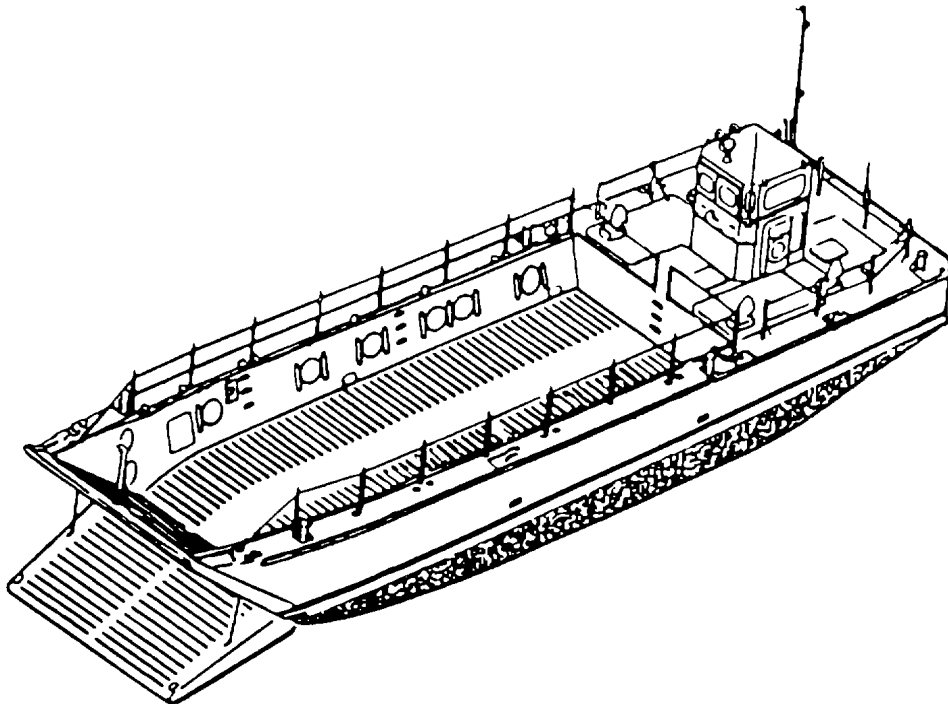


**TECHNICAL MANUAL
OPERATOR, UNIT AND INTERMEDIATE
(DIRECT AND GENERAL SUPPORT)
MAINTENANCE MANUAL**

**LANDING CRAFT, MECHANIZED
STEEL, DED, OVERALL LENGTH 74 FEET,
MOD 1, MARK VIII, NAVY DESIGN LCM-8**

**HULL NUMBERS 8500 THROUGH 8519 (MARINETTE MARINE CORP.)
NSN 1905-01-169-0938**



**INTRODUCTION
PAGE 1-1**

**OPERATING
INSTRUCTIONS
PAGE 2-1**

**OPERATOR
MAINTENANCE
PAGE 3-1**

**UNIT
MAINTENANCE
PAGE 4-1**

**INTERMEDIATE
DIRECT SUPPORT
MAINTENANCE
PAGE 5-1**

**INTERMEDIATE
GENERAL SUPPORT
MAINTENANCE
PAGE 6-1**

APPENDIXES

Approved for public release, distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY

30 June 1989

INTRODUCTION

This manual is printed in four volumes as follows:

TM 55-1905-221-14-1, consisting of Chapter 1 thru 4.

TM 55-1905-221-14-2, consisting of Chapter 5.

TM 55-1905-221-14-3, consisting of Chapter 6.

TM 55-1905-221-14-4, consisting of Chapter 6 (continued) and Appendices.

WARNING

DANGEROUS CHEMICALS

are used in this equipment

SERIOUS INJURY OR DEATH

may result if personnel fail to observe
these safety precautions:

- Be sure all cargo is secure, especially during rough seas.
- Corrosive battery electrolyte, and potassium hydroxide, are potentially dangerous to personnel and property. Wear rubber gloves, apron, and face shield when handling leaking batteries. If potassium hydroxide is spilled on clothing or other material, wash immediately with clean water. If spilled on personnel, start flushing the affected area immediately with clean water. Continue washing until medical assistance arrives.
- Wipe or flush any spillage. Volatile materials will not be brought aboard; electrical circuits will not be energized; fuel tanks will not be topped off; and engines will not be started before CO₂ firefighting equipment is available and operative.
- Observe NO SMOKING rules when refueling. Do not work on live circuits. Tag circuit and warn other personnel not to energize the circuit. Never use a blow torch or other similar means for heating fuel or oil lines.

ASPHYXIATION DANGER

- Be sure engine room ventilators are open when operating the engine(s). The engine exhaust gases contain carbon monoxide, which is a colorless, odorless, and poisonous gas.
- All piping and exhaust lines shall be treated as being insulated with Asbestos material. Protective clothing and respirators shall be worn at all times when handling suspect asbestos-covered piping and exhaust lines.

WARNING (Continued)**SERIOUS INJURY OR DEATH**

may result if personnel fail to observe these safety precautions:

- Hatches must be opened before energizing any electrical circuit or starting engines. Do not smoke or use open flame in the vicinity when servicing batteries as hydrogen gas, an explosive is generated. Use only distilled water to maintain battery electrolyte level. Do not fill fuel tank while engine is running. Provide metallic contact between the fuel container and fuel tank to prevent a static spark from igniting fuel.
- When cutting with a torch, or when welding, always station fire watches, ready with fire extinguishers, in the vicinity on both sides of the plate that is being cut or welded. Prior to cutting or welding on the ramp, remove drain plugs on both sides of the ramp and check if ramp interior is primer coated. If primer coated, flush thoroughly with steam, carbon dioxide, or water. Do not reinstall drain plugs until the cutting and/or welding operations is completed. Failure to take this precaution may result in explosion of accumulated primer vapors.
- When refueling, shut down the electrical system. Observe the no smoking rule. Do not permit anyone to operate tools or equipment which may produce sparks near the refueling operation. Sparks or fire may ignite the diesel fuel and produce an explosion.
- Fuel oil and other petroleum products are highly volatile in extreme heat. To minimize the possibility of explosion, wipe up all spills at once, see that fuel lines and valves are not leaking and pump bilges regularly.
- Before attempting to remove any compressed air system lines or components, relieve air pressure from system. Failure to do so may result in injury or possible death to maintenance personnel.
- Before disconnecting a line in the hydraulic system, bleed the pressure from the portion of the line. Failure to do so may result in injury or possible death to maintenance personnel.

b

TECHNICAL MANUAL
55-1905-221-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 30 June 1989

OPERATOR, UNIT, AND INTERMEDIATE DIRECT AND GENERAL SUPPORT
MAINTENANCE MANUAL

LANDING CRAFT, MECHANIZED:
STEEL: DED: OVERALL LENGTH 74 FEET
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NSN 1905-01-169-0938

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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake 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. AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798 A reply will be furnished directly to you.

TABLE OF CONTENTS

	Page
CHAPTER 1	INTRODUCTION
Section I.	General Information 1-1
Section II.	Equipment Description and Data 1-5
Section III.	Technical Principles of Operation 1-39
CHAPTER 2	OPERATING INSTRUCTIONS
Section I.	Description and Use of Operator's Controls and Indicators..... 2-1
Section II.	Preventive Maintenance Checks and Services. 2-25

TABLE OF CONTENTS (Continued)

		Page
Section III.	Operation Under Usual Conditions.....	2-44
Section IV.	Operation Under Unusual Conditions.....	2-54
Section V.	Operation of Auxiliary Equipment.....	2-58
CHAPTER 3.	OPERATOR MAINTENANCE INSTRUCTIONS	
Section I.	Lubrication Instructions.....	3-1
Section II.	Troubleshooting.....	3-2
Section III.	Maintenance Procedures.....	3-5
CHAPTER 4.	UNIT MAINTENANCE INSTRUCTIONS	
Section I.	Repair Parts, Special Tools, TMDE, and Support Equipment.....	4-2
Section II.	Service Upon Receipt of Material.....	4-3
Section III.	Troubleshooting.....	4-5
Section IV.	Maintenance Procedures.....	4-21
CHAPTER 5.	INTERMEDIATE DIRECT SUPPORT MAINTENANCE PROCEDURES	
Section I.	Repair Parts, Special Tools, TMDE and Support Equipment.....	5-1
Section II.	Troubleshooting.....	5-3
Section III.	Maintenance Procedures.....	5-16
CHAPTER 6.	INTERMEDIATE GENERAL SUPPORT MAINTENANCE PROCEDURES	
Section I.	Repair Parts and Special Tools.....	6-1
Section II.	Troubleshooting.....	6-1
Section III.	Maintenance Procedures.....	6-17
APPENDIX A	REFERENCES.....	A-1
APPENDIX B	MAINTENANCE ALLOCATION CHART.....	B-1
APPENDIX C	COMPONENTS OF END ITEMS AND BASIC ISSUE ITEMS LIST.....	C-1
APPENDIX D	EXPENDABLE SUPPLIES AND MATERIAL LIST.....	D-1
FOLD OUTS	WIRING DIAGRAMS.....	FP-1/FP-2
INDEX.....		INDEX-1

LIST OF ILLUSTRATIONS

Figure	Title	
1-1	Location and Description of Major Components.....	1-6
1-2	Engine Arrangement.....	1-39
1-3	Crankshaft Rotation	1-40
1-4	Engine Fuel System	1-41
1-5	Engine Exhaust System.....	1-43
1-6	Fresh Water Cooling System.....	1-44
1-7	Raw (Sea) Water Cooling System.....	1-45
1-8	Hydraulic Starting System Diagram.....	1-46
1-9	Hydraulic Steering System	1-48
1-10	Power Take-Off.....	1-49
1-11	Ramp Hoist Hydraulic System.....	1-51
1-12	Ramp Chain Hoist.....	1-53
1-13	Bilge Pumps, Oil Water Separator Lines and Fittings.....	1-54
1-14	Plan View Wiring Diagram.....	1-56, 57
2-1	Pilothouse Controls and Instruments.....	2-2
2-2	Distribution Panel.....	2-5
2-3	Steering System Expansion Tank With Sight Glass.....	2-7
2-4	Engine Controls	2-8
2-5	Engine Electrical START Button.....	2-10
2-6	Hydraulic Starting Solenoid Valve On Engine.....	2-10
2-7	Fuel System Valves	2-12
2-8	Sea Water Discharge Valve	2-12
2-9	Bilge Drainage System	2-14, 15
2-10	Steering System And Ramp Hoist System Suction Valves.....	2-16
2-11	Hydraulic Starting System Tank and Valves.....	2-16
2-12	Hydraulic Starting System Accumulator.....	2-17
2-13	Hydraulic Starting System Hand Pump.....	2-18
2-14	Steering System Valves, Pump Discharge.....	2-19
2-15	Steering System Cylinder Valves.....	2-19
2-16	Clutch Lever and Ramp Hoist Pump.....	2-20
2-17	Cooling System Expansion Tank Sight Glass.....	2-20
2-18	Ramp Hoist Hydraulic System Filters and Indicator.....	2-21
2-19	Steering System Filter Gage.....	2-21
2-20	Ramp Emergency Lowering Instructions.....	2-23
2-21	Steering System Valves.....	2-51
2-22	Emergency Tiller	2-52
2-23	Ramp Hoist Hydraulic System Suction Strainer.....	2-53
2-24	Starting Aid	2-55
2-25	Bilge Overboard Discharge Valves.....	2-59
5-1	Ramp Hoist Hydraulic System Diagram.....	5-63
5-2	Hydraulic Steering System Diagram.....	5-116
5-3	Hydraulic Starting System Diagram.....	5-202
6-1	Hydraulic Steering System Diagram.....	6-20

LIST OF TABLES

Table	Title	Page
1-1	Engine Repair and Replacement Standards (American Standard)	1-12
1-2	Engine Repair and Replacement Standards (Metric)	1-20
1-3	Standard Bolt and Nut Torque Specifications.....	1-28
1-4	Special Bolt and Nut Torque Specifications (American Standard)	1-29
1-5	Special Bolt and Nut Torque Specifications (Metric)	1-33
1-6	Stud Torque and Height Specifications	1-37
1-7	Special Plug Torque Specifications.....	1-38

CHAPTER 5

DIRECT SUPPORT MAINTENANCE PROCEDURES

	Page
• Maintenance Procedures	5-15
• Repair Parts, Special Tools, Test, Measurement and Diagnostic Equipment (TMDE); and Support Equipment	5-1
• Troubleshooting	5-2

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

5-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

5-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special tools required to perform Direct Support Maintenance on the Landing Craft are listed in Appendix C.

5-3. REPAIR PARTS.

Maintenance Repair Parts are listed and Illustrated in TM 55-1905-221-34P

SECTION II. TROUBLESHOOTING

5-4. DIRECT SUPPORT MAINTENANCE, and TROUBLESHOOTING

Table 5-1 contains troubleshooting information useful to you in diagnosing and correcting malfunctions or unsatisfactory operation of the landing craft.

- a. The troubleshooting table lists the common malfunctions and unsatisfactory conditions you are most likely to run into.
- b. You should first find the malfunction in the table which most closely describes the problem; then perform the tests, inspections and corrective actions in the order in which they are listed.
- c. This manual cannot list all possible symptoms which may occur. If a condition exists which cannot be resolved by you, notify your supervisor.
- d. You should verify the fault before performing the troubleshooting procedures.

NOTE

Before you use this table, be sure you have performed all applicable operating checks.

Table 5-1. Troubleshooting.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
--------------------	---------------------------	--------------------------

PROPULSION ENGINE

- 1. Engine will not turn over.
 Hand-crank the engine at least one revolution. If engine cannot be rotated a complete revolution, internal damage is indicated.
 Report condition to GENERAL SUPPORT MAINTENANCE.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

PROPULSION ENGINE (Cont.)

2. Low cranking speed.

Step 1. Check batteries for low or discharged condition.

Replace or charge as necessary.

Step 2. Check electric starting motor.

a. Perform no-load test and torque test per paragraph 5-12.2.

b. Replace starter.

c. Repair as required. Refer to paragraph 5-12.2.

Step 3. Check hydraulic starting system.

Refer to paragraphs 5-13.1. through 5-13.7.

3. Low compression.

Step 1. Check for burned or sticking exhaust valves.

Remove cylinder head and repair as per paragraph 5-15.

Step -2. a. Check valve guide for carbon deposits or distortion.

1. Remove carbon deposits. Refer to paragraph 5-15.

2. Replace bent or worn guide. Refer to paragraph 5-15.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

PROPULSION ENGINE (Cont.)

- b. Check for valve-to-guide clearance.
 - 1. Reface valve if necessary. Refer to paragraph 5-15.
 - 2. Replace worn valve. Refer to paragraph 5-15.
- c. Check valve for improper seating.
 - 1. Reface if necessary. Refer to paragraph 5-15.
 - 2. Replace worn valve. Refer to paragraph 5-15.
- Step 3. a. Check for broken or bent valve.
 - Replace bent or broken valve. Refer to paragraph 5-15.
- b. Check for defective valve spring.
 - Replace defective valve spring. Refer to paragraph 5-15.
- c. Check valve guide and insert for damage.
 - Replace damaged or defective insert or valve guide. Refer to paragraph 5-15.
- d. Check cylinder head and piston for damage.
 - 1. Replace damaged or defective cylinder head. Refer to paragraph 5-15.
 - 2. Replace defective or damaged piston. Refer to paragraph 6-31.1.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

PROPULSION ENGINE (Cont.)

- e. Check for contact between valve head and piston for incorrect valve clearance.
Replace damaged valve. Refer to paragraph 5-15.
- Step 4. a. Check valve stem for varnish deposits.
Reface valve. Refer to paragraph 5-15.
- b. Check for worn valve guide or excessive back pressure.
 - 1. Reface valve and insert. Refer to paragraph 5-15.
 - 2. Replace valve and insert if necessary. Refer to paragraph 5-1.
- Step 5. a. Check for bent valve guide or stem.
Replace damaged stem or guide. Refer to paragraph 5-15.
- b. Check for scuffed or scored valve stem.
 - 1. Clean valve stem with crocus cloth dampened with fuel oil.
 - 2. Replace valve if unable to clean.

NOTE

When installing valve, use care in depressing spring so that cap DOES NOT SCRAPE valve stem.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****PROPULSION ENGINE (Cont.)**

c. Inspect for dirt or metal chips.

Remove.

d. Inspect for lack of lubrication.

1. Replace defective oil pump. Refer to paragraph 6-26.

2. Replace clogged oil tubes and lines.

Step 6. a. Check ALL valves for bent condition.

Replace bent valves. Refer to paragraph 5-15.

b. Check for gear train failure.

Report condition to GENERAL SUPPORT MAINTENANCE.

c. Check for improper gear train timing.

Report condition to GENERAL SUPPORT MAINTENANCE.

4. Insufficient or no fuel.

Step -1. Check filters and fuel lines for obstructions.

a. Disassemble and clean out obstructions.

b. Service strainers and filters.

Step 2. Check for defective fuel pump.

Replace defective pump.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

PROPULSION ENGINE (Cont.)

5. Governor unstable (hunting).

Step 1. Check for faulty governor.

Replace if defective.

Step 2. Check linkage to injectors.

Replace defective or damaged parts.

6. Black exhaust smoke (incompletely burned fuel).

Step 1. Check for obstruction in exhaust piping.

Disassemble system and replace or repair parts as required.

Step 2. Check for faulty air silencer.

Remove and clean screen.

7. High engine coolant temperature.

Step 1. Check for defective fresh water pump.

a. Remove and repair as required.

b. Replace pump if damaged beyond repair.

Step 2. Check for obstruction(s) in raw water system.

Disassemble raw water (muffler) cooling system, remove obstruction(s) and reassemble.

Step 3. Check for defective muffler.

Replace or repair as required.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****ALTERNATOR**

1. Alternator fails to charge.

Step 1. Check for open isolation diode.

Remove and disassemble alternator, replace diode and reassemble. Refer to paragraph 5-12.1.

Step 2. Check for open rotor winding.

Remove and disassemble alternator, and verify rotor winding continuity.

Replace rotor if open. Refer to paragraph 5-12.1.

Step 3. Check for bilge pump leaking sea water causing voltage regulator to short out.

Replace leaking gland.

2. Unsteady or low charging rate.

Step 1. Check for grounded, open, or shorted turns in stator coils.

Remove and disassemble alternator, and replace stator. Refer to paragraph 5-12.1.

Step 2. Check for grounded or shorted turns in rotor winding.

Remove and disassemble alternator, and replace rotor. Refer to paragraph 5-12.1.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****ALTERNATOR (Cont)**

Step 3. Check for shorted or open rectifier diode(s).

Remove, disassemble alternator, and test diode plates to determine which plate has faulty diode(s). Replace defective diode(s). Refer to paragraph 5-12.1.

3. Alternator noisy.

Check for worn bearings.

Remove and disassemble alternator and replace worn or defective bearings.

Refer to paragraph 5-12.1.

ELECTRIC STARTING MOTOR

Starter does not crank engine adequately.

Step 1. Check for defective brushes.

Replace brushes. Refer to paragraph 5-12.2.

Step 2. Check for damaged Bendix drive.

Replace Bendix drive. Refer to paragraph 5-12.2.

Step 3. Check for worn bearings.

Remove starter from engine, disassemble, and replace defective bearings. Refer to paragraph 5-12.2.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****HYDRAULIC STARTING SYSTEM**

1. Cranking speed too low.

Step 1. a. Check for excessive internal leakage in starting motor

Remove starting motor, disassemble and replace parts as necessary.

Refer to paragraph 5-13.2.

b. Check for broken or weak cylinder spring.

Remove starting motor, disassemble and replace parts as necessary.

Refer to paragraph 5-13.2.

c. Check for damaged seal surfaces.

Remove starting motor, disassemble and replace parts as necessary.

Refer to paragraph 5-13.2.

d. Check cylinder and port plate for scored face.

Remove starting motor, disassemble and replace parts as necessary.

Refer to paragraph 5-13.2.

e. Check for broken cylinder.

Remove starting motor, disassemble and replace parts as necessary.

Refer to paragraph 5-13.2.

2. Fluid loss from reservoir.

Check for worn starting motor shaft seals.

a. Remove starting motor, and housing plate and check system for fluid inside housing.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****HYDRAULIC STARTING SYSTEM (Cont)**

- b. Replace shaft seal if inspection reveals fluid is in housing.
Refer to paragraph 5-13.2.
- 3. Hydraulic starting motor turns, but engine does not.
 - Check for damaged or overrunning clutch.
 - Replace Bendix drive. Refer to paragraph 5-13.2.
- 4. Hand pump fails to charge system.
 - Check for damaged piston seal rings.
 - Remove, disassemble hand pump and replace defective seal rings.
 - Refer to paragraph 5-13.6.
- 5. Loss of accumulator precharge (nitrogen).
 - Step 1. Check for damaged piston or seal rings.

NOTE

Release all hydraulic pressure in the system prior to performing any maintenance on the accumulator.

- a. Release nitrogen in accumulator.
- b. Remove accumulator and disassemble.
Refer to paragraph 5-13.5.
- c. Replace defective piston or sealing rings.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****HYDRAULIC STARTING SYSTEM (Cont)**

Step 2. Check for damaged seal ring between end cap and tube.

- a. Apply liquid soap on threaded end of accumulator end cap.

Bubbling of soap indicates a leak past the end cap seal.

NOTE

Release all hydraulic pressure in the system prior to performing any maintenance on the accumulator.

- b. Release nitrogen in accumulator.
- c. Remove accumulator. Refer to paragraph 5-13.5.
- d. Replace defective seal.

6. High pressure in system (3500 psi (24,133 kpa) or above).

- a. Check relief valve for proper operation.

NOTE

There is a 500 psi (3,447.5 kpa) differential between cut-in and cut-out.

Clean and adjust to specified operating pressure of 3400 psi (23,443 kpa).

- b. Check plunger for sticking or binding.
Replace defective relief valve.

Table 5-1. Troubleshooting.

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

STEERING SYSTEM

1. Steering pump noisy.

Check pump intake for partial obstruction.

- a. Service intake strainers.
- b. Check internal flow path for cleanliness. Clean if required.

2. Oil too hot.

Check for relief valve leaking at high pressure.

NOTE

Release pressure in system prior to performing maintenance on the relief valve.

Remove and replace relief valve.

Refer to paragraph 5-7.6.

RAMP HOIST HYDRAULIC SYSTEM

Hydraulic pump noisy.

Step 1. Check pump intake for partial obstruction.

- a. Service intake strainers.

Table 5-1. Troubleshooting.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
<u>RAMP HOIST HYDRAULIC SYSTEM (Cont)</u>		
	Step 2. Check for binding of drive shaft.	b. Check internal flow path for cleanliness. Clean if required.
		Remove pump, disassemble and replace defective parts as required. Refer to paragraph 5-6.1.

SECTION III. MAINTENANCE PROCEDURES

The following is an index to the maintenance procedures.

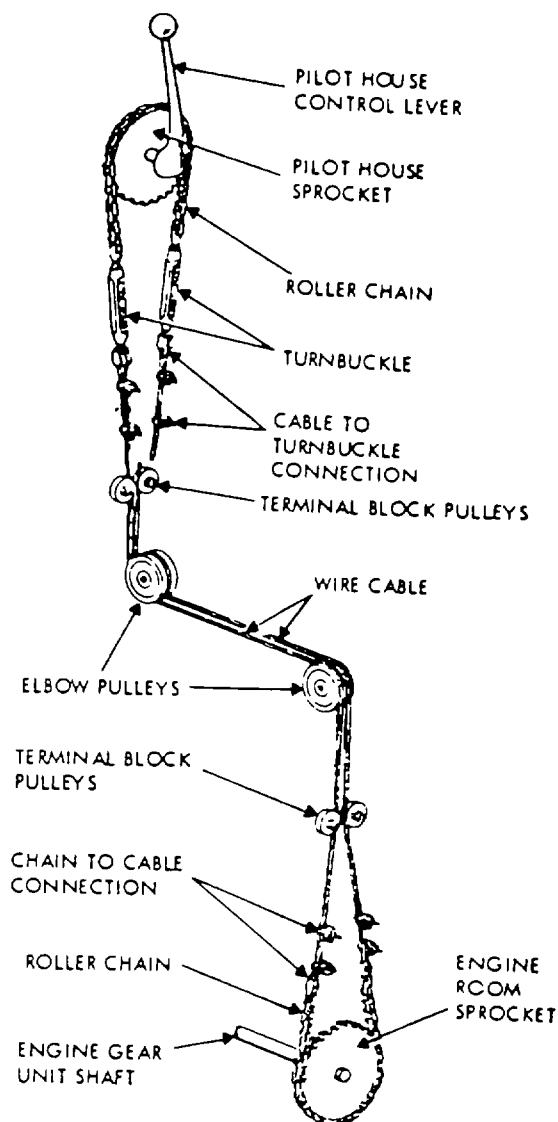
<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Common Tools and Equipment.....	5-1
Communication Equipment -Electric Power.....	5-8
Cylinder Block.....	5-16
Cylinder Head.....	5-15
Direct Support Maintenance, and Troubleshooting.....	5-4
Engine Cooling Piping.....	5-22
Engine Electrical System.....	5-12
Engine Speed Governor.....	5-29
Fresh Water Expansion Tank.....	5-26
Fresh Water Pump	5-25
Fuel Injector.....	5-18
Fuel Pump.....	5-17
Heat Exchanger, Thermostat and Housing, Hoses and Clamps.....	5-21
Hydraulic Starting System.....	5-13
Hydraulic Steering System.....	5-7
Injector Control Tube.....	5-19
Muffler and Exhaust Piping.....	5-24
Pilothouse Canopy.....	5-31
Radio Set AN/VRC-46/47.....	5-9
Radio Set AN/VRC-80.....	5-10
Radio Set URC-92.....	5-11
Ramp Controls.....	5-6
Raw Water Pump.....	5-27
Repair Parts.....	5-3
Rocker Arms, Cam Followers and Pushrods.....	5-14
Sea Water Duplex Strainer.....	5-28
Sea Water Piping.....	5-23
Special Tools, TMDE, and Support Equipment.....	5-2
Throttle Controls - Engine Room.....	5-20
Throttle Controls - Pilothouse.....	5-5
Transmission Control Valve.....	5-30

5-5. THROTTLE CONTROLS - PILOTHOUSE.

a. Each propulsion unit consists of two engines connected by clutches to a common gear box. The throttle adjustment is made so that each engine of a twin unit will carry its share of the load.

b. This Landing Craft is equipped with a model MD engine control system which consists of a pilothouse control head, terminal blocks, elbows, engine control unit, conduit and cable as shown below. The twin engine control is designed to allow the operator to control both propulsion units with one hand. Clutch action occurs in the first 30° travel each side of neutral, while the remaining 60° travel provides governor control from idle-to-full ahead or astern. Separate neutral throttle controls and separate stop controls for each engine are located on the pilothouse control panel.

5-5. THROTTLE CONTROLS - PILOTHOUSE.



Refer to the following paragraphs for maintenance procedures

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Pilot House Control Chains, Cabling, Terminal Block Pulley, and Marine Control Elbow	5-5.1
Engine Control Levers and Brackets	5-5.2
Engine Control Unit	5-5.3
Free-Wheeling Brake	5-5.4
	5-5.5

5-5.1. PILOTHOUSE CONTROLS.

This task covers-

- a. Inspection
- b. Removal

- c. Cleaning
- d. Repair/Replace

- e. Installation
-

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

NONE

Equipment
Condition Condition Description

NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Material/Parts
Cleaning solvent P-D-680
Clean cloths
Grease

Personnel Required
2 MOS 61C10

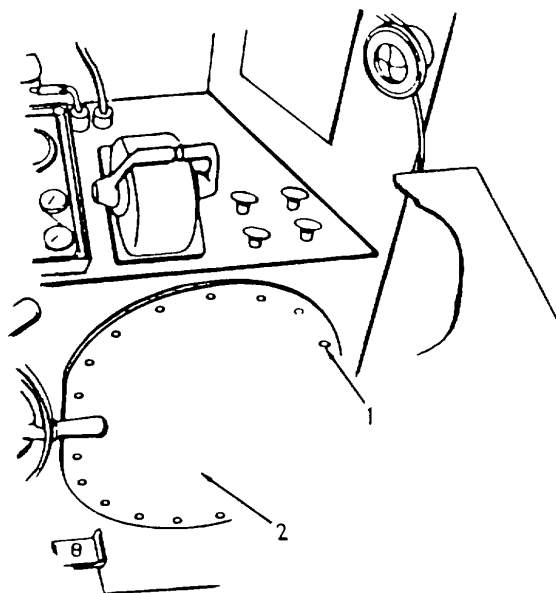
General Safety Instructions
Observe WARNINGS in
procedure.

5-5.1. PILOTHOUSE CONTROLS (Continued).

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

INSPECTION

- | | | |
|-----------------|---|--|
| 1. Control Unit | <ul style="list-style-type: none"> a. Remove screw-assembled washers (1). b. Remove access cover (2). c. Inspect chains and chain links for signs of wear. d. Inspect cable, cable terminals, and cable clamps for signs of wear. | |
|-----------------|---|--|

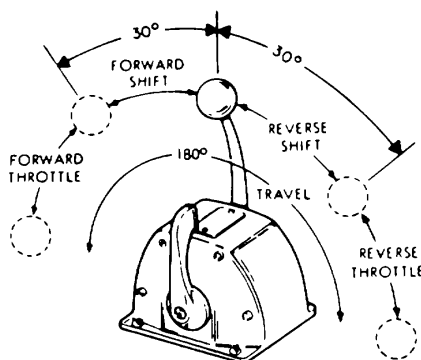


5-5.1. PILOTHOUSE CONTROLS (Continued).

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

INSPECTION (Cont)

- | | |
|--|--|
| e. Place control lever 30° each side of neutral. | In engine room, observe operation of clutch lever or marine gear of clutch lever or marine gear. |
| f. Advance control lever to full ahead, or astern. | In engine room, observe operation of clutch lever or marine gear. In engine room, observe operation of throttle lever on governor. |



NOTE

Starboard view shown, Port view is similar.

REMOVAL

- | | | |
|-----------------|---|-------------------------------|
| 2. Control Unit | a. Loosen turnbuckles (1). | |
| | b. Remove keeper from chain connecting link (2), and remove link. | Remove total of four places. |
| | c. Remove nuts (3), lockwashers (4), screws (5), and sealing washers (6). | |
| | d. Lift and remove control station (7), and gasket (8). | 1. Lift high to clear struts. |

5-5.1. PILOTHOUSE CONTROLS (Continued).

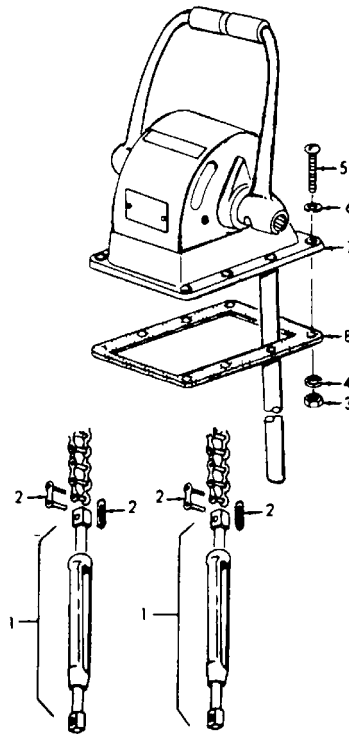
LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

2. Discard gasket, if damaged.

NOTE

Starboard view shown, Port view is similar.



5-5.1. PILOTHOUSE CONTROLS (Continued).

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

CLEANING

3. Control Unit

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 103°F (38° 59°C).

Clean all metal parts (except bearings) with cleaning solvent P-D-680 and dry thoroughly.

REPAIR/REPLACE

4. Control Unit (12).

- | | |
|---|---------------------------|
| <ul style="list-style-type: none"> a. Remove nuts (9), lockwashers (10), screws (11), and struts b. Remove screws (13), and lockwashers (14). c. Remove mounting plate (15), supports (16), and gasket (17). | <p>Remove two places.</p> |
|---|---------------------------|

NOTE

The following steps apply to the starboard engine only. The port engine is similar.

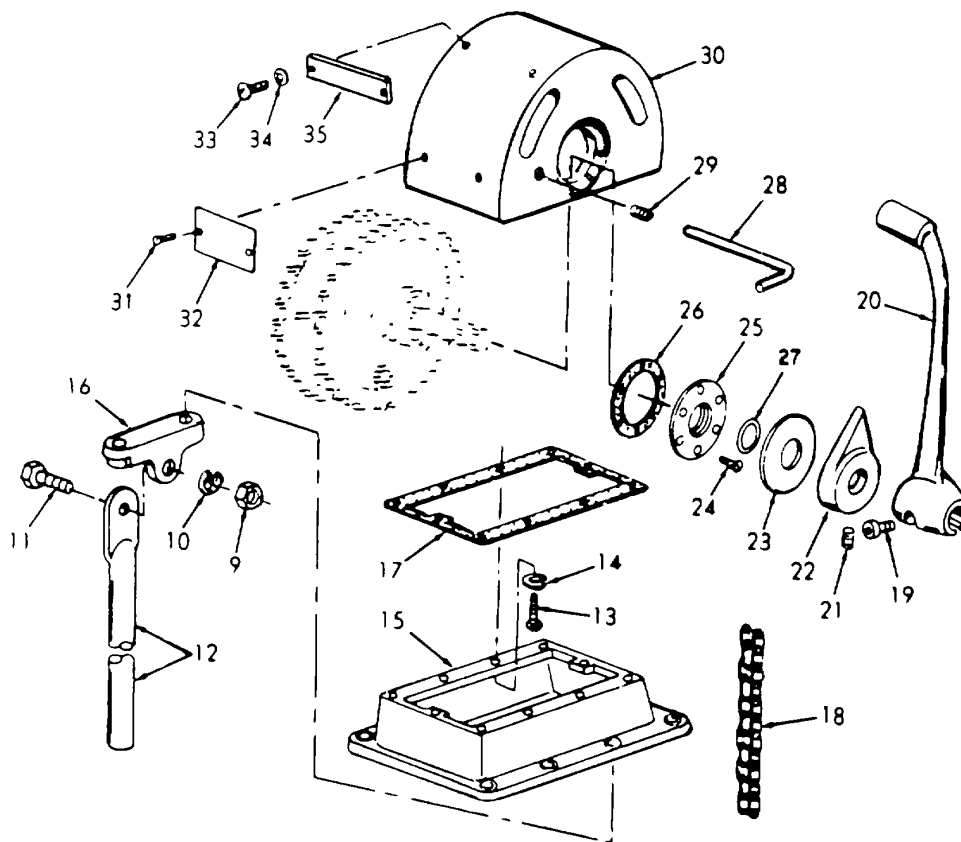
- d. Remove two chains (18).
- e. Remove socket head screw (19), and control arm (20).
- f. Remove setscrew (21), indicator (22), and washer (23).
- g. Remove screws (24), flange (25), and gasket (26).

5-5.1. PILOTHOUSE CONTROLS (Continued).

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

REPAIR/REPLACE (Cont)

- h. Remove preformed packing (27) from flange (25).
 - i. Remove lock pin (28), and/or pipe plug (29).
 - j. Remove sprockets and shaft assembly from housing (30).
 - k. Remove screws (31) and nameplate (32).
 - l. Remove screws (33), sealing washers (34), and neutral indicator nameplate (35).
- If damaged.
- If necessary.
- If necessary.



5-5.1. PILOTHOUSE CONTROLS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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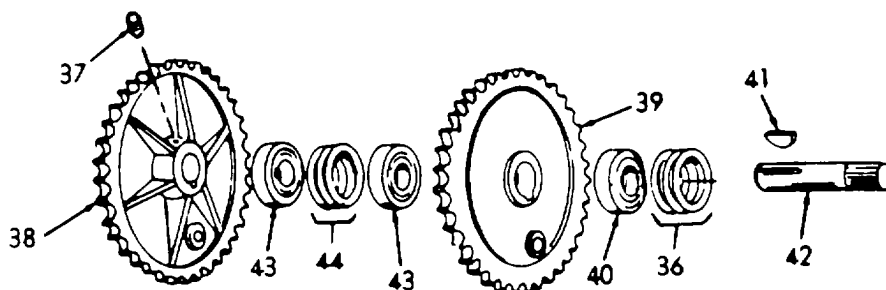
REPAIR/REPLACE (Cont)

- m. Remove bearing spacers (36).
- n. Remove setscrews (37) from sprockets (38 and 39).
- o. Remove sprocket (38).
- p. Remove bearing (40).
- q. Remove sprocket (39) and key (41) from shaft (42).
- r. Remove bearings (43) and spacers (44) from shaft (42).

NOTE

Inspect all parts prior to reassembly for nicks, burrs, damaged threads, defective bearings and other signs of damage.

- s. Install bearings (43), and spacers (44) on shaft (42).
- t. Install sprockets (38 and 39), and key (41), on shaft (42).
- u. Install setscrews (37) in sprockets (38 and 39).
- v. Install bearing (40), and spacers (36). 5-25

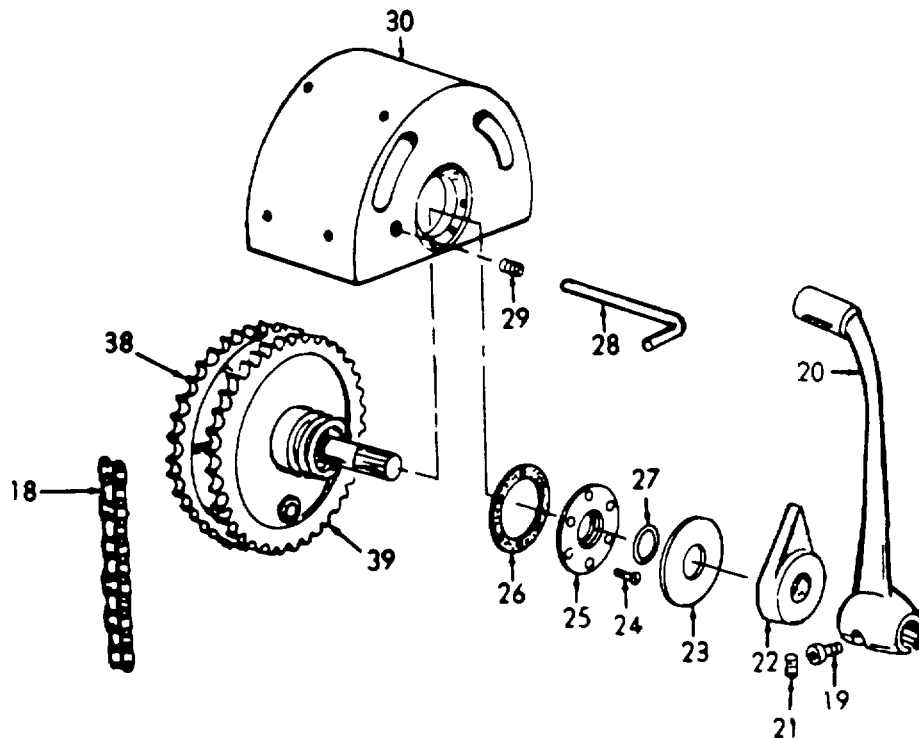


5-5.1. PILOTHOUSE CONTROLS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACE (Cont)

- w. Install sprocket and shaft assembly in housing (30).
- x. Install pipe plug (29), and/or lock pin (28).
- y. Install preformed packing (27) in flange (25).
- z. Install new gasket (26), flange (25), and screws (24).
- aa. Install washer (23), indicator (22), and setscrew (21).
- ab. Install control arm (20), and socket head screw (19).
- ac. Install two chains (18) over sprockets (38 and 39).

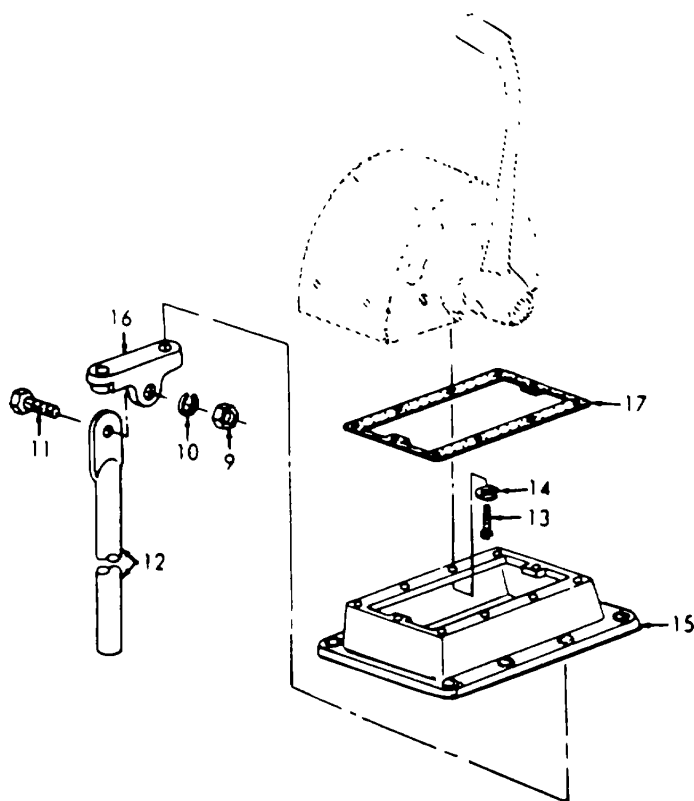


5-5.1. PILOTHOUSE CONTROLS (Continued).

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

REPAIR/REPLACE (Cont)

- ad. Reassemble mounting plate (15), supports (16), and gasket (17) using screws (13), and lockwashers (14).
- ae. Install screws (11), struts (12), lockwashers (10), and nuts (9).
- af. Lubricate chain with grease.

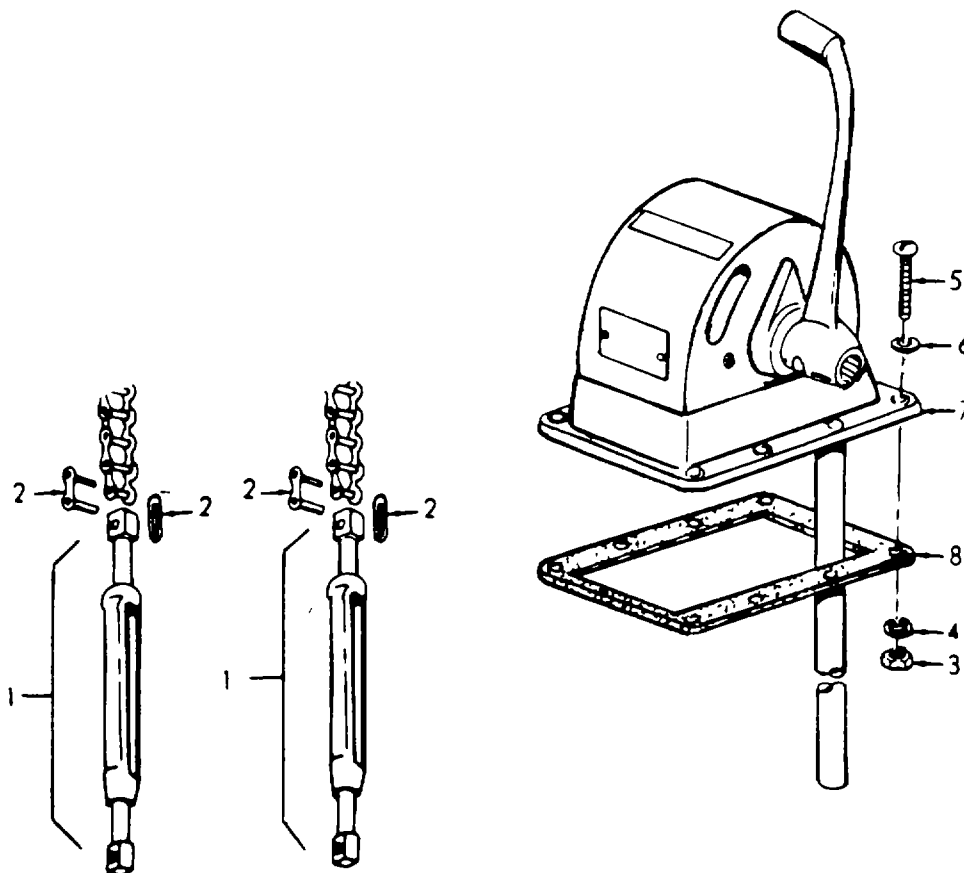


5-5.1. PILOTHOUSE CONTROLS (Continued).

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

INSTALLATION

5.
 - a. Install control station (7), and new gasket (8), using screws (5), sealing washers (6), lockwashers (4), and nuts (3).
 - b. Install chain connecting links and keepers (2).
 - c. Tighten and readjust turn-buckles (1).
 - d. Install access cover and screw-assembled washers.



5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW.

This task covers:

- a. Inspection b. Cleaning c. Repair/Replace
-

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools
General Mechanic's Tool Set
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Material/Parts

Cleaning solvent P-D-680
Clean cloths
Grease

Personnel Required
2 MOS 61C10

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION

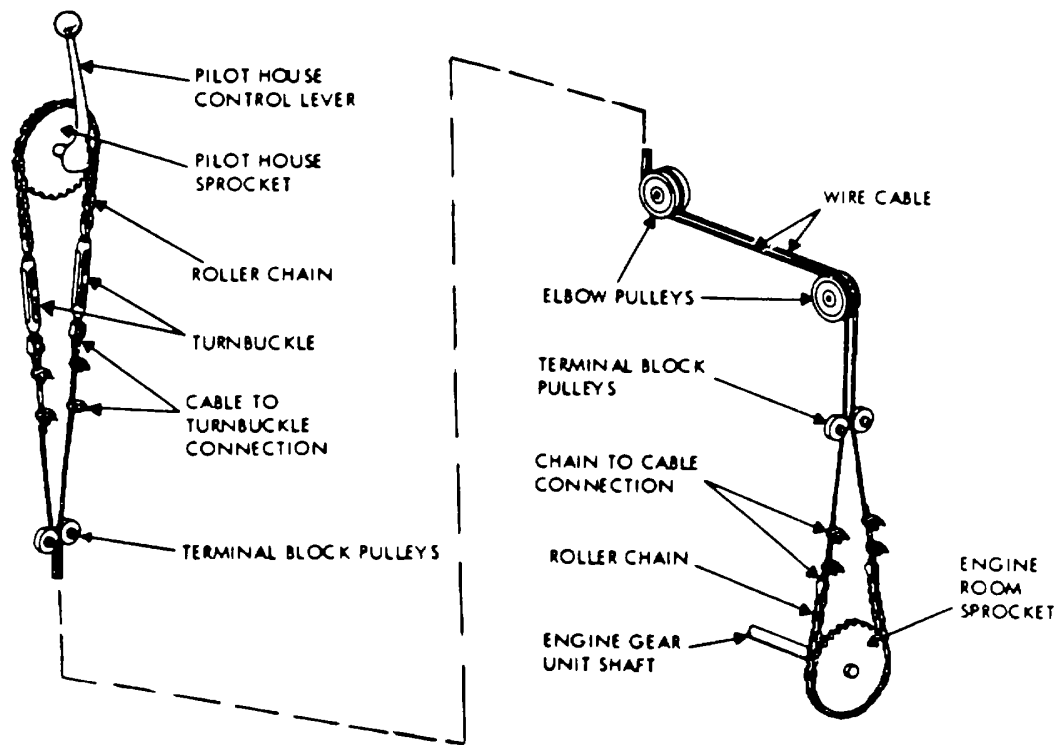
- | | | |
|------------|--|--|
| 1. Chains | Inspect chains for binding, kinks, and defective links. | |
| 2. Cabling | Inspect cables for binding, kinks, wear, and defective components. | |

5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW (Continued).

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

INSPECTION (Cont)

- | | |
|--------------------------|--|
| 3. Terminal Block Pulley | Inspect for ease of operation, and defective components. |
| 4. Marine Control Elbow | Inspect for ease of operation, and defective components. |



5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW (Continued).

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

CLEANING

WARNING

Dry cleaning solvent, P-D680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° 138°F (38° 59°C).

- | | |
|--------------|---|
| 5. All Parts | Clean all parts with cleaning solvent P-D-680 and dry thoroughly. |
|--------------|---|

REPAIR/REPLACE

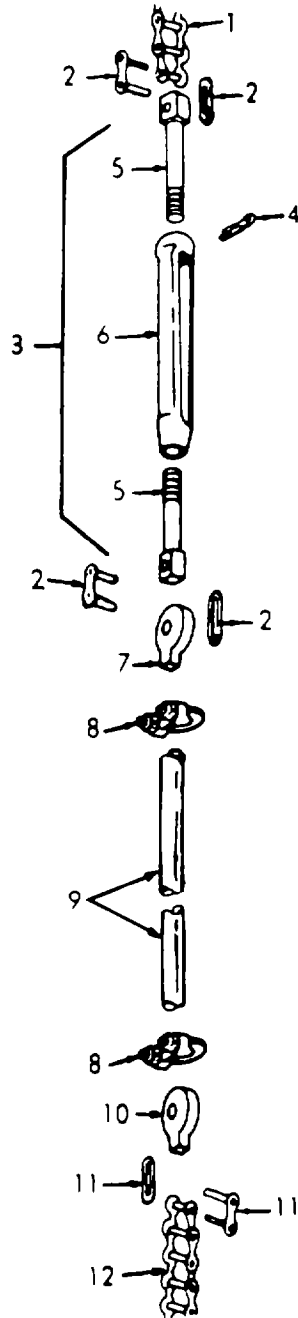
- | | |
|---------------------|---|
| 6. Chains or Cables | Repair or replace the following as necessary. |
|---------------------|---|

ITEM	DESCRIPTION
1	Chain
2	Chain Connecting Link
3	Turnbuckle Assembly
4	Cotter Pin
5	Chain Connecting End, Turnbuckle
6	Ringing, Turnbuckle
7	Wire Rope Thimble
8	Wire Rope Clamp
9	Wire Rope
10	Wire Rope Thimble
11	Chain Connecting Link
12	Chain

5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACE (Cont)

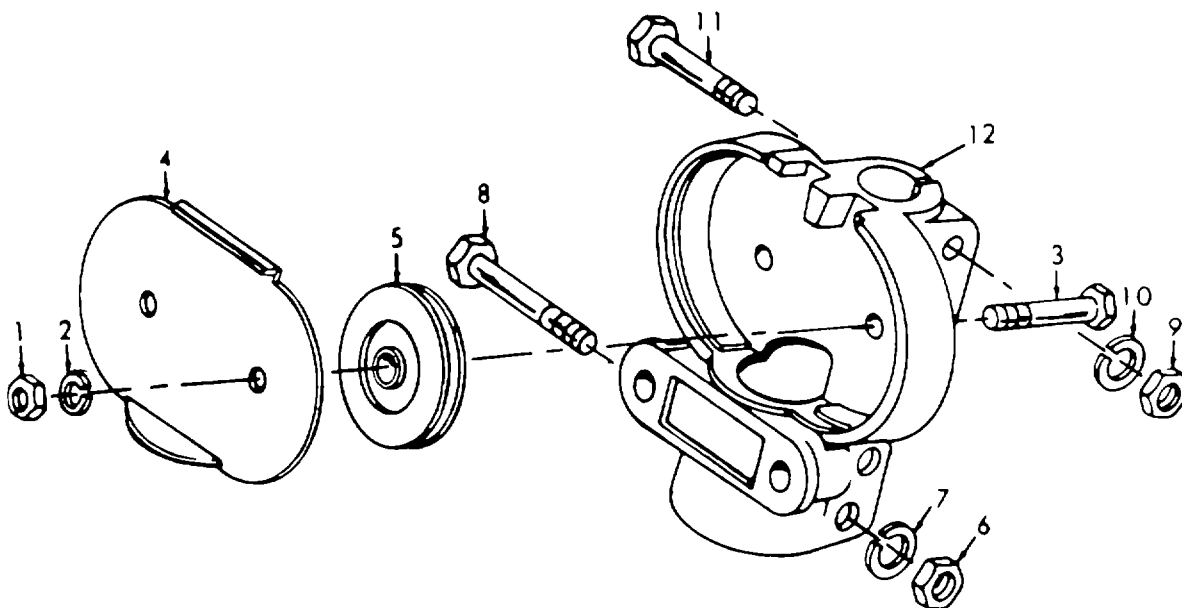


5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW (Continued).

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

REPAIR/REPLACE (Cont)

7. Terminal Block Pulley	a. Disconnect cables as necessary.	Refer to step 5.
	b. Remove nuts (1), and lock-washers (2).	
	c. Remove screws (3), cover (4), and pulleys (5).	
	d. Remove nuts (6), lockwashers (7), and screws (8). long.	Screws are 3/8-24 x 2 1/4 inch
	e. Remove nuts (9), lockwashers (10), and screws (11). long.	Screws are 3/8-24 x 1 3/4 inch
	f. Remove body (12).	

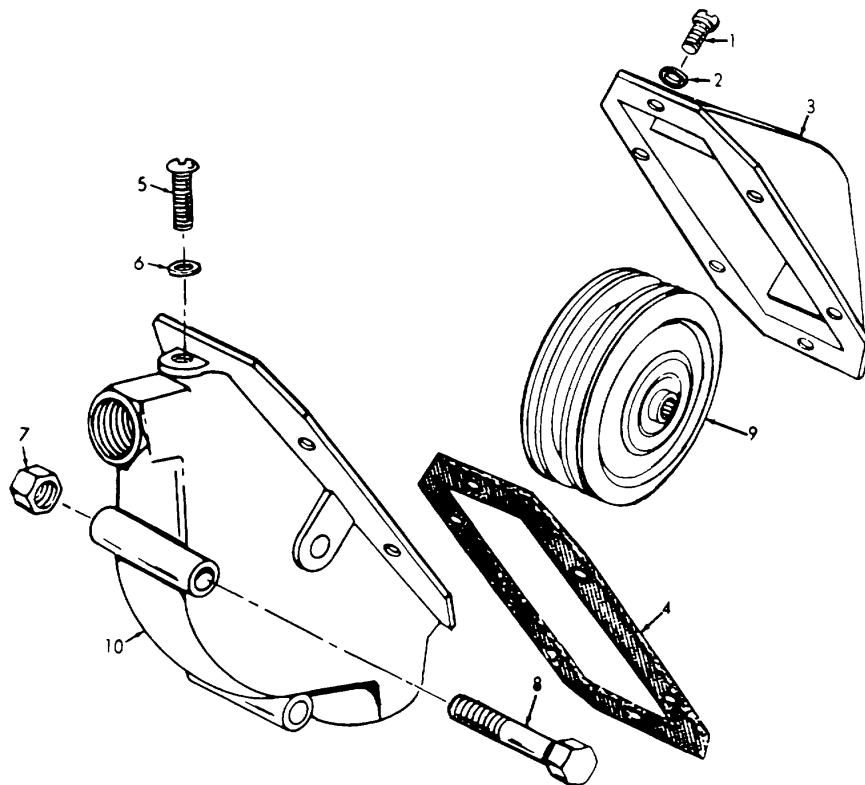


5-5.2. CHAINS, CABLING, TERMINAL BLOCK PULLEY, AND MARINE CONTROL ELBOW (Continued).

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

REPAIR/REPLACE (Cont)

- | | | |
|-------------------------|--|------------------|
| 8. Marine Control Elbow | <ul style="list-style-type: none"> a. Disconnect cables as necessary. b. Remove screws (1) and sealing washers (2). c. Remove cover (3), and gasket (4). d. Remove screw (5), and sealing washer (6). e. Remove nut (7), and bolt (8). f. Withdraw pulley (9) from body (10). Refer to step 5. | Refer to step 5. |
|-------------------------|--|------------------|



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Material/Parts

Cleaning solvent P-D-680

Personnel Required

2 MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION

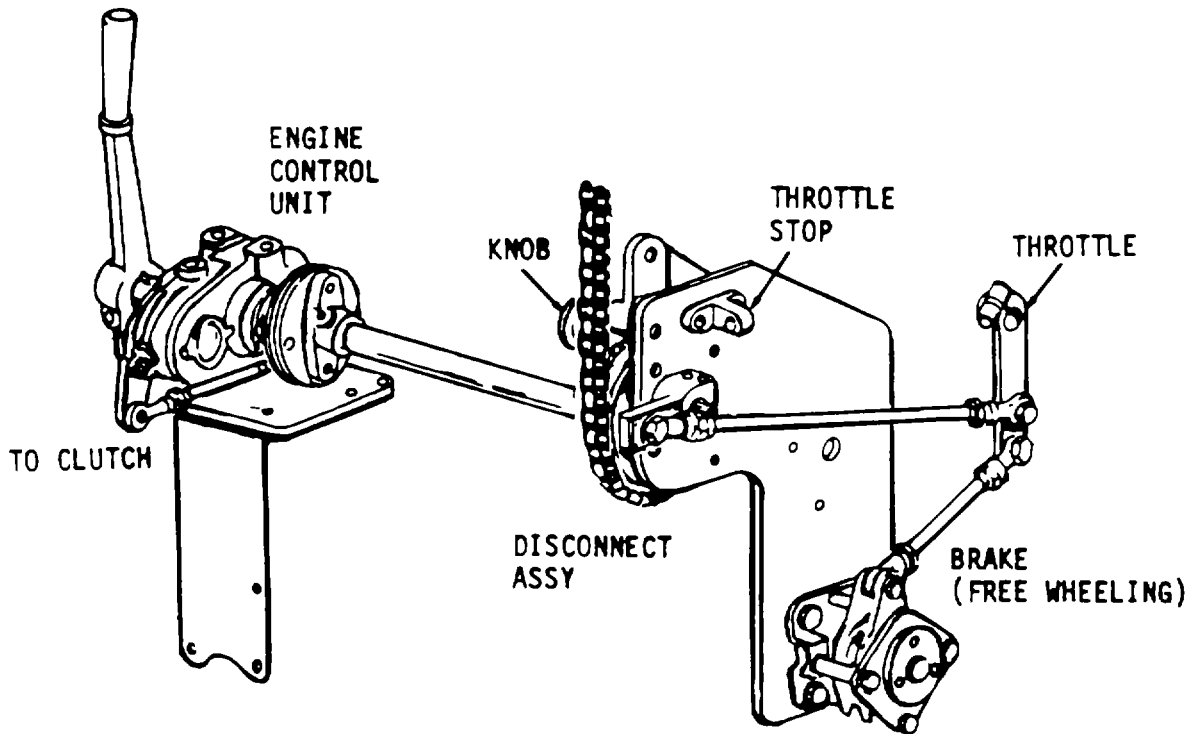
- | | |
|--------------------|---|
| 1. Engine Controls | <ul style="list-style-type: none"> a. Pull and turn knob on disconnect assembly. b. Inspect for proper operation of clutch. c. Inspect for proper operation of throttle and brake. |
|--------------------|---|

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

INSPECTION (Cont)

- d. Refer to paragraph 2-5.1.2 for inspection of chains and cables.
- e. Refer to paragraph 2-5.1.4 for inspection of engine control unit.
- f. Refer to paragraph 2-5.1.5 for inspection of brake.
- g. Inspect for bends, breaks, cracks, and signs of damage.



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

CLEANING

2.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38° 59°C).

Clean all metal parts with cleaning solvent P-D-680 and dry thoroughly.

REMOVAL

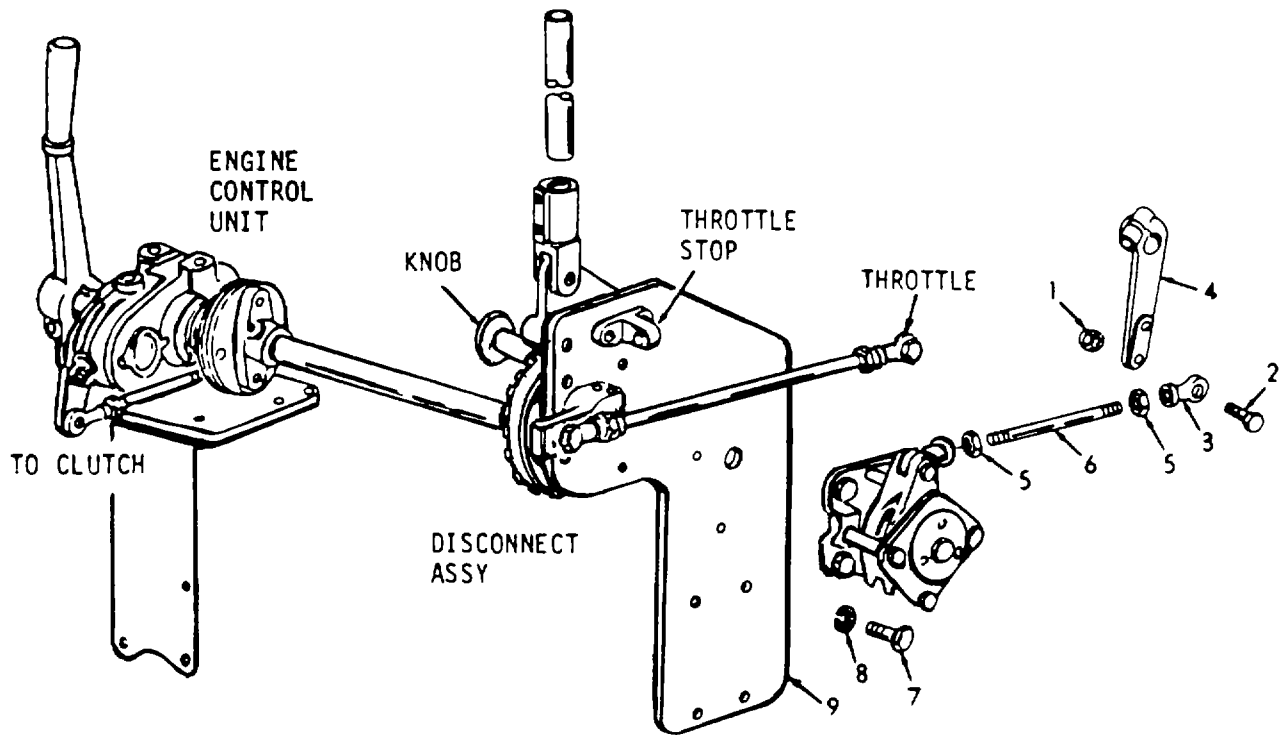
3. Brake Unit

- a. Remove self-locking nut (1), and screw (2).
- b. Disconnect rod end (3) from throttle jack arm (4).
- c. Disassemble rod end (3), lock-nuts (5), and linkage rod (6).
- d. Remove screws (7), and lock-washers (8).
- e. Remove brake from bearing plate (9).

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY. (Continued).

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

REMOVAL (Cont)



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

REMOVAL (Cont)

- | | | |
|------------------------|--|--|
| 4. Engine Control Unit | <ul style="list-style-type: none"> a. Remove nut (10), lockwasher (11), and screw (12). b. Remove right-hand arm (13), or left-hand arm (14). c. Remove self-locking nut (15), and screw (16). d. Remove rodend (17) from clutch arm (18). e. Disassemble rod end (17), nut (19), and rod (20). f. Remove nut (21), locknut (22), and screw (23). g. Remove clutch arm (18). h. Loosen setscrews (24 and 25) in coupling flange (26). i. Remove screws (27), and lockwashers (28) from bottom of plate (29). j. Separate engine control unit from coupling flange (26). k. Remove machine key (30) and Woodruff key (31). | |
| 5. Disconnect Assembly | | |

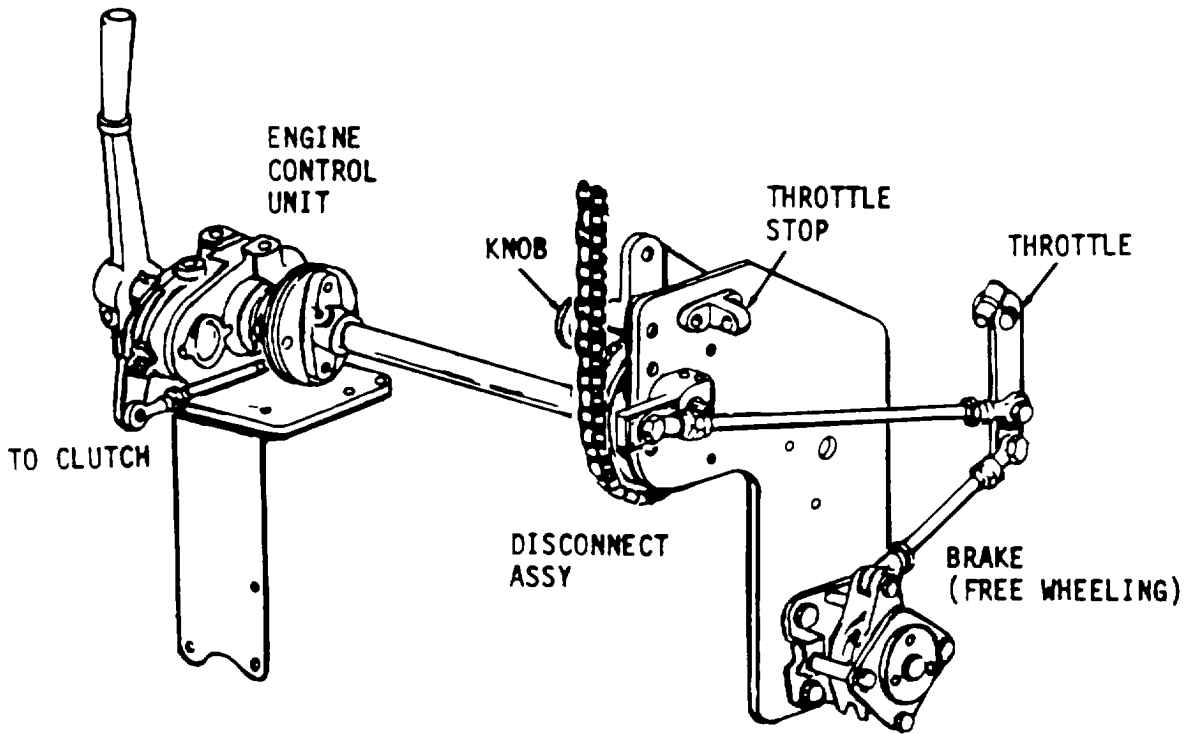
NOTE

The disconnect assembly is removed in step ~~6~~7.

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

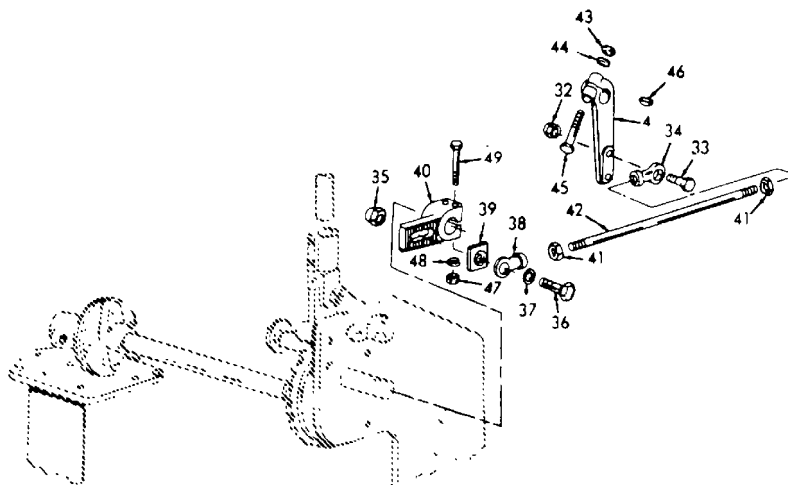


**5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).**

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

DISASSEMBLY

- | | | |
|---------------------|--|--|
| 6. Throttle Linkage | a. Remove self-locking nut (32), and screw (33). | |
| | b. Remove rod end (34) from throttle jack arm (4). | |
| | c. Remove nut (35), screw (36), flatwasher (37), rod end (38), and lock plate (39) from adjustable arm (40). | |
| | d. Disassemble rod ends (34 and 38), locknuts (41), and throttle rod (42). | |
| | e. Remove nut (43), lockwash (44), and screw (45) from throttle jack arm (4). | |
| | f. Remove throttle jack arm (4), and Woodruff key (46). | |
| | g. Remove nuts (47), lockwashers (48), and screws (49). | |
| | h. Remove adjustable arm (40)
L A | |

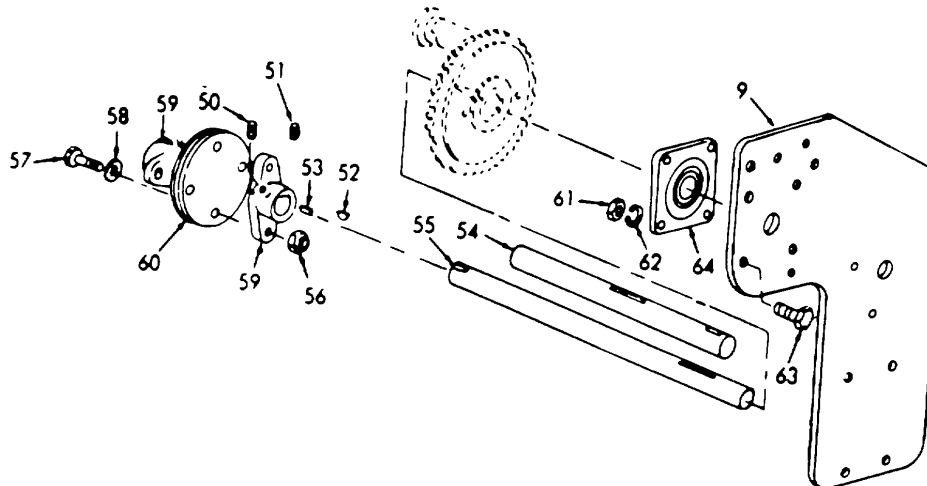


5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

DISASSEMBLY (Cont)

- | | | |
|----------------------------------|---|--|
| 7. Shaft and Attached Components | <ul style="list-style-type: none"> a. Withdraw shaft and attached components. b. Remove setscrews (50 and 51). c. Remove coupling and Woodruff key (52), and machine key (53) from port engine unit shaft (54), or stbd engine unit shaft (55). d. Disassemble coupling, if necessary as follows: <ul style="list-style-type: none"> 1. Remove nuts (56), screws (57), and washers (58). 2. Disassemble flanges (59) from coupling (60). e. Remove nuts (61), lockwashers (62), and screws (63). f. Remove cartridge flange (64) from plate (9). | |
|----------------------------------|---|--|



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

LOCATION/ITEM	ACTION	REMARKS
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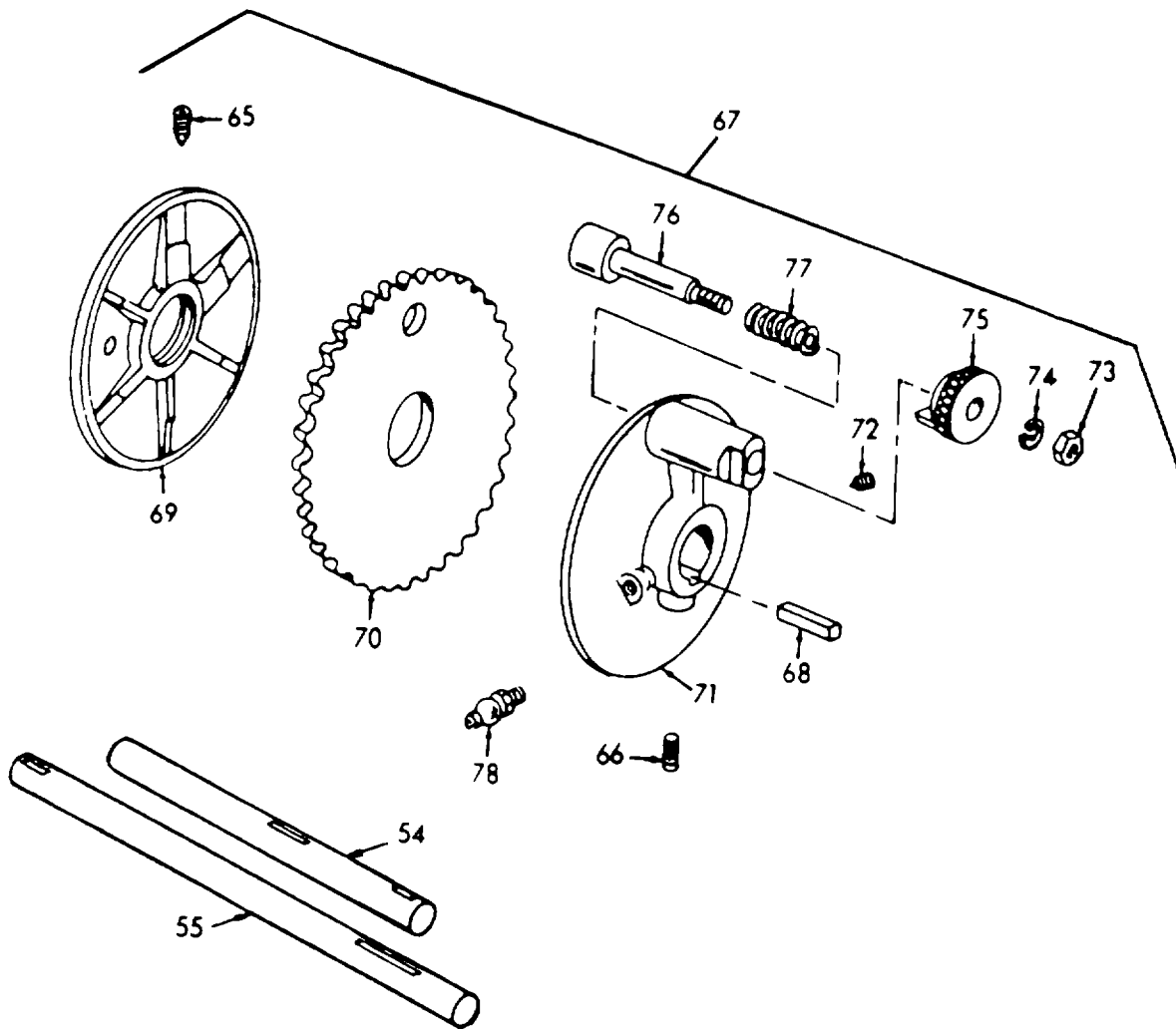
DISASSEMBLY (Cont)

- | | | |
|--|--|--|
| | <p>g. Disassemble disconnect assembly, if necessary, as follows:</p> <ol style="list-style-type: none"> 1. Loosen setscrews (65 and 66). 2. Remove disconnect assembly (67), and key (68) from shaft (54 or 55). 3. Disassemble plate (69), sprocket (70), and adapter (71). 4. Disassemble disconnect, by loosening setscrew (72), and removing nut (73), lockwasher (74), knob (75), pin (76), and spring (77). 5. Remove lubrication fitting (78). | |
|--|--|--|

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

DISASSEMBLY (Cont)



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

LOCATION/ITEM	ACTION	REMARKS
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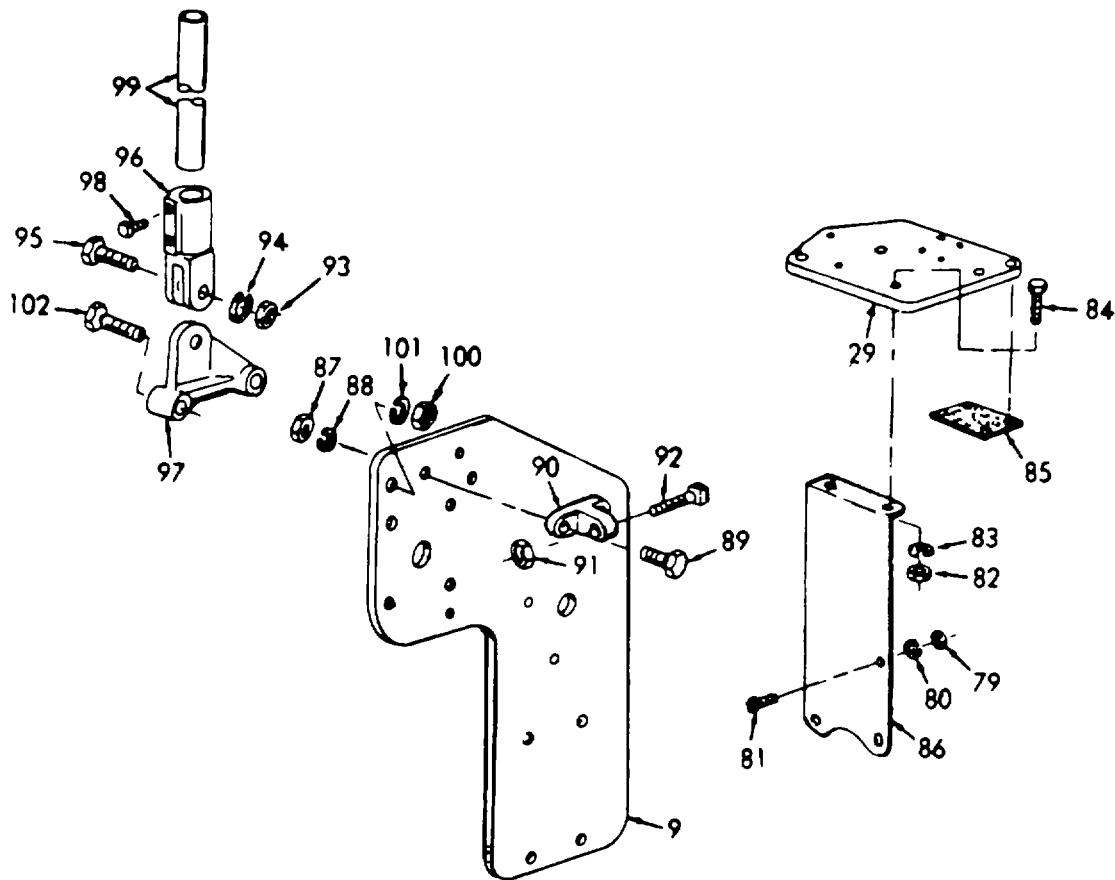
DISASSEMBLY (Cont)

- | | | |
|--|--|--|
| 8. Strut,
Throttle
Stop,
and
Miscellaneous
Components | <ul style="list-style-type: none"> a. Remove nuts (79), lockwashers (80), and screws (81). b. Remove nuts (82), lockwashers (83), and screws (84). c. Separate mounting plate (29), gasket (85), and brace (86) from selectorvalve. d. Remove nuts (87), lockwashers (88), and screws (89), and remove stop (90) from plate (9). e. Disassemble nut (91), screw (92), and stop (90). f. Remove nut (93), lockwasher (94), and screw (95). g. Remove clevis (96) from strut support (97). h. Remove screws (98), and disassemble strut (99) from clevis (96). i. Remove nuts (100), lockwashers (101), and screws (102). j. Remove strut support (97) from plate (9). | |
|--|--|--|

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY.
(Continued).

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

DISASSEMBLY (Cont)



5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

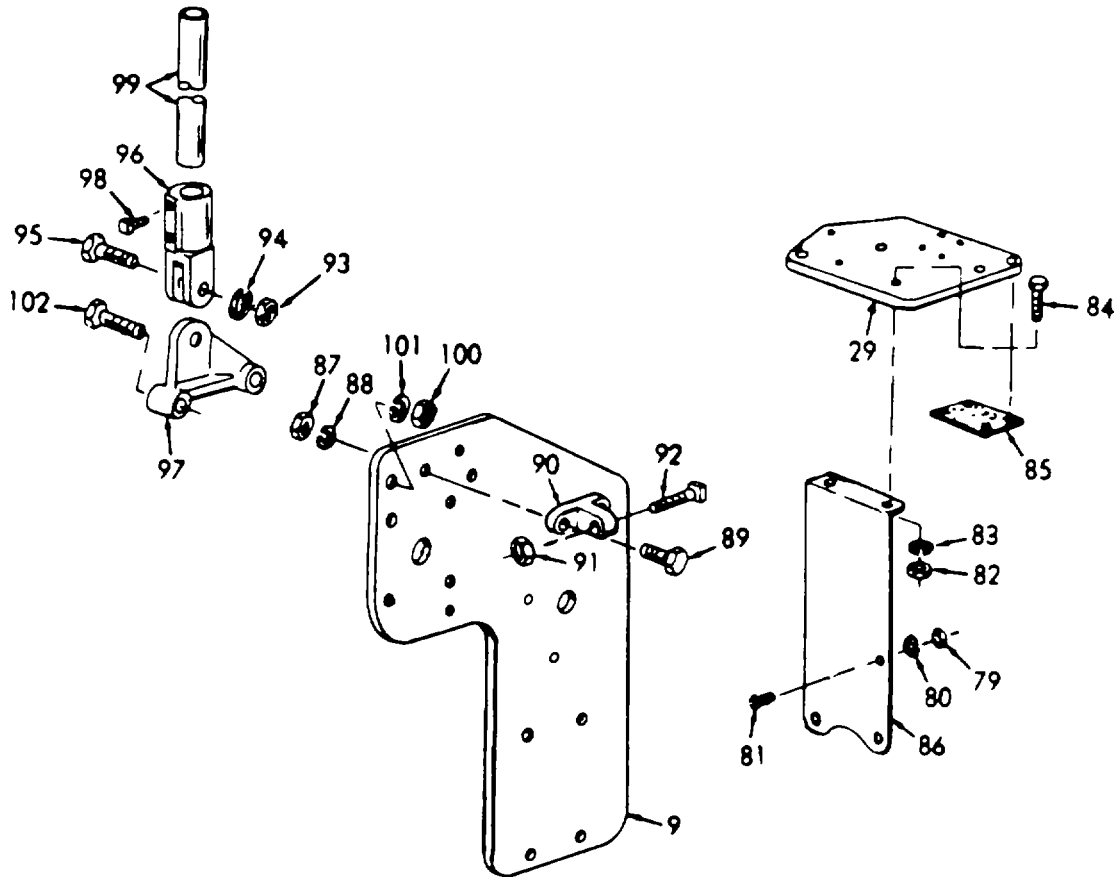
REASSEMBLY

- | | | |
|--|---|--|
| 9. Strut,
Throttle
Stop and
Miscellaneous
Components | <ul style="list-style-type: none"> a. Install strut support (97) to plate (9) using screws (102), lockwashers (101), and nuts (100). b. Reassemble strut (99) to clevis (96) with screws (98). c. Install clevis (96) to strut support (97) using screw (95), lockwasher (94), and nut (93). d. Reassemble stop (90), screw (92), and nut (91). e. Install stop (90) on plate (9) using screws (89), lockwashers (88), and nuts (87). f. Reassemble mounting plate (29) to brace (86), using screws (84), lockwashers (83), and nuts (82). g. Install gasket (85). h. Install brace (86) with screws (81), lockwashers (80), and nuts (79). | |
|--|---|--|

5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

REASSEMBLY (Cont)

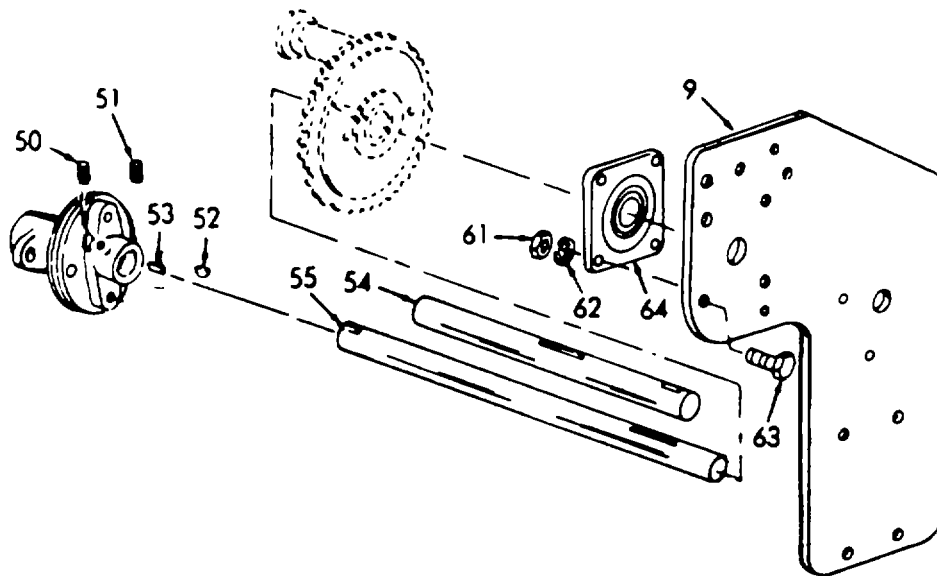


5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

REASSEMBLY (Cont)

- | | |
|------------------------------|---|
| 10. Shaft and Attached Parts | a. Install cartridge flange (64) on plate (9) using screws (63), lockwashers (62), and nuts (61). |
| | b. Install coupling on shaft (54 or 55), Woodruff key (52), and machine key (53). |
| | c. Install setscrews (50 and 51). |
| | d. Install shaft assembly. |

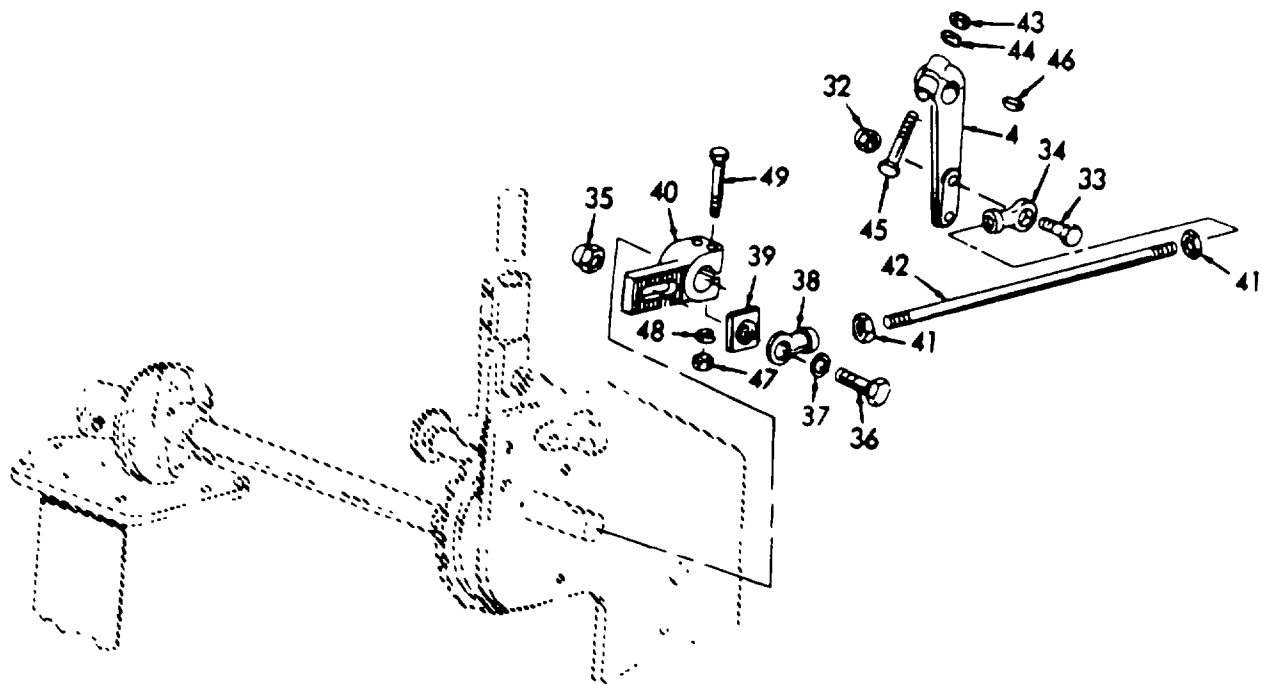


5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

REASSEMBLY (Cont)

- | | |
|-----------------------------|---|
| <p>11. Throttle Linkage</p> | <p>a. Install adjustable arm (40) on shaft with screws (49), lockwashers (48), and nuts (47).</p> <p>b. Install throttle jack arm (4), and Woodruff key (46), using screw (45), lockwasher (44), and nut (43).</p> <p>c. Reassemble rod ends (34 and 38), and locknuts (41) on throttle rod (42).</p> <p>d. Install lockplate (39), rod end (38), flatwasher (37), screw (36), and nut (35).</p> <p>e. Install rod end (34) to throttle jack arm (4), using screw (33) and self-locking nut (32).</p> |
|-----------------------------|---|

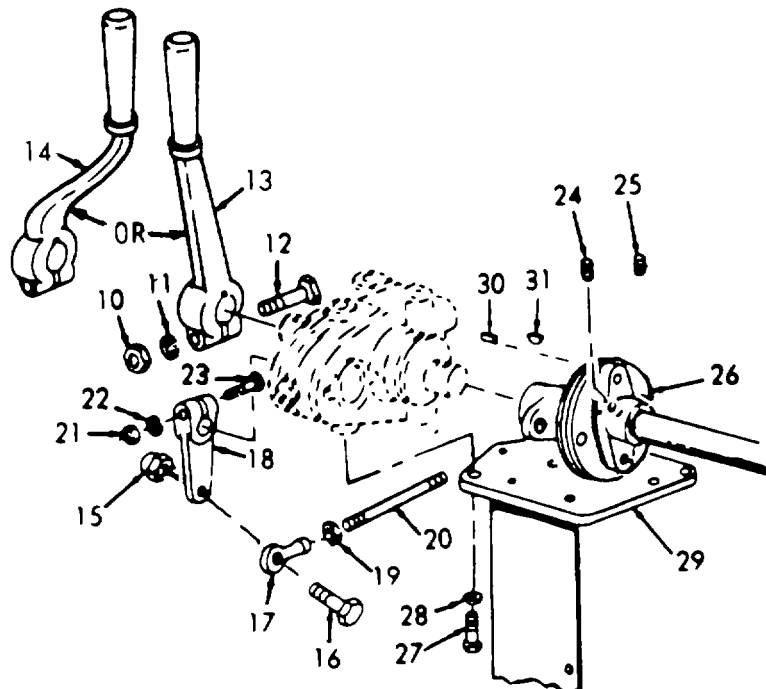


5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

INSTALLATION

- | | | |
|-------------------------|---|--|
| 12. Engine Control Unit | <ul style="list-style-type: none"> a. Attach engine control unit to coupling flange (26), and install machine key (30), and Woodruff key (31). b. Attach engine control unit to bottom plate (29), using screws (27), and lockwashers (28). c. Tighten setscrews (24 and 25) in coupling flange (26). d. Install clutch arm (18) with screw (23), locknut (22), and nut (21). e. Reassemble rod (20), nut (19), and rod end (17). f. Attach rod end (17) to clutch arm (18), with screw (16), and self-locking nut (15). g. Install right-hand arm (13), or left-hand arm (14), using screw (12), lockwasher (11), and nut (10). | |
|-------------------------|---|--|

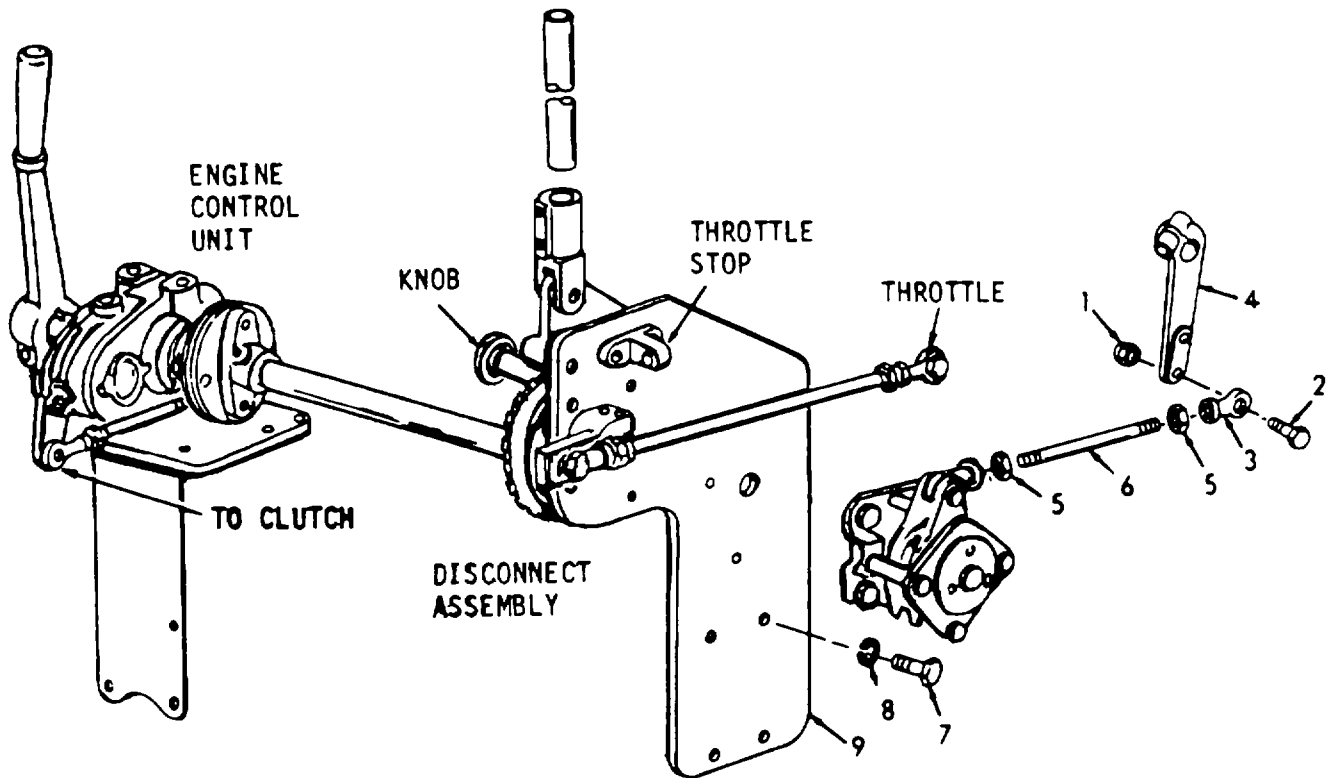


5-5.3. ENGINE CONTROL LEVERS AND BRACKETS AND DISCONNECT ASSEMBLY
(Continued).

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

INSTALLATION (Cont)

- | | |
|-----------------------|--|
| <p>13. Brake Unit</p> | <p>a. Install brake to bearing plate (9), with screws (7), and lock-washers (8).</p> <p>b. Reassemble linkage rod (6), locknuts (5), and rod end (3).</p> <p>c. Reconnect rod end (3) to throttle jack arm (4), using screw (2), and self-locking nut (1).</p> |
|-----------------------|--|



5-5.4. ENGINE CONTROL UNIT.

This task covers:

- a. Inspection
 - b. Cleaning
 - c. Repair/Replace
-

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

NONE

Equipment
Condition Condition Description
Paragraph
5-5.3. Control Unit Removal

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Material/Parts

Cleaning solvent P-D-680
Grease

Personnel Required

2 MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

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

INSPECTION

- | | |
|-----------------|--|
| 1. Control Unit | a. Inspect for breaks, cracks, and signs of leaking. |
| | b. Inspect for binding and ease of operation. |
| | c. Inspect for proper operation. |

5-5.4. ENGINE CONTROL UNIT (Continued).

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

CLEANING

2.

WARNING

Dry cleaning solvent, P-D- 680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° - ~~138~~(38° - 59°C).

Clean all metal parts (except bearings), with cleaning solvent P-D-680 and dry thoroughly.

REPAIR/REPLACE

3.

- a. Remove detent plug (1), spring (2), ball bearing (3), and lockwasher (4).
- b. Remove lubrication fitting (5).
- c. Remove cotter pin (6).
- d. Remove retaining ring (7), and bearing retainer (8).
- e. Remove retaining ring (9), and bearing cap (10).
- f. Remove four screws (11), and lockwashers (12).
- g. Remove side (13), and gasket (14).
- h. Remove dowel pins (15) from side.
- i. Remove throttle shaft assembly (16).

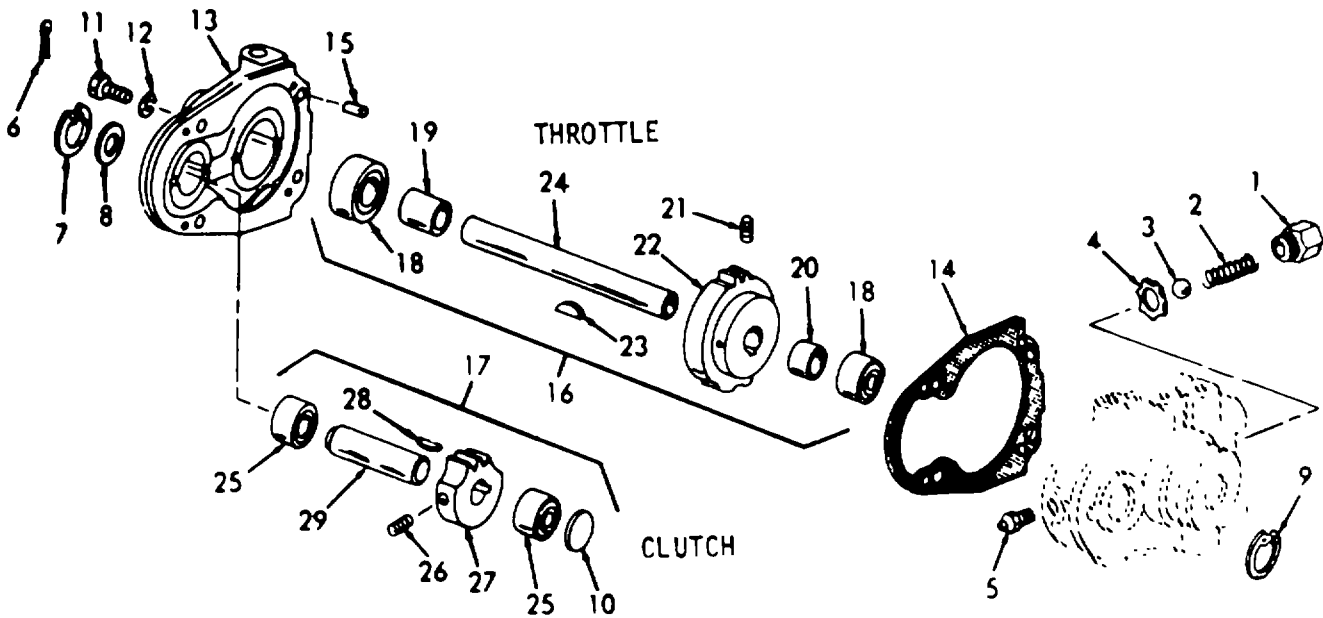
If necessary.

5-5.4. ENGINE CONTROL UNIT (Continued).

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

REPAIR/REPLACE (Cont)

- j. Remove clutch shaft assembly (17).
- k. Remove bearings (18), and spacers (19 and 20).
- l. Loosen setscrew (21) in throttle gear (22).
- m. Disassemble gear (22), Woodruff key (23), and shaft (24).
- n. Remove bearings (25) from clutch shaft assembly.
- o. Loosen setscrew (26) in clutch gear (27).
- p. Disassemble gear (27), Woodruff key (28), and clutch shaft (29).



5-5.4. ENGINE CONTROL UNIT (Continued).

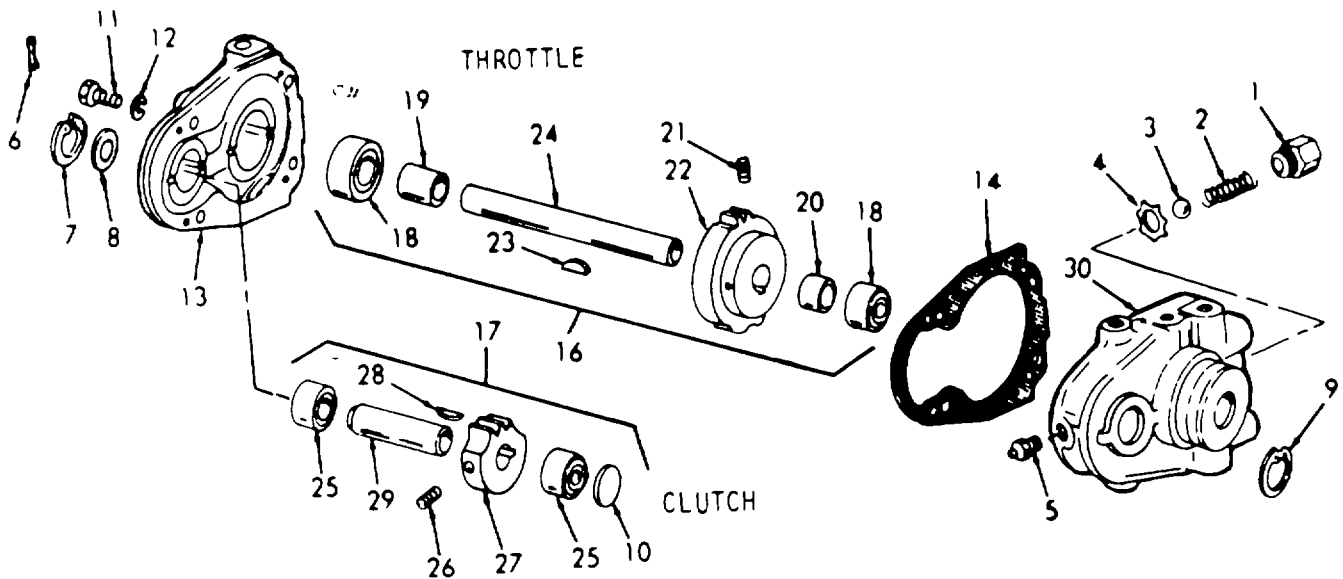
LOCATION/ITEM	ACTION	REMARKS
REPAIR/REPLACE (Cont)		
	q. Inspect all parts for damage. Replace parts as needed.	
	r. Reassemble clutch gear (27), Woodruff key (28), and clutch shaft (29).	
	s. Tighten setscrew (26).	
	t. Install bearings (25) on clutch shaft assembly (17).	
	u. Reassemble throttle gear (22), Woodruff key (23), and throttle shaft (24).	
	v. Tighten setscrew (21).	
	w. Install spacers (19 and 20), and bearings (18) on throttle shaft.	
	x. Install clutch shaft (17), and throttle shaft (16) in case (30).	
	y. Install side (13), and gasket (14) on case (30), using screws (11), and lockwashers (12).	
	z. Install bearing cap (10), and retaining ring (9).	

5-5.4. ENGINE CONTROL UNIT (Continued).

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

REPAIR/REPLACE (Cont)

- aa. Install bearing retainer (8), and retaining ring (7).
- ab. Install cotter pin (6).
- ac. Install lubrication fitting (5).
- ad. Reassemble detent lockwasher (4), ball bearing (3), spring (2), and plug (1).
- ae. Lubricate.



5-5.5. FREE-WHEELING BRAKE.

This task covers:

- a. Inspection b. Cleaning c. Repair/Replace
-

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

NONE

Equipment
Condition Condition Description
Paragraph

5-5.3. Control Unit Removal

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Material/Parts

Cleaning solvent P-D-680

Personnel Required

2 MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

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

INSPECTION

- | | | |
|----------|---|--|
| 1. Brake | Inspect for bent, missing, and damaged parts. | |
|----------|---|--|

5-5.5. FREE-WHEELING BRAKE (Continued).

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

CLEANING

2.

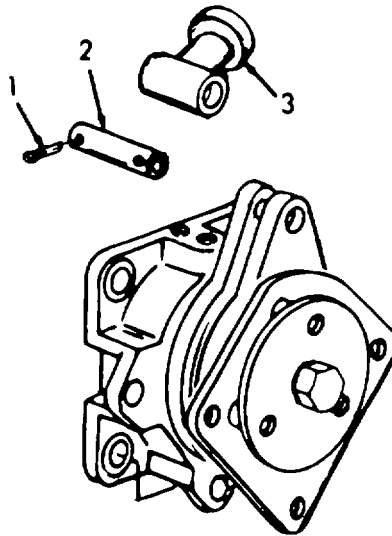
WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° - 138°F (38° - 59°C).

Clean all metal parts with cleaning solvent P-D-680, and dry thoroughly.

REPAIR/REPLACE

3. a. Remove cotter pins (1), linkage (2), and coupling (3).



