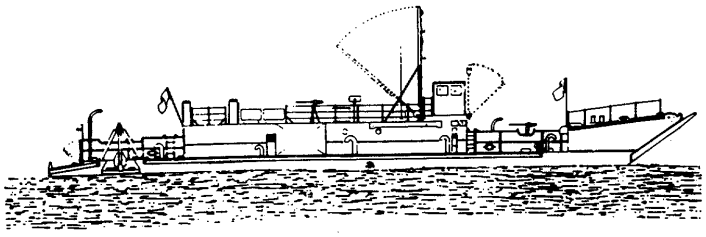
TECHNICAL MANUAL

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

OPERATOR MAINTENANCE
FOR AUXILIARY
EQUIPMENT INSTRUCTIONS

LANDING CRAFT UTILITY
LCU 1667-1670
NSN 1905-00-168-5764



***This manual supersedes TM 55-1905-219-14-8, 30 September 1980**

HEADQUARTERS, DEPARTMENT OF THE ARMY
9 JULY 1984

TM 55-1905-219-14-8
C2

CHANGE

NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 13 March 1992

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

LANDING CRAFT UTILITY
LCU 1667-1670
NSN 1905-00(168-5764

Approved for public release; distribution is unlimited

TM 55-1905-219-14-8, 9 July 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is-indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
4-567 through 4-578	4-567 through 4-577
4-579 through 4-584	4-584
4-769 and 4-770	4-769 and 4-770
4-773/4-774	4-773/4-774
4-823 and 4-824	4-823 and 4-824
4-939 and 4-940	4-939 and 4-940
4-943/4-944	4-943/4-944

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
00754

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25E, (qty rqr block no. 1057).

URGENT

TM 55-1905-219-14-8
C 1

CHANGE

HEADQUARTERS
DEPARTMENT OF THE ARMY

NO. 1

WASHINGTON, D.C., 3 August 1984

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

LANDING CRAFT UTILITY
LCU 1667-1670
NSN 1905-00-168-5764

TM 55-1905-219-14-8, 9 July 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
c and d	c and d

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25D, Operator Maintenance Requirements for Marine Equipment, All.

URGENT

WARNING

DEATH

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

- Wear safety glasses, safety shoes, and a hard hat to provide adequate protection.
- Death or severe injury may result if personnel fail to use a lifting device that is adequate for the item to be lifted.
- Ear protection must be worn when engines or machinery are 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.
- 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.
- Use extreme care when near rotating fans, belts, and pulleys.
- 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).
- 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.
- 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.

WARNING

- Store all flammable material in the Flammable Storage Compartment.
- HIGH VOLTAGE is used in the operation of this equipment.
- DEATH ON CONTACT may result if personnel fail to observe safety precautions.
- Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid.
- Whenever possible, the input power supply to the equipment must be shut off before beginning work on the equipment. When working inside the equipment, after power has been turned off, always ground every part before touching it.
- Do not be misled by the term "low voltage". Potentials as low as 50 volts may cause death under adverse conditions.
- Sewage is an inclusive term generally applied to the mixture of all liquid domestic wastes, especially human body wastes. The character of sewage changes from place to place but it always contains very large numbers of bacteria -hundreds of millions per milliliter - some of which can cause dangerous illness in man. Typhoid and polio viruses are two examples.
- The ingress of these bacteria to the human body is through the mouth or open sores. It is important therefore to observe certain elementary precautions.

  a. No food or drink of any nature should be taken into sewage handling areas.

  b. Personnel with open cuts or sores should not work on sewage handling equipment.

  c. Any sewage spill should be dealt with immediately, before it dries; by washing down with water and a good quality, non-scented disinfectant. Liquid soaps or scented disinfectants should not be used since they only serve to disguise improper clean-up.

WARNING

d. All personnel should be encouraged to wash their hands on exit from a sewage handling area or after being in contact with sewage handling equipment.

REFRIGERANT-12.

- Refrigerant-12 is practically odorless and non-toxic. It is not necessary to wear a gas mask when servicing equipment in which it is contained unless the conditions necessary for the decomposition of R-12 to phosgene gas exist.

- Never use a torch or attempt a repair on a line containing R-12 until it is certain that all gas has been pumped out of the section of pipe to be repaired, the area is well ventilated and the line has been valved off. Refrigerant-12 in contact with an open flame of high temperature (about 1,000°F (557.8*C)) decomposes into phosgene, a highly toxic gas.

- Always wear goggles when handling R-12, or servicing equipment in which it is contained, to avoid the possibility of liquid refrigerant coming in contact with the eyes.

- If liquid R-12 accidentally comes in contact with the eyes, take person suffering the injury to the medical officer at once. Do not rub or irritate the eyes and give the following first aid treatment immediately:
  a. Introduce drops of sterile mineral oil into the eyes as an irrigant.
  b. If irritation continues at all, wash the eyes with a weak boric acid solution, or a sterile salt solution not to exceed 2% sodium chloride.

- Should liquid R-12 come in contact with the skin, treat the injury the same as though the skin had been frost bitten or frozen.

- Do not work in a closed space where R-12 may be leaking unless adequate ventilation is provided.

WARNING

- Should a person be overcome in a space which lacks oxygen because of high concentrations of R-12 being present, treat such person the same as for suffocation, i.e., through artificial respiration.
- 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.
- 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.
- 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.

TECHNICAL MANUAL

NO. 55-1905-219-14-8

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 9 July 1984

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

LANDING CRAFT UTILITY
LCU 1667-1670
NSN 1905-00-168-5764

REPORTING OF 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, U.S. Army Troop Support Command, ATTN: DRSTR-MPS, 4300 Goodfellow Blvd., St. Louis, MO63120. A reply will be furnished to you.

TABLE OF CONTENTS

CHAPTER 4

OPERATOR MAINTENANCE INSTRUCTIONS

FOR AUXILIARY EQUIPMENT

OVERVIEW

The operator maintenance instructions in this chapter apply to the following:

Chapter 3 contains the maintenance instructions for all major equipment.

SECTION I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

4-1. GENERAL.

Repair parts, special tools, test, maintenance, diagnostic equipment, (TMDE), and support equipment are listed and illustrated in TM 55-1905-219-20P.

SECTION II. SERVICE UPON RECIPT

4-2. PRELIMINARY SERVICING OF EQUIPMENT.

a. General. When a landing craft is received, inspect all items for damage that may have occurred during shipping or setting-up operations. Particular attention should be directed toward loose or missing nuts, bolts, screws, drainplugs, draincocks, oil plugs, assemblies, subassemblies, or components that may be easily lost or broken in transit. All other onboard equipment listed in basic issue items list, or packing lists, on new or used equipment should be similarly inspected and all discrepancies carefully noted.

b. Batteries. Batteries may be shipped separately, or installed for convenience with the electrolyte shipped separately.

(1) If batteries are not installed, uncrate and install.
(2) If batteries are installed, remove filler caps and carefully fill each cell with electrolyte until level is 3/8 inch (9.53 mm) above plates. Replace filler caps.
(3) Charge battery if required.

WARNING

Handle electrolyte with care. It is capable of inflicting severe burns. Solution contacting the body must be washed off with fresh water immediately. Do not smoke or use open flame while servicing batteries. Batteries generate a hydrogen gas which is highly explosive.

(4) For testing of batteries, refer to PMCS Table 2-14, item 15.

c. Inspection. All areas will be carefully inspected for proper component attachment, or damaged components.

d. Servicing and Equipment. When a landing craft is received, perform all preventive maintenance checks and services. Before filling fuel tanks, cooling system, hydraulic reservoir, engine crankcase, transmission oil reservoir, or oil reservoir of any component, ensure that associated draincocks are closed, and all barrier material has been removed.

(1) Filters. Hydraulic filters are susceptible to easy contamination on new equipment. Check frequently and change elements after first 50 hours of operation.

4-3. INSTALLATION OF SEPARATELY PACKED COMPONENTS.

Normally, there are no components packed separately. Loose items of equipment subject to loss, damage, or pilferage, may be boxed and secured on the landing craft. Such items should be unpacked and properly stowed during inspection and servicing of equipment on receipt.

SECTION III. LUBRICATION

4-4. GENERAL.

Refer to Lubrication Order LO-55-1905-219 for lubrication instructions.

SECTION IV. TROUBLESHOOTING - SYMPTOM INDEX

4-5. GENERAL.

a. This table lists the common malfunctions which you may find during the operation and maintenance of the following components:

- Commissary Space Equipment
- Electronic/Navigation System
- Fire Detection and Extinguishing Equipment
- Heating, Ventilation, and Air Conditioning System
- Hull and Outfit
- Interior Communication System
- Oil/Water Separation System
- Piping System
- Plumbing and Deck Drains
- Pump Sets
- Sewage System
- Tanks and Voids
- Vents and Sounding Tubes

b. You should perform the tests/inspections and corrective actions in the order listed.

c. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

d. Refer to Chapter 3 for the maintenance procedures for major machinery.

4-5. GENERAL (Continued).

SYMPTON INDEX

NOTE

M in Table number indicates malfunction item number.

EQUIPMENT	MALFUNCTION	TABLE
Portable Fire Pump	Ignition troubleshooting	4-1
(Gale Marine P250)	Spark plug	4-1-M1
	Breaker points - magneto	4-1-M2
	Condenser - magneto	4-1-M3
	Ignition coil - magneto	4-1-M4
	Wiring magneto	4-1-M5
	Flywheel	4-1-M6
	Carburetion troubleshooting	4-2
	Filter - fuel	4-2-M1
	Fuel tanks	4-2-M2
	Carburetor	4-2-M3
	Motor floods	4-2-M4
	Motor starves	4-2-M5
	Poor Carburetion	4-2-M6
	Power head troubleshooting	4-3
	Cooling system troubleshooting	4-4
Portable Fire Pump	Hard starting or will not run	4-1A
(Prosser PE-250)	Lack of fuel	4-1A-M1
	Poor or no ignition spark	4-1A-M2
	Engine flooded	4-1A-M3
	Carburetor lean, too much air	4-1A-M4
	Poor compression	4-1A-M5
	Running troubles	4-2A
	Lacks power	4-2A-M1
	Runs unevenly	4-2A-M2
	Poor acceleration	4-2A-M3
	No acceleration	4-2A-M4
	Engine backfires through carburetor	4-2A-M5
	Pings under heavy load, full throttle	4-2A-M6
	Engine stops	4-2A-M7
	Pump troubles	4-3A
	Pump primes slowly or not at all	4-3A-M1
	Magnetic clutch slipping	4-3A-M2
	Pump will not pump water - or is not pumping enough	4-3A-M3

4-5. GENERAL (Continued).

SYMPTON INDEX

4-5. GENERAL (Continued).

SYMPTON INDEX (Continued)

EQUIPMENT	MALFUNCTION	TABLE
Air Conditioner (Continued)	Partial frosting of coil - failure to cool	4-11-M2
	No frosting of coil - failure to cool	4-11-M3
	Complete frosting of coil - failure to cool	4-11-M4
	Too much cooling	4-11-M5
Drinking Fountain	Water leaks	4-12-M1
	Water not cold or not cold enough	4-12-M2
	Little or no water from bubbler valve	4-12-M3
	Bubbler valve stream too high or too low	4-12-M4
	Compressor runs continuously	4-12-M5
	Compressor inoperative	4-12-M6
Milk Dispenser	Compressor will not start - no hum	4-13-M1
	Compressor will not start - hums but cycles on overload	4-13-M2
	Compressor starts but starting winding remains in circuit	4-13-M3
	Compressor starts and runs but cycles on overload	4-13-M4
	Compressor tries to start when control closed but cuts out on overload, finally starts after several attempts	4-13-M5
	Compressor starts but immediately cuts out on overload	4-13-M6
	Relay burned out	4-13-M7
	Head pressure too high	4-13-M8
	Head pressure too low	4-13-M9
	Compressor running cycle too long or operating continuously	4-13-M10
	Milk can compartment temperature too high	4-13-M11
	Noisy unit	4-13-M12
	Evaporator freezes but defrosts while compressor is running	4-13-M13
	Suction line sweating or frosting	4-13-M14

4-5. GENERAL (Continued).

SYMPTON INDEX (Continued)

EQUIPMENT	MALFUNCTION	TABLE
Commode	Improper volume of flush water and/or inadequate bowl rinsing	4-14-M1
	Leakage of flapper valve	4-14-M2
	Flapper valve at bottom of bowl does not open sufficiently to evacuate wastes	4-14-M3
	Stopper does not close quickly	4-14-M4
	UrinalImproper volume of flush water	4-15-M1
Macerator Pump	Pump runs but does not deliver capacity	4-16-M1
	Pump does not operate	4-16-M2
	Pump is noisy with high pitch singing noise	4-16-M3
Macerator Pump - Electronic Controls	Pump does not operate when commode or urinal is flushed	4-17-M1
	Pump operates only when micro-switch is depressed or water is running through flowswitch	4-17-M2
	Pump does not turn off after 10 seconds of operation	4-17-M3
	Motor starter activates, pump hums but does not pump	4-17-M4
Washer/Dryer	No product operation	4-18-M1
	No operation - washer unit only	4-18-M2
	No operation - dryer unit only	4-18-M3
	Washer vibration during spin or agitate	4-18-M4
	Motor will not operate	4-18-M5
	Won't agitate - motor operating	4-18-M6
	Noisy operation	4-18-M7
	Insufficient water level	4-18-M8
	Overfill	4-18-M9
	Water leaking onto deck	4-18-M10
	Wash water not hot enough, controls set for hot wash	4-18-$M11
	Clothing too wet after final spin	4-18-M12
	Odor in washer unit	4-18-M13
	Torn clothing	4-18-M14
	Dryer drum will not rotate - motor operating	4-18-M15
	Drum speed too fast	4-18-M16
	Drum speed too slow - noisy or vibrating	4-18-M17

4-5. GENERAL (Continued).

SYMPTON INDEX (Continued)

EQUIPMENT	MALFUNCTION	TABLE
Washer/Dryer (Continued)	No heat - drum rotates	4-18-M18
	Improper drying temperature	4-18-M19
	Drying time too long or clothes not dry when removed from drum	4-18-M20
	Clothing tears or holes	4-18-M21
Fire Detection and Extinguishing System	Failure of all detectors to respond to test	4-19-M1
	Failure of all detectors in one compartment to respond to test	4-19-M2
Public Address System	No sound from reproducer when operating trigger switch	4-20-M1
	Click but no speech reproduction	4-20-M2
	Acoustic howl at all speech settings of volume control	4-20-M3
	Voice signals badly distorted	4-20-M4
	Voice reproduction weak	4-20-M5
Hot Water Heater	No hot water	4-21-M1
	Water temperature below setting at all time	4-21-M2
	Relief valve discharges continuously	4-21-M3
	Monitoring thermostat	4-21-M4
	Magnetic contactor	4-21-M5
Signaling Searchlight	No light	4-22-M1
	Weak beam	4-22-M2
	Shutter leaks light	4-22-M3
	Short lamp life	4-22-M4

4-5. GENERAL (Continued).

Table 4-1. Portable Fire Pump (P-250) Ignition Troubleshooting.

NOTE

Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump. Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Spark plug problems.
Step 1. Loose in cylinder head. Refer to paragraph 4-7.5.
Step 2. Loose connection. Refer to paragraph 4-7.5.
Step 3. Spark gap not properly adjusted. Refer to paragraph 4-7.5.
Step 4. Fouled. Refer to paragraph 4-7.5.
Step 5. Burned out. Refer to paragraph 4-7.5.
Step 6. Faulty gasket. Refer to paragraph 4-7.5.
2. Breaker points - magneto.
Step 1. Improperly adjusted. Refer to paragraph 4-7.5.
Step 2. Pitted or corroded. Refer to paragraph 4-7.5.

4-5. GENERAL (Continued).

Table 4-1. Portable Fire Pump (P-250) Ignition Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 3.	Broken or weak spring. Refer to paragraph 4-7.5.
Step 4.	Loose or corroded connection. Refer to paragraph 4-7.5.
Step 5.	Breaker arm binding on pivot post. Refer to paragraph 4-7.5.
Step 6.	Broken or worn cam follower. Refer to paragraph 4-7.5.
Step 7.	Broken or cracked cam. Refer to paragraph 4-7.5.
3. Condenser - magneto.	
Step 1.	Weak. Refer to paragraph 4-7.5.
Step 2.	Shorted. Refer to paragraph 4-7.5.
Step 3.	Improperly mounted. Refer to paragraph 4-7.5.
Step 4.	Faulty connections. Refer to paragraph 4-7.5.
4. Ignition coil - magneto.	
Step 1.	Weak. Refer to paragraph 4-7.5.

4-5. GENERAL (Continued).

Table 4-1. Portable Fire Pump (P-250) Ignition Troubleshooting (Continued).

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
	Step 2.	Shorted. Refer to paragraph 4-7.5.
	Step 3.	Improperly mounted. Refer to paragraph 4-7.5.
	Step 4.	Loose or faulty connection. Refer to paragraph 4-7.5.
5. Wiring - magneto.		
	Step 1.	Loose, corroded or otherwise faulty connections. Refer to paragraph 4-7.5.
	Step 2.	Broken wires (under insulation). Refer to paragraph 4-7.5.
	Step 3.	Oil soaked to cause leaks. Refer to paragraph 4-7.5.
	Step 4.	Broken insulation. Refer to paragraph 4-7.5.
6. Flywheel.		
		Loose on crankshaft. Refer to paragraph 4-7.5.

4-5. GENERAL (Continued).

Table 4-2. Portable Fire Pump (P-250) Carburetion Troubleshooting.

NOTE

Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump. Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Filter - fuel.	
Step 1.	Clogged filter element. Refer to paragraph 4-7.2.
Step 2.	Air leak due to faulty or misplaced filter bowl gasket. Refer to paragraph 4-7.2.
Step 3.	Faulty fuel line connections. Refer to paragraph 4-7.2.
2. Fuel tanks.	
Step 1.	Loose filler cap - faulty gasket. Refer to paragraph 4-7.4.
Step 2.	Faulty fuel line connectors. Refer to paragraph 4-7.4.
Step 3.	Clogged fuel line. Refer to paragraph 4-7.4.
Step 4.	Leaks in fuel and air lines. Refer to paragraph 4-7.4.
Step 5.	Pressure leaks in fuel tank. Refer to paragraph 4-7.4.

4-5. GENERAL (Continued).

Table 4-2. Portable Fire Pump (P-250) Carburetion Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 6.	Faulty diaphragm. Refer to paragraph 4-7.4.
Step 7.	Faulty acting check discs in pump mechanism. Refer to paragraph 4-7.4.
Step 8.	Clogged screen. Refer to paragraph 4-7.4.
Step 9.	Water in fuel tank. Refer to paragraph 4-7.4.
3. Carburetor.	
Step 1.	Improperly adjusted high and slow speed needles. Refer to paragraph 4-7.2.
Step 2.	Carburetor loosely mounted. Refer to paragraph 4-7.2.
Step 3.	Faulty fuel line connection. Refer to paragraph 4-7.2.
Step 4.	Shutter (butterfly) improperly adjusted. Refer to paragraph 4-7.2.
Step 5.	Faulty float action. Refer to paragraph 4-7.2.
Step 6.	Faulty float valve action. Refer to paragraph 4-7.2.
Step 7.	Damaged needle and float valve seats. Refer to paragraph 4-7.2.

4-5. GENERAL (Continued).

Table 4-2. Portable Fire Pump (P-250) Carburetion Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
4. Motor floods.	
Step 1.	Choke improperly adjusted. Adjust choke.
Step 2.	Dirt between float needle and seat. Clean carburetor.
Step 3.	Float level set too high. Adjust float level.
Step 4.	Float valve stem "GUMMED" so valve does not close. Clean with solvent (P-D-680, general cleaner) or replace assembly.
Step 5.	Damaged needle valve or seat. Replace valve, carburetor body or float bowl - whichever is necessary.
5. Motor starves.	
Step 1.	Water or dirt clogging passages, jets, or screens. Clean carburetor and filter.
Step 2.	Float valve corroded - gummed so that valve does not open properly. Clean or replace valve.
Step 3.	Float level set low. Adjust float level.
Step 4.	Float hinge and pin dirty, corroded, or worn. Clean float hinge and replace hinge pin.

4-5. GENERAL (Continued).

Table 4-2. Portable Fire Pump (P-250) Carburetion Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
6. Poor Carburetion.	
Step 1.	Jets, needle valves, fuel lines, and filter obstructed. Clean.
Step 2.	Loose mounting or defective gasket between carburetor and crankcase. Tighten bolts or replace gasket, if required.
Step 3.	Faulty or gummed check valve. Refer to paragraph 4-7.2.
Step 4.	Dirty under leaf valve. Clean leaf valve, refer to paragraph 4-7.2.
Step 5.	Broken or damaged leaf valve. Replace leaf, refer to paragraph 4-7.2.

4-5. GENERAL (Continued).

Table 4-3. Portable Fire Pump (P-250) Power Head - Troubleshooting.

NOTE

Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump. Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Power head.	
Step 1.	Faulty, broken or cracked leaf valves. Refer to paragraph 4-7.6.
Step 2.	Faulty or blown cylinder head gasket. Refer to paragraph 4-7.6.
Step 3.	Exhaust ports clogged with carbon. Refer to paragraph 4-7.6.
Step 4.	Piston ring grooves clogged with carbon. Refer to paragraph 4-7.6.
Step 5.	Cylinder walls scored. Refer to paragraph 4-7.6.
Step 6.	Piston crown eroded or carboned. Refer to paragraph 4-7.6.

4-5. GENERAL (Continued).

Table 4-4. Portable Fire Pump (P-250) Cooling System - Troubleshooting.

NOTE

Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump. Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Cooling system.	
Step 1.	Clogged water inlet. Refer to paragraph 4-7.10.
Step 2.	Blown or faulty cylinder head gasket to cause piston damage or failure to prime. Refer to paragraph 4-7-10.
Step 3.	Clogged water lines. Refer to paragraph 4-7-10.

4-5. GENERAL (Continued).

Table 4-1A. Portable Fire Pump (PE-250) - Hard Starting or Will Not Start.

NOTE

Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump. Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Lack of fuel.	
Step 1.	Empty fuel tank. Refill fuel tank (Mixture: 2 cans of BIA-TC-W oil and 6 gallons (22.7 liters) of 90 octane gasoline.
Step 2.	Fuel line pinched or disconnected. Check feed lines and repair or replace as required.
Step 3.	Plugged vent hole in fuel tank filler cap. Remove filler cap and clean vent hole.
Step 4.	Fuel line connector plugged. Remove connector and clean.
Step 5.	In pulse tube loose or pinched. Check impulse tube and repair or replace as required.
2. Poor or no ignition spark.	
Step 1.	Ignition not turned on. Turn ignition on.
Step 2.	Spark plugs wet or carbon fouled. Check spark plugs.
Step 3.	Spark plug electrode broken. Check spark plugs.

4-5. GENERAL (Continued).

Table 4-1A. Portable Fire Pump (PE-250) - Hard Starting or Will Not Start (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 4.	Spark plug cables loose or broken. Tighten cable connections or replace as necessary.
Step 5.	Faulty ignition system. Troubleshoot ignition system, refer to paragraph 4-7. 10A.
3. Engine flooded.	
	Dirt in carburetor. Replace, refer to paragraph 4-7.7A.
4. Carburetor lean, too much air.	
Step 1.	Dirt in idle fuel channels. Replace carburetor, refer to paragraph 4-7.7A.
Step 2.	Hole in diaphragm. Replace carburetor, refer to paragraph 4-7.7A.
Step 3.	Impulse line plugged. Remove line and clean.
Step 4.	Leaky manifold gaskets. Replace gaskets.
Step 5.	Leaky diaphragm check valve. Replace carburetor, refer to paragraph 4-7.7A.
Step 6.	Faulty fuel delivery system. Check fuel tank, lines and connector.

4-5. GENERAL (Continued).

Table 4-1A. Portable Fire Pump (PE-250) - Hard Starting or Will Not Start (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
5. Poor compression.	
Step 1.	Loose spark plug. Torque tighten spark plug to 20 ft-lb (27.lNm).
Step 2.	Cylinder head loose. Torque tighten cylinder head nuts to 16 ft-lb (21.7 Nm).
Step 3.	Blown cylinder head gasket. Replace gasket.
Step 4	Piston rings broken. Replace engine.
Step 5.	Piston and cylinder badly worn. Replace engine.

4-5. GENERAL (Continued).

Table 4-2A. Portable Fire Pump (PE-250) - Running Troubles

NOTE

Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump. Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Lacks power.
Step 1. Poor quality or improperly mixed fuel.
Empty fuel tank and refill.
Step 2. Water in fuel.
Empty fuel tank and refill.
Step 3. Exhaust port and/or muffler plugged.
Remove blockage from exhaust part and/or muffler.
Step 4. Improperly adjusted carburetor.
Adjust carburetor, refer to paragraph 4-7.7A.
Step 5. Ignition timing wrong.
Check ignition timing, refer to paragraph 4-7.10A.
Step 6. Poor compression.
Replace engine, refer to paragraph 4-7.10A.
2. Runs unevenly.
Step 1. Bad spark plug.
Replace.
Step 2. Wrong spark plug.
Replace with correct spark plug.

4-5. GENERAL (Continued).

Table 4-2A. Portable Fire Pump (PE-250) - Running Troubles (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 3.	Spark plug cable loose. Tighten spark plug cable connection.
Step 4.	Faulty ignition system. Troubleshoot ignition system, refer to paragraph 4-7. 10A.
3. Poor acceleration.	
Step 1.	Choke closed. Open choke.
Step 2.	Carburetor improperly adjusted. Adjust carburetor, refer to paragraph 4-7.7A.
Step 3.	Dirt in carburetor inlet needle valve. Replace carburetor, refer to paragraph 4-7.7A.
Step 4.	Exhaust port heavily coated with carbon. Remove carbon, refer to paragraph 4-7.10A.
4. No acceleration.	
Step 1.	Carburetor idle mixture to lean. Adjust carburetor, refer to paragraph 4-7.7A.
Step 2.	Carburetor diaphragm cover plate loose. Tighten screws securing cover plate.
Step 3.	Carburetor diaphragm gasket leaking. Replace carburetor, refer to paragraph 4-7.7A.

4-5. GENERAL (Continued).

Table 4-2A. Portable Fire Pump (PE-250) - Running Troubles (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 4.	Intake manifold loose or leaking.
	Replace gasket, refer to paragraph 4-7.10A.
Step 5.	Carburetor leaking or malfunctioning.
	Replace carburetor, refer to paragraph 4-7.7A.
5. Engine backfires through carburetor.	
Step 1.	Insufficient fuel.
	Check fuel tank and fuel lines.
Step 2.	Wrong spark plug.
	Check spark plug and/or replace.
Step 3.	Air leakage from faulty gasket or oil seals.
	Check gaskets and seals and replace as necessary.
6. Pings under heavy load, full throttle.	
Step 1.	Ignition timing too early.
	Check ignition timing, refer to paragraph 4-7.10A.
Step 2.	Wrong spark plug.
	Check spark plug and/or replace.
Step 3.	Carburetor main fuel.
	Adjust carburetor, refer to paragraph 4-7.7A.
Step 4.	Adjustment too lean.
	Adjust carburetor, refer to paragraph 4-7.7A.

4-5. GENERAL (Continued).

Table 4-2A. Portable Fire Pump (PE-250) - Running Troubles (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
7. Engine stops.	
Step 1.	Fuel tank empty.
	Refill fuel tank.
Step 2.	Ignition inadvertently turned off.
	Restart pump.
Step 3.	Exhaust port and/or muffler plugged.
	Remove blockage from exhaust port and/or muffler, refer to paragraph 4-7.6A.
Step 4.	Insufficient oil content in fuel.
	Empty fuel tank and refill.
Step 5.	Plugged fuel line.
	Check fuel lines and clean as required.
Step 6.	Impulse tube plugged, pinched or loose.
	Clean, tighten, or repair as required.
Step 7.	Carburetor inlet screen or passages clogged.
	Replace carburetor, refer to paragraph 4-7.7A.
Step 8.	Faulty pressure switch.
	Replace pressure switch.

4-5. GENERAL (Continued).

Table 4-3A. Portable Fire Pump (PE-250) - Pump Troubles

NOTE

Tables 4-1A thru 4-3A apply to the Prosser PE250 electric start portable fire pump. Tables 4-1 thru 4-4 apply the Gale Marine P-250 portable fire pump.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Pump primes slowly or not at all.
Step 1. Air leaking into the priming system or suction hose.
Determine location of air leakage - perform hydrostatic leakage test in paragraph 4-7Ac(2).
Step 2. Defective check valve in exhaust cooling line.
Remove and replace check valve.
Step 3. Defective priming switch.
Remove and replace priming switch.
2. Magnetic clutch slipping.
Step 1. Clutch slipping.
Refer to paragraph 4-7.5A.
Step 2. Defective magnetic clutch.
Remove and replace magnetic clutch, refer to paragraph 4-7.5A.
Step 3. Defective priming pump pulley.
Replace magnetic clutch, refer to paragraph 4-7.5A.
Step 4. Improper fan belt tension.
Check fan belt tension.
Step 5. Defective priming pump.
Repair or replace priming pump, refer to paragraph 4-7. 5A.

4-5. GENERAL (Continued).

Table 4-3A. Portable Fire Pump (PE-250) - Pump Troubles (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
3. Pump will not pump water or is not pumping enough.	
Step 1.	Clogged strainer-foot valve. Clean strainer-foot valve.
Step 2.	Foreign matter in suction hose. Clean suction hose.
Step 3.	Clogged discharge valve. Clean discharge valve, refer to paragraph 4-7.3A.
Step 4.	Foreign matter in discharge hose. Clean discharge hose.
Step 5.	Clogged pump impeller waterway. Clean impeller waterways, refer to paragraph 4-7.4A.
Step 6.	Engine lacks power. Refer to table 4-2A step 4.

4-5. GENERAL (Continued).

Table 4-5. Lube Oil Transfer Hand Pump - Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Pump does not deliver or delivers below rated capacity.
Step 1. Plugged condition.
Refer to paragraph 4-14.
Step 2. Air leak in suction line.
Refer to paragraph 4-14.
Step 3. Reverse direction of rotation.
Correct direction rotation.
Step 4. Excessive pressure or vacuum.
Check valves in line and see if there are obstructions in the lines. Check strainer if one is used.
Step 5. Worn vanes.
Replace all vanes.
Step 6. Suction terminal not submerged enough.
Check level in storage tank.
2. Evidence of excessive leakage.
Step 1. Worn packing.
Replace packing as required.
Step 2. Defective seal ring.
Replace seal ring as required.

4-5. GENERAL (Continued).

Table 4-5. Lube Oil Transfer Hand Pump - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
3.	Pump is excessively noisy and vibrates in operation; turns hard or binds.
Step 1.	Worn or damaged vanes. Disassemble and inspect vanes. Replace if necessary.
Step 2.	Damaged vane springs. Replace faulty vane springs.

4-5. GENERAL (Continued).

Table 4-6. Air Conditioner Abnormal Operating Pressures/Temperatures - Troubleshooting.

NOTE

Refer to paragraph 4-28 for air conditioning system maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. High head pressure.

Step 1. Air or noncondensable gas in system.

Purge through condenser purge valve.

Step 2. Condenser water inlet temperature too high.

Increase water flow by adjusting water regulating valve.

Step 3. Insufficient water flow through condenser:

a. Obstruction in water supply line, dirty strainer or partially closed stop valve.

b. Low water main supply pressure.

c. Water regulating valve set to open at too high head pressure.

Increase water flow through condenser:

a. Remove obstruction, clean strainer or open stop valve.

b. Restore pressure.

c. Adjust water regulating valve to maintain a discharge pressure of 90 to 125 psig (620.6 to 861.9 kPa).

Step 4. Condenser tubes clogged or water baffles corroded.

Clean tubes. Replace tubes or water heads, if necessary.

4-5. GENERAL (Continued).

Table 4-6. Air Conditioner Abnormal Operating Pressures/Temperatures - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 5.	Refrigerant overcharge. Condenser tubes submerged in liquid refrigerant. Remove excess refrigerant.
Step 6.	Compressor discharge stop valve partially closed. Open valve fully.
2. Low head pressure.	
Step 1.	Condenser water inlet temperature too low. Reduce water flow by adjusting water regulating valve.
Step 2.	Excessive water flow through condenser. Adjust water regulating valve.
Step 3.	Liquid refrigerant flooding back from evaporator. Defective or improperly set thermal expansion valve. Replace or adjust expansion valve to 80 - 10°F superheat. Examine fastening of thermal bulb. Close hand expansion valves tightly.
Step 4.	Compressor suction stop valve partially closed. Open valve fully.
Step 5.	Leaky compressor discharge valve. Test for leaks. If leaking, pump down, remove cylinder head, examine valve and replace if necessary.
Step 6.	Leaky compressor suction valves. Pump down, remove cylinder head, examine valve discs and valve seats. Replace if necessary.
Step 7.	Worn piston rings. Replace if worn.

4-5. GENERAL (Continued).

Table 4-6. Air Conditioner Abnormal Operating Pressures/Temperatures - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
3. High suction pressure.
Step 1. Overfeeding of thermal expansion valve.
Adjust expansion valve. Check installation of thermal bulb.
Step 2. Leaky compressor suction valves.
Pump down, remove cylinder head, examine valve discs and valve seats. Replace if necessary.
Step 3. Capacity control system unloading at too high suction pressure.
Adjust capacity control valve to begin unloading at a lower control point.
Step 4. Clogged bronze screen strainer in compressor suction manifold or temporary suction felt filter not removed after initial operation.
Pump down, remove and clean screen strainer. Remove felt filter after 50 hours of initial operation. If dirty, clean and replace for another 50 hours.
4. Low suction pressure.
Step 1. Insufficient refrigerant in system.
Add refrigerant.
Step 2. Excessive superheat.
Adjust thermal expansion valve(s) to 80 - 10°F superheat.
Step 3. Restricted liquid line or compressor suction strainer.
Pump down, remove and clean strainer.

4-5. GENERAL (Continued).

Table 4-6. Air Conditioner Abnormal Operating Pressures/Temperatures - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 4. Improper operation of solenoid valves. Check power supply to solenoids. Examine solenoid coil for burn-out. Check settings of solenoid thermostat. Repair or adjust as required.
Step 5. Capacity control system set to unload at too low suction pressure. Adjust capacity control valve to begin unloading at a higher control point.
5. Compressor crankcase cold (sweating or frosting).
Step 1. Liquid refrigerant returning to compressor: a. Open hand expansion valve. b. Refrigerant overcharge. c. Defective or improperly adjusted thermal expansion valve. Stop liquid refrigerant return to compressor: a. Close tightly. b. Remove excess refrigerant. c. Replace or adjust expansion valve to 80 -10°F superheat. Examine fastening of thermal bulb, tighten if loose.
Step 2. Too much oil in circulation. Remove excess oil. Oil level to be no higher than half-way up on bull's-eye sight glass.

4-5. GENERAL (Continued).

Table 4-6. Air Conditioner Abnormal Operating Pressures/Temperatures - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
6. High crankcase temperature (exceeds 1050-180°F at seal housing).	
Step 1. Clogged liquid line strainer.	
Pump down. Remove and clean strainer.	
Step 2. Excessive superheat.	
Reset thermal expansion valve(s) to 8° -10° F superheat.	
Step 3. Leaking compressor suction or discharge valves.	
Pump down, remove cylinder heads and examine suction and discharge valves. Replace if necessary.	
Step 4. Discharge temperature exceeds 240° F.	
By-pass heat interchanger.	

4-5. GENERAL (Continued).

Table 4-7. Air Conditioner Erratic Operation Troubleshooting.

NOTE

Refer to paragraphs 4-28 and 4-29 for air conditioning and compressor maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Compressor will not start.

Step 1. Power off.

Check main switch and fuses. Throw in switch or replace blown fuses.

Step 2. Loose electrical connections or faulty wiring.

Tighten connections. Check wiring and rewire, if necessary.

Step 3. Dirty control switch contacts.

Clean contacts on all control switches.

Step 4. Low voltage, relay tripped.

Reset relay. Correct cause of low voltage.

Step 5. High pressure control switch contacts opened.

Find and eliminate cause of high pressure cut-out before restarting. (If provided, press reset button on dual pressurestat.)

Step 6. Oil safety switch tripped.

Find and eliminate cause of low oil pressure. If provided, press oil switch reset button.)

Step 7. Solenoid thermostat set too high.

Reset.

4-5. GENERAL (Continued).

Table 4-7. Air Conditioner Erratic Operation Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 8. Solenoid valve will not open preventing low pressure control switch from closing. Turn on electric power to solenoid valve. Examine solenoid coil. If burned out or defective replace.
Step 9. Lack of refrigerant. With little or no refrigerant, suction pressure will be too low and low pressure control switch will not close. Recharge system and repair any leaks.
Step 10. Condenser water pressure failure switch opened. (If provided). Provide adequate condenser water flow and pressure.
2. Compressor short cycles or high pressure cut-out.
Step 1. Insufficient water flow through condenser or clogged condenser. Open any valves in water supply line or adjust water regulating valve to increase flow. Check water strainer and condenser tubes. Clean as required.
Step 2. High pressure control switch set to cut-out at too low head pressure. Reset high pressure control switch to cut-out at not less than 175 psig.
Step 3. Refrigerant overcharge. Too much refrigerant will reduce condenser capacity and cause high head pressure. Remove excess refrigerant.
Step 4. Air or noncondensable gas in system. Purge through condenser purge valve.

4-5. GENERAL (Continued).

Table 4-7. Air Conditioner Erratic Operation Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 5. Compressor discharge stop valve partially closed. Open valve fully.
3. Compressor short cycles or low pressure cut-out.
Step 1. Air or water flow through evaporator(s) restricted or stopped. Frosted coils or plugged or dirty tubes. Remove restriction to restore air or water flow. Clean coils or tubes. Defrost if iced.
Step 2. Liquid, suction or expansion valve screens plugged. Pump down, remove and clean screens.
Step 3. Compressor discharge valve leaks slightly. Test valve for leaks. If leaking, pump down, remove cylinder head, examine valve and replace if necessary.
Step 4. Relief valve leaks slightly. Test valve and replace if necessary.
Step 5. Thermal bulb on expansion valve has lost its charge. Detach thermal bulb from suction line and hold in palm of one hand. Grip suction line with other hand. If flooding through is observed, bulb has not lost charge. If there is no flooding through, repair or replace with new expansion valve or power element.
Step 6. Capacity control system set to unload at too low a suction pressure. Adjust capacity control valve to begin unloading at a higher control point.

4-5. GENERAL (Continued).

Table 4-7. Air Conditioner Erratic Operation Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 7.	Low pressure control switch set too high or defective. Reset low pressure control or repair or replace, if defective.
Step 8.	Internal leak in heat interchanger. Test for leaks and replace, if necessary.
4. Compressor runs continuously.	
Step 1.	Shortage of refrigerant. Test for refrigerant undercharge. Add refrigerant. Test and repair any leaks.
Step 2.	Compressor discharge valve leaks badly. Test valve. If leaking, pump down, remove cylinder head, and repair or replace valve.
Step 3.	Solenoid valve at evaporator does not close tightly. Pump down and check solenoid. If pin or seat are worn, replace parts or valve.
Step 4.	Leaking piston rings or worn cylinder sleeve. Replace worn rings or cylinder sleeve.

4-5. GENERAL (Continued).

Table 4-8. Air Conditioner Lubrication Troubles
Troubleshooting.

NOTE

Refer to paragraphs 4-28 and 4-29 for air conditioning and compressor maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Oil leaves compressor crankcase.

   Step 1. Too much refrigerant flooding back to compressor.

   Adjust thermal expansion valve(s) to 8° -10° F superheat to avoid flooding.

   Step 2. Leaking piston rings or worn cylinder sleeve.

   Replace worn rings or cylinder sleeve.

2. Oil does not retrun to crankcase.

   Step 1. Thermal expansion valve not flooding coil. Oil trapped in coils.

   Adjust to flood coil. Refrigerant liquid should extend to midpoint of last coil bank of circuit.

   Step 2. Oil return check valve in compressor stuck closed.

   Pump down, and remove check valve. Clean, repair, or replace.

3. Low oil pressure, or no oil pressure.

   Step 1. Insufficient oil pressure.

   Oil level should be half-way up on the bull's-eye sightglass. Minimum level is one-quarter up on glass. Add Carrier No. PP36-1 oil as required.

   Step 2. Faulty oil gage.

   Check and replace gage if faulty.

   Step 3. Oil filter screen in bottom of crankcase clogged with dirt.

   Pump down, remove screen, clean and reinstall.

4-5. GENERAL (Continued).

Table 4-8. Air Conditioner Lubrication Troubles Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 4.	Oil pump worn or defective or rotating in wrong direction.
	Check oil pump for proper rotation. If rotation is correct, disassemble oil pump and check for broken oil pump tang or other worn or defective parts. Because of accuracy required in positioning pump rotor, stator, and bushing, it is advisable to replace complete pump and bearing head assembly when oil pump gives trouble.
Step 5.	Faulty oil piping or clogged oil line.
	Check oil piping to oil pressure switch and gauge.
	Check oil piping to compressor crankcase. Clean, repair, or replace piping.
Step 6.	Defective oil pressure regulator (relief valve).
	Oil pressure regulator on side of crankcase is non-adjustable. Remove, check and replace if required.
Step 7.	Worn compressor bearings.
	Replace worn bearings.
4. Compressor cuts out on low oil pressure.	
Step 1.	Low oil pressure.
	Restore normal oil pressure.
Step 2.	Oil pressure safety switch incorrectly set or defective.
	Check switch cut-in and cut-out settings. Reset or replace switch.

4-5. GENERAL (Continued).

Table 4-9. Air Conditioner System Noises - Troubleshooting.

NOTE

Refer to paragraph 4-28 and 4-29 for air conditioner and compressor maintenance instructions.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. Compressor noises.

Step 1. Loose hold-down bolts.

Tighten bolts.

Step 2. Improperly aligned, loose or worn compressor drive:

a. Direct drive. Loose or misaligned coupling.

b. Direct drive. Loose coupling flange on compressor or motor shaft.

c. Belt drive. Loose, misaligned or worn belts.

d. Belt drive. Loose flywheel.
e. Belt drive. Loose motor pulley.

Realign, tighten or replace worn parts:

a. Realign coupling or tighten bolts.

b. Tighten setscrews. Replace key if worn.

c. Realign or adjust belt tension. Belt slack should be at the top. Replace belts if worn.

d. Check flywheel nut, washer and key. Tighten or replace if worn.

Step 3. Insufficient clearance between piston and valve plate. (A sharp, medium pitched metallic hammer is heard as a cylinder is unloaded.) Replace over-tolerance parts.

Step 4. Motor or compressor bearings worn.

Replace worn bearings.

4-5. GENERAL (Continued).

Table 4-9. Air Conditioner System Noises Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 5. Slugging due to floodback of refrigerant:
a. Improperly set thermal expansion valve.
b. Expansion valve remote bulb loose or incorrectly placed.
c. Suction lines not looped.
Eliminate liquid refrigerant return:
a. Adjust thermal expansion valve.
b. Check installation and location of thermal bulb. Correct if necessary.
c. Loop suction lines to prevent floodback on off cycle.
Step 6. Hydraulic knock due to excess oil in circulation.
Remove excess oil. Check for floodback.
Step 7. Noise level varies with unloading due to defective valve lifter mechanism.
Refer to capacity control troubles.
Step 8 Wear of parts such as piston pins, connecting rod bearings, etc.
Replace worn parts.
Step 9. Vibration of disc in discharge stop valve causes rattle or howl.
Backseat valve fully.
2. Pipe rattles.
Step 1. Improper support or isolation of piping.
Check piping. Support firmly with suitable hangers.

4-5. GENERAL (Continued).

Table 4-9. Air Conditioner System Noises Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

Step 2. Loose pipe connections.

Check pipe connections. Tighten as required.

3. Hissing.

Step 1. Insufficient refrigerant flow through thermal expansion valves.

Adjust expansion valves and check refrigerant charge. Add refrigerant, if required.

Step 2. Clogged liquid line strainer.

Pump down, remove and clean strainer.

4-5. GENERAL (Continued).

Table 4-10. Air Conditioner Capacity Control Troubles Troubleshooting.

NOTE

Refer to paragraphs 4-28 and 4-29 for air conditioning and compressor maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Compressor will not unload.

   Step 1. Capacity control valve inoperative.

   Repair or replace.

   Step 2. External adjusting stem damage.

   Remove stem housing and inspect. Replace if necessary.

2. Compressor will not load.

   Step 1. Low oil pressure.

   Check oil pressure with capacity control valve adjusting stem turned all the way out. Oil pressure should be 45 - 55 psi above crankcase pressure.

   Step 2. Capacity control valve stuck open.

   If control oil pressure is low for all adjustment stem positions, repair or replace control valve.

   Step 3. Control valve adjusting stem traveling nut out of guide or stem broken.

   Remove stem housing and inspect. Engage nut or replace stem.

   Step 4. Control oil strainer blocked.

   If control oil pressure cannot be raised by adjusting control valve, clean or replace strainer.

4-5. GENERAL (Continued).

Table 4-10. Air Conditioner Capacity Control Troubles Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 5. Bellows of control valve leaking refrigerant into the atmosphere. Leak test valve. Replace valve if bellows leak.
Step 6. Foaming in crankcase due to oil dilution. Examine thermal expansion valves and piping for cause of flooding.
3. Any one cylinder will not unload.
Step 1. Unloader power element stuck. Repair or replace.
Step 2. Plugged oil pressure line to power element. Clean out line.
Step 3. Suction valve lifter mechanism defective. Insufficient valve lifter pin or spring lift. Remove cylinder heads and valve plates. Valve lifter springs should project at least .33 inch above valve seats for 5F compressors. Remove cylinder sleeve and replace lifter parts, if defective.
4. Any one cylinder will not load.
Step 1. Unloader power element stuck. Repair or replace.
Step 2. Broken oil pressure line to power element. Low control oil pressure, with a drop in pressure at one step of unloading, indicates a broken oil line to a power element. Repair line.
Step 3. Plugged oil pressure line to power element. Clean out line.

4-5. GENERAL (Continued).

Table 4-10. Air Conditioner Capacity Control Troubles Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 4. Valve lifter mechanism defective. Lifter pins and springs do not retract below valve seats. Remove cylinder heads and valve plates. Secure cylinder sleeves. Operate compressor and by adjusting control valve check that lifter pins and springs retract below valve seats. Remove cylinder sleeve and replace lifter parts, if defective. Remove sleeve, piston, and connecting rod, and replace unloader power element, if defective.
5. Compressor noise varying with unloading.
Step 1. Valve lifter pins stuck. Check and replace stuck lifter pins.
Step 2. Unloader power element piston stuck. Repair or replace.
Step 3. Misaligned unloader power element fork. Realign or replace.
Step 4. Leaking oil pressure line at connection to unloader power element. Repair leaking line.
Step 5. Insufficient oil pressure. Increased and steady valve clatter when cylinder is unloaded. Clean control oil strainer. Check and remove any other cause of low oil pressure.
6. Rapid unloader cycling.
Step 1. Partially plugged control oil strainer. Clean or replace strainer.
Step 2. Low oil pressure (less than 45 psi above suction pressure). Clean control oil strainer. Check and remove any other cause of low oil pressure.

4-5. GENERAL (Continued).

Table 4-11. Air Conditioner Cooling Coil Troubles Troubleshooting.

NOTE

Refer to paragraph 4-28 for air conditioning maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Loud hissing at thermal expansion valve.

   Step 1. Insufficient refrigerant in system.

   Add refrigerant as required.

   Step 2. Clogged liquid line strainer.

   Clean strainer screen.

2. Partial frosting of coil - failure to cool.

   Step 1. Insufficient refrigerant in system.

   Add refrigerant as required.

   Step 2. Restriction in liquid line or clogged liquid line strainer screen.

   Pump down and clean out line or strainer screen.

   Step 3. Suction pressure regulator set too high.

   Reset regulator to maintain refrigerant in coils at 20°F less than compartment temperature for bare pipe coils and 15°F less for finned coils.

   Step 4. Solenoid valve partially clogged.

   Pump down and clean solenoid.

   Step 5. Thermal expansion valve improperly set.

   Reset expansion valve to 8 - 10° superheat.

3. No frosting of coil - failure to cool.

   Step 1. Solenoid valve clogged.

   Pump down and clean solenoid.

4-5. GENERAL (Continued).

Table 4-11. Air Conditioner Cooling Coil Troubles
Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 2. Solenoid coil burned out. Check to see if coil responds to current. If not, replace coil.
Step 3. Solenoid thermostat set too high. Reset thermostat to maintain desired temperature.
Step 4. Compressor not running. Determine cause of compressor shutdown. Make any adjustments required and restart.
Step 5. Thermal expansion valve improperly set. Reset expansion valve to 8 - 10° superheat.
Step 6. Thermal expansion valve remote bulb has lost its charge or improperly installed or insulated. Check installation and insulation of remote bulb. Visibly check bulb charge.
Step 7. Thermal expansion valve orifice clogged. Clean valve orifice with compressed air.
Step 8. Stop valve in liquid line closed. Open valve.
4. Complete frosting of coil - failure to cool.
Step 1. Fan not running. Check switches, wiring, fuses, and thermostat. Correct any faulty condition.

4-5. GENERAL (Continued).

Table 4-11. Air Conditioner Cooling Coil Troubles
Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 2.	Insufficient air flow.
	Check dampers, fan speed, etc. On bare pipe coils, check for proper air circulation.
Step 3.	Loose fan belts.
	Adjust belt tension refer to paragraph 4-29.
Step 4.	Excessive frost on coils.
	Defrost coils.
5. Too much cooling.	
Step 1.	Solenoid thermostat set too low.
	Reset thermostat to maintain desired temperature.
Step 2.	Local overcooling due to improper outlet adjustment on fan units.
	Adjust air outlet deflector.

4-5. GENERAL (Continued).

Table 4-12. Drinking Fountain Troubleshooting.

NOTE

Refer to paragraph 4-38 for drinking fountain maintenance.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

WARNING

Unplug the service cord before attempting any adjustments or repairs.

1. Water leak.

   Step 1. Condensation around cold water or refrigerant line.

   Insulate line to eliminate sweating.

   Step 2. Defective tube or connection.

   Repair or replace.

   Step 3. Defective cooling tank.

   Replace drinking fountain.

2. Water not cold or not cold enough.

   Step 1. Excessive usage.

   Restrict usage.

   Step 2. Dirty condenser.

   Thoroughly clean condenser.

   Step 3. Cold control not set cold enough.

   Adjust cold control CW to colder setting.

   Step 4. Defective electrical system.

   Troubleshoot electrical system.

4-5. GENERAL (Continued).

Table 4-12. Drinking Fountain Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
3. Little or no water from bubbler valve.
Step 1. Low or no supply water pressure, pressure should be 20 - 125 psi (137.9 - 861.9 kPa). Restore supply water pressure.
Step 2. Stoppage in the bubbler valve. Disassemble, inspect and repair bubbler valve.
Step 3. Cold water line or cooling tank frozen (compressor runs continuously). Replace cold control. Check that cold control bulb is fully and firmly installed into thermowell.
4. Bubbler valve stream to high or too low.
Step 1. Bubbler valve flow regulator improperly set. Adjust bubbler valve flow regulator.
Step 2. Improper supply pressure. Check supply pressure - 20 - 125 psi (137.9 -861.9 kPa).
5. Compressor runs continuously.
Step 1. Improper usage. Check for and correct excessive usage or hot supply water.
Step 2. Cold control set too cold. Adjust cold control CCW to lower setting.

4-5. GENERAL (Continued).

Table 4-12. Drinking Fountain - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

Step 3. Cold control bulb loose or out of contact with cooling tank.

Check that bulb is fully and firmly installed into thermowell.

Step 4. Defective cold control.

Repair or replace.

Step 5. Dirty condenser.

Thoroughly clean condenser.

Step 6. Defective fan motor.

Repair or replace.

Step 7. Defective starting relay.

Repair or replace.

6. Compressor inoperative.

Step 1. Defective overload protector.

Repair or replace.

Step 2. Defective starting relay.

Repair or replace.

Step 3. Defective cold control.

Repair or replace.

Step 4. Defective compressor or refrigeration system.

Contact Direct Support Maintenance.

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting.

NOTE

Refer to paragraph 4-39 for milk dispenser maintenance instructions.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. Compressor will not start - no hum.

Step 1. Power cord disconnected.

Plug in cord.

Step 2. Temperature control in OFF position.

Reposition control knob.

Step 3. Blown power source fuse or tripped breaker.

Replace fuse or reset breaker.

Step 4. Overload protector tripped.

Wait five minutes and reset again.

Step 5. Defective wiring.

Repair or replace.

Step 6. Defective temperature control.

Replace.

Step 7. Defective overload protector.

Replace.

2. Compressor will not start - hums but cycles on overload.

Step 1. Low voltage.

Power source must be 110 vac.

Step 2. Unit improperly wired.

Rewire.

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 3. High head pressure. See Head Pressure Too High (see malfunction 8).
Step 4. Relay contacts not closing. Replace relay.
Step 5. Compressor defective. Replace.
3. Compressor starts but starting winding remains in circuit.
Step 1. Low voltage. Power source must be 110 vac.
Step 2. Unit improperly wired. Rewire.
Step 3. High head pressure. See Head Pressure Too High (see manfunction 8).
Step 4. Defective relay. Replace.
Step 5. Defective compressor. Replace.
4. Compressor starts and runs but cycles on overload.
Step 1. Low voltage. Power source must be 110 vac.
Step 2. High head pressure. See Head Pressure Too High (see malfunction 8).

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 3. Defective overload protector. Replace.
5. Compressor tries to start when control closes but cuts out on overload, finally starts after several attempts.
Step 1. Low voltage. Power source must be 110 vac.
Step 2. Temperature control differential too close. Replace temperature control.
Step 3. Temperature control sensing element not in tight contact with evaporator. Tighten.
Step 4. Relay contacts defective. Replace relay.
Step 5. Restriction, air, or noncondensable gases in refrigeration system. Evacuate and recharge.
6. Compressor starts but immediately cuts out on overload.
Step 1. Low voltage. Power source must be 110 vac.
Step 2. Relay contacts welded together. Replace relay.

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
7. Relay burns out.
Step 1. Incorrect voltage.
Power source must be 110 vac.
Step 2. Compressor short-cycling.
See Compressor Troubles (see malfunctions 1 thru 6).
Step 3. Incorrect relay.
Replace.
8. Head pressure too high.
Step 1. Air passage at air duct panel restricted.
Remove restriction.
Step 2. Restriction, air or noncondensable gases in refrigeration system.
Evacuate and recharge.
9. Head pressure too low.
Step 1. Dispenser location too cold.
Move unit to warmer location.
Step 2. Leak in refrigeration system.
Detect and seal.
Step 3. Insufficient refrigerant charge.
Add refrigerant.

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
10. Compressor running cycle too long or operating continuously.
Step 1. Leak in refrigeration system.
Detect and seal.
Step 2. Temperature control contacts stuck.
Replace temperature control.
Step 3. Insufficient refrigerant charge.
Add refrigerant.
Step 4. Restriction, air or noncondensable gases in refrigeration system.
Evacuate and recharge.
Step 5. Defective compressor.
Replace.
11. Milk can compartment temperature too high.
Step 1. Temperature control setting too high.
Reduce setting.
Step 2. Leak in refrigeration system.
Detect and seal.
Step 3. Insufficient refrigerant charge.
Add refrigerant.
Step 4. Restriction, air or noncondensable gases in refrigeration system.
Evacuate and recharge.
Step 5. Defective compressor.
Replace.

4-5. GENERAL (Continued).

Table 4-13. Milk Dispenser Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
12. Noisy unit.
Step 1. Tube rattle.
Stop metal-to-metal contact.
Step 2. Loose compressor or condenser mountings.
Tighten.
Step 3. Defective compressor.
Replace.
13. Evaporator freezes but defrosts while compressor is running.
Moisture in refrigeration system.
Evacuate and recharge.
14. Suction line sweating or frosting.
Overcharge of refrigerant
Bleed system.

4-5. GENERAL (Continued).

Table 4-14. Waste Collection System - Commode - Troubleshooting

NOTE

Refer to paragraph 4-15 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Improper volume of flush water and/or inadequate bowl rinsing.

   Operate and observe flush water volume and bowl rinsing.

   a. Check that main water supply valve is open and that the water supply pressure is 30 psig (206.8 kPa) minimum.

   b. Disassemble and clean mineral deposits from flush valve.

   c. Adjust valve flush volume to 1 pint (.473 liter) by removing cap at top of valve and using screwdriver in slot of float rod; clockwise rotation reduces flow, counterclockwise rotation increases flow.

   d. Clean out orifices in flush pipe (located under bowl ring) with small wire.

2. Leakage of flapper valve.

   Observe level of flush water to determine leakage.

   a. Clean bowl, rubber stopper, and support cup with soft bristle brush.

   b. Check and adjust pedal linkage and spring force.

   c. Adjust and tighten rubber stopper, if possible, without removing commode.

   d. Remove commode and adjust or replace rubber stopper check for leakage before replacing commode.

4-5. GENERAL (Continued).

Table 4-14. Waste Collection System - Commode - Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
3. Flapper valve at bottom of bowl does not open sufficiently to evacuate wastes.
Observe waste evacuation.
Remove commode and adjust arm and cup flapper valve; check for leakage before replacing commode.
4. Stopper does not close quickly.
Observe operation of stopper.
Check and adjust pedal linkage and check spring force. Lubricate linkage if necessary.

4-5. GENERAL (Continued).

Table 4-15. Waste Collection System - Urinal - Troubleshooting

NOTE

Refer to paragraph 4-15 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Improper volume of flush water. Observe proper volume of flush water. Refer to maintenance regarding servicing of flush valve.

4-5. GENERAL (Continued).

Table 4-16. Macerator Pump - Troubleshooting

NOTE

Refer to paragraph 4-15 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Pump runs but does not deliver capacity. Observe operation of pump. a. If motor is 3 phase impeller rotation may be wrong. Interchange any two line leads to motor. b. Impeller or grinder ring may be clogged with solids. Remove pump from line and check for clogging. c. Discharge head may be too high. Check vertical elevation from sump level to point of discharge. A pressure gage attached to discharge line outside sump will indicate line pressure. Pounds pressure times 2.31 = feet head. Check performance table for maximum pump head.
2. Pump does not operate. Observe operation of pump. a. Check fused disconnect and verify that power is coming into the starter box. b. Check performance of the time control circuitry. c. Check reset on starter box. d. On single phase pumps, check start capacitors in starter box. e. Remove pump from line and check for clogged pump volute or jammed impeller.

4-5. GENERAL (Continued).

Table 4-16. Macerator Pump - Troubleshooting (Continued)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
3. Pump is noisy with high pitched sining noise.
Listen while pump is operated.
a. The impeller in grinder unit may not be properly adjusted causing impeller to rub against cutter Ring.
b. Noise may be caused by defective ball bearing. If grinder unit is free and noise still persists check bearing in motor.

4-5. GENERAL (Continued).

Table 4-17. Macerator Pump - Electronic Controls - Troubleshooting.

NOTE

Refer to paragraph 4-15 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Pump does not operate when commode or urinal is flushed.

   Observe operation of pump.

   a. Check 115 VAC supply power coming into the Timing Control Box by measuring the voltage across TB-1 and TB-2. If there is no voltage check power supply.

   b. Push "RESET" button on motor starter and recheck operation.

   c. Inside the Timing Circuit Control Box, measure the voltage across TB-1 and TB-3. At the same time have someone flush the commode or urinal. Voltage should be 115 VAC whenever the commode or urinal is flushed. If no voltage is detected check wiring from microswitch or flow switch to TB-2 and TB-3. If wiring is OK. readjust or replace microswitch or check water flow through flow switch. Replace flow switch.

   d. Check for faulty time delay relay TD, replace if necessary.

2. Pump operates only when microswitch is depressed or water is running through flow switch.

   Operate pump by depressing microswitch or by flushing commode or urinal.

   Control relay is not holding ocntacts CR. Replace control relay.

3. Pump does not turn off after 10 seconds of operation.

   Time duration of pump operation.

   Time delay relay is faulty or the timing resistor is not 200 K ohms. Replace resistor and/or replace time delay relay.

4-5. GENERAL (Continued).

Table 4-17. Macerator Pump - Electronic Controls - Troubleshooting.
(Continued)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
4. Motor starter activates, pump hums but does not pump.
Observe operation of pump.
Refer to table 4-16 for the pump. Pump is probably jammed. On 115 VAC pump check the starting and running capacitors inside the motor starter box.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting.

NOTE

Refer to paragraph 4-41 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. No product operation.
Lack of power.
Check circuit breaker.
Check for proper service cord connections.
2. No operation - washer unit only.
Step 1. Lid switch.
Check operation of lid switch and continuity through the switch.
Check switch contact arm (lid hinge pin) for to activate switch when closed.
Step 2. Timer.
Check operation of timer knob and dial assembly (push-pull switch).
Step 3. Motor overload protector.
Protector should automatically reset after several minutes. Check for cause of overload, bind in mechanism or clutch. If not, replace motor.
Step 4. Washer motor capacitor.
Check motor capacitor.
3. Washer vibration during spin or agitation.
Step 1. Unbalanced load product not properly leveled.
Readjust load and re-spin.
Re-level product side to side and front to back.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 2. Snubber operation faulty - water or foreign matter on snubber surfaces. Dry and clean snubbing surfaces and snubber ring. If oil or grease is present, clean with a high grade of lighter fluid. Locate source of water or foreign matter and correct.
4. Motor will not operate.
Step 1. Motor leads off, loose, broken in connector or inside motor. Disconnect plug connector at motor.
Step 2. Defective motor. Disconnect plug connector at motor.
Step 3. Timer switch contacts inoperative. See timer test.
5. Won't agitate - motor operating.
Step 1. Driver slipping on motor shaft. Check for driver secure on motor shaft. Tighten set screws as necessary.
Step 2. Belts not in tension, off. Check primary and secondary belts for tension. Adjust if necessary.
Step 3. Pulley binding - not rotating. Check pulleys for rotation. Repair or replace.
Step 4. Drive brace or cable set off or out of place. Check drive brace and cable set for reversing motion and tension. Adjust if necessary.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
6. Noisy operation.
Step 1. Knocking sound - driver brace.
Check cable set for proper adjustment. Tighten as necessary.
Step 2. Knocking sound - hose clamp.
Hose clamps out of position, vibrating against mechanism plate. Reposition as necessary.
Step 3. Slapping sound - water level safety switch line hitting outer tub.
Check pressure tube. Sound isolator in place and tension on tube. Adjust as necessary.
Step 4. No brake or long brake time slippage in agitate clutch.
Agitate clutch adjustment.
7. Insufficient water level.
Step 1. Timer dial not properly aligned.
Realign timer dial.
Step 2. Low water pressure.
Check flowing water pressure to be at least 20 psi (137.9 kP) at product. Have plumbing corrections made as necessary.
Step 3. Restriction in water system.
Check for kinked fill hoses, dirty inlet screws, damaged flow washer or torn diaphragm in water valve. Make necessary correction or replacement.
Step 4. Other water usage during fill period.
Where water supply is limited, caution user against other water usage during wash operation.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

8. Overfill.

Step 1. Pressure too great in water supply system.

Check flowing water pressure at product to be below 120 psi (825.5 kPa). Reduce flowing pressure by partially closing supply faucets.

Step 2. Damaged or improper flow washer.

Replace flow washer as necessary.

9. Water leaking onto deck.

Step 1. Overfill - water valve or timer malfunction and water level safety switch inoperative.

Check water level safety switch for operation with outer tub 1/3 to 1/2 full. Check fill period for proper timer sequencing and water valve operation. With continuous fill, disconnect electric supply and observe the action. If water fill stops, trouble is indicated in timer or electrical connections. If water fill continues, trouble is indicated in water valve. Repair or replace as necessary.

Step 2. Water thrown out over top.

Check spin acceleration. If spin clutch torque is too high, water can be spun out over top of tub.

Step 3. Leak at seal between outer tub and sub-top.

Remove sub-top and adjust seal between sub-top and outer tub.

Step 4. Leak at pump seal or tub shaft seal.

Check for source of water and reinstall new seal as necessary.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 5.	Fill hose out of place. Check placement of fill hose from water valve through dryer base pan and secured in clamp. Slots should be facing tub. Adjust or replace as necessary.
10. Wash water not hot enough, controls set for hot wash.	
Step 1.	Water from water heater not hot enough or water heater not of sufficient capacity. Check the temperature of the water at the water heater. Best washing results are obtained with water temperatures at 140° to 160° F (60° C). If the water temperature at the heater is below 140° , inform the user. If the water temperature at the heater is correct, check for exceptionally long run of water pipe between heater and washer.
Step 2.	Cold water leaking through the water valve. Make necessary repairs to the water valve.
Step 3.	Inoperative water temperature selector switch. Check switch continuity. Replace the faulty switch if necessary.
Step 4.	Hot and cold inlet hose reversed. Connect hose to water valve correctly.
Step 5.	Water temperature selector switch or water valve solenoids wired incorrectly. Check wiring to be as shown in wiring diagram.
Step 6.	Screen in the hot water hose connection of the water valve stopped up. Clean the valve inlet screens.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 7. Faulty water temperature selector switch. Check the selector switch and replace as necessary.
Step 8. Inoperative hot water solenoid on the water valve. Replace the solenoid.
Step 9. Dirty or damaged plunger or diaphragm on the hot side of the water valve. Clean or replace the diaphragm and plunger.
11. Clothing too wet after final spin.
Step 1. Drain is restricted causing outer tub to fill sufficiently to restrict speed of agi-tub. Correct cause of drain restriction. Check pump cover gasket to be properly in place.
Step 2. Improper spin speed. Check as for NO SPIN.
12. Odor in washer unit.
Step 1. Soap scum accumulation on walls and bottom of outer tub from use of soap in hard water. Remove sub-top from outer tub and use stiff brush to remove scum. Dissolve one pound of Calgon during FILL period. Permit Calgon water to spin into outer tub and stop the washer. Allow to sit for one hour, then place washer into final rinse and permit washer to finish complete cycle.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
13. Torn clothing.
Step 1. Improper use of bleach.
Review with user the proper use of bleach in the washer.
Step 2. Sharp projection in polypropylene Agi-tub.
Check surface of Agi-tub with nylon stocking over hand. A sharp object may have cut agi-tub resulting in a projection on surface. Smooth off any sharp projections and re-check with stocking.
14. No operation - dryer unit only.
Step 1. Dryer motor capacitor.
Check capacitor.
Step 2. Timer.
Check dryer timer operation and continuity.
Correct or replace.
Step 3. Door switch.
Check dryer door switch operation and continuity.
Correct or replace.
Step 4 Safety thermal fuse.
Check thermal fuse for continuity. Replace if necessary. If fuse is open check heat control thermostat for permanently closed contacts.
Step 5. Motor overload protector.
Protector should automatically reset after several minutes. Check for cause of overload. If not, replace motor.
Step 6. Dryer motor.
Check motor.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
15. Dryer drum will not rotate - motor operating.
Step 1. Drive pulley loose on motor shaft.
Check for driver secure on motor shaft. Tighten as necessary.
Step 2. Belt loose - improper tension.
Check for proper alignment of belt and idler pulley.
Check idler pulley spring and arm. Replace spring, if unable to adjust.
16. Drum speed too fast.
Belt engagement with drive pulley not correct.
Check belt to be sure the ribs are against drum and that ribs fit into grooves of motor driver.
17. Drum speed too slow - noisy or vibrating.
Step 1. Belt slippage.
Check belt for proper tension supplied by idler arm and drive pulley.
Step 2. Felt seals out of place.
Check felt seals on each rim of drum for proper position.
Step 3. Drum support wheels binding.
Check for proper rotation of wheels and lubricate or replace if necessary.
Step 4. Motor or motor mount loose.
Check for secure positioning of motor mount and motor.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 5. Timer does not advance.
No current to timer motor terminal when contact should be closed per timer sequence chart. Check timer motor for operation or check ohms resistance of motor.
18. No heat - drum rotates.
Step 1. Inoperative heating element.
Check OHMS resistance and replace if necessary.
Step 2. Inoperative timer.
Check continuity through timer and replace if necessary.
Step 3. Fabric selector.
Check fabric selector. If set on NO HEAT, advise user.
Step 4. Heat control thermostat.
Check continuity through thermostat per wiring diagram in paragraph 4-41 and operating temperature limits. If improper, replace. An open thermal fuse usually indicates permanently closed contacts in the control thermostat.
Step 5. Motor speed switch.
The motor speed switch must be closed to provide a complete circuit for the heat source. Use a 240 volt test light or voltmeter to test for a closed switch circuit with the motor in operation. R to R motor terminals with the harness leads in position should measure 0 volts or a NO LIGHT condition. A 200 + volt indication or bright light indicates an open speed switch contact and the motor switch should be replaced.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 6. Safety limiter thermostat. Check the safety limiter thermostat to be a closed circuit and operate within temperature limits. If improper, replace.
19. Improper drying temperature.
Step 1. Fabric selector switch. Check to assure switch is wired properly and all connections are tight. Check continuity through switch. Correct as necessary.
Step 2. Heat control thermostat. Check cut-out and cut-in temperatures with oven tester. If improper, replace thermostat.
Step 3. Safety limiter thermostat. Check cut-out and cut-in temperatures with oven tester.
Step 4. Poor air circulation. Check lint screen. Check for overloaded drum. Check for lint clogged blower or blocked exhaust duct.
20. Drying time too long or clothes not dry when removed from drum.
Step 1. Lint screen. Check lint screen for lint collection and proper assembly. Instruct user.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Step 2.	Drum seal.
	Check the felt seals and retaining bands located at either edge of the drum for proper positioning.
	Correct as necessary.
Step 3.	Poor air circulation.
	Check for overloaded drum - advise user.
	Check for lint clogged blower or blocked exhaust duct.
	Check for proper placement of rear access panel and cover plate for alternate exhaust.
Step 4.	Heater element.
	Check connections and element continuity and resistance.
Step 5.	Heat control thermostat.
	Check cut-out and cut-in temperatures with oven tester.
Step 6.	Safety limiter thermostat.
	Check cut-out and cut-in temperatures with oven tester.
Step 7.	Clothes excessively wet.
	Check washer unit operation for proper spin speed and length of spin period.
Step 8.	Clothes not tumbling properly.
	Check drum revolutions. It should be 56-59 RPM.
	If small load of delicate items, instruct user to add towels to assist tumbling.
Step 9.	Timed cycle too short.
	Customer selected too short a drying time.

4-5. GENERAL (Continued).

Table 4-18. Washer/Dryer Troubleshooting (Continued.)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
21. Clothing tears or holes.
Step 1. Pins or foreign objects in drum.
Remove all objects and caution user.
Step 2. Rough drum surface or vane surface.
Replace damaged part.

4-5. GENERAL (Continued).

Table 4-19. Fire Detection and Extinguisher System Troubleshooting.

NOTE

Refer to paragraph 4-45 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Failure of all detectors to respond to test.
Lack of power or faulty wiring.
Check continuity of electrical wiring and all connections. Check for 28 volts direct current (VDC) at various points to insure proper line voltage. Repair or replace wiring and/or connections as required. Perform test procedure again, noting results.
2. Failure of all detectors in one compartment to respond to test.
Step 1. Lamp failure.
Check wiring and connections of appropriate lamp on Control Panel. Insert new lamp and test. If lamp still fails to light .
Step 2. Faulty wiring.
Check continuity of wiring between compartment detectors and the control amplifier. If wiring is faulty, repair or replace and perform test again. If wiring is not at fault...
Step 3. Defective control amp.
With test switch in TEST 1 position, check signal input pins of control amplifier mating connector MS24266R-12B-12SN, using a vaccum tube volt meter (VTVM) for a minimum signal voltage of 14 VDC +1. Test signal input for all detectors in compartment.
If signal is present, the control amplifier is defective. Replace with a new control amplifier.

4-5. GENERAL (Continued).

Table 4-20. Public Address Set, AN/PIC-2 Troubleshooting.

NOTE

Refer to paragraph 4-46.3 for loud hailer maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. No sound from reproducer when operating trigger switch.
Switch operation produces slight click.
Open battery contact springs.
Defective microswitch.
Battery dead.
Open circuit in wiring.
Open circuit in driver unit.
Defective transistor.
Toggle switch defective.
2. Click but no speech reproduction.
Sound at microphone should be heard in speaker.
Defective microphone unit.
Open wiring.
Defective volume control.
Defective transistor.
Defective transformer.
3. Acoustic howl at all settings of volume control.
No howling with volume control turned down.
Low side of volume control open.

4-5. GENERAL (Continued).

Table 4-20. Public Address Set, AN/PIC-2 Troubleshooting

(Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
4. Voice signals badly distorted.
Undistorted voice reproduction.
One output transistor defective.
Thermistor open.
Driver transistor defective.
An open or shorted resistor.
Batteries very weak.
Power transistor case shorted to chassis.
Defective transformer.
5. Voice reproduction weak.
Full power on normal command voice.
Volume control turned down.
Defective volume control.
Defective microphone unit.
Open or shorted wiring.
Batteries very weak.
Defective transistor.
Defective transformer.
Defective resistor.

4-5. GENERAL (Continued).

Table 4-21. Hot Water Heater Troubleshooting.

NOTE

Refer to paragraph 4-65 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1.	No hot water.
Step 1.	Check circuit breaker #6 on power distribution panel (P-401).
	Tighten loose wires.
	Reset circuit breaker.
Step 2.	Low line voltage.
	Check incoming power.
Step 3.	Move thermostat dial up and down. A definite "snap" should occur.
	Replace thermostat.
2.	Water temperature below setting at all times.
Step 1.	Check thermostat adjustment.
	Readjust if necessary.
Step 2.	Check that element is working on all phases. Clamp amprobe individually around each of the three wires and compare readings. If reading is not the same on all wires check for blown fuse.
	If fuses are O.K. then element must be replaced.

4-5. GENERAL (Continued).

Table 4-21. Hot Water Heater Troubleshooting (Continued).

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. Relief valve discharges continuously.

Temperature and pressure relief valves are made to operate if the water temperature exceeds 210° F (99° C) or water pressure exceeds 125 lbs (861.85 kPa).

Check for excessive temperature or pressure and correct condition. If trouble is excessive temperature, then thermostat is not shutting off at the right setting.

Replace.

4. Monitoring thermostat.

Step 1. Let water heater completely heat to a designated thermostat setting.

After thermostat satisfies, draw water from heater.

Step 2. Compare water temperatures of drawn water to the temperature setting of the thermostat when it satisfies (that is, when the thermostat actually clicks off).

If these two readings do not coincide within acceptable tolerances and verification has been made of the accuracy of the temperature reading gauge, re-calibrate the thermostat.

5. Magnetic contactor.

If magnetic contactor will not energize, and support components are functioning properly (thermostat opens and closes manually, hi limit is open).

Replace complete magnetic contactor.

4-5. GENERAL (Continued).

Table 4-22. Twelve Inch Signalling Searchlight Troubleshooting.

NOTE

Refer to paragraph 4-77 for maintenance instructions.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. No light.
Step 1. Loss of power.
Check fuses.
Check circuit continuity.
Step 2. Burned out lamp.
Replace lamp.
2. Weak beam.
Step 1. Improper lamp.
Install lamp rated for supply voltage.
Step 2. Lamp blackened with age.
Replace.
Step 3. Dirty optical system.
Clean coverglass and reflector.
Step 4. Shutter blades not properly opened.
Adjust shutter stops.
Replace worn stop screw.
Step 5. Low voltage.
Check control panel.

4-5. GENERAL (Continued).

Table 4-22. Twelve Inch Signalling Searchlight Troubleshooting (Continued).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
3.	Shutter leaks light.
	Not fully closed.
	Adjust shutter stops.
	Replace broken shutter spring.

4-6. PUMP SETS.

The maintenance instructions for the various pump sets are as follows:

DESCRIPTION	PARAGRAPH
Portable Fire Pump Set (P250)	4-7
Portable Fire Pump Set (PE-250)	4-7A
Fire Pump	4-8
Bilge Pump Set	4-9
Lube Oil Pump Set (Standby)	4-10
Fresh Water Pump	4-11
Air Conditioning Water Circulation Pump Set	4-12
Diesel Oil Cooling Pump Set	4-13
Lube Oil Transfer Pump	4-14

4-7. PORTABLE FIRE PUMP (P-250).

NOTE

Refer to paragraph 4-7A for portable fire pump PE-250, manufactured by Prosser East Division of Purex Industries Inc.

a. The Portable Fire Pump (Type P-250) (manufactured by Gale Product Division of Outboard Marine Corp.) consists of a 2-cylinder, 2-cycle, 25-hp engine, single stage centrifugal pump, primer pump, water outlet gate valve, fuel tank, pressure regulating system, mechanical starter and a mounting frame and covers. The accessories necessary for the operation of the pump are the foot valve and strainer, suction hose, exhaust hose, pressure hose and nozzles. The latter two items are not furnished by the pump manufacturer. The purpose of the equipment is to draw water from the sea (or other sources) and pump it through suitable hoses and nozzles under high-pressure to combat fire. It is also used for large volume pumping at low pressure as in the case of damage control work and emptying the peak ballast tank.

b. The following is an index to the maintenance procedures:

4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS.

a. The starter consists of a rope attached to a starter pulley, which is in turn connected by spring-loaded pawls to a clutch "dog" bracket, located on the engine flywheel. When the starter rope is pulled, the starter pulley rotates. This rotation increases the spring tension applied to the pawls. The pawls then pull forward to engage the clutch "dogs" on the clutch dog bracket. While the pawls are engaged to the "dogs", the torque applied to the starter pulley is transmitted directly to the engine flywheel.

b. As soon as the engine starts, the starter rope is allowed to return into the starter housing. The starter pulley is also spring-loaded, and re-winds the starter rope in preparation for the next start. At the same time, the pulley releases the tension applied to the pawls, and allows them to disengage from the clutch "dogs". Thus the starter engages automatically when the starter cord is pulled, and disengages automatically as soon as the starter cord is released. As soon as the cord is re-wound on the starter pulley, the starter is ready for the next start. Never allow the starter rope to snap back. Keep the handle in your hand until the rope is fully re-wound.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition: NONE

Condition Description

Material/Parts

Grease

Special Environmental Conditions

NONE

Personnel Required

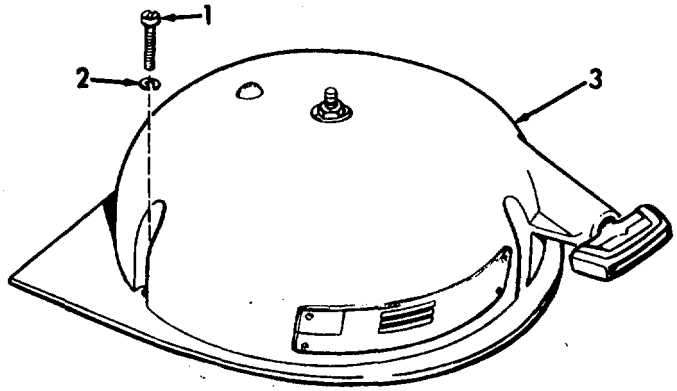
1

General Safety Instructions

Observe WARNING.

4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

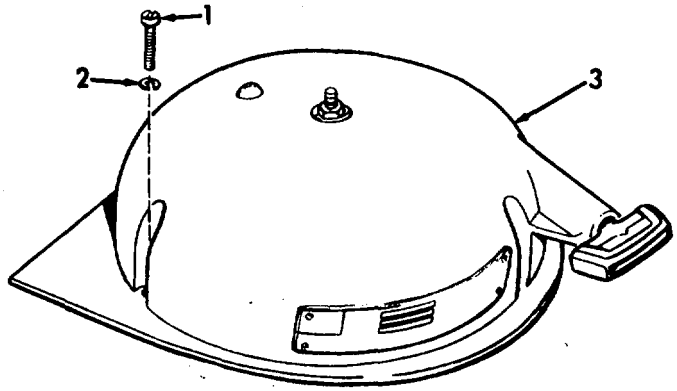
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Starter	a. Housing	Inspect for breaks, cracks, and dents.	
	b. Handle	Inspect for breaks, cracks, and signs of damage.	
	c. Rope	Inspect for fraying and wear.	1. Slowly pull handle to expose rope. 2. If rope is free the spring may be broken.
REMOVAL			
2.	a. Covers	Unlatch and remove.	
	b. Screws (1), and lock-washers (2)	Remove.	
	c. Starter housing (3)	Remove.	



4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

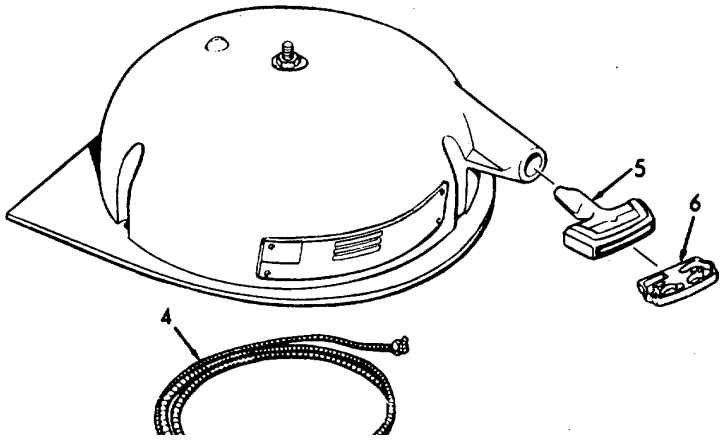
REPAIR (Cont)



WARNING

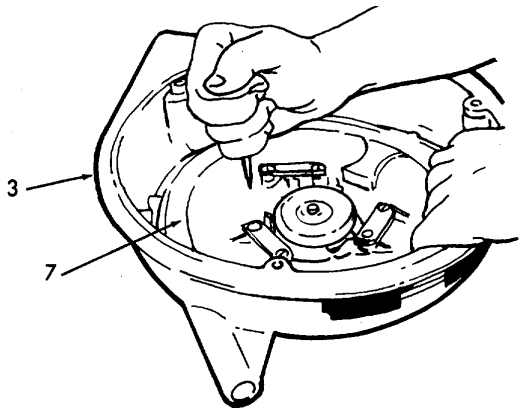
When handling the starter, the spring can cause severe cuts and injury.

3.	Starter rope	a. Rope (4)	Tie a knot in one end of the new rope.
		b. Starter grip (5), and grip insert (6)	1. Separate. 2. Remove old rope.
		c. Rope (4)	Pull old rope out to the extreme limit.



4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

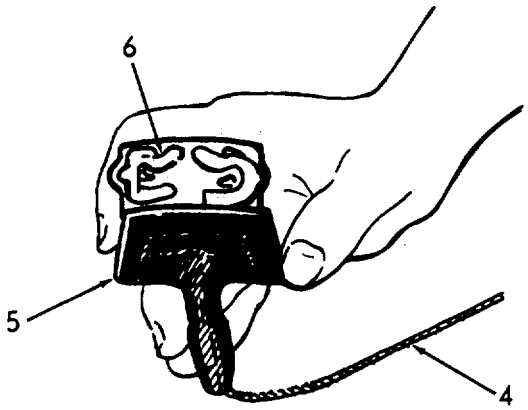
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)I			
d.	Starter Pulley (7)	Grasp and hold.	Keep it from moving. moving.
e.	Rope (4)	Remove from starter pulley (7).	
f.	Starter pulley	Gradually release tension.	Allow the Pulley to rotate slowly.
g.	Starter housing (3)	Insert a straight punch in the hole in the starter pulley (7).	



h.	Start pulley (7)	1. Wind pulley in a counter-clockwise direction until fully wound. 2. Allow pulley to unwind one complete revolution. 3. Hold in this position.	
i.	Rope (4)	Thread opposite end of rope thru slot in the starter pulley.	

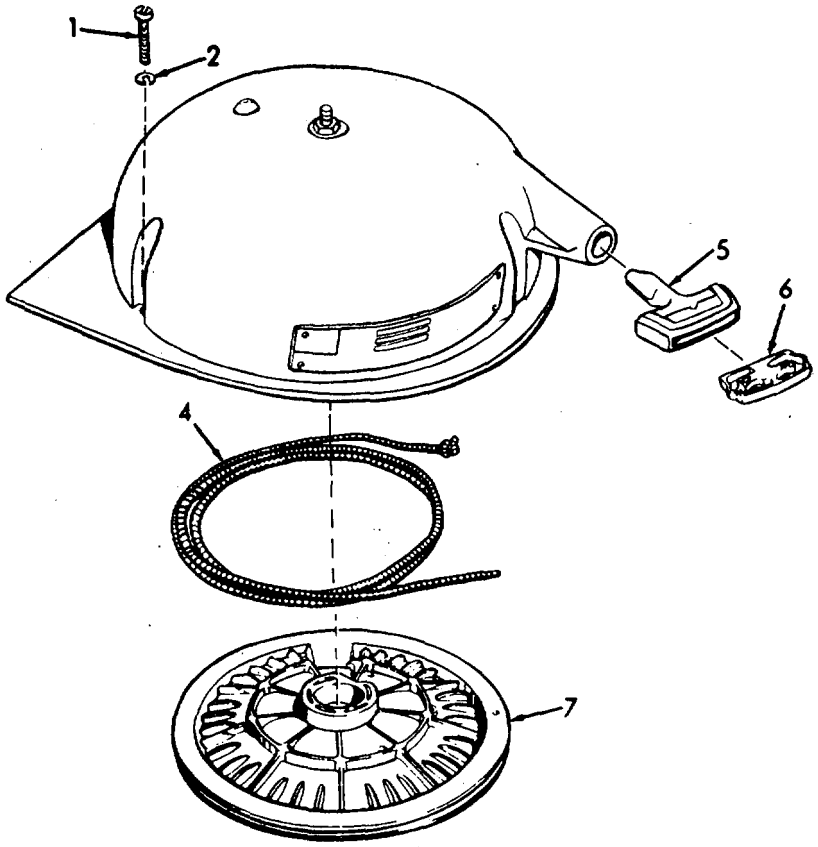
4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Rope (4), starter grip (5), and grip insert (6)	1. Thread rope through grip insert. 2. Assemble grip and insert.	
	k. Starter pulley (7)	Release to rewind all of the rope.	
	l. Starter housing (3), screws (1), and lock - washers (2)	Install.	



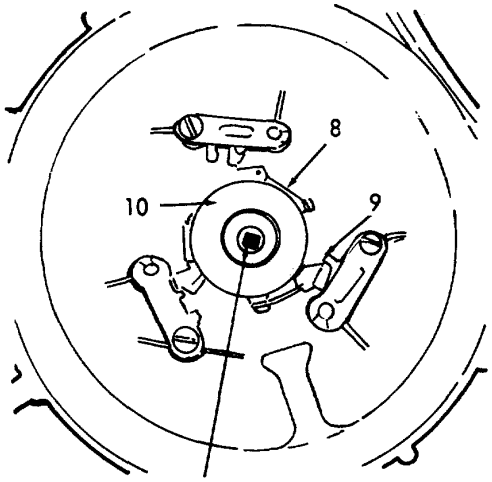
4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



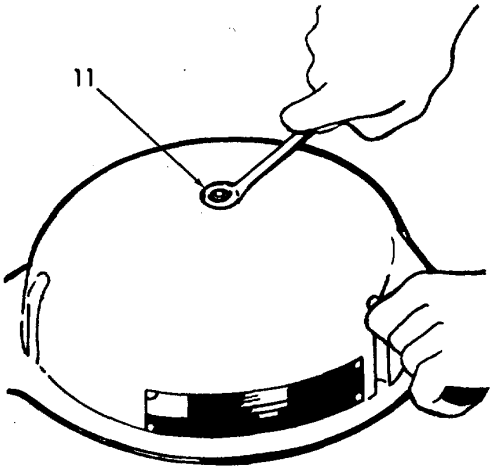
4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Starter spring (13)	a. Starter rope	Remove.	See Step 3a to f.
	b. Equalizer springs (8)	Remove from pawl (9) and spindle and pin assembly (10).	



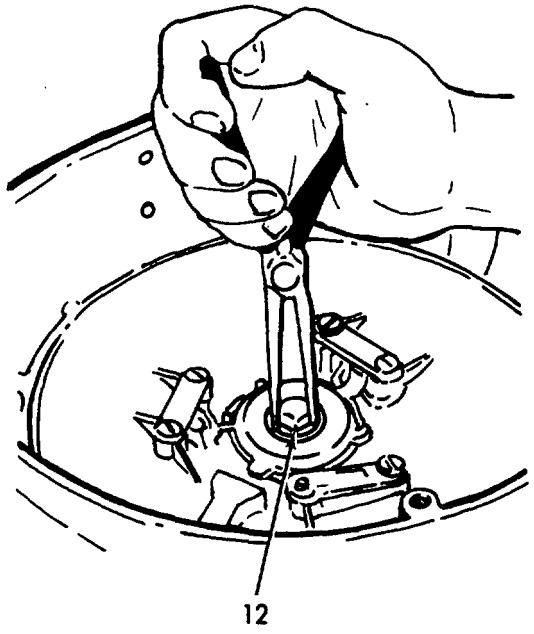
RADIO SHIELDING
GROUND BRUSH

C. Nut (11) Remove.

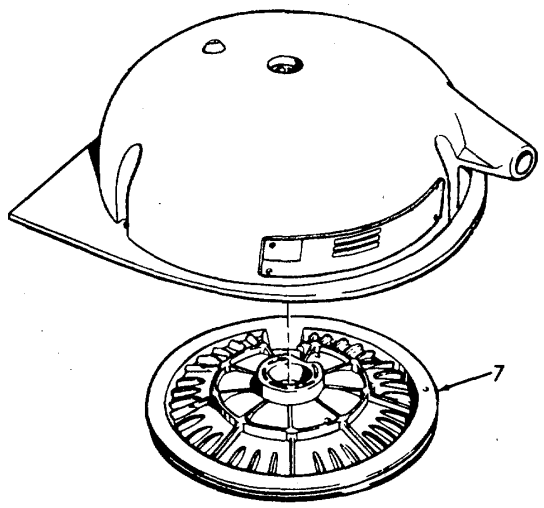


4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Adapter brush (12)	Remove.	The carbon ground brush protrudes from the center core and is held by spring tension.



	e. Starter pulley (7)	Remove.	

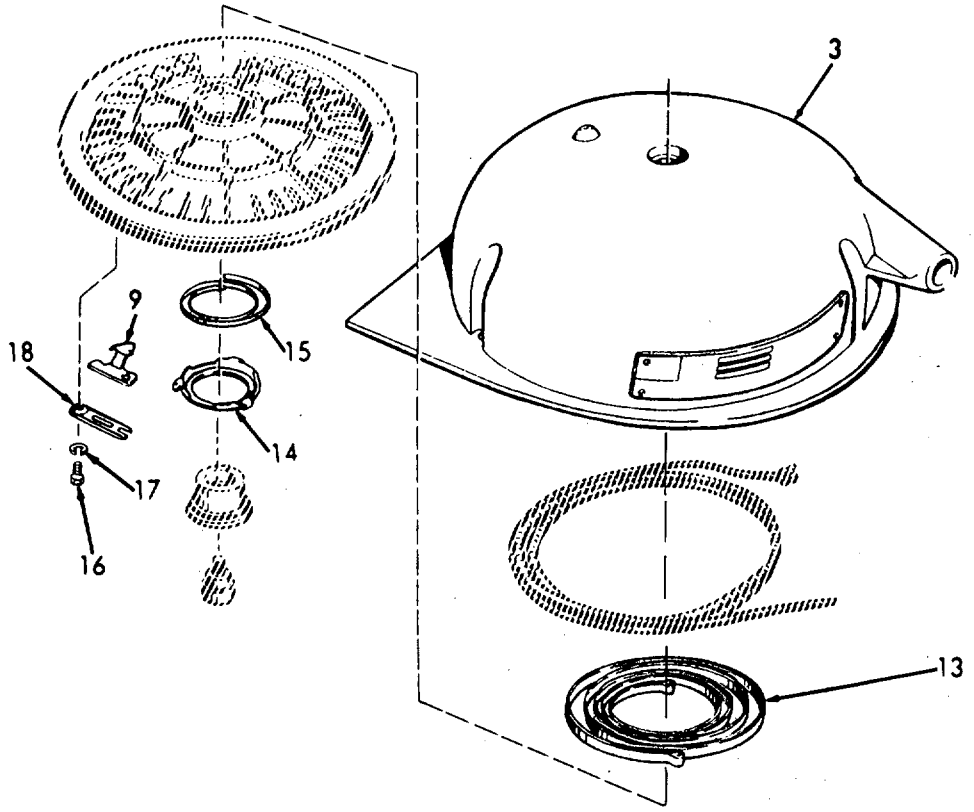


4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Starter spring (13)	Remove.	
	g. Equal-lizer cup (14), and spring (15)	Remove.	
	h. Screw (16), lock-washer (17), retainer (18), and pawl (9)	Remove	If necessary.
	i. Starter housing (3)	1. Attach loop on outer pin. 2. Coil spring in a counter-clockwise direction. 3. Bend the looped free end of the coiled spring up or outward to permit slipping loop over correspond-ing pin on the starter pulley.	

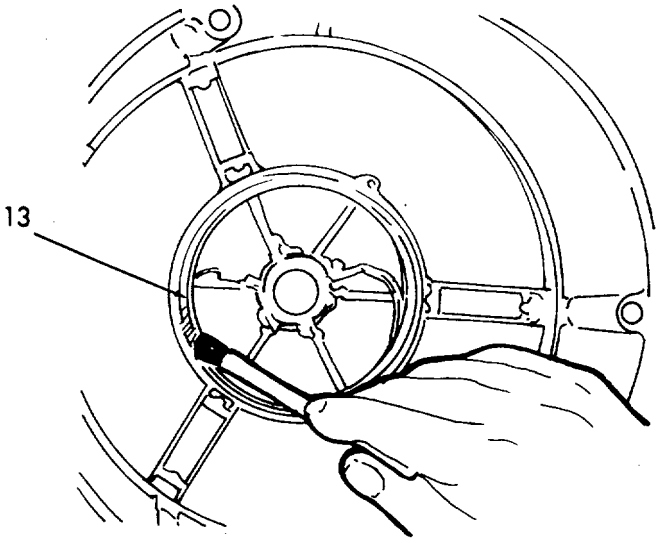
4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

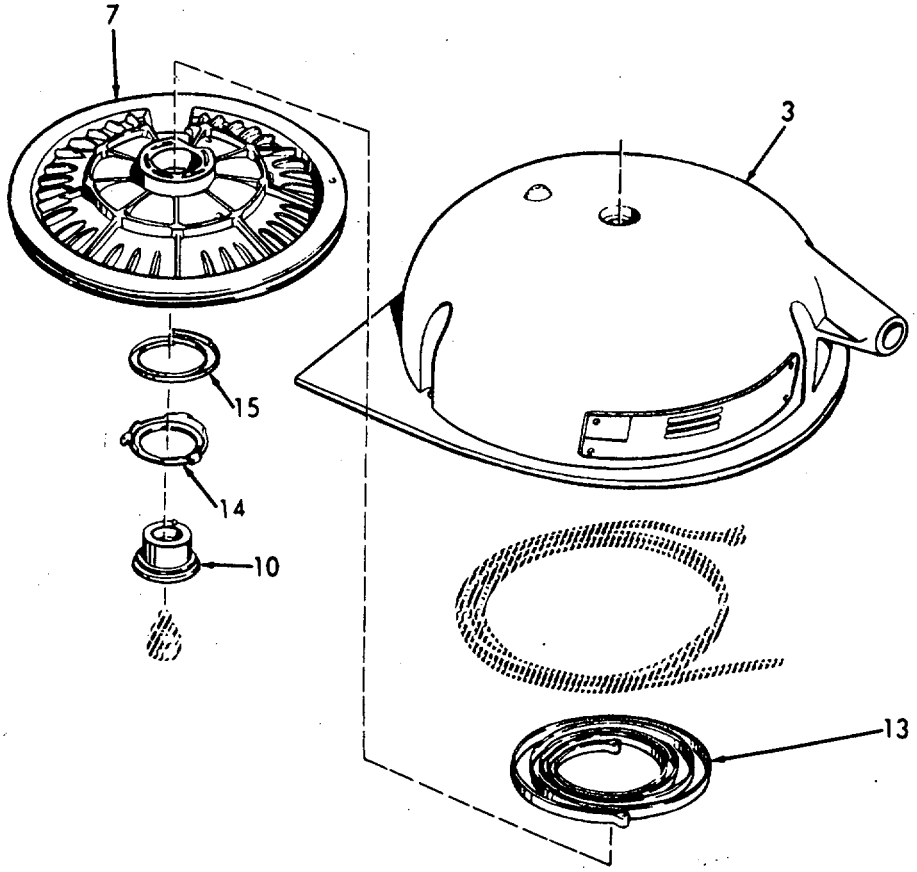
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Starter spring (13)	Apply grease liberally over spring coils.	Use a small brush or a finger.

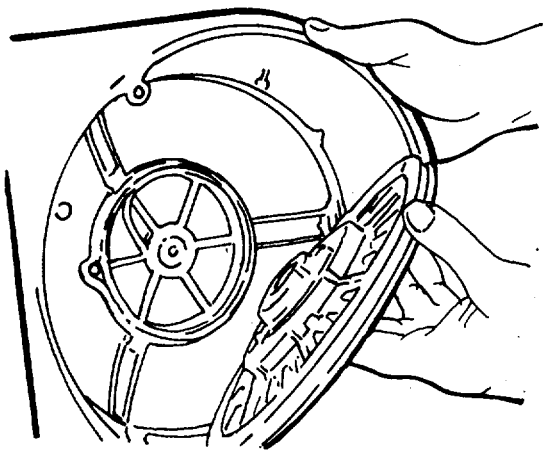


	k. Starter pulley (7), and housing (3)	Assemble - Make certain that the loop in the free end of the spring is properly guided to fit over the corresponding pin on the pulley.	
	l. Equalizer spring (15)	Install.	Wrap clockwise looking down on assembly.
	m. Equal lizer cup (14), and spindle and pin assembly (10)	Install.	The pin-like boss on the end of the cup and the small hole in the starter housing adjacent to the boss must be engaged for proper assembly.

4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



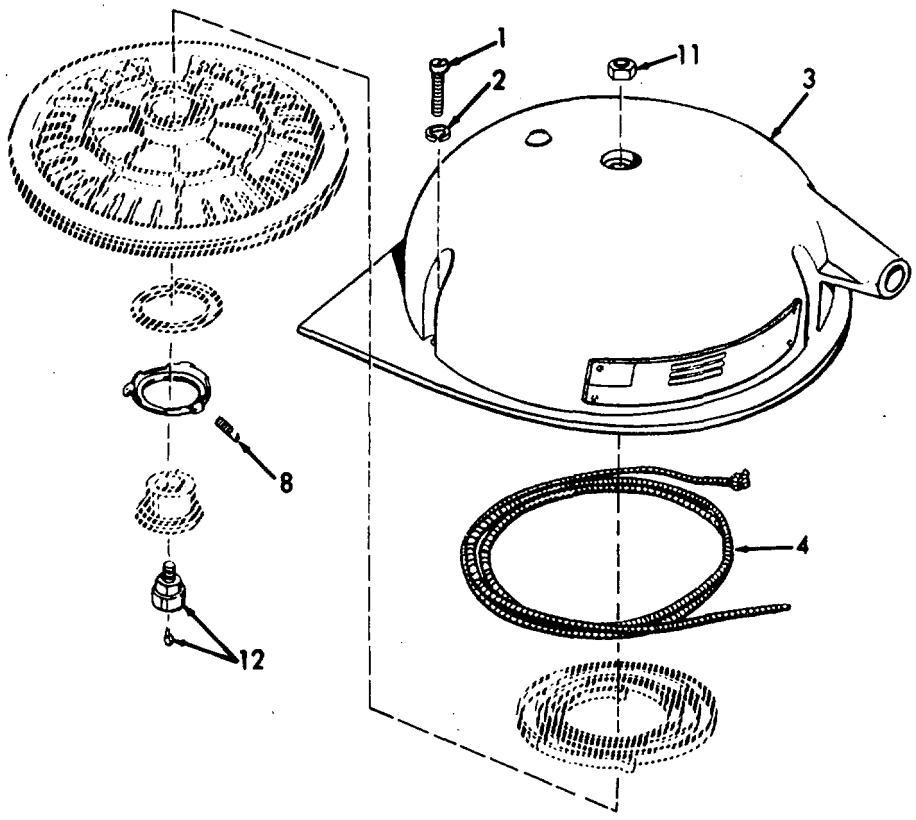


4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	n. Brush and adapter (12), and nut (11)	Install.	
	o. Equal-izer springs (8)	Install.	
	p. Starter rope (4)	Replace.	See Step 3g thru 1.
INSTALLATION			
5. Starter	a. Starter housing (3), screws (1), and lock-washers (2)	Install.	
	b. Covers	Install and latch.	

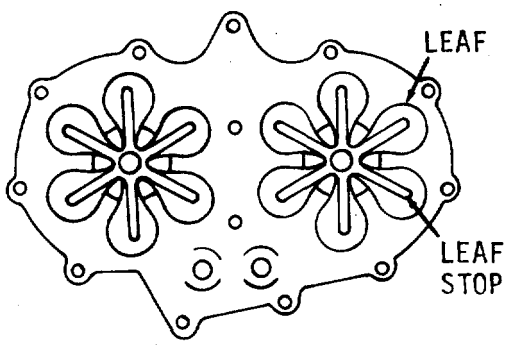
4-7.1. STARTER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

a. Fuel is supplied to the carburetor under pressure from the fuel tank. As a piston rises on its upward stroke, it creates a partial vacuum in the crankcase. This vacuum opens the leaf valves pulling a stream of air through the carburetor mixing chamber, vaporizing the fuel. The vapor thus produced passes through the leaf valves into the crankcase, where it remains until forced into the cylinder to be ignited.



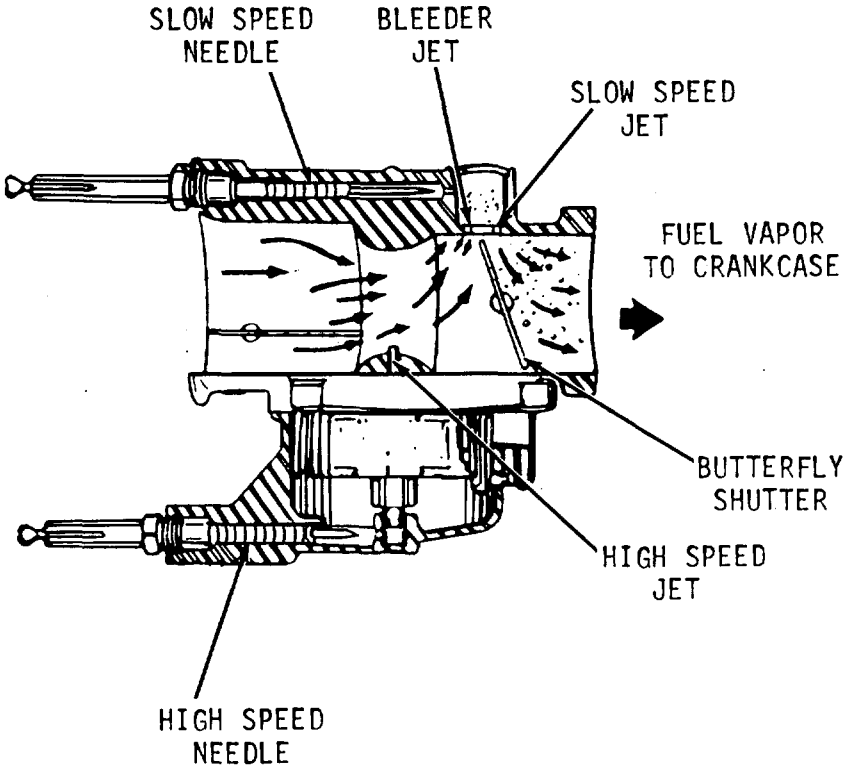
b. The leaf valve consists of two assemblies of six leaves, each anchored to the leaf plate; one assembly for each crankcase chamber. The plate must be flat and true to maintain a tight seal with the like surface of the leaf. A leaf stop is attached to the assembly to limit movement of each segment of the leaf valve. All six leaves lift from their respective seats simultaneously to admit fuel vapor into the crankcase when sufficient vacuum is produced. They close together when the vacuum is reduced. Do not, under any circumstances, overflex these leaves. If this is done, the leaves may be ruined, requiring replacement.

c. The amount of leaf opening depends upon crankcase pressure which varies with the rate of speed at which the engine is operating. This results in more satisfactory performance throughout the entire range of the motor.

d. The carburetor is of the float-feed, two-jet type, consisting of a mixing chamber and conventional float chamber. Two adjustments are provided for high and slow speed performance, respectively.

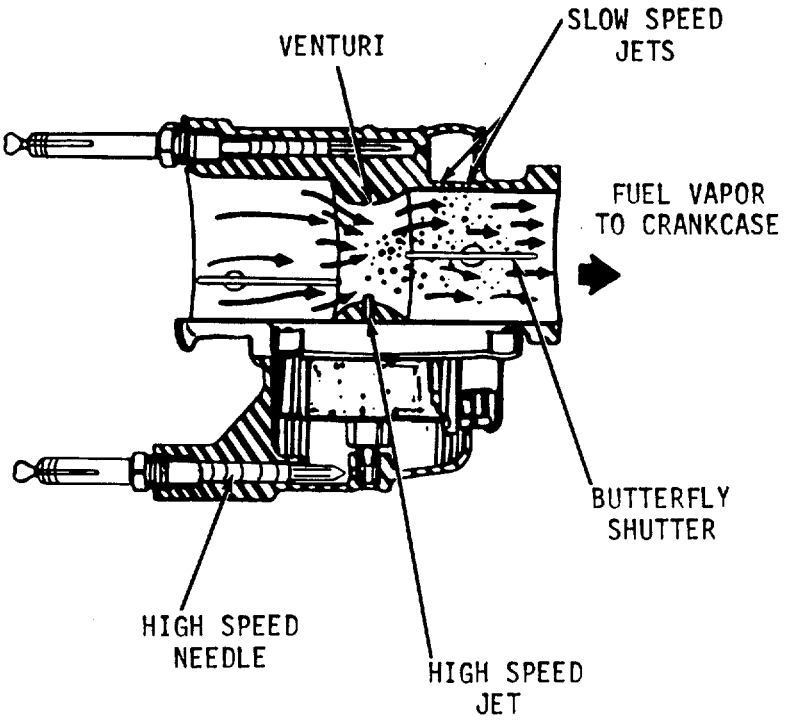
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

e. The figure below illustrates carburetor action at the time when the engine is operating at slow speed. Note that the butterfly shutter is closed to permit very little air to enter except air passing the slow speed bleeder jet. Since the ultimate speed of the engine is dependent on the volume of fuel vapor entering the crankcase, further opening of the butterfly shutter admits more air to be mixed with the liquid fuel, thus developing a greater crankcase charge, and more engine speed and power.



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

f. The figure below illustrates carburetor action during high speed operation of the engine. Note that the butterfly shutter is full open to permit maximum flow of air through the mixing chamber. Velocity through the mixing chamber at this time is comparatively high, but may be varied by re-positioning the butterfly shutter. To obtain maximum air velocity in the area of the high speed jet, a venturi ring has been installed. The ring consists of a funnel-like constriction in the air stream. This constriction is an abrupt curve on the input air side, gradually tapering to a full diameter on the output side to result in maximum air velocity in the area of the high speed jet.



g. High and slow speed jets do not function independently of each other. However, maximum vaporization takes place at the slow speed jet only when the butterfly shutter opening is partially closed. As the butterfly shutter is opened, vaporization increases at the high speed jet, reaching maximum at full butterfly shutter opening. At the same time, slow speed jet vaporization is at a minimum. Therefore, the slow speed jet functions in various degrees throughout the entire speed range of the engine, while the high speed jet remains relatively idle when the butterfly shutter is closed for slow speed engine operation.

4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

Straight edge (ruler)

References

NONE

Equipment Condition	Condition Description
Paragraph 4-7.3	Carburetor Linkage removed.

Material/Parts

Carburetor kit P/N 573771

Special Environmental Conditions

Drain fuel into a suitable container and dispose of properly.

Personnel Required

1

General Safety Instructions

Observe WARNINGS and CAUTIONS.

LOCATION	ITEM	ACTION	REMARKS

WARNING

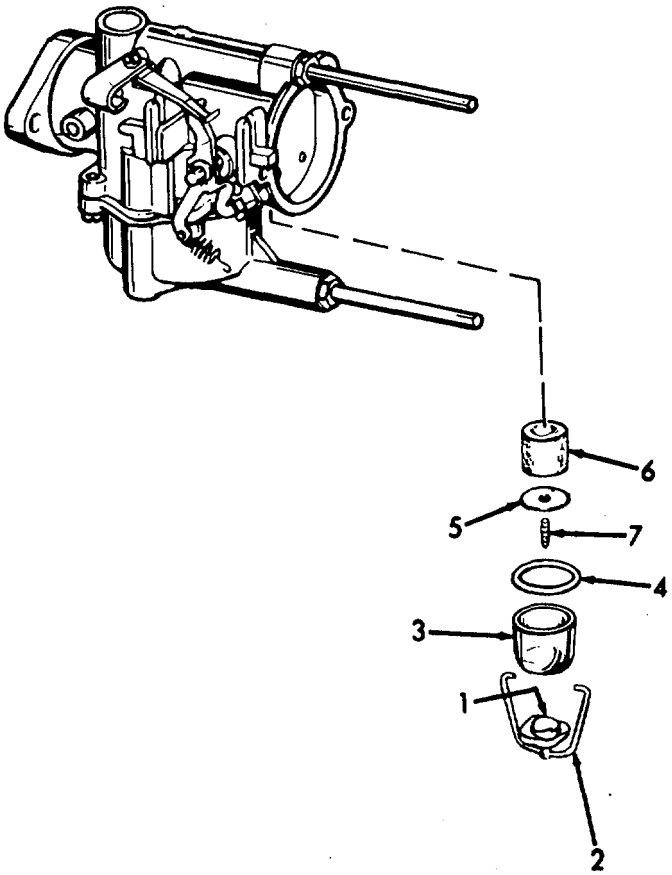
Handle gasoline in the fuel tank with extreme care. Keep all flames and possible sparks away from the fuel tank. Gasoline is combustible and explosive.

4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Carburetor	a. Piping	Inspect for breaks, cracks and leaks.	
	b. Controls	Inspect for defective operation.	
	c. Carburetor	Inspect for breaks, cracks, and broken linkage.	Refer to paragraph 4-7.3 for linkage repair.
	d. Fuel filter	1. Inspect for breaks, and cracks.	
		2. Inspect for dirt and water in sediment bowl.	
SERVICE			
2. Fuel Filter	a. Thumb nut (1)	Loosen.	
	b. Bracket (2)	Swing aside.	
	c. Filter bowl (3), and gasket (4)	1. Remove	Discard gasket.
		2. Rinse bowl in clean gasoline.	
	d. Filter nut (5)	Unscrew.	
	e. Filter element (6)	1. Remove.	
		2. Clean element in gasoline.	Replace element if badly gummed.
	f. Filter stud (7)	Replace if damaged.	

4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	g. Filter element (6), and filter nut (5)	Install.	
	h. Gasket (4), and filter bowl (3)	Install.	
	i. Bracket (2), and thumb nut (1)	1. Swing bracket into place. 2. Tighten nut.	

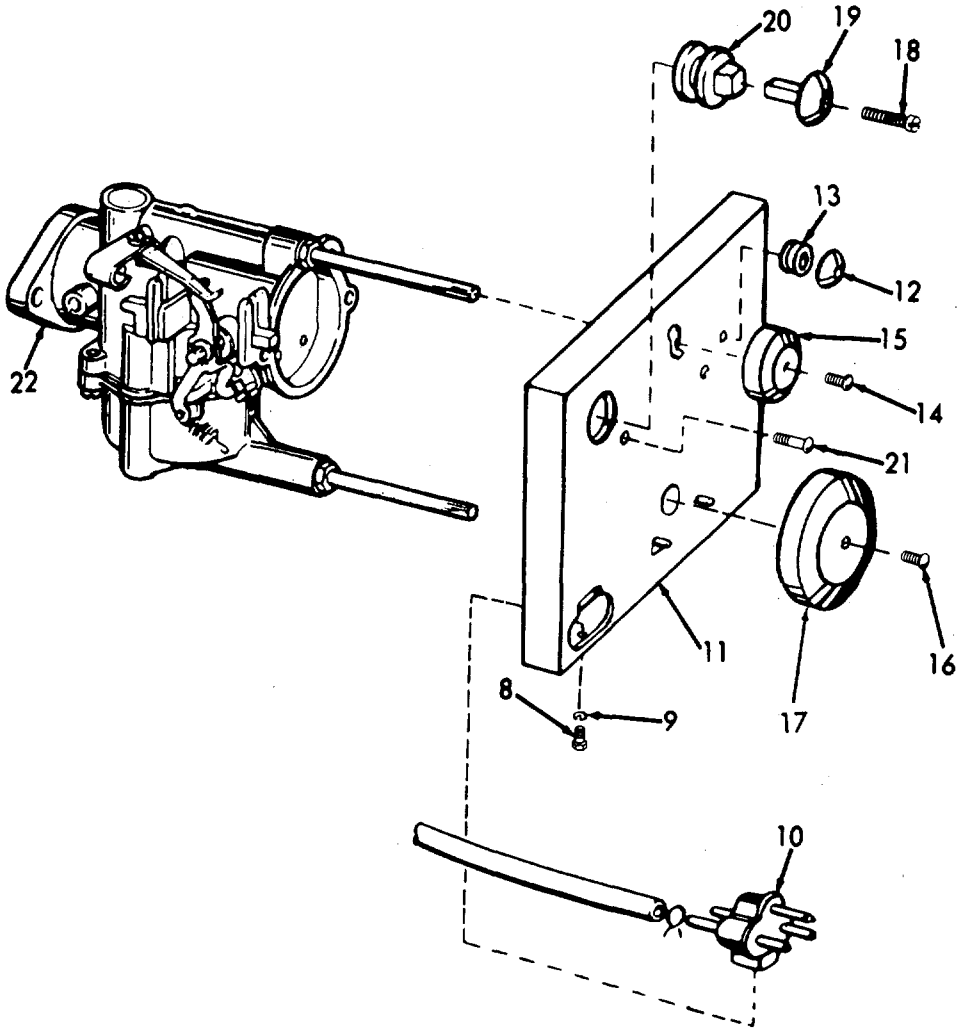


4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Control Panel	a. Screw (8), and lock-washer (9)	Remove.	
	b. Fuel assem-bly body (10)	Remove from control panel (11).	
	c. Stop button (12), and grommet (13)	Remove.	
	d. Slow adjust-ing screw (14), and knob (15)	Remove.	
	e. High adjust-ing screw (16), and knob (17)	Remove.	
	f. Choke control screw (18), knob (19), and grommet (20)	Remove.	

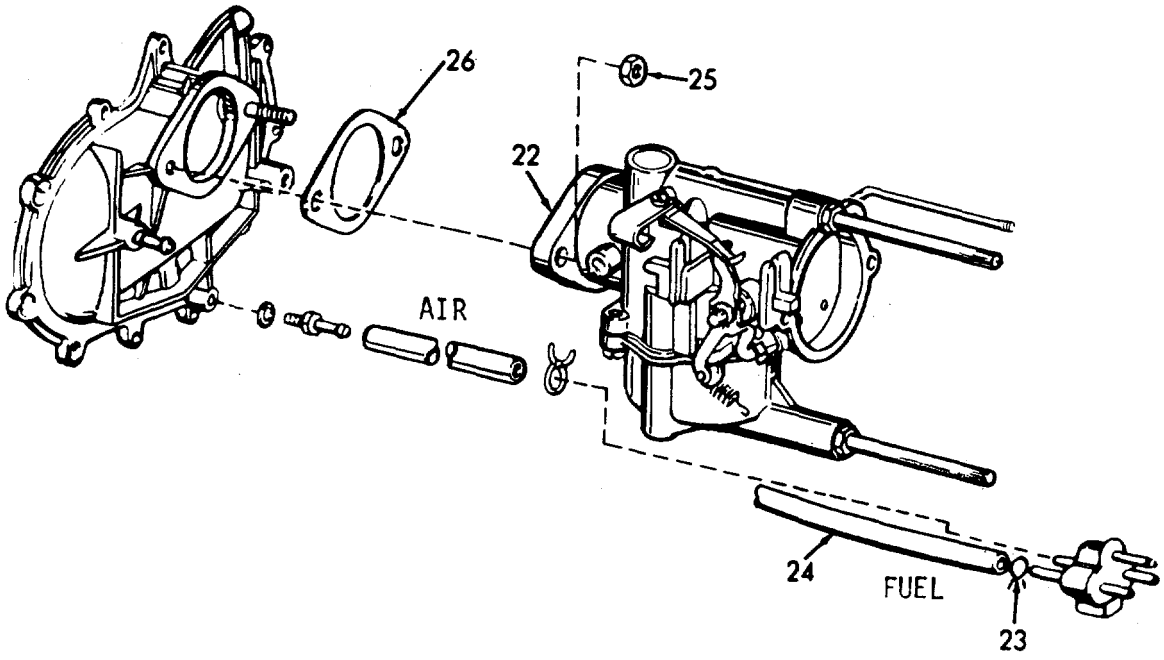
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	g. Screws (21)	Remove.	
	h. Control panel (11)	Remove from carburetor (22).	



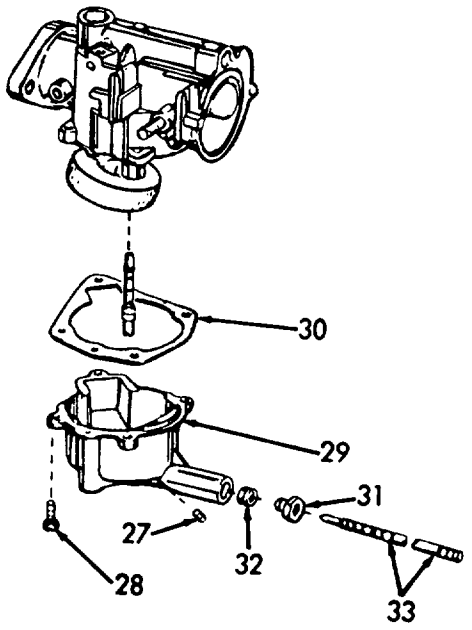
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Carbu-Retor	a. Hose clamps (23), and fuel hose (24)	Remove.	
	b. Nuts (25), and gasket (26)	Remove.	Discard gasket.
	c. Carburetor (22)	Remove.	



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5. High speed jet	a. Screw (27)	Remove.	To drain float chamber.
	b. Screws (28)	Remove.	
	c. Float chamber (29), and gasket (30)	Remove.	1. Remove carefully. 2. Discard gasket.
	d. Packing nut (31), needle packing (32), and needle valve (33)	Remove.	Discard packing.



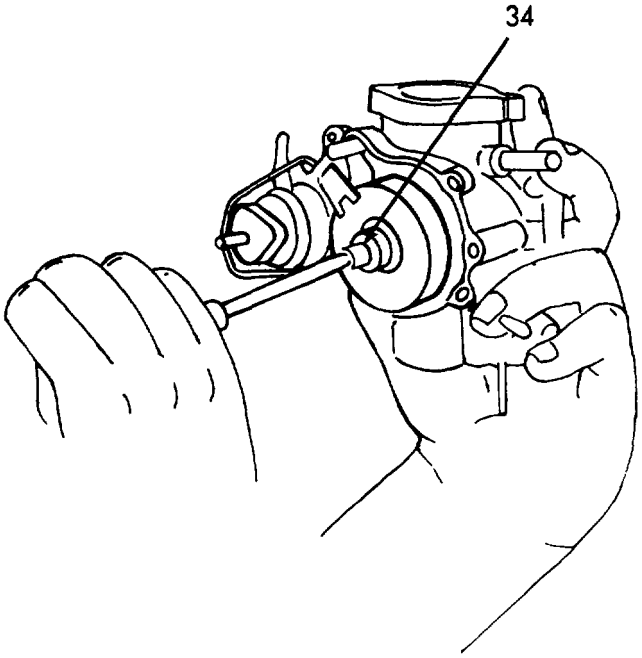
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

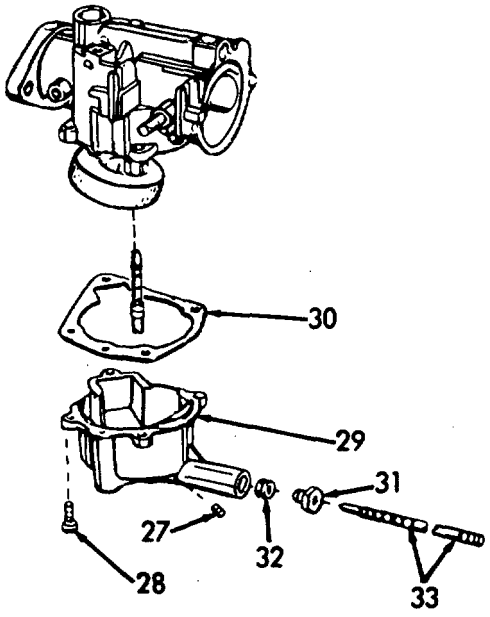
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. High speed nozzle (34)	1. Remove.	Use screwdriver.
		2. Inspect.	Discard if damaged.
		3. Replace.	
	f. Needle valve (33), packing nut (31), and needle packing (32)	Reassemble into float chamber (29).	Use new packing.
	g. Float chamber (29), gasket (30), and screws (28)	Install.	Use new gasket.
	h. Screw (27)	Install.	

4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



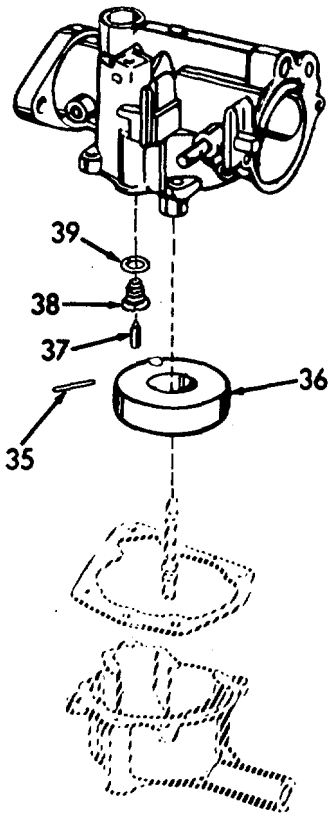


4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Float and valve assembly	a. High speed jet	Remove.	Refer to step 5a thru e.
	b. Pin (35)	Remove.	
	c. Float (36), and float valve (37)	1. Lift float free. 2. Remove.	
	d. Float valve seat (38), and washer (39)	Remove.	Use screwdriver.
	e. Float (36)	Check for defects.	Discard if damaged.
	f. Float valve (37), and seat (38)	1. Rinse in gasoline to clean.	Make sure no gum or deposit remains on seat or valve point. Sluggish action will result.
		2. Inspect tapered face of valve and seat for damage.	Discard if damaged.
	g. Washer (39), and float valve seat (38)	Install tightly.	Use screwdriver.

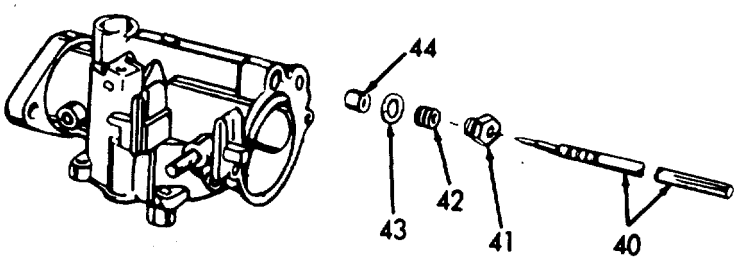
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Float valve (37), float (36), and pin (35)	Install.	
	i. Float (36)	Adjustment.	Refer to step 13.
	j. Float chamber	Replace	Refer to step 5f thru h.



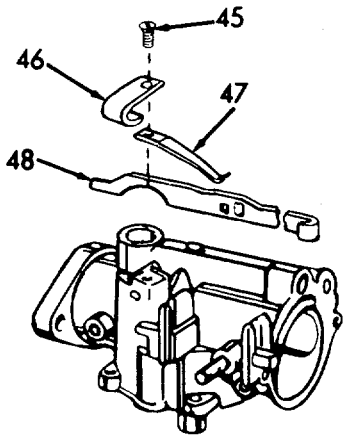
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Low speed jet	a. Low speed needle valve (40)	Unscrew and remove.	
	b. Packing nut (41), packing (42), and washer (43)	Remove.	Discard packing.
	c. Slow speed bushing (44)	Remove.	Discard.
	d. Bushing (44), washer (43), packing (42), and packing nut (41)	Replace.	Use new bushing and packing.
	e. Low speed needle valve (40)	Install.	Do not screw in tightly, or seat will be damaged.



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Choke Control and bell Crank	a. Screw (45)	Remove.	
	b. Small choke spring (46), choke spring (47), and choke control rod (48)	Remove.	

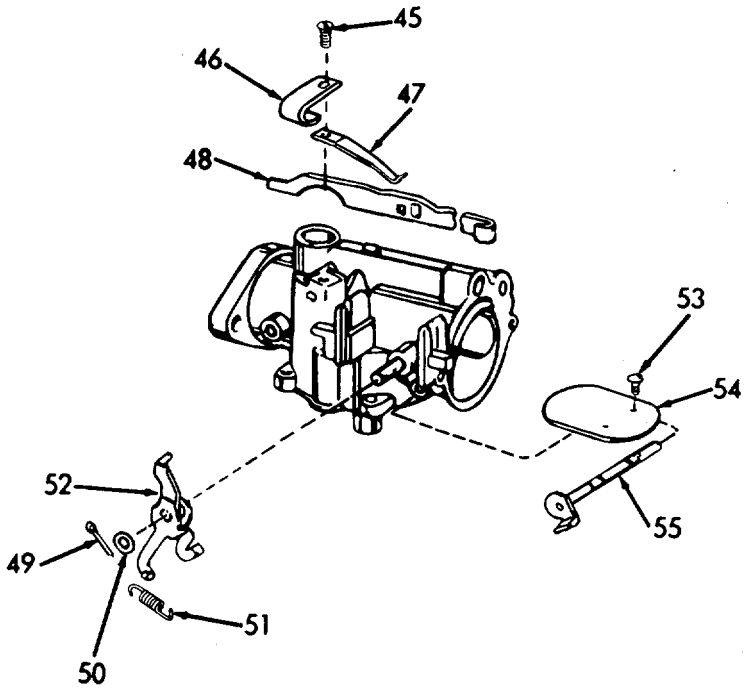


4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Cotter pin (49), and bell crank washer (50)	Remove.	
	d. Spring (51)	Remove.	
	e. Bell crank (52)	Remove.	
	f. Bell crank (52), bell crank washer (50), and cotter pin (49)	Install.	
	g. Spring (51)	Install.	
	h. Choke control rod (48), choke spring (47), small choke spring (46), and screw (45)	Install.	
9. Choke valve	a. Screws (53)	Remove.	
	b. Choke valve (54)	Remove.	

4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Arm and pin assembly (55)	Replace.	
	d. Choke valve (54), and screws (53)	Install.	

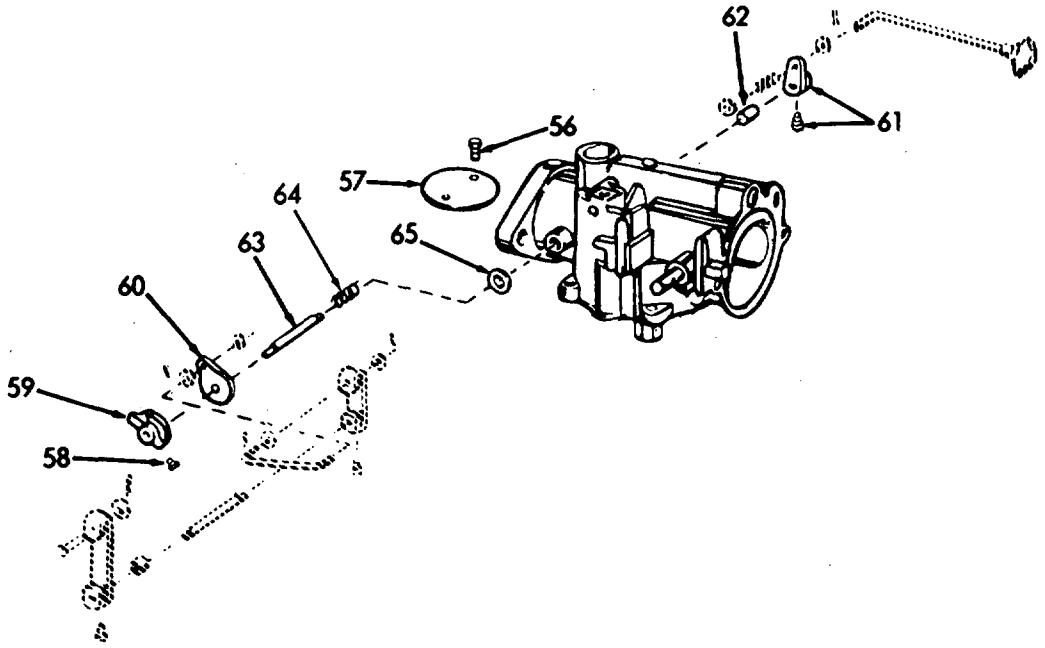


4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Throttle	a. External linkage	Remove.	Refer to paragraph 4-7.3.
	b. Screws (56)	Remove.	
	c. Throttle valve (57)	Remove.	
	d. Friction setscrew (58), collar (59), and drive plate (60)	Remove.	
	e. Screw and collar (61), and spacer (62)	Remove.	
	f. Shaft and arm assembly (63), spring (64), and washer (65)	Remove.	
	g. Washer (65), spring (64), and shaft and arm assembly (63)	Install.	

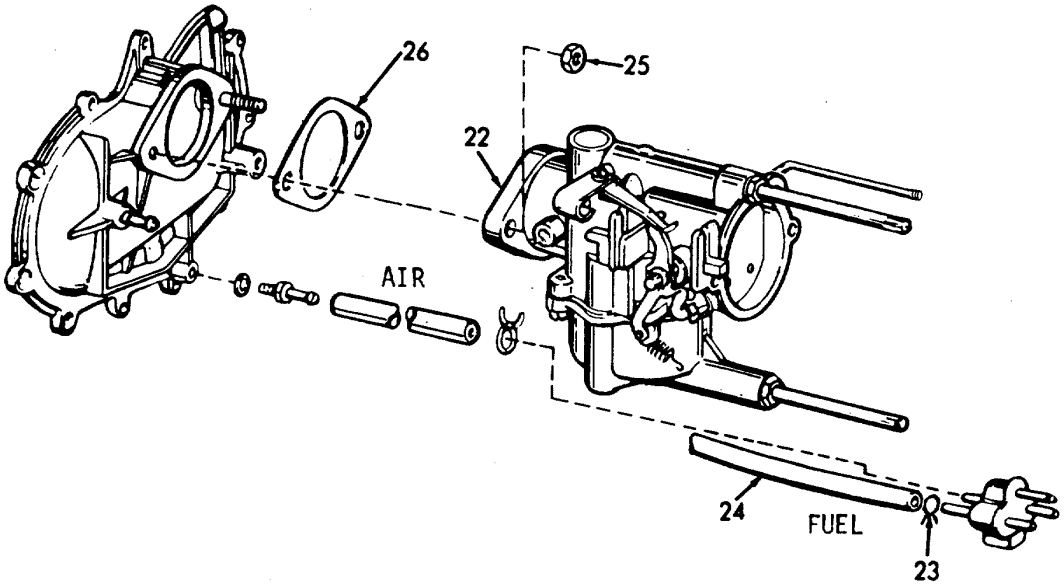
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Spacer (62), screw, and collar (61)	Install	
	i. Drive plate (60), collar (59), and friction setscrew (58)	Install.	
	j. Throttle valve (57), and screws (56)	Install.	
	k. External linkage	Install.	Refer to paragraph 4-7.3.



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

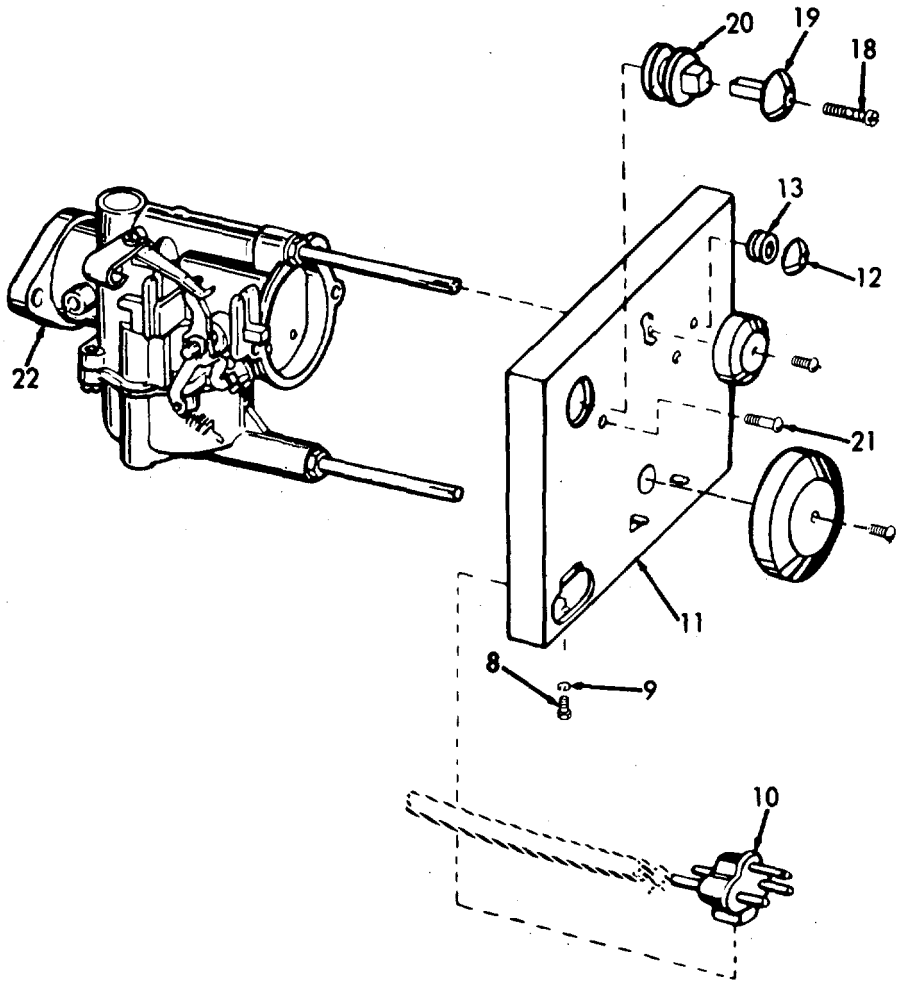
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11. Carburetor	a. Carburetor (22), gasket (26), and nuts (25)	Install.	Use new gasket.
	b. Fuel hose (24), and Clamps (23)	Install.	a. Use new hose. b. Cut new hose to 6-1/2 inch (16.5 cm) length.



12. Control	a. Control panel panel(11), and screws (21)	Attach to carburetor (22).	
	b. Grommet (20), choke control knob (19), and screw (18)	Install.	
	c. Stop button (12), and grommet (13)	Install.	

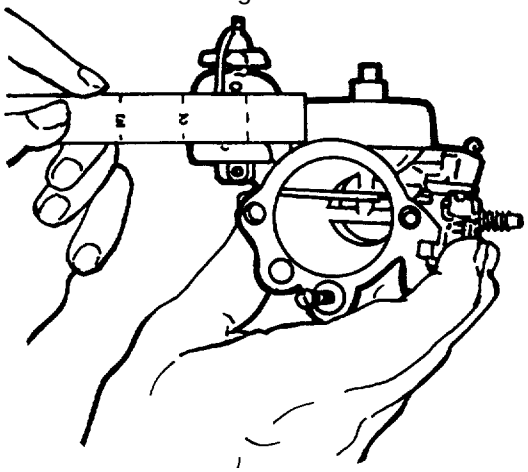
4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Fuel assembly body (10), screw (8), and lock-washer (9)	Install.	



4-7.2. CARBURETOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS			
13. Float level	Float	Check for correct float level. The top face of the float should come to rest flush with the face of the carburetor body. If it does not, carefully bend float arm up or down as required to obtain correct level. Check that the float action is free from binding.	
14. High and low speed needle valves		1. Note stops built into the backs of the dial knobs and the mounting. These stops limit the compensating variations in the carburetor adjustments possible during normal operation. The dials are held in place by a counter-sunk screw in the head of the respective needle valves.	

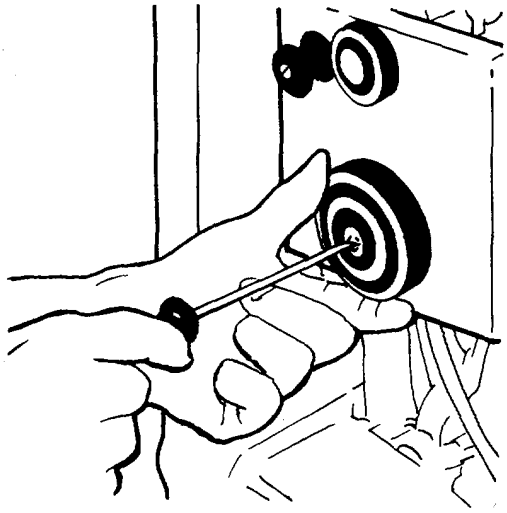


CAUTION

Do not screw down tightly, since this will result in severe damage to the needle point or the seat, making proper adjustment impossible. If the needle or its seat has been damaged in this manner, always replace them. Do not attempt repairs.

4-7.2. CARBURETOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS			
		2. Carefully close both needles against their respective seats.	
		3. Open the low speed needle approximately one turn, and the high speed needle about three-quarter turn.	
		4. Replace both dials in their respective positions with a point between numerals four and five directly above the centerline of the needle in each case. This will allow maximum adjustment on each side of the normal setting of each needle by the use of the adjusting dials. Secure dials to needles with their connecting screws, making sure the needles are not moved from their adjusted position in the process.	



4-7.2. CARBURETOR-MAINTENANCE INSTRUCTIONS (Continued).

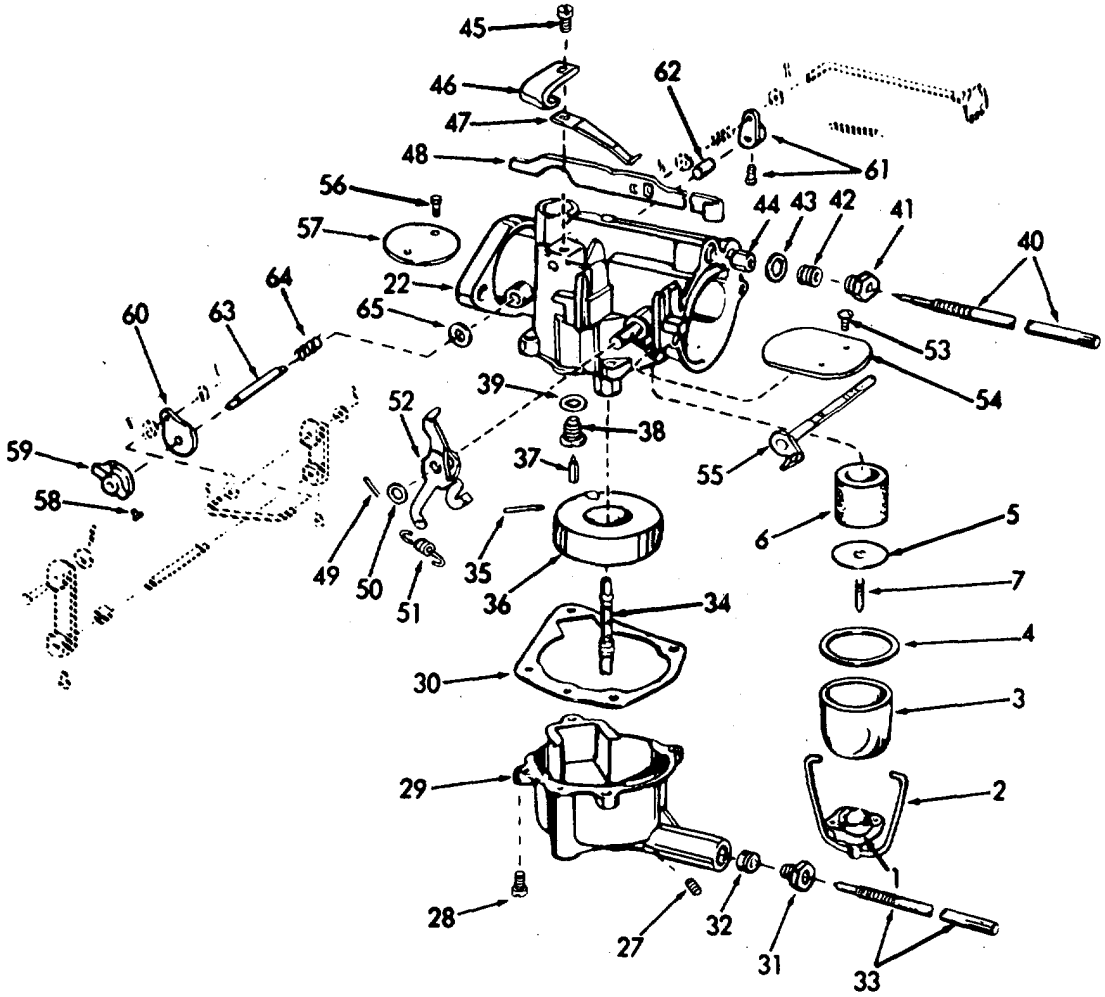
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			

Carburetor Legend

1.	Thumb nut	34.	High speed nozzle
2.	Bracket	35.	Pin
3.	Filter bowl	36.	Float
4.	Gasket	37.	Float valve
5.	Filter nut	38.	Float valve seat
6.	Filter element	39.	Washer
7.	Filter stud	40.	Low speed needle valve
8.	Screw	41.	Packing nut
9.	Lockwasher	42.	Packing
10.	Fuel assembly body	43.	Washer
11.	Control panel	44.	Slow speed bushing
12.	Stop button	45.	Screw
13.	Grommet	46.	Small choke spring
14.	Slow adjusting screw	47.	Choke spring
15.	Knob	48.	Choke control rod
16.	High adjusting screw	49.	Cotter pin
17.	Knob	50.	Bell crank washer
18.	Choke control screw	51.	Spring
19.	Knob	52.	Bell crank
20.	Grommet	53.	Screws
21.	Screws	54.	Choke valve
22.	Carburetor	55.	Arm and pin assembly
23.	Hose clamps	56.	Screws
24.	Fuel hose	57.	Throttle valve
25.	Nuts	58.	Friction setscrew
26.	Gasket	59.	Collar
27.	Screw	60.	Drive plate
28.	Screws	61.	Screw and collar
29.	Float chamber	62.	Spacer
30.	Gasket	63.	Shaft and arm assembly
31.	Packing nut	64.	Spring
32.	Needle packing	65.	Wsher
33.	Needle valve		

4-7.2. CARBURETOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			



4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

Paragraph 4-7.2. Carburetor Assembly

Special Tools

NONE

Equipment Condition: NONE

Condition Description

Material/Parts

Carburetor kit P/N 573771

Special Environmental Conditions

Drain fuel into a suitable container and dispose of properly.

Personnel Required

1

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

Handle gasoline in the fuel tank with extreme care. Keep all flames and possible sparks away from the fuel tank. Gasoline is combustible and explosive.

INSPECTION

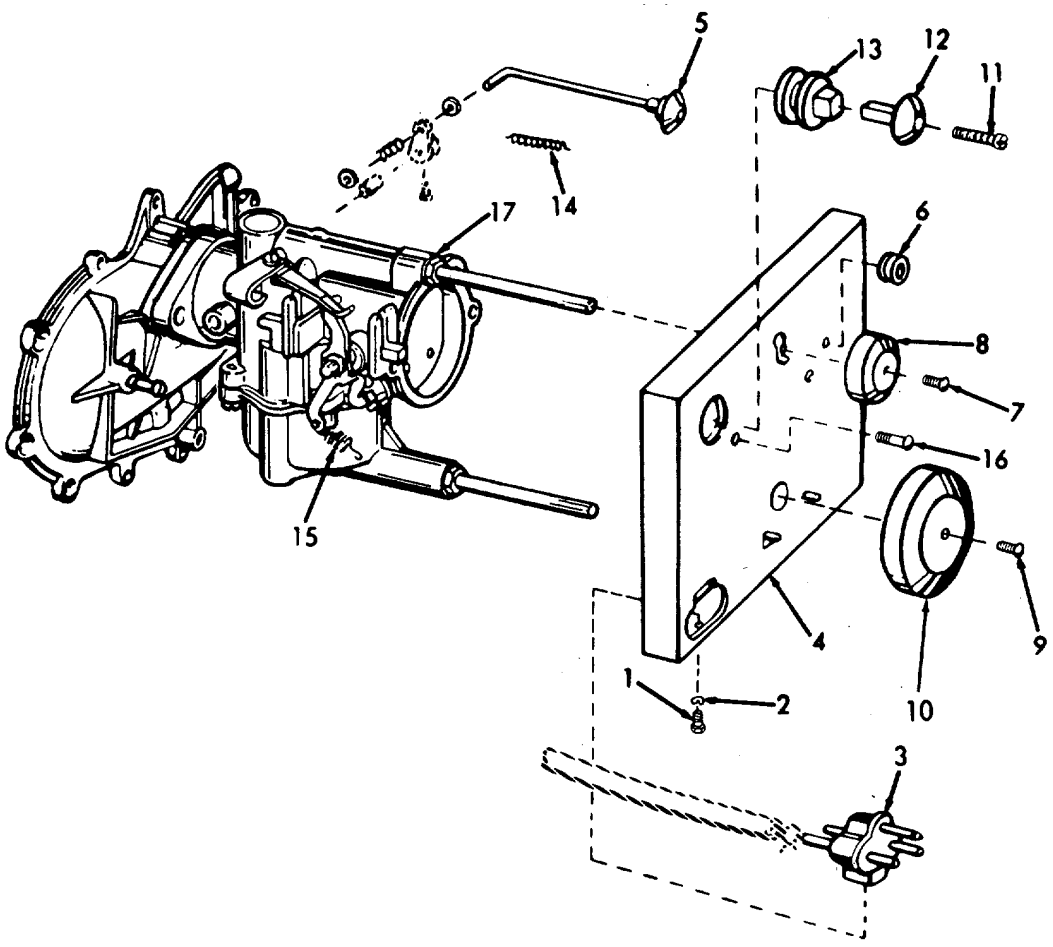
1.	Carburetor linkage, control panel, and manifold	a. Carburetor	Inspect for leaks, cracks or breaks.	Refer to paragraph 4-7.2.
		b. Control panel	1. Inspect for broken, or missing controls.	
			2. Inspect for broken or leaking fuel connections.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Linkage	1. Inspect for missing or damaged parts.	
		2. Inspect for binding and wear.	
	d. Manifold	Inspect for breaks, leaks, and cracks.	
REMOVAL			
2. Control panel	a. Screw (1), and lock-washer (2)	Remove.	
	b. Fuel assembly body (3)	Remove from control panel (4).	
	c. Stop button (5), and grommet (6)	Remove.	
	d. Slow ad-justing screw (7), and knob (8)	Remove.	
	e. High ad- justing screw (9), and knob (10)	Remove.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	f. Choke control screw (11), knob (12), and grom-met (13)	Remove.	
	g. Springs (14 and 15)	Disconnect from control panel.	
	h. Screws (16)	Remove.	
	i. Control panel (4)	Remove from carburetor (17).	

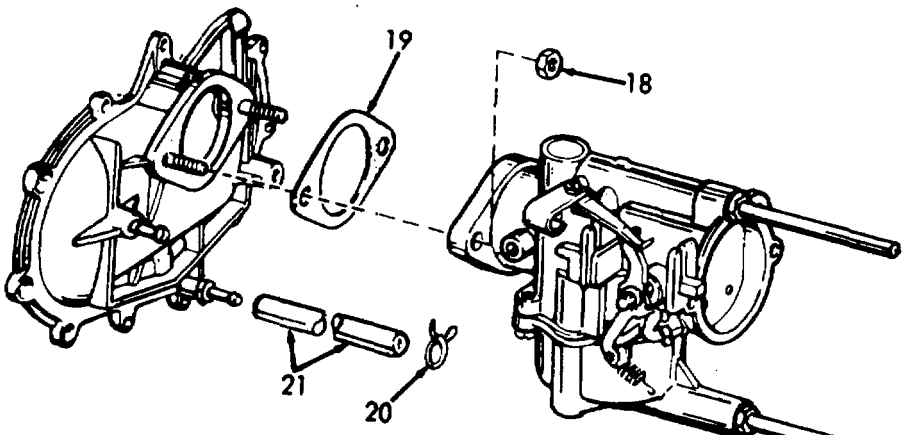


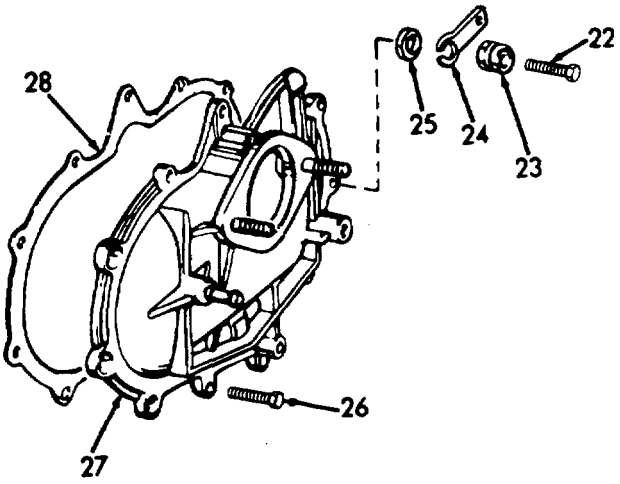
4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
REMOVAL (Cont)				
3.	Carburetor	a. Nuts (18)	Remove.	
		b. Gasket (19)	Remove.	Discard.
4.	Air hose	a. Hose clamps (20)	Loosen.	
		b. Hose (21)	Remove.	Discard hose.
5.	Manifold and shaft assembly	a. Screw (22), grommet (23), support (24), and lockwasher (25)	Remove.	
		b. Eleven screws (26)	Remove.	
		c. Manifold and shaft assembly (27), and leaf plate gasket (28)	Remove.	Discard gasket.

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			



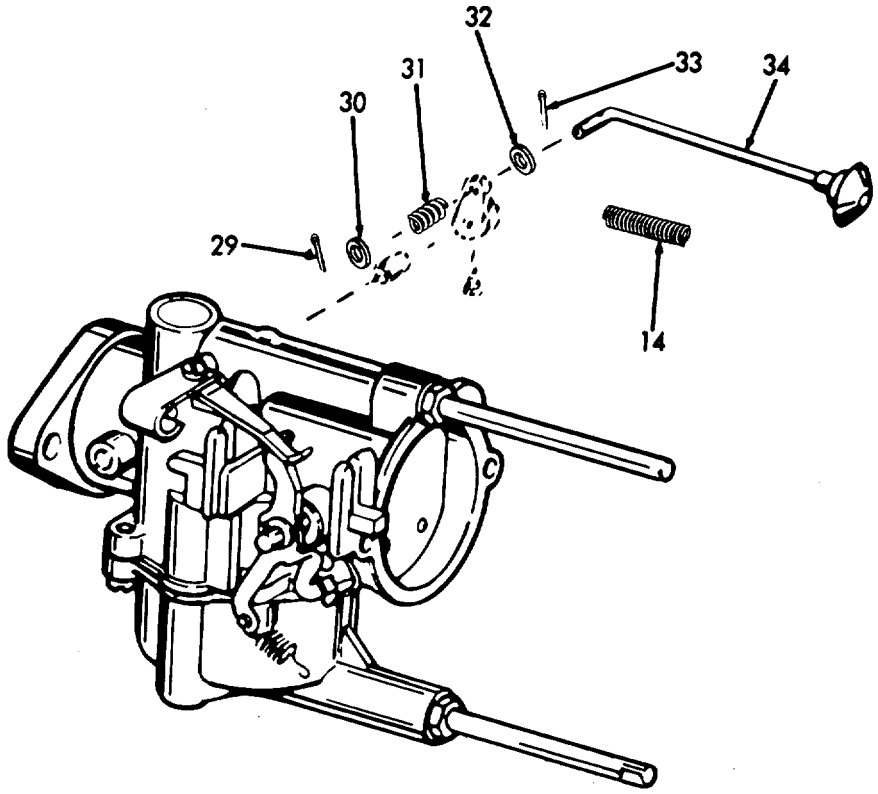


4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
REPAIR				
6.	Stop button linkage	a. Carburetor linkage	Remove.	Refer to paragraph 4-7.2.
		b. Cotter pin (29)	Remove.	
		c. Flat washer (30), and spring (31)	Remove.	
		d. Spring (14)	Remove.	
		e. Flatwasher (32), cotter pin (33), and rod assembly (34)	Disassemble.	
		f. Rod assembly (34), cotter pin (33), and flatwasher (32)	Assemble.	
		g. Spring (14)	Install.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Spring (31), flat-washer (30), and cotter pin (29)	Assemble.	

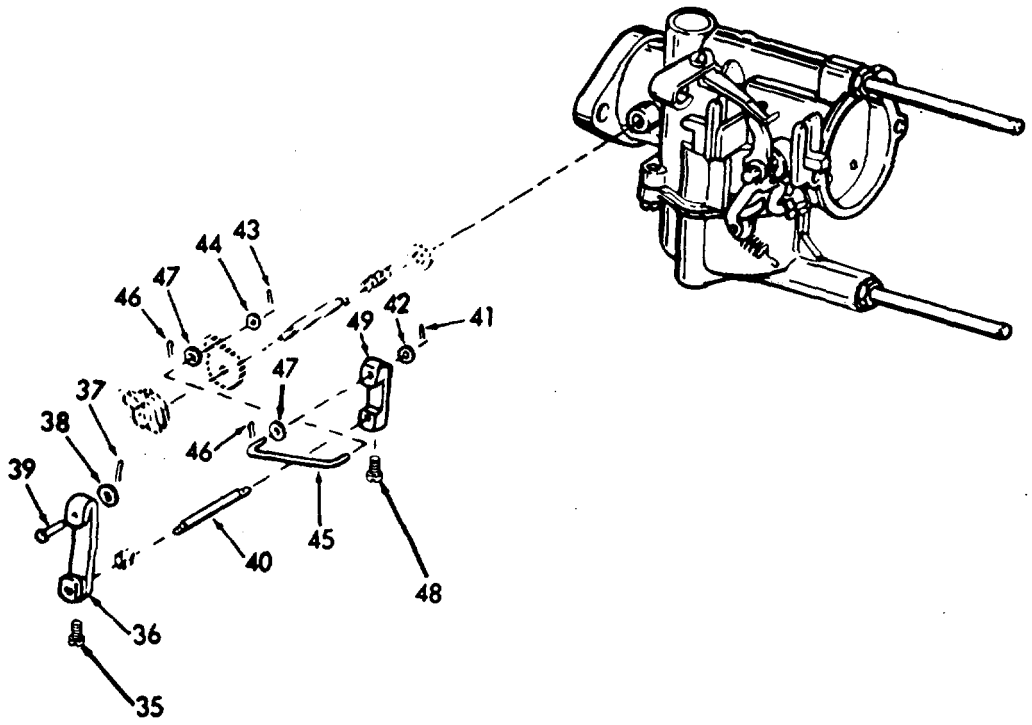


4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Choke linkage	a. Lever screw (35)	Loosen.	
	b. Cross-shaft lever (36)	Remove.	
	c. Cotter pin (37), flat-	Disassemble.	If necessary.
	d. Cross-shaft adapter (40)	Remove.	
	e. Cotter pin (41), and flat washer (42)	Remove	
	f. Cotter pin (43), and, flat washer (44)	Remove.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Shaft linkage (45), cotter pin (46), and flat-washers (47)	Disassemble.	If necessary.
	h. Lever screw (48), and cross-shaft lever (49)	Loosen and remove.	If necessary.

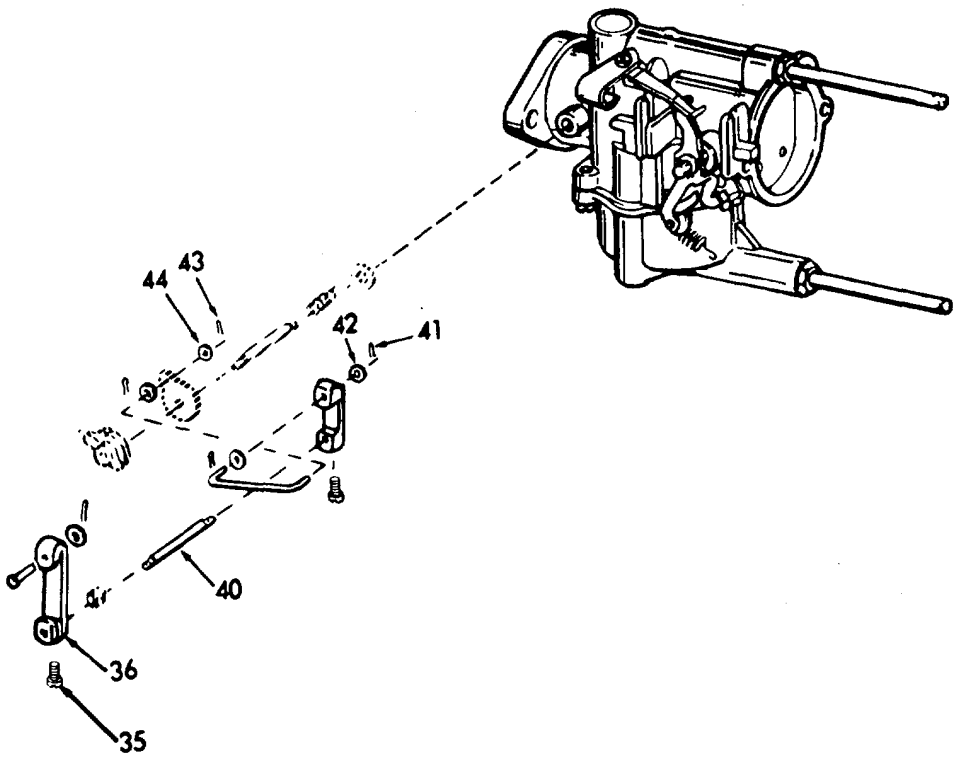


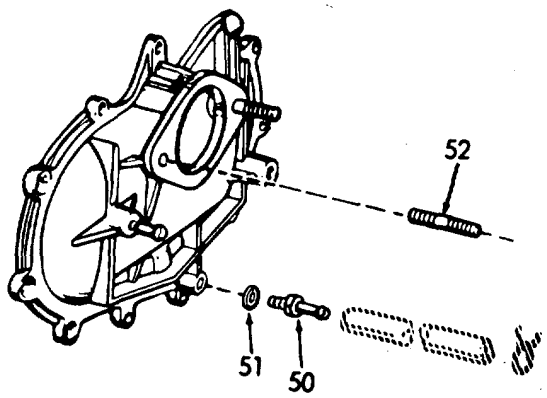
4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
REPAIR (Cont)				
		i. Flat-washer (44), and cotter pin (43)	Install.	
		j. Cotter pin (41). and flat-washer (42)	Install.	
		k. Cross-shaft adaptor (40)	Install.	
		l. Cross-shaft lever (36), and lever screw (35)	Install.	
8.	Manifold and shaft assembly	a. Airline nipple (50), and washer (51)	Remove.	If necessary.
		b. Studs (52)	Remove.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



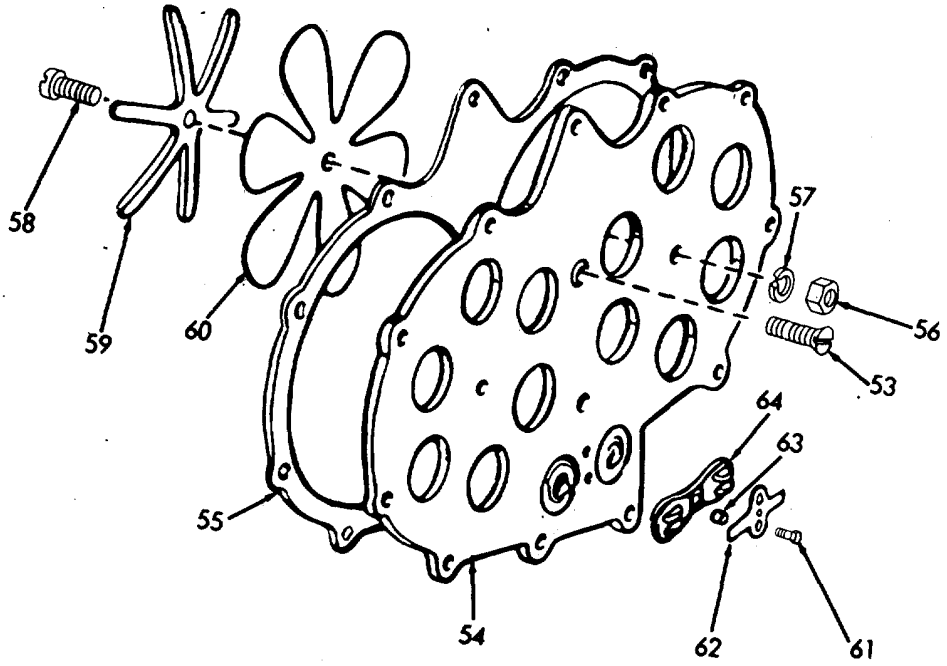


4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Leaf plate	a. Screws (53)	Remove.	
	b. Leaf plate (54), and gasket (55)	Remove.	Discard gasket.
	c. Nuts (56), lock-washer (57), screws (58), leaf stops (59), and carbu-retor leafs (60)	Disassemble.	If necessary.
	d. Screws (61), check valve spring (62), spacer (63), and check valve (64)	Disassemble.	If necessary.

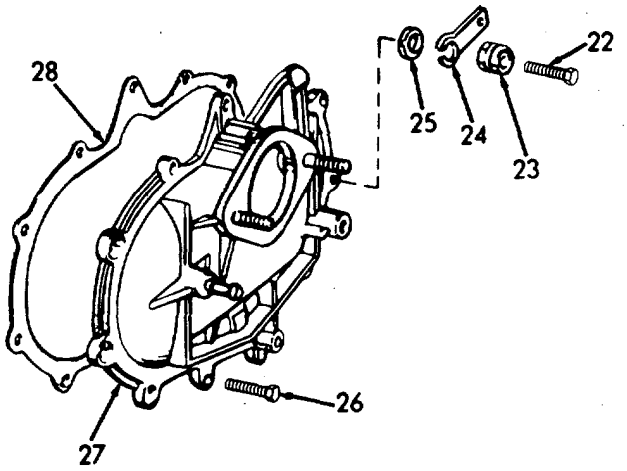
4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Gasket (55), leaf plate (54), and screw (53)	Install.	Use new gasket.



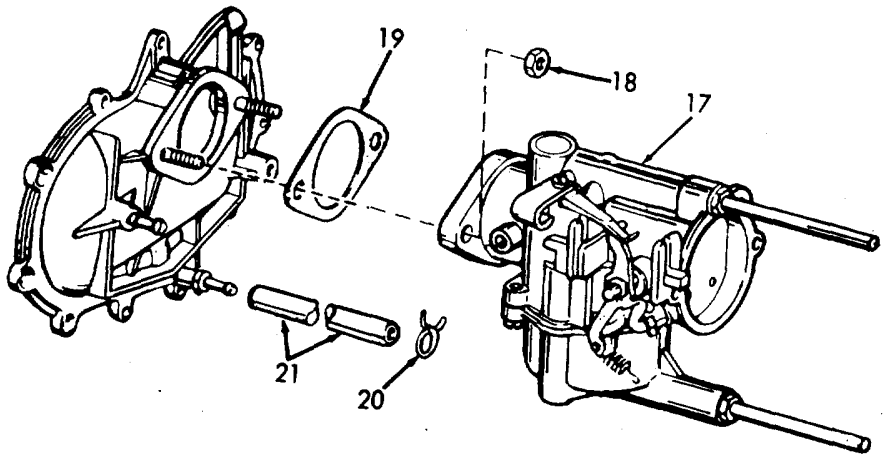
4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
10. Manifold and shaft assembly	a. Leaf plate gasket (28), manifold and shaft assembly (27), and eleven screws (26)	Install.	Use new gasket.
	b. Screw (22), grommet (23), support (24), and lock-washer (25)	Install.	



4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
INSTALLATION (Cont)				
11.	Air hose	a. Air hose (21)	Manufacture.	Cut air hose to 14 inches (35.6 cm).
		b. Hose clamps (22)	Install.	
12.	Carburetor	Gasket (19), carburetor (17), and nuts (18)	Install.	Use new gasket.

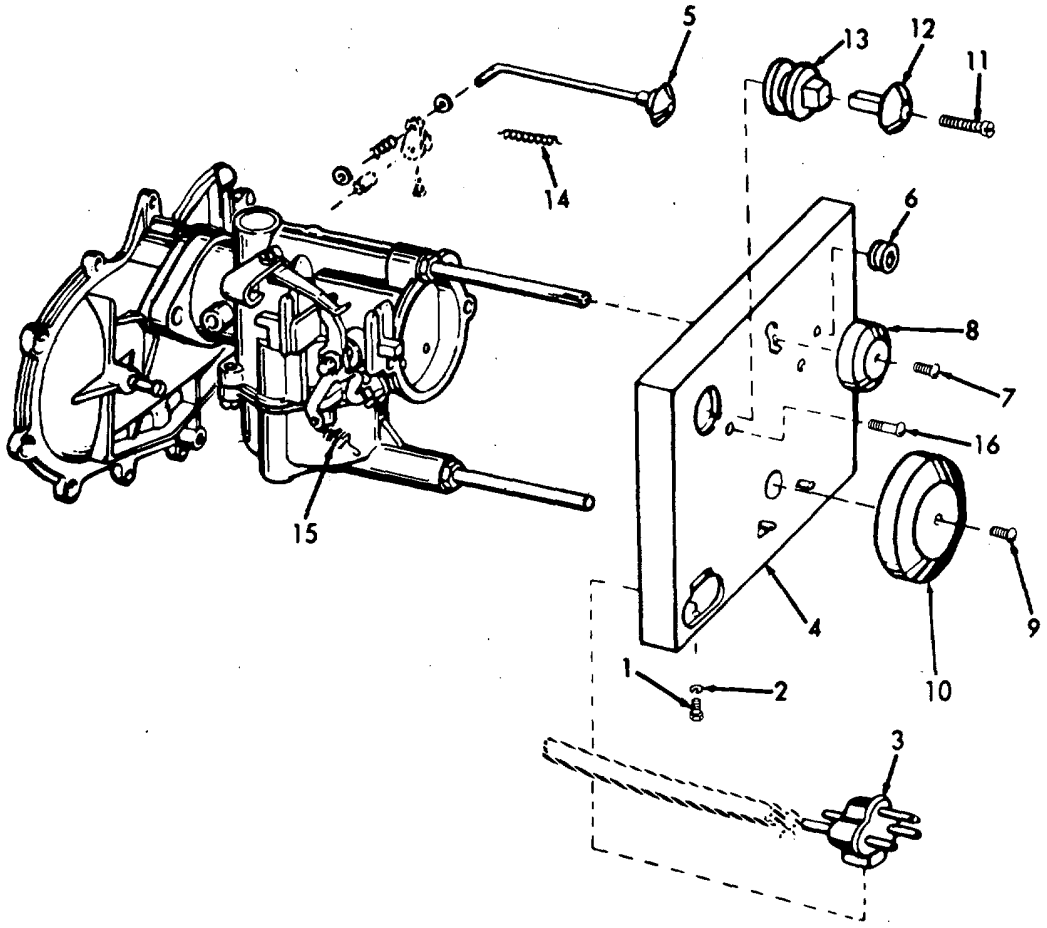


4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
13. Control panel	a. Control panel (4), and screws (16)	Install.	
	b. Springs (14 and 15)	Attach to control panel, and carburetor.	
	c. Choke control screw (11), knob (12) ,and grommet (13)	Install.	
	d. High ad justing screw (9), and knob (10)	Install.	
	e. Slow ad-justing screw (7), and knob (8)	Install.	
	f. Stop button (5), and grommet (6)	Install.	
	g. Fuel as-sembly body (3), screw (1), and lock-washer (2)	Install.	

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).

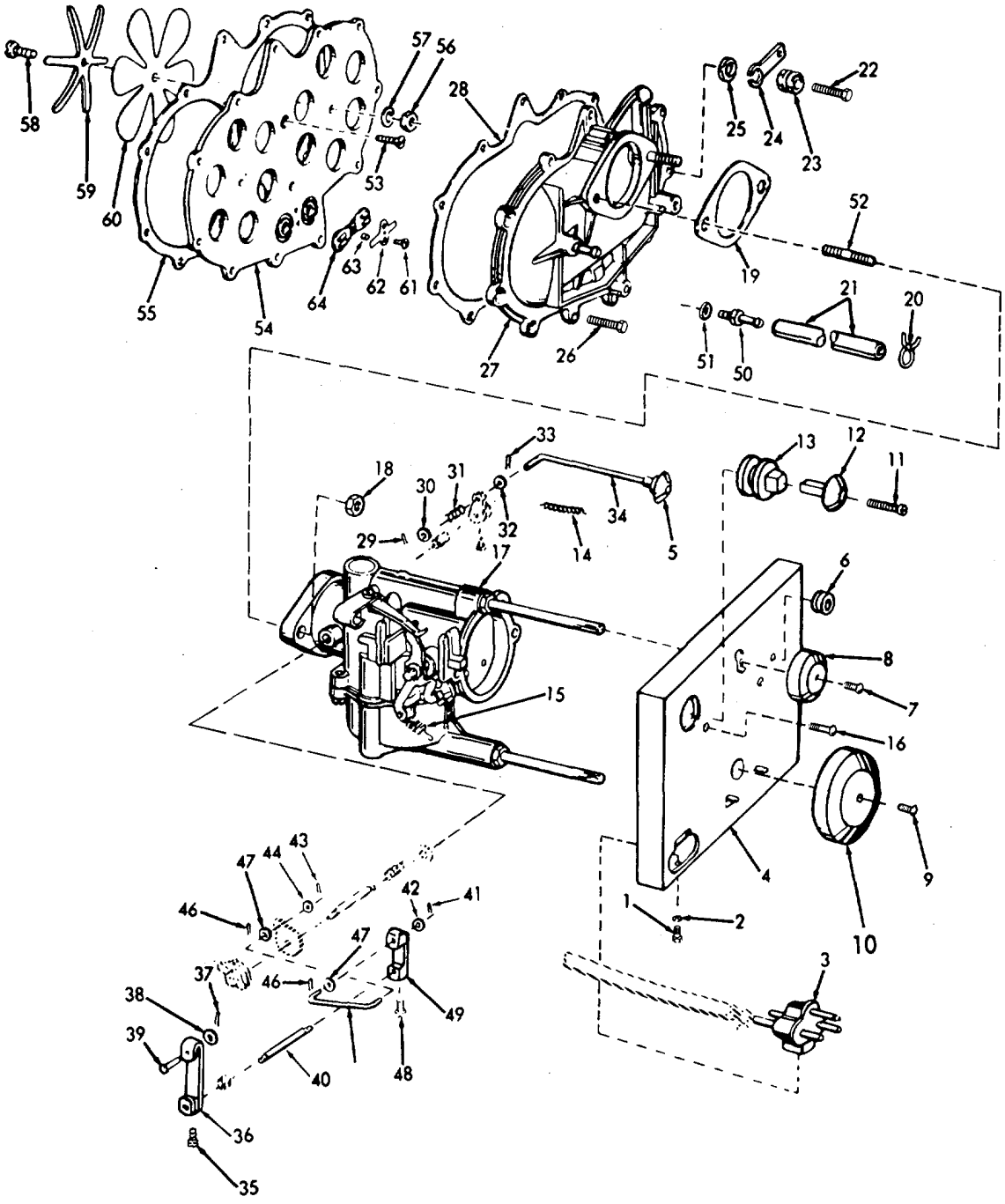
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

Carburetor Linkage, Control Panel, and Manifold Legend

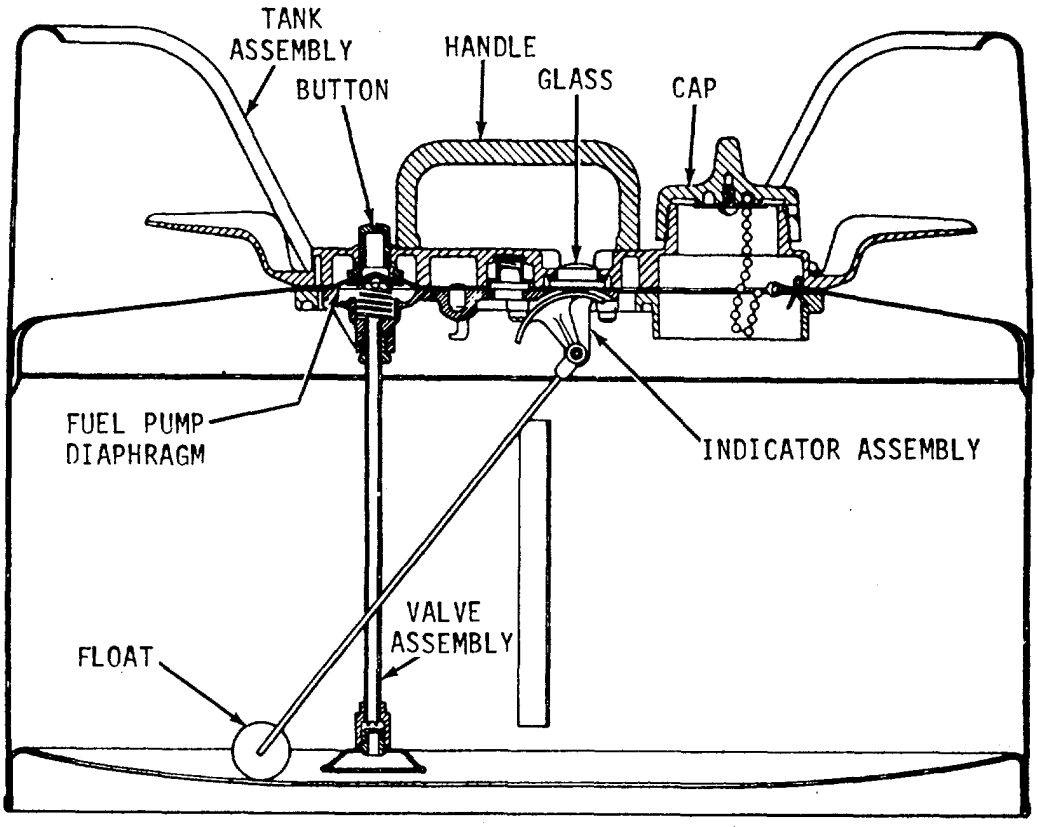
1. Screw
2. Lockwasher
3. Fuel assembly body
4. Control panel
5. Stop button
6. Grommet
7. Slow adjusting screw
8. Knob
9. High adjusting screw
10. Knob
11. Choke control screw
12. Knob
13. Grommet
14. Springs
15. Srpings
16. Screws
17. Carburetor
18. Nuts
19. Gasket
20. Hose clamps
21. Hose
22. Screw and shaft assembly
23. Grommet
24. Support
25. Lockwasher
26. Screws
27. Manifold and shaft assembly
28. Leaf plate gasket
29. Cotter pin
30. Flatwasher
31. Spring
32. Flatwasher
33. Cotter pin
34. Rod assembly
35. Lever screw
36. Cross-shaft lever
37. Cotter pin
38. Flatwasher
39. Pin
40. Cross-shaft adapter
41. Cotter pin
42. Flatwasher
43. Cotter pin
44. Flatwasher
45. Shaft linkage
46. Cotter pin
47. Flatwashers
48. Lever screw
49. Cross-shaft lever
50. Airline nipple
51. Washer
52. Studs
53. Screws
54. Leaf plate
55. Gasket
56. Nuts
57. Lockwasher
58. Screws
59. Leaf stops
60. Carburetor leafs
61. Screws
62. Check valve spring
63. Spacer
64. Check valve

4-7.3. CARBURETOR LINKAGE, CONTROL PANEL, AND MANIFOLD-MAINTENANCE INSTRUCTIONS (Continued).



4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS.

a. The fuel tank is mounted on the top of the frame and cover assembly. It has a dual hose which connects to the carburetor: one hose for gasoline to the carburetor, and the other for compressed vapor from the crankcase to the fuel tank. Ihe vapor maintains pressure within the fuel tank, forcing a supply of fuel back to the carburetor. The pressure can not escape back to the crankcase during the time the crankcase pressure is low, due to a check valve arrangement at the leaf valve.

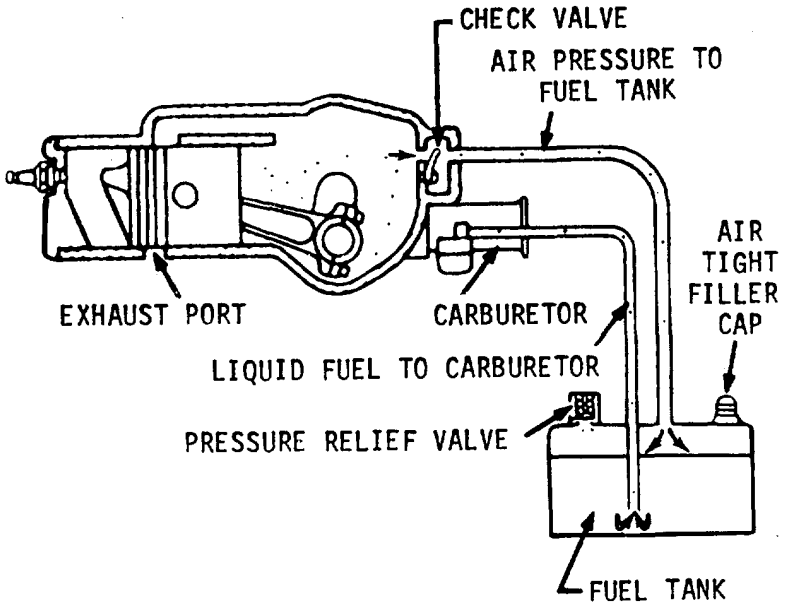


b. A diaphragm pump is built into the top of the fuel tank for the purpose of initially priming the carburetor with fuel. It is necessary to use this pump only when the unit has bee standing idle for some time, or when the filler cap has been removed.

c. Removing the filler cap releases pressure within the tank.

d. Initial priming of the carburetor with gasoline is accomplished by a hand operated plunger-diaphragm pump located on the fuel tank. The only time it will be necessary to operate the plunger on the fuel tank is when the engine has been standing idle for some time, or has been run dry of fuel. After the engine has been started, the fuel tank pressure is maintained by crankcase pressure to the fuel tank.

4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).



This task covers:

a. Inspection b. Repair

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

Drain fuel into a suitable container and dispose of properly.

General Safety Instructions

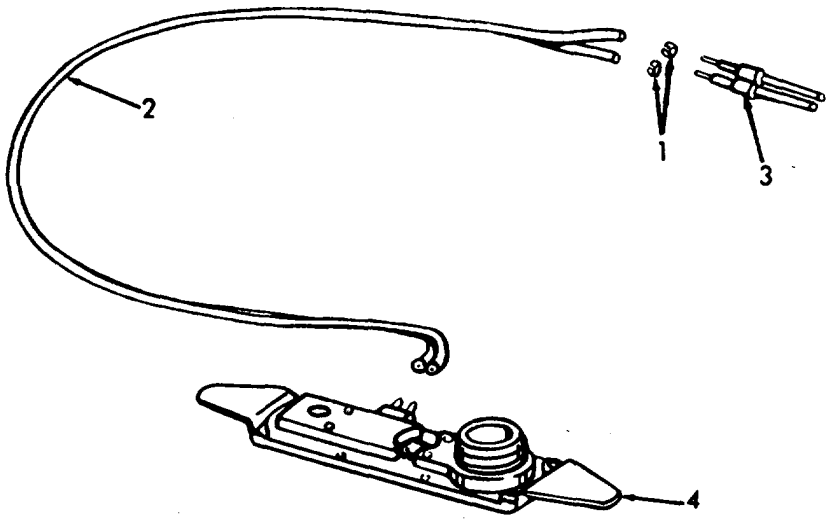
Observe WARNING.

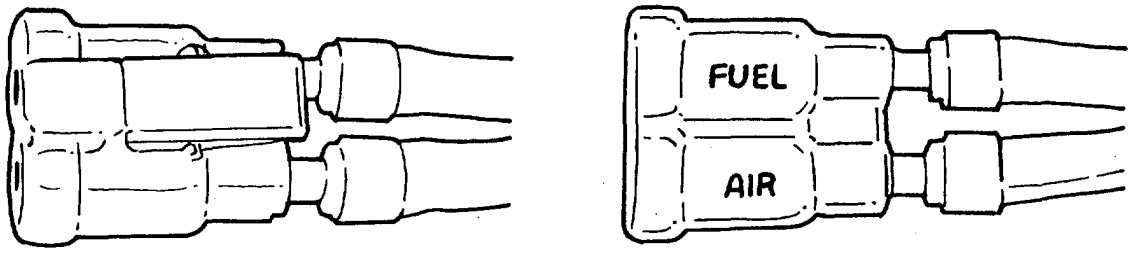
4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
		WARNING Handle gasoline in the fuel tank with extreme care. Keep all flames and possible sparks away from the fuel tank. Gasoline is combustible and explosive.	
INSPECTION			
1. Fuel tank	a. Fuel and air hose	Inspect for breaks, cracks, and leaks.	
	b. Filler cap	Inspect for damage.	
	c. Fuel tank dents, cracks, and leaks.	Inspect for breaks,	
	d. Fuel gage operation.	Inspect for proper	
REPAIR			
2. Hoses	a. Hose clamps (1)	Remove at four places.	
	b. Hose (2), and fuel line connector (3)	Disassemble.	Discard hose.
	c. Hose (2) housing (4).	Remove from upper	
	d. Hose (2)	1. Assemble to housing (4).	a. Air line is rib molded, and connected to AIR on tank and connector.
		2. Assemble to fuel line connector (3).	b. Connect fuel line to FUEL.

4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
	e. Hose clamps (1)	Install and tighten.	





TOP VIEW

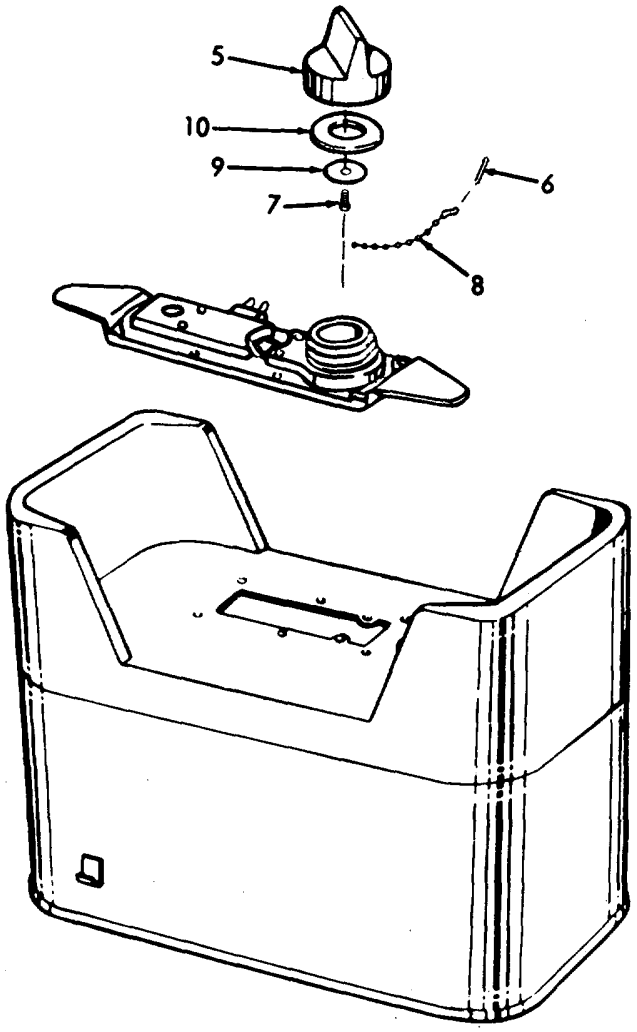
BOTTOM VIEW

4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Filler cap	a. Filler cap (5)	Unscrew and remove.	
	b. Cotter pin (6)	Remove.	
	c. Screw (7), chain (8), plate (9), and gasket (10)	Disassemble.	
	d. Cap (5), gasket (10), plate (9), chain (8), and screw (7)	Reassemble.	
	e. Cotter pin (6)	Reinstall.	
	f. Filler cap (5)	Install.	

4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

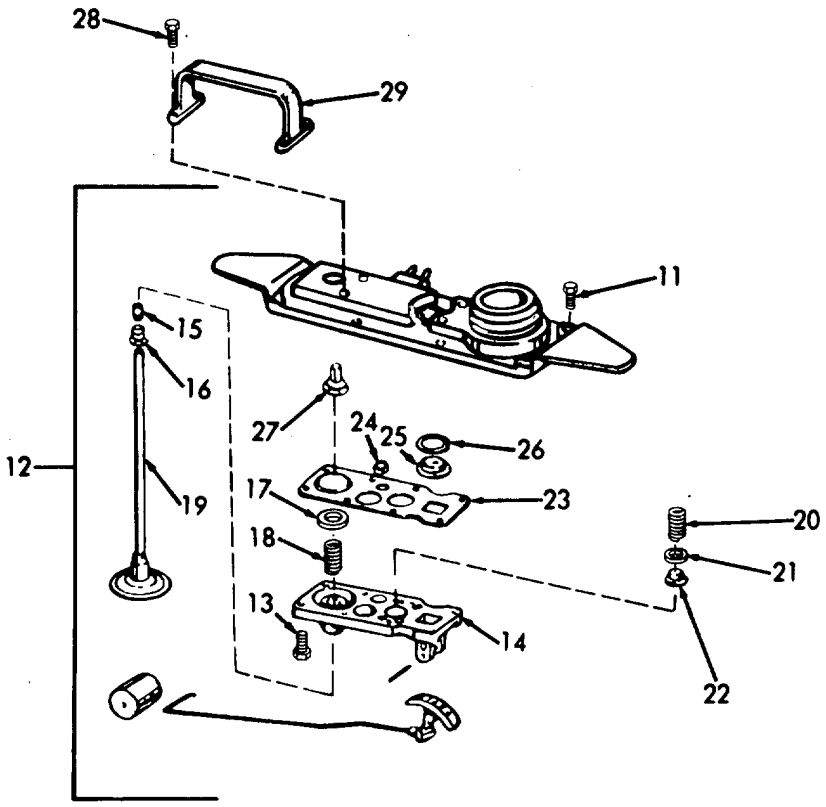


4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Diaphragm	a. Screws (11)	Remove.	
	b. Upper housing assembly (12)	Remove as an assembly.	Handle bracket, float, gage, and hoses.
	c. Screws (13)	Remove.	
	d. Priming pump	1. Remove housing (14).	
		2. Remove gland (15) and nut (16).	
		3. Remove support (17), spring (18), and valve (19).	
	e. Pressure valve	Remove spring (20), washer (21), and valve (22).	
	f. Diaphragm (23)	Remove.	Discard.
	g. Disc valve (24)	Remove.	
	h. Glass (25), and seal (26)	Remove.	
	i. Fuel push-button (27)	Remove.	
	j. Handle	Remove screws (28), and handle (29).	Disassemble if necessary

4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



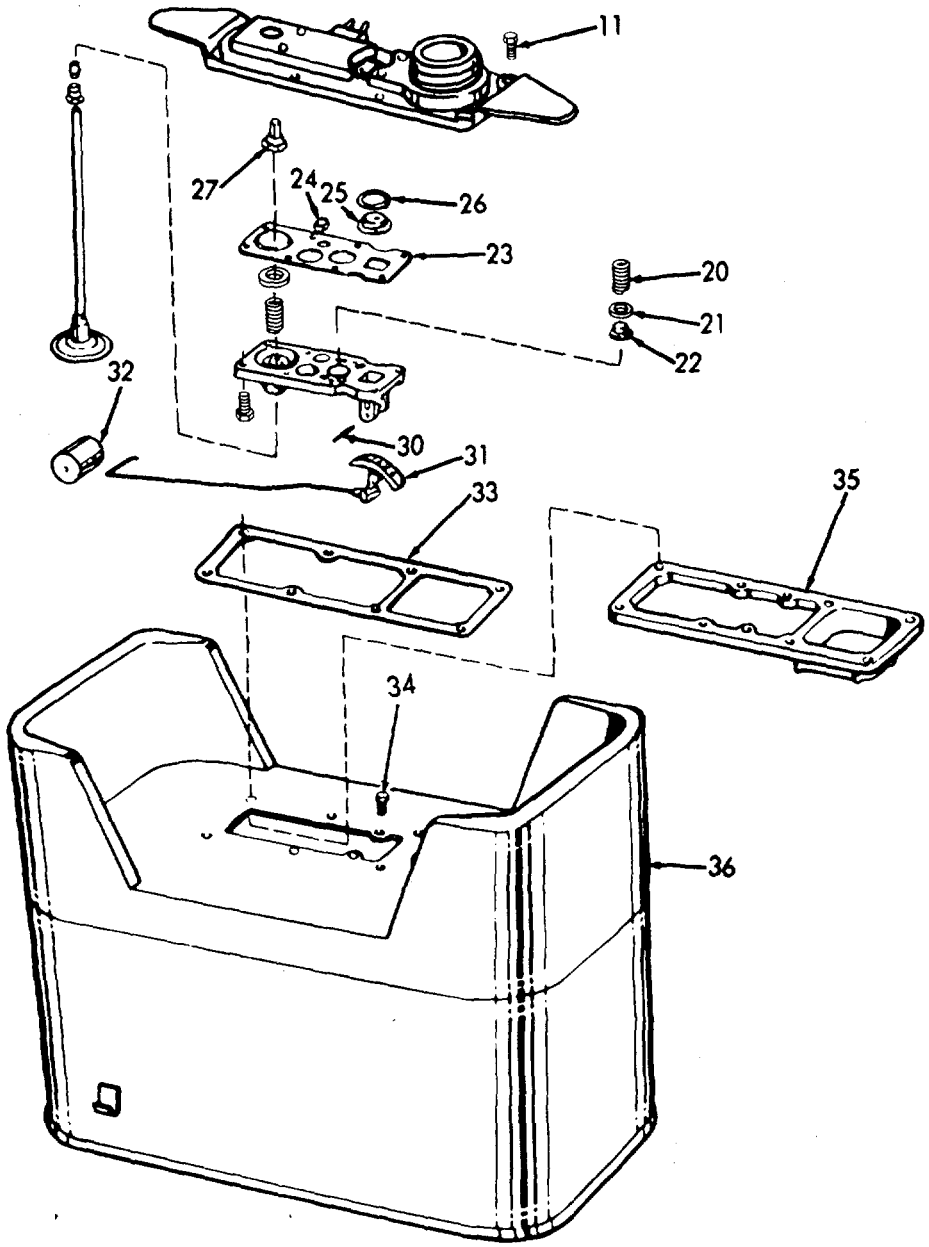
4-7.4. FUEL TANK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Float assembly	1. Remove pin (30).	Disassemble if necessary.
		2. Remove indicator assembly (31).	
		3. Remove float (32).	
	l. Gasket (33)	Remove.	Discard.
	m. Screws (34) and plate (35)	Remove from tank (36).	Disassemble if necessary.
	n. Fuel push button (27)	Install.	
	o. Seal (26), and glass (25)	Install.	
	p. Disc valve (24)	Install.	
	q. Dia-phragm (23)	Install.	Use new diaphragm.
	r. Pressure valve (22), washer (21), and spring (20)	Assemble.	

4-7.4. FUEL TANK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



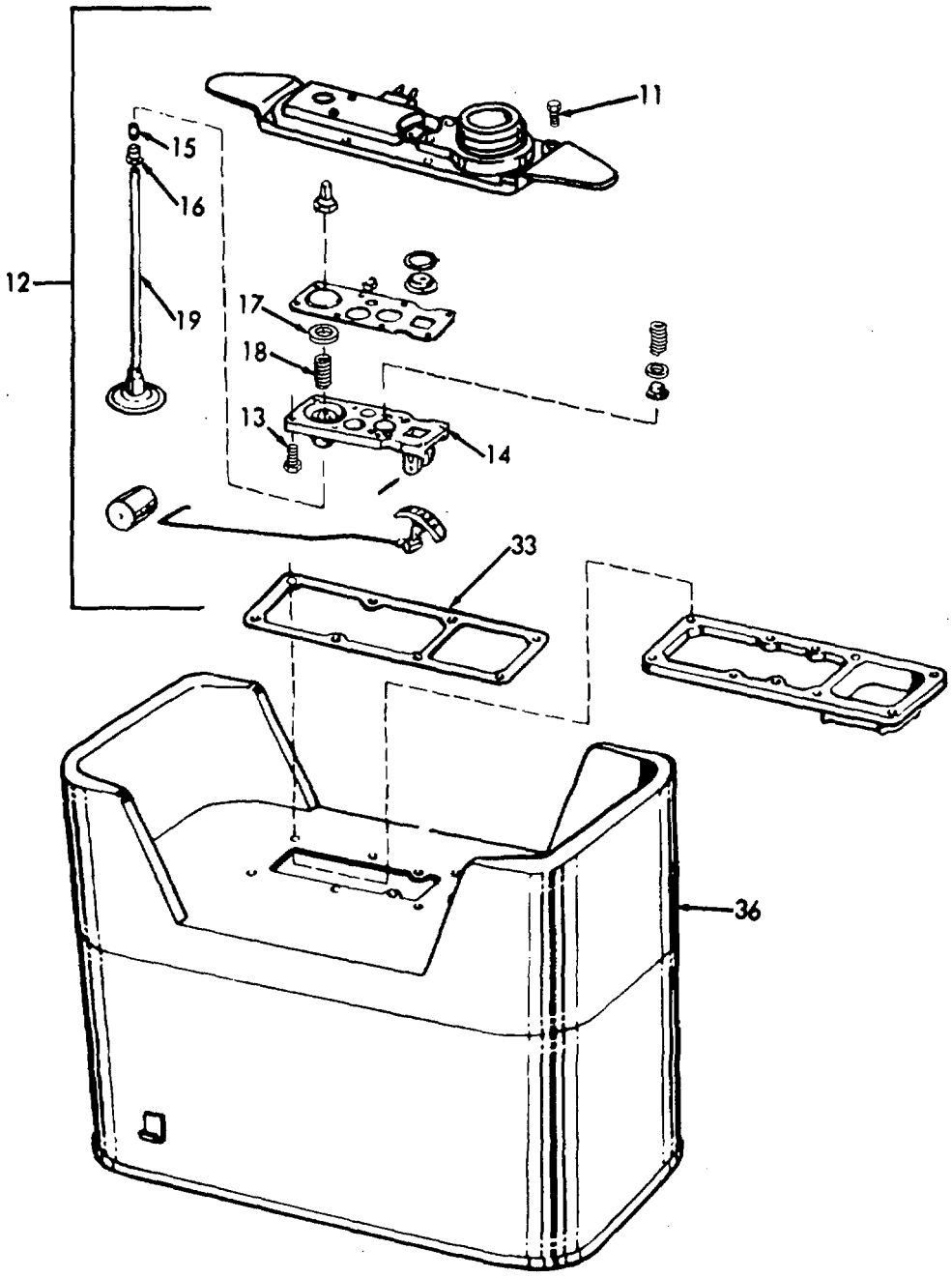
4-7.4. FUEL TANK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	s. Valve (19), spring (18), and support (17)	Reassemble.	
	t. Nut (16), and gland (15)	Assemble to housing (14).	
	u. Screws (13), and upper housing assembly (12)	Reassemble.	
	v. Gasket (33), upper housing assembly (12), and screws (11)	Reassemble.	Use new gasket.

4-7.4. FUEL TANK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS.

a. Operation.

(1) The magneto is essentially a generator. It is mounted on the cylinder and crankcase assembly and consists of an armature plate upon which are mounted the ignition coil and lamination assemblies, condensers, and breaker assemblies. A magnet is cast into the rim of the flywheel.

(2) In operation, as the permanent magnet poles in the flywheel pass over the pole shoes of the coil laminations, the magnetic field causes a current to flow through the primary winding of the coil. This current flow induces a voltage in the secondary winding. The current flow through the primary winding is normally grounded through the closed breaker points. When the pistons near their top dead-center positions, a cam arrangement opens the breaker points, breaking the ground connection on the primary windings. This causes the magnetic field around the primary coil to collapse. The collapse is hastened by the action of the condenser, which tends to store up the current induced by the collapse of the primary field and suddenly discharges it in the reverse direction. The condenser also prevents sparking across the breaker points to minimize deterioration of the contact surfaces.

(3) At the instant the primary field collapses, a high voltage is induced into the secondary winding. This voltage is applied to the spark plugs through the high tension spark plug wire. It arcs across the spark plug gap, and ignites the fuel charge which has just been compressed by the piston. This cycle is repeated for each cylinder, each revolution of the crankshaft.

b. Description.

(1) The ignition spark is supplied to the spark plugs by a magneto, which uses a permanent magnet built into the engine flywheel as a means of generating the necessary voltage. As the piston nears its top dead-center position on the compression stroke, a cam arrangement on the crankshaft opens the magneto breaker points, which, through the magneto circuitry causes voltage to be applied to the spark plug. This ignites the compressed vapor within the cylinder, initiating another power stroke. The power thus generated is used to drive the fire pump.

(2) The magneto and throttle are synchronized, functioning through a system of linkages so that a proportionate volume of fuel-vapor charge is admitted to the compression chamber for any given degree of spark advance throughout the speed range of the engine. The degree of spark advance and throttle valve opening is controlled by the operating cylinder.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS. (Continued)

c. Maintenance. The ignition system ordinarily requires little attention except for replacing of spark plugs and occasional cleaning and adjusting of the breaker points. In event of failure, replacement of the breaker points, ignition coils and condensers may be necessary. The magneto should not be completely disassembled for general reconditioning purposes.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

Special Tools

Feeler gage
Mallet
Point dresser

Material/Parts
Dow Chemical DC-4

Personnel Required

1

References
NONE

Equipment Condition | Condition Description | Paragraph
4-7.1 | Starter Assembly Removal

Special Environmental Conditions
NONE

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

TESTING

1. Magneto assembly — If difficulty is encountered when starting the pump or if the engine does not start or operates irregularly and there is reason to suspect faulty ignition, the following procedures should be followed:

   a. Disconnect and remove both spark plugs.

   b. Ground one of the spark plug leads to a convenient part of the engine by holding the contact end of the lead snugly against the cylinder block or other exposed parts of the engine.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

TESTING (Cont)

c. Hold the live end of the remaining lead approximately 1/8 inch from some exposed part of the engine. Do not hold the lead too near the spark plug port because the escaping fuel mixture may be ignited.

d. Pull rapidly on the starter handle to crank the engine. If the magneto is operating properly, a spark between the lead and the engine will be visible. Repeat operation for the other spark plug lead.

2. Spark plug — The condition of the spark plug can be checked in the plug same manner by attaching the leads to the spark plugs, grounding the shell of the plugs against an exposed part of the engine and cranking the engine rapidly. Weak or intermittent sparking at the spark plug is often caused by the following conditions:

a. Corroded, pitted or improperly adjusted breaker points.

b. Defective condenser.

c. Defective ignition coil.

d. Faulty electrical connections.

e. Faulty insulation, or a breakdown between the ignition system and the radio shielding.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

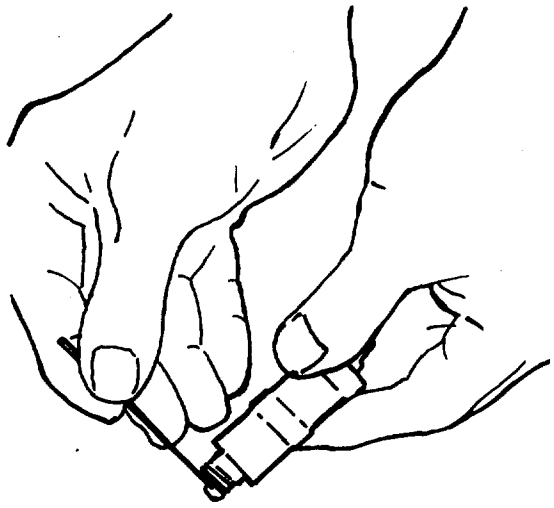
LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS

WARNING

In order to prevent accidental starting remove and ground each spark plug lead.

3. Spark plugs — The spark plug should be checked for excessive carbon accumulation and the proper gap setting between points. The correct point setting for the spark gap is 0.030 inch. If the spark plug has an excessive accumulation of carbon or if the electrodes are eroded excessively and readjustment of the point gap is impractical, replace it.



4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

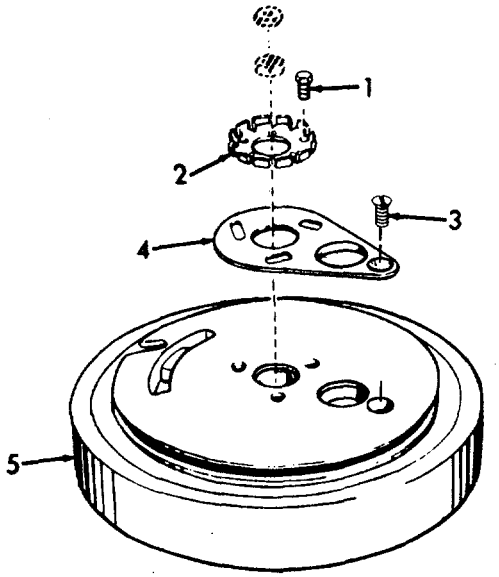
LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

WARNING

In order to prevent accidental starting remove and ground each spark plug lead.

4.	Breaker points	a.	Inspection.	
		(1)	To inspect the condition of the breaker points proceed as follows:	
		(a)	Starter housing assembly	Remove.	Refer to paragraph 4-7.1.
		(b)	Screws (1), and ratchet (2)	Remove.	
		(c)	Screw (3), and flywheel cover (4)	Remove.	Rotate flywheel (5) until breaker points are visable.

