)	Remove six gaskets.	Discard.
	g. Oil and water gasket (7)	Remove.	Discard.
	h. Exhaust valves	Remove.	Refer to paragraph 3-87.2.
	i. Valve and injector operating mechanism	Remove.	Refer to paragraph 3-90.1.



3-1453

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
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.**

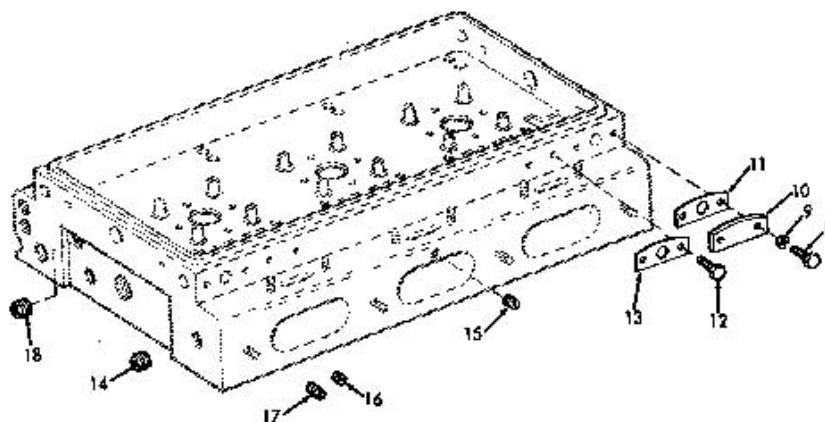
**DISASSEMBLY**

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.
	c. Screws (12), and governor tapped hole cover (13)	Remove.	
	d. Pipe plugs (14)	Remove seven plugs.	Plug is a ¼ inch raised square drive.

**3-1454**

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
	e. Oil gallery plugs (15)	Remove four plugs.	Plug is a special 3/8-16.
	f. Fuse plug (16)	Remove.	
	g. Plugs (17)	Remove four plugs.	Plug is a special 7/16-14.
	h. Pipe plugs (18)	Remove two plugs.	Plug is a 3/4 inch square drive.



3-1455

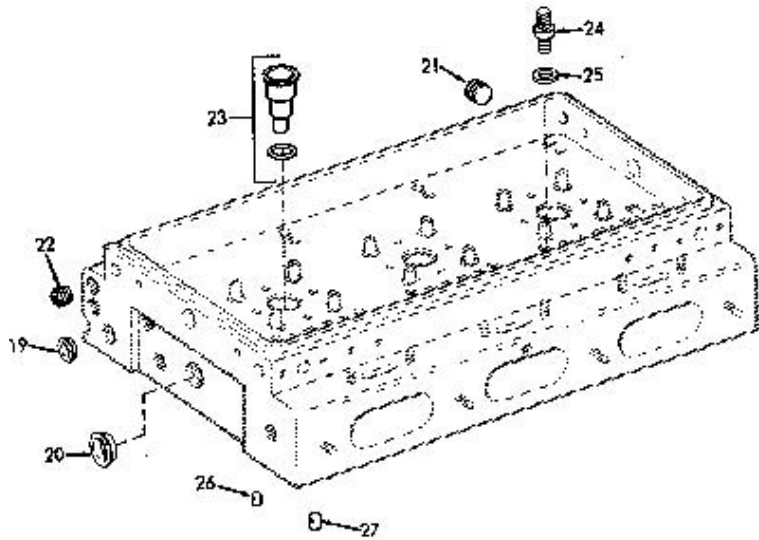
**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
	i. Cup plugs (19 and 20)	DO NOT REMOVE, unless damaged. Cup plugs are located in six places.	
	j. Pipe plugs (21)	Remove five plugs.	Plug is a 1/4-18.
	k. Pipe plug (22)	Remove one plug.	Plug is a 3/8-18.
	l. Valve insert	Remove.	Refer to paragraph 3-90.2.
	m. Valve guide	Remove.	Refer to paragraph 3-90.2.
	n. Fuel injector tube (23)	Remove if heavily coated with scale.	Refer to paragraph 3-89.2.
	o. Fuel pipe connectors (24), and washer (25)	Remove six.	
	p. Water nozzle (single outlet) (26)	Remove if heavily coated with scale. The water nozzle (single outlet) is located in four places.	
	q. Water nozzle (double outlet) (27)	Remove if heavily coated with scale. The water nozzle (double outlet) is located in ten places.	

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**DISASSEMBLY (Cont)**



**CLEANING**

- 15. Cylinder head  
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 paragraph 3-89.2.)

**WARNING**

**Wear eye protection when using compressed air.**

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**CLEANING (Cont)**

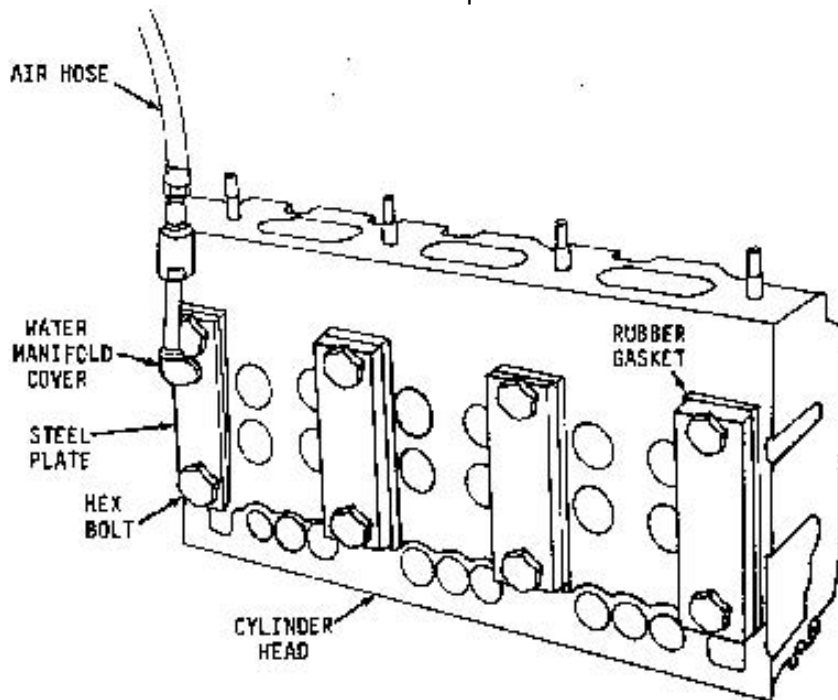
Clean all of the cylinder head components with fuel oil and dry them with compressed air.

**INSPECTION and REPAIR**

16. Cylinder head

1. Pressure check cylinder head.

a. Seal off the 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.



3-1458



**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION AND REPAIR (Cont)**

- 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). 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.
- d. Relieve the air pressure and remove the cylinder head from the water tank. 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.

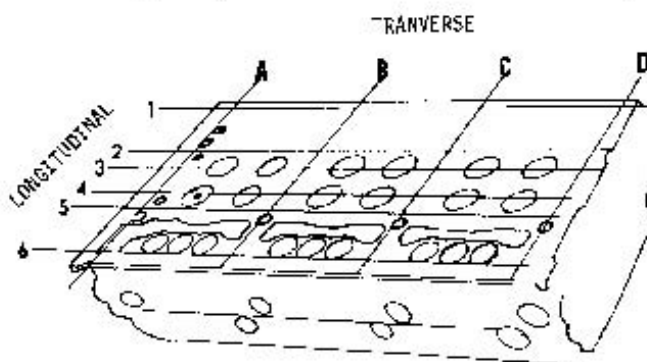
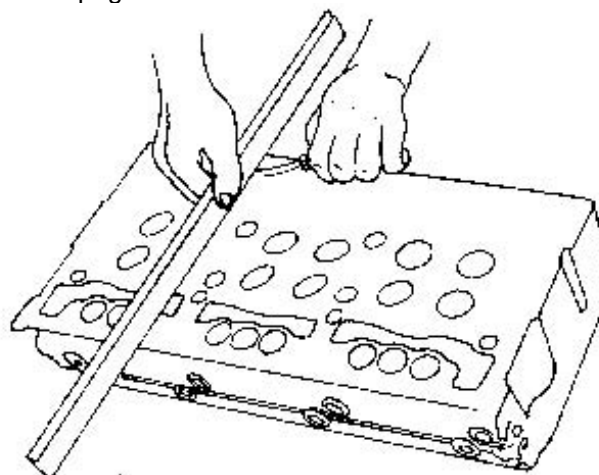
**3-1459**

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION AND REPAIR (Cont)**

2. Check the bottom (fire deck) of the cylinder head for flatness.
  - a. Use a heavy, accurate, straight-edge, and feeler gage, to check for transverse warpage at each end, and between all cylinders. Also check for longitudinal warpage in six places. Refer to table for maximum allowable warpage.



**3-89.1. 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 the measurements obtained and the limits given in the table as a guide to determine the advisability 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.

**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 re-installed in the engine.

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION AND REPAIR (Cont)</b>			
17. Exhaust valve areas	Exhaust valve seat inserts and valve guides	Inspect.	Refer to paragraph 3-90.2.
<b>REPAIR</b>			
18. Cam follower	Cam follower 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.
19. Water holes	Water hole nozzles (single outlet) (26), and (double outlet) (27)	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.

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

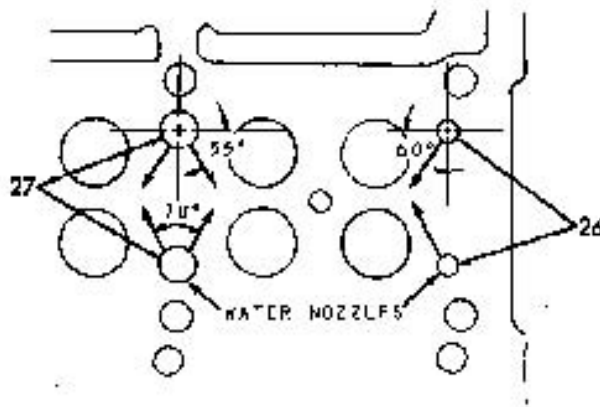
LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

The water holes at each end of the head may be cleaned up with a 1/2 inch (1.27 cm) drill and the intermediate holes may be cleaned up with a 13/16 inch (2.063 cm) drill. Break the edges of the holes slightly.

- c. Press the nozzles in place with the nozzle openings parallel to the longitudinal center-line.

Press the nozzles flush to .0312 inch (.0792 cm) recessed below the surface of the cylinder head.



3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

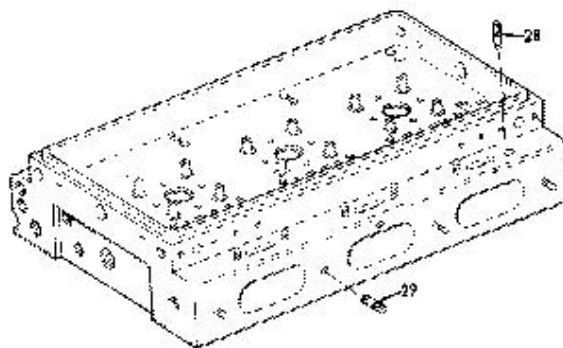
d. Check to make sure the nozzles fit tight. If necessary, use a wood plug or other suitable tool to expand the nozzles, or tin the outside diameter with solder to provide a tight fit. If solder is used, make sure the orifices in the nozzles are not closed with solder.

20. 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 as follows:  
 water manifold cover studs (28) to 10-25 lb-ft (14-34 Nm) torque,  
 exhaust manifold studs (29) to 25-40 lb-ft (34-54 Nm) torque.

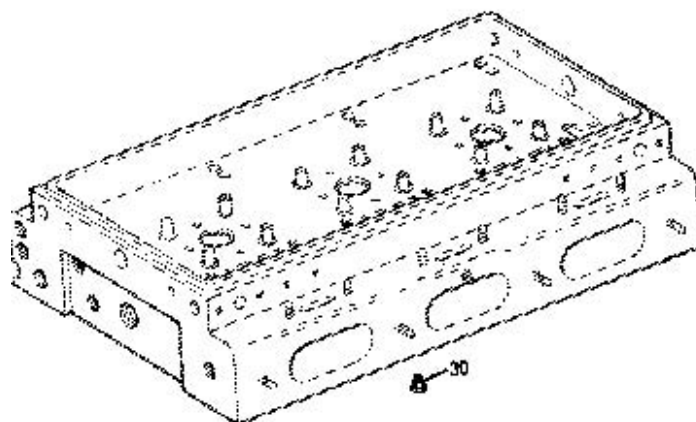


3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

21. 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.
------------------	--------------------	---	--



22.	Overall	Inspect all other components removed from the cylinder head.
-----	---------	--

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**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 attaching a 1/8" (.3175 cm) diameter brass rod to a brush. After cleaning, dry the cylinder head with 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.

23. Cylinder head	a. Pipe plugs (22)	Install one plug.	Tighten to (18-22 lb-ft), (24.4-29.8 Nm).
	b. Pipe plugs (21)	Install five plugs.	Tighten to (14-16 lb-ft), (18.9-21.7 Nm).
	c. Pipe plugs (18)	Install two plugs.	Tighten to flush or 1/8 inch recessed.
	d. Pipe plugs (14)	Install seven plugs.	Tighten to (14-16 lb-ft), (18.9-21.7 Nm).
	e. Plugs (17)	Install four plugs.	



3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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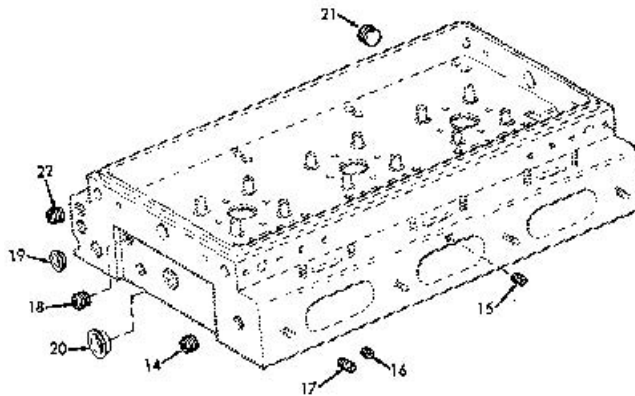
**ASSEMBLY (Cont)**

- |    |                |          |          |
|----|----------------|----------|----------|
| f. | Fuse plug (16) | Install. | Tighten. |
|----|----------------|----------|----------|

**NOTE**

**Apply sealant to threads of pipe plugs 14, 20 and 21.**

- |    |                        |                       |   |
|----|------------------------|-----------------------|---|
| g. | Cup plugs (19 and 20)  | Drive into head.      | Flush to .0625 inch (.1588 cm) below the surface of the cylinder head.  |
| h. | Oil gallery plugs (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. |



3-1467

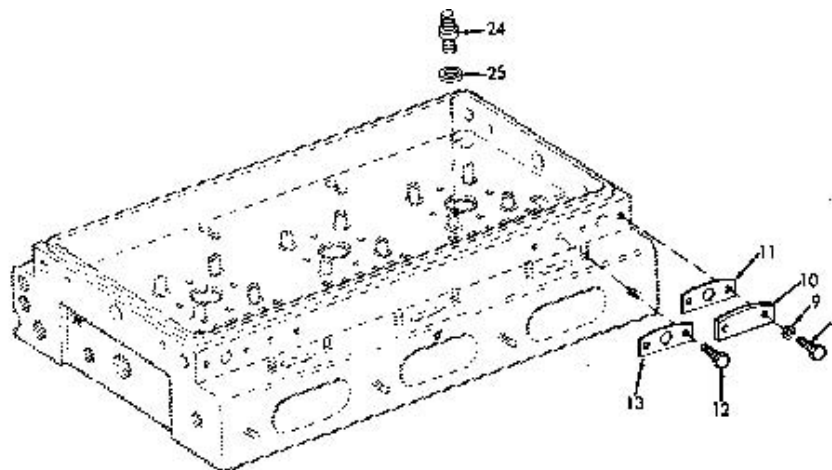
3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY (Cont)</b>			
	i. Fuel pipe connectors (24), and washers (25)	Install twelve.	Use new washers. Tighten to 40-45 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.
24. Fuel injector tubes	Tubes	Install.	Refer to paragraph 3-89.2.
25. Cylinder head	a. Exhaust valve guides	Replace.	Refer to paragraph 3-90.2.
	b. Cam followers	Replace.	Refer to paragraph 3-90.1.
	c. Exhaust valves	Replace.	Refer to paragraph 3-90.2.
	d. Rocker arm assemblies	Replace.	Refer to paragraph 3-90.1.

3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**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 in-stalled on the engine.

3-1469

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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<b>PRE-INSTALLATION INSPECTION</b>
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26. 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 3-96.

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 through the end. This is important since serious engine damage will be prevented when the crankshaft is rotated during engine tune-up.

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.

**3-1470**

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**PRE-INSTALLATION INSPECTION (Cont)**

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**

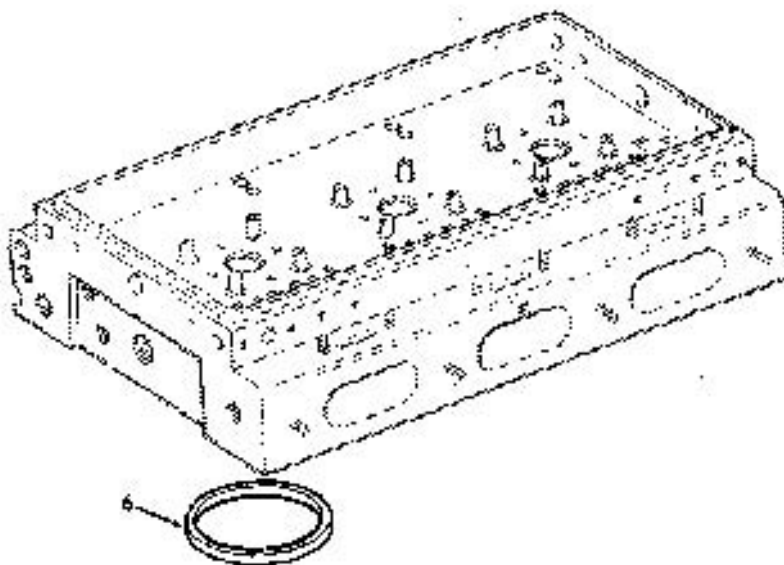
The 3/4" (1.905 cm) diameter cup pipe plug at the front end of the head must be removed prior to installation to prevent blocking the coolant flow out of the head.

**INSTALLATION**

**NOTE**

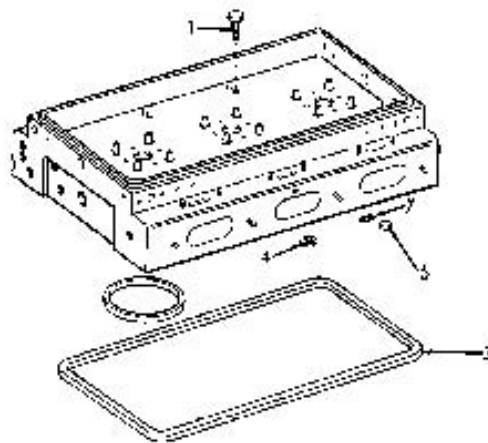
**Never install used compression gaskets or seals.**

- |                  |                                       |                                      |                 |
|------------------|---------------------------------------|--------------------------------------|-----------------|
| 27. Engine block | a. Compression gaskets (6) water hole | Place on top of each cylinder liner. | Use new gasket. |
|------------------|---------------------------------------|--------------------------------------|-----------------|



3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	b. Water-hole 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. b. The seal must lay flat in the groove.	Use new seal.  Do not stretch the seal and do not use any adhesive or other material to secure it in the groove.



3-1472

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

28. 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 important 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 underside 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 cylinder block.

**NOTE**

**Cylinder head bolts are especially designed for this purpose and must not be replaced by ordinary bolts.**

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**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 rod 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**

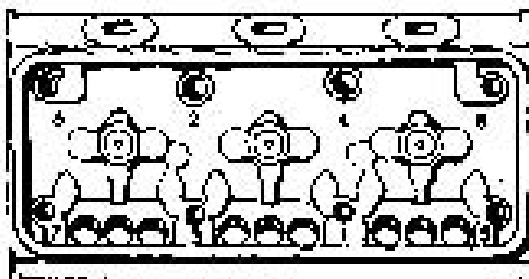
**Tightening the cylinder head bolts will not correct a leaking compression gasket or seal. The head must be removed and the damaged gasket or seal replaced.**



3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



- |    |                          |   |   |
|----|--------------------------|---|---|
| a. | Fuel injectors           | Install.  | Refer to paragraph 3-71.                  |
| b. | Exhaust valve bridges    | Adjust.   | Refer to paragraph 3-90.2.                |
| 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 bearings.**

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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<b>INSTALLATION (Cont)</b>
----------------------------

- |  |   |
|--|---|
| e. Injec-<br>tor<br>control<br>tube<br>assem-<br>bly | <ol style="list-style-type: none"> <li>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 bracket. Tighten the bracket bolts to 10-12 lb-ft 14-16 Nm) torque.</li> <li>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 lightly 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.</li> </ol> |
|--|---|

**3-89.1. CYLINDER HEAD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	f. Fuel rods	Install.	Refer to paragraph 3-66.
	g. Fuel lines	Connect.	
	h. Thermostat and housing	Install.	Refer to paragraph 3-78.
	i. Water manifold	Install.	Refer to paragraph 3-77.
	j. Water by-pass tube, hoses, and clamps	Install.	
	k. Exhaust manifold	Install.	Refer to paragraph 3-85.

**NOTE**

**Fill lubrication system and cooling system. Start engine and perform necessary adjustments.**

**3-89.2. 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 set 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. Inspection
- b. Cleaning
- c. Installation

**INITIAL SETUP:**

**Test Equipment**

NONE

**References**

NONE

**Special Tools**

Injector tube service tool  
Kit J22525 (Consisting  
of tool J5286) Torque wrench

**Equipment**

<u>Condition</u>	<u>Condition Description</u>
<u>Para</u>	

3-89	Cylinder head removed.
------	------------------------

**Material/Parts**

NONE

**Special Environmental Conditions**

NONE

**Personnel Required**

1

**General Safety Instructions**

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

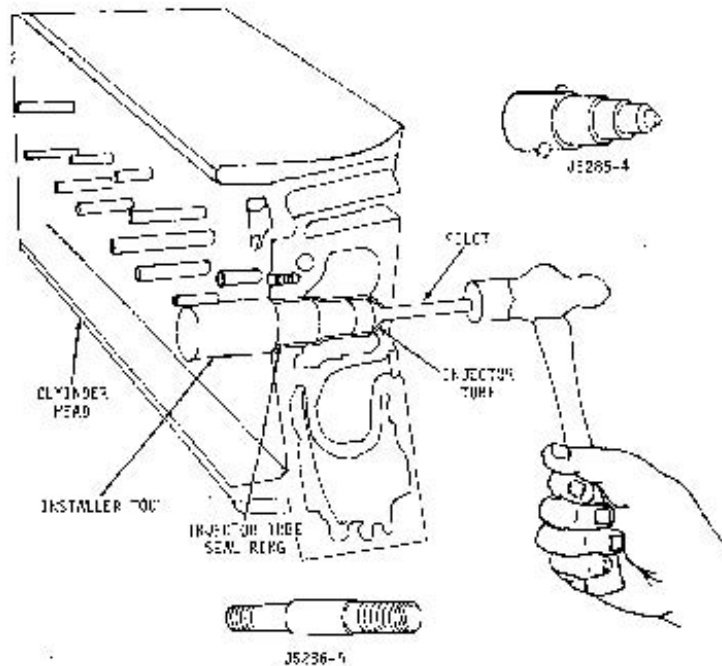
1.	Cylinder head	Head	Remove, disassemble, and clean.	Refer to paragraph 3-89.
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3-89.2. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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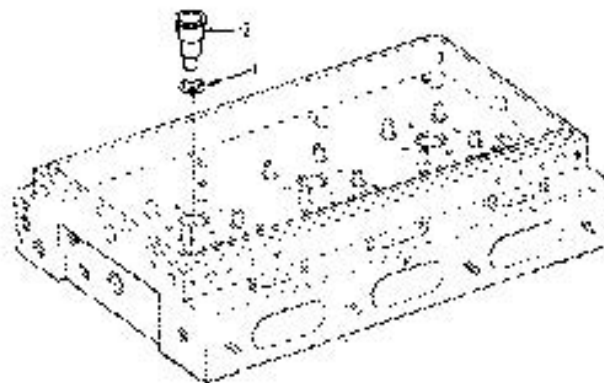
**REMOVAL (Cont)**

- |                  |  |   |                    |
|------------------|--|---|--------------------|
| 2. Injector tube | a. Installer                           | 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. |
|                  | c. Pilot                               | Tap on end of pilot to loosen the injector tube.  |                    |
|                  | d. Injector tube, installer, and pilot | Remove from cylinder head.  |                    |



**3-89.2. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont).**

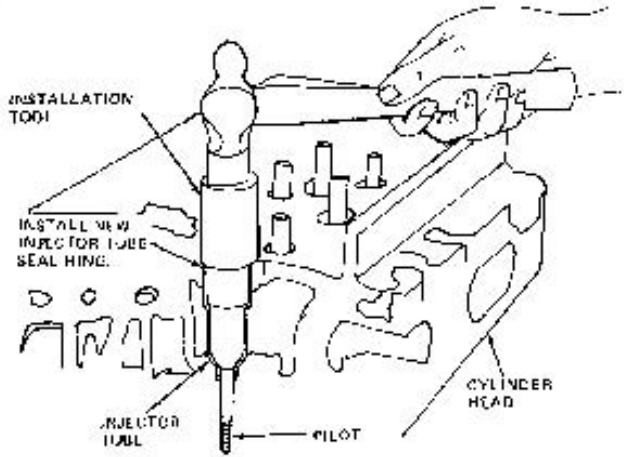
LOCATION	ITEM	ACTION	REMARKS
<b>CLEANING</b>			
3. Injector tube hole (in cylinder head)		Thoroughly clean the hole to remove dirt, burrs, or foreign material that may prevent injector tube from seating at the upper end.	
<b>INSTALLATION</b>			
4. Injector tube	a. Injector tube seal ring (1)	Place in counterbore in cylinder head.	
	b. Installer (2)	Place in injector tube (2).	Use tool J5286-4.
	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.



3-89.2. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



**NOTE**

With the injector tube properly positioned in the cylinder head, upset (flare) the lower end of the injector tube.

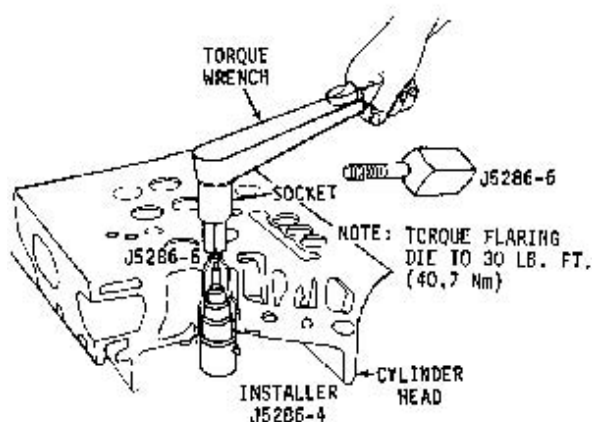
- e. Cylinder head                      Turn bottom side up.
- f. Pilot (J5286-5)                      Remove.

3-89.2. FUEL INJECTOR TUBE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

- |    |               |  |  |
|----|---------------|--|--|
| g. | Upsetting die | 1. Screw into tapped end of installer. | Use tool J5286-6.                      |
|    |               | 2. Using a socket and torque wrench    | Apply approximately 30 lb-ft (40.7 Nm) |
|    |               | 3. Remove installing tools.            |  |



5. Injector tube (reaming)

After an injector tube has been installed in a cylinder head, it must tube 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.



3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

**NOTE**

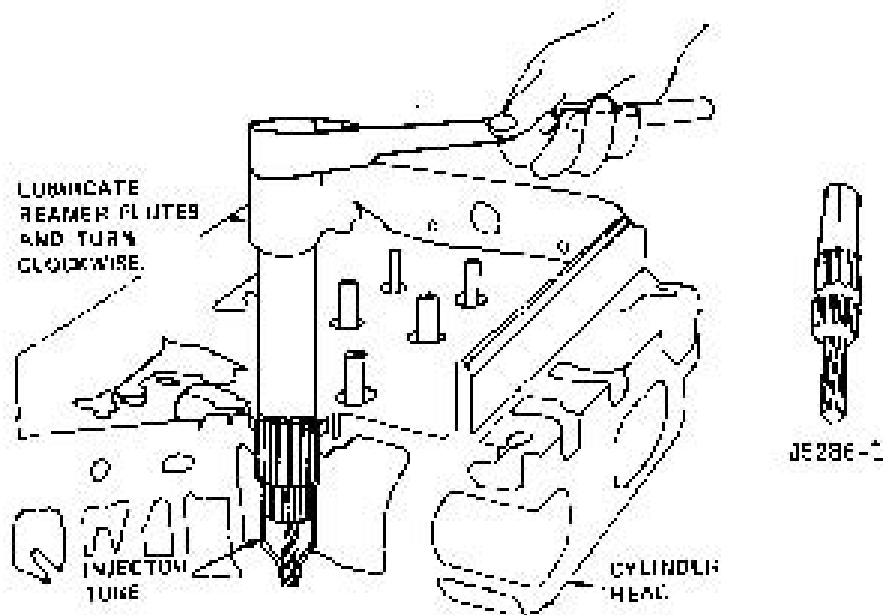
The reamer should be turned in a clockwise direction only both when inserting, and when withdrawing the reamer because movement in the opposite direction will dull the cutting edges of the flutes.

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 J5286-1.



3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

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 chips.

b. Spot facing

Remove excess stock:

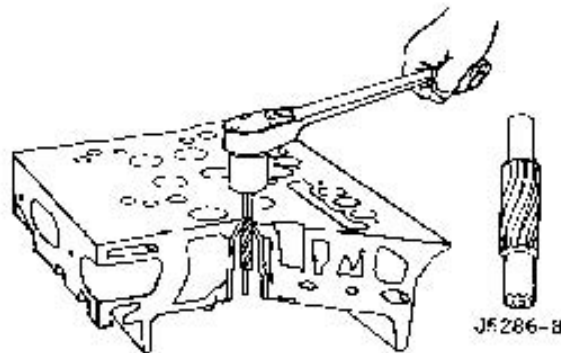
1. With the cylinder head bottom side up, insert the pilot of cutting tool into the small hole of the injector tube.
2. Place a few drops of cutting oil on the tool. Then, using a socket and a speed handle, remove the excess stock so that the lower end of the injector tube is from flush to .005 inch (0.0127 cm) below the finished surface of the cylinder head.

Use tool J5286-8.

3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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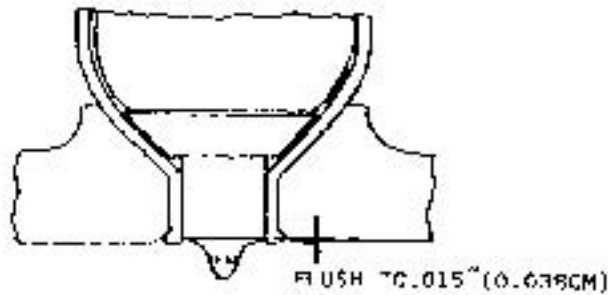
**INSTALLATION (Cont)**



- 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.



**3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

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.

**WARNING**

Wear 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:

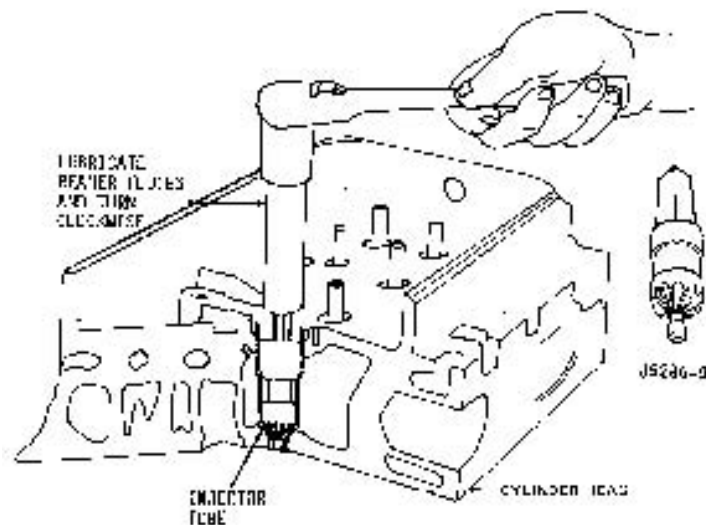
1. Place a few drops of cutting oil on the bevel seat of the tube. Carefully lower the reamer into the injector tube until it contacts the bevel seat.

Use tool  
J5286-9

3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



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.

**WARNING**

Wear eye protection when using compressed air.

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**3-89.2. FUEL INJECTOR TUBE - MAINTENANCE INSTRUCTIONS (Cont).**

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LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

4. Remove the chips from the injector tube and using an injector as a gage, continue the reaming 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.

**3-1488**

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**3-90. 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 3-90.1).
  - (2) Rocker arm shaft or shaft bracket removal and installation. (Refer to paragraph 3-90.1).
  - (3) Fuel injector removal and installation. (Refer to paragraph 3-71).
- 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 3-90.1).
- 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 3-90.2).
  - (2) Exhaust valve bridge adjustment. (Refer to paragraph 3-90.2).
  - (3) Valve spring removal and installation. (Refer to paragraph 3-90.2).
  - (4) Exhaust valve bridge or bridge guide removal and installation. (Refer to paragraph 3-90.2).
- e. In addition, the following operations require removal of the cylinder head. These operations are:
  - (1) Remove and install exhaust valves. (Refer to paragraph 3-90.2).
  - (2) Remove and install exhaust valve guides. (Refer to paragraph 3-90.2).

---

**3-90.1. 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 then 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.



**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Removal
- b. Cleaning and Inspection
- c. Repair/Adjust
- d. Installation

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

Service fixture cam  
 follower J5840-01  
 Remover set pushrod  
 J3092-01  
 Torque wrench  
 Fuel pipenut wrench  
 J1928-01

Equipment

<u>Condition</u>	<u>Condition Description</u>
<u>Para</u>	

3-86	Rocker Arm Cover removed
3-89	Cylinder Head Maintenance Instructions

Material/Parts

Cindol 1705 NONE

Special Environmental Conditions

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |    |                       |    |                |                                      |                    |
|----|-----------------------|----|----------------|--------------------------------------|--------------------|
| 1. | Rocker shaft Assembly | a. | Fuel pipes (1) | Remove from injector and connectors. | Use tool J1928-01. |
|----|-----------------------|----|----------------|--------------------------------------|--------------------|

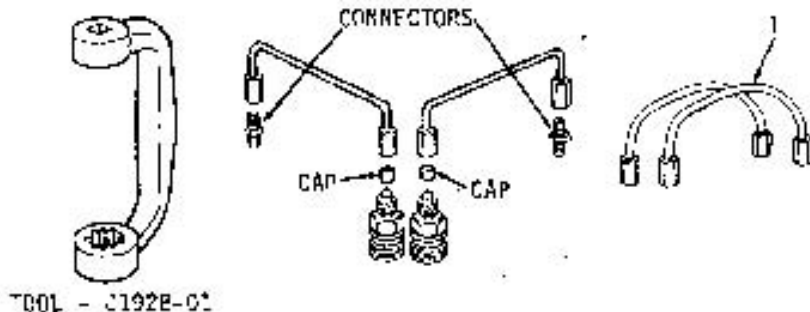
**CAUTION**

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.

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

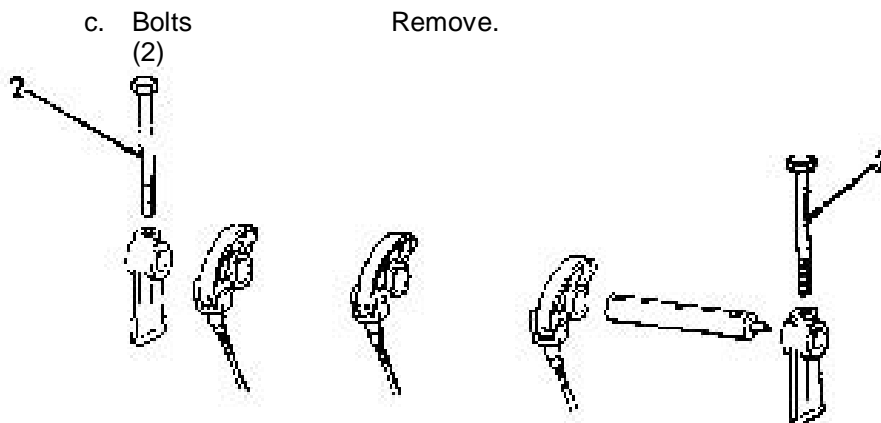


b. Engine

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.



**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL (Cont)**

- |    |   |         |
|----|---|---------|
| d. | Rocker shaft brackets (3) and shaft (4) | Remove. |
|----|---|---------|

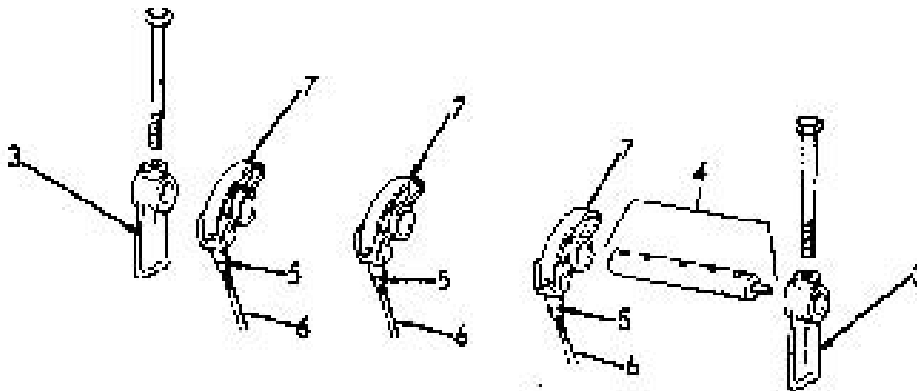
**CAUTION**

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 nut (5) | Loosen.                      |
| f. | Push rod (6) | Unscrew from rocker arm (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.



**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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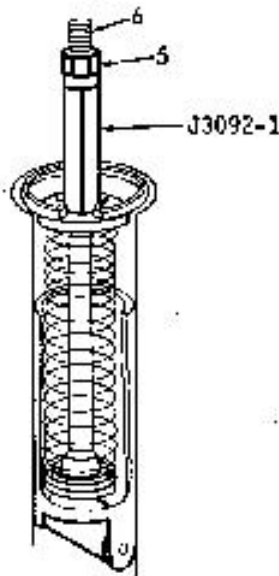
**REMOVAL - CYLINDER HEAD ON ENGINE**

- 2. Cam followers 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)                   | Loosen.   |   |
| b. Push rod (6)                   | Install remover J3092-01, a flat washer and the lock nut on the push rod, with the lower end of the tool resting on the upper spring seat |   |
| 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. |



3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

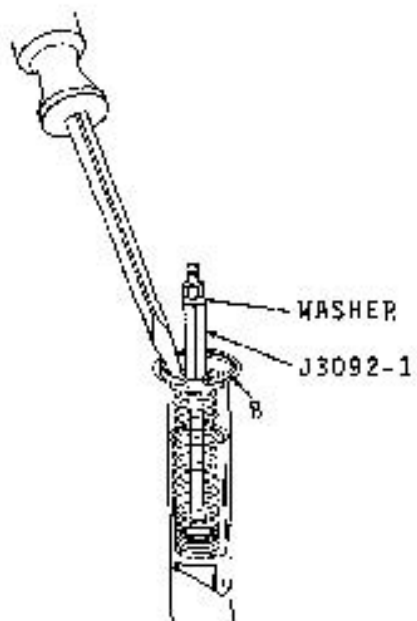
LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL - CYLINDER HEAD ON ENGINE (Cont)**

d. Push rod  
retainer  
(8)

Remove.

Use a screwdriver to re-lease retainer from groove in cylinder head.



e. Lock nut  
(5)

Remove.

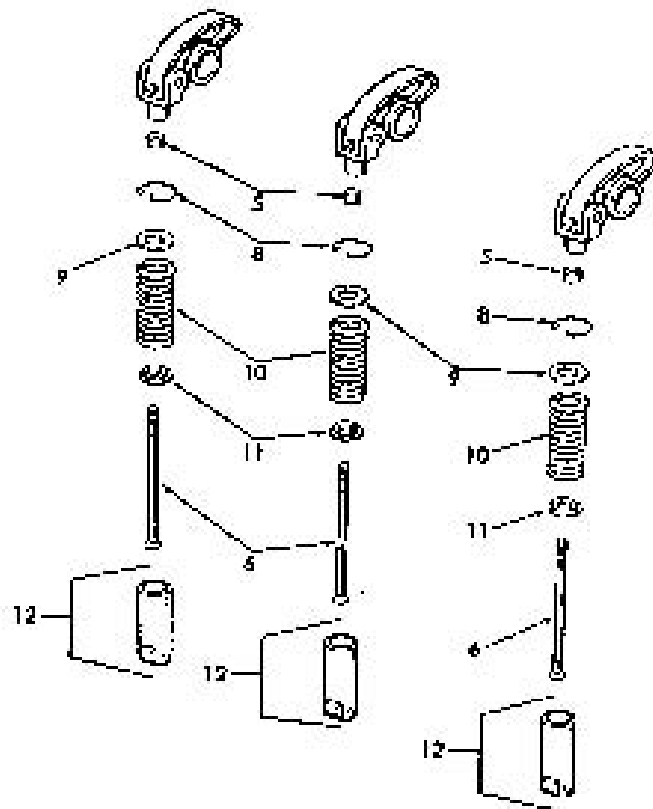
Disassemble tool J3092-01, and flat washer. Remove.

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL - CYLINDER HEAD ON ENGINE (Cont)**

- |    |  |                            |  |
|----|--|----------------------------|--|
| f. | Push rod (6), upper spring seat (9), spring (10), lower spring seat (11) and cam follower (12) | Pull out of cylinder head. |  |
|----|--|----------------------------|--|



**NOTE**

Removal Cam Follower and Push Rod (Cylinder Head Removed)

**3-90.1. 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 lock-washers (14) | Remove.                              | Rest cylinder head on its side. |
| b. Cam follower guide (15)            | Remove.                              |                                 |
| c. Cam Follower (12)                  | Pull out of cylinder head.           |                                 |
| d. Fuel pipes (1)                     | Remove from injector and connectors. |                                 |

**CAUTION**

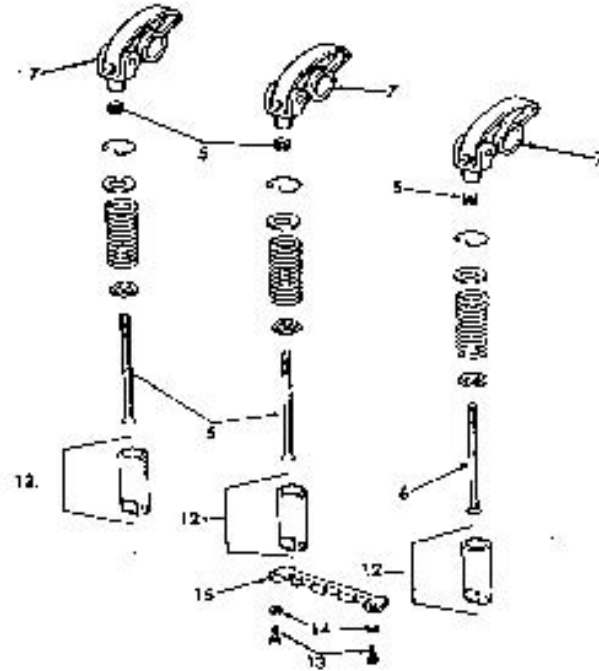
Immediately after removing the fuel pipes, cover the injector fuel inlet and outlet openings with shipping caps to prevent dirt or foreign material from entering.

- |                 |                              |  |
|-----------------|------------------------------|--|
| e. Lock nut (5) | Loosen.                      |  |
| f. Push rod (6) | Unscrew from rocker arm (7). |  |

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

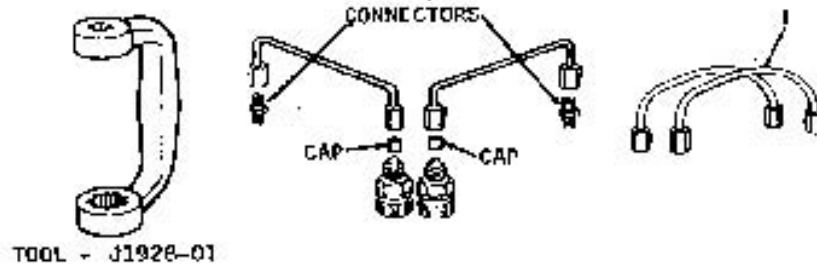
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD REMOVED (Cont)



NOTE

Removal Cam Follower and Push Rod (Cylinder Head Removed)





**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL - CYLINDER HEAD REMOVED (Cont)**

- |  |   |                                    |  |
|--|---|------------------------------------|--|
|  | g. Push rod (6), upper Spring seat (9), spring (10), and lower spring seat (11)               | Pull from bottom of cylinder head. |  |
|  | h. Lock nut (5), push rod (6), upper spring seat (9), spring (10), and lower spring seat (11) | Disassemble.                       |  |

**NOTE**

If the cylinder head is to be replaced, remove the spring retainers (8) and install them in the new head.

**CLEANING and INSPECTION**

**WARNING**

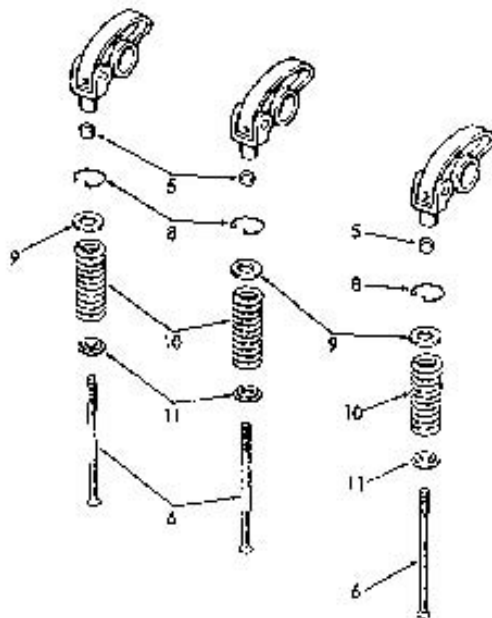
Wear eye protection when using compressed air.

- |                          |   |
|--------------------------|---|
| 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. |

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**CLEANING and INSPECTION (Cont)**



**NOTE**

Remover Cam Follower and Push Rod (Cylinder Head Removed)

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.

3-1501

**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**CLEANING and INSPECTION (Cont)**

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.

**WARNING**

Wear eye protection when using compressed air.

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.

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.

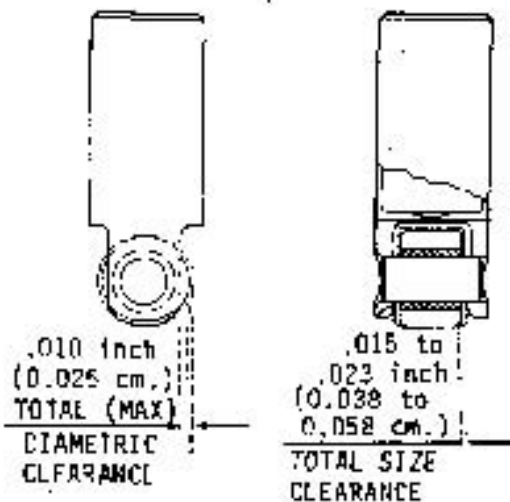
Examine the camshaft lobes for scoring, pitting or flat spots. Replace the camshaft if necessary. (Refer to Direct Support Maintenance). Check the cam follower-to-cylinder head clearance. The clearance must not exceed .006 inch (0.015 cm) with used parts.

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.

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**CLEANING and INSPECTION (Cont)**



- |    |                            |  |  |
|----|----------------------------|--|--|
| 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). |  |

**3-90.1. 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) | <ol style="list-style-type: none"> <li>1. Clamp fixture J5840 securely in a vise. Then place the cam follower in the groove in the top of the fixture, with the follower pin resting on top of the corresponding size plunger in the fixture.</li> <li>2. Drive the pin from the roller with a suitable drift. Exercise caution in removing the cam follower body and roller from the fixture as the roller pin is seated on a spring-loaded plunger in the fixture.</li> <li>3. Before installing the new roller pin, remove the preservative by washing the 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.</li> <li>4. Position the cam follower body in the groove of the fixture, with the small plunger extending through the roller pin hole in the lower leg of the fol-lower body.</li> <li>5. Position the 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.</li> <li>6. Start the new pin in the cam follower body, then carefully tap it in until it is centered in the cam follower body.</li> </ol> |
|----------------------|---|

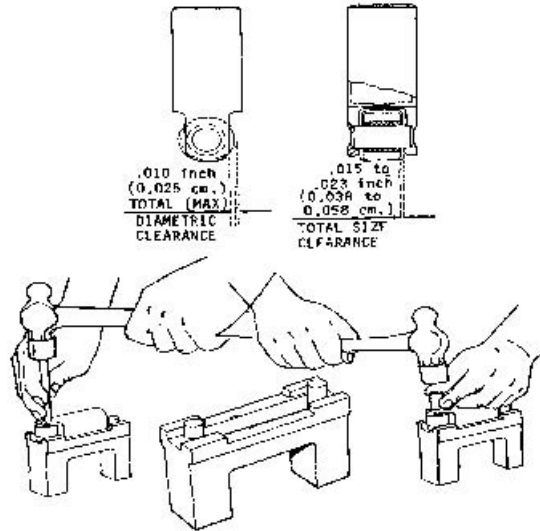
**3-1504**

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

- 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).



**J5840-01 Service Fixture Camfollowers  
3-1505**

**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

**NOTE**

- If new cam follower assemblies are to be installed, remove the preservative by washing 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 or 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.
- 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.

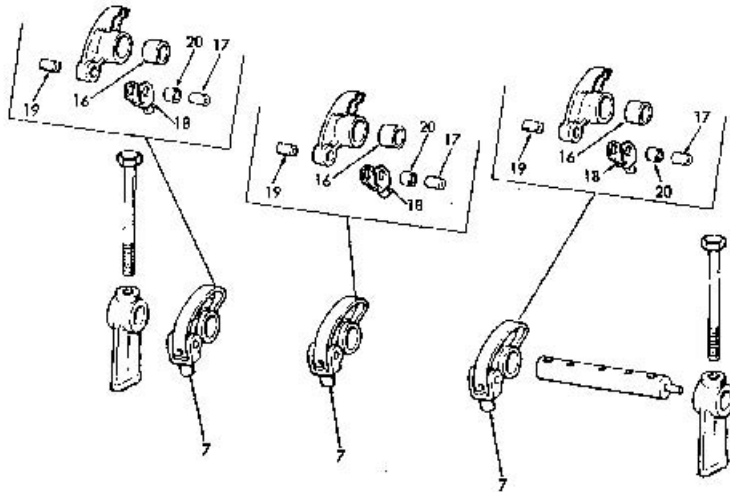
9. Rocker arm assembly (7)	a. Rocker arm large bushing (16)	Press out of rocker arm.	
	b. Clevis pin (17)	Press out of rocker arm.	
	c. Clevis (18)	Remove.	
	d. Rocker arm small bushing (19)	Press out of rocker arm.	

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**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.



3-1507

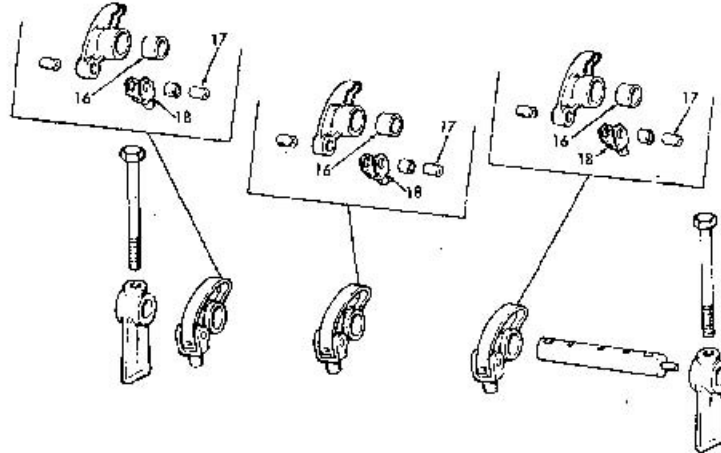


3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**REPAIR (Cont)**

- h. Clevis (18) Assemble.
- i. Clevis pin (17) Press into clevis and rocker arm.
- j. Rocker arm large bushing (16) Press into rocker arm.



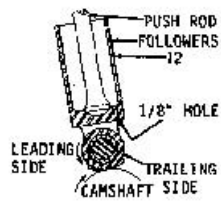
3-1508

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**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 ex-haust valve.
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3-1509

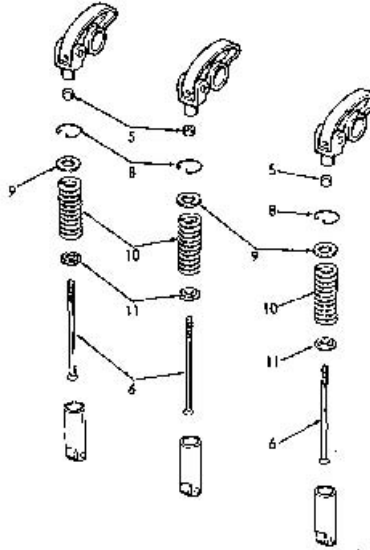
**3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)</b>			
	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 assembly 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	Reinstall.	Thread it as (5) far as possible on the push rod.

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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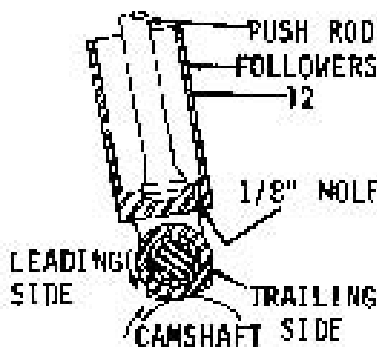
**INSTALLATION - CYLINDER HEAD ON ENGINE**



3-1511

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION- CYLINDER HEAD REMOVED FROM ENGINE</b>			
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 the 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 the bottom of the cam follower. The oil hole should be directed away from the ex-haust valve.



3-1512

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

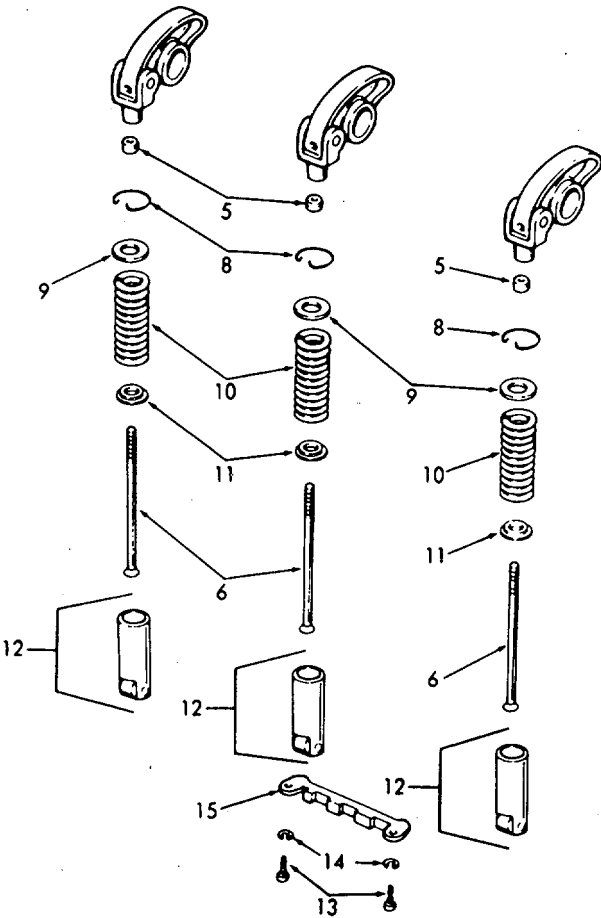
LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION - CYLINDER HEAD REMOVED FROM ENGINE (Cont)

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 clearance between the cam followers and the cam follower guide. Tighten the guide bolts to 12-15 lb-ft (16-20 Nm) torque.



**3-90.1. 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 the end of the push rod is flush with or above the inner side of the clevis yoke.	Provide sufficient initial clearance between the exhaust valve and the piston when the crankshaft is turned during the 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.

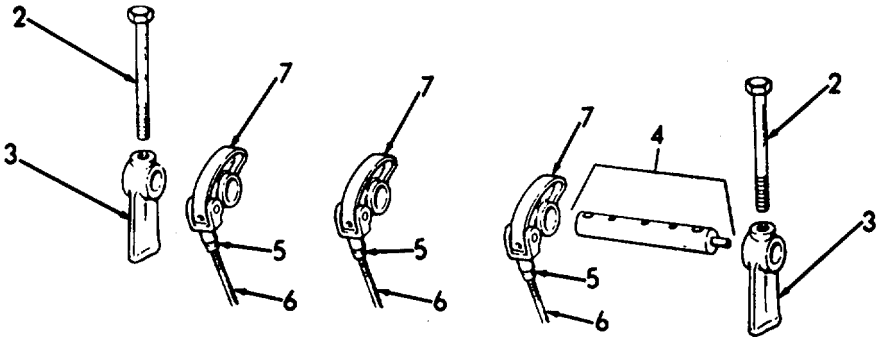
**NOTE**

Bracket bolts go through the bracket and the shaft.

3-90.1. VALVE AND INJECTOR OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

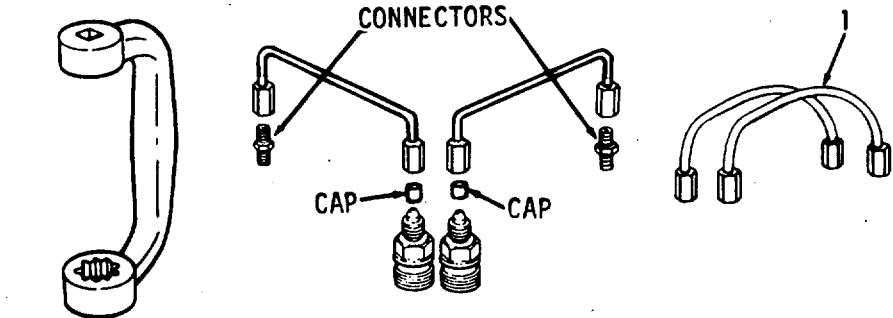


e. Caps on injectors and connectors Remove.



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 the fuel pipe nuts to 12-15 lb-ft (16-20 Nm) torque.



TOOL - J1928-01

3-1515



3-90.1. VALVE AND INJECTOR-OPERATING MECHANISM - MAINTENANCE INSTRUCTIONS (Cont).

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LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



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.

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**3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS.**

---

a. 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.

b. Pre-finished replaceable valve guides are pressed into the cylinder head. Reaming of these guides is unnecessary.

c. 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.

d. The exhaust valve springs are held in place by the valve spring caps and tapered two-piece valve locks.

e. 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.

f. 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.

g. 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.

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**3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).**

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(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. Thus, 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 and 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.

**3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>a. Removal</li> <li>b. Inspection</li> </ul> | <ul style="list-style-type: none"> <li>c. Installation</li> <li>d. Adjustment</li> </ul> |
|---|--|

**INITIAL SETUP:**

Test Equipment  
Micrometers and Gages

References  
NONE

Special Tools  
  
Compressor, valve springs J 7455-7  
Installer, valve seat insert J 6568  
Remover, valve seat insert J 6567-02  
Feeler gage

Equipment  
Condition   Condition Description  
Para

<ul style="list-style-type: none"> <li>3-71.</li> <li>3-86.</li> <li>3-89.</li> <li>3-90.</li> </ul>	<ul style="list-style-type: none"> <li>Fuel Injector removal</li> <li>Rocker Arm Cover removal</li> <li>Cylinder Head Maintenance Instructions</li> <li>Valve and Injector Operating Instructions</li> </ul>
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Material/Parts  
Gasket kit P/N 5193116  
Gasket kit P/N 5193113

Special Environmental Conditions  
NONE

Personnel Required  
  
1

General Safety Instructions  
  
Observe all WARNINGS and CAUTIONS.

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD ON ENGINE .
-------------------------------------

- |    |                      |  |   |
|----|----------------------|--|---|
| 1. | Exhaust valve spring | <ul style="list-style-type: none"> <li>a. Rocker arm cover</li> <li>b. Valve Remove. and injector operating mechanism</li> </ul> | <ul style="list-style-type: none"> <li>Remove.</li> </ul> <p style="margin-top: 20px;">Refer to paragraph 3-86.</p> <p style="margin-top: 20px;">Refer to paragraph 3-90.1.</p> |
|----|----------------------|--|---|

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

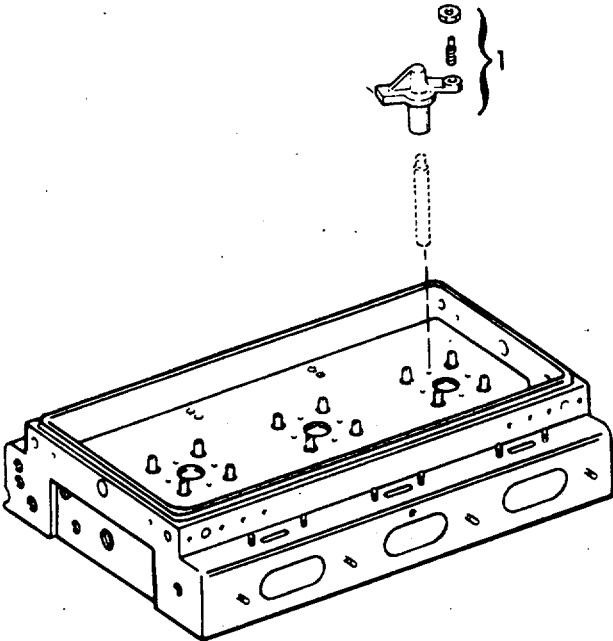
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD ON ENGINE (Cont)



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. |
|----|---------------------------|---------|--------------------|

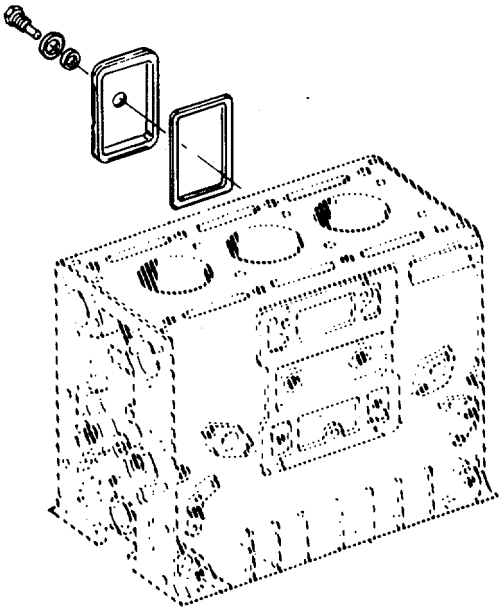


- |    |               |  |                 |
|----|---------------|--|-----------------|
| d. | Air box cover | Remove nuts, lockwashers, flatwashers, cover and gasket. | Discard gasket. |
|----|---------------|--|-----------------|

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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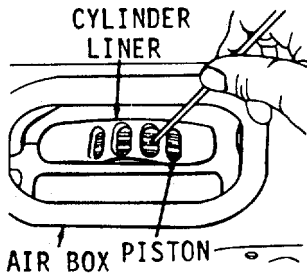
REMOVAL - CYLINDER HEAD ON ENGINE (Cont)



e. Piston	Observe piston while turning crankshaft.	Piston should be at top of its' stroke.
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**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.



3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD ON ENGINE (Cont)

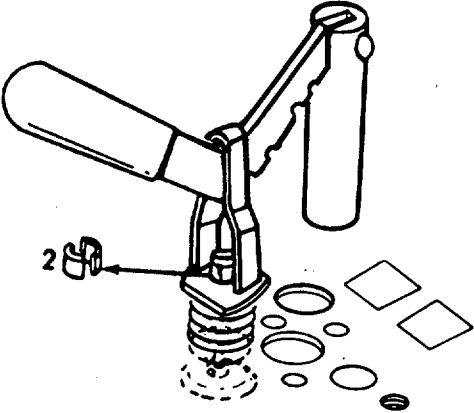
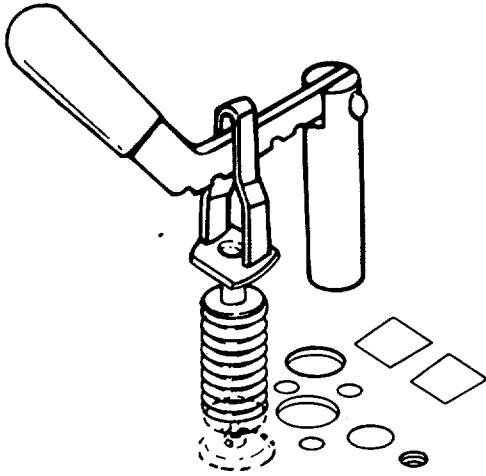
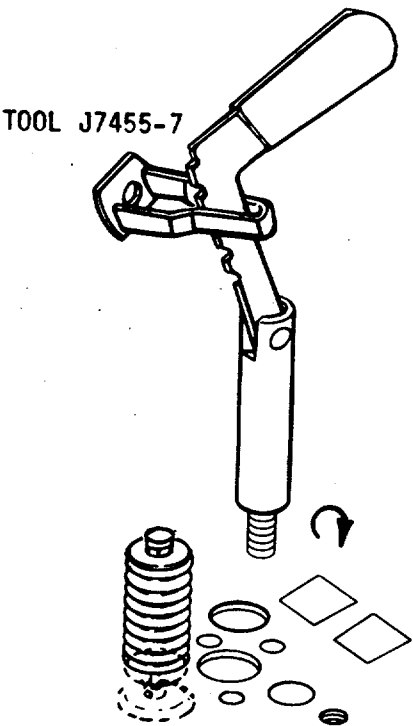
f. Valve spring compressor

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.

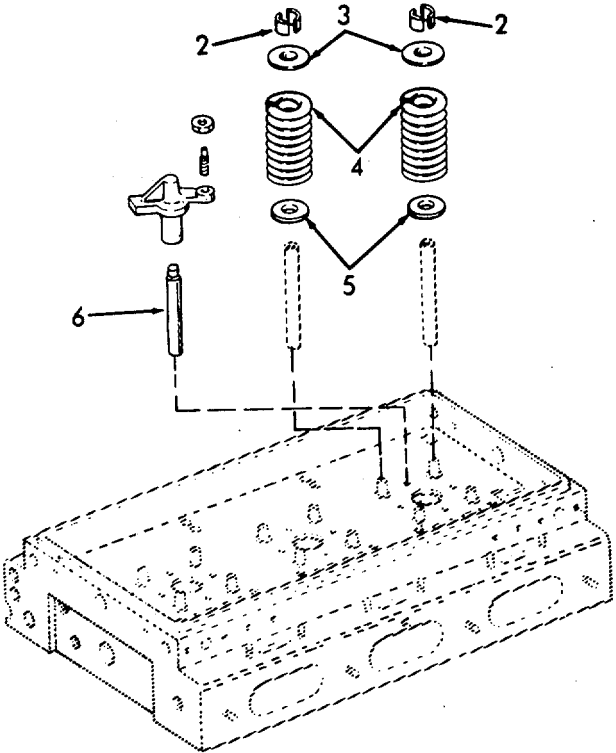


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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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 3-71.



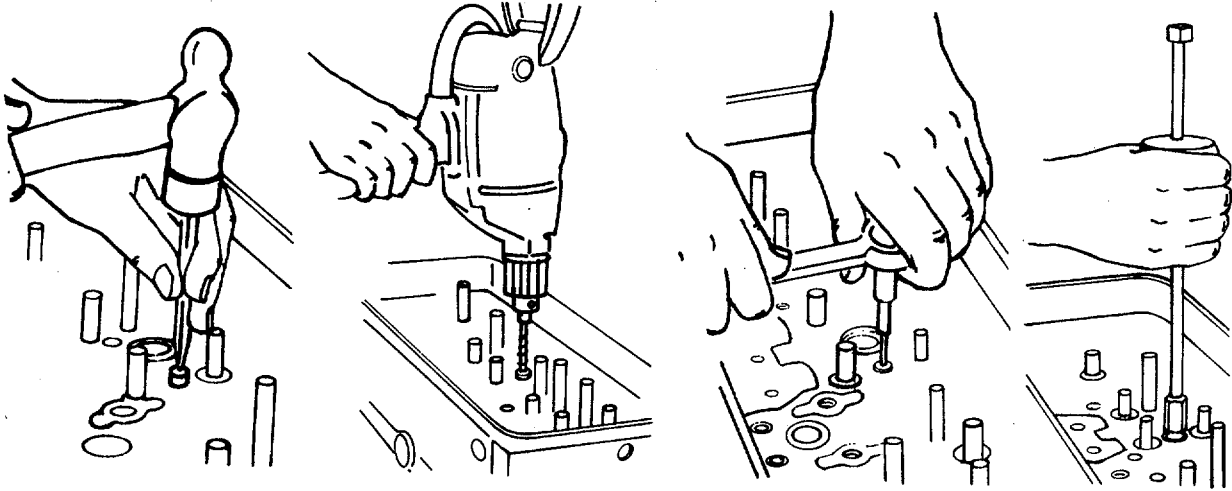


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD ON ENGINE (Cont)

- 2. Drill a hole approximately 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.



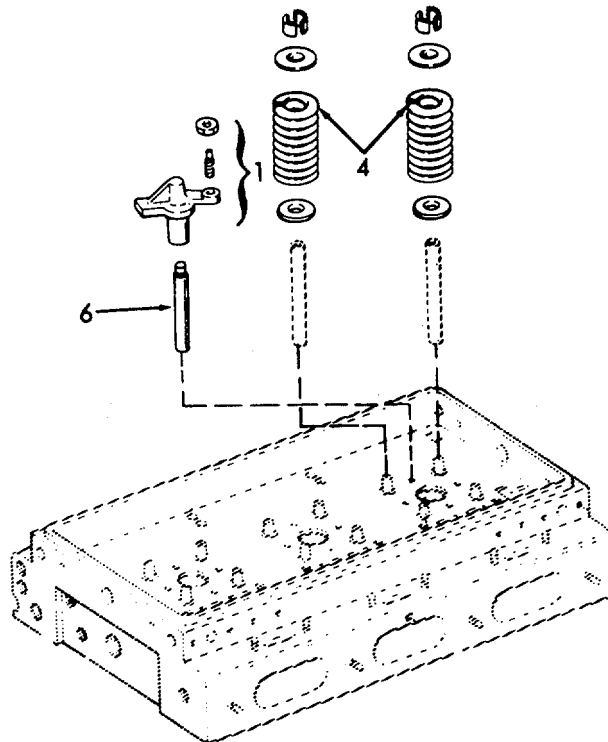
INSPECTION

**WARNING**

Wear eye protection when using compressed air.

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
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.		
4. Exhaust valve bridge (1), and guide (6)	Inspect the valve bridge guide, valve bridge, and adjusting screw for wear. Replace excessively worn parts.		

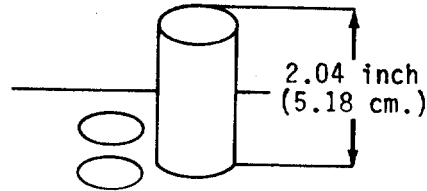
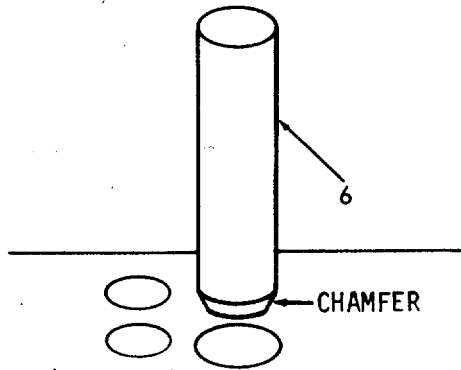


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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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.). |

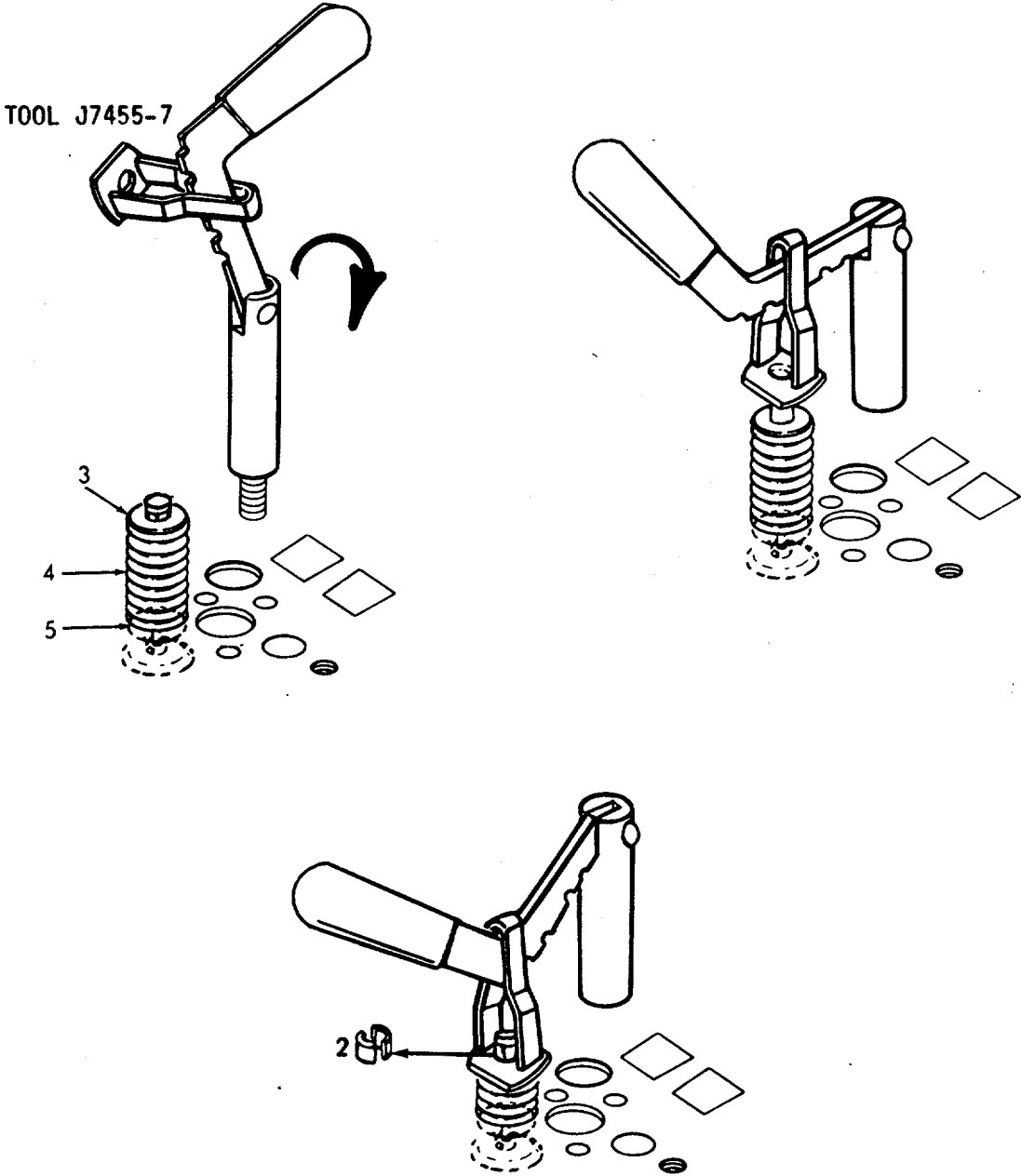


- |    |                      |  |  |   |
|----|----------------------|--|--|---|
| 6. | Exhaust valve spring | a. Spring seat (5), spring (4), and spring cap (3) | Place over valve stem.   |   |
|    |                      | b. Valve spring compressor                         | 1. Thread the valve spring compressor into one of the rocker shaft bolt holes in the cylinder head.                          | Use tool J7455-7.   |
|    |                      |  | 2. 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. |
|    |                      | 3. Remove tool.                                    |  |   |

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)

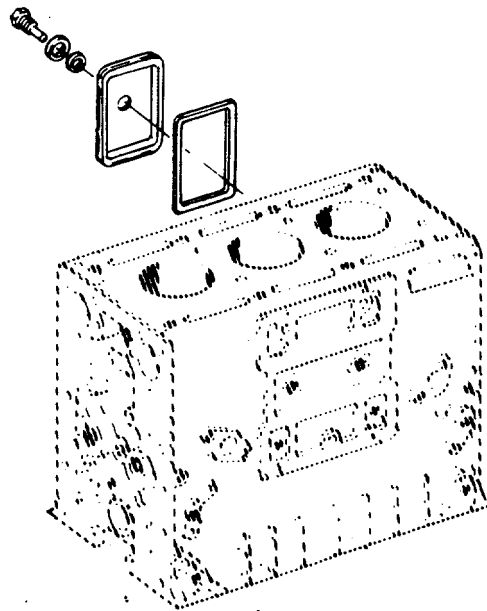


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)			
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c.	Air box covers	Install gasket, cover, lockwashers, nuts, and flatwashers.	Use new gasket.
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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 3-90.1.
f.	Injector	Install.	Refer to paragraph 3-71.
g.	Rocker arm cover	Install.	Refer to paragraph 3-86.

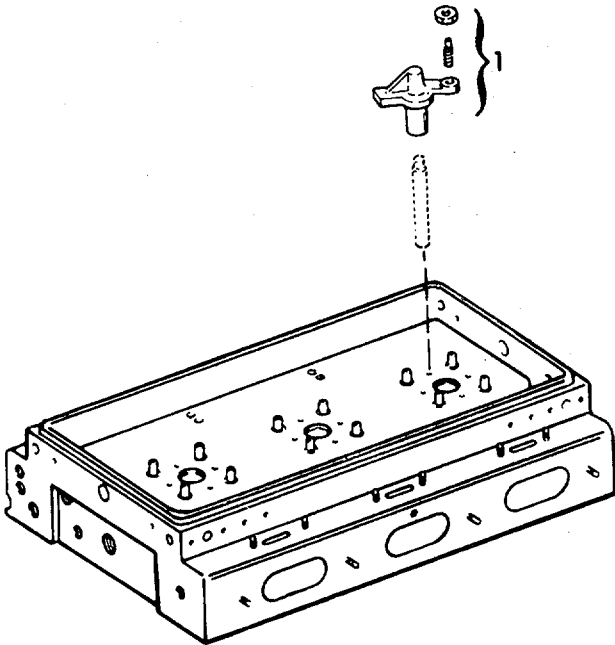
3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

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LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION - CYLINDER HEAD ON ENGINE (Cont)



3-1529

## 3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS			
7. Exhaust valve bridge		<p>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:</p>	
		<p>a. Place the valve bridge (8) in a vise and loosen the lock nut (9) on the bridge adjusting screw (7).</p>	



Loosening or tightening the lock nut with the bridge in place may result in a bent bridge guide or bent rear valve stem.

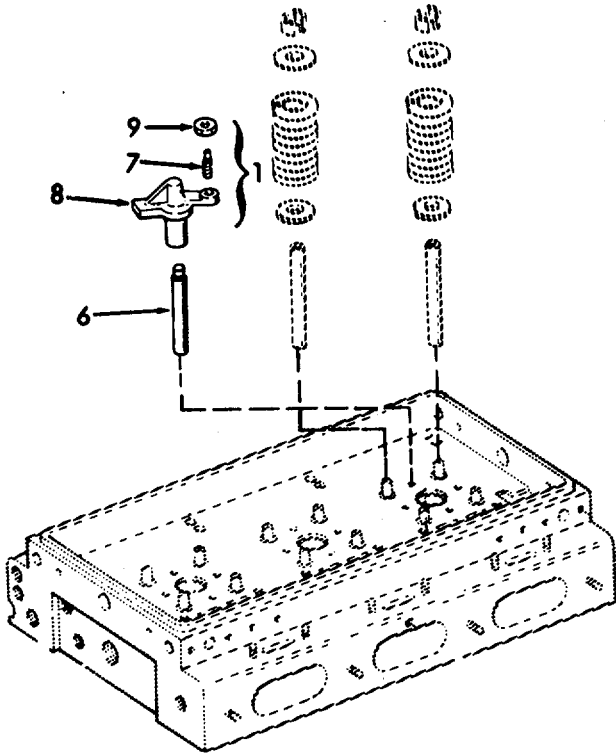
- b. Install in the valve bridge (1) on the valve bridge guide (6).
- c. While firmly pressing straight down on the pallet surface of the valve bridge (8) turn the adjusting screw (7) clockwise until it just touches the valve stem. Then, turn the screw an additional 1/8 to 1/4 turn clockwise and tighten the lock nut (9) finger tight.

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

- 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.
- 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.





3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

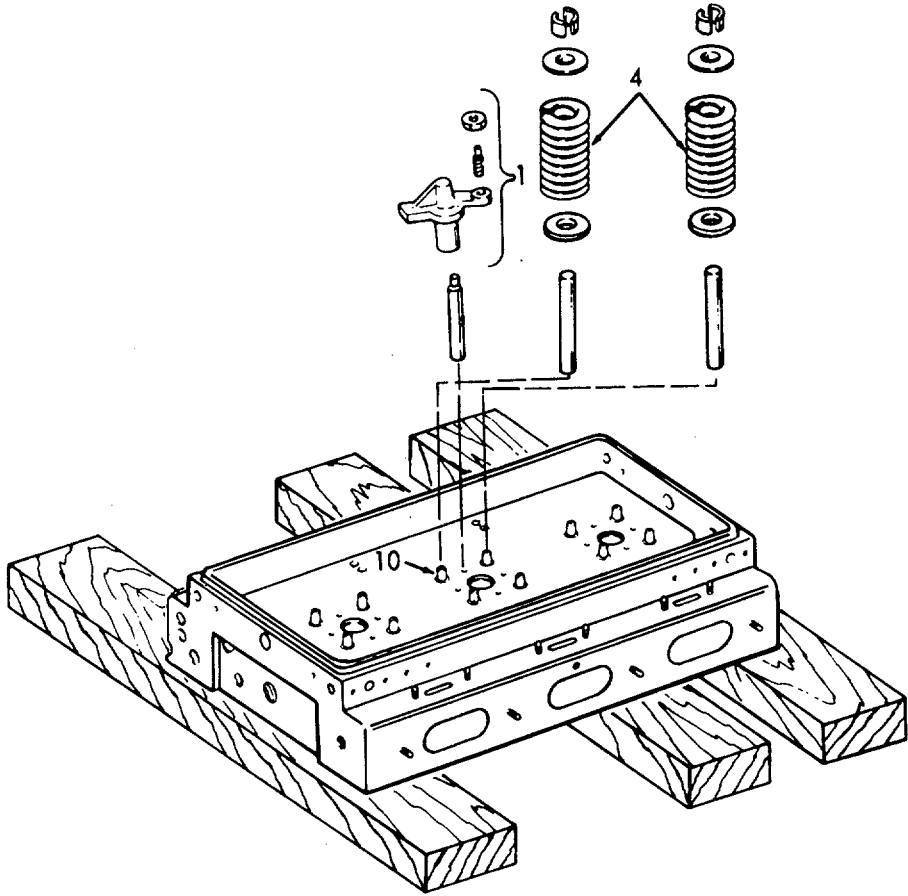
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			
		<p>g. Place a .0015 inch feeler gage under each end of the valve bridge or use a narrow strip cut from .0015 inch feeler stock to fit in the bridge locating groove over the inner exhaust valve. While pressing down on the pallet surface of the valve 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.</p>	
		<p>h. Remove the valve bridge and reinstall it in its' ORIGINAL position.</p>	
		<p>i. Adjust the remaining valve bridges in the same manner.</p>	
		<p>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.</p>	

REMOVAL - CYLINDER HEAD OFF ENGINE

<p>8. Exhaust valve springs (4)</p>	<p>a. Cylinder head</p>	<p>Place on 2 inch wood blocks.</p>	<p>Keeps cam followers clear of work bench.</p>
	<p>b. Exhaust valves (10)</p>	<p>Place a 2 inch wood block under valves.</p>	

3-90.2. 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 in their original locations.

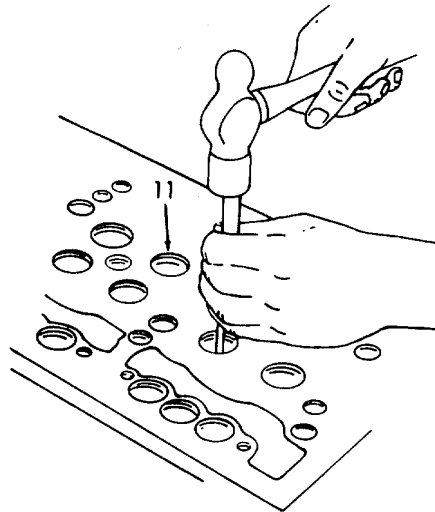


**3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD OFF ENGINE (Cont)

- |                               |                  |  |  |
|-------------------------------|------------------|--|--|
| 10. Exhaust valve guides (11) | a. Cylinder head | <ol style="list-style-type: none"> <li>1. Place on 2 inch wood blocks, bottom side up.</li> <li>2. Drive the valve guide (11) out from the bottom of the cylinder head.</li> </ol> |  |
|-------------------------------|------------------|--|--|



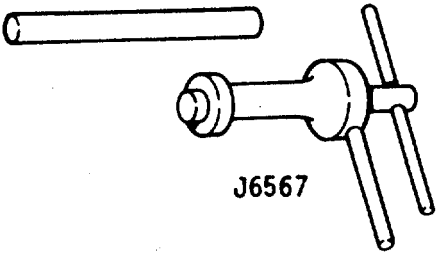
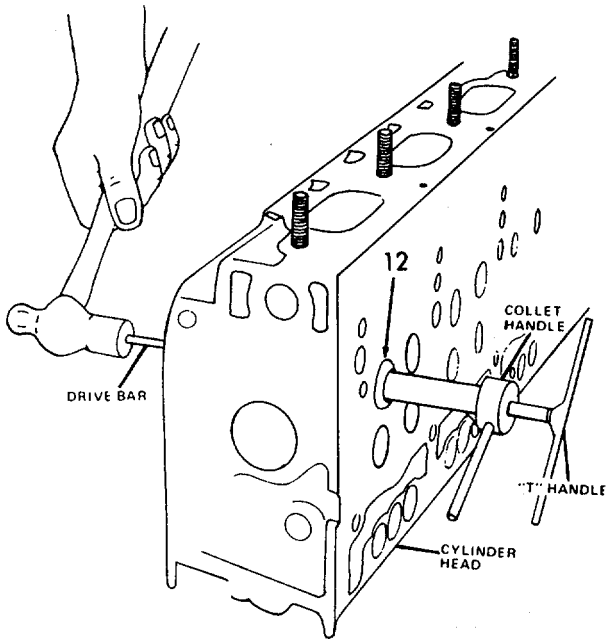
- |                                    |                                  |   |  |
|------------------------------------|----------------------------------|---|--|
| 11. Exhaust valve seat insert (12) | a. Cylinder head                 | Place on side.  |  |
|                                    | b. Remove valve seat insert (12) | <ol style="list-style-type: none"> <li>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.</li> <li>2. Hold the collet handle and turn the T handle to expand the collet cone until the insert is held securely by the tool.</li> </ol> |  |

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL - CYLINDER HEAD OFF ENGINE (Cont)

- 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.
- 5. Tighten the collet cone and continue to drive the insert out of the cylinder head.