5-5.5. FREE-WHEELING BRAKE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACE (Cont)

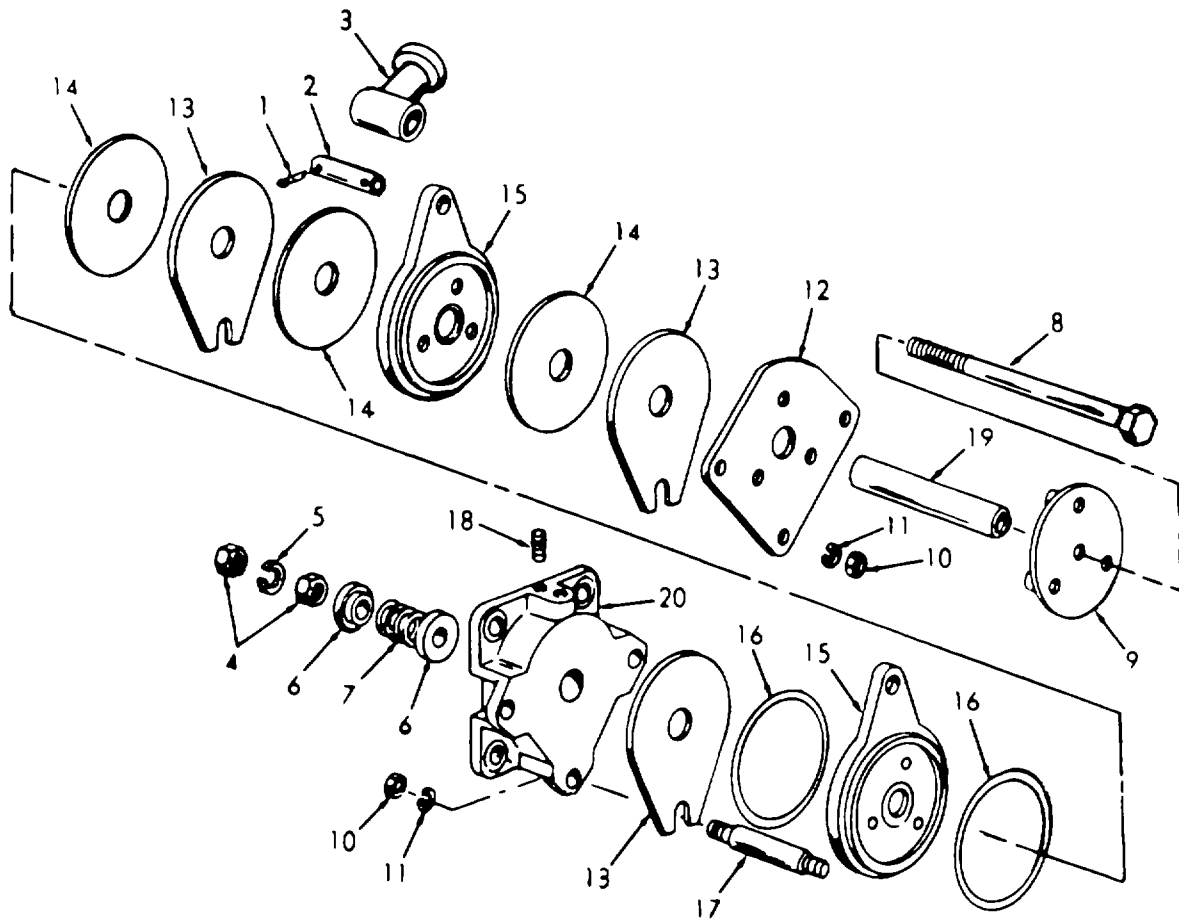
- | | | |
|----|---|--|
| b. | Using two wrenches, loosen and remove nuts (4), and lockwasher (5). | |
| c. | Remove guide bushings (6) and spring (7). | |
| d. | Remove bolt (8), and thrust-plate (9). | |
| e. | Remove nuts (10), and lock-washers (11). | |
| f. | Remove support plate (12), brake arms (13), brake discs (14), rotor assemblies (15), preformed packings (16), and studs (17). | |
| g. | Disassemble setscrews (18), brake shaft (19), and base (20). | |
| h. | Reassemble base (20), shaft (19), and tighten setscrews (18). | |
| i. | Reassemble preformed packings (16), rotor assemblies (15), brake discs (14), brake arms (13), and support plates (12), using studs (17), nuts (10), and lockwashers (11). | |
| j. | Install thrustplate (9), and bolt (8). | |

5-5.5. FREE-WHEELING BRAKE (Continued).

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

REPAIR/REPLACE (Cont)

- k. Install guide bushings (6), and spring (7).
- l. Install nuts (4), and lock-washer (5).
- m. Install coupling (3), linkage (2), and cotter pins (1).



5-6. RAMP CONTROLS.

a. The ramp hoisting arrangement consists of a hoisting cable deadended to one side of the craft, running through fairlead sheaves through the ramp, and to a winch on the opposite side. The winch is on the port side.

b. Winches are powered by hydraulic motors. Other system components include a four-way control valve, counterbalance valve, two engine-driven pumps, two check valves, suction line strainers, and return line filters. See figure 5-1.

c. Emergency lowering of the ramp is accomplished by a manual brake release. Two chain hoists are stored in the lazarette to be used for emergency lifting of the ramp.

5-6. RAMP CONTROLS (Continued).

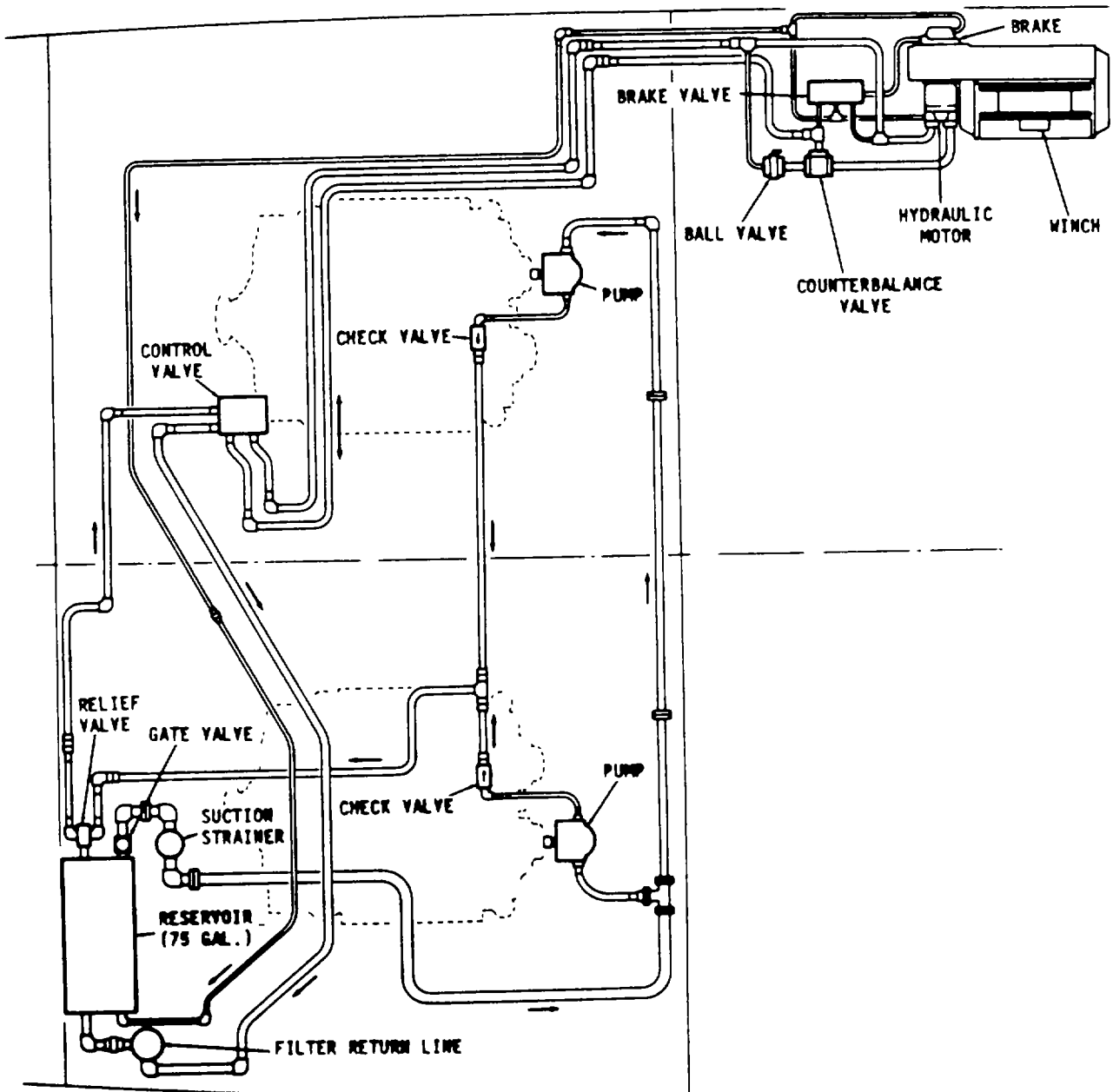


Figure 5-1. Ramp Hoist Hydraulic System Diagram.

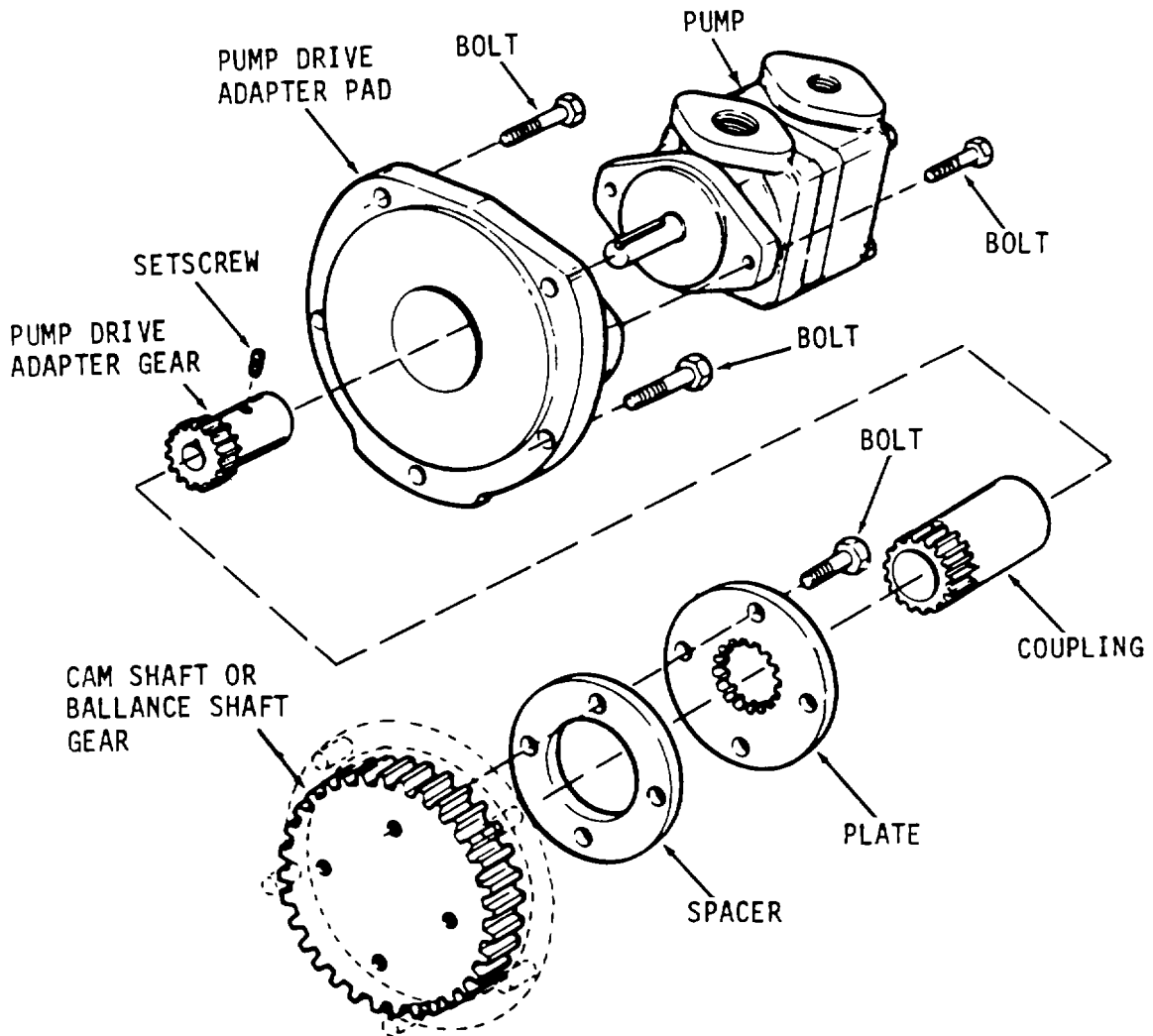
5-6. RAMP CONTROLS (Continued).

d. The following is an index to the maintenance instructions.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Ramp Hoist Hydraulic Pump	5-6.1
Ramp Hoist Control Valve	5-6.2
Ramp Hoist Counterbalance Valve	5-6.3
Ramp Hoist Relief Valve	5-6.4
Ramp Hoist Hydraulic Check Valve	5-6.5

5-6.1. RAMP HOIST HYDRAULIC PUMP.

Pumps are mounted aft on the outboard engine of each propulsion unit.



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

This task covers:

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

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

Arbor press
Torque wrench

Equipment
Condition Condition Description
Paragraph

NONE

5-5.3. Control Unit Removal

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Soft hammer

Material/Parts

Petroleum jelly
Masking tape
Non-hardening gasket cement
Sealant
"O" Rings
Hydraulic fluid

Special Environmental Conditions

NONE

Personnel Required

2 MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

LOCATION/ITEM

ACTION

REMARKS

REMOVAL

- 1. Pump
 - a. Close both accumulator valves.
 - b. Release the oil pressure in the hydraulic starting system.

5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

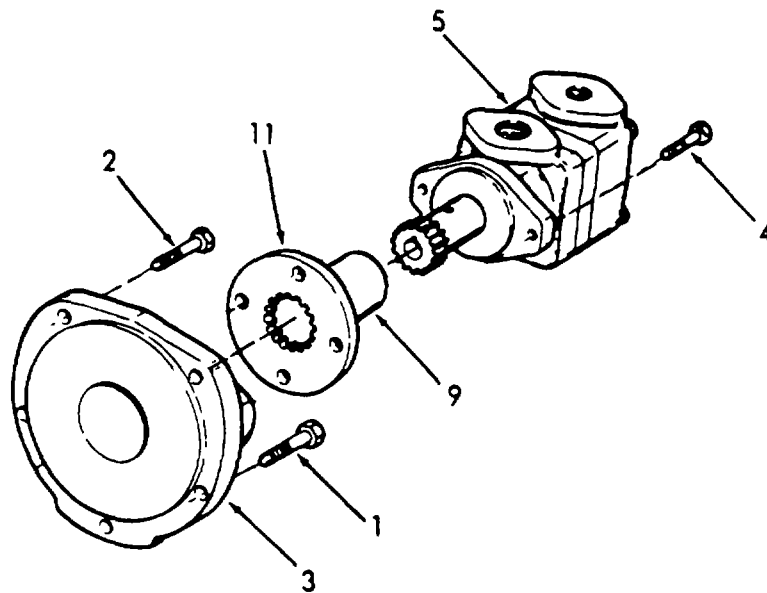
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

REMOVAL (Cont)

WARNING

The oil pressure in the system must be released prior to servicing the engine-driven pump, or other parts to prevent possible injury to personnel or equipment.

- | | | |
|----------------------------------|--|---|
| | <ul style="list-style-type: none"> c. Clean all of the exterior dirt from the pump and the hydraulic lines. d. Disconnect the hydraulic lines from the pump. Cap lines. e. Loosen the bolts holding the mounting plate, and remove plate and pump as an assembly. | |
| <p>2. Drive Adapter Assembly</p> | <ul style="list-style-type: none"> a. Remove bolts (1 and 2) from pump drive adapter pad (3). b. Remove bolts (4) securing pump (5) to pump drive adapter pad (3). c. Separate pump (5) from adapter pad (3). | <p>Coupling (9) may stay in plate (11).</p> |

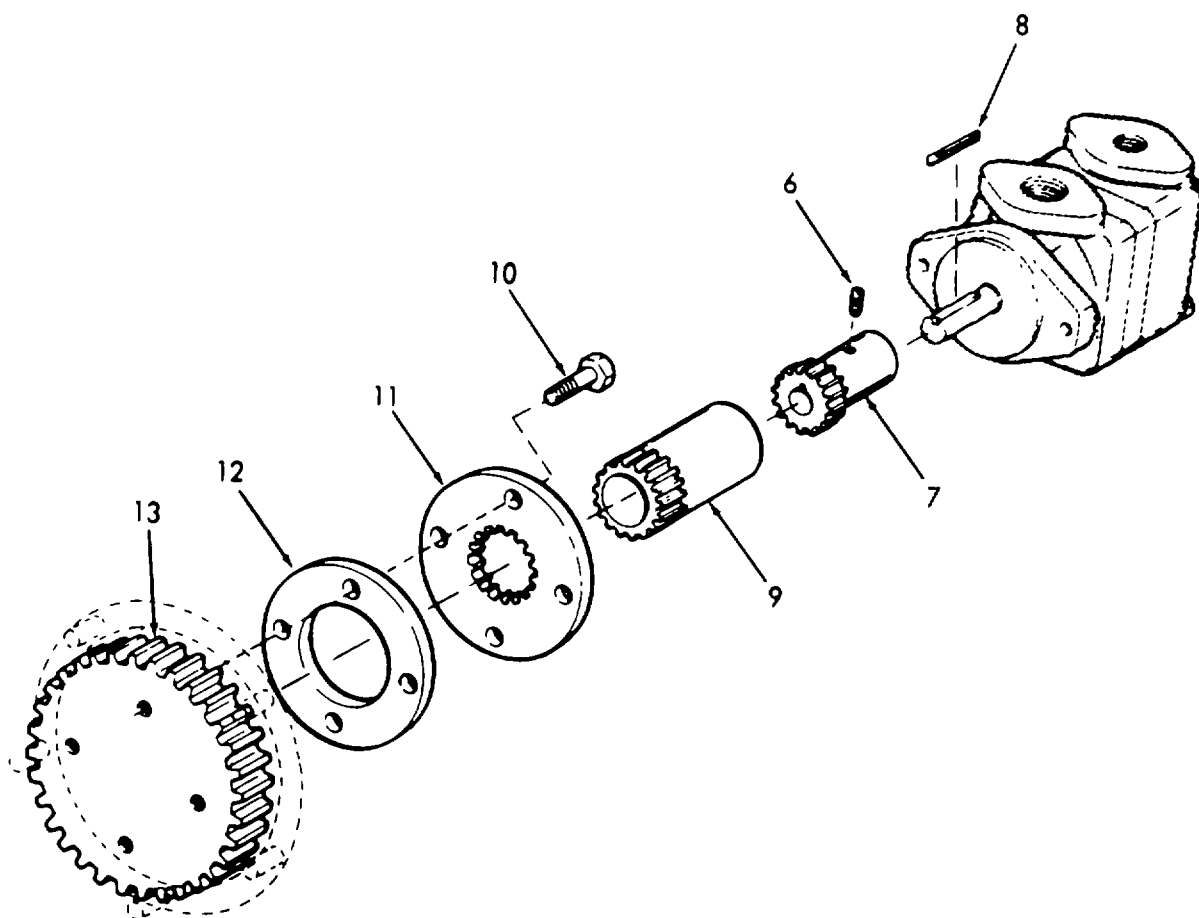


5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

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

REMOVAL (Cont)

- d. Loosen setscrew (6) and remove pump drive adapter gear (7) from pump.
- e. Remove key (8) from pump shaft.
- f. Remove coupling (9) from plate (11).
- g. Remove bolts (10), plate (11), spacer (12) from camshaft or balance shaft gear (13).



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

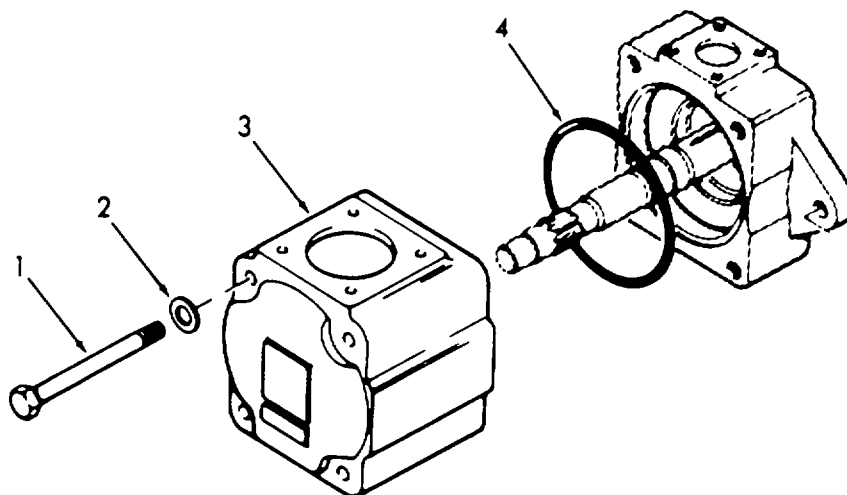
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

DISASSEMBLY

NOTE

Identify parts during disassembly for reassembly in proper relationship.

- | | | |
|---------|---|---|
| 3. Pump | <ul style="list-style-type: none"> a. Remove four cover bolts (1), washers (2), and cover (3).
 b. Grasp the pump cartridge (inner assembly), and while turning, pull it from drive shaft. Loosening the pump cartridge can be accomplished by prying under the flats of the ring with two screw drivers.
 c. Remove large O-ring (4) from recess in body. | <p>Note relative position of inlet port in cover to the outlet port in body for correct assembly.</p> |
|---------|---|---|



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

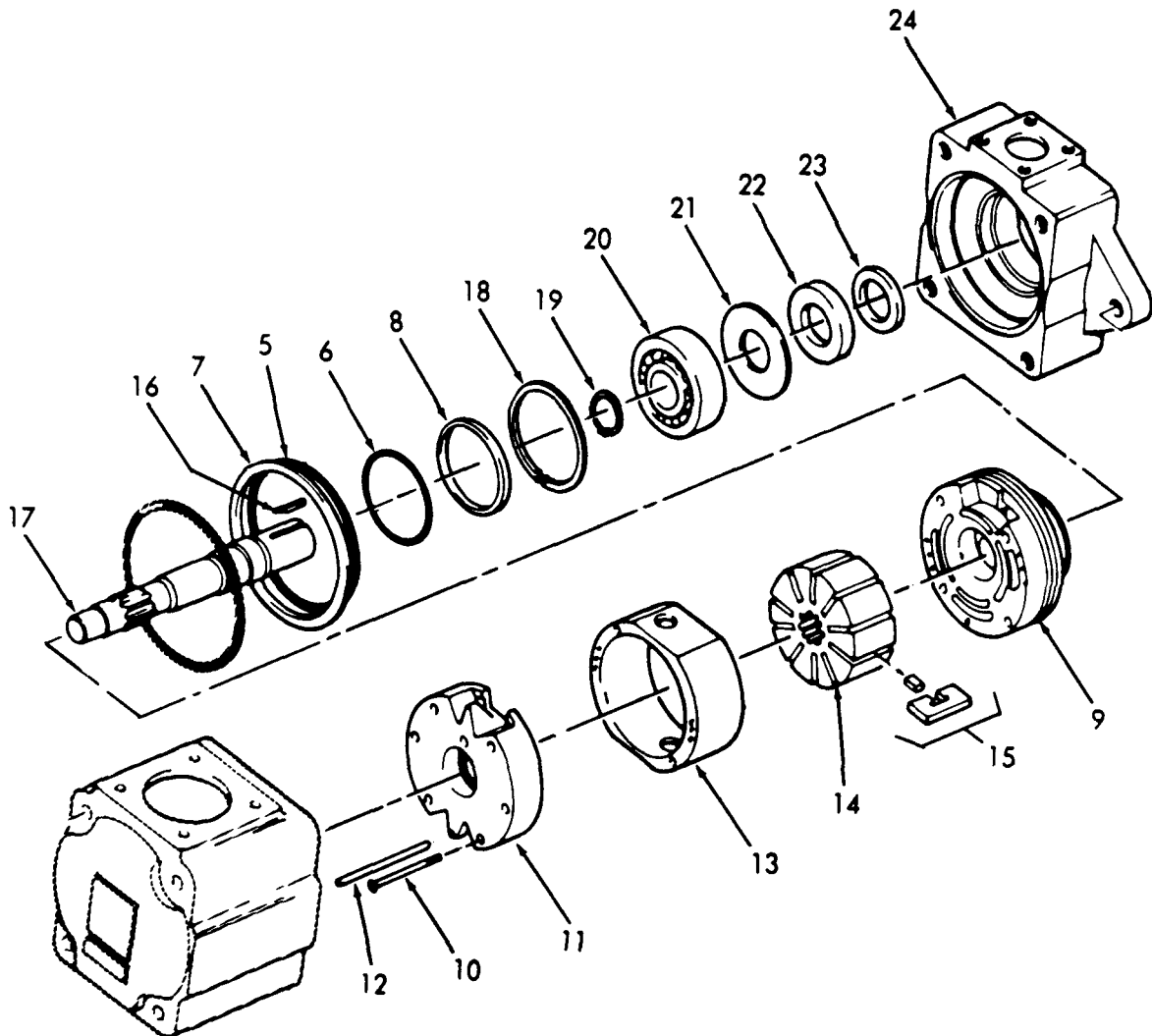
LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY (Cont)]</u>		
d.	Remove O-rings (5 and 6) and backup rings (7 and 8) from hub and outside diameter of pressure plate (9).	
e.	Remove two screws (10) from face of wear plate (11). Lift wear plate from locating pins (12), and remove pins.	
f.	Remove ring (13) from around the rotor (14).	
g.	Remove vanes and inserts (15) from rotor, and remove rotor from the pressure plate.	
h.	Lift out shaft key (16) from its seat in shaft (17). Remove shaft snap ring (18) and bearing retaining ring (19), and fully remove drive shaft and bearing (20) from body by gently tapping the keyed end of shaft with a soft hammer.	Check bearing for wear before removing it from shaft. Rotate bearing applying a little pressure to outer race, to determine if balls or races are pitted, galled, or cracked. Check for looseness. If in doubt, remove bearing from shaft at point of contact with bushing and sealing lip of shaft oilseal. If excessive scoring or wear is noted, replace shaft.

5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

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

DISASSEMBLY (Cont)

- i. Remove washer (21) from bore in body. Using a suitable hooked tool or a drift, remove shaft oil seal (22), and felt seal (23) from body (24).



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

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

CLEANING

- | | | |
|----|--|--|
| 4. | Wash and dry all cartridge parts in clean hydraulic fluid. | |
|----|--|--|

INSPECTION

- | | | |
|----|---|--|
| 5. | <ul style="list-style-type: none"> a. Inspect surfaces of wear plate, pressure plate, ring and rotor for scoring and excessive wear. Light scoring may be carefully stoned or lapped. Discard parts that are heavily scored. b. Check edges of vanes for wear. Vanes shall not have excessive play in rotor slots or burrs on edges. c. Inspect inside diameter of bushing (25). Remove bushing if wear or scoring is evident. If wear plate is to be replaced, do not remove bushing, as a new plate comes with bushing inserted. | |
|----|---|--|

REPAIR

- | | | |
|----|---|--|
| 6. | <ul style="list-style-type: none"> a. Replace O-rings and felt seal. b. Replace other damaged or defective parts as required. | |
|----|---|--|

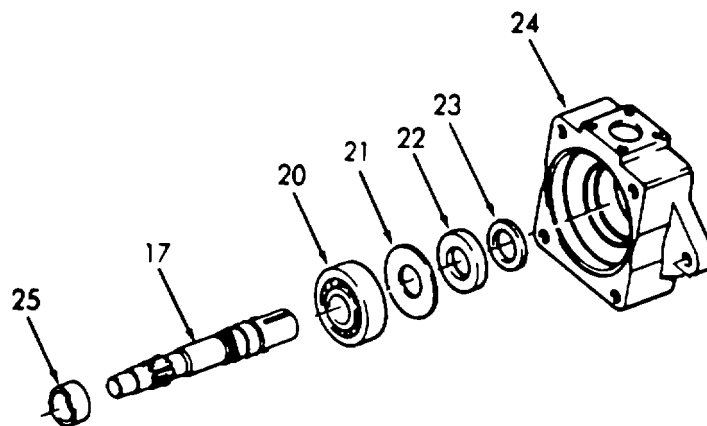
5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY**NOTE**

Lubricate parts before reassembly using clean hydraulic fluid.

- | | |
|---------|---|
| 7. Pump | <p>a. Install a new felt seal (23), shaft oil seal (22), and washers (21), in counterbore of body (24). Soak both seals thoroughly in hydraulic oil before installing. Make sure lipped edge of seal is toward inside of body. Use a suitable drift that will not damage the seal during installation. Lubricate the shaft oil seal journal with petroleum jelly.</p> <p>b. Position shaft bearing (20) in place on drive shaft, being careful not to cock the bearing. Using an arbor press, support inner race of bearing and press bearing against shoulder of shaft (17). Apply tape around the end of the shaft to protect the seal. Install shaft and bearing into body until bearing is fully seated. If necessary, gently tap shaft with a soft hammer.</p> |
|---------|---|



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- c. Install shaft snap ring (18), and bearing retaining ring (19). Make sure that both parts are firmly seated in place. Remove tape from end of shaft (17).
- d. Install the shaft key (16).

NOTE

Direction of rotation is designated as viewed from the shaft end of pump. R. H. rotation is clockwise; L. H. rotation is counter-clockwise.

- e. Place rotor (14) on pressure plate (9) with arrow pointing in desired direction of rotation. Install inserts in vanes (15), and position both parts in rotor slots. The sharp edges of the vanes must be toward the direction of rotation.
- f. Install locating pins (12) in pressure plate (9). Install ring (13) over locating pins against pressure plate with arrow pointing in direction of shaft rotation. Lubricate rotor (14), and ring with clean hydraulic oil.
- g. Install O-ring (5), and backup ring (8) in groove on hub diameter of pressure plate (9). Install a backup ring (7) and O-ring (6) around large step diameter of pressure plate. Make sure that the smooth sides of the backup rings face the sealing rings.

5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

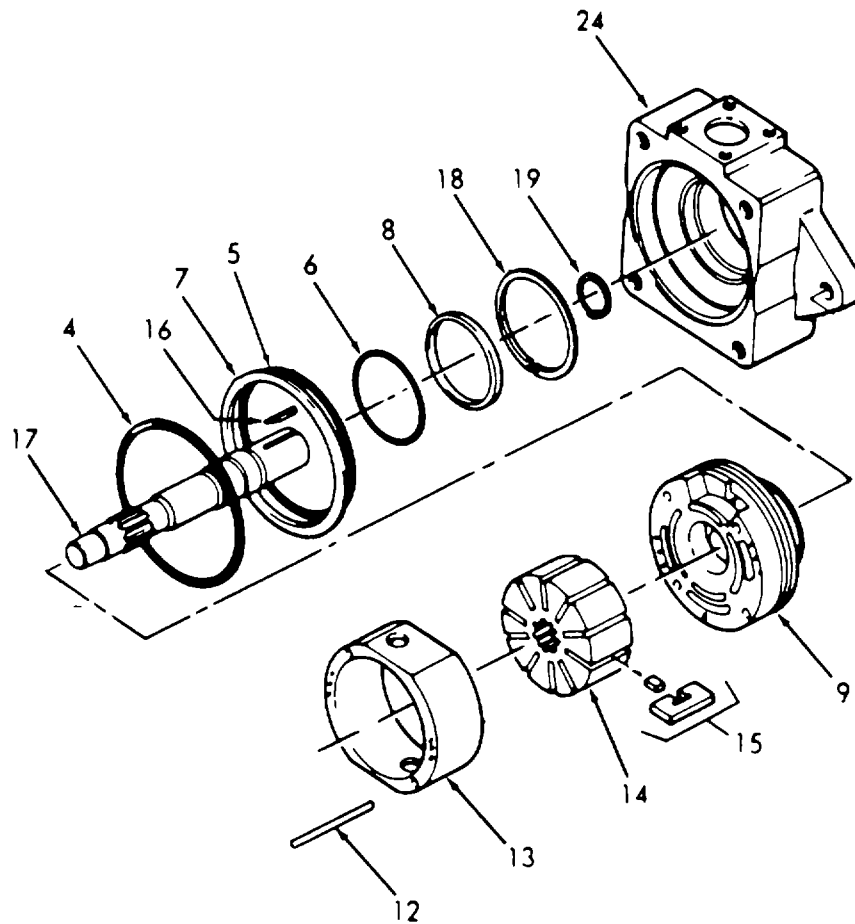
LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

NOTE

Backup rings must always be installed away from the pressure chamber.

- h. Position large O-ring (4) in recess of body (24). Use petroleum jelly to hold O-ring in position during reassembly of pump cartridge.

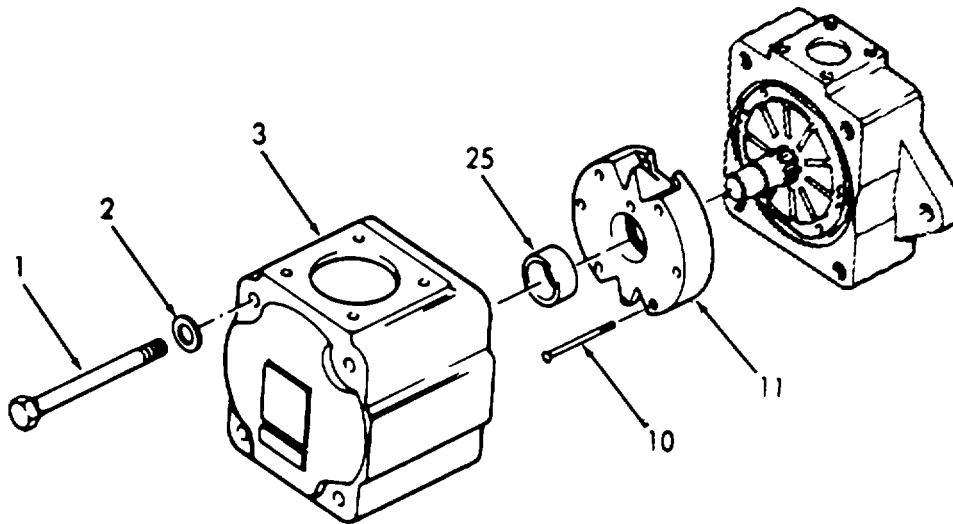


5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- i. If wear plate bushing (25) was removed, press a new bushing into wear plate bore. Install plate (11) on locating pin against ring. Install two screws (10) and tighten.
- j. Carefully install pump cartridge on drive shaft, and seat it firmly in place in the body.
- k. Install cover (3) making certain that the two locating pins fit into holes inside cover. Seat cover firmly and secure it in place with four washers (2), and cover bolts (1). The threads of the bolts should be oiled lightly, and torqued to 85-95 ft. lbs (115.2 - 128.8 Nm).



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

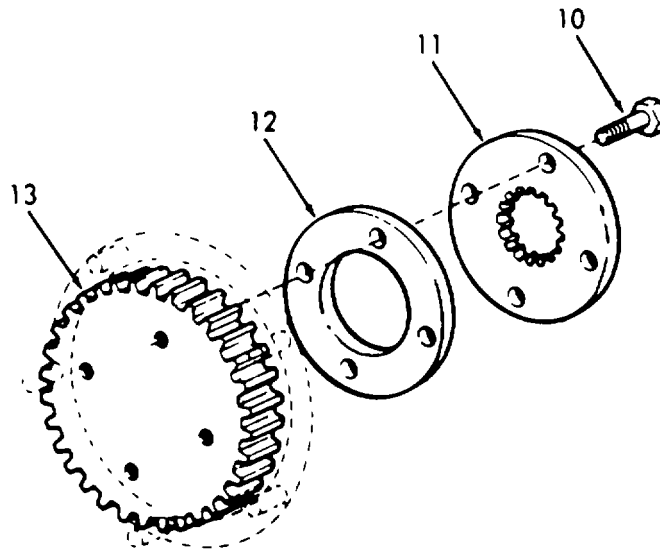
LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- i. After the unit has been completely reassembled, pour a small quantity of clean hydraulic oil into the cover inlet port. Rotate the drive shaft several turns by hand to check for free rotation and to make sure of complete lubrication of the cartridge parts. Cap the pump inlet and outlet ports to prevent entrance of foreign materials.

INSTALLATION

8. Drive Adapter Assembly
 - a. Install spacer (12), and plate (11) to camshaft or balance shaft gear (13) with four bolts (10).



5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
INSTALLATION (Cont)		
	b. Install coupling (9) in plate (11).	
	c. Install key (8) in pump shaft.	
	d. Install pump drive adapter gear (7) on pump shaft. removed.	Reinstall set-screw (6) if
	e. Position pump (5) in place on adapter pad (3).	
	f. Install bolts (4) to secure.	
	g. Secure pump (5), and adapter pad (3) to flywheel housing with bolts (1 and 2).	

CAUTION

Do not force the pump into place. Use of force, or tightening the bolts when the mounting flange is not against the flywheel housing, will force the drive arm against the pump body and result in damage to the pump when the engine is started. h. Apply sealant sparingly to all MALE PIPE THREADS only and work it into the threads.

CAUTION

Do not apply sealant to the last thread (that nearest the open end), or to female fittings, as it may wash into the system.

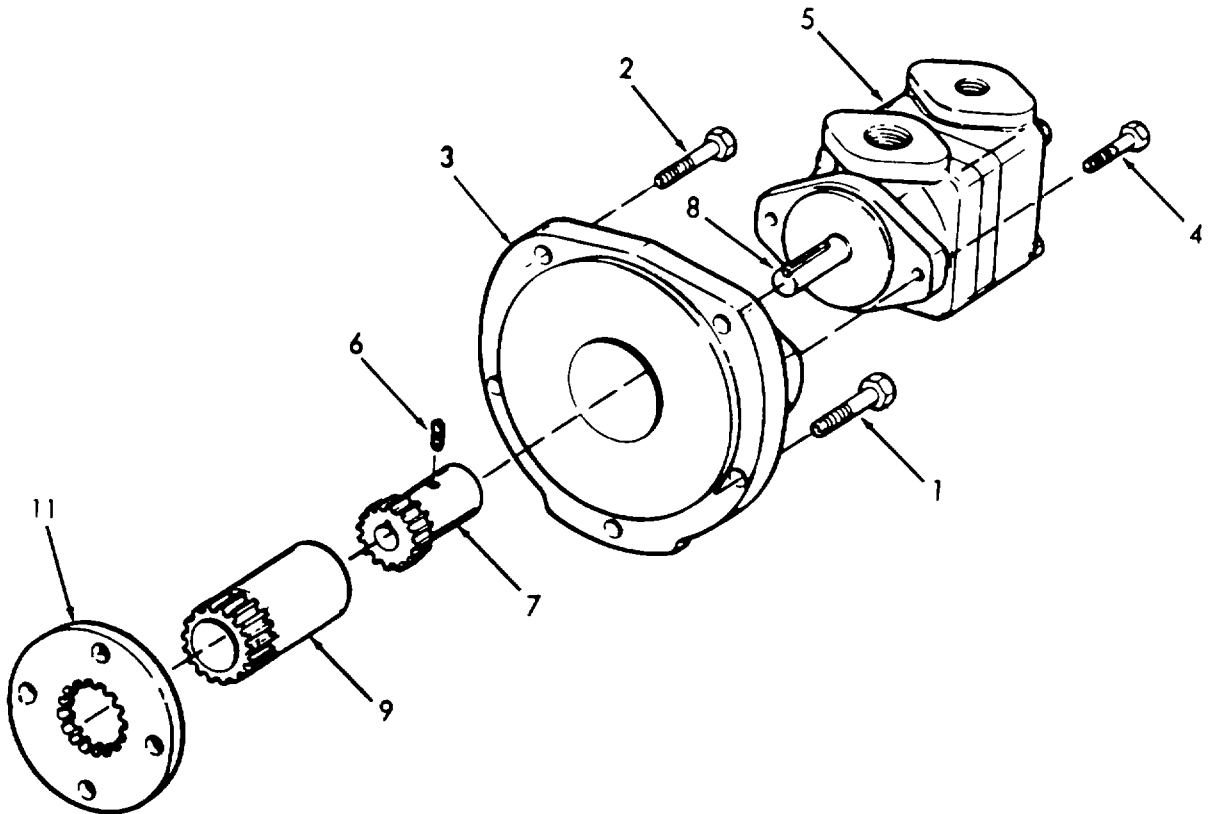
- i. Remove caps from lines, and connect the hydraulic lines to the pump.

5-6.1. RAMP HOIST HYDRAULIC PUMP (Continued).

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

INSTALLATION (Cont)

- j. Open both accumulator valves and pressurize the hydraulic starting system.



5-6.2. RAMP HOIST CONTROL VALVE

The control valve is a four-way directional valve with an inlet port, two motor ports, and an outlet. The valve consists of a body incorporating a sliding spool, centering springs, and check valves. The inlet section contains a relief valve assembly which is set at 2000 psi. The control valve is a Vickers CM2-NO2-R20B-L30.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | f. Reassembly |
| b. Disassembly | e. Repair | g. Installation |
| c. Cleaning | | |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
Paragraph
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Material/Parts

Special Environmental Conditions

- Tags
- Mineral oil solvent
- Petroleum jelly
- Clean cloths
- Packing
- Hydraulic fluid

NONE

Personnel Required

General Safety Instructions

MOS 61C10

NONE

5-6.2. RAMP HOIST CONTROL VALVE (Continued).

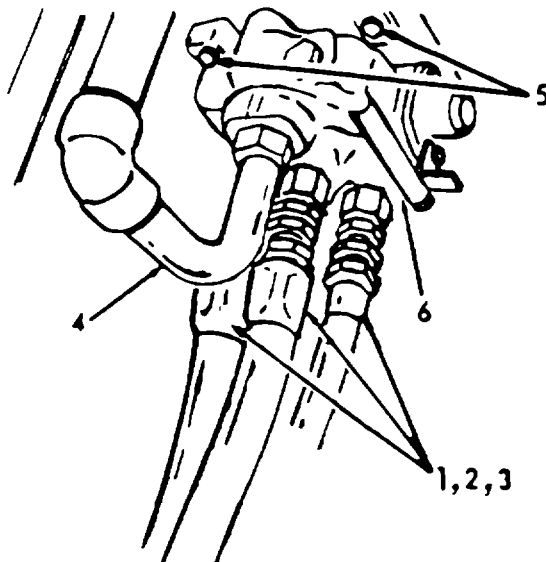
LOCATION/ITEM	ACTION	REMARKS
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WARNING

The oil pressure in the system must be released prior to servicing the pump or other parts, to prevent possible injury to personnel or equipment.

REMOVAL

- | | |
|---------------------|---|
| 1. Hose Connections | a. Clean hose connections (1, 2 and 3), disconnect, and cap open ends. Tag hoses to assure proper reconnection. |
| | b. Disconnect return line (4). |
| | c. Remove mounting bolts (5), and remove control valve (6). |



5-6.2. RAMP HOIST CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY

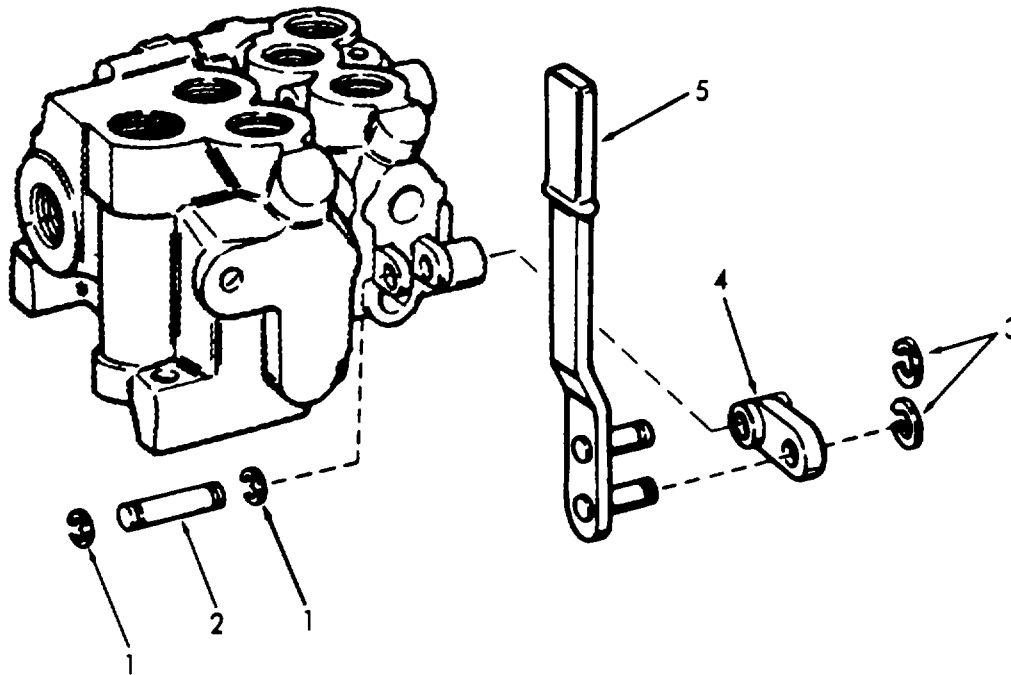
2. Control Valve

a. PARTS IDENTIFICATION

During disassembly, particular attention should be given to the identification of parts for reassembly. Spools are selectively fitted to valve bodies, and must be returned to the same bodies from which they were removed. Valve sections should be reassembled in the same order.

b. Levers, Fulcrum, and Studs.

If hand levers are used, remove "E" rings (1), fulcrum rod (2), "E" rings (3), links (4), and lever (5).

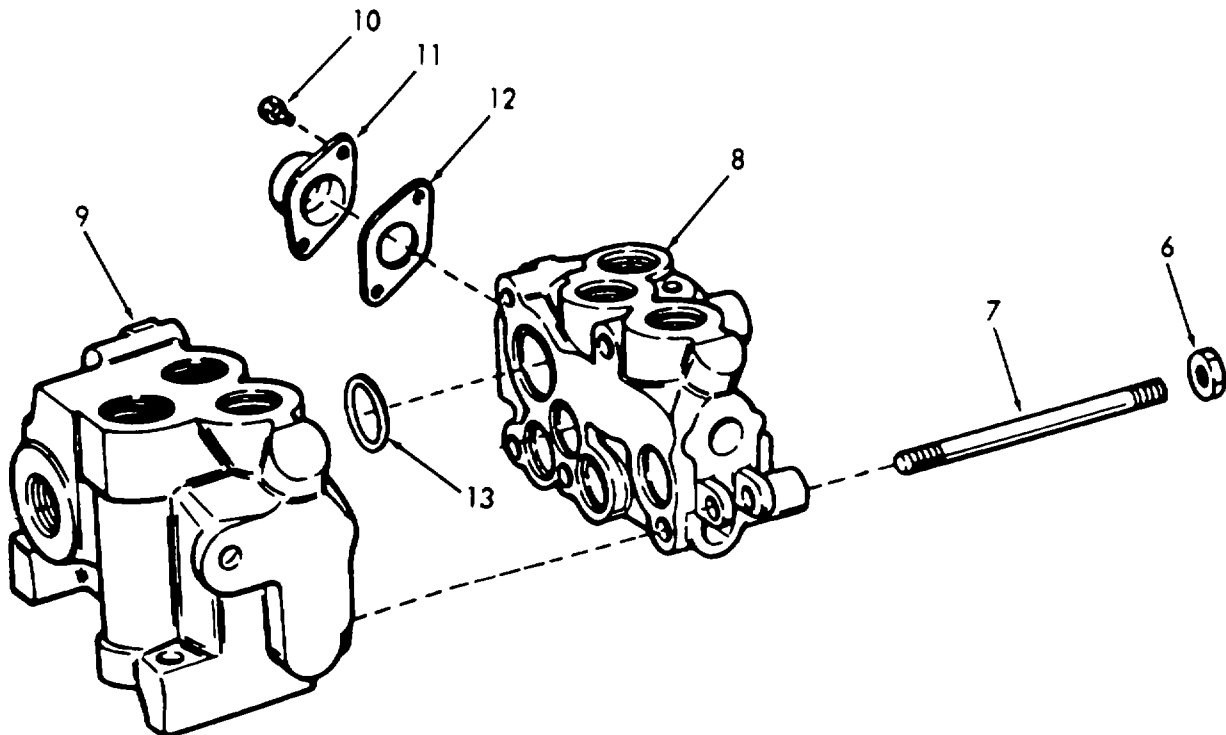


5-6.2. RAMP HOIST CONTROL VALVE (Continued).

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

DISASSEMBLY (Cont)

- | | | |
|----|--|---|
| c. | Attaching Parts. | |
| | Remove four tie rod nuts (6), and studs (7), and separate valve sections (8 and 9). | Do not destroy or lose spacers if used. |
| d. | End Caps | |
| | (1) Remove two screws (10) which secure spool and cap. Remove end cap (11) and flat retainer (12). | |
| | (2) Remove preformed packing (13) from body (8). | |



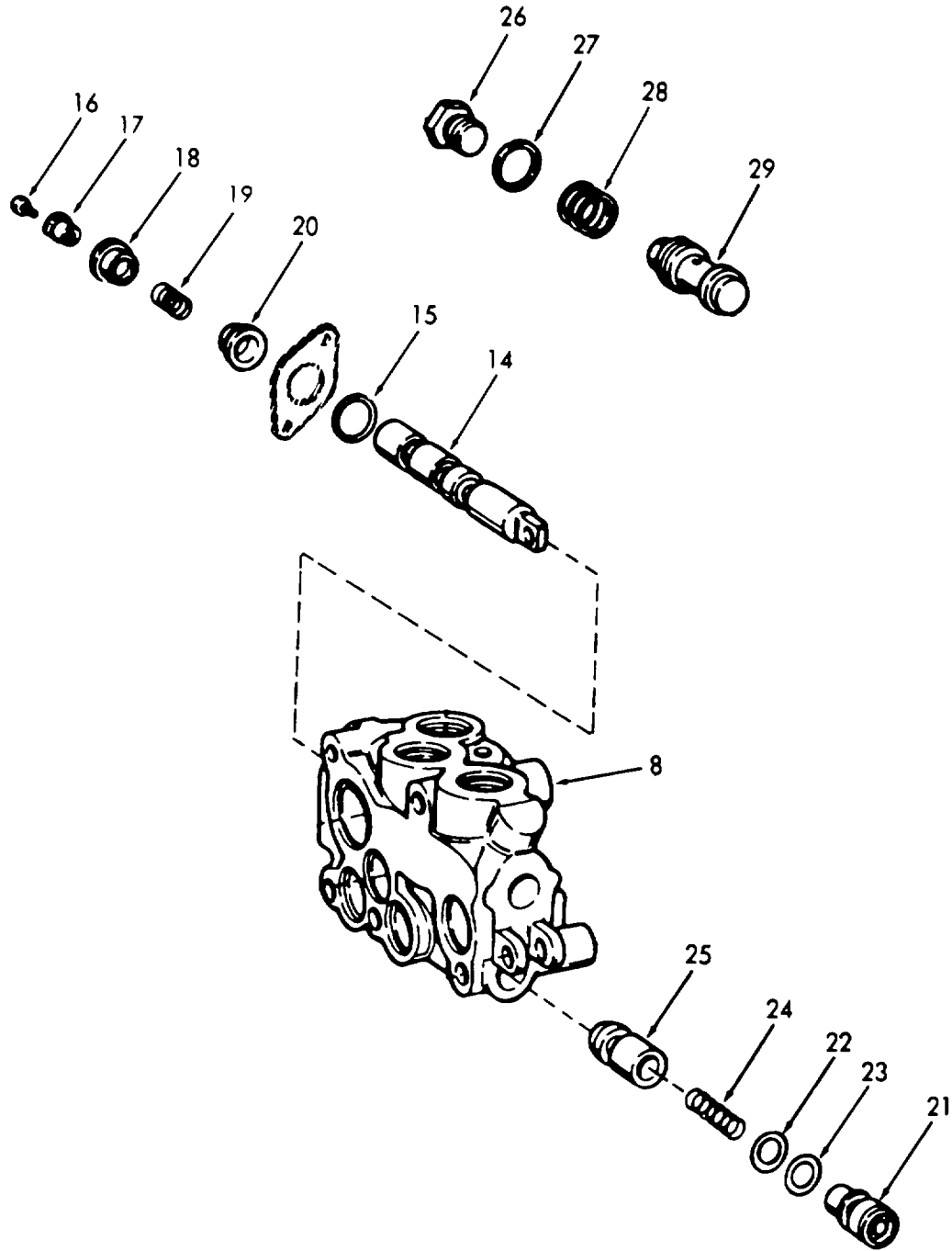
5-6.2. RAMP HOIST CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
e.	<p>Operating Spool.</p> <p>Slide spool (14) out of its bore from the cap end, and remove the preformed packing (15) from around the spool bore.</p>	<p>Do not remove screw (16), guide (17), retainer (18), spring (19), or retainer (20), unless it is necessary to replace them.</p>
f.	<p>Check Valve.</p> <p>(1) Grip stem of check valve plug (21) with pliers, and pull it out of valve body (8).</p> <p>(2) Remove preformed packing (22), and backup ring (23).</p> <p>(3) Remove spring (24), and poppet (25) from valve body (8).</p>	
g.	<p>Relief Valve Sub-Assembly.</p> <p>(1) Screw out plug (26) which retains the relief valve, and remove preformed packing (27) from plug.</p> <p>(2) Remove the spring (28), and the relief valve sub-assembly (29).</p>	

5-6.2. RAMP HOIST CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



5-6.2. RAMP HOIST CONTROL VALVE (Continued),

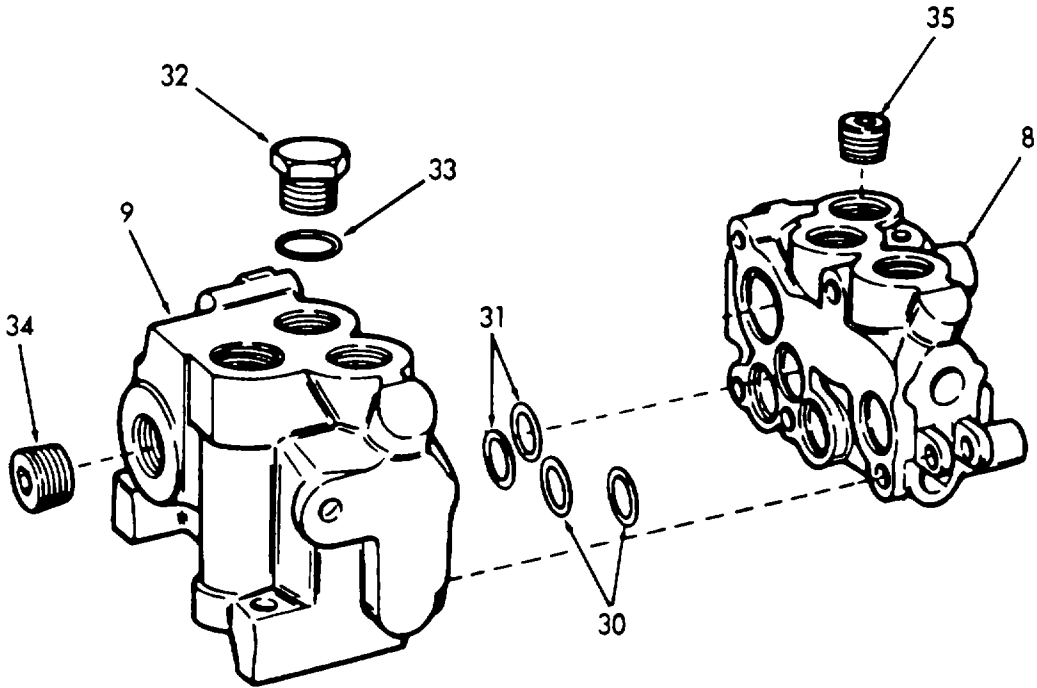
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- h. Valve Body.
 - (1) Remove preformed packings (30 and 31) from valve body (8).
 - (2) Remove plug (32), and preformed packing (33) from the blocked cylinder port.
 - (3) If alternate discharge port is plugged, it's not necessary to remove plug (34) unless body (9) is to be replaced.
 - (4) Remove plug (35) from body (8).

Used on models with a single-acting spool only.

- i. Discard all old seals.



5-6.2. RAMP HOIST CONTROL VALVE (Continued).

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

CLEANING

- | | | |
|----|--|--|
| 3. | Wash all parts in a clean mineral oil solvent, and place on a clean surface. | |
|----|--|--|

INSPECTION

- | | | |
|----|--|--|
| 4. | <ul style="list-style-type: none"> a. Inspect mating surfaces of valve bodies for paint or burrs. b. Inspect valve spools and bores for scoring or burrs. c. Inspect valve spool for freedom of movement in bore. d. Inspect relief valve for smooth movement in its bore. | |
|----|--|--|

REPAIR

- | | | |
|----|---|--|
| 5. | <ul style="list-style-type: none"> a. Remove scoring and burrs from valve spools or bores, using crocus cloth. b. Remove other burrs by light stoning, or lapping. c. Replace valve sections with a new one if scored. d. Replace other defective parts as necessary. | |
|----|---|--|

5-6.2. RAMP HOIST CONTROL VALVE (Continued).

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

REASSEMBLY**NOTE**

Coat all parts with clean hydraulic oil to facilitate reassembly, and provide initial lubrication. Petroleum jelly can be used to hold packings in place on assembly.

6. Control Valve	<p>a. Valve Body</p> <p>(1) Install plug (35) in inlet body (8).</p> <p>(2) Install preformed packing (33), and plug (32). only.</p> <p>(3) Install preformed packings (31 and 30) in valve body (8).</p> <p>b. Relief Valve Sub-Assembly.</p> <p>(1) Place relief valve sub-assembly (29) in its bore; hex nut ends towards the opening.</p> <p>(2) Install spring (28) in relief valve subassembly (29).</p> <p>(3) Install preformed packing (27) on plug (26), install plug and tighten securely.</p> <p>c. Check Valve.</p> <p>(1) Install poppet (25) and spring (24).</p>	<p><u>DO NOT</u> over-tighten plug.</p> <p>Used on models with a single-acting spool</p> <p><u>DO NOT</u> over-tighten plug.</p>
------------------	--	--

5-6.2. RAMP HOIST CONTROL VALVE (Continued).

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

REASSEMBLY (Cont)

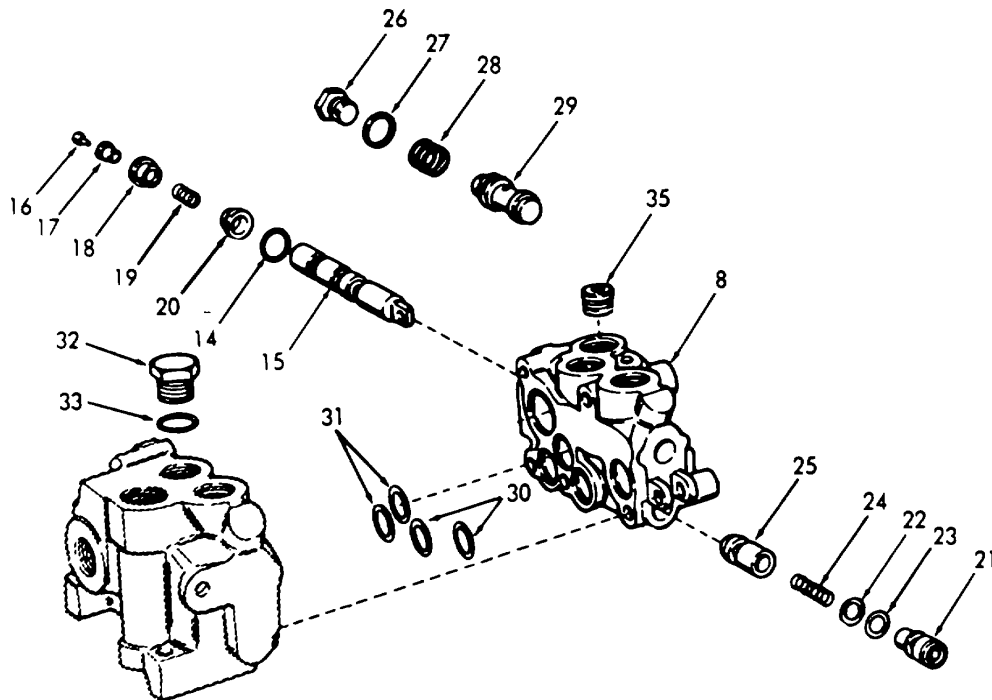
- (2) Install backup ring (23) and preformed packing (22) toward spring and poppet and install plug (21).

d. Operating Spool.

- (1) Install retainer (20), spring (19), retainer (18), guide (17), and screw (16).

If removed. Tighten screw (18) securely.

- (2) Install preformed packing (15) on operating spool (14).



5-6.2. RAMP HOIST CONTROL VALVE (Continued).

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

REASSEMBLY (Cont)

(3) Install preformed packings (13) in valve body (8).

(4) Install retainer (12).

Align flat retainer by shifting spool. Spool bind is an indication of flat retainer misalignment.

(5) Install end cap (11) using screws (10).

e. Attaching Parts.

CAUTION

Make sure all mating surfaces of valve bodies are free of burrs and paint.

(1) With mounting feet on a flat surface, carefully place valve sections (9 and 8 together.

Use petroleum jelly to hold the preformed packings (31, 30, and 13) in place in valve sections.

NOTE

The mounting feet must be maintained in a flat plane to prevent spool bind (due to body distortion) when the valve is mounted for operation.

5-6.2.

RAMP HOIST CONTROL VALVE (Continued).

LOCATION/ITEM

ACTION

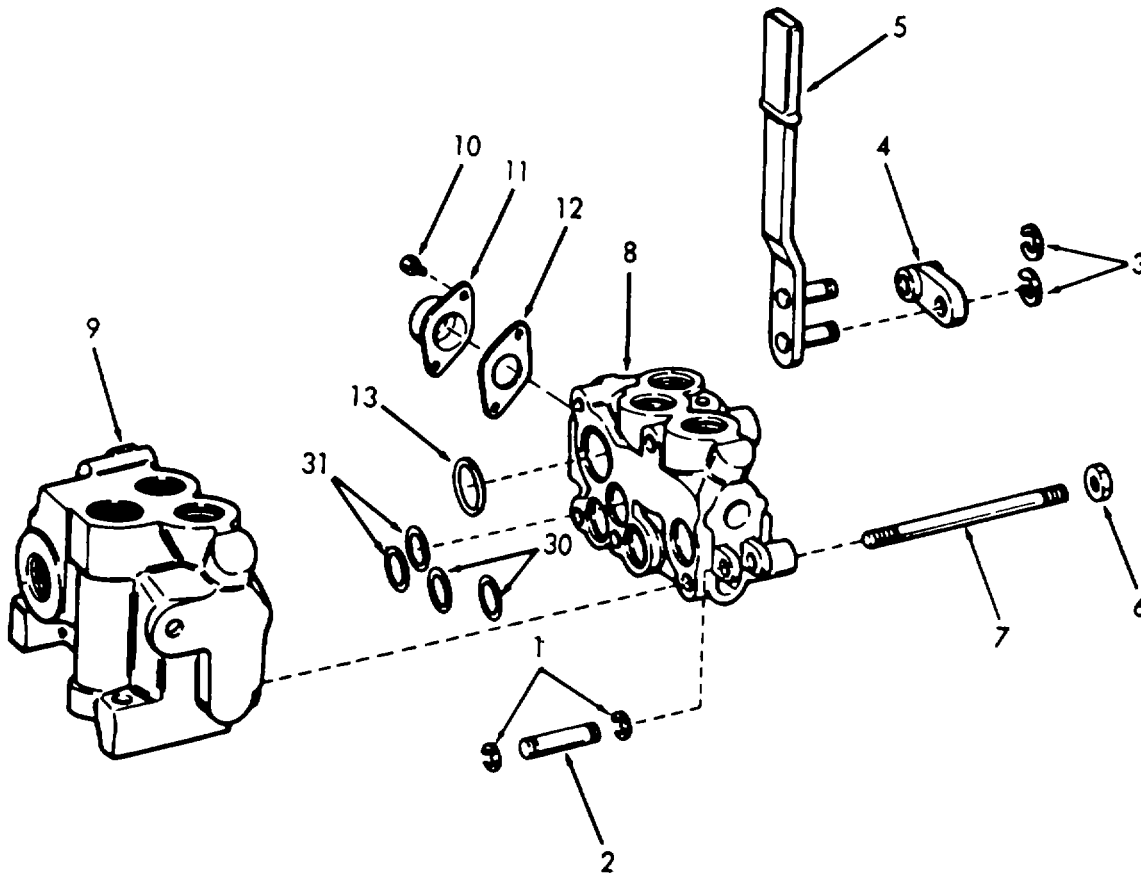
REMARKS

REASSEMBLY (Cont)

- (2) Install studs (7) and nuts (6).

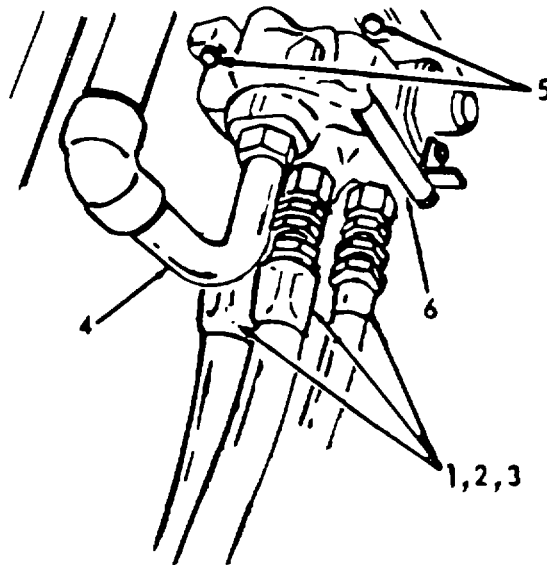
Install spacers to insure against spool bind when studs are tightened. Torque stud nuts to 45-50 lb. ft. (61.- 67.8 Nm)

- (3) Install levers (5), link (4), "E" rings (3), fulcrum rod (2), and "E" rings (1).



5-6.2. RAMP HOIST CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
INSTALLATION		
7. Control Valve	a. Position control valve (6) in place and secure with mounting bolts (5). b. Reconnect return line (4). c. Remove caps from hose connections and reconnect hoses (3, 2, and 1).	Remove tags.



5-6.3. RAMP HOIST COUNTERBALANCE VALVE.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | |
| b. Disassembly | e. Repair | g. Installation |
| c. Cleaning | f. Assembly | h. Adjustment |

INITIAL SETUP

Test Equipment

3000 PSI Pressure gage

References

NONE

Equipment

Condition Condition Description

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit

NSN 5180-00-629-9783

Special Environmental Conditions

NONE

Materials/Parts

Gaskets

Packing

Crocus cloths

Clean cloths

Cleaning solvent

Fed. Spec. P-D 680

Mineral oil solvent

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

LOCATION/ITEM

ACTION

REMARKS

REMOVAL

- | | |
|---|--|
| 1. Lines, Pipe Connections, and Winch Cable | a. The Landing craft has a double A SA2-185-B-IT-K44 counterbalance valve. |
|---|--|

5-6.3.

RAMP HOIST COUNTERBALANCE VALVE (Continued).

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

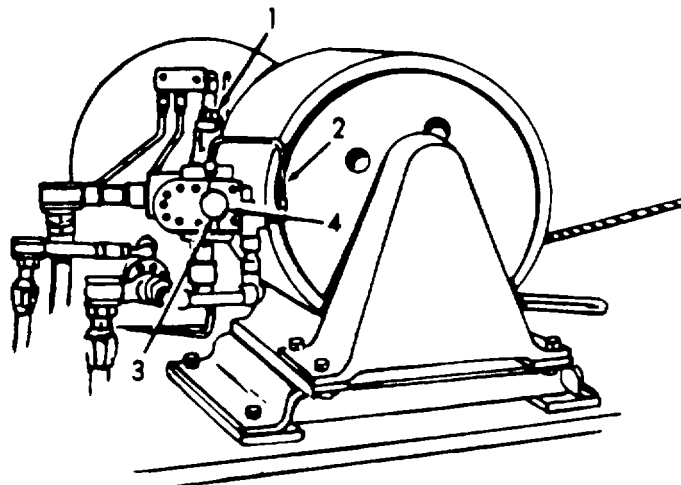
REMOVAL (Cont) |

- b. This bypass and check valve is used as an adjustable pressure bypass valve to maintain sufficient pressure in pump circuit for operation of the winch brake. It ensures positive control of the ramp lowering.

WARNING

The oil pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or equipment.

- (1) Disconnect cable from winch to remove load from system.
- (2) Open ball valve (1), and disconnect line (2).
- (3) Clean pipe connections (3), disconnect pipe from valve, and cap the open ends.
- (4) Remove counterbalance valve (4).



5-6.3. RAMP HOIST COUNTERBALANCE VALVE (Continued).

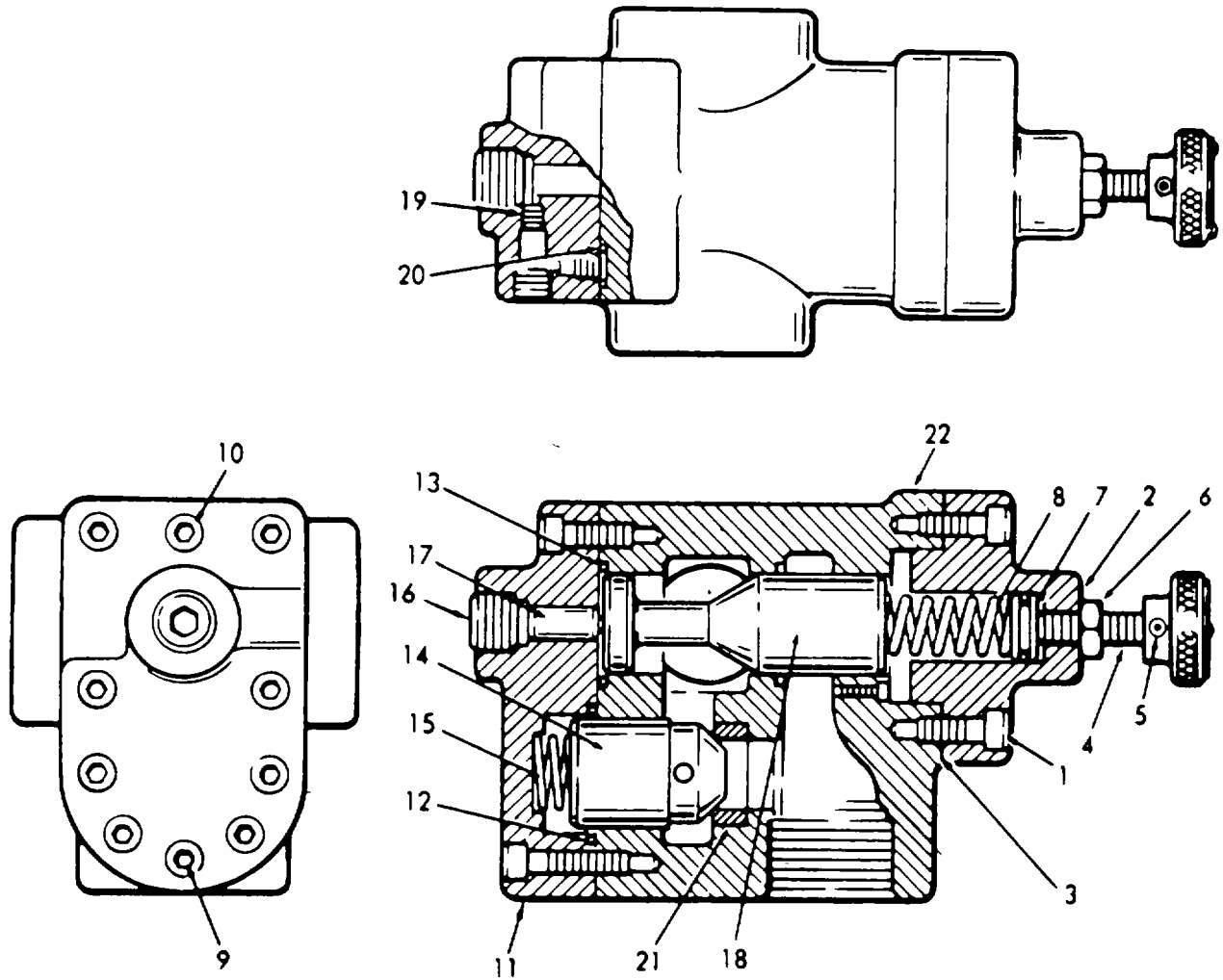
LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>		
2. Counter-balance Valve	<ul style="list-style-type: none"> a. Remove six socket head cap screws (1) from top cap. b. Remove top cap (2), and gasket (3). c. Remove adjusting screw (4), setscrew (5), and adjusting screw nut (6). d. Remove spring follower (7), and counterbalance valve spring (8). e. Remove seven socket head cap screws (9), and three socket head capscrews (10) from bottom cap (11). f. Remove bottom cap (11) from valve body. g. Remove packings (12 and 13). h. Remove flow control valve spool (14), and spring (15). i. Remove pipe plug (16), plunger (17), and valve spool (18). j. Remove orifice plug (19), and packing (20). k. Remove valve seat (21) from valve body (22). 	<p>If necessary.</p> <p>Discard.</p> <p>Discard packing.</p>

5-6.3.

RAMP HOIST COUNTERBALANCE VALVE (Continued).

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

DISASSEMBLY (Cont)



5-6.3. RAMP HOIST COUNTERBALANCE VALVE (Continued).

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

CLEANING

3. a. Clean counterbalance valve parts in mineral oil solvent, and place on a clean cloth.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°~~59~~°C).

- b. Clean exterior of counterbalance valve in cleaning solvent Federal Specification PD-680, and dry thoroughly.

INSPECTION

4. a. Inspect springs for loss of tension, distortion, or broken coils.
 b. Inspect valve spools, plunger, and spring follower for nicks, or burrs.
 c. Inspect valve spools, plunger, and spring follower for nicks, or burrs.

REPAIR

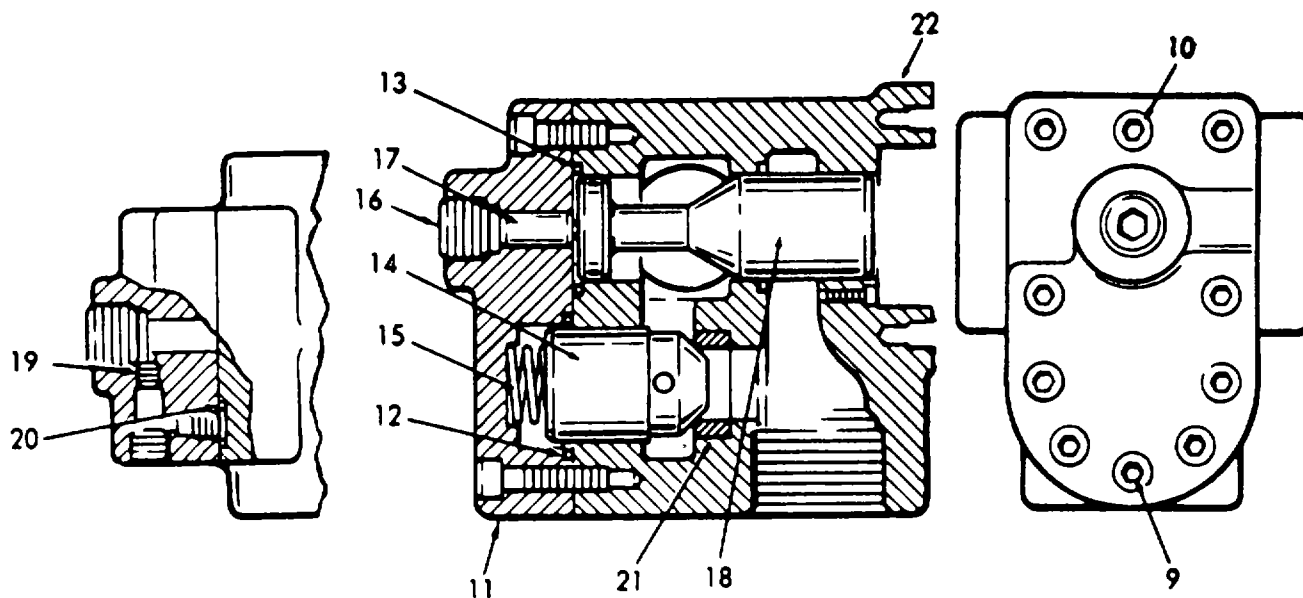
5. a. Replace all packings and gaskets.
 b. Replace other defective parts as required.
 c. Remove burrs or nicks using crocus cloth.

5-6.3. RAMP HOIST COUNTERBALANCE VALVE (Continued).

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

ASSEMBLY (Cont)

- | | | |
|--------------------------|---|--|
| 6. Counter-balance Valve | <ul style="list-style-type: none"> a. Install valve seat (21) in body (22). b. Install packing (20) over orifice plug, and install plug (19). c. Install valve spool (18), plunger (17), and pipe plug (16). d. Install spring (15), and flow control valve spool (14). e. Install packings (13 and 12) into valve body (22). f. Position bottom cap (11) in place on valve body (22) and secure with three socket cap screws (10), and seven socket head cap screws (9). | |
|--------------------------|---|--|

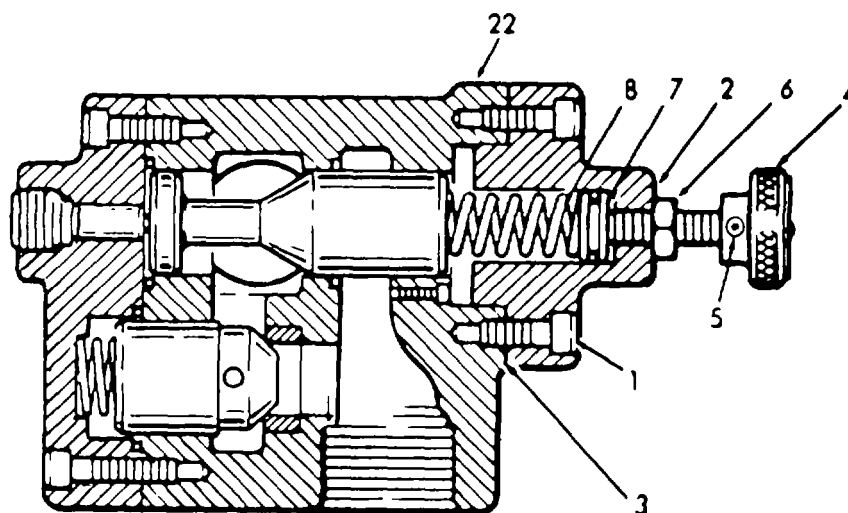


5-6.3. RAMP HOIST COUNTERBALANCE VALVE (Continued).

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

ASSEMBLY (Cont)

- g. Install counterbalance valve spring (8), and spring follower (7).
- h. Install adjusting screw nut (6) on adjusting screw (4), and secure with setscrew (5). Install adjusting screw (4).
- i. Position new gasket (3) in place on valve body (22), and install top cap (2) using six socket head cap screws (1).



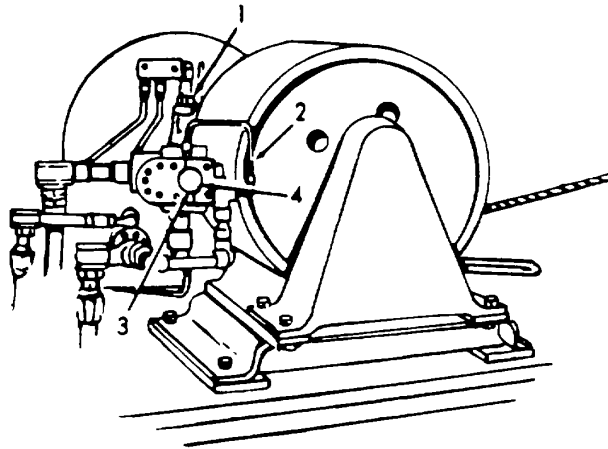
INSTALLATION

- 7. Lines, Pipe Connections, and Winch Cable
 - a. Position counterbalance valve (4) in place.
 - b. Remove caps (3) from open ends.
 - c. Reconnect line (2).
 - d. Close ball valve (1).

5-6.3. RAMP HOIST COUNTERBALANCE VALVE (Continued).

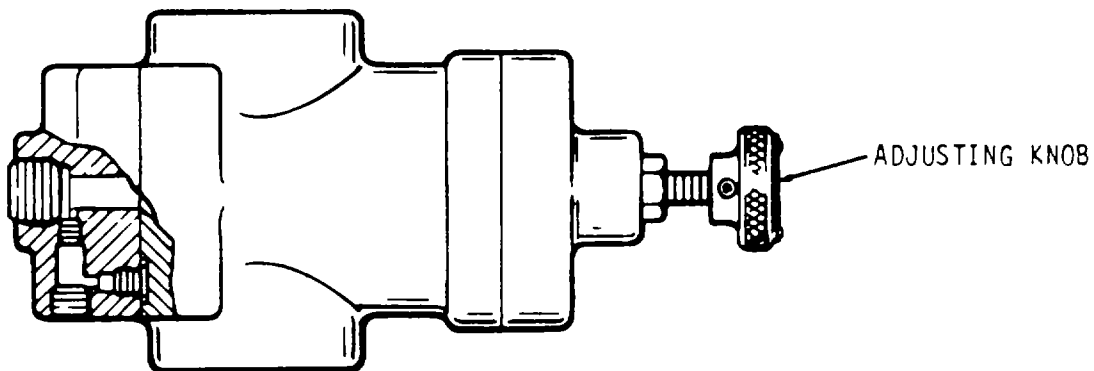
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

INSTALLATION (Cont)



ADJUSTMENT

- | | |
|-------------------------|--|
| 8. Counterbalance valve | <ul style="list-style-type: none"> a. Disconnect cable from winch to remove load from system. b. Install 3000 psi pressure gage, with shutoff valve, in system at tee fitting or port in counterbalance valve. c. Place control valve in position for lowering pump. d. Adjust knob on top of valve until system pressure is 300 psi. A pilot pressure of 300 psi will open the counterbalance valve and allow the ramp to be lowered. |
|-------------------------|--|



5-6.4. RAMP HOIST RELIEF VALVE

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | |
| b. Disassembly | e. Repair | g. Installation |
| c. Cleaning | f. Assembly | h. Adjustment |
-

INITIAL SETUP

Test Equipment

3000 PSI Pressure gage

References

NONE

Special Tools

NONE

Equipment

Condition Condition Description

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions

NONE

Materials/Parts

Packing
Clean cloths
Cleaning solvent
Fed. Spec P-D-680

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

5-6.4. RAMP HOIST RELIEF VALVE (Continued).

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

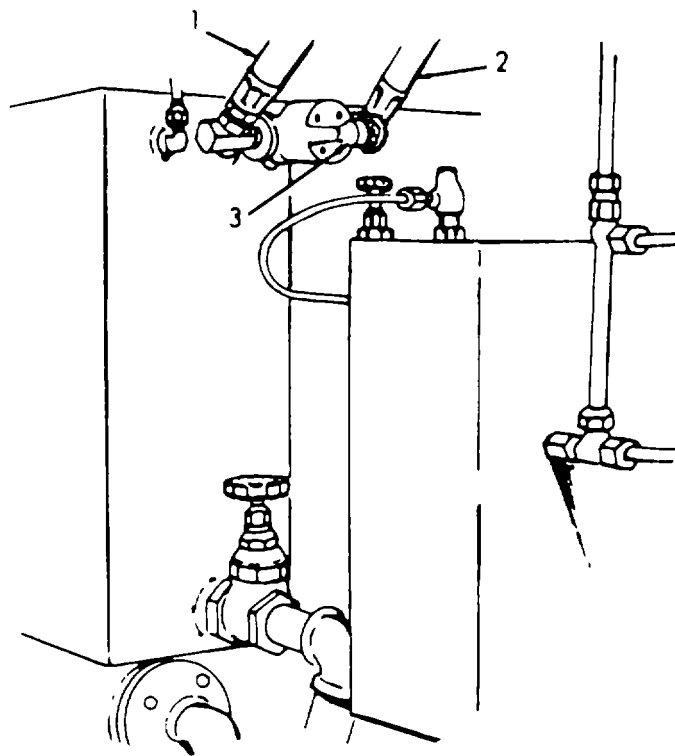
REMOVAL

- | | | |
|---------------------|--|--|
| 1. Hose Connections | <p>a. The main system relief valve is used for system protection. It has an operating range of 1500 to 3000 psi, but is normally adjusted to 2000 psi.</p> <p>b. Clean hose connections.</p> | |
|---------------------|--|--|

WARNING

The oil pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or equipment.

- | | |
|--|----------------|
| <p>c. Disconnect hoses (1 and 2).</p> <p>d. Remove relief valve (3).</p> | Cap open ends. |
|--|----------------|



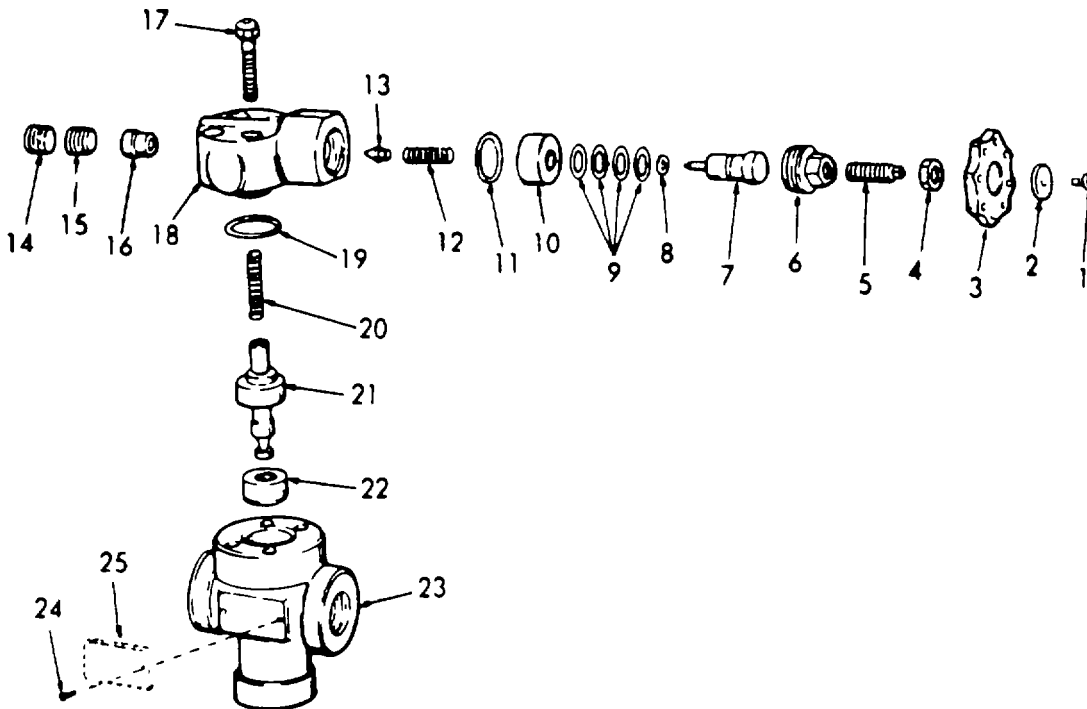
5-6.4. RAMP HOIST RELIEF VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>		
2. Relief Valve	a. Remove screw (1), plate (2) and knob (3) from adjusting screw (5).	
	b. Unscrew adjusting screw (5) from retainer (6).	Remove adjusting nut (4) from screw (5) if damaged.
	c. Unscrew retainer(6) from valve cover (18).	
	d. Remove plunger (7); then remove packing (8) from plunger.	Discard packing.
	e. Remove spacers (9), bushing (10), preformed packing (11), spring (12), and piston (13).	Discard packing.
	f. Unscrew plugs (14 and 15) from cover (18) and remove seat (16).	
	g. Remove four self-locking screws (17), and separate cover (18) from body (23).	
	h. Remove seal (19), spring (20), piston (21), and seat (22).	
	i. Remove self-locking screws (24), and remove nameplate (25) if damaged or illegible.	Discard seal.

5-6.4. RAMP HOIST RELIEF VALVE (Continued).

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

DISASSEMBLY (Cont)



CLEANING

3.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°-59°C).

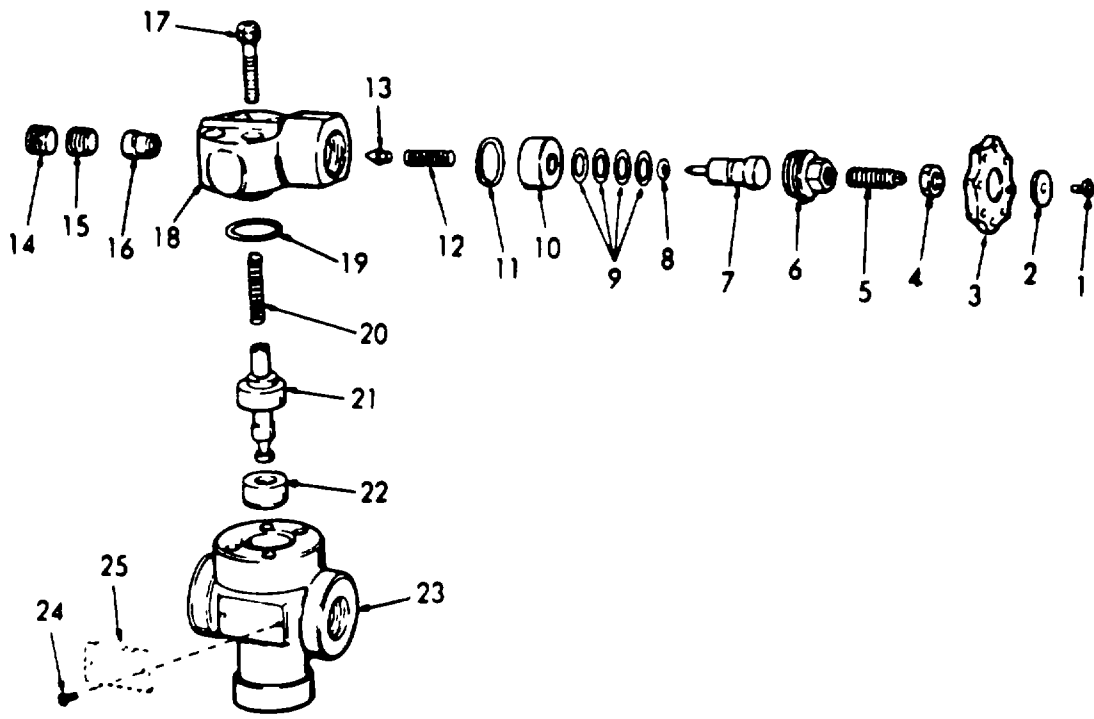
Clean all metal parts in solvent and dry thoroughly.

5-6.4. RAMP HOIST RELIEF VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSPECTION</u>		
4.	<ul style="list-style-type: none"> a. Inspect spring for distortion, loss of tension, or broken coils. b. Inspect threaded parts for thread damage. c. Inspect pistons, seals, plunger, and bushing for nicks or burrs. 	
<u>REPAIR</u>		
5.	<ul style="list-style-type: none"> a. Remove burrs or nicks using crocus cloth. b. Replace all packings and seals. c. Replace other damaged or defective parts as necessary. 	
<u>ASSEMBLY</u>		
6. Relief Valve	<ul style="list-style-type: none"> a. Install nameplate (25) to body (23) with self-locking screws (24). b. Install seat (22), piston (21), spring (20), and seal (19). c. Install seat (16), and plugs (15 and 14) in cover (18). d. Secure cover (18) to body (23) with four self-locking screws (17). 	If removed.

5-6.4. RAMP HOIST RELIEF VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
ASSEMBLY (Cont)		
e. Install piston (13), spring (12), preformed packing (11), bushing (10), and spacers (9).		Use new packing.
f. Install packing (8) over small end of plunger (7). Install plunger and secure by screwing retainer (6) into cover (18).		Use new packing.
g. Install adjusting screw (5) into retainer (6).		First, install adjusting nut (4) onto adjusting screw (5) if removed.
h. Install knob (3), plate (2), and screw (1).		



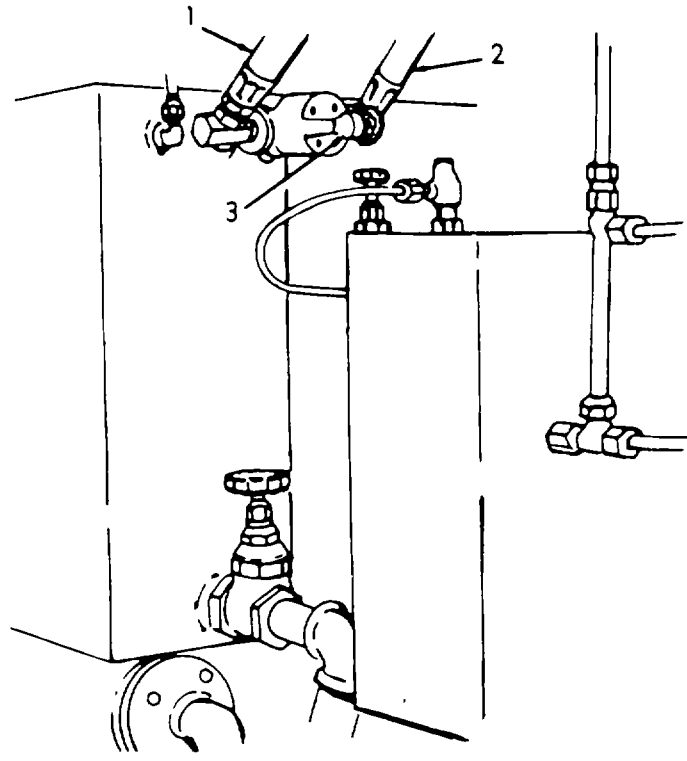
5-6.4. RAMP HOIST RELIEF VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION</u>		
7. Relief Valve	<ul style="list-style-type: none"> a. Install relief valve (3). b. Reconnect hoses (2 and 1). 	
<u>ADJUSTMENT</u>		
8.	<ul style="list-style-type: none"> a. Install 3,000 psi pressure gage, with shutoff valve, in system at tee fitting or port in relief valve. b. Wrap several turns of heavy manila rope around winch drum, and belay running end to prevent operation of winch. c. Slowly open control valve to fully open position, and check indication on test gage. Pressure should be no greater than 2,000 psi. d. Adjust pressure, if necessary, by rotating adjusting screw on relief valve. Turn screw in (clockwise) to increase pressure; turn out (counter-clockwise) to decrease pressure. e. Close shutoff valve at test gage to prevent rapid and sudden changes from damaging gage. 	

5-6.4. RAMP HOIST RELIEF VALVE (Continued).

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

ADJUSTMENT (Cont)



5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | f. Assembly |
| b. Disassembly | e. Repair | g. Installation |
| c. Cleaning | | |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

Equipment
Condition Condition Description

NONE

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Special Environmental Conditions
NONE

Materials/Parts
Packing
Clean' cloth
Cleaning solvent
Fed. Spec. P-D-680

General Safety Instructions

Personnel Required

MOS 61C10

Observe WARNING in-procedure.

LOCATION/ITEM

ACTION

REMARKS

WARNING

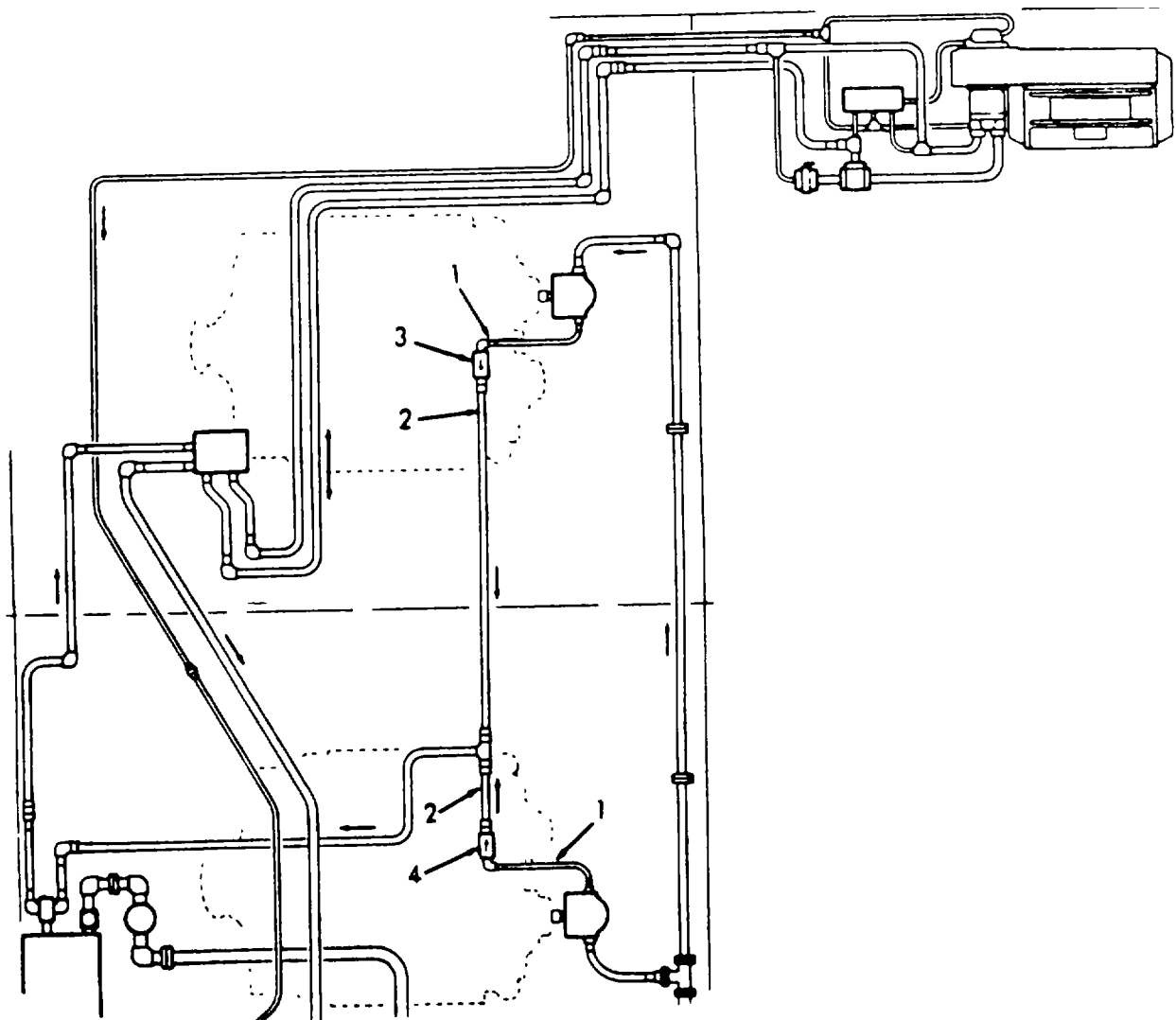
The oil pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or equipment.

5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE (Continued).

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

REMOVAL

- | | | |
|----------|---|----------------|
| 1. Lines | <ul style="list-style-type: none"> a. Clean line connections. b. Remove inlet line (1) and outlet line (2) from check valve (3). c. Remove check valve (3). d. Remove other check valve (4) in the same manner. | Cap open ends. |
|----------|---|----------------|

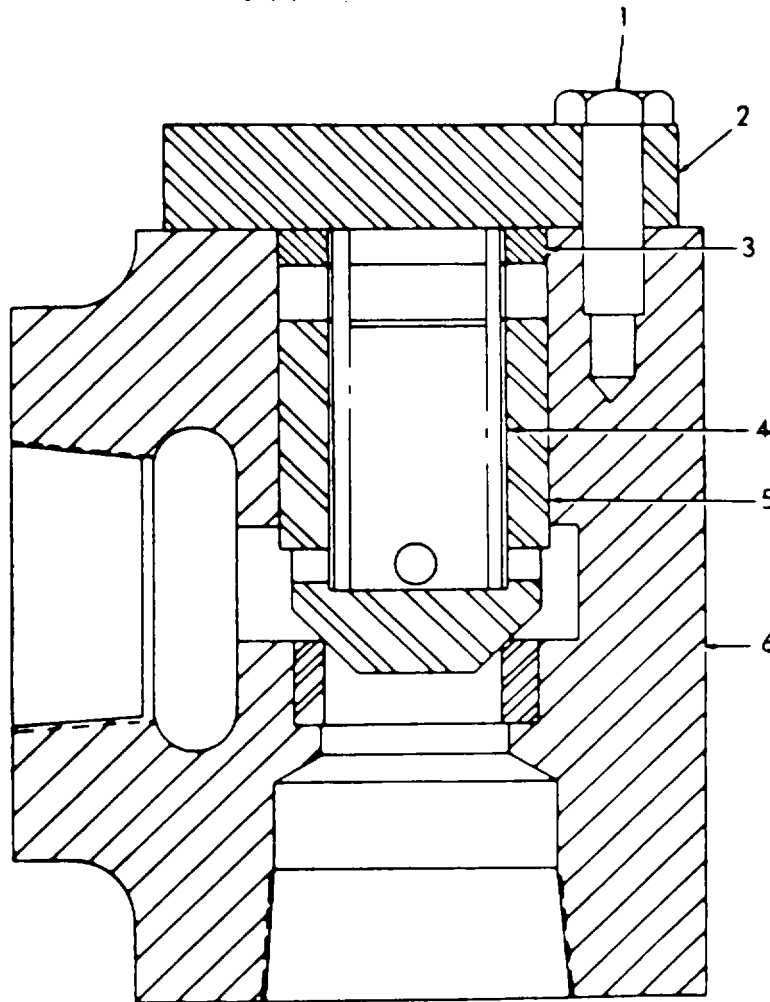


5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE (Continued).

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

DISASSEMBLY

- | | | |
|----------|--|------------------|
| 2. Check | <ul style="list-style-type: none"> a. Remove screws (1) from cap (2) and remove cap. b. Remove preformed packing (3). c. Remove spool spring (4) and oil control spool (5) from valve body (6). | Discard packing. |
|----------|--|------------------|



5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE (Continued).

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

CLEANING

3.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°-59°C).

Clean all metal parts in solvent and dry thoroughly.

REPAIR

4.

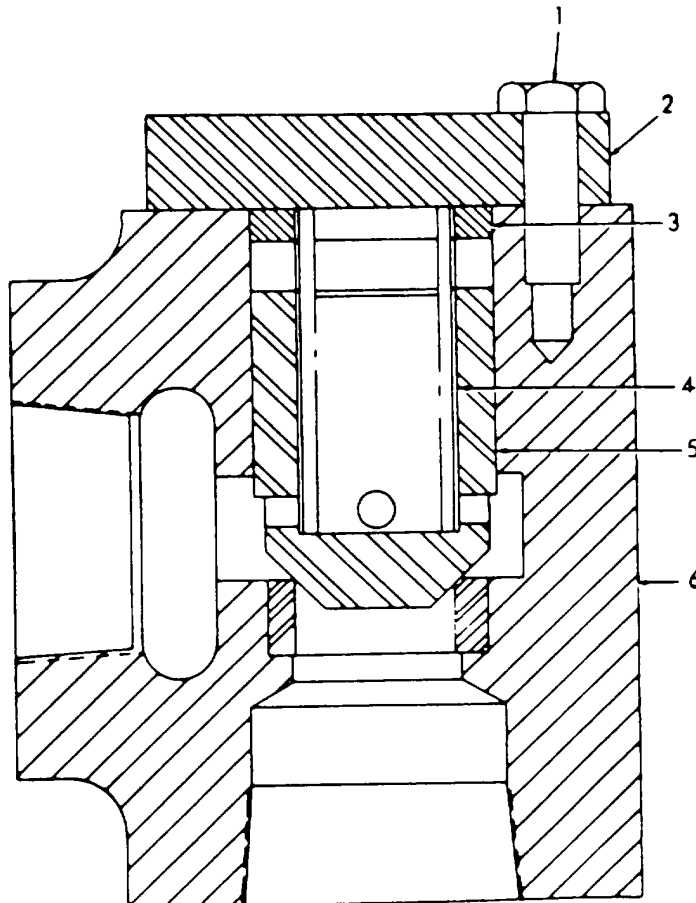
- a. Replace packing.
- b. Remove burrs or nicks from spool with crocus cloth.
- c. If other parts are defective or damaged, replace valve.

5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE (Continued).

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

ASSEMBLY

- | | | |
|----------------|--|------------------|
| 5. Check Valve | a. Install oil control spool (5) and spool spring (4) in valve body (6). | |
| | b. Install preformed packing (3). | Use new packing. |
| | c. Secure cap (2) to body, using screws (1), and tighten. | |

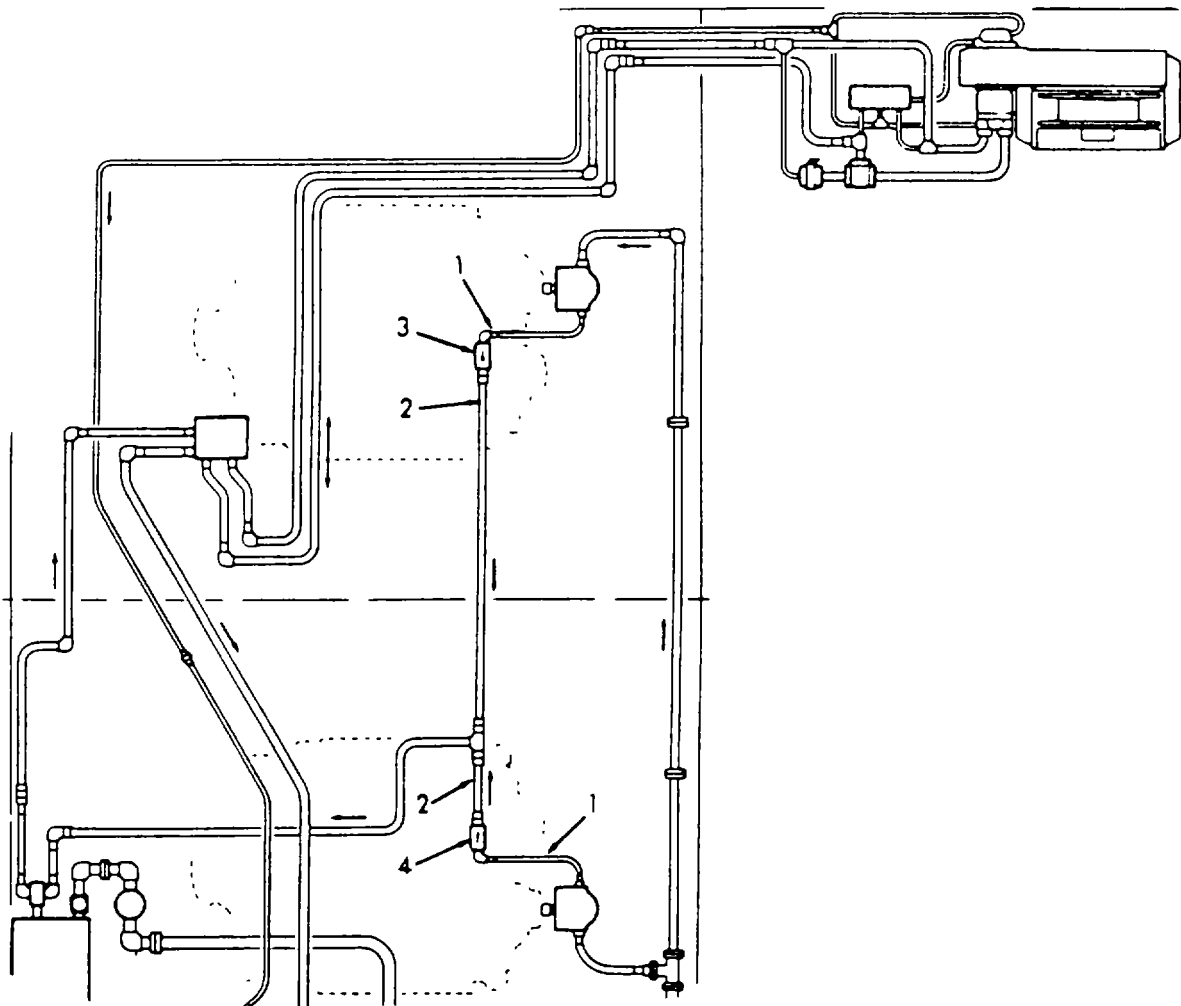


5-6.5. RAMP HOIST HYDRAULIC CHECK VALVE (Continued).