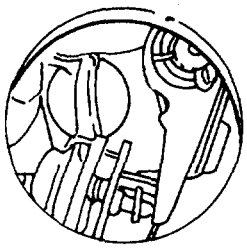


4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

(2) The breaker point surface becomes pitted after a long period of service and after a long period of idleness the surfaces may become oxidized. Both conditions prevent proper operation of the magneto and result in a faulty spark at the spark plug. To function properly, the breaker point surfaces must be clean and smooth, and may be cleaned in the following manner:



(a) Carefully spread the points with a small screw driver, and insert a point dresser. A strip of fine sandpaper folded back to back may be used for a point dresser.

(b) Release points and work point dresser up and down until point surfaces are clean and smooth. If points do not clean up easily, replace the points.

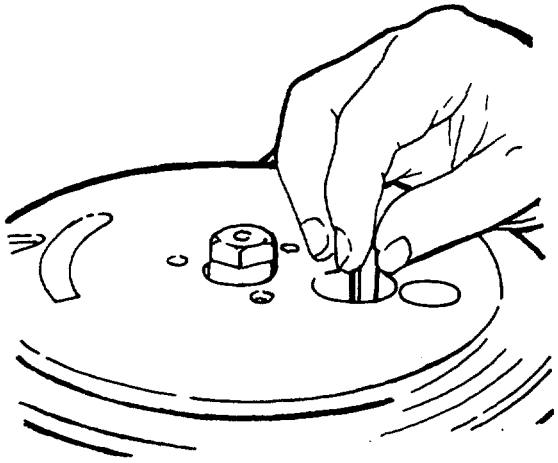
(c) Insert a strip of clean, stiff paper, and remove any traces of corrosion or point dressing material which may have adhered to the point surfaces.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

(d) Using a feeler gage, check the gap between the points in their full open position. The gap should be 0.020 inch (0.051 cm).



b. To adjust the breaker point gap. The breaker points are actuated by the cam attached to the camshaft and are attached to the armature plate by an anchor or pivot screw and an adjusting screw. A rubbing block is attached to the breaker arm which rides on the cam and as the crankshaft is rotated, the breaker points are opened and closed. The breaker gap setting is accomplished by shifting the breaker baseplate toward or away from the breaker cam on the crankshaft. Breaker point gap is increased by moving the assembly toward the cam and is decreased when moving away from the cam. Adjust the breaker point according to the following procedures:

(1) Turn the flywheel until rubbing block rides on the high side of the cam thereby giving the maximum gap opening.
(2) Insert gage strip of 0.020 inch thickness to check gap. If the gap is incorrect, adjust as follows:

(3) Loosen the anchor screw. A slightly.

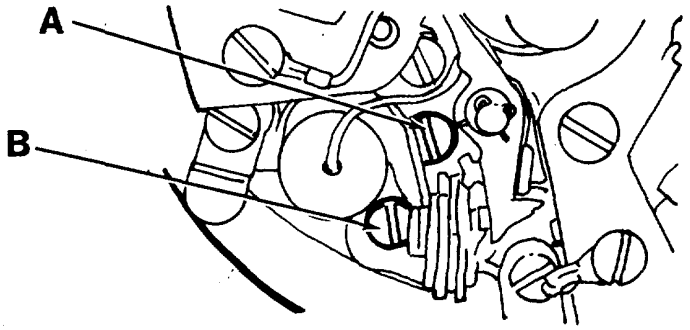
4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)

(4) Turn the adjusting screw B to right or left to obtain desired gap opening. When correct, both faces of the gage strip should bear slightly against both breaker point faces and should neither be too tight or too loose.

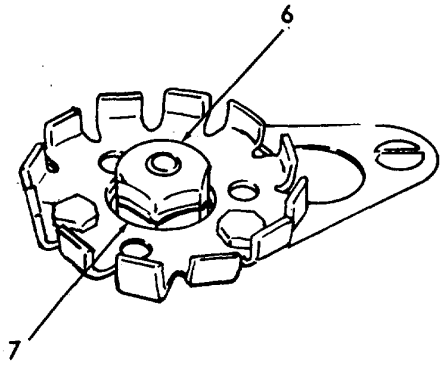
(5) Tighten the anchor screw A securely. Repeat as above to adjust gap of other breaker point set.

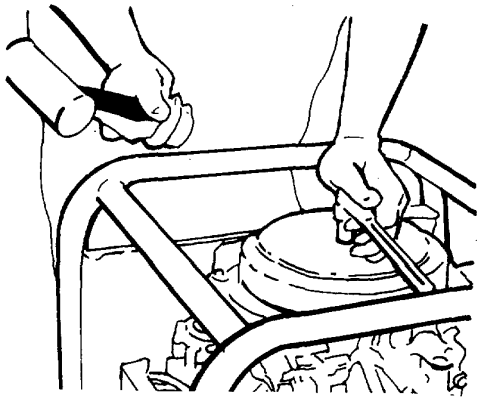


A Anchor screw
B Adjusting screw

REMOVAL

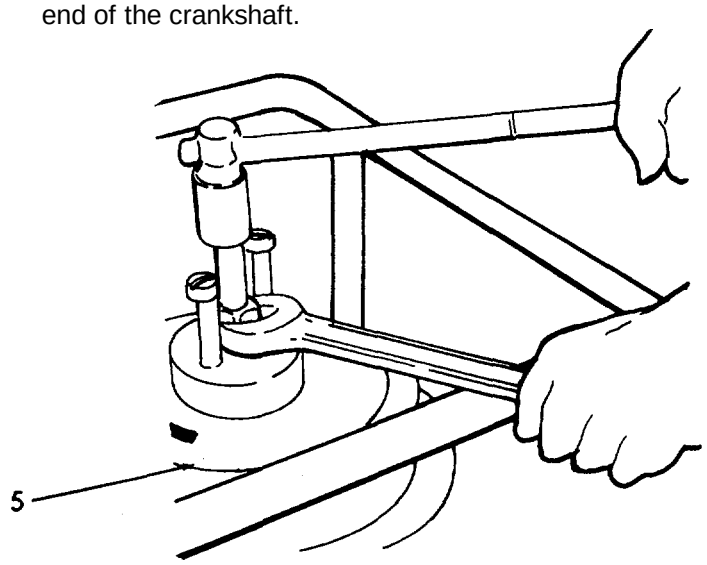
5. Flywheel	a. Nut and cap assembly (6)	Remove.	
	b. Crank-shaft nut (7)	Remove.	Remove the flywheel nut by striking the handle of a socket wrench sharply with a mallet or small hammer.





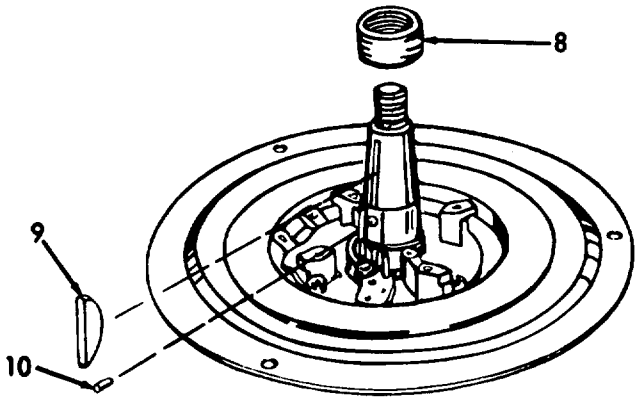
4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Flywheel (5)	1. Attach a flywheel puller making certain that the large center screw is turned to the outer limit.	
		2. Turn the large center screw down until it comes to rest against the end of the crankshaft.	
		3. Hold the flywheel and flywheel puller with a wrench and turn down on the large screw with another wrench until the flywheel can be lifted from the tapered end of the crankshaft. If necessary to jar loose, lift up on the rim of flywheel to absorb the shock, then strike the end of the puller screw sharply with a light hammer.	



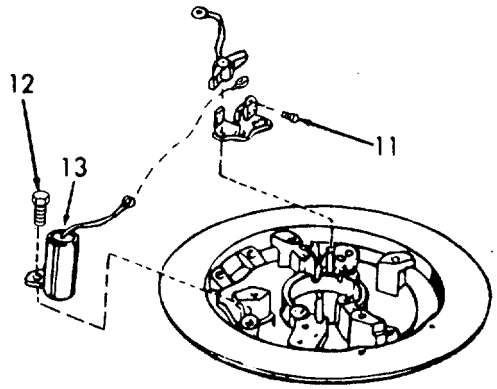
4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		4. Detach the puller from the flywheel.	
REPAIR			
6. Breaker Cam	a. Breaker cam (8)	Lift off.	
	b. Key (9), and pin (10)	Remove.	
	c. Pin (10), key (9), and breaker cam (8)	Install.	Align the slot in the cam with the key and pin in the crankshaft and push down squarely and carefully over the crank-shaft. The side marked "TOP" should be out. Do not force; if lined up squarely, it will slip easily into position.



4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

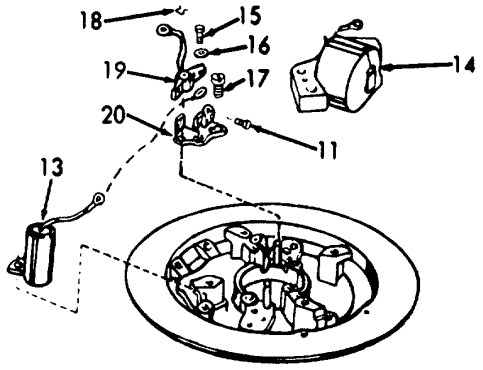
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Condensers (typical)	a. Screw (11) and lead	Remove.	
	b. Screw (12), and condenser (13)	Remove.	
	c. Condenser (13), and screw (12)	Install.	Make certain that all contact surfaces and screw are clean and free of foreign matter and that terminal nuts or screws are made secure to guard against faulty ignition. All electrical connections must be clean, free of corrosion, and tight.
	d. Screw (11), and lead	Install.	



8. Breaker point assembly (typical)	a. Screw (11)	Remove.	
	b. Coil (14), and condenser leads (13)	Remove.	

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

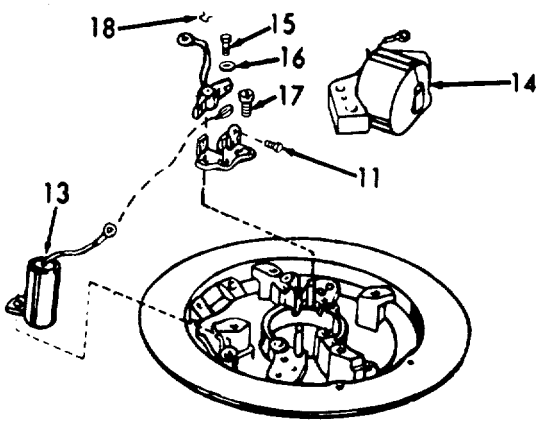
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Screw (15), and flat-washer (16)	Remove.	
	d. Eccentric screw (17)	Remove.	
	e. Spring clip (18)	Remove.	
	f. Arm assembly (19), and base assembly (20)	Remove.	
	g. Base assembly (20), and arm assembly (19)	Install.	All electrical connections must be free of corrosion, clean and tight to assure proper contact. Adjust wires to rest close to assemblies to prevent rubbing against the breaker cam or hub of the flywheel which may cause short circuit and faulty ignition.



4-169

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

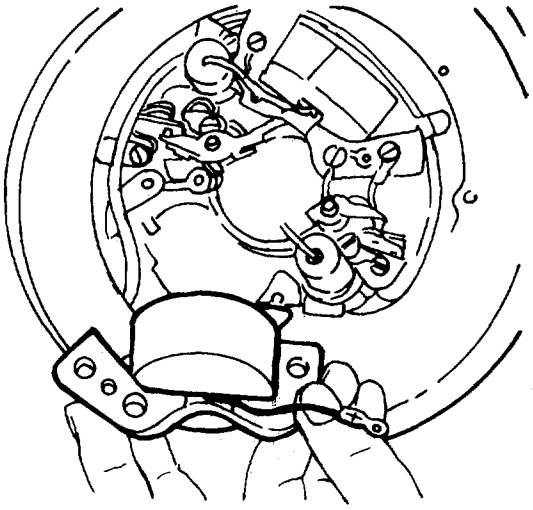
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Spring clip (18)	Install.	
	i. Eccentric screw (17)	Install.	
	j Screw (15), and flat-washer (16)	Install.	
	k. Screw (11), coil (14), and condenser (13) leads	Install.	

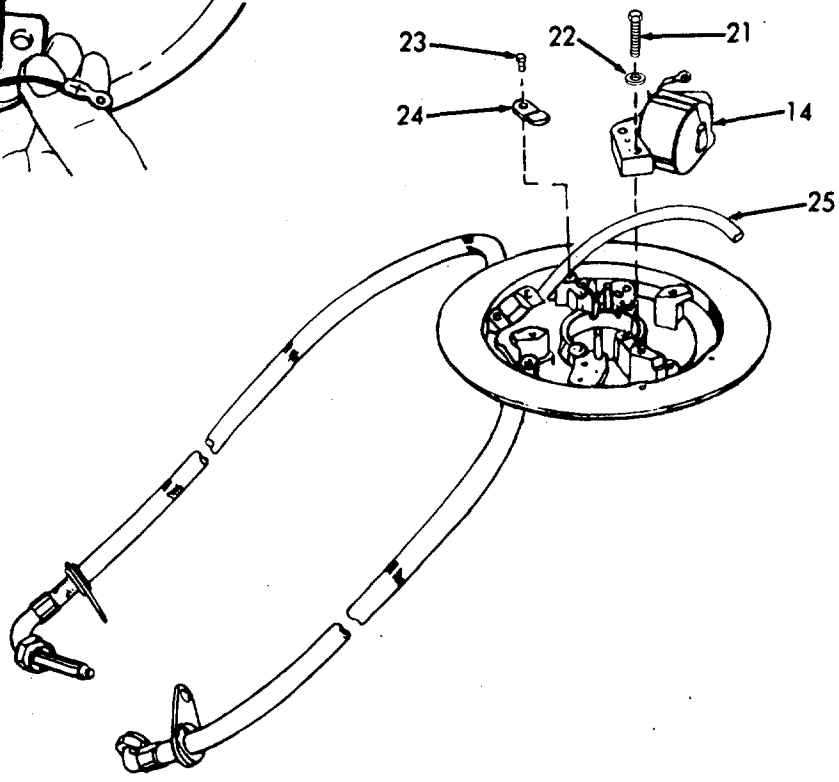


9.	Coil assembly (typical)	a	Screws (21), and flat-washers (22)	Remove.
		b	Leads	Remove.
		c.	Coil (14)	Lift and move to one side.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Screw (23), and high tension clip (24)	Remove.	
	e. Coil (14)	Pull iginition lead (25) out of coil.	The lead is inserted over a needle imbedded in the coil tube.



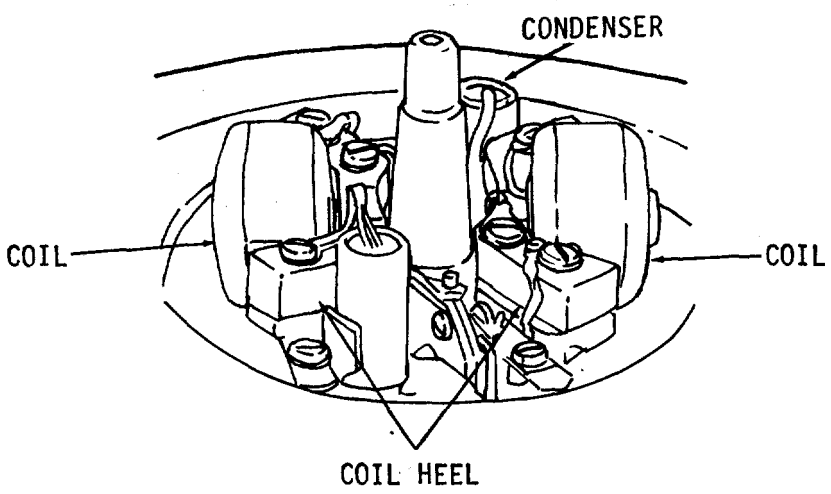


4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Ignition lead (25)	1. Insulation.	Coat end of lead liberally with DC-4 or equivalent.
		2. Force end of ignition lead into coil tube with the needle penetrating stranded core of the lead.	
	g. Coil (14) with ignition lead attached, screws (21), and flat washers (22)	Position and insert screws.	Tighten to hold snugly but not tight.

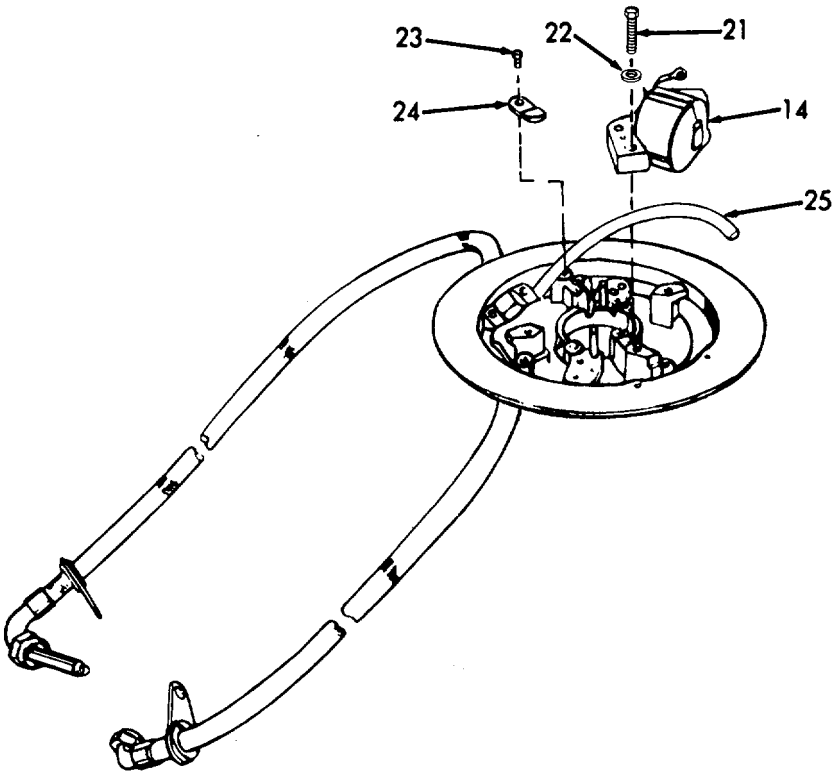
NOTE

Note machined bosses on armature plate casting and adjust position of the coil to where face of the coil heel rests flush with the face of the machined boss.



4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Screws (21)	Tighten.	Tighten the screws attaching the coil securely. This operation provides correct clearance or space between the coil heels and pole shoes of the magnet cast into the flywheel.
	i. Clip (24), ignition lead (25), and screw (23)	Install.	

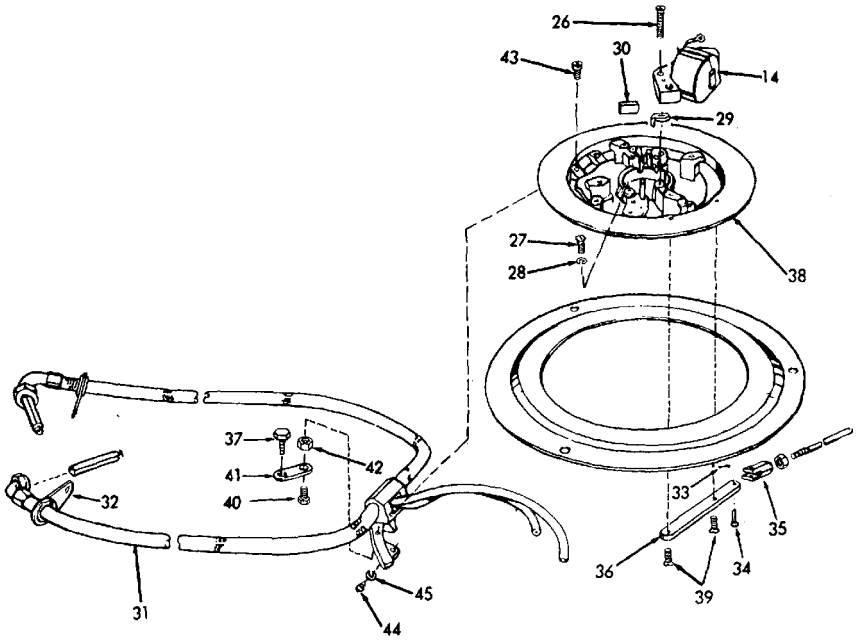


4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Armature plate	a. Screws (26)	Remove.	
	b. Screws (27), and lock-washers (28)	Remove.	
	c. Coil (14), oiler clip (29), and oiler wick (30)	Remove.	
	d. Spark plug leads (31)	Remove from spark plugs.	
	e. Lead brackets (32)	Disconnect from cylinder head.	
	f. Cotter pin (33), and pin (34)	Remove.	
	g. Clevis (35), and arm (36)	Separate.	
	h. Screw (37)	Remove.	
	i. Spark plug leads (31), armature plate (38)	Remove.	As a unit.

4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Screws (39), and arm (36)	Remove.	If necessary.
	k. Screw (40), link (41), and spacer (42)	Remove.	If necessary.
	l. Screws (43)	Remove.	
	m. Screws (44), and lock-washers (45)	Remove.	
	n. Armature plate (38), and spark plugs (31)	Seperate.	
	o. Spark Plug leads (31), and armature plate (38)	Assemble.	

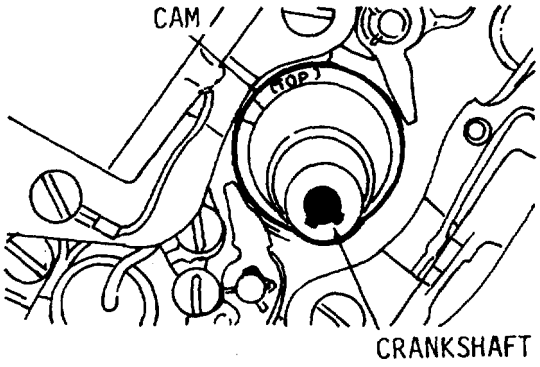


4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	p Screws (43)	Install.	
	q. Spark plug leads (31), and armature plate (38)	Install.	

NOTE

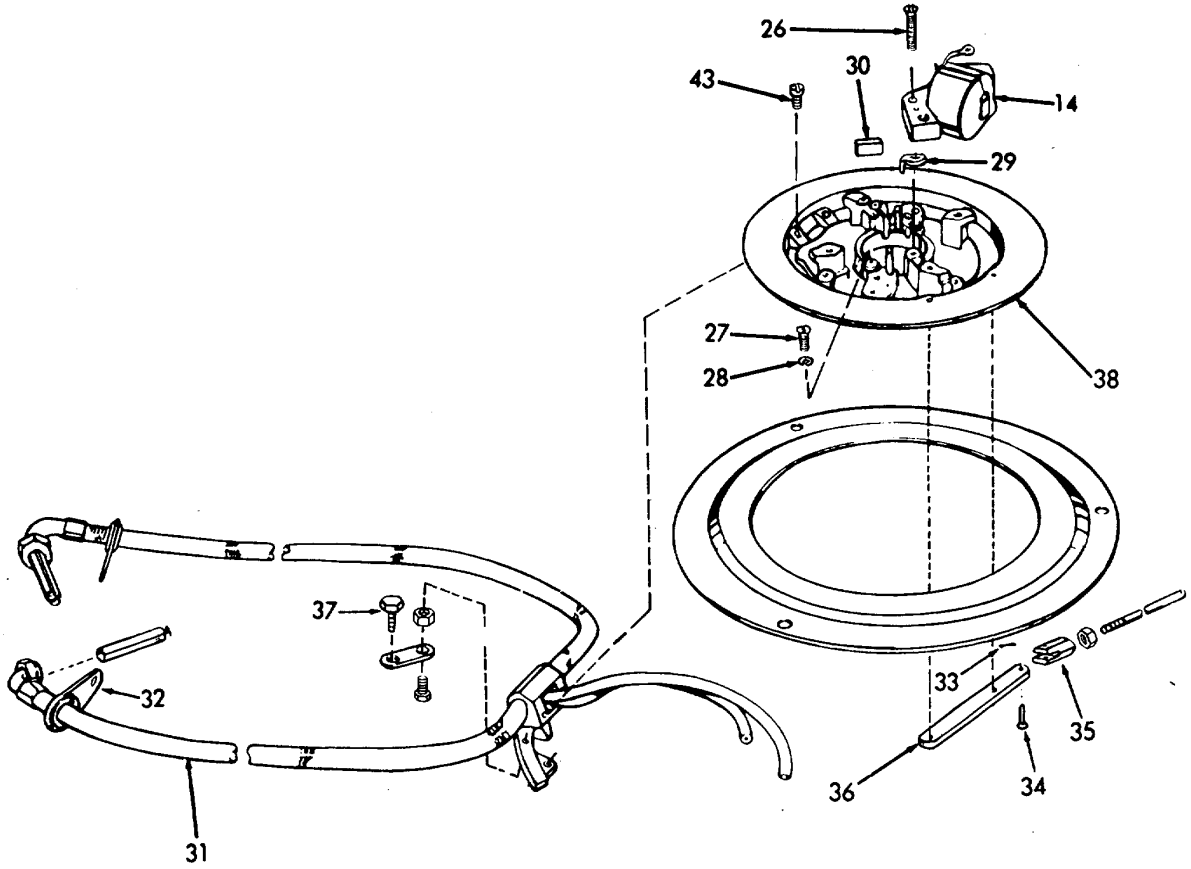
When replacing the armature plate, turn the high side of the breaker cam toward the core in the center of the ignition coil indicated by the arrow. This is to prevent damage to the rubbing blocks on the breaker point arms during installation of the armature plate or cam.



r. Screw (37)	Install	
s. Clevis (35), arm (36), pin (34), and cot-ter pin (33)	Assemble.	
t. Lead brackets (32)	Install on cylinder head.	

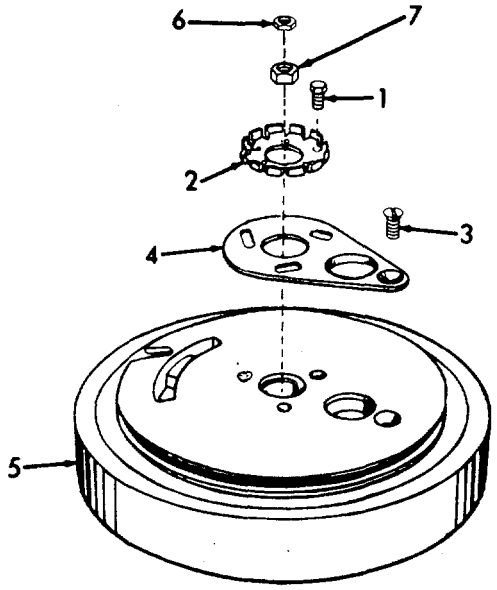
4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	u. Spark plug leads (31)	Reconnect to spark plugs.	
	v. Oiler wick (30), and oiler cap (29)	Install.	Saturate wick with light oil.
	w. Coil (14)	Install.	
	x. Screw (27), and lock-washers (28)	Install.	
	y. Screws (26)	Install.	
	z. Breaker points	Refer to step 4b.	

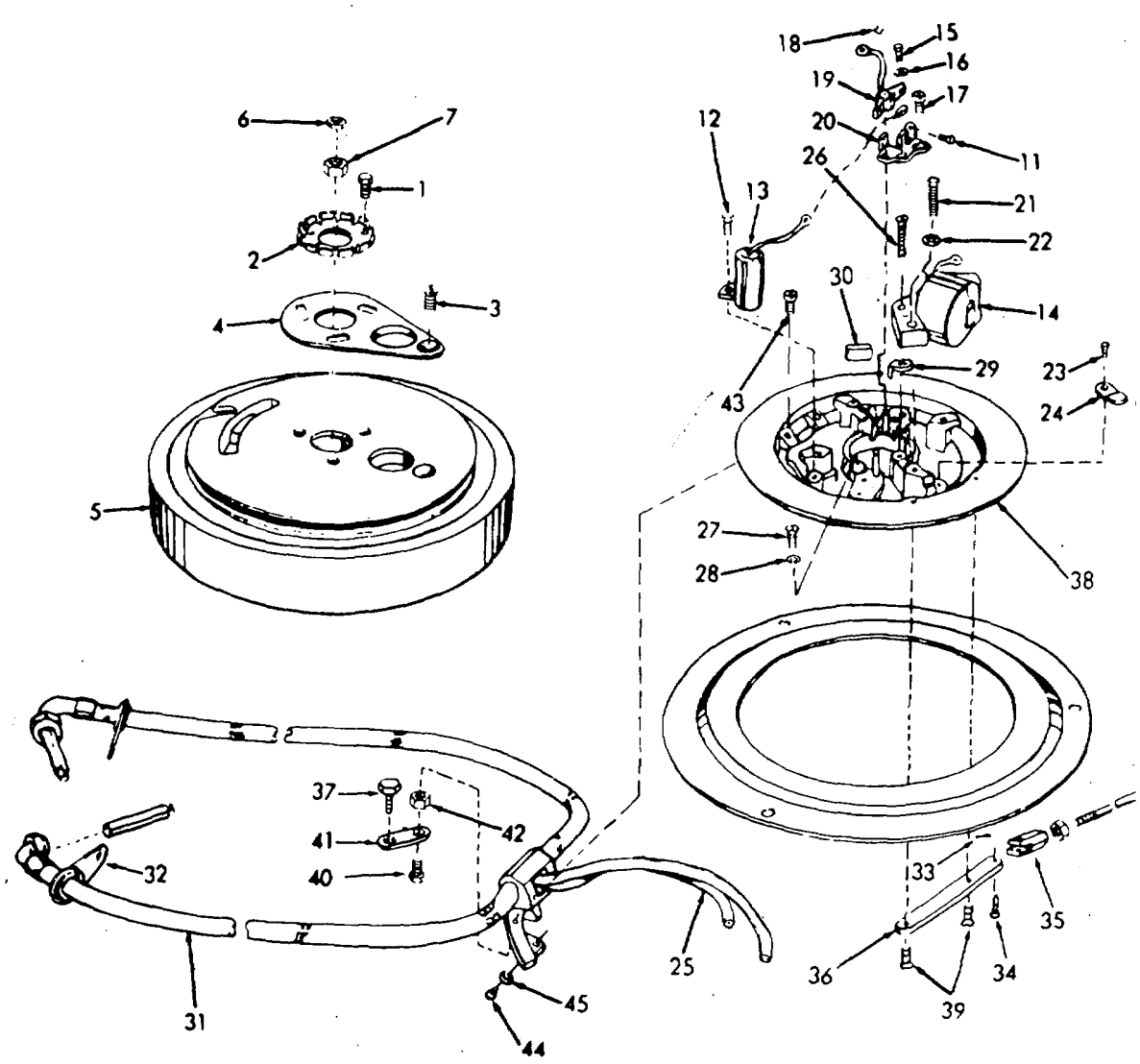


4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11. Flywheel	a. Crankshaft nut (7)	Install.	
	b. Nut and cap assembly (6)	Install.	
	c. Flywheel (5)	Install.	
12. Breaker Points	a. Flywheel cover (4), and screw (3)	Install.	
	b. Ratchet (2), and screws (1)	Install.	
	c. Starter housing assembly	Install.	Refer to paragraph 4-7.1.



4-7.5. MAGNETO ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).



1. Screws
2. Ratchet
3. Screw
4. Cover
5. Flywheel
6. Nut and cap assembly
7. Crankshaft nut
11. Screw
12. Screw
13. Condenser leads
14. Coil
15. Screw
16. Flatwasher
17. Eccentric screw
18. Spring clip
19. Arm assembly
20. Base assembly
21. Screws
22. Flatwashers
23. Screw
24. High tension clip
25. Ignition lead
26. Screws
27. Screws
28. Lockwashers
29. Oiler clip
30. Oilerwick
31. Spark plug leads
32. Lead brackets head
33. Cotter pin
34. Pin
35. Clevis
36. Arm
37. Screw
38. Armature plate
39. Screws
40. Screw
41. Link
42. Spacer
43. Screws
44. Screws
45. Lockwashers

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS.

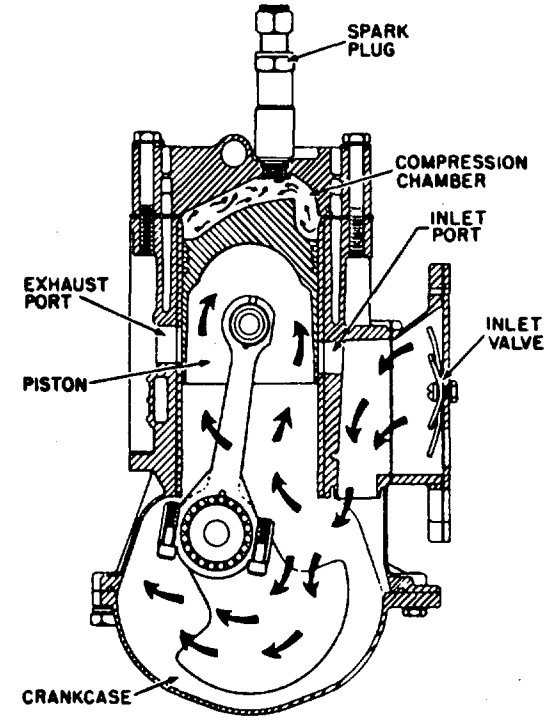
a. Power head, crankshaft, and pistons. Combustible vapor from the carburetor is inducted into the crankcase as described. As one piston reaches the bottom of its power stroke, this vapor charge is compressed and forced through the inlet ports into the cylinders. This action drives out the burned gases which were previously ignited during the last power stroke, and leaves the cylinder charged with a new supply of combustible vapor. The burned gases are driven through the exhaust ports into the receiver, where they are cooled by a spray of water.

b. As the piston starts its upward stroke, the inlet and exhaust ports are closed, and the vapor trapped within the cylinder is compressed in preparation for the next power stroke. Engine cooling is accomplished by the circulation of part of the water being pumped by the fire pump.

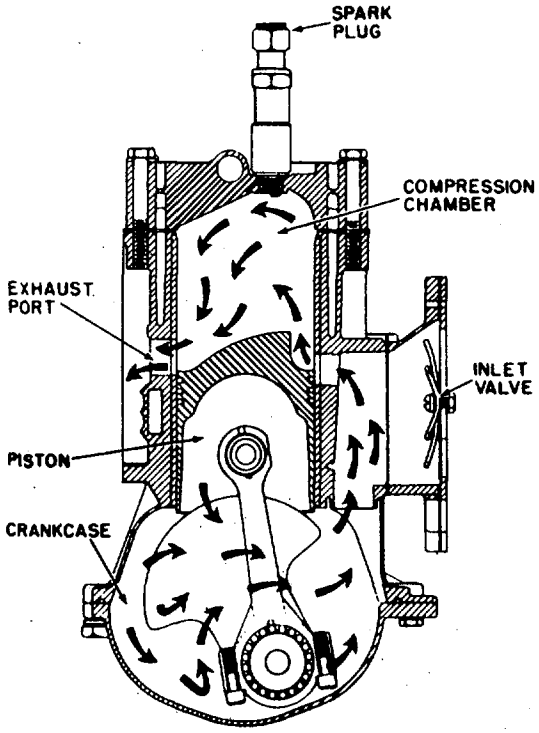
c. The power head consists of the cylinder head, cylinder block, pistons, connecting rods, crankshaft and crankcase. The cylinder head is attached to the top of the cylinder block and forms the combustion chamber. The cylinder block contains the cylinder bores, water jacket, intake and exhaust ports and the upper bearing supports. The pistons are connected to the connecting rod by full floating piston pins and are attached to the crankshaft by means of cap screws. The crankcase is attached to the bottom of the cylinder block and provides the lower crankshaft bearing supports.

d. When major repairs on the power head (engine) such as installation of new piston rings, pistons, connecting rods, crankshaft, etc, is required, a disassembly operation becomes necessary, which should be carefully performed in clean surroundings with clean tools and on a clean and orderly bench top with sufficient space to temporarily store the various parts as they are removed for inspection, corrective measures or replacement.

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).



PISTON ON COMPRESSION STROKE



PISTON ON EXHAUST STROKE

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a.	Inspection	c.	Disassembly	e.	Reassembly
b.	Removal	d.	Cleaning	f.	Installation

INITIAL SETUP

Test Equipment

NONE

Special Tools

Flat punch

References

NONE

Equipment Condition Paragraph	Condition Description
4-7.1	Starter Assembly removal
4-7.2	Carburetor Assembly removal
4-7.3	Manifold Assembly removal
4-7.5	Magneto Assembly removal
4-7.9	Pressure Regulator removal
4-7.10	Pump removal
4-7.11	Priming Pump' and Gear Case removal

Material/Parts

Cement, Permatex #1 (Hardening)
Cement, Permatex #2 (Non-hardening)

Special Environmental Conditions

NONE

Personnel Required

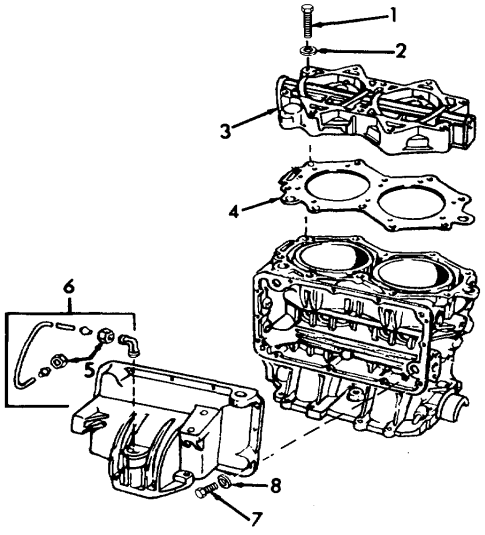
1

General Safety Instructions

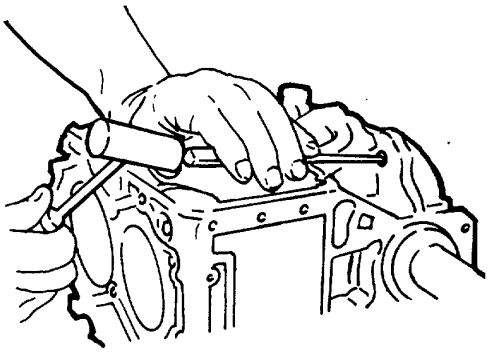
NONE

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Power head and receiver assembly	a. Hoses and tubing	Inspect for breaks, cracks, and leaks.	
	b. Crank-case	Inspect for cracks and leaks.	
	c. Receiver	Inspect for cracks and leaks.	
	d. Cylinder	Inspect for breaks, cracks and leaks.	
REMOVAL			
2. Power head	a. Screws (1), and flat-washers (2)	Remove.	
	b. Cylinder head (3), and gasket (4)	Remove.	
	c. Tube nuts (5)	Loosen.	
	d. Tube (6)	Remove.	
	e. Screws (7), and lock-washers (8)	Remove.	

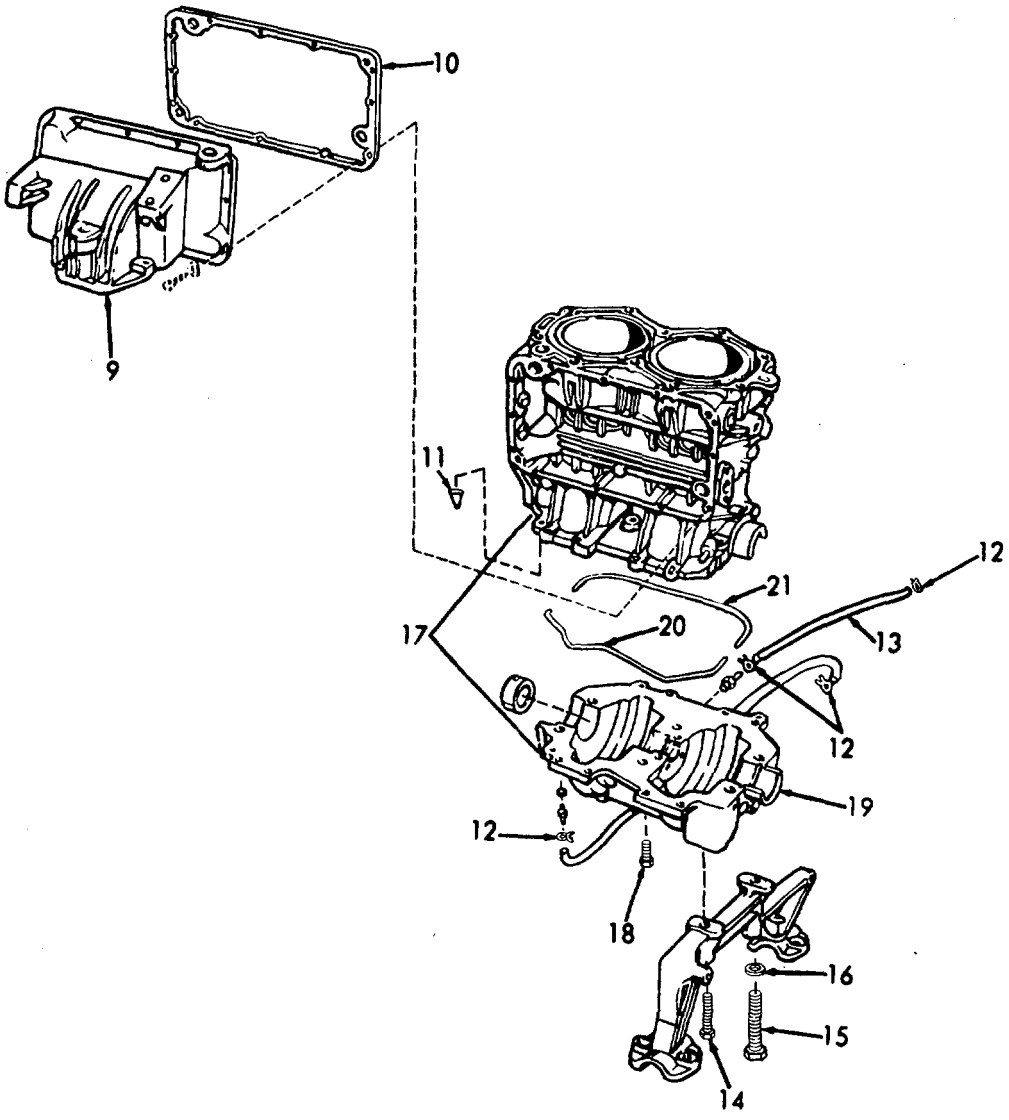


4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	f. Receiver body and core assembly (9), and gasket (10)	Remove.	Discard gasket.
	g. Taper pins (11)	Drive out.	Use a flat punch.
	h. Hose clamps (12)	Loosen.	
	i. Oil line (13)	Remove.	
	j. Screw (14), screw (15), and flat-washer (16)	Remove.	
	k. Crank-case and cylinder assembly (17)	Remove.	Place on work bench with crankcase up.
	1. Screws (18), and crank-case (19)	Remove.	Tap crankcase lightly with mallet to free.
	m. Seals - port (20) starboard (21)	Remove.	Discard seals.

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	n. Crankshaft and connecking rod and piston assemblies	Inspect and remove.	Refer to paragraph 4-7.7.

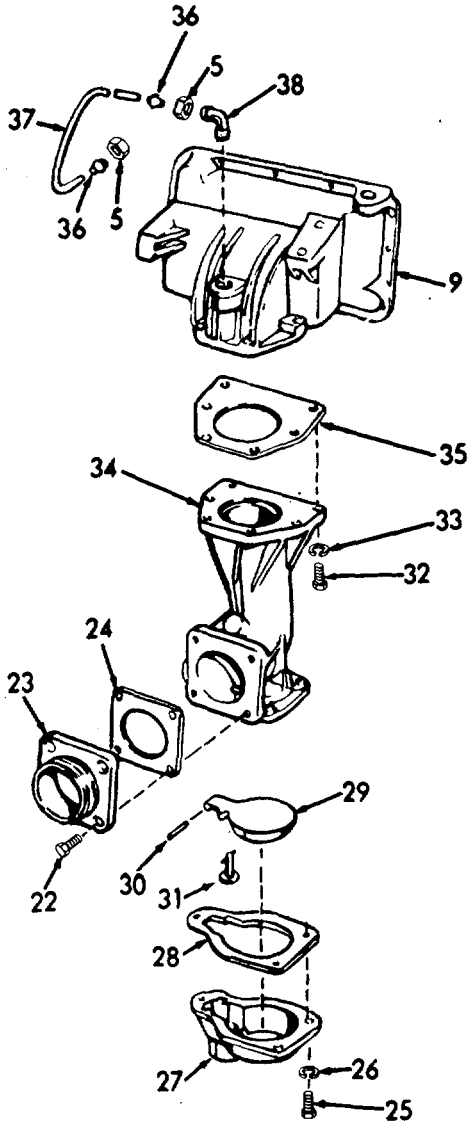


4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Receiver body and core assembly	a. Screws (22), and flange (23)	Remove.	
	b. Gasket (24)	Remove.	Discard gasket.
	c. Screws (25), and lock-washers (26)	Remove.	
	d. Bowl assembly (27), and gasket (28)	Remove.	Discard gasket.
	e. Float assembly (29), pin (30), and valve/pin assembly (31)	Disassemble.	If necessary.
	f. Screws (32), and lock-washers (33)	Remove.	
	g. Lower receiver body (34), and gasket (35)	Remove.	Discard gasket.

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	h. Tube nut (5), sleeve (36), and tube (37)	Disassemble.	If necessary.
	i. Elbow (38)	Remove.	If necessary.
	j. Receiver body and core (9)	Clean.	Refer to step 7.



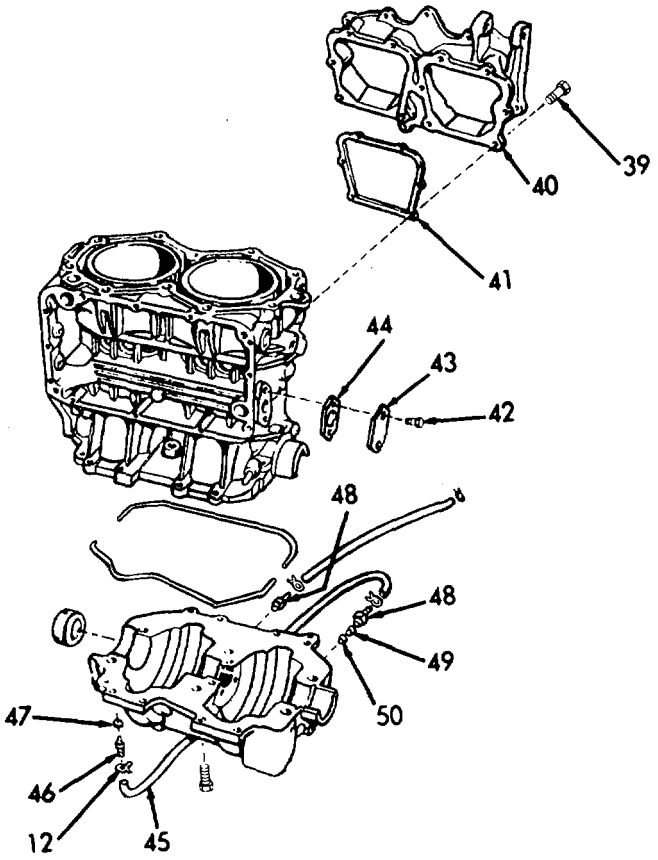
4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
4. Adapter and bushing assembly	a. Screws (39)	Remove.	
	b. Adapter and bushing assembly (40), and gasket (41)	Remove	Discard gasket.
5. Water passage cover (44)	Screws (42) cover (43), and gasket	Remove.	If necessary.
6. Oil line	a. Clamps (12), oil line (45)	Remove.	If necessary.
	b. Nipple (46), and flatwashers (47)	Remove.	If necessary.
	c. Nipple (48), va1ve spring (49), and bleed valve (50)	Remove	If necessary.

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



CLEANING

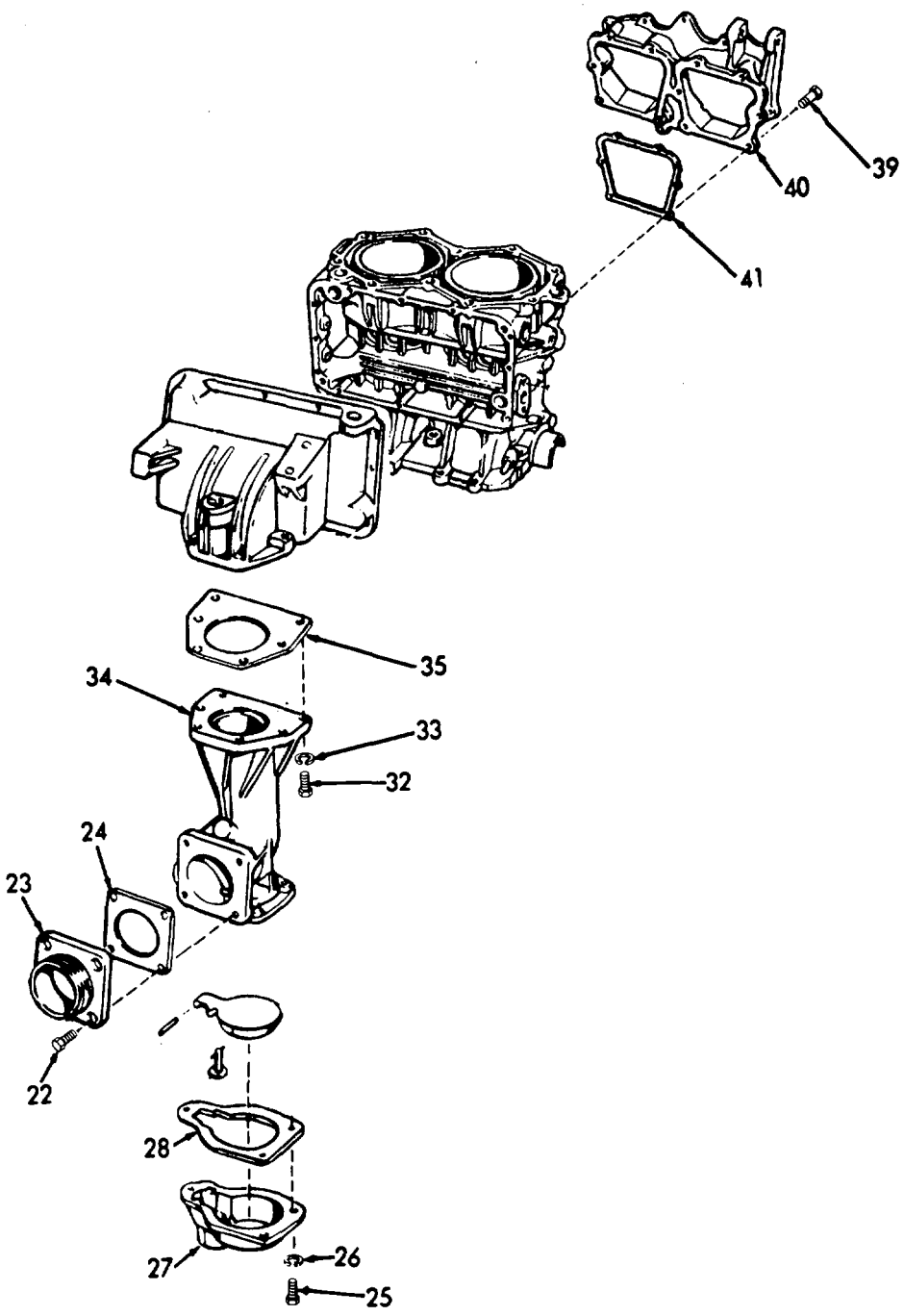
7. Exhaust ports		If there is a loss of power after an extended period of operation, which is ports indicated by decreased discharged water pressure and lower operating efficiency, the engine exhaust ports May have excessive accumulation of carbon deposits. These carbon deposits may be removed by detaching the receiver assembly and scraping the carbon. This may be done without removal of any parts from unit except the exhaust receiver.

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
8. Adapter and bushing assembly	Adapter and bushing assembly (40), gaskets (41), and screws (39)	Install.	Use new gasket.
9. Receiver body and core assembly	a. Lower receiver body (34), gasket (35), screws (32), and lockwashers (33)	Install.	Use new gasket.
	b. Bowl assembly (27), gasket (28), screws (25), and lock - washers (26)	Install.	Use new gasket.
	c. Flange (23), gasket (24), and screws (22)	Install.	Use new gasket.

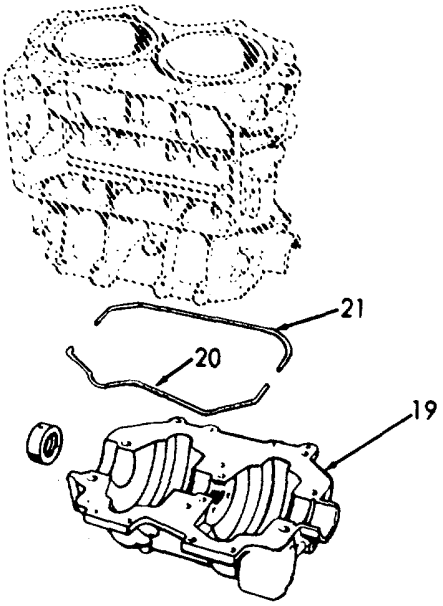
4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSAMBLY (CONT)			



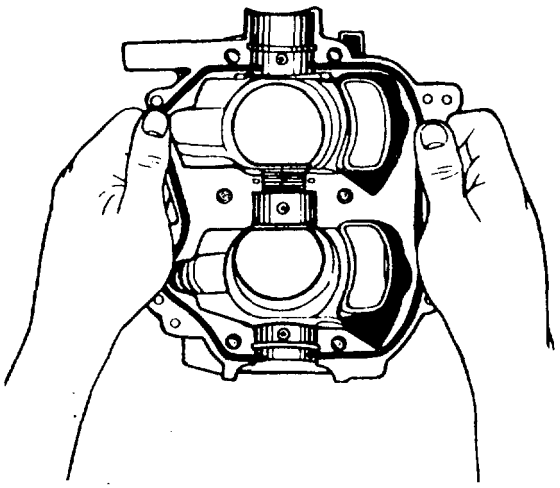
4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
10. Power head	a. Crankshaft and connecting rod and piston assemblies	Install.	Refer to paragraph 4-7.7.
	b. Crankcase (19) seals-port (20) and starboard (21)	Install	1. When installing new seal strips to the crankcase, note that they are longer than necessary and must be trimmed on installation. To install seal strips, remove all traces of cement on crankcase faces and grooves. Apply hard drying cement at several points along the grooves and particularly at the end of each groove. Place the seal strip into position immediately, before the sealer dries, allowing each end to overhang slightly. Then, before the sealer sets, guide the entire length of the strip towards the outside edge of the groove. Use the thumbs of each hand to accomplish this as illustrated.

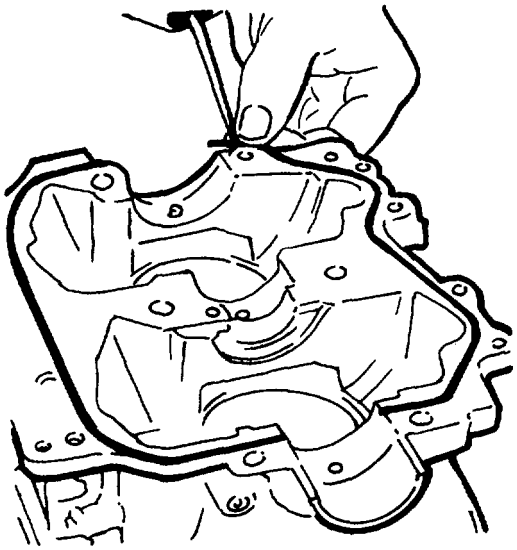


4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (CONT)			



2. Trim the ends with a knife so the ends extend approximately 1/16 inch to insure proper seal at the end of the strip. Apply a thin coat of hard drying cement to the mating surfaces of the crankcase and cylinder block before reinstalling crankcase.



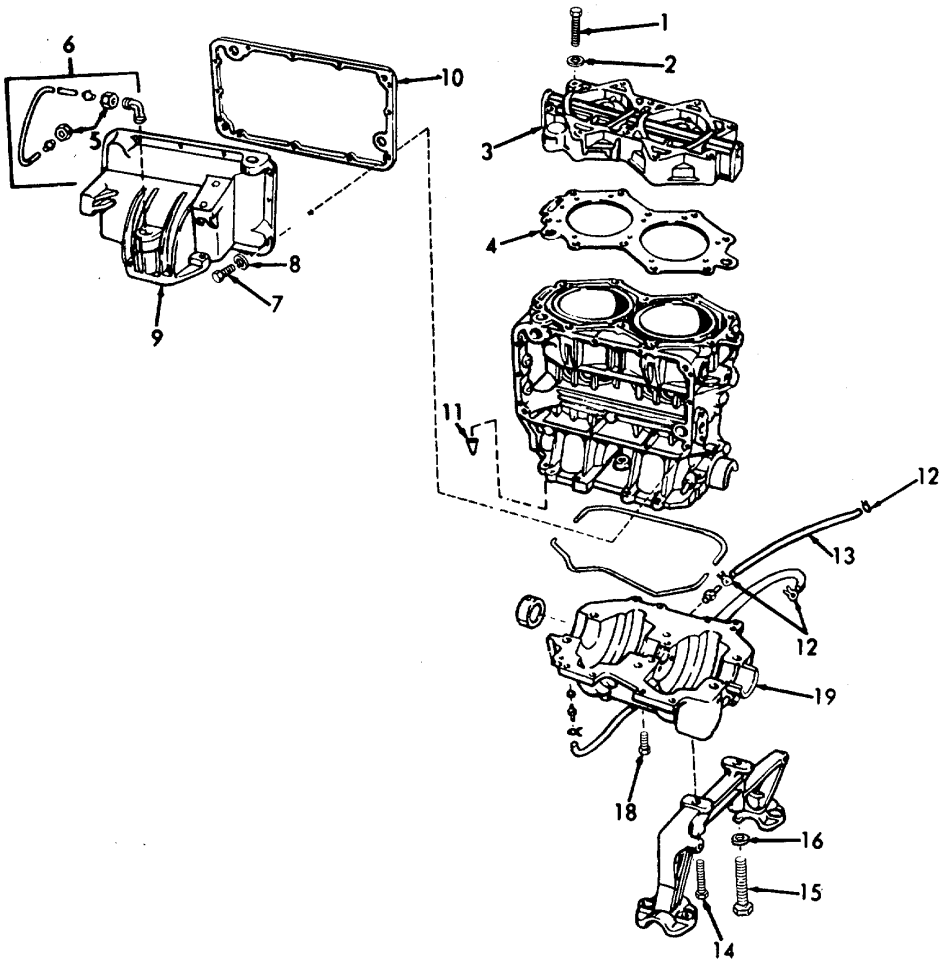
4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Crank-case (19), taper pins (11), and screws (18)	Install.	Replace crankcase and drive in the aligning taper pins. Replace and tighten the screws. Put non-hardening cement on the threads and under two center screws to prevent leakage.
	d. Screw (14), screw (15), and flat-washer (16)	Install crankcase to mount.	Install crankcase
	e. Oil line (13), and hose clamps (12)	Install.	
	f. Receiver body and core assembly (9), gasket (10), screws (7), and lock - washers (8)	Install.	Use new gasket.
	g. Tube (6), and tube nuts (5)		

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued)

.

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Cylinder head (3), gasket (4), screws (1) and flat-washers (2)	Install	When replacing the cylinder head make certain that a new cylinder head gasket is installed. If possible, soak new head gasket in fuel mixture for five to ten minutes to soften. Attach the front mount to the crankcase with the attaching screws. Assemble the receiver to the powerhead with a new gasket. A non-drying cement should be used on this gasket to promote sealing.



4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

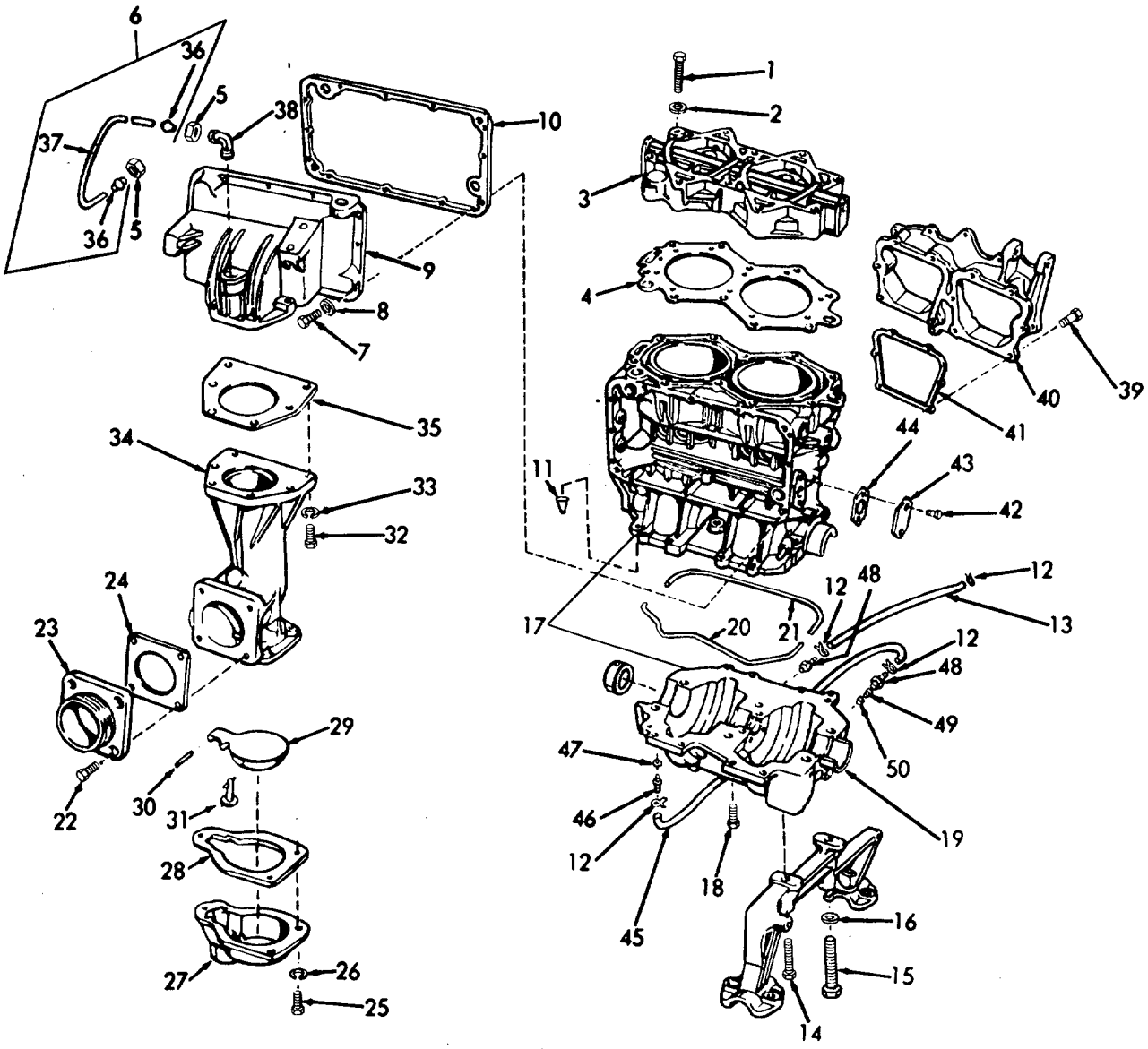
INSTALLATION (Cont)

Power Head and Receiver Assembly Legend

1. Screws
2. Flatwashers
3. Cylinder head
4. Gasket
5. Tube nuts
6. Tube
7. Screws
8. Lockwashers
9. Receiver body and core assembly
10. Gasket
11. Taper pins
12. Hose clamps
13. Oil line
14. Screw
15. Screw
16. Flatwasher
17. Crankcase and cylinder assembly
18. Screws
19. Crankcase
20. Seal
21. Seal
22. Screws
23. Flange
24. Gasket
25. Screws
26. Lockwashers
27. Bowl assembly
28. Gasket
29. Float assembly
30. Pin
31. Valve/pin assembly
32. Screws
33. Lockwashers
34. Lower receiver body
35. Gasket
36. Sleeve
37. Tube
38. Elbow
39. Screws
40. Adapter and bushing assembly
41. Gasket
42. Screws
43. Cover
44. Gasket
45. Oil line
46. Nipple
47. Flatwashers
48. Nipple
49. Valve spring
50. Bleed valve

4-7.6. POWER HEAD AND RECEIVER ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

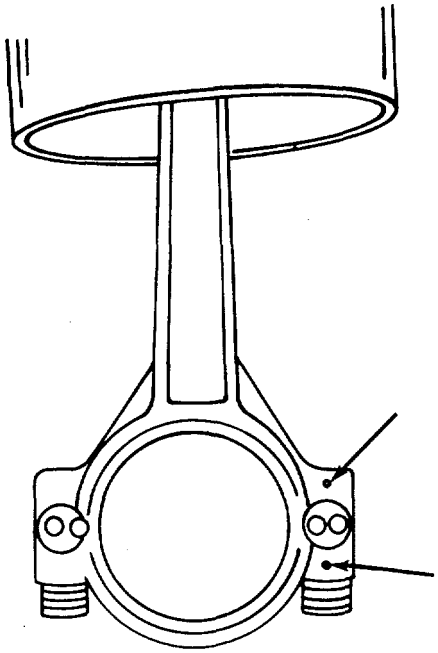
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS.

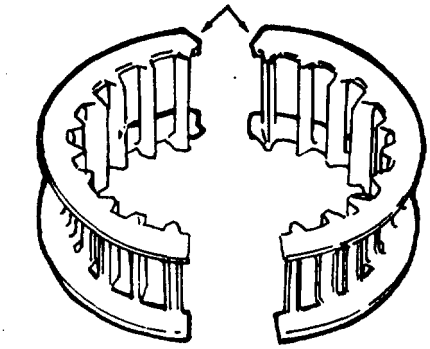
a. The crankshaft and connecting rod and piston assemblies are accessible for inspection and removal. Connecting rods should be marked No. 1 (magneto end) and No. 2 (impeller end) with pencil or chalk to avoid interchanging on reassembly if same assemblies are reinstalled. Make certain that the roller bearing retainer assemblies and connecting rod caps are not interchanged because the connecting rod and cap are matched assemblies and are not interchangeable.

b. The connecting rod and cap are matched assemblies and are therefore not interchangeable. In the process of manufacturing, the rod and cap are machined as an integral unit and are then broken or split apart. This operation leaves both the rod and cap with rough or serrated-like surfaces which, when replaced, provide correct alignment of bearing surface and side walls. Care should be exercised when attaching the cap to assure that the fractured areas match. To avoid turning the cap end for end, the rod and the cap are marked as shown.



4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

c. The connecting rod roller bearing retainers are machined as one piece and later split by sawing to permit assembly on the crankpin, and proper matching is required. The retainer halves are not interchangeable and must at all times be kept together to prevent intermixing during the repair procedure. Neither can they be placed or turned end for end on assembly. The figure illustrates the ground ends.



d. The outer and center main crankshaft bearings are the caged needle roller type; the inner main bearing is of the double row ball type and it is therefore necessary to provide seals to prevent loss of crankcase compression. Lip-type seals are provided on outer end of the crankshaft and a grooved bronze bushing is installed adjacent to the center and inner bearing. A rubber O-ring is provided between the outer bearing assembly and the crankcase support.

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Removal b. Repair c. Installation

INITIAL SETUP

Test Equipment	References Paragraph	
NONE	4-7.5.	Manifold Assembly

Special Tools	Equipment Condition Paragraph	Condition Description
Arbor press	4-7.6	Power Head Receiver
Allen wrenches	4-7.6	Assembly removal
Bearing puller		
Calipers		
Feeler gage		
Rawhide mallet		

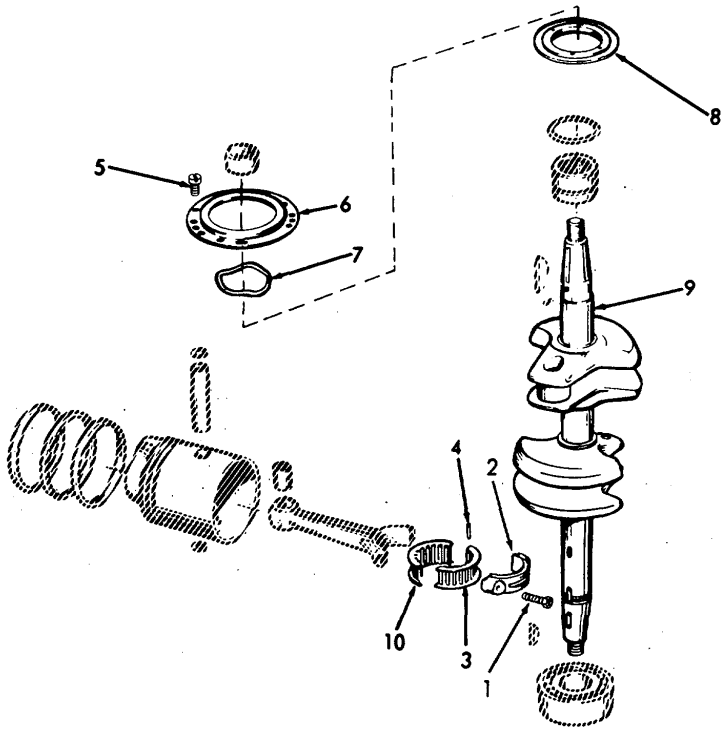
Material/Parts	Special Environmental Conditions
Grease MIL-L-15719A	NONE

Personnel Required	General Safety Instructions
1	NONE

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Piston and connecking rod assemblies	a. Connecting rod screws (1)	Remove.	
	b. Caps (2), Remove and bearing retainers (3)		1. Place bearing retainers (3) and needle bearings (4) on a clean surface. 2. Prevent interchanging.

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2. Retaining ring (armature plate)	Screws (5), retaining ring (6), wave washer (7) ,and mounting support (8)	Remove.	
3. Connecting rod piston assembly	a. Crankshaft (9)	Remove from crankcase.	
	b. Bearing retainers (10)	Remove.	1. Place bearing retainers (3) and needle bearings (4) on a clean face.surface. 2. Prevent interchangeability.

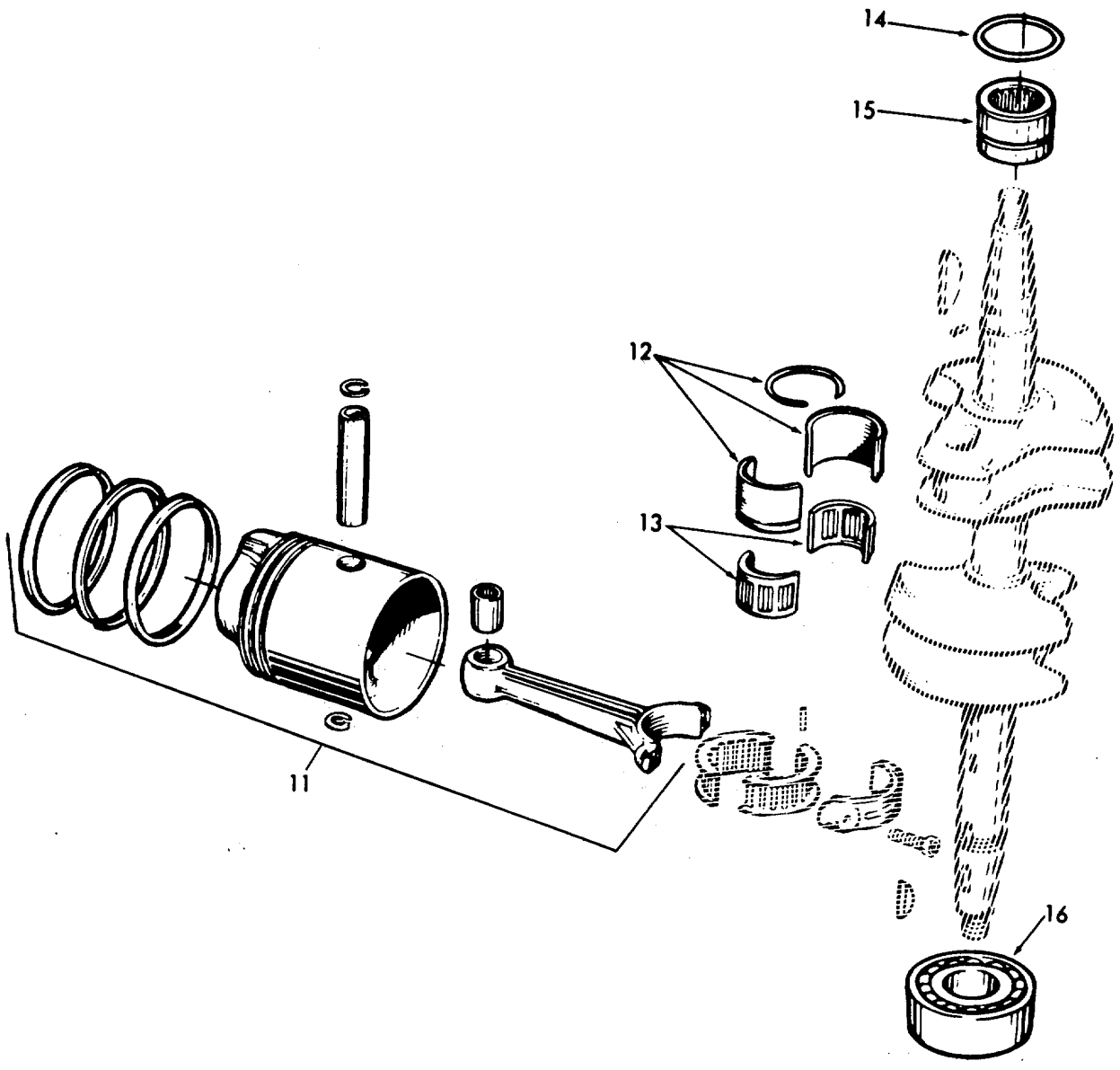


4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Connecting rod/ piston assemblies (11)	1. Push out of cylinder bores. 2. Temporarily replace bearing rod retainers and caps.	
4. Crankshaft assembly	a. Split seals (12), and retainer and bearing assembly (13)	Remove.	
	b. Preformed packing (14), and roller bearing (15)	Remove.	Use bearing puller.
	c. Ball bearing (16)	Remove.	Use bearing puller.

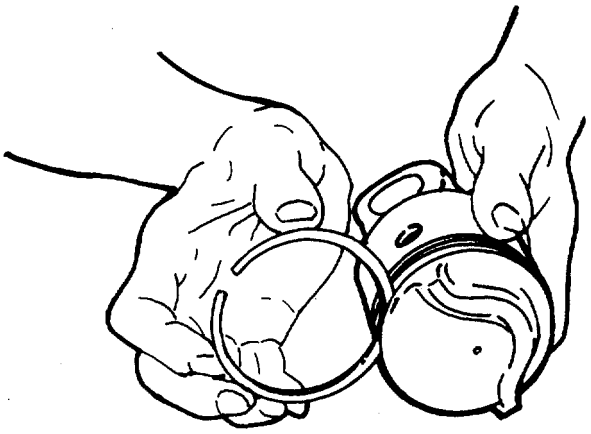
4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			



4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

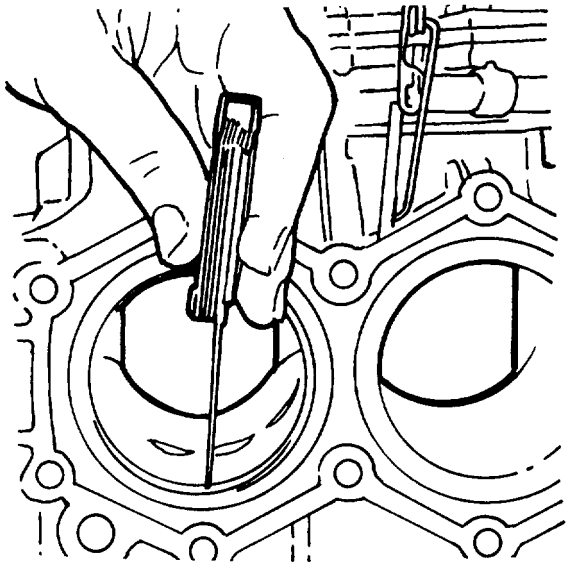
LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5. Connecting rod piston assembly	a. Piston rings (17)	Remove.	1. Spread ring between thumb and forefinger.



2. Check the piston rings for wear. If the faces exposed to the cylinder wall are worn to a high polish (glass-like appearance) replace the rings. A properly seated ring wears to a dull luster. If in doubt, install new piston rings. Before installing new rings on piston, place new rings in the respective cylinder making certain they seat squarely in the bore. Check the gap clearance between ends of the ring with a feeler strip or gauge of corres-

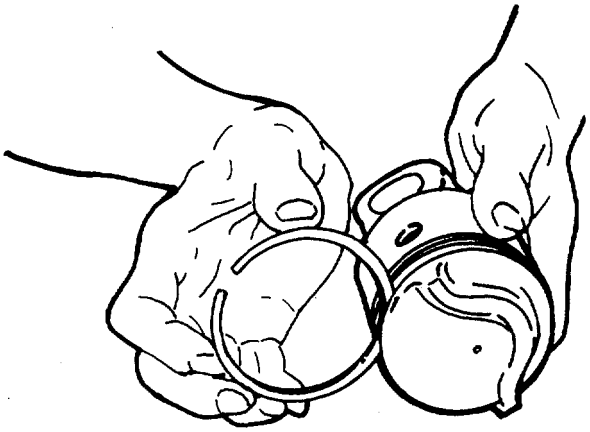
4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			ponding thickness. The recommended clearance is 0.007 to 0.017 inch.



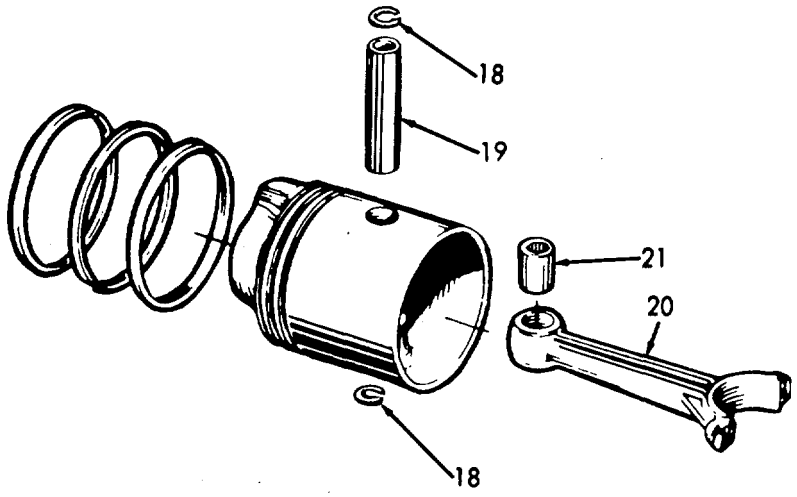
3. Remove the carbon from piston ring grooves to prevent rings from sticking and becoming partially inactive with a resultant loss of compression. This operation may be easily performed with a small, narrow scraper, being careful not to scratch or otherwise damage the groove walls. Check each ring in respective piston ring groove for possible tightness. Roll the ring around the groove as shown in figure. There should be no indication of sticking or

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			binding. If sticking is present, check ring grooves and side wall for possible causes (burrs, nicks, or other damage) and dress down high or tight areas.
			
			4. After the piston rings have been installed, apply oil to the ring grooves. Roll the rings around the piston to spread the oil evenly. Pins are located in the ring grooves and the ring gap should be located over the pin.

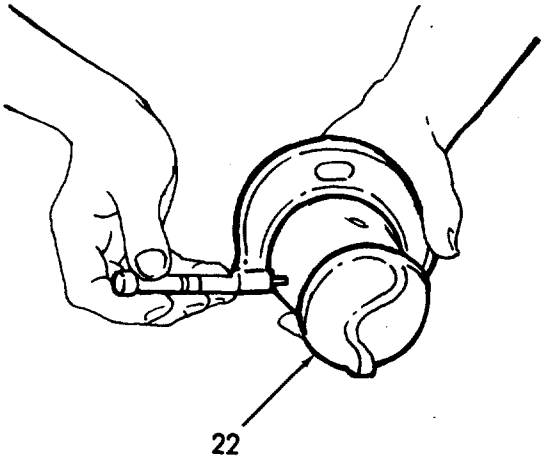
4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

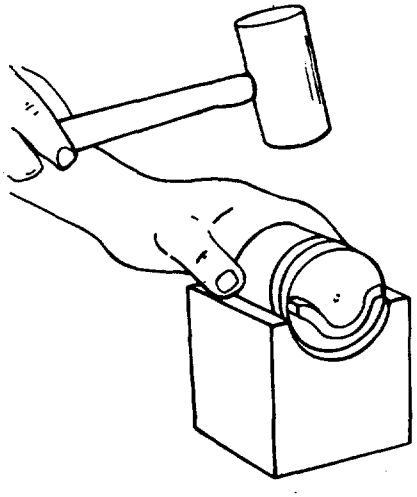
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Piston pin retainer (18)	Remove.	Use sharp long nose pliers.
	c. Piston pin (19)	Remove.	Push out with thumb or finger.
	NOTE The piston pin is a full floating type which is free in the piston bosses as well as being free in the connecting rod top end.		
	d. Connecting rod (20), needle bearing (21), and piston (22)	Disassemble.	



4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

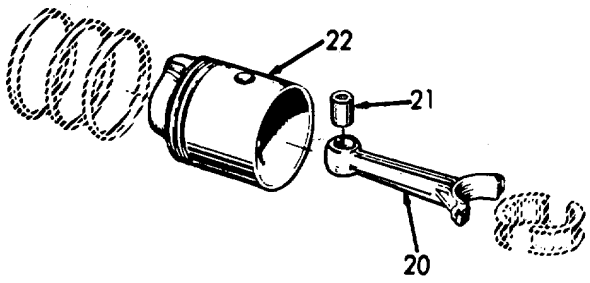
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Piston (22)	Inspect.	Check the roundness of the piston with caliper as as lillustrated. If the piston is out-of-round it may be re-paired by plac-ing it in a hollowed block and striking it on the high side lightly with a rawhide mallet.
	f. Connect-ing rod (20), needle bearing (21), and piston (22)	Reassemble.	Oil all' sur-faces that should be lu-bricated.



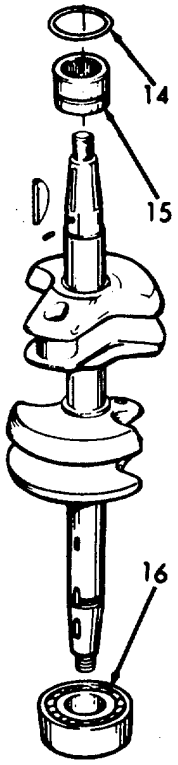


4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

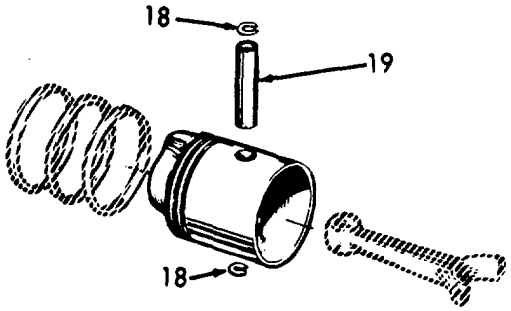


6.	Crank-shaft	a.	Ball bearing (16)	Install.	Use arbor press.
		b.	Roller bearing (15)	Install.	Use arbor press.

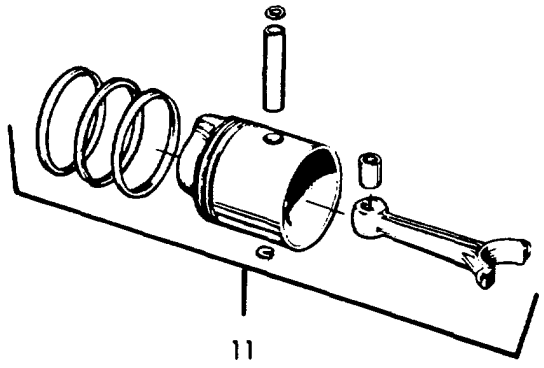


4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
INSTALLATION				
7. Piston assembly	a.	Piston pin (19), and retaining rings (18)	Install.	Oil all surface that should be lubricated.

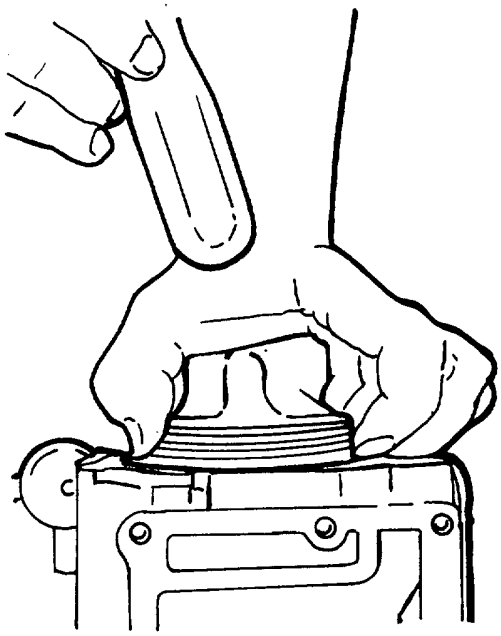


	b.	Piston assembly (11)	1. Insert the piston and rod assembly in the respective cylinder bore. Compress the piston rings with fingers and carefully tap piston into bore with the handle of a screw driver. The gap between the ends of the piston ring should cover the pin in the piston ring groove.	During the installation of the piston and connecting rod assembly, note that the straight side of the deflector on the top of the piston must be directed toward the intake or bypass port in the cylinder which is opposite the exhaust port.



4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



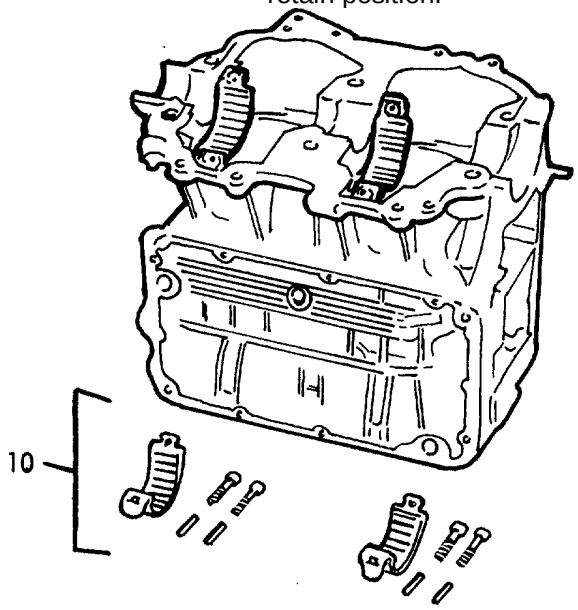
NOTE

It is important that the pistons are installed properly or the engine will operate at reduced efficiency.

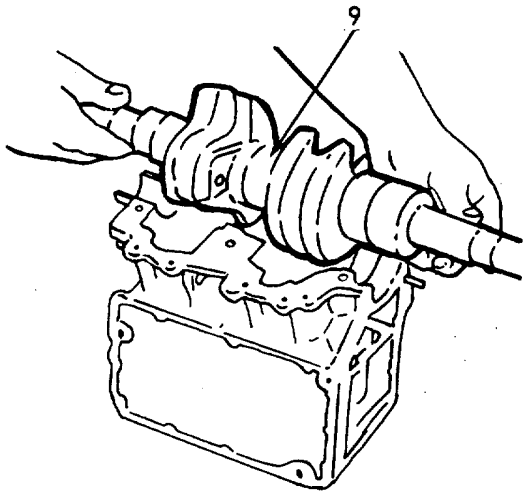
2. Turn the cylinder block so that the crankcase side is up and pull the piston and rod assemblies up to the limit.

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		3. Insert the connecting rod retainer (10) with rollers installed, using light, clean grease (specification MIL-L-15719A), to retain position.	

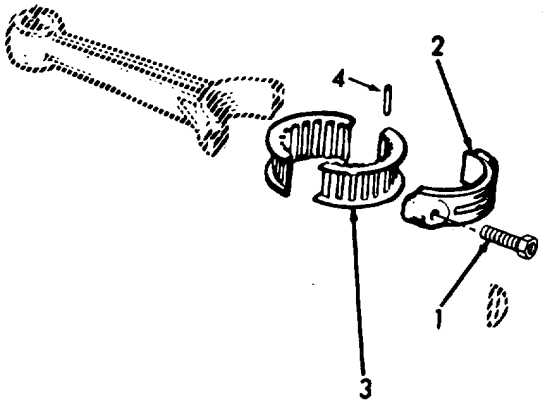


c.	Crankshaft (9)	Install	



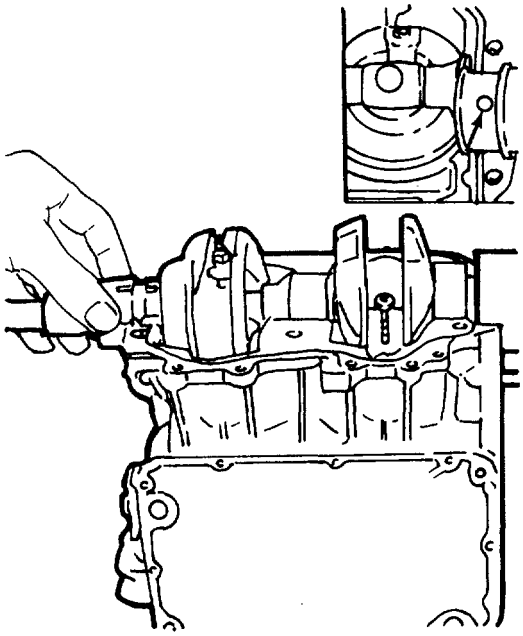
4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

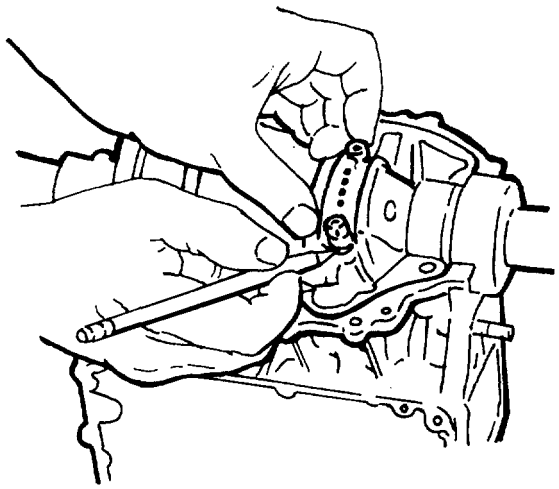
LOCATION	ITEM		ACTION	REMARKS
INSTALLATION (Cont)				
	d.	Connecting rod retainer (3) and needle bearings (4)	Match and replace top half of the connecting rod retainer and rollers using light, clean grease grease (specification MIL-L-15719A) to retain position. There are a total of 20 rollers in the bearing assembly.	
	e.	Connecting rod caps (2)	1. Match and replace. 2. Lock the cap on the connecting rod.	Make sure proper seating is obtained.
	f.	Connecting screw (1)	Replace.	Do not tighten at this time.



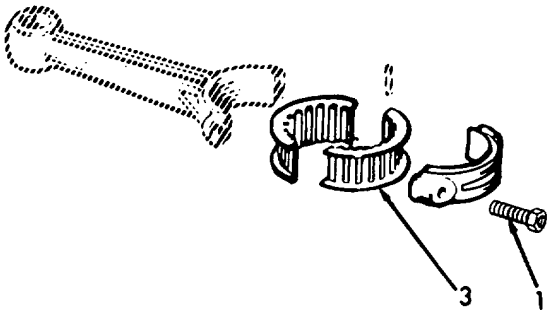
4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
INSTALLATION (Cont)				
	g.	Crankshaft, cylinder block, and connecting rod assemblies	1. Seat the entire assembly of crankshaft and connecting rod assemblies into the crankcase. Note the pins in the crankcase main bearing bosses, and the corresponding holes in the crankshaft main bearing assembly's outer cages. Align the bearings to engage the pins in the crankcase bearing supports.	
			2. Check the outside surfaces with a sharp pencil point to determine that they are flush.	





4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
INSTALLATION (Cont)				
	h.	Connecting rod screws (1)	Tighten.	Torque to 20 ft lbs (27.12 Nm) torque.
	i.	Bearing retainer (3)	1. Retainer should revolve freely on the crankpin and within the connecting rod.	
			2. Check for binding in the retainer assembly by pushing back and forth with a thumb.	Binding in the retainer indicates improper assembly, and should be corrected.
				
	j.	Power head and receiver assembly	Reassemble.	Refer to paragraph 4-7.2.

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

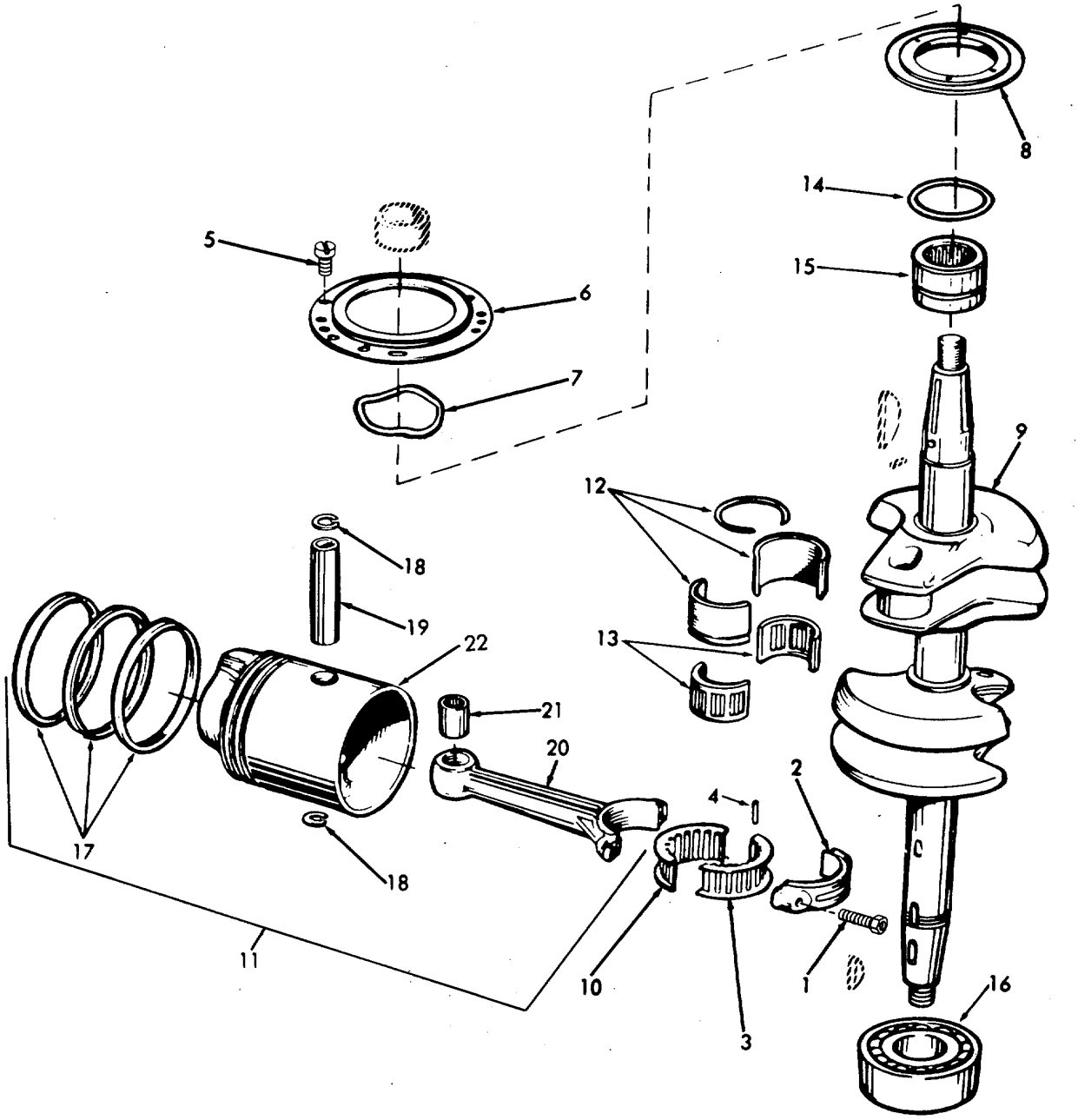
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

Crankshaft and Piston Legend

1. Connecting rod screws
2. Caps
3. Bearing retainers
4. Needle bearings
5. Screws
6. Retaining ring
7. Wave washer
8. Mounting support
9. Crankshaft
10. Bearing retainers
11. Connecting rod/piston assemblies
12. Split seals
13. Retainer and bearing assembly
14. Preformed packing
15. Roller bearing
16. Ball bearing
17. Piston rings
18. Piston pin retainer
19. Piston pin
20. Connecting rod
21. Needle bearing
22. Piston

4-7.7. CRANKSHAFT AND PISTON - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Service
c. Disassembly
d. Reassembly

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition | Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

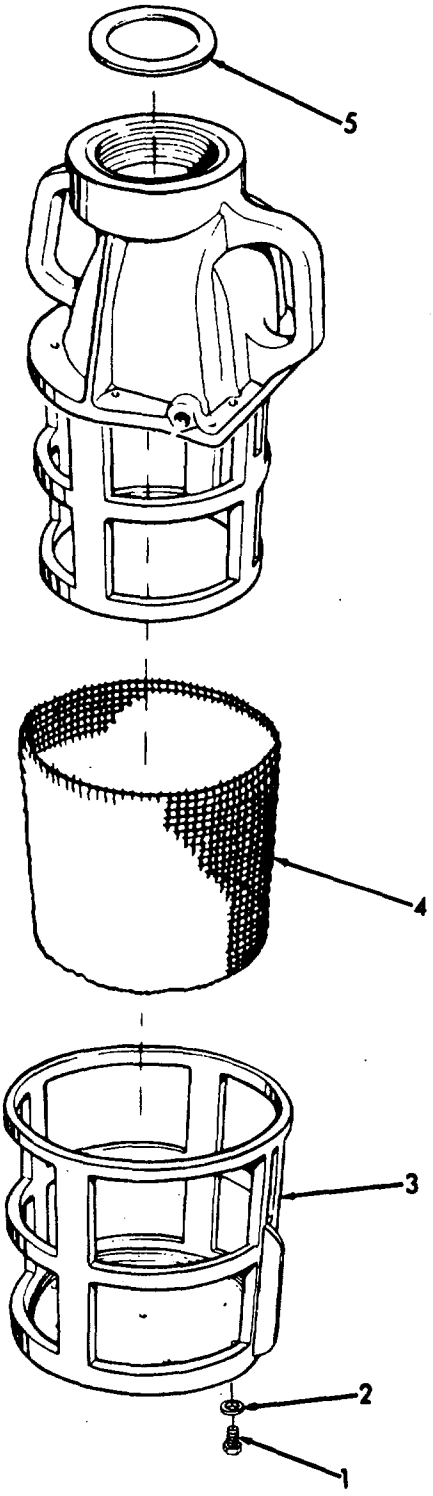
LOCATION	ITEM		ACTION		REMARKS
INSPECTION					
1. Foot valve	a.	Foot valve	1.	Inspect for breaks, cracks and signs of damage.	
			2.	Insure all hardware is tight.	
	b.	Screen	1.	Inspect for holes, and damage.	
			2.	Inspect for accumulation of debris.	
	c.	Release valve	Inspect for binding, and signs of damage.		

4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
SERVICE				
2.	a.	Screws (1), and flat-washers (2)	Remove.	
	b.	Screen retainer (3), and screen (4)	Remove.	
	c.	Screen (4)	Clean.	
	d.	Screen (4), screen retainer (3), screws (1), and flat-washers (2)	Reassemble.	
	e.	Washer (5)	Replace.	If necessary.

4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

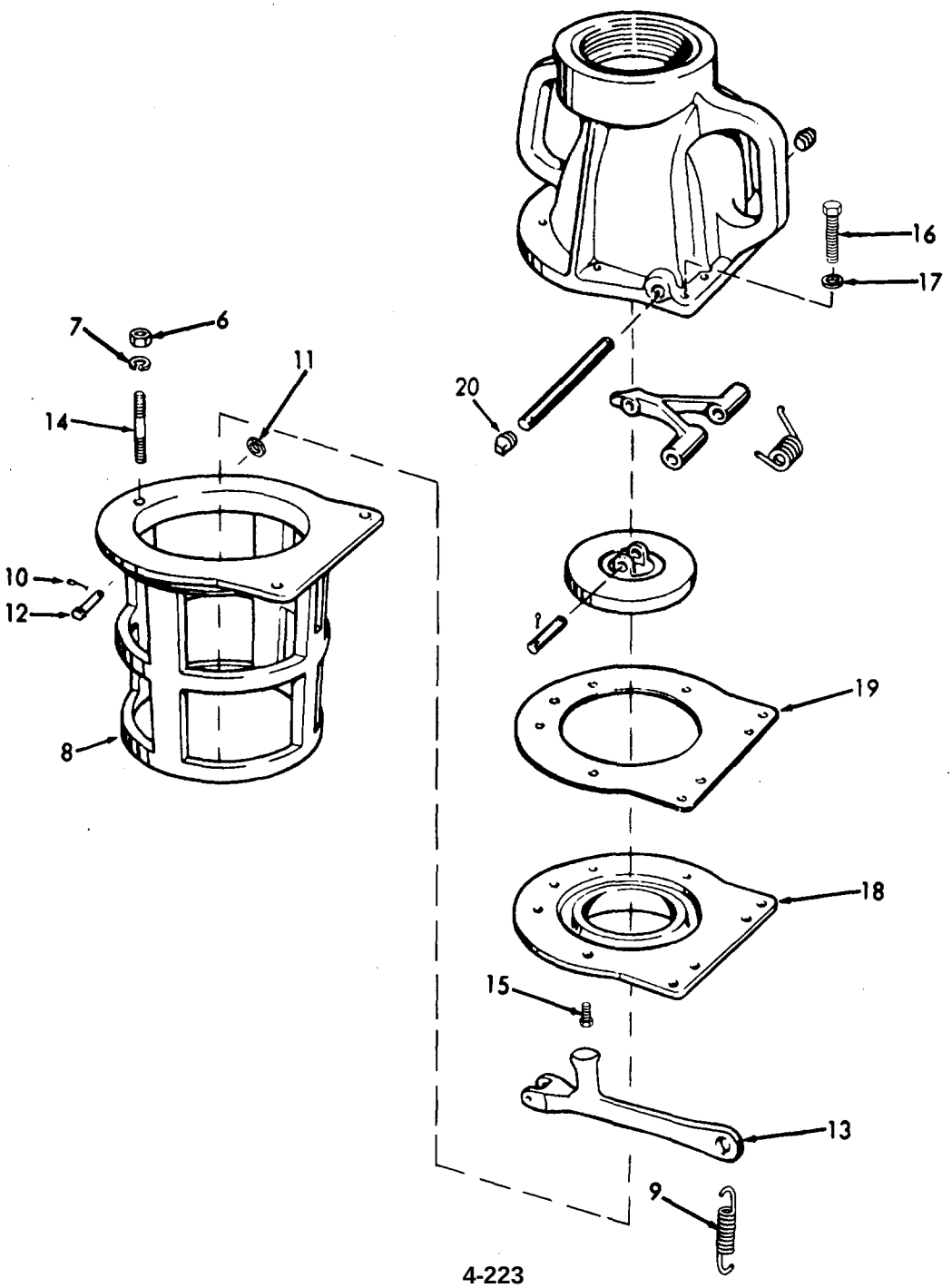


4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
DISASSEMBLY				
3.	a.	Nuts (6), and lock-washers (7)	Remove.	
	b.	Retainer screen (8)	Remove.	
	c.	Spring (9)	Remove.	
	d.	Cotter pin (10), felt washer (11), valve release pin (12), and valve release arm (13)	Disassemble.	
	e.	Studs (14)	Remove.	If necessary.
	f.	Screws (15), screws (16), and lock-washer (17)	Remove.	
	g.	Valve seat (18), and gasket (19)	Remove.	Replace gasket if damaged.
	h.	Pipe plugs (20)	Remove.	

4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

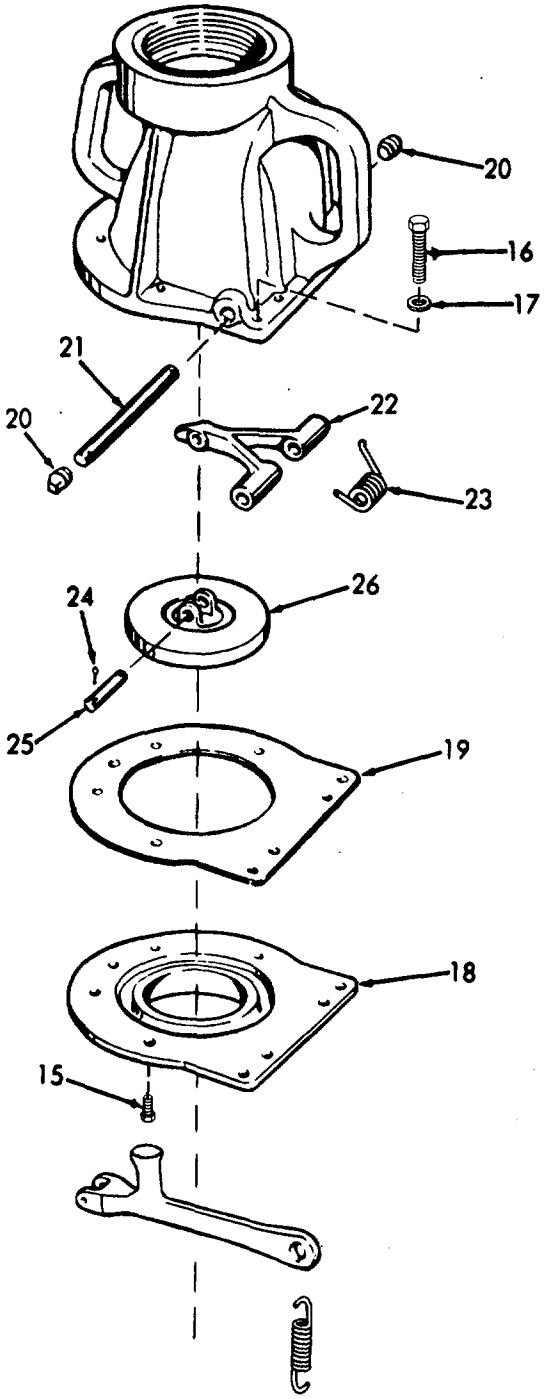


4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
DISASSEMBLY (Cont)				
	i.	Hinge pin (21), hinge arm (22), and valve spring (23)	Remove.	
	j.	Cotter pin(s) (24), pivot pin (25), and valve disc (26)	Disassemble from hinge arm (22).	
REASSEMBLY				
4.	a.	Valve disc (26), pivot pin (25), and cotter pin(s) (24)	Assemble to hinge arm (22).	
	b.	Hinge arm (22), valve spring (23), and hinge pin (21)	Install.	
	c.	Pipe plugs (20)	Install.	
	d.	Gasket (19), valve seat (18), and screws (15)	Install.	

4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

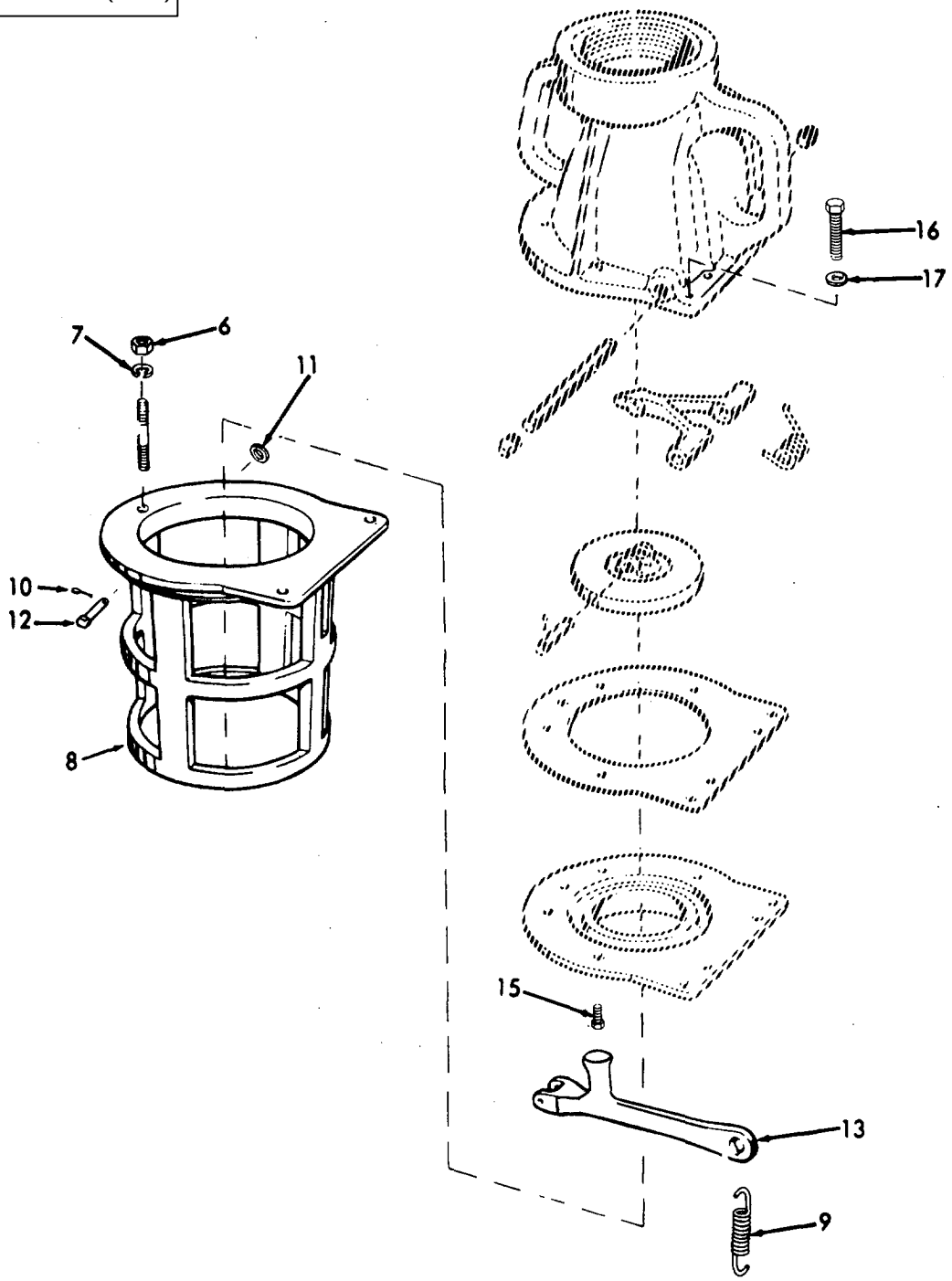


4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REASSEMBLY (Cont)				
	e.	Screws (16), and lock-washers (17)	Install.	
	f.	Valve release arm (13), release pin (12), flat-washer (11), and cotter pin (10)	Install in screen retainer (8).	
	g.	Spring (9)	Install.	
	h.	Nuts (6), and lock-washer (7)	Install.	

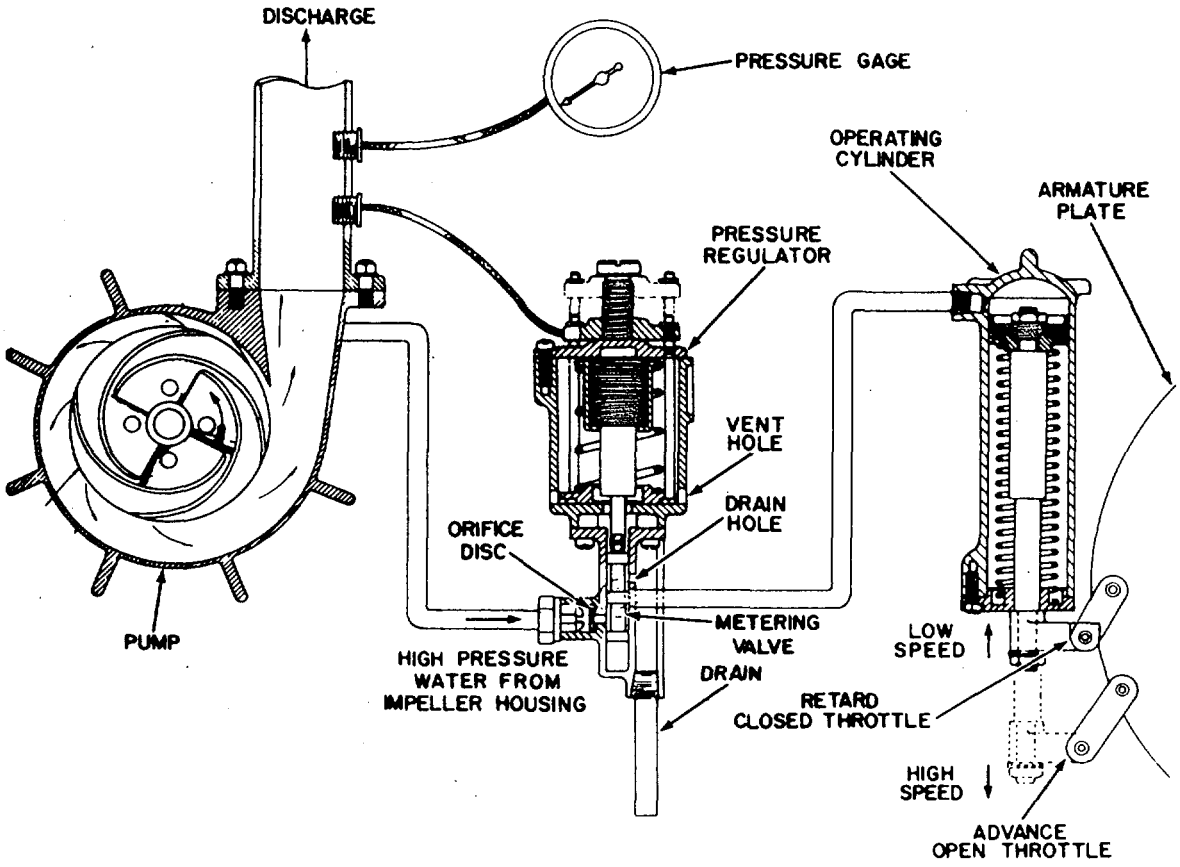
4-7.8. FOOT VALVE ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS.

a. The pressure regulator is mounted on the pump end of the exhaust receiver, and its adjusting screw is accessible through a hole in the hood. By means of this adjusting screw, the pressure of the water delivered by the fire pump may be adjusted within a range from 80 pounds per square inch to 120 pounds per square inch, (551.6 -827.4 kPa), depending on the volume of water being delivered by the pump, which is determined by the size and number of nozzles used.



b. Inside the regulator is a bellows, which is connected by tubing to a similar bellows on the pressure side of the pump. The bellows and tube assembly is filled with a non-freezing liquid. The bellows in the regulator operates a small metering valve. There is a water line from the pump to this valve, and a pressure line from the regulator to the operating cylinder. The metering valve regulates the water pressure delivered to the operating cylinder.

c. The operating cylinder is in turn connected by mechanical linkage to both the throttle valve (carburetor) and the magneto. When the engine is not running, there is no water pressure transmitted to the operating cylinder.

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

d. The operating cylinder then holds the throttle valve of the carburetor nearly closed, and the ignition spark retarded. This is the proper condition for starting. When the engine is started, the operating cylinder holds engine speed down until the pump is properly primed. In case the pump should lose its prime (as when the foot valve is lifted from the water allowing air to enter), the engine would tend to race to dangerous speeds. However, the loss of pressure to the operating cylinder retards the spark, and partially closes the throttle valve, therefore keeping the engine speed within safe limits.

e. With the regulator set at a given pressure, and the engine running normally, a constant pressure is maintained on the operating cylinder. The ignition timing, and throttle valve settings remain constant, and the unit operates in static conditions. Should the input pressure vary, the operating cylinder will take up a new position, and automatically re-set throttle valve and ignition timing to maintain the regulated pressure.

f. If the pressure regulator allows the discharge water pressure to go above the normal limit or operates erratically, any of the following may be the cause.

(1) Damaged, lost or plugged orifice disc.

(2) One or both of the bellows of the pressure regulator assembly may be broken. In that case, replace entire bellows assembly.

(3) The pressure line from the impeller housing to the pressure regulator housing may be closed due to pinching or kinking.

(4) The pressure regulator cylinder may be fouled with an accumulation of salt, preventing movement of the spool valve.

g. If the carburetor throttle linkage from the armature plate has become worn or damaged and is replaced, it may be necessary to reset the throttle position with respect to the armature plate. This is done as follows:

(1) Move the operating cylinder linkage to the full advance position with 40 psi (275.8 kPa) air pressure. If air pressure is not available, the spring may be removed from the operating cylinder.

(2) Remove the carburetor instrument panel.

(3) Adjust the rod from the armature plate arm to the cross shaft lever to bring the throttle valve to full open position (horizontal).

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

(4) Tighten the jam nut on the rod.

(5) Replace the instrument panel.

(6) Replace the operating cylinder spring if it was removed.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition: Paragraph 4-7.3 — Condition Description: Manifold Assembly removal

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Operating cylinder	Operating cylinder	1. Inspect for leaking. 2. Inspect for breaks, cracks, and damaged tubes. 3. Insure all hardware is tight.	

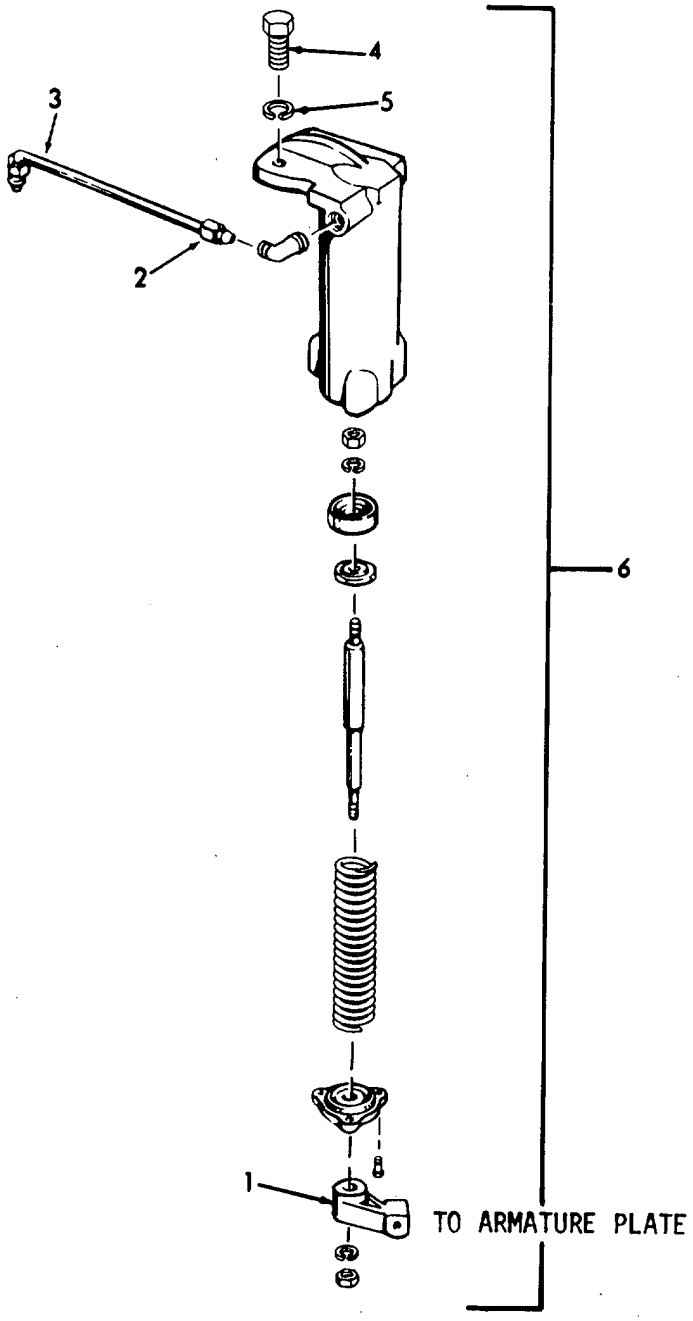
4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Pressure regulator	Pressure regulator	1. Inspect for leaking. 2. Inspect for breaks, cracks, and damaged tubes. 3. Insure all hardware is tight.	
REMOVAL			
3. Operating cylinder	a. Shaft arm (1)	Disconnect from mangneto armature plate.	
	b. Sleeve nuts (2)	Loosen.	
	c. Tube (3)	Remove.	
	d. Screws (4), and lock-washers (5)	Remove.	
	e. Operating cylinder (6)	Remove.	

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

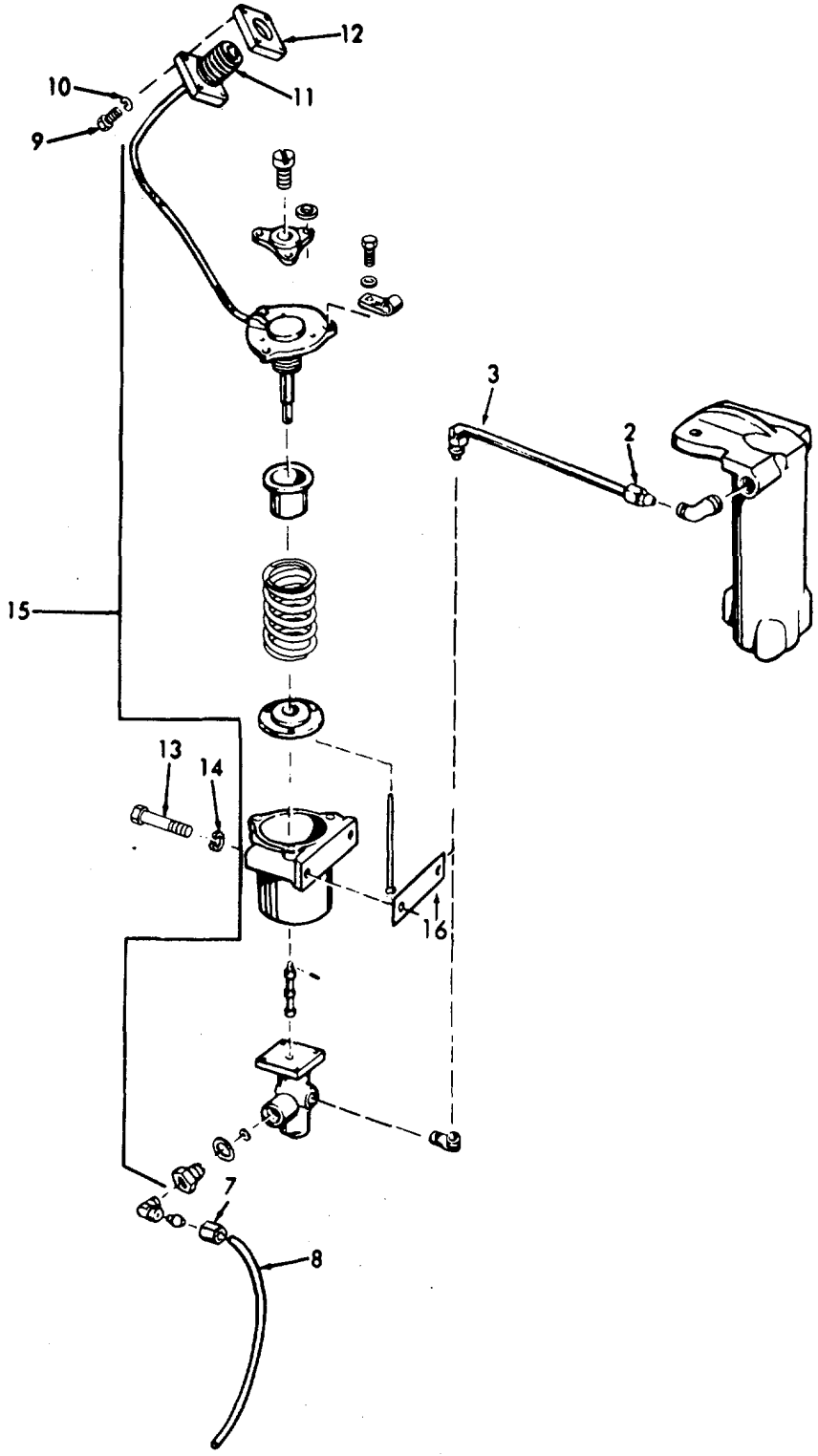


4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Pressure regulator	a. Sleeve nuts (2)	Loosen.	
	b. Tube (3)	Remove.	
	c. Sleeve nuts (7)	Loosen.	
	d. Tube (8)	Remove.	
	e. Screws (9), and lock - washers (10)	Remove.	
	f. Bellows assembly connector (11), and gasket (12)	Remove.	Discard gasket if damaged.
	g. Screws (13), and lock- washers (14)	Remove.	
	h. Pressure regulator (15), and gasket (16)	Remove.	Discard gasket if damaged

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

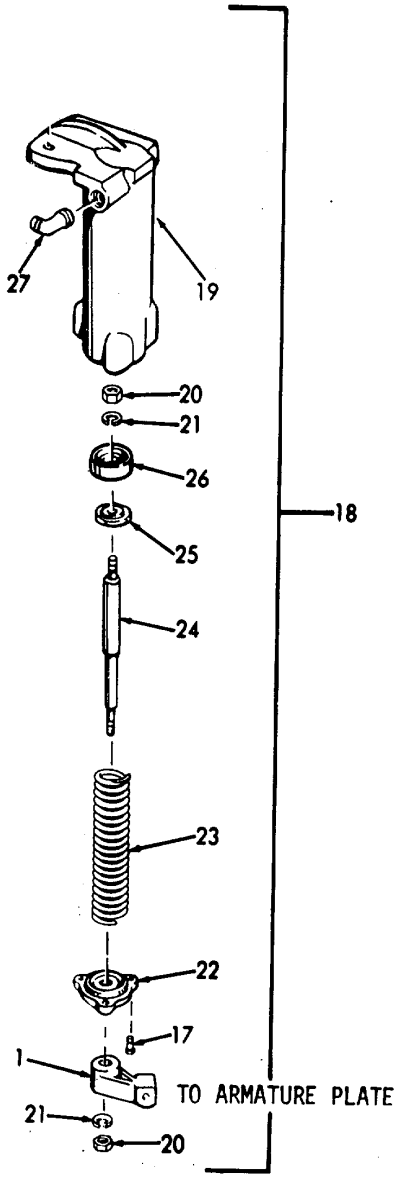


4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR				
5. Operating cylinder	a.	Screws (17)	Remove.	
	b.	Base and associ - ated parts (18)	Remove from housing (19).	
	c.	Nuts (20), and shaft washers (21)	Remove.	
	d.	Shaft arm (1), base (22), spring (23), shaft (24), cylinder support (25), and cup (26)	Disassemble.	
	e.	Elbow (27)	Remove.	If necessary.
	f.	Shaft (24), cylinder support (25), cup (26), spring (23), base (22), shaft arm (1), nuts (20), shaft washers (21)	Reassemble.	

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Base and associated parts (18)	Install in housing (19).	
	h. Screws (17)	Install	

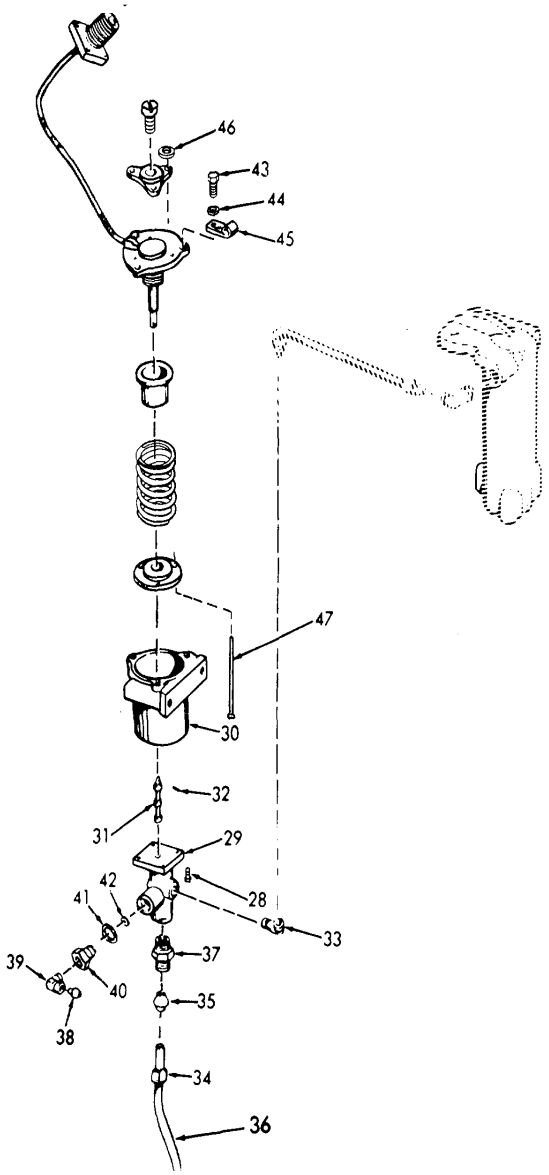


4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
6. Pressure regulator	a.	Screws (28)	Remove.	
	b.	Plug and cylinder assembly (29)	Disassemble from housing (30).	
	c.	Piston (31), and piston pin (32)	Remove.	
	d.	Elbow (33)	Remove.	If necessary.
	e.	Ball nut (34), ball (35), and water outlet tube (36)	Disassemble.	
	f.	Connec-tor (37)	Remove.	If necessary.
	g.	Ball (38), elbow (39), adapter (40), gasket (41), and orifice disc (42)	Remove.	If necessary.
	h.	Screws (43), flat-washers (44), and tube clamp (45)	Remove.	

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Retaining Rings (46). piston guide pins (47)	Remove.	

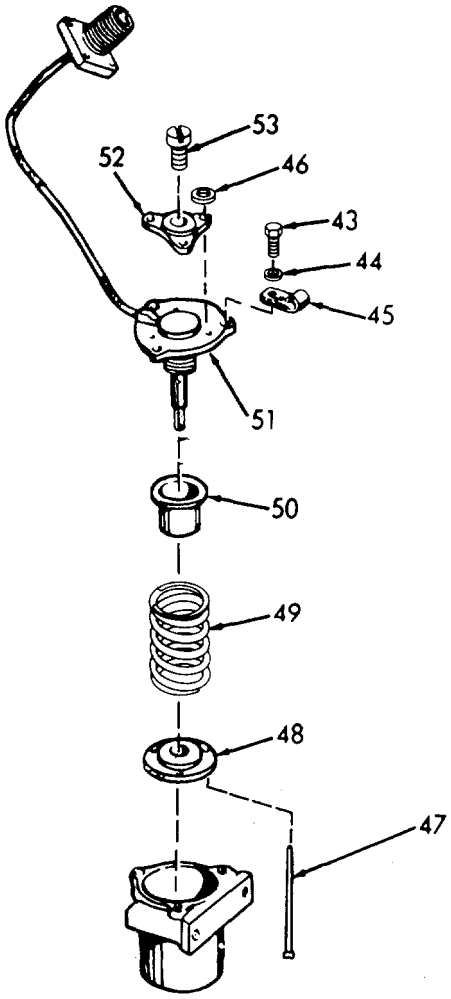


4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	j.	Backing plate (48), spring (49), spring cup (50), bellows assembly (51), yoke and plug (52)	Disassemble.	
	k.	Adjusting screw (53)	Remove.	If necessary.
	l.	Yoke and plug (52), bellows assembly (51), spring cup (50), spring (49), backing plate (48), piston guide pins (47), and retaining rings (46)	Reassemble.	
	m.	Screws (43), fl at-washers (44), and tube clamp (45)	Install.	

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



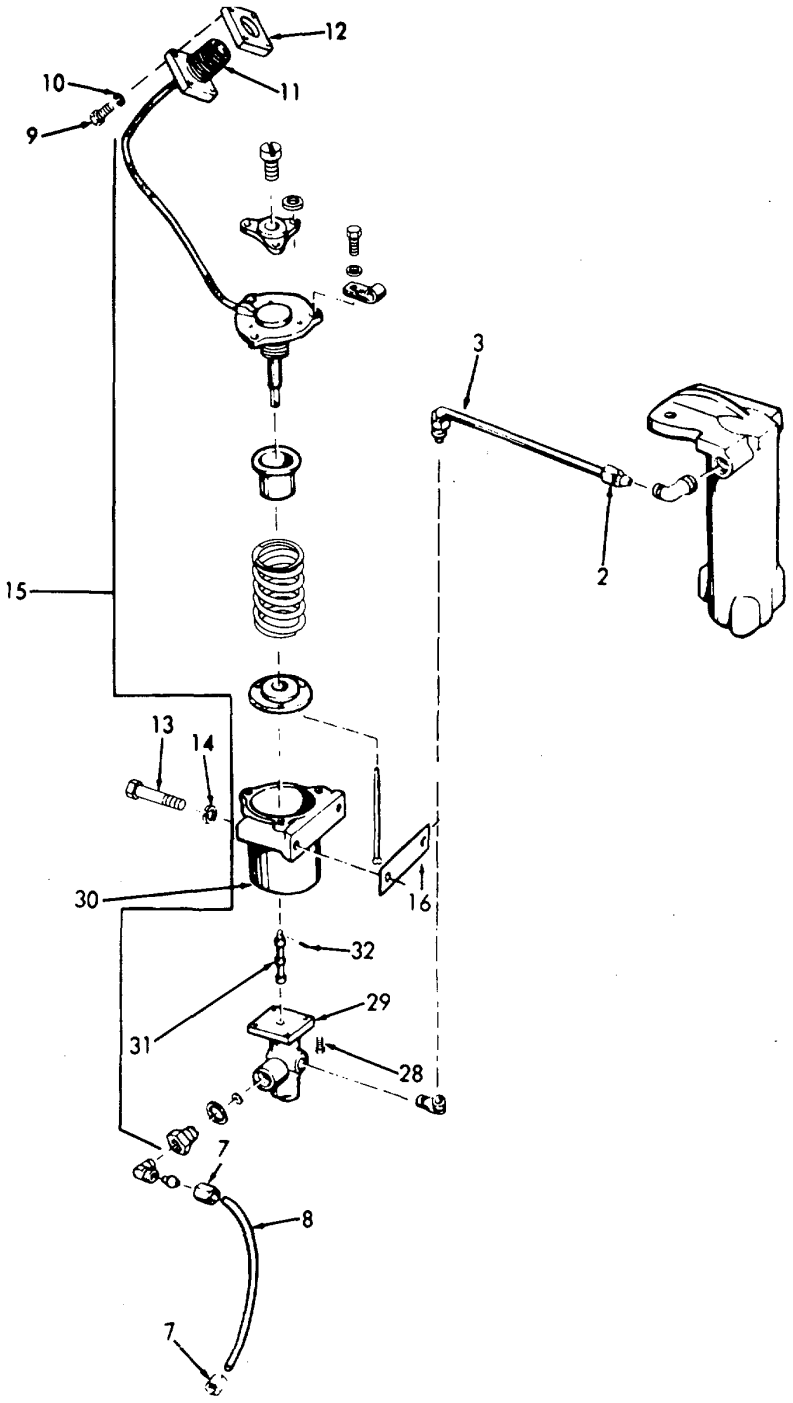
4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	n.	Piston (31), and piston pin (32)	Install.	
	o.	Plug and cylinder assembly (29), housing (30), and screws (28)	Reassemble.	
INSTALLATION				
7. Pressure regulator	a.	Pressure regulator (15), gasket (16), screws (13), and lock-washers (14)	Install.	Use new gasket.
	b.	Bellows assembly connector (11), gasket (12), screws (9), and lock-washers (10)	Install.	
	c.	Tube (8), sleeve nuts (7)	Install and tighten.	
	d.	Tube (3), sleeve nuts (2)	Install and tighten.	

4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

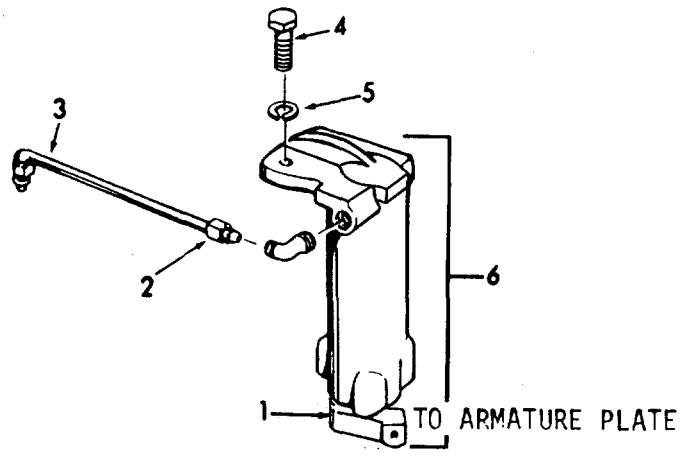
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



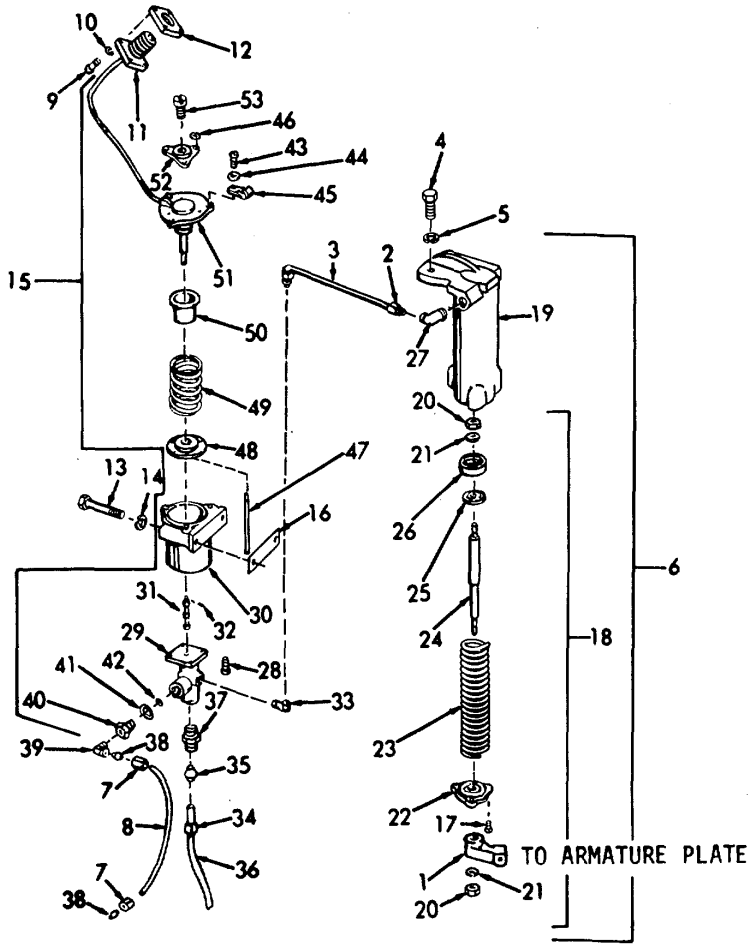
4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Operating cylinder	a. Operating cylinder (6), screws (4), and lock-washers (5)	Install.	
	b. Tube sleeve nuts (2)	Tube (3), Install and tighten.	
	c. Shaft arm (1)	Reconnect to magneto armature plate.	



4-7.9. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS



1. Shaft arm
2. Sleeve nuts
3. Tube
4. Screws
5. Lockwashers
6. Operating cylinder
7. Sleeve nuts
8. Tube
9. Screws
10. Lockwashers
11. Bellows assembly connector
12. Gasket
13. Screws
14. Lockwasher
15. Pressure regulator
16. Gasket
17. Screws
18. Base associated parts
19. Housing
20. Nuts
21. Shaft washers
22. Base
23. Spring
24. Shaft
25. Cylinder support
26. Cup
27. Elbow
28. Screws
29. Plug and cylinder assembly
30. Housing
31. Piston
32. Piston pin
33. Elbow
34. Ball nut
35. Ball
36. Water outlet tube
37. Connector
38. Ball
39. Elbow
40. Adapter
41. Gasket
42. Orifice disc
43. Screws
44. Flatwashers
45. Tube clamp
46. Retaining rings
47. Piston guide pins
48. Backing plate
49. Spring
50. Spring cup
51. Bellows assembly
52. Yoke plug
53. Adjusting screw

4-7.10. PUMP AND WATER OUTLET VALVE - MAINTENANCE INSTRUCTIONS.

a. General. The fire pump impeller is enclosed within the inner and outer impeller housings, and mounted on the crankshaft. It is secured in place by a key and nut. Water is forced into the impeller housing when air is evacuated from the housing and the suction hose by the action of the primer pump. As the water enters, the fire pump impeller throws the water outward, creating pressure within the impeller housing. This pressure shuts off the primer pump by disengaging the primer pump clutch. It is also the pump discharge pressure measured by the pressure gage.

(1) The ball type water outlet valve is located in the discharge opening of the impeller housing. It consists of a ball with a hole through it. Pressing against the ball is a plastic sleeve, which helps channel water from the ball to the discharge line, when the ball is in the open position. When the ball is in the closed position, (turned 90 degrees), the plastic sleeve presses against the ball sealing the discharge passage against the entry of air and preventing discharge of water.

CAUTION

Always keep the valve either fully open or fully closed. An intermediate position will allow the water being discharged to erode the sealing surfaces of the valve, resulting in eventual damage.

(2) This valve should always be closed when starting the pump, to prevent air from entering the impeller housing during priming. This permits pump pressure to build up properly, thus insuring that the fire pump is completely primed, and that the primer pump is disengaged. When pump pressure begins to build up, as indicated on the pressure gage, the valve should be opened slowly and water will be available in the discharge line. Regulation of water flow should be made at the discharge nozzles. The external handle which positions the water outlet valve locks in either the open or closed positions.

(3) The discharge hose is connected to the flange at the outlet valve, and the suction hose to the opening in the intake side of the impeller housing.

(4) If one and one-half inch discharge hoses are desired, the three-way gate valve supplied with the pump should be connected to the flange at the pump outlet valve.

(5) The manual primer consists of a lever-arm plug arrangement mounted on the primer bowl in the impeller housing. Its function is to allow water to be poured into the impeller housing to prime the fire pump in the event of failure of the primer pump, or if the

4-7.10. PUMP AND WATER OUTLET VALVE - MAINTENANCE INSTRUCTIONS (Continued).

suction lift is too great for the primer pump to prime the fire pump (lifts greater than 16 to 20 feet (4.9 - 6.1 m)). While the pump is operating, the primer lever and plug should always be tightly secured in place with the wing nut provided.

(6) To prime the fire pump manually, loosen the wing nut securing the manual priming lever and lift the lever, fill the impeller housing and suction hose with water through the bowl, close and lock the priming lever with the wing nut, and start the pump.

b. Description. The fire pump consists of the impeller housing (inner and outer halves), impeller, and various seals and attaching parts. Maintenance and repair procedures follow.

c. Maintenance. Little maintenance will ordinarily be required. If leaks should develop around the impeller housing, disassemble the pump, replace any damaged gaskets, seals, and any parts which show signs of wear. While the pump is dismantled, clean any accumulation of dirt or scale out of the impeller and impeller housing.

This task covers:

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

INITIAL SETUP

Test Equipment	References Paragraph	
NONE	4-7.11	Priming Pump and Gear Housing

Special Tools	Equipment Condition	Condition Description
Impeller puller Strap wrench Torque wrench	NONE	

Material/Parts	Special Environmental Conditions
Gaskets and seals	NONE

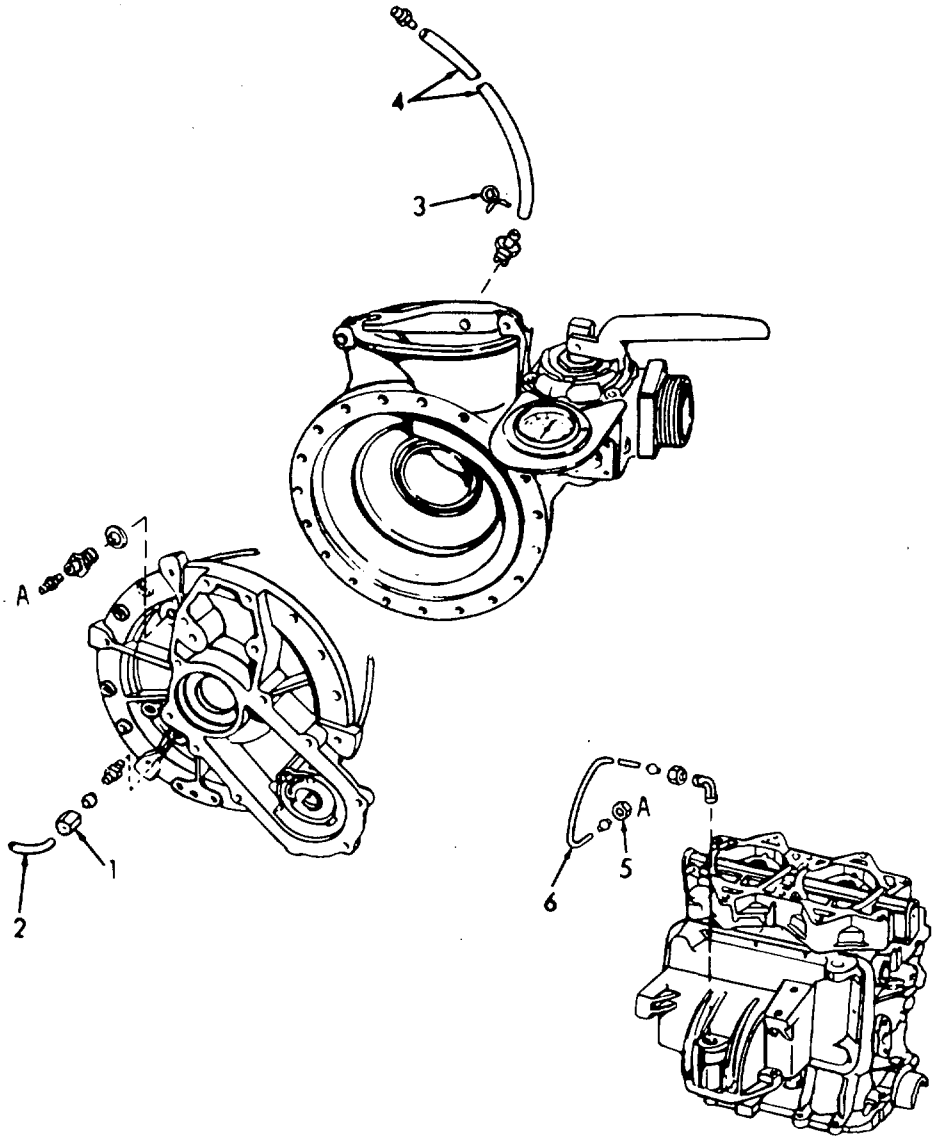
Personnel Required	General Safety Instructions
1	NONE

4-7.10 PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Fire pump	a. Hoses	Inspect for breaks, cracks and leaks.	
	b. Tubing	Inspect for bends, breaks, cracks and leaks.	
	c. Housing	Inspect for breaks, cracks and leaks.	
	d. Filler	Inspect for wear and proper operation.	
	e. Water gate valve	Inspect for leaks, breaks, cracks and proper operation.	
REMOVAL			
2. Fire pump	a. Ball sleeve nut (1)	Loosen.	
	b. Tube (2)	Disconnect.	
	c. Hose clamps (3)	Loosen.	
	d. Primer intake hose (4)	Remove.	
	e. Ball sleeve nut (5)	Loosen.	
	f. Tube (6)	Disconnect.	

4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

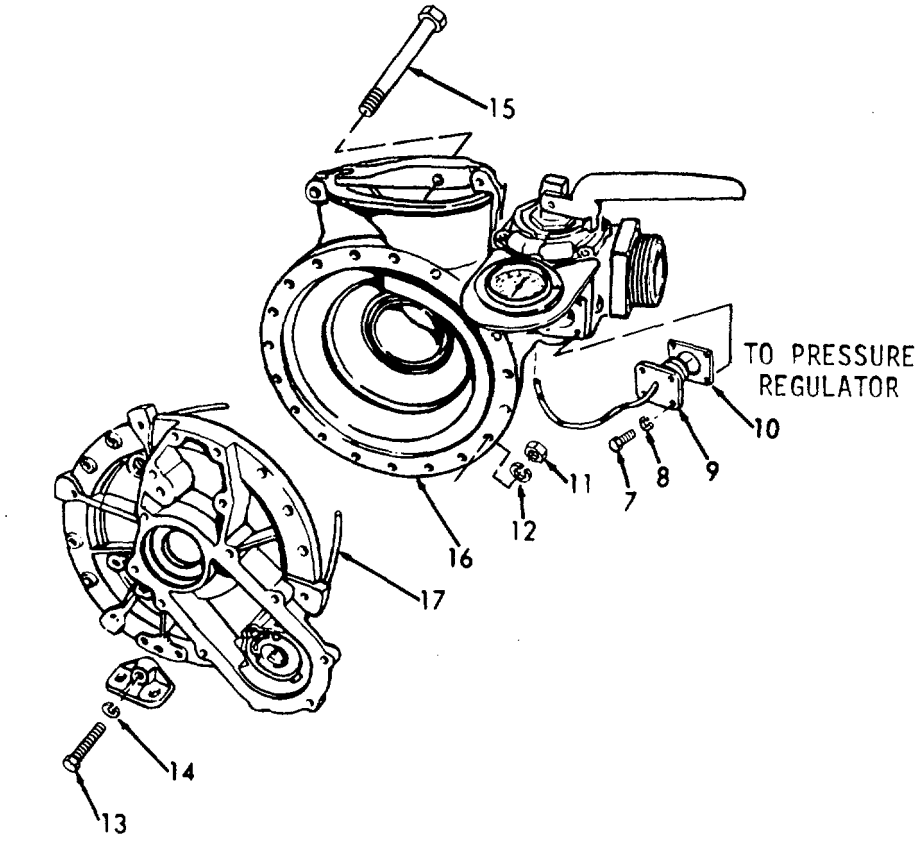


4-7.10 PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	g. Screws (7), and lock-washer (8)	Remove.	
	h. Pressure tube (9), and dia-phragm (10)	Remove.	Do not bend or kink tube.
	i. Nuts (11), and lock - washers (12)	Remove at 17 places.	
	j. Screw (13), and lock-washer (14)	Remove.	
	k. Screw (15)	Remove.	
	1. Impeller housing (16), and seal (17)	Remove.	Discard seal.

4-7.10 PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

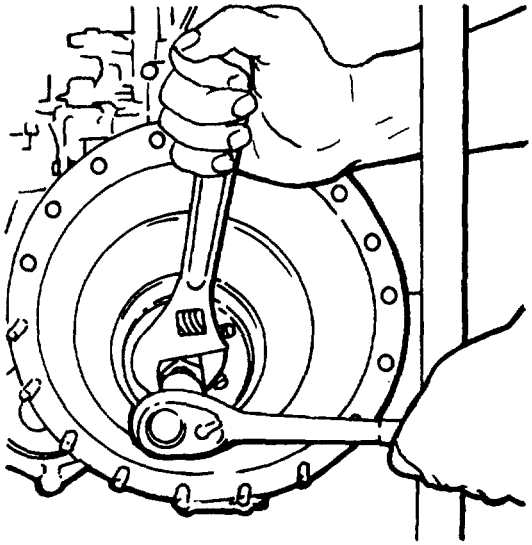


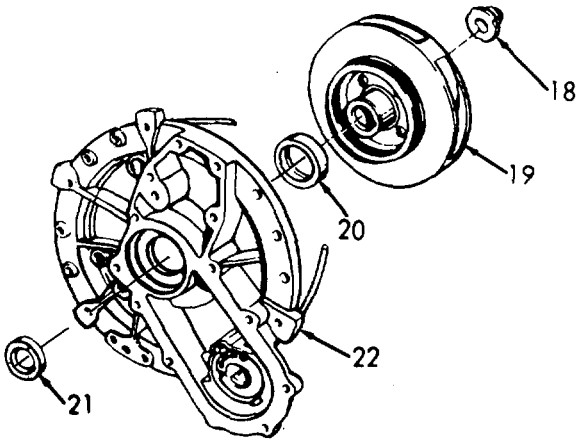
4-7.10 PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Impeller and seals	a. Impeller nut (18)	Remove.	It may be necessary to hit handle of the wrench with a hammer in order to get enough force to break the nut loose.
	b. Impeller (19)	Remove.	Use impeller puller method shown.
		CAUTION	
	Do not drop the impeller or mar the face which fits into seals within the inner impeller housing, as this face of the impeller forms part of the seal.		
	c. Seals (20 and 21)	1. Inspect for damage or wear.	If damaged: a. Remove power head (paragraph 4-7.6). b. Remove gear housing and rear impeller housing (paragraph 4-7.11).
		2. Remove.	Drive out with punch and hammer using care not to cock the seal or damage the housing (22).

4-7.10 PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



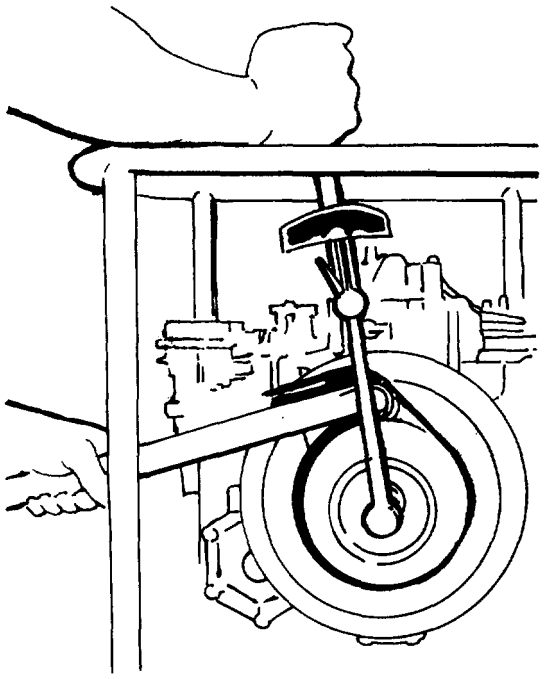


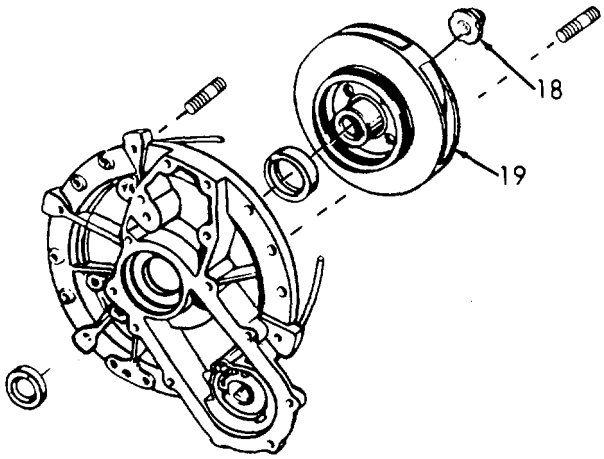
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		3. Install.	Install new seals using an arbor press, making sure the pressure is applied only to the outer diameter of the seal. If the seal chips, or is off-center when force is applied, it will be damaged beyond repair. If an arbor press is not available, the seals may be replaced by mounting the pump housing in a lathe chuck, and pressing the seal in with the lathe tail spindle.
	d. Impeller (19)	Install.	
	e. Impeller nut (18)	Install.	a. When replacing the impeller locknut, use a torque wrench and a strap wrench as illustrated and torque the nut to 60 ft pounds (54.23 Nm).

4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

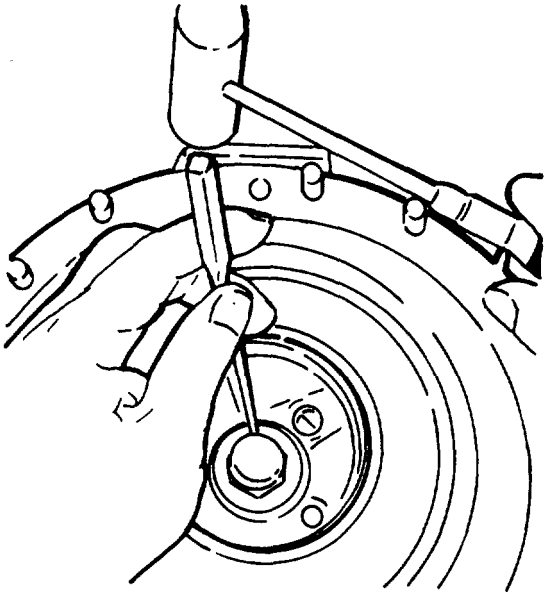
LOCATION	ITEM	ACTION	REMARKS
REPAIR (cont)			





4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

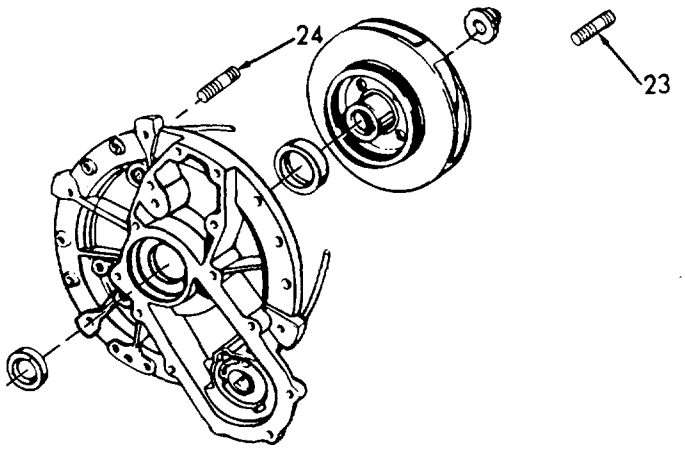
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)		b. Then,,stake the edge of counterbore in impeller into slots in nut to make certain it does not loosen, as illustrated.	



		c. Make sure all parts seat properly, and that all gaskets and O-rings are replaced.	

4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Studs (23 and 24)	Replace.	If necessary.

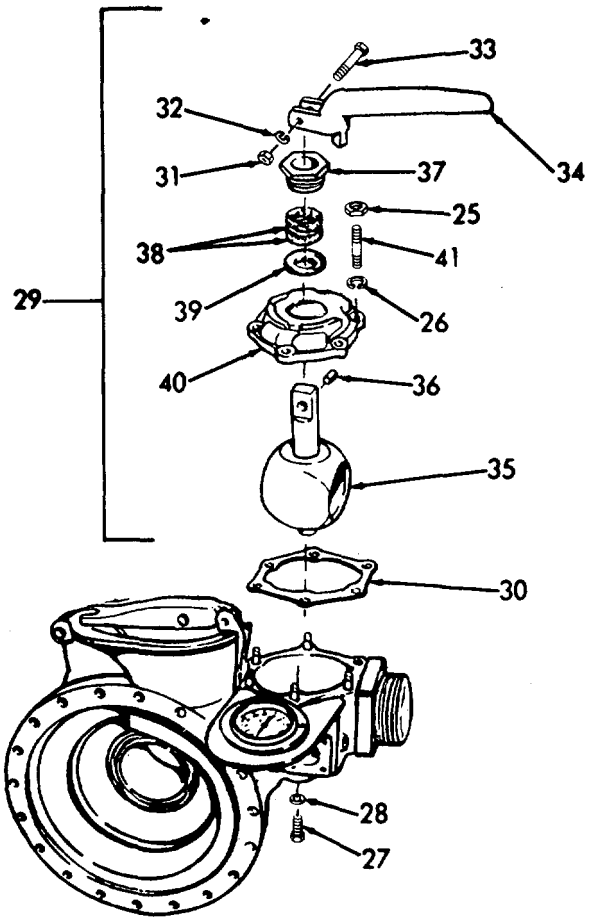


4-710. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Water Gate	a. Nuts (25), valve and lock - washers (26)	Remove.	
	b. Screw (27), and stop screw washer (28)	Remove.	
	c. Cap and bushing assembly (29), and gasket (30)	Remove.	Discard gasket.
	d. Nut (31), lock-washer (32), and screw (33)	Remove.	
	e. Handle (34), ball valve (35), and bushing (36)	1. Remove. 2. Inspect.	Inspect surface of ball for scoring, erosion or other damage which might cause air leaks during priming.
	f. Packing nut (37), packing (38), and bushing (39)	Remove from cap (40).	
	g. Stud (41)	Remove.	If necessary.

4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

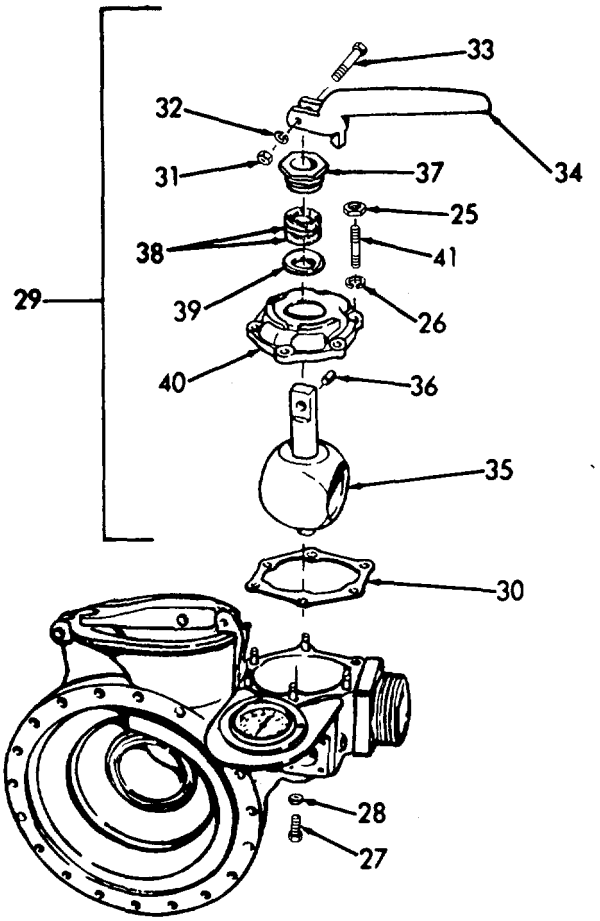


4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Cap (40), bushing (39), packing (38), and packing nut (37)	Reassemble.	
	i. Bushing (36), ball valve (35), and handle (34)	Reassemble.	
	j. Screw (33), lock-washer (32), and nut (31)	Install.	
	k. Cap and bushing assembly (29), and gasket (30)	Install.	Use new gasket.
	1. Screw (27), and stop screw washer (28)	Install.	
	m. Lock-washers (26), and nuts (25)	Install.	

4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

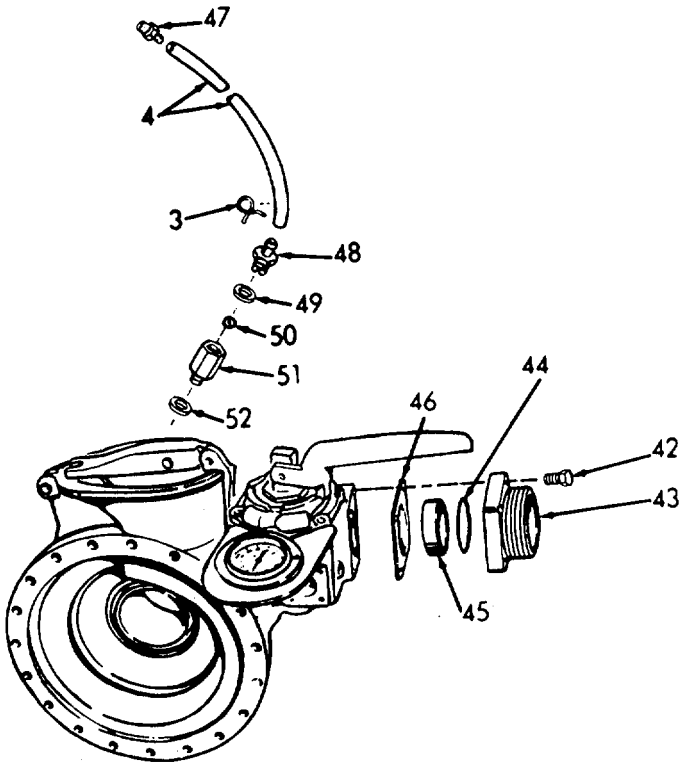


4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Outlet Hose connection	a. Screws (42)	Remove.	
	b. Flange (43), seal ring (44), seal sleeve (45), and gasket (46)	Remove.	Replace gasket and seals if damaged.
	c. Gasket (46), seal sleeve (45), seal ring (44), and flange (43)	Reassemble.	
	d. Screws (42)	Install.	
6. Primer intake hose	a. Hose clamps (3), and hose (4)	Remove.	
	b. Intake nipple (47)	Remove.	

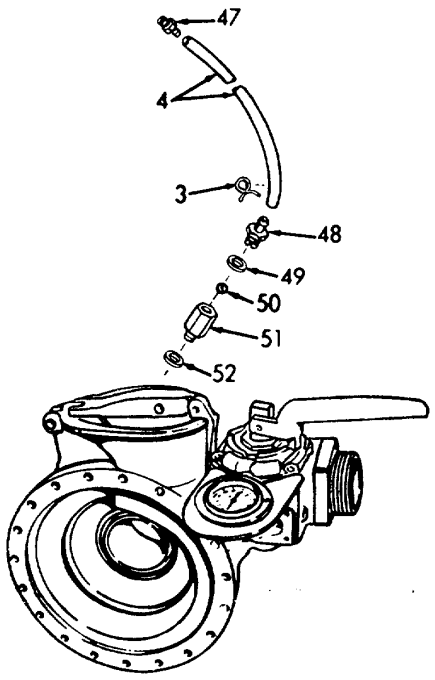
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Ball check nipple (48), gasket (49), ball check (50), check valve body (51), and gasket (52)	Disassemble.	Discard gaskets.



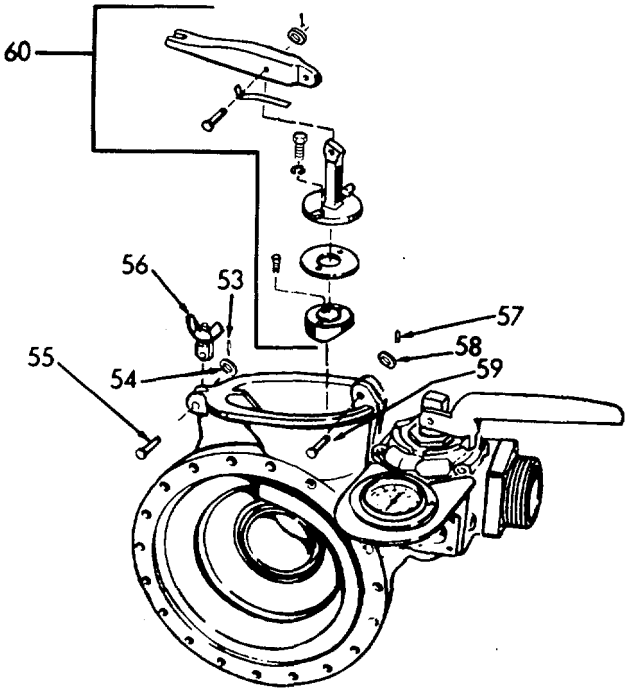
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Gasket (52), check valve body (51), ball check (50), gasket (49), and ball check nipple (48)	Reassemble.	Use new gaskets.
	e. Intake nipple (47)	Install.	
	f. Hose (4) and hose clamps (3)	Install.	



4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Filler	a. Cotter pin (53), washer (54), pin (55), and wing nut and screw assembly (56)	Remove.	If necessary.
	b. Cotter pin (57), washer (58), and pin (59)	Remove.	
	c. Filler plug assembly (60)	Remove.	

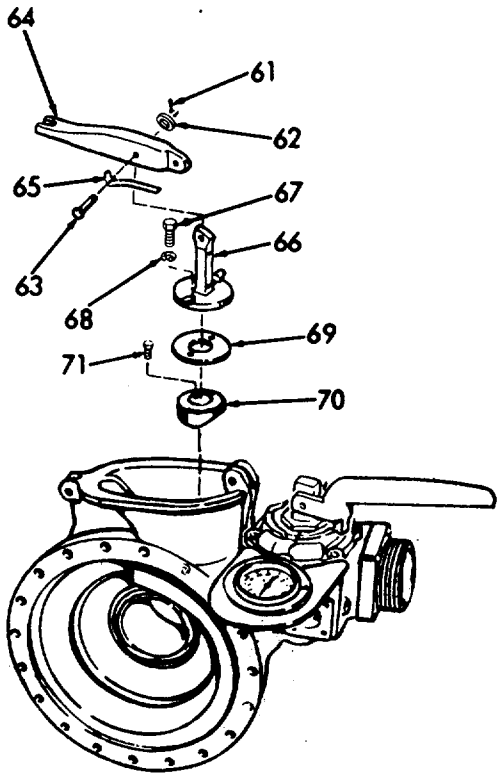


4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Cotter pin (61), washer (62), and pin (63)	Remove.	
	e. Handle (64), spring (65), and filler plug arm (66)	Disassemble.	
	f. Screw (67), lock-washer (68), filler plug arm (66), gasket (69), and filler plug (70)	Disassemble.	
	g. Pin (71)	Remove.	If necessary.
	h. Filler plug (70), gasket (69), filler plug arm (66), lock-washer (68), and screw (67)	Reassemble.	

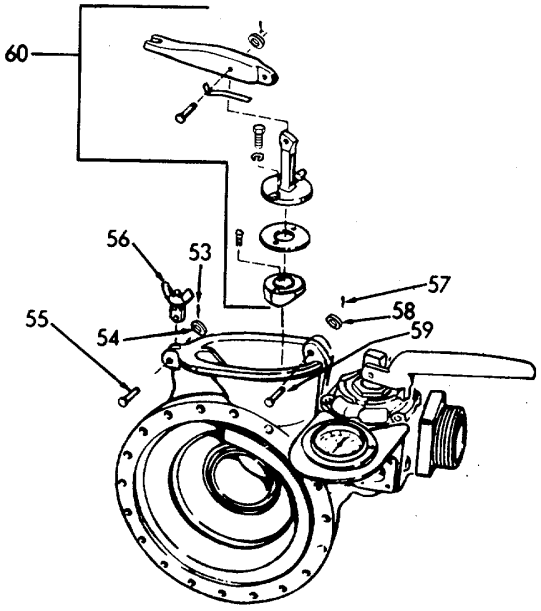
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Filler plug arm (66), spring (65), handle (64), pin (63), washer (62), and cotter pin (61)	Reassemble.	



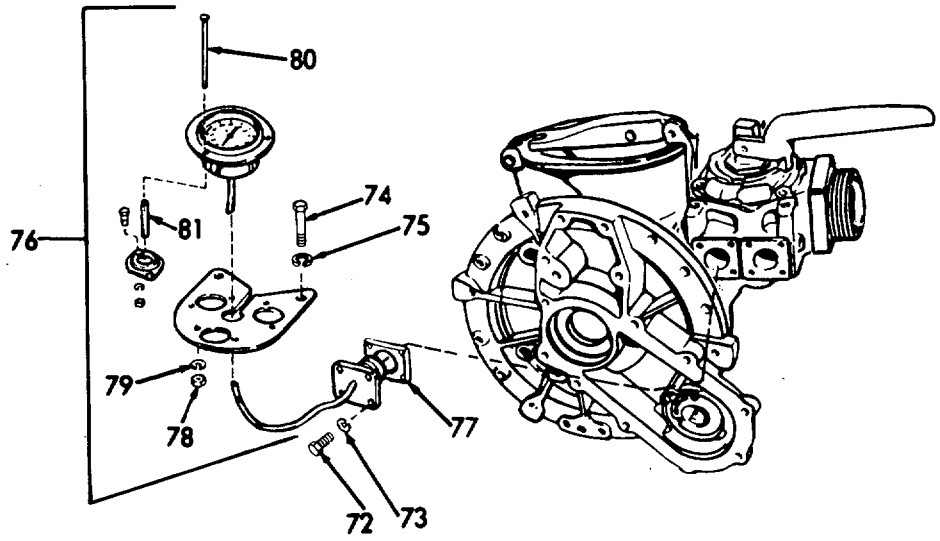
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Filler plug assembly (60), pin (59), washer (58), and cotter pin (57)	Install.	
	k. Wingnut and screw assembly (56), pin (55), washer (54), and cotter pin (53)	Install	



4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Pressure gage and bellows assembly	a. Screws (72), and lockwasher (73)	Remove.	
	b. Screws (74), and lockwashers (75)	Remove.	
	c. Pressure gage and bellows assembly (76), and gasket (77)	Remove.	Do not bend tube.
	d. Mounting nuts (78), lockwashers (79), screws (80), and spacers (81)	Remove.	

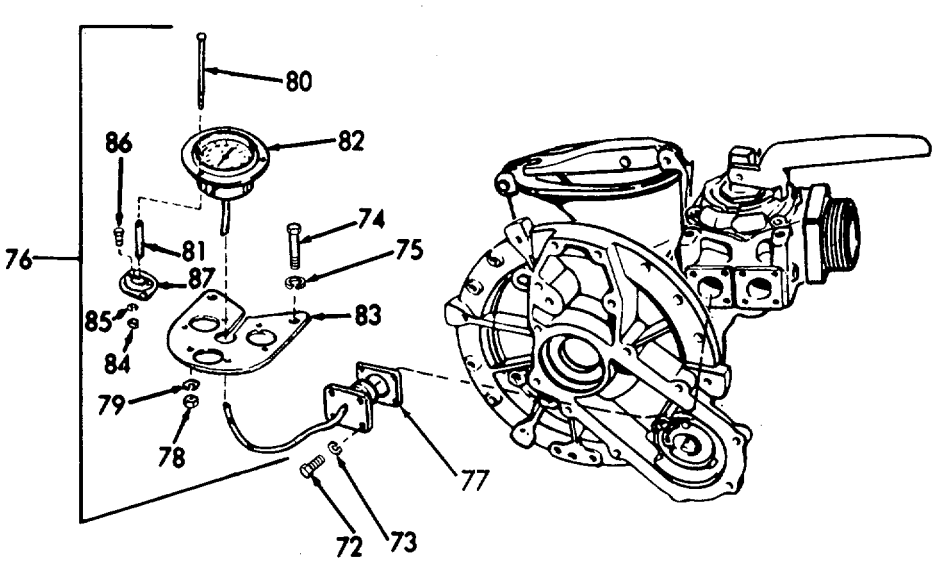


4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Gage and bellows assembly (82)	Remove from mounting panel (83).	Do not bend tube.
	f. Nuts (84), lock-washers (85), screws (86), and mounting (87)	Disassemble.	If necessary.
	g. Gage and bellows assembly (82), mounting panel (83), spacers (81), screws (80), lock-washers (79), and mounting nut (78)	Assemble.	
	h. Pressure gage and bellows assembly (76), and gasket (77)	Install.	Use new gasket.
	i. Screws (74), and lock-washers (75)	Install.	

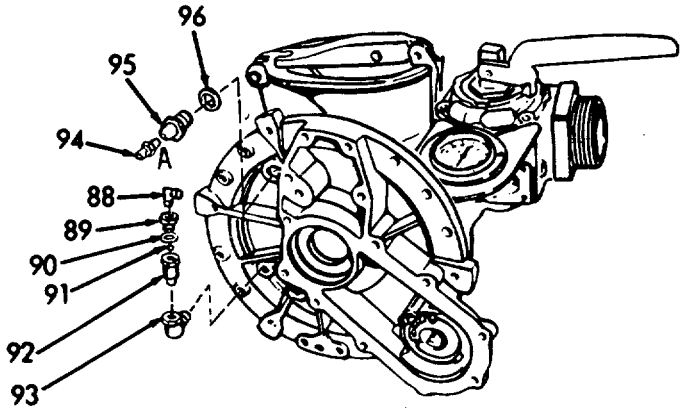
4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

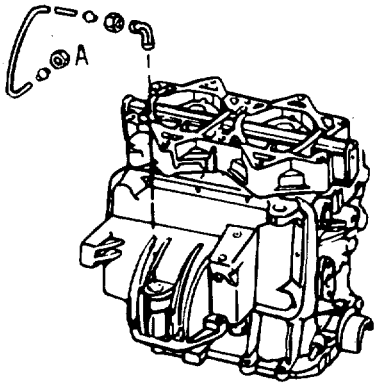
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Screws (72), and lock - washers (73)	Install.	



4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

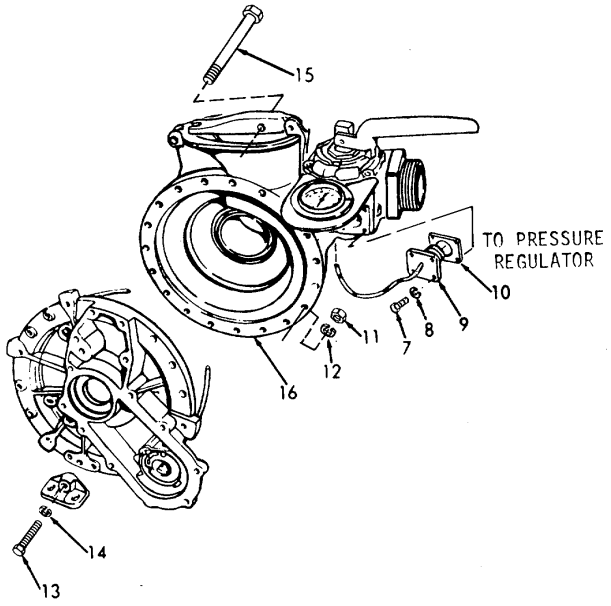
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Check valve	Elbow (88), adapter (89), gasket (90), ball (91), ball seat (92), and adapter (93)	Disassemble, clean and reassemble.	
10. Body and screen assembly	Impeller connector (94), body and screen (95), and gasket (96)	Disassemble, clean and reassemble.	





4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11. Fire Pump	a. Impeller housing (16), seal (17), screw (15), screw (13), lock-washer (14), nuts (11), and lock - washers (12)	Reasemble.	
	b. Pressure Install. tube (9), and dia-phagram (10), screws (7), and lock-washers (8)		

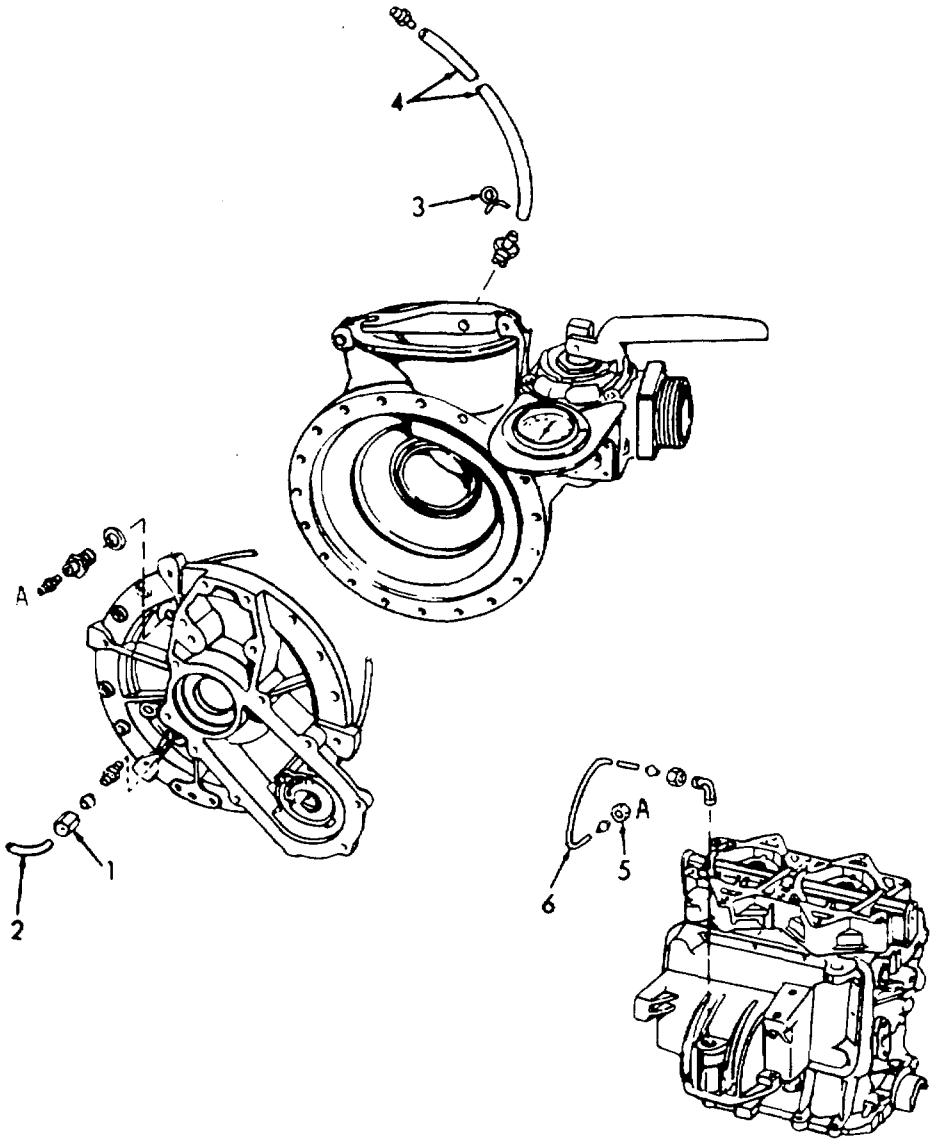


4-7.10. PRESSURE REGULATOR AND OPERATING CYLINDER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Tube (6), and ball sleeve nut (5)	Install.	
	d. Primer intake hose (4), and hose clamps (3)	Install.	
	e. Tube (2), and ball sleeve nut (1)	Install.	

4-7.10. PUMP AND WATER OUTLET VALVE-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

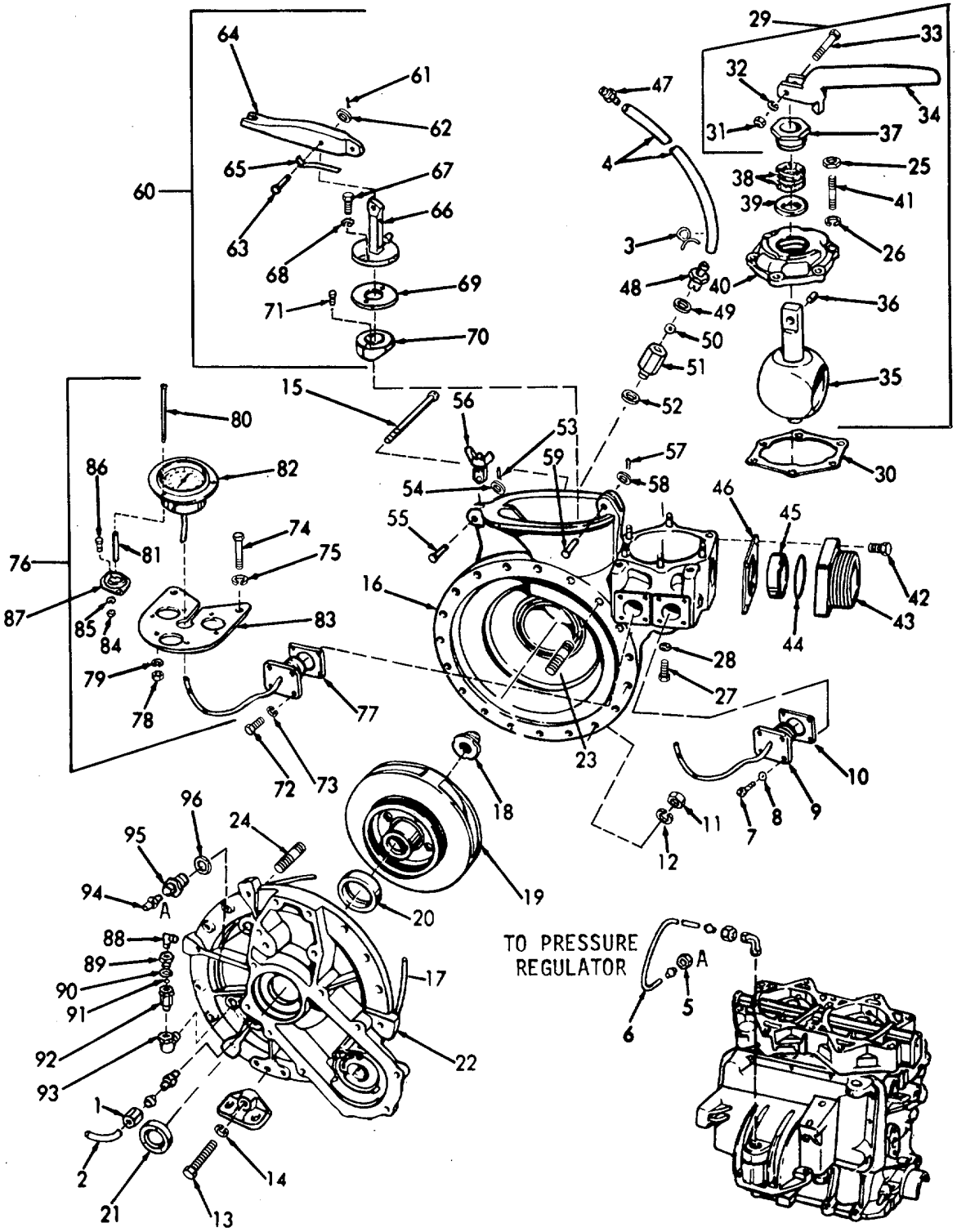


4-7.10. PUMP AND WATER OUTLET VALVE-MAINTENANCE INSTRUCTIONS (Continued).

Pump and Water Outlet Valve Legend

1. Ball sleeve nut
2. Tube
3. Hose clamps
4. Primer intake hose
5. Ball sleeve nut
6. Tube
7. Screws
8. Lockwasher
9. Pressure tube
10. Diaphragm
11. Nuts
12. Lockwashers
13. Screw
14. Lockwasher
15. Screw
16. Impeller housing
17. Seal
18. Impeller nut
19. Impeller
20. Seals
21. Seals
22. Housing
23. Studs
24. Studs
25. Nuts
26. Valve and lockwashers
27. Screw
28. Stop screw washer
29. Cap and bushing assembly
30. Gasket
31. Nut
32. Lockwasher
33. Screw
34. Handle
35. Ball valve
36. Bushing
37. Packing nut
38. Packing
39. Bushing
40. Cap
41. Stud
42. Screws
43. Flange
44. Seal ring
45. Seal sleeve
46. Gasket
47. Intake nipple
48. Ball check nipple
49. Gasket
50. Ball check
51. Check valve body
52. Gasket
53. Cotter pin
54. Washer
55. Pin
56. Wing nut and screw assembly
57. Cotter pin
58. Washer
59. Pin
60. Filler plug assembly
61. Cotter pin
62. Washer
63. Pin
64. Handle
65. Spring
66. Filer plug arm
67. Screw
68. Lockwasher
69. Gasker
70. Filler plug
71. Pin
72. Screws
73. Lockwasher
74. Screws
75. Lockwashers
76. Pressure gage and bellows assembly
77. Gasket
78. Mounting nuts
79. Lockwashers
80. Screws
81. Spacers
82. Gage and bellows assembly
83. Mounting panel
84. Nuts
85. Lockwashers
86. Screws
87. Mounting
88. Elbow
89. Adapter
90. Gasket
91. Ball
92. Ball seat
93. Adapter
94. Impeller connector
95. Body and screen
96. Gasket

4-7.10. PUMP AND WATER OUTLET VALVE-MAINTENANCE INSTRUCTIONS (Continued).



4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS.

a. General.

(1) The priming pump is of the positive displacement type, and is mounted on the gear housing beneath the carburetor. The gear on the crankshaft drives an idler gear, which in turn transmits power to the gear on the primer pump shaft.

(2) The intake tube to the primer pump is connected to the intake side of the fire pump. A pressure tube is connected from the impeller housing to the diaphragm side of the primer pump.

(3) When the engine is started, the primer pump evacuates the air from the fire pump impeller housing and the suction hose. Because of this suction, atmospheric pressure forces water up through the suction hose and into the impeller housing. As soon as the water enters the center of the rotating impeller, the fire pump begins to build up pressure. This pressure is carried through the pressure tube from the impeller housing to the diaphragm on the outboard end of the primer pump. The diaphragm is in contact with the end of the primer pump drive shaft, and when the pressure builds up, it forces the primer pump drive shaft against the clutch plate, which separates the clutch face from the primer pump drive gear, disengaging the primer pump. Therefore, the priming pump is in operation only until the fire pump has been primed.

(4) The gear housing and primer pump are lubricated from the oil that accumulates in the bottom of the engine crankcase. There are two spring-loaded valves at the bottom of the crankcase which allow the oil to bleed out the crankcase into rubber lines to the primer pump and gear housing.

b. Description.

(1) The gear housing is mounted between the impeller housing and the power head. It contains a crankshaft-mounted pinion gear, an idler gear, and the primer drive gear, which are the means of transmitting power from the crankshaft to the primer pump. As the crankshaft rotates, the pinion gear drives the idler gear, which in turn drives the primer pump driver gear. A friction clutch arrangement transmits power from the primer pump drive gear to the primer pump impeller.

(2) The primer pump consists of two end plates, a housing, impeller, and vanes. The impeller is mounted off-center within the housing. Located axially in slots along the impeller surfaces are the four vanes. These vanes are free to move, and, as the impeller rotates, they move outward due to centrifugal force, until they contact the inside of the housing. They thus trap air drawn from the impeller housing and suction hose between the housing, the impeller, and the vanes. Air trapped in this manner is forced to the primer pump outlet.

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS.

(3) If the pump should fail to prime, and it is established that the primer pump is in good operating condition, and all suction connections are tight, it may be necessary to clean the check valve from the impeller housing to the exhaust receiver. Refer to paragraph 4-7.10.

(4) If the pump primes but fails to maintain its prime, primer intake check valve may be leaking. Refer to paragraph 4-7.10.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

Spanner wrench

References

Paragraph	
4-7	Portable Fire Pump

Equipment

Condition	Condition Description
Paragraph	
4-7.10	Pump and Water Outlet Valve removed

Material/Parts

"O" rings
Preformed packing
Seals

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

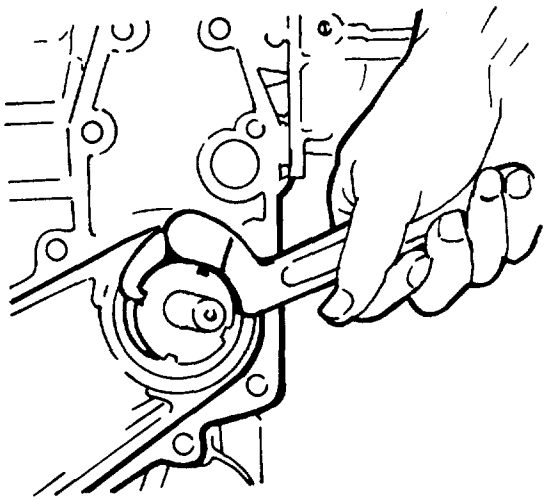
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Priming pump and gear housing	a. Hoses	Inspect for breaks, cracks, and leaks.	
	b. Pump	Inspect for breaks, cracks and leaks.	
	c. Gear housing	Inspect for breaks, cracks and leaks	

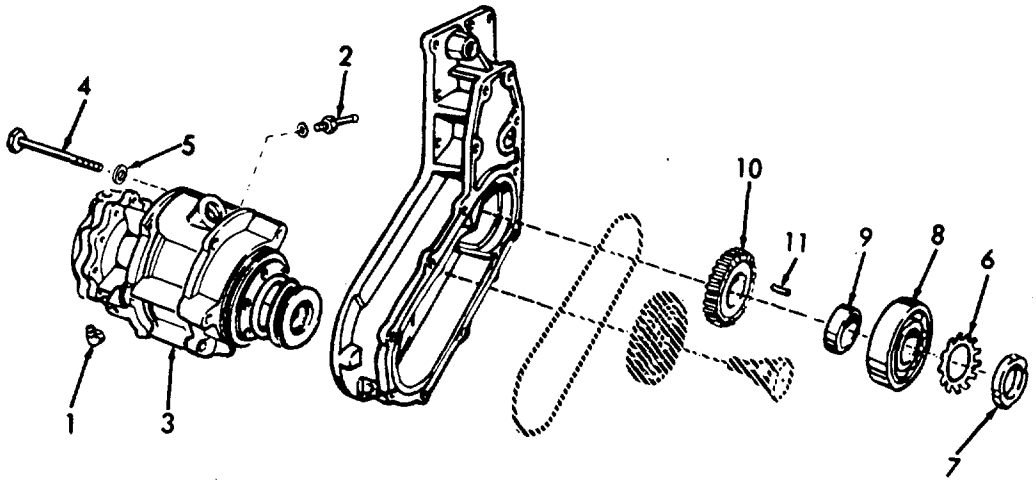
4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
2.	Primer pump	a. Tubing-to elbow (1)	Remove.	
		b. Tubing-to oil line nipple (2)	Remove.	
		c. Tubing-to pump body (3)	Remove.	
		d. Screws (4), and flat-washers (5)	Remove.	
3.	Gear housing	a. Fire pump and impeller	Remove.	Refer to paragraph 4-7.10.
		b. Lock-washer (6)	Unstake from locknut (7).	
		c. Locknut (7)	Remove.	Use spanner wrench.
		d. Ball bearing (8), crank-shaft spacer (9), pinion gear (10), and key (11)	Remove.	

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			



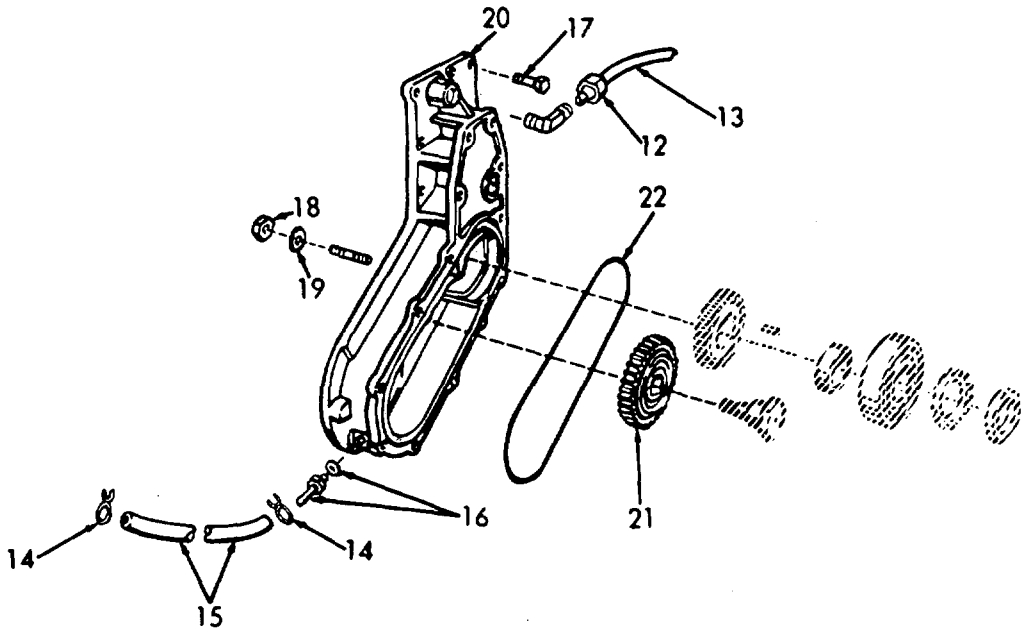


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Tube nut (12), and tube (13)	Loosen and remove.	
	f. Hose clamps (14), and hose (15)	Loosen and remove.	
	g. Oil line nipple and washer (16)	Replace.	If necessary.
	h. Screws (17)	Remove.	
	i. Nuts (18), and flat-washers (19)	Remove.	
	j. Gear housing (20)	Remove.	1. Use a broad-blade screwdriver between prying lugs. 2. Remove gear housing idler gear and bearing (21) as a unit. 3. Do not further disassemble unless idler gear or bearing is damaged and must be replaced.
	k. Seal (22)	Remove.	Discard.

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

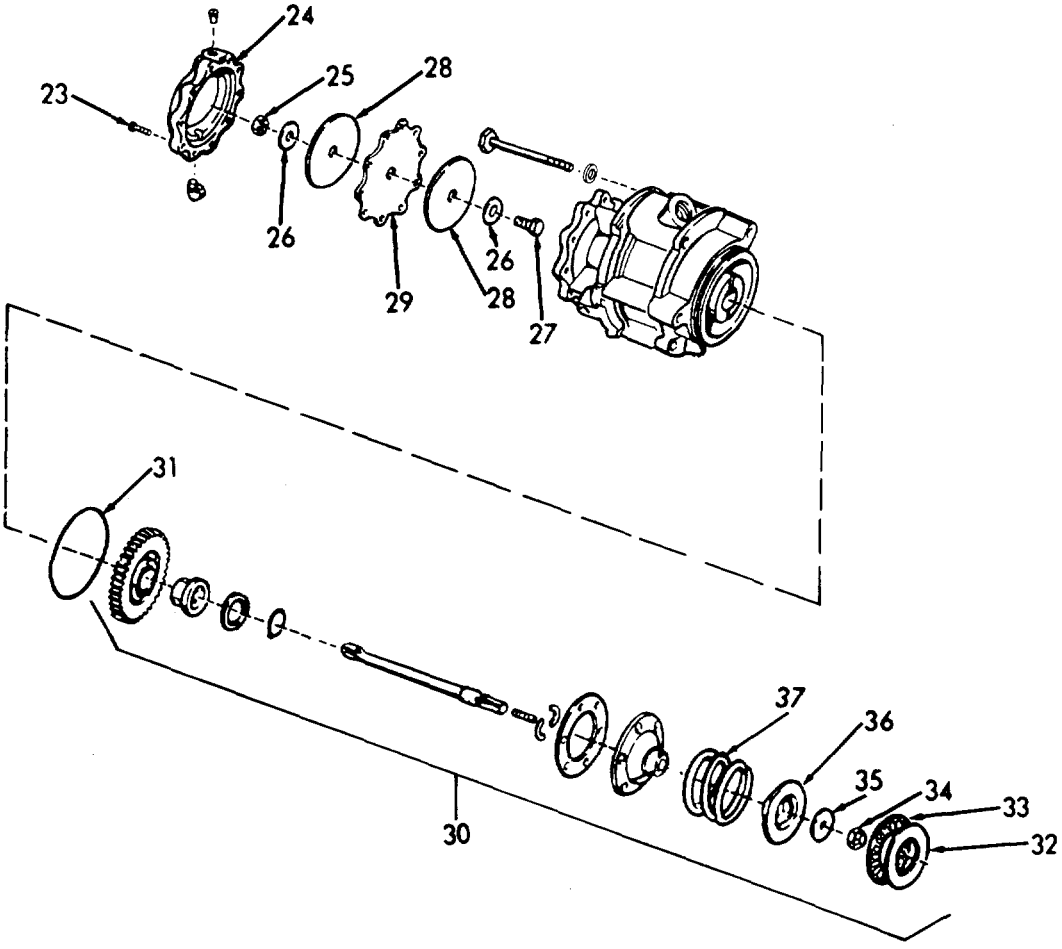


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
REPAIR				
4.	Primer pump diaphragm	a. Screws (23)	Remove.	
		b. Pump cover (24)	Remove.	
		c. Diaphragm nut (25), washers (26), screw (27), followers (28), and diaphragm (29)	Disassembly.	If necessary.
		d. Pump cover (24) ,and screws (23)	Install.	
5.	Primer pump clutch and drive shaft	a. Clutch and drive shaft (30)	Remove.	
		b. Preformed packing (31)	Remove.	
		c. Thrust washer (32), and thrust bearing (33)	Remove.	

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Nut (34), washer (35), shaft dog (36), and clutch spring (37)	Remove.	

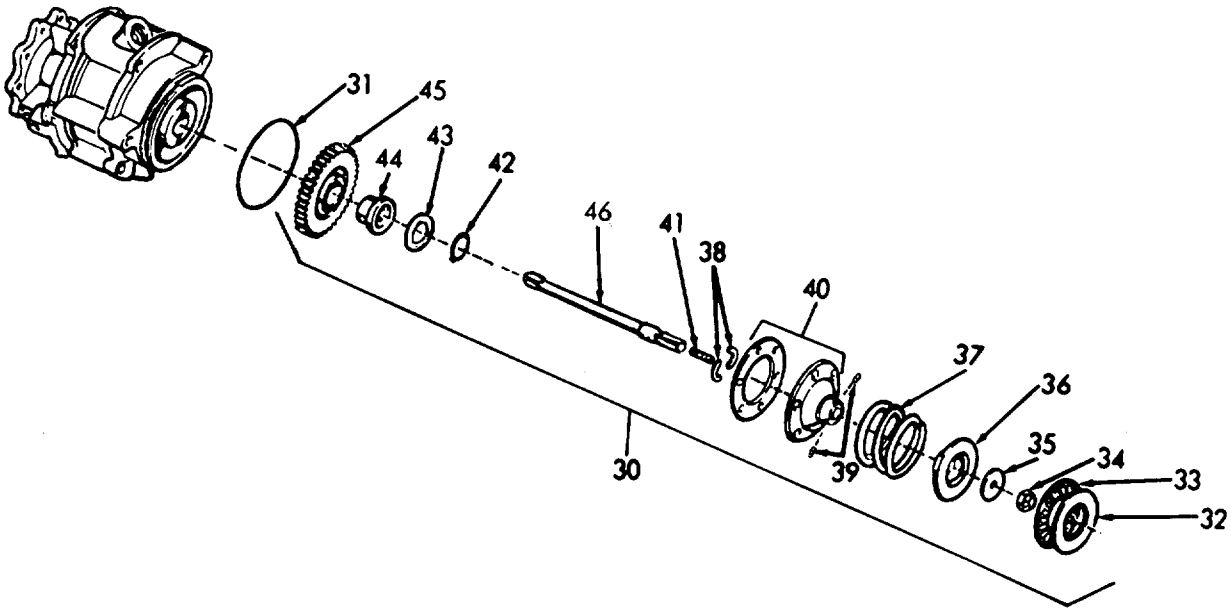


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Retaining ring (38)	Remove.	
	f. Pins (39)	Remove.	
	g. Clutch plate assembly (40)	Remove.	
	h. Stud (41)	Remove	If necessary.
	i. Retaining ring (42), washer (43), bushing (44), gear (45), and drive shaft (46)	Disassemble	If necessary.
	j. Clutch plate assembly (40), and pins (39)	Install.	
	k. Retaining ring (38)	Install.	
	l. Clutch spring (37), shaft dog (36), washer (35), and nut (34)	Install.	