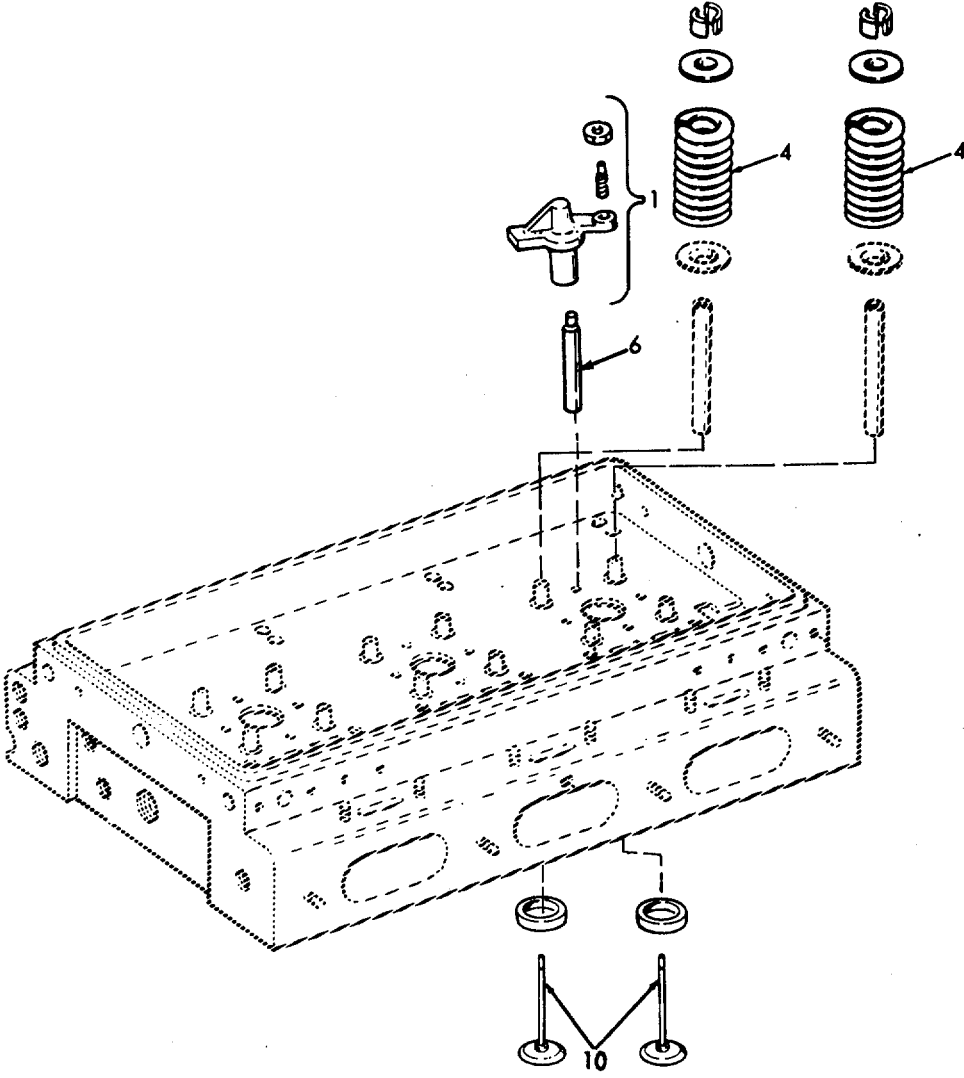
3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

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)	<p>a. 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.</p> <p>b. Clean the carbon from the valve stems and wash the valves with fuel oil. The valve stems must be free from scratches or scuff 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.</p> <p>c. 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.</p>		

3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

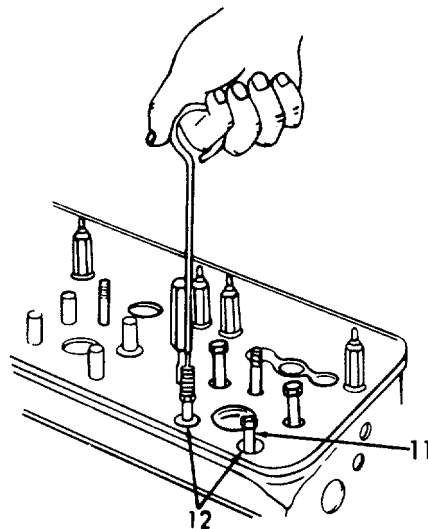
LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)



3-90.2. 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.		

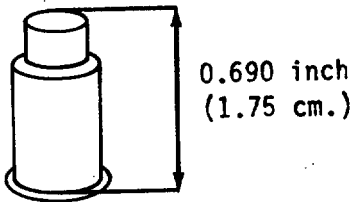
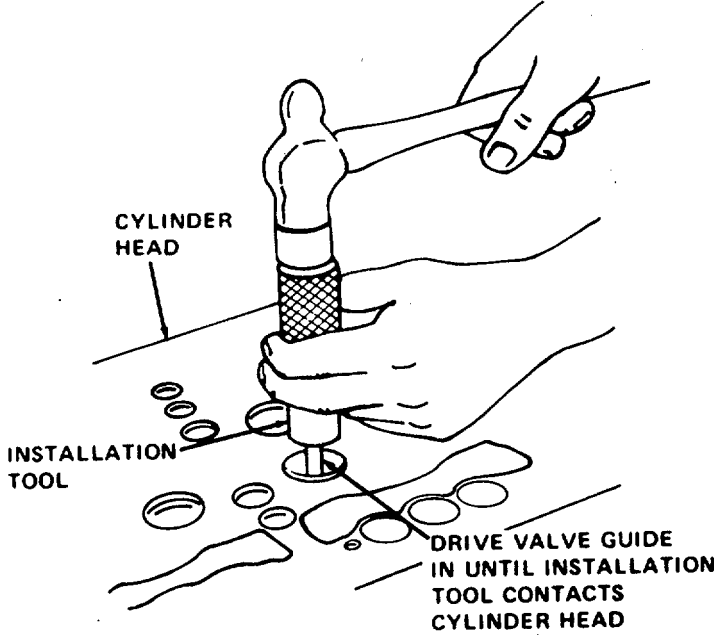


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

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).



Do not use the valve guides as a means of turning the cylinder head over or in handling the cylinder head.





3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)

18. Exhaust valve seat insert

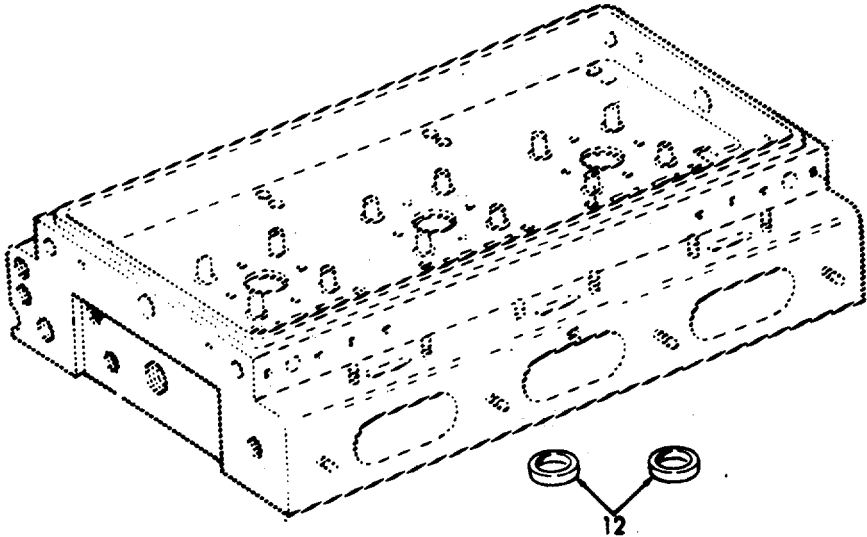
**WARNING**

Wear eye protection when using compressed air.

**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.   |
| b. Valve insert (12) | Clean. | Wash the valve insert counter-bore and valve insert with a good solvent. Dry with compressed air. |

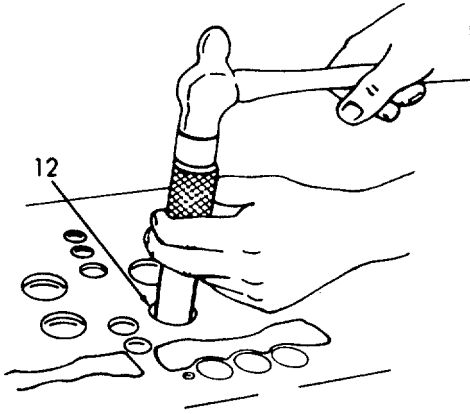
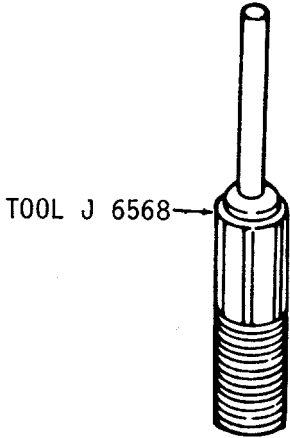


3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
	c. Valve insert counter-bore	Inspect.	Inspect the valve seat insert counter-bore in the cylinder head for cleanliness, concentricity, flatness and cracks. The counterbores in a four valve cylinder head have a 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 counterbores 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.

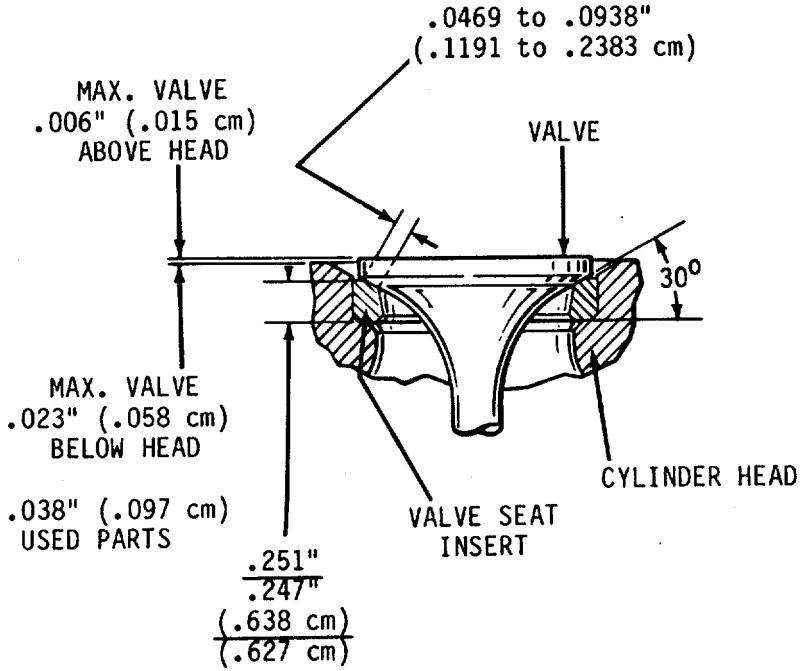
3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
	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 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 J 6568.



3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)			
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 both the valve and valve insert is 30°.

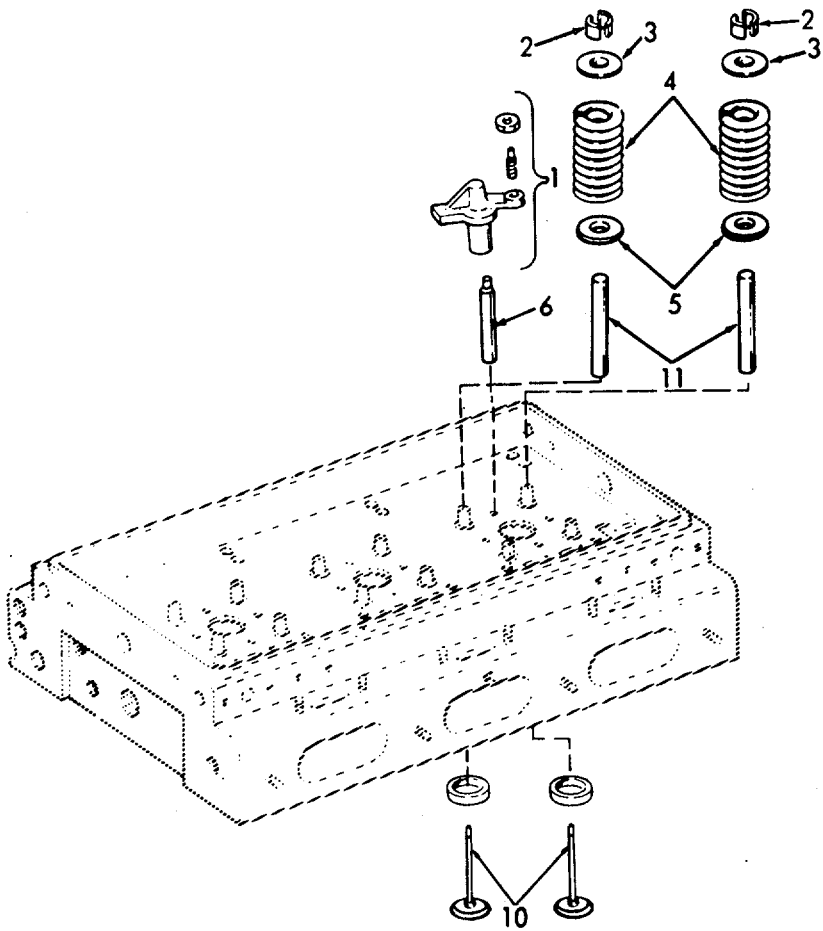


**3-90.2. EXHAUST VALVE - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<p>INSTALLATION - CYLINDER HEAD OFF ENGINE (Cont)</p>			
	<p>b. Valve guides (11)</p>	<p>Clean.</p>	
	<p>c. Valves stems (10)</p>	<p>Lubricate.</p>	<p>Slide valves all the way into the guides.</p>
<p>NOTE</p>			
<p>If reconditioned valves are used, install them in the same relative location from which they were removed.</p>			
	<p>d. Valve seat (5), spring (4), spring cap (3) and valve lock (2)</p>	<p>Install.</p>	<p>Hold the valves in place with a strip of masking tape and turn the cylinder head right side up on the work bench. Place a board under the head to support the valves and to provide clearance between the cam followers and the bench.</p>
	<p>e. Exhaust valve bridges (1)</p>	<p>Place on exhaust valve bridge guides (6).</p>	<p>Refer to step 6.</p>
			<p>Adjust, refer to step 7.</p>

3-90.2. 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 3-90.1.
	g. Injector	Install.	Refer to paragraph 3-71.
	h. Rocker arm Cover	Install.	Refer to paragraph 3-86.



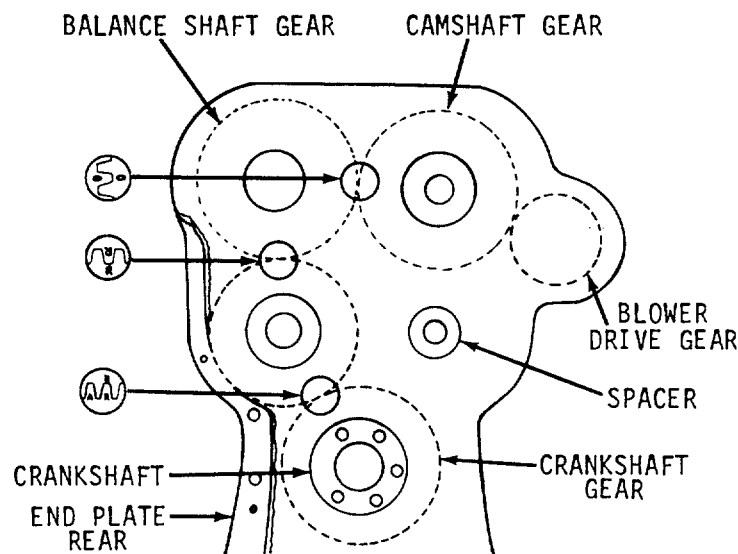
**3-91. CAMSHAFT AND GEAR TRAIN**

The camshaft, gear train and associated parts maintenance instructions are contained in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Gear Train	3-91.1
Engine Timing	3-91.2
Idler Gear and Bearing Assembly	3-91.3
Crankshaft Timing Gear	3-91.4
Camshaft and Balance Shaft	3-91.5

**3-91.1. GEAR TRAIN.**

a. A completely enclosed train of five helical gears is located at the rear end of the engine. A gear bolted to the crankshaft flange drives the camshaft and balance shaft gears, as well as the blower drive gear, through an idler gear mounted between the crankshaft and balance shaft gears.



b. The camshaft gear and balance shaft gear mesh with each other and run at the same speed as the crankshaft. Since these two gears must be in time with each other, and the two as a unit in time with the crankshaft gear, the letter "O" is placed on one tooth of one of the gears with a corresponding mark at the root of the mating teeth of the other gear.

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**3-91.1. GEAR TRAIN (Cont).**

---

c. The camshaft and balance shaft gears are keyed to their respective shafts and held securely against the shoulder on the shaft by a nut. Viewing the engine from the flywheel or gear train end, the righthand gear is the camshaft and has lefthand helical teeth.

d. The idler gear rotates on a double-row, tapered roller bearing on the cylinder block end plate at the left-hand side of the engines, as viewed from the gear train end.

e. A blower drive gear is located on the blower side to transmit power to the blower, governor, fuel pump and water pump.

f. Since the camshaft must be in time with the crankshaft, identification marks are located on two teeth of the idler gear with corresponding match marks stamped on the crankshaft gear and the camshaft gear.

g. However, the timing is advanced on certain engines by aligning the "A" on the crankshaft gears with the "L" or "R" (depending upon engine rotation) on the idler gears.

h. Before removing or replacing any of the gears, note whether standard or advanced timing is used on the engine. To do this rotate the crankshaft until the timing marks are aligned on the camshaft gears. Then check whether the "A", "L" or "R" timing mark on the crankshaft gear is aligned with the "L" or "R" on the idler gear and record this information for reassembly purposes.

i. Balance weights, one fastened to the inner face of each gear (camshaft and balance shaft) are important in maintaining perfect engine balance. These are in addition to the weights cast integral with the gears.

j. Gear train noise is usually an indication of excessive gear lash, scoring, pitting or excessive bearing wear. Therefore, when noise develops in a gear train, the flywheel housing should be removed and the gear train and its bearings inspected. A rattling noise usually indicates excessive gear lash whereas a whining noise is a result of too little gear lash.

k. Excessive wear and scoring may result from abrasive substances or foreign material in the oil, introduced in the engine by such a means as removal of the valve rocker cover without first cleaning away the dirt.

l. Since the camshaft and balance shaft gears each have the same number of teeth as the crankshaft gear, they will turn at crankshaft speed. However, as the blower drive gear has only about half as many teeth as the camshaft or balance shaft gear, it turns at approximately twice the speed of the crankshaft.



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**3-91.1. GEAR TRAIN (Cont).**

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m. Lubrication.

The gear train is lubricated by overflow oil from the camshaft and balance shaft pockets spilling into the gear train compartment. A certain amount of oil also spills into the gear train compartment from the camshaft and balance shaft end bearings, and idler gear bearings. The blower drive gear bearing is lubricated through an external pipe leading from the main cylinder block oil gallery to the gear hub bearing support. The idler gear bearing is pressure lubricated by oil passages in the idler gear hub which connect to the oil gallery in the cylinder block.

---

**3-91.2. ENGINE TIMING.**

---

a. The correct relationship between the crankshaft and camshaft must be maintained to properly control fuel injection and the opening and closing of the exhaust valves.

b. The crankshaft timing gear can be mounted in only one position due to one attaching bolt hole being offset. The camshaft gear can also be mounted in only one position as a result of the location of the keyway relative to the cams. Therefore, when the engine is properly timed, the markings on the various gears will match as shown.

c. An engine which is "out of time" may result in pre-ignition, uneven running and a loss of power.

d. When an engine is suspected of being out of time, due to an improperly assembled gear train, a quick check can be made without having to remove the flywheel and flywheel housing by following the procedure outlined below.

e. Checking Engine Timing

Access to the vibration damper or crankshaft pulley, to mark the top-dead-center position of the selected piston, and to the front end of the crankshaft or flywheel for barring the engine over is necessary in performing the timing check. Then, proceed as follows:

(1) Remove the valve rocker cover.

(2) Select any cylinder for the timing check -- it is suggested that a cylinder adjacent to one of the cylinder head cover studs be chosen since the stud may be used for mounting a dial indicator.

(3) Remove the fuel lines (at the cylinder selected) and install shipping caps on the injector fuel fittings to prevent the entry of dirt. Make sure that the valve and injector rocker arms are all in the "up" position, then remove the rocker shaft bracket bolts and swing the rocker arm assemblies back out of the way. Remove the injector assembly.

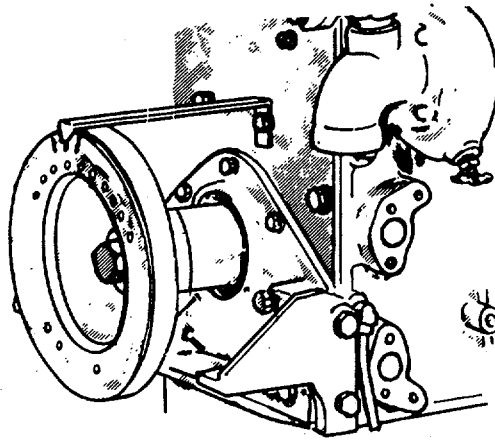
(4) Carefully place (do not drop) a rod approximately 12" long through the injector hole and on top of the piston.

(5) With the throttle in the NO FUEL position, turn the crankshaft slowly in the direction of rotation of the engine, and stop when the rod reaches the end of its upward travel. Remove the rod and turn the crankshaft opposite the direction of rotation between 1/16 and 1/8 of a turn.

**3-91.2. ENGINE TIMING (Cont).**

- (6) Select a dial indicator with .001" graduations and with a spindle movement of at least 1". Use suitable mounting attachments for the indicator so that it can be mounted over the injector hole in the cylinder head. Provide an extension for the spindle of the indicator. The extension must be long enough to contact the piston as it approaches its upper position.
- (7) Mount the indicator over the injector hole and tighten the mountings sufficiently to hold the indicator rigid.

The mounting leg may be threaded into the rocker cover stud, or the stud may be removed from the cylinder head and the leg threaded into the tapped hole, depending upon the length of the rod used in making up the mounting attachments. Make sure that the spindle extension is free in the injector hole, does not bind, and is free to travel its full 1" movement.



- (8) Provide a suitable pointer and attach it to the engine front end plate. The pointer should extend over the vibration damper, or crankshaft pulley.
- (9) Rotate the crankshaft in the direction of rotation slowly until the hand on the dial indicator just stops moving.
- (10) Rotate the crankshaft in the direction of rotation until the indicator hand just starts to move. Reset the dial to "0". Continue turning the crankshaft slowly until the indicator reading is .010" -- then stop turning.
- (11) Scribe a line on the damper in line with the end of the pointer.

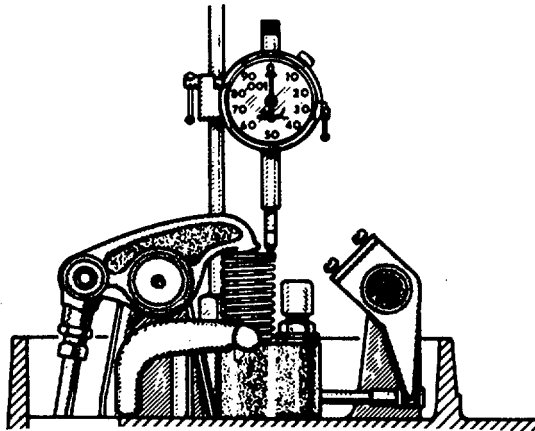
**3-91.2. ENGINE TIMING (Cont).**

- (12) Rotate the crankshaft opposite the direction of rotation slowly until the hand on the dial indicator just stops moving.
- (13) Rotate the crankshaft opposite the direction of rotation until the indicator hand just starts to move. Reset the dial to "0". Continue turning the crankshaft slowly until indicator reading is .010" - then stop turning.
- (14) Scribe a second line on the vibration damper in the same manner as in step 11.
- (15) Scribe a third line halfway between the first two lines. This is positive top-dead-center. The three scribed lines are shown on the crankshaft pulley. Remove the indicator from the engine.

**NOTE**

Make certain that the crankshaft pulley retaining bolt is not loosened while turning the crankshaft. The bolt must be tightened to 290-310 lb-ft (431.5-461.3 kg/m) torque if it becomes loose.

- (16) Install the injector assembly. Swing the injector and the rocker arm brackets and tighten the bolts to the specified torque. Adjust the valve clearance and time the injector. Rotate the crankshaft until the valve rocker arms back into position and install specified torque. Adjust the valve clearance and exhaust valves in the selected cylinder are open.
- (17) Install the dial indicator again so the spindle of the indicator rests on top of the injector follower as illustrated. Set the indicator dial to "0". Rotate the crankshaft slowly in the direction of rotation, and stop when the TDC mark on the vibration damper or crankshaft pulley lines up with the pointer.



**3-91.2. ENGINE TIMING (Cont).**

(18) Note the reading on the dial indicator and compare it with the chart.

After completing the timing check, remove the dial indicator. Remove the shipping caps from the injector, and install the injector fuel lines, making sure that they are tightened to prevent any leaks.

**\*INDICATOR READING**

Standard	Retarded 1-tooth	Advanced 1-Tooth
<b>STANDARD TIMING</b>		
.230" (.584 cm)	.197" (.500 cm)	.262" (.665 cm)
<b>ADVANCED TIMING</b>		
.262" (.665 cm)	.230" (.584 cm)	.289" (.734 cm)

\* Indicator readings shown are nominal values. The allowable tolerance is ± .005 in. (.013 cm). Remove the pointer attached to the front of the engine.

(19) Adjust the exhaust valves and time the injectors as outlined in paragraph 3-87.

(20) Install the valve rocker cover.

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**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

---

a. The idler gear mounts on a double row, tapered roller bearing which, in turn, is supported on a stationary hub. A hollow pin serves a two-fold purpose; first, as a locating dowel it prevents the idler gear hub from rotating and, second, the hollow pin conducts oil under pressure from an oil gallery in the cylinder block through a passage in the gear hub to the roller bearing inner races.

b. The inner races of the idler gear bearing are pressed onto the gear hub and, therefore, do not rotate since the hub is doweled to the end plate and bolted to the cylinder block and also bolted to the flywheel housing. A spacer separates the two bearing inner races.

c. The bearing outer race has a light press fit in the idler gear and is held against a flanged lip inside the idler gear on one side and by a retainer secured tightly with six bolts on the other side.

d. A left-hand helix gear with "R" timing marks is provided for right-hand rotation engines.

e. An idler gear hole spacer (dummy hub) is used on the side opposite the idler gear. No gasket is used between the idler gear hub or dummy hub and the flywheel housing. The flywheel housing bears against the inner races of the idler gear bearing and also against the dummy hub. Three self-locking bolts and steel washers are used to attach the flywheel housing at the idler gear and dummy hub locations. The washers seat in 7/8" spot faces at the flywheel housing attaching bolt holes, thus preventing oil leakage at these locations.

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- |                |               |                              |
|----------------|---------------|------------------------------|
| a. Removal     | c. Inspection | e. Pre-Load Check of Bearing |
| b. Disassembly | d. Reassembly | f. Installation              |

INITIAL SETUP:

Test Equipment

Spring Scale

References

NONE

Special Tools

Arbor press  
Torque wrench

Equipment

<u>Condition</u>	<u>Condition Description</u>
Para	

3-92	Flywheel Housing - removed
------	----------------------------

Material/Parts

Oil MIL-L-2104 Type OE/HDO

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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NOTE

The flywheel housing must be removed to perform the following maintenance procedures.

REMOVAL

- |     |                                      |    |  |                                 |                          |
|-----|--------------------------------------|----|--|---------------------------------|--------------------------|
| 1.  | Idler gear or idler gear hole spacer | a. | Cylinder block screw (1) and flat-washer | Remove.                         | Screw is 1/2-13 x 2 1/2. |
| (2) |                                      | b. | Idler gear hole spacer (3)               | Remove from rear end plate (4). |                          |
|     |                                      | c. | Idler gear (5)                           | Remove from rear end plate (4). |                          |

**3-1554**

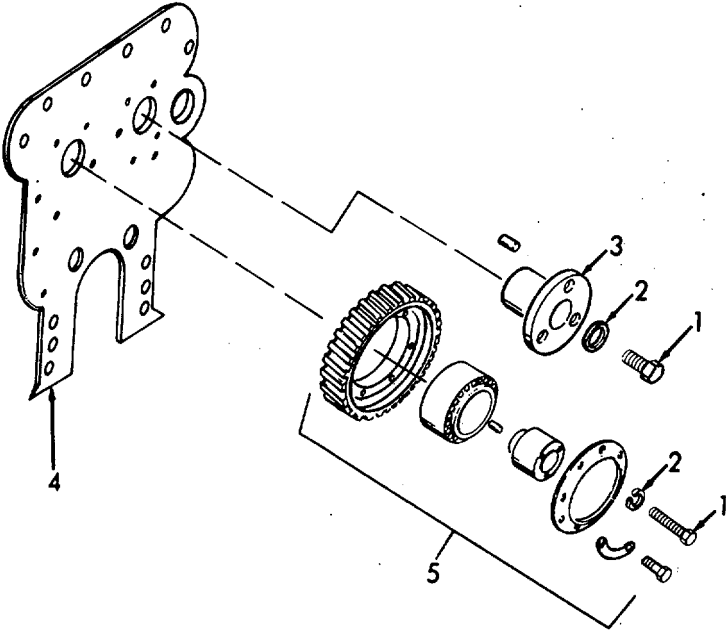
**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

NOTE

Before removing the idler gear check the idler gear, hub and bearing assembly for any perceptible wobble or shake when pressure is applied; by firmly grasping the rim of the gear with both hands and rocking in relation to the bearing. The bearing must be replaced if the gear wobbles or shakes. If the gear assembly is satisfactory, it is only necessary to check the pre-load before reinstallation.





**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont)**

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY</b>			
2.	Idler gear hub and bearing assembly		

**NOTE**

While removing or installing an idler gear bearing, the bearing **MUST** be rotated to avoid the possibility of damaging the bearing by brinelling the bearing races. Brinelling refers to the marking of the races by applying a heavy load through the rollers of a non-rotating bearing in such a way that the rollers leave impressions on the contact surfaces of the races. These impressions may not be easily discerned during normal inspection. For example, a bearing may be brinelled if a load were applied to the inner race of the bearing assembly in order to force the outer race into the idler gear bore, thus transmitting the force through the bearing rollers. A brinelled bearing may have a very short life.

- a. Six bolts (6), three bolt locks (7) and bearing retainer (8) Remove.



Wear eye protection when using compressed air.

- b. Idler gear and bearing assembly (9) Clean with fuel oil and dry with compressed air.

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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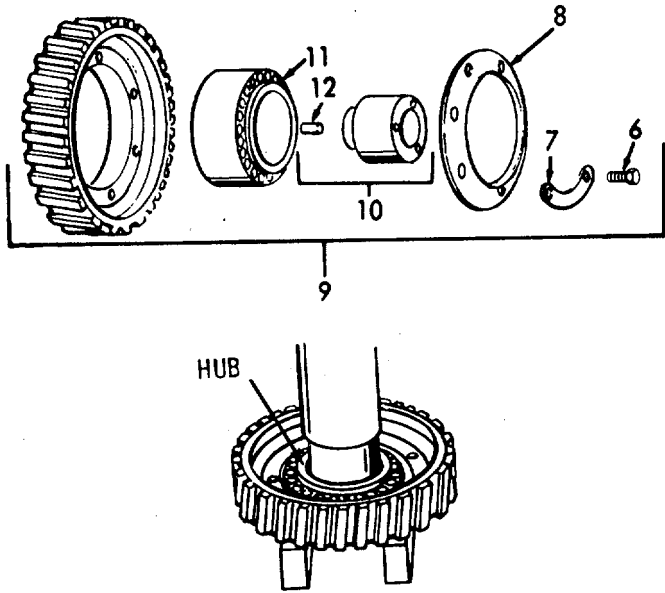
**DISASSEMBLY (Cont)**

c.	Bearing hub (10)	Place the idler gear and bearing assembly (9) in an arbor press with the bearing cone or inner race supported on steel blocks as shown. While rotating the gear assembly (9) press the hub (10) out of the bearing. Remove the gear assembly from the arbor press and remove the bearing cones and spacer (11).
----	------------------	---

**NOTE**

Component parts of the idler gear bearing are mated; therefore, match-mark the parts during disassembly to assure they will be reassembled in their original positions.

d.	Dowel (12)	Remove.
----	------------	---------



**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

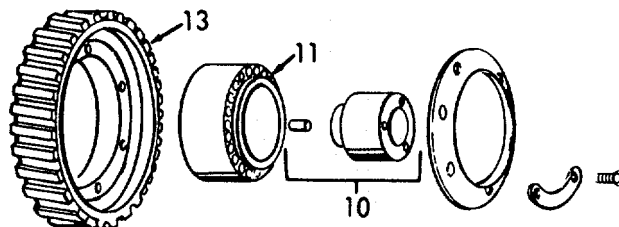
LOCATION	ITEM	ACTION	REMARKS
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INSPECTION
------------

**WARNING**

Wear eye protection when using compressed air.

- |    |   |  |
|----|---|--|
| 3. | a. Idler gear (13), hub (10) and bearing (11) | <ol style="list-style-type: none"> <li>1. Wash in clean fuel oil and dry with compressed air.</li> <li>2. Inspect all parts for wear.</li> </ol>                   |
|    | b. Bearing (11)                               | Inspect bearings carefully. Wear, pitting, scoring or flat spots on rollers or races are sufficient cause for rejection and the bearing assembly must be replaced. |
|    | c. Hub (10)                                   | Check the idler gear hub and spacer.   |
|    | d. Idler gear (13)                            | Examine the gear teeth for evidence of scoring, pitting and wear. If severely damaged or worn, replace the gear. Also, inspect other gears in the gear trains.     |



**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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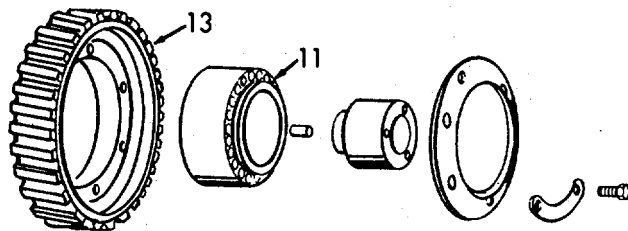
REASSEMBLY
------------

4. Idler gear

NOTE

Align match marks on the bearing components before proceeding.

- |  |  |
|--|--|
| <p>a. Idler gear (13) and bearing (11)</p> | <ol style="list-style-type: none"> <li>1. Support the idler gear, shoulder down, on the bed of an arbor press and start the outer bearing race squarely into the bore of the gear. Then, press the bearing race tight against the shoulder of the gear, using a steel plate between the ram of the press and the bearing race.</li> <li>2. Support one bearing cone, numbered side down, on bed of arbor press and lower the idler gear and bearing cup assembly down over the bearing cone.</li> <li>3. Lay spacer ring on face of bearing cone.</li> </ol> |
|--|--|



3-1559

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

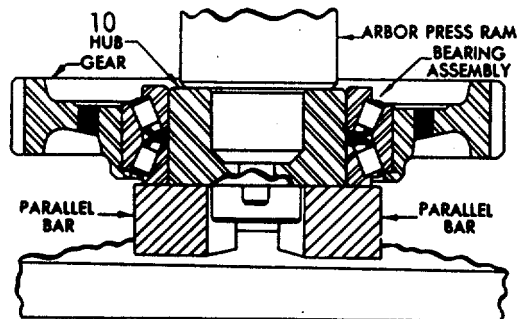
LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)			
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4. Place second bearing cone, numbered side up, in idler gear and bearing cup assembly and against spacer ring.
5. Then, position the idler gear-hub over the bearing cones so that the oil hole in the hub is 1800 from the gap in the spacer ring.

b. Hub (10)

Press the hub into the idler gear bearing cones, while rotating the gear (to seat rollers properly between cones) until the face of the hub which will be adjacent to the cylinder block end plate is flush with the corresponding face of the bearing cone. The bearing cones should be supported so as not to load the bearing rollers during this operation.



**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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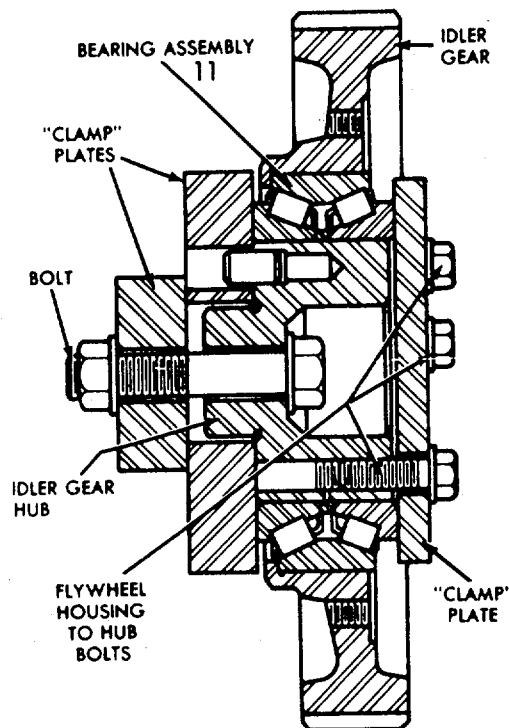
PRE-LOAD CHECK OF BEARING
---------------------------

5. Bearing  
(11)

NOTE

Prior to installing and securing the bearing retainer, check the preload of the bearing assembly as outlined below.

a. The rollers of the bearing are loaded between the bearing cup and bearing cones in accordance with design requirements to provide a rigid idler gear and bearing assembly. As the bearing cones are moved toward each other in a tapered roller bearing assembly, the rollers will be more tightly held between the cones and cup. In the idler gear bearings, a slight pre-load is applied by means of a selected spacer ring between the bearing cones, to provide rigidity of the gear and bearing assembly when it is mounted on its hub. This method of preloading is measured, in terms of "pounds-pull", by the effort required at the outer diameter of the gear to turn the bearing cup in relation to the bearing cones.



3-1561

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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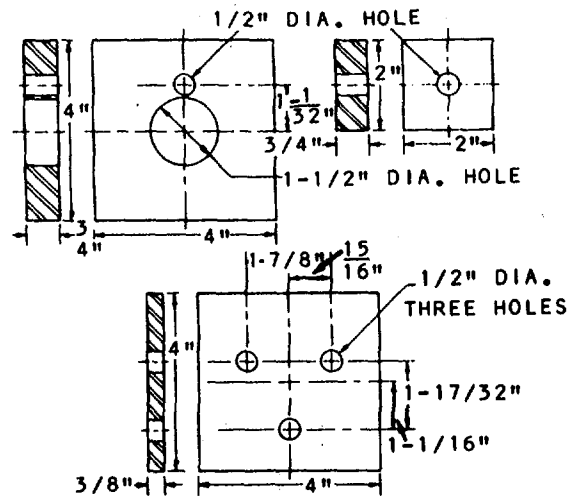
**PRE-LOAD CHECK OF BEARING (Cont)**

- b. Any time an idler gear assembly has been removed from an engine for servicing or inspection, while performing engine overhaul or other repairs, the pre-load should be measured as part of the operation.
- c. After the idler gear, hub and bearing are assembled together, the bearing should be checked to ascertain that the gear may be rotated on its bearing without exceeding the maximum torque specifications, nor be so loose as to permit the gear to be moved in relation to the hub by tilting, wobbling or shaking the gear.
- d. If the mating crankshaft and camshaft or balance shaft gears are not already mounted on the engine, the torque required to rotate the idler gear may be checked by mounting the idler gear in position on the engine, using a steel plate 4" square and 3/8" thick against the hub and cone as outlined below.
- e. However, If the crankshaft and camshaft gears are on the engine, a suitable fixture, which may be held in a vise, may be made.
- f. Three plates, a 1/2"-13 x 2 3/4" bolt and a plain washer are used with a 1/2"-13 nut and plain washer for mounting. One of the plates is used to take the place of the flywheel housing, and the other two plates, the cylinder block. "Engine-mounted" conditions are simulated by tightening the nut to 80-90 lb-ft torque and tightening the three plate-to-hub attaching bolts to 25-40 lb-ft torque. The components of the fixture may be made from steel stock in accordance with the dimensions.
- g. The idler gear bearing should be clean and lubricated with clean light engine oil prior to the preload test. Idler gear assemblies which include new bearings should be "worked in" by grasping the gear firmly by hand and rotating the gear back and forth several times.
- h. To check the pre-load by the first method:
  - (1) Mount the idler gear assembly on the engine.
  - (2) Install the center bolt and washer through the gear hub and thread into the cylinder block a 1/2"-13 x 2 1/2" bolt replaced the 1/2"-13 x 2" bolt). Tighten the bolt to 80-90 lb-ft torque.

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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PRE-LOAD CHECK OF BEARING (Cont)
----------------------------------



(3) Place steel plate (lower plate) against hub and bearing. Insert three 3/8"-16 bolts through plate and threaded into hub. Tighten the bolts to 25-40 lb-ft torque.

(4) Tie one end of a piece of lintless 1/8" cord around a 1/8" round piece of wood (or soft metal stock). Place the wood between the teeth of gear, then wrap the cord around the periphery of the gear several times. Attach the other end of the cord to spring scale. Maintain a

straight, steady pull on the pounds and ounces, required to start the gear reading. If the pull is within 1 1/4 lb. minimum to more than 2 lbs. 11 ounces, the idler gear and

scale, 90° to the axis of the hub, and note the pull, in rotating. Make several checks to obtain an average 6 lbs. 12 ounces maximum and does not fluctuate bearing assembly are satisfactory for use.

i. To check the pre-load by the second method:

(1) Attach the plates (two upper plates) to the idler gear with 1/2"-13 center bolt, washers and nut as shown. Tighten the bolt to 80-90 lb-ft (119-134 kg/m) torque.

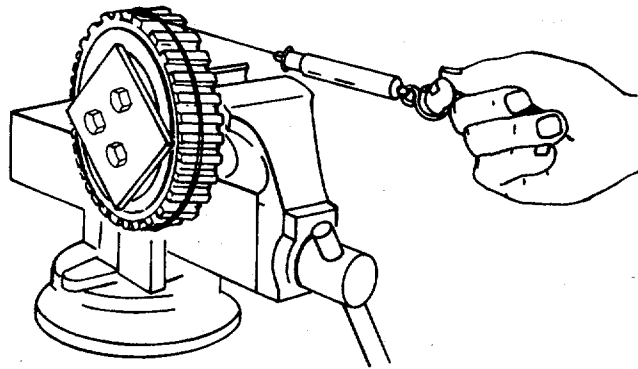


**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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PRE-LOAD CHECK OF BEARING (Cont)
----------------------------------

- (2) Attach the other plate to the idler gear with three 3/8"-16 bolts. Tighten the bolts to 25-40 lb-ft (37.2-59.5 kg/m) torque.
- (3) Clamp the idler gear assembly and fixture in vise as shown.



- (4) Attach the cord to the idler gear and spring scale and check the pre-load as outlined in item 4 of the first method.

j. If the scale reading is within the specified 1 1/4 to 6 3/4 lbs., but fluctuates more than the permissible 2 lbs. 11 ounces (12 N), the idler gear and bearing assembly must NOT be installed on the engine. Fluctuations in scale reading may be caused by the races not being concentric to each other, damaged races or rollers, or dirt or foreign material within the bearings. In these cases, the bearing should be inspected for the cause of fluctuation in the scale readings and corrected or a new bearing installed.

k. A scale reading which exceeds the specified maximum indicates binding of the bearing rollers, or rollers improperly installed. When the scale reading is less than the specified minimum, the bearing is more likely worn and should be replaced.

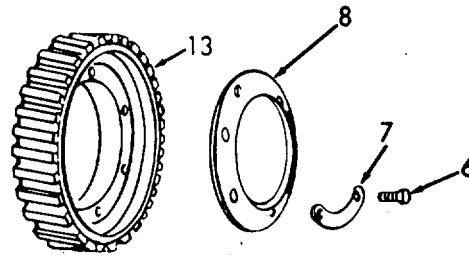
l. After the pre-load test is completed, remove the steel plates and attach bearing retainer as follows:

- (1) Attach the bearing retainer (8) to the idler gear (13) with six screws (6) and locks (7). Tighten the screws to 24-29 lb-ft (35.7 - 43.2 kg/m) torque.
- (2) Bend the ears of each bolt lock against the flat side of the attaching screw heads to secure the bolts.

**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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PRE-LOAD CHECK OF BEARING (Cont)
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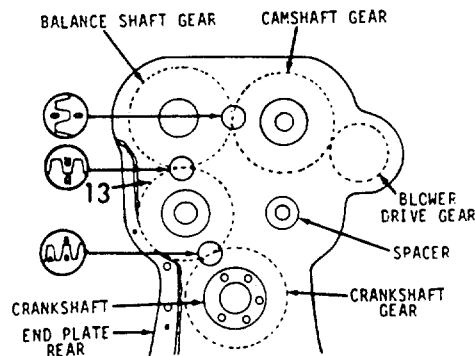


INSTALLATION
--------------

6.	Idler gear hub and bearing assembly gear (13)
----	---

Crankshaft gear balance shaft gear and idler
--

1. Position gears so that match marks will align with those on the idler gear.
2. With these marks in alignment, start the idler gear into mesh with the crankshaft gear and either the camshaft or balance shaft gear, and simultaneously rotate the gear hub so that the hollow pin at the inner face of the hub nearly registers with the oil hole in the end plate.



**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
INSTALLATION (Cont)				
		3. Roll the idler gear into position, align the hollow pin with the hole in the end plate, and gently tap the hub until it seals against the end plate. Thus the hollow dowel pin in the hub will conduct oil through the end plate and into the hub where it flows through a drilled passage to the roller bearing.		
		4. After making sure that the hub is tight against the end plate, secure the idler gear assembly in place with a 1/2"-13 screw and washer.	Tighten the screw to 80-90 lb-ft (119-134 kg/m), torque.	
7.	Idler gear hole spacer	a. Hollow dowel pin (12)	Insert into rear end plate (4).	Tighten the screw to 80-90 lb-ft (119-134 kg/m) torque.
		b. Spacer (3), washer (2) and 1/2-13 screw (1)	Install over dowel pin (12).	
8.	Idler gear and spacer	a. Idler gear (5) and spacer (3)	Lubricate liberally with clean engine oil.	

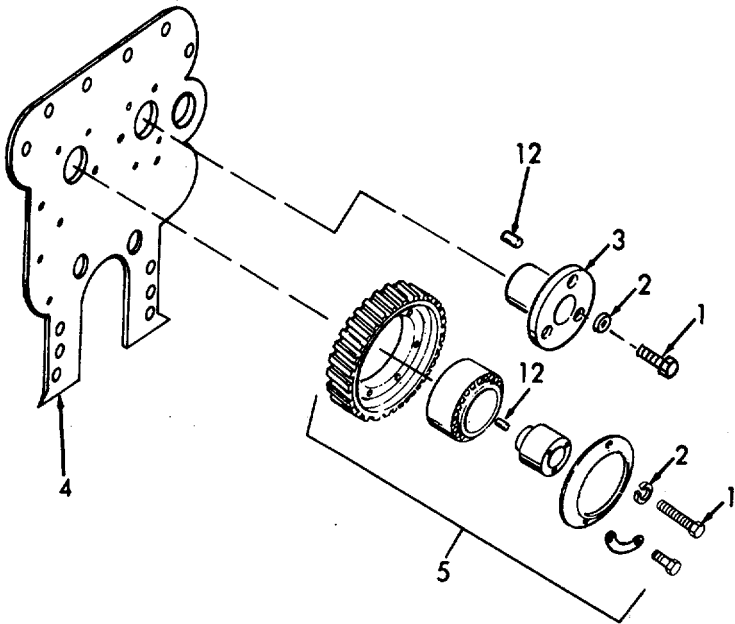
**3-91.3. IDLER GEAR AND BEARING ASSEMBLY - MAINTENANCE  
INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

b. Crankshaft gear, balance shaft gear and idler gear

Check backlash between mating gears. The backlash must be .003 to .008 inch.



**3-91.4. CRANKSHAFT TIMING GEAR - MAINTENANCE INSTRUCTIONS.**

a. The crankshaft timing gear is bolted to the flange at the rear end of the crankshaft and drives the balance shaft gear through an idler gear.

b. Since the camshaft must be in time with the crankshaft, timing marks are located on two teeth of the idler gear with corresponding timing marks stamped on the crankshaft gear and camshaft and balance shaft gears (refer to paragraph 3-91.2).

This task covers:

- a. Removal
- c. Inspection
- f. Installation**

INITIAL SETUP:

<u>Test Equipment</u>	<u>References</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition</u> <u>Condition Description</u>
NONE	Para 3-92      Flywheel Housing Removed
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

NOTE

The flywheel housing and flywheel must be removed to perform the following maintenance instructions.

**REMOVAL**

- |                    |                                 |   |
|--------------------|---------------------------------|---|
| 1. Crankshaft Gear | a. Crankshaft rear oil seal (1) | Peen the outside diameter of the seal until it stretches sufficiently so it can be slipped off of the crankshaft. |
|--------------------|---------------------------------|---|

3-91.4. CRANKSHAFT TIMING GEAR - MAINTENANCE INSTRUCTIONS (Cont).

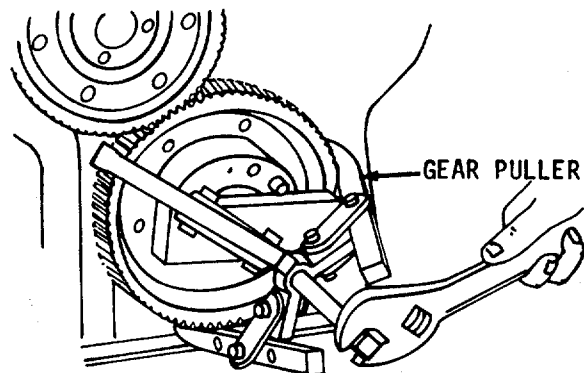
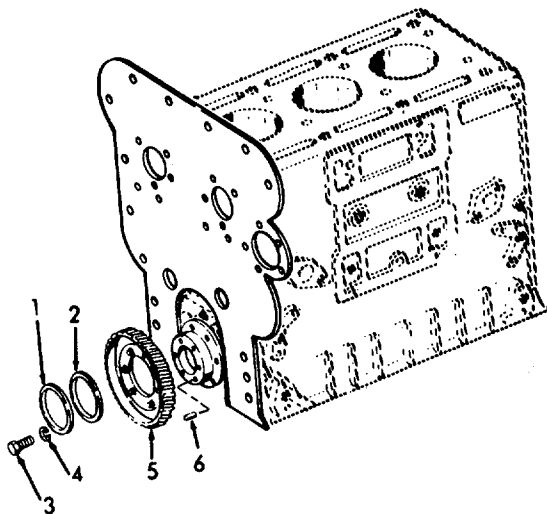
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

NOTE

Before removing the crankshaft gear, align the timing marks of the gear train and note their location so the gear can be reinstalled in its original position.

- |    |                                    |  |
|----|------------------------------------|--|
| b. | Oil seal spacer (2)                | Remove.  |
| c. | Six bolts (3) and lock-washers (4) | Remove.  |
| d. | Crankshaft gear (5)                | Provide a base for the puller screw by placing a steel plate across the cavity in the end of the crankshaft. Then remove the gear with a suitable puller as shown. |
| e. | Dowel (6)                          | Remove.  |



**3-91.4. CRANKSHAFT TIMING GEAR - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION

**WARNING**

Wear eye protection when using compressed air.

- |    |  |  |  |
|----|--|--|--|
| 2. |  | Clean the gear with fuel oil and dry it with compressed air. Examine the gear teeth for evidence of scoring, pitting or wear. If severely damaged or worn, install a new gear. Also check the other gears in the gear train. |  |
|----|--|--|--|

INSTALLATION

- |    |              |   |  |
|----|--------------|---|--|
| 3. | a. Dowel (6) | Install.  |  |
|    | b. Gear (5)  | <ol style="list-style-type: none"> <li>1. Position the gear on the rear end of the crankshaft with the flat finish hub of the gear facing toward the cylinder block and with all six bolt holes in the gear aligned with the tapped holes in the crankshaft. One bolt hole is offset so the gear can be attached in only one position.</li> <li>2. Align the proper timing mark ("L" or "R") on the crankshaft gear tooth with the corresponding mark on the idler gear.</li> </ol> |  |

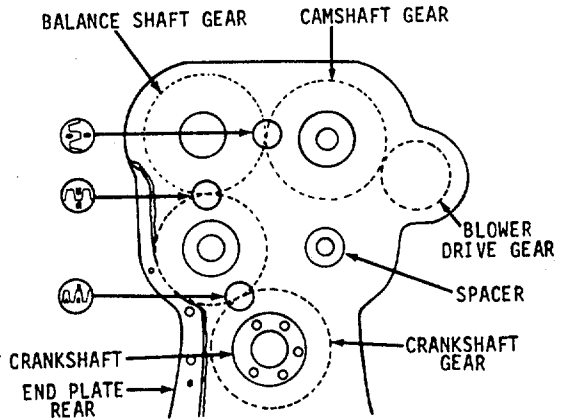
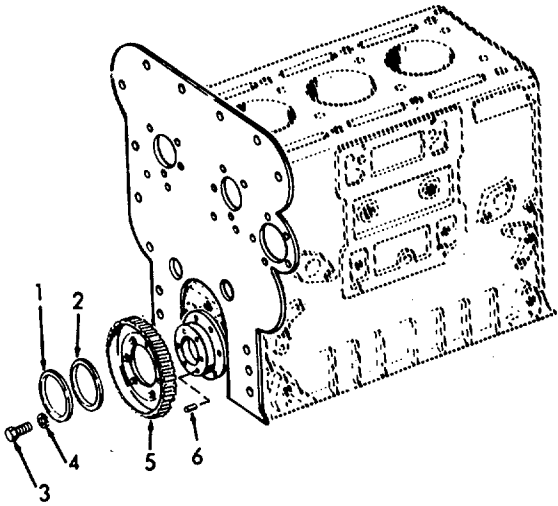
**NOTE**

When advanced timing is required, align the timing mark "A" with the timing mark on the idler gear.

3-91.4. CRANKSHAFT TIMING GEAR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Six bolts (3) and lock-washers (4)	<ol style="list-style-type: none"> <li>1. Start the bolts through the gear and into the crankshaft.</li> <li>2. Draw the gear tight against the shoulder on the crankshaft.</li> <li>3. Check the backlash with the mating gear. The backlash should be .003" to .008" with new gears or .010" maximum with used gears.</li> </ol>	<p>Bolts are 3/8-24.</p> <p>Tighten bolts to 35-39 lb-ft (52.1-58.0 kg/m) torque.</p>

b. Spacer (2) and oil seal (1)  
Install.





---

**3-91.5. CAMSHAFT AND BALANCE SHAFT - MAINTENANCE INSPECTIONS.**

---

a. The camshaft and the balance shaft are located near the top of the cylinder block. The camshaft actuates the valve and injector operating mechanism.

b. The accurately ground cams on the camshaft ensure efficient, quiet cam follower roller action and are heat treated to provide a hard wear surface.

c. The engine is equipped with a low velocity, low lift injector cam lobe and a long closing ramp exhaust cam lobe design camshaft and can be identified by the numeral "7" stamped on one end, is serviced.

d. Both ends of the cam and balance shaft are supported by bearing assemblies, each consisting of a flanged housing and two bushings. In addition, intermediate two-piece bearings support the camshaft at uniform intervals throughout its length. The intermediate bearings are secured to the camshaft by lock rings, thereby permitting them to be inserted into the cylinder block with the shaft. Each intermediate bearing is secured in place, after the camshaft is installed, with a lock screw threaded into a counterbored hole in the top of the cylinder block.

e. On both the camshaft and the balance shaft, the gear thrust load is absorbed by two thrust washers. The thrust washers bear against thrust shoulders on the shafts.

f. A helical drive gear with a counterweight is secured to each shaft with a Woodruff key, nut, nut retainer, retainer bolts and lock washers. The drive gears are attached to the rear end of the shafts on all engines.

g. To help maintain engine balance, a balance weight is installed on the front end of each shaft.

h. Lubrication.

(1) Lubricating oil is supplied under pressure to the bearings from the longitudinal main oil gallery through a horizontal transverse passage at each end of the cylinder block, then up the connecting vertical passages in each corner of the block to the camshaft and balance shaft end bearings. The camshaft intermediate bearings are lubricated by the oil from the end bearings passing through the drilled passage in the shaft.

(2) The lower halves of the camshaft intermediate bearings are grooved along the horizontal surface that mates with the upper halves of the bearings. Oil from the passage in the camshaft is forced through the milled slots in the bearing and then out the grooves to furnish additional oil to the cam follower assemblies. This permits the cam pocket to be filled rapidly to the operating oil level immediately after starting the engine.



**3-91.5. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

NOTE

This procedure is to be used when removing the camshaft or balance shaft without removing the flywheel housing and disconnecting the generator. Refer to Direct Support Maintenance to remove the camshaft and balance shaft when the engine is removed from vessel.

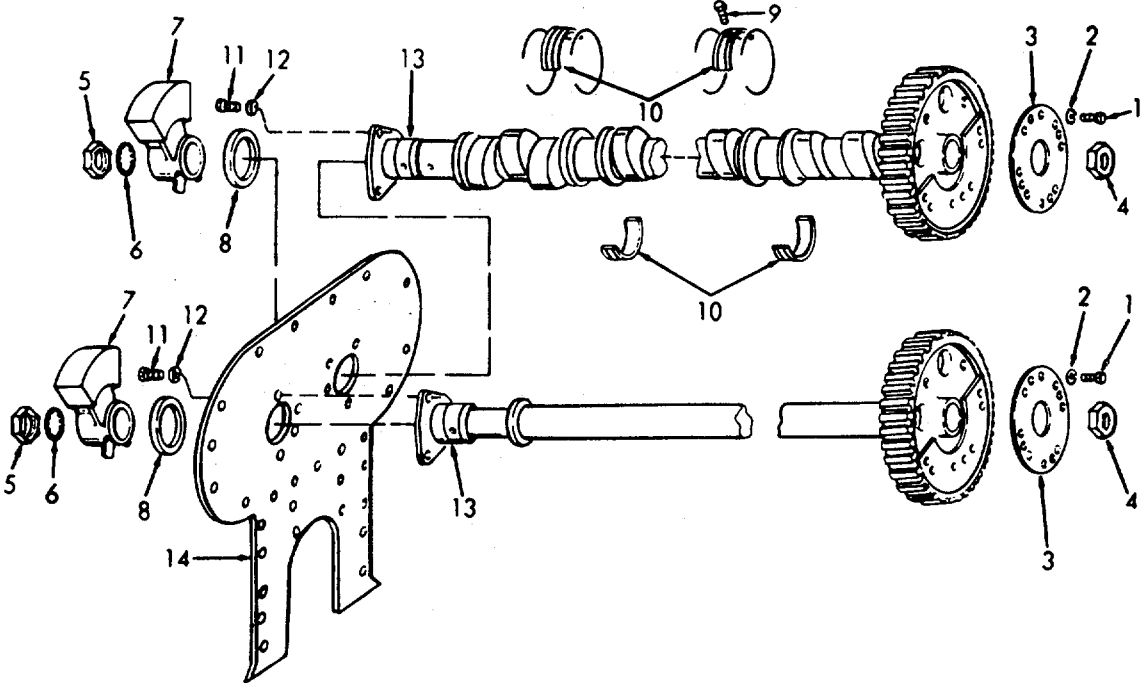
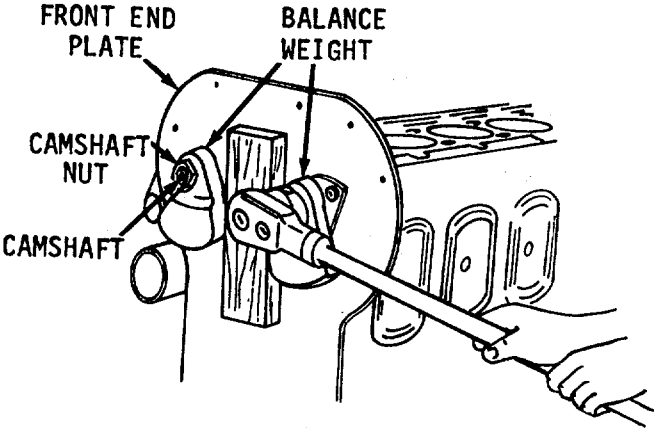
**REMOVAL**

1. Engine (front)	Balance weights	Place a wooden block between the weights.	
2. Camshaft balance shaft	a. Screws (1), lock-washers (2) and gear nut retainer (3)	Remove.	
	b. Nuts (4)	Remove from camshaft gear end.	
	c. Nuts (5) and lock-washers (6)	Remove from balance weight end.	
	d. Balance weights (7)	Remove.	
	e. Thrust washers (8)	Remove.	
	f. Lock screws (9)	Remove from camshaft intermediate bearings (10).	
	g. Screws (11), lock-washers (12)	Remove screws that attach camshaft bearings (13) to the front end plate (14).	

3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

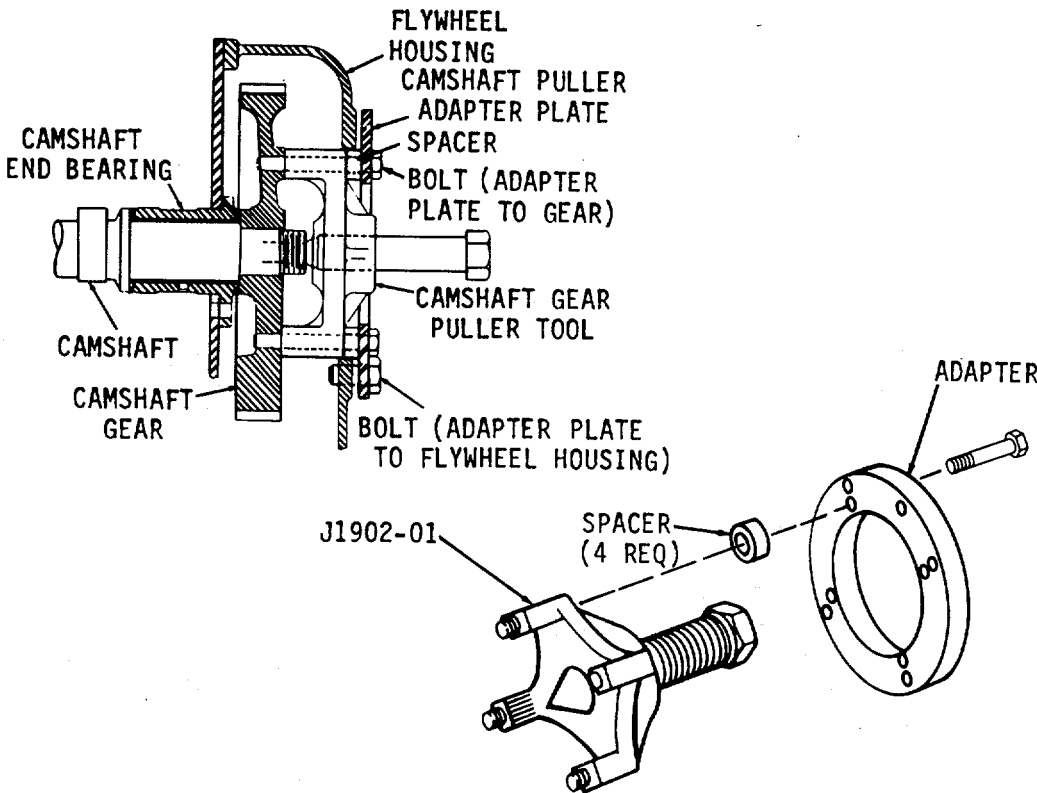


3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- h. Camshaft gear puller, spacers and adapter. Install as shown.
- i. Camshaft gear pul-ler Turn the center screw clockwise to disengage gear.



3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

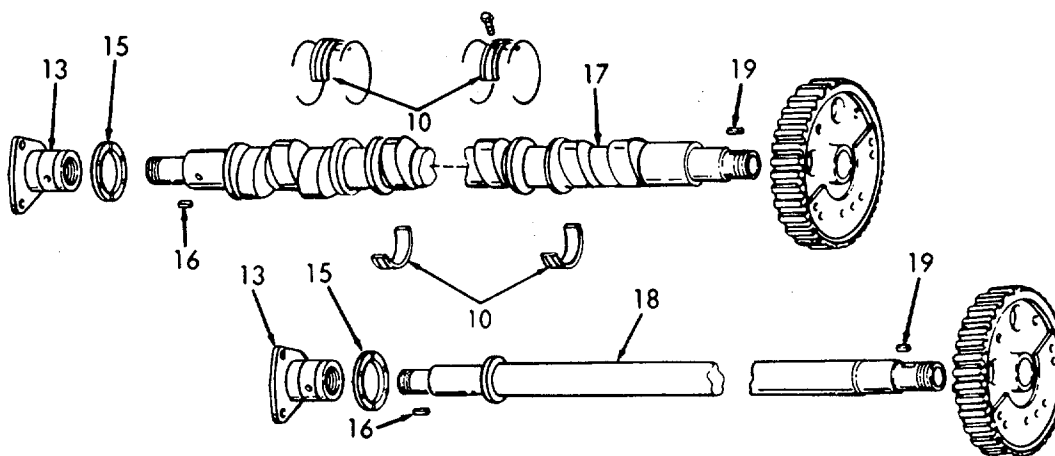
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

NOTE

Do not remove the puller or the adaptor plate until the camshaft or balance shaft is reinstalled. The adaptor plate, secured to both the flywheel housing and the camshaft gear, will hold the gear securely in place and in alignment which will aid in the reinstallation of the camshaft.

- |    |  |                             |
|----|--|-----------------------------|
| j. | Front bearings (13), thrust washers (15) and woodruff keys (16)    | Remove.                     |
| k. | Camshaft (17) and intermediate bearings (10) or balance shaft (18) | Remove from cylinder block. |
| l. | Woodruff keys (19)   | Remove.                     |



3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION



Wear eye protection when using compressed air.

NOTE

Clean the camshaft, balance shaft and related parts with fuel oil. All foreign matter must be removed from the camshaft oil passage. Dry all parts with compressed air.

3.	a. Cams and journals	Examine for wear and bad scoring.	Replace if damaged.
	b. Center bearings	Check the runout at the center bearing with the camshaft mounted on the end bearing surfaces. Runout should not exceed .0002".	
	c. Cam followers	Check the cam followers if the cam surfaces are scored.	
	d. Thrust washers	Inspect both faces of each thrust washer. Replace excessively scored or worn washers. Thrust washers are available in .005" and .010" oversize. The clearance between the thrust washer and the thrust shoulder of the shafts is .004" to .012" with new parts or a maximum of .018" with used parts.	

**3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	e. Shaft end bearings	Examine the faces of the shaft end bearings and any other surface which comes into contact with the thrust washers. Parts that are badly marred must be replaced; parts with slight scratches may be cleaned up with an oil stone.	
	f. Camshaft intermediate bearings	Replace excessively scored or worn camshaft intermediate bearings. The clearance between the camshaft journals and the intermediate bearings is .0025" to .005" with new parts or a maximum of .009" with worn parts. Camshaft intermediate bearings are available in .010" and .020" undersize for use with worn or re-ground shafts in which the clearances exceed the specified limits. Examine the intermediate bearing lock screws and the tapped holes in the block. Damaged holes in the cylinder block may be plugged, re-drilled and tapped. Discard lock screws with damaged threads.	

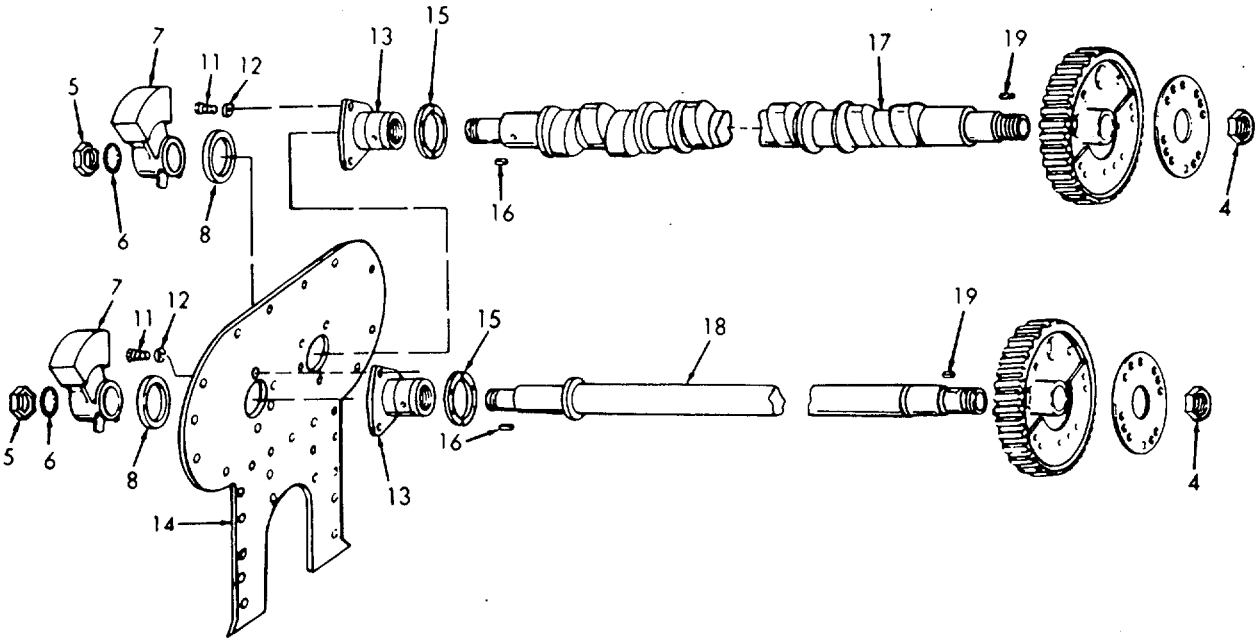


3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
4. Camshaft or balance shaft	a. Camshaft (17) or balance shaft (18) and woodruff keys (19)	Push into cylinder block. Align key with keyway in gear.	Tap shaft into gear with a soft hammer.
	b. Camshaft gear puller, spacers and adapter plate	Remove.	
	c. Retaining nuts (4)	Install finger tight.	
	d. Thrust washers (15)	1. Apply grease to the steel face of each washer  2. Place thrust washer against the inner end of the shaft front end bearing	The steel face of the thrust-washer must be against the bearing.
	e. Front end bearings (13), screws (11) and lock-washers (12)	Install and secure to front end plate (14).	Tighten screws to 35-40 lb-ft (52.1-59.5 kg/m).
	f. Thrust washers (8) kg/m).	Install and secure to front end plate (14).	Tighten screws to 35-40 lb-ft (52.1-59.5

3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Balance weights (7) and woodruff keys (16)	Install.	
	h. Retaining nuts (5) and lockwashers (6)	Install finger tight.	
	i. Wooden block	Place between balance weights (7).	
	j. Retaining nuts (4 and 5)	Tighten.	Tighten to 300-325 lb-ft (446-484 kg/m) torque.

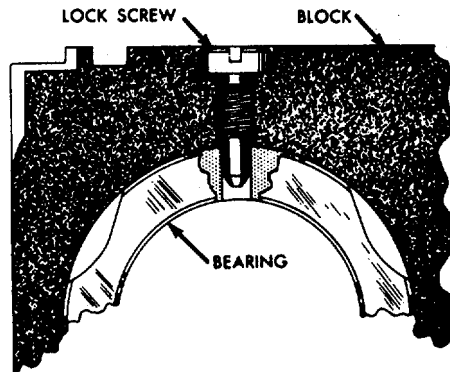


3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- |   |  |   |
|---|--|---|
| k. Camshaft intermediate bearings (10), lock screws (9) | Align holes in bearings with holes in the top of the cylinder block. | Tighten to 15-20 lb-ft (22.3-29.8 kg/m) torque. |
|---|--|---|

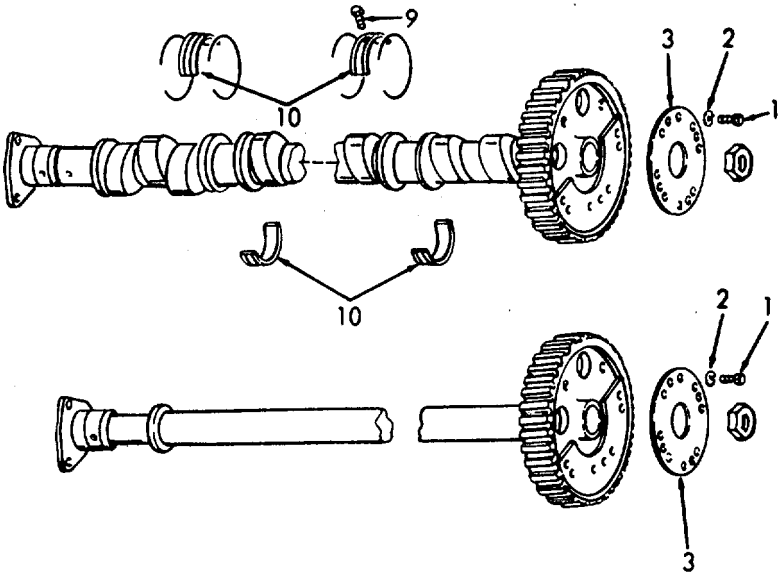


- |   |  |
|---|--|
| l. Gear nut Install. retainers (3), screws (1) and lock-washers (2) | Replace and refill the cooling system. |
| m. Components removed from engine                                   |  |

3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



---

**3-92. FLYWHEEL AND HOUSING.**

---

The maintenance instructions for the flywheel and housing are contained in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Flywheel	3-92.1
Flywheel Housing	3-92.2

---

**3-92. FLYWHEEL-MAINTENANCE INSTRUCTIONS.**

---

- a. The flywheel is attached to the rear end of the crankshaft with six self-locking bolts. Two dowels in the end of the crankshaft aid flywheel alignment and provide support when the flywheel bolts are removed. A scuff plate is used between the flywheel and the bolt heads to prevent the bolt heads from scoring the flywheel surface.
- b. A steel ring gear, which meshes with the starting motor pinion, is shrunk onto the rim of the flywheel.
- c. The flywheel is machined to provide true alignment with the generator fan.
- d. The flywheel must be removed for service operations such as replacing the starter ring gear, crankshaft or flywheel housing.

**3-92.1 FLYWHEEL-MAINTENANCE INSTRUCTIONS (Cont)**

This task covers:

- a. Removal
- b. Inspection
- c. Installation

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

Chain hoist  
Dial Indicator  
Lifting tool-J6361-01  
Torque wrench

<u>Equipment Condition</u>	<u>Condition Description</u>
Para	

3-63.	Generator (40kw) removed
-------	--------------------------

Material/Parts

International Compound #2  
or equivalent

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |    |          |   |   |
|----|----------|---|---|
| 1. | Flywheel | <ul style="list-style-type: none"> <li>a. Six bolts (1) and scuff plate (2)</li> <li>b. Flywheel (3)</li> </ul> | <p>Remove.</p> <ul style="list-style-type: none"> <li>1. Attach flywheel lifting tool J 6361-01 to the flywheel with two 7/16"-14 bolts of suitable length. Remove the remaining flywheel attaching bolt.</li> <li>2. Attach a chain hoist to the lifting tool to support the flywheel as shown.</li> </ul> |
|----|----------|---|---|

3-92.1. FLYWHEEL-MAINTENANCE INSTRUCTIONS (Cont).

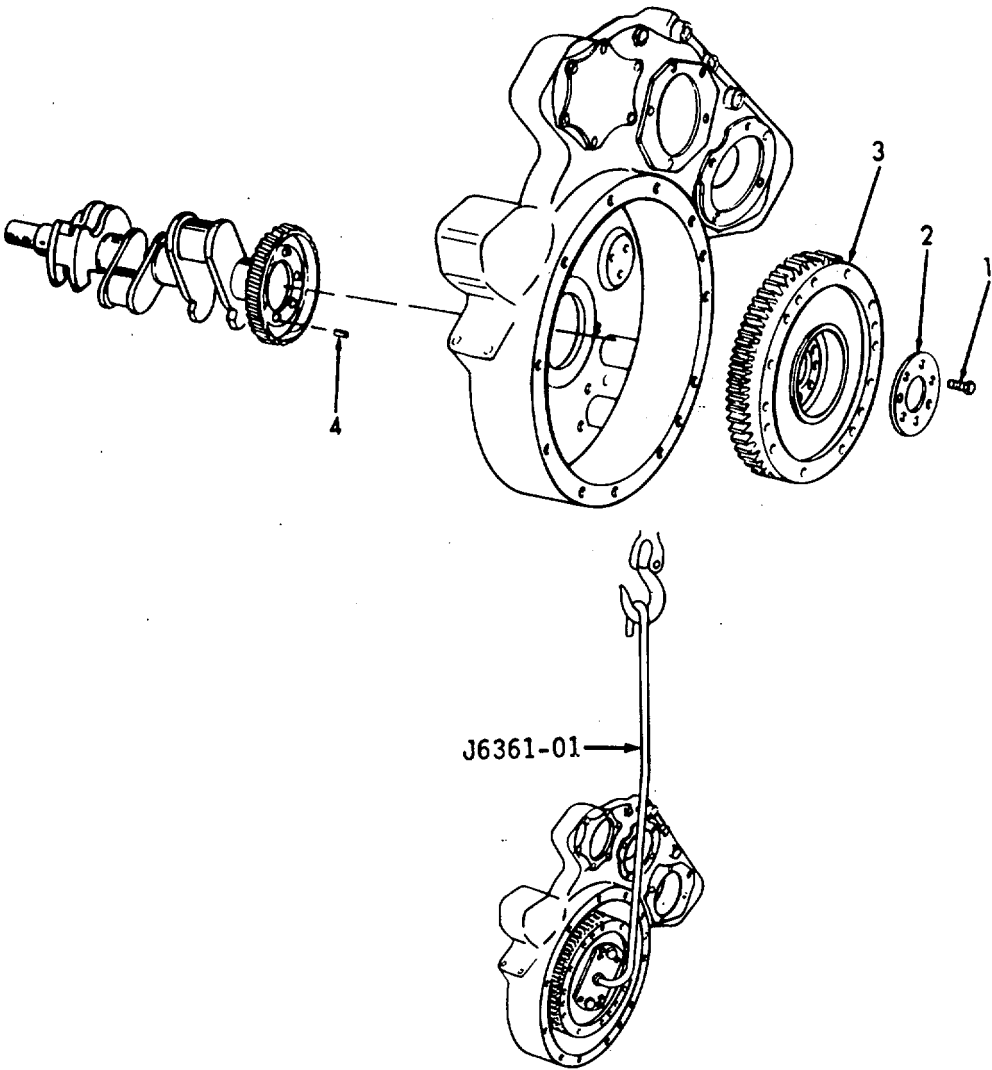
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

3. Move the upper end of the lifting tool in and out to loosen the flywheel, then withdraw the flywheel from the crankshaft and the flywheel housing.

c. Dowels (4)

Remove if necessary.



**3-92.1. FLYWHEEL-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
2.		<p>Check the contact face of the flywheel for scoring, over-heating or cracks. If scored, the flywheel may be refaced. However, do not remove more than .020" of metal from the flywheel. Maintain all of the radii when refacing the flywheel. Although the flywheel seldom requires replacement, the flywheel ring gear may become worn due to normal usage or damaged by improper use of the starting motor to the extent that it must be replaced. If replacement of the ring gear is necessary, refer to Direct Support Maintenance.</p>	
<b>INSTALLATION</b>			
3.	a. Dowel pins (4)	Check the extension.	The dowels must not extend more than 1/2 inch (2.7 cm) from the crankshaft.
	b. Flywheel (3)	<ol style="list-style-type: none"> <li>1. Attach flywheel lifting tool J 6361-01 to the flywheel with two 7/16"-14 bolts. Then, with the use of a chain hoist, position the flywheel in the flywheel housing and over the dowels in the crankshaft.</li> </ol>	

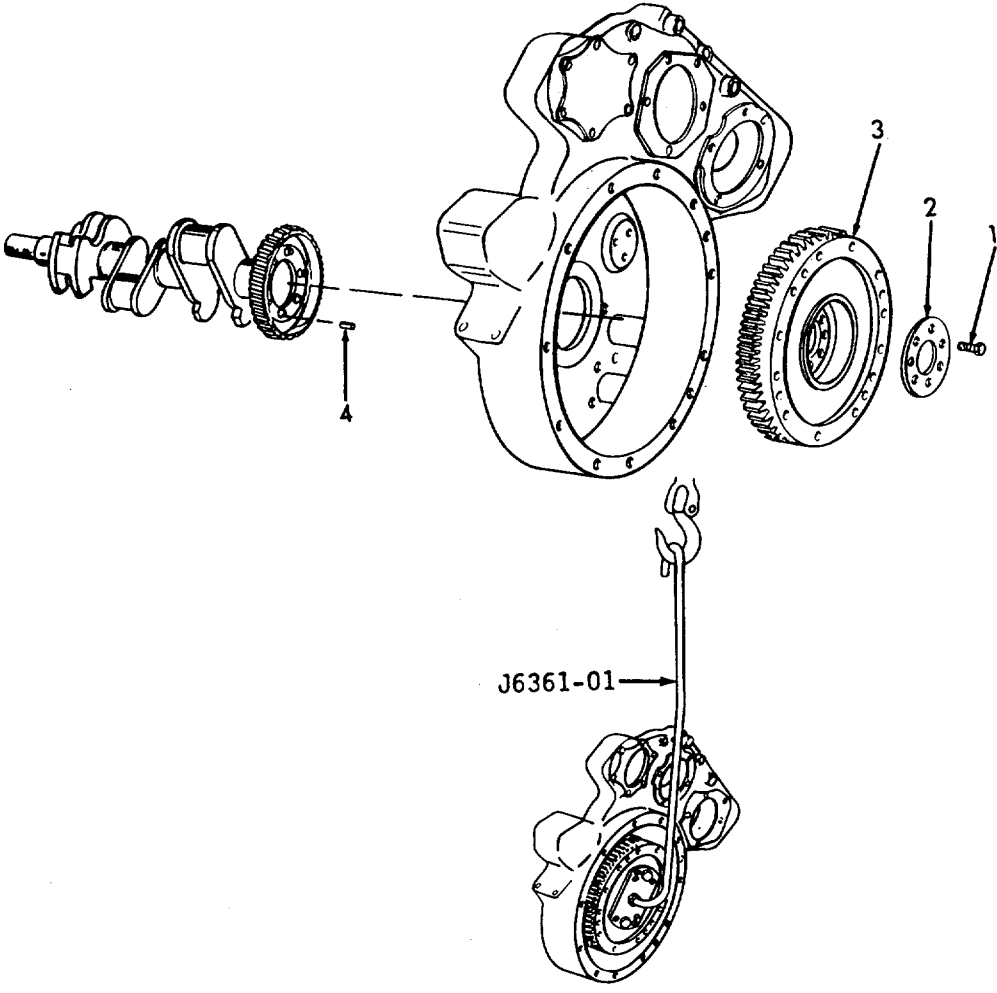
**NOTE**

Since one bolt hole is offset, the flywheel can be installed in only one position.



3-15. FLYWHEEL-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
		2. Remove the flywheel lifting tool.	
	c. Scuff plate (2)	Place against flywheel.	
	d. Bolts (1)	Apply a small quantity of International Compound No. 2, or equivalent, to the threads and contact area of the six attaching bolts.	Install and tighten the 9/16"-18 bolts to 180-190 lb-ft (267.8-282.7 kg/cm) torque.



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**3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).**

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LOCATION	ITEM	ACTION	REMARKS
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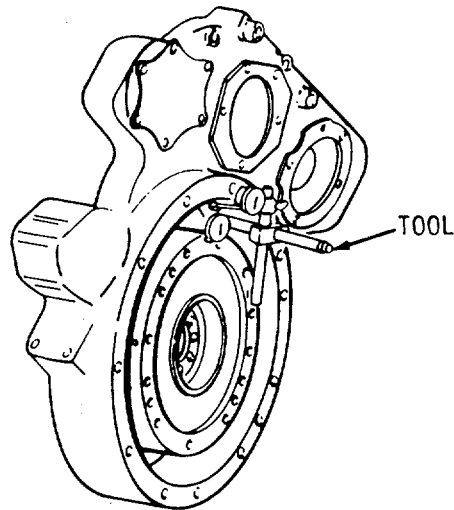
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INSTALLATION (Cont)			
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**NOTE**

Tighten the flywheel bolts accurately, but do not exceed the specified torque. International Compound No. 2 must never be used between two surfaces where maximum friction is desired, such as between the crankshaft and the flywheel.

Mount a dial indicator on the flywheel housing and check the runout of the flywheel at the clutch contact face. Maximum allowable runout is .001" total indicator reading per inch of radius (the radius is measured from the center of the flywheel to the outer edge of the clutch contact face of the flywheel).

**3-1590**

**3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).**

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 the flywheel. It also serves as a support for the starting motor and the generator.

b. The crankshaft rear oil seal, which is pressed into the housing, may be removed or installed without removing the housing (paragraph 3-91).

This task covers:

a. Removal

b. Inspection

c. Installation

**INITIAL SETUP:**

Test Equipment

Concentricity Test  
Gauges

References

Para 3-79	Overspeed Governor-Removed
Para 3-80	Tachometer Drive Removed
Para 3-88	Oil Pan Removed
Para 3-99	Instrument Panel-Removed
Para 3-101	Starter Motor-Removed

Special Tools

Chain hoist  
Hammer (soft)  
Studs (four)  
1/2-13 x 3 1/4 lg.

Equipment  
Condition  
Para

Condition Description

3-63	Generator-Removed
3-79	Overspeed Governor-Removed
3-80	Tachometer Drive Removed
3-88	Oil Pan Removed
3-92.1	Flywheel Removed
3-99	Instrument Panel-Removed
3-101	Starter Motor-Removed

Material/Parts

Gasket kit P/N 5193113

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

NONE

3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

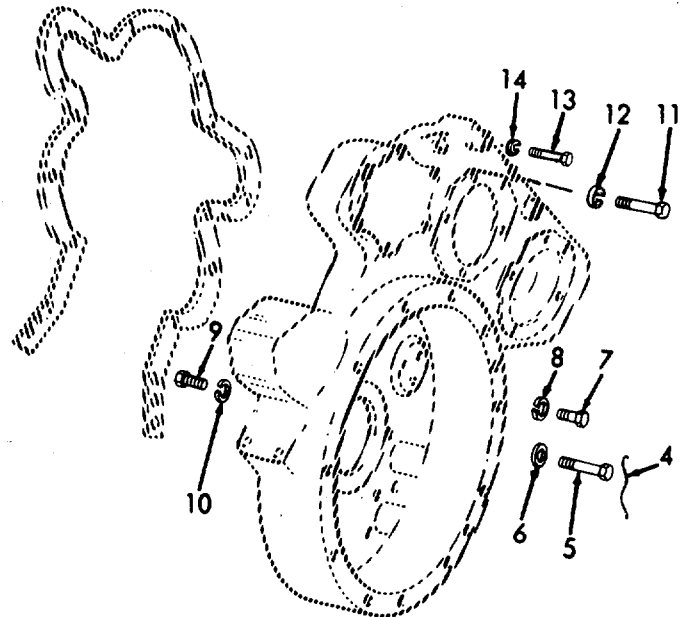
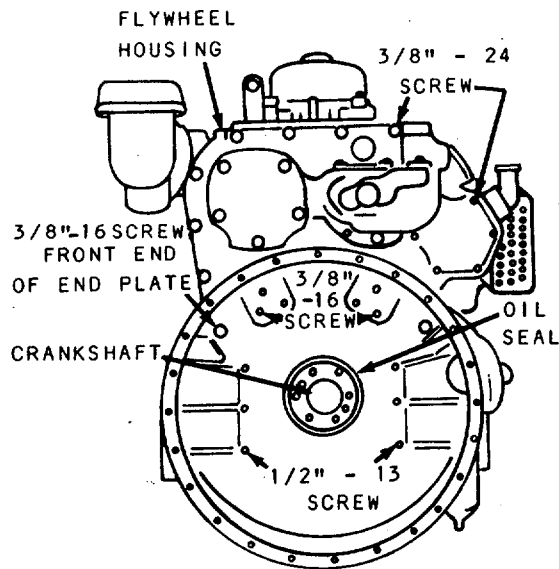
LOCATION	ITEM	ACTION	REMARKS
<b>(REMOVAL)</b>			
1. Engine	<p>a. Engine</p> <p>b. Two screws (1) and lock-washers (2)</p>	<p>Block rear of engine.</p> <p>Remove screws that attach rear engine lifter bracket (3) to cylinder head.</p>	<p>The lifter bracket is left attached to the flywheel housing for ease in removal.</p>
2. Flywheel housing	<p>a. Two lock-wires (4)</p> <p>b. Six bolts (5) and flatwashers (6)</p> <p>c. Six screws (7) and lockwashers (8)</p>	<p>Cut and remove.</p> <p>Remove bolts inside flywheel housing bell which attach the housing to the idler gear hub and spacer.</p> <p>Remove screws inside flywheel housing bell which attach the housing to the cylinder block.</p>	<p>Bolts are 3/8-2 x 16.</p> <p>Screws are 1/2-12 x 3 1/4 lg.</p>

3-15. CAMSHAFT AND BALANCE SHAFT-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- |  |  |   |                           |
|--|--|---|---------------------------|
|  | d. Two screws (9) and lock-washers (10)    | Remove screws which go through the rear end plate from the front and thread into the housing. | Screws are 3/8-16 x 1 lg. |
|  | e. Four screws (11) and lockwashers (12)   | Remove.   | Screws are 3/8-24 x 4 lg. |
|  | f. Eight screws (13) and lock-washers (14) | Remove.   | Screws are 3/8-24 x 5 lg. |



3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

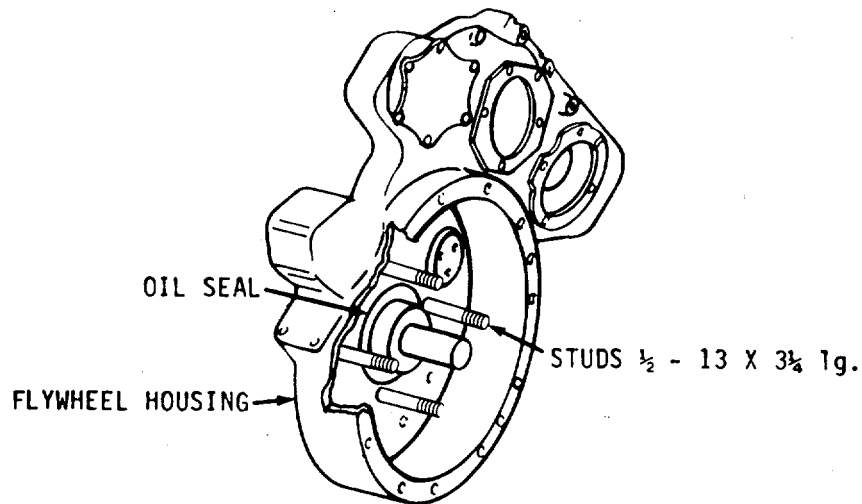
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

NOTE

When removing the flywheel housing bolts, note the location of the various bolts and washers so they may be reinstalled in their proper location.