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

INSTALLATION

- | | | |
|----------------|---|--|
| 6. Check Valve | <p>a. Position check valve (3) in place and install inlet and outlet lines (1 and 2).</p> <p>b. Install other check valve (4) in the same manner.</p> | |
|----------------|---|--|



5-7. HYDRAULIC STEERING SYSTEM.

GENERAL

a. See figures 5-5 for diagram of steering system.

b. The hydraulic steering systems use medium pressure hydraulic fluid to actuate cylinders which position the rudders. Fluid is supplied by the hydraulic pumps to the helm unit which is the principal metering and directional controlling device. By directing hydraulic fluid to one side or the other of the cylinders, they will extend or retract, giving the desired position to the rudders.

c. The helm unit and other valves control the direction and volume of flow of hydraulic fluid. The relief valve protects the system by limiting hydraulic fluid pressure. The flow control valve (flow divider) limits the volume of fluid to the valve at which this system is designed to work. The flow control valve (flow divider) divides the fluid supplied into two flows (2.5 gpm) to the helm unit, and the remainder returned to the storage tank.

NOTE

- The steering system is designed to be supplied by one pump. Using both pumps will only cause a doubled bypass flow resulting in excessive heating of fluid. The steering system pump discharge valves should be set with one valve open and one valve closed.

5-7. HYDRAULIC STEERING SYSTEM. (Continued).

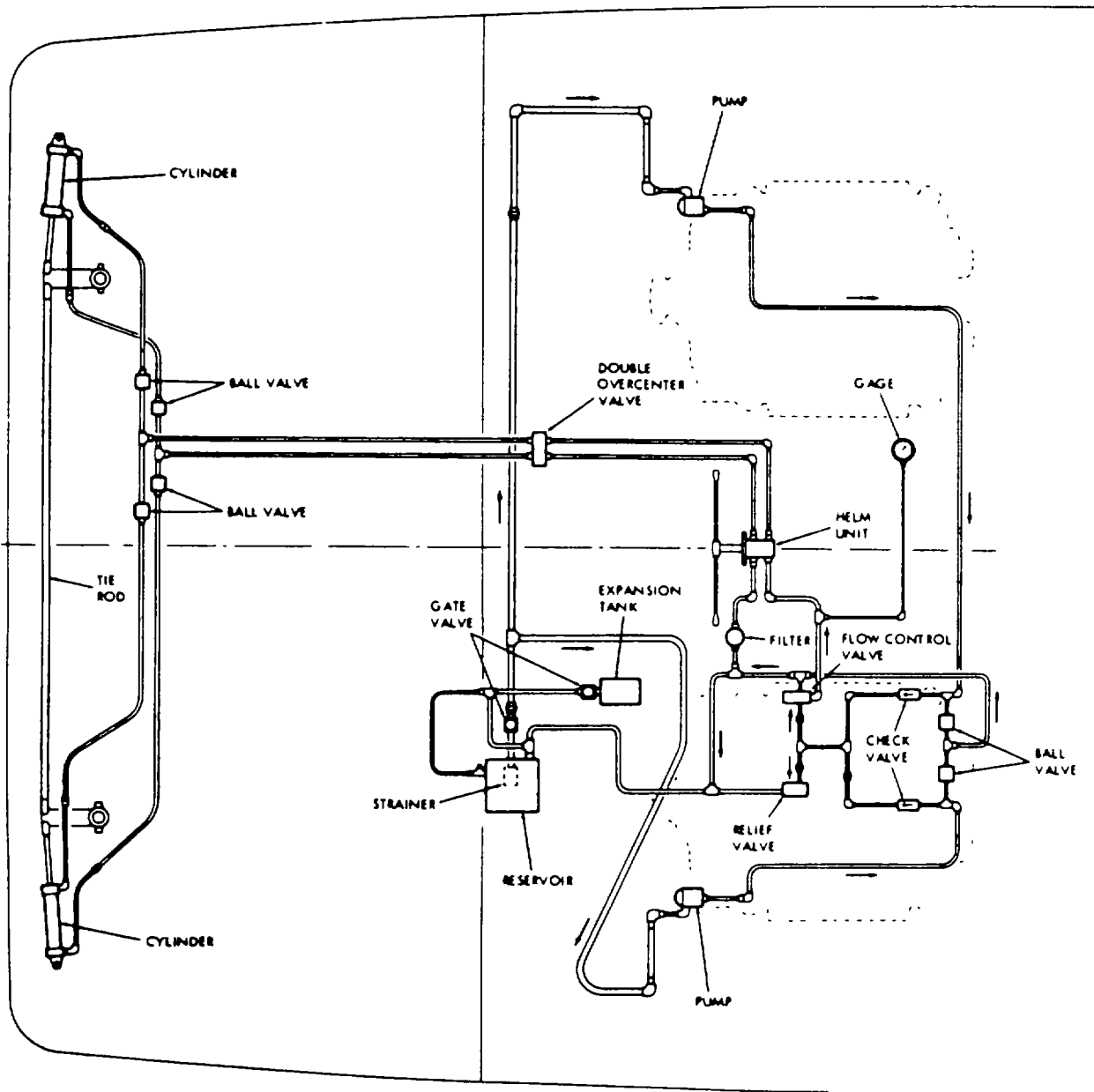


Figure 5-2. Hydraulic Steering System Diagram

5-7. HYDRAULIC STEERING SYSTEM (Continued).

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

GENERAL (Cont)

NOTE

The hydraulic fluid for this system should be a high grade fluid compounded for use in a hydraulic system. The recommended fluids are 2135 TH. , MIL-17672B; and 2075 TH. , MIL-17672B.

- d. The following is an index of the maintenance instructions.

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Hydraulic Steering Pump	5-7.1
Hydraulic Pump Drive	5-7.2
Steering Cylinders	5-7.3
Steering System Helm Unit	5-7.4
Steering System Overcenter Valve	5-7.5
Steering System Relief Valve	5-7.6
Steering System Flow Control Valve	5-7.7

5-7.1. HYDRAULIC STEERING PUMP.

Steering system pumps are mounted aft on the outboard engine of each propulsion unit. Pumps mounted on the starboard propulsion unit are left-hand rotating as viewed from the shaft end of the pump. Pumps for the port propulsion unit are right-hand rotating. The pump made for the left-hand rotation is identified by an "L" in the model code.

NOTE

Pumps must be driven in the direction of the arrows cast on the pump ring. If it is desired to change the direction of drive rotation, it is necessary to reverse the ring.

This task covers:

- | | |
|------------|-----------------|
| a. Removal | b. Installation |
|------------|-----------------|

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts

Clean cloths

Personnel Required

MOS 61C10

References

NONE

Equipment

Condition Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING in procedure

5-7.1. HYDRAULIC STEERING PUMP.(Continued)

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

REMOVAL

1. Hydraulic Pump

WARNING

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

- | | |
|--|------------------------|
| a. Remove inlet and outlet hose connections (1 and 2) and cap open ends after disconnecting. | Clean hose connections |
| b. Remove two bolts (3) securing steering pump (4) to adapter on engine. | |
| c. Remove steering pump (4). | |

5-7.1. HYDRAULIC STEERING PUMP.(Continued)

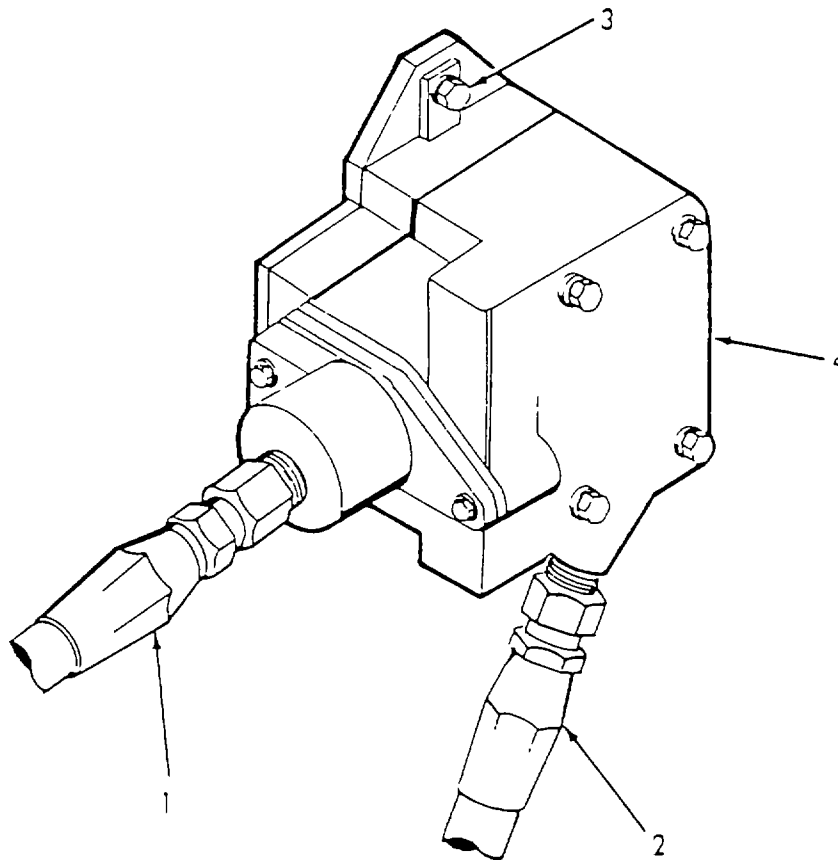
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

INSTALLATION

2. Hydraulic Pump

- a. Position (4) in place on adapter.
- b. Secure with two mounting bolts (3).
- c. Reconnect inlet and outlet hose connections (1 and 2) ends

Remove caps from open



5-7.2. HYDRAULIC PUMP DRIVE.

This task covers:

- a. Removal b. Replacement c. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

<u>Equipment</u>	
<u>Condition</u>	<u>Condition Description</u>
Paragraph	
5-7.1	Hydraulic Steering Pump Removed

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

5-7.2. HYDRAULIC PUMP DRIVE (Continued).

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

REMOVAL**WARNING**

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

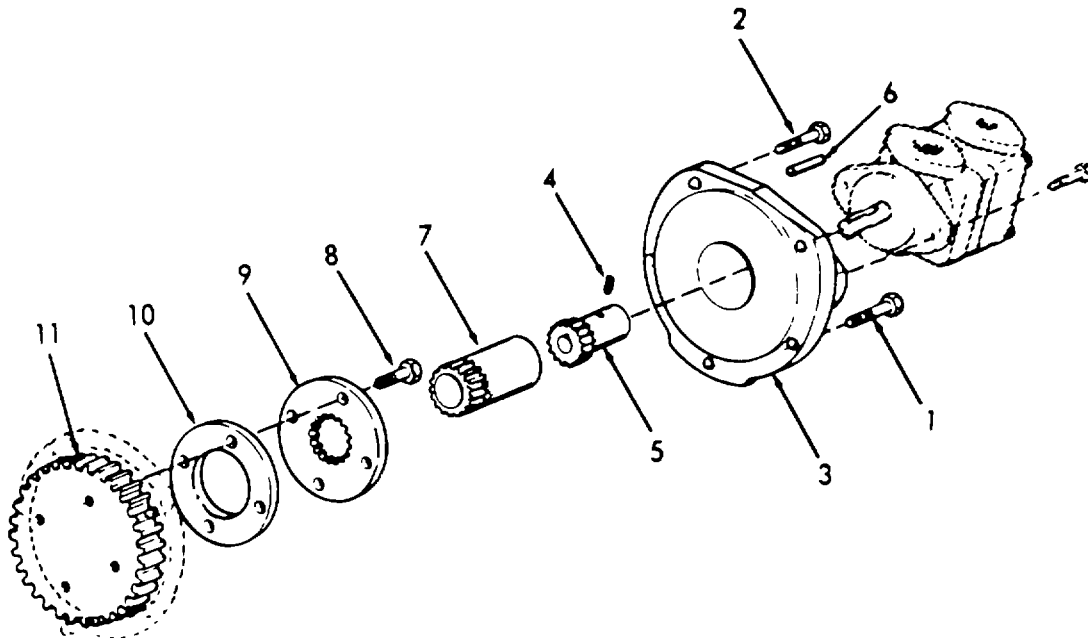
- | | | |
|---------------------------|---|--|
| 1. Drive Adapter Assembly | <ul style="list-style-type: none"> a. Remove one 1/2 x 13 inch bolt (1), and four 7/16 x 14 inch bolts (2) from pump drive adapter pad. b. Remove pump drive adapter pad (3). c. Loosen setscrew (4) in pump drive adapter gear (5). d. Remove pump drive adapter gear (5) from pump shaft and remove key (6) from shaft. e. Remove coupling (7) from plate (9). f. Remove four bolts (8) securing plate (9), and spacer (10) to camshaft or balance shaft gear (11). g. Remove plate (9) and spacer (10). | |
|---------------------------|---|--|

REPLACEMENT

- | | | |
|----|-------------------------------|--|
| 2. | Replace defective pump drive. | |
|----|-------------------------------|--|

5-7.2. HYDRAULIC PUMP DRIVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
INSTALLATION		
3.	a. Install spacer (10) and plate (9) to camshaft or balance shaft gear (11) with four bolts (8).	
	b. Install coupling (7) in plate.	
	c. Install key (6) in pump shaft.	
	d. Install pump drive adapter gear (5) and tighten setscrew (4).	Install set-screw if removed.
	e. Secure pump drive adapter pad (3) to flywheel housing with four 1/2x13 inch bolts (2) and one 7/16x14 inch bolt (1).	
	f. Install steering pump.	Refer to paragraph 5-7.1.



5-7.3. STEERING CYLINDERS.

Steering cylinders are mounted in the lazarette with the rod ends attached to rudder post arms. There are two ball valves in the lazarette for each cylinder. The valves can be closed to isolate a cylinder in case of failure.

This task covers:

- a. Removal
- b. Replacement
- c. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

Equipment
Condition Condition Description

NONE

NONE

Tools

General Mechanics's Tool Kit
NSN 5180-00-629-~~7~~83

Materials/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required

General Safety Instructions

MOS 61C10

Observe WARNING in procedure

LOCATION/ITEM

ACTION

REMARKS

REMOVAL

- 1. Hose Connections
 - a. Close ball valves for cylinder being removed.

5-7.3. STEERING CYLINDERS. (Continued).

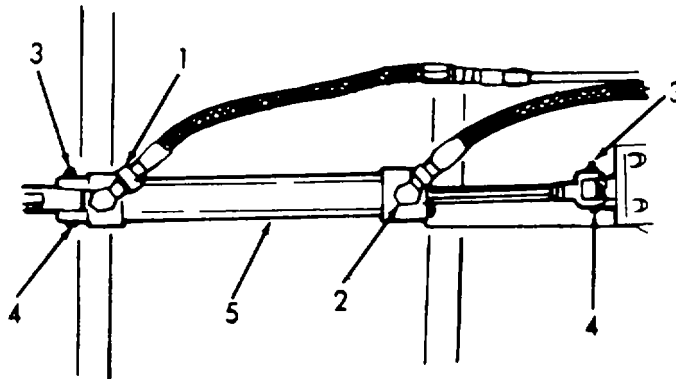
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

REMOVAL (Cont)

WARNING

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

	b. Disconnect cylinder hose connections (1 and 2).	Cap open ends.
2. Steering Cylinder	a. Remove retaining rings (3) from clevis pins (4).	
	b. Remove clevis pins (4) and remove cylinder (5).	

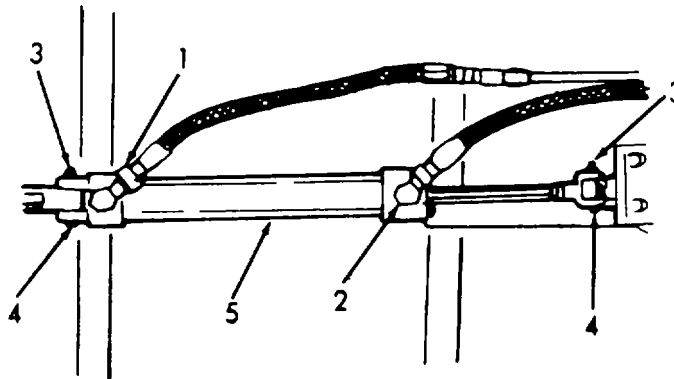


REPLACEMENT

3. Steering Cylinder	Replace defective steering cylinders.
----------------------	---------------------------------------

5-7.3. STEERING CYLINDERS. (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION</u>		
4. Steering Cylinder	a. Position steering cylinder (5) in place. b. Install clevis pins (4). c. Secure clevis pins with retaining rings (3).	
5. Hose Connections	a. Reconnect hose connections (2 and 1). b. Open ball valves for cylinder being installed.	Remove caps from hose ends..



5-126

5.7.4. STEERING SYSTEM HELM UNIT.

The helm unit and other valves control the direction and volume of flow of the hydraulic fluid in the steering system. The helm unit directs the fluid to one side or the other of the cylinders, and limits the flow according to the speed at which the steering wheel is turned. In the event of pump failure, the helm unit will also act as a pump when turned manually.

This task covers:

- a. Removal b. Replacement c. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

Equipment
Condition Condition Description

NONE

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts

Cleaning solvent
Fed. Spec. P-D-680
Clean cloths

Special Environmental Conditions
NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

5.7.4. STEERING SYSTEM HELM UNIT (Continued).

REMOVAL (Cont)

1. Steering Wheel and Access Covers
 - a. Remove capnut (1).
 - b. Remove steering wheel (2) and key (3).
 - c. Remove bolts securing access cover.
 - d. Remove access cover and cover gasket.

2. Helm, Control Unit

WARNING

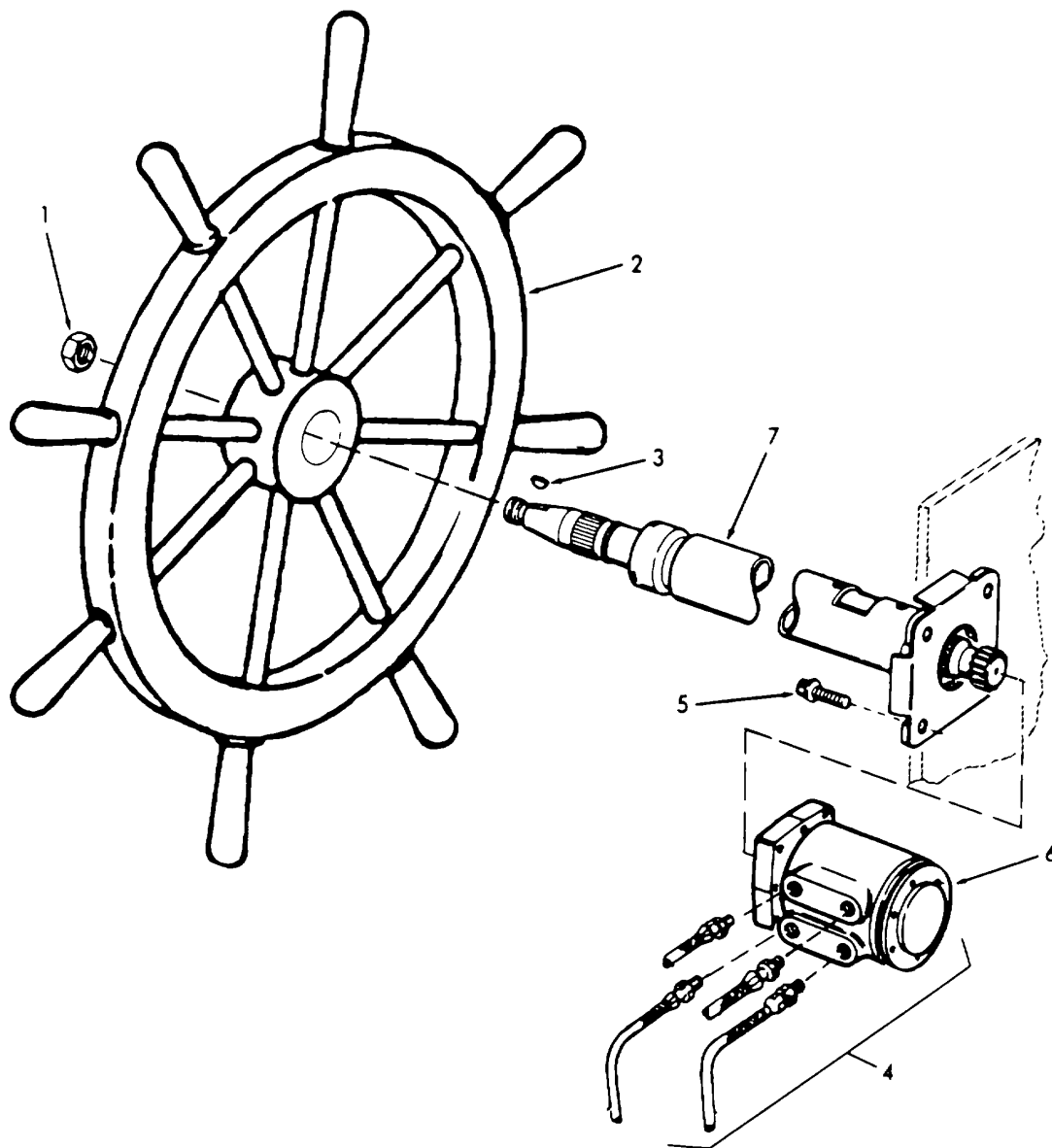
The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

- a. Disconnect the four tubes or Cap open ends. hoses (4) from helm unit.
- b. Remove four mounting bolts (5).
- c. Remove helm unit (6).
- d. Remove control unit (7).

REPLACEMENT

3. Helm, Control Unit
Replace defective helm unit or control unit.

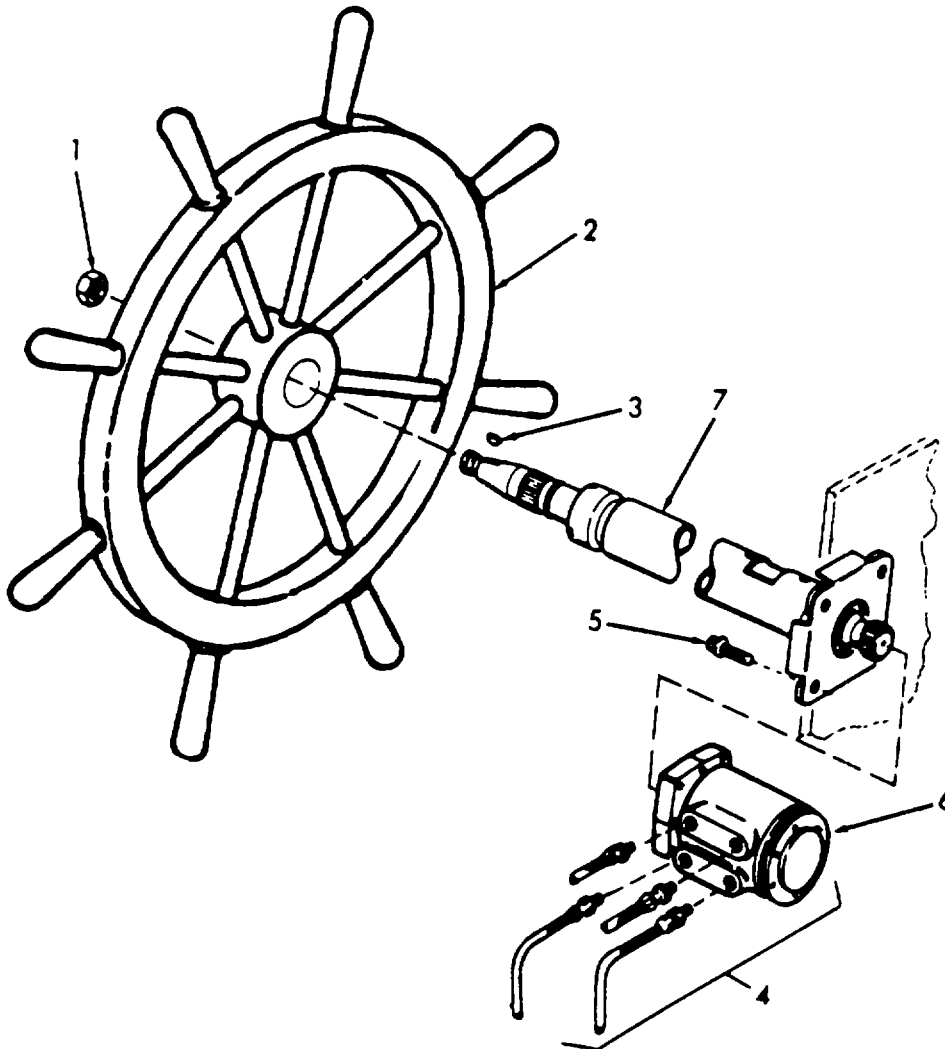
5.7.4. STEERING SYSTEM HELM UNIT (Continued).

REMOVAL (Cont)**INSTALLATION****NOTE**

Rotate control unit shaft while bringing surfaces into contact. This will allow splines on control unit and helm unit to engage.

5.7.4. STEERING SYSTEM HELM UNIT (Continued).

LOCATION/ITEM	ACTION	REMARKS
4. Helm, Control Unit	a. Install control unit (7) and helm unit (6) using bolts (5). b. Install tubes or hoses (4). c. Install key (3) and steering wheel (2). d. Install capnut (1). e. Replace access cover and gasket.	Torque bolts to 280 lb. in. (31.6 Nm).



5-7.5. STEERING SYSTEM OVERCENTER VALVE

This valve is located in the center of the engine room, near the aft bulkhead, just below the deck. It is connected into both lines between the helm unit and the steering system valves.

This task covers:

- | | | |
|------------|----------------|-----------------|
| a. Removal | b. Replacement | c. Installation |
|------------|----------------|-----------------|

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts
Clean cloths
Container

Special Environmental Conditions
NONE

Personnel Required
MOS 61C10

General Safety Instructions
NONE

5-7.5. STEERING SYSTEM OVERCENTER VALVE

REMOVAL

'WARNING

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

- | | | |
|---|---|--|
| 1. | Drain the hydraulic system to a level below the valve. | Use a suitable container. Cap open ends. |
| 2. Hose or Tube Connections and Over-Center Valve | a. Clean tube or hose connections.
b. Disconnect four tubes or hose connections (1, 2, 3 and 4).
c. Remove bolts (5) and lock-washers (6).
d. Remove overcenter valve (7). | |

REPLACEMENT

- | | |
|---------------------|-------------------------------------|
| 3. Overcenter Valve | Replace defective overcenter valve. |
|---------------------|-------------------------------------|

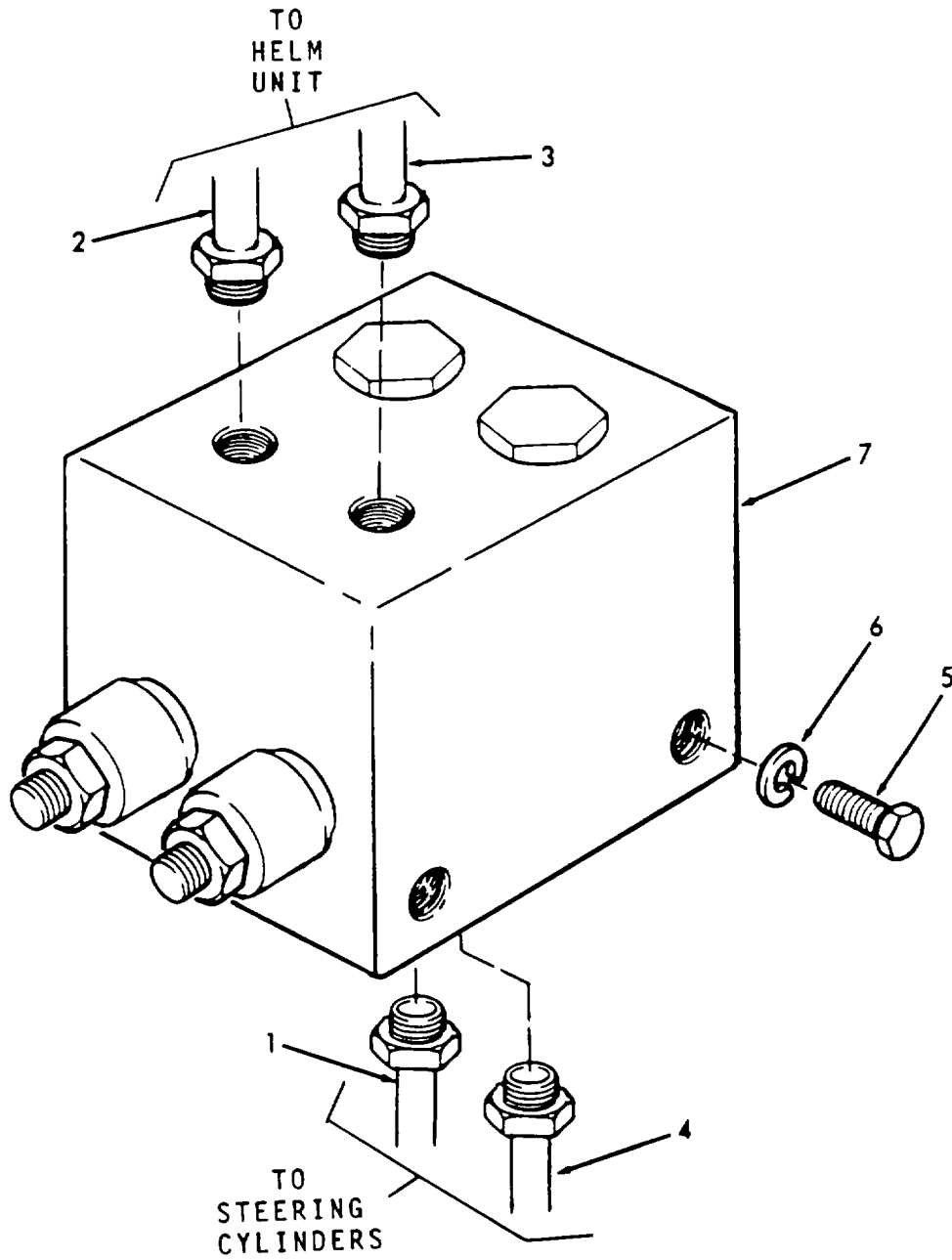
INSTALLATION

- | | |
|---------------------|---|
| 4. Overcenter Valve | a. Remove caps from open ends.
b. Install overcenter valve (7) using bolts (5) and lockwashers (6).
c. Reconnect tube or hose connections (1, 2, 3 and 4) to valve. |
|---------------------|---|

5-7.5. STEERING SYSTEM OVERCENTER VALVE

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

REMOVAL (Cont)



5-7.6. STEERING SYSTEM RELIEF VALVE

This relief valve is located in the engine room near the aft bulkhead, just below the deck, and near the pump discharge valves. It is connected into the pressure line between the check valves and the 10 gallon (13. 8 liter) tank.

This task covers:

- | | |
|----------------|-----------------|
| a. Removal | c. Installation |
| b. Replacement | d. Adjustment |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment

Condition Condition Description

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts

Clean cloths
Container
Hydraulic fluid

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

NONE

5-7.6. STEERING SYSTEM RELIEF VALVE

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

REMOVAL**WARNING**

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

- | | | |
|--|--|---|
| 1. | Drain the hydraulic steering system to a level below the valve. | Use a suitable container and cap open ends. |
| 2. Hose or Tube Connections and Relief Valve | a. Clean hose/tube connections.

b. Disconnect hose/tube connections (1 and 2), and remove relive valve (3). | Cap open ends. |

REPLACEMENT

- | | | |
|-----------------|---------------------------------|--|
| 3. Relief Valve | Replace defective relief valve. | |
|-----------------|---------------------------------|--|

INSTALLATION

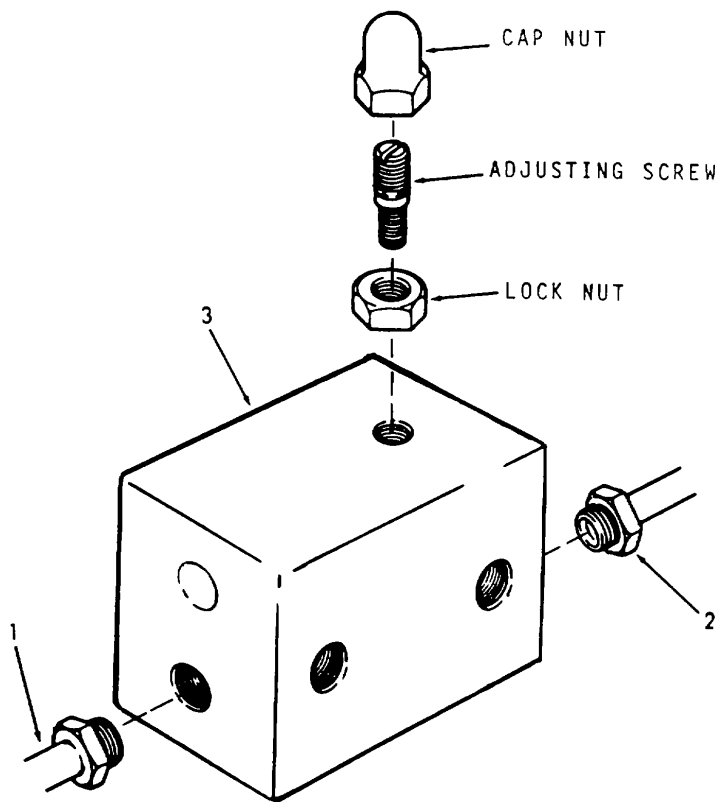
- | | | |
|--|---|--|
| 4. Relief Valve and Hose or Tube Connections | a. Remove caps from open ends.

b. Install relief valve (3) by connecting hose or tube connections (2 and 1). | |
|--|---|--|

5-7.6. STEERING SYSTEM RELIEF VALVE

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

INSTALLATION (Cont)



ADJUSTMENT

5. Relief Valve

Adjust by putting the helm hardover in either direction with engines running (1 pump only supply system). Remove cap from the relief valve, loosen nut, and back off screw until it no longer bears on the spring. Hold the helm in a hardover position and slowly turn down screw until the pressure gage reads 1,500 psi (10342.5 kpa) indicating that the valve is relieving at 1,500 psi (10342.5 kpa). Lock this setting with nut and replace cap.

5-7.7. STEERING SYSTEM FLOW CONTROL VALVE

The flow control valve is located in the engine room, near the aft bulkhead, just below the deck, and near the relief valve. It has three tube connections. One connection is in the pressure line, one is to the helm unit, and the third connection is to the return line to the tank.

This task covers:

- | | | |
|------------|----------------|-----------------|
| a. Removal | b. Replacement | c. Installation |
|------------|----------------|-----------------|

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

Equipment
Condition Condition Description

NONE

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts
Clean cloths
Container

Special Environmental Conditions
NONE

Personnel Required

General Safety Instructions

MOS 61C10

Observe WARNING in procedure

5-7.7. STEERING SYSTEM FLOW CONTROL VALVE (Continued).

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

REMOVAL

1.

WARNING

The fluid pressure in the system must be released prior to servicing the pump or other parts to prevent possible injury to personnel or damage to equipment.

Drain the hydraulic steering system to a level below the valve.

Use a suitable container.

2. Tube
Connections
and Flow
Control
Valve

- a. Clean tube connections.
- b. Disconnect tube connection (1) in the pressure line.
- c. Disconnect tube connection (2) going to helm unit.
- d. Disconnect tube connection (3) in the return line going to expansion tank.
- e. Remove flow control valve (4).

Cap open end.

Cap open end.

Cap open end.

REPLACEMENT

3. Flow
Control
Valve

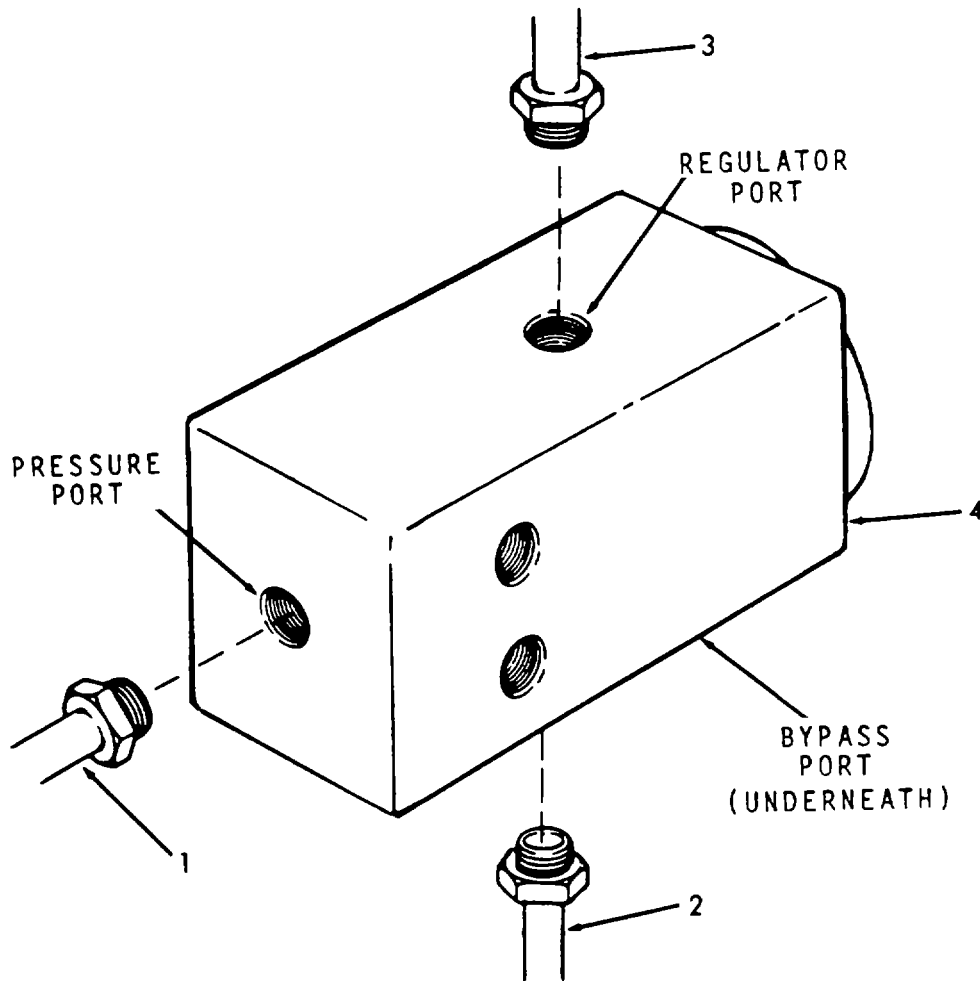
Replace defective flow control valve.

5-7.7. STEERING SYSTEM FLOW CONTROL VALVE (Continued).

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

INSTALLATION

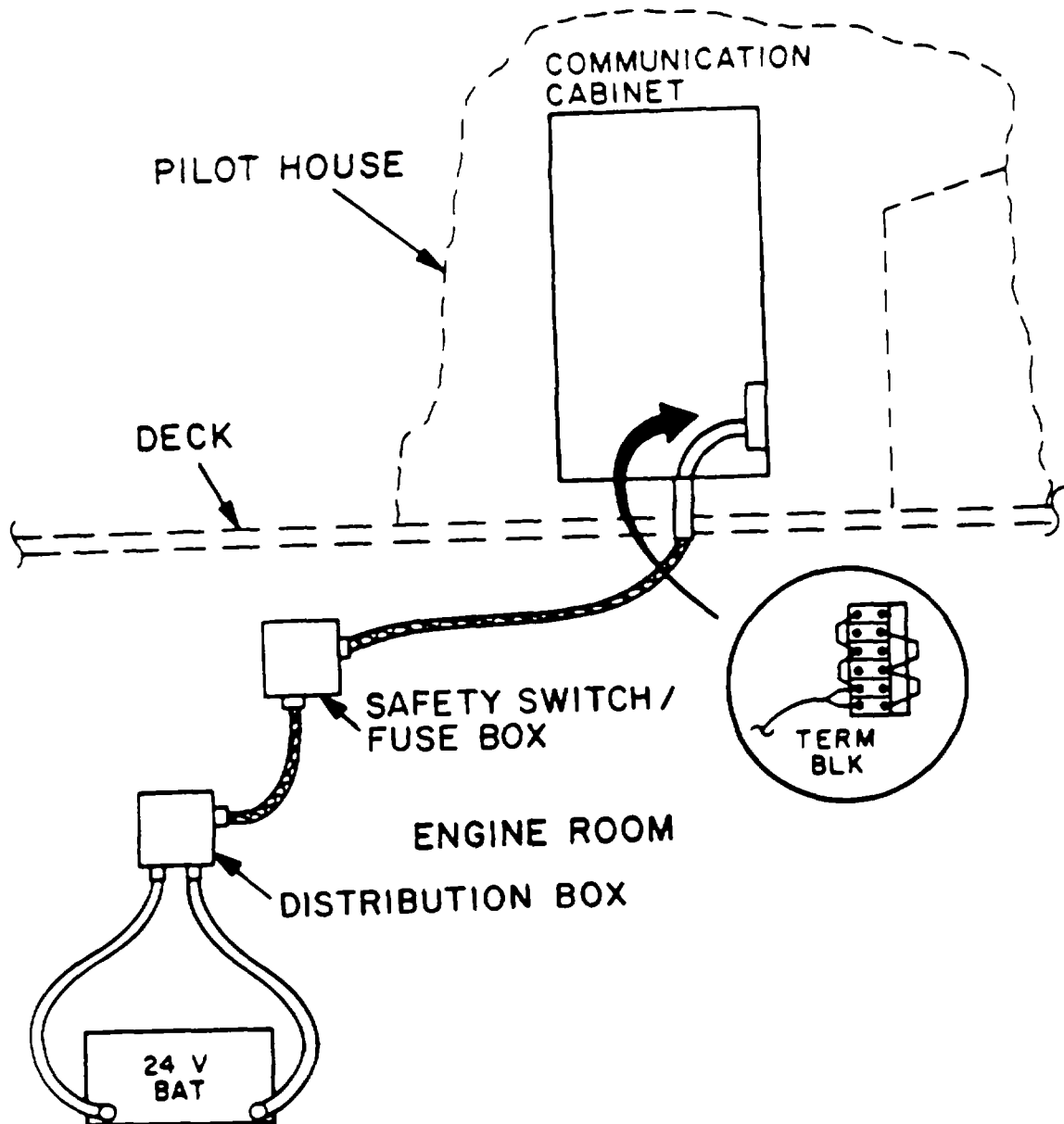
- | | | |
|--|---|--|
| 4. Tube Connections and Flow Control Valve | <p>a. Remove caps from open ends.</p> <p>b. Reconnect tube connection (3) from return line to flow control valve (4).</p> <p>c. Reconnect tube connection (2) from helm unit to flow control valve (4).</p> <p>d. Reconnect tube connection (1) from pressure line to flow control valve (4).</p> | |
|--|---|--|



5-8. COMMUNICATION EQUIPMENT - ELECTRIC POWER (Continued).

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

SERVICE (Cont)



5-8. COMMUNICATION EQUIPMENT - ELECTRIC POWER (Continued).

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

SERVICE (Cont)

- | | |
|--|-----------------|
| c. Clean panels and covers using a detergent solution. | Dry thoroughly. |
|--|-----------------|

WARNING

Wear safety goggles when using compressed air.

CAUTION

Maximum air pressure should not exceed 15 PSI.

- d. Remove panels and covers, and blow out dust or dirt by directing a jet of dry, compressed air into cabinets.

REPLACEMENT

2.

WARNING

Place and tag safety switch in the engine room in the OFF position prior to removal of radio set or components to avoid shock or injury.

Replace components as necessary.

5-9. RADIO SET AN/VRC-46/47.

This task covers:

a. Service

b. Replacement

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts
Clean cloths
Detergent
Goggles
Tags

Special Environmental Conditions
NONE

Personnel Required

MOS 31V

General Safety Instructions

Observe WARNINGS in procedures.
Wear safety goggles when using
compressed air.

LOCATION/ITEM

ACTION

REMARKS

SERVICE

1.

WARNING

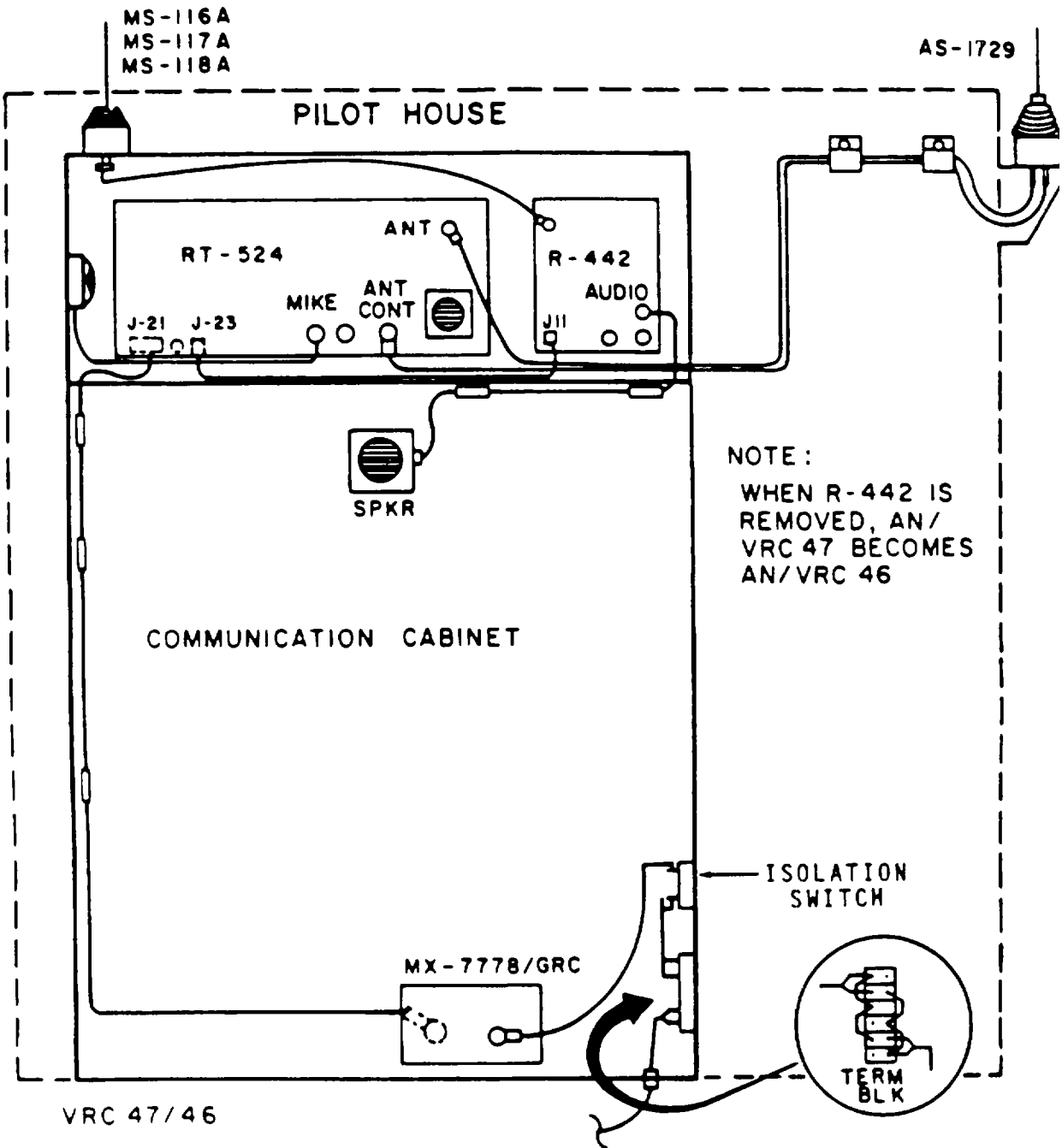
Place and tag safety switch, in the engine room, in the OFF position prior to servicing the radio set.

- a. Clean cables using clean cloths.

5-9. RADIO SET AN/VRC-46/47 (Continued).

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

SERVICE (Cont)



VRC 47/46

5-9. RADIO SET AN/VRC-46/47 (Continued).

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

SERVICE (Cont)

b. Tighten loose hardware.

c. Clean panels and covers using a detergent solution.

Dry thoroughly.

WARNING

Wear safety goggles when using compressed air.

CAUTION

Maximum air pressure should not exceed 15 psi.

d. Remove panels and covers and blow out dust or dirt by directing a jet of dry compressed air into cabinets.

REPLACEMENT

2.

WARNING

Place and tag safety switch, in the engine room, in the OFF position prior to removal of radio set or components to avoid shock or injury.

Replace components as necessary.

5-10. RADIO SET AN/VRC-80.

This task covers:

- a. Service
- b. Replacement

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts

Clean cloths
Detergent
Tags
Tape

Special Environmental Conditions
NONE

General Safety Instructions

Personnel Required

MOS 31V

Observe WARNINGS in procedure.
Wear safety goggles when using compressed air.

LOCATION/ITEM

ACTION

REMARKS

SERVICE

1.

WARNING

Place and tag safety switch, in the engine room, in the OFF position prior to servicing radio set.

- a. Clean cables using clean cloths.
- b. Tighten loose hardware.
- c. Clean panels and covers using a detergent solution.

Dry thoroughly.

5-9. RADIO SET AN/VRC-80 (Continued).

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

SERVICE (Cont)

WARNING

Wear safety goggles when using compressed air.

CAUTION

Maximum air pressure should not exceed 15 psi.

- d. Remove panels and covers and blow out dust or dirt by directing a jet of dry compressed air into cabinets.

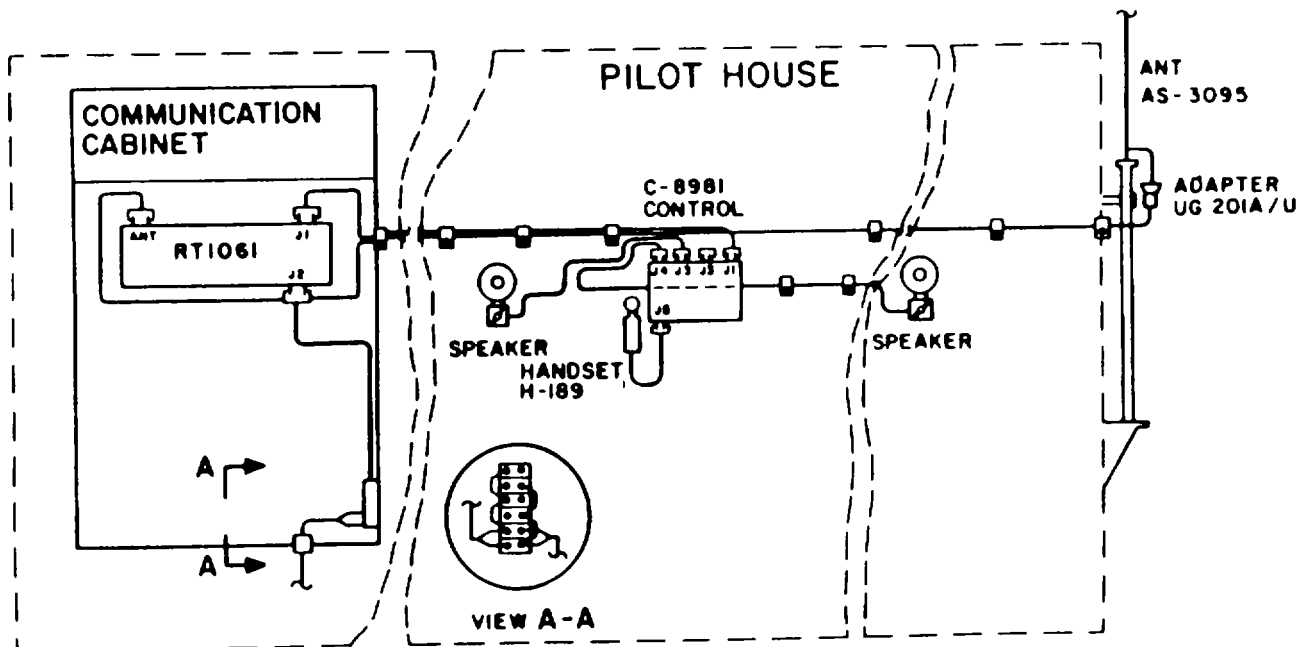
REPLACEMENT

2.

WARNING

Place and tag safety switch, in engine room, in the OFF position prior to removal of radio set or components to prevent shock or injury.

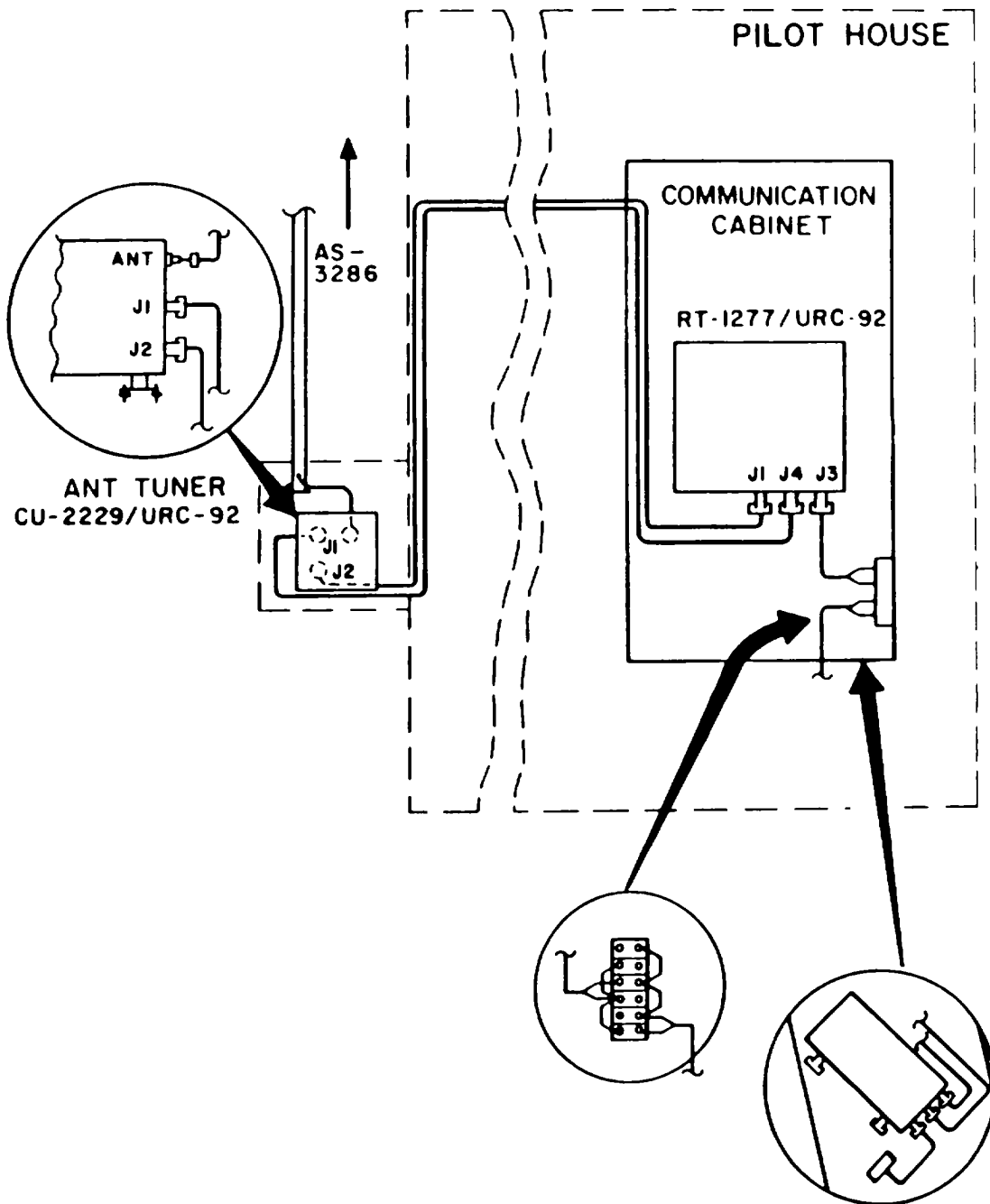
Replace components as necessary.



5-11. RADIO SET URC-92 (Continued).

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

SERVICE (Cont)



5-11. RADIO SET URC-92 (Continued).

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

SERVICE (Cont)

- | | |
|--|-----------------|
| c. Clean panels and covers using a detergent solution. | Dry thoroughly. |
|--|-----------------|

WARNING

Wear safety goggles when using compressed air.

CAUTION

Maximum air pressure should not exceed 15 psi.

- | |
|---|
| d. Remove panels and covers and blow out dust or dirt by directing a jet of dry compressed air into cabinets. |
|---|

REPLACEMENT

2.

WARNING

Place and tag safety switch, in the engine room, in the OFF position prior to removal of radio set or components to prevent shock or injury.

5-12. ENGINE ELECTRICAL SYSTEM.

a. GENERAL.

The electrical system includes two 70-amp, 24-volt alternators; one alternator mounted on the inboard engine of each propulsion unit. Four 6-volt batteries, connected in series to provide 24-volt current, are contained in the battery box located aft in the engine room. The alternators and batteries provide electrical power to operate all lights and electrical accessories on the landing craft and for the electric starters which are mounted on the outboard engines of each propulsion unit.

b. ALTERNATORS

One 70-amp, 24-volt alternator is belt-driven from the inboard engine crankshaft pulley. The electrical circuit of the alternator uses six silicon diodes in a full wave rectifier circuit. Since the diodes will pass current from the alternator to the battery or load, but will not pass current from the battery to the alternator, the alternator does not require the use of a cutout relay. A voltage regulator is the only control required.

c. VOLTAGE REGULATORS

The all-electronic transistorized voltage regulator is an electronic device using no mechanical contacts or relays. When the voltage supply is below a predetermined amount, the transistor conducts, acting like a closed switch between the supply voltage and the field of the alternator. When the supply is above a predetermined amount the transistor is cut off, acting like an open switch which removes the excitation from the field, reducing the alternator output.

d. ELECTRIC STARTING MOTORS.

Electric starting motors are installed on the outboard engines of each propulsion unit. The two electric starting motors, model numbers 1108850 and 1108890, are identical except for direction of rotation. Model number 1108850 has a clockwise rotation, viewing from the drive end, and is installed on the outboard engine of the starboard propulsion unit. Model number 1008890 has a counter-clockwise rotation, viewing from the drive end, and is installed on the outboard engine of the port propulsion unit.

e. See foldout located in the back for schematic.

5-12. ENGINE ELECTRICAL SYSTEM (Continued).

f. The following is an index of the Maintenance instructions:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Alternator	2-12.1
Starting Motors (Electric)	2-12.2

5-12.1. ALTERNATOR

This task covers:

- | | | |
|-------------|-----------------------|-----------------|
| a. Testing | d. Disassembly | g. Assembly |
| b. Removal | e. Inspection | h. Installation |
| c. Cleaning | f. Repair/Replacement | |

INITIAL SETUP

Test Equipment

DC Ammeter
Ohmmeter
DC Voltmeter
Multimeter
DC Test Lamp

References

NONE

Special Tools

NONE

Equipment Condition Condition Description

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Bearing puller
Arbor press
Soldering iron

Materials/Parts

Ball bearing grease
Red Glyptal
Cleaning solvent P-D-680
Solder Fed. Spec QQ-S-571
Tape

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10, 5IR

General Safety Instructions

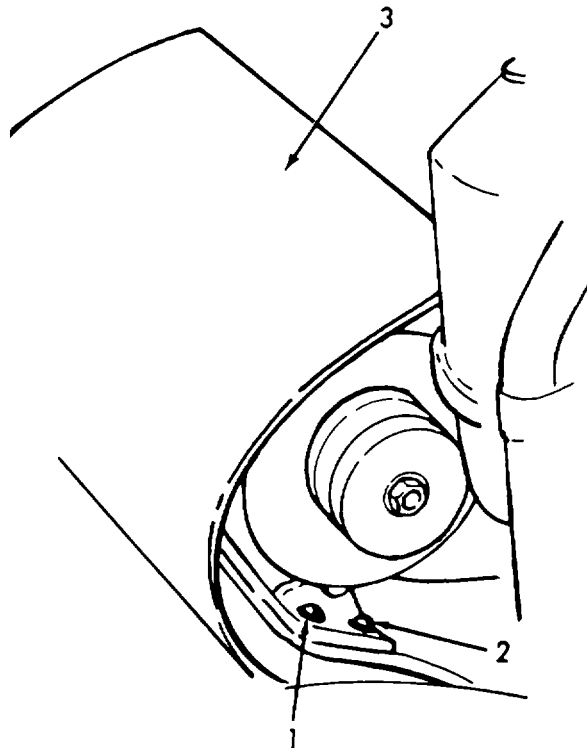
Observe WARNINGS and CAUTIONS in procedure.

5-12.1. ALTERNATOR (Continued)

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

TESTING

- | | | |
|---------------------|--|--|
| 1. Alternator Cover | <ul style="list-style-type: none"> a. Remove screws (1) and washers (2) from alternator cover. b. Remove alternator cover (3). | |
|---------------------|--|--|



5-12.1. ALTERNATOR (Continued)

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

TESTING (Cont)

2. In-Vessel Testing

CAUTION

Do not under any circumstances, short FIELD terminal of alternator to ground. Do not disconnect regulator while alternator is operating. Do not disconnect alternator output lead from alternator while the alternator is operating.

NOTE

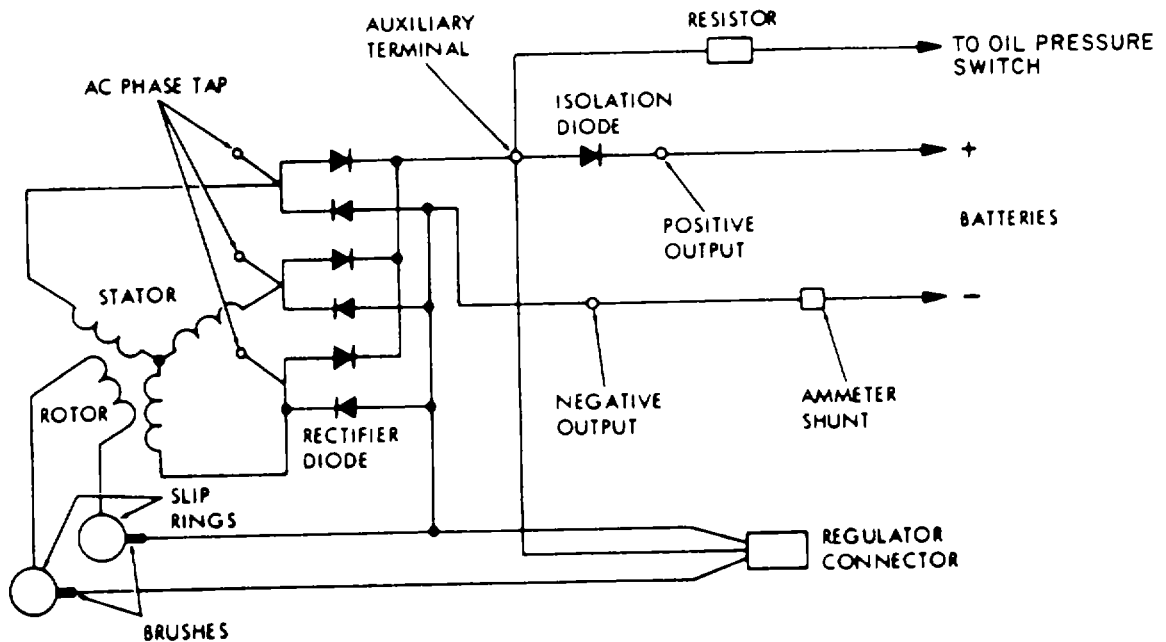
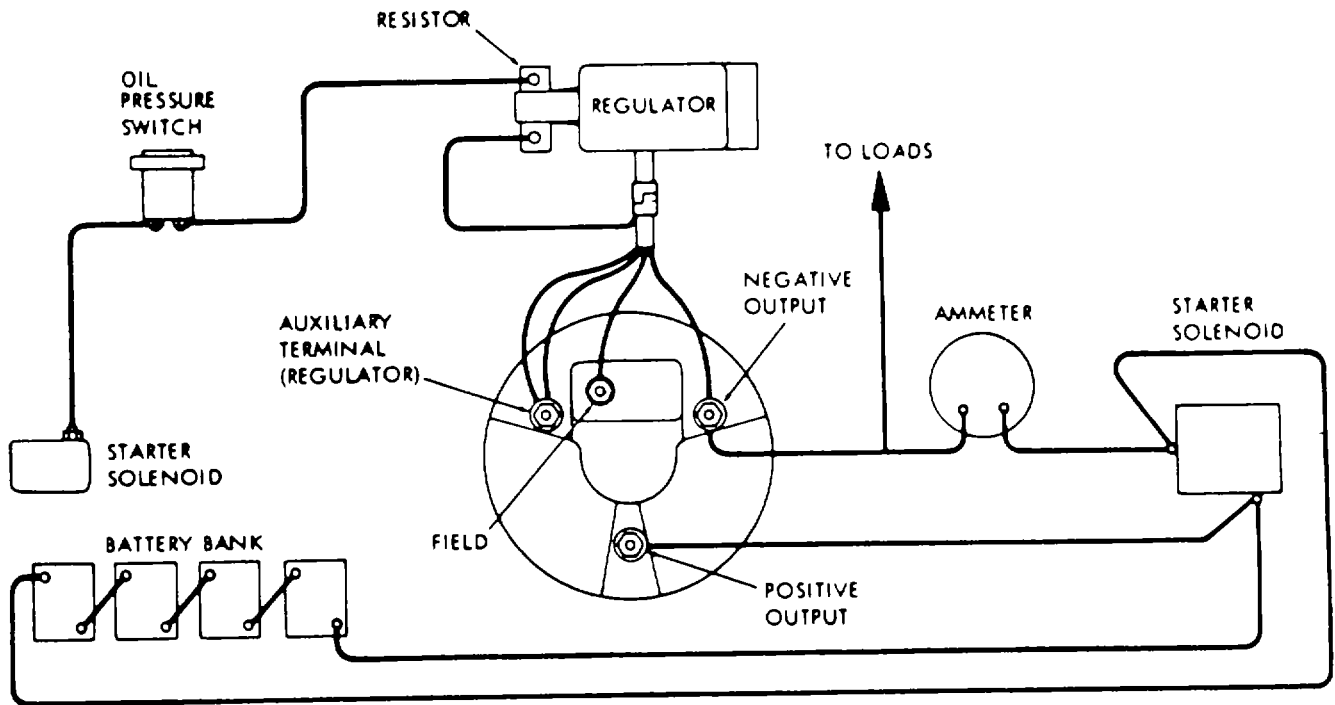
The following test procedures may be performed to determine the condition of the alternator and regulator while still in the vessel. When making the alternator system test, the batteries must be in good condition and fully charged.

- a. Check voltage across auxiliary terminal and negative output terminal with DC voltmeter. Correct voltage is 0.2 volt. If the voltage exceeds this value, the isolation diode is defective.
- b. Place jumper wire across oil pressure switch on propulsion unit to short out switch. Check voltage across auxiliary terminal, and negative output terminal with DC voltmeter. Correct voltage is 1.8 - 2.5 volts. This test evaluates field circuit. If voltage at auxiliary terminal is higher than specified, field circuit is defective - check brushes. If voltage reads 0 volts at auxiliary terminal, check field excitation device and associated circuit. If voltage is not correct, perform test in step f.

5-12.1. ALTERNATOR (Continued)

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

TESTING (Cont)



5-12.1. ALTERNATOR (Continued)

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

TESTING (Cont)**NOTE**

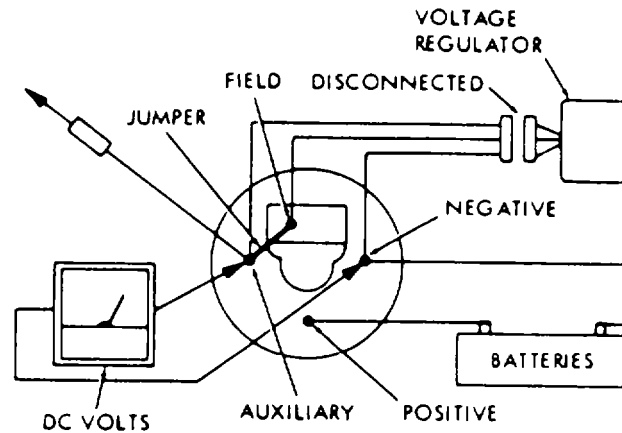
Disconnect jumper wire after testing.

- c. With propulsion unit or engine running, check voltage across auxiliary and negative output terminals with DC voltmeter. Correct voltage is 29.4 ± 0.2 volts. If voltage is low, proceed with tests.
- d. With engine running, check voltage across positive and negative output terminals with DC voltmeter. Correct voltage at positive output terminal is 1.0 volt less than voltage in c. above. If voltage difference exceeds 1.0 volt, isolation diode is defective.
- e. Stop engine and disconnect voltage regulator. Place jumper wire across auxiliary and field terminals. With engine running at idle, check voltage across auxiliary and negative output terminals. Correct voltage is 29.4 ± 0.2 volts. If voltage was low in c. above, and now rises to correct voltage, regulator is defective and shall be replaced. If voltage remains low, alternator is defective.

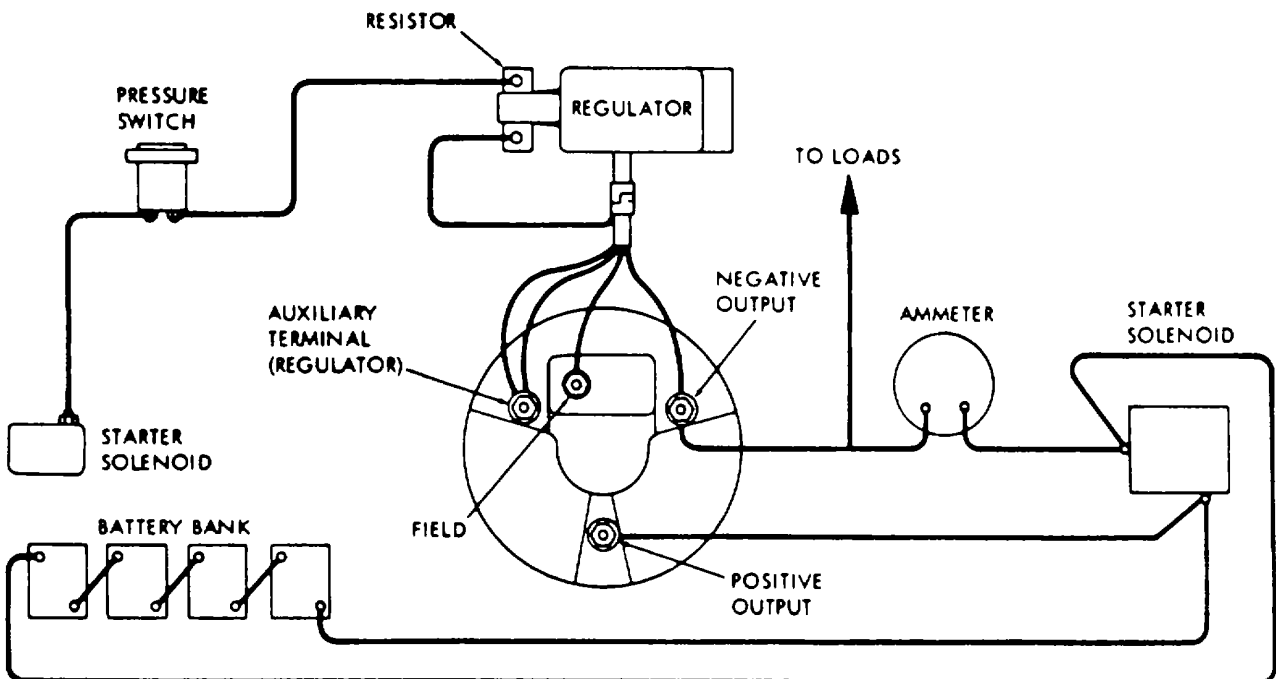
5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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TESTING (Cont)



- f. Stop engine and remove jumper wire across auxiliary and field terminals. Connect a DC ammeter across field and positive output terminals to measure field current (regulator disconnected). Current should be 1.5 to 2.0 amperes. Disassemble and repair alternator if current is excessive or low.



5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL

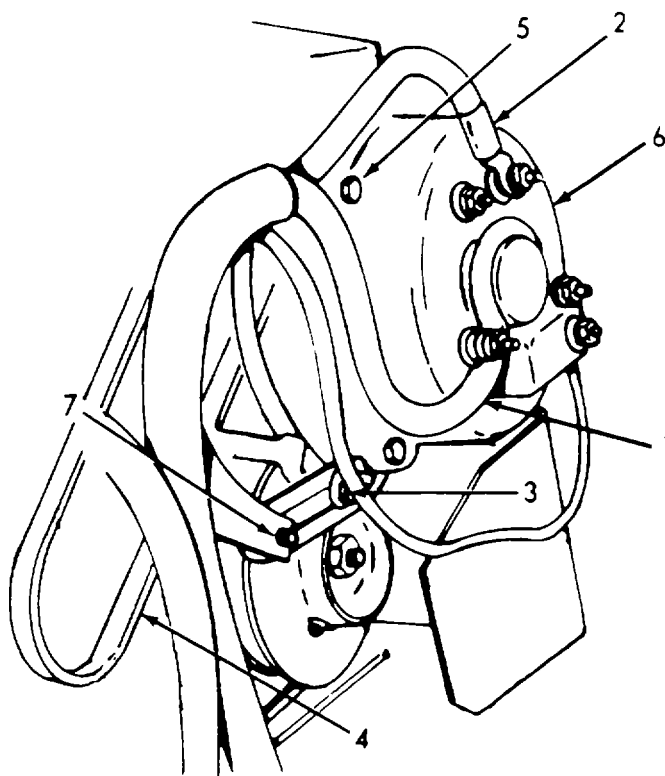
3. Alternator

WARNING

Disconnect negative battery lead to avoid electrical shock.

- a. Remove electrical leads (1 and 2).
- b. Remove adjusting screw (7), and adjustment strap bolt (3).
- c. Move alternator as necessary and remove drive belt (4).
- d. Remove mounting bolts (5), and alternator (6).

Tag to insure proper reconnection.



5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

NOTE

Alternator illustrated is mounted on the inboard engine of the starboard propulsion unit. Alternators on port propulsion units are mounted differently, but removal procedures are similar.

CLEANING

- | | | |
|----|---|--|
| 4. | Clean all foreign matter (oil, grease, dirt, etc) from alternator and wiring. | |
|----|---|--|

DISASSEMBLY

- | | | |
|-----------------------------------|---|--|
| 5. Alternator into Sub-Assemblies | <ul style="list-style-type: none"> a. Clamp driven pulley (1) in a vise. b. Remove self-locking nut (2) and washer (3) from rotor shaft. c. Remove pulley (1) and fan (4). d. Remove key (5) from rotor shaft. e. Remove two self-tapping screws (6) and remove rear cover (7) and cover gasket (8). f. Loosen two lock screws (9). Remove connecting clips from terminals. g. Remove two self-tapping screws (10), insulator (11), and brush assembly (12) from the rear housing. | Use an old belt or suitable rag to prevent damage to pulley. A slight rocking motion of the alternator body will help loosen a tight pulley. |
|-----------------------------------|---|--|

5-12.1. ALTERNATOR (Continued)

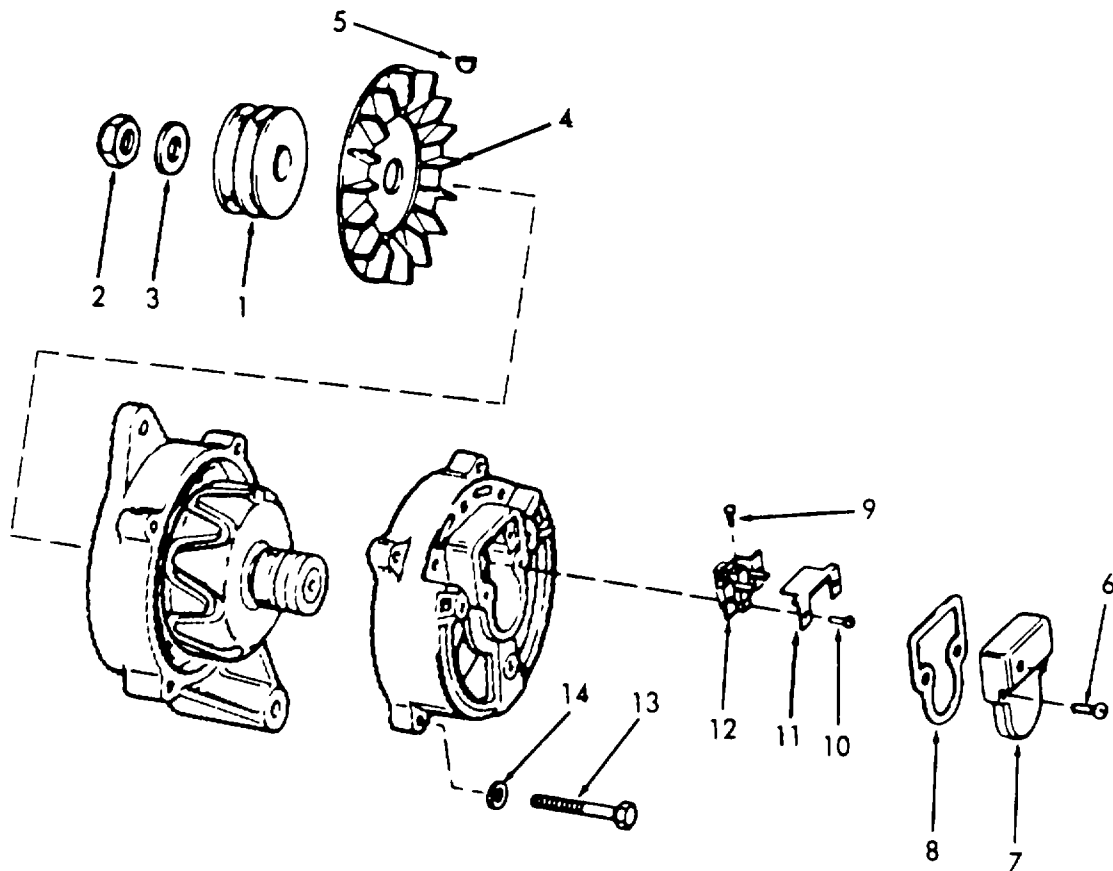
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- h. Remove four thru-bolts (13), and washers (14) securing front and rear sections together.
- i. Using a screwdriver and a wedge, pry the front and rear sections apart at housing "ears".

CAUTION

Do not insert sharp tools (screwdriver, etc.) between stator and housing. Permanent damage to the stator windings or laminations may result.



5-12.1. ALTERNATOR (Continued)

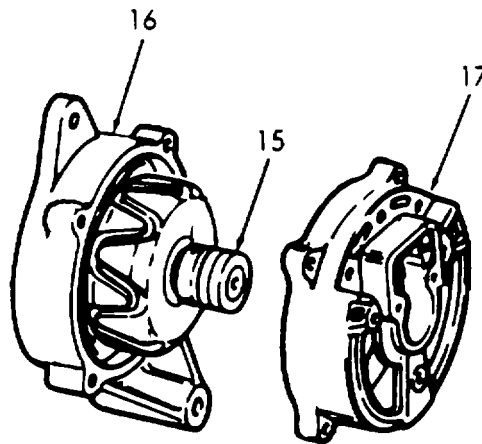
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- j. Push against outer slip ring (15) with thumb to completely separate the front and rear housings (16 and 17).

NOTE

When the alternator is separated, the rotor assembly will come out with the front housing (16). The stator will come out with the rear housing (17).



- 6. Rear Housing Assembly

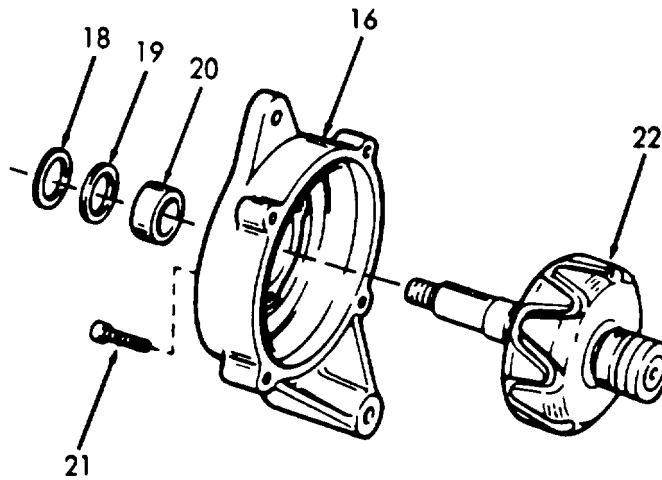
Refer to General Support Maintenance.

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|---------------------------------------|---|--|
| 7. Front Housing Assembly/Disassembly | <p>a. Remove flatwashers (18), felt washers (19), and pulley spacer (20) from rotor shaft.</p> <p>b. Remove three retainer screws (21) from front housing (16).</p> <p>c. Press rotor assembly (22) from front housing, using an arbor press.</p> | |
|---------------------------------------|---|--|



5-12.1. ALTERNATOR (Continued)

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

It is not necessary to remove grease seal (unless it is damaged.).

- | | | |
|----|---|----------------------|
| d. | If necessary, remove grease seal (23) by tapping on the seal through opening in the rear housing (16) with a flat-face punch. | |
| e. | Remove front ball bearing (24) from rotor shaft. | Use bearing puller. |
| f. | Remove grease seal (25), retainer gasket (26), and bearing retainer (27) from front housing. | |
| g. | Remove hex socket screw (28), and lockwasher (29). | Discard lock-washer. |
| h. | Unsolder two connections on slip rings (15). | |

NOTE

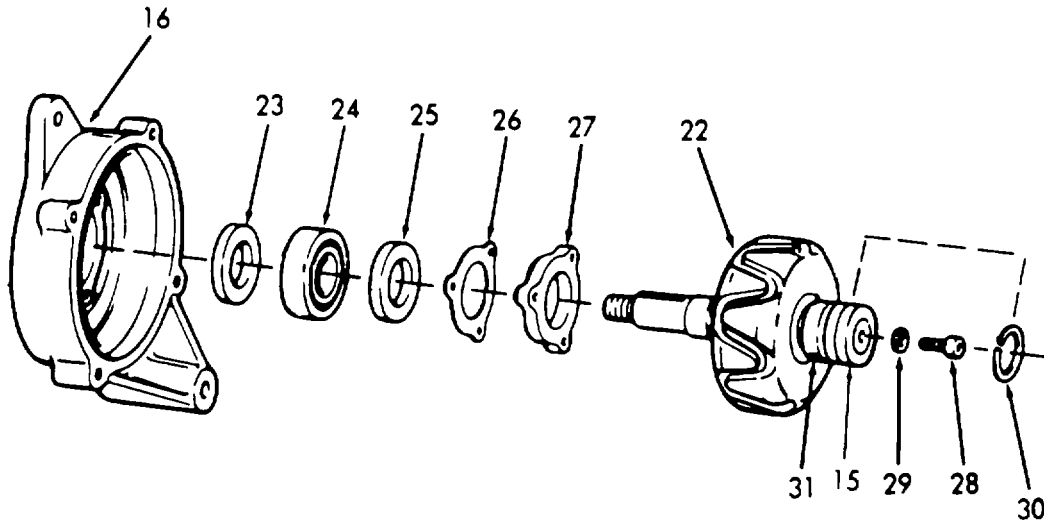
Do not damage the fiber washer between the rings or break the wires.

- | | | |
|----|--|---------------------|
| i. | Thread a 1/4-28 x 1 1/4 inch machine screw into the end of the shaft (slip ring end). As screw is tightened, slip rings will back off shaft. | |
| j. | Remove bearing retainer (30). | |
| k. | Remove ball bearing (31) from rotor shaft (22). | Use bearing puller. |

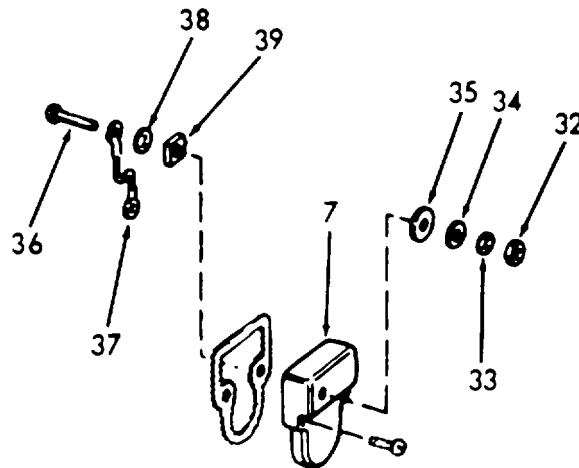
5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



8. Rear Cover Disassembly
- a. Remove hex nut (32), lock-washer (33), flatwasher (34), and insulating washer (35) from rear cover (7).
 - b. Remove carriage bolt (36), field wire (37), flatwasher (38), and terminal insulator (39) from rear cover (7).



5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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CLEANING

9.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38° -59° C).

- a. Wipe grease seals with a clean cloth to remove foreign matter and lubricant.

CAUTION

Do not soak a grease seal in cleaning solvent to clean.

- b. Clean ball bearings in solvent (Fed. Spec. PD-680) to remove dirt and old lubricant. Do not spin ball bearings or use compressed air to dry bearings after cleaning. Allow bearings to air dry.
- c. Clean metal parts in approved cleaning solvent.
- d. Wipe off stator and rotor windings with a clean cloth.

CAUTION

Do not use compressed air hose on rotor or stator windings. Undetectable flaws may be created making assembly less than acceptable.

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
<u>INSPECTION</u>		
10.	<ul style="list-style-type: none"> a. Inspect seals for damage. b. Inspect ball bearings for flat spots, nicks, or burrs. c. Inspect front and rear housing for cracks, breaks, or other damage. d. Inspect brushes for excessive wear. length is less than 1/4 inch. e. Inspect threaded parts for thread damage. 	Replace brush assembly if

TESTING

NOTE

Perform tests on electrical components using a suitable ohmmeter or multimeter as follows:

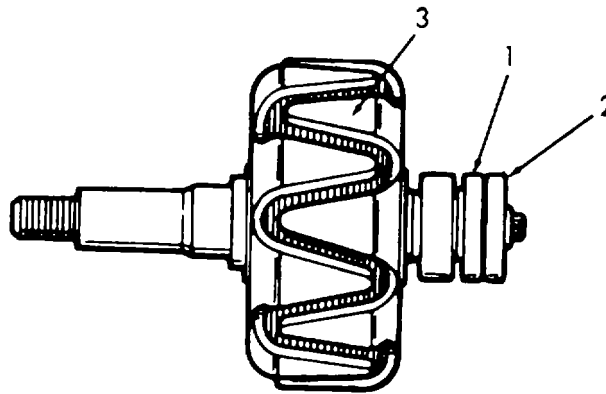
11. Stator Assembly	Refer to General Support Maintenance.
12. Rotor Assembly	<ul style="list-style-type: none"> a. Check resistance between slip rings (1 and 2) installed on the rotor with an ohmmeter. Resistance should be 14 to 18 ohms. If resistance is low, it indicates a short between windings. Very high resistance indicates an open winding. Replace defective rotor assembly.

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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TESTING (Cont)

- b. Check resistance between each rotor slip ring (1 and 2), and rotor frame (3) with an ohmmeter. Resistance should be very high or indicate open circuit. If resistance is low, winding is shorted, and rotor assembly must be replaced.



13. Brush Assembly

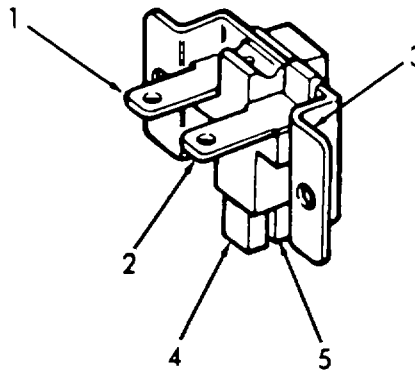
- a. Check resistance between brush terminals (1 and 2), and brush holder (3). Ohmmeter should indicate open circuit or very high resistance. If there is no or low resistance, replace brush assembly.

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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TESTING (Cont)

- b. Check resistance between brush terminal (1) and brush (4). Ohmmeter should indicate very low resistance (near zero). If resistance is high, replace brush assembly. Perform same test between brush terminal (2) and brush (5).



REPAIR

- 14. Grease
Seals and
Ball
Bearings

CAUTION

Do not overpack grease seals. Excess lubricant in alternator may flow into electrical parts and cause malfunction.

- a. Replace defective grease seals.
- b. Repack seals if necessary to 2/3 full with a suitable ball bearing grease.

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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REPAIR (Cont)**CAUTION**

Do not overpack ball bearings. Excess lubricant in alternator may flow into electrical parts and cause malfunction.

- c. Replace defective ball bearings as follows:
 - (1) Place a small quantity of grease on a clean, flat surface.
 - (2) Press bearing into lubricant until grease starts to flow through to opposite side of bearing.
 - (3) Wipe off excess grease from sides and outside of bearings with a clean cloth.

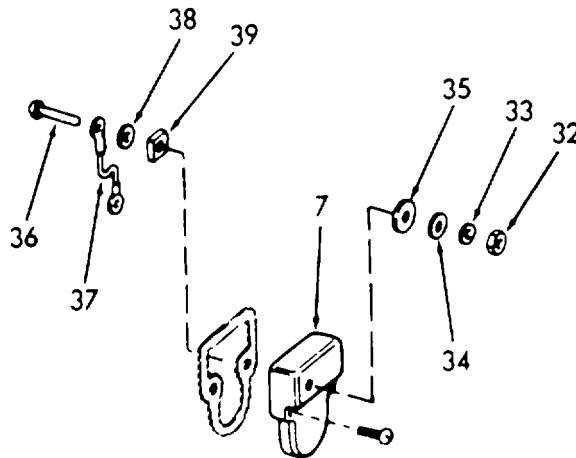
ASSEMBLY

- 15. Rear Cover
 - a. Place field wire (37), flat-washer (38), and terminal insulator (39) onto carriage bolt (36), and insert carriage bolt thru cover (7).
 - b. Place insulating washer (35), flatwasher (34), and lock-washer (33) onto carriage bolt (36), and secure with hex nut (32).

5-12.1. ALTERNATOR (Continued)

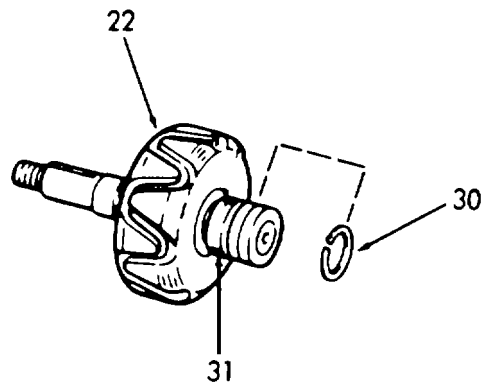
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)



16. Front Housing

- a. Place slip ring connecting wires in the groove of the rotor shaft.
- b. Press rear ball bearing (31) onto rotor shaft (22) applying pressure on INNER race only.
- c. Install bearing retainer (30).



5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | | |
|----|---|-------------------------|
| d | Place slip rings (15) on rotor shaft (22) and draw them into place with lock-washer (29), and hex head socket screw (28). | Use new lock-washer. |
| e. | Solder the two leads, using resin core solder QQ-S-571. | Wipe off excess solder. |

NOTE

Leads are interchangeable.

- | | | |
|----|---|--|
| f. | With an acceptable material such as red glyptal, cement wires to slip rings to prevent them from loosening. | |
| g. | Press seal (25) into bearing retainer (27). | |

CAUTION

Apply pressure to the outer metal ring only. Otherwise, permanent damage may result.

- | | | |
|----|--|--|
| h. | Press seal (23) into front housing (16). | |
|----|--|--|

CAUTION

Apply pressure on outer race only.

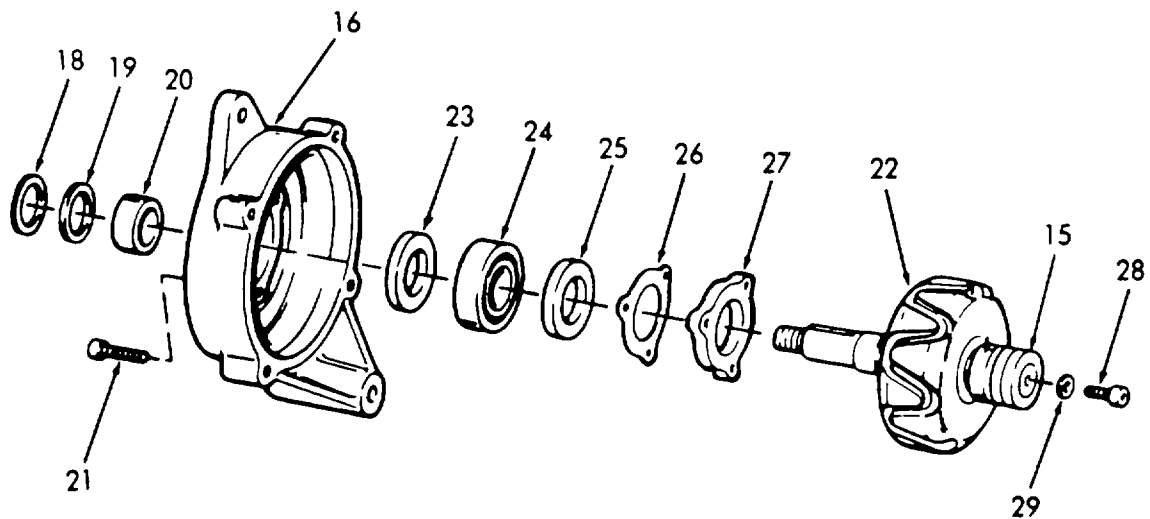
- | | | |
|----|---|--|
| i. | Press ball bearing (24) into front housing. | |
|----|---|--|

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- j. Position retainer gasket (26) and retainer (27) in place and secure to front housing (16) with three retainer screws (21).
- k. Press front housing assembly (24) onto rotor shaft assembly (22). Use arbor press and a suitable jig.
- l. Install pulley spacer (20), felt washer (19), and flat-washer (18) on end of rotor shaft.



5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | | |
|------------------|--|--|
| 17. Rear Housing | Refer to General Support Maintenance. | |
| 18. Alternator | <ul style="list-style-type: none"> a. Carefully align front housing (16) with rotor shaft assembly (22), and rear housing (17). b. Press housings together. c. Install washers (14), and three bolts (13). Tighten bolts. | |

CAUTION

If a new brush assembly is being installed, insure that replacement is identical to the original since an error could cause serious damage to the alternator.

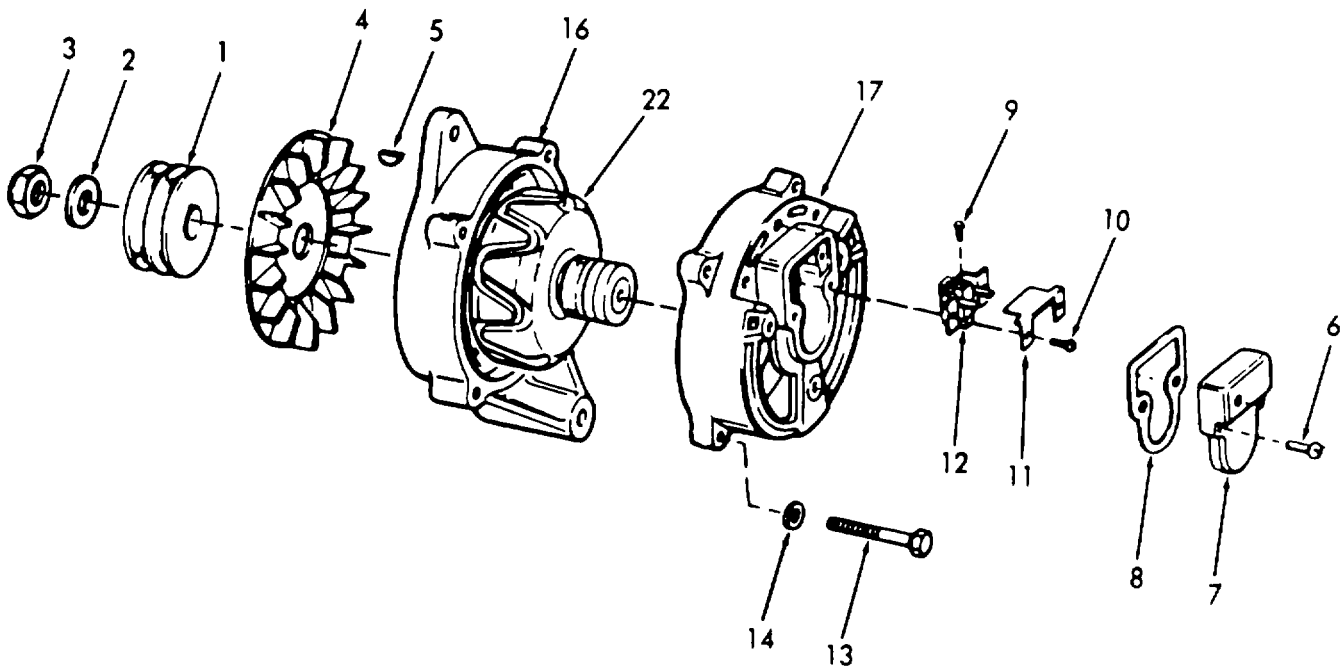
- d. Secure brush assembly (12) to rear housing (17) with insulator (11) and two self-tapping screws (10).
- e. Secure internal field wire and auxiliary wire to brush assembly terminals with two self-tapping screws (9).
- f. Secure rear cover (7) and cover gasket (8) to rear housing (17) with two self-tapping screws (6).
- g. Place key (5) in keyway of rotor shaft.
- h. Install fan (4).

5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- i. Install pulley (1).
- j. Install flatwasher (3) on shaft and secure with self-locking nut (2).
- k. Check assembly of all parts, particularly electrical connections.
- l. Examine rotor assembly for freedom of movement. There should be no binding or contact between internal components.
- m. Perform in-vessel tests to determine that alternator is functioning properly. Refer to step 2a.

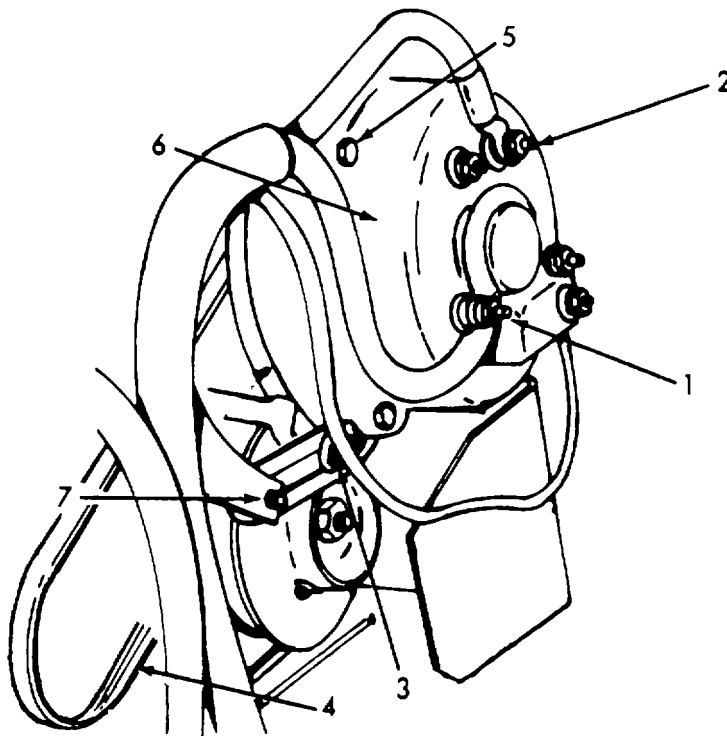


5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION

- | | | |
|----------------|--|---|
| 19. Alternator | <ul style="list-style-type: none"> a. Position alternator (6) in place and secure with mounting bolts (5). b. Install adjustment strap bolt (3). c. Install belt (4). d. Install adjusting screw (7). e. Adjust belt until there is a deflection of approximately 1/2 inch at a point midway between alternator drive pulley and crankshaft pulley. f. Tighten adjustment strap bolt (3), and adjusting screw (7). | <p>Do not tighten.</p> <p>Do not tighten.</p> |
|----------------|--|---|

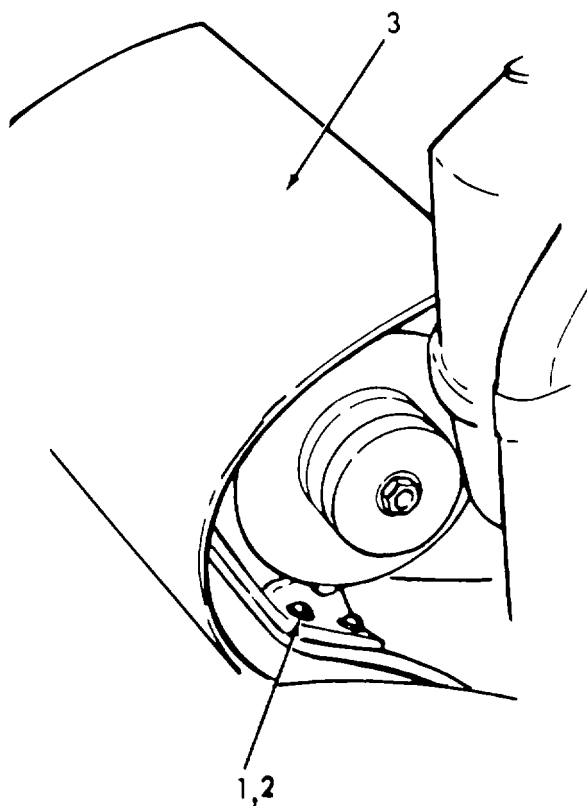


5-12.1. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- | | | |
|----------------------|---|--|
| | g. Reconnect electrical leads (2 and 1). | |
| | h. Reconnect negative battery lead. | |
| 20. Alternator Cover | a. Position alternator cover (3) into place. | |
| | b. Secure with flatwashers (2), and screws (1). | |



5-12.2. STARTING MOTORS (ELECTRIC).

Electric starting motors are installed on the outboard engines of each propulsion unit. The two electric starting motors, model numbers 1108850 and 1108890, are identical except for direction of rotation. Model number 1108850 has a clockwise rotation, viewing from the drive end, and is installed on the outboard engine of the Starboard propulsion unit. Model number 1108890 has a counterclockwise rotation, viewing from the drive end, and is installed on the outboard engine of the Port propulsion unit.

This task covers:

- | | | | |
|----------------|--|-----------------------|-----------------|
| a. Removal | | d. Inspection | f. Assembly |
| b. Disassembly | | e. Repair/Replacement | g. Installation |
| c. Cleaning | | | |

INITIAL SETUP

Test Equipment

- Ammeter
- RPM indicator
- Spring gage
- 110V test lamp

References

Refer to BuShips Instructions 6260.5 SER 660-50513, dated 7 October 1958 and change No. 1, SER 660-4980 dated 19 January 1959 for characteristics, toxicity, flammability effect on material and application of inhibited methylchloroform.

Special Tools

- Torque wrench

Equipment

<u>Condition</u>	<u>Condition Description</u>
NONE	

Tools

- General Mechanic's Tool Kit
NSN 5180-00-629-9783
- Rawhide mallet
- Soldering iron

Materials/Parts

- Pail
- Inhibited Methylchloroform
- Clean cloths
- Solder OQ-S-571
- Engine oil OE-10 (MIL-L-2104)

Special Environmental Conditions

NONE

Personnel Required

- MOS 61C10, SIR

General Safety Instructions

Observe WARNING in procedure.

5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL**WARNING**

Disconnect negative lead from battery prior to performing maintenance on the starting motor. Severe shock could result.