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	m. Thrust bearing (33), and thrust washer (32)	Install.	
	n. Pre-formed packing (31)	Install.	Using new packing.
	o. Clutch and drive shaft (30)	Install.	

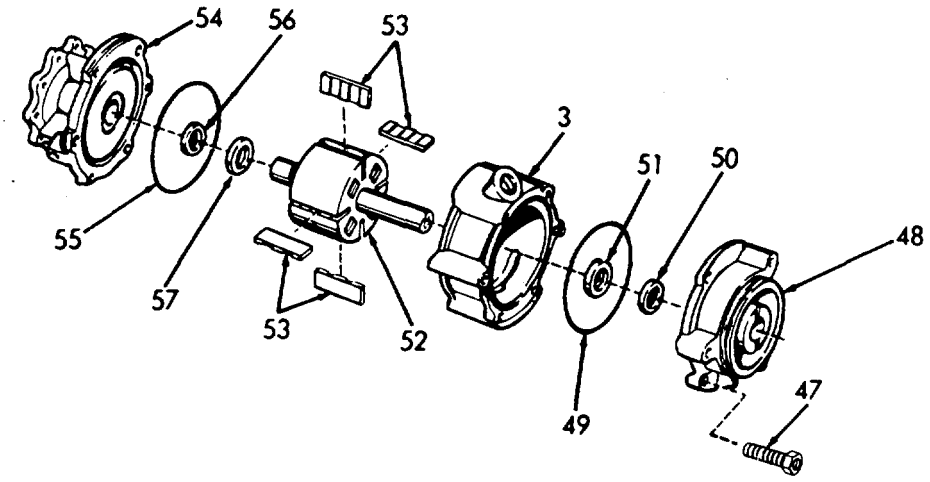


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
REPAIR (Cont)				
6.	Impeller and shaft assembly	a. Screws (47)	Remove.	
		b. Inboard head (48)	Remove.	
		c. "O" ring (49)	Remove.	Discard.
		d. Outer seal (50), to inner seal (51)	Remove.	
		e. Cylinder (3)	Remove.	
		f. Impeller and shaft assembly (52), and impeller vanes (53)	Remove from outboard head (54).	
		g. "O" ring (55)	Remove.	Discard.
		h. Outer seal (56), and inner seal (57)	Remove.	
		i. Inner seal (57), and outer seal (56)	Install.	
		j. "O" ring (55)	Install in outboard head (54).	Use new "O" ring.

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Impeller and shaft assembly (52), and impeller vanes (53)	Install in outboard head (54).	
	l. Cylinder (3)	Install to outboard head (54).	
	m. "O" ring (49)	Install in cylinder (3).	Use new "O" ring.
	n. Inner seal (51), and outer seal (50)	Install.	
	o. Inboard head (48), and screws (47)	Install.	

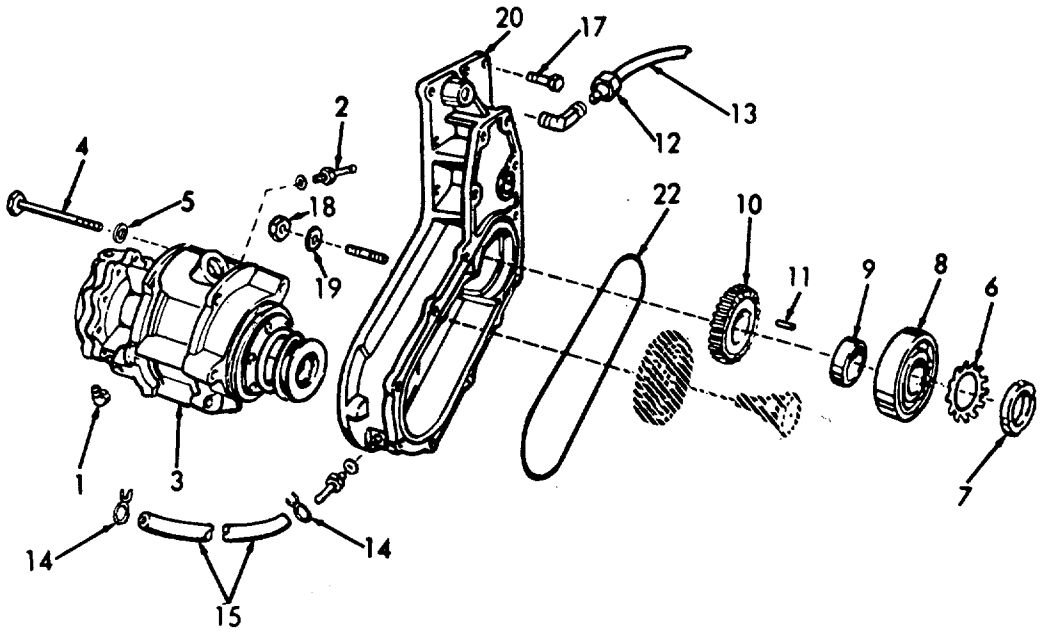


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
7. Gear housing	a. Seal (22)	Install.	Use new seal.
	b. Gear housing (20)	Install.	
	c. Nuts (18), and flat-washers (19)	Install.	
	d. Screws (17)	Install.	
	e. Hose (15), and hose clamps (14)	Install.	
	f. Tube (13), and tube nuts (12)	Install and tighten.	
	g. Pinion gear (10), and key	Install	
	h. Crank-shaft spacer (9), and ball bearing (8)	Install.	
	i. Lock-washer (6), and locknut (7)	Install.	Use spanner wrench.

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION		ITEM	ACTION	REMARKS
INSTALLATION (Cont)				
		j. Lock-washer (6)	Stake.	
8.	Primer pump	a. Screws (4), flat-washers (5), and pump body (3)	Assemble.	
		b. Tubing to pump body (3)	Install.	
		c. Tubing to oil line nipple (2)	Install.	
		d. Tubing to elbow (1)	Install.	

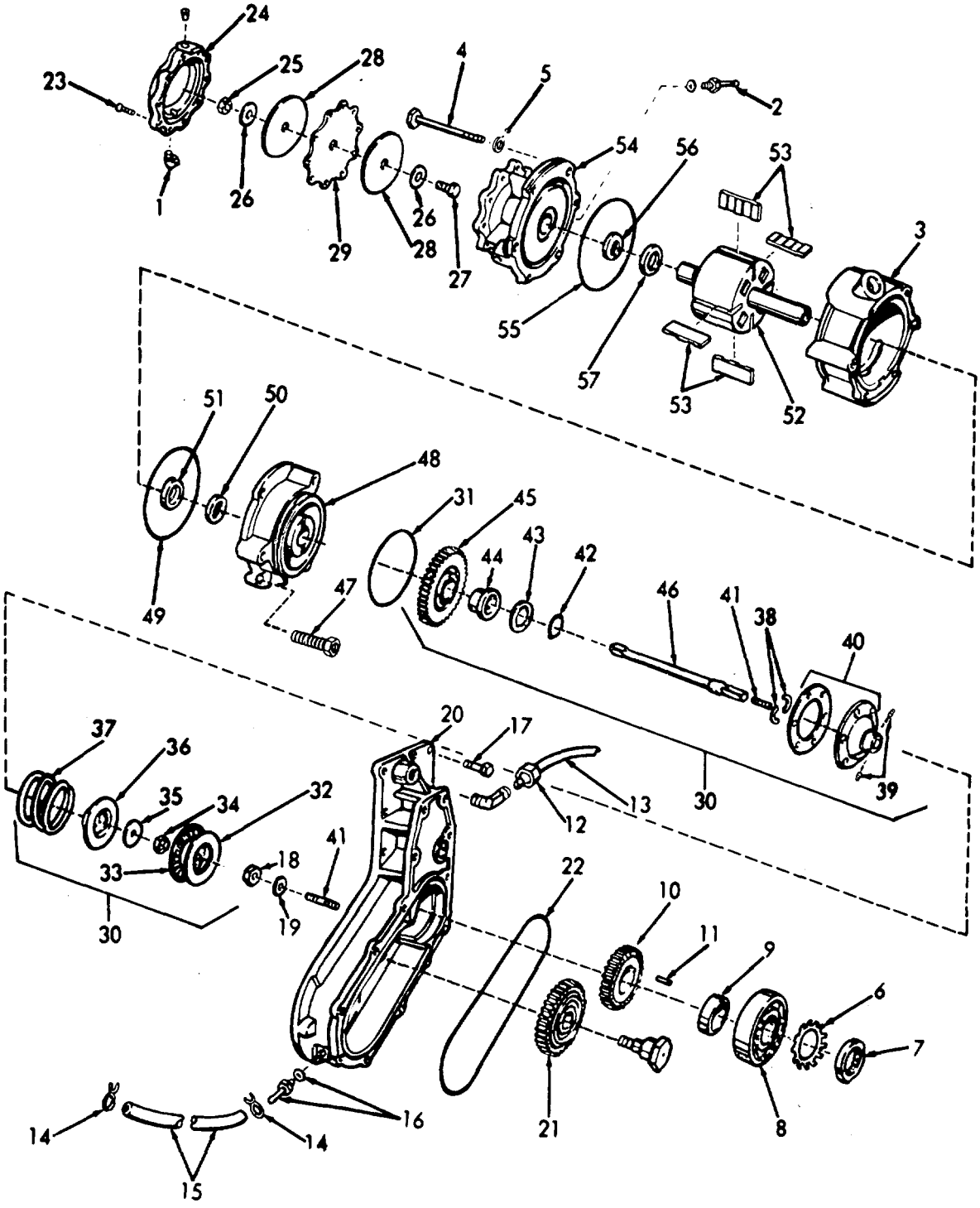


4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

Priming Pump and Gear Housing Legend

1. Tubing-to elbow
2. Tubing-to oil line nipple
3. Tubing-to pump body
4. Screws
5. Flatwashers
6. Lockwasher
7. Locknut
8. Ball bearing
9. Crankshaft spacer
10. Pinion gear
11. Key
12. Tube nut
13. Tube
14. Hose clamps
15. Hose
16. Oil line nipple and washer
17. Screws
18. Nuts
19. Flatwashers
20. Gear housing
21. Idler gear and bearing
22. Seal
23. Screws
24. Pump cover
25. Diaphragm nut
26. Washers
27. Screw
28. Followers
29. Diaphragm
30. Clutch and drive shaft
31. Preformed packing
32. Thrust washer
33. Thrust bearing
34. Nut
35. Washer
36. Shaft dog
37. Clutch spring
38. Retaining ring
39. Pins
40. Clutch plate assembly
41. Stud
42. Retaining ring
43. Washer
44. Bushing
45. Gear
46. Drive shaft
47. Screws
48. Inboard head
49. "0" ring
50. Outer seal
51. Inner seal
52. Impeller and shaft assembly
53. Impeller Vanes
54. Outobard head
55. "0" ring
56. Outer seal
57. Inner seal

4-7.11. PRIMING PUMP AND GEAR HOUSING-MAINTENANCE INSTRUCTIONS (Continued).

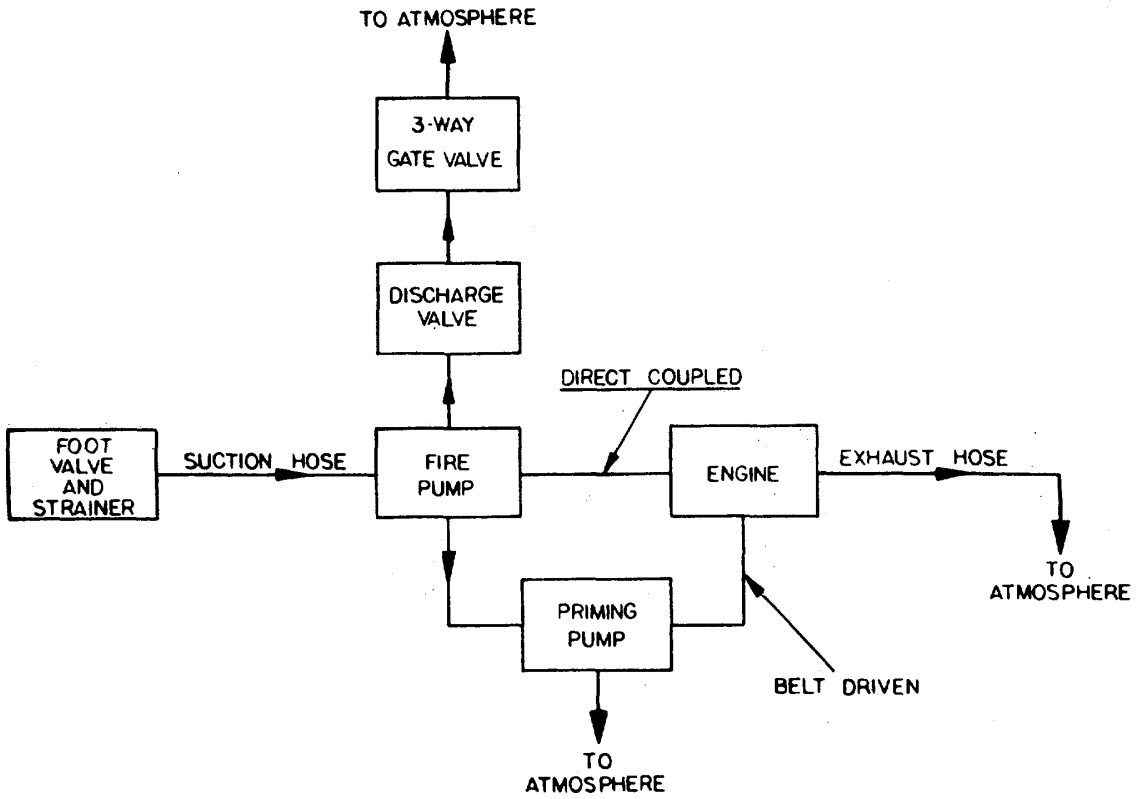


4-7A. PORTABLE FIRE PUMP (PE-250).

NOTE

Refer to paragraph 4-7 for portable fire pump P-250, manufactured by Gale Product Division of Outboard Marine Corp.

a. The portable fire pump (PE-250) (manufactured by Posser East Division of Purex Industries Inc. consists of a 2-cylinder, 2-cycle, 42 HP engine, single stage centrifugal pump, priming pump, 3-way gate valve, fuel tank, foot valve and strainer, suction hose, and exhaust hose. The purpose of the pump is to draw water from the sea (or other sources) and pump it through suitable hoses and nozzles under high pressure to combat fire. The pump can also be used for large volume pumping at low pressure as in the case of damage control work.



4-7A. PORTABLE FIRE PUMP (PE-250) (Continued).

b. The following is an index to the maintenance procedures:

c. Performance Testing.

(1) Performance test. To perform the performance test, proceed as follows:

(a) Operate the pump (refer to Chapter 2) at a suction lift of 16 feet (4.9m).

(b) Verify that the pump pumps 250 gpm (946.3 lpm) at a discharge pressure of 100 psi (689.5 kPa).

(c) Check piping, valves, and fittings for any indication of leakage.

(d) Replace any leaking component and retest the pump.

(e) Shut down pump.

4-7A. PORTABLE FIRE PUMP (PE-250) (Continued).

(2) Hydrostatic leakage test. To perform the hydrostatic leakage test, proceed as follows:

(a) Remove check valve (1) in exhaust cooling line and reinstall it in the opposite direction.

(b) Remove check valve (2) in priming system line and reinstall it in the opposite direction.

(c) Connect pump to a water pressure source not to exceed 150 psi (1034.2 kPa).

(d) With water pressure applied, open discharge valve until water comes out of discharge valve.

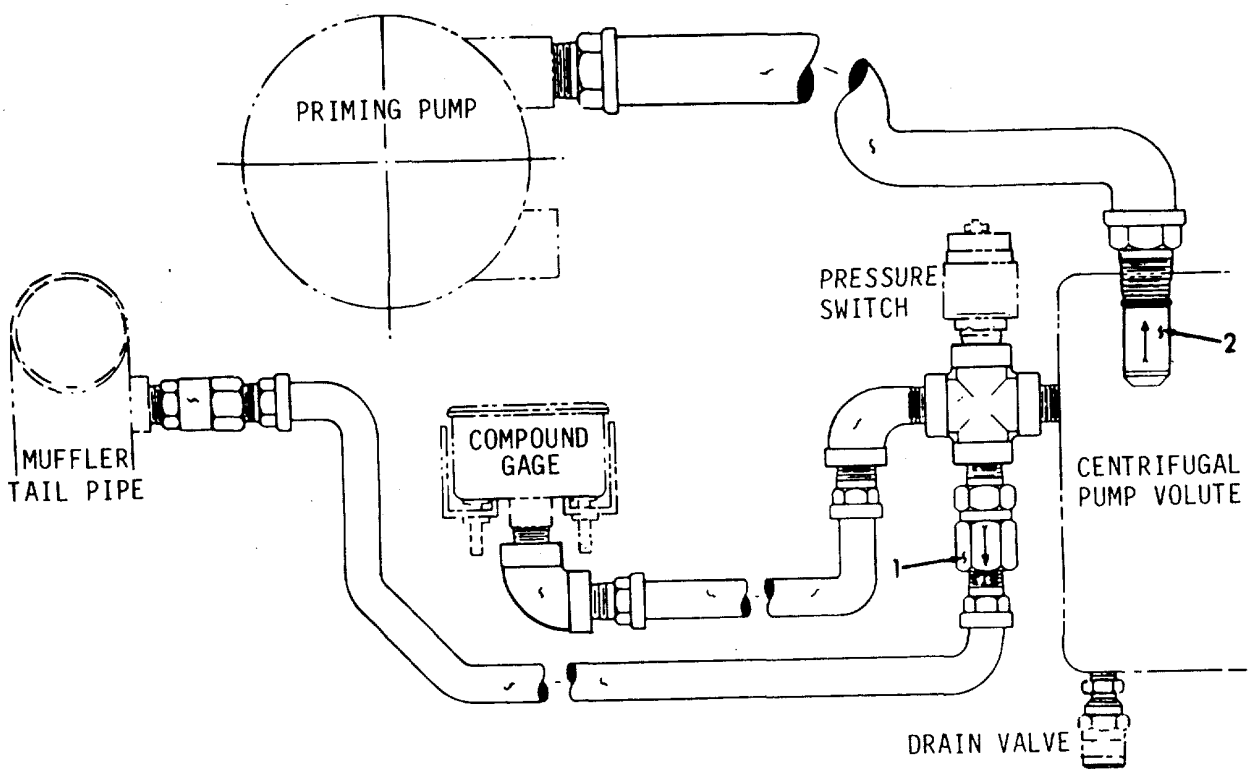
(e) Close discharge valve and allow pressure to rise in pump.

(f) Inspect pump for leakage.

(g) Shut down water pressure to pump.

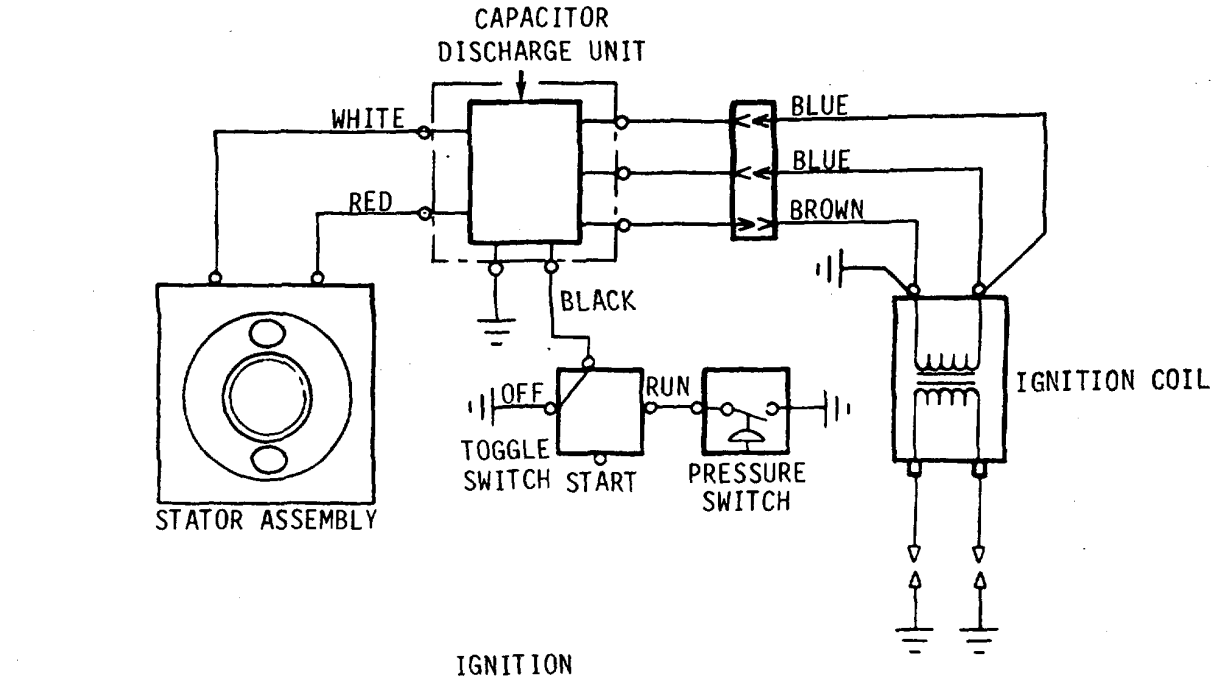
(h) Replace any leaking component and retest pump.

(i) Test shut down after hydrostatic leakage test consists of removing water pressure source and reversing exhaust cooling line and priming system check valves. Upon completion of shut down the pump is operable and ready for service.

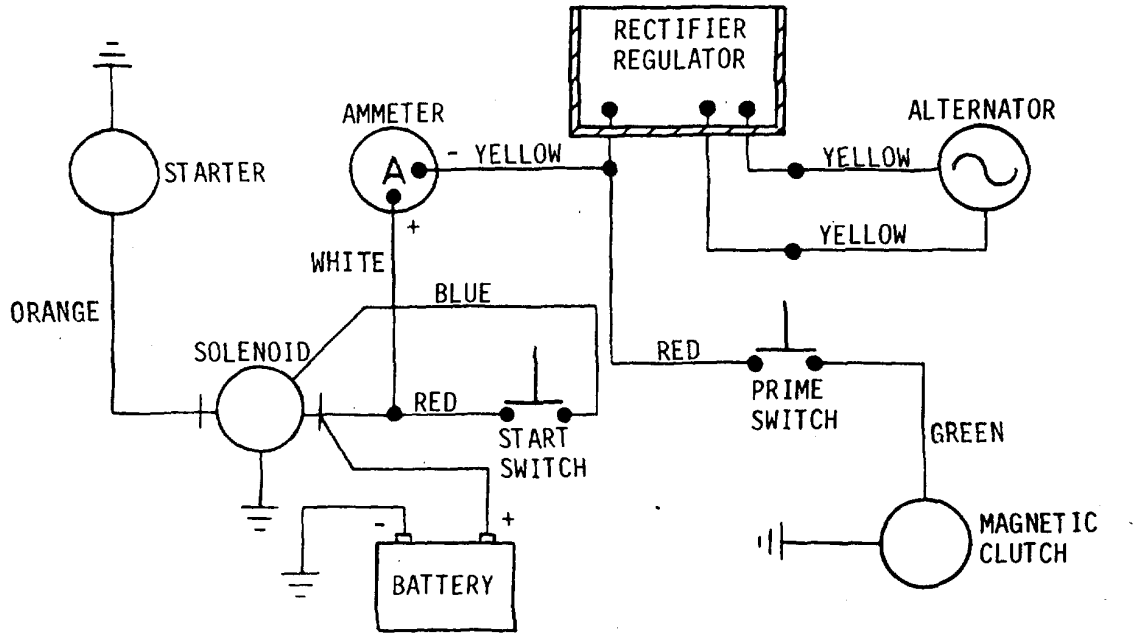


4-7A. PORTABLE FIRE PUMP (PE-250) (Continued).

d. Schematic.



IGNITION



ELECTRICAL

4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS.

This task covers:

a. Disassembly
b. Cleaning
c. Inspection
d. Reassembly

INITIAL SETUP

Test Equipment

NONE

References

Paragraph	
4-7Ad	Schematic

Special Tools

NONE

Equipment Condition: NONE

Material/Parts

Silicone compound MIL-S-8660

Special Environmental Conditions

NONE

Personnel Required

1

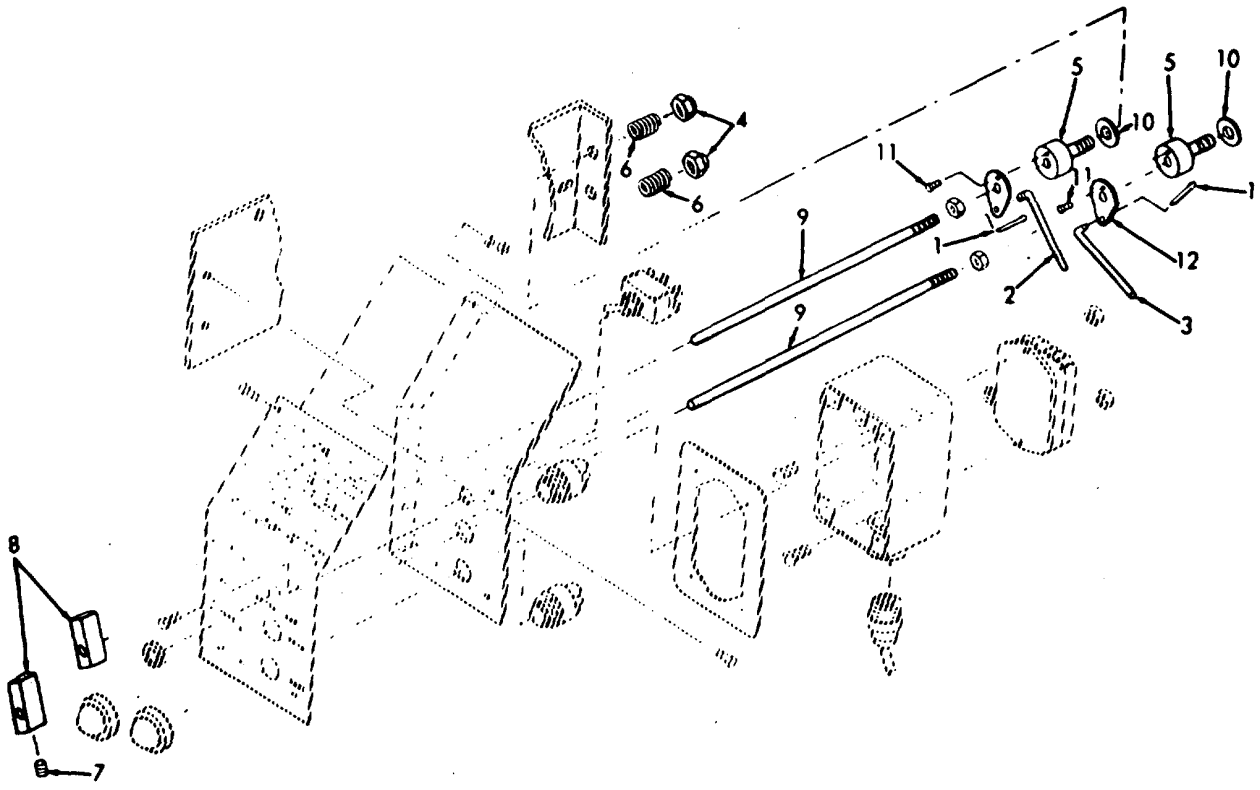
General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Engine control panel	a. Cotter pins (1)	Remove.	
	b. Speed rod (2), and choke rod (3)	Unscrew from carburetor.	
	c. Nuts (4)	Unscrew from both control spindles (5).	
	d. Springs (6)	Remove.	
	e. Setscrews (7)	Loosen.	
	f. Speed and choke knobs (8)	Remove.	

4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	g. Control spindles assemblies (5)	Unscrew from speed and choke shafts (9).	
	h. Washers (10)	Remove.	
	i. Screws (11)	Remove from control spindles (5).	
	j. Control arms (12)	Remove from control spindles (5).	

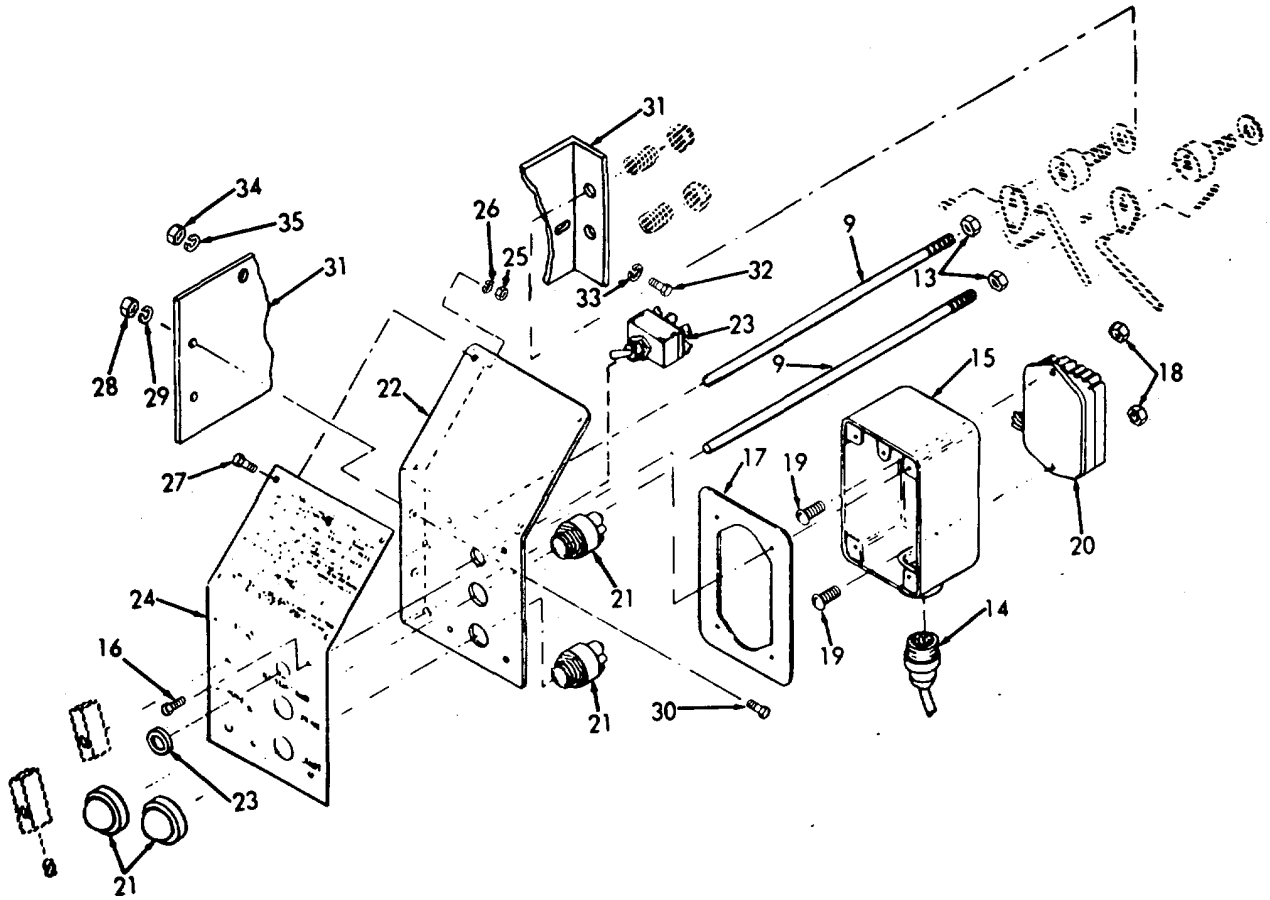


4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	k. Speed and choke shafts (9), and nuts (13)	Remove.	
	l. Connector (14)	Unscrew and remove from control box (15).	
	m. Screws (16)	Remove.	
	n. Control box (15), and gasket (17)	Remove from engine control panel.	
	o. Electrical leads	Tag and disconnect.	Refer to schematic in paragraph 4-7Ad.
	p. Nuts (18) and screws (19)	Remove.	
	q. Voltage regulator (20)	Remove from control box (15).	
	r. Pushbutton switches (21)	Remove from control panel (22) by unscrewing and removing nuts.	
	s. Toggle switch (23)	Remove from control panel (22) by unscrewing and removing nuts.	
	t. Information plate (24)	1. Remove nuts (25), lockwashers (26), and screws (27). 2. Remove plate (24).	If necessary.
	u. Control panel (22) screws (30).	Remove nuts (28), lockwashers (29), and	

4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	v. Bracket (31)	1. Remove four screws (32), and lockwashers (33). 2. Remove two nuts (34), and flatwashers (35).	

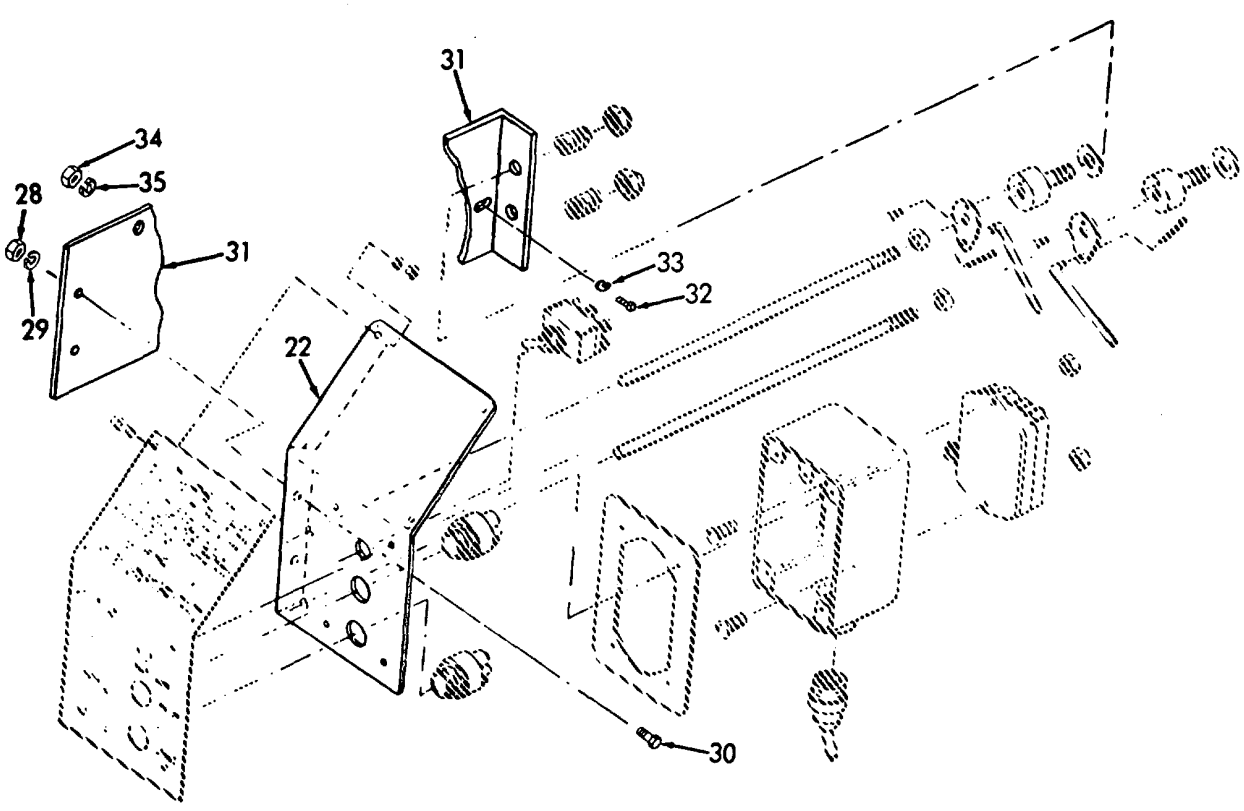


4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
2.		**WARNING** Wear eye protection when using compressed air.	
	a. Speed and choke control parts	1. Clean with general purpose cleaner. 2. Dry with compressed air.	
	b. Switches	1. Clean outer surfaces with a mild solvent that will not affect rubber. 2. Wipe dry with clean cloth.	
	c. Control panel, information plate, voltage regulator and attached wires	1. Clean with mild solvent that will not affect plastic. 2. Wipe dry with clean cloth.	
INSPECTION			
3.	a. Switches, connectors, linkage, and wiring	Inspect for abrasions, looseness, and accumulations of dirt.	Discard all parts that show wear or damage.
	b. Gasket	Inspect for deterioration.	Discard if gasket shows signs of wear or damage.

4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
4.	a. Bracket (31)	1 Install two nuts (34), and flatwashers (35). 2. Install four screws (32), and lockwashers (33).	
	b. Control panel (22) nuts (28).	Install screws (30), lockwashers (29), and	

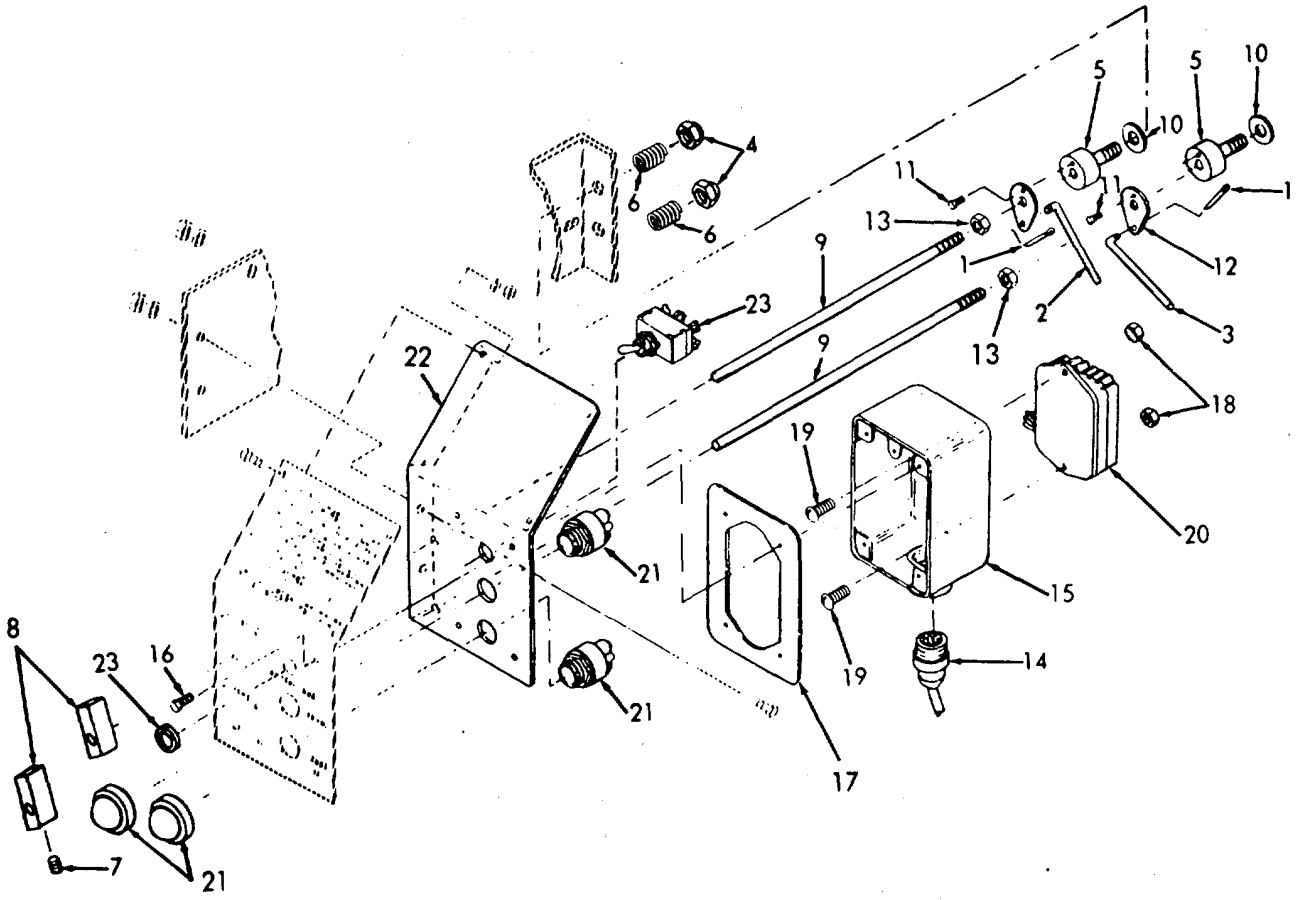


4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Toggle switch (23) nut.	Install in control panel (22), tighten	
	d. Pushbutton switches (21)	Install in control panel (22), tighten nuts.	
	e. Voltage regulator (20)	Install in control box (15), using screws (19), and nuts (18).	
	f. Electrical leads	Reconnect.	Refer to schematic in paragraph 4-7Ad.
	g. Control box (15), and gasket (17)	Install on engine control panel using screws (16).	
	h. Connector (14)	Reconnect to control box (15).	
	i. Speed and choke shafts (9), and nuts (13)	Install.	
	j. Control arms (12), and screws (11)	Install on control spindles (5).	
	k. Washers (10)	Install.	
	l. Control spindels assemblies (5)	Screw onto speed and control shafts (9).	
	m. Speed and choke knobs (8)	1. Install. 2. Tighten setscrews (7).	
	n. Springs (6)	Install.	

4-7.1A. ENGINE CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	o. Nuts (4)	Install on control spindles (5).	
	p. Speed rod (2), and choke rod (3)	1. Apply a thin coat of silicone compound.	Use MIL-S-8660.
		2. Screw into carburetor.	
	r. Cotter pins (1)	Install.	



4-7.2A. GAGE PANEL-MAINTENANCE INSTRUCTIONS.

This task covers:

a, Removal
b. Disassembly
c. Cleaning
d. Inspection
e. Reassembly
f. Installation

INITIAL SETUP

Test Equipment

NONE

References

Paragraph 4-7Ad Schematic

Special Tools

NONE

Equipment Condition: NONE

Condition Description

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

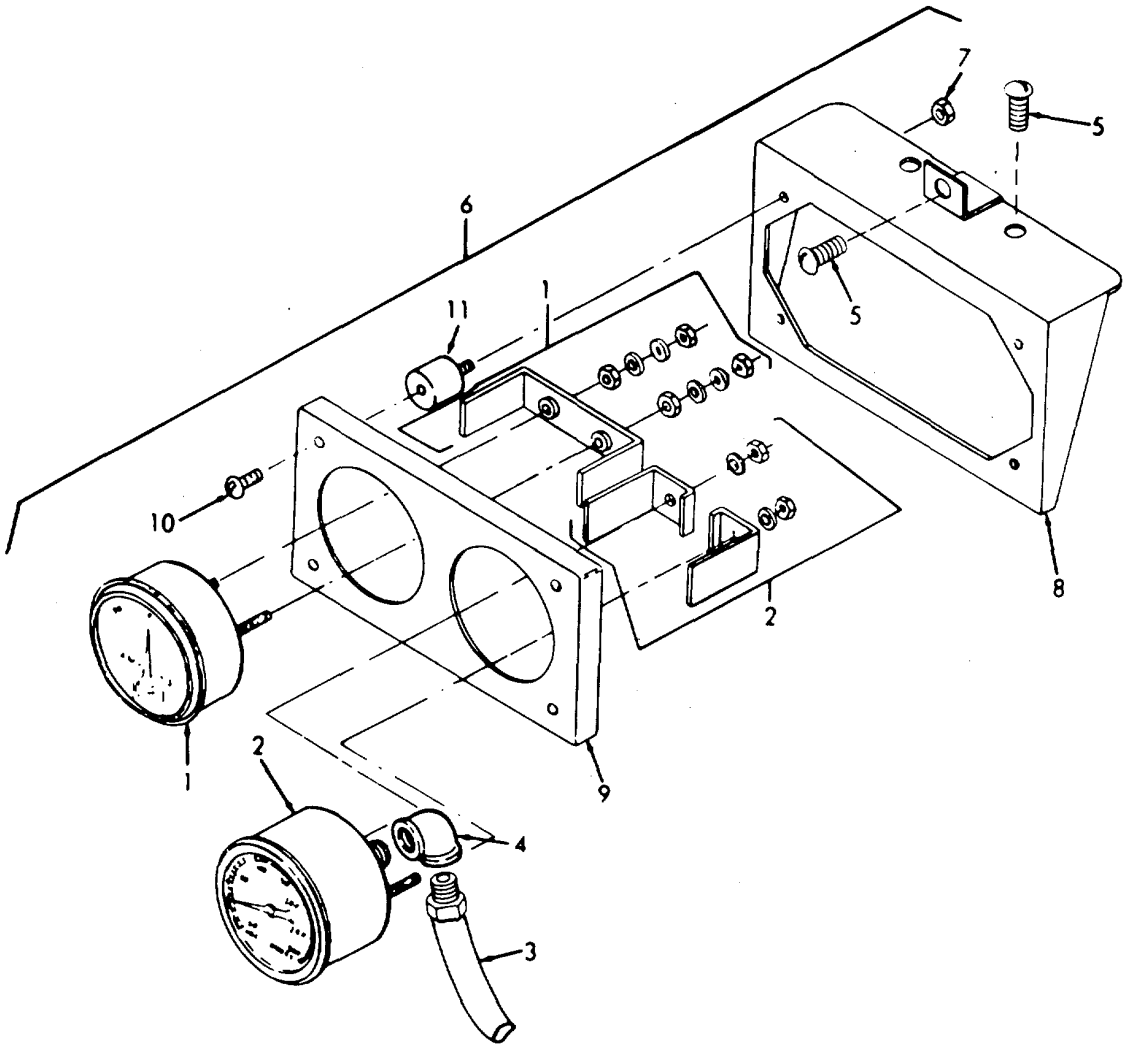
General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Gage panel	a. Ammeter (1)	Tag and disconnect electrical wires.	See schematic in paragraph 4-7Ad.
	b. Compound gage (2)	Unscrew hose (3), and elbow (4).	
	c. Screws (5)	Remove three screws.	
	d. Gage panel (6)	Remove.	
DISASSEMBLY			
2.	a. Nuts (7)	Remove.	
	b. Mounting bracket (8) ,and gage plate (9)	Separate.	

4-7.2A. GAGE PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	c. Screws (10), and vibration isolators (11)	Remove from gage plate (9).	
	d. Compound gage (2)	Remove two nuts, lockwashers, and brackets.	
	e. Ammeter (1)	Remove four nuts, two lockwashers, and bracket.	

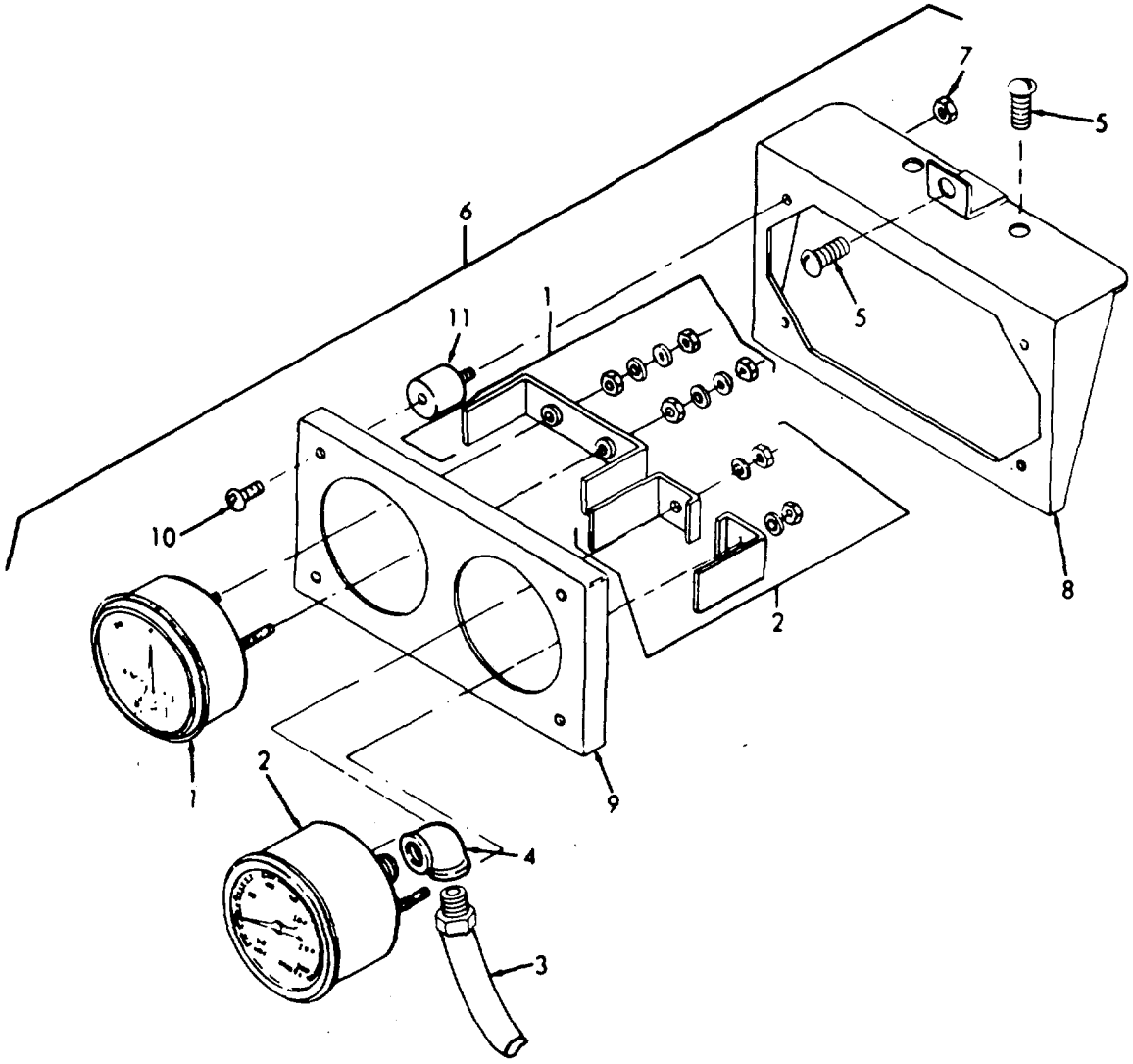


4-7.2A. GAGE PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		WARNING Wear eye protection when using compressed air.	
3.	All parts	a. Wipe carefully with clean cloth dampened with a general purpose cleaner. b. Dry with compressed air. c. Wipe dry with clean cloth.	
INSPECTION			
4.	Gages, vibration isolators, and wiring	Inspect for abrasions looseness and accumulations of dirt.	Discard all parts that show signs of wear or damage.
REASSEMBLY			
5.	a. Ammeter (1)	Install using four nuts, two lockwashers, and bracket.	
	b. Compound gage (2)	Install using two nuts, lockwashers, and brackets.	
	c. Vibration isolators (11), and screws (10)	Install on gage plate (9).	
	d. Mounting bracket (8), gage plate (9), and nuts (7)	Reassemble.	

4-7.2A. GAGE PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6.	a. Gage panel (6) and screws (5)	Install.	
	b. Hose (3), and elbow (4)	Install on compound gage (2).	
	c. Ammeter (1)	Install wiring.	Refer to schematic in paragraph 4-7Ad.



4-7.3A. DISCHARGE VALVE - MAINTENANCE INSTRUCTIONS.

a. The water discharge valve is a ball type water outlet valve which is located in the discharge opening of the pump housing. The discharge valve consists of a ball with a hole through it. Pressing against the ball is a plastic sleeve, which helps channel water from the ball to the discharge line, when the ball is in the open position. When the ball is in the closed position, turned 90 degrees, the plastic sleeve presses against the ball sealing the discharge passage against the entry of air and preventing discharge of water.

b. The water discharge valve should always be closed when starting the pump to prevent air from entering the pump housing during priming and to permit pump pressure to build up properly. This ensures that the fire pump is completely primed. When water is discharged from the priming pump the water discharge valve should be opened slowly and water will be available in the discharge line. At this time the priming button can be released. The water discharge valve is used to regulate the flow through the pump and also the pressure at the pump. With the engine running at full throttle it may be necessary to close the valve slightly to restrict the flow to 250 gpm (946.3 lpm) and maintain the pressure at 100 psi (689.5 kPa). The engine controls will not automatically regulate the flow and pressure.

c. The discharge hose (not supplied with pump) is screwed onto the discharge valve and the suction hose to the intake side of the pump housing.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Silicone compound
MIL-S-8660
Sulphamic acid PS-120

Personnel Required

1

References

NONE

Equipment Condition Condition Description

NONE

Special Environmental Conditions

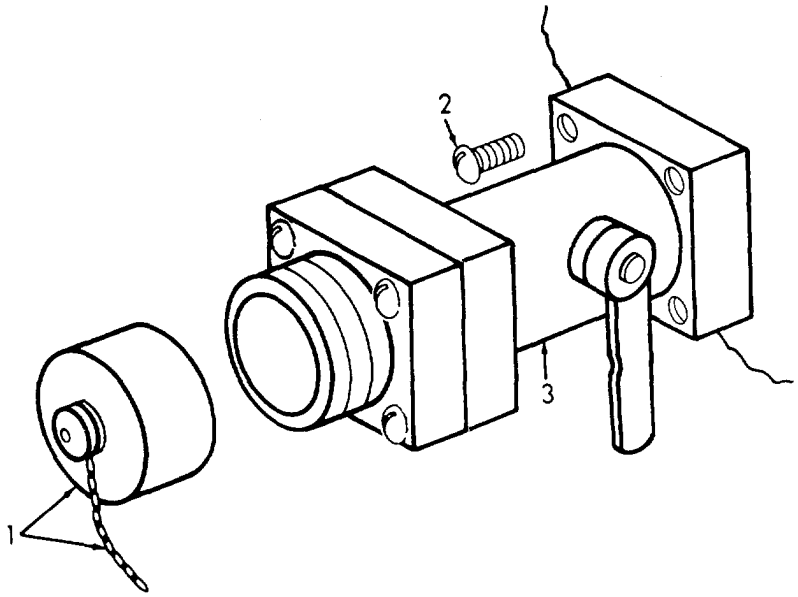
NONE

General Safety Instructions

Observe WARNING in procedure.

4-7.3A. DISCHARGE VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1.Discharge valve	a. Discharge cap and	Unscrew from discharge valve. chain (1)	
	b. Screws (2)	Remove four screws.	
	c. Discharge	Remove. valve (3)	

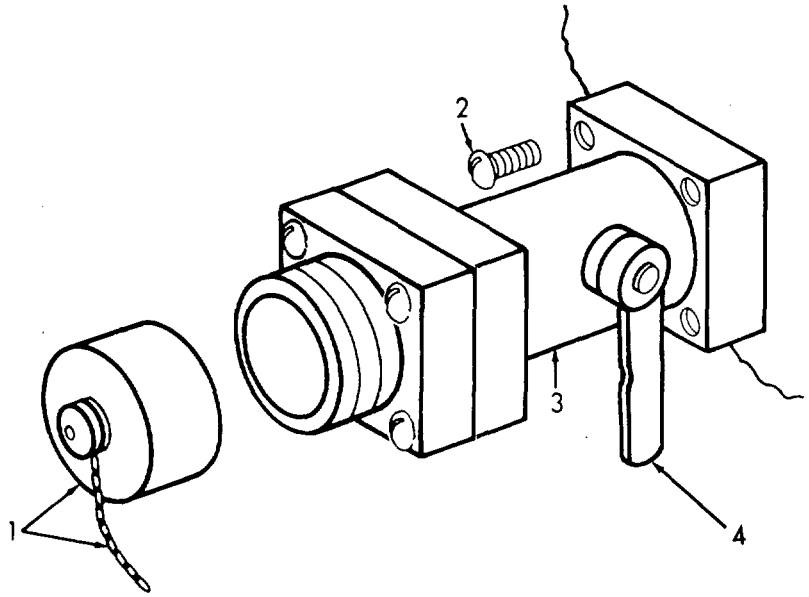


4-7.3A. DISCHARGE VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
		WARNING	
		• Observe no smoking regulation and avoid prolonged contact with, or inhalation of, cleaning solvents. Avoid use near heat or open flame and provide adequate ventilation.	
		• Wear eye protection when using compressed air.	
2.	All parts	a. Wash valve carefully with general purpose cleaner.	
		b. Remove salt or scale deposits by using scale removing compound.	Use PS-120.
		c. Blow out and dry internally and externally with filtered compressed air.	
		d. Wipe external surfaces with clean cloth.	
INSPECTION			
3.	Discharge valve	Inspect for damaged threads, looseness, and leaking. or damage.	Discard if valve shows signs of wear
INSTALLATION			
4.	a. Discharge valve (3)	Install using screws (2).	
	b. Discharge cap and chain (1)	Install.	
	c. Handle (4)	Lubricate	Use silicone compound MIL-S-8660.

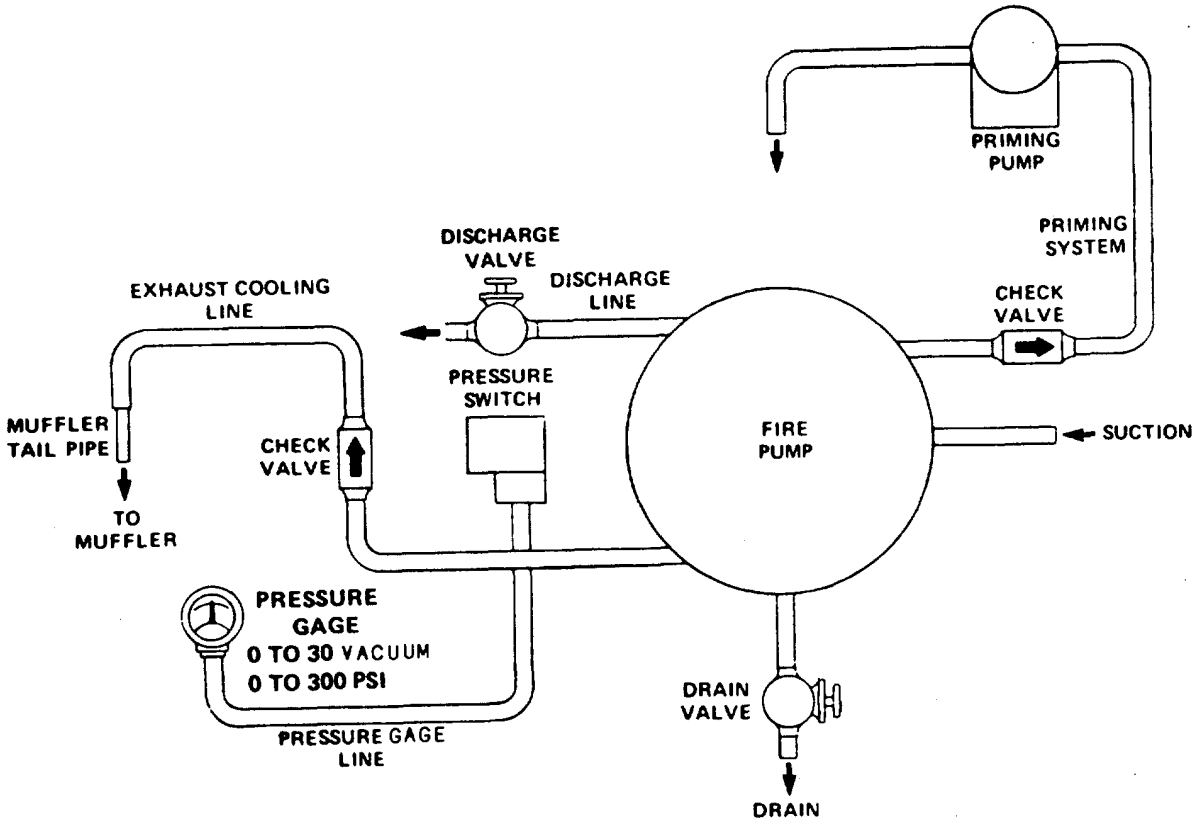
4-7.3A. DISCHARGE VALVE - MAINTENANCE INSTRUCTIONS (Continued).			
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS.

a. The fire pump impeller is enclosed within the pump housing and is mounted on the crankshaft. The impeller is secured by a bolt and behind the impeller is a water seal which prevents water from leaking out of pump housing. Water is drawn into the pump housing when air is evacuated from the housing and the suction hose by the action of the priming pump. As water is drawn into the pump housing the impeller throws the water outward, creating pressure within the impeller housing. A pressure gage is provided to measure the pump discharge pressure.



b. The manual priming consists of priming bowl and plug in the pump housing. Its function is to allow water to be poured into the pump housing to prime the fire pump when lifting water greater than 20 feet (6 m). While the pump is operating, the plug should be securely in place.

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Disassembly
b. Removal
c. Cleaning
d. Inspection
e. Installation
f. Reassembly

INITIAL SETUP

Test Equipment
NONE

Special Tools
Torque wrench

Material/Parts
Sulphamic acid - PS-120

Personnel Required
1

References
NONE

Equipment Condition
Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

NOTE

The pump body does not have to be removed so that repair can be accomplished on pump. If damage to pump body is indicated, first disassemble pump.

DISASSEMBLY

1. Pump

WARNING

Exercise care when removing water seal from impeller assembly. All spring tension should be released to prevent spring from accidentally disengaging and causing injury. Wear safety glasses when repairing water seal assembly components.

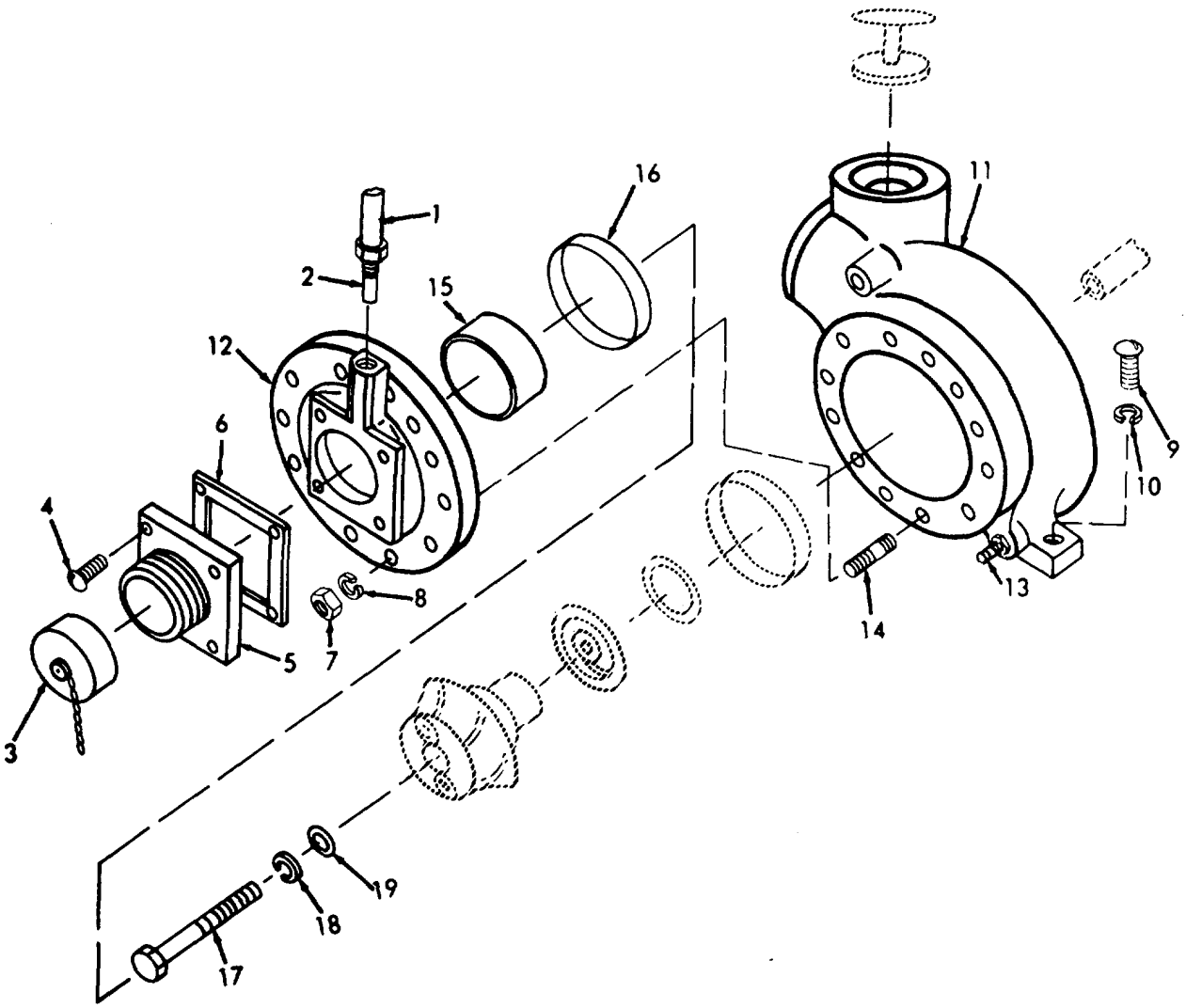
4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	a. Priming pump hose (1), and check valve (2)	Remove from priming pump suction port.	
	b. Suction cap and chain (3)	Unscrew.	
	c. Screws (4)	Remove.	
	d. Hose adapter assembly (5), and gasket (6)	Remove.	Discard gasket if damaged.
	e. Nuts (7), flatwashers (8), screw (9), and lockwasher (10)	Remove ten nuts and one screw.	
	f. Suction head (11), and gasket (12)	Remove.	Discard gasket.
	g. Drain valve (13)	Remove.	If necessary.
	h. Studs (14)	Remove.	If necessary.
	i. Clearance ring inner front (15), and clearance ring outer (16)	Remove.	
	j. Impeller screw (17), washer (18), and seal (19)	Remove.	

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	k. Impeller assembly (20)	1. Install puller screw into impeller.	Screw is 5/8 x 2-1/2 in long.
		2. Continue screwing until impeller comes free.	

WARNING

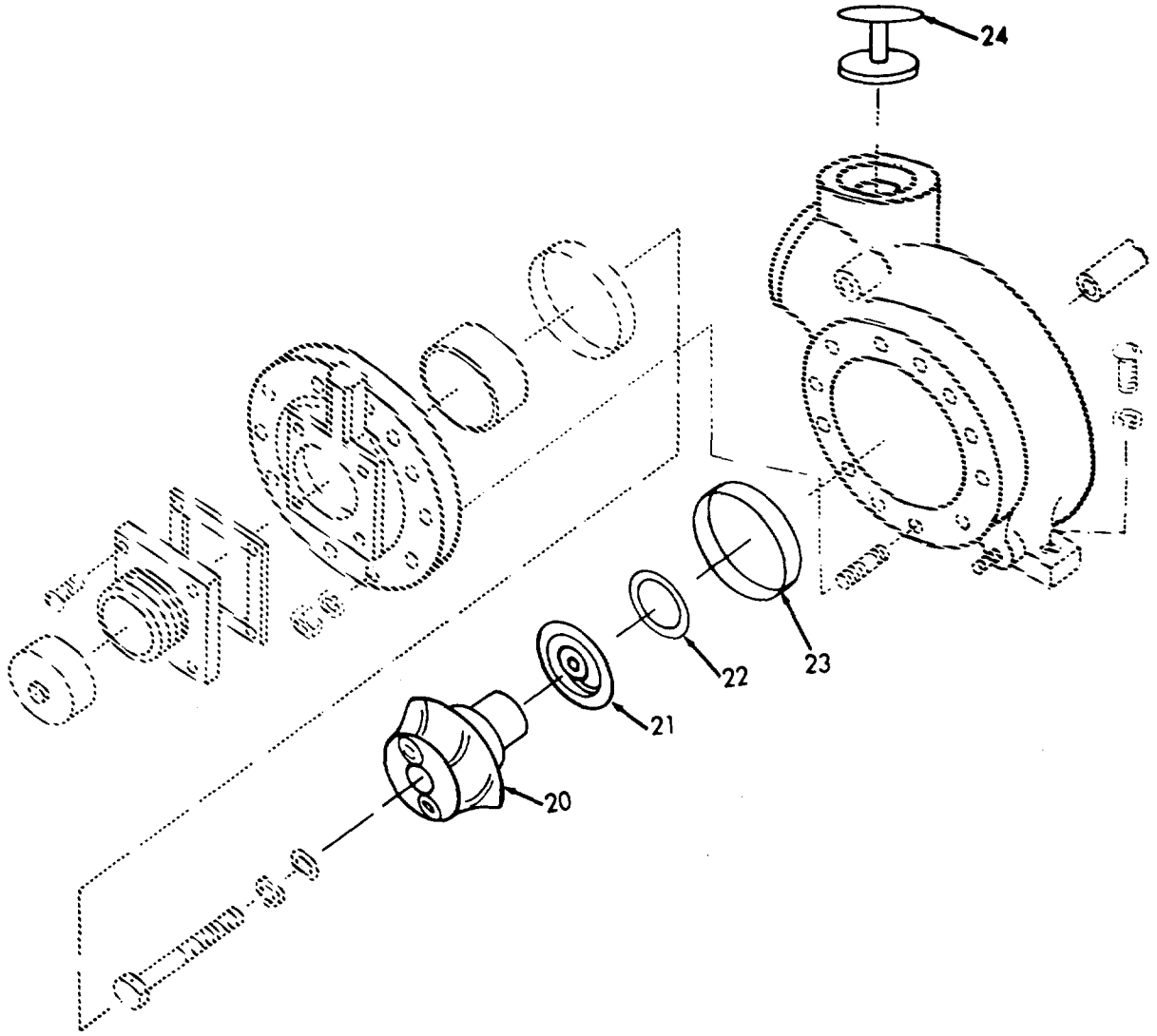
Exercise care when removing water seal from impeller assembly. All spring tensions should be released to prevent spring from accidentally disengaging and causing injury. Wear safety glasses when repairing water seal assembly components.

		3. Carefully remove impeller assembly.
	1. Spring (21), and seal (22)	Remove.
	m. Clearance ring inner (23)	Remove.
	n. Body plug (24)	Remove.

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2. Pump body	a. Electrical wiring from pressure switch (25)	Remove.	
	b. Gage hose (26)	Unscrew.	It may be necessary to hold hose with pliers while turning the hose fitting. The fitting will turn inside the hose.
	c. Exhaust cooling hose (27)	Unscrew.	It may be necessary to hold hose with pliers while turning the hose fitting. The fitting will turn inside the hose.
	d. Pipe elbow (28)	Unscrew and remove.	
	e. Check valve (2)	Unscrew and remove.	
	f. Pressure switch (25)	Unscrew and remove.	
	g. Pipe cross (29)	Unscrew and remove.	
	h. Pipe nipple (30)	Unscrew and remove.	
	i. Drain valve (13)	Unscrew and remove.	

CAUTION

Check shims between pump body base and mounting support plate, accurately record each shim location.

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

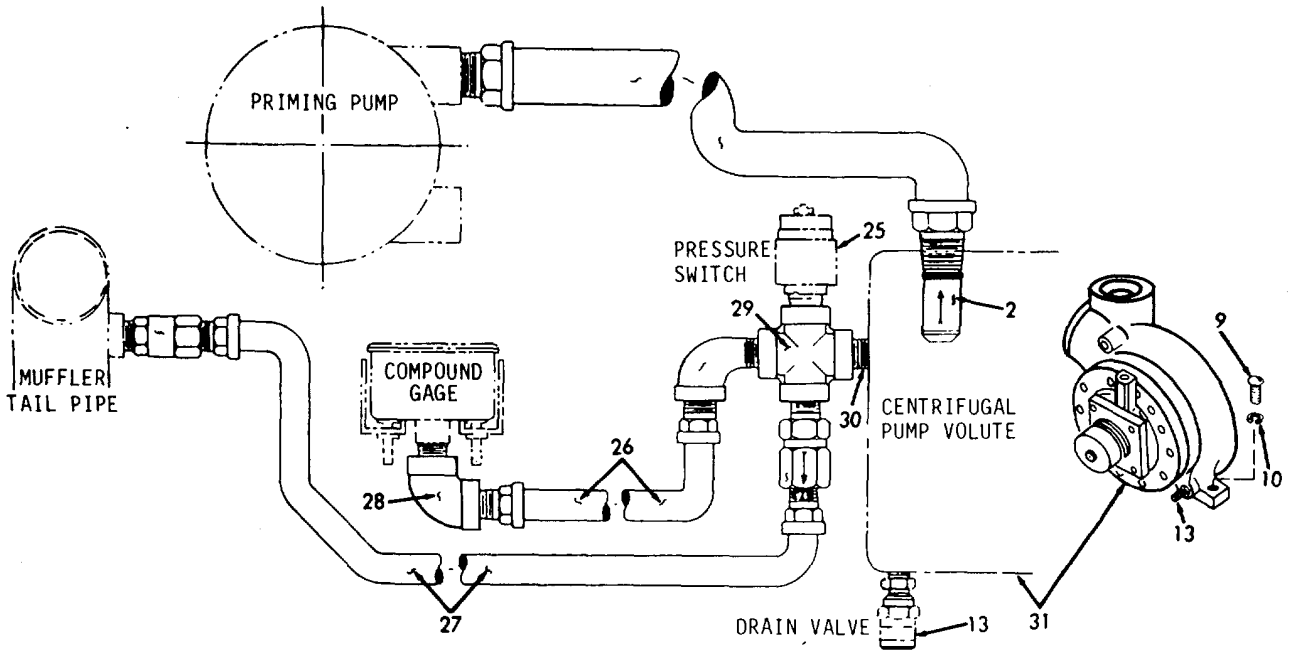
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

NOTE

Shims are required for alignment of pump body. Keep for reassembly.

j.	Screws (9), and lock-washers (10)	Remove.
k.	Pump body (31)	Remove.



4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
3.		**WARNING**	
		• Observe no smoking regulation and avoid prolonged contact with, or inhalation of cleaning solvents. Avoid use near heat or open flame and provide adequate ventilation.	
		• Wear eye protection when using compressed air.	
	All removed parts	a. Wash all parts with general purpose cleaner.	
		b. Remove scale or salt deposits on surfaces with scale removing compound.	Use sulphamic acid PS-120.
		c. Dry all internal parts with filtered compressed air and wipe dry with clean cloth external surfaces.	
		d. Blow out all passages, hoses, pipe fittings, and impeller with filtered compressed air.	
INSPECTION			
4. Pump and body	a. Hoses	Inspect for abrasions, cuts, chafing, and permanent set.	Replace damaged or leaking hoses.
	b. Threads	Inspect for nicks, burrs, and distortion.	Replace all worn or damaged parts.
	c. Gasket surfaces	Inspect for nicks, burrs, and deterioration.	Smooth out minor nicks and scratches with fine emery cloth.

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Water seal surfaces	1. Surfaces are polished finish. 2. Wipe with soft clean cloth. 3. Inspect for nicks, scoring, chipping, and distortion.	
	e. All parts	Inspect all parts for nicks, scoring, chipping, or distoriton.	Discard.
	f. Impeller	Inspect for ridges, scoring, or nicks.	Replace if impeller cannot be repaired.
	g. Impeller wear ring	1. Carefully smooth out ridges, scoring, or minor nicks with fine emery cloth. 2. Excessive machining of impeller suction rings can cause damage to impeller capacity for pumping.	
	h. Pump housing wearing	Inspect for accumulations of deposits of foreign material.	Remove deposits with fine emery cloth.
	i. Wear rings (items g and h above)	Inspect for signs of rubbing, damage, distortion, or impairing the rotation of the impeller.	1. Replace if necessary. 2. The differences in the diameters of the wear rings and the impeller should not exceed 0.040 inch (0.102 cm).

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Pump body	a. Pump body (31)	Install on frame.	
	b. Screws (9), lockwashers (10), and shims	1. Install.	

CAUTION;

Accurately install shims as recorded during disassembly.

2. Replace alignment shims.

3. Tighten screws to 24 lb ft (32.5 Nm) torque.

c. Body plug and chain (24) — Install.

NOTES

- Apply a thin coat of silicone compound, MIL-S-8660, to bolt threads and pump housing surface.
- Apply a thin coat of pipe thread sealant to pipe threads, check valve, elbow, nipple, cross, and pressure switch.
- All pipe threads should engage 3/8 inch (9.5 mm).

d. Drain valve (13) — Install.

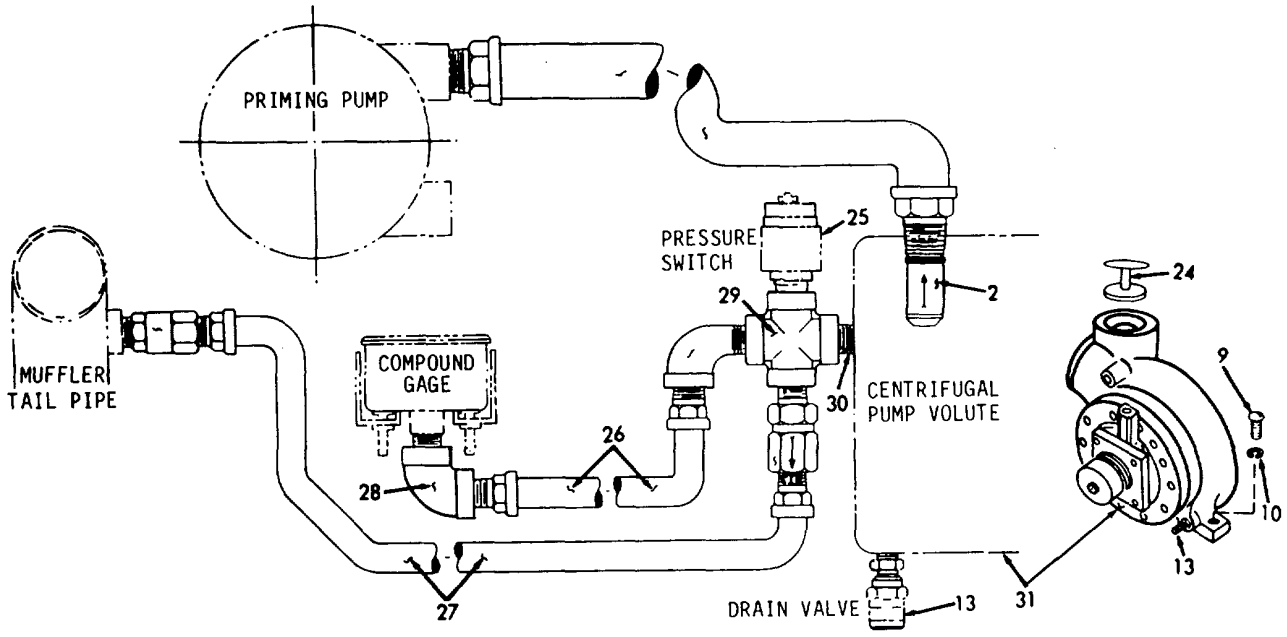
e. Pipe nipple (30) — Install.

f. Pipe cross (29) — Install.

g. Pressure switch (25) — Install.

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
	h. Check valve (2)	Install.	
	i. Pipe elbow (28)	Install.	
	j. Gage hose (26)	Install to elbow (28).	
	k. Exhaust cooling hose (27)	Install to check valve (2).	
	1. Electrical wiring	Install on pressure switch (25).	



4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY

6. Pump

CAUTION

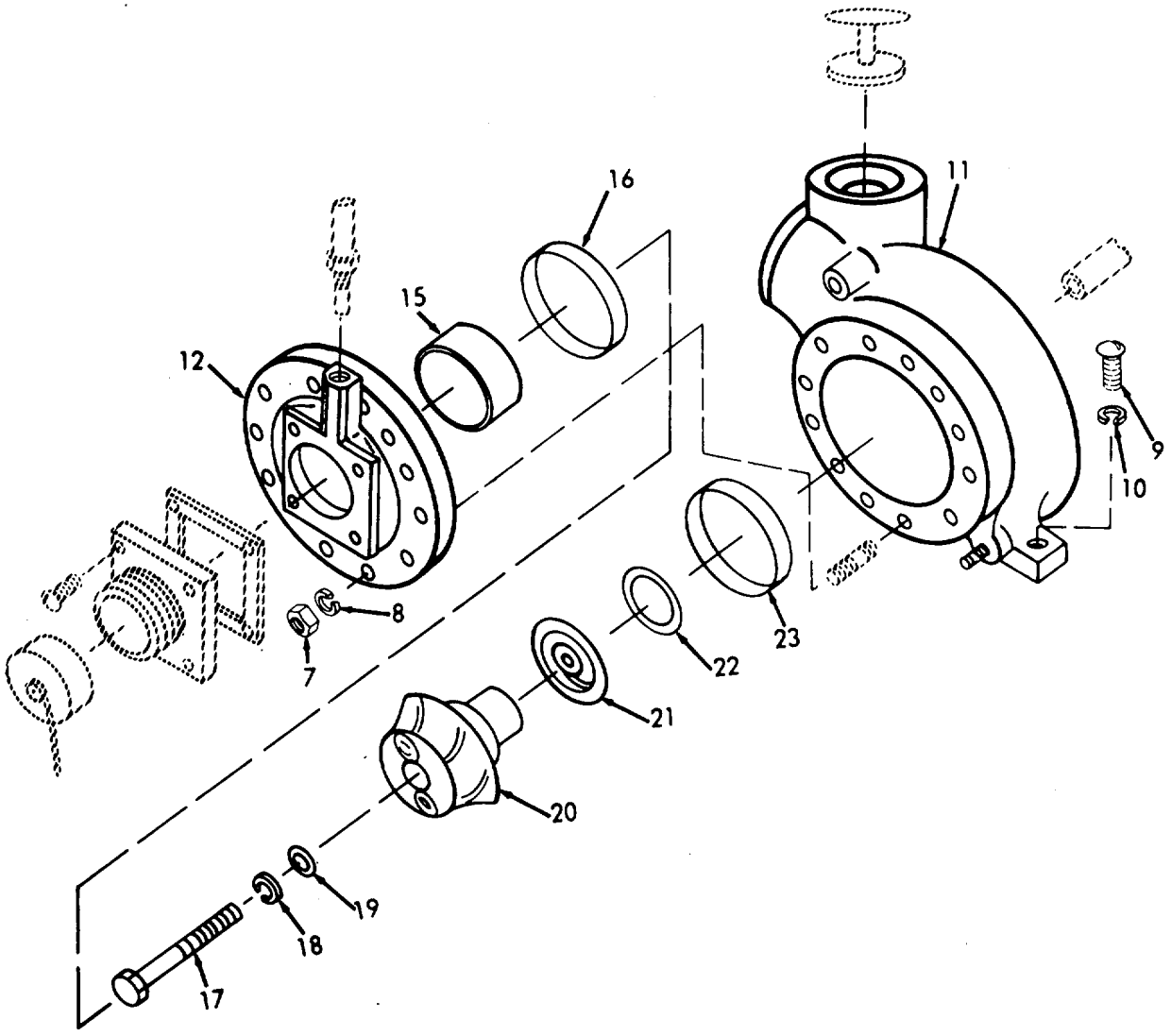
Water seal assembly spring loaded.

a.	Clearance ring inner (23)	Install.	
b .	Seal (22), and spring (21)	Install on impeller (20).	
c.	Impeller (20)	Install.	
d.	Impeller screw (17), washer (18), and seal (19)	1. Assemble. 2. Install. 3. Tighten screw to 70 lb-ft (94.9Nm) torque.	
e.	Clearance ring outer (16), and clearance ring inner front (15)	Install.	
f.	Suction head (11), and gasket (12)	Install	Use new gasket.
g.	Nuts (7), and flat-washers (8)	1. Install. 2. Tighten nuts to 14 lb ft (19.0 Nm) torque.	
h.	Screw (9), and lock-washer (10)	Install.	

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY



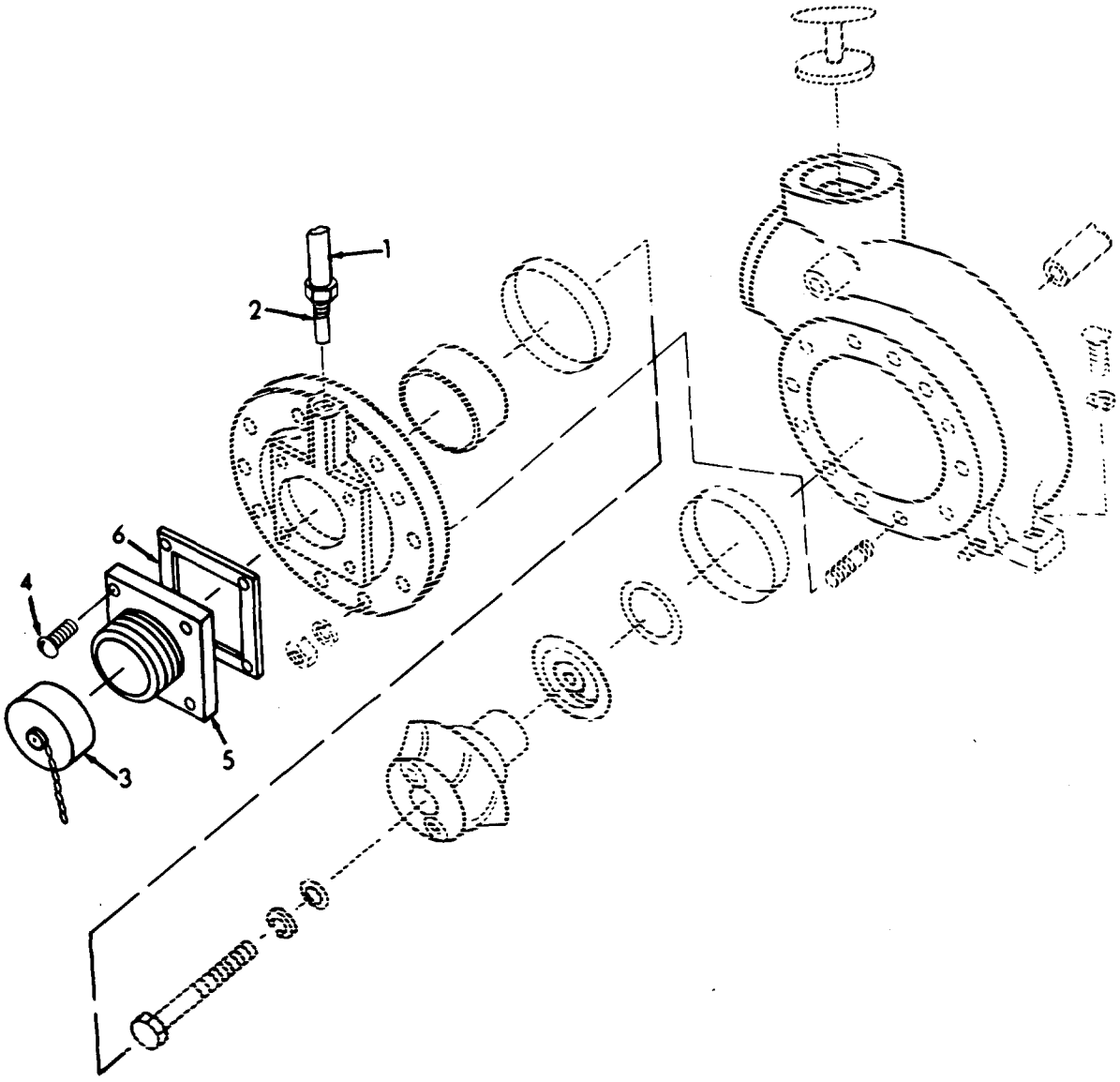
4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
	i. Hose adapter assembly (5), and gasket (6)	Install.	Use new gasket.
	j. Screws (4)	Install.	
	k. Suction cap and chain (3)	Install.	
	l . Priming pump hose (1), and check valve (2)	Install.	
	m.	To check alignment, remove spark plugs and rotate engine by pulling on retractable starter rope. Engine and pump should rotate freely without binding. If impeller is rubbing, check for proper shiming.	

4-7.4A. PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY



4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS.

a. The priming pump is a rotary vane type pump. The magnetic clutch is mounted on the priming pump shaft. The priming pump is driven by a sheave, part of the magnetic clutch, which is driven by the engine fan belt.

b. The intake side of the priming pump is connected to the intake side of the fire pump. There is a check valve in this line to prevent air from being sucked through the priming pump once the pump has been pressurized.

c. With the engine running, water discharge valve closed, and the prime pushbutton depressed, the magnetic clutch is engaged and the priming pump evacuates the air from the fire pump housing and the suction hose. If priming pressure is lost, a pressure switch located on the discharge side of the fire pump will automatically stop the engine. The pressure switch is preset for 10 to 15 psi (68.9 to 103.4 kPa).

This task covers:

a. Removal
b. Disassembly
c. Cleaning
d. Inspection
e. Reassembly
f. Installation
g. Repair

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Arber press
Lead hammer
Spanner wrench

Equipment Condition Condition Description

NONE

Material/Parts

General purpose cleaner
Silicone compound
MIL-S-8660
Sulphamic acid PS-120

Special Environmental Conditions

NONE

Personnel Required

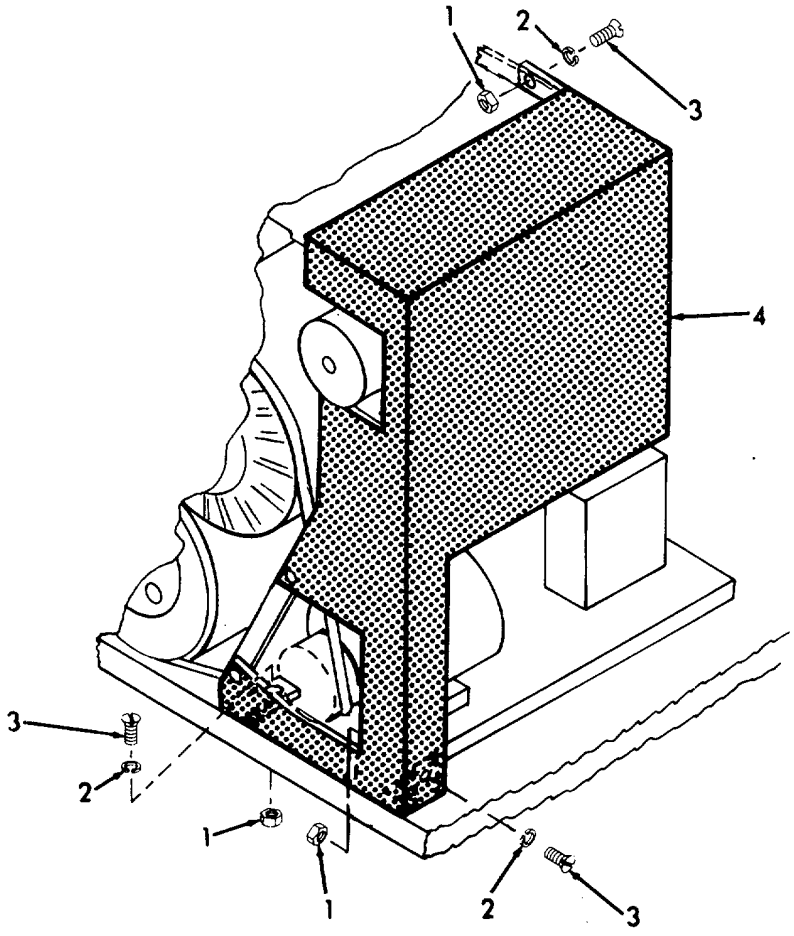
1

General Safety Instructions

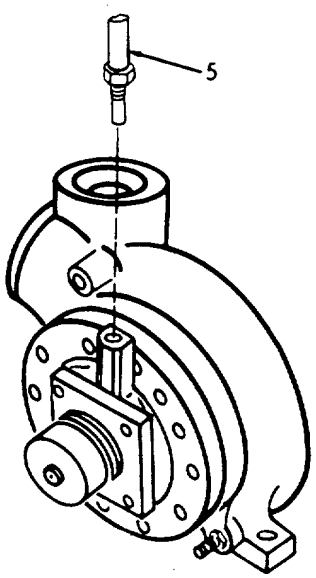
Observe WARNING in procedure.

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
	1. Priming pump and magnetic clutch	a. Nuts (1), lockwashers (2), and screws (3)	Remove.
		b. Guard assembly (4)	Remove.

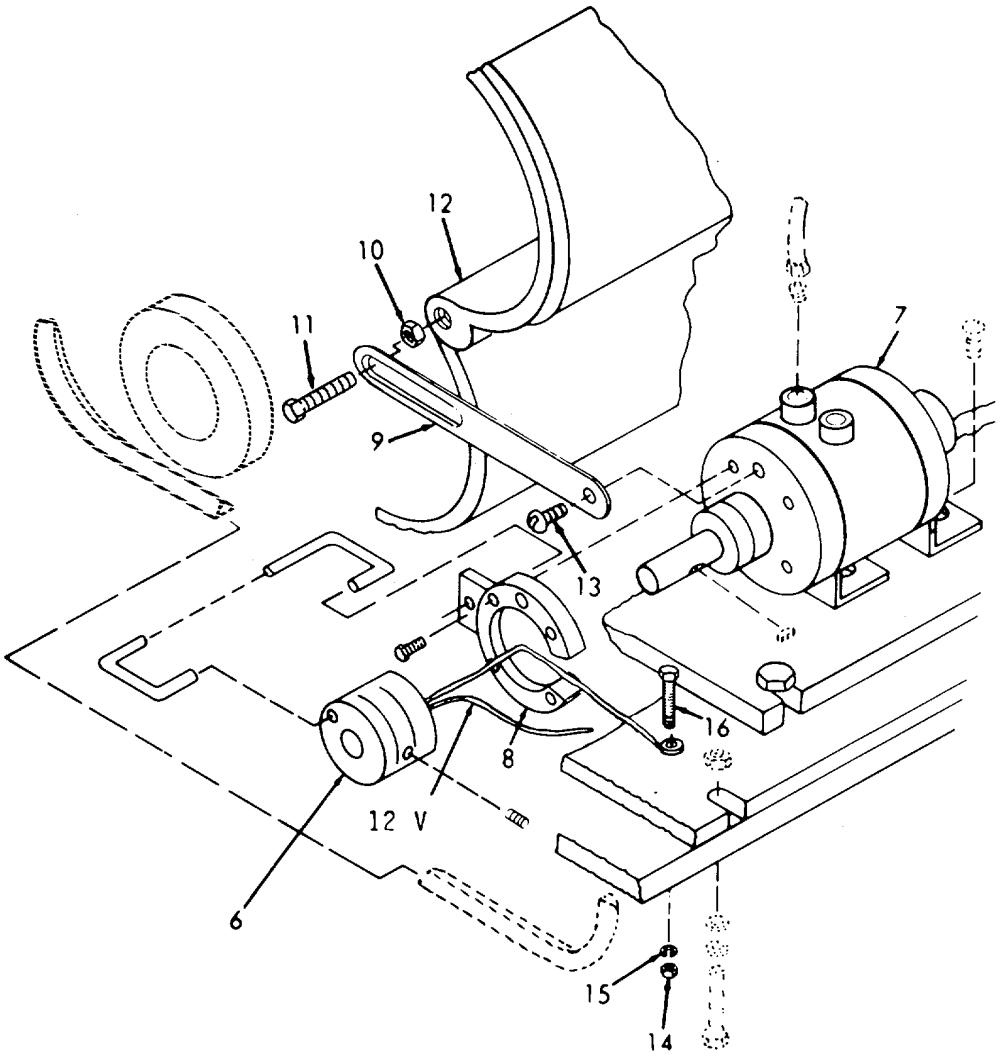


4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
	c. Priming pump hose (5)	Unscrew from the fire pump suction cover.	
			
	d. Magnetic clutch (6)	1. Loosen setscrews and slide clutch on drive shaft towards priming pump (7).	
		2. Remove hook end of clutch stabalizer (8) from magnetic clutch (6) staba-lizer hole.	
		3. Unscrew clutch stabilizer (8) from priming pump (7).	
		4. Carefully unwrap magnetic clutch power 12 V lead and remove clutch stabilizer (8).	
	e. Priming pump stabilizer bracket (9)	1. Remove nut (10), and screw (11) from fan housing (12).	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
		2. Remove screw (13) from priming pump (7).	
		3. Remove bracket (9).	
	f. Magnetic clutch (6) ground wire	Remove by removing nut (14), washer (15), and screw (16).	



-4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
	g. Oiler assembly (17)	1. Remove nuts (18), washers (19), and screws (20). 2. Remove oiler assembly (17).	
	h. Priming pump base plate (21)	Remove nut (22), two washers (23), and screw (24).	
	i. Priming pump (7), and magnetic clutch (6) assembly	Carefully remove pump and clutch by sliding it toward engine, releasing fan belt tension.	
	j. Fan belt (25) pulley (26).	Remove from magnetic clutch (6), drive	

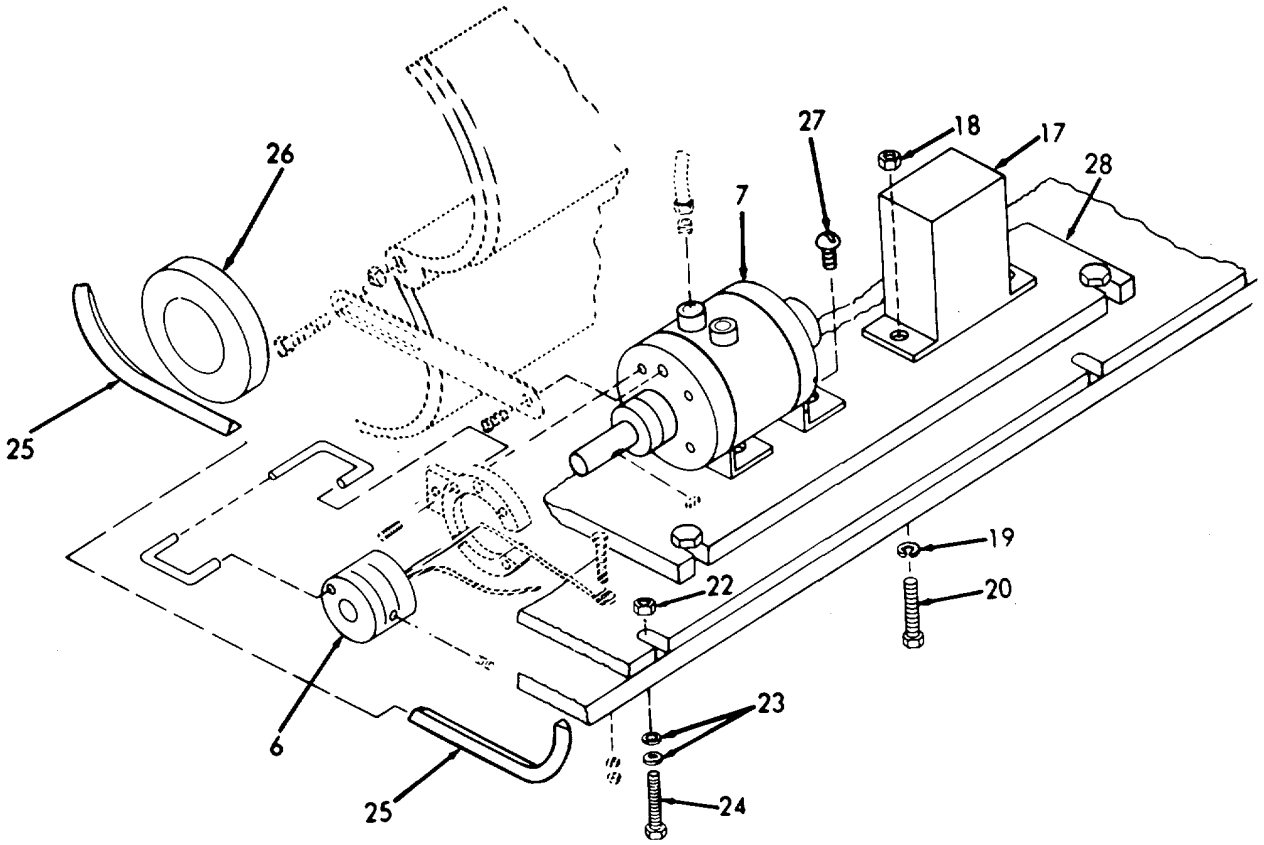
CAUTION

Protect magnetic clutch wiring harness during removal, because clutch 12V power lead remains attached to primary electrical harness.

	k. Screws (27)	Unscrew two screws that secure priming pump (7) to mounting bracket (28).	
	l. Priming pump (7), and magnetic clutch (6) assembly	1. Carefully remove from mounting bracket (28).	

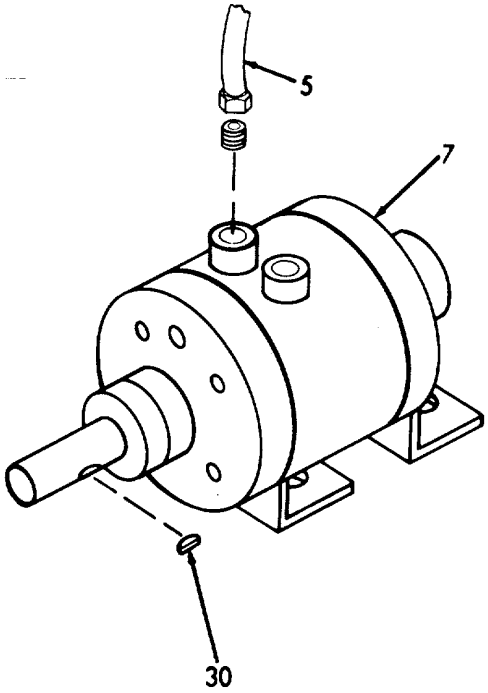
-4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
		2. Keep adjacent to engine until magnetic clutch (6) is removed from priming pump drive shaft.	
	m. Magnetic clutch (6)	1. Carefully slide magnetic clutch (6) off the priming pump drive shaft (29)	
		2. Place clutch (6) near engine with 12V power lead attached.	



-4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

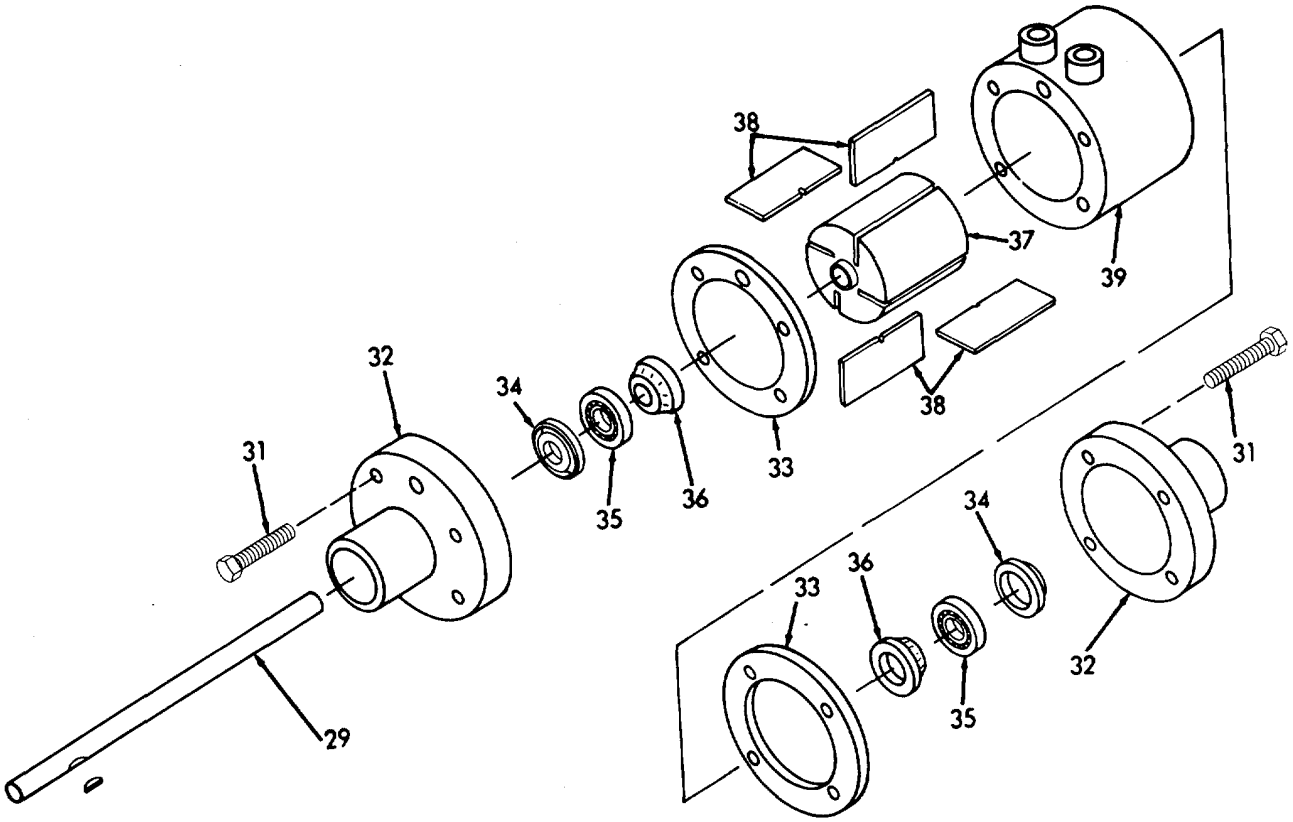
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
	n. Woodruff key (30)	Remove.	



	o. Priming pump hose (5)	Remove from priming pump (7) by unscrewing hose from priming pump inlet port.	

-4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2. Priming pump	a. Screws (31)	Remove nine screws on each end plate (32).	
	b. End plates (32), and gaskets (33)	Remove both.	Discard gaskets.
	c. Outer seals (34), bearings (35), and inner seals (36)	Remove from both end end plates (32).	
	d. Rotor (37), shaft (29), and vanes (38)	Remove from pump body (39).	



-4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
3. Priming pump			

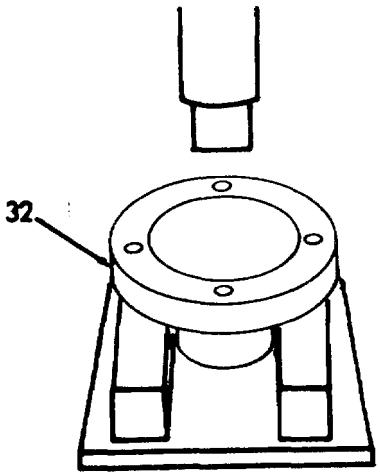
WARNING

- Observe no smoking regulation. Avoid prolonged contact with, or inhalation of cleaning solvents. Avoid use near heat or open flame and provide adequate ventilation.
- Wear eye protection when using compressed air.

	a. All internal parts	1. Clean with a general purpose cleaner.	
		2. Remove salt or scale deposits.	Use scale removing compound (sulphamic acid (PS-120)).
		3. Dry all internal parts with filtered compressed air and wipe dry external surfaces with clean cloth.	
	b. Body	Blow out all passages, hoses, and pipe fittings with filtered compressed air.	
INSPECT ION			
4.	a. Hoses	Inspect for cuts, chafing, and permanent set.	Replace hose if damaged or shows wear to cause leaking in priming systems.
	b. Threads	Inspect for nicks, burrs, and distortion.	Replace all parts that show signs of wear or damage.

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Gasket surfaces	Inspect surface for nicks, burrs, and deterioration.	Smooth out minor nicks, scratches, and burrs with fine emery cloth.
	d. Shaft seals	Inspect for signs of leaking or excessive wear.	
	e. Bearings	Inspect if they feel rough when rotated.	
	f. Vanes	Inspect for signs of excessive wear.	If height is less than 1/2 inch (.127 cm) discard.
REASSEMBLY			
5. Priming pump	a. End plate (32)	Place in press with counterbore up.	



4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Inner seal (36)	1. Place seal with lip of seal face down in end plate bore.	
		2. Slowly press seal into end plate bore.	
		3. Press in until seated.	
	c. Bearing (35)	1. Place on top of end plate bore.	
		2. Slowly press bearing down into end plate bore until seated on inner seal (36).	
	d. Outer seal (34)	1. Place outer seal on top of end plate with lip side facing up.	
		2. Slowly press outer seal into end plate bore until sealed.	
	e. Repeat steps 5a thru d for the other end plate.		

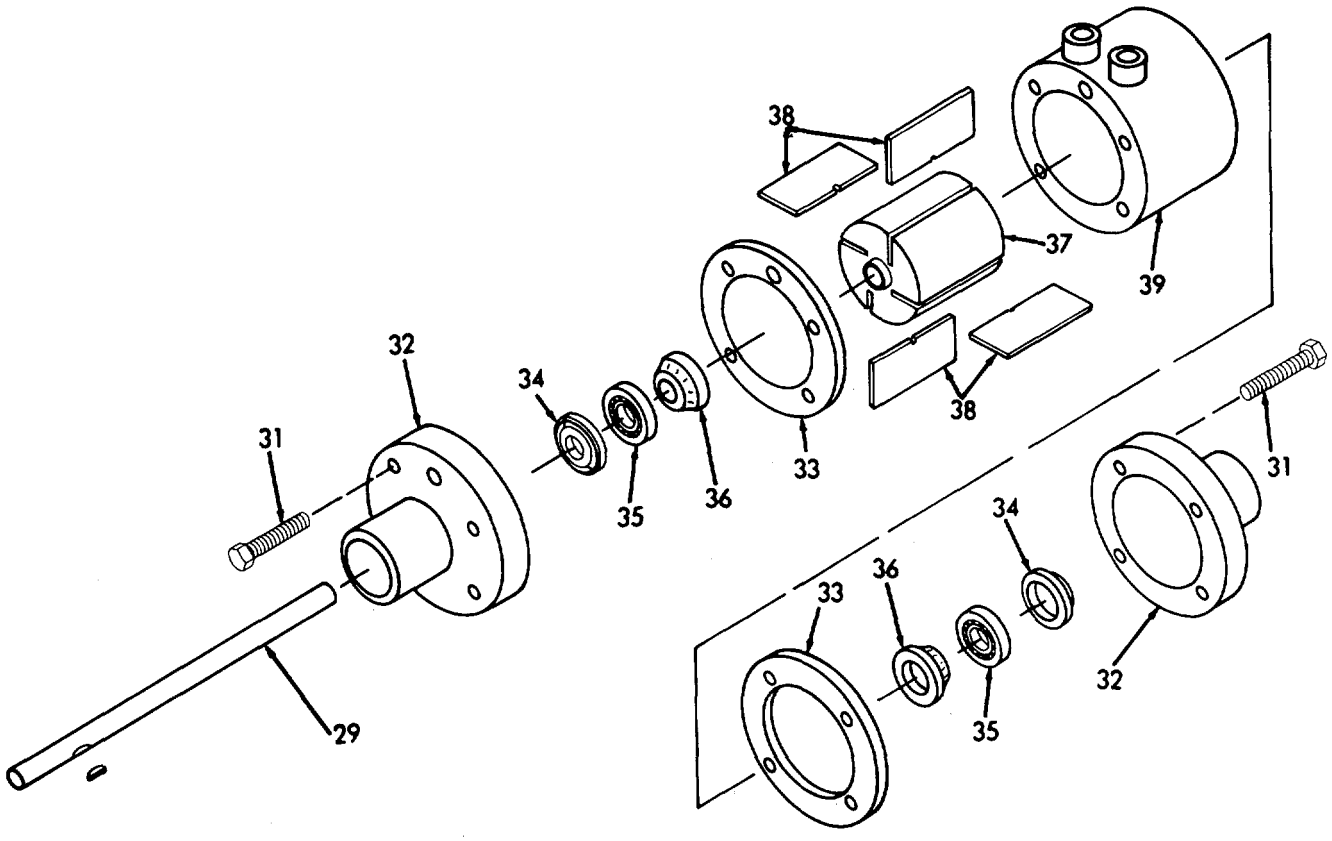
NOTE

Apply a thin coat of silicone compound, MIL-S-8660, to screw threads and pump housing surfaces.

f. Rotor (37) and shaft (29)	Press into one of the end plates (32).	Make sure that shaft is pressed in until seated.
g. Gasket (33)	Place one gasket on face of end plate (32).	Use new gasket.
h. Body (39)	Place on top of gasket.	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	i. Screw (31)	Start nine screws into holes.	Do not tighten.
	j. Vanes (38)	Insert in rotor.	
	k. Gasket (33)	Place the other gasket on top of face of body.	Use new gasket.
	l. End plate (32)	1. Press the other end plate on shaft. 2. Press until seated on body. 3. Align screws holes.	



4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	m. Screws (31)	1. Start screws into holes.	
		2. Tighten screws in both end plates while rotating shaft back and forth.	
		3. If you are unable to rotate shaft back and forth - tap body with lead hammer lightly.	
		4. If the shaft does not free up - install another gasket (33).	
		5. Repeat steps 1 thru 3 above.	Side clearance of 0.005 inch to 0.010 inch (0.013 io 0.025 cm) is standard.
		6. Tighten all screws to 7 lb-ft (9.5 Nm) torque.	

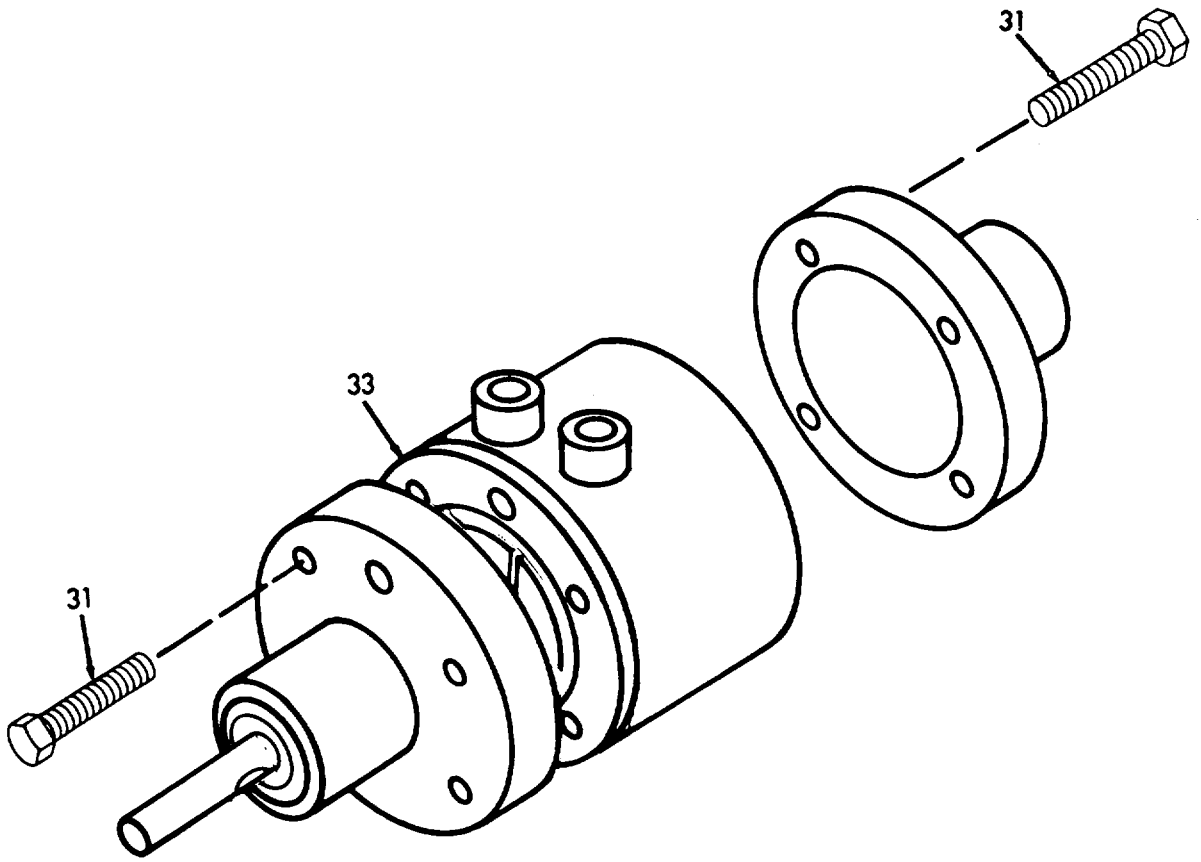
NOTE

Shaft must rotate freely to meet required performance.

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

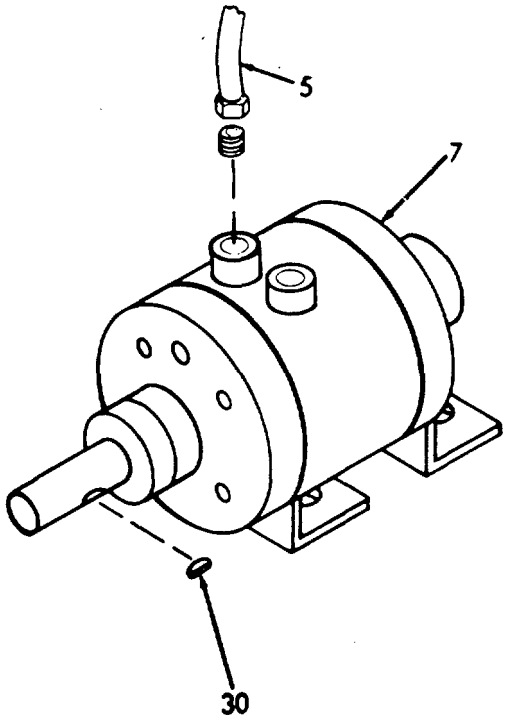
LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



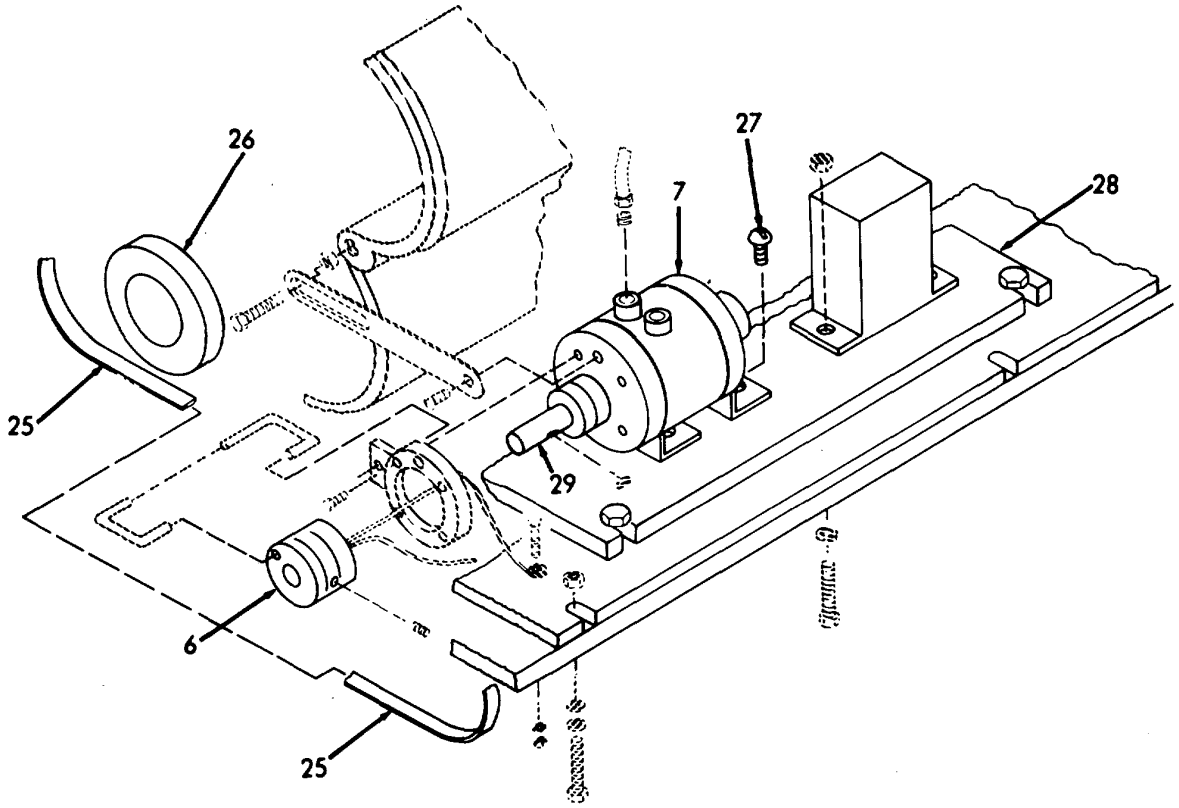
4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6.	Priming pump and magnetic clutch		
		NOTE Apply a thin coat of pipe sealant to pipe threads.	
	a.	Priming pump hose (5)	Install on priming pump (7).
	b.	Woodruff key (30)	Install.



4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Magnetic clutch (6)	Carefully slide on priming pump drive shaft (29).	
	d. Priming pump (7), and magnetic clutch (6) assemblied	Carefully install in mounting bracket (28).	
	e. Screws (27)	Install.	
	f. Fan belt (25)	Install on magnetic clutch and drive pulley (26).	
	d. Priming pump (7) And magnetic clutch (6)	Carefully install by sliding towards engine.	



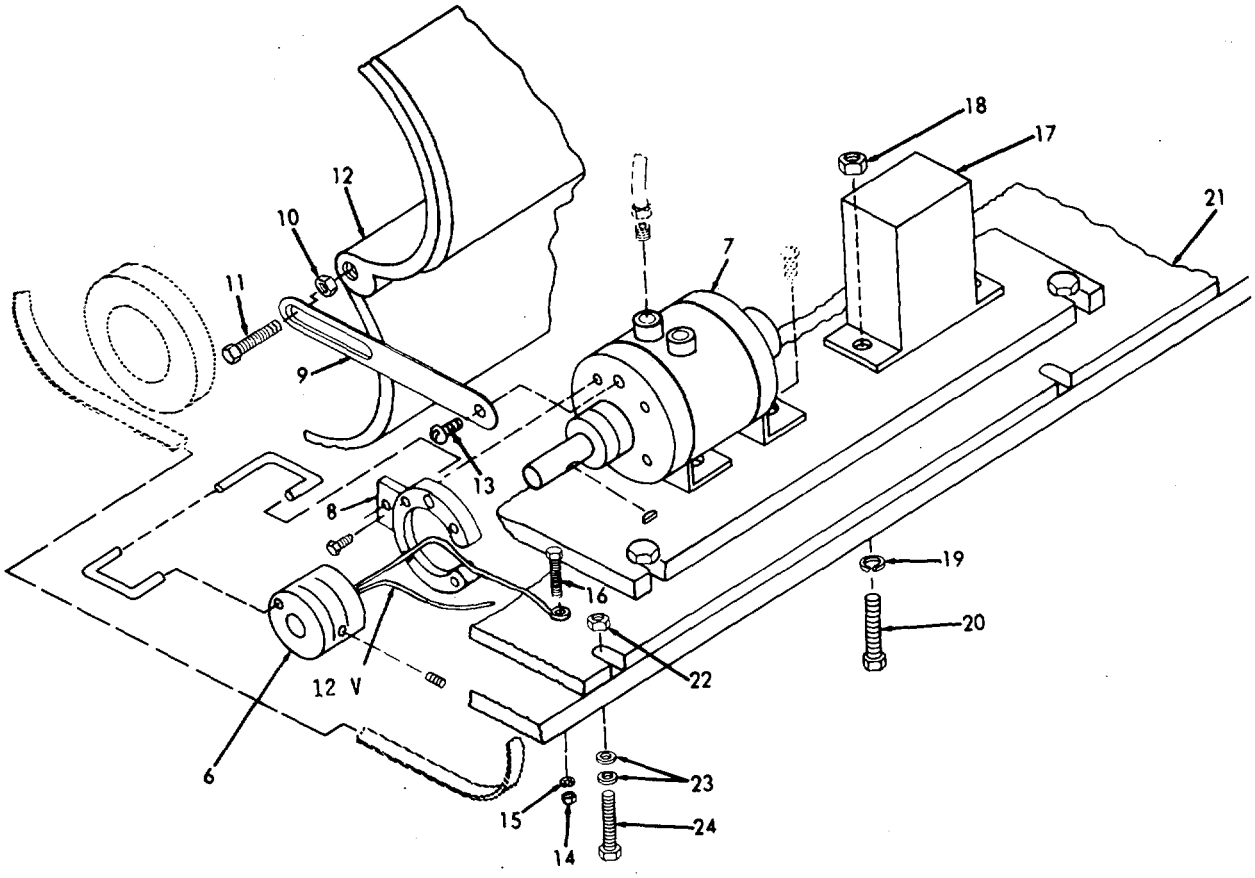
4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Priming pump base plate (21)	1. Install. 2. Use screw (24), two washers. (23), and nut (22).	
	i. Oiler assembly (17)	1. Install. 2. Use screws (20), washers (19), and nuts (18).	
	j. Magnetic clutch (6) ground wire	1. Install. 2. Use screw (16), washer (15), and nut (14).	
	k. Priming pump stabilizer bracket (9)	1. Install screw (13) to priming pump (7). 2. Install screw (11) and nut (10) to fan housing (12).	
	l. Magnetic clutch (6)	1. Carefully rewrap 12V lead and install clutch stabilizer (8). 2. Screw clutch stabilizer (8) onto priming pump (7). 3. Install hook end of clutch stabilizer (8) into magnetic clutch (6) stabilizer hole. 4. Slide clutch on drive shaft towards priming pump (7). 5. Tighten set screws.	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

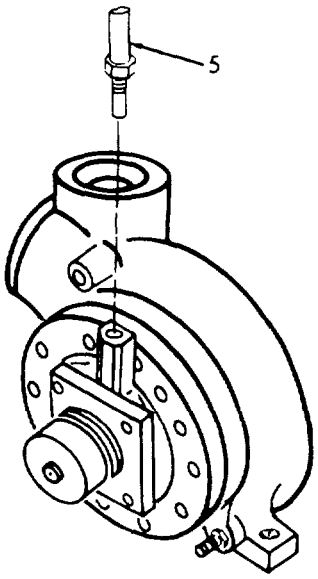
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

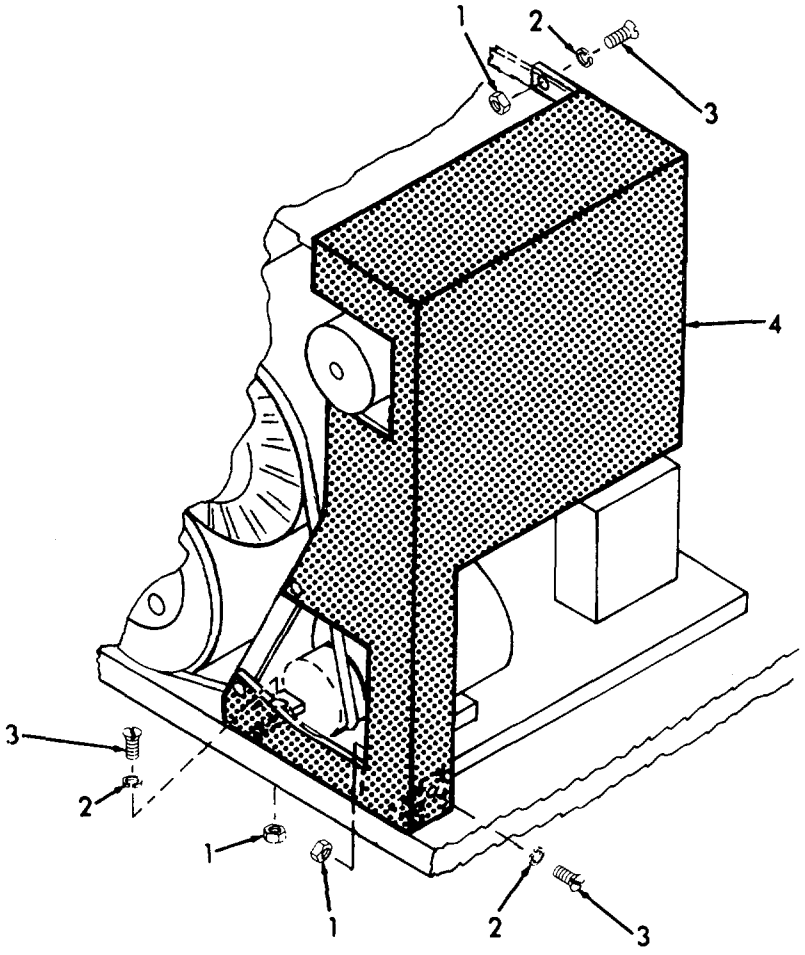
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	m. Priming pump hose (5)	Screw into fire pump suction cover.	



	n. Guard assembly (4)	Install.	
	o. Screws (3), lockwashers (2), and nuts (1)	Install.	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

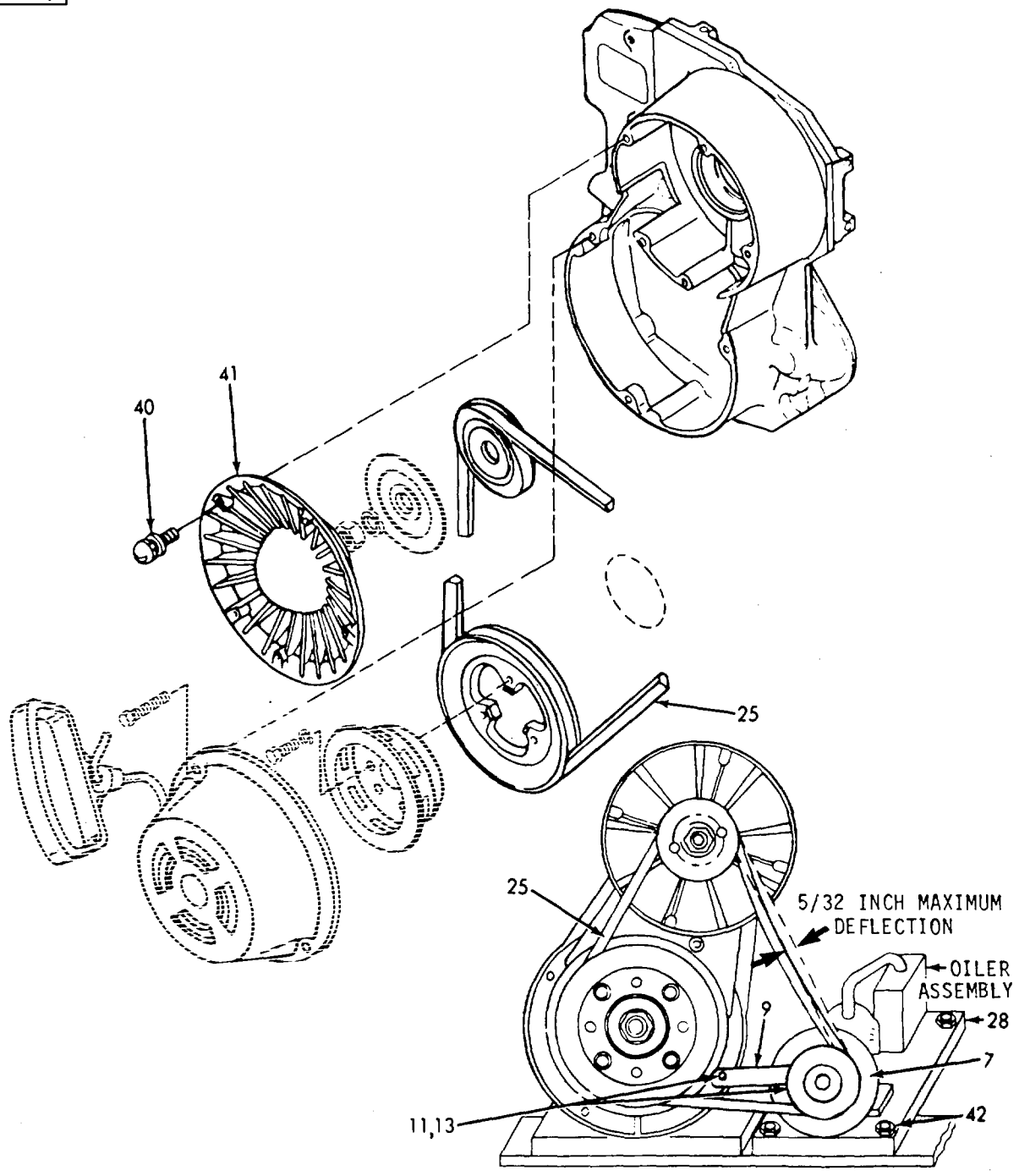


4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
7. Fan belt	a. Screws (40)	Remove two places.	
	b. Fan belt guard (41)	Remove.	
	c. Fan belt (25)	1. Check fan belt tension by pushing fan belt in at point shown below. Verify that fan belt deflection is 5/32 inch. 2. Adjust fan belt as follows: (a) Loosen the four screws (42) on the priming pump mounting bracket (28), and the two screws (11) and (13) on the priming pump stabilizer bracket (9). (b) Slide the priming pump (7) out to tighten fan belt (25). (c) When fan belt deflection is 5/32 inch: Tighten four screws (42) on the priming pump mounting bracket (28), and the two screws (11) and (13) on the priming pump stabilizer bracket (9).	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



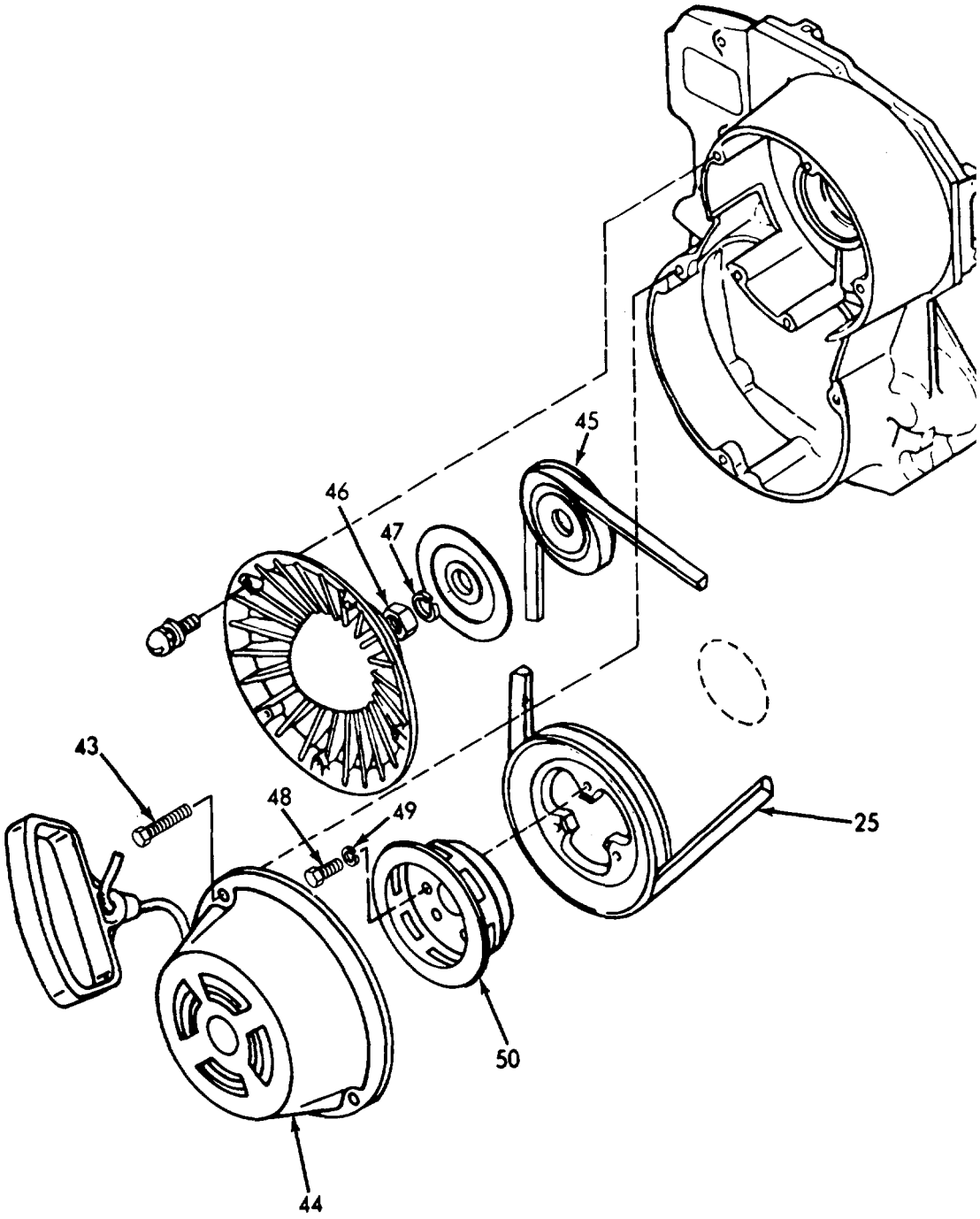
4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		NOTE If fan belt shows signs of wear or proper tension cannot be obtained, replace fan belt as follows:	
	d. Screws (43)	Remove.	
	e. Retractable starter (44)	Remove.	
	f. Fan pulley (45)	Hold while removing nut (46) and washer (47).	Use spanner wrench.
	g. Screws (48), and lock-washers (49)	Remove.	
	h. Starter pulley (50)	Remove.	
	i. Fan belt (25)	Replace.	
	j. Starter pulley (50)	Install using screws (48), and lockwashers (49).	
	k. Washer (47), and nut (46)	1. Install. 2. Tighten to 35 lb-ft (47.5 Nm) torque.	
	l. Belt tension	Recheck and adjust per step 7c.	

4-7.5A. PRIMING PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal
b. Disassembly
c. Cleaning
d. Inspection
e. Reassembly
f. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
Condition Description
NONE

Material/Parts
General purpose cleaner
Silicone compound
MIL-S-8860

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

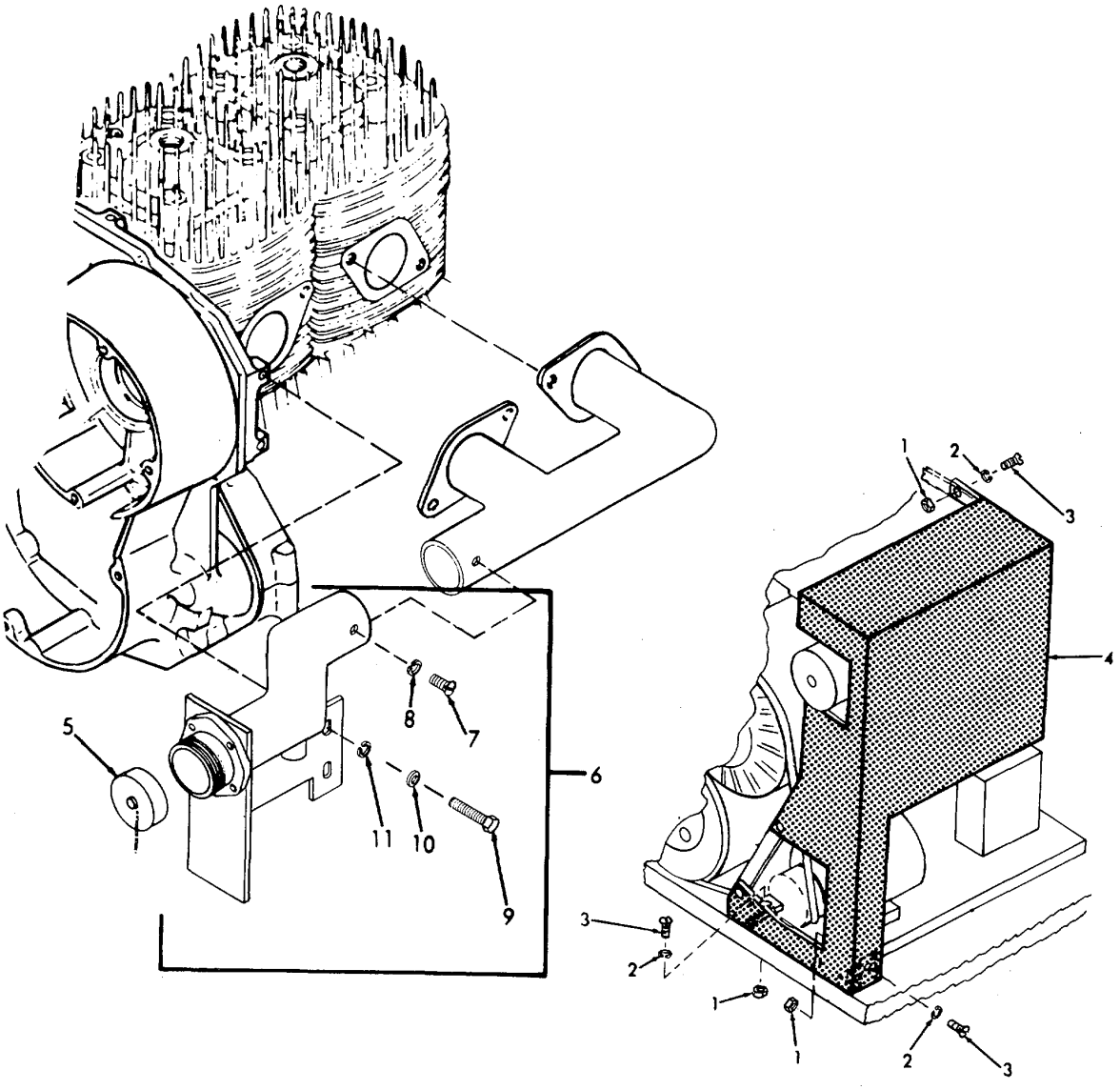
WARNING

Exhaust system when hot can cause personal injury.

1.	Exhaust Muffler	a. Nuts (1), washers (2), and screws (3)	Remove.
		b. Guard assembly (4)	Remove.
		c. Exhaust cap and chain (5)	Unscrew and remove.

4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Exhaust muffler (6)	1. Remove tapping screw (7), and lockwasher (8). 2. Remove screws (9), washers (10), and lockwashers (11). 3. Remove muffler (6).	



4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Nuts (12), and screws (13)	Remove.	
	b. Outlet cap (14), and gasket (15)	Remove.	Discard gasket.
	c. Long nipple (16), coupling (17), and check valve (18)	Unscrew and remove from muffler tail-pipe (19).	
CLEANING			
3.			

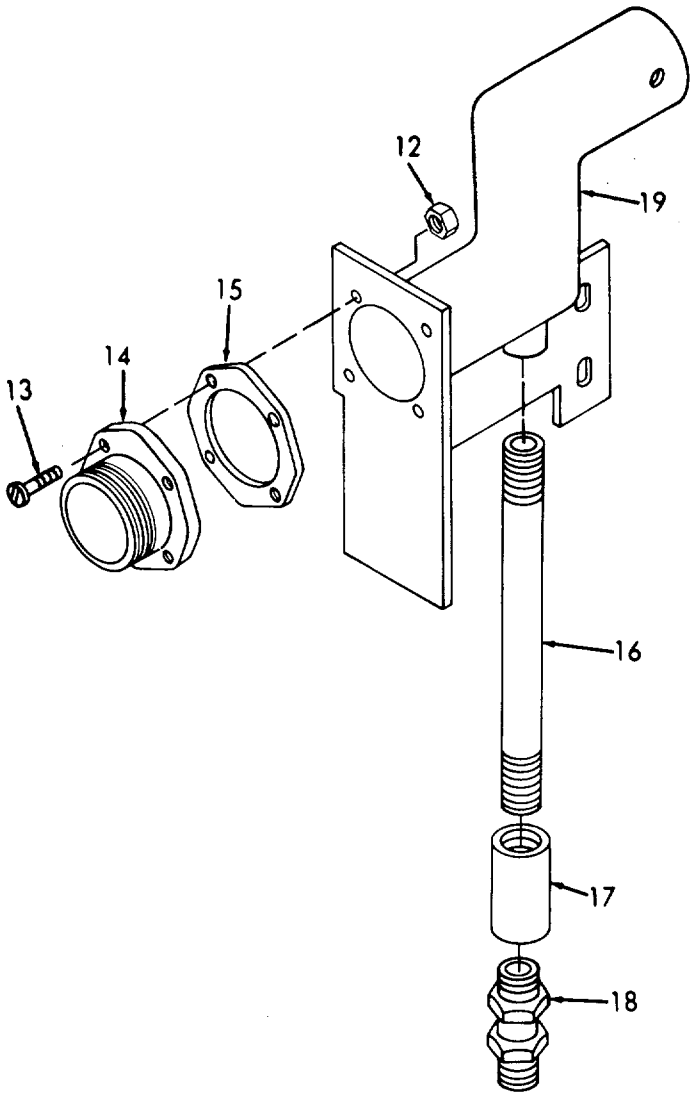
WARNING

- Observe no smoking regulations. Avoid prolonged contact with or inhalation of cleaning solvents. Avoid use near heat or open flame and provide adequate ventilation.
- Wear eye protection when using compressed air.

a. Muffler tailpipe (19), outlet cap (14), long nipple (16) and coupling (17)	1. Clean with general purpose cleaner. 2. Remove accumulated scale, carbon deposits, and dirt. 3. Blow compressed air through the pass-ages and wipe exter-nal surfaces dry with clean cloth. 4. Clean threads and gasket surfaces.

4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING (Cont)			
	b. Check valve (18)	1. Clean external surface with general purpose cleaner. 2. Air dry and wipe with clean cloth.	

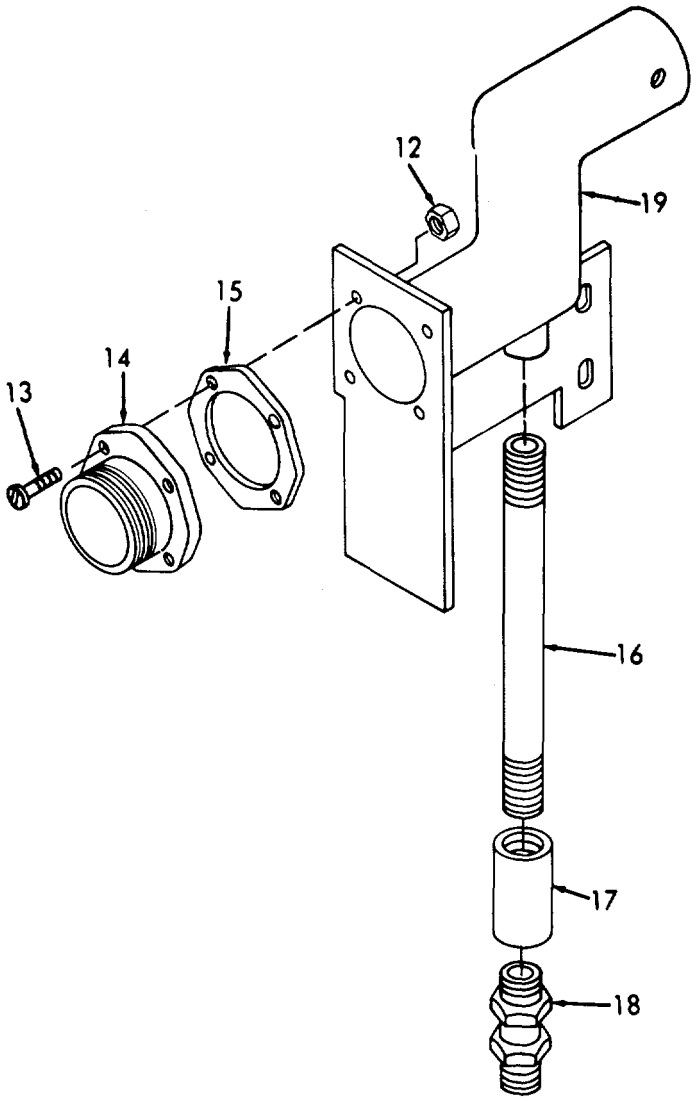


4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
3.	a. Gasket surfaces	Inspect for nicks, burrs, and deterio-ration.	Smooth out minor nicks, scratches, and burrs with fine emory cloth.
	b. Threads	Inspect for nicks, burrs, and distortion.	
	c. All parts	Inspect for signs of wear or damage.	
	d. Check valve	Inspect for signs of excessive wear or leaking.	
REASSEMBLY			
4.		NOTE Apply a thin coat of silicone compound, MIL-S-8860, to screw threads and outlet cap threads.	
	a. Check valve (18), coup-ling (17), and long nipple (16)	Reassemble to muffler tailpipe (19).	
	b. Gasket (15), and outlet cap (14)	Install.	Use new gasket
	c. Screws (13), and nuts (12)	Install.	

4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



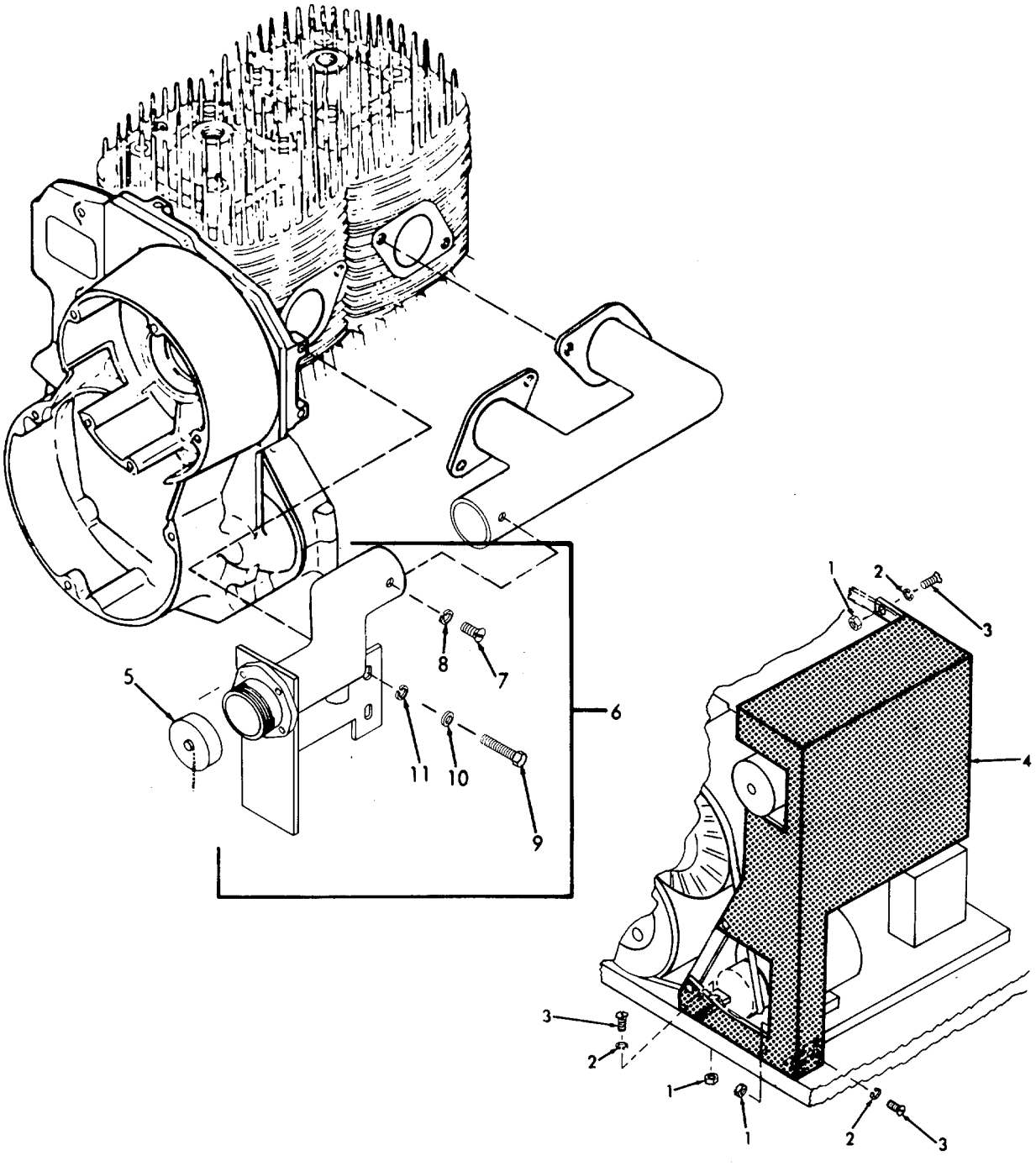
4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Exhaust muffler (6)	1. Install. 2. Install screws (9), washers (10), and lockwashers (11). 3. Install tapping screw (7), and lockwasher (8).	
	b. Exhaust cap and chain (5)	Install.	
	c. Guard assembly (4)	Install.	
	d. Screws (3), washers (2), and nuts (1)	Install.	

4-7.6A. EXHAUST MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS.

a. Fluctuations in crank-case pressure are introduced into the pump chamber (1,2) through impulse port (3). Negative pressures move the diaphragm (4) to the pump chamber (1) side drawing fuel from the tank through inlet check valve (5) into pump chamber (2). Outlet check valve (6) remains closed. Positive crank-case pressures move the diaphragm (4) to pump chamber (2) side, opening outlet check valve (6), closing inlet check valve (5), and transferring the fuel from chamber (2) side to starting well (7). The rate of fuel flow from well (7) to adjusting chamber (8) is controlled by engine cylinder pressures opening or closing the inlet needle (9) by means of the main diaphragm (10) and control lever (11). Negative pressure (suction stroke) causes the main diaphragm (10) to act against the set load on the tension spring (12) and open the inlet needle (9) by control lever (11) allowing fuel to enter adjusting chamber (8).

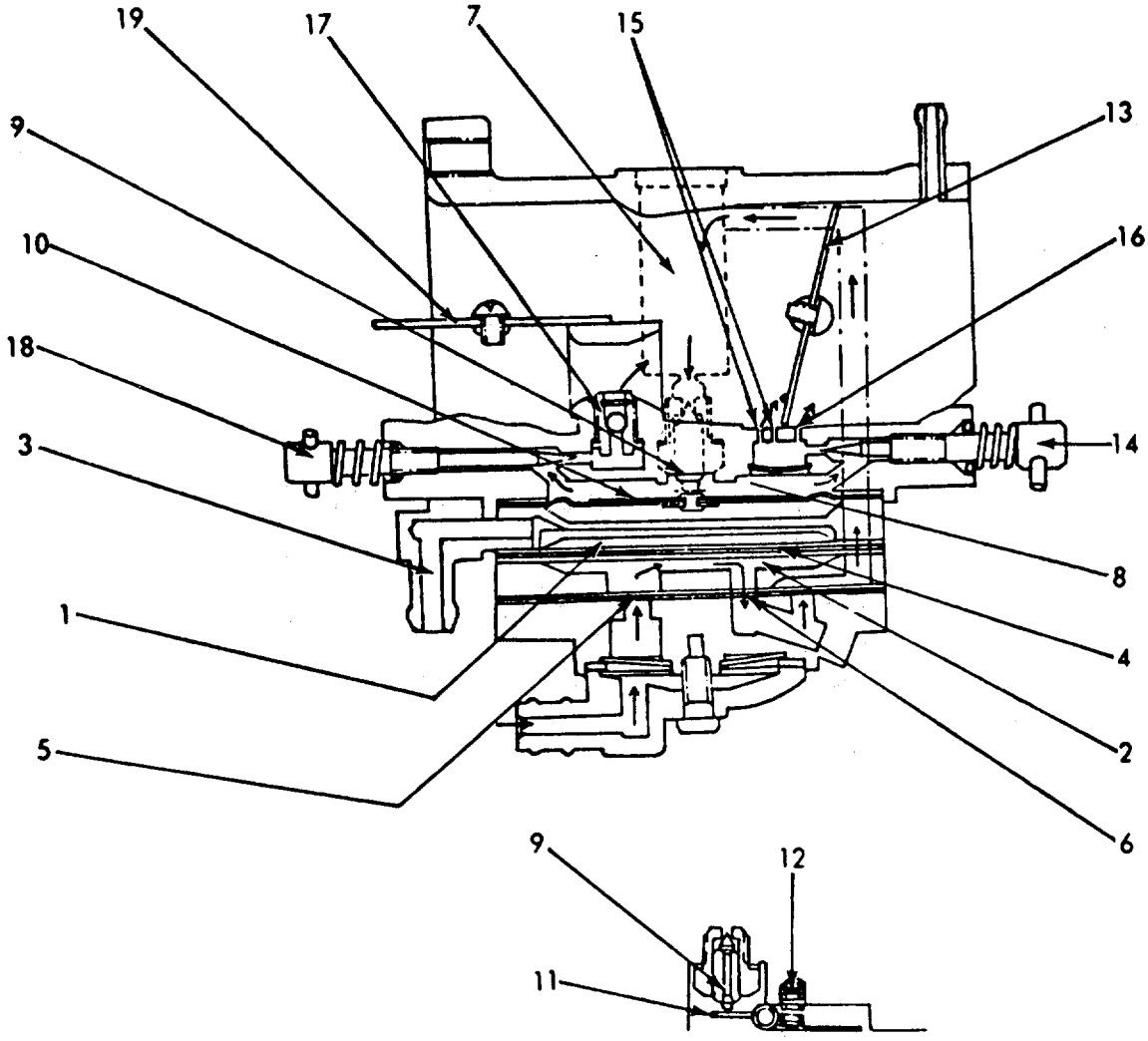
b. When the throttle valve (13) is opened for idling the fuel flow from chamber (8) is controlled by the idling screw (14). Air taken from by-pass hole (15) is mixed with the fuel to produce a vapor. This vapor is metered to the engine cylinder through pilot outlet (16). When the throttle valve (13) is moved more than 20% open, increased air flow through the venturi begins to jet fuel through the main nozzle (17). As the throttle valve opens further the fuel supply is controlled by main fuel mixture screw (18). The ball check in main nozzle is to prevent air entering chamber (8) during low speed operation.

c. With the choke valve (19) fully closed and the throttle valve (13) half open the increase in pressure drop at the main nozzle (17) increases the flow of fuel from chamber (8) to the air flow to the engine cylinder. This creates a rich mixture vapor for starting purposes.

Carburetor Legend

1. Pulse chamber
2. Pump chamber
3. Impulse port
4. Pump diaphragm
5. Inlet check valve
6. Outlet check valve
7. Starting well
8. Adjusting chamber
9. Inlet needle
10. Main diaphragm
11. Control lever
12. Tension spring
13. Throttle valve
14. Low fuel mixture screw
15. By-pass
16. Pilot outlet
17. Main nozzle
18. Main fuel mixture screw
19. Choke valve

4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS.



4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Removal
b. Disassembly
c. Cleaning
d. Inspection
e. Reassembly
f. Installation
g. Adjustment

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
Condition Description
NONE

Material/Parts
Carbon removing compound MIL-C-19853

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

WARNING

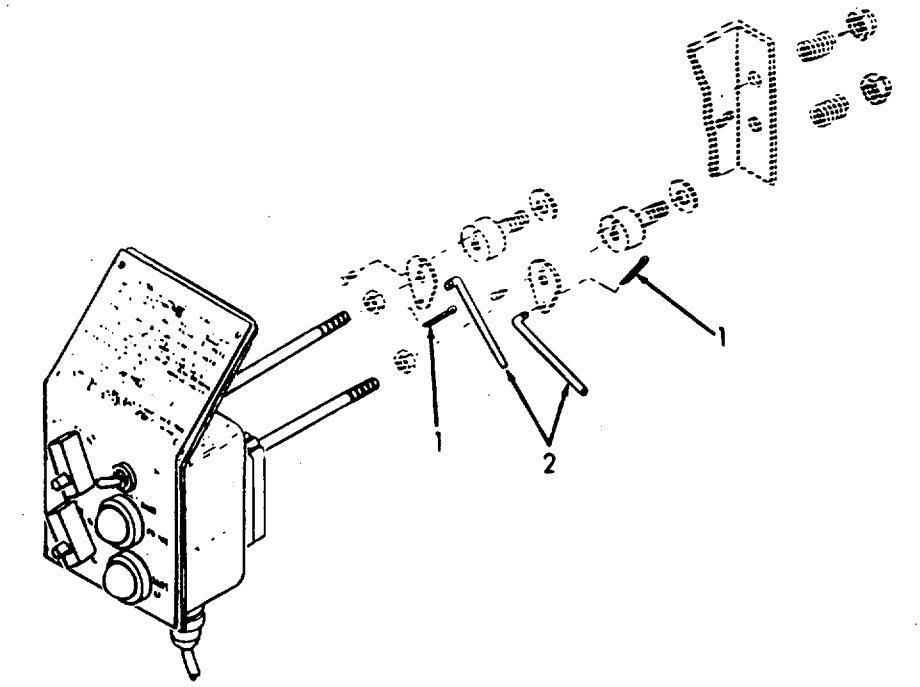
Observe no smoking regulations.

1.	Engine control panel	a. Cotter pins (1)	Remove.
		b. Throttle, and choke rods (2)	Unscrew and remove.

4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



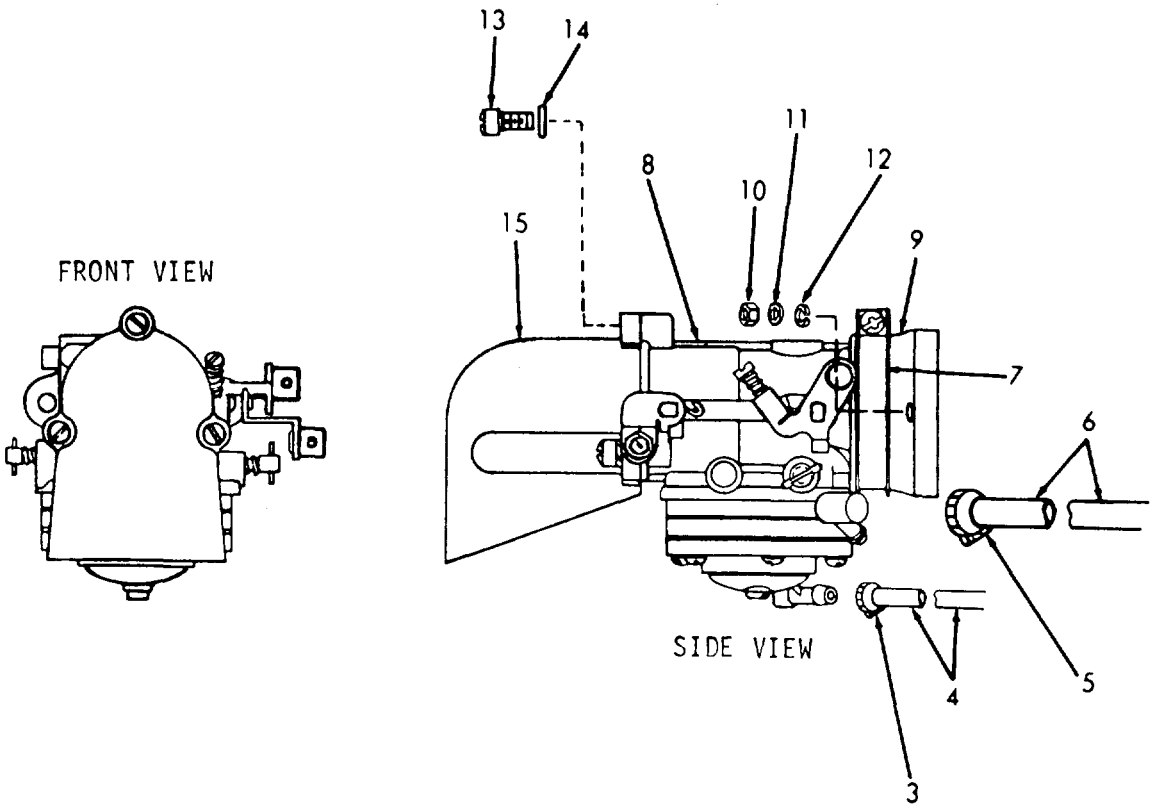
4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2. Carburetor	a. Hose clamp (3)	Loosen	
	b. Fuel hose (4)	Remove.	
	c. Hose clamp (5)	Loosen.	
	d. Impulse hose (6)	Remove.	
	e. Clamp (7)	Unscrew	
	f. Carburetor (8)	1. Carefully swivel and pull carburetor from rubber adapter (9). 2. If the carburetor cannot be removed from the adapter without excessive force, remove the adapter (9) with the carburetor (8) attached by unscrewing two nuts (10), and washers (11) and lockwashers (12).	
DISASSEMBLY			
3.	a. Clamp (7)	Unscrew.	
	b. Rubber adapter (9)	Remove.	
	c. Screws (13), and lock-washers (14)	Remove.	
	d. Cover (15)	Remove.	

4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



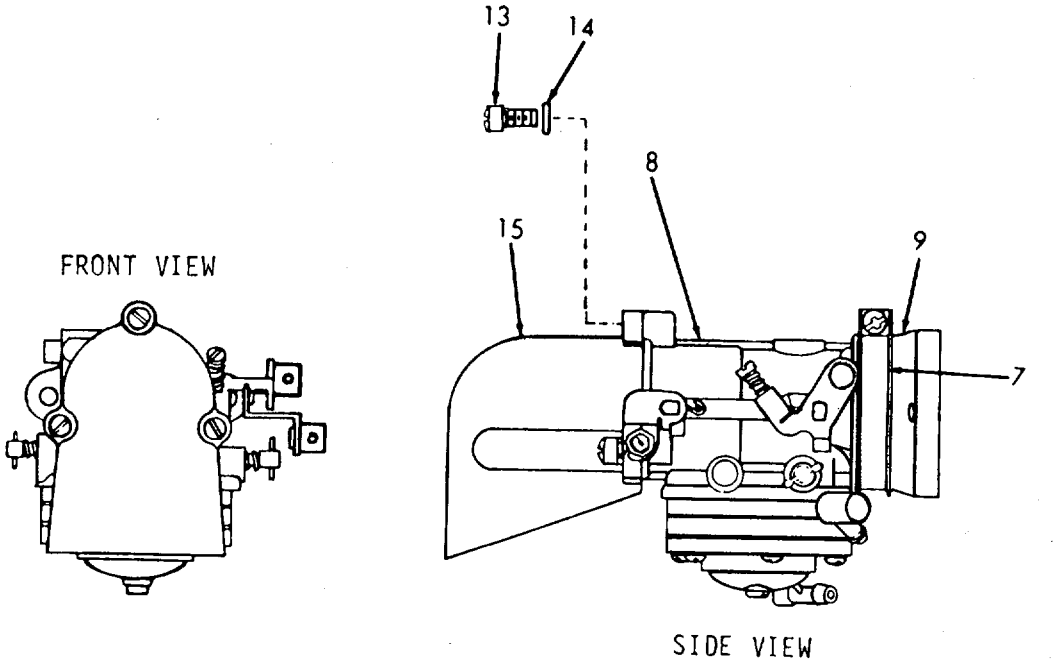
4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
4.		**WARNING** • Observe no smoking regulations. Avoid prolonged contact with, or inhalation of cleaning solvent. Avoid use near heat or open flame and provide adequate ventilation. • Wear eye protection when using compressed air.	
	a. Carburetor	1. Clean with carbon removing compound.	Use MIL-C-19853.
		2. Dry all parts with filtered compressed air.	At 20 psi (137.9 kPa).
	b. Passages	Blow out all passages in carburetor and ram tube with filtered compressed air.	
INSPECTION			
5.	Carburetor (8), and cover (15)	Inspect for wear or damage.	Replace if necessary.
REASSEMBLY			
6.	a. Cover (15)	Install.	
	b. Screws (13), and lock-washers (14)	1. Install. 2. Tighten to 8 lb-ft (10.8 Nm) torque.	
	c. Rubber adapter (9)	Install.	
	d. Clamp (7)	Install and tighten.	

4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



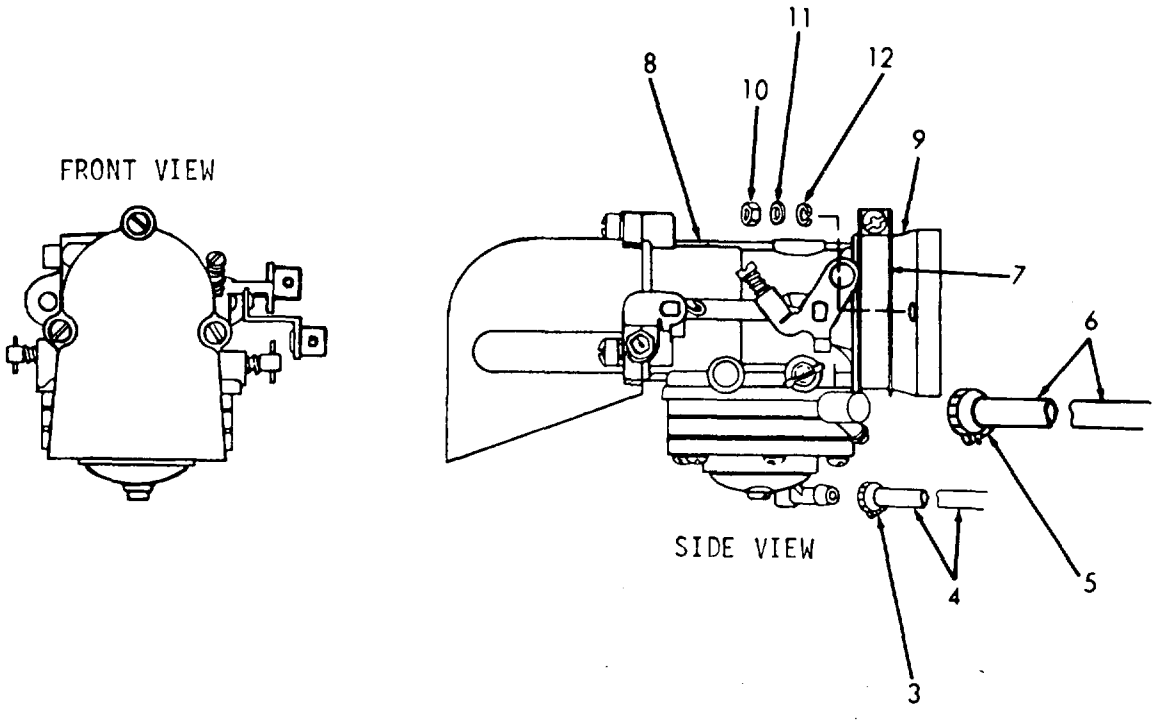
4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
7.	a. Carburetor (8) and adapter (9) assembled	If removed together - install.	
	b. Nuts (10), washers (11), and lockwashers (12)	1. Install. 2. Tighten to 3.5 lbft (4.8 Nm) torque.	
	c. Carburetor (8)	Install in adapter (9).	
	d. Clamp (7)	Install and tighten.	
	e. Impulse hose (6), and clamp (5)	Install and tighten clamp.	
	f. Fuel hose (4), and clamp (3)	Install and tighten clamp.	

4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

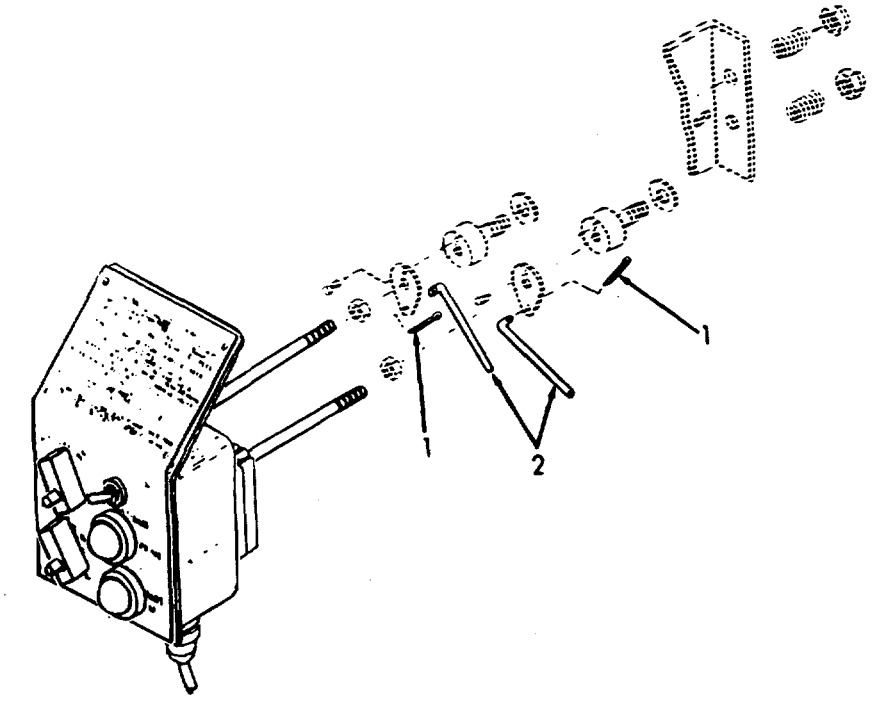
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Engine control panel	a. Throttle and choke rods (2)	Install.	
	b. Cotter pins (1)	Install.	



4-7.7A. CARBURETOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT			
9.	Carburetor	Twice a year, adjust the carburetor as follows:	

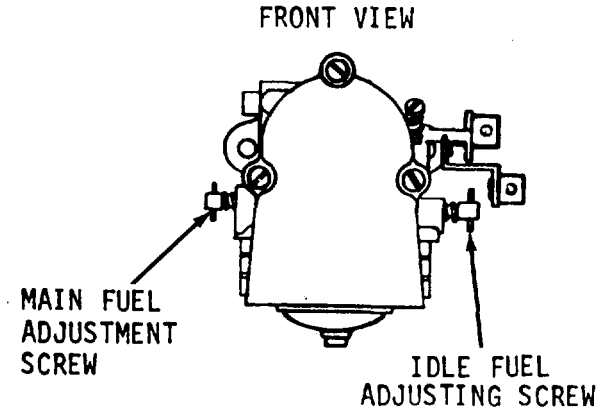
CAUTION

Fuel adjustment screws must be bottomed lightly. Do not force.

a. Turn idle fuel and main fuel adjustment screws clockwise until they bottom.
b. Turn idle fuel and main fuel adjustment screws counterclockwise one turn.

NOTE

The carburetor is not adjusted slight to the rich side. If a leaner adjustment is required, turn adjustment screws clockwise 1/8 of a turn.



4-7.8A. BATTERY - MAINTENANCE INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Equipment
Special Tools
Condition Condition Description
NONE
NONE

Material/Parts
Grease

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

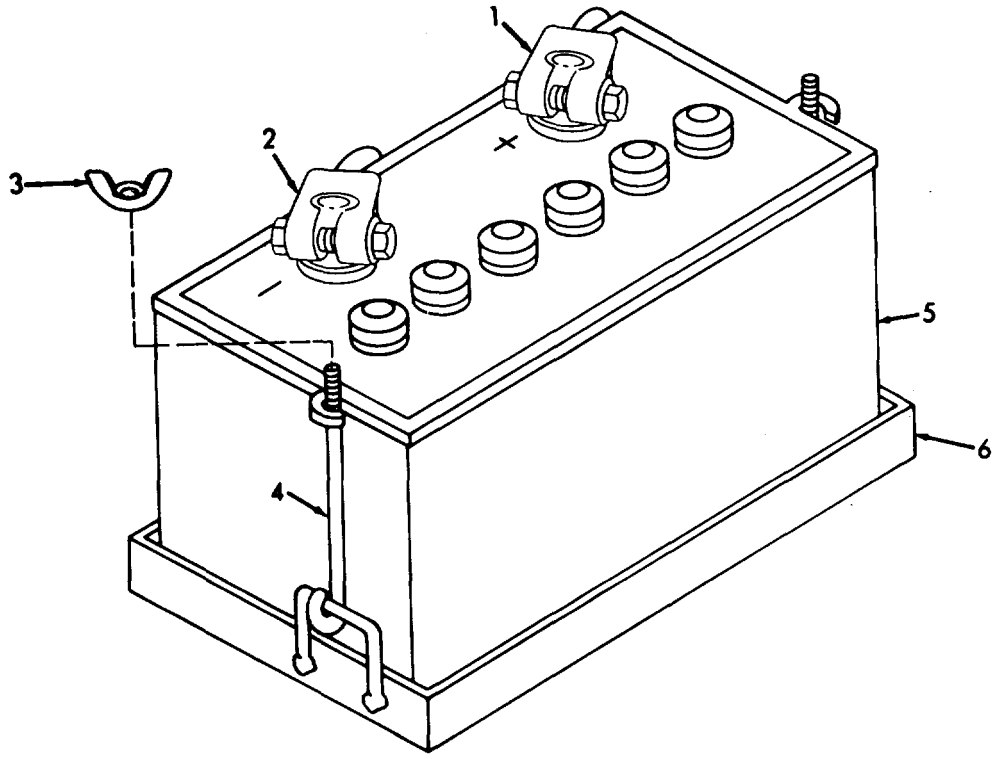
DANGER! Contains sulfuric acid. Avoid contact with skin, eyes, or clothing.

REMOVAL

1.	a.	Battery positive (+) cable (1)	Remove.
	b.	Battery negative (-) cable (2)	Remove.
	c.	Wing nut (3)	Loosen.
	d.	Cup hook (4)	Swing out of the way.

4-7.8A. BATTERY - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Battery (5)	Remove from tray (6).	
INSTALLATION			
2.	a. Battery (5)	Place in tray (6).	
	b. Cup hook (4)	Engage.	
	c. Wing nut (3)	Tighten.	
	d. Battery negative (-) cable (2)	Install.	Coat with grease.
	e. Battery positive (+) cable (1)	Install.	Coat with grease.



4-7.9A. SOLENOID AND ELECTRIC STARTER - MAINTENANCE INSTRUCTIONS.

The engine has a Bendix type electric starting motor. Energy for cranking the starting motor is provided by a 12-volt battery. As the starter spins, a pinion engages on ring gear on the crankshaft assembly.

This task covers:

a. Removal b. Inspection c. Installation

INITIAL SETUP

Test Equipment
NONE

References
Paragraph
4-7.5A Priming Pump - Removal

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

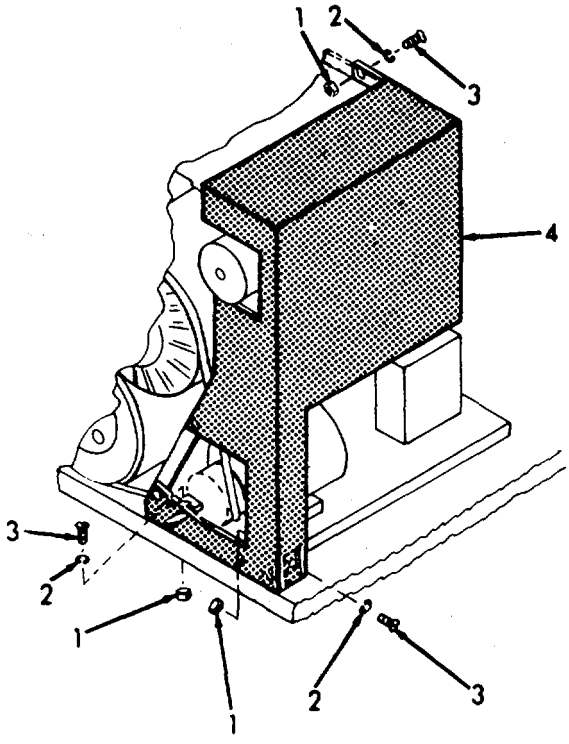
Personnel Required
1

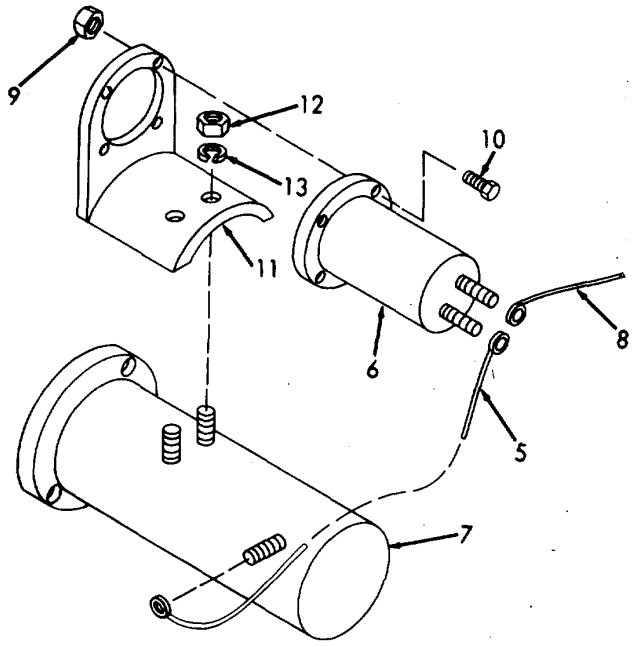
General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Solenoid and electric starter	a. Nuts (1), washers (2), and screws (3)	Remove.	
	b. Guard assembly (4)	Carefully remove from support bracket.	
	c. Priming pump assembly	Remove.	Refer to paragraph 4-7.5A.
	d. Solenoid to starter wire from (5)	Tag and disconnect solenoid (6), and starter (7).	

4-7.9A. SOLENOID AND ELECTRIC STARTER- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Positive (+) battery cable (8)	Tag and disconnect from solenoid (6).	
	f. Electrical wires	Tag and remove the remaining wires from the solenoid (6).	
	g. Solenoid (6)	1. Remove nuts (9), and screws (10). 2. Remove from bracket (11).	
	h. Bracket (11)	1. Remove nuts (12), and lockwashers (13). 2. Remove form starter (7).	





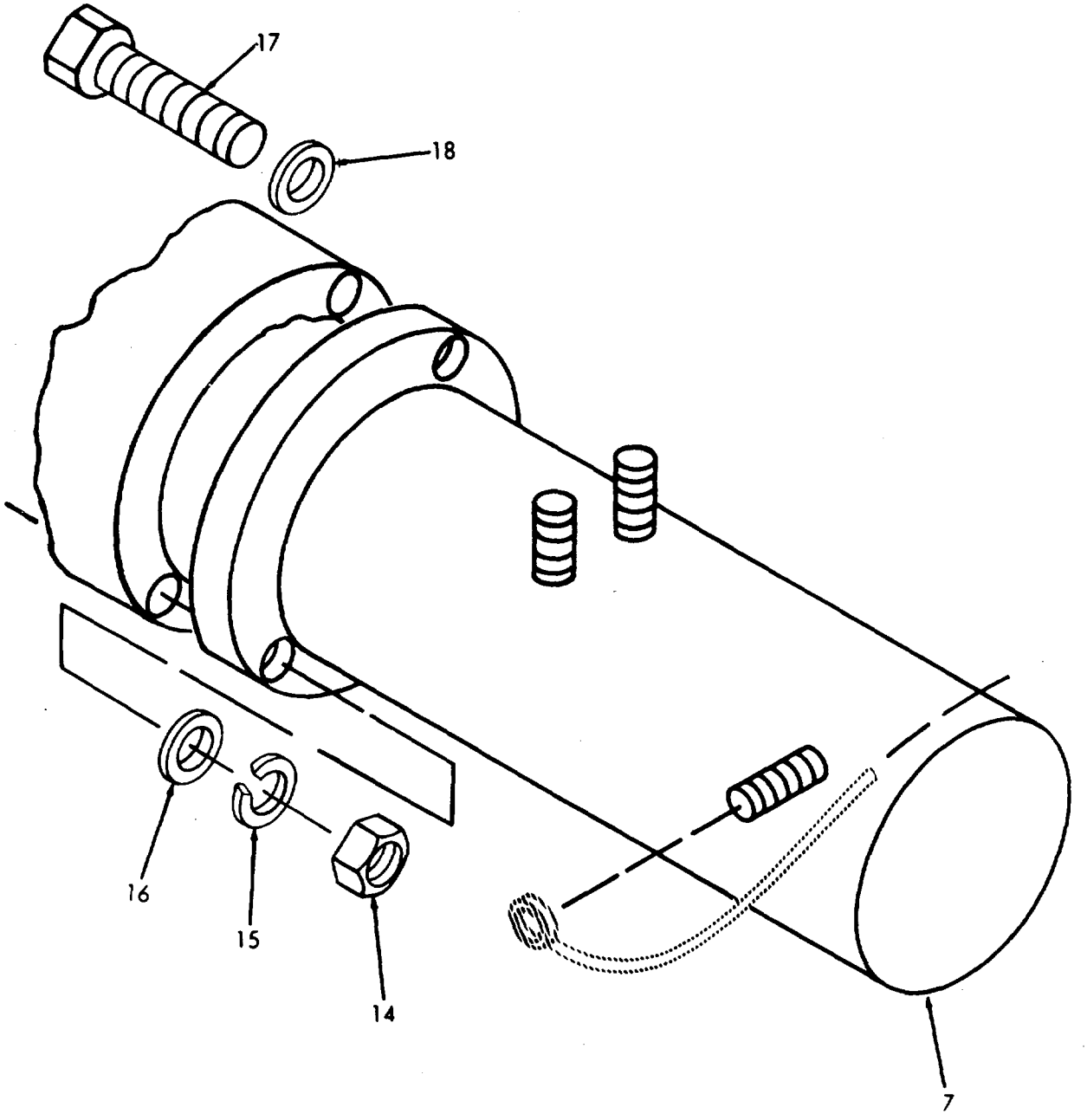
4-7.9A. SOLENOID AND ELECTRIC STARTER- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	i. Electric starter (7)	1. Remove two nuts (14), lockwashers (15), and washers (16). 2. Remove screw (17), and washer (18). 3. Remove starter (7).	
INSPECTION			
2.		Inspect solenoid or electric starter that show signs of obvious damage.	
INSTALLATION			
3.	a. Electric starter (7)	1. Install. 2. Install screw (17), and washer (18). 3. Install washers (16), lockwashers (15), and nuts (14). 4. Tighten screws and nuts to 16 to 18 lb-ft (21.7 to24.4 Nm).	

4-7.9A. SOLENOID AND ELECTRIC STARTER- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION



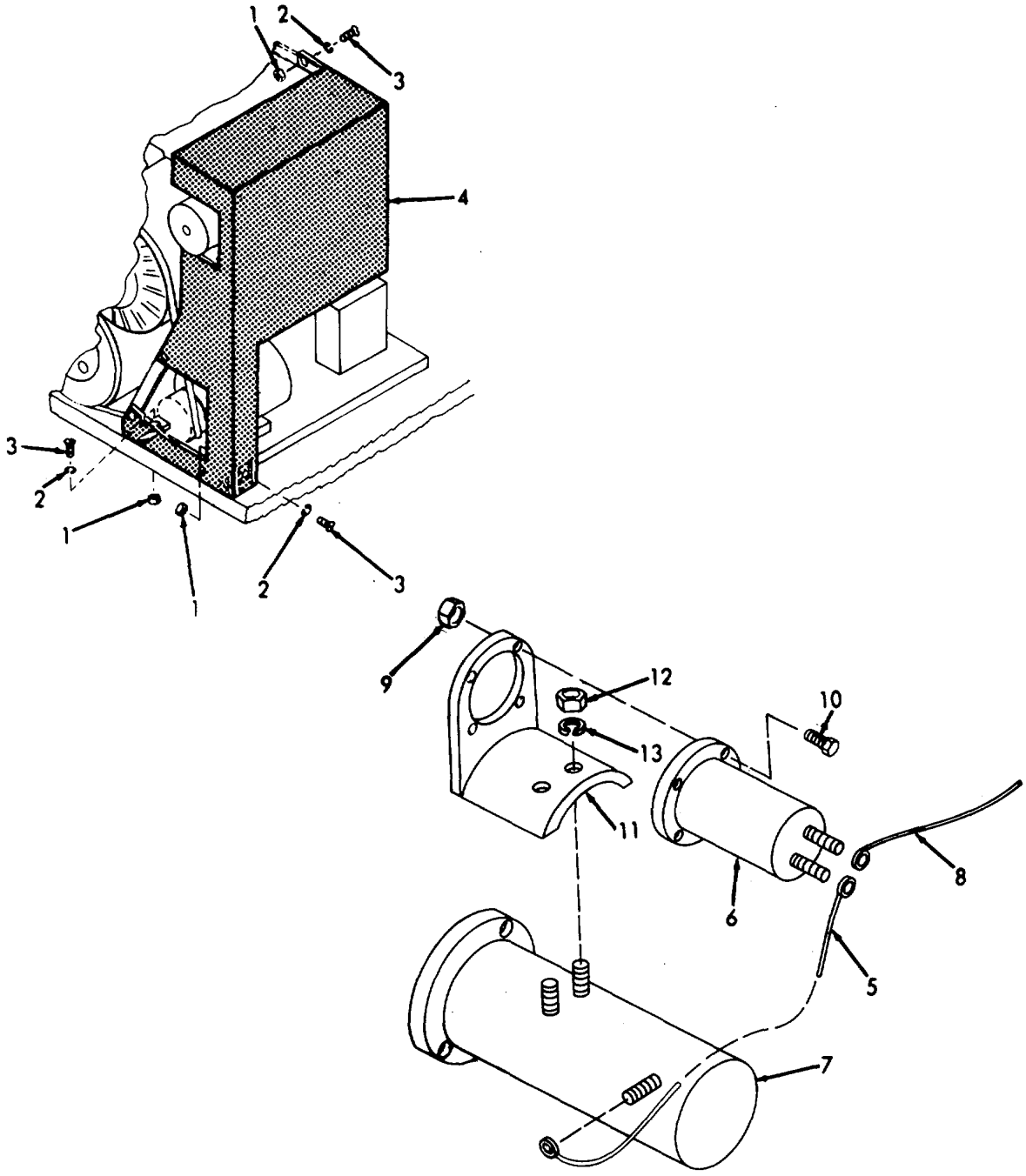
4-7.9A. SOLENOID AND ELECTRIC STARTER- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
	b. Bracket (11)	1. Install on starter (7). 2. Install nuts (12), and lockwashers (13).	
	c. Solenoid (6)	1. Install on bracket (11). 2. Install screws (10), and nuts (9).	
	d. Electrical wires	Reconnect to solenoid (6).	
	e. Positive (+) battery cable (8)	Remove tag and reconnect to solenoid (6).	
	f. Solenoid to starter wire (5)	Reconnect to solenoid (6) and starter (7).	
	g. Priming pump assembly	Install.	Refer to paragraph 4-7.5A.
	h. Guard assembly (4)	Locate in support bracket.	
	i. Screws (3), washers (2), and nuts (1).	Install.	

4-7.9A. SOLENOID AND ELECTRIC STARTER- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

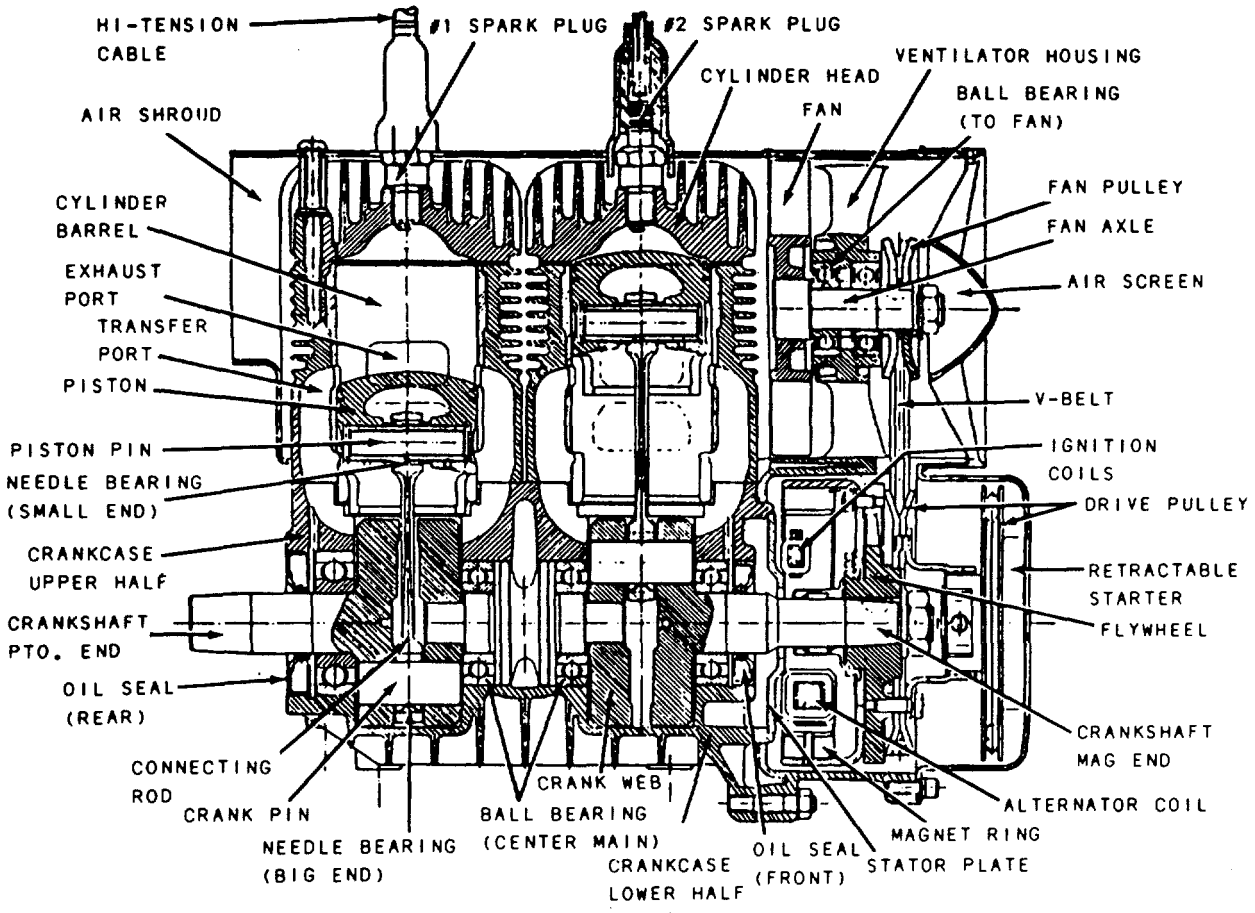
INSTALLATION



4.7.10A. ENGINE - MAINTENANCE INSTRUCTIONS.

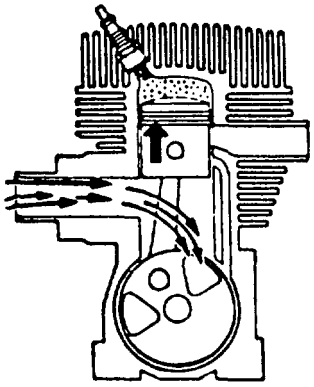
a. General.

(1) The PE-250 pump, 2 cycle air-cooled gasoline engine, is an axial fan-cooled twin cylinder engine of the loop-scavenged third port type. It uses a mixture of gasoline, oil and air for combustion, lubrication and cooling. It fires on every stroke for every revolution of the crankshaft.



4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

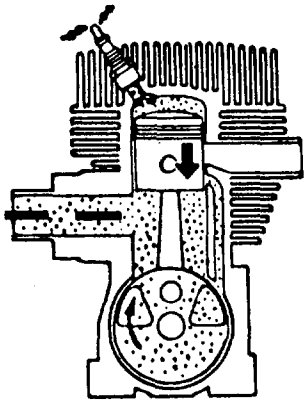
(2) As the piston moves upward in the cylinder it draws the fuel/air mixture into the crankcase through the intake manifold while at the same time compressing fuel that has been forced into the combustion chamber.



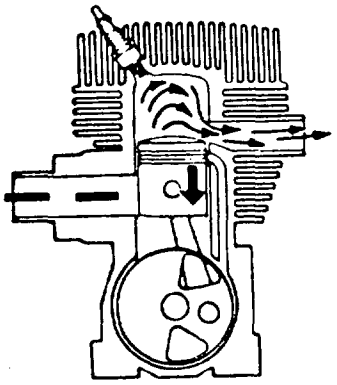
A - INTAKE

(3) As the piston nears top dead center the spark plug is fired and the compressed fuel/air mixture burns and expands, thereby forcing the piston downward on a power stroke.

(4) As the downward stroke of the piston turns the crankshaft, it also starts to compress the fuel/air mixture in the crankcase and simultaneously, opens the exhaust port and closes the intake port.

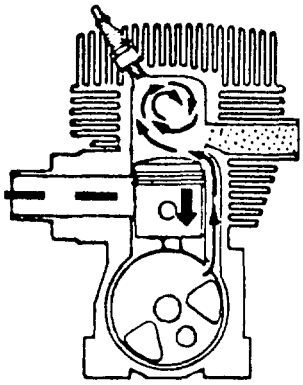


B - POWER STROKE



C - EXHAUST

(5) After the exhaust port is fully opened and the intake port is fully closed, further piston travel starts to open the transfer ports. The compressed fuel/air mixture from the crankcase then travels up the transfer ports and into the combustion area.



D - TRANSFER

(6) After most of the burned exhaust gases have left the cylinder, an incoming charge of fuel/air mixture scavenges the combustion area giving it a fresh charge and the cycle is then repeated.

(7) Because lubrication is dependent on the mixing of oil and fuel, it is extremely important that good quality oil and gasoline are properly mixed. The proper ration of oil to gasoline will prevent possible engine overheating, piston or cylinder scoring, or eventual engine seizure. Too much oil and not enough gasoline can lead to incomplete combustion, fouled plugs, carbon buildup, and muffler clogging.

b. Ignition System.

(1) The capacitor discharge ignition (CDI) system consists of a flywheel with four magnets evenly spaced about the circumference and a stator. The stator serves as a mount for three coils. The exciter coil charges the capacitor in the CDI igniter; the pulser coil signals the CDI igniter to fire the spark plugs (both spark plugs fire simultaneously); and the lighting coil supplies current to the voltage regulator.

(2) As the flywheel rotates, an alternating current is induced in the coils mounted on the stator.

(3) The CDI igniter capacitor stores the charge generated by the exciter coil. The amount of charge the exciter coil gives the capacitor effects the intensity of the spark. Current generated by the pulser coil causes the capacitor in the CDI igniter to release its stored charge to the ignition coil. The ignition coil primary induces a high voltage in the secondary winding, and causes a spark to jump across the spark plug electrodes.

This sequence occurs twice every rotation of the flywheel. The pulser coil has no effect on the intensity of the spark. Its sole purpose is to signal the capacitor when to release its charge to the ignition coil.

c. Crankcase and Pistons.

(1) Combustible vapor from the carburetor is inducted into the crankcase. As one piston reaches the bottom of its power stroke, the vapor is compressed and forced through the inlet ports into the cylinders. This action drives out the burned gases which were previously ignited during the last power stroke, and leaves the cylinder charged with a new supply of combustible vapor. The burned gases are driven through the exhaust ports into the exhaust system where they are cooled by a spray of water.

(2) As the piston starts its upward stroke, the inlet and exhaust ports are closed, and the vapor trapped within the cylinder is compressed in preparation for the next power stroke. Engine cooling is accomplished by a fan which is coupled to a pulley that is driven by a sheave on the crankshaft.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. General Maintenance
b. Overhaul
c. Reconditioning
d. Reassembly
e. Ignition Timing

INITIAL SETUP

Test Equipment
Dial indicator
Feeler gages
Micrometer

Special Tools
Flywheel puller
Metric wrenches
Piston pin puller
Ring compressor
Torque wrench

Material/Parts
Carbon removing compound MIL-C-19853
Crankcase sealer 3M EC847 or equivalent
Grease multipurpose DOD-G-24508
Oil, BIA-TC-W
Oil, SAE 10 weight

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNINGS in procedure.

GENERAL MAINTENANCE

CAUTION

Certain parts of engine have been modified by pump manufacturer. To ensure replacement parts order them from pump manufacturer.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

GENERAL MAINTENANCE (Cont)

a. Carbon Removal.

(1) If excessive carbon is noted on the spark plug, check the condition of the combustion chamber and top of the piston as these, too, may be carbon fouled.

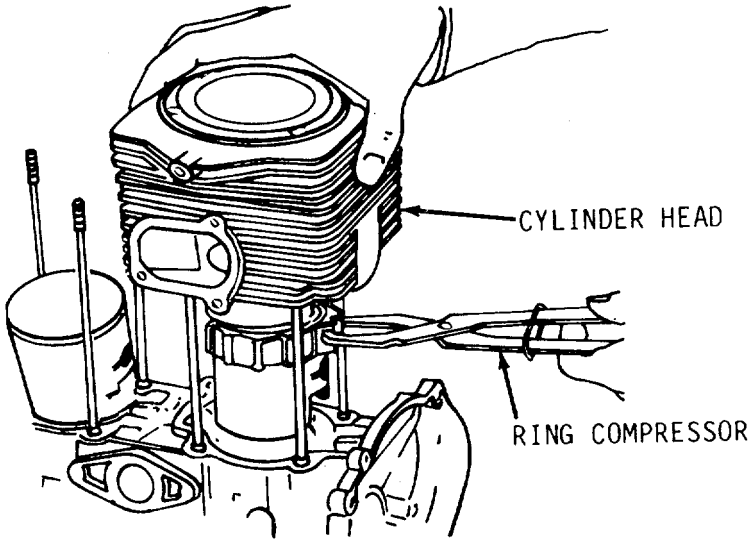
(2) Remove the cylinder heads and remove the carbon deposits with a wood or plastic scraper to avoid cutting or scratching the aluminum heads and pistons.

(3) If carbon build-up is heavy on top of the piston, the rings are often stuck or about ready to stick in the grooves.

(4) Use carbon removing compound, MIL-C-19853, (NSN 6850-00-702-8451) to clean carbon build-up on rings and other engine components.

(5) Clean off the carbon removing compound before reinstalling cylinder heads.

(6) Apply lubricant to cylinder wall, then use the ring compressor (for 2-cylinder engines) and install the cylinder heads over piston.



(7) Tighten nuts and cylinder heads to 16 lbft (21.7 Nm) torque. Always use a new cylinder head gasket.