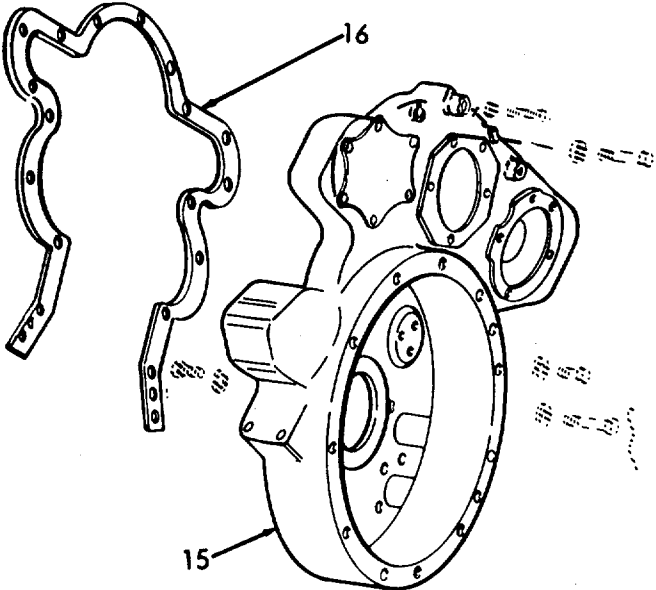
- |          |  |                              |
|----------|--|------------------------------|
| g. Studs | <ol style="list-style-type: none"> <li>1. Obtain four pilot studs.</li> <li>2. Insert in holes where screws were removed.</li> </ol> | Studs are 1/2-13 x 3 1/4 lg. |
|----------|--|------------------------------|



- |                          |   |
|--------------------------|---|
| h. Flywheel housing (15) | <p>With the flywheel housing supported by a chain hoist attached to the lifter bracket, strike the front face of the housing alternately on each side with a soft hammer to work it off the dowels and away from the cylinder block rear end plate.</p> |
|--------------------------|---|

3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	i. Gasket (16)	Remove.	It is very important that all old gasket material be thoroughly removed from the flywheel housing and the end plate.



**INSPECTION**

3.	Flywheel housing (15)	Clean and inspect for cracks and other damage.
----	-----------------------	--

**INSTALLATION**

4. Engine rear plate	a. Gear train	Lubricate the teeth with clean engine oil.
	b. Gasket (16)	Attach to end plate.

3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Oil seal	Coat the lip of the seal with engine oil.	
	d. Pilot studs	Install if necessary.	
5. Flywheel housing	a. Flywheel housing (15)	1. Lift with chain hoist 2. Position housing over the crankshaft and up against the cylinder block rear end plate and gasket.	
	b. Six bolts (5) and flat washers (6)	Install in positions 1 thru 6 (Idler gear hub and idler gear hole spacer).	Bolts are 3/8-16. Tighten finger tight.

**NOTE**

When tightening the idler gear hub bolts, turn the crankshaft to prevent any bind or brinelling of the idler gear bearing. The crankshaft must be rotated for the flywheel housing bell tightening also.

	c. Pilot studs	Remove.	
	d. Six screws (7) and lockwashers (8)	Install in positions 7 thru 12.	Screws are 1/2-13 x 3 1/4 long. Tighten finger tight.
	e. Two screws (9) and lockwashers (10)	Install in positions 13 and 14.	Screws are 3/8-16 x 1 lg. Tighten finger tight.

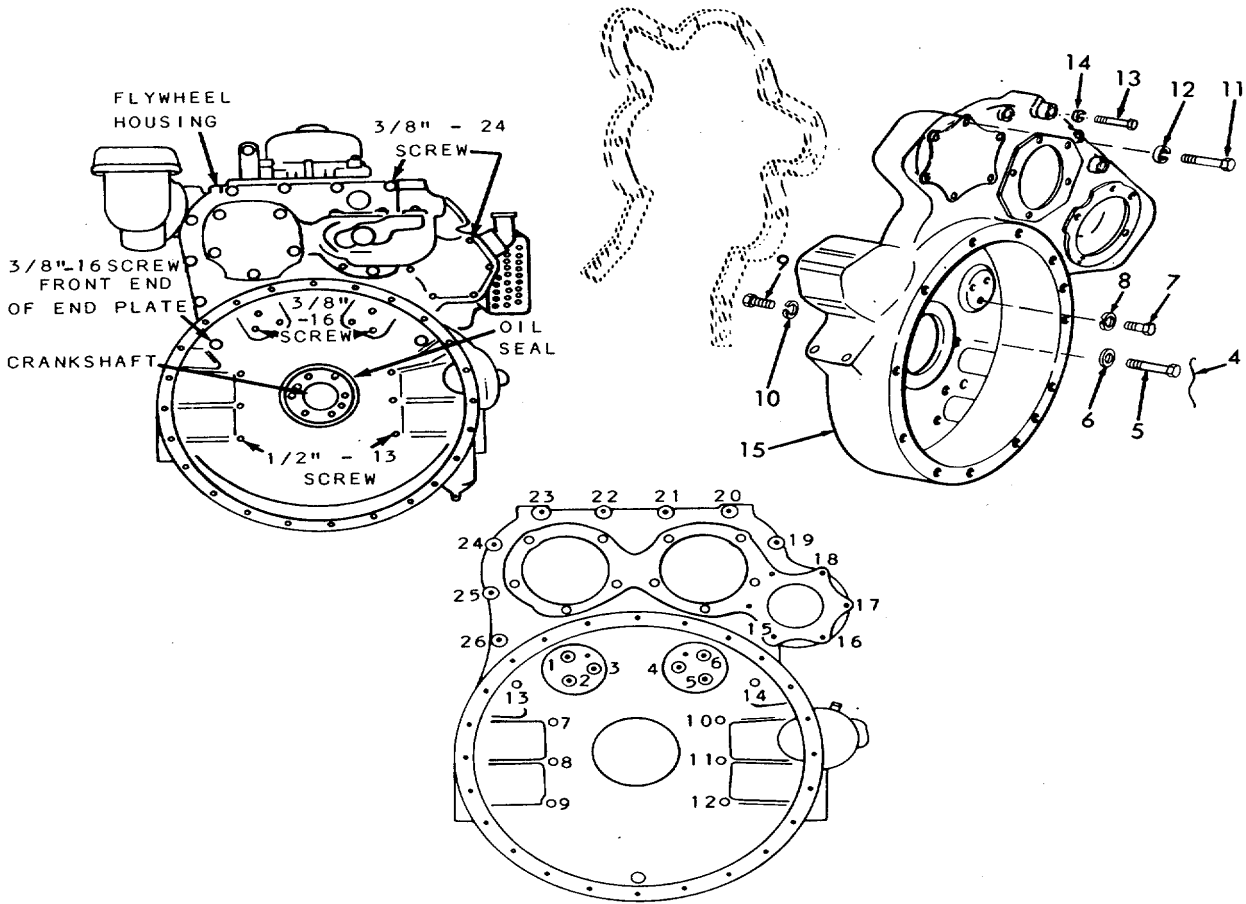


3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- |   |  |                                  |   |
|---|--|----------------------------------|---|
| f | Four screws (11) and lockwashers (12)  | Install in positions 15 thru 18. | Screws are 3/8-24 x 4 lg. Tighten finger tight. |
| g | Eight screws (13) and lockwashers (14) | Install in positions 19 thru 26. | Screws are 3/8-24 x 5 lg. Tighten finger tight. |

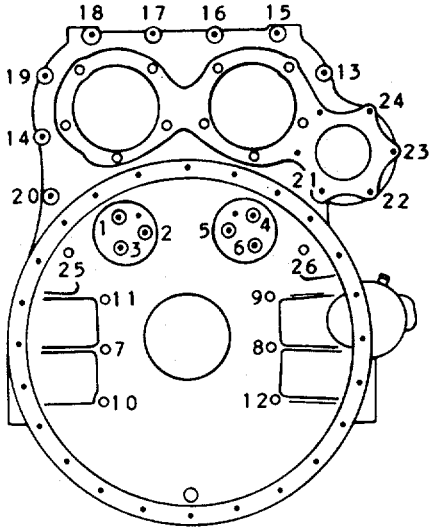


3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Bolts and screws	Start at one and tighten in sequence, drawing mat-parts together evenly.	Tighten to torque shown in table.

TORQUE

Bolts and Screws	lb-ft	Nm
1/2-13	75-85	102.4-116.0
3/8-16 (bolts)	15-25	20.5- 34.1
3/8-16	15-20	20.5- 27.3
3/8-24	15-20	20.5- 27.3



**3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			

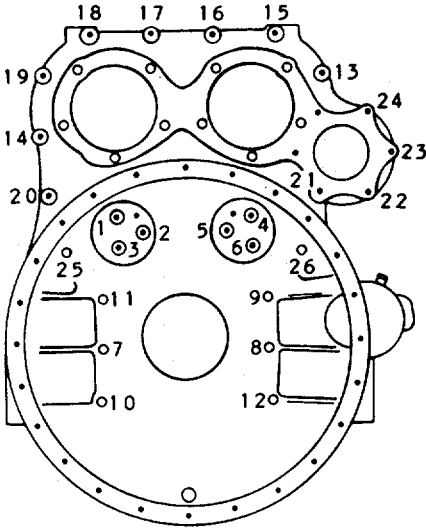
i.	Bolts and screws	Start at one and tighten in sequence.	Tighten to torque shown in table.
----	------------------	---------------------------------------	-----------------------------------

TORQUE

Bolts and Screws	lb-ft	Nm
1/2-13	90-100	122.9-136.5
3/8-16 (bolts)	25-40	34.1- 54.6
3/8-16	25-30	34.1- 41.0
3/8-24	25-30	34.1- 41.0

NOTE

Be sure to rotate the crankshaft when tightening the idler gear hub bolts and flywheel housing bell.



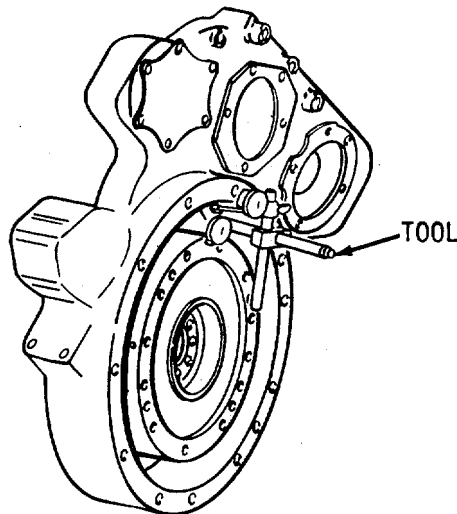
3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	j. Lockwire bolts 3, 1, 6, and 5, 2, and 4	Install two lockwires, locking each group of three bolts together.	The bolts heads should be lined-up.

**NOTE**

The idler gear hub and spacer bolts are tightened to 25-40 lb-ft (34.1-54.6 Nm) torque. The wide range in torque specification permits alignment of the bolt heads.

- 6. Flywheel  
Install. Refer to paragraph 3-90.1.
- 7. Flywheel housing  
Check the flywheel housing concentricity and bolting flange face as follows:
  - a. Thread the base post tightly into one of the tapped holes in the flywheel. Then assemble the dial indicators on the base post.



**3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)
---------------------

- b. Position the dial indicators straight and square with the flywheel housing bell face and inside bore of the bell. Make sure each indicator has adequate travel in each direction.

**NOTE**

If the flywheel extends beyond the housing bell, the bore and face must be checked separately. Use the special adaptor in the tool set to check the housing bore.

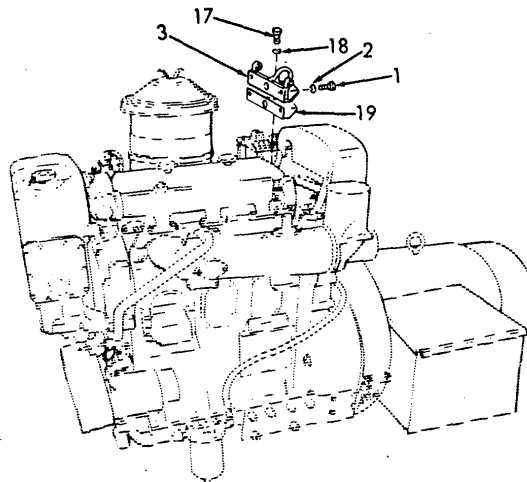
- c. Pry the crankshaft toward one end, play is in one direction only.
- d. Adjust each dial indicator to read zero at the twelve o'clock position. Then rotate the crankshaft one full revolution, taking readings at 450 intervals (8 readings each for the bore and the bolting flange face). Stop and remove the wrench or cranking bar before recording each reading to ensure accuracy. The maximum total indicator reading must not exceed .013" for either the bore or the face.

3-15. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		<p>e. If the run-out exceeds the maximum limits, remove the flywheel housing and check for dirt or foreign material, such as old gasket material, between the end plate, flywheel housing and the new gasket end plate, flywheel housing and the new gasket (and between the end plate and the cylinder block).</p>	
		<p>f. Reinstall the flywheel housing and the flywheel and tighten the attaching bolts in the proper sequence and to the specified torque. Then recheck the run-out. If necessary, replace the flywheel housing.</p>	
<p>8. Lifter bracket (3)</p>	<p>a. Screws (17), lock-washers (18) and bracket (3)</p>	<p>Remove from flywheel housing.</p>	
(19)	<p>b. Gasket</p>	<p>Remove.</p>	<p>Discard gasket.</p>
	<p>c. Gasket (19)</p>	<p>Affix new gasket to bracket.</p>	

3-92.2. FLYWHEEL HOUSING-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	d. Screws (1 and 17) and lock-washers (2 and 18)	Install.	Alternately tighten the bracket-to-flywheel housing screws (17) and the bracket-to-cylinder headscrews (1). Drawing the bracket into the corner formed by the cylinder head and housing.



- 9. Oil pan Reinstall-Refer to paragraph 3-88.
- 10. Components Removed-Reinstall.

---

**3-93. LUBE OIL PRESSURE REGULATOR AND OIL BY-PASS VALVE.**

---

The maintenance instructions for the lube oil pressure regulator and the oil by-pass valve are contained in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Lube Oil Pressure Regulator	3-93.1
Oil By-pass Valve	3-93.2

---

**3-93.1. LUBE 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 regulator installed between the oil pump outlet pipe and the cylinder block.

b. The regulator assembly consists of a body, a hollow piston-type valve, a compression spring, and a plug to retain the spring in the body.

c. The valve is held on its seat by the spring, which is compressed by the plug screwed into the valve opening in the regulator body. The entire assembly is bolted to the lower flange of the cylinder block and sealed against oil leaks by a gasket between the two members. When conditions are such that the oil pressure at the valve exceeds 50 pounds per square inch (35.2 kg/cm sq) the valve is forced from its seat and oil from the engine gallery is by-passed to the engine oil pan. Thus stabilized lubricating oil pressure is maintained at all times regardless of oil temperature.

d. Under normal conditions, the pressure regulator should require very little attention. If sludge has been allowed to accumulate in the lubricating system, the valve may not work freely, thereby remaining open or failing to open at the normal operating pressure.

e. Whenever the lubricating oil pump is removed for inspection, the regulator valve and spring should also be removed, thoroughly cleaned in fuel oil and inspected.



3-93.1. LUBE OIL PRESSURE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

- a. Removal
- b. Disassembly
- c. Inspection
- d. Reassembly
- e. Installation

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Description  
Para

3-88 Oil Pan-Removed

Material/Parts

Gasket Kit P/N 5193113

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

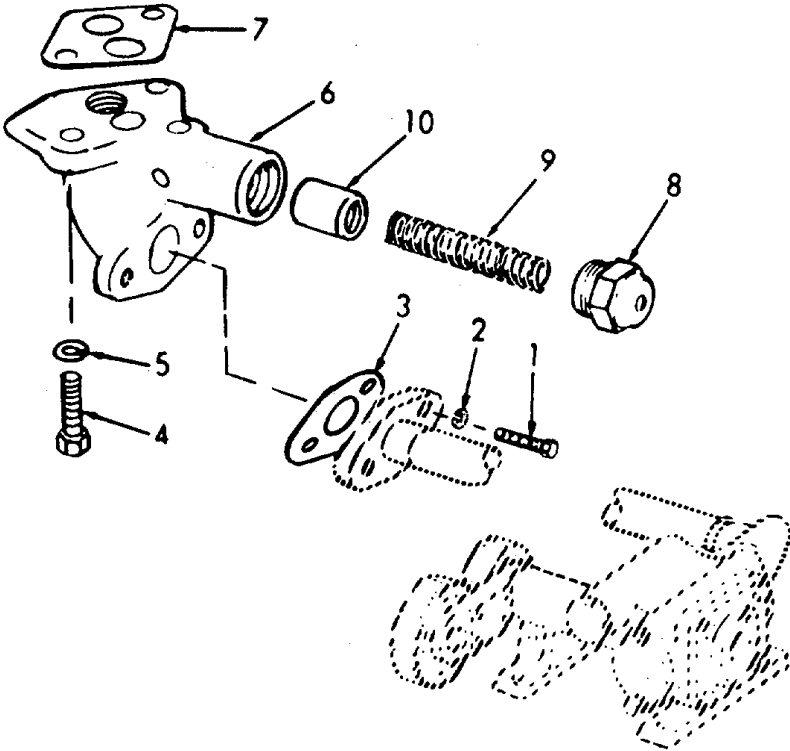
**REMOVAL**

1. Oil pressure regulator	a. Screws (1) and lock-washers (2)	Remove.	
	b. Gasket (3)	Remove.	Discard gasket.
	c. Screws (4) and lock-washers (5)	Remove.	
	d. Regulator (6) and gasket (7)	Remove.	Discard gasket.

3-93.1 LUBE OIL PRESSURE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)



DISASSEMBLY

- |    |                              |   |
|----|------------------------------|---|
| 2. | a. Plug (8)                  | Clamp the flange of the body in a vise and remove plug. |
|    | b. Spring (9) and valve (10) | Remove.   |

3-93.1 LUBE OIL PRESSURE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

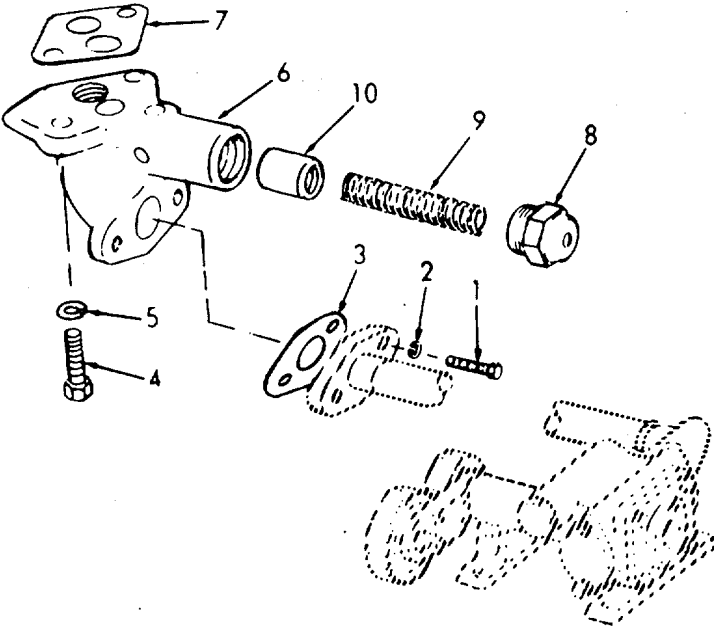
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
<b>WARNING</b>			
Wear eye protection when using compressed air.			
3.		a. Clean all parts in fuel oil, dry with compressed air.	
		b. Inspect all parts for wear or damage.	
<b>REASSEMBLY</b>			
4.	a. Valve (10)	Apply clean engine oil to the outer surface of the valve and slide the valve into the regulator body, closed end first.	
	b. Spring (9) and plug (8)	Insert the spring in the valve and, while compressing the spring, start the plug into the body. Tighten the plug.	
<b>INSTALLATION</b>			
5.	a. Gaskets	Remove all traces of the old gaskets from the regulator body, cylinder block and pump outlet pipe flange.	
	b. Gasket (7)	Affix new gasket to regulator body with oil passage holes in the gasket in alignment with the oil passages in the body.	
	c. Screws (4) and lockwasher (5)	Install.	

3-93.1 LUBE OIL PRESSURE REGULATOR-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- d. Gasket (3)                      Insert new gasket.
- e. Screws (1) and lockwashers (2)



**3-93.2. OIL BY-PASS VALVE-MAINTENANCE INSTRUCTIONS.**

a. To assure proper lubrication if the oil cooler core becomes clogged, a valve, located between the oil inlet and the core, bypasses the oil around the cooler directly to the oil gallery in the cylinder block.

b. The by-pass valve should be removed, cleaned and reassembled whenever the cooler core is cleaned or replaced. However, if occasion requires, the by-pass valve can be removed without removing the oil cooler.

This task covers:

- a. Removal                      b. Inspection                      c. Installation

INITIAL SETUP:

Test Equipment

None

References

None

Special Tools

None

Equipment  
Condition   Condition Description  
Para

None

Material/Parts

Gasket Kit P/N 5192637

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

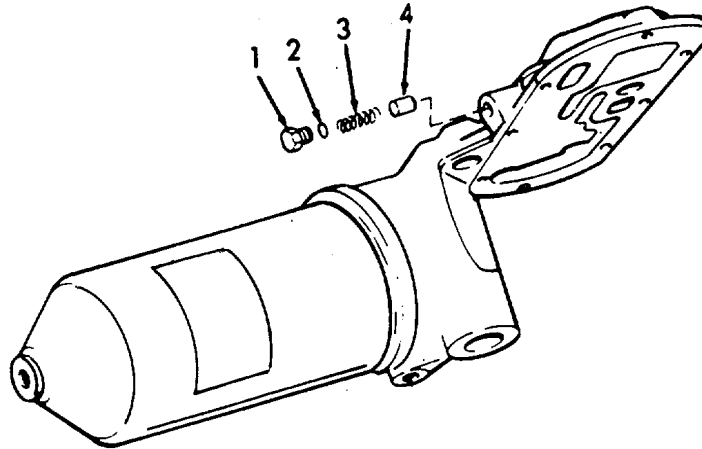
**REMOVAL**

1.	By-pass valve	a. Cap (1) and gasket (2)	Remove.	Discard gasket.
		b. Spring (3)	Remove.	
		c. Valve (4)	Remove.	

3-93.2 OIL BY-PASS VALVE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)



INSPECTION

**WARNING**

Wear eye protection when using compressed air.

- |    |  |  |  |
|----|--|--|--|
| 2. | a. Wash all parts with clean fuel oil and dry with compressed air. |  |  |
|    | b. Inspect all parts for wear.                                     |  |  |

INSTALLATION

- |    |                             |                       |                 |
|----|-----------------------------|-----------------------|-----------------|
| 3. | a. Valve (4) and spring (3) | Insert.               |                 |
|    | b. Cap (1) and gasket (2)   | Assemble and install. | Use new gasket. |

---

**3-94. LUBE OIL PUMP.**

---

- a. The gear type oil pump is mounted on the first and second main bearing caps and is gear driven from the front end of the crankshaft.
- b. The oil pump helical gears rotate inside a housing. The drive gear is keyed to the drive shaft which is supported inside the housing on two bushings with a drive-driven gear keyed to the outer end of the shaft. The driven gear is supported on the driven gear shaft which is pressed into the pump body.
- c. An integral plunger-type relief valve by-passes excess oil to the inlet-side of the pump when the pressure in the oil lines exceeds 105 pounds per square inch.
- d. An inlet pipe, attached to the inlet opening in the pump body, leads to the inlet screen which is mounted with brackets to a main bearing cap.
- e. The inlet screen is located below the oil in the pan and serves to strain out any foreign material which might damage the pump.
- f. The oil pump inlet screen should be removed and cleaned periodically in addition to the cleaning it receives each time the engine is reconditioned.
- g. An idler gear is mounted on a support bracket which is attached to the pump body.
- h. Pressure lubrication of the idler gear bushing is provided by means of a drilled passage in the pump body and a connecting passage in the idler gear support bracket.

**3-94. LUBE OIL PUMP (Cont).**

This task covers:

- a. Removal
- b. Inspection
- c. Installation

INITIAL SETUP:

Test Equipment

Feeler gage

References

Para 3-93 Oil Pressure Regulator

Special Tools

Torque wrench

Equipment Condition Description  
Para

3-88 Oil Pan-Removed

Material/Parts

Gasket Kit P/N 5193113

Special Environmental Conditions

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

Personnel Required

1

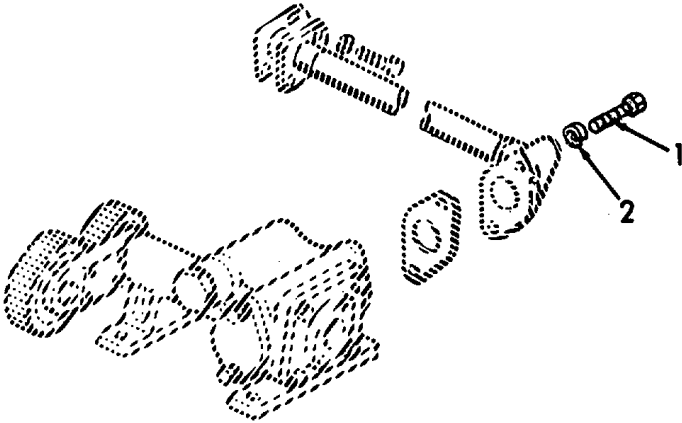
General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL**

- |    |          |                                    |         |
|----|----------|------------------------------------|---------|
| 1. | Oil pump | a. Screws (1) and lock-washers (2) | Remove. |
|----|----------|------------------------------------|---------|





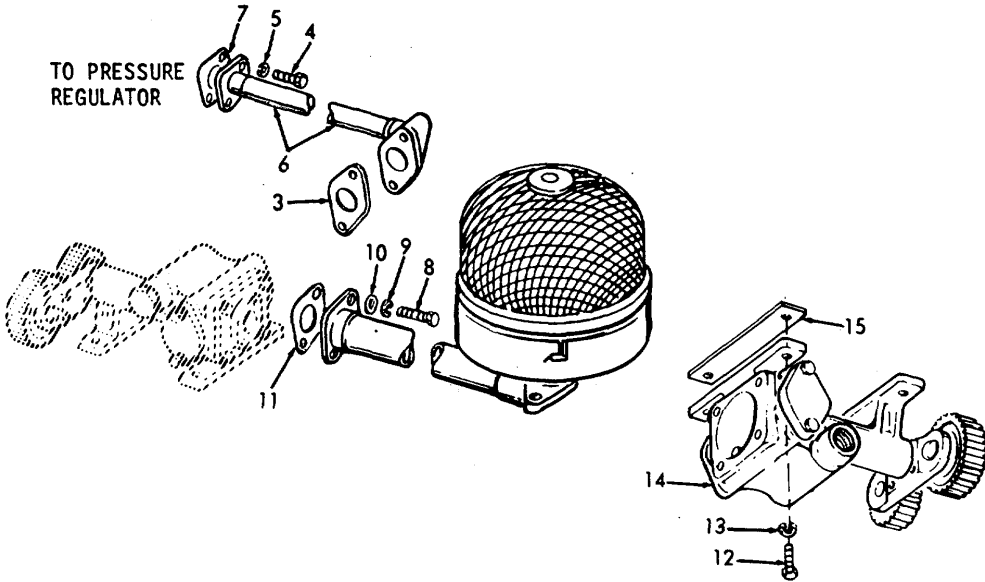
## 3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	b. Gasket (3)	Remove.	Discard gasket.
	c. Screws (4) and lock- washers (5)	Remove.	
	d. Outlet pipe (6)	Remove.	
	e. Gasket (7)	Remove.	Discard gasket.
	f. Screws (8) lock- washers (9) and flat- washers (10)	Remove.	Discard gasket.
	g. Gasket (11)	Remove.	Discard gasket.
	h. Screws (12) and lock- washers (13)	Remove.	
	i. Oil pump (14) and shims (15)	Remove.	Do not discard shims.

3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



INSPECTION

**WARNING**

Wear eye protection when using compressed air.

- 2. a. Wash all parts in clean fuel oil and dry with compressed air.

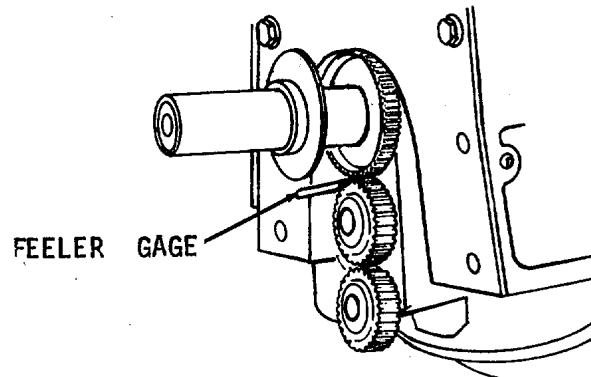
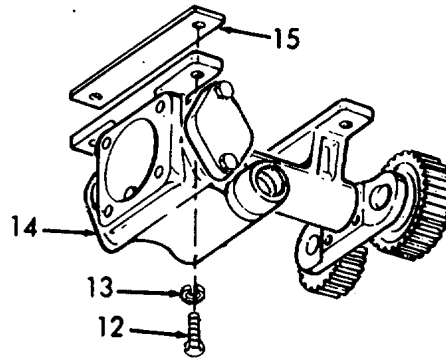
3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
		b. Gears	Gears should have a free-running fit (not loose) in the pump housing. If the gear teeth are scored or worn. Refer to Direct Support Maintenance.
<b>INSTALLATION</b>			
3.	a. Oil pump (14), and shim (15)	Hold the pump assembly against the main bearing caps so the idler gear meshes with the driving gear on the crankshaft.	
	b. Screws (12) and lock-washers (13)	Insert the four bolts with lockwashers through the mounting feet of the pump and into the bearing caps. Align the pump so that the teeth of crankshaft gear and the idler gear are parallel; then tighten the bolts to 35-39 lb-ft (47.8-53.2 Nm) and check clearance between the gear teeth with a feeler gage. Proper clearance between the crankshaft gear and idler gear is .005 inch (0.013 cm) minimum, .012 inch (0.030 cm) maximum.	

3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



**CAUTION**

Always check the clearance between the crankshaft gear and the oil pump idler gear with the engine in the upright or running position.

If shims were used between the pump mounting feet and the bearing caps and new gears are not installed, the same shims (cleaned) or the same number of new (identical) shims should be installed and the number then adjusted to obtain the proper clearance between gear teeth. However, if new gears have been installed, a larger number of shims will be required under the mounting feet. In either event, the pump must be tightened on the bearing cap before the clearance between the gear teeth is measured.

3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

NOTE

When adjusting for gear tooth clearance by installing or removing shims, the same number of shims must be changed under each foot so that the pump will always be level on the main bearing caps. The insertion or removal of one .005 inch (0.013 cm) shim will change the gear tooth clearance by .0035 inch (0.0089 cm).

- |    |   |           |   |
|----|---|-----------|---|
| c. | Gasket (7), outlet pipe (6), screws (4) and lockwashers (5) | Assemble. | Use new gasket. Do not tighten screws, leave loose. |
| d. | Gasket (3), screws (1) and lockwashers (2)                  | Assemble. | Use new gasket. Do not tighten screws, leave loose. |

NOTE

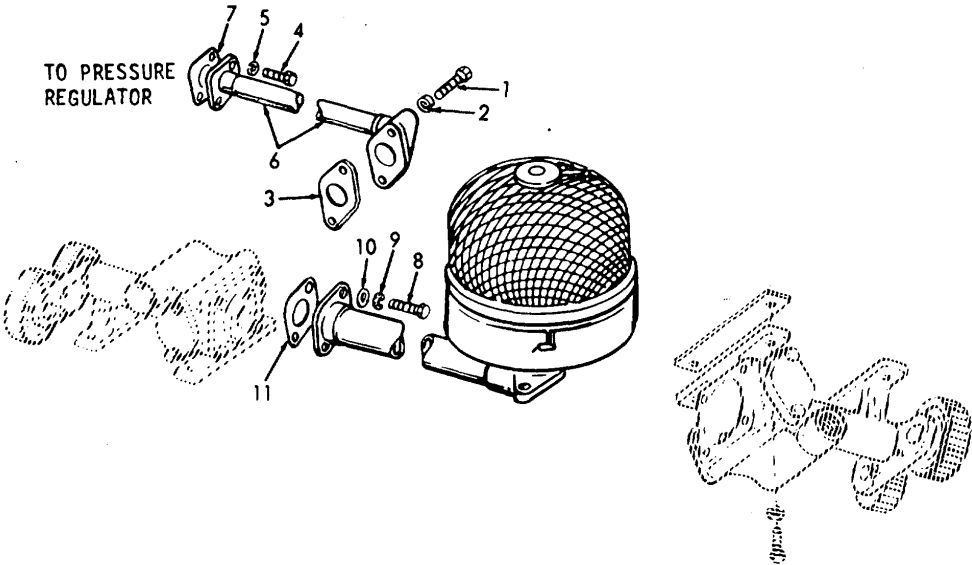
When attaching the pump outlet and the pressure regulator, none of the bolts should be tightened until all the bolts have been started. After all bolts are started, the outlet pipe bolts (1) should be tightened alternately, then the pressure regulator bolts (8) should be tightened, and finally the pipe-to-regulator screws (4) should be secured. This procedure prevents twisting the outlet pipe.

- |    |   |           |                   |
|----|---|-----------|-------------------|
| e. | Gasket (11), screws (8), lockwashers (9) and flatwashers (10) | Assemble. | Use a new gasket. |
|----|---|-----------|-------------------|

3-94 LUBE OIL PUMP (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)



**3-95. LUBE OIL DISTRIBUTION SYSTEM-MAINTENANCE INSTRUCTIONS.**

The oil distribution system consists of the oil inlet pipe and screen.

This task covers:

- a. Removal
- b. Inspection
- c. Installation

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition      Condition Description  
Para

NONE

Material/Parts

Gasket Kit P/N 5193113

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

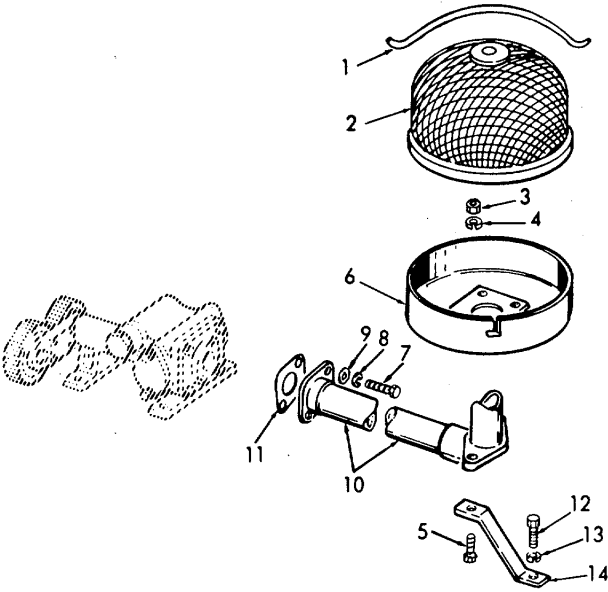
- |                          |  |         |  |
|--------------------------|--|---------|--|
| 1. Oil pump inlet screen | a. Retainer (1) and screen (2)                   | Remove. |  |
|                          | b. Two nuts (3), lock-washers (4) and screws (5) | Remove. |  |
|                          | c. Cover (6)                                     | Remove. |  |

3-95. LUBE OIL DISTRIBUTION SYSTEM-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL (Cont)

- d. Screws (7), lock-washers (8), flat-washers (9)
- e. Inlet pipe (10) and gasket (11)
- f. Screws (12), lock-washers (13) and brackets (14)





3-95. LUBE OIL DISTRIBUTION SYSTEM-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
Wear eye protection when using compressed air.			
2.		<ul style="list-style-type: none"> <li>a. Clean all parts in clean fuel oil and dry with compressed air.</li> <li>b. Inspect all parts for wear or damage.</li> </ul>	
<b>INSTALLATION</b>			
3.	<ul style="list-style-type: none"> <li>a. Brackets (14), screws (12) and lock-washers (13)</li> </ul>	Install.	
	<ul style="list-style-type: none"> <li>b. Inlet pipe (10), gasket (11), screws (7), lock-washers (8) and flat-washers (9)</li> </ul>	Reassemble.	Use new gasket.
	<ul style="list-style-type: none"> <li>c. Screws (5), cover (6), nuts (3) and lock-washers (4)</li> </ul>	Reassemble	

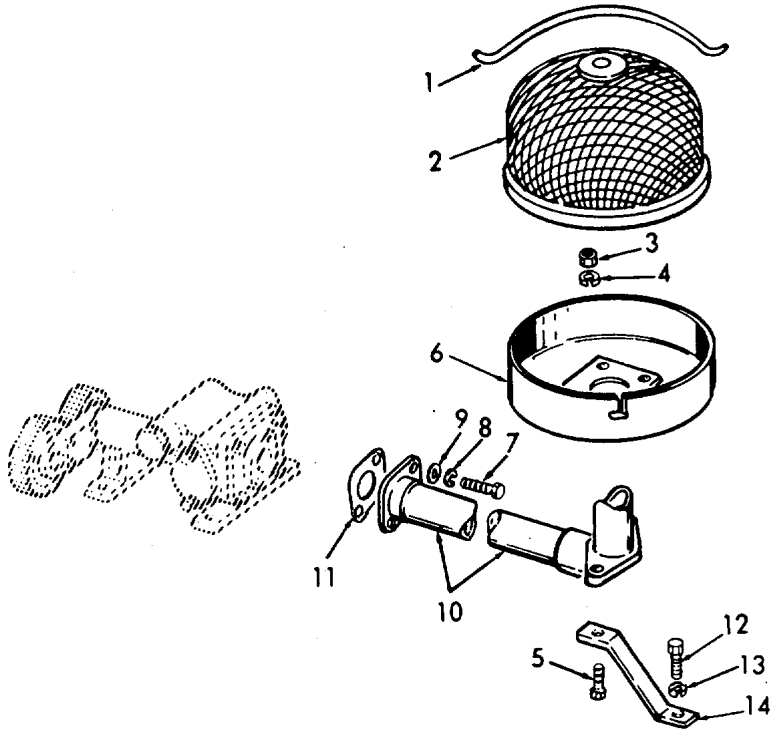
3-95. LUBE OIL DISTRIBUTION SYSTEM-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

d. Screen (2) and retainer (1)

Reassemble.



**3-96. PISTONS, CONNECTING RODS, AND LINERS.**

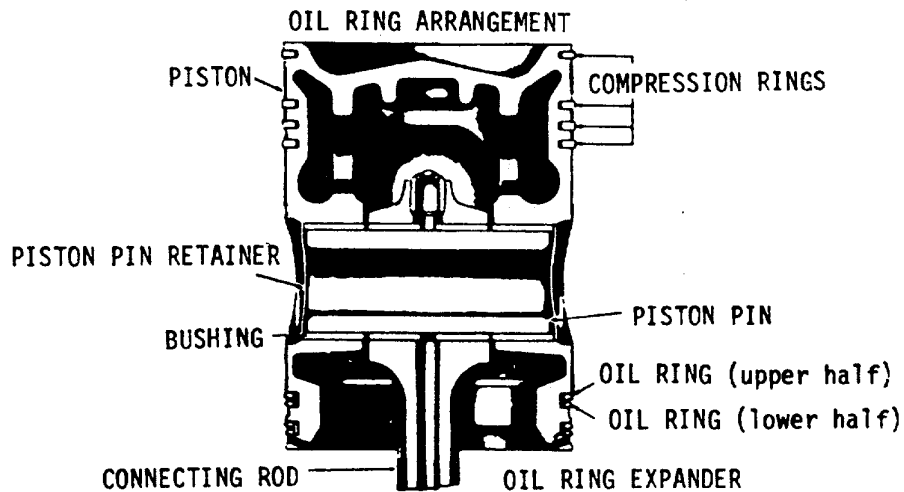
<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Piston	3-96.1
Connecting Rods	3-96.2
Connecting Rod Bearings	3-96.3
Cylinder Liner	3-96.4

**3-96.1. 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.



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**3-96.1. PISTON-MAINTENANCE INSTRUCTIONS (Cont).**

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d. Each piston is balanced to close limits by machining a balancing rib, provided on the inside at the bottom of the piston skirt.

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.

**3-96.1. PISTON-MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- |                   |                |                 |
|-------------------|----------------|-----------------|
| a. Pre-Inspection | c. Disassembly | e. Reassembly   |
| b. Removal        | d. Inspection  | f. Installation |

INITIAL SETUP:

Test Equipment

Feeler gage

References

NONE

Special Tools

Assembly tool piston ring  
J8128  
Pump, hand NSN 4930-00-263-  
9886

Equipment  
Condition Condition Description  
Para

3-88 Oil Pan removed  
3-89 Cylinder Head removed  
3-94 Lube Oil Pump removed  
3-95 Oil Inlet Pipe removed

Material/Parts

Cylinder Kit P/N 5149262

Special Environmental Conditions

Do not drain oil in bilges. Use  
oil separation and recovery system  
to collect drained oil.

Personnel Required

2

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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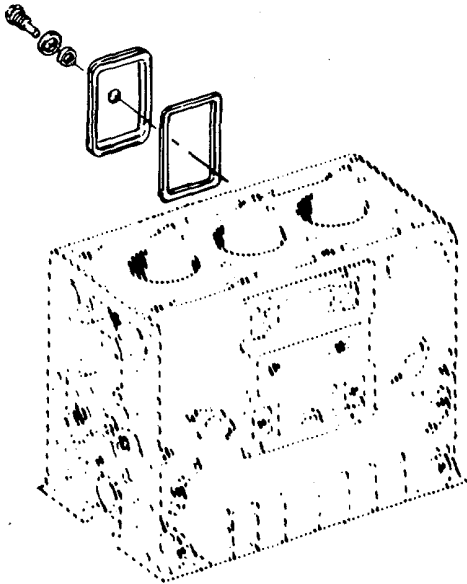
**PRE-INSPECTION**

- |    |                          |                    |  |                  |
|----|--------------------------|--------------------|--|------------------|
| 1. | Piston-compression rings | a. Air box covers  | Remove nuts, flatwashers, lockwashers, covers, and gaskets.  | Discard gaskets. |
|    |                          | b. Cylinder liners | Check that piston rings are free, and are not worn to the extent that plating or grooves are gone. |                  |

3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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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 3-88.
	c. Oil inlet pipe	Remove.	Refer to paragraph 3-95.
	d. Lube oil pump	Remove.	Refer to paragraph 3-94.
e. Cylinder head	Remove.	Refer to paragraph 3-89.	

3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

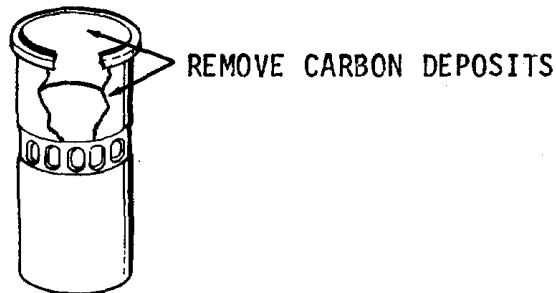
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- |    |                |  |  |
|----|----------------|--|--|
| f. | Cylinder liner | <ol style="list-style-type: none"> <li>1. Remove the carbon deposits from the upper inner surface of the cylinder liner.</li> <li>2. Use a ridge cutter to remove any ridge in the cylinder liner at the top of the piston ring travel.</li> </ol> |  |
|----|----------------|--|--|

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.



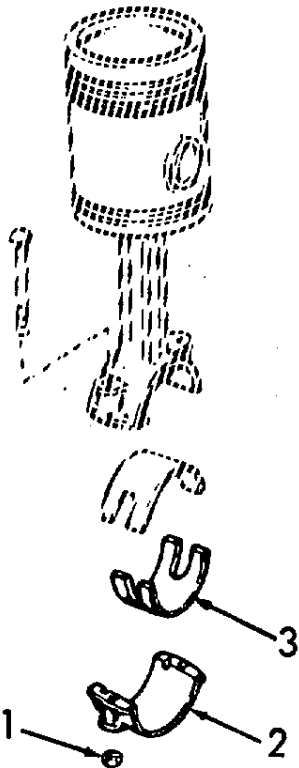
- |    |   |   |   |
|----|---|---|---|
| g. | Nut (1), bearing cap (2), and lower bearing shell (3) | Remove.   |   |
| h. | Piston and connecting rod assembly                    | Push the piston and rod assembly out through the top of the cylinder block. | The piston cannot be removed from the bottom of the cylinder block. |

3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- 1. Lower bearing shell (3), bearing cap (2), and nuts (1)
- Reassemble to connecting rod.



DISASSEMBLY

- 3. Piston and connecting rod assembly
    - a. Piston and connecting rod assembly
- Place connecting rod in a vise with soft jaws.

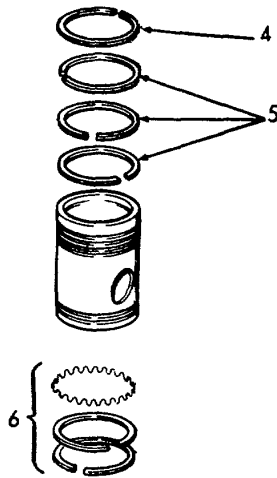


3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- |    |                             |                     |                 |
|----|-----------------------------|---------------------|-----------------|
| b. | Ring (compression fire) (4) | Remove.             | Use tool J8128. |
| c. | Rings compression (5)       | Remove three rings. | Use tool J8128. |
| d. | Oil rings (6)               | Remove.             | Use tool J8128. |

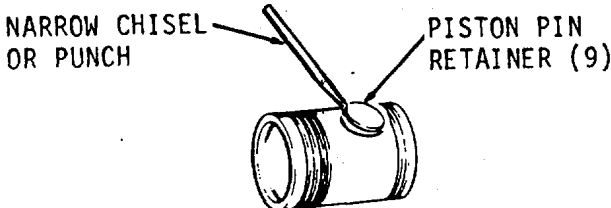


- |    |                         |  |  |
|----|-------------------------|--|--|
| e. | Piston pin retainer (9) | Punch a hole through the center of one of the piston pin retainers with a narrow chisel or punch and pry the retainer from the piston. | Be careful not to damage the piston or bushings. |
|----|-------------------------|--|--|

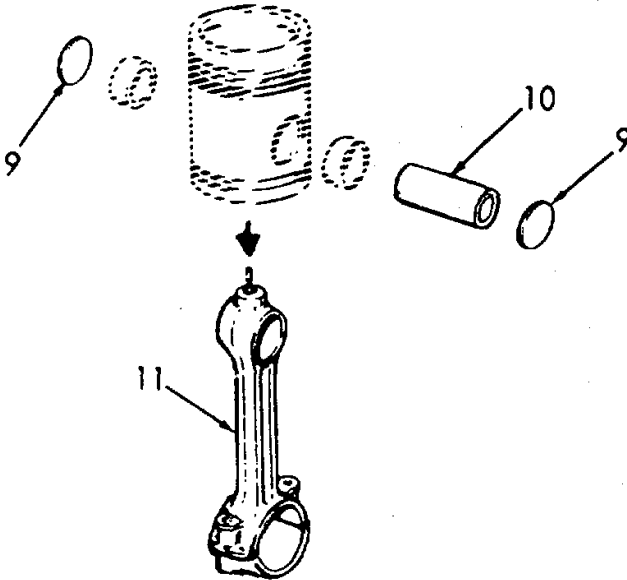
3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



- 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.



3-96.1 PISTON-MAINTENANCE INSTRUCTIONS (Cont).

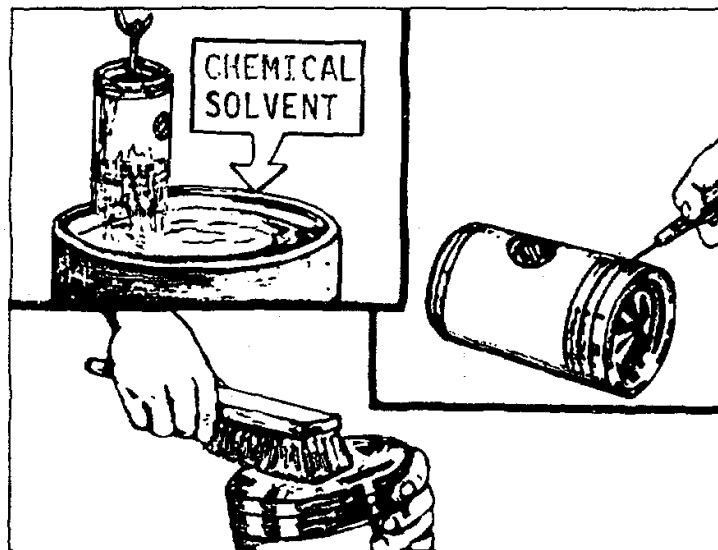
LOCATION	ITEM	ACTION	REMARKS
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CLEANING			
----------	--	--	--

**WARNING**

Wear eye protection when using compressed air.

- |                      |   |
|----------------------|---|
| 4. Piston components | <ul style="list-style-type: none"> <li>a. 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.</li> <li>b. 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.</li> <li>c. 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.</li> </ul> |
|----------------------|---|

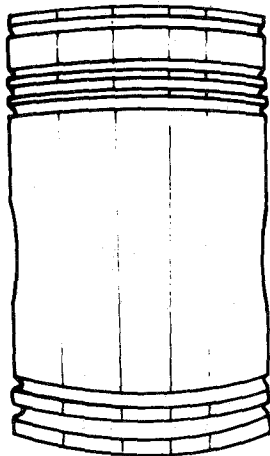


3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

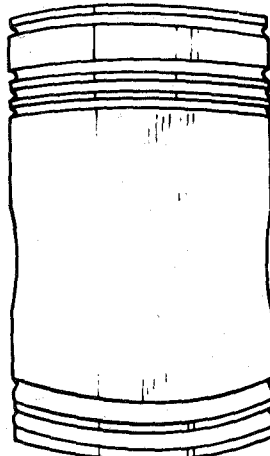
LOCATION	ITEM	ACTION	REMARKS
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INSPECTION
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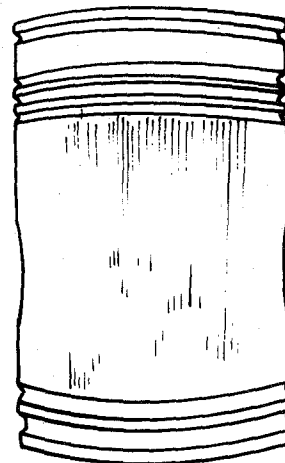
- |           |  |
|-----------|--|
| 5. Piston | <ul style="list-style-type: none"> <li>a. If the tin-plate on the piston and the original grooves in the piston rings are intact, it is an indication of very little wear.</li> <li>b. Examine the piston for score marks, cracks, damaged ring groove lands 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.</li> <li>c. Replace the piston if cracks are found across the internal struts. Use the magnetic particle inspection method for locating cracks in the piston.</li> </ul> |
|-----------|--|



**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**

**3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>INSPECTION (Cont)</b>				
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 3-96.4.
7.	Connecting rod and piston pin	Inspect.		Refer to paragraph 3-96.2.
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 3-96.2.		
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).		

**CAUTION**

Do not remove the bushings from the piston. They are not serviced separately.

**REASSEMBLY**

10.	Piston	a. Piston and cylinder liner fitting	1. 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 below for piston diameter specifications.
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3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION				REMARKS	
REASSEMBLY (Cont)							
ENGINE PARTS		MINIMUM		MAXIMUM		LIMITS	
(Standard Size, New)		(inches)	(cm)	(inches)	(cm)	(inches)	(cm)
<b>PISTON</b>							
	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

2. 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.

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**3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)			
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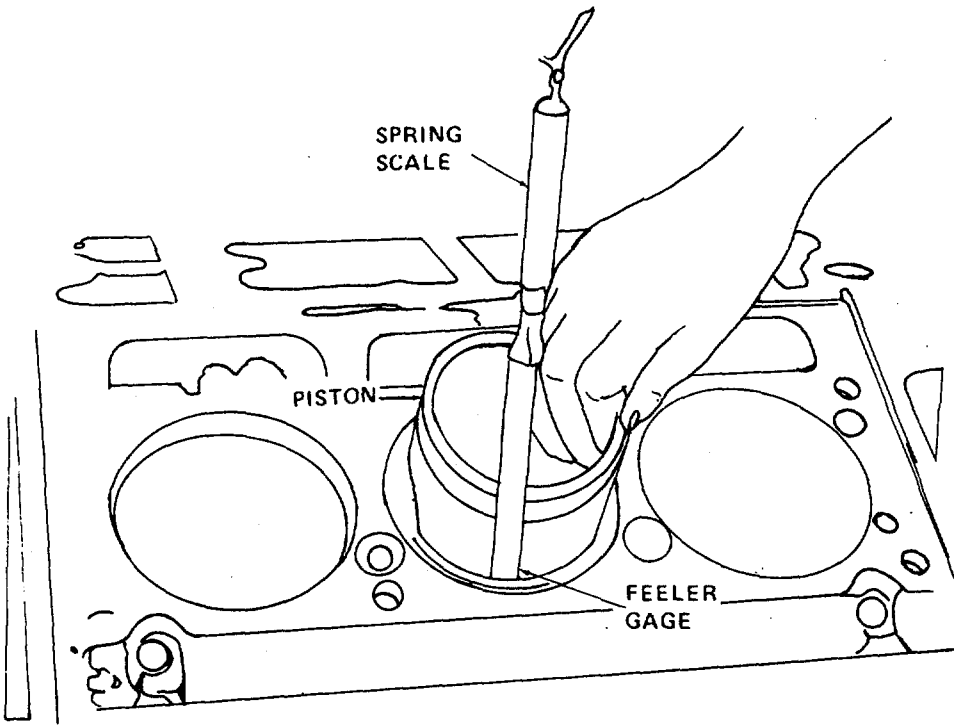
3. With the cylinder liner installed in the cylinder block, hold the piston upside down in the liner and check the clearance in four places 90° apart.
4. Use feeler gage set to check the clearance. The spring scale, attached to the proper feeler gage, is used to measure the force in pounds required to withdraw the feeler gage.
5. Select a feeler gage with a thickness that will require 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.

3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- 6. If any bind occurs between the piston and the liner, examine the piston and liner for burrs. Remove burrs with a fine hone (a flat one is preferable) and check the clearance.



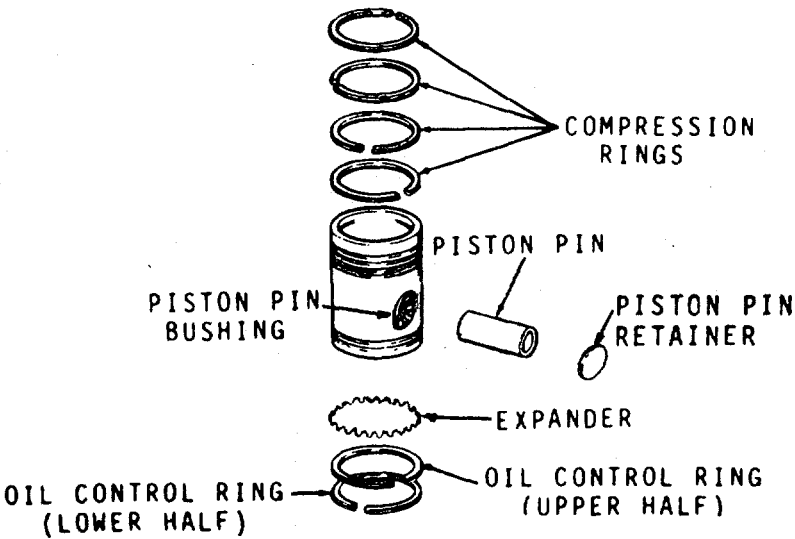


3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REASSEMBLY (Cont)

- |                               |   |
|-------------------------------|---|
| <p>b. Piston ring fitting</p> | <ol style="list-style-type: none"> <li>1. Each piston is fitted with a fire ring, three compression rings and two oil control rings.</li> <br/> <li>2. 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 pre-stressed fire ring is further identified by an oval mark.</li> </ol> |
|-------------------------------|---|

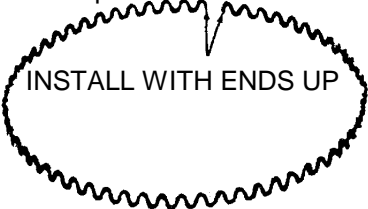


3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- 3. A pre-stressed compression ring is also used in the ring groove immediately below the fire ring.
- 4. 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

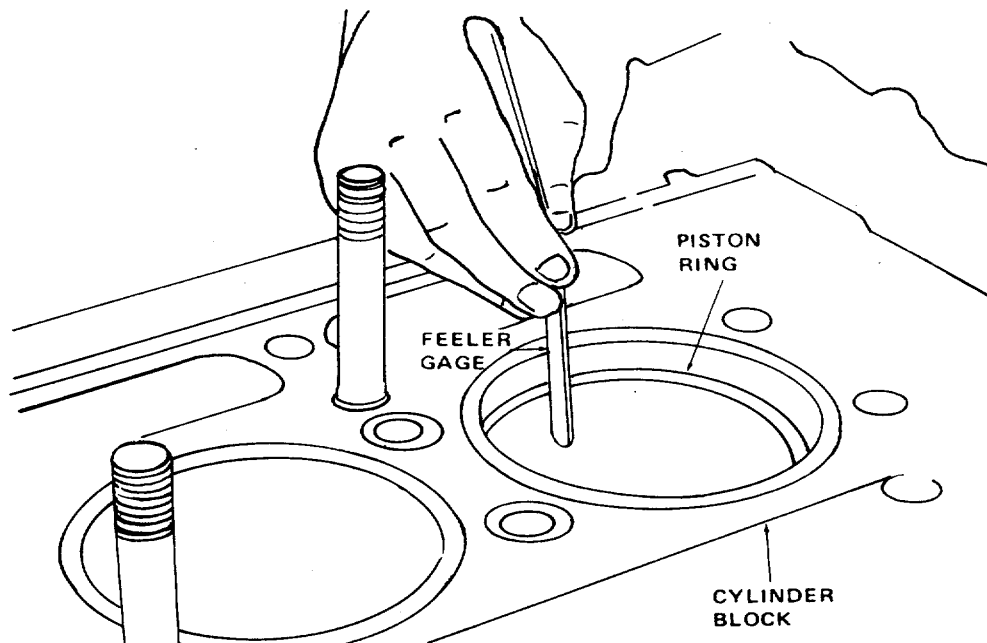
- 5. All new piston rings must be installed whenever a piston is removed, regardless of whether a new or used piston or cylinder liner is installed.
- 6. Insert one ring at a time inside of the cylinder liner and far enough down to be within the normal area of ring travel.

3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)
-------------------

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.



7. If the gap on a compression ring is insufficient, it may be increased by filling or stoning the ends of the ring. File or stone both ends of the ring so the cutting action is from the outer surface to the inner surface.

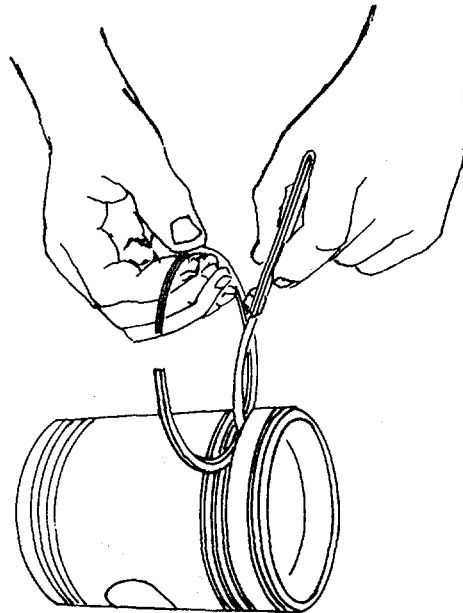
3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)
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This will prevent any chipping or peeling of the chrome plate on the ring. The ends of the ring must remain square and the chamfer on the outer edge must be approximately .015 inch (0.038 cm).

8. Check the ring side clearance as shown. Refer to ring side clearances.



3-1641

3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Piston and connecting rod	Assemble.	Refer to paragraph 3-40.2.
	d. Piston and all piston rings	Lubricate for installation.	Use engine oil.
	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.
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**CAUTION**

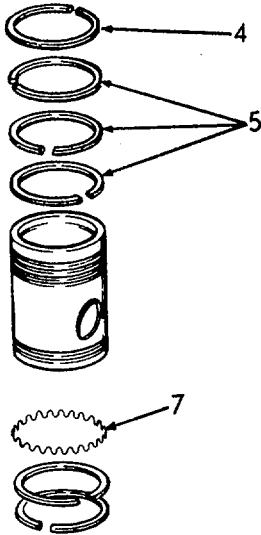
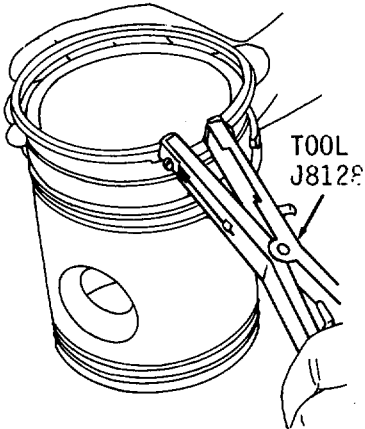
When installing the top compression (fire) ring, be sure the black oxide or copper color side (also identified by an oval mark) is toward the top of the piston.

g.	Compression rings (4 and 5)	Stagger ring gaps around the piston.	Rotate rings or piston.
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3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)



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 if the ends of the expander are overlapped and corrective action can be taken before ring breakage occurs.

**3-96.1. 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 the upper half with the gap 180° from the gap in the expander. Then install the lower half with the gap 45° from the gap in the upper half of the ring. Make sure the scraper edges are facing down (toward the bottom of the piston).
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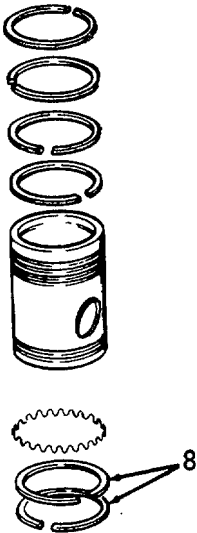
**NOTES**

- The face of the top half of the upper oil control ring used on 71N engines is chrome-plated.
- The scraping edges of all oil control rings must face downward (toward the bottom of the piston) for proper oil control.
- If there is a noticeable resistance during installation of the piston, check for an overlapped ring expander.

3-96.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)



INSTALLATION

- 12. Piston, connecting rod, and cylinder liner

For installation, refer to paragraph 3-96.4.



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**3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS.**

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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.

**3-96.2. 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

References

NONE

Special Tools

Remover 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

Equipment

<u>Condition</u>	<u>Condition Description</u>
<u>Para</u>	

3-88.	Oil Pan removed
3-89.	Cylinder Head removed
3-94.	Lube Oil Pump removed
3-95.	Oil Inlet Pipe removed
3-96.1.	Piston removed

Material/Parts

Cylinder kit P/N 5149262

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation and recovery system to collect drained oil.

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS and WARNINGS.

<b>LOCATION</b>	<b>ITEM</b>	<b>ACTION</b>	<b>REMARKS</b>
-----------------	-------------	---------------	----------------

REMOVAL
---------

1. Engine	a. Oil pan	1. Remove oil.	Pump oil into a suitable container.
		2. Remove.	Refer to paragraph 3-88.
	b. Oil in-let pipe	Remove.	Refer to paragraph 3-95.

**3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	c. Lube oil pump	Remove.	Refer to paragraph 3-94.
	d. Cylinder head	Remove.	Refer to paragraph 3-89.
2. Connecting rod(s)			

**NOTE**

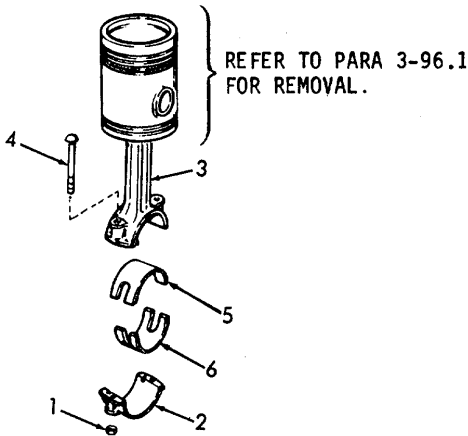
The connecting rod bearing caps are numbered IL, IR, 2L, 2R, etc., with matching numbers and letters stamped on the connecting rods. When removed, each bearing cap and the bearing shells must always be reinstalled on the original connecting rod.

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.
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 3-96.1.

3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



CLEANING

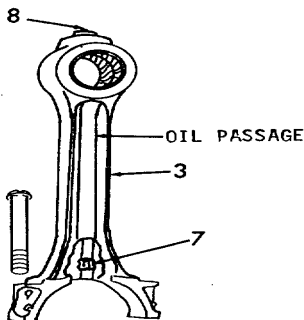
**WARNING**

Wear eye protection when using compressed air.

3. Connecting rod

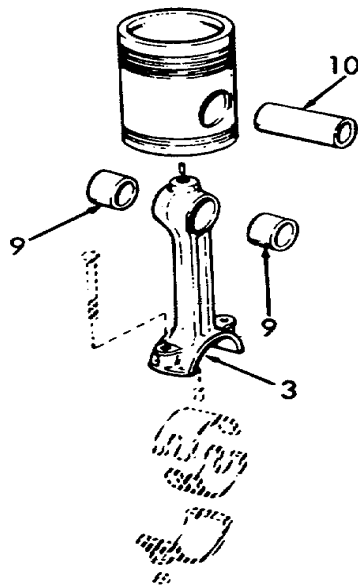
Connecting rod (3), orifice (7) and spray nozzle (8)

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, oil passage and spray nozzle are not clogged.



3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
4. Connecting rod	Connecting rod (3)	Inspect for cracks.	Magnetic particle is the preferred method.
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 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.

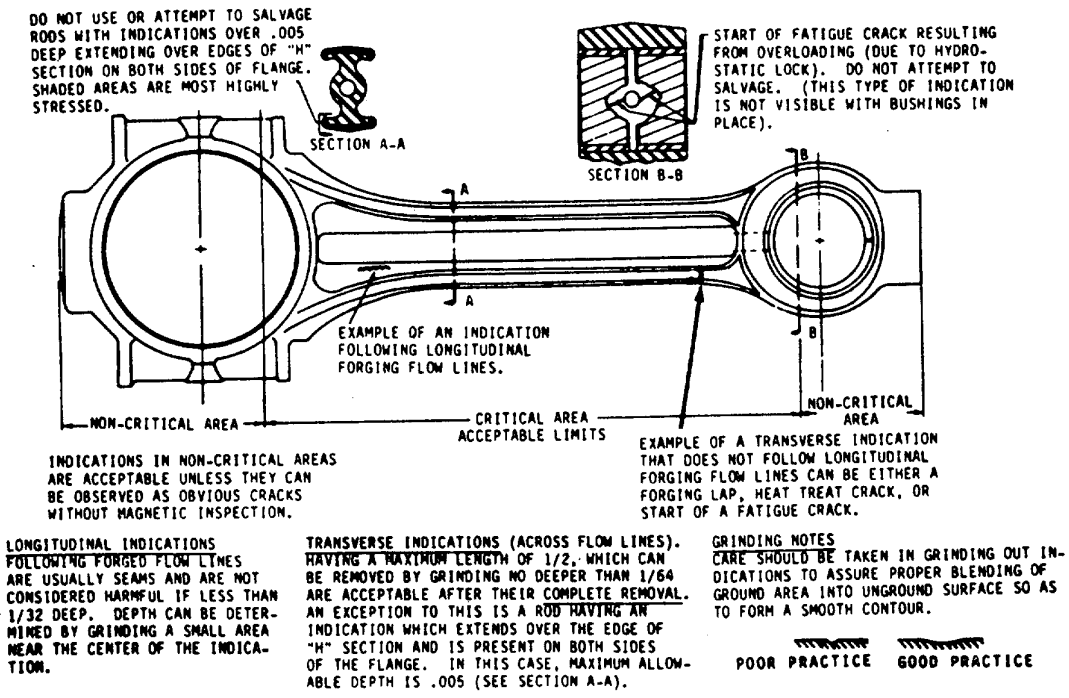


3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)
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Since it is subjected to downward loading 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.



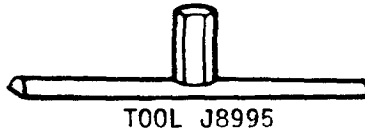
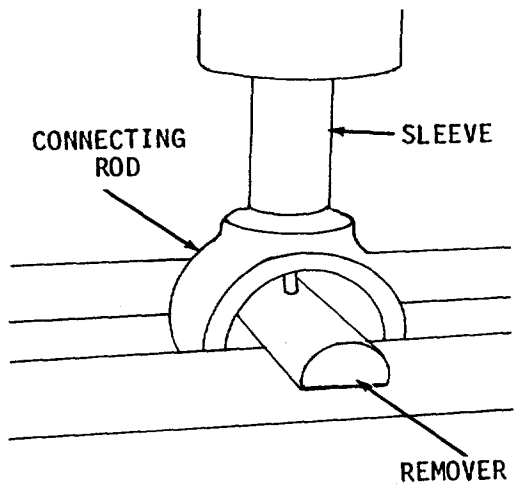
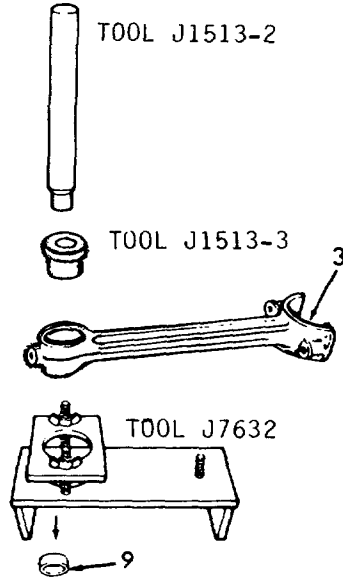
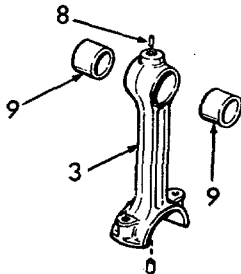
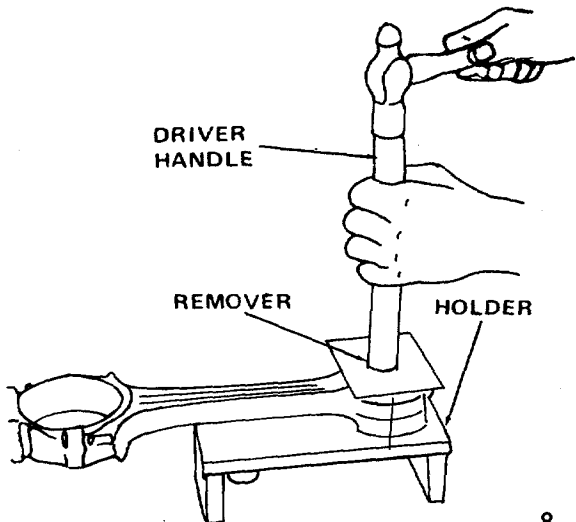
**3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
7. Bushings	a. Connecting rod (3)	<ol style="list-style-type: none"> <li>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.</li> <li>2. Place bushing remover in the connecting rod bushing.</li> <li>3. Insert handle in the remover and drive the bushings (9) from the rod (3).</li> </ol>	<p>Use tool J7632.</p> <p>Use tool J1513-2.</p> <p>Use tool J1513-3.</p>
8. Spray nozzle (8)	a. Connecting rod bushings (9)	Remove.	Refer to step 7.
	b. Spray nozzle (8)	<ol style="list-style-type: none"> <li>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.</li> <li>2. Support the connecting rod and tool in an arbor press.</li> <li>3. Place a short sleeve directly over the spray nozzle. Then press the nozzle out of the connecting rod.</li> <li>4. Remove the tool.</li> </ol>	Use tool J8995.

3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION                      ITEM                      ACTION                      REMARKS

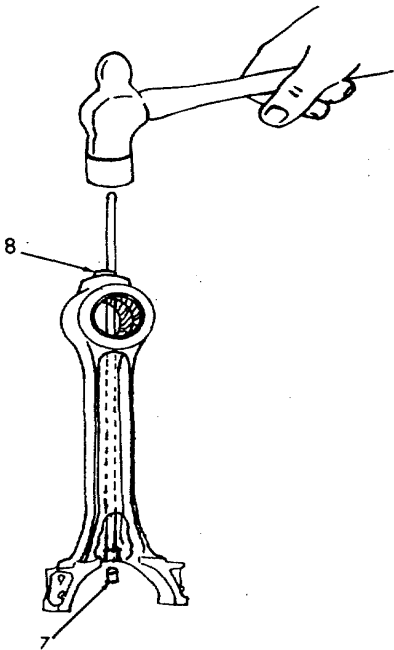
DISASSEMBLY (Cont)





3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
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.	



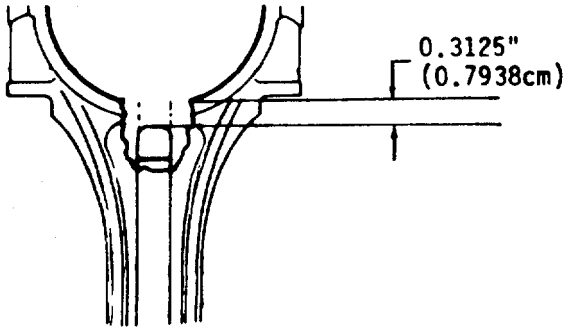
**REASSEMBLY**

10. Orifice	a. Orifice (7)	Install from the upper bearing area.	Install orifice 0.3125 inch (0.7938 cm) from lower surface.
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3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)



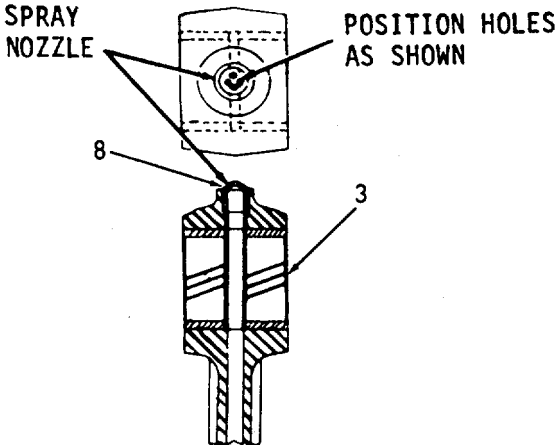
11. Spray nozzle

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.

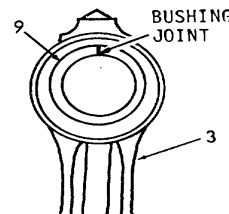
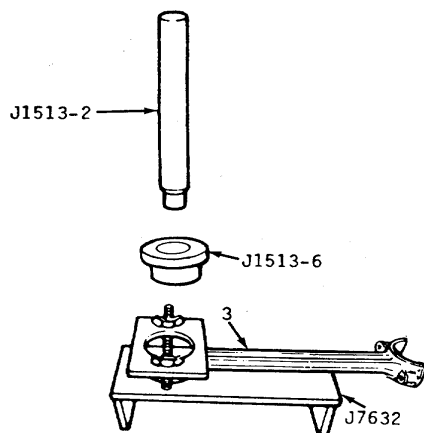


3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

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 the tool.
	b. Bushing (9)	<ol style="list-style-type: none"> <li>1. Start a new bushing straight into the bore of the connecting rod, with the bushing joint at the top of the rod.</li> <li>2. Insert installer in bushing, then insert handle in the installer.</li> <li>3. Drive the bushing in until the flange of the installer bottoms on the connecting rod.</li> </ol>	Use installer tool J1513-6, and handle tool J1513-2.



c. Connecting rod (3)

Turn the connecting rod over in the holder and install the second bushing in the same manner.

**NOTE**

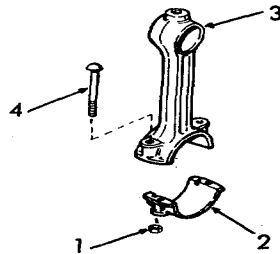
The bushings must withstand an end load of 2000 pounds (907 kg) without moving after installation.

3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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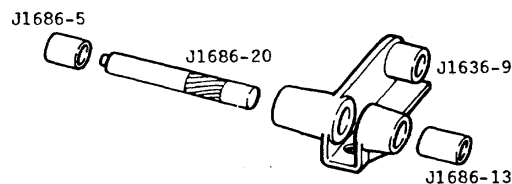
REASSEMBLY (Cont)

- |                     |  |  |  |
|---------------------|--|--|--|
| 13. Bushing reaming | a. Connecting rod (3), bolts (4), bearing cap (2) and nuts (1) |  |  |
|---------------------|--|--|--|



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 (lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (plain nut).
4. Slide the front guide bushing J1686-11 (with the pin end facing out in the fixture).



**3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REASSEMBLY (Cont)</b>			
	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.		
	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 3-96.1.).

**ASSEMBLY**

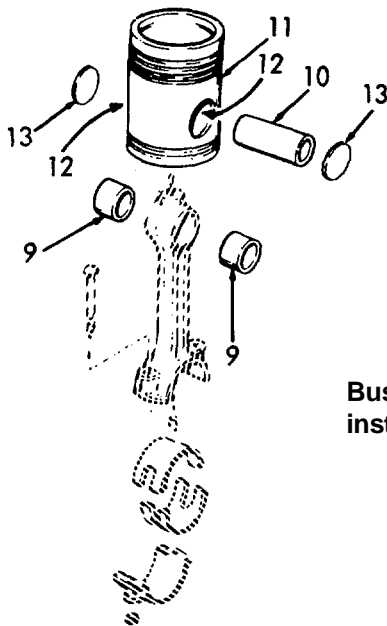
14. Connecting rod to piston	a. Piston pin (10), piston bushings (12), and connecting rod bushings (9)	Lubricate.	Use clean engine oil. Refer to paragraph 3-96.1.
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3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

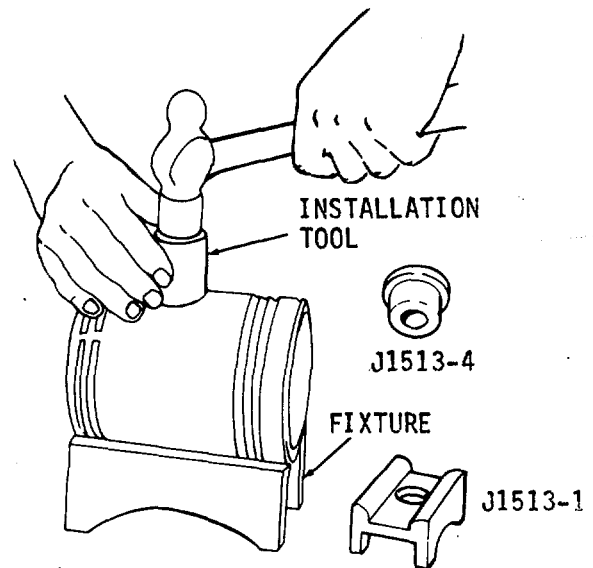
LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY (Cont)</b>			
	b. Piston (11)	Place in holding fixture.	Use tool J1513-1.
	c. Piston pin retainer (13)	1. Place on piston, then place crowned end of installer against the retainer.  2. Place handle on installer.  3. Strike the handle enough to deflect the retainer and seat it evenly in the piston.	Use tool J1513-4.  Use tool J1513-2.

**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.



**NOTE**  
Bushings are installed in piston.



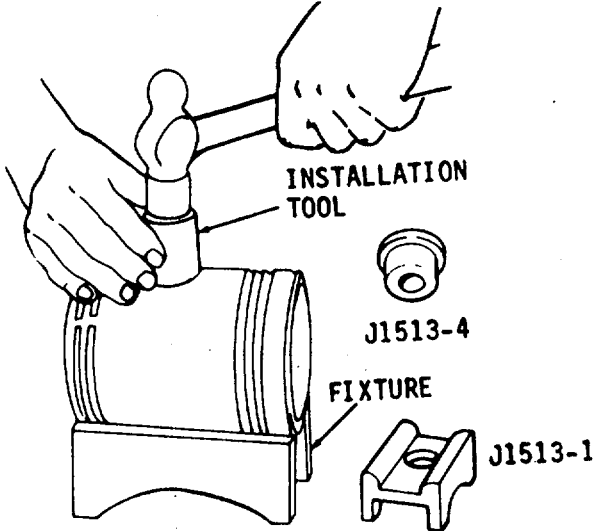
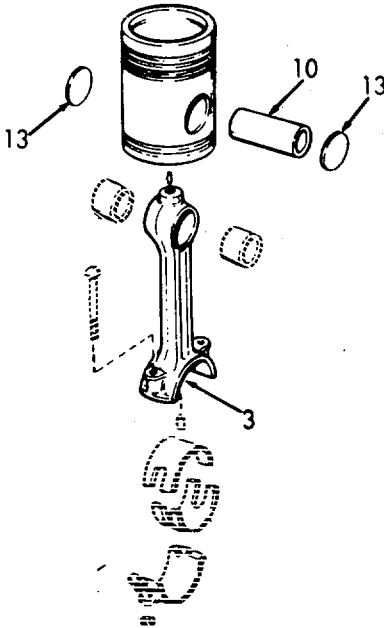
**3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	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)	<ol style="list-style-type: none"> <li>1. Place on piston; then place crowned end of installer against the retainer.</li> <li>2. Place handle on installer.</li> <li>3. Strike the handle just hard enough to deflect the retainer and seat it evenly in the piston.</li> </ol>	<p>Use tool J1513-4.</p> <p>Use tool J1513-2.</p>
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	After the piston pin retainers have been installed, check for piston pin end clearance by cocking the connecting rod and shifting the pin its bushings.	

3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)





3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY (Cont)</b>			
	h. Piston and connecting rod assembled	<p>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:</p> <ol style="list-style-type: none"> <li>1. Place the piston and connecting rod assembly upside down on a bench.</li> <li>2. Pour clean fuel oil in the piston to a level above the piston pin bosses.</li> <li>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.</li> <li>4. Check for seepage of fuel oil around the retainers. If the fuel oil leaks around the retainers, install new retainers. In extreme cases it may be necessary to replace the piston.</li> </ol>	



Wear eye protection when using compressed air

3-96.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)	i. Piston and connecting rod assembly, and cylinder liner	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.  Assembly.	Refer to paragraph 3-96.4.

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**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS.**

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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 endwise 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.

**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

**a. Removal**

**b. Inspection**

**e. Installation**

**INITIAL SETUP**

Test Equipment

Micrometer

References

NONE

Special Tools

Pump, hand NSN 4930-00-263-9886  
Torque wrench

Equipment Condition Description  
Para

3-80. Oil Pan and Dipstick Removal  
3-94. Lubricating Oil Pump Removal  
3-95. Lube Oil Distribution System - Inlet Pipe Removal

Material/Parts

NONE

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation and recovery system to collect drained oil.

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

1. Engine	a. Oil pan	1. Remove oil.	Pump oil into suitable container.
		2. Remove.	Refer to paragraph 3-88.
	b. Oil inlet pipe	Remove.	Refer to paragraph 3-95.
	c. Lube oil pump	Remove.	Refer to paragraph 3-94.

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**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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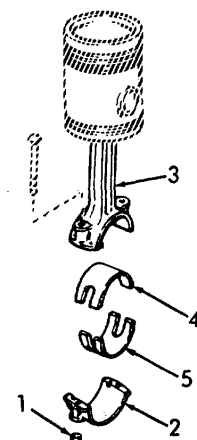
**REMOVAL (Cont)**

2. Connec-  
ting  
rod(s)

**NOTE**

The connecting rod bearing caps are numbered IL,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. | Connec-<br>ting rod<br>(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.   |



**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**

**NOTE**

Do not remove another bearing cap or bearing shells.

**INSPECTION**

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. Bearing seizure may be due to low or no oil.

a. Upper and lower shells

1. Clean the bearings and inspect them for scoring, pitting, flaking, chipping, cracking, loss of babbitt or signs of overheating.

If any of these defects are present, the bearings must be discarded. 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. The bearings should not be replaced for these minor surface imperfections. The upper bearing shells, which carry the load, will normally show signs of distress before the lower bearing shells do.

**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		<p>2. Inspect the backs of the bearing shells for bright spots which indicate they have been shifting in their supports.</p>	<p>If such spots are present, discard the bearing shells.</p>
		<p>3. Measure the thickness of the bearing shells, using a micrometer and ball attachment.</p>	<p>The minimum thickness of a worn standard connecting rod bearing shell should not be less 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).</p>
<p>4. Connecting rod</p>	<p>Bearing bore</p>	<p>Inspect for burrs, foreign particles and so forth.</p>	
<p>5. Crankshaft journal</p>	<p>Bearing shells</p>	<p>Check the clearance between the connecting rod bearing shells and the crankshaft journal.</p>	<p>This clearance may be checked by means of a soft plastic measuring strip which is squeezed between the journal and the bearing. The</p>

**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			maximum connecting rod bearing-to-journal clearance with used parts is .006 inch (0.015 cm).

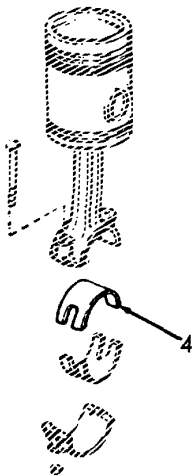
**INSTALLATION**

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. Do not use these bearing shells.

- |                            |  |   |
|----------------------------|--|---|
| 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. |
|----------------------------|--|---|





**3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).**

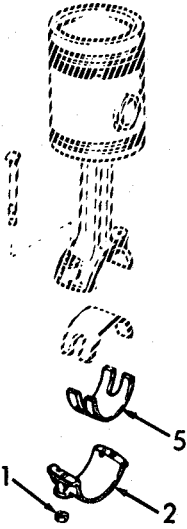
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	b. Crankshaft journal	Wipe clean and lubricate with clean engine oil.	
	c. Connecting rod and piston assembly	Pull assembly down until the upper bearing seats firmly on the crankshaft journal.	
	d. Bearing cap (2) and lower bearing shell (5)	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 (castellated nut).
	f. Lube oil pump	Install.	Refer to paragraph 3-38.
	g. Oil inlet pipe	Install.	Refer to paragraph 3-39.

3-96.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- h. Oil pan                      Install.                      Refer to para-graph 3-35.
- i. Engine oil                      Fill.



3-1671

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**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS.**

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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 counter bore in the cylinder block and rests on a replaceable cast iron insert which permits accurate alignment of the cylinder liner. Compression is sealed with an individual laminated 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.

**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

**a. Removal**

**b. Inspection**

**e. Installation**

**INITIAL SETUP**

Test Equipment

Gage cylinder diameter checking J5347-01  
Gage master ring J8386-01

References

NONE

Special Tools

Hold down clamp cylinder liner J21793-01  
Pump, hand NSN 4930-00-263-9886  
Remover cylinder liner J1918-02

Equipment

Condition Description

Para

3-86. Rocker Arm Cover removal  
3-88. Oil Pan removed  
3-89. Cylinder Head removed  
3-94. Lube Oil Pump Removed  
3-96.1. Piston Removed

Material/Parts

Cylinder kit P/N 514926

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation and recovery system to collect drained oil.

Personnel Required

2

General Safety Instructions

Observe all CAUTIONS.

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

1. Engine	a. Rocker arm cover	Remove.	Refer to paragraph 3-86.
	b. Oil pan	1. Remove oil.  2. Remove.	Pump into suitable container.  Refer to paragraph 3-88.

**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	c. Lube oil pump	Remove.	Refer to paragraph 3-94.
	d. Cylinder head	Remove.	Refer to paragraph 3-89.
	e. Piston	Remove.	Refer to paragraph 3-96.1.

2. Cylinder liner

**NOTE**

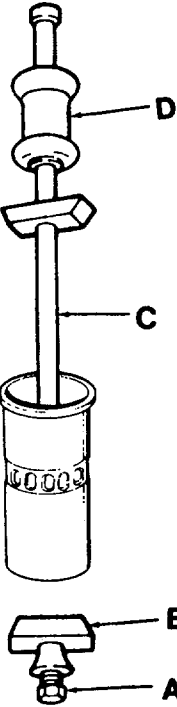
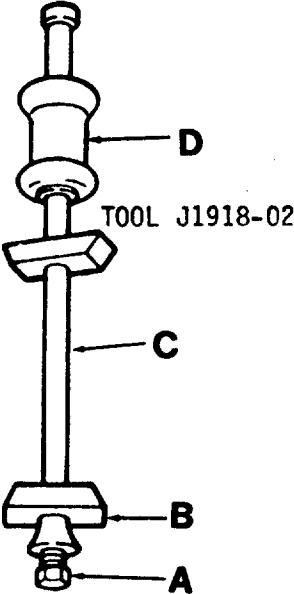
It is very important that the proper method is followed when removing a cylinder liner. Do not attempt to push the liner out by inserting a bar in the liner ports and rotating the crankshaft, otherwise the piston may be damaged or the upper ring groove may collapse.

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. Lower the shaft (C) into the cylinder liner.	
	4. Attach lower shoe (B) and bolt (A) to shaft (C).	