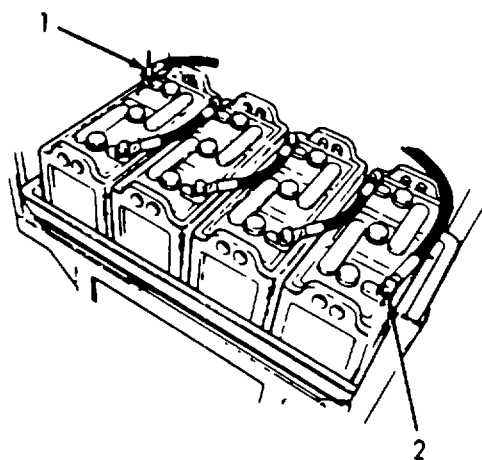
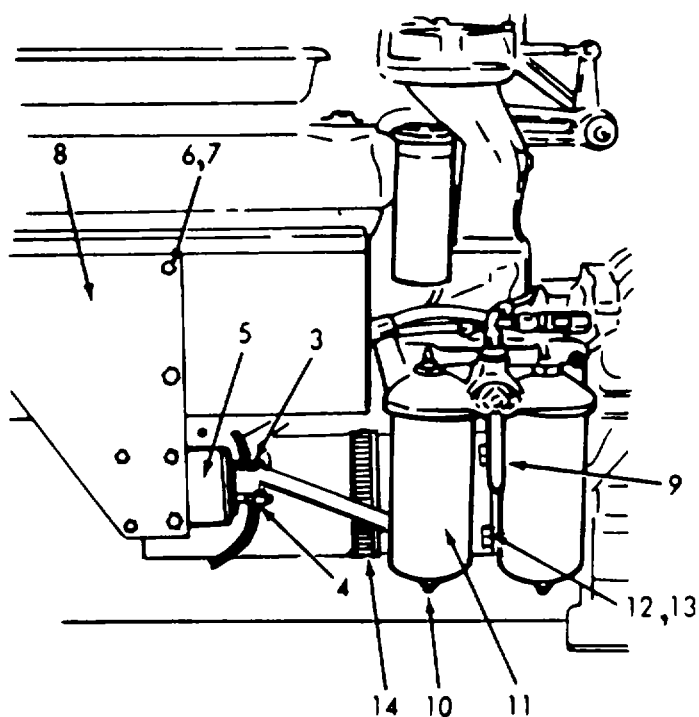
1. Battery Leads	Disconnect battery leads (1 and 2).	Tag for proper
2. Solenoid Switch Leads	Disconnect solenoid switch leads (3 and 4) from solenoid (5).	Tag for proper reconnection.
3. Support Bracket support bracket (8).	a. Remove four screws (6), and lockwashers (7) from b. Remove support bracket (8) with solenoid switch (5) attached.	
4. Fuel Filter off forward filter.	a. Turn fuel filter valve lever (9) to OFF to shut b. Open petcock (10) at bottom of filter and drain filter. dispose of properly. c. Remove shell and element (11) from filter head.	Drain fuel into a suitable container and

5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- | | | |
|------------|--|--|
| 5. Starter | <p>a. Remove three bolts (12), and lockwashers (13) securing starting motor to the flywheel housing.</p> <p>b. Remove starting motor (14) from engine.</p> | |
|------------|--|--|

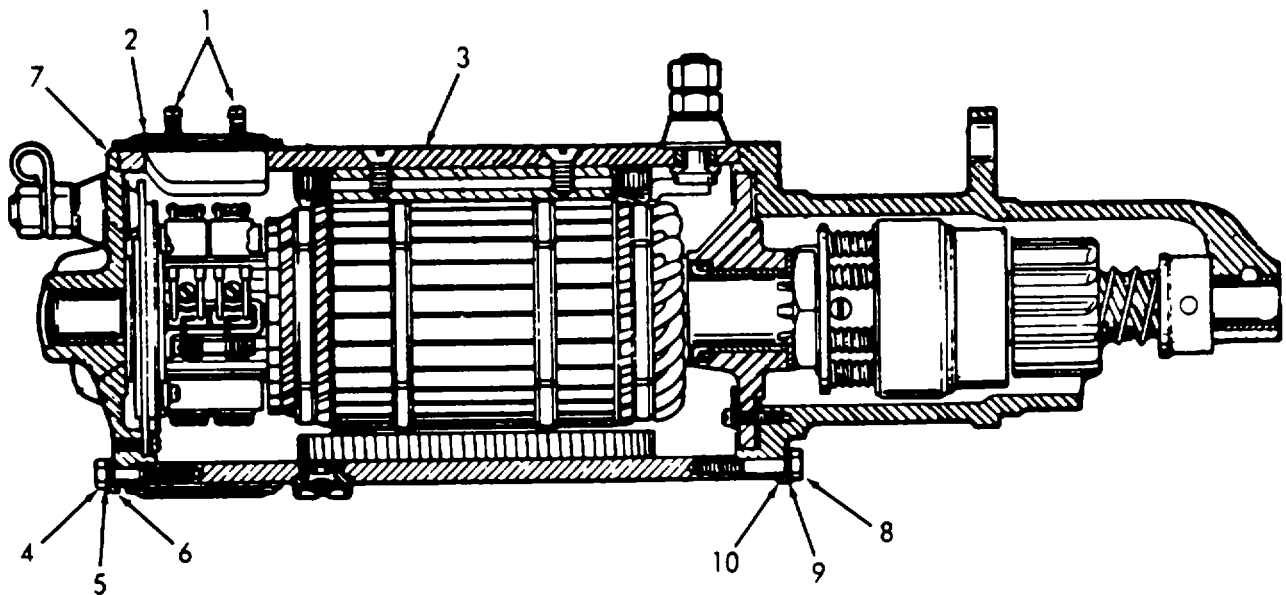


5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|---------------------------------------|--|---|
| 6. Starter
Into Sub-
assemblies | a. Loosen two cover band bolts (1) and slide cover band assembly (2) from frame and field assembly (3). | Do not disassemble cover band assembly (3). |
| | b. Remove four commutator end bracket bolts (4), flat-washers (5) and lockwashers (6). | |
| | c. Tap end bearing and brush assembly and remove assembly (7) from field and frame assembly (3). | Use rawhide mallet to loosen. |
| | d. Remove twelve drive housing bolts (8), flatwashers (9), and lockwashers (10) from field and frame assembly (3). | |
| | e. Remove frame and field assembly (3). | |



5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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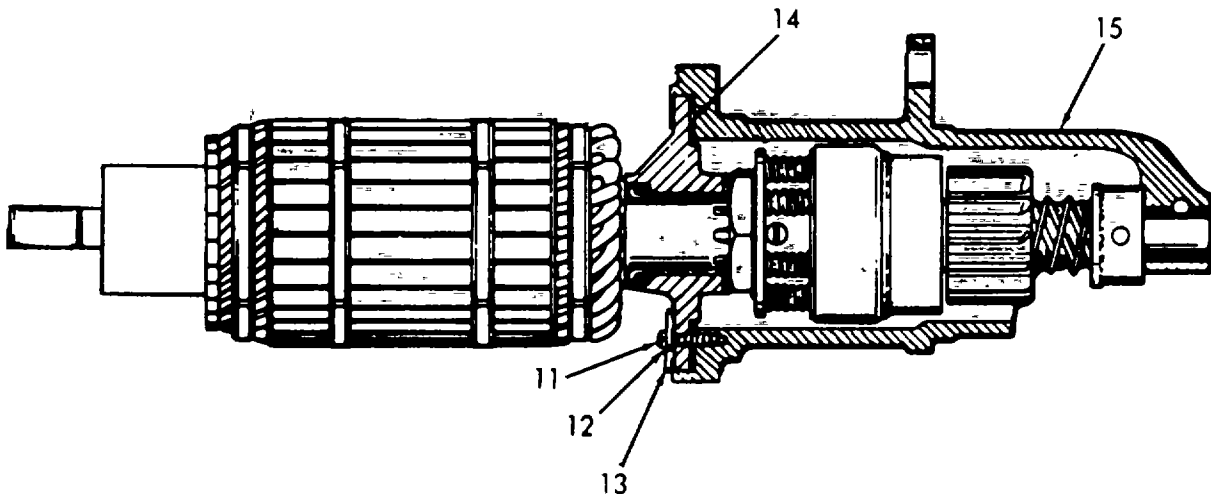
DISASSEMBLY (Cont)

- 7. Drive Housing Assembly

NOTE

To disassemble drive housing, it must be removed from middle bearing assembly and Bendix drive assembly.

- a. Remove locking wire (11) from middle bearing attaching screws (12).
- b. Remove six attaching screws (12) and lockwashers (13) from middle bearing assembly (14).
- c. Remove middle bearing assembly (14) with Bendix drive and armature assembly from drive housing assembly (15).



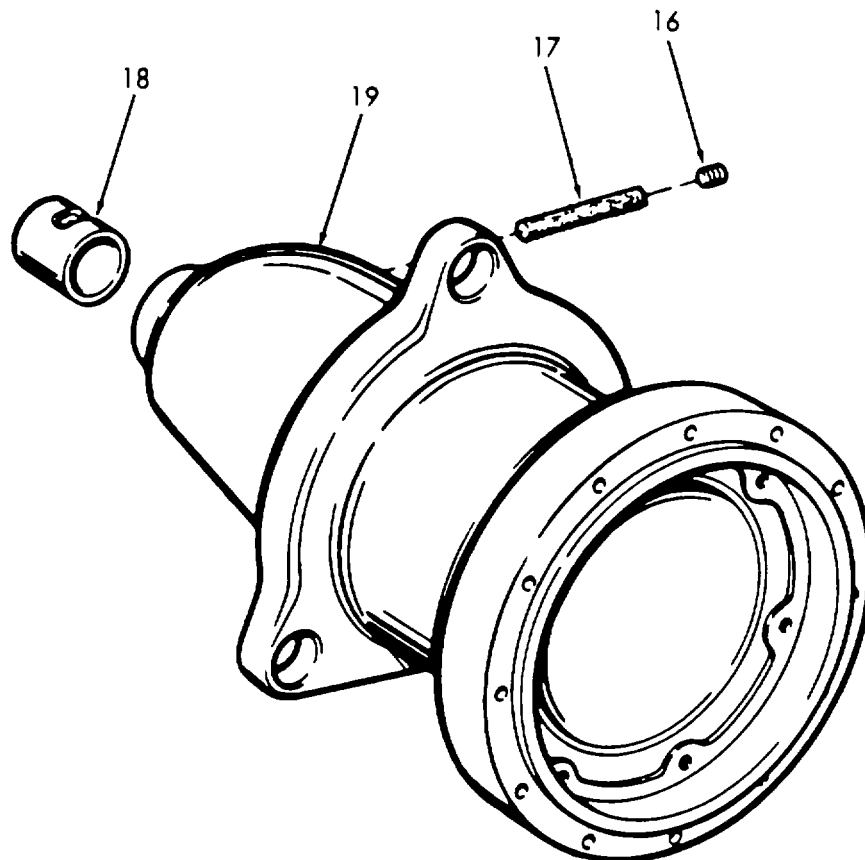
5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- d. Remove drive end pipe plug (16) and lubricating wick (17) from drive housing (19).
- e. Press sleeve bearing (18) from drive housing (19).

Remove only if replacement is necessary. Use an arbor press and rod to remove bearing.

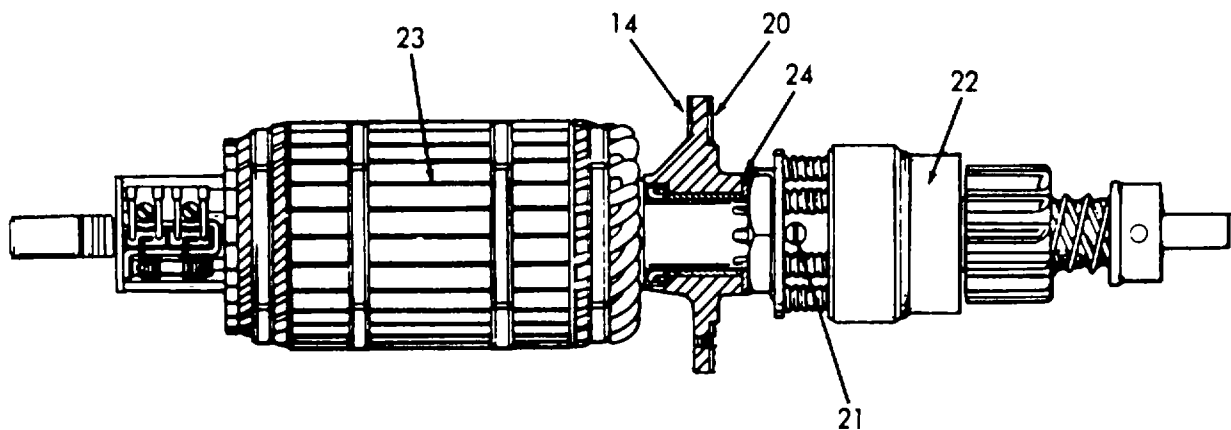


5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|----------------------------|---|--|
| 8. Middle Bearing Assembly | a. Remove middle bearing gasket (20). | |
| | b. Move retaining wire to one side. Then loosen setscrew (21) holding Bendix drive assembly (22) to armature assembly (23). | |
| | c. Pull Bendix drive assembly (22) from armature assembly (23). | |
| | d. Remove middle bearing assembly (14), spacer washer (24), from armature assembly (23). | |



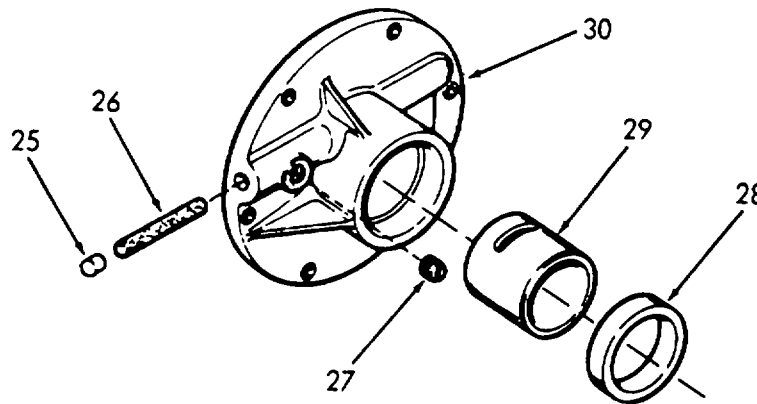
5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- e. Remove oil hole plug (25).
- f. Remove lubricating wick (26).
- g. Remove pipe plug (27).
- h. Press oil seal (28) and middle sleeve bearing (29) from middle bearing bracket (30).

Do not remove oil seal or bearing unless replacement is necessary. Use an arbor press and suitable rod to remove bearing and seal.



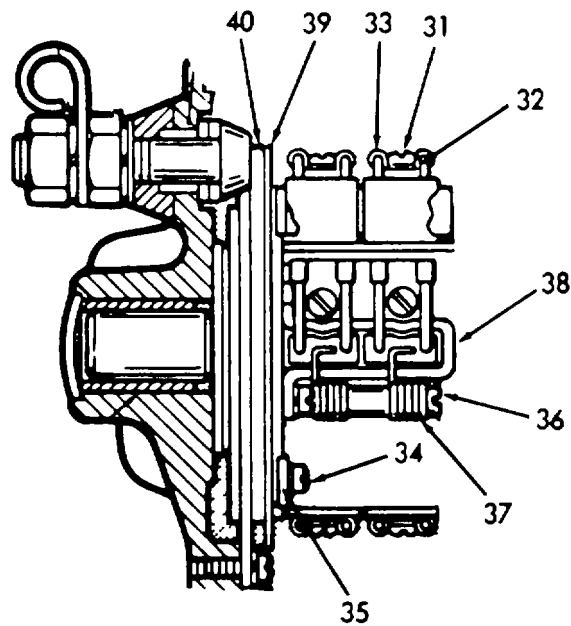
- | | |
|------------------------------------|--|
| 9. Commutator End Bearing Assembly | a. Remove eight brush lead attaching screws (31), and lockwashers (32) from brush assemblies (33). |
|------------------------------------|--|

5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- b. Remove the four brush assemblies (33).
- c. Remove two brush holders as follows:
 - (1) Remove four brush holder screws (34), lockwashers (35), two brush holder screws (36), and four brush springs (37).
 - (2) Remove two brush holders (38), and brush holder spacer plates (39) from brush and stud plate (40).



5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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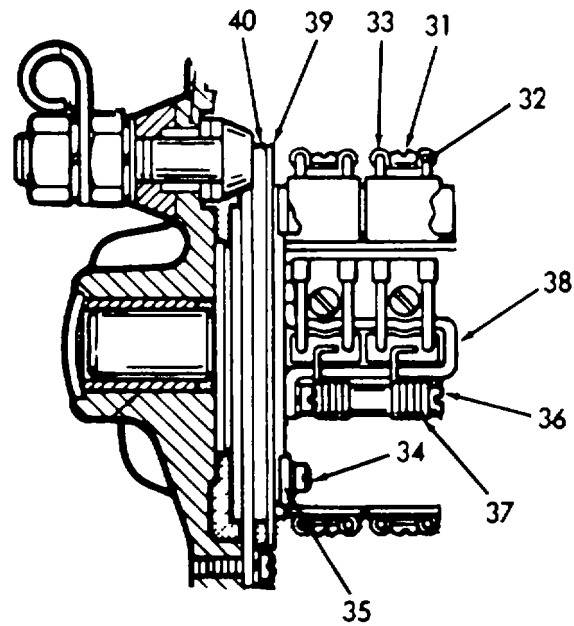
DISASSEMBLY (Cont)

- | | | |
|----|---|--|
| d. | Remove the other two brush holders as follows: | |
| | (1) Remove four brush holder screws (34), lockwashers (35), two brush holder screws (36), and four brush springs (37). | |
| | (2) Remove two brush holders (38), and brush holder spacer plates (39) from brush and stud plate (40). | |
| e. | Remove three screws (41), and lockwashers (42) from brush and stud plate (40). | |
| f. | Remove brush and stud plate (40) from commutator end bracket (43). | |
| g. | Remove terminal stud nuts (44), lockwashers (45), plain washer (46), terminal stud insulator (47), and insulated terminal stud bushing (48). | Remove only if replacement of parts is required. |
| h. | To remove commutator end bearing (49), remove expansion plug (50), pipe plug (51), wick (52), and press sleeve bearing (49) from commutator end bracket (43). | Remove only if replacement of bearing is required. |

5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



CLEANING

10. Use inhibited methylchloroform to remove grease and dirt from all parts except armature.

5-12.2. ALTERNATOR (Continued)

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

INSPECTION

- | | | |
|----|--|--|
| 11 | <ul style="list-style-type: none"> a. Inspect pigtail leads on brushes for tightness. b. Inspect pigtail lead clips for secure mounting to leads. c. Inspect brush springs for loss of tension or broken coils. d. Inspect sleeve bearings for wear. Wear will be greatest on the side which sustains the greatest thrust during cranking. e. Inspect brush holders, spacer plates, insulators, etc., for warped, bent, burned, cracked or otherwise damaged condition. f. Inspect Bendix drive pinion teeth for chips, burrs, or worn condition. g. Inspect threaded parts for crossed or damaged threads, bends, or other damage. | |
|----|--|--|

REPAIR

- | | | |
|-----|--|---------------------------------------|
| 12. | <ul style="list-style-type: none"> a. Replace brushes if worn down to 5/16 inch (7.9mm) or less. b. Sleeve bearings worn more than 0.005 inch (0.013 cm) beyond maximum dimension listed below should be replaced:

 Drive end housing bearing, ID 0.8145 0.8165 inch (2.0688 2.0739 cm) | Original length is 1/2 inch (12.7mm). |
|-----|--|---------------------------------------|

5-12.2. ALTERNATOR (Continued)

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

REPAIR (Cont)

Middle bearing, ID	0.9970	0.9990 inch (2.5320 2.5370 cm)
Commutator end bearing, ID	0.5620	0.0564 inch (1.4270 1.4330 cm)

- c. Replace other defective parts as required.

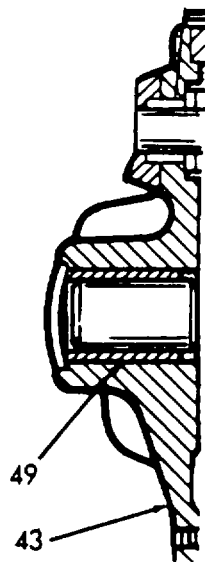
ASSEMBLY

- 13. Commutator End Bearing

- a. Install sleeve bearing (49) in commutator end bracket (43) if removed, as follows:

Use arbor press.

If bearing is worn more than 0.005 inch (0.013 cm) beyond maximum dimension, as listed below, they should be replaced. Wear will be greatest on side which sustains greatest thrust during cranking. After a new bearing is pressed into place, cross-drill oil hole. Ream to finish size as listed below, and remove burrs in oil passage.



5-12.2. ALTERNATOR (Continued)

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

Finish size of bearing is:

Commutator end bearing, ID	0.562	0.564 inch
.....	(1.427	1.433 cm)

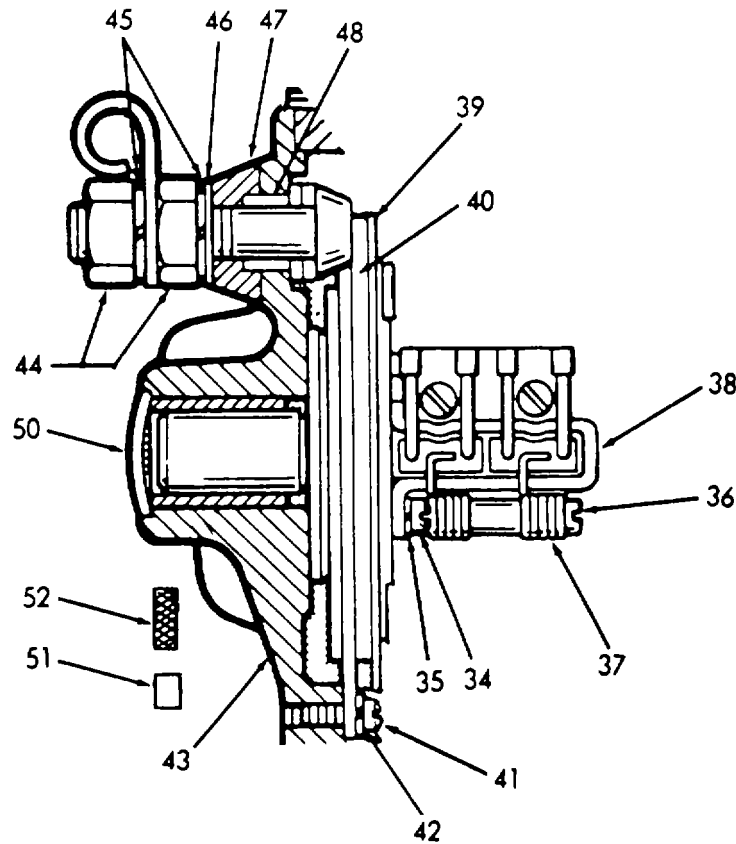
- | | | |
|----|--|-------------|
| b. | Apply 8 to 10 drops of engine oil OE-10 (MIL-L-2104) to lubricating wick (52) and install wick (52), and pipe plug (51). | If removed. |
| c. | Install expansion plug (50). | If removed. |
| d. | Attach brush screw support plate to brush and stud plate (40) with lockwashers (42) and screws (41). | |
| e. | Place this assembly into commutator end bracket (43). | |
| f. | Install in the following order: | |
| | (1) Insulated terminal stud bushing (48). | |
| | (2) Terminal stud insulator (47). | |
| | (3) Flatwasher (46). | |
| | (4) Terminal stud lockwasher (45). | |
| | (5) Terminal stud nut (44). | |
| | (6) Terminal stud lockwasher (45). | |
| | (7) Terminal stud nut (44). | |

5-12.2. ALTERNATOR (Continued)

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

ASSEMBLY (Cont)

- g. Install two brush holders (38) as follows:
 - (1) Place two brush holders (38) and brush holder spacer plates (39) onto brush and stud plate (40).
 - (2) Install four brush springs (37), two brush holder screws (36), four lockwashers (35) and secure with four brush holder screws (34).



5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

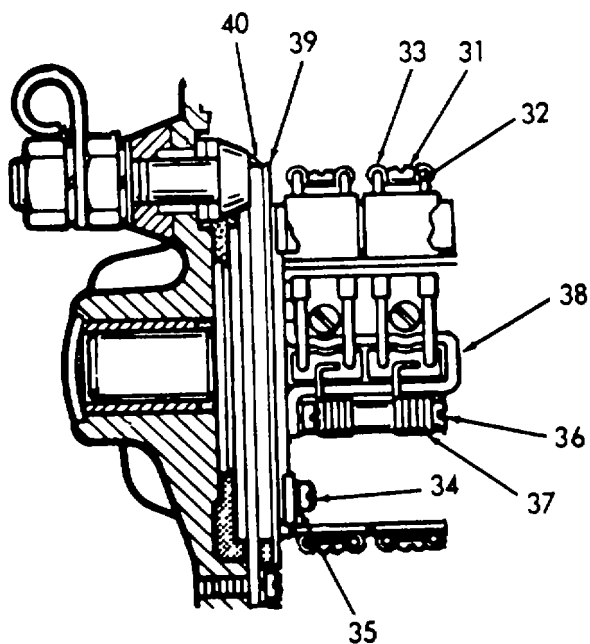
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- h. Install the other two brush holders (38) as follows:
 - (1) Place two brush holders (38) and brush holder spacer plates (39) onto brush and stud plate (40).
 - (2) Install four brush springs (37), two brush holder screws (36), four lock-washers (35) and secure with four brush holder screws (34).

- i. Install brush lead attaching lockwashers (32), and screws (31) into brush assemblies (33).

Do not tighten.

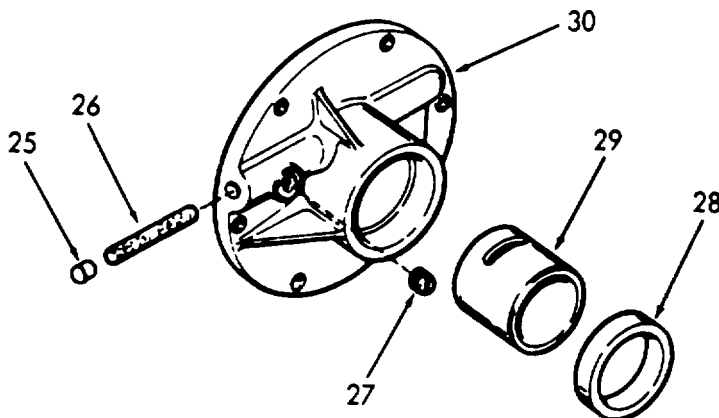


5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | | |
|-----------------------------|--|------------------|
| 14. Middle Bearing Assembly | <p>a. Install sleeve bearing (29) in bearing bracket (30) if removed, as follows:</p> <p>If bearing is worn more than 0.005 inch (0.013 cm) beyond maximum dimension, as listed below, they should be replaced. Wear will be greatest on side which sustains the greatest thrust during cranking. After a new bearing is pressed into place, cross-drill oil hole. Ream to finish size as listed below, and remove burrs in oil passage. Finish size of bearing is:</p> <p style="padding-left: 40px;">Middle bearing, ID..... 0.997..... 0.999 inch
(2.532..... 2.537 cm)</p> | Use arbor press. |
| | b. Press new seal (28) into bearing bracket. | |
| | c. Install oil hole plug (27). | |
| | d. Apply 8 to 10 drops of engine oil OE-10 (MIL-L-2104) to lubricating wick (26) and install wick (26), and pipe plug (25). | If removed. |

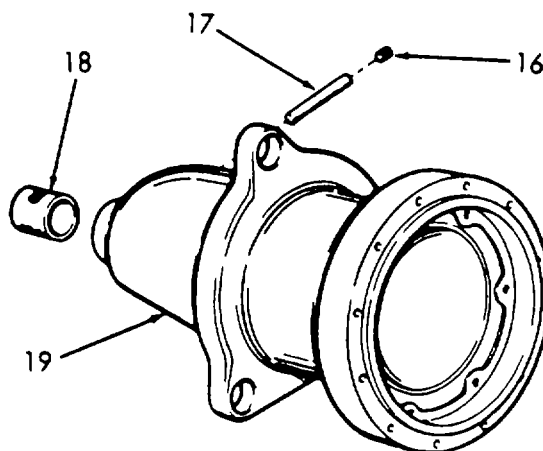


5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

15. Drive Housing	<p>Install sleeve bearing (18) in drive housing (19) as follows:</p> <p>a. If bearing is worn more than 0.005 inch (0.013 cm) beyond maximum dimension, as listed below, they should be replaced. Wear will be greatest on side which sustains greatest thrust during cranking. After a new bearing is pressed into place, cross-drill oil hole. Ream to finish size as listed below, and remove burrs in oil passage. Finish size of bearing is:</p> <p style="margin-left: 40px;">Drive end housing bearing, ID..... 0.8145..... 0.8165 inch (2.0688..... 2.0739 cm)</p> <p>b. Place lubricating wick (17) in housing.</p> <p>c. Apply 8 to 10 drops of engine oil OE-10 in reservoir and secure passage with pipe plug (16).</p>	<p>If removed. Use arbor press.</p> <p>If removed.</p>
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5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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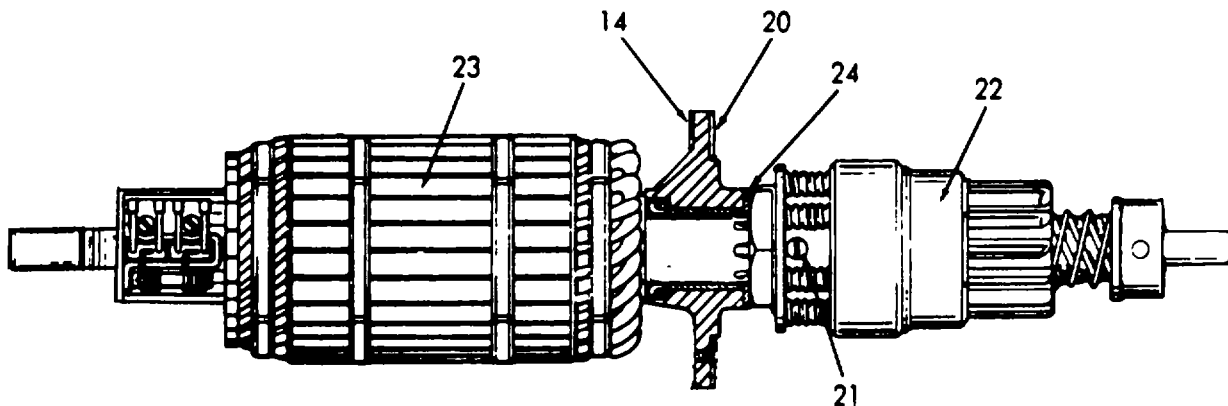
ASSEMBLY (Cont)

16. Starting Motor

NOTE

Apply a light coat of OE-10 engine oil (MIL-L-2104) to inside of all sleeve bearings prior to final assembly.

- a. Install spacer washer (24) and middle bearing assembly (14) on Bendix drive end of armature shaft.
- b. Press Bendix drive assembly (22) on armature assembly (23).
- c. Install setscrew (21) and tighten to secure. Then, slide retaining wire into place.
- d. Position middle bearing gasket (20) in place.



5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

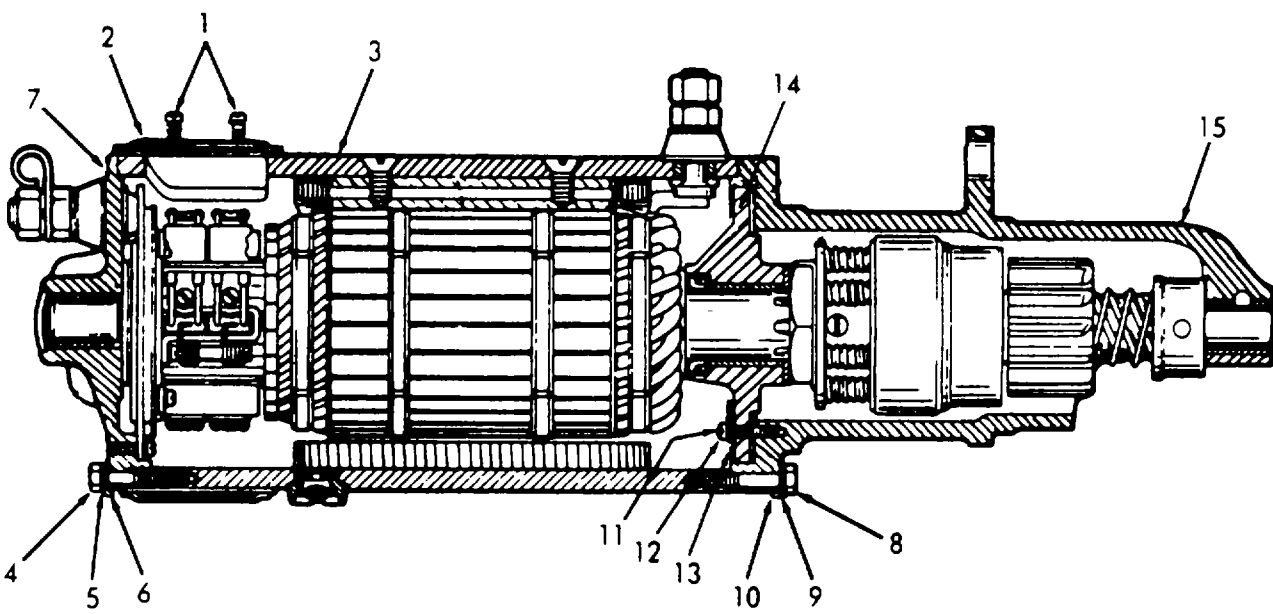
- e. Position drive housing assembly (15) and middle bearing assembly (14) in place on frame and field assembly (3) and secure to middle bearing assembly with six lockwashers (13) and screws (12).
- f. Secure screws (12) with locking wire (11).
- g. Secure middle bearing assembly (14) and Bendix drive housing assembly (15) to field and frame assembly (3) with twelve lockwashers (10), flatwashers (9) and bolts (8).
- h. Position commutator end of bearing assembly (7) in place and secure to frame and field assembly (3) with four lockwashers (6), flatwashers (5), and end bracket bolts(4).
- i. Remove brush lead attaching screws and lockwashers from brush assemblies.
- j. Position two field coil leads to the proper brush assemblies, and secure brushes with eight brush lead attaching screws. Tighten screws.

5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- k. Slide cover band assembly (2) in place on field and frame assembly (3), and tighten bolts (1) to secure.



5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

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

INSTALLATION

- | | | |
|---------------------|--|--|
| 17. Starter | a. Position starter motor (14) in place on flywheel housing.

b. Secure with three lockwashers (13), and bolts (12). | |
| 18. Fuel Filter | a. Install filter element and shell (11) on filter head.

b. Close petcock (10) at bottom of filter.

c. Turn fuel filter valve lever (9) to ON on forward filter. | |
| 19. Support Bracket | a. Position support bracket (8) in place on air silencer.

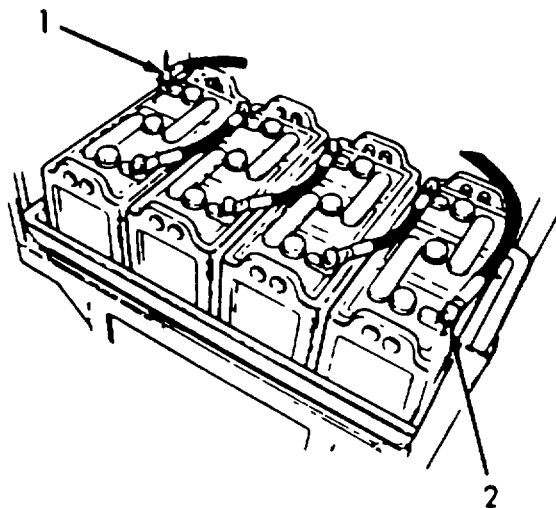
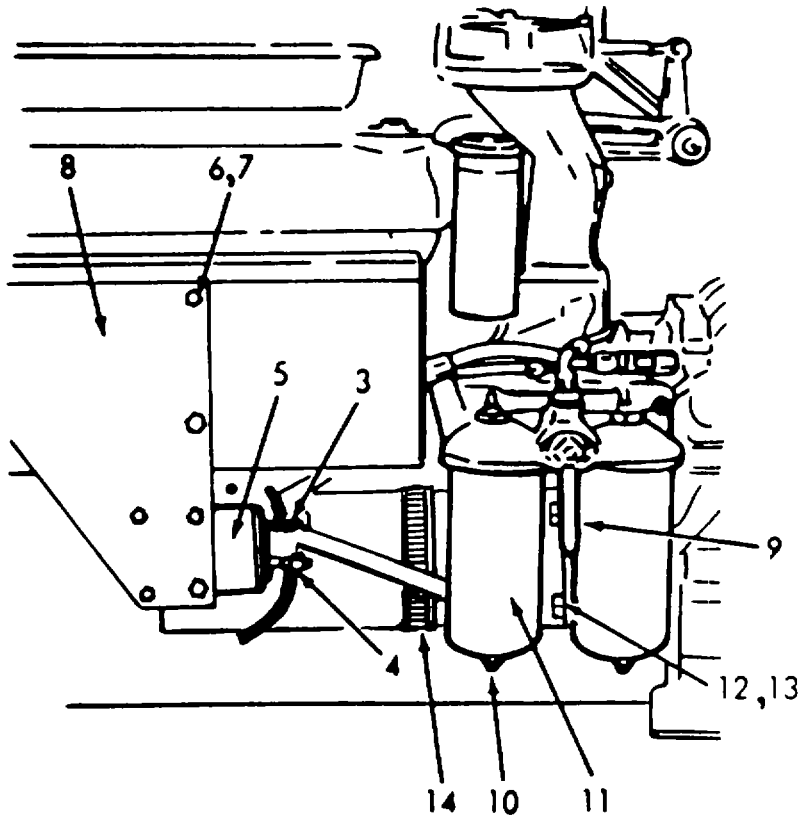
b. Secure with four lockwashers (7), and screws (6). | |
| 20. Leads | a. Reconnect solenoid switch leads (4 and 3) to solenoid (5).

b. Reconnect battery leads (2 and 1) to battery(s). | |

5-12.2. STARTING MOTORS (ELECTRIC) (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION Cont)



5-13. HYDRAULIC STARTING SYSTEMS.

- a. The landing craft is fitted with a dual cranking system for the propulsion engines. The inboard engine of each propulsion unit is equipped with a hydraulic starting motor. See figure 5-9.
- b. Energy required for hydraulic cranking is supplied by fluid stored under approximately 3,000 psi pressure in two interconnected accumulators. These accumulators are charged first by a hand operated hydraulic pump, and then by engine-driven pumps. They can not be overcharged during long periods of engine operation because of pressure control built into the pumps. There is also a system relief valve set at 3,400 psi, which is the safe maximum pressure for this system.
- c. The following is an index of the maintenance instructions:

<u>DESCRIPTION</u>	<u>PARAGRAPH</u>
Hydraulic Starting System Reservoirs	5-13.1
Hydraulic Starting Motor.....	5-13.2
Solenoid Valve, Starting Motor Control.....	5-13.3
Pump, Hydraulic Starter	5-13.4
Accumulator	5-13.5
Hydraulic Hand Pump	5-13.6
Hydraulic Starting Piping System	5-13.7

5-13. HYDRAULIC STARTING SYSTEMS. (Continued).

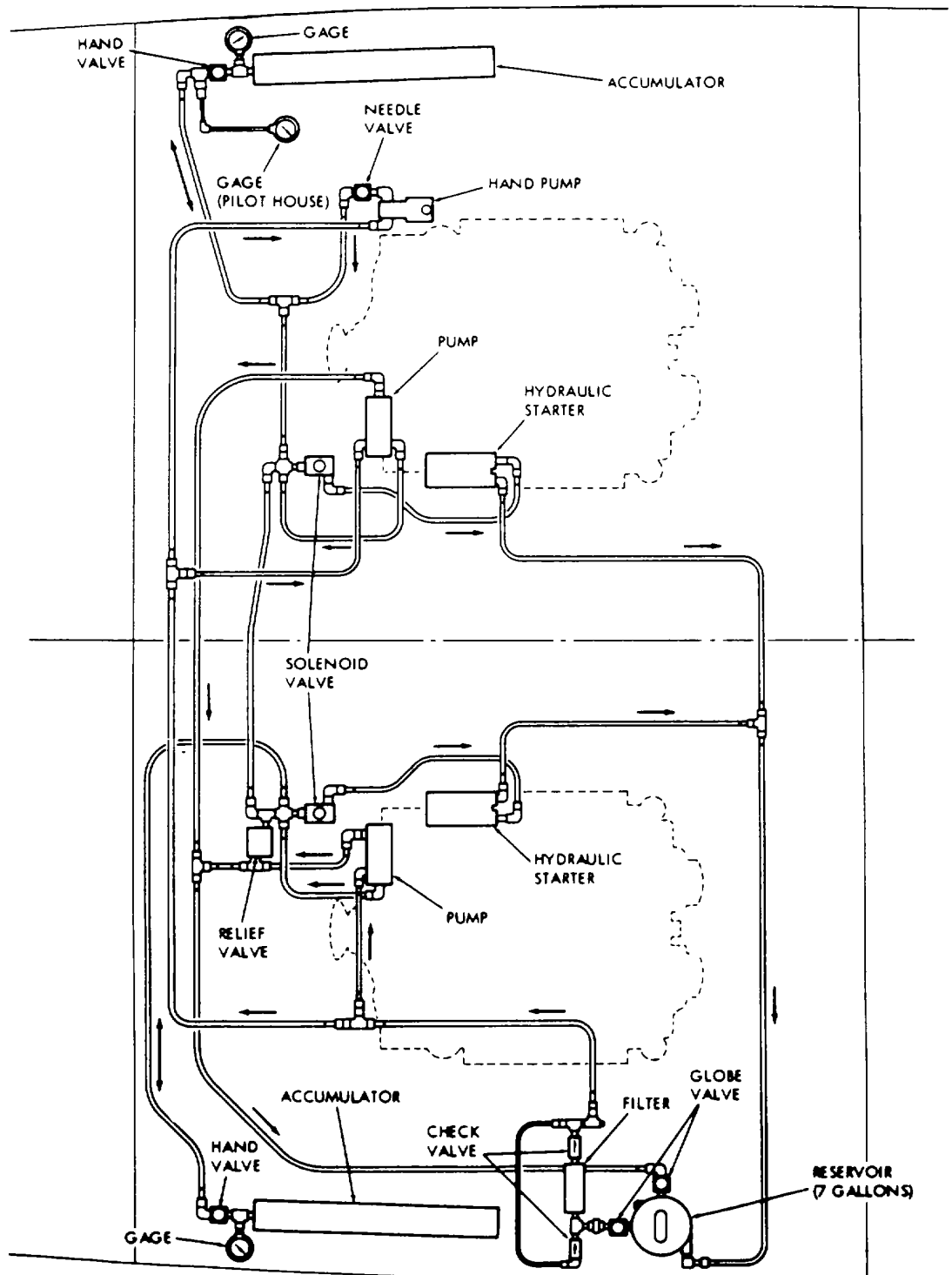


Figure 5-3. Hydraulic Starting System Diagram.

5-13.1. HYDRAULIC STARTING SYSTEMS FILTERS AND RESERVOIRS.

The filter is mounted near the reservoir on the starboard side of the engine room.

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Welding Tools

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Welding torch

Equipment

Condition Condition Description

NONE

Materials/Parts

Cleaning solvent P-D-680
Solder QQ-S-571

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION/ITEM

ACTION

REMARKS

REMOVAL



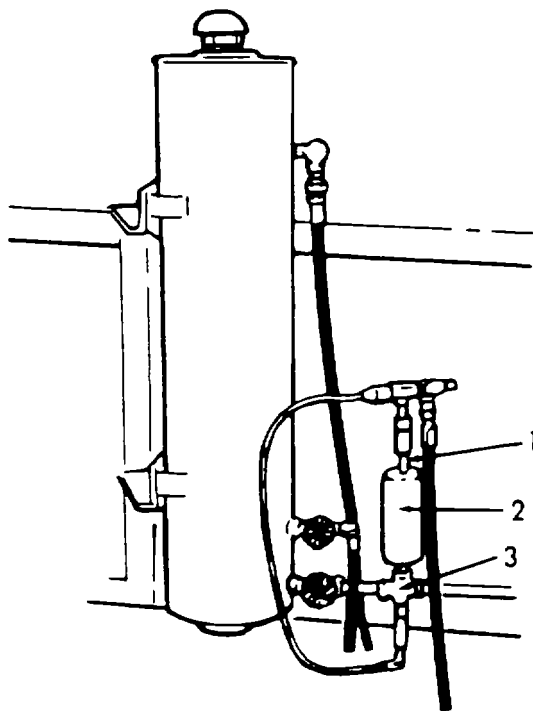
The fluid pressure in the hydraulic starting system must be released prior to servicing the engine-driven pump or other parts to prevent possible injury to personnel or damage to equipment.

5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

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

REMOVAL (Cont)

1. Hydraulic Filter	<ul style="list-style-type: none"> a. Close outlet valve at reservoir. b. Disconnect lines (1 and 2) from filter. c. Remove filter (3). 	Cap open ends to prevent entry of dirt.
---------------------	--	---



WARNING

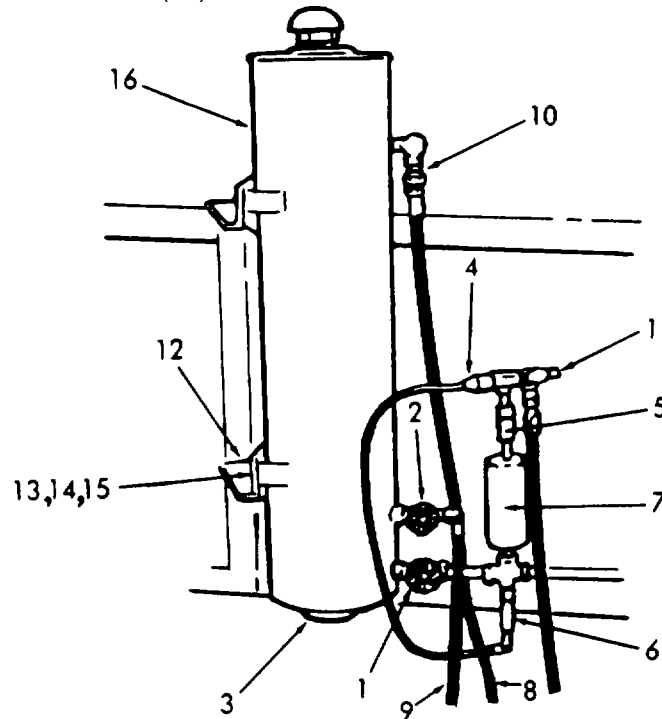
The fluid pressure in the hydraulic starting system must be released prior to servicing the engine-driven pump or other parts to prevent possible injury to personnel or damage to equipment.

5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

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

REMOVAL (Cont)

- | | | |
|--------------|---|--------------------------------------|
| 2. Reservoir | a. Close shutoff valves (1 and 2). | Turn clockwise to close. |
| | b. Remove pipe plug (3) from reservoir. | Drain oil into a suitable container. |
| | c. Disconnect line (4) from check valves. | Cap open end. |
| | d. Remove check valves (5 and 6) and filter (7). | |
| | e. Disconnect lines (8 and 9) from shutoff valves (1 and 2). | Cap open ends. |
| | f. Disconnect intake line (10) and return line (11). | Cap open ends. |
| | g. Remove nuts (12), screws (13), and lockwashers (14) from mounting bracket (15), and remove reservoir (16). | |

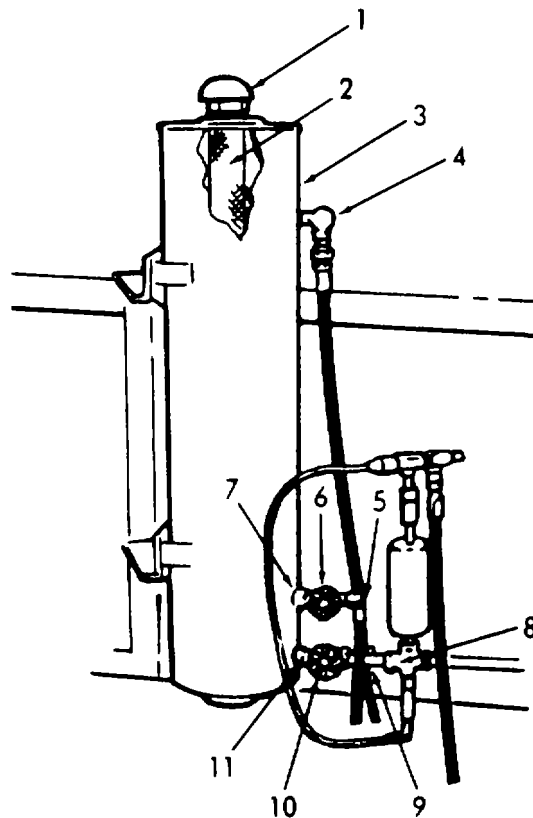


5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

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

DISASSEMBLY.

- | | | |
|--------------|---|--|
| 3. Reservoir | <ul style="list-style-type: none"> a. Unscrew and remove breather cap (1). b. Lift strainer screen (2) from reservoir (3). c. Remove elbow (4). d. Remove elbows (5), shutoff valve (6), and nipple (7). e. Remove tee (8), nipple (9), shutoff valve (10), and nipple (11). | |
|--------------|---|--|



5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

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

CLEANING

4.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° - 138°F (38° -59°C).

Clean all parts of the hydraulic oil reservoirs in cleaning solvent P-D-680, and dry thoroughly.

INSPECTION

5.

Inspect all parts for cracks, corrosion, dents, and defective hardware.

REPAIR

6.

WARNING

Be sure reservoir is filled with sand or water before attempting any welding. Explosion or fire could result in injury or death to personnel. Welding should be done only by a qualified welder.

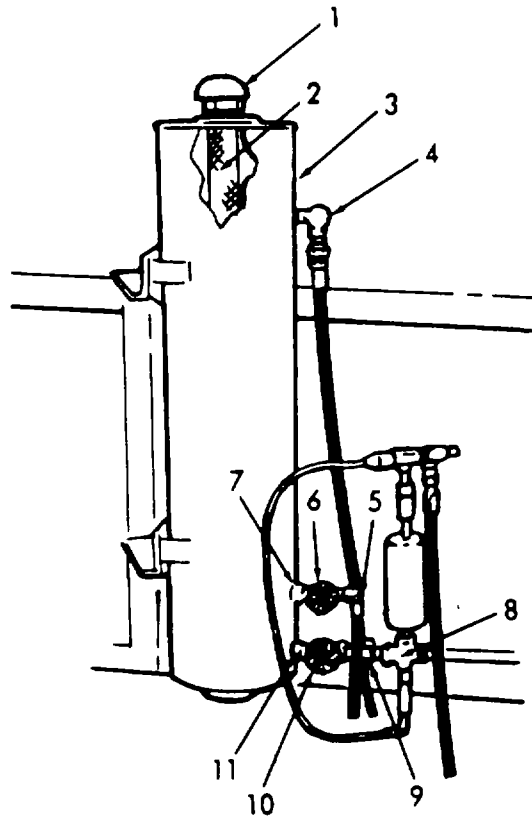
- a. Straighten dents.
- b. Replace defective hardware.
- c. Weld minor cracks and breaks.
- d. Replace any reservoir damaged beyond repair.

5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

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

ASSEMBLY (Cont)

- | | | |
|--------------|---|--|
| 7. Reservoir | <ul style="list-style-type: none"> a. Install nipple (11), shutoff valve (10), nipple (9), and tee (8). b. Install nipple (7), shutoff valve (6), and elbow (5). c. Install elbow (4). d. Place strainer screen (2) in reservoir (3). e. Install breather cap (1). | |
|--------------|---|--|



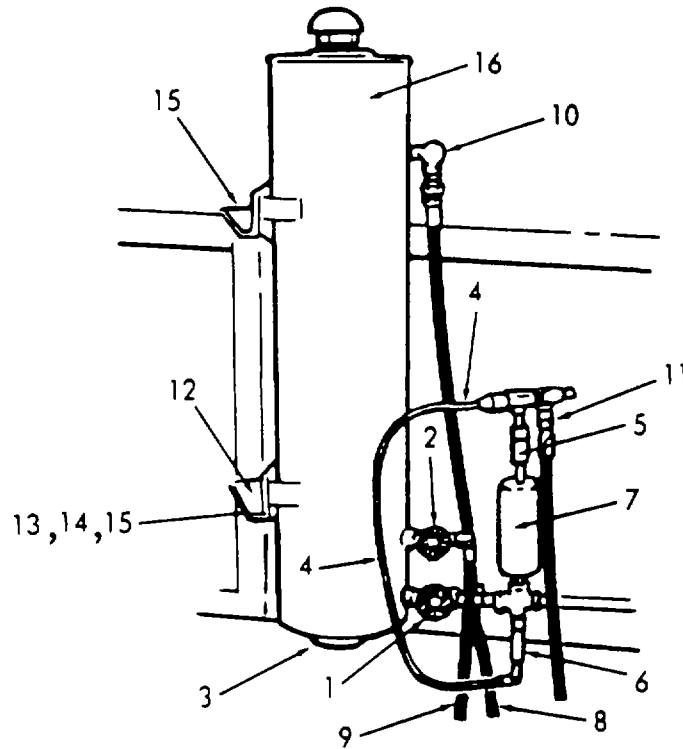
5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION (Cont)</u>		
8. Reservoir	a. Position reservoir (16) in place in mounting brackets (15).	
	b. Secure with lockwashers (14), screws (13), and nuts (12).	
	c. Reconnect return line (11), and intake line (10).	Remove caps.
	d. Reconnect lines (9 and 8) to shutoff valves (1 and 2).	Remove caps.
	e. Install filter (7) and check valves (6 and 5).	
	f. Reconnect line (4) to check valves (6 and 5).	Remove caps.
	g. Install pipe plug (3) in reservoir.	
	h. Open shutoff valves (2 and 1).	Turn counterclockwise to open.

5-13.1. HYDRAULIC STARTING SYSTEM FILTERS AND RESERVOIRS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)



5-13.2. HYDRAULIC STARTING MOTOR.

Hydraulic starting motors are installed on the inboard engine of each propulsion unit. The two hydraulic starting motors, CMD-2A-111 and CMD-2A-221, are similar except for direction of rotation. Model CMD-2A-111 has a clockwise rotation, viewing from the starter drive end, and is mounted on the inboard engine of the starboard propulsion unit. Model CMD-2A-221 rotates counterclockwise, viewing from the drive end, and is mounted on the inboard engine of the port propulsion unit.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Torque torch

<u>Equipment</u>	<u>Condition</u>	<u>Description</u>
------------------	------------------	--------------------

NONE

Materials/Parts

Cleaning solvent
Fed Spec. P-D-680
Clan cloths
Safety goggles

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

5-13.2. HYDRAULIC STARTING MOTOR (Continued).

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

REMOVAL (Cont)

- | | | |
|-------------------|-----------------------------------|--|
| 1. Starting Motor | a. Close both accumulator valves. | |
|-------------------|-----------------------------------|--|



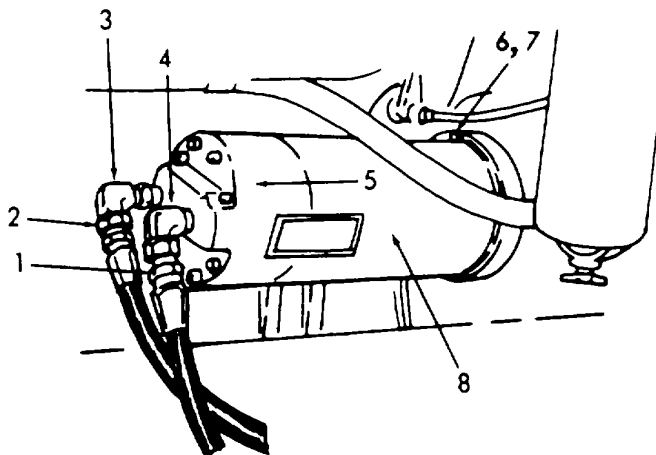
The fluid pressure in the hydraulic starting system must be released prior to servicing the engine-driven pump or other parts to prevent possible injury to personnel or damage to equipment.

- | | | |
|--------------------|--|--|
| 2. Hydraulic Lines | b. Clean all exterior dirt from starter and hydraulic lines.

c. Release pressure in hydraulic system lines. | |
| 3. Starting Motor | Disconnect the hydraulic lines (1 and 2) from the starting motor. Cover the open ends of the lines with masking tape to prevent entry of dirt.

a. Remove elbows (3 and 4) from port plate (5).

b. Remove three retaining bolts (6), and lockwashers (7), and lift starting motor (8) away from the flywheel housing. | |

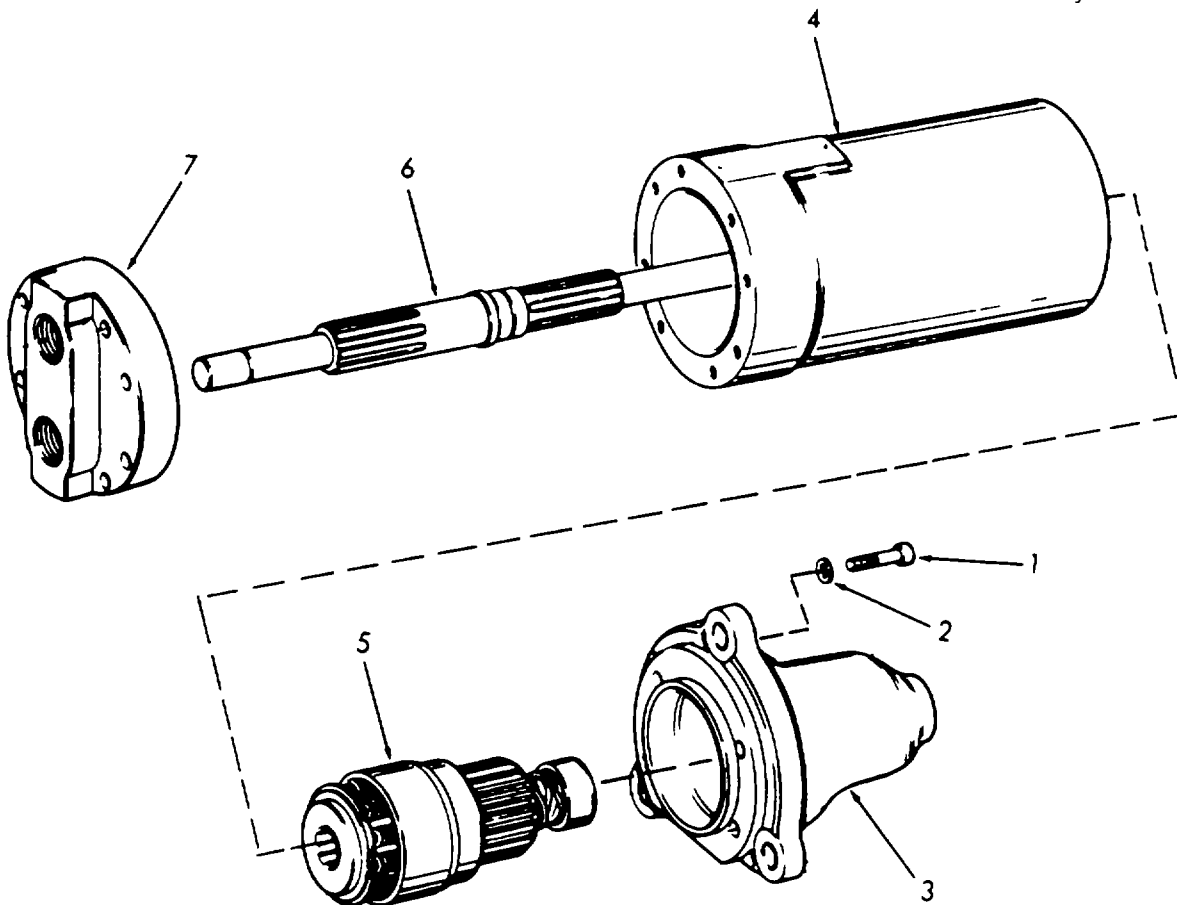


5-13.2. HYDRAULIC STARTING MOTOR (Continued).

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

DISASSEMBLY

- | | | |
|-------------------|--|---|
| 4. Starting Motor | <ul style="list-style-type: none"> a. Clamp starter motor housing in a vise. b. Remove four screws (1), and lockwashers (2). c. Remove pinion gear housing (3) from motor housing (4). d. Slide Bendix drive assembly (5) from drive shaft (6). e. Scribe an index mark on port plate (7), and motor housing (4). | Enables proper positioning of port plate at reassembly. |
|-------------------|--|---|



5-13.2. HYDRAULIC STARTING MOTOR (Continued).

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

There is a slight spring load on the port plate. Upon loosening the screw, any oil left in the housing will drain out.

- | | |
|---|--|
| f. Remove port plate screws (8), and lockwashers (9) from the port plate, and remove port plate (7). | |
| g. Invert housing (4) allowing barrel (10) and pistons (11) to slide off drive shaft (6). | |
| h. Remove pistons (11) from barrel (10). | |
| i. Remove retaining ring (12) from drive shaft. | |
| j. Press drive shaft (6) out of housing (4) from port plate end. | Seals (13, 14 and 15), seal holder (16), retaining ring (17), and shaft bearing (18) will come out with shaft. |
| k. Remove inner seal (13), slipper seal (14), outer seal (15), seal holder (16) from drive shaft. | Remove only if defective. |
| l. Remove retaining ring (17), and shaft ball bearing (18) from drive shaft. | |
| m. Press against thrust bearing housing (19) with a little pressure and remove thrust bearing assembly. | |

5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

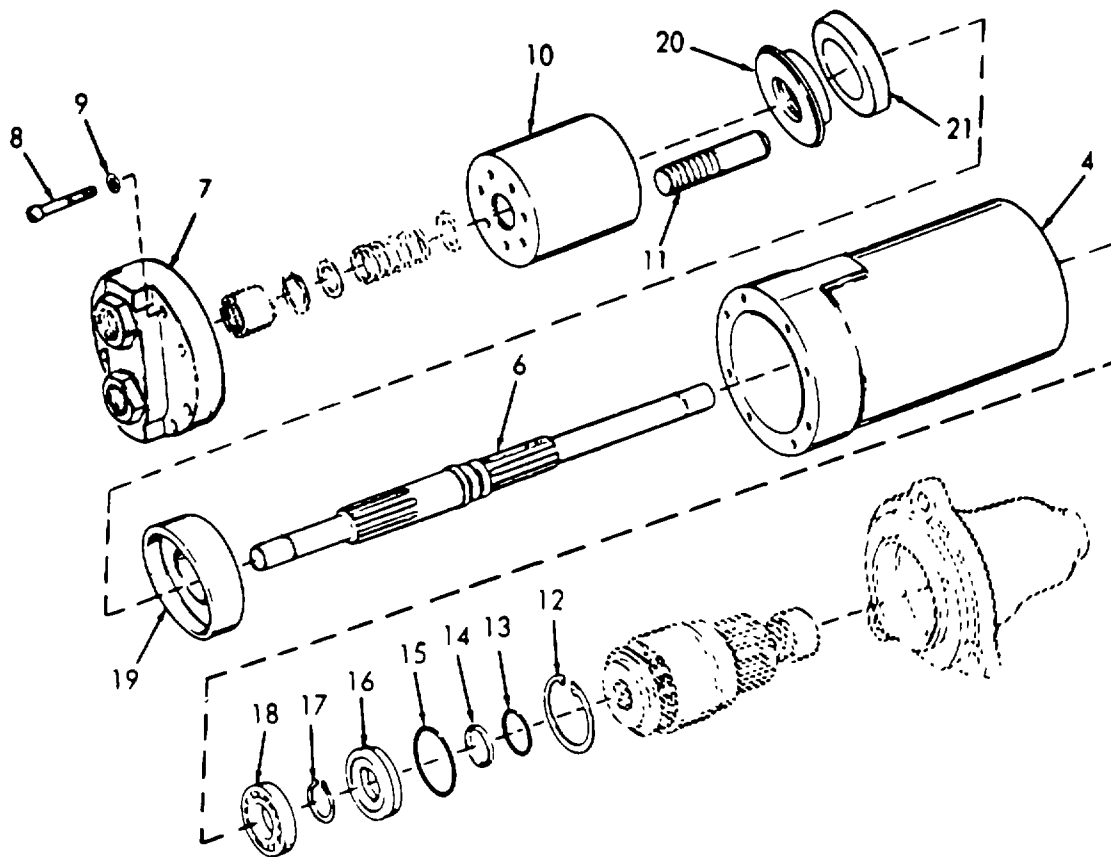
- n. Remove thrust bearing plate (20).

CAUTION

Do not apply excessive heat to thrust bearing. Do not remove thrust bearing unless it is to be replaced.

- o. Apply heat to thrust bearing housing (19) and press out thrust bearing (21).

Remove thrust bearing only if damaged or defective.

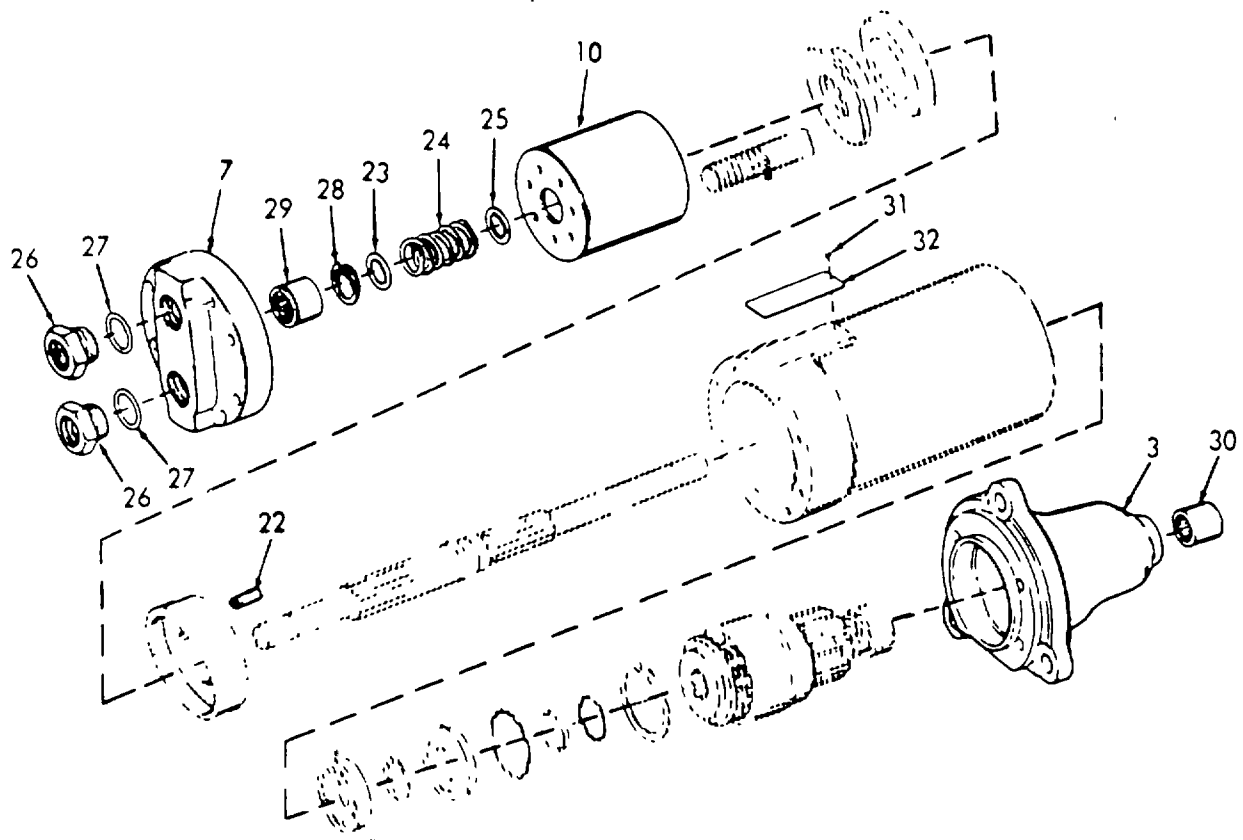


5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|----|--|--------------------------------------|
| p. | Remove dowel pin (22), washer (23), spring (24) and washer 1(25) from barrel (10). | If damaged. |
| q. | Remove adapter fittings (26) and gasket (27) from port plate (7). | If damaged or defective. |
| r. | Remove retaining ring (28) and roller bearing (29) from port plate. | If damaged or defective. |
| s. | Press needle bearing (30) from pinion gear housing (3). | If damaged or defective. |
| t. | Remove screws (31) and remove nameplate (32). | Only if nameplate is to be replaced. |



5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING

5. Starting Motor

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100 -138°F (38°-59°C).

- a. Clean metal parts in P-D-680, and dry thoroughly.

WARNING

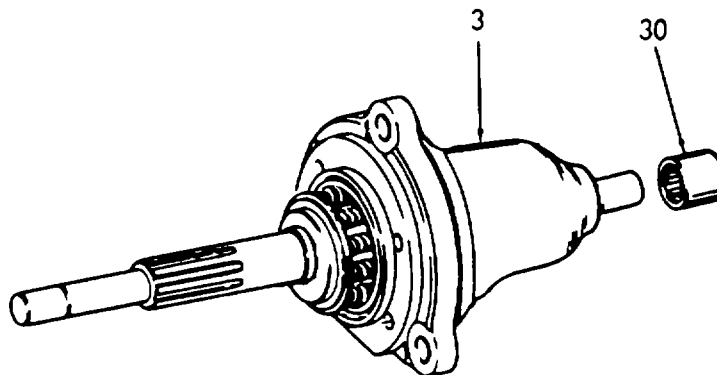
Wear protective eye goggles when using compressed air to prevent eye injury. Do not exceed 15 PSI.

- b. Blow out all passages with compressed air to remove any dirt or other matter.

INSPECTION

6. Starting Motor

- a. Pinion Gear Housing (3). Visually check housing for cracks or other damage. Examine bearing (30) for damage or wear.



5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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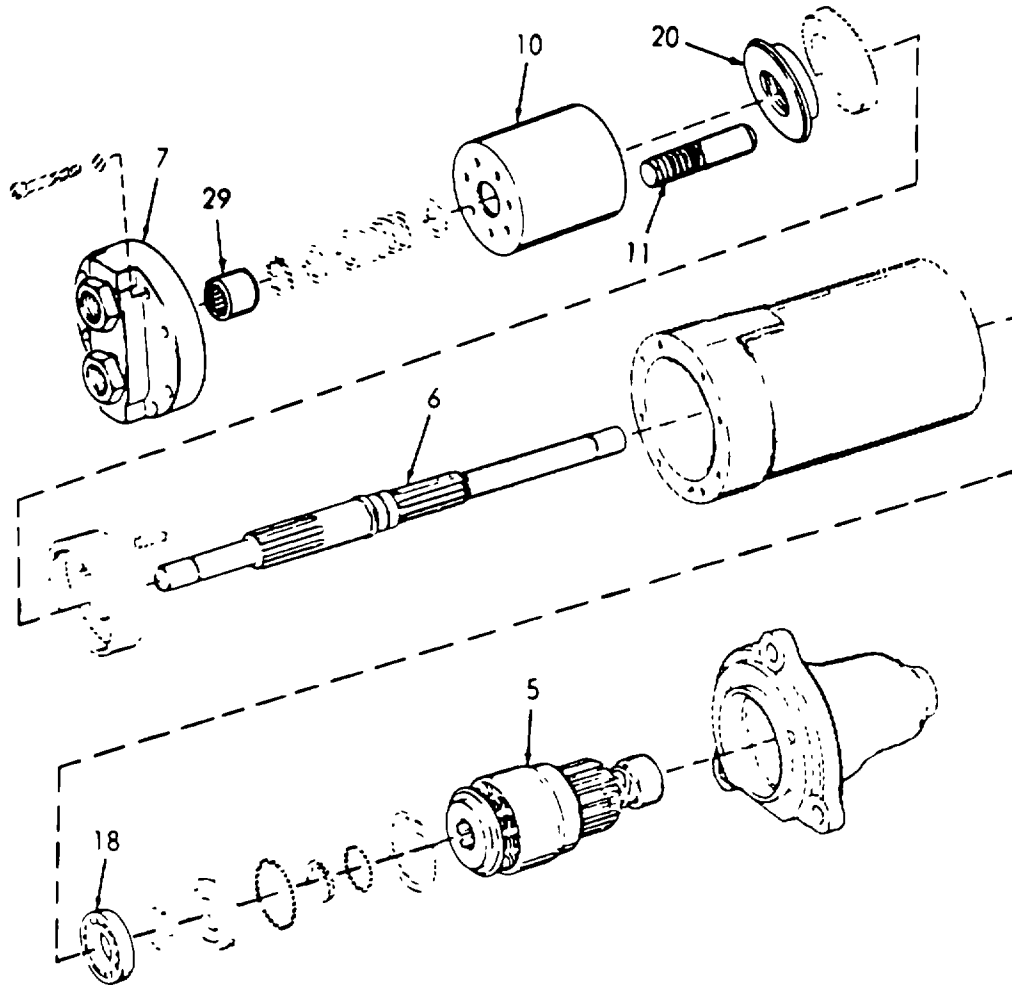
INSPECTION (Cont)

- | | | |
|----|---|--|
| b. | Drive Assembly (5). Examine pinion gear to be sure that the teeth are not worn excessively or chipped from interference with ring gear. Check to insure that the compressing spring is not damaged or broken. | |
| c. | Port Plate Assembly (7). The port plate face, where cylinder rides, must be smooth and free of scoring. Also check the bearing (29). | |
| d. | Motor Barrel (10). Examine the potted face of the cylinder for scratching or scoring. Slight scuff marks can be removed by lapping on a surface plate. The bores of the cylinder should be smooth and free of scoring. | |
| e. | Pistons (11). The diameter of the pistons (11) should be smooth and free of scoring. The closed end of the pistons may show brinnelling where they contact the thrust bearing plate (20), but no burrs or flat spots are permissible. | |
| f. | Shaft (6). Check the ends of the shaft for wear or scoring. The splines should be smooth and free of nicks. Check bearing (18). | |

5-13.2. HYDRAULIC STARTING MOTOR (Continued).

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

INSPECTION (Cont)



REPAIR

- | | |
|-------------------|---|
| 7. Starting Motor | <ul style="list-style-type: none"> a. Replace seals and gaskets. b. Replace all other defective parts as necessary. |
|-------------------|---|

ASSEMBLY

- | | | |
|-------------------|--|---------------------------|
| 8. Starting Motor | <ul style="list-style-type: none"> a. Lubricate parts with clean, light engine oil before assembly. | Use oil OE-10 MIL-L-2104. |
|-------------------|--|---------------------------|

5-13.2. HYDRAULIC STARTING MOTOR (Continued).

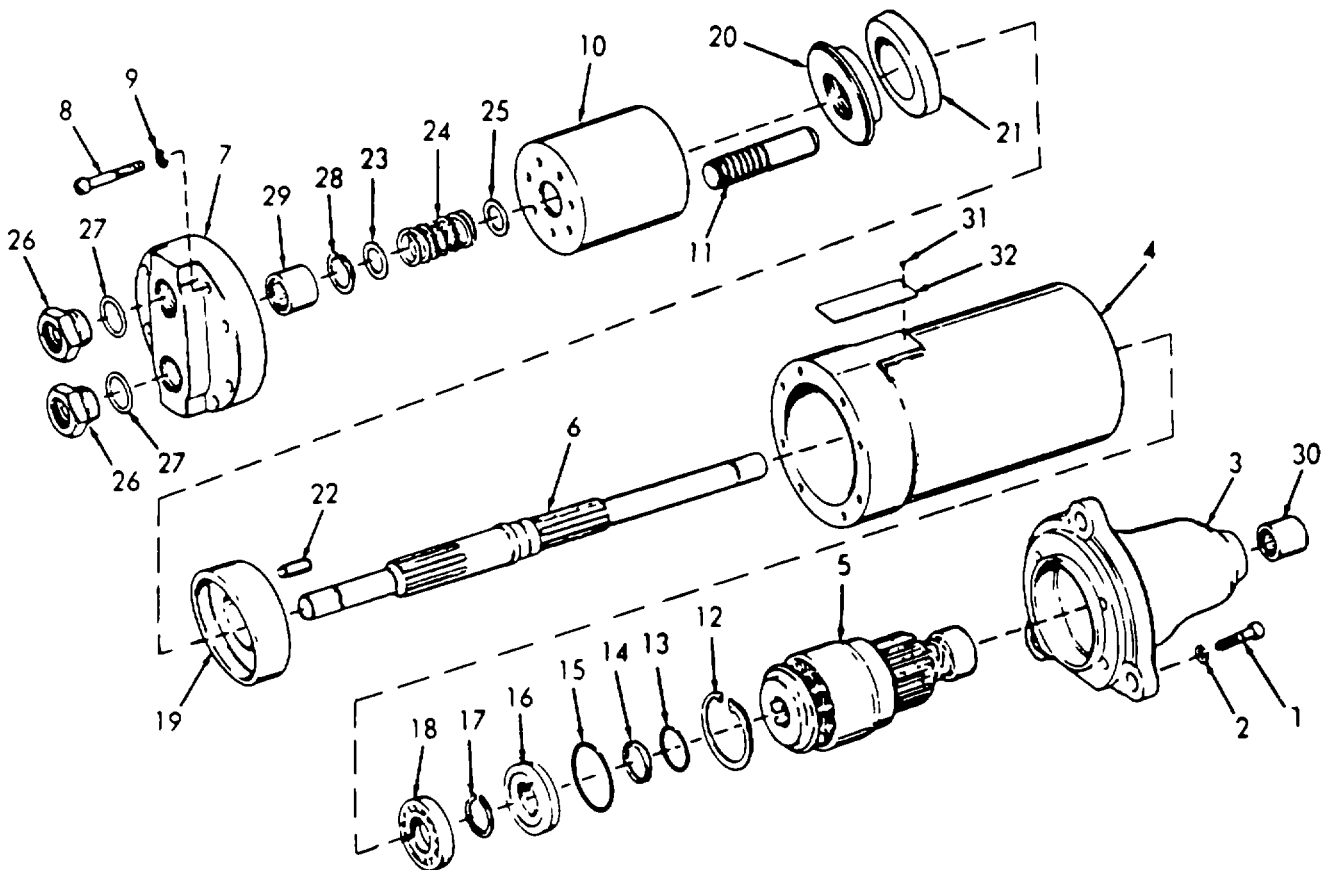
LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>		
	b. Install nameplate (32) using two screws (31).	If removed.
	c. Press needle bearing (30) into pinion gear housing (3).	If removed.
	d. Install roller bearing (29) in port plate (7), securing with retaining ring (28).	If removed.
	e. Install adapter fitting gaskets (27), and adapter fittings (26).	If removed.
	f. Install washer (25), spring (24), and washer (23) onto motor barrel (10).	
	g. Install dowel pin (22).	If removed.
	h. Press thrust bearing (21) into housing (19), and install housing (19), and thrust bearing plate (20).	Press in housing until it bottoms against housing (4). Be sure dowel pin (22) is in place.
	i. Install drive shaft ball bearing (18) on drive shaft, and secure with retaining ring	
	j. Install with seal holder (16).	
	k. Install outer seal (15), slipper seal (14), and inner seal (13) onto drive shaft.	
	l. Press assembled drive shaft (6) into housing (4) from port plate end (7).	
	m. Secure with retaining ring (12).	
	n. Install pistons (11) onto barrel (10), and install barrel (10).	

5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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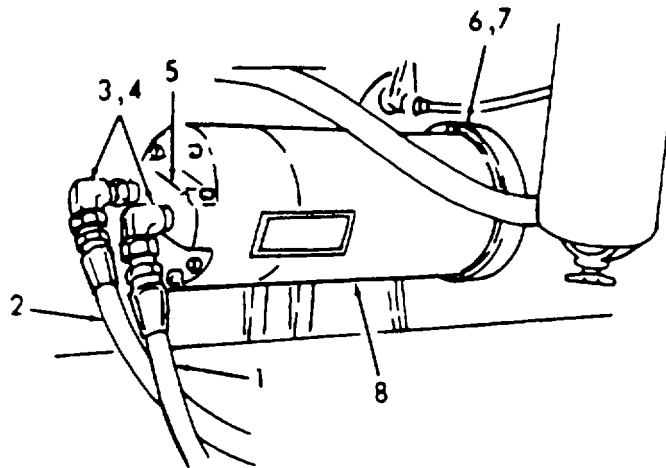
ASSEMBLY (Cont)

- o. Position assembled port plate (7) onto motor housing (4).
- p. Align scribe marks on port plate (7) and motor housing (4).
- q. Secure with lockwashers (9) and screws (8). Torque screws to 300 lb. in. (33.89 Nm).
- r. Install Bendix drive (5) onto drive shaft (6).
- s. Position pinion gear housing (3) in place on motor housing (4).
- t. Secure with four lockwashers (2), and screws (1). Tighten screws.



5-13.2. HYDRAULIC STARTING MOTOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION</u>		
9. Starting Motor	a. Position starter assembly (8) in place on flywheel housing. b. Secure with three lockwashers (7), and retaining bolts (6).	
10. Hydraulic Lines	a. Install elbows (3 and 4) into port plate (5). b. Reconnect hydraulic lines (2 and 1) to starter motor (8).	Remove caps from ends of lines.
11. Accumulator Valve	Open accumulator valves.	



5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL.

Solenoid valves are used to control the hydraulic starting motors. They can be actuated electrically from the pilothouse or manually in the engine room.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment

Condition Condition Description

NONE

Materials/Parts

Cleaning solvent
Fed Spec. P-D-680
Tags
Clean cloths

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

LOCATION/ITEM	ACTION	REMARKS
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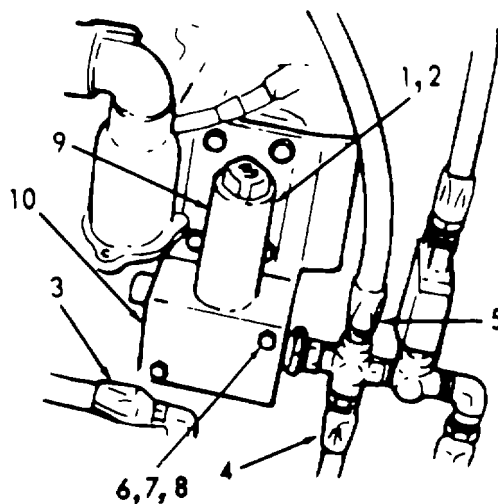
REMOVAL

- | | | |
|-----------------------|------------------------------|--|
| 1. Accumulator Valves | a. Close accumulator valves. | |
|-----------------------|------------------------------|--|



The fluid pressure in the hydraulic starting system must be released prior to servicing the engine-driven pump or other parts to prevent possible injury to personnel or damage to equipment.

- | | | |
|---------------------------|---|--|
| | b. Relieve pressure in lines. | |
| 2. Electrical Connections | Remove and tag electrical connections (1 and 2). | |
| 3. Hydraulic Lines | a. Remove hydraulic lines (3, 4, and 5) from solenoid valve.
b. Remove associated piping from solenoid valve. | |
| 4. Solenoid Valve | a. Remove nuts (6), washers (7), (if used), and screws (8) securing solenoid valve.
b. Remove solenoid valve (9) from mounting bracket (10). | |



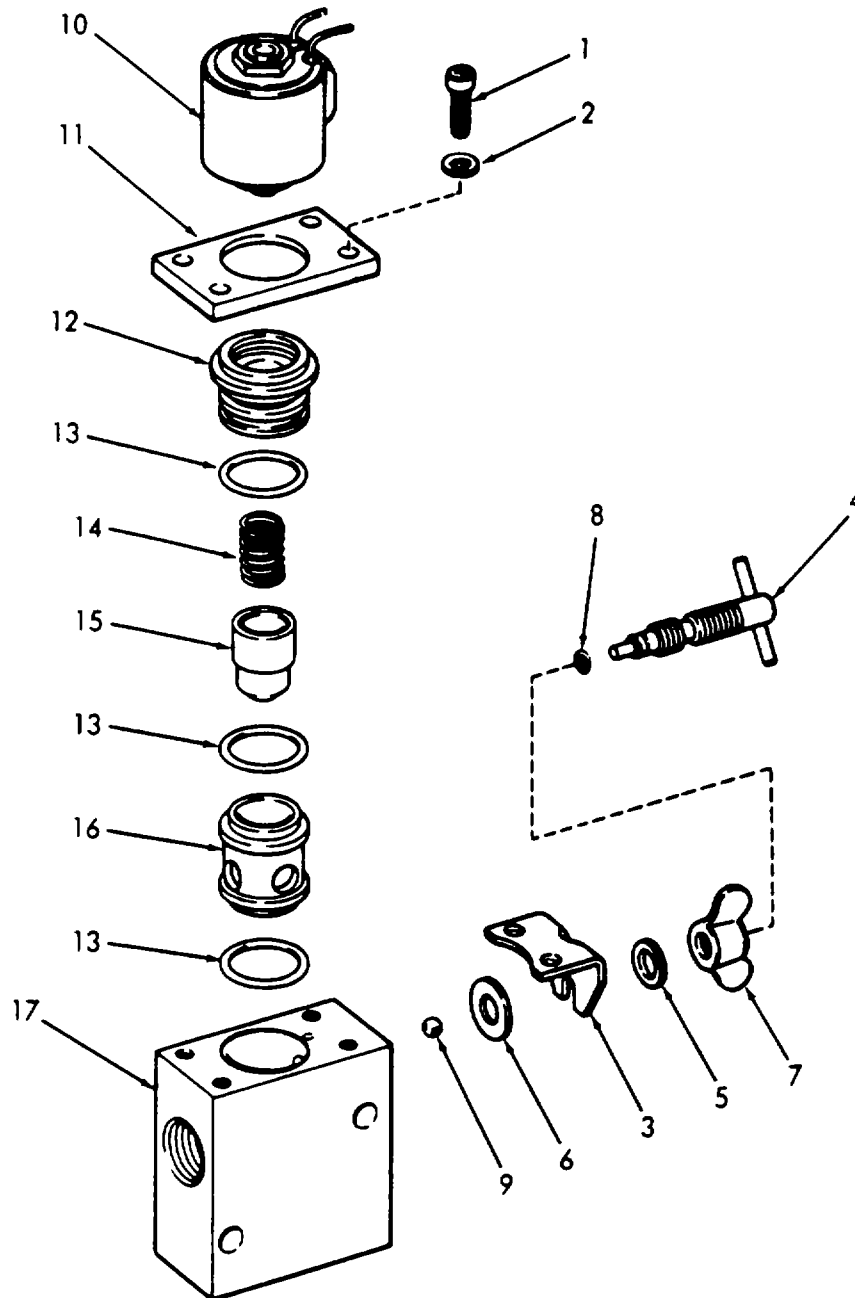
5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>		
5. Solenoid Valve	a. Remove four screws (1), and lockwashers (2) from retainer plate (11) and housing (17).	
	b. Remove screw stop (3).	
	c. Unscrew and remove control screw (4), lockwasher (5), and flatwasher (6).	
	d. Remove wing nut (7), and "O" ring seal (8) from control screw.	Discard "O" ring, and seal.
	e. Turn housing on its side and remove ball valve (9).	
	f. Unscrew and remove solenoid valve (10), and retainer plate (11).	
	g. Remove actuator housing (12), gaskets (13), valve spring (14), poppet valve (15), and solenoid valve body (16), from housing (17).	Discard gaskets.

5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

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

CLEANING

6.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°-59°C).

Clean metal parts in cleaning solvent P-D-680, and dry thoroughly.

INSPECTION

- 7.
- a. Inspect housing for cracks.
 - b. Inspect actuator housing, poppet valve, and solenoid body for nicks, burrs, cracks, or other visible damage.
 - c. Inspect spring for loss of tension or cracked coils.
 - d. Inspect control screw for stripped or crossed threads.
 - e. Inspect ball valve for nicks, burrs, or flat spots.

REPAIR

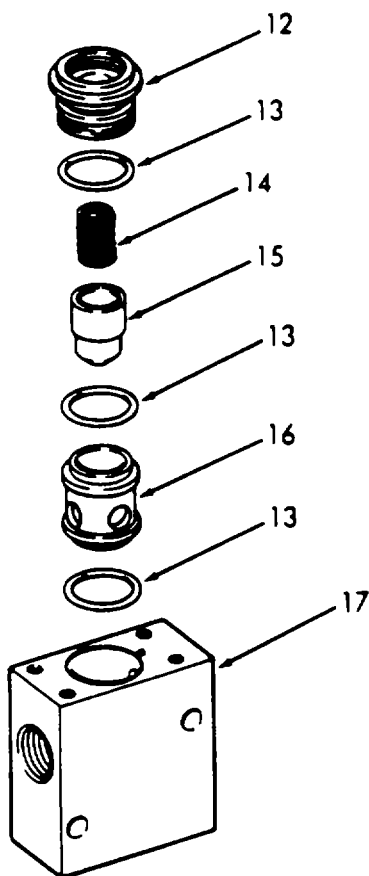
- 8.
- a. Replace "O" ring seals and gaskets.
 - b. Replace other defective parts as required.

5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

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

ASSEMBLY (Cont)

- | | | |
|-------------------|--|--|
| 9. Solenoid Valve | <ul style="list-style-type: none"> a. Install gaskets (13) onto solenoid body (16). b. Insert solenoid body into housing (17). c. Insert spring (14) into valve poppet (15). d. Insert valve poppet (15) into housing. e. Install gasket (13) onto actuator housing (12). | |
|-------------------|--|--|

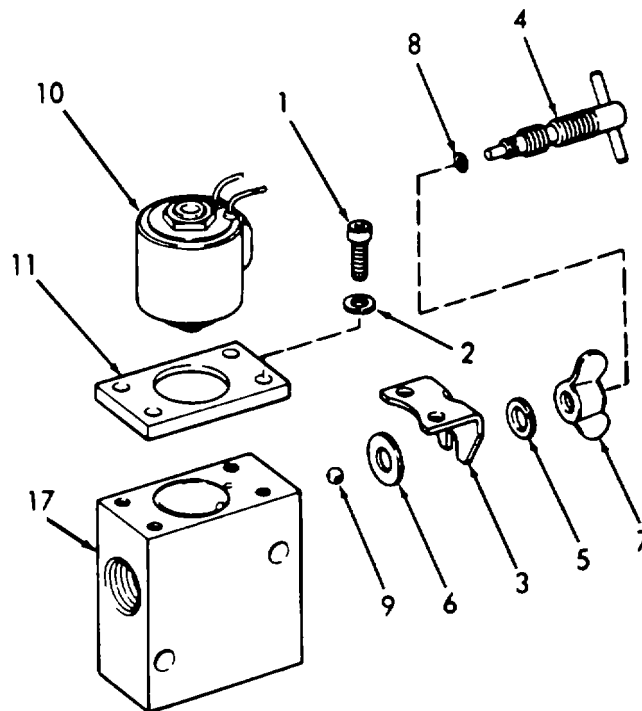


5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

LOCATION/ITEM	ACTION	REMARKS
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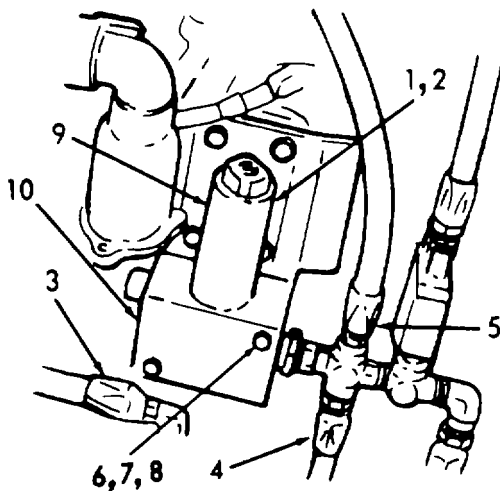
ASSEMBLY (Cont)

- f. Position retainer plate (11) in place on housing (17), and install solenoid valve (10).
- g. Turn housing on its side and install ball valve (9).
- h. Install "O" ring gasket (8), wing nut (7), and lockwasher (5) onto control screw (4).
- i. Position screw stop (3) and flatwasher (6) in place on housing.
- j. Screw assembled control screw (4) into valve housing.
- k. Secure installed parts to valve housing with lockwashers (2), and screws (1).



5-13.3. SOLENOID VALVE STARTING MOTOR CONTROL (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION</u>		
10. Solenoid Valve	a. Position solenoid valve (9) in place on mounting bracket (10). b. Secure with nuts (8), washers (7), if used, and screws (6). c. Install associated piping.	
11. Hydraulic Piping	Reconnect hydraulic lines (5, 4, and 3).	
12. Electrical Connections	Reconnect electrical connections	Remove tags. (2, and 1).
13. Accumulator Valves	Open.	



5-13.4. PUMP, HYDRAULIC STARTER

The engine-driven charging pump is a single piston, positive displacement type. The ball check valves, and the unloading valve are automatically controlled by the accumulator pressure. The pump shaft is supported on ball bearings; a seal, pressed into the pump bearing retainer, prevents leakage. The pump is attached to the flywheel housing, and is driven by a drive plate bolted to the balance shaft gear.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment
Condition Condition Description

NONE

Materials/Parts

Sealant

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING and CAUTION
in this procedure.

LOCATION/ITEM

ACTION

REMARKS

INSPECTION

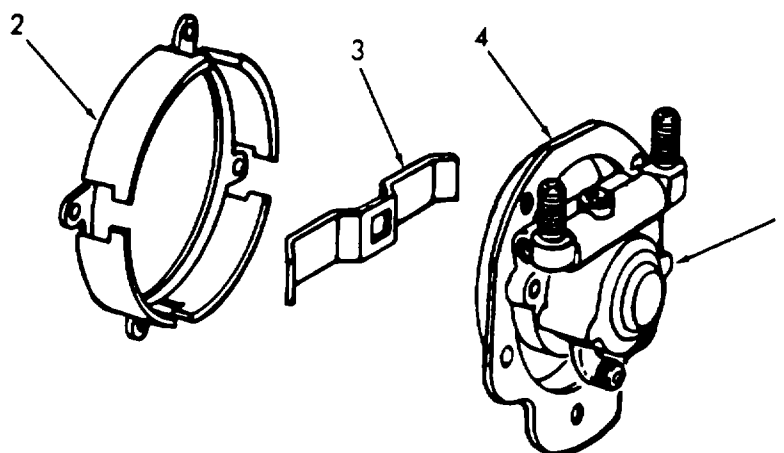
- | | |
|----------------------------|--|
| 1. Pump and Mounting Plate | a. Inspect pump (1) for evidence of leaking. |
|----------------------------|--|

5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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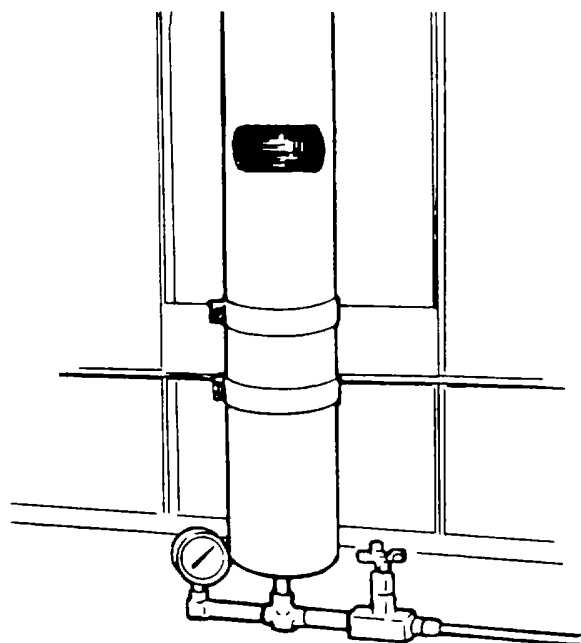
INSPECTION (Cont)

- b. Inspect drive plate (2), pump drive (3), and mounting plate (4) for cracks or breaks.



REMOVAL

- | | |
|---|---|
| <ol style="list-style-type: none"> 2. Accumulator Valves | <ol style="list-style-type: none"> a. Close both accumulator valves. |
|---|---|



5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)**WARNING**

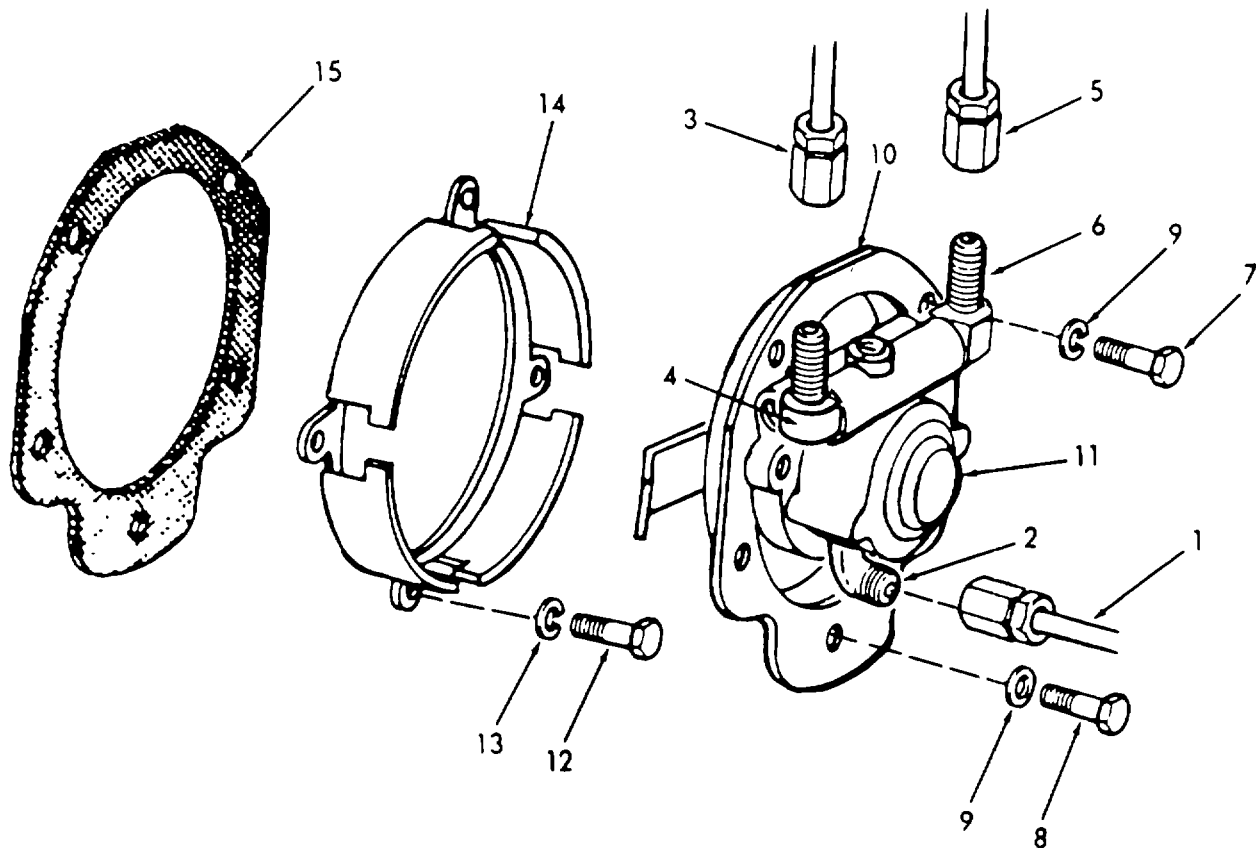
The fluid pressure in the hydraulic starting system must be released prior to servicing the enginedriven pump or other parts to prevent possible injury to personnel or damage to equipment.

3. Hydraulic Lines	b. Clean all dirt from pump and hydraulic lines. a. Disconnect return line (1) at elbow (2). Then remove elbow.	Cap open end.
	b. Disconnect inlet line (3) at elbow (4). Then remove elbow.	Cap open end.
	c. Disconnect pump outlet line (5) at elbow (6). Then remove elbow.	Cap open end.
4. Pump and Mounting Plate	a. Remove bolts (7 and 8), and lockwashers (9) from mounting plate (10). b. Remove mounting plate (10) with pump (11) attached.	
5. Pump Drive Plate	a. Remove bolts (12) and lockwashers (13). b. Remove drive plate (14) and gasket (15).	Discard gasket

5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

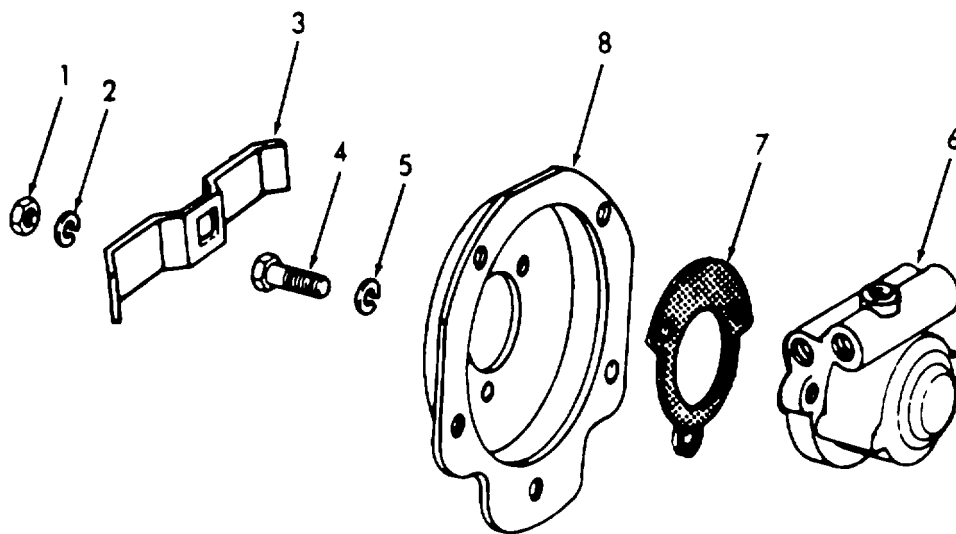


5-13.4. PUMP, HYDRAULIC STARTER Continued

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

REPLACEMENT

- | | | |
|---------|---|-----------------|
| 6. Pump | a. Remove nut (1), lockwasher (2), and pump drive (3) from pump drive shaft. | |
| | b. Remove three bolts (4) and lockwashers (5) securing pump body (6) to mounting plate (8). | |
| | c. Remove pump (6) and gasket (7) from mounting plate. | Discard gasket. |
| | d. Replace pump with a serviceable-like item. | |



5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION

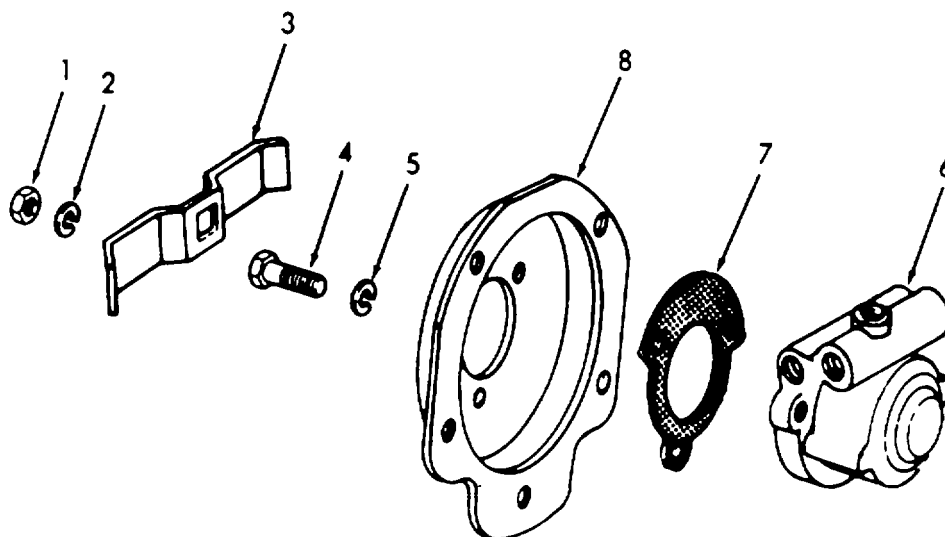
- | | | |
|---------------------------|--|--|
| 7. Pump-to-Mounting Plate | <ol style="list-style-type: none"> a. Position a new pump mounting gasket (7) in place on mounting plate (8). b. Secure pump (6) and gasket (7) to mounting plate (8) with three lockwashers (5), and bolts (4). | |
|---------------------------|--|--|

- | | | |
|---------------|--|--|
| 8. Pump Drive | | |
|---------------|--|--|

NOTE

Align the tangs on the pump drive with the slots in the drive plate.

Install pump drive (3) with lockwasher (2), and nut (1).



5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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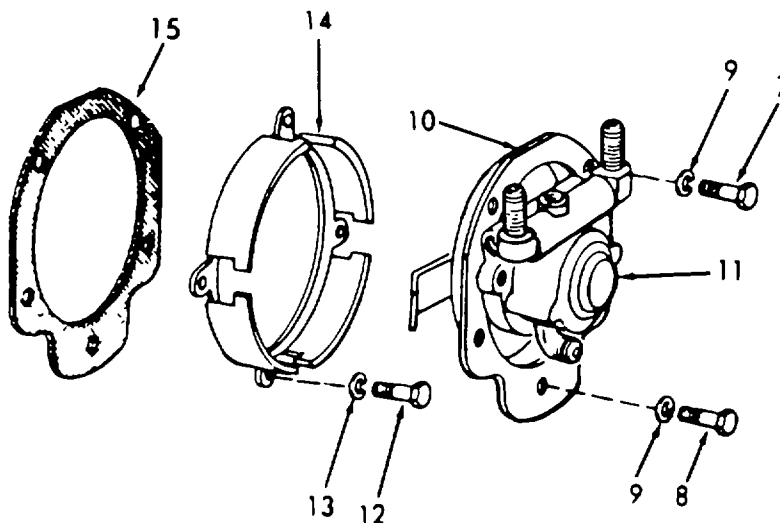
INSTALLATION (Cont)

9. Flywheel Housing Gasket	a. Affix new gasket (15) to flywheel housing. b. Install drive plate (14) with bolts (12) and lockwashers (13).	Use a non-hardening gasket cement on flywheel housing side only.
10. Pump		

CAUTION

Do not force the pump into place. Use of force or tightening the bolts when the mounting flange is not against the flywheel housing, will force the drive arm against the pump body and result in damage to the pump when the engine is started.

- a. Position assembled pump (11) and mounting plate (10) onto flywheel housing.
- b. Secure with lockwashers (9), and bolts (7 and 8).



5-13.4. PUMP, HYDRAULIC STARTER Continued

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

11. Hydraulic Lines.

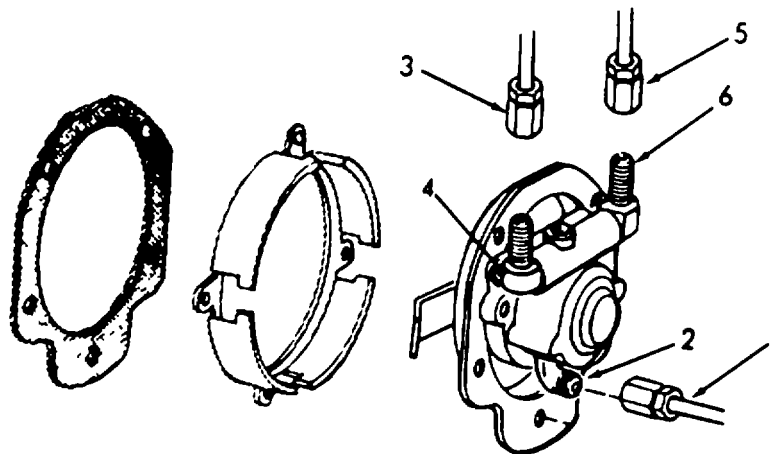
CAUTION

Do not apply sealant to the last thread (that nearest the open end), or to female fittings, as it may wash into the system.