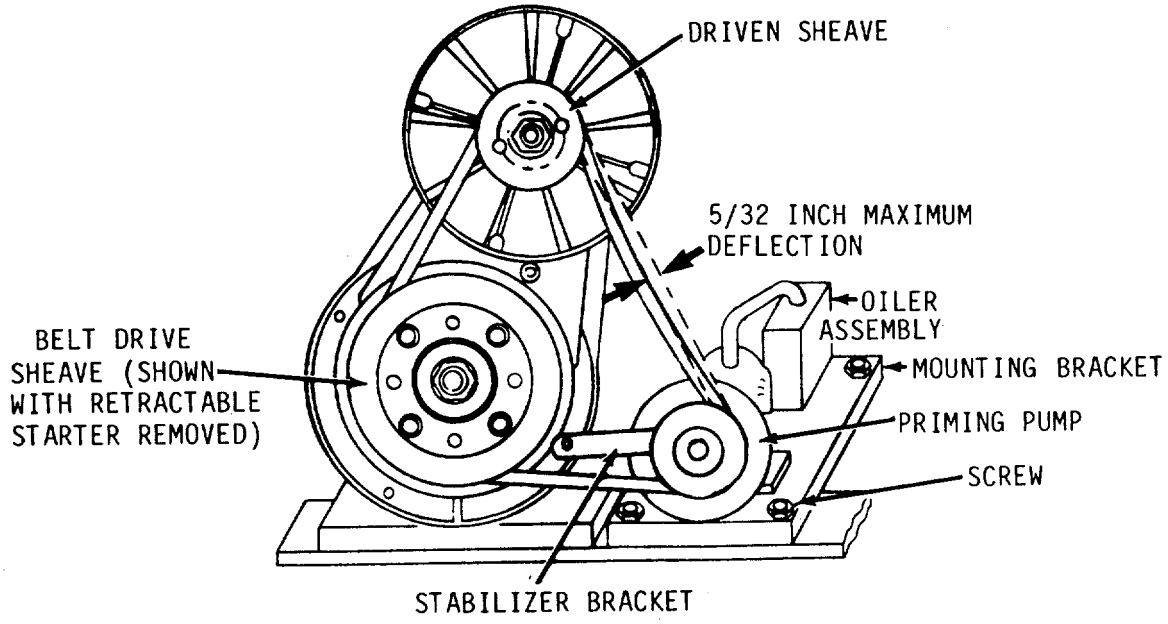
b. Cooling System.

Engines are cooled by a belt driven blower. Never operate your engine with missing or loose air shroud covers. Keep air intake openings on pump and engine clean and unobstructed at all times to prevent overheating. Proper belt tension must be maintained for proper cooling. Fan belt deflection is 5/32 inch. Adjust by tightening the four screws on the priming pump mounting bracket and the two screws on the priming pump stabilizer bracket

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

GENERAL MAINTENANCE (Cont)

Do not operate axial flow engines with broken or badly frayed belts.



ENGINE OVERHAUL

WARNING

Before starting to disassemble an engine, make sure that the work area is clean and well lighted. Observe all rules of safety when working on an engine - for instance, wear safety glasses and do not smoke or use and open flame around the cleaning solvents or other flammable materials found in many shops.

a. General.

Start looking for causes of engine problems before you remove it from the pump. If cracked or broken parts are evident, check for loose engine mounts. Some other types of damage and probable causes follow.

ENGINE OVERHAUL (Cont)

b. Piston Burn-thru.

If a hole is burned right through the piston, look for an improperly adjusted carburetor or incorrect timing. If these items check out OK, check use of wrong oil or improperly mixed fuel. The wrong type of spark plug for conditions involved may also be the cause of abnormally high combustion temperatures which cause burn-thru. Use Champion RN-3 spark plugs.

c. Foreign Material.

CAUTION

When inspecting spark plugs, clean out around spark plug openings before removing plugs. Otherwise, damage can result from foreign objects dropping into the engine. If the damage is on the piston crown, something probably fell into the opening when the plug was removed. Damage on the sides of piston may indicate that an object was drawn into the intake.

d Loose Needle, Retainers, Pins.

Piston and cylinder damage caused by loose needle bearings, pin retainers, or piston pins is usually quite easy to diagnose. A needle bearing is hard enough to cut right through piston rings without leaving jagged edges - a loose retainer will not cut but will break the ring. If retainer falls out or is not installed in the first place, the pin may rub a regular groove in the cylinder wall. Often damage such as this goes by unnoticed until power becomes extremely poor due to lack of compression.

e. Ring Breakage.

If a ring breaks, the engine may continue running; however, it will probably back-fire badly and it cannot be restarted after it is shut down. Ring breakage occurs from overheating due to lack of proper lubrication. A poor quality or wrong type of oil may have been used or the oil may have been poorly mixed or mixed in incorrect proportion with the gasoline. A ring that has been subjected to overheating often becomes soft and is easily bent.

f. Rings Sticking.

If there has been repeated occurrence of spark plug fouling, the rings might be stuck in the grooves due to carbon fouling. This usually occurs from an "over-rich" fuel mixture. If the build-up is varnish rather than carbon, this probably indicates use of an unauthorized lubricating oil.

ENGINE OVERHAUL (Cont)

g. Broken, Damaged Rods.

Pounding on the end of the crankshaft to remove the flywheel can play havoc with connecting rods and rod bearings. the practice can push the counterweights together squeezing the rod small end bearing, indicated by the metal lapped over edges. This, of course, freezes the needle bearing and snaps the connecting rod. Always use a puller to remove the flywheel and also to get the impeller off the taper of the crankshaft.

ENGINE RECONDITIONING

a. Crankshaft - Connecting Rod.

NOTE

If a visual check fails to uncover any damage, install crankshaft-rod assembly in vise - use protective caps on jaws. Make following tests to determine if the crankshaft-rod assembly and be reused. Do not attempt to disassemble crankshaft for reconditioning - special tools and equipment are required for this. If center main or rod bearings or crankshaft are damaged, or connecting rods have any noticeable radial play replace assembly as a unit. Do not reinstall outer main bearing until after end play is established.

(1) Outer Main Bearing.

First check crankshaft outer main bearings for evidence of binding or roughness. Turn bearings by hand - if bearings are in good condition, rotation will be smooth. The outer main bearing may be removed and replaced if necessary. To install new bearings, heat inside bearing race with a heat gun or set bearing on light bulb, then press them onto the crankshaft.

(2) Inner Main Bearing and Labyrinth Seal.

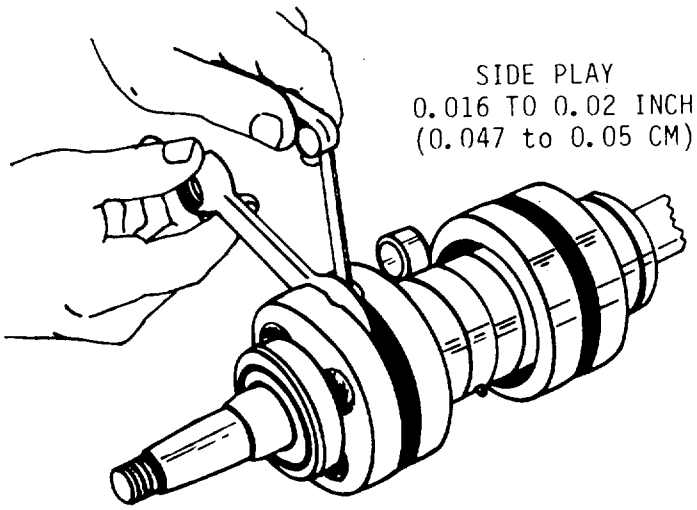
These bearings cannot be removed - if these are damaged, replace crankshaft assembly.

(3) Rod Side Play.

Check lateral movement of connecting rod as shown below. If side play stays within the 0.016 to 0.020 inch (0.047 to 0.051 cm) range, end play is within allowable limits.

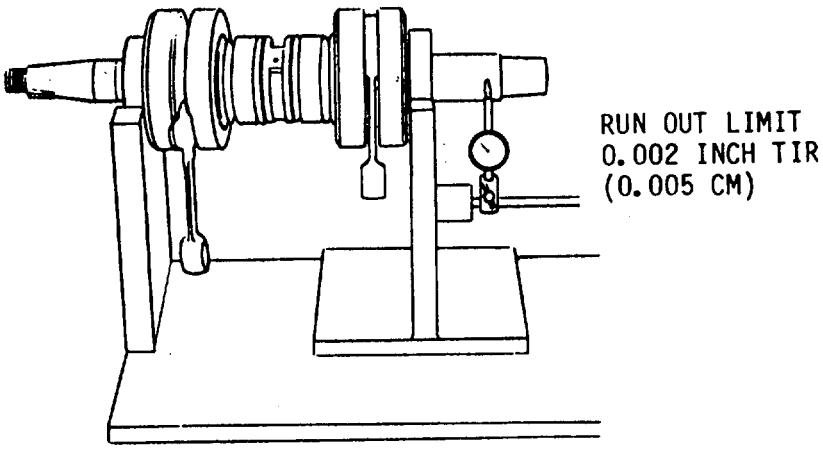
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE RECONDITIONING (Cont)



(4) Shaft Alignment.

Install crankshaft in V blocks with outer mains resting in blocks and check concentricity with dial indicator riding on shaft as shown below. If run-out exceeds 0.002 inch (0.005 cm) TIR, remove shaft and try to bring back into alignment by either pinching weights closer together in a vise or by spreading them further apart with a metal wedge. Repeat alignment check after repositioning weights. If this fails to bring shafts back into alignment, a new assembly must be used.



ENGINE RECONDITIONING (Cont)

WARNING

Observe no smoking regulations, Avoid prolonged contact with, or inhalation of cleaning solvent. Avoid use near heat or open flame and provide adequate ventilation.

(5) Cleaning.

After checking shaft, thoroughly clean assembly with general purpose cleaner. DO NOT use kerosene as this leaves an oily film. Alcohol or lacquer thinner also must not be used as these, on the other hand, leave parts too dry and may cause seizure during initial start up after reconditioning.

b. Crankcase.

Carefully inspect upper and lower halves of crankcase assembly. Check mating surfaces. Replacement of the crankcase assembly may be required if surfaces are badly nicked or grooved. Make sure that all screws, threads, studs, etc., are clean and undamaged. Remove varnish, gum, etc., deposits from internal and external surfaces by using carbon removing compound, MIL-C-19853, NSN 6850-00-702-8451.

c. Cylinder head.

Make certain that cooling fins are unbroken and that threads for spark plug are clean and undamaged. Also check gasket surface of head. Replace head if internal surface is scratched, nicked or distorted.
Clean out any carbon deposits from inside the combustion dome by using carbon removing compound MIL-C-19853, (NSN 6850-00-702-8451) if badly varnished or if carbon deposits cannot be removed, use a new cylinder head.

d. Cylinders

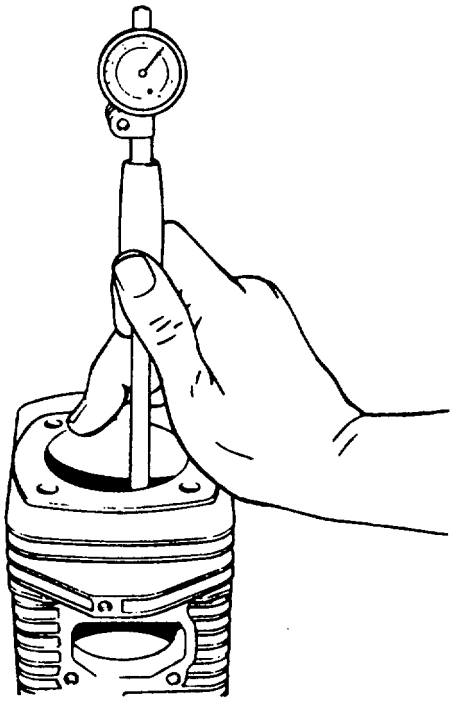
NOTE

Carefully observe cylinder bore for signs of scuffing, check gasket surfaces for nicks or grooves which could prevent proper sealing, check for badly chipped or broken fins. Also make sure threads are not stripped. Use a new cylinder head if damage is noted.

ENGINE RECONDITIONING (Cont)

NOTE (Continued)

If none is evident, measure cylinder bore for wear. Use inside micrometer or bore gage and check area just below top of bore. Wear will be indicated by a "step" worn into wall. Move the micrometer in a circular direction, 90 degrees at a time. If worn more than 0.002 inch (0.005 cm) cylinder will have to be replaced.



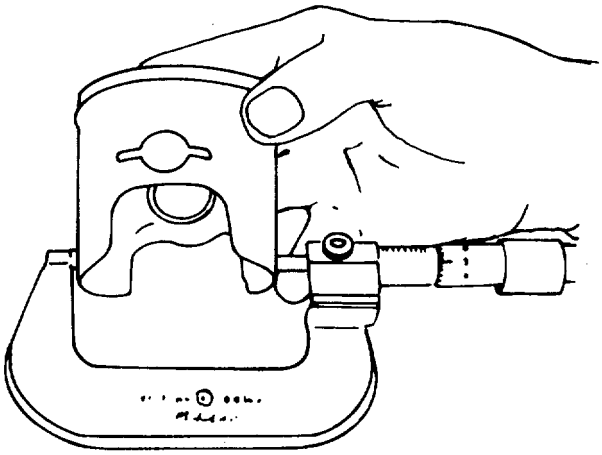
BORE WEAR LIMIT
0.002 INCH
(0.005 CM)

STANDARD (NEW)	SERVICE LIMIT (USED)
2.6774 to 2.6781 INCH (6.8006 to 6.8024 CM)	2.681 INCH (6.810 CM)

ENGINE RECONDITIONING (Cont)

e. Piston - Piston Rings.

(1) To check wear, measure piston at the top level of the piston skirt (just below bottom ring) and at right angle to the piston pin. If wear exceeds between 0.002 to 0.004 inch (0.005 to 0.010 cm), the piston must be replaced. Also replace if there is any evidence of pitting on top of the piston.



WEAR LIMIT
0.002 to 0.004 INCH
(0.005 to 0.010 CM)

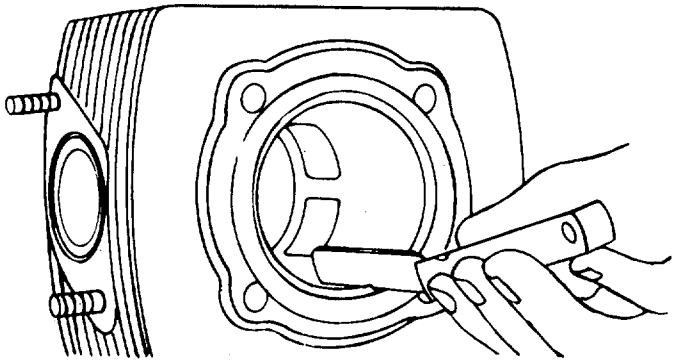
STANDARD (NEW)	SERVICE LIMIT (USED)
2.6744 to 2.6752 INCH (6.7930 to 6.7950 CM)	2.670 INCH (6.782 CM)

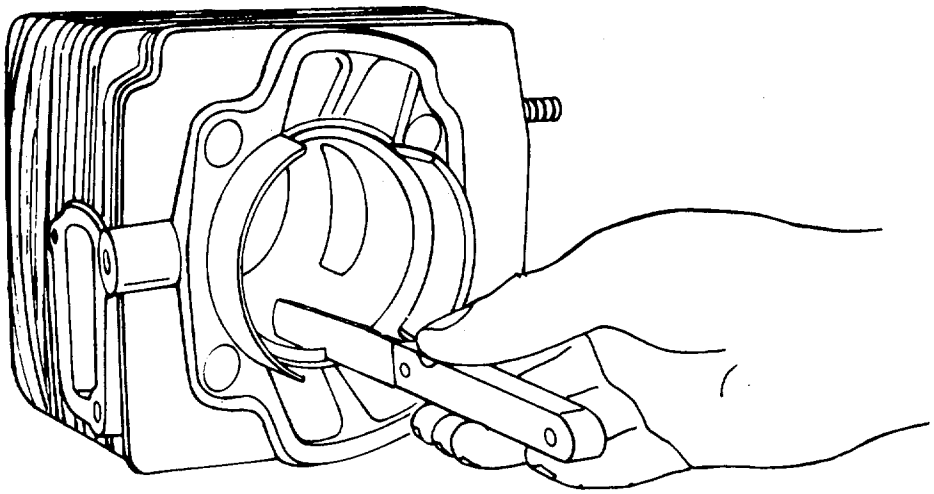
(2) If piston is undamaged and can be reused, remove used rings and fit new rings; never reuse rings. After removing oil rings, break one of the oil rings in half and use this to clean carbon deposits from the ring grooves - be careful not to scratch or enlarge grooves when doing this. Carbon removing compound, MIL-C-19853, (NSN 6850-00-702-8451) may also be used.

(3) Before installing new rings, insert each ring into the bottom of the cylinder bore, square with piston then check ring end gap with feeler gage.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE RECONDITIONING (Cont)





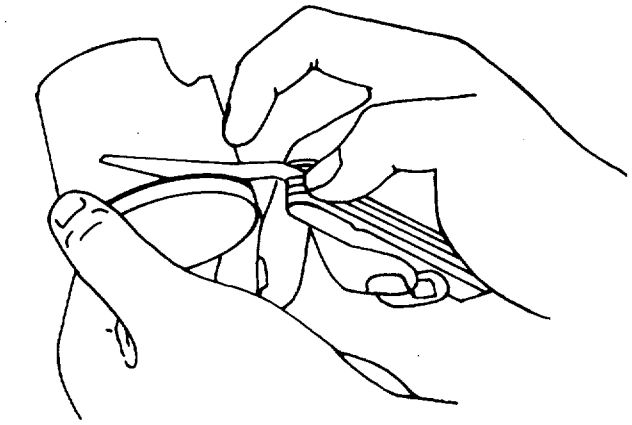
PISTON RING CLEARANCE

STANDARD (NEW)	SERVICE LIMIT (USED)
0.008 to 0.016 INCH (0.020 to 0.041 CM)	0.028 INCH (0.071 CM)

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE RECONDITIONING (Cont)

(4) Ring side clearance must also be checked before installation. To do this, place in its proper groove and check side clearance with feeler gage as shown in the accompanying illustration. Side clearance must not be more than that specified below. If more than this, groove is worn beyond limits and piston must be replaced.



PISTON RING SIDE GAP

TOP RING

STANDARD (NEW)	SERVICE LIMIT (USED)
0.0020 to 0.0047 INCH (0.0051 to 0.0119 CM)	0.009 INCH (0.023 CM)

BOTTOM RING

STANDARD (NEW)	SERVICE LIMIT (USED)
0.0020 to 0.0035 INCH (0.0051 to 0.0089 CM)	0.008 INCH (0.020 CM)

(5) The Axial Flow engines use "L" shaped ring in the top groove. Use ring expander to install ring. On all models, turn rings so that the ring gap is over the small locating pins in the piston grooves.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY

NOTE

The following is sequence for reassembly of a typical two cylinder engine. The procedure does not, in most cases, cover reassembly of the various sub-assemblies. This has been covered elsewhere in this paragraph. Make sure work area and all parts are kept clean during final assembly of the engine.

a. Crankshaft End Play Adjustment.

If bearings are replaced you must measure crankshaft and shim as required to assure correct end play exists when crankshaft is installed in crankcase. Proper end play is to be established by the following procedure:

(1) With a suitable micrometer, measure distance B. (The distance across the outer surfaces of each pair of crankshaft fly-weights as shown below.)

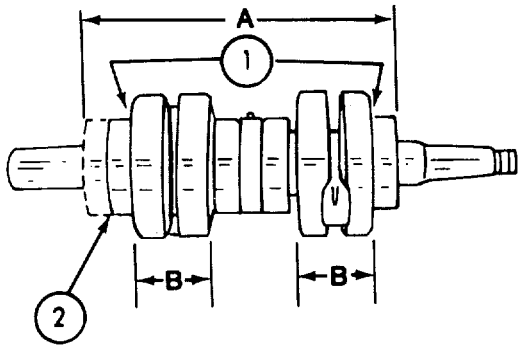
(2) Refer to Shim Chart (distance B) for the appropriate shim to be placed between the bearings and outer flyweights.

(3) After installing the first two bearings, and shims B, distance A is to be computed by measuring the total distance between the outer-most race surfaces of the two bearings already installed, and adding to that measurement, the thickness dimension of the bearing yet to be installed. The arrived-at sum of these dimensions will constitute distance A.

(4) Refer to Shim Chart (distance A) and select the appropriate shim(s) required between the two left hand main bearings.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)



1. Shim B Location
2. Shim A Location

CRANKSHAFT END PLAY

Shim(s) Required for Distance A

Distance A	Required Shim Reference Number(s)
8.0158 to 8.0256 inch (203.61 to 203.84 mm)	None
8.0119 to 8.0157 inch (203.51 to 203.60 mm)	1
8.0080 to 8.0118 inch (203.41 to 203.50 mm)	2
8.0040 to 8.0079 inch (203.31 to 203.40 mm)	3
8.0001 to 8.0039 inch (203.20 to 203.30 mm)	4
7. 9962 to 8.0000 inch (203.11 to 203.20 mm)	5
7.9922 to 7.9961 inch (203.01 to 203.10 mm)	6
7.9898 to 7.9921 inch (202.93 to 203.00 mm)	6+1, or 5+2, or 4+4

Shim(s) Required for Distance B

Distance B	Required Shim Reference Number(s)
1.9551 to 1.9634 inch (49.66 to 49.87 mm)	None
1.9469 to 1.9547 inch (49.45 to 49.65 mm)	2
1.9378 to 1.9465 inch (49.22 to 49.44 mm)	4

Shim Description Chart

Shim Reference Number	Part Number	Thickness
1	92025-513	0.0039 in. (0.1 mm)
2	92025-518	0.0078 in. (0.2 mm)
3	92025-523	0.0118in. (0.3 mm)
4	92025-527	0.0157 in. (0.4 mm)
5	92025-530	0.0197 in. (0.5 mm)
6	92025-533	0.0236 in. (0.6 mm)

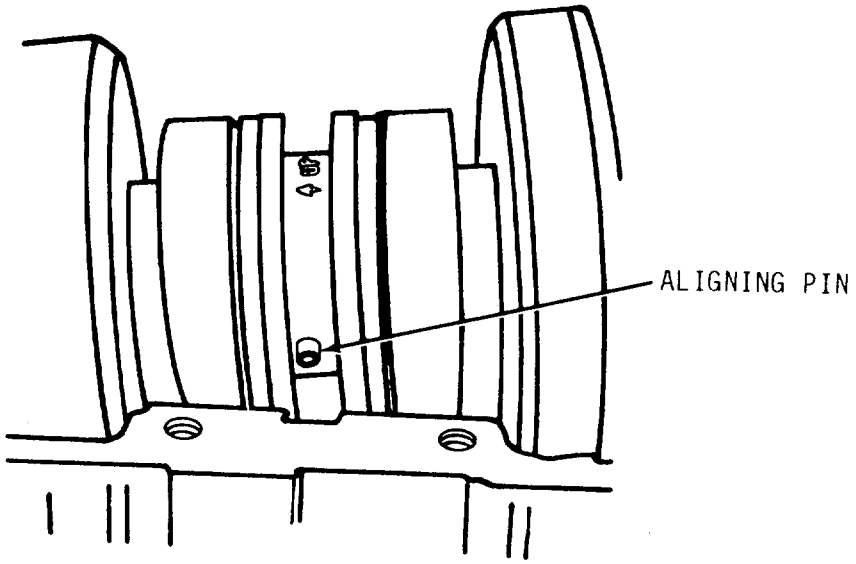
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

b. Crankcase, Crankshaft.

(1) Lubricate all bearings with SAE 10 weight oil.

(2) Align crankshaft labyrinth seal aligning pin with recess in upper crankcase half and carefully insert crankshaft into crankcase.



CAUTION

When replacing bearings, crankshaft surface that oil seal contacts may be scratched which will cause excessive seal wear. Always remove any irregularities on the shaft surface using No. 400 emery cloth before installing new oil seals.

(3) Install washers in crankcase grooves. Apply a thin coat of multipurpose, DOD-G-24508, grease to inner section of oil seals and install oil seals to crankshaft.

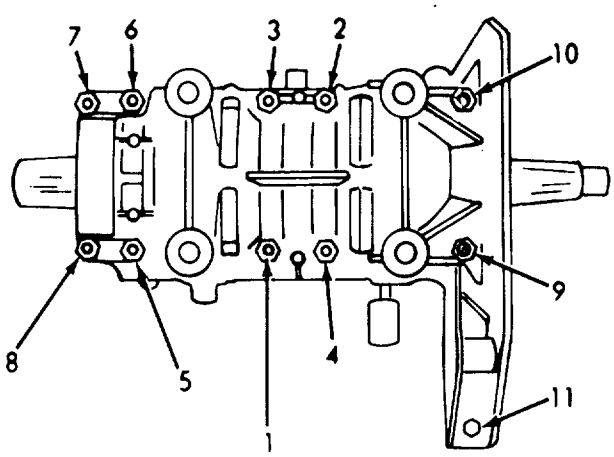
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

WARNING

The solvents in these sealers are toxic and highly flammable while drying. Ensure adequate ventilation and the absence of all sources of ignition while using these sealers.

(4) Apply crankcase sealer 3M EC847 or equivalent to lower crankcase half and carefully attach crankcase halves.



SEQUENCE FOR SECURING CRANKCASE HALVES

NOTE

Apply torque in one third increments to prevent distortion of crankcase halves.

c. Piston - Ring Assembly.

(1) Apply light coat of BIA-TC-W oil (NSN 9150-00-117-8791) to piston pin needle bearings and insert needle bearing into upper connecting rod.

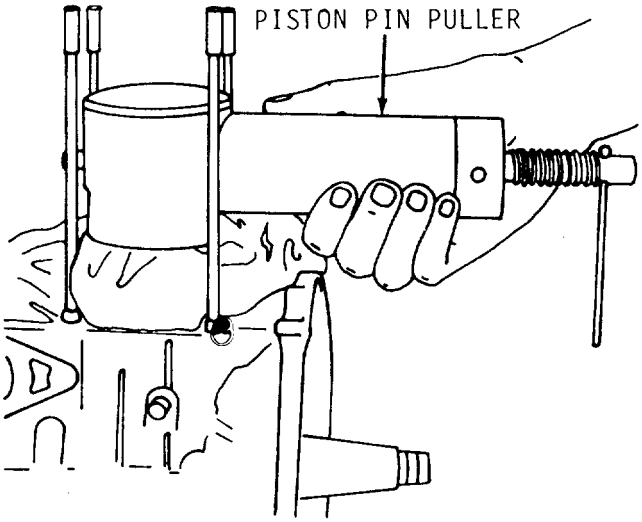
(2) Install piston to connecting rod with arrow pointing toward exhaust side. Insert piston pin and secure piston pin using new circlips, snap rings, or equivalent. Use the piston pin tool when installing pin.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

CAUTION

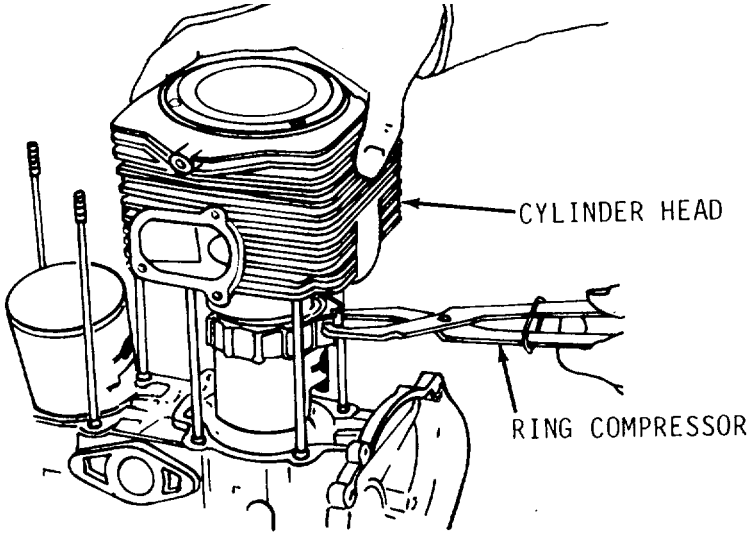
New circlips must be used to prevent serious engine damage.



d. Cylinders.

(1) Install new base gaskets on crankcase.

(2) Apply a light coat of BIA-TC-W oil (NSN 9150-00-117-8791) to bearing on each end of rod, inside of cylinders and outside of pistons. Align piston rings with locating pins on piston and using ring compressor tool, compress the rings and install cylinders over pistons.



4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

CAUTION

Make sure piston rings are in correct position to prevent breakage.

e. Cylinder Heads.

(1) Install new head gaskets to cylinders.

(2) Set cylinder heads in place on correct cylinders and loosely install the eight nuts, washers, and lockwashers. Do not tighten cylinder nut until intake manifold is installed. Torque to 16 foot-pounds (21.7 Nm).

NOTE

The long nuts are installed on the outside studs of the power takeoff side cylinder head.

f. Air Shrouds.

Install air shrouds and intake manifolds to engine. Torque to 5 to 6 foot-pounds (6.8 to 8.1 Nm). Tighten cylinder nuts to 16 foot-pounds (21.7 Nm).

g. Fan Housing.

Install fan housing to crankcase. Torque to 5 foot-pounds (6.8 Nm).

h. Stator Assembly.

Insert electrical leads through grommet in crankcase and reinstall stator assembly to crankcase. Align mark made during disassembly. Torque to 5.5 foot-pounds (7.2 Nm).

i. Flywheel.

Install fan drive pulley and starter cup to flywheel. Torque to 47 foot-pounds (63.1 Nm). Make sure fan drive pulley with machined shoulder is towards the flywheel. Install flywheel on crankshaft. Torque to 60 foot-pounds (81.3 Nm).

j. Fan Belt.

Install fan belt and check belt tension.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

k. Engine System, Accessories.

Reinstall carburetor, exhaust system, and starter to complete reassembly of engine. Use new gasket or parts whenever applicable. Tighten screws and nuts to torque value as specified.

Torque Table

	Foot-Pounds	Nm
ENGINE		
Mounting Bolts	30	40.7
Flywheel Nut	60	81.3
Cylinder Head Nuts	16	21.7
Spark Plugs	20	27.1
Crankcase Bolts	16	21.7
Carburetor Mounting Nuts	3.5	4.8
Intake Manifold Bolts	5 to 6	6.8 to 8.1
Exhaust Manifold Nuts	12	16.3
Fan Shaft Nut	47	63.7
Fan Case Mounting Screws	5	6.8
Starter Mounting Bolts	16 to 18	21.7 to 24.4
Fan Case to Crankcase Mounting Bolts	10 to 12	13.6 to 16.3
Duct to Engine Screws	3	4.1
Stator Assembly Mounting Screws	5 to 6	6.8 to 8.1
Recoil Starter Drive Plate Nut	8 to 10	10.8 to 13.6
Recoil Starter Pulley Mounting Bolts	5	6.8
Recoil Starter Mounting Bolts	5	6.8
Carburetor Ram Tube Screws	8	10.8
Exhaust Assembly	12	13.6
PRIMING PUMP		
Priming Pump Mounting (Belt Tension Assembly)	7	9.5
Priming Pump Assembly Capscrews	7	9.5
PUMP		
Cover Nuts	14	19.0
Impeller Screw	70	94.9
Pump Mounting Bolts	24	32.5

4-7. 10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

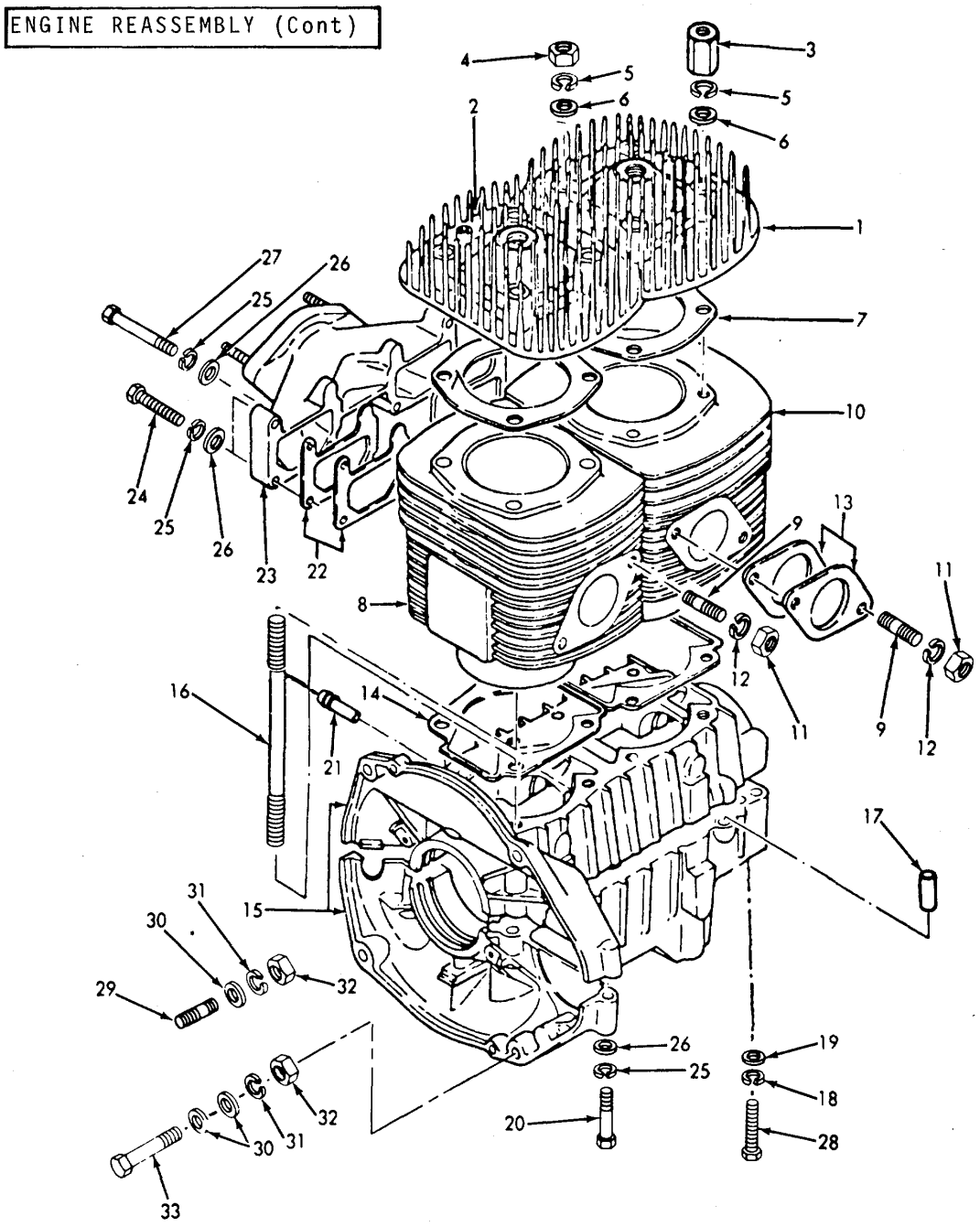
1. Run-in Procedure.

After engine has been completely reassembled, bench test engine if facilities are available and make necessary adjustments. If engine cannot be bench tested, reinstall engine in pump and make final adjustments under actual load conditions. Run-in recommendations for a reconditioned engine are the same as for a new engine.

Item Number	Description	Quantity
*	ENGINE	1
1	HEAD, Cylinder, No. 1'	1
2	HEAD, Cylinder, No. 2	1
3	NUT, 8 mm long	2
4	NUT, 8 mm	6
5	WASHER, Spring, 8 mm	8
6	WASHER, Plain, 8 mm	8
7	GASKET, Head	2
8	CYLINDER, NO. 2	1
9	STUD, 8 x 20	4
10	CYLINDER, No. 1	1
11	NUT, 8 mm	4
12	WASHER, Spring, 8 mm	4
13	GASKET, Exhaust	4
14	GASKET, Cylinder Base	2
15*	CRANKCASE SET	1
16	STUD	8
17	PIN, Dowel, 8 x 16	2
18	WASHER, Spring, 8 mm	10
19	WASHER, Plain, 8 mm	10
20	BOLT, Hex head, 6 x 40	1
21	PIPE, Pulse	1
22	GASKET, Intake	4
23*	MANIFOLD, Intake	1
24	BOLT, Hex head, 6 x 35	4
25	WASHER, Spring, 6 mm	7
26	WASHER, Plain	7
27	BOLT, Hex head, 6 x 55	2
28	BOLT, Hex head, 8 x 63	10
29	STUD, 8 x 20	1
30	WASHER, Plain 8 mm	3
31	WASHER, Spring, 8 mm	2
32	NUT, 8 mm	2
33	BOLT, Hex head, 8 x 68	1

* Items are modified and must be ordered from the pump contractor.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).



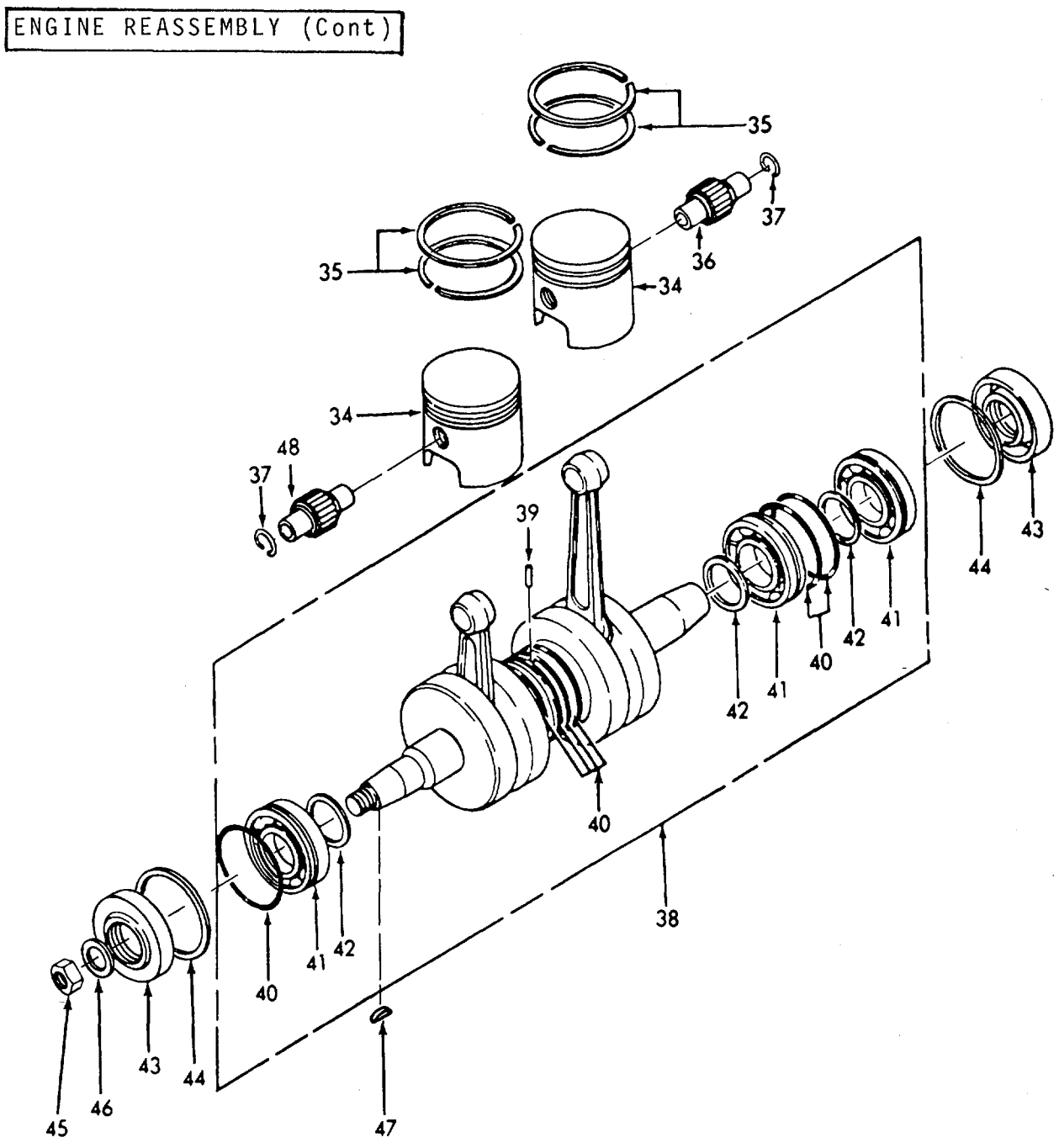
CRANKCASE AND CYLINDER ASSEMBLY (SHEET 1 OF 5)

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

Item Number	Description	Quantity
34	PISTON	2
35	PISTON RING SET	2
36	PIN, Piston	2
37	CIRCLIP	4
38	CRANKSHAFT ASSEMBLY	1
39	PIN, Dowel, 4 x 10	1
40	O-RING	7
41	BEARING, Ball 6206NC3	3
42	SHIM, 0.1 t	AR
42	SHIM, 0.2 t	AR
42	SHIM, 0.3 t	AR
42	SHIM, 0.4 t	AR
42	SHIM, 0.5 t	AR
42	SHIM, 0.6 t	AR
43	SEAL, OIL, TCYO6210	2
44	WASHER	2
45	NUT, 18 mm	1
46	WASHER	1
47	KEY, Woodruff	1
48	BEARING, Small end	2

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).



CRANKCASE AND CYLINDER ASSEMBLY (Sheet 2 of 5)

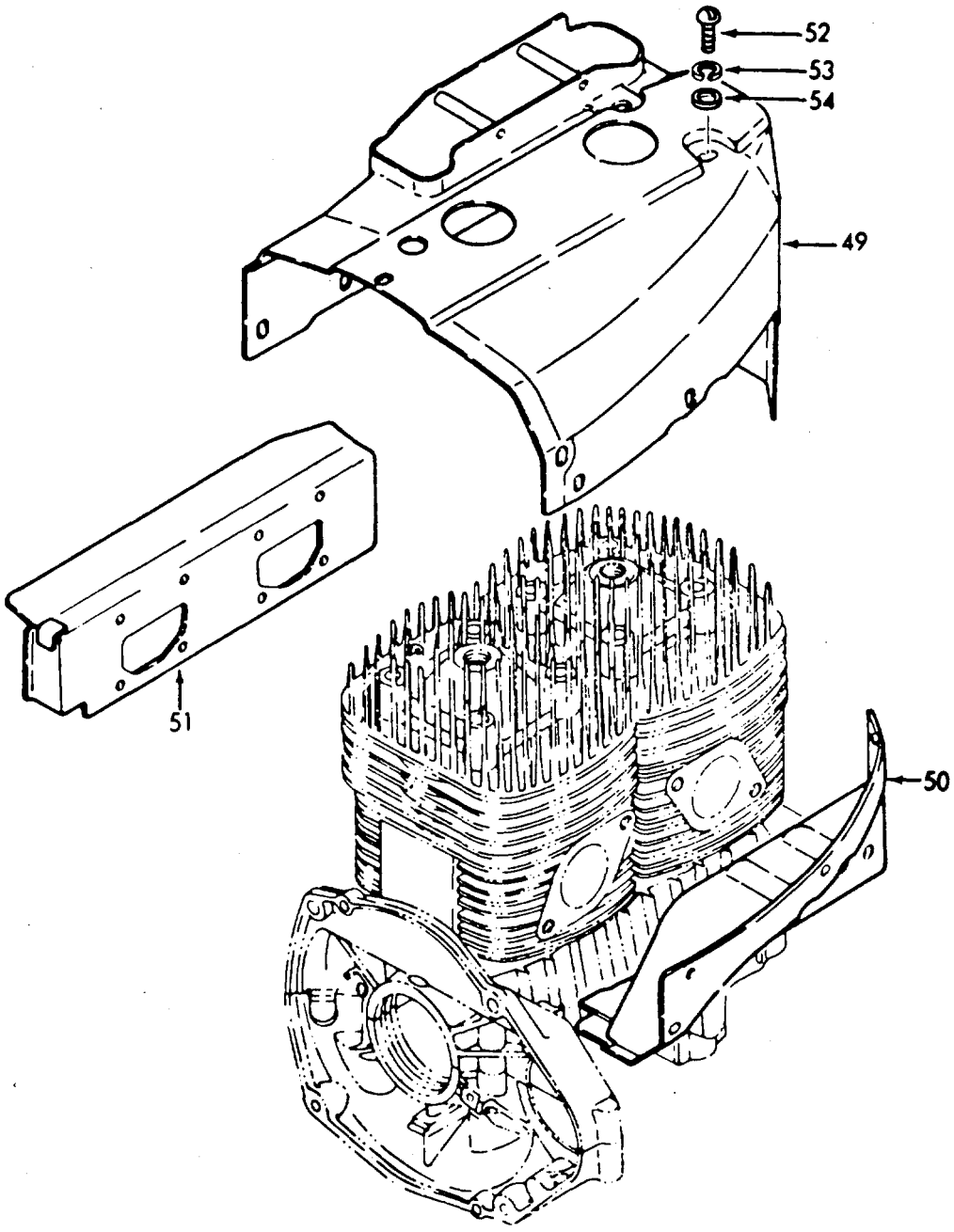
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

Item Number	Description	Quantity
49	SHROUD, Engine, main	1
50	SHROUD, Engine, exhaust.....	1
51	SHROUD, Engine, intake	1
52	SCREW, Pan head, 8 x 12	2
53	WASHER, Spring, 8 mm	2
54	WASHER, Plain, 8 mm	2
55	DELETED	

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)



CRANKCASE AND CYLINDER ASSEMBLY (Sheet 3 of 5)

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

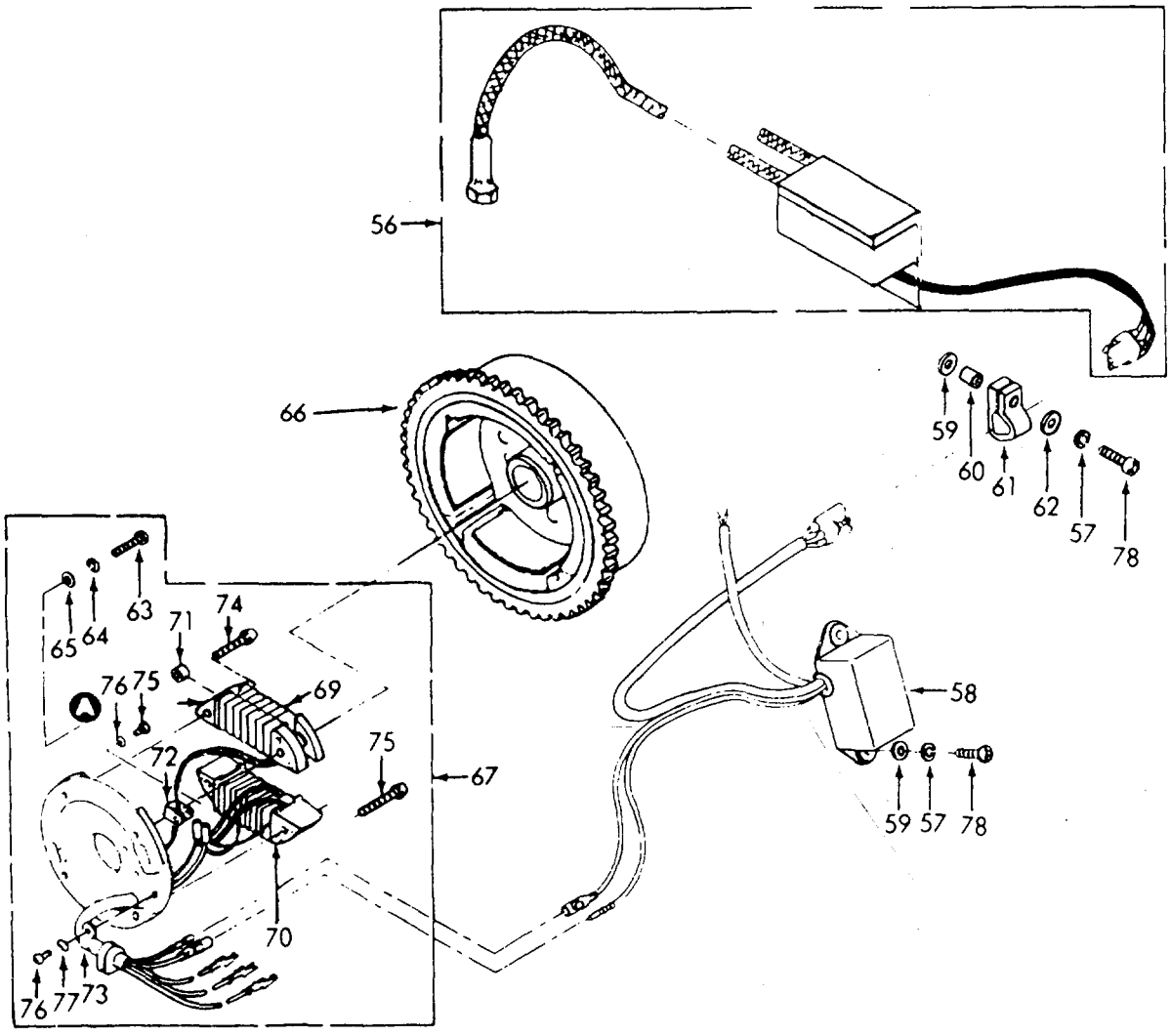
ENGINE REASSEMBLY (Cont)

Item Number	Description	Quantity
56*	ENCLOSURE, Coil	1
57	WASHER, Spring, 6 mm	3
58	IGNITER	1
59	WASHER, Plain, 6 mm	3
60	COLLAR, 6.5 x 8.5 x 14	1
61	CLAMP, Igniter	1
62	WASHER, Plain, 6 mm	1
63	SCREW, Pan Head, 5 x 20	2
64	WASHER, Spring, 5 mm	2
65	WASHER, Plain, 5 mm	2
66	FLYWHEEL (with ring gear)	1
67	STATOR ASSEMBLY	1
68	COIL, Exciter	1
69	COIL, Pulser	1
70	COIL, Lighting	1
71	COLLAR, Coil	2
72	CLAMP	1
73	CLAMP	1
74	Screw, Pan Head, 5 x 38	2
75	Screw, Pan Head, 5 x 34	2
76	Screw, Pan Head, 4 x 8	2
77	WASHER, Spring, 4 mm	2
78	Screw, Pan Head, 6 x 25	3

* Items available only from pump contractor.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)



CRANKCASE AND CYLINDER ASSEMBLY (Sheet 4 of 5)

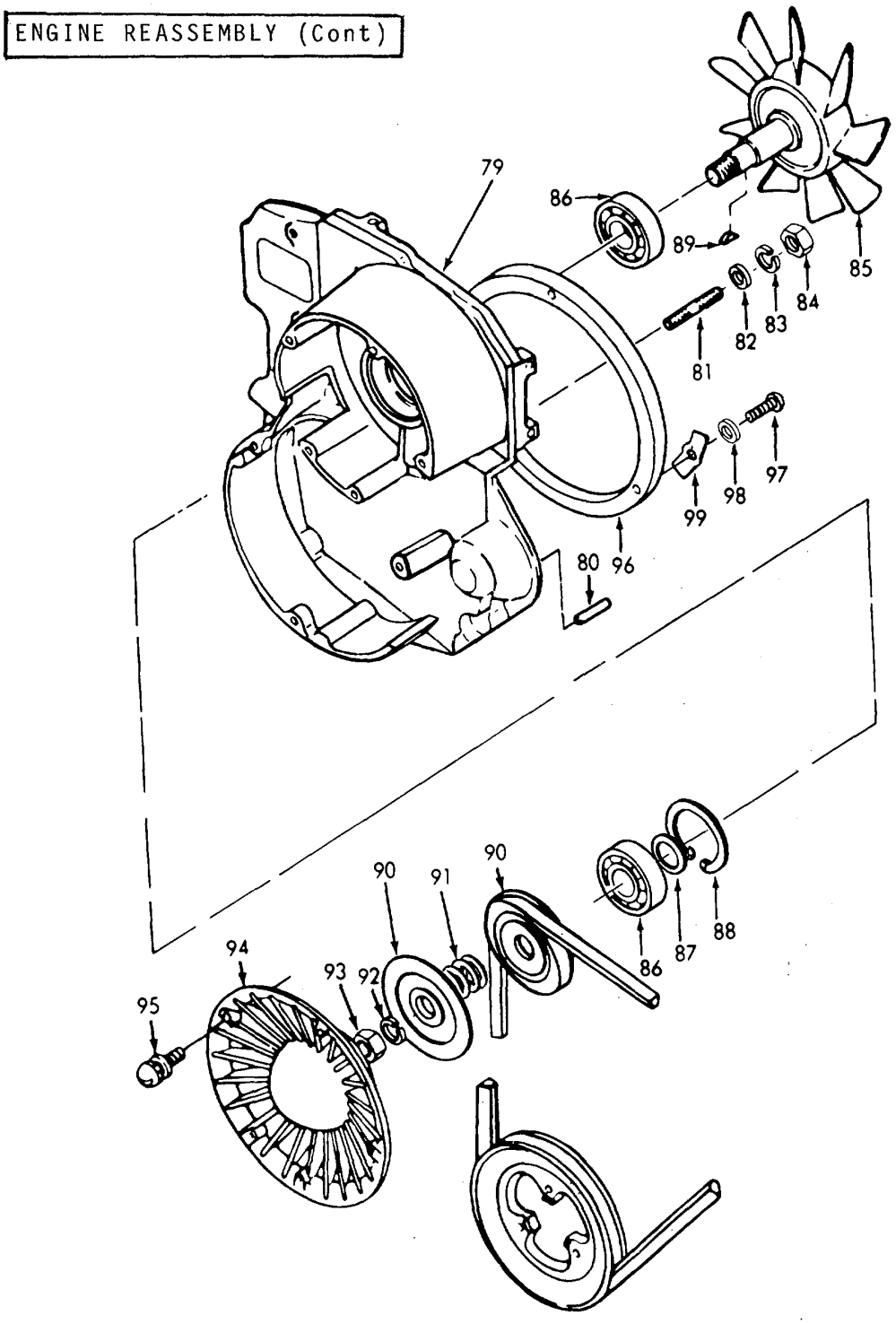
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

ENGINE REASSEMBLY (Cont)

Item Number	Description	Quantity
79*	HOUSING, Fan	1
80	PIN, Dowel, 6 x 12	2
81	STUD, 8 x 20	4
82	WASHER, Plain, 8 mm	4
83	WASHER, Spring, 8 mm	4
84	NUT, 8 mm	4
85	COOLING FAN ASSEMBLY'	1
86	BEARING, Ball, 6204C3ZZ	2
87	SHIM, 1.0 t	2
88	CIRCLIP, 47 mm	1
89	KEY, Woodruff	1
90	-PULLEY, Fan	2
91	SHIM, Pulley, 0.6 t	AR
92	WASHER, Spring, 14 mm	1
93	NUT, 14 mm	1
94	COVER, Fan	1
95	SCREW, Pan head 4 x 20	5
96	PLATE, Seal	1
97	SCREW, Pan head, 4 x 10	3
98	WASHER, Spring, 4 mm	3
99	WASHER, Lock	3
100	PULLEY, Fan drive	2

* Items are modified and must be ordered from pump contractor.

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).



CRANKCASE AND CYLINDER ASSEMBLY (Sheet 5 of 5)

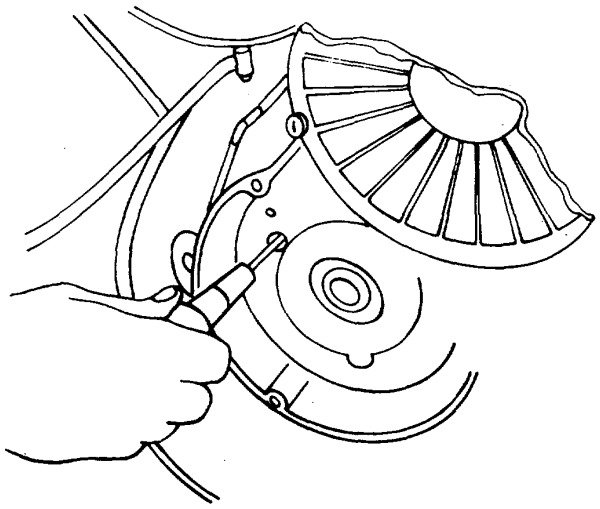
4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
IGNITION TIMING			
	a. S(ark plug wires	Remove from spark plugs.	
	b. Screws (2)	Remove.	
	c. Retractable starter (3)	Remove.	
	d. Screws (4), and lockwashers (5)	Remove.	
	e. Starter pulley (6)	Remove.	
	f. Fan pulley (7), and belt (8)	Move.	

CAUTION

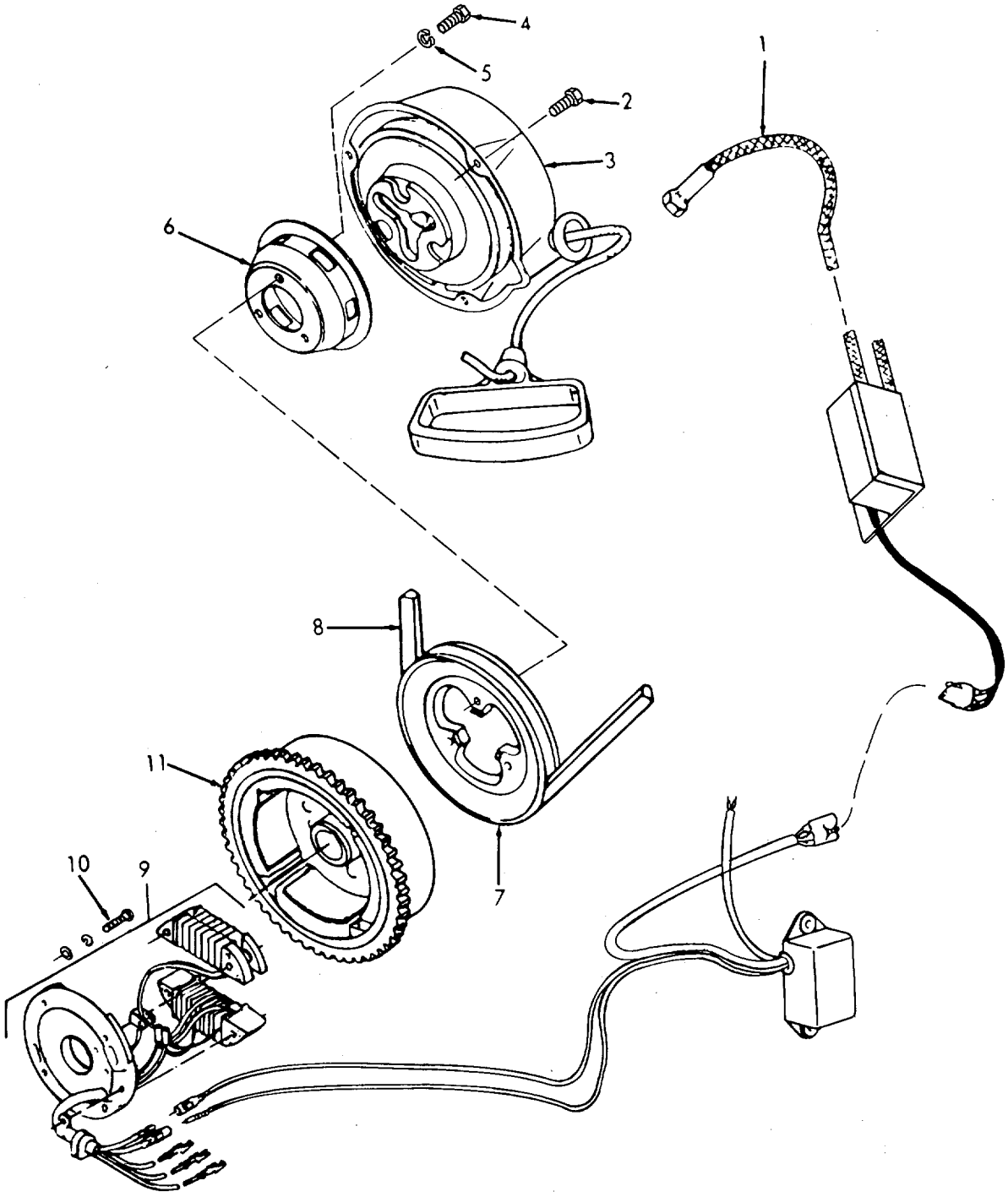
When adjusting the stator assembly, take care not to damage the coil windings.

	g. Stator assembly (g)	1. Loosen the strator assembly mounting screws (10) through the holes in the flywheel (11) To correct timing rotate the strator assembly as required (clockwise to retard the timing counter clock wise to advance the timing). 2. Tighten the Strator assembly mounting screws (10).	



4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
IGNITION TIMING (Cont)			

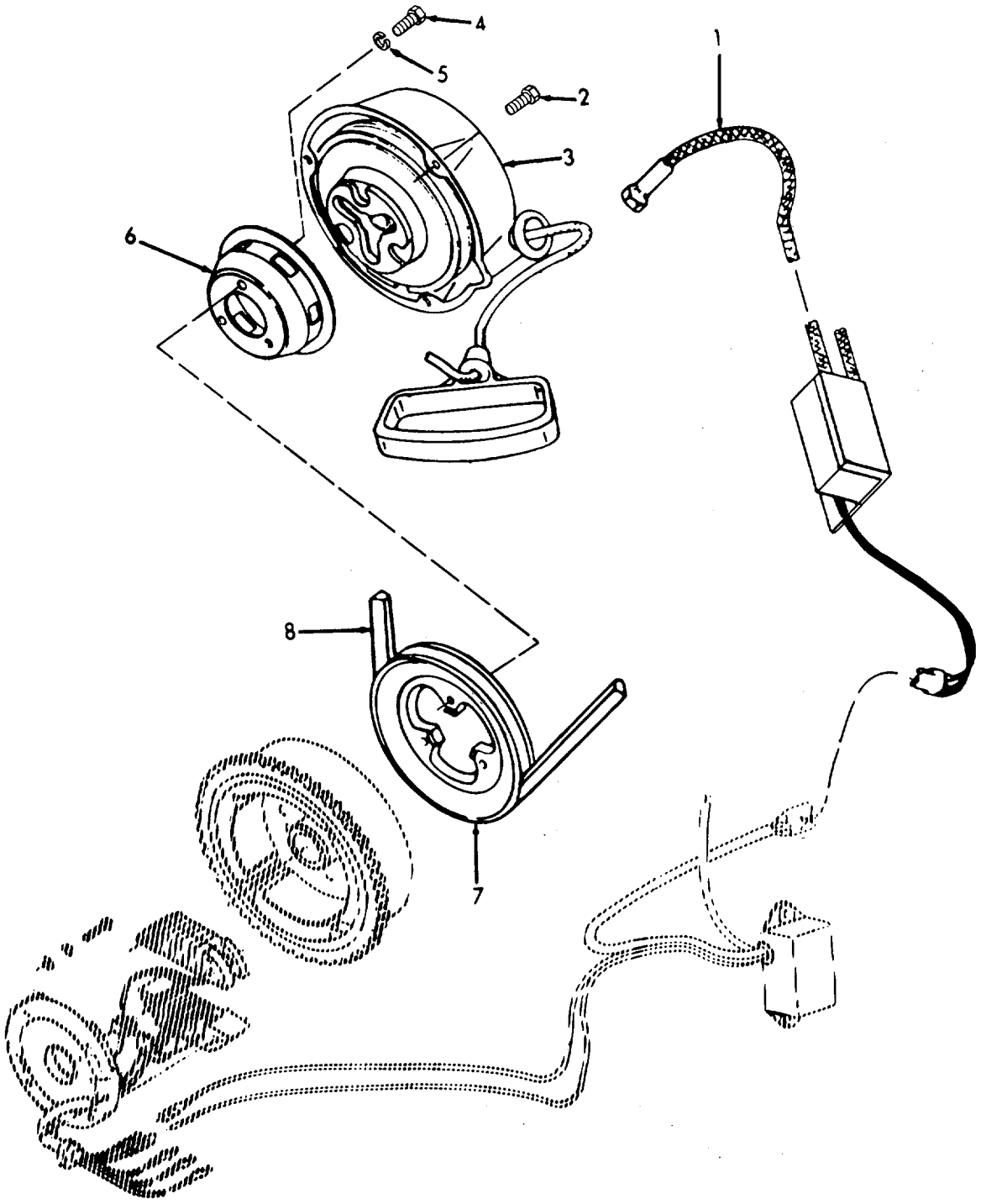


4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
IGNITION TIMING (Cont)			
	g. Fan pulley (7), starter pulley (6), and fan belt (8)	1. Assemble and install screws (4), and lockwashers (5). 2. Tighten to 5 lb-ft (6.8 Nm) torque.	
	h. Retractable starter (3)	1. Install using screws (2). 2. Tighten to 5 lb-ft (6.8 Nm) torque.	
	i. Spark plug wires (1)	Install.	

4-7.10A. ENGINE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
IGNITION TIMING (Cont)			



4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

a. The retractable starter consists of a rope attached to a starter pulley which is, in turn, connected by spring-loaded dogs, to a starter cup located on the crankshaft assembly. When the starter rope is pulled, the starter pulley rotates. This rotation increases the spring tension applied to the dogs and the dogs engage the starter cup. While the dogs are engaged in the starter cup, the torque applied to the starter pulley is transmitted directly to the engine flywheel.

b. As soon as the engine starts, the starter rope is allowed to return into the starter housing. The starter pulley is also spring- loaded and rewinds the starter rope in preparation for the next start. At the same time, the pulley releases the tension applied to the dogs and allows them to disengage from the starter cup. After the engine has started, the starter pinion disengages from the ring gear.

This task covers:

a. Removal
b. Disassembly
c. Reassembly
d. Inspection

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts

Grease - multi-purpose
DOD-G-24508

Personnel Required

1

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING in procedure.

4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

WARNING

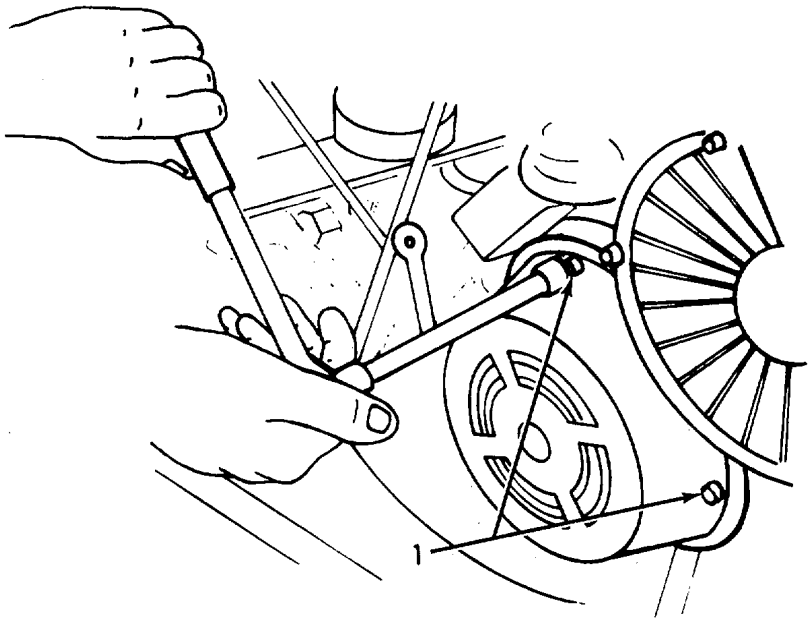
Exercise care when removing recoil reel from starter assembly. All spring tension should be released to prevent spring from accidentally disengaging and causing injury. Wear safety glasses when repairing starter assembly components.

CAUTION

While retractable starters do not need regular service, they should be checked occasionally to make sure they are secure and that the rope is in good condition. If the rope is frayed, replace it immediately before it breaks. If it does break, the pulley is free to rewind violently which can result in a broken rewind spring or other internal damage.

REMOVAL

1. Retractable starter	a. Slotted hex head screws (1)	Remove three screws.



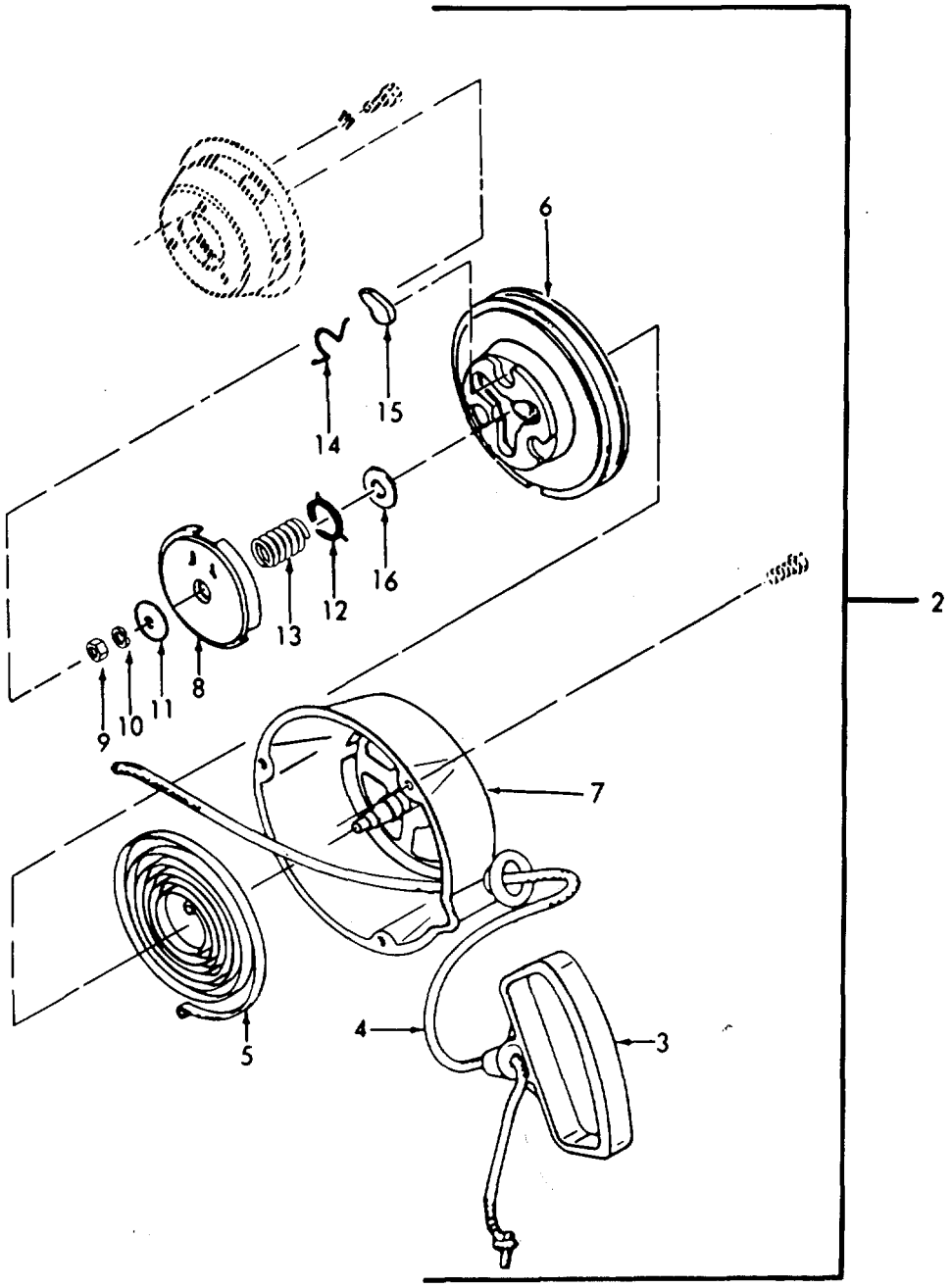
4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Starter assembly (2)	Remove.	
	c. Starter handle (3)	1. Pull out a short distance.	
		2. Tie knot in rope (4).	
		3. Untie knot in handle.	
		4. Remove handle (3).	
DISASSEMBLY			
2.	a. Return spring (5)	1. Release spring tension by removing handle (3) (step c above).	
		2. Allow rope (4) to retract slowly by applying thumb pressure on recoil reel (6).	Exercise care when handling recoil case (7).
	b. Friction plate (8)	1. Exert slight downward pressure.	
		2. Remove securing nut (9), lockwasher (10), and flatwasher (11).	
		3. Slowly remove friction plate (8).	
	c Plate return spring (12), friction spring (13), pawl return spring (14), pawls (15), and thrust washer (16)	1. Remove.	
		2. Inspect return spring (12), and friction spring (13), for breaks, rust, distortion, and weakened condition.	

4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



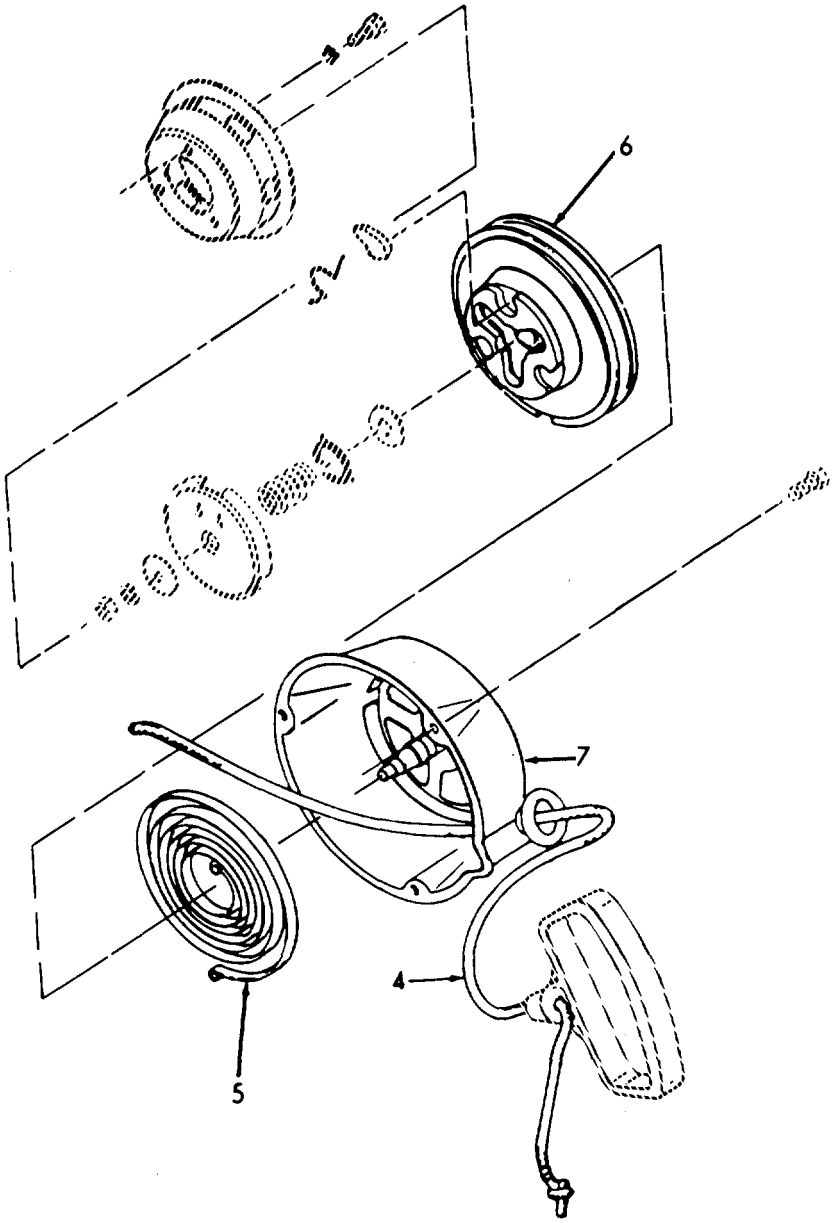
4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Starter rope (4)	1. Carefully withdraw recoil reel (6) from starter assembly. 2. Untie knot and remove rope. 3. Install new rope and tie a securing knot. 4. With recoil reel (6) removed, examine return spring (5) for cracks, crystallization, or abnormal bends. Exercise care when handling recoil case (7) to prevent return spring (5) from accidentally disengaging. Spring should remain in the recoil case (7). 5. Replace recoil reel.	
	e. Return spring (5)	1. Hold recoil case (7) approximately 2 inches (50.8 mm) above work bench with flat surface of housing towards palm of hand. 2. Slap mounting surface of recoil case (7) against bench, to release spring (5) from housing.	

4-7.11A.. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

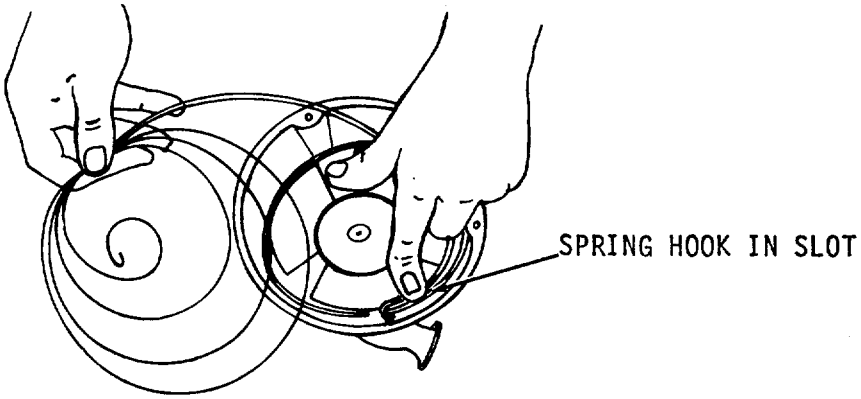
LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
		NOTE Thoroughly clean all parts prior to reassembly of starter.	
3.	a. Return spring (5)	1. Insert outside spring hook into slot, and carefully wind spring in direction shown, while applying pressure with fingers to prevent spring from jumping out of case.	

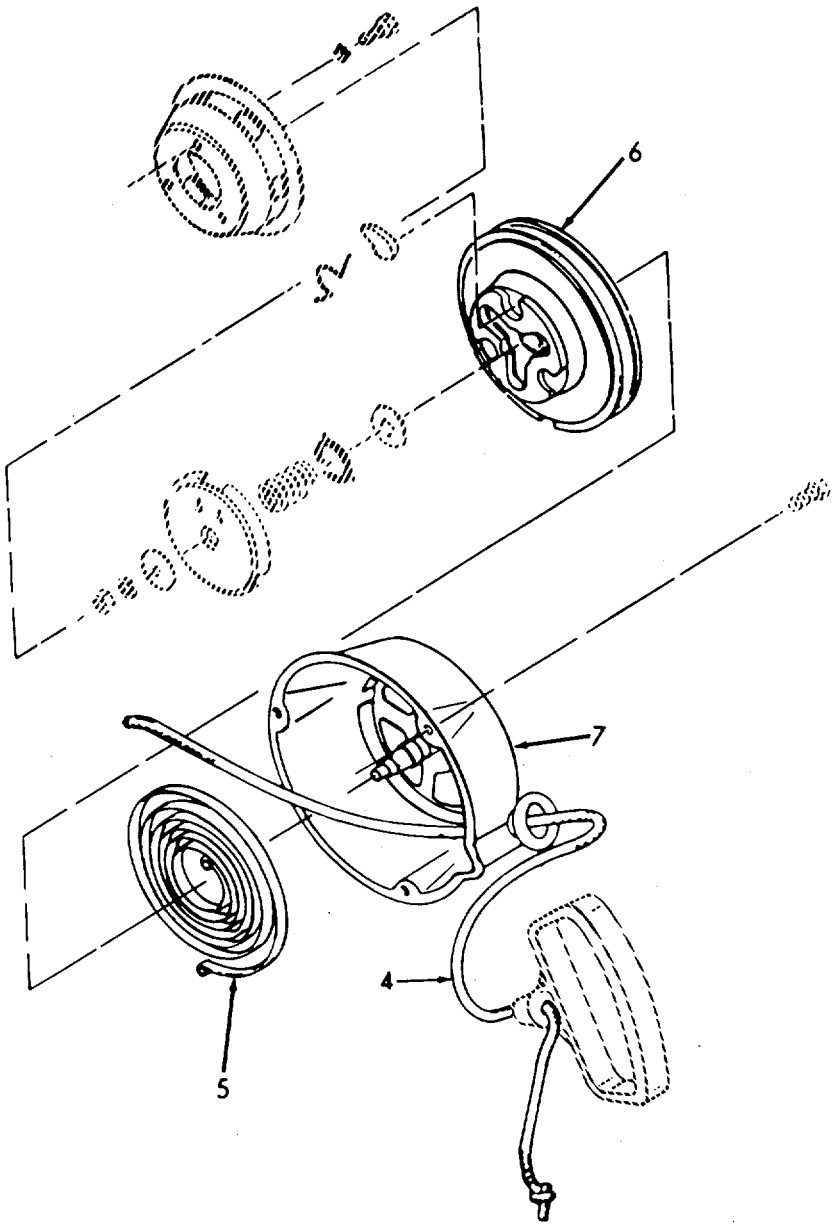


2. Apply light coat of multi-purpose grease, DOD-G-24508, to spring and housing.

3. With the rope (4) installed on reel (6), insert reel assembly into case (7). Be sure to engage reel (6) with spring hook near center of case (7).

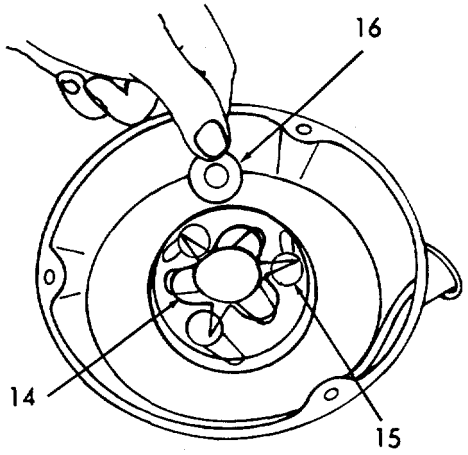
4-7. 11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

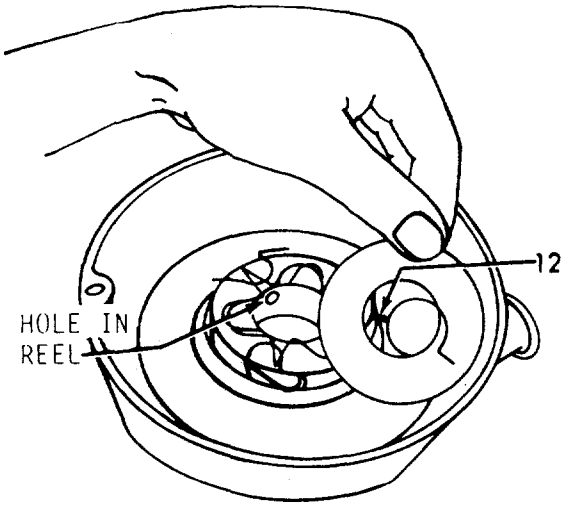


4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Pawls (15), pawl return springs (14), and thrust washer (16)	Assemble.	

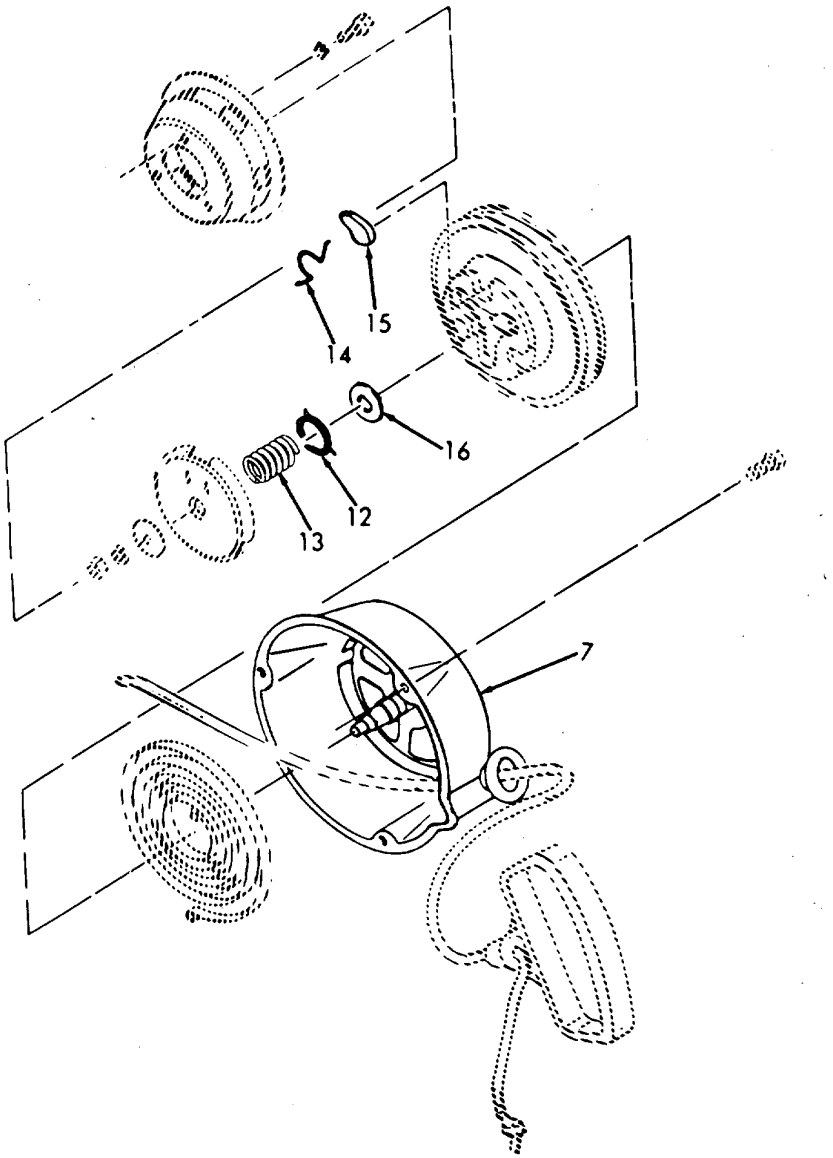


	c. Plate return spring (12)	Insert straight end of spring into hole in reel.	



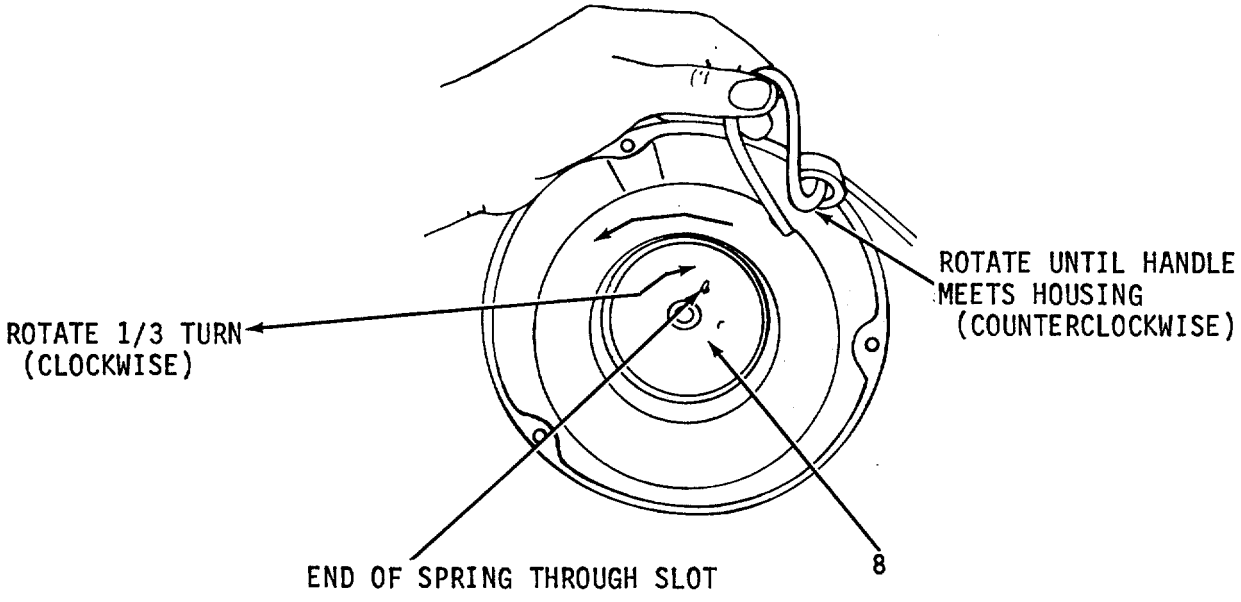
4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		NOTE Apply multi-purpose grease, DOD-G-24508, to dimples in friction plate side of thrust washer prior to performing next step.	
	d. Friction spring (13)	Install spring onto stub in recoil case (7).	



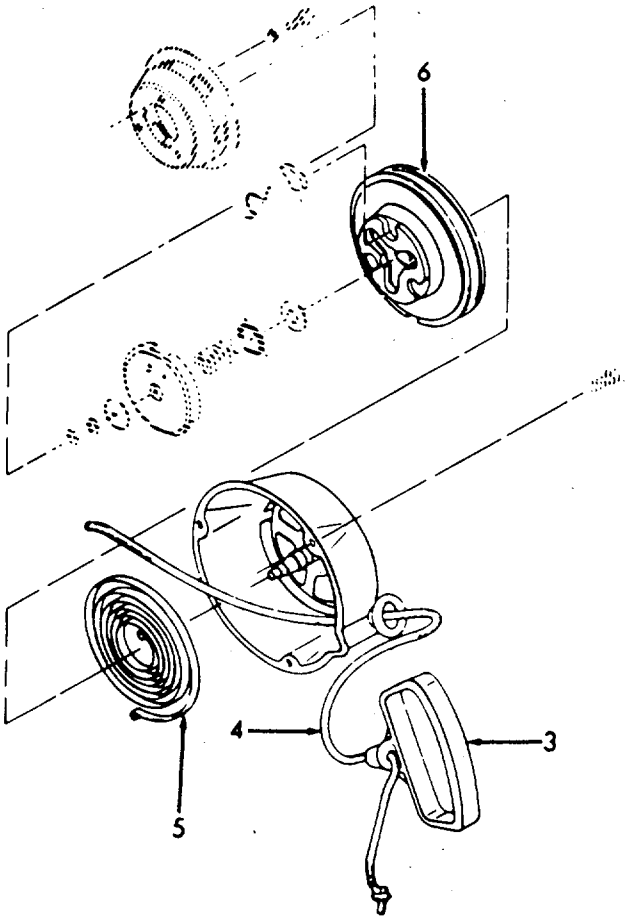
4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	e. Friction plate (8)	Carefully proceed: 1. Lower friction plate (8) only until bent end of plate return spring (12) enters slot. 2. Preload friction plate (8) by turning plate 1/3 turn clockwise. 3. With preload applied to friction plate (8) lower plate completely into position (guide cutouts in plate over end of pawls (15)) and secure.	



4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	f. Handle (3)	1. Fasten handle (3) to rope (4) with knot, then apply preload to return spring (5) by placing rope (4) in notch of recoil reel (6) and rotate reel counterclockwise until handle (3) retracts into housing.	See figure in step e above.



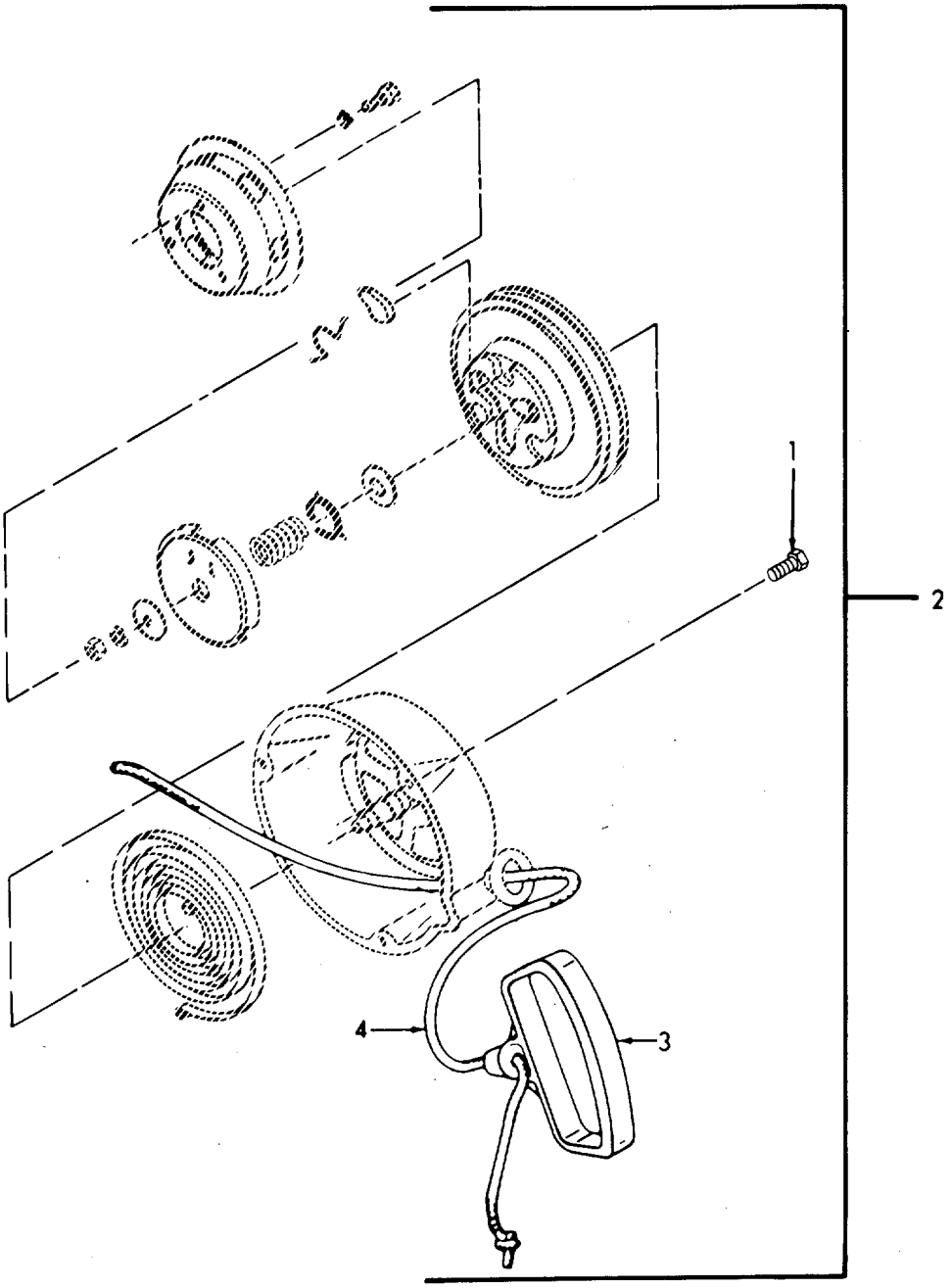
4-7. 11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		NOTE After assembly check to be sure pawl return springs remained properly positioned by moving tip of pawl outward and release. If pawl does not return to disengaged position remove friction plate and repeat steps 3b through f, above.	
		2. Pull starter handle (3) and check starter assembly (2) for proper operation.	
INSTALLATION			
4.	a. Starter assembly (2)	1. Install with screws (1).	
		2. Tighten to 60 in-1b (6.8 Nm) torque.	
	b. Pull starter rope (4) a few times and observe starter operation.		

4-7.11A. RETRACTABLE STARTER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-8. FIRE PUMP.

a. The fire pump is a multi-purpose pump. The fire pump does the following:

- Provides water for fires
- Empties bilges
- Empties and fills ballast tanks
- Empties bilges while fighting fires

b. The following is an index to the maintenance instructions:

4-8.1. FIRE PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Service c. Repair

INITIAL SETUP

Test Equipment
NONE

References
Paragraph

4-8.2	Fire Pump
4-8.3	Fire Pump Motor
4-8.4	Fire Pump Motor Controller
4-8.5	Simplex Strainer

Equipment Condition
Special Tools — Condition Description
NONE — NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS.

4-8.1. FIRE PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

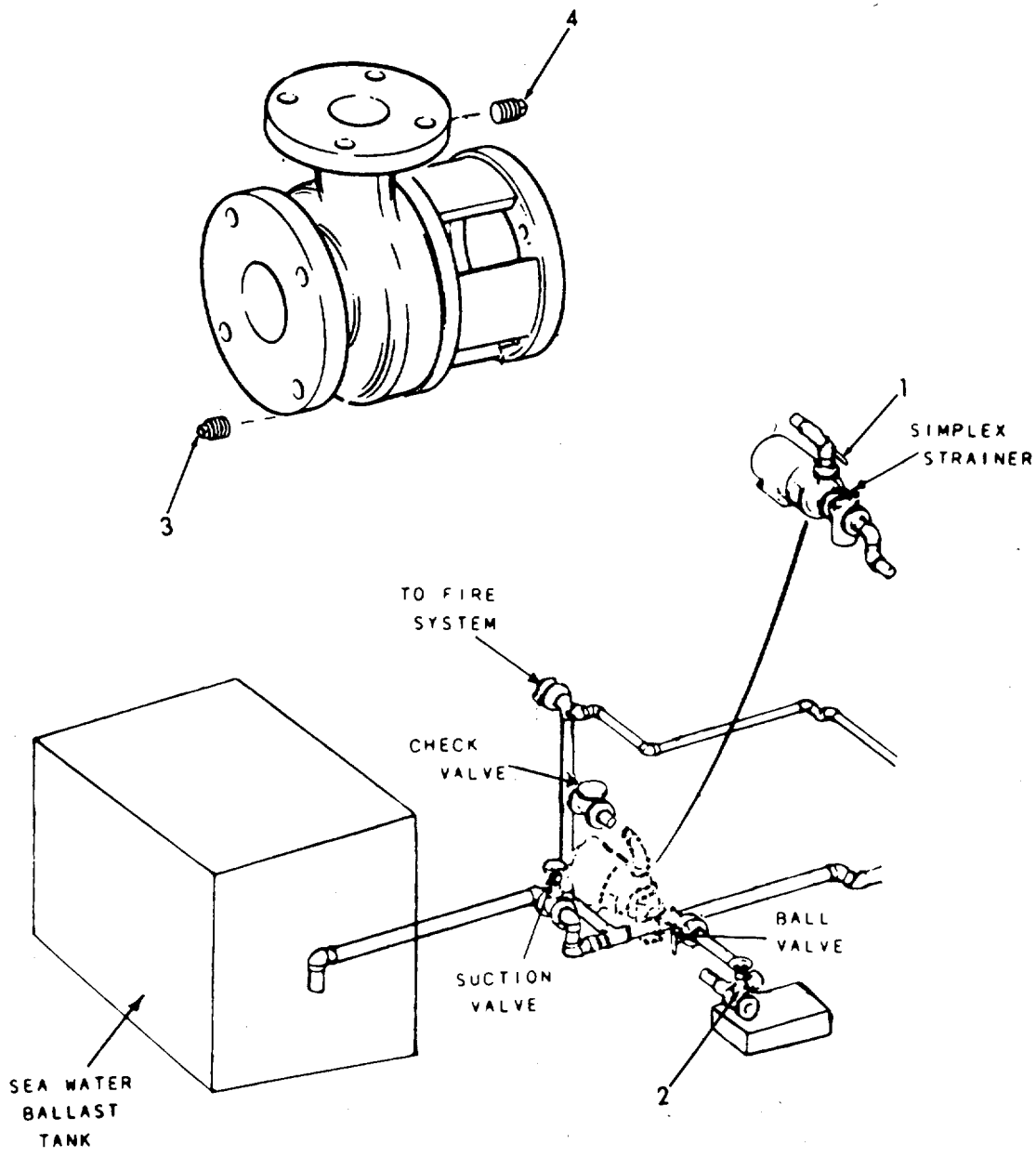
LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position.	
INSPECTION			
		WARNING In order to avoid the possibility of scuttling the craft, make sure all valves are shut off.	
1. Fire pump	a. Motor	1. Inspect for worn, frayed, or damaged wiring.	Refer to paragraph 4-8.3.
		2. Inspect for cracks, leaks, and signs of damage.	
		3. Insure all hardware is tight.	
	b. Pump	1. Inspect for cracks, breaks, and signs of damage.	
		2. Inspect for leaking.	
		3. Insure all hardware is tight.	
	c. Piping	1. Inspect for cracks, breaks, dents and bends.	Refer to Direct Support Maintenance.
		2. Insure all hardware is tight.	
	d. Simplex strainer	1. Inspect for clogged strainer.	Refer to paragraph 4-8.5.
		2. Inspect for cracks and breaks.	

4-8.1. FIRE PUMP SET - MAINTENANCE INSTRTUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		3. Inspect for leaking.	
		4. Insure all hardware is tight.	
	e. Con-troller	1. Inspect for breaks, cracks and dents.	Refer to para-graph 4-8.4.
		2. Inspect for worn, frayed or damaged wiring.	
SERVICE			
2. Simplex strainer	Strainer	Perform service and fill with water.	Refer to para-graph 4-8.5.
3. Fire pump	a. Valve (1)	Rotate clockwise to shut valve.	
	b. Valve (2)	Rotate clockwise to shut valve.	
	c. Drain plug (3)	Remove.	Drain water from pump.
	d. Vent plug (4)	Remove.	
	e. Drain plug (3)	Install.	
	f. Simplex strainer	Refer to step 2.	
	g. Valves (1 and 2)	Rotate counter-clockwise to open valve.	
	h. Vent plug (4)	Install.	

4-8.1. FIRE PUMP SET - MAINTENANCE INSTRTUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-8.1. FIRE PUMP SET - MAINTENANCE INSTRTUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Fire pump set	a. Fire pump	Refer to paragraph 4-8.2.	
	b. Fire pump motor	Refer to paragraph 4-8.3.	
	c. Fire pump motor con-troller	Refer to paragraph 4-8.4	
	d. Simplex strainer	Refer to paragraph 4-8.5.	

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS.

This task covers:

a. Inspection
b. Service
c. Inspection - Internal Components
d. Disassembly
e. Reassembly

INITIAL SETUP

Test Equipment	References	
	Paragraph	
NONE	4-8.3	Fire Pump Motor
	Equipment	
Special Tools	Condition	Condition Description
	paragraph	
NONE	4-8.5	Simplex Strainer removed

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

WARNING

In order to avoid the possible scuttling of the craft, make sure all valves are shut off.

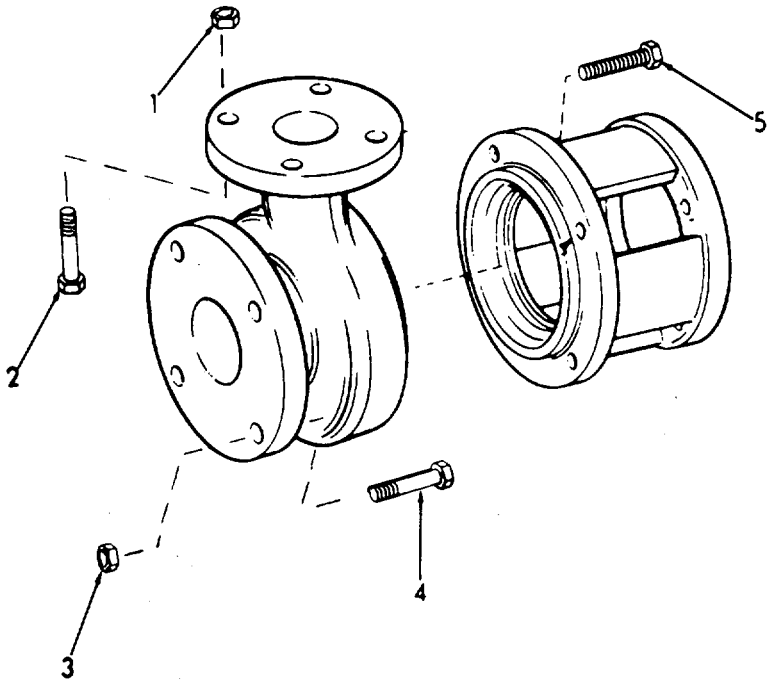
1. Fire pump	a. Motor	1. Inspect for worn, frayed or damaged wiring.	Refer to para graph 4-8.3.

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		2. Inspect for cracks, leaks, and signs of damage.	
		3. Insure all hardware is tight.	
	b. Pump	1. Inspect for cracks, breaks, and signs of damage.	
		2. Inspect for leaking.	
		3. Insure all hardware is tight.	
	c. Piping	1. Inspect for cracks, breaks, dents and bends.	Refer to Direct Support Maintenance.
		2. Insure all hardware is tight.	
2. Simplex stainer	Simplex strainer	1. Inspect for clogged strainer.	Refer to paragraph 4-8.5.
		2. Inspect for cracks and breaks.	
		3. Inspect for leaking.	
		4. Insure all hardware is tight.	
SERVICE			
3. Simplex strainer	Strainer	Perform service and fill with water.	Refer to paragraph 4-8.5.

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
4. Fire pump	a. Nuts (1), and screws (2)	Remove.	
	b. Nuts (3), and screws (4)	Remove.	
	c. Pump and motor assembly	Remove hardware and slide away from Simplex strainer.	Refer to para graph 3-8.1.
	d. Screws (5)	Remove.	

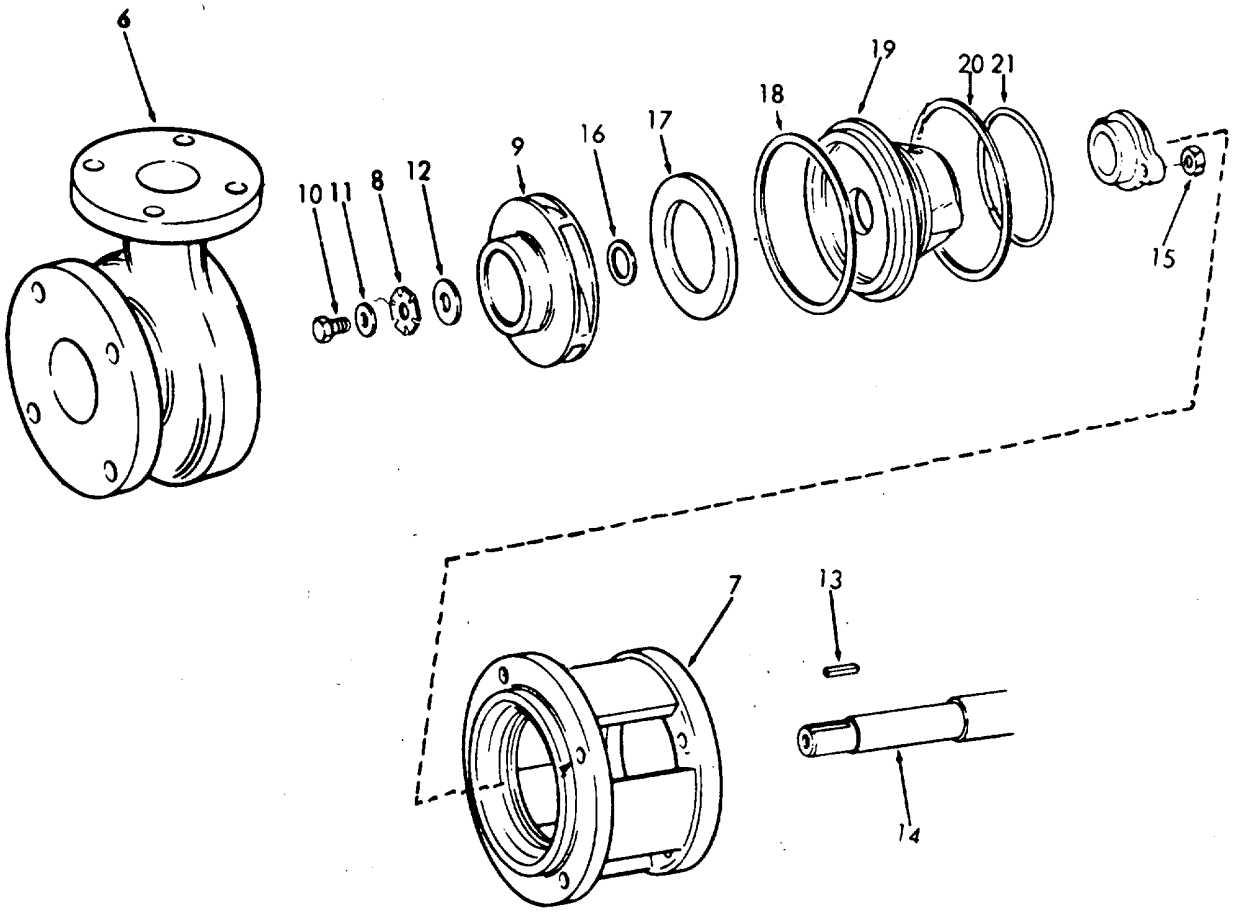


4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Casing (6)	Slide away from adapter (7) and remove.	
	f. Lock-washer (8)	Bend back locking tab.	Use a sharp tool.
	g. Impeller (9)	Keep from rotating.	Use a block of wood or a suitable tool.
	h. Screw (1 0), screw gasket (11), lock-washer (8), and lock-washer gasket (12)	Remove.	
	i. Impeller (9)and key (13)	Remove from shaft (14).	
	j. Nuts (15)	Remove.	
	k. Gasket (16), adapter ring cover (17), gasket (18), and stuffing box cover (19)	Remove.	

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	1. Cover gasket (20), and "0" ring (21)	Remove.	



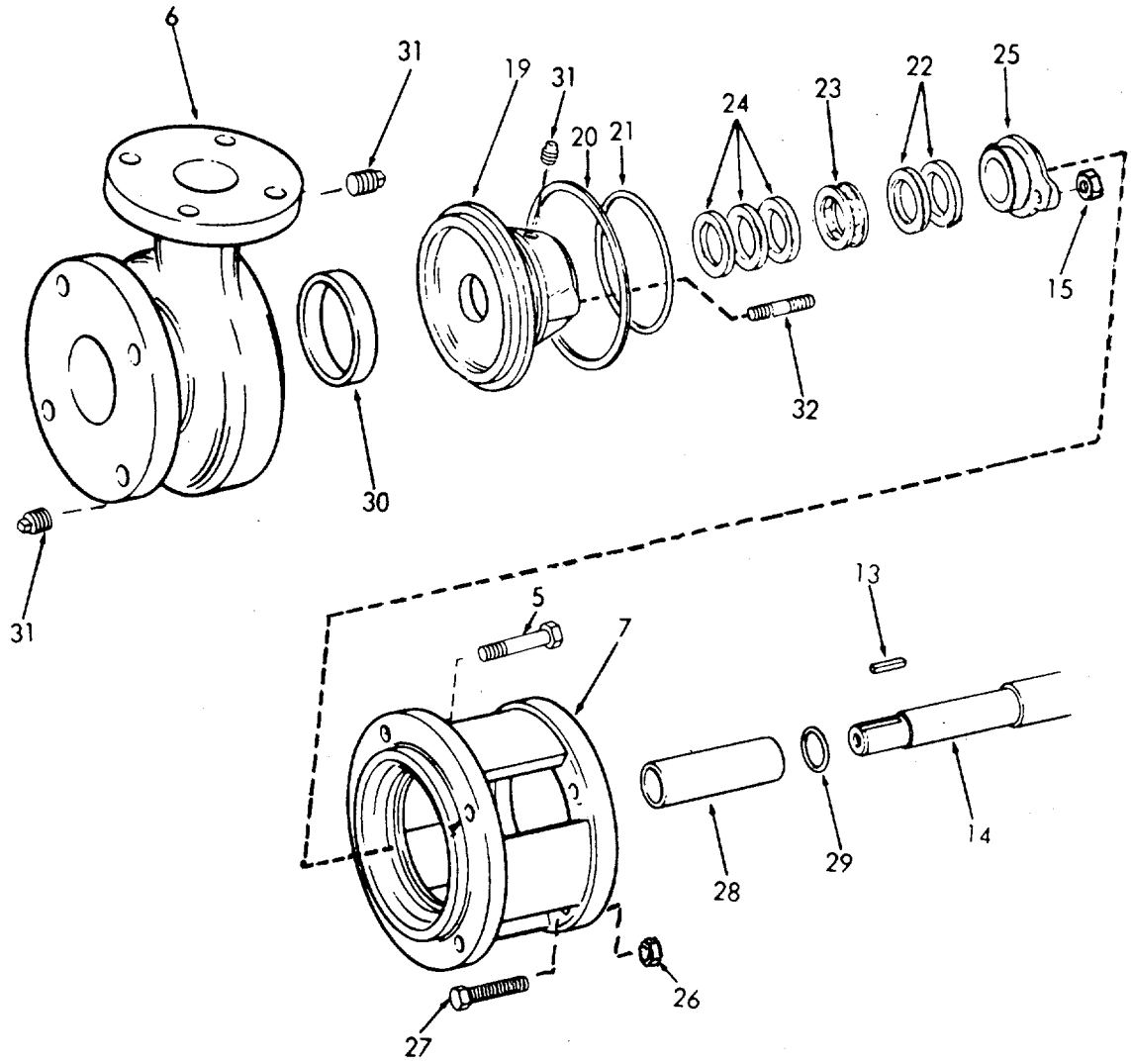
4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	m. Two pre-Formed packing (22), lantern ring (23), and three performed packing (24)	Remove from cover (19).	
	n. Packing Gland (25)	Remove from shaft (14).	
	o. Nuts (26), and screws (27)	Remove.	
	p. Adapter	Separate from motor. (7)	
	q. Sleeve (28), and packing ring (29)	Remove from shaft (14).	
	r. Casing wear ring (30)	Remove from casing (6).	
	s. Pipe plugs (31), and studs (31)	Remove if necessary.	

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

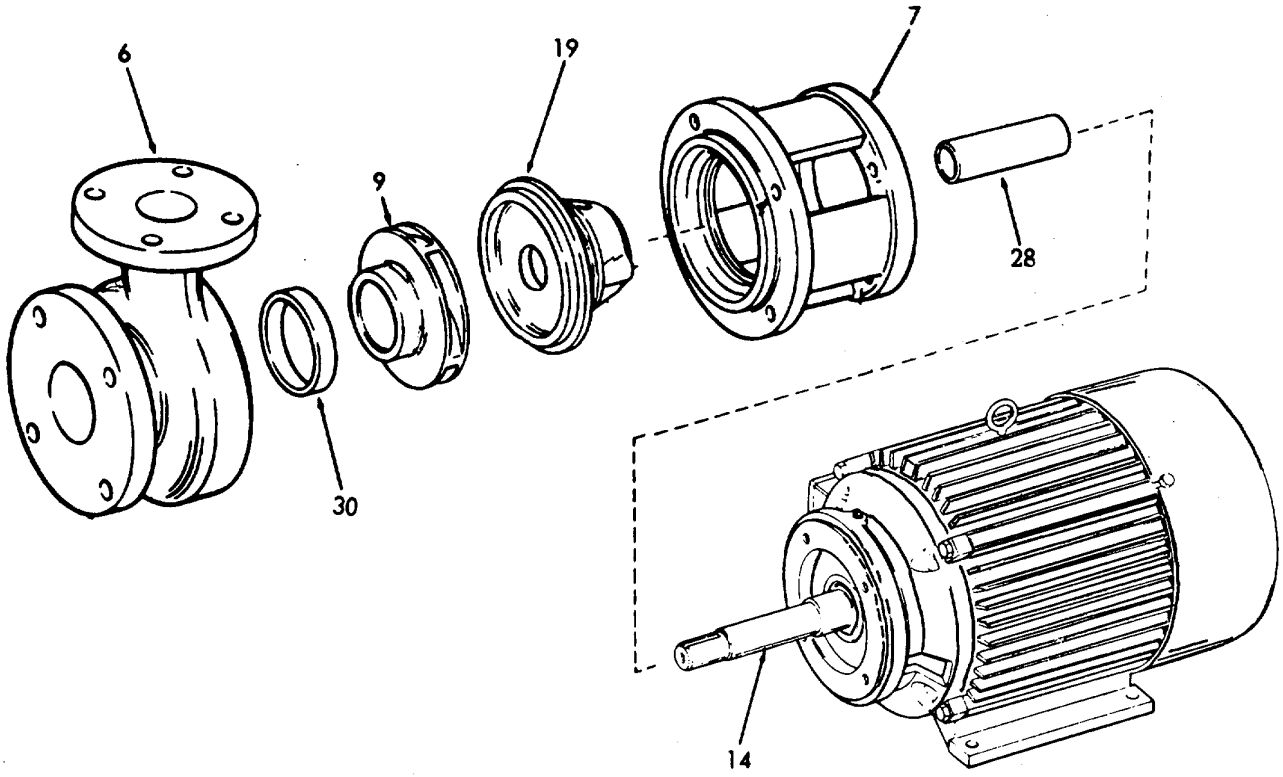


4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION - INTERNAL COMPONENTS			
5. Casing	a. Casing (6)	Clean and inspect gasket surfaces for damaged areas that would cause leaks.	
	b. Wear ring (30)	Inspect for excessive wear on surfaces.	Wear ring clearances are 0.018-0.024 inch.
6. Impeller	Impeller (9)	1. Check wearing ring surfaces for excessive wear.	If excessively worn or eroded, the impeller must be replaced.
		2. Check gasket surfaces of impeller hub for damage.	
7. Motor shaft	Shaft (14)	Inspect for bending.	Insert sleeve (28) on shaft (14). Install a dial indicator. Rotate shaft by hand. Maximum allowable runout is 0.002 inch.
8. Stuffing box cover	Cover (19)	1. Clean and inspect gasket surfaces.	
		2. Remove any dirt and scale from cavity.	
		3. Check cover ring for wear and excess clearance.	
9. Adapter	Adapter (7)	1. Check for damage to precision surfaces that locate casing and bearing frame to preserve proper internal alignment.	

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION		ITEM	ACTION	REMARKS
INSPECTION - INTERNAL COMPONENTS (Cont)				
			2. Check for corrosion due to leakage from stuffing box.	
10.	Shaft sleeve	Sleeve (28)	Check for damage to gasket surface on im peller end and internal packing grooves.	Any scoring on outside of sleeve will shorten the life of the performed pack ing.

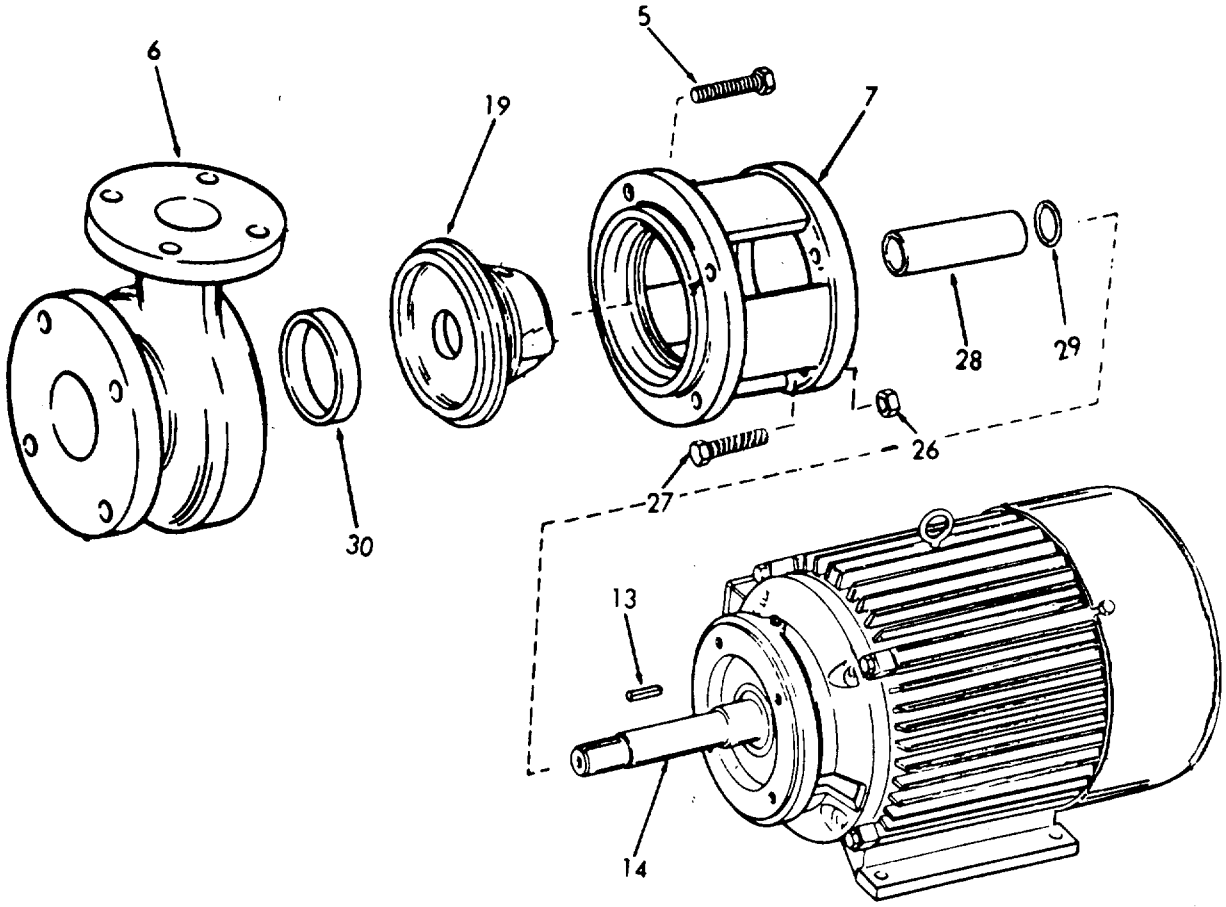


4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
11. Fire Pump			
		NOTE	
		Make sure all parts are clean. Remove all dirt and pieces of the old gasket in the joints between the motor, adapter, and casing.	
	a. Packing ring (29)	Install on motor shaft (14).	Don't let the ring get cut by the sharp edges of the keyway.
	b. Shaft sleeve (28) onto shaft.	Slide on motor shaft (14).	It should slide on easily. Do not drive sleeve
	c. Adapter (7), screws (27), and nuts (26)	Install on motor.	
	d. Cover ring (17)	Install in stuffing. box cover (19).	The ring should be pressed in, beveled edge first, using a pressing tool which will hold the ring square with the cover bore.

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

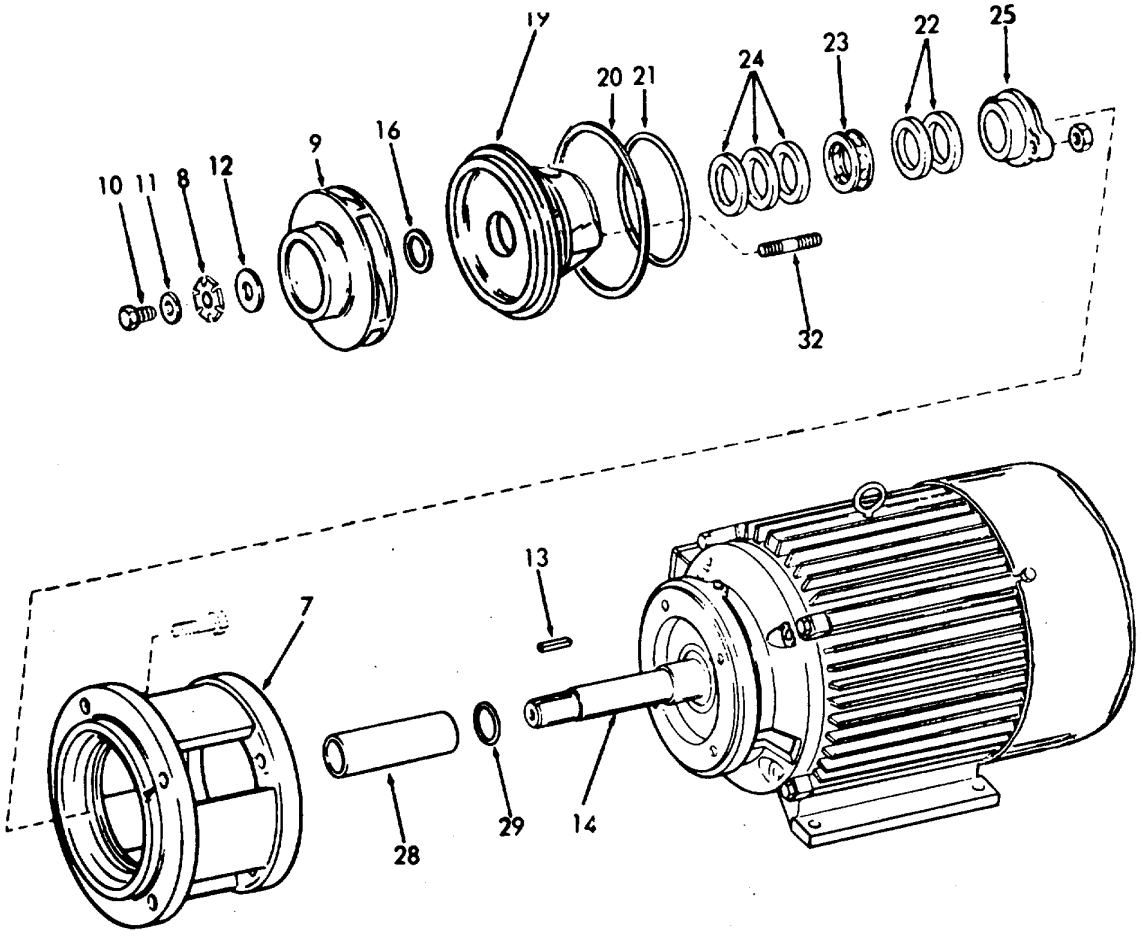


4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	e. Gland studs. (32)	Install.	
	f. Packing Gland (25)	Install on sleeve (28).	
	g Three pre-formed packing (24), lantern ring (23), and two pre-formed packing (22)	Install in stuffing box cover (19).	
	h. Gasket (20), "0" ring (21), and stuffing box cover (19)	Install on adapter (7).	
	i. Pump shaft gasket (16)	Place on shaft (14).	
	j. Impeller (9), and key (13)	Align keyways and install on shaft (14).	

4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	k. Washer gasket (12), lock-washer (8), screw gasket (11), and screw (10)	Install and hand tighten screw.	
	1. Shaft sleeve (28)	Check that sleeve has moved to cover most of packing ring (29).	

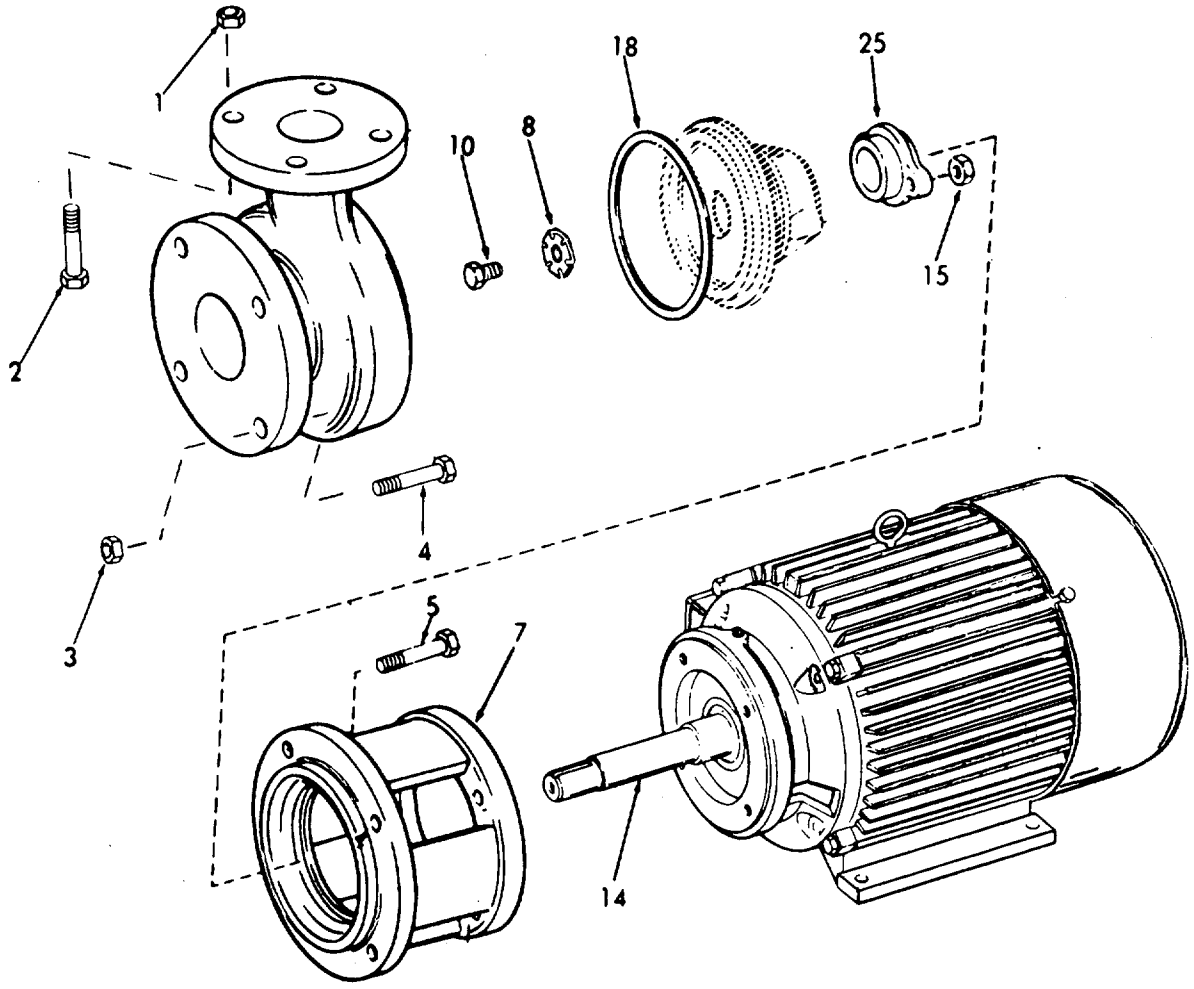


4-8.2. FIRE PUMP - MAINTENANCE INSTRTUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	m. Screw (10)	Tighten.	Tighten to 50 ft 1b (67.8 Nm).
	n. Lock-washer (8)	Crimp against one flat of screw (10).	Use vice grips-do not use a hammer.
	o. Casing gasket (18)	Install on shoulder of adapter (7).	
	p. Casing (6)	Install on adapter (7).	
	q. Screws (5)	Install.	
	r. Packing gland (25), and nuts (15)	Install and tighten.	
	s. Screws (4), and nuts (3)	Install.	
	t. Screws (2), and nuts (1)	Install.	
	u. Motor shaft (14)	Rotate by hand and check for binding and rubbing.	Correct any binding and rubbing con-ditions.
	v. Simplex strainer	Perform service and fill with water.	Refer to para graph 4-8.5.

4-8. 2. FIRE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-8. 3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment
NONE

Special Tools
Chain hoist

Material/Parts
NONE

Personnel Required
2

References
Paragraph
4-8.1 Fire Pump Set

Equipment
Condition Condition Description
Paragraph
4-8.2 Fire Pump removed

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNINGS.

LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.	
INSPECTION			
1. Fire pump motor	a. Wiring	1. Inspect for wear, fraying or damage.	
		2. Insure all connections are tight.	
	b. Motor	Inspect for cracks and breaks.	
	c. Hardware	Insure all hardware is tight.	

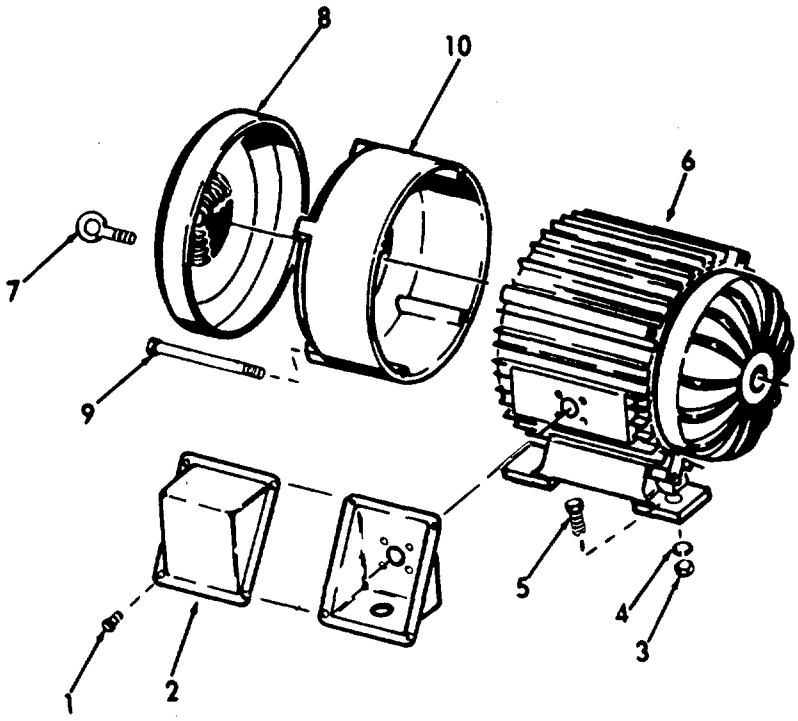
4-8. 3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1)	Remove.	
	b. Box cover (2)	Remove.	
	c. Wiring	Tag and disconnect.	
	d. Fire pump	Disconnect.	Refer to paragraph 4-8.2.
	e. Chain hoist	Attach to motor.	
	f. Nuts (3), lock - washers (4), and screws (5)	Remove.	
	g. Motor (6)	Lift and remove.	
	h. Fire pump	Remove.	Refer to para 4-8.2.
DISASSEMBLY			
3. Fire pump Motor	a. Eye bolts or screws (7)	Remove.	
	b. Top fan cover (8)	Remove.	
	c. Thru bolts (9)	Remove.	
	d. Fan cover (10)	Remove.	

4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

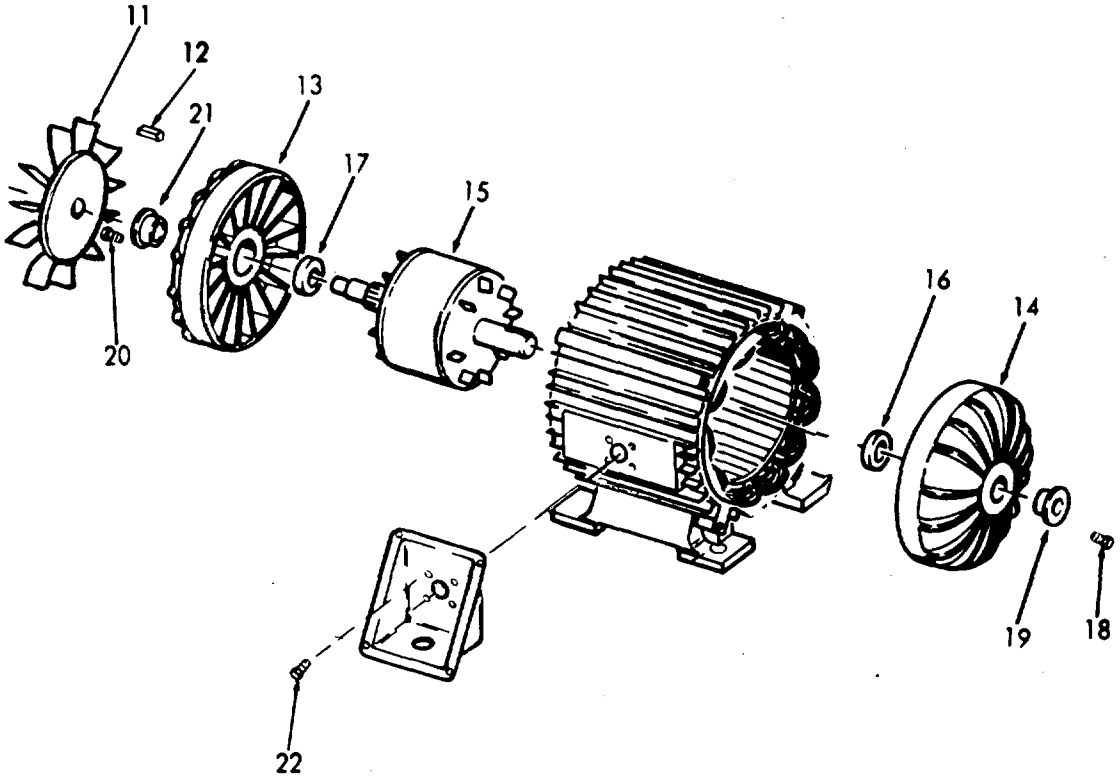


4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Fan (11), and key (12)	Remove.	
	f. Bearing brackets (13, and 14)	Remove.	
	g. Rotor and shaft (15)	Remove.	If necessary.
	h. Bearings (16) and 17)	Remove.	Use bearing puller.
	i. Screws (18), and bearing inner cap (19)	Remove.	
	j. Screws (20), and bearing inner cap (21)	Remove.	
	k. Screws (22), and terminal	Remove.	If necessary.
REASSEMBLY			
4.	a. Bearing inner cap (21), and screws (20)	Install.	
	b. Bearing inner cap (19), and screws (18)	Install.	

4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



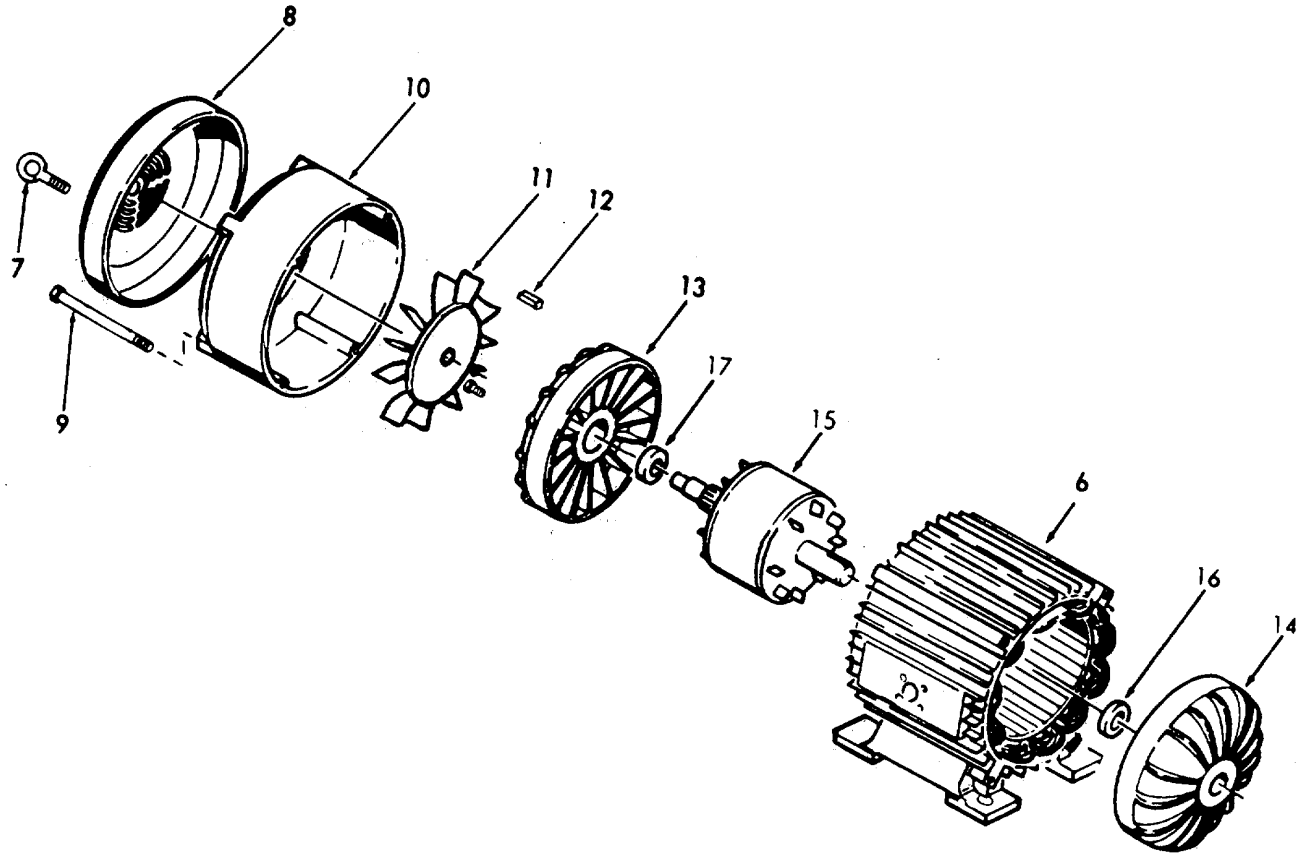
4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Bearings (16 and 17)	Install on rotor and shaft (15).	Heat bearing in an oven to 250°F (121.1°C). This will expand the inner race, allowing it to slip over the bearing seat.
	d. Rotor and shaft (15)	Insert in motor (6).	
	e. Bearing brackets (13 and 14)	Install.	
	f. Fan (11) and key (12)	Install.	
	g. Fan cover (10)	Install.	
	h. Thru bolts (9)	Install.	
	i. Top fan cover (8)	Install.	
	j. Eye bolts or screws (7)	Install.	
INSTALLTION			
5.	a. Fire pump	Install.	Refer to paragraph 4-8.2
	b. Motor (6)	Move into place.	

4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

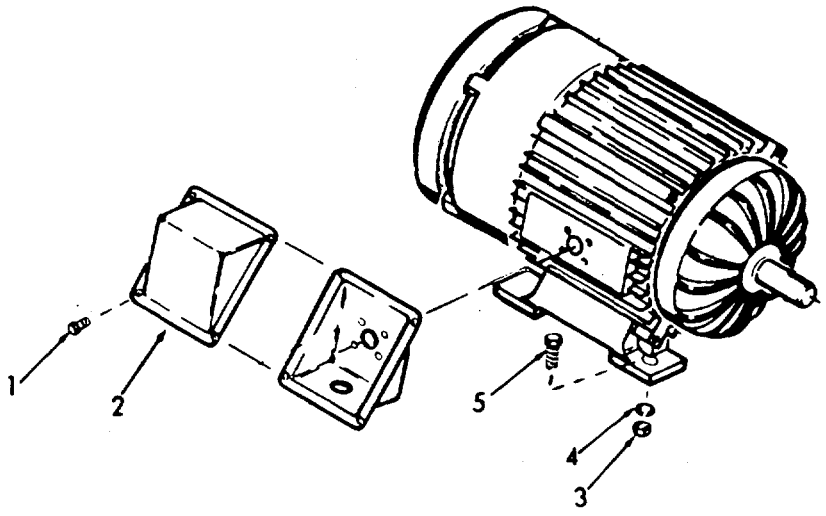
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-8.3. FIRE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Screws (5), lock-washers (4), and nuts (3)	Install.	
	d. Chain hoist	Remove.	
	e. Fire pump	Reconnect.	Refer to paragraph 4-8.2.
	f. Wiring	Reconnect.	
	g. Box cover (2), and screws (1)	Install.	



4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS.

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
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
Observe WARNING.

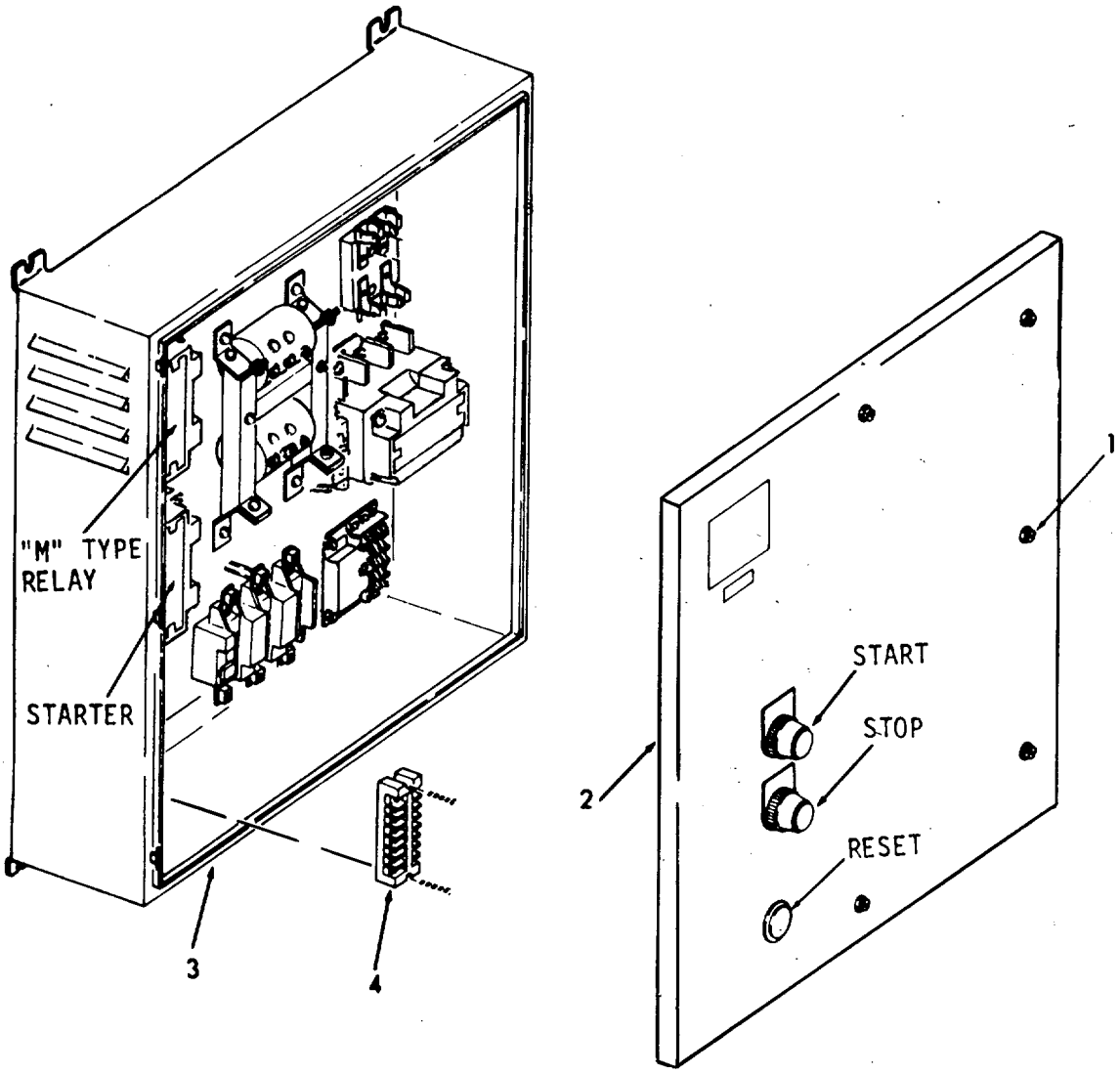
LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.	
INSPECTION			
1. Controller (external)	a. Enclosure	1. Inspect for breaks, cracks, dents, and bending. 2. Insure all mounting hardware is tight.	
	b. Wiring	Inspect for wear, fraying, and damage.	

4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Switches	Inspect for signs of failure or improper operation.	
2. Controller (internal)	a. Contactors, relays and starters	1. Inspect for worn contact tip material. 2. Inspect for cleanliness. 3. Insure all mounting hardware is tight.	
	b. Wiring	1. Install for wear, fraying and damage. 2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure. 2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components. 2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks. 2. Insure all mounting hardware is tight.	
REMOVAL			
3. Controller	a. Captive screws (1)	Rotate counter-clockwise to loosen.	
	b. Door (2)	Swing open.	

4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Wiring	Tag and disconnect from terminal block (4).	
	d. Controller (3)	Remove from bulkhead.	



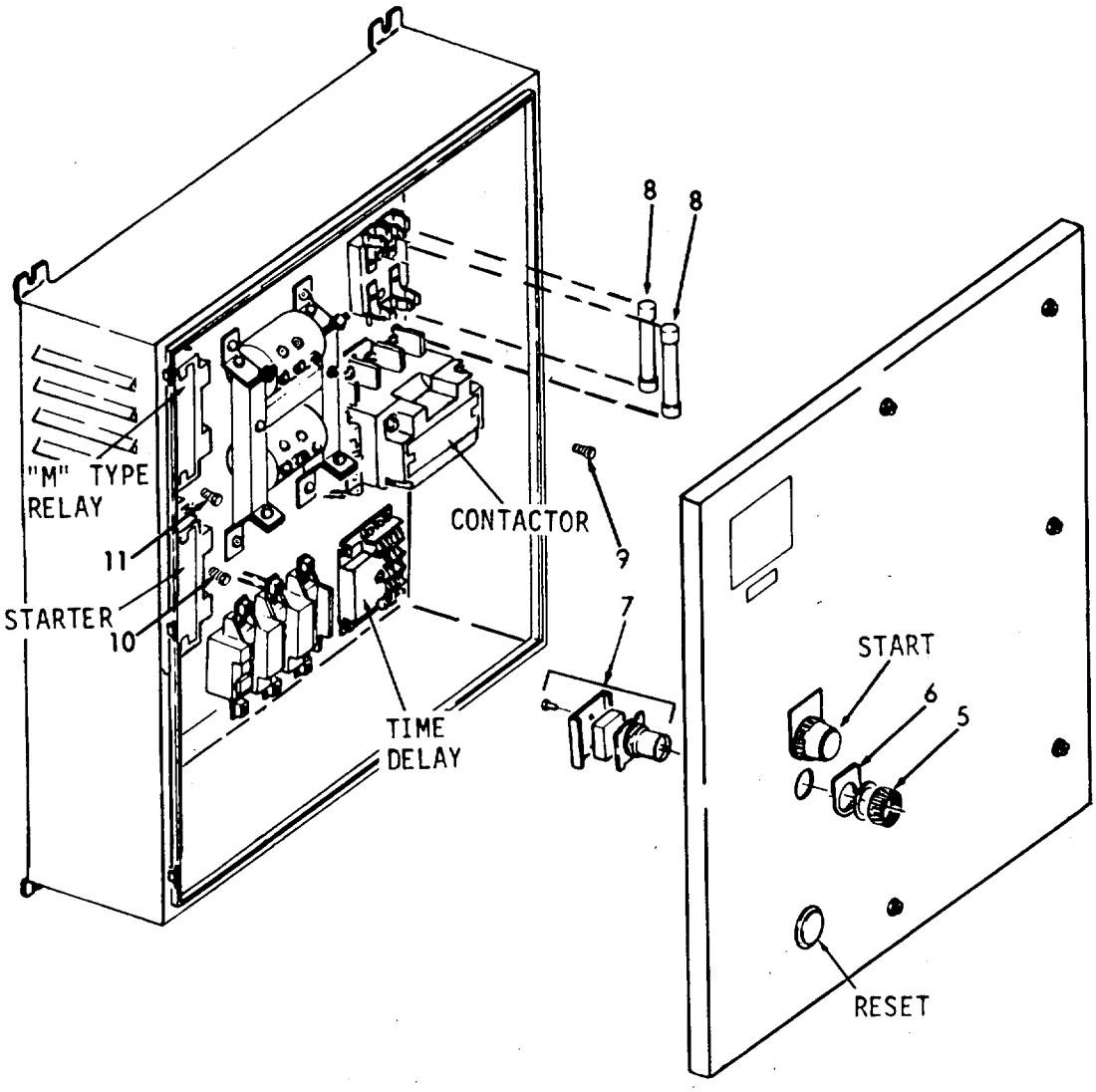
4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Push-button switches	a. Wiring	Tag and disconnect.	
	b. Retaining nut (5)	Unscrew and remove.	
	c. Identi-fication plate (6), and switch (7)	Remove.	
	d. Switch (7), identi - fication plate (6), and retaining nut (5)	Install.	
	e. Wiring	Reconnect.	
5. Fuses	Fuses (8)	Remove and replace.	
6. Contactor	a. Wiring	Tag and disconnect.	
	b. Three screws (9)	Remove.	
	c. Repair	Refer to Direct Support Maintenance.	
7. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws (10)	Remove.	
	c. Repair	Refer to Direct Support Maintenance.	

4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

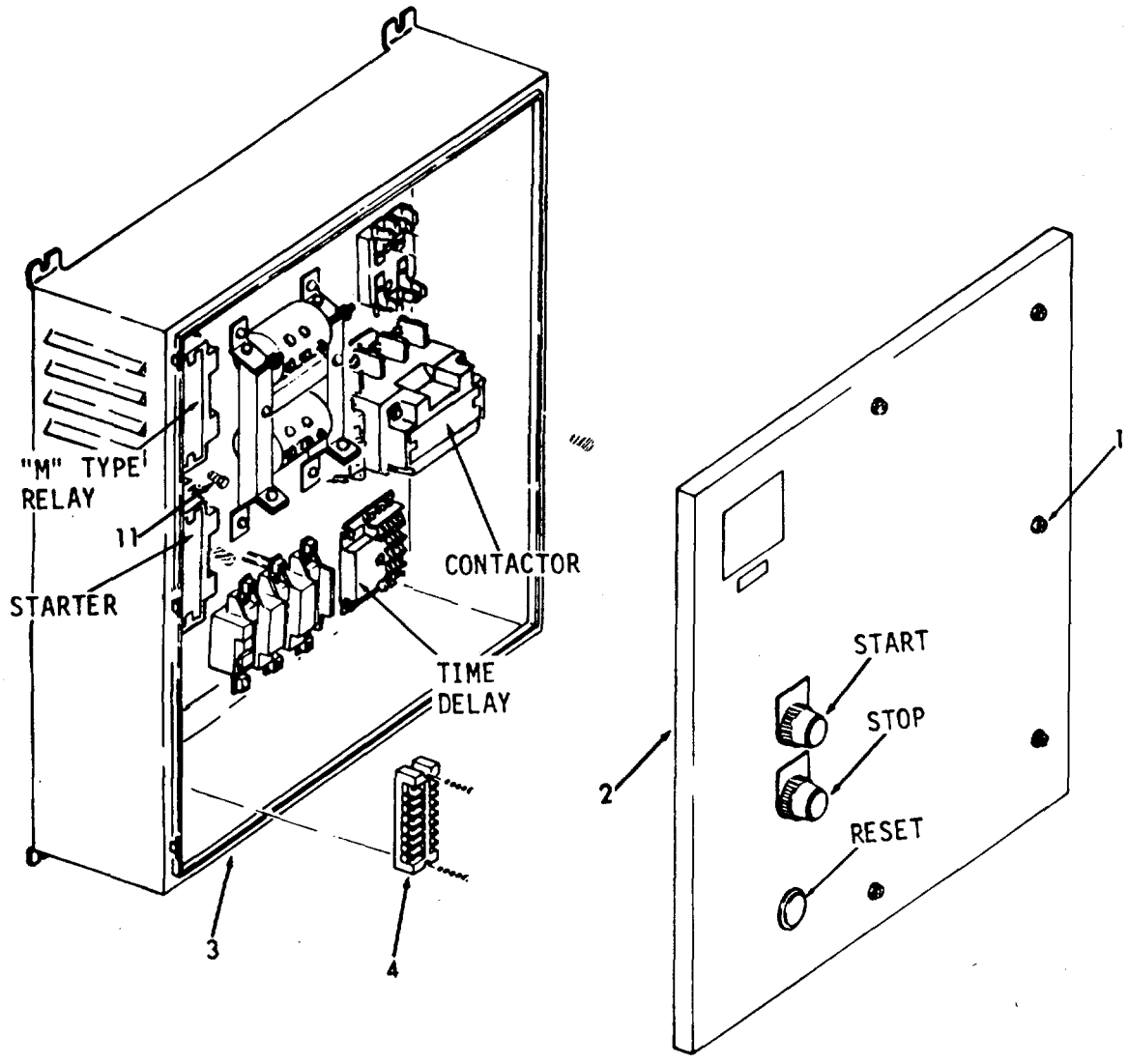


4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. M Type relay	a. Wiring	Tag and disconnect.	
	b. Three screws (11)	Remove.	
	c. Repair	Refer to Direct Support Maintenance.	
INSTALLATION			
9. Controller	a. Controller (3)	Install on bulkhead.	
	b. Wiring	Reconnect to terminal block (4).	
	c. Door (2) and captive screws (1)	Swing closed and rotate screws clockwise.	

4-8.4. FIRE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Service c. Replace

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNINGS.

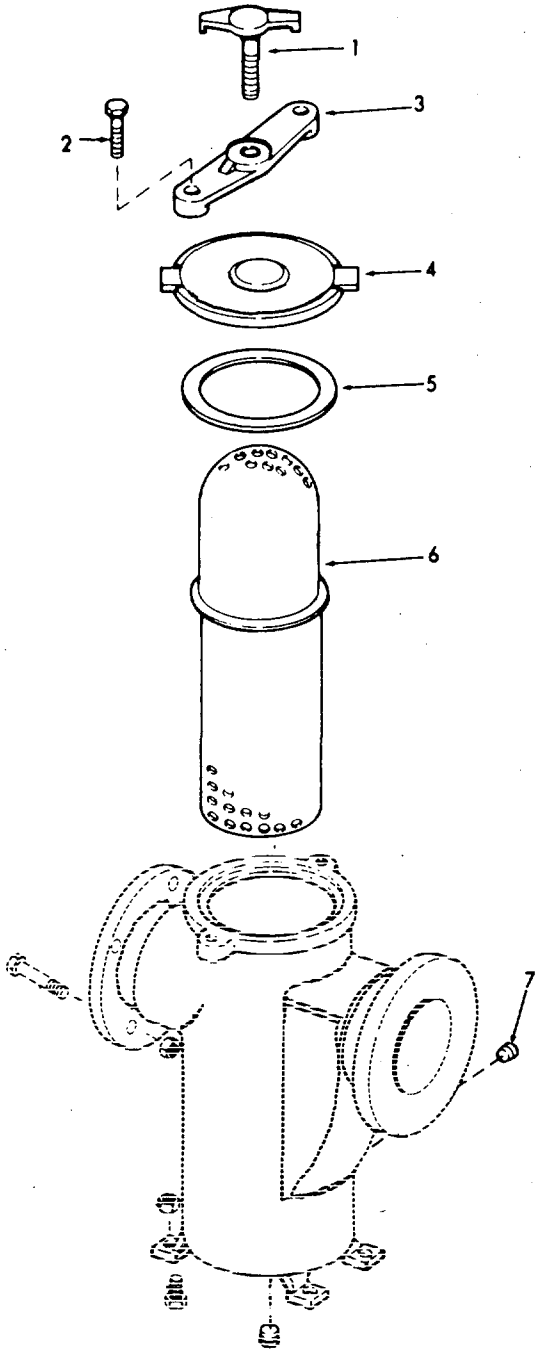
LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.	
INSPECTION			
		WARNING In order to avoid the possibility of scuttling the craft, make sure all valves are shut off.	
1. Simplex strainer	a. Piping	1. Inspect for cracks, breaks, dents and bends. 2. Inspect for leaking.	Refer to Direct Support Maintenance.

4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		3. Insure all hardware is tight.	
	b. Strainer	1. Inspect for clogged strainer.	
		2. Inspect for cracks and breaks.	
		3. Inspect for leaking.	
		4. Insure all hardware is tight.	
SERVICE			
2.	a. Yoke screw (1)	Rotate counter-clockwise to loosen.	
	b. Screws (2)	Remove.	
	c. Yoke (3)	Remove.	
	d. Cover (4), and gasket (5)	Remove.	
	e. Strainer basket (6)	Remove.	Clean.
	f. Pipe plug (7)	Remove.	Drain.
	g. Body	Clean out accumulated dirt from the inside.	
	h. Pipe plug (7)	Replace.	

4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			

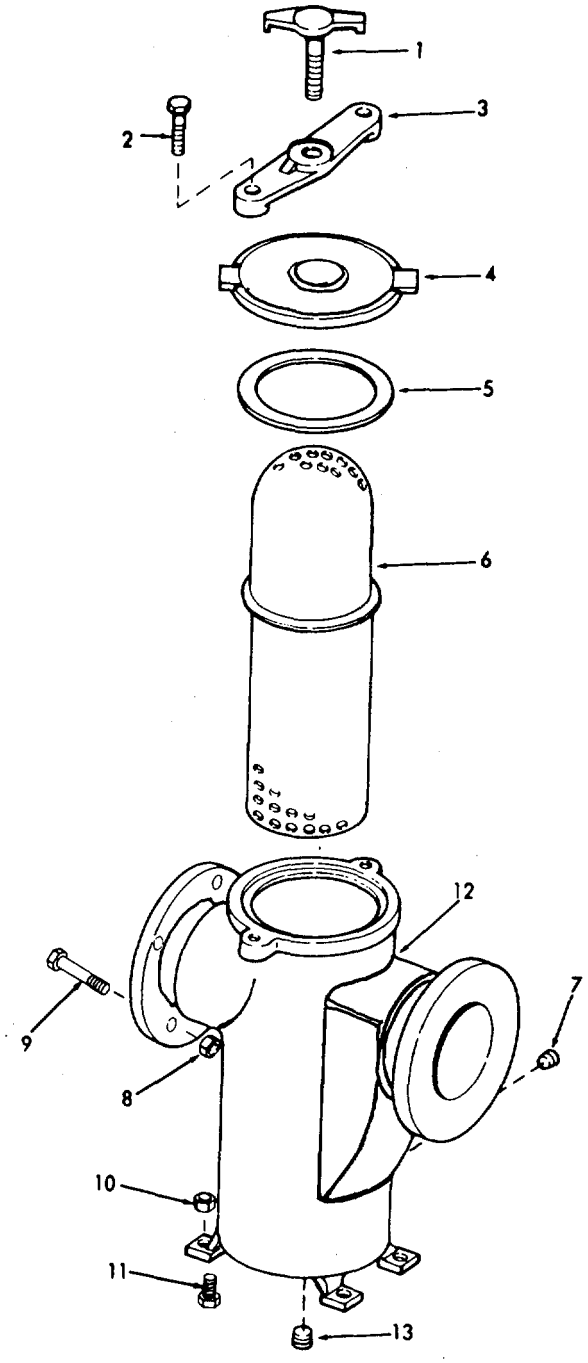


4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	i. Strainer basket (6)	Insert in body.	Fill with water.
	j. Gasket (5), and cover (4)	Install.	
	k. Yoke (3) and screws (2)	Install	
	1. Yoke screw (1)	Rotate clockwise.	
REPLACE			
3.	a. Pipe plug (7)	Remove.	Drain.
	b. Eight nuts (8), and screws (9)	Remove.	
	c. Nuts (10), and screws (11)	Remove.	
	d. Body (12)	Remove.	
	e. Pipe plug (13)	Remove.	If necessary.

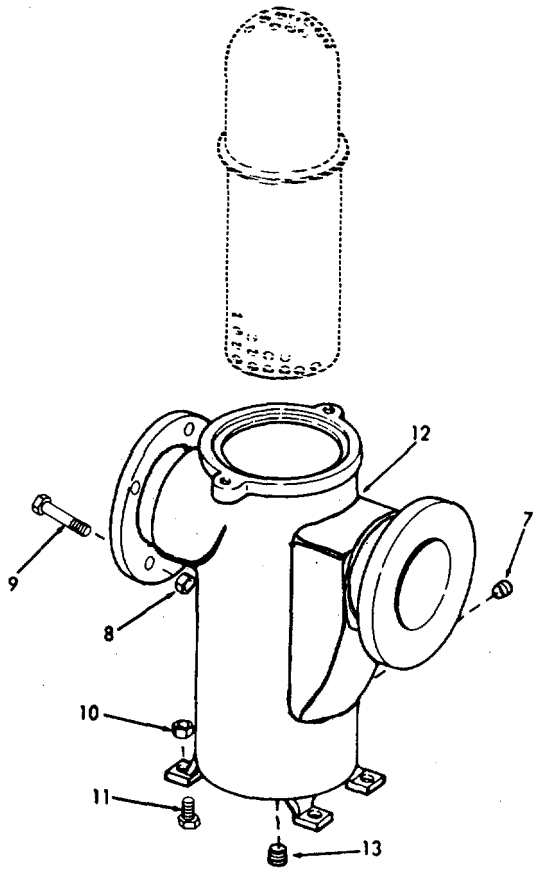
4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			



4-8.5. SIMPLEX STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	f. Body (12)	Relocate on base.	
	g. Screws (11), and nuts (10)	Replace.	
	h. Eight screws (9), and nuts (8)	Install.	
	i. Pipe plug (7)	Install	



4-474

4-9. BILGE PUMP.

a. The bilge pump is located in the forward engine room. The pump is belt-driven, and powered by the main propulsion engine. The pump can be turned off and on by movement of a shift lever on a clutch.

b. The following is an index to the maintenance instructions:

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING.

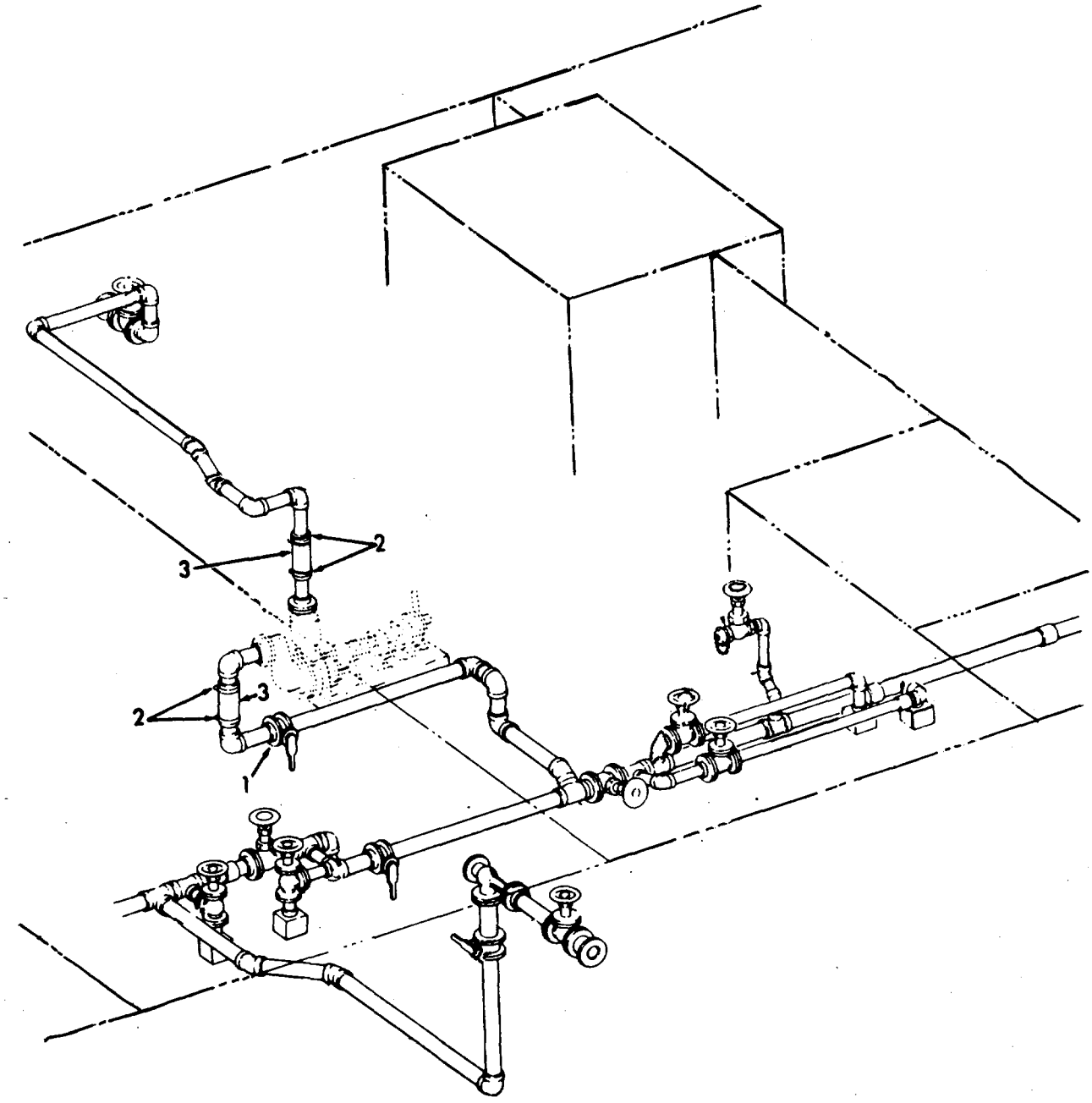
4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
		WARNING Tag start buttons in both the pilot house and forward engine room.	
INSPECTION			
1. Pump foundation and drive	a. Jack shaft	Inspect for cracks, dents, or bends.	
	b. Body	Inspect for cracks, dents, or bends.	
	c. Belt	Inspect for tightness or fraying.	
	d. Hardware	Inspect for tightness.	
	e. Hoses	1. Inspect for breaks, cracks, leaks and deterioration. 2. Inspect for loose hose clamps.	
REMOVAL			
2.	a. Valve (1)	Place in the off position.	
	b. Hose clamps (2)	Loosen.	
	c. Hoses (3)	Remove.	

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



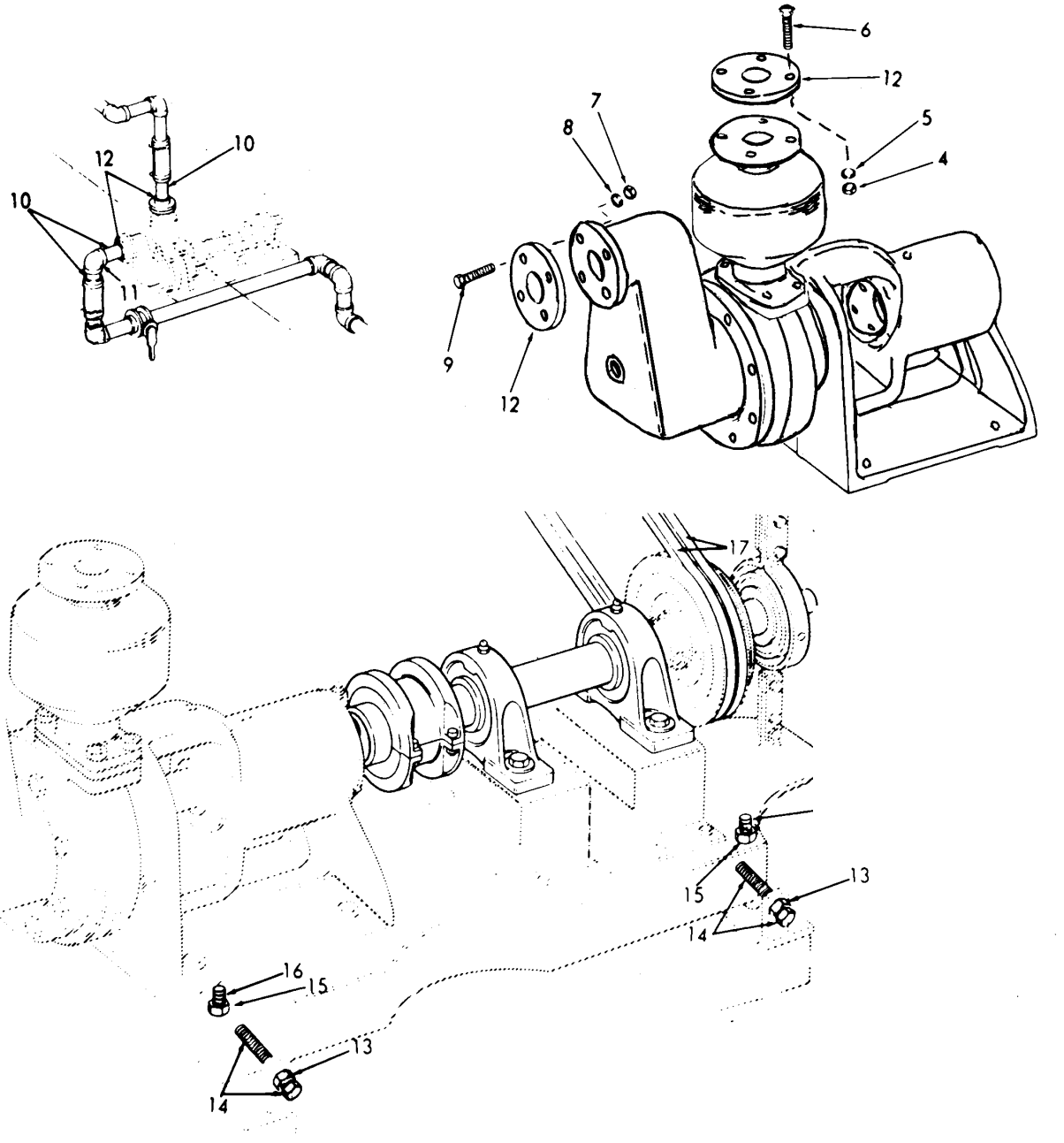
4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Nuts (4), lock - washers (5), and screws (6)	Remove.	
	e. Nuts (7) lock - washers (8), and screws (9)	Remove.	
	f. Pipes (10), elbows (11), and flanges (12)	Disassembly.	If needed.
	g. Lock nuts (13) and bolts (14)	Loosen.	
	h. Nuts (15), and screws (16)	Remove.	
	i. Belt guard	1. Remove all hardware. 2. Remove belt guard.	
	j. Belts (17)	Remove from main pro-pulsion engine.	
	k. Pump assembly	Remove.	

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

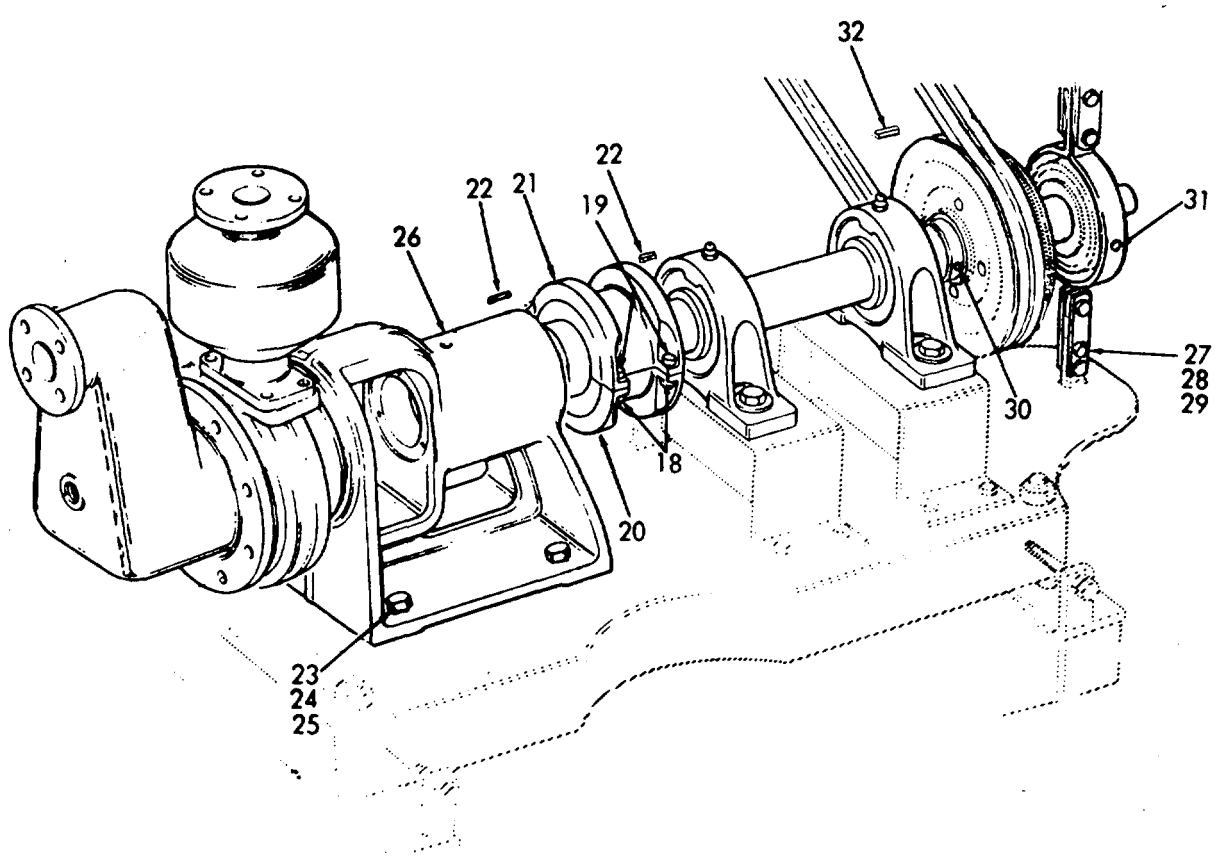


4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Coupling	a. Nuts (18), and screws (19)	Remove.	
	b. Driving coupling half (20), driven coupling half (21) and keys (22)	Remove.	
4. Pump	a. Nuts (23), lock-washers (24), and nuts (25)	Remove.	
	b. Pump (26)	Remove.	
5. Clutch	a. Nuts (27), lock-washers (28), and screws (29)	Remove.	
	b. Setscrews (30)	Loosen.	
	c. Shifter yolk (31), and key (32)	Remove.	

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

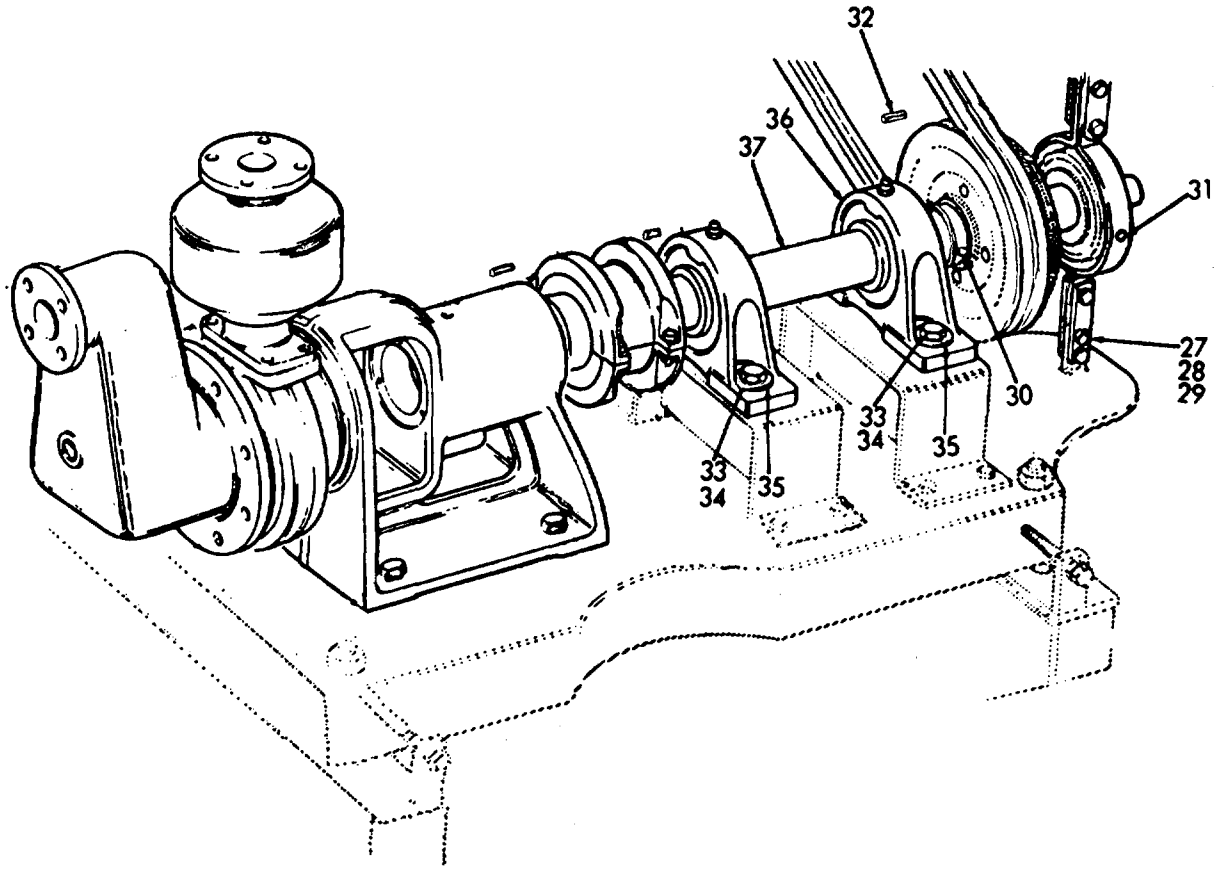


4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
6. Pillow Block	a. Nuts (33), lock-washers (34), and screws (35)	Remove.	
	b. Pillow block (36), and jackshaft (37)	Remove.	
REASSEMBLY			
7. Pillow block	a. Pillow block (36), and jackshaft (37)	Reassemble.	
	b. Screws (35), lock - washers (34) ,and nuts (33)	Install.	
8. Clutch	a. Key (32), and shifter yolk (31)	Assemble to jackshaft (37).	
	b. Setscrews (30)	Tighten.	
	c. Screws (29), lock-washers (28), and nuts (27)	Install.	

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

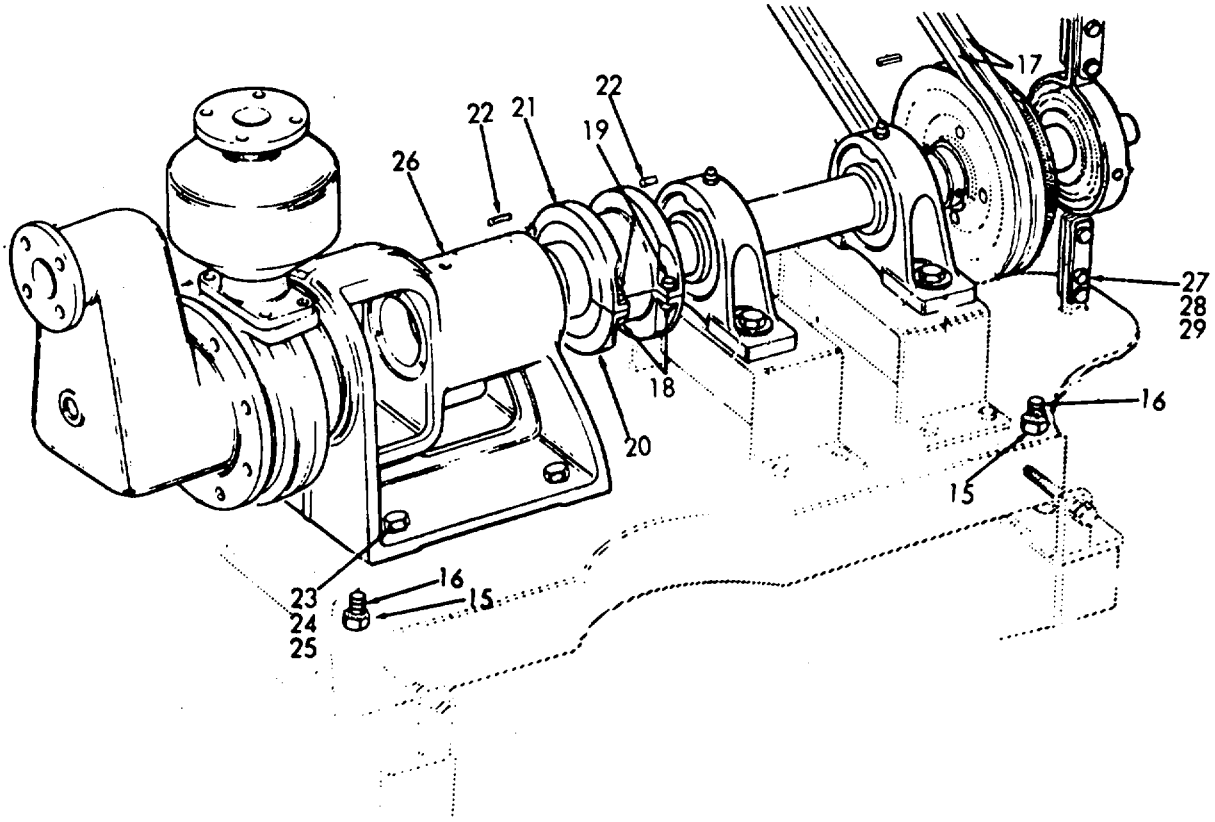


4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
9. Pump	Pump (26), screw (25), lockwashers (24), and nuts (23)	Install.	
10. Coupling	a. Keys (22), driven coupling half (21), and driving coupling half (20)	Reassemble.	
	b. Nuts (19), and screws (18)	Install.	
INSTALLATION			
11. Pump foundation and Drive	a. Belts (17)	Install.	
	b. Belt guard and hardware	Install.	
	c. Screws (29), lockwashers (28), and nuts (27)	Install.	
	d. Screws (16), and nuts (15)	Install.	Do not tighten.

4-9.1. BILGE PUMP FOUNDATION AND DRIVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



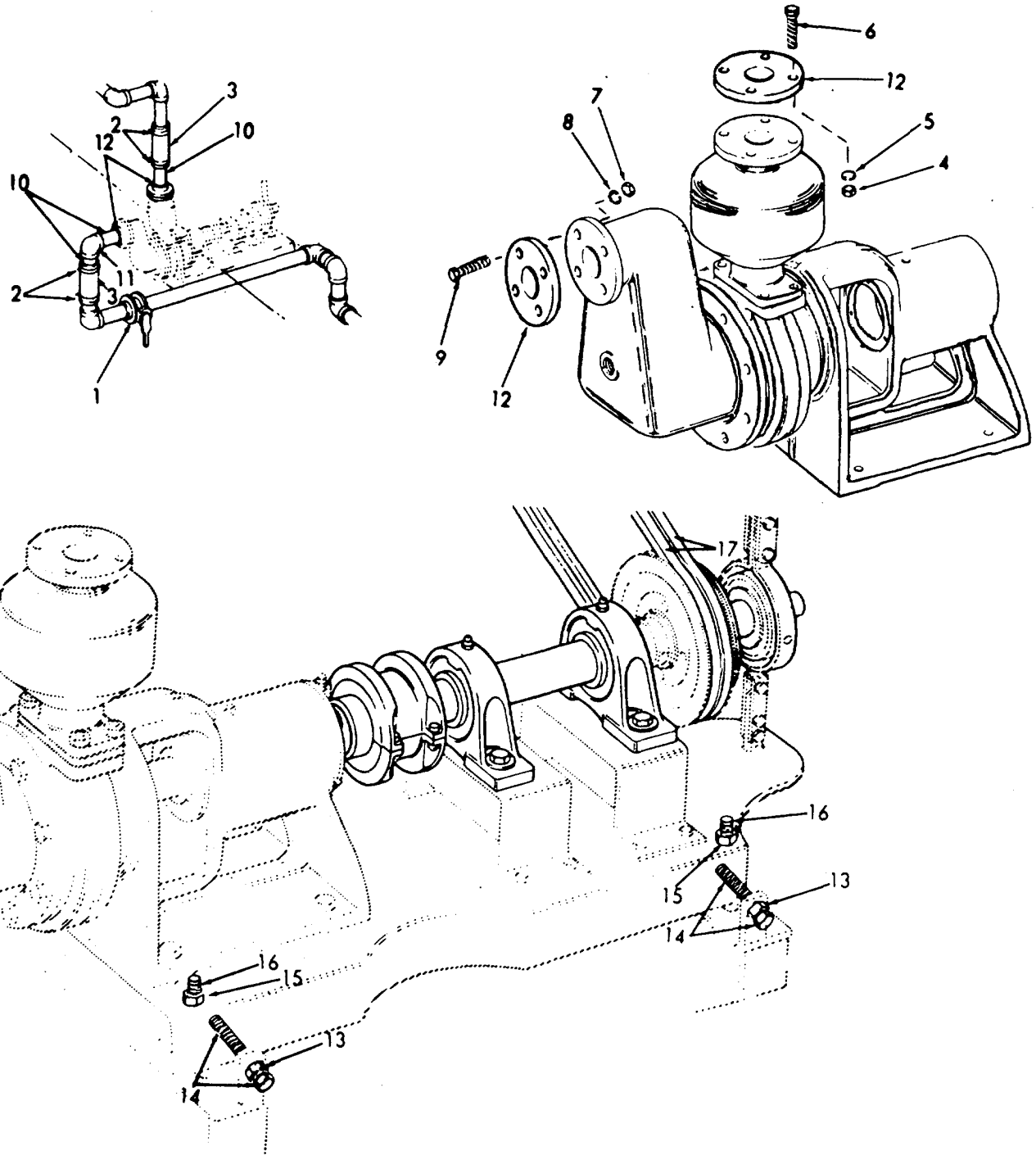
4-9.1. FOUNDATION AND DRIVE - MAINTENANCE INSTRUCIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	e. Bolts (14), and lock-nuts (13)	1. Adjust to tighten belts. 2. Tighten.	
	f. Screws (15), and nuts (16)	Tighten.	
	g. Pipes (10), elbows (11), and flanges (12)	Install.	If removed.
	h. Screws (9), lock - washers (8) and nuts (7)	Install.	
	i. Screws (6), lock - washers (5) and nuts (4)	Install.	
	j. Hoses (3) and hose clamps (2)	Install.	
	k. Valve (1)	Turn on.	
PRIME			
12. Pump	Pipe plug	1. Remove pipe plug on top of pump. 2. Fill with water.	

4-9.1. FOUNDATION AND DRIVE - MAINTENANCE INSTRUCIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Disassembly
c. Reassembly
d. Service

INITIAL SETUP

Test Equipment
NONE

Special Tools

Hammer (soft)
Wheel puller

Material/Parts
Grease MIL-G-10924
Type GAA

Personnel Required
2

References
NONE

Equipment
Condition Condition Description
Paragraph
4-9.1 Bilge Pump Removal

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNINGS.

LOCATION	ITEM	ACTION	REMARKS

WARNING

Tag start buttons in both pilot house and forward engine room.

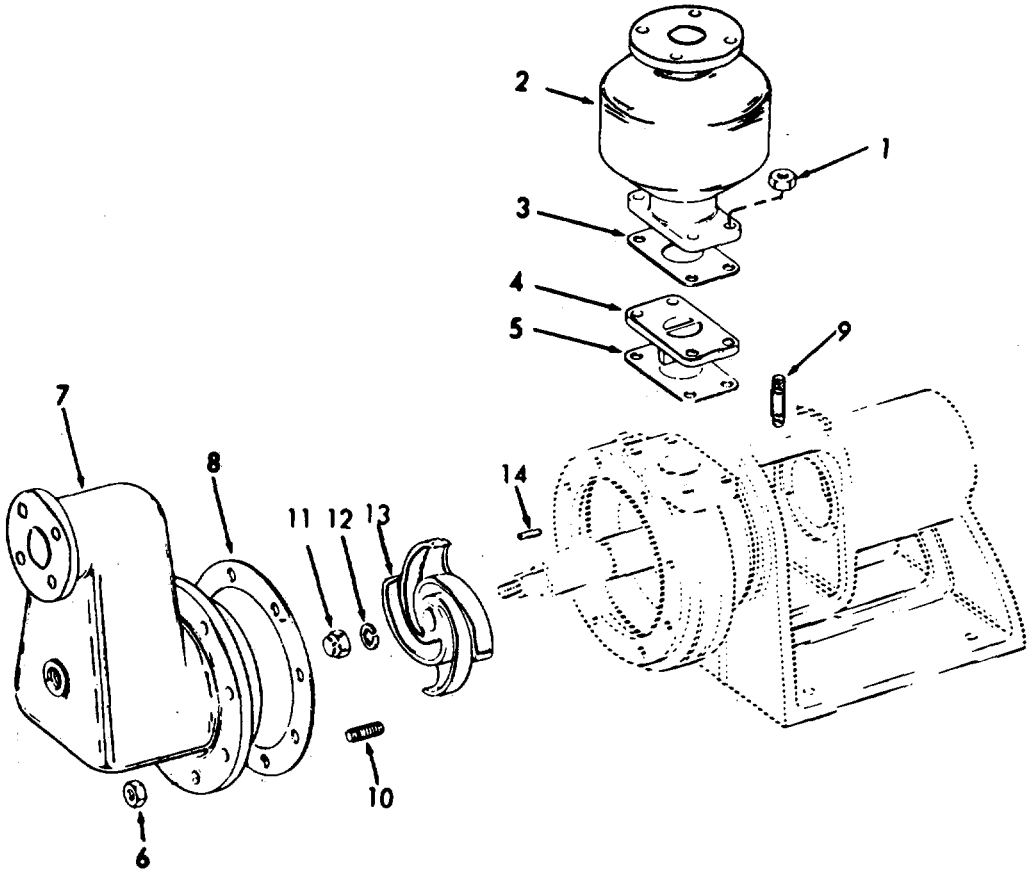
INSPECTION			
1.	a. Casing	Inspect for breaks, cracks of leaks.	
	b. Hardware	Inspect for tightness.	

4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Nuts (1)	Remove.	
	b. Discharge chamber (2), upper port gasket (3), recir-culating port (4), and lower port gasket (5)	Remove.	
	c. Nuts (6)	Remove.	
	d. Suction chamber (7) ,and casing gasket (8)	Remove.	Discard gasket.
	e. Studs (9 and 10)	Replace.	If damaged.
	f. Nuts (11)	1. Block coupling so that shaft does not turn.	
		2. Remove nut.	Right hand thread.
	g. Lockwasher (12)	Remove	
	h. Impeller (13), and key (14)	Remove.	The impeller should slide off the end of the shaft. If the impeller is frozen or corroded -
			a. Strike the casing with a soft ham-mer. Do not ex-ert too much force as bearings might be damaged.

4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		b. Use a wheel puller. Remove the mounting studs (10), and insert puller bolts in stud holes - protect shaft end from damage.	

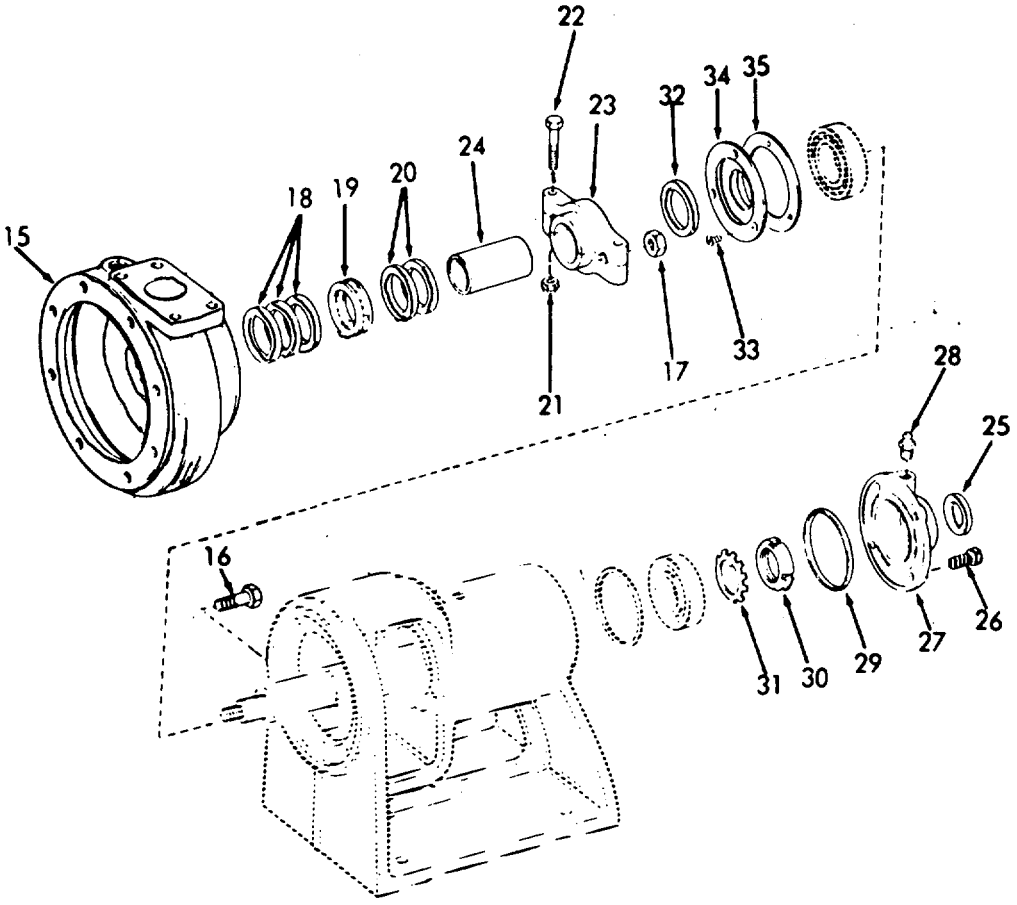


4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	i. Pump casing (15)	Inspect for clogging.	
	j. Bearing cover bolts (16)	Remove.	
	k. Gland nuts (17)	Remove.	
	l. Pump casing (15)	Pull back and remove.	
	m. Packing rings (18), seal cage (19), and packing rings (20)	Remove.	Discard packing rings.
	n. Nuts (21), capscrews (22), gland (23), and shaft sleeve (24)	Remove.	
	o. Slinger (25)	Remove.	
	p. Screws (26), and bearing thrust cover (27)	Remove.	
	q. Lubrication fitting (28)	Remove.	If necessary.
	r. Bearing shim (29), bearing locknut (30), and lockwasher (31)	Remove.	

4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	s. Slinger (32)	Remove.	
	t. Screws (33), line bearing cover (34), and cover gasket (35)	Remove.	Discard gasket.

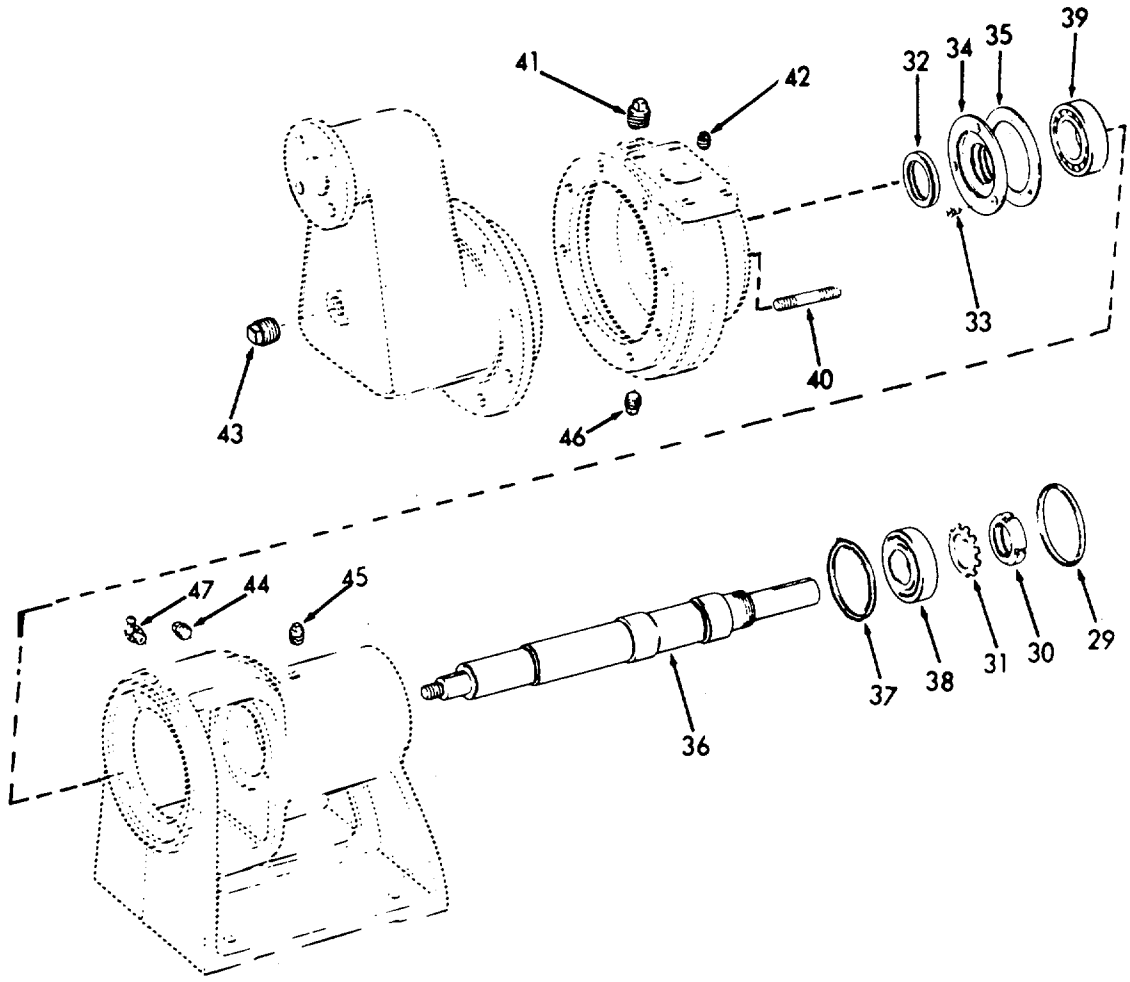


4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	u. Shaft (36)	Remove.	Press out.
	v. Bearing (37), and seal ring (38)	Remove.	
	w. Bearing (39)	Remove.	
	x. Studs (40)	Remove.	If necessary.
	y. Pipe plugs (41, 42, 43, 44, 45, and 46)	Remove.	If necessary.
	z. Lubrication fitting (47)	Remove.	If necessary.
REASSEMBLY			
3.	a. Bearing (39)	Install.	Use arbor press.
	b. Seal ring (38), and bearing (37)	Install.	Use arbor press.
	c. Shaft (36)	Install.	Use arbor press.
	d. Cover gasket (35), line bearing cover (34), and screws (33)	Install.	Use new gasket.
	e. Slinger (32)	Install.	

4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	f. Lockwasher (31), bearing locknut (30), and bearing shim (29)	Install.	Use new shim if shim was damaged.