3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

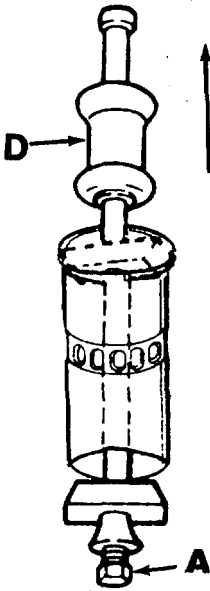


3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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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.                          |   |

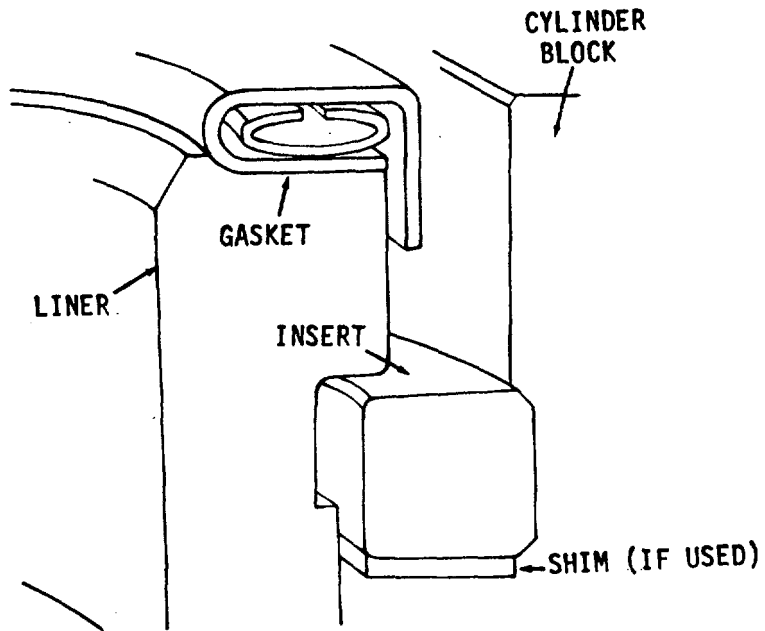


3. Cylinder liner insert	Insert and-shims (if used)	Remove and tag.	Remove from counterbore of engine block.
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3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



INSPECTION

4. Cylinder liner	a. Liner	<ol style="list-style-type: none"> <li>1. Clean thoroughly.</li> <li>2. Inspect for cracks or excessive scoring.</li> <li>3. Inspect for excessive liner-to-block clearance or block bore distortion.</li> </ol>	<p>Discard. A slightly scored liner may be cleaned-up and reused.</p> <p>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</p>
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3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

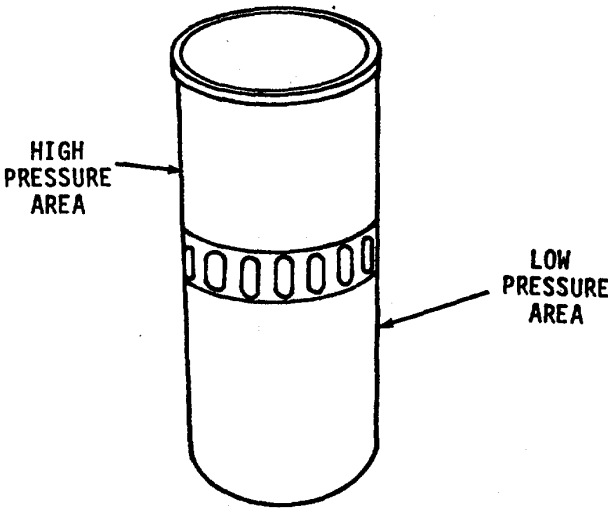
LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)

4. Examine the outside diameter of the liner for fretting.

the block bore may be indicated by stains or low pressure areas on the outer surface of the liner.

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 liner with a stone.



3-1678

**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)		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 evidence of brinelling.
		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**

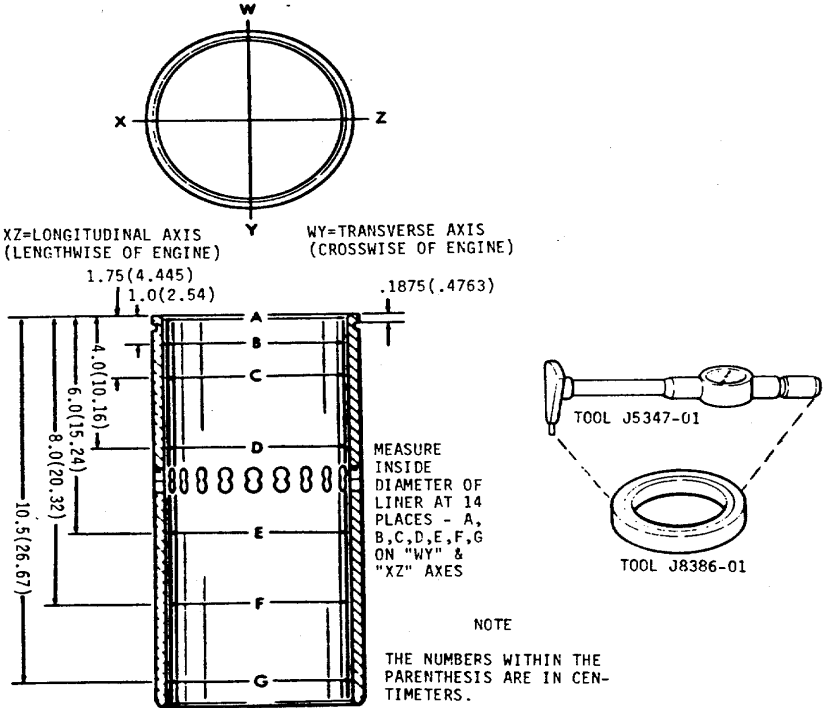
- Cylinder liners are available in .001, .005, .010, .020 and .030 inch oversize on the outside diameter. When an oversize liner is used, the amount of over-size is stamped on top of the cylinder block adjacent to the liner counter bore.
- New service liners, standard and oversize, have an inside diameter of 4.2495 to 4.2511 inch (10.7937 to 10.7978 cm).
- 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.

3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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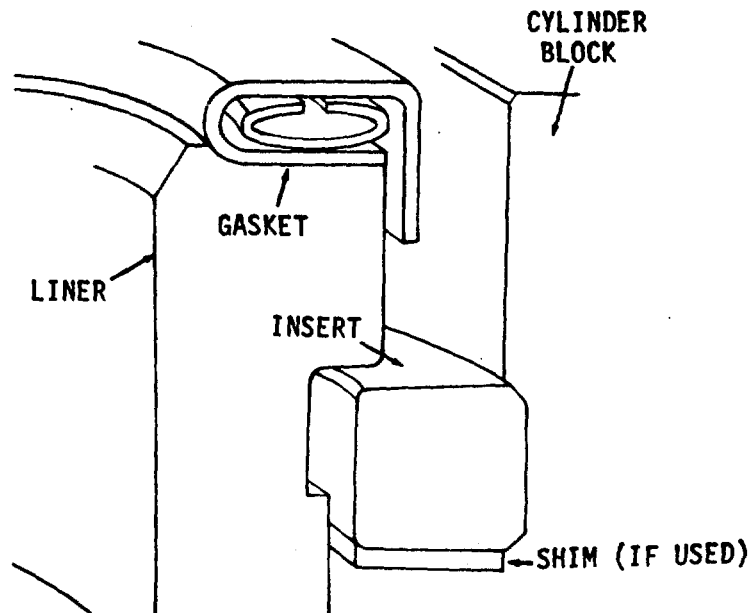
INSPECTION (Cont)

		<p>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 accurate measurements 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.</p>	<p>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 the liner 90° in the block bore and recheck.</p>
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3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
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).





**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	c. Cylinder liner	<ol style="list-style-type: none"> <li>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 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.</li> </ol>	
<b>NOTE</b>			
<p>A .002 inch (.0051 cm) thick shim is available for adjusting the liner height. The shim must be installed 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.</p>			
		<ol style="list-style-type: none"> <li>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.</li> </ol>	
	d. Hold down clamp and cylinder liner	Remove.	

3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

**NOTE**

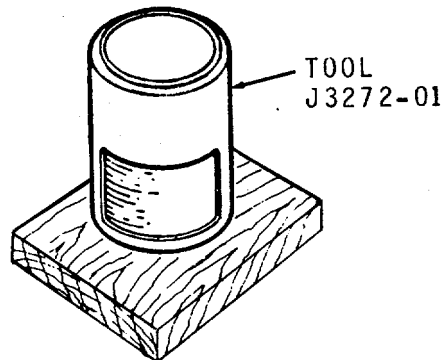
Do not remove the liner insert.

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.
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**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.

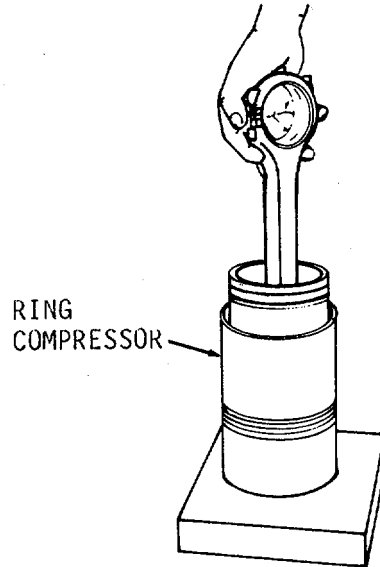
b. Compressor	Place on wood block with chamfered end up.	
c. Piston and connecting rod assembly	Position (stagger) the piston ring gaps properly on the piston.	Make sure the ends of the oil control ring expanders are not overlapped.
d. Assembly and compressor	Start the top of the piston straight into the ring compressor. Then push the piston down until it contacts the wood block.	



**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



- |    |   |   |
|----|---|---|
| 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. |



**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

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LOCATION	ITEM	ACTION	REMARKS
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**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 service 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**

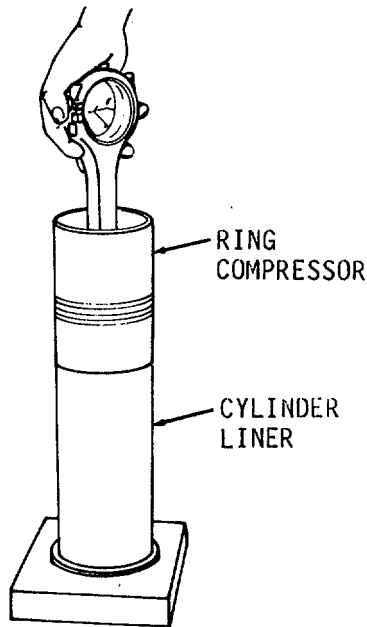
Do not force the piston into the liner. The peripheral abutment type expanders apply considerably more force on the oil ring than the standard expander. Therefore, extra care must be taken during the loading operation to prevent ring breakage.

- g. Connecting rod cap and ring compressor
  - 1. Remove.
  - 2. Push piston down until the compression rings pass the cylinder liner ports.

**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**



- 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.

**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	a. Upper bearing shell (1)	Install in connecting rod (2). Lubricate.	The upper bearing shell does not have a continuous oil groove. Lubricate the bearing shell with clean engine oil.

**NOTE**

Each connecting rod and its cap is numbered on one side - IL, 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.

- |                                       |   |
|---------------------------------------|---|
| b. Piston, rod and liner assembly (3) | <ol style="list-style-type: none"> <li>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 matchmarks on the liner and the block are in alignment.</li> <li>2. Guide the end of the connecting rod through the block bore carefully to avoid damaging or dislodging the bearing shell.</li> <li>3. Slide the piston, rod and liner assembly straight into the block bore until the liner flange rests against the insert in the counter bore in the block.</li> </ol> |
|---------------------------------------|---|

3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

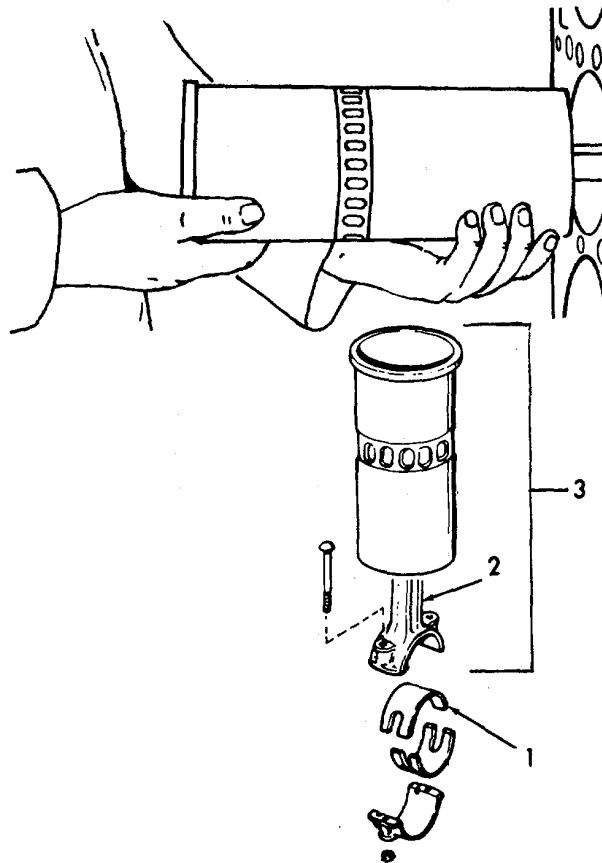
LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- |    |                               |   |  |
|----|-------------------------------|---|--|
| 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.



**3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
	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), nuts (6), and bolts (1)	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 "0" lubrite nut) to 65-75 lb-ft (88-102 Nm) torque (castellated nut).
	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.

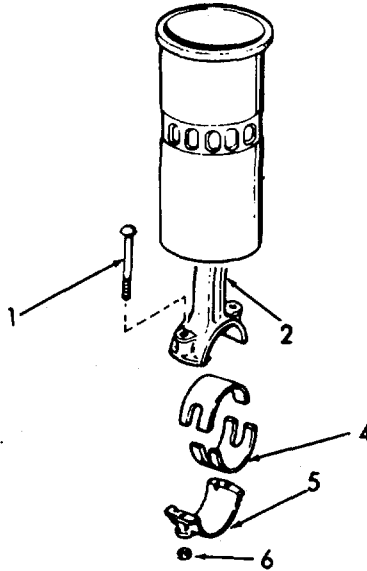
**NOTES**

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.

3-96.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



g.	Cylinder head	Install.	Use new compression gas-kets, 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.	

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**3-97. CRANKSHAFT.**

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The crankshaft maintenance instructions are as follows:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Crankshaft Bearings	3-97.1.
Crankshaft	3-97.2.
Crankshaft Seals	3-97.3.

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**3-97.1. 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 rap; 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.

**3-97.1. CRANKSHAFT BEARINGS (Cont).**

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.

**This task covers:**

**a. Removal**

**b. Inspection**

**e. Installation**

**INITIAL SETUP**

Test Equipment

Cylinder diameter gage  
J5347-01  
Micrometer (with ball end)

References

None

Special Tools

Pump, hand NSN 4930-00-  
263-9886  
Torque wrench

Equipment

Condition Condition Description  
Para

3-88. Oil Pan Removed  
3-94. Lube Oil Pump Removed  
3-95. Oil Inlet Pipe Removed

Material/Parts

None

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation and recovery system to collect drained oil.

Personnel Required

2

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

1. Engine	a. Oil pan	1. Remove oil.	Pump into a suitable container.
		2. Remove.	Refer to paragraph 3-88.
	b. Oil inlet pipe	Remove.	Refer to paragraph 3-95.



**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	c. Lube oil pump	Remove.	Refer to paragraph 3-94.
2.	Main bearings, numbers 1, 2 and 3		

**NOTE**

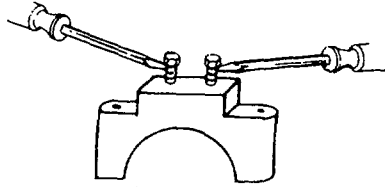
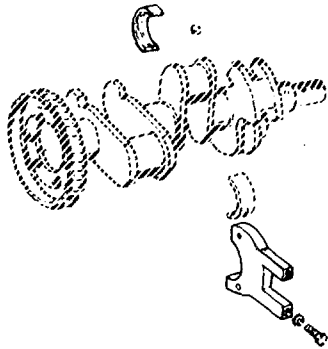
- All crankshaft main bearing journals, except the rear journal, are drilled for an oil passage. Therefore, the procedure for removing the upper bearing shells with the crankshaft in place is somewhat different on the drilled journals than on the rear journal.
- If shims are used between the oil pump 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 bearing cap before removing another bearing cap.

- |                                   |   |
|-----------------------------------|---|
| a. Bolts (1), and lockwashers (2) | Remove.   |
| b. Bearing cap (3)                | <ol style="list-style-type: none"> <li>1. Insert two bolts in bearing cap, leaving bottom of head accessible.</li> <li>2. Pry bearing cap off.</li> <li>3. Remove.</li> </ol> |

3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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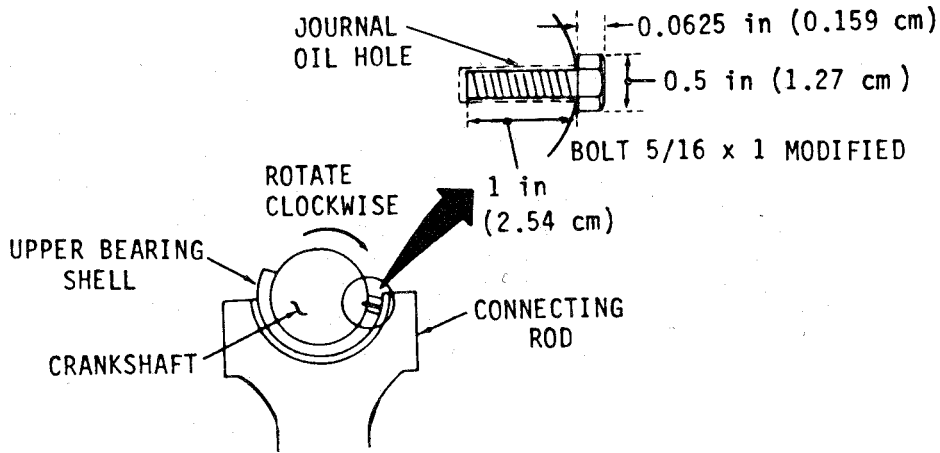
REMOVAL (Cont)



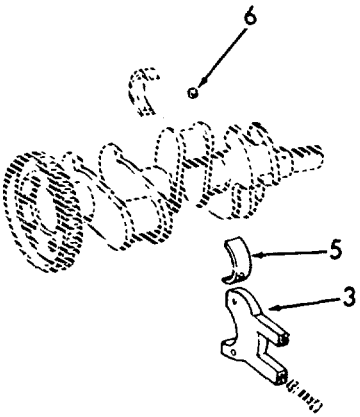
c. Upper main bearing shell (4)

1. Insert bolt in crankshaft journal oil hole.
2. Rotate crankshaft to the right (clockwise), and roll bearing shell out of piston.
3. Remove bolt.

Make bolt from 5/16 x 1 (standard bolt). Modify head to 1/2 inch (1.27 cm). The head of bolt must not extend beyond the outside diameter of the bearing shell.



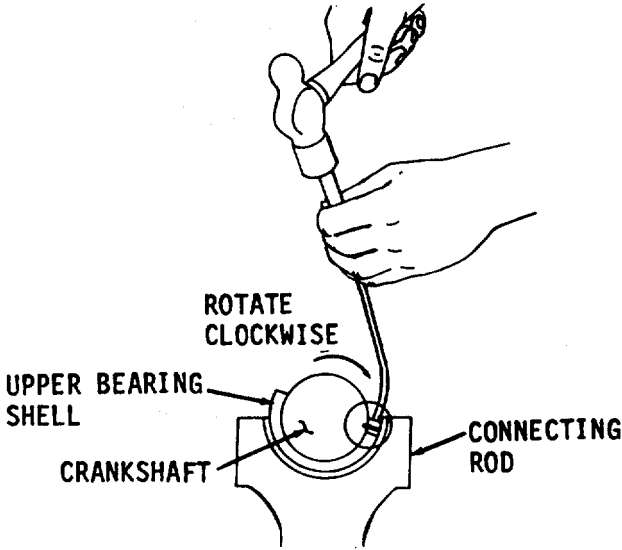
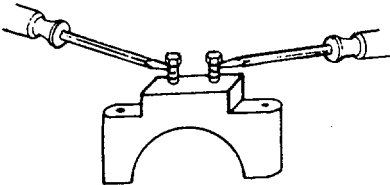
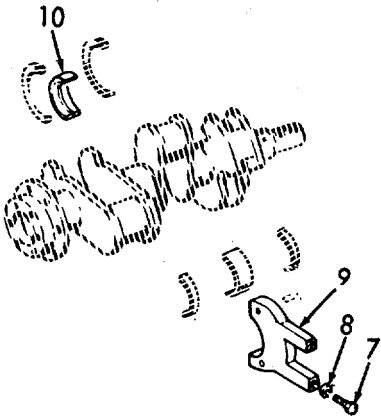
**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	d. Lower housing shell (5)	Remove from bearing cap (3).	
	e. Pipe plug (6)	Remove if necessary.	
			
3. Main bearing numbers 4	a. Bolts (7) and lockwashers (8)	Remove.	
	b. Bearing cap (9)	<ol style="list-style-type: none"> <li>1. Insert two bolts in bearing cap, leaving bottom of head accessible.</li> <li>2. Pry bearing cap off.</li> <li>3. Remove.</li> </ol>	
	c. Upper main bearing shell (10)	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.	

3-97.1. CRANKSHAFT BEARINGS (Cont).

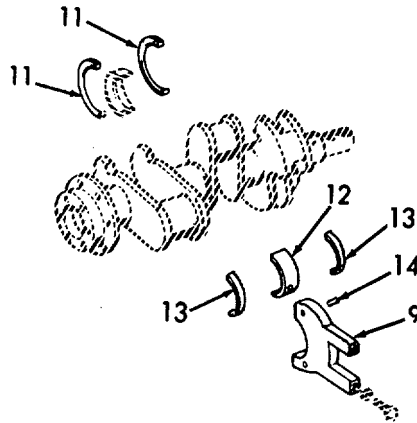
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)



**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	d. Upper thrust washers (11)	Remove by pushing on end of washers with a small rod. Force washers around and out.	
	e. Lower bearing shell (12) and lower thrust washers (13)	Remove from bearing cap (9).	
	f. Dowel pins (14)	Remove if necessary.	



3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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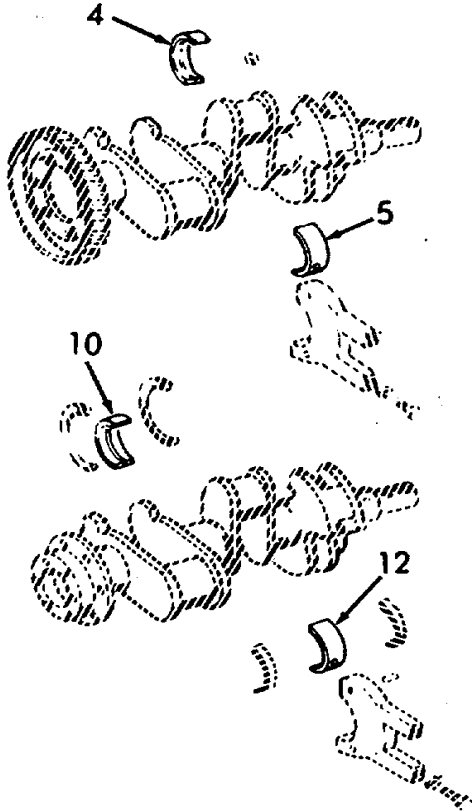
INSPECTION

4. Upper and lower bearing shells

a. Bearing shells (4 and 10), (5 and 12)

- 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.



3-97.1. CRANKSHAFT BEARINGS (Cont).

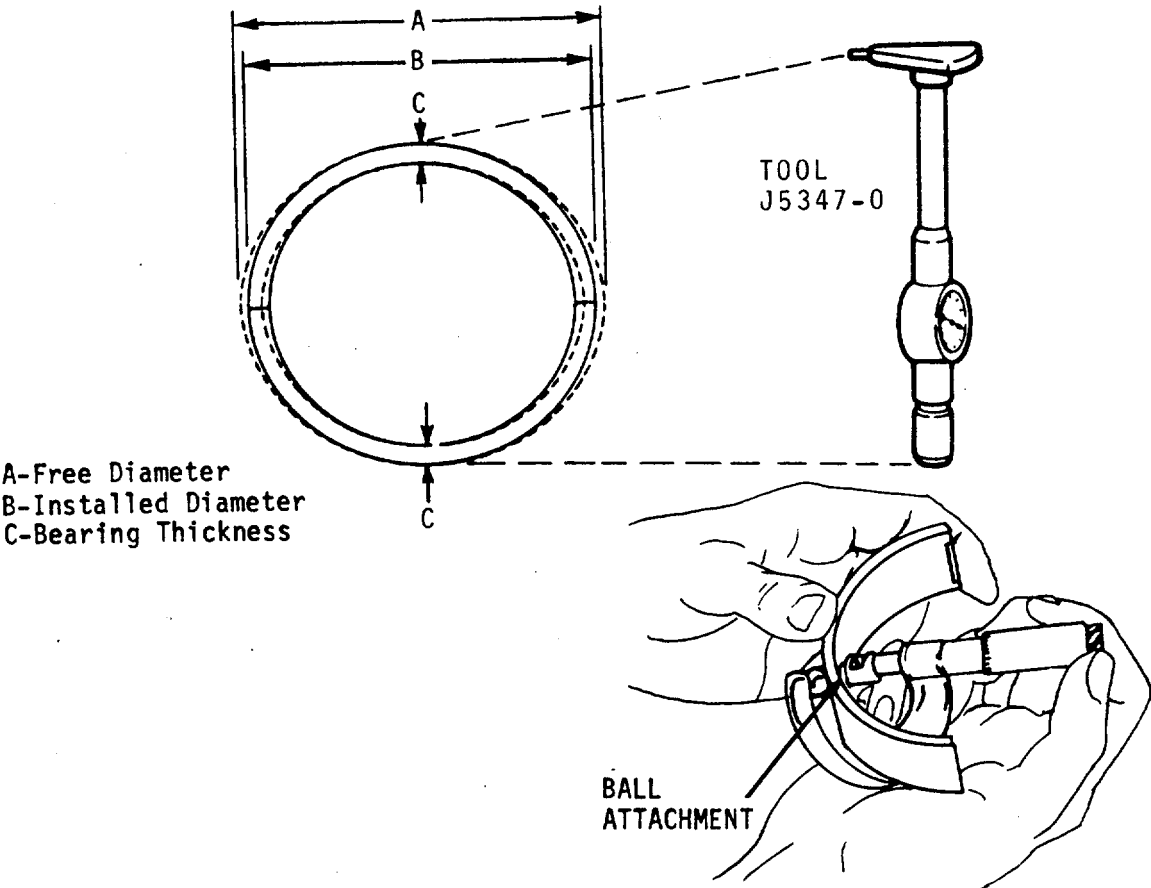
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		<p>3. Inspect the backs of the bearing shells for bright spots which indicate they have been moving in the bearing caps or bearing supports.</p>	<p>If such spots are present, discard the bearing shells.</p>
		<p>4. Measure the thickness of the bearing 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 (0.3932 to 0.3957 cm).</p>	

3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)

Bearing Size	Bearing Thickness	Minimum Thickness
Standard	.1548-/.1553"	.1530"
.002" Undersize	.1558-/.1563"	.1540"
.010" Undersize	.1598-/.1603"	.1580"
.020" Undersize	.1648-/.1653"	.1630"
.030" Undersize	.1698-/.1703"	.1680"





**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)
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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.

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,

**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION (Cont)**

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 3-97.2 under Crankshaft Inspection for removal of ridges and inspection of the crankshaft.

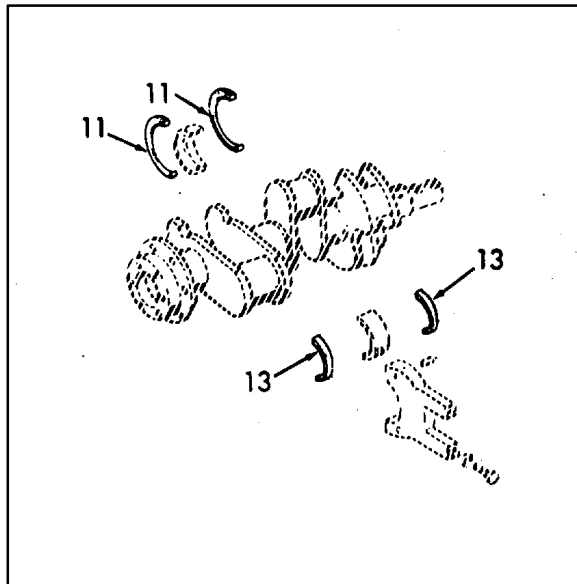
Do not replace one main bearing shell alone. If one bearing shell requires replacement, install both new upper and lower bearing shells. Also, if a new or reground crankshaft is to be used, install all new bearing shells.

5. Upper and lower thrust washers

Thrust washers (11 and 13)

Inspect.

If the washers are scored or worn excessively or the crankshaft and 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 install over-size thrust washer on one or both sides of the rear main bearing.

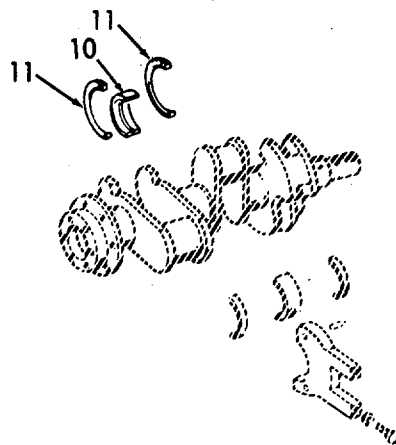
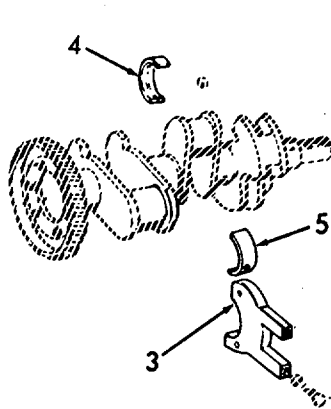


3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
			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.
<b>INSTALLATION</b>			
6. Upper bearings Numbers (4) 1, 2 and 3	Upper bearing shells	1. Clean. 2. Lubricate.	Use clean engine oil.
<b>NOTE</b>			
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 flow to the bearings and to the upper end of the connecting rods will be blocked off. Used bearing shells must be reinstalled 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.

3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
7.	Lower bearings numbers (5) 1, 2 and 3	<ol style="list-style-type: none"> <li>1. Clean.</li> <li>2. Lubricate.</li> <li>3. Install so that the tang on the bearing fits into the groove in the bearing cap (3).</li> </ol>	Use clean engine oil.
8.	Upper bearing number 4	<ol style="list-style-type: none"> <li>1. Clean.</li> <li>2. Lubricate.</li> <li>3. Inspect for burrs.</li> <li>4. Slide the upper halves of thrust washers into place.</li> </ol>	<p>Use clean engine oil.</p> <p>Remove from washer seats—the slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.</p>



**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
		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 4	Lower bearing shell (12) and thrust washers (13)	1. Clean. 2. Lubricate. 3. Inspect for burrs.	Use clean engine oil. Remove from washer seats- the slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.
10. Bearing caps numbers 1 thru 3	a. Bolts (1)  b. Bearing caps (3)	Place a small quantity of compound on threads and the bolt head contact area.  Position on crankshaft.	Use International Compound #2 or equivalent.

**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.

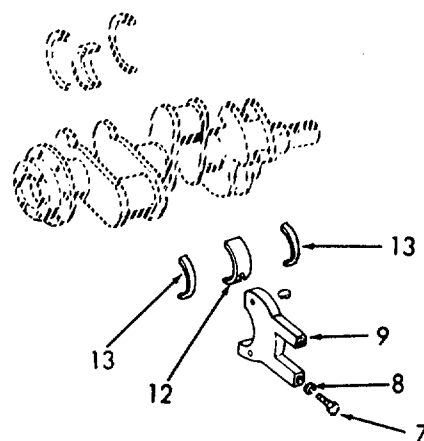
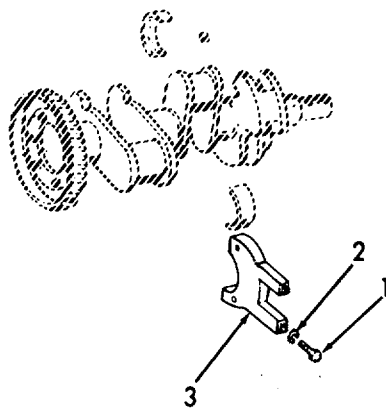
c. Bolts (1) and Lock-washers (2)	1. Install and draw up tight. 2. Rap the bearing cap sharply with a soft hammer.	To seat the bearing caps.
-----------------------------------	---	---------------------------

3-97.1. CRANKSHAFT BEARINGS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		3. Tighten bolts uniformly.	Torque to 180-190 lb-ft (244.1-257.6 Nm).
11. Bearing cap number 4	a. Bolts (7)	Place a small quantity of compound on threads and the bolt head contact area.	Use International Compound #2 or equivalent.
	b. Bearing caps (9)	Position on crankshaft.	
	c. Bolts (7) and lock-washers	Install.	Torque to 70-75 lb-ft (94.9-101.7 Nm).
		1. Install and draw up (8) 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.



**3-97.1. CRANKSHAFT BEARINGS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
12. Engine	a. Lube oil pump	Install.	Refer to paragraph 3-94.
	b. Oil inlet pipe	Install.	Refer to paragraph 3-95.
<b>NOTE</b>			
If shims were used between the lube oil pump and the bearing caps, install them in their original positions.			
	c. Oil pan	1. Install. 2. Fill with oil.	Refer to paragraph 3-88.

**3-1708**

**3-97.2. CRANKSHAFT MAINTENANCE INSTRUCTIONS.**

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a. The crankshaft is 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 hardened.

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.

**3-1709**



**3-97.2. CRANKSHAFT-MAINTENANCE INSTRUCTIONS (Cont)**

This task covers:

- a. Removal                      b. Inspection                      c. Installation

**INITIAL SETUP:**

Test Equipment

NONE

Special Tools

Chain hoist  
Gear puller  
Pump, hand NSN 4930-00-  
263-9886

References

NONE  
Equipment

Condition      Condition Description  
Para

- |         |                                       |
|---------|---------------------------------------|
| 3-82.   | Crankshaft Pulley-Removed             |
| 3-88.   | Oil Pan Removed                       |
| 3-89.   | Cylinder Head-Removed                 |
| 3-92.   | Flywheel and Housing-<br>Removed      |
| 3-94.   | Lube Oil Pump Removed                 |
| 3-95.   | Oil Inlet Pipe Removed                |
| 3-97.1. | Oil Inlet Pipe Removed                |
| 3-97.3. | Front Cover and Oil Seals-<br>Removed |

Material/Parts

NONE

Special Environmental Conditions

Do not drain oil in bilges. Use oil separation and recovery system to collect drained oil.

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

- |    |        |                   |                                 |
|----|--------|-------------------|---------------------------------|
| 1. | Engine | a. Cooling system | Drain.                          |
|    |        | b. Engine oil     | Pump into a suitable container. |

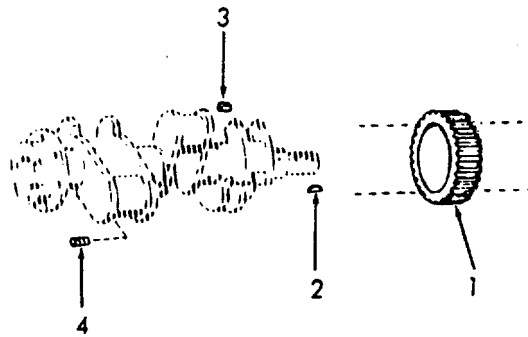
**3-1710**

**3-97.2. CRANKSHAFT-MAINTENANCE INSTRUCTIONS (Cont)**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
	c. Engine mounts	Disconnect	
	d. Accessories and assemblies	Remove to permit engine to be laid over on one side.	
	e. Oil pan	Remove.	Refer to paragraph 3-88.
	f. Lube oil pump	Remove.	Refer to paragraph 3-94.
	g. Flywheel and housing	Remove.	Refer to paragraph 3-92.
	h. Crankshaft pulley	Remove.	Refer to paragraph 3-82.
	i. Front engine support	Remove.	Refer to paragraph 3-97.2
	j. Cylinder head	Remove.	Refer to paragraph 3-89.
	k. Connecting rod bearing caps	Remove.	Refer to paragraph 3-96.
	l. Pistons and connecting rods	Remove.	Refer to paragraph 3-97.1.

3-97.2. CRANKSHAFT-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	m. Crankshaft, timing gear and oil pump drive gear	Remove.	
	n. Timing gear	Remove.	Refer to paragraph 3-91.4.
2. Oil pump drive gear	a. Gear (1)	Install a gear puller and remove gear.	
	b. Woodruff key (2)	Remove.	
3. Crankshaft	a. Pipe plugs (3)	Remove if necessary.	
	b. Pipe plugs (4)	Remove if necessary.	



**3-97.2. CRANKSHAFT-MAINTENANCE INSTRUCTIONS (Cont)**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
4. Engine	Crankshaft	<ol style="list-style-type: none"> <li>1. Inspect for cracks which start at an oil hole and follow the journal surface at an angle of 45° to the axis.</li> <li>2. Inspect for cracks or wear around keyways.</li> <li>3. Inspect for overheating.</li> <li>4. Inspect the oil seal for roughness or grooves.</li> <li>5. Check the gears for damage.</li> </ol>	
<b>INSTALLATION</b>			
5. Oil pump drive gear	a. Woodruff key (2)	Place in crankshaft. Slide on crankshaft. The gear should be tight against the shoulder on the crankshaft.	
6. Timing gear		Install.	Refer to paragraph 3-91.4.
7. Crankshaft		Install in engine.	
8. Engine		Replace all assemblies and parts removed in step 1 above.	

- a. The crankshaft front cover is mounted against the cylinder block end plate at the lower front end of the engine. The engine is supported at the front end by engine supports attached to the front cover.
- b. It will be necessary to remove the crankshaft front cover to remove and install the crankshaft.
- c. 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.
- d. 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.
- e. 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.
- f. 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.

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### 3-97.2. CRANKSHAFT-SEALS (Cont)

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This task covers:

- a. Inspection                      b. Removal                      c. Installation
- 

#### INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

Hammer (soft)

Equipment

Condition    Condition Description

Para

- 3-82. Crankshaft Pulley Removed
- 3-84. Lifter Brackets and Supports
- 3-88. Oil Pan Removed
- 3-92. Flywheel and Housing Removed
- 3-94. Lube Oil Pump Removed
- 3-95. Oil Inlet Pipe Removed
- 3-94. Lube Oil Pump Removed
- 3-96.1. Piston Removed

Material/Parts

Gasket kit P/N 5193113  
Grease or vegetable shortening  
Oil seal P/N 5115454  
Oil seal P/N 5115335  
Shellac

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

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LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL**

- |                           |                 |   |                          |
|---------------------------|-----------------|---|--------------------------|
| 1. Engine front supports. | Lifter Supports | Place a wooden block under engine. Remove | Refer to paragraph 3-84. |
|---------------------------|-----------------|---|--------------------------|

3-97.3. CRANKSHAFT SEALS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
2. Crankshaft front cover	a. Three screws (1) and lock-washers (2)	Remove.	Screws are 3/8-24 x 3/4 lg.
	b. Two screws (3) and lock-washers (4)	Remove.	Screws are 1/2-13 x 2 1/4 lg.
	c. Two screws (5) and lock-washers (6)	Remove.	Screws are 1/2-13 x 3 3/4 lg.
	d. Front cover (7)	<ol style="list-style-type: none"> <li>Strike the rear face of the ears on the cover with a soft hammer to free the cover from the dowels.</li> <li>Pull the cover straight off the end of the crankshaft.</li> </ol>	
	e. Gasket (8)	Remove.	Discard gasket.
	f. Dowels (9)	Remove if necessary.	
3. Oil seal front	a. Oil seal (10)	<ol style="list-style-type: none"> <li>Drive the seal out of front cover.</li> <li>Clean the seal bore in the front cover.</li> </ol>	Discard oil seal.
	b. Spacer (11) and Woodruff key (12)	Remove.	

3-97.3. CRANKSHAFT SEALS. (Cont).

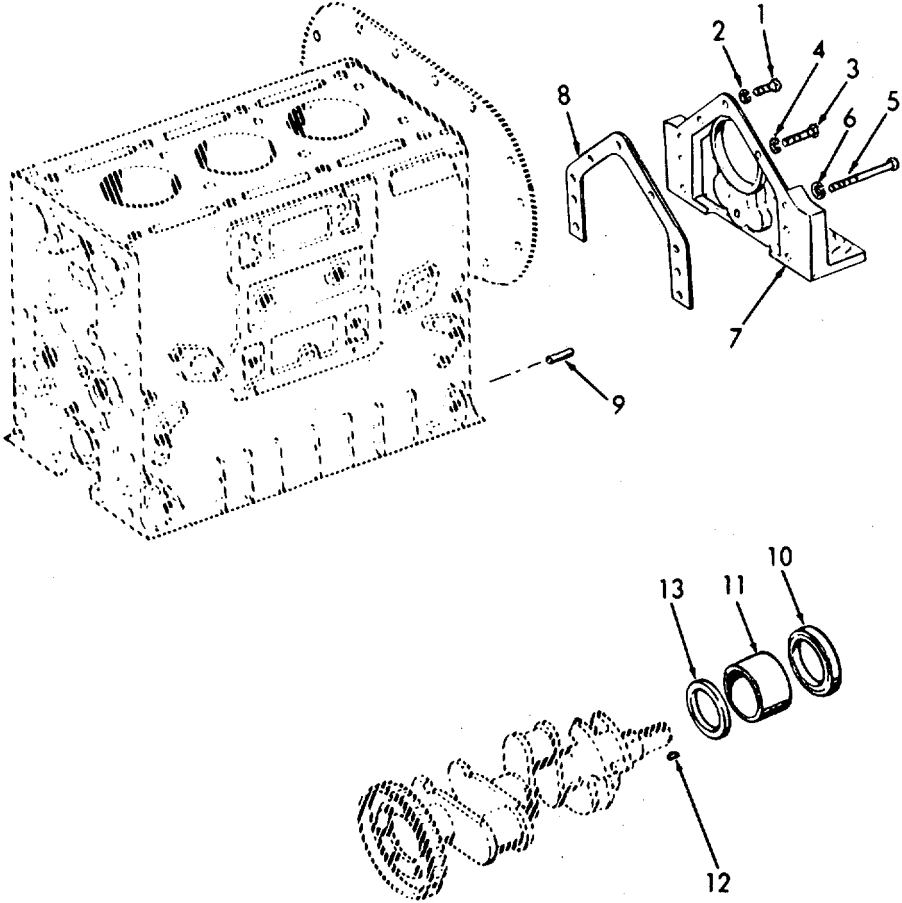
LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- c. Oil slinger (13) Remove.

NOTE

When necessary, an oil seal may be removed without removing the front cover or flywheel housing. This may be done by drilling diametrically opposite holes in the seal casing and threading metal screws, backed by flat washers, into the casing. Remove the seal by prying against the washers with pry bars.





**3-97.3. CRANKSHAFT SEALS. (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
4. Oil seal rear	a. Flywheel and flywheel housing	Remove.	Refer to paragraph 3-92.
	b. Oil seal (14)	1. Drive the seal out of the flywheel housing. 2. Clean the seal bore in the flywheel housing.	
	c. Spacer (15)	Remove.	
<b>INSPECTION</b>			
5. Engine	a. Oil seals rear (14) and spacer	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 (10) and spacer (11)	1. Inspect for wear or dirt build-up.  2. Check for oil leaks.	

**INSTALLATION**

**NOTE**

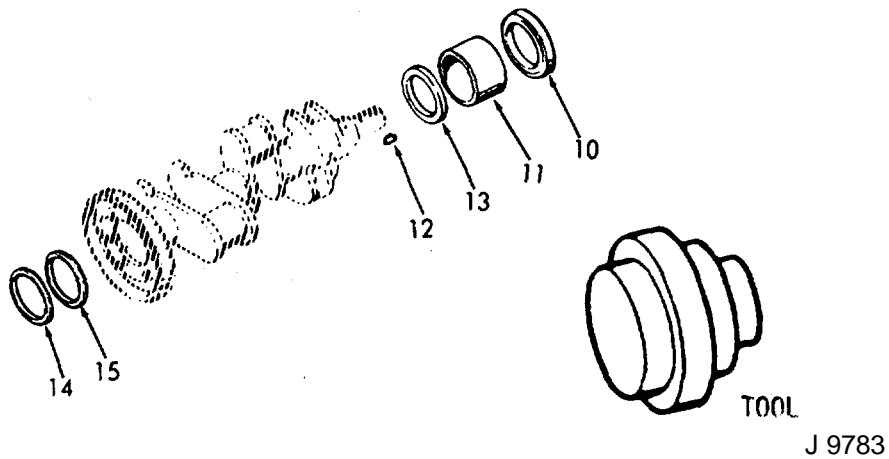
Oil seals are made of an oil resistant synthetic rubber which is pre-lubricated with a special lubricant. Do not remove this lubricant. Keep the sealing lip clean and free from scratches. In addition, a plastic coating which acts as a sealant has been applied to the outer surface of the casing. Do not remove this coating.

3-97.3. CRANKSHAFT SEALS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- |    |                |  |  |
|----|----------------|--|--|
| 6. | Front oil seal | <p>a. Oil slinger (13), spacer (11) and key (12)</p> <p>b. Oil seal (10)</p> | <p>Install slinger with the dished outer diameter of the slinger facing away from the gear.</p> <ol style="list-style-type: none"> <li>1. Coat the lip of the new oil seal lightly with grease or vegetable shortening. Then position the seal in the front cover with the lip of the seal pointed toward the inner face of the cover.</li> <li>2. Drive the seal into the front cover with installer J 9783. The installer prevents damage to the seal by exerting force only on the outer edge of the seal casing.</li> <li>3. Remove any excess sealant from the front cover and seal.</li> </ol> |
|----|----------------|--|--|



**3-97.3. CRANKSHAFT SEALS. (Cont).**

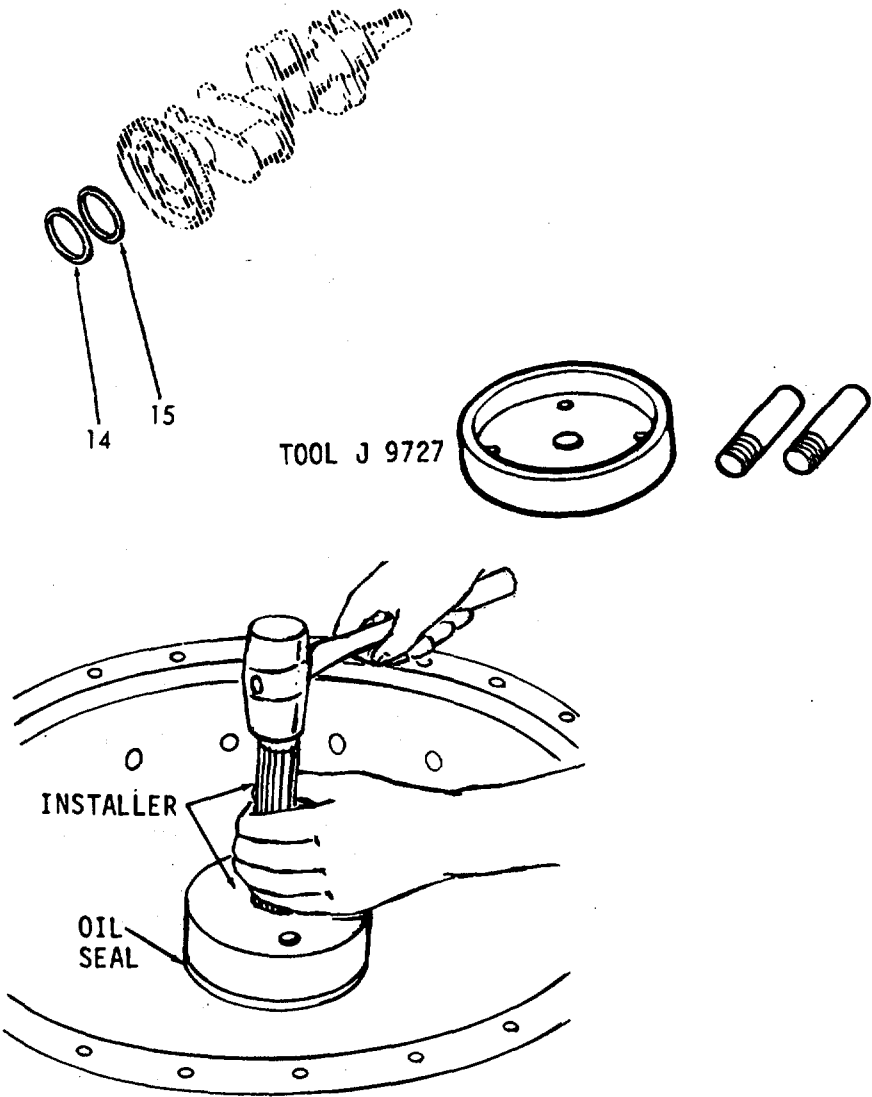
LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
7. Rear oil seal	<ul style="list-style-type: none"> <li>a. Spacer (15)</li> <li>b. Oil seal (14)</li> </ul>	<p>Install in spacer against the shoulder in the flywheel housing oil seal bore.</p> <ol style="list-style-type: none"> <li>1. Coat the lip of the oil seal lightly with engine oil (single-lip seal) or vegetable shortening (double-lip seal). Do not scratch or nick the sealing edge of the oil seal.</li> <li>2. Drive the seal into the housing with installer J 9727 and handle until it is seated against the seal spacer (if used) or on the shoulder in the housing bore. The installer prevents damage to the seal by exerting force only on the outer edge of the seal casing.</li> </ol>	<p>If it is necessary to install the oil seal with the flywheel housing on the engine, place oil seal expander against the end of the crankshaft. Then with the lip of the seal pointed toward the engine, slide the seal over the tool and on the crankshaft. Remove the seal expander and drive the seal in place with installer J 9727 and handle.</p>

3-97.3. CRANKSHAFT SEALS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- 3. Remove any excess sealant from the flywheel housing and the seal.



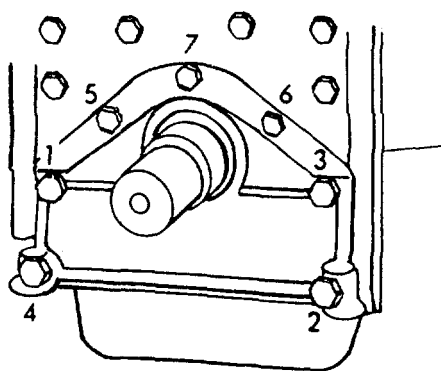
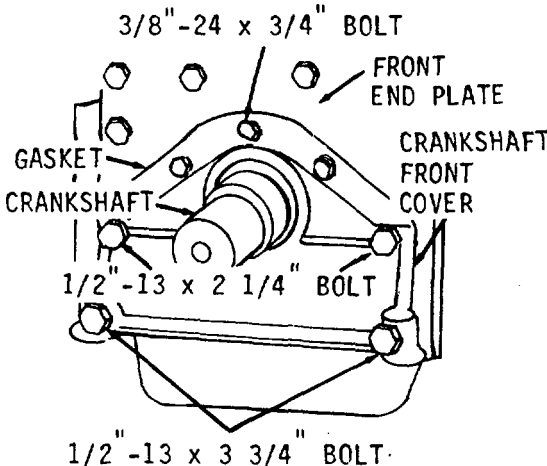
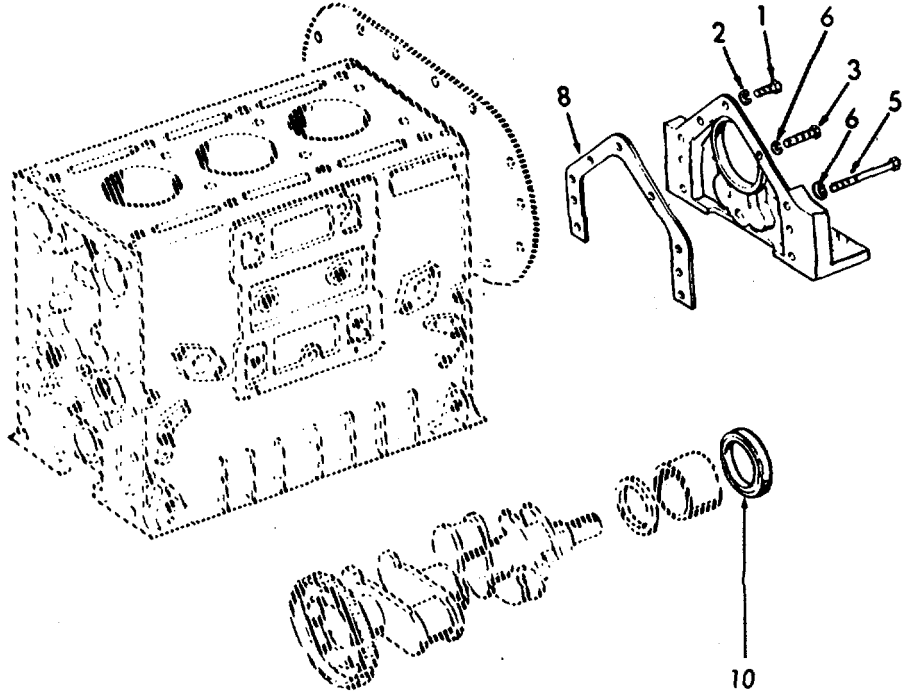
**3-97.3. CRANKSHAFT SEALS. (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
8. Front cover	a. Gasket (8)	Shellac a new gasket to the bolting flange of the front cover.	
	b. Oil seal (10)	Coat the lip of the seal lightly with cup grease.	
	c. Two screws (5) and lock washers (6)	Install.	Screws are 1/2-13 x 3 3/4 lg.
	d. Two screws (3) and lock-washers (6)	Install.	Screws are 1/2-13 x 2 1/4 lg.
	e. Three screws (1) and lock washers (2)	Install.	Screws are 3/8-24 x 3/4 lg.
	f. Screws (1, 3 and 5)	Tighten the cover attaching screws by following the tightening sequence shown. Follow this sequence as the screws are drawn up and then tightened to their proper torque to effect a good seal between the mating parts. Tighten the 3/8-24 screws to 25-30 lb-ft (34.1-41.0 Nm) and the 1/2-13 screws to 80-90 lb-ft (109.2-122.9 Nm) torque.	
9. Flywheel housing		Replace the flywheel housing and flywheel.	Refer to paragraph 3-92.

3-97.3. CRANKSHAFT SEALS. (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



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**3-98. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS.**

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- 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 integral 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 counterbore 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.

**3-98. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).**

This task covers:

- a. Inspection
- b. Repair

**INITIAL SETUP**

Test Equipment  
NONE

References  
NONE

Special Tools  
  
NONE

Equipment Condition   Condition Description  
para  
  
NONE

Material/Parts  
Gasket kit P/N 5196375

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

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. End plate gaskets	Inspect for leaking gaskets.	Replace.



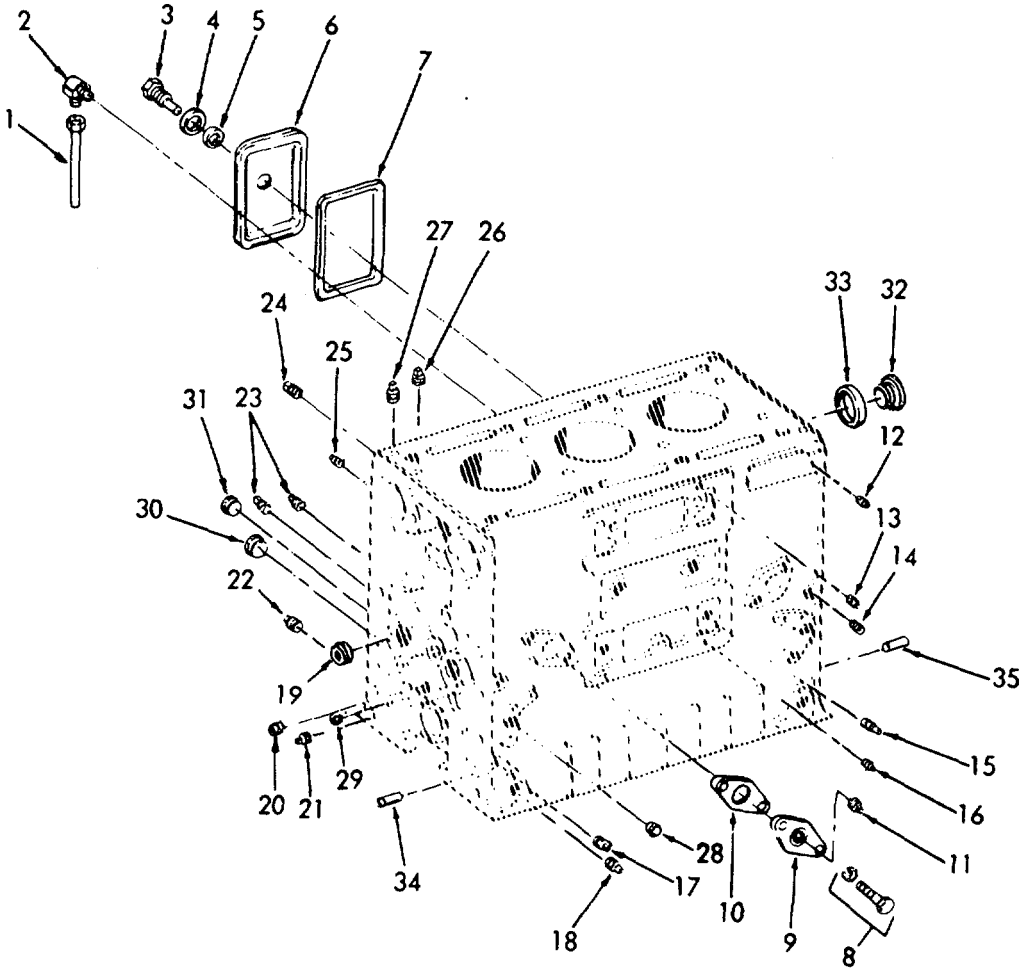
**3-98. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
2. Cylinder block	a. Air box drain	Remove tube (1) and elbow (2).	If damaged
	b. Air box cover	Remove bolt (3), flat washer (4), copper gasket (5), cover (6) and gasket (7).	If gasket is leaking
	c. Water hole cover	Remove bolt assemblies (8), cover (9), gasket (10) and pipe plug (11)	If gasket is leaking
	d. Pipe plugs (12 thru 26)	Replace.	If damaged
	e. Special plug (27)	Replace.	If damaged
	f. Plug cups (28 thru 31)	Replace.	If damaged
	g. Four plugs (32) and gasket (33)	Replace.	If gasket is leaking
	h. Dowel pins (34 and 35)	Remove, if damaged.	The dowels must exceed 5/8 inch from block.

3-98. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



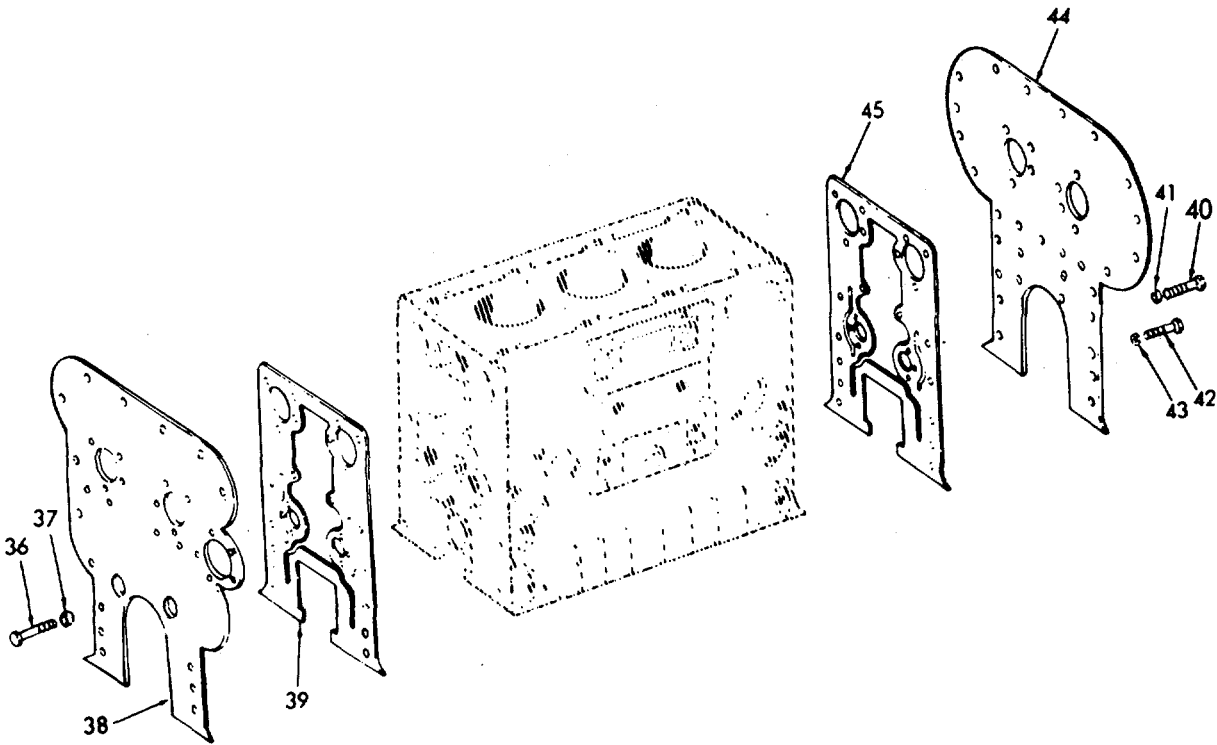
**3-98. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Cylinder block end rear plate	a. Six screws (36) and lock-washers (37)	Remove, if necessary.	
	b. Rear plate (38) and gasket (39)	Remove, if necessary.	
4. Cylinder Block front end plate	a. Six screws (40) and lock-washers (41)	Remove, if necessary.	
	b. Two screws (42) and lock-washers (43)	Remove, if necessary.	
	c. Front end plate (44) and gasket (45)	Remove, if necessary.	

3-98. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



**3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS.**

- a. The instrument panel consists of an engine oil pressure gage, an ammeter gage and water temperature gage. The engine starting and stopping controls are mounted in various locations.
- b. 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.
- c. Water Temperature Gage. The engine coolant temperature is registered on the water temperature gage.
- d. 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.
- e. Engine Ammeter. The engine ammeter indicates the amount of electrical energy created to power the alarm system.

**This task covers:**

- a. Inspection**
- b. Repair**

**INITIAL SETUP**

Test Equipment  
NONE

References  
NONE

Special Tools  
NONE

Equipment  
Condition Condition Description  
Para  
NONE

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

**3-99. INSTRUMENT PANEL MAINTENANCE INSTRUCTIONS (Cont).**

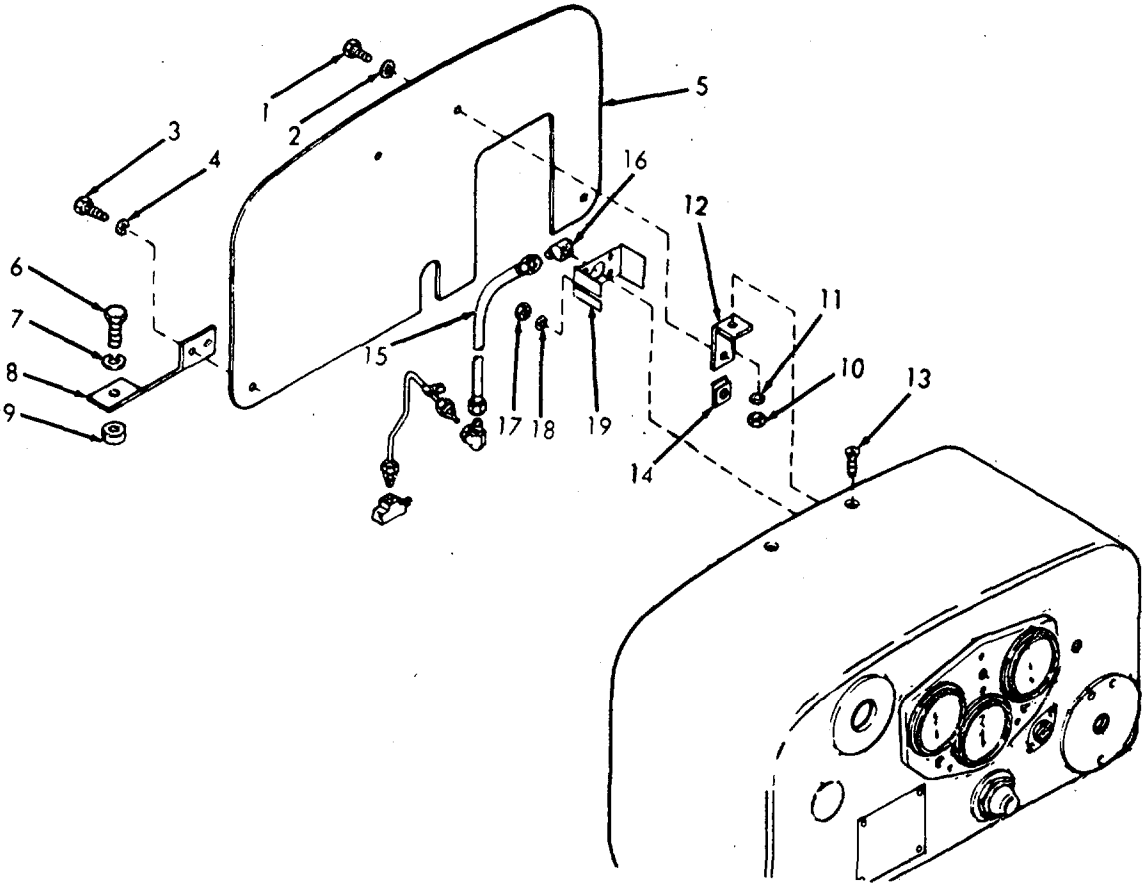
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Instrument panel	a. Oil pressure gage	1. Inspect for broken glass, bent pointer and other signs of damage.	Defective gage or tubing.
		2. Presence of water in gage.	
		3. With engine running, does gage function and indicate properly.	
	b. Water temperature gage	1. Inspect for broken glass, bent pointer and other signs of damage.	Defective gage or tubing.
		2. Presence of water in gage.	
		3. With engine running, does gage function and indicate properly.	
c. Start switch	Inspect for proper operation.		

**3-99. INSTRUMENT PANEL MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
2. Instrument panel cover	a. Two screws (1) and flat-washers (2)	Remove.	
	b. Two screws (3) and lock-washers (4)	Remove.	
	c. Cover (5)	Lift up and remove.	
3. Upper bracket	a. Screws (6) and lock-washers (7)	Remove.	
	b. Brackets (8) and spacers (9)	Remove.	
4. Panel bracket	a. Nuts (10), lock-washers (11), brackets (12) and screws (13)	Remove.	
	b. Spring locknut (14)	Remove, if necessary.	

3-99. INSTRUMENT PANEL MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
5. Oil Pressure gage	a. Flexible hose (15)	Loosen at hose nuts.	Remove hose.
	b. Elbow (16)	Remove.	
	c. Nuts (17) and lock-washers (18)	Remove.	
	d. Gage clamp (19)	Remove.	





3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).

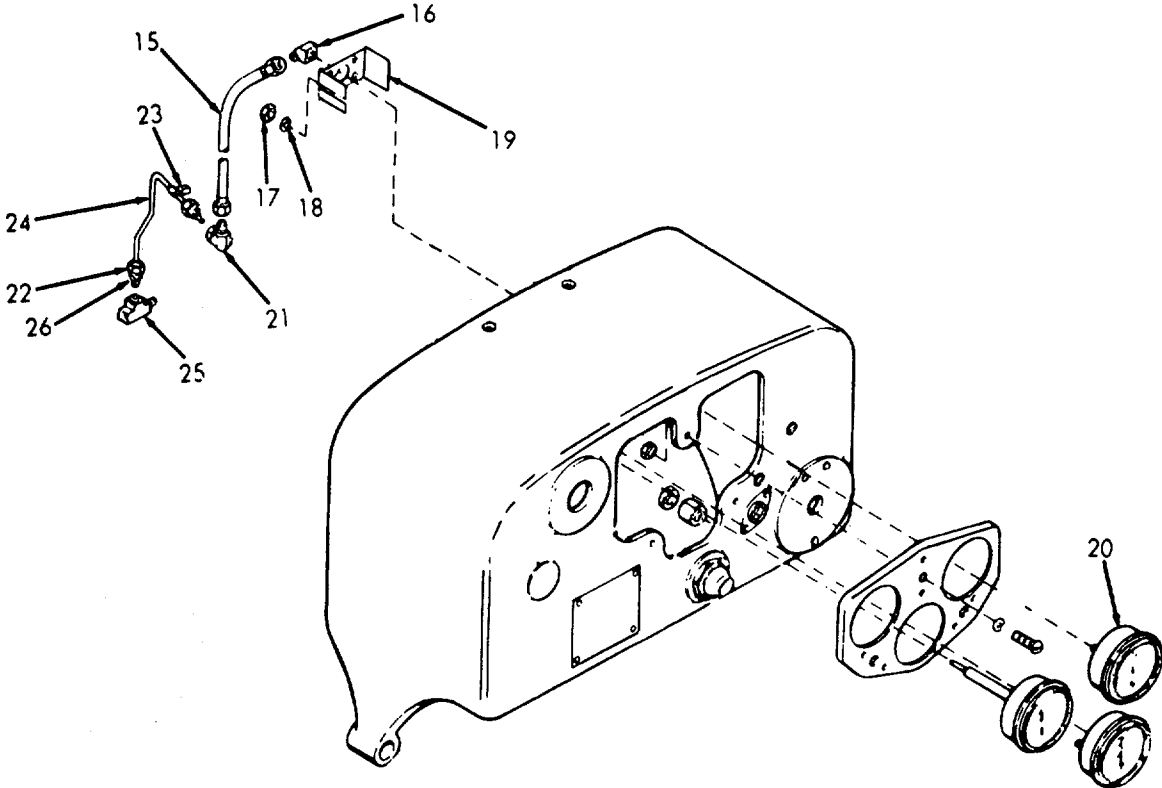
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Gage (20)	Remove.	
	f. Elbow (21)	Remove.	
	g. Connec- tor (22)	Loosen	
	h. Tube clip (23)	Loosen.	
	i. Tube (24)	Remove.	
	j. Pipe tee (25)	Remove.	
	k. Restric- tion fitting (26)	Replace, if necessary.	
	l. Pipe tee (25)	Install.	
	m. Tube (24)	Install.	
	n. Tube clip (23)	Install.	
	o. Connec- tor (22)	Tighten	
	p. Elbow (21)	Install.	
	q. Gage (20)	Install.	

3-99 INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- r. Gage clamp (19) Install.
- s. Nuts (17), lock-washers (18), and elbow (16) Install
- t. Flexible Install hose (15)



**3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

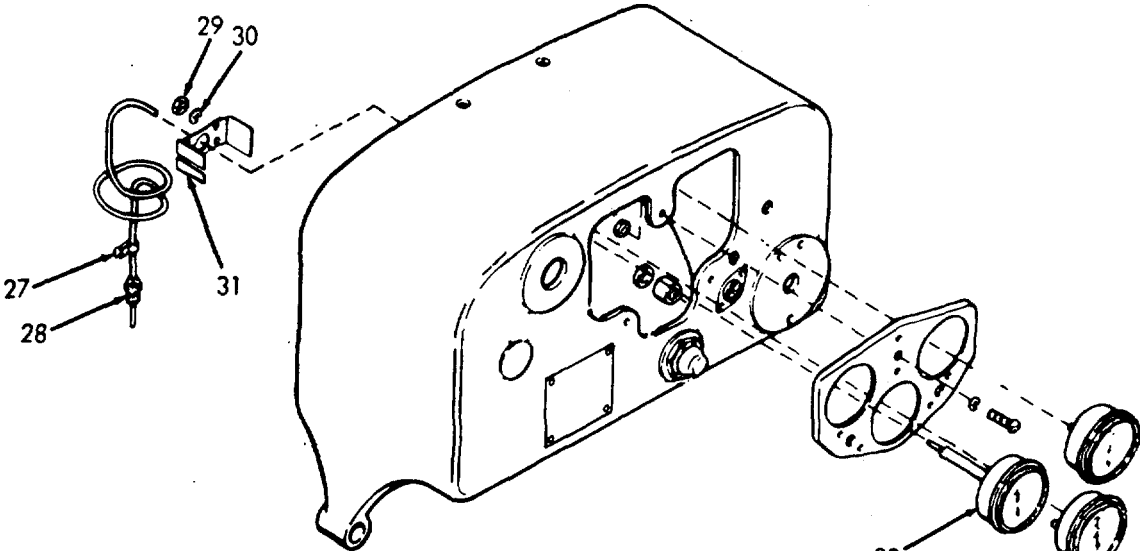
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Water temperature gage	a. Clip (27)	Remove.	
	b. Adaptor	Remove. (28)	
	c. Nuts (29), lock-washers (30) and gage clamp (31)	Disassemble.	
	d. Gage (32)	Remove.	
	e. Gage (32)	Install.	
	f. Gage clamp (31), nuts (29) and lock-washers (30)	Assemble	Incorrect coolant temperature readings will be registered if the gage assembly is incorrectly installed or the capillary tube is damaged.
	g. Clip (27)	Install	To prevent damage to the gage assembly from vibration, the capillary tube must be securely fastened to the engine the full length with suitable clips at intervals of ten inches or less.

3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

Sharp bends in the tube must be avoided, particularly at the gage or bulb connection areas. Where the tube must be bent around any object, the bend must not be less than one inch 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.



**3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Adaptor Install. (28)		
7. Ammeter	a. Wiring	Tag and disconnect wires.	
	b. Nut (33) and lock-washers (34)	Remove.	
	c. Clamp (35)	Remove.	
	d. Ammeter	Remove (36)	
	e. Ammeter (36)	Install	
	f. Clamp (35)	Install.	
	g. Nuts (33) and lock-washers (34)	Install.	
	h. Wiring	Reconnect.	
8. Start switch	a. Wiring	Tag and disconnect	
	b. Nut (37)	Remove.	On front of panel
	c. Remove as a unit: lock-washer (38), flat-washer (39), switch (40), and nut (41)	Remove.	

3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).

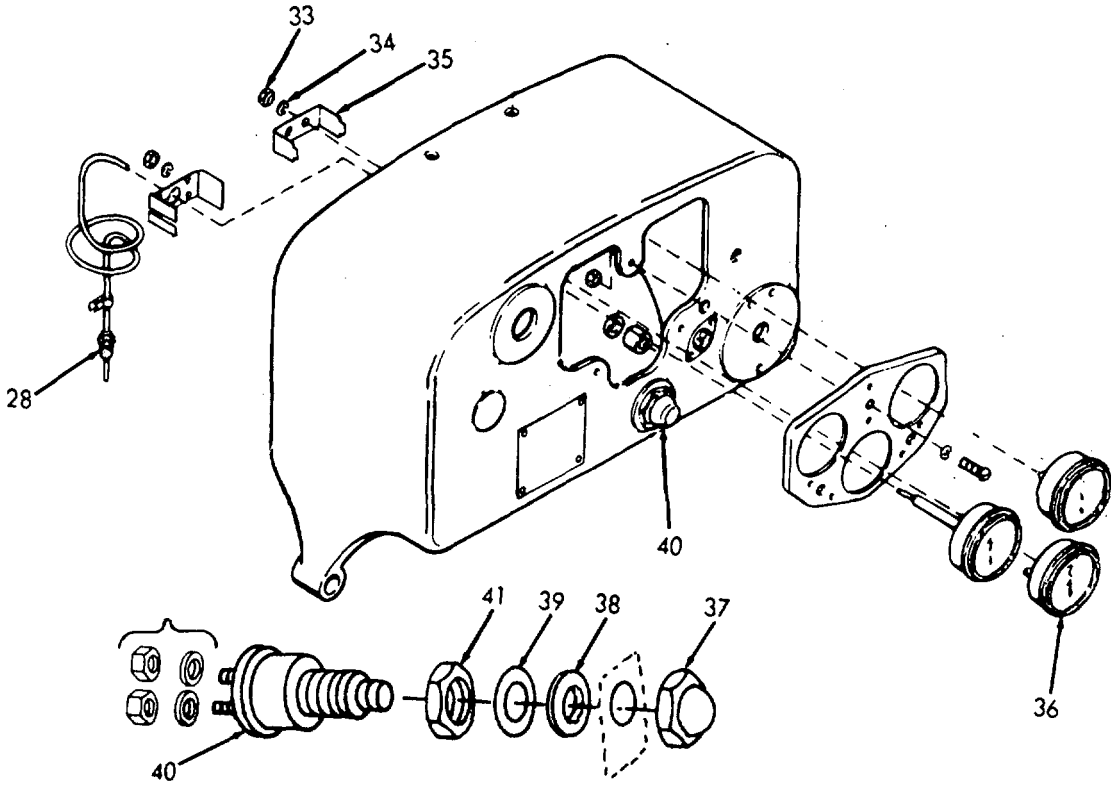
LOCATION	ITEM	ACTION	REMARKS
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REPAIR (cont)

d. Install as a unit: switch (40) nut (41) flat washer (39) and lockwasher (38)	Assemble.	Position assembled switch in panel. Adjust nut (41) as required.
---	-----------	--

e. Nut (37)	Install.	Torque to 36-48 in-lbs (4.07-5.42 Nm).
-------------	----------	--

f. Wiring	Reconnect.	
-----------	------------	--



**3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
9. Panel Cluster	a. Three nuts (42), pan head-screws (43) and lock-washers (44)	Remove.	
	b. Panel cluster (45)	Remove.	
	c. Vibration mounts (46)	Remove, if necessary.	
	d. Panel cluster (45), screws (43), lock-washers (44) and nuts (42)	Reassemble.	
10. Instrument Panel	a. Screw (47 and lock-washer 48)	Remove.	
	b. Nut (49), flat-washer (50), bracket (51), screw (52) and lock-washer (53)	Remove.	

3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

d. Screw (54), flat-washer (55) and spacers (56 and 57)

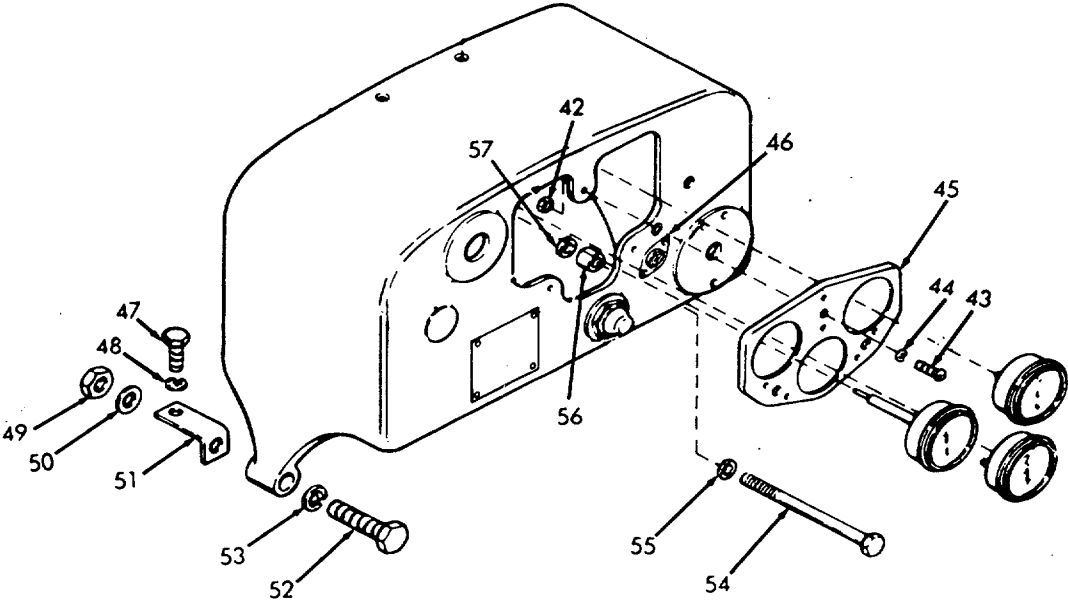
Install.

e. Screw (52), lock-washer (53), bracket (51), flat washer (50) and nut (49)

Install.

f. Screw (47) and lockwasher (48)

Install.





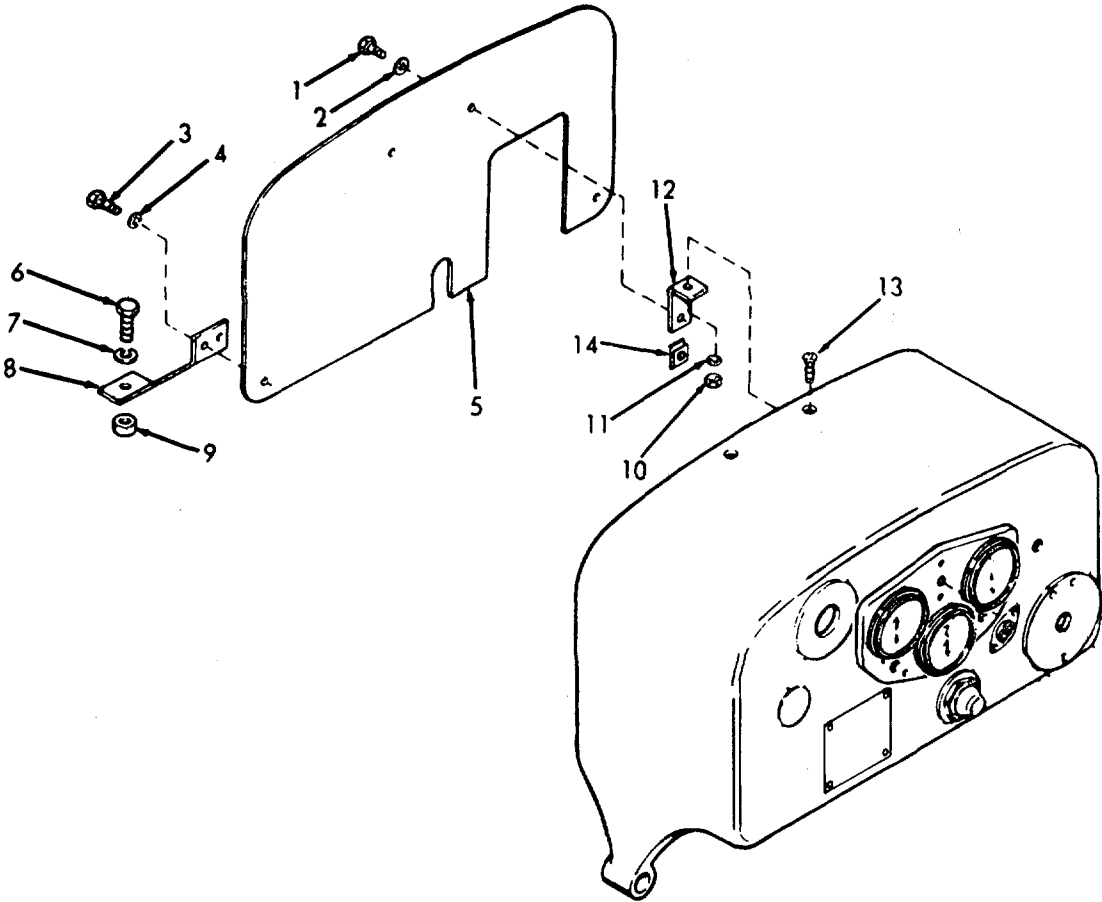
**3-99. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
11. Instrument Panel cover	a. Screws (13), bracket (12), lock- washer (11) and nuts (10)	Reassemble.	
	b. Screws (6), lock- washers (7), brackets (8) and spacers (9)	Reassemble.	
	c. Cover (5)	Lower in place.	
	d. Two screws (3) and lock- washers (4)	Install.	
	e. Two screws (1) and flatwash- ers (2)	Install.	

3 99. INSTRUMENT PANEL MAINTENANCE INSTRUCTIONS (Cont ).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



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**3-100. STARTING AID - MAINTENANCE INSTRUCTIONS.**

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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.
  
- To assist engine starting in low temperatures
- use the cold weather starting device.

**NOTE**

- The starting aid is not intended to correct defici-
- encies but for use when other conditions are normal
- and air temperature is too low for heat of compres-
- sion to ignite the fuel-air mixture.

**3-1745**

**3-100. STARTING AID - MAINTENANCE INSTRUCTIONS (Cont).**

This task covers

- |                             |                                  |               |
|-----------------------------|----------------------------------|---------------|
| a. Inspection<br>b. Service | c. Replacement<br>d. Disassembly | e. Reassembly |
|-----------------------------|----------------------------------|---------------|

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition Condition Description  
Para

NONE

Material/Parts

Cylinder starting aid  
LP-535  
Valve repair kit LP-3250

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all CAUTIONS.

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

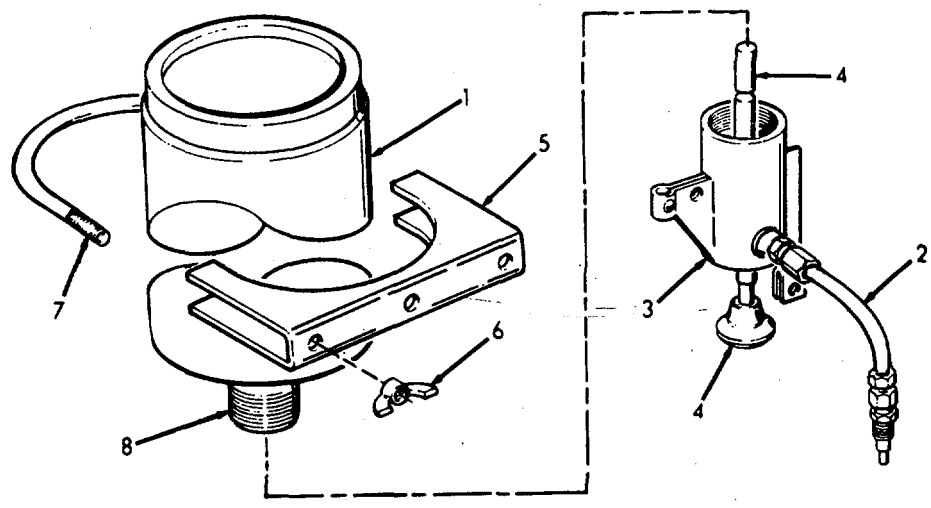
- |                         |   |  |
|-------------------------|---|--|
| 1. Start-<br>ing<br>aid | Cylinder<br>(1)                                       | a. Visually inspect for<br>wear and cracks.<br><br>b. Check for fluid leak-<br>age.  |
| 2. Engine               | Atomizer<br>and fill-<br>ing valve<br>assembly<br>(2) | a. Visual.<br><br>b. Check fitting valve<br>for wear, cracks, and<br>leakage.<br><br>c. Check atomizer for<br>wear, cracks and<br>leakage. |

**3-100. STARTING AID - MAINTENANCE INSTRUCTIONS (Cont).**

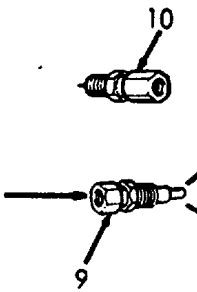
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
3. Start- ing aid	Body quick start (3)	a. Visually inspect for wear and cracks.  b. Check for leakage.	
4.	Pin as- sembly (4)	Check for wear and cracks.	

**SERVICE**

5. Start- ing 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.
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**3-100. STARTING AID - MAINTENANCE INSTRUCTIONS (Cont).**

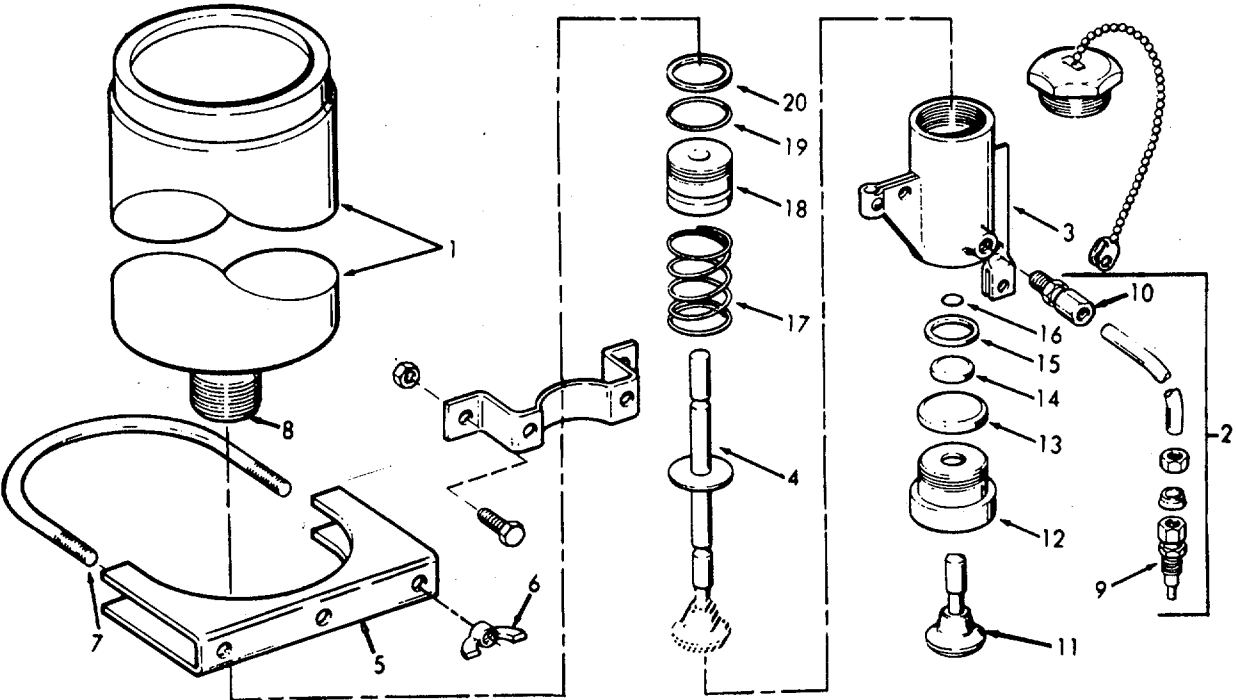
LOCATION	ITEM	ACTION	REMARKS
<b>REPLACEMENT</b>			
6. Engine	Atomizer and fitting valve assembly (2)	<ul style="list-style-type: none"> <li>a. Remove atomizer (9) and fitting valve (10).</li> <li>b. Remove dirt from atomizer orifice (9) and screen.</li> <li>c. Blow air through orifice end only.</li> <li>d. Replace atomizer (9) and fitting valve (10) to assembly (2)</li> </ul>	 <p>The diagram consists of two parts. The top part shows a small cylindrical component labeled '10' with a hexagonal base. The bottom part shows a larger assembly labeled '9' with a central orifice and several arrows pointing outwards, representing air flow.</p>
<b>DISASSEMBLY</b>			
7. Starting aid	Pin assembly (4)	<ul style="list-style-type: none"> <li>a. Remove knob (11).</li> <li>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).</li> </ul>	Discard.
8. Starting aid	Body quick start (3)	<ul style="list-style-type: none"> <li>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).</li> <li>b. Install knob (11).</li> <li>c. Lubricate pin assembly (4) and gasket (20).</li> </ul>	Replace with new parts.