NOTE

Apply sealant sparingly to all MALE PIPE THREADS only and work it into the threads.

- | | |
|--|--------------------|
| <ul style="list-style-type: none"> a. Install elbow (6) and reconnect pump outlet line (5). b. Install elbow (4) and reconnect inlet line (3). c. Install elbow (2) and reconnect return line (1). d. Open accumulator valves. | <p>Remove cap.</p> |
|--|--------------------|



5-13. 5. ACCUMULATORS

Two accumulators are provided, one mounted on each side of the engine room. When both accumulators are at full pressure, one should be secured (valve closed), and held in reserve. One accumulator will service both engines under normal conditions.

This task covers:

- | | | | | | |
|----|-------------|----|----------------|----|--------------|
| a. | Removal | d. | Inspection | g. | Charging |
| b. | Disassembly | e. | Repair/Replace | h. | Installation |
| c. | Cleaning | f. | Assembly | | |

INITIAL SETUP

Test Equipment

Hose Assembly
 Accumulator Charging
 NSN 4730-00-412-3805
 P/N TSE8600 (01843)
 Gage Assembly, Accumulator
 P/N TSE8601 (01843)

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
 NSN 5180-00-629-9783
 Torque wrench
 Drop light

Equipment

Condition Condition Description

NONE

Materials/Parts

Sealant
 Clean cloths
 Wooden dowel
 Nitrogen gas cylinder
 Cleaning solvent P-D-680
 Grease BM1146

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

5-13.5. ACCUMULATORS (Continued)

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

REMOVAL

- | | | |
|----|--------------------------------------|--|
| 1. | Close valve on opposite accumulator. | |
|----|--------------------------------------|--|

WARNING

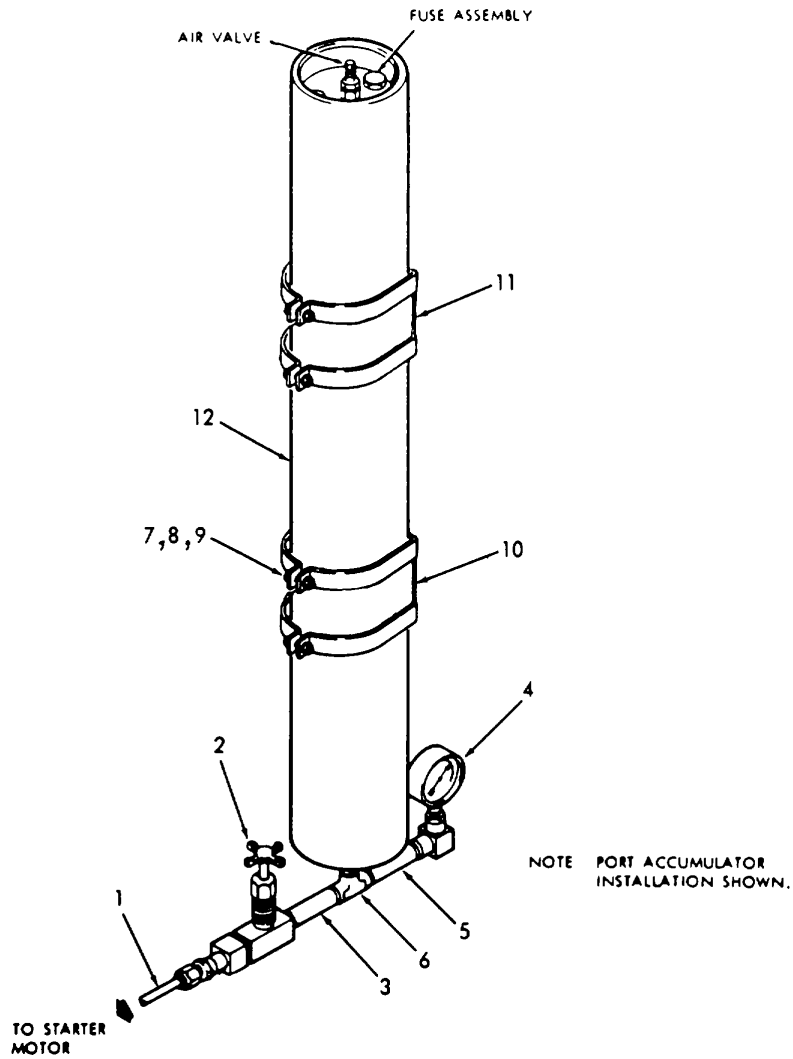
The fluid pressure in the system must be released prior to any maintenance to the accumulator to prevent possible injury to personnel or damage to equipment.

- | | | |
|---------------------------|---|---------------|
| 2. Gage, Valve and Piping | a. Disconnect line (1) at valve (2).
b. Remove valve (2) and nipple (3).
c. Remove gage (4), and nipple (5).
d. Remove tee (6). | Cap open end. |
| 3. Accumulator | a. Remove nuts (7), lockwashers (8), and screws (9) from mounting brackets (10 and 11).
b. Remove accumulator (12) from mounting brackets. | |

5-13.5. ACCUMULATORS (Continued).

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

REMOVAL (Cont)



DISASSEMBLY

NOTE

Prior to any disassembly, the nitrogen gas must be released from the accumulator.

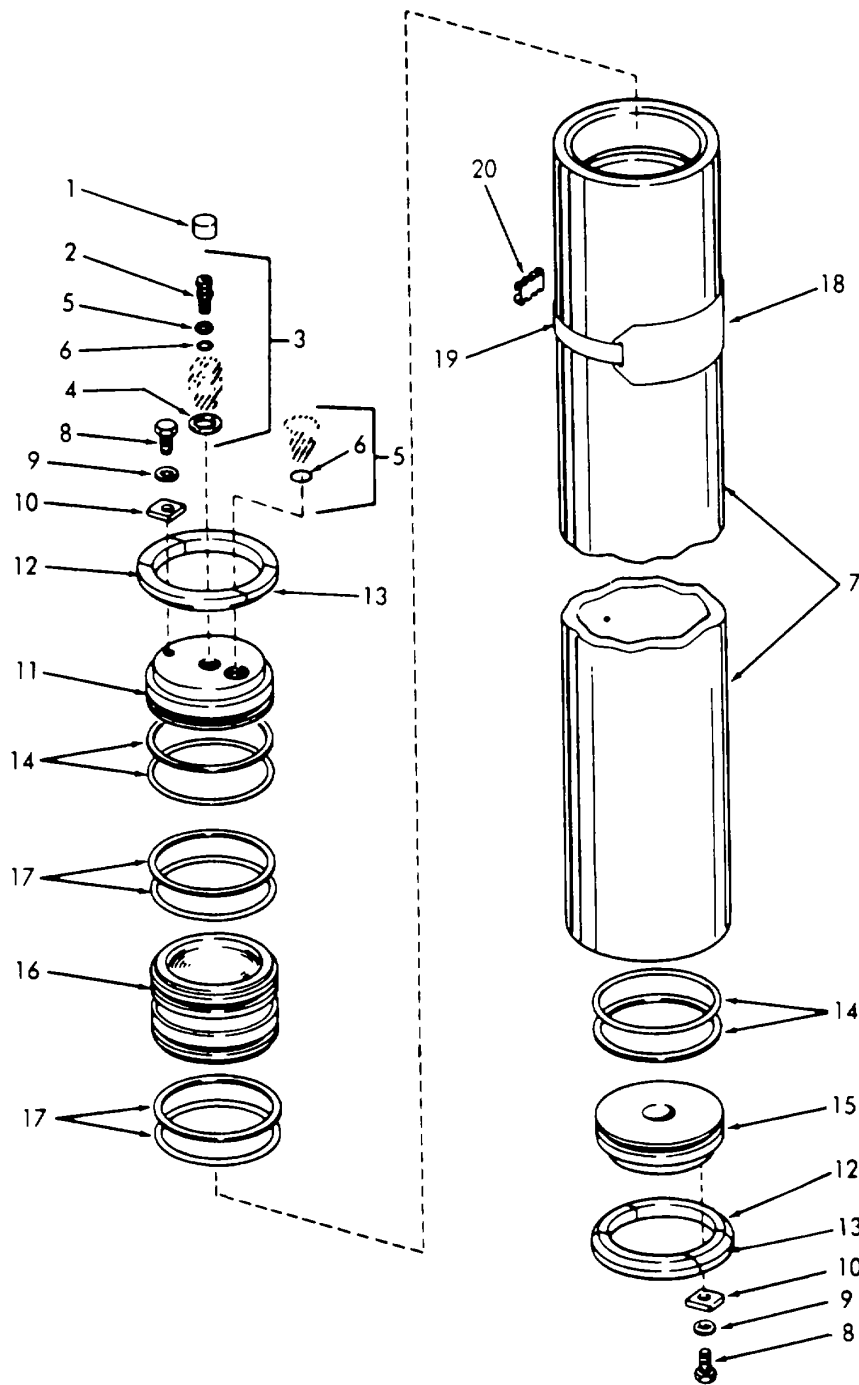
5-13.5. ACCUMULATORS (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY (Cont)</u>		
4.	a. Remove cap (1). b. Loosen air valve (2) until gas escapes.	
5. Air Valve Assembly	Remove air valve assembly (3), and gasket (4).	Discard gasket.
6. Fuse Assembly	a. Remove fuse assembly (5) and gasket (6). b. Secure housing (7) in a vise.	Discard gasket.
7. Air End Cap	a. Remove screws (8), lock-washers (9), and retaining plate (10) from end cap. b. Screw a 1/2 - 20 fitting into air valve assembly (3) port. c. Push end cap (11) away from ring segments (12 and 13). d. Remove ring segments (12 and 13), and remove end cap (11). e. Remove backup seal rings (14).	Discard gaskets.
8. Oil End Cap	a. Repeat steps a. thru e. and remove oil end cap (15) using proper fitting for oil port size. b. Using a wooden dowel, push piston (16) out of housing (7). c. Remove seal rings (17) from piston (16). d. Remove nameplate (18), strap (19) and locking clip (20).	Discard gaskets. Remove only if damaged or defaced.

5-13.5. ACCUMULATORS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



5-13.5. ACCUMULATORS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING**WARNING**

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100' 138°F (38' 59°C). Clean metal parts in cleaning solvent P-D-680 and dry thoroughly.

INSPECTION

- 10.
- a. Housing. Use a drop-light to examine the bore of the cylinder. The bore must be smooth and free of scratches. Check segment ring grooves.
 - b. Caps. Examine for damage. Check fitting threads, valve threads, and fuse holder thread if holder has been removed.
 - c. Piston. Examine for scratches or scoring on O.D. The piston must be checked in cylinder to be sure it moves freely throughout the entire length of cylinder.
 - d. Air Valve. Examine threads and replace if damaged. Check for damaged valve seat.
 - e. Seal Rings. Inspect for damage.

5-13.5. ACCUMULATORS (Continued).

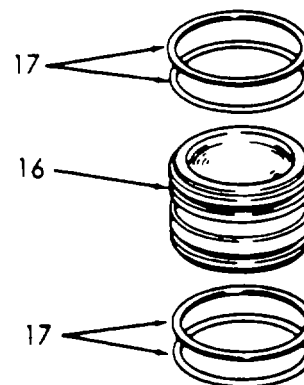
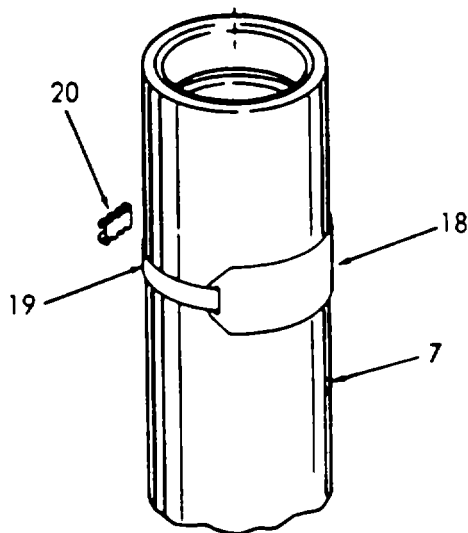
LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT

- | | | |
|-----|---|--|
| 11. | <ul style="list-style-type: none"> a. Replace any accumulator damaged beyond repair. b. Replace all gaskets. c. Replace other defective parts as required. | |
|-----|---|--|

ASSEMBLY

- | | | |
|------------|--|---|
| 12. Piston | <ul style="list-style-type: none"> a. Install nameplate (18), strap (19), and locking clip (20) onto housing (7). If removed. b. Install seal rings (17) onto piston (16). c. Coat inside diameter of housing (7) with light oil. d. Using a loading sleeve, covering the split ring groove, insert piston (16) into housing bore with the closed end first. | <p>Lubricate seal</p> <p>OE-10, or grease BM1546.</p> <p>Check seal rings to be sure they are not twisted or otherwise damaged.</p> |
|------------|--|---|



5-13.5. ACCUMULATORS (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>		
13. Oil End Cap	<ul style="list-style-type: none"> e. Push piston half way down in housing bore. a. Install backup seal rings (14) to oil end cap (15). b. Slide end cap (15) with oil port into housing (7) beyond the normal position. 	<p>Coat seal rings with light grease BM1546 to hold in place.</p> <p>Use loading sleeve.</p>
NOTE		
Be sure end cap is on side with head of the piston.		
14. Air End Cap	<ul style="list-style-type: none"> c. Install ring segments (13 and 12) and hold in place. d. Push piston (16) against ,oil end cap (15) to position end cap against retainer plate. e. Install retainer plate (10). Then, secure end cap (15) with lockwashers (9), and screws (8). a. Install backup seal rings (14) to end cap (11). b. Slide end cap (11) into housing (7) beyond the normal position. c. Install ring segments (13 and 12) and hold in place. d. Apply pneumatic or mechanical force of 50 PSI (344.7 kpa) maximum to position end cap against retainer plate (10). 	<p>Coat seal rings with light grease BM1546 to hold in place.</p>

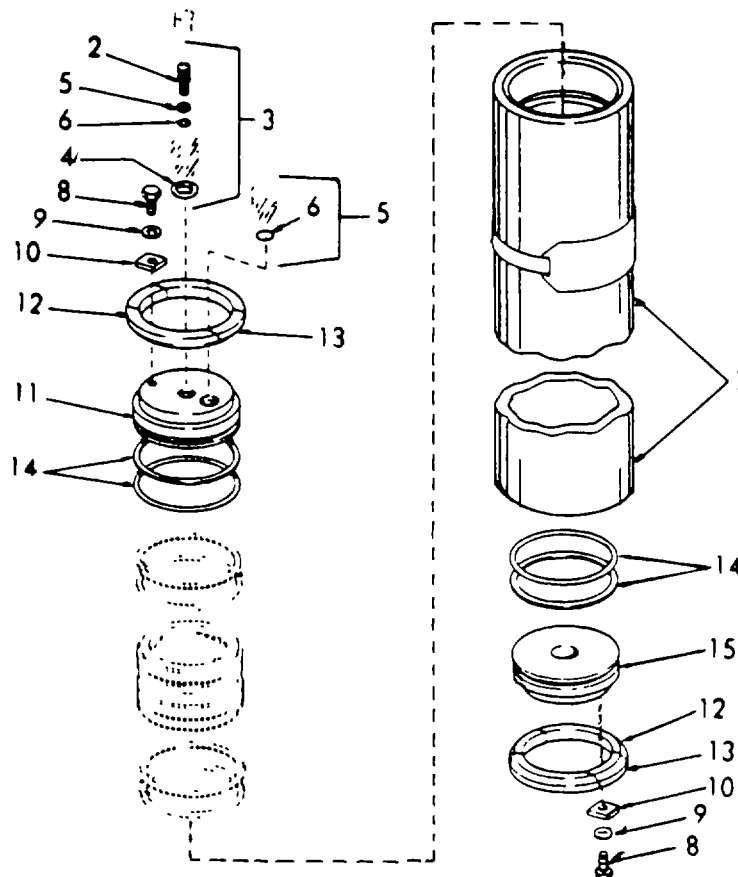
5-13.5. ACCUMULATORS (Continued).

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

ASSEMBLY (Cont)

- e. Install retainer plate (10). Then, secure assembly with lockwashers (9), and screws (8).
- f. Release pressure and remove assembly fittings.

15. Fuse Assembly	Install fuse assembly gasket (6), and fuse (5).	Torque to 20-25 lbs.ft.(27.1 - 33.9 Nm).
16. Air Valve	Install air valve gasket (4) and air valve (3).	Torque to 45-50 lb. ft.(61.0 - 67.8 Nm). DO NOT tighten locknut (2).



5-13.5 ACCUMULATORS (Continued).

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

CHARGING

- | | | |
|----------------------------|---|--|
| 17. Recharging Accumulator | <ul style="list-style-type: none"> a. Attach gage (1) end of the charging kit to nitrogen tank. b. Install air valve stem extension (2) on the air valve (3). c. Completely back off shaft pin in the air check valve connector (4) on the charging kit hose (5). <ul style="list-style-type: none"> (1) Install connectors on the air valve stem extension (2). (2) Draw swivel nut (6) up tight. d. Loosen hex locknut (7) on the accumulator air valve stem. <ul style="list-style-type: none"> (1) Turn counter-clockwise. (2) Turn locknut 1-1/2 turns only. e. Turn the shaft pin in the air check valve connector (8) clockwise until the valve core air valve is depressed. f. Open valve (9) on the nitrogen tank, and allow small flow of nitrogen to enter the accumulator until the charging kit gage registers 1300 Psi (8964 kPa). Close nitrogen tank valves (9). <ul style="list-style-type: none"> (1) Check the precharge pressure during charging. | |
|----------------------------|---|--|

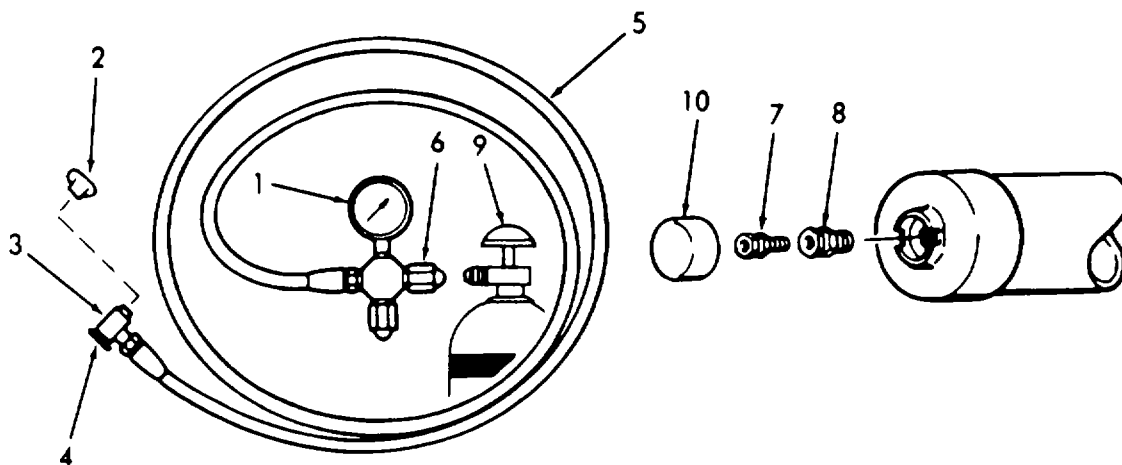
5-13.5. ACCUMULATORS (Continued).

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

CHARGING (Cont)

- (2) Shut off the valve to nitrogen tank.
- (3) Allow time for pressure to stabilize.
- (4) Pressure indicated on pressure gage is accumulator precharge pressure.
- g. Back off the shaft pin in air check valve (3). Tighten hex locknut (7) on accumulator valve stem.
- h. Disconnect the accumulator charging kit.
 - (1) From accumulator
 - (2) From nitrogen tank
- i. Replace cap on air valve (8) and accumulator cap (10).

Torque to 140-160 In. Lbs.
(6.4 - 6.6 Nm).

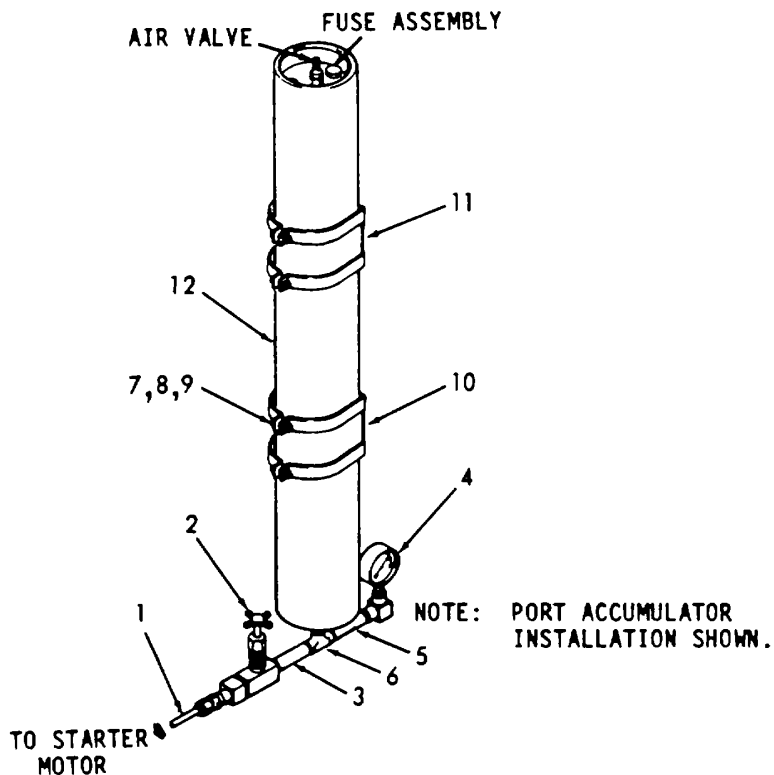


5-13.5. ACCUMULATORS (Continued).

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

INSTALLATION

- | | | |
|----------------------------|---|--|
| 18. Accumulator | <ul style="list-style-type: none"> a. Position accumulator (12) in place on mounting brackets (10 and 11). b. Secure with screws (9), lock-washers (8), and nuts (7). | |
| 19. Piping, Valve and Gage | <ul style="list-style-type: none"> a. Install tee (6), nipple (5), and gage (4). b. Install nipple (3) and valve (2). c. Reconnect line (1) to valve (2). | <p>Remove cap.</p> <p>Install other accumulators in the same manner.</p> |



5-13.6. HYDRAULIC HAND PUMP.

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

The hand pump is used to provide the initial hydraulic pressure for first starts or to build up pressure in the hydraulic starting system if it has been released for any reason.

This task covers:

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

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment

Tools Condition Condition Description

General Mechanic's Tool Kit
NSN 5180-00-629-9783

NONE

Materials/Parts

Sealant

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING and CAUTION
in this procedure.

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

REMOVAL

- | | | | |
|----|-------------------|----|---------------------------|
| 1. | Accumulator Valve | a. | Close accumulator valves. |
|----|-------------------|----|---------------------------|

5-13.6. HYDRAULIC HAND PUMP Continued

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

REMOVAL (Cont)

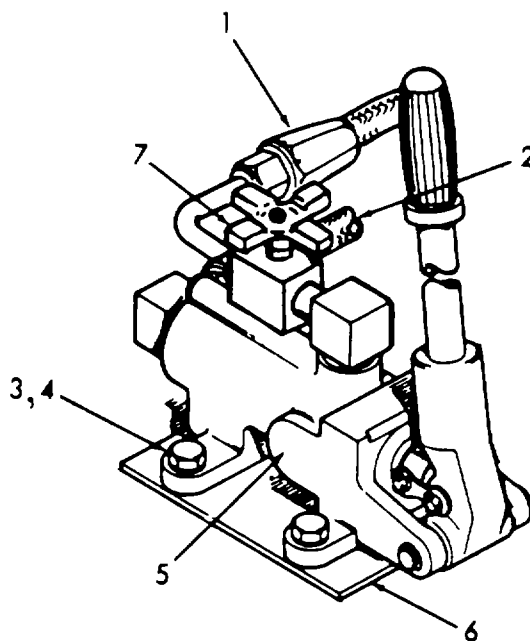
WARNING

The fluid pressure in the system must be released prior to any maintenance to the hand pump, or any other components of the system, to prevent possible injury to personnel or equipment.

2. Hand Pump

- b. Release pressure in the hydraulic starting system.
- a. Clean all exterior dirt from hand pump and hydraulic lines.
- b. Disconnect hydraulic lines (1 and 2).
- c. Remove four bolts (3) and lockwashers (4) securing pump.
- d. Remove pump (5) from mounting plate (6).
- e. Remove valve and piping (7) from pump (5).

Cap open ends.

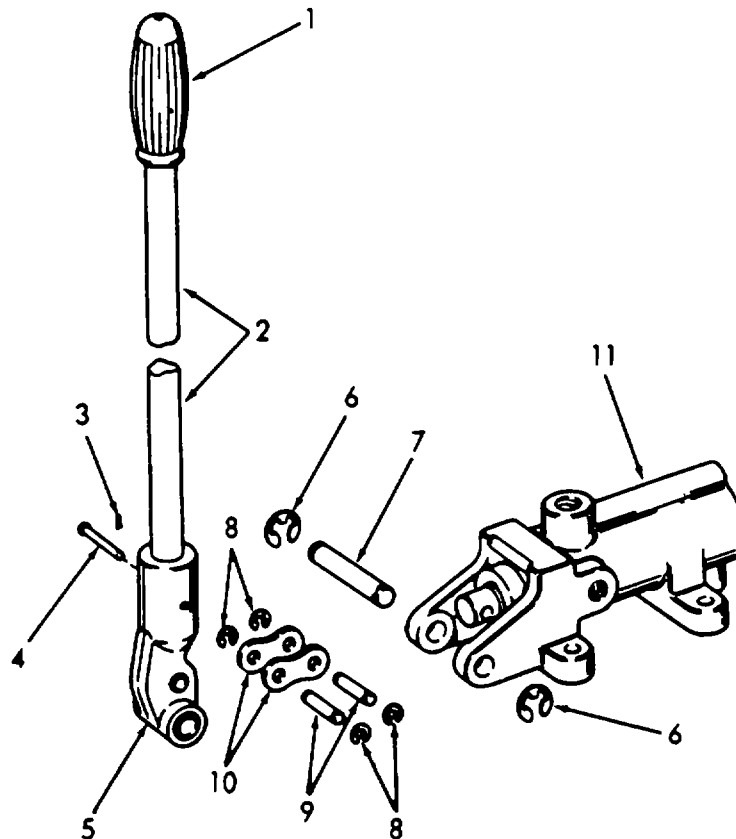


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

REMOVAL (Cont)

- | | | |
|----------------|--|--------------------------|
| 3. Pump Handle | <ul style="list-style-type: none"> a. Pull pump handle grip (1) from hand pump operating handle (2). b. Remove cotter pins (3) and 4). Lift handle (2) from operating lever (5). c. Remove retaining rings (6) from clevis pin (7). d. Remove retaining ring (8), clevis pin (9), and links (10), to remove hand pump operating lever (5) from the pump body (11). | Only if grip is damaged. |
|----------------|--|--------------------------|

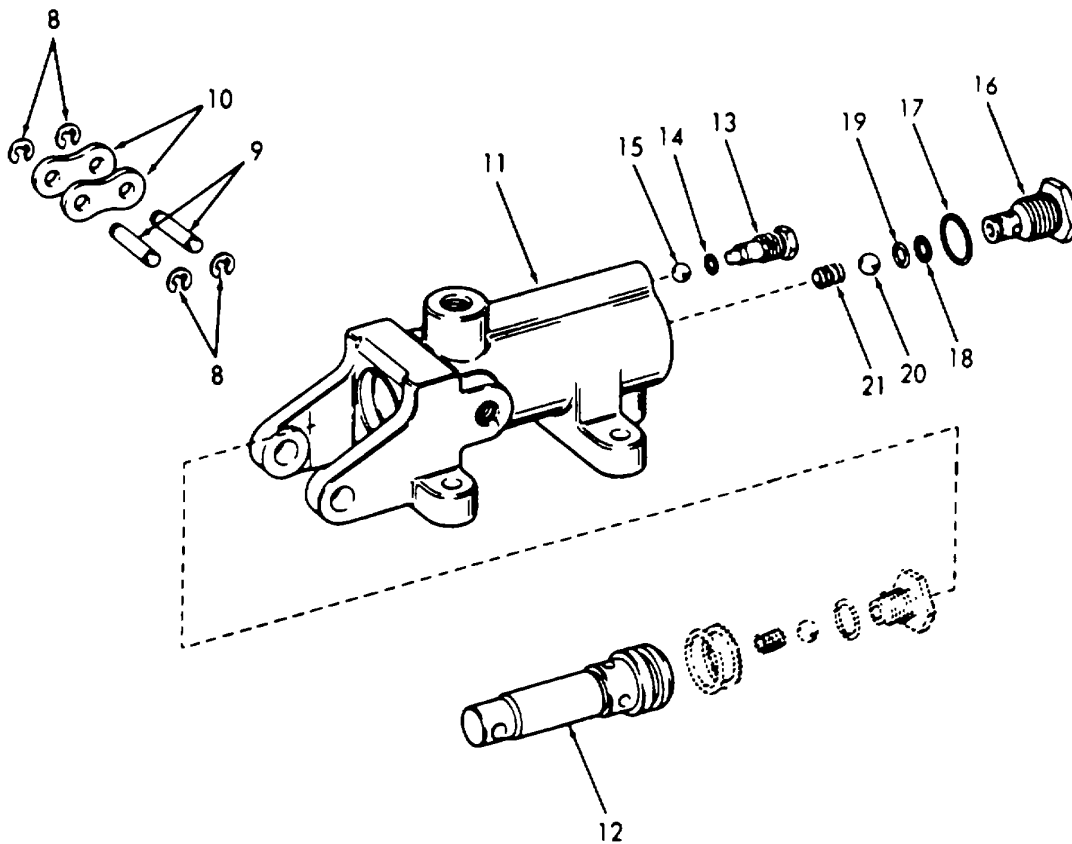


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

DISASSEMBLY

- | | | |
|--------------|--|--|
| 4. Pump Body | <p>a. Remove retaining rings (8), clevis pin (9), and links (10) from plunger (12).</p> <p>b. Remove bleeder screw (13), "O" ring gasket (14), and ball bleed valve (15) from pump body' (11).</p> <p>c. Remove inlet oil fitting (16), "O" ring gasket (17), back-up ring (18), "O" ring gasket (19), ball check valve (20), and spring (21) from pump body (11).</p> | <p>Discard "O" ring gasket.</p> <p>Discard "O" ring gasket (17), back-up ring (18), "O" ring gasket (19), and spring (21).</p> |
|--------------|--|--|

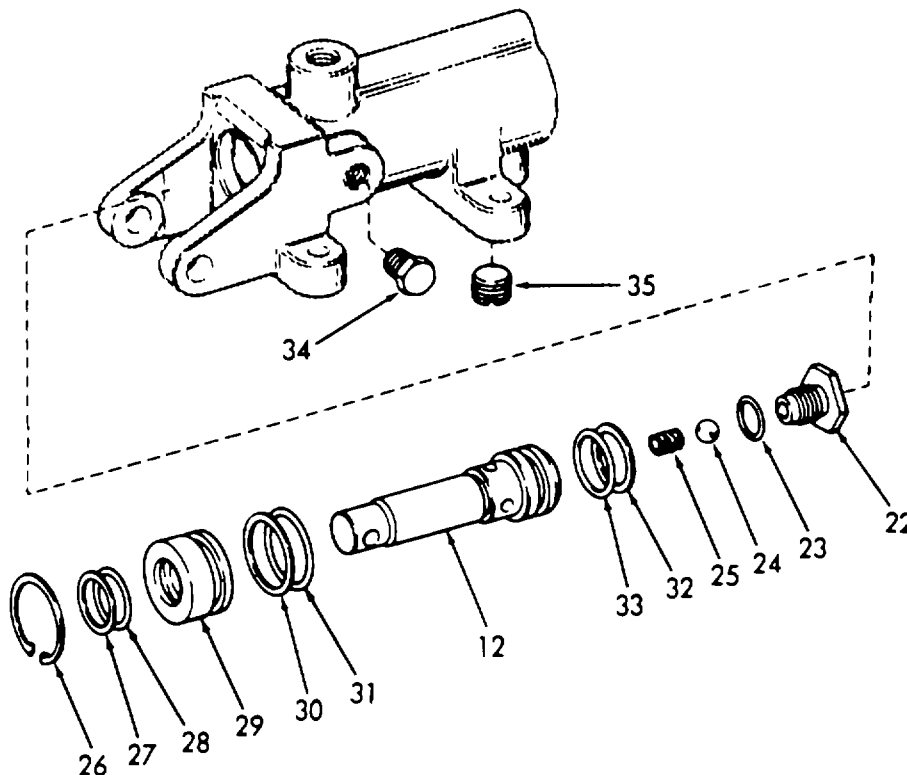


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

DISASSEMBLY (Cont)

- | | | |
|---|--|---|
| d. Remove seat check valve (22), "O" ring gasket (23), ball check valve (24), and spring check valve (25) | | Discard "O" ring gasket (22), and spring check valve (25). |
| e. Remove retaining ring (26) , back-up ring (27), "O" ring gasket (28), plunger gland (29), back-up ring (30), and "O" ring gasket (31). | | Discard back-up ring (27), "O" ring gasket (28), back-up ring (30), and "O" ring gasket (31). |
| f. Remove back-up ring (32), "O" ring gasket (33), and plunger (12). | | Discard back-up ring (32) and "O" ring gasket (33). |
| g. Remove pipe plugs (34 and 35). | | If necessary. |

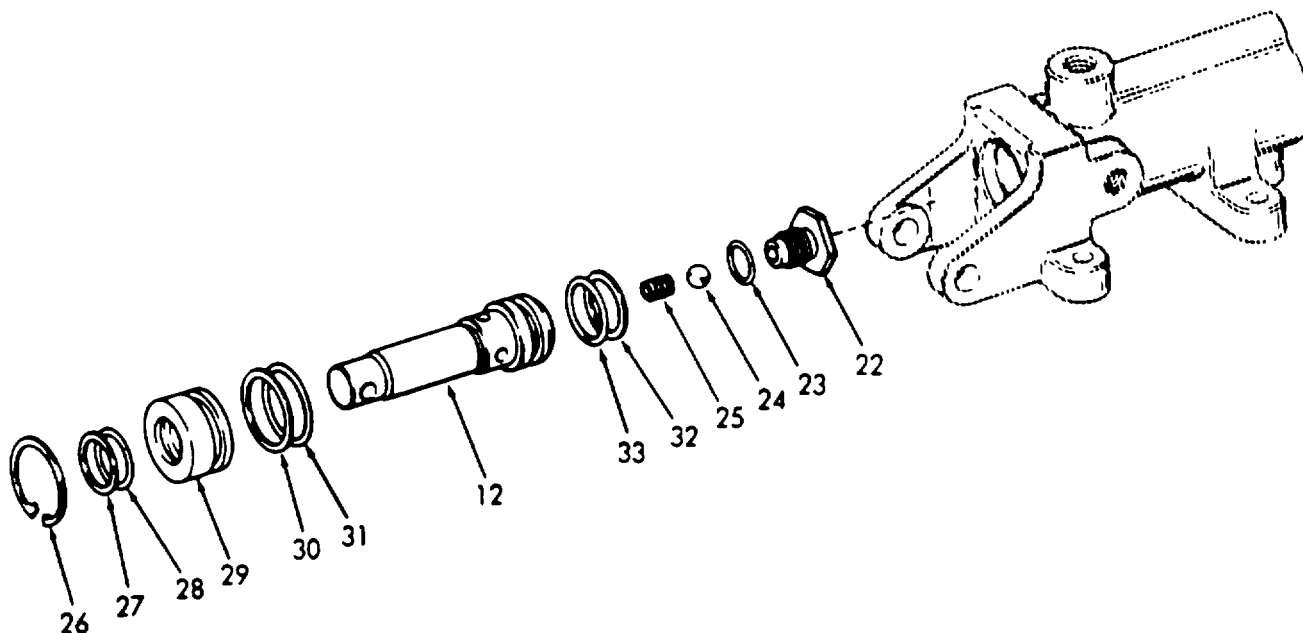


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

ASSEMBLY

- | | | |
|----------------------|---|--|
| 5. Pump Body Plunger | a. Install "O" ring gasket (31), back-up ring (30), plunger gland (29), "O" ring gasket (28), back-up ring (27), and retaining ring (26). | Thoroughly soak new back-up rings (27, 30, and 33) in warm oil. Use repair kit for back-up ring (27), gasket (28), back-up ring (30), and gasket (31). |
| | b. Insert plunger (12). | |
| | c. Install "O" ring gasket (32), back-up ring (33), spring (25), ball check valve (24), "O" ring gasket (23), and seat check valve (22) on plunger. | Use repair kit for back-up ring (33), "O" ring gasket (32), spring (25), and "O" ring gasket (23). |

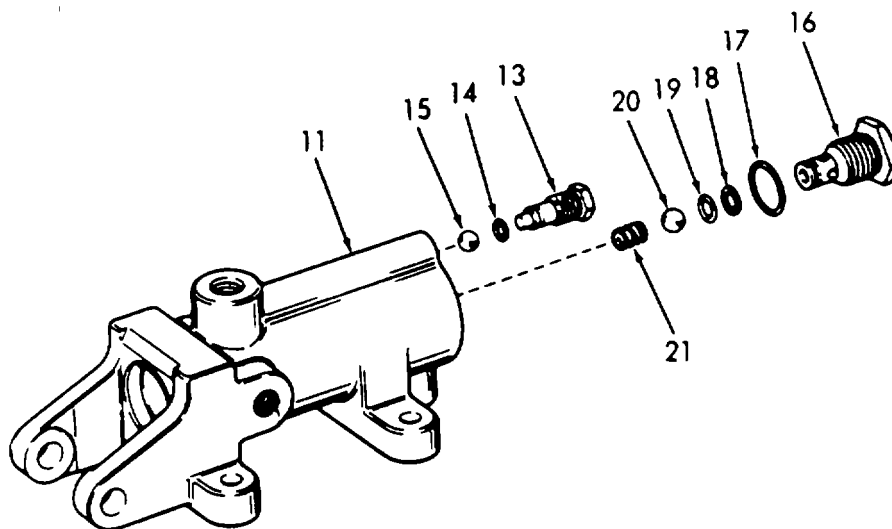


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

ASSEMBLY (Cont)

- | | | |
|----------------------------|---|--|
| 6. Inlet Oil Fitting Valve | Install spring (21), ball valve (20), "O" ring gasket (19), back-up ring (18), "O" ring gasket (17), and inlet oil fitting (16), into pump body (11). | Use repair kit for spring (21), "O" ring gasket (17), back-up ring (18), and "O" ring gasket (19). |
| 7. Bleeder Screw Valve | <ul style="list-style-type: none"> a. Install "O" ring gasket (14) onto bleeder screw valve (13). b. Insert bleeder ball valve (15) in place. c. Secure with bleeder screw valve (13). | Use repair kit for "O" ring gasket (14). |

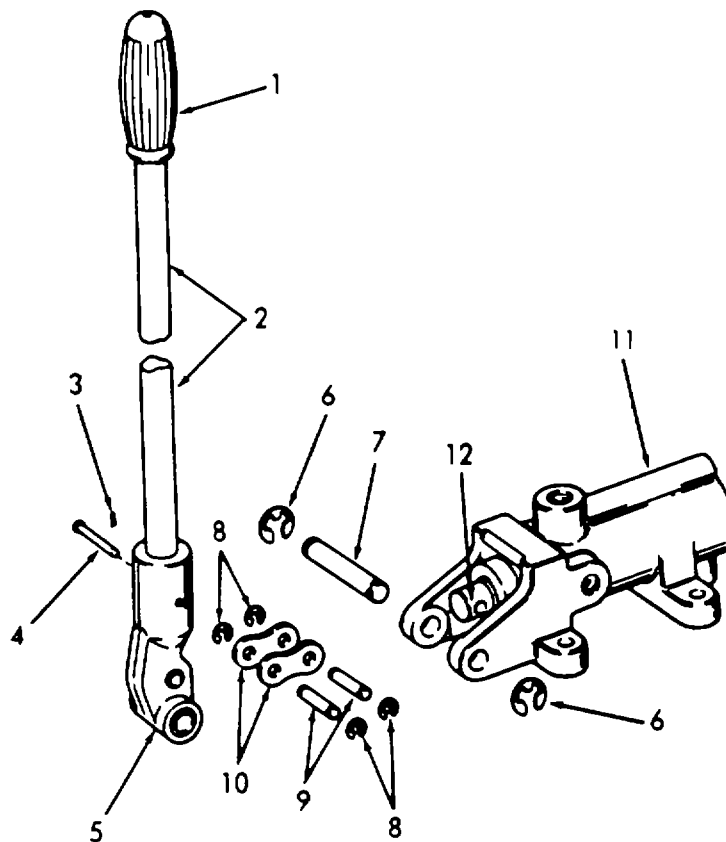


5-13.6. HYDRAULIC HAND PUMP (Continued).

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

ASSEMBLY (Cont)

- | | | |
|-----------|--|--|
| 8. Handle | <p>a. Install retaining rings (8), clevis pin (9), and links (10) to hand pump operating lever (5) and piston (12).</p> <p>b. Insert clevis pin (7), and retaining ring (6) into hand pump operating lever (5), and pump body (11).</p> <p>c. Insert handle (2), pin (4), and cotter pin (3) into hand pump operating lever (5).</p> <p>d. Install grip (1).</p> | |
|-----------|--|--|



5-13.6 HYDRAULIC HAND PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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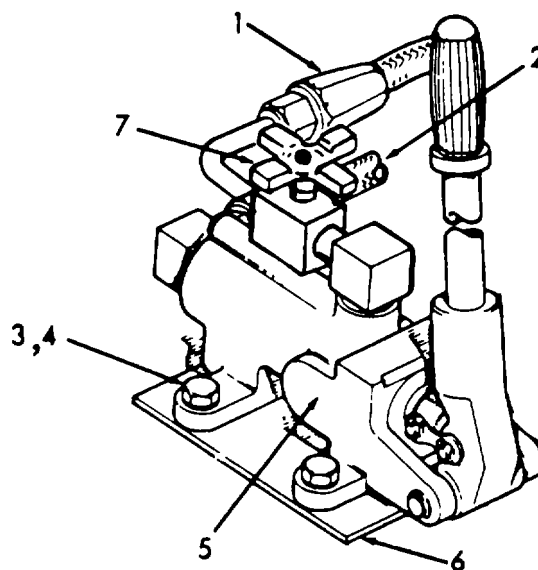
INSTALLATION (Cont)

- | | | |
|--------------|--|--|
| 9. Hand Pump | <ul style="list-style-type: none"> a. Install valve and piping (7) to pump (5). b. Position pump (5) in place on mounting plate (6). c. Secure with four lockwashers (4) and bolts (3). | |
|--------------|--|--|

NOTE

Make sure the lines and fittings are clean before any connections are made. With the exception of the thread nearest the open end, sealant must be applied in a small amount to ONLY the male threads. Never apply sealant to the female threads. Work the sealant into the threads and wipe off the excess with a clean, lint-free cloth so that the sealant will not be washed into the system.

- | | | |
|-----------------------|--|--------------|
| 10. Accumulator Valve | <ul style="list-style-type: none"> d. Install hydraulic lines (2 and 1). <p>Open accumulator on applicable hull number.</p> | Remove caps. |
|-----------------------|--|--------------|



5-13.6. HYDRAULIC STARTING PIPING SYSTEM.

This task covers:

Replacement

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment

Tools Condition Condition Description

General Mechanic's Tool Kit
NSN 5180-00-629-9783

NONE

Materials/Parts

Sealant

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING and CAUTION
in this procedure.

LOCATION/ITEM

ACTION

REMARKS

REPLACEMENT

WARNING!

The fluid pressure in the system must be released prior to any maintenance to prevent possible injury to personnel or equipment.

NOTE

- Replace damaged or defective parts as required.
- Wipe all connections clean prior to removal of any part requiring replacement.

5-13.7. HYDRAULIC STARTING PIPING SYSTEM (Continued).

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

REPLACEMENT (Cont)

Remove and Replace the following items, as necessary:

<u>ITEM</u>	<u>DESCRIPTION</u>
1.	Gage, Press: Accumulator
2.	Hose: Accumulator to Solenoid Valve, 108 In. Lg.
3.	Hose: 6 Ft. Lg.
4.	Hose: 5 Ft. 4 In. Lg.
5.	Hose: 18 In. Lg.
6.	Hose: 4 Ft. 8 In. Lg.
7.	Hose, 9 Ft. Lg.
8.	Hose: 34 In. Lg.
9.	Hose: 23 In. Lg.
10.	Hose: 31 In. Lg.
11.	Hose, Rubber: Starter to Return Tee
12.	Hose: 4 In. Lg.
13.	Hose: 43 In. Lg.
14.	Hose: 17 In. Lg.
15.	Hose: 162 In. Lg.,
16.	Hose: 21 In. Lg.
17.	Hose: 9 In. Lg.
18.	Plug, Pipe: Hand Pump
19.	Valve, Globe

5-13.7. HYDRAULIC STARTING PIPING SYSTEM (Continued).

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

REPLACEMENT (Cont)

Remove and Replace the following items, as necessary:

<u>ITEM</u>	<u>DESCRIPTION</u>
20.	Valve, Check: Inlet
21.	Valve, Hand: Accumulator
22.	Valve, Needle: Hand Pump
23.	Reducer, Bushing
24.	Reducer, Pipe
25.	Elbow, Pipe: 90 Degree
26.	Elbow, Pipe: 90 Degree
27.	Cross, Pipe
28.	Elbow, Pipe: 90 Degree
29.	Tee, Pipe
30.	Bushing, Pipe
31.	Nipple, Pipe: Hand Pump
32.	Nipple, Pipe
33.	Nipple, Hexagon: Hydraulic Pump
34.	Elbow, Pipe
35.	Tee, Pipe
36.	Tee, Pipe
37.	Connector, Hose
38.	Connector, Hose
39.	Connector, Hose: Swivel Ends

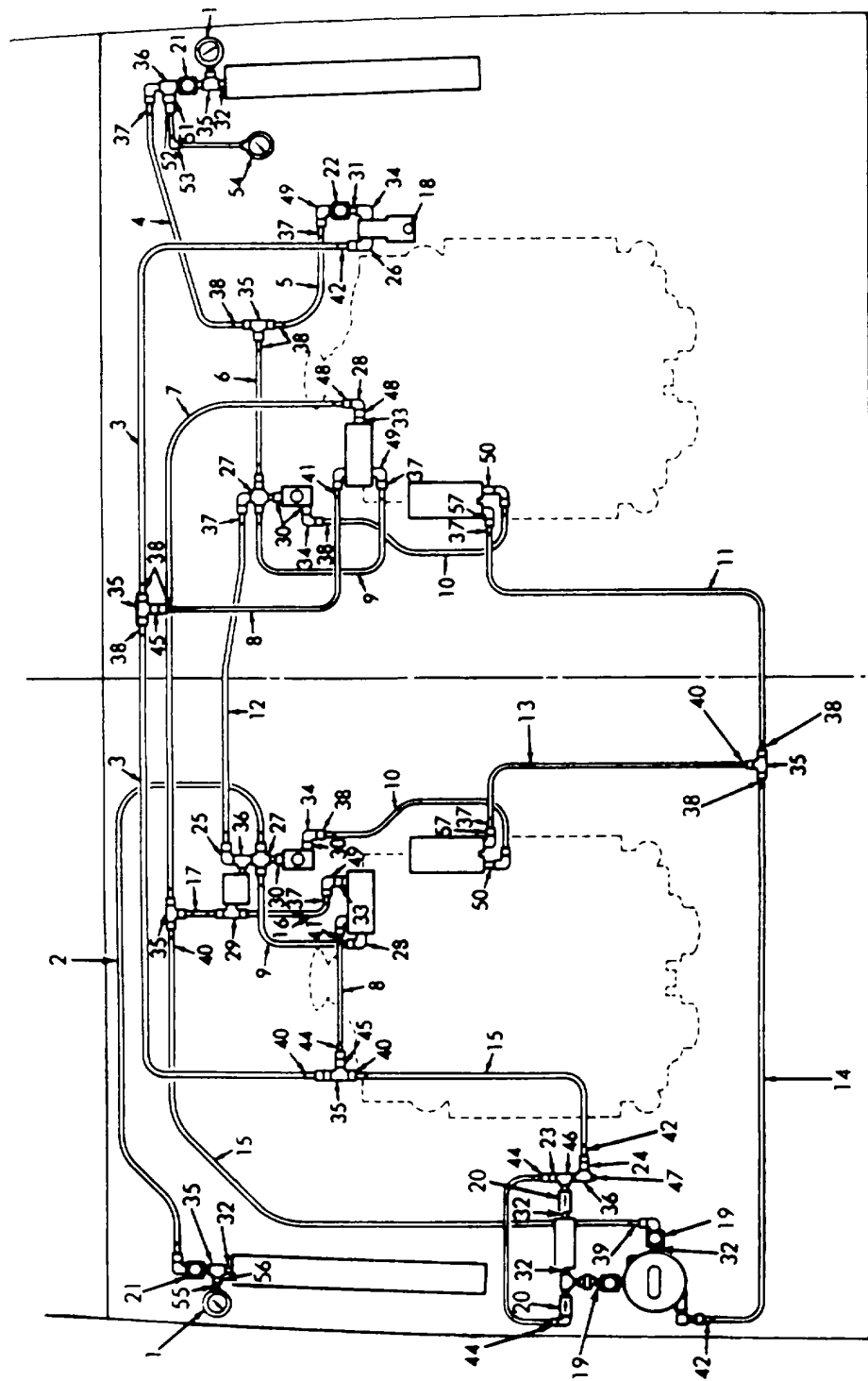
5-13.7. HYDRAULIC STARTING PIPING SYSTEM (Continued).

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

REPLACEMENT (Cont)**Remove and Replace the following items, as necessary:**

<u>ITEM</u>	<u>DESCRIPTION</u>
40.	Connector, Hose
41.	Connector, Hose
42.	Connector, Hose: Swivel, 3/4 In.
43.	Connector, Hose
44.	Nut, Tube
45.	Bushing, Pipe
46.	Tee, Pipe
47.	Plug, Pipe Hexagon
48.	Bushing, Pipe
49.	Elbow, Pipe
50.	Bushing, Pipe: Starting Motor
51.	Reducer, Tube
52.	Adapter, Straight
53.	Elbow, Tube
54.	Adapter, Straight: Pipe To Tube
55.	Nipple, Pipe
56.	Connector, Pipe
57.	Adapter, Straight: Motor Outlet

5-13.7. HYDRAULIC STARTING PIPING SYSTEM (Continued).



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | h. Adjustments |
| c. Cleaning | f. Assembly | |

INITIAL SETUP

Test Equipment

NONE

References

Paragraph 5-24. Exhaust Piping Removal

Special Tools

Injector remover J1227-01
 Governor wrench J4242
 Cam follower fixture J5840
 Governor gap tool J5407
 Feeler gage tool J39708
 Injector timing J1853
 Chain hoist
 Torque wrench

Equipment
Condition Condition Description

Tools

General Mechanic's Tool Kit
 NSN 5180-00-629-9783
 Safety goggles

NONE

Materials/Parts

Special Environmental Conditions

Fuel oil
 Gasket set 5150329 (72582)
 Clean cloths
 Cleaning solvent P-D-680
 Engine oil

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNINGS in procedure.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL

1. Exhaust Manifold	<u>WARNING</u>	
------------------------	-----------------------	--

- All piping and exhaust lines shall be treated as being insulated with asbestos material. Protective clothing and respirators shall be worn at all times when handling suspect asbestos-covered piping and exhaust lines.

- If engines have been running, make sure exhaust system has cooled sufficiently prior to performing any maintenance. Improper handling could result in serious burns to personnel.

- a. Drain the cooling system to a level below the cylinder head.
- b. Open the drain cock (1) installed in the bottom of the exhaust manifold (2).
- c. Remove nuts (3) and lockwashers (4).
- d. Remove the water outlet tube (5) and gasket (6).
- e. Remove the water inlet tube (7) and gasket (8).

2. Exhaust Pipe	a. Remove nuts (9), lockwashers (10), bolts (11), and flatwashers (12).	
--------------------	---	--

- b. Remove exhaust pipe (13) and gaskets (14).

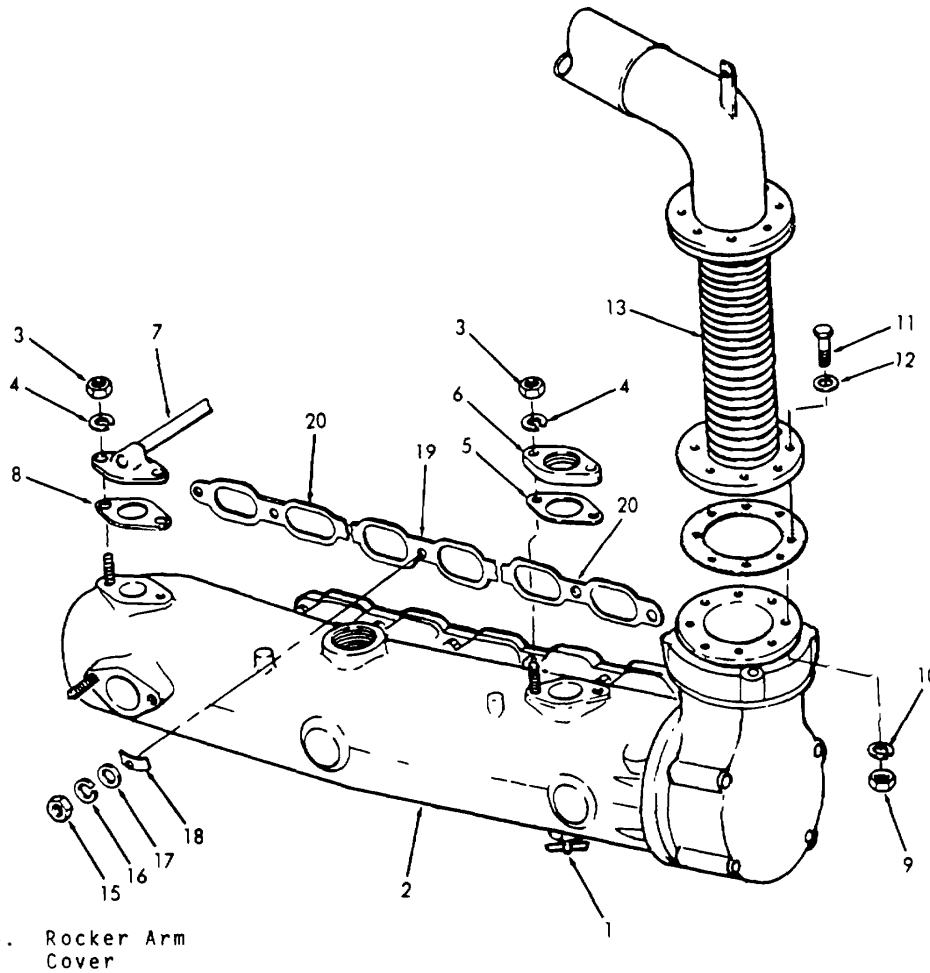
3. Exhaust manifold	a. Remove nuts (15), lockwashers Manifold (16), flatwashers (17), and crab brackets (18).	
------------------------	---	--

- b. Remove manifold (2) and gaskets (19 and 20). Discard gaskets.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL



NOTE

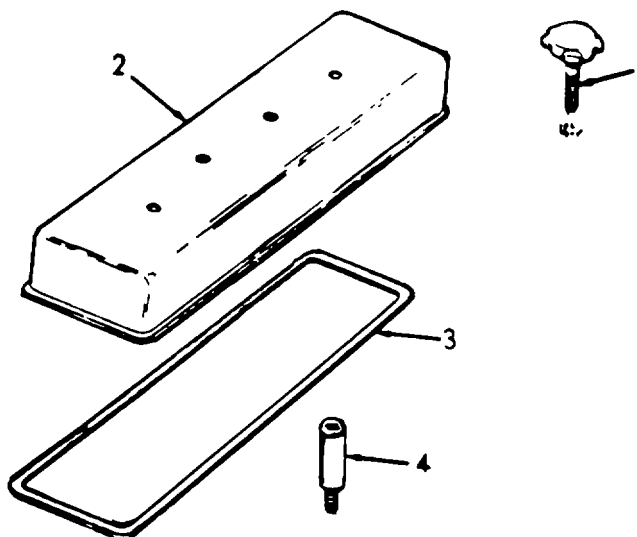
Using clean cloths, remove any dirt, grease, oil or other matter from rocker arm cover and cylinder head to prevent entry of any matter into the cylinder head opening.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued)..

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

REMOVAL (Cont)

- a. Unscrew four thumbscrews (1) from stud extensions (4).
- b. Remove rocker arm cover (2) and cover gasket (3).



5. Water Manifold

- a. Loosen thermostat housing clamp (1) and slide packing (2) and clamp (1) back on water manifold (3).
- b. Remove hose clamps (4), and hose (5) from thermostat housing outlet (6).
- c. Remove hose tee (7).
- d. Remove four capscrews (8), and lockwashers (9) from thermostat housing (10).
- e. Remove thermostat housing (10), and gasket (11) from expansion tank (12).

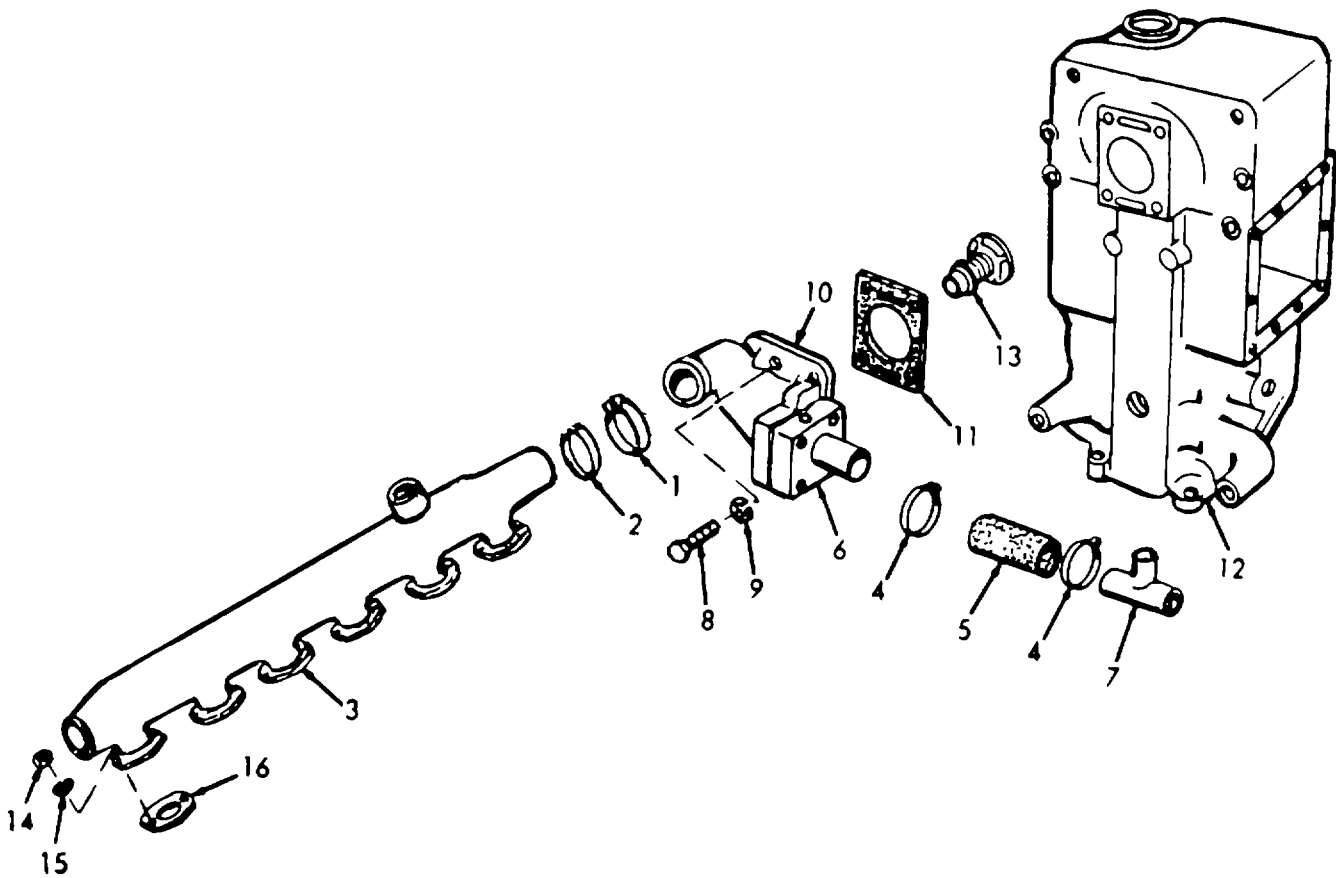
5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL (Cont)

- f. Remove thermostat (13) from housing (10).
- g. Remove nuts (14) and lockwashers (15).
- h. Remove water manifold (3) and gaskets (16).

Discard gaskets.

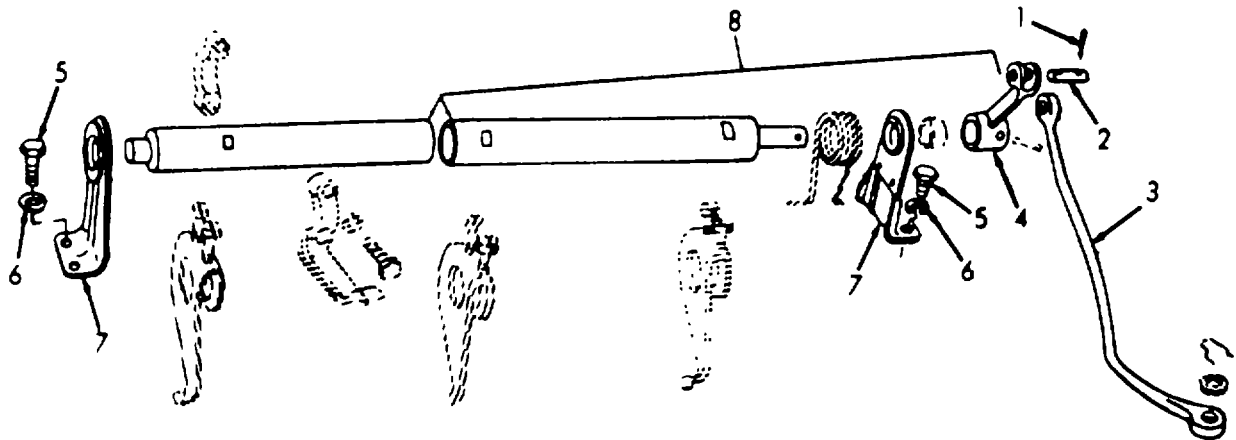


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL (Cont)

- | | |
|--------------------------|---|
| 6. Injector Control Tube | a. Remove cotter pins (1) from link pins (2). |
| | b. Remove link pins (2) from governor control link (3). |
| | c. Push up on control tube lever (4) to free control link (3). |
| | d. Remove capscrews (5), and lockwashers (6) from bracket assemblies (7). |
| | e. Lift up on control tube (8), and swing away from cylinder head. |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

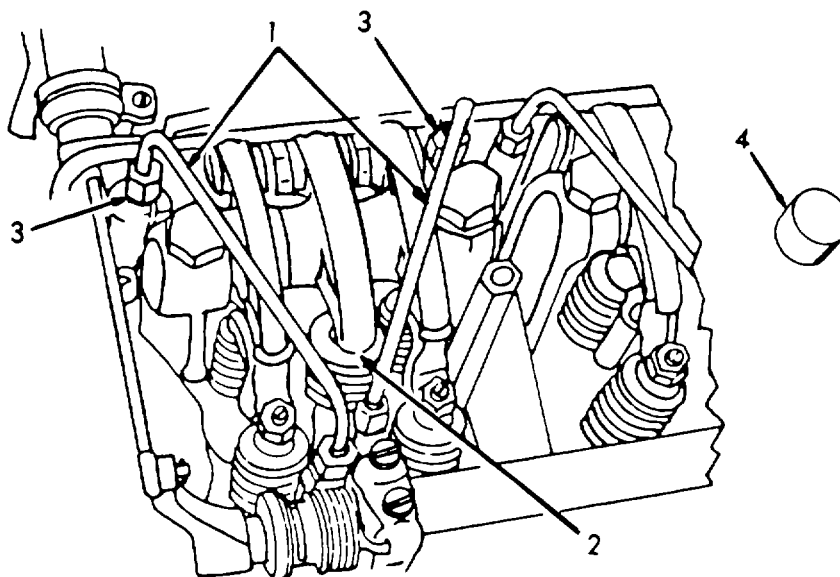
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

REMOVAL (Cont)

7. Fuel
Injectors
and
Connectors

DESCRIPTION. Fuel injectors are installed as shown. They are mounted in the cylinder head with their spray tips projecting slightly below the top of the inside surface of the combustion chambers.

- a. Remove fuel pipes (1) from both the injectors (2), and fuel connectors (3).
- b. Install clean shipping caps (4) on injector inlet and outlet and on fuel connectors.
- c. Crank engine to bring outer ends of pushrods of injector and valve rocker arms into line horizontally.

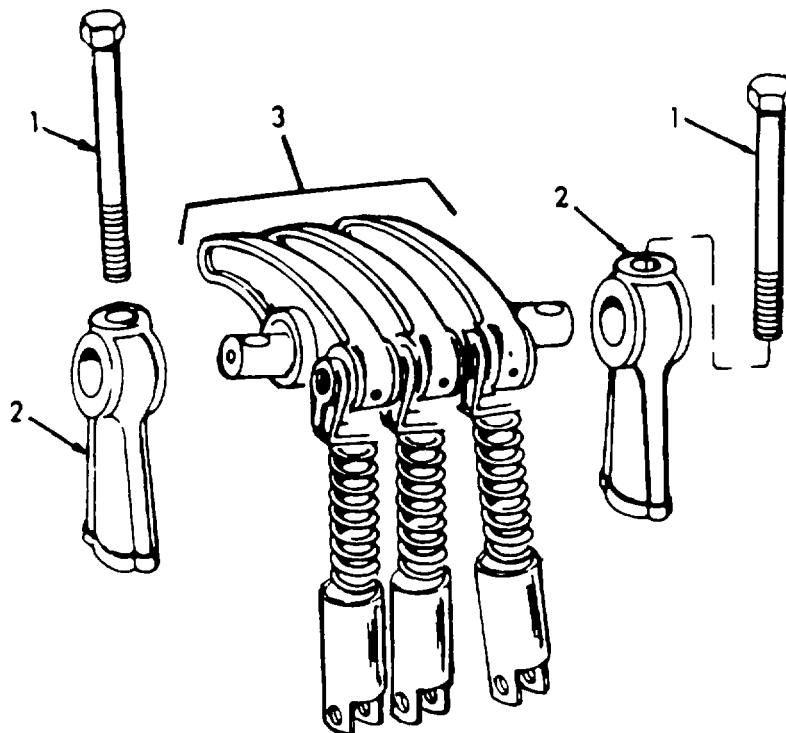


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL (Cont)

- | | | |
|-------------------------------|---|--|
| 8. Rocker Shaft Bracket Bolts | a. Remove rocker shaft bracket bolts (1) from brackets (2).
b. Swing rocker arms (3) away from injector. | |
|-------------------------------|---|--|



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

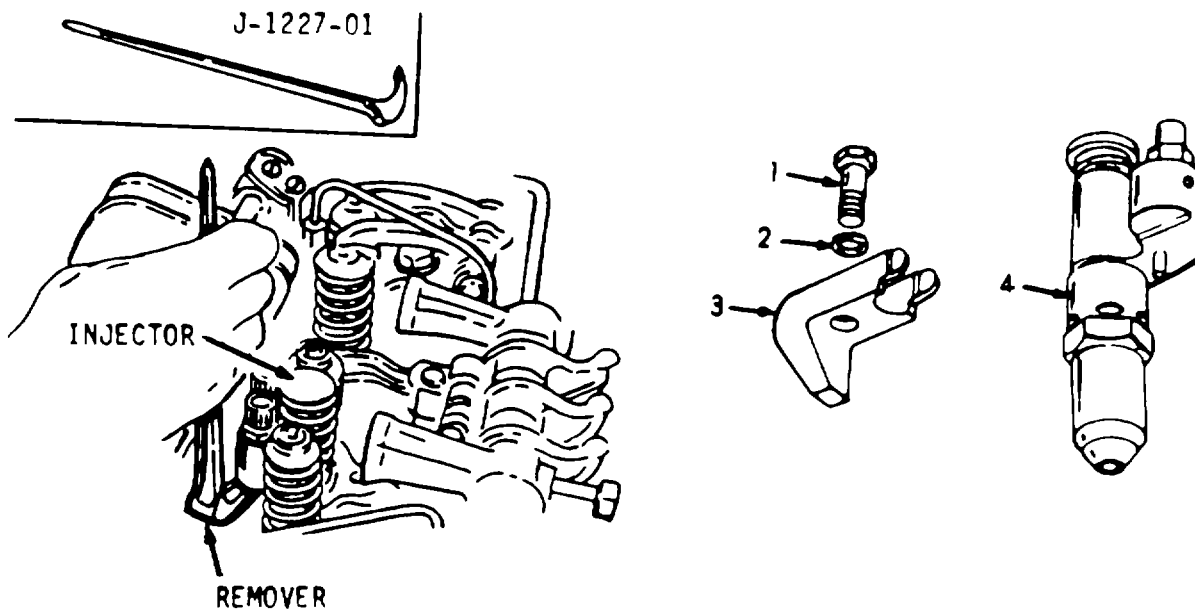
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

REMOVAL (Cont)

9. Injector Clamps and Injectors

- a. Remove injector clamp cap-screws (1), and ball socket washers (2).
- b. Remove injector clamps (3) from injectors (4).
- c. Lift the injectors (4) from cylinder head.
- d. Cover injector holes in cylinder head to prevent entry of foreign matter.

Use special tool J1227-01.

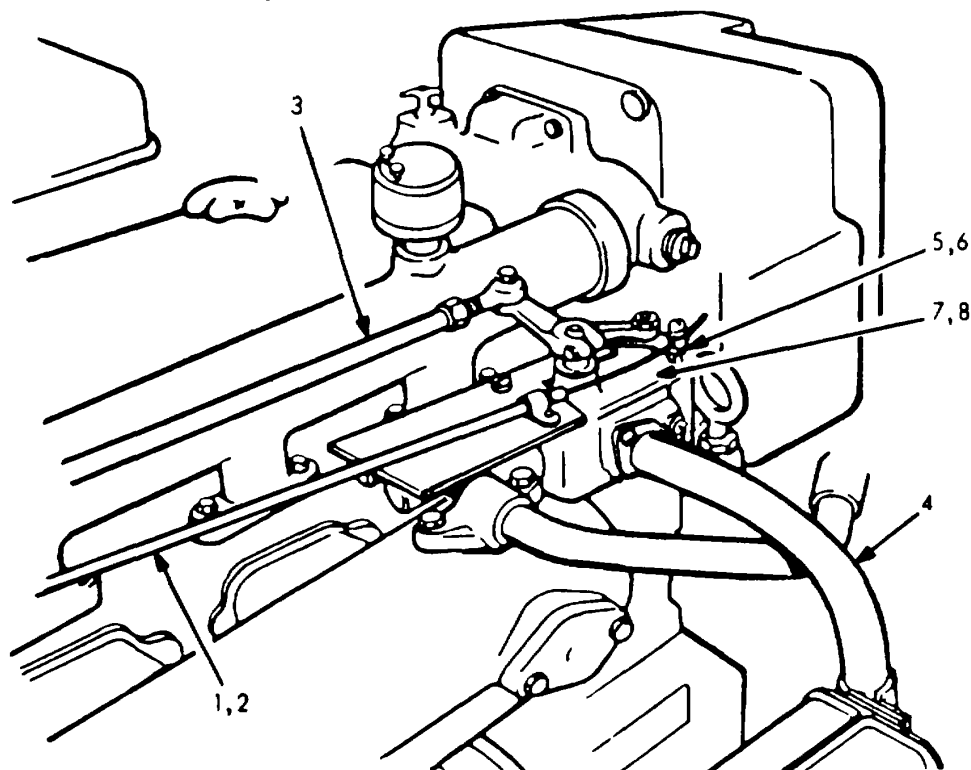


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

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

REMOVAL (Cont)

- | | | |
|--------------|--|--|
| 10. Governor | a. Disconnect stop control cable (1) and throttle control cable (2) (if used) from governor. | |
| | b. Disconnect governor control rod (3) from governor. | |
| | c. Remove screws, lockwashers, and breather tube (4) from governor. | |
| | d. Remove four screws (5), and lockwashers (6) from governor cover (7). | |
| | e. Lift governor cover (7) and gasket (8) from housing. | |

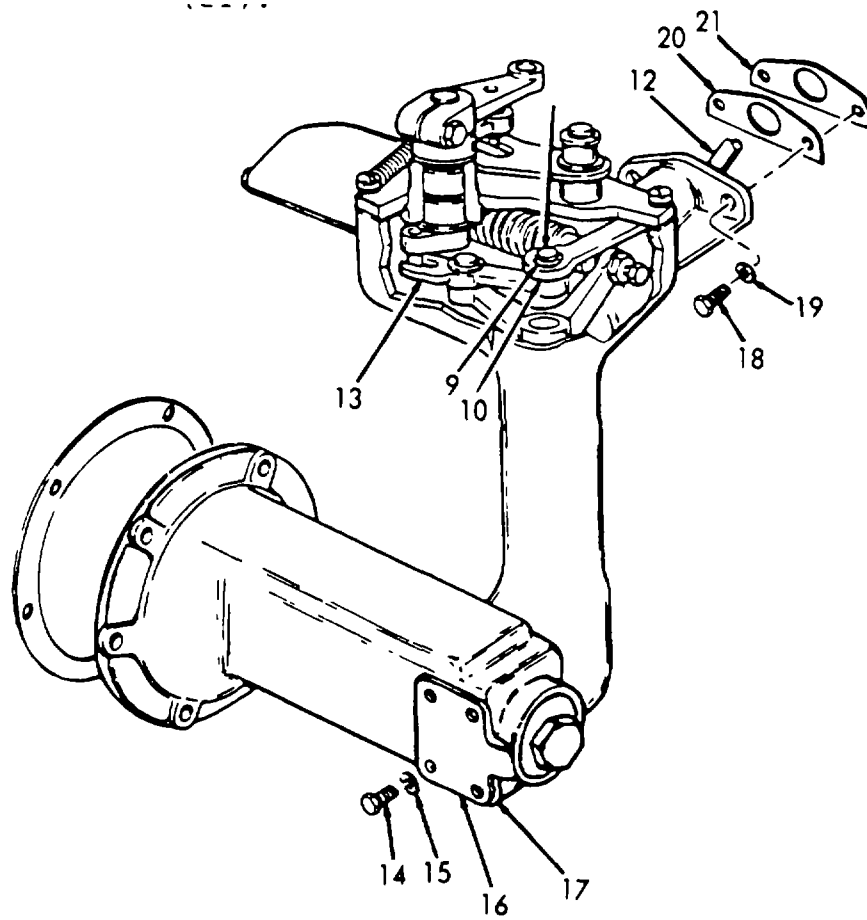


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- f. Remove retainer (9) and flatwasher (10) from differential lever pin (11). Then, disconnect the fuel rod (12) from the differential lever (13).
- g. Remove four bolts (14), and lockwashers (15) from weight housing cover (16).
- h. Remove cover (16) and gasket (17).
- i. Remove two governor-to-cylinder head bolts (18), lockwashers (19), gasket (20), and spacer (21).

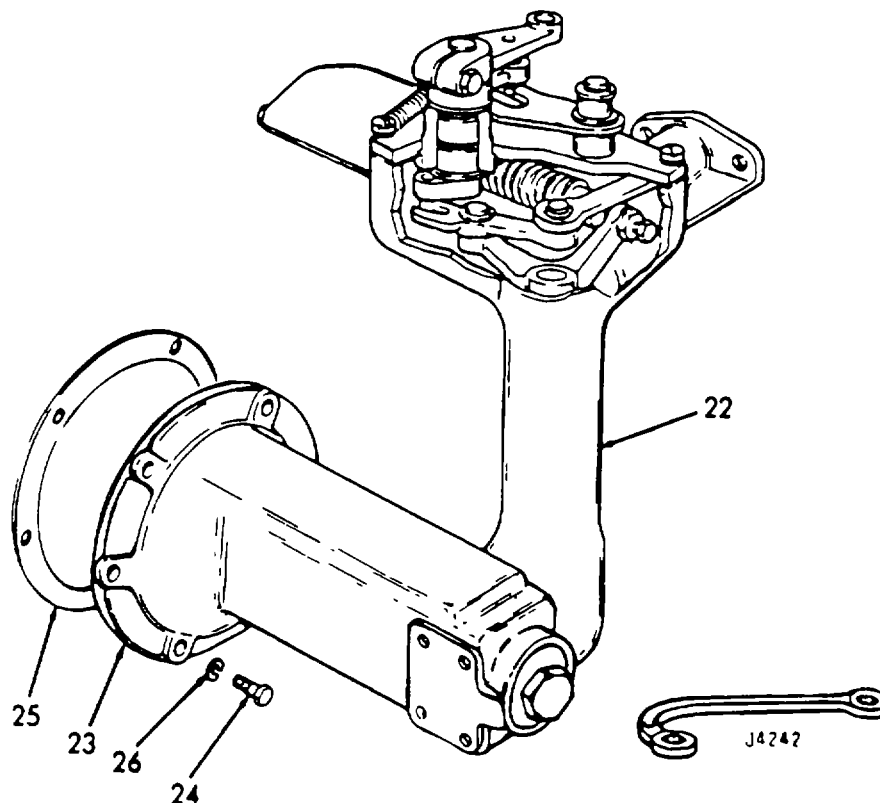


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- | | | |
|----|---|----------------------------|
| j. | Move upper end of control housing (22) away from cylinder head and free lower end from weight housing (23). | |
| k. | Remove six governor weight housing-to-blower bolt assembled washers (24). | Use tool J4242. |
| 1. | Withdraw housing (23) from blower. | Remove copper gaskets (26) |
| m. | Remove gasket (25). | |

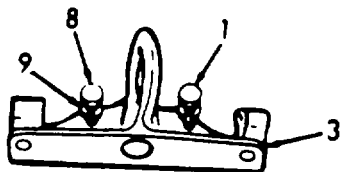
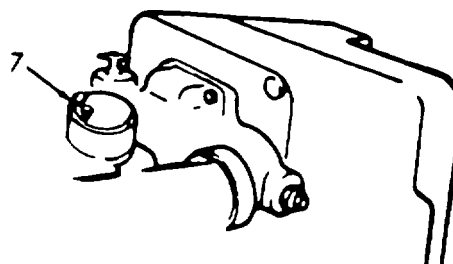
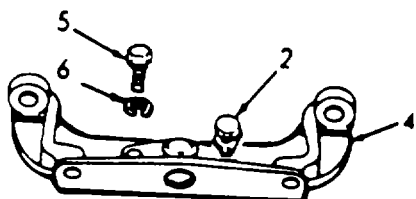


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- | | | |
|-------------------|--|--|
| 11. Cylinder Head | <ul style="list-style-type: none"> a. Loosen the two bolts (1 and 2) on each lifter bracket (3 and 4) which attach the balance weight cover and flywheel housing to the front and rear end plates. b. Remove capscrews (5) and lockwashers (6) from expansion tank vent. c. Remove expansion tank vent (7). d. Remove bolts (8), and lock-washers (9) from lifter bracket (3). | |
|-------------------|--|--|



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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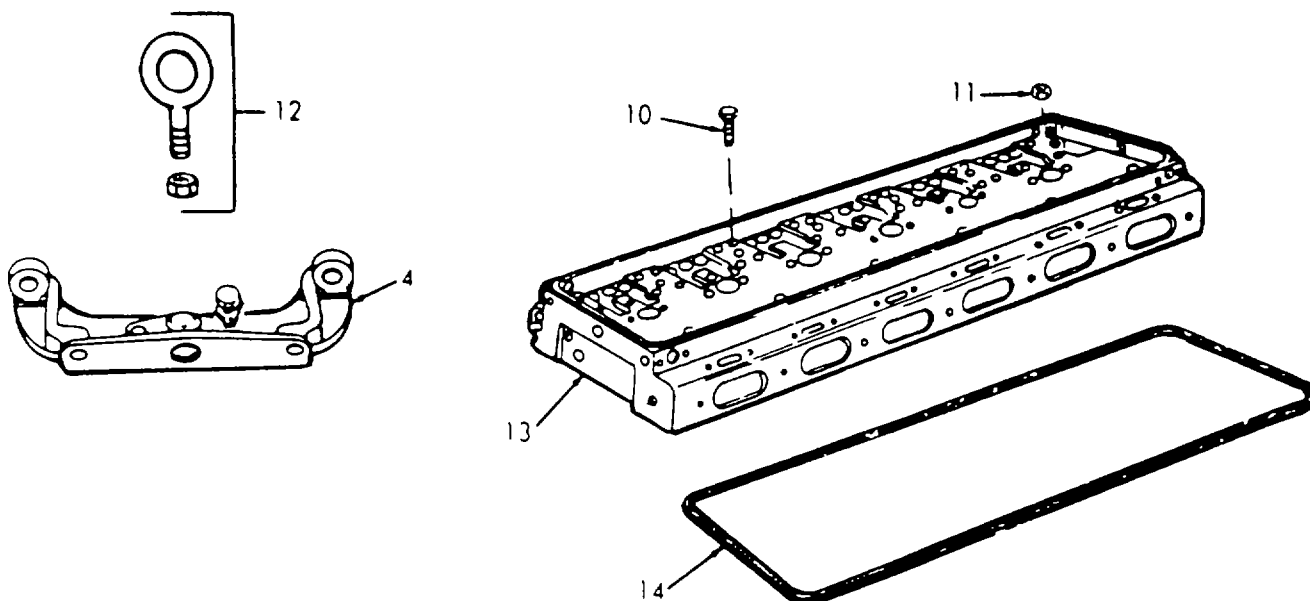
REMOVAL (Cont)

- | | | |
|----|--|-------------|
| e. | Remove cylinder head mounting bolts (10), and nuts (11). | |
| f. | Insert lifting eye bolt (12) into lifting bracket (4). | If removed. |

CAUTION

Do not set cylinder head with the bottom face down on work bench as this will damage the cam followers and injector spray tips. Lay cylinder head on its side or on blocks of wood.

- | | | |
|----|---|--|
| g. | Insert lifting hooks into lifting eye bolts (12), and with a hoist, lift cylinder head (13) evenly off cylinder head studs. | |
| h. | Remove cylinder head gasket (14). | |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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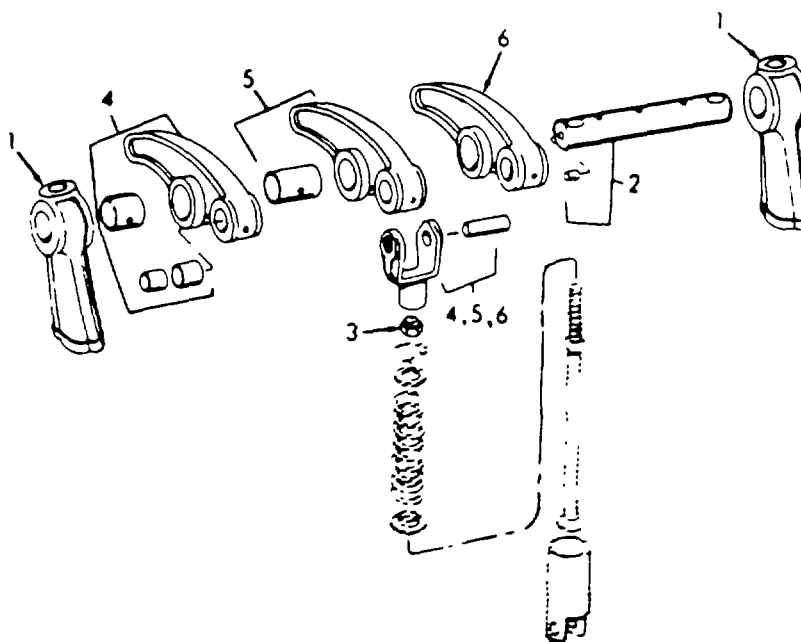
DISASSEMBLY

12. Rocker Arms, Cam Followers and Pushrods

CAUTION

When removing rocker arm shafts, fold back rocker arms just far enough so that the shaft may be removed. Do not force rocker arms all the way back with shaft in place, as this may impose a load that could bend the pushrods.

- a. Remove brackets (1) from shafts.
- b. Remove shaft (2) from rocker arm assemblies.
- c. Loosen locknut (3) at upper end of pushrod.
- d. Remove rocker arms (4, 5, and 6) from pushrods. Unscrew to remove.
- e. Remove all rocker arms in the same manner.

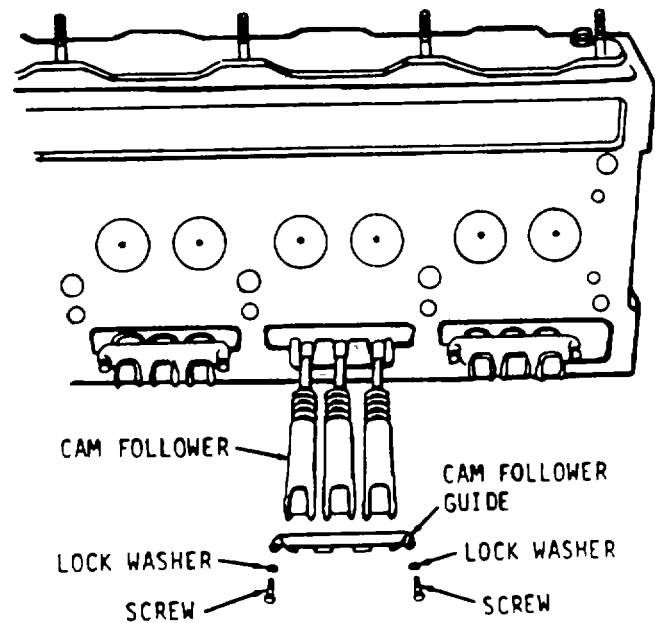
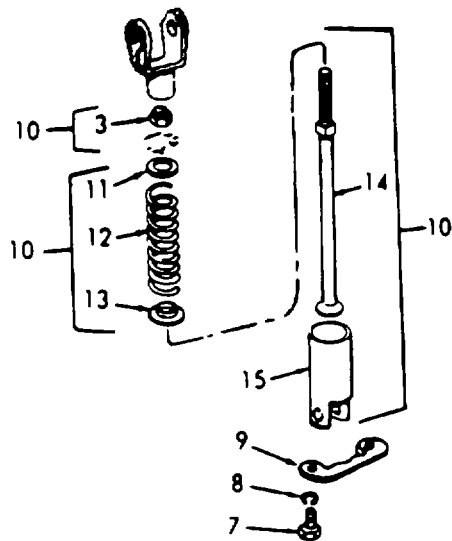


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- f. Rest the cylinder head on its side as shown, and remove capscrews (7) and lockwashers (8) from cam follower guide.
- g. Remove cam follower guides (9).
- h. Pull cam followers and associated parts (10) as a unit from bottom of cylinder head.
- i. Remove pushrod locknut (3), upper spring seat (11), spring (12), lower spring seat (13), and pushrod (14) from cam follower (15).



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

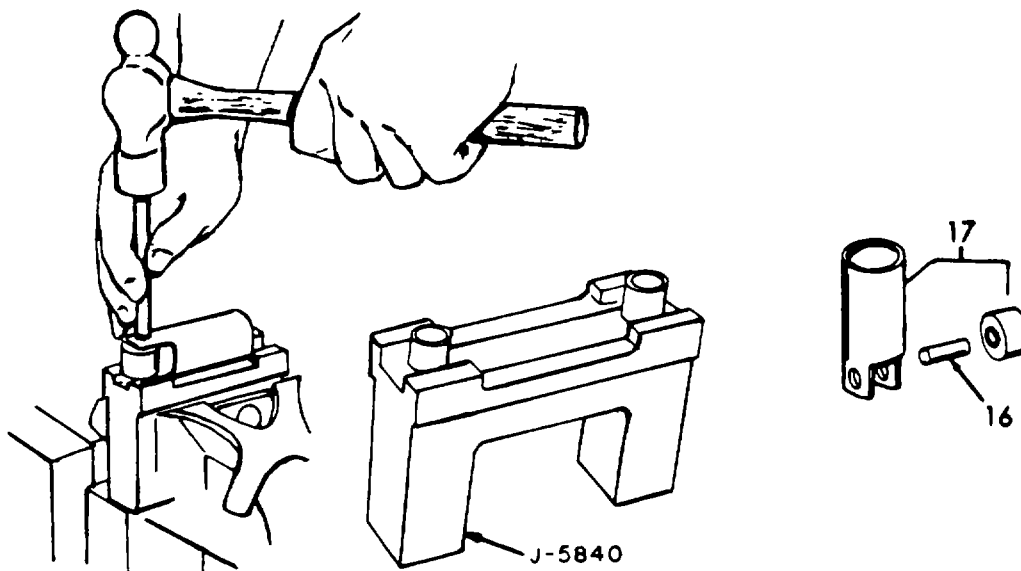
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

j. Remove pin (16) from roller set (17) as follows:

- (1) Lock fixture securely in a vise as shown. Then, place the cam follower in groove in the top of the fixture with the follower pin resting on top of the corresponding size plunger in the fixture.
- (2) With a suitable drift, drive the pin from the roller. Exercise caution in removing the cam follower body and roller from the fixture as the follower pin is seated on top of a spring-loaded plunger in the fixture body.

Use tool J5840.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

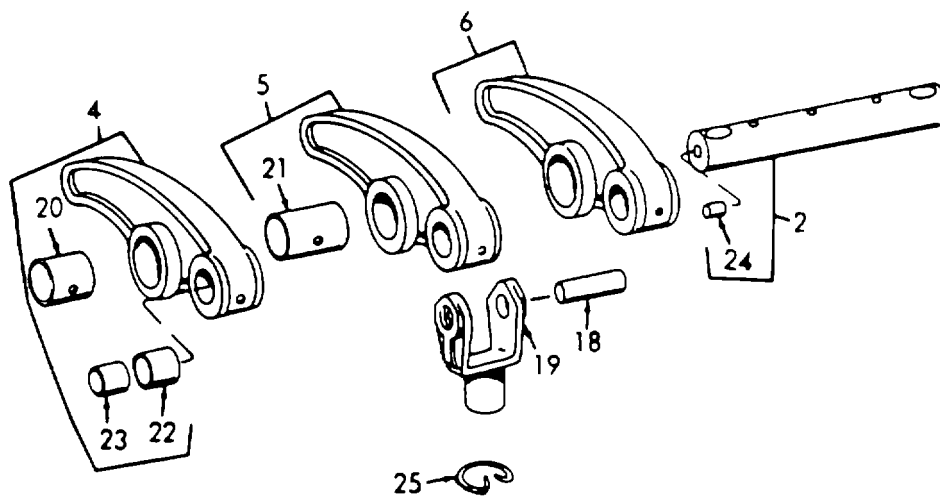
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

NOTE

In following steps k, l, and m, use an arbor press to press out the part if replacement is necessary.

- | | |
|--|----------------|
| k. Remove clevis pins (18) from clevises (19). | |
| l. Remove bushing sleeves (20) from rocker arms (4 and 6). Remove bushing sleeve (21) from rocker arm (5). | |
| m. Remove sleeve bearings (22 and 23) from rocker arms (4, 5, and 6). | |
| n. Remove plugs (24) from rocker shaft (2). | If required. |
| o. The pushrod spring seat retainer (25) remains in the cylinder head. | Do not remove. |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING

13.

WARNING

- Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°-59°C).
- When using compressed air, wear safety goggles to prevent eye injury.
 - a. Clean out oil passages in the rocker arms, bracket bolts and rocker arm shafts with fuel oil and a small wire, and dry them with compressed air. It is very important to inspect the rocker arm shaft bolts for plugged oil passages.
 - b. Clean the cam followers and all their associated parts thoroughly with solvent P-D-680, and dry them with compressed air.

INSPECTION

14. a. Inspect the rocker arm shaft and the bushings inside the rocker arms for excessive wear. The diameter of a rocker arm shaft is .8735 inch (2.2187 cm) to .8740 inch (2.2199 cm), and the inside diameter of a rocker arm bushing is .8750 inch (2.2225 cm) to .8760 inch (2.2250 cm). Thus, the clearance is .001

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

inch (0.0025 cm) to .0025 inch (0.0064 cm). A maximum clearance of .004 inch (0.0102 cm) is allowable with used parts. Service replacement bushings must be reamed to size after installation.

- b. Inspect the rocker arms for wear or galling on the pallets (valve contact surfaces).
- c. Inspect the pushrods, and pushrod spring seats for wear.
- d. The purpose of a pushrod spring is to maintain a predetermined load on the cam follower to insure contact of the cam roller on the camshaft lobe at all times. Check the push rod spring load whenever the cam followers and their related parts are removed for inspect on.
- e. The pushrod spring is made of wire .177 inch (0.450 cm) in diameter and has a free length of 2-5/8 inches (6.655 cm). Replace the spring when a load of less than 172 pounds (78.019 kg) will compress it to a length of 2-1/8 inches (5.398 cm).
- f. Examine the cam follower bores in the cylinder head to make sure they are clean, smooth, and free of score marks to permit proper functioning of the cam followers. Clean up any existing score marks.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSPECTION (Cont)</u>		
g.	The diameter of a cam follower is 1.060 inches (2.692 cm) to 1.061 inches (2.695 cm), and the clearance between the cam follower and the cylinder head bore with new parts is .001 inch (0.003 cm) to .003 inch (0.008 cm). With used parts, a maximum clearance of .006 inch (0.015 cm) is allowable.	
h.	The cam rollers must turn smoothly and freely on their pins, and the rollers must be free from flat spots or scuff marks. If the rollers do not turn freely, or have been scored or worn flat, then examine the cams on which they operate. If the cams are excessively worn or damaged, replace the camshaft.	
i.	Measure the total clearance between the roller bushing and pin, crosswise of the pin, and, if the bushing is worn to the extent that more than .010 inch (0.025 cm) diametric clearance exists, install a new cam roller and pin, which are serviced as a set, in the follower assembly. Also, check the total side clearance between the roller and follower: this clearance must be .015	

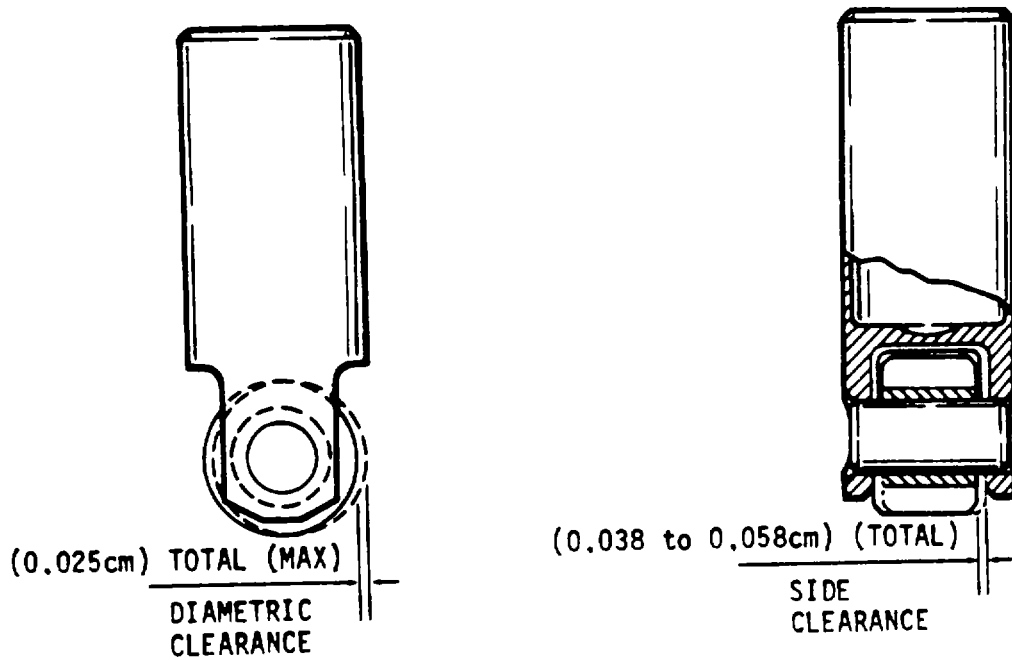
5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

inch to .023 inch (0.038 to 0.058 cm). See figure below.

- j. Cam followers stamped with the letter "S" on the pin, roller and follower body are equipped with an oversize pin and roller. An oversize roller and pin are available as a set for service. Do not attempt to bore out the legs of a standard cam follower for an oversize pin. The same clearances apply to either a standard or oversize cam follower assembly.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

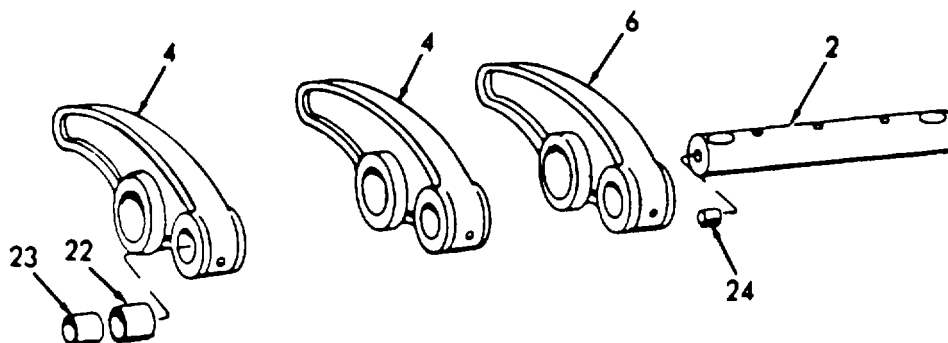
LOCATION/ITEM	ACTION	REMARKS
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REPAIR (Cont)

- 15.
- a. Replace defective rocker arms and shafts.
 - b. Replace damaged or defective cam followers and pushrod assemblies as required.
 - c. Worn rocker arm pallets may be refaced to a maximum depth of .010 inch (0.025 cm). However, proceed with caution when surface grinding so that the rocker arms are not overheated. Maintain the radius and finish as close to the original surface as possible.

ASSEMBLY

16. Rocker Arms, Cam Followers and Pushrods
- a. Install plugs (24) in rocker shaft (2). If removed.
Use arbor press.
 - b. Install sleeve bearings (23 and 22) in rocker arms (4, 5 and 6). If removed.
Use arbor press.

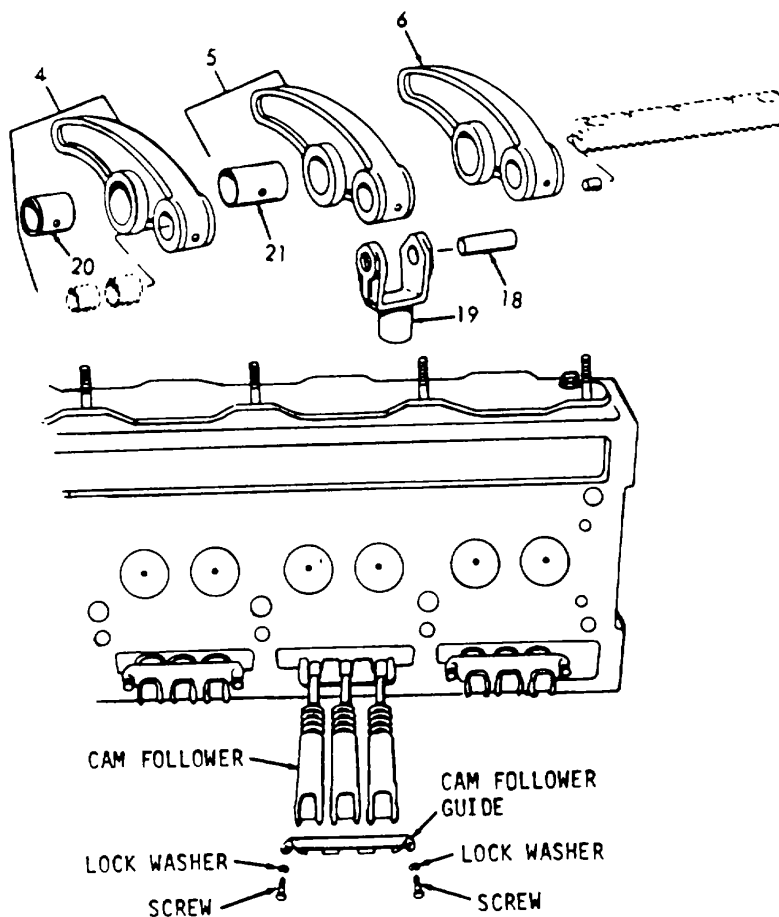


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | |
|---|---|
| <p>c. Install bushing sleeve (21) in rocker arm (5). Install bushing sleeves (20) in rocker arms (4 and 6).</p> <p>size after installation.</p> | <p>If removed. Replacement bushings must be reamed to</p> |
| <p>d. Position rocker arms (4, 5, and 6) and install clevis pins (18) in clevises (19).</p> | <p>If removed. Use arbor press.</p> |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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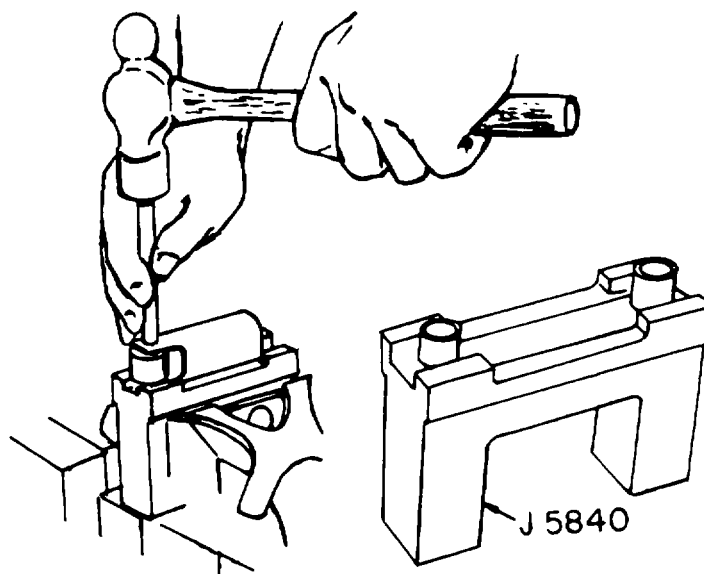
ASSEMBLY (Cont)

- e. Replace cam follower rollers, using fixture J5840 as follows:
- (1) Lock the fixture securely in a vise as shown. Then, place the cam follower in the groove in the top of the fixture with follower pin resting on top of the corresponding size plunger in the fixture.

NOTE

Prior to installing new rollers or pins, insure that any burrs on the surfaces of the cam followers at the pin holes are removed.

- (2) Position the follower body in the groove of the fixture with the proper size plunger extending thru the roller pin hole in one of the legs of the follower body. Coat the roller bushing and roller pin with engine oil.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

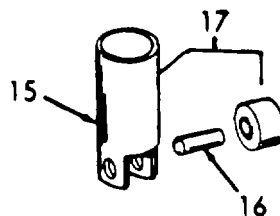
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- (3) Install roller (17) in position in cam roller body. The plunger, when released, will extend into the roller bushing and assure accurate alignment of the bushing with the roller pin holes in the follower body.
- (4) Start the roller pin (16) squarely into the follower. Then, carefully drive the pin into the assembly (15) until the pin is centered in the legs of the follower.
- (5) Check the side clearance between the roller and the follower body. This clearance must be .015 inch (0.038 cm) to .023 inch (0.058 cm).

NOTE

Immerse a new or solvent-cleaned cam follower assembly in clean engine oil for at least five minutes before placing it in the cylinder head. This will ensure initial lubrication over the full length of the cam follower roller pin, and is essential to satisfactory cam follower performance. Rotating the cam roller during this period will aid in introduction of oil to the cam roller pin.