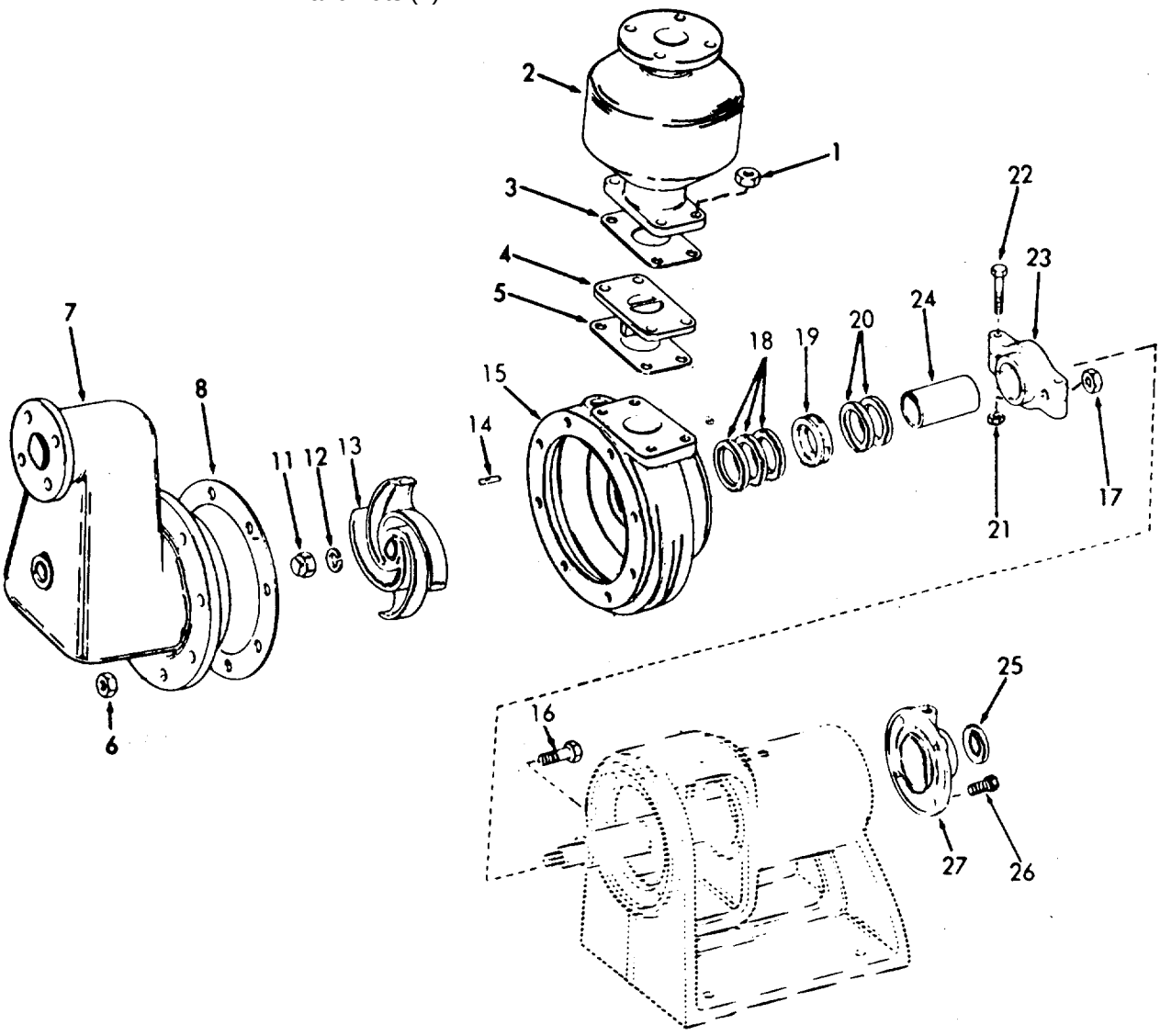


4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Bearing thrust. cover (27), and screws (26)	Install.	
	h. Slinger (25)	Install.	
	i. Shaft sleeve (24), gland (23), cap-screws (22), and nuts (21)	Install.	
	j. Packing rings (20), seal cage (19), and packing rings (18)	Install.	
	k. Gland nuts (17)	Install.	
	l. Bearing cover bolts (16)	Install pump casing (15) to frame.	
	m. Impeller (13), key (14), lock-washer (12), and nut (11)	Install.	
	n. Casing gasket (8), suction chamber (7) and nuts (6)	Install.	Use new gasket.

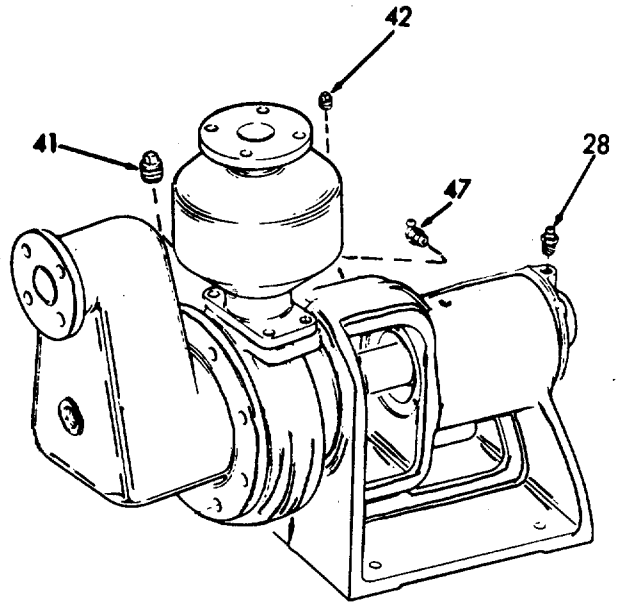
4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	o. Lower port gasket (5), recirculating port (4), upper port gasket (3), discharge chamber (2), and nuts (1)	Reassemble.	



4-9.2. BILGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
4. Lubrication	Lubrication fittings (28), and (47)	Grease.	Use grease, MIL-G-10924 Type GAA.
5. Priming	Pipe plugs (41 and 42)	1. Remove. 2. Fill with water until water flows from vent. 3. Replace both pipe plugs.	



4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition: Condition Description
Paragraph
4-9.1: Clutch removed

Material/Parts
NONE

Special Environmental Conditions
NONE

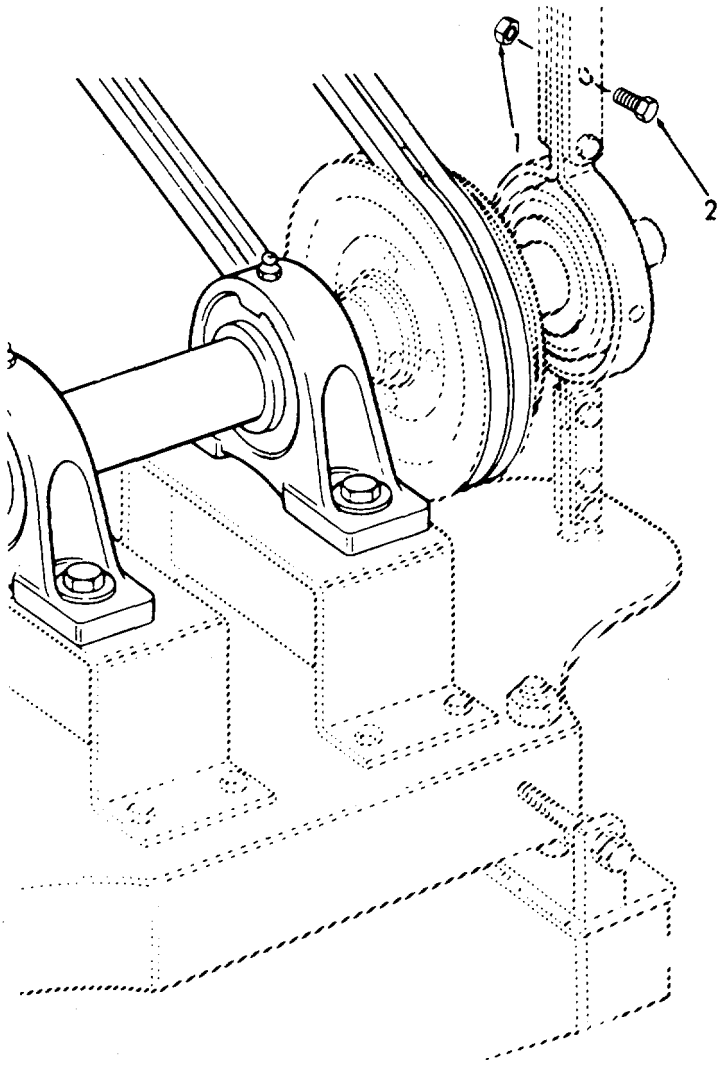
Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Clutch	a. Lever	Inspect for bend, leaks, and cracks.	
	b. Belts	Inspect for breaks, cracks and wear.	
	c. Hardware	Insure all hardware is tight.	
DISASSEMBLY			
2.	a. Nuts (1), and screws (2)	Remove.	

4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

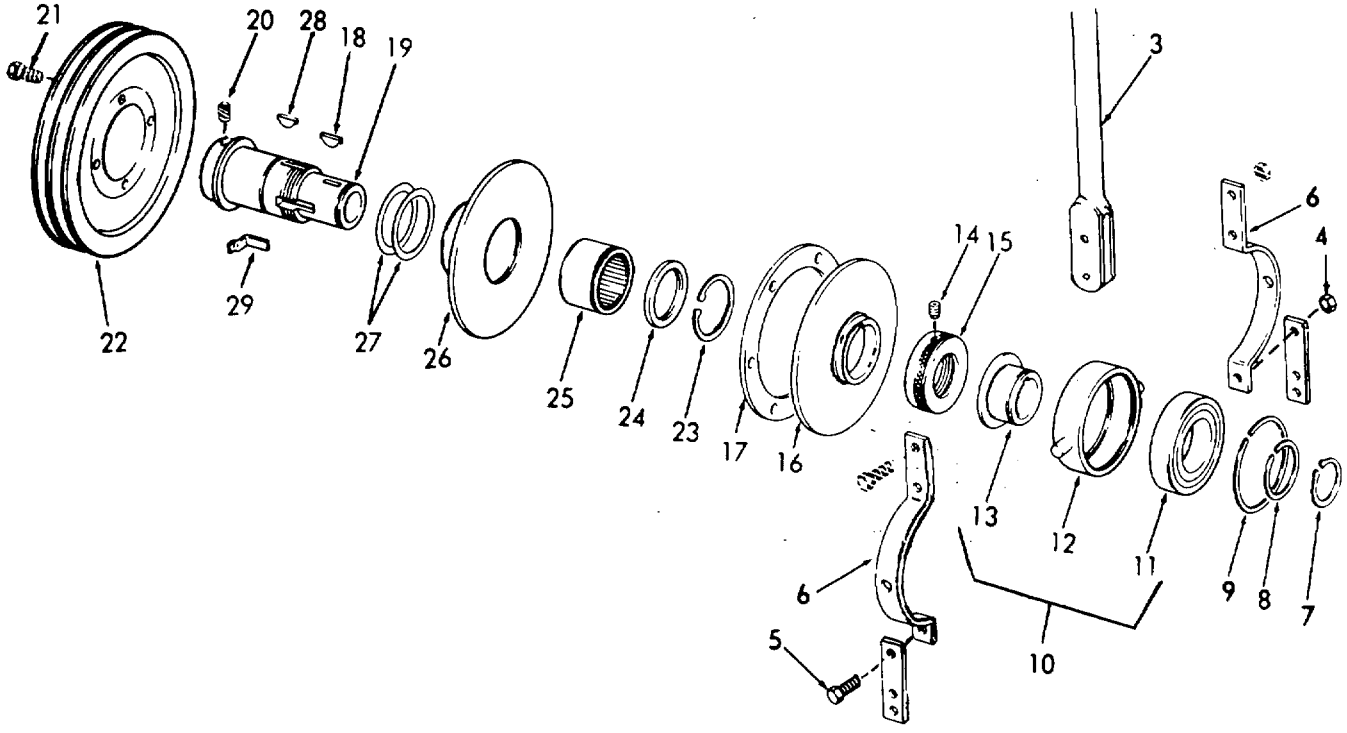


4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	b. Handle (3)	Remove.	
	c. Nuts (4) and screws (5)	Remove.	
	d. Shifter yoke (6)	Remove.	
	e. Cam snap ring (7), and exterior snap ring (8)	Remove.	
	f. Interior snap ring (9), and ball bearing assembly cam (10)	Remove.	
	g. Ball bearing (11), cam assembly (12), and ball bearing cam (13)	Disassemble.	
	h. Setscrew (14)	Loosen.	
	i. Adjuster (15)	Unscrew.	
	j. Assembly plate (16), and friction liner (17)	Remove.	
	k. Key (18)	Remove from body (19).	
	l. Setscrew (20)	Remove.	

4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	m. Screws (21), and pulley assembly (22)	Remove.	
	n. Shim ring (23), needle bearing seal (24), and needle bearing (25)	Remove.	
	o. Adapter assembly (26)	Remove.	
	p. Thrust washer (27), key (28), and levers (29)	Remove.	

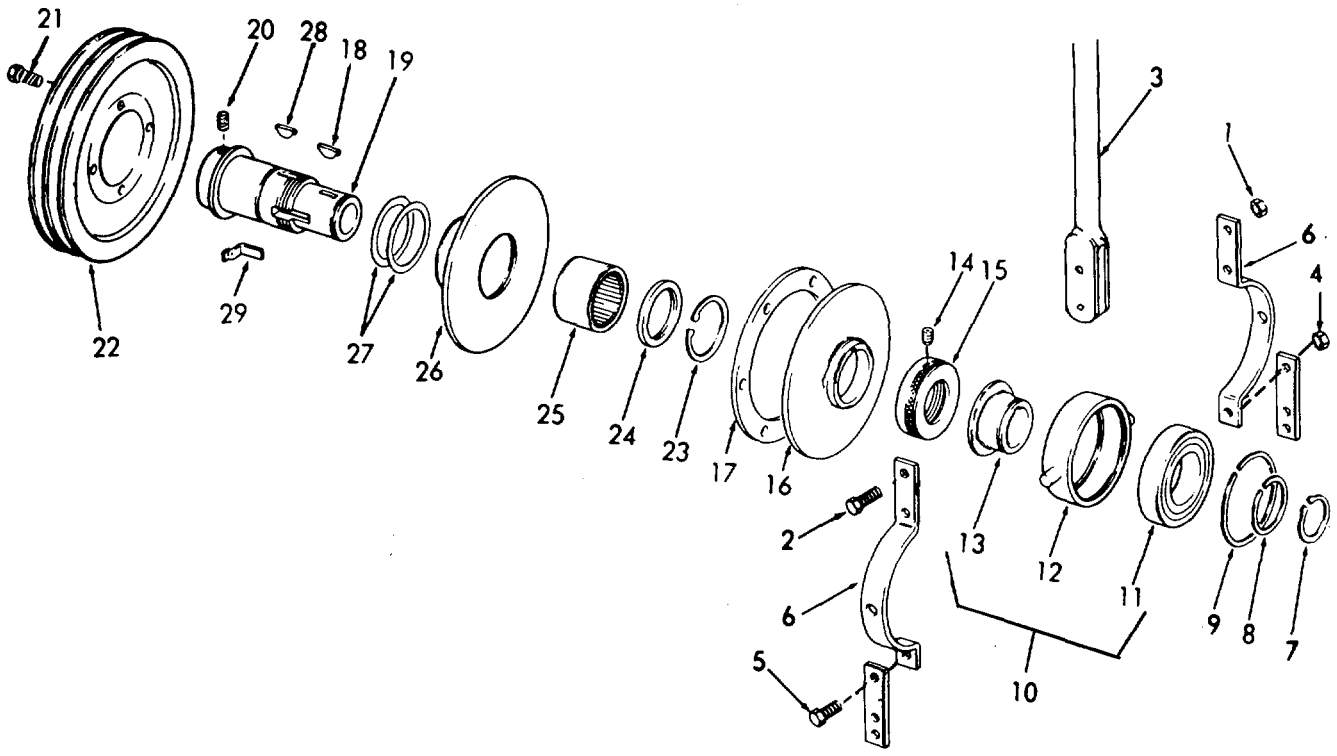


4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Lever (29), key (28), and thrust washers (27)	Place on body (19).	
	b. Pulley assembly (22), adapter assembly (26), and screws (21)	Install on body (19).	
	c. Setscrew (20)	Install.	
	d. Needle bearing (25), needle bearing seal (24), and shim ring (23)	Install.	
	e. Key (18), friction liner (17), and assembly plate (16)	Install.	
	f. Adjuster (15)	Install.	
	g. Setscrew (14)	Install.	
	h. Cam assembly (12), ball bearing (11), and ball bearing cam (13)	Assemble.	

4-9.3. BILGE PUMP CLUTCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	i. Interior snap ring (9)	Install.	
	j. Exterior snap ring (8)	Install.	
	k. Cam snap ring (7)	Install.	
	l. Shifter yoke (6), screws (5), and nuts (4)	Install.	
	m. Handle (3), screws (2), and nuts (1)	Install.	



4-10. STAND-BY LUBE OIL PUMP.

a. The standby lube oil pump is used to supply oil to the Marine Gear when the Main Propulsion Engine is not running and the vessel is being towed.

b. The following is an index to the maintenance procedures.

4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Oil MIL-L2104 Type OE/HDO

Personnel Required
2

References
NONE

Equipment Condition Condition Description
NONE

Special Environmental Conditions
Do not drain oil into bilges. Use the oil/water separation and recovery system to collect drained oil.

General Safety Instructions
Observe WARNINGS.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

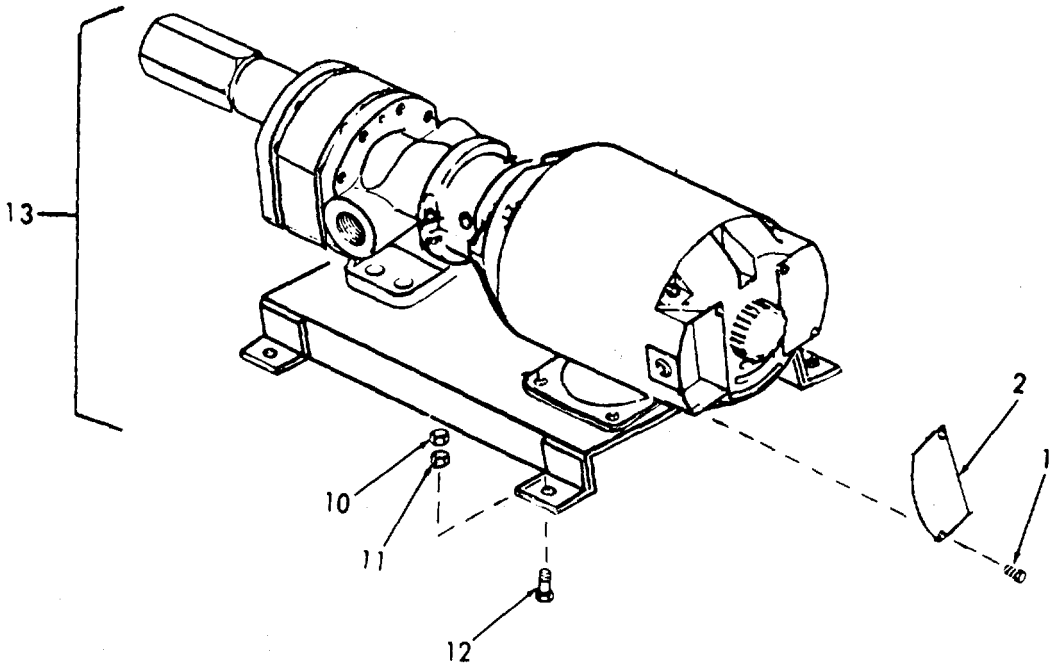
1. Lube oil pump	a. Pipes	Inspect for breaks, cracks, or leaks.	
	b. Housing	Inspect for breaks, cracks or leaks.	
	c. Hardware	Inspect for tightness.	

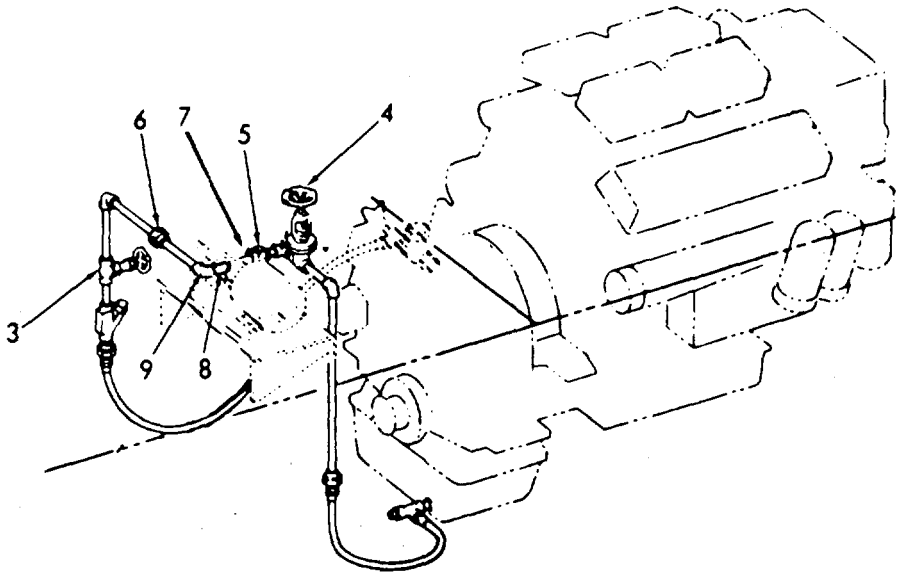
4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Wiring	Inspect for breaks, cracks, and signs of damage.	
REMOVAL			
2.	a. Screws (1), and cover plate (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Valves (3 and 4)	Turn off.	
	d. Union (5)	Loosen and separate.	
	e. Union (6)	Loosen and separate.	
	f. Pipe (7)	Remove.	
	g. Pipe (8), and elbow (9)	Remove.	
	h. Nuts (10 and 11), and screws (12)	Remove	
	i. Lube oil pump assembly (13)	Remove.	

4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			



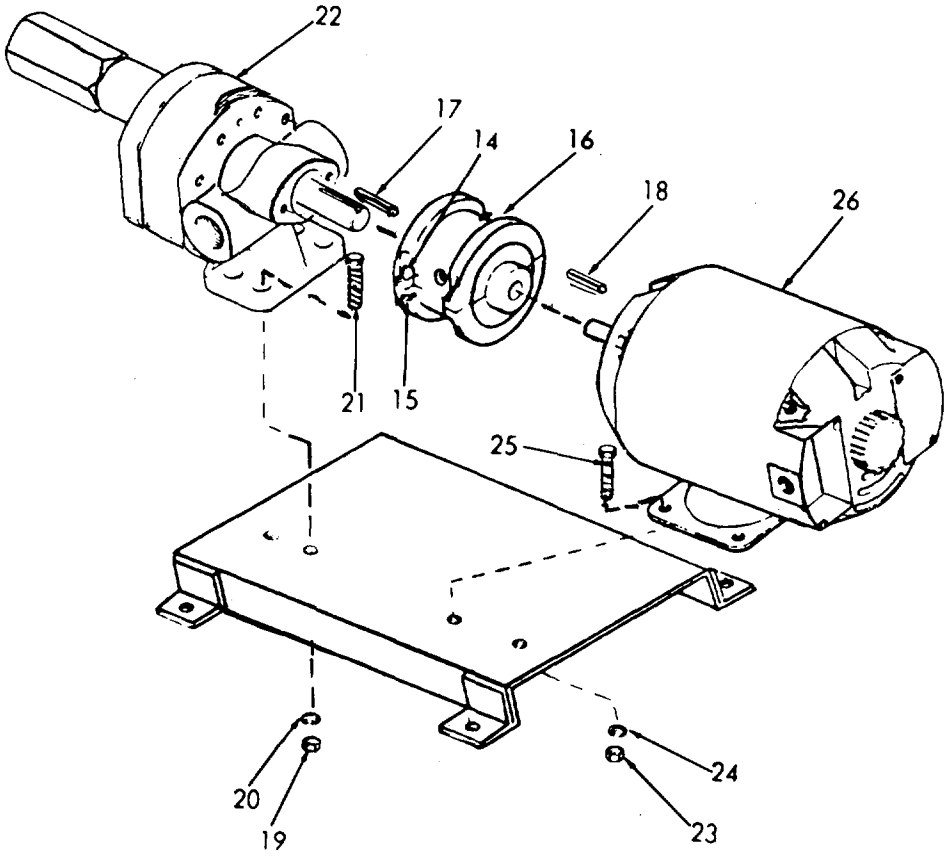


4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3.	a. Nuts (14), and screws (15)	Remove.	
	b. Coupling halves (16)	Disassemble.	
	c. Keys (17 and 18)	Remove.	
	d. Nuts (19), lockwashers (20), and screws (21)	Remove.	
	e. Pump (22)	Remove.	
	f. Nuts (23), lockwashers (24), and screws (25)	Remove.	
	g. Motor (26)	Remove.	
REASSEMBLY			
4.	a. Motor (26), screws (25), lockwashers (24), and nuts (23)	Reassemble.	
	b. Pump (22), screws (21), lockwashers (20), and nuts (19)	Reassemble.	
	c. Keys (17 and 18) and coupling halves (16)	Reassemble.	
	d. Screws (15), and nuts (14)	Install.	

4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Lube oil pump assembly (13), screws (12), and nuts (10 and 11)	Install.	
	b. Pipe (8), and elbow (9)	Install.	
	c. Pipe (7)	Install.	
	d. Unions (6 and 5)	Connect and tighten.	
	e. Valves (3 and 4)	Turn on.	
	f. Wiring	Reconnect and remove tags.	
	g. Cover plate (2), and screws (1)	Install.	

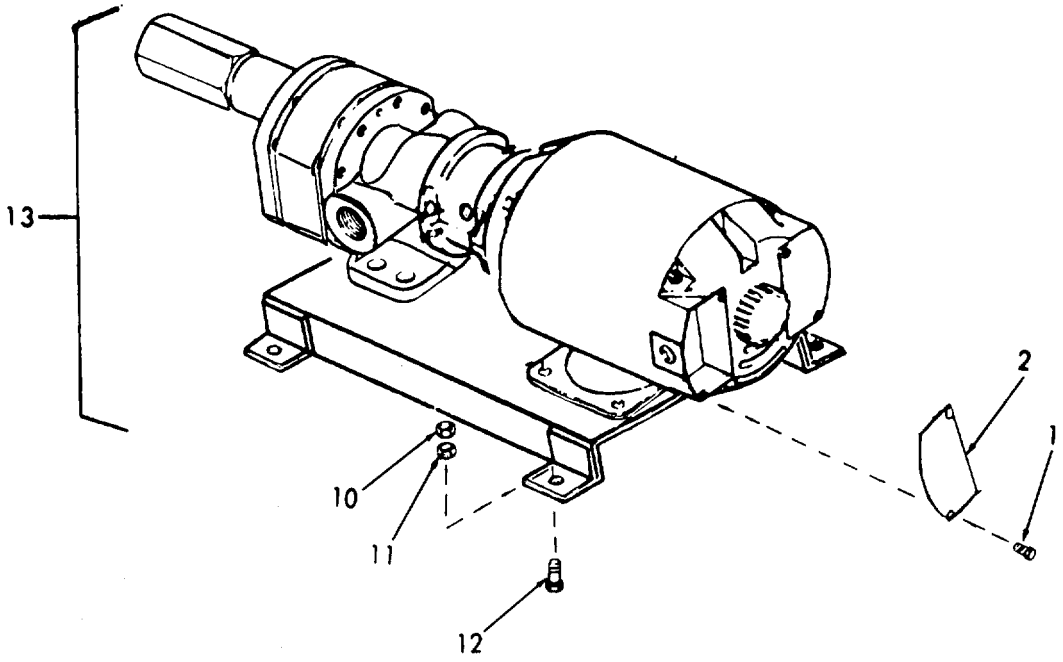
CAUTION

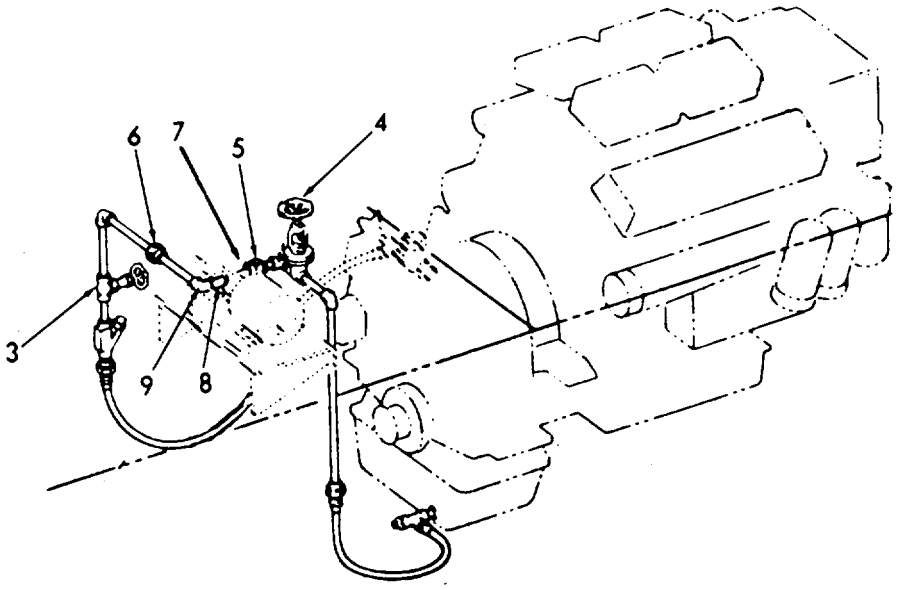
Do not run pump dry. Permanent damage will destroy the pump. Always run the Main Propulsiong Engine to circulate the oil through the Marine Gear and Lube Oil Pump.

	h. Oil	1. Add oil to Marine Gear.	Use type OE/HDO.
		2. Operate Main Propulsion Engine to fill pump.	

4-10.1. LUBE OIL PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			





4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
3M Company - Grinding Paper No. 600 or equivalent
Molybdenum sulfide
Plate glass

Personnel Required
1

References
NONE

Equipment Condition Condition Description
Paragraph
4-10.1 Lube Oil Pump Set removed

Special Environmental Conditions
NONE

General Safety Instructions
NONE

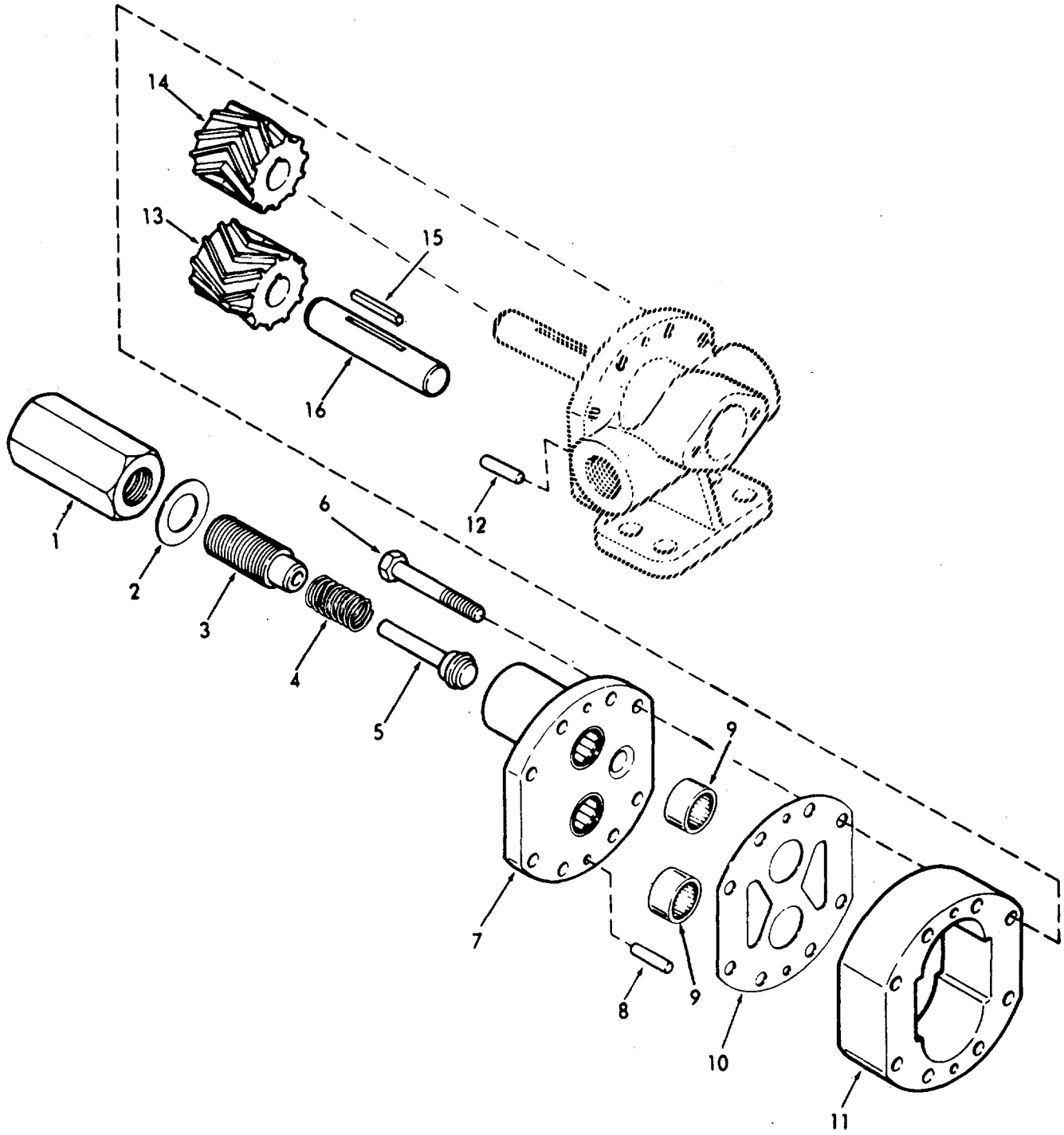
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Pump	a. Housing	Inspect for breaks, cracks or leaks.	
	b. Shaft	Inspect for bends, dents, or cracks.	
	c. Hardware	Inspect for tightness.	

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2. Relief Valve	a. Cover nut (1), and gasket (2)	Remove.	Discard gasket.
	b. Adjusting screw (3)	Turn counter-clockwise.	
	c. Spring (4), and relief valve (5)	Remove.	
3. Pump body	a. Screws (6)	Remove.	
	b. Side plate (7), and pins (8)	Remove.	Bearings may remain inside plate.
	c. Bearings (9)	1. Inspect for pitting and general overall condition. 2. Remove.	
	d. Gasket (10), pump body (11), and pins (12)	1 . Remove. 2. Hold driven gear (13) and driving gear (14).	Discard gasket. If allowed to be free, driven gear (13) would fall and possible damage may occur. Driving gear (14) would hang putting excessive pressure on bearings.
	e. Driven gear (13), key (15), and driven shaft (16)	Remove and disassemble.	

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

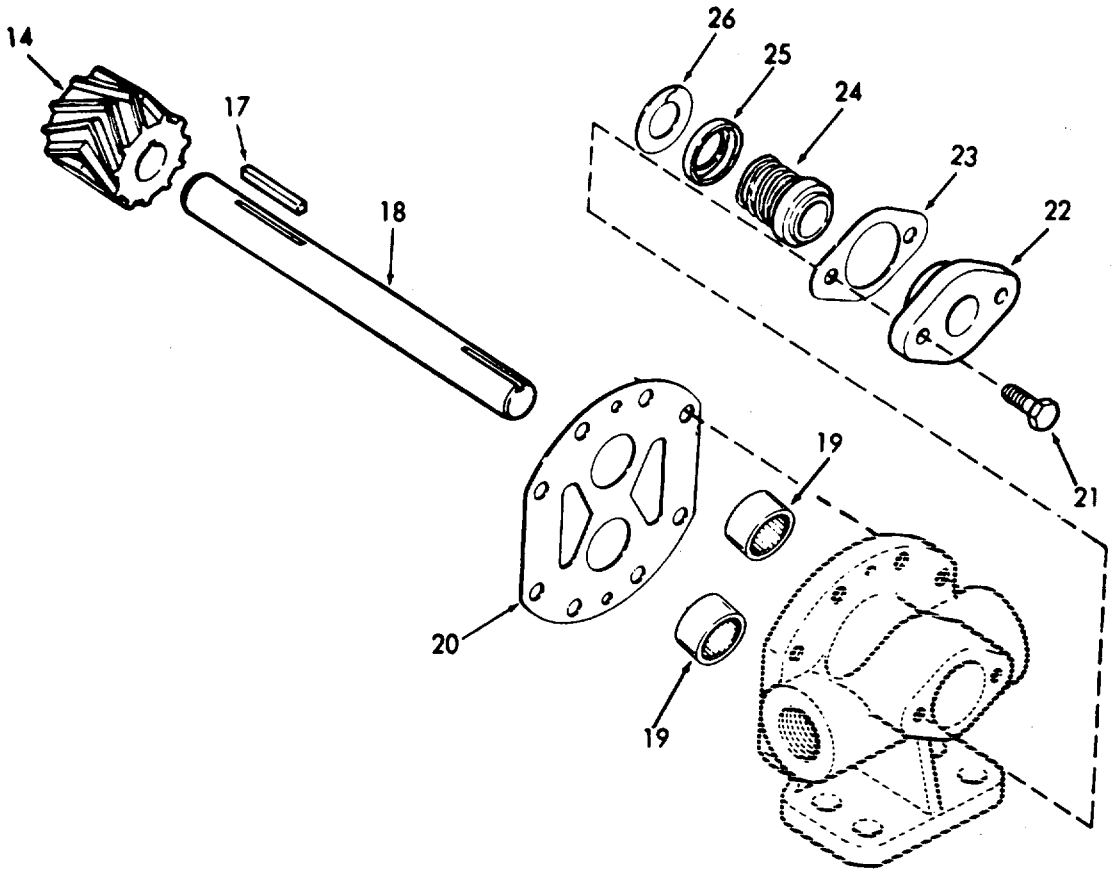


4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	f. Driving gear (14), key (17), and driving shaft (18)	Remove and disassemble.	
	g. Bearings (19)	1. Inspect for pitting and overall condition. 2. Remove.	
	h. Gasket (20)	Remove.	Discard gasket.
4. Stuffing box	a. Screws (21)	Remove.	
	b. Gland (22), and gasket (23)	Remove carefully.	Discard gasket.
	c. Mechanical seal (24)	1. Very carefully remove. 2 . Place, face up, in a safe location.	
	d. Seal collar (25), and retaining ring (26)	Remove.	Separate retaining ring from seal collar, if attached.

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			



4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

RELAPPING

a. The Mechanical Seal (24) and the Stuffing Box Gland (22) must be relapped prior to installation or replaced.

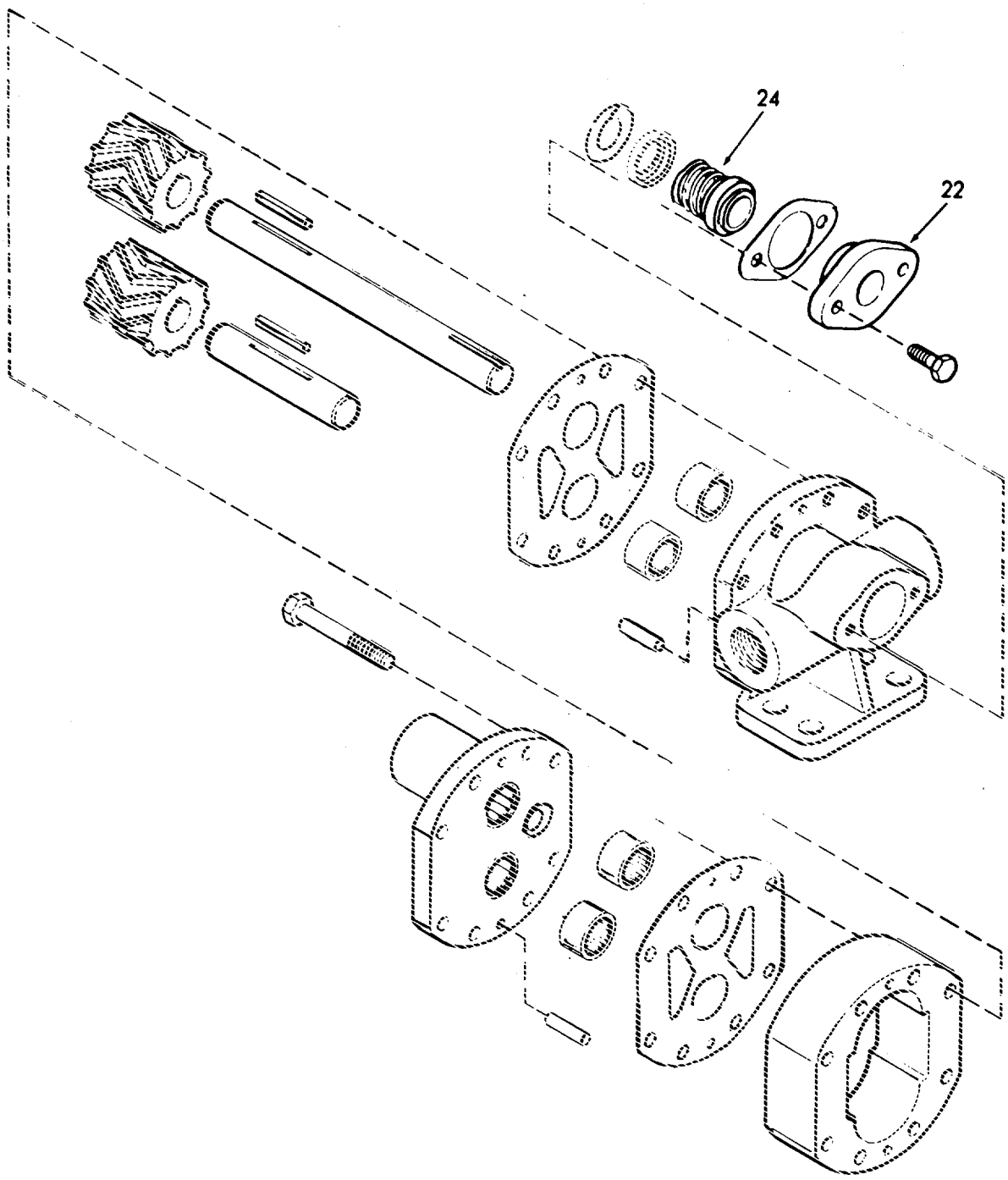
b. The carbon seal face/stationary seat in a new condition, should have a perfectly lapped face. If the seal is slightly marred, (no large scratches, chips, etc.) it is possible, by relapping, to recondition the seals. To accomplish relapping, the following materials are essential: a true surface, which can be either a lapping plate or a sheet of plate glass; lapping paper, which could be No. 600 Minnesota Manufacturing Company grinding paper, or an approved equal, and a work bench, which should be clear of debris.

c. The following steps should be followed to assure successful lapping:

1. On a clean bench, lay the true surface flat.
2. Air-blow the true surface and back of lapping paper to remove foreign material.
3. Place lapping paper on true surface, and hold firmly with either hand.
4. With your other hand, grab the seal/seat, and, being careful not to drop same, place it on the lapping paper-face down.
5. With a firm grip, and an even, light pressure, move seal/seat in a figure eight pattern for a total of five complete figures. Be careful not to rock or tip element during this process. Further, this process should be accomplished with- out releasing the grip of either hand.
6. Rotate element approximately 90°, and repeat Step 5.
7. Repeat Step 6 until such time as the face is cleaned up.
8. Carefully wipe off using very clean, soft cloth which has been saturated in solvent.
9. Position piece in stuffing box immediately to avoid redamaging face.

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
RELAPPING			

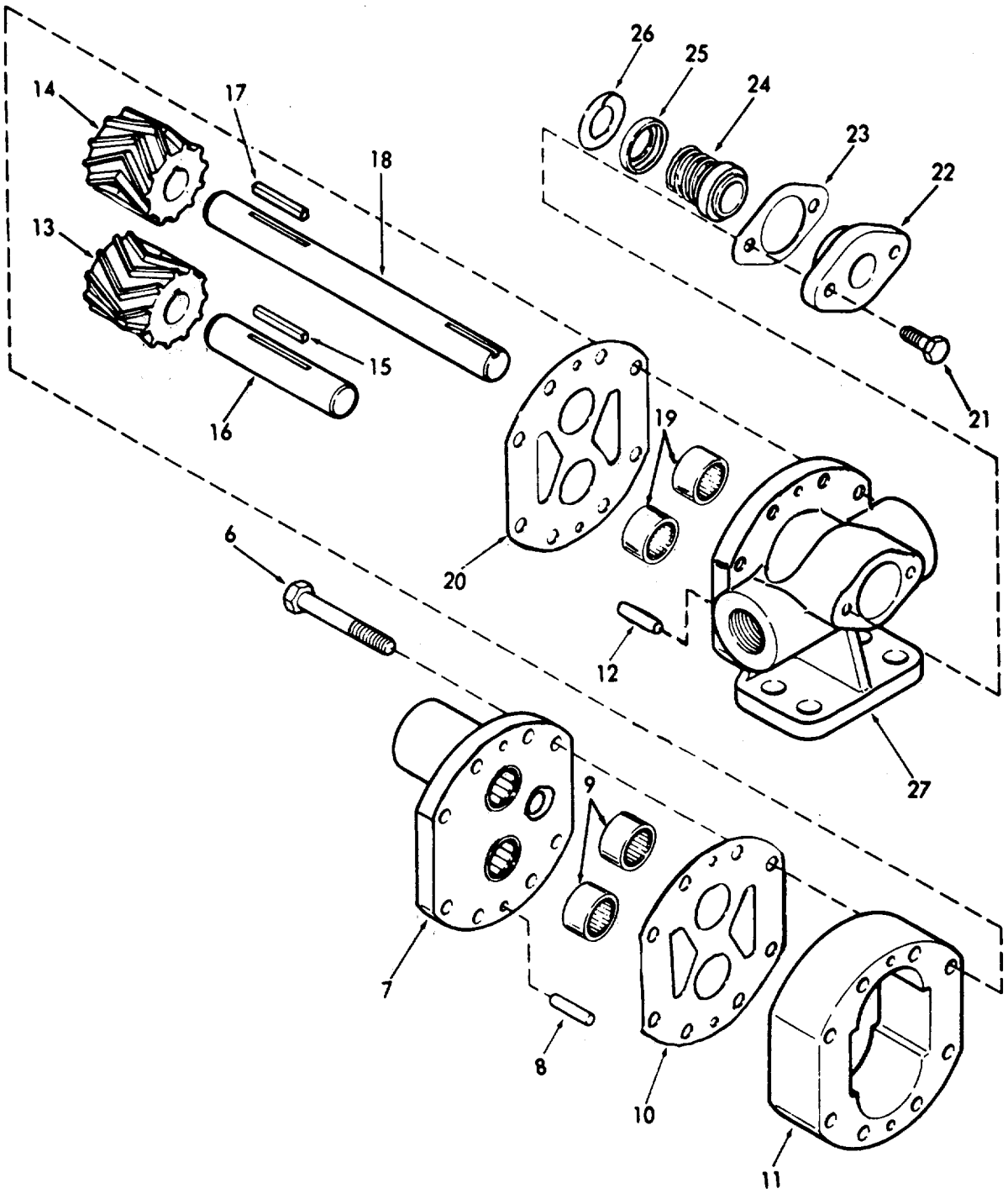


4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Stuffing box	Retaining ring (26),seal collar (25), mechanical seal (24), gasket (23), gland (22), and screws (21)	Reassemble carefully.	Replace gasket.
6. Pump body	a. Gasket (20), bearings (19), and mounting bracket (27)	Reassemble.	Replace gasket and bearings if necessary.
	NOTE Apply an molybdenum disulfide-based lubricant to gears (13 and 14), side plate (7) and mounting bracket (27).		
	b. Driving shaft (18), key (17), and driving gear (14)	Reassemble.	
	c. Driven shaft (16), key (15), and driven gear (13)	Reassemble.	
	d. Pins (12), pump body (11), and gasket (10)	Reassemble.	Replace gasket.
	e. Bearings (9), pins (8), side plate (7), and screws (6)	Reassemble.	Replace bearing if necessary.

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

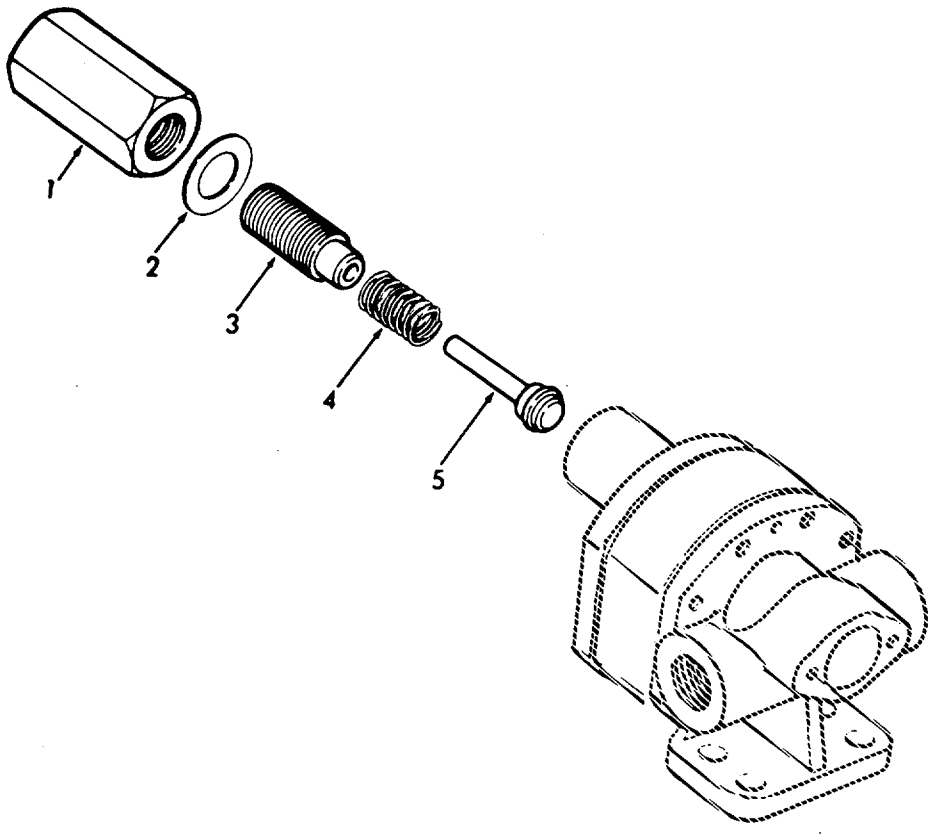


4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
7. Relief Valve	a. Relief valve (5), and spring (4)	Reassemble.	
	b. Adjusting screw (3)	Turn clockwise.	
	c. Gasket (2), and cover nut (1)	Reassemble.	Replace gasket.
	d. Lube oil pump	1. Operate. 2. Observe Marine Gear oil pressure gage on Propulsion Engine instrument panel. 3. Rotate adjustment screw until the normal marine gear oil pressure is obtained.	

4-10.2. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-10.3. LUBE OIL PUMP - MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment
Condition Condition Description
Paragraph
4-10.1 Lube Oil Pump Set removed

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

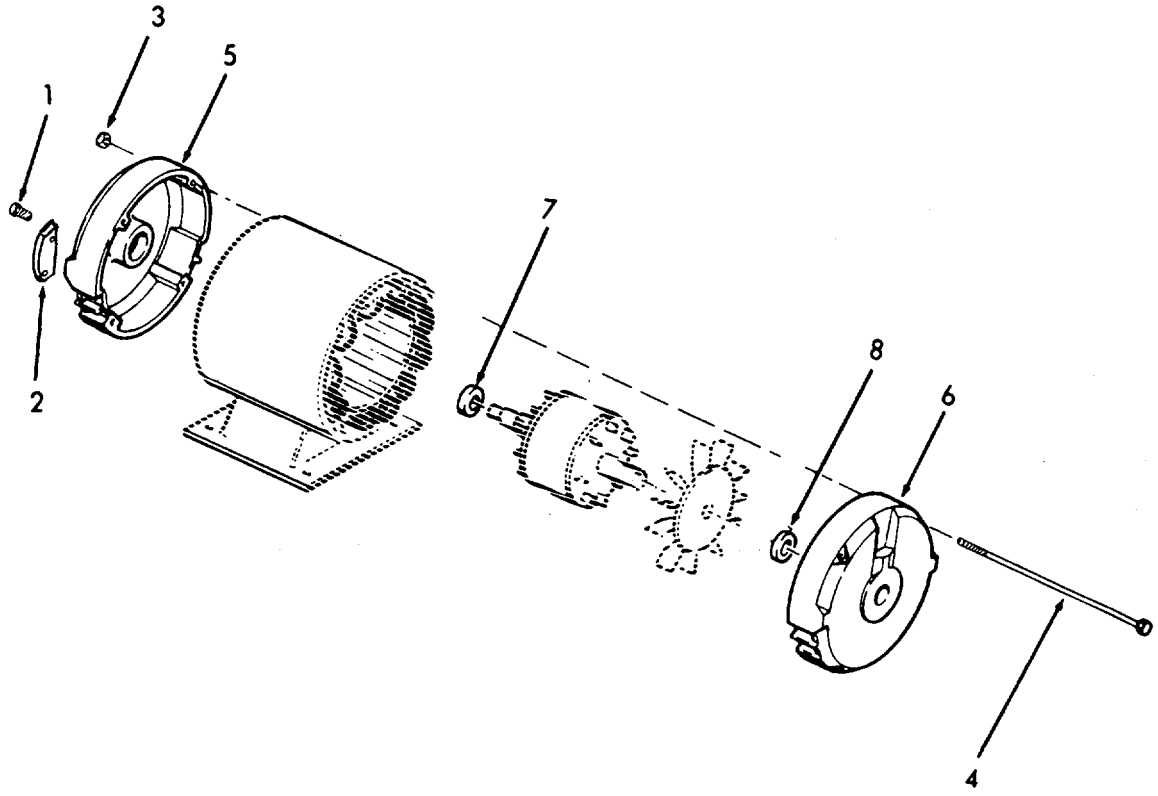
1. Motor	a. Frame	Inspect for cracks, dents, or breaks.	
	b. Shaft	Inspect for bends, cracks, or dents.	
	c. Hardware	Inspect for tightness.	
	D . Wiring	Inspect for breaks, cracks, and signs of damage.	

4-10.3. LUBE OIL PUMP - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Screws (1), and cover (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Nuts (3), and screws (4)	Remove.	
	d. Brackets (5 and 6)	Remove.	
	e. Ball bearings (7 and 8)	Remove from brackets.	a. Use bearing puller. b. Inspect for flat spots, burrs, or excessive wear.
REASSEMBLY			
3.	a. Ball bearings (8 and 7)	Reassemble to brackets. Use arbor press.	
	b. Brackets (6 and 5), screws (4), and nuts (3)	Reassemble.	
	c. Wiring	Reconnect and remove tags.	
	d. Cover (2), and screws (1)	Install.	

4-10.3. LUBE OIL PUMP - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
2

References
NONE

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Controller (external)	a. Enclosure	1. Inspect for breaks, cracks, dents, and bending.	
		2. Insure all mounting hardware is tight.	
	b. Wiring	Inspect for wear, fraying, and damage.	

4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

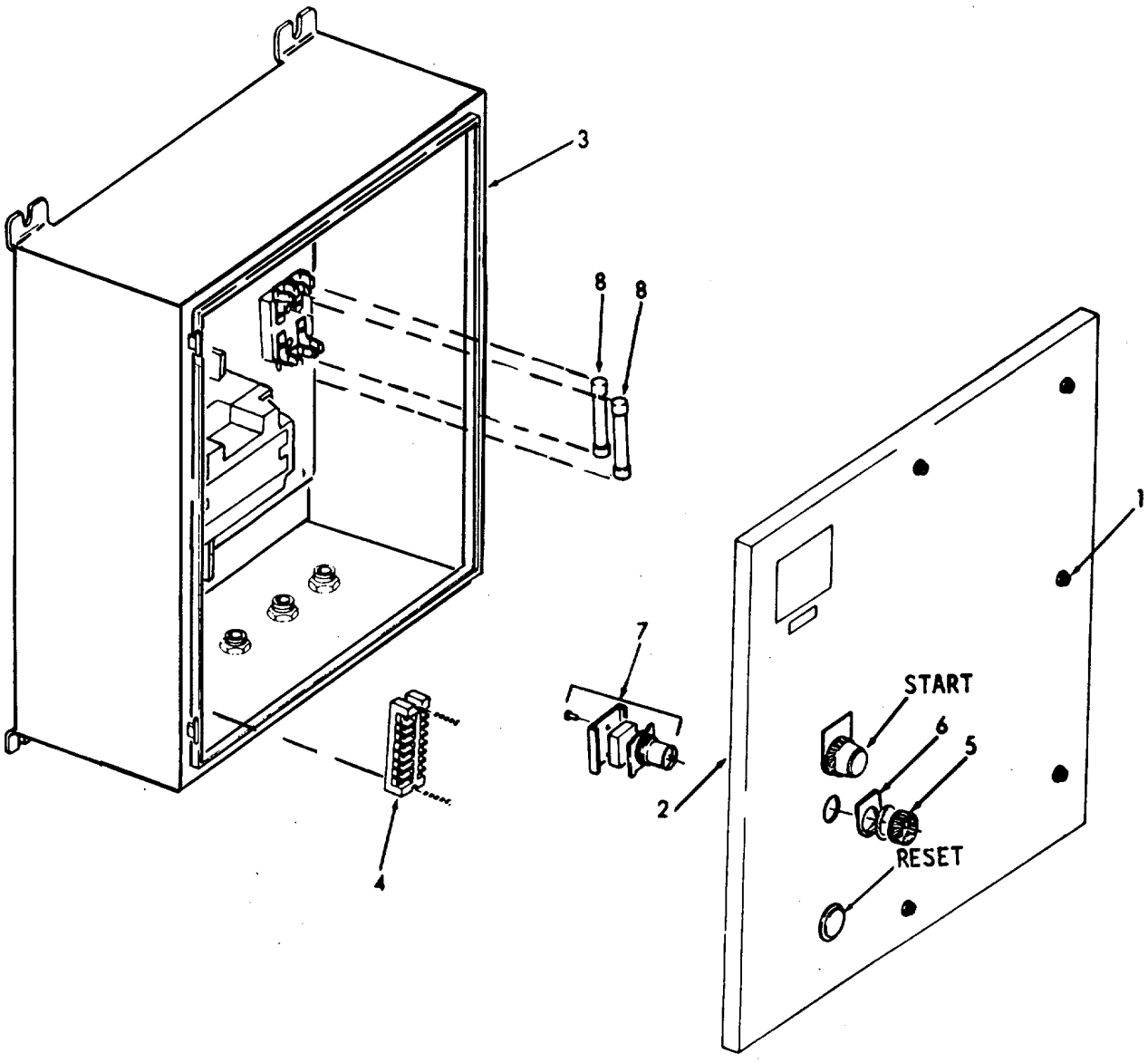
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Switches	Inspect for signs of failure or improper operation.	
2. Controller (internal)	a. Starters	1. Inspect for worn contact tip material.	
		2. Inspect for clean-liness.	
		3. Insure all mounting hardware is tight.	
	b. Wiring	1. Install for wear, fraying, and damage.	
		2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure.	
		2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components.	
		2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks.	
		2. Insure all mounting hardware is tight.	

4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Controller	a. Captive screws (1)	Rotate counter-clockwise to loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect from terminal block (4).	Refer to schematic.
	d. Controller (3)	Remove from bulkhead.	
REPAIR			
4. Pushbutton switches	a. Wiring	Tag and disconnect.	
	b. Retaining nut (5)	Unscrew and remove.	
	c. Identification plate (6), and switch (7)	Remove.	
	d. Switch (7), identification plate (6), and retaining nut (5)	Install.	
	e. Wiring	Reconnect.	
5. Fuses	Fuses (8)	Remove and replace.	

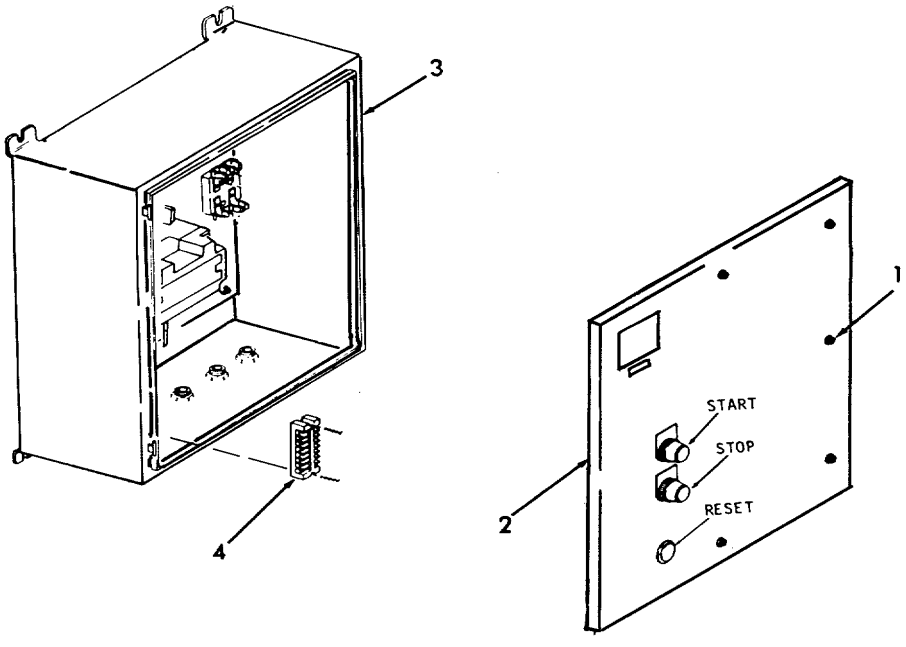
4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

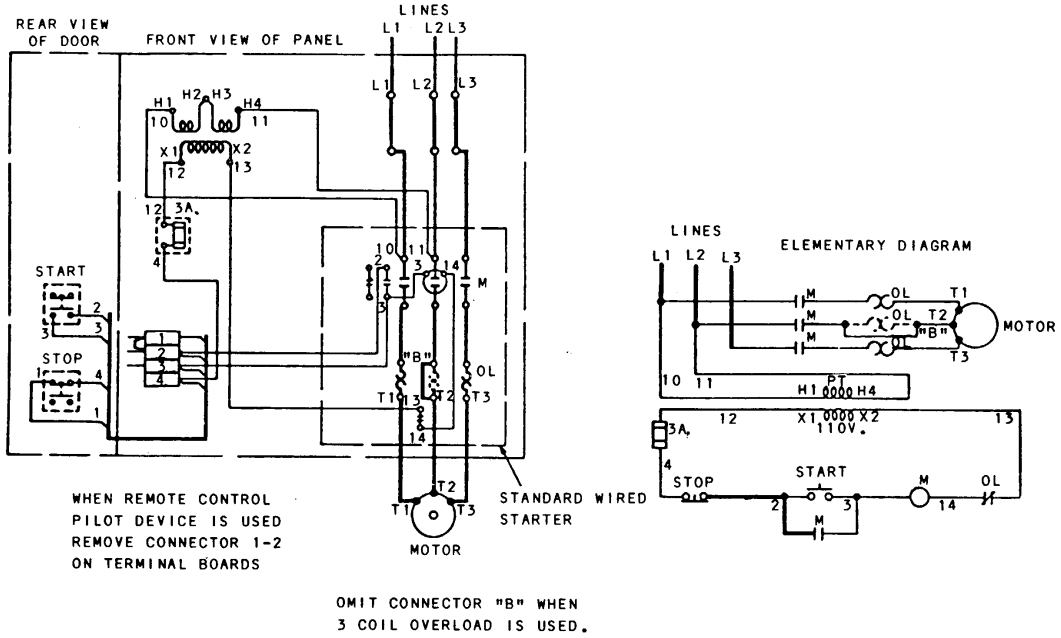
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws (9)	Remove.	
	c. Repair	Refer to Direct Support Maintenance.	
INSTALLATION			
7. Controller	a. Controller (3)	Install on bulkhead.	
	b. Wiring	Reconnect to terminal block (4).	Refer to schematic.
	c. Door (2), and captive screws (1)	Swing closed and rotate screws clockwise.	



4-10.4. LUBE OIL PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

DESCRIPTION OF OPERATION

TO START THE MOTOR PRESS THE START BUTTON. THIS ENERGIZES CONTACTOR M CONNECTING THE MOTOR ACROSS THE LINE. M MAINTAINS ITSELF THROUGH ITS OWN AUXILIARY CONTACT. TO STOP THE MOTOR PRESS THE STOP BUTTON.
A VOLTAGE FAILURE WILL CAUSE M TO OPEN, STOPPING THE MOTOR. TO RESTART, WHEN VOLTAGE IS RESTORED, PRESS THE START BUTON (LOW VOLTAGE PROTECTION).
AN OVERLOAD WILL CAUSE THE OL CONTACTS TO OPEN CAUSING M TO OPEN STOPPING THE MOTOR. TO RESTART, PRESS THE STOP-RESET BUTTON AND THEN THE START BUTTON



4-11. FRESH WATER PUMP.

a. The fresh water pump supplies the pressure for the ships fresh water system.

b. The following is an index to the maintenance procedures.

4-11.1. FRESH WATER PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Removal c. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

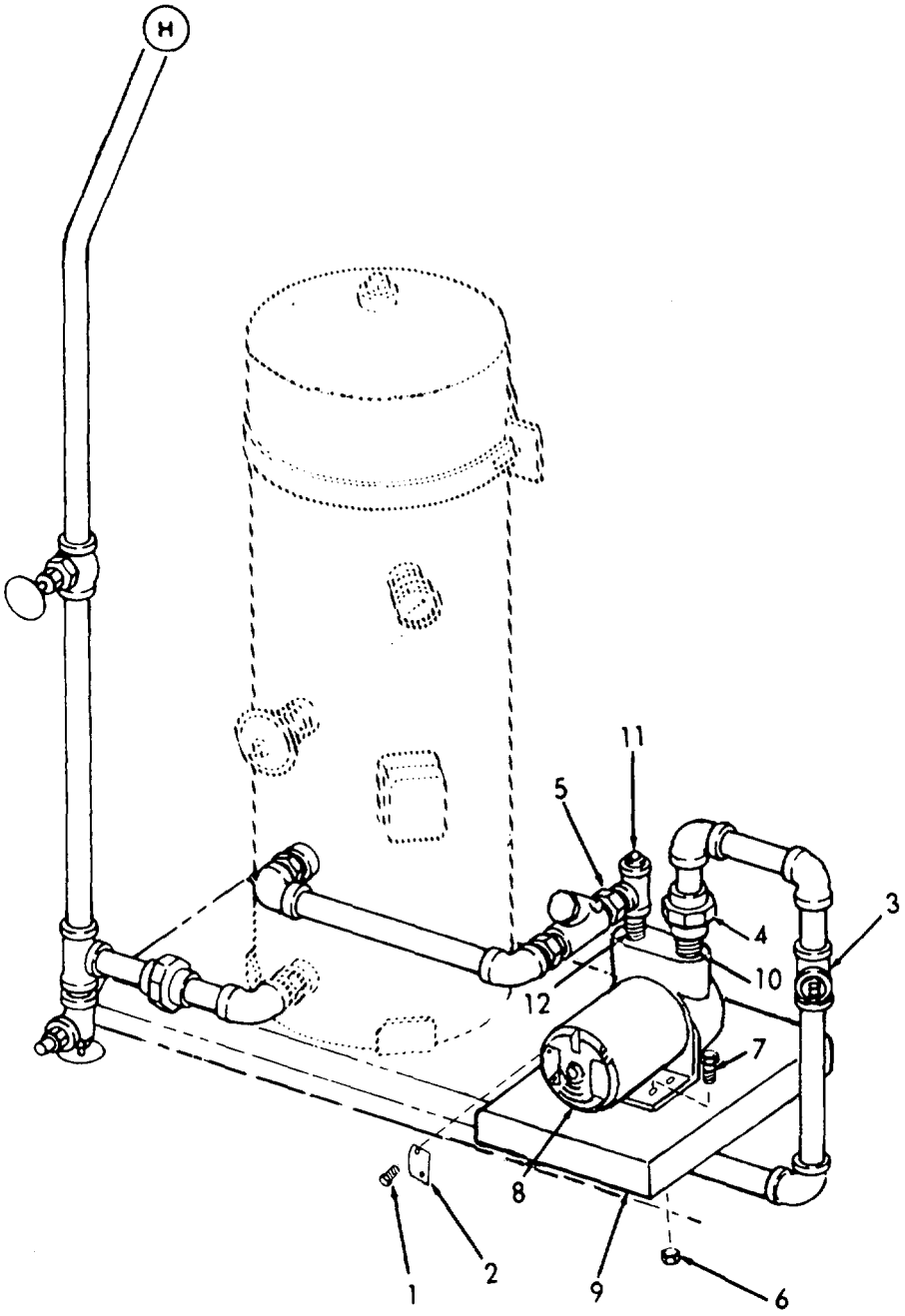
1. Pump set	a. Piping	Inspect for breaks, cracks, or leaks.	
	b. Pump	Inspect for breaks, cracks or leaks.	
	c. Hardware	Inspect for tightness.	
	d. Wiring	Inspect for breaks, cracks and signs of damage.	

4-11.1. FRESH WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1), and cover plate (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Valve (3)	Turn off.	
	d. Unions (4 and 5)	Loosen and separate.	
	e. Nuts (6), and screws (7)	Remove.	
	f. Pump (8)	Remove from platform (9).	
	g. Pump nipple (10), tee, (11) and pump nipple (12)	Remove.	

4-11.1. FRESH WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

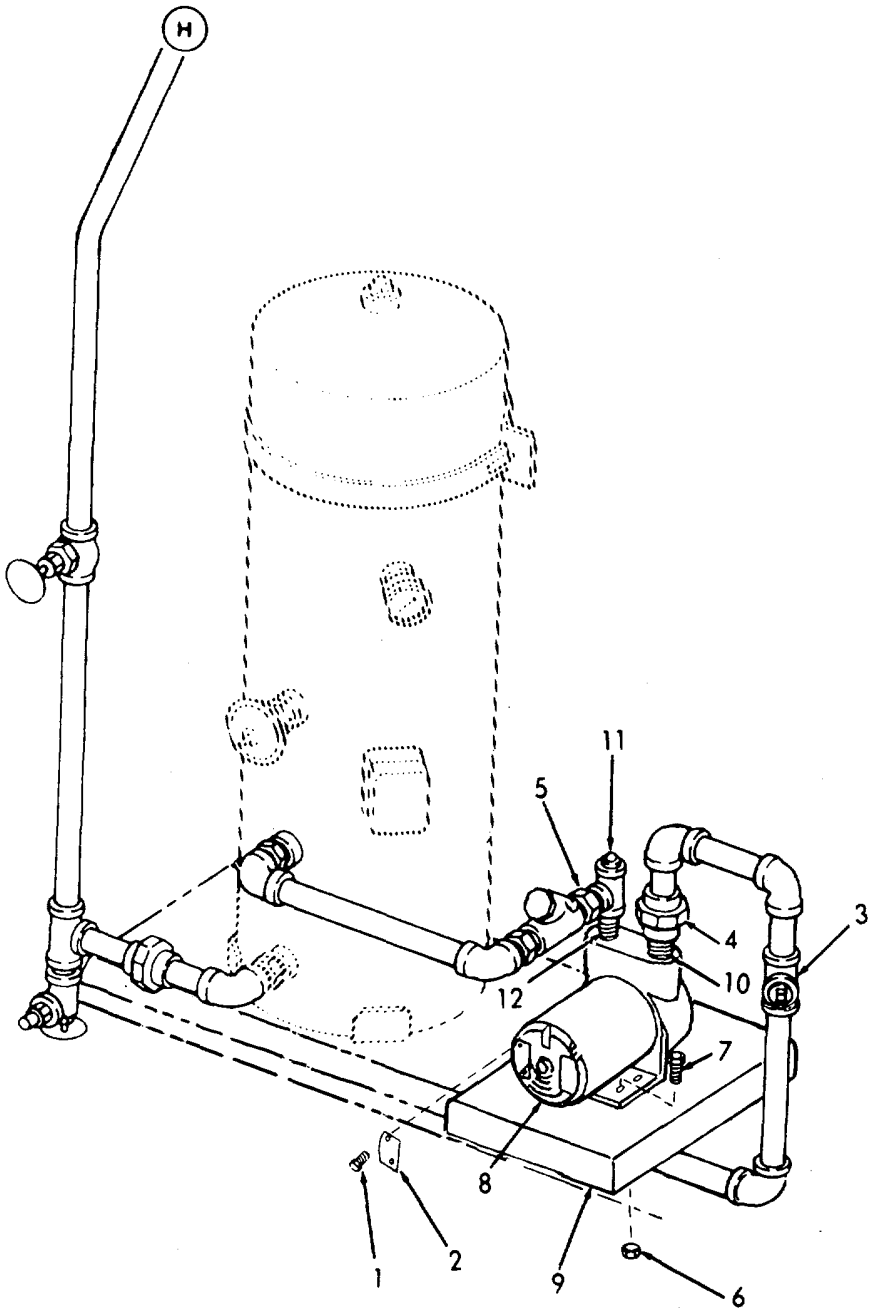


4-11.1. FRESH WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3	a. Pump pipe nipple (12), tee (11), and pump pipe nipple (10)	Reassemble.	
	b. Pump plat-form (9), pump (8), screws (7), and nuts (6)	Reassemble.	
	c. Unions (4 and 5)	Reassemble.	
	e. Valve (3)	Turn on.	
	f. Wiring tags.	Reconnect and remove	
	g. Cover plate (2), and screws (1)	Install.	

4-11.1. FRESH WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
Hammer - soft
Screwdriver
Spanner wrench
Torque wrench

Equipment Condition: Paragraph 4-11.1
Condition Description: Fresh Water Pump Set removed

Material/Parts
Preformed packing 50718
Seal assembly 43008

Special Environmental Conditions
NONE

Personnel Required
2

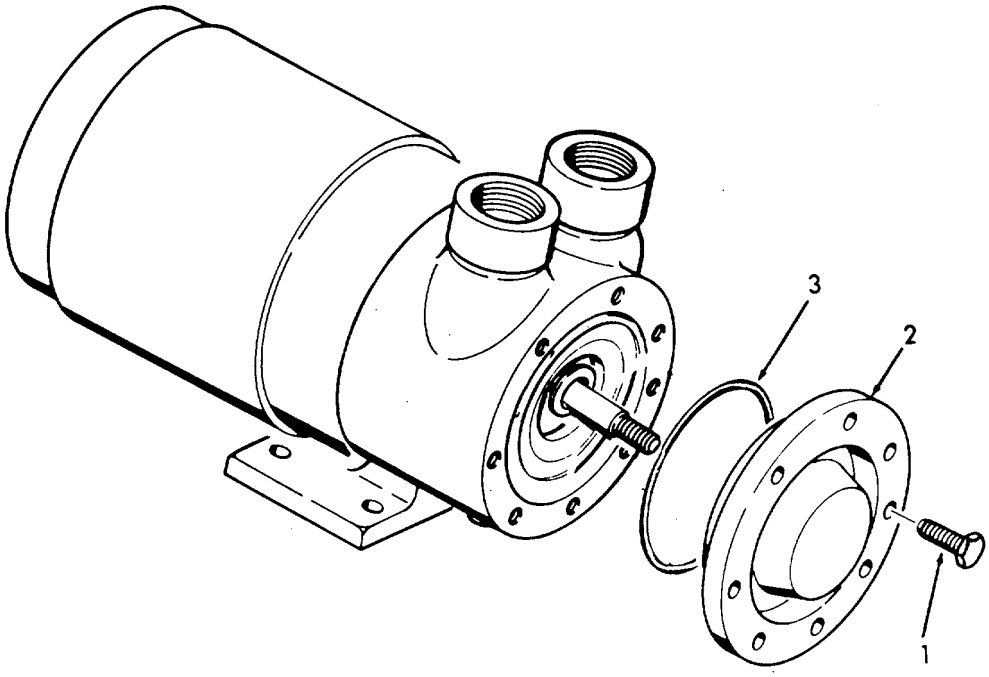
General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Pump	a. Casing	Inspect for breaks, cracks, or leaks.	
	b. Hardware	Inspect for tightness.	
DISASSEMBLY			
2.	a. Screws (1)	Remove.	
	b. Head (2)	Remove.	Strike with soft hammer.
	c. Prefromed packing (3)	Remove	Discard packing.

4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



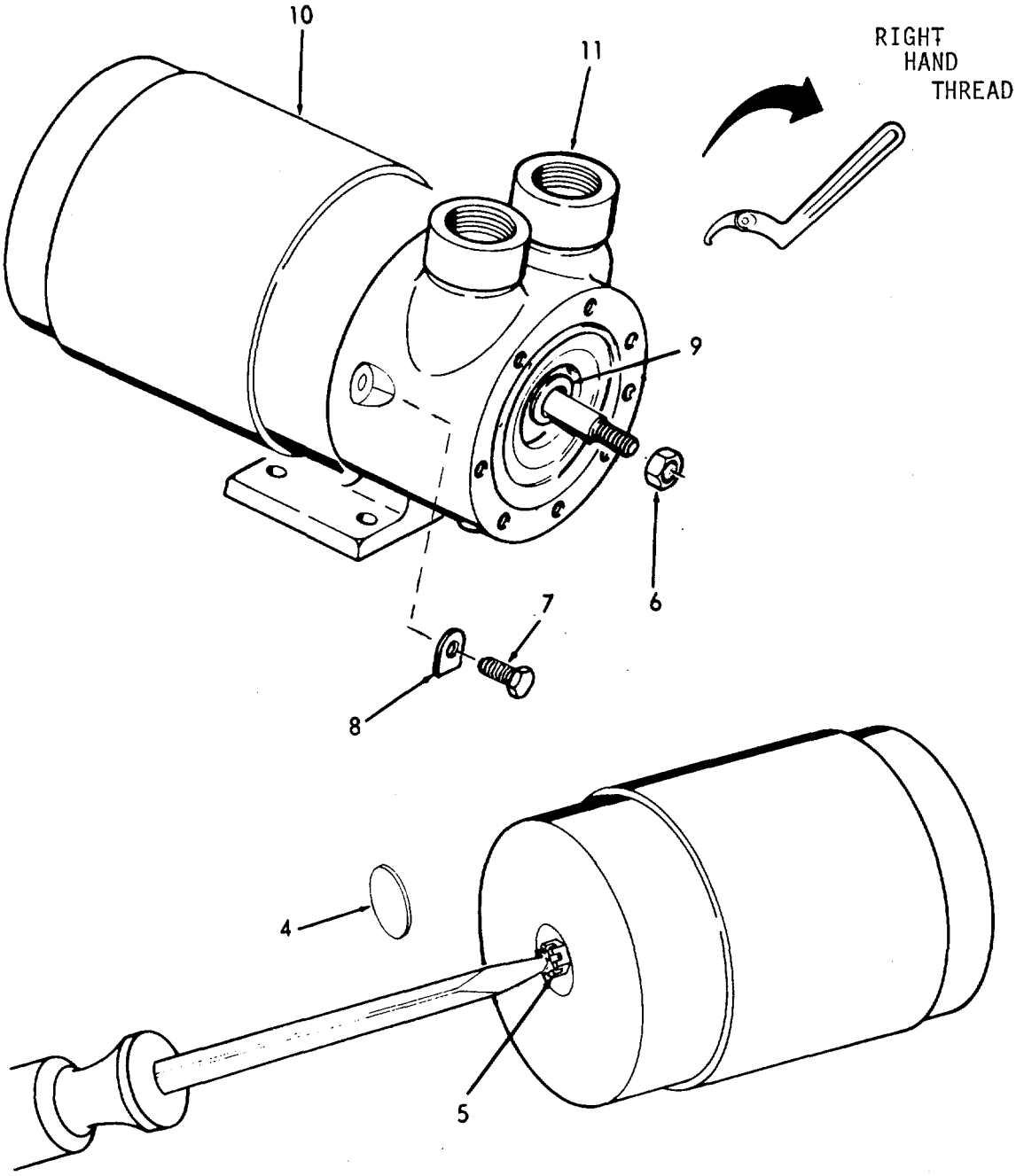
4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Motor end plug (4)	1. Remove.	
		2. Insert screw-driver in slot in shaft (5).	Locks shaft in order to remove nut.
	e. Nut (6)	Unscrew.	1. Nut is a Hylock self-locking type. 2. Right hand thread.
	f. Casing mounting bolts (7), and impeller nut washers (8)	Remove.	
	g. Bushing (9)	Turn bushing off of shaft.	1. Use a spanner wrench. 2. Motor and shaft (10) will come away from the back of the casing (11) as the bushing is turned off.

4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

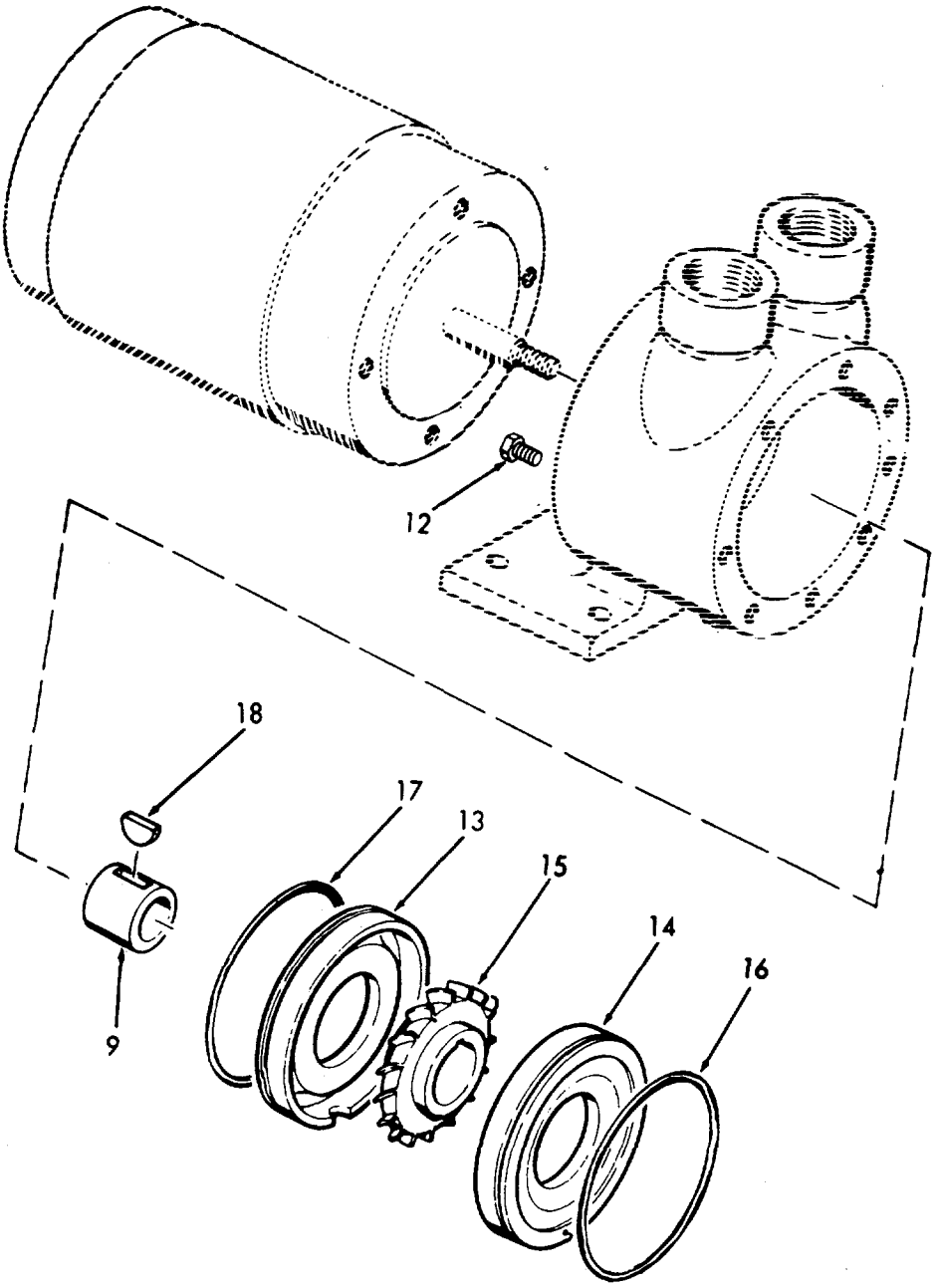


4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
		NOTE After the casing has been removed, clean and lubricate the bore where the front cover was removed to make it easier to remove the plates.	
	h. Allen head plugs (12)	Remove.	
	i. Rear plate (13)	Exert pressure through allen head plug holes.	1. Either tap gently or use jack screws. 2. This will force the front plate (14), impeller (15) and rear plate (13) out of casing.
	j. Front plate (14), impeller (15), and rear plate (13)	Remove.	
	k. Preformed packings (16 and 17)	Remove.	Discard.
	l. Bushing (9), and key (18)	Remove from impeller (15).	

4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			

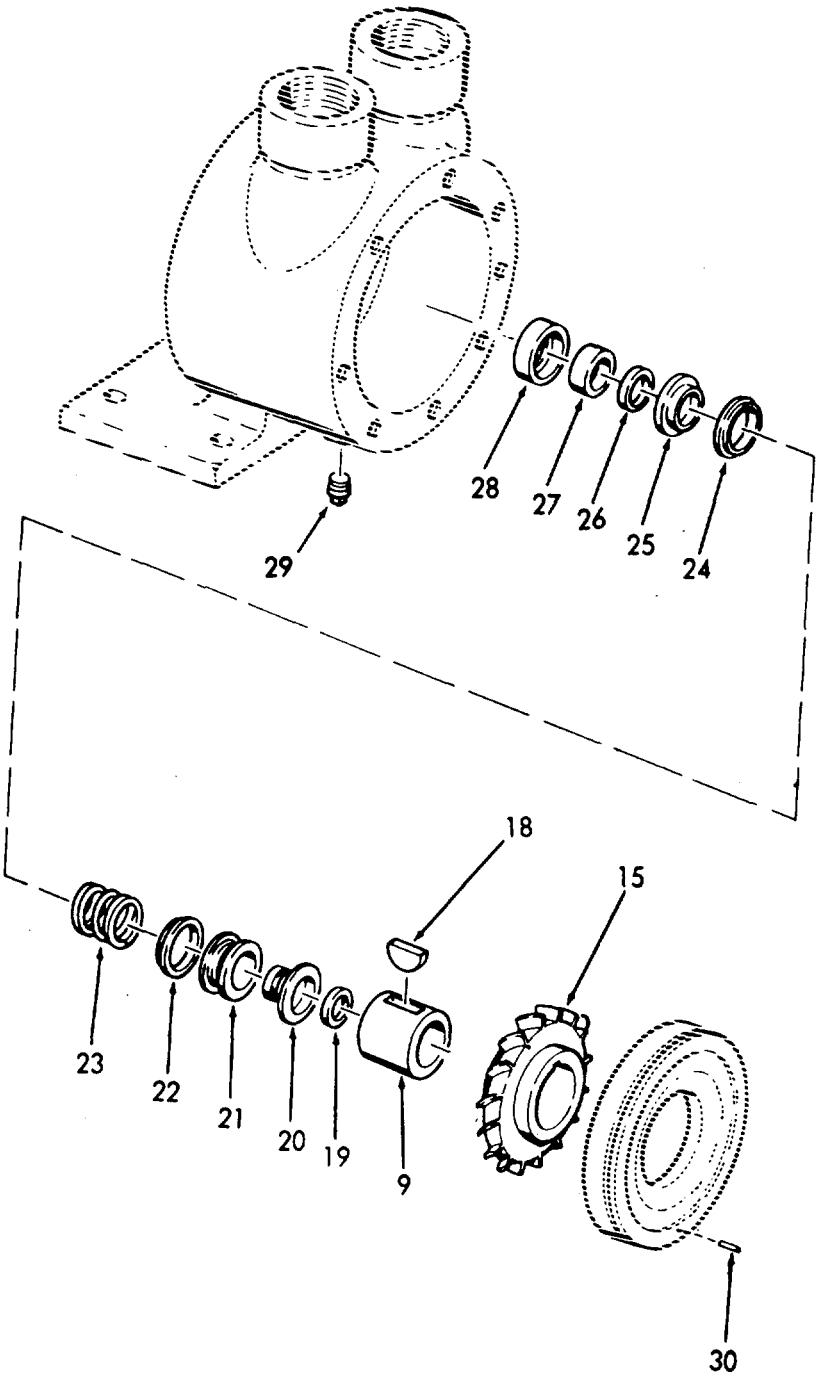


4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTION (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	m. Seal ring (19), sleeve seal (20), bellows (21), metal seal (22), spring seal (23), metal seal (24), washer seal (25), washer seal (26), floating seat seal (27), and seal ring (28)	Remove.	Discard all parts.
	n. Drain plug (29)	Remove.	If necessary.
	o. Pin (30)	Remove.	If necessary.
REASSEMBLY			
3.	a. Ring seal (28), floating seat seal (27), seal washer (26), washer seal (25), metal seal (24), spring seal (23), metal seal (22), bellows (21), sleeve seal (20) and seal ring (19)	Replace	Use new parts.
	b. Bushing (9) and key (18)	Install in impeller (15).	

4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTION (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

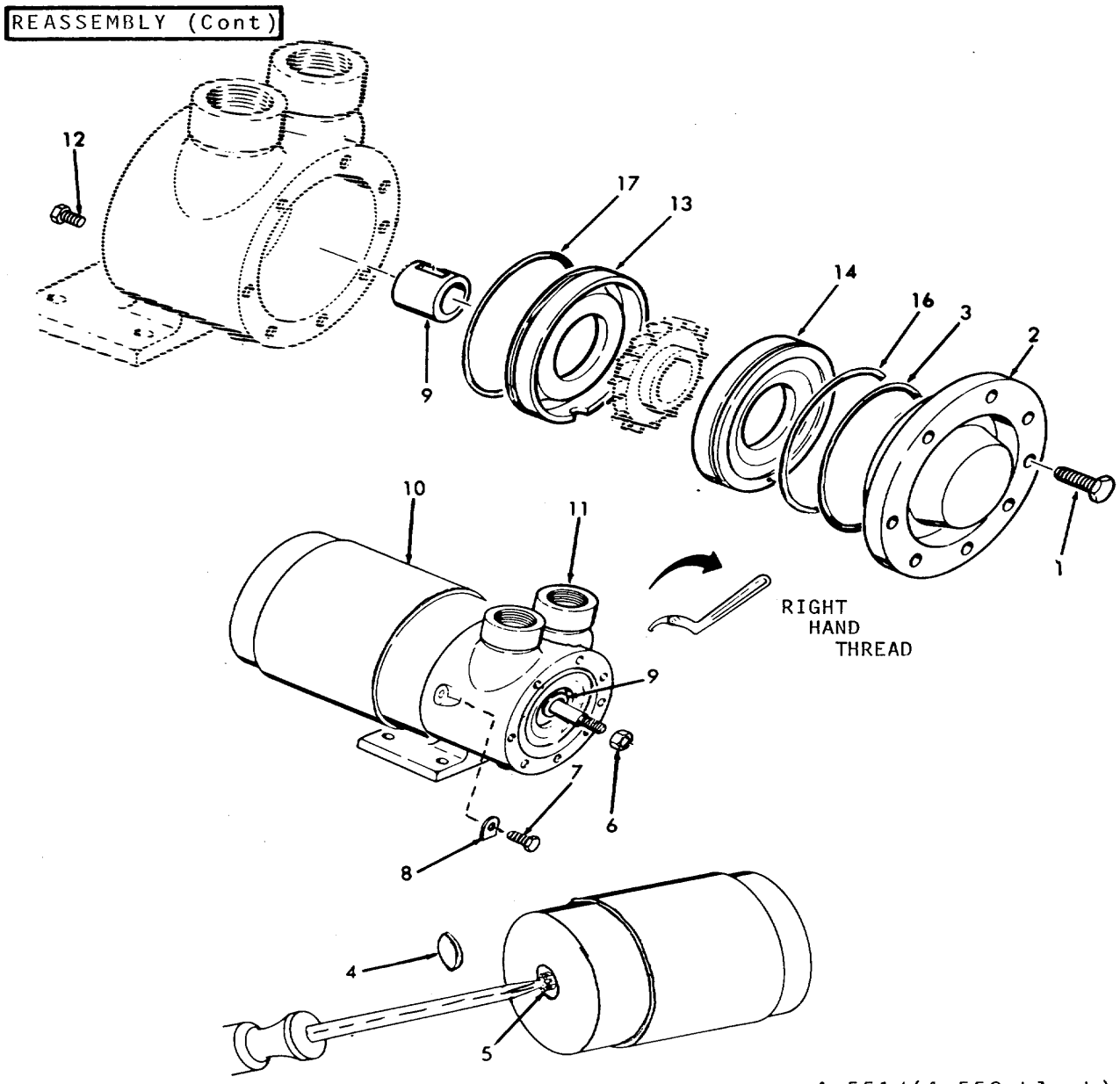


4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTION (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Preformed packings (16 and 17)	Install on front plate (1-4) and rear plate (13).	Use new preformed packings.
	d. Casing (11)	Clean and lubricate casing bore.	
	e. Allen head plugs (12)	Install.	
	f. Motor (10), casing (11), bolts (7), and impeller nut washers (8)	Reassemble.	
	g. Rear plate (13)	Install.	Press into place.
	h. Motor end shaft (5)	1. Insert screwdriver in shaft slot.	Use a spanner wrench on bushing (9).
		2. Turn impeller onto shaft.	
	i. Nut (6)	Install.	
	j. Front plate (14)	Install.	Press into place.
	k. Preformed packing (3)	Install on head (2).	
	l. Head (2) and screws (1)	Install.	Torque to 20 lb ft (27.116 Nm).
	m. Motor end plug (4)	Replace.	

4-11.2 FRESH WATER PUMP - MAINTENANCE INSTRUCTION (Continued).

LOCATION	ITEM	ACTION	REMARKS



4-551/(4-552 blank)

4-11.3. FRESH WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition Condition Description**
Arbor press Bearing puller	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
1	Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

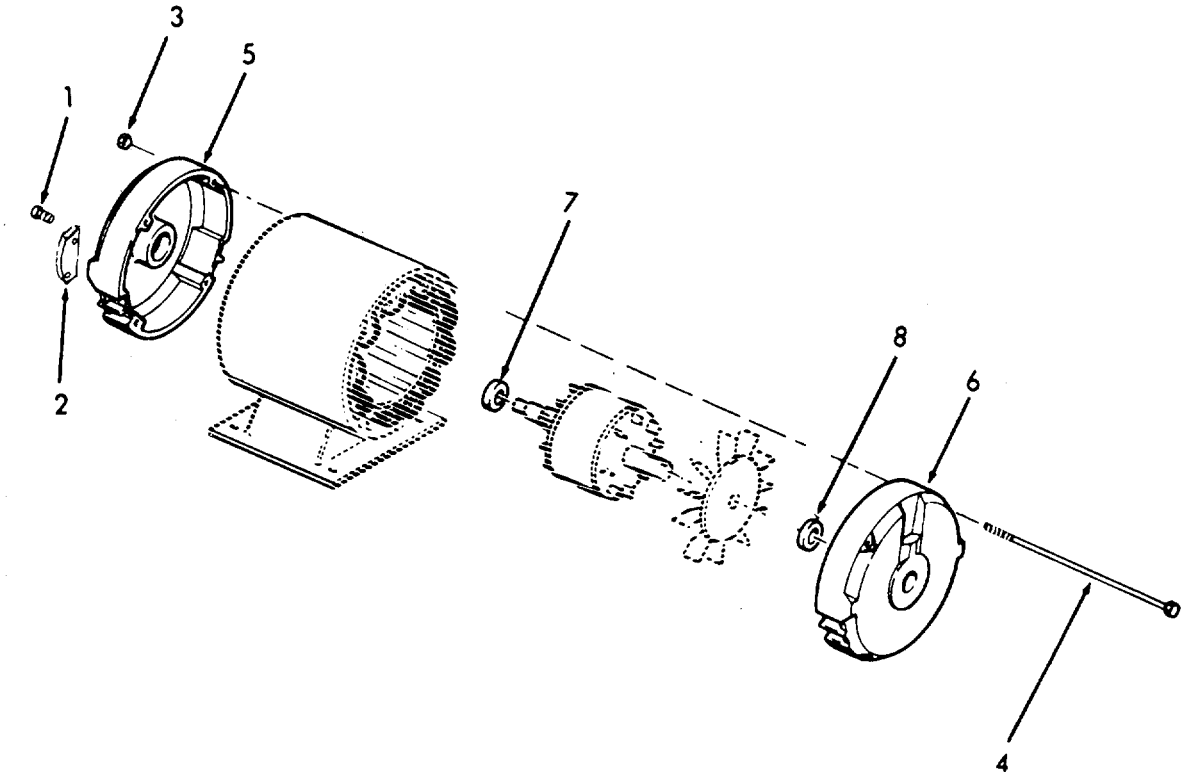
1.	Pump motor	a. Frame	Inspect for cracks, dents, or breaks.
		b. Shaft	Inspect for bends, cracks, or dents.
		c. Hardware	Inspect for tightness.
		d. Wiring	Inspect for breaks, cracks, and signs of damage.

4-11.3. FRESH WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2	a. Screws (1), and cover (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Nuts (3), and screws (4)	Remove.	
	d. Brackets (5 and 6)	Remove.	
	e. Ball bearings (7 and 8)	Remove from brackets.	1. Use bearing puller. 2. Inspect for flat spots, burrs, or excessive wear.
REASSEMBLY			
3.	a Ball bearings (7 and 8)	Reassemble to brackets.	Use arbor press.
	b. Brackets (6 and 5), screws (4), and nuts (3)	Reassemble.	
	c. Wiring	Reconnect and remove tags.	
	d. Cover (2), and screws (1)	Install.	

4-11.3. FRESH WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS.

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
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

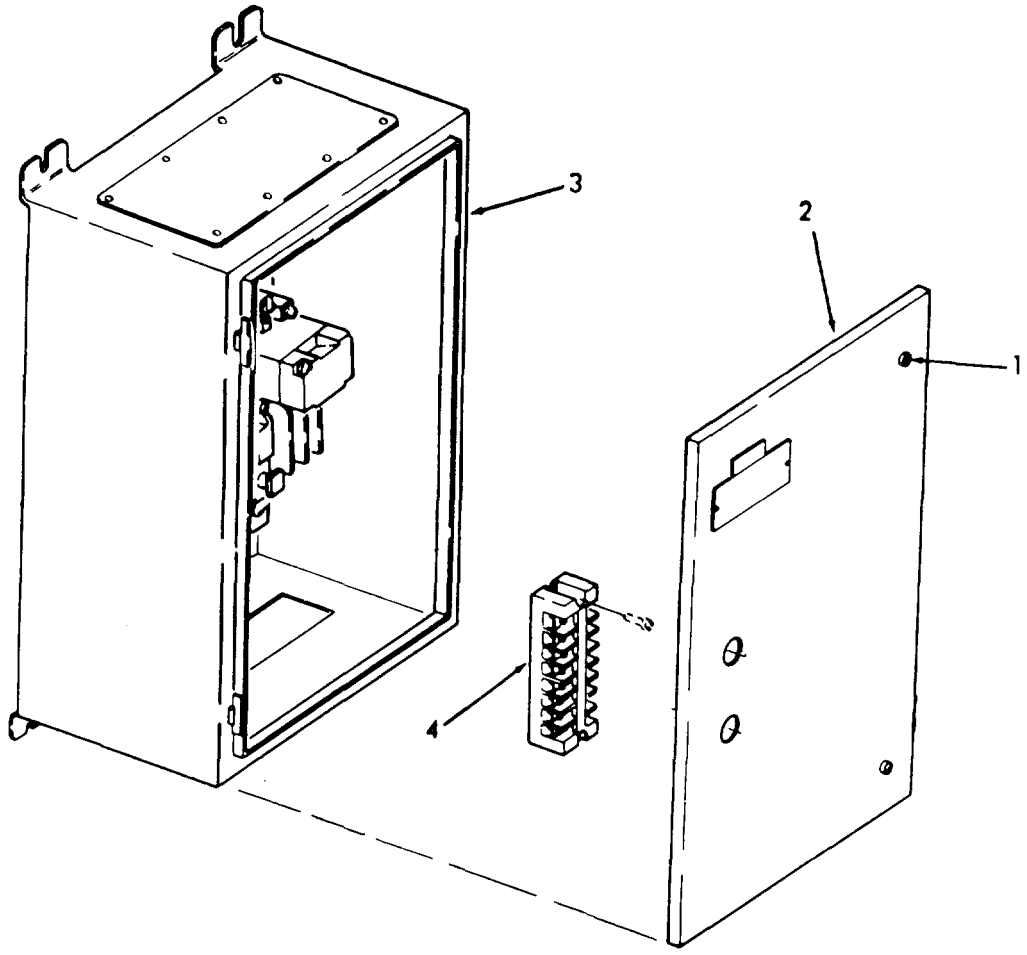
1. Controller (internal)	a. Relays and starters	1. Inspect for worn contact tip material. 2. Inspect for cleanliness. 3. Insure all mounting hardware is tight.	

4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. Wiring	1. Inspect for wear, fraying, and damage.	
		2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure.	
		2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components.	
		2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks.	
		2. Insure all mounting hardware is tight.	
REMOVAL			
2. Controller	a. Captive screws (1)	Rotate counter-clockwise to loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect from terminal block (4).	
	d. Control-ler (3)	Remove from bulkhead.	

4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

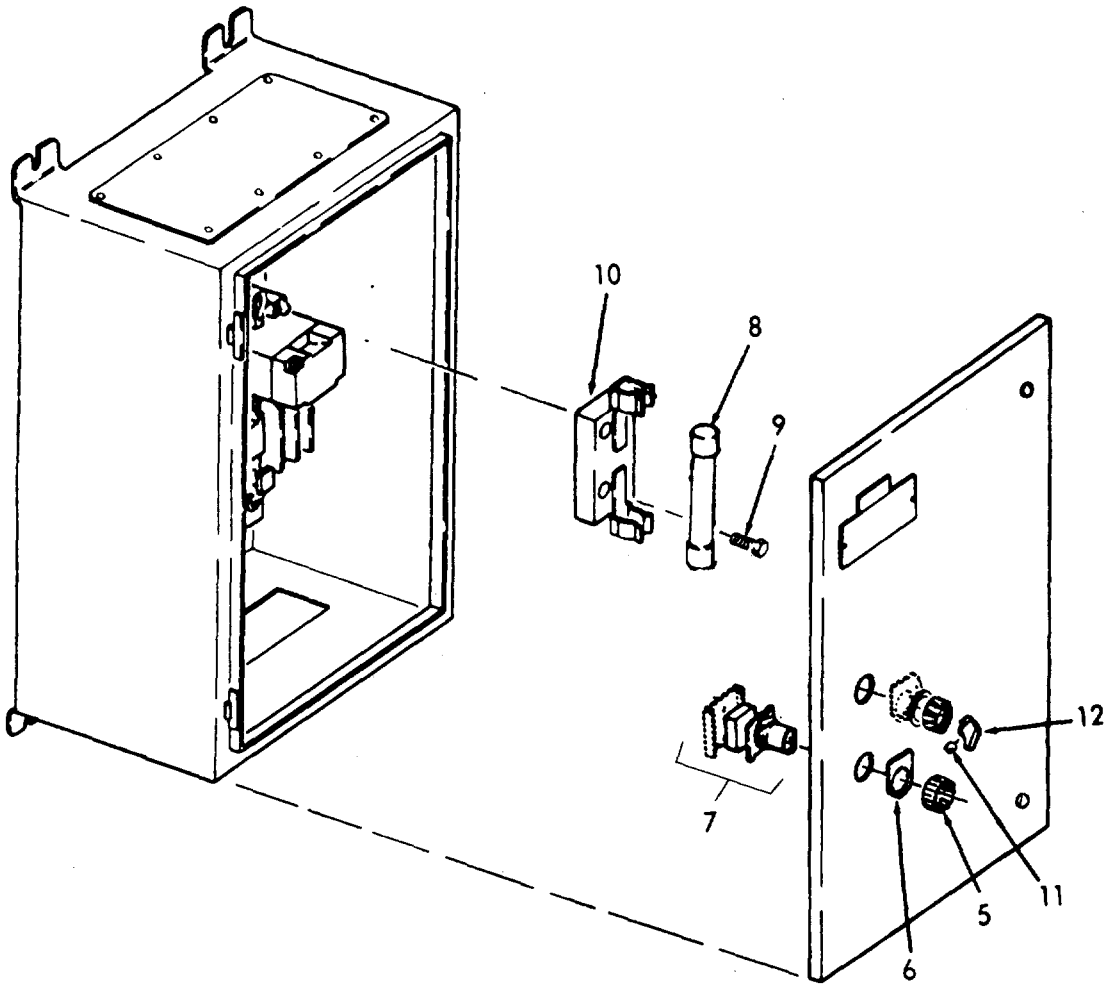


4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Push-button switches	a. Wiring	Tag and disconnect.	
	b. Retaining nut (5)	Unscrew and remove.	
	c. Identification plate (6), and switch (7)	Remove.	
	d. Switch (7), identification plate (6), and retaining nut (5)	Install.	
	e. Wiring	Reconnect.	
4. Fuses	Fuses (8)	Remove and replace.	
5. Fuse block	a. Wiring	Tag and disconnect.	
	b. Screws (9)	Remove.	
	c. Fuse block (10)	Replace.	
	d. Screws (9)	Replace.	
	e. Wiring tags.	Reconnect and remove	
6. Selector switch	a. Wiring	Tag and disconnect.	
	b. Setscrew (11)	Loosen.	
	c. Knob (12)	Remove.	

4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

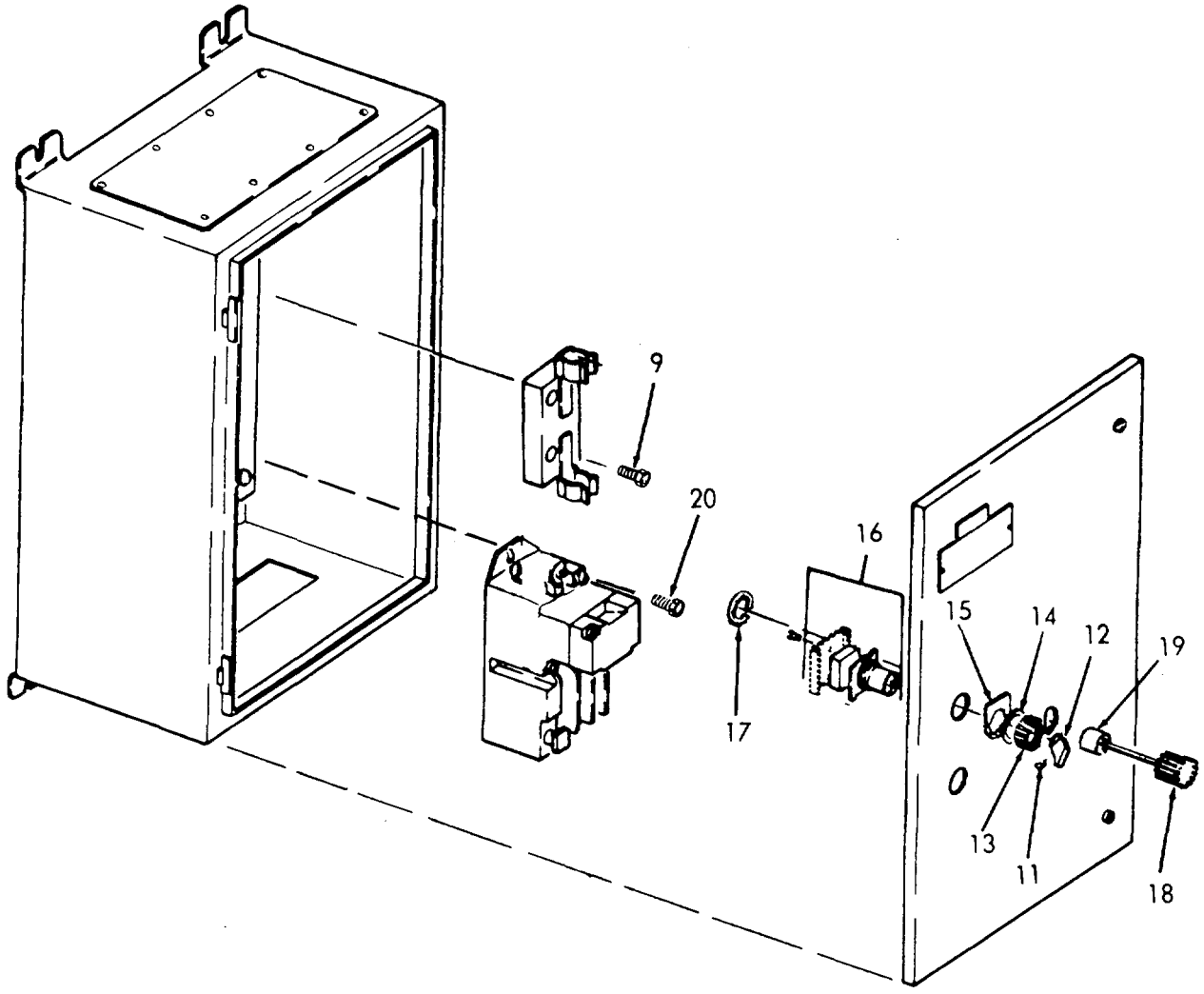


4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Retaining nut (13), gasket (14), and identi-fication plate (15)	Remove.	
	e. Switch (16)	Replace.	
	f. Identi-fication plate (15), gasket (14), and retaining nut (13)	Reassemble.	
	g. Knob (12)	Replace.	
	h. Setscrew (11)	Tighten.	
	i. Wiring	Reconnect and remove tags.	
7. Reset button	Retaining nut (17), push button (18), and sleeve (19)	Remove.	If necessary.
8. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws 20)	Remove.	

4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

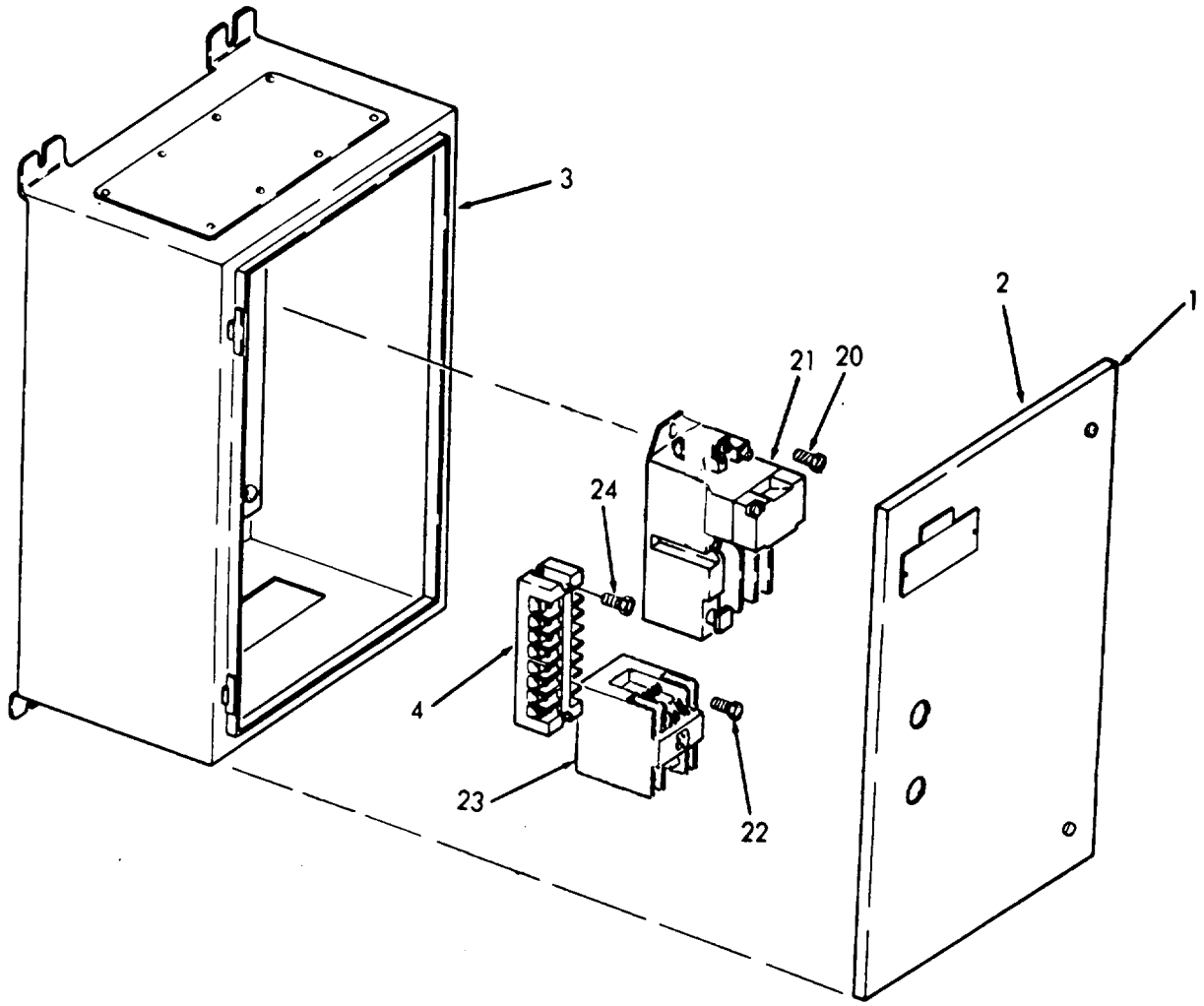


4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Starter (21)	Replace.	
	d. Screws (20)	Replace.	
9. "M" Type relay	a. Wiring	Tag and disconnect.	
	b. Screws (22)	Remove.	
	c. Relay (23)	Replace.	
	d. Screws (22)	Replace	
	e. Wiring	Reconnect. Remove tags.	
10. Terminal block	a. Wiring	Tag and disconnect.	
	b. Screws (24)	Remove.	
	c. Terminal block (4)	Replace.	
	d. Screws (24)	Replace.	
	e. Wiring tags.	Reconnect and remove	
INSTALLATION			
11. Control-Ler	a. Control-ler (3)	Install on bulkhead.	
	b. Wiring block (4).	Reconnect to terminal	
	c. Door (2), and cap-tive screws (1)	Swing closed and rotate screws clockwise.	

4-11.4. FRESH WATER PUMP CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-12. AIR CONDITIONER WATER CIRCULATION PUMP.

a. The air conditioner water circulation pump supplies cooling water for the air conditioning system.

b. The following is an index to the maintenance procedures.

4-12.1. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Pump set		a. Piping cracks,	Inspect for breaks, or leaks.
		b. Housing cracks,	Inspect for breaks, or leaks.
		c. Hardware	Inspect for tightness.
		d. Wiring	Inspect for breaks, cracks, and signs of damage.

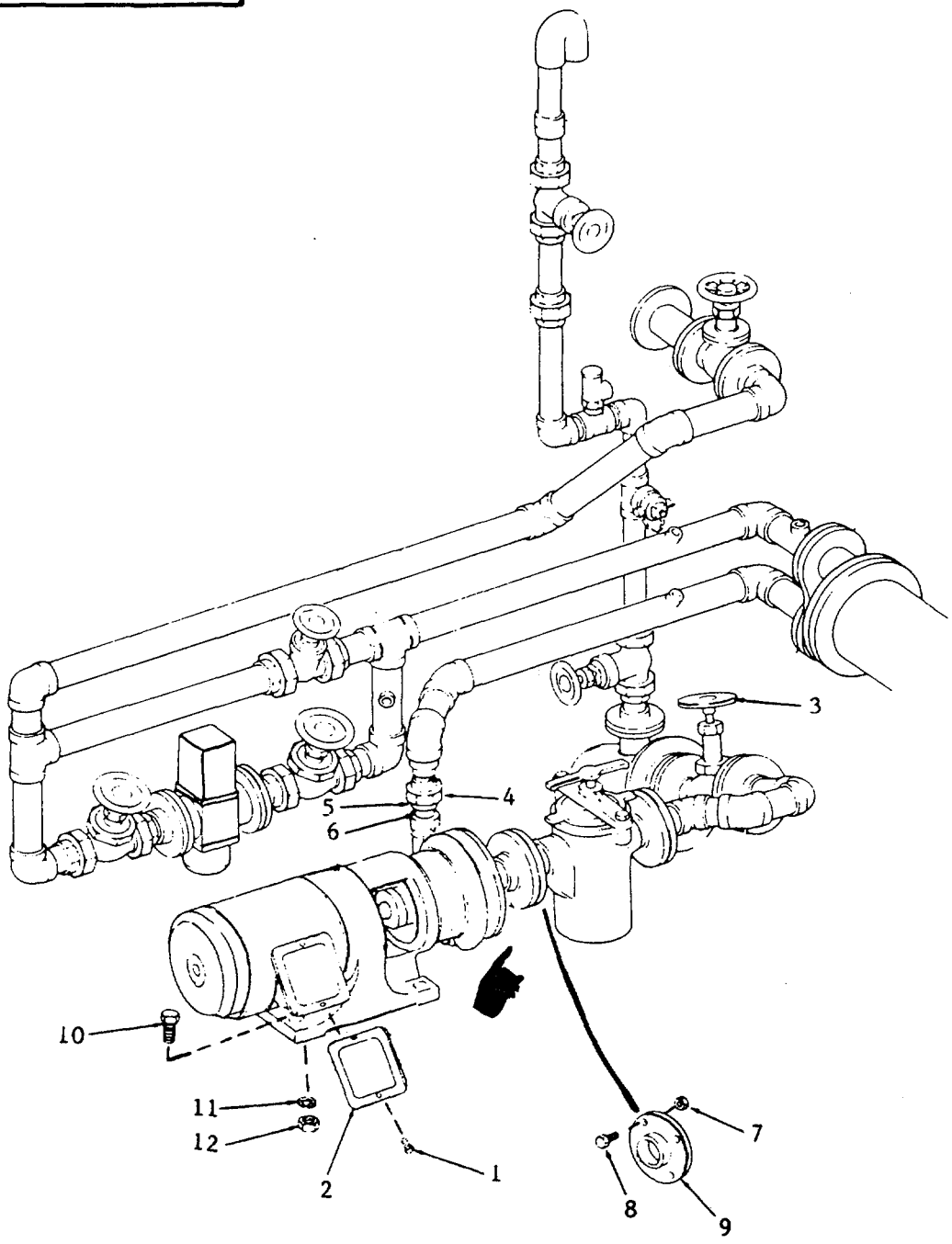
4-12.1. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Screws (1) and cover (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Valve (3)	Turn off.	
	d. Union cover (4)	Loosen.	
	e. Union half (5) and adapter (6)	Remove.	
	f. Nuts (7) and screws (8)	Remove.	
	g. Flange (9)	Remove.	
	h. Screws (10), lock-washers (11), and nuts (12)	Remove.	

4-12.1. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



4-12.1. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Screws (10), Lockwashers (11), and nuts (12)	Install	
	b. Flange (9), screws (8), and nuts (7)	Reassemble.	
	c. Adapter (6), and union half (5)	Reassemble.	
	d. Union cover (4)	Tighten	
	e. Valve (3)	Turn on.	
	f. Wiring	Reconnect and remove tags.	
	g. Cover (2), and screws (1)	Install	

CAUTION

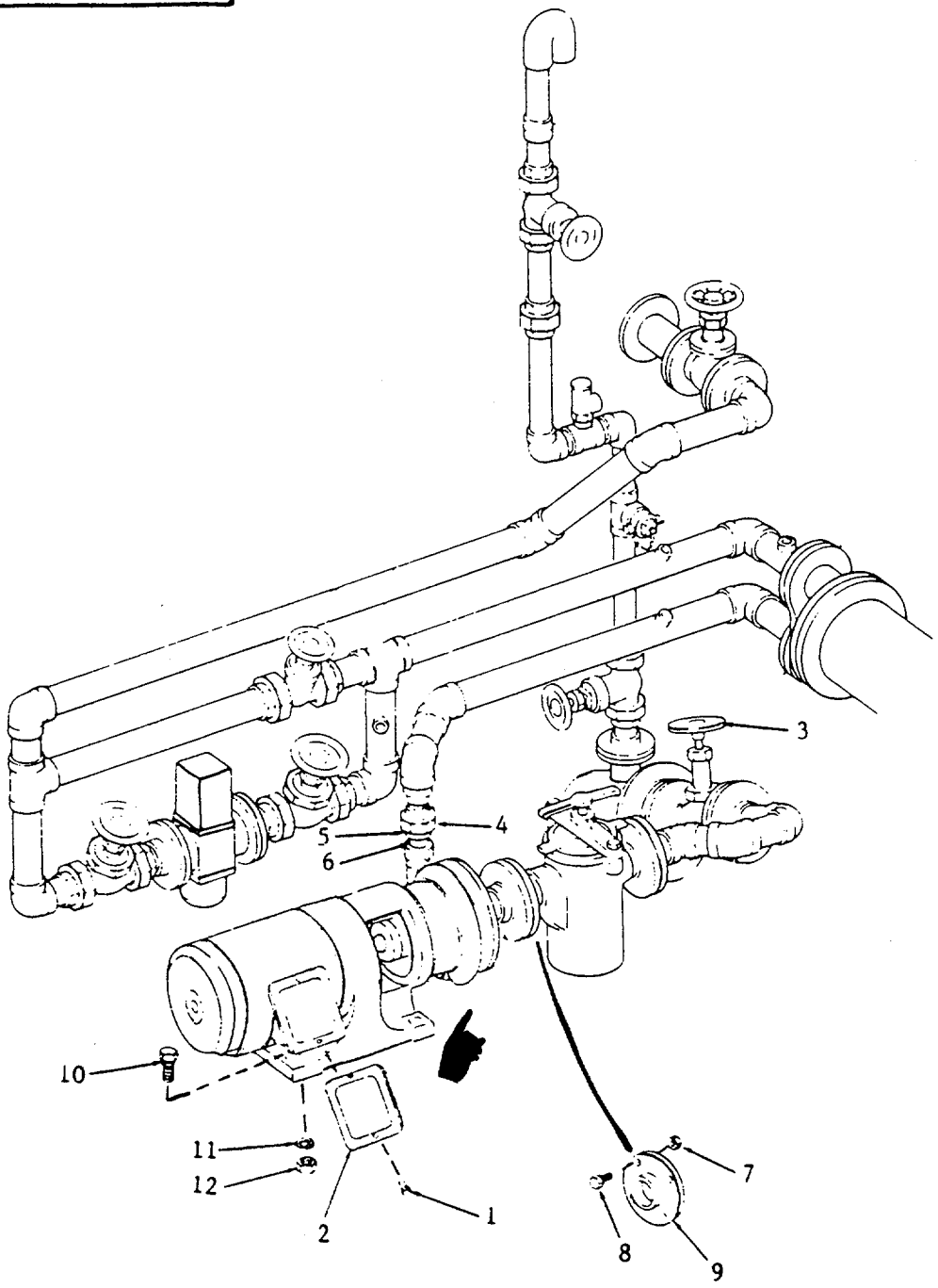
Do not run pump dry. Dry operation will cause seal failure within minutes.

	h. Pump	Prime.	

4-12.1. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



4-12.2. AIR CONDITIONER WATER PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket 9514

Personnel Required

1

References

NONE

Equipment Condition Condition Description

Paragraph

4-12.1 Pump set removed

Special Environmental Conditions

NONE

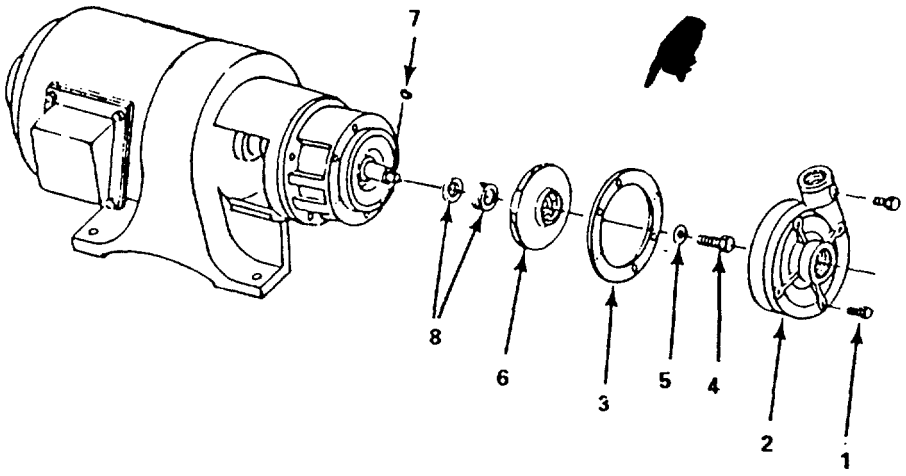
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1.	a. Housing	Inspect for breaks, cracks, or leaks.	
	b. Hardware	Inspect for tightness.	

4-12.2. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Screws (1), casting (2), and gasket (3)	Remove.	Discard gasket.
	b. Screw (4) and washer (5)	Remove.	
	c. Impeller (6). and key (7)	Remove.	



4951-164

	d. Mechanical seal (8)	Remove	Inspect seals for excessive wear, replace if necessary.

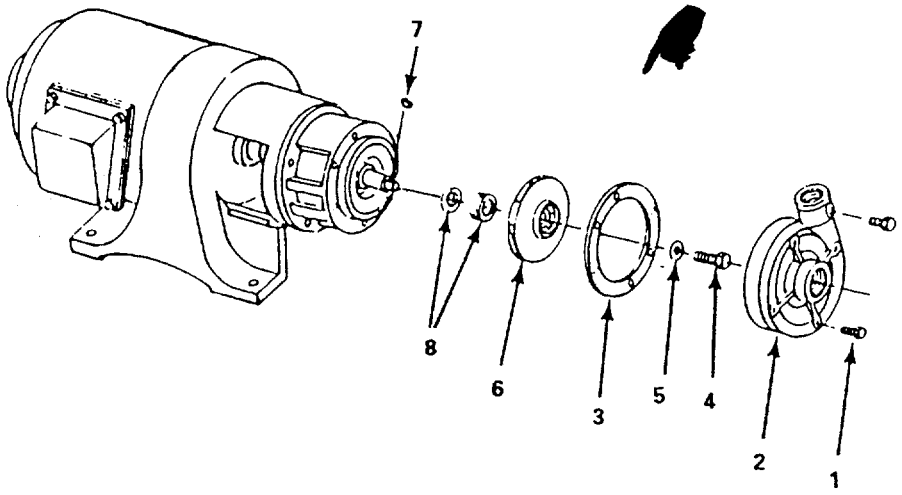
4-12.2. AIR CONDITIONER WATER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Mechanical seal (8)	Reassemble.	Inspect seals for excessive wear, replace if necessary.
	b. Impeller(6), and key (7)	Reassemble.	
	c. Washer (5) and screw (4)	Reassemble.	
	d. Gasket (3), casting (2) and screws (1)	Reassemble	Use new gasket.

CAUTION

Do not run pump dry. Dry operation will cause seal failure within minutes.

	e. Pump	Prime.



4951-165

4-12.3. AIR CONDITIONER WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Removal c. Installation

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition Condition Description

Paragraph	
4-12.1	Pump set removed
4-12.2	Pump disassembly

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

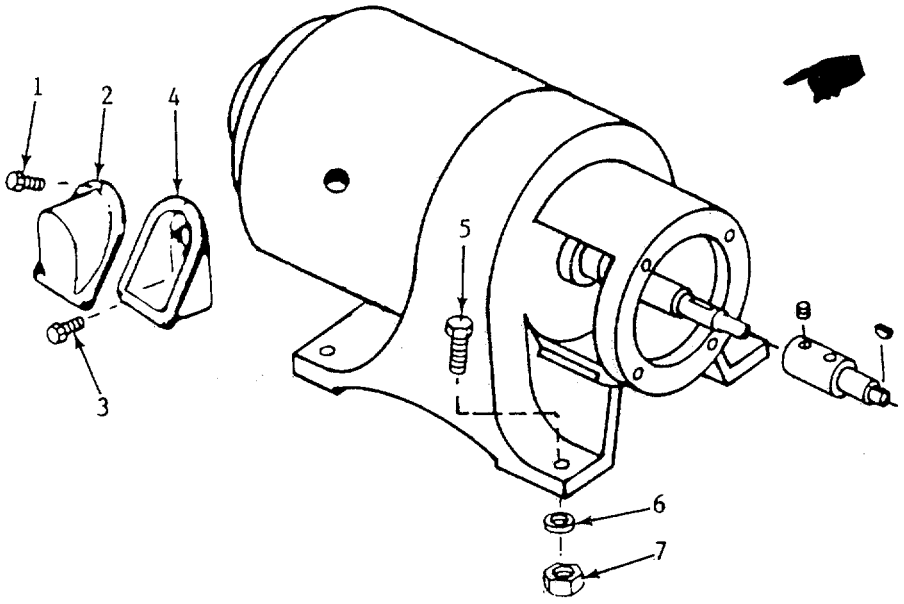
To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Motor	a. Casing	Inspect for breaks, cracks, or dents.
	b. Shaft	Inspect for bends, cracks or burrs.
	c. Hardware	Inspect for tightness.
	d. Wiring	Inspect for breaks, cracks, and signs of damage.

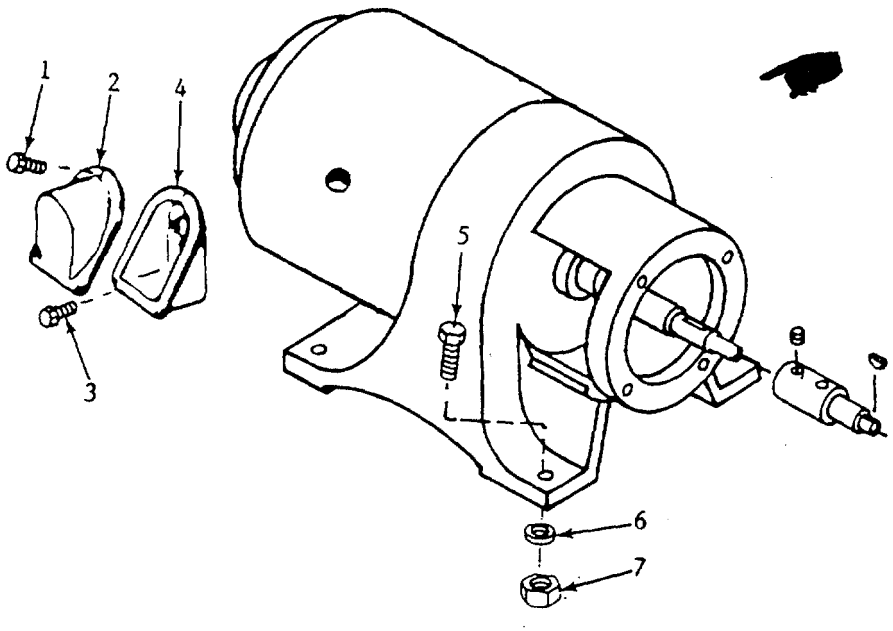
4-12.3. AIR CONDITIONER WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1), and cover (2)	Remove.	
	b. External wiring	Tag and disconnect.	
	c. Screws (3) and terminal box (4)	1. Remove 2. Route wires through hole in box.	
	d. Bolt (5), Washer (6), and nut (7)	Remove	



4-12.3. AIR CONDITIONER WATER PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Bolt (5), Washer (6), and nut (7)	Install.	
	b. Terminal Box (4) and screws (3)	Install	
	c. External wiring	Reconnect and remove tags.	
	d. Cover (2) and screws (1)	Install.	



All data on pages 4-578 thru 4-583 deleted.

4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS.

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

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Controller (external)	a. Enclosure	1. Inspect for breaks, cracks, dents, and bending.	
		2. Insure all mounting hardware is tight.	
	b. Wiring	Inspect for wear, fraying, and damage.	

4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS Continued)

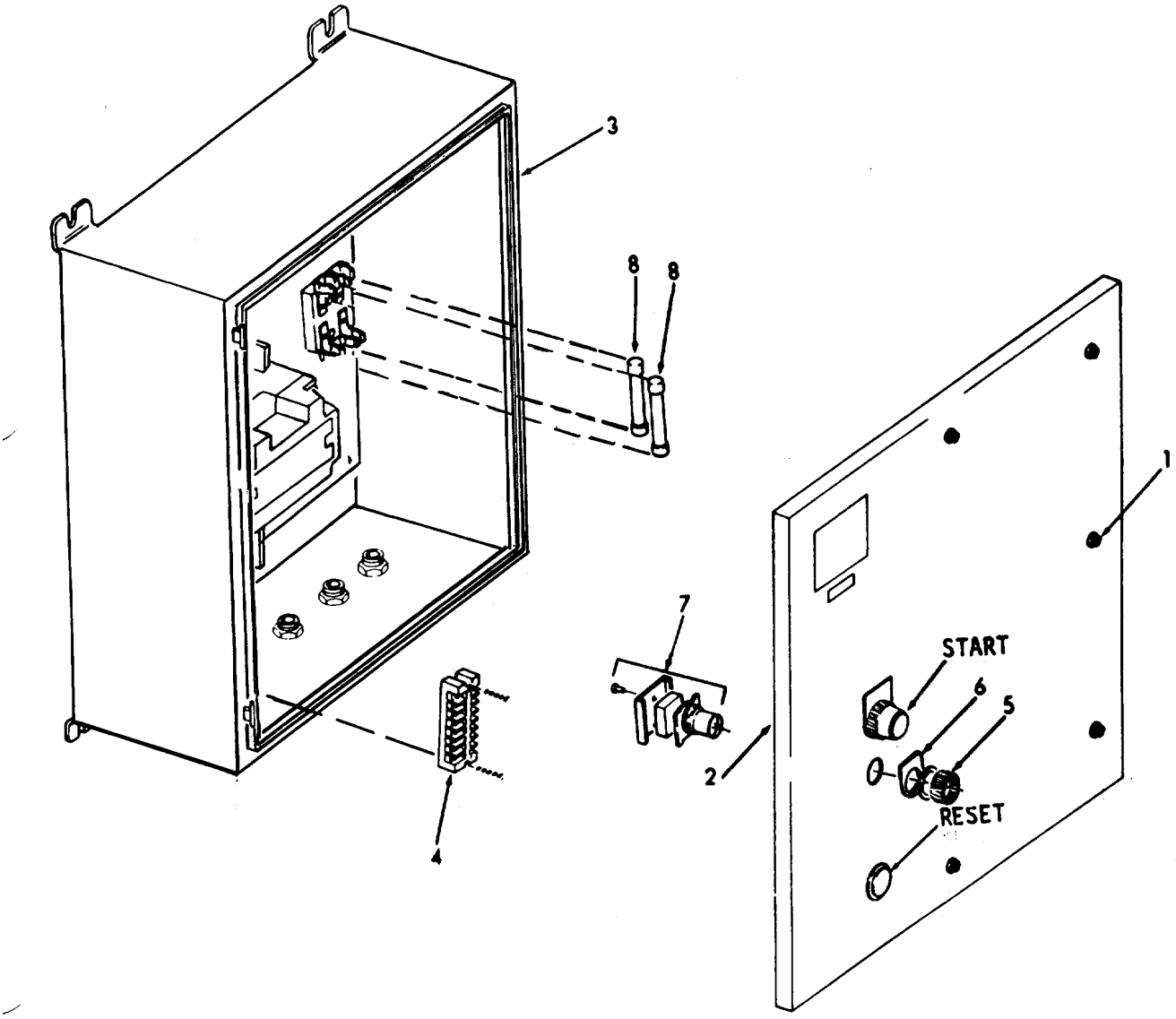
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Switches	Inspect for signs of failure, or improper operation.	
2. Controller (internal)	a. Starters	1. Inspect for worn contact tip material.	
		2. Inspect for clean-liness.	
		3. Insure all mounting hardware is tight.	
	b. Wiring	1. Install for wear, fraying and damage.	
		2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure.	
		2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components.	
		2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks.	
		2. Insure all mounting hardware is tight.	

4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Controller	a. Captive screws (1)	Rotate counter-clockwise to loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect from terminal block (4).	
	d. Controller (3)	Remove from bulkhead.	
REPAIR			
4. Push-button switches	a. Wiring	Tag and disconnect.	
	b. Retaining nut (5)	Unscrew and remove.	
	c. Identification plate (6), and switch (7)	Remove.	
	d. Switch (7), identification plate (6), and retaining nut (5)	Install.	
	e. Wiring	Reconnect.	
5. Fuses	Fuses (8)	Remove and replace.	

4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued)

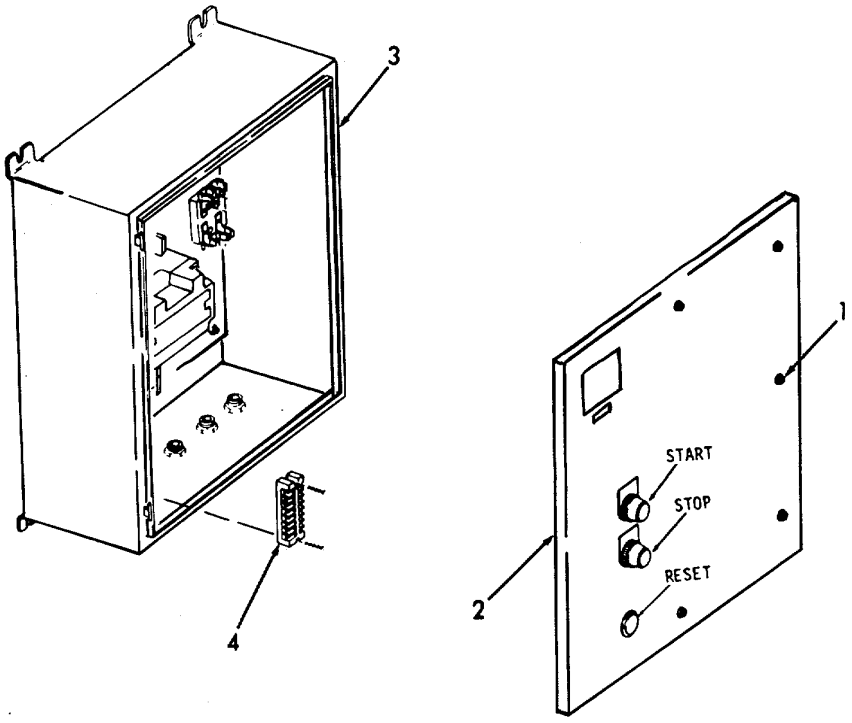
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE

INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws (9)	Remove.	
	c. Repair	Refer to Direct Support Maintenance.	
INSTALLATION			
7. Controller	a. Control-ler (3)	Install on bulkhead.	
	b. Wiring block (4).	Reconnect to terminal	Refer to schematic.
	c. Door (2), and cap-tive screws (1)	Swing closed and rotate screws clockwise.	

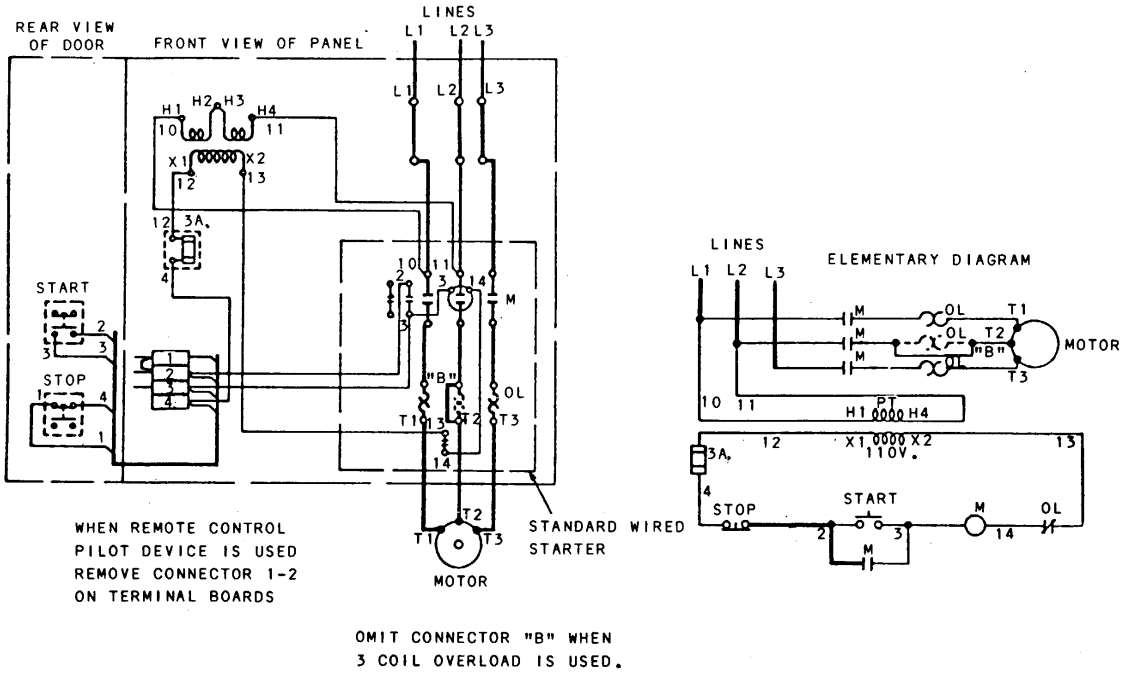


4-12.4. AIR CONDITIONER WATER PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

DESCRIPTION OF

OPERATION

TO START THE MOTOR PRESS THE START BUTTON. THIS ENERGIZES CONTACTOR M CONNECTING THE MOTOR ACROSS THE LINE. M MAINTAINS ITSELF THROUGH ITS OWN AUXILIARY CONTACT. TO STOP THE MOTOR PRESS THE STOP BUTTON. A VOLTAGE FAILURE WILL CAUSE M TO OPEN, STOPPING THE MOTOR. TO RESTART, WHEN VOLTAGE IS RESTORED, PRESS THE START BUTON (LOW VOLTAGE PROTECTION). AN OVERLOAD WILL CAUSE THE OL CONTACTS TO OPEN CAUSING M TO OPEN STOPPING THE MOTOR. TO RESTART, PRESS THE STOP-RESET BUTTON AND THEN THE START BUTTON.



OMIT CONNECTOR "B" WHEN 3 COIL OVERLOAD IS USED.

4-13. DIESEL OIL COOLING PUMP.

a. The diesel oil cooling pump supplies sea water for cooling the diesel engine oil being returned to the diesel oil tanks.

b. The following is an index to the maintenance procedures.

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition** / **Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
2	Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

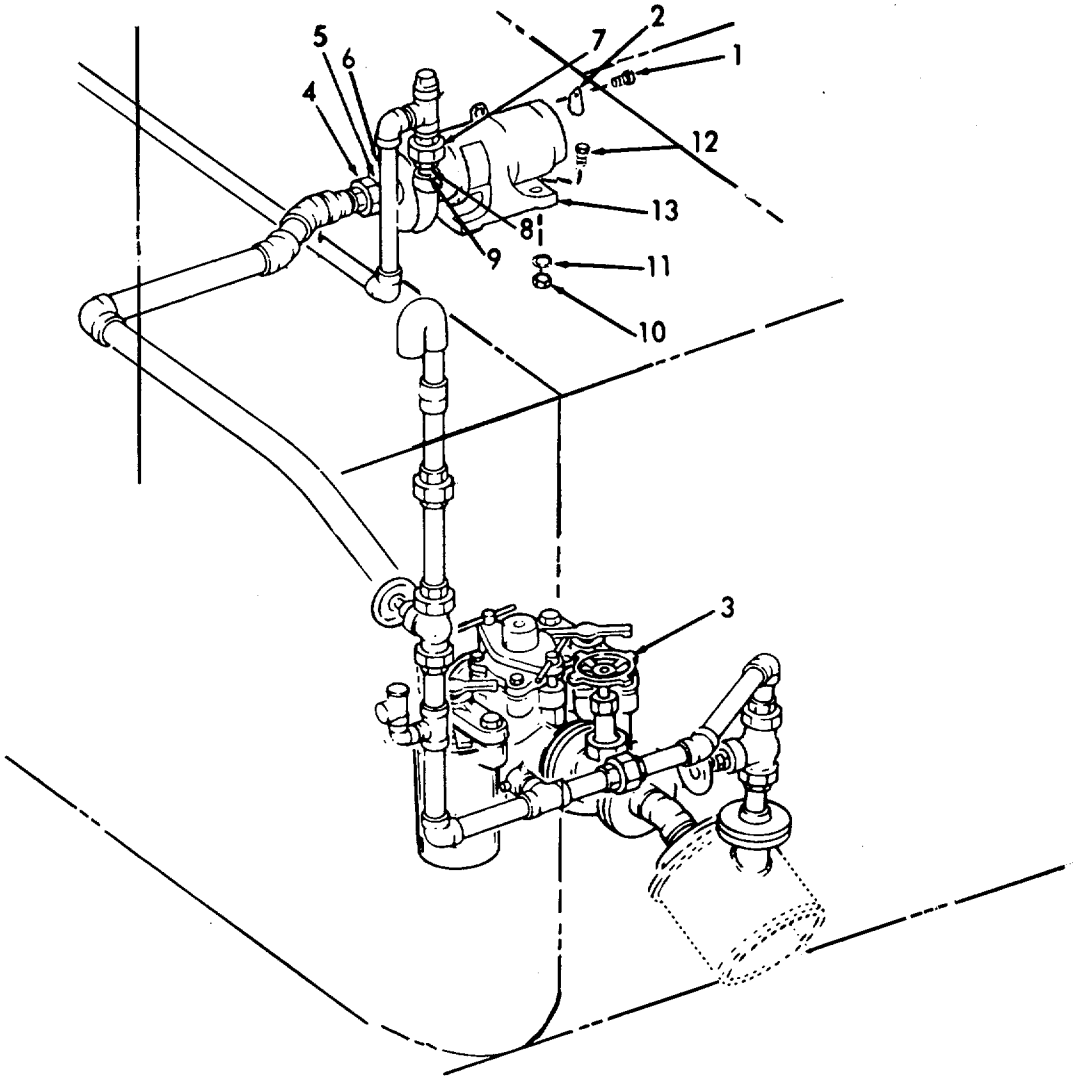
1. Pump set	a. Piping	Inspect for breaks, cracks, or leaks.	
	b. Wiring	Inspect for breaks, cracks, fraying or loose connections.	
	c Housing	Inspect for cracks, dents, or leaks.	
	d. Hardware	Insure all hardware is tight.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1), and cover plate (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Valve (3)	Turn off.	
	d. Union (4)	Loosen.	
	e. Union half, (5) and nipple (6)	Remove.	
	f. Union (7)	Loosen.	
	g. Union half, (8) and nipple (9)	Remove.	
	h. Nuts (10) lock-washers (11), and screws (12)	Remove.	
	i. Pump set (13)	Remove.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

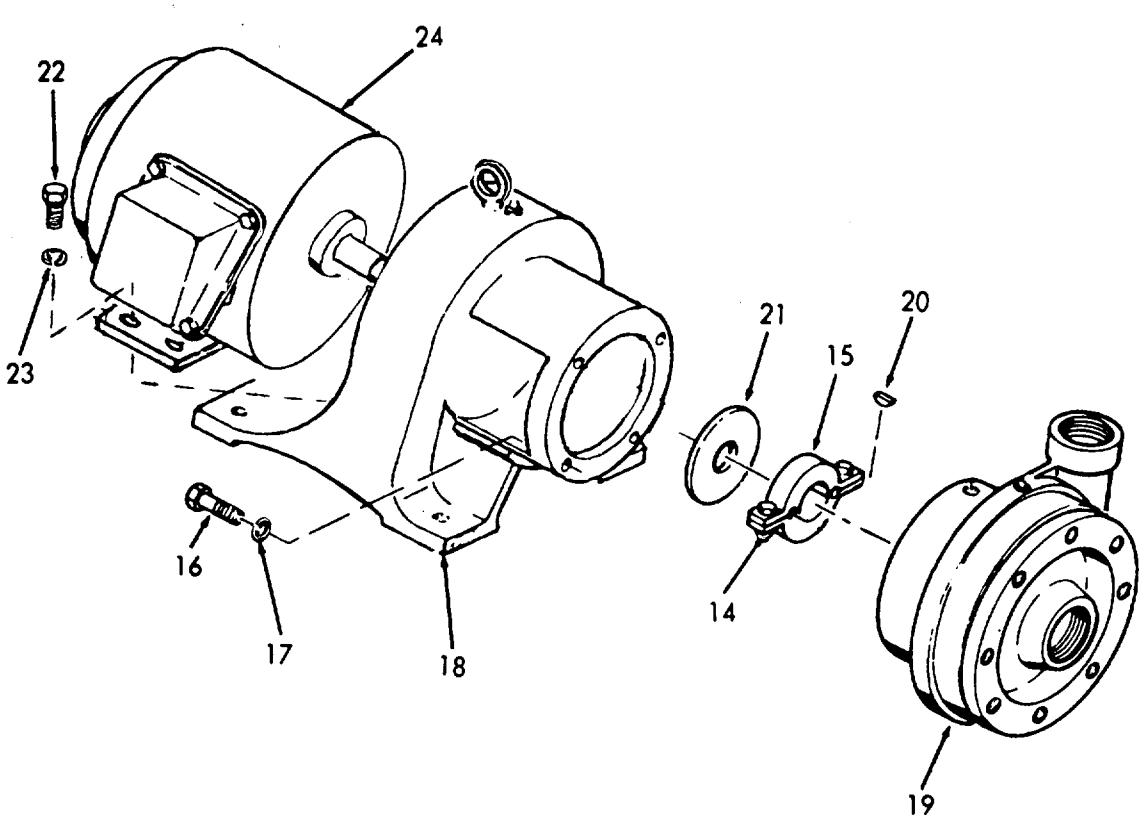


4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Motor - housing pump	a. Screws (14), and clamp (15)	Loosen.	
	b. Bolts (16), and lock-washers (17)	Remove.	
	c. Housing (18), and pump (19)	Separate.	
	d. Key (20)	Remove.	
	e. Clamp (15), and oil slinger (21)	Remove.	
	f. Bolts (22), and lock-washers (23)	Remove.	
	g. Motor (24)	Remove from housing (18).	
REASSEMBLY			
4.	a. Motor (24), housing (18), bolts (22), and lock washers (23)	1. Align motor with housing. 2. Install bolts.	
	b. Oil slinger (21), and clamp 15)	Place on motor shaft.	
	c. Key (20)	Place in motor shaft.	
	d. Pump (19), housing (18), and motor shaft and key (20)	Align.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	e. Bolts (16), and lock-washers (17)	Install.	
	f. Screws (14)	Tighten on clamp (15).	



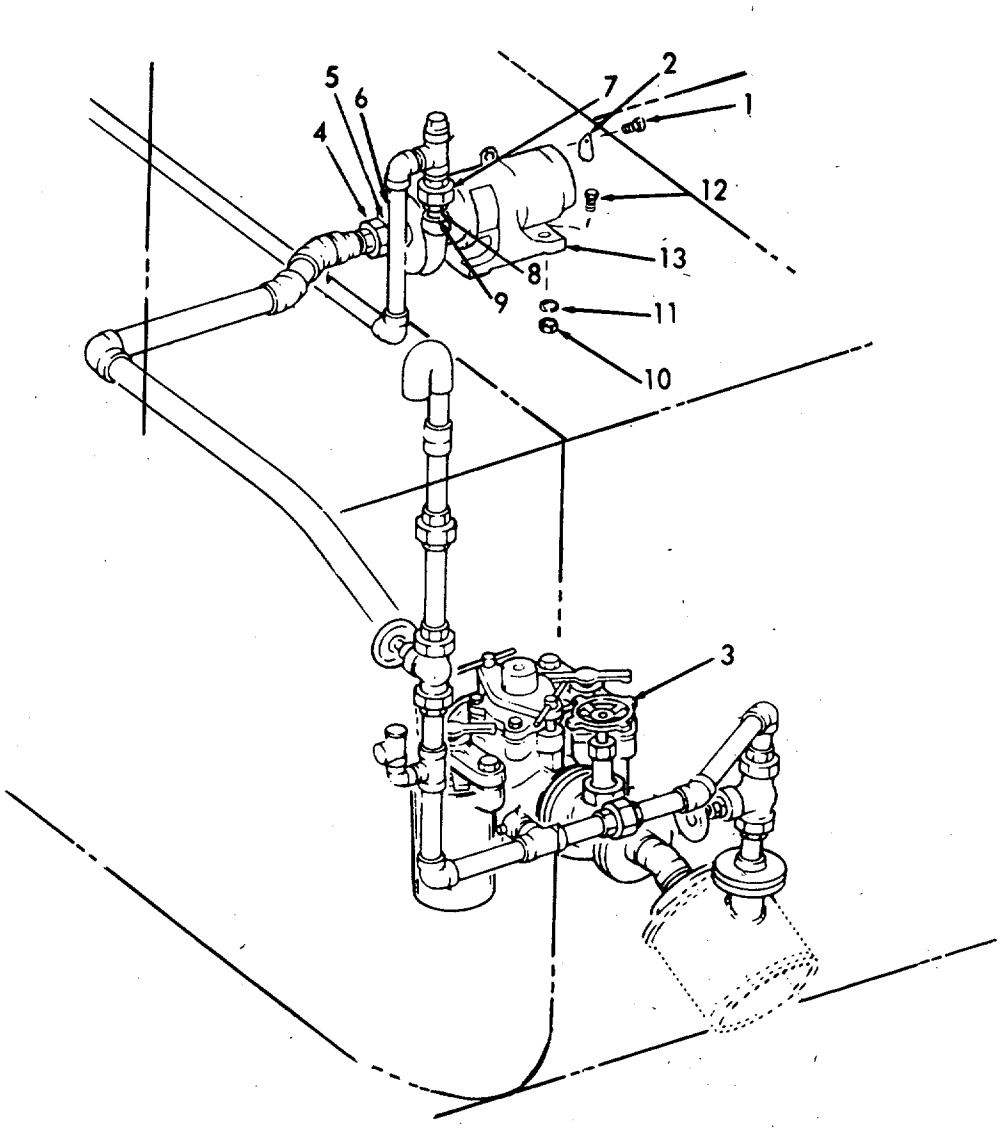
4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Pump set (13), screws (12), lock-washers (11), and nuts (10)	Install	
	b. Nipple (9) ,and union half (8)	Reassemble.	
	c. Union (7)	Tighten.	
	d. Nipple (6), and union half (5)	Reassemble.	
	e. Union (4)	Tighten.	
	f. Valve (3)	Turn on.	
	g. Wiring	Reconnect and remove tags.	
	h. Cover plate (2), and screws (1)	Install.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

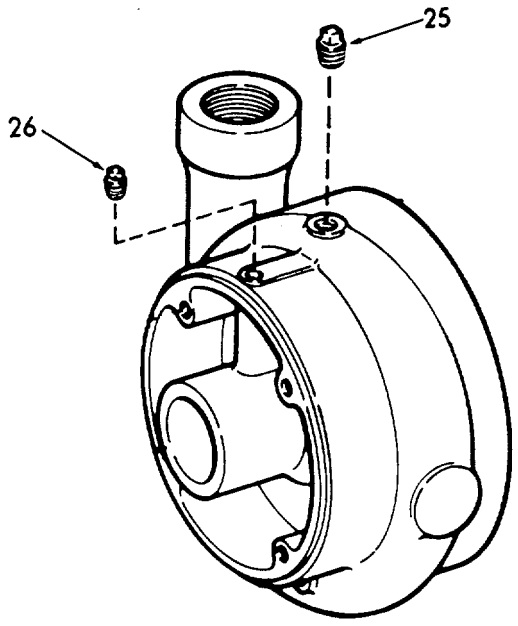
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		CAUTION In order to avoid damage, do not run the pump until it is primed.	
	i. Pipe plugs - fill (25), and vent (26)	1. Remove. 2. Fill with water until water flows from vent.	
	j. Pipe plugs (25 and 26)	Replace.	



4-13.2. DISEAL OIL COOLING PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

References

NONE

Equipment Condition Paragraph	Condition Description
4-12.1	Pump set removal and disassembly.

Material/Parts

Gasket DNH-91

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

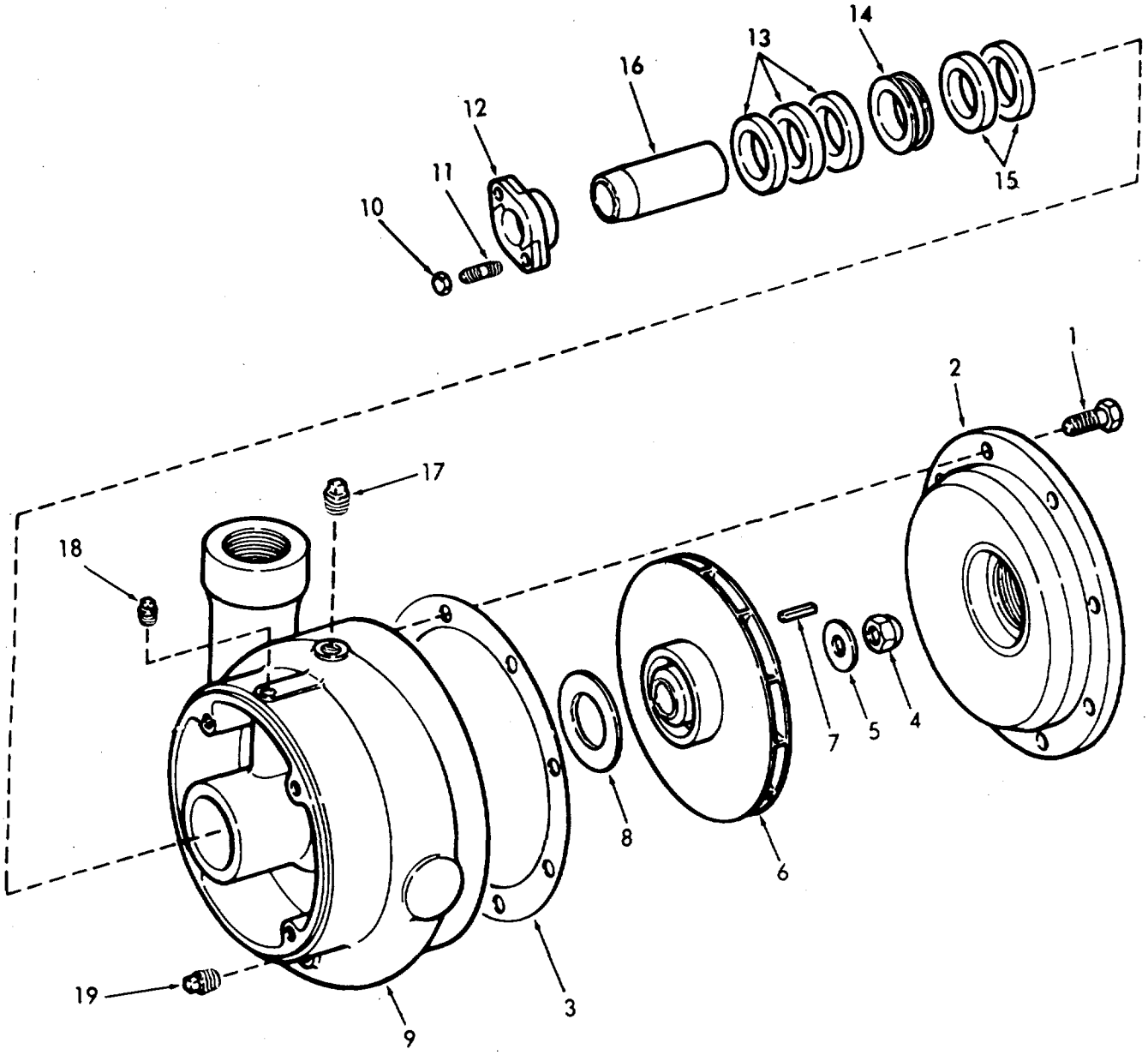
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Cooling pump	a. Casing	Inspect for breaks, cracks, or leaks.	
	b. Impeller	Inspect for breaks, cracks, dents or bends.	
	c. Sleeve	Inspect for nicks, burrs, dents or cracks.	
	d. Hardware	Insure all hardware is tight.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Screws (1), head (2), and suction head gasket (3)	Remove.	Discard gasket.
	b. Nut (4), washer (5), impeller (6), key (7), and shaft seal ring (8)	Remove from casing (9).	Line up hole in shaft with hole in gland and insert pin that is provided before removing nut.
	c. Nuts (10), and studs (11)	Remove.	
	d. Gland (12)	Remove.	
	e. Packing (13), cage (14), packing (15), and sleeve (16)	Remove.	Discard packing.
	f. Fill pipe plug (17), vent pipe plug (18), and drain pipe plug (19)	Remove.	If necessary.
REASSEMBLY			
3.	a. Sleeve (16), (16), packing (15), cage (14), and packing (13)	Reassemble.	Replace packing.

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			

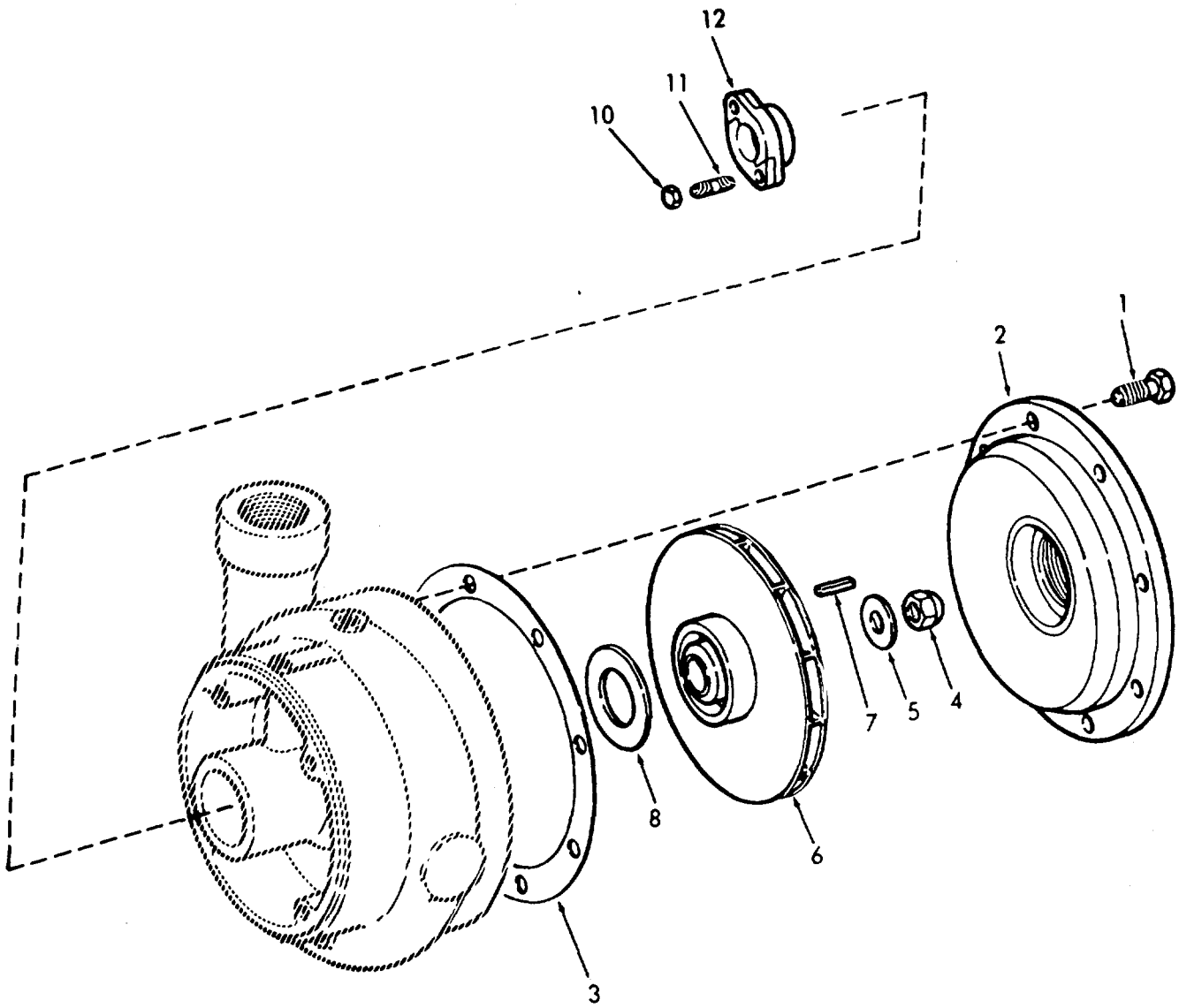


4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Gland (12), studs (11), and nuts (10)	Reassemble.	
	c. Shaft seal ring (8), key (7), impeller (6), washer (5), and nut (4)	Reassemble.	
	d. Suction head gasket (3), head (2), and screws (1)	Reassemble.	Replace gasket.

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			



4-13.3. DIESEL OIL COOLING PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Inspection b. Disassembly c. Reassembly

INITIAL SETUP

Test Equipment

NONE

Special Tools

Arbor press
Bearing puller

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition Paragraph	Condition Description
4-13.1	Pump Set removed and disassembled.

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Motor	a. Frame	Inspect for cracks, dents, or breaks.
	b. Shaft	Inspect for bends, cracks, or dents.
	c. Hardware	Insure all hardware is tight.

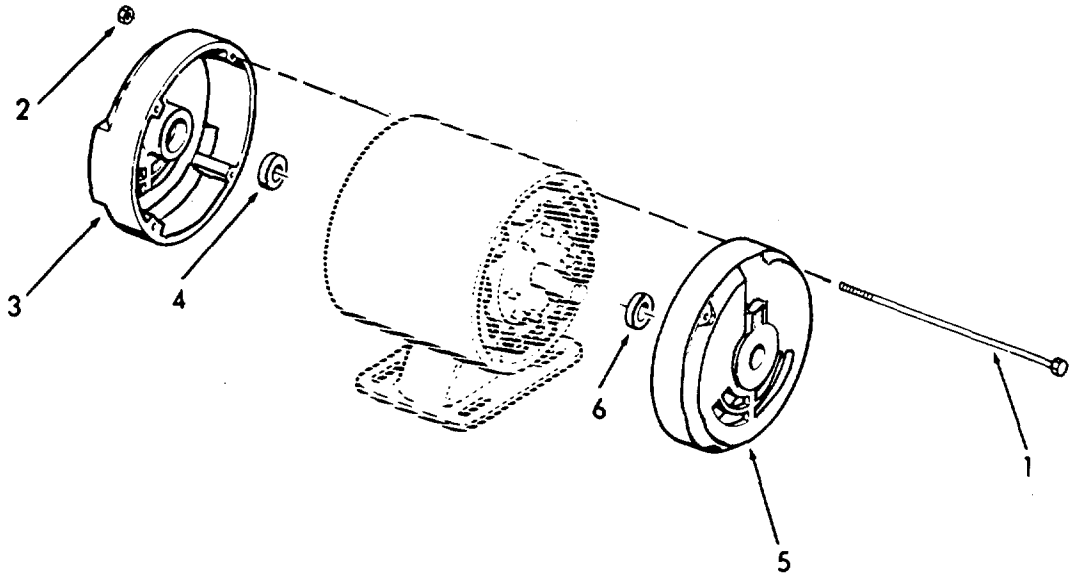
4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Thru bolts (1), and nuts (2)	Remove.	
	b. Bracket (3). and ball bearing (4)	Remove.	Use bearing puller.
	c. Bracket (5), and ball bearing (6)	Remove.	Use bearing puller.
REASSEMBLY			
	a. Ball bearing (6), and bracket (5)	Reassemble.	Use arbor press.
	b. Ball bearing (4), bracket (3), thru bolts (1), and nuts (2)	Reassemble.	Use arbor press.

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY



4-13.4. DIESEL OIL COOLING PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
1	Observe WARNING.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION

1. Controller (external)	a. Enclosure	1. Inspect for breaks, cracks, dents, and bending.	
		2. Insure all mounting hardware is tight	
	b. Wiring	Inspect for wear, fraying, and damage.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

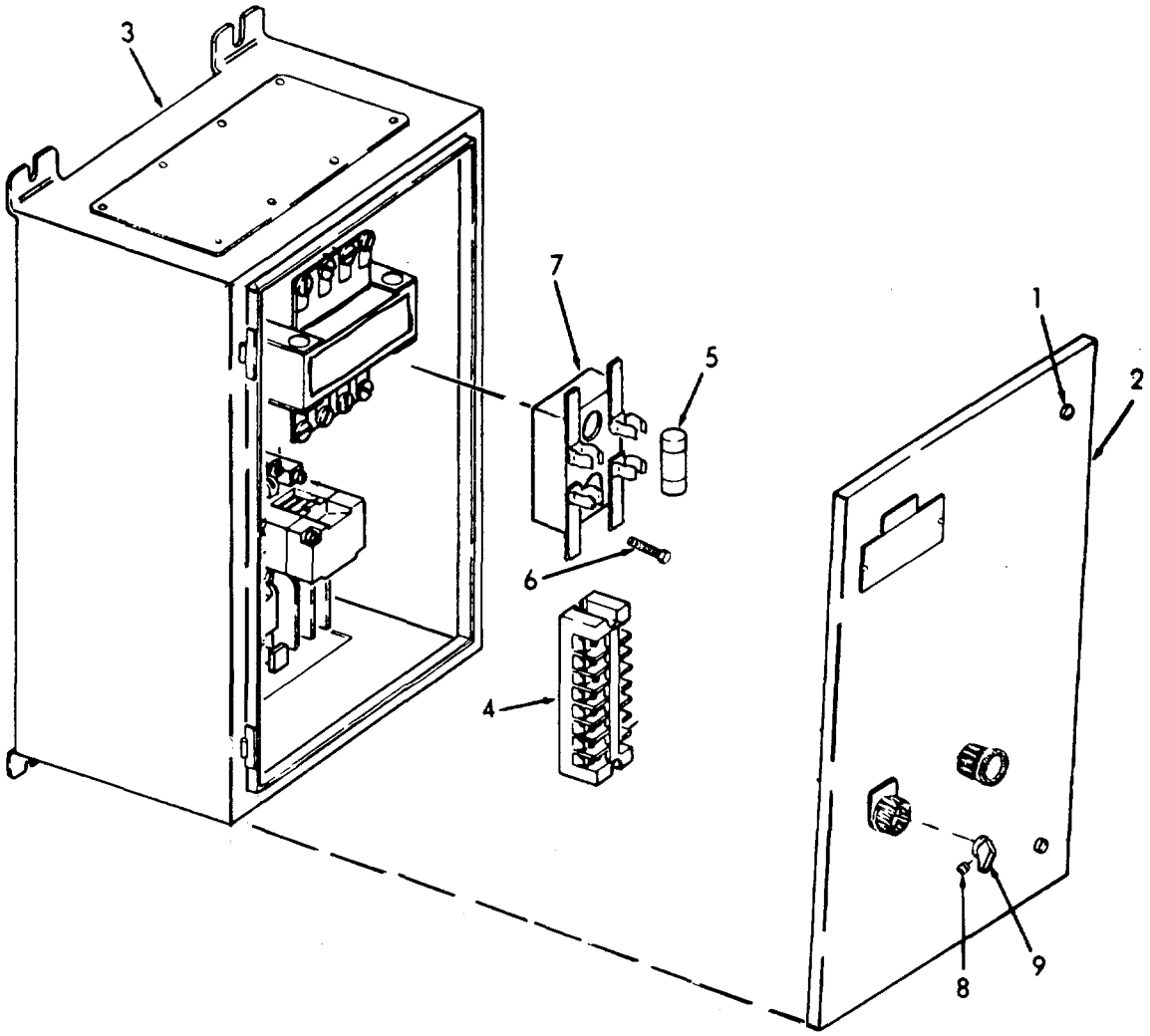
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Switches	Inspect for signs of failure or improper operation.	
2. Controller (internal)	a. Relays and starters	1. Inspect for worn contact tip material.	
		2. Inspect for clean-liness.	
		3. Insure all mounting hardware is tight.	
	b. Wiring	1. Inspect for wear, fraying, and damage.	
		2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure.	
		2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components.	
		2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks.	
		2. Insure all mounting hardware is tight.	
	f. Trans-former	1. Inspect for damaged wiring and terminals.	
		2. Insure all hardware is tight.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	g. Disconnect switch	1. Inspect for signs of failure.	
		2. Insure all hardware is tight.	
REMOVAL			
3. Controller	a. Captive screws (1)	Rotate counterclockwise to loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect from terminal block (4).	
	d. Controller (3)	Remove from bulkhead.	
REPAIR			
4. Fuses	Fuses (5)	Remove and replace.	
5. Fuse block	a. Wiring	Tag and disconnect.	
	b. Screws (6)	Remove.	
	c. Fuse block (7)	Replace.	
	d. Screws (6)	Replace.	
	e. Wiring	Reconnect and remove tags.	
6. Selector switch	a. Wiring	Tag and disconnect.	
	b. Setscrew (8)	Loosen.	
	c. Knob (9)	Remove.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

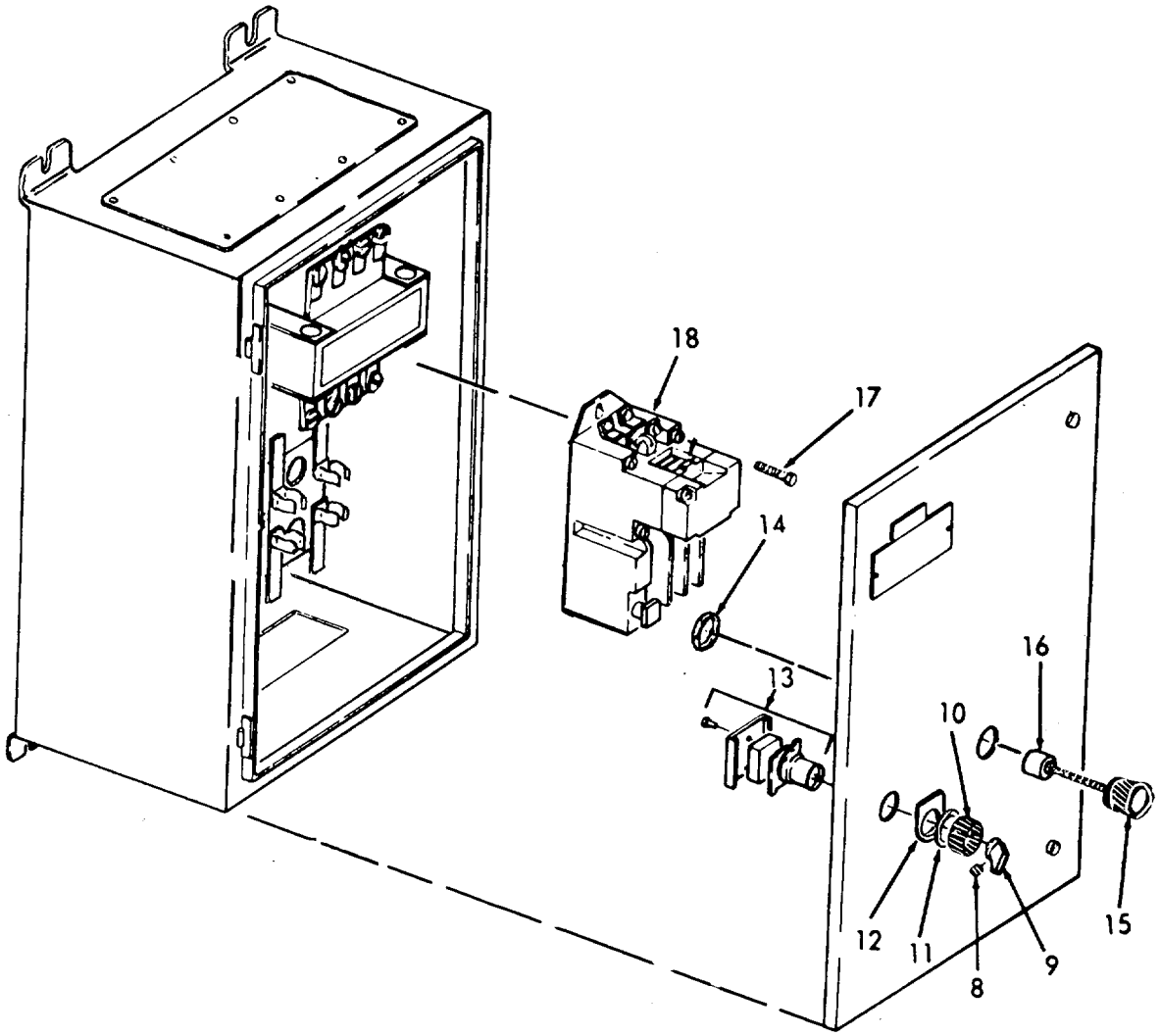


4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Retaining nut (10), gasket (11), and identification plate (12)	Remove.	
	e. Switch (13)	Replace.	
	f. Identification plate (12), gasket (11), and retaining nut (10)	Reassemble.	
	g. Knob (9)	Replace.	
	h. Setscrew (8)	Tighten.	
	i. Wiring	Reconnect and remove tags.	
7. Reset button	Retaining nut (14), pushbutton (15), and sleeve (16)	Remove.	If necessary.
8. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws (17)	Remove.	
	c. Starter (18)	Replace.	
	d. Screws (17)	Replace.	
	e. Wiring	Reconnect.	

4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

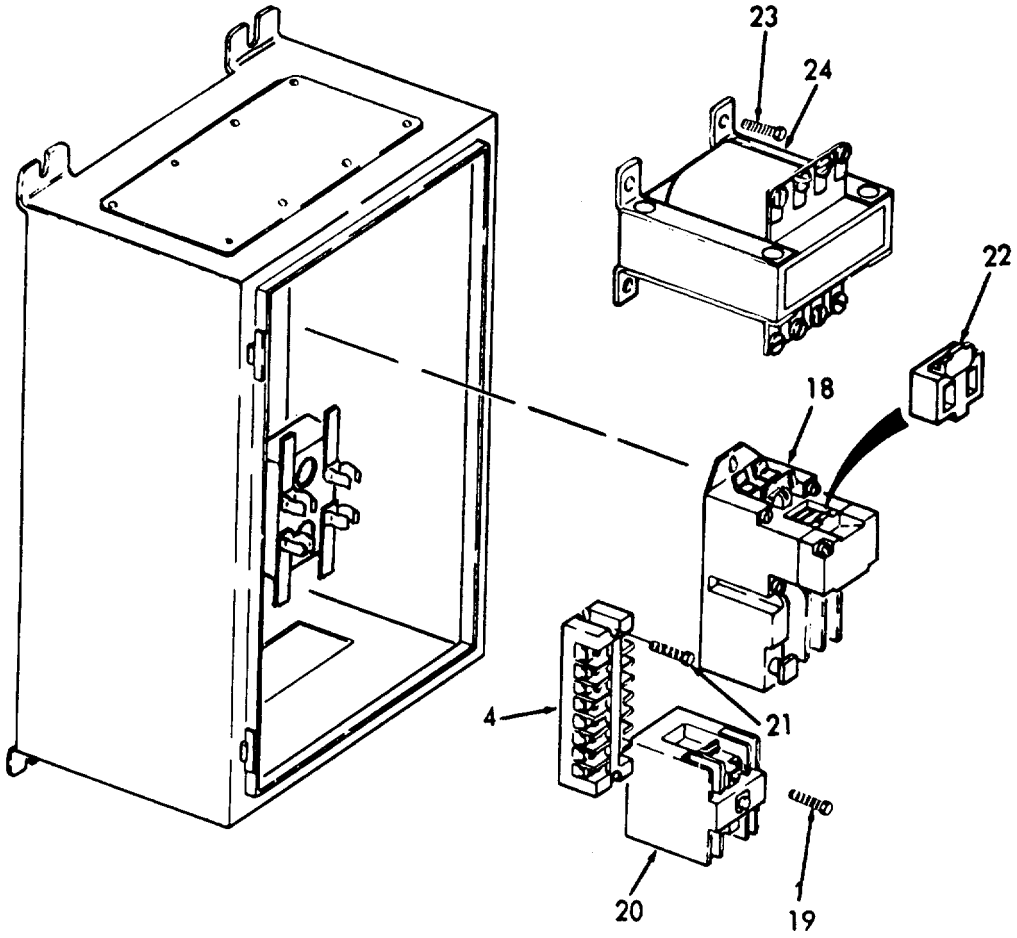


4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. "M" Type relay	a. Wiring	Tag and disconnect.	
	b. Screws (19)	Remove.	
	c. Relay (20)	Replace.	
	d. Screws (19)	Replace	
	e. Wiring	Reconnect and remove tags.	
10. Terminal block	a. Wiring	Tag and disconnect.	
	b. Screws (21)	Remove.	
	c. Terminal block (4)	Replace.	
	d. Screws (21) (21)	Replace.	
	e. Wiring	Reconnect and remove tags.	
11. Shunt coil	Shunt coil (22)	Remove from starter (18).	
12. Control trans - former	a. Wiring	Tag and disconnect.	
	b. Screws (23)	Remove.	
	c. Transformer (24)	Replace.	
	d. Screws (23)	Replace.	
	e. Wiring	Reconnect and remove tags.	

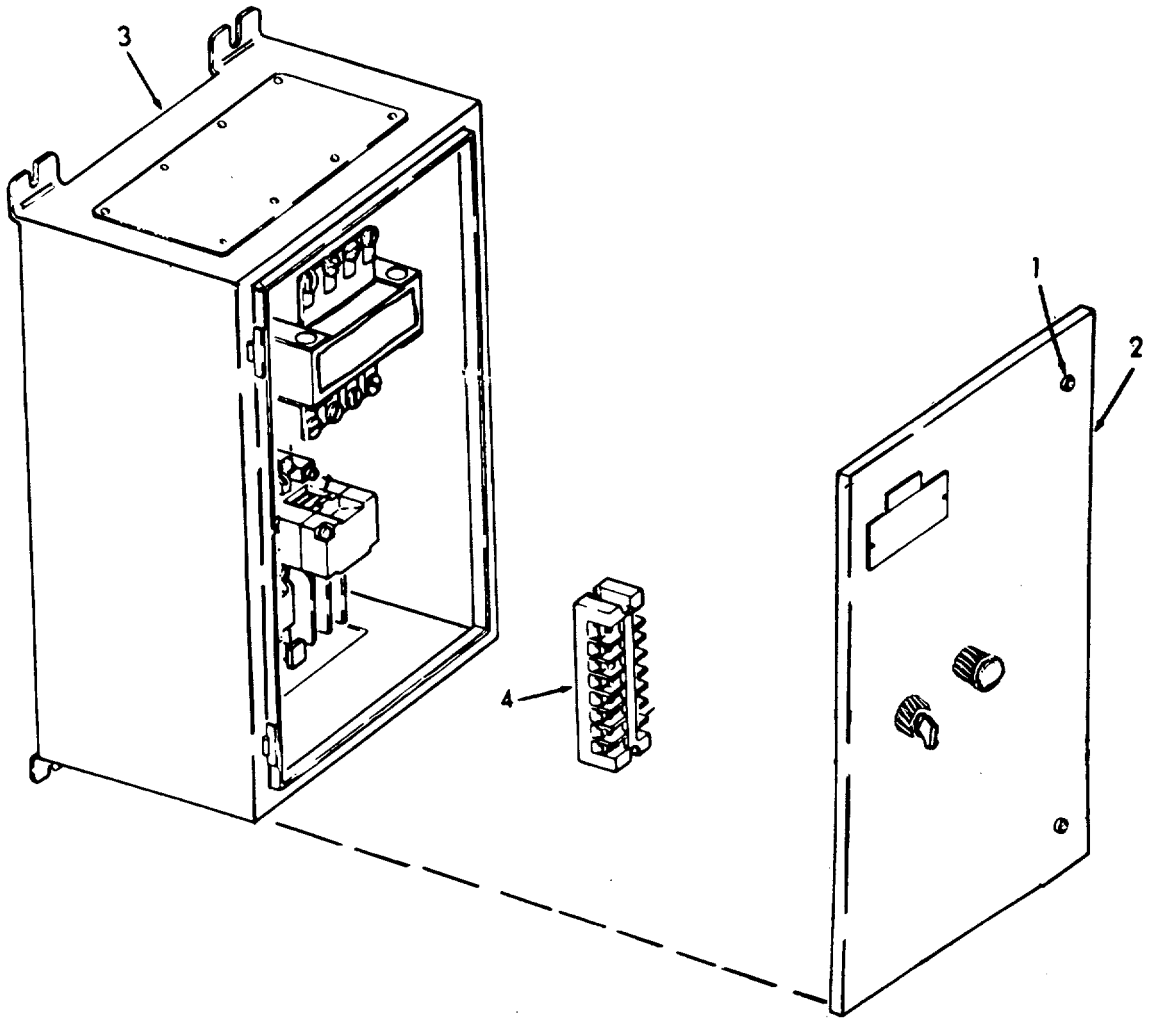
4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-13.1. DIESEL OIL COOLING PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
13 Control-Ler	a. Controller (3)	Install on bulkhead.	
	b. Wiring	Reconnect to terminal block (4).	
	c. Door (2), and captive screws (1)	Swing closed and rotate screws clock-wise.	



4-14. LUBE OIL TRANSFER PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition: NONE
Condition Description

Material/Parts

NONE

Special Environmental Conditions

Do not drain oil into bilges. Use the oil/water separation and recovery system to collect drained oil.

Personnel Required

1

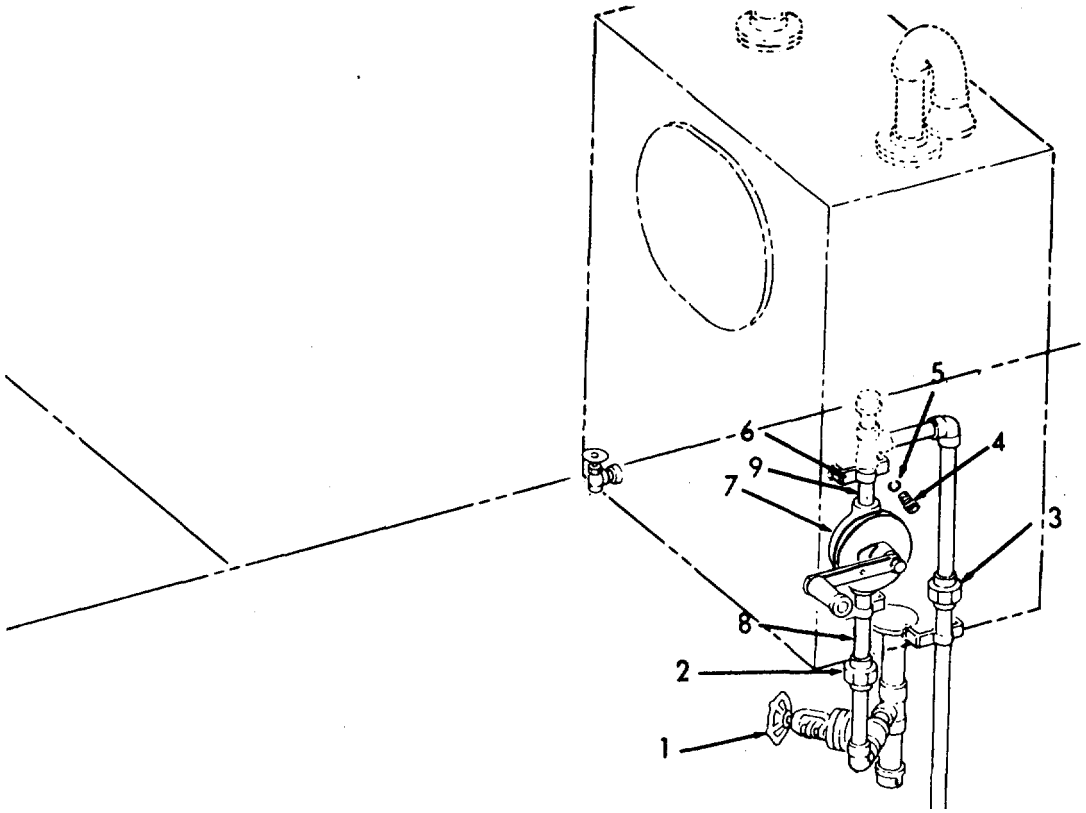
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Pump	a. Cylinder	Inspect for breaks, cracks, or leaks.	
	b. Handle	Inspect for bends, cracks, or dents.	
	c. Hardware	Inspect for tightness.	

4-14. LUBE OIL TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Valve (1)	Shut off.	
	b. Unions (2 and 3)	1. Loosen and separate.	
		2. Drain oil into a suitable container.	
	c. Screws (4), and lock-washers (5)	Remove.	
	d. Brackets (6), and lube oil pump (7)	Remove.	
	e. Nipple (8)	Remove.	
	f. Pump (7)	Unscrew from pipe (9).	



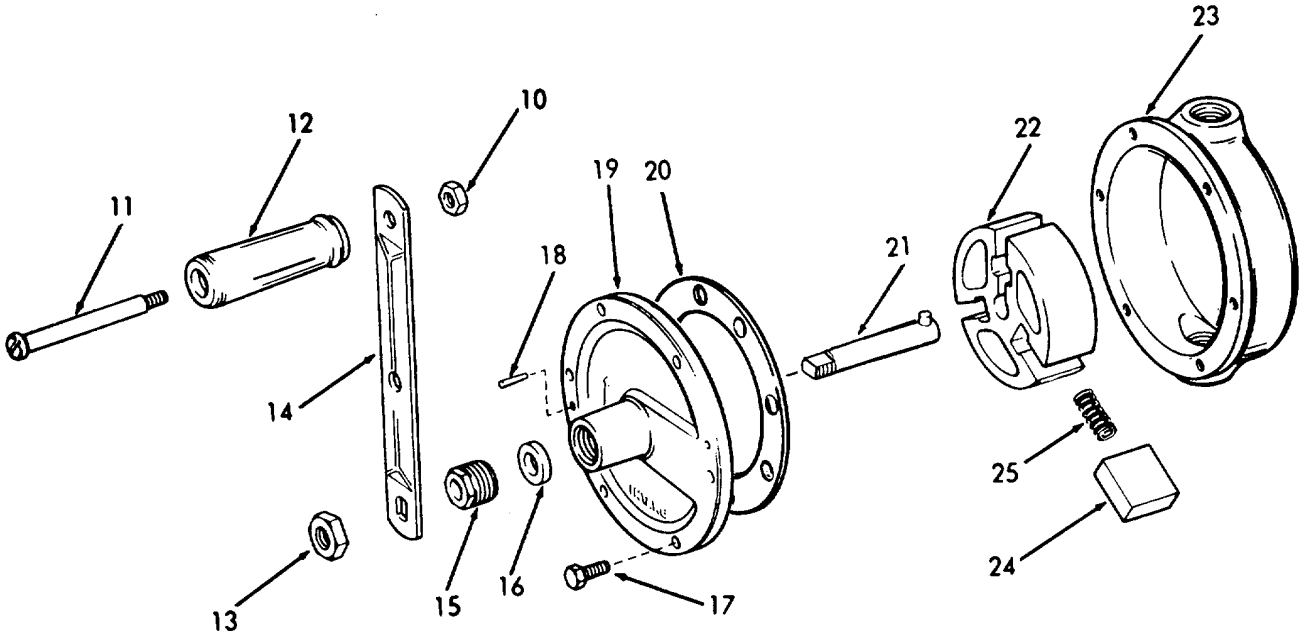
4-619

4-14. LUBE OIL TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3.	a. Nut (10), screw (11), and grip (12)	Remove.	
	b. Nut (13), and crank (14)	Remove.	
	c. Packing nut (15), and packing (16)	Remove	Discard packing.
	d. Screws (17), and pins (18)	Remove.	It may be necessary to tap head loose with a soft hammer.
	e. Head (19), and gasket (20)	Remove.	Discard gasket.
	f. Shaft (21)	Turn the shaft until it can be pulled away.	
	g. Rotor (22)	Remove from the cylinder (23).	
	h. Vanes (24), and springs (25)	Remove.	
REASSEMBLY			
4.	a. Springs (25), vanes (24), and rotor (22)	Reassemble and put into cylinder (23).	
	b. Shaft (21)	Turn until secure in rotor (21).	
	c. Head (19), and gasket (20)	Reassemble.	Use new gasket.

4-14. LUBE OIL TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued)

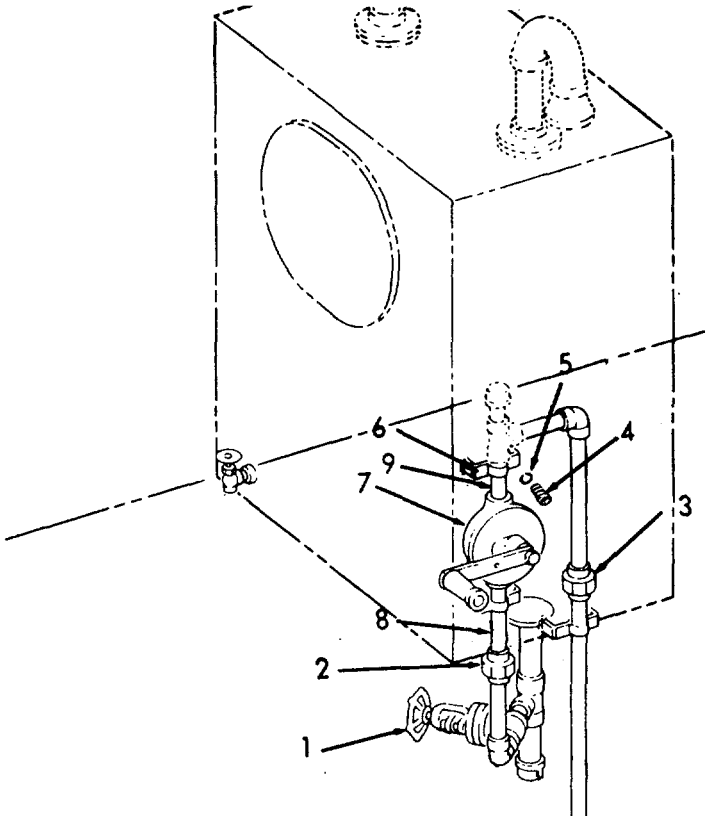
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Pins (18), and screws (17)	Reassemble.	
	d. Packing (16), and packing nut (15)	Reassemble.	Replace packing.
	e. Crank (14), nut (13), grip (12), screw (11), and nut (10)	Reassemble.	



4-621

4-14. LUBE OIL TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Pipe (9), and pump (7)	Reassemble.	
	b. Nipple (8), and pump (7)	Reassemble.	
	c. Pump (7), bracket (6), screws (4), and lock-washers (5)	Reassemble.	
	d. Unions (2 and 3)	Reconnect.	
	e. Valve (1)	Open.	



4-622

4-15. SEWAGE SYSTEM - MAINTENANCE INSTRUCTIONS.

WARNING

- HIGH VOLTAGE is used in the operation of this equipment.
- DEATH ON CONTACT may result if personnel fail to observe safety precautions.
- Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid.
- Whenever possible, the input power supply to the equipment must be shut off before beginning work on the equipment. When working inside the equipment, after power has been turned off, always ground every part before touching it.
- Do not be misled by the term "low voltage". Potentials as low as 50 volts may cause death under adverse conditions.
- Sewage is an inclusive term generally applied to the mixture of all liquid domestic wastes, especially human body wastes. The character of sewage changes from place to place but it always contains very large numbers of bacteria - hundreds of millions per milliliter - some of which can cause dangerous illness in man. Typhoid and polio viruses are two examples.

  The ingress of these bacteria to the human body is through the mouth or open sores. It is important therefore to observe certain elementary precautions.

  a. No food or drink of any nature should be taken into sewage handling areas.

  b. Personnel with open cuts or sores should not work on sewage handling equipment.

  c. Any sewage spill should be dealt with immediately, before it dries; by washing down with water and a good quality, non-scented disinfectant. Liquid soaps or scented disinfectants should not be used since they only serve to disguise improper clean-up.

4-15. SEWAGE SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

WARNING

(Continued)

d. All personnel should be encouraged to wash their hands on exit from a sewage handling area or after being in contact with sewage handling equipment.

a. General. The sewage collection system uses a limited amount of flush water, and is used in conjunction with a suitable holding tank. In addition, with proper valving, the wastes can be directed overboard when the vessel is operating in unrestricted waters. The collection system consists of controlled volume flush (CVF) urinals and commodes, macerator/transfer pumps, and a timing circuit to control the operation of the pumps.

b. Operation. Operation of the system is as follows:

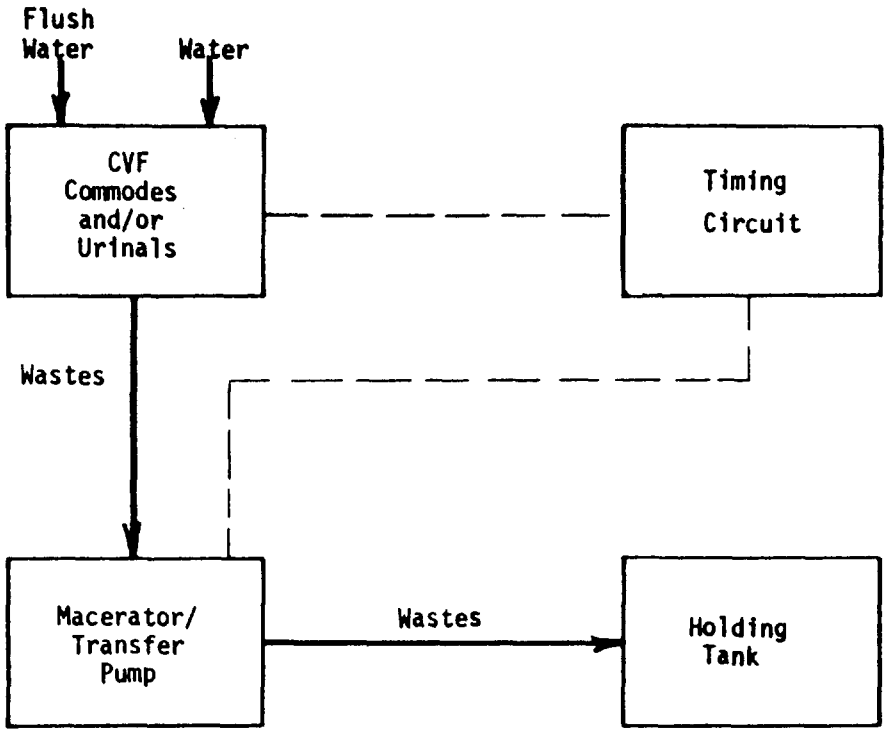
(1) Wastes are collected in the controlled (limited) volume flush urinals or commodes, which use 1 pint and 3 pints of flush water respectively; this results in a water savings of approximately 90 percent over conventional flushing systems.

(2) Each time a controlled volume flush (CVF) commode or urinal is flushed, a switch turns on the macerator/transfer (M/T) pump for approximately ten seconds; the duration of M/T pump operation is controlled by a time delay relay within the control panel enclosure.

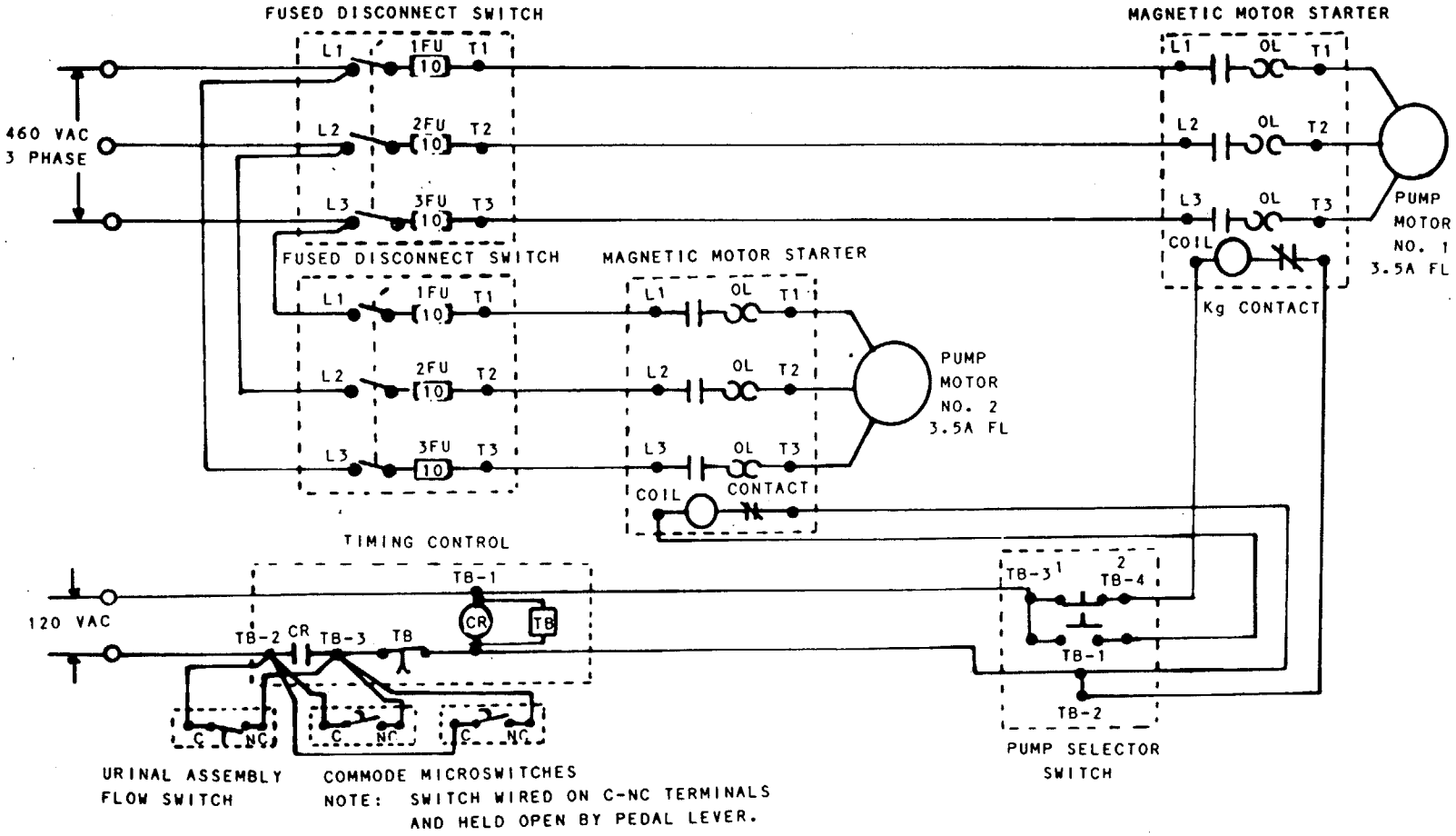
(3) The macerator/transfer pumps reduce the wastes to a homogenous slurry and transfers them to a holding tank, which is pumped out at suitable facilities when full.

c. The following is an index to the sewage system maintenance instructions.

4-15. SEWAGE SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



4-15. SEWAGE SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



4-16. SEWAGE PUMP.

a. The sewage discharge pump is used to pump the effluent from the collection tank to a shore based installation. If the vessel is in unrestricted waters the effluent can be pumped overboard.

b. The following is an index to the maintenance procedures.

DESCRIPTION	PARAGRAPH
Sewage Pump Set	4-16.1
Sewage Pump	4-16.2
Sewage Pump Motor	4-16.3
Sewage Pump Motor Controller	4-16.4

4-16.1. SEWAGE PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal b. Installation

INITIAL SETUP

Test Equipment	References Paragraph	
NONE	4-16.2	Pump maintenance
	4-16.3	Motor maintenance
Special Tools	**Equipment Condition**	**Condition Description**
NONE	NONE	
Material/Parts	**Special Environmental Conditions**	
NONE	Observe WARNINGS in paragraph 4-15.	
Personnel Required	**General Safety Instructions**	
2	Observe WARNINGS in paragraph 4-15 and in this procedure.	

4-16.1. SEWAGE PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

WARNING

In order to eliminate possible shock and injury, tag and place disconnect switch in the OFF position, and pull fuses as an added safety precaution.