3-100. STARTING AID - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REASSEMBLY (Cont)

9.	Cylinder (1)	<p>a. Lubricate valve (8).</p> <p>b. Screw cylinder (1) into body quick-start (3).</p> <p>c. Install U-bolt (7) and wing nut (6) on clamp (5).</p>	Hand tight.
10.	Atomizer and fitting valve assembly (2)	<p>a. Check for fluid leakage on engine air inlet housing.</p> <p>b. Actuate starting aid with engine stopped.</p>	If leakage occurs - disassemble and retighten air inlet housing fitting to housing.



**3-101. HYDROSTARTER - MAINTENANCE 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

References

Refer to paragraph 3-105 for forward engine room piping and to paragraph 3-106 for aft engine room piping.

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

Teflon tape

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |                  |               |  |  |
|------------------|---------------|--|--|
| 1. Hydro-starter | Hydro-starter | <ul style="list-style-type: none"> <li>a. Check for leaks, cracks, dents or wear.</li> <li>b. Check inlet and outlet connections for leaks.</li> <li>c. Check gasket for leaks.</li> </ul> |  |
|------------------|---------------|--|--|



3-101. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Cont).

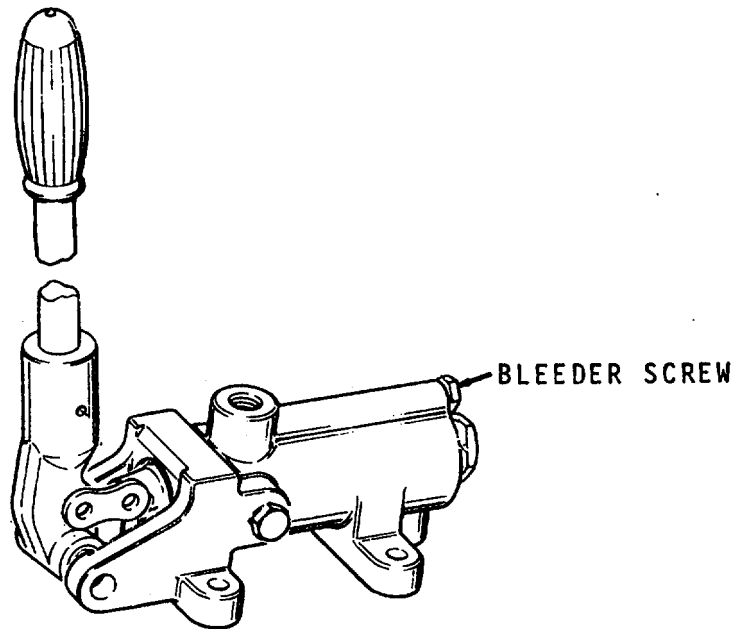
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT

**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.

- |                    |                |   |
|--------------------|----------------|---|
| 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. |
| 3. Hydraulic hoses | a. Inlet hose  | Disconnect from hydrostarter.   |
|                    | b. Outlet hose | Disconnect from hydrostarter.   |

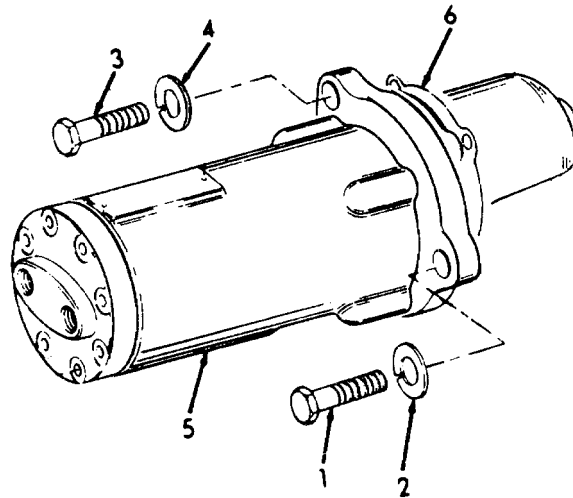


3-101. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Cont).

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

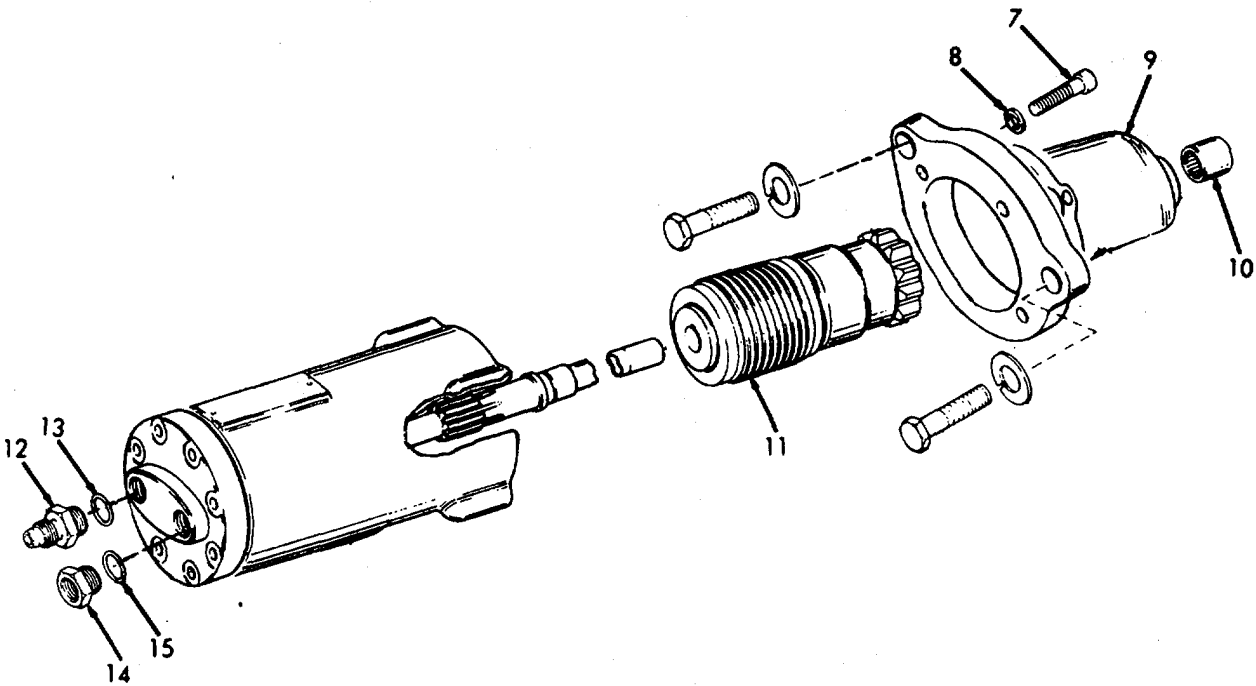
5. Hydro-Starter	a. Hydro-starter	1. Clamp motor in a vise.	
		2. Remove screws (7) and lockwashers (8).	
		3. Remove pinion gear housing (9).	Inspect for cracks and damage.
		4. Remove needle bearing (10)	Inspect for damage or wear. Replace, if necessary.

3-101. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

- 5. Slide Bendix drive assembly (11) off shaft. Inspect drive for worn, or chipped teeth. Inspect spring for damage or breaks.
- 6. Remove hose adapter (12) and O-ring gasket (13). Remove only if damaged. If removed discard adapter and gasket.
- 7. Remove hose adapter (14) and O-ring gasket (15). Remove only if damaged. If removed, discard adapter and gasket.



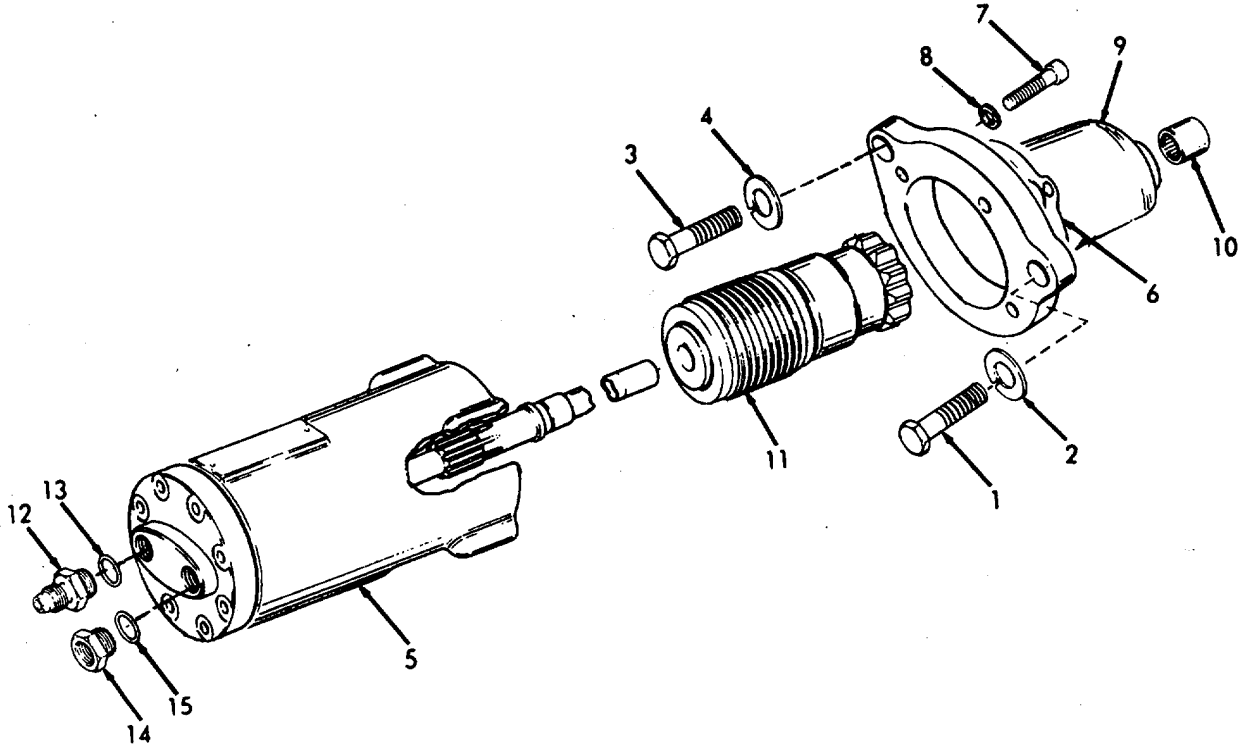
3-101. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	b. Hydro-starter	1. Install Bendix drive assembly (11).	Lubricate with light oil before assembly.
		2. Install needle bearing (10) into pinion gear housing (9).	Lubricate with light oil before assembly.
		3. Install pinion gear housing (9) with lockwashers (8) and screws (7).	
		4. Install hose adapter (12), and O-ring gasket (13).	Use new gasket and adapter.
		5. Install hose adapter (14) and O-ring gasket (15).	Use new gasket and adapter.
<b>INSTALLATION</b>			
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 inlet.	
		f. Install outlet hose to outlet.	
7. Hand pump	Hand pump	Operate until all air is purged from the system.	Refer to paragraph 3-104.

3-101. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



**3-102. ACCUMULATOR - MAINTENANCE 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 preloaded with nitrogen through a small valve and sealed at the time of manufacture. A seal ring which is 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, compressing the nitrogen and stores energy to operate the system.
- e. Service replacement accumulators are supplied with a precharge of nitrogen (1250 ±50 psi (8691 ±345 kpa)).

This task covers:

a. Removal

b. Installation

INITIAL SETUP:

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment  
Condition    Condition Description  
Para  
NONE

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

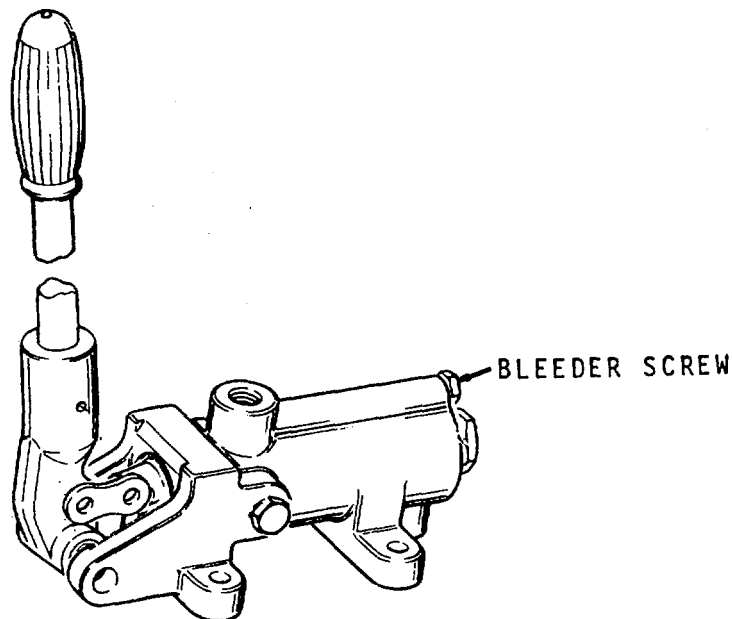
General Safety Instructions  
Observe WARNINGS in this procedure.

3-102. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1.	Accumulator	a. Visually inspect accumulator cylinder for leakage. b. Apply a light oil or soapy solution on the end of the accumulator.	Bubbling indicates a leak, 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.
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**3-102. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**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 injury to personnel or equipment.

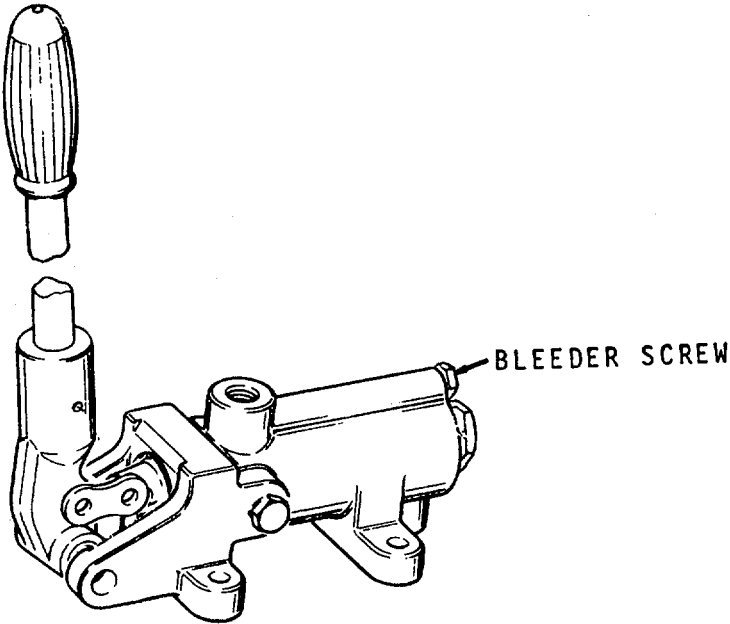
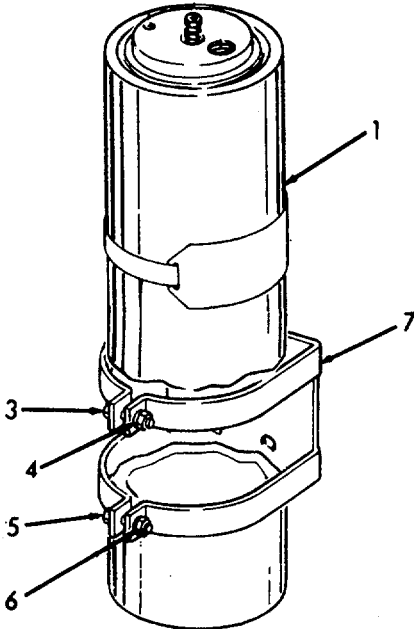
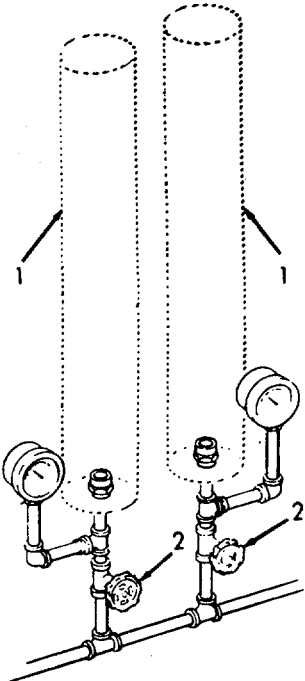
- |    |                    |   |  |
|----|--------------------|---|--|
| 5. | Accumulator<br>(1) | <ul style="list-style-type: none"> <li>a. Turn shut off valve (2) clockwise to close.</li> <li>b. Remove capscrews (3 and 5) and nuts (4 and 6) from bracket (7).</li> <li>c. Unscrew accumulator (1) from piping.</li> <li>d. Replace accumulator (1) with a new cylinder supplied with a precharge of nitrogen (1250 + 50 psi (8919 + 345 kPa)).</li> <li>e. Install capscrews (3 and 5) and nuts (4 and 6) to bracket (7).</li> <li>f. Open shut-off valve by rotating counter-clockwise.</li> </ul> |  |
| 6. | Hand pump          | <ul style="list-style-type: none"> <li>a. Close bleeder screw valve.</li> <li>b. Operate to pressurize system.</li> </ul>   |  |



3-102. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT (Cont)



**3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS**

a. The hydrostarter charging pump maintains a pressure of approximately 2900-3300 psi (19996 - 22754 kPa) in the accumulator. Do not drive pump at a speed over 2500 rpms. The pump body has an unloading valve. The unloading valve 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. Removal

b. Installation

INITIAL SETUP:

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment  
Condition    Condition Description  
Para  
NONE

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
Observe all CAUTIONS AND WARNINGS in this procedure.

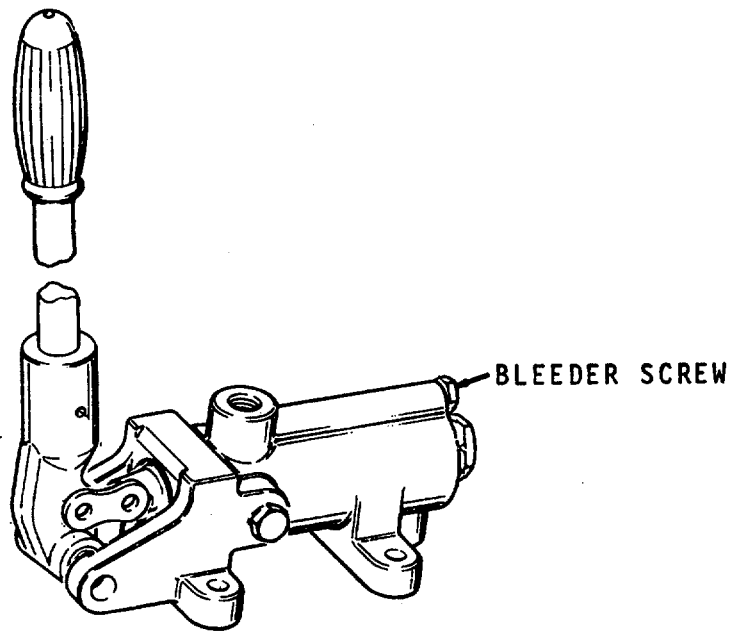
**3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Engine	Charging pump assembly	<ul style="list-style-type: none"> <li>a. Check for cracks, dents, and wear.</li> <li>b. Check for leaks.</li> </ul>	
2.	Housing assembly	<ul style="list-style-type: none"> <li>a. Check for cracks, dents, and wear.</li> <li>b. Check for leaks.</li> </ul>	
3.	Supply hose	<ul style="list-style-type: none"> <li>a. Check fittings.</li> <li>b. Check for leaks.</li> <li>c. Check for cracks, breaks, or wear.</li> </ul>	
4.	Pressure hose	<ul style="list-style-type: none"> <li>a. Check fittings.</li> <li>b. Check for leaks.</li> <li>c. Check for cracks, breaks, or wear.</li> </ul>	
5.	Return hose	<ul style="list-style-type: none"> <li>a. Check fittings.</li> <li>b. Check for leaks.</li> <li>c. Check for cracks, breaks, or wear.</li> </ul>	

**3-1761**

3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL</b>			
6. Hand pump	a. Bleeder screw valve	Release the oil pressure in the system by opening bleeder screw valve on side of the hand pump about 1/2 turn.	



**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.

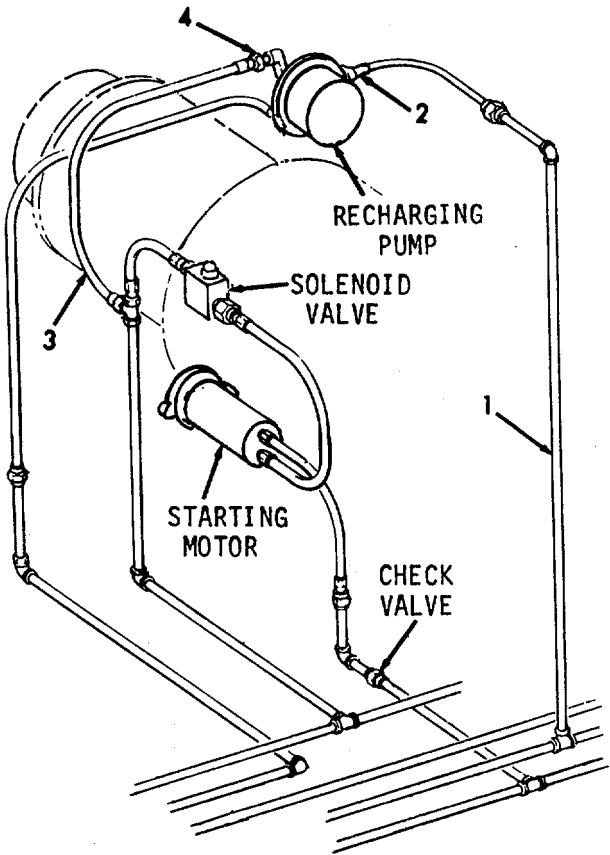
7.	Supply hose	a. Clean exterior dirt off. b. Disconnect supply hose (1) at swivel fitting (2).
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3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

		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 out dirt.	Use masking tape.



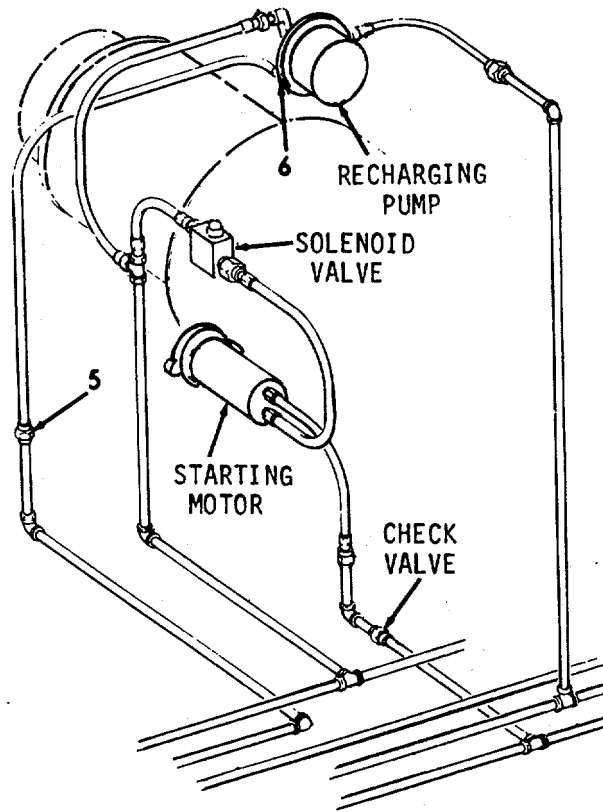
Diesel Generator Engine Connections

3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL (Cont)

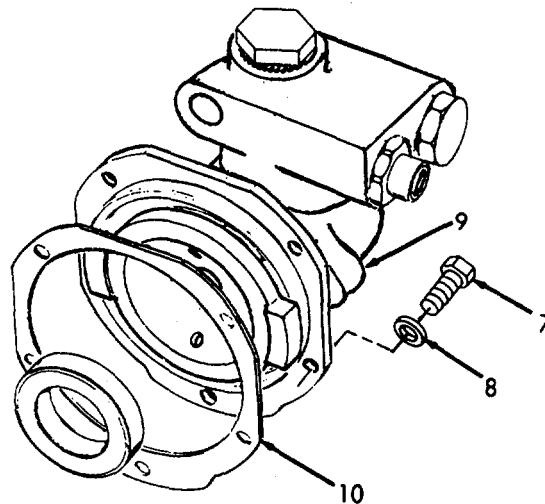
9.	Return hose	<ol style="list-style-type: none"> <li>a. Clean exterior dirt off.</li> <li>b. Disconnect return hose (5) at swivel fitting (6).</li> <li>c. Tape hose end to keep dirt out.</li> </ol>	Use masking tape.
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*Diesel Generator Engine Connections*

**3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL (Cont)</b>			
10.	Charging pump	<ol style="list-style-type: none"> <li>Remove five capscrews (7) and lockwashers (8).</li> <li>Remove charging pump (9) from fly wheel housing.</li> <li>Remove gasket (10).</li> </ol>	
<b>INSTALLATION</b>			
11. Engine driven pump	Charging pump	<ol style="list-style-type: none"> <li>Align the tangs on the pump drive with the slots in the drive plate.</li> <li>Install gasket (10) and charging pump (9).</li> </ol>	Use a new gasket. Use Permatex #2 sealant on the flywheel side only.



**3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).**

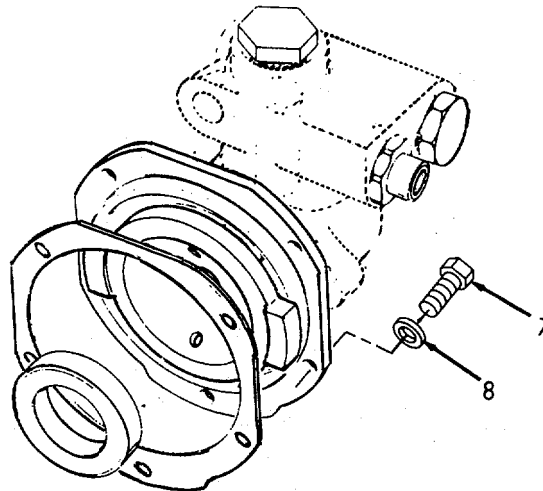
LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION (Cont)**

- c. Install five lock-washers (8) and cap-screws (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.

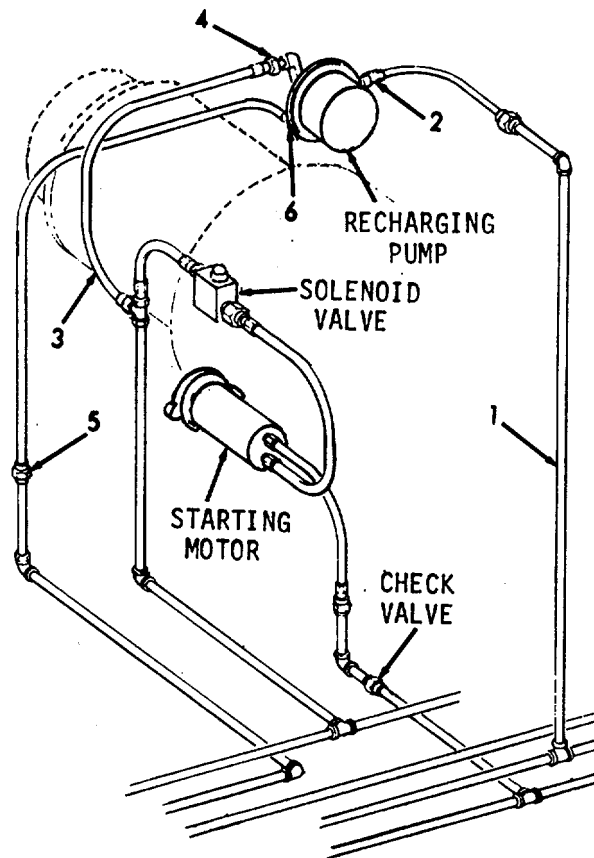


- |     |             |  |
|-----|-------------|--|
| 12. | Return hose | <ul style="list-style-type: none"> <li>a. Remove tape from hose.</li> <li>b. Connect return hose (5) at swivel fitting (6).</li> </ul> |
|-----|-------------|--|



3-103. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION (Cont)</b>			
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 Valve	Bleeder screw	Close and pressurize system.



*Diesel Generator Engine Connections*

**3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS**

a. The hand pump is a single piston 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. Assembly |                 |

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

Repair kit KT202565

Special Environmental Conditions

NONE

Personnel Required

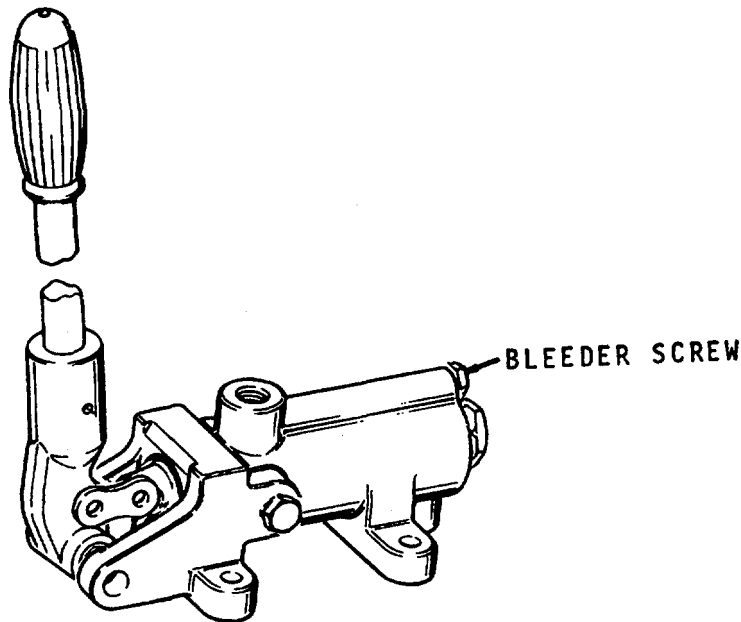
1

General Safety Instructions

Observe WARNINGS in this procedure.

**3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1.	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, and wear. Check to see that hoses are installed properly.	
<b>REMOVAL</b>			
4.	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.	



**3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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**REMOVAL (Cont)**



The oil pressure in this 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.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>b. Hand pump assembly</li> </ul> | <ul style="list-style-type: none"> <li>a. Clean exterior dirt from hand pump and hydraulic hoses.</li> <li>b. Disconnect hydraulic hoses at the pump.</li> <li>c. Remove nut (1), lock-washer (2), and cap-screw (3) and lift pump from its mounting.</li> </ul> |
|---|--|

**REPAIR**

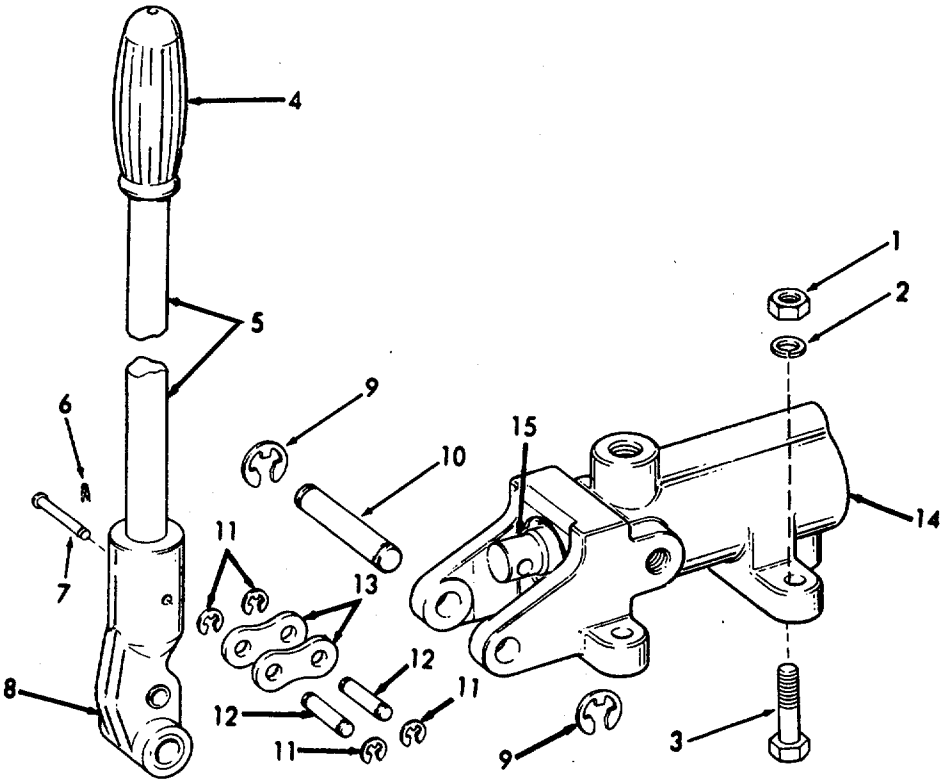
- |  |   |   |  |
|--|---|---|--|
| <ul style="list-style-type: none"> <li>5.</li> </ul> | <ul style="list-style-type: none"> <li>Pump handle</li> </ul> | <ul style="list-style-type: none"> <li>a. Pull pump handle grip (4) from hand pump operating handle (5).</li> <li>b. Remove cotter pin (6), pin (7). Then lift handle (5) from operating lever (8).</li> <li>c. Remove retaining rings (9) from clevis pin (10).</li> <li>d. Remove retaining ring (11), clevis pin (12), links (13), to remove hand pump operating lever (8) from the pump body (14).</li> </ul> | <ul style="list-style-type: none"> <li>Only if grip is damaged.</li> </ul> |
|--|---|---|--|

3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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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 the pump body (14).



**3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
		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 (35) and O-ring gasket (36).
		g. Remove pipe plugs (37 and 38).	If necessary.
<b>ASSEMBLY</b>			
7.	Pump body	Plunger	a. Install O-ring gasket (34), back-up ring (33), plunger gland (32), O-ring gasket (31), back-up ring
			Thoroughly soak new back-up rings (30, 33, 35) in warm oil. Use ring (33) and gasket (34).

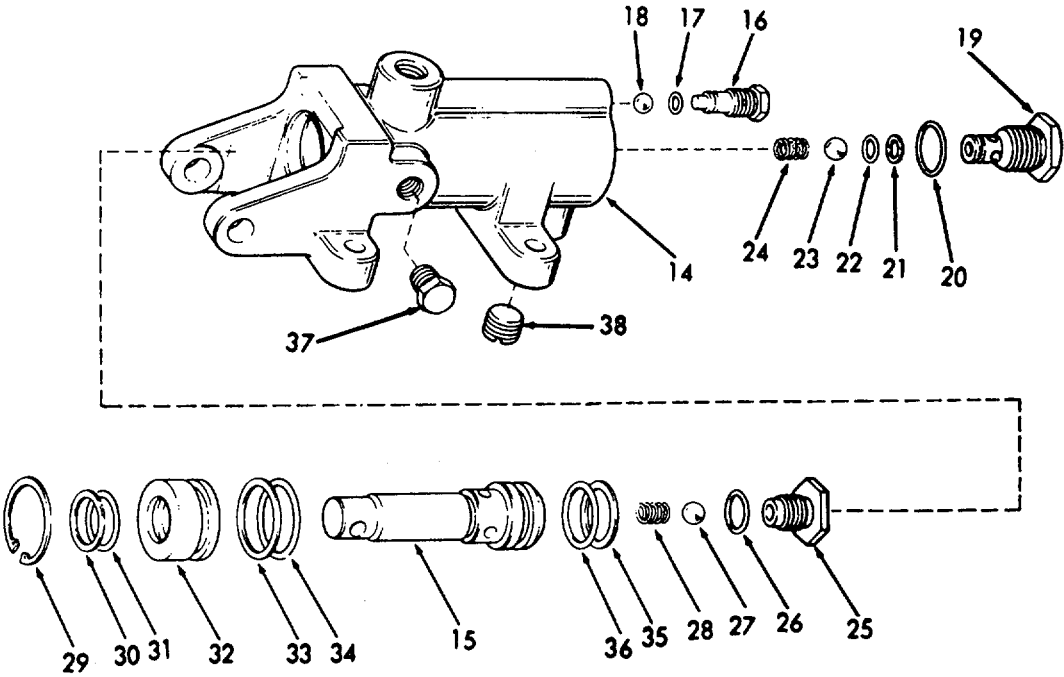
3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

		<p>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 on plunger (25).</p>	<p>Use repair kit for back-up ring (35), O-ring gasket (36) spring (28), and O-ring gasket</p>
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8.	Inlet oil fitting valve (26)	<p>Install spring (24), ball valve (23), O-ring gasket (22), back-up ring (21), O-ring gasket (20) and inlet oil fitting (19), into pump body (14).</p>	<p>Use repair kit for spring (24), O-ring gasket (20) back-up ring (21) and O-ring gasket (22).</p>
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**3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>ASSEMBLY (Cont)</b>			
9.	Bleeder screw valve	<ol style="list-style-type: none"> <li>a. Install O-ring gasket (17), on bleeder screw valve (16).</li> <li>b. Insert bleeder ball valve (18) in place.</li> <li>c. Secure with bleeder screw valve (16).</li> </ol>	Use repair kit for O-ring gasket (17).
10.	Handle	<ol style="list-style-type: none"> <li>a. Install retaining rings (11), clevis pin (12), links (13) to hand pump operating lever (8) and piston (15).</li> <li>b. Insert clevis pin (10), and retaining ring (9) to hand pump operating lever (8) and pump body (14).</li> <li>c. Insert handle (5), pin (7), and cotter pin (6) in hand pump operating lever (8).</li> <li>d. Install grip (4).</li> </ol>	
<b>INSTALLATION</b>			
11.	Hand pump assembly	<ol style="list-style-type: none"> <li>a. Place hand pump on its mounting.</li> <li>b. Attach to mount with capscrews (3), lockwashers (2) and nuts (1).</li> <li>c. Connect the hydraulic hoses to pump.</li> </ol>	



3-104. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Cont).

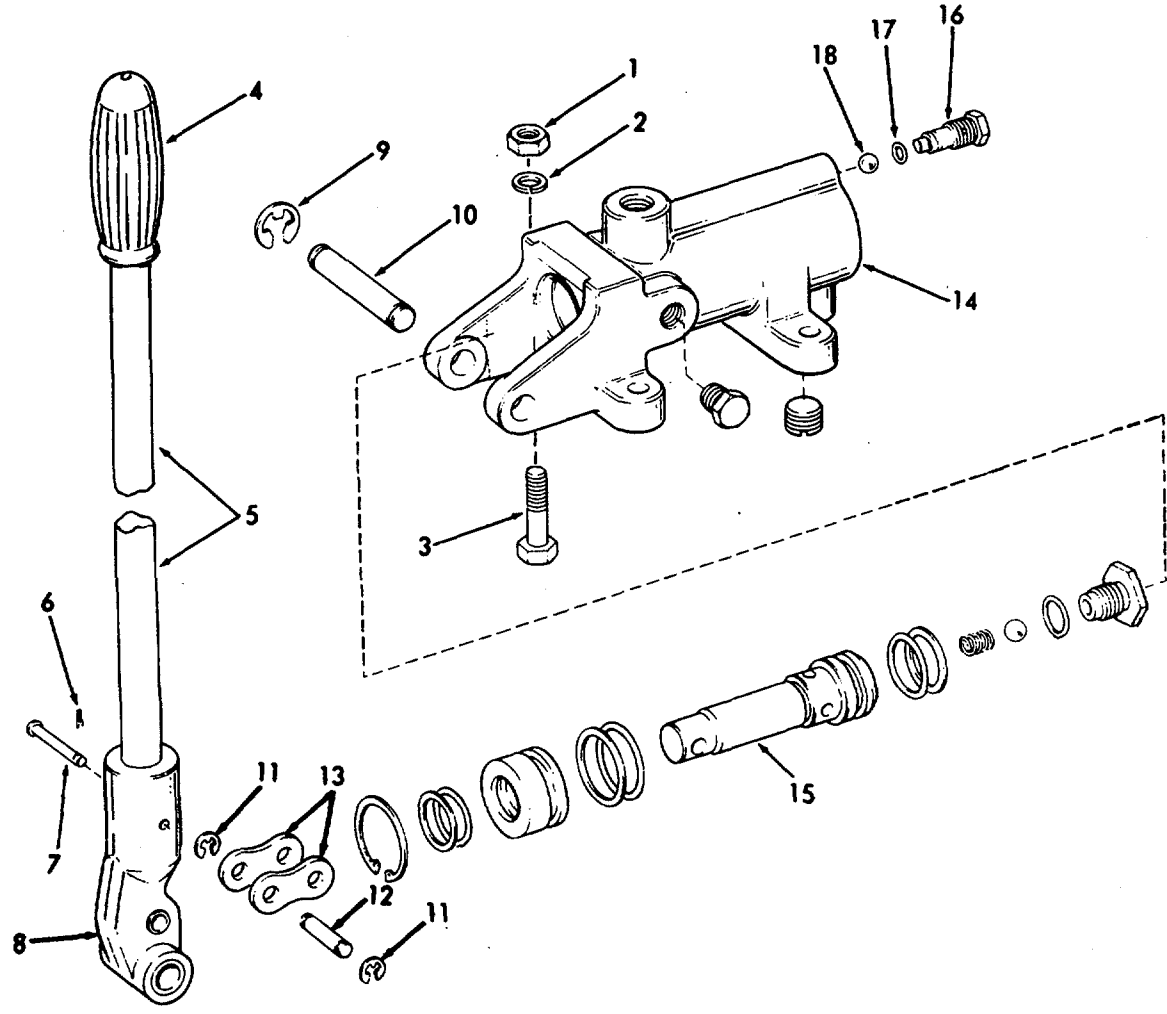
LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

**NOTE**

Make sure the hose and fittings are clean before any connections are made.

- d. Check assemblies. Make sure all fittings are tight and that there are no leaks.



**3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS**

a. The hydrostarter supply lines carry the 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 the 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

Reference

NONE

Special Tools

NONE

Equipment Condition   Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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**NOTE**

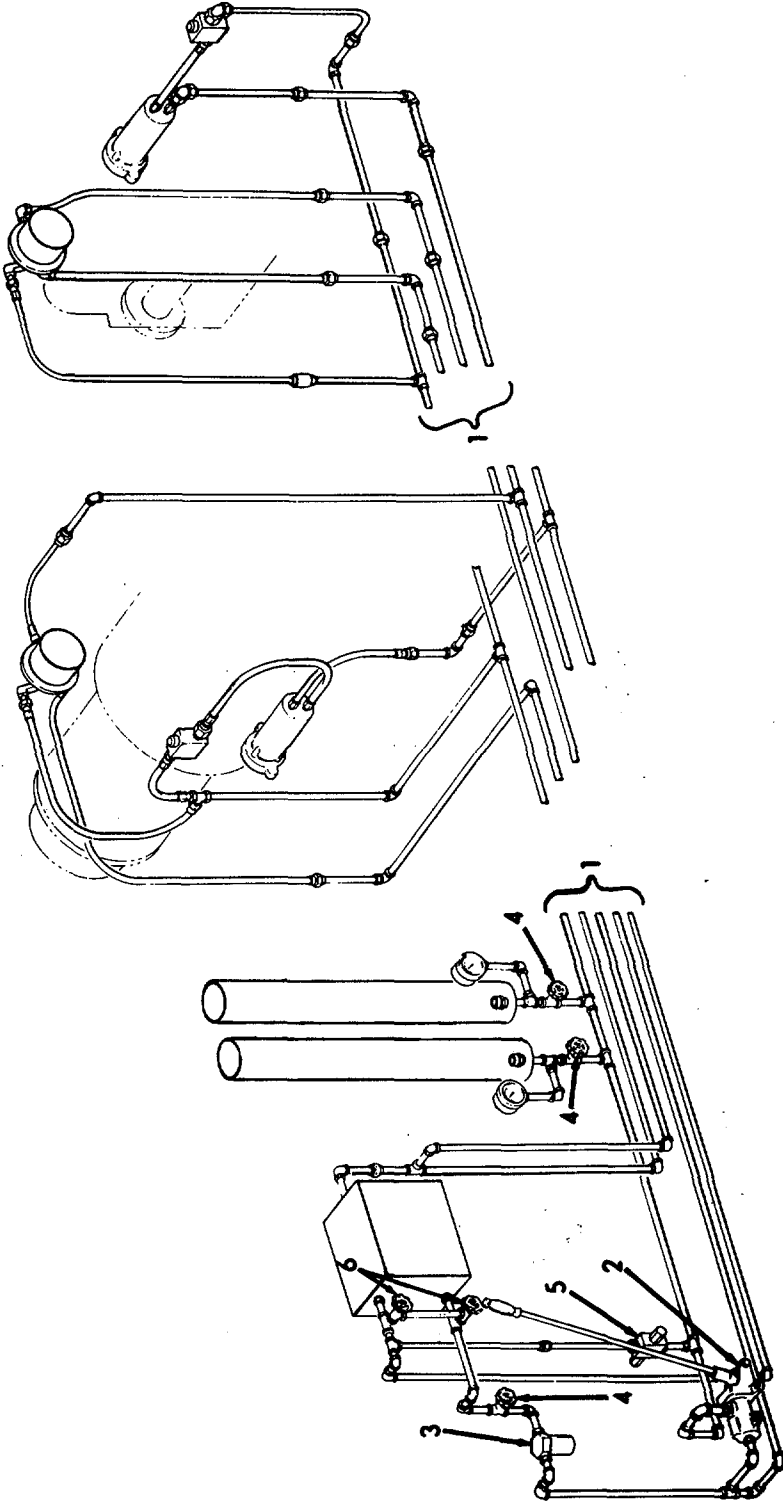
All maintenance to be preformed by Direct Support Maintenance unless otherwise noted.

**3-1777**

**3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1.	Hydro-starter piping (1)	<ul style="list-style-type: none"> <li>a. Check all pipes for leaks, damage, dents, cracks or breaks.</li> <li>b. Check all pipe fittings. Make sure they are tight and do not leak.</li> </ul>	
2.	Hand pump (2)	Check for leaks.	Refer to paragraph 3-104. for maintenance.
3.	Suction filter (3)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Checks fittings. Make sure they are tight.</li> </ul>	Refer to paragraph 3-107. for maintenance.
4.	Shut-off valves (4)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check for cracks, or wear.</li> <li>c. Check fittings for tightness.</li> </ul>	
5.	Relief valve (5)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check for cracks, wear or dents.</li> <li>c. Check fittings for tightness.</li> </ul>	
6.	Sight glass with valves (6)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check glass for cracks or breaks.</li> <li>c. Check valves for wear, cracks, or dents.</li> </ul>	

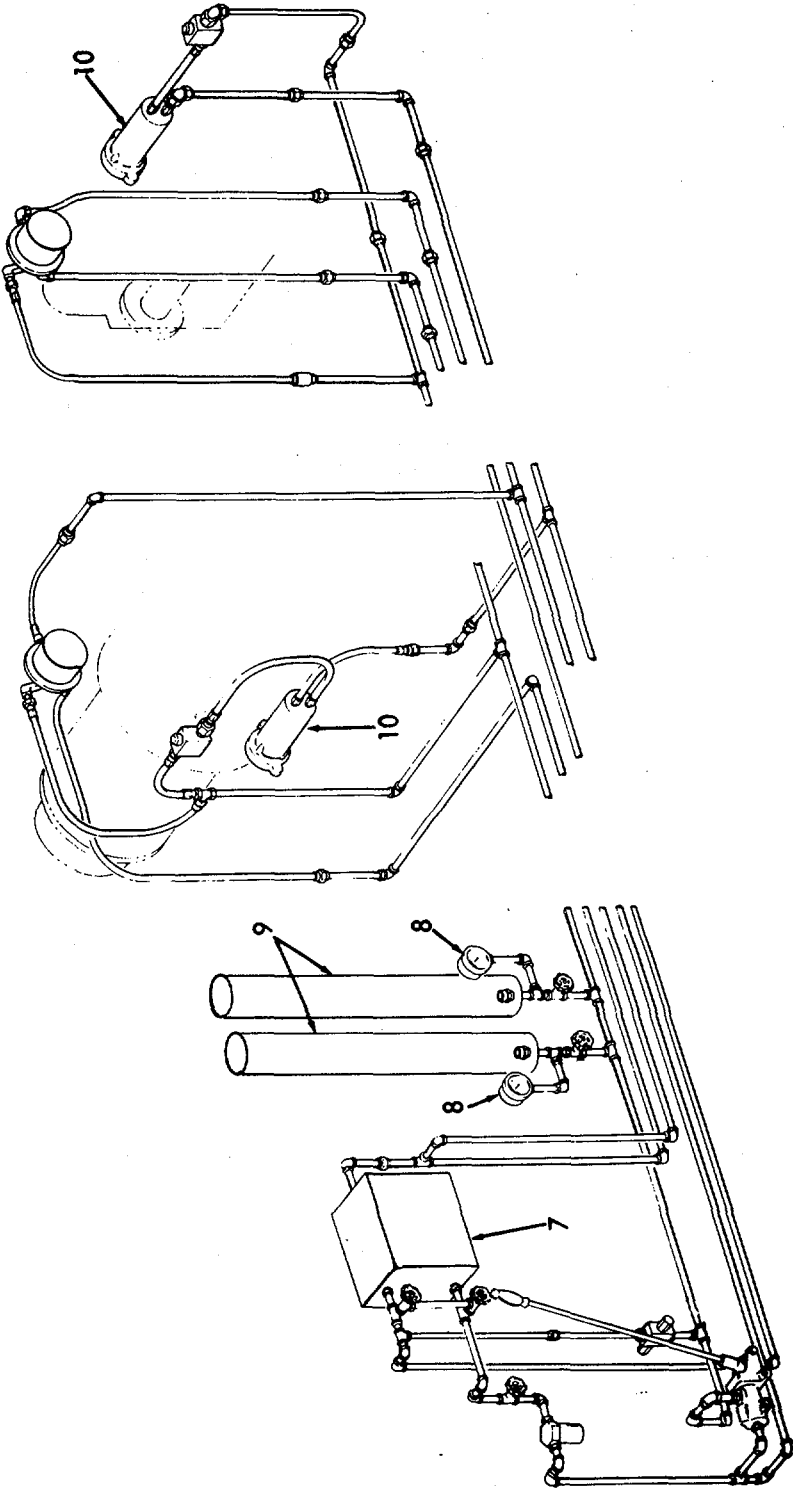
3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).



**3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
7.	Reservoir (7)	<ul style="list-style-type: none"> <li>a. Check for leaks, dents or cracks.</li> <li>b. Check pipe connections for leaks.</li> </ul>	Refer to paragraph 3-107. for maintenance.
8.	Pressure gage (8)	<ul style="list-style-type: none"> <li>a. Check gage glass for cracks or breaks.</li> <li>b. Check fitting and connections for tightness and leaks.</li> </ul>	
9.	Accumulators (9)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check for dents or cracks.</li> <li>c. Check pipe connections for leaks.</li> <li>d. Make sure all fittings are tight.</li> </ul>	Refer to paragraph 3-102. for replacement and to Direct Support Maintenance for repair.
10.	Hydrostarter (10)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check piping connections for leaks.</li> <li>c. Check to see that the return, supply and accumulator (pressure) lines are tight.</li> </ul>	Refer to paragraph 3-101 for maintenance.

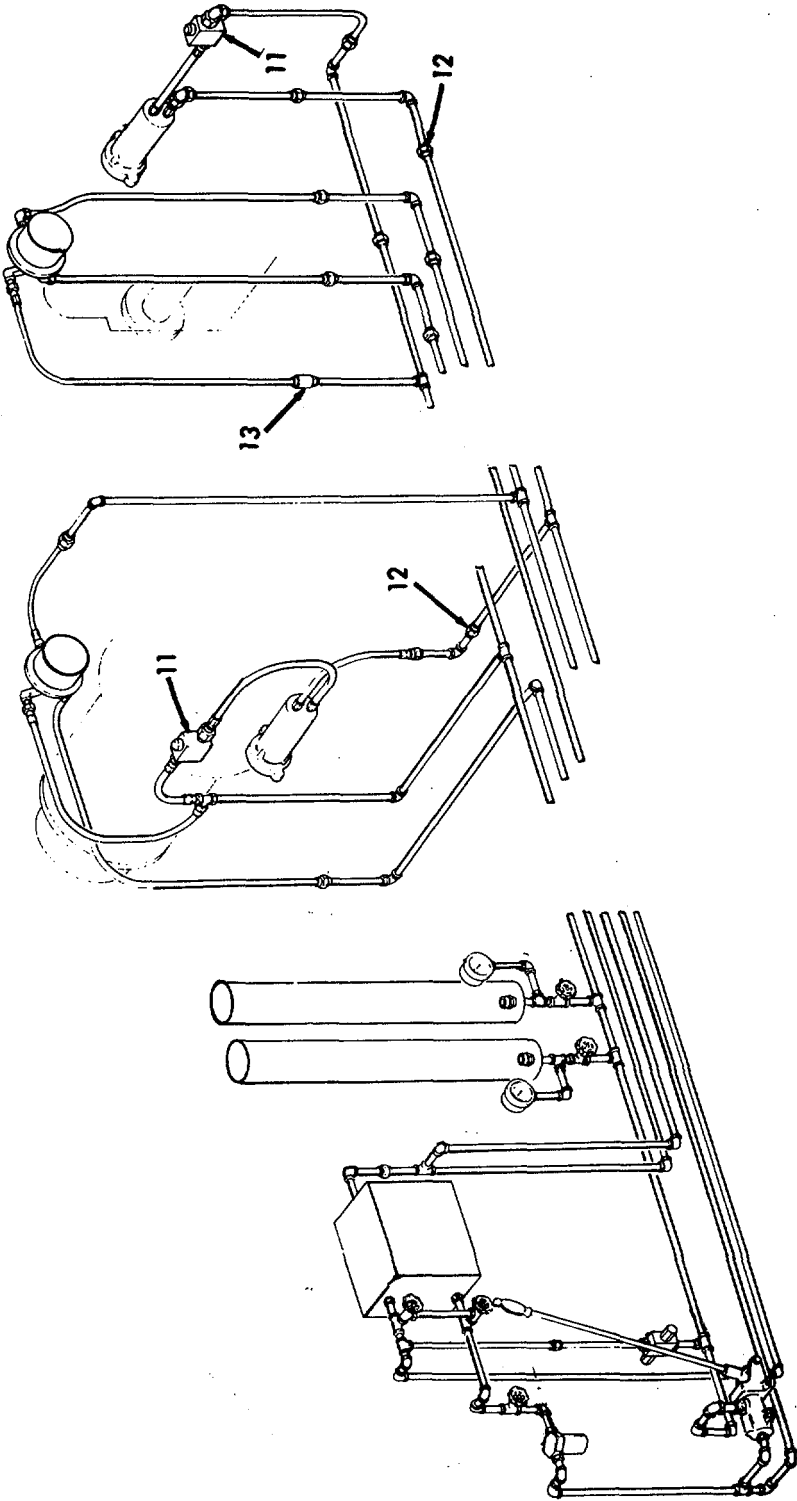
3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).



**3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
11.	Solenoid valve (11)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check fittings, pipes, and wiring. Make sure they are tight.</li> </ul>	Refer to paragraph 3-107. for maintenance.
12.	Check valve (12)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Make sure all fittings are tight.</li> </ul>	
13.	High pressure filter (13)	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check for cracks, dents and wear.</li> <li>c. Check fittings. Make sure they are tight.</li> </ul>	Refer to paragraph 3-107. for maintenance.

3-105. HYDROSTARTER PIPING (FORWARD ENGINE ROOM) - MAINTENANCE INSTRUCTIONS (Cont).





**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE INSTRUCTIONS.**

- a. The hydrostarter supply lines carry the 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 the 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

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
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**NOTE**

All maintenance to be performed by Direct Support Maintenance unless otherwise noted.

**3-1785**

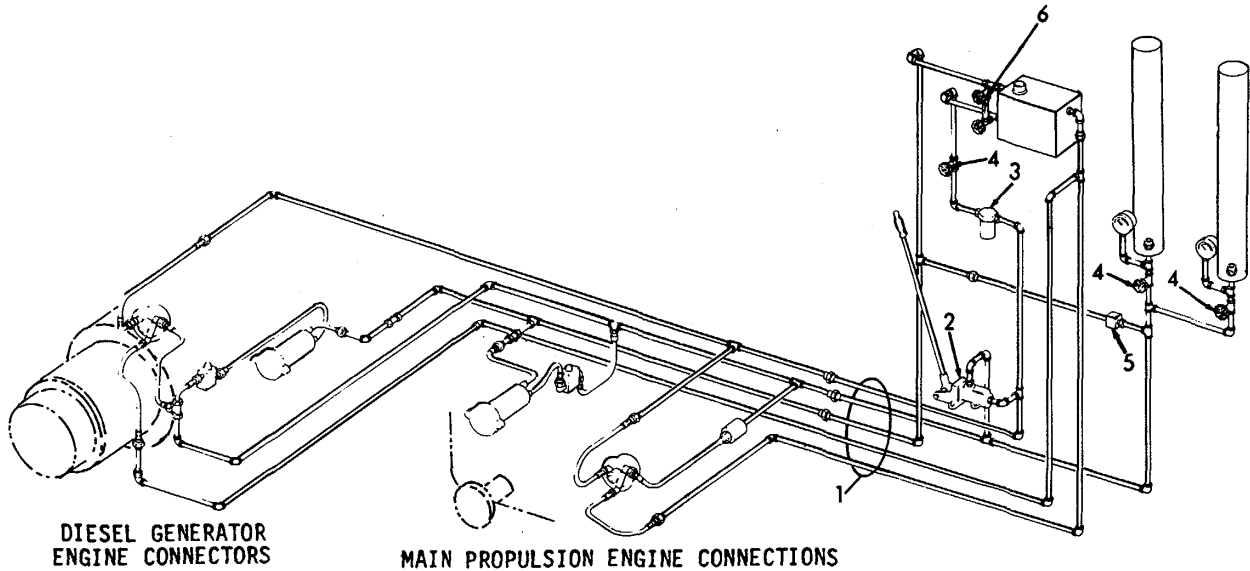
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**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE  
INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1.	Hydro- starter piping (1)	a. Check all pipes for leaks, damage, dents, cracks or breaks.  b. Check all pipe fit- tings. Make sure they are tight and do not leak.	
2.	Hand pump (2)	a. Check for leaks.	Refer to para- graph 3-104. for maintenance.
3.	Suction filter (3)	a. Check for leaks.  b. Check fittings. Make sure they are tight.	Refer to para- graph 3-107. for maintenance.
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.	
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.	

**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE  
INSTRUCTIONS (Cont).**



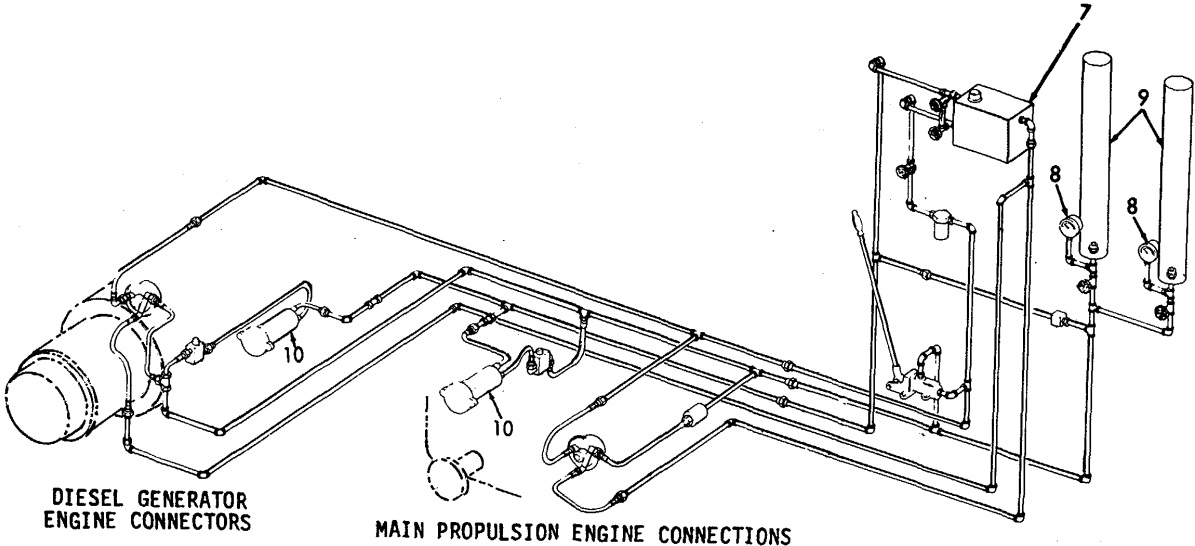
3-1787

**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE**

**INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
7.	Reservoir (7)	a. Check for leaks, dents or cracks.  b. Check pipe connec- tions for leaks.	Refer to para- graph 3-107. for maintenance.
8.	Pressure gage (8)	a. Check gage glass for cracks or breaks.  b. Check fittings and connections for tightness and leaks.	
9.	Accumula- tors (9)	a. Check for leaks.  b. Check for dents or cracks.  c. Check pipe connec- tions for leaks.  d. Make sure all fit- tings are tight.	Refer to para- graph 3-102. for replacement and to Direct Sup- port Mainte- nance for repair.
10	Hydro starter (10)	a. Check for leaks.  b. Check piping connec- tions for leaks.  c. Check to see that return, supply and accumulator (pres- sure) lines are tight.	Refer to para- graph 3-101. for maintenance.

**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE  
INSTRUCTIONS (Cont).**

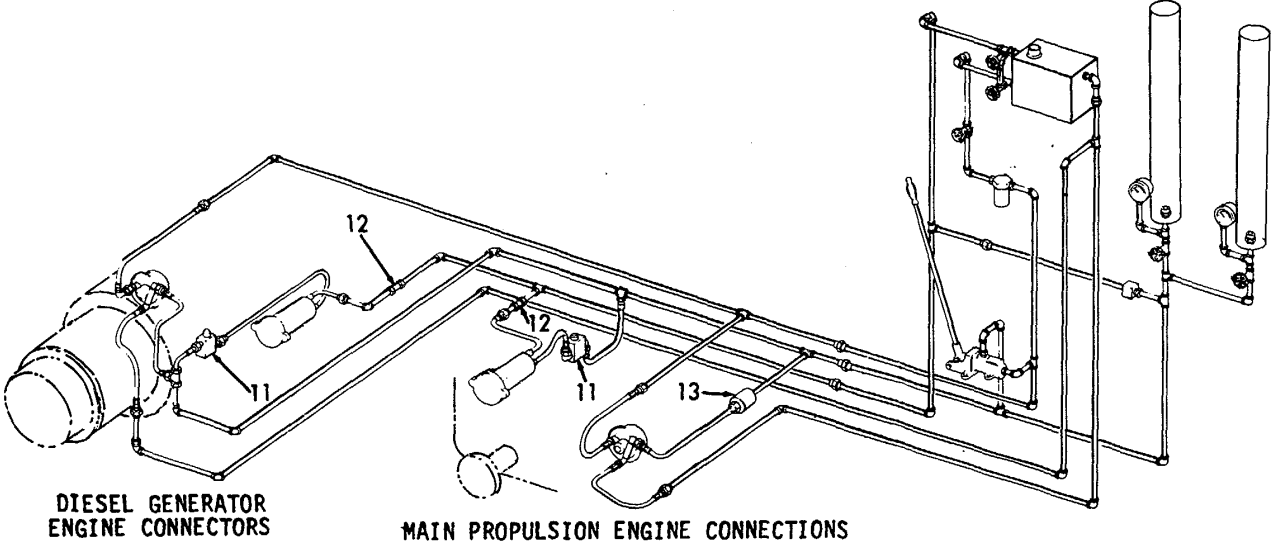


**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE**

**INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
11.	Solenoid valve (11)	a. Check for leaks.  b. Check fittings, pipes, and wiring. Make sure they are tight.	Refer to paragraph 3-107. for maintenance.
12.	Check valve (12)	a. Check for leaks.  b. Make sure all fittings are tight.	
13.	High pressure filter (13)	a. Check for leaks.  b. Check for cracks, dents and wear.  c. Check fittings Make sure they are tight.	Refer to paragraph 3-107. for maintenance.

**3-106. HYDROSTARTER PIPING (AFT ENGINE ROOM) - MAINTENANCE  
INSTRUCTIONS (Cont).**



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**3-107. HYDROSTARTER RESERVOIR, FILTER, AND SOLENOID - MAINTENANCE  
INSTRUCTIONS (Cont).**

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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 line to provide a finer filtration that protects the pump mechanism. The filter contains an 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.

DESCRIPTION	PARAGRAPH
Hydrostarter Reservoir	3-107.1.
Hydrostarter Suction Filter	3-107.2.
Hydrostarter Solenoid	3-107.3.
Hydrostarter High Pressure Filter	3-107.4.



**3-107. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS).**

This task covers:

- a. Inspection
- b. Service
- c. Replace
- d. Installation

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

Hydraulic fluid (MIL-L-17672 Type 2135 TH)

Special Environmental Conditions

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

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure.

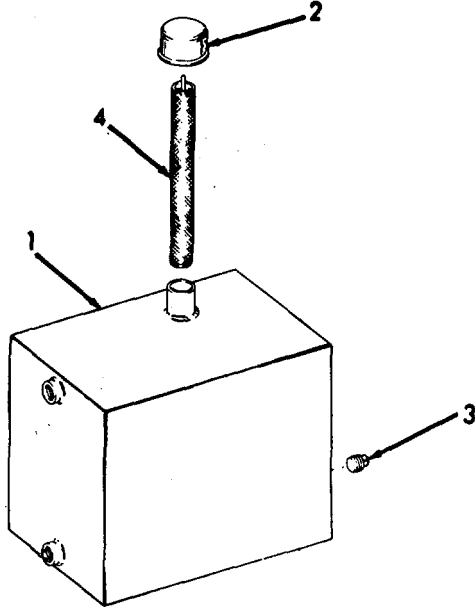
LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

1.	Reservoir (1)	<ul style="list-style-type: none"> <li>a. Check for dents, cracks and leaks.</li> <li>b. Check return, relief, and supply pipes, and all fittings for leaks.</li> </ul>	Refer to Direct Support Maintenance for maintenance.
2.	Breather ventilator cap (2)	<ul style="list-style-type: none"> <li>a. Check for dents, cracks, and leaks.</li> <li>b. Check for tightness.</li> <li>c. Check for clogging.</li> </ul>	

3-107.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
3.	Drain plug (3)	<ul style="list-style-type: none"> <li>a. Check fittings for tightness.</li> <li>b. Check for leaks.</li> </ul>	
<b>SERVICE</b>			
4.	Drain plug (3)	<ul style="list-style-type: none"> <li>a. Place suitable container under drain plug (3).</li> <li>b. Turn drain plug (3) counter-clockwise to remove.</li> <li>c. Drain reservoir</li> </ul>	Use oil separation recovery system.
5.	Strainer screen (4)	<ul style="list-style-type: none"> <li>a. Remove breather ventilator cap (2).</li> <li>b. Remove strainer screen (4)</li> </ul>	Replace, if necessary.



3-107.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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SERVICE (Cont)



Wear eye protection when using compressed air.

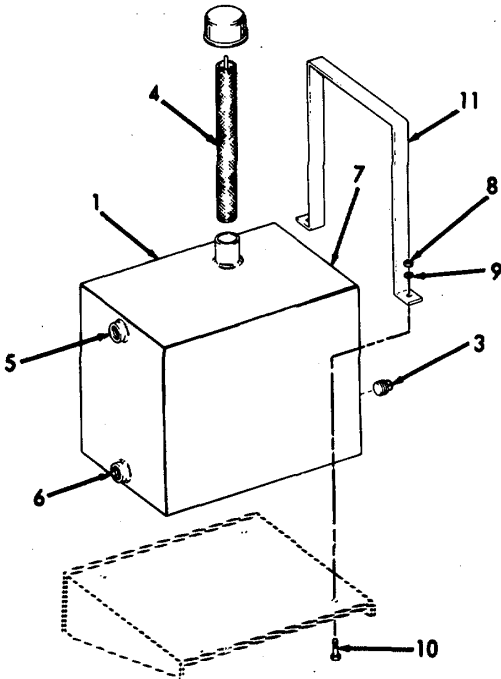
- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>c. Clean strainer screen (4).</li> <li>d. Clean reservoir (1) by flushing out the old hydraulic fluid.</li> </ul> | <p>Clean in fuel oil and dry with compressed air.</p> |
|--|---|

REPLACE

- |           |                      |  |
|-----------|----------------------|--|
| <p>6.</p> | <p>Reservoir (1)</p> | <ul style="list-style-type: none"> <li>a. Place suitable container under drain plug (3).</li> <li>b. Turn drain plug (3) counter-clockwise to remove.</li> <li>c. Drain hydraulic oil into a suitable container.</li> <li>d. Disconnect return piping (5).</li> <li>e. Disconnect supply piping (6).</li> <li>f. Disconnect relief piping (7).</li> <li>g. Remove nuts (8), lockwashers (9) and capscrews (10) from brackets (11).</li> <li>h. Remove reservoir (1) from its mountings.</li> </ul> |
|-----------|----------------------|--|

3-107.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
7.	Reservoir (1)	<ul style="list-style-type: none"><li>a. Replace reservoir (1).</li><li>b. Install brackets (11), nuts (8), lockwashers (9), and capscrews (10).</li><li>c. Install strainer screen (4).</li><li>d. Install drain plug (3).</li><li>e. Connect supply piping (5).</li><li>f. Connect return piping (6).</li><li>g. Connect relief piping (7).</li></ul>	



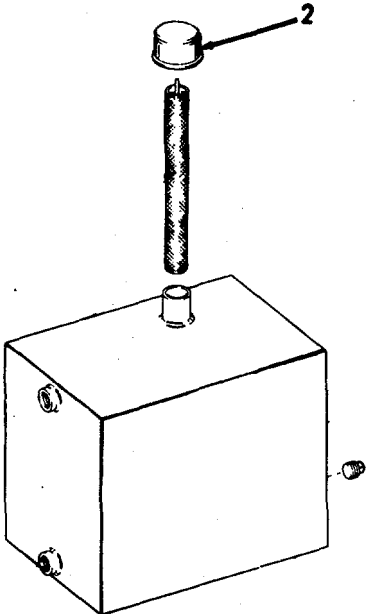
3-107.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

- h. Fill reservoir with hydraulic fluid (MIL-L-17672, Type 2135 TH).
- i. Replace and tighten breather ventilator cap (2).
- j. Check all fittings and plugs for leaks.

Reservoir capacity is 7.5 gallons (28.4 liters).



3-1798

**3-107.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Inspection
- b. Service
- c. Removal
- d. Installation

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition   Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

<b>INSPECTION</b>			
-------------------	--	--	--

1. Filter assembly	a. Cap	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	
	b. Filter body	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	
	c. Adapter	1. Check connections at cover and elbow for leaks.	
		2. Check for cracks.	

3-107.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS . (Cont).

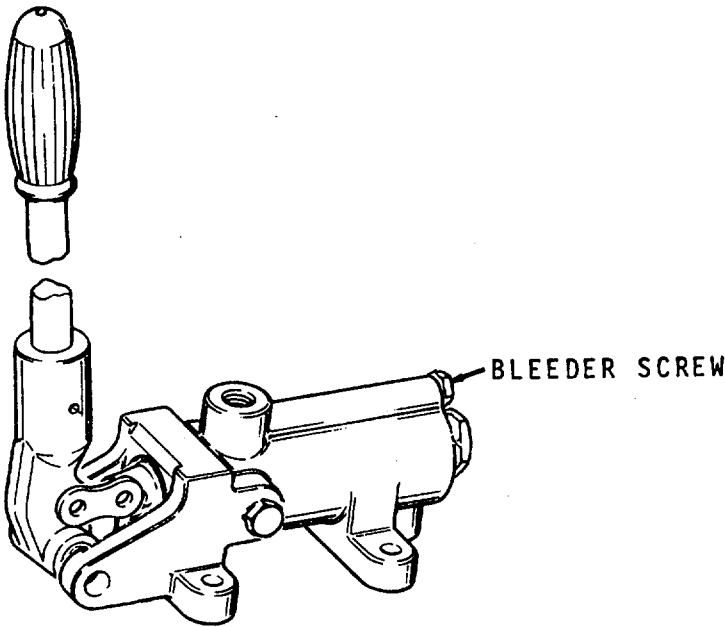
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION (Cont)

- |           |   |
|-----------|---|
| d. Piping | 1. Check connection at adapter and supply hose for leaks.<br>2. Check for cracks. |
|-----------|---|

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. |
|--------------|---------------------|--|



3-107.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS . (Cont).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
<b>WARNING</b>			
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. 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.



3-107.2. HYDROSTARTER SUCTION FILTER - MAINTENANCE INSTRUCTIONS . (Cont).

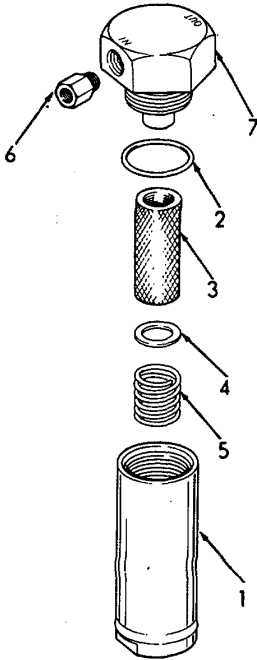
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

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. |



**3-107.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

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

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

1.	Solenoid housing	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check for cracks, dents, and wear.</li> <li>c. Check electrical connections.</li> </ul>	
2.	Manual control valve	<ul style="list-style-type: none"> <li>a. Check for leaks.</li> <li>b. Check fittings.</li> </ul>	
3.	Supply pipe	Check fittings for leaks.	
4.	Return pipe	Check fittings for leaks.	

3-107.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS . (Cont).

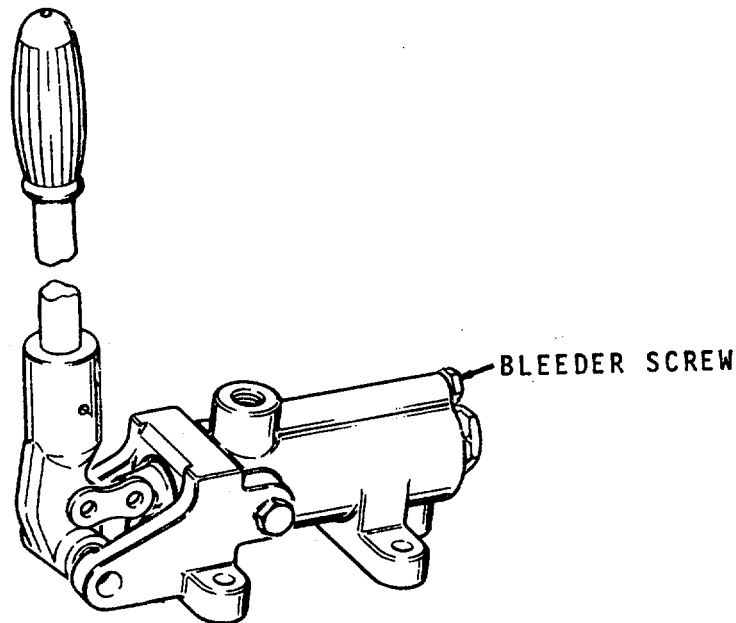
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL

5.	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 this 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.

3-107.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS . (Cont).

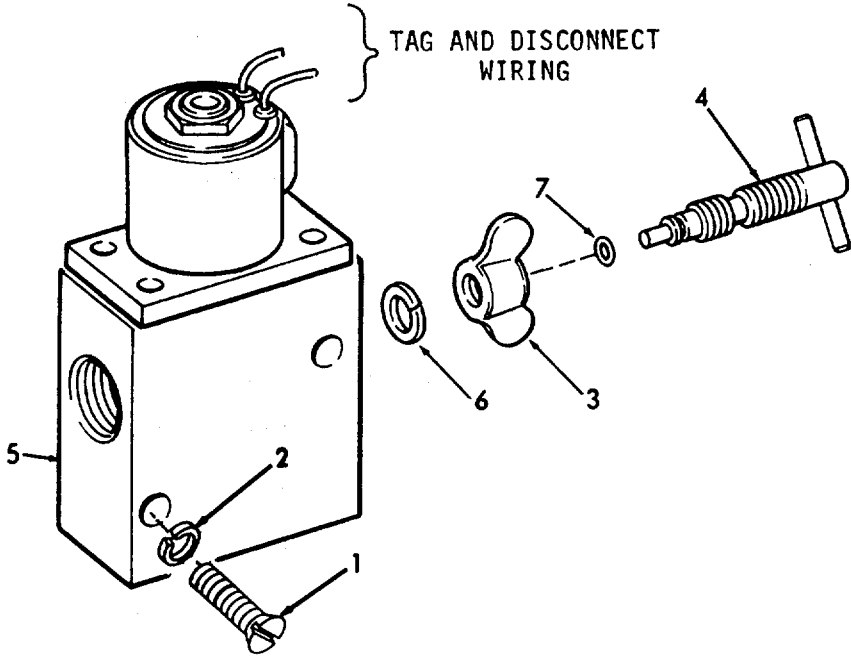
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
8.	Solenoid housing	<ul style="list-style-type: none"> <li>a. Disconnect electrical connections.</li> <li>b. Remove screws (1) and lockwashers (2).</li> <li>c. Remove from mount.</li> </ul>	
<b>REPAIR</b>			
9.	Solenoid housing	Repair.	Refer to Direct Support Maintenance.
10.	Manual control screw	<ul style="list-style-type: none"> <li>a. Loosen wing nut (3).</li> <li>b. Unscrew manual control screw (4) from solenoid housing (5).</li> <li>c. Remove lockwasher (6).</li> <li>d. Remove wing nut (3).</li> <li>e. Remove seal ring (7) from manual control screw (4).</li> </ul>	Discard seal ring.
11.	Manual control screw (4)	<ul style="list-style-type: none"> <li>a. Install new seal ring (7) on manual control screw (4).</li> <li>b. Replace wing nut (3) on manual control screw (4).</li> <li>c. Install manual control screw (4) into solenoid housing (5) and lockwasher (6).</li> <li>d. Tighten wing nut (3).</li> </ul>	

3-107.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS . (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION

12.	Solenoid housing	a. Place on mounting. b. Install lockwashers (2) and screws (1). c. Connect electrical connections.	
13.	Return piping	Connect.	
14.	Supply Piping	Connect.	



**3-107.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS ..**

**This task covers:**

- a. **Inspection**
- b. **Removal**
- c. **Service**
- d. **Installation**

INITIAL SETUP

**Test Equipment**

NONE

**Reference**

NONE

Special Tools

NONE

Equipment  
Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

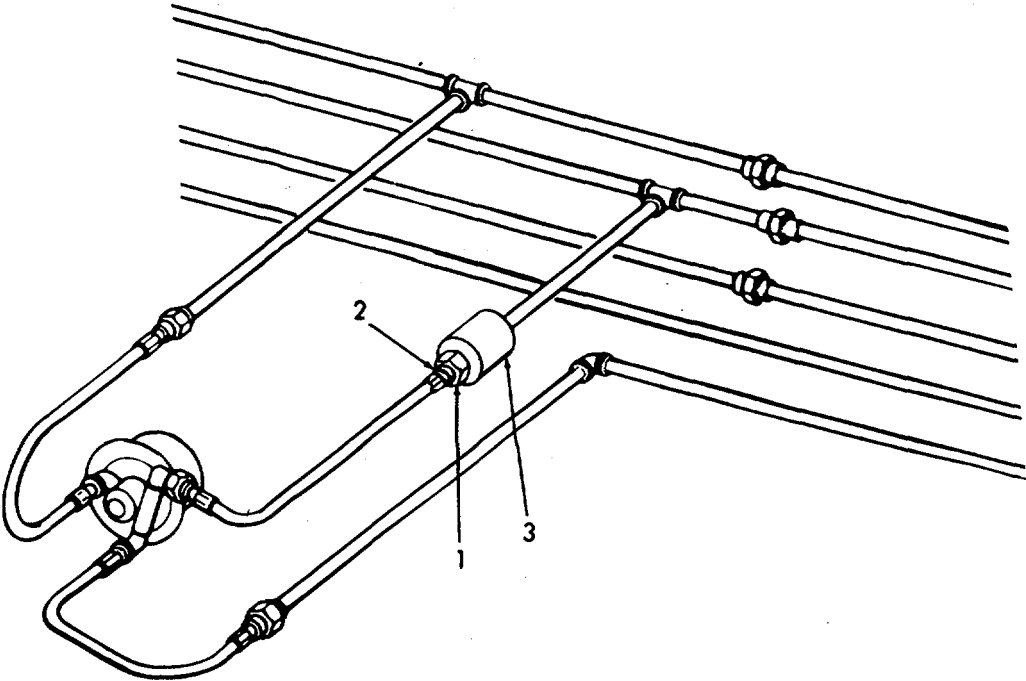
1. Filter assembly	a. Filter	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	
	b. Piping	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	

3-107.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS.(Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL

- 2.
  - a. Connectors (1) and adapters (2) Loosen.
  - b. Filter (3) Remove.



3-107.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS.(Cont)

LOCATION	ITEM	ACTION	REMARKS
<b>SERVICE</b>			
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.	
	f. Filter body (5), spring (9), and spring seat (8)	Assembly.	
	g. Filter (7), gasket (6), filter body (5) and cap (4)	Reassemble.	Use new filter and gasket.
<b>INSTALLATION</b>			
4.	a. Filter (3), adapters (2), and connectors (1)	Install.	



3-107.4. HYDROSTARTER HIGH PRESSURE FILTER - MAINTENANCE INSTRUCTIONS.(Cont)

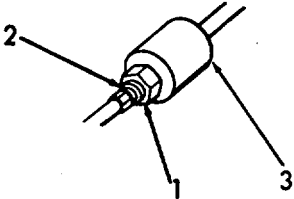
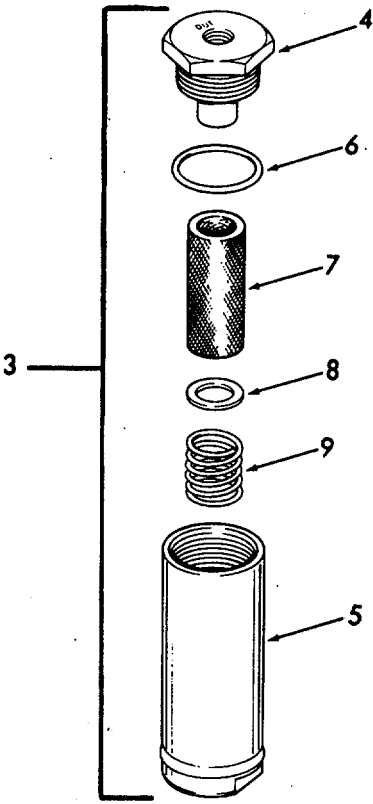
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSTALLATION (Cont)

b. System

Operate.

Make sure all fittings are tight and leaks do not occur.



**3-108. 24 VDC RECTIFIER - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

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

INITIAL SETUP

Test Equipment

Volt-ohm meter

Reference

NONE

Special Tools

NONE

Equipment Condition   Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION

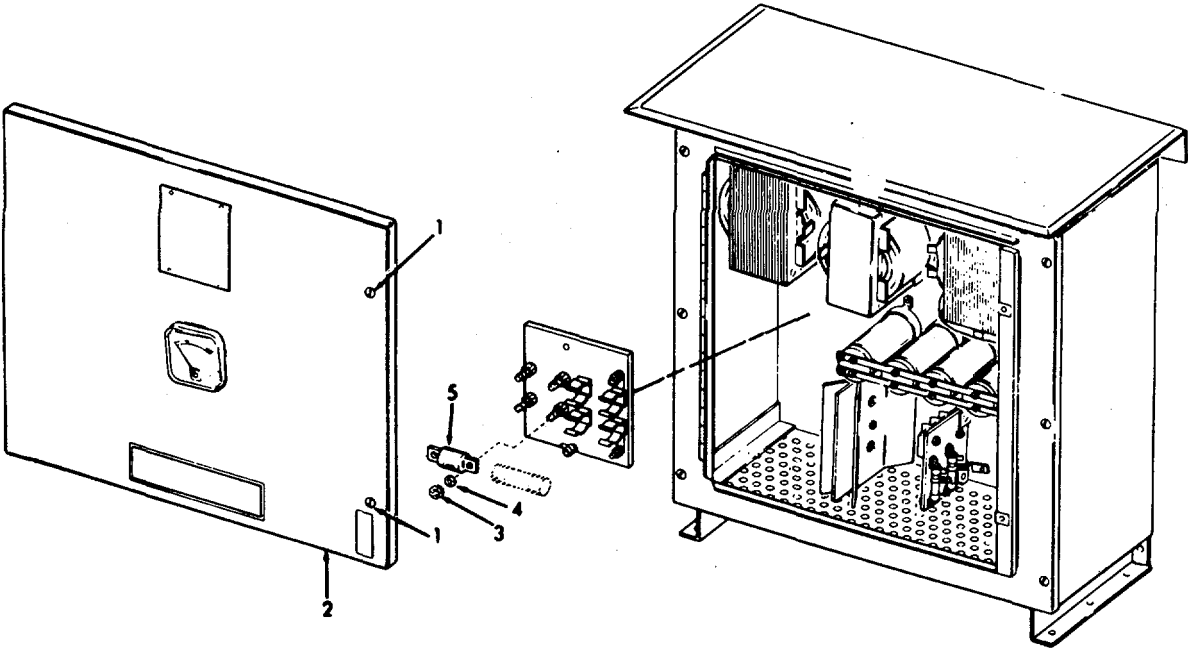


Make sure all incoming power is shut off. Tag circuit breakers to prevent accidental turn-on.

1.	Pilothouse	24 VDC Rectifier	<ul style="list-style-type: none"> <li>• Broken glass malfunctioning ammeter.</li> <li>• Blown fuses.</li> <li>• Loose hardware or wire terminations.</li> <li>• Defective wiring.</li> <li>• Cracks in terminal boards.</li> </ul>	Look for damage or malfunctioning of equipment.
----	------------	------------------	---	---

3-108. 24 VDC RECTIFIER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
2. Fuses and terminal board	a. Output fuse	<ol style="list-style-type: none"> <li>1. Loosen screws (1) on front panel (2).</li> <li>2. Remove nut (3) and lockwasher (4).</li> <li>3. Remove fuse (5).</li> <li>4. Install new fuse (5).</li> <li>5. Secure, using nut (3) and lockwasher (4).</li> <li>6. Close front panel (2) and tighten screws (1).</li> </ol>	<p>Door will swing open on hinge</p> <p>Check with ohm-meter, discard if defective.</p>



3-108. 24 VDC RECTIFIER - MAINTENANCE INSTRUCTIONS.(Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	b. Input fuse	<ol style="list-style-type: none"> <li>Loosen screws (1) on front panel (2).</li> <li>Unsnap fuse (6) from retaining spring-clip.</li> <li>Install new fuse (6) into retaining spring-clip (7).</li> <li>Close front panel door (2) and tighten screws (1).</li> </ol>	<p>Door will swing open on hinge.</p> <p>Check fuse with ohmmeter, discard if defective.</p>



Make sure all sources of power are shut off. Tag and disconnect all incoming AC wiring, and outgoing DC wiring. Failure to do so may result in severe injury to personnel, and damage to landing craft.

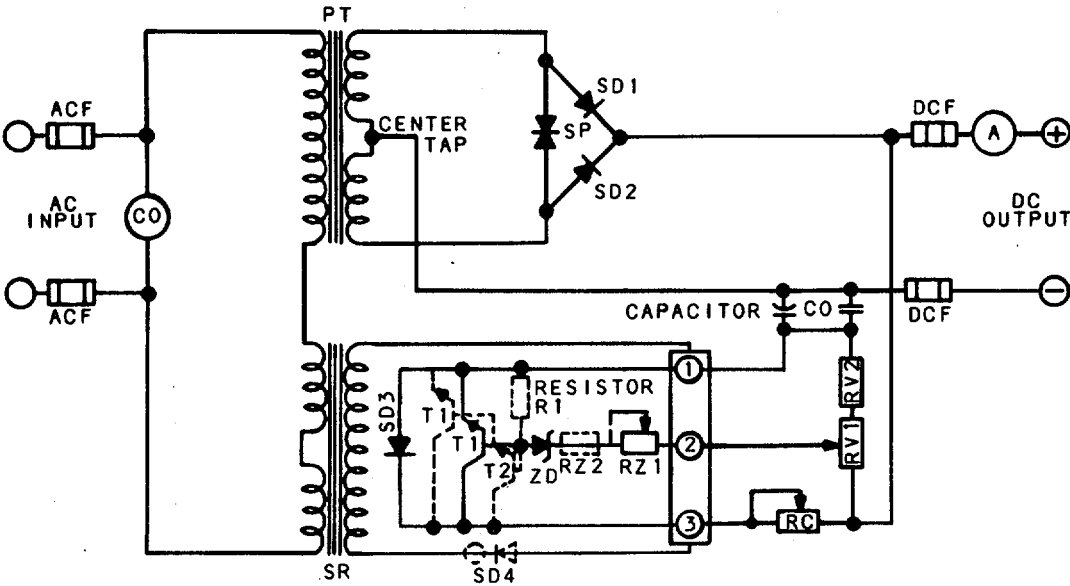
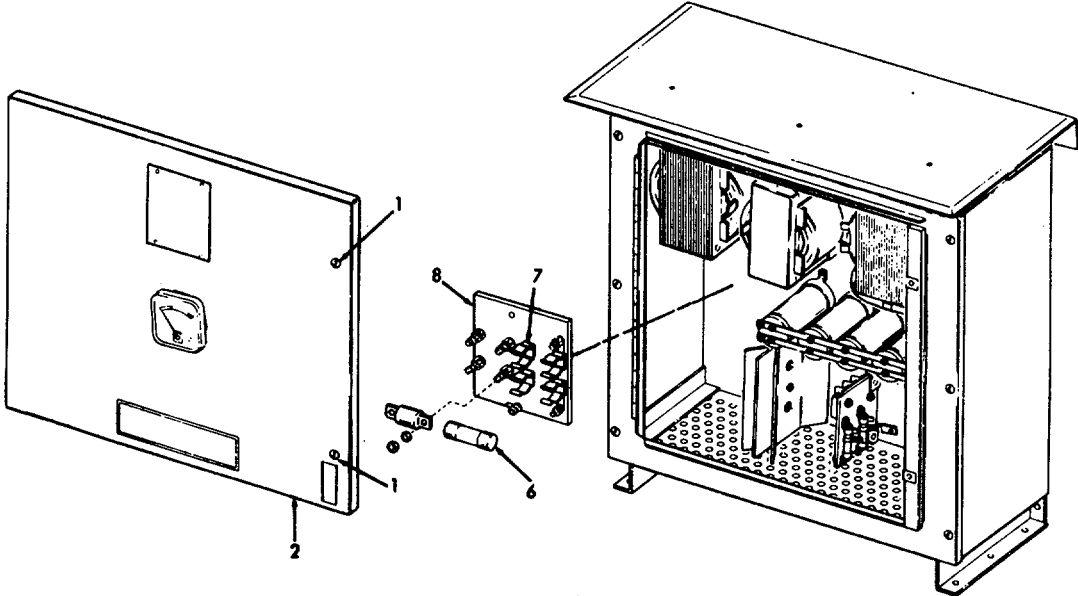
	c. Terminal board	<ol style="list-style-type: none"> <li>Loosen screws (1) on front panel (2).</li> <li>Tag and disconnect wiring from terminal board (8).</li> <li>Remove hardware attaching terminal board (8) to chassis.</li> <li>Install new terminal board (8).</li> <li>Attach wiring to terminal board (8). Remove all tags from wiring.</li> </ol>	<p>Door will swing open on hinge.</p> <p>Refer to schematic.</p> <p>Discard.</p> <p>Refer to schematic.</p>
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3-108. 24 VDC RECTIFIER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

- Close front panel door (2) and tighten screws (1).