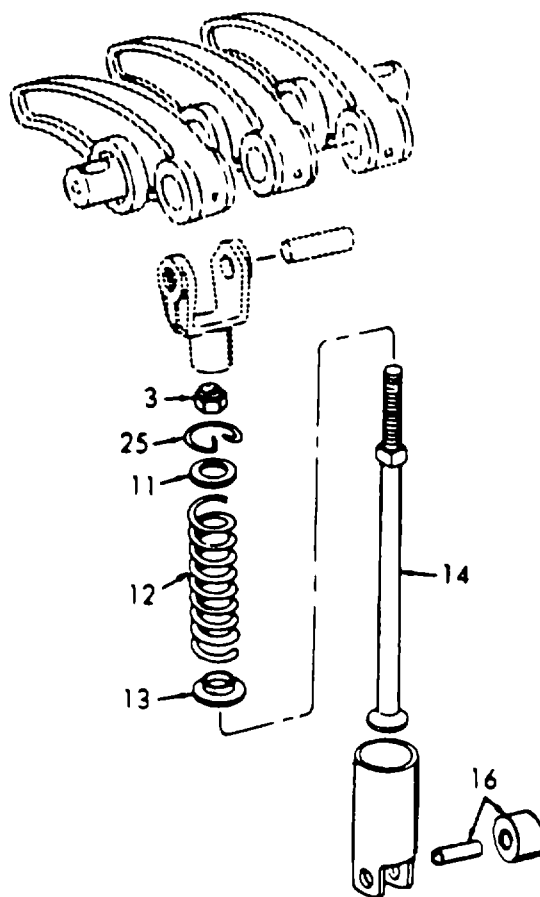


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | | |
|-----|--|---|
| (f) | Assemble the lower spring seat (13), pushrod spring (12), upper spring seat (11), and locknut (3) on pushrod (14). | Place cylinder head on its side as shown. |
| (g) | With the spring seat retainer (25) in place in the cylinder head, slide the pushrod and spring assembly (16) into position from the bottom of the cylinder head. | |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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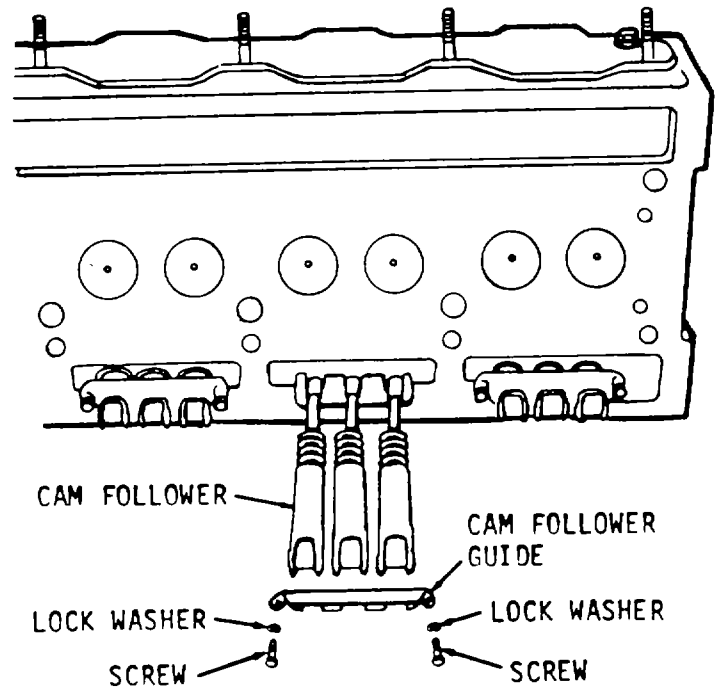
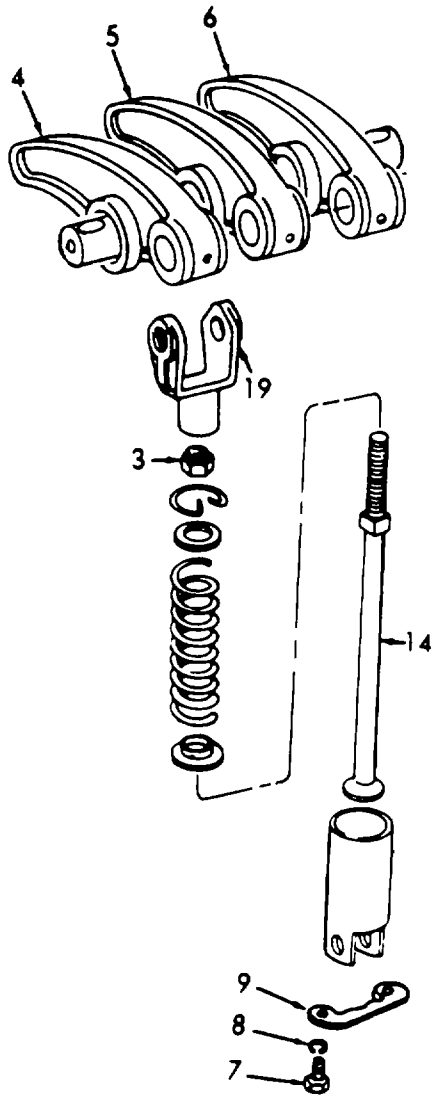
ASSEMBLY (Cont)

- | | | |
|----|---|--|
| h. | Install rocker arm assemblies (4, 5, and 6) onto pushrods (14). | |
| i. | Screw the pushrod (14), and locknut (3) down on the upper end of the pushrod as far as possible; then, screw the pushrod into the clevis (19) until the end of the rod is flush with or above the inner side of the clevis. | |
| j. | Lubricate the cam roller and cam follower body. | |
| k. | Note the 1/8 inch oil hole in the bottom of the cam follower. With this hole pointing away from the exhaust valves and injectors, so that the hole is not covered by the cam follower guide, slide the cam follower into position from the bottom of the head. | |
| l. | Attach the follower guide (9) to the cylinder head to hold the group of cam followers in place using lockwashers (8), and cap screws (7). Check to make sure there is clearance between the cam followers and the cam follower guide. Tighten the guide cap screws to 12-15 lb. ft. torque (16.3 to 20.3 Nm). | |

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

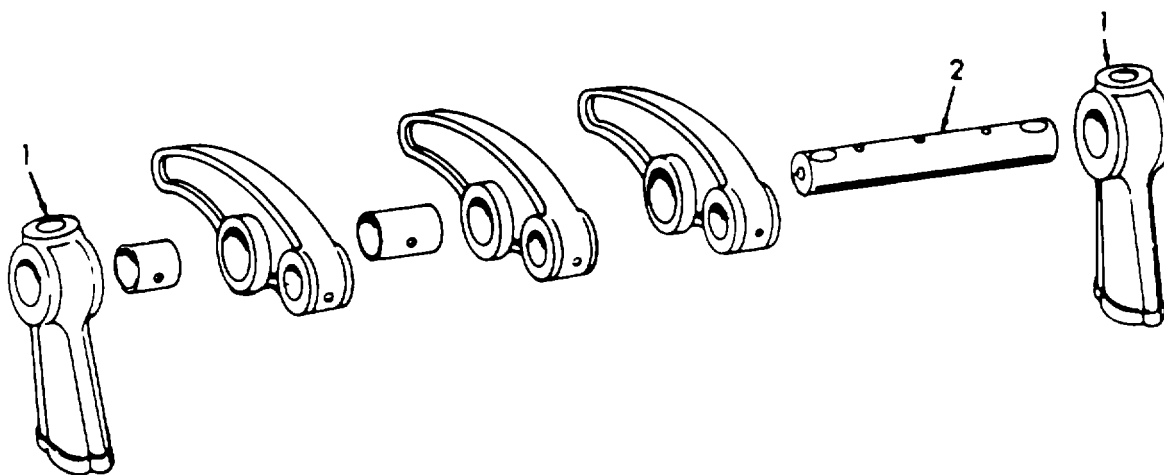
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

CAUTION

Whenever a push rod has been disconnected from the rocker arm clevis, the push rod must be threaded into the clevis until the end of the rod is flush with or above the inner side of the clevis yoke at the time of reassembly, before the valve clearance is adjusted. If this is not done, the valve may strike the piston (due to the small clearance between the valve head and the piston head when the piston is at top dead center), and thus be seriously damaged when the crankshaft is turned.

- m. Insert rocker arm shafts (2) through rocker arms and into brackets (1).



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION

17. Cylinder
Head

- a. Pre-Installation Inspection.
The following inspections shall be made just prior to installing the cylinder head onto the engine. Make these inspections regardless of whether the head was removed from the engine for servicing only the head assembly, or to facilitate other repairs to the engine.
1. Check the cylinder head studs for damaged threads.
 2. Check for extruded areas around the stud holes in the cylinder block.
 3. Check the cylinder liner height with relationship to the cylinder block.
 4. Check to be sure the tops of the pistons are clean and free of foreign material.
 5. Check to see that ALL the push rods are threaded into their clevises until the ends of the push rods project through the clevises. This is important since serious engine damage will be prevented when the engine is cranked or barred-over during tune-up.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- 6. Check the cylinder block and cylinder head gasket surfaces and counterbores to ascertain that these sealing surfaces are clean and free from foreign material. Also check to ensure that there are no burrs or sharp edges in the counterbores.
- 7. Check the four corner plugs or drive pins used to plug the vertical oil galleries to ensure that they are flush with, or below, the top surface of the cylinder block.

b. Install new cylinder head gasket (14) onto block.

c. Insert lifting eye bolts (12) into lifting bracket (4). If removed.

d. Insert lifting hooks into lifting eye bolts (12).

CAUTION

Exercise care when lowering cylinder head onto block to prevent damage to mounting studs.

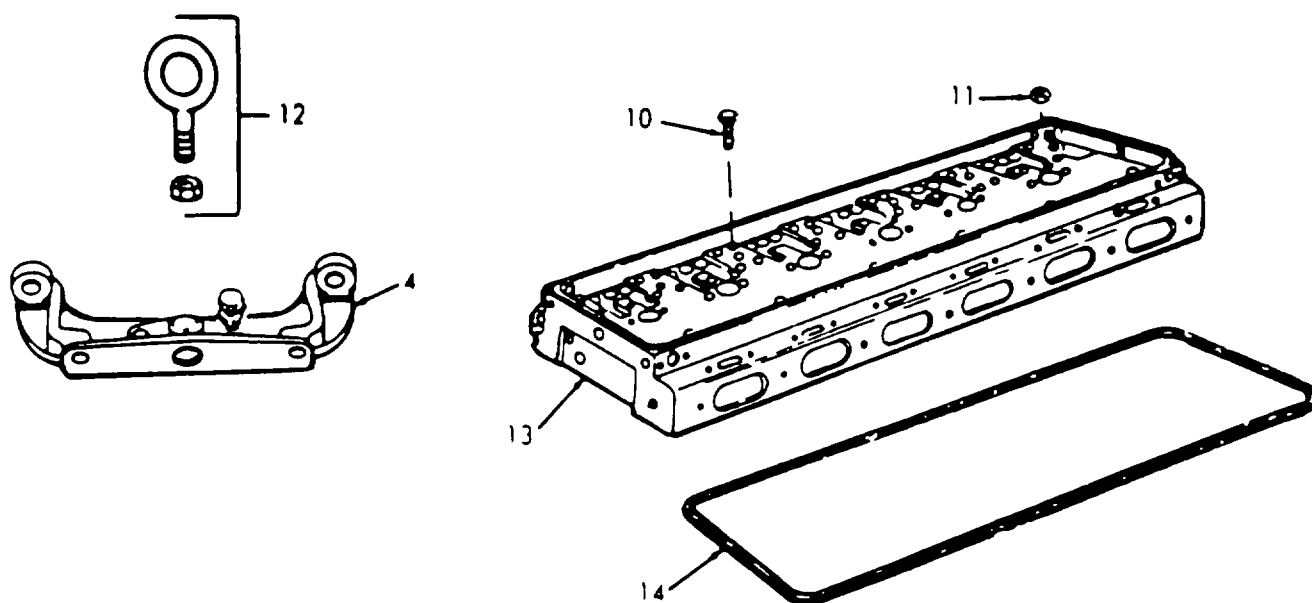
- e. Using a hoist, place cylinder head (13) onto mounting studs. Detach lifting hooks from hoist and remove hoist.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- f. Install cylinder head mounting nuts (11) and bolts (10).



NOTE

Refer to the following table for standard nut and bolt torque specifications.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

Standard Bolt and Nut Torque Specifications.

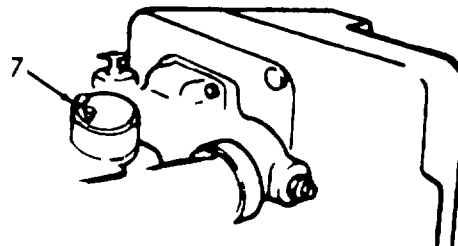
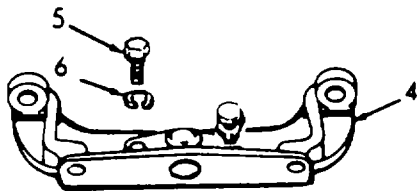
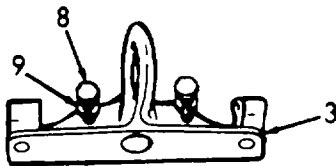
SIZE NUT OR BOLT	TORQUE (lb. ft.)	TORQUE (Nm)
1/4 - 20	7 - 9	9.4907 - 12.2024
1/4 - 28	8 - 10	10.8465 - 13.5582
5/16 - 18	13 - 17	17.6256 - 23.0489
5/16 - 24	15 - 19	20.3373 - 25.7605
3/8 - 16	30 - 35	40.6745 - 47.4536
3/8 - 24	35 - 39	47.4536 - 52.8769
7/16 - 14	46 - 50	62.3676 - 67.7909
7/16 - 20	57 - 61	77.2816 - 82.7049
1/2 - 13	71 - 75	96.2631 - 101.6863
1/2 - 20	83 - 93	112.5329 - 126.0911
9/16 - 12	90 - 100	122.0236 - 135.5818
9/16 - 18	107 - 117	145.0725 - 158.6307
5/8 - 11	137 - 147	185.7471 - 199.3052
5/8 - 18	168 - 178	227.7774 - 241.3356
3/4 - 10	240 - 250	325.3963 - 338.9545
3/4 - 16	290 - 300	393.1872 - 406.7454
7/8 - 9	410 - 420	555.8854 - 569.4436
7/8 - 14	475 - 485	644.0132 - 657.5714
1 - 8	580 - 590	786.3744 - 799.9326
1 - 14	685 - 695	928.7353 - 942.2935

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- h. Install lifter brackets (3) with lockwashers (9), and bolts (8).
- i. Install expansion tank vent (7) using lockwashers (6) and cap screws (5).



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- | | | |
|--------------|---|--------------------|
| 18. Governor | a. Position a new gasket (25) in place on governor weight housing (23). | |
| | b. Start splined end (26) of weight shaft in the upper blower rotor. | |
| | c. Position housing (23) against blower end plate. | |
| | d. Install new copper gasket (27) onto each housing-to-blower bolt. | |
| | e. Install housing-to-blower bolts (24) into blower end plate. | Finger-tight only. |
| | f. Place new gasket over dowels and against the side of the weight housing facing engine. | |
| | g. Move thrust bearing assembly (28) and riser (29) toward weight end of shaft (23). | |

NOTE

The finished surface of the operating fork must be placed against outer side of thrust bearing.

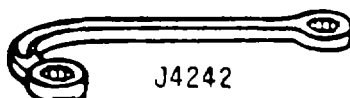
- h. Position lower end of control housing (22) over dowel pins in weight housing (23).
- i. Install new gasket (21) to governor control housing (22).
- j. Secure housing (22) to cylinder head with spacer (20), two lockwashers (19), and bolts (18).

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

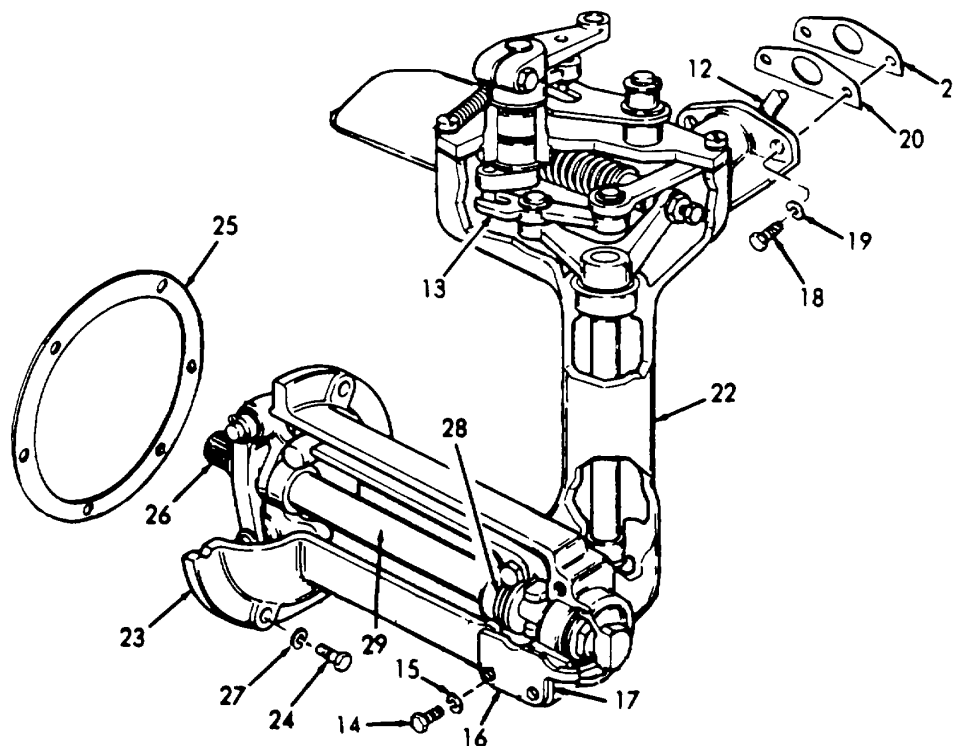
LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- | | |
|--|-------------------|
| k. Tighten housing-to-blower bolts (24). | Use wrench J4242. |
|--|-------------------|



- | |
|---|
| l. Install weight housing cover gasket (17) and cover (16) with four lockwashers (15) and bolts (14). |
| m. Reconnect fuel rod (12) to differential lever (13). |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

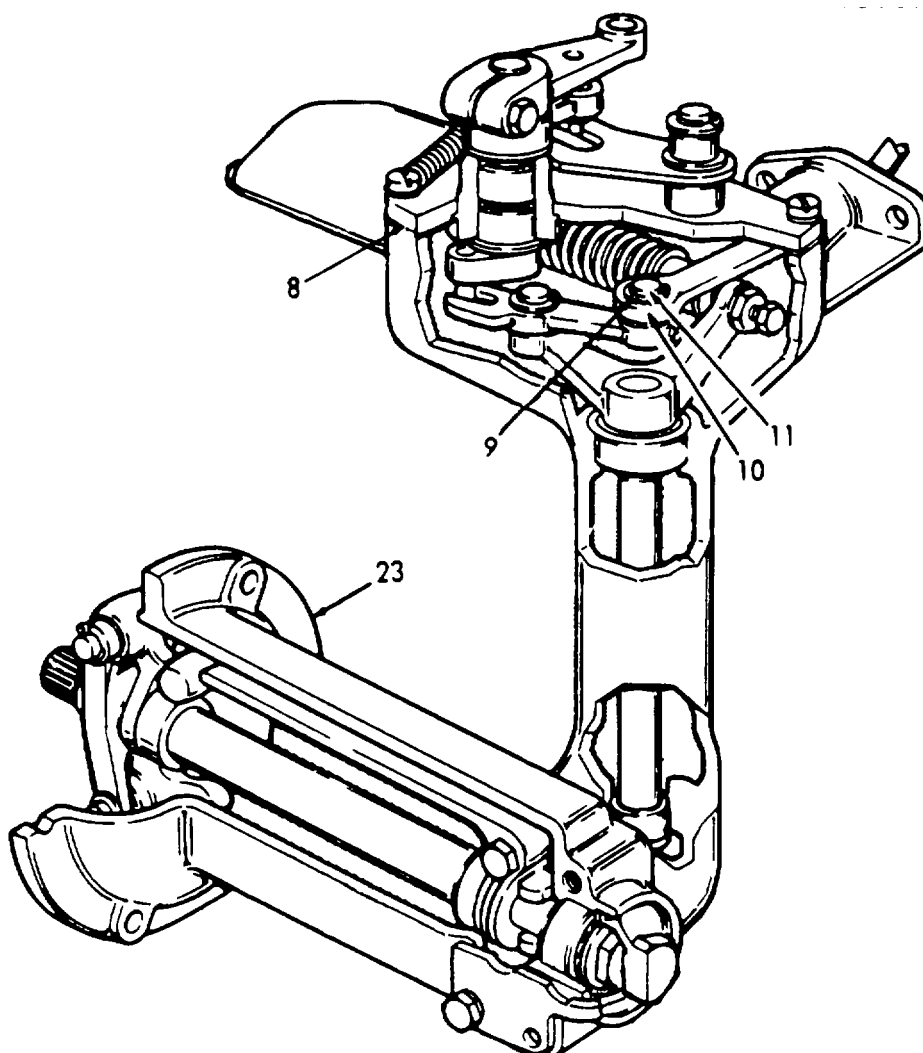
LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

n. Install flatwasher (10) and retainer (9) to differential lever pin (11).

o. Position governor cover gasket (8) on governor housing (23).

Make sure pin on throttle shaft registers with machined slot in the differential lever.

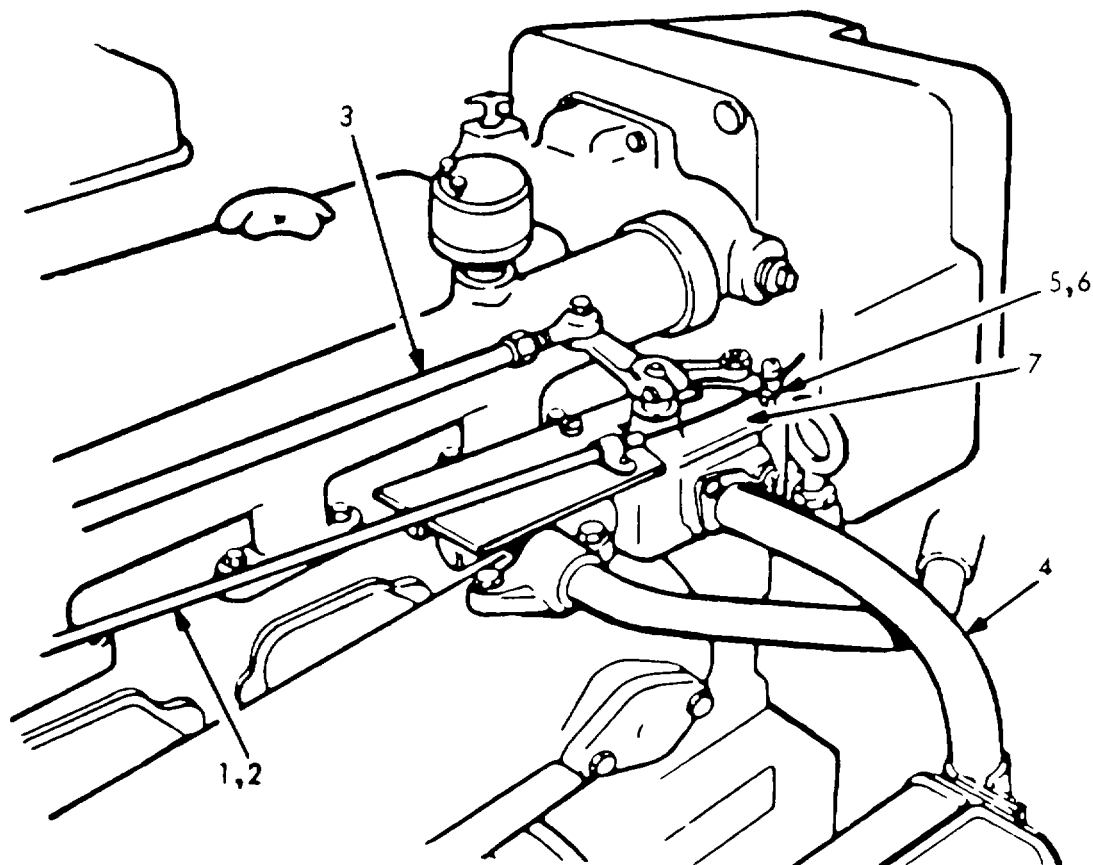


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- p. Install cover (7) with four lockwashers (6), and screws (5).
- q. Reconnect breather tube (4) to governor using screws and lockwashers.
- r. Reconnect governor control rod (3).
- s. Reconnect stop control cables (1) and throttle control cable (2). If used.

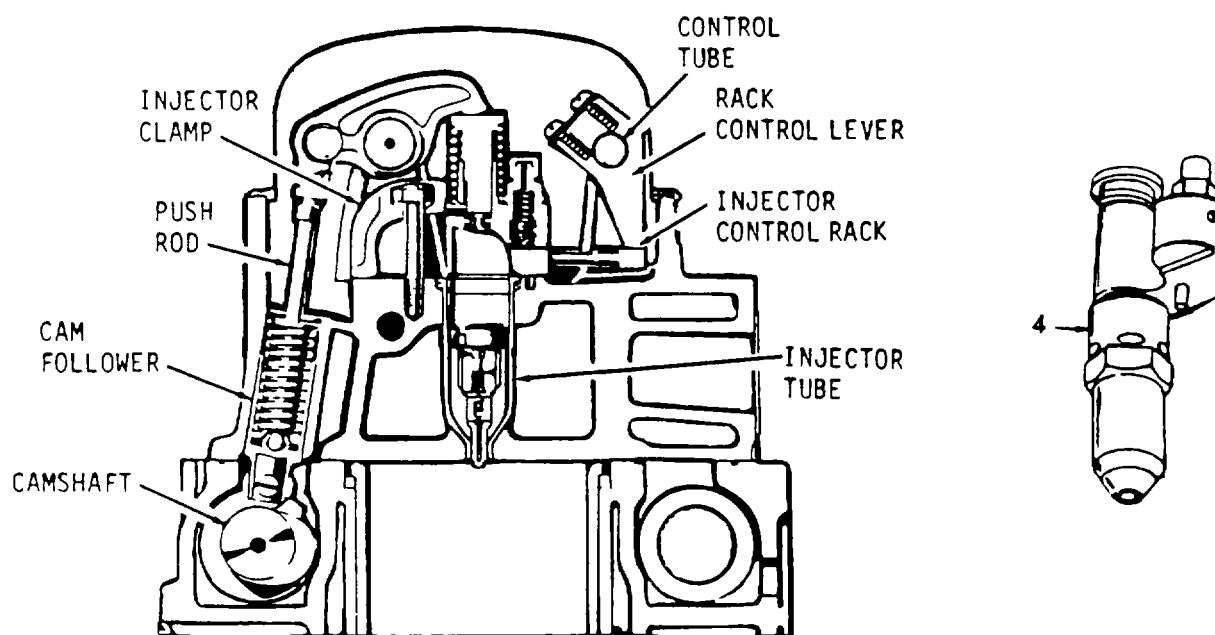


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- | | | |
|-------------------------------|--|------------------------|
| 19. Fuel Injectors and Clamps | a. Insert injectors (4) into injector tubes. | Refer to figure below. |
|-------------------------------|--|------------------------|



NOTE

Insure that dowel registers with locating hole in the cylinder head.

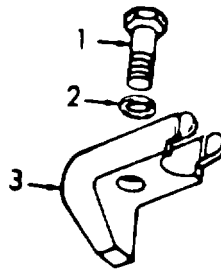
- b. Place injector clamps (3) in place.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- | | | |
|---|--|--|
| c. Place ball socket washers (2) on injector capscrews. | | |
| d. Install cap screws (1). | | Torque to 12-15 lb. ft (16.3 - 20.3 Nm). |
| e. Slide rack control lever over so that it registers with injector rack. | | |



NOTE

Check injector control racks for free movement. Excess torque can cause control rack to stick or bind.

- f. Make sure that injector clamps do not interfere with exhaust valves or injector springs.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

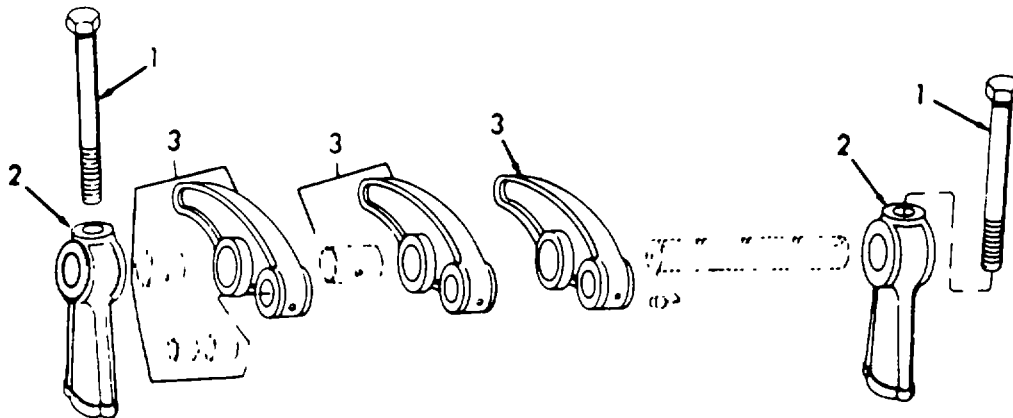
LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

20. Rocker Arms, Cam Followers, and Pushrod Assembly

- a. Place assembly in position on cylinder head.
- b. Move rocker arm assemblies (3) into position.
- c. Insert bracket bolts (1) into brackets (2).
- d. Tighten bolts (1) to cylinder head.

Torque to 90-100 lb. ft (122.0 - 135.6 Nm).



21. Fuel Connectors and Pipes

- a. Remove shipping caps (4).
- b. Install fuel pipes (1) to injectors (2) and fuel connectors (3).
- c. Torque connections to 12-15 lb. ft. (16.3 - 20.3 Nm).

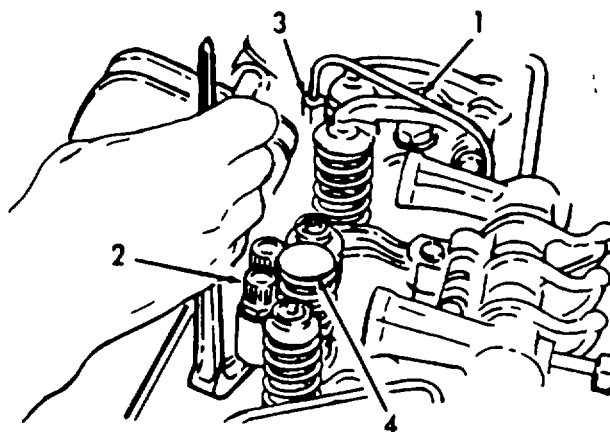
5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

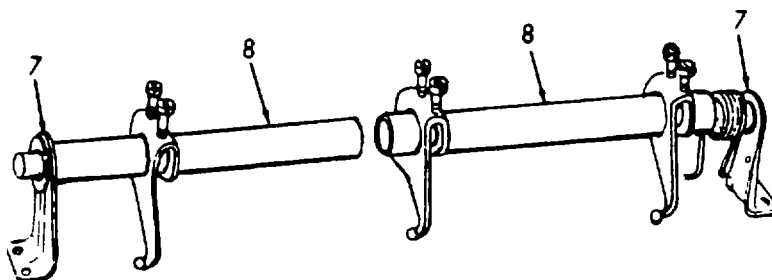
CAUTION

Do not bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared end of the fuel line and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.



22. Injector Control Tube

a. Position control tube assembly (8) and brackets (7) in place on cylinder head.

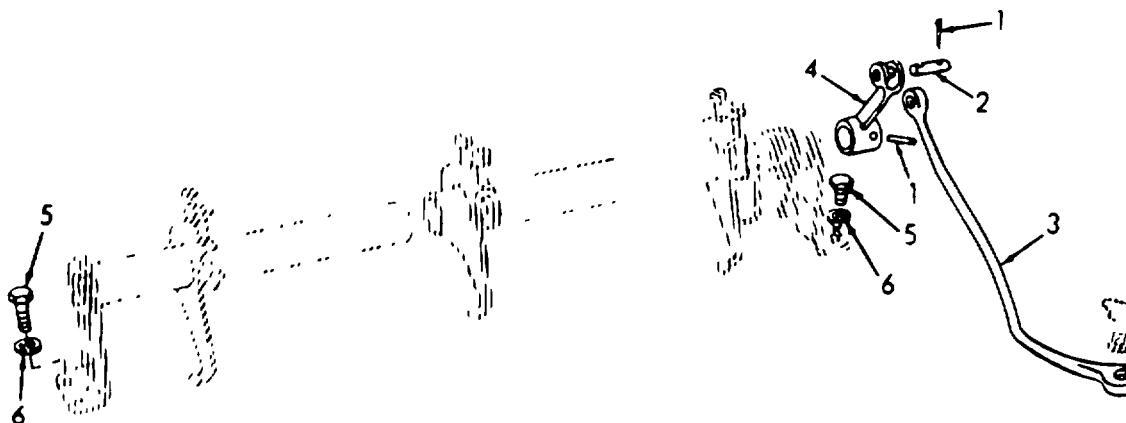


5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- b. Secure with lockwashers (6) and capscrews (5).
- c. Position governor control link (4) in place in control tube lever (3) and install link pins (2).
- d. Secure with cotter pins (1).



23. Thermostat Housing

- a. Install thermostat (13) in housing (10).
- b. Position housing gasket (11) in place on housing (10).
- c. Secure housing (10) to expansion tank (12) with four lockwashers (9) and capscrews (8).
- d. Slide hose clamp (4) over ends of hose (5).
- e. Secure one end of hose (5) to hose tee (7).

If removed.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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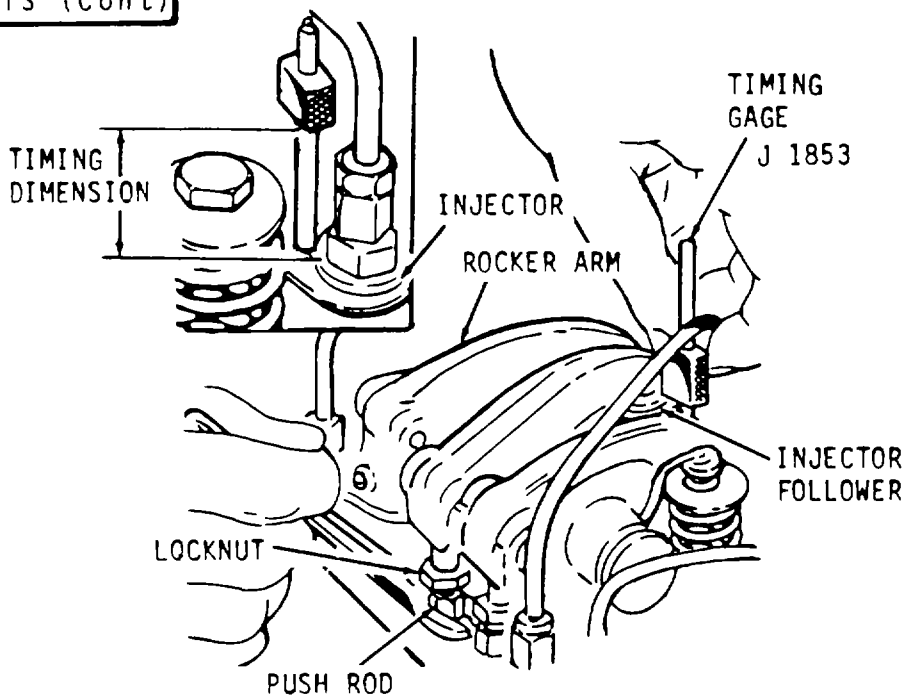
ADJUSTMENTS

- | | | |
|------------------------|---|--|
| 24. Injector
Timing | <ul style="list-style-type: none">a. Pull the engine stop control out to the NO-FUEL position.b. Rotate crankshaft until the exhaust valves are fully depressed on the cylinder to be timed.c. Place the small end of the injector timing gage J1853 in the hole provided in the top of the injector body, with flat of gage toward the injector follower. See figure below.d. Loosen the pushrod locknut.e. Turn the pushrod and adjust the injector rocket arm until the extended part of the gage will just pass over the top of the injector follower.f. Hold the pushrod and tighten the locknut. Check the adjustment and, if necessary, readjust the pushrod.g. Time remaining injectors in the same manner. | |
|------------------------|---|--|

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)



25. Governor and Injector Rack Control Adjustments

a. Governor Gap Adjustment.
 With the engine at operating temperature, adjust the governor gap using tool J5407.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

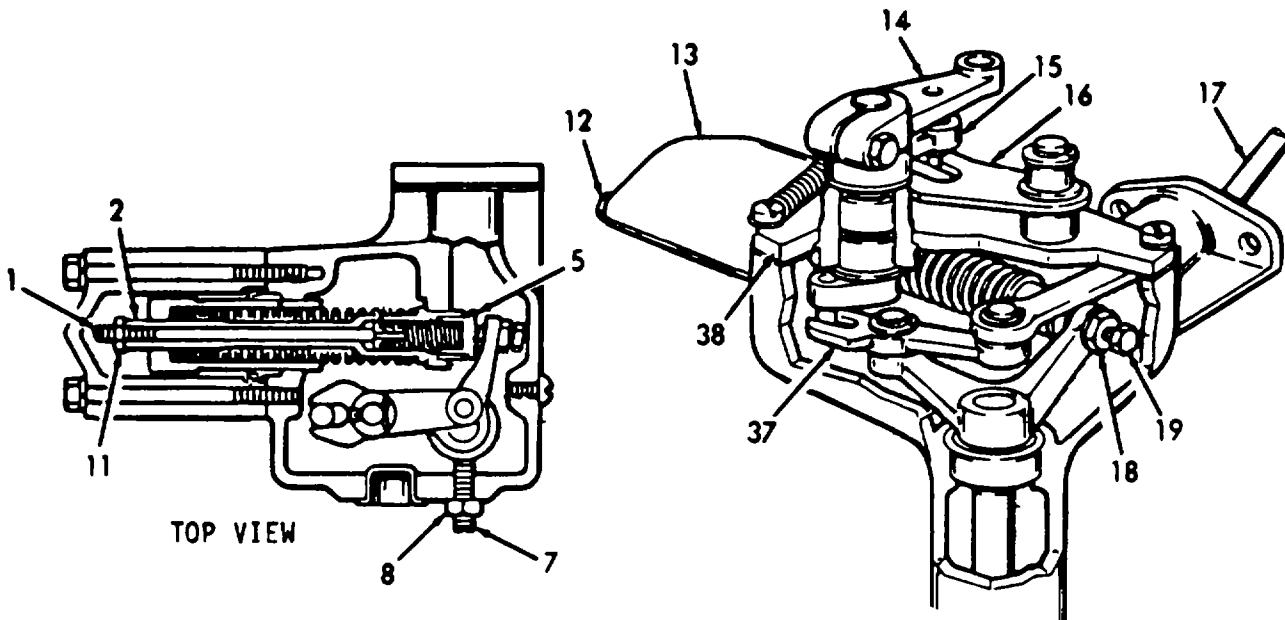
1. With the engine stopped, remove the two attaching bolts (12), and withdraw the governor high speed spring retainer cover (13).
2. Back out the buffer screw (7) until it extends approximately 5/8 inch (1.588 cm) from the locknut (8).
3. Start the engine, and loosen the idle speed adjusting screw locknut (11), and adjust the idle screw (1) to obtain the desired idle speed. Hold the screw and tighten the locknut to retain the adjustment. The recommended idle speed is 550 rpm.
4. Stop the engine and remove the governor cover (38) including lever (14, 15 and 16) as an assembly.
5. Remove the valve rocker cover.
6. Remove the fuel rod (17) from the differential lever (37), and the injector control tube lever.
7. Check the gap between the low speed spring cap (5), and the high speed spring plunger (2) with gage J5407 as shown in the previous figure.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

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|-----|--|---------------|
| 8. | If required, loosen the locknut (18), and turn the gap adjusting screw (19) until a slight drag is felt on the gage. | |
| 9. | Hold the adjusting screw (19), and tighten the locknut (18). | |
| 10. | Recheck the gap and readjust. | If necessary. |
| 11. | Install the fuel rod (17) between the governor and injector control tube lever. | |
| 12. | Install the governor cover and lever assembly. | |



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

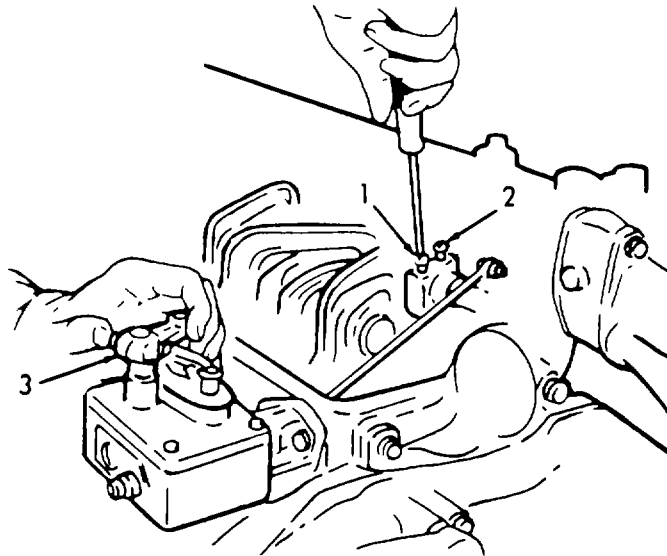
- b. Positioning The Injector
 Rack Control Levers: The position of the injector racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Adjust the No. 1 injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers.
1. Disconnect any linkage attached to the governor speed control lever.
 2. Loosen the idle speed adjusting screw locknut and back out the idle speed adjusting screw until 1/2 inch (1.27 cm) of the threads project from the locknut when the nut is against the high speed plunger.
 3. Loosen all the inner (1) and outer (2) injector rack control lever adjusting screws. Be sure all the control levers are free on the injector control tube.
 4. Move the governor speed control lever (3) to the maximum speed position as shown in figure below. Hold lever in that position with light finger pressure. Turn the inner adjusting

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

screw (1) on the No. 1 injector rack control lever down until a slight movement of the control tube is observed or a step up in effort is noted. This will place the No. 1 injector rack in the full-fuel position. Turn the outer adjusting screw (2) down until it bottoms lightly on the injector control tube. Then, alternately tighten both the inner and outer adjusting screws.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)**NOTE**

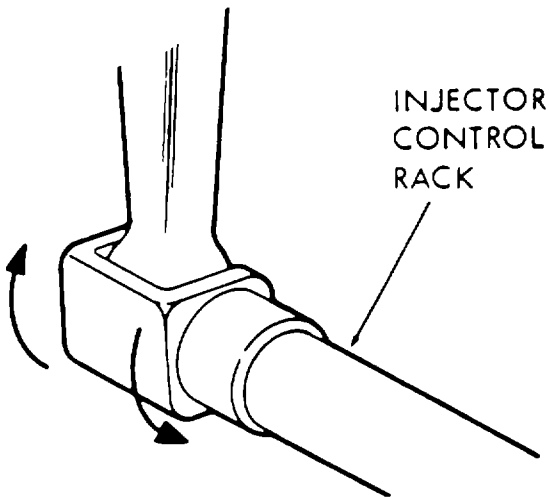
The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full load.

5. To be sure the control lever is properly adjusted, hold the speed control lever in the maximum speed position and press down on the injector rack with a screwdriver or finger tip and note the "rotating" movement of the injector control rack when the speed control lever is in the maximum speed position. Hold the speed control lever in the maximum speed position and, using a screwdriver, press downward on the injector control rack. The rack should tilt downward and when the pressure of the screwdriver is released, the control rack should "spring" back upward.
6. If the rack does not return to its original position, it is too loose. To correct this condition, back off outer adjusting screw slightly and tighten the inner adjusting screw slightly.

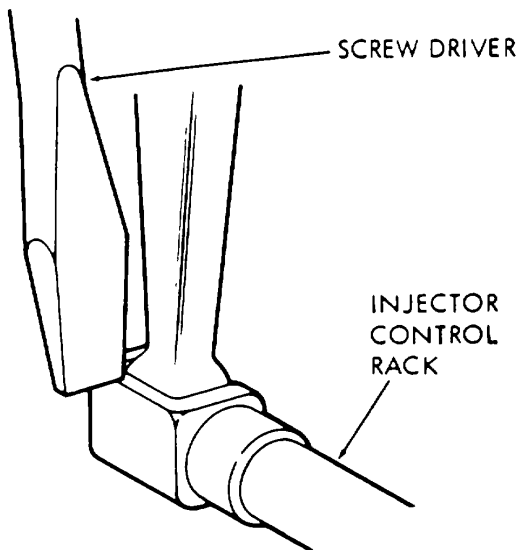
5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)



Check rotating movement of injector control rack.



Check injector control rack "spring".

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

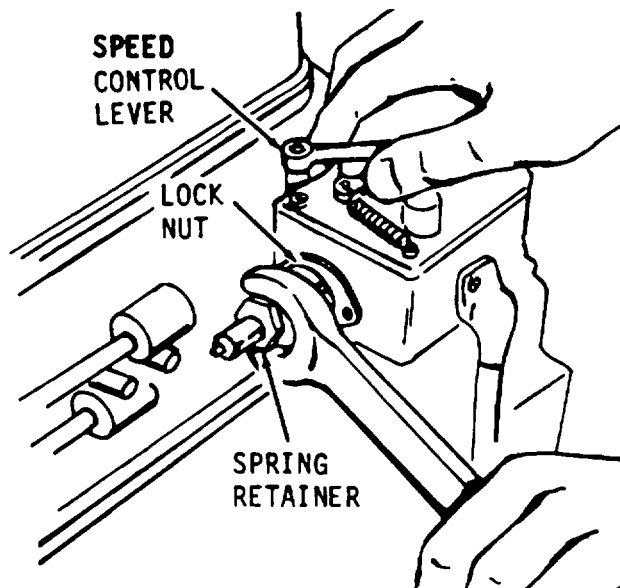
7. The setting is too tight if, when moving the speed control lever from the idle to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel as determined by the stop under the governor cover). This will result in a step-up in effort required to move the speed control lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.
8. Disconnect the fuel rod from the injector control tube and manually hold the No. 1 injector in the full-fuel position and turn down the inner adjusting screw of the No. 2 injector until the injector rack has moved into the full-fuel position, and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then, alternately tighten both the inner and outer adjusting screws.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

9. Recheck the No. 1 injector rack to be sure that it has remained snug on the ball end of the injector rack control lever while adjusting the No. 2 injector. If the rack of the No. 1 injector has become loose, back off slightly on the inner adjusting screw on the No. 2 injector rack control lever and tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

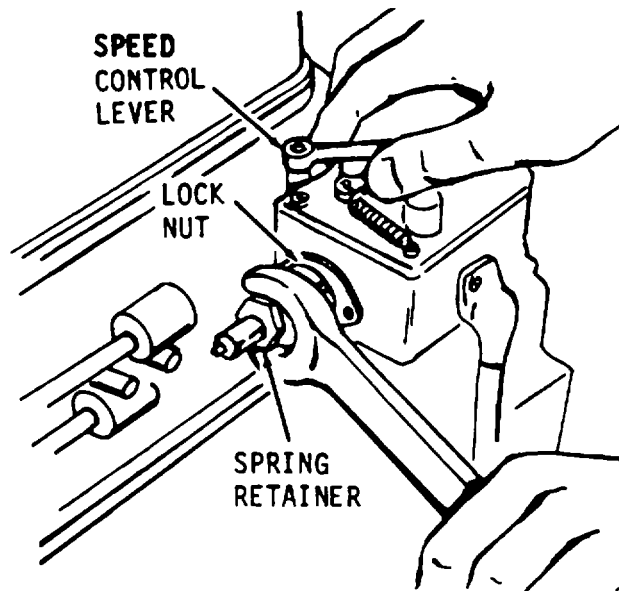
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| | 10. Position the remaining injector rack control levers as outlined in steps 8 and 9. | |
| | 11. Connect the fuel rod to the injector control tube lever. | |
| | 12. Turn the idle speed adjusting screw until it projects 3/8 inch (0.953 cm) beyond the locknut. Tighten the locknut. | |
| c. | Adjusting Maximum No-Load Engine Speed. All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the option plate, the maximum no-load speed may be set as follows: | |
| | 1. Loosen locknut and back off the high speed spring retainer approximately five turns. | |
| | 2. With engine at operating temperature and no load on the engine, place the speed control lever in the full-fuel position.. Turn high speed retainer IN until the engine is operating at the recommended no-load speed. | |

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

3. Hold the high speed spring retainer and tighten the locknut.



- d. Adjusting Idle Speed. With the maximum no-load speed properly adjusted, adjust the idle speed as follows:
 1. Remove the spring housing to uncover the idle speed adjusting screw.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

2. With engine at the normal operating temperature and with the buffer screw backed out to avoid contact with the differential lever, turn the idle speed adjusting screw until the engine is operating at approximately 15 RPM below the recommended idle-speed of 550 rpm.
 3. Hold the idle screw and tighten the locknut.
 4. Install the high speed spring retainer and retain with the two bolts.
- e. Adjusting Buffer Screw.
With the idle speed set, adjust the buffer screw as follows:
1. With the engine running at normal operating temperature, turn the buffer screw in so that it contacts the differential lever as lightly as possible and still eliminates "engine roll".

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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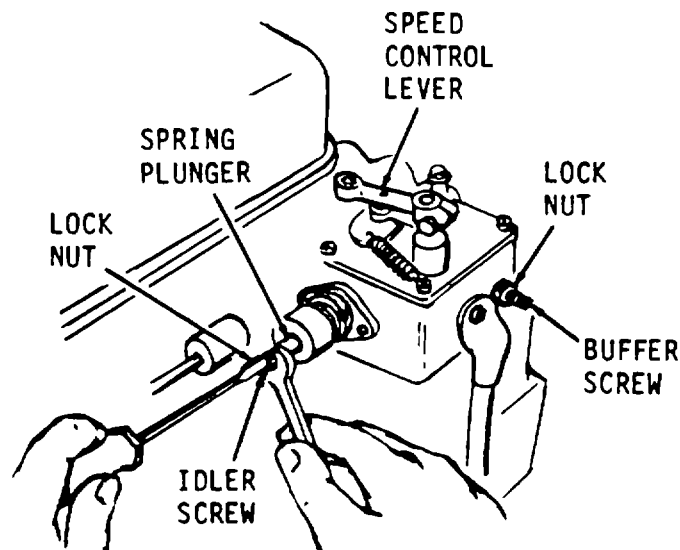
ADJUSTMENTS (Cont)

NOTE

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

2. Hold the buffer screw, and tighten the locknut.

3. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

26. Throttle
Controls
Adjustment

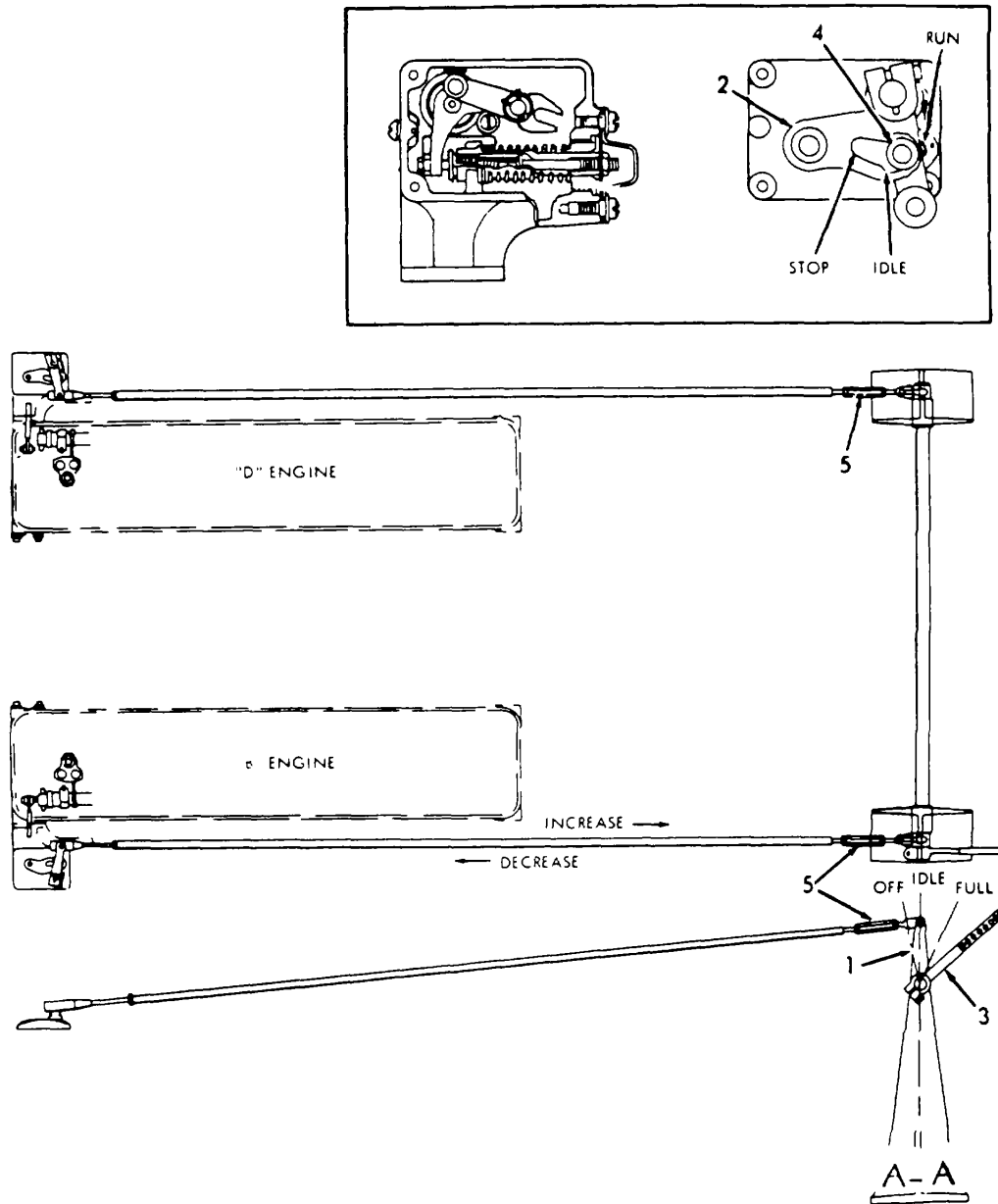
The throttle linkage may be adjusted after setting the valves, timing the injectors, adjusting the governor and the injector operating linkage as follows:

- a. With engines stopped, set the throttle control cross shaft so that the throttle control levers (1) are in a vertical position as shown at "A -A A".
- b. With engines stopped, adjust turnbuckles on the two throttle control rods so that pins in the throttle control levers at governor cover rest against the shoulders of the control cams (2) in the "IDLE" position at the two governors.
- c. Now move the master throttle (3) to "FULL" open position, at which setting the pin in throttle lever (4) at both governors should just strike the extreme end of the slot in the cam (2) at the "RUN" position. If either or both pins do not reach end of slot in cams, adjust turnbuckles (5) to bring about this condition.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

- d. The linkage must be adjusted so that the pins in the throttle levers at governor covers reach "RUN" position in the control cam at exactly the same time. Do not put any strain in the throttle linkage when making this adjustment.
- e. Start and warm up both engines to operating temperature. Move master throttle to "IDLE" position. Declutch both engines and set idling speed of each engine to 500 rpm.

NOTE

Engine may be brought up to operating temperature by declutching engines and setting throttle to approximately 1,200 engine rpm.

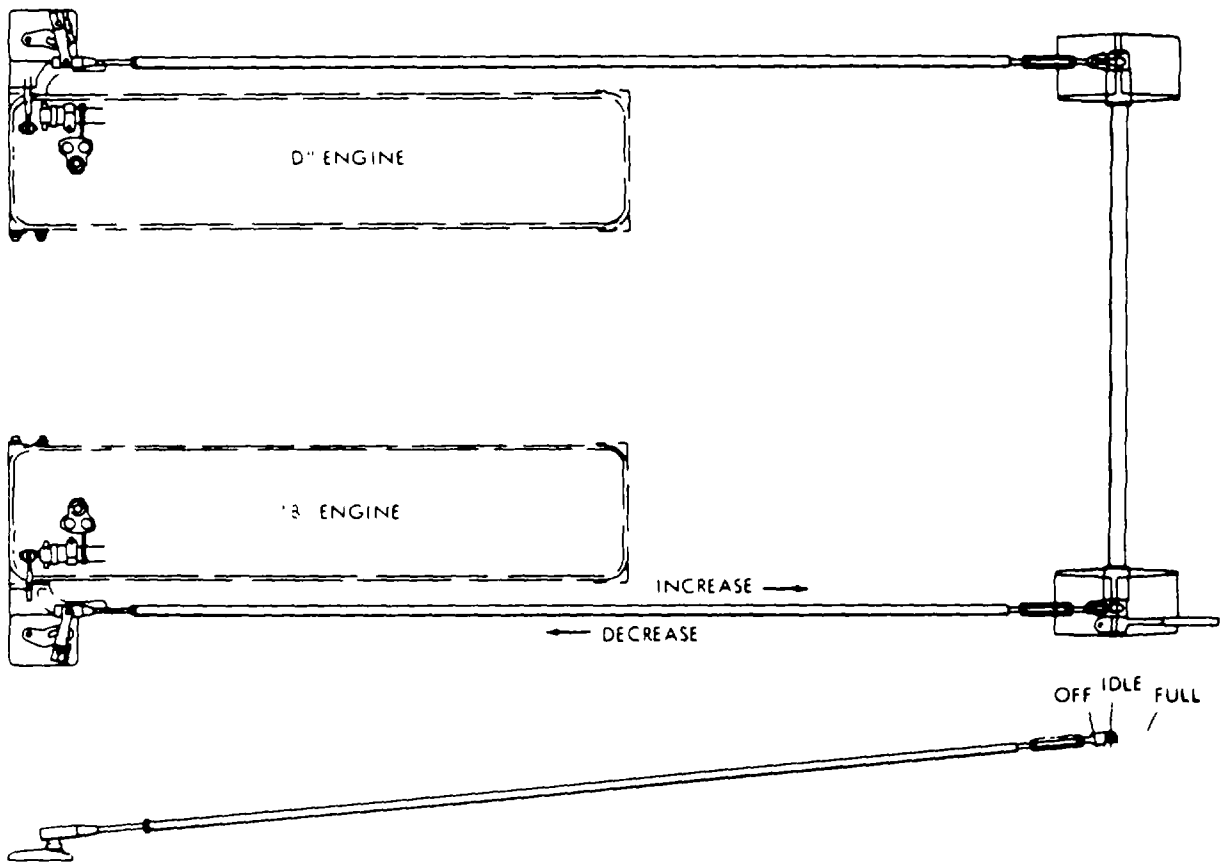
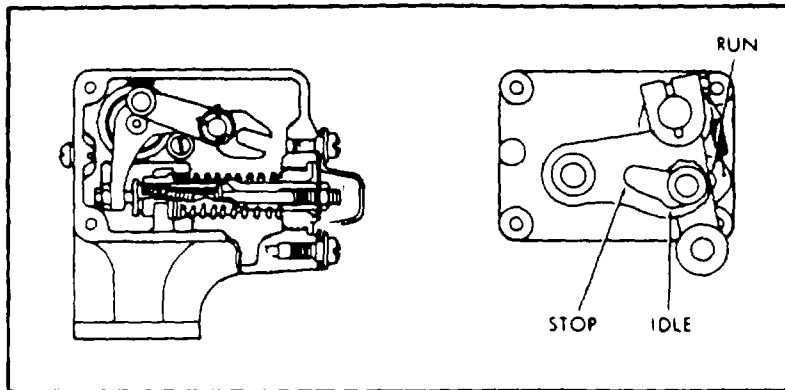
If quick warm-up is attempted by turning the propeller, the ship must be securely tied to the dock with no loose lines or floating obstructions to foul the propeller.

- f. Set governor no-load to top speed. Usually the top no-load speed is set the same on both governors of twin units before the engines leave the factory.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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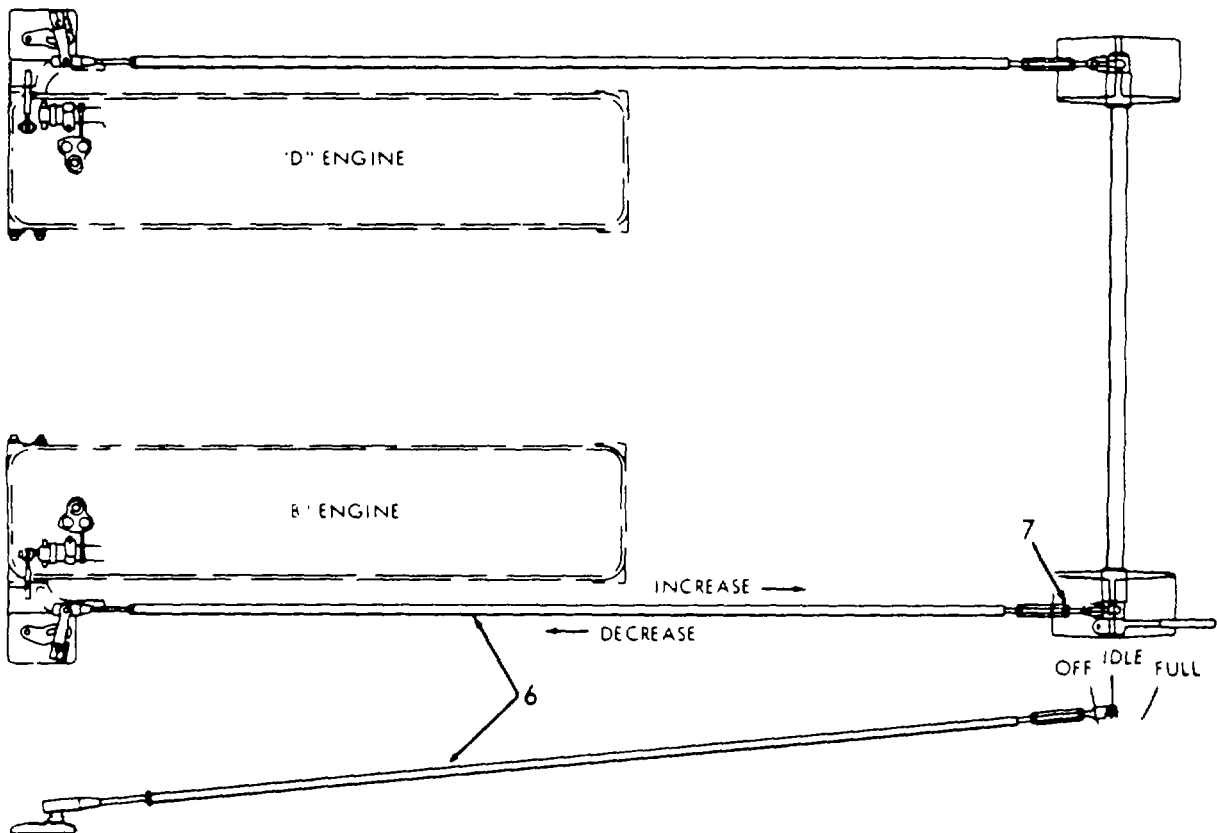
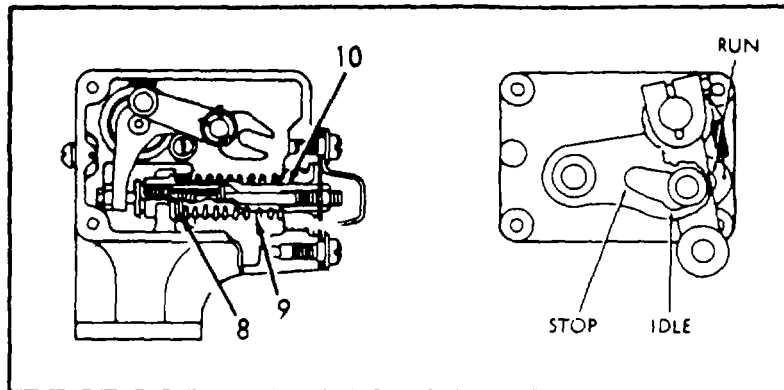
ADJUSTMENTS (Cont)

- g. If check as outlined below shows top no-load speeds to be different on the two governors, correct as follows:
1. With both engines warmed up, stop engines and disconnect throttle control rod (6) for "B" engine by removing pin at clevis (7).
 2. Start "D" engine, declutch and move master throttle to "FULL" open position.
 3. Note and record maximum no-load speed as indicated by tachometer.
 4. Stop engine and connect throttle control tube "B" engine and disconnect "D" engine.
 5. Start "B" engine, declutch, and with master throttle in "FULL" open position, note and record speed.
 6. If no-load speeds of the two engines are not the same, increase the speed of low engine by adding shims (8) between the high speed spring (9), and the spring plunger (10).

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)



5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

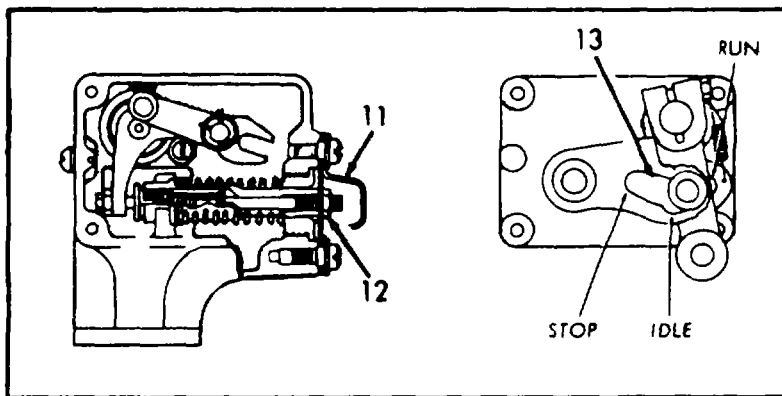
- | | | |
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| | <p>7. To add shims, remove low-speed adjusting screw cover (11), back-out nut (12), and place shims between inner end of spring and shoulder on the plunger. Add one shim at a time. Check speed after each shim is added.</p> <p>h. Synchronize engine speeds at no-load. Speeds of the two engines must be synchronized to obtain, as nearly as possible, the same no-load speeds in the range just below the rated load speed by adjusting the linkage to each governor. Thus, a unit rated at 1,850 rpm should have engines synchronized at 1,700-1,800 rpm. Synchronize as follows:</p> <ol style="list-style-type: none"> 1. With engines warmed up, declutch both engines and move master throttle to such position that speed of "B" engine is 1,750 rpm as recorded by the tachometer. Lock the master throttle in this position. 2. Note speed of "D" engine. If the speeds of the two engines are not the same, loosen the two locknuts at the turnbuckle on "D" engine, and by adjusting the turnbuckle, shorten throttle rod to increase, or lengthen throttle rod to decrease engine speed. | |
|--|---|--|

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

3. Unlock and move master throttle to "FULL" open position. In the "FULL" open position, without strain on the throttle linkage, the pins in the throttle control levers (13) at the governor covers of both engines should be within 1/16 inch (0.159 cm) of the same distance from end of the slot in cam. If the levers are not within this limit, the chances are that the governor gaps or the injector rack adjustments are not identical on the two engines and should be rechecked. The governor with the pin closest to the end of the cam slot may have a "close" gap or the governor with the pin farthest from the end of the cam slot may have the injector racks too "tight". If adjustments are necessary, recheck engine speeds after making adjustments.



5-14. **ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).**

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

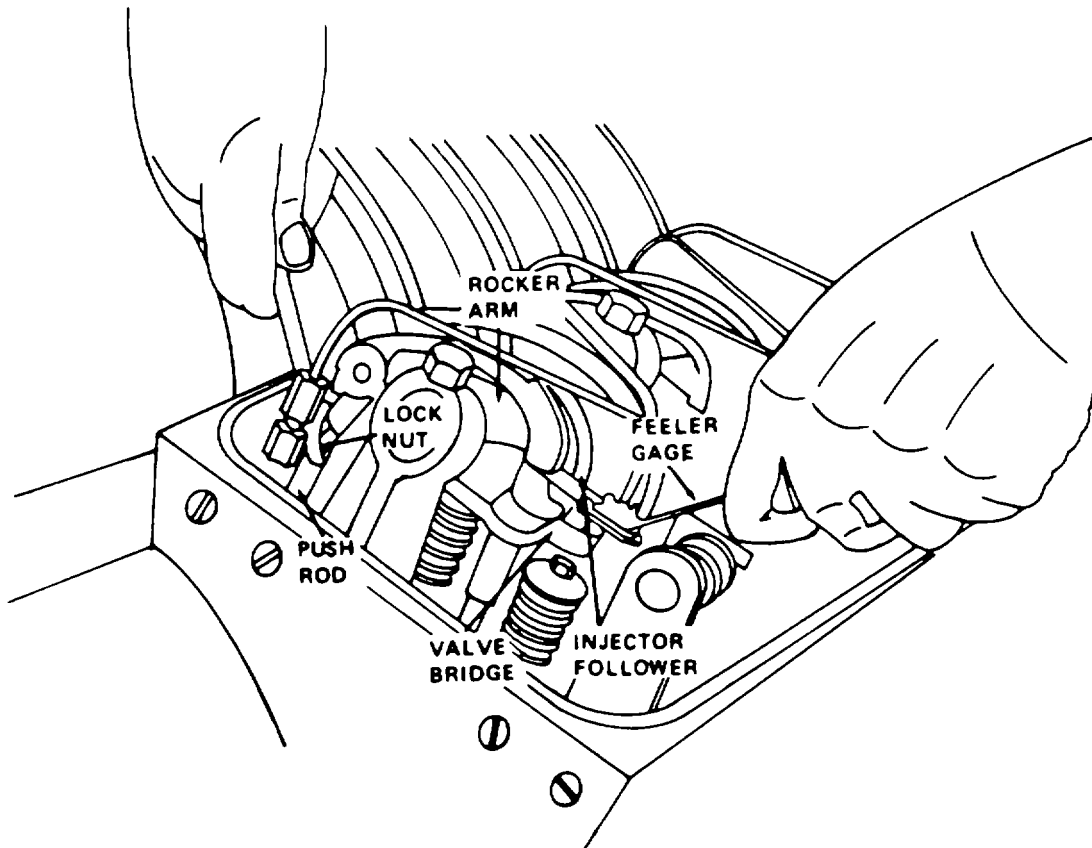
- | | | |
|--|--|--|
| 27. Exhaust Valve Clearance Adjustment | <p>a. <u>General</u>. The correct exhaust valve clearance at normal operating temperature is important for smooth, efficient operation of the engine. Whenever the cylinder head is overhauled, the exhaust valves are reconditioned or replaced, or if the valve operating mechanism is replaced or disturbed in any way, the valve clearance must be adjusted to the cold setting to allow for normal expansion of the engine parts during the engine warm-up period. This will insure a valve setting that is close enough to the specified clearance to prevent damage to the valves when the engine is started.</p> <p>b. Exhaust Valve Clearance Adjustment (Cold Engine).</p> <ol style="list-style-type: none"> 1. Place governor throttle control lever in the NO-FUEL position. Pull engine stop control out. 2. Remove rocker arm cover. 3. Rotate crankshaft until the injector follower is fully depressed on the cylinder to be adjusted. 4. Loosen the pushrod locknut. 5. Place a 0.013 inch feeler gage, tool J9708, between the valve stem and the rocker arm. Adjust the pushrod to obtain a smooth "pull" on the feeler gage. | |
|--|--|--|

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

6. Remove feeler gage. Hold the pushrod with a 5/16" wrench and tighten the locknut with a 1/2 inch wrench.
7. Recheck the clearance. At this time, if the adjustment is correct, the 0.011 inch feeler gage J9708 will pass freely between the valve stem and the rocker arm, but the 0.013 inch feeler gage will not.
8. Check and adjust the remaining valves in the same manner as above.



Valve clearance adjustment.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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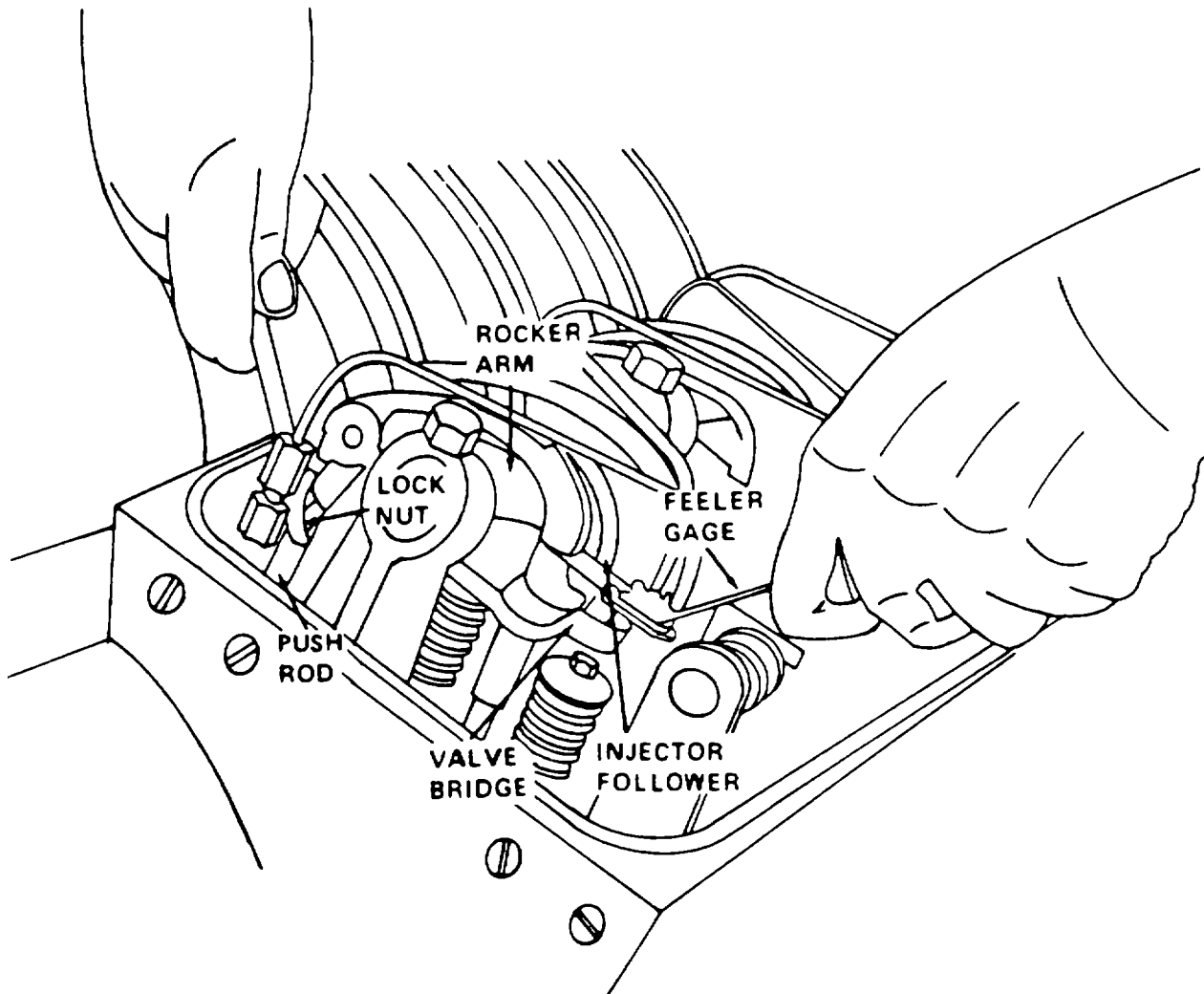
ADJUSTMENTS (Cont)

- c. Exhaust Valve Clearance Adjustment (Hot Engine).
 - 1. Maintaining the normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance when running at full load may become insufficient.
 - 2. With the engine at normal operating temperature (160°-185°F), recheck the exhaust valve clearance with feeler gage J9708. At this time, if valve clearance is correct, the 0.08 inch feeler gage will pass freely between the valve stem and the rocker arm, but the 0.010 inch gage will not.
 - 3. Install rocker arm cover.

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENTS (Cont)

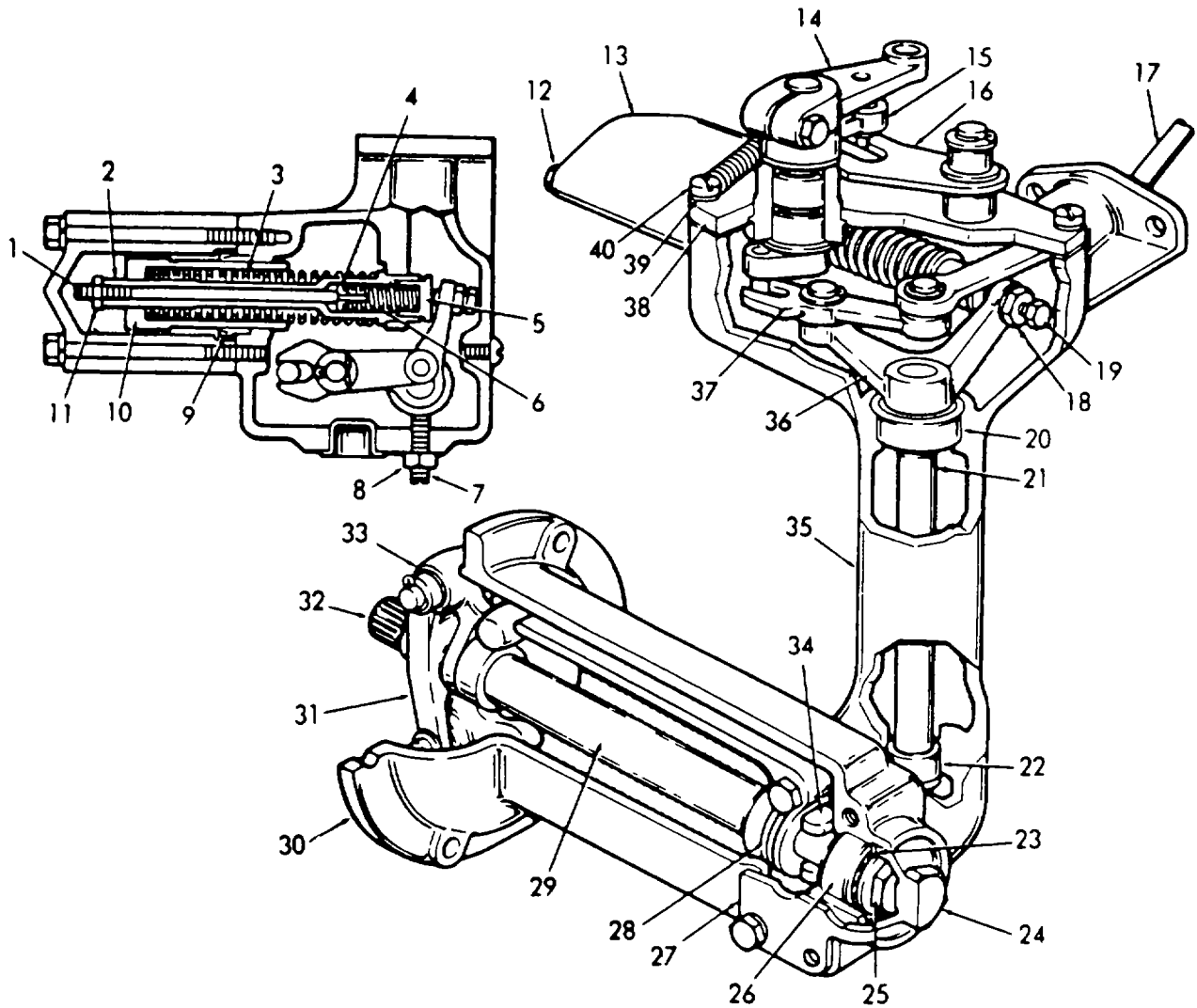


5-14. **ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).**

LOCATION/ITEM	ACTION	REMARKS
<u>ADJUSTMENTS (Cont)</u>		
<u>GOVERNOR COMPONENTS</u>		
1. IDLE SPEED ADJUSTING SCREW	21.	OPERATING SHAFT
2. HIGH SPEED SPRING PLUNGER	22.	OPERATING SHAFT BUSHING
3. HIGH SPEED SPRING	23.	GASKET
4. LOW SPEED SPRING SEAT	24.	WEIGHT HOUSING PLUG
5. LOW SPEED SPRING CAP	25.	RETAINING BOLT
6. LOW SPEED SPRING	26.	SHAFT END BEARING
7. BUFFER SCREW	27.	WEIGHT HOUSING COVER
8. LOCKNUT	28.	RISER THRUST BEARING
9. RETAINER LOCKNUT	29.	GOVERNOR RISER
10. HIGH SPEED SPRING RETAINER	30.	WEIGHT HOUSING
11. LOCKNUT	31.	WEIGHT CARRIER
12. BOLT	32.	WEIGHT SHAFT ASSEMBLY
13. HIGH SPEED SPRING RETAINER COVER	33.	WEIGHT ASSEMBLY
14. SPEED CONTROL LEVER	34.	OPERATING SHAFT FORK
15. THROTTLE SHAFT LEVER	35.	GOVERNOR CONTROL HOUSING
16. CAM	36.	OPERATING SHAFT LEVER
17. FUEL ROD	37.	DIFFERENTIAL LEVER
18. LOCKNUT	38.	GOVERNOR COVER
19. GAP ADJUSTING SCREW	39.	LOCKWASHER
20. OPERATING SHAFT BEARING	40.	SCREW

5-14. ROCKER ARMS, CAM FOLLOWERS AND PUSHRODS (Continued).

LOCATION/ITEM	ACTION	REMARKS
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5-15. CYLINDER HEAD.

This task covers:

- | | | |
|----------------|-----------------------|---------------|
| a. Disassembly | d. Repair/Replacement | g. Adjustment |
| b. Cleaning | e. Assembly | |
| c. Inspection | f. Installation | |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

- Valve seat grinder set
J8165
- Brush J5437
- Valve spring compressor
tool J7455
- Valve guide remover J267
- Valve guide installer J9530
- Insert remover J4824-01
- Insert installer J1736
- Valve spring tester J9666
- Torque wrench

Tools

- General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment

<u>Condition</u>	<u>Condition Description</u>
Paragraph	

5-14	Rocker Arms, Cam Followers and Pushrods.
------	---

Materials/Parts

- Dual purpose sealer
- Cleaning solvent
Fed. Spec. P-D-680
- Trichloroethylene
- Prussian blue
- Fuel oil

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10, MOS 44E

General Safety Instructions

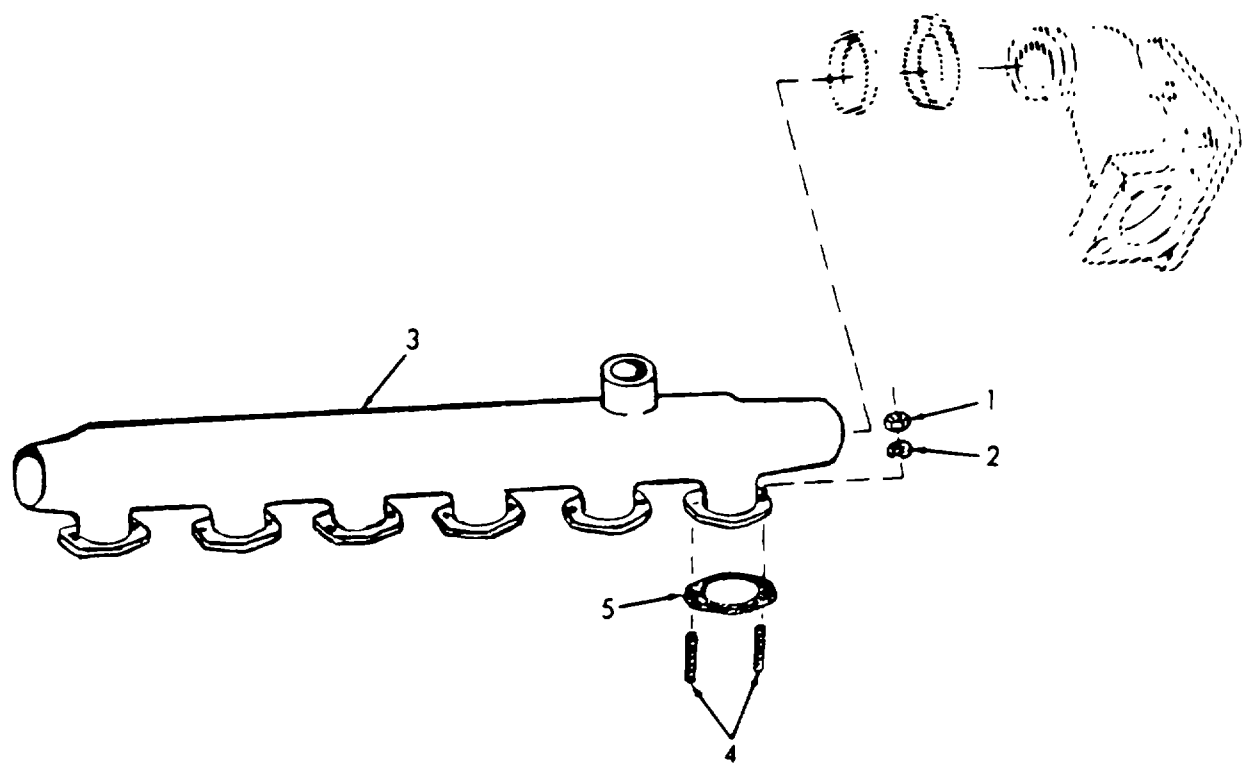
Observe CAUTIONS and WARNINGS
in procedure.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY

- | | |
|-------------------|--|
| 1. Water Manifold | <ul style="list-style-type: none"> a. Remove twelve mounting nuts (1), and lockwashers (2). b. Lift water manifold (3) off studs (4). c. Remove mounting gaskets (5). |
|-------------------|--|



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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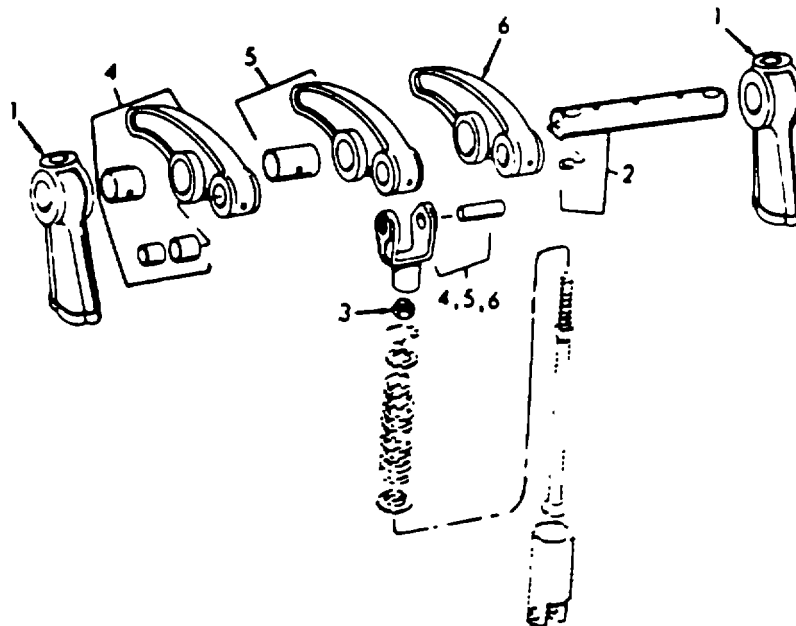
DISASSEMBLY (Cont)

2. Rocker Arms,
Cam Followers
and Pushrods



When removing rocker arm shafts, fold back rocker arms just far enough so that the shaft may be removed. Do not force rocker arms all the way back with shaft in place, as this may impose a load that could bend the pushrods.

- a. Remove brackets (1) from shafts.
- b. Remove shaft (2) from rocker arm assemblies.
- c. Loosen locknut (3) at upper end of pushrod.
- d. Remove rocker arms (4, 5, and 6) from pushrods. Unscrew to remove.
- e. Remove all rocker arms in the same manner.

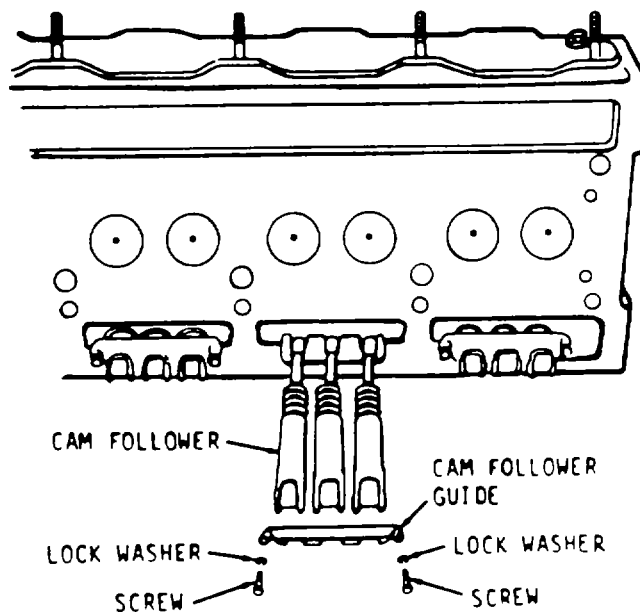
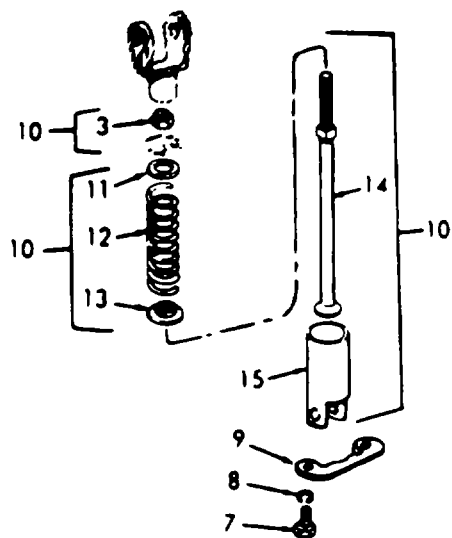


5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- f. Rest the cylinder head on its side as shown, and remove capscrews (7) and lockwashers (8) from cam follower guide.
- g. Remove cam follower guides (9).
- h. Pull cam followers and associated parts (10) as a unit from bottom of cylinder head.
- i. Remove pushrod locknut (3), upper spring seat (11), spring (12), lower spring seat (13), and pushrod (14) from cam follower (15).



5-15. CYLINDER HEAD (Continued).

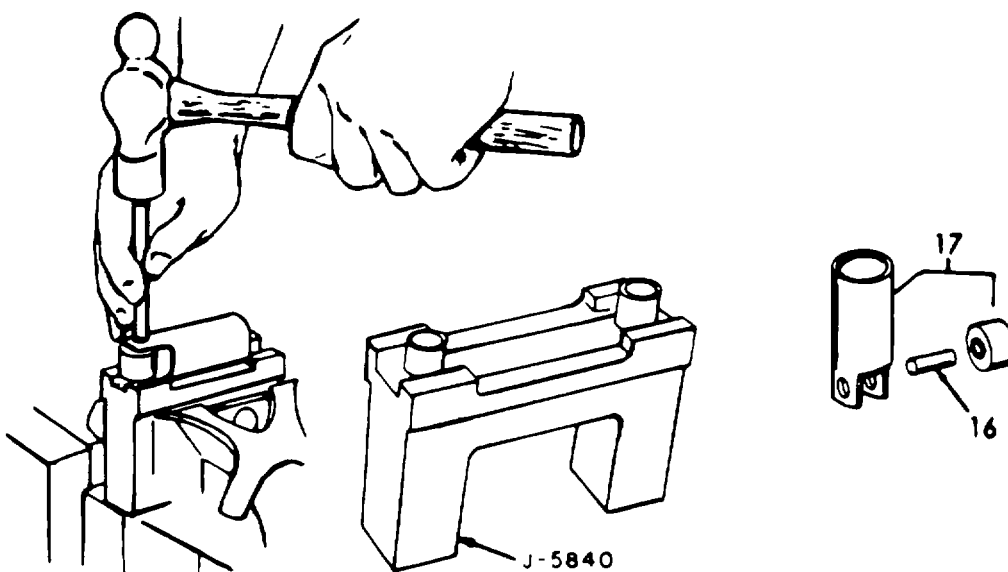
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

j. Remove in (16) from roller set (17) as follows:

- (1) Lock fixture securely in a vise as shown. Then, place the cam follower in groove in the top of the fixture with the follower pin resting on top of the corresponding size plunger in the fixture.
- (2) With a suitable drift, drive the pin from the roller. Exercise caution in removing the cam follower body and roller from the fixture as the follower pin is seated on top of a spring-loaded plunger in the fixture body.

Use tool J5840.



5-15. CYLINDER HEAD (Continued).

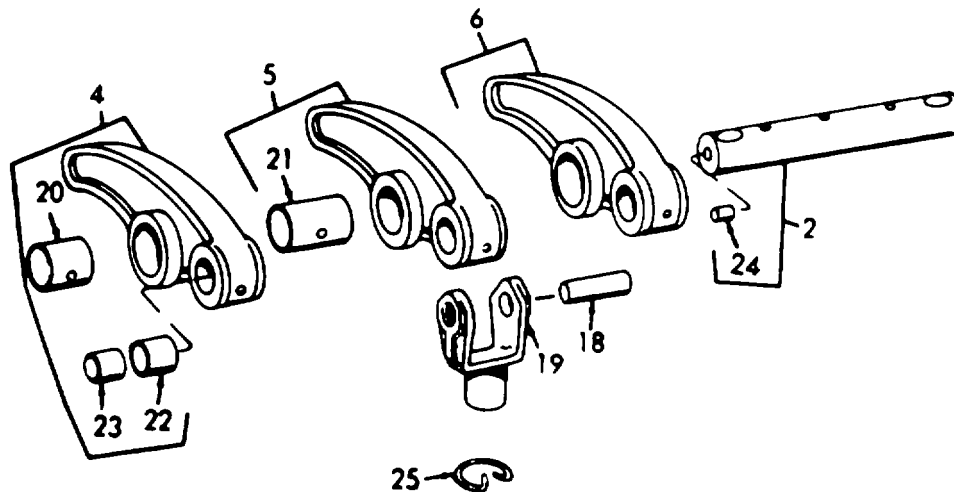
LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

NOTE

In following steps k, l, and m, use an arbor press to press out the part if replacement is necessary.

- k. Remove clevis pins (18) from clevises (19).
- l. Remove bushing sleeves (20 from rocker arms (4 and 6). Remove bushing sleeve (21) from rocker arm (5).
- m. Remove sleeve bearings (22 and 23) from rocker arms (4, 5, and 6).
- n. Remove plugs (24) from rocker shaft (2). If required.
- o. The pushrod spring seat retainer (25) remains in the cylinder head. Do not remove.

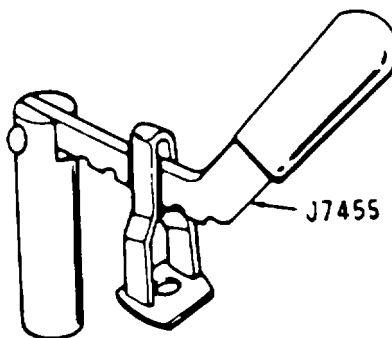


5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|-----------|--|-----------------|
| 3. Valves | a. Place a block between the cylinder head and the work bench to support valves. | |
| | b. Thread spring compressor tool into the rocker shaft bolt hole. | Use tool J7455. |



- | | |
|--|--|
| c. Apply pressure to handle and compress valve spring far enough to remove the two-piece tapered valve lock (1). | |
| d. Release pressure from tool and remove spring retainer (2), spring (3), shouldered washer (4), and gasket (5). | |

NOTE

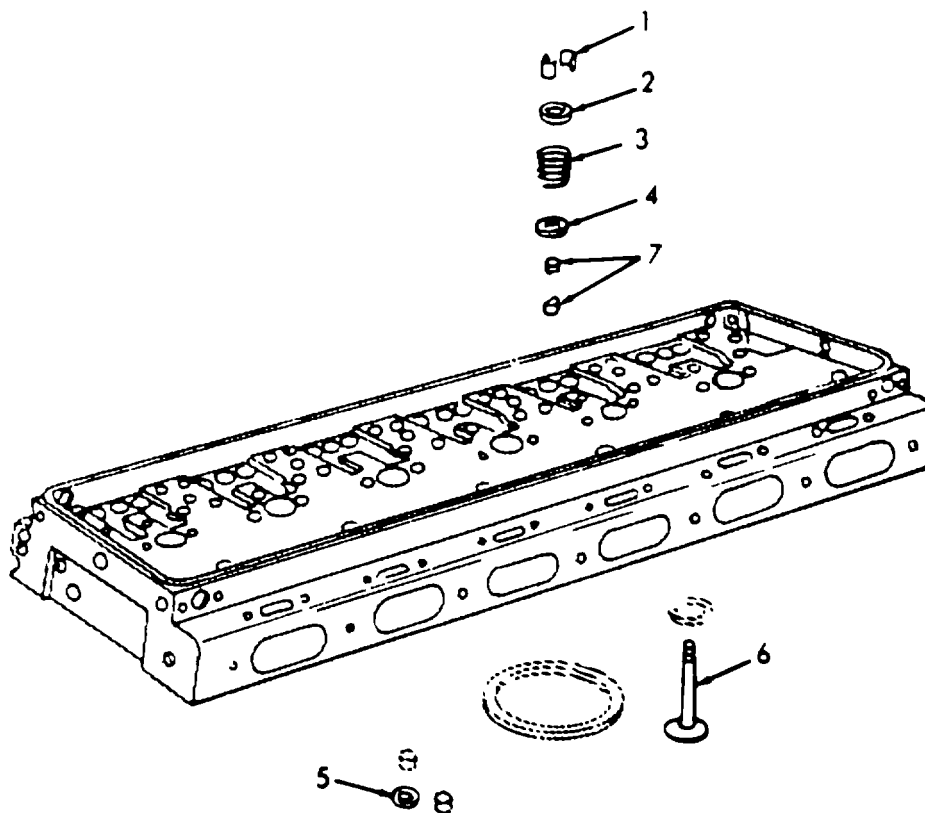
Turn cylinder head over using care to keep valves from dropping out, and number each valve to facilitate reinstallation in the same position.

- | | |
|--|--|
| e. Remove valves (6) from cylinder head. | |
|--|--|

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



4. Guides, Inserts, Gaskets and Pipe Plugs

- a. Support cylinder head, bottom side up, on two-inch (50.80 cm) thick wood blocks.
- b. Remove valve guide (7) from head.

Use tool J267 and drive out from bottom of cylinder head.



5-15. CYLINDER HEAD (Continued).

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

Valve seat inserts are pressed into the head. Inserts must be removed as described below to avoid damage to the head.

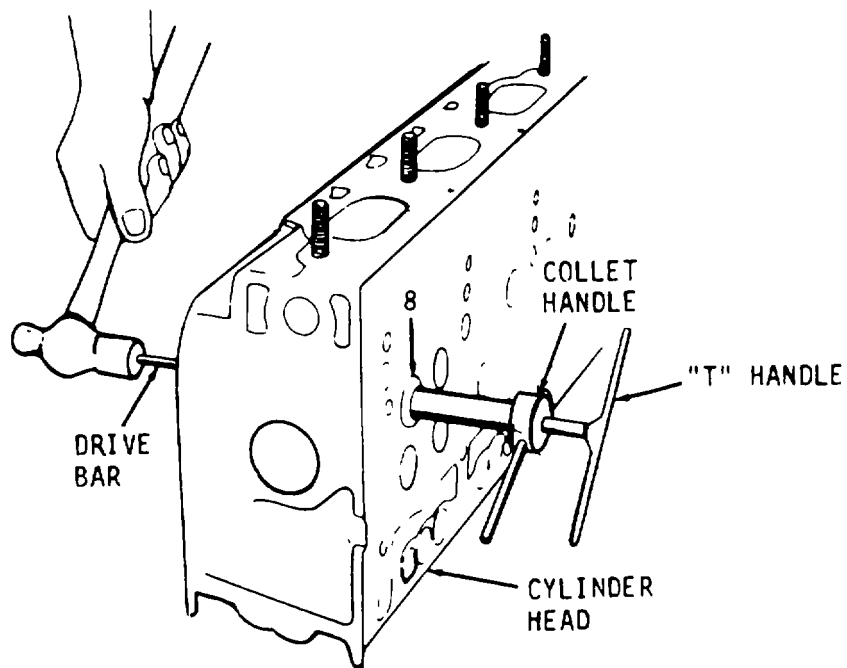
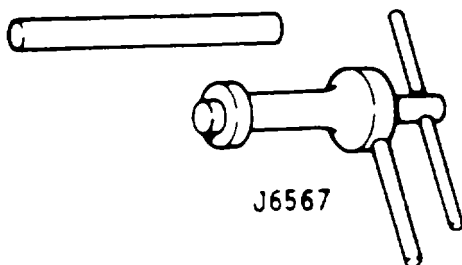
- c. Place cylinder head on its side as shown.
- d. Place the collet of tool J6567 inside the valve insert (8) so that the bottom of the collet is flush with bottom of the insert.
- e. Hold the collet handle and turn the T handle to expand the collet cone until the insert (8) is held securely by the tool.
- f. Insert the drive bar of the tool through the valve insert (8).
- g. Tap the drive bar once or twice to move the insert about 1/16 inch away from its seat in the cylinder head.
- h. Turn the T handle to loosen the collet cone and move the tool into the insert (8) slightly so that the narrow flange at the bottom of the collet is below the valve seat insert (8).

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- i. Tighten the T handle, and continue to drive the insert (8) out of the cylinder head.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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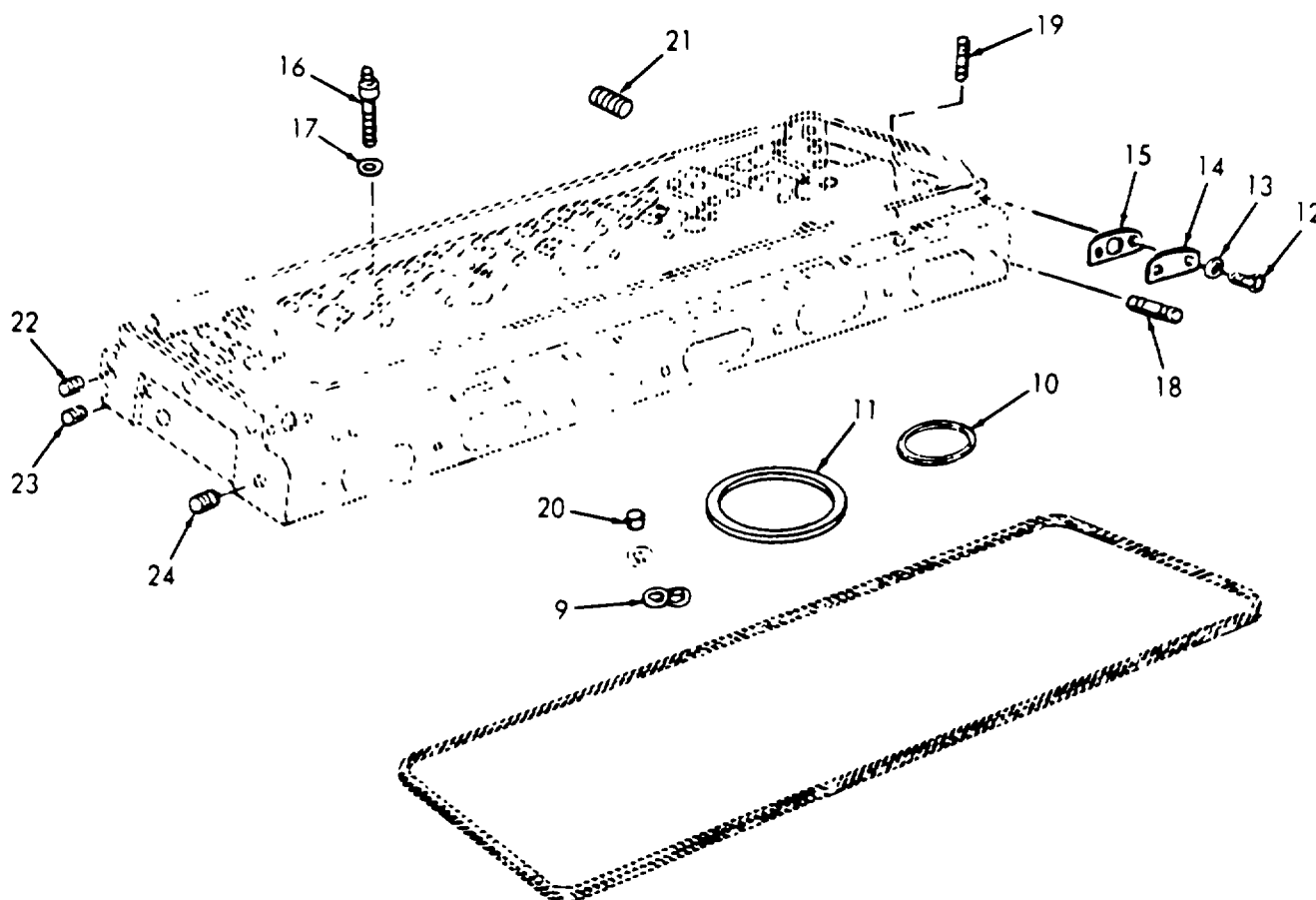
DISASSEMBLY (Cont)

- | | | |
|----|---|----------|
| j. | Remove oil gaskets (9) and water hole gaskets (10). | Discard. |
| k. | Remove oil ring seal gaskets (11). | Discard. |
| l. | Remove governor hole cover screws (12), lockwashers (13), covers (14), and gaskets (15). | |
| m. | Remove fuel line connectors (16), and washers (17). | |
| n. | Remove exhaust manifolds studs (18). | |
| o. | Remove water manifold studs (19). | |
| p. | Remove pipe plugs (20, 21, 22, 23, and 24). If a core hole plug is difficult to remove, hold a 3/4 inch drift against the plug, and give it a few sharp blows with a one pound hammer. With a 1/2 inch flexible handle, and a short extension placed in the countersunk hole in the plug, turn the plug slightly in the direction of tightening. Then, turn it in the opposite direction and back the plug out. | |

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



CLEANING

- 5. Cylinder Head

NOTE

The following cleaning procedure may be used on all ordinary cast-iron and steel parts of the engine. Special cleaning procedures will be mentioned when necessary.

5-15. CYLINDER HEAD (Continued).

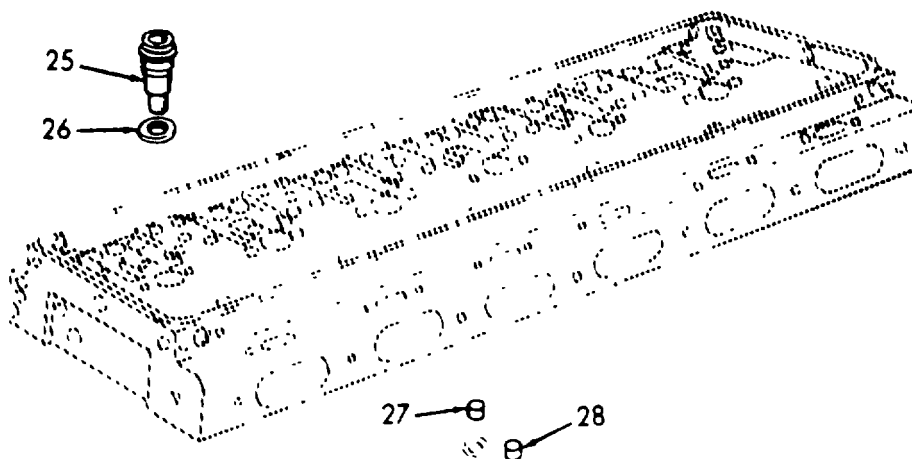
LOCATION/ITEM	ACTION	REMARKS
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CLEANING (Cont)

After the cylinder head has been stripped of all its component parts and all the plugs have been removed, steam clean the head thoroughly. If the water passages have been heavily scaled remove the copper injector tubes (25), washers (26), and water nozzles (27 and 28), and clean the cylinder head as follows:

Remove injector tubes if necessary.