REMOVAL

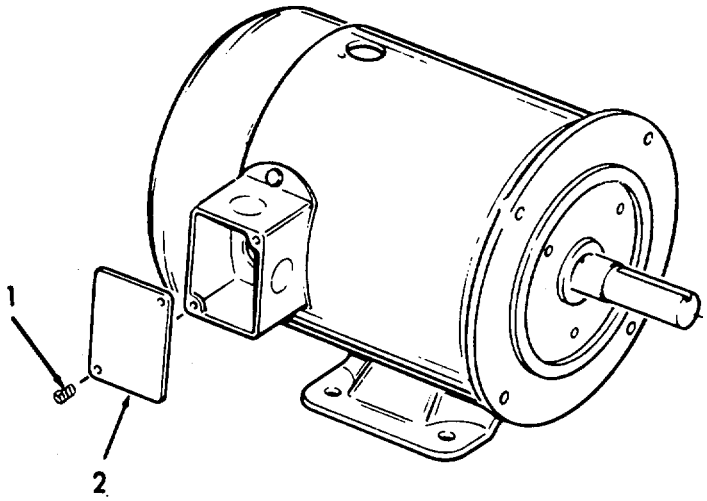
1.	Wiring	a. Screws (1), and cover (2)	Remove.
		b. Wiring	Tag and disconnect.
2.	Piping	a. Union (3)	Disconnect.
		b. Nuts (4), lockwasher (5), and screws (6)	Remove.
		c. Flange (7)	Separate.
3.	Pump set	a. Nuts (8), lockwashers (9), and screws (10)	Remove.
		b. Pump set	Remove.

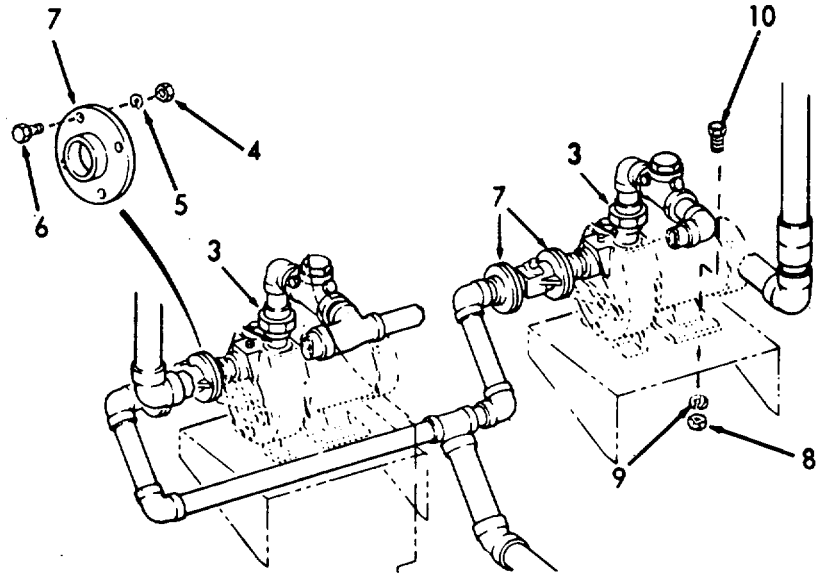
INSTALLATION

4.	Pump set	Screws (10), lockwashers (9), and nuts (8)	Install.
5.	Piping	a. Flange (7)	Align flange sections.
		b. Screws (6), lockwashers (5), and nuts (4)	Install.
		c. Union (3)	Reconnect.

4-16.1. SEWAGE PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
6. Wiring	a. Wiring	Reconnect and remove tags.	
	b. Cover (2), and screws (1)	Install.	
7. Pump set	Pipe plug	Remove and prime.	





4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Service c. Repair

INITIAL SETUP

Test Equipment	References	
Feeler gages	Paragraph 4-16.3	Pump Motor
Special Tools	**Equipment Condition**	**Condition Description**
Grease gun Impeller pulling tool	Paragraph 4-16.1	Pump Set removed
Material/Parts	**Special Environmental Conditions**	
Grease MIL-G-10924 Type GAA	Observe WARNINGS in paragraph 4-15.	
Personnel Required	**General Safety Instructions**	
1	Observe WARNINGS in paragraph 4-15 and in this procedure.	

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Pump	a. Piping	Inspect for leaks, breaks and cracks.	Refer to General Support Maintenance.
	b. Pump	1. Inspect for leaks, breaks, and cracks. 2. Insure all hardware is tight. 3. Listen for any abnormal noise.	
	c. Motor	Inspect.	Refer to paragraph 4-16.3.

4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2.	a. Volute	Remove pipe plug to drain.	Do not drain into bilges.
	b. Automatic lubricating grease cup		

NOTE

The grease-lubricated mechanical seal applies grease to the seal from a spring-loaded grease cup. When the plunger bottoms on the grease cup cap, the grease cup must be refilled.

	1. To fill -turn the cross arm clockwise.	This raises the plunger and compresses a spring.
	2. Fill the cup using the grease fitting at the top of the plunger.	Use a grease gun and Grease type GAA.
	3. Fill until grease comes out of relief hole.	
	4. Grease cup can be filled by hand by removing the cap.	

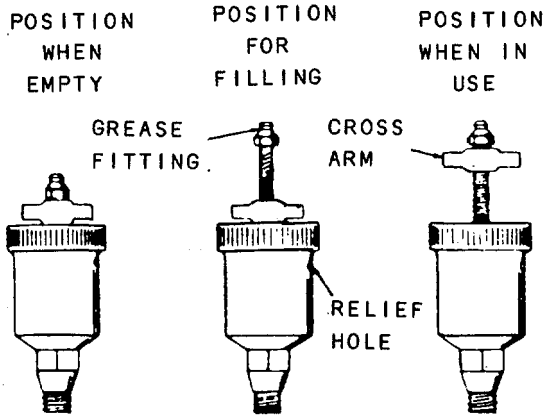
NOTE

Make sure cross arm is turned counter-clockwise until it is at the tip of the threaded plunger. This applies spring pressure to the grease. This automatically lubricates the seal.

4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

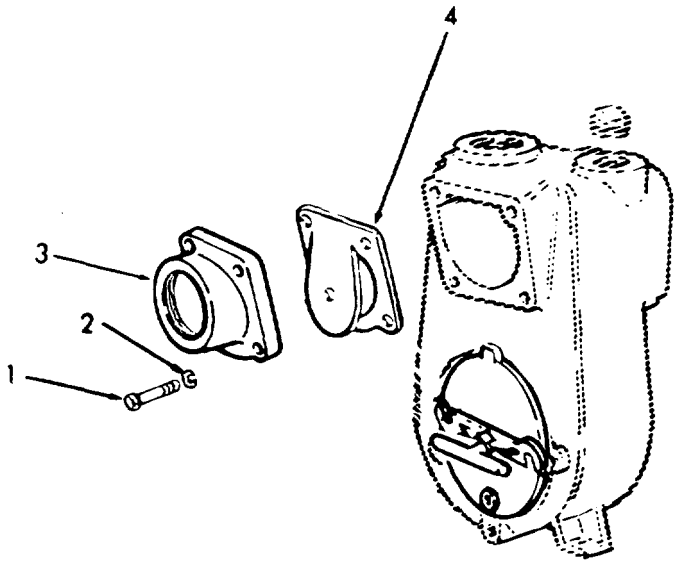
LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)



REPAIR

3.	Flap valve	a. Screws (1), and lock-washers (2)	Remove.
		b. Flange suction (3)	Remove.
		c. Flap valve (4)	Remove.

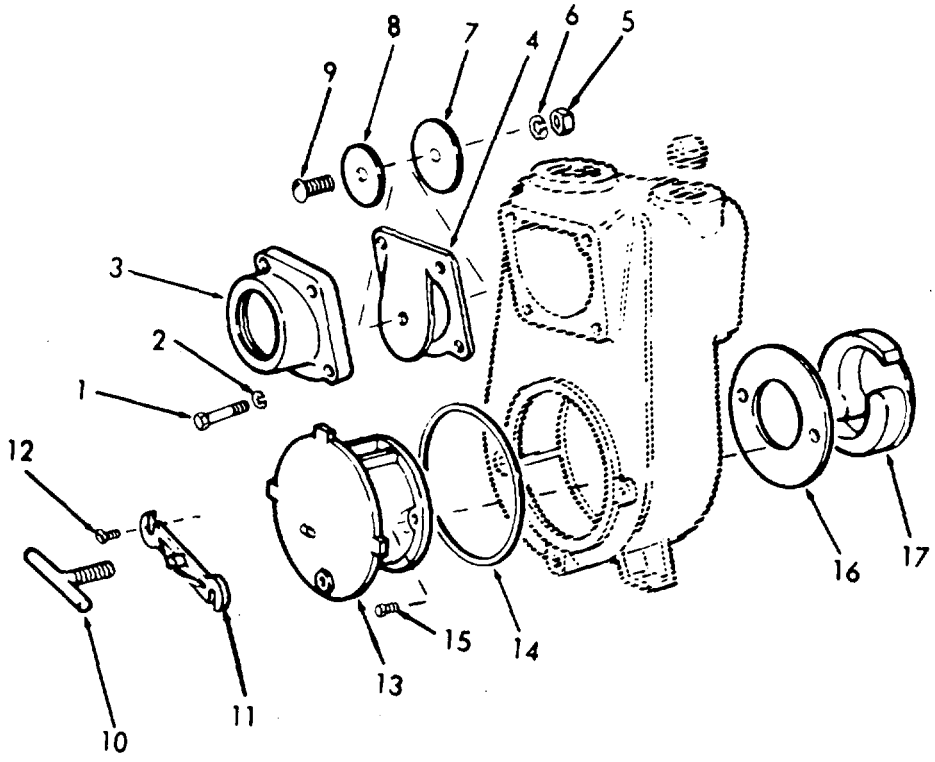


4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Nut (5), lockwasher (6), large weight (7), small weight (8), flap valve (4) and screw (9)	Disassemble and replace parts as needed.	
	e. Flap valve (4), flange section (3), screw (1) and lock-washers (2)	Reassemble.	
4. Wear plate	a. Clamp bar screw (10)	Loosen.	
	b. Clamp bar (11)	Rotate and remove.	
	c. Screws (12)	Remove.	If necessary.
	d. End plate (13), and gasket (14)	Remove.	Discard gasket.
	e. Screws (15)	Remove.	
	f. End plate (13), and wear plate (16)	Disassemble.	
	g. Wear plate (16), and impeller (17)	Adjust.	

4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

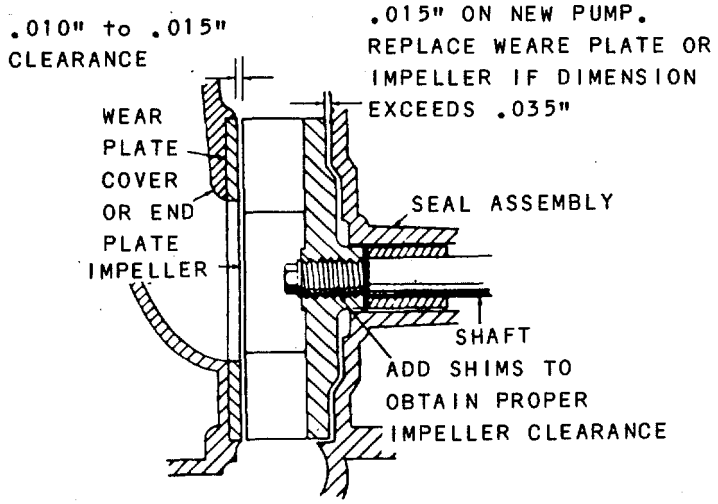


4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

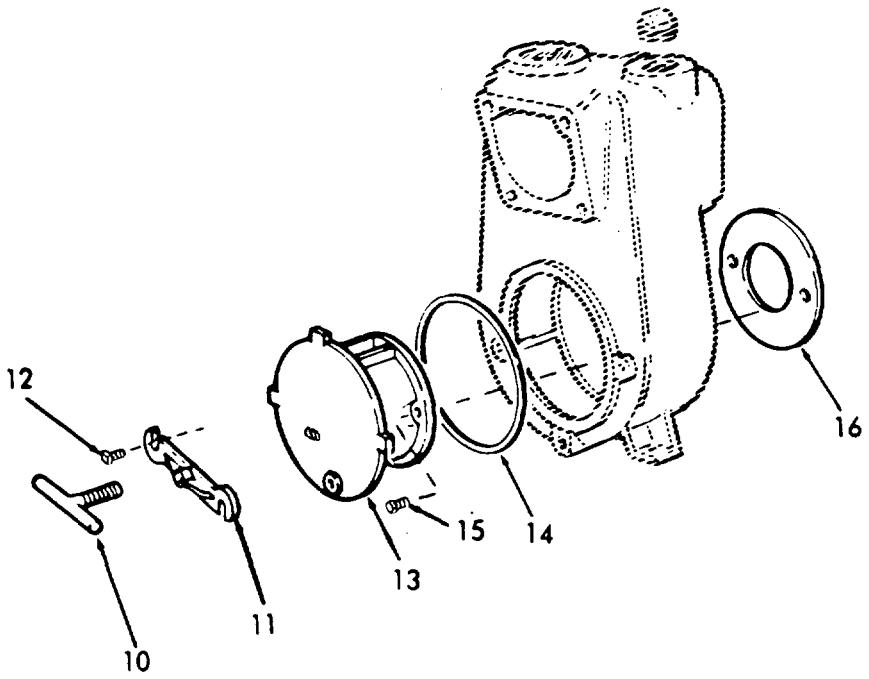
NOTE

The wear plate normally receives most of the wear. Pump efficiency will decrease considerably when the clearance between the wear plate and the impeller exceeds .035 inch (0.089 cm). Normally shims can be added to bring the clearance within limits. Add shims until rubbing just starts to occur with the impeller and cover or end plate are secured in place. Then remove enough shims to back the impeller away from the wear plate or cover a distance of 0.015 inch (0.038 cm). Install the cover and rotate the pump by hand to make sure that the impeller is not binding or scraping. Minor nicks on the edges of the impeller vanes can be removed by refinishing with a stone. If the impeller and wear plate are worn excessively, they must be replaced. After replacement of the impeller, wear plate, or impeller shaft, select shims to obtain the proper clearance between the back of the impeller and the pump casing. If the impeller scrapes when the cover is installed, add another gasket of sufficient thickness between the cover and the pump casing.



4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Wear plate (16), end plate (13), and screws (15)	Reassemble.	
	i. End plate (13), and gasket (14)	Reassemble.	
	j. Screws (12)	Replace, if removed.	
	k. Clamp bar (11), and clamp bar screw (10)	Install and tighten.	

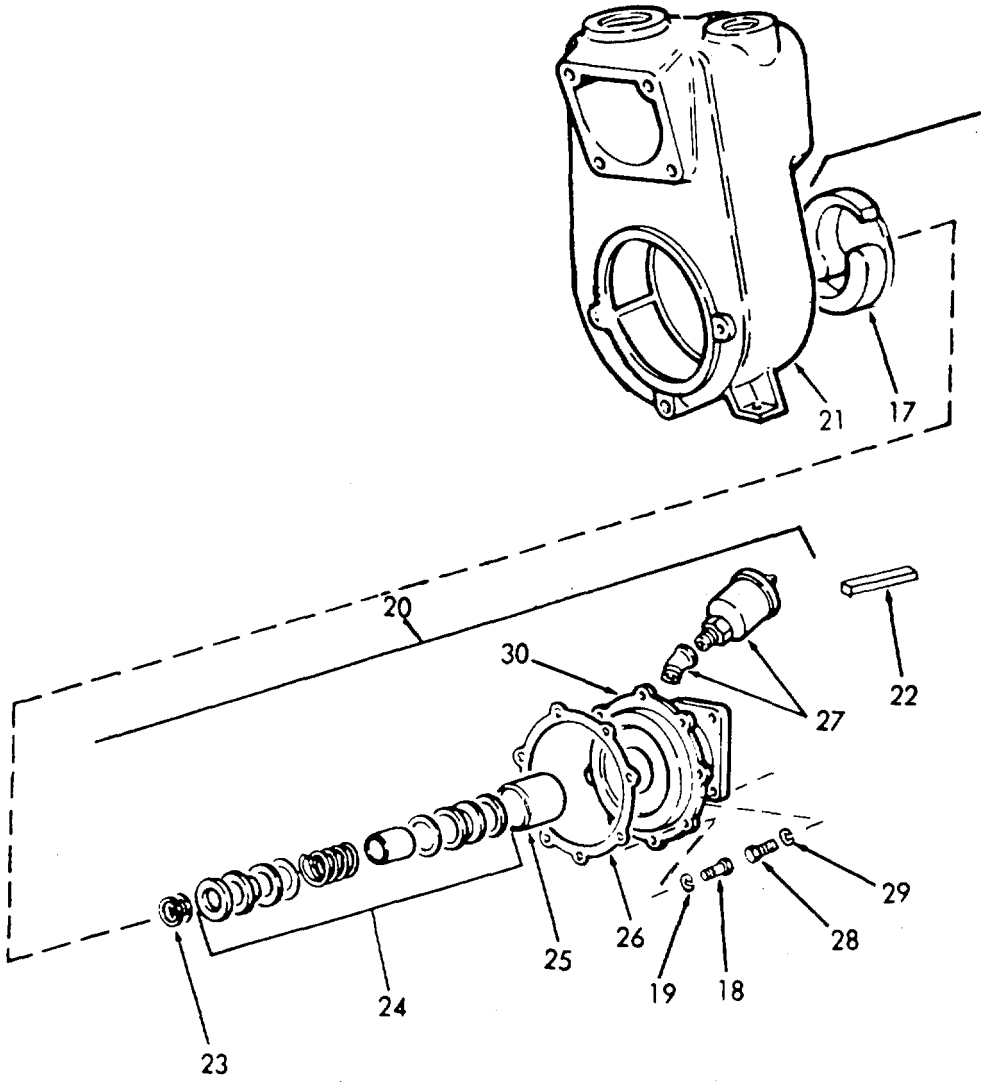


4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Seals			
		NOTE Before removing the seals from the pump, tighten the cross arm on the grease cup against the cover. This will prevent unused grease from squirting out of the cup when the seal is removed.	
	a. Screws (18), and lock-washers (19)	Remove.	
	b. Inter-mediate housing, shaft, seal, and impeller assembly (20)	Withdraw from volute (21).	
	c. Impeller (17), and key (22)	Remove.	Use impeller pulling tool.
	d. Adjusting shim (23), seal assem-bly (24), seal liner (25), and gasket (26)	1. Remove. 2. Inspect for wear. 3. Clean all parts and dry thoroughly.	a. If any parts of the seal are worn, discard the entire seal. b. If the seal liner is worn or grooved, discard.
	e. Grease cup, and adapter (27)	Remove.	

4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Screws (28), and lockwashers (29)	Remove.	
	g. Intermediate housing (30)	1. Remove. 2. Clean all parts and dry thoroughly.	



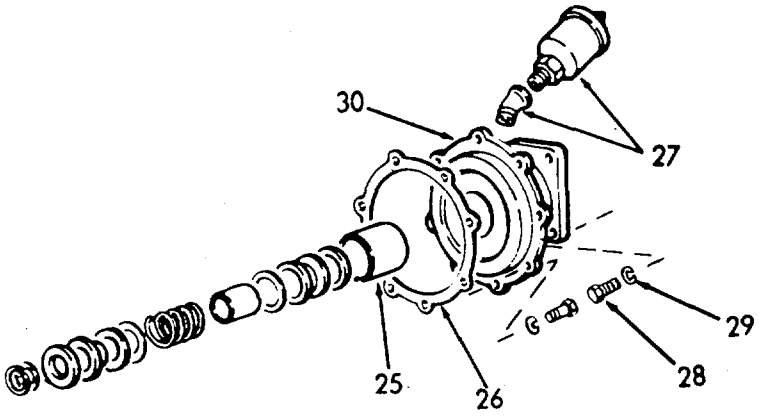
4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Intermediate housing (30), screws (28), and lockwashers (29)	Reassemble to motor.	
	i. Seal liner (25), and assembly (26), and adjusting shim	Assemble as shown in the following figure.	

CAUTION

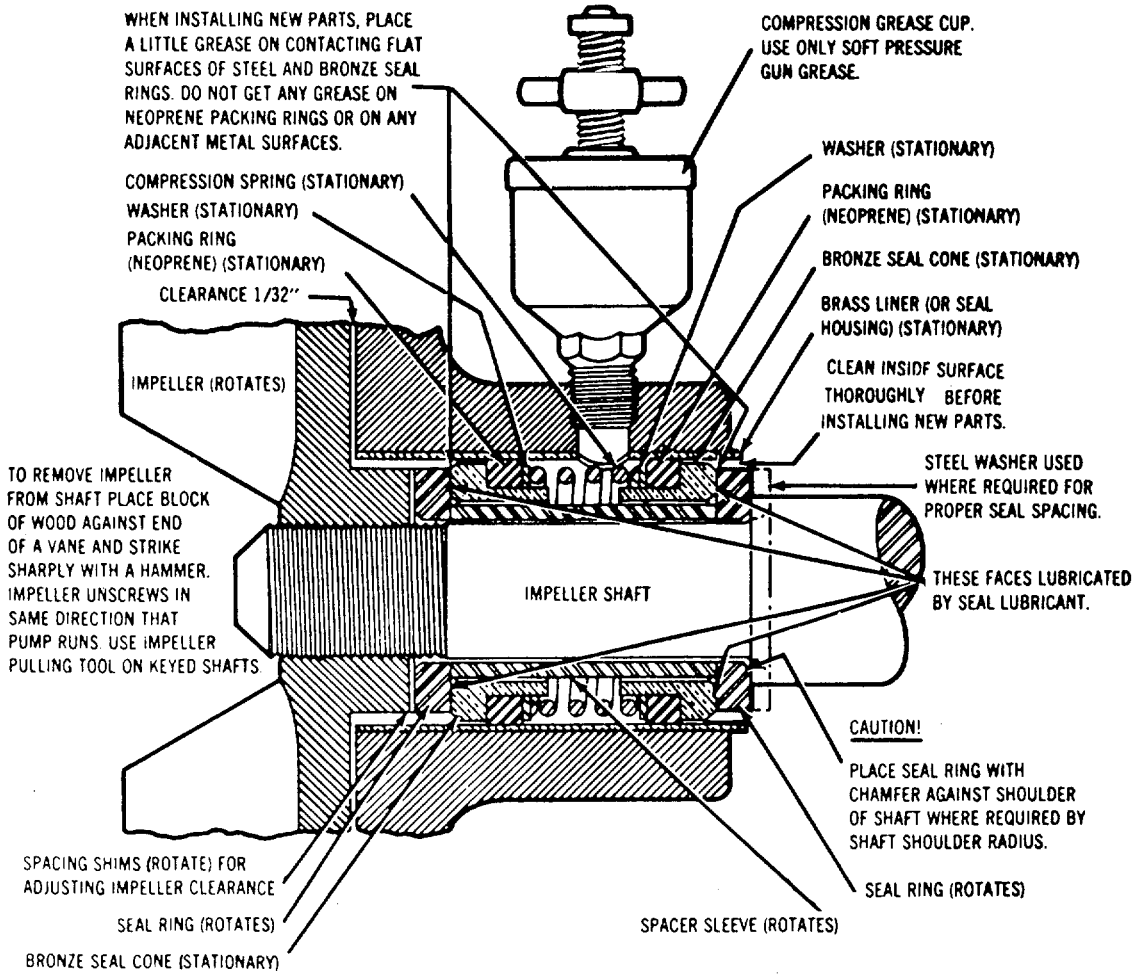
Improper seal installation, marred mating surfaces, or dirt will cause the seal to leak when the pump is returned to service.

	j. Grease cup and adapter (27)	Reinstall.	



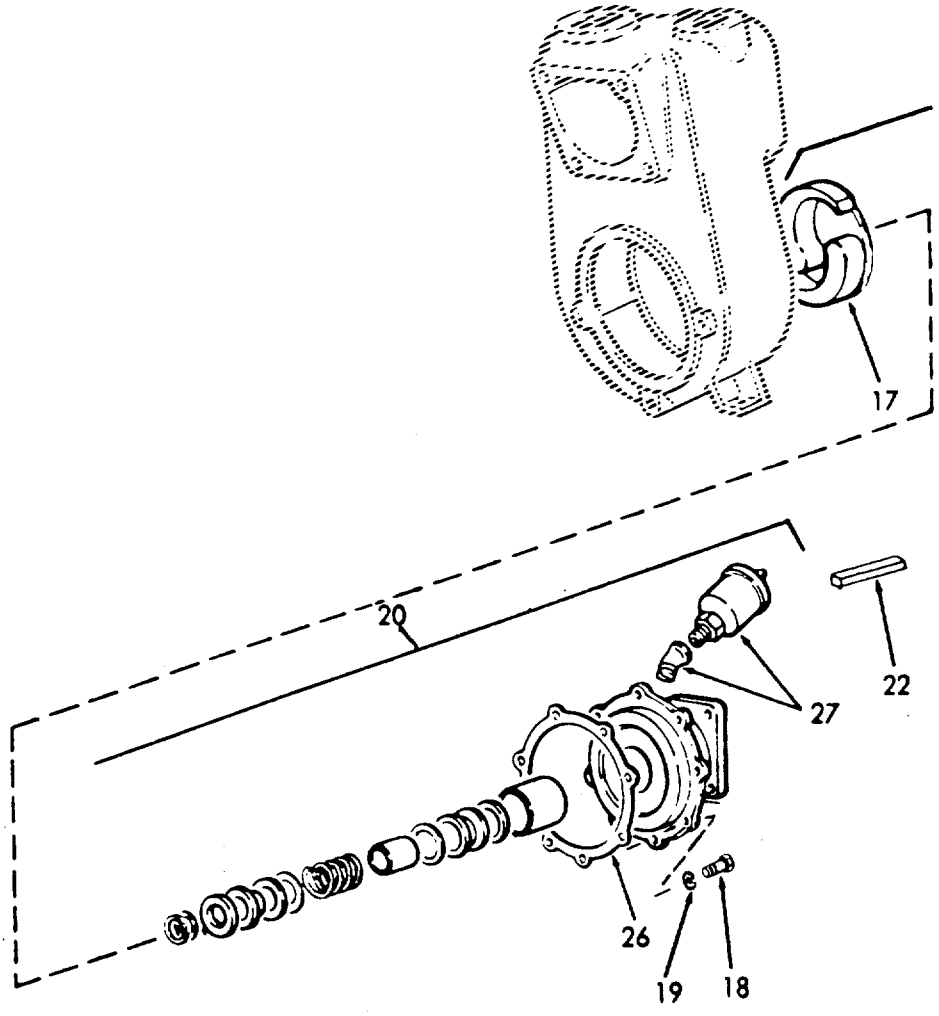
4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-16.2. SEWAGE PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Impeller (17), and key (22)	Install.	Check clearances.
	l. Intermediate housing assembly (20), gasket (26), screws (18), and lockwashers (19)	Reassemble.	Use new gasket.
	m. Grease cup (27)	Service.	Refer to step 2.



4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
Bearing puller

Equipment Condition Paragraph	Condition Description
4-16.1	Sewage Pump Set removed
4-16.2	Sewage Pump removed

Material/Parts
Grease Type GAA (MIL-G-10942)

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe WARNINGS

LOCATION	ITEM	ACTION	REMARKS

WARNING

In order to eliminate possible shock and injury, tag and place disconnect switch in the OFF position, and pull fuses for added safety precaution.

INSPECTION

1. Motor	a. Wiring	Inspect for breaks, cracks, and defective insulation.	
	b. Frame	1. Inspect for breaks, cracks, and signs of damage. 2. Check for unusual noise and vibration.	

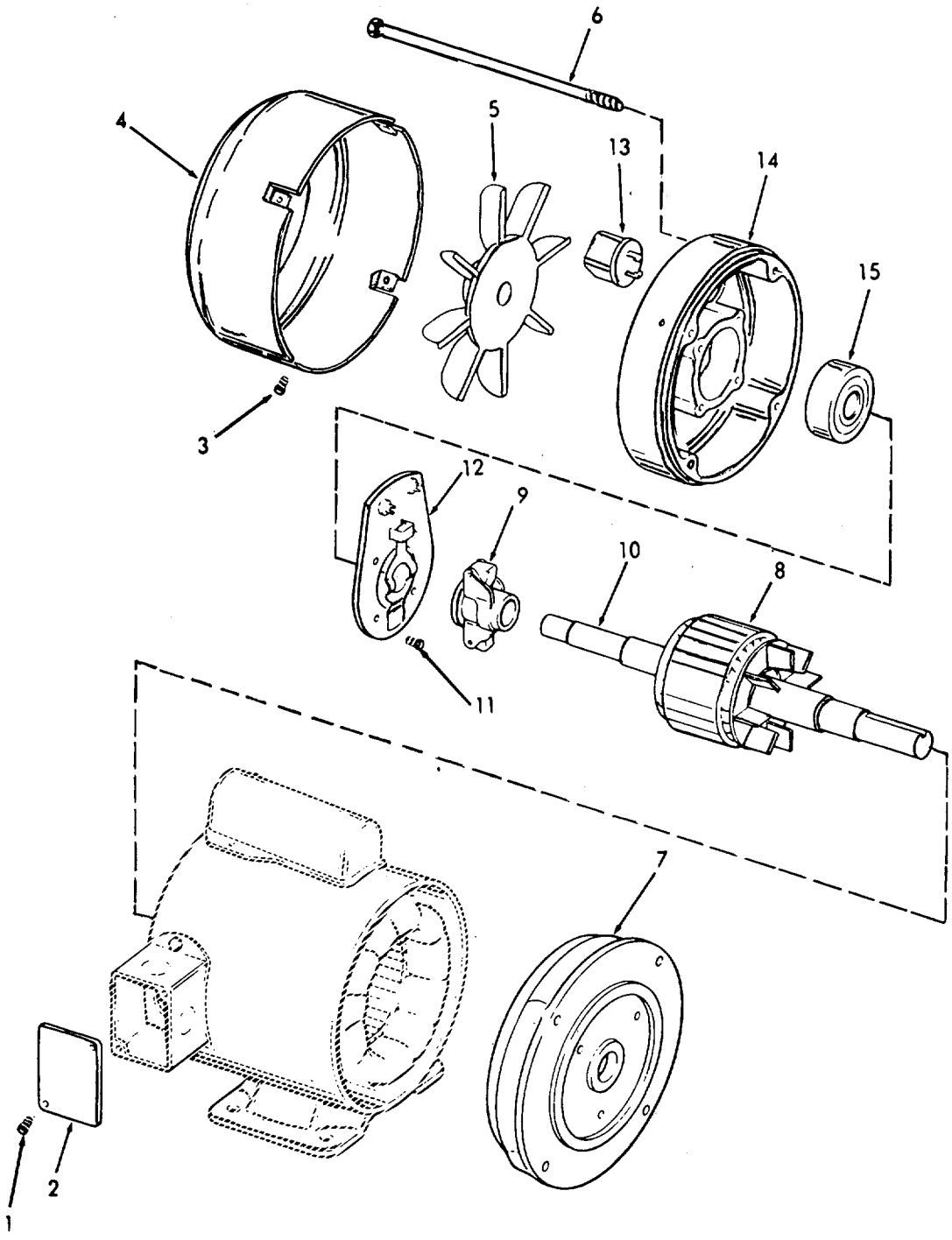
4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	Refer to paragraphs 4-16.1 and 4-16.2 for removal procedures.		
DISASSEMBLY			
3.	a. Screws (1), and cover (2)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Screws (3), and fan guard (4)	Remove.	
	d. Fan (5)	Remove.	
	e. Bolt studs (6)	Remove.	
	f. End bracket (7)	Remove.	
	g. Rotor (8), and attached parts	Remove.	
	h. Centrifugal device (9)	Remove from shaft (10).	If necessary.
	i. Screws (11), stator switch assembly (12), and armature relay (13)	Remove from end bracket (14).	
	j. Bearing (15)	Remove from bearing bore.	

4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

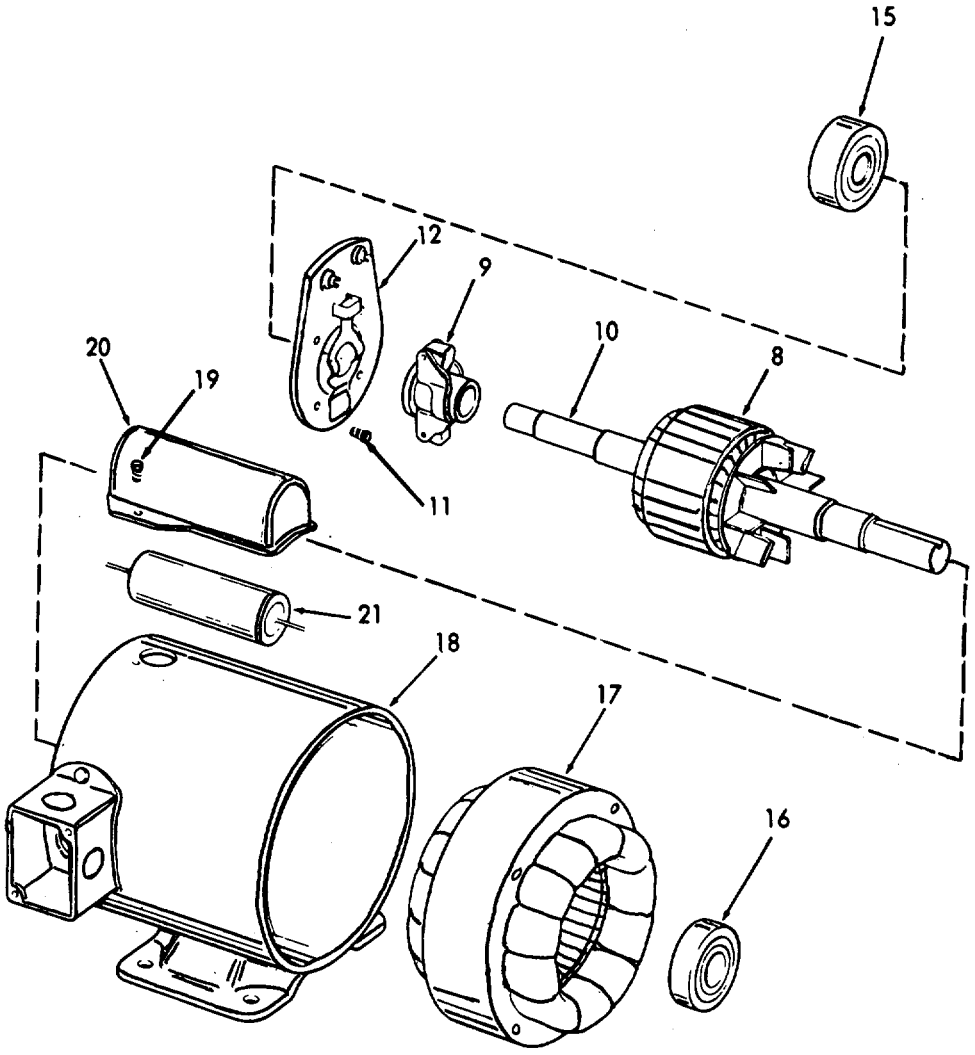


4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	k. Bearing (16)	Remove.	Bearings should be remove with bearing pullers using a center insertion in the end of the shaft to protect the shaft center. If a puller is not available, use a fiber hammer and transmit blows through a hard wood block.
	l. Winding kit (17)	Remove from body (18).	Disconnect wiring.
	m. Screws (19), and capacitor housing (20)	Remove.	
	n. Capacitor (21)	Remove.	Disconnect wiring.
REASSEMBLY			
	a. Capacitor (21), housing (20), and screws (19)	Reassemble.	Reconnect wiring.
	b. Winding kit (17)	Reinstall in body (18).	Reconnect wiring.
	c. Bearing (16 and 15)	Reinstall.	To reinstall ball bearings, either in a press or on the bench, pressure should be applied to the inner race by using a square faced sleeve or piece of pipe that will fit over the shaft, to avoid damaging the bearing.

4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
			If a press is not available and a hammer is used, the blows should be transmitted against the sleeve by a block of wood or fiber.



4-647

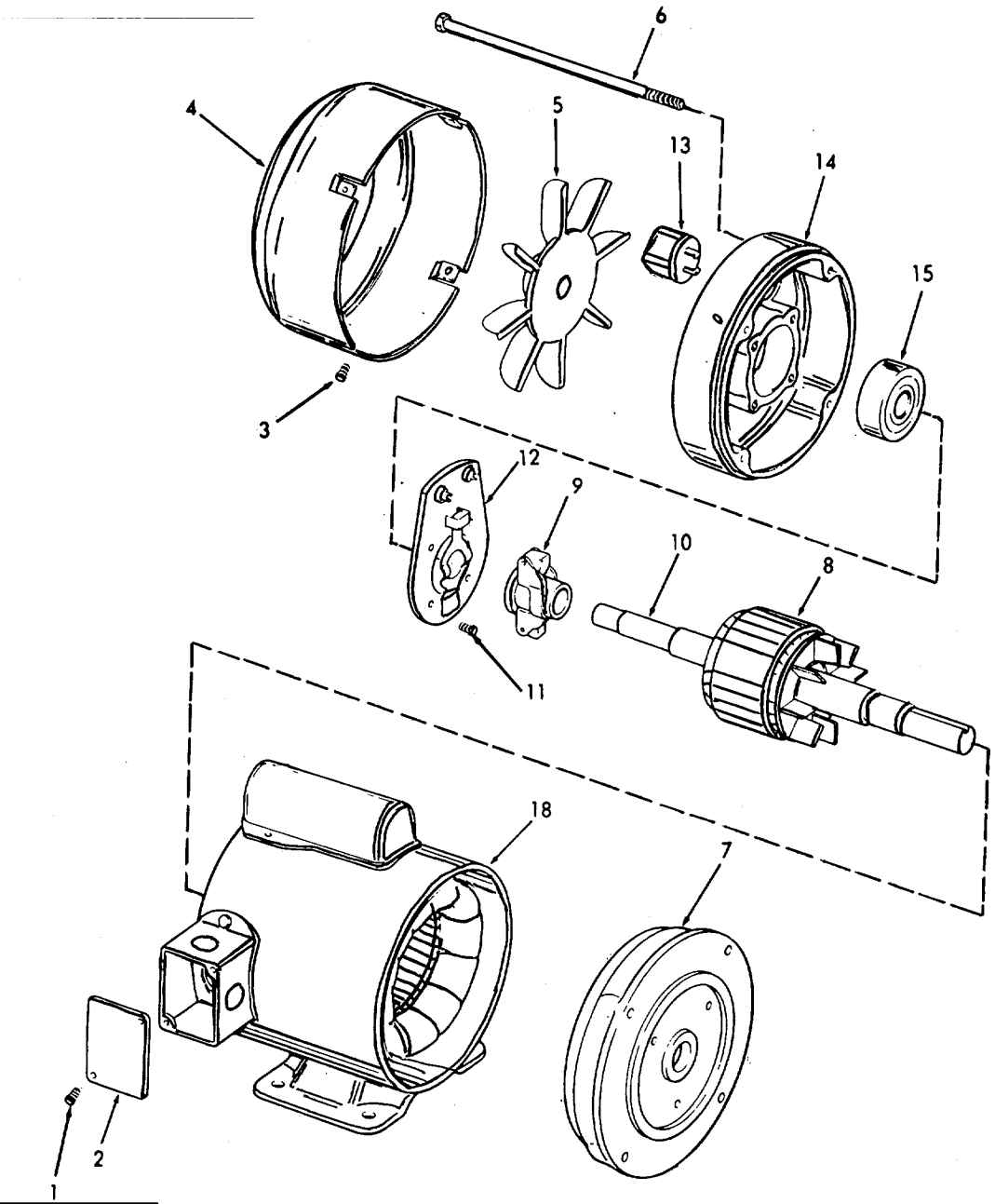
4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Armature relay (13), stator switch assembly (12), and screws (11)	Reassemble to end bracket (14).	
	e. Centrifugal device (9)	Reinstall on shaft (10).	
	f. Rotor (8), and attached parts	Reinstall.	
	g. End bracket (7)	Realign with body (18).	
	h. Bolt studs (6)	Install.	
	i. Fan (5)	Install.	
	j. Fan guard (4), and screws (3)	Install.	
	k. Wiring	Reconnect, remove tags.	
	l. Cover (2), and screws (1)	Install.	

4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



INSTALLATION

4. Refer to paragraphs 4-16.1 and 4-16.2 for installation procedures.

4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

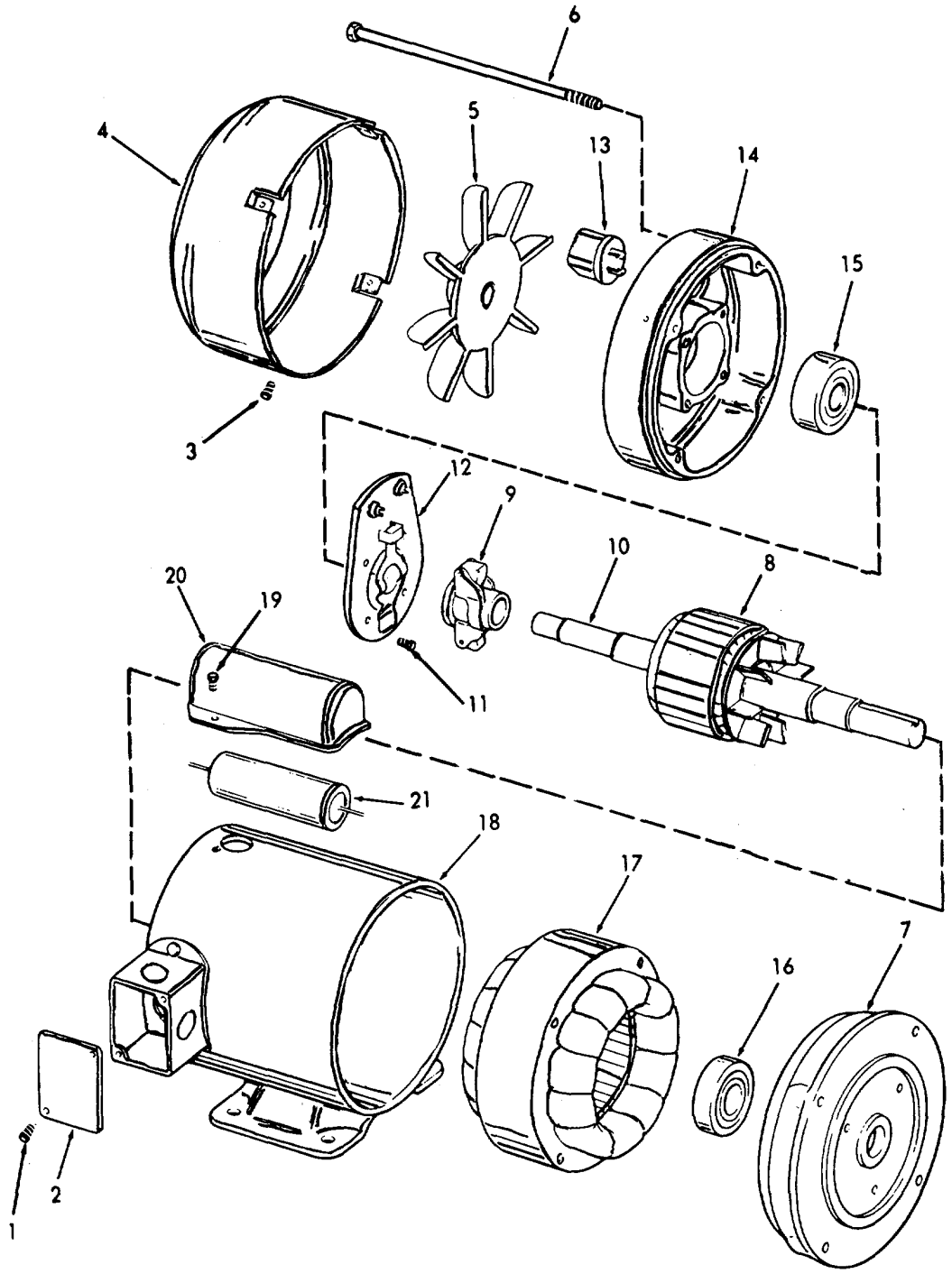
LOCATION	ITEM	ACTION	REMARKS

Sewage Pump Motor Legend

1. Screws
2. Cover
3. Screws
4. Fan guard
5. Fan
6. Bolt studs
7. End bracket
8. Rotor and attached parts
9. Centrifugal device
10. Shaft
11. Screws
12. Stator switch assembly
13. Armature relay
14. End bracket
15. Bearing
16. Bearing
17. Winding kit
18. Body
19. Screws
20. Capacitor housing
21. Capacitor

4-16.3. SEWAGE PUMP MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS



4-16.3. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

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

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition / Condition / Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
2	Observe WARNING

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position, and pull fuses for an added precaution.

INSPECTION

1.	Controller (external)	a. Enclosure	1. Inspect for breaks, cracks, dents, and bending.
			2. Insure all mounting hardware is tight.
		B Wiring	Inspect for wear, fraying and damage.
		c. Switches	Inspect for signs of failure or improper operation.

4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

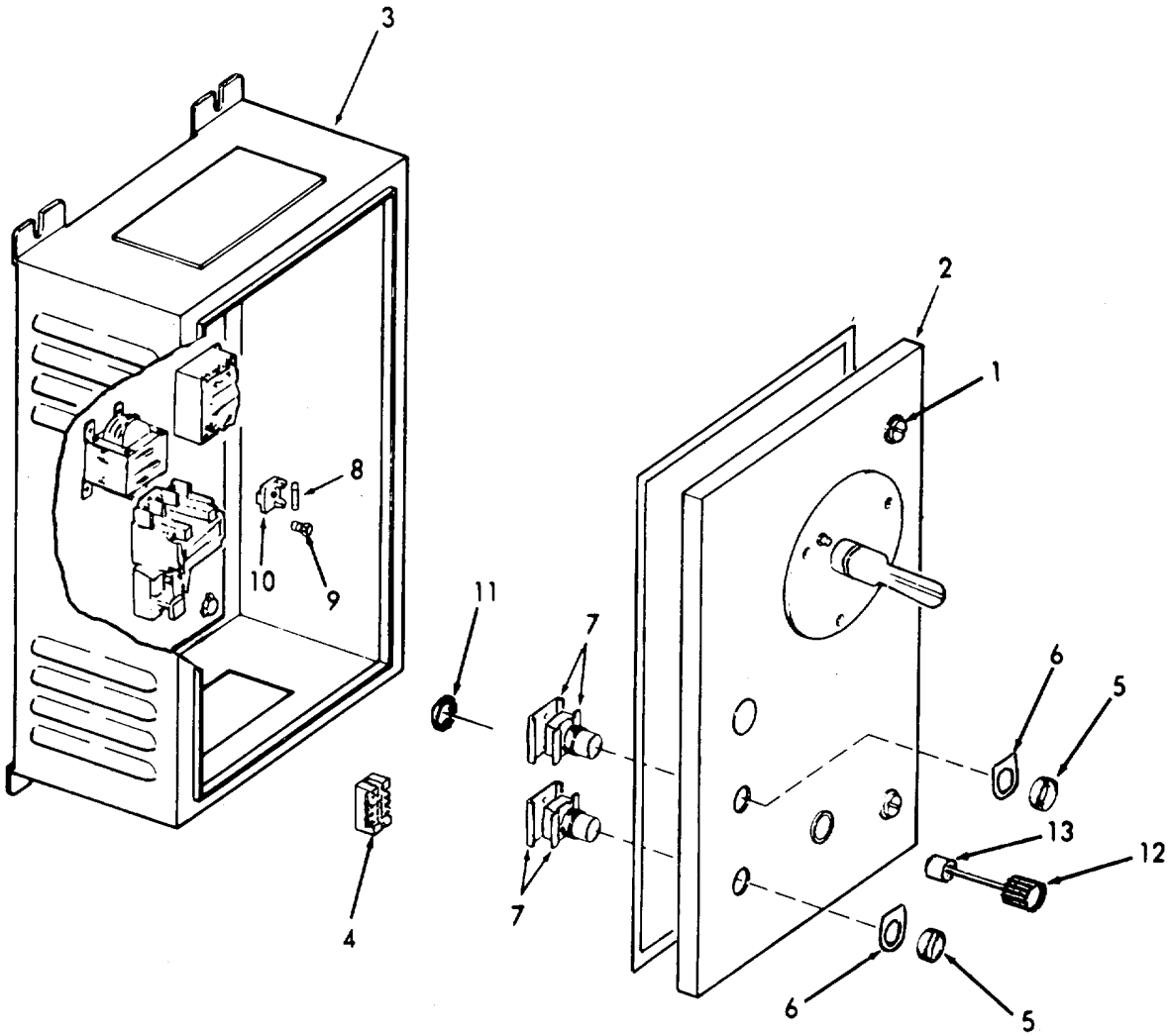
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Controller (internal)	a. Relays and starters	1. Inspect for worn contact tip material.	
		2 Inspect for cleanliness.	
		3. Insure all mounting hardware is tight.	
	b. Wiring	1. Inspect for wear, fraying, and damage.	
		2. Insure all terminals are tight.	
	c. Switches	1. Inspect for signs of failure.	
		2. Insure all mounting hardware is tight.	
	d. Fuses and fuse blocks	1. Inspect for defective components.	
		2. Insure all mounting hardware is tight.	
	e. Terminal block	1. Inspect for breaks, and cracks.	
		2. Insure all mounting hardware is tight.	
	f. Trans-former	1. Inspect for damaged wiring and terminals.	
		2. Insure all hardware is tight.	
	g. Discon-nect switch	1. Inspect for signs of failure.	
		2. Insure all hardware is tight.	

4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
3. Controller	a. Captive screws (1)	Rotate counterclockwise to loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect from terminal block (4).	Refer to schematic at end of paragraph.
	d. Controller (3)	Remove from bulkhead.	
REPAIR			
4. Pushbutton switch	a. Wiring	Tag and disconnect.	
	b. Retaining nut (5)	Remove.	
	c. Identification plate (6), and switch (7)	Remove.	
	d. Switch (7), identification plate (6), and retaining nut (5)	Install.	
	e. Wiring	Reconnect and remove tags.	
5. Fuses	Fuses (8)	Remove and replace.	
6. Fuse block	a. Wiring	Tag and disconnect.	
	b. Screws (9)	Remove.	
	c. Fuse block (10)	Replace.	
	d. Screws (9)	Replace.	

4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Wiring	Reconnect and remove tags.	
7. Reset Button	Retaining nut (11), push-button (12), and sleeve (13)	Remove	If necessary.

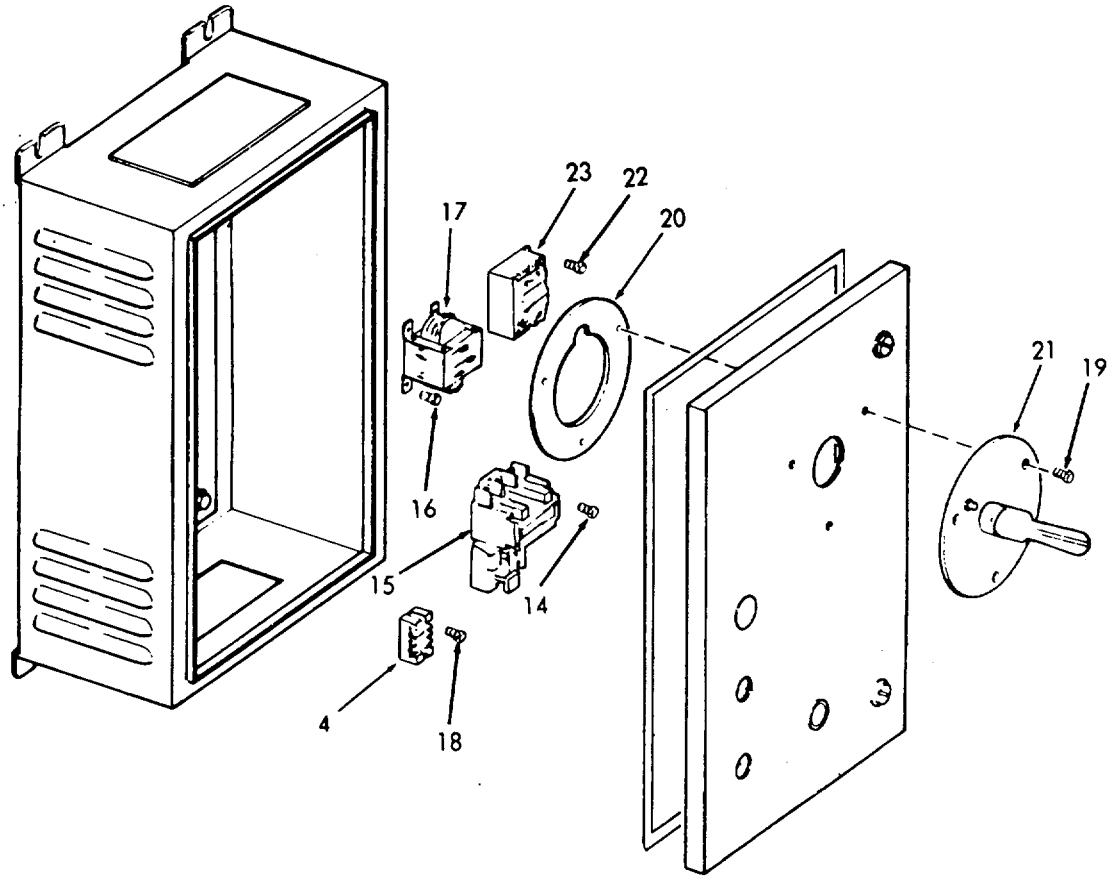


4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Starter	a. Wiring	Tag and disconnect.	
	b. Three screws (14)	Remove.	
	c. Starter (15)	Replace.	
	d. Screws (14)	Replace.	
	e. Wiring	Reconnect and remove tags.	
9. Trans-former	a. Wiring	Tag and disconnect.	
	b. Screws (16)	Remove.	
	c. Transformer (17)	Replace.	
	d. Screws (16)	Replace.	
	e. Wiring	Reconnect and remove tags.	
10. Terminal block	a. Wiring	Tag and disconnect.	
	b. Screws (18)	Remove.	
	c. Terminal block (4)	Replace.	
	d. Screws (18)	Replace.	
	e. Wiring	Reconnect and remove tags.	
11. Discon-nect switch	a. Three screws (19)	Remove.	
	b. Back plate (20)	Remove.	
	c. Handle as-sembly (21)	Remove.	

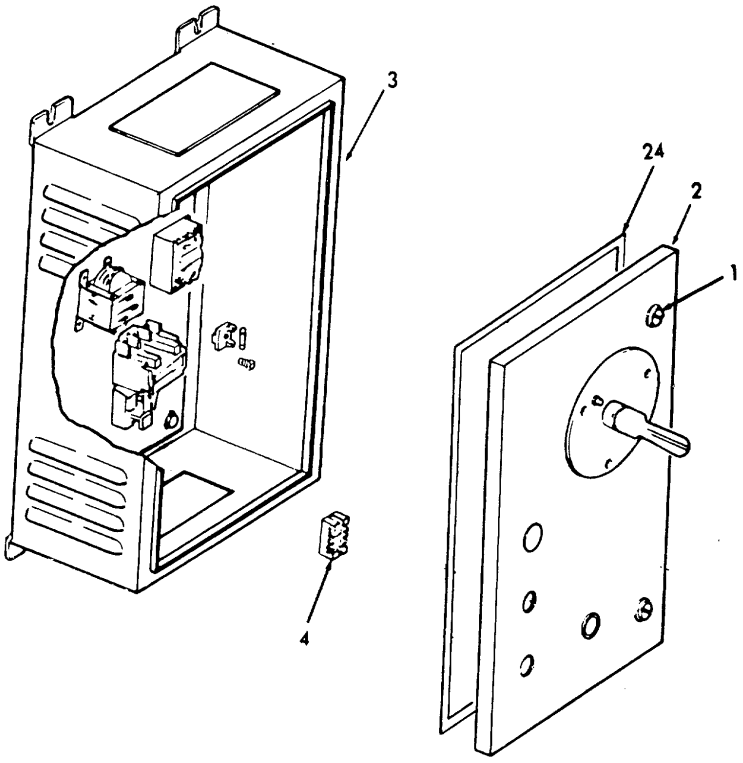
4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Wiring	Tag and disconnect.	
	e. Screws (22)	Remove.	
	f. Switch (23)	Replace.	
	g. Screws (22)	Replace.	
	h. Wiring	Reconnect and remove tags.	
	i. Handle assembly (21), back plate (20), and screws (19)	Install.	

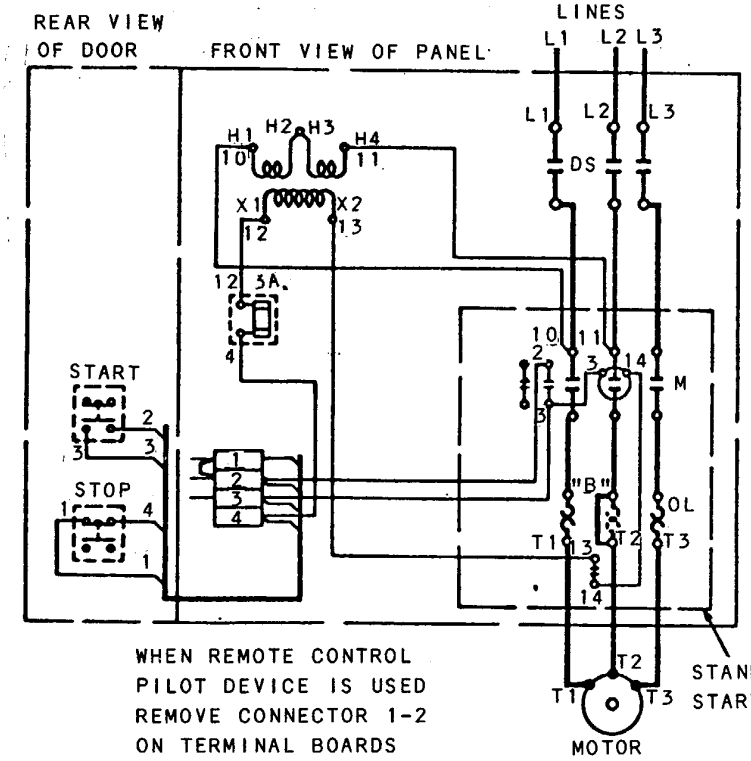


4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
12. Door gasket	Gasket (24)	Replace.	If necessary.
INSTALLATION			
13. Controller	• Controller (3)	Install on bulkhead.	
	b. Wiring	Reconnect to terminal block (4).	Refer to schematic at end of paragraph.
	c. Door (2), and captive screws (1)	Swing closed and rotate screws clockwise.	



4-16.4. SEWAGE PUMP MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).



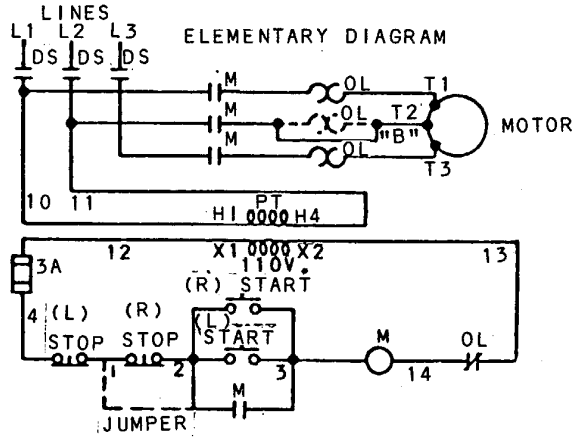
OMIT CONNECTOR "B" WHEN 3 COIL OVERLOAD IS USED.

DESCRIPTION OF OPERATION

TO START THE MOTOR PRESS THE START BUTTON. THIS ENERGIZES CONTACTOR M CONNECTING THE MOTOR ACROSS THE LINE. M MAINTAINS ITSELF THROUGH ITS OWN AUXILIARY CONTACT. TO STOP THE MOTOR PRESS THE STOP BUTTON.

A VOLTAGE FAILURE WILL CAUSE THE M TO OPEN, STOPPING THE MOTOR. TO RESTART, WHEN VOLTAGE IS RESTORED, PRESS THE START BUTTON (LOW VOLTAGE PROTECTION).

AN OVERLOAD WILL CAUSE THE OIL CONTACTS TO OPEN CAUSING M TO OPEN STOPPING THE MOTOR. TO RESTART, PRESS THE STOP-RESET BUTTON AND THEN THE START BUTTON.



4-17. MACERATOR/TRANSFER PUMP.

a. The Macerator/Transfer (M/T) pump grinds the waste materials from the commodes and urinals and transfers the generated slurry through lines to the holding tank. The GATX system uses specially designed, heavy duty units for this purpose. The pumps run on a cycle of 10-12 seconds upon signal from the flush switch located on either the CVF commode or urinal.

b. The pumps employ specially designed cutters for macerating all normal sanitary wastes, and for grinding of a large range of deleterious materials which may be accidentally dropped into the water closet. The cutter and pump materials have been chosen to withstand the corrosive nature of the sanitary wastes.

c. The following is an index to the maintenance procedures.

4-17.1. MACERATOR/TRANSFER PUMP SET - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Removal c. Installation

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe WARNINGS in paragraph 4-15 and in this procedure.

4-17.1. MACERATOR/TRANSFER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

WARNING

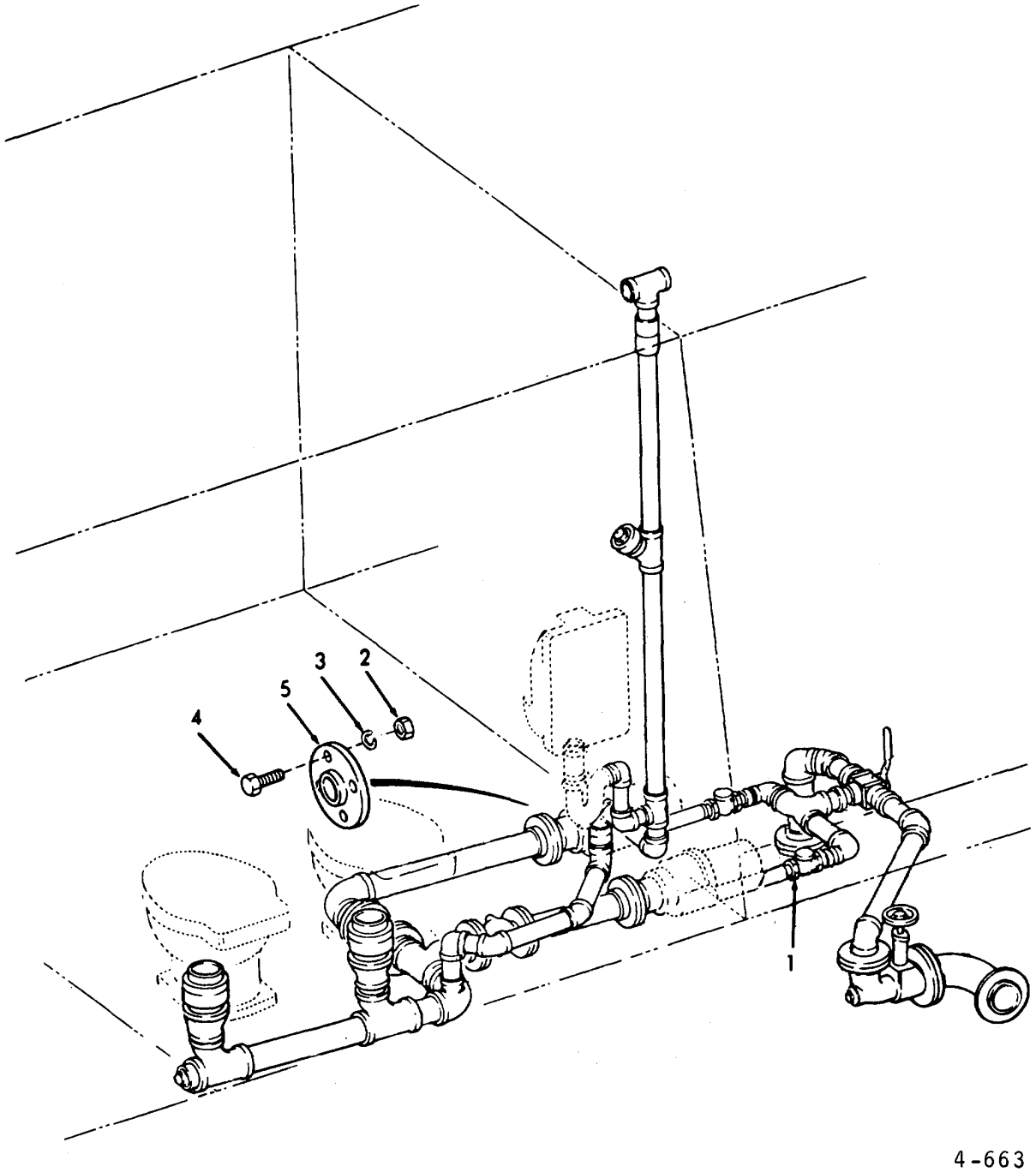
In order to eliminate possible shock and injury, tag and place disconnect switch in the OFF position, and pull fuses for an added precaution.

INSPECTION			
1. Pump set	a. Wiring	Inspect for breaks, cracks, and damaged insulation.	
	b. Piping	1. Inspect for breaks, cracks, and bends.	Refer to Direct Support Maintenance.
		2. Inspect for leaks.	
	c. Housing	1. Inspect for breaks, cracks, and bends.	Refer to Direct Support Maintenance.
		2. Inspect for leaks.	
	d. Pump	When running, inspect for noise which would indicate problems.	
REMOVAL			
2.	a. Wiring	Tag and disconnect.	
	b. Union (1)	Loosen and separate.	
	c. Nuts (2), lockwashers (3), and screws (4)	Remove.	
	d. Flange (5)	Separate.	
	e. Mounting hardware	Remove.	
	f. Pump	Remove.	

4-17.1. MACERATOR/TRANSFER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

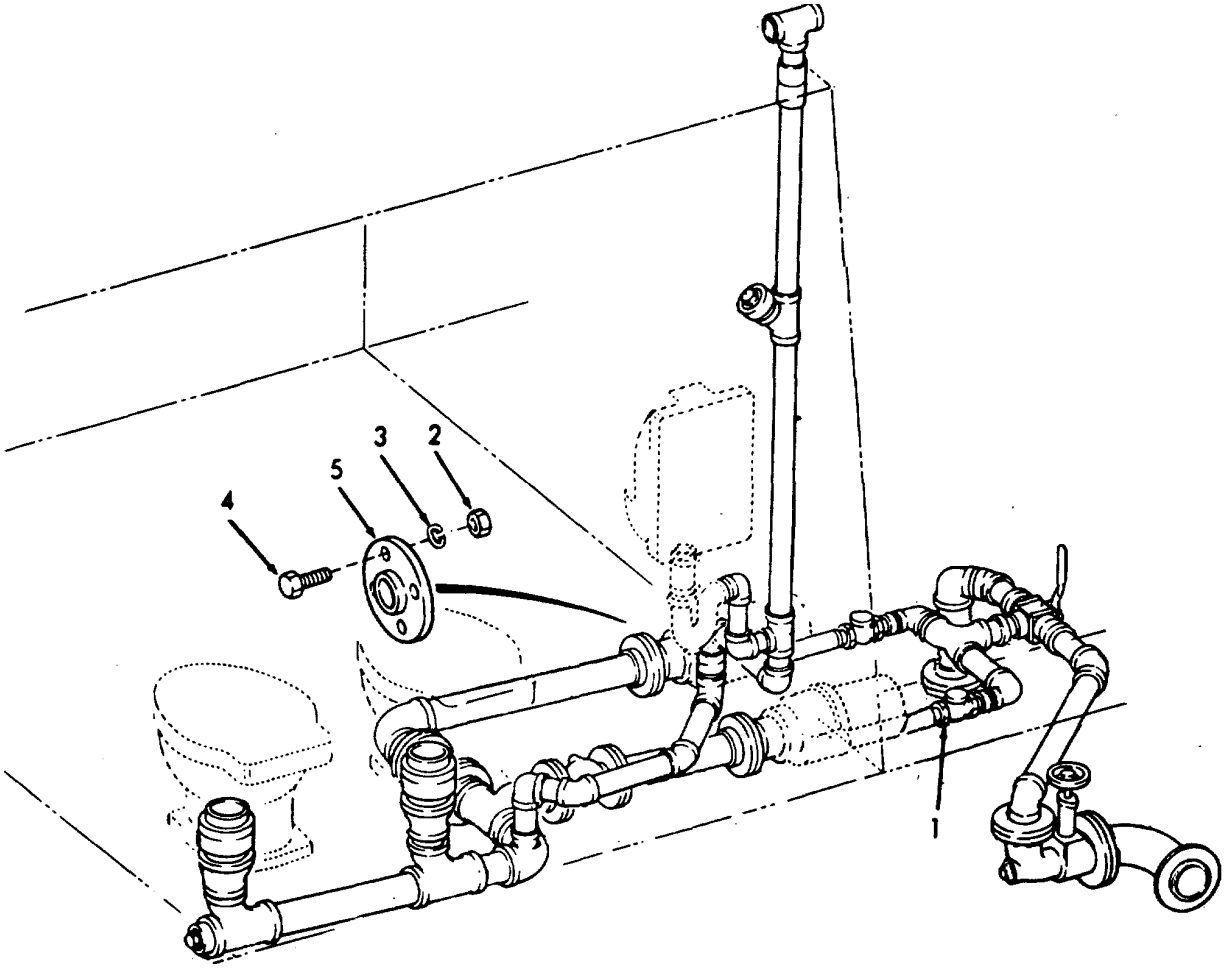
REMOVAL (Cont)



4-663

4-17.1. MACERATOR/TRANSFER PUMP SET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Pump and mounting hardware	Install.	
	b. Flange (5), screws (4), lockwashers (3), and nuts (2)	Reassemble.	
	c. Union (1)	Reconnect.	
	d. Wiring	Reconnect and remove tags.	



4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection b. Repair c. Adjustment

INITIAL SETUP

Test Equipment	References
NONE	NONE

Special Tools	Equipment Condition	Condition Description
	Paragraph	
Packing puller	4-17.1	Pump set removed
Plastic hammer		

Material/Parts	Special Environmental Conditions
Oil (MIL-L-2104 Type OE/HDO 20)	NONE
Oil Hydr-O-Matic-submersible	

Personnel Required	General Safety Instructions
1	Observe WARNINGS in paragraph 4-15 and in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

In order to eliminate possible shock and injury, tag and place disconnect switch in the OFF position, and pull fuses for an added safety precaution.

INSPECTION

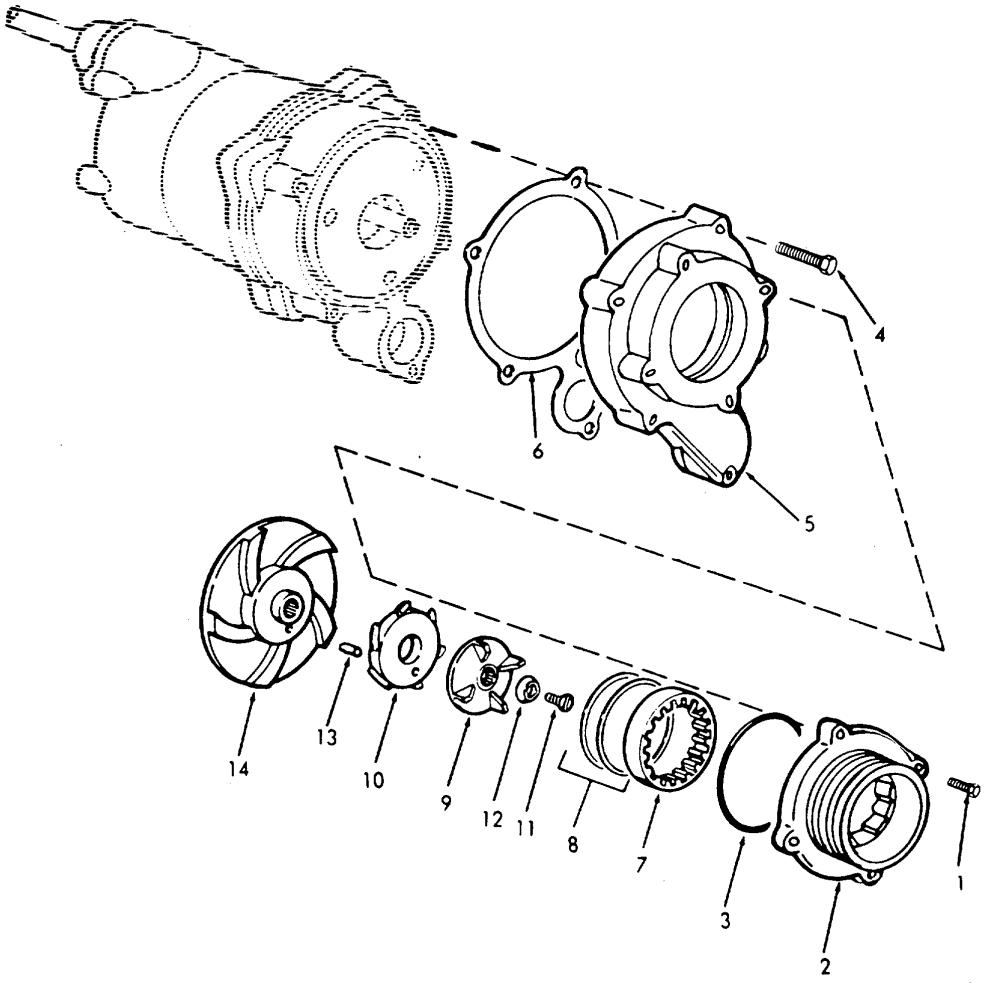
1. Pump	Housing	a. Inspect for breaks, cracks, and dents.	
		b. Inspect for leaking.	
		c. Inspect for loose hardware.	Do not tighten until after adjustments in step 4.

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
	NOTE Make sure all parts are cleaned prior to replacement.		
2. Volute and grinder	a. Screws (1)	Remove.	
	b. Inlet adapter and suction casting (2), and pre-formed packing (3)	Remove.	Discard packing if damaged.
	c. Bolts (4)	Remove.	
	d. Pump volute case (5) and gasket (6)	Remove.	Discard gasket.
	e. Cutter ring (7)	Remove from case (2).	
	f. Shims (8)	Remove.	Keep for reassembly.
	g. Radial cutter (9), and axial cutter (10)	1. Check for clogging. 2. Clean.	If it is necessary to replace grinder, proceed. If not skip to step m.
	h. Screw (11), and retainer (12)	Remove.	
	i. Radial cutter (9)	Unscrew from shaft.	Thread is right hand. Bump with a plastic hammer if necessary to loosen.

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Axial cutter (10)	Lift off of shaft.	Cutter is kept from rotating by pin (13).
	k. Pump impeller (14)	1. Unscrew from shaft, if necessary.	Thread is right hand.
		2. Replace.	If a new impeller is used, face clearance may have to be adjusted from top bearing.

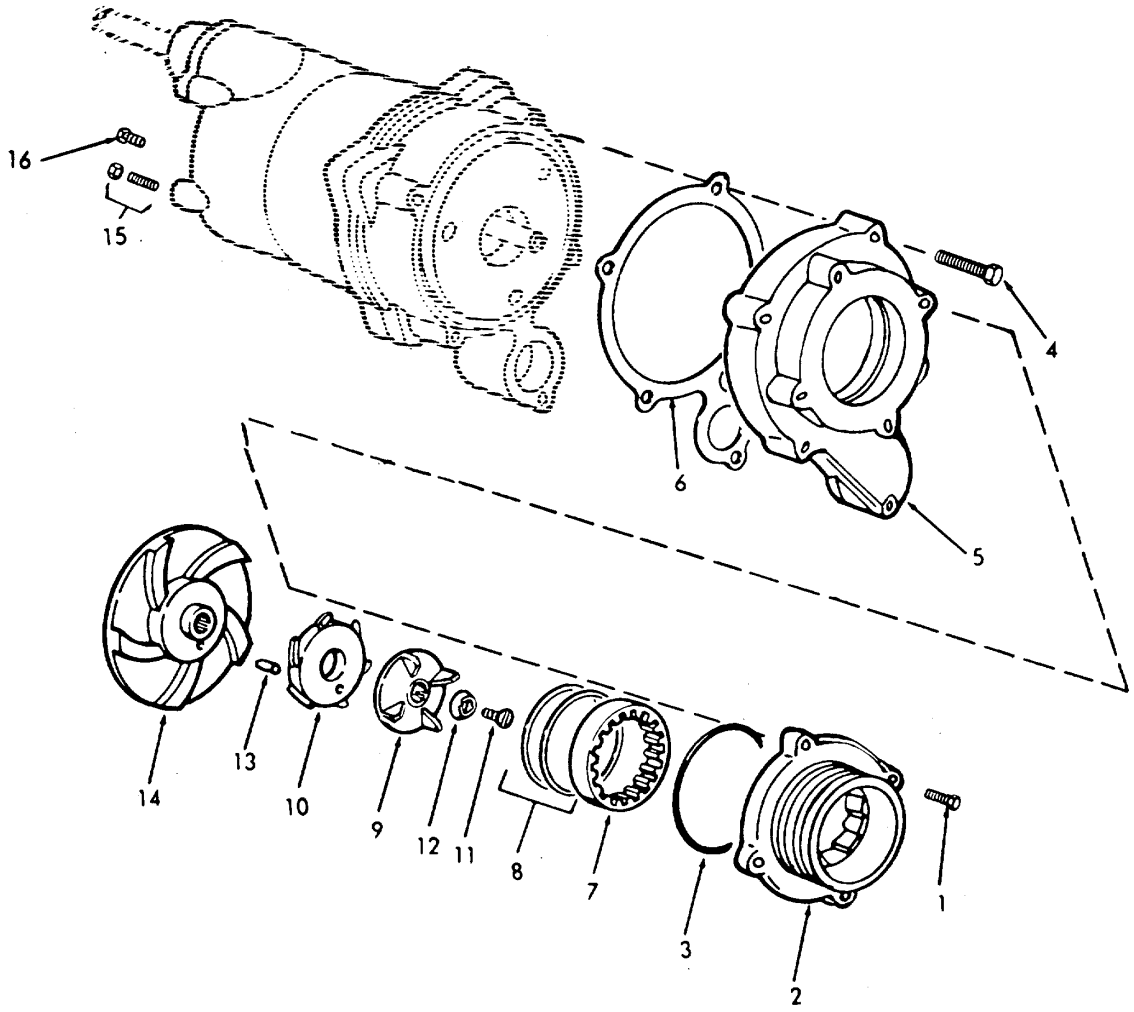


4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	l. Pump impeller (14), axial cutter (10), and radial cutter (9)	Install.	Pin (13) keeps impeller (14) from turning.
	m. Cutter ring (7)	Do not install at this time.	
	n. Retainer (12), and screw (11)	Install.	
	o. Jam nuts and allen screws (15)	Loosen.	
	p. Screws (16)	1. Tighten until pump impeller (14) just drags on casting (2). 2. Back-off on screws (16) 1/8 turn.	
	q. Jam nuts and allen screws (15)	Tighten to lift impeller (14) for proper face clearance.	
	r. Cutter ring (7), shims (8), gasket (6), and pump volute case (5)	Replace.	
	s. Bolts (4)	Replace.	

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	t. Preformed packing (3), suction casting (2), and screws (1)	Replace.	1. Turn radial cutter (9) by hand, it must run free. 2. If it does not turn freely and some rubbing exists, disassemble and add more shims (8). The shims must be stainless steel.

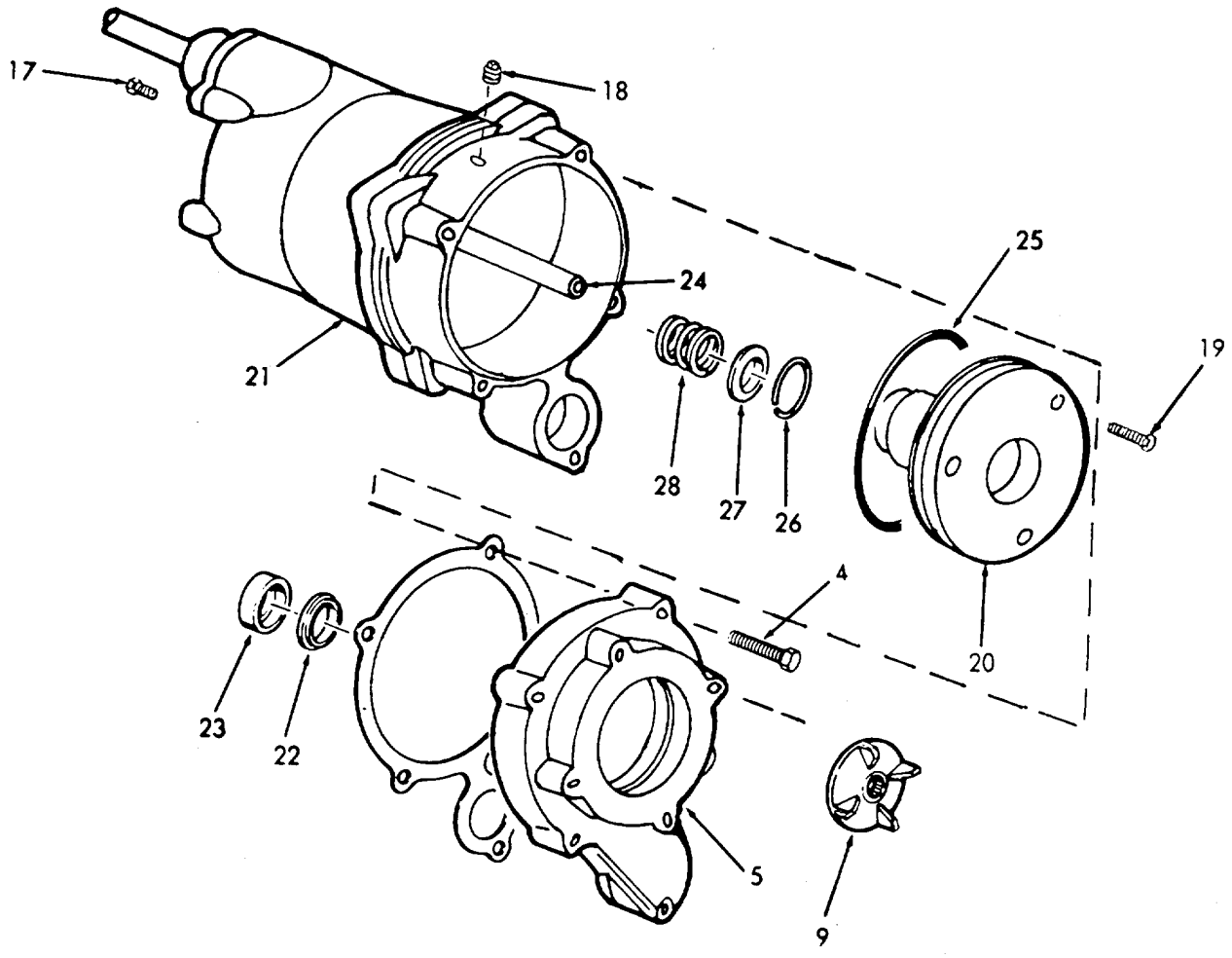


4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			3. It may be necessary to loosen screws (4) and volute case (5) and tap with a hammer to get proper clearance on O.D. of radial cutter (9).
3. Seals	a. Plugs (17 and 18)	1. Remove plug (17) from motor.	a. Check for water in oil.
		2. Remove plug (18) from seal chamber.	b. Check for grounding.
		3. Drain out all oil.	c. If there is water in oil, the pump must be completely dismanteled and stator dried out or replaced if grounds do not clear up after drying operation.
	b. Volute and grinder	Perform step 2a thru k.	
	c. Screws (19)	Remove from seal plate (20).	
	d. Seal plate (20)	1. Use two screws in tapped back off holes to force plate (20) from housing (21).	
		2. Pushing plate (20) off will force seals (22 and 23) from shaft (24).	

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Preformed packing (25)	Remove.	Discard if damaged.
	f. Snap ring (26)	Remove.	
	g. Upper seal (27)	Pull from shaft.	It may be necessary to use packing puller to remove.
	h. Spring (28)	Remove.	



4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Upper stationary ceramic seal ring (29)	1. Hit ring with screwdriver to crack. 2. Remove.	
	j. Rubber seal cup (30), seal (31), and sleeve bearing (32)	Remove.	

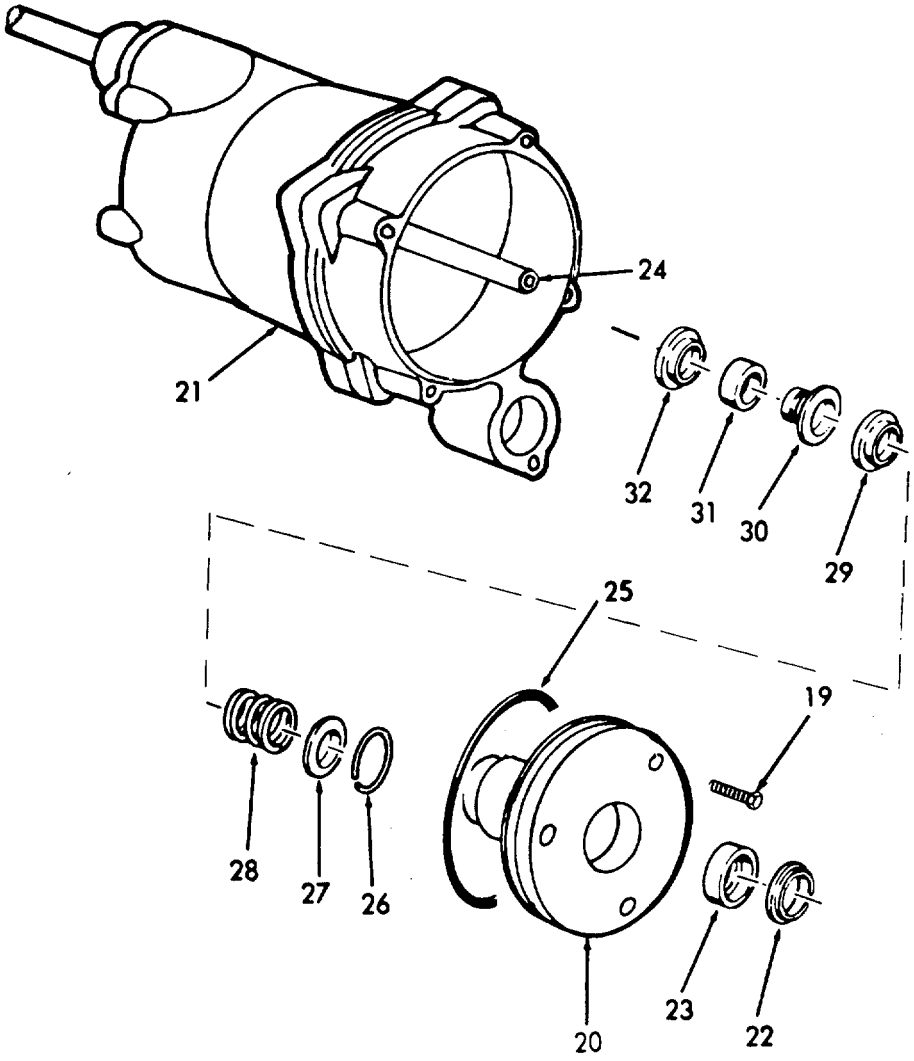
CAUTION

Do not use any old seal parts. Replace all parts with new pieces. Using old and new parts can cause immediate failure.

	k. All parts	1. Clean thoroughly.	
		2. Inspect sleeve bearing and shaft for wear.	Replace.
		3. Inspect preformed packing for cuts and nicks.	Replace.
	l. Sleeve bearing (32), seal (31), and rubber seal cup (30)	Install.	
	m. Ceramic seal ring (29)	Install.	
	n. Spring (28), upper seal (27), and snap ring (26)	Install.	

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	o Preformed packing (25), seal plate (20), and screws (19)	Install in housing (21).	
	p. Seals (23 and 22)	Install on shaft (24).	

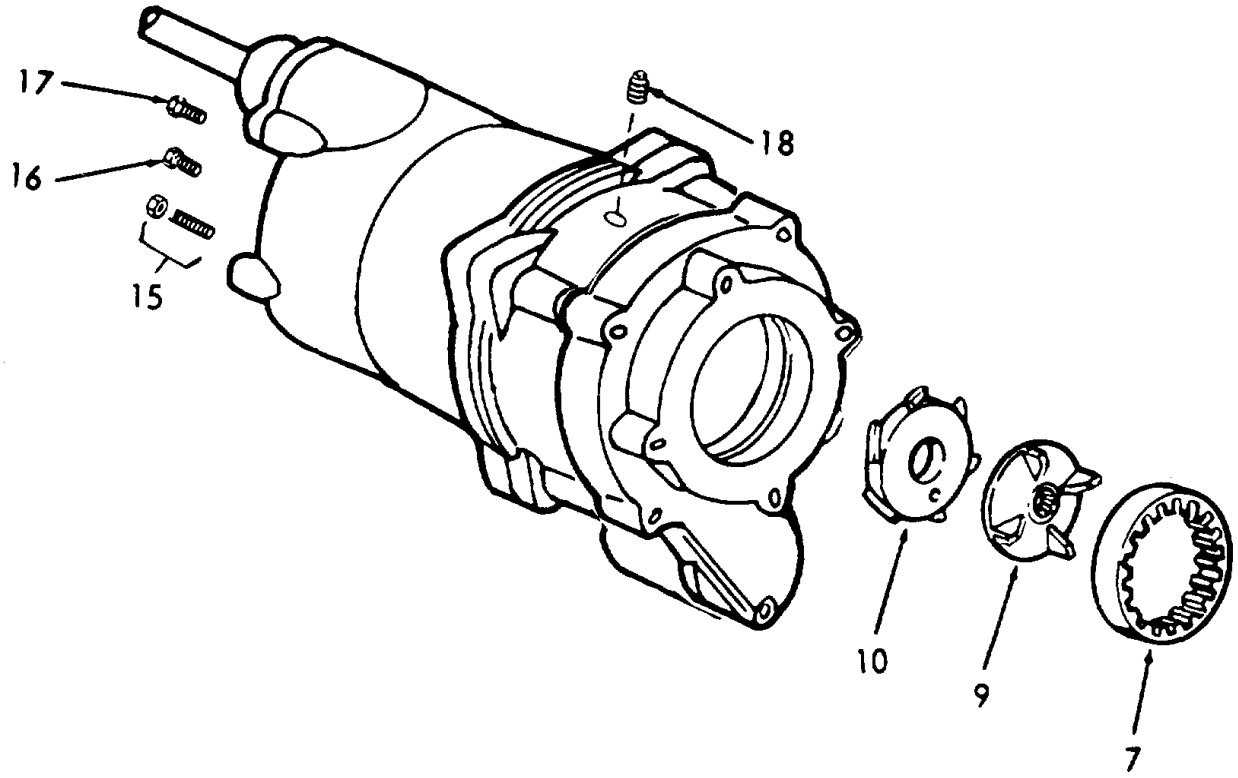


4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	q. Pump - seal chamber	1. Lay on side to fill seal chamber.	Use oil OE/HDO 20.
		2. Do not fill completely allow 1/2 inch below fill plug.	Allow air space for expansion.
		3. Plug (18) - replace.	
	r. Pump motor	1. Set pump upright.	
		2. Fill with oil so that oil level is just over the top of winding.	a. Use hydromatic submersible oil. b. Allow air space for expansion.
		3. Plug (17) - replace.	
	s. Volute and grinder	Perform Step 2 1 thru t.	
ADJUSTMENT			
4.	a. Pump	1. Lay on side so that pump inlet is accessible.	
		2. Turn radial cutter (9).	a. Use thumb and forefinger tighten finger tight. b. Make sure shaft turns freely.
	b. Jam nuts on allen screws (15)	Loosen nuts and Allen screws.	

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

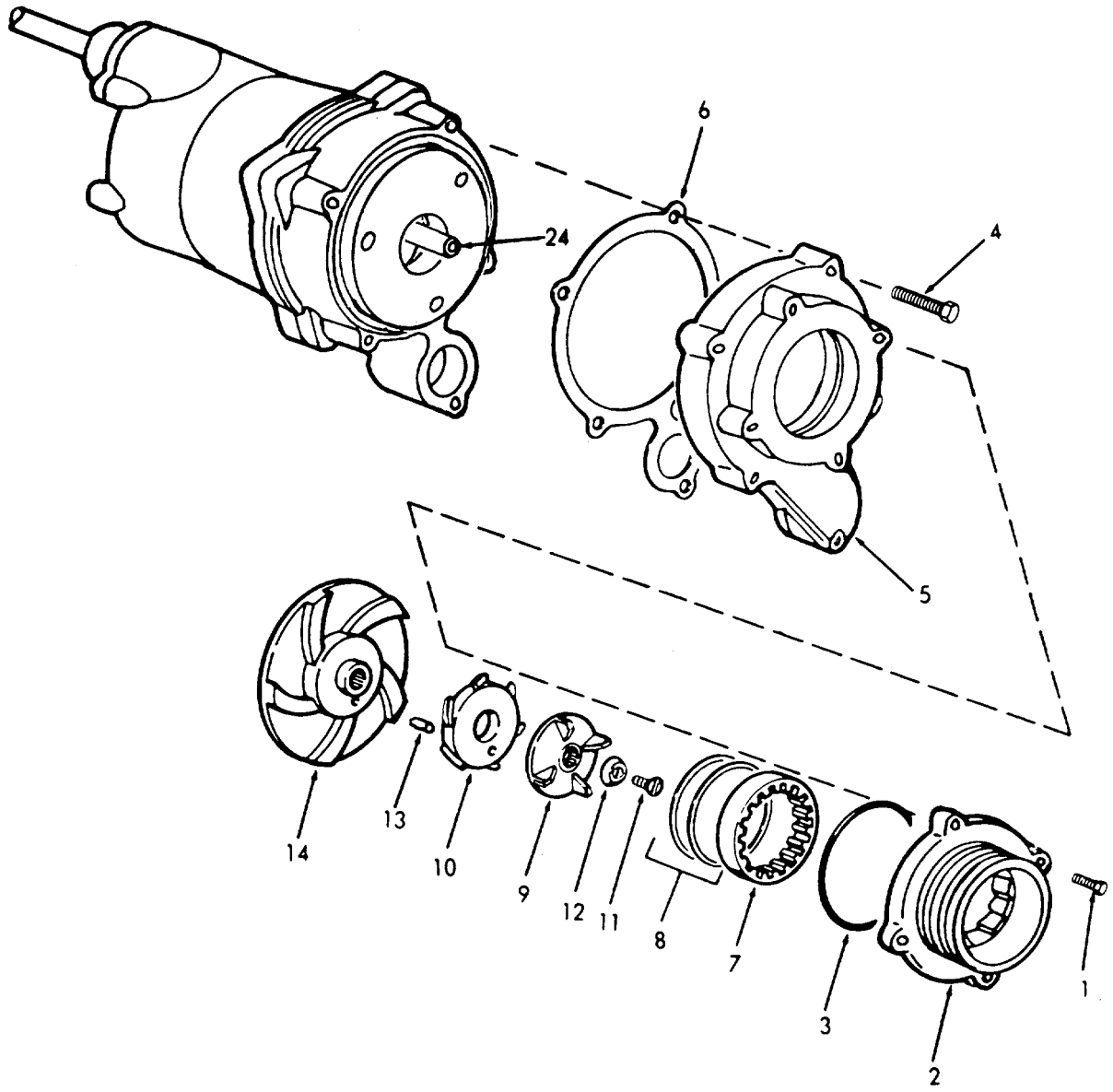
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
	c. Screws (16)	1. Tighten until axial cutter (10) just drags on cutter ring (7) 2. Back off 1/8 turn.	
	d. Allen screws (15)	1. Tighten to lift cutter for proper clearance. 2. Tighten jam nuts.	



4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
	e. Radial cutter (9)	1. Turn with thumb and forefinger to determine if shaft has any drag.	
		2. If there is still some drag repeat step b thru e above.	
		3. Back off on screws (16) further.	
		NOTE	
		IMPORTANT - Remember to adjust both screws (16) approximately the same amount when tightening or loosening. The same would apply to the Allen screws (15). Also, remember that the Allen screws (15)raise the shaft while the screws (16) push the shaft downward.	

4-17.2. MACERATOR/TRANSFER PUMP - MAINTENANCE INSTRUCTIONS (Continued).



1. Screws
2. Inlet adapter and suction casting
3. Preformed packing
4. Bolts
5. Pump volute case
6. Gasket
7. Cutter ring
8. Shims
9. Radial cutter
10. Axial cutter
11. Screw
12. Retainer
13. Pin
14. Pump impeller
24. Shaft

4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS.

Whenever a commode or urinal is flushed, a micro-switch or flow switch closes and completes the circuit of a control relay (CR) and a time delay (delay on operate) relay (TD). The coil of relay (CR) becomes energized and closes contact CR. This set of contacts maintains power on the coils of the control relay and the time relay after the microswitch or flow switch opens. Contact CR also energizes the coil of the magnetic motor starter which in turn starts the macerator/transfer pump. When the time delay relay completes its timing cycle, normally closed contact TD opens and interrupts the power to the coils of the control relay and the time delay relay. Simultaneously the power to the coil of the magnetic motor starter is interrupted and the macerator/transfer pump is turned off. The length of the operating cycle is controlled by a resistor in the time delay relay circuit. For a 10 second cycle the required resistance is 220 K ohms.

This task covers:

a. Inspection b. Replace

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	Equipment Condition Condition Description
NONE	NONE
Material/Parts	Special Environmental Conditions
NONE	Tag water closets and urinals - SECURED
Personnel Required	General Safety Instructions
2	Observe WARNINGS in paragraph 4-15 and in this procedure.

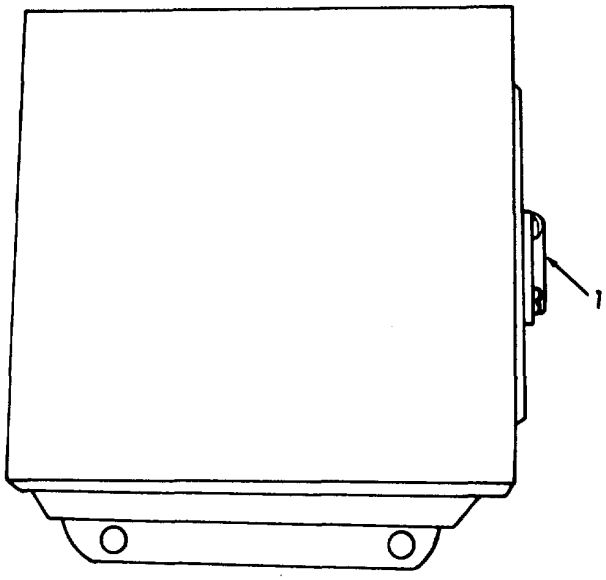
4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

WARNING

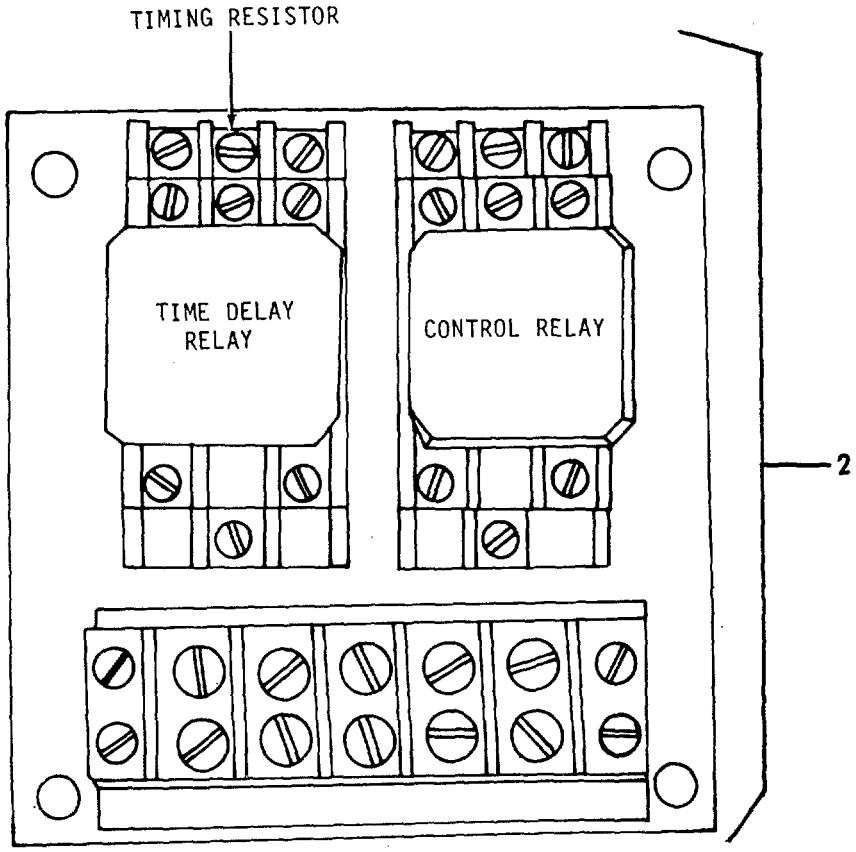
In order to eliminate possible shock and injury, tag and place disconnect switch in the OFF position, and pull fuses as an added precaution.

INSPECTION				
1.	Timer	a.	Wiring	Inspect for worn, broken and damaged wiring.
		b.	Housing	Inspect for signs of damage.
2.	Selector switch	a.	Wiring	Inspect for worn, broken and damaged wiring.
		b.	Housing	Inspect for signs of damage.
REPLACE				
3.	Timer	a.	Cover Latch (1)	Raise and open cover.



4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

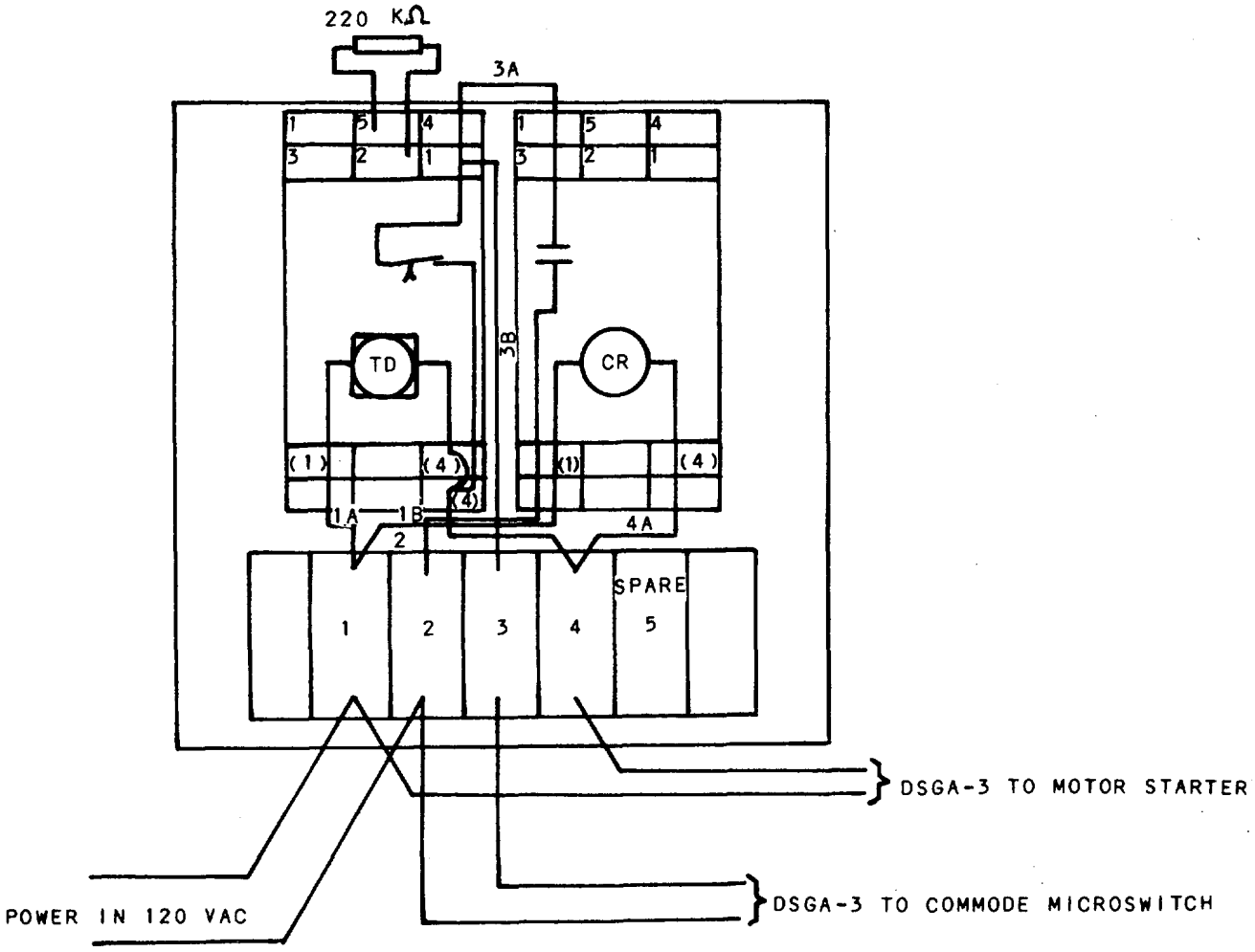
LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	b. Wiring	Tag and disconnect.	Refer to wiring diagram.
	c. Mounting hardware	Remove.	
	d. Timer control (2)	Remove.	
	e. Timer control (2), and mounting hardware	Install.	
	f. Wiring	Reconnect and remove tags.	



4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

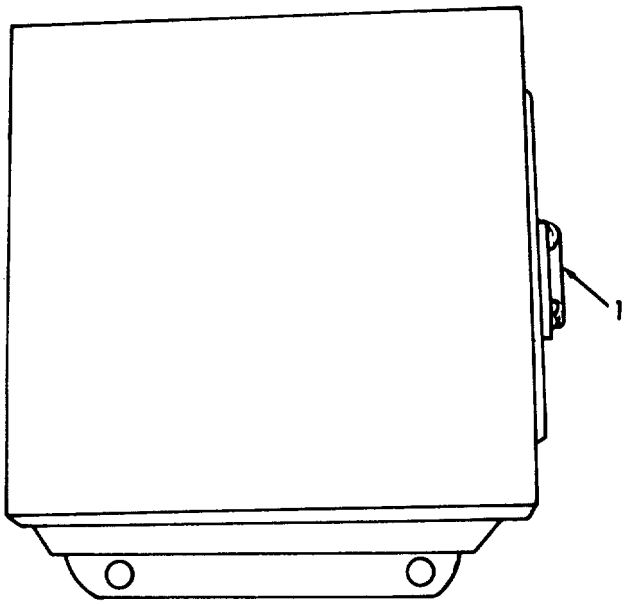
LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	g. Cover latch (1)	Close cover and secure latch.	

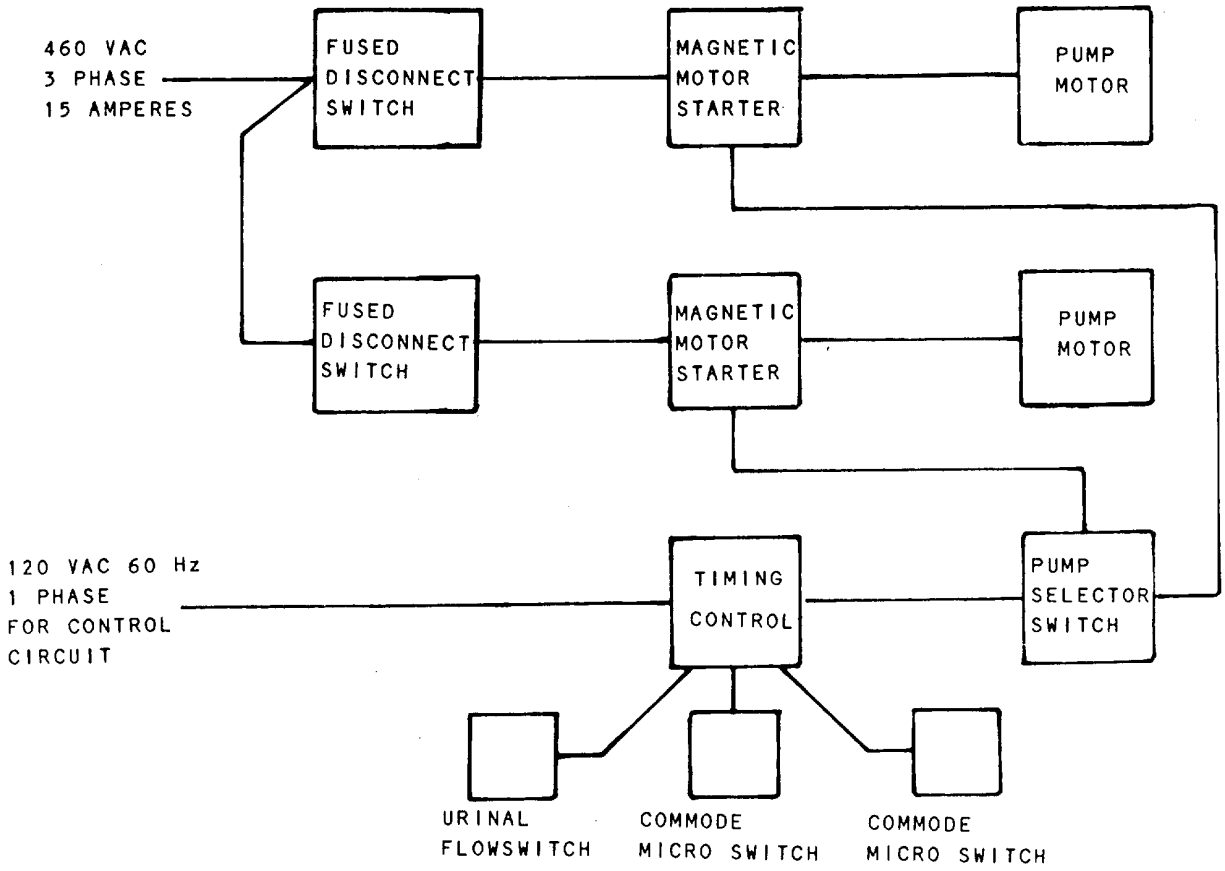


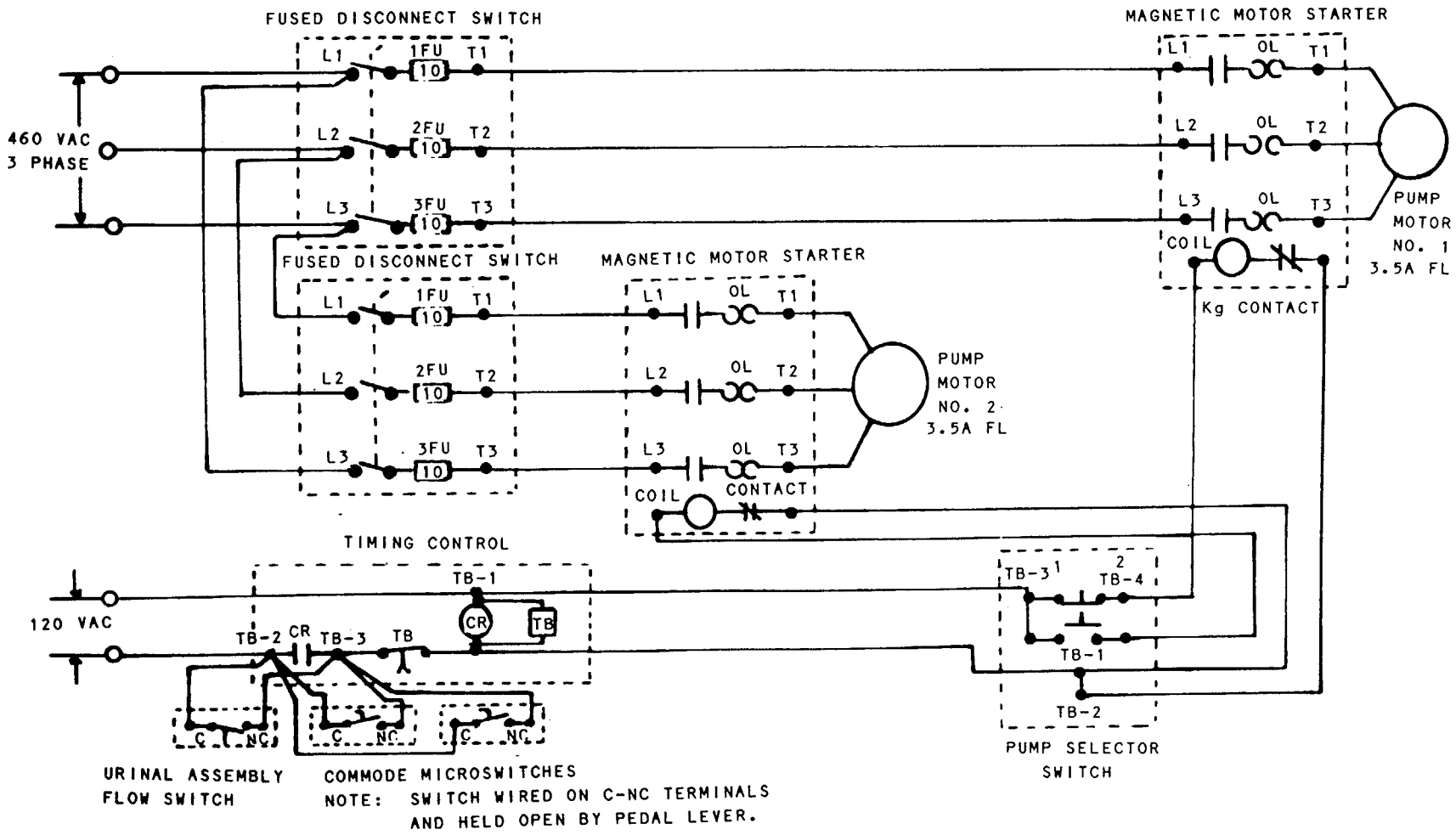
4.	Selector switch	a. Cover	Open.	
		b. Wiring	Tag and disconnect.	Refer to wiring diagram.
		c. Mounting hardware	Remove.	
		d. Switch box	Remove.	
		e. Switch box, and mounting hardware	Install.	
		f. Wiring	Reconnect and remove tags.	
		g. Cover	Close.	

4-17.3. MACERATOR/TRANSFER PUMP TIMER AND SELECTOR SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)




FUSED DISCONNECT SWITCH
MAGNETIC MOTOR STARTER
460 VAC
3 PHASE
L1
L2
L3
1FU
2FU
3FU
10
T1
T2
T3
OL
PUMP
MOTOR
NO. 1
3.5A FL
COIL
Kg CONTACT
FUSED DISCONNECT SWITCH
MAGNETIC MOTOR STARTER
PUMP
MOTOR
NO. 2
3.5A FL
CONTACT
TIMING CONTROL
120 VAC
TB-1
TB-2
CR
TB-3
TB
TB-3 1
2 TB-4
C
NC
URINAL ASSEMBLY
FLOW SWITCH
COMMODE MICROSWITCHES
NOTE: SWITCH WIRED ON C-NC TERMINALS
AND HELD OPEN BY PEDAL LEVER.
PUMP SELECTOR
SWITCH

4-18 .SEWAGE AIR PUMP.

a. The sewage air pump is used to blow air into the holding tank to agitate the effluent.

b. The following is an index to the maintenance instructions.

DESCRIPTION	PARAGRAPH
Sewage Air Pump	4-18.1
Sewage Air Pump Motor	4-18.2

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Disassembly
c. Repair
d. Assembly
e. Service

INITIAL SETUP

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Oil OEDHO-30-Non Detergent

Personnel Required
1

References
NONE

Equipment Condition
Condition Description	Paragraph
Motor disconnected	4-18.2

Special Environmental Conditions
Do not drain oil into bilges. Use the oil/water collection and recovery system to collect drained oil .

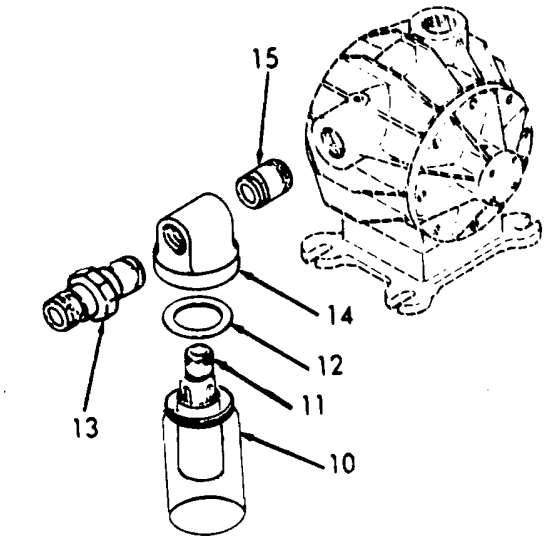
General Safety Instructions
NONE

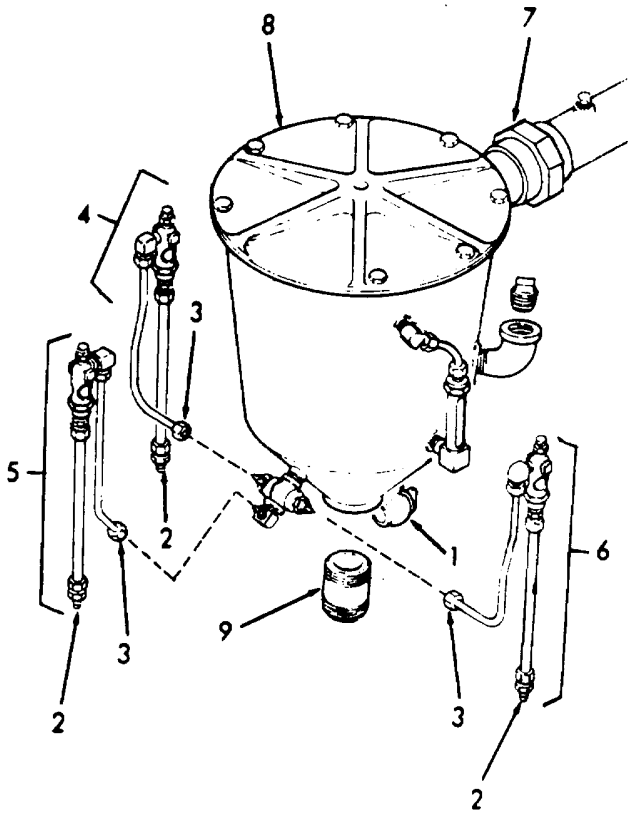
4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTIONI			
1. Sewage air pump	a. Motor	Inspect per paragraph 4-18.2.	
	b. Oiling system	1. Inspect for leaking.	
		2. Inspect for bent or broken tubing.	
		3. Inspect for broken sight glass.	
		4. Inspect for proper oil level.	
	c. Inlet filter assembly	1. Inspect for broken glass.	
		2. Inspect for dirty or damaged filter bag.	
	d. Pump	Inspect for noise while running as this is an indication of damaged parts.	
DISASSEMBLY			
2. Oiling system	a. Drain cock (1)	Drain oil into a suitable container.	Do not drain oil into bilges.
	b. Adapter (2)	Disconnect.	
	c. Connector (3)	Disconnect.	
	d. Three automatic oilers (4, 5 and 6)	Remove from pump body.	For repairs refer to step 4.
	e. Union (7)	Loosen and separate.	
	f. Tank (8)	Unscrew and remove.	
	g. Pipe nipple (9)	Remove.	If necessary.

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
3. Inlet filter assembly	a. Jar (10)	Unscrew.	
	b. Filter bag holder (11)	Unscrew.	
	c. Gasket (12)	Remove.	
	d. Union (13)	Loosen and separate.	
	e. Top (14)	Unscrew.	
	f. Pipe nipple (15)	Remove.	If necessary.



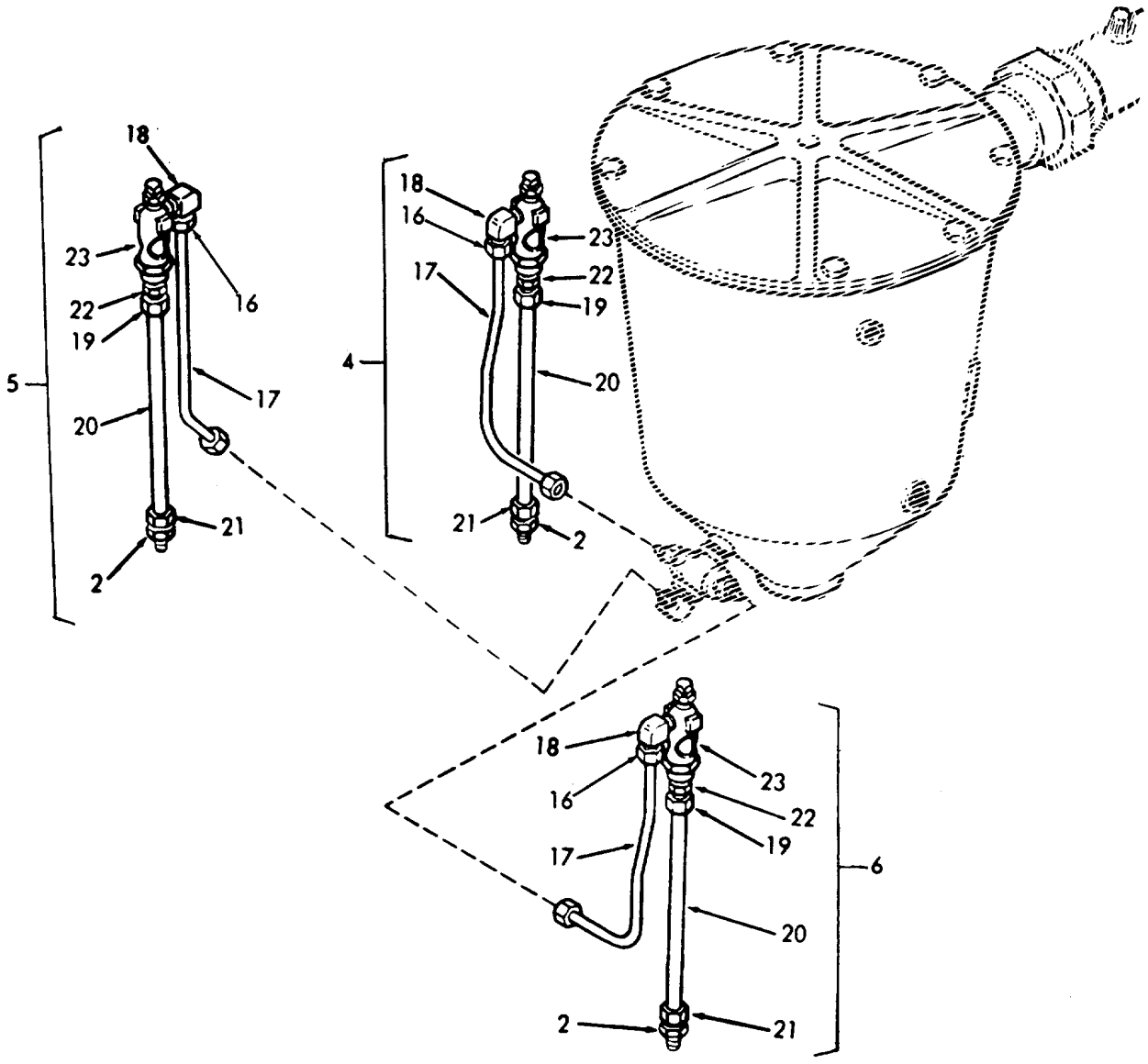


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIRI			
4. Automatic oilers (4, 5 and 6)	a. Connectors (16), and oil tubes (17)	Unscrew and remove.	
	b. Elbows (18)	Remove.	
	c. Connectors (19), and copper tubes (20)	Unscrew and remove.	
	d. Adapters (2), and connectors (21)	Unscrew.	
	e Adapter (22), and sight valve (23)	Disassemble.	
	f. Sight valve (23), and adapter (22)	Reassemble.	
	g. Connectors (21), and adapters (2)	Reassemble.	
	h. Copper tubes (20), and connec-tors (19)	Reassemble.	
	i. Elbows (18)	Install.	
	j. Oil tubes (17), and connectors (16)	Reassemble	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

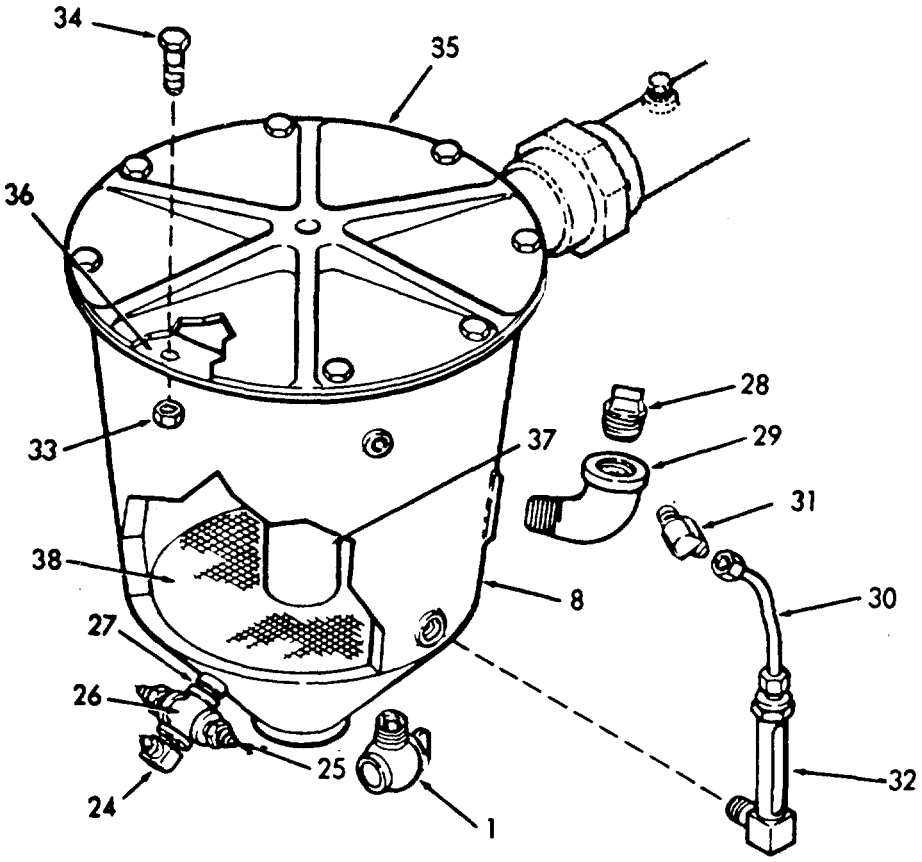


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Oil system tank (8)	a. Drain cock (1)	Unscrew.	
	b. Elbow (24)	Unscrew.	
	c. Connectors (25)	Unscrew.	
	d. Cross (26)	Unscrew.	
	e. Nipple (27)	Remove.	
	f. Nipple (9)	Remove.	
	g. Pipe plug (28), and elbow (29)	Remove.	
	h. Connectors with tube (30)	Unscrew and remove.	
	i. Elbow (31)	Unscrew.	
	j. Oil sight gage (32)	Unscrew.	
	k. Nuts (33), and screws (34)	Remove.	
	l. Cover (35), and gasket (36)	Remove.	Discard gasket.
	m. Oil tube (37), and screen (38)	Remove.	
	n. All parts	Clean.	
	o. Screen (38) and oil tube (37)	Insert in tank (8).	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

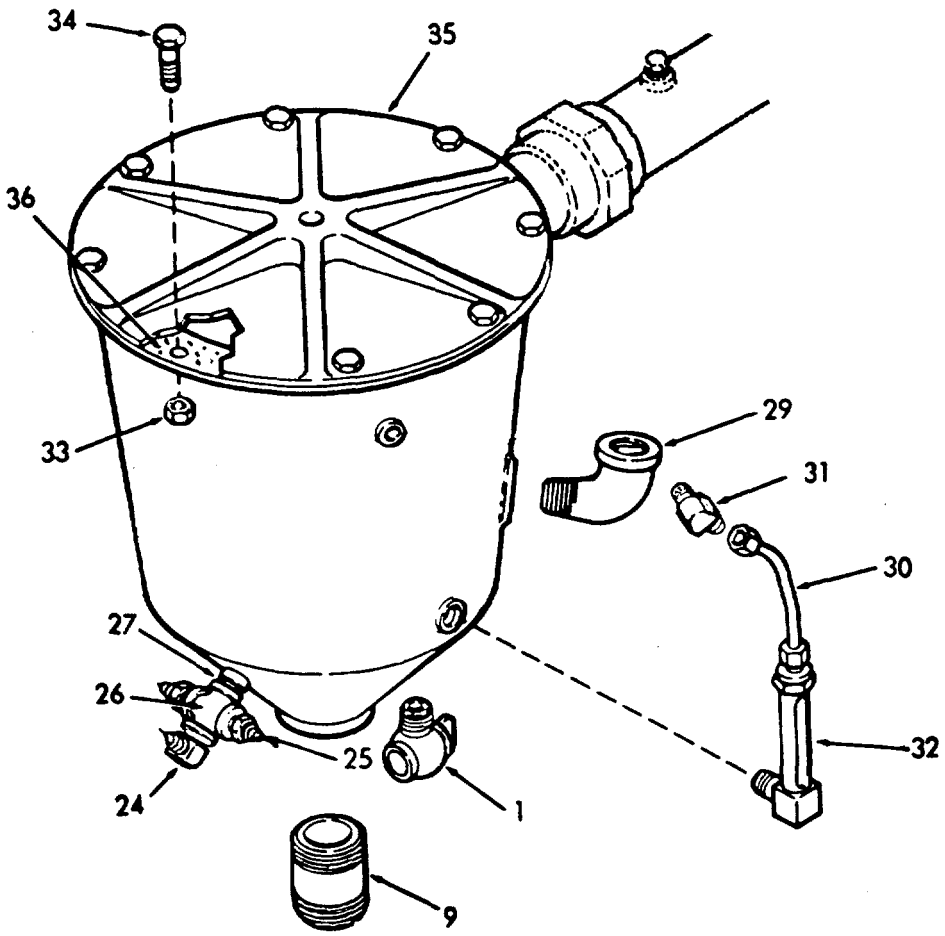


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	p. Gasket (36), cover (35), screws (34), and nuts (33)	Reassemble.	Use new gasket.
	q. Oil sight gage (32)	Install.	
	r. Elbow (31)	Install.	
	s. Tube with connectors (30)	Install.	
	t. Elbow (29)	Install.	
	u. Nipple (9)	Install.	
	v. Nipple (27), cross (26), connectors (25), and elbow (24)	Reassemble. and install.	
	w. Drain cock (1)	Install.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

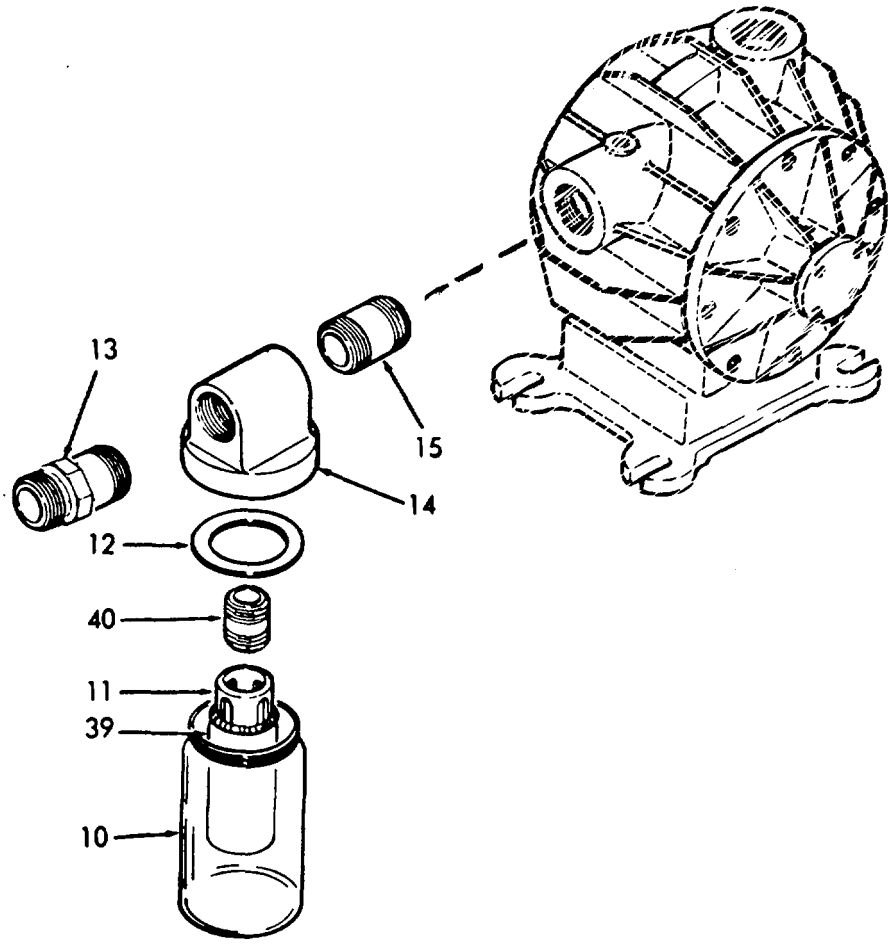


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Inlet filter assembly	a. Jar (10), and gasket (12)	Remove.	
	b. Filter bag (39)	Remove.	
	c. Filter bag holder (11), and adapter (40)	Remove from top (14).	
	d. Nipple (15), and top (14)	Remove.	
	e. Nipple and union (13)	Remove from top (14).	
	f. Union and nipple (13)	Install in top (14).	
	g. Nipple (15), and top (14)	Install.	
	h. Adapter (40), and filter bag holder (11)	Assemble and install in top (14).	
	i. Filter bag (39)	Install.	
	j. Gaskets (12), and jar (10)	Install.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Pump	a. Screws (41)	Remove.	
	b. Key (42)	Remove.	
	c. Eight screws (43)	Remove.	

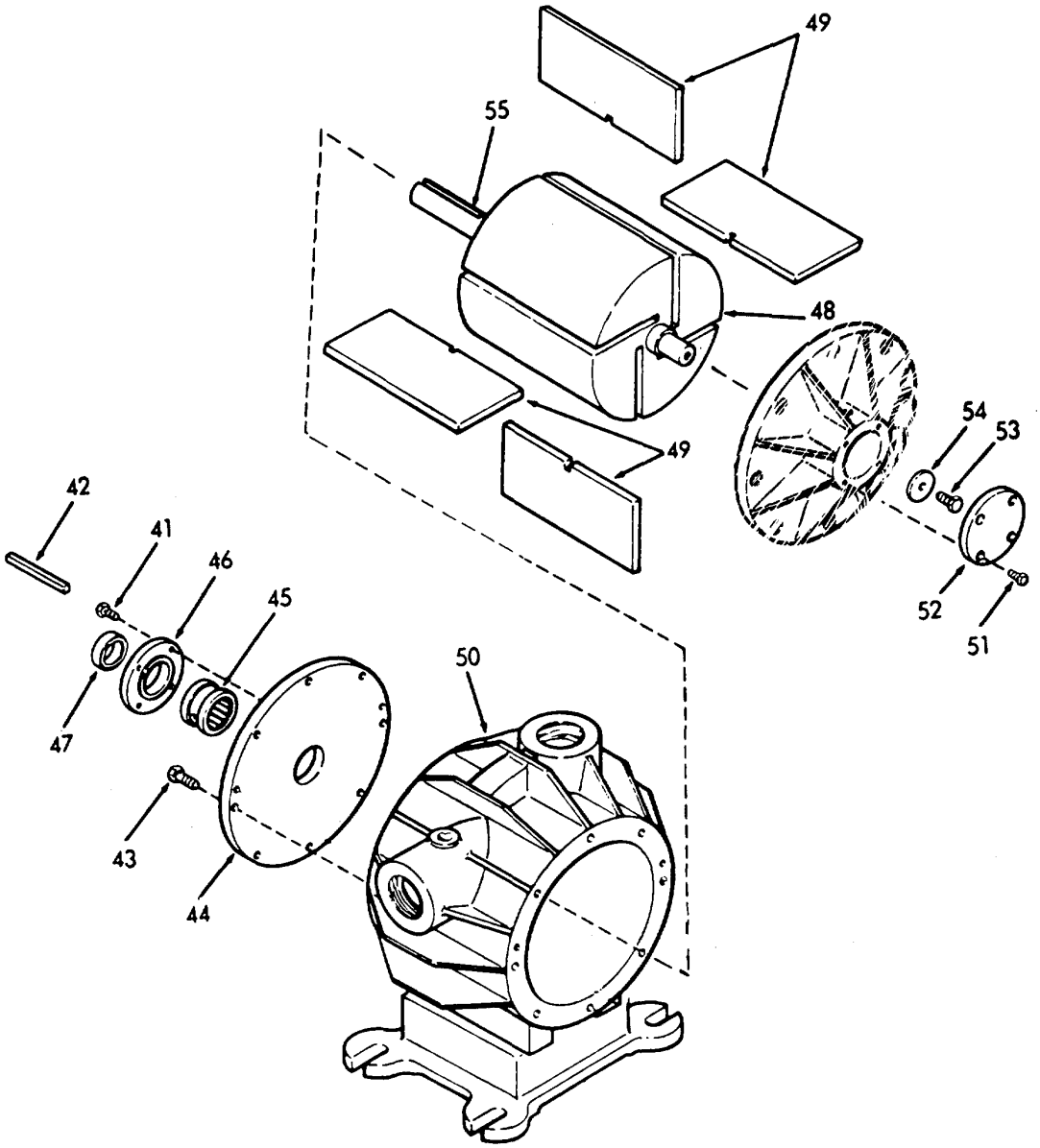
CAUTION

Be careful that the vanes in the rotor and shaft assembly are not damaged after the cylinder head shaft end is removed from the pump body. The rotor and shaft assembly are no longer supported on that end.

d. Cylinder head shaft end (44)	Remove.	
e. Roller bearing (45), seal housing (46), and seal (47)	Remove.	
f. Rotor (48), and vanes (49)	Slide out of pump body (50).	
g. Four screws (51), and end cap (52)	Remove.	
h. Lockscrew (53), and bearing washer (54)	Remove.	
i. Shaft (55)	Remove.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

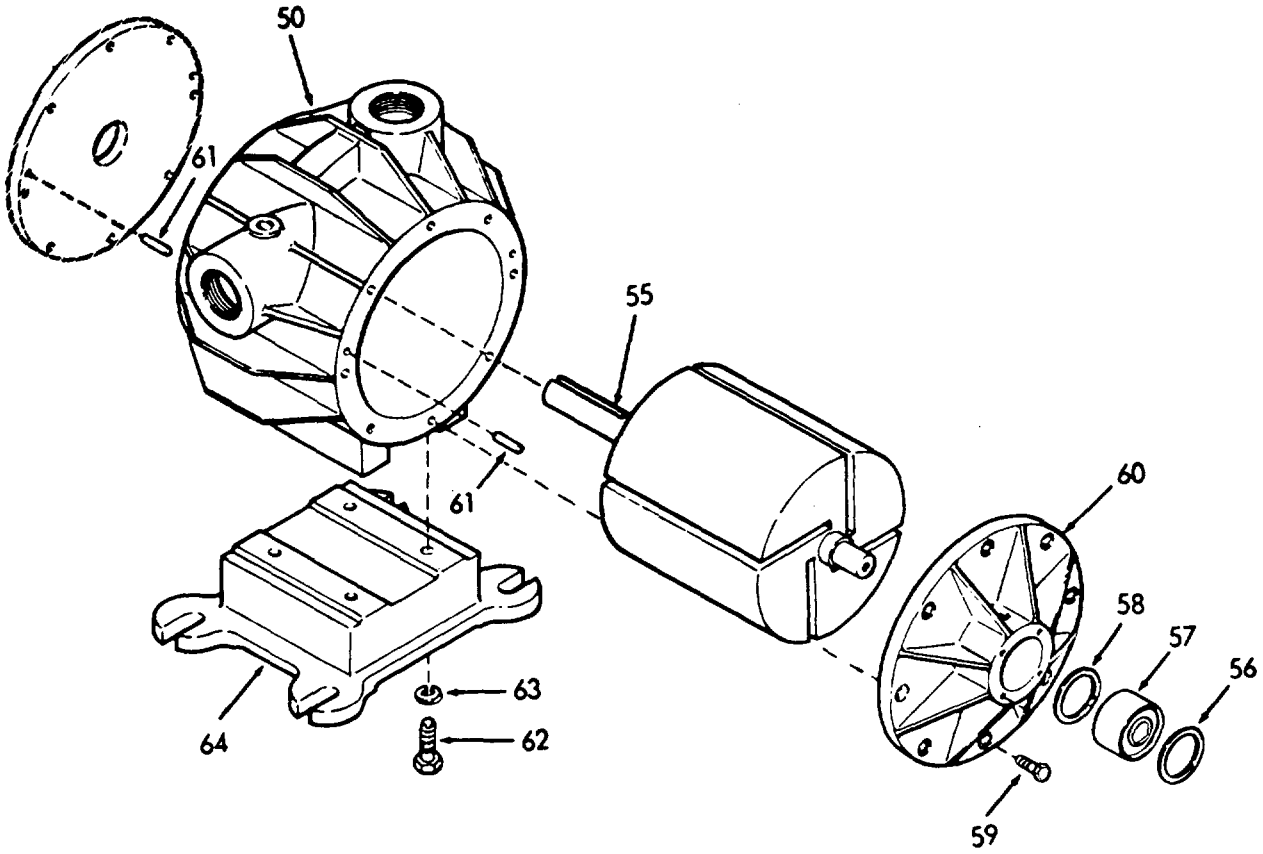


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Shim (56), bearing (57), and shim (58)	Remove.	
	k. Eight screws (59)	Remove.	
	l. Cylinder head blind end (60)	Remove.	
	m. Dowell pins (61)	Remove.	If necessary.
	n. Screws (62), and lock-washers (63)	Remove.	
	o. Base (64), and pump body (50)	Separate.	
	p. Reducing bushing (65), and retaining ring (66)	Remove from shaft (55).	
	q. Retaining ring (66), and reduc-ing bush-ing (65)	Assemble to shaft (55).	
	r. Base (64), pump body (50), screws (62), and lockwashers (63)	Assemble.	
	s. Cylinder head blind end (60), and screws (59)	Install.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

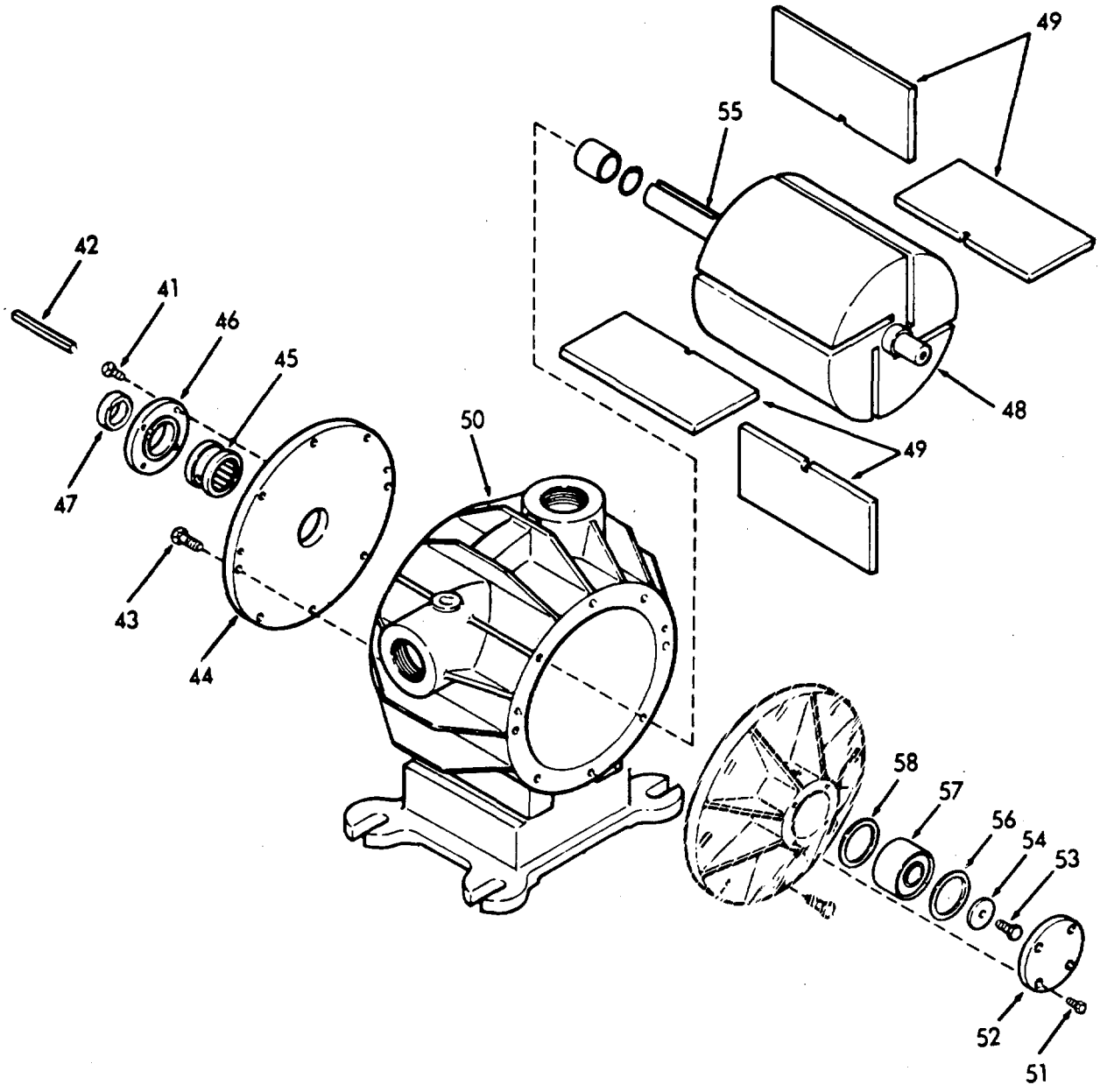


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	t. Shim (58), bearing (57), and shim (56)	Install.	
	u. Shaft (55), bearing washer (54), and lockscrew (53)	Install.	
	v. End cap (52), and screws (51)	Install.	
	w. Rotor (48), and vanes (49)	Install on shaft (55) in pump body (50).	
	x. Seal (47), seal housing (46), and roller bearing (45)	Install in cylinder head shaft end (44).	
	y. Cylinder head shaft end (44), and screws (43)	Install.	Make sure the shaft turns freely. If not determine the reason for the binding and correct.
	z. Key (42)	Install on shaft (55).	
	aa. Screws (41)	Install.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

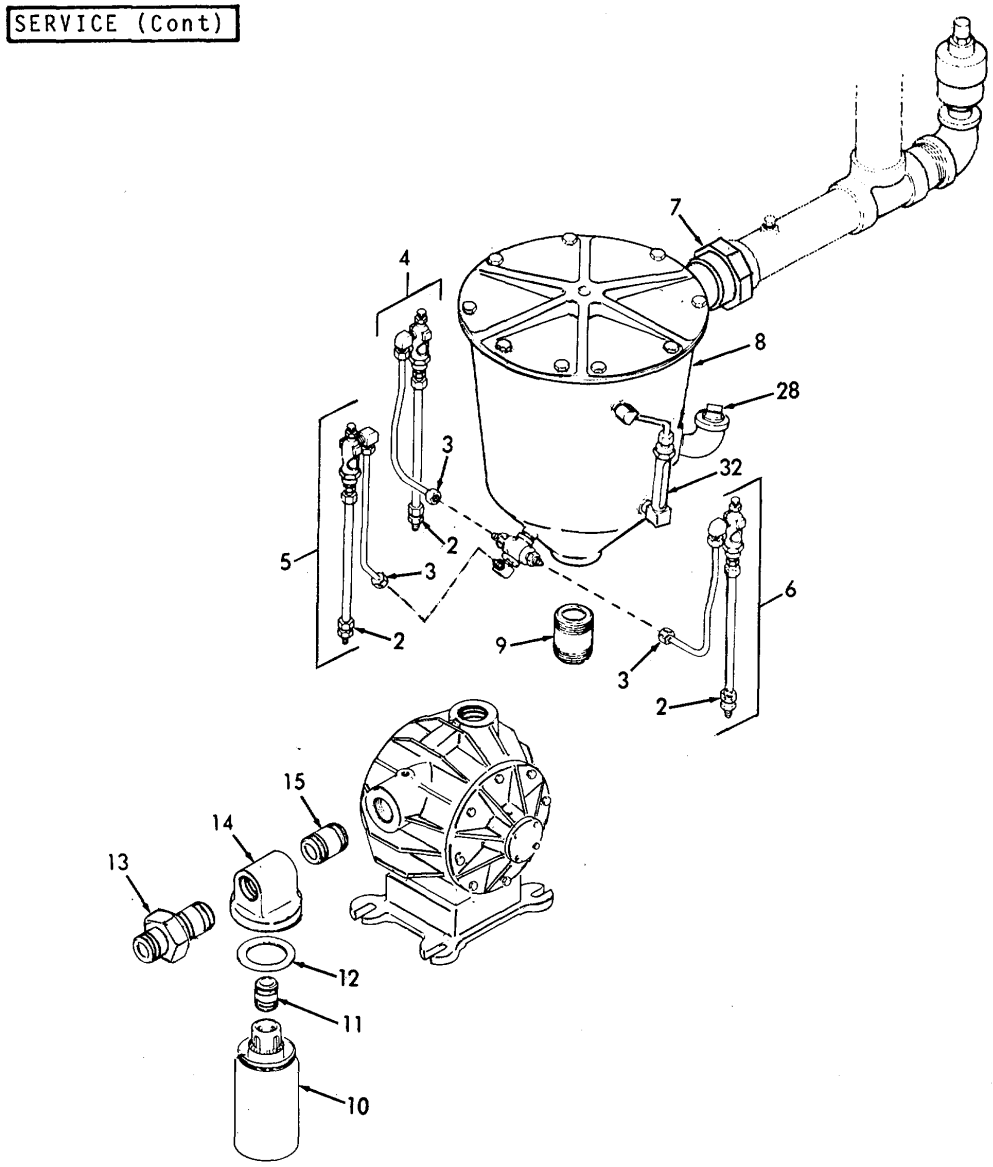


4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY			
8. Oiling system	a. Pipe nipple (9), and tank (8)	Install.	
	b. Union (7)	Reassemble.	
	c. Automatic oilers (4, 5, and 6)	Install and assemble adapters (2) and connectors (3).	
9. Inlet filter assembly	a. Top (14), and pipe nipple (15)	Install.	
	b. Union (13)	Reconnect.	
	c. Filter bag holder (11)	Install.	
	d. Gasket (12), and jar (10)	Install.	
	NOTE Turn the rotor shaft assembly on the cylinder head shaft end of pump body and check for any binding or rubbing that may be caused by damaged or misaligned components. Correct any such condition by straightening misaligned parts and replacing damaged components. The pump is now ready to be put into operation.		
SERVICE			
10. Sewage air pump	a Oil	Fill tank (8) to level on sight glass (32).	Use oil OE/HDO-30-non detergent.
	b. Pipe plug (28)	Replace.	
	c. System	1. Operate. 2. Recheck oil level.	

4-18.1. SEWAGE AIR PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (CON'T)			



4-18.2. SEWAGE AIR PUMP MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

NONE

General Safety Instructions

LOCATION	ITEM	ACTION	REMARKS

NO INFORMATION AVAILABLE.

4-19. TOILET - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
Lubriplate

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
Observe WARNINGS in paragraph 4-15 and in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Toilet	a. Wiring	Inspect for breaks, cracks, and worn insulation.	Refer to Direct Support Maintenance.
	b. Piping	1. Inspect for breaks, cracks, or dents 2.Inspect for leaking.	Refer to Direct Support Maintenance.
	c. Hoses	1. Inspect for breaks, cracks, or bends. 2. Inspect for leaking. 3. Insure all base clamps are tight.	
	d. Flush valve	Inspect for breaks, cracks, or leaking.	Refer to paragraph 4-21.

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

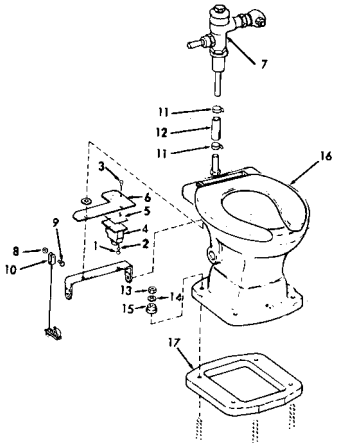
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	e. Commode	1. Inspect for breaks and cracks.	
		2. Inspect for leaks.	
		3. Insure all hardware is tight.	
		4. Inspect for ease of operation.	
		5. Inspect seat for wear, broken hinges and splinters.	
	f. Cable assembly	1. Inspect for breaks and kinks.	
		2. Insure all hardware is tight.	
		3. Inspect for proper operation.	
SERVICE			
		CAUTION Do not repeatedly flush the commode during the cleaning operation as this will reduce the useful capacity of the holding tank. Flush commode and observe flow of water from flush pipe. This unit is designed to spray all areas of the bowl. It may be necessary to use a small wire to unclog a clogged orifice if uneveness of spray is observed.	
	a. Bowl	1 Clean with a non-foaming cleanser.	
		2. Use a soft brush to remove clinging solids.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	b. Mechanical linkage	Lubricate.	Use a water insoluable grease (Lubriplate).
	c. Checks	Refer to step 11.	
REMOVAL			
3.		**WARNING** In order to prevent electrical shock and possible death, tag and disconnect circuit breaker on control circuit, and pull fuses as an added precaution.	
	a. Two nuts (1), flat-washer (2), and screws (3)	Remove.	
	b. Switch (4), and gasket (5)	Remove from bracket (6).	
	c. Wiring	1. Tag, disconnect and cover exposed ends with electrical tape, or wire nut.	Refer to schematic in paragraph 4-15.
		2. Turn on circuit breaker in order to continue use of the system.	
	d. Flush valve (7)	Shut off water.	Refer to paragraph 4-21.
	e. Nut (8), and screw (9)	Remove.	
	f. Clevis fitting (10)	Remove from flush valve.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	g Hose clamps (11)	Loosen.	
	h. Hose (12)	Remove.	
	i. Four nuts (13), flat-washers (14), and neoprene cushions (15)	Remove.	
	j. Commode hopper (16)	Lift up and remove.	This step requires 2 persons.
	k. Shockmount pad (17)	Remove	If necessary

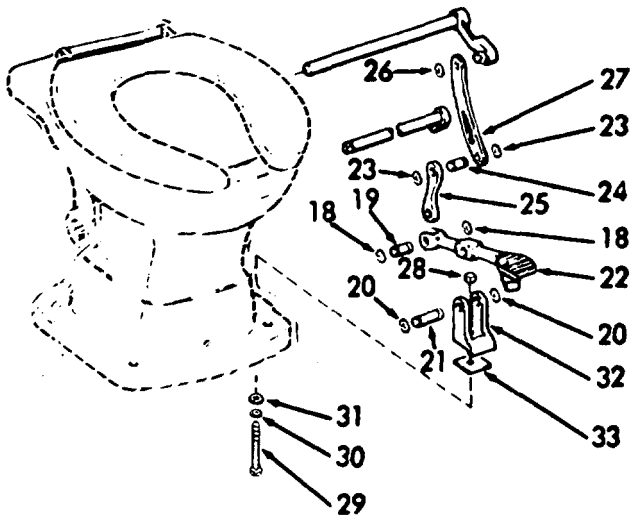


4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Foot pedal and linkage	a. Retaining rings (18), and straight pin (19)	Remove.	
	b. Retaining rings (20), and straight pin (21)	Remove.	
	c. Foot pedal (22)	Remove.	
	d. Retaining rings (23), and straight pin (24)	Remove.	
	e. Link (25)	Remove.	
	f. Retaining ring (26)	Remove.	
	g. Link (27)	Remove.	
	h. Nut (28), screw (29), flatwasher (30), neoprene flatwasher (31), bracket (32), and pad (33)	Remove.	If necessary.
	i. Link (27), and retaining rings (26)	Replace	
	j. Link (25), straight pin (24) and retaining rings (23)	Replace.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Foot pedal (22), straight pin (21), and retaining rings (20)	Replace.	
	l. Straight pin (19) and retaining rings (18)	Replace.	

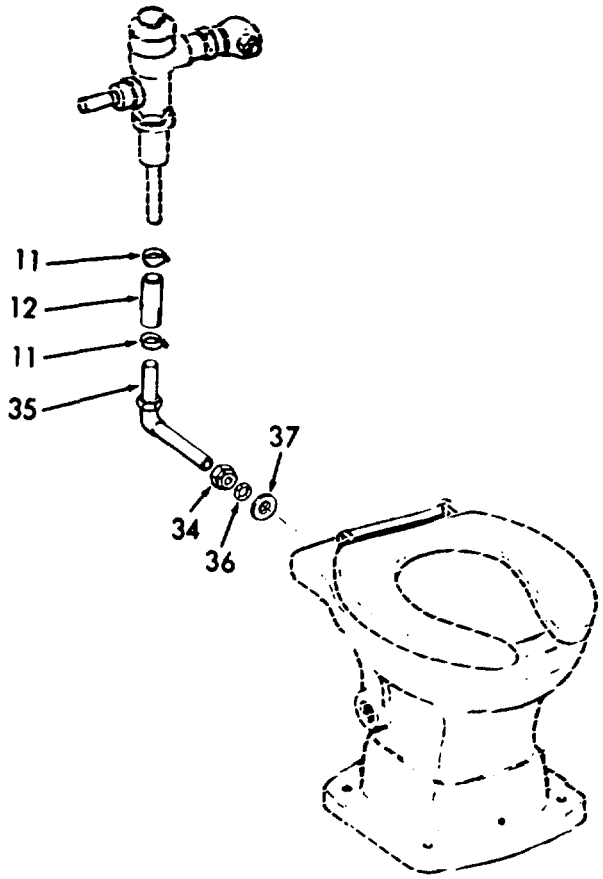


4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Flush pipe	a. Hose clamps (11), and hose (12)	Loosen and remove.	
	b. Nut (34)	Loosen.	
	c. Flush pipe (35)	Remove.	
	d. Nut (34), neoprene washer (36), and washer (37)	Remove.	
	e. Washer (37), neoprene washer (36) and nut (34)	Insert in bowl.	
	f. Flush pipe (35)	Insert in nut (34).	
	g. Hose (12) and hose clamps (11)	Install.	
	h. Flush pipe (35)	Align vertical pipe with hose to form a straight line.	
	i. Hose clamps (11), and nut (34)	Tighten.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

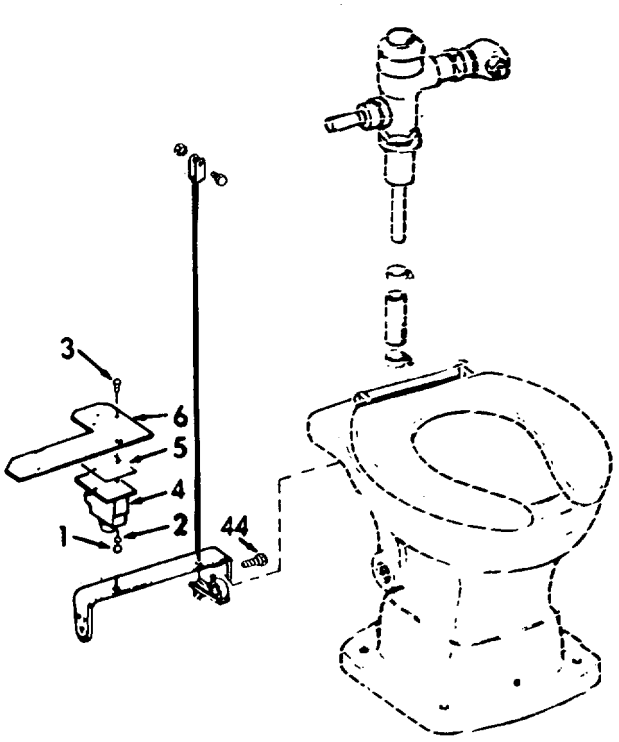


4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Switch			
		WARNING In order to prevent electrical shock and possible death, tag and disconnect circuit breaker on control circuit, and pull fuses as an added precaution.	
	a. Two nuts (1), flatwashers (2), and screws (3)	Remove.	
	b. Switch (4), and gasket (5)	Remove from bracket (6).	
	c. Wiring	Disconnect.	Refer to schematic in paragraph 4-15.
	d. Switch (4)	Replace.	
	e. Wiring	Reconnect.	Refer to schematic in paragraph 4-15.
	f. Gasket (5), and switch (4)	Align holes with bracket (6).	
	g. Two screws (3), flatwashers (2), and nuts (1)	Install.	

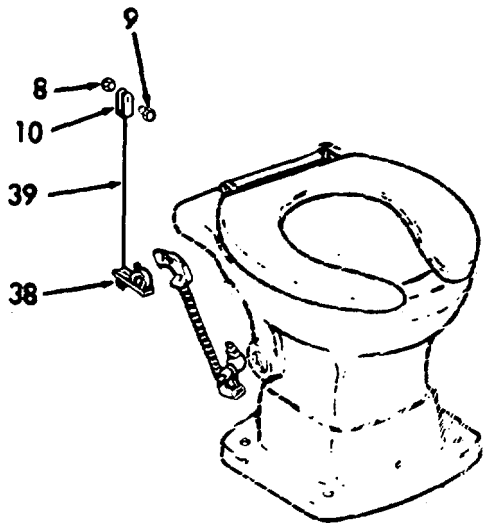
4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



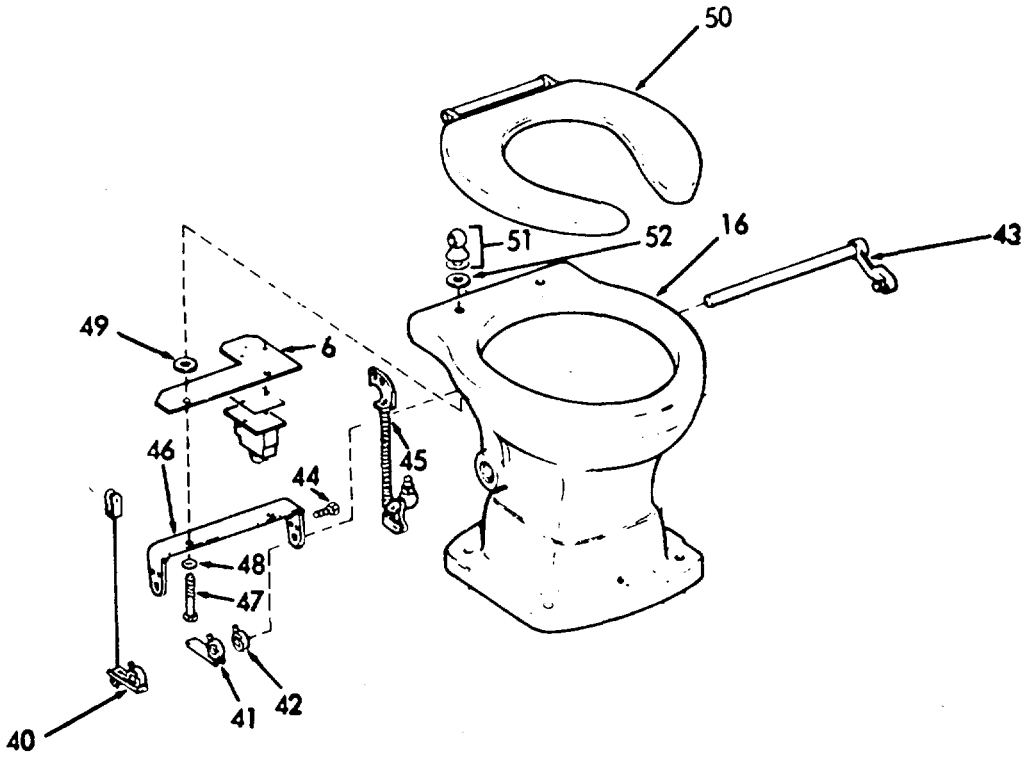
4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Cable Assembly	a. Nut (8), and screw (9)	Remove.	
	b. Clevis fitting (10)	Remove from flush valve.	
	c. Retainer (38)	Remove.	
	d. Cable (39)	Replace.	
	e. Retainer (38)	Replace.	
	f. Clevis fitting (10), screw (9), and nut (8)	Install on flush valve handle.	



4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Seat, Shaft and valve plate	a. Cable collar (40), micro collar (41), and collar (42)	Loosen setscrew.	
	b. Shaft (43)	Pull out and remove.	The collars (40, 41 and 42) will slide off shaft.
	c. Two screws (44)	Remove.	
	d. Spring assembly (45)	Remove from valve plate (46).	



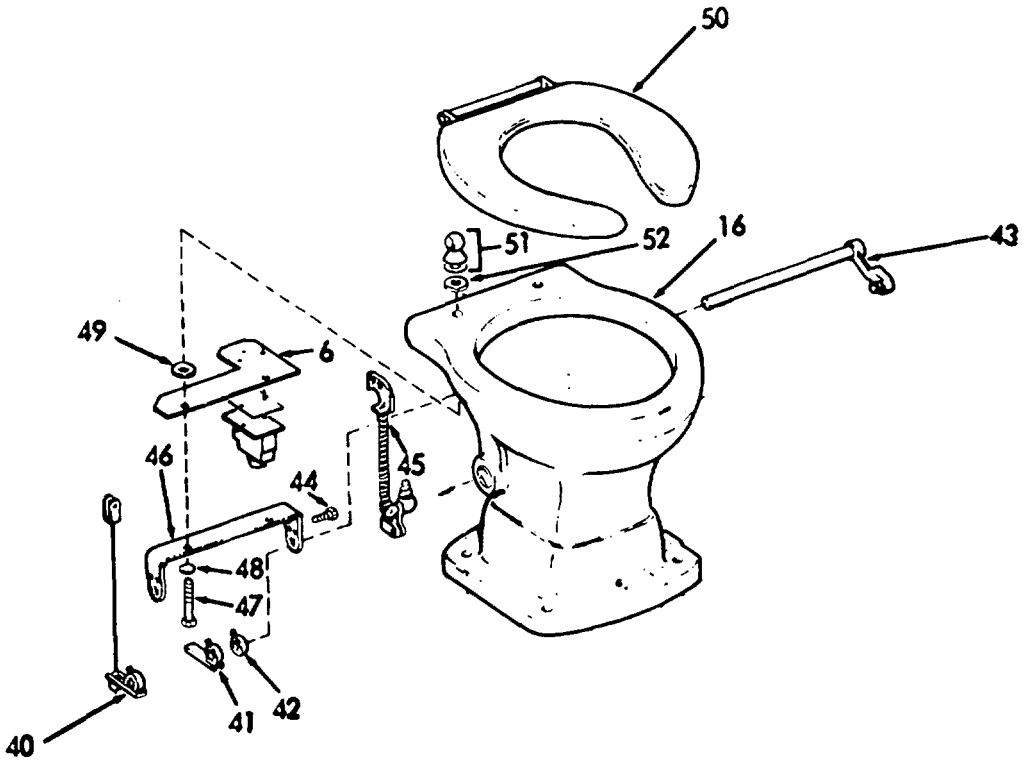
4-717

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Screws (47), flatwashers (48), valve plate (46), bracket (6), rubber washers (49), seat (50), hinge posts (51), and rubber washers (52)	Remove.	
	f. Seat (50), hinge posts (51), and rubber washers (52)	Assemble to top of hopper (16).	
	g. Rubber washers (49), bracket (6), valve plate (46), flatwashers (48), and screws (47)	Install.	
	h. Spring assembly (45)	Assemble to valve plate (46) with screws (44).	
	i. Shaft (43), collar (42), micro collar (41), and cable collar (40)	1. Install. 2. Adjust collars and tighten setscrews.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

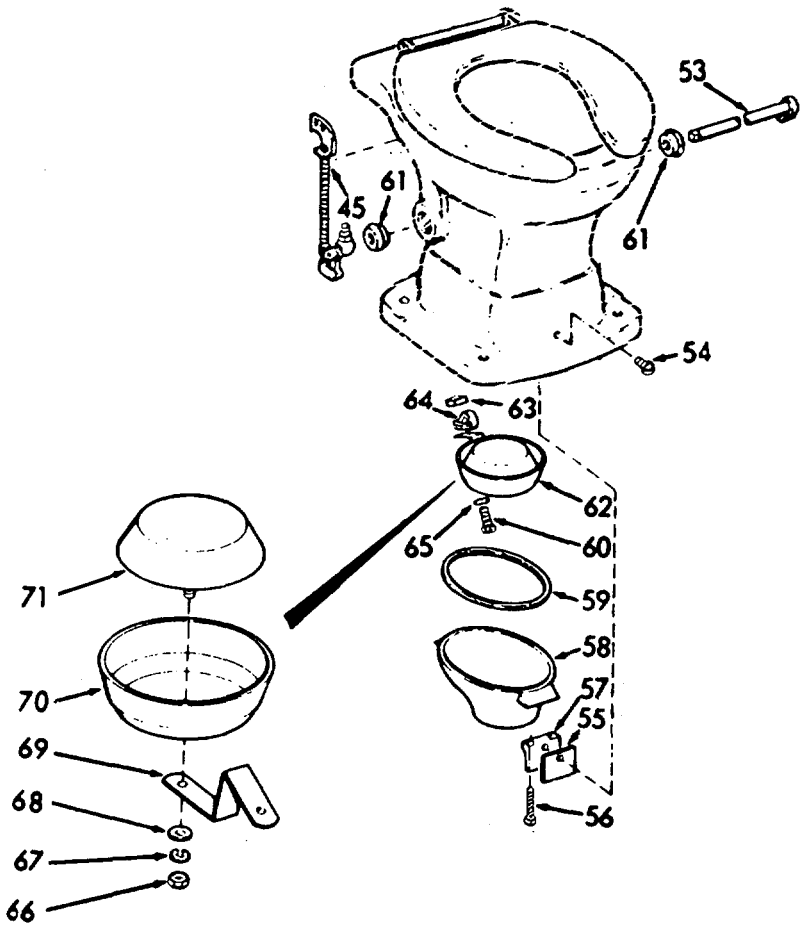


4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Stopper disc assembly	a. Spring assembly (45)	Remove from crankshaft (53).	
	b. Two screws (54)	Remove.	
	c. Pads (55)	Remove.	
	d. Four screws (56), and two lugs (57)	Remove.	
	e. Insert (58), and bowl seat gasket (59)	Remove.	
	f. Screw (60)	Loosen.	
	g. Crankshaft (53), and two sleeves (61)	Remove.	
	h. Disc assembly (62)	Remove.	
	i. Nut (63), clamp (64), screw (60), and flatwasher (65)	Remove.	
	j. Nut (66), lockwasher (67), flatwasher (68), bracket (69), stopper disc (70), and stopper (71)	Disassemble.	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Stopper (71), stopper disc (70), bracket (69) ,flat-washer (68), lockwasher (67), and nut (66)	Reassemble.	

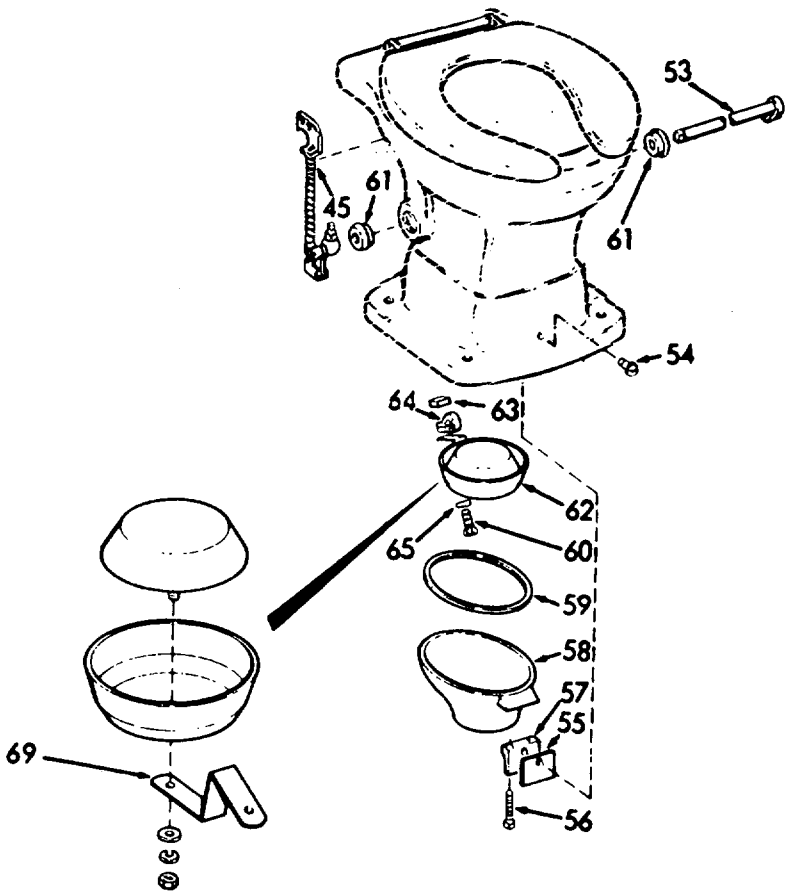


4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	l. Screw (60), flatwasher (65), disc assembly (62), clamp (64) and nut (63)	1. Assemble to bracket (69). 2. Do not tighten screw (60).	
	m. Sleeves (61)	Insert on both sides of hopper.	
	n. Crankshaft (53)	Insert in hopper and through disc assembly clamp (64).	
	o. Insert (58), lugs (57) and screws (56)	Assemble.	
	p. Bowl seat gasket (59), and assembled insert	Insert in hopper.	
	q. Pads (55), and screws (54)	Install.	
	r. Spring assembly (45)	Install on crankshaft (53).	
	s. Disc assembly (62)	1. Press pedal and adjust disc assembly so that it closes properly. 2. Tighten screw (60).	

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
10. Toilet	a. Shock mount pad (17)	Replace.	If removed.
	b. Commode hopper (16)	Place over mounting studs.	
	c. Four neoprene cushions (15), flat-washers (14) and nuts (13)	Install.	
	d. Hose (12), and hose clamps (11)	Install and tighten clamps.	
	e. Clevis fitting (10), screw (9) and nut (8)	Install on flush valve lever.	
	f. Flush valve (7)	Turn on water.	Check for leaks.

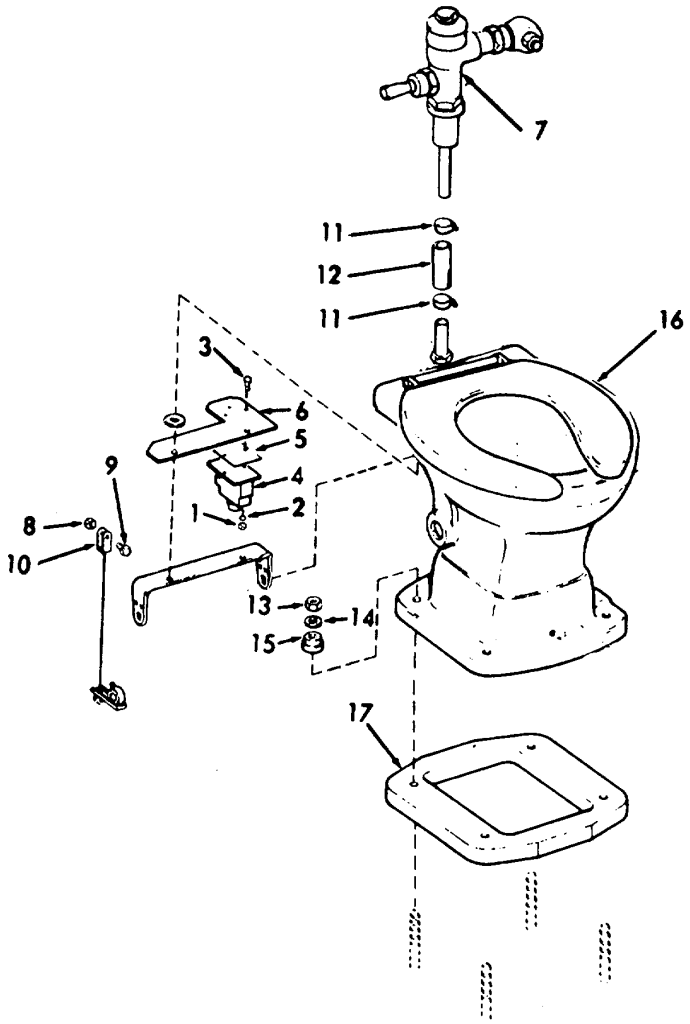
WARNING

In order to prevent electrical shock and possible death, tag and disconnect circuit breaker on control circuit.

	g. Wiring.	1. Remove electrical tape.	
		2. Reconnect wires to switch. Connect wires to C and NC terminals.	Refer to schematic in paragraph 4-15.
		3. Remove tags.	

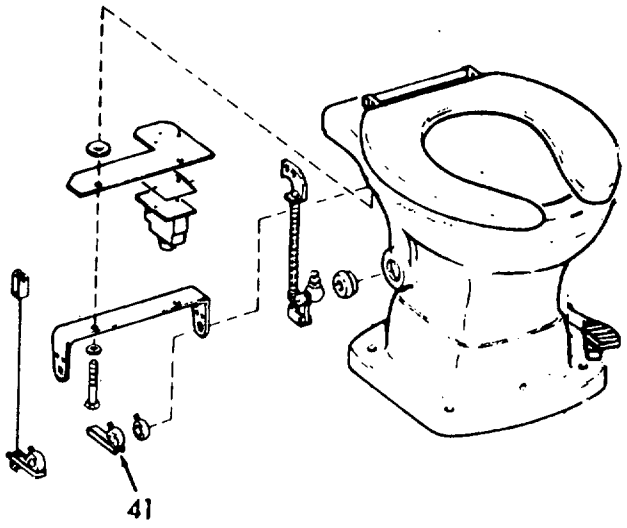
4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Switch (4), gasket (5), two screws (3), flat-washers (2), and nuts (1)	Install on bracket (6).	
	i. Adjustments and check-out	Refer to step 11.	



4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CHECKS			
11. Toilet	a. Flush pedal	Press and observe the following:	
		1. The flush cable pulls the flush valve handle and operates the flush valve.	
		2. The micro switch (foot pedal switch) lever, pulls away from the switch and starts the macerator/transfer pump.	To adjust the micro switch, loosen and rotate the switch collar (41).



3. If the pump is not turned on, a "click" can be heard within the switch each time the foot-pedal is pressed and released.

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CHECKS (Cont)			
	b. Flush valve	Check the volumetric output of the flush valve as follows: 1. Add one pint of water to an empty commode. 2. Mark the water level in the commode with a crayon or marker. 3. Empty the water by pressing the flush pedal and holding it down until the flush valve has completed its operation. 4. Release the flush pedal and add a single flush from the flush valve by pressing the handle once. 5. The amount of water added to the bowl should be approximately the same as when one pint was added to the bowl. 6. Refer to paragraph 4-21 for flush valve adjustment.	
	c. Stopper disc	The operation of the stopper disc is checked as follows: 1. Press the foot pedal all the way to the stop.	

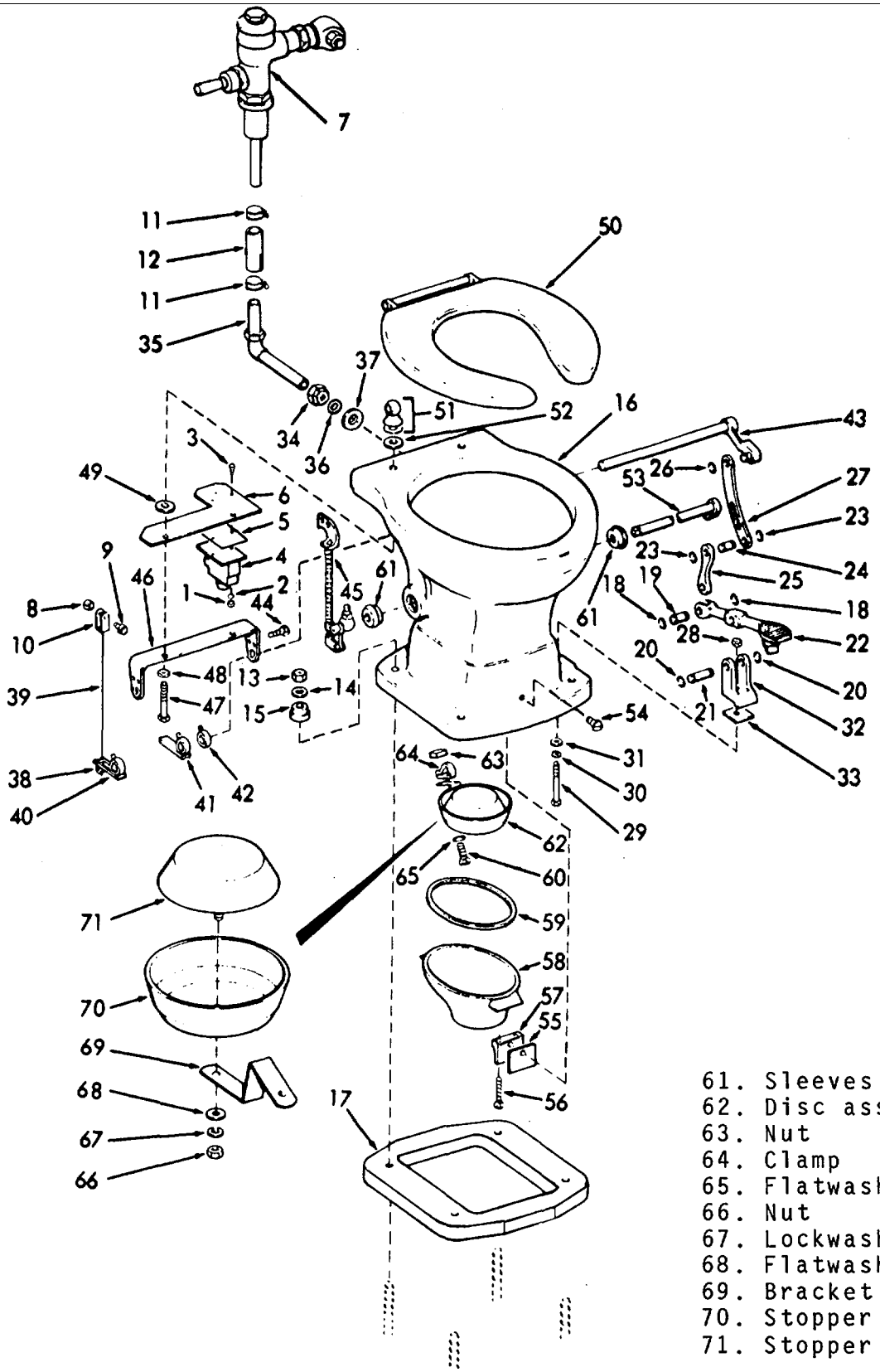
4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
CHECKS (Cont)			
		2. The stopper disc assembly should swing open until it is almost vertical.	
		3. Adjust clamp on stopper disc.	
	d. Stopper disc seal	Check the stopper disc seal as follows:	
		1. Add one or two pints of water to the bowl with the flush valve.	
		2. Mark the water bowl.	
		3. No noticeable decrease in water level should occur within a fifteen minute time.	

Toilet Legend

1. Nuts
2. Flatwashers
3. Screws
4. Switch
5. Gasket
6. Bracket
7. Flush valve
8. Nut
9. Screw
10. Clevis fitting
11. Hose clamps
12. Hose
13. Nuts
14. Flatwashers
15. Neoprene cushions
16. Commode hopper
17. Shock mount pad
18. Retaining rings
19. Straight pin
20. Retaining rings
21. Straight pin
22. Foot pedal
23. Retaining rings
24. Straight pin
25. Link
26. Retaining ring
27. Link
28. Nut
29. Screw
30. Flatwasher
31. Neoprene flatwasher
32. Bracket
33. Pad
34. Nut
35. Flush pipe
36. Neoprene washer
37. Washer
38. Retainer
39. Cable
40. Cable collar
41. Micro collar
42. Collar
43. Shaft
44. Screws
45. Spring Assembly
46. Valve plate
47. Screws
48. Flatwashers
49. Rubber washers
50. Seat
51. Hinge posts
52. Rubber washers
53. Crankshaft
54. Screws
55. Pads
56. Screws
57. Lugs
58. Insert
59. Bowl seat gasket
60. Screw

4-19. TOILET - MAINTENANCE INSTRUCTIONS (Continued).



4-20. URINAL - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Equipment
Special Tools
NONE

Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
Observe WARNINGS in paragraph 4-15 and in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Urinal	a. Wiring	Inspect for breaks, cracks, or worn insulation	Refer to Direct Support Maintenance.
	b. Piping	1. Inspect for breaks, cracks, or dents.	Refer to Direct Support Maintenance.
		2. Inspect for leaking.	
	c. Hoses	1. Inspect for breaks, cracks, or bends.	
		2. Inspect for leaking.	
		3. Insure all hose clamps are tight.	

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Flush valve	Inspect for breaks, cracks, or leaking.	Refer to paragraph 4-21.
	e. Urinal	1. Inspect for breaks and cracks.	
		2. Inspect for leaks.	
		3. Insure all hardware is tight.	
	f. Flow switch	1. Inspect for breaks and cracks.	
		2. Inspect for proper operation.	
		3. Inspect for leaks.	
SERVICE			
2.			

CAUTION

Do not repeatedly flush the urinal during the cleaning operation as this will reduce the useful capacity of the holding tank. Flush urinal and observe flow of water from flush pipe. This unit is designed to spray all areas of the bowl. It may be necessary to use a small wire to unclog a clogged orifice if unevenness of spray is observed.

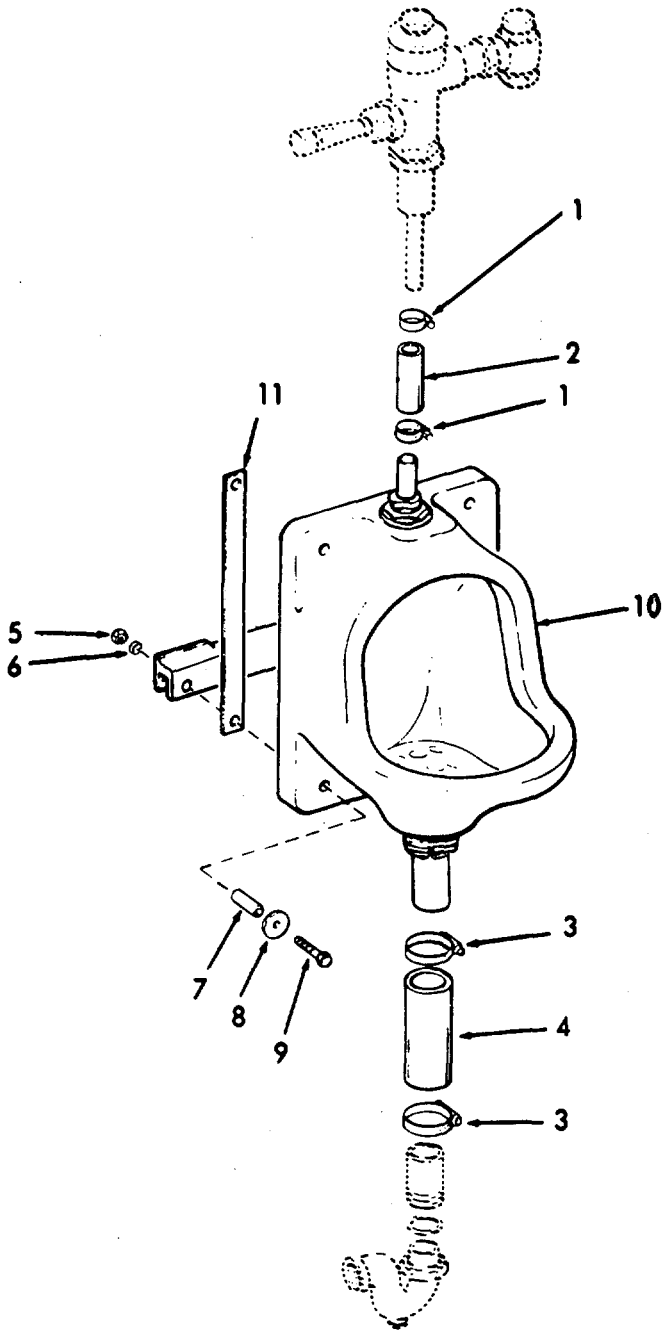
Urinals should receive daily janitorial cleaning service. Non-foaming household cleaners are suitable for this purpose.

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
		WARNING To prevent electrical shock and possible death, tag and disconnect circuit breaker on control circuit.	
3.	Flow switch	a. Flush water	Shut off valve.
		b. Wiring	Tag and disconnect.
		c. Piping	Disconnect.
4.	Urinal	a. Hose clamps (1)	Loosen.
		b. Hose (2)	Remove.
		c. Hose clamps (3)	Loosen.
		d. Hose (4)	Remove.
		e. Four retaining nuts (5), neoprene flatwashers (6), sleeve cushions (7), brass flatwashers (8), and bolts (9)	Remove.
		f. Urinal (10)	Remove. Use two persons.
		g. Two white neoprene strips (11)	Remove.

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			



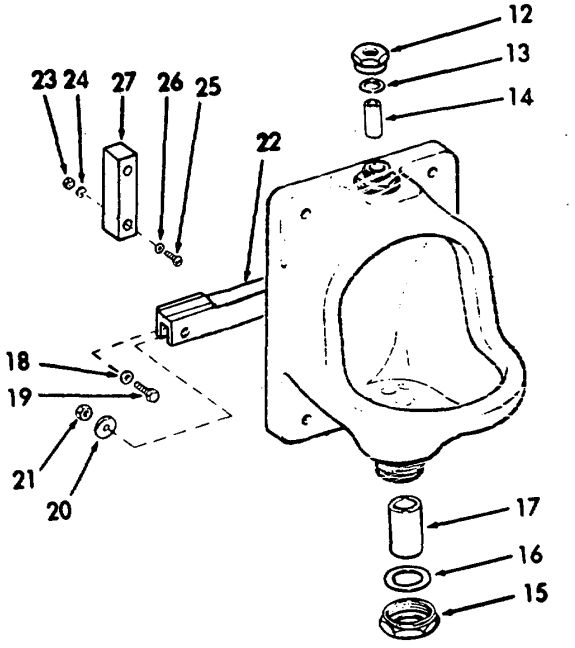
4-733

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5. Inlet Tail piece	a. Union ring (12)	Unscrew and remove.	
	b. Rubber gasket (13), and tail piece (14)	Remove.	
	c. Tail piece (14), rubber gasket (13), and union ring (12)	Install and tighten union ring (12).	
6. Outlet Tail piece	a. Union ring (15)	Unscrew and remove.	
	b. Rubber gasket (16), and tail piece (17)	Remove.	
	c. Tail piece (17), rubber gasket (16), and union ring (15)	Install and tighten union ring (15).	
7. Shock mounts	a. Nuts (18), lockwashers (19), screws (20), and washers (21)	Remove in three places on both shock mounts (22).	
	b. Shock mounts (22)	Remove and replace.	

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Screws (20), washers (21) lock-washers (19), and nuts (18)	Install in three places on both shock mounts (22).	
8. Concus-sion snubber	a. Nuts (23), lockwashers (24), screws (25), and flatwashers (26)	Remove in two places.	
	b. Concussion snubber (27)	Remove from urinal and replace.	
	c. Screws (25), flatwashers (26), lock-washers (24), and nuts (23)	Install in two places on concussion snubber (27).	



4-735

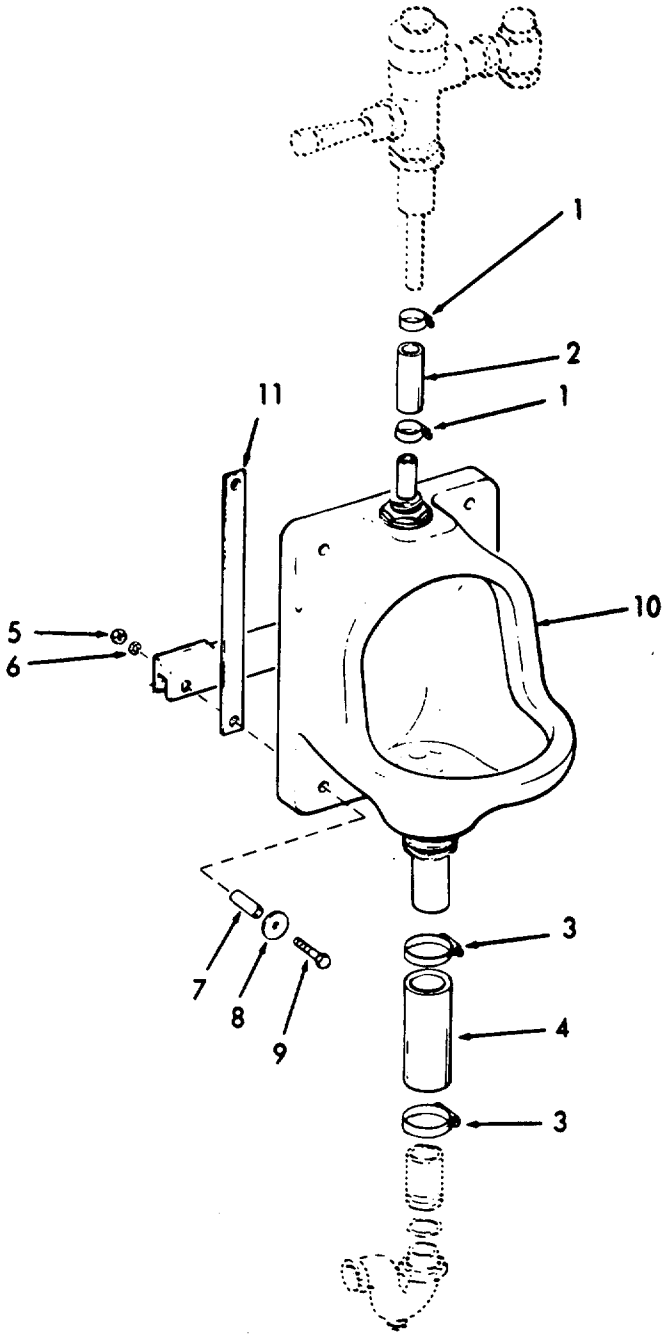
4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
9. Urinal	a. Two white neoprene strips (11), urinal (10), four cushion sleeves (7), brass flat-washers (8), and screws (9)	Assemble to bulkhead.	
	b. Neoprene flatwashers (6), and retaining nuts (5)	Install and tighten.	
	c. Hose (4), and hose clamps (3)	Install and tighten hose clamps.	
	d. Hose (2), and hose clamps (1)	Install and tighten hose clamps.	
10. Flow switch	a. Piping	Reconnect.	
	b. Wiring	Reconnect, remove tags.	
	c. Flush water	Turn on valve.	

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



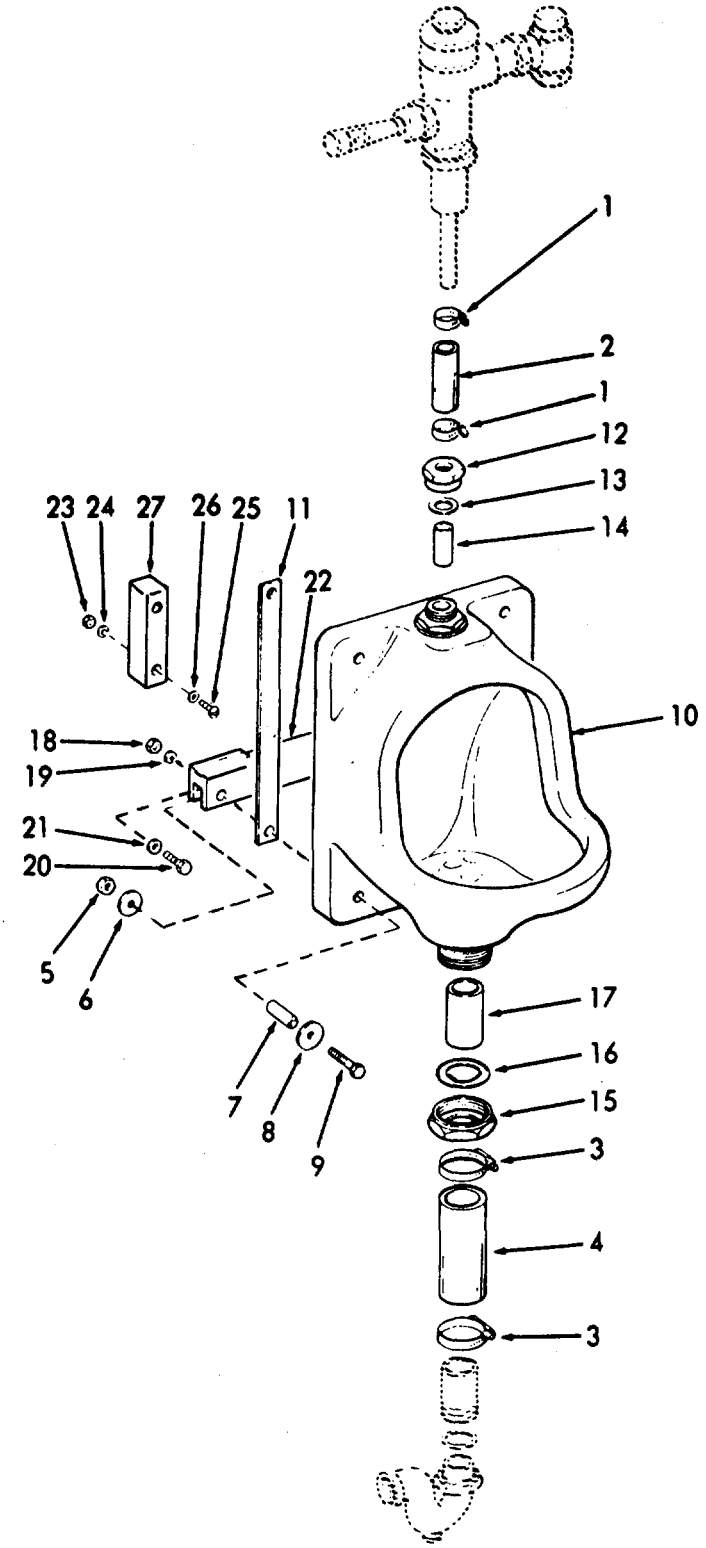
4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			

Urinal Legend

1. Hose clamps
2. Hose
3. Hose clamps
4. Hose
5. Retaining nuts
6. Neoprene flatwashers
7. Sleeve cushions
8. Brass flatwashers
9. Bolts
10. Urinal
11. White neoprene strips
12. Union ring
13. Rubber gasket
14. Tail piece
15. Union ring
16. Rubber gasket
17. Tail piece
18. Nuts
19. Lockwashers
20. Screws
21. Washers
22. Shock mounts
23. Nuts
24. Lockwashers
25. Screws
26. Flatwashers
27. Concussion snubber

4-20. URINAL - MAINTENANCE INSTRUCTIONS (Continued).



4-21. FLUSH VALVE - MAINTENANCE INSTRUCTIONS.

The flush valve (Sloan Valve Assembly) consists of three subassemblies: a manually operated flush valve, a control stop upstream, and a vacuum breaker downstream.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Piston repair kit
2-28-14942-16
Vacuum breaker kit
2-28-14938-16

Personnel Required

1

References

NONE

Equipment Condition Condition Description

NONE

Special Environmental Conditions

Observe WARNINGS in paragraph 4-15.

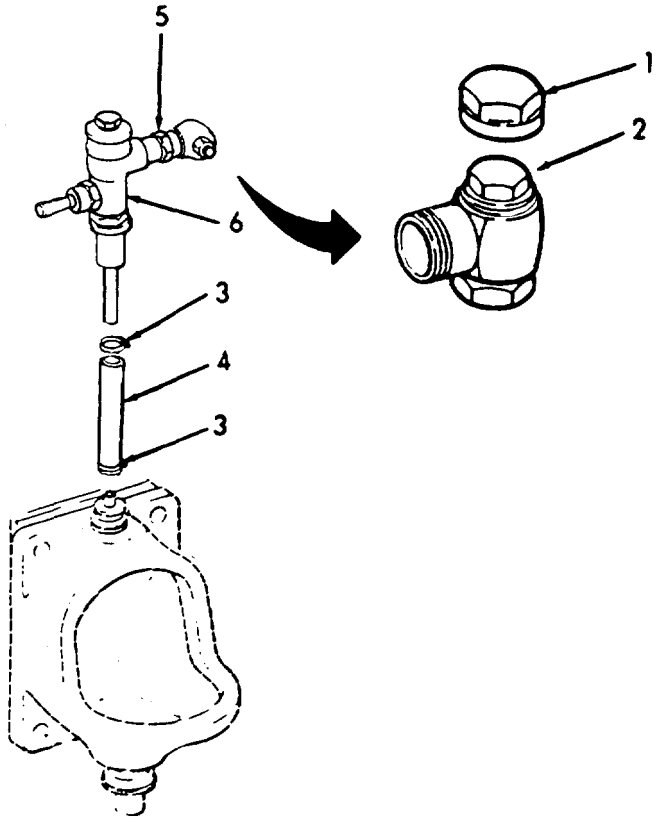
General Safety Instructions

Observe WARNINGS in paragraph 4-15.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Flush valve	a. Piping	Inspect for breaks, cracks, and leaks.	Refer to Direct Support Maintenance.
	b. Hoses	Inspect for breaks, cracks, and leaks.	
	c. Valve	Inspect for breaks, cracks, and leaks.	

4-21. FLUSH VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Cap (1)	Remove.	
	b. Shut-off screw (2)	Rotate to shut off water supply.	
	c. Hose clamps (3)	Loosen	
	d. Hose (4)	Remove.	
	e. Union nut (5)	Loosen.	
	f. Valve (6)	Remove.	