**3-108. 24 VDC RECTIFIER-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

**WARNING**

Make sure all sources of power are shutoff. Tag and disconnect all incoming AC wiring, and outgoing DC wiring. Failure to do so may result in severe injury to personnel, and damage to landing craft.

d. Ammeter	<ol style="list-style-type: none"> <li>1. Loosen screws (1) on front panel (2).</li> <li>2. Tag and disconnect wiring from ammeter (9).</li> <li>3. Remove hardware attaching ammeter (9) to door.</li> <li>4. Install ammeter (9).</li> <li>5. Attach wiring and remove tags to ammeter (9).</li> <li>6. Close front panel door (2) and tighten screws (1).</li> </ol>	<p>Door will swing open on hinge. Refer to schematic.</p> <p>Replace if defective.</p>
------------	---	--

REMOVAL

**WARNING**

Make sure all sources of power are shutoff. Tag and disconnect all incoming AC wiring, and outgoing DC wiring. Failure to do so may result in severe injury to personnel, and damage to landing craft.

3. 24 VDC rectifier	Rectifier assembly	<ol style="list-style-type: none"> <li>1. Loosen screws (1) on front panel (2).</li> <li>2. Tag and disconnect external wiring to rectifier assembly.</li> <li>3. Remove screws (10).</li> </ol>	<p>Door will swing open on hinge.</p> <p>Refer to schematic.</p>
---------------------	--------------------	--	--

3-108. 24 VDC RECTIFIER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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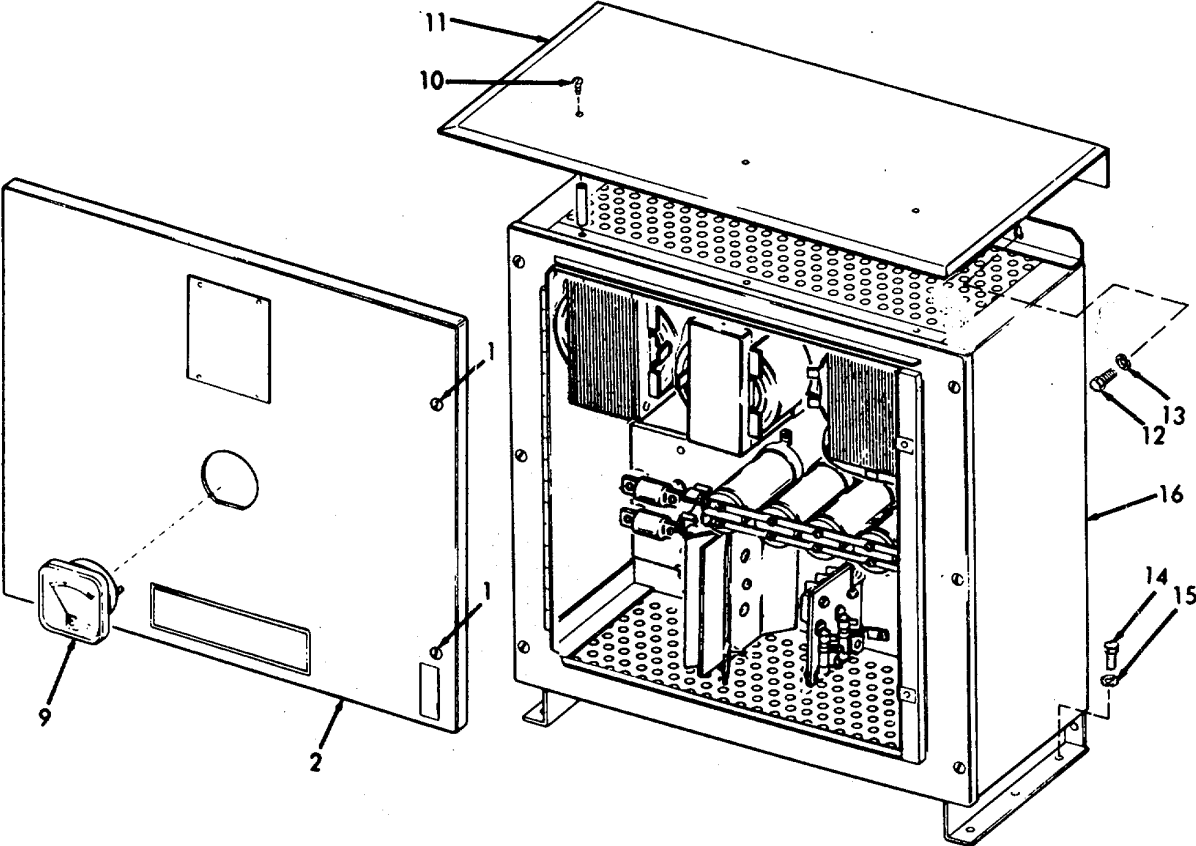
REMOVAL (Cont)

4. Remove drip shield (cover) (11).

5. Remove screws (12) and lockwashers (13).

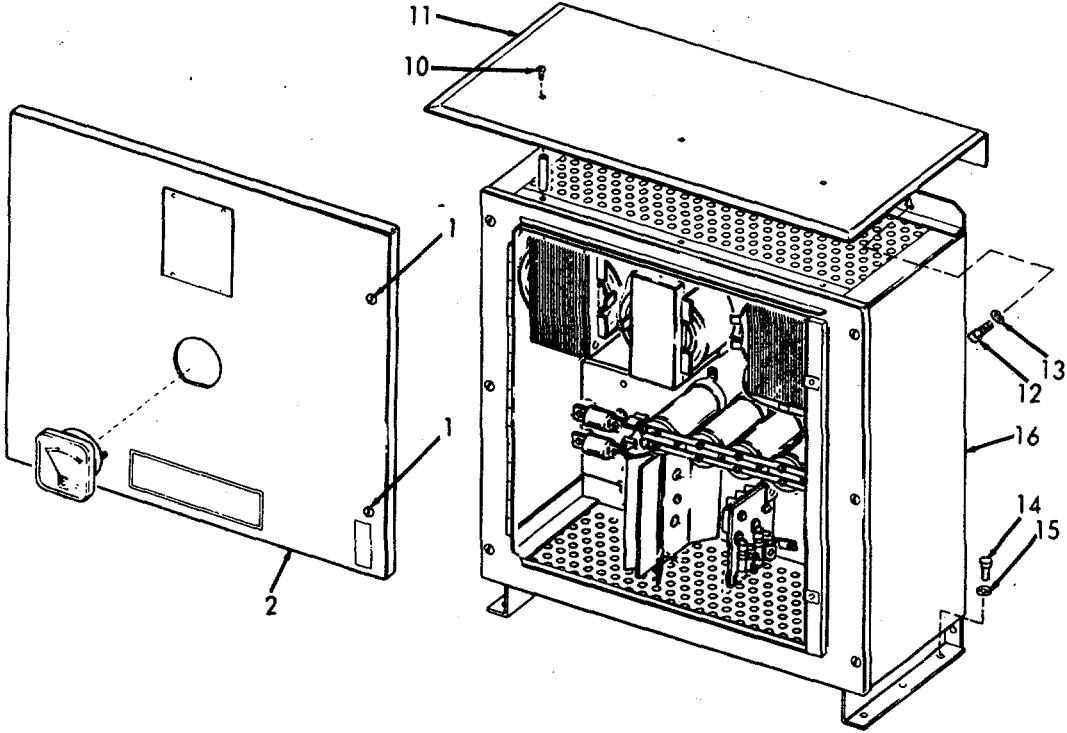
6. Remove screws (14) and lockwashers (15).

7. Remove rectifier assembly (16). Replace.



3-108. 24 VDC RECTIFIER-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSTALLATION</b>			
4. 24 VDC rectifier	Rectifier assembly	<ul style="list-style-type: none"> <li>a. Install rectifier assembly (16).</li> <li>b. Replace screws (14) and lockwashers (15).</li> <li>c. Replace screws (12) and lockwashers (13).</li> <li>d. Replace drip shield cover (11) and secure with screws (10).</li> <li>e. Attach external wiring and remove tags.</li> <li>f. Close front panel (2) and secure with screws (1).</li> <li>g. Turn all sources of power back on.</li> </ul>	<p>Refer to schematic.</p> <p>Check to see that all operations are correct.</p>





**3-109. DISTRIBUTION PANELS LIGHTING-MAINTENANCE INSTRUCTIONS.**

The maintenance instructions for the lighting distribution panels are contained in this paragraph. The lighting distribution panels are designated in the L100 series. Also included in this paragraph are terminal boxes.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Lighting Distribution Panels	3-109.1
Terminal Boxes	3-109.2

**3-109.1. LIGHTING DISTRIBUTION PANEL-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition Description</u> <u>Para</u>
NONE	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	OBSERVE WARNINGS

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------



- MAKE SURE ALL INCOMING POWER IS SHUT OFF. Tag circuit breakers to prevent accidental turn on.
- Voltage in panel is lethal and can cause death.

**3-109.1. LIGHTING DISTRIBUTION PANEL-MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Panels designated L1--	Lighting Distribution Panel	a. Operate circuit breakers to see if functioning properly.  b. Check exterior wires and cables for signs of fraying or deterioration.  c. Check to see that interior wiring and cable connections are tight.	If defects are found, refer to Direct Support Maintenance.

**WARNING**

ALL SOURCES OF POWER MUST BE TURNED OFF before performing any maintenance procedures. Failure to do so will result in severe injury or loss of life, and major damage to the landing craft.

**REPAIR**

2.	Circuit breakers	a. Remove screws (1) from Lighting Distribution Box (2).  b. Remove front panel (3).  c. Tag and disconnect all wiring.  d. Remove circuit breakers (4).  e. Install new circuit breakers (4) and secure.  f. Attach all wiring and remove tags.	Discard.
----	------------------	--	----------

**3-109.1. LIGHTING DISTRIBUTION PANEL-MAINTENANCE INSTRUCTIONS  
(Cont).**

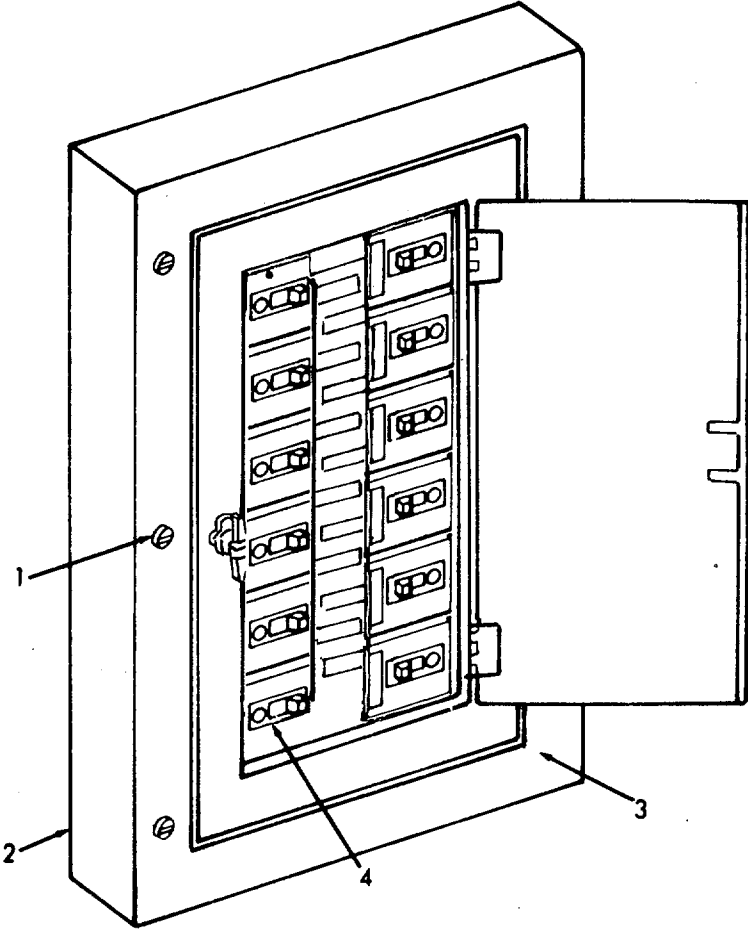
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

g. Install front panel (3) on Lighting Distribution Box (2).

h. Secure with screws (1).

i. Turn on all sources of power.



**3-109.2. TERMINAL BOXES-MAINTENANCE INSTRUCTIONS.**

This task covers:  
 a. Inspection

b. Repair

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------



- Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.
- Voltage in panel is lethal and can cause death.

**INSPECTION**

1. Terminal boxes symbol 432.1 and symbol 433.1

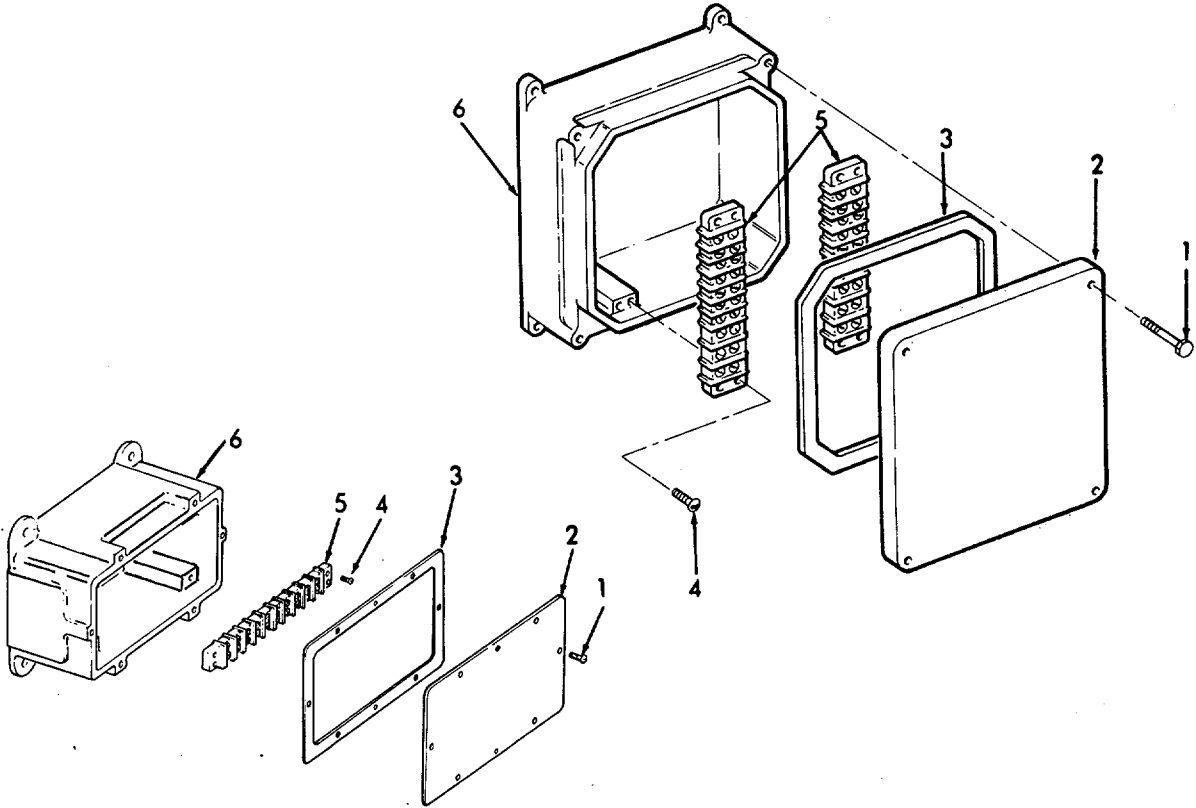
Check both terminal boxes for the following:

a. Check exterior wires and cables for signs of fraying or deterioration.

If defects are found, refer to Direct Support Maintenance.

3-109.2. TERMINAL BOXES-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		b. Check to see that interior wiring and cable connections are tight.	
		c. Check that hardware is not damaged.	
REPAIR			
2.	a. Cover	Remove screws (1), cover (2) and gasket (3).	If necessary
	c. Terminal strip(s)	1. Tag and disconnect wiring. 2. Remove screws (4), and terminal strip(s) (5) from box (6).	If necessary



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**3-110. SWITCH-MAINTENANCE INSTRUCTIONS.**

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The maintenance instructions for the switches are contained in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Toggle Switch	3-110.1.
Break Glass Station	3-110.2.
Water Tight Receptacles	3-110.3.
Duplex Receptacles	3-110.4.
Interlock Door Operated Switch	3-110.5.
Disconnect Switch	3-110.6.

**3-1824**

**3-110.1. TOGGLE SWITCH-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Replace

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

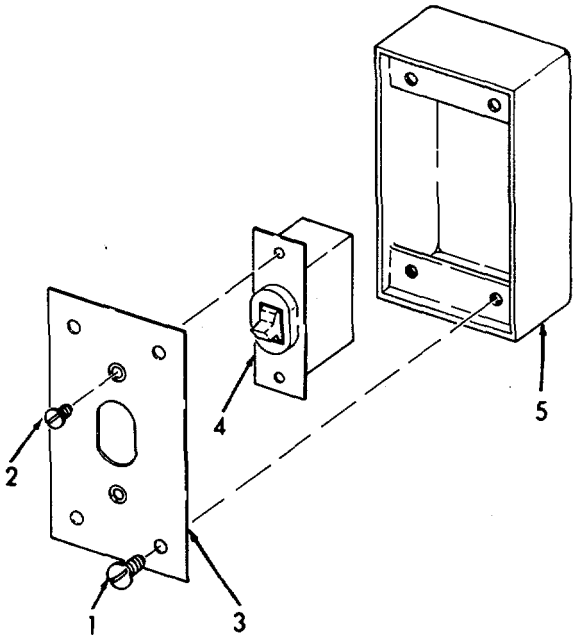
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |                  |   |  |
|------------------|---|--|
| 1. Toggle switch | <ul style="list-style-type: none"> <li>a. Check exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that hardware is not damaged.</li> </ul> | If defects are found, refer to Direct Support Maintenance. |
|------------------|---|--|

3-110.1. TOGGLE SWITCH-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
2.	a. Screws (1)	Remove.	
	b. Screws (2)	Remove.	
	c. Cover (3)	Remove.	
	d. Switch (4)	1. Remove from box (5).	
		2. Disconnect wiring. Reconnect wires.	Use new switch.
	e. Switch (4)	Reassemble.	
	f. Switch (4), cover (3) and screws (2)		
	g. Cover (3) and screw (1)	Reassemble on box (5).	





**3-110.2. BREAKGLASS CONTROL STATION-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1. Control station	<ul style="list-style-type: none"> <li>a. Check exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that hardware is not damaged.</li> <li>c. Check that glass is not damaged.</li> </ul>	If defects are found, refer to Direct Support Maintenance.
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**3-110.2. BREAKGLASS CONTROL STATION-MAINTENANCE INSTRUCTIONS (Cont).**


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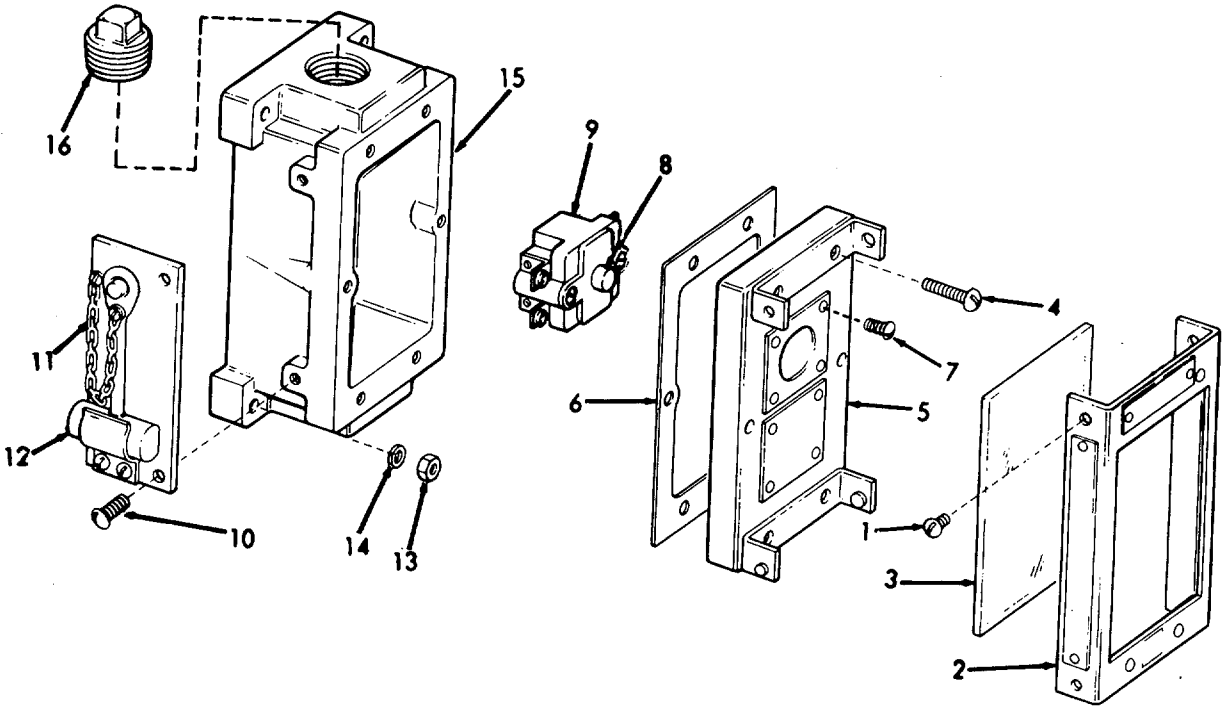
LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2.	a. Screws (1)	Remove.	
	b. Glass cover (2)	Remove.	
	c. Glass (3)	Remove.	Replace if broken.
	d. Screws (4)	Remove.	
	e. Cover (5) and gasket (6)	Remove.	
	f. Wiring	Tag and disconnect.	
	g. Screws (7)	Remove.	
	h. Switch element (8) and contact block (9)	Remove.	
	i. Screws (10), hammer chain and plate (11), and hammer (12)	Remove and repair.	If necessary.
	j. Nuts (13), lock- washers (14), and case (15)	Remove.	If necessary.

3-110.2. BREAKGLASS CONTROL STATION-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

	k. Pipe plug (16)	Replace.	If necessary.
	l. Contact block (9), switch element (8), cover (5), and screws (7)	Assemble.	
	m. Gasket (6)	Install.	
	n. Wiring	Reconnect, remove tags.	



3-110.2. BREAKGLASS CONTROL STATION-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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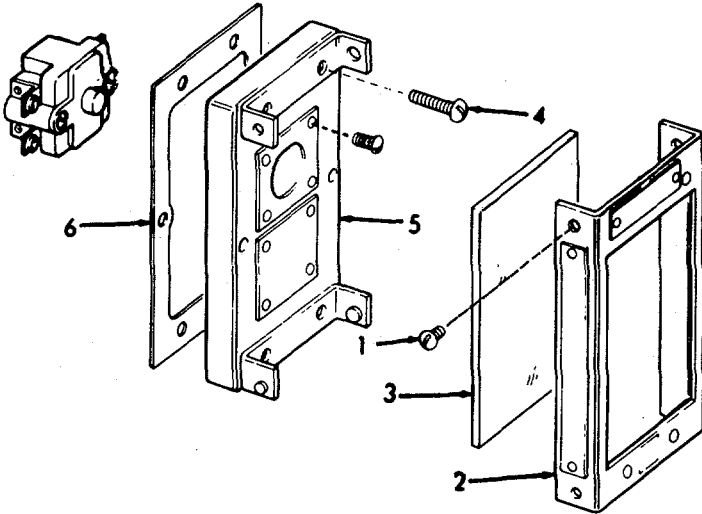
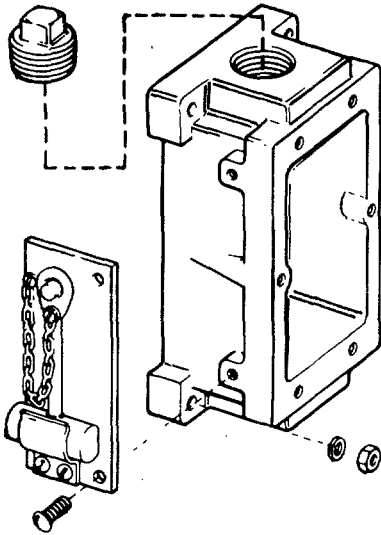
REPAIR (Cont)

o. Screws (4), cover (5), and gasket (6)

Assemble.

p. Glass (3), glass cover (2), and screws (1)

Install.



**3-110.3. WATER TIGHT RECEPTACLES-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1. Receptacles	<ul style="list-style-type: none"> <li>a. Check exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that hardware is not damaged.</li> </ul>	If defects are found, refer to Direct Support Maintenance.
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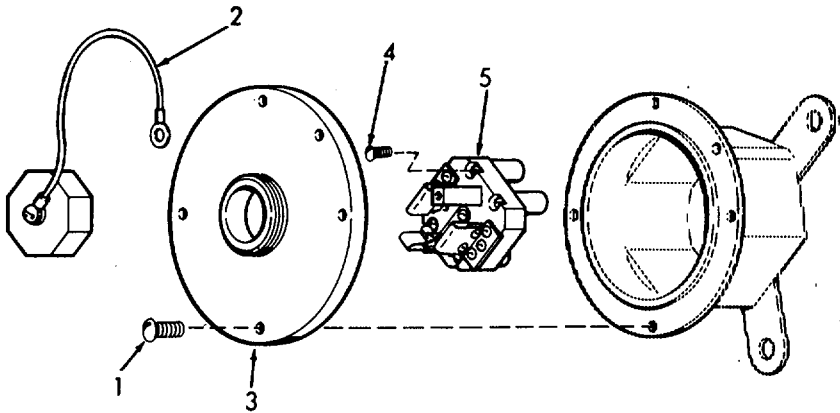
**3-110.3. WATER TIGHT RECEPTACLES-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
		c. Check that gaskets and seals do not leak.	
		d. Check that switch operates normally.	
<b>REPAIR</b>			
2. Water Tight receptacle symbol 735.3	a. Screws (1)	Remove.	
	b. Cap assembly (2) and cover (3)	Remove.	
	c. Screws (4)	Remove.	
	d. Receptacle (5)	1. Remove wiring. 2. Remove from box.	
	e. Receptacle (5) and screws (4)	Reinstall wiring and install in box.	
	f. Cover (3), cap assembly (2) and screws (1)	Reassemble.	

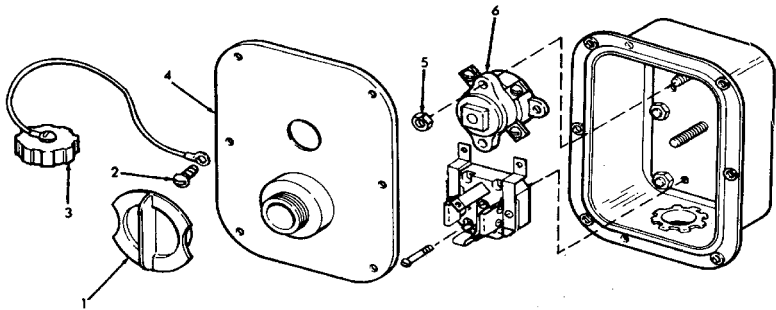
3-110.3. WATER TIGHT RECEPTACLES-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

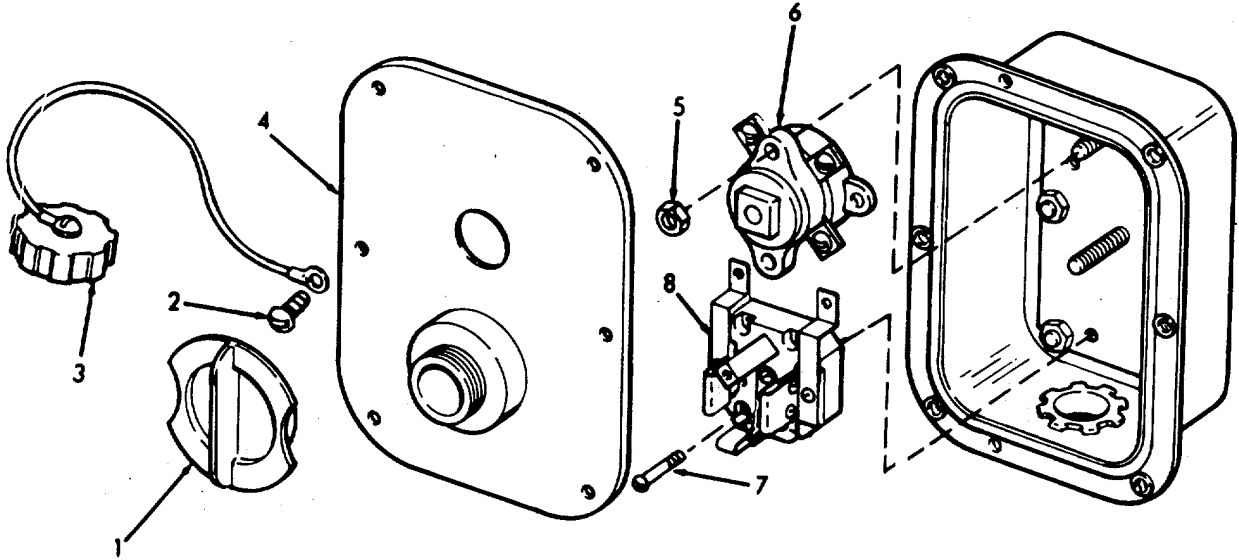


- |  |   |   |
|--|---|---|
| 3. Water-tight receptacle symbol 900.1 | a. Switch knob (1)                            | Loosen setscrew and remove.               |
|  | b. Screws (2), cap assembly (3) and cover (4) | Remove.                                   |
|  | c. Nuts (5) and switch (6)                    | 1. Tag and disconnect wires.<br>2. Remove |



3-110.3. WATER TIGHT RECEPTACLES-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<div style="border: 1px solid black; padding: 2px; display: inline-block;">REPAIR (Cont)</div>	d. Screws (7) and receptacle (8)	1. Tag and disconnect wires. 2. Remove.	
	e. Receptacle (8) and screws (7)	1. Reassemble. 2. Reconnect wires.	
	f. Switch (6) and nuts (5)	1. Reassemble. 2. Reconnect wires.	
	g. Cover (4), cap assembly (3) and screws (2)	Reassemble.	
	h. Switch knob (1)	Install.	





**3-110.4. DUPLEX RECEPTACLES-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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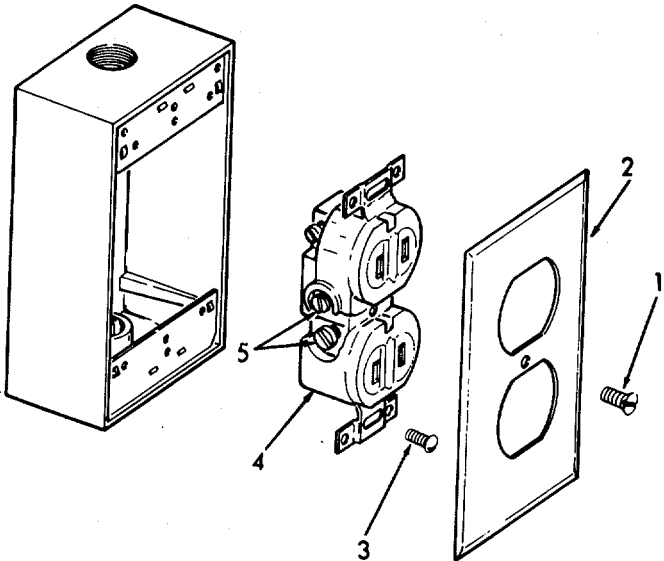
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |                              |   |   |
|------------------------------|---|---|
| <p>1. Duplex receptacles</p> | <ul style="list-style-type: none"> <li>a. Check exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that hardware is not damaged.</li> <li>c. Check that receptacle is not damaged.</li> </ul> | <p>If defects are found, refer to Direct Support Maintenance.</p> |
|------------------------------|---|---|

3-110.4. DUPLEX RECEPTACLES-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2.	a. Screw (1) and cover plate (2)	Remove.	
	b. Screws (3)	Remove.	
	c. Receptacle (4)	1. Remove from box.	
		2. Loosen screws (5) and remove wires.	
	d. Receptacle (4)	1. Install wires and tighten screws (5).	
	e. Receptacle (4) and screws (3)	Install in box.	
	f. Cover plate (2) and screw (1)	Reassemble.	



**3-110.5. INTERLOCKING DOOR OPERATED SWITCH-MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection
- b. Repair

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |   |  |   |
|---|--|---|
| <p>1. Interlocking door operated switch</p> | <ul style="list-style-type: none"> <li>a. Check that exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that lock operates.</li> <li>c. Check that switch operates.</li> </ul> | <p>If defects are found, refer to Direct Support Maintenance.</p> |
|---|--|---|

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**3-110.5. INTERLOCKING DOOR OPERATED SWITCH-MAINTENANCE  
INSTRUCTIONS (Cont).**


---

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2.	a. Screws (1) and flat- washers (2)	Remove.	
	b. Cover (3) and gasket (4)	Remove.	
	c. Stationary flat contact (5), contact post (6), moveable crowned contact (7) and contact connector (8)	Disassemble, if neces- sary.	
	d. Locknuts (9) and striker assembly (10)	Remove, if necessary.	
	e. Taper pin (11) and lever (12)	Remove, if necessary.	
	f. Locking pin (13), knob (14), spring (15), locking shaft (16), housing (17), and locking tab washer (18)	Disassemble, if neces- sary.	
	g. Gland bush- ing (19) and preformed packing (20)	Remove, if necessary.	

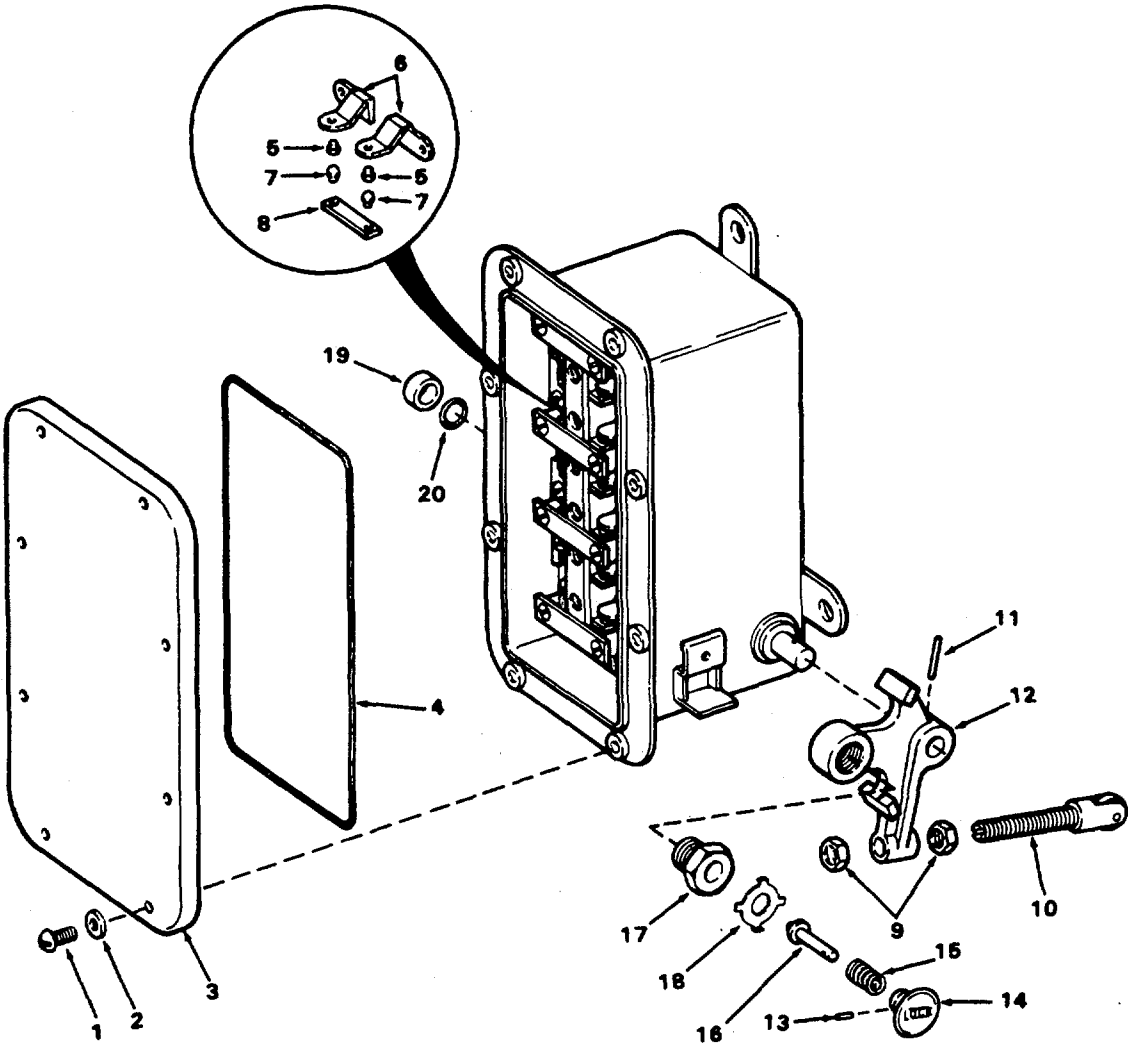
**3-110.5. INTERLOCKING DOOR OPERATED SWITCH-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

h. Cover (3),  
gasket (4),  
screws (1),  
and flat-  
washers (2)

Assemble.



**3-110.6. DISCONNECT SWITCH-MAINTENANCE INSTRUCTIONS.**

This task covers:  
Inspection

INITIAL SETUP

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition</u> <u>Condition Description</u>
NONE	<u>Para</u>
	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

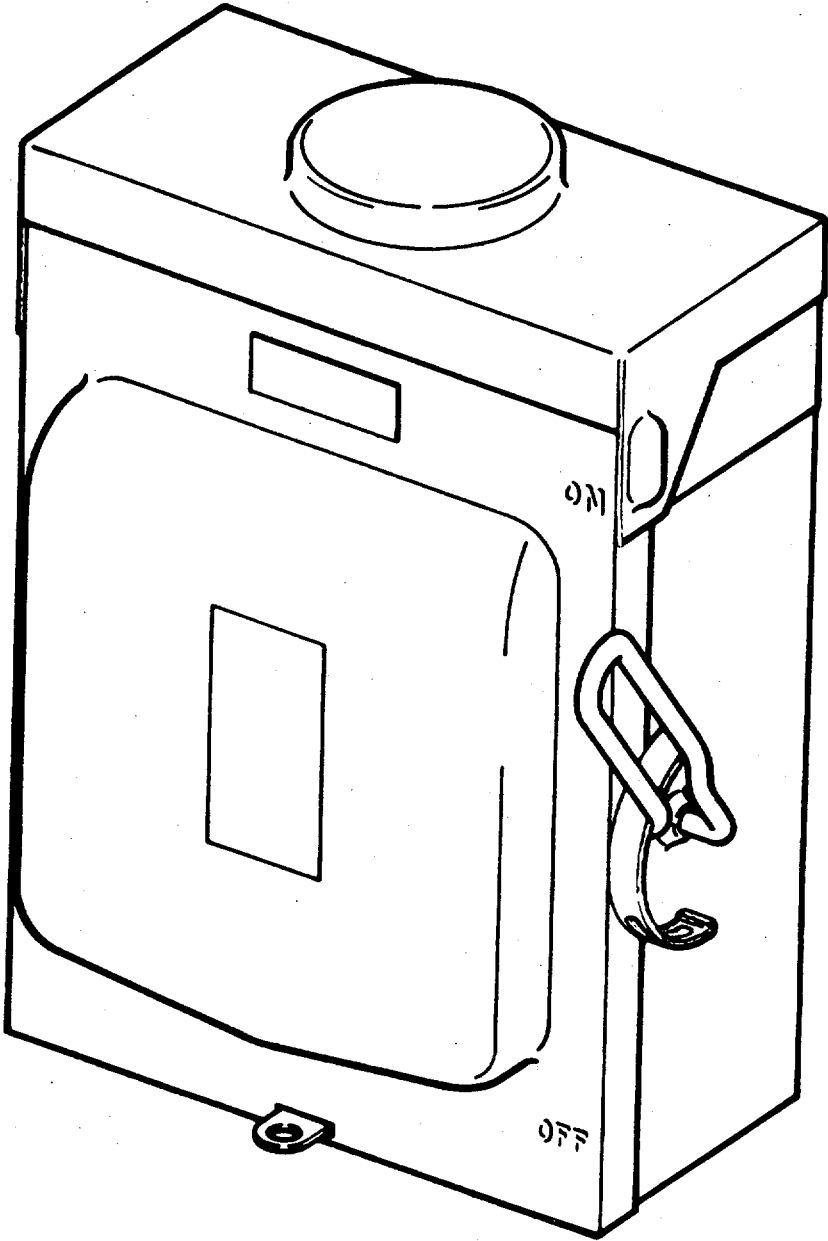
INSPECTION

- |    |   |  |
|----|---|--|
| 1. | <ul style="list-style-type: none"> <li>a. Check exterior wires and cables for signs of fraying or deterioration.</li> <li>b. Check that hardware is not damaged.</li> </ul> | If defects are found, refer to Direct Support Maintenance. |
|----|---|--|

3-110.6. DISCONNECT SWITCH-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)



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**3-111. LIGHTS-MAINTENANCE INSTRUCTIONS.**

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The maintenance instructions for the lights both incandescent and fluorescent are contained in the following paragraphs.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Incandescent Bulkhead Fixture Numbers 3532F6 and 3532F6R	3-111.1.
Incandescent Bulkhead Fixture Number 3541	3-111.2.
Incandescent Ceiling Fixture Number 3528F6	3-111.3.
Floodlight-Symbol 300.2	3-111.4.
Fluorescent Desk Lamp	3-111.5.
General Purpose Fluorescent Fixture (2 tube)	3-111.6.
General Purpose Fluorescent Fixture (1 tube)	3-111.7.
Berth Light	3-111.8.
General Purpose Fluorescent Fixture (2 tube) Conning Tower	3-111.9.
Rotating Fire Lamp (Amber and Red)	3-111.10.

**Change 2      3-1842**



**3-111.1. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS.  
Numbers 3532F6 and 3532F6R**

This task covers:

- a. Inspection
- b. Removal/Repair
- c. Replace

INITIAL SETUP

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition    Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1. Bulkhead	Bulkhead fixture	Burned out lamps. Broken globes. Frayed wiring. Bent or damaged metal. Loose nuts, screws and bolts.	
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**3-111.1. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS  
(Cont).  
Numbers 3532F6 and 3532F6R**

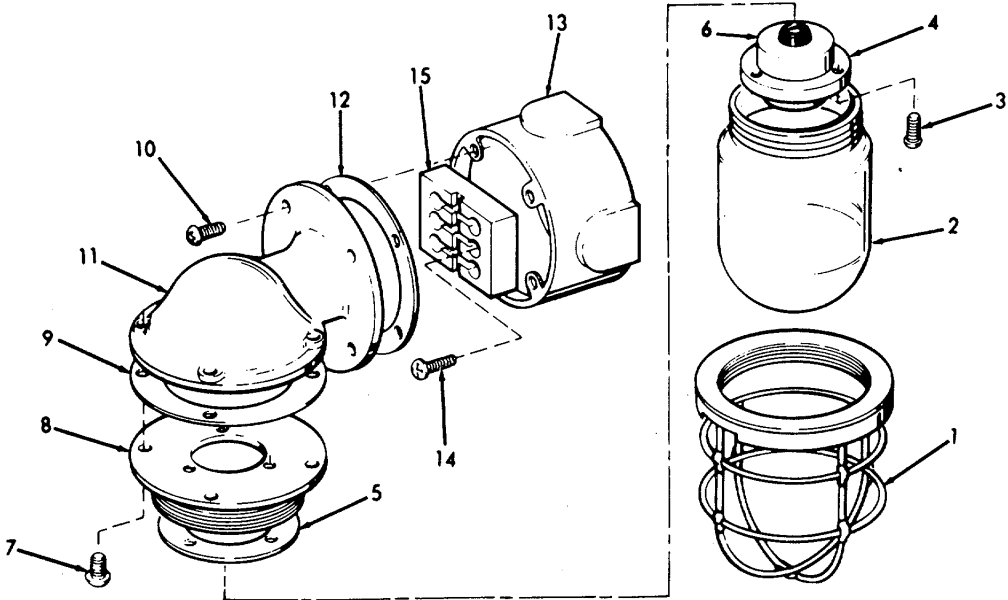
LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Bulkhead	a. Lamp cover (guard)	Remove guard assembly (1).	Replace if damaged.
	b. Light fixture	Remove glass globe (2).	Replace if damaged.
	c. Lamp-holder	1. Remove screws (3) from lampholder (4). 2. Remove gasket (5).	Replace if worn.
	d. Lamp	Remove lamp (6).	Replace if broken or burned out.
	e. Base (fixture housing) or damaged.	1. Remove screws (7).	
		2. Remove flange (8).	Replace if bent
3. Remove gasket (9).		Replace if worn.	
f. Wiring	4. Remove screws (10). 5. Elbow (11), gasket (12), and junction box (13) can now be removed.	Replace if damaged or worn.	
	1. Remove screws (14) from wiring block (15).	Check block for worn or damaged wiring.	
<b>REPLACE</b>			
3.	a. Wiring	Replace wiring block (15), using screws (14).	
	b. Base (fixture housing)	1. Replace junction box (13), gasket (12) and elbow (11) and secure with screws (10).	

**3-111.1. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS**  
**(Cont).**  
**Numbers 3532F6 and 3532F6R**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPLACE (Cont)**

- |    |                     |   |
|----|---------------------|---|
|    |                     | 2. Replace gasket (9) and flange (8) and secure with screws (7).      |
| c. | Lamp                | Replace lamp (6).   |
| d. | Lamp-holder         | 1. Replace gasket (5).<br>2. Install lampholder (4), using screw (3). |
| e. | Light fixture       | Replace glass globe (2).  |
| f. | Light cover (guard) | Replace assembly light guard (1).                                     |



**3-111.2. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS. Part Number 3541**

This task covers:

- a. Inspection                      b. Removal/Repair                      c. Replace

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

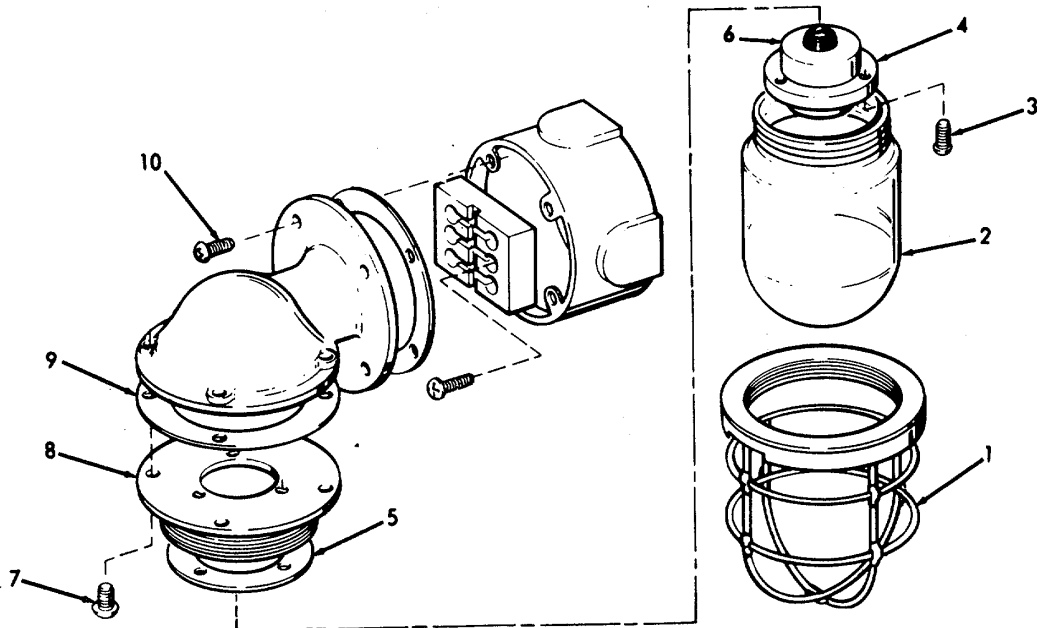
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |    |                  |  |
|----|------------------|--|
| 1. | Bulkhead fixture | <ul style="list-style-type: none"> <li>ù Burned out lamps.</li> <li>ù Broken globes.</li> <li>ù Frayed wiring.</li> <li>ù Bent or damaged metal.</li> <li>ù Loose nuts, screws and bolts.</li> </ul> |
|----|------------------|--|

**3-111.2. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).**  
**Part Number 3541**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Bulkhead	a. Lamp cover (guard)	Remove guard assembly (1).	Replace if damaged.
	b. Light fixture	Remove glass globe (2).	Replace if damaged.
	c. Lamp-holder	1. Remove screws (3) from lampholder (4).	
		2. Remove gasket (5).	Replace if worn.
	d. lamp	Remove lamp (6).	Replace if broken or burned out.
e. Base (fixture housing)	1. Remove screws (7), flange (8), gasket (9) and screws (10).	Replace if damaged or defective.	



**3-111.2. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).**  
**Part Number 3541**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR (Cont)</b>			
		2. Elbow (11), gasket (12), and junction box (13) can now be removed.	Replace if damaged or worn.
	f. Wiring	Remove screws (14) from wiring block (15).	Check wiring block for worn or damaged wiring.

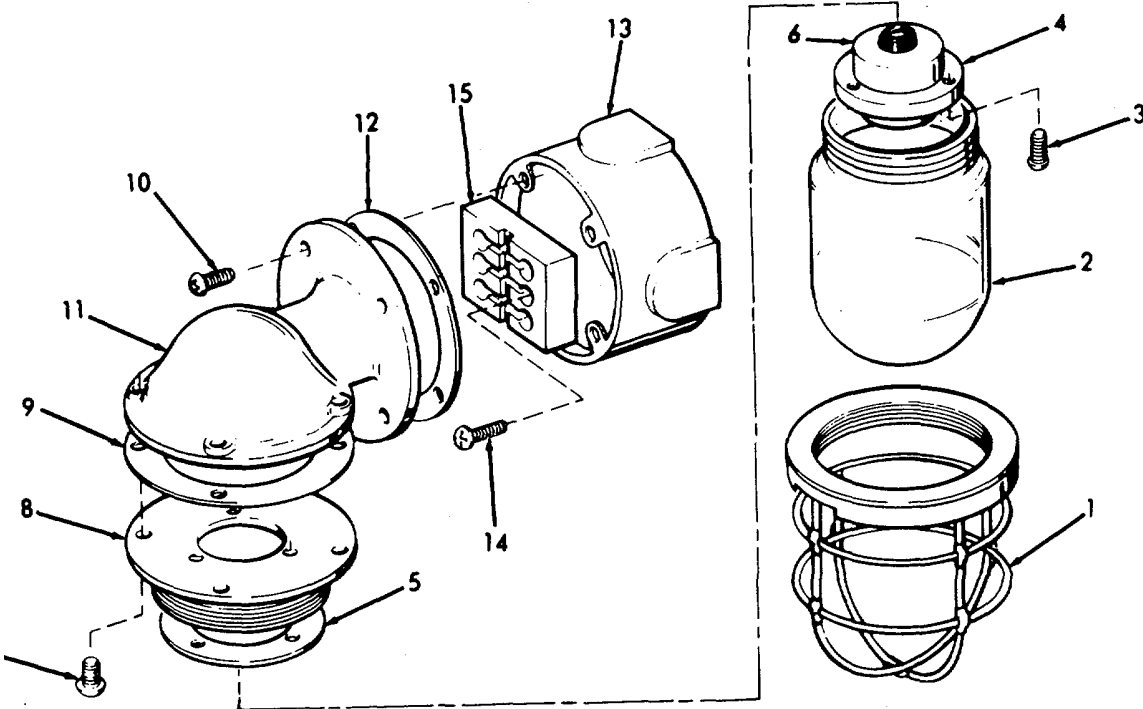
**REPLACE**

3.	a. Wiring	Replace wiring block (15), using screws (14).	
	b. Base (fixture housing)	1. Replace junction box (13), gasket (12) and elbow (11), and secure with screws (10).  2. Replace gasket (9) and flange (8) and secure with screws (7).	
	c. Lamp	Replace lamp (6).	
	d. Lamp-	1. Replace gasket (5). holder  2. Install lampholder (4), using screws (3).	
	e. Light	Replace glass globe (2). fixture	
	f. Light cover (guard)	Replace assembly light guard (1).	

3-111.2. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).  
Part Number 3541

LOCATION	ITEM	ACTION	REMARKS
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REPLACE (Cont)



**3-111.3. INCANDESCENT CEILING FIXTURE-MAINTENANCE INSTRUCTIONS. Part Number 3528F6**

This task covers:

- a. Inspection                      b. Removal/Repair                      c. Replace

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

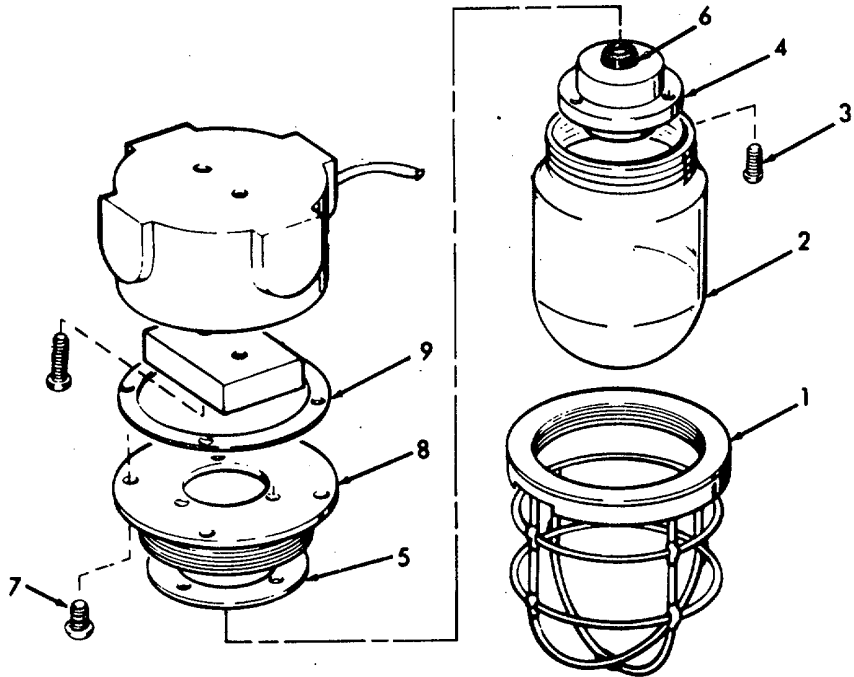
**INSPECTION**

- |    |         |                 |  |
|----|---------|-----------------|--|
| 1. | Ceiling | Ceiling fixture | <ul style="list-style-type: none"> <li>ù Burned out lamps.</li> <li>ù Broken globes.</li> <li>ù Frayed wiring.</li> <li>ù Bent or damaged metal.</li> <li>ù Loose nuts, screws and bolts.</li> </ul> |
|----|---------|-----------------|--|



**3-111.3. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).**  
**Part Number 3528F6**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Ceiling	a. Lamp cover (guard)	Remove guard assembly (1).	Replace if damaged.
	b. Light fixture	Remove glass globe (2).	Replace if damaged.
	c. Lamp-holder	1. Remove screws (3) from lampholder (4).	Replace if damaged.
		2. Remove gasket (5).	Replace if worn.
	d. Lamp	Remove lamp (6).	Replace if broken or burned out.
e. Base (fixture housing)	1. Remove screws (7), from flange (8) and gasket (9).		



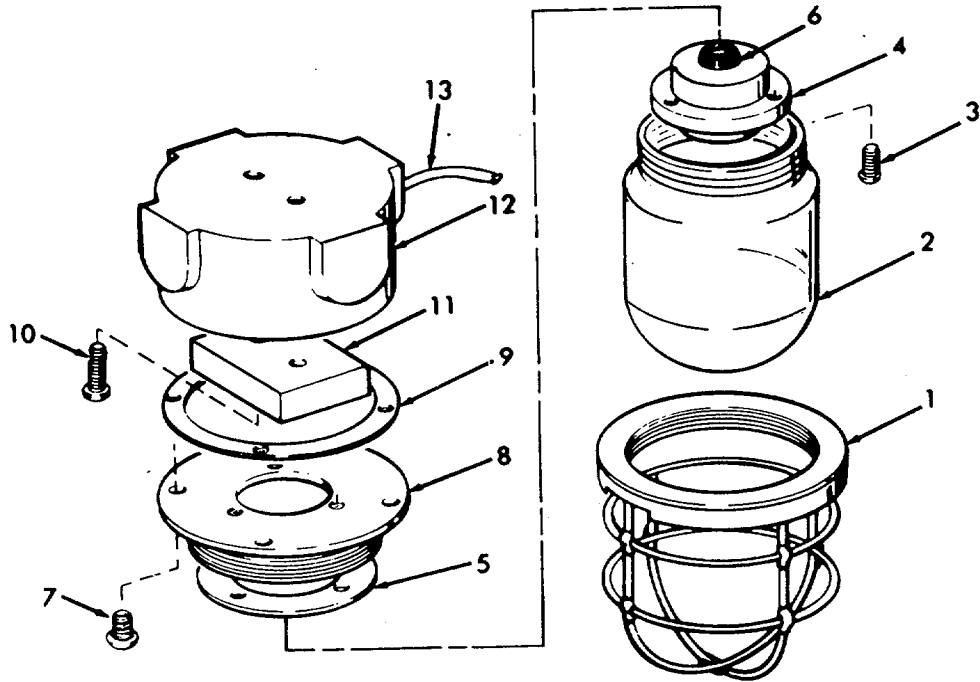
**3-111.3. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).**  
**Part Number 3528F6**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR (Cont)</b>			
		2. Remove screws (10) from connection box (11) and junction box (12).	Boxes can now be inspected for damage or defects.
	f. Wiring	Inspect wiring (13) block for worn or damaged wiring.	Check wiring
<b>REPLACE</b>			
3.	a. Wiring	Replace wiring (13).	Refer to General Support Maintenance.
	b. Base (fixture housing) (10).	1. Replace junction box (12) and connection box (11) using screws (10).  2. Replace gasket (9) and flange (8) and secure with screws (7).	
	c. Lamp	Replace lamp (6).	
	d. Lamp-holder	1. Replace gasket (5).  2. Install lampholder (4), using screws (3).	
	e. Light fixture	Replace glass globe (2).	
	f. Light cover (guard)	Replace light cover (1) (guard assembly).	

3-111.3. INCANDESCENT BULKHEAD FIXTURE-MAINTENANCE INSTRUCTIONS (Cont).  
Part Number 3528F6

LOCATION	ITEM	ACTION	REMARKS
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REPLACE (Cont)



**3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENANCE INSTRUCTIONS.**

This task covers:

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

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition  
Condition Description  
Para

NONE

Material/Parts

Rivets P/N 700 398-32

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

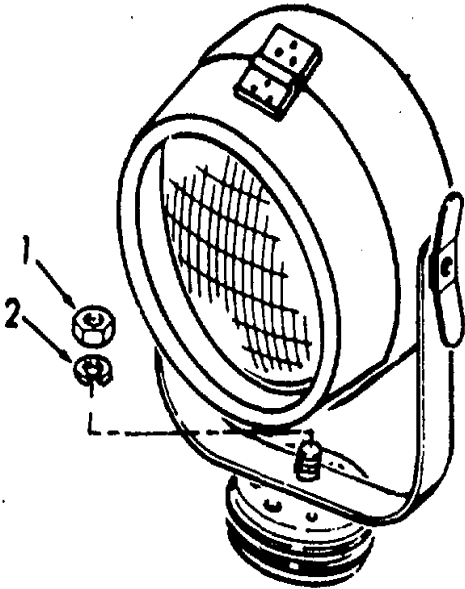
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |               |             |  |
|---------------|-------------|--|
| 1. Floodlight | a. Wiring   | Check for worn, damaged or frayed wiring.        |
|               | b. Lamp     | Check for burned out lamp.                       |
|               | c. Hardware | Check for loose, bent, missing or damaged parts. |

3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL</b>			
2.	a. Wiring	Disconnect at source of power.	
	b. Nut (1) and lock-washer (2)	Remove.	
	c. Flood-light assembly	Remove from mounting.	



## 3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

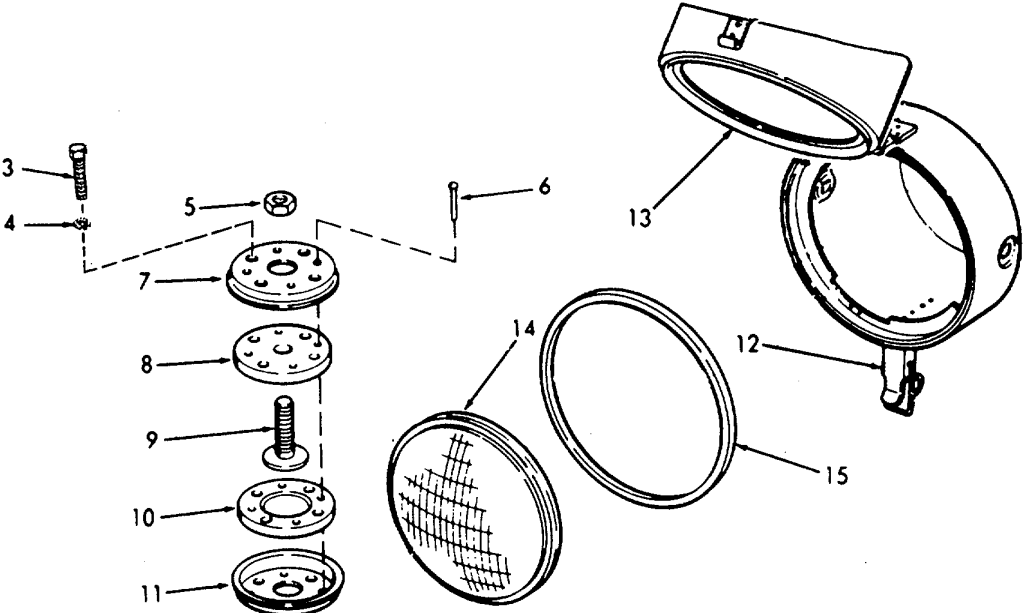
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
3. Mounting base	a. Four screws (3) and lock-washers (4)	Remove.	
	b. Nut (5)	Remove.	
	c. Rivets (6)	Drill out and remove.	
	d. Upper cup re-tainer (7), rubber disc (8), stud (9), rubber disc (10) and lower cup re-tainer (11)	Disassemble.	
	e. Lower cup re-tainer (11), rubber disc (10), stud (9), rubber disc (8) and upper cup re-tainer (7)	Reassemble.	
	f. Rivets (6)	Install.	
	g. Nut (5)	Install.	

3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

	h. Four screws (3) and lock-washers (4)	Install.	
4. Lamp	a. Latch (12)	Release.	
	b. Hood (13)	Swing up.	
	c. Lamp (14)	Remove wires and remove.	
	d. Gasket (15)	Remove.	Replace if damaged.
	e. Gasket (15)	Replace.	



3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	f. Lamp (14)	Replace wiring.	
	g. Hood (13) and latch (12)	Close and secure latch.	
5. Wiring	a. Two nuts (16) and lock-washer (17)	Remove.	
	b. Ground wire	Remove.	
	c. Screw (18)	Remove.	
	d. Stuffing tube collar (19)	Loosen.	
	e. Wiring (20)	Remove.	
	f. Stuffing tube collar (19), packing (21) and stuffing tube (22)	Disassemble.	
	g. Stuffing tube (22), packing (21), stuffing tube collar (19) and wiring (20)	Reassemble.	

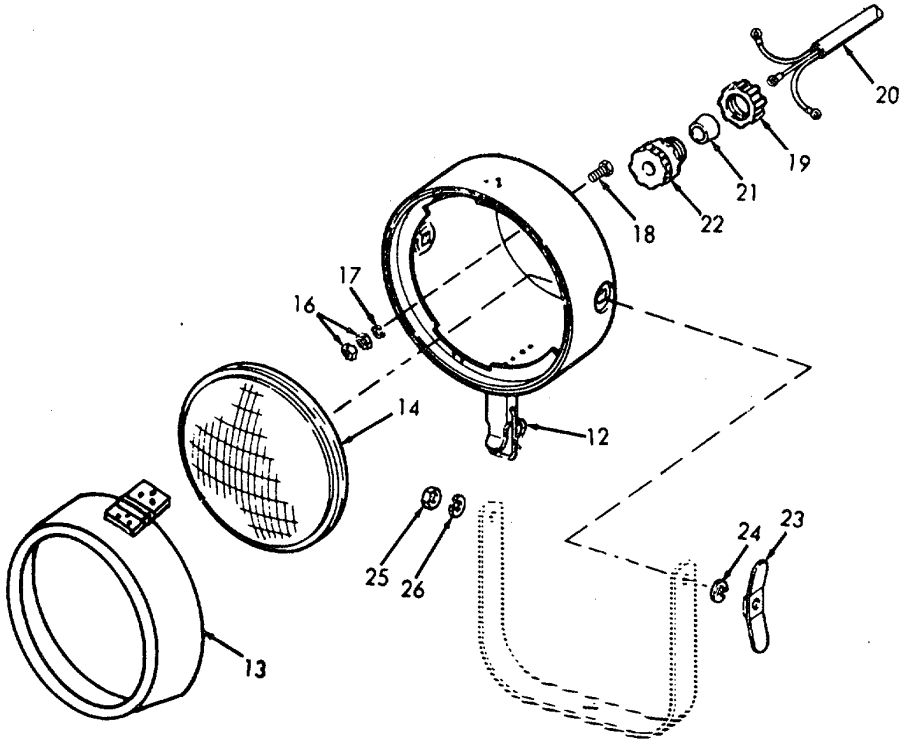


3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

	h. Ground wire, screw (18), lock-washer (17) and nuts (16)	Reassemble.	
6. Housing	a. Handle (23) and lock-washer (24)	Remove.	
	b. Nut (25) and lock-washer (26)	Remove.	



## 3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	c. Carriage bolts (27), flat-washers (28 and 29) and nut (30)	Remove.	
	d. Yoke (38) and lamp housing (31)	Disassemble.	
	e. Rivets (32) and three springs (33)	Drill out rivets, if necessary.	
	f. Rivets (34) and hinge (35)	Drill out rivets, if necessary.	
	g. Hood (13) and housing (31)	Separate.	
	h. Rivets (36) and strike latch (37)	Drill out rivets, if necessary.	
	i. Rivets and hood latch (12)	Drill out rivets, if necessary.	

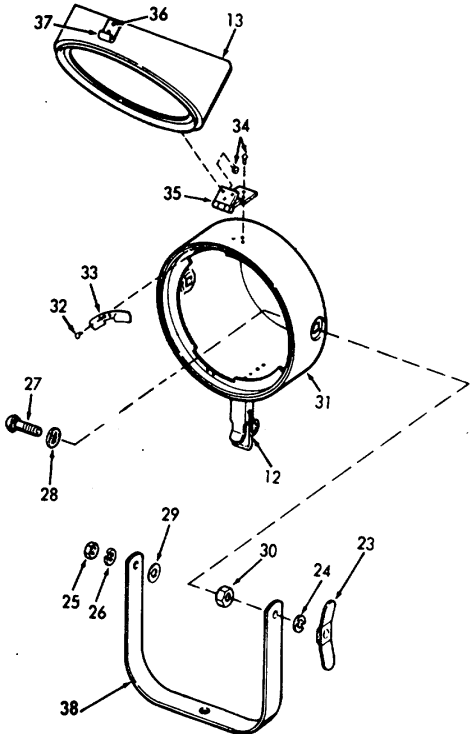
3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

j. Yoke (38), lamp housing (31), carriage bolts (27), flat-washers (28), nut (30), flat-washer (29), lock-washer (26), nut (25) lock-washer (24) and handle (23)

Reassemble

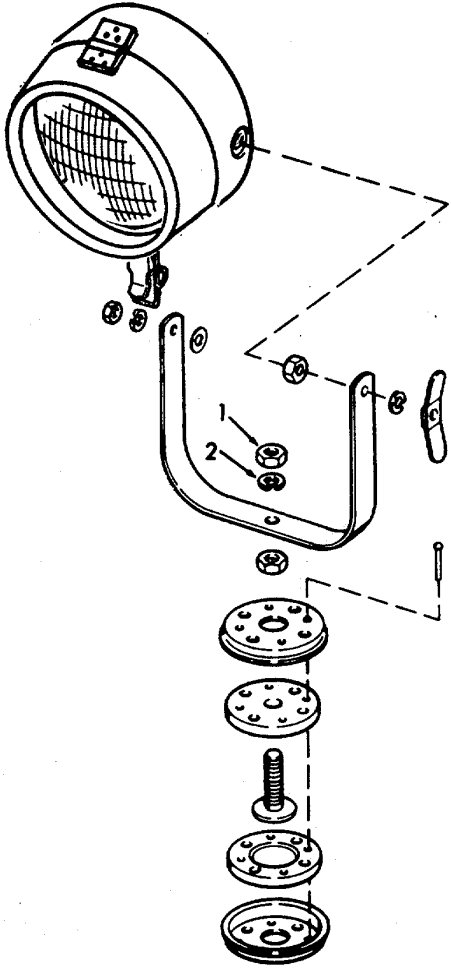


3-111.4. FLOODLIGHT SYMBOL 30012-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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**INSTALLATION**

- 7. Floodlight
  - a. Flood-light assembly                      Install on mounting.
  - b. Nut (1) and lock-washer (2)              Install.
  - c. Wiring                                      Reconnect.



**3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENANCE INSTRUCTIONS.**

This paragraph contains the maintenance instructions for the desk light and the desk light red filter.

This task covers:

- a. Inspection
- c. Repair

INITIAL SETUP:

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition Description</u>
NONE	<u>Para</u>
	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1.	Desk Lamp	a. Wiring	Inspect for frayed, worn or broken wiring.	Replace.
		b. Lamp	1. Inspect for broken, loose lamps.	Replace.

3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

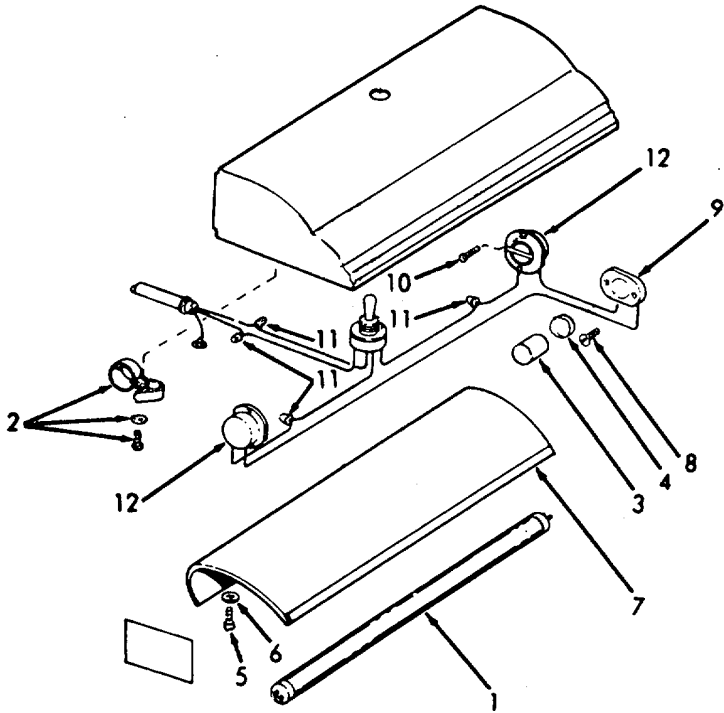
LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
		2. Inspect for burnt marks on end of tube.	
	c. Switch	Check its operation.	
	d. Starter	Check that lamp lights.	Replace.
2. Desk lamp filter	a. Shield	Check that shield moves freely.	
	b. Attachment clips	Inspect for cracks or breaks and loose hardware.	
<b>REPAIR</b>			
3. Fluorescent lamp	Lamp (1)	Rotate one-half turn and remove from lamplock (2).	
4. Starter	a. Starter (3)	Rotate one-half turn and remove.	
	b. Washer (4)	Remove.	
5. Reflector shield	a. Screws (5) and lock-washers (6)	Remove.	
	b. Shield (7)	Remove.	
	c. Screws (5) and lock-washers (6)	Install.	
6. Starter socket	a. Screws (8)	Remove.	

3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

	b. Socket (9)	Disconnect wires and remove.	
	c. Socket (9) and screws (8)	Reconnect wires to socket and install.	
7. Lamp sockets	a. Screws (10)	Remove.	
	b. Wirenuts (11)	Remove and disconnect wires.	
	c. Socket (12)	Remove.	
	d. Socket (12) and screws (10)	Reassemble.	



3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	e. Wire and wirenuts (11)	Twist wirenuts on wires.	
8. Switch	a. Wirenuts (11)	Remove and disconnect wires.	
	b. Nut (13) and switch (14)	Remove.	
	c. Switch (14) and nut (13)	Reassemble.	
	d. Wirenuts (11)	Twist wirenuts on wires.	
9. Wiring head	a. Wirenuts (11) and ground wire (15)	Remove if necessary.	
	b. Strain relief (16) and wire (17)	1. Remove from head (18), front arm (19) and rear arm (20). 2. Remove from ballast housing (21) and ballast (22).	
10. Arm	a. Screws (23) and head (18)	Disassemble.	
	b. Screws (24) and ballast housing (21)	Disassemble.	

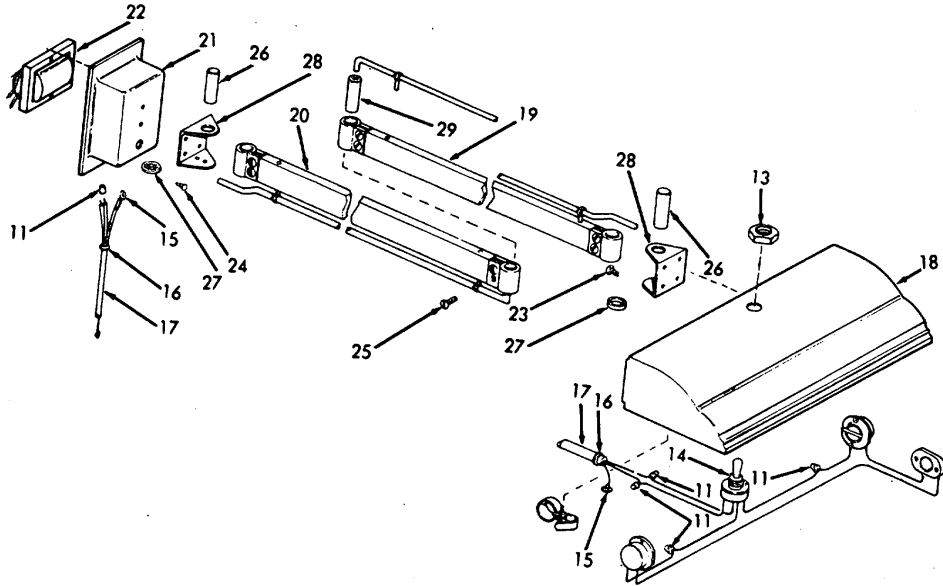


3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- c. Screws (25), pin (26), spacer (27) and bracket (28) Disassemble.
- d. Pin (29), front arm (19) and rear arm (20) Disassemble.
- e. Rear arm (20), pin (29) and front arm (19) Reassemble.



3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

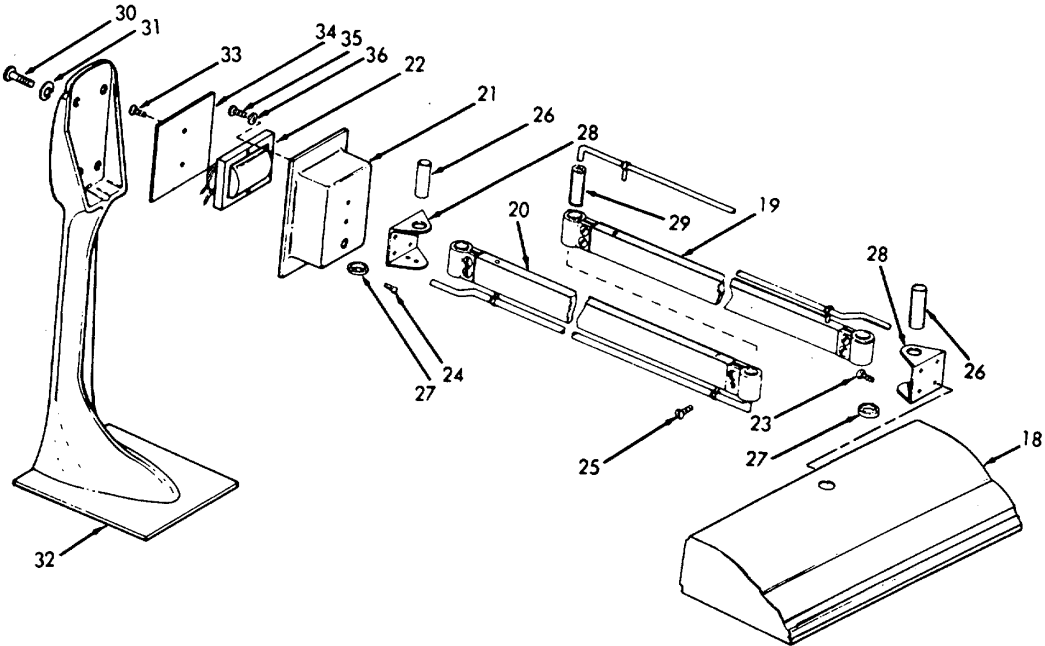
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	f. Bracket (28), spacer (27), pin (26) and screws (25)	Reassemble.	
	g. Screws (24) and ballast housing (21)	Reassemble.	
	h. Screws (23) and head (18)	Reassemble.	
11. Ballast	a. Screws (30), lock-washers (31) and stand (32)	Disassemble.	
	b. Screws (33) and back cover (34)	Disassemble.	
	c. Screws (35), lock-washers (36) and ballast (22)	Disassemble.	

3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- d. Ballast (22), screws (35) and lock-washers (36)
- e. Back cover (34) and screws (33)
- f. Stand (32), screws (30) and lock-washers (31)



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**3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
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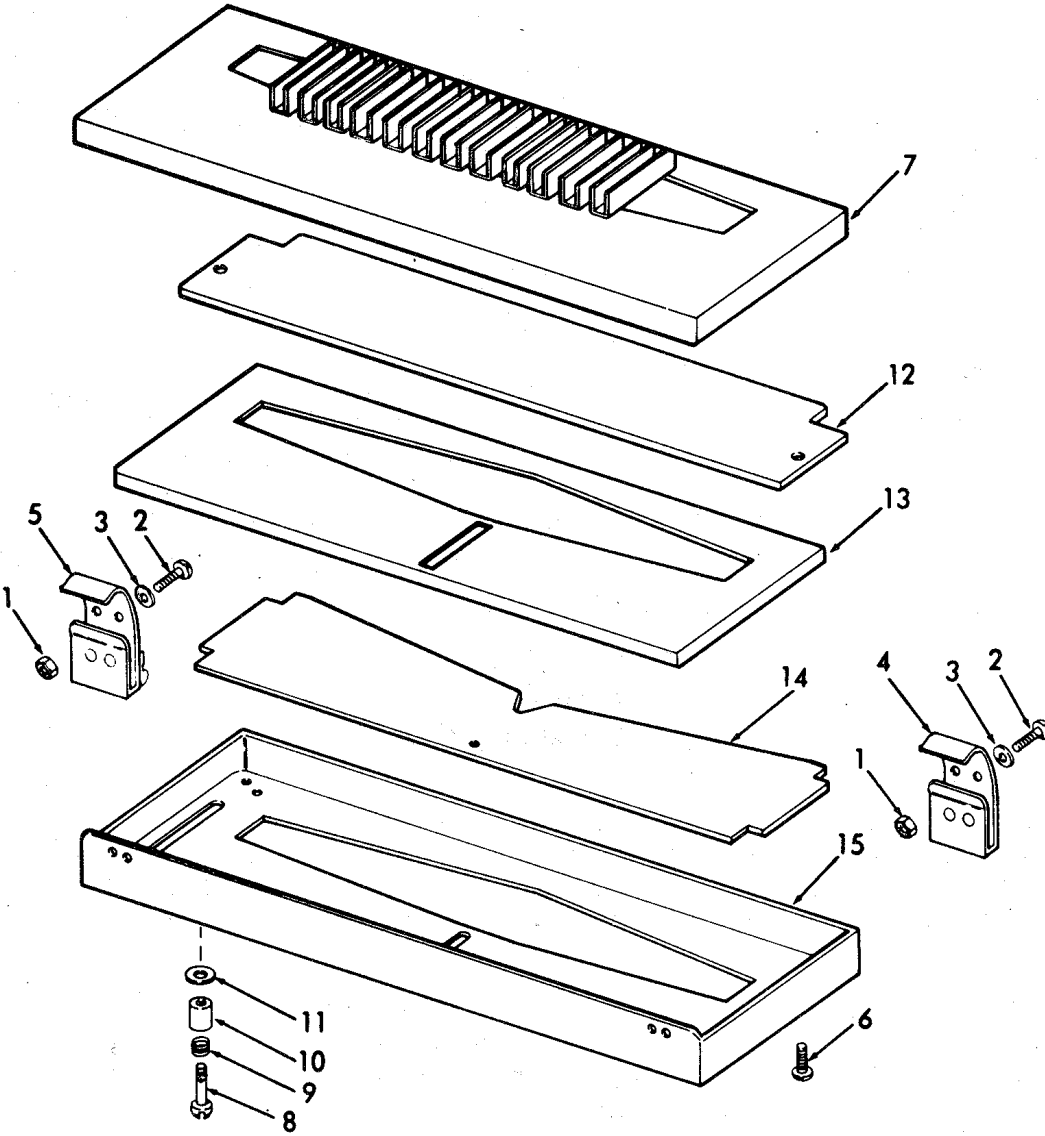
REPAIR (Cont)
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12. Desk lamp filter	a. Nuts (1), screws (2), lock-washers (3), attachment clips (4 and 5)	Disassemble, if necessary.	
	b. Four screws (6)	Remove.	
	c. Deep baffle (7)	Remove, if necessary.	
	d. Three knobs (8), springs (9), ferrules (10) and nylon washers (11)	Disassemble, if necessary.	
	e. Red filter (12), shallow baffle (13), shield (14) and frame (15)	Disassemble, if necessary.	

3-111.5. FLUORESCENT DESK LIGHT FIXTURE-MAINTENACE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection                      b. Disassembly                      c. Repair

INITIAL SETUP:

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1.	Light fixture	a. Window	Inspect for breaks, cracks and loose mounting.	
		b. Lamps	1. Inspect for broken or loose lamps.  2. Inspect for burnt marks on end of tube.	Replace.

**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENACE INSTRUCTIONS (Cont).**

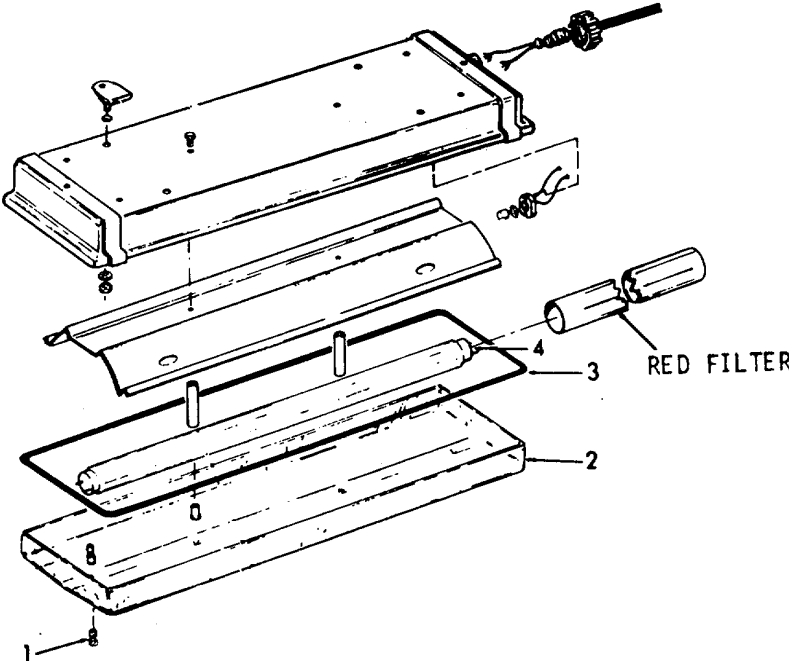
LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION (Cont)**

- c. Starter                      Inspect for looseness or damage.
- d. Wiring                      Inspect for worn, frayed or damaged wiring.

**DISASSEMBLY**

- 2.
  - a. Four screws (1)                      Loosen.
  - b. Window (2) and gasket (3)                      Remove.
  - c. Lamps (4)                      Rotate and remove.



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**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)
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- |  |  |                        |  |
|--|--|------------------------|--|
|  | d. Starter (5) and washer (6)  | Remove.                |  |
|  | e. Posts (7), screws (8) and reflector (9)                               | Remove.                |  |
|  | f. Cable cap (10)  | Loosen.                |  |
|  | g. Wire (11)   | Disconnect and remove. |  |
|  | h. Nuts (12) and washers (13)  | Remove.                |  |
|  | i. Housing (14)  | Remove.                |  |
|  | j. Shock-mount (15) and o-ring (16)                                      | Remove.                |  |
|  | k. Shock-mount (15), o-ring (16), housing (14), washer (13) and nut (12) | Assemble and install.  |  |
|  | l. Wiring (11)   | Reconnect.             |  |

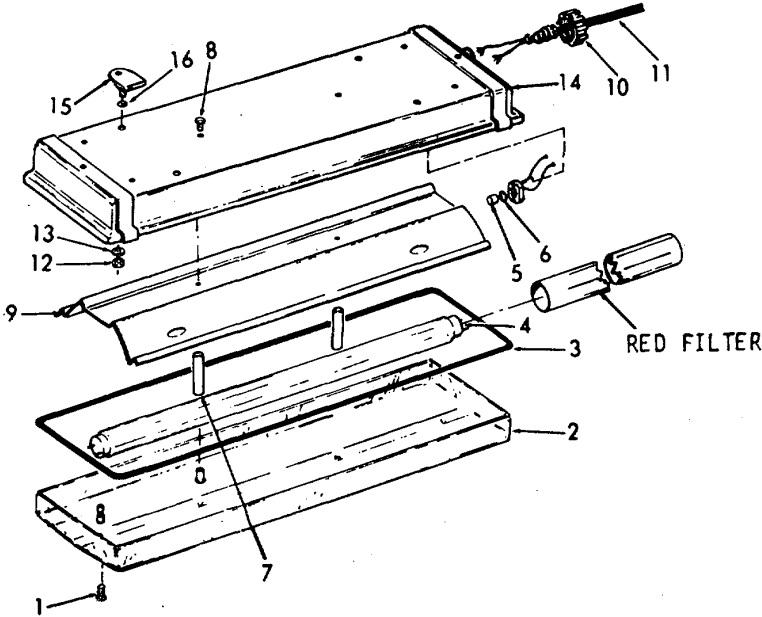


**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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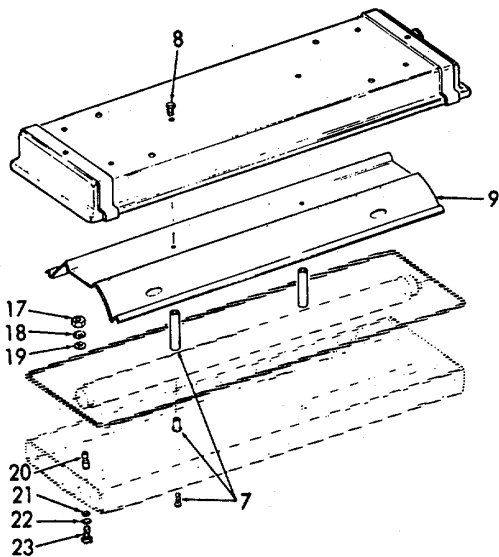
**DISASSEMBLY (Cont)**

- m. Cable cap (10) Tighten.
- n. Reflector (9), screws (8) and posts (7) Reassemble.
- o. Starter (5) and washer (6) Install.
- p. Lamps (4) Install and rotate.
- q. Window (2), gasket (3) Assemble.
- r. Screws (1) Tighten.