- a. Scrape all gasket material from the cylinder head.



- b. Remove grease by agitating the cylinder head in a hot bath of heavy-duty alkaline solution.
- c. Wash the block in hot water or steam clean it to remove the alkaline solution.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING (Cont)

- d. If the water jackets are heavily scaled, proceed as follows:
 1. Agitate the head in a bath of inhibited commercial pickling acid.
 2. Allow the head to remain in the acid bath until the bubbling action stops (approximately 30 minutes).
 3. Lift the head, drain it, and reimmerse it in the same acid solution for 10 minutes.
 4. Repeat step 3. until all scale is removed.
 5. Rinse the head in clear hot water to remove the acid solution.
 6. Neutralize the acid that may cling to the casting by immersing the head in an alkaline bath.
 7. Wash the head in clean water or steam clean it.
- e. Make certain that all water passages and oil galleries have been thoroughly cleaned.

5-15. CYLINDER HEAD (Continued).

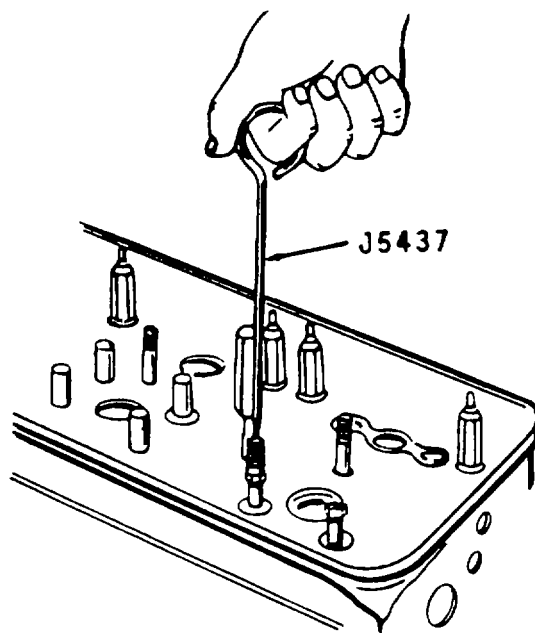
LOCATION/ITEM	ACTION	REMARKS
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CLEANING (Cont)

WARNING

Wear protective eye goggles when using compressed air.

- | | | |
|--------------------------------|---|------------------------|
| 6. Springs, Valves, and Guides | <ul style="list-style-type: none"> f. After cleaning the cylinder head, dry with compressed air. a. Clean springs and valves with clean fuel oil, and dry with compressed air. b. Remove carbon deposits from valve stems. c. Remove all carbon or gum deposits from inside of valve guides including the spiral grooves. | <p>Use tool J5437.</p> |
|--------------------------------|---|------------------------|



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING (Cont)

- d. Be sure that the water inlet ports in the bottom of the head are clean and free of scale. The water holes at each end of the head may be cleaned up with 1/2 inch drill and all of the other water holes may be cleaned up with a 13/16 inch drill. Break the edges of the holes slightly.



Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38°-59°C).

- e. Clean all other threaded parts in cleaning solvent P-D-680 and dry thoroughly.

INSPECTION

- 7.
 - a. Valve Springs.
 - 1. Inspect springs for fractured or pitted coils.

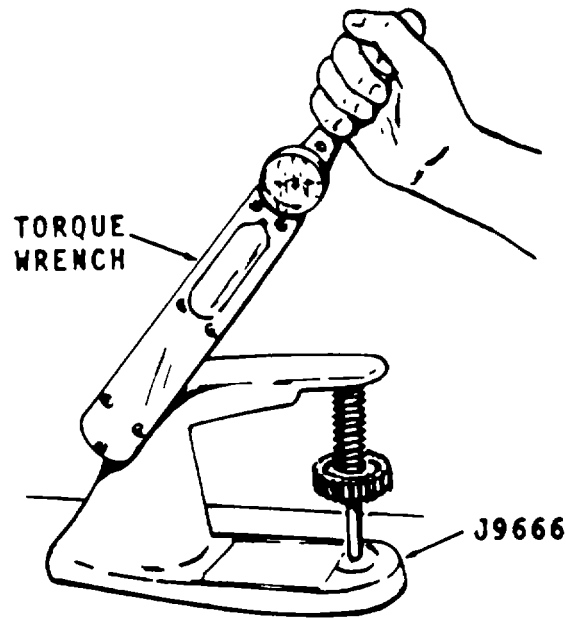
5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

2. Check springs for spring load. wrench.

Use tool J9666 and torque



NOTE

The valve springs should be replaced when a load less than 135 pounds (183.03 Nm) will compress the spring to 1 49/64 inches (4.48 cm).

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

- | | | |
|----|---|--|
| b. | Valve Guides. | |
| | 1. Inspect the valve guides for fractures, chipping, scoring, or excessive wear. | |
| | 2. Check the valve-to-guide clearance, since worn valve guides may eventually result in improper valve seat contact. | |
| | 3. If the clearance exceeds .006 inch (0.015 cm), replace the valve guides. | |
| c. | Exhaust Valve Seat Inserts. | |
| | 1. Inspect the valve seat inserts for excessive wear, pitting, cracking or an improper seat angle. | |
| | 2. The proper angle for the seating face of both valve and insert is 30°. | |
| d. | Cylinder Head. | |
| | 1. Over a prolonged period of operation, the cylinder head may assume a contour to match that of the cylinder block, which is normal. However, if the cylinder head is allowed to become overheated because of coolant loss, the resultant high temperatures cause stresses to occur in the casting which will affect the flatness of the head. | |

5-15. CYLINDER HEAD (Continued).

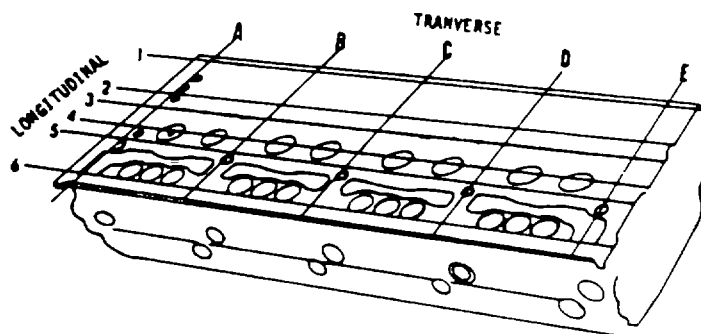
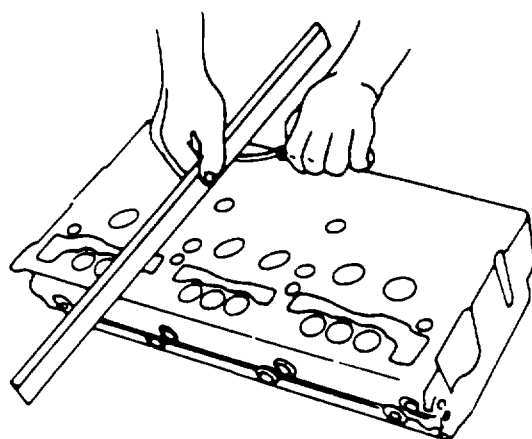
LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

Therefore, check the bottom (fire deck) of the cylinder head for flatness as follows:

- a. Use a heavy, accurate straight-edge and feeler gage to check for transverse warpage at each end and between all cylinders. Check for longitudinal warpage in six places as shown. Maximum allowable warpage is given below.

Maximum Longitudinal Warpage	Maximum Transverse Warpage
.010 inch (0.025 cm)	.004 inch (10.16 cm)



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

- | | | |
|--|--|--|
| | <ul style="list-style-type: none"> b. Use maximum allowable warpage limits as a guide in determining the advisability of re-installing the head on the engine or of refacing it. The number of times a cylinder head may be re-faced will depend upon the amount of stock removed from the head during previous reworking operations. <p>2. Check the cylinder head for leaks and cracks as follows:</p> <ul style="list-style-type: none"> a. Seal off water holes in the head by using steel plates and suitable rubber gaskets clamped in place by bolts. b. Install scrap or dummy injectors to insure seating of the injector tubes. Dummy injectors may be made up from old injector nuts and bodies. The injector spray tip is not necessary. Tighten the injector clamp nuts or bolts to 20-25 lb. ft. torque (27.1 - 33.9 Nm). | |
|--|--|--|

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSPECTION (Cont)

- c. Drill and tap into one of the water hole cover plates for an air hose connection and apply 80-100 psi (551.6 - 689.5 kpa) air pressure to the water jacket. Then, immerse the head in a tank of water previously heated to 180° -200° F (82.2° - 93.3°C) for about fifteen to twenty minutes to thoroughly heat the cylinder head. Leaks will be detected by noting any air bubbles which may appear in the water. Check for leaks at oil gallery, cylinder head stud holes, exhaust ports, and the top, bottom and sides of the head itself.



Wear protective eye goggles when using compressed air.

- d. Relieve the air pressure, remove the cylinder head from the water tank, remove the water hole plates and gaskets and dry the cylinder head with compressed air. If inspection revealed any cracks, replace the cylinder head.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSPECTION (Cont)</u>		
	3. Check the valve seat inserts for cracks or burning. Also check the valve guides for scoring.	
	4. Inspect the cam follower bores in the cylinder head for scoring or wear. Light score marks may be cleaned up with crocus cloth wet with fuel oil. The inside diameter of the bores are 1.062 inches (2.697 cm) to 1.063 inches (2.700 cm) in a new cylinder head (1.065 inches (2.705 cm) maximum on a used head). If the bores are excessively scored or worn so that the cam follower-to-head clearance exceeds .006 inches (0.015 cm), reject the cylinder head.	
	5. Check cylinder head water nozzles for looseness.	

REPAIR/REPLACEMENT

- | | |
|------------------|---|
| 8. Cylinder Head | <ul style="list-style-type: none"> a. Replace cylinder head if damaged beyond repair. b. Over a prolonged period of operation, the cylinder head may assume a contour to match that of the cylinder block, which is normal. However, if the cylinder head is allowed to become overheated because of coolant loss, the resultant high temperatures cause stresses to occur in the casting which |
|------------------|---|

5-15. CYLINDER HEAD (Continued).

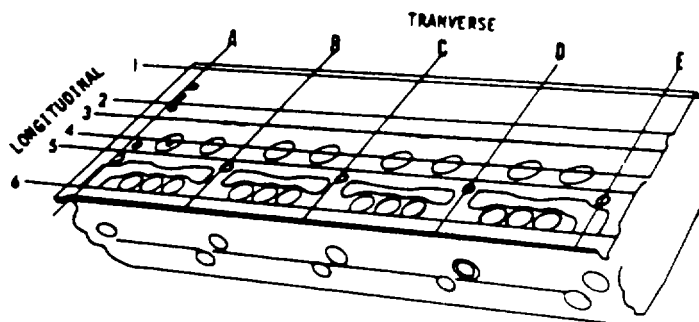
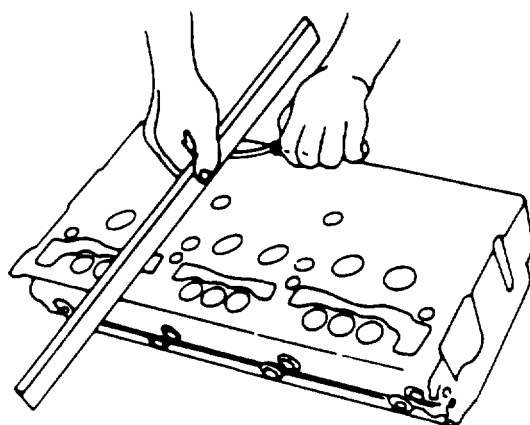
LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

will affect the flatness of the head. Therefore, check the bottom (fire deck) of the cylinder head for flatness as follows:

1. Use a heavy, accurate straight-edge, and feeler gage to check for transverse warpage at each end and between all cylinders. Also, check for longitudinal warpage in six places as shown. Maximum allowable warpage is given by the following:

Maximum Longitudinal Warpage	Maximum Transverse Warpage
.010 inch (0.025 cm)	.004 inch (0.1016 cm)

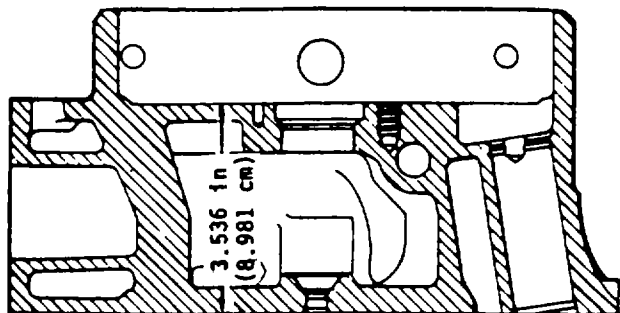


5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

2. Use the maximum allowable warpage limits as a guide to determine the advisability of reinstalling the head on the engine or of refacing it. The number of times a cylinder head may be refaced will depend upon the amount of stock removed from the head during previous reworking operations.
 - a. When refacing a cylinder head, stamp the amount of stock removed on the face of the fire deck. Do not remove over .020 inch (0.051 cm) of metal from the fire deck of any cylinder head. The distance from the top deck to the bottom (fire deck) of the cylinder head must not be less than 3.536 inch (8.981 cm). See figure below.

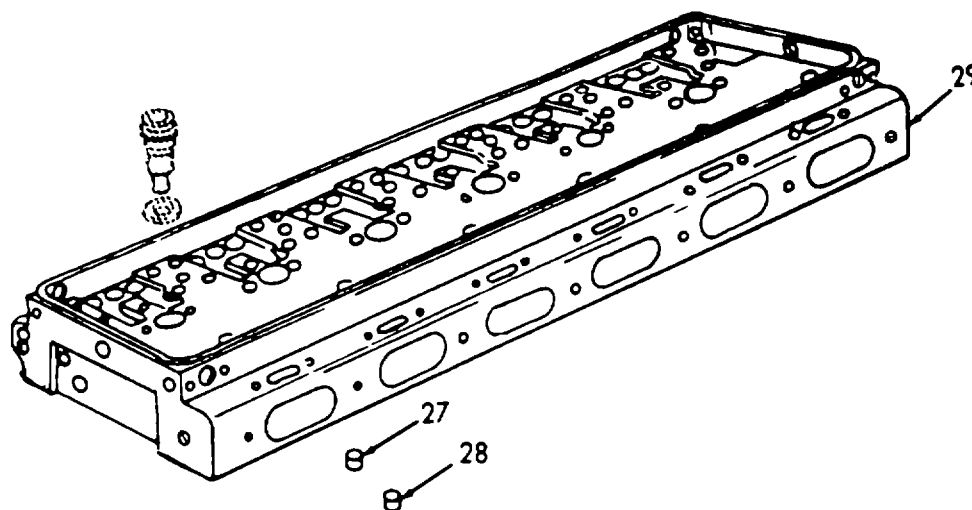


5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- b. When a cylinder head has been refaced, check and correct such critical dimensions as the protrusion of the valve inserts, valves, injector tubes, and injector spray tips from the fire deck. Adjust pushrod length in order to prevent the valves from striking the top of the piston when the head is reinstalled on the engine.
- c. Install water nozzles (27 and 28) in cylinder head (29).

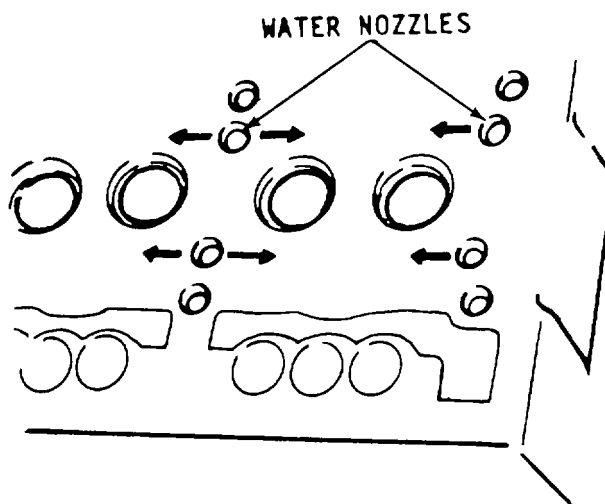


5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

1. Be sure the water inlet ports in the bottom of the head are clean and free of scale. The water holes at each end of the head may be cleaned up with a 1/2 inch drill and all the other water holes may be cleaned up with a 13/16 inch drill. Break the edges of the holes slightly.
2. Press the nozzles in place with the nozzle openings parallel to the longitudinal center line of the cylinder head. Install the 1/2 inch diameter nozzles at the ends of the cylinder head with their openings toward the



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- | | | |
|----|--|-----------------|
| 3. | Install the nozzles flush to 1/32 inch below (recessed) the bottom surface of the cylinder head; otherwise, interference with proper seating of the head on the cylinder block may be encountered. | |
| 4. | Check to make sure the nozzles fit tight in the cylinder head. If the water holes have been enlarged by corrosion, expand the nozzles by means of a wood plug or other suitable tool, or tin the outside diameter with solder to provide a tight fit. If solder is used, exercise care so that the orifices in the nozzles are not closed with solder. | |
| d. | Install valve guides (7) as follows: | |
| 1. | Turn the cylinder head (29) right side up on the work bench. | |
| 2. | Insert the internally threaded end of the valve guide (7) in the valve guide installing tool. | Use tool J9530. |

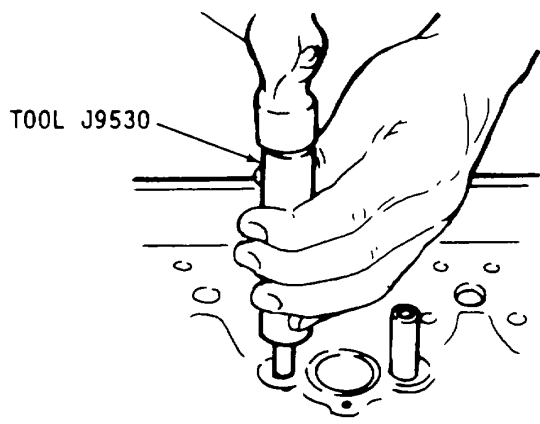


Be sure to use the correct tool (J9530) to avoid damage to the valve guide, and to locate the valve guide to the proper dimension above top of head.

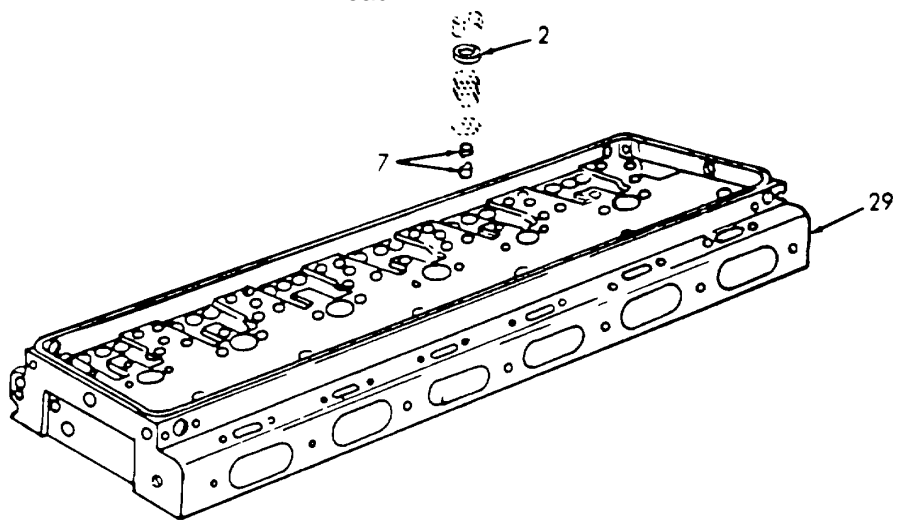
5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)



3. Position the valve guide (7) squarely in the bore in the cylinder head (29) and tap the installing tool gently to start the guide (2) in place. Then, drive the guide in until the tool contacts the cylinder head.



NOTE

Do not use the valve guides as a means of turning the cylinder head over or in handling the cylinder head.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)**WARNING**

Wear protective eye goggles when using compressed air.

NOTE

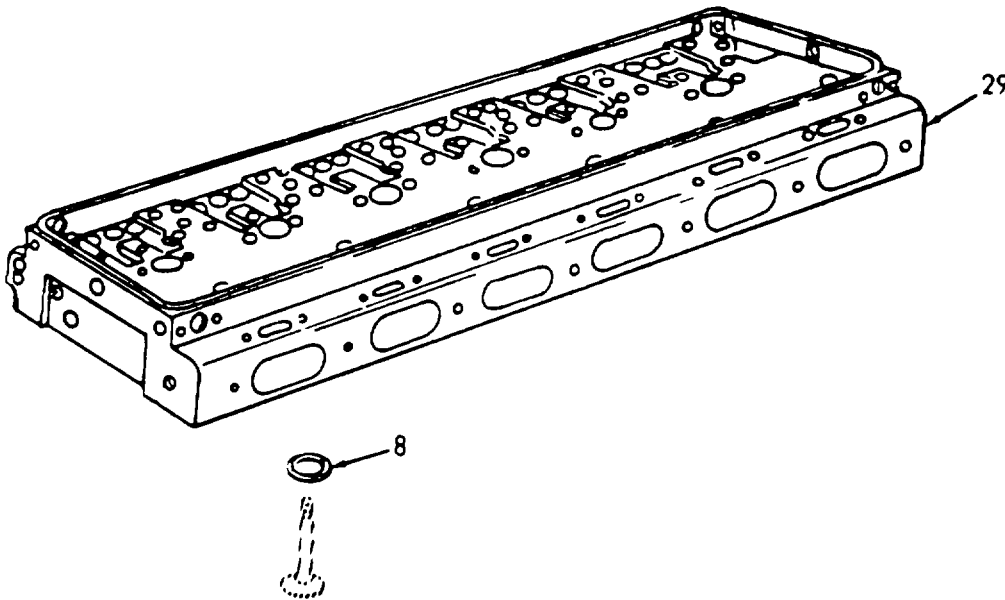
- Service replacement valve guides are completely finish-reamed during manufacture and, therefore, do not require reaming after installation.
- Great care must be used during the installation of a valve seat insert since this part has a press-fit in the cylinder head.
 - e. Wash the cylinder head (29) with fuel oil and dry it with compressed air.
 - f. Clean the valve insert counterbore in the cylinder head with trichloroethylene or other good solvent. Wash the valve inserts with the same solvent. Dry both the counterbores and the inserts with compressed air.
 - g. Inspect the valve seat insert counterbores in the cylinder head for cleanliness. The counterbores in the cylinder heads have a diameter of 1.626 inch (4.130 cm) to 1.627 inch (4.133 cm) and a depth of .3705 inch (0.9411 cm) to .3845 inch (0.9766 cm). If required, use valve seat inserts which are .010 inch (0.025 cm) oversize on the outside diameter.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- h. Immerse the cylinder head for at least 30 minutes in water heated to a temperature of 185°F to 200° F (82.2°C to 93.3° C).
- i. Rest the cylinder head, bottom side up, on a work bench and locate the insert (8) squarely in the counter-bore, seating face up. Install the insert (8) in the cylinder head while the head is still hot and the insert is at room temperature, otherwise installation will be difficult and the parts may be damaged.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- j. Drive the inserts (8) in place until they seat solidly in the cylinder head.

Use tool J6568.



- k. Grind the valve seat inserts and check them for concentricity in relation to the valve guides.
- l. Reface an exhaust valve which is to be reused. The edge of the valve at the valve head must be not less than 1/32 Inch (0.079 cm) in thickness after refacing.
- m. Before installing either a new or used valve, examine the valve seat insert in cylinder head for proper valve seating. The proper angle for the seating face of both the valve and valve insert is 30° .
- n. The angle of the valve seat insert must be exactly the same as the angle of the valve face so as to provide proper seating of the valve.
- o. When a new valve seat insert is installed or an old insert is reconditioned, work must be done with a grinding tool.

If necessary.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)**NOTE**

- The eccentric grinding method for reconditioning valve seat inserts is recommended. This method produces a finer, more accurate finish since only one point of the grinding wheel is in contact with the valve seat at any time. A micrometer feed permits feeding the grinding wheel into the work .001 inch at a time.
- The eccentric valve seat grinder set, tool J8165, used to recondition or grind the valve seat inserts consists of:
 - a. Grinder, tool J8165-1
 - b. Dial gage, tool J8165-2
 - c. Pilot, tool J8165-3
 - d. Grinding wheel (15°), tool J8165-4
 - e. Grinding wheel (30°), tool J8165-5
 - f. Grinding wheel (60°), tool J8165-7

CAUTION

Do not permit the grinding wheel to contact the cylinder head when grinding the insert.

- p. Grind the inserts as follows:
 1. Use the 30° grinding wheel on the valve seat.
 2. Use the 60° grinding wheel to open the throat of the insert.

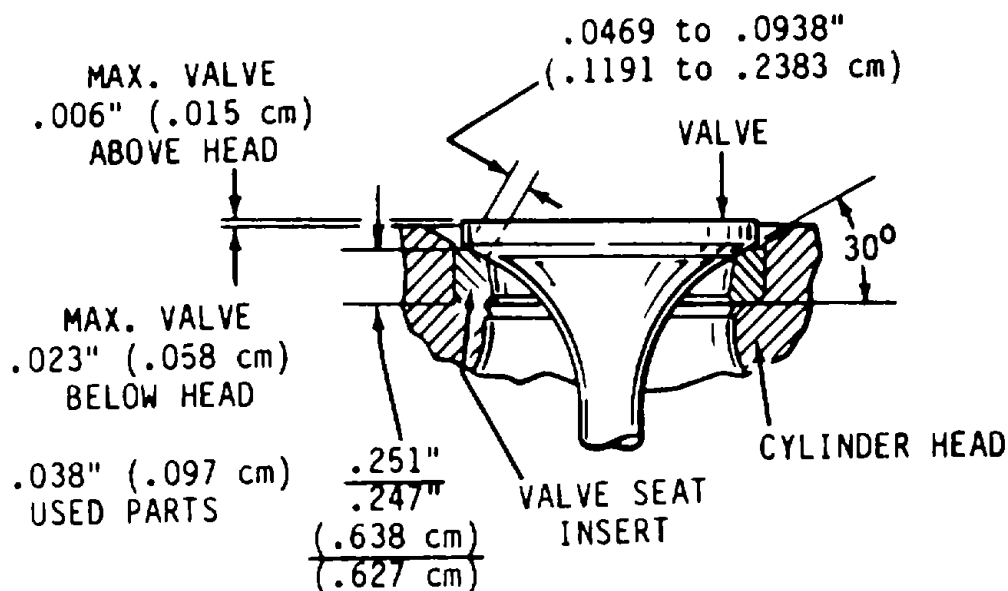
5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

3. Grind the top surface of the insert with the 15° wheel to narrow the width of the seat to the dimensions shown. Adjust the 30° face of the insert, relative to the center of the valve face, with the 15° and 60° grinding wheels.

- q. The maximum allowable limits the exhaust valve should protrude beyond the cylinder head (when the valve is closed) for the valve seat inserts is shown. Grinding will reduce the thickness of the valve seat insert, which will allow the valve to recede into the head. These maximum allowable limits are also shown and if the grinding operations reduce the valve seat thickness so that the valve recedes beyond these limits, the valve seat insert must be replaced.



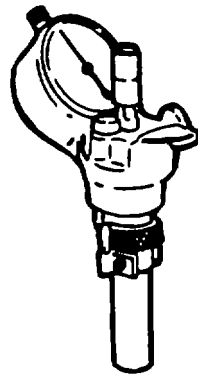
5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)**WARNING**

Wear protective eye goggles when using compressed air.

- r. After the grinding has been completed, clean the valve seat insert thoroughly with fuel oil and blow it dry with compressed air. Set the dial indicator J8165-2 in position and rotate it to determine the concentricity of each valve seat insert relative to the valve guide. Total runout should not exceed .002 inch (0.005 cm). If a runout of more than .002 inch (0.005 cm) is indicated, check for a bent valve guide before regrinding the insert.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- s. When a valve seat insert runout within the desired limits is obtained, determine the position of the contact area between the valve and the valve seat insert in the following manner:
 - 1. Apply a light coat of Prussian blue, or a similar paste, to the valve seat insert.
 - 2. Lower the stem of the valve in the valve guide and bounce, but do not rotate the valve on the insert. This procedure will indicate the area of contact on the valve face. The most desirable area of contact is at the center of the valve face.
- t. Dress the grinding wheel to obtain the proper seat angle. After the valve seat inserts have been ground and inspected, clean the cylinder head thoroughly before installing the valves.
- u. Install valves (6) as follows:
 - 1. Clean the valve guides (7).
 - 2. Lubricate the valve stems and slide the valves (6) all the way into the guides.

NOTE

If reconditioned valves are used, install them in the same relative location from which they were removed.

5-15. CYLINDER HEAD (Continued).

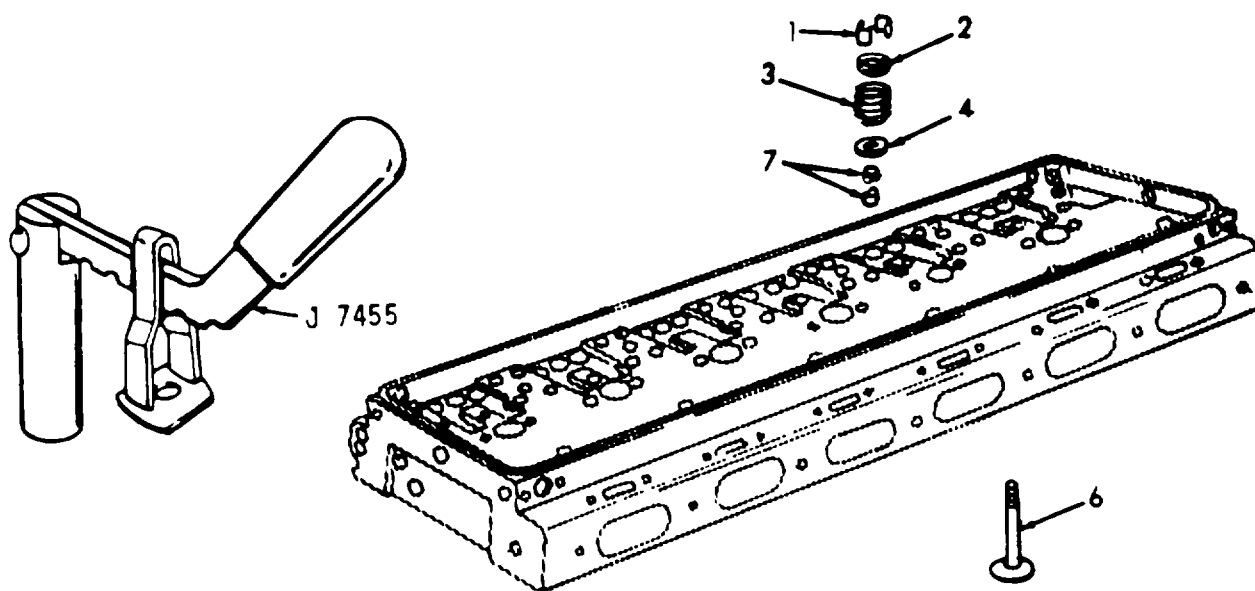
LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)]

- | | | |
|----|--|-----------------|
| 3. | Hold the valves in place with a strip of masking tape and turn the cylinder head right side up on the work bench. Place a board under the head to support the valves and to provide clearance between the cam followers and the bench. | |
| 4. | Install the valve spring seats (4), valve springs (3), and valve spring caps (2). | |
| 5. | Thread the valve spring compressor into one of the rocker shaft bolt holes in the cylinder head. | Use tool J7455. |
| 6. | Apply pressure to the free end of the tool to compress the valve spring and install the two-piece tapered valve lock (1). | |

NOTE

Exercise care to avoid scoring the valve stem with the valve cap when compressing the spring.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

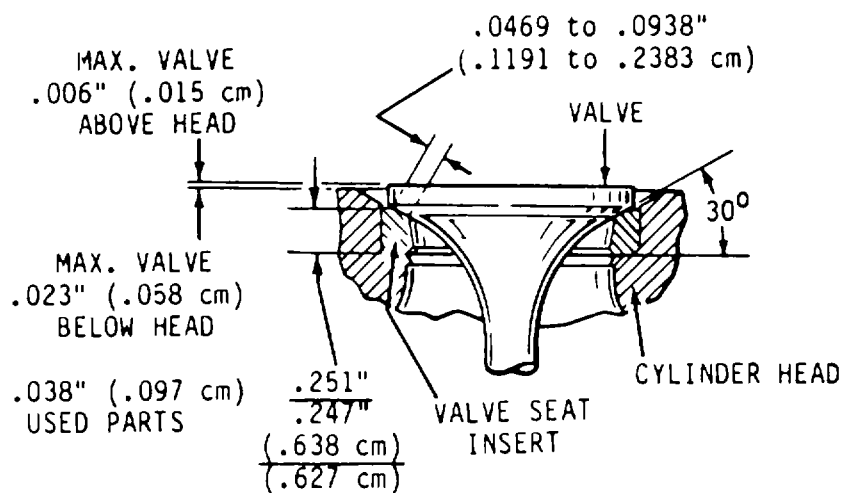
CAUTION

Compress the valve spring only enough to permit installation of the valve locks. Compressing the spring too far may result in damage to the valve guide oil seal if used.

7. Release the tool and install the valve locks on the remaining exhaust valves in the same manner.

NOTE

After the valves have been installed, make sure that none of the valve heads protrude more than the limits shown above the surface of the cylinder head when the valves are fully closed.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

NOTE

Refer to the following two tables for bolt and nut torque specifications and proceed with reassembly of cylinder head.

Standard Bolt and Nut Torque Specifications.

SIZE NUT OR BOLT	TORQUE (lb. ft.)	TORQUE (Nm)
1/4- 20	7 - 9	9.4907 -12.2024
1/4- 28	8 - 10	10.8465 -13.5582
5/16 - 18	13 - 17	17.6256 -23.0489
5/16 - 24	15 - 19	20.3373 -25.7605
3/8- 16	30 - 35	40.6745 -47.4536
3/8- 24	35 - 39	47.4536 -52.8769
7/16 - 14	46 - 50	62.3676 -67.7909
7/16 - 20	57 - 61	77.2816 -82.7049
1/2- 13	71 - 75	96.2631 - 101.6863
1/2- 20	83 - 93	112.5329 - 126.0911
9/16 - 12	90 - 100	122.0236 - 135.5818
9/16 - 18	107 - 117	145.0725 - 158.6307
5/8- 11	137 - 147	185.7471 - 199.3052
5/8- 18	168 - 178	227.7774 - 241.3356
3/4- 10	240 - 250	325.3963 - 338.9545
3/4- 16	290 - 300	393.1872 - 406.7454
7/8- 9	410 - 420	555.8854 - 569.4436
7/8- 14	475 - 485	644.0132 - 657.5714
1- 8	580 - 590	786.3744 - 799.9326
1- 14	685 - 695	928.7353 - 942.2935

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

Special Bolt and Nut Torque Specifications (American Standard).

APPLICATION	SIZE NUT OR BOLT	TORQUE (lb. ft.)
CYLINDER HEAD		
Cam follower guide bolt	1/4 - 20	12 - 15
Injector control shaft bracket bolt	1/4 - 20	10 - 12
Exhaust valve bridge adjusting screw locknut	5/16 - 24	20 - 25
Injector clamp bolt	3/8 - 16	20 - 25
Injector clamp nut	3/8 - 24	20 - 25
Exhaust manifold outlet flange nuts (brass)	3/8 - 24	20 - 25
Water manifold nut	3/8 - 24	25 - 30
Fuel pipe nut	3/8 - 24	12 - 15
Lifter bracket bolt	7/16 - 14	55 - 60
*Threaded exhaust valve bridge guide (nylon insert)	7/16 - 14	46 - 50
Exhaust manifold nuts	7/16 - 20	30 - 35
*Fuel manifold connectors	7/16 - 20	30 - 35
Fuel manifold connector nuts	7/16 - 20	30 - 35
#Rocker shaft bolt	1/2 - 13	90 - 100
*Cylinder head bolts	5/8 - 11	175 - 185
*Cylinder head nuts	5/8 - 18	175 - 185

* Lubricate before assembling to cylinder head.

75-85 lb-ft torque on the two bolts attaching load limit screw bracket to the rocker arm shaft bracket.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

Special Bolt and Nut Torque Specifications (Metric).

APPLICATION	SIZE NUT OR BOLT	TORQUE (Nm)
CYLINDER HEAD		
Cam follower guide bolt	1/4 - 20	16.2698 -20.3373
Injector control shaft bracket bolt	1/4 - 20	13.5552 -16.2698
Exhaust valve bridge adjusting screw locknut	5/16 - 24	27.1164 - 33.8954
Injector clamp bolt	3/8 - 16	27.1164 -33.8954
Injector clamp nut	3/8 - 24	27.1164 -33.8954
Exhaust manifold outlet flange nuts (brass)	3/8 - 24	27.1164 -33.8954
Water manifold nut	3/8 - 24	33.8954 -40.6745
Fuel pipe nut	3/8 - 24	16.2698 -20.3373
Lifter bracket bolt	7/16 - 14	74.5700 -81.3491
*Threaded exhaust valve bridge guide (nylon insert)	7/16 - 14	62.3676 -67.7909
Exhaust manifold nuts	7/16 - 20	40.6745 -47.4536
*Fuel manifold connector	7/16 - 20	40.6745 -47.4536
Fuel manifold connector nuts	7/16 - 20	40.6745 -47.4536
#Rocker shaft bolt	1/2 - 13	122.0236 - 135.5818
*Cylinder head bolts	5/8 - 11	237.2650 - 250.8263
*Cylinder head nuts	5/8 - 11	237.2650 - 250.8263

* Lubricate before assembly to cylinder head.

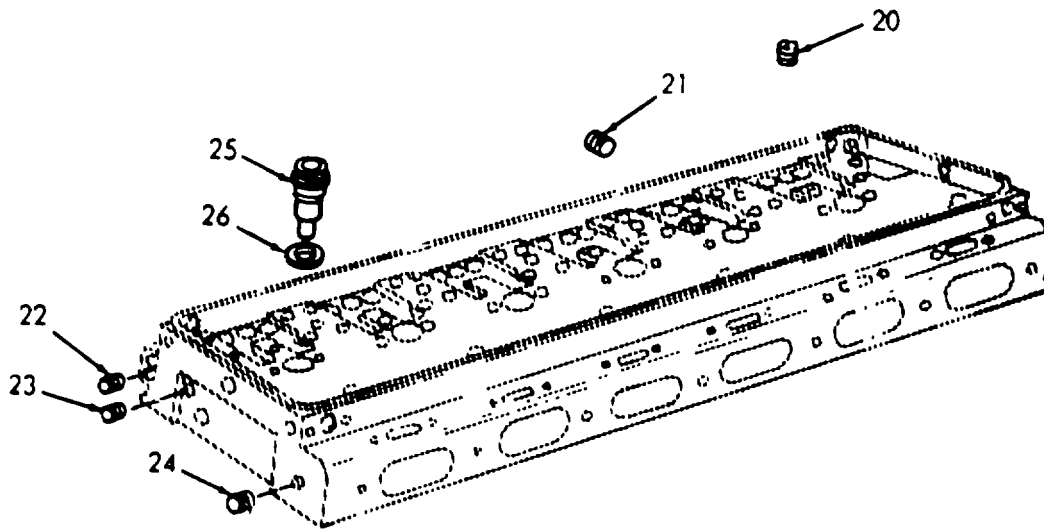
101.6850-115.2430 Nm torque on the two bolts attaching load limit screw bracket to the rocker arm shaft bracket.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- | | |
|---|-------------|
| v. Install injector tube washers (26), and injector tubes (25). | If removed. |
| w. Install pipe plugs (20, 21, 22, 23, and 24). Apply a small amount of "dual purpose" sealer to the threads of the pipe plugs only. Work the sealer into the threads and wipe off the excess with a clean, lint-free cloth so that the sealer will not be washed into the fuel or oil passages. Drive headless plugs flush to 1/16 inch (0.159 cm) below the surface of the cylinder head. | |



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

SPECIAL PLUG TORQUE SPECIFICATIONS.

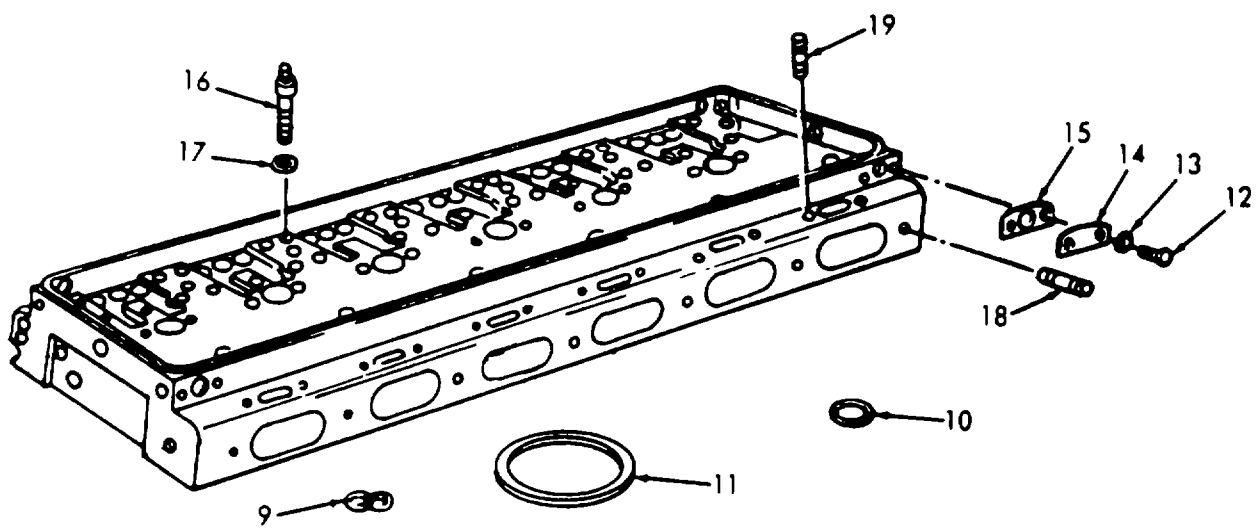
Application	** Plug	Assembly Data
Oil Gallery Plug	3/8" Dryseal P.T.F.Thd.	*Assemble with max. 1/16" protrusion from surface.
Cylinder Head Plug ..	3/8" - 16	Assemble flush to 1/16" protrusion from surface.
Cylinder Head (Top) .	1/2" P.T.F. - S.A.E. Short	Flush to 1/8" recessed.
Cylinder Head (End) .	3/4" Dryseal P.T.F. - S.A.E. Short	Flush to 1/8" recessed.
Water Plug	1" N.P.T.F. Thd.	Assemble 2" to 2 1/4" below machined surface.
Water Plug	1 3/4" - 16	75-100 lb. ft. torque (101.6863-135.5818 Nm)
Oil Drain Plug	18 MM	35-40 lb. ft. torque. (47.4536 - 54.2327 Nm).

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

** Apply sealing compound to plugs used without gaskets.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
REPAIR/REPLACEMENT (Cont) 		
x. Install water manifold studs (19).		Torque to 10-25 lb. ft. (13.56-20.34 Nm).
y. Install exhaust manifold studs (18).		Torque to 25-40 lb. ft. (33.90-54.23 Nm).
z. Install fuel line connector washers (17), and connectors (16).		
aa. Position governor hole gasket (15) in place.		Use new gasket.
ab. Install cover (14) using washers (13), and screws (12).		
ac. Install oil ring seal gaskets (11), water hole gaskets (10), and oil gaskets (9).		Use new gaskets.



5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- | | | |
|---|-------------------------------------|--|
| 9. Rocker
Arms,
Cam
Followers
And
Pushrods | Refer to paragraph 2-14 - ASSEMBLY. | |
| 10. Cylinder
Head | | |

NOTE

The following inspections shall be made just prior to installing the cylinder head onto the engine. Make these inspections regardless of whether the head was removed from the engine for servicing only the head assembly, or to facilitate others repairs to the engine.

- a. Check the cylinder head studs for damaged threads.
- b. Check for extruded areas around the stud holes in the cylinder block.
- c. Check the cylinder liner height with relationship to the cylinder block.
- d. Check to be sure tops of the pistons are clean and free of foreign material.
- e. Check to see that ALL the pushrods are threaded into their clevises until ends of the pushrods project through the clevises. This is important since serious engine damage will be prevented when the engine is cranked or barred-over during tune-up.

5-15. CYLINDER HEAD (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)

- f. Check the cylinder block and cylinder head gasket surfaces and counterbores to ascertain that these sealing surfaces are clean and free from foreign material. Also check to ensure that there are no burrs or sharp edges in the counterbores.
- g. Check the four corner plugs or drive pins used to plug the vertical oil galleries to ensure that they are flush with, or below, the top surface of the cylinder block.
- h. Refer to paragraph 2-14 and install cylinder head, injector control tube, injectors and clamps.
- i. Refer to paragraph 2-14 for adjustment procedures.
- j. Refer to paragraph 2-14 and install governor, thermostat housing and rocker arm cover.
- k. Refer to paragraph 2-14 and reconnect exhaust pipe, and water connections.

5-16. CYLINDER BLOCK.

This task covers:

Inspection

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Tools
NONE

Equipment
Condition Condition Description
NONE

Materials/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required

MOS 61C10

General Safety Instructions

Practice safety precautions.

LOCATION/ITEM

ACTION

REMARKS

INSPECTION

- a. Inspect for evidence of leaks around end plates.
- b. Inspect for loose or missing hardware.
- c. Inspect pipe plugs for evidence of leaks.
- d. Inspect for leaks around air box covers, and around head gaskets.
- e. Inspect block for cracks.

5-17. FUEL PUMP.

a. The positive displacement gear-type fuel pump transfers the fuel from the supply tank to the fuel injectors. The pump circulates an excess supply of fuel through the injectors which purges the air from the system, and cools the injectors. The unused portion of fuel returns to the fuel tank by means of a fuel return manifold and fuel return line.

b. The pump is attached to the rear end plate cover of the blower assembly with three bolt and seal assemblies. The seals are flat, soft copper washers which prevent the oil in the blower cover from seeping out around the bolt threads. The pump is driven off the end of the blower lower rotor by means of a drive coupling fork attached to the end of the pump drive shaft and mating with a drive disc attached to the blower rotor.

c. Fuel pumps are furnished in left-hand or right-hand rotation, according to the engine model, and are stamped "LH IN", or "RH IN". The left hand pumps are used on LB-RB engines while the right hand pumps are used on LD-RD engines. These pumps are not interchangeable, nor can a pump made for one rotation be rebuilt for the other rotation since the relief valve can be installed in only one position in the pump body.

5-17. FUEL PUMP (Continued).

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Fuel pump tool set J1508
Wrench J4242
Torque wrench

Equipment
Condition Condition Description

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Bench vise
Safety goggles

Materials/Parts

Crocus cloth
Emery cloth
Sea 1 ant
Vegetable shortening

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

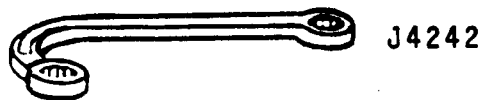
Observe WARNINGS in procedure.

5-17. FUEL PUMP (Continued).

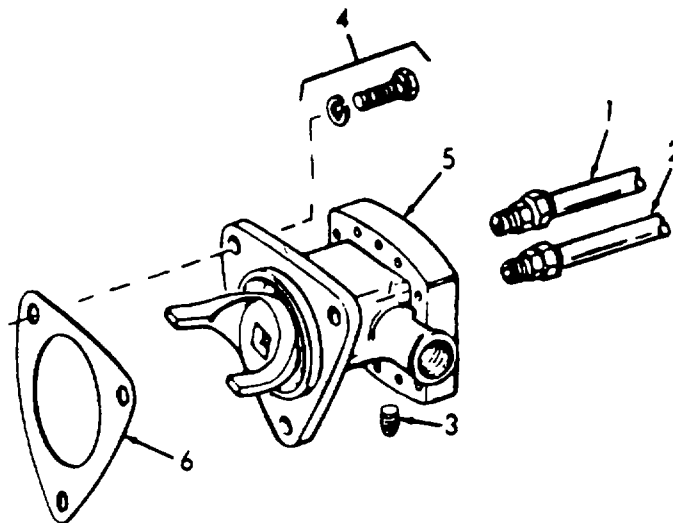
LOCATION/ITEM	ACTION	REMARKS
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REMOVAL

- | | | |
|--------------|---|-------------------|
| 1. Fuel Pump | a. Disconnect inlet line (1) and outlet line (2). | Cap open ends. |
| | b. Disconnect drain tube (3) from pump body. | |
| | c. Remove three bolt assembled washers (4) securing pump. | Use wrench J4242. |



- | |
|--|
| d. Withdraw fuel pump (5) from blower. |
| e. Remove mounting gasket (6). |



5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY

- | | | |
|--------------|---|------------|
| 2. Fuel Pump | a. Mount pump in a vise. | |
| | b. Remove fuel line connecting adapters (1). | If damaged |
| | c. Remove drain adapter (2) and drain plug (3). | If damaged |

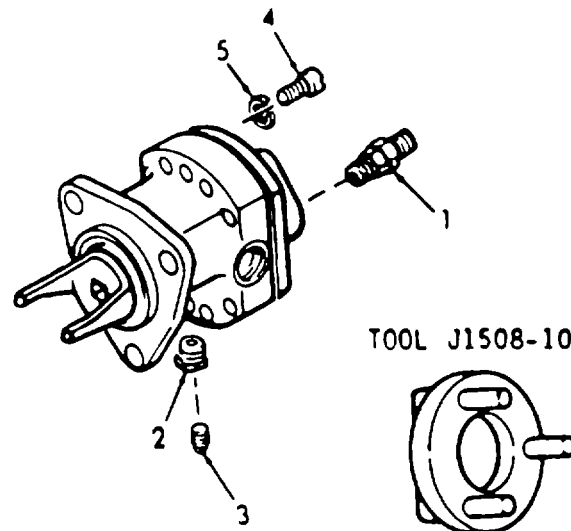
NOTE

Mount fuel pump in holding fixture J1508-10 and then disassemble.

- d. Remove capscrews (4), and lockwashers (5) from cover.

CAUTION :

Use care not to damage the finished faces of the pump body and cover when removing cover.



5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY (Cont)</u>		
	e. Remove cover (6) from pump body (21).	
	f. Remove coupling fork (7) from gearshaft (8).	If damaged
	g. Withdraw gearshaft (8), spur gear (9), and spur gear locking ball (10) as a unit from pump body.	
	h. Insert gearshaft unit in press and press gearshaft (8) just far enough to remove locking ball (10).	<u>Do not</u> misplace locking ball.

CAUTION

Do not press squared end of shaft through gear as slight marks will damage oil seal contact surface.

- | | |
|--|---|
| i. Insert unit in press and press shaft (8) from gear (9). | |
| j. Remove pump drive shaft and gear (11) as an assembly. | <u>Do not</u> remove gear (12) from shaft (13). |
| k. Remove plug (14), flat-washer (15), spring (16), pin (17), and relief valve (18) from pump body (21). | |

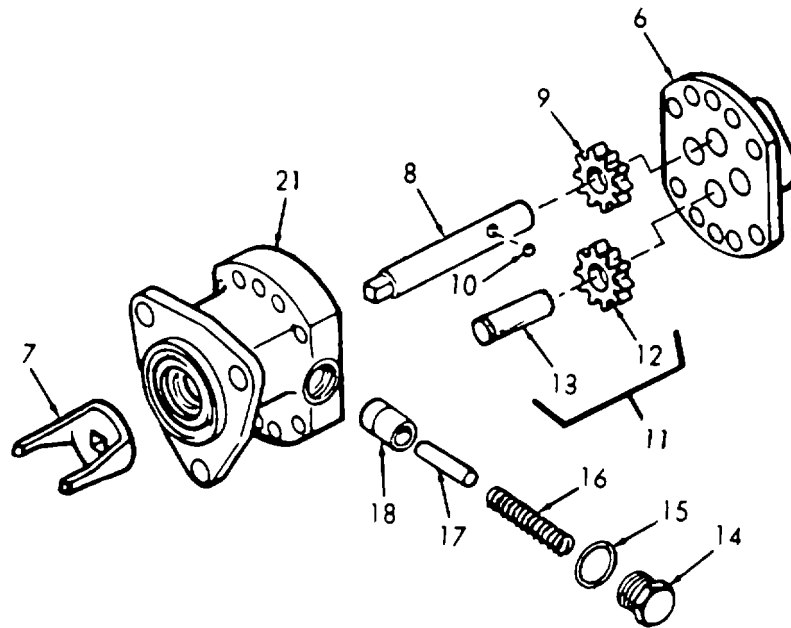
5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

NOTE

Observe position of the inner oil seal lip before removing the seal to permit installation of a new seal in the same position.

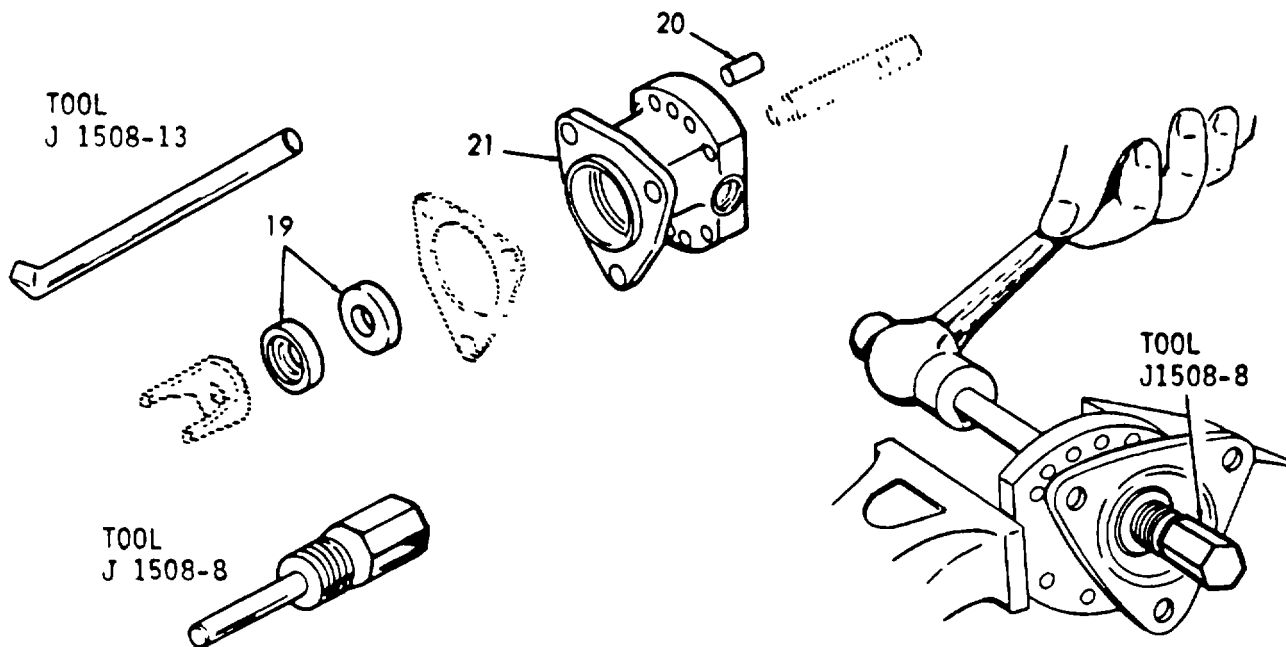


5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | |
|---|---------------------------------------|
| <p>i. To replace the oil seals (19), remove with tool as shown in figure by clamping pump body in a bench vise and screwing the threaded end of the tool shaft into the outer oil seal (seal nearest to bolting flange). Then, tap the pilot end of the shaft with a hammer to remove seal. Repeat this operation to remove the inner oil seal.</p> | <p>Use tool J1508-13 and J1508-8.</p> |
| <p>m. Remove dowell pins (20) from body (21).</p> | <p>If damaged.</p> |



5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING**WARNING**

- | | | |
|----|---|--|
| 3. | <ul style="list-style-type: none"> • Wear protective eye goggles when using compressed air to prevent eye injury. • Clean with clean fuel oil. Dry parts with compressed air. | |
|----|---|--|

INSPECTION

- | | | |
|----|---|--|
| 4. | <ul style="list-style-type: none"> a. Inspect drive and driven shafts for wear. b. Inspect gear teeth for scoring, chipping, or wear. c. Inspect pump body for scratches or nicks as damage may result in pressure leaks. d. Inspect pump body for wear at areas contacted by gears and shafts. e. Inspect mating surfaces of pump body and cover for flatness and smoothness. f. Inspect relief valve for score marks and burrs. Insure that valve fits its seat in pump body. g. Inspect valve spring for loss of compression. | |
|----|---|--|

5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>REPAIR</u>		
5.	<ul style="list-style-type: none"> a. Replace damaged or defective coupling. b. Replace the seals, and any damaged or defective drive shafts. Replace a damaged or defective drive shaft and gear as an assembly. c. Replace defective relief valve. 	<p>The valve spring has a free length of 1.97 inch (5.004 cm) and requires a load of $7.3 \pm .2$ lbs. to compress it to a length of 1.18 inches (2.997 cm) when new. If the spring falls below the specifications, replace the spring.</p>

ASSEMBLY

6. Fuel Pump	<ul style="list-style-type: none"> a. Install dowell pins (20). b. Lubricate the lips of the oil seals (19) with a light coat of vegetable shortening. Then install the oil seals in the pump body as follows: <ul style="list-style-type: none"> 1. Place the inner oil seal on the pilot of installer handle J1508-8 so that the lip of seal will face in the same direction as the original seal. 	If removed.
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5-17. FUEL PUMP (Continued).

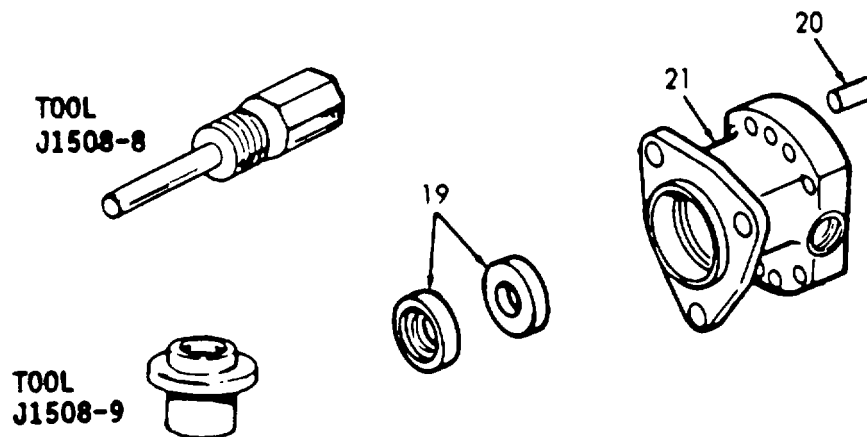
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

2. With the pump body (21) supported on wood blocks, insert oil seal and tool in the pump body and drive the seal in until it bottoms.

3. Place the shorter end of adapter over the pilot and against the shoulder of installer handle. Place outer oil seal on the pilot of the installer handle with lip of seal facing the adapter. Insert pilot of the installer handle into pump body (21), and drive the seal in until shoulder of the adapter contacts pump body. Thus, the oil seals (19) will be positioned so that the space between them will correspond with the drain holes located in the bottom of the pump body (21).

Use tool J1508-9.



5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>	<p>c. Clamp the pump body in the soft jaws of a bench vise with the valve cavity up. Lubricate the outside diameter of the valve (18), and place the valve in the cavity with the hollow end up. Insert the spring (16) inside the valve, and the pin (17) inside the spring. With a new gasket (15) in place next to the head of the valve plug, place the plug (14) over the spring and thread it into the pump body. Tighten plug (14).</p> <p>d. Install the fuel pump drive gear (9) over the end of the drive shaft (8) which is not squared (so the slot in the gear will face the plain end of the shaft when installed). This operation is very important; otherwise fine score marks caused by pressing the gear into position from the square end of the shaft may cause rapid wear of the oil seals. Press the gear (9) beyond the gear retaining ball detent (22). Then, place the ball (10) in the detent and press the gear back until the end of the slot contacts the ball.</p> <p>e. Lubricate the pump shaft and insert the square end of the shaft into the opening at the gear side of the pump body and through the oil seals.</p>	Tighten plug to 18-24 lb-ft (24-33 Nm) torque.

5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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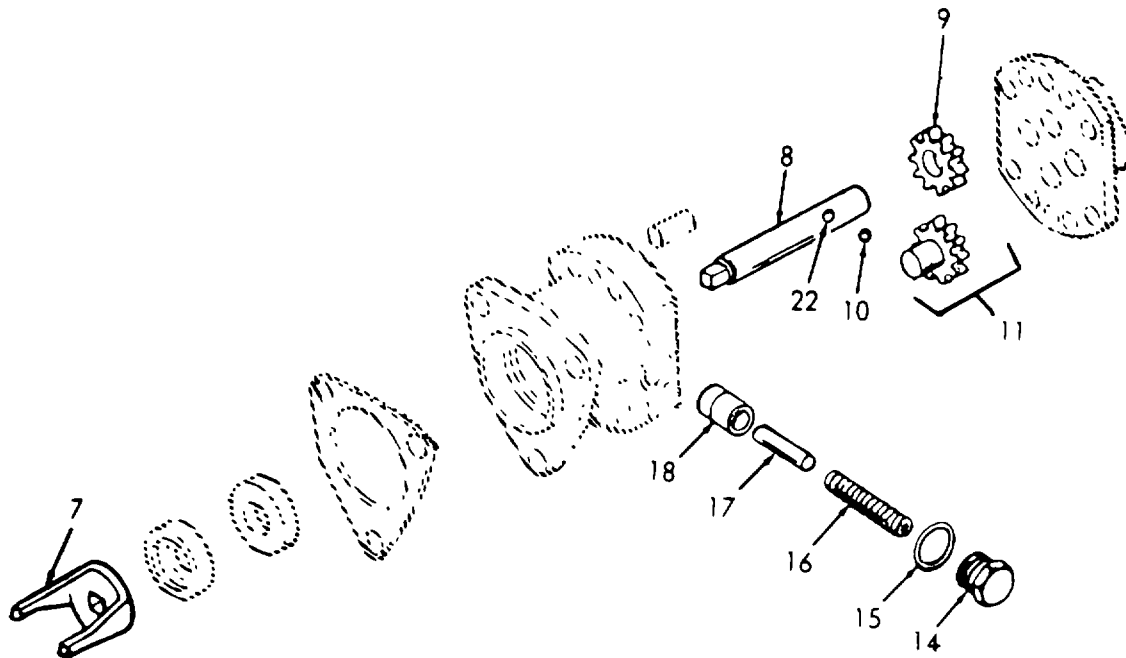
ASSEMBLY (Cont)

- f. Place the driven shaft and gear assembly (11) in the pump body.

CAUTION

The driven gear must be centered on the shaft to give proper end clearance. Also, the chamfered end of the gear teeth of the reduction gear must face the pump body. If a service replacement gear with slot is used, the slot must face toward the pump cover.

- g. Install drive coupling (7).
- h. Lubricate the gears and shafts with clean engine oil.



5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- i. Apply a thin coating of sealant on the face of the pump cover (6) outside the gear pocket area. Then, place the cover against the pump body with two dowel pins (20) in the cover entering holes in the pump body. The cover can be installed in only one position over the two shafts.

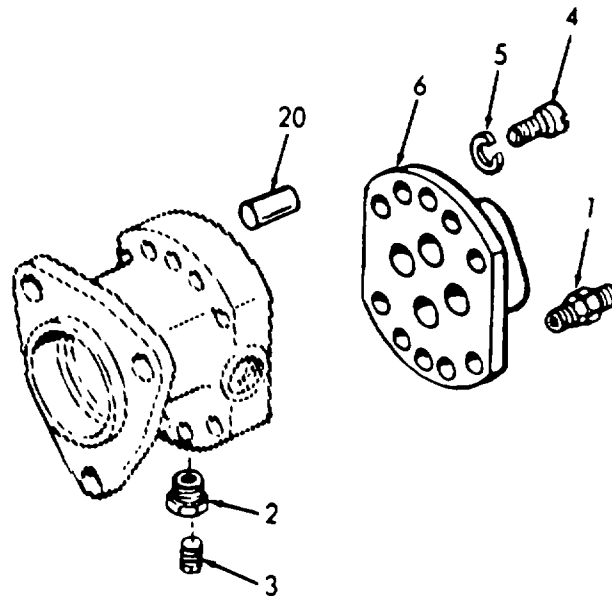
CAUTION .

The coating of sealant must be extremely thin since the pump clearances have been set up on the basis of metal-to-metal contact. Too much sealant could increase the clearances and affect the efficiency of the pump. Use care that sealant is not squeezed into the gear compartment; otherwise damage to the gears and shafts may result.

- j. Secure the cover in place with eight bolts (4), and lockwashers (5), tightening the bolts alternately and evenly.
- k. After assembly, rotate the pump shaft by hand to make certain that the parts rotate freely. When the shaft does not rotate freely, attempt to free it by tapping a corner of the pump.
- l. Install drain plug (3). If removed.
- m. Install drain adapter (2). If removed.
- n. Install fuel line connector adapters (1). If removed.

5-17. FUEL PUMP (Continued).

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

7. Fuel Pump

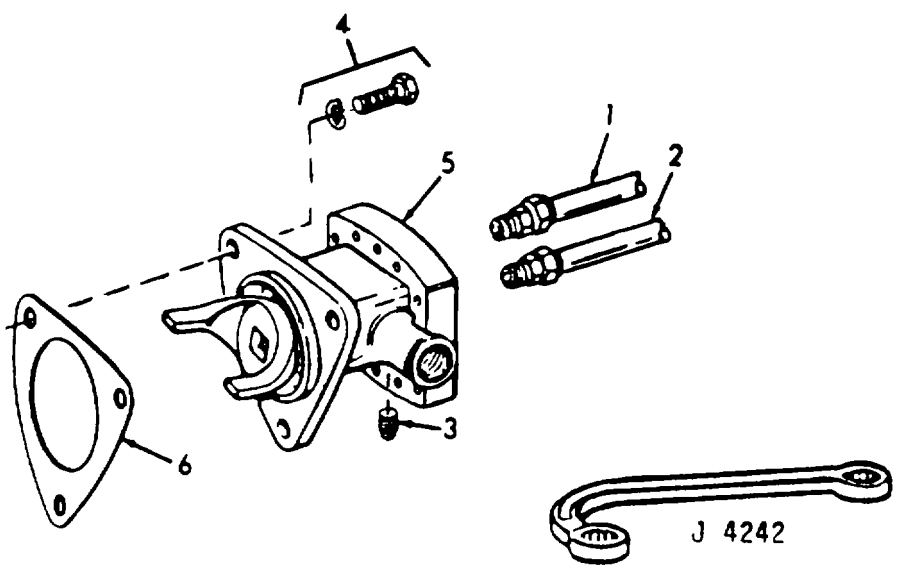
NOTE

The left-hand pump is used on "B" engines, and the right-hand pump is used on "D" engines. The pumps are not interchangeable. The pump must always be installed with the inlet opening in the pump cover (marked "LH IN" or "RH IN") on the side toward the cylinder block. Install the pump as follows:

- Step 1. Affix a new gasket to the pump body mounting flange and locate the pump drive coupling fork over the squared end of the drive shaft with prongs of fork directed away from the pump.
- Step 2. Place the fuel pump assembly up against the blower with the prongs of drive coupling fork in registration with slots in drive disk on the blower rotor shafts.

5-17. FUEL PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
INSTALLATION (Cont)		
a. Position mounting gasket (6) in place on blower.		
b. Secure fuel pump (5) to blower with three bolt-assembled washers (4).		Use wrench J4242.
c. Reconnect drain tube (3).		
d. Reconnect fuel outlet line (2).		Remove cap.
e. Reconnect fuel inlet line (1).		Remove cap.

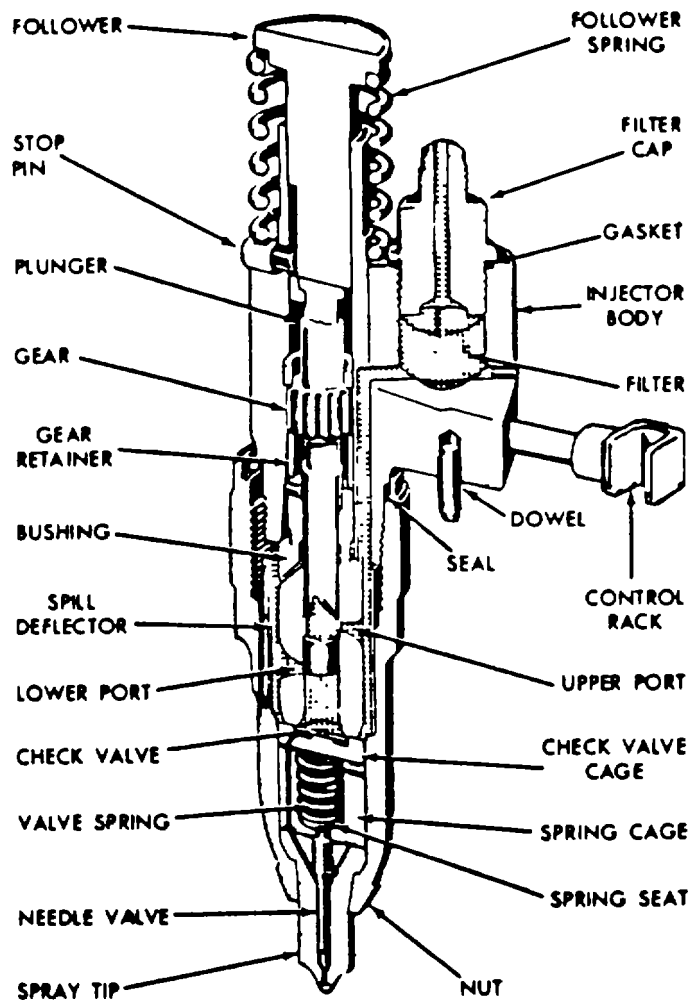


5-18. FUEL INJECTOR.

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

b. The fuel injector performs four functions:

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



5-18. FUEL INJECTOR (Continued).

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

d. The continuous fuel flow through the injector:

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

e. Both the injector plunger and plunger bushing are marked with identical part numbers to properly identify them as mating parts. Therefore, if either plunger or bushing requires replacement, both must be replaced as an assembly.

CAUTION

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

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

g. Fuel under pressure enters the injector from a fuel manifold. Motion of the rocker arm allows the injector to release a spray of fuel into a cylinder. A control rack on the side of the injector controls the amount of fuel being dispensed, and the speed of the engine. The injector control rack is actuated by a lever on the injector control tube which, in turn, is connected to the governor by means of a fuel rod. These levers can be adjusted independently on the control tube, thus permitting a uniform setting of all injector racks. Excess fuel exits the injector and is returned to a fuel manifold. The fuel then returns to the fuel tank.

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

5-18. FUEL INJECTOR (Continued).

i. Fuel, under pressure, enters the injector at the inlet side through a filter cap and a filter element. From the filter element the fuel passes through a drilled passage into the supply chamber, that area between the plunger bushing and the spill deflector, in addition to that area under the injector plunger within the bushing. The plunger operates up and down in the bushing, the bore of which is open to the fuel supply in the annular chamber by two funnel-shaped ports in the plunger bushing.

j. The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the follower spring. In addition to the reciprocating motion, the plunger can be rotated, during operation, around its axis by the gear which meshes with the control rack. For metering the fuel, an upper helix and a lower helix are machined in the lower part of the plunger. The relation of the helicities to the two ports, changes with the rotation of the plunger.

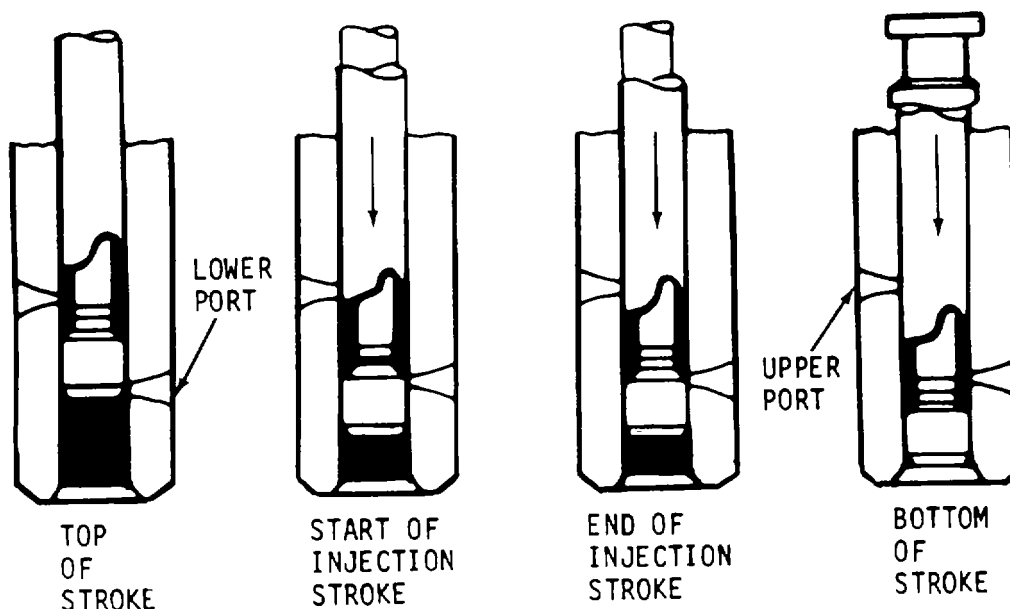
k. As the plunger moves downward, under pressure of the injector rocker arm, a portion of that fuel trapped under the plunger is displaced into the upper chamber through the lower port until the port is closed off by the lower end of the plunger. A portion of the fuel trapped below the plunger is then forced up through a central passage into the plunger fuel metering recess and into the supply chamber through the upper port until the port is closed off by the upper helix of the plunger. With the upper and lower ports both closed off, the remaining fuel under the plunger is subjected to increased pressure by the continued downward movement of the plunger.

l. When sufficient pressure is built up, the injector valve is lifted off its seat and the fuel is forced through small orifices in the spray tip and atomized into the combustion chamber.

m. A check valve mounted in the spray tip, prevents air leakage from the combustion chamber into the fuel injector in case the injector valve is accidentally held open by a small particle of dirt. The injector plunger is then returned to its original position by the injector follower spring. The figure below shows the various phases of injector operation by the vertical travel of the injector plunger.

5-18. FUEL INJECTOR (Continued).

n. On the return upward movement of the plunger, the high pressure cylinder within the bushing is again filled with fuel oil through the ports, the constant circulation of fresh cool fuel through the injector renews the fuel supply in the chamber, helps cool the injector and also effectively removes all traces of air which might otherwise accumulate in the system and, interfere with accurate fuel metering.

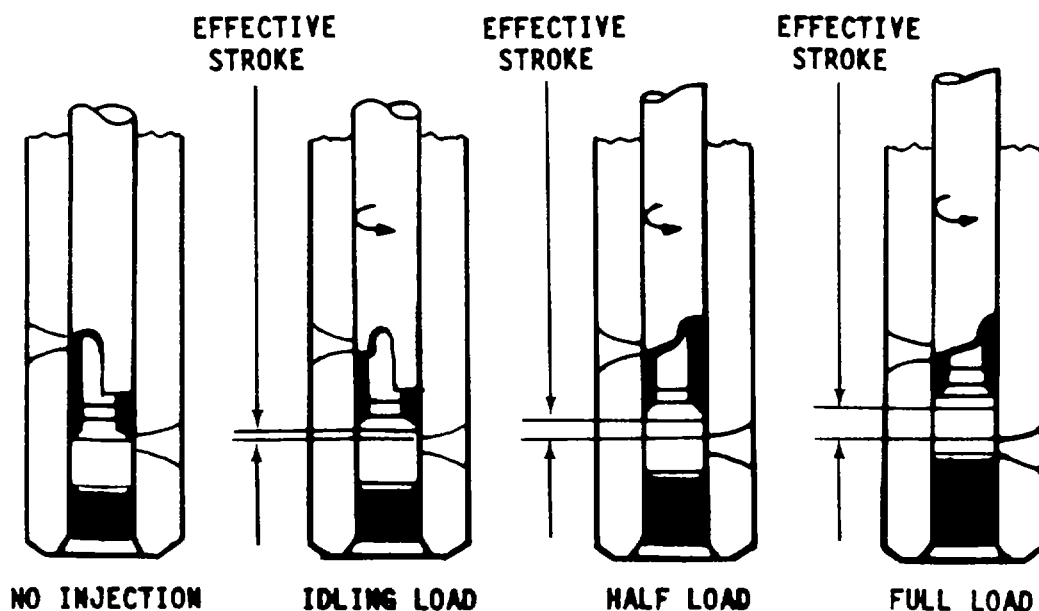


o. The fuel injector outlet opening through which the excess fuel oil returns to the fuel return passage and then back to the fuel tank, is directly adjacent to the inlet opening, and contains a filter element exactly the same as that in the inlet side.

p. Changing the position of the helices, by rotating the plunger, retards the advances of the closing of the ports, and the beginning or ending of the injection period. At the same time, it increases or decreases the amount of fuel injected into the cylinder. The figure below shows the various plunger positions from NO LOAD to FULL LOAD. With the control rack pulled out all the way (no injection), the upper port is not closed by the helix until after the lower port is

5-18. FUEL INJECTOR (Continued).

uncovered. Consequently, with the rack in this position, all the fuel is forced back into the supply chamber so no injection of fuel takes place. With the control rack pushed in (full injection), the upper port is closed shortly after the lower port has been covered thus producing a maximum effective stroke and maximum injection. From this no injection position to full injection position (full rack movement), the contour of the upper helix advances the closing of the ports and the beginning of injection.



5-18. FUEL INJECTOR (Continued).

This task covers:

- | | | |
|-------------|----------------|---------------|
| a. Removal | c. Testing | e. Inspection |
| b. Cleaning | d. Disassembly | f. Repair |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

- Comparator J7041
- Magnifying glass
- Injector Tester J9787
- Holding Fixture J6868-01

Tools

- General Mechanic's Tool Kit
- NSN 5180-00-629-9783
- 500 Grit stone

Equipment
Condition Condition Description
Paragraph

5-14 Rocker arm cover
removed.

Materials/Parts

- Parts kit 5228701 (72582)
- Lint-free cloth

Special Environmental Conditions

NONE

Personnel Required
MOS 61C10

General Safety Instructions
Observe WARNINGS and CAUTIONS
in procedure.

LOCATION/ITEM

ACTION

REMARKS

REMOVAL

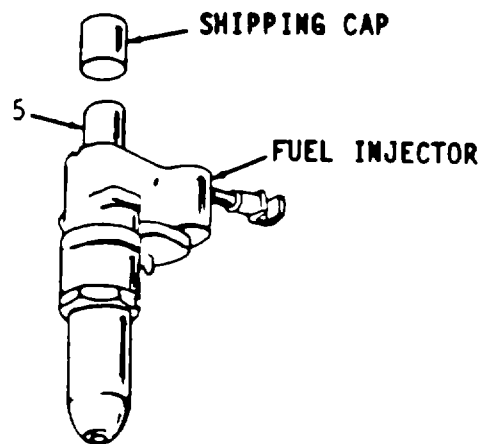
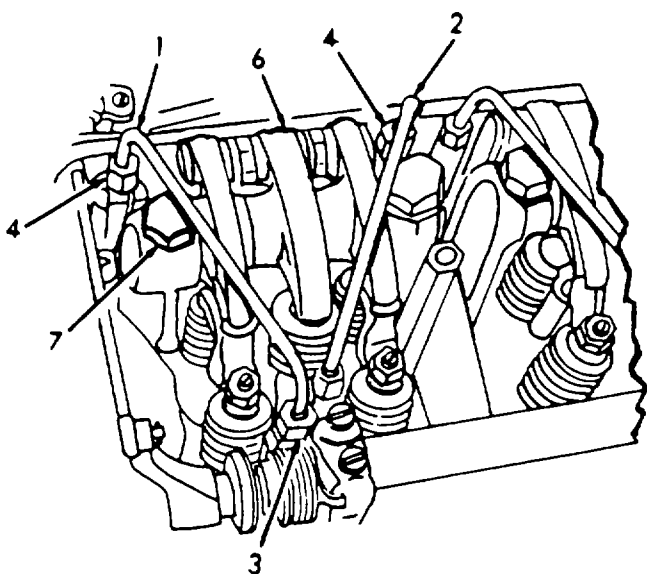
- | | | |
|---------------------------------------|---|---|
| 1. Fuel Pipes
(Top of
Cylinder) | Remove fuel pipes (1 and 2) from
injectors (3) and fuel connectors
(4). | Protect fuel
pipes and fuel
connectors from
dirt or foreign
particles . |
|---------------------------------------|---|---|

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- | | | |
|--|---|---------------------------------|
| 2. Filter Cap (5) are removed. | Cover filter cap (5) with shipping cap. | Do immediately after fuel pipes |
| 3. Engine Start Switch | Crank engine to bring outer ends of injector pushrods and rocker arms in line horizontally. | |
| 4. Rocker Arms (6), and Two Rocker Shaft Bracket Bolts | Remove bolts (7) and swing rocker arms away from injector and valves. | |

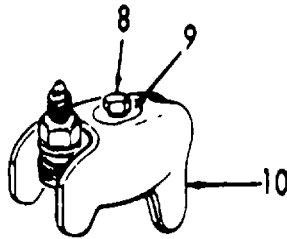


5-18. FUEL INJECTOR (Continued).

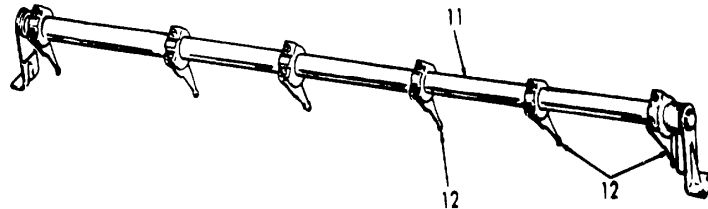
LOCATION/ ITEM	ACTION	REMARKS
----------------	--------	---------

REMOVAL (Cont)

- | | | |
|---|---|--|
| 5. Injector
Clamp
Underneath
Rocker
Arm | Loosen injector clamp bolt (8).
Remove bolt (8), special washer
(9) and clamp (10). | |
|---|---|--|



- | | | |
|--|---|--|
| 6. Injector
Tube (11)
(Outer
Side of
Cylinder
Head, and
Injector
Rack
Control
Lever | Loosen two screws on lever (12).
Slide lever away from injector. | |
|--|---|--|



5-18. FUEL INJECTOR (Continued).

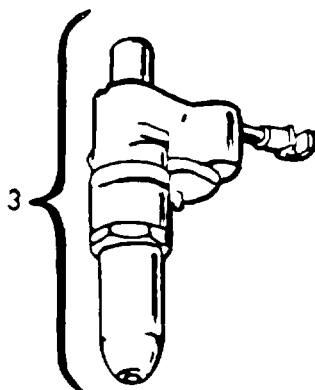
LOCATION/ ITEM	ACTION	REMARKS
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REMOVAL (Cont)

7. Injector

Lift injector (3) out of cylinder head.

Cover injector hole immediately after removal to keep out dirt or foreign particles.

**CLEANING**

8. Injector

WARNING

Wear protective eye goggles when using compressed air.

Clean exterior with fuel oil and dry with compressed air.

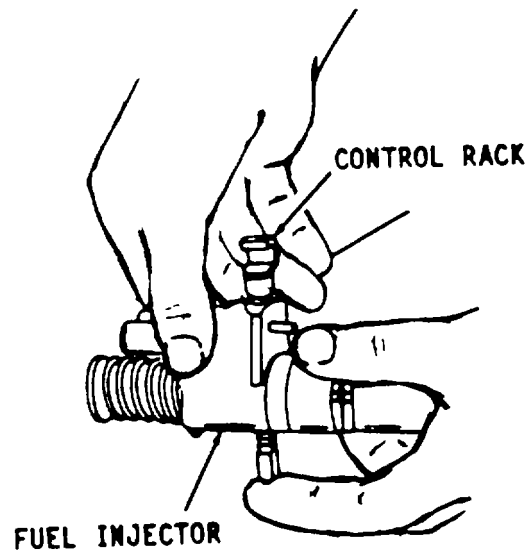
5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING

9. Injector
Rack and
Plunger
Movement

a. Place injector against a bench as shown.



b. Check to see if plunger works freely in its bushing by depressing follower to the bottom of its stroke, while moving the rack back and forth.

Failure to produce a free rack indicates internal parts of injector are dirty or damaged.

10. Valve Opening
(Pop Pressure)
Test

WARNING

The injector must always be held in such a way as to prevent any fuel spray from penetrating a person's skin. Fuel oil which enters the blood stream may cause a serious infection.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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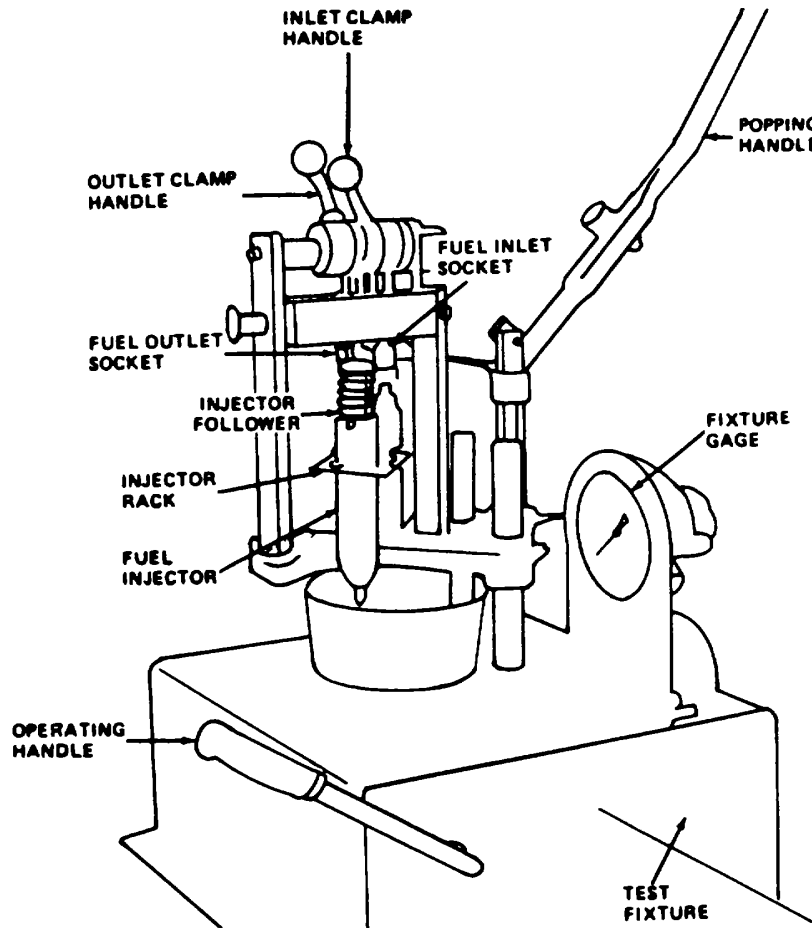
TESTING (Cont)

NOTE

Before using the injector tester, or when refilling it with fuel oil, disconnect the gage tube and pump the handle until all air is expelled from the system. Then connect the tube to the gage.

- a. Place injector in testing and popping fixture J9787 as shown. located in the proper slot of the adaptor plate.

Make sure dowel on underside of injector is



5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

b. Position injector support plate and popping handle support to the proper height.

WARNING

The injector must always be in proper position in relation to the spray deflector before it is tested in order to prevent the fuel spray from penetrating the skin. Fuel entering a person's blood stream may cause serious infection.

- c. Connect the fuel injector to the fuel line by rotating inlet clamp handle to move fuel inlet socket against the fuel injector inlet filter cap.
- d. Purge injector of air by stroking the operating handle until clear fuel flows from the outlet cap.
- e. Connect the outlet line to fuel injector by rotating outlet clamp handle to seal socket against fuel injector outlet filter cap.
- f. Operate the tester to build up slight pressure in system and stroke the popping handle two or three times.
- g. With the injector rack in FULL FUEL position, pump handle of test fixture with smooth, even strokes.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
<u>TESTING (Cont)</u>	h. Check fixture gage and record the injector valve opening (pop) pressure, indicated when the injector sprays fuel.	
11. Valve Holding Pressure Tester (3,103 kpa).	i. The pop pressure should be 450 to 850 pounds per square inch (3,103 to 5,860 kpa).	If pop pressure does not fall within the 450 to 850 psi (3,103 to 5,860 kpa) range, repair or replace injector.
	a. Operate the pump handle to bring the fuel injector pressure up to a point just below the injector pop pressure (450 psi)	
	b. Close the fuel shutoff valve and note the pressure drop. The time for a pressure drop from 450 pounds per square inch to 250 pounds per square inch (3,103 kpa to 1,724 kpa) should not be less than 40 seconds.	
	c. If the injector pressure drops from 450 pounds per square inch to 250 pounds per square inch (3,103 kpa to 1,724 kpa) in less than 40 seconds, perform the following:	

WARNING

Wear protective eye goggles when using compressed air to avoid eye injury.

1. Thoroughly dry the injector with compressed air.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
<u>TESTING (Cont)</u>		
	2. Open the test fixture fuel valve and operate the pump handle to maintain the testing pressure of 450 pounds per square inch (3,103 kpa).	
	3. Observe for leaks at the injector rack opening. indicated.	If this occurs, a poor bushing-to-body fit is
	4. A leak around the spray tip or seal ring usually is caused by a loose injector nut, damaged seal ring, or a hardened surface on the injector nut or spray tip.	
	5. A leak at filter cap indicates a loose filter cap or damaged filter cap gasket.	
	6. A "dribble" at the spray tip orifices indicates a leaky valve assembly due to damaged surface or dirt.	Leakage at tip will cause pre-ignition in the engine.

5-18. FUEL INJECTOR (Continued).

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

A drop or two of fuel at the spray tip is only an indication of the fuel trapped in the spray tip at the beginning of the test, and is not detrimental as long as the pressure drop specified (in step 11c) is not less than 40 seconds.

- | | | |
|------------------------|---|--|
| 12. High Pressure Test | <p>a. The high pressure test is necessary to detect any leaks at the injector filter caps, body plugs, nut seal ring, and internal lapped surfaces which did not appear during the valve holding pressure test (step 11). It also indicates whether or not the plunger and bushing clearances are satisfactory.</p> | |
|------------------------|---|--|

WARNING

Wear protective eye goggles when using compressed air to avoid eye injury.

- | | |
|---|-------------------------------------|
| b. Thoroughly dry the injector with compressed air. | |
| c. Check all fuel connections for leaks and tighten if necessary. | If leaks occur, dry injector again. |

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

- d. With the injector rack in FULL FUEL position, and the popping handle locked in position by means of a handle lock, stroke pump operating handle to build up and maintain pressure.
- e. Use the adjusting screw in the injector tester handle and depress the injector plunger just far enough to close both ports in the injector bushing. The point at which both ports are closed is easily noticed because the injector spray will decrease appreciably and the pressure will rise.
- f. If there is excessive clearance between the plunger and bushing, the operator will be unable to pump up pressure beyond normal valve opening (pop) pressure. Replacement of the plunger and bushing is then necessary.

CAUTION

Do not permit the pressure in the test fixture to equal or exceed the capacity of the pressure gage.

- g. Pump the test fixture and maintain a pressure of 1600-2000 psf. Inspect for leaks at the injector filter cap gaskets, body plugs, injector nut seal ring area, and injector rack hole.

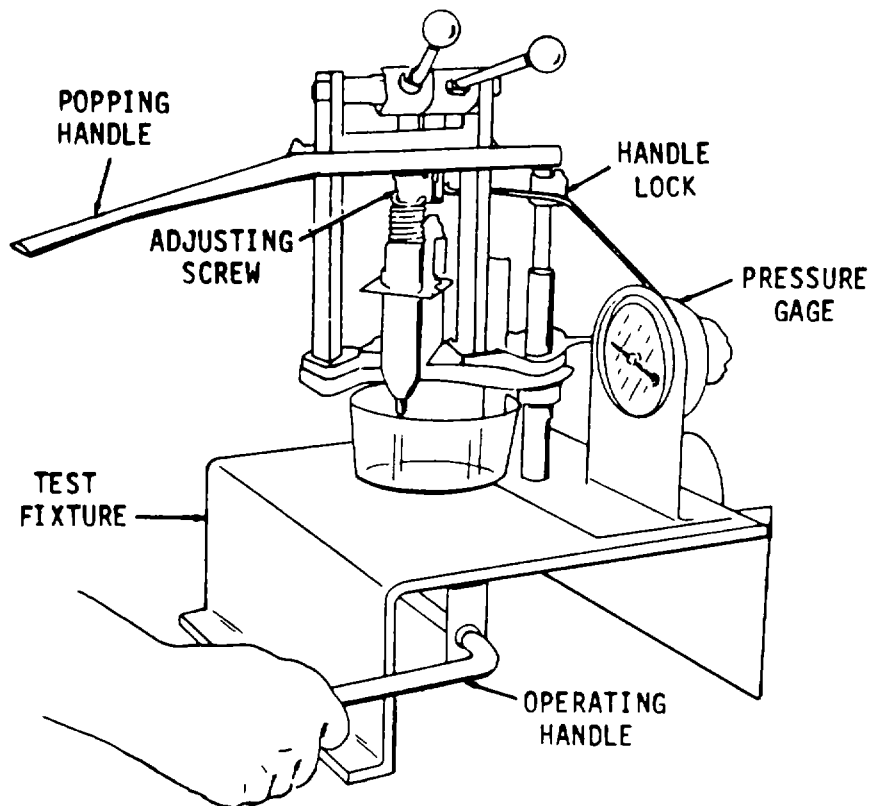
5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

13. Spray
Pattern
Test

- a. With the injector in the FULL FUEL position, stroke the pump operating handle to maintain a fuel pressure just below the valve opening (pop) pressure (step 10).
- b. Pop the injector several times with the popping handle and observe the spray pattern at the spray tip orifice. Fuel should be discharged from each orifice, and the spray should produce a uniform pattern.
- c. If the spray tip does not produce a uniform pattern, clean spray tip orifice during the overhaul of the injector.



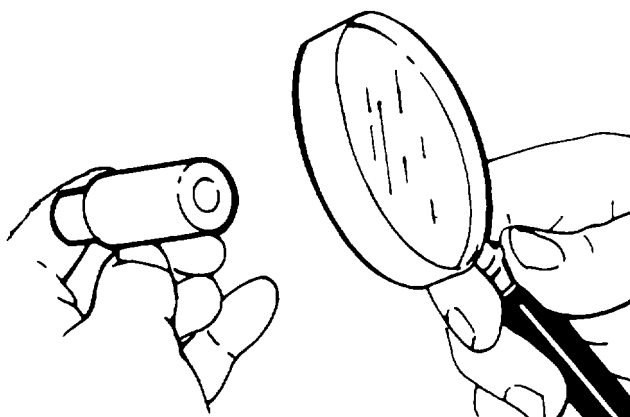
5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

14. Visual
Inspection
of Injector
Plunger

- a. If the injector passes all of the above tests (steps 9 through 13), visually check the plunger under a magnifying glass for excessive wear or a possible chip on the bottom helix. There is a small area on the bottom helix and lower portion of the upper helix, that if chipped, will not be indicated in any of the tests.



- b. Remove the plunger from the injector as follows:
1. Position the injector in the holding fixture (1) right side up.
 2. Compress follower spring (2). Then, using a screwdriver, raise the spring above the stop pin and remove the pin (3). Allow the plunger spring to raise gradually.

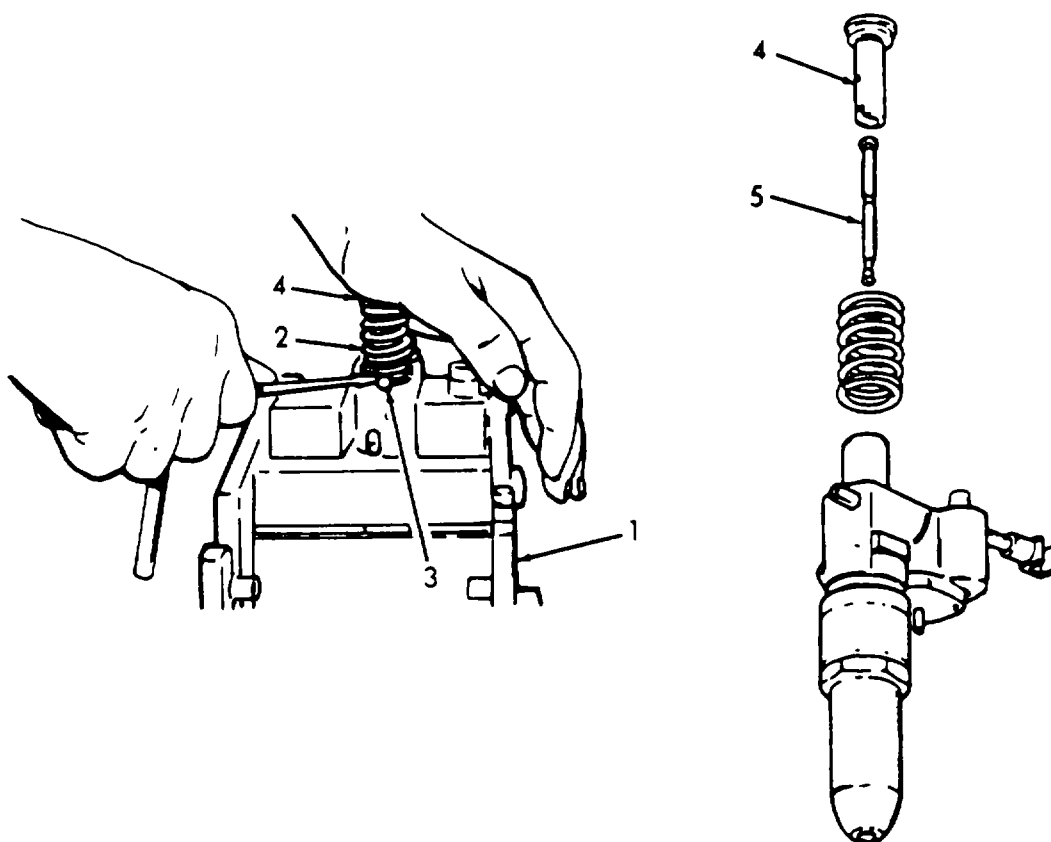
Use tool
J6868-01.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

3. Remove the injector from the holding fixture, and turn injector upside down to prevent the entry of dirt into the injector, and catch the spring (2), plunger (5) and follower (4), in hand.

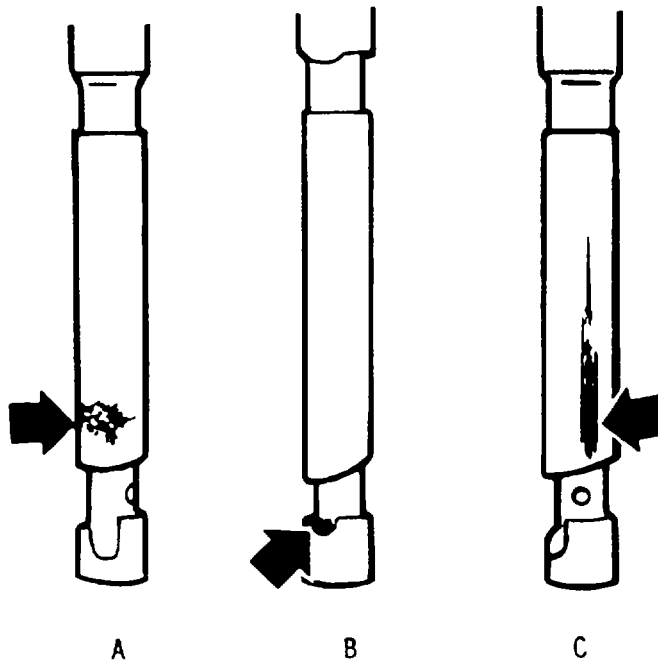


4. Inspect the plunger, and if chipped, replace plunger and bushing after the fuel output test is performed. Plunger (B as shown on the following page), illustrates a chipped plunger at the helix.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)



- A. Dirt in fuel. Shows advanced stages of abrasive matter in fuel.
- B. Chipped at low helix.
- C. This condition caused by lack of fuel at high speed, or water in fuel.

15. Fuel Output Test

- a. Set comparator (1) at 1000 strokes.
- b. Place injector (2) in the comparator.
- c. Seal firmly, and check the injector fuel output as follows:
- d. Pull control rack (3) out to NO FUEL position.
- e. Turn comparator ON-OFF switch (4) to ON position.

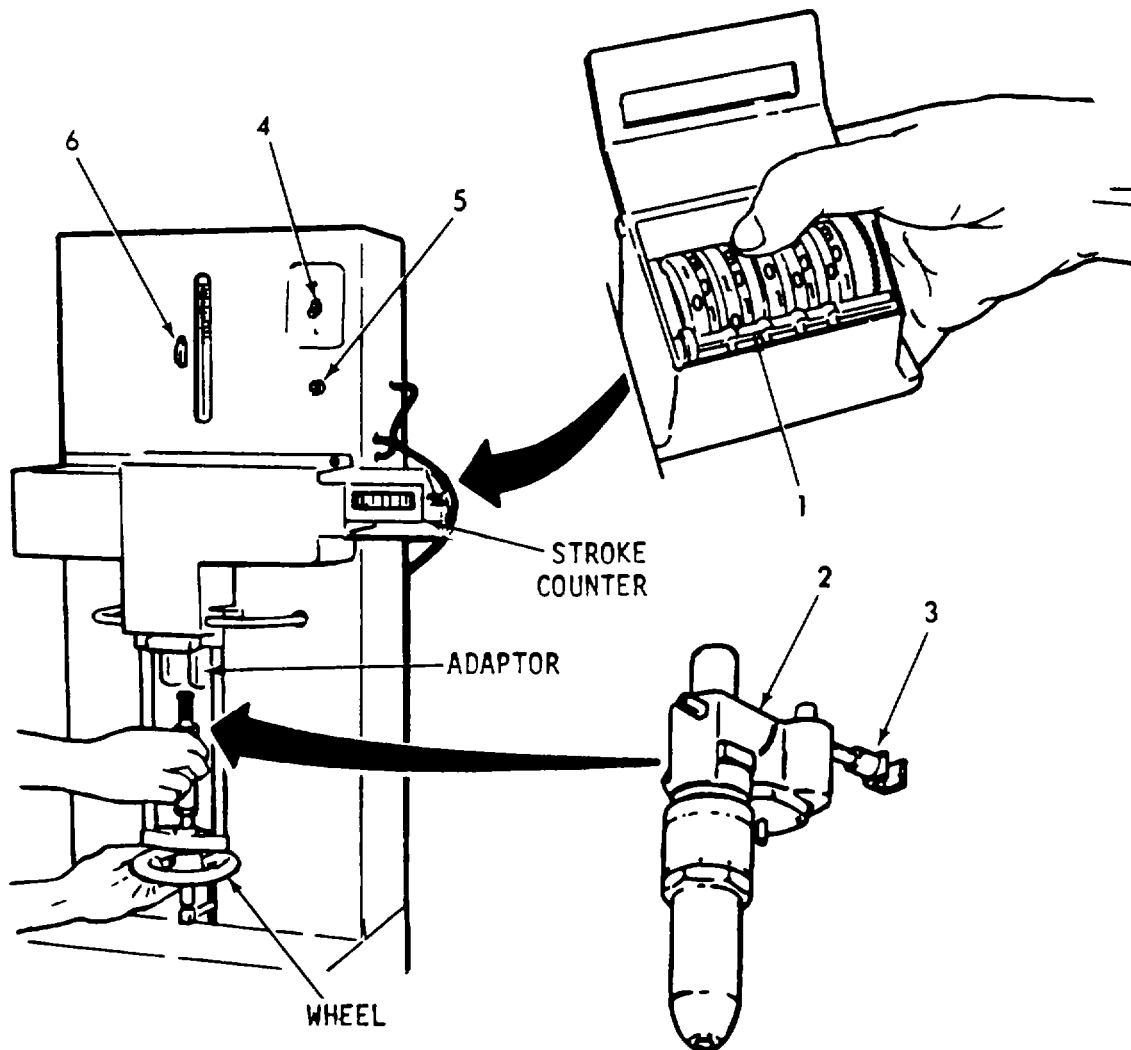
Use tool J7041.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

- f. After comparator has started, push the injector rack to FULL FUEL position.
- g. Run injector for 30 seconds to purge all air from system.
- h. Press fuel flow start button (5) to start flow of fuel into vial (6). The comparator will automatically stop the fuel flow after 1000 strokes.



5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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TESTING (Cont)

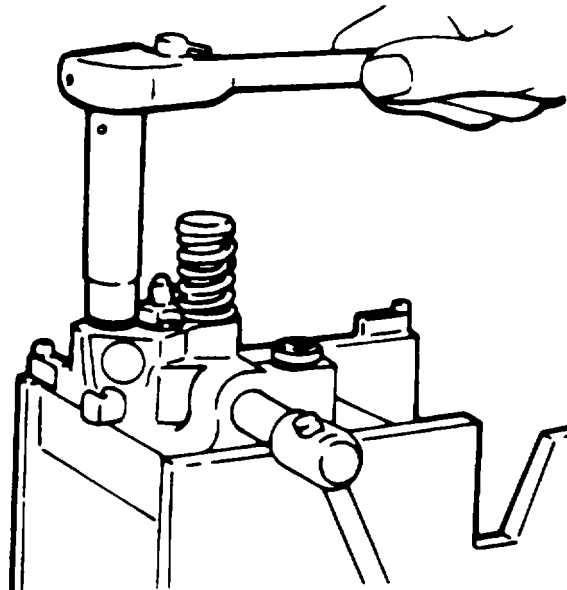
- i. After fuel stops flowing into vial, pull the rack out to the NO FUEL position, turn the comparator off, reset the counter, and observe the vial reading.
- j. If the injector fuel output in the vial does not fall within a minimum of 30cc (cubic centimeters) or a maximum of 36cc, the injector is defective, and must be replaced.