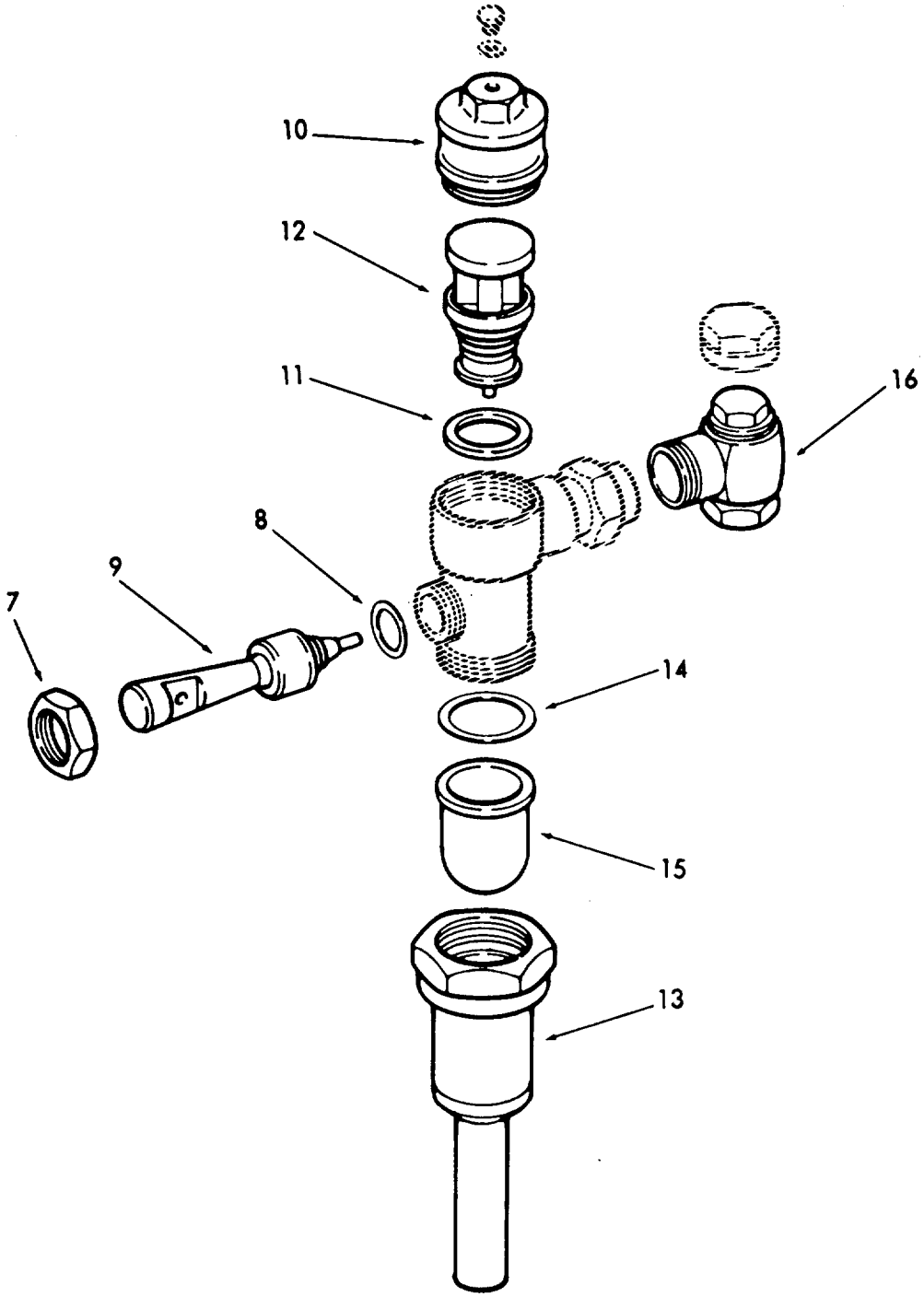


4-21. FLUSH VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3.	a. Retaining nut (7), and gasket (8)	Remove.	
	b. Handle (9) (9)	Remove.	
	c. Cap (10), and gasket (11)	Remove.	Discard gasket.
	d. Piston (12)	Remove.	Discard piston.
	e. Tail piece (13), and gasket (14)	Unscrew and remove.	Discard gasket.
	f. Vacuum breaker (15)	Remove.	Discard breaker.
	g. Inlet tee (16)	Remove.	If necessary.
	h. Vacuum breaker (15), gasket (14), and tail piece (13)	Install.	Use new gasket and breaker.
	i. Piston (12), gasket (11), and cap (10)	Install.	Use new gasket and piston.
	j. Handle (9)	Insert.	
	k. Gasket (8), and retaining nut (7)	Install.	

4-21. FLUSH VALVE - MAINTENANCE INSTRUCTIONS (Continued).

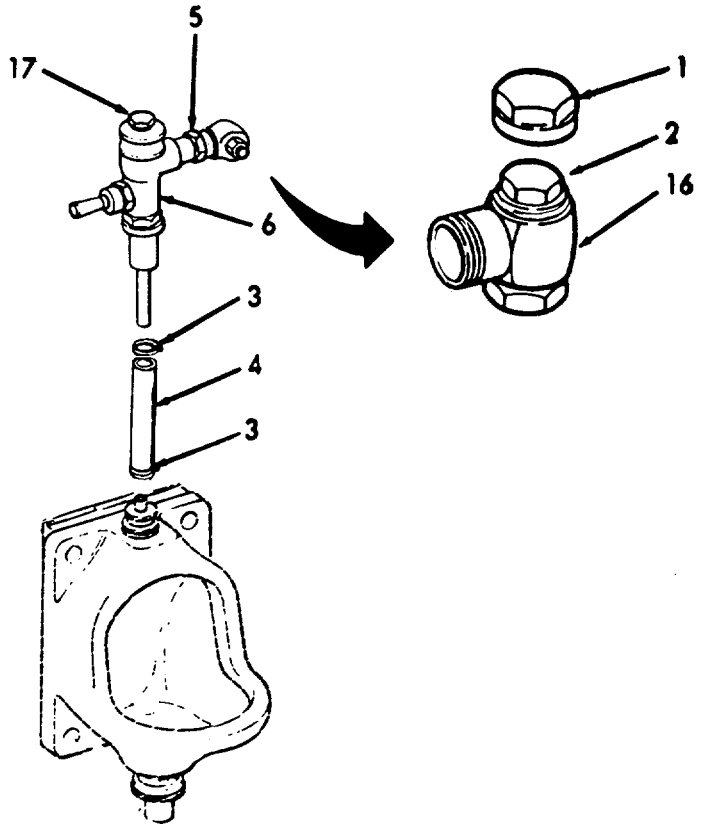
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-743

4-21. FLUSH VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
4.	a. Valve (6)	Install on tee (16).	
	b. Union nut (5)	Tighten.	
	c. Hose (4), and hose clamps (3)	Install.	
	d. Hose clamps (3)	Tighten.	
	e. Shut-off screw (2)	Rotate to turn on water supply.	
	f. Cap (1)	Remove.	
	g. Volume screw (17)	Adjust for proper amount of water flow.	



4-22. HEATING, VENTILATION AND AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS.

The following is an index to the maintenance procedures.

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
Arbor press
Bearing puller

Equipment Condition
Condition Description
NONE

Material/Parts
Oil - light machine

Special Environmental Conditions
NONE

Personnel Required
4

General Safety Instructions
Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent death or possible injury, tag and place circuit breaker in the OFF position.

INSPECTION

1. Fan	a. Wiring	Inspect for breaks, cracks, and defective insulation.	
	b. Fan	1. Inspect for loose hardware	
		2. Check for vibration.	
		3. Inspect for dirt accumulations.	

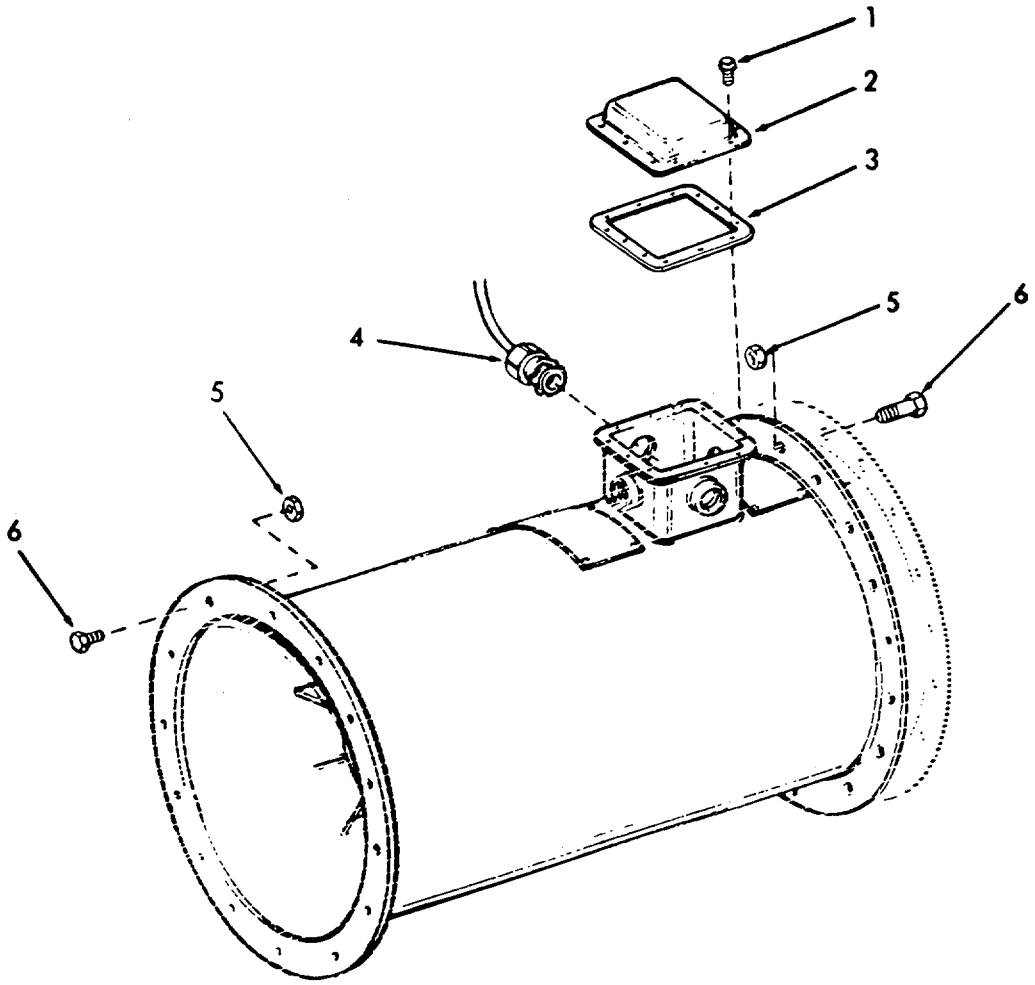
4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1)	Remove.	
	b. Conduit box cover (2), and gasket (3)	Remove.	
	c. Wiring	Tag and disconnect.	
	d. Coupling (4)	Disconnect.	
		WARNING In order to avoid personal injury and damage to the equipment, obtain help to hold the fan while disconnecting ducts.	
	e. Nuts (5), and screws (6)	Remove.	On both ends-total 28 places.
	f. Fan	1. Lower to deck. 2. Block to prevent rolling.	
SERVICING			
3.		Clean interior of housing and wheel assembly.	

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

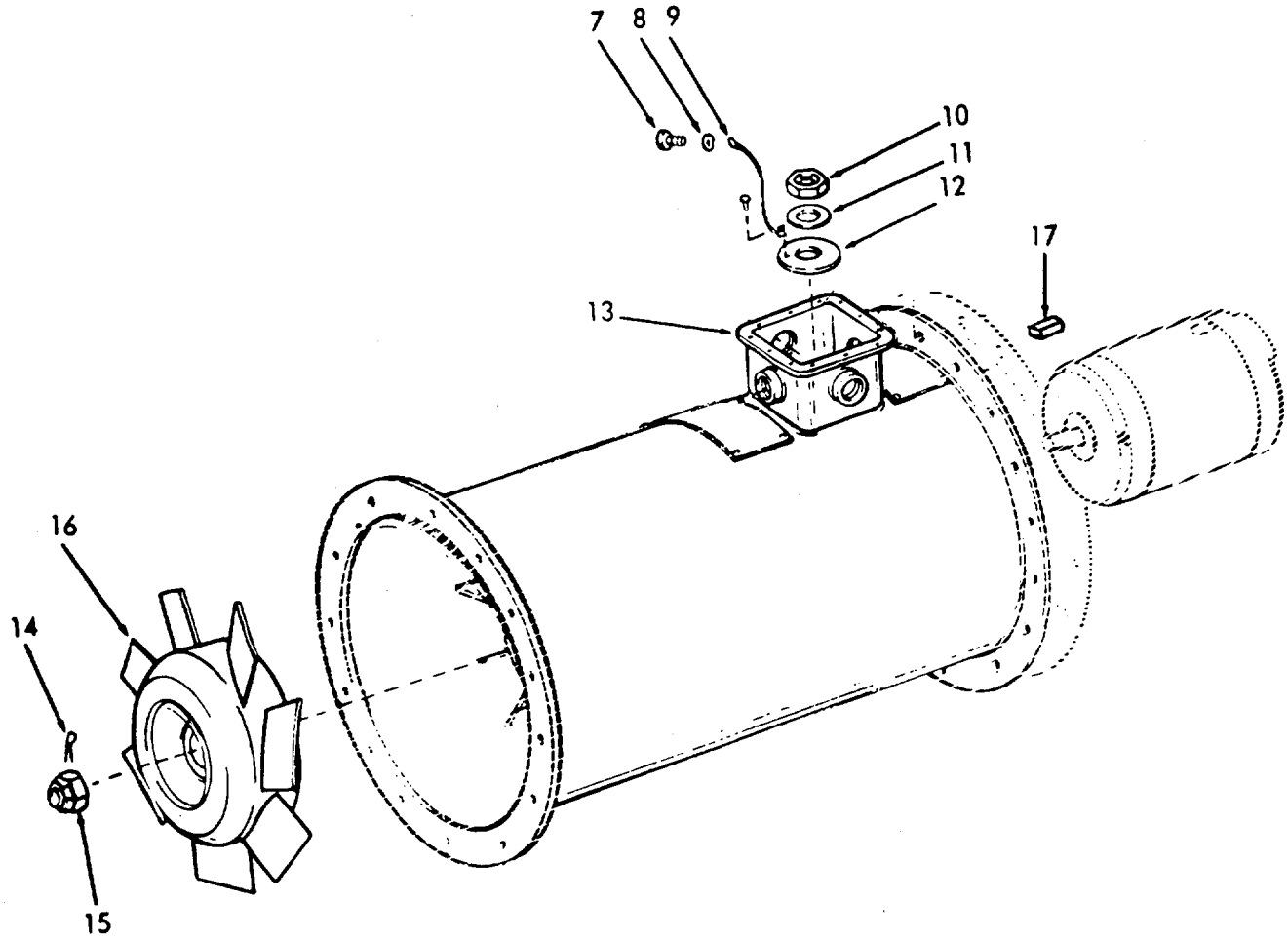


4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Fan	a. Screw (7) and lock-washer (8)	Remove.	
	b. Ground wire (9)	Move.	
	c. Nut (10), copper washer (11), and conduit gasket (12)	Remove.	
	d. Conduit box (13)	Remove.	Do not damage wiring.
	e. Cotter pin (14) and castle nut (15)	Remove.	
	f. Wheel assembly (16)	Remove carefully.	
	g. Key (17)	Remove.	
	h. Wheel assembly (16) and key (17)	Install.	a. Clean the base of the wheel. b. Lightly coat with oil. c. Slide wheel on shaft d. Adjust wheel in housing so there is equal clearance between tips of blade and inside of housing.

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)		e. Motor might have to be shimmed or moved to one side.	

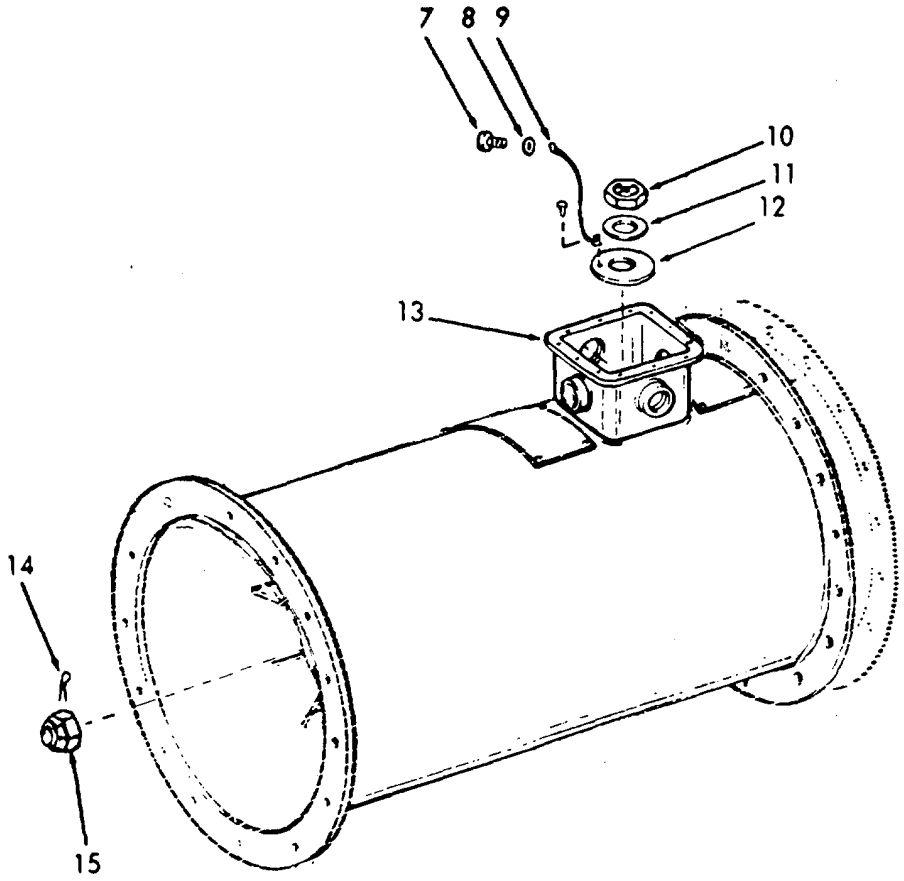


4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Castle nut (15), and cotter pin (14)	Install.	
	j. Conduit box (13)	Locate on fan housing and cable.	
	k. Conduit gasket (12), copper washer (11), and nut (10)	Install.	
	l. Ground wire (9), screw (7), and lockwasher (8)	Install.	
	m. Installation	Complete.	Refer to step 7.

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

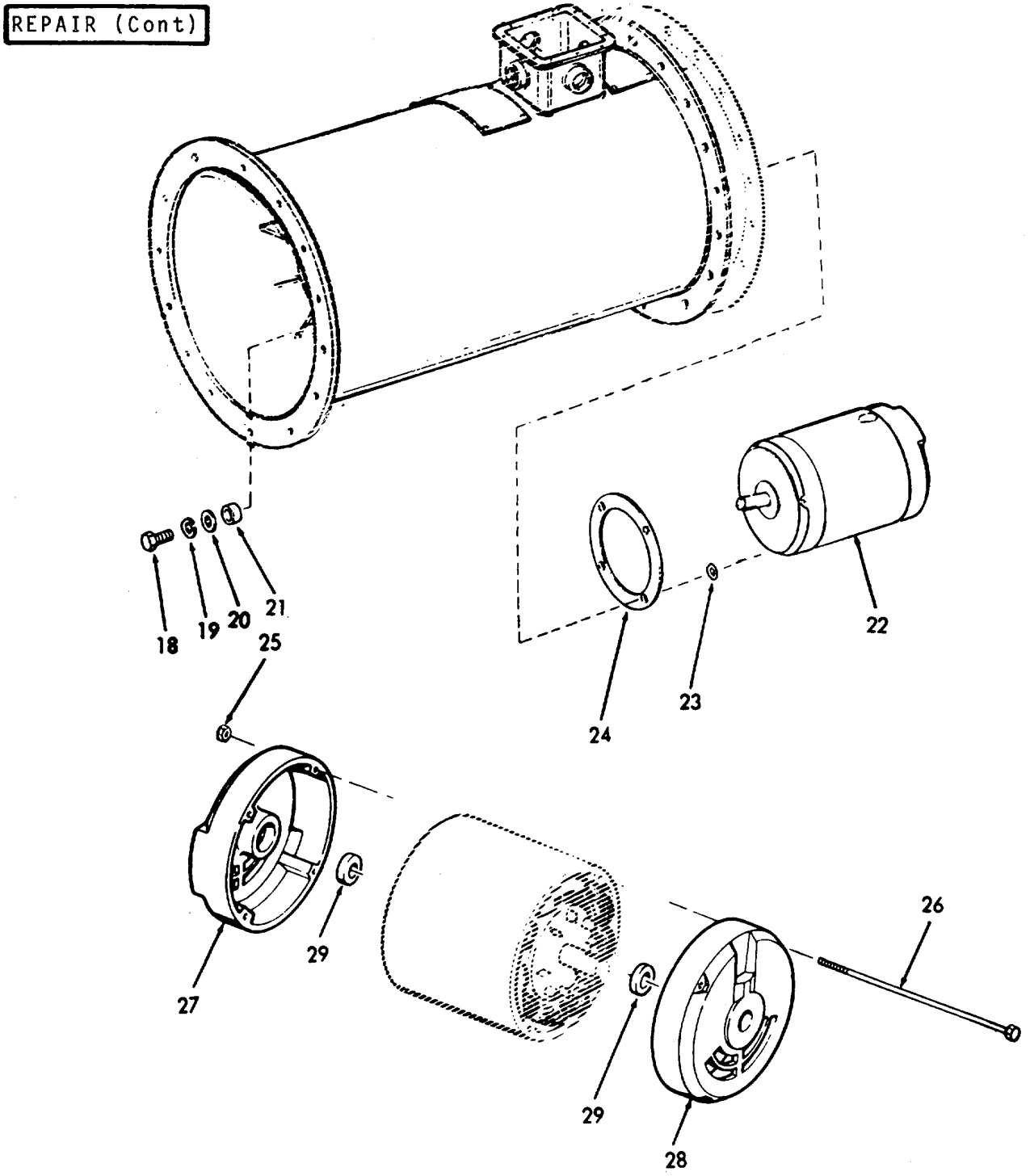


4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
5. Motor	a.	Fan	Remove.	Refer to step 4.
	b.	Screws (18), lock-washers (19), flat-washers (20), and bushings (21)	Remove.	
	c.	Motor (22), washers (23), and gasket (24)	Remove.	
	d.	Nuts (25), and thru bolts (26)	Remove.	
	e.	End shields (27 and 28)	Remove.	
	f.	Bearings (29)	Remove.	Use bearing puller.
	g.	Bearings (29)	Install.	Use arbor press.
	h.	End shields (27 and 28), thru bolts (26), and nuts (25)	Install.	

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

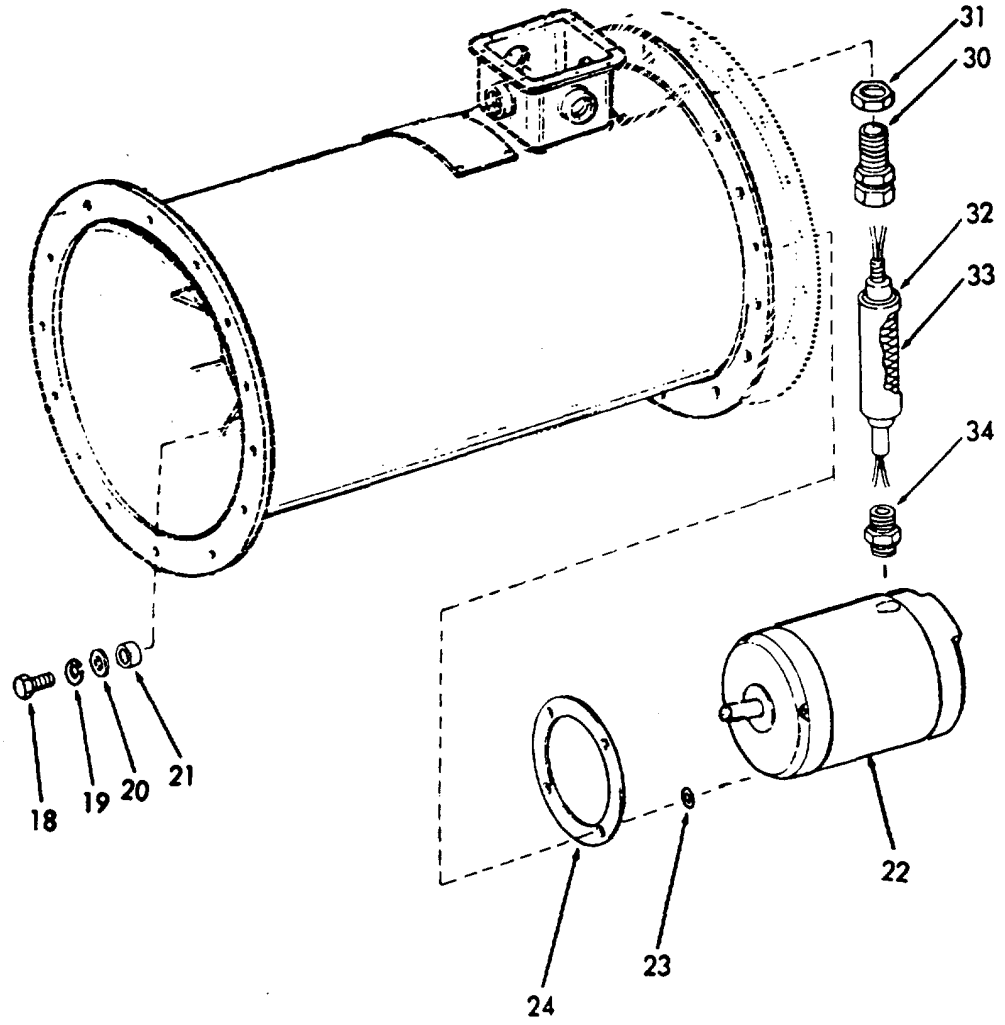


4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	i.	Motor (22), washers (23), and gasket (24)	Install.	
	j.	Bushings (21), flat-washers (20), lock-washers (19) ,and screws (18)	Install.	
	k.	Fan	Install	Refer to step 4.
6. Conduit assembly	a.	Fitting (30)	Remove.	
	b.	Adjust-ing nut (31)	Remove.	If necessary.
	c.	Rubber sleeve (32)	Remove.	
	d.	Motor end shields	Remove.	Refer to step 5d.
	e.	Wiring	Tag and disconnect.	
	f.	Wiring and braid sheath (33)	Remove.	

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Nipple (34)	Remove.	If necessary.
	h. Conduit Assembly	Reassemble and install.	

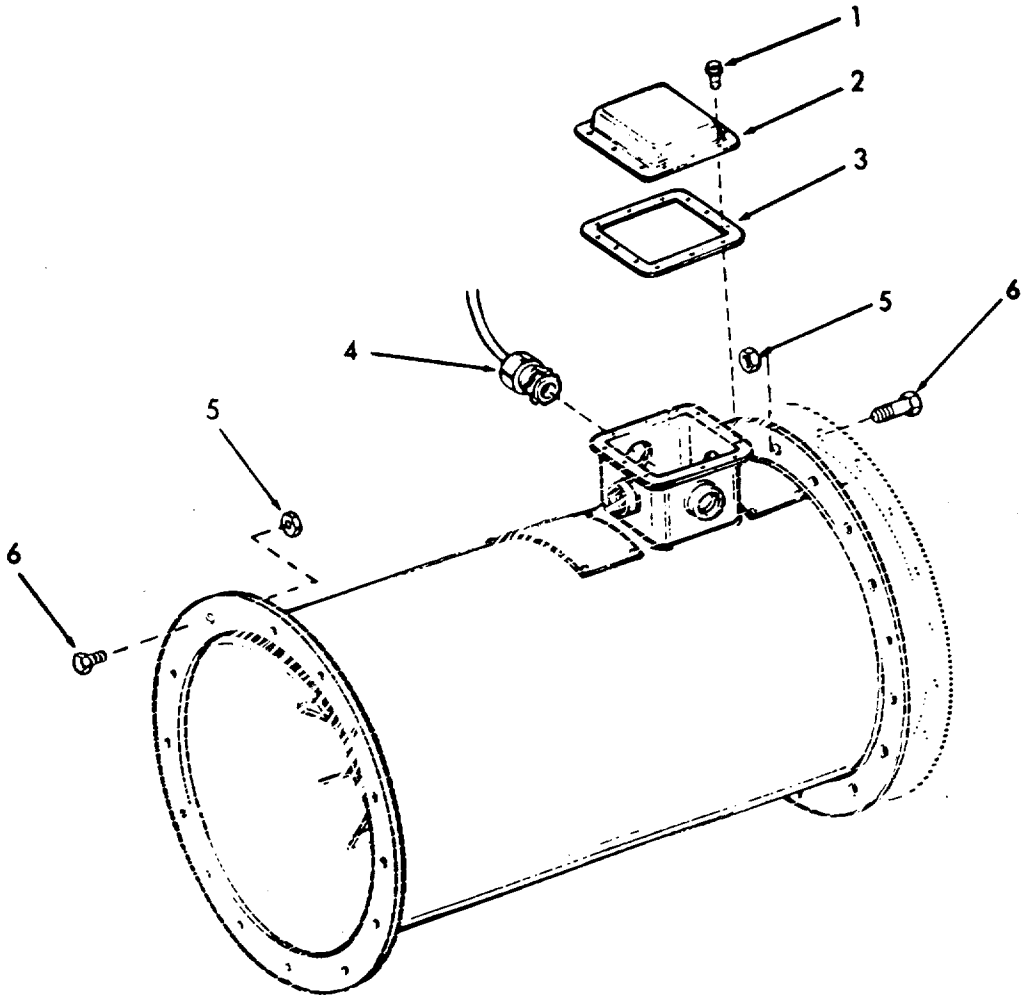


4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
INSTALLATION				
	WARNING In order to avoid personal injury and damage to the equipment, obtain help to hold the fan while disconnecting ducts.			
7. Fan	a.	Fan	Raise to desired position.	
	b.	Screws (6), and nuts (5)	Install.	In 28 places.
	c.	Coupling (4)	Install.	
	d.	Wiring	Reconnect. Remove tags.	
	e.	Gasket (3), conduit box cover (2), and screws (1)	Install.	

4-23. HVAC SUPPLY FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS.

The only duct maintenance, outside of inspection, is the cleaning of the range hood filter and air screens.

This task covers:

a. Inspection b. Service

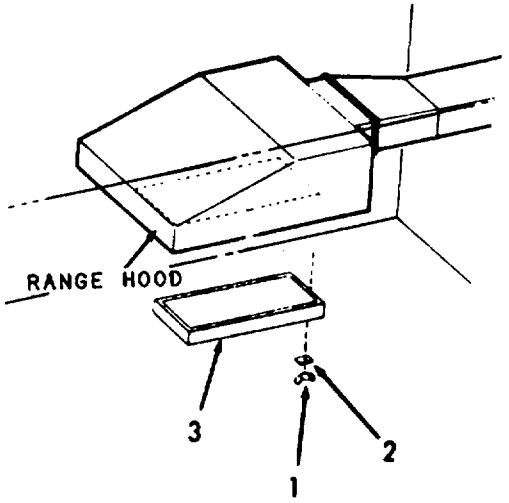
INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition** / **Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
Detergent Hot water	NONE
Personnel Required	**General Safety Instructions**
1	NONE

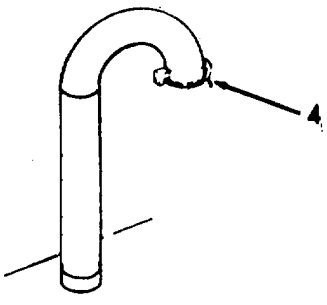
LOCATION	ITEM		ACTION	REMARKS
INSPECTION				
1. Ducts	a.	Ducts	Inspect for accumulation of dirt.	
	b.	Range hood	Inspect for accumulation of grease.	
SERVICE				
2. Range	a.	Wing nuts (1), and retainers (2)	Remove.	

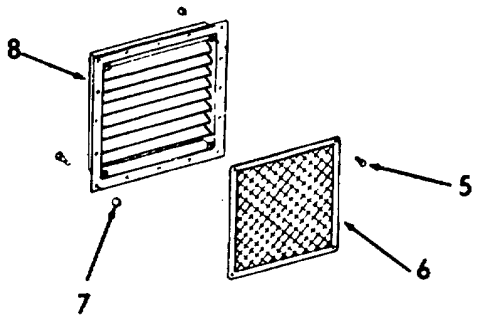
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	b. Grease Filter (3)	1. Remove. 2. Clean.	Use a detergent and hot water to dissolve grease.



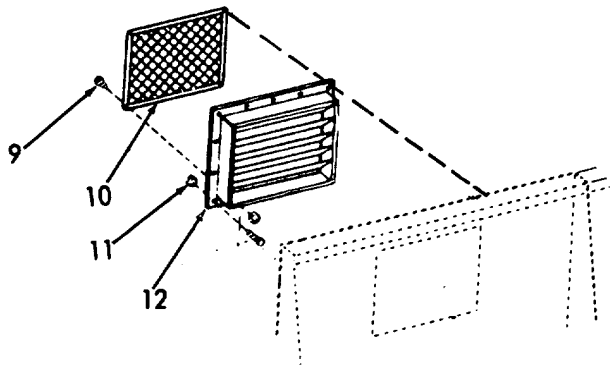
3. Air intake vents	Watertight cover (4)	1. Remove. 2. Clean.	
4. Airlift intakes	a. Screws (5)	Remove.	
	b. Screen (6)	1. Remove. 2. Clean.	
	c. Nuts (7)	Remove.	
	d. Louver (8)	1. Remove. 2. Clean.	





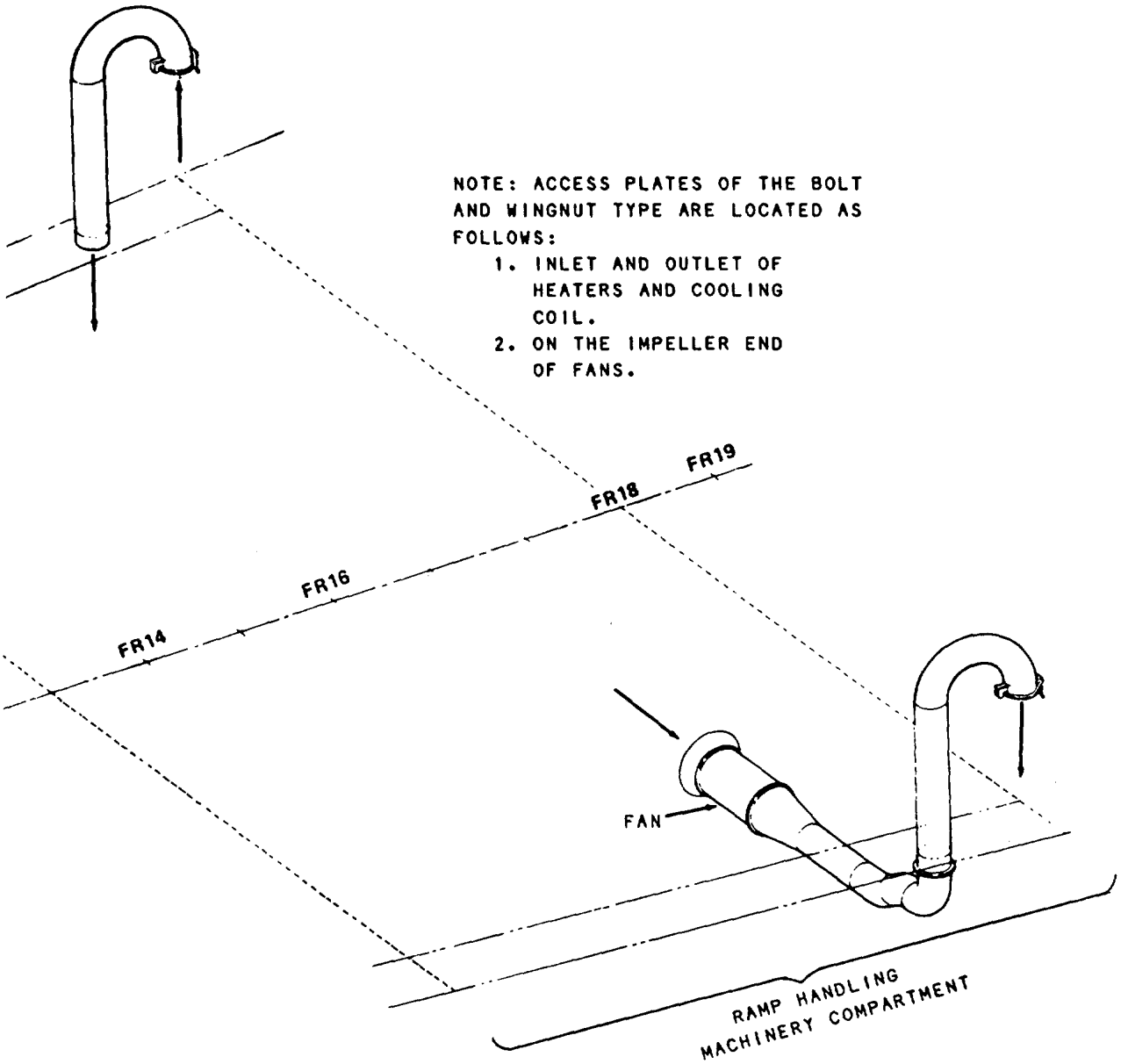
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM		ACTION	REMARKS
SERVICE (Cont)				
5. Exhaust outlets	a.	Screws (9)	Remove.	
	b.	Screen (10)	1. Remove. 2. Clean.	
	c.	Nuts (11)	Remove.	
	d.	Louver (12)	1. Remove. 2. Clean.	



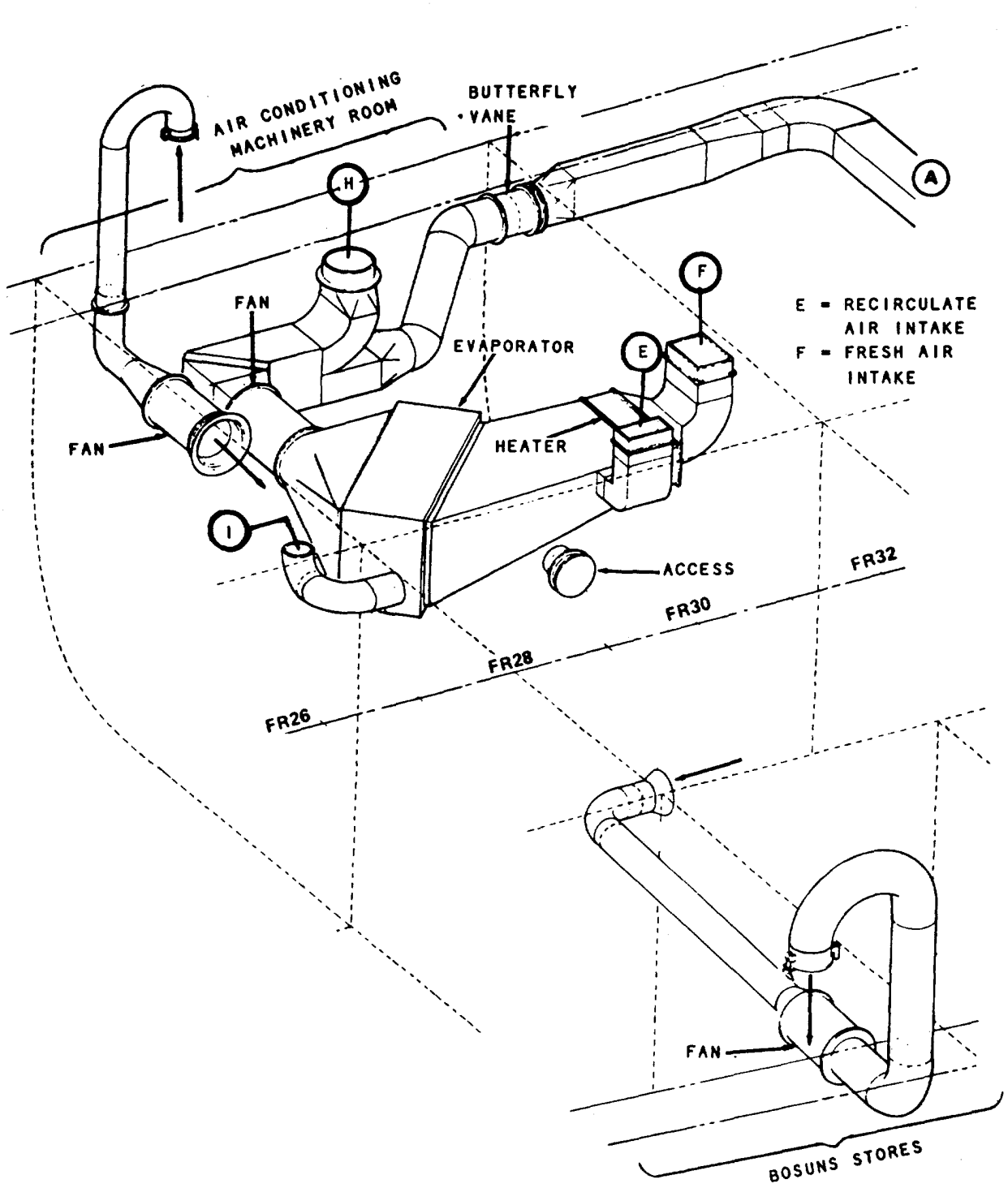
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



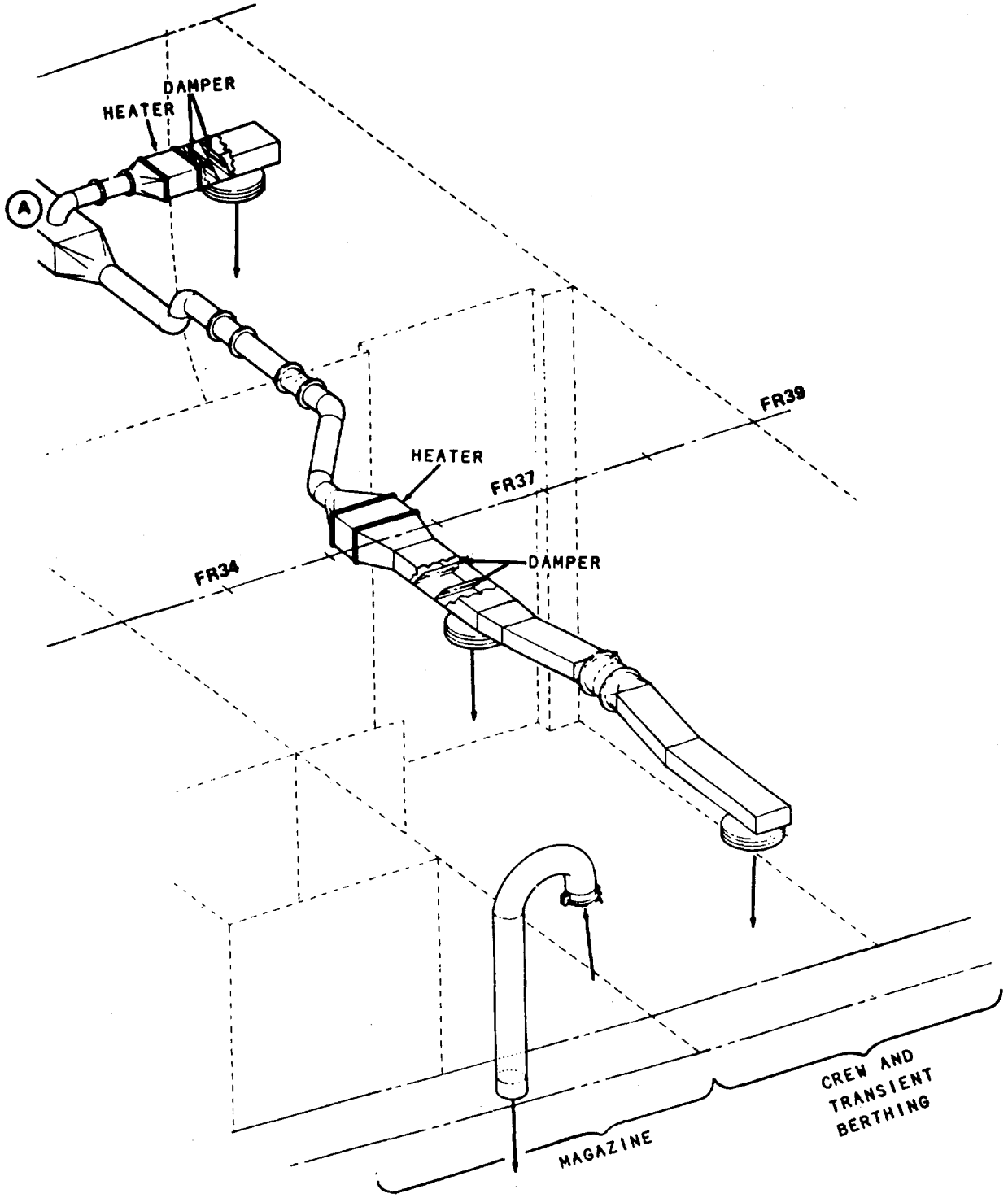
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



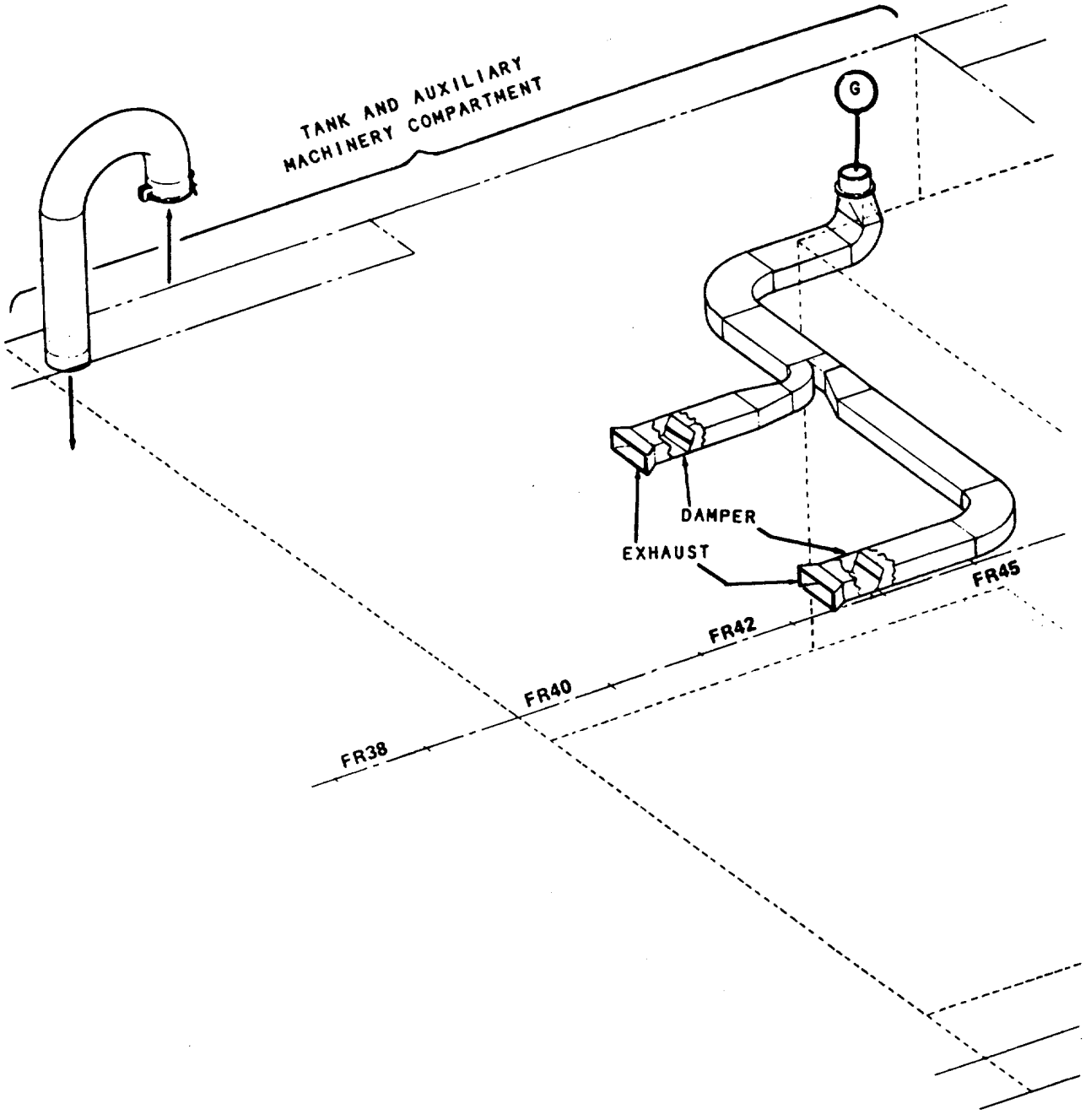
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



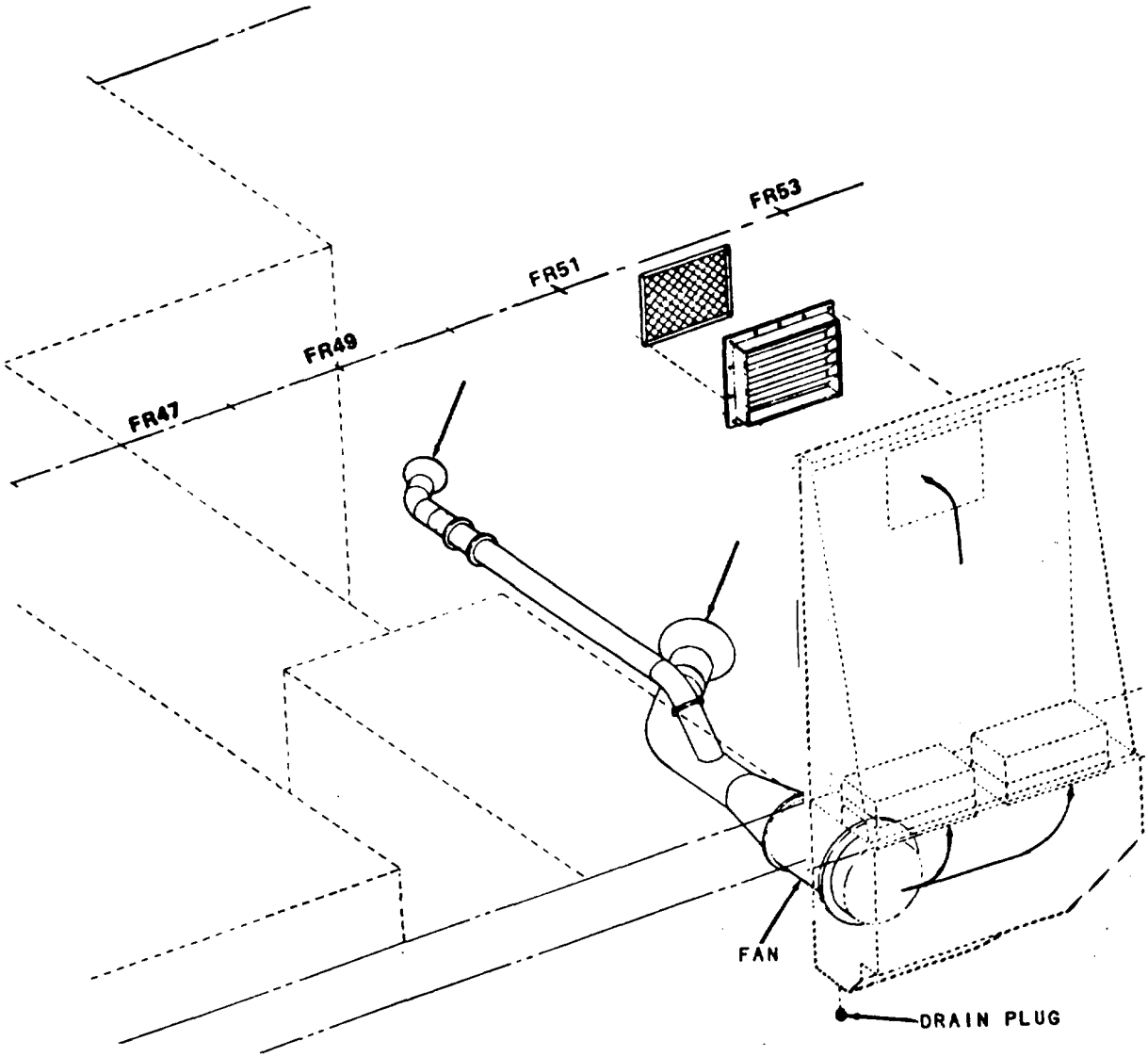
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



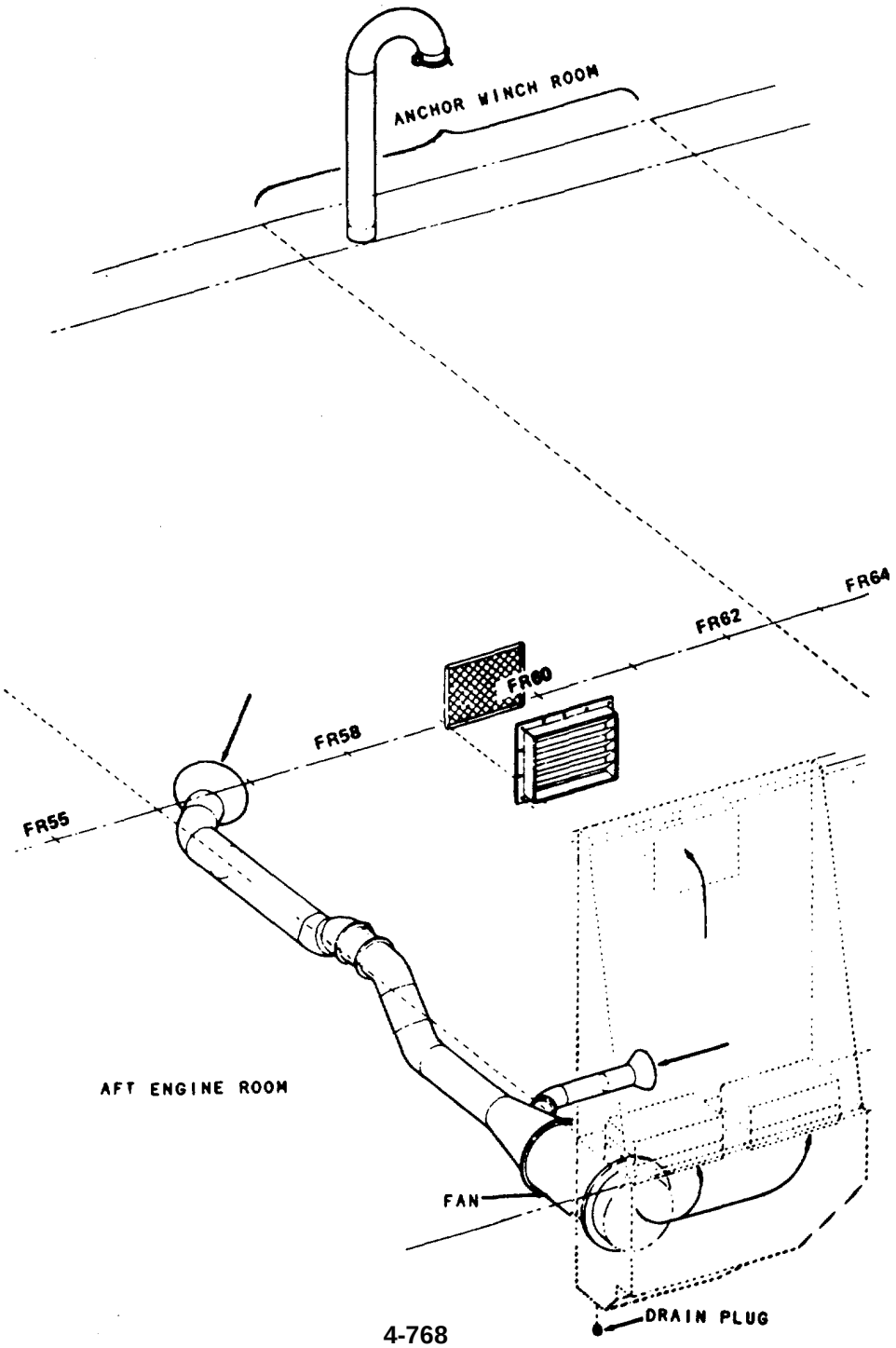
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

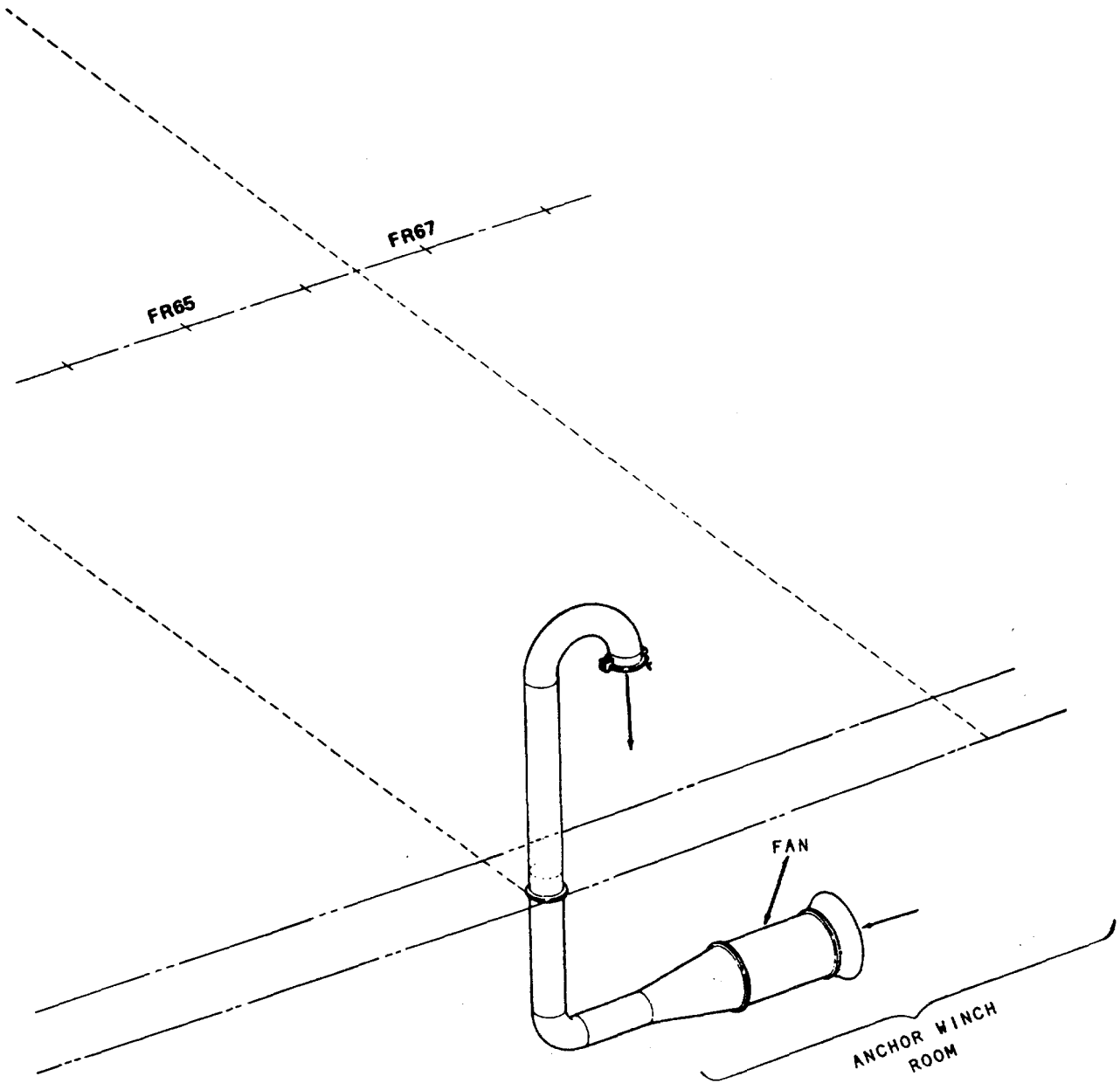
LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-768

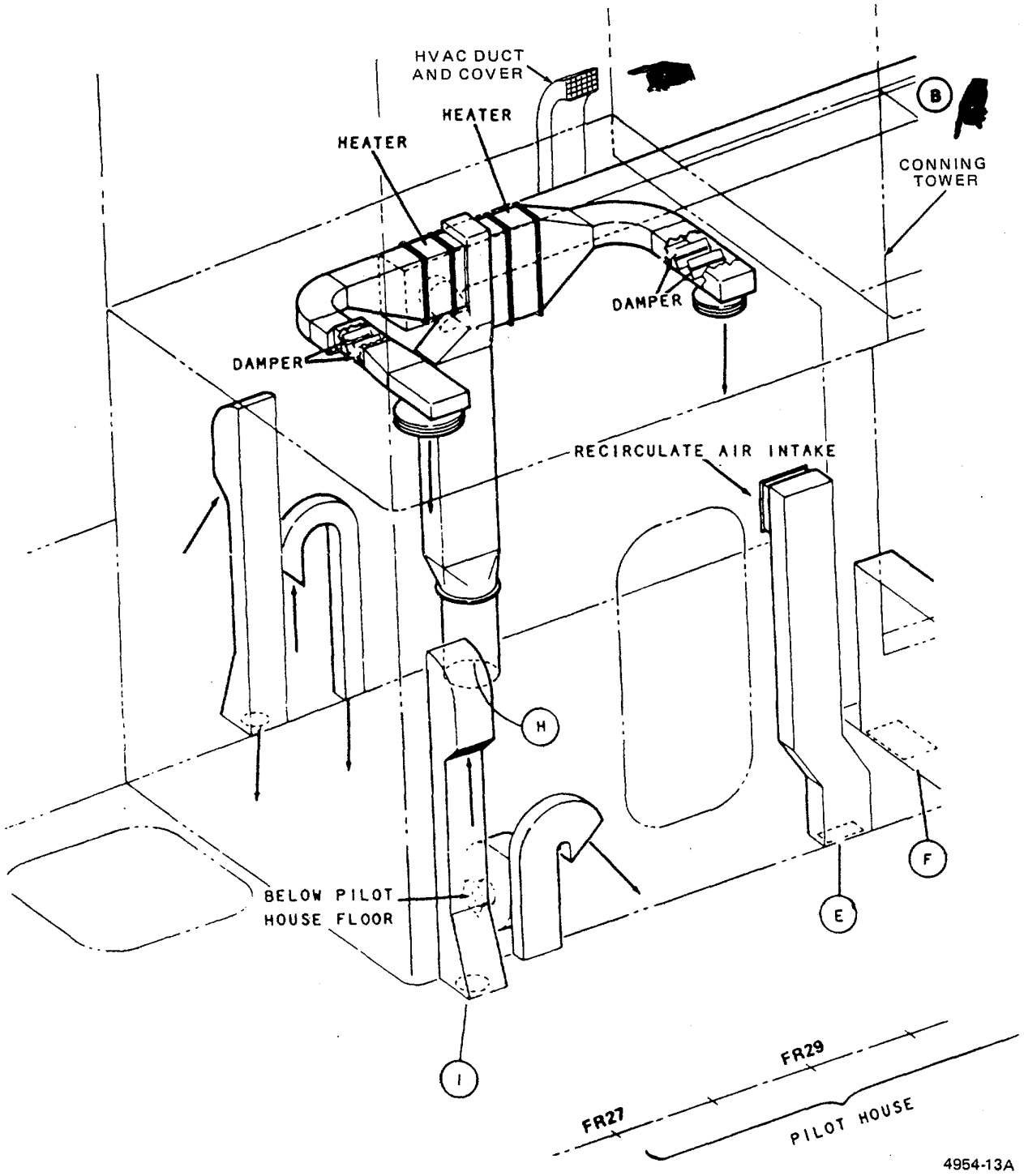
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



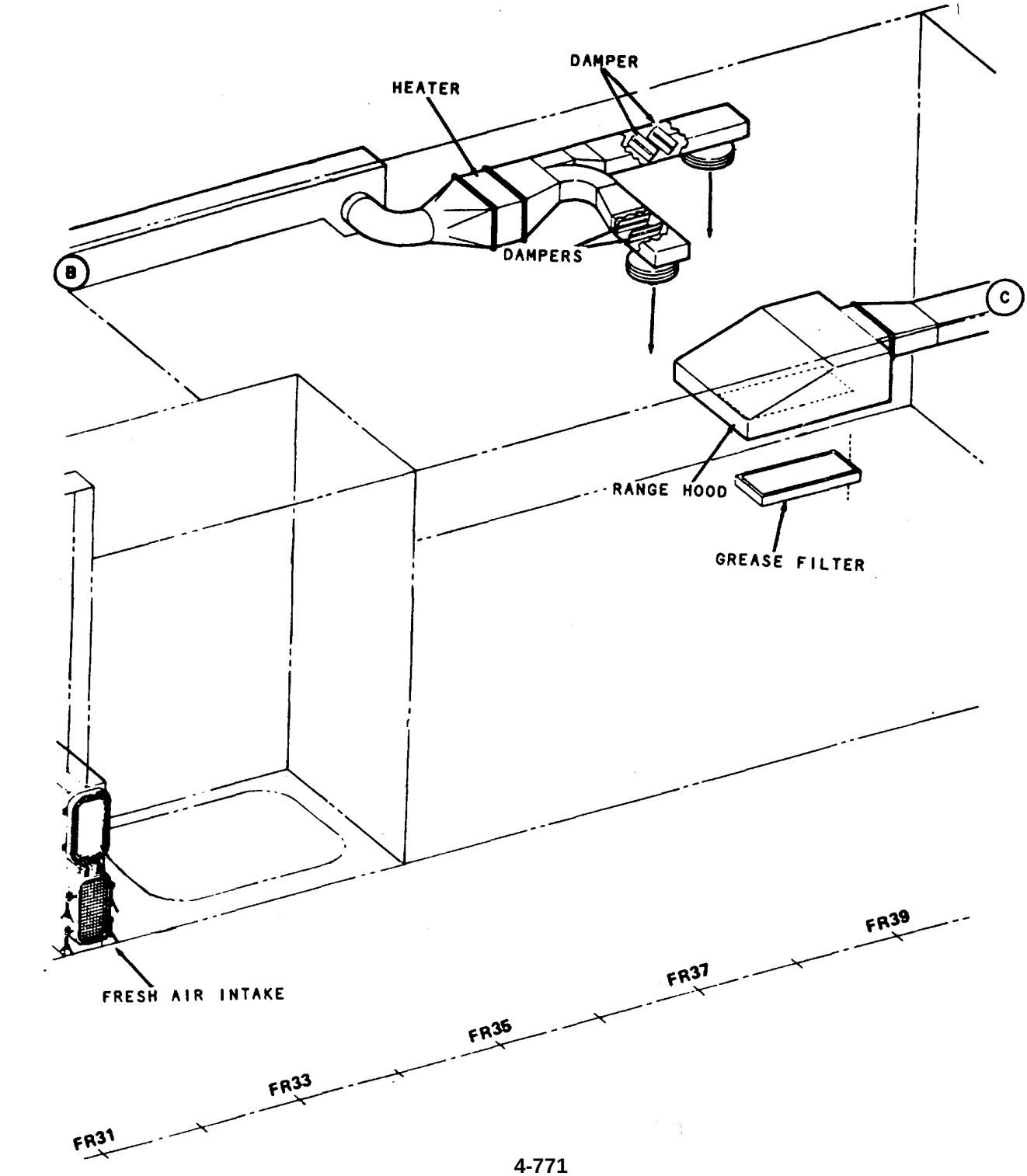
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



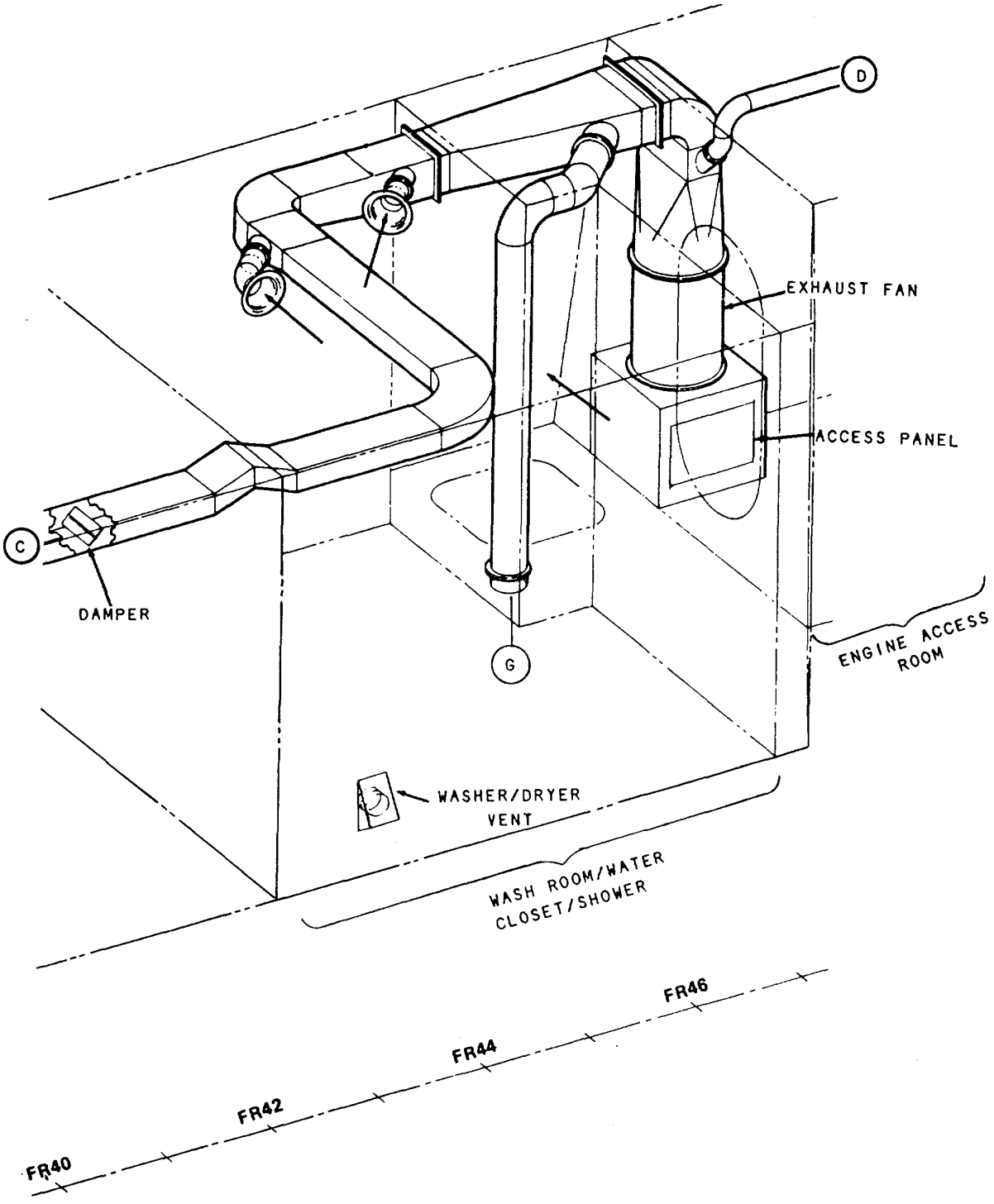
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



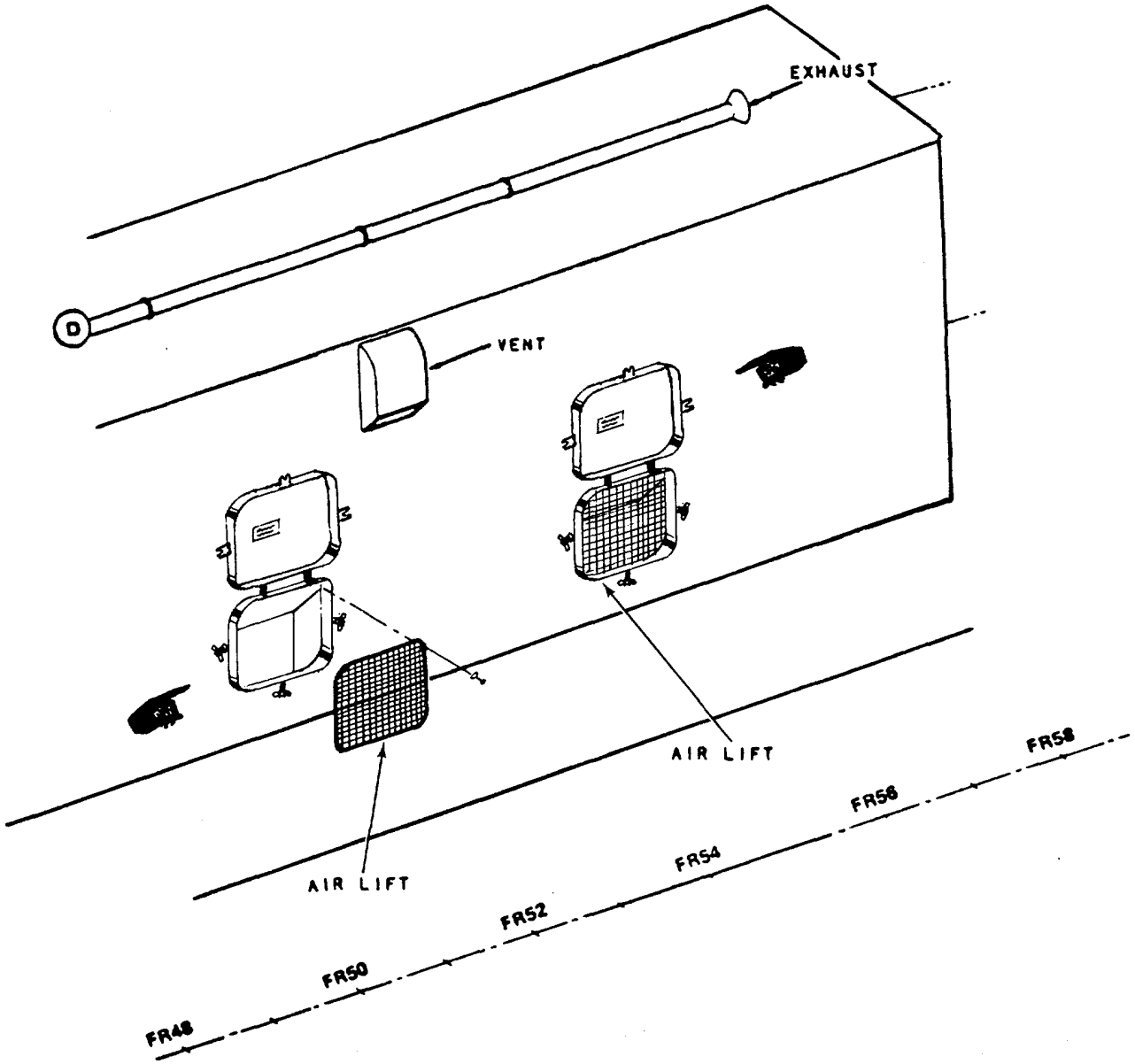
4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-24. HVAC DUCTING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Arbor press
Bearing puller

Equipment Condition: Condition Description

NONE

Material/Parts

Oil - light machine

Special Environmental Conditions

NONE

Personnel Required

4

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent death or possible injury, tag and place circuit breaker in the OFF position.

INSPECTION

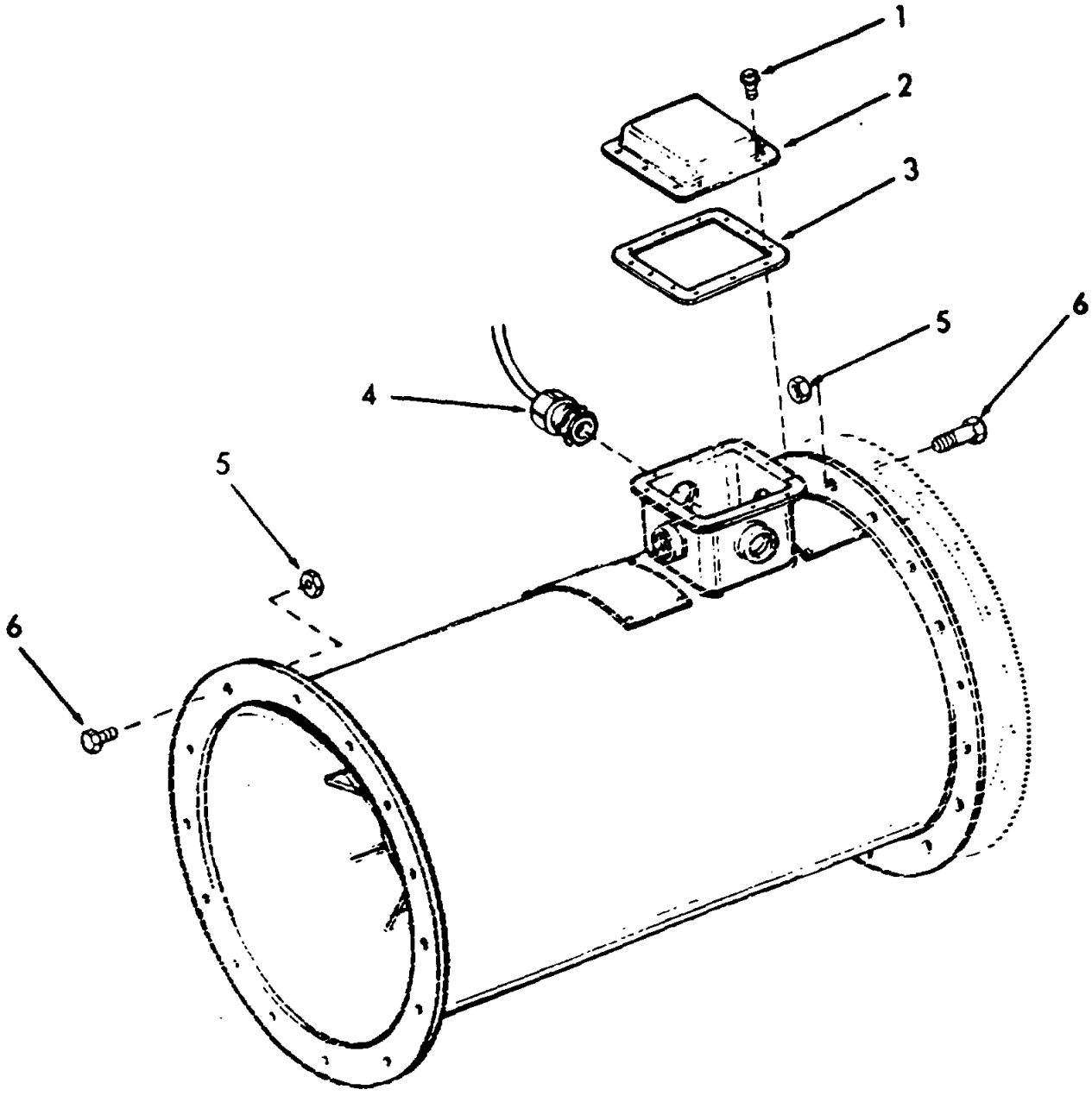
1. Fan	a. Wiring	Inspect for breaks, cracks, and defective insulation.	
	b. Fan	1. Inspect for loose hardware	
		2. Check for vibration.	
		3. Inspect for dirt accumulations.	

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1)	Remove.	
	b. Conduit box cover (2), and gasket (3)	Remove.	
	c. Wiring	Tag and disconnect.	
	d. Coupling (4)	Disconnect.	
		WARNING In order to avoid personal injury and damage to the equipment, obtain help to hold the fan while disconnecting ducts.	
	e. Nuts (5), and screws (6)	Remove.	On both ends-total 28 places.
	f. Fan	1. Lower to deck. 2. Block to prevent rolling.	
SERVICING			
3.		Clean interior of housing and wheel assembly.	

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

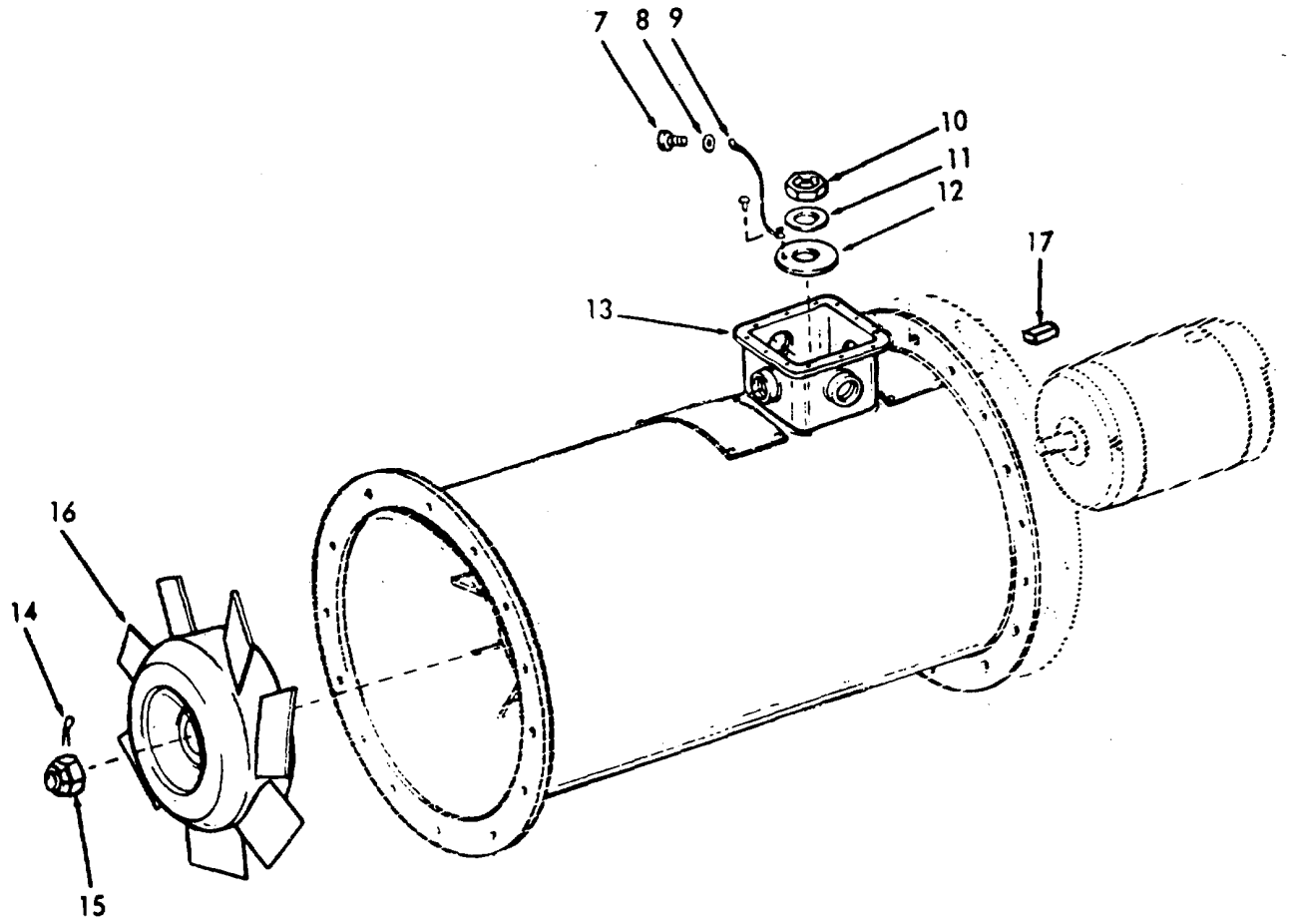


4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Fan	a. Screw (7) and lockwasher (8)	Remove.	
	b. Ground wire (9)	Move.	
	c. Nut (10), copper washer (11), and conduit gasket (12)	Remove.	
	d. Conduit box (13)	Remove.	Do not damage wiring.
	e. Cotter pin (14) and castle nut (15)	Remove.	
	f. Wheel assembly (16)	Remove carefully.	
	g. Key (17)	Remove.	
	h. Wheel assembly (16) and key (17)	Install.	a. Clean the base of the wheel. b. Lightly coat with oil. c. Slide wheel on shaft d. Adjust wheel in housing so there is equal clearance between tips of blade and inside of housing.

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			e. Motor might have to be shimmed or moved to one side.

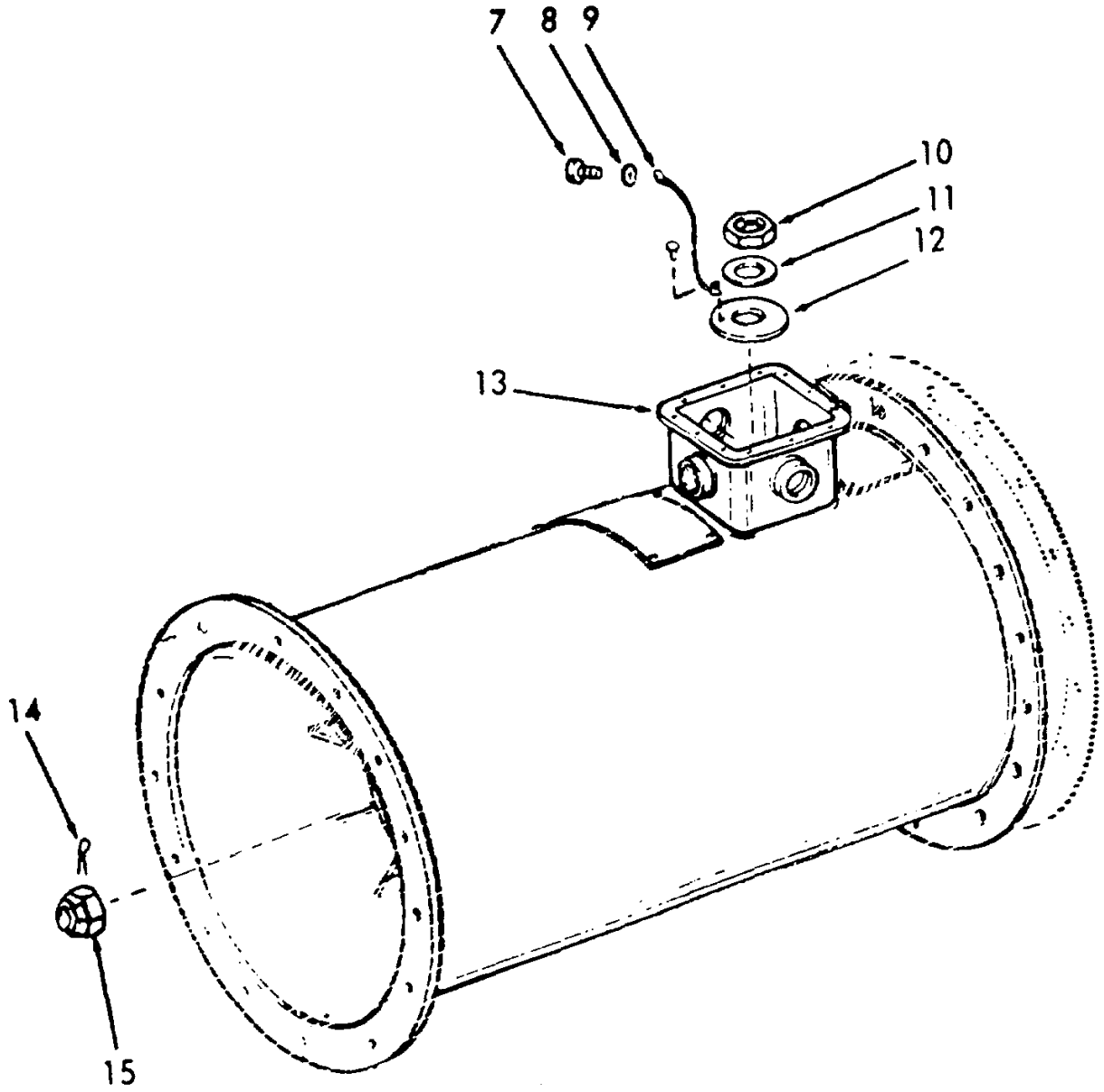


4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Castle nut (15), and cotter pin (14)	Install.	
	j. Conduit box (13)	Locate on fan housing and cable.	
	k. Conduit gasket (12), copper washer (11), and nut (10)	Install.	
	l. Ground wire (9), screw (7), and lockwasher (8)	Install.	
	m. Instal-lation	Complete.	Refer to step 7.

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

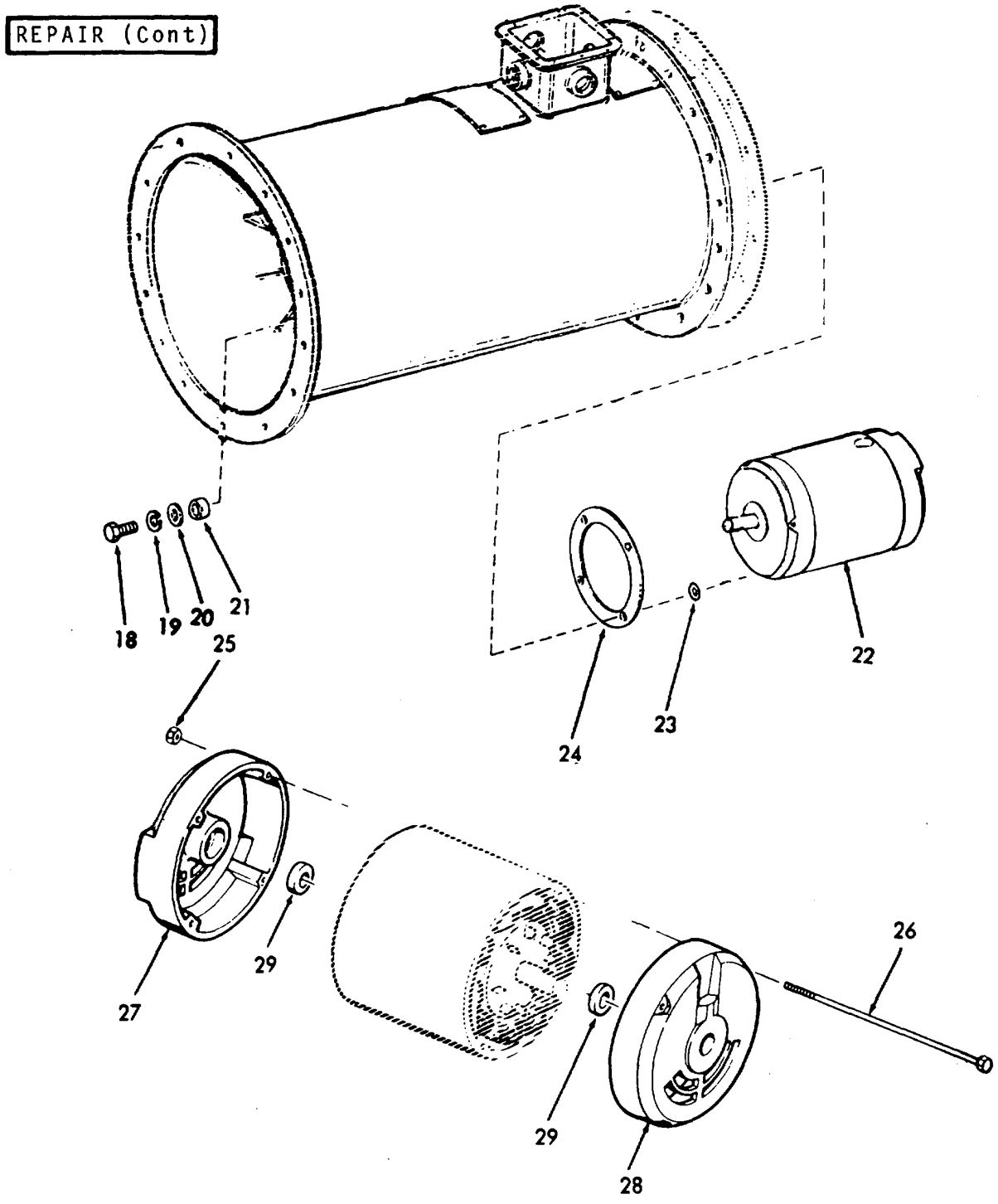


4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Motor	a. Fan	Remove.	Refer to step 4.
	b. Screws (18), lock-washers (19), flat-washers (20), and bushings (21)	Remove.	
	c. Motor (22), washers (23), and gasket (24)	Remove.	
	d. Nuts (25), and thru bolts (26)	Remove.	
	e. End shields (27 and 28)	Remove.	
	f. Bearings (29)	Remove.	Use bearing puller.
	g. Bearings (29)	Install.	Use arbor press.
	h. End shields (27 and 28), thru bolts (26), and nuts (25)	Install.	

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

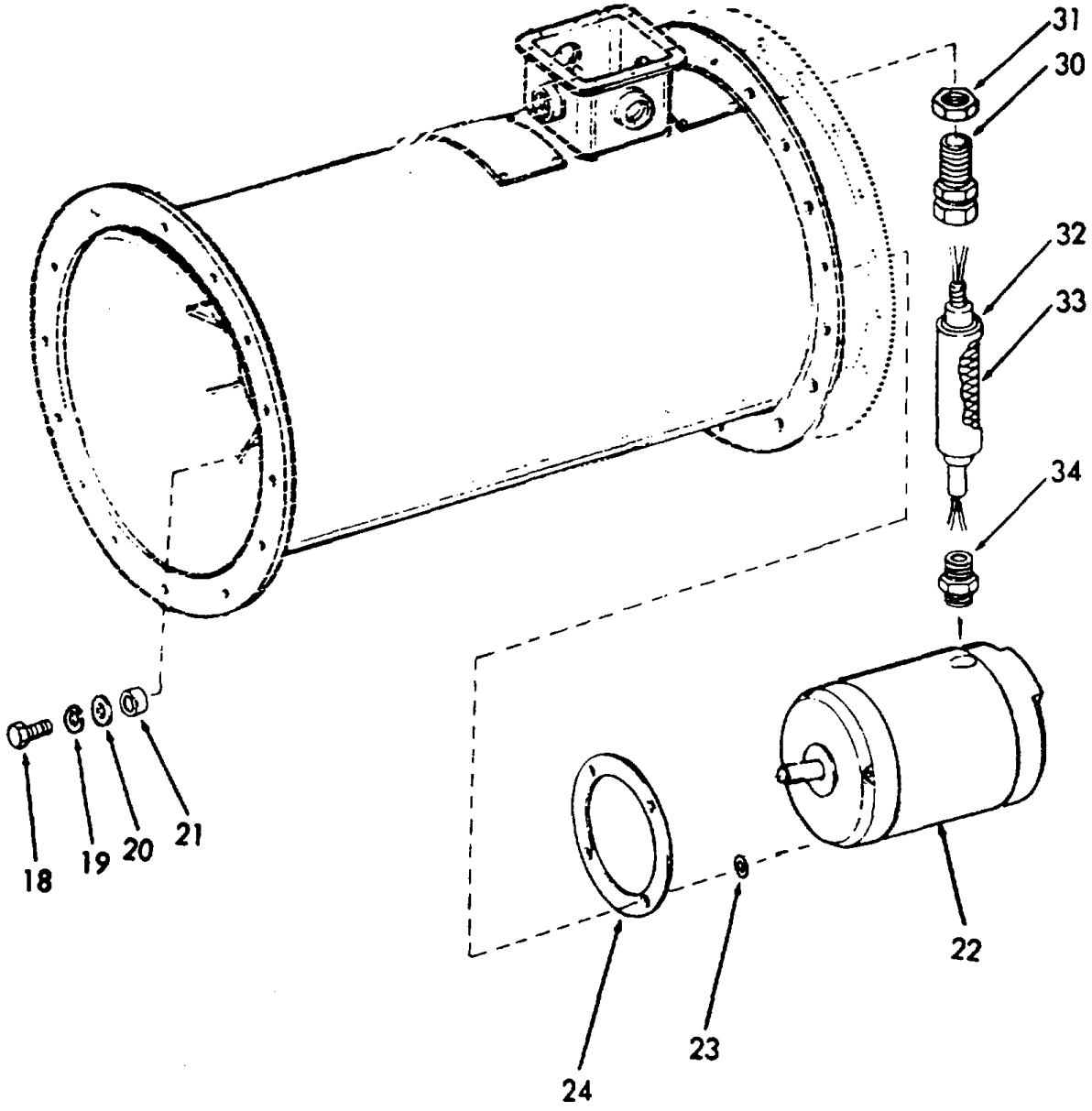


4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Motor (22), washers (23), and gasket (24)	Install.	
	j. Bushings (21), flat-washers (20), lock-washers (19) ,and screws (18)	Install.	
	k. Fan	Install.	Refer to step 4.
6. Conduit assembly	a. Fitting (30)	Remove.	
	b. Adjust-ing nut (31)	Remove.	If necessary.
	c. Rubber sleeve (32)	Remove.	
	d. Motor end shields	Remove.	Refer to step 5d.
	e. Wiring	Tag and disconnect.	
	f. Wiring and braid sheath (33)	Remove.	

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Nipple (34)	Remove.	If necessary.
	h. Conduit assembly	Reassemble and install.	



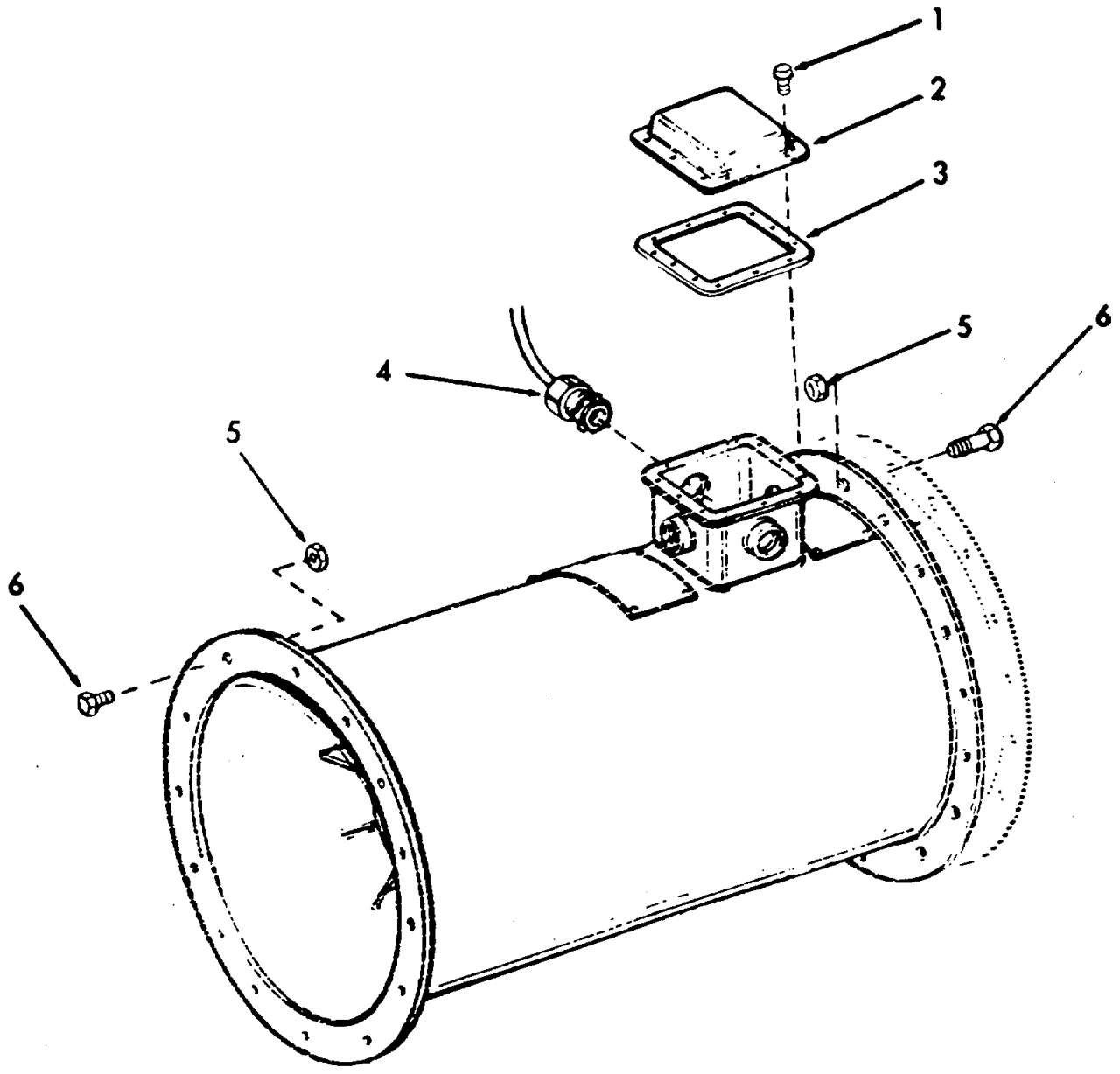
4-785

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
	WARNING In order to avoid personal injury and damage to the equipment, obtain help to hold the fan while disconnecting ducts.		
7. Fan	a. Fan	Raise to desired position.	
	b. Screws (6), and nuts (5)	Install.	In 28 places.
	c. Coupling (4)	Install.	
	d. Wiring	Reconnect. Remove tags.	
	e. Gasket (3), conduit box cover (2), and screws (1)	Install.	

4-25. HVAC EXHAUST FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-26. HVAC HEATING SYSTEMS.

a. The HVAC heating systems are electric.

b. The following is an index to the maintenance procedures.

DESCRIPTION	PARAGRAPH
Electric Turret Heater	4-26.1
Duct Heaters	4-26.2
Thermostats	4-26.3

4-26.1. ELECTRIC TURRET HEATER - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition: Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

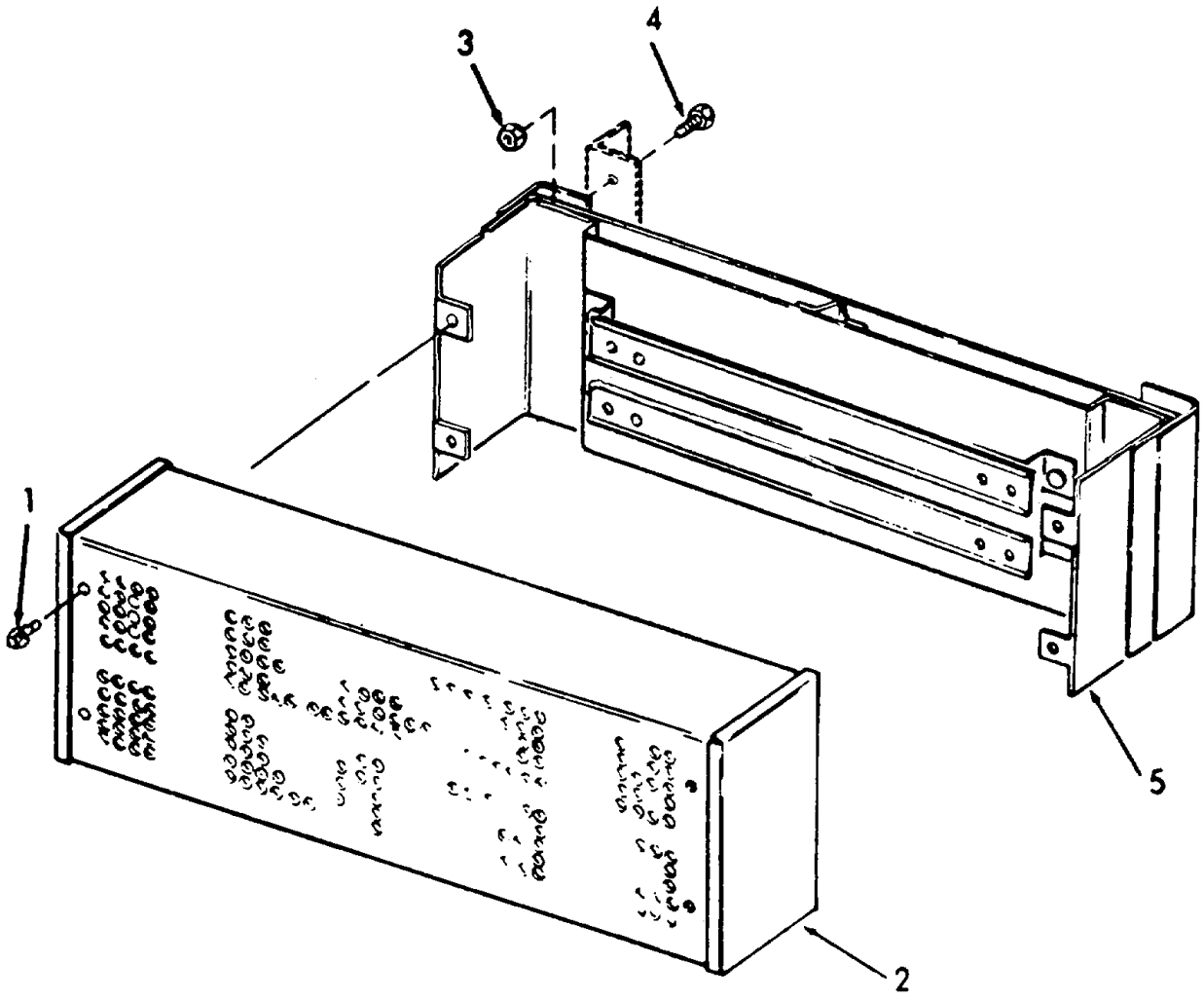
Observe WARNINGS in this procedure.

4-26.1. ELECTRIC TURRET HEATER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent death or possible injury, tag and place circuit breaker in the off position, and pull fuses as an added precaution.	
INSPECTION			
1. Electric turret heater	a. Wiring	Inspect for breaks, cracks and damaged insulation.	
	b. Heater	1. Inspect for proper operation. 2. Inspect for accumulations of dirt. 3. Inspect for signs of damage. 4. Insure all hardware is tight.	
REMOVAL			
2.	a. Sheet metal screws (1)	Remove.	
	b. Cover (2)	Remove.	
	c. Wiring	Tag and disconnect.	
	d. Nuts (3) and screws (4)	Remove.	
	e. Heater (5)	Remove.	

4-26.1. ELECTRIC TURRET HEATER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			

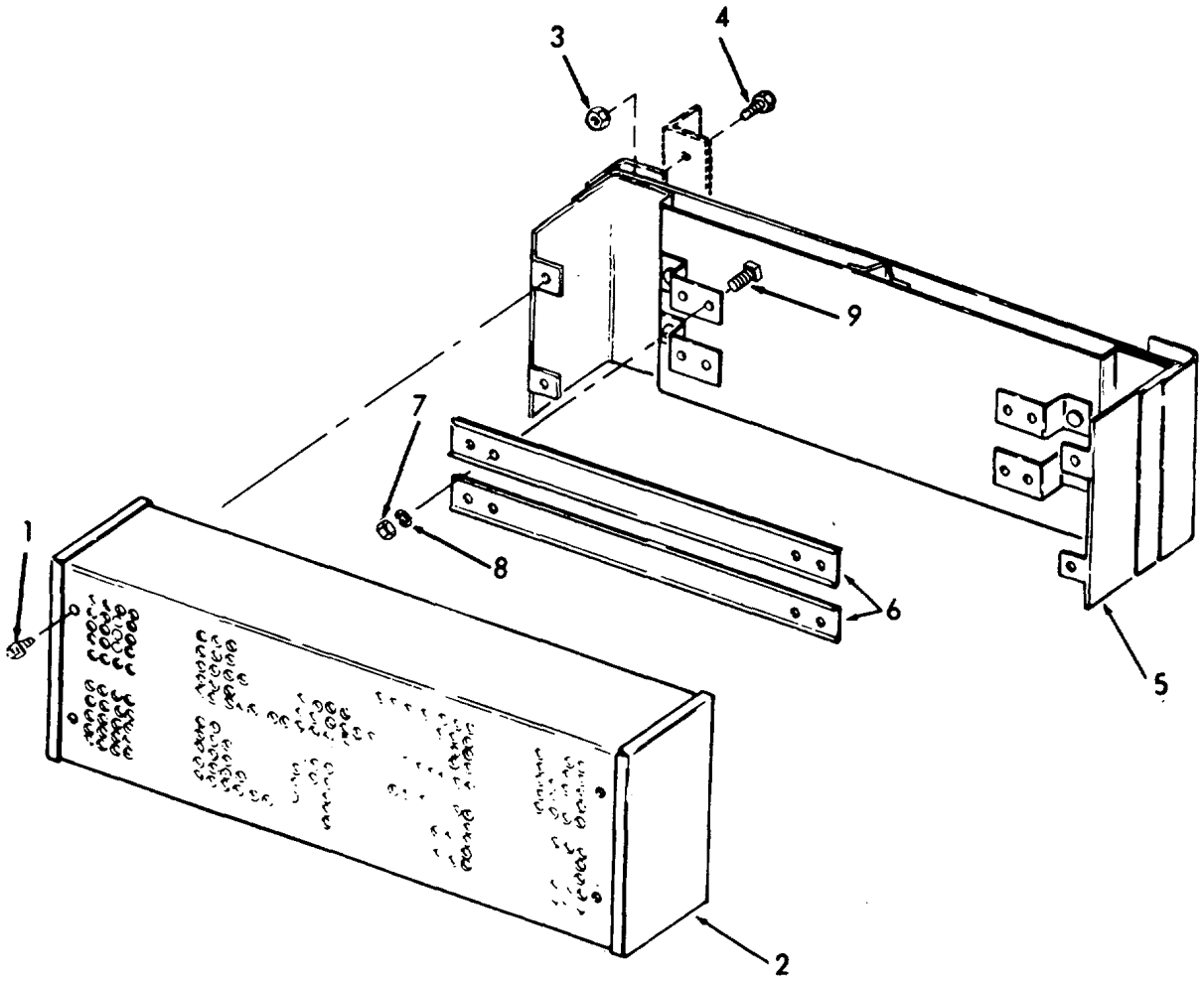


4-26.1. ELECTRIC TURRET HEATER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
3.	a. Cover (2)	Clean.	
	b. Heating elements (6)	Clean.	
REPAIR			
4.	a. Nuts (7), lock-washers (8), and screws (9)	Remove.	
	b. Heating element (6)	Replace.	
	c. Screws (9), lock-washers (8), and nuts (7)	Install.	
INSTALLATION			
5.	a. Heater (5), screws (4), and nuts (3)	Install.	
	b. Wiring	Reconnect, remove tags.	
	c. Cover (2) and screws (1)	Install	
	d. Heater	Check for proper operation.	

4-26.1. ELECTRIC TURRET HEATER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-26.2. ELECTRIC DUCT HEATER - MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

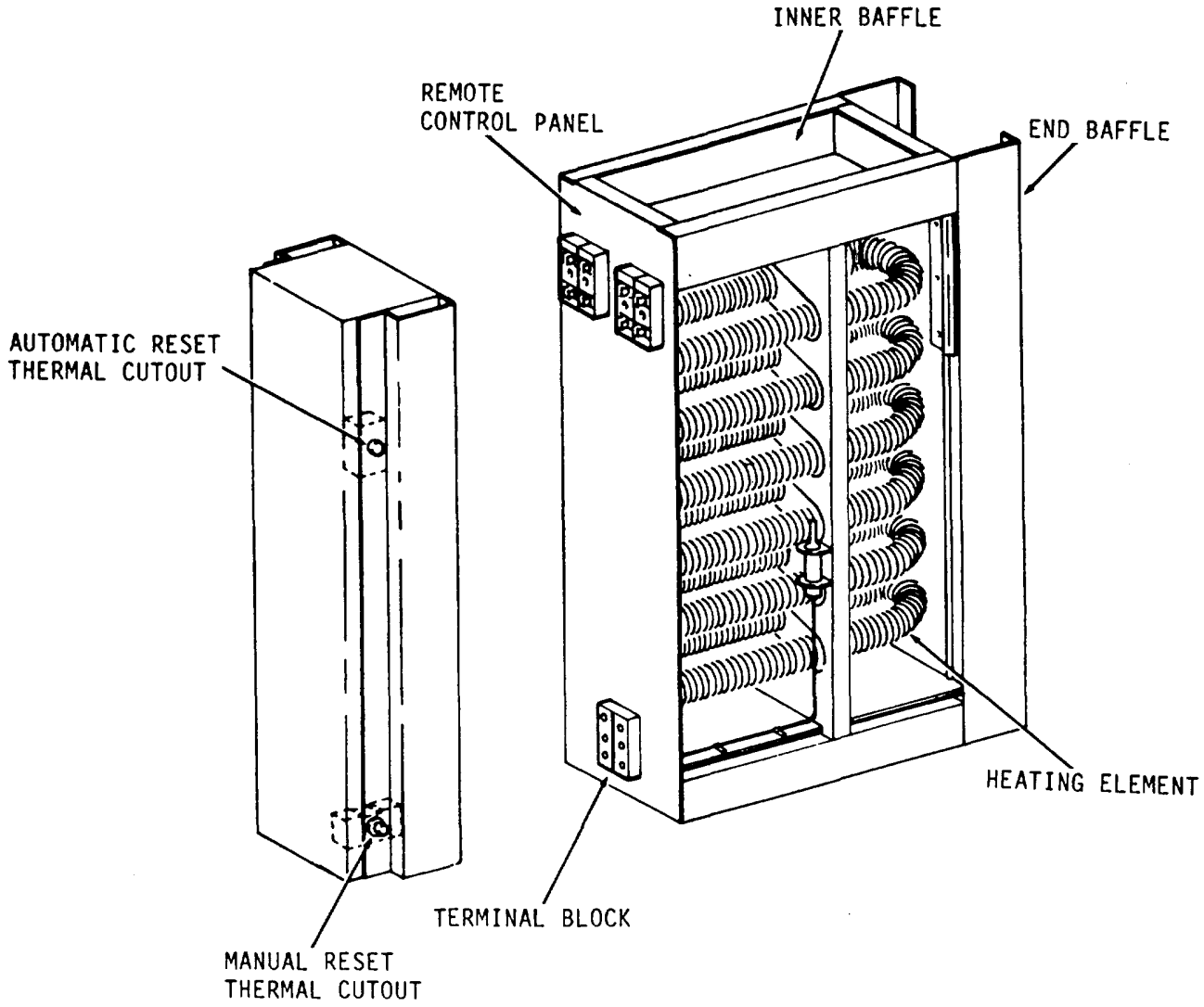
Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
		WARNING To prevent death or possible injury, tag and place circuit breaker in the off position, and pull fuses as an added precaution.	
INSPECTION			
1. Electric duct heater	a. Wiring	Inspect for breaks, cracks and damaged insulation.	
	b. Heater	1. Inspect for proper operation. 2. Inspect for accumulations of dirt.	

4-26.2. ELECTRIC DUCT HEATER - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



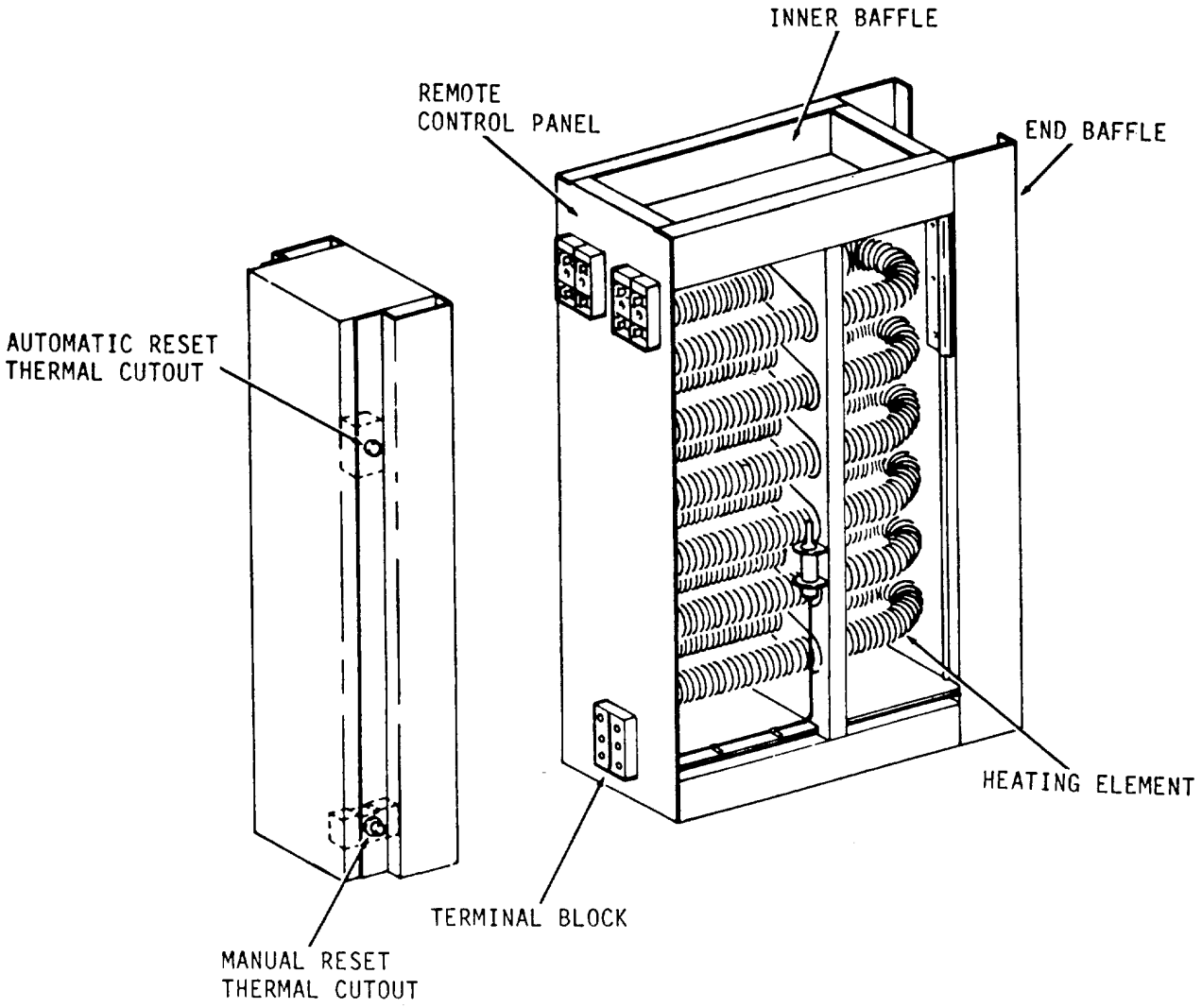
4-26.2. ELECTRIC DUCT HEATER - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		3. Inspect for signs of damage.	
		4. Insure all hardware is tight.	
REMOVAL			
2.	a. Cover	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Heater	1. Remove attaching hardware.	
		2. Remove heater.	
SERVICE			
3.	Heater	Clean.	
REPAIR			
4.	Heater	Repair or replace defective parts as required.	
INSTALLATION			
5.	a. Heater	Install using attaching hardware.	
	b. Wiring	Reconnect, remove tags.	
	c. Cover	Install.	
	d. Heater	Turn on power and check operation.	

4-26.2. ELECTRIC DUCT HEATER - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



4-26.3. THERMOSTATS - MAINTENANCE INSTRUCTIONS.

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

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

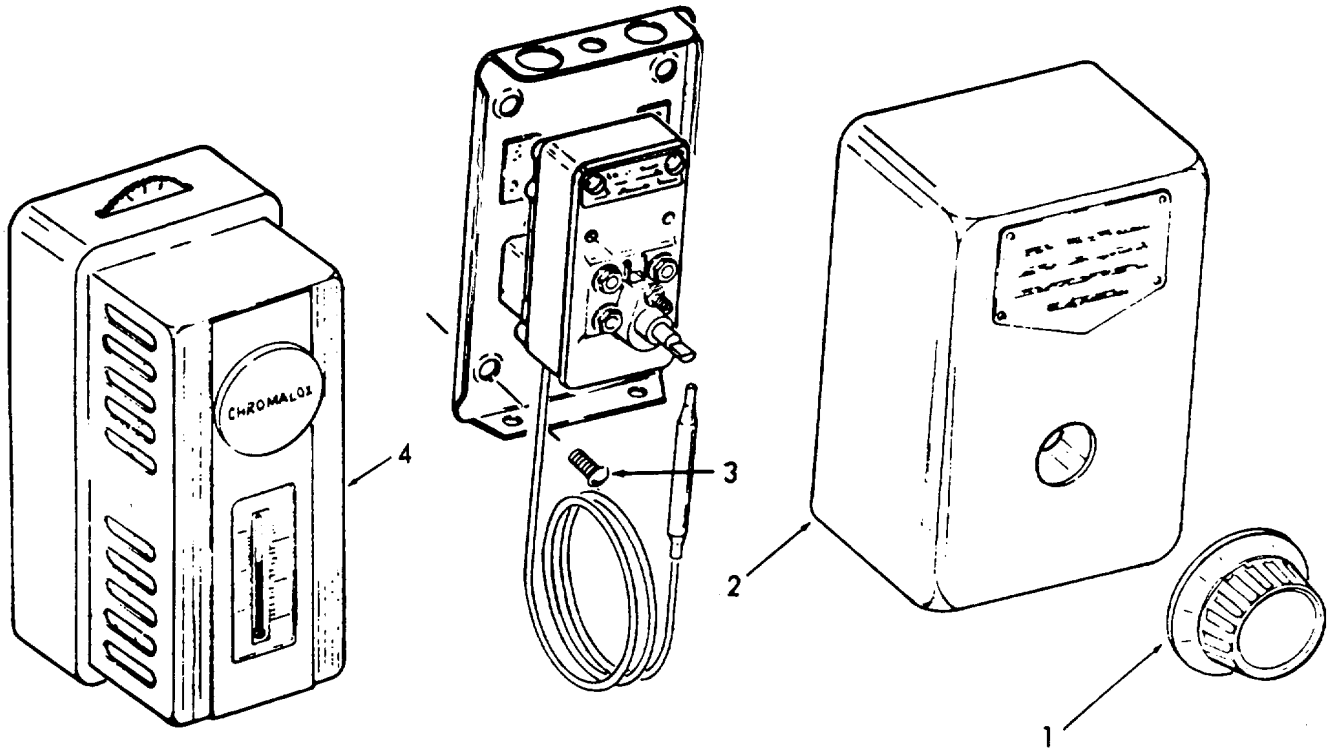
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Thermostat (both styles)	a. Control	Inspect for proper operation.	
	b. Case	Inspect for signs of damage.	
	c. Wiring	Inspect for wear or breaks.	
REMOVAL			
2. Thermo-Stat (with control knob)	a. Control knob (1)	Remove.	
	b. Cover (2)	Remove.	
	c. Wiring	Tag and disconnect.	

4-26.3. THERMOSTATS - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Mounting screws (3)	Remove.	
	e. Thermo-stat	Remove.	
3. Thermo-stat (Chro-malox) (4)	a. Cover	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Mounting hardware	Remove.	
	d. Thermo-stat	Remove.	

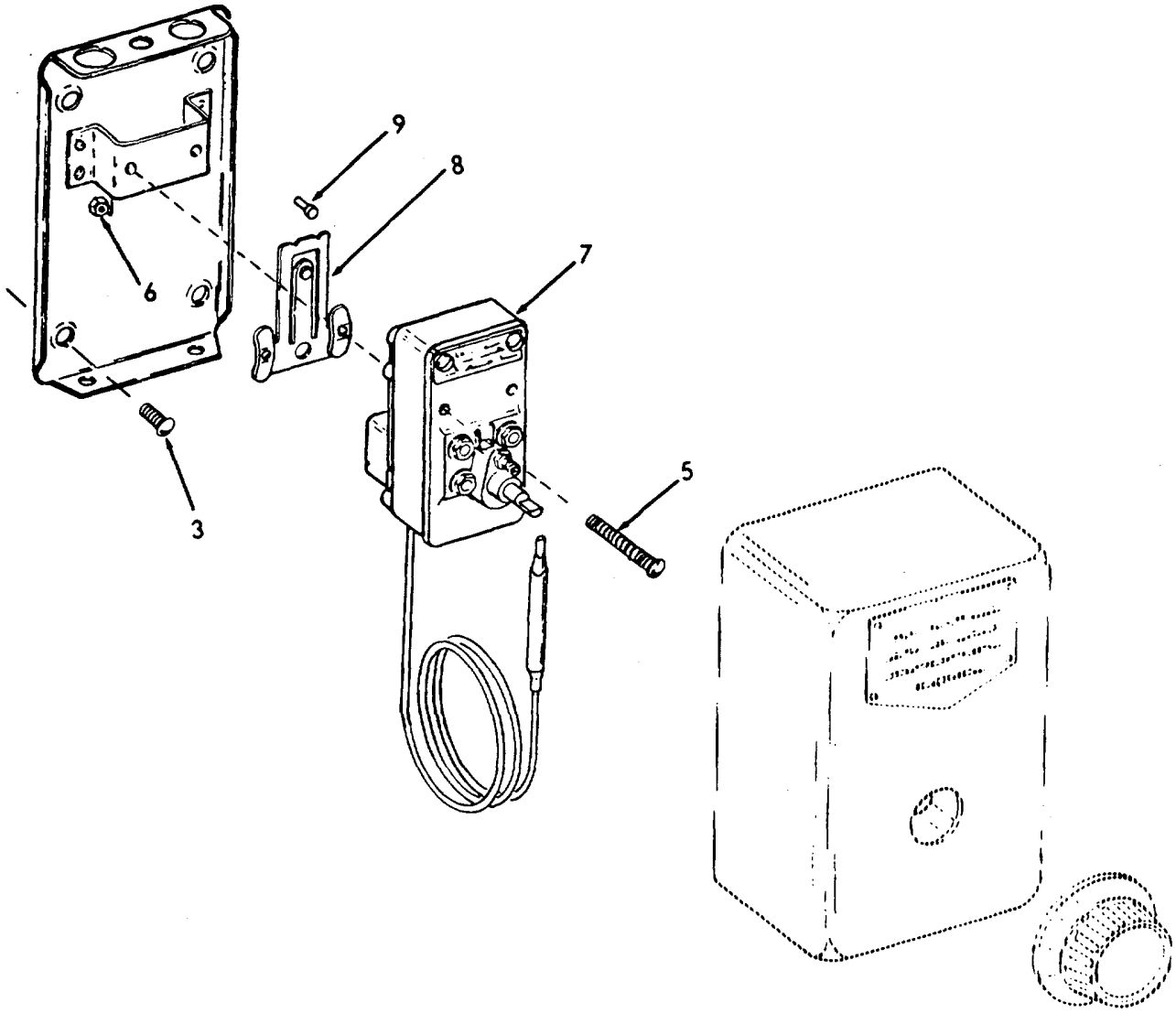


4-26.3. THERMOSTATS - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Thermostat (with control knob)	a. Screws (5) and nuts (6)	Remove.	
	b. Subassembly (7) moveable contact (8), and four stationary contacts (9)	1. Remove.	
		2. Disassemble.	Replace defective parts.
		3. Reassemble.	
	c. Subassembly (7)	Install.	
	d. Screws (5) and nuts (6)	Install.	
5. Thermostat (Chromalox) (4)		Not repairable.	
INSTALLATION			
6.	a. Mounting hardware and thermostat	Install.	
	b. Wiring	Reconnect, remove tags.	
	c. Cover	Install.	

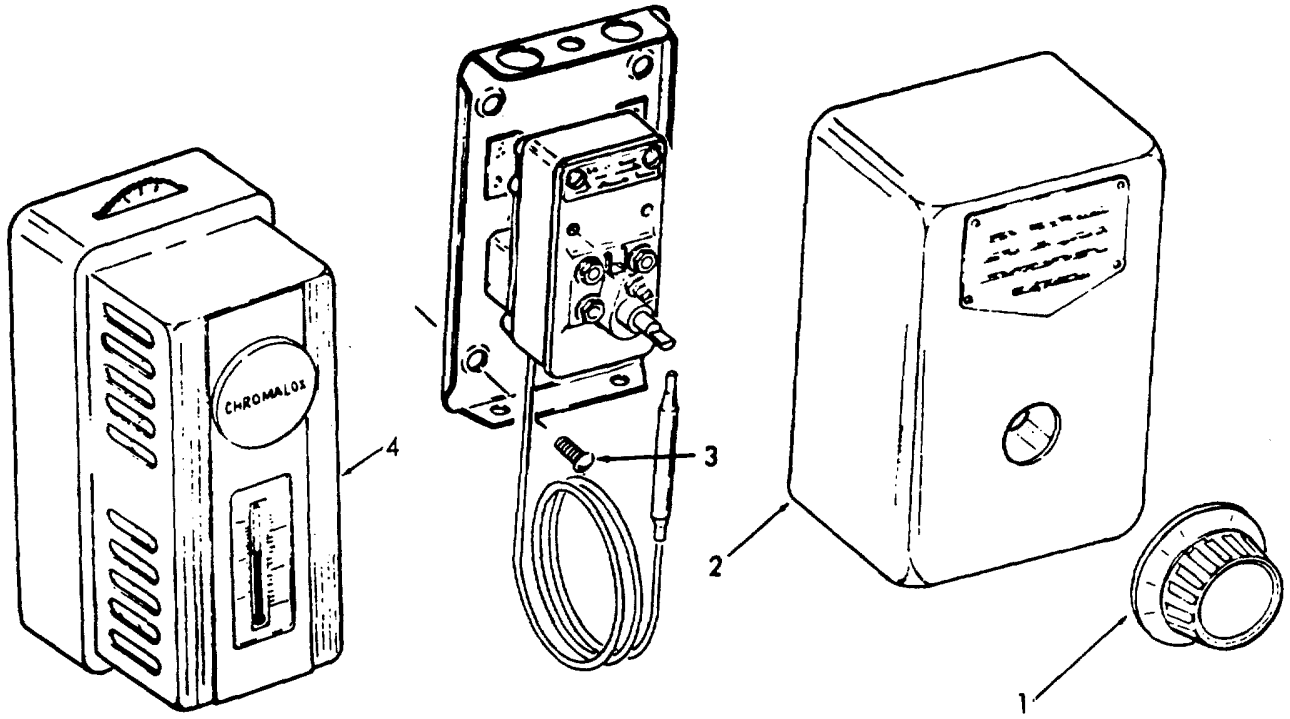
4-26.3. THERMOSTATS - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



4-26.3. THERMOSTATS - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
7. Thermostat (with control knob)	a. Thermostat and screws (3)	Install.	
	b. Wiring	Reconnect, remove tags.	
	c. Cover (2)	Install.	
	d. Knob (1)	Install.	



4-27. CENTRIFUGAL FAN AND MOTOR - MAINTENANCE INSTRUCTIONS.

This fan is located under the pilothouse floor. The fan is an exhaust fan for the batteries.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
2

General Safety Instructions
Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
		WARNING	
		To prevent death or possible injury, tag and place circuit breaker in the off position.	
INSPECTION			
1. Centrifugal fan	a. Wiring	Inspect for breaks, cracks and defective insulation.	
	b. Motor	Inspect for signs of damage.	

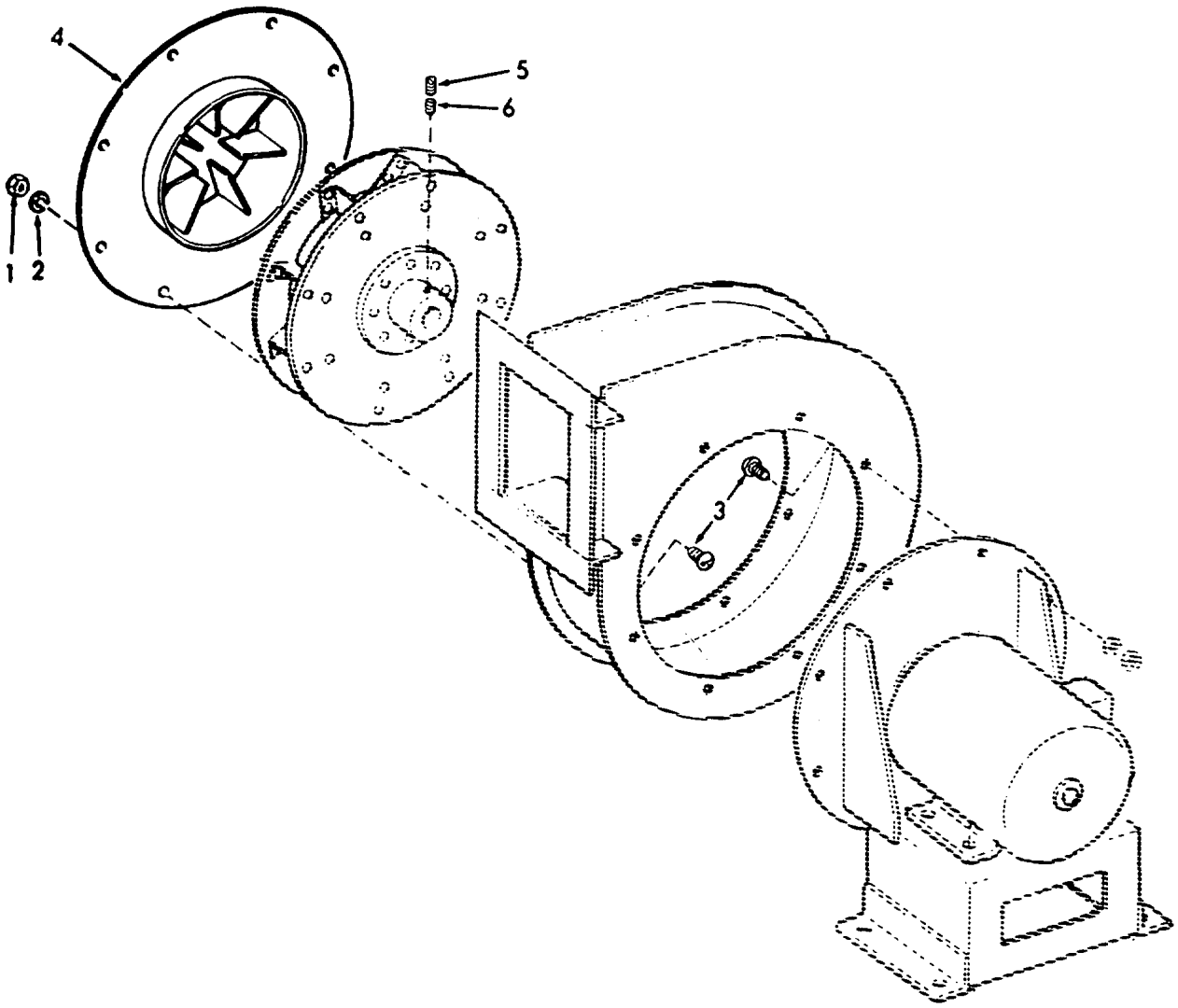
4-27. CENTRIFUGAL FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Fan	1. Inspect for loose hardware.	
		2. Check for vibration.	
		3. Inspect for dirt accumulations.	
REMOVAL			
2.	a. Wiring	1. Remove conduit box cover.	
		2. Tag and disconnect wires.	
	b. Mounting hardware	Remove.	
	c. Fan	Remove.	
SERVICE			
3.		Clean interior of fan housing and wheel assembly.	
REPAIR			
4.	a. Nuts (1) and lockwashers (2)	Remove.	Screws (3) are attached into the housing.
	b. Inlet assembly (4)	Remove.	
	c. Setscrews (5 and 6)	Remove.	

4-27. CENTRIFUGAL FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

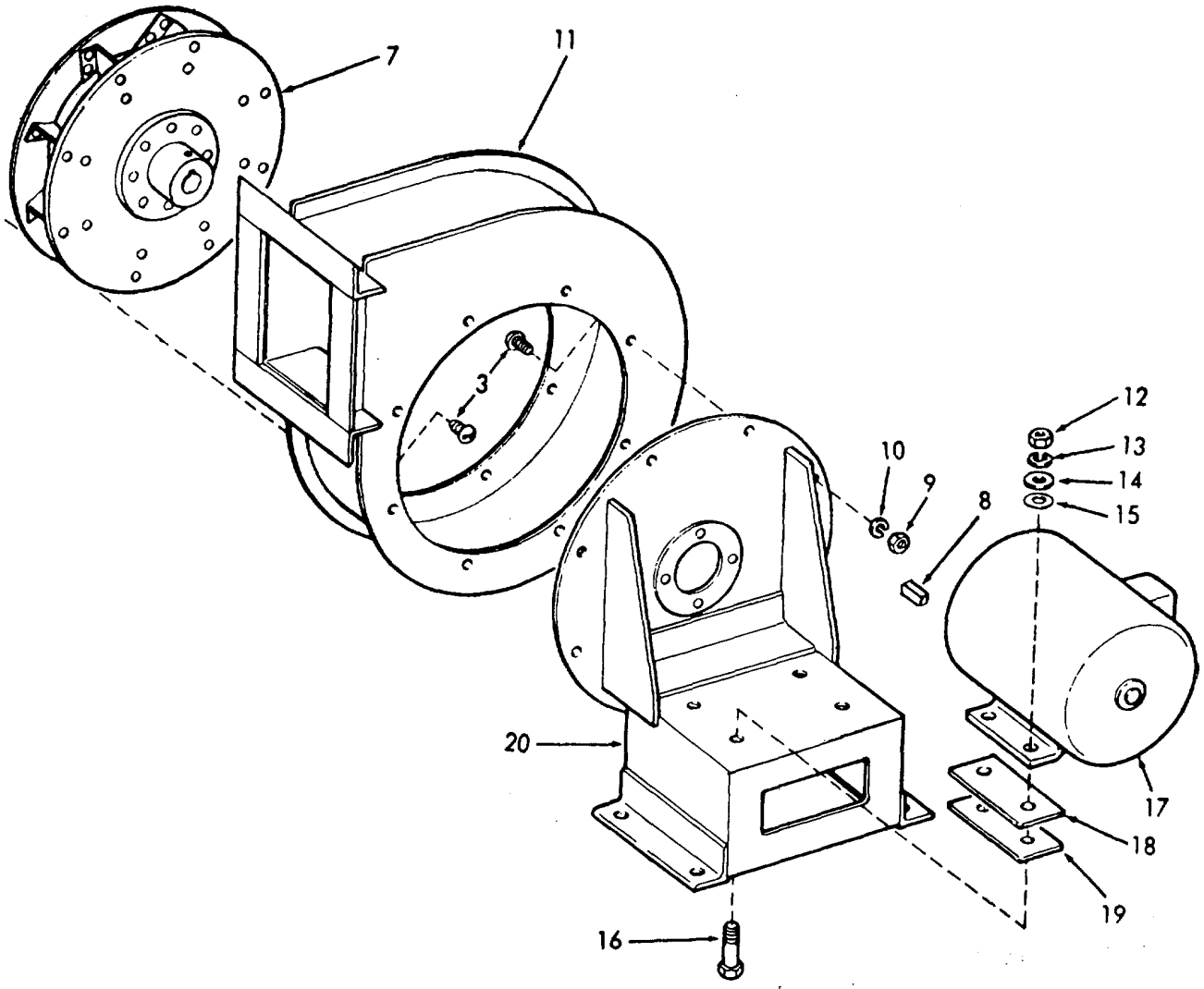


4-27. CENTRIFUGAL FAN AND MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Wheel assembly (7) and key (8)	Remove.	
	e. Nuts (9) and lock-washers (10)	Remove.	Screws (3) are attached into the housing.
	f. Housing (11)	Remove.	
	g. Nuts (12), lock-washers (13), flat washers (14), non-metallic washers (15), and bolts (16)	Remove.	
	h. Motor (17), shims (18), and gaskets (19)	Remove from motor base (20).	
	i. Gaskets (19), shims (18), motor (17), and bolts (16)	Assemble to motor base. (20).	

4-27. CENTRIFUGAL FAN AND MOTOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

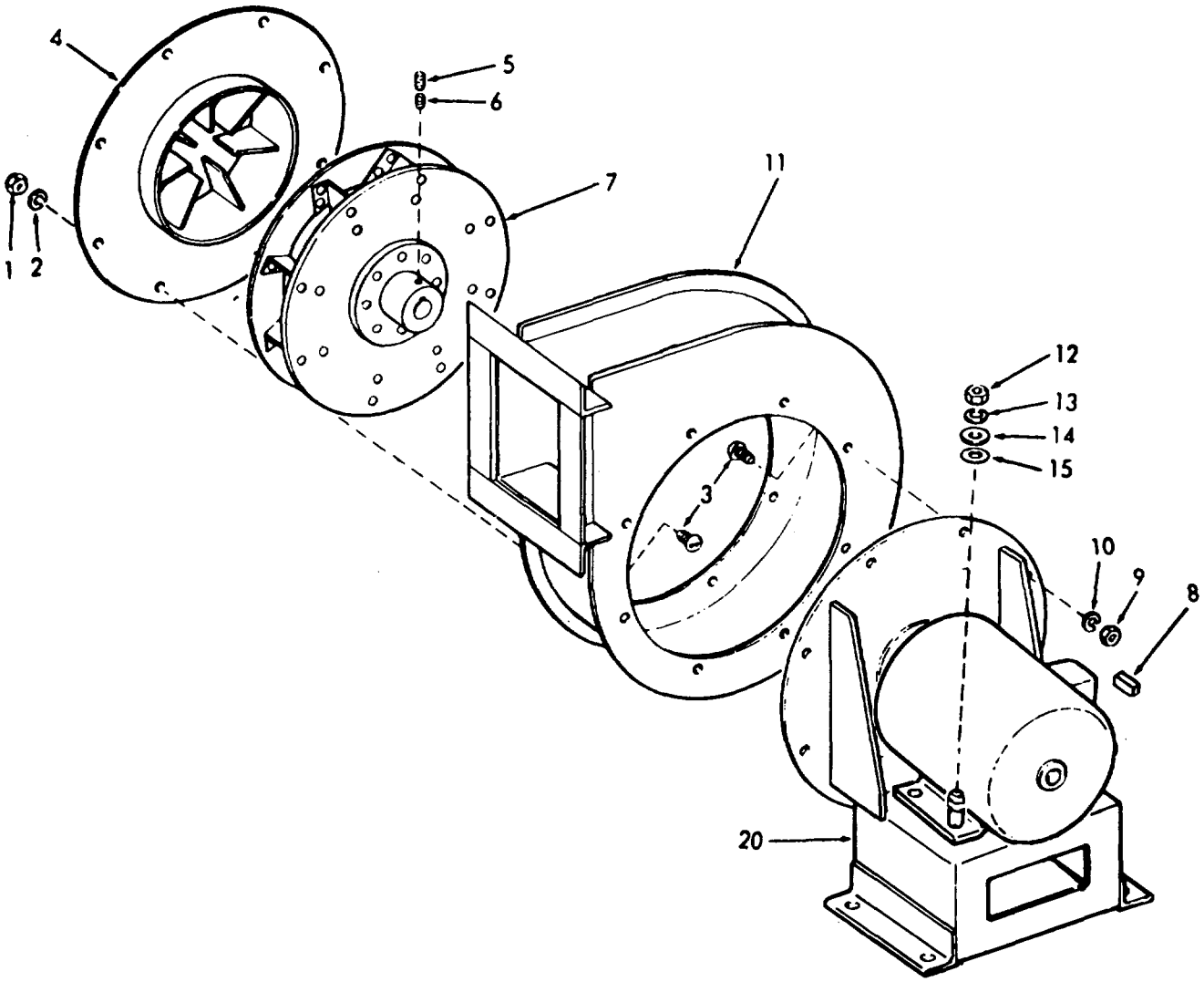


4-27. CENTRIFUGAL FAN AND MOTOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Non-metallic washers (15), flat washers (14), lock-washers (13), and nuts (12)	Install.	
	k. Screws (3)	Position in housing (11).	
	l. Housing (11)	Install to motor base (20).	
	m. Lock-washers (10) and nuts (9)	Install	
	n. Wheel assembly (7) and key (8)	Install on motor shaft.	
	o. Setscrews (5 and 6)	Install.	
	p. Inlet assembly (4)	Install.	
	q. Lock-washers (2) and nuts (1)	Install.	

4-27. CENTRIFUGAL FAN AND MOTOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



4-27. CENTRIFUGAL FAN AND MOTOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Fan and mounting hardware	Install	
	b. Wiring	1. Reconnect, remove tags.	
		2. Install conduit box cover.	
	c. Fan	Operate and check for vibration.	

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS.

OVERVIEW

The following is an index to this paragraph:

a. General Description.

(1) The air conditioning equipment consists of (1) condensing unit assembly, (1) heat interchanger, (1) air conditioning cooling coil, and gage board.

(2) The condensing unit assembly is designed for automatic operation to supply liquid refrigerant-12 to the direct expansion cooling coil. The condenser has an operating capacity of 8 tons at 40° F (40°C) suction temperature and 105° F (40.6°C) condensing temperature, and requires a refrigerant-12 charge of approximately 70 lbs (31.75 kg).

(3) A description of the refrigeration system components is given below. See illustration for a diagrammatic piping layout showing the interconnection of the components on pages 4-822 and 4-823.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(4) Compressor.

(a) The compressor is of the reciprocating type, that is, of positive displacement with pistons moving in a straight line but alternately in divergent directions. The compressor withdraws refrigerant gas from the evaporator and delivers it to the condenser at an increased pressure. The pressure is such that refrigerant heat can be absorbed by sea water at ordinary temperatures.

(b) The compressor is direct driven by a 10 hp, 440 volt a-c, 3 ph, 60 hertz, 1750 rpm motor. The compressor has a cast iron crankcase and is mounted with the motor on a steel base. General data on the compressor is tabulated below.

Compressor Data

Carrier Model No.	5F30
Cylinders	3
Bore	2-1/2"
Stroke	2"
Speed	1750 rpm
Capacity	7.8 tons at 40° F (4°C) suction temp and 105° F (40.6°C) condensing temp

(c) The compressor has the following features:

1 Force feed lubrication by an oil pump driven directly from the end of the compressor crankshaft.

2 Automatic capacity control which permits unloaded starting and provides automatic operation at reduced capacities of 6-2/3% and 33-1/3%. The capacity is reduced in step with a reduction in suction pressure.

3 An external relief valve set to relieve at 225 psi (1551.4 kPa) above the existing suction pressure.

4 An oil pressure safety switch which will stop the compressor if the oil pressure drops below the minimum required for satisfactory lubrication.

5 A high pressure control switch which stops the compressor if discharge pressure becomes excessive.

6 A low pressure control switch which automatically starts and stops the compressor during normal operation.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(5) Condenser.

(a) The condenser is a shell and sea water tube heat exchanger in which the compressed refrigerant gas is condensed (liquefied) and lowered in temperature by the removal of heat.

(b) The condenser is of the multipass shell and finned tube type with circulating sea water flowing through the tubes. The condenser is constructed of a steel shell with copper nickel finned tubes and tube sheet and bronze water heads. The refrigerant vapor is admitted to the shell and is condensed on the outer surface of the tubes. Sea water flow through the condenser is controlled by a water regulating valve in response to changes in condenser refrigerant pressure. Operation of this valve is described in paragraph 4-28a(20). General data on the condenser is tabulated below.

Condenser Data

Carrier Model No.	9W50-129-4
Shell Diameter	6-5/8"
Overall Length	57-9/16"
Effective Cooling Surface	50 sq ft
No. of Tubes	26
No. of Passes	2
Tube Size	3/4" OD x.049W
Sea Water Quality (Design)	48 gpm (181.7 1pm)

(6) Receiver.

(a) Liquid refrigerant from the condenser drains into the receiver. The receiver serves as a liquid refrigerant reservoir when there are surges due to load changes in the system; as a storage space when pumping down the system; and as a liquid seal against the entrance of refrigerant gas into the liquid line.

(b) Receivers are provided with two bull's-eye sight glasses or with a magnetic, gauge type, liquid level indicator for the observation of liquid level in the receiver. To maintain a liquid seal, there should always be a minimum liquid level in the receiver when the plant is in operation. During shutdown, the refrigerant charge is pumped into the receiver so that only gas remains in the rest of the system.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(c) The receiver is a steel shell with steel dished heads welded at each end. The receiver collects the liquid refrigerant drawing from the condenser. The shell is provided with refrigerant inlet and outlet connections and a magnetic float type liquid level indicator for observing the refrigerant liquid level. General data on the receiver is tabulated below.

Receiver Data

Carrier Assembly No.	8M15-314-3
Type Mounting	Horizontal
Refrigerant Capacity	120 lb (54.43 kg)
Shell Diameter	10"
Overall Length	38-1/8"

(7) Evaporator

(a) The evaporator is that part of the system in which refrigerant is vaporized to produce refrigeration. The types of evaporators used on shipboard is finned cooling coils mounted on bulkheads or in a unit (cold diffuser) for cooling circulated air.

(b) The operation of the compressor maintains a reduced refrigerant pressure within the coils. At this reduced pressure, the liquid refrigerant evaporates or boils at a temperature sufficiently low to absorb heat from the air, fresh water or brine in contact with the outside of the coils.

(8) Heat interchanger.

(a) The heat interchanger is a shell and tube heat exchanger connected in the main suction and liquid lines near the compressor. Within the interchanger, the cold suction gas is used to cool the warm liquid refrigerant. This results in greater system capacity and efficiency. A liquid line bypass valve is usually provided to isolate the interchanger should either: (a) a liquid leak develop in the suction line, or (b) the compressor discharge gas temperature rise above 240° F (115.6°C).

(b) A heat interchanger is installed in the main suction and liquid lines leading from the condensing unit to the air conditioning cooling coil. Suction gas circulates through the tubes of the interchanger while liquid refrigerant passes through the shell. The cold suction gas cools the warm refrigerant thus increasing the efficiency and capacity of the system. Liquid inlet and bypass stop valves are provided in the liquid lines to the interchanger. Heat interchanger data is tabulated below.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

Heat Interchanger Data	
Manufacturer	Dunham Bush (Heat X Inc.)
Model No.	7-1/2 SX
Overall Length	22-3/4" (56.7 cm)
Shell Diameter	3-1/2" OD
Connections	7/8" OD liquid, 1-5/8" suction

(9) Dryer.

(a) The dryer or dehydrator, installed in the main liquid line or in a bypass, is a cylinder containing renewable cartridges filled with activated alumina or silica gel. The dryer is used to keep the system free of moisture.

(b) When the dryer is installed in the main liquid line, it remains in operation at all times. When it is installed in a bypass, the dryer is to be used when charging refrigerant or for freeing the system of moisture. If the system is properly purged and dehydrated when first installed, and operated with care, it will be necessary to use the dryer only when charging.

(c) Some dryers are equipped with a "dry eye" or moisture indicator consisting of a paper disc visible through a sight glass. The paper disc changes in color from blue to pink. A blue tinge indicates an acceptable level of moisture in the refrigerant. A pink color indicates excessive moisture and the need for replacement of dryer cartridges.

(10) Cooling Coil.

(a) The cooling coil is of the direct expansion type (refrigerant-12 flows through the coil). The coil is constructed of copper finned tubes, headers and connections. The parts are encased in a steel casing and hot dipped galvanized.

(b) The cooling coil lowers the supply air in temperature and dehumidifies to meet design conditions. Refrigerant flow through the coil is regulated by a thermostatic expansion valve in response to changes in superheat of refrigerant gas leaving the coil. Refrigerant flow to the expansion valve is controlled by a solenoid valve, which is regulated by the temperature control switch in response to changes in return air temperature. General data on the cooling coil is tabulated below.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

Cooling Coil Data

Manufacturer	McIntyre
Model No.	56DF
Capacity	7.5 tons
Air Quantity	1260 cfm (117 cmm)
Face Velocity	252 fpm (76.8 mpm)
Entering Air Temp	85.2° F DB (dry bulb) (29.6°C)
	74.0° F WB (wet bulb) (23.3°C)
Leaving Air Temp	* DB
	* WB

* Leaving Air Temperature to be established by the shipyard.

(11) Strainers.

Since the refrigerant is capable of removing particles of dirt and scale from surfaces, refrigerant strainers are provided in the liquid line and in the compressor suction manifold. An oil strainer in the compressor crankcase is also provided.

(12) Sight Flow Indicator.

The sight flow indicator is a sight glass, installed in the main liquid line, which permits observation of the liquid refrigerant in the line. A solid column of liquid should be visible. If bubbles appear in the liquid, it is an indication that there is a shortage of refrigerant in the system.

(13) High and Low Pressure Control Switches.

(a) The high pressure control switch is a safety device which stops the compressor in the event of excessive pressure in the high pressure side of the system. Either switch permits the compressor to be started again without resetting or starting through motor controller, when the pressure drops to its cut-in setting.

(b) The low pressure control switch is an operating control which stops and starts the compressor at predetermined suction pressures.

(c) These two controls are usually combined in one switch box called the dual pressurestat.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(d) For adjustment procedures refer to paragraph 4-33.

High Pressure Control Switch Data

Manufacturer	Detroit Switch
Part No.	223876CB7
Range	60 to 350 psig (412.7 to 2413.3 kPa)
Differential	24 to 90 psi (165.5 to 620.5 kPa)
Recommended Settings:	
Close Setting	125 psig (861.9 kPa)
Open Setting	175 psig (1206.6 kPa)

Low Pressure Control Switch Data

Manufacturer	Detroit Switch
Part No.	223875CB3
Range	20" vac to 80 psig (551.6 kPa)
Differential	9 to 15 psi (62.1 to 103.4 kPa)
Recommended Settings:	
Close Setting	37 psig (255.1 kPa)
Open Setting	28 psig (193.1 kPa)

(14) Oil Pressure Safety Switch.

The oil pressure safety switch is a differential pressure control which measures net oil pressure (difference between oil pump discharge pressure and crankcase pressure) and stops the compressor in the event that: (a) compressor lubricating oil pressure should drop below a safe minimum during operation, i.e., less than 12 psi (82.7 kPa) above crankcase pressure; or (b) oil pressure should fail to build up to a satisfactory minimum at start up, i.e., at least 18 psi (124.1 kPa) above crankcase pressure. The oil safety switch is interlocked with a time delay mechanism to permit a short operating period (less than one minute) at start up under low oil pressure to allow oil pressure to develop.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

Oil Pressure Differential Switch Data

Manufacturer	Penn Controls
Carrier Part No.	HKO6UL012 (5F20-212)
Open Setting (differential)	16 to 19 psi (110.3 to 131.0 kPa)
Close Setting (differential)	11 to 15 psi (75.8 to 103.4 kPa)
Type Reset	Manual pushbutton

(15) Thermal Expansion Valve.

The thermal expansion valve is an automatic device which controls the flow of liquid refrigerant to the evaporator according to changes in superheat of the refrigerant gas leaving the evaporator. The thermal expansion valve maintains a relatively constant degree of superheat in the refrigerant gas leaving the evaporator regardless of suction pressure. Thus, the valve has a dual function: (a) automatic expansion control, and (b) prevention of liquid refrigerant return to compressor.

(16) Solenoid Valve.

The solenoid valve located in the liquid line at the evaporator is actuated by a temperature control switch or thermostat. This valve closes and cuts off the supply of liquid refrigerant to the thermal expansion valve when the space or other medium being cooled reaches the desired temperature (thermostat cut-out setting). When the thermostat calls for cooling (cut-in setting) the solenoid valve opens and refrigerant flow is restored.

(17) Hand Expansion Valve.

The hand expansion valve is located in the bypass for the liquid strainer, solenoid valve and thermal expansion valve of each refrigerant circuit. Thus, the hand expansion valve permits plant operation to be continued manually when the automatic controls or the strainer are being serviced. Hand expansion valves must be cracked open with care to avoid the return of liquid refrigerant to the compressor, but enough to supply sufficient refrigerant to the circuit.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(18) King Solenoid Valve.

The king solenoid valve is a solenoid valve located in the main liquid line leaving the receiver. The king solenoid valve is energized from the compressor motor controller to remain open when the compressor is operating normally under control of the low pressure control switch. The valve is de-energized and will close when the compressor is stopped by any other device, i.e., high pressure control switch, low voltage or overload relay, oil pressure failure switch, stop button or other safety device. The function of the king solenoid valve is to prevent excessive flooding of the low pressure side of the system with consequent danger of liquid refrigerant return to the compressor upon restarting.

(19) Temperature Control Switches (Thermostats).

(a) Operating thermostat.

The operating thermostat has a temperature sensing bulb in the space or medium being cooled and is electrically connected to the solenoid valve. The thermostat controls the flow of liquid refrigerant to the evaporator by opening or closing the solenoid valve. The thermostat closes and completes the electrical circuit to the solenoid valve, thus energizing and opening the valve, when the space or other medium being cooled rises above the desired temperature (thermostat cut-in setting). When the desired temperature is obtained (thermostat cut-out setting), the thermostat opens, de-energizing and closing the solenoid valve.

(b) Safety or low limit thermostat.

When there is danger of freezing the medium being cooled, such as the case of water in a chiller, a safety or low limit thermostat is employed. The low limit thermostat is a safety device which has a temperature sensing bulb in the medium being cooled and is wired to the compressor motor controller. The thermostat stops the compressor when the medium being cooled drops to a dangerously low temperature (thermostat cut-out setting). When the temperature of the medium being cooled rises to a safe level (thermostat cut-in setting), the compressor may be restarted by pressing the motor controller START button.

(c) The temperature control switch is wired to the cooling coil solenoid valve and functions as an operating thermostat. The switch bulb is located in the return air stream to the cooling coil. Automatic control sequence is described in paragraph 4-28a(22). Recommended settings and other data are tabulated below.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

Temperature Control Switch Data

Manufacturer	Detroit Switch
Model	2504150RN
Range	25° to 90° F (-3.9° to 32.2°C)
Differential	2° to 5° F (-16.7° to-15°C)
Recommended Settings:	
Close	80° F (26.7°C)
Open	78° F (25.6°C)

(20) Water Regulating Valve.

The water regulating valve automatically controls the sea water flow through the condenser to maintain a relatively constant condensing pressure to temperature. The water regulating valve is actuated by the refrigerant head pressure in the condenser and must be adjusted so as to maintain the required condensing pressure and to shut off water flow when the compressor is stopped. The water regulating valve is usually located in the condenser water outlet line and is provided with a bypass to permit servicing.

(21) Water Pressure Failure Control Switch.

The water pressure failure control switch (when provided) stops the compressor in the event that sea water pressure to the condenser should fall below the operating minimum (5 psig (34.5 kPa)). The water pressure failure switch will allow the compressor to start again when water pressure is restored to the minimum level required at start up (15 psig (103.4 kPa)).

Water Pressure Failure Switch Data

Manufacturer	Detroit Switch
Model	223875CB3
Range	20" vac to 80 psig (551.6 kPa)
Differential	9 to 15 psi (62.1 to 103.4 kPa)
Recommended Settings:	
Close	15 psi (103.4 kPa)
Open	5 psi (34.5 kPa)

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(22) Automatic Control Sequence.

(a) Each refrigerant circuit is fitted with a thermal expansion valve and a solenoid valve in the liquid line. The solenoid valve is actuated by a thermostat having its thermal control bulb located in the medium being cooled. The thermal expansion valve is actuated by its control bulb which is located at the leaving end of the refrigerant circuit (suction line). A strainer is provided ahead of the solenoid valve to keep the controls clean. A hand expansion bypass valve and stop valves before the strainer and at the thermal expansion valve outlet permit servicing the controls without shutdown of the circuit. Note that each set of cooling coils, each water chiller, or other evaporator may consist of one or more refrigerant circuits each with its set of controls.

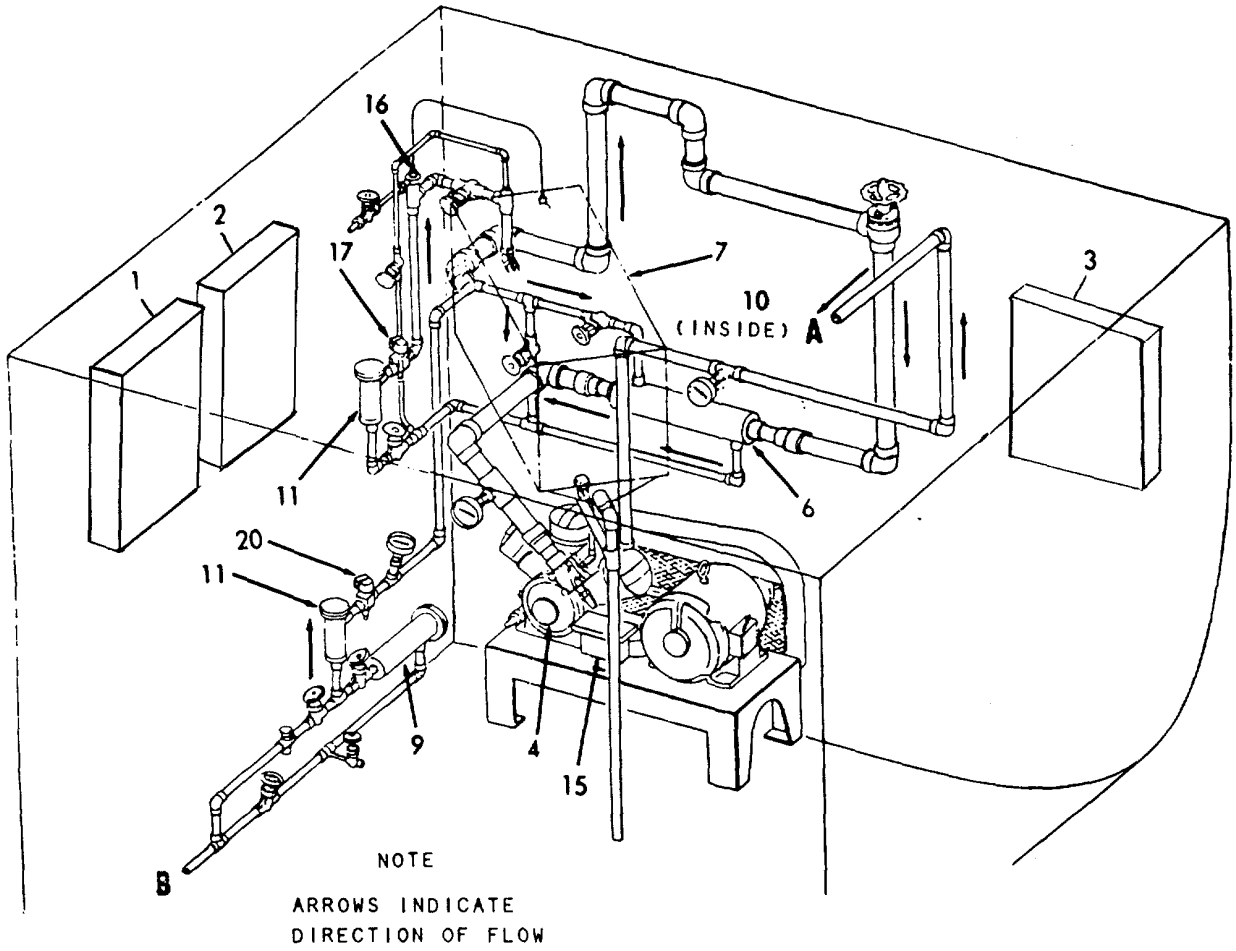
(b) The thermal expansion valve regulates the flow and expansion of the refrigerant in the circuit. The valve is factory set to remain open as long as the temperature of the refrigerant gas at the point of bulb attachment is 8°-10° F (-13.3°-23.3°C) or more above the refrigerant saturation temperature. This regulation supplies the circuit with a maximum amount of refrigerant while preventing liquid refrigerant from surging back to the compressor.

(c) When the compartment or other medium being cooled reaches the desired temperature, the thermostat opens, the solenoid valve closes and the flow of liquid refrigerant to the thermal expansion valve and circuit is cut off. (An open solenoid valve can be detected by observing the contacts of its thermostat, which should be closed, or by a humming sound when the ear is pressed against the valve casing.)

(d) With the solenoid valve closed or, in the case of multiple circuits, after the last solenoid valve closes and refrigerant flow is cut off to all circuits, the compressor continues to operate for a very short time until the suction pressure drops to the cut-out setting of the low pressure control switch, opening the switch contacts and stopping the compressor motor.

(e) As soon as the temperature of the compartment or other medium being cooled rises just above the cut-in setting of the thermostat, the thermostat closes and the solenoid valve opens allowing liquid refrigerant to flow to the thermal expansion valve. The thermal expansion valve meters the flow of refrigerant to the circuit. The refrigerant expands (vaporizes) in the circuit and the suction pressure rises. When the suction pressure rises above the cut-in setting of the low pressure control switch, the switch contacts close and the compressor motor starts.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

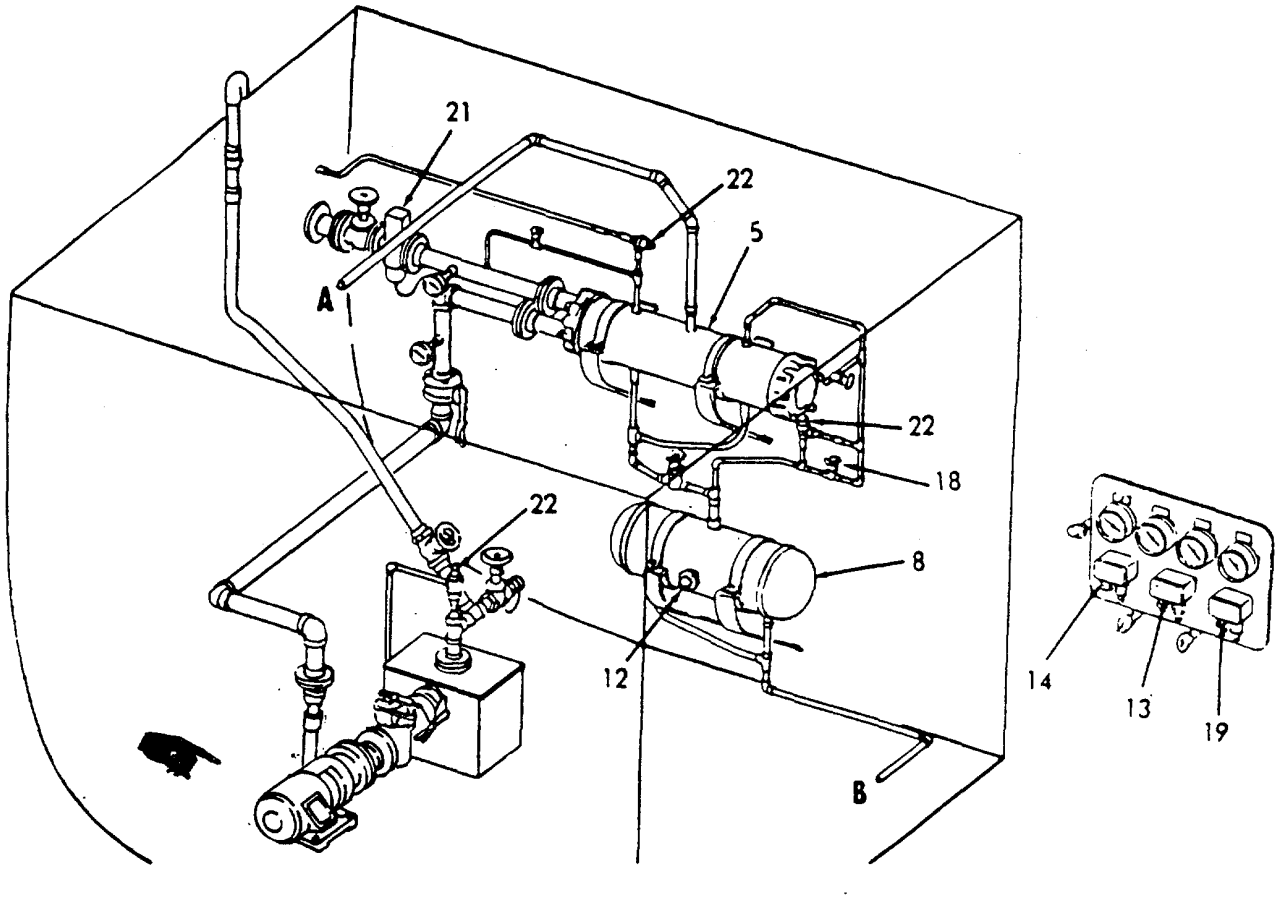


NOTE

ARROWS INDICATE
DIRECTION OF FLOW

1. Main Air Circulating Vent Motor Controller
2. Sea Water Pump Motor Controller
3. Compressor Motor Controller
4. Compressor
6. Heat Interchanger
7. Evaporator
9. Dryer
10. Cooling Coil
11. Strainers
15. Oil Pressure Control Switch
16. Thermal Expansion Valve
17. Solenoid Valve
20. Liquid Solenoid Valve

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).



4954-168

5. Condenser
8. Receiver
12. Sight Flow Indicator
13. High Pressure Control Switch
14. Low Pressure Control Switch
18. Hand Expansion Valve
19. Water Pressure Control Switch
21. Water Regulating Valve
22. Relief Valves

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(23) Safety Devices.

(a) Each compressor is equipped with high and low pressure control switches, an oil pressure safety switch and a pressure relief valve. The functions of the high and low pressure control switches and the oil pressure safety switch have been described above. Refer to paragraphs 4-28a(13) and 4-28a(19).

(b) The compressor relief valve is connected between the high and low pressure sides of the system and allows excessive head pressure to relieve back to the suction or low pressure side of the compressor. The compressor is equipped with an external relief valve set at 225 psi (1551.4 kPa). If the high side pressure rises to exceed the low side pressure by the relief valve setting, the relief valve opens and permits refrigerant gas to discharge from the high to the low pressure side of the system.

(c) A relief valve set at 225 psi (1551.4 kPa) is also installed in the equalizing line connecting the condenser and receiver. This valve will relieve excessive pressure which might build up in a full receiver during shutdown when the stop valves are closed. If the pressure in the receiver should rise above 225 psi (1551.4 kPa), the relief valve will open and allow refrigerant to flow into the condenser.

(d) Another relief valve, also set at 225 psi (5151.4 kPa), is installed in a line connecting the refrigerant side of the condenser to the overboard discharge. This valve will protect the system should refrigerant pressure ever be greatly increased by very high temperatures, such as during a fire.

b. Principles of Operation.

(1) Principles of Refrigeration.

(a) Refrigeration is the process of extracting heat at one temperature level and discharging it at a higher temperature level for the purpose of reducing and maintaining the temperature of an enclosed space below that of the surrounding atmosphere.

(b) The refrigerant is the fluid which carries heat through the refrigeration cycle from the evaporator where heat enters the refrigerant, to the condenser where the heat is discharged to the coolant. It should be understood that heat will always flow from a warm body to a cool body, and the rate of transfer will depend on the existing difference in temperature.

(c) The evaporation temperature, or boiling point, is that at which the refrigerant turns into a gaseous state, and no matter at what temperature this occurs, in order to bring about the change, heat must be added to the liquid. Conversely, the condensation temperature is that at which the gas returns to its liquid state and, similarly, heat must be removed from it to obtain the change.

(d) Pressure also affects the boiling point. Thus, if the pressure is increased, the boiling point is raised, and if the pressure is reduced, the boiling point is lowered. For example, refrigerant-12 boils at-21° F (-29.4°C) under normal atmospheric pressure, but if the pressure is increased to 117 psig (75.8 kPa), the boiling point (or condensing point) is raised to 100° F (37.8°C).

(e) By allowing the refrigerant to boil in the evaporator at a temperature sufficiently lower than that of the surrounding medium, heat transfer from the surrounding medium to the refrigerant is established. The vapor formed in the evaporator is then raised in pressure (by the compressor) until its new boiling temperature exceeds the temperature of the condenser coolant; under these conditions heat transfer is established from the refrigerant vapor to the condenser coolant with resultant condensation of the refrigerant. When condensed, the high pressure liquid refrigerant is reduced in pressure and again allowed to boil in the evaporator.

(f) The first column of the table gives the range of refrigerant-12 saturation temperatures likely to occur in practice. The third column gives the saturation pressure expressed in pounds per square inch gauge corresponding to each given temperature. These relationships hold true only when both liquid and gas are present together, as is the case in the evaporator, condenser, and receiver. The gas will be in the superheated state in all other parts of the system.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

PHYSICAL PROPERTIES OF SATURATED REFRIGERANT-12*

Temp. Deg. F. Col.1	PRESSURE LBS. PER SQ. IN Absolute Col.2	Gauge Col.3	DENSITY LBS. PER CU.FT. Liquid Col.4	Vapor Col.5	HEAT CONTENT ABOVE-40° F B.T.U. PER LB. Liquid Col.6	Latent Col.7	Total of Vapor Col.8	Temp Deg. F. Col.9
-40	9.32	10.92+	94.58	0.2557	0.00	73.50	73.50	-40
-38	9.82	9.91+	94.39	.2683	0.40	73.34	73.34	-38
-36	10.34	8.87+	94.20	.2815	0.81	73.17	73.98	-36
-34	10.87	7.80+	93.99	.2951	1.21	73.01	74.22	-34
-32	11.43	6.66+	93.79	.3092	1.62	72.84	74.46	-32
-30	12.02	5.45+	93.59	0.3238	2.03	72.67	74.70	-30
-28	12.62	4.23+	93.39	.3390	2.44	72.50	74.94	-28
-26	13.26	2.93+	93.18	.3546	2.85	72.33	75.18	-26
-24	13.90	1.63+	92.98	.3706	3.25	72.16	75.41	-24
-22	14.58	0.24+	92.78	.3871	3.66	71.98	75.64	-22
-20	15.28	0.58	92.58	0.4042	4.07	71.80	75.87	-20
-18	16.01	1.31	92.38	.4219	4.48	71.63	76.11	-18
-16	16.77	2.07	92.18	.4403	4.89	71.45	76.34	-16
-14	17.55	2.85	91.97	.4593	5.30	71.27	76.57	-14
-12	18.37	3.67	91.77	.4789	5.72	71.09	76.81	-12
-10	19.20	4.50	91.57	0.4993	6.14	70.91	77.05	-10
-8	20.08	5.38	91.35	.5203	6.57	70.72	77.29	-8
-6	20.98	6.28	91.14	.5420	6.99	70.53	77.52	-6
-4	21.91	7.21	90.93	.5644	7.41	70.34	77.75	-4
-2	22.87	8.17	90.72	.5872	7.83	70.15	77.98	-2
0	23.87	9.17	90.52	0.6109	8.25	69.96	78.21	0
2	24.89	10.19	90.31	.6352	8.67	69.77	78.44	2
4	25.96	11.26	90.11	.6606	9.10	69.57	78.67	4
6	27.05	12.35	89.88	.6864	9.53	69.37	78.90	6
8	28.18	13.48	89.68	.7129	9.96	69.17	79.13	8
10	29.35	14.65	89.45	0.7402	10.39	68.97	79.36	10
12	30.56	15.86	89.24	.7687	10.82	68.77	79.59	12
14	31.80	17.10	89.03	.7981	11.26	68.56	79.82	14
16	33.08	18.38	88.81	.8288	11.70	68.35	80.05	16
18	34.40	19.70	88.58	.8598	12.12	68.15	80.27	18
20	35.75	21.05	88.37	0.8921	12.55	67.94	80.49	20
22	37.15	22.45	88.13	.9251	13.00	67.72	80.72	22
24	38.58	23.88	87.91	.9588	13.44	67.51	80.95	24
26	40.07	25.37	87.68	.9930	13.88	67.29	81.17	26
28	41.59	26.89	87.47	1.028	14.32	67.07	81.39	28
30	43.16	28.46	87.24	1.065	14.76	66.85	81.61	30
32	44.77	30.07	87.02	1.102	15.21	66.62	81.83	32
34	46.42	31.72	86.78	1.140	15.65	66.40	82.05	34
36	48.13	33.43	86.55	1.180	16.10	66.17	82.27	36
38	49.88	35.18	86.33	1.221	16.55	65.94	82.49	38

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

PHYSICAL PROPERTIES OF SATURATED REFRIGERANT-12* (Continued)

Temp. Deg. F. Col.1	PRESSURE LBS. PER SQ. IN Absolute Col.2	Gauge Col.3	DENSITY LBS. PER CU.FT. Liquid Col.4	Vapor Col.5	HEAT CONTENT ABOVE-40° F B.T.U. PER LB. Liquid Col.6	Latent Col.7	Total of Vapor Col.8	Temp Deg. F. Col.9
40	51.68	36.98	86.10	1.263	17.00	65.71	82.71	40
42	53.51	38.81	85.88	1.304	17.46	65.47	82.93	42
44	55.40	40.70	85.66	1.349	17.91	65.24	83.15	44
46	57.35	42.65	85.43	1.393	18.36	65.00	83.36	46
48	59.35	44.65	85.19	1.438	18.82	64.74	83.57	48
50	61.39	46.69	84.94	1.485	19.27	64.51	83.78	50
52	63.49	48.79	84.71	1.534	19.72	64.27	83.99	52
54	65.63	50.93	84.50	1.583	20.18	64.02	84.20	54
56	67.84	53.14	84.28	1.633	20.64	63.77	84.41	56
58	70.10	55.40	84.04	1.686	21.11	63.51	84.62	58
60	72.41	57.71	83.78	1.740	21.57	63.25	84.82	60
62	74.77	60.07	83.57	1.795	22.03	62.99	85.02	62
64	77.20	62.50	83.34	1.851	22.49	62.73	85.22	64
66	79.67	64.97	83.10	1.909	22.95	62.47	85.42	66
68	82.24	67.54	82.86	1.968	23.42	62.20	85.62	68
70	84.82	70.12	82.60	2.028	23.90	61.92	85.82	70
72	87.50	72.80	82.37	2.090	24.37	61.65	86.02	72
74	90.20	75.50	82.12	2.153	24.84	61.38	86.22	74
76	93.00	78.30	81.87	2.218	25.32	61.10	86.42	76
78	95.85	81.15	81.62	2.284	25.80	60.81	86.61	78
80	98.76	84.06	81.39	2.353	26.28	60.52	86.80	80
82	101.7	87.00	81.12	2.423	26.76	60.23	86.99	82
84	104.8	90.1	80.87	2.495	27.24	59.94	87.18	84
86	107.9	93.2	80.63	2.569	27.72	59.65	87.37	86
88	111.1	96.4	80.37	2.645	28.21	59.35	87.56	88
90	114.3	99.6	80.11	2.721	28.70	59.04	87.74	90
92	117.7	103.0	79.86	2.799	29.19	58.73	87.92	92
94	121.0	106.3	79.60	2.880	29.68	58.42	88.10	94
96	124.5	109.8	79.32	2.963	30.18	58.10	88.28	96
98	128.0	113.3	79.06	3.048	30.67	57.78	88.45	98
100	131.6	116.9	78.80	3.135	31.16	57.46	88.62	100
102	135.3	120.6	78.54	3.224	31.65	57.14	88.79	102
104	139.0	124.3	78.27	3.316	32.15	56.80	88.95	104
106	142.8	128.1	78.00	3.411	32.65	56.46	89.17	106
108	146.8	132.1	77.73	3.509	33.15	56.12	89.21	108
110	150.7	136.0	77.46	3.610	33.65	55.78	89.43	110
112	154.8	140.1	77.18	3.714	34.15	55.43	89.58	112
114	158.9	144.2	76.89	3.823	34.65	55.08	89.73	114
116	163.1	148.4	76.60	3.934	35.15	54.72	89.87	116
118	167.4	152.7	76.32	4.049	35.65	54.36	90.01	118

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

PHYSICAL PROPERTIES OF SATURATED REFRIGERANT-12* (Continued)

Temp. Deg. F. Col.1	PRESSURE LBS. PER SQ. IN Absolute Col.2	Gauge Col.3	DENSITY LBS. PER CU.FT. Liquid Col.4	Vapor Col.5	HEAT CONTENT ABOVE-40° F B.T.U. PER LB. Liquid Col.6	Latent Col.7	Total of Vapor Col.8	Temp Deg. F. Col.9
120	171.8	157.1	76.02	4.167	36.16	53.99	90.15	120
122	176.2	161.5	75.72	4.288	36.66	53.62	90.28	122
124	180.8	166.1	75.40	4.413	37.16	53.24	90.40	124
126	185.4	170.7	75.10	4.541	37.67	52.85	90.52	126
128	190.1	175.4	74.78	4.673	38.18	52.46	90.64	128
130	194.9	180.2	74.46	4.808	38.69	52.07	90.76	130
132	199.8	185.1	74.13	4.948	39.19	51.67	90.86	132
134	204.8	190.1	73.81	5.094	39.70	51.26	90.96	134
136	209.9	195.2	73.46	5.247	40.21	50.85	91.06	136
138	215.0	200.3	73.10	5.405	40.72	50.43	91.15	138
140	220.2	205.5	72.73	5.571	41.24	50.00	91.24	140

+Inches of Mercury Vacuum.
*Reproduced from Circular No. 12 of the American Society of Refrigerating Engineers.

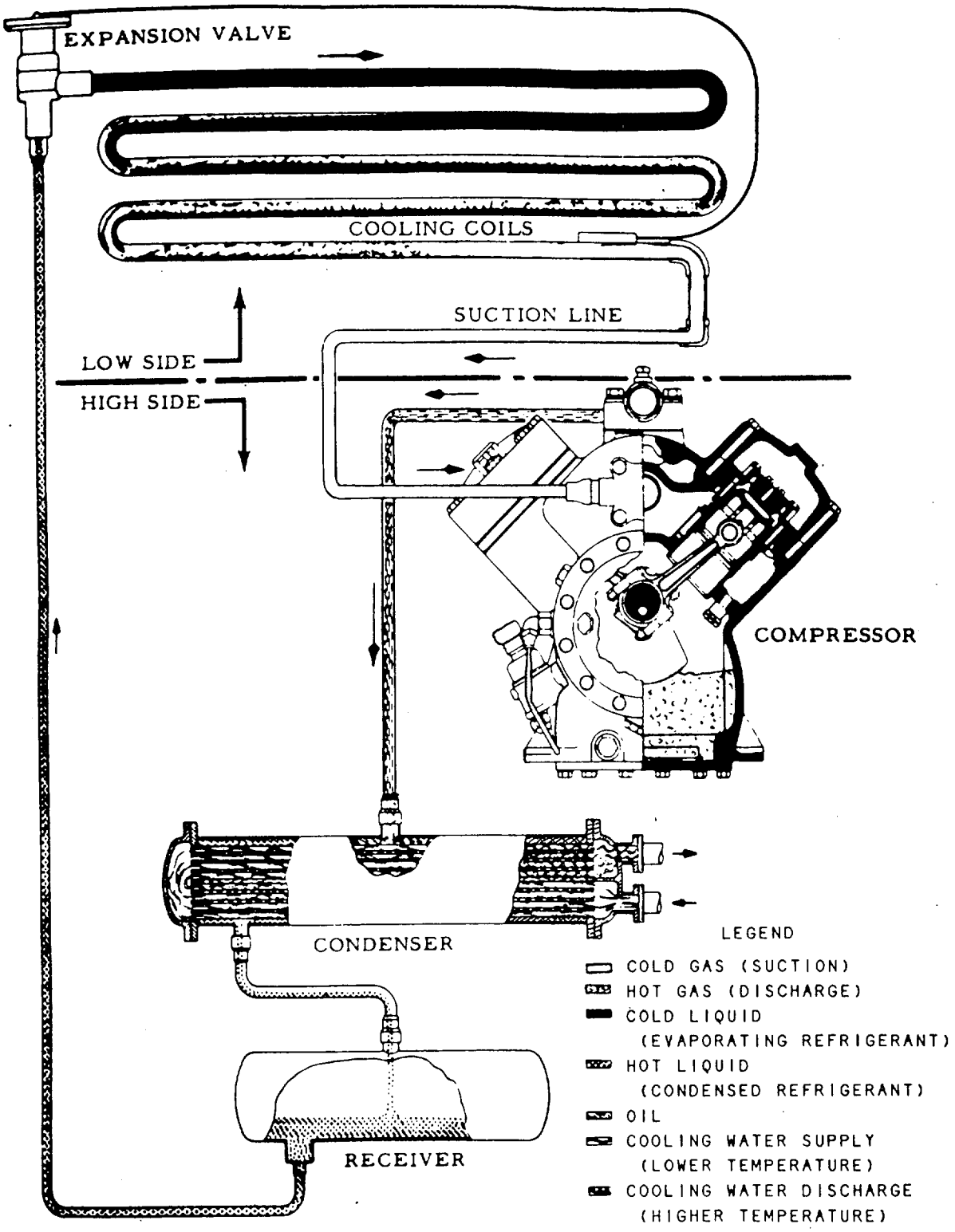
(2) Cycle of Operation.

(a) The cycle of operation of a refrigeration system comprises four distinct functions:

1 The absorption of heat by the evaporation of liquid refrigerant under low pressure.
2 Forcing the heat contained in the resulting gas to a higher temperature level by compression.
3 The rejection of heat by the condensation and liquefaction of the compressed refrigerant vapor.
4 The reduction of pressure within the evaporator so that the liquid refrigerant may be evaporated and the cycle repeated.

(b) The refrigeration cycle can be traced from any point in the system. Therefore, referring to the following figure, let us start with the liquid refrigerant entering the evaporator (cooling coils). The refrigerant is supplied to the cooling coils by an automatic throttling device called the expansion valve, which is actuated by both pressure and temperature. The refrigerant as supplied to the inlet side of the expansion valve is in a liquid state and under high pressure. The expansion valve is one of the division points between the "high side" and the "low side" of the system.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

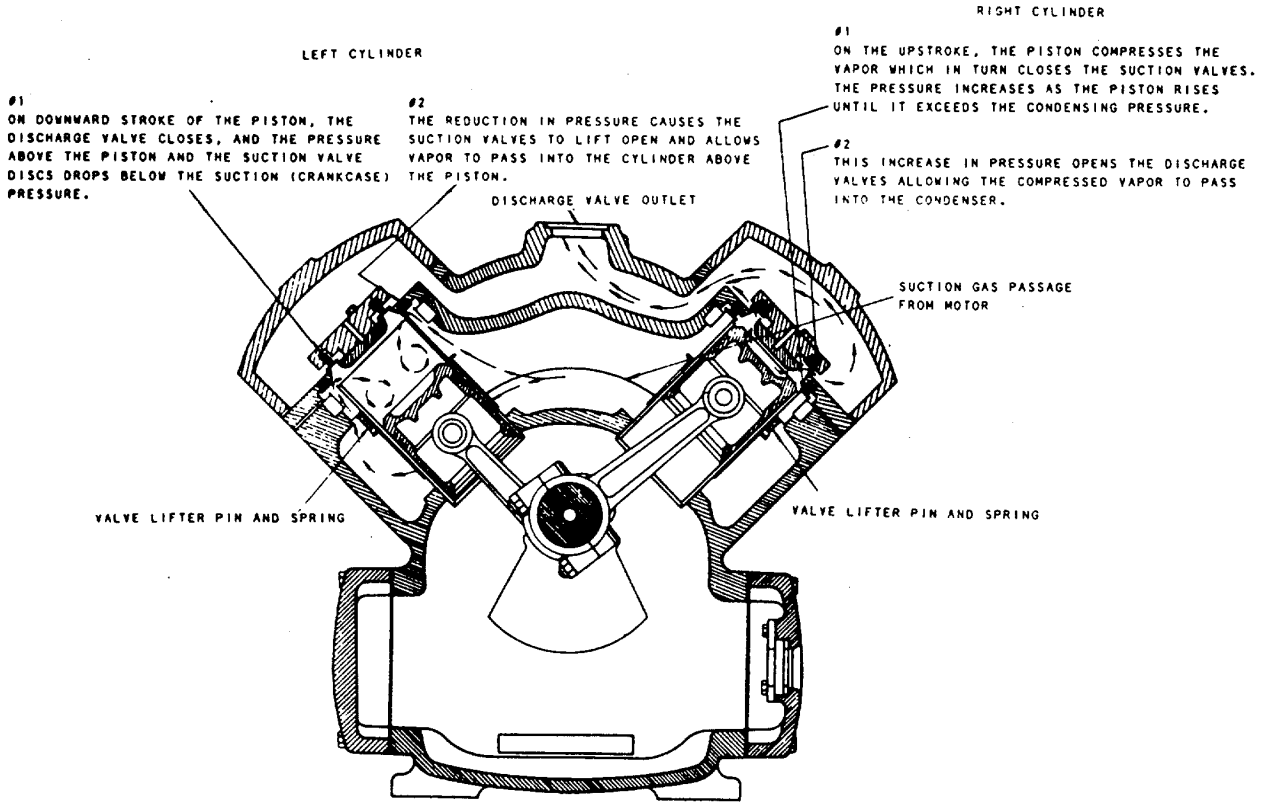


Compression Refrigeration Cycle.

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(c) The liquid refrigerant, when passing through the orifice with the expansion valve, expands into the cooling coils at a lower pressure than that on the inlet side of the valve. The reduction of pressure permits the refrigerant to boil or vaporize at a low temperature, which it immediately begins to do by absorbing heat from the air or other substance to be cooled. This heat flows into the cooling coil surface and then into the liquid, which is at a lower temperature. The expanded liquid, as it continues to pass through the cooling coil, continues to absorb heat until it is completely evaporated.

(d) Due to the pressure difference between the "high" and "low side" of the system, and also the suction effect of the compressor, the gas thus produced is drawn through the suction line into the compressor cylinder. The downstroke of the piston admits a cylinder full of gas through the suction valve, and then compresses this gas on the upstroke, thereby raising its temperature and pressure. The compressed gas is presented from re-entering the cylinder on its next downstroke by the compressor discharge valve. This hot gas, under high pressure, then flows to the condenser. The compressor discharge valve, like the expansion valve, is the other division between the "high side" and the "low side" of the system.



Gas Paths Through Compressor

4-28. AIR CONDITIONING SYSTEM-MAINTENANCE INSTRUCTIONS (Continued).

(e) After the compressed gas passes the discharge valve and enters the condenser, heat flows from the hot gas into the condenser coolant, thus cooling the compressed gas and changing the state of the refrigerant from a gas to a liquid. This liquid then drains into the receiver from which the liquid refrigerant (under pressure) is forced through the liquid line to the expansion valve for a repetition of the cycle.

c. Characteristics of Refrigerant-12.

(1) The chemical formula for refrigerant-12 (R-12) is $CCl_2 F_2$ dichlorodifluoromethane. R-12 resembles carbon tetrachloride (the fire extinguishing fluid) in odor, and at ordinary temperatures it is a liquid when under pressure of about 75 psig (517.1 kPa). R-12 is shipped in a liquid state and under pressure in steel cylinders. For safety precautions in handling refrigerant-12, refer to paragraph 4-28d(2).

(2) Liquid R-12 is colorless (like water) and free from cloudiness. It is odorless in concentrations of less than 20% by volume of air. Its vapor or vapor air mixture higher than 20% is mildly ethereal. In general it may be stated that R-12 is:

(a) A non-combustible, non-toxic, non-irritating, non-explosive, non-inflammable refrigerant under normal conditions, where volume of air is sufficient and no open flame is present. (This may not be the case in a ship's hold where refrigeration machinery may be installed in a confined space with poor ventilation.)

(b) A stable compound capable of undergoing, without decomposition, the physical changes to which it is commonly subjected in refrigeration service.

(c) Non-corrosive to iron, steel, copper, brass, monel metal, etc., in the absence of moisture.

(3) For pressure-temperature relationship of refrigerant-12 refer to table on page 4-826 thru 4-828.

NOTE

If R-12 should come into contact with an open flame of high temperature (about 1,000° F (537.8° C) it may be decomposed into phosgene, a highly toxic gas. However, in such a case the pungent and irritating fumes would be noticed long before a concentration dangerous to health could be reached.

WARNING

Wear goggles to prevent liquid R-12 from getting into the eyes when charging, purging or opening the system for repairs.

d. Safety Precautions.

(1) Operating.

(a) Inspect oil level in compressor crankcase periodically. The proper time to check oil level is immediately after the compressor has been shut down following a long period of operation. The oil level should also be checked before starting the compressor. The ideal oil level is from one-half to three-quarters up on the bull's-eye sight glass. The minimum oil level is one-quarter up on the glass.

(b) Check compressor oil pressure periodically. It should be 45-55 psi (310.3-379.2 kPa) above suction pressure.

(c) Never start a compressor without making sure that any shutoff valve between the compressor and the condenser is open.

(d) Do not jack or turn the compressor by hand when power is on.

(e) Whenever the compressor motor is first started, the operator should stand by the switch and start the motor in short intermittent spurts until it is certain that the compressor is operating properly. If possible, the compressor should be turned over several times by hand, to clear the cylinders of any oil that may have collected there during shipment or erection. When starting up the compressor, avoid rapid pumping down of the low side pressure. The operator should also be certain that liquid refrigerant is not being returned to the compressor. Liquid return will be indicated by the crankcase and cylinder being relatively cold, sweating or frosted.

(f) In case of severe vibration or unusual noise, stop the unit and investigate.

(g) Do not attempt to add oil to compressor crankcase while compressor is in operation. Isolate and pump down to slightly above atmospheric pressure in crankcase before removing filler plug.

(h) Never bridge an overload or any other protective device because it kicks out during operation. Find the trouble and make the proper repairs.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(i) Do not wipe down near moving parts.

(j) In case of electrical fire, open circuit switch and extinguish with CO_2 (never use water).

(k) Be sure power is turned off before working on motors, controllers, solenoid valves and electrical control switches. Tag circuit breaker to prevent accidental energizing of circuit.

(l) When isolating any part of the system in which there is liquid refrigerant, close the cut-out valve on inlet side of the part to be isolated and allow the compressor to remove all liquid refrigerant. This will be indicated by a sudden chilling of the part being isolated. When the part begins to get warm again it may be considered devoid of liquid refrigerant. Close valve on outlet side of isolated part before opening bypass valves, if provided.

(m) Never open any part of the system which is under a vacuum. If this is done, air and moisture will be drawn into the system and are almost certain to cause trouble at some later date. The section to be opened should be under 1 - 2 psig (6.9 - 13.8 kPa) pressure to prevent the admission of air and moisture into the system.

(n) During the shutdown period of any condenser, if there is a possibility of obtaining freezing temperatures in the machinery room, drain the condenser and connecting piping to prevent a freeze-up and damage to condenser tubes.

(o) After an inspection or repairs have been made, always be sure to expel all the air from the part of the system that has been opened by admitting a small amount of refrigerant gas into that part of the system.

(2) Handling Refrigerant-12.

(a) Refrigerant-12 is practically odorless and non-toxic. It is not necessary to wear a gas mask when servicing equipment in which it is contained unless the conditions necessary for the decomposition of R-12 to phosgene gas exist. Refer to item (b) below.

(b) Never use a torch or attempt a repair on a line containing R-12 until it is certain that all gas has been pumped out of the section of pipe to be repaired, the area is well ventilated and the line has been valued off. Refrigerant-12 in contact with an open flame of high temperature (about 1,000° F (557.8°C)) decomposes into phosgene, a highly toxic gas.

(c) Always wear goggles when handling R-12, or servicing equipment in which it is contained, to avoid the possibility of liquid refrigerant coming in contact with the eyes.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(d) If liquid R-12 accidentally comes in contact with the eyes, take person suffering the injury to the medical officer at once. Do not rub or irritate the eyes and give the following first aid treatment immediately:

1 Introduce drops of sterile mineral oil into the eyes as an irrigant.

2 If irritation continues at all, wash the eyes with a weak boric acid solution, or a sterile salt solution not to exceed 2% sodium chloride.

(e) Should liquid R-12 come in contact with the skin, treat the injury the same as though the skin had been frost bitten or frozen.

(f) Do not work in a closed space where R-12 may be leaking unless adequate ventilation is provided.

(g) Should a person be overcome in a space which lacks oxygen because of high concentrations of R-12 being present, treat such person the same as for suffocation, i.e., through artificial respiration.

e. Operating Procedures.

(1) Starting.

Proceed as outlined below to start the condensing unit:

CAUTION

When starting the compressor, avoid rapid pumping down of the low pressure side. Rapid evacuation may pull the oil from the compressor crankcase. A variable percentage of refrigerant is always mixed with the oil in the crankcase and is subject to evaporation at lowering pressures. Rapid boiling of the refrigerant and consequent high velocity gas will carry large percentages of oil. The crankcase oil may leave with the evaporating refrigerant and circulate through the system with perhaps considerable delay in returning to the crankcase. If the oil is pulled from the crankcase as described, do not run the compressor without lubricant. Stop the compressor and add oil temporarily. The added oil may later be removed on evidence of an excess in the crankcase.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(a) Check oil level in compressor crankcase. The level should be at the center of the bull's-eye sight glass. If necessary, add Carrier No. PP36-1 oil. Check compressor motor lubrication.

(b) Open any stop valves in refrigerant, oil and sea water lines to pressure gauges and control switches.

(c) Line up condenser sea water circulating system:

1 Open condenser water regulator cut-out valves, water regulator bypass valve, water regulator actuating line valve, and condenser water inlet valve.

2 Close condenser water vents and drains.

3 Open sea water circulating pump suction and discharge valves, water pump gauge line valve at the pump, and any other valves in pump discharge line.

NOTE

On systems having sea water circulating pumps, water supply from firemain should be obtained in case of emergency, or when ship is beached, by opening condenser water supply valve from firemain.

4 Open any valves in condenser overboard discharge line.

(d) Line up refrigerant system valves:

1 Open compressor discharge stop valve, condenser inlet and outlet valves, condenser-receiver equalizing line valve, and heat interchanger liquid inlet valve.

2 Close charging and drain valves, purge valve, and heat interchanger liquid bypass valve.

3 Open dryer bypass line valve.

4 Close dryer inlet and outlet valves.

5 Open thermal expansion and solenoid cut-out valves, thermal expansion valve equalizing line valve and coil return (outlet) valves at the evaporator.

6 Close hand expansion valves at the evaporator.

7 Close hot gas defrosting supply valves at compressor and cooling coil. Close hot gas defrosting hand expansion valves.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

8 During pulldown, bypass suction pressure regulator. Open bypass valve and close cut-out valves.

9 After pulldown, place suction pressure regulator on the line. Open cut-out valves and close bypass valve.

10 Close suction pressure regulator test connection or gauge line valve.

(e) Start sea water circulating through condenser. Test for water flow by slightly opening drains at bottom of condenser water heads. At short intervals, open vents atop condenser water heads to release all air from water side and fill condenser tubes with water. When venting is completed (water will squirt from the vents) close vents.

(f) Start air circulating fans in fan rooms and compartments.

(g) Check electrical power supply to all solenoid valves. Power supply may be fan motor controller, compressor motor controller, or separate source. Solenoids powered from compressor motor controller will not be energized until compressor is started.

(h) On initial start-up, charge refrigerant. Refer to paragraph 4-28e(5).

(i) Open compressor suction stop valve approximately one full turn.

(j) With compressor motor controller selector switch in AUTO position, push START button. If motor controller is equipped with L.P. BYPASS button, momentarily push START button while holding in L.P.BYPASS button continuously. When motor is running at full speed, release L.P. BYPASS button. Proceed with step (k) immediately.

NOTE

On systems where the condenser water pump motor controller is interlocked with the compressor motor controller, the pump will start first. As soon as sea water pressure to the condenser has built up closing the water pressure failure switch contacts, the compressor will also start. Vent condenser water side as per step (g).

(k) Continue to open compressor suction stop valve as suction pressure is reduced to normal (cut-in pressure of low pressure control switch). Open suction valve slowly to prevent rapid pumping down of low pressure side which could cause oil foaming with consequent pumping of oil from compressor crankcase.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(l) Observe compressor operation for approximately five minutes. If there is not evidence of liquid refrigerant return to compressor, open suction valve wide. If there is evidence of liquid returning to the compressor, throttle suction valve until proper suction pressure is obtained. Liquid return to compressor will be indicated by a sudden drop in suction temperature and rapid fluctuation in suction pressure. If these conditions continue, or the compressor develops a knock, stop it immediately and shutoff liquid supply to evaporator. After about five minutes, open liquid supply to evaporator and restart with suction valve throttled. When all evidence of liquid return disappears, open suction valve wide.

(m) Check compressor oil pressure. Should be 45 - 55 psi (310.3 - 379.2 kPa) above suction pressure.

(n) Check operation of condenser water regulator. If it is operating properly, close condenser water regulator bypass valve. Adjust water regulator to maintain a head pressure of 90 to 125 psig (620.5 to 861.9 kPa). If a water regulator is not provided, throttle water outlet valve to maintain required head pressure.

(3) Operating.

(a) A complete check should be made every hour of all temperatures, pressures, and the oil level in the compressor crankcase.

(b) Avoid frost formation on compressor cylinders, suction lines and crankcase. This is caused by liquid refrigerant returning to the compressor. If this condition persists, check expansion valves for proper operation. Suction gas entering the compressor should be about 65° F (18.3°C) for air conditioning.

(c) Adjust sea water flow through condenser to maintain a condensing refrigerant pressure not exceeding 125 psig (861.9 kPa).

(d) Compressor oil pressure not to exceed 45 - 55 psi (310.3 - 379.2 kPa) above suction pressure.

(e) The temperatures of the refrigerated spaces should be maintained as specified.

(f) If the compressor discharge gas temperature exceeds 240° F (115.6°C), the heat interchanger should be bypassed by closing the liquid inlet valve and opening the bypass valve. The heat interchanger should otherwise be kept in operation.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(g) Hand expansion valves in the refrigerant circuits permit manual operation when the automatic control valves are isolated for service, inspection or repairs. After isolating the expansion and solenoid valves by closing cut-out valves, a circuit can be operated by throttling the hand expansion valve. Crack hand expansion valves open gradually (about 1/4 turn at a time) and not too much to avoid flooding coils and liquid return to compressor.

(4) Securing.

(a) Before stopping the compressor for any time longer than several minutes, the supply of liquid refrigerant to the evaporator should be shut off. This will prevent flooding the evaporator and avoid liquid refrigerant return to the compressor when restarting.

(b) If the solenoid valves at the evaporator are energized from the compressor motor controller, or a king solenoid valve wired to the motor controller is provided, the solenoids automatically close and cut off the flow of liquid to the evaporator when the controller STOP button is depressed.

(c) To secure a condensing unit, proceed as outlined below. If the plant consists of two or more interconnected units, with the plant operating under split plant conditions, proceed as outlined below for each unit.

NOTE

For extended periods of compressor shutdown, the system should be pumped down. Refer to paragraph 4-28e(4).

1 Close main liquid line stop valve (dryer bypass or inlet valve).

2 Let compressor run until it cuts out on low pressure setting of low pressure control switch.

3 Stop compressor at motor controller. Depress STOP button.

4 Close compressor suction and discharge stop valves.

5 Secure condenser sea water circulating system. Open vents atop and drains at bottom of water heads and drain condenser if there is danger of water freezing in condenser tubes.

6 All other valves of condensing unit may be closed.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(5) Pumping Down.

If the system is to be opened for inspection or service, or is to be secured for an extended period (a month or more), the system should first be pumped down. The system should never be opened while under a vacuum to avoid harmful admission of air and moisture. Proceed as outlined below for the condensing unit.

NOTE

If compressor only is to be opened for service or repair, it is not necessary to pump down entire system. To pump down compressor only, gradually close suction stop valve while unit is operating. Run compressor (refer to step (b) below) until suction pressure remains at 2 psig (13.8 kPa). Then stop the unit and close discharge stop valve.