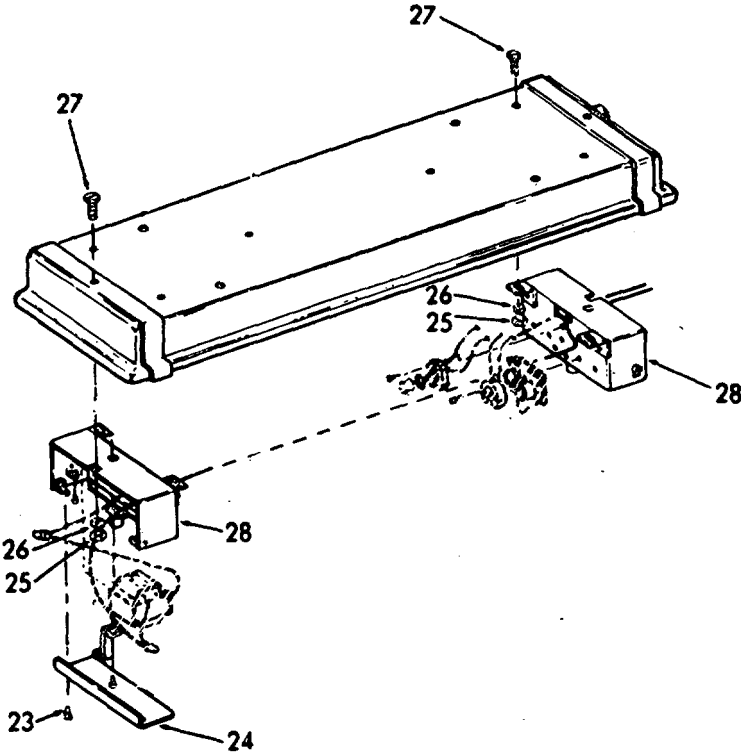
**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR</b>			
3. Window Assembly	a. Nut (17), lock-washer (18), flat-washer (19), bushing (20), leather washer (21), o-ring (22) and screw (23)	Disassemble.	If necessary
4. Column assembly	Post, bushing and screw (7), reflector (9) and screw (8)	Disassemble.	If necessary



3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
5. Barrier assemblies	a. Screws (23) and cover (24)	Remove.	
	b. Nuts (25), lock-washers (26), screws (27) and barrier assembly (28)	Remove.	

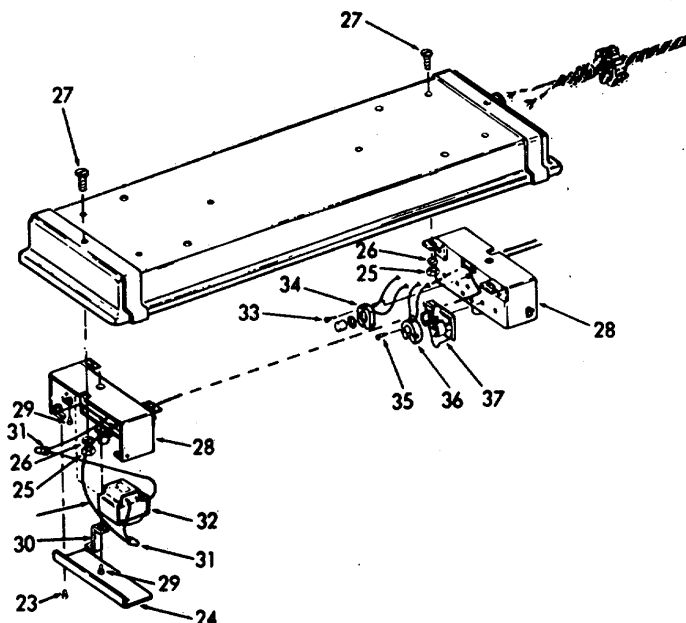


**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Ballast lamp	c. Barrier assemblies (28), screws (27), washers (26) and nuts (25)	Reassemble.	
	d. Cover (24) and screws (23)	Install.	
	a. Screw (29), retainer (30)	Remove.	
	b. Closed end connectors (31)	Unscrew and separate wires.	
	c. Ballast (32)	Remove.	
d. Ballast (32), retainer (30) and screw (29)	Assemble.		
e. Closed end connectors (31)	Twist wires and attach connector.		
7. Starter socket	a. Screws (33) and socket (34)	Disconnect wiring and remove socket.	

**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Wiring, socket (34) and screws (33)	Reconnect wires and reassemble.	
8. Lamp-Holder	a. Screws (35), lamp-holder (36) and lamplock (37)	Disassemble.	
	b. Wiring	Disconnect and remove lampholder.	



**3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Wiring	c. Wiring, lamplock (37), lamp-holder (36) and screws (35)	Reconnect wires and re-assemble.	
	a. Wiring (11)	Disconnect internal wiring.	
	b. Cable cap (10)	Loosen and remove wire.	
	c. Washer (38), grommet (39), slip washer (40) and cap (10)	Slide from wire.	
	d. Cap (10), slip washer (40), grommet (39) and retainer washer (38)	Slide on wire.	
	e. Wiring (11)	Insert in housing and reconnect.	
	f. Cable cap (10)	Tighten.	

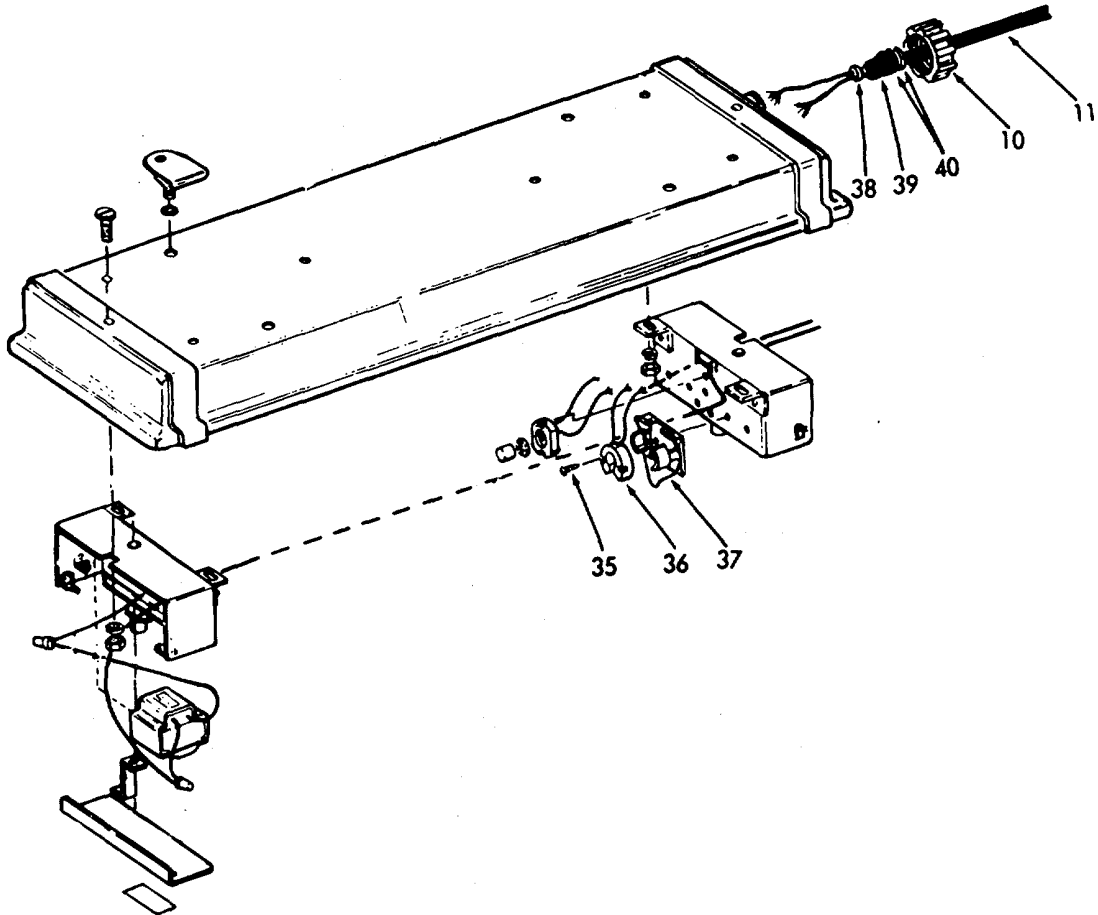
3-111.6. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

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LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



LOCATION	ITEM	ACTION	REMARKS
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**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE NSTRUCTIONS .**

This task covers:

- a. Inspection
- b. Disassembly
- c. Repair

INITIAL SETUP

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
	Equipment
<u>Special Tools</u>	<u>Condition</u> <u>Condition Description</u>
NONE	<u>Para</u>
	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	Observe all WARNINGS

LOCATION	ITEM	ACTION	REMARKS
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WARNING

Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

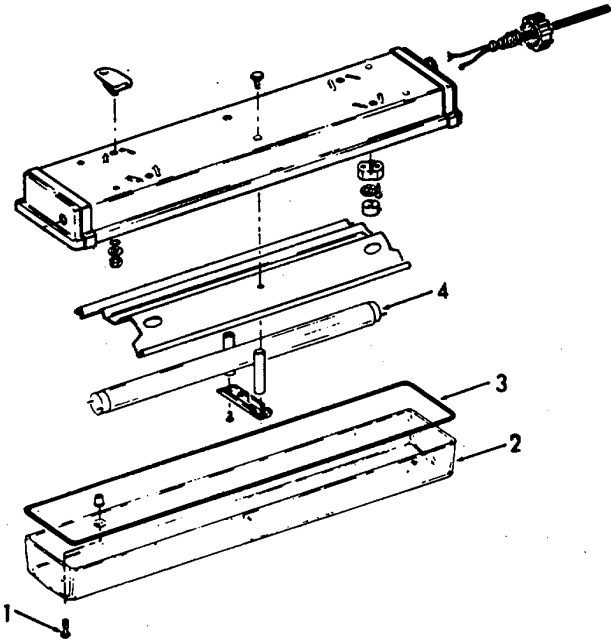
INSPECTION

1.	Light fixture	a.	Window	Inspect for breaks, cracks and loose mounting.	
		b.	Lamps	<ol style="list-style-type: none"> <li>1. Inspect for broken or loose lamps.</li> <li>2. Inspect for burnt marks on end of tube.</li> </ol>	Replace.



**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	c. Starter	Inspect for looseness or damage.	
	d. Wiring	Inspect for worn, frayed or damaged wiring.	
<b>DISASSEMBLY</b>			
2.	a. Three screws (1)	Loosen.	
	b. Window (2) and gasket (3)	Remove.	
	c. Lamp (4)	Rotate and remove.	



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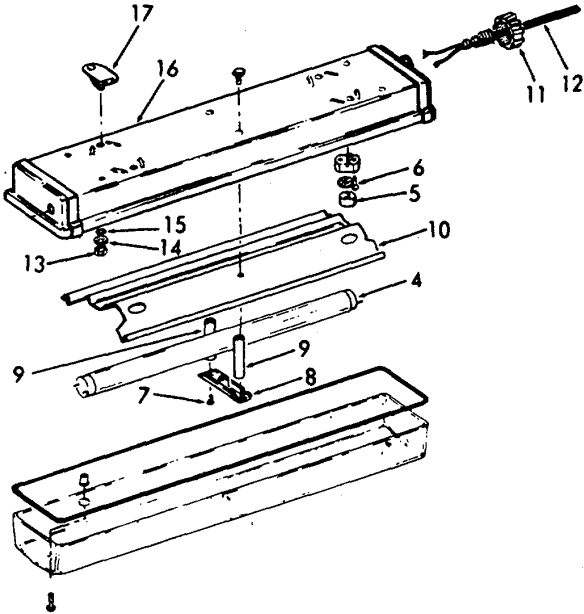
**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**


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LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Starter (5) and washer (6)	Remove.	
	e. Screw (7), bracket (8), posts (9) and reflector (10)	Remove.	
	f. Cable cap (11)	Loosen.	
	g. Wire (12)	Disconnect and remove.	
	h. Nuts (13), washers (14) and o-ring (15)	Remove.	
	i. Housing (16)	Remove.	
	j. Shock- mount (17)	Remove.	
	k. Shock- mount (17), housing (16), o-ring (15), washer (14) and nuts (13)	Assemble and install.	

**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	l. Wiring (12)	Reconnect.	
	m. Cable cap (11)	Tighten.	
	n. Reflector (10), posts (9) brackets (8) and screws (7)	Reassemble.	
	o. Starter (5) and washer (6)	Install.	
	p. Lamps (4)	Install and rotate.	



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**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

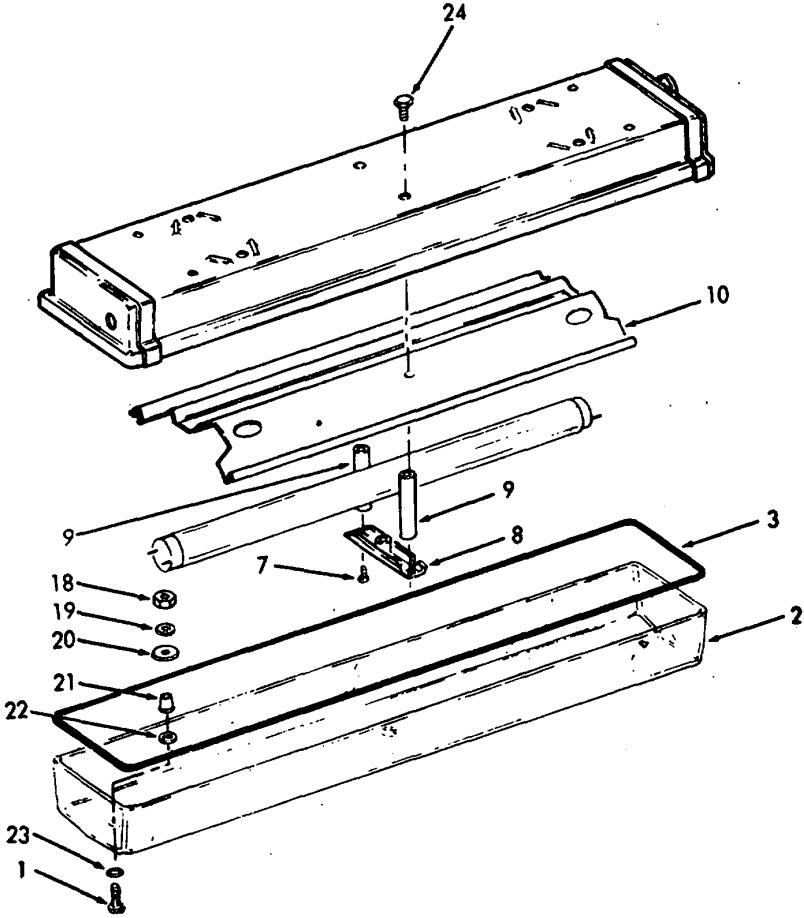

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LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
	q. Window (2) and, gasket (3)	Assemble.	
	r. Screws (1)	Tighten.	
<b>REPAIR</b>			
3. Window Assembly	a. Nut (18), lock-washer (19), flat-washer (20), bushing (21), leather washer (22), o-ring (23) and screw (1)	Disassemble.	If necessary.
4. Column assembly	Posts (9), reflector (10) and screw (24)	Disassemble.	If necessary.

3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

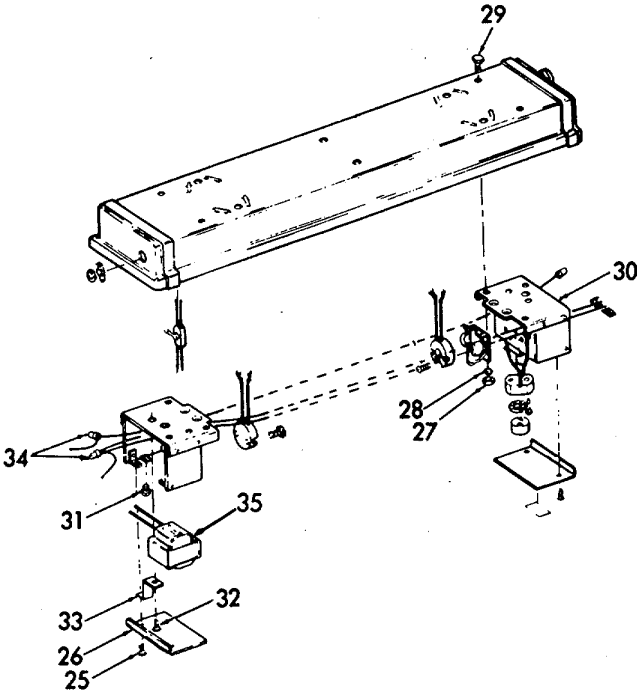


**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
5. Barrier assemblies	a. Screws (25) and cover (26)	Remove.	
	b. Nuts (27), lock-washers (28), screws (29) and barrier assembly (30)	Remove.	
	c. Barrier assemblies (30), screws (29), lock-washers (28) and nuts (27)	Reassemble.	
	d. Cover (26) and screws (25)	Install.	
6. Ballast lamp	a. Screw (31), screw and washer assembly (32) and retainer (33)	Remove.	
	b. Closed end connectors (34)	Unscrew and separate wires.	

3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS	
	<b>REPAIR (Cont)</b>			
	c. Ballast (35)	Remove.		
	d. Ballast (35), retainer (33), screw and washer assembly (32) and screw (31)	Assemble.		
	e. Closed end connectors (34)	Twist wires and attach connector.		



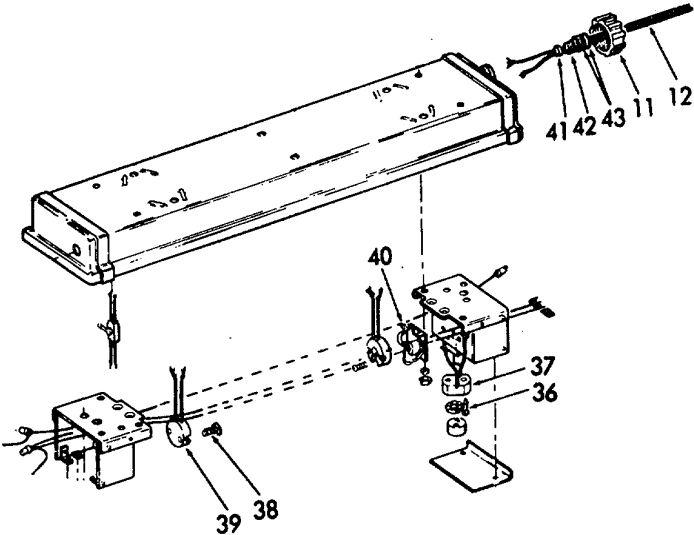
**3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Starter socket	a. Screws (36) and socket (37)	Disconnect wiring and remove socket.	
	b. Wiring, socket (37) and screws (36)	Reconnect wires and reassemble.	
8. Lamp-holder	a. Screws (38), lamp-holder (39) and lamplock (40)	Disassemble.	
	b. Wiring lampholder.	Disconnect and remove	
	c. Wiring, lamplock (40), lamp-holder (39) and screws (38)	Reconnect wires and reassemble.	
9. Wiring	a. Wiring (12)	Disconnect internal wiring.	
	b. Cable cap (11)	Loosen and remove wire.	
	c. Retainer washer (41), grommet (42), slip washer (43) and cap (11)	Slide from wire.	



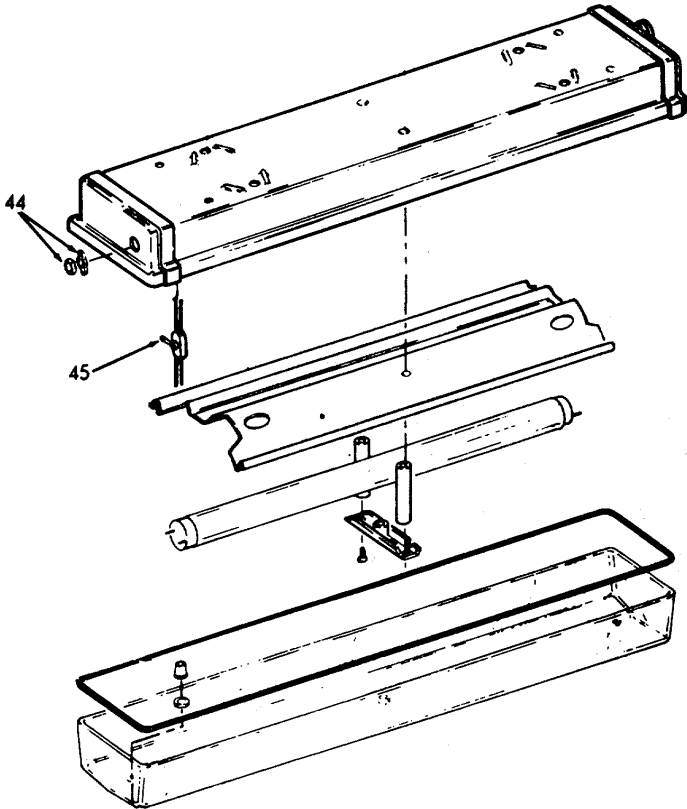
3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Cap (11), washer (43), grommet (42) and washer (41)	Slide on wire.	
	e. Wiring (12)	Insert in housing and reconnect.	
	f. Cable cap (11)	Tighten.	



3-111.7. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
10. Switch	a. Nut, boot and plate (44)	Unscrew.	
	b. Switch (45)	Disconnect wiring and remove.	
	c. Wiring, switch (45) and nut, boot and plate (44)	Reconnect wiring and reassemble.	



3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS.

This task covers:

- |    |             |    |            |
|----|-------------|----|------------|
| a. | Inspection  | c. | Repair     |
| b. | Disassembly | d. | Reassembly |

INITIAL SETUP

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition</u> <u>Condition Description</u>
Crimping tool Drill Rivet gun	<u>Para</u> NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

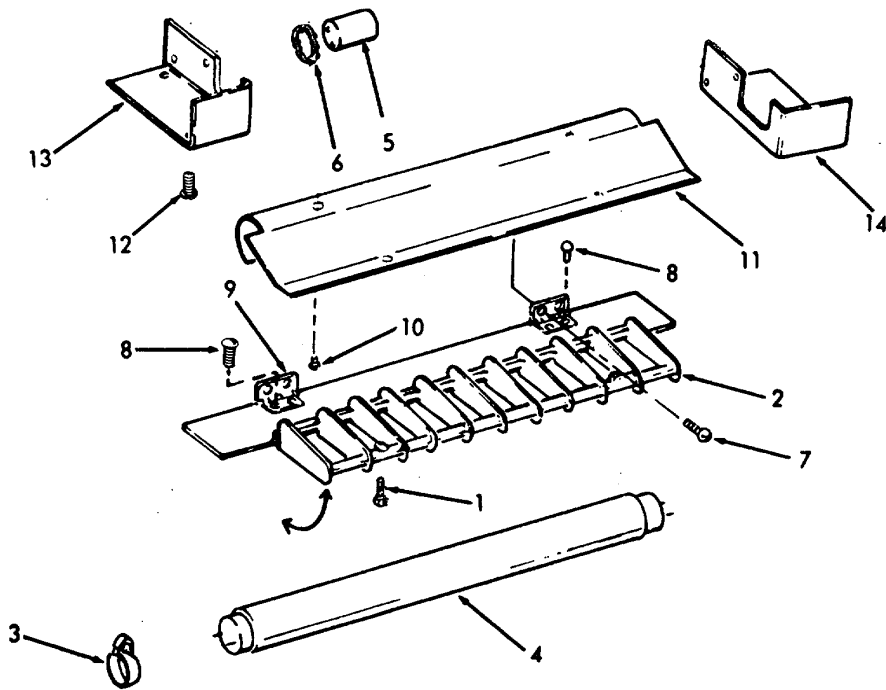
1.	Berth light	a.	Window	Inspect for breaks, cracks and loose mounting.	
		b.	Lamps	1. Inspect for broken or loose lamps. 2. Inspect for burnt marks on end of tube.	Replace.

3-111.8. BERTH LIGHT-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	c. Starter damage.	Inspect for looseness or	
	d. Wiring or damaged wiring.	Inspect for worn, frayed	
<b>DISASSEMBLY</b>			
2.	a. Two screws (1)	Remove.	
	b. Louver assembly (2)	Swing out of way.	
	c. Lamp lock assembly (3), and lamp (4)	Release lamplock and rotate lamp to remove.	
	d. Starter (5) and washer (6)	Rotate to remove.	
<b>REPAIR</b>			
3. Louver	a. Screws (7)	Remove.	
	b. Rivets (8)	Drill out.	
	c. Hinge (9)	Remove from louver (2).	
	d. Hinge (9), louver (2), and rivets (8)	Reassemble using rivet gun.	

3-111.8. BERTH LIGHT-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Screws (7)	Install.	
4. Reflector	a. Two screws (10)	Remove, if necessary.	
	b. Reflector (11)	Remove.	
5. Lamp sockets	a. Self-tapping screws (12) and barrier (13)	Remove.	
	b. Self-tapping screws (12) and barrier (14)	Remove.	



3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS (Cont)

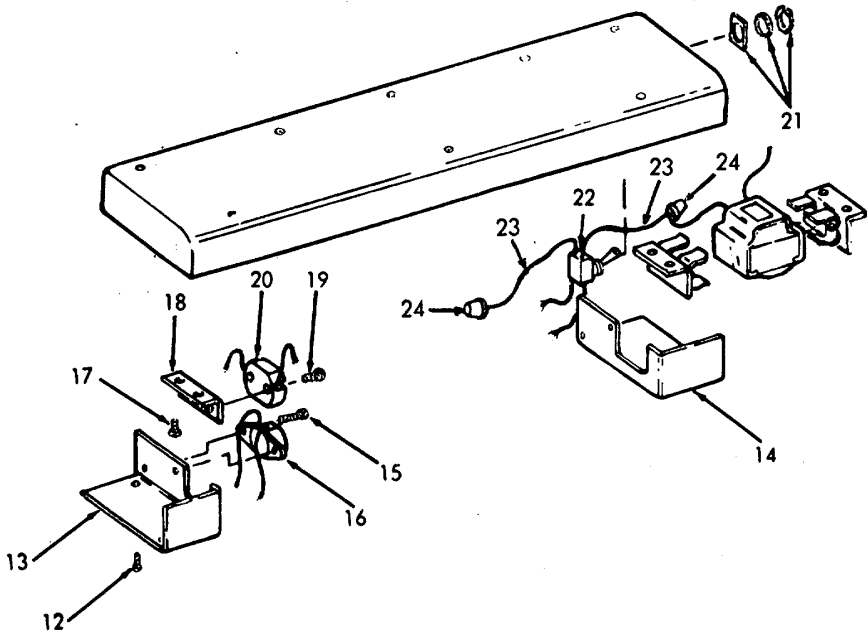
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Starter socket	c. Self-tapping screws (15) and lamp-sockets (16)	Disconnect wiring and remove.	
	d. Lamp sockets (16) and self-tapping screws (15)	Reconnect wiring and install.	
	e. Barriers (13 and 14) and self-tapping screws (12)	Reassemble.	
	a. Self-tapping screws (17) and bracket (18)	Remove.	
	b. Self-tapping screws (19) and starter socket (20)	Disconnect wiring and remove.	
	c. Starter socket (20) and self-tapping screws (19)	Reconnect wiring and install.	

3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

	d. Bracket (18) and self-tapping screws (17)	Install.	
7. Switch	a. Nut, lock-washer, and plate (21)	Remove.	
	b. Switch (22) remove.	Disconnect wiring (23) and wire nuts (24) and	



3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Ballast	c. Switch (22), plate, lock-washer and nut (21)	Reconnect wiring and install.	
	a. Screws (25) and brackets (26)	Disassemble.	
	b. Ballast (27)	Disconnect wiring and remove.	
9. Ballast bracket assemblies	c. Ballast (27), brackets (26) and screws (25)	Reconnect wires and install.	
	a. Rivets (28)	Drill out.	
	b. Clips (29) and brackets (30)	Disassemble.	
10. Wiring	c. Brackets (30), clips (29) and rivets (28)	Reassemble using rivet gun.	
	a. Wire connectors (31)	Disconnect.	

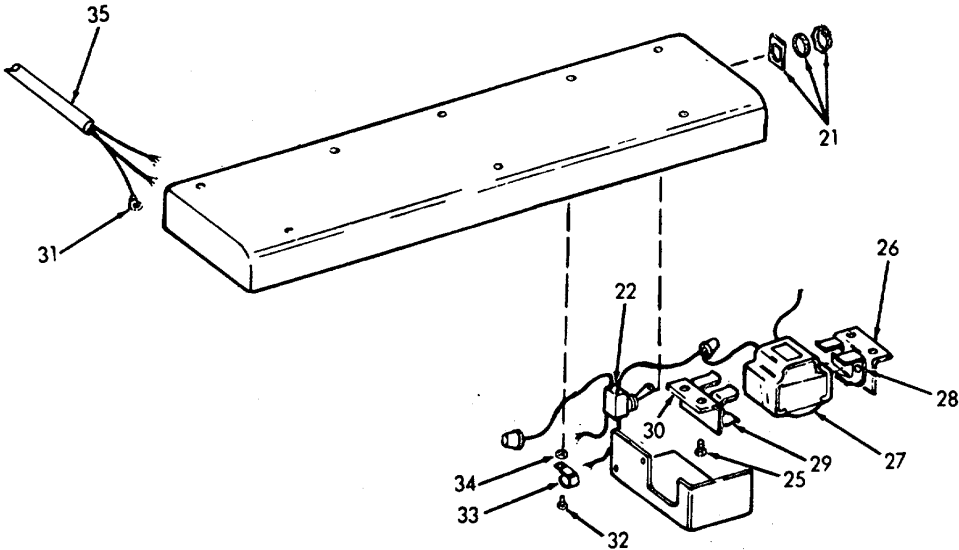


3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- b. Self-tapping screw (32), clip (33) and washer (34) Remove.
- c. Wiring (35) Remove.
- d. Wire connectors (31) Install.
- e. Wiring (35) Reconnect.



3-111.8. BERTH LIGHT- MAINTENANCE INSTRUCTIONS (Cont)

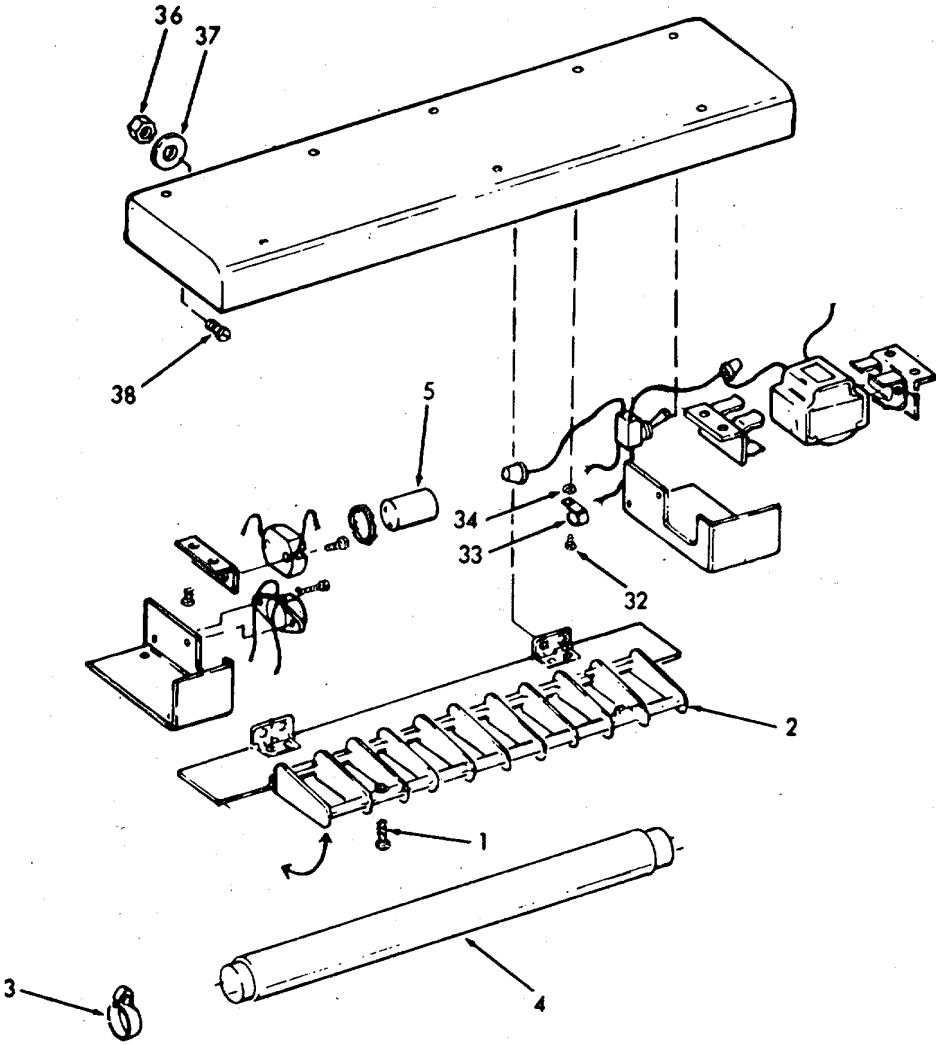
LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
11. Mounting hardware	f. Washer (34), clip (33) and self-tapping screw (32)	Install on wiring.	
	a. Nuts (36), spacers (37) and screws (38)	Remove.	
	b. Housing assembly (39)	Remove from bunk.	
	c. Housing assembly (39), screws (38), spacers (37), nuts (36)	Install.	
<b>REASSEMBLY</b>			
12. Berth light	a. Starter (5) and washer (6)	Install.	
	b. Lamp (4) and lamp lock assembly (3)	Rotate lamp and secure.	

3-111.8. BERTH LIGHT-MAINTENANCE INSTRUCTIONS (Cont)

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- c. Louver assembly (2) and screws (1) Close and secure.



**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)- CONNING TOWER  
MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Testing                      b. Removal                      c. Installation**

**INITIAL SETUP:**

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition      Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

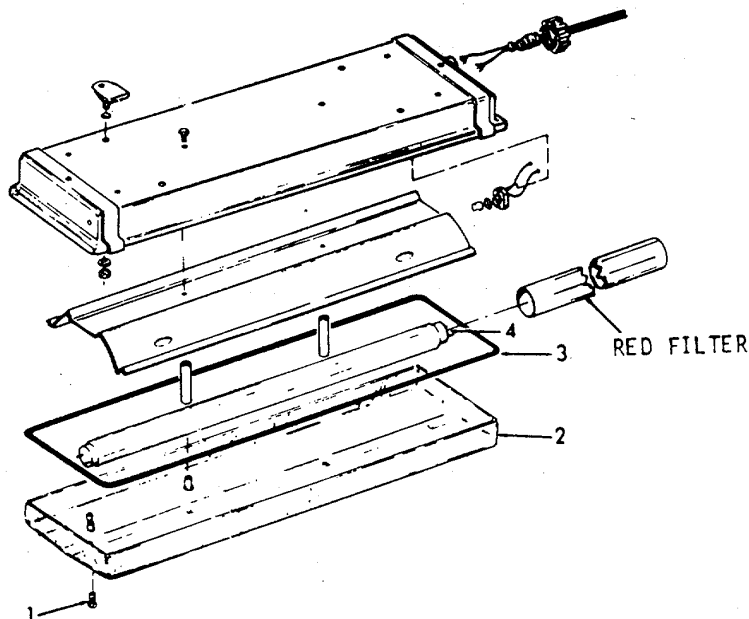
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

1. Light fixture	a. Window cracks and loose mounting.	Inspect for breaks,	
	b. Lamps	1. Inspect for broken or loose lamps. 2. Inspect for burnt marks on end of tube.	Replace.

**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube)-CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION (Cont)</b>			
	c. Starter	Inspect for looseness or damage.	
	d. Wiring	Inspect for worn, frayed or damaged wiring.	
<b>DISASSEMBLY</b>			
2.	a. Four screws (1)	Loosen.	
	h. Window (2) and gasket (3)	Remove.	
	c. Lamps (4)	Rotate and remove.	



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**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (1 tube)-CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**


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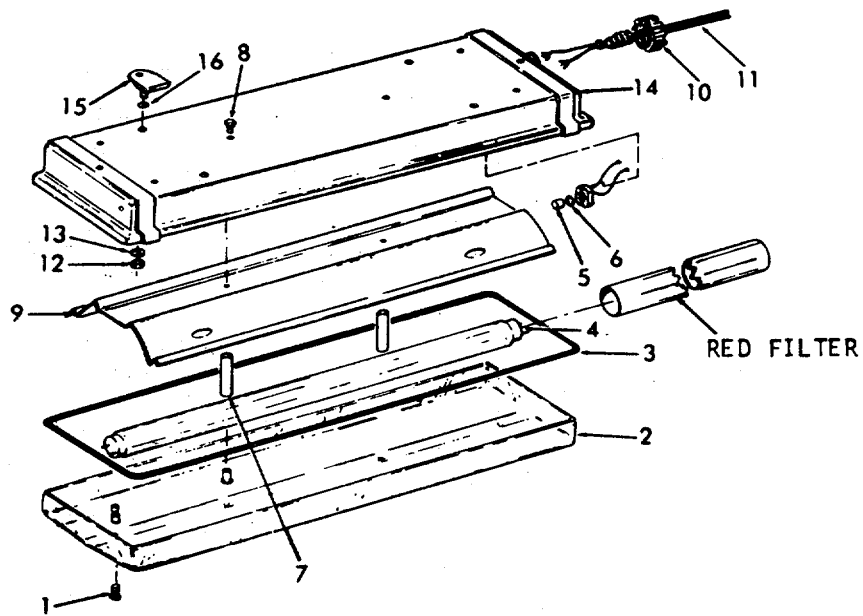
LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
	d. Starter (5) and was her (6)	Remove.	
	e. Posts (7), screws (8) and reflector (9)	Remove.	
	f. Cable cap (10)	Loosen.	
	g. Wire (11)	Disconnect and remove.	
	h. Nuts (12) and washers (13)	Remove.	
	i. Housing (14)	Remove.	
	j. Shock-mount (15) and o-ring (16)	Remove.	
	k. Shock-mount (15), o-ring (16), housing (14), washer (13) and nut (12)	Assemble and install.	
	l. Wiring (11)	Reconnect.	

**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
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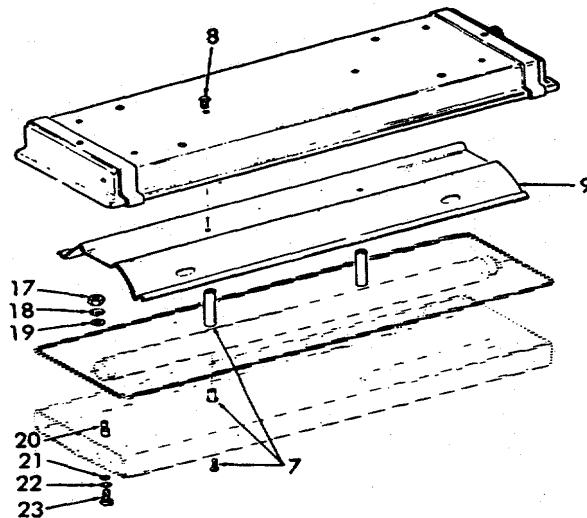
**DISASSEMBLY (Cont)**

- m. Cable cap (10) Tighten.
- n. Reflector (9), screws (8) and posts (7) Reassemble.
- o. Starter (5) and washer (6) Install.
- p. Lamps (4) Install and rotate.
- q. Window (2), gasket (3) Assemble.
- r. Screws (1) Tighten.



**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Window Assembly	a. Nut (17), lock-washer (18), flat-washer (19), bushing (20), leather washer (21), o-ring (22) and screw (23)	Disassemble.	If necessary
4. Column assembly	Post, bushing and screw (7), reflector (9) and screw (8)	Disassemble.	If necessary



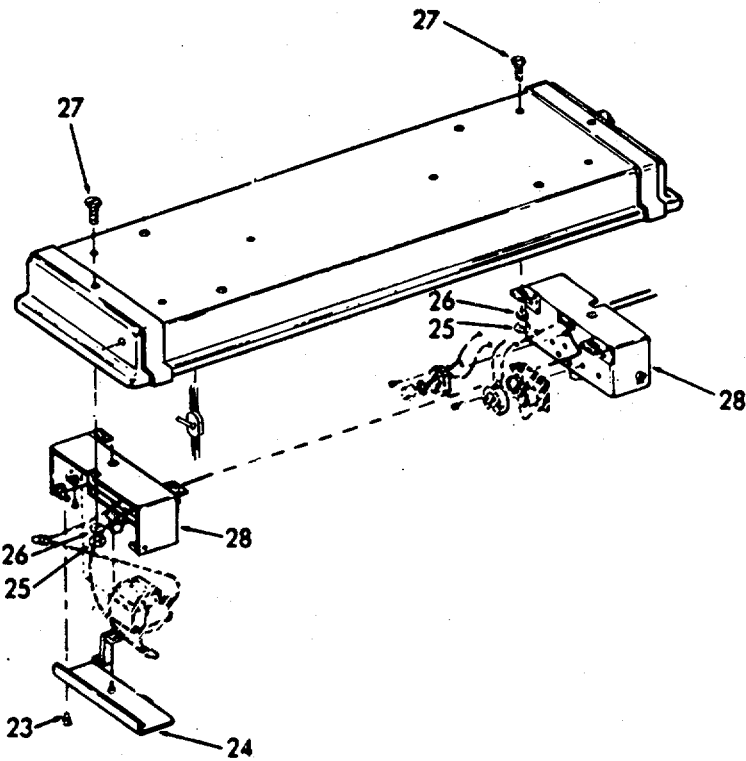


3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)

- 5. Barrier Assemblies
  - a. Screws (23) and cover (24) Remove.
  - b. Nuts (25), lock-washers (26), screws (27) and barrier assembly (28) Remove.



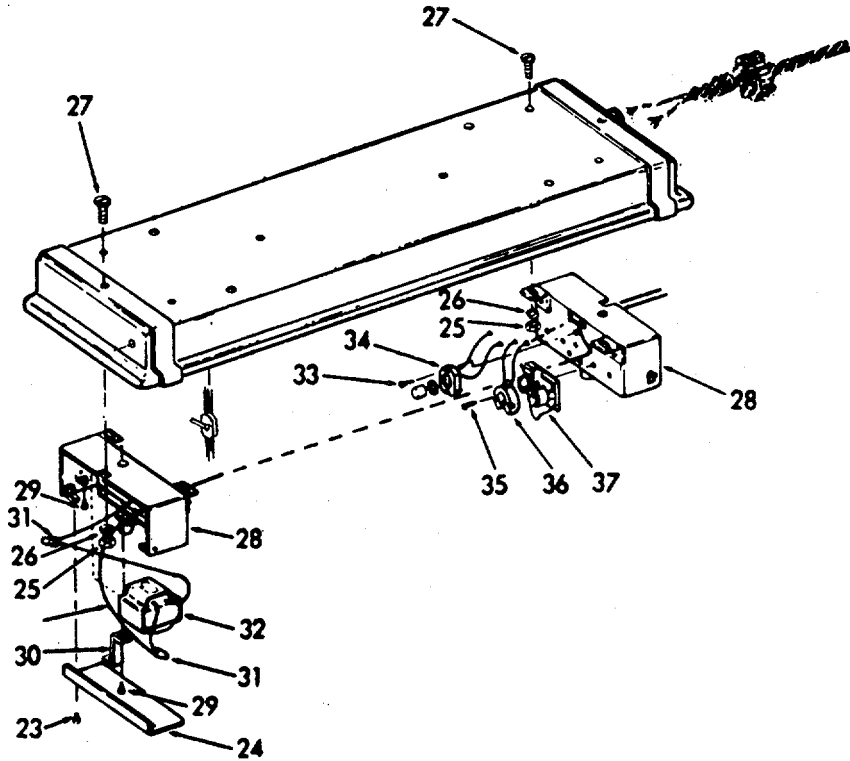
**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Ballast Lamp	c. Barrier assemblies (28), screws (27), washers (26) and nuts (25)	Reassemble.	
	d. Cover (24) and screws (23)	Install.	
	a. Screw (29), retainer (30)	Remove.	
	b. Closed end connectors (31)	Unscrew and separate wires.	
	c. Ballast (32)	Remove.	
7. Starter socket	d. Ballast (32), retainer (30) and screw (29)	Assemble.	
	e. Closed end connectors (31)	Twist wires and attach connector.	
	a. Screws (33) and socket (34)	Disconnect wiring and remove socket.	

**Change 2 3-1902.6**

3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	b. Wiring, socket (34) and screws (33)	Reconnect wires and reassemble.	
8. Lamp-Holder	a. Screws (35), lamp-holder (36) and lamplock (37)	Disassemble.	
	b. Wiring	Disconnect and remove lampholder.	



**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

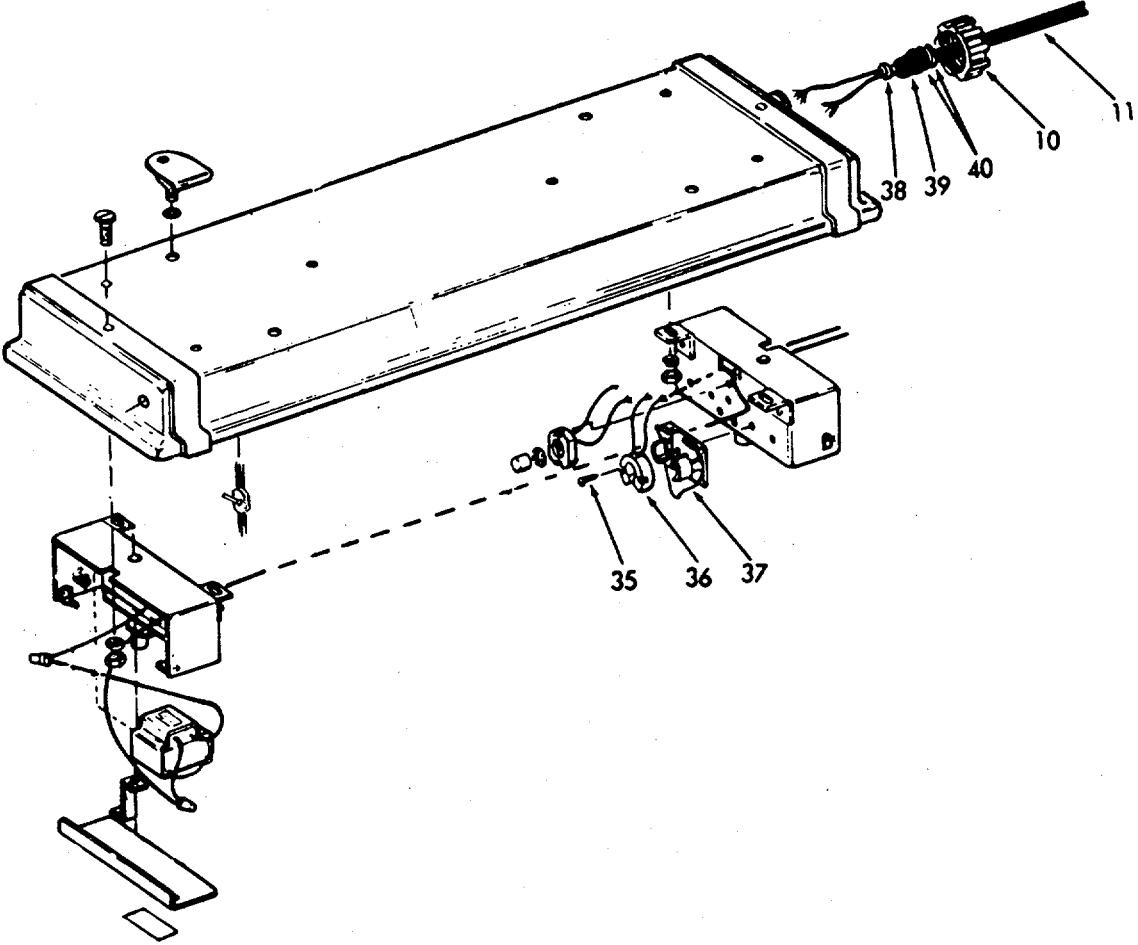
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Wiring	c. Wiring, lamplock (37), lamp-holder (36) and screws (35)	Reconnect wires and re-assemble.	
	a. Wiring (11)	Disconnect internal wiring.	
	b. Cable cap (10)	Loosen and remove wire.	
	c. Washer (38), grommet (39), slip washer (40) and cap (10)	Slide from wire.	
	d. Cap (10), slip washer (40), grommet (39) and retainer washer (38)	Slide on wire.	
	e. Wiring (11)	Insert in housing and reconnect.	
	f. Cable cap (10)	Tighten.	

**Change 2 3-1902.8**

3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Con t).

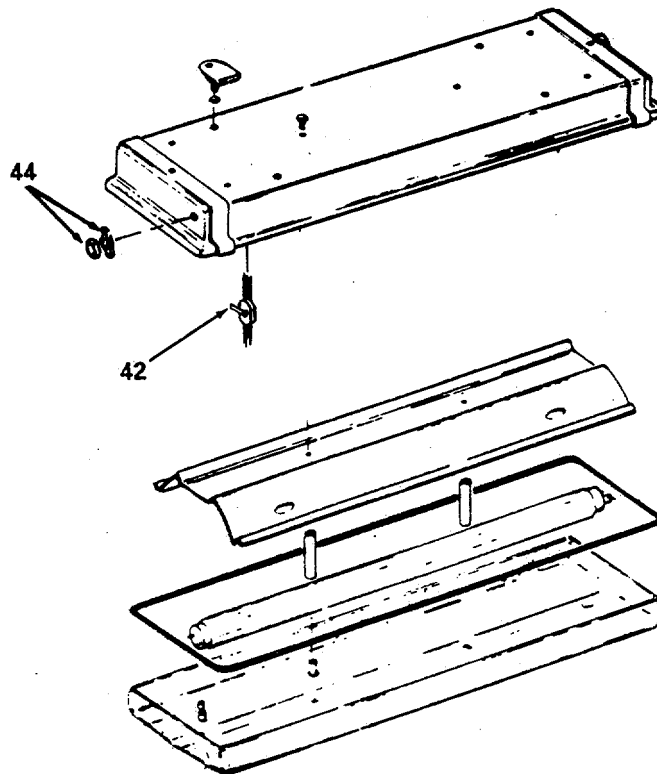
LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



**3-111.9. GENERAL PURPOSE FLUORESCENT LIGHT FIXTURE (2 tube) - CONNING TOWER  
MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Switch	a. Nut, boot and plate (41)	Unscrew.	
	b. Switch (42)	Disconnect wiring and remove.	
	c. Wiring, switch (42) and nut, boot and plate (41)	Reconnect wiring and reassemble.	



**3-111.10 ROTATING FIRE LAMP (AMBER AND RED) - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Inspection      b. Removal/Repair      c. Replace**

INITIAL SETUP:

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment Condition  
Para  
NONE

Condition Description

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
Observe all WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
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**WARNING**

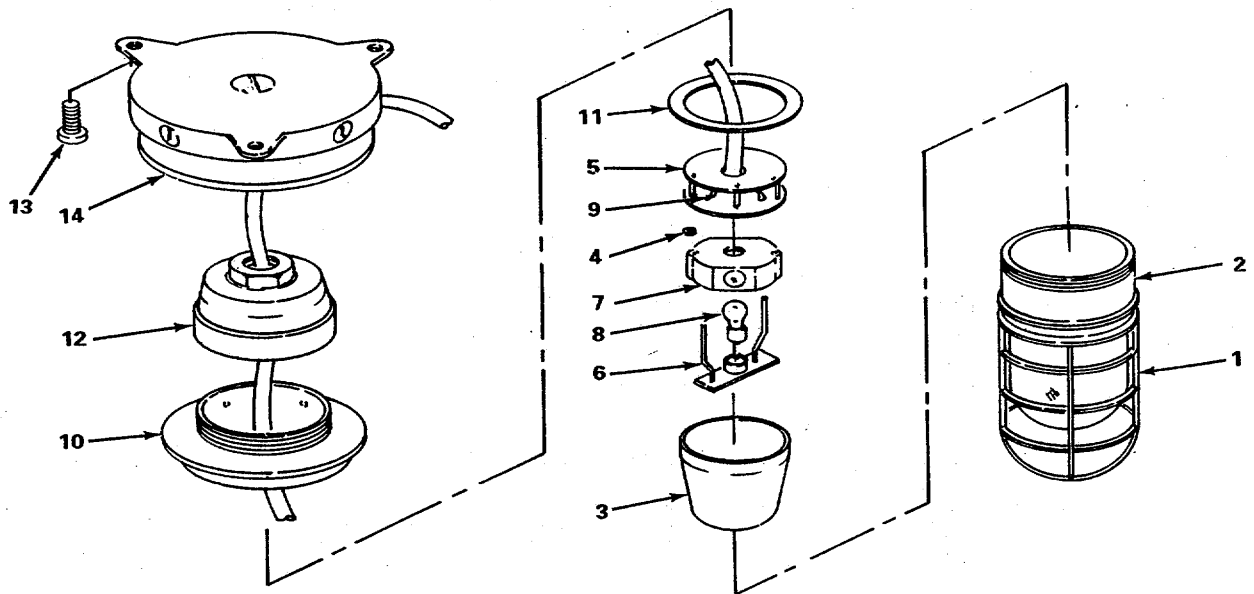
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

- |            |                 |  |
|------------|-----------------|--|
| 1. Ceiling | Ceiling fixture | <ul style="list-style-type: none"> <li>• Burned out lamps.</li> <li>• Broken globes.</li> <li>• Frayed wiring.</li> <li>• Bent or damaged metal.</li> <li>• Loose nuts, screws and bolts.</li> </ul> |
|------------|-----------------|--|

**3-111.10. ROTATING FIRE LAMP (AMBER AND RED) - MAINTENANCE INSTRUCTIONS  
(Cont).**

LOCATION	ITEM	ACTION	REMARKS	
<b>REMOVAL/REPAIR</b>				
2. Ceiling	a. Guard (aluminum)	Remove guard (1)	Replace if damaged.	
	b. Glass cover (pyrex)	Remove glass cover (2).	Replace if damaged.	
	c. Lens (pyrex)	Remove lens (3).	Replace if damaged.	
	d. Tie rod Assembly		1. Remove nuts (4) from motor assembly (5).	Replace if damaged.
			2. Remove tie rod (6).	Replace if damaged.
		3. Remove frame assembly (7).	Replace if damaged.	
		4. Remove lamp (8).	Replace if damaged.	
	e. Wiring	Remove wiring (9) from motor assembly (5).	Check wiring for worn or damaged wiring.	





**3-111.10. ROTATING FIRE LAMP (AMBER AND RED) - MAINTENANCE INSTRUCTIONS  
(Cont).**

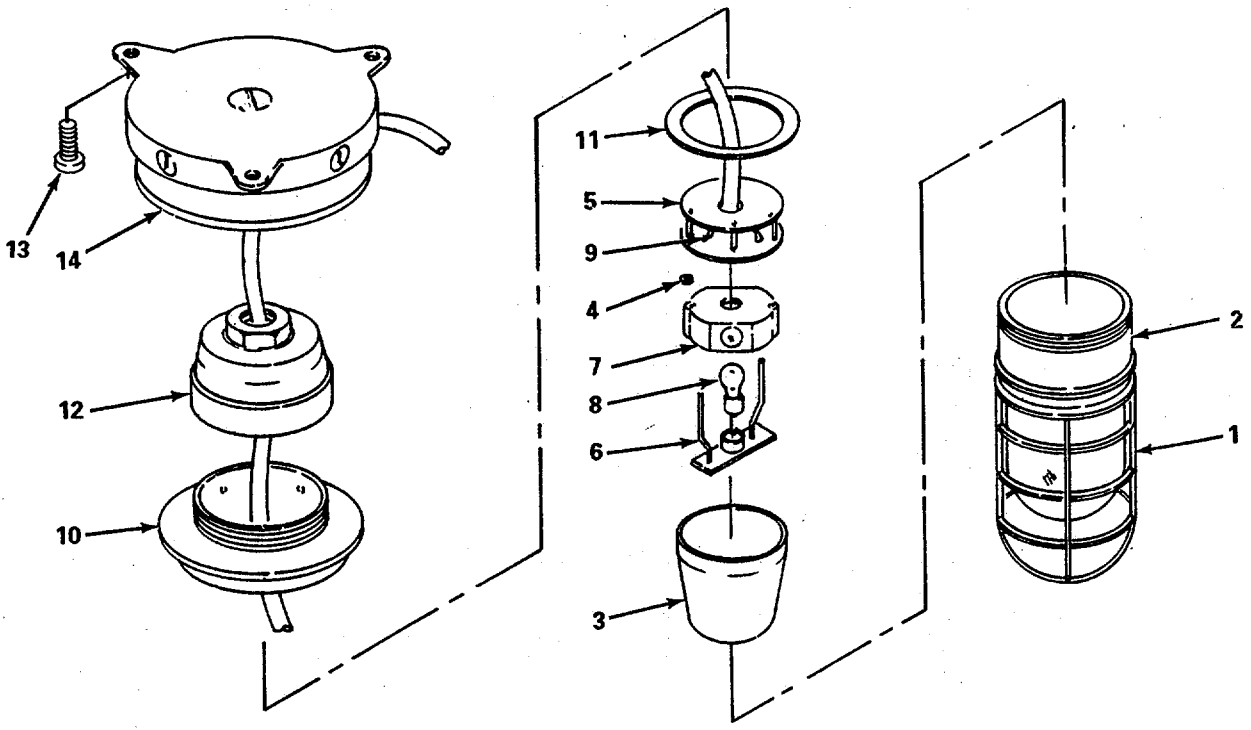
LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
	f. Motor Assembly base (10).	1. Remove motor assembly (5) from	Replace if damaged.
		2. Remove gasket (11).	Replace if worn.
	g. Base (aluminum)	Remove base (10).	Replace if damaged.
	h. Cap (aluminum)	Remove cap (12).	Replace if damaged.
	i. Ceiling box	Remove screws (13). from ceiling box (14).	Replace if damaged.
<b>REPLACE</b>			
3.	a. Wiring	Replace wiring (7).	Refer to General Support Maintenance.
	b. Ceiling box	Replace ceiling box (14) using screws (13).	
	c. Cap (aluminum)	Replace cap (12).	
	d. Base (aluminum)	Replace base (10).	
	e. Motor assembly	1. Replace gasket (11). 2. Install motor assembly (5). 3. Install wiring (9).	
	f. Tie rod assembly	1. Install lamp (8). 2. Install frame assembly (7). 3. Install tie rod assembly (6). using nuts (4).	

3-111.10. ROTATING FIRE LAMP (AMBER AND RED) - MAINTENANCE INSTRUCTIONS  
(Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPLACE (Cont)

- g. Lens (pyrex)                      Install lens (3).
- h. Glass cover (pyrex)              Install glass cover (2).
- i. Guard (aluminum)                Install guard (1).



4955-132

**3-112. EMERGENCY LIGHTING - MAINTENANCE INSTRUCTIONS.**

The maintenance instructions for emergency lights are contained in the following paragraphs.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Incandescent Lighting Fixture Symbol 98.1	3-112.1
Relay Operated Lantern	3-112.2
Portable Lantern	3-112.3

**3-112.1. INCANDESCENT LIGHTING FIXTURE - SYMBOL 98.1 - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Inspection                      b. Disassembly                      c. Reassembly**

INITIAL SETUP:

<u>Test Equipment</u> NONE	<u>Reference</u> NONE	
<u>Special Tools</u> Soldering iron	<u>Equipment Condition</u> <u>Para</u> NONE	<u>Condition Description</u>
<u>Material/Parts</u> Solder, rosen core	<u>Special Environmental Conditions</u> NONE	
<u>Personnel Required</u> 1	<u>General Safety Instructions</u> Observe all WARNINGS	

<b>LOCATION</b>	<b>ITEM</b>	<b>ACTION</b>	<b>REMARKS</b>
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**WARNING**

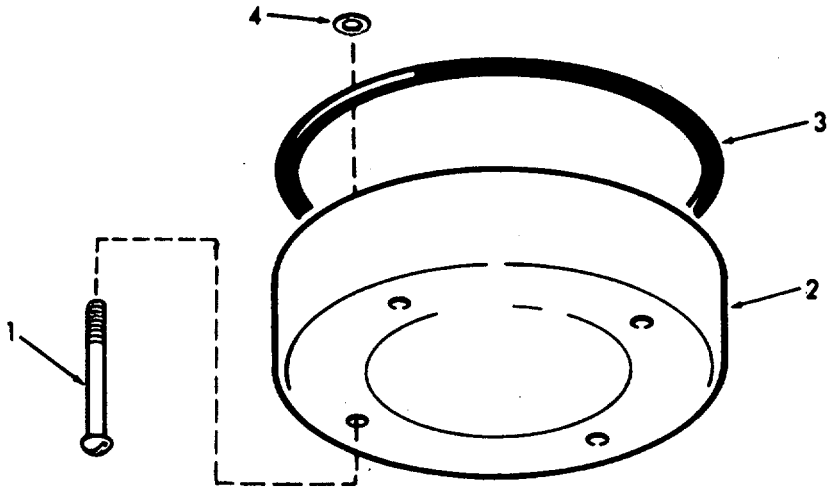
Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

3-112.1. INCANDESCENT LIGHTING FIXTURE - SYMBOL 98.1 - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>INSPECTION</b>			
1. Lighting fixture	a. Window	Inspect for breaks, cracks and loose mounting.	
	b. Lamps	1. Inspect for broken or loose lamps. 2. Inspect for burnt marks on end of tube.	Replace.
	c. Starter	Inspect for looseness or damage.	
	d. Wiring	Inspect for worn, frayed or damaged wiring.	

**DISASSEMBLY**

- 2. a. Screws (1), window (2), gasket (3) and o-ring (4)



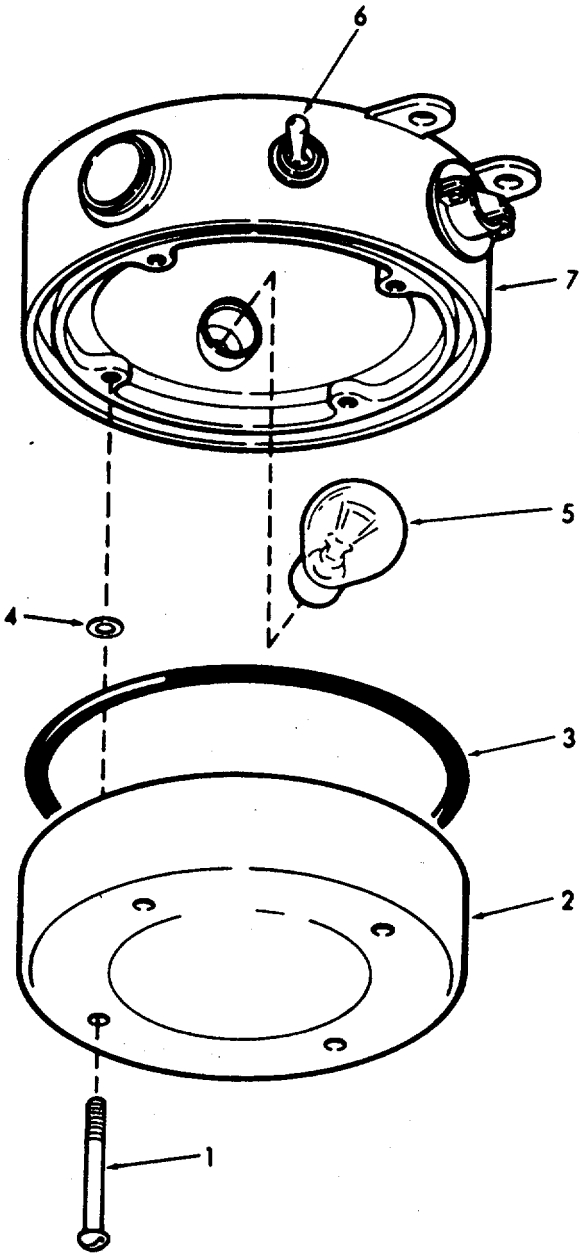
**3-112.1. INCANDESCENT LIGHTING FIXTURE - SYMBOL 98.1 - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>DISASSEMBLY (Cont)</b>			
	b. Lamp (5)	Rotate and remove.	
	c. Switch (6)	1. Remove nut and lock-washer. 2. Remove switch from lampholder (7). 3. Unsolder wiring.	
<b>REASSEMBLY</b>			
3.	a. Switch (6)	1. Resolder wiring.  2. Insert switch in lamp-holder (7). 3. Secure with lockwasher and nut.	
	b. Lamp (5)	Install.	
	c. Screws (1), window (2), gasket (3) and o-ring (4)	Assemble and install.	

3-112.1. INCANDESCENT LIGHTING FIXTURE - SYMBOL 98.1 - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)



**3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection                      b. Replace                      c. Repair

**INITIAL SETUP:**

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment Condition  
Para  
NONE

Condition Description

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

1. Lantern	a. Lamp	Check to see if lamp lights, probable causes: 1. Lamp burnt out. 2. Lamp defective. 3. Defective battery. 4. Battery discharged. 5. Defective wiring. 6. Defective switch.	
	b. Switch	1. Inspect switch boot for leaks. 2. Check operation of switch.	

3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.

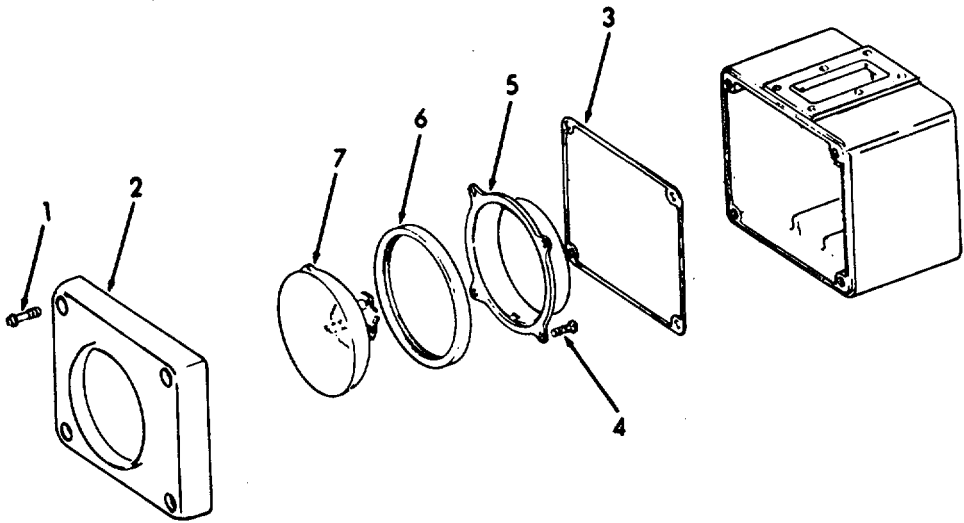
LOCATION	ITEM	ACTION	REMARKS
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INSPECTION (Cont)

- c. Handle and body  
Inspect for break, cracks and signs of damage.

REPLACE

- 2. Lamp
  - a. Four screws (1), cover (2) and gasket (3)  
Remove.
  - b. Four screws (4), retainer (5), gasket (6) and lamp (7)  
Disassemble.



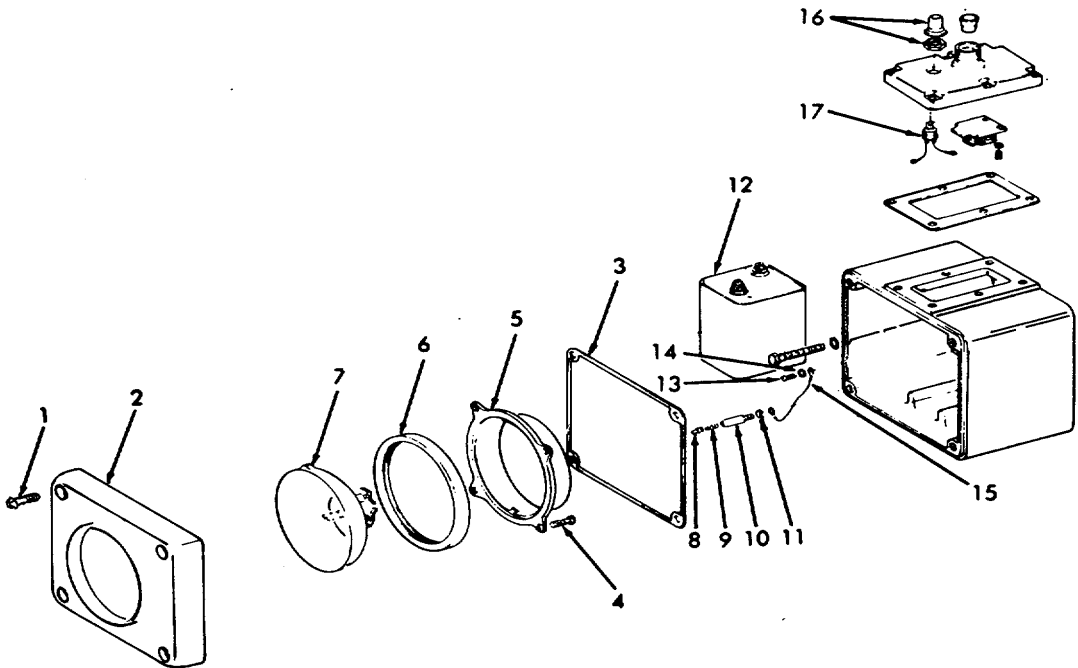


3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
<b>REPLACE (Cont)</b>			
	c. Lamp (7), gasket (6), retainer (5) and four screws (4)	Reassemble.	
	d. gasket (3), cover (2) and screws (1)	Install.	
3	Battery	Disconnect wires and remove.	Observe polarity.
<b>REPAIR</b>			
4	Lamp contact assembly	a. Plunge (8), spring (9), sleeve (10) and lock-washer (11)	Disassemble.
		b. Lock washer (11), sleeve (10), spring (9) and plunger (8)	Reassemble.
5.	Wiring	a. Two brass screws (13), washers (14)	Disassemble.

3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Wires (15)	Disconnect and remove from battery (12).	
	c. Wires (15), washers (14) and brass screws (13)	Reassemble and connect wires to battery.	Observe polarity.
6. Switch	a. Boot and nut (16) remove.	Remove.	
	b. Switch (17)	Disconnect wires and remove.	
	c. Switch (17), nut and boot 16	Reconnect wires and reassembly.	



3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS	
REPAIR (Cont)				
7.	Wiring	a. Stuffing tube cap (18)	Loosen.	
		b. Wire (19)	Disconnect and remove.	
		c. Packing (20)	Remove from wire.	
8.	Body cover	a. Screws (21), lock-washers (22), cover (23) and gasket (24)	Disassemble.	
		b. Gasket (24), cover (23), lock-washers (22) and screws (21)	Reassemble.	
9.	Relay	Relay (25)	Disconnect wiring and remove.	
10.	Body	a. Screws (26 and 27), and o-ring (28)	Remove.	Screw (26) is 1 inch long. Screw (27) is 7/8 inch long.
		b. Body (29) and bracket (30)	Disassemble.	

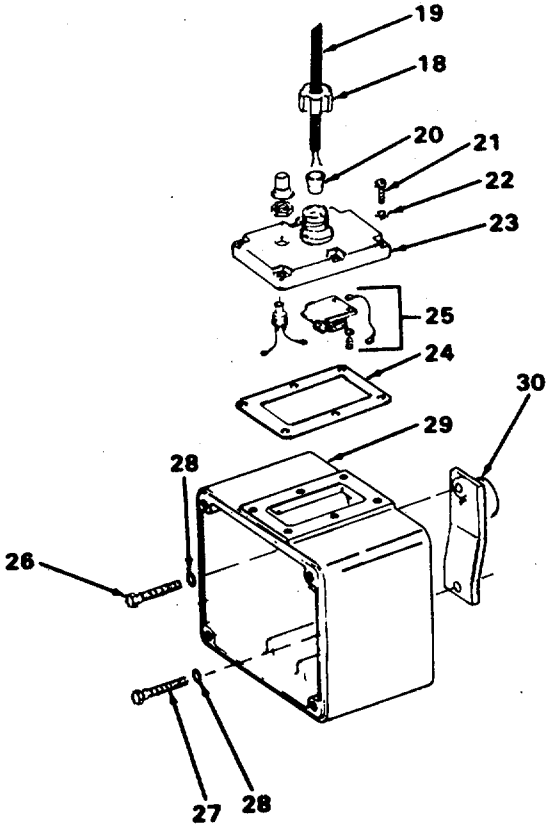
3-112.2. RELAY OPERATED LANTERN - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPAIR (Cont)

c. Body (29), bracket (30), o-rings (28) and screws (26 and 27)

Reassemble.



**3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Inspection                      b. Replace                      c. Repair**

INITIAL SETUP:

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment Condition  
Para  
NONE

Condition Description

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
NONE

LOCATION	ITEM	ACTION	REMARKS
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<b>INSPECTION</b>
-------------------

- |            |           |  |  |
|------------|-----------|--|--|
| 1. Lantern | a. Lamp   | Check to see if lamp lights, probable causes:<br>1. Lamp burnt out.<br>2. Lamp defective.<br>3. Defective battery.<br>4. Battery discharged.<br>5. Defective wiring.<br>6. Defective switch. |  |
|            | b. Switch | 1. Inspect switch boot for leaks.<br>2. Check operation of switch.   |  |

3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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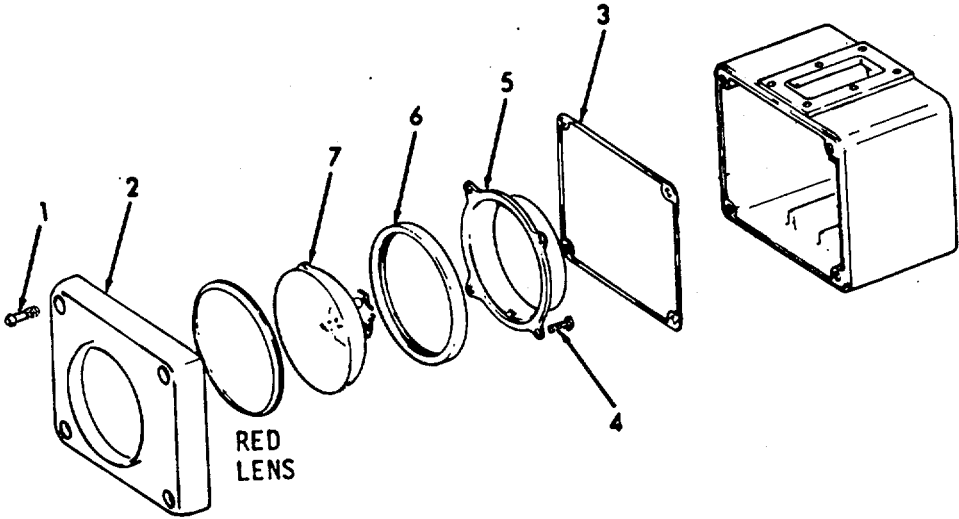
INSPECTION (Cont)

c. Handle and body  
Inspect for leaks, cracks and signs of damage.

REPLACE

2. Lamp  
a. Four screws (1), cover (2) and gasket (3)  
Remove.

b. Four screws (4), retainer (5), gasket (6) and lamp (7)  
Disassemble.

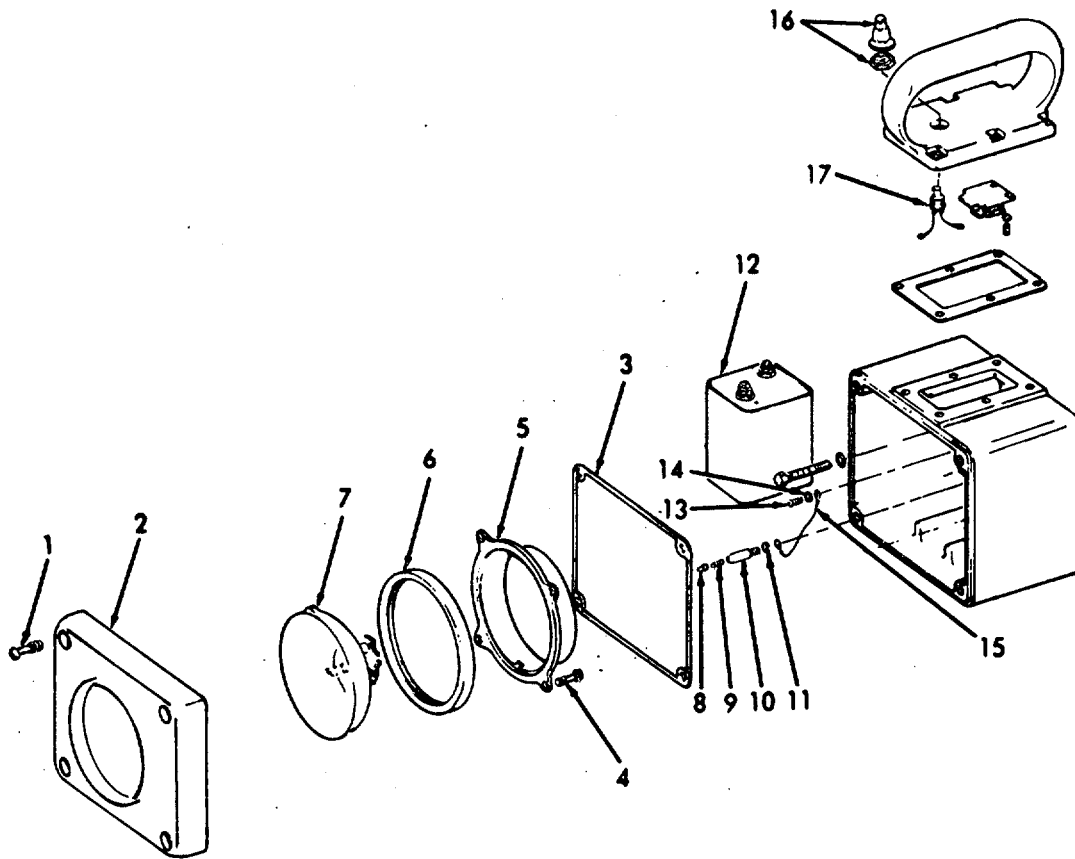


3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REPLACE (Cont)</b>			
	c. Lamp (7), gasket (6), retainer (5) and four screws (4)	Reassemble.	
	d. Gasket (3), cover (2) and screws (1)	Install.	
3. Battery	Battery	Disconnect wires and remove.	Observe polarity.
<b>REPAIR</b>			
4. Lamp contact assembly	a. Plunger (8), spring (9), sleeve (10) and lock-washer (11)	Disassemble.	
	b. Lock-washer (11), sleeve (10), spring (9) and plunger (8)	Reassemble.	
5. Wiring	a. Two brass screws (13), washers (14)	Disassemble.	

3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Wires (15)	Disconnect and remove from battery (12).	
6. Switch	a. Boot and nut (16) remove.	Remove.	
	b. Switch (17)	Disconnect wires and remove.	
	c. Switch (17), nut and boot (16)	Reconnect wires and reassemble.	





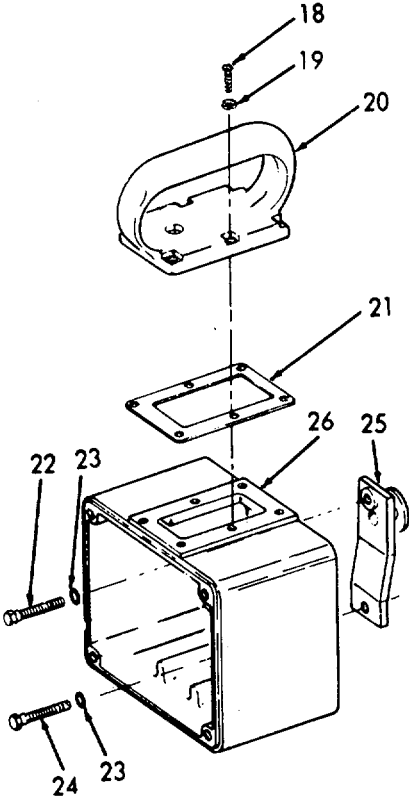
3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Body Cover	a. Screws (18), lock- washers (19), cover (20) and gasket (21)	Disassemble.	
	b. Gasket (21), cover (20), lock- washer (19) and screws (18)	Reassemble.	
8. Body	a. Screws (22 and 24), and o-ring (23)	Remove.	Screw (22) is 1 inch long. Screw (24) is 7/8 inch long.
	b. Body (26) and bracket (25)	Disassemble.	
	c. Body (26), bracket (25), o-rings (23) and screws (22 and 24)	Reassemble.	

3-112.3. PORTABLE LANTERN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REPAIR (Cont)



**3-113. RUNNING, SIGNAL and ANCHOR LIGHTS - MAINTENANCE INSTRUCTIONS.**

The maintenance instructions for the running, signal and anchor lights are in the following paragraphs:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Navigation Light - Starboard	3-113.1
Navigation Light - Port	3-113.2
Navigation Light - Towing	3-113.3
Navigation Light - Masthead	3-113.4
Navigation Light - Stern	3-113.5
Signal Light - Task	3-113.6
Navigation Light - Anchor and Boom	3-113.7
Signal Light - Manoverboard	3-113.8
Navigation Light - Blinker	3-113.9
Wake Light	3-113.10

**3-113.1. STARBOARD RUNNING LIGHT - MAINTENANCE INSTRUCTIONS.**

**This task covers:**

- a. Inspection                      b. Removal/Repair                      c. Replacement**

INITIAL SETUP:

Test Equipment  
NONE

Reference  
NONE

Special Tools  
NONE

Equipment Condition  
Para  
NONE

Condition Description

Material/Parts  
NONE

Special Environmental Conditions  
NONE

Personnel Required  
1

General Safety Instructions  
Observe WARNINGS in this procedure.

3-113.1. STARBOARD RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

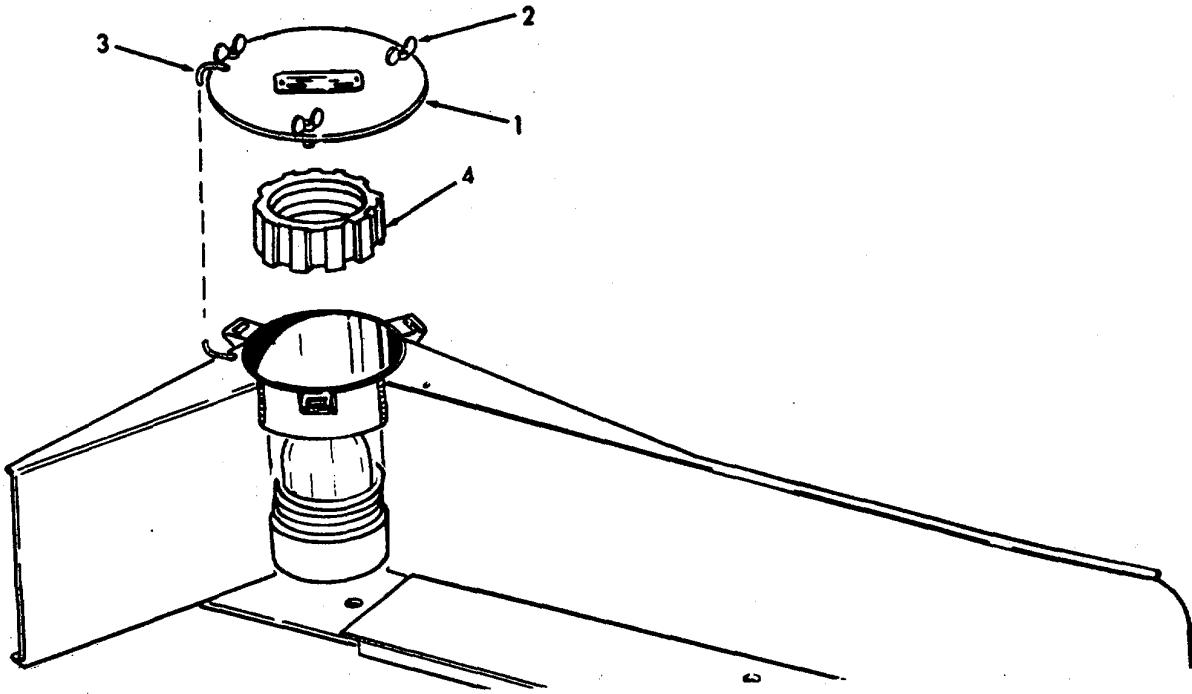
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**INSPECTION**

- |              |                  |   |  |
|--------------|------------------|---|--|
| 1. Stbd side | Navigation light | a. Burned out lamp.<br>b. Broken globe or lamp.<br>c. Broken, bent or damaged metal.<br>d. Loose screws or wing nuts. |  |
|--------------|------------------|---|--|

**REMOVAL/REPAIR**

- |              |                  |  |  |
|--------------|------------------|--|--|
| 2. Stbd side | a. Light cover   | 1. Loosen wing nuts (2).<br>2. Remove light cover (1). | Cover will hang down on wire rope cable (3). |
|              | b. Light fixture | 1. Remove retaining ring (4).                          | Replace if threads are worn.                 |



3-113.1. STARBOARD RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR (Cont)</b>			
		2. Remove globe (5).	Replace if damaged.
		3. Remove gasket (6).	Replace if damaged.
	c. Lamp	Unscrew lamp (7) from lampholder (8).	Replace if damaged.
	d. Lamp-holder	1. Remove lampholder (8) from light base (12) by removing screw (9) and lockwasher (10).	Replace if damaged.

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on circuit breaker to prevent accidental turn on.

		2. Remove wires from lamp-holder (8).	Replace if frayed.
	e. Base (Light fixture)	1. Remove screws (11).	
		2. Remove base (12).	Replace if damaged.
	f. Screens	Remove screens (13).	Replace if damaged.
	g. Wiring	Remove rest of wiring (14).	Replace if frayed or damaged.

**REPLACEMENT**

3. Stbd side	a. Screens	Replace screens (13).	
	b. Base (Light fixture)	1. Replace base (12).	
		2. Install screws (11).	

3-113.1. STARBOARD RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

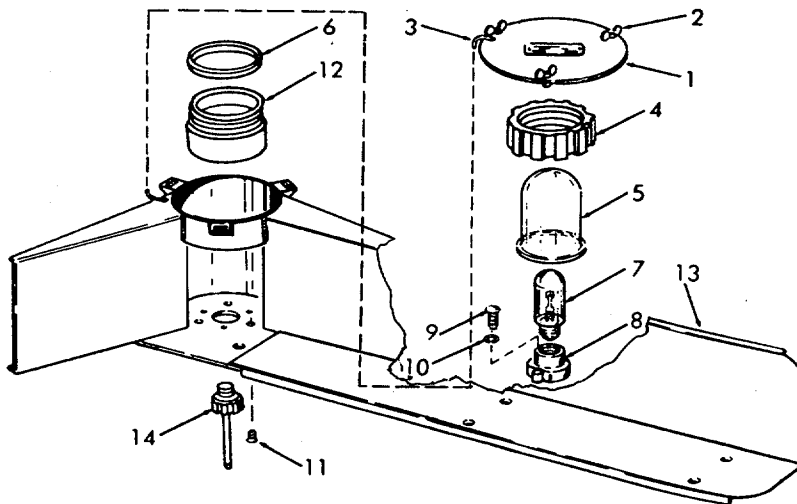
LOCATION	ITEM	ACTION	REMARKS
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REPLACEMENT (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on circuit breaker to prevent accidental turn on.