DISASSEMBLY

16. Injector Filters

a. Support injector assembly in fixture.

Use tool J6868-01.



5-420

5-18. FUEL INJECTOR (Continued).

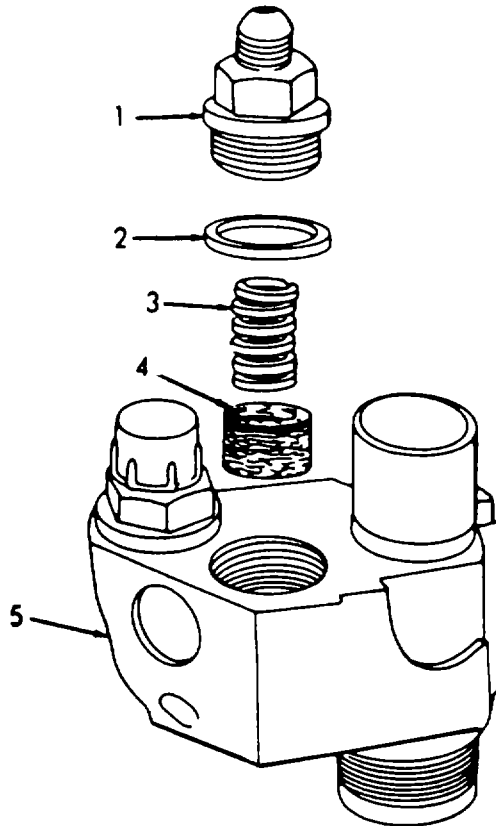
LOCATION/ ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

b. Remove filter cap (1), and cap gasket (2).

Discard gasket.

c. Remove compression spring (3), and filter element (4) from body (5).



5-421

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
<u>INSPECTION</u>		
17.	Inspect plunger for scoring, erosion, chipping, wear at helix, or sharp edges.	
<u>REPAIR</u>		
18.	<ul style="list-style-type: none"> a. Replace filters, and cap gaskets. b. Replace defective plungers. c. Remove sharp edges from plunger using a 500 grit stone. Wash plunger after stoning . 	
<u>ASSEMBLY</u>		
19. Filters	<ul style="list-style-type: none"> a. Place new elements (4) Into injector body (5). b. Install compression spring (3). c. Install new cap gasket (2) onto filter cap. 	Elements have a dimple on one end. When installing elements always install element with the dimple down.

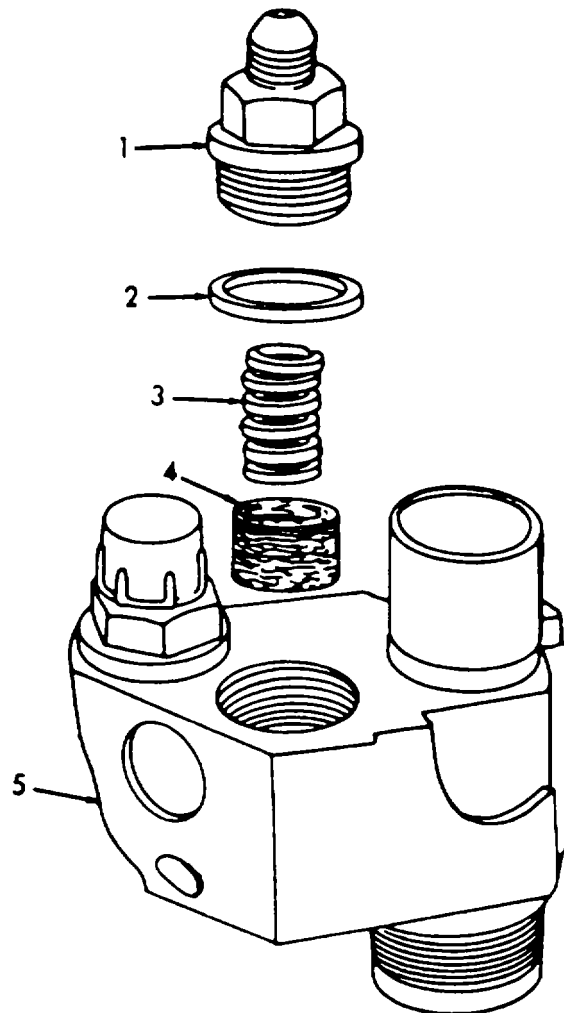
5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

d. Install filter cap (1) into injector body (5). Lubricate filter cap threads. Cap all open ends to prevent entry of dirt or particles into injectors.

Torque to 65-70 lb. ft. (88.13 to 94.91 Nm).



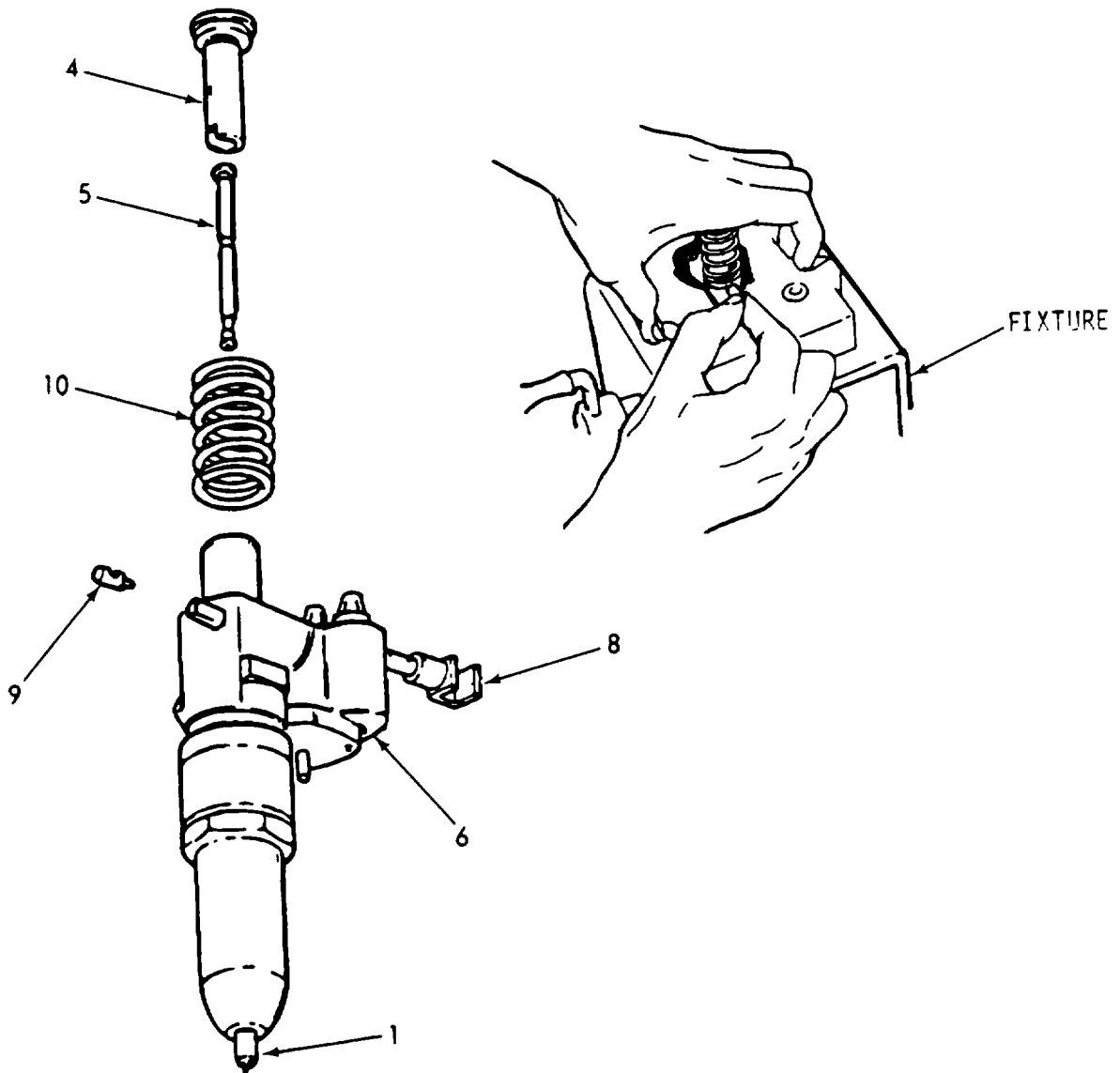
5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
ASSEMBLY (Cont)		
20. Injector Plunger and Follower Assembly	<ul style="list-style-type: none"> a. Position injector body (6) in fixture (spray tip (7) down). b. Push control rack (8) all the way in. c. Insert free end of plunger (5) into injector body. d. Place stop pin (9) on injector body so that bottom coil of follower spring (10) rests on narrow flange of pin. e. Align slot in follower with stop pin hole in injector body. f. Align flat side of plunger with flat in gear. g. Press down on follower (4) and at the same time press stop pin (9) into position. h. When in place, spring (10) will hold stop pin (9) in place. 	Use tool J6868-01.

5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)



5-18. FUEL INJECTOR (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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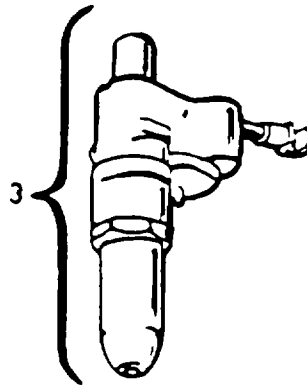
INSTALLATION

21. Injector

NOTE

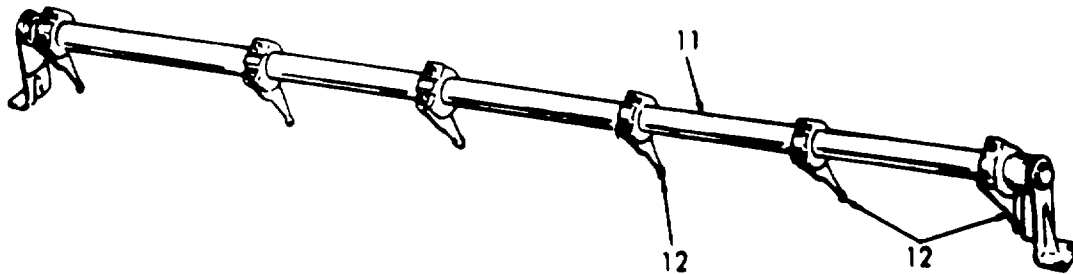
Make sure all accumulations of dirt around the injector holes is removed.

Remove protective covers and install injector (3) in cylinder head.



22. Injector Tube (11)

Place lever (12) in position in control rack.



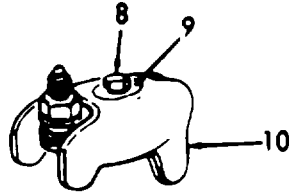
5-18. FUEL INJECTOR (Continued).

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

INSTALLATION (Cont)

23. Injector
Clamp

Install clamp (10), special washer (9), and bolt (8).

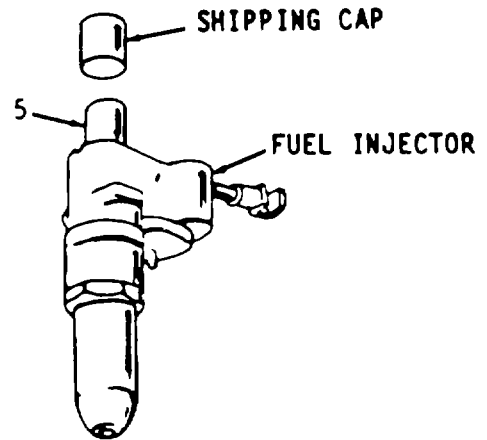
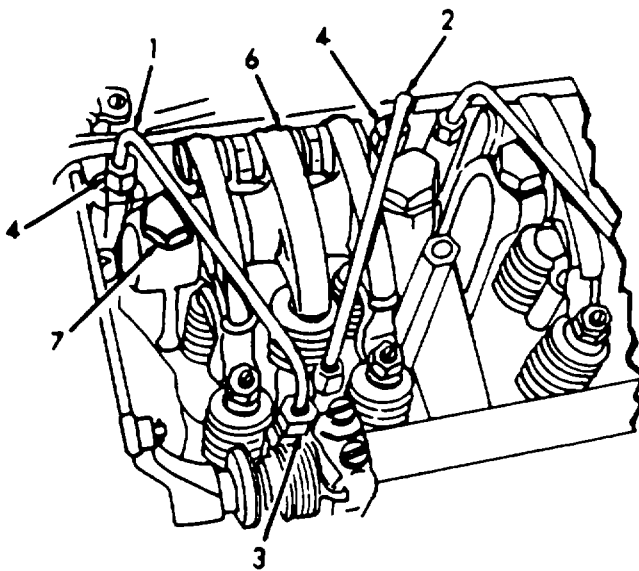


24. Rocker
Arms (6)

Install bolts (7) in rocker arm assembly (6).

25. Fuel
Pipes

- a. Remove shipping cap from filter cap (5).
- b. Install fuel pipes (1 and 2) to injectors (3) and fuel connectors (4).



5-19. FUEL INJECTOR (Continued).

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | h. Adjustment |
| c. Cleaning | f. Assembly | |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment
Condition Condition Description
NONE

Materials/Parts

Clean cloth
Cleaning solvent P-D-680

Special Environmental Conditions
NONE

Personnel Required

MOS 61C10

General Safety Instructions
Observe WARNING in procedure.

LOCATION/ ITEM	ACTION	REMARKS
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REMOVAL

- Rocker Arm Cover

NOTE

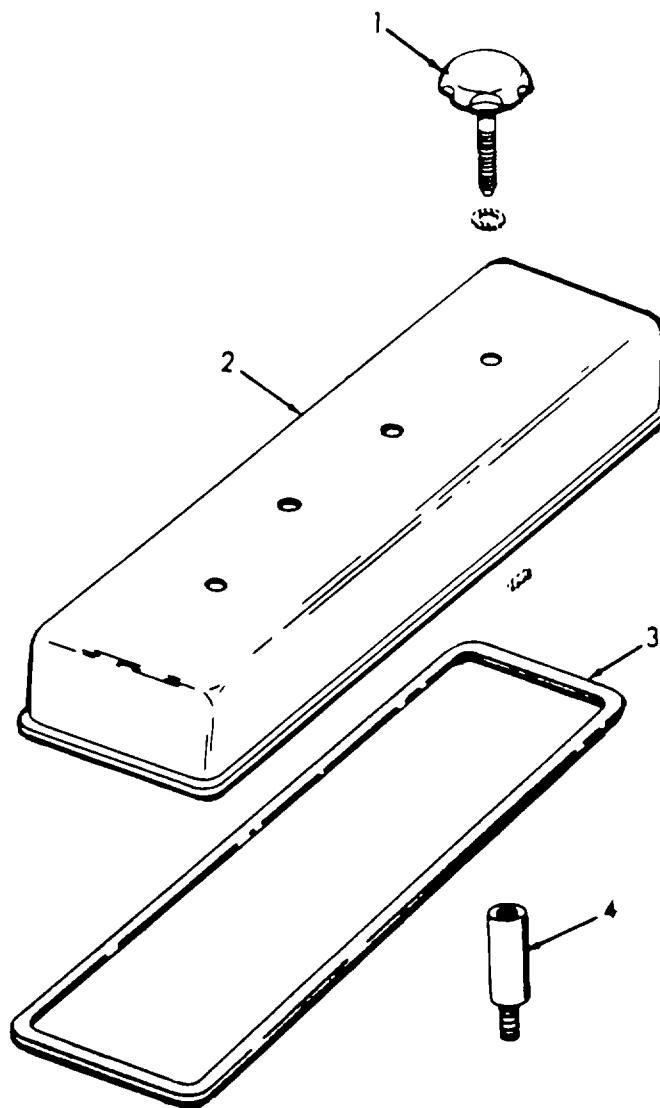
Using clean cloths, remove any dirt, grease, oil, or other matter from rocker arm cover and cylinder head to prevent entry of any foreign matter into the cylinder head opening.

5-19. INJECTOR CONTROL TUBE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- a. Unscrew four thumbscrews (1) from stud extensions (4).
- b. Remove rocker arm cover (2) and cover gasket (3).



5-429

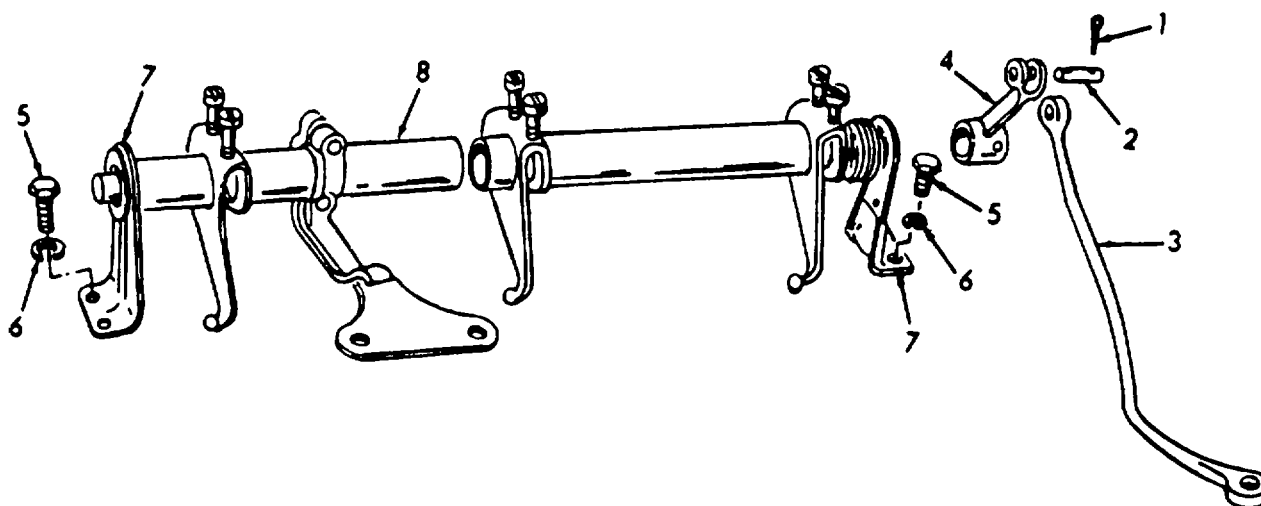
5-19. INJECTOR CONTROL TUBE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

2. Injector Control Tube

- a. Remove cotter pins (1) from link pin (2).
- b. Remove link pin (2) from governor control link (3).
- c. Push up on control tube lever (4) to free control link (3).
- d. Remove capscrews (5) and lockwashers (6) from bracket assemblies (7).
- e. Lift up on control tube (8), and remove from cylinder head.



DISASSEMBLY

3.
 - a. Remove grooved pin (9) and control tube lever (4).
 - b. Remove spacer sleeve (10).
 - c. Remove bracket assemblies (7) and helical spring (11).
 - d. Remove load limit adjusting bolts (12), hexagon nuts (13), and injector plates (14).

5-19. INJECTOR CONTROL TUBE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

e. Remove capscrews (15), lock-washers (16), and injector arms (17) from control tube (8).

f. Loosen screws (18) in lever assemblies (19).

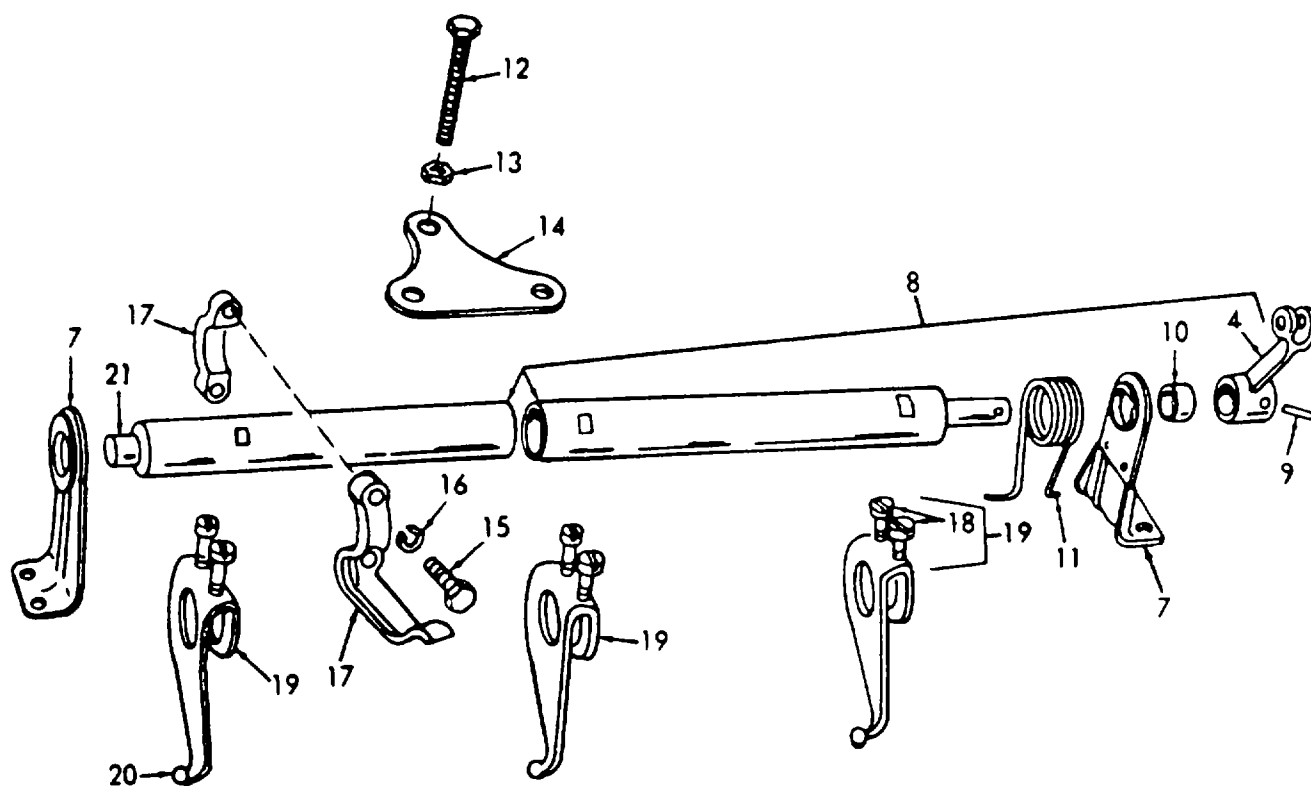
g. Remove injector control lever assemblies (19).

h. Remove pins (20) from lever assemblies.

If necessary.

i. Remove shoulder headless pins (21) from control tube (8).

If necessary.



5-19. INJECTOR CONTROL TUBE (Continued).

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

CLEANING

4.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° 138° F (38° 59° C).

Clean all parts in cleaning solvent P-D-680 and dry thoroughly.

INSPECTION

5.

- a. Inspect threaded parts for crossed or stripped threads.
- b. Inspect pins for burrs, flat spots, and wear.
- c. Inspect lever assemblies and brackets for distortion, cracks or elongated holes.
- d. Inspect spacer sleeve for cracks, burrs and wear.

REPAIR

6.

Replace damaged or defective parts as necessary.

ASSEMBLY7. Injector
Control
Tube

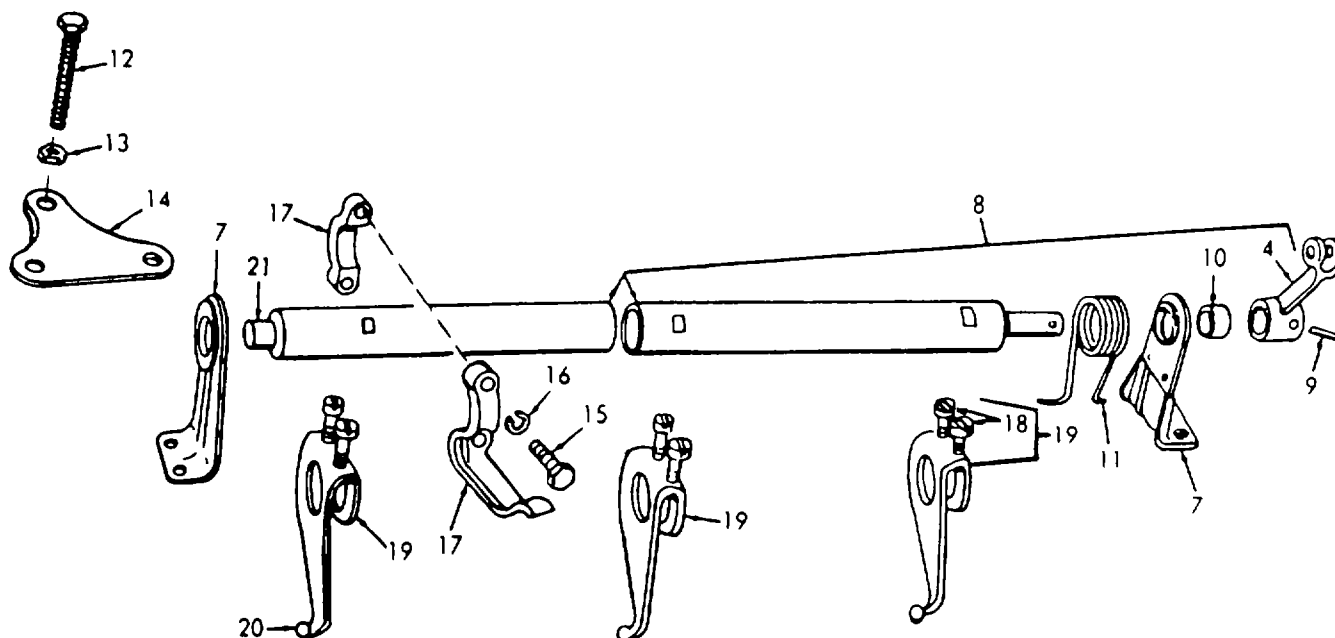
- a. Install shoulder headless pins (21) in control tube. If removed.
- b. Install pins (20) in lever assemblies. If removed.

5-19. INJECTOR CONTROL TUBE (Continued).

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

ASSEMBLY (Cont)

- c. Position lever assemblies (19) in place on control tube. Tighten screws (18).
- d. Install injector arms (17) using lockwashers (16), and capscrews (15).
- e. Install injector plates (14) using hex nuts (13) and adjusting bolts (12).
- f. Place spring (11), bracket assembly (7), spacer sleeve (10), and control tube lever (4) on end of control tube (8).
- g. Secure with pin (9).
- h. Place other bracket assembly (7) over end of control tube (8).



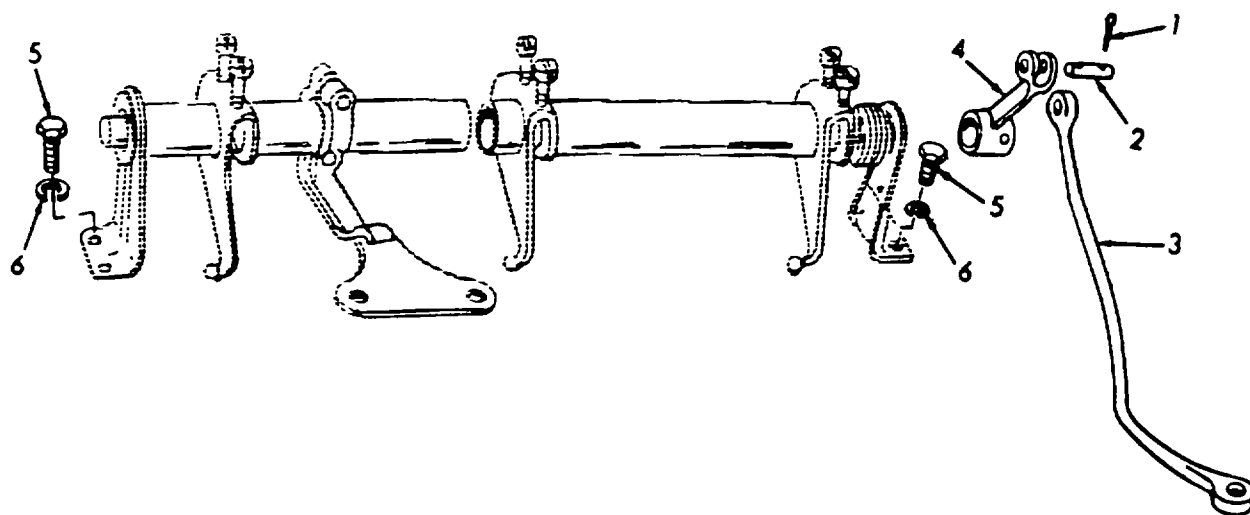
5-19. INJECTOR CONTROL TUBE (Continued).

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

INSTALLATION

8. Injector Control Tube

- a. Position assembled control tube in place on cylinder head.
- b. Secure to head with lock-washers (6), and capscrews (5).
- c. Position governor control link (3) in slot on control tube lever (4).
- d. Insert link pin (2) into control tube lever.
- e. Secure with cotter pins (1).



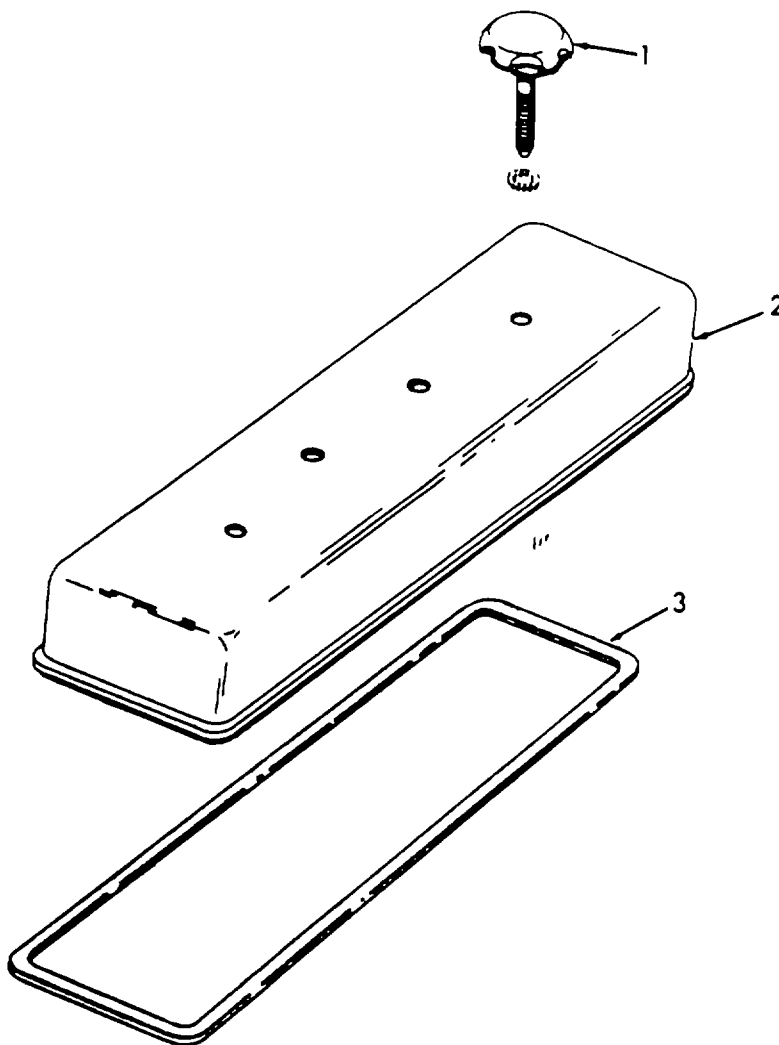
5-19. INJECTOR CONTROL TUBE (Continued).

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

INSTALLATION (Cont)

9. Rocker
Arm
Cover

- a. Position rocker arm cover gasket (3) in place on cylinder head.
- b. Install cover (2).
- c. Secure by tightening thumbscrews (1).

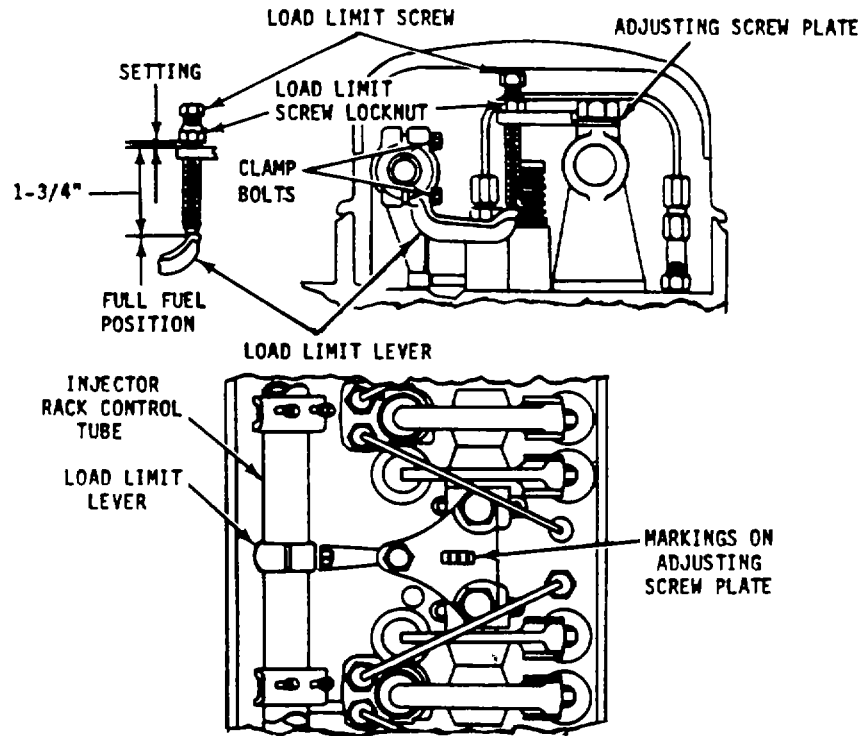


5-19. INJECTOR CONTROL TUBE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENT

- | | | |
|-----------------------|--|--|
| 10. Load Limit Device | <p>a. Perform an engine tune-up.</p> <p>b. Make sure all parts of load limit device are installed properly as shown below.</p> | |
|-----------------------|--|--|



- c. Adjust as follows:
1. Loosen the load limit screw locknut.
 2. Back the load limit screw out of the adjusting screw plate until approximately 1 inch (2.54 cm) of screw is below plate.

5-19. INJECTOR CONTROL TUBE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ADJUSTMENT (Cont)

3. Adjust the load limit screw locknut so the bottom of the locknut is 1-3/4 inch (4.45 cm) from the bottom of the load limit screw.
4. Loosen load limit lever clamp bolts so the lever is free to turn on the injector rack control tube.
5. Thread the load limit screw into the adjusting screw plate until the locknut "bottoms" against the top of the plate.
6. Hold the injector rack control tube in the FULL FUEL position, and place the load limit lever against the bottom of the load limit screw. Then, tighten the load limit lever clamp bolts.
7. Check to ensure that the injector racks will just go into the FULL-FUEL position-readjust the load limit lever. If necessary.

5-19. INJECTOR CONTROL TUBE (Continued).

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

ADJUSTMENT (Cont)

8. Hold the load limit screw to keep it from turning. Then "set" the locknut until the distance between the bottom of the locknut and the top of the adjusting screw plate correspond to the markings on the adjusting screw plate.
9. Thread the load limit screw into the plate until the locknut "bottoms" against the top of the plate.
10. Hold the load limit screw to keep it from turning. Then tighten the locknut to secure the setting.

5-20. THROTTLE CONTROLS - ENGINE ROOM.

This task covers:

- | | |
|---------------|-----------------------|
| a. Removal | d. Repair/Replacement |
| b. Cleaning | e. Installation |
| c. Inspection | |
-

INITIAL SETUP

Test Equipment
NONE

Special Tools

NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Materials/Parts
Cleaning solvent P-D-680

Personnel Required

MOS 61C10

References
Para 5-5 Throttle Controls -
Pilothouse

Equipment
Condition Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions

Observe WARNING in procedure.

5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

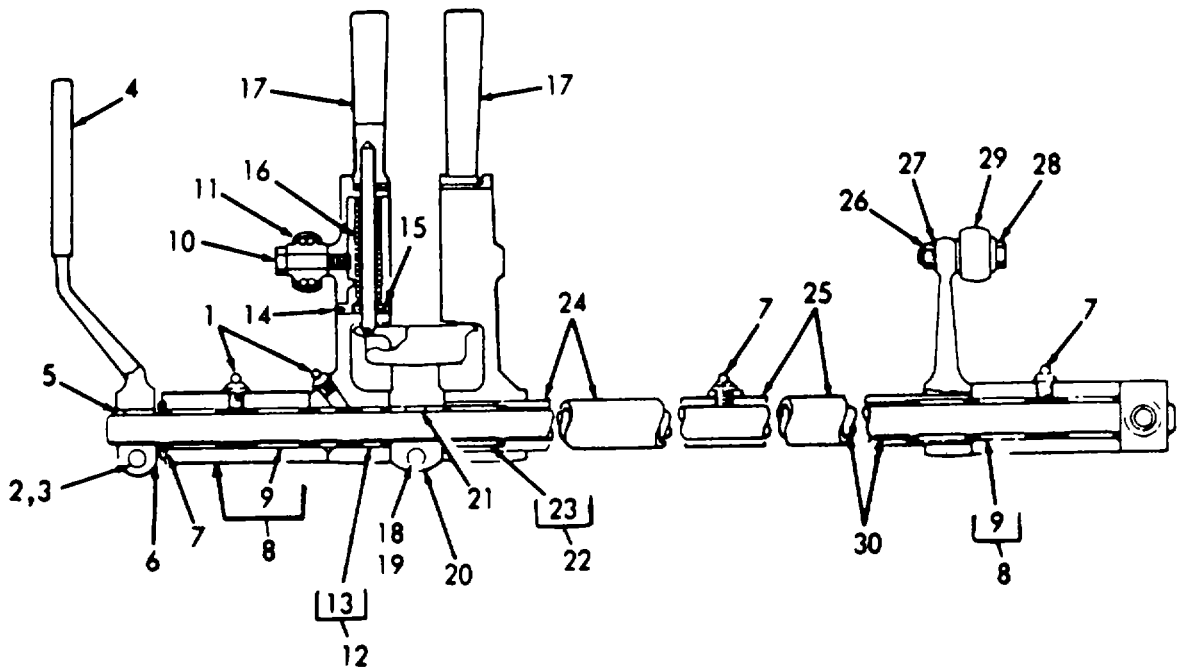
LOCATION/ITEM	ACTION	REMARKS
<u>REMOVAL</u>		
1. Throttle Controls - Engine Room	a. Remove lubrication fittings (1).	If damaged.
	b. Remove capscrews (2), and lockwashers (3) from master throttle control lever.	
	c. Remove master throttle control lever (4).	
	d. Remove Woodruff key (5).	
	e. Remove shaft ring (6), and collar (7).	
	f. Remove bracket assembly (8), and bearing sleeves (9).	If necessary.
	g. Remove machine bolts (10), and throttle control links (11).	
	h. Remove lever assembly (12).	
	i. Remove sleeve bearings (13), grooved pins (14), spacers (15), return springs (16), and handle and pin assemblies (17) from lever assembly (12).	If necessary for replacement.
	j. Remove capscrews (18), and lockwashers (19) from quadrant (20).	
	k. Remove quadrant (20) and Woodruff key (21).	
	1. Remove lever assembly (22) and sleeve bearings (23).	If necessary.

5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

REMOVAL (Cont)

- m. Remove covers (24 and 25).
- n. Remove nuts (26), lockwashers (27), and capscrews (28) from links (29).
- o. Remove throttle control links (29).
- p. Remove cross shaft (30).

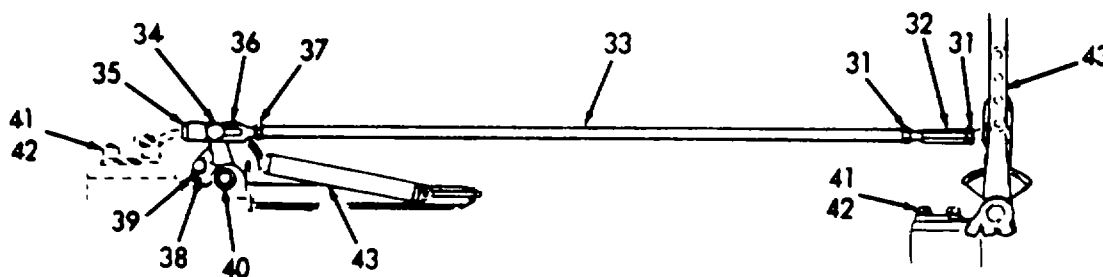


5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

REMOVAL (Cont)

- | | | |
|----|---|--|
| q. | Remove nut (31) and turn-buckles (32) from control rod (33). | Remove other nut (31) from control rod if necessary. |
| r. | Remove cotter pins (34) and straight pins (35). | |
| s. | Remove coupling (36) and throttle control rods (33). | Remove nuts (37) from control rods (33), if necessary. |
| t. | Remove cotter pin (38), straight pin (39), and throttle lever shaft (40). | |
| u. | Remove capscrews (41), and lockwashers (42) from cross shaft bracket. | |
| v. | Remove cross shaft brackets (43). | |



5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

CLEANING**WARNING**

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° - 138°F (38⁺ - 59°C).

- | | | |
|----|---|--|
| 2. | Clean metal parts in cleaning solvent P-D-680 and dry thoroughly. | |
|----|---|--|

INSPECTION

- | | | |
|----|--|--|
| 3. | <ul style="list-style-type: none"> a. Inspect threaded parts for crossed or stripped threads. b. Inspect sleeve bearings for nicks, burrs, flat spots or excessive wear. c. Inspect rods for bends or distortion. d. Inspect lever and bracket assemblies for cracks, breaks, or other damage. | |
|----|--|--|

REPAIR/REPLACEMENT

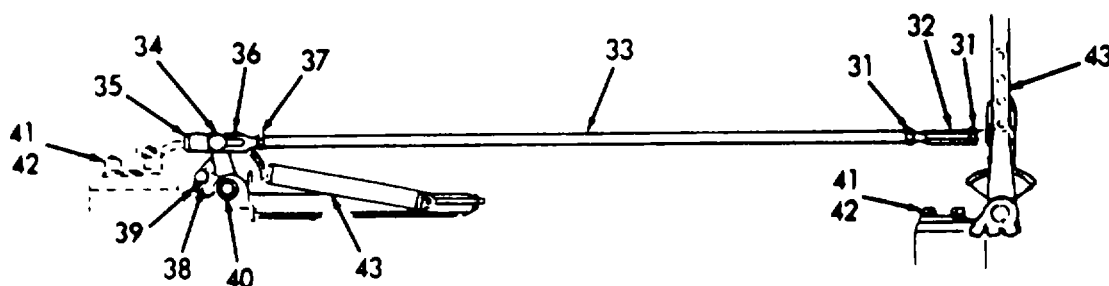
- | | | |
|----|---|--|
| 4. | <ul style="list-style-type: none"> a. Straighten bent or distorted rods. b. Grind any burrs smooth. c. Replace cover gaskets and seals with new ones. d. Replace all other defective parts. | <p>Use new cotter pins.</p> <p>If necessary.</p> |
|----|---|--|

5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

INSTALLATION

- | | | |
|----|---|--|
| 5. | <ul style="list-style-type: none"> a. Install cross shaft brackets (43) using lockwashers (42), and capscrews (41). b. Install throttle lever shaft (40), straight pin (39), and cotter pin (38). c. Install nuts (37) on control rods (33). If removed. d. Install coupling (36) on control rod (33), and install control rods, straight pins (35), and cotter pins (34). e. Install nut (31) on one end of control rod (33). If removed. | |
|----|---|--|



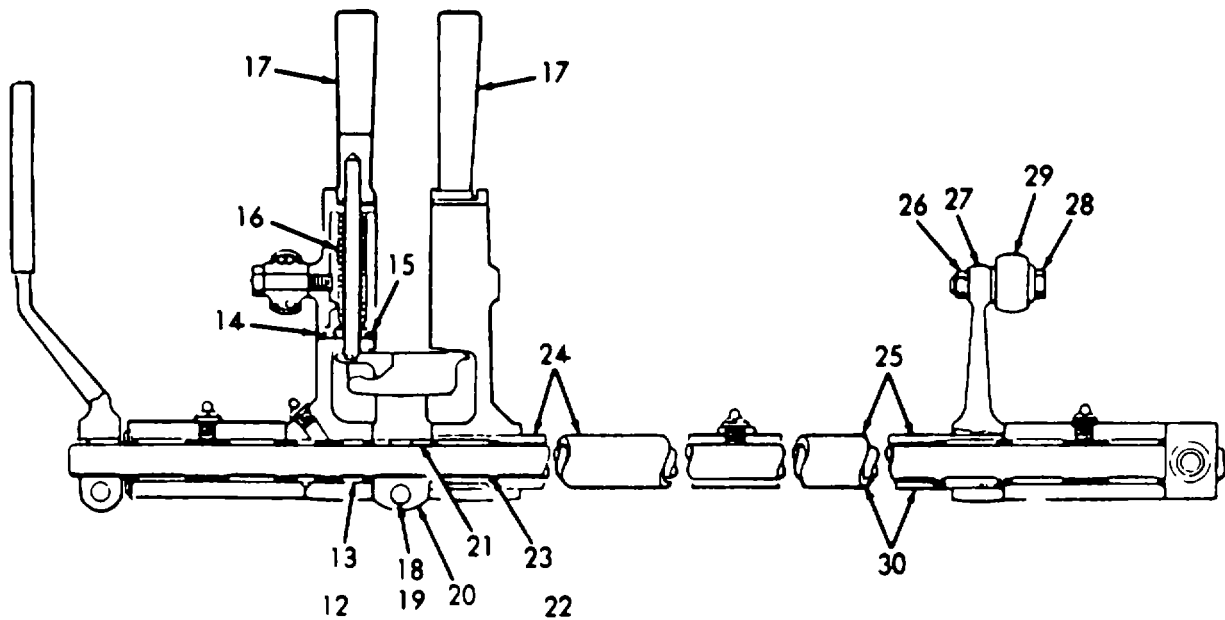
- f. Install turnbuckles (32), nut (31), and cross shaft (30).
- g. Install throttle control links (29) using capscrews (28), lockwashers (27), and nuts (26).

5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

INSTALLATION (Cont)

- | | | |
|----|--|--|
| h. | Install covers (25 and 24) over cross shaft. | |
| i. | Install sleeve bearings (23) in lever assemblies (22). Then install lever assemblies. | If removed. |
| j. | Install Woodruff key (21), and quadrant (20) using lockwashers (19) and cap-screws (18). | |
| k. | Install handle and pin assemblies (17), return springs (16), spacers (15), grooved pins (14), and sleeve bearings (13) in lever assemblies (12). | If any parts were removed for replacement. |

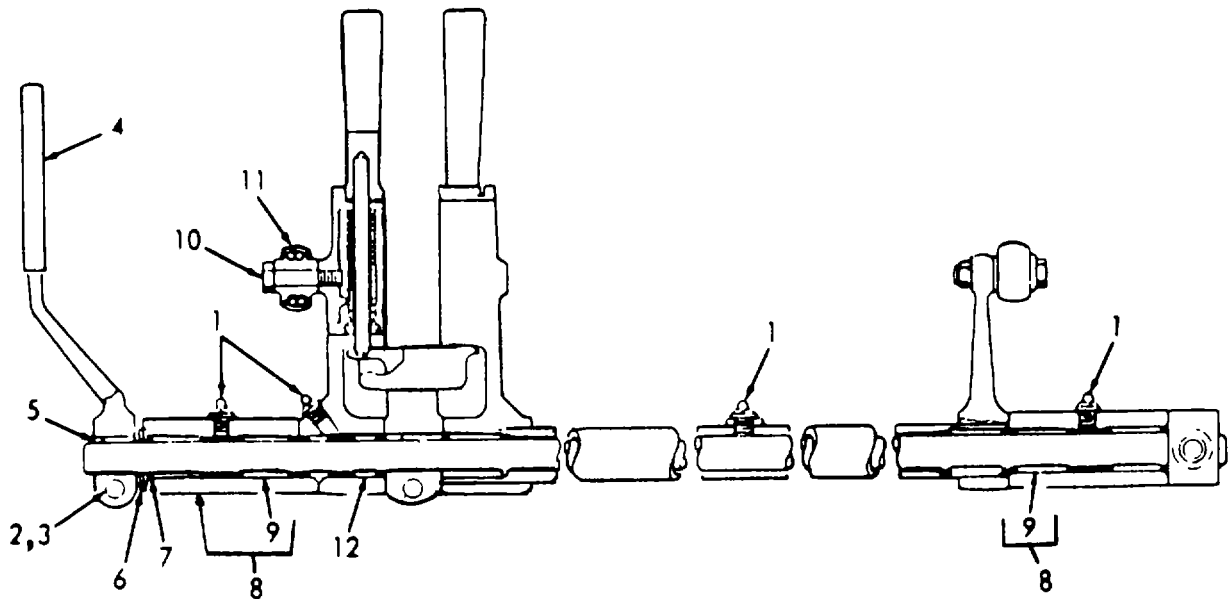


5-20. THROTTLE CONTROLS - ENGINE ROOM (Continued).

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

INSTALLATION (Cont)

- 1. Install lever assemblies (12), throttle control links (11) and bolts (10).
- m. Install sleeve bearings (9) in bracket assembly (8). If removed.
- n. Install collar (7), shaft ring (6), and Woodruff key (5).
- o. Install master throttle control lever (4), lockwashers (3), and capscrews (2).
- p. Install lubrication (1). If removed.



5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSES AND CLAMPS - ENGINE.

This task covers:

- | | |
|----------------|-----------------|
| a. Removal | d. Replacement |
| b. Disassembly | e. Assembly |
| c. Inspection | f. Installation |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment
Condition Condition Description
NONE

Materials/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
MOS 61C10

General Safety Instructions
NONE

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

Removal

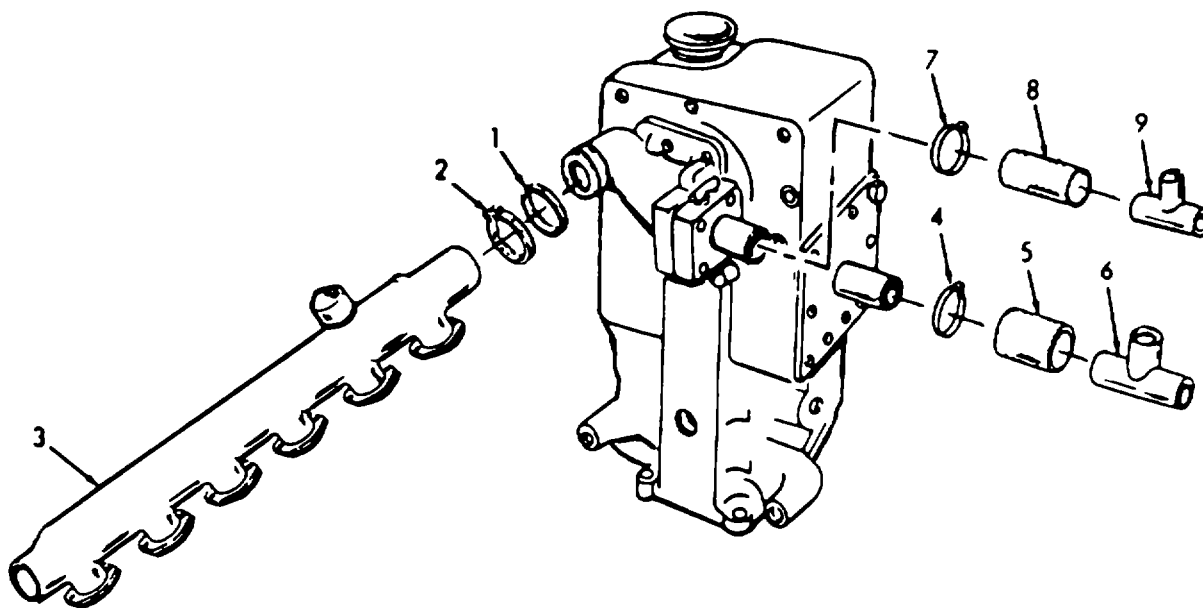
- | | | |
|-------------------|---|--|
| 1. Heat Exchanger | a. Drain cooling system to a level below the cylinder head. | |
|-------------------|---|--|

5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).

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

REMOVAL (Cont)

- b. Loosen thermostat housing clamps (1), and slide the packing (2) and clamp (1) back on water manifold (3).
- c. Loosen hose clamps (4) securing preformed hose (5) to keel cooler tee (6), and inlet cover.
- d. Slide hose clamp (4), and hose (5) off of inlet cover.
- e. Loosen hose clamps (7) securing preformed hose (8) to thermostat housing tee (9) and outlet.



5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS - ENGINE (Continued).

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

REMOVAL (Cont)

f. Slide hose clamps (7) and hose (8) off of thermostat housing outlet.

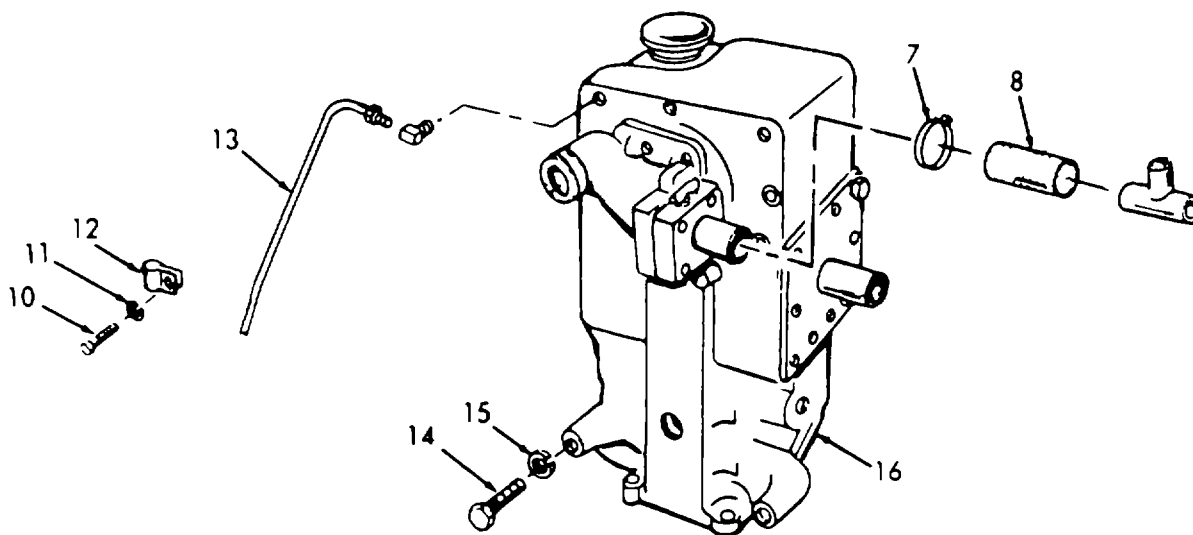
g. Remove capscrews (10), lockwashers (11), and tube clips (12) from overflow tube (13).

h. Remove overflow tube (13).

Unscrew from elbow.

i. Remove sixteen capscrews (14) and lockwashers (15).

j. Remove heat exchanger (16).

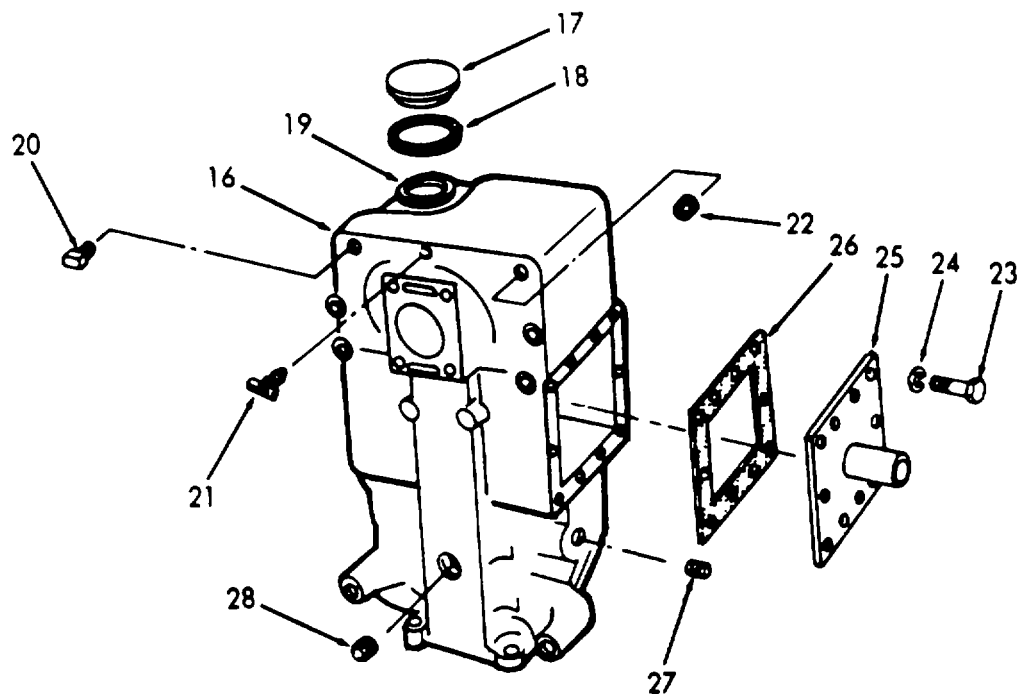


5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS - ENGINE (Continued).

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

DISASSEMBLY

- | | | |
|-------------------|--|---------------------|
| 2. Heat Exchanger | a. Remove cap (17), cap gasket (18), and filler neck (19) from heat exchanger (16). | Discard cap gasket. |
| | b. Remove elbow (20), draincock (21), and pipe plug (22). | |
| | c. Remove machine bolts (23), lockwashers (24), inlet cover (25), and cover gasket (26). | Discard gasket. |
| | d. Remove pipe plugs (27 and 28). | |

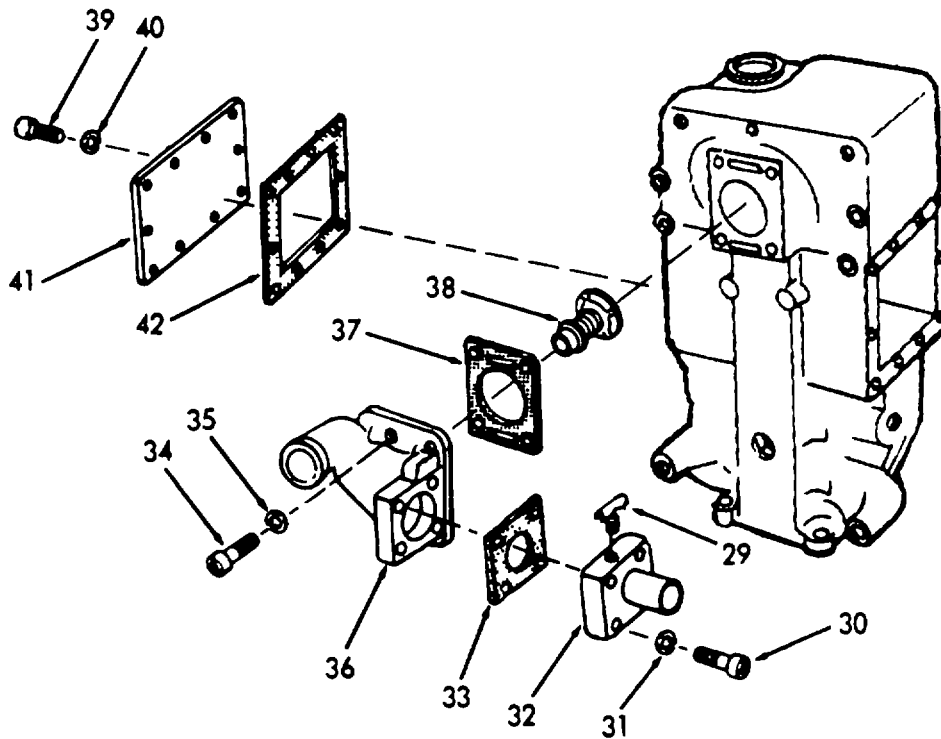


5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).

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

DISASSEMBLY (Cont)

- | | | |
|----|--|-----------------|
| e. | Remove draincock (29) from thermostat housing outlet (32). | |
| f. | Remove capscrews (30), lock-washers (31), outlet (32), and outlet gasket (33). | Discard gasket. |
| g. | Remove capscrews (34), lock-washers (35), thermostat housing (36) and gasket (37). | Discard gasket. |
| h. | Remove thermostat (38) from housing (36). | |
| i. | Remove capscrews (39), lock-washers (40), cover plate (41), and gasket (42). | Discard gasket. |



**5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).**

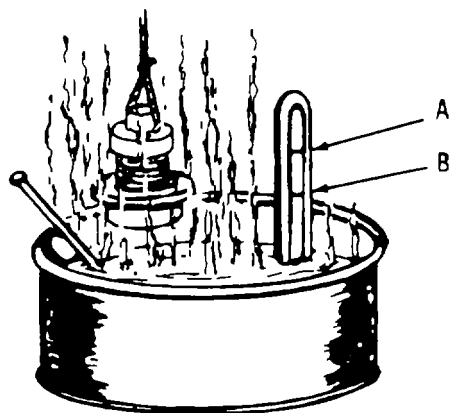
LOCATION/ ITEM	ACTION	REMARKS
<u>INSPECTION</u>		
3.	<ul style="list-style-type: none"> a. Inspect threaded parts for crossed or stripped threads. b. Inspect preformed hose for cracks, breaks, or deterioration. c. Inspect thermostat housing for cracks, breaks, burrs, or other damage. d. Inspect covers for cracks, breaks, or warpage. e. Inspect tank assembly for cracks or breaks. f. Inspect thermostat for rust and corrosion, and for proper operation operation as follows: <ul style="list-style-type: none"> 1. Place thermostat in a container of hot water. 	Discard defective thermostat.

**5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).**

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

INSPECTION (Cont)

2. Insert a thermometer of known accuracy into the water.
3. Thermostat should begin to open at 160°F (71.1°C) and be fully open at 185°F (85.0°C).
4. Remove thermostat and thermometer.
5. Empty water from container.



A - STARTS TO OPEN
B - FULLY OPEN

REPLACEMENT

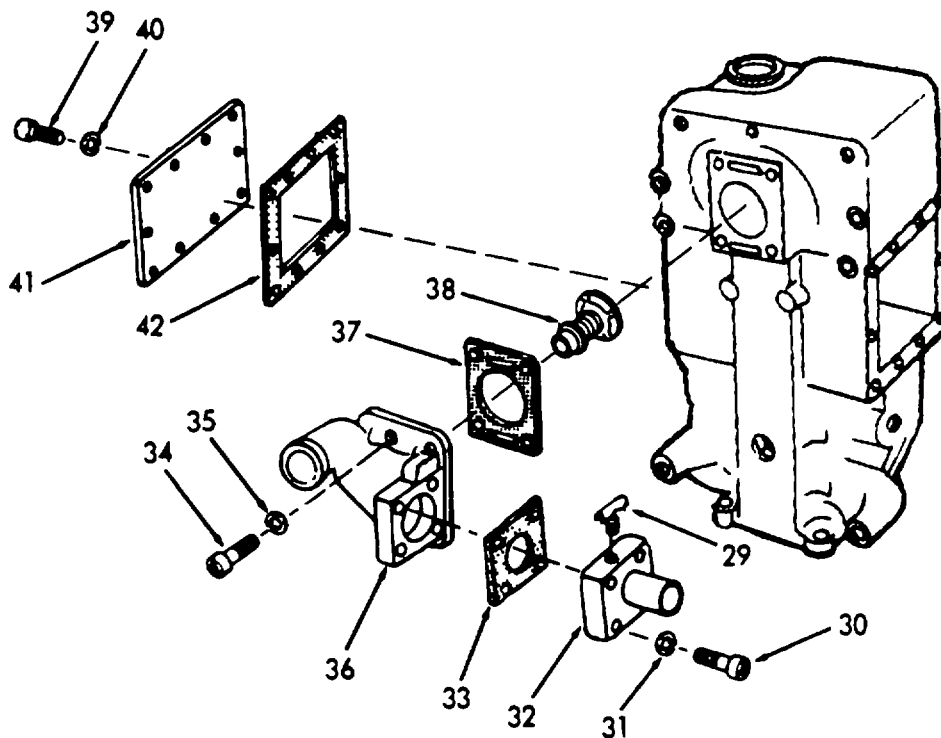
4. Replace defective and damaged parts as required.

5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).

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

ASSEMBLY (Cont)

- | | | |
|-------------------|--|-----------------|
| 5. Heat Exchanger | a. Position cover plate gasket (42) in place on tank assembly (16). | Use new gasket. |
| | b. Install cover (41) with lock-washers (40), and capscrews (39). | |
| | c. Insert thermostat (38) into housing (36). | |
| | d. Position gasket (37) in place on housing. | Use new gasket. |
| | e. Install housing (36) onto tank assembly with lockwashers (35) and capscrews (34). | |

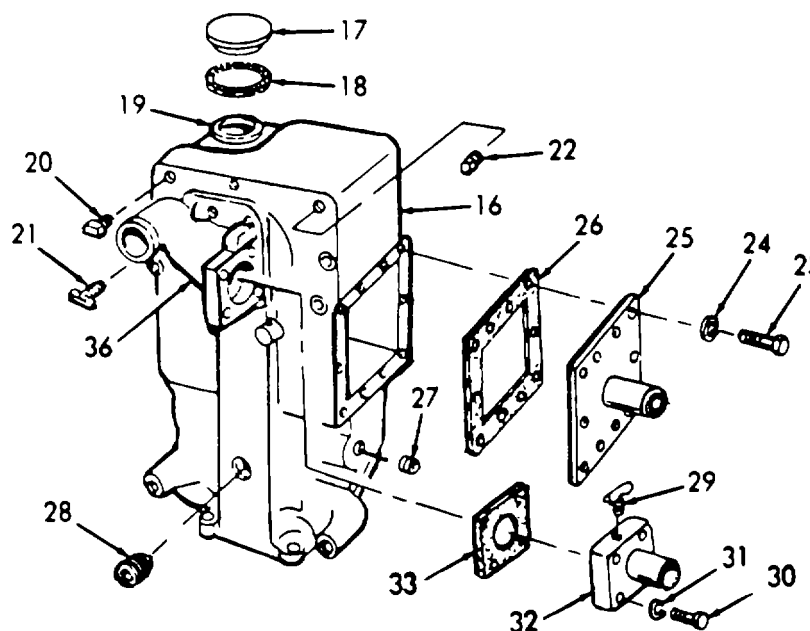


5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).

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

ASSEMBLY (Cont)

- | | |
|--|-----------------|
| f. Position outlet gasket (33) in place on housing (36). | Use new gasket. |
| g. Install outlet (32) onto housing (36) using lockwasher (31) and capscrews (30). | |
| h. Install draincock (29) and pipe plugs (27 and 28). | |
| i. Position inlet cover gasket (26) in place on tank assembly (16). | Use new gasket. |
| j. Install cover (25) using lockwashers (24) and machine bolts (23). | |
| k. Install pipe plug (22), draincock (21), and elbow (20) into housing. | |
| l. Install filler neck (19), cap gasket (18), and filler cap (17). | Use new gasket. |

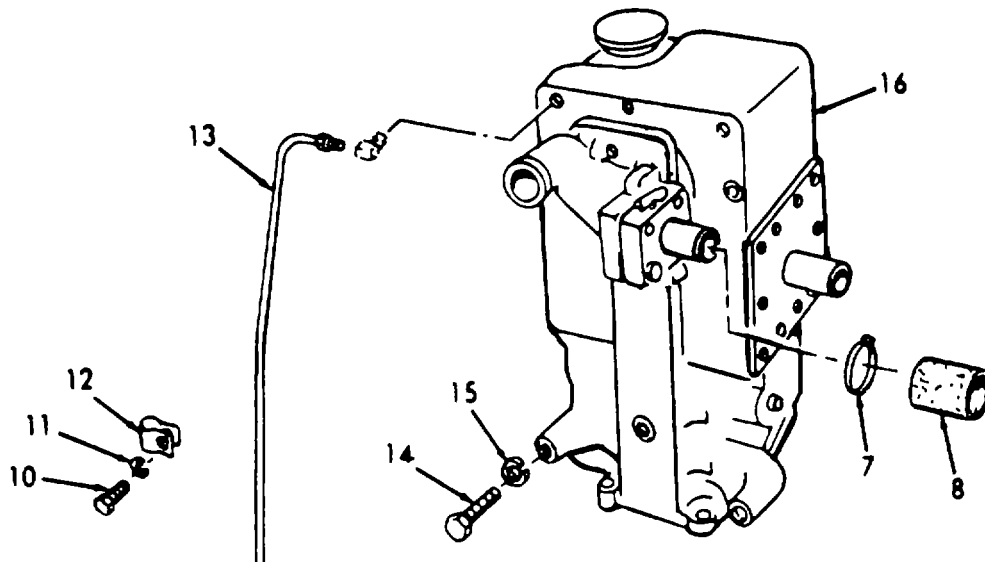


5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS - ENGINE (Continued).

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

INSTALLATION

- | | | |
|-------------------|---|--|
| 7. Heat Exchanger | <ul style="list-style-type: none"> a. Position heat exchanger (16) in place. b. Secure, using sixteen lockwashers (15), and capscrews (14). c. Slide tube clips (12) over overflow tube (13). d. Install overflow tube (13) using lockwashers (11) and capscrews (10). e. Slide hose clamps (7) over hose (8). | |
|-------------------|---|--|

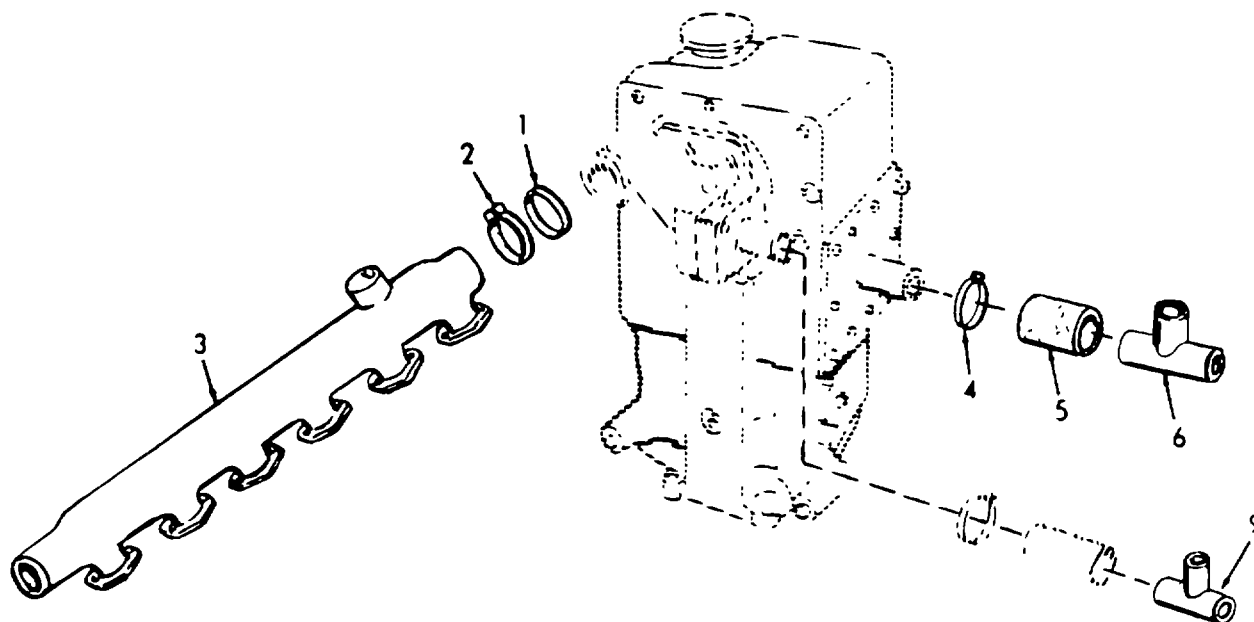


5-21. HEAT EXCHANGER, THERMOSTAT AND HOUSING, HOSES AND CLAMPS -
ENGINE (Continued).

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

INSTALLATION (Cont)

- f. Install hose to thermostat housing outlet tee (9), and housing. Tighten hose clamps.
- g. Slide hose clamps (4) over keel cooler hose (5).
- h. Install hose (5) to keel cooler tee (6), and inlet cover. Tighten hose clamps.
- i. Install packing (2) and clamp (1) to water manifold (3), and thermostat housing.



5-22. ENGINE COOLING PIPING.

This task covers:

Repair/Replace

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783
Welding set
Safety goggles

Equipment
Condition Condition Description
NONE

Materials/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
MOS 61C10, 44B

General Safety Instructions
Observe WARNING in procedure.

5-22. ENGINE COOLING PIPING (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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NOTE

Drain engine cooling system prior to removal of any part requiring repair. Wipe all connections clean before performing maintenance on the piping system.

REPAIR/REPLACE

WARNING

Wear safety goggles when welding to prevent eye injury.

- a. Welding must be done by a qualified welder only.
- b. Weld cracks and breaks in piping and grind smooth.
- c. Replace defective hose and clamps.
- d. Wipe off excess solder when welding copper tubing.
- e. Replace other parts as required.

Repair or replace the following items. If necessary

ITEM	DESCRIPTION
1	Hose Clamp, 2-7/8 Inch
2	Hose, 2-3/8 inch ID
3	Hose Clamp, 2-5/8 Inch
4	Hose, 2-1/8 Inch ID
5	Flax Packing
6	Hose Clamp, 7/8 Inch
7	Hose, 5/8 Inch ID
8	Drain Cock
9	Check Valve
10	Globe Valve
11	Water Gage
12	Check Valve

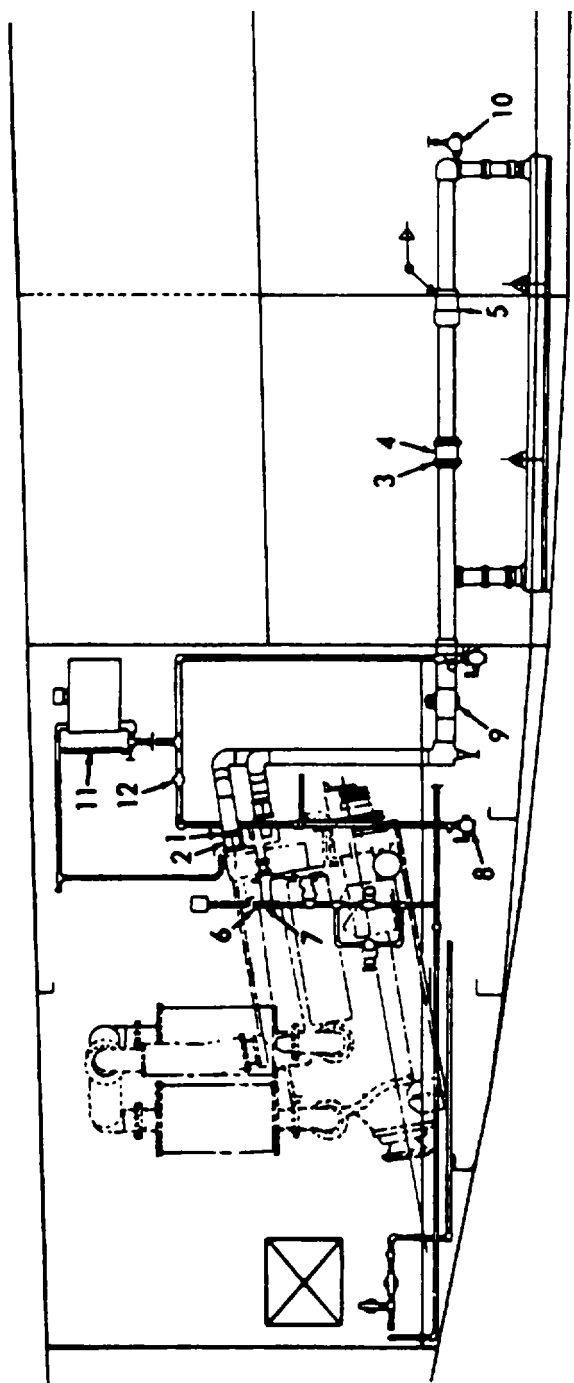
5-22. ENGINE COOLING PIPING (Continued).

LOCATION/ ITEM

ACTION

REMARKS

REPAIR/REPLACE (Cont)



5-23. SEA WATER PIPING

This task covers:

Repair/Replace

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment
Condition Condition Description
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783
Safety goggles
Welding set

Materials/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10, 448

General Safety Instructions

Observe WARNING in procedure.

LOCATION/ ITEM	ACTION	REMARKS
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NOTE

Drain piping system prior to removal of any part requiring repair. Wipe all connections clean before performing maintenance on the piping system.

REPAIR/REPLACE

WARNING

Wear safety goggles when welding to prevent eye injury.

5-23. SEA WATER PIPING (Continued).

LOCATION/ ITEM	ACTION	REMARKS
REPAIR/REPLACE (Cont)		
	<ul style="list-style-type: none"> a. Welding must be done by a qualified welder only. b. Weld cracks and breaks in piping and grind smooth. c. Wipe off excess solder when welding copper tubing. d. Replace defective hose and clamps. 	
	Repair or replace all defective parts.	If necessary.

ITEM	DESCRIPTION
1.	Clamp, Hose: 1 1/16 in., 2 in.
2.	Hose, Rubber: 1 5/16 in., ID, 5 in, lg.
3.	Valve, Globe: Bronze, 125 lbs, 1 in. Tube to 1 in. Pipe
4.	Hose, Rubber: 1 5/8 in ID, 5 in. lg
5.	Clamp, Hose
6.	Hose, Rubber: 7/8 in., ID, 5 in. lg
7.	Cock, Drain: 1/2 in. IPS
8.	Valve, Globe: Bronze, 125 Lbs
9.	Clamp, Hose
10.	Hose, Rubber: 2 1/8 in. ID
11.	Nut, Tube: 1/2 in.
12.	Adapter: 1/2 in. Tube to 3/8 in. IPSM

5-23. SEA WATER PIPING (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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REPAIR/REPLACE (Cont)

ITEM	DESCRIPTION
13.	Clamp, Hose
14.	Hose, Rubber: 2 3/8 in. ID
15.	Packing, Hemp: 1/4 in. SQ
16.	Gasket: Neoprene, 1/16 in. Thk
17.	Valve, Seacox: Bronze, 2 in.
18.	Nut, Hexagon Head: Brass, 5/16-18 NC
19.	Tubing, Copper: Type K Hard, 1 1/2 in. 30 5/8 in. lg.
20.	Elbow: 90 Deg, Street, 3/4 in. Tube
21.	Adapter, Hose: 1/2 in. Tube x 1/2 in. Hose
22.	Coupling, w/Stop: 1 1/2 x 1 1/2 in.
23.	Flange, Pump
24.	Gasket: Raw Water Pump Flange
25.	Elbow, Tube: 90 Deg, 1 1/2 in.
26.	Tee, Reducing, Tube: 2 x 1 1/2 x 1 1/2 in.
27.	Elbow, Tube: 2 in., 90 Deg.
28.	Tee, Reducing, Tube: 2 x 2 x 1/2 in. IPS
29.	Tubing, Copper: Type K Hard, 2 in., 20 3/8 in. lg
30.	Stud, Brass: 5/16-18 NC, 1 1/2 in. lg
31.	Adapter: 2 in. IPSM x 2 in., Tube
32.	Tee, Reducing, Screwed: 2 x 1 1/2 x 2 in. IPS

5-23. SEA WATER PIPING (Continued).

LOCATION/ ITEM	ACTION	REMARKS
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REPAIR/REPLACE (Cont)

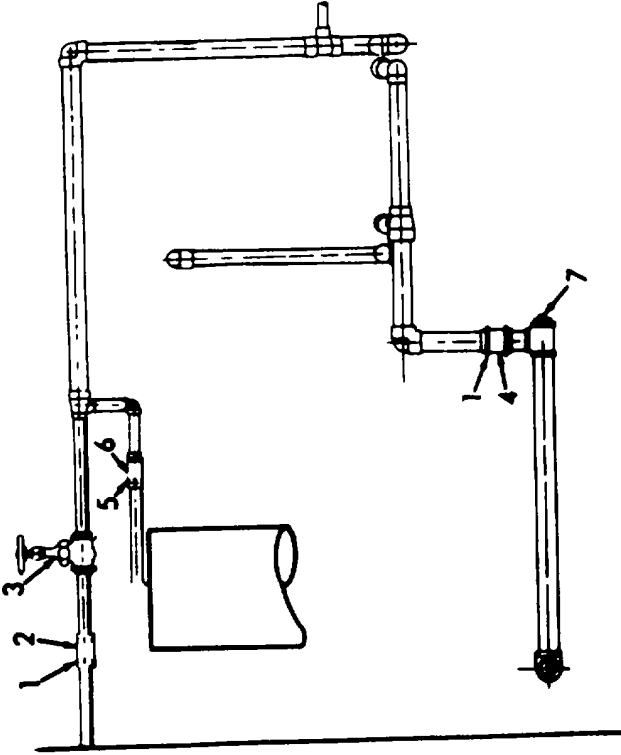
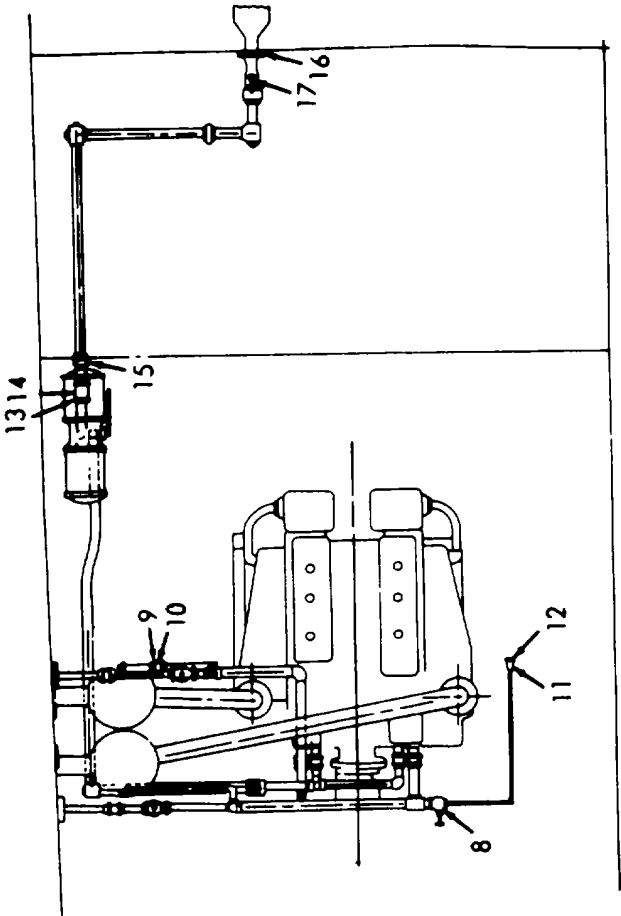
ITEM	DESCRIPTION
33.	Pipe, Brass: 2 in., 40 5/8 in. lg
34.	Cock, Pet Bronze w/8s Wrench
35.	Valve, Hose: w/Cap and Chain, 1 1/2 IPS x 1 1/2 in. Hose
36.	Nipple, Close, Brass: 1 1/2 in. IPS
37.	Nipple, Long: Schedule 40, 2 1/2 IPS x 2 1/2 in. lg, Brass
38.	Cap, Pipe: 150 Lbs, Screwed, 2 1/2 in. IPS
39.	Plug, Square Head: 1/2 in., Brass
40.	Connector, w/Flange: 2 in. NPT x 2 in. Tube
41.	Tubing, Copper: Type K Soft, 3/8 in., 30 3/8 in., lg
42.	Flange, Pump
43.	Coupling, w/stop: 1 1/2 x 1/2 in. Tube
44.	Adapter, Male: IPS, 1/2 Tube x 3/8 in. IPSM
45.	Tee, Reducing, Tube: 1 1/2 x 1 1/2 x 1/2 in.
46.	Tubing, Copper: Type K Hard, 1 in., 15 3/8 in. lg
47.	Tee, Reducing, Tube: 1 1/2 x 1 x 3/4 in.
48.	Nipple, Brass: Schedule 40, 1 in., IPS X 8 in., lg
49.	Nipple, Thread One end, Schedule 40, 1 in., IPS
50.	Tubing, Copper: Type K Hard, 3/4 in., 15 3/8 in. lg
51.	Elbow: 90 Deg, 3/4 Tube x 3/4 in. IPSM

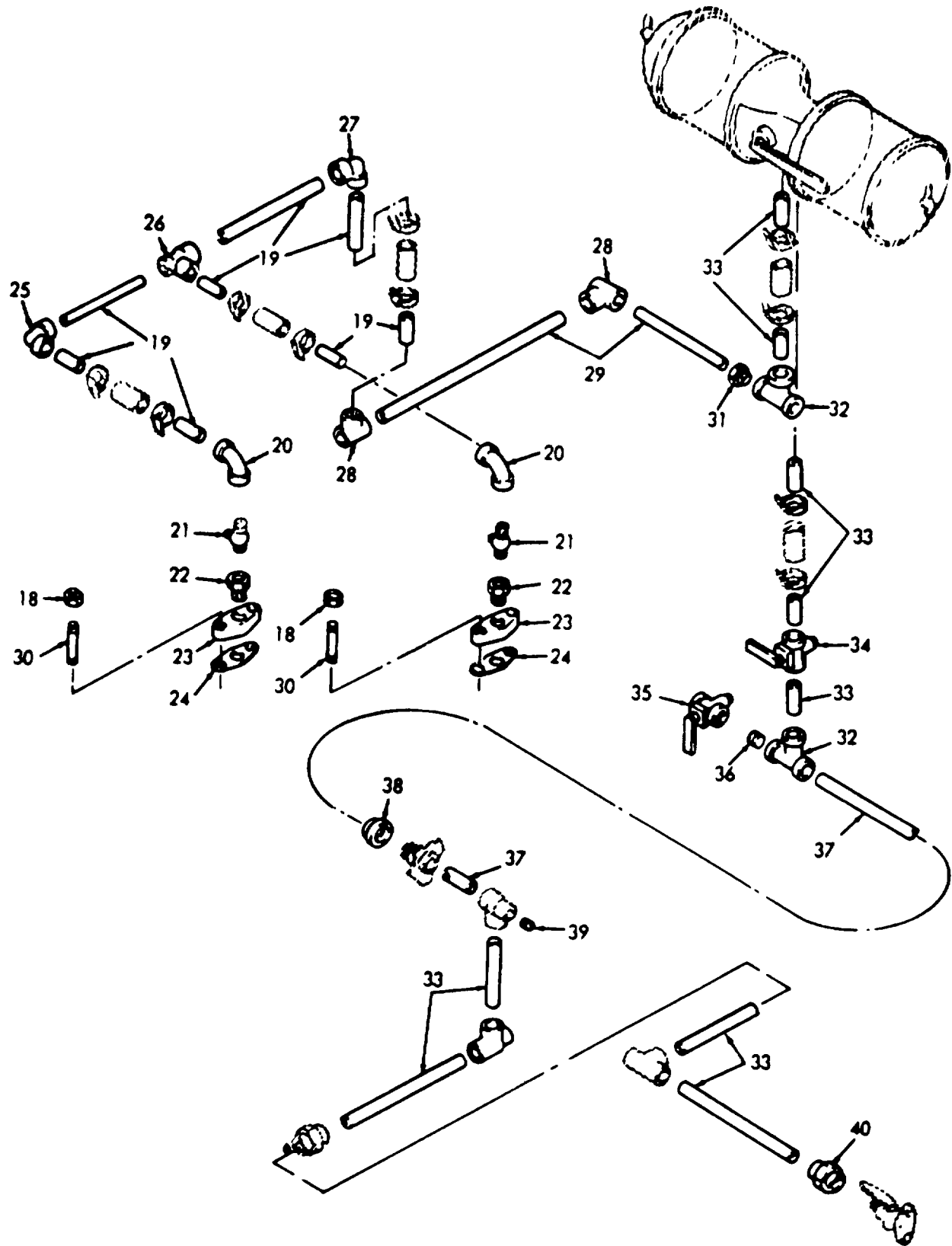
5-23. SEA WATER PIPING (Continued).

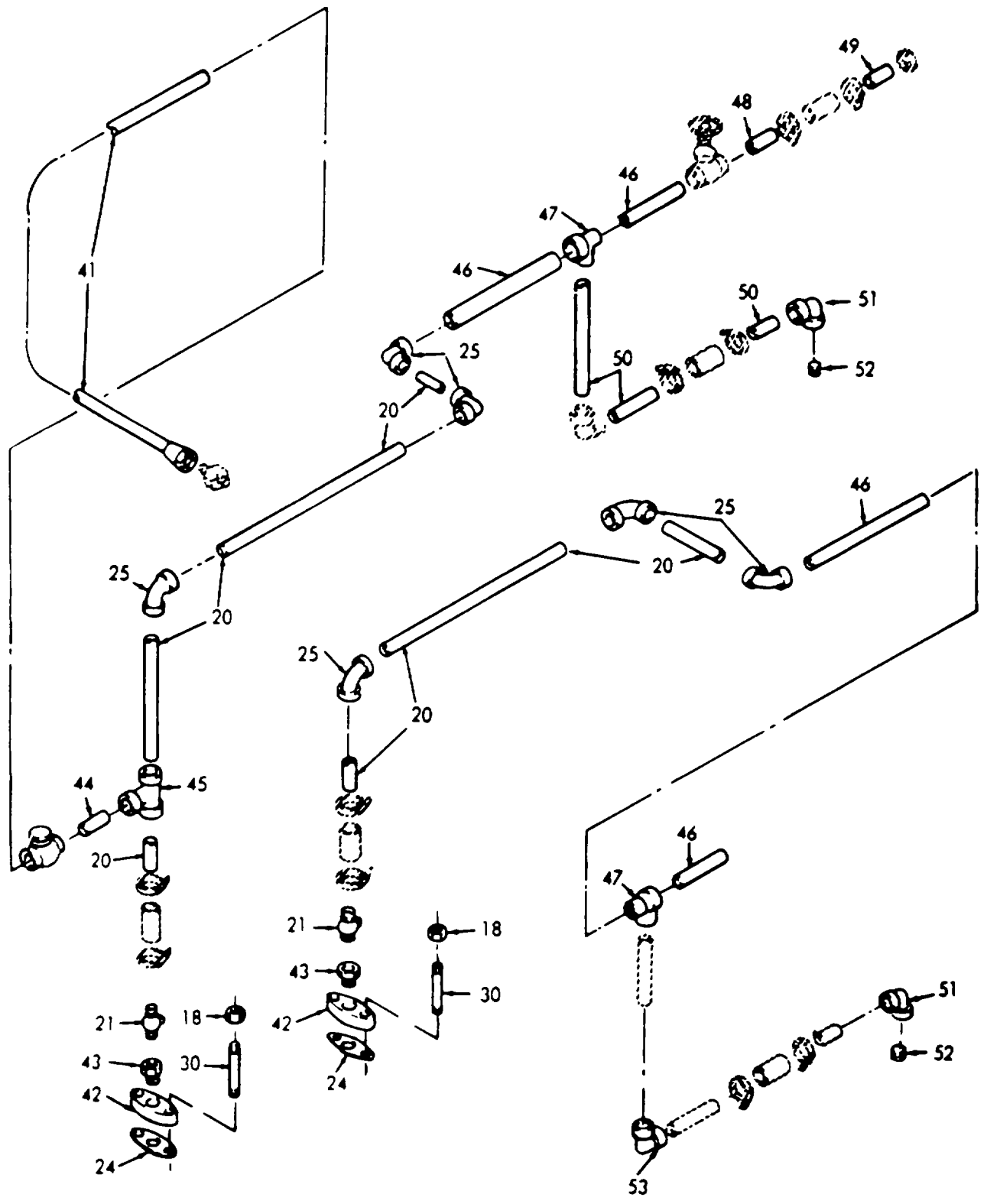
LOCATION/ ITEM	ACTION	REMARKS
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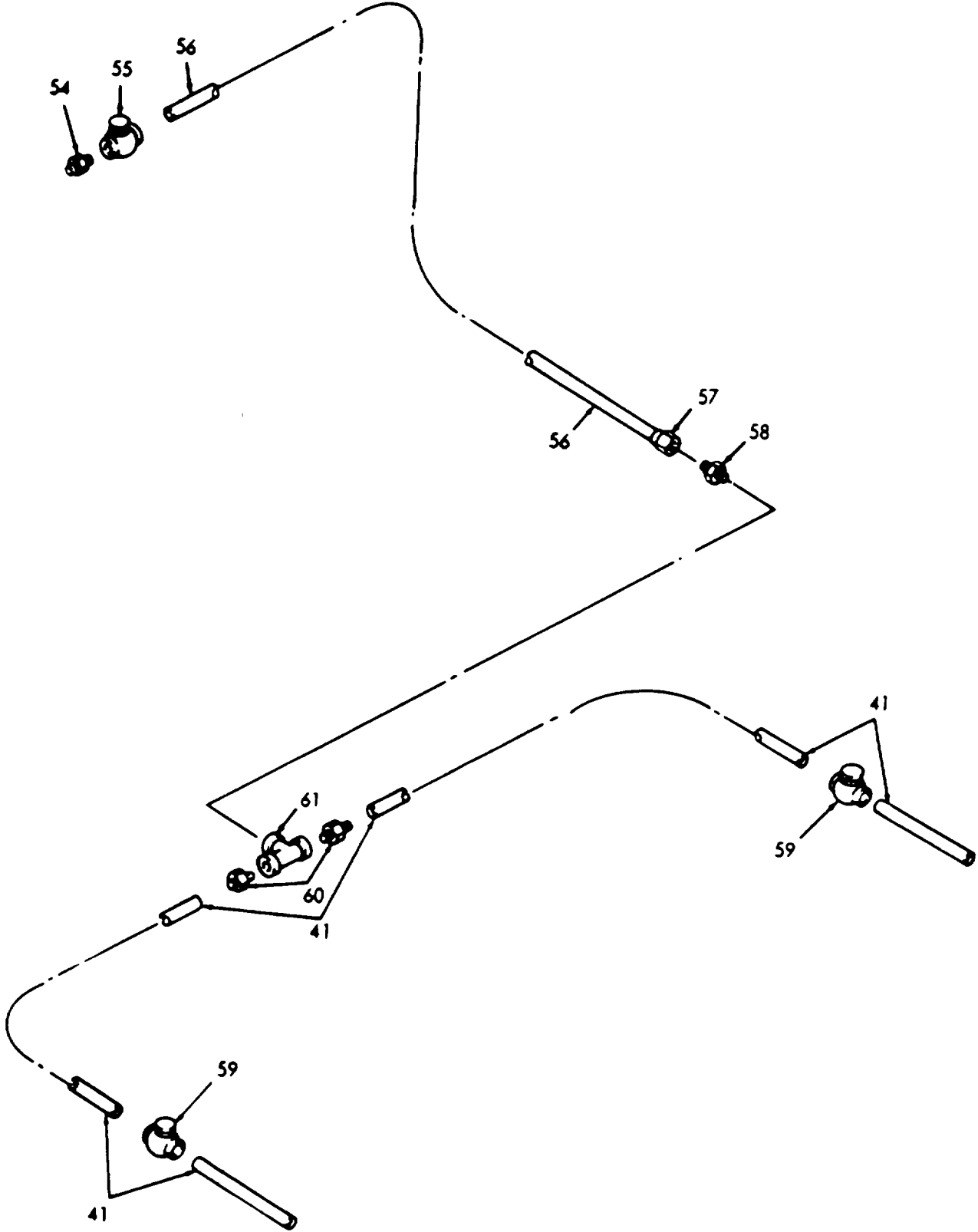
REPAIR/REPLACE (Cont)

ITEM	DESCRIPTION
52.	Nipple, Close, Brass: 3/4 in. IPS
53.	Elbow: 90 Deg, 3/4 in. Tube
54.	Adapter, Male: IPS, 1/2 in. Tube x 1/2 in. IPSM
55.	Valve, Globe: 3/8 in. Tube
56.	Tubing, Copper: Type K Soft, 1/2 in., 20 3/8 in. lg
57.	Nut, Tube: 3/8 in.
58.	Connector, Male: 3/8 in. Tube x 1/2 in. IPSM
59.	Valve, Globe: 45 Deg. Flare, 3/8 in. Tube
60.	Connector, Male: 1/2 in. Tube x 1/2 in. IPSM
61.	Tee: 125 Lbs, Screwed, 1/2 in. IPS, Bronze









5-24. MUFFLER AND EXHAUST PIPING.

This task covers:

- a. Removal
- b. Repair
- c. Replace/Repair
- d. Installation

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools
NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783
Welding set
Protective clothing
Respirator
Safety goggles

Equipment
Condition Condition Description
NONE

Materials/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required

MOS 61C10, 44E

General Safety Instructions

Observe WARNING in procedure.

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

WARNING

- ALL PIPING AND EXHAUST LINES SHALL BE TREATED AS BEING INSULATED WITH ASBESTOS MATERIAL. PROTECTIVE CLOTHING AND RESPIRATORS SHALL BE WORN AT ALL TIMES WHEN HANDLING SUSPECT ASBESTOS-COVERED PIPING AND EXHAUST LINES.
- IF ENGINES HAVE BEEN RUNNING, MAKE SURE EXHAUST SYSTEM HAS COOLED SUFFICIENTLY PRIOR TO PERFORMING ANY MAINTENANCE. IMPROPER HANDLING COULD RESULT IN SERIOUS BURNS TO PERSONNEL.

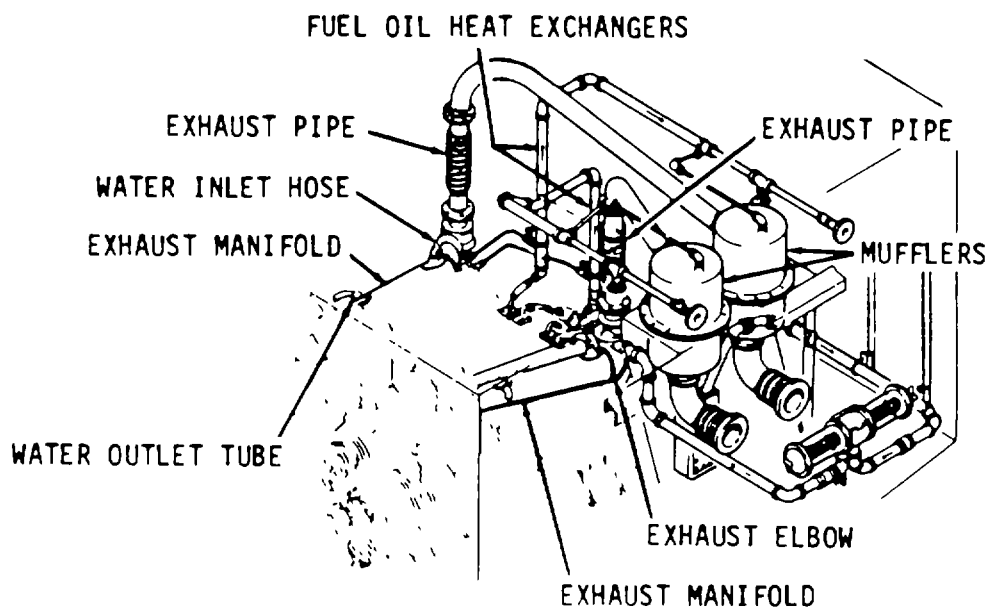
5-24. MUFFLER AND EXHAUST PIPING (Continued).

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

REMOVAL

- | | | |
|----|---|----------|
| 1. | a. Remove asbestos covering from mufflers and piping.

b. Disconnect piping from top of mufflers. | If used. |
|----|---|----------|

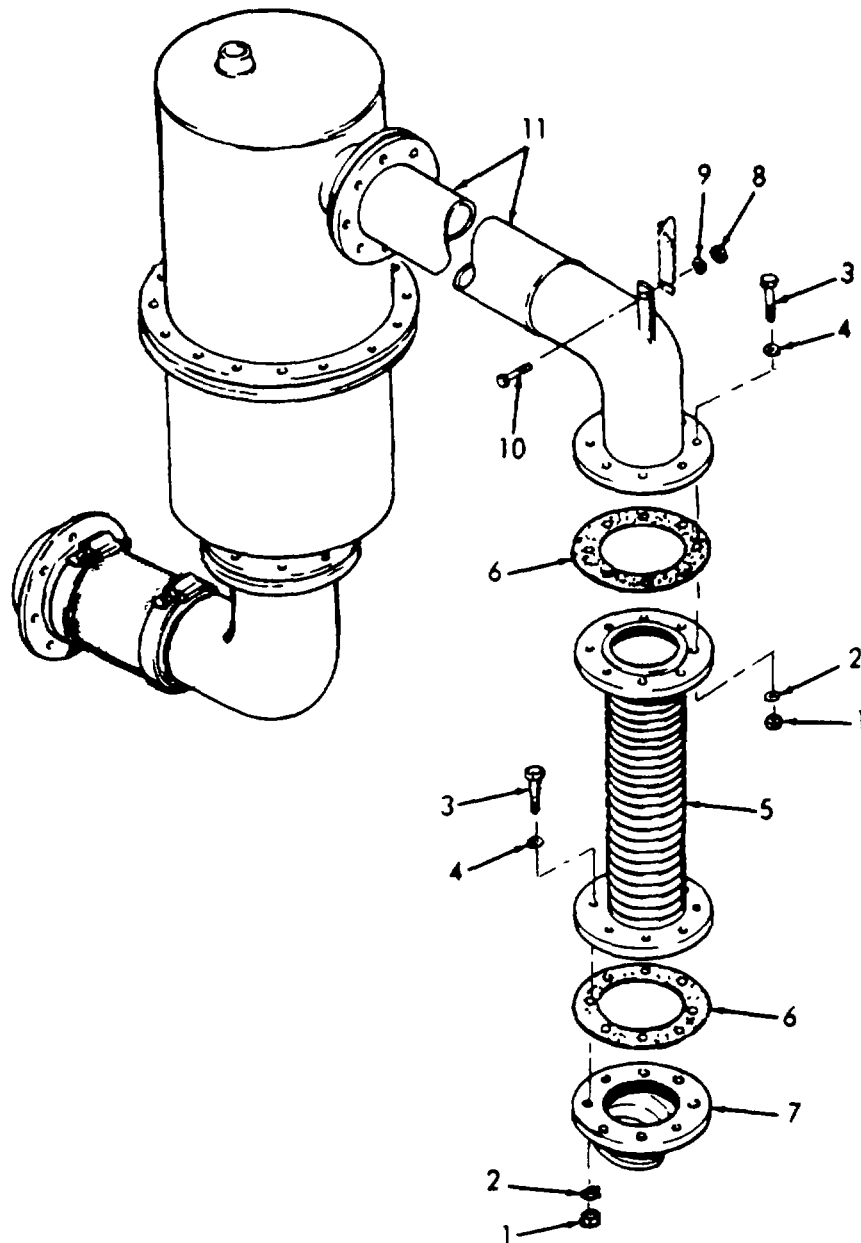


- | | |
|---|-----------------|
| c. Remove nuts (1), lockwashers (2), capscrews (3), and flatwashers (4) from flexible connection (5). | |
| d. Remove flexible connection (5) and gaskets (6). | Discard gasket. |
| e. Remove connector assembly (7). | Unscrew. |
| f. Remove hex nuts (8), lockwashers (9), and capscrews (1Q) from pipe assembly (11). | |

5-24. MUFFLER AND EXHAUST PIPING (Continued).

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

REMOVAL (Cont)



5-24. MUFFLER AND EXHAUST PIPING (Continued).

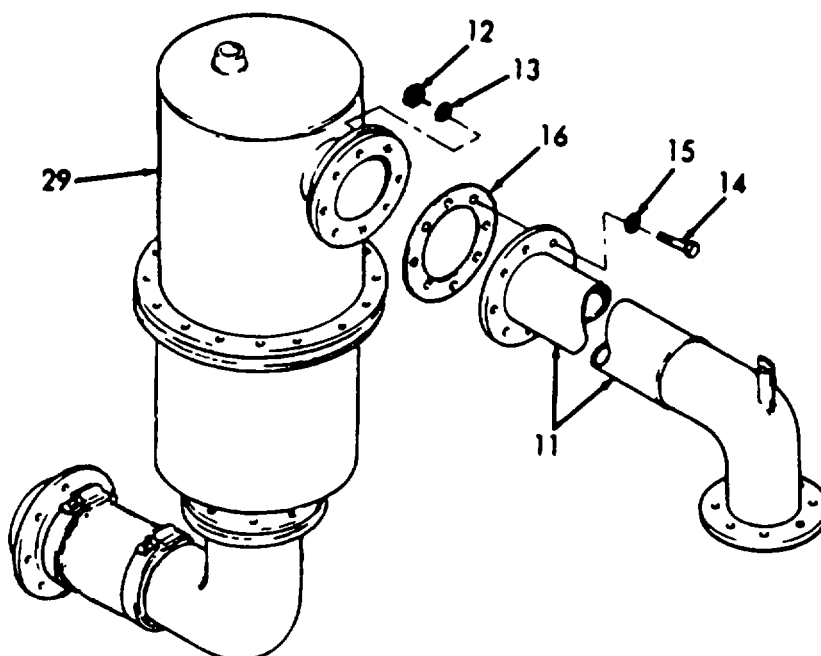
LOCATION/ ITEM	ACTION	REMARKS
----------------	--------	---------

REMOVAL (Cont)

g. Remove nuts (12), lockwashers (13), capscrews (14), and flatwashers (15) securing pipe assembly (11) to muffler (29).

h. Remove pipe assembly (11) and gasket (16).

Discard gasket.



i. Loosen hose clamps (17), and remove hose (18) and clamps from elbow assembly