(a) Close main liquid line stop valve (dryer bypass or inlet valve).

(b) Run compressor with compressor motor controller in AUTO position or L.P.BYPASS button held in. Run compressor until a suction pressure of 2 - 3 psig (13.8 - 20.7 kPa) is obtained. Stop the unit. After a few minutes, suction pressure may rise gradually. If this happens, restart unit and pump down again. Repeat this operation until suction pressure remains at 2 psig (13.8 kPa). If compressor pounds or knocks while pumping down, stop it for a few minutes, then restart.

(c) Close compressor suction and discharge stop valves.

CAUTION

If compressor is to be shut down for an extended period, tag starting switch and compressor stop valves. If compressor is started with discharge valve closed it may be seriously damaged.

(d) Secure sea water circulating system to condenser.

(e) For an extended shutdown, or if there is danger of water freezing in condenser tubes, open vents top and drains at bottom of water heads and drain condenser.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

f. Refrigerant Charge.

(1) The initial refrigerant charge for the entire system was done at a shipyard. This is an estimated quantity based on the internal volume of system piping and components.

(2) In practice, it may be necessary to add or remove refrigerant. High head pressure may indicate refrigerant overcharge. Low head pressure may indicate refrigerant undercharge. (Refer to troubleshooting in Volume 3 for other possible causes of high or low head pressure.)

(3) The actual amount of refrigerant to be removed from or added to a charged system for optimum operation must be determined by trial and error. Add or remove small amounts to obtain desired head pressure (not to exceed 125 psig (861.9 kPa).

(4) Charging Refrigerant.

(a) Liquid refrigerant is charged into the system through the charging valve connected to the main liquid line upstream of the dryer. Pressure in the refrigerant drum forces the liquid refrigerant through the dryer, liquid line and thermal expansion valves. The refrigerant evaporates in the cooling coils or other evaporator. It is withdrawn by the compressor and pumped into the condenser where it is liquefied and drains to collect in the receiver. To charge with refrigerant, proceed as outlined below:

1 Check compressor oil level, line up condenser sea water and refrigerant system valves, start air circulating fans or circulating pump(s) if brine or chilled water is to be cooled, and start sea water flow through condenser. Refer to paragraph 4-28e(2) steps (a) through (g).

NOTE

When adding refrigerant to a charged system, leave valves in their normal operating positions and start with step (2) below.

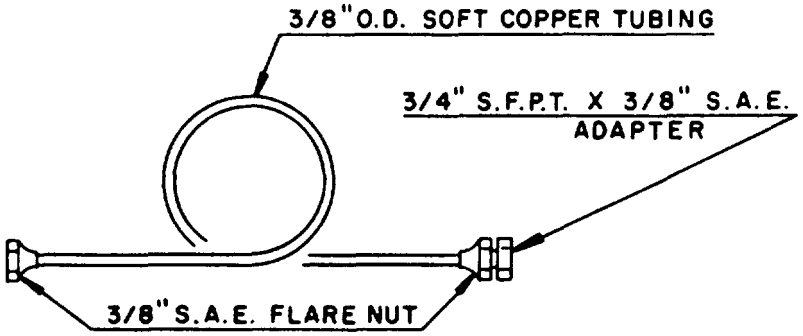
2 Close dryer bypass and inlet valves, if dryer is provided with bypass. If not, close dryer inlet valve. Refrigerant must be charged through dryer to exclude air and moisture from system.

3 Check to see that solenoid valves are open. The solenoid thermostat contacts should be closed and a humming sound should be heard with ear pressed against solenoid valve casing.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

4 Weigh refrigerant drum. Weight of refrigerant contained in drum can be determined by comparing total weight with tare weight stamped on drum. Amount of refrigerant charged can also be determined by comparing drum weights before and after charging.

5 Connect refrigerant drum to charging valve with flexible charging line. A charging line which can be easily made up is as shown below. Before securing charging line tightly to charging valve, crack open valve on refrigerant drum slightly and blow out charging line. With charging line connections made tight, open drum valve slightly to test connections for leaks. Incline drum with valve end down.



Charging or Drain Line

NOTE

When adding refrigerant to a charged system, start compressor and pump down system to a suction pressure of 1 - 2 psig (6.9 - 13.8 kPa). Refer to paragraph 4-28(5)(b).

6 Open charging valve and carefully open valve on refrigerant drum. Liquid refrigerant will flow into the system.

7 Start compressor as outlined in paragraph 4-28(5)(b) steps (9) through (14).

8 Continue charging until estimated amount of refrigerant required has been charged. If required refrigerant charge by weight is not known, observe liquid level in receiver. When receiver is nearly full, close charging valve, close dryer outlet valve, and open dryer bypass valve. If dryer has no bypass, close charging valve and open dryer inlet valve. With system operating, observe

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

liquid refrigerant flow through sight glass. If bubbles appear, additional refrigerant is required. If a solid column of liquid appears, the refrigerant charge is sufficient.

9 To completely empty a refrigerant drum, pressure in drum must be greater than pressure in liquid line. As drum is emptied, pressures equalize. To maintain a pressure difference great enough to force refrigerant into liquid line, heat drum with steam or hot water.

10 When a drum has been emptied and it is necessary to connect another drum to complete charging, close charging valve and drum valve. Stop compressor and disconnect empty drum. Connect a new drum as per step (5) and resume charging.

11 When required amount of refrigerant has been charged, close drum valve. Allow compressor to stop by action of low pressure cut-out switch. Close charging valve. Close dryer outlet valve and open dryer bypass valve. If dryer has no bypass, open dryer inlet valve. Place suction pressure regulator(s) in operation by opening cut-out valves and closing bypass valve. Allow compressor to operate until normal operating conditions are reached. Then, check liquid level in receiver. There should be enough liquid refrigerant in bottom of receiver to prevent passage of refrigerant gas into liquid lines. If there is no liquid in receiver, reposition valves and charge additional refrigerant.

12 When sufficient refrigerant has been charged, close charging valve. Close drum valve and disconnect charging line and drum. Close dryer outlet valve and open dryer bypass valve. If dryer has no bypass, open dryer inlet valve. Store empty refrigerant drums for re-use.

(5) Removing Refrigerant.

(a) Refrigerant-12 may be removed from the system through the refrigerant drain valve. The charging valve is often installed at a low point in the system so that it can also be used as a drain valve or a separate drain valve in the main liquid line is provided.

(b) With all refrigerant system valves in their normal operating positions, proceed as follows to drain refrigerant:

1 Shut off liquid supply to evaporator(s). Close dryer bypass valve, open dryer inlet valve, and be sure dryer outlet valve is closed. If dryer has no bypass, close heat interchanger liquid inlet valve and be sure that heat

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

interchanger liquid bypass valve is closed. If a heat interchanger is not installed, close cut-out valves installed upstream of solenoid and thermal expansion valves at the evaporator(s).

2 Weigh an empty refrigerant-12 drum.

3 Place empty drum on deck at an angle slightly above horizontal with drum valve at high end.

4 Connect drum to drain valve with a flexible drain line identical to charging line. Tighten connection at drain valve. Purge air from drain line by momentarily cracking open drain valve and tighten connection at drum.

5 With compressor operating automatically, open drum valve and drain valve. Liquid refrigerant will flow into drum.

6 Weigh drum while filling with refrigerant and compare with weight of empty drum obtained in step 2. Drum should be filled only to its rated weight of liquid refrigerant. To fill drum to its rated capacity, immerse it in an ice water bath. Cooling of drum will also permit rapid drainage of refrigerant.

CAUTION

Never fill a drum beyond its rated capacity. Damage may result from excessive hydraulic pressure upon temperature rise.

7 When required amount of refrigerant has been removed, close drain valve and drum valve. Loosen drain line connections, allow any liquid refrigerant in drain line to evaporate, and remove drain line. Store filled refrigerant drum.

8 When removing only some refrigerant to correct system overcharge, open liquid supply to evaporator(s) shut off in step 1 and resume normal system operation.

9 If entire refrigerant charge is to be removed, attach new drum as per step 4 and repeat draining operation. If may be necessary to pump down system several times to insure complete removal of refrigerant.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(6) Refrigerant Undercharge.

(a) If the conditions listed below exist simultaneously, the system is short of refrigerant. Test for leaks and repair any found. Add refrigerant to restore charge to correct level.

1 No liquid level in receiver.

2 Vapor bubbles in liquid line sight glass.

3 Compressor runs continuously or short cycles on low pressure cut-out.

4 Low suction and head pressures.

5 Required temperatures in refrigerated spaces or other medium being cooled cannot be maintained.

6 Hissing sound at control valves (caused by vapor in liquid lines).

(7) Refrigerant Overcharge.

If the system is overcharged with refrigerant, it will result in high head pressure. The condenser will be flooded with liquid refrigerant and its capacity will be reduced. This may cause the compressor to short cycle on high pressure cut-out and possibly cause damage to the compressor. System overcharge will also result in high power consumption and, if an expansion valve is leaky, in increased flooding of refrigerant to the compressor during the off cycle. If refrigerant overcharge is indicated, remove refrigerant to restore charge to correct level.

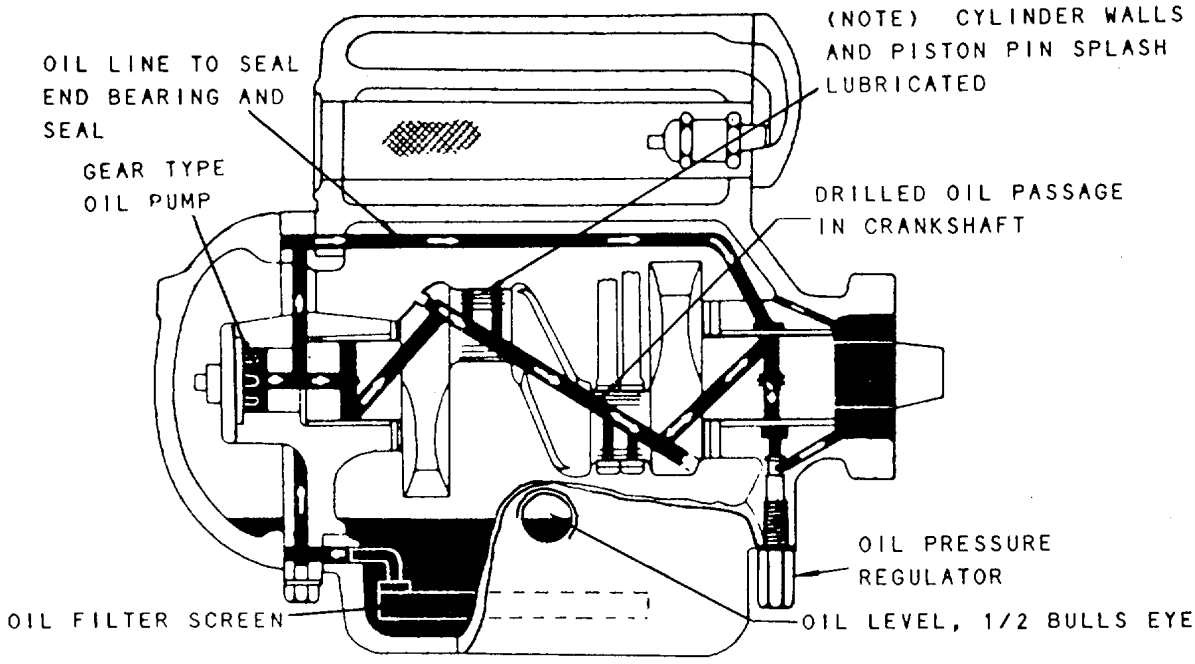
(8) Refrigerant Flooding.

Whenever a refrigeration system is started after a shutdown, liquid refrigerant may flood back to the compressor. If an excessive amount of liquid refrigerant has been laying in the coils, it will overflow into the suction line on start up. Avoid flooding by temporarily throttling the compressor suction stop valve. The thermal expansion valves must not be reset to avoid flooding at this time or their performance will be faulty during normal operation.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

g. Compressor Lubrication.

(1) A typical compressor lubrication system is shown below.



Typical Lubrication System

(2) Oil Circulation in System.

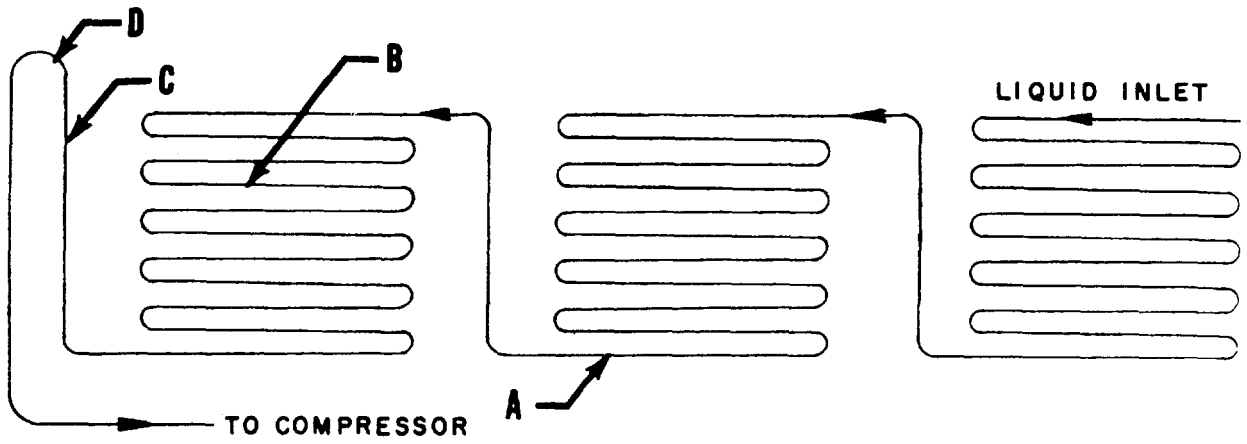
(a) A certain amount of compressor oil will always circulate through the refrigerant system because oil is miscible in refrigerant 12. To allow for oil circulation, systems requiring a large refrigerant charge will require the addition of oil in excess of the normal compressor crankcase oil charge.

(b) When the system is first placed in operation, closely observe the oil level in the compressor crankcase. Add oil whenever the oil level drops below normal (half-way up on bull's-eye sight glass). Allow sufficient time for the system to balance after adding oil, since some of the circulating oil may return to the compressor. Then, again check oil level. Generally, the addition of one quart of oil for each fifty pounds (22.7 kg) of refrigerant charge will be an adequate allowance for oil circulation.

(c) After adding oil, if the oil level in the crankcase still falls below normal, oil is not returning to the compressor. The oil is probably being trapped in the cooling coils by an improperly adjusted thermal expansion valve.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(d) To prevent an oil pocket at (A), liquid refrigerant in the coil should extend at least to point (B). Riser line (C) is sized so that the velocity of the refrigerant suction gas will carry the oil up and over suction loop (D).



Wetted Surface of Cooling Coil

(e) If necessary to adjust the expansion valve to eliminate an oil trap at (A), do it soon after defrosting, before new frost has accumulated on the coils. At that time, it will be easy to determine the end of the wetted portion of the coil, that is, how far liquid refrigerant extends in the coil. (A decided difference in the rate of frost accumulation will exist in the area where the liquid refrigerant completes evaporating and becomes a superheated gas.)

(3) Compressor Oil Level and Oil Charge.

(a) After the compressor has been stopped for several minutes, the oil level in the compressor crankcase should be about half-way up on the bull's-eye sight glass. During operation, the oil level will be slightly lower but will appear higher when oil is foaming.

(b) Check the oil level hourly. Add or remove oil to bring level in crankcase to about the middle of the bull's-eye sight glass during steady operating conditions. Follow procedures for adding or removing oil given in paragraphs 4-28f(4) and 4-28f(5).

(c) The initial oil charge for the compressor is shown in table below, but it may be necessary to charge additional oil, since the refrigerant will carry some oil to other parts of the system. Refer to paragraph 4-28f(2).

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(4) Adding Oil.

(a) The method of adding oil given below, if properly followed, will prevent air and moisture from entering the system. Since refergerant-12 gas is heavier than air, and the crankcase is loaded with this gas, the position of the oil charging hole prevents the admission of air.

NOTE

Use only clean oil from sealed containers, Carrier Part No. PP36-1.

1 Pump down compresser. Refer to paragraph 4-28d(5).

2 Slowly remove oil filler plug.

3 Add oil to center of bull's-eye sight glass through a clean, well-dried funnel.

4 Replace oil filler plug tightly.

5 Open compressor suction and discharge stop valves.

6 Start compressor.

(5) Removing Oil.

(a) Pump down compressor. Refer to paragraph 4-28d(5).

(b) Loosen crankcase oil drain plug. Since crankcase is under slight pressure, do not fully remove drain plug. Allow amount of oil to be drained to seep out slowly around the threads of loosened plug.

(c) Retighten drain plug.

(d) Open compressor suction and discharge stop valves.

(e) Start compressor.

(6) Oil Pressure.

(a) Correct oil pressure will insure adequate compressor lubrication and satisfactory operation of the compressor capacity control system (described in paragraph 4-28g).

(b) All compressors are designed to operate with a normal oil pressure of 45 to 55 psi (310.3 to 379.2 kPa) above suction pressure. For example, if the suction gauge reading is 40 psi (275.8 kPA), the oil pressure gauge reading should be 85 to 95 psig (586.1 to 655.0 kPa).

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(c) During start up, observe the oil pressure gauge to be sure that oil pressure develops during the first few minutes. Always check oil pressure when starting. The oil pressure should be normal after steady operating conditions have been reached and the oil has stopped foaming. Oil foaming may last fifteen minutes or longer.

(d) If normal oil pressure does not develop, find and correct the trouble. Low oil pressure may be caused by:

1 Insufficient oil in crankcase.

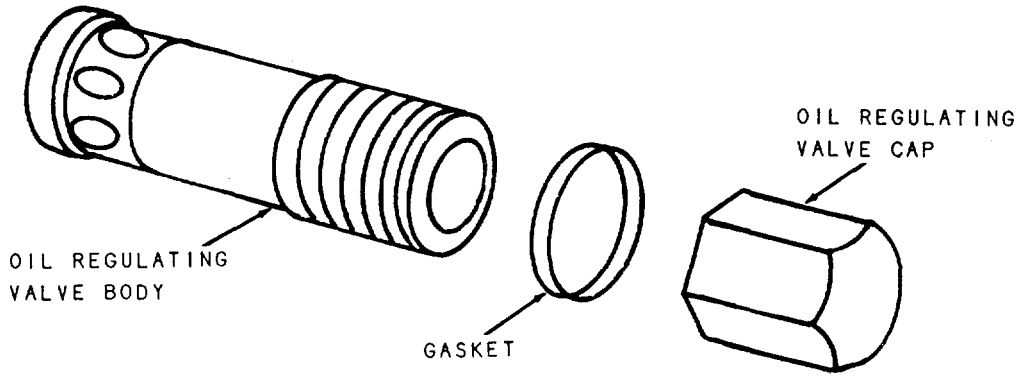
2 Oil pressure regulator not seating properly.

3 Oil filter screen in bottom of crankcase clogged withdirt.

4 Oil pump worn or defective or rotating in wrong direction.

5 Faulty oil piping.

(7) Oil Pressure Regulator.



OIL REGULATING VALVE (NON-ADJUSTABLE)

Oil Pressure Regulator

(b) If correct oil pressure is not obtained, remove and check the oil pressure regulator to see if it is seating properly. Refer to paragraph 4-29.

(c) After checking it, replace oil pressure regulator, start compressor, and check oil pressure. If oil pressure is still too low, oil pump rotation is correct, and oil filter screen in bottom of crankcase is clean, replace the regulator.

(8) Oil Pressure Safety Switch.

(a) The operation of the oil pressure safety switch should be checked periodically (at least once a month) and whenever the compressor is put back in operation after it has cut-out on the oil safety switch. Test operation of oil safety switch.

CAUTION

Do not bypass or manually control oil safety switch to operate compressor if switch has cut-out. To protect compressor from damage, find and correct cause of low oil pressure before placing compressor back in operation. Possible causes of low oil pressure are given in paragraph 4-28f(6) and troubleshooting procedures in volume 3.

(9) Oil Pressure Gauges.

(a) The compressor is provided with: (1) and oil pressure gauge which indicates the oil pump discharge pressure, and (2) a control oil pressure gauge which indicates the oil pressure metered to the capacity control system. The oil pump pressure gauge is mounted either on the compressor or on a separate gauge board. The control oil pressure gauge is mounted on the compressor.

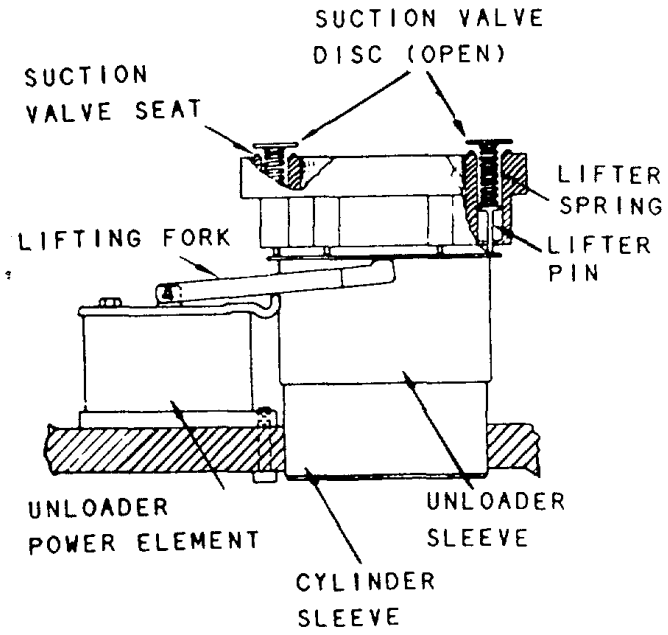
(b) After the capacity control system has been adjusted, isolate the control oil pressure gauge by closing the shut-off valve at the compressor. Leave the oil pump pressure gauge in operation, but crack the shut-off valve so that the needle does not vibrate excessively.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

h. Capacity Control System.

(1) Description of Capacity Control.

(a) The compressor is equipped with a capacity control system operated by oil pressure from the compressor lubrication system. The capacity control system unloads cylinders (that is, cuts cylinders out of operation) in response to decreases in the refrigeration load imposed on the compressor. Unloading of a controlled cylinder is accomplished by holding the cylinder suction valve off its seat (open) so that no gas can be compressed. The suction valve lifting arrangements for the compressor is shown below.



Suction Valve Lifting Arrangement

(b) The capacity control system operates in steps, each step on a given compressor unloading one or more of the controlled cylinders as shown in the table below.

Capacity Control System Steps of Unloading

Compressor Model	No. of Controlled Cylinders	Step 1 No. of Unloaded Cylinders (Compressor Capacity After Unloading	Step 2 No. of Unloaded Cylinders (Compressor Capacity After Unloading
5F30	2 of 3	1 (66-2/3%)	2 (33-1/3%)

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

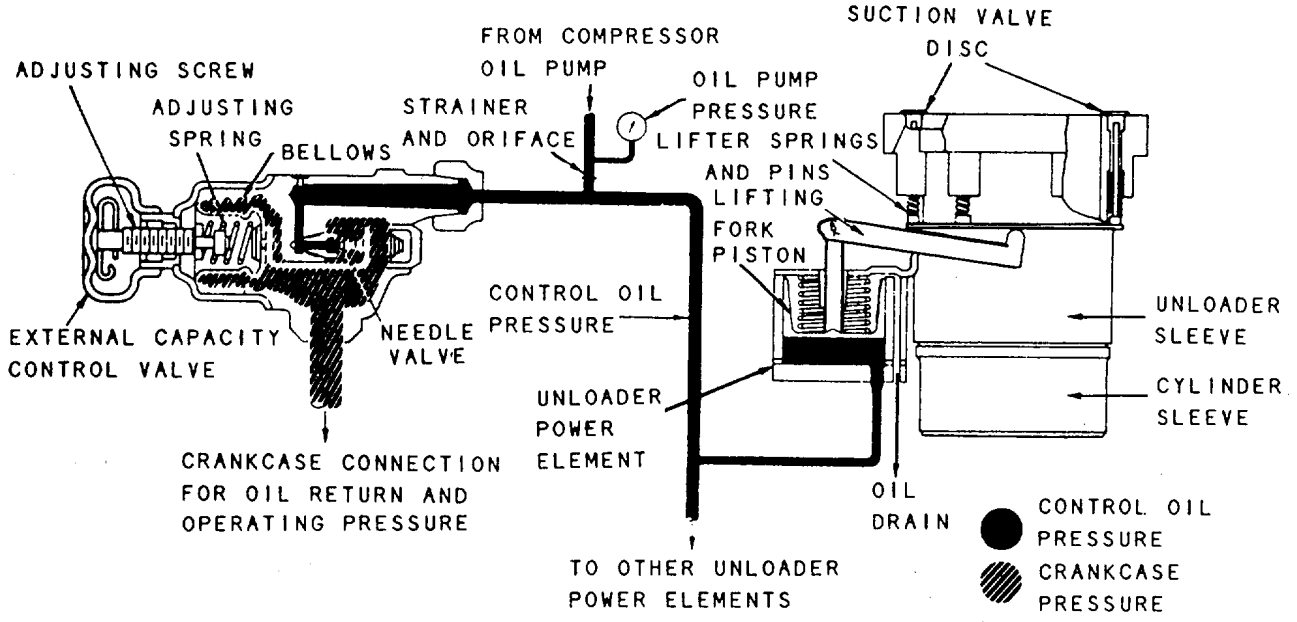
(2) Operation of Capacity Control.

(a) Since oil pressure is required to load or put cylinders into operation, the compressor will start with all controlled cylinders unloaded. But, as soon as the compressor comes up to speed and full oil pressure is developed, all cylinders become operative.

(b) After the temperature pulldown period, the refrigeration load imposed on the compressor will decrease and the capacity control system will unload cylinders accordingly. The unloading will result in reduced power consumption.

(c) On those applications where numerous evaporators are supplied by one compressor, the capacity control system will delay the suction pressure from dropping to the low pressure cut-out setting and prevent stopping the compressor before all the solenoid valves are closed.

(d) The capacity control system for the compressor consists of a power element and its linkage for each controlled cylinder, an externally mounted capacity control valve, and an oil line connecting the control valve with the compressor oil pump discharge.



Capacity Control System

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(e) In operation, compressor oil is pumped through the control oil strainer and orifice to the unloader power element supply line. As soon as pump oil pressure reaches a power element the piston rises, the lifting fork pivots and the unloader sleeve is lowered, permitting the suction valve to seat. The system is governed by suction pressure which actuates the capacity control valve. The capacity control valve controls the flow of compressor oil to an unloader power element by metering the amount of oil allowed to bypass back to the crankcase.

(f) Suction pressure increases or decreases according to increases or decreases in the refrigeration load requirements of the plant. With a decrease in suction pressure the capacity control valve moves to increase the oil bleed to the crankcase from the unloader power element supply line. The resulting decrease in oil pressure in a power element allows the piston to move downwards, the suction valve rises and that cylinder unloads. With an increase in suction pressure, the above process is reversed and the controlled cylinders will load in succession.

(3) Checking Capacity Control.

(a) Before setting the capacity control, check its operation. Compressors are shipped from the factory with the adjusting stem or screw of the control valve backed out all the way. In this position all cylinders will be fully loaded as soon as normal oil pressure is established. The control valve adjusting stem is located under a seal cap.

(b) A quick check on the operation of the capacity control system may be made by connecting gauges to read oil pump and control oil pressures. First, be sure that correct oil pump pressure is established. (Oil pressure should be 45 to 55 psi (310.1 to 379.2 kPa) above suction pressure.) Next, with the compressor running loaded, turn the adjusting stem of the capacity control valve clockwise and listen for the first cylinder to unload. As each cylinder unloads, there will be a change in sound level and a sudden change in control oil pressure which will cause the control oil pressure gauge needle to jump. Continue to turn the adjusting stem slowly until the proper number of steps of unloading have taken place. Refer to the previous table. Then, turn the stem counter-clockwise slowly until the same number of steps of loading have taken place.

(4) Setting Capacity Control.

(a) The capacity control valve adjusting stem should be backed out all the way (counter-clockwise) during the temperature pulldown period. This will insure that all cylinders will remain loaded and the full capacity of the compressor will be available for fast pulldown.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(b) After pulldown, the capacity control system should be set at the control point. The control point is the suction pressure at which the first step of unloading occurs. The control point will depend on the lowest temperature load being handled by the compressor and, usually, it is 0 to 5 psi (0 to 34.5 kPa) below the normal operating suction pressure of a fully loaded system. The recommended control point is 36 psi (248.2 kPa).

NOTE

In practice, the capacity control should be set at a control point which will maintain the refrigerated compartments or other medium being cooled at the required temperatures while making full use of the unloading feature. That is, the control point should be high enough so that the compressor will be fully unloaded before it is stopped on low pressure cut-out.

(c) The control point is set by operating the compressor at the suction pressure corresponding to the control point and, then, slowly turning the adjusting stem clockwise until the first step of unloading takes place. If the suction pressure is higher than the control point, reduce it to control point by slowly throttling the compressor suction stop valve. If the suction pressure is below the control point, stop the compressor for several minutes and allow suction pressure to rise above control point. Then, restart compressor and reduce suction pressure to control point by throttling the suction stop valve.

(d) To check the control point adjustment, open the compressor suction stop valve and then slowly close it. Observe suction pressure gauge reading and listen for the first cylinder to unload when the suction pressure reaches the control point. Open the suction stop

i. Thermal Expansion Valves.

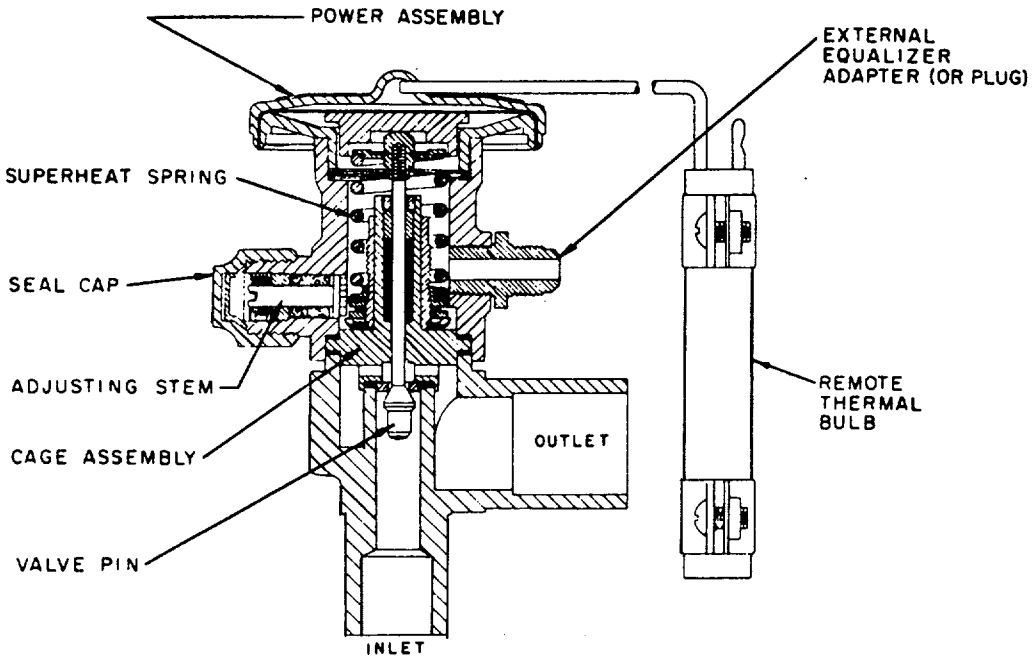
(1) Operation of Thermal Expansion Valve.

(a) The thermal expansion valve meters the flow of liquid refrigerant to the evaporator in response to changes in superheat of the refrigerant suction gas leaving the evaporator. A gas is said to be superheated whenever its temperature is higher than the saturation temperature corresponding to its pressure. The amount of superheat is the increase in temperature above the saturation temperature at the existing pressure.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(b) As the refrigerant flows through the evaporator, the liquid boils off into a vapor. The amount of liquid decreases until it reaches the last passes of the evaporator where it will have evaporated completely due to the absorption of a quantity of heat from the surrounding medium equal to the latent heat of vaporization of the refrigerant. The refrigerant suction gas continues to flow through the evaporator and remains at the same pressure, but its temperature increases due to the continued absorption of heat from the surrounding medium. By the time the suction gas reaches the end of the evaporator, it is superheated. The amount of superheat depends on the amount of refrigerant being fed to the evaporator and the load imposed on the evaporator.

(c) The thermal expansion valve is operated by the pressure differential between: (a) the combined suction pressure in the evaporator and the valve superheat spring pressure; and (b) the vapor pressure in the remote thermal bulb (connected to the valve power assembly and attached to the suction line at the point it leaves the evaporator). Since the pressure in the thermal bulb and power assembly is function of the suction gas temperature, the operation of the valve is controlled by changes in suction gas superheat.



Thermal Expansion Valve

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(d) The remote thermal bulb assumes the temperature of the suction gas at the point of bulb installation. Any change in suction gas superheat tends to move the valve in a compensating direction to restore the superheat to a predetermined value (valve setting). For example, if too much liquid refrigerant is fed into the evaporator, the suction gas superheat decreases and the remote bulb is lowered in temperature. The resultant pressure decrease in the remote bulb and power assembly allows the valve pin to be moved in the closing direction by the combined evaporator and valve spring pressures. On the other hand, if not enough liquid refrigerant is fed into the evaporator, the suction gas superheat increases and the remote bulb temperature rises. The resultant pressure increase in the remote bulb and power assembly overcomes the combined evaporator and valve spring pressures and moves the valve pin in the opening direction.

(2) Adjustment of Thermal Expansion Valves.

(a) The thermal expansion valves are factory set to maintain the suction gas leaving the evaporator at 8° to -10° F (13.3° to -23.3°C) superheat.

(b) To adjust superheat setting remove seal cap on side of valve and turn adjusting stem. Turning stem to right decreases refrigerant flow and raises superheat. Turning stem to left increases refrigerant flow and lowers superheat. Two turns of stem will change superheat about 1° F (17.2°C). Adjust two turns at a time.

(c) Adjust each expansion valve separately and wait between adjustments to observe results. Always tighten any loose connections and replace seal cap after adjustments.

(d) To adjust a pilot operated thermal expansion valve, adjust the pilot valve in the same manner as above.

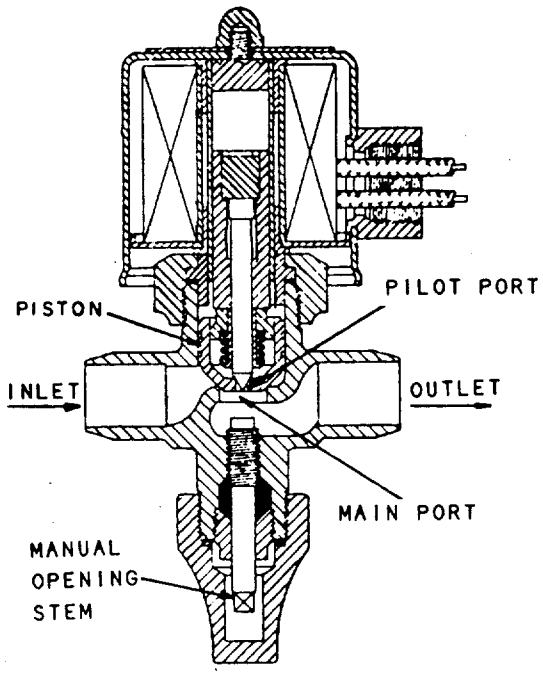
j. Solenoid Valves.

(1) Solenoid valves are piston type valves operated by the magnetic action of an electric coil on a moveable steel core or plunger. An evaporator solenoid valve is electrically actuated by a thermostat responsive to temperature changes in the medium being cooled. A king solenoid valve, is acutated from the compressor motor controller. Normal valve operation is automatic, but a manual opening stem is provided in the bottom of valve.

(2) Direct Acting Solenoid Valves.

When the electrical circuit is completed by the thermostat (or motor controller), the solenoid valve coil is energized, the magnetic field produced lifts the steel plunger, and the valve snaps open. When the thermostat or motor controller breaks the circuit, the solenoid coil is de-energized and the weight of the plunger and stem closes the valve.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



(3) Pilot Operated Solenoid Valves.

Larger solenoid valves are pilot operated. This type of solenoid is actuated in the same manner as a direct acting solenoid, but the plunger does not open the main port directly. Plunger action opens the pilot port. Pressure trapped on top of the piston is released through the pilot port, creating a pressure unbalance across the piston. Pressure underneath the piston is then greater than that above and the piston moves upward, opening the main port. When the valve is de-energized, the pressures above and below the piston equalize and the piston drops to close main port. The pressure difference across the valve, acting on the area of the valve seat, holds the piston tightly closed.

(4) Checking Solenoid Valve Operation.

When a solenoid valve opens, a definite click is heard. When it closes, a click of less intensity is heard. An open solenoid can be detected by pressing the ear against the valve casing. A humming sound should be heard. To check the operation of a solenoid valve, open or close the thermostat contacts with an insulated screw driver and listen for the valve to click. (The operation of a king solenoid valve can be checked by pressing the motor controller STOP button. The valve should click shut.)

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

k. Water Regulating Valves.

(1) The water regulating valves are modulated type valves which automatically control the sea water flow through the condenser to maintain a relatively constant condensing pressure and temperature. Water regulating valves are actuated by refrigerant head pressure in condenser.

(2) Operation.

(a) Refrigerant head pressure from condenser is applied to bellows assembly. When refrigerant head pressure increases, the bellows plate is compressed forcing the bellows push rod upward, moving the valve seat in the opening direction and allowing increased water flow through condenser. As the valve unseats, pressure is exerted upward through valve disc, valve disc holder, guide post and valve center assembly screw to compress range spring.

(b) Increased water flow through condenser reduces head pressure. When head pressure decreases, the range spring expands moving the valve seat in the closing direction and reducing water flow.

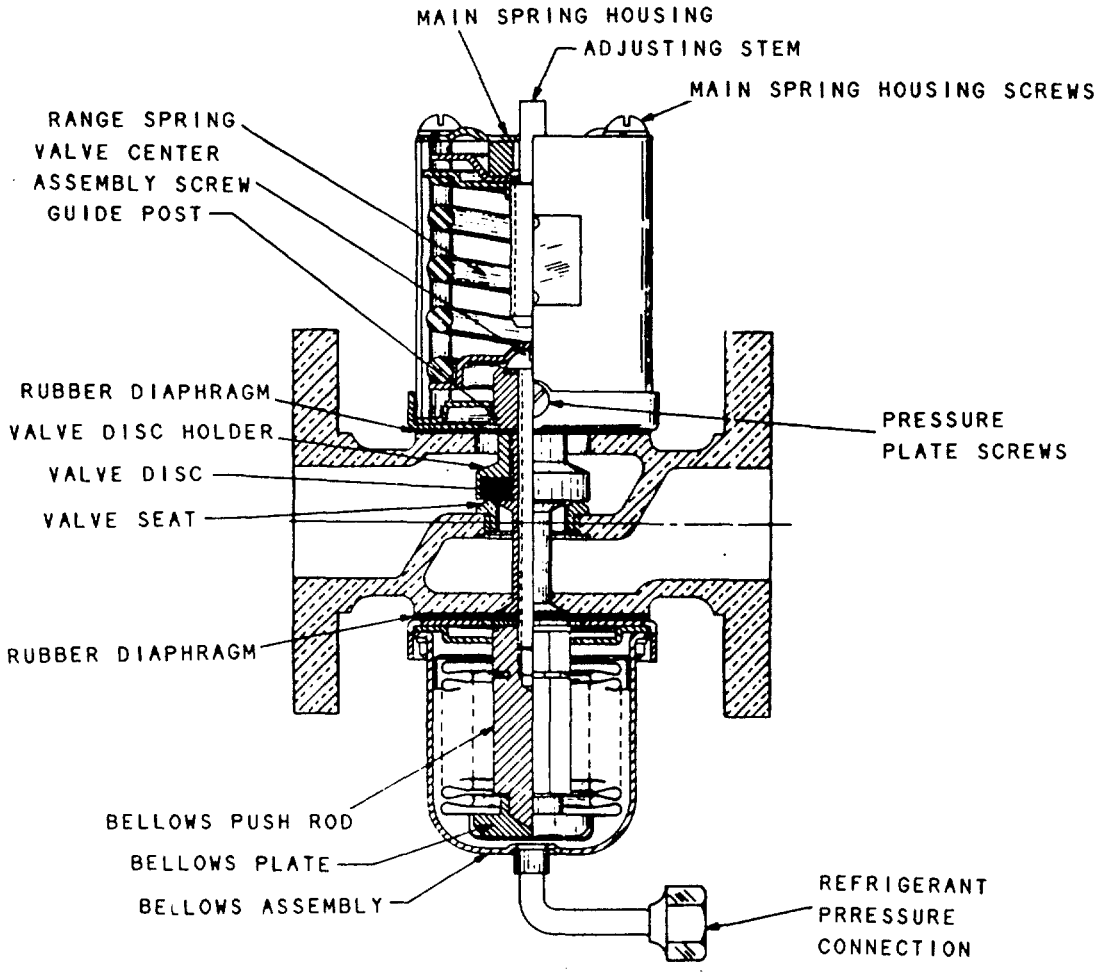
(3) Adjustment.

The opening point of the valve can be adjusted by turning the adjusting stem. To raise valve opening point, turn adjusting stem counterclockwise. To lower valve opening point, turn adjusting stem clockwise. Closing point of valve is about 3 to 7 psi (20.7 to 48.3 kPa) below opening point and is non-adjustable. Adjust valve to maintain a refrigerant head pressure of 90 to 125 psig (620.5 to 861.9 kPa).

NOTE

If compressor operates in high ambient temperatures, gas pressure may at times remain high enough to cause valve to partly open when compressor is idle. In such a case, raise opening point of valve just enough to cause valve to close during compressor stand-by periods.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



Penn Water Regulating Valve

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

l. High and Low Pressure Control Switches.

(1) The safety and operating functions of the high and low pressure control switches are given in paragraph 4-28a(13).

(2) The high pressure switch is actuated by discharge pressure and the low pressure switch by suction pressure.

(3) When the discharge pressure rises above a safe limit (cut-out setting), the high pressure switch contacts open, the electrical circuit is interrupted, and the compressor stops. The contacts reclose automatically when the discharge pressure drops to a safe level (cut-in setting).

(4) When the suction pressure has been pumped down to the desired level (cut-out setting), the low pressure switch contacts open and stop the compressor. When the pressure rises (cut-in setting), the switch contacts close, the electrical circuit is completed, and the compressor starts.

(5) Operation.

(a) Separate high and low pressure control switches, similar in construction and operation, are furnished.

(b) Pressure applied at the switch connection actuates a seamless metallic bellows power element which operates the switch mechanism to open or close the electrical circuit. A permanent magnet in the switch mechanism provides a positive snap-action on both the opening and closing cycles, preventing excessive arcing at the contacts.

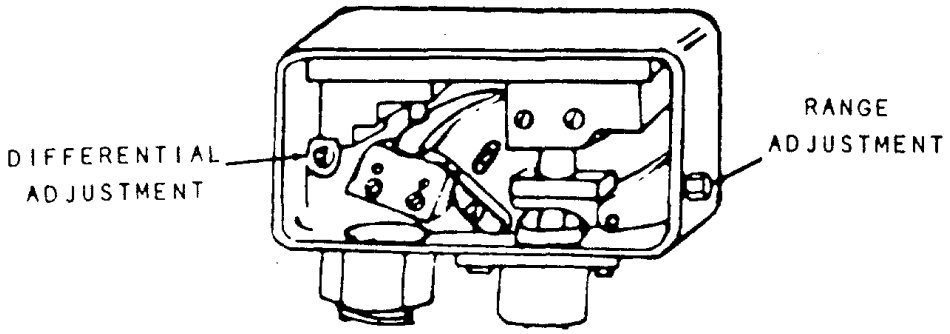
(6) Adjustment.

(a) The switch operating range and differential are both adjustable.

(b) The range adjustment screw located on the right side of the switch, outside the case, changes both the cut-in and cut-out points by an equal amount. Turning the range screw clockwise raises both set points and turning it counterclockwise lowers both set points.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(c) The differential adjustment, inside the switch case, governs the cut-out point but does not affect the cut-in point. Turning the differential screw clockwise widens the differential.



(d) Recommended switch settings are given in paragraph 4-28a. Proceed as follows to set switches:

1 Setting high pressure control switch.

a Turn differential screw to minimum (counterclockwise) and range screw to high limit (clockwise).

b Start compressor and control discharge pressure by throttling condenser water flow.

c Raise discharge pressure to about 10 psi (68.9 kPa) above cut-in point. Turn range screw counterclockwise until contacts open, stopping compressor. When discharge pressure drops to cut-in point, turn range screw slowly clockwise until contacts close, starting compressor. The cut-in point is now set.

d With the compressor running, turn differential screw (clockwise) to wide limit. Raise discharge pressure to cut-out point and turn differential screw counterclock wise until contacts open, stopping compressor. The cut-out point is now set.

e Control discharge pressure and check switch settings and operation.

2 Setting low pressure control switch.

a Turn differential adjustment clockwise to maximum position and range screw counterclockwise to low limit.

b Start compressor and control suction pressure by throttling the compressor suction stop valve.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

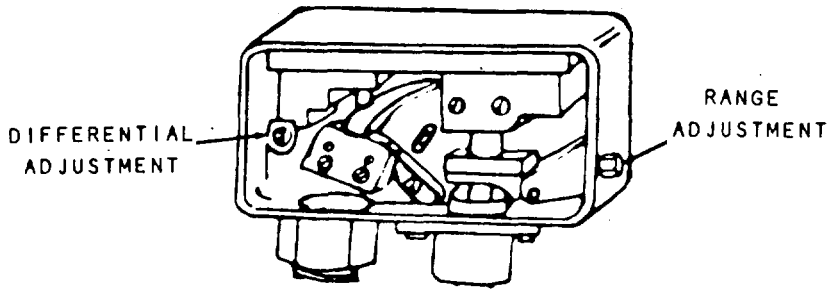
c Lower suction pressure to about 10 psi (68.9 kPa) below cut-in point. Turn range screw clockwise until contacts open, stopping compressor. Allow suction pressure to rise to cut-in point and close suction valve to hold it there. Turn range screw counterclockwise until contacts close, starting compressor.

d Lower suction pressure to cut-out point and turn differential screw counterclockwise until contacts open, stopping compressor. This fixes the cut-out point.

e Control suction pressure and check switch settings and operation.

m. Temperature Control Switches (Thermostats).

(1) The operating and safety functions of thermostats are described in paragraph 4-28a(19). The construction and operation of the thermostat is similar to the pressure or temperature control switch shown below.



(2) Operation.

Operating and safety thermostats cut-in and complete the electrical circuit on temperature rise. The remote bulb of the thermostat is filled with a voltatile liquid charge and exposed to the temperature of the medium being cooled. Changes in temperature cause changes in the pressure exerted by the remote bulb charge on the seamless metallic bellows of the switch. On temperature rise, the pressure increases and the bellows operates the switch mechanism to close the switch contacts and complete the electrical circuit. On temperature fall, the pressure to the bellows decreases, the switch contacts open, and the electrical circuit is interrupted. A permanent magnet imparts a positive snap-action to the switch contacts on both the opening and closing cycles, preventing excessive arcing at the contacts.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(3) Adjustment.

(a) The thermostat cut-in and cut-out points are adjustable within the operating range. The range adjustment screw changes both the cut-in and cut-out points by an equal amount. Turning range screw clockwise raises both set points and turning it counterclockwise lowers both set points.

(b) The differential adjustment governs the cut-out point but does not affect the cut-in point. Turning the differential adjustment screw clockwise widens the differential. (The minimum differential will vary from 2° to 5° F (-16.7° to -15° C) with changes in range adjustment. On the high end of the thermostat temperature range it will be about 2° F (-16.7° C) on the low end of the range it will be 5° F (-15° C) .)

(c) Thermostat recommended set points are given in paragraph 4-28-1-s. To set a thermostat proceed as follows:

1 Turn differential screw clockwise to wide limit.

2 Turn range screw counterclockwise to low limit.

3 Bring the compartment or other medium being cooled to cut-in temperature and turn range screw clockwise until contacts open; then turn range screw slowly counterclock-wise until contacts just close. This fixes the cut-in point.

4 Lower the compartment or other medium being cooled to cut-out temperature, then turn differential screw counter-clockwise until contacts open. This fixes the cut-out point.

NOTE

As a general rule, if an operating thermostat is to be reset to maintain a temperature other than as specified in paragraph 4-28-1-s, set differential at a minimum (2° to -5° F (-16.7 to -20.6° C) and adjust range so that desired temperature of medium being cooled is half-way between cut-in and cut-out points. For example, if a space is to be maintained at 2° F (-6.7°C), and minimum differential obtained is 4° F (-15.6° C), set the thermostat to cut-in at 22° F (-5.6° C) and cut-out at 18° F (-7.8°C).

5 Allow system to stabilize and observe thermostat settings during an operating cycle.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

NOTE

To check the settings of a low limit or safety thermostat, such as used for a water chiller, it may be necessary to bypass the operating thermostat and the compressor low pressure control switch.

n. Water Pressure Failure Control Switch.

(1) Operation.

The safety function of the water pressure failure switch is described in paragraph 4-28a(20). The water pressure failure switch is similar in construction and operation to the low pressure control switch shown below and described in paragraph 4-28k.

(2) Adjustment.

Set the water pressure failure switch to cut-in at 15 psig (103.4 kPa) and cut out at 5 psig (34.5 kPa). Proceed as follows:

(a) Turn differential adjusting screw counterclockwise to minimum limit.

(b) Turn range screw clockwise to high limit.

(c) Throttle water valves until condenser water supply pressure is 15 psig (103.4 kPa). Turn range screw slowly counterclockwise until contacts just close. This fixes the cut-in point.

(d) Slowly throttle condenser water supply decreasing pressure. Switch contacts should open at 5 psig (34.5 kPa). If switch contacts open above 5 psig (34.5 kPa), turn differential screw clockwise to widen differential slightly.

(e) Control condenser water supply and check switch settings.

o. Pressure and Leak Test.

(1) The entire refrigerant piping system should be tested for leaks at a pressure of 150 psig (1034 kPa). The high pressure side of the system should be tested at 225 psig (1551 kPa).

(2) To build up pressure, use a refrigerant or a dry stable gas such as nitrogen. When using dry nitrogen, guard against building up dangerous pressures in the system. It is advisable to use pressure reducing valves on gas cylinders.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

WARNING

Never use oxygen to build up pressure. An explosion may result.

CAUTION

Do not use the compressor to build up pressure. If used to compress air, overheating and damage may result.

(3) To pressurize the system and test for leaks proceed as follows:

(a) With all refrigerant piping connections completed, open all liquid and suction line stop valves.

(b) Disconnect refrigerant lines to condenser water regulating valve, high and low pressure control switches, and suction pressure gauge. Close any stop valves in actuating lines to this equipment or close the lines with flared fitting plugs or flared caps. This is done to prevent injury to belows by the high test pressure.

(c) Break the union in condenser overboard discharge line and plug line to prevent loss of pressure through overboard discharge relief valve. The relief valve is left in the line for later testing.

NOTE

The safety head type bursting disc diaphragm or the throwaway type rupture disc assembly, located between the union and the overboard discharge relief valve, is not to be installed until after pressure tests and dehydration of the system have been completed.

(d) Connect a refrigerant-12 (R-12) drum to charging valve in liquid line.

(e) Open valves between R-12 drum and liquid line and introduce enough refrigerant to raise system pressure to 20 psig (137.9 kPa). Close valves and disconnect drum. Test for leaks with an electronic or an halide leak detector. Repair any leaks.

(f) Connect a drum of dry nitrogen to charging valve and add gas until system pressure is 150 psig (1034 kPa).

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(g) Test entire system for leaks with an electronic or an halide leak detector. Be sure to test all fittings and joints. The small amount of refrigerant in the system will act as an indicator. Test tightness of shell and tube condensers by removing water heads and passing the leak detector probe or exploring tube over the tube sheets. Repair any leaks.

WARNING

When heat must be applied to repair a leak, the leaking section of the system should be opened and the machinery space ventilated. High concentrations of test gas in the space will cause a deficiency of oxygen and a health hazard.

(h) Close hand expansion valves and stop valves downstream of thermal expansion valves at the evaporator. Add dry nitrogen and raise the pressure in the high side of the system to 225 psig (1551 kPa). Any pressure rise in the low side of the system will indicate a leaky stop valve or hand expansion valve. Repair such leaks before proceeding. Repeat step (g).

(i) Open condenser purge valve and drop test pressure to 150 psig (1034 kPa). Remove plug from condenser overboard discharge line and test for a leaky relief valve.

(j) After all leaks have been repaired and system may be considered perfectly tight, open condenser purge valve and release test pressure. Be sure machinery space is well ventilated while purging.

(k) Reconnect lines disconnected in step (b). Open all line valves and close condenser purge valve.

p. Evacuation and Dehydration.

(1) Preparation.

(a) Many serious refrigeration troubles can be traced to faulty system dehyration at the time of installation or following extensive repairs which require the system to be opened to the atmosphere.

(b) Moisture in the-system causes oil sludge and corrosion and it is likely to freeze up the expansion valves of a low temperature system. Tests and field experience have shown that most troubles with seals and internal valves are caused by moisture in the system.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(c) Before dehydrating a system, make the following preparations and keep in mind the following points:

1 The best means of dehydration is by evacuation with a pump especially built for the purpose. Obtain a pump that will produce a vacuum of .2" Hg absolute. Do not use the compressor as a vacuum pump. It is not designed for such use and may be seriously damaged.

2 Pressure test the system to be sure it is free of leaks. Refer to paragraph o. When installing the vacuum pump, make sure that there is no leak in the tubing connecting the pump to the system.

3 Obtain a vacuum indicator. The vacuum indicator is described below.

4 Keep ambient temperature above 60° F (15.6° C) to speed the evaporation of moisture.

CAUTION

Do not attempt dehydration if ambient temperature is below 60° F (15.6° C). Moisture may freeze in the system.

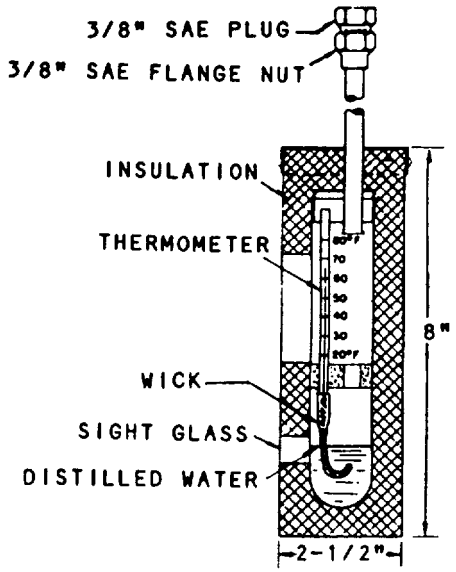
5 Carefully follow the dehydration procedure, paragraph (3). Be sure to open all stop valves so that no part of the system will be blocked off.

6 Frequently, valuable time is spent in dehydrating a system in which refrigerant is held in solution with the oil in the compressor crankcase. This usually does not apply to a newly installed system, since only a small holding charge of refrigerant is present in the crankcase. When it is necessary to dehydrate an existing system after repairs, drain the oil from the compressor crankcase. Replace with new oil after dehydration.

(2) Vacuum Indicator.

(a) The vacuum indicator consists of a wet-bulb thermometer in an insulated glass tube containing distilled water. Part of the tube is exposed so the thermometer can be read and the water level checked. When the vacuum indicator is connected to the vacuum pump suction line, the thermometer reads the temperature of the water in the tube. The temperature is related to the absolute pressure in the tube. The table below gives the absolute pressures corresponding to various temperature.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



Vapor Pressures of Water

Temperature Observed on Vacuum Indicator		Absolute Pressure Inches of Mercury	
° F	°C	"Hg	kPa Hg
70	17.8	.739	2.496
60	15.6	.522	1.763
55	12.8	.436	1.472
50	10.0	.363	1.226
45	7.2	.300	1.013
40	4.4	.248	0.837
35	1.7	.204	0.689
32	0	.180	0.608

NOTE: To determine vacuum in inches of mercury, subtract absolute pressure from barometer reading.

(b) Handle the vacuum indicator with care. It must be vacuum tight to give a true reading. The top seal of the indicator is not designed to support a long run of connecting tubing. Fasten tubing to supports to prevent damage.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(c) Use only distilled water in the indicator. Be sure the wick is clean. Oil or dirt on the wick causes erroneous readings. To prevent loss of oil from the vacuum pump and contamination of the indicator:

1 Install a shut-off valve in the suction line at the vacuum pump.

2 Install a shut-off valve in the suction line at the vacuum indicator.

3 When shutting off the pump, close the indicator valve, the pump valve and turn off the pump in that sequence.

(3) Dehydration Procedure.

(a) Connect a tee to refrigerant liquid line charging valve. Install copper tubing from one branch of tee to vacuum pump suction and from other branch to vacuum indicator. Provide shut-off valves in suction lines at vacuum pump and at indicator.

(b) Open compressor stop valves and all line stop valves in system. Close all valves and connections to atmosphere. Be sure to open hand expansion valves, coil return valves and any other line valves which will connect the high and low sides of system and allow the pump to draw a vacuum on entire system. If necessary, install a "jumper" line between the high and low sides of system.

(c) Open shut-off valve in pump suction line, start vacuum pump, and open charging valve.

(d) Open vacuum indicator shut-off valve occasionally and take a reading. Keep valve open at least three minutes for each reading. (Keep valve closed at all other times to decrease amount of water pump must handle and to hasten dehydration.) When the pressure in the system drops to a value corresponding to the vapor pressure of the water in the indicator, the temperature will start to drop. In the example shown the ambient temperature and the temperature of the water in the indicator is 60° F (15.6°C). Starting at 60° F (15.6° C) and zero time the temperature of the water in the indicator remains at 60° F (15.6° C) until the pressure in the system is pulled down to the pressure corresponding to the saturation temperature of the water (60° F (15.6° C)). At this point the moisture in the system will start to boil. The temperature drops slowly until the free moisture is removed (35° F (1.7° C)). Dehydration is nearly completed at this point, provided the ambient temperature remains at 60° F (15.6° C) or higher. If the ambient temperature were lower than 60° F (15.6° C), ice might form before moisture removal is complete.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

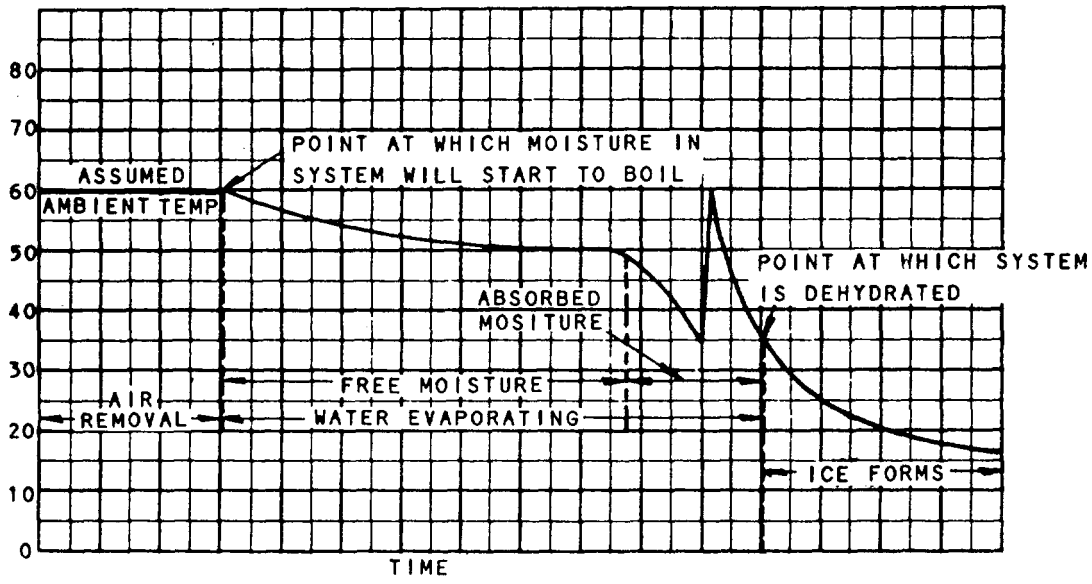
(e) Continue dehydrating until a temperature of 35° F (1.7°C) is reached on vacuum indicator (corresponding to a vacuum of .2" Hg (0.675 kPa) absolute pressure). The time required to complete dehydration depends on the amount of moisture in the system and the size of the plant. The operation will probably take from 18 to 72 hours. If a temperature of 35° F (1.7°C) cannot be reached on the vacuum indicator, it may be due to one or more of the following faults:

1 Leak in system or connecting tubing to vacuum pump.

2 Closed line valves.

3 Inefficient vacuum pump.

4 Defective vacuum indicator.



Dehydration Pulldown Curve

(f) With pump still running, open system at a point furthest from pump and admit air through a dryer. Close system and repeat steps (d) and (e). Moisture left in the system can thus be greatly diluted and almost completely removed by "double dehydration".

(g) When dehydration is completed, close shut-off valve at vacuum indicator, charging valve, shut-off valve at vacuum pump and stop pump in that sequence. Do not allow pump to operate longer than absolutely necessary after connection is broken. Disconnect vacuum pump and vacuum indicator.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(h) Connect vacuum indicator to charging valve. Hold vacuum for about five hours and observe vacuum indicator reading hourly (by opening charging valve) to see if system is maintaining vacuum.

(i) If system holds vacuum, disconnect indicator and connect a refrigerant-12 drum to charging connection. Introduce enough refrigerant to break vacuum (about 5 psig (34.5 kPa)). The system is now ready for charging and operation.

q. Opening System.

(1) When a refrigeration system is to be opened for service or repairs, avoid the admission of air and moisture. Before opening a charged or functioning system or part of a system, pump down or evacuate the part to a pressure slightly above atmospheric (1 to 2 psig (6.9 to 13.8 kPa)).

(2) If the final evacuation reaches a pressure lower than zero psig, bleed enough refrigerant into the evacuated part to raise the pressure to about 2 psig (13.8 kPa). Connections may then be broken and the replacement part installed. First make one connection on the part. Second, sweep out any air or other foreign gas through the free end by purging with refrigerant gas bled from the charge in the system. Then quickly make the other connection or connections. If more than a few minutes must elaspe after breaking connections, plug the free ends of the system.

(3) Purge refrigerant or oil charging lines (though small and short) with refrigerant gas immediately before charging.

r. Refrigerant Charge and Leaks.

(1) Refrigerant Charge.

Refer to paragraph f for refrigerant charging and removal procedures, discussion of refrigerant overcharge and undercharge, procedure for transfer of refrigerant from one receiver to another in same system, and discussion of refrigerant flooding.

(2) Testing for Piping Leaks.

(a) The most positive method for finding leaks in a refrigerant-12 system is with an electronic or a halide leak detector. Testing with oil or soap suds at joints will only detect the larger leaks and, therefore, is ineffective in determining the tightness of a system. An electronic or a halide leak detector, on the other hand, will also locate the smaller leaks.

(b) Do not attempt a leak test in a compartment where a leak is suspected until the compartment has been vell ventilated. The sensitivity of the test is lessened if large concentrations of refrigerant are present in the air.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

(c) If the system is losing refrigerant, and a piping leak cannot be detected, the condenser should be tested for leaks.

(d) Before testing for leaks, at times it may be necessary to raise the pressure in the system by reducing the flow of condenser water. Proceed to test for leaks as follows:

1 Using electronic leak detector.

First, adjust the sensitivity of the electronic leak detector according to the instructions of the manufacturer. Next, move detector probe tip around the joint or suspected leak area at about 1 or 2 inches (2.54 to 5.08 cm) per second. The probe continuously draws in air. As the probe tip passes near a leak, leaking refrigerant gas is drawn in and detected. A light in the transparent probe gives a short flash for a small leak and a long flash for a large leak.

2 Using halide leak detector.

The halide leak detector consist of a burner, needle valve, suction (exploring) tube and a chimney with a copper reaction plate. Some torches use alcohol and others propane as fuel. First, adjust the detector flame so that top of blue flame cone is level with or slightly above reaction plate. Next, place end of exploring tube at point to be tested. The exploring tube draws in a sample of air to the burner where the refrigerant decomposes by reaction with the copper plate and changes the flame color. Observe the flame. Small leaks give a greenish tint and larger ones a vivid blue.

(3) Testing for Condenser Leaks.

(a) To avoid serious loss of refrigerant or possible entrance of sea water into the refrigerant system, test the condenser for leaks periodically, perferably every two weeks. Also test the condenser for leaks whenever the system is losing refrigerant and a piping leak cannot be found.

(b) If possible, test the condenser after it has been shut down for twelve hours. At the end of this time, usually there is a small air pocket at the top of the water heads. To test, slowly open the water head vent valves, one at a time, and insert the exploring probe or tube of the leak detector. If this test indicates the presence of refrigerant-12, test the tube sheets and individual tubes for leaks after draining water and removing water heads.

(c) If the condenser cannot stand idle and must be tested immediately, first flush and vent condenser for at least fifteen minutes to purge any foreign gases. Then, close refrigerant inlet and outlet valves and all water valves. Drain condenser water side through drain valves or plugs in bottom of water heads. Test for presence of refrigerant-12 in water heads through drain openings. If this test detects a refrigerant leak, remove water heads and test individual tubes and tube sheets for leaks.

(4) Leaks to Overboard Discharge.

(a) Where a relief valve connected to an overboard discharge line is provided, refrigerant may be lost without detection if the relief valve is not seated tightly.

(b) To test for a leaky relief valve, remove a plug from overboard discharge line or disconnect a section of line downstream of relief valve. Test for leak by applying exploring probe or tube of leak detector to open connection.

s. General Compressor Maintenance.

(1) Lubrication.

Instructions on the compressor lubrication system, including routine maintenance normally performed by operating personnel, are given in paragraph g. Refer to these instructions for procedures on adding or removing oil, data on proper oil level and pressure, and other information on compressor lubrication. Troubleshooting charts for the lubrication system are given in Volume 3.

NOTE

Check operation of oil pressure safety switch at least monthly. Refer to paragraph 4-28g(8).

(2) Operating Pressures and Temperatures.

When abnormal operating pressures and temperatures are observed, refer to troubleshooting charts given in Volume 3. Some of the more important temperature and pressure indications related to the compressor are also discussed below.

(a) Crankcase Temperature.

After the compressor has been started, the crankcase should warm up so that it can be felt by the hand (105° F (40.6°C) or above). Maximum permissible crankcase temperature, measured at seal housing, is 212° F (100°C). A crankcase warmer than normal (above 180° F (82.2°C)) may indicate a clogged liquid line strainer or other trouble. Refer to Volume 3. A crankcase cooler than normal (well

below 105° F (40.6°C)) may indicate liquid refrigerant return to compressor or excessive oil circulatin in system. Refer to Volume 3. Take corrective action promptly if crankcase temperature is abnormal.

(b) Discharge Temperature.

With the compressor warmed up and operating normally, the discharge gas temperature should not exceed 240° F (115.6°C). If it should, bypass the heat interchanger.

(c) Head and Back Pressure.

Head and back pressures are basic indicators of system operation. Refer to Volume 3. Head and back pressures will also show whether the compressor suction and discharge valves are operating correctly. If suction pressure is abnormally high and discharge pressure abnormally low, either the suction or discharge valves may be leaking. Leaky valves will usually result in lack of refrigeration and long running time.

(3) Compressor Noises.

(a) Compressor noises may be due to vibration because of improper mounting, or improperly aligned, loose or worn compressor drive. These and other possible sources of compressor noises are listed with corresponding remedies in Volume 3.

(b) In some cases, noise may seem to come from the compressor but originate elsewhere in the system. Other possible sources of system noises are given in Volume 3.

(c) When investigating noisy operation, keep in mind that the operation of the capacity control system will change the characteristic operating sound level of the compressor.

(4) Adjustment of Belt Drives.

(a) After a period of operation, new V-belts will stretch and slip if not kept tight. If the flywheel or motor pulley appears to be warm, the belts are probably slipping. Slippage will cause loss of speed to the compressor and excessive belt wear. Keep all belts at proper tension or they will soon be ruined.

(b) Belts can be adjusted by moving the universal adjustable motor rails. V-belts when properly adjusted can be depressed about 1/2 to 3/4 inch (1.27 to 1.9 cm) with the pressure of one finger. Do not tighten belts too much. Very tight belts will cause excessive wear of both the belts and main bearings of the motor and compressor. In extreme cases, tight belts may cause shaft seal leaks.

(c) Fan belts should be checked and adjusted for proper tension in the same manner as above.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

t. Torque Values.

Size Dia. In.	Wrench Size, In.		Thread Per Inch	Torque Range	
	Nut	Allen		lb-ft	Nm
1/4 5/16	7/16 9/16	3/16	20 (Coarse) 24 (Fine)	6 - 10 25 - 28	8.134 - 13.558 33.895 - 37.962
5/16 3/8	9/16 5/8	7/32 5/16	18 (Coarse) 16 (Coarse)	18 - 22 30 - 35	24.404 - 29.828 40.674 - 47.453
7/16 7/16	3/4 3/4	 5/16	20 (Fine) 14 (Coarse)	42 - 47 45 - 50	56.904 - 63.723 61.011 - 67.790
1/2 5/8	13/16 15/16	3/8	13 (Coarse) 18 (Fine)	50 - 60 100 - 120	67.790 - 81.349 135.581 - 138.937

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

u. Wear Limits.

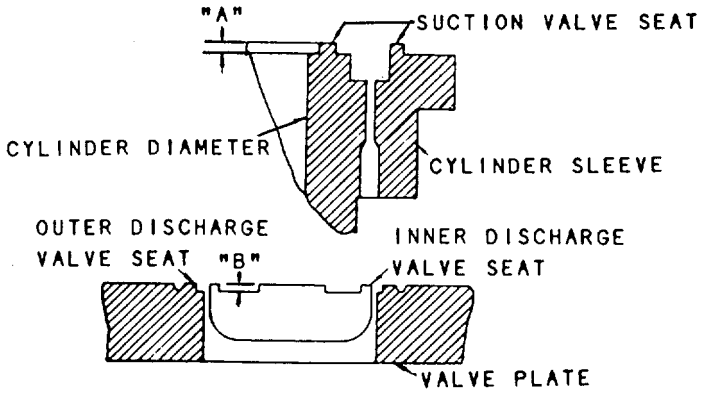
	Factory Maximum		Factory Minimum		Maximum Wear Before Repair	
Part Name	in.	Cm	in	cm	in	cm
Seal End						
Main Bearing Diam.	1.6266	4.1232	1.6233	1.6233	.002	.005
Main Bearing Journal Diam.					.003	.008
Pump End						
Main Bearing Dia.	1.6266	4.1232	1.6233	1.6233	.002	.005
Main Bearing Journal Diam.					.003	.008
Connecting Rod						
Bearing Diam. (after assembly)	1.6255	4.1288			.002	.005
Bearing Thickness			.06225	.15812	.001	.003
Crankpin Diam.			1.6233	4.1231	.003	.008
Crankshaft						
Throw	1.005	2.553	.9985	2.5362		
Thrust Washers (Thickness)						
Seal End			.129	.328		
Seal End (Steel)			.155	.394		
Pump End			.129	.328		
Replace Thrust Washers When End Clearance Exceeds					.035	.079
Cylinders						
Bore	2.501	6.353			.003	.008
Piston (Diam.)			2.4980	6.3449	.003	.008
Wrist Pin (Diam.)			.7498	1.9045	.001	.003
Wrist Pin Bushing	.7507	1.9068			.001	.003
Piston Ring End Gap (Comp. and Oil)	.017	.043	.007	.018	.030	.076
Piston Ring Side Clearance (Comp. And Oil)	.0025	.0064	.001	.003	.003	.008

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

Part Name	Factory Maximum		Factory Minimum		Maximum Wear Before Repair	
	in.	cm	in	cm	in	cm
Oil Pump *Axial Clearance Drive Shaft Diam. Drive Shaft Bushing Diam.	.0015 .4375	.0038 1.1112	.0005 .4354	.0013 1.1059	.0025 .000 .000	.0064 .000 .000
Suction Valve Suction Valve Disc. (Depth of Wear Below Face) Suction Valve Seat (See Fig. For Dim. "A") Minimum Height of "A" before replacing cylinder sleeve (.010 in (.025 cm))			.012	.030	.005	.013
Discharge Valve Discharge Valve Disc. (Depth of Wear Below Face) Discharge Valve Seat (See Fig. For Dim. "B") Minimum Height of "B" before replacing valve plate and discharge valve inner seat (.010 in (.025 cm))			.012	.030	.005	.013

*Return assemblies for factory exchange.

4-28. AIR CONDITIONING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



Suction and Discharge Valve Seat Height

v. Service Tools.

Name	Carrier Part No.	Description	Robinair Part No.
Suction Valve Clips (1)	5F20-2061	Used when assembling valve plates on compressors	-
Bearing Puller (2)	5F20-932	Used to remove seal end main bearing or install seal and pump end main bearings	12240
Cylinder Sleeve Puller (2)	5F20-572	Used to remove cylinder sleeves from compressor	12238 12239

(1) Furnished with valve plate onboard repair parts package.

(2) Obtain from Robinair Manufacturing Corp., Edgerton, Ohio.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

w. The following is an index to the maintenance procedures:

DESCRIPTION	PARAGRAPH
Compressor	4-29
Condenser	4-30
Strainer	4-31
Dryer	4-32
Gage Board	4-33
Thermal Expansion Valves	4-34
Misc. Valves and Headers	4-35

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS

This task covers:

a. Inspection b. Service c. Repair

INITIAL SETUP

Test Equipment

NONE

References

Paragraph	
4-28e(5)	Pumping Down
4-28g(4)	Adding Oil
4-28g(5)	Drainig Oil
4-28r	Leak Detecting

Special Tools

Arbor press
Bearing puller
Carrier P/N 5F20-932

Equipment Condition Condition Description

NONE

Material/Parts

Gasket set 5330-01-040-7867

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

Observe WARNINGS in this procedure. Observe safety precautions in paragraph 4-28d.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Compressor	a. Wiring	Inspect for breaks, cracks and worn insulation.	
	b. Belt guard	1. Inspect for bends and damage.	
		2. Insure hardware is tight.	
	c. Belts	Inspect for breaks, cracks and fraying.	

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Motor	1. Inspect for signs of damage.	
		2. Insure hardware is tight.	
	e. Piping	Inspect for breaks, cracks, dents, bends and signs of wear.	
	f. Compressor	1. Inspect for breaks and leaking.	Refer to Direct Support Maintenance
		2. Insure all hardware is tight.	
	g. Oil failure switch	Inspect for defective wiring and signs of damage.	
	h. Relief valve	Inspect for damage.	
SERVICE			

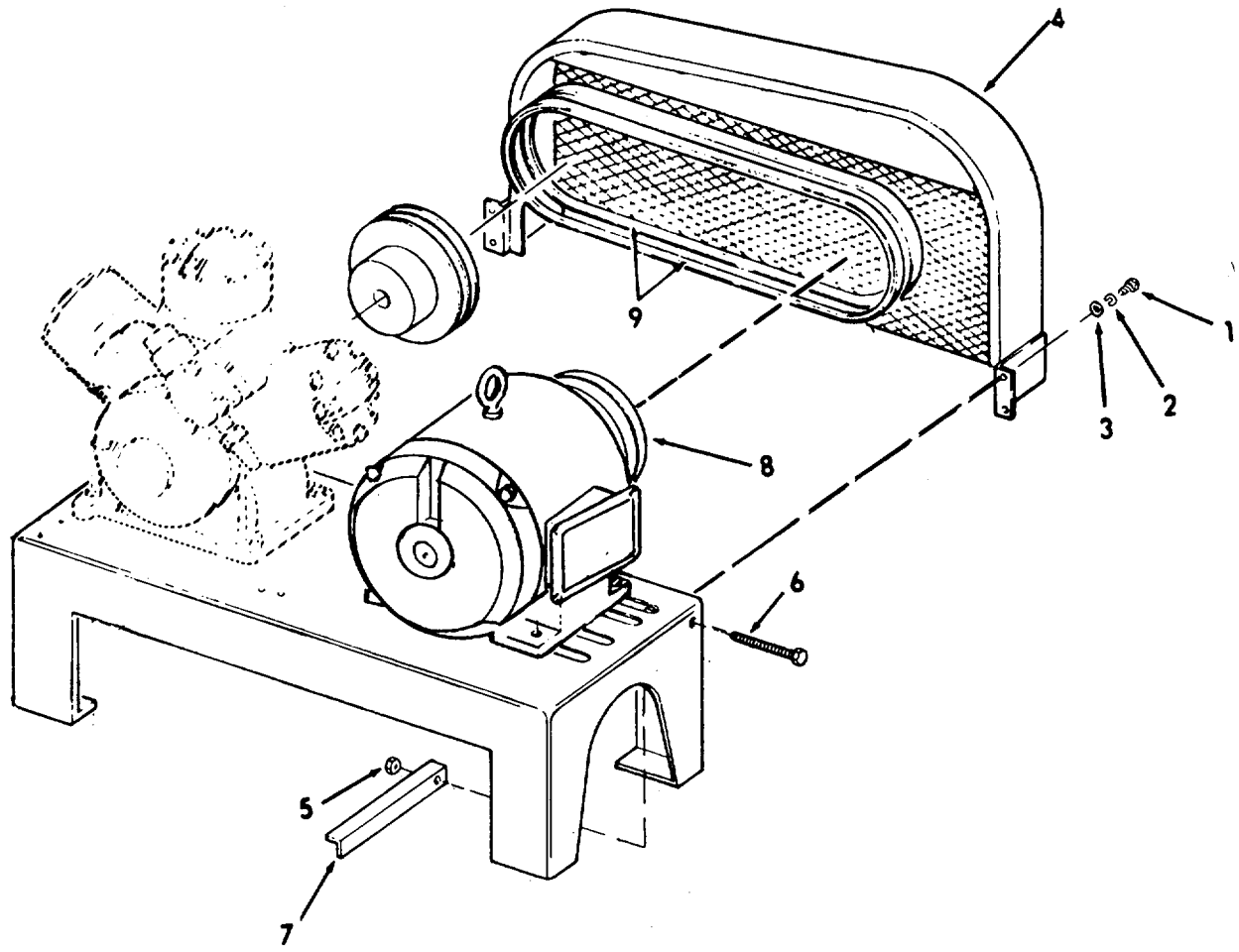
WARNING

- To prevent accidental shock and possible injury, tag and place disconnect switch in the OFF position.
- Tag starting switch to warn against starting compressor with discharge stop valve closed. Pull fuses so that compressor cannot be started. Serious compressor damage (and possibly injury to personnel) will result if discharge stop valve is not opened before compressor is started.

2. Belts	a. Screws (1), lockwashers (2), and flatwashers (3)	Remove.
	b. Belt guard (4)	Remove.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	c. Nut (5), and bolt (6)	Loosen.	
	d. Motor adjusting angle (7), and motor (8)	Move to loosen belts (9).	
	e. Belts (9)	Remove and replace.	

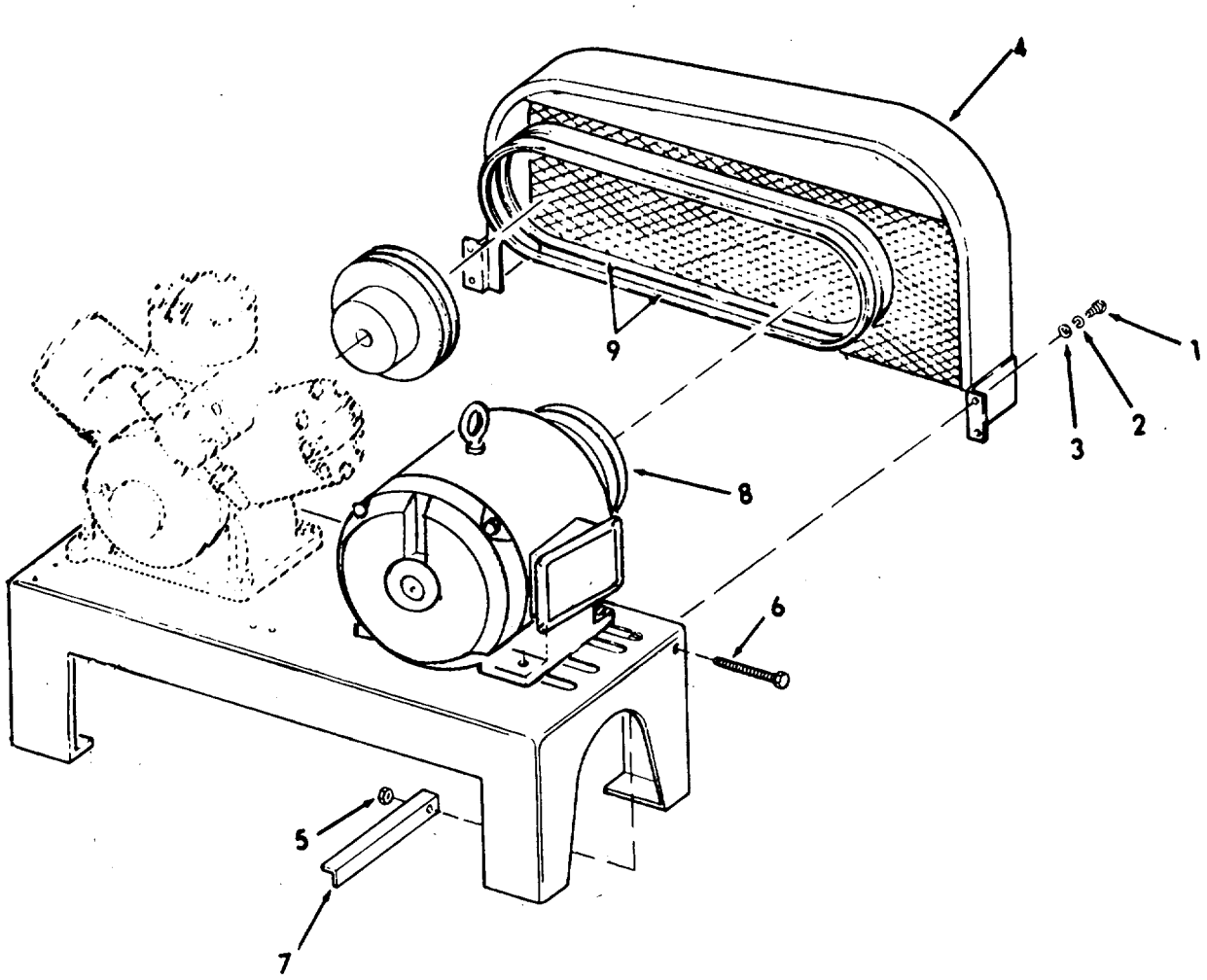


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	f. Motor (8), motor adjusting angle (7), nut (5), and bolt (6)	Adjust motor to tighten belts (9).	Belt should deflect 1/2 to 3/4 inch (1.27 to 1.91 cm).
	g. Belt guard (4)	Align holes.	
	h. Screws (1), lockwashers (2), and flatwashers (3)	Install and tighten.	

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			

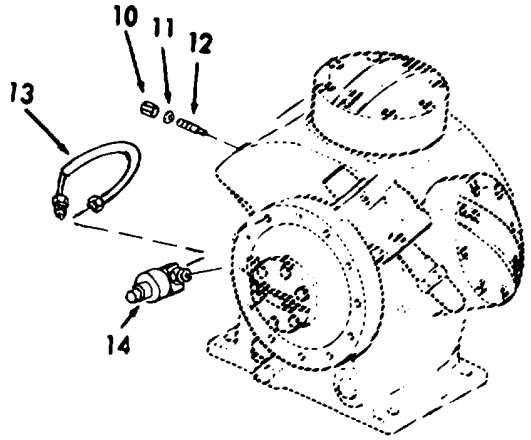


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
3. Oil pressure regulator	a. Compressor	Pump down to 1 or 2 psig (6.9 or 13.8 kPa).	Refer to para 4-28e(5)(e).
	b. Valve cap (10), and gasket (11)	Remove.	Discard gasket.
	c. Valve body (12)	1. Remove.	Use 5/16 Allen wrench across flats.
		2. Examine valve stem and see that it is seating properly.	
	d. Valve body (12)	Install.	Use Allen wrench.
	e. Gasket (11), and valve cap (10)	Install.	Use new gasket.
	f. Compressor	Restart.	
4. Capacity control valve	a. Compressor	Drain oil.	Refer to para 4-28g(5).
	b. Inlet tubing (13)	1. Unscrew flare nuts.	
		2. Carefully move copper tubing to one side.	Avoid kinking of tube.
	c. Capacity control valve (14)	1. Disassemble.	a. Remove strainer. The strainer has a conical flange on its outer end which forms a seat for the flared end of the copper tubing.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
			b. Copper gasket - Do not misplace.
		2. Clean strainer or replace control valve.	
	d. Inlet tubing (13)	Reconnect.	
	e. Compressor	Add oil.	Refer to para 4-28g(4).
	f. Capacity control valve (14)	Adjust.	Refer to para 4-28h(4).

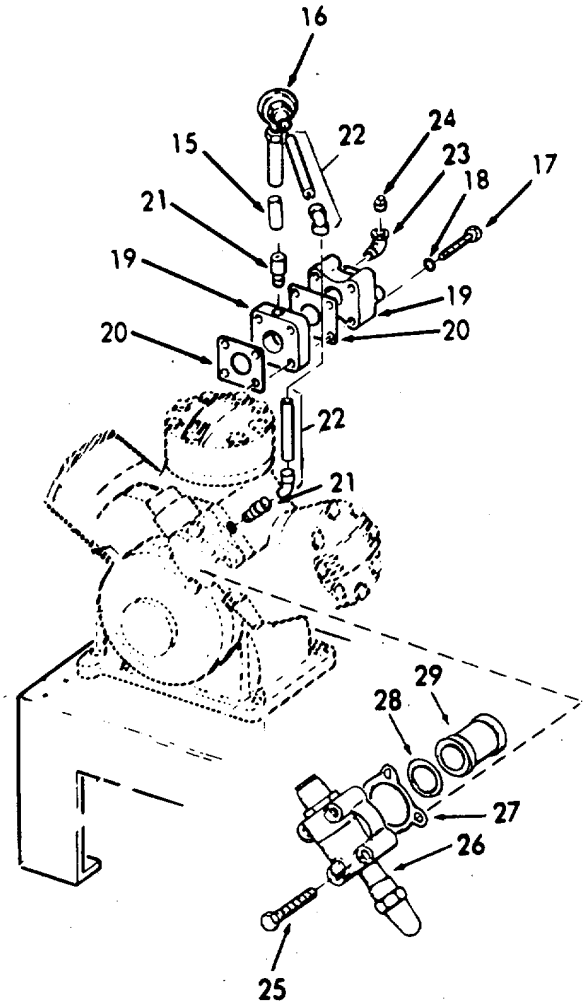


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
SERVICE (Cont)				
5. Oil pressure valve and adapter	a.	Tube nuts (15)	Loosen.	Move tubing carefully to avoid bends.
	b.	Relief valve (16)	Remove.	Discard.
If the oil pressure relief valve adapter require maintenance proceed as follows:				
	c.	Screws (17) and lock-washers (18)	Remove.	
	d.	Adapter (19) and asbestos gaskets (20)	Remove.	Discard gaskets.
	e.	Couplings (21)	Unscrew.	
	f.	Tubing (22)	Replace.	If damaged.
	g.	Elbow (23) and pipe plug (24)	Replace.	If necessary.
6. Suction strainer and suction service valve valve	a.	Screw (25)	Remove.	
	b.	Suction service (26)	Move.	Do not bend pipe.
	c.	Gaskets (27 and 28)	Remove.	Discard.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
SERVICE (Cont)				
	d. Strainer (29)	1.	Remove.	a. Use care when replacing strainer. b. If strainer is broken, corroded, or unsuitable discard.
		2.	Clean.	Use a solvent.



4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			

NOTE

- To keep dirt out of the compressor during initial operation of a new system, a hard wool felt filter is installed inside the regular bronze screen strainer provided in the compressor suction manifold.

- The felt filter is intended for use only during initial operation to trap any fine particles of dirt which may enter the system during installation. This filter, is supplied with all new compressors. The arrangement of the filter within the suction strainer is shown below. To install the temporary felt filter proceed as follows:

  1. Remove suction strainer.

  2. Insert ends of bail into holes of retaining band.

  3. Insert retaining band and bail into felt filter so that bail is at right angles to filter seam and approximately 1/16 inch (.159 cm) of felt extends beyond edge of band. Work ends of bail through the felt.

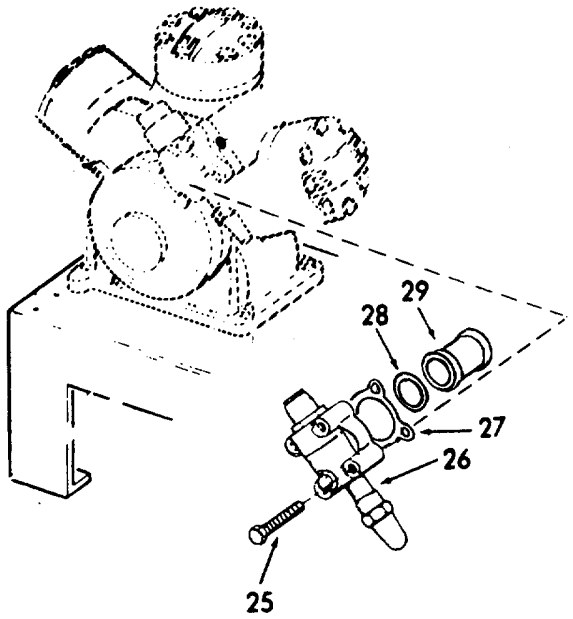
  4. Insert filter assembly into suction strainer of compressor with the seam out. Be sure filter does not extend beyond edge of strainer.

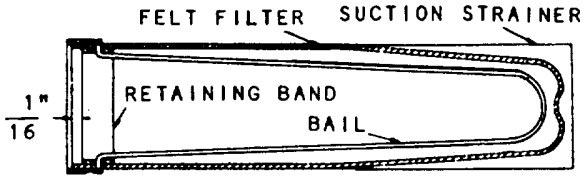
  5. Attach warning tag to suction valve as a reminder that a felt sock is installed.

- Remove the filter after 50 hours of operation. If the filter is reasonably clean it may be left out. Otherwise clean and replace it for another 50 hours.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	e. Strainer (29)	Insert.	When replacing strainer, insure that bail is compressed by manifold cover plate when plate is in position. If bail is too short, grasp sides of bail so as to elongate it sufficiently to be compressed by cover plate. Insure that strainer is positioned so that bail fits between two bosses on inside of cover plate and thus is restrained from turning.





NOTE

Remove temporary felt sock filter installed inside suction strainer after 50 hours operation. If felt sock is quite dirty, clean it and replace it for another 50 hours. Clean suction strainer whenever felt sock is removed.

Temporary Suction (Felt) Filter

	f. Gasket (27 and 28), suction service valve (26), and screws (25)	Install.	Torque to 50 to 60 lb. ft.

NOTE

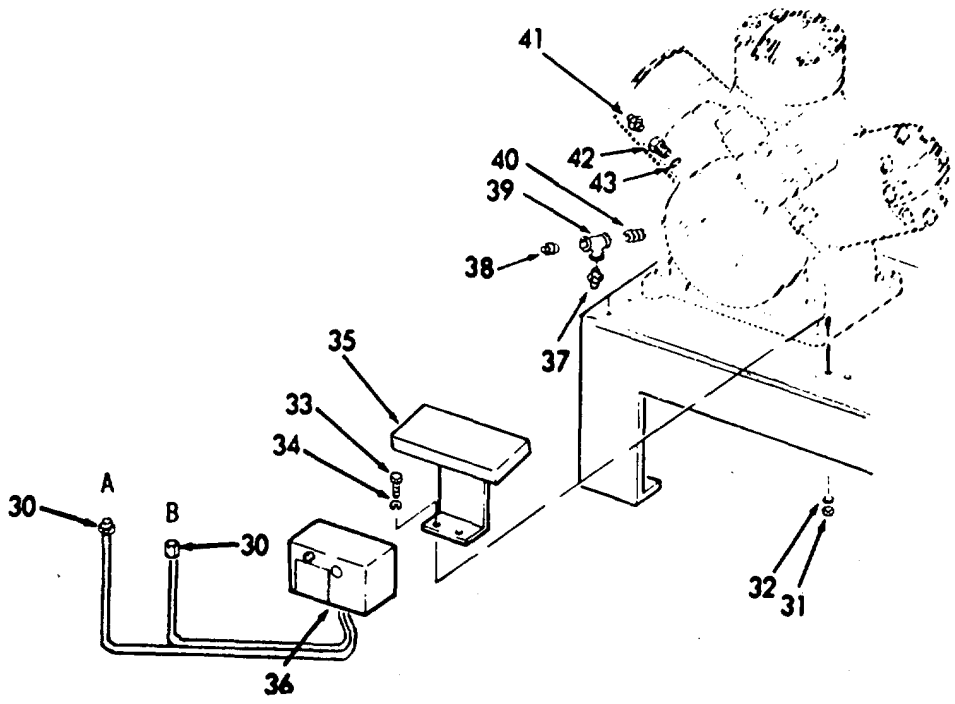
If this suction service valve is to be replaced. Unscrew valve from pipe adapter.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
7. Oil failure switch	a. Tube nuts (30)	Loosen.	
	b. Nuts (31), flat washers (32), screws (33), and lock-washers (34)	Remove.	
	c. Shroud (35) and oil failure switch (36)	Remove.	Use care not to bend tubing.
	d. Wiring	Disconnect.	
	e. Oil failure switch (36) and shroud (35)	1. Disassemble. 2. Replace switch.	
	f. Coupling (37), pipe plug (38), tee (39), and pipe nipple (40)	Disassemble.	If necessary.
	g. Coupling (41), adapter (42), and washer (43)	Disassemble.	If necessary.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	h.	Wiring	Reconnect.	
	i.	Shroud (35) and oil failure switch (36), screws (33), lock-washers (34), flat washers (32) and nuts (31)	Install.	Do not bend tubing.
	j.	Tube nuts (30)	Tighten.	

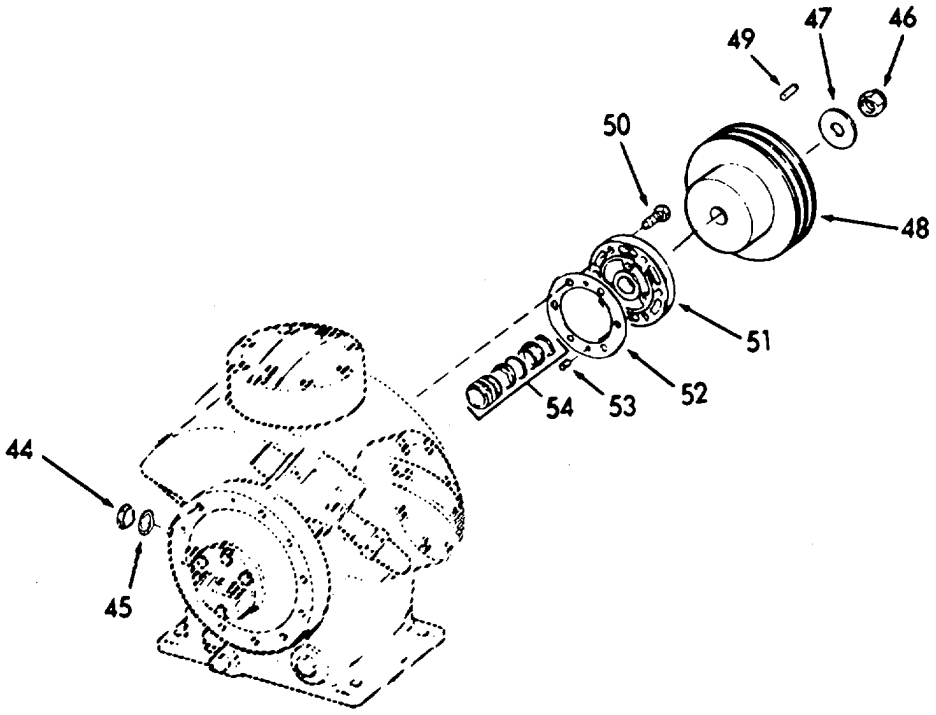


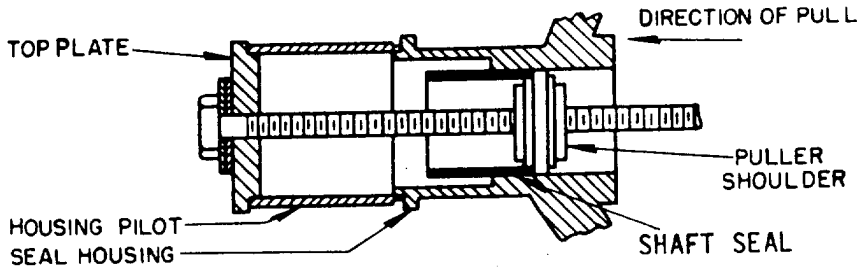
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
8. Sight glass	a.	Sight glass (44), and gasket (45)	Remove.	Discard gasket.
	b.	Gasket (45), and sight glass (44)	Install.	Use new gasket.
9. Compressor flywheel	a.	Nut (46), and flat-washer (47)	Remove.	
	b.	Wheel (48), and key (49)	Remove.	
	c.	Key (49), and wheel (48)	Install.	
	d.	Flatwasher (47), and nut (46)	Install.	
10. Seal end main bearing	a.	Flywheel	Remove.	Refer to step 9.
	b.	Screws (50)	Remove.	
	c.	Cover plate (51), and gasket (52)	Remove.	Discard gasket.
	d.	Dowel pins (53)	Remove.	If necessary.
	e.	Shaft seal assembly (54)	Remove.	a. Use seal puller. b. The puller shoulder is threaded and acts as a traveling nut. Friction will keep the puller shoulder from turning with the bolt unless the threads are damaged.

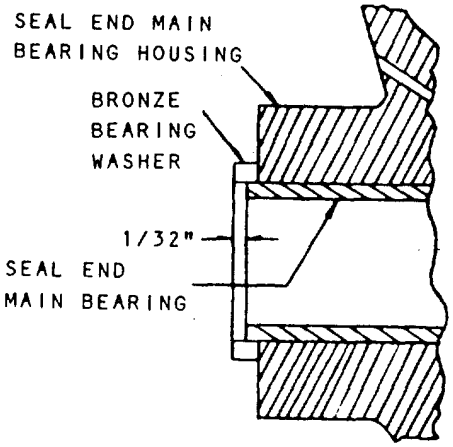
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			If they are damaged, use a 3/4"-16 nut between the thrust washer and bolt head. Hold bolt head stationary and turn nut.
	f. Cover plate (51)	Inspect.	If a burr or sharp edge is in the cover, remove



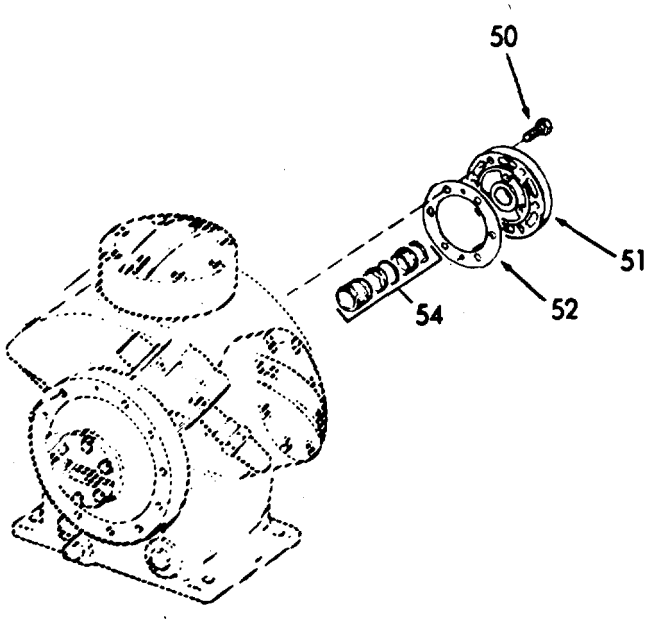


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	g. Shaft seal assembly (54)	1.	Lubricate.	Use heavy grease.
		2.	Install.	a. Position bearing so that chamfered edge (notched edge) enters bearing housing first and oil holes in bearing and housing are in line. b. Using puller, pull bearing into housing until positioned as shown below. Edge of bearing is 1/32" (0.794 cm) below surface of bronze bearing washer.  c. Look through oil pressure regulator opening in crankcase to see that oil passage to bearing is not blocked. d. Check to see that relief groove in bearing is at top.

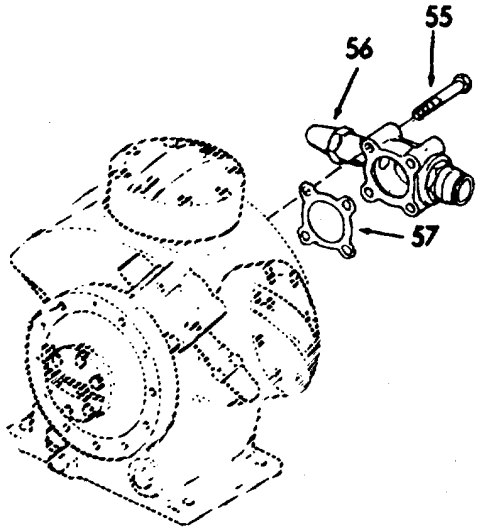
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
				WARNING Wear eye protection when using compressed air.
				e. Blow out oil groove in bearing housing.
	h.	Cover plate (51) and gasket (52)	Install.	Use new gasket.
	i.	Screws (50)	Install.	Torque to 30 to 35 lbft (40.67 to 47.45 Nm).
	j.	Flywheel	Install.	Refer to step 9.



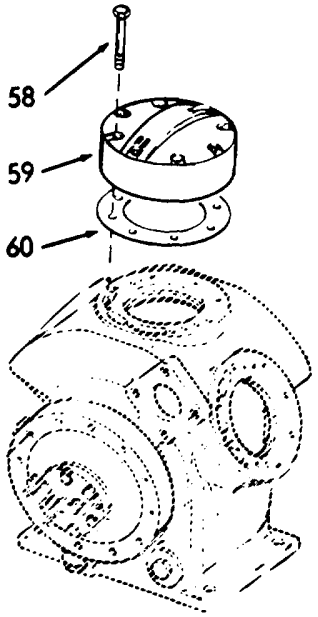
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
11. Discharge service valve	a. Screws (55)	Remove.	
	b. Discharge service valve (56)	Move.	Do not bend pipe.
	c. Gasket (57)	Remove.	Discard.
	NOTE If discharge service valve is to be replaced, unscrew valve from pipe adapter.		
	d. Gasket (57), and discharge service valve (56)	Install.	Use new gasket.
	e. Screws (55)	Install.	Torque to 50 to 60 lbft (67.79 to 81.35 Nm).



4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
12. Cylinder heads	a.	Screws (58)	Remove.	
	b.	Cylinder head (59)	Remove.	Do not drop or damage gasket sealing surfaces.
	c.	Gasket (60)	Remove.	Discard.
	d.	Cylinder head (59)	1. Clean.	Remove gasket material.
			2. Inspect.	Inspect for cracks, and satisfactory gasket sealing surfaces.
	e.	Cylinder head (59), gasket (60), and screws (58)	Reinstall.	Torque screws to 30 to 35 lbft (40.67 to 47.45 Nm).

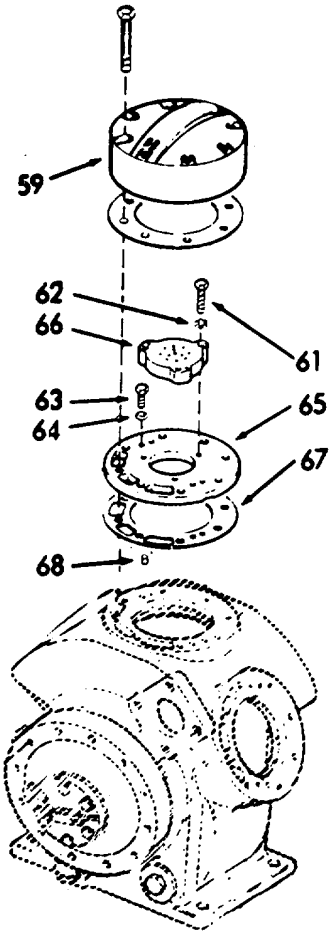


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	NOTE This procedure should not be performed without the use of valve retainer clips.		
13. Discharge valve	a. Cylinder head (59)	Remove.	Refer to step 12.
	b. Screws (61) and lockwashers (62)	Loosen.	
	c. Screws (63) and screw gaskets (64)	Remove.	Discard gasket.
	d. Valve plate (65)	Remove from cylinder block.	
	e. Screws (61) and lockwashers (62)	Remove.	
	f. Valve guide (66) and valve plate (65)	Separate.	
	g. Gasket (67)	Remove.	Discard.
	h. Suction valve springs (68)	Remove.	Six places.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

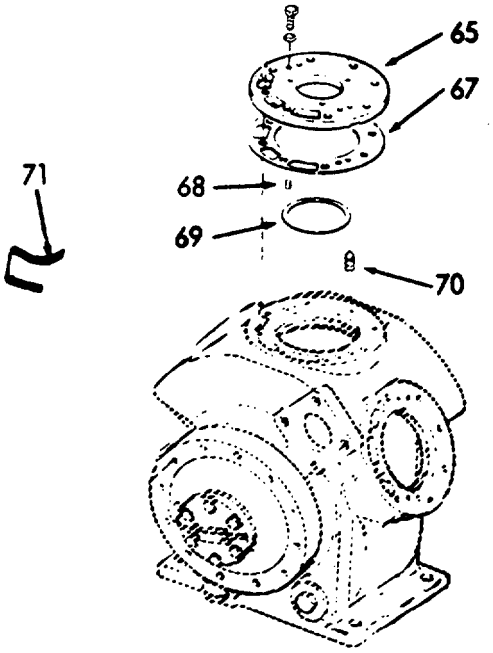


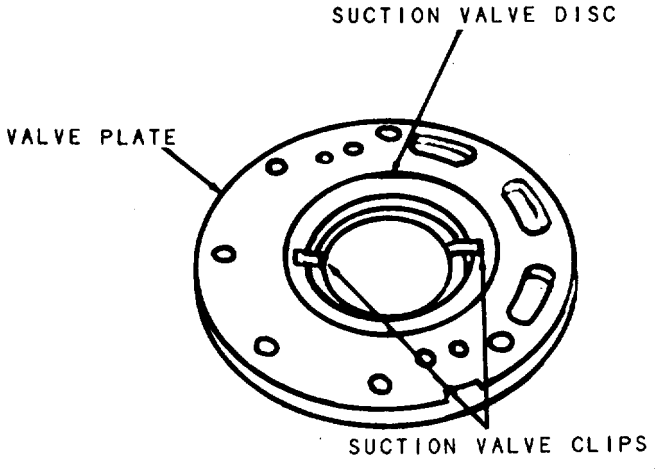
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	i.	Suction valve (69)	1. Remove. 2. Inspect.	Inspect for cracks or wear. Limits .005 inch (0.013 cm).
	j.	Valve lift springs (70)	Remove.	Four places.
	k.	Suction valve springs (68) and valve lift springs (70)	Inspect for signs of failure.	Replace any broken or distorted springs.
	l.	Suction valve springs (68)	Place in valve plate (65).	Large coil in contact with bottom.
	m.	Suction valve (69)	1. Place on valve springs (68). 2. Press down in valve plate recess. 3. Install slide retainer clips (71) as shown.	Locate clips so they do not cover any valve lift pins and springs (70).
	n.	Valve plate (65) and gasket (67)	Align holes with cylinder block.	Use new gasket.

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

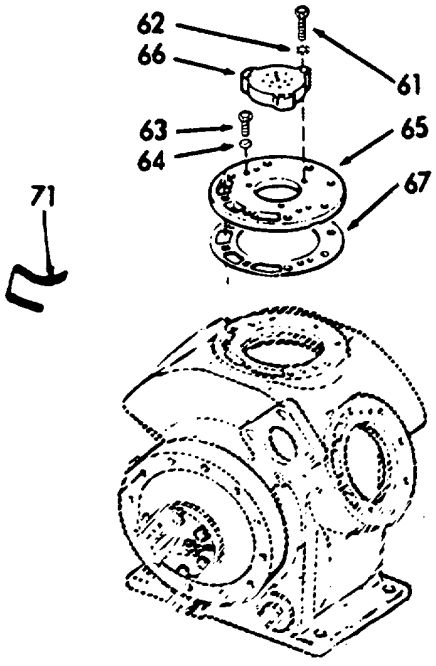
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			





4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

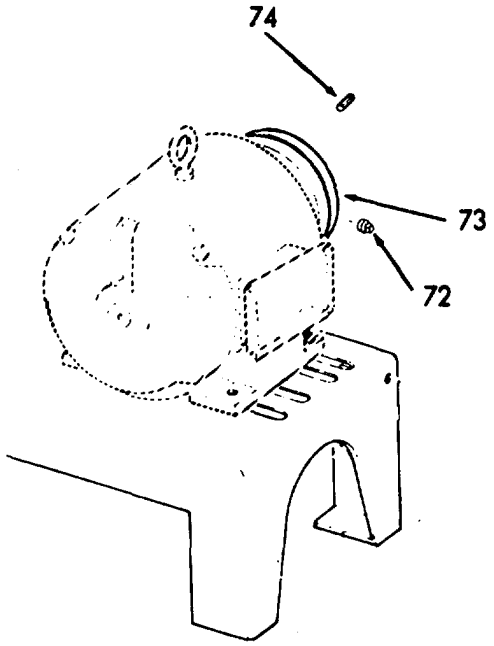
LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	o.	Screws (63), and screw gaskets (64	Install.	a. Use new gaskets. b. Torque to 6 to 10 lbft (8.135 to 13.56 Nm).
	p.	Retainer clips (71)	Remove.	Furnished with on board spares for valve plate (65).
	q.	Discharge valve guide (66), screws (61), and lockwashers (62)	Install.	Torque screws to 6 to 10 lbft (8.135 to 13.56 Nm).
	r.	Cylinder head	Install.	Refer to step 12.



4-902

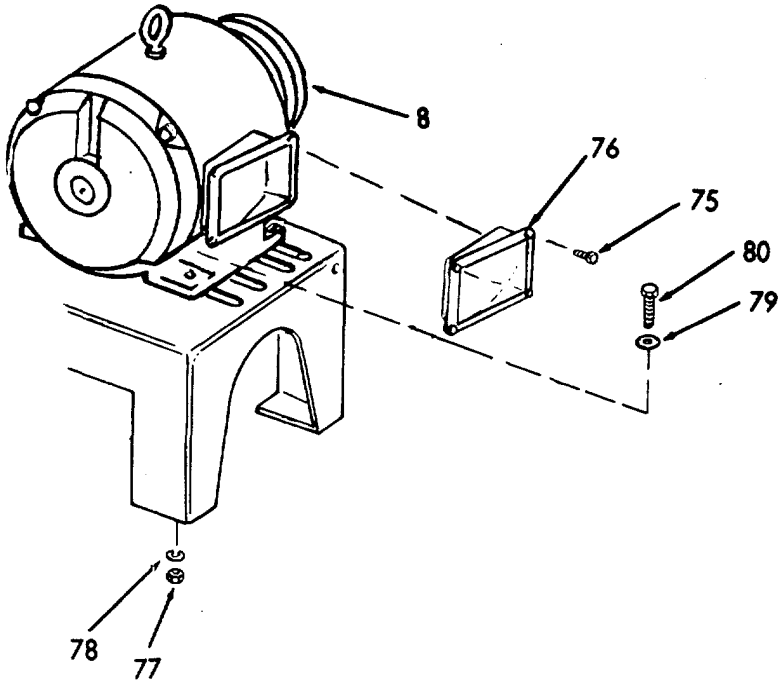
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
14. Motor pulley	a.	Setscrews (72)	Remove.	
	b.	Pulley (73) and key (74)	Remove.	
	c.	Key (74) and pulley (73)	Install.	
	d.	Setscrews (72)	Install.	



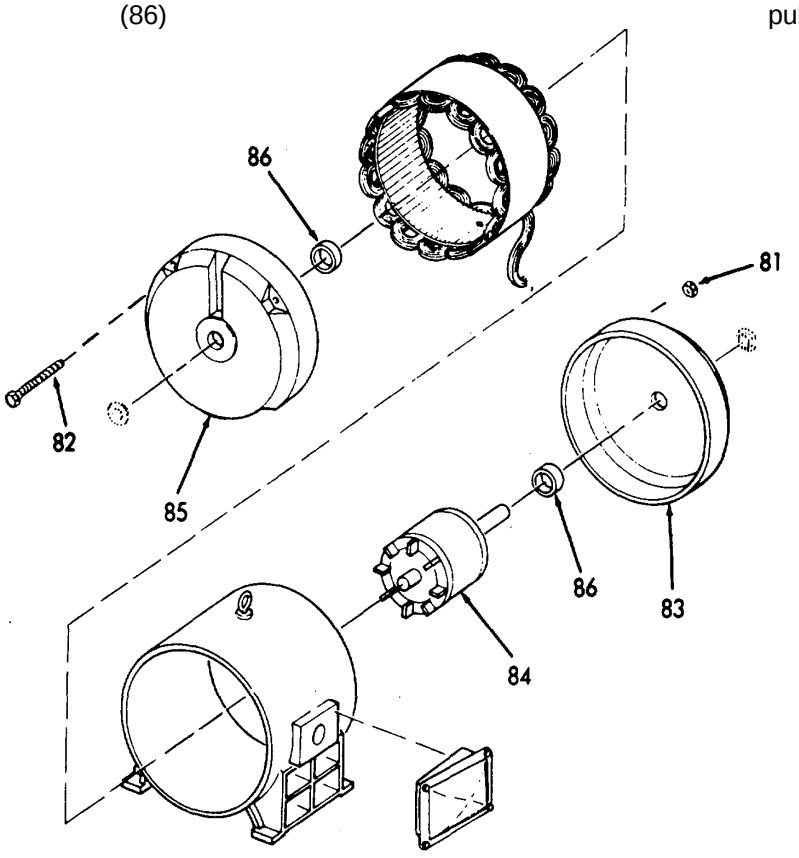
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
15. Motor	a.	Screws (75)	Remove.	
	b.	Cover (76)	Remove.	
	c.	Wiring	Tag and disconnect.	
	d.	Nuts (77), lock-washers (78), flat washers (79), and screws (80)	Remove.	



4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	e.	Motor (8)	Remove.	
	f.	Nuts (81) and thru bolts (82)	Remove.	
	g.	Bracket (83)	Remove.	
	h.	Rotor and shaft (84)	Remove.	
	i.	Bracket (85)	Remove.	
	j.	Bearings (86)	Remove.	Use bearing puller.



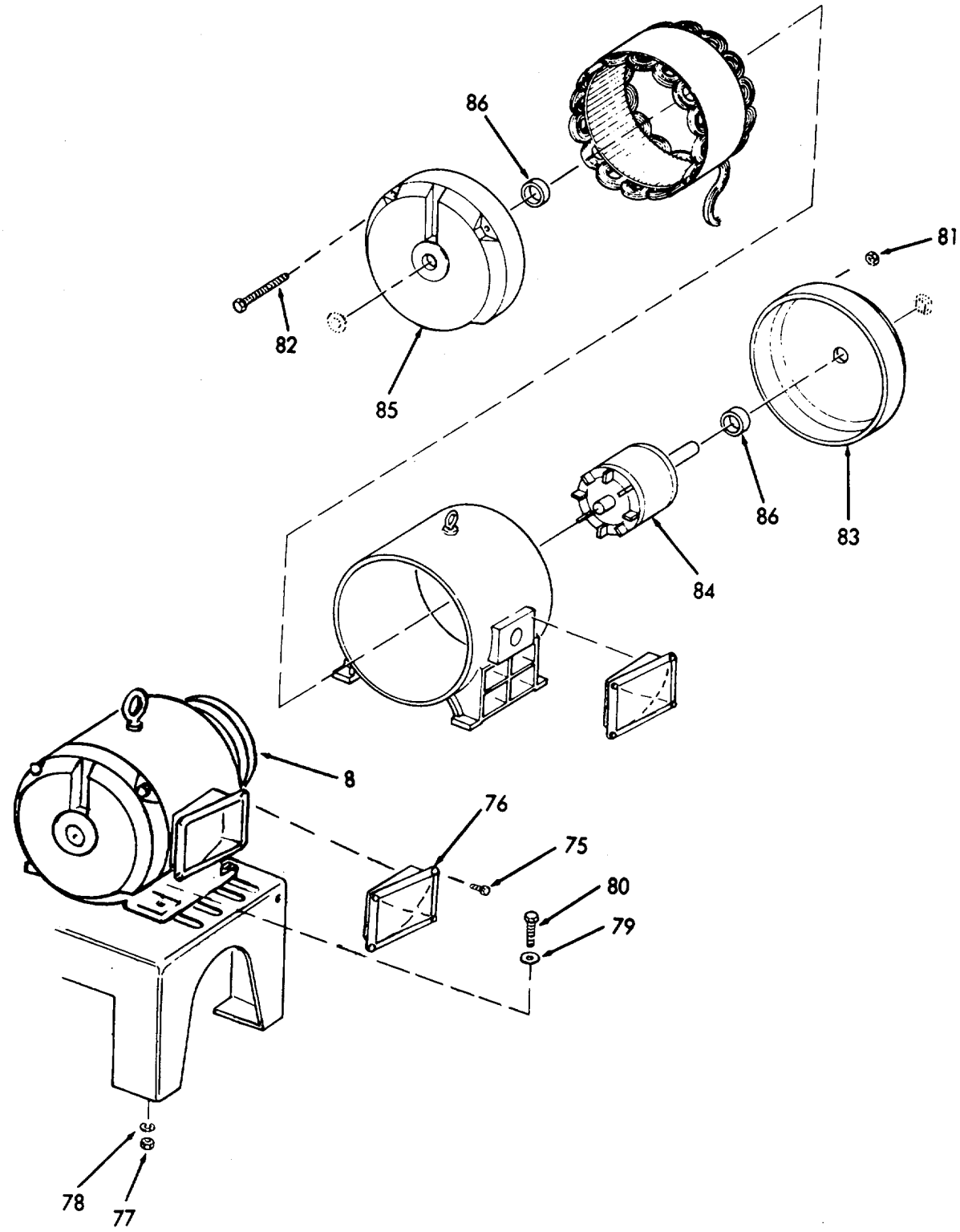
4-905

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM		ACTION	REMARKS
REPAIR (Cont)				
	k.	Bearings (86)	Install.	Use arbor press.
	l.	Rotor and shaft (84), bracket (85), and bracket (83)	Install.	
	m.	Thru bolts (82), and nuts (81)	Install.	
	n.	Motor (8)	Install.	
	o.	Screws (80), flat washers (79), lock-washers (78), and nuts (77)	Install.	Do not tighten until belts are tight and adjusted.
	p.	Wiring	Reconnect, remove tags.	
	q.	Cover (76) and screws (75)	Install.	

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



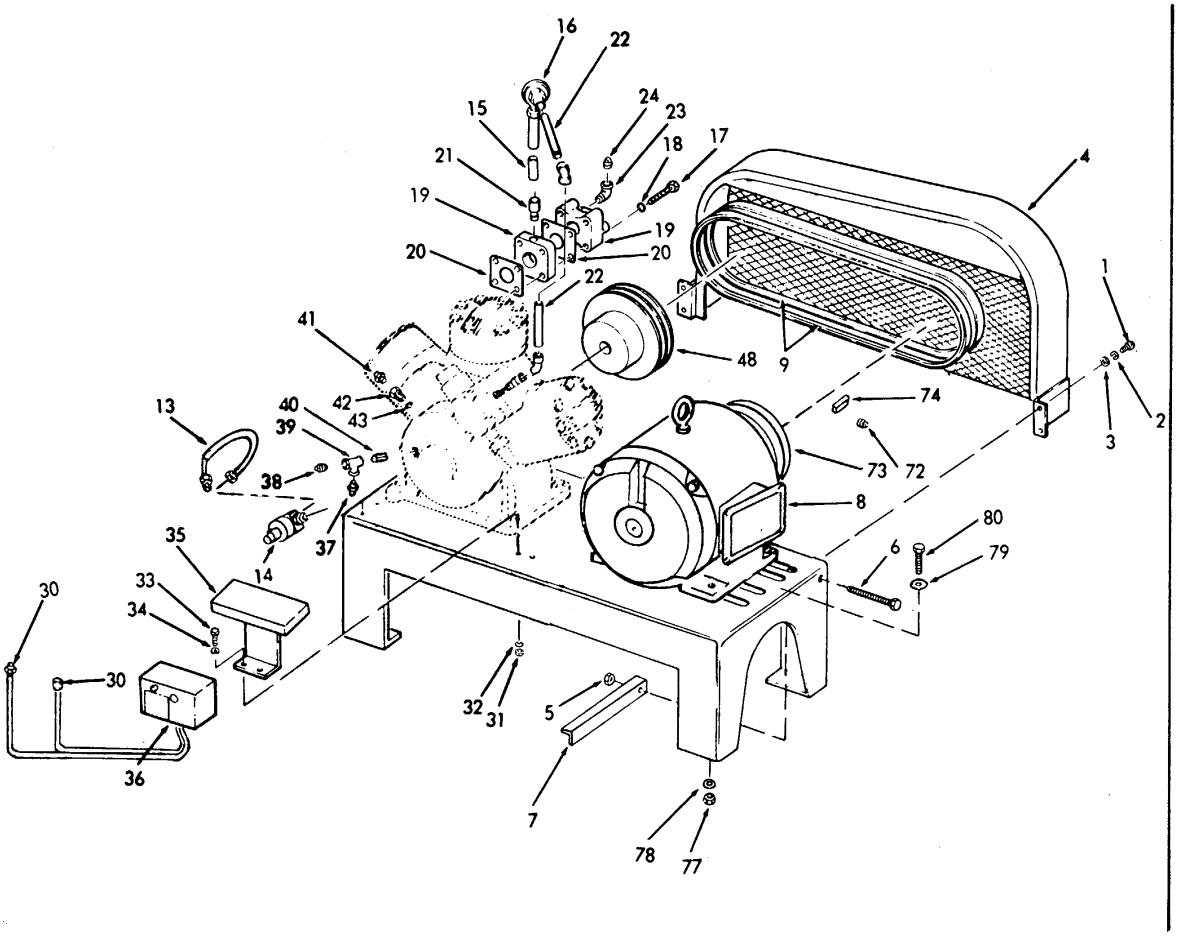
4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

REPAIR (Cont)

Legend Compressor - HVAC

1. Screws
2. Lockwashers
3. Flatwashers
4. Belt guard
5. Nut
6. Bolt
7. Motor adjusting angle
8. Motor
9. Belts
13. Inlet tubing
14. Capacity control valve
15. Tube nuts
16. Relief valve
17. Screws
18. Lockwashers
19. Adapter
20. Asbestos gaskets
21. Couplings
22. Tubing
23. Elbow
24. Pipe plug
30. Tube nuts
31. Nuts
32. Flatwashers
33. Screws
34. Lockwashers
35. Shroud
36. Oil failure switch
37. Coupling
38. Pipe plug
39. Tee
40. Pipe nipple
41. Coupling
42. Adapter
43. Washer
48. Wheel
72. Setscrews
73. Pulley
74. Key
77. Nuts
78. Lockwashers
79. Flatwashers
80. Screws

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

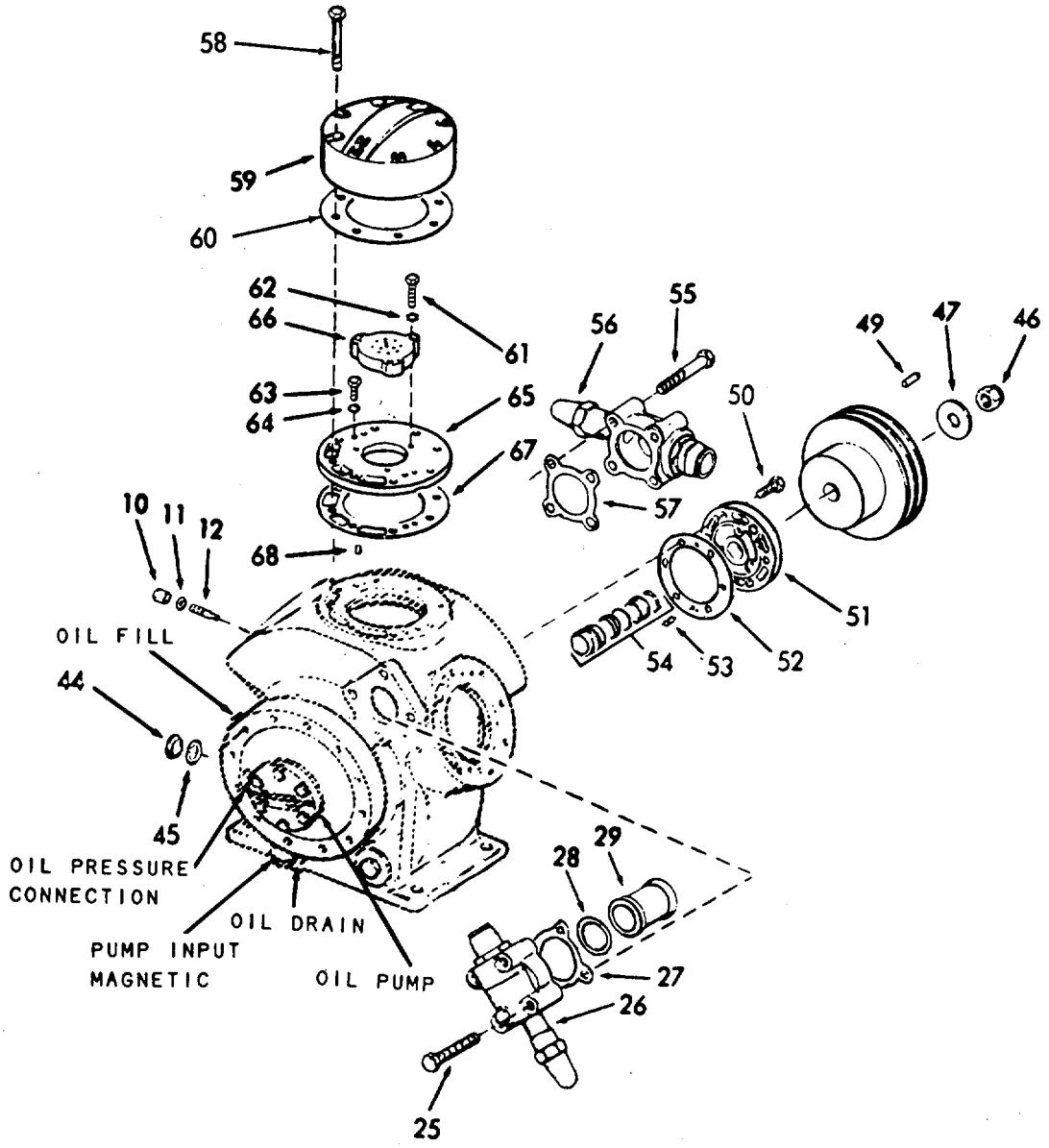


4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

Legend Compressor - HVAC

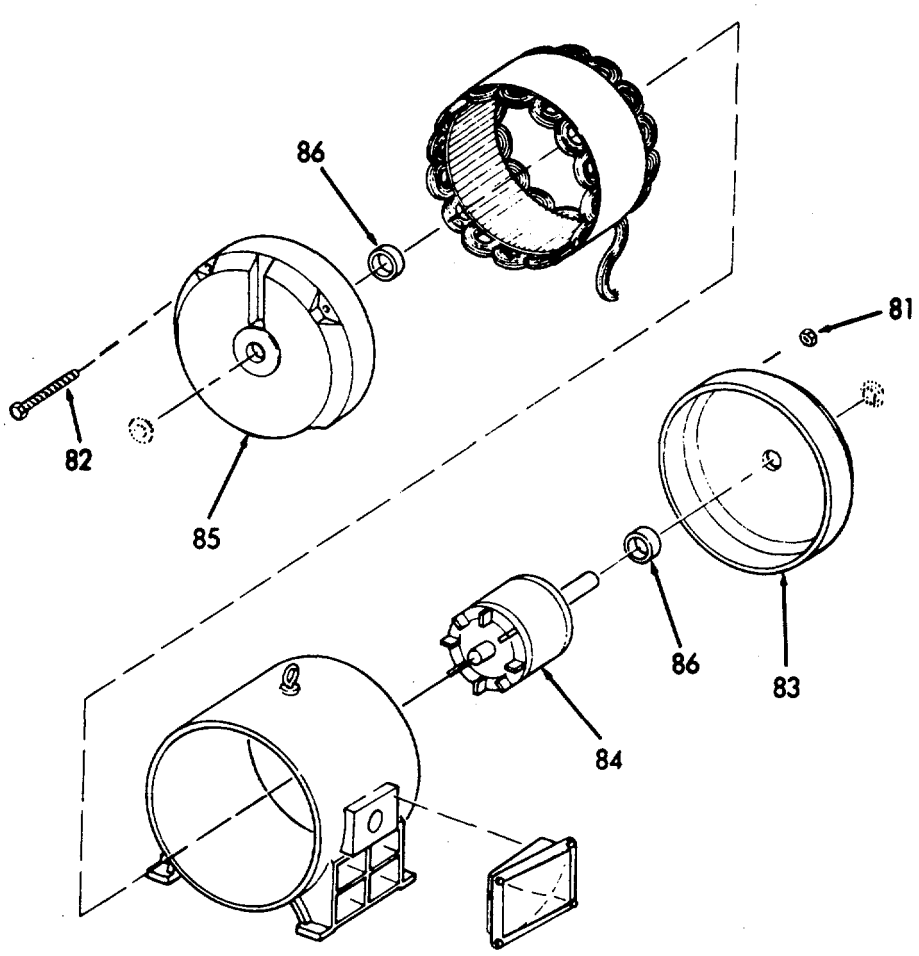
10. Valve cap
11. Gasket
12. Valve body
25. Screw
26. Suction service valve
27. Gasket
28. Gasket
29. Strainer
44. Sight glass
45. Gasket
46. Nut
47. Flatwasher
49. Key
50. Screws
51. Cover plate
52. Gasket
53. Dowel pins
54. Shaft seal assembly
55. Screws
56. Discharge service valve
57. Gasket
58. Screws
59. Cylinder head
60. Gasket
61. Screws
62. Lockwashers
63. Screws
64. Gaskets
65. Valve plate
66. Valve guide
67. Gasket
68. Suction valve springs

4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).



4-29. COMPRESSOR - HVAC - MAINTENANCE INSTRUCTIONS (Continued).

81. Nuts
82. Thru bolts
83. Bracket
84. Rotor and shaft
85. Bracket
86. Bearings



4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS.

a. Water supply and Operating Pressures.

(1) The discharge or head pressure at which the compressor operates is determined by the temperature and quantity of cooling sea water circulated through the condenser. Keep the cooling water quantity at the minimum necessary to maintain the refrigerant head pressure between 90 and 125 psig (620.5 to 861.9 kPa). A minimum amount ofwater will prolong condenser tube life (by reducing water velocities) and will lessen the frequency of cleaning and repairs. However, do not operate the system in excess of 125 psig (681.9 kPa) head pressure.

(2) Adjust the condenser water regulating valve to automatically maintain the desired head pressure. If a water regulating valve is not installed, control the flow of condenser water by throttling a valve in the condenser water outlet line. As a general rule, the quantity of condenser water should not exceed 6 gpm (22.71 lpm) per ton of refrigeration.

NOTE

Always supply sufficient water pressure to condenser but do not exceed 50 psig (344.7 kPa) at water regulating valve.

(a) Low Head Pressure.

Low head pressure may be caused by too much cooling water or too low water temperature. If head pressure drops below 90 psig (620.5 kPa), decrease water flow through condenser. Refer to troubleshooting in Volume 3 for other possible causes of low head pressure.

(b) High Head Pressure.

Head pressure may rise above 125 psig (861.9 kPa) for several reasons:

1 Condenser water flow may be insufficient or water temperature may be high. High water temperatures often exist in tropical climates. Adjust water regulating valve or condenser water outlet valve to increase water flow and maintain 125 psig (861.9 kPa) or less head pressure.

2 Air or other noncondensable gases may be present in the refrigerant side of the condenser. If head pressure rises above 125 psig (861.9 kPa), and maximum water flow when sea water temperature is below 88° F (31.1° C) does not reduce pressure to normal, test for noncondensable gases.

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

Stop compressor, close liquid line stop valve downstream of receiver, and open water valves to obtain maximum flow through condenser. When compressor discharge gauge holds a steady pressure (no further decrease is noted in discharge pressure), read corresponding refrigerant temperature on outer scale of gauge. If this temperature is more than 5° F (-15°C) higher than the condenser water outlet temperature, noncondensable gases are present. Purge condenser. Refer to paragraph 4-30b.

3 Condenser tubes or water strainer may be clogged or dirty. Clean the strainer and tubes regularly. Refer to paragraph 4-30c.

4 Refer to troubleshooting in Volume 3 for other possible causes of high head pressure.

b. Purging.

(1) Check for the presence of air or other noncondensable gases in the refrigerant side of the condenser as outlined in paragraph 4-30a(2)(b)2.

(2) To purge noncondensable gases from the condenser shell, stop the compressor for ten or fifteen minutes leaving all valves in their normal operating positions. Close condenser-receiver equalizing line valve. Open purge valve connected to top of condenser and allow gas to blow for a few seconds. Purge slowly to keep refrigerant loss to a minimum.

(3) Refrigerant-12 resembles carbon tetrachloride in odor, but it is oderless in concentrations of less than 20% by volume of air. If odor cannot be detected at the purge valve, the necessity for further purging may be determined on the basis of pressures. Purging noncondensable gases such as air causes a pressure drop after the purge valve is closed. Observe the discharge gauge after each opening of purge valve. Repeat purging until there is no further pressure drop or until the temperature comparison test (paragraph 4-30a(2)(b)2 no longer indicates the presence of noncondensable gases.

(4) Avoid unnecessary waste of refrigerant. If the temperature comparison test does not indicate that purging is necessary, but head pressure is still high, drain condenser, remove water heads, and clean tubes as required.

c. Cleaning and Inspection.

(1) The frequency of condenser cleaning and inspection will vary depending on the condition of circulating sea water. The internal surface of condenser tubes should be cleaned at least once ever three months or more often if necessary.

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

(2) To inspect the condenser water side, secure the compressor without pumping down the system. Drain water side by removing drain plugs (or opening drain valves) in bottom of water heads and removing vent plugs (or opening vent valves) atop water heads. Remove water heads on both ends of condenser and if inspect tubes and water heads.

(3) Clean condenser tubes with a soft, flexible brass or nylon bristle tube cleaning brush attached to a rod long enough to pass through entire length of tubes. Flush water through tubes during scrubbing. Take care not to destroy the thin protective film of corrosion products on the inner surfaces of tubes during cleaning. After cleaning, reassemble water heads, connect water lines and flush condenser to remove any sediment.

(4) Inspect zinc protector rods in condenser water heads about once a month. Replace rods showing appreciable corrosion.

(5) Disassemble and clean the condenser water regulating valve at regular intervals.

CAUTION

Whenever a condenser is shut down, if there is danger of reaching freezing temperatures in machinery room, drain condenser water. A freeze-up may seriously damage condenser tubes.

d. Tube Repairs.

(1) The condenser should be tested for leaks periodically, preferably every two weeks.

(a) Temporary Tube Repairs.

A leaking condenser tube (whether split or pitted) may be temporarily repaired by means of tapered plugs *(1/16"/ft* taper). Insert a plug into each end of a leaking tube and drive it in tight enough to hold and not leak at maximum condenser pressure. Plugs can be made of wood, plastic or rawhide of sufficient length to allow removal if and when a new tube is installed.

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

(b) Permanent Tube Repairs.

Replace defective condenser tubes as soon as practicable. Close water valves and drain all water from condenser. Keep refrigerant gas pressure in condenser higher than water pressure until all water has been drained. This will prevent water from entering refrigerant side of condenser through leaky tubes. Close condenser refrigerant inlet and outlet valves and vent remaining refrigerant vapor from condenser shell through purge valve. Run a line from purge valve to open deck while venting shell. Remove defective tube(s) and install new tube(s) as described below.

NOTE

Procedures given below for removal and installation of condenser tubes also apply to replacement of water or brine chiller tubes.

CAUTION

Permanent condenser repairs should be made only by skilled personnel.

1 Removing tubes.

a Thread defective tube on one end with a special knockout plug having a fine "V" buttress thread. Threads should extend well beyond tube sheet.

b Thin tube wall at each end to about .015 inch thick. For 3/4 inch OD tubes, use a 23/32 inch cutter having a 5/8 inch diameter pilot plug to properly guide and center the cutter. (For 5/8 inch OD tubes, use a 19/32 inch cutter having a 1/2 inch diameter pilot plug.) Take care not to damage holes in tube sheet. Stop cutting tool 1/8 inch from back face of tube sheet to prevent buckling tube when removing it (threaded end only).

c Turn knockout plug well into end of tube threaded in step a.

d Insert a 7/16 inch rod into end of tube opposite plug. Rod must be at least a foot longer than tube. Drive out tube by hammer blows on rod.

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

2 Installing tubes.

a Obtain tubes of correct length. Tubes should be of the length shown on the condenser assembly drawing. If too long, tubes should be cut to required length. Edges of tubes should be chamfered.

b Place tube in position between tube sheets.

c "Set" or expand one end of tube into tube sheet hole to prevent tube from rotating while it is being rolled. Use a drift pin to "set" one end of tube while using a dolly bar to back opposite end of tube.

d Expand tube using special "tube expander" tool furnished for this purpose. Use of tube expander is described below. After tubes are expanded, face them off flush with tube sheet.

3 Use of tube expander.

Attach condenser tube expander to a slow speed reversing air motor or hand brace. Apply lubricating oil freely to expander rollers before using. Place expander into tube and roll tube until a tight joint is made. At frequent intervals remove tube expander, rinse in kerosene to remove scale and apply oil to prevent overheating. Keep tube expander clean and well lubricated. Avoid using worn, rough or chipped rollers or mandrel. After rolling tube, test for a tight joint and reroll if necessary.

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection - External b. Repair c. Service and Inspection

INITIAL SETUP

Test Equipment
NONE

References
Paragraph
4-28r Leak Detection
4-35.6 Tubing Maintenance

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

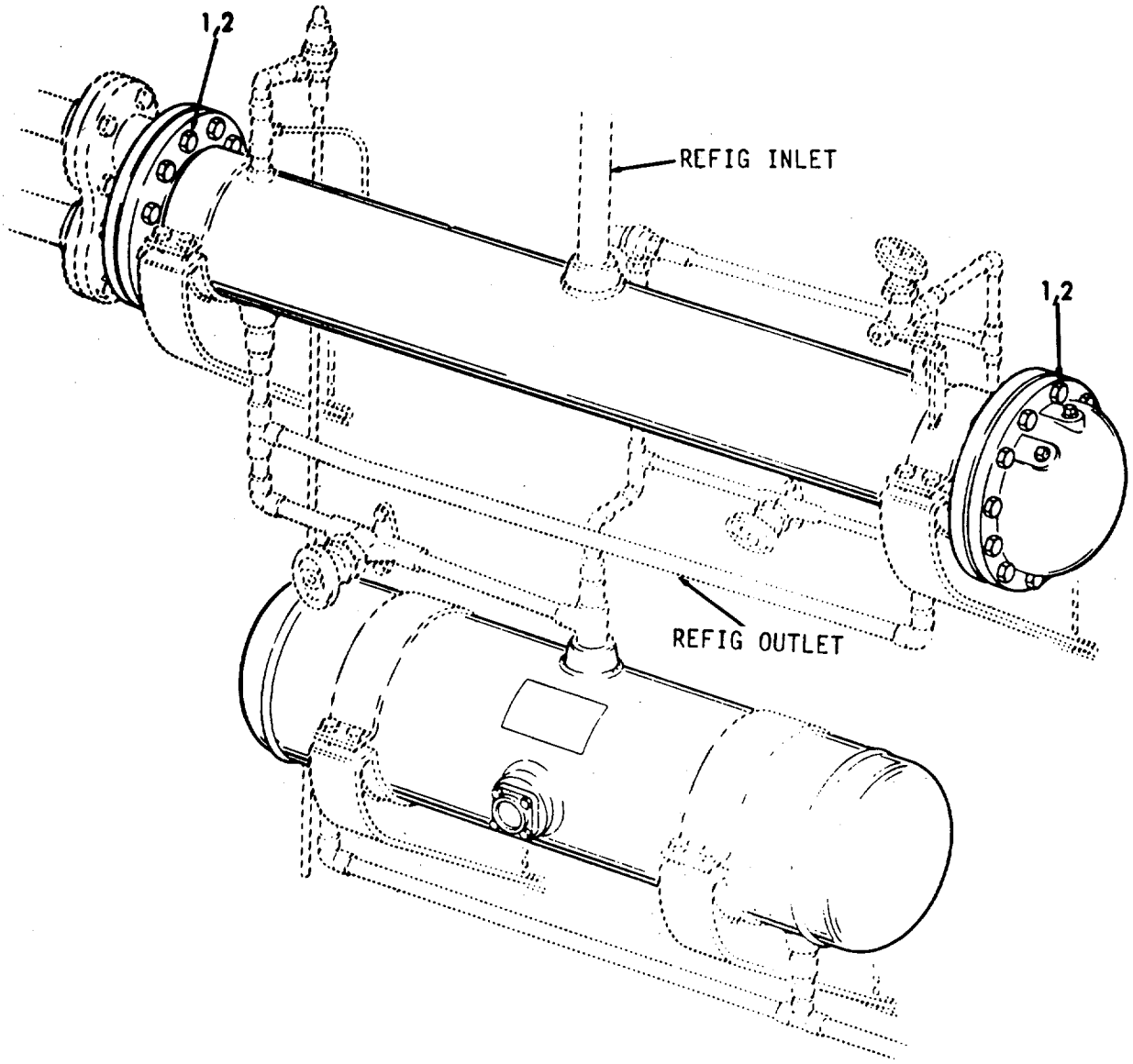
Personnel Required
1

General Safety Instructions
Observe safety precautions in paragraph 4-28d.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION - EXTERNAL			
1. Condenser	a. Tubing	Inspect for breaks and cracks.	
	b. Condenser guard	1 Inspect for breaks and cracks. 2. Inspect for leaking.	
REPAIR			
2.	a. Screws (1) and lock-washers (2)	Remove.	

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			

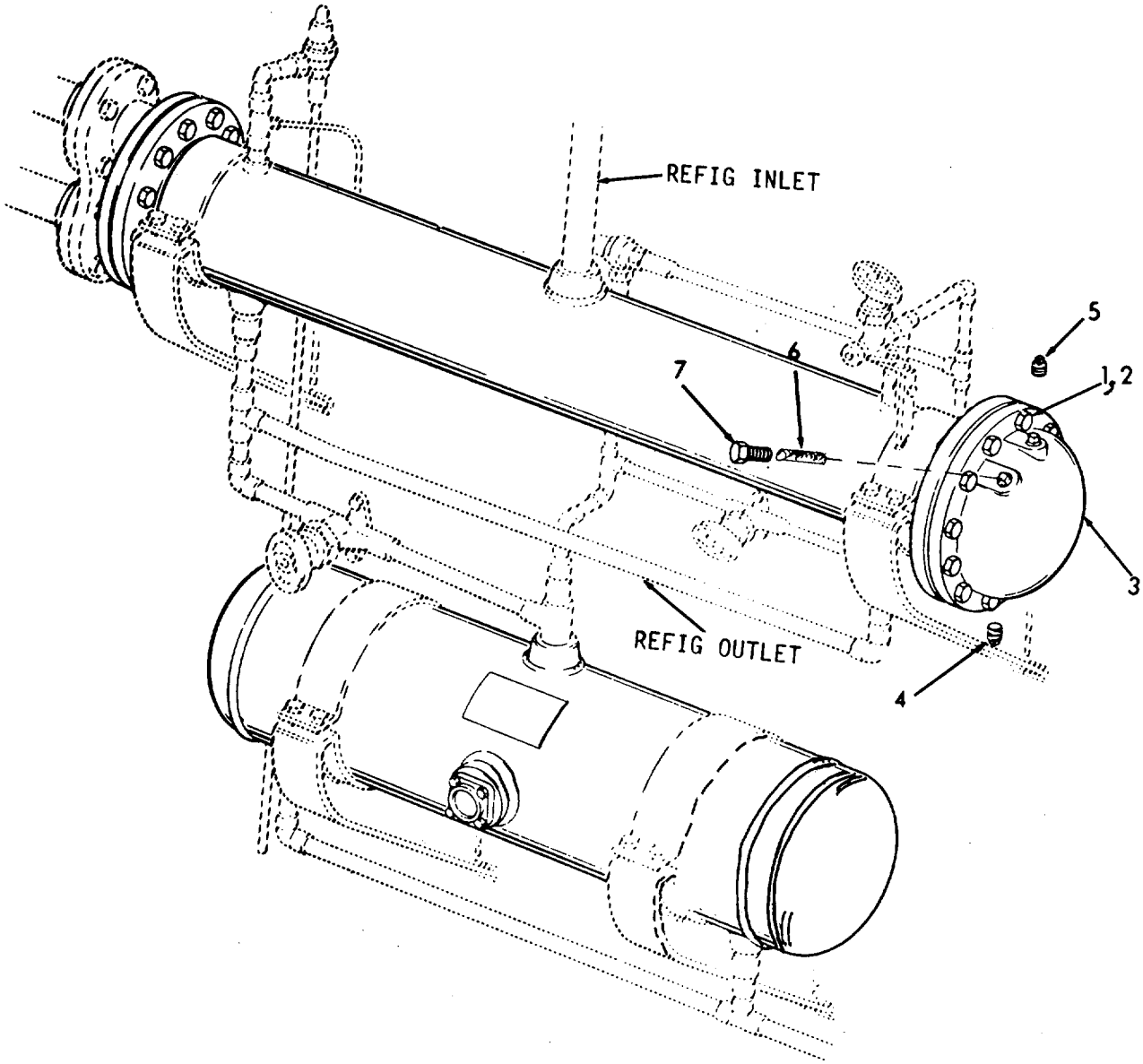


4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b.. Water heads (3)	Remove.	
	c. Tube repairs	Perform.	Refer to paragraph 4-30d.
	d. Water heads (3), screws (1), and lock-washers (2)	Install.	
SERVICE AND INSPECTION			
3	a. Drain plug (4)	Remove.	
	b. Vent plugs (5)	Remove.	
	c. Conden-ser	Perform cleaning and inspection in paragraph 4-30c.	
	d. Zinc protec-tors (6) and caps (7)	1. Remove. 2. Perform cleaning and inspection in para-graph 4-30c(4).	

4-30. CONDENSER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE AND INSPECTION			



4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS.

a. Refrigerant-12 acts as a cleanser, loosening particles of dirt and scale which will collect in the strainers. Clean liquid line strainers soon after a plant is placed in operation and, after that, as often as required. Dirty liquid line strainer screens will throttle and cause some expansion, so that a difference in temperature on either side of a strainer indicates a stoppage and the need for cleaning.

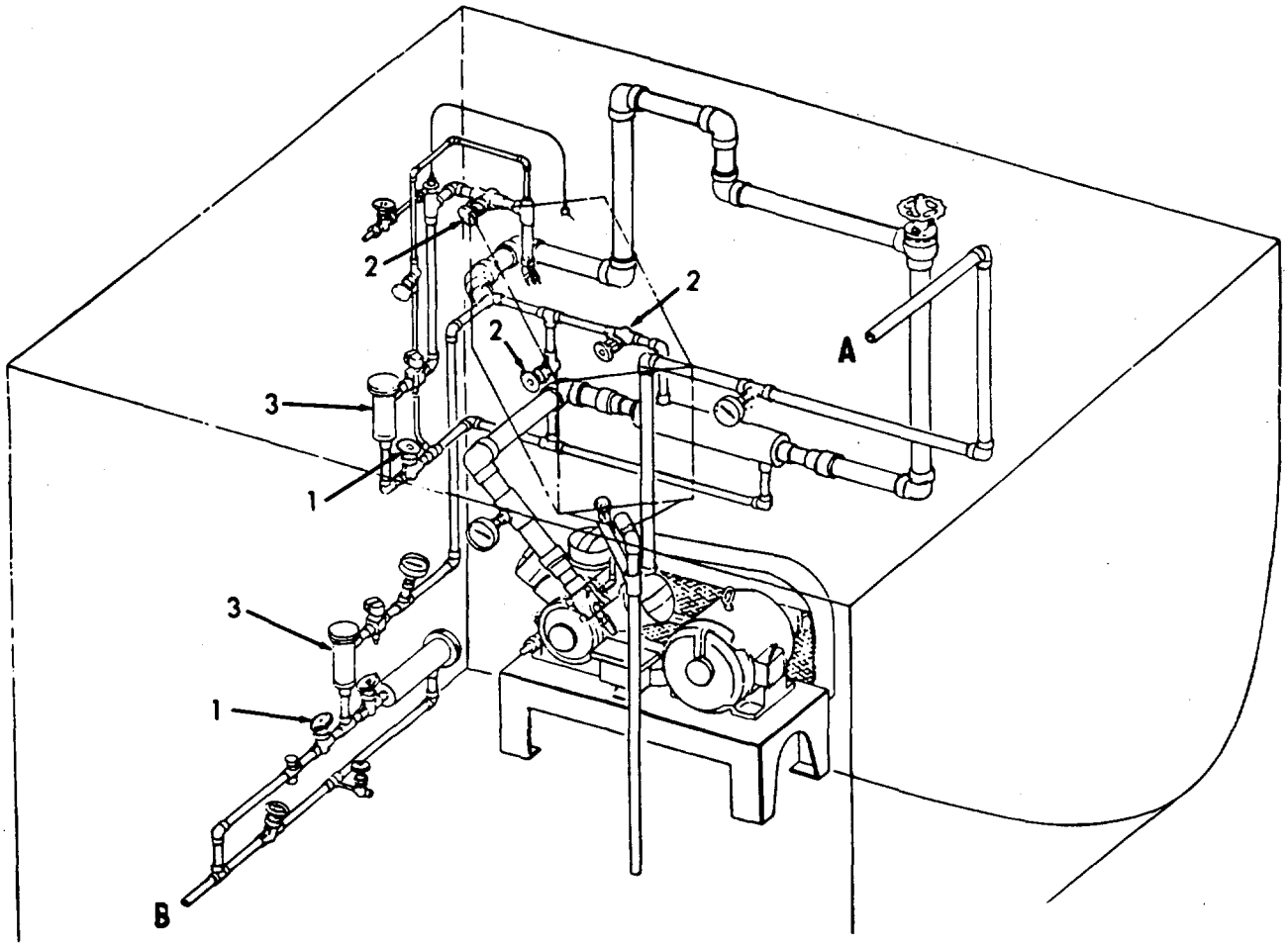
b. To remove and clean a liquid line strainer screen, first pump down strainer. Close cut-out valve on inlet side of strainer and allow plant to pump down. As pressure is reduced, the strainer will become cold and then begin to warm up as soon as liquid refrigerant has been removed. At that time, close cut-out valve on outlet side of strainer, that is, downstream of thermal expansion valve. (The automatic control valves, expansion and solenoid, have also been isolated and can be disassembled for cleaning, repair or replacement as required.)

c. Remove flange strainer cover and strainer screen. Plug strainer to exclude air and moisture. Clean screen thoroughly and reinstall leaving flanged cover partly disconnected. Slightly open cut-out valves on both sides of strainer one at a time and allow a small quantity of refrigerant to blow the air out of the line. Then quickly tighten strainer cover. Open cut-out valves to place strainer and automatic control valves back on the line.

NOTE

When strainer and automatic control valves are isolated for service, liquid refrigerant flow to circuit may be continued by opening hand expansion valve in bypass line. Crack hand expansion valves open gradually (about 1/4-turn at a time) and not too much to avoid flooding.

4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS
(Continued)



1. Inlet cut-out vanes
2. Outlet cut-out vanes
3. Strainers

4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection b. Service c. Replace

INITIAL SETUP

Test Equipment
NONE

References
Paragraph
4-28r Leak Detection
4-35.6 Tubing Maintenance

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe safety precautions in paragraph 4-28d.

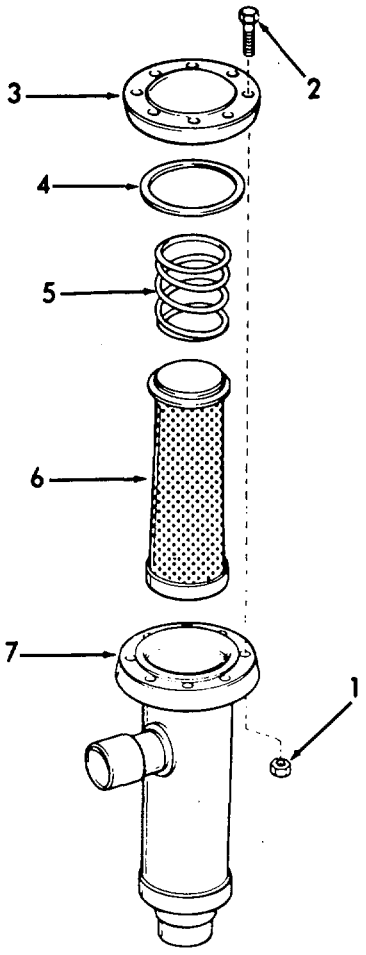
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Strainer	a. Tubing	Inspect for breaks, cracks and leaking.	
	b. Strainer	1. Inspect for breaks, cracks and leaking. 2. Insure all hardware is tight.	
SERVICE			

NOTE

Prior to performing maintenance perform pump down in paragraph 3-31b.

4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
2	a. Nuts (1), and screws (2)	Remove.	
	b. Cover plate (3), and gasket (4)	Remove.	Discard gasket.
	c. Spring (5)	Remove.	
	d. Screen (6)	1. Remove	Replace if damage.
		2 Clean.	



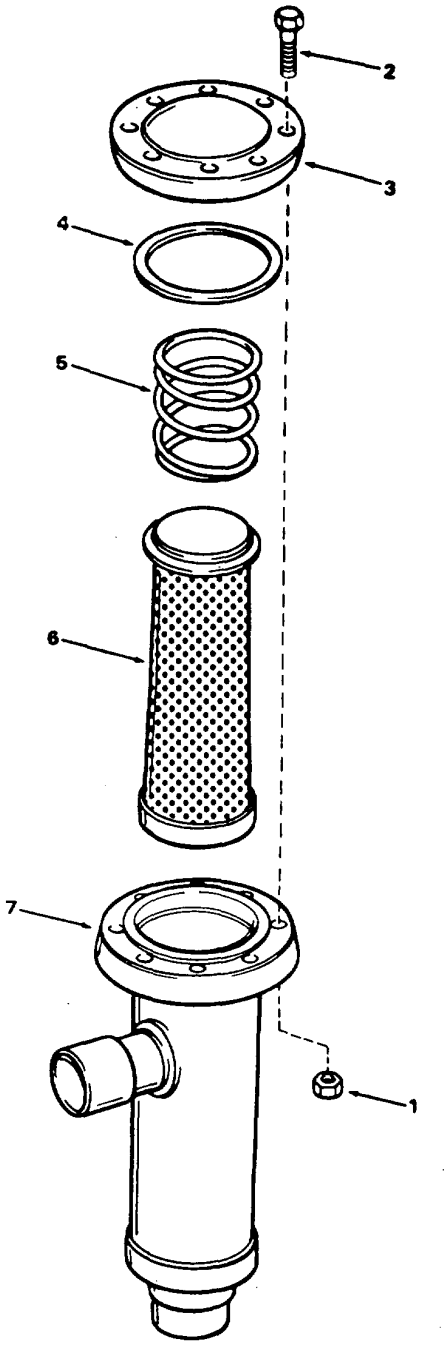
4-925

4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	e. Screen (6), and spring (5)	Replace.	
	f. Cover plate (3), and gasket (4)	Install.	Use new gasket.
	g. Screws (2), and nuts (1)	Install.	Do not tighten.
	h Strainer	Place on line	Refer to paragraph 4-31c.
REPLACE			
3.		Remove strainer in accordance with standard soldering methods. Be careful to retain all the solder in the connections. Refer to paragraph 4-35.6 for soldering procedures.	

4-31. STRAINER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			



4-32. DRYER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS.

a. The dryer is a cylinder containing one or more cartridges filled with activated alumina or silica gel. After prolonged use, the dryer becomes saturated with moisture and oil and the cartridges must be replaced.

b. The dryer cartridges are accessible for replacement by removing the flanged cover plate. Before opening dryer, pump it down. The dryer is installed in a bypass, close dryer inlet and bypass valve, open dryer outlet valve, and allow plant to pump down. When dryer begins to warm up, liquid refrigerant has been removed. Close dryer outlet valve and open bypass valve to restore liquid refrigerant flow to evaporator. Open dryer by removing capscrews and nuts around cover plate. Remove cover and gasket. Pull out safety cap, spring and cartridges. Do not let dirt get into dryer shell. Insert new cartridges and reassemble dryer with a new cover plate gasket. Secure cover plate firmly.

NOTE

Only in an emergency, reactivate dryer cartridges by heating to 250° - 300° F (121° - 149°C) to drive out moisture. Otherwise, install only new cartridges taken from sealed containers.

This task covers:

a. Inspection b. Service c. Replace

INITIAL SETUP

Test Equipment

NONE

References

Paragraph	
4-28e(5)	Pumping Down
4-28r	Leak Detection
4-35.6	Tubing Maintenance

Special Tools

NONE

Equipment

Condition Condition Description

NONE

Material/Parts

Cartridge 4440-00-494-9427

Special Environmental Conditions

NONE

Personnel Required

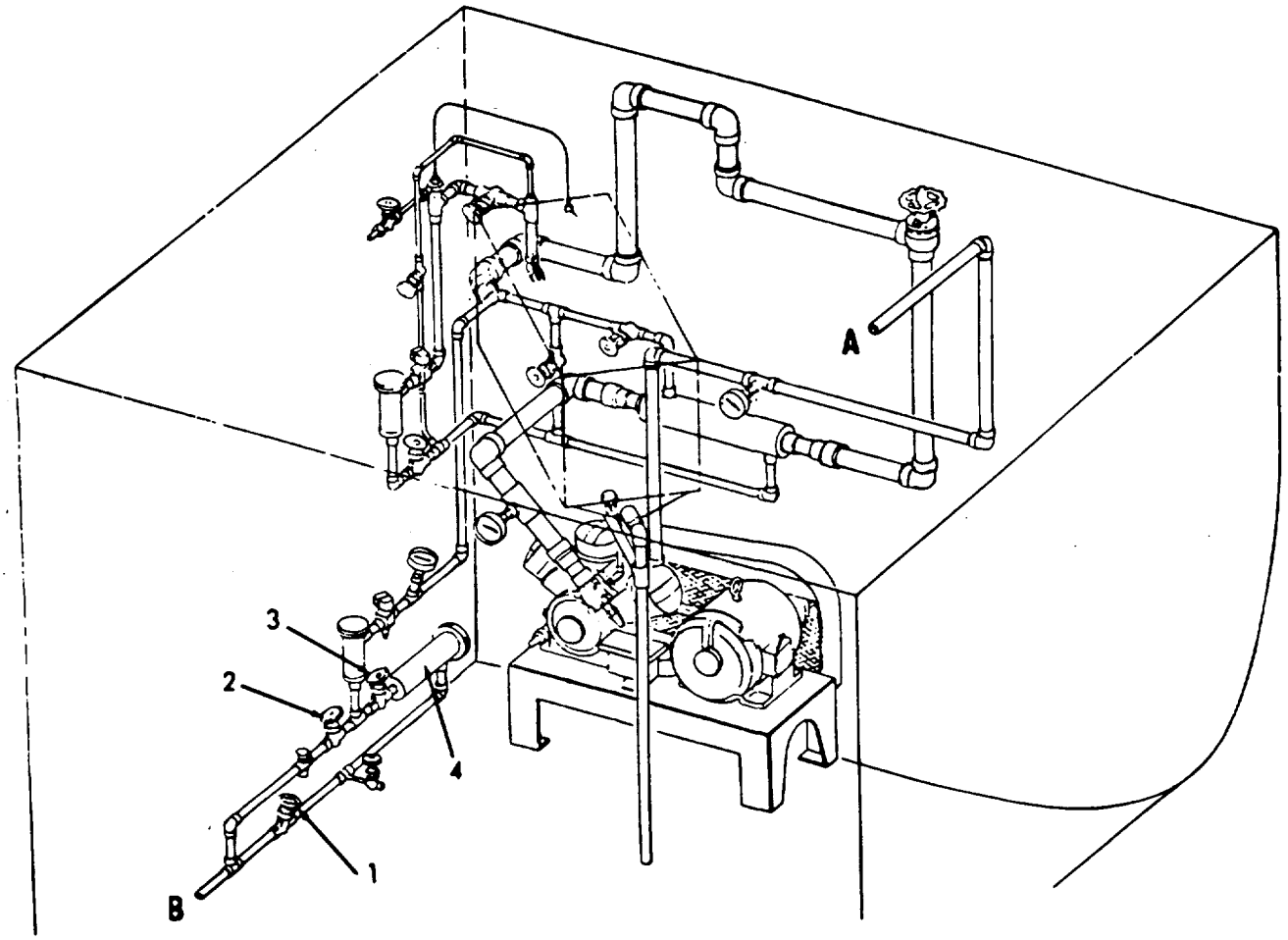
1

General Safety Instructions

Observe safety precautions in paragraph 4-28d.

4-32. DRYER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS



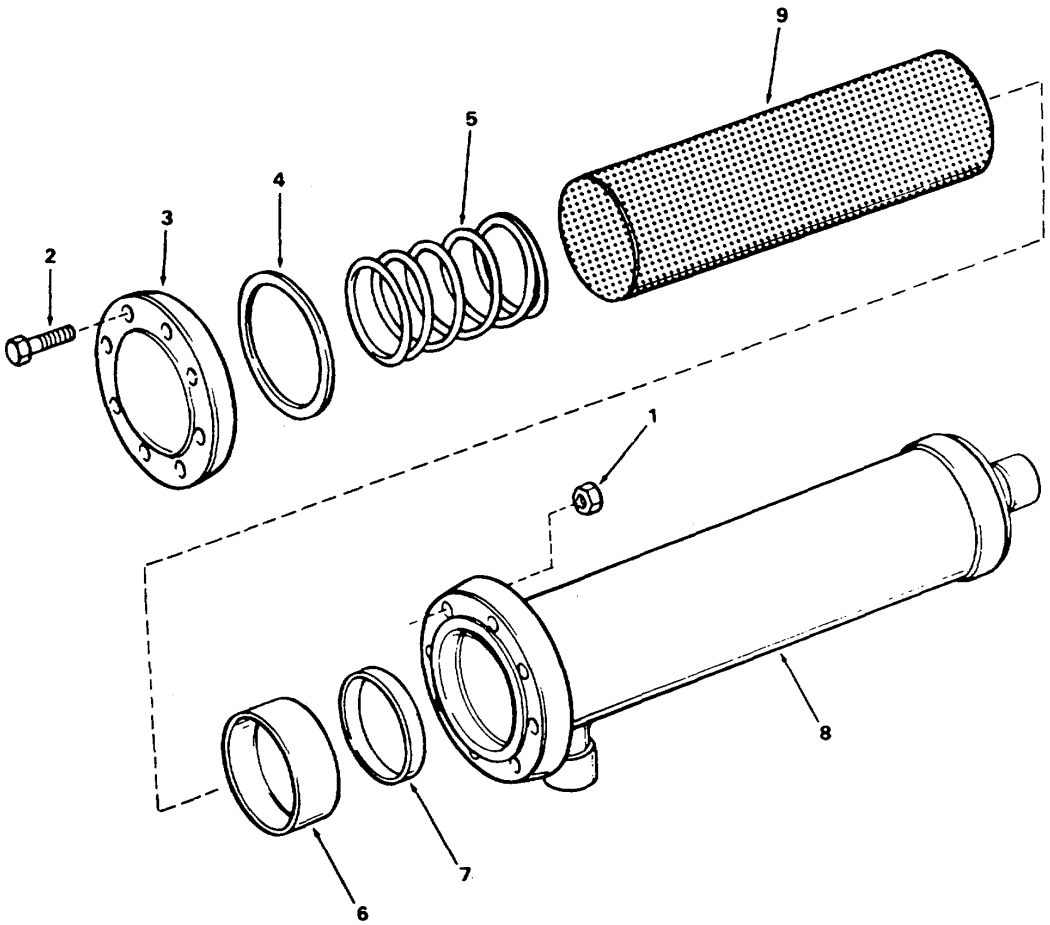
1. Dryer inlet valve
2. Dryer by-pass valve
3. Dryer outlet valve
4. Dryer

4-32. DRYER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Dryer	a. Tubing	Inspect for leaks, cracks, or breaks.	
	b. Dryer	1. Inspect for leaks, cracks or breaks. 2. Insure all hardware is tight.	
SERVICE			
2.	a. Nuts (1) and screws (2)	Remove.	
	b. Cover plate (3) and cover gasket (4)	Remove.	Discard gasket if damaged.
	c Spring (5)	Remove.	
	d. Cart-ridge (6)	Remove.	Discard.
	e. Safety cap (7) and gas-ket (8)	Remove	If necessary.
	f. Cart ridge (6)	Install.	Use new cart-ridge from a sealed contain-er.
	g. Spring (5), cover plate (3) and gasket (4)	Install.	

4-32. DRYER - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
	h. Screws (2) and nuts (1)	Install.	
REPLACE			
3.		Remove dryer in accordance with standard soldering methods. Be careful to retain all the solder in the connections. Refer to paragraph 4-35.6 for soldering procedures.	



4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS.

a. High and Low Pressure Control Switches.

(1) Operation.

(a) Separate high and low pressure control switches. Similar in construction and operation, are furnished.

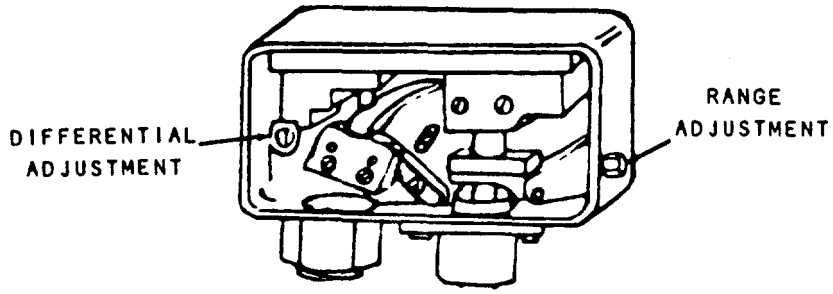
(b) Pressure applied at the switch connection actuates a seamless metallic bellows power element which operates the switch mechanism to open or close the electrical circuit. A permanent magnet in the switch mechanism provides a positive snap-action on both the opening and closing cycles, preventing excessive arcing at the contacts.

(2) Adjustment.

(a) The switch operating range and differential are both adjustable.

(b) The range adjustment screw located on the right side of the switch, outside the case, changes both the cut-in and cut-out points by an equal amount. Turning the range screw clockwise raises both set points and turning it counterclockwise lowers both set points.

(c) The differential adjustment, inside the switch case, governs the cut-out point but does not affect the cut-in point. Turning the differential screw clockwise widens the differential.



Pressure or Temperature Control Switch (American-Standard)

(3) Schematic and Wiring Diagram. (See foldout 1.)

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References

Paragraph	
4-28r	Leak Detection
4-35.6	Tubing Maintenance

Special Tools
NONE

Equipment Condition
Condition Description
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe safety precautions in paragraph 4-28d.

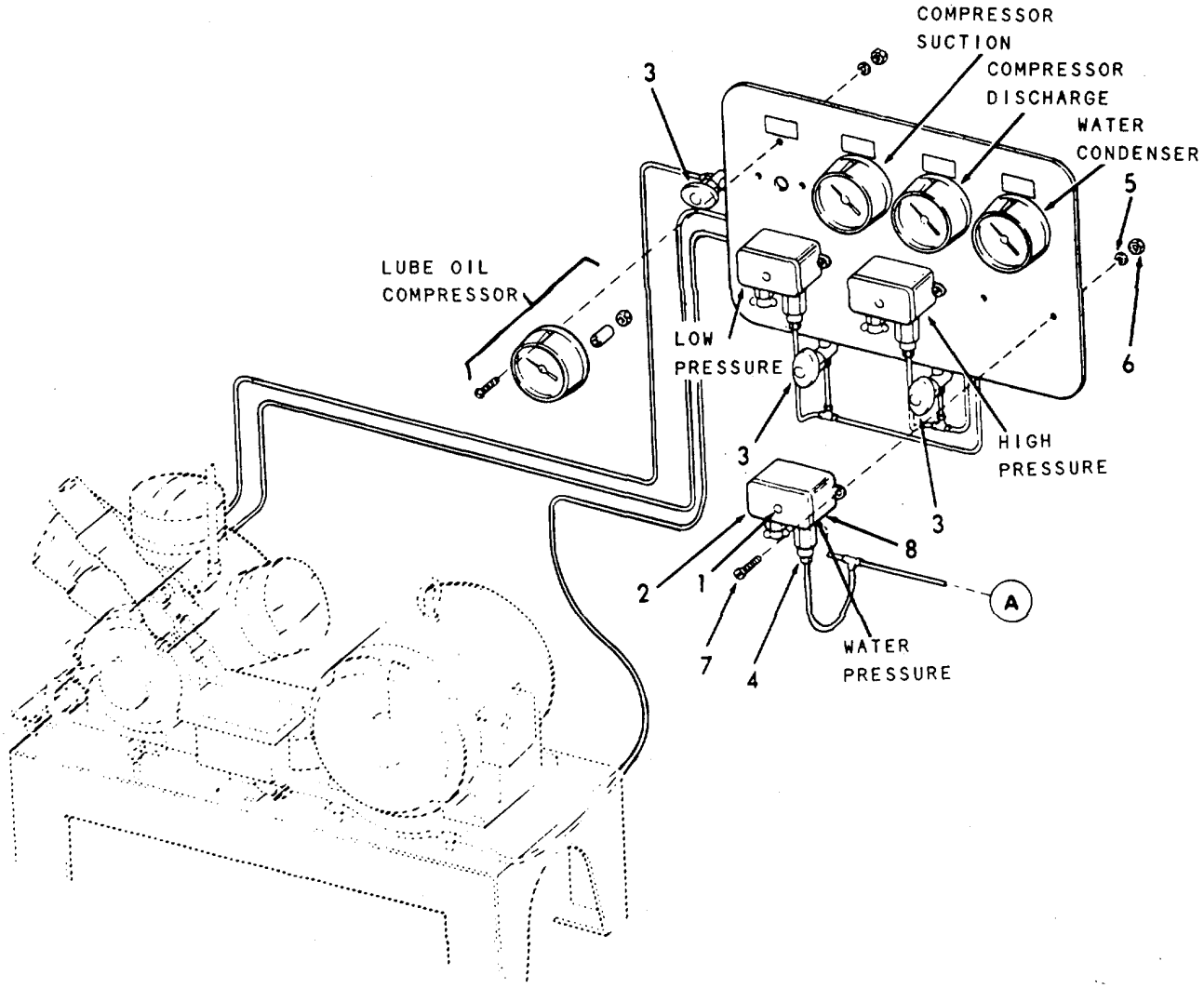
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. High, low and water pressure switch	a. Wiring	Inspect for breaks, cracks, and worn insulation.	
	b. Switch	Inspect for breaks, cracks and signs of damage.	
	c. Tubing	Inspect for bends, breaks, and cracks.	
2. Gages	a Tubing	Inspect for bends, breaks and cracks.	

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. Gage	1 Inspect for broken glass.	
		2. Inspect for erratic operation.	
REMOVAL			
3. High, low and water pressure switch	a Screw (1) and cover (2)	Loosen screw and remove cover.	
	b. Wiring	Tag and disconnect.	
	c. Shut-off valve (3)	Rotate clockwise.	Shut-off valve for switch.
	d. Switch adapter (4)	Loosen.	
	e. Nuts (5), lock-washers (6), and screws (7)	Remove.	
	f. Switch (8)	Replace.	
	g. Screws (7), lock-washers (6), and nuts (5)	Install.	
	h. Switch adapter (4)	Tighten.	

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	i. Shut-off valve (3)	Turn on.	Check for leaks.
	j. Wiring	Reconnect, remove tags.	
	k. Cover (2), and screw (1)	Install and tighten screw.	
	1. Switch	Adjust.	Refer to step 6.



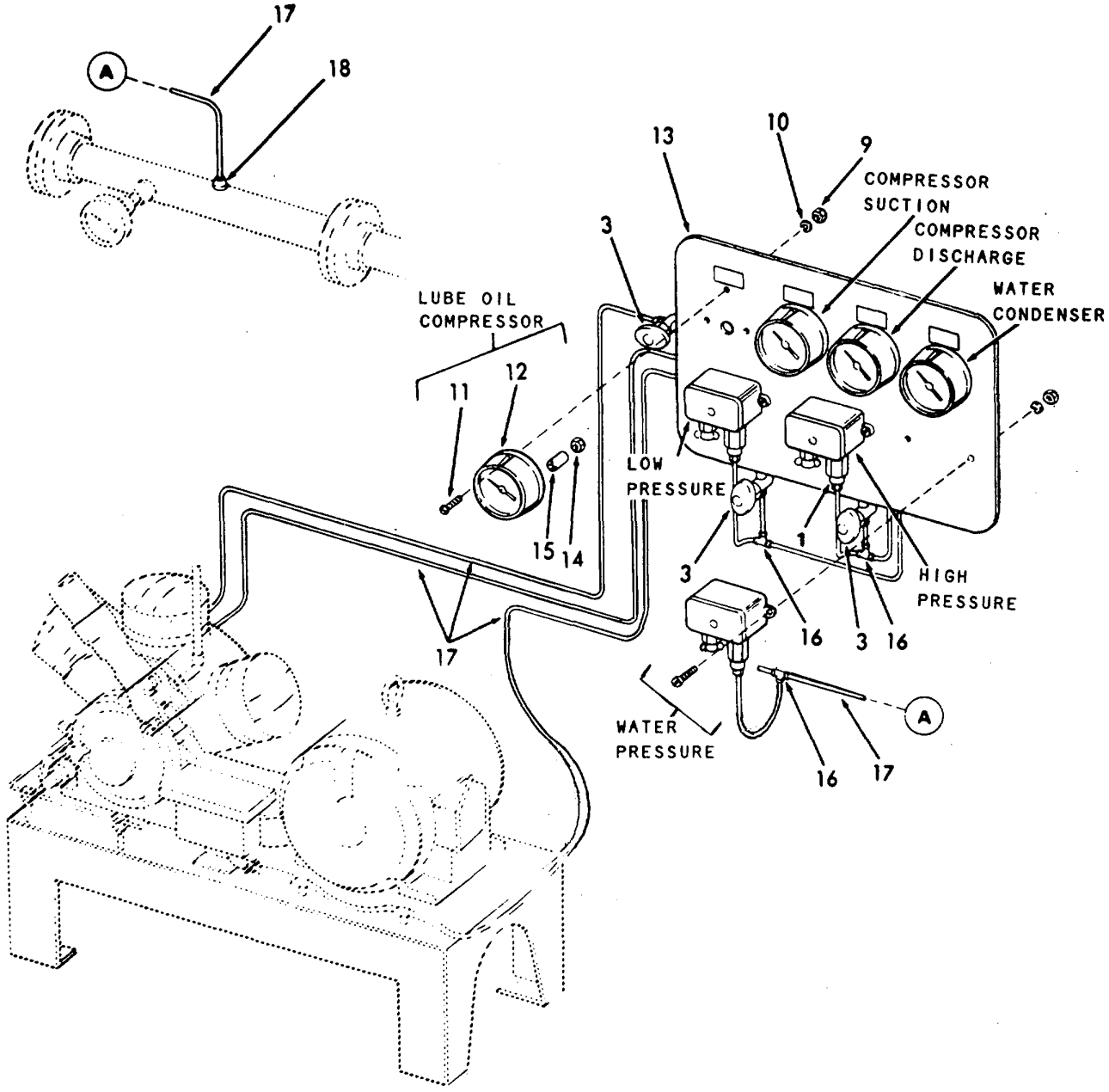
4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Gages	a. Nuts (9), lock-washers (10), and screws (11)	Remove.	
	b. Gage (12)	Pull from gage board (13).	
	c. Tube nut (14) and sleeve (15)	Disconnect.	
	d. Gage (12)	Replace.	
	e. Sleeve (15) and tube nut (14)	Install.	
	f. Gage (12), screws (11), lock-washers (10) and nuts (9)	Install.	
REPAIR			
5. Copper tubing and valves	Valves (3), tees (16), tubing (17), and brazeolet socket (18)	Unsolder and replace as required.	Refer to paragraph 4-35.6 for soldering procedures.

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



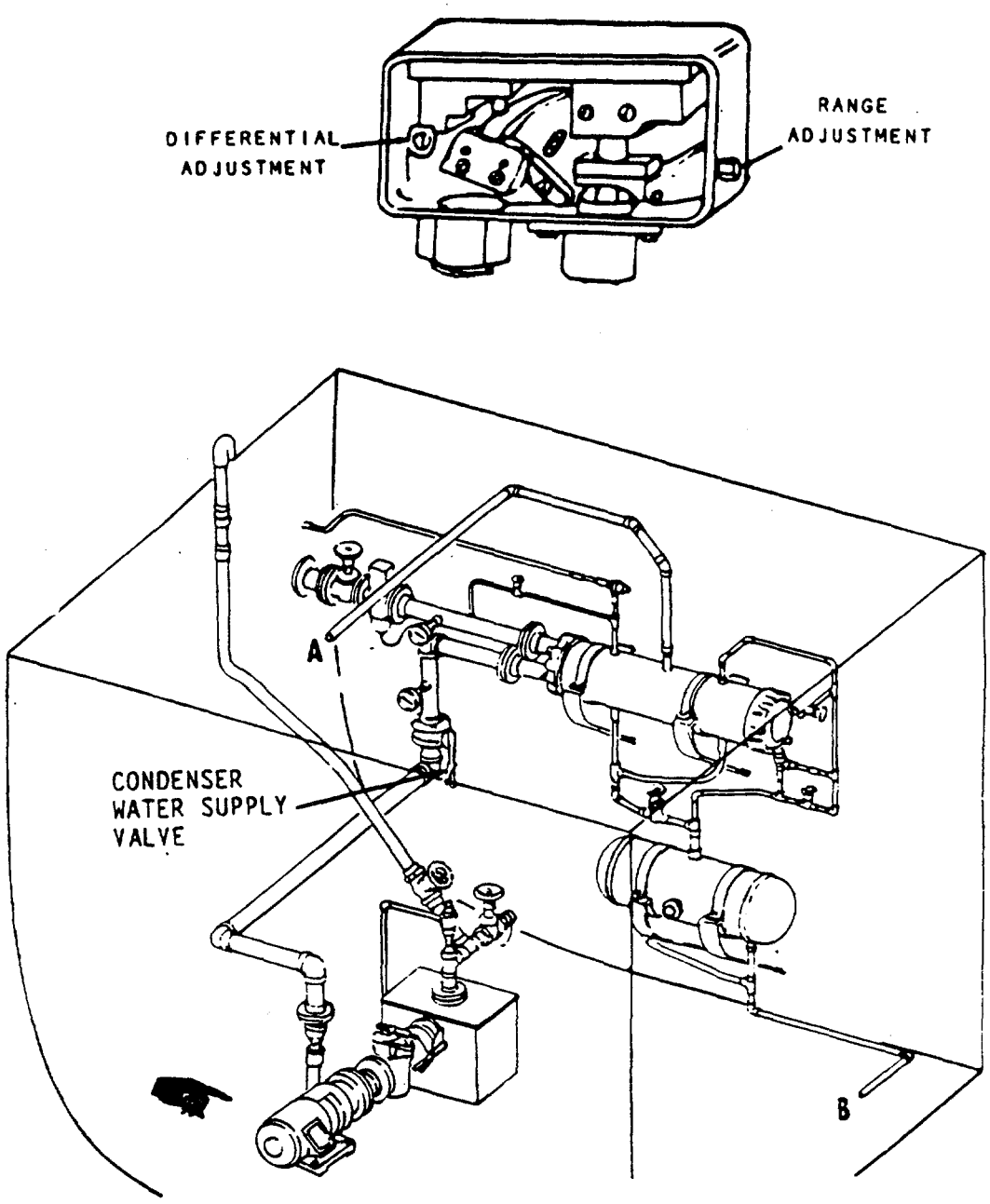
4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS			
6. High pressure control switch		a. Turn differential screw to minimum (counterclockwise) and range screw to high limit (clockwise). b. Start compressor and control discharge pressure by throttling condenser water flow. c. Raise discharge pressure to about 10 psi (69 kPa) above cut-in point. Turn range screw counterclockwise until contacts open, stopping compressor. When discharge pressure drops to cut-in point, turn range screw slowly clockwise until contacts close, starting compressor. The cut-in point is now set. d. With the compressor running, turn differential screw (clockwise) to wide limit. Raise discharge pressure to cut-out point and turn differential screw counterclockwise until contacts open, stopping compressor. The cut-out point is now set. e. Control discharge pressure and check switch settings and operation. f. Recommended settings: Close - 125 psig (861.9 kPa) Open - 175 psig (1206.6 kPa)	

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)



4954-166

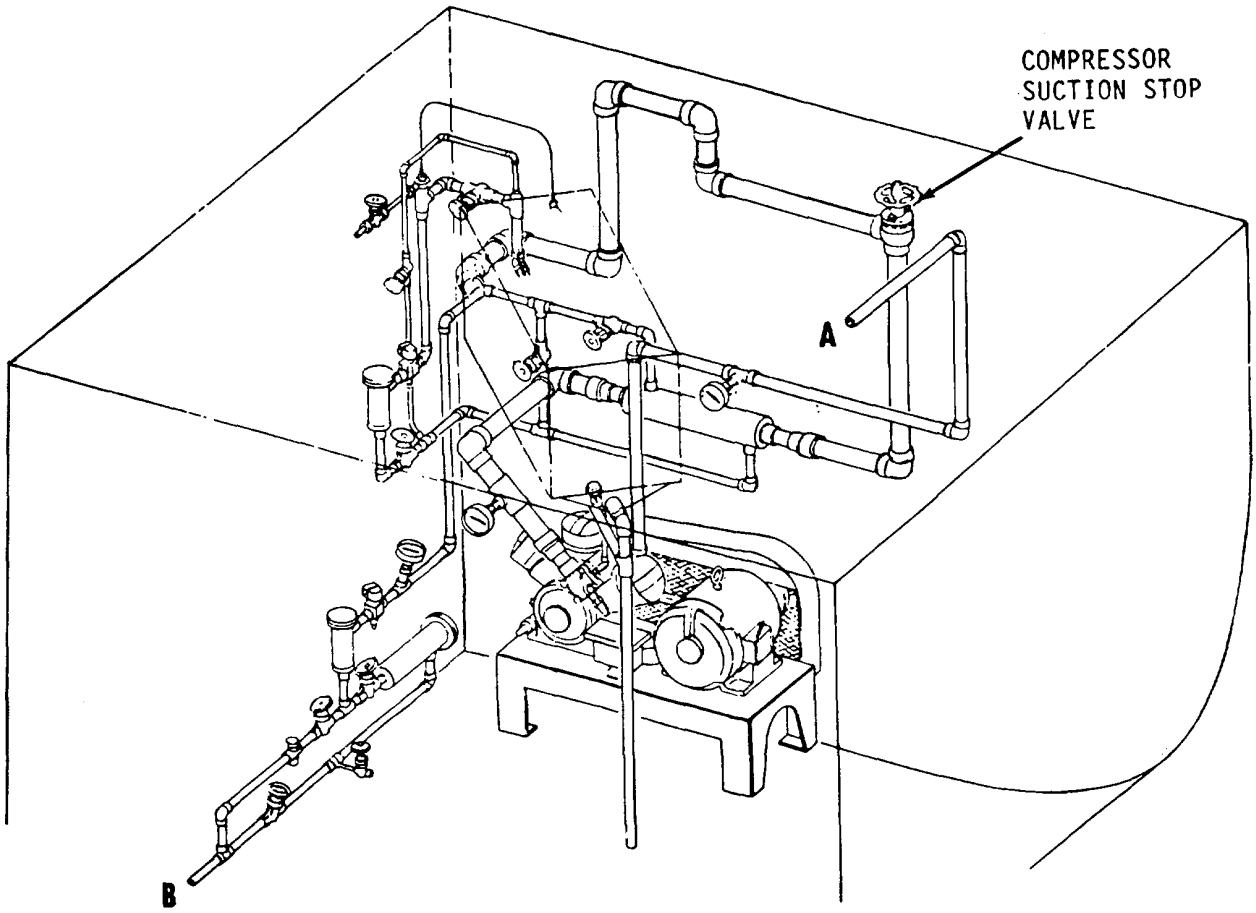
4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			
7.	Low pressure control switch	a. Turn differential adjustment clockwise to maximum position and range screw counterclockwise to low limit.	
		b. Start compressor and control suction pressure by throttling the compressor suction stop valve.	
		c. Lower suction pressure to about 10 psi (69 kPa) below cut-in point. Turn range screw clockwise until contacts open, stopping compressor. Allow suction pressure to rise to cut-in point and close suction valve to hold it there. Turn range screw counterclockwise until contacts close, starting compressor.	
		d. Lower suction pressure to cut-out point and turn differential screw counterclockwise until contacts open, stopping compressor. This fixes the cut-out point.	
		e. Control suction pressure and check switch settings and operation.	
		f. Recommended settings: Close - 37 psig (255.1 kPa) Open - 28 psig (193.1 kPa)	

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)



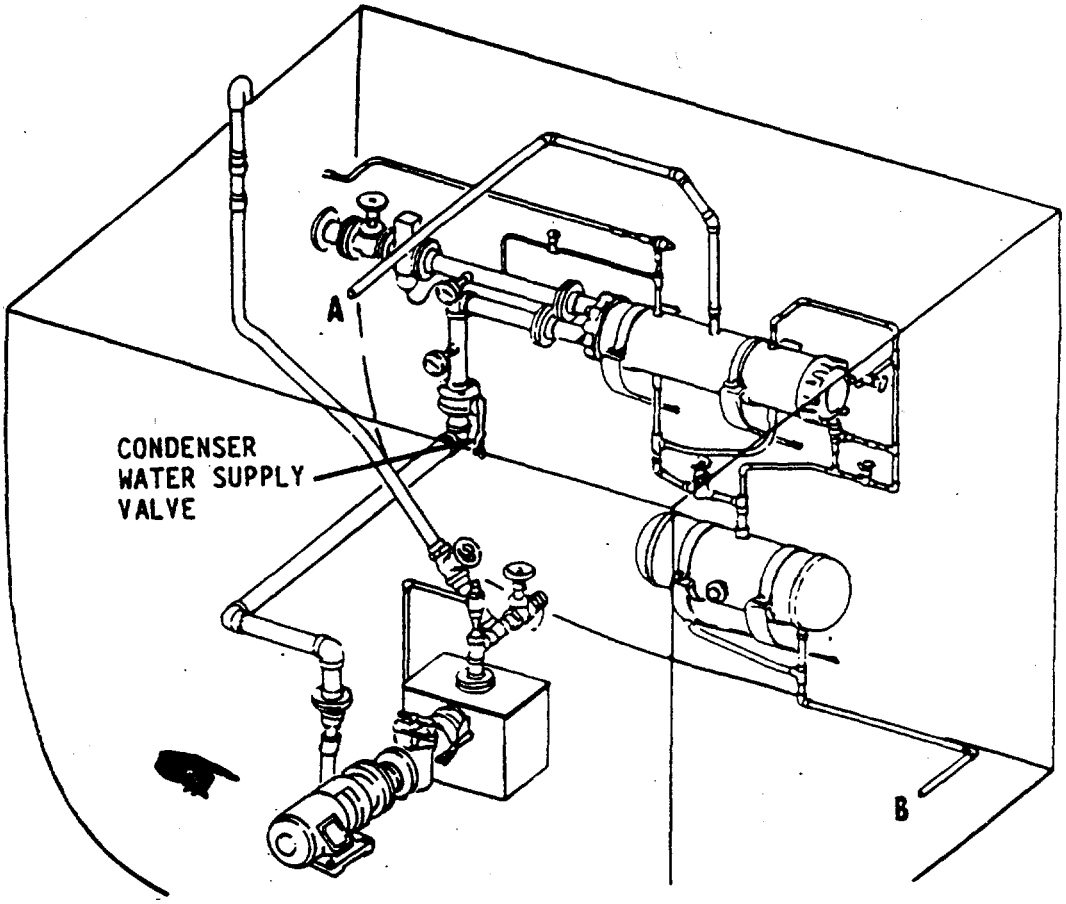
4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENTS (Cont)			
8.	Water pressure control switch	a. Turn differential adjusting screw counterclockwise to minimum limit.	
		b. Turn range screw clockwise to high limit.	
		c. Throttle water valve until condenser water supply pressure is 15 psig (103.4 kPa). Turn range screw slowly counterclockwise until contacts just close. This fixes the cut-in point.	
		d. Slowly throttle condenser water supply decreasing pressure. Switch contacts should open at 5 psig (34.5 kPa). If switch contacts open above 5 psig (34.5 kPa), turn differential screw clockwise to widen differential slightly.	
		e. Control condenser water supply and check switch settings.	
		f. Recommended settings: Close - 15 psig (103.4 kPa) Open - 5 psig (34.5kPa)	

4-33. GAGE BOARD - AIR CONDITIONING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENTS (Cont)



4954-167

*U.S. GOVERNMENT PRINTING OFFICE: 1992 - 654-028/60052

APPENDIX A

REFERENCES

Refer to Volume 12.

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.

B-2. EXPLANATION OF COLUMNS IN SECTION II (Continued).

(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 percision measurement. Consist 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 an equipment or system.

(8) Replace. The act of substituting a serviceable like type part, subassembly 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, subassembly, 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 perscribed 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 to classifying Army equipments/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.

B-2. EXPLANATION OF COLUMNS IN SECTION II (Continued).

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 C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
0900	Pump Sets								
0910	Portable Fire Pump Set	Inspect	.6						
		Service	1.2						
		Test	1.5						
		Replace	5.0						
		Repair	3.5						
		Adjust	1.5						
		Overhaul	15.0						
0911	Fire Pump	Inspect	.2						
		Service	.4						
		Replace	2.5						
		Repair	2.0		3.5				
0912	Motor	Inspect	.2						
		Service	.4						
		Replace	5.0						
		Repair	2.5		4.5				
0913	Controller (Starter)	Inspect	.2						
		Replace			3.5				
		Repair	2.0		4.0				
0920	Bilge Pump Set								
0921	Pump	Inspect	.4						
		Service	.5						
		Replace	4.5						
		Repair	2.5		5.0				
		Overhaul			12.0				
0922	Foundation and Drive	Inspect	.2						
		Replace	3.0		3.5				
		Repair	3.0		1.5				
0930	Lube Oil Pump Set	Inspect	.4						
		Service	.5						
		Replace	5.0						
		Repair	8.5						
		Overhaul	14.0						
0931	Pump	Inspect	.2						
		Replace	4.0						
		Repair	2.5		4.5				
0932	Motor	Inspect	.2						
		Replace	1.5						
		Repair	2.5		4.5				
0933	Controller (Starter)	Inspect	.2						
		Replace			3.5				
		Repair	2.0		6.0				
0940	Fresh and Flush Water Pump Set	Inspect	.4						
		Replace	5.0						
		Repair	2.5						
		Overhaul	13.5						
0941	Pump	Inspect	.2						
		Replace	2.5						
		Repair	7.5						
0942	Motor	Inspect	.2						
		Replace	2.5						
		Repair	2.5		4.5				

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
0943	Controller (Starter)	Inspect	.2						
		Replace	3.5						
		Repair	2.0		6.0				
0950	Air Conditioning Water Circulating Pump Set	Inspect	.4						
		Replace	5.5						
		Repair	8.0						
		Overhaul	13.0						
0951	Pump	Inspect	.2						
		Replace	3.5						
		Repair	2.0		6.5				
0952	Motor	Inspect	.2						
		Replace	1.5						
		Repair	2.5		4.5				
0953	Controller (Starter)	Inspect	.2						
		Replace	3.5						
		Repair	2.0		4.0				
0960	Diesel Oil Cooling Pump Set	Inspect	.4						
		Replace	5.5						
		Repair	5.0						
		Overhaul	13.0						
0961	Pump	Inspect	.2						
		Replace	3.5						
		Repair	4.5						
0962	Motor	Inspect	.2						
		Replace	3.5						
		Repair	2.5		4.5				
0963	Controller (Starter)	Inspect	.2						
		Replace	3.5						
		Repair	4.0						
0970	Lube Oil Transfer Pump (Hand)	Inspect	.2						
		Service	.2						
		Replace	2.0						
		Repair	2.0						
1000	Sewage System								
1010	Sewage System Discharge Pump	Inspect	.4						
		Service	.5						
		Replace	6.0						
		Repair	5.5						
		Overhaul	12.5						
1011	Pump	Inspect	.2						
		Service	.3						
		Replace	3.5						
		Repair	4.5						
1012	Motor	Inspect	.2						
		Service	.2						
		Replace	3.8						
		Repair	5.0						
1020	Sewage System Macerator/Transfer Pump	Inspect	.4						
		Service	2.0						
		Replace	3.0						
		Repair	2.0						
		Overhaul	12.5						

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
1021	Motor	Inspect	.2						
		Replace	3.5						
		Repair	2.0		4.5				
1030	Sewage System Air Pump	Inspect	.3						
		Service	.2						
		Replace	3.0						
		Repair	2.0						
		Overhaul	7.5						
1031	Motor	Inspect	.2						
		Replace	3.5						
		Repair	2.0		4.5				
1040	Toilet	Inspect	.2						
		Service	.7						
		Replace	3.8						
		Repair	5.0						
1050	Urinal	Inspect	.2						
		Replace	2.0						
		Repair	2.0						
1060	Controller (Starter)	Inspect	.2						
		Replace	3.5						
		Repair	2.0		4.0				
1070	Sewage System Piping	Inspect	1.0						
		Replace			20.0				
		Repair	2.0		18.0				
1080	Sewage Holding Tank	Inspect	.5						
		Replace	90.0						
1100	Heating, Ventilation and Air Conditioning System (HVAC)								
1111	HVAC Supply, Fan and Motor Sets	Inspect	.5						
		Service	1.0						
		Replace	5.0						
		Repair	2.5		5.0				
1112	HVAC Ducting	Inspect	.5						
		Service	1.0						
		Replace			12.0				
		Repair			6.0				
1121	HVAC Exhaust System Fan - Motor Sets	Inspect	.5						
		Service	1.0						
		Replace	5.0						
		Repair	2.5		5.0				
1131	HVAC Heating System Heaters	Inspect	.5						
		Service	1.0						
		Replace	3.0						
		Repair	2.5						

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
1140	HVAC Air Conditioning System								
1141	Compressor	Inspect	.3						
		Service	1.0		6.0				
		Replace			2.5				
		Repair	2.0		6.5				
		Overhaul			7.5				
1142	Condenser	Inspect	3.0						
		Service	1.0						
		Replace	3.5						
		Repair	4.5						
1143	Strainer	Inspect	.3						
		Service	.6						
		Replace	1.2						
1144	Drier	Inspect	.2						
		Service	.5						
		Replace	1.0						
1145	Gage Board	Inspect	.3						
		Replace	3.0						
		Repair	2.5						
		Adjust	.5						

INDEX

INDEX (continued)

INDEX (continued)

INDEX (continued)

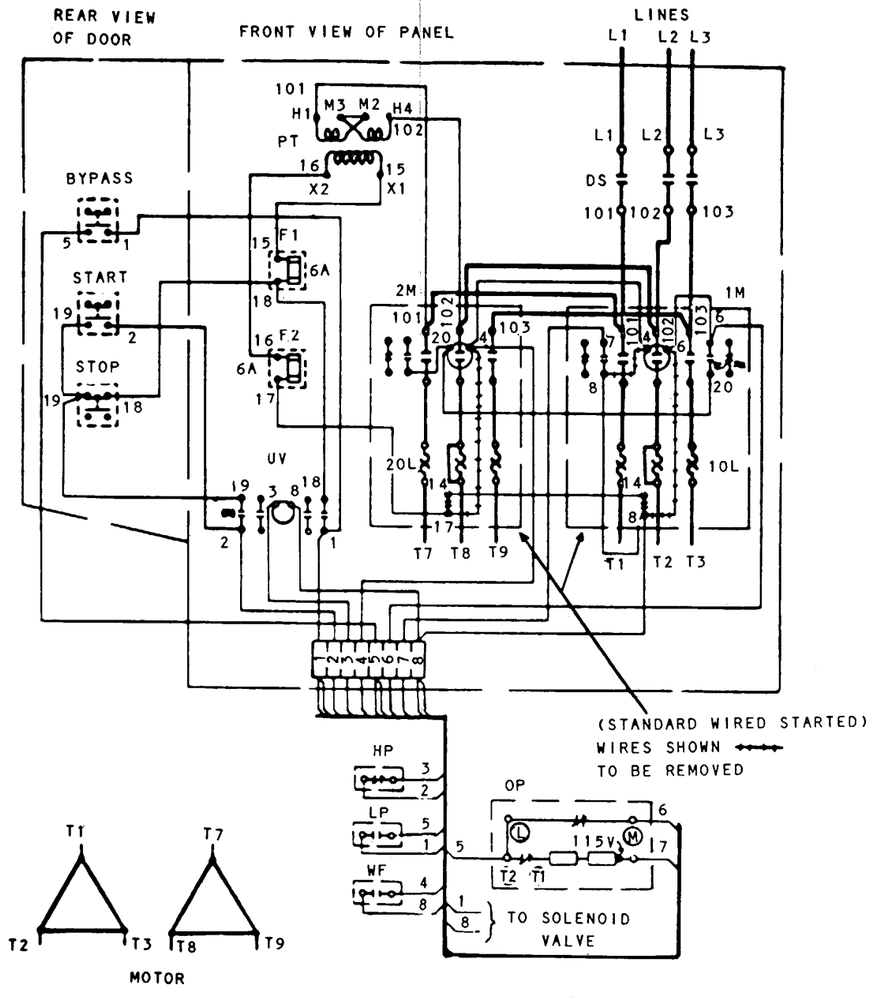
By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25D, Operator Maintenance requirements for Marine Equipment, All.



DESCRIPTION OF OPERATION

THE WATER FAILURE SWITCH (WF) MUST FIRST BE CLOSED FOR MOTOR OPERATION.

PRESSING THE START BUTTON ENERGIZES RELAY UV WHICH MAINTAINS ITSELF THROUGH ITS OWN NORMALLY OPEN CONTACTS. ANOTHER UV NORMALLY OPEN CONTACT CLOSES TO ENERGIZE IN THROUGH LP AND OP. IN CONTACTS CLOSE TO CONNECT ONE MOTOR WINDING ACROSS THE LINE.

AFTER A TIME INTERVAL, INT WILL CLOSE TO ENERGIZE 2M TO CONNECT OTHER MOTOR WINDING ACROSS THE LINE.

AFTER A SET TIME, IF THE MOTOR HAS NOT DEVELOPED SUFFICIENT OIL PRESSURE. THE REMOTE OP SWITCH WILL FUNCTION TO DE-ENERGIZE "M" DISCONNECTING THE MOTOR.

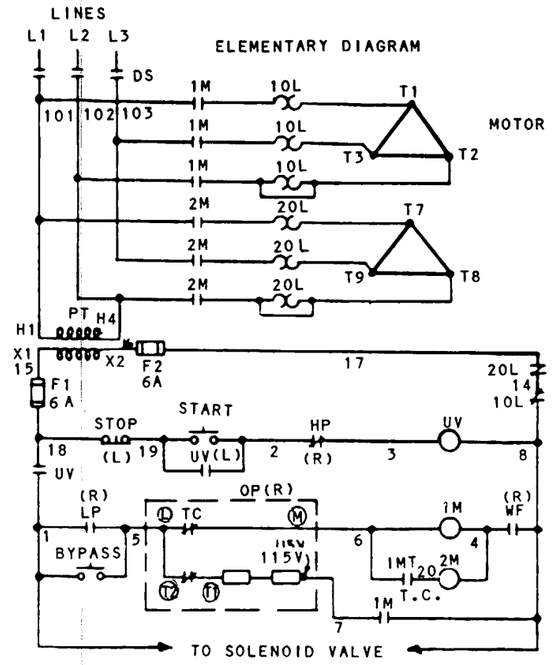
HIGH PRESSURE WILL CAUSE HP CONTACTS TO OPEN STOPPING THE MOTOR. TO RESTART, WHEN NORMAL PRESSURE HAS BEEN RESTORED, PRESS THE START BUTTON.

THE MOTOR, ONCE STARTED, WILL CYCLE ON AND OFF AS LP OR WF CONTACTS CLOSE AND OPEN. TO STOP THE MOTOR, PRESS THE STOP BUTTON, THE LP CONTACT MAY BE BYPASSED BY HOLDING DOWN THE LP BYPASS BUTTON.

A LOW VOLTAGE CONDITION WILL CAUSE THE CONTROL TO BE DE-ENERGIZED STOPPING THE MOTOR. TO RESTART, WHEN NORMAL VOLTAGE HAS BEEN RESTORED. IT IS NECESSARY TO AGAIN PRESS THE START BUTTON. (LOW VOLTAGE PROTECTION).

AN OVERLOAD WILL CAUSE OL NORMALLY CLOSED CONTACTS TO OPEN STOPPING THE MOTOR. TO RESTART, PRESS THE STOP-RESET BUTTON AND THEN THE START BUTTON.

(L) = LOCAL
(R) = REMOTE
(HP) = HIGH PRESSURE SWITCH
(LP) = LOW PRESSURE SWICH
(WF) = WATER FAILURE SWITCH
(OP) = LOW OIL PRESSURE SAFETY SWITCH WITH TIMER



FO-1. Sewage System Controller, Schematic and Wiring.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

TEAR ALONG • PERFORATED LINE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

° F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C