- |    |               |   |
|----|---------------|---|
| c. | Lamp-holder   | <ol style="list-style-type: none"> <li>1. Attach wires to lamp-holder (8).</li> <li>2. Install lampholder using screws (9) and lock-washer (10).</li> </ol> |
| d. | Lamp          | Screw lamp (7) into lampholder (8).   |
| e. | Light fixture | <ol style="list-style-type: none"> <li>1. Replace globe (5).</li> <li>2. Replace gasket (6).</li> <li>3. Replace retaining ring (4).</li> </ol>             |
| f. | Light cover   | <ol style="list-style-type: none"> <li>1. Replace light cover (1).</li> <li>2. Tighten wing nuts (2).</li> </ol>  |



**3-113.2. PORT RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. Testing
- b. Removal
- c. Installation

**INITIAL SETUP:**

Test Equipment

NONE

References

NONE

Special Tools

NONE

<u>Equipment Condition</u>	<u>Condition Description</u>
Para	

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION

1. Port side	a. Navigation light	a. Burned out lamp. b. Broken globe or lamp. c. Broken, bent or damaged metal. d. Loose wing nuts or screws. e. Frayed wiring.	
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REMOVAL/REPAIR

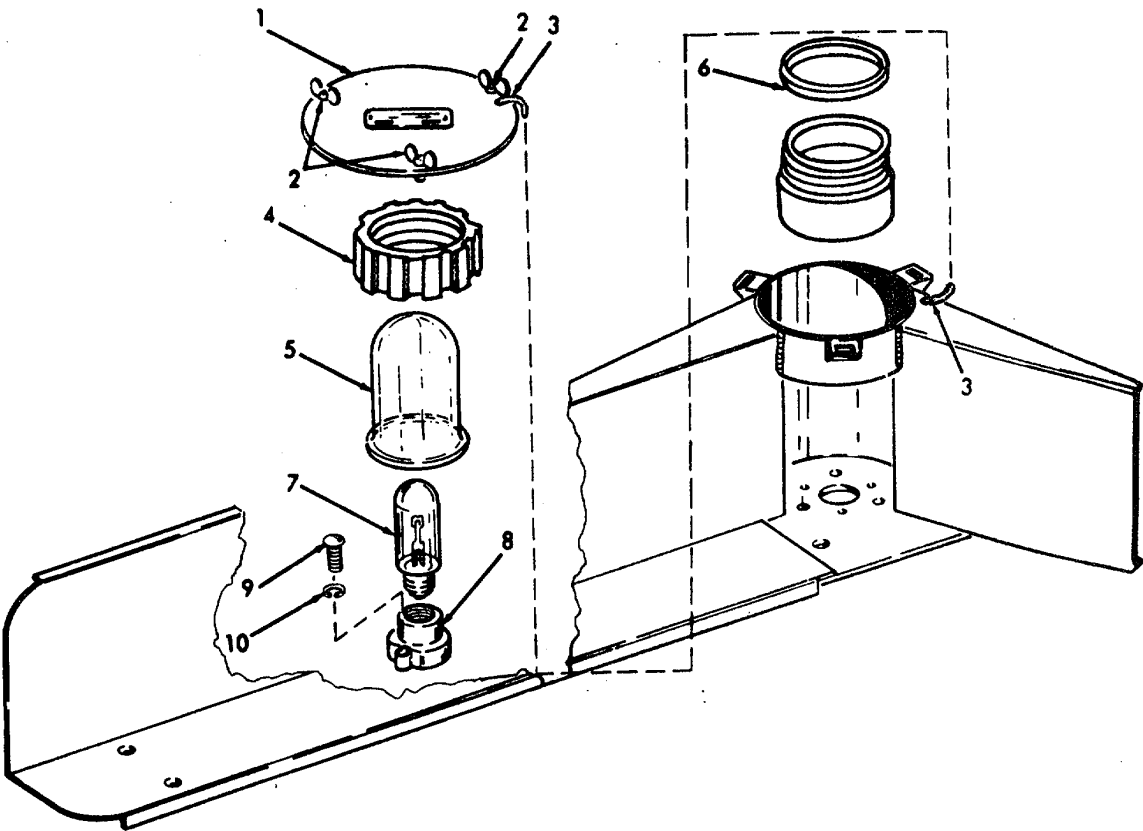
2. Port side	a. Light cover	1. Loosen wing nuts (2).  2. Remove light cover (1).	Cover will hang down on wire rope cable (3).
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3-113.2. PORT RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

- |    |               |  |  |
|----|---------------|--|--|
| b. | Light fixture | <ol style="list-style-type: none"> <li>1. Remove retaining ring (4).</li> <li>2. Remove glass globe (5).</li> <li>3. Remove gasket (6).</li> </ol> | <p>Replace if threads are worn.</p> <p>Replace if damaged.</p> <p>Replace if cracked or damaged.</p> |
| c. | Lamp          | Unscrew lamp (7) from lampholder (8).  | Replace if burned out.   |
| d. | Lamp-holder   | 1. Remove screws (9) and lockwashers (10).   | Replace if damaged.  |





3-113.2. PORT RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL/REPAIR (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on circuit breakers to prevent accidental turn on.

		2. Remove wires (14).	Replace if damaged or frayed.
		3. Remove lampholder (8).	
e.	Base (Light fixture)	1. Remove screws (11). 2. Remove base (12).	Replace if damaged.
f.	Screens	Remove screens (13).	Replace if damaged.
g.	Wiring	Remove rest of wiring.	Replace if worn or frayed.

REPLACEMENT

3.	Port side	a. Screens	Replace screens (13).
		b. Base (Light fixture)	1. Replace base (12). 2. Install screws (11).
		c. Lampholder	1. Attach wires to lampholder (8). 2. Install lampholder (8) using screws (9) and lockwashers (10).
		d. Lamp holder (8).	Screw lamp (7) into lampholder (8).

3-113.2. PORT RUNNING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

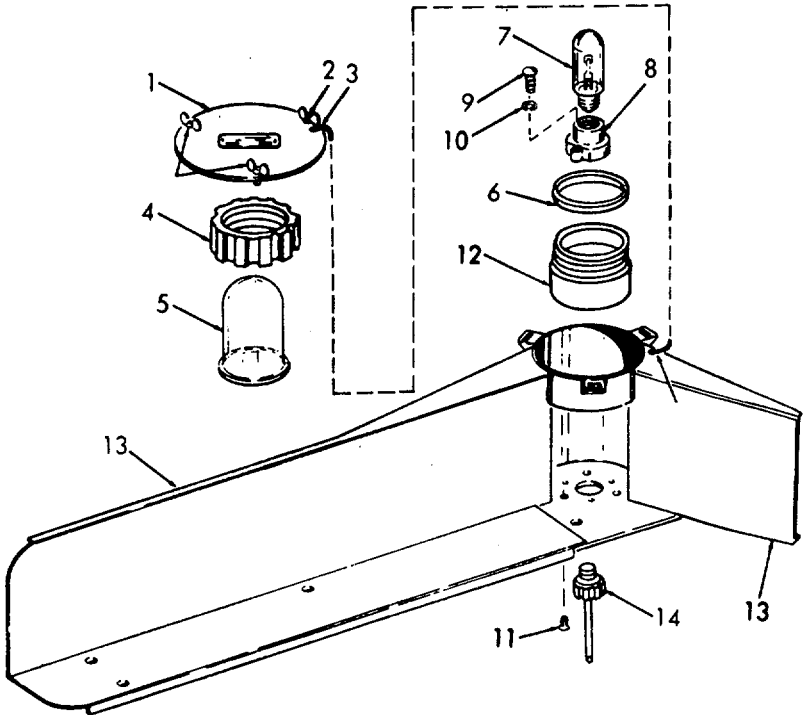
LOCATION	ITEM	ACTION	REMARKS
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REPLACEMENT (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on circuit breakers to prevent accidental turn on.

- e. Light fixture
  - 1. Replace globe (5).
  - 2. Replace gasket (6).
  - 3. Replace retaining ring (4).
  
- f. Light cover
  - 1. Replace light cover (1).
  
  - 2. Tighten wing nuts (2).



**3-113.3. TOWING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. Inspection                      b. Removal/Repair                      c. Replacement**

**INITIAL SETUP:**

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition                      Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

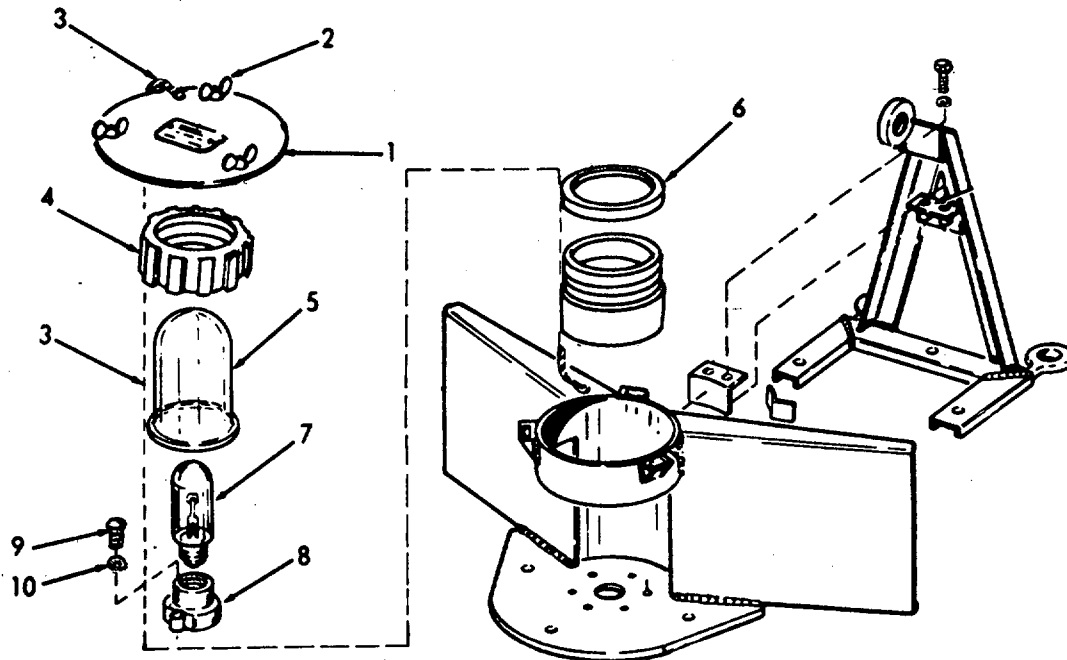
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

<b>INSPECTION</b>
-------------------

1.	Mast	Navigation light (Towing)	<ul style="list-style-type: none"> <li>a. Burned out lamp.</li> <li>b. Broken globe or lamp.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose wing nuts or screws.</li> <li>e. Loose, missing, or bent support angles on tow bar.</li> <li>f. Frayed wiring.</li> </ul>
----	------	---------------------------	---

3-113.3. TOWING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Mast	a. Light cover	1. Loosen wing nuts (2).  2. Remove light cover (1).	Cover will hang down on wire rope cable (3).
	b. Light fixture	1. Remove retaining ring (4).  2. Remove globe (5).  3. Remove gasket (6).	Replace if damaged.  Replace if broken.  Replace if damaged.
	c. Lamp	Unscrew lamp (7) from lampholder (8).	Replace if broken or burned out.
	d. Lampholder	1. Remove screws (9) and lockwashers (10).	Replace if damaged.



3-113.3. TOWING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL/REPAIR (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on circuit breakers to prevent accidental turn on.

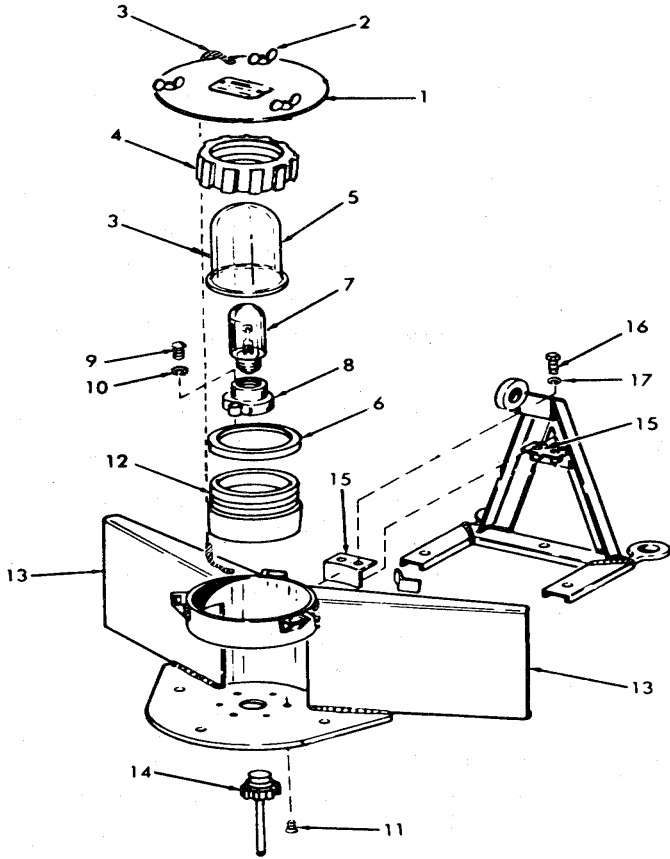
- |    |                      |  |                               |
|----|----------------------|--|-------------------------------|
|    |                      | 2. Remove wires from lamp-holder (8).                            | Replace if damaged or frayed. |
| e. | Base (Light fixture) | 1. Remove screws (11).<br>2. Remove base (12).                   | Replace if damaged.           |
| f. | Screens              | Remove screens (13).   | Replace if damaged.           |
| g. | Wiring               | Remove rest of wiring (14).                                      | Replace if damaged or frayed. |
| h. | Angle support        | Remove screws (16) and lockwashers (17) from angle support (15). | Replace if bent or damaged.   |

REPLACEMENT

- |    |      |                         |  |
|----|------|-------------------------|--|
| 3. | Mast | a. Angle support        | 1. Install screws (16) and lockwashers (17) into angle support (15).                               |
|    |      | b. Screens              | Replace screens (13).  |
|    |      | c. Base (Light fixture) | 1. Replace base (12).<br>2. Install screws (11).   |
|    |      | d. Lamp-holder          | 1. Attach wires to lampholder (8).<br>2. Install lampholder using screws (9) and lockwashers (10). |

3-113.3. TOWING LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT	e. Lamp	Screw lamp (7) into lamp-holder (8).	
	f. Light fixture	Replace globe (5), gasket (6) and retaining ring (4).	
	g. Light cover	1. Replace light cover (1). 2. Tighten wing nuts (2).	



**3-113.4. MASTHEAD LIGHT - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. **Inspection**
- b. **Removal/Repair**
- c. **Replacement**

**INITIAL SETUP:**

<u>Test Equipment</u>	<u>Reference</u>
NONE	NONE
<u>Special Tools</u>	<u>Equipment Condition</u> <u>Condition Description</u>
NONE	<u>Para</u>
	NONE
<u>Material/Parts</u>	<u>Special Environmental Conditions</u>
NONE	NONE
<u>Personnel Required</u>	<u>General Safety Instructions</u>
1	Observe WARNING in this procedure.

<b>LOCATION</b>	<b>ITEM</b>	<b>ACTION</b>	<b>REMARKS</b>
-----------------	-------------	---------------	----------------

<b>INSPECTION</b>
-------------------

1. Mast	Masthead light	<ul style="list-style-type: none"> <li>a. Burned out lamp.</li> <li>b. Broken globe or lamp.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose wing nuts or screws.</li> <li>e. Frayed wiring.</li> </ul>	
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<b>REMOVAL/REPAIR</b>
-----------------------

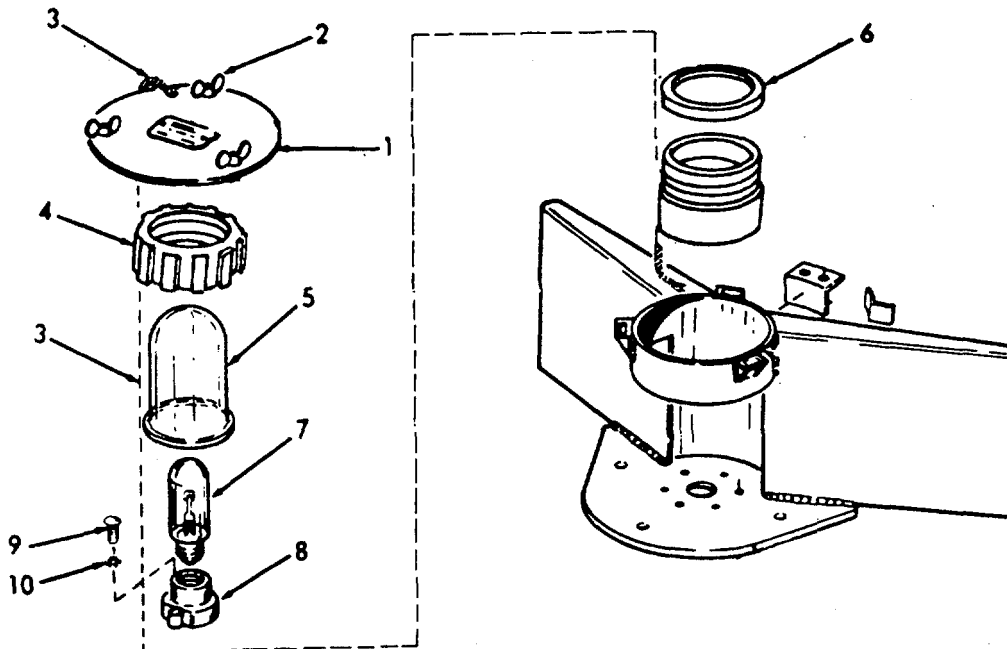
2. Mast	a. Light cover	<ul style="list-style-type: none"> <li>1. Loosen wing nuts (2).</li> <li>2. Remove light cover (1).</li> </ul>	Cover will hang down on wire rope cable (3).
---------	----------------	--	--

3-113.4. MASTHEAD LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

- |    |               |  |                                |
|----|---------------|--|--------------------------------|
| b. | Light fixture | 1. Remove retaining ring (4).                                  | Replace if threads are worn.   |
|    |               | 2. Remove glass globe (5).                                     | Replace if broken.             |
|    |               | 3. Remove gasket (6).  | Replace if cracked or damaged. |
| c. | Lamp          | Unscrew lamp (7) from lampholder (8).                          | Replace if burned out.         |
| d. | Lamp-holder   | 1. Remove screws (9) and lockwashers (10) from lampholder (8). | Replace if damaged.            |





3-113.4. MASTHEAD LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

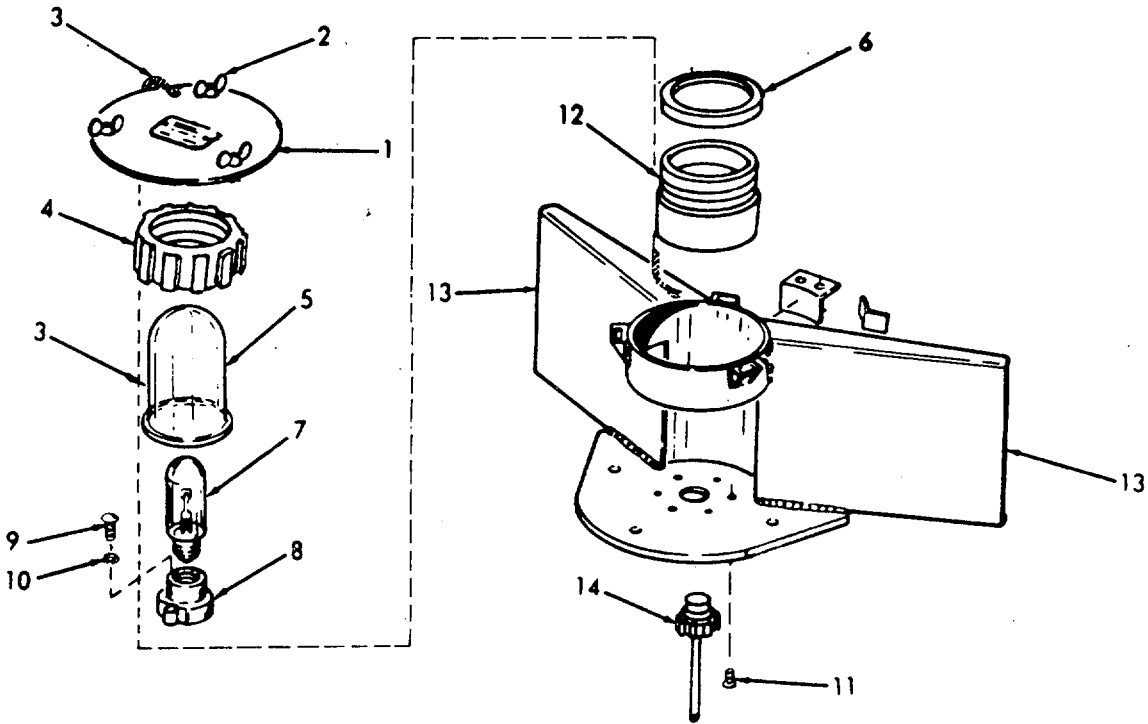
LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR (Cont)</b>			
<b>WARNING</b>			
Place all circuit breakers in the OFF position. Place red tag on all circuit breakers to prevent accidental turn on.			
		2. Remove wiring from lampholder (8).	Replace if damaged or frayed.
	e. Base (Light fixture)	1. Remove screws (11). 2. Remove base (12).	Replace if damaged.
	f. Screens	Remove screens (13).	Replace if damaged.
	g. Wiring	Remove rest of wiring (14).	Replace if frayed or damaged.

**REPLACEMENT**

3. Mast	a. Wiring	Replace wiring (14).	
	b. Screens	Replace screens (13).	
	c. Base (Light fixture)	1. Replace base (12). 2. Install screws (11).	
	d. Lampholder	1. Attach wires (14) to lampholder (8).  2. Install lampholder (8) using screws (9) and lockwashers (10).	
	e. Lamp	Screw lamp (7) into lampholder (8).	

3-113.4. MASTHEAD LIGHT - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
	f. Light fixture	1. Replace globe (5). 2. Replace gasket (6). 3. Replace retaining ring (4).	
	g. Light cover	1. Replace light cover (1). 2. Tighten wing nuts (2).	



**3-113.4. MASTHEAD LIGHT - MAINTENANCE INSTRUCTIONS (Cont).**

**This task covers:**

- a. Inspection                      b. Removal/Repair                      c. Replacement**

**INITIAL SETUP:**

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment

Condition                      Condition Description

Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

INSPECTION
------------

- |          |                  |  |  |
|----------|------------------|--|--|
| 1. Stern | Navigation light | <ul style="list-style-type: none"> <li>a. Burned out lamp.</li> <li>b. Broken globe or lamp.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose wing nuts or screws</li> <li>e. Frayed wiring</li> </ul> |  |
|----------|------------------|--|--|

REMOVAL/REPAIR
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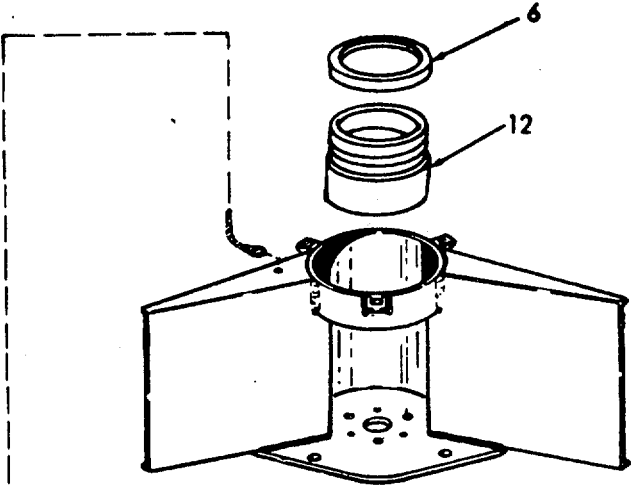
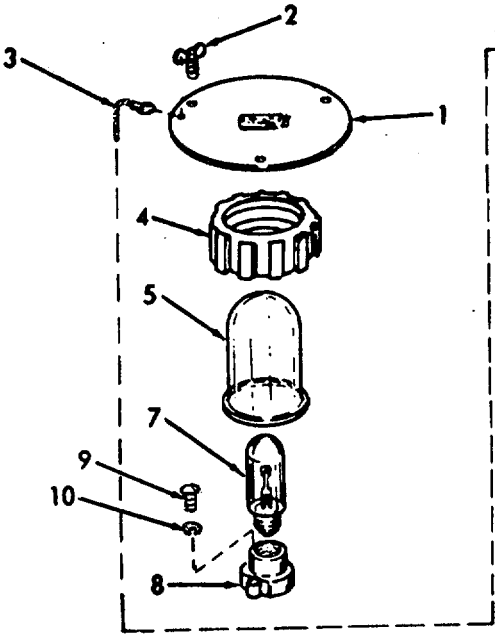
- |          |                |  |  |
|----------|----------------|--|--|
| 2. Stern | a. Light cover | <ul style="list-style-type: none"> <li>1. Loosen wing nuts (2).</li> <li>2. Remove light cover (1).</li> </ul> | Cover will hang down on wire rope cable (3). |
|----------|----------------|--|--|

3-113.5. NAVIGATION LIGHT - STERN - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

b.	Light cover	1. Unscrew retaining ring (4).	Replace if threads are worn.
		2. Remove glass globe (5).	Replace if damaged.
		3. Remove rubber gasket (6).	Replace if damaged.
c.	Lamp	Unscrew lamp (7) from lampholder (8).	Replace if burned out or cracked.
d.	Lamp-holder	1. Remove lampholder (8) from light base (12) by removing screws (9) and lockwashers (10).	Replace if damaged.



3-113.5. NAVIGATION LIGHT - STERN - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place a red tag on all circuit breakers to prevent accidental turn on.

- |    |                      |  |                               |
|----|----------------------|--|-------------------------------|
|    |                      | 2. Remove wiring from lamp-holder (8).         | Replace if frayed or damaged. |
| e. | Base (Light fixture) | 1. Remove screws (11).<br>2. Remove base (12). | Replace if damaged.           |
| f. | Screens              | Remove screens (13).                           | Replace if damaged.           |
| g. | Wiring               | Remove rest of wiring (14).                    | Replace if frayed.            |

REPLACEMENT

- |    |       |                         |   |
|----|-------|-------------------------|---|
| 3. | Stern | a. Screens              | Replace screens (13).   |
|    |       | b. Base (Light fixture) | 1. Replace base (12).<br>2. Install screws (11).  |
|    |       | c. Lamp-holder          | 1. Attach wiring to lamp-holder (8).<br>2. Install lampholder (8) into light base (12) by using screws (9) and lock-washers (10). |
|    |       | d. Lamp                 | Screw lamp (7) into lamp-holder (8).  |

3-113.5. NAVIGATION LIGHT - STERN - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

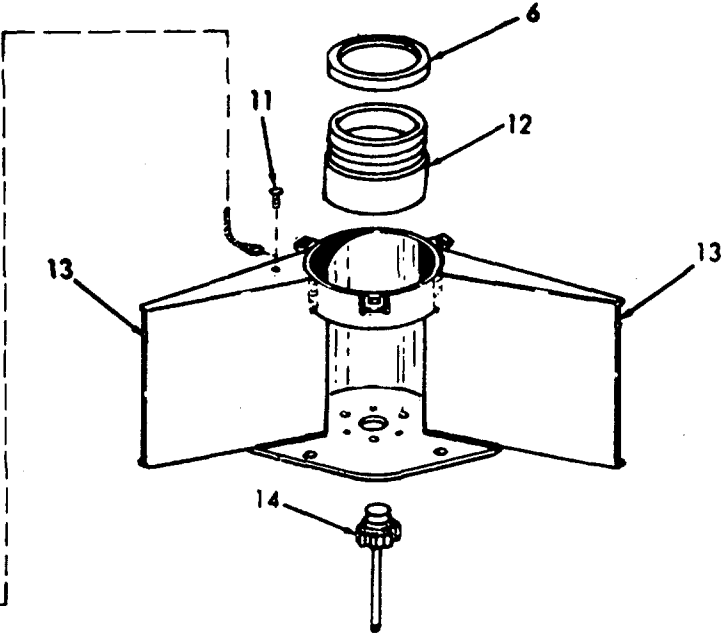
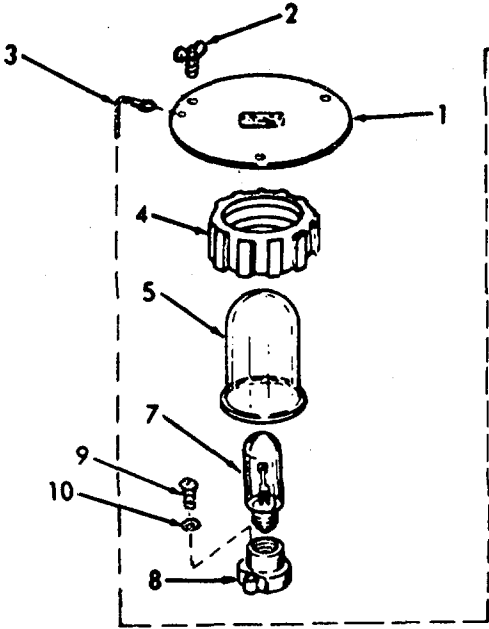
REPLACEMENT

e. Light fixture

- 1. Replace glass globe (5).
- 2. Replace gasket (6).
- 3. Replace retaining nut (4).

f. Light cover

- 1. Replace light cover (1).
- 2. Tighten wing nuts (2).



**3-113.6. SIGNAL LIGHT - TASK - MAINTENANCE INSTRUCTIONS.**

This task covers:

- a. Inspection                      b. Removal/Repair                      c. Replacement

**INITIAL SETUP:**

Test Equipment

NONE

Reference

NONE

Special Tools

NONE

Equipment Condition                      Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
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**INSPECTION**

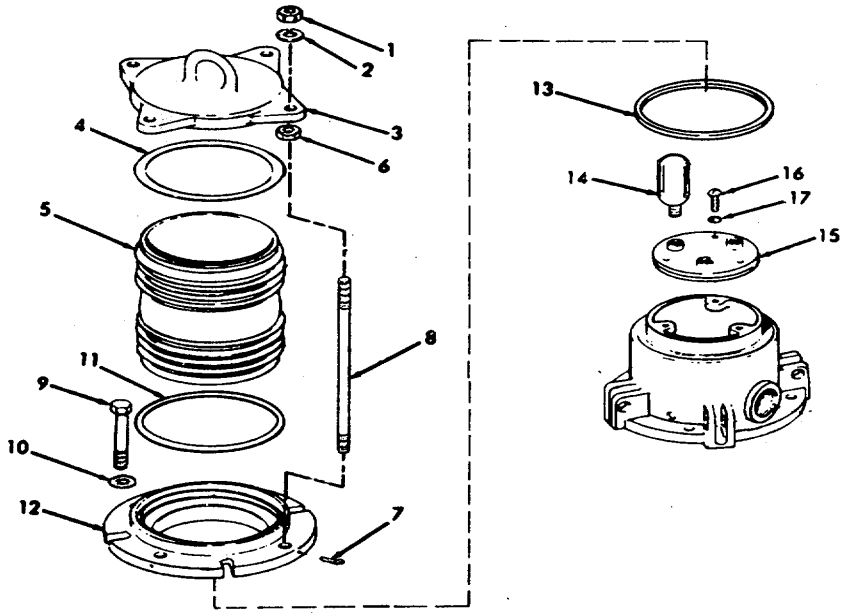
- |    |      |                     |   |
|----|------|---------------------|---|
| 1. | Mast | Signal light (Task) | <ul style="list-style-type: none"> <li>a. Burned out lamps.</li> <li>b. Broken globe or lamps.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose nuts or screws.</li> <li>e. Frayed wiring.</li> <li>f. Leaking bushings,</li> </ul> |
|----|------|---------------------|---|

**REMOVAL/REPAIR**

- |    |      |                |  |
|----|------|----------------|--|
| 2. | Mast | a. Light cover | <ul style="list-style-type: none"> <li>1. Remove hex nuts (1), and lockwashers (2).                      Replace if damaged.</li> <li>2. Remove light cover (3).                      Replace if damaged.</li> </ul> |
|----|------|----------------|--|

3-113.6. SIGNAL LIGHT - TASK - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL/REPAIR (Cont)			
	b. Light fixture (5).	<ol style="list-style-type: none"> <li>1. Remove washer (4).</li> <li>2. Remove glass globe</li> <li>3. Remove hex nuts (6), cotter pins (7) and studs (8).</li> <li>4. Remove hex screws (9) flatwashers (10) and washer (11) from box ring (12).</li> <li>5. Remove gasket (13).</li> </ol>	<p>Replace if damaged.</p> <p>Replace if damaged.</p> <p>Replace if damaged.</p> <p>Replace if damaged.</p>
	c. Lamp	Unscrew lamps (14) from lampholder (15).	Replace if burned out or broken.
	d. Lamp-holder	1. Remove screws (16) and flatwashers (17).	Replace if damaged.





3-113.6. SIGNAL LIGHT - TASK - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on all circuit breakers to prevent accidental turn on.

- |    |                      |  |                                |
|----|----------------------|--|--------------------------------|
|    |                      | 2. Remove wiring from lampholder (15).                     | Replace if damaged or frayed.  |
|    |                      | 3. Remove lampholder (15).                                 |                                |
| e. | Base (Light fixture) | 1. Remove hinge (18) and plug (19).                        | Replace if damaged.            |
|    |                      | 2. Remove cap (21) and clamp (22).                         | Replace if damaged.            |
|    |                      | 3. Remove base (20).                                       |                                |
|    |                      | 4. Remove all bushings, spacers, washers and packing (23). | Replace if damaged or leaking. |
| f. | Wiring               | Remove rest of wiring (24).                                | Replace if damaged or frayed.  |

REPLACEMENT

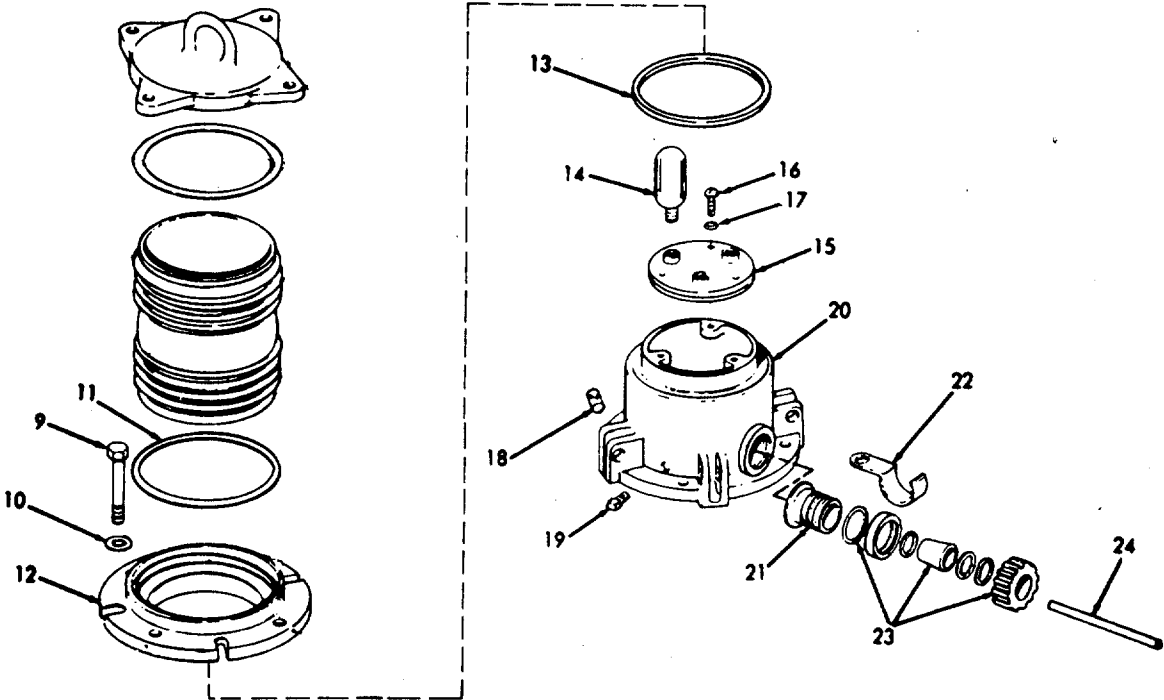
- |    |      |                         |  |
|----|------|-------------------------|--|
| 3. | Mast | a. Wiring               | Thread wiring (24) through light base (20).        |
|    |      | b. Base (light fixture) | 1. Replace watertight bushings (23).               |
|    |      |                         | 2. Replace clamp (22) and cap (21) onto base (20). |
|    |      |                         | 3. Install pipe plug (19) and hinge (18).          |

3-113.6. SIGNAL LIGHT - TASK - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT (Cont)

- |    |               |   |  |
|----|---------------|---|--|
| c. | Lamp-holder   | <ol style="list-style-type: none"> <li>1. Attach wires to lamp-holder (15).</li> <li>2. Install lampholder (15) onto light base (20) by using flat-washers (17) and screws (16).</li> </ol> |  |
| d. | Lamps         | Screw lamps (14) into lampholder (15).  |  |
| e. | Light fixture | <ol style="list-style-type: none"> <li>1. Replace rubber gasket (13).</li> <li>2. Install box ring (12) using washer (11). Secure, using flat-washers (10) and hex screws (9).</li> </ol>   |  |



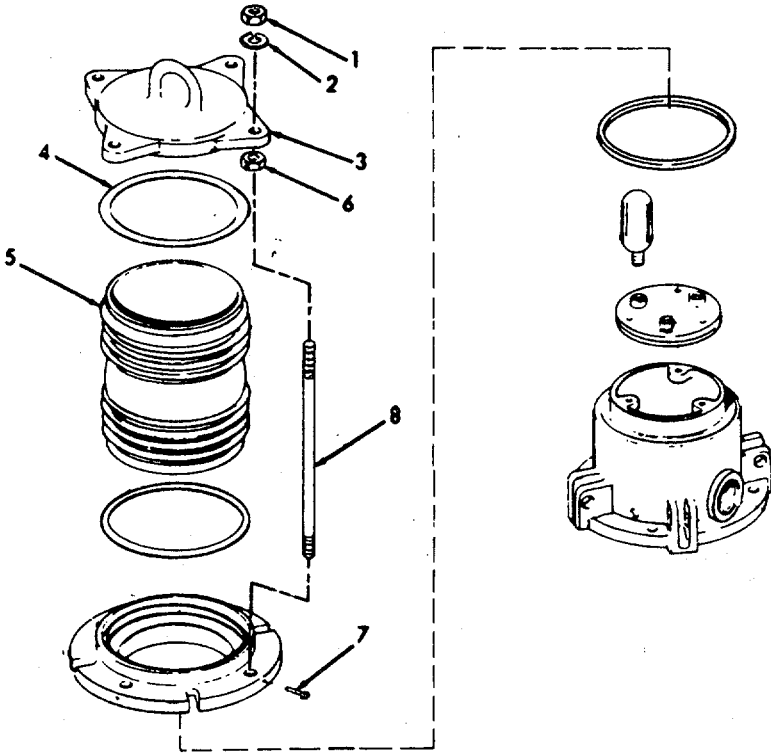
3-113.6. SIGNAL LIGHT - TASK - MAINTENANCE INSTRUCTIONS. (Cont)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT (Cont)			
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f.	Light cover		
----	-------------	--	--

3. Install studs (8) and secure with cotter pins (7) and hex nuts (6).
4. Replace globe (5).
5. Replace washer (4).
1. Replace light cover (3).
2. Secure, using lock-washers (2) and hex nuts (1).



**3-113.7. NAVIGATION LIGHT-ANCHOR AND BOOM-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**a. Inspection**

**b. Removal/Repair**

**c. Replacement**

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

**LOCATION**

**ITEM**

**ACTION**

**REMARKS**

**INSPECTION**

- |    |      |                       |   |  |
|----|------|-----------------------|---|--|
| 1. | Mast | Anchor and boom light | <ul style="list-style-type: none"> <li>a. Burned out lamp.</li> <li>b. Broken globe or lamp.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose nuts or screws.</li> <li>e. Frayed wiring.</li> </ul> |  |
|----|------|-----------------------|---|--|

**REMOVAL/REPAIR**

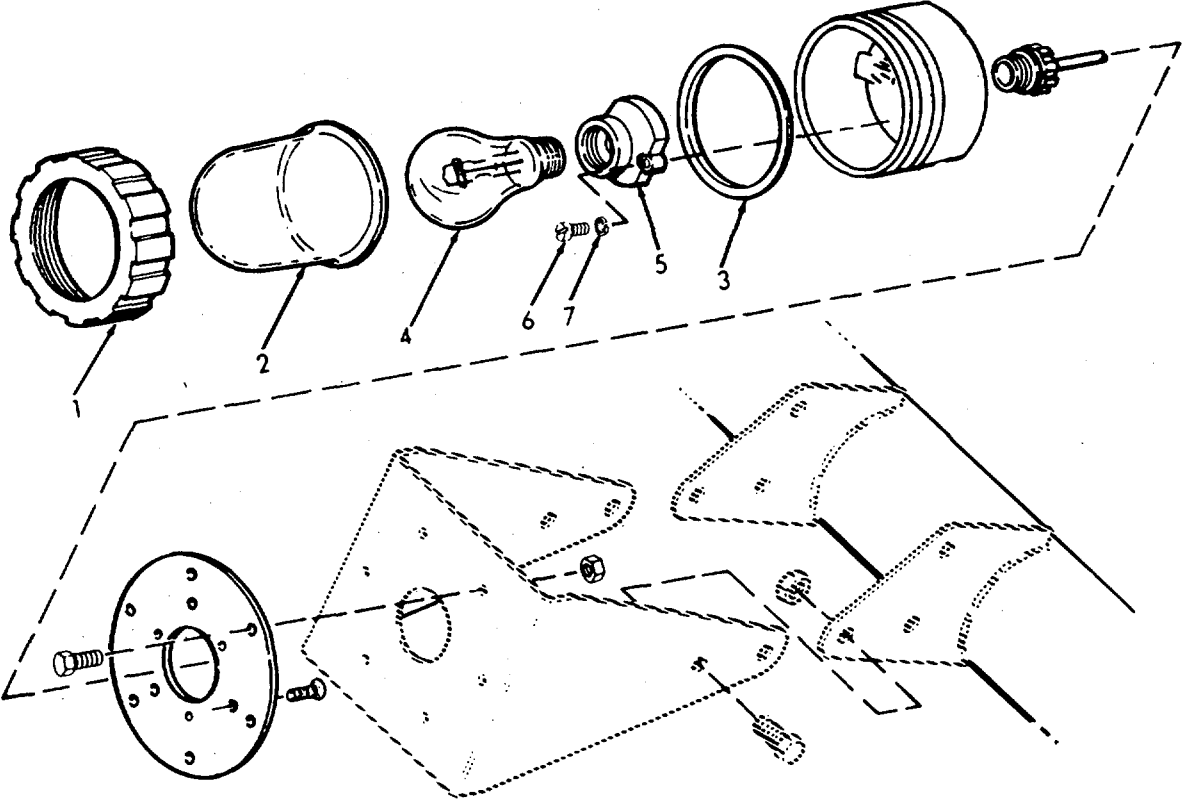
- |    |      |                |                        |                     |
|----|------|----------------|------------------------|---------------------|
| 2. | Mast | a. Light cover | Unscrew globe cap (1). | Replace if damaged. |
|----|------|----------------|------------------------|---------------------|

3-113.7. NAVIGATION LIGHT-ANCHOR AND BOOM-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

b.	Light fixture	1. Remove glass globe (2).	Replace if damaged.
		2. Remove rubber gasket (3).	Replace if damaged.
c.	Lamp	Unscrew lamp (4) from lampholder (5).	Replace if broken or burned out.
d.	Lamp-holder	1. Remove screws (6) and lockwashers (7).	



**3-113.7. NAVIGATION LIGHT-ANCHOR AND BOOM-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

**WARNING**

Place all circuit breakers in the OFF position. Place red tag on all circuit breakers to prevent accidental turn on.

- |  |                         |   |                               |
|--|-------------------------|---|-------------------------------|
|  |                         | 2. Remove wiring from lampholder (5).                 | Replace if frayed or damaged. |
|  |                         | 3. Remove lampholder.                                 | Replace if damaged.           |
|  | e. Base (Light fixture) | 1. Remove nuts (8), bolts (9) and stuffing tube (11). | Replace if damaged.           |
|  |                         | 2. Remove base (10).                                  |                               |
|  | f. Wiring               | Remove rest of wiring.                                | Replace if damaged or frayed. |

REPLACEMENT

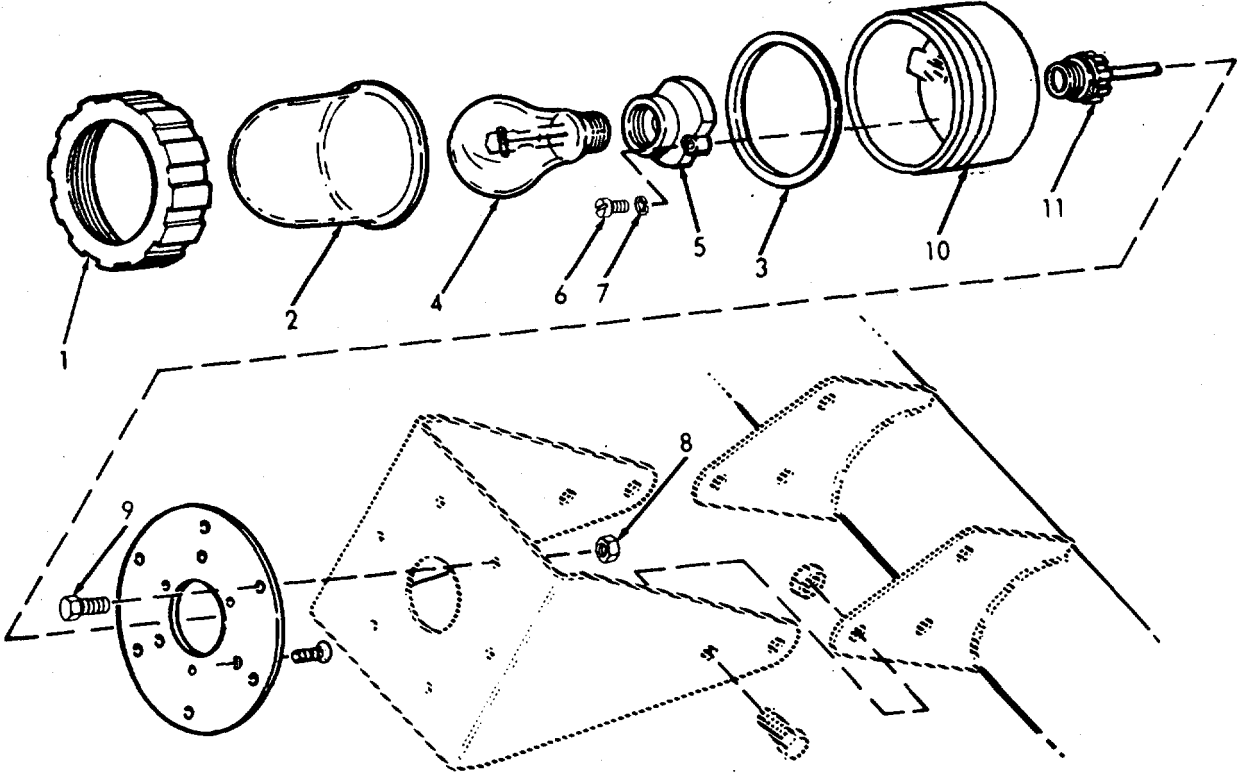
- |         |                         |  |  |
|---------|-------------------------|--|--|
| 3. Mast | a. Wiring               | Install wiring through base (10).                              |  |
|         | b. Base (Light fixture) | 1. Replace base (10).  |  |
|         |                         | 2. Replace stuffing tube (11).                                 |  |
|         |                         | 3. Secure base, using bolts (9) and nuts (8).                  |  |
|         | c. Lampholder           | 1. Attach wires to lampholder (5).                             |  |
|         |                         | 2. Replace lampholder by using lockwashers (7) and screws (6). |  |

3-113.7. NAVIGATION LIGHT-ANCHOR AND BOOM-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT (Cont)

- |    |               |  |  |
|----|---------------|--|--|
| d. | Lamp          | Screw lamp (4) into lampholder (5).                          |  |
| e. | Light fixture | 1. Replace rubber gasket (3).<br>2. Replace glass globe (2). |  |
| f. | Light Cover   | Screw on globe cap (1).                                      |  |



**3-113.8. SIGNAL LIGHT-MAN-OVERBOARD-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**a. Inspection**

**b. Removal/Repair**

**c. Replacement**

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment  
Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

<b>LOCATION</b>	<b>ITEM</b>	<b>ACTION</b>	<b>REMARKS</b>
-----------------	-------------	---------------	----------------

<b>INSPECTION</b>
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1. Mast	Signal light (Manover-board)	<ul style="list-style-type: none"> <li>a. Burned out lamp.</li> <li>b. Broken globe or lamp.</li> <li>c. Broken, bent or damaged metal.</li> <li>d. Loose nuts or screws.</li> <li>e. Frayed wiring.</li> <li>f. Leaking bushings.</li> </ul>	
---------	------------------------------	---	--



**3-113.8. SIGNAL LIGHT-MAN-OVERBOARD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Mast	a. Light cover	1. Remove hex nuts (1), and lockwashers (2).	Replace if damaged.
		2. Remove light cover (3).	Replace if damaged.
	b. Light fixture	1. Remove washer (4).	Replace if damaged.
		2. Remove glass globe (5).	Replace if damaged.
		3. Remove hex nuts (6), cotter pins (7) and studs (8).	Replace if damaged.
		4. Remove hex screws (9) flatwashers (10) and washer (11) from box ring (12).	Replace if damaged.
		5. Remove gasket (13).	
	c. Lamp	Unscrew lamps (14) from lampholder (15).	Replace if burned out or broken.
	d. Lamp-holder	1. Remove screws (16) and flatwashers (17).	Replace if damaged.
		2. Remove wiring from lampholder.	Replace if damaged or frayed.
		3. Remove lampholder.	



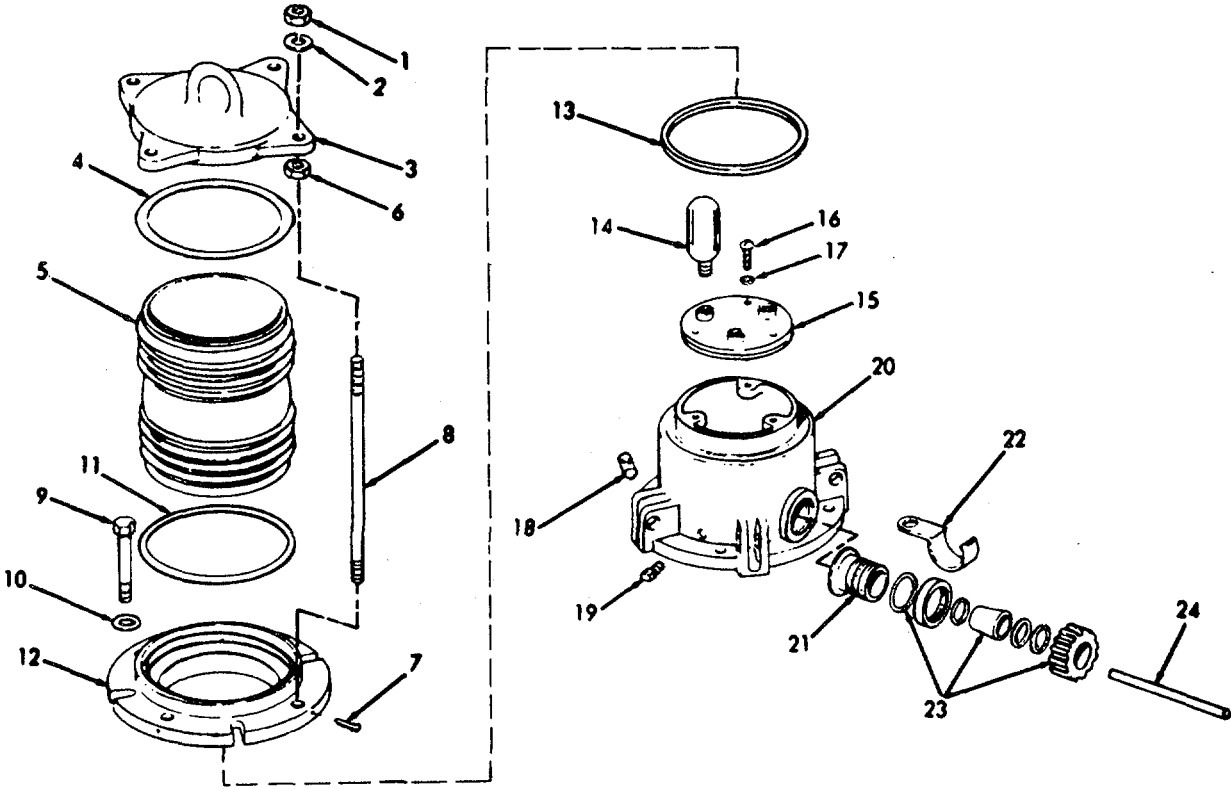
Place all circuit breakers in the OFF position. Place red tag on all circuit breakers to prevent accidental turn on.

3-113.8. SIGNAL LIGHT-MAN-OVERBOARD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REMOVAL/REPAIR (Cont)

e. Base (Light fix- ture)	<ol style="list-style-type: none"> <li>1. Remove hinge (18) and plug (19).</li> <li>2. Remove clamp (20) and cap (21).</li> <li>3. Remove base (22).</li> <li>4. Remove all bushings, spacers, washers and packing (23).</li> </ol>	<p>Replace if damaged.</p> <p>Replace if damaged.</p> <p>Replace if damaged or leaking.</p>
f. Wiring	Remove rest of wiring (24).	Replace if frayed.



**3-113.8. SIGNAL LIGHT-MAN-OVERBOARD-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPLACEMENT</b>			
3. Mast	a. Wiring	Thread wiring (24) through light base (22).	
	b. Base (light fixture)	<ol style="list-style-type: none"> <li>1. Replace watertight bushings (23).</li> <li>2. Replace base (22), by attaching cap (21) and clamp (20).</li> <li>3. Install pipe plug (19) and hinge (18).</li> </ol>	
	c. Lamp-holder	<ol style="list-style-type: none"> <li>1. Attach wires to lamp-holder (15).</li> <li>2. Install flatwashers (17) and screws (16) onto lampholder (15).</li> </ol>	
	d. Lamps	Screw lamps (14) into lampholder (15).	
	e. Light fixture	<ol style="list-style-type: none"> <li>1. Replace rubber gasket (13).</li> <li>2. Install box ring (12) using washer (11). Secure, using flatwashers (10) and hex screws (9).</li> <li>3. Install studs (8) and secure with cotter pins (7) and hex nuts (6).</li> <li>4. Replace globe (5).</li> <li>5. Replace washer (4).</li> </ol>	

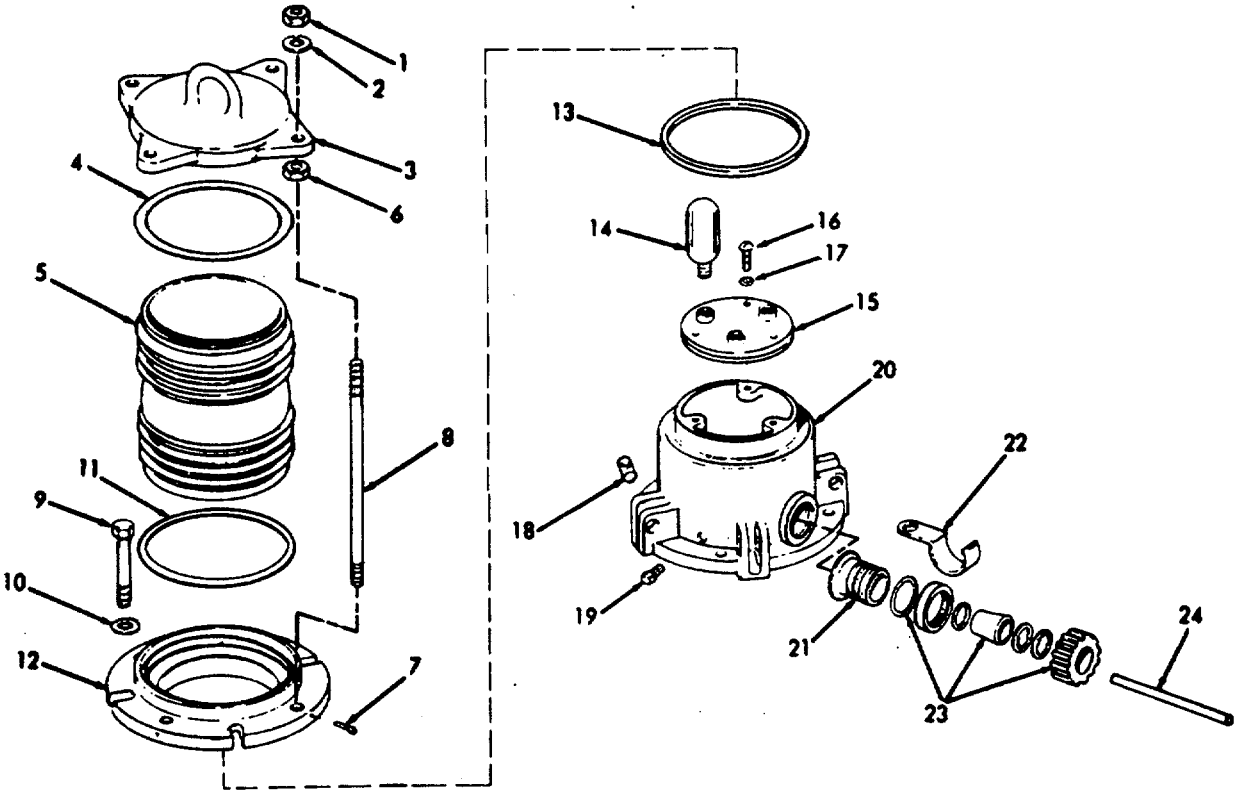
3-113.8. SIGNAL LIGHT-MAN-OVERBOARD-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

REPLACEMENT (Cont)

f. Light cover

- 1. Replace light cover (3).
- 2. Secure, using lock-washers (2) and hex nuts (1).



3-1953

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**3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.**

---

**This task covers:**

- a. Inspection**
  - b. Removal/Repair**
  - c. Replacement**
- 

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment  
Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

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LOCATION	ITEM	ACTION	REMARKS
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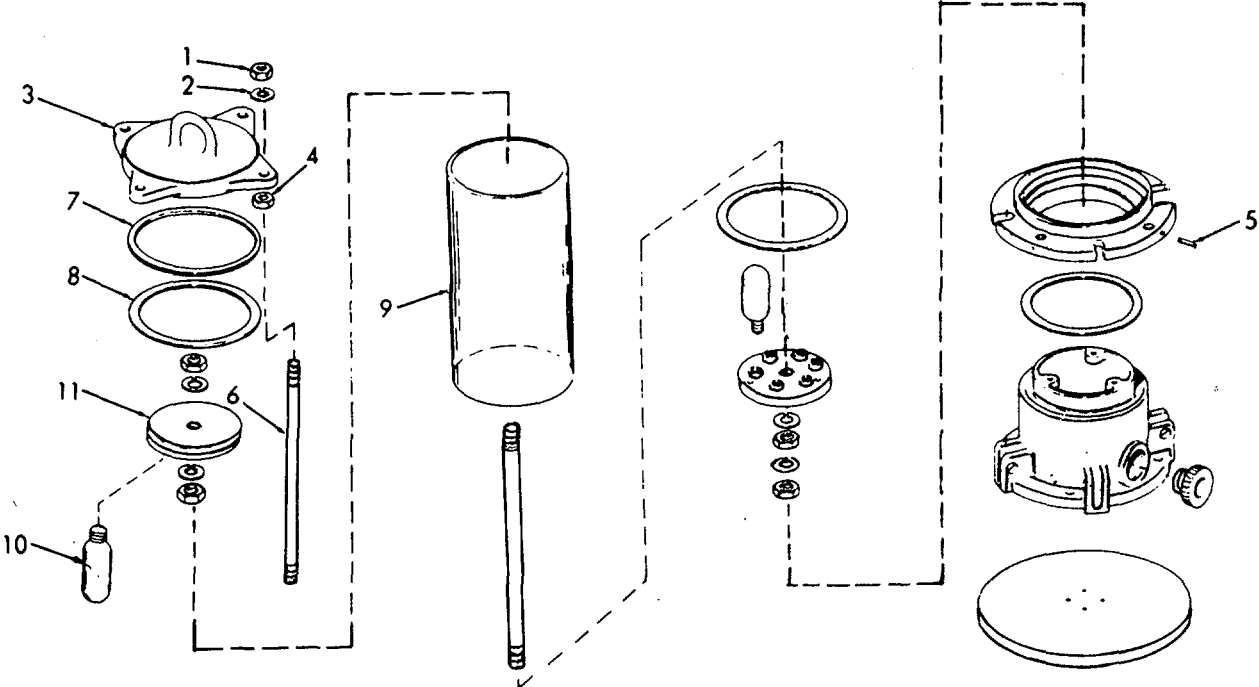
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INSPECTION
------------

- |    |      |                            |   |
|----|------|----------------------------|---|
| 1. | Mast | Navigation light (Blinker) | a. Burned out lamp.<br>b. Broken lamps or globe.<br>c. Broken, bent or damaged metal.<br>d. Loose nuts or screws.<br>e. Frayed wiring.<br>f. Leaking seals or bushings. |
|----|------|----------------------------|---|

3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR</b>			
2. Mast	a. Light cover	1. Remove hex nuts (1) and lockwashers (2). 2. Remove light cover (3).	Replace if damaged. Replace if damaged.
	b. Light fixture	1. Remove nuts (4), pins (5) and brass studs (6). 2. Remove rubber gasket (7). 3. Remove washers (8). 4. Remove glass globe (9).	Replace if damaged. Replace if damaged. Replace if damaged.
	c. Lamps	Unscrew lamps (10) from 1st socket assembly (11).	Replace if damaged or burned out.



**3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
REMOVAL/REPAIR (Cont)			
	d. Socket assembly (1st)	<ol style="list-style-type: none"> <li>1. Remove hex nuts (12), and lockwashers (13).</li> <li>2. Remove hex nuts (14) and lockwashers (15).</li> <li>3. Lift 1st lamp-socket assembly (11) off of upper lamp holder support (16).</li> <li>4. Remove washer (17).</li> </ol>	Replace if damaged.
	e. Lamps	Unscrew lamps (18) from 2nd socket assembly (19).	Replace if damaged or burned out.
	f. Socket assembly (2nd)	<ol style="list-style-type: none"> <li>1. Remove screws (20) and lockwashers (21).</li> <li>2. Remove hex screws (22) and lockwashers (23).</li> </ol>	
	g. Base (Light fixture)	<ol style="list-style-type: none"> <li>1. Remove hex screws (24), lockwashers (25) and hinge pins (26).</li> <li>2. Lift off box ring (27).</li> <li>3. Remove rubber gasket (28), pipe plug (29), and tube (30) from light base (31).</li> <li>4. Remove base (32).</li> </ol>	<p>Replace if damaged.</p> <p>Replace if damaged.</p> <p>Replace if worn.</p> <p>Replace if damaged.</p>

**CAUTION**

Place all circuit breakers in the OFF position. Place red tags on all circuit breakers to prevent accidental turn on.

**3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.**

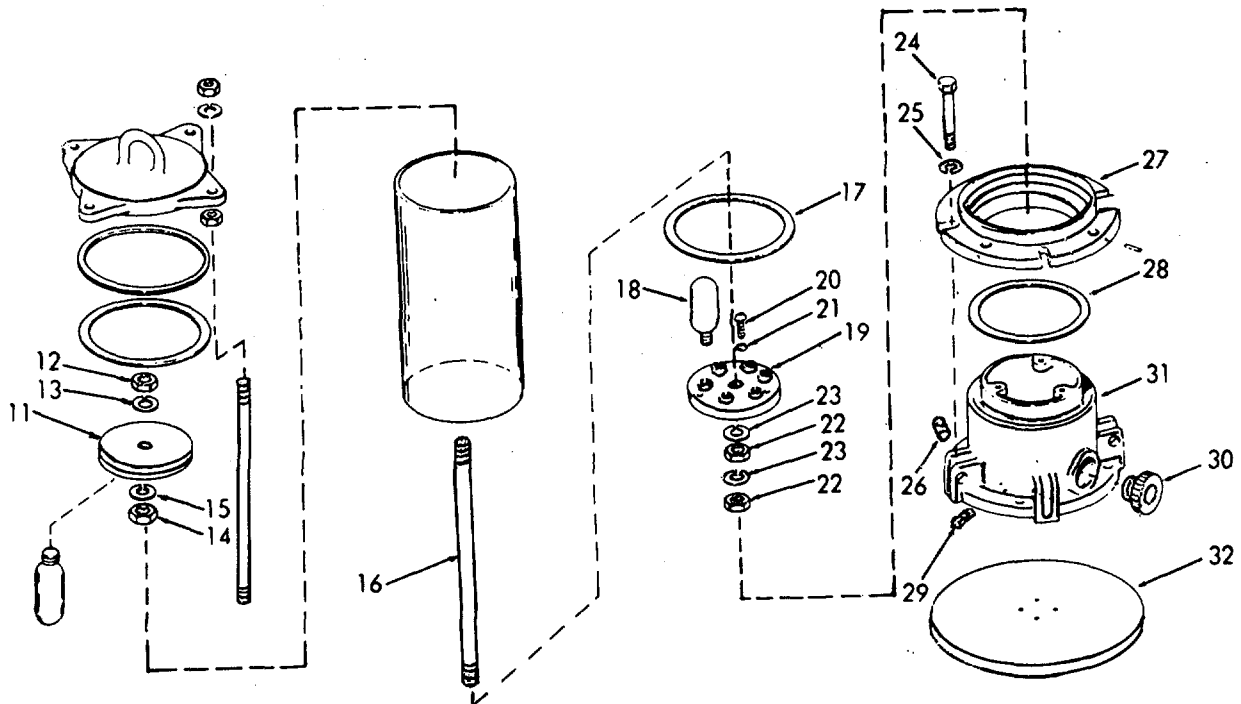
LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REMOVAL/REPAIR (Cont)**

	h. Wiring	Remove wiring.	Replace if damaged or frayed.
--	-----------	----------------	-------------------------------

**REPLACEMENT**

3. Mast	a. Wiring	Thread wiring through light base (31).	
	b. Base (Light fixture)	<ol style="list-style-type: none"> <li>1. Replace stuffing tube (30), and pipe plug (29).</li> <li>2. Replace rubber gasket (28).</li> <li>3. Replace box ring (27) and secure, using hinge pins (26), flatwashers (25) and hex screws (24).</li> </ol>	





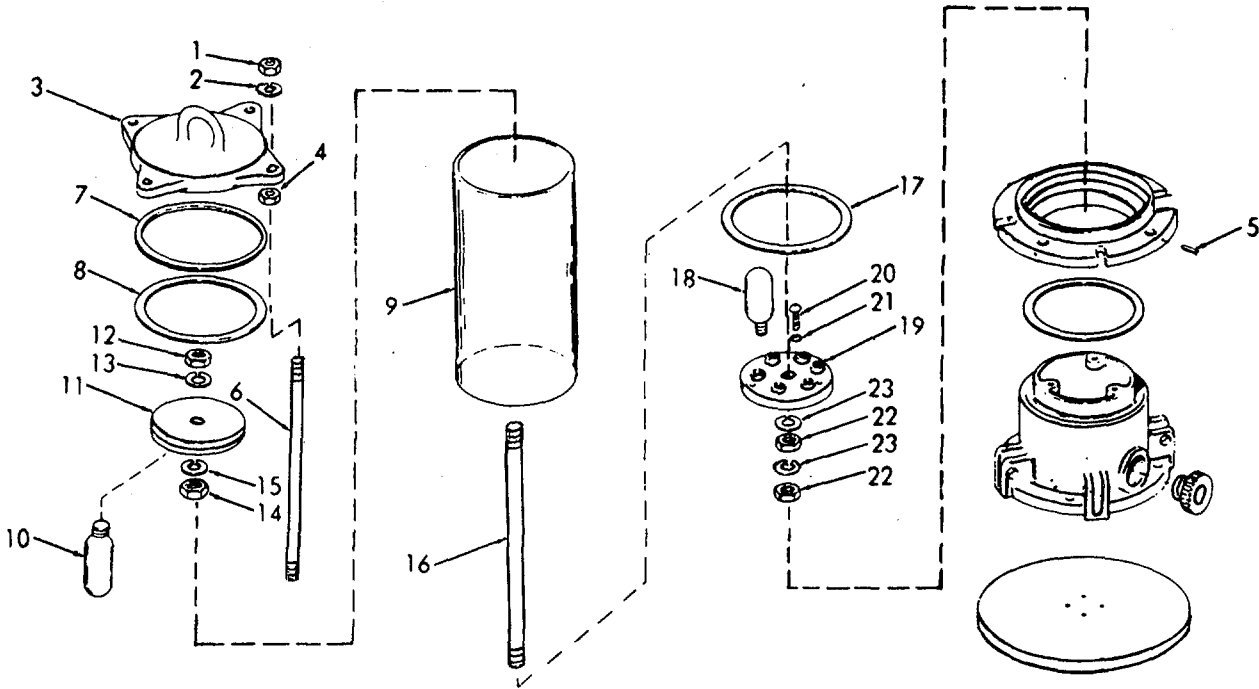
**3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
	c. Socket assembly (2nd)	<ol style="list-style-type: none"> <li>1. Install 2nd socket assembly (19), using lockwashers (23) and hex screws (22).</li> <li>2. Attach lockwashers (21) and screws (20) to top of 2nd socket assembly (19).</li> </ol>	
	d. Lamps	Replace lamps (18).	
	e. Socket assembly (1st)	<ol style="list-style-type: none"> <li>1. Replace washer (17).</li> <li>2. On upper lampholder support (16), install lockwasher (15) and nut (14).</li> <li>3. Lower 1st socket assembly (11) onto lampholder support (16) and secure on top with lockwasher (13) and hex nut (12).</li> </ol>	
	f. Lamps	Replace lamps (10).	
	g. Light fixture	<ol style="list-style-type: none"> <li>1. Replace glass globe (9).</li> <li>2. Replace washer (8).</li> <li>3. Replace rubber gasket (7).</li> </ol>	
	h. Lamp cover	<ol style="list-style-type: none"> <li>1. Replace brass stud (6), and secure with pin (5) and nut (4).</li> <li>2. Replace light cover (3), and secure with lockwashers (2) and hex nuts (1).</li> </ol>	

3-113.9. NAVIGATION LIGHT-BLINKER-MAINTENANCE INSTRUCTIONS.

LOCATION                      ITEM                      ACTION                      REMARKS

REPLACEMENT (Cont)



**3-113.10. NAVIGATION LIGHT-WAKE-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**a. Inspection**

**b. Removal/Repair**

**c. Replacement**

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

**LOCATION**

**ITEM**

**ACTION**

**REMARKS**

**INSPECTION**

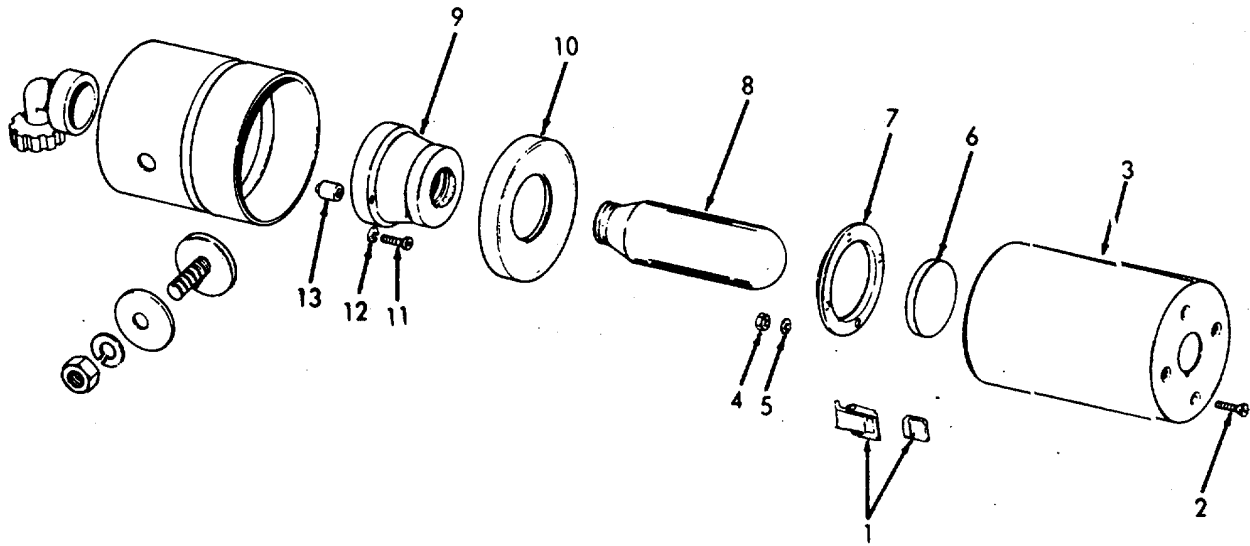
- |    |             |                               |   |
|----|-------------|-------------------------------|---|
| 1. | Port<br>Aft | Navigation<br>light<br>(Wake) | <ul style="list-style-type: none"> <li>a. Burned out lamps.</li> <li>b. Broken lamps or lens.</li> <li>c. Bent, broken, or damaged metal.</li> <li>d. Loose screws or nuts.</li> <li>e. Frayed wiring.</li> </ul> |
|----|-------------|-------------------------------|---|

**REMOVAL/REPAIR**

- |    |             |                                    |  |   |
|----|-------------|------------------------------------|--|---|
| 2. | Port<br>Aft | a. Light<br>cover<br>(bar-<br>rel) | <ul style="list-style-type: none"> <li>1. Open latch &amp; striker (1).</li> <li>2. Remove screws (2).</li> <li>3. Remove barrel (3).<br/>(light cover)</li> </ul> | <ul style="list-style-type: none"> <li>Replace if damaged.</li> <li>Replace if damaged.</li> <li>Replace if damaged.</li> </ul> |
|----|-------------|------------------------------------|--|---|

3-113.10. NAVIGATION LIGHT-WAKE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL/REPAIR (Cont)			
	b. Light fixture	1. Remove hex nuts (4) and lockwashers (5). 2. Remove lens (6). 3. Remove lens holder (7).	Replace if damaged. Replace if damaged. Replace if damaged.
	c. Lamp	Unscrew lamp (8) from lampholder (9).	Replace if broken or burned out.
	d. Lamp-holder	1. Remove wake light reflector (10). 2. Remove screws (11) and lockwashers (12). 3. Remove lampholder pad (13).	Replace if damaged. Replace if damaged. Replace if damaged.



**3-113.10. NAVIGATION LIGHT-WAKE-MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REMOVAL/REPAIR (Cont)</b>			
	e. Base (Light fixture)	1. Stud assemblies (14) and (15) are welded to light base (16).	Refer to General Support Maintenance if found to be defective.
		2. Remove tube (17).	Replace if defective.



Place all circuit breakers in the OFF position. Place red tags on all circuit breakers to prevent accidental turn on.

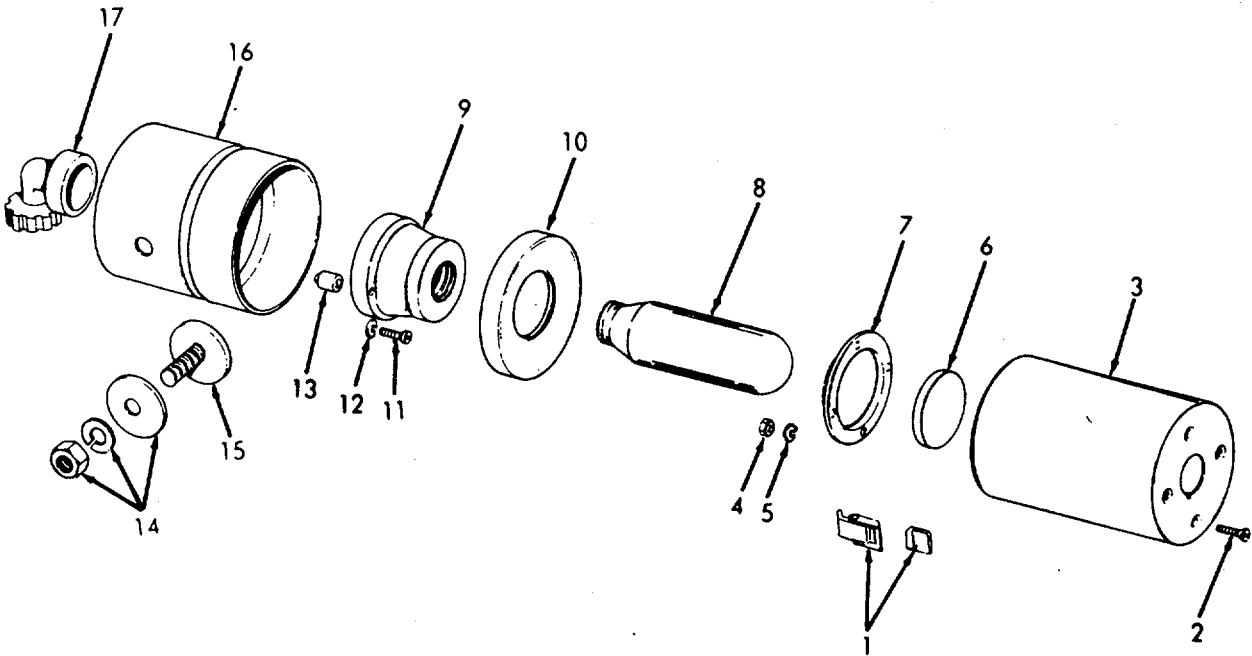
	f. Wiring	Remove all wiring.	Replace if defective or frayed.
--	-----------	--------------------	---------------------------------

**REASSEMBLY**

3. Port Aft	a. Wiring	Replace all wiring.	
	b. Base (light fixture)	1. Replace tube (17) into light base (16).	
		2. Stud assemblies (15) and (14) will be replaced by General Support Maintenance if needed.	
	c. Lampholder	1. Replace lampholder pad (13).	
		2. Install lampholder (9) by using lockwashers (12) and screws (11).	
		3. Replace wake light reflector (10) over lampholder (9).	

3-113.10. NAVIGATION LIGHT-WAKE-MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Lamp	<ol style="list-style-type: none"> <li>1. Replace lamp (8).</li> <li>2. Replace lens holder (7).</li> <li>3. Replace lens (6).</li> </ol>	
	e. Light fixture	<p>Replace lockwashers (5) and hex screws (4).</p>	
	f. Light cover	<ol style="list-style-type: none"> <li>1. Replace barrel (3) (light cover), and screws (2).</li> <li>2. Secure with latch and striker (1).</li> </ol>	



**3-114. NAVIGATION LIGHT-PANEL-MAINTENANCE INSTRUCTIONS.**

**This task covers:**

**a. Inspection**

**b. Repair**

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition   Condition Description  
Para

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------



Make sure the source of electrical power is shut off. Tag all switches and circuit breakers. Failure to do this could result in serious injury or loss of life, and major damage to the landing craft.

**INSPECTION**

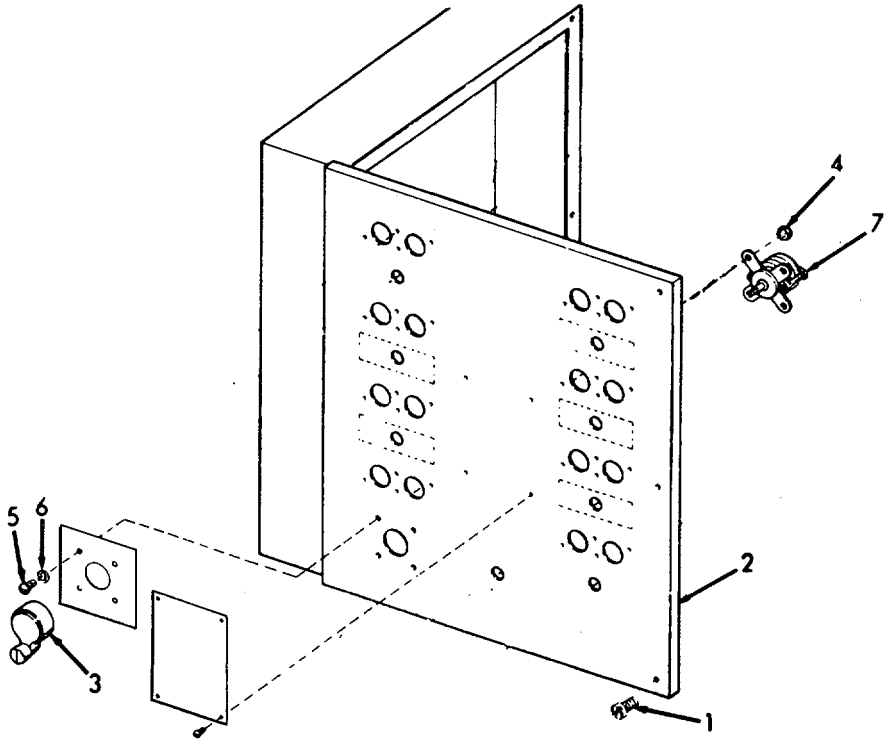
- |    |       |                         |   |
|----|-------|-------------------------|---|
| 1. | Panel | Navigation light (Wake) | <ul style="list-style-type: none"> <li>a. Burned out lamps.</li> <li>b. Broken lamps or lens.</li> <li>c. Bent, broken, or damaged metal.</li> <li>d. Loose screws or nuts.</li> <li>e. Frayed wiring.</li> </ul> |
|----|-------|-------------------------|---|

**3-114. NAVIGATION LIGHT-PANEL-MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

**REPAIR**

- |    |                     |  |  |
|----|---------------------|--|--|
| 2. | Front panel         | Screws (1)                                   | Loosen and swing panel (2) open.                   |
| 3. | Switch power supply | a. Knob (3)                                  | Loosen set screw and remove.                       |
|    |                     | b. Nuts (4), screws (5) and lock-washers (6) | Remove.  |
|    |                     | c. Switch (7)                                | 1. Tag and disconnect wiring.<br>2. Remove switch. |
|    |                     | d. Switch (7)                                | Reconnect wiring and install switch.               |





**3-114. NAVIGATION LIGHT-PANEL-MAINTENANCE INSTRUCTIONS.**

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Switches	e. Screws (5), lock-washers (6) and nuts (4)	Install.	
	f. Knob (3)	Install and tighten set screw.	
	a. Switch face nut (8)	Remove.	
	b. Switch (9)	1. Tag and disconnect wires.  2. Remove switch.	
	c. Switch (9)	Install switch and reconnect wires.	
	d. Switch face nut (8)	Install.	
5. Fuses/ Holders	a. Cap (10) and fuse (11)	Remove.	
	b. Nuts (12), lock-washers (13) and screws (14)	Remove.	
	c. Fuse-holder (15)	1. Disconnect wires.  2. Remove holder.	
	d. Fuse-holder (15)	Install fuseholder and reconnect wires.	

**3-114. NAVIGATION LIGHT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

LOCATION	ITEM	ACTION	REMARKS
<b>REPAIR (Cont)</b>			
	e. Screws (14), lock-washers (13) and nuts (12)	Install.	
	f. Cap (10) and fuse (11)	Install.	
6. Terminal strip	a. Wiring	Tag and disconnect.	
	b. Screws (16) and lock-washers (17)	Remove.	

---

**3-114. NAVIGATION LIGHT PANEL - MAINTENANCE INSTRUCTIONS (Cont).**

---

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

---

REPAIR (Cont)
---------------

- |  |                                      |                            |  |
|--|--------------------------------------|----------------------------|--|
|  | c. Terminal strip (18)               | Replace.                   |  |
|  | d. Screws (16) and lock-washers (17) | Install.                   |  |
|  | e. Wiring                            | Reconnect and remove tags. |  |

**3-1968**

**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 SECTION 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.

(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 subcolumns 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

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
0200	Electric Power Generation and Distribution								
0205	Switchboard (main)	Inspect Replace Repair	.4  .5		24.0 25.5				
0208	Transformers	Inspect Service Replace	.5 1.0		6.6				
0210	Power Distribution Panel Boards	Inspect Repair Replace Overhaul	.5 2.0		3.5 6.0				
0215	Generator 12V	Inspect Service Test Replace Repair	.3 1.0 1.0 1.0 5.0						
0218	Generator (40 KW)	Inspect Replace Service Overhaul	.2 16.0 2.0	40.0					
0220	Engine Assy	Inspect Service Replace Repair Overhaul Test	.3 1.5 8.5	40.0	40.0 8.0				
0221	Engine Controls	Inspect Adjust Replace Repair	.5 2.0 8.0 2.0						
0221A	Emergency Stop Solenoid	Inspect Adjust Replace Repair	.5 .5 1.0 1.0						
0221B	Alarm Switches	Inspect Adjust Replace Repair	.3 .2 .5 .5						
		<b>B-4</b>							



SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
0221C	Emergency Shut-Off	Inspect Adjust Replace Repair	.5 .2 2.0 1.0						
0222	Governor (Hydraulic)	Inspect Service Adjust Replace Repair Test Overhaul	.2 .2 .2 1.0 1.0		.4 1.0  4.5 6.0			3, 4, 5, 6	
0223	Air Intake	Inspect Service Replace Repair	.2 .4 1.5 3.0						
0224	Blower	Inspect Service Replace Repair Overhaul	.2 .4 1.5 1.0		8.0			7, 8, 9 55	
0225	Fuel Pump & Drain Lines	Inspect Replace Repair	.2 1.0 2.0					10, 11	
0226	Fuel Filter and Strainer	Inspect Service Replace Repair	.2 .5 1.5 1.5						
0227	Fuel Injector	Inspect Test Replace Repair Overhaul	.1 .3 1.5 1.5		.5  1.0			12, 13, 14 15, 56	
0228	Fuel Lines and Manifold Connections	Inspect Replace	.2 1.5						
0229	Lube Oil Filter and Housing	Inspect Service Replace Repair	.2 .4 1.5 1.4						
0230	Lube Oil Cooler	Inspect Replace Repair	.2 1.2 1.5						
		<b>B-5</b>							

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
0231	Fresh Water Pump	Inspect Replace Repair	.2 1.2 2.5					15, 16, 17 18, 19, 56	
0232	Heat Expansion Tank and Water Connections	Inspect Replace	.2 1.2						
0233	Water Manifold	Inspect Replace Repair	.2 1.2			3.0 (Weld)			
0234	Thermostat and Housing	Inspect Replace Repair	.2 .4 1.3			2.0 (Weld)			
0235	Overspeed Governor	Inspect Test Service Adjust Replace Repair	.2 1.0 1.0 .5 1.0 1.0						
0236	Tachometer Drive	Inspect Replace Repair	.2 1.6 1.5						
0237	Air Cleaner	Inspect Service Replace Repair	.1 .3 1.0 1.0						
0238	Crankshaft Pulley	Inspect Replace Repair	.2 2.5 1.7					21, 56	
0239	Balance Weight Cover	Inspect Replace	.2 1.5	.2				56	
0240	Lift Brackets and Supports	Inspect Repair Replace	.2 1.0 1.6						
0241	Exhaust Manifold	Inspect Replace Repair	.2 2.0 2.5						
0242	Rocker Arm Cover	Inspect Replace	.1 1.0						
0243	Injector Controls	Inspect Adjust Replace Repair	.2 .3 1.5 2.0						
		<b>B-6</b>							

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
0244	Oil Pan, Dipstick, Oil Filler	Inspect Replace Repair	.2 1.5 1.5						
0245	Cylinder Head	Inspect Replace Repair	.2 1.5 1.5				27 28, 29, 30, 31, 32, 33, 34		
0246	Valve Operating Mechanism	Inspect Adjust Replace Repair	.2 .8 1.5 2.5				26		
0247	Camshaft & Gear Train	Inspect Replace Repair	.4 6.0 3.5				23, 24, 25		
0248	Flywheel & Housing	Inspect Replace Repair	.2 3.5 2.0			2.0 (Weld)	22		
0249	Lube Oil Pressure Regulator	Inspect Adjust Replace Repair	.1 .4 1.0 1.5						
0250	Lube Oil Pump	Inspect Replace	.2 1.0				54		
0251	Repair Lube Oil Distribu- tion system	Inspect Replace	.2 1.2		2.0				
0252	Pistons, Connecting Rods & Cylinder Liners	Inspect Replace Repair	1.0 4.5 5.5				37, 38, 39, 40, 41, 42, 43, 44, 45, 46		
0253	Crankshaft	Inspect Replace	.5 6.5				47		
	Bearings	Inspect Replace	0.4 1.0						
	Front Cover and Oil Seal	Inspect Replace	.2 1.0						
0254	Cylinder Block	Inspect	.5						
	Replace				10.5				
	Repair		1.0		4.5				
		<b>B-7</b>							

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
0255	Instrument Panel	Inspect	.2						
		Replace	1.5						
		Repair	2.0						
0256	Starting Aid	Inspect	.1						
		Service	.2						
		Replace	.5						
		Repair	1.2						
0260	Hydrostarter (hydrotor)	Inspect	.2				58		
		Test			1.5				
		Replace	1.2						
		Repair	1.2						
		Overhaul			4.5				
0262	Accumulator	Inspect.	.1						
		Service			1.0				
		Replace	1.4				57		
		Repair			3.5				
0264	Hydrostarter Pump (Engine Driven)	Inspect	.1						
		Replace	.4						
		Repair			1.8				
		Overhaul			3.0				
0266	Hydrostarter Pump (Hand)	Inspect	.1						
		Replace	1.2						
		Repair	2.5						
0267	Hydrostart Piping (Fwd Eng Rm)	Inspect	.2						
		Replace			2.7				
		Repair			1.5				
0268	Hydrostarter Piping (Aft Eng Rm)	Inspect	.2						
		Replace.			2.7				
		Repair			1.5				
0269	Reservoirs.	Inspect	.2						
		Replace	1.0						
		Repair.			1.0				
0270	Rectifier, 24VDC.	Inspect	.5						
		Replace	2.0						
		Repair	2.0						
		Overhaul			10.0				
0272	Distribution Panels Lighting	Inspect.	.4						
		Replace			1.5				
		Repair	.5						
0274	Switches	Inspect	.1						
		Replace	1.0						
0281	Lights	Inspect	.1						
		Replace	1.0						

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
			0282	Emergency Lighting	Inspect	.2			
		Replace	1.5						
		Repair	1.0						
0284	Running, Signal, & Anchor Lights	Inspect	.2						
		Replace	1.5						
		Repair	1.0						
0285	Navigational Light Control Panel	Inspect	.2						
		Replace			10.0				
		Repair	.4						

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By Order of the Secretary of the Army:

Official:

ROBERT M. JOYCE  
*Major General, United States Army*  
*The Adjutant General*

JOHN A. WICKHAM, JR.  
*General, United States Army*  
*Chief of Staff*

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25D, Operator's Maintenance Requirements for Marine Equipment, ALL.



**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

**Liquid Measure**

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

**Weights**

1 centigram = 10 milligrams = .15 grain  
 inches  
 1 decigram = 10 centigrams = 1.54 grains  
 sq. feet  
 1 gram = 10 decigram = .035 ounce  
 sq. feet  
 1 dekagram = 10 grams = .35 ounce  
 2.47 acres  
 1 hectogram = 10 dekagrams = 3.52 ounces  
 mile  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

**Square Measure**

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inch  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. meters  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. meters  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 100 sq. hectometers  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. kilometers

**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**

<b>To change</b>	<b>To</b>	<b>Multiply by</b>	<b>To change</b>	<b>To</b>	<b>Multiply by</b>
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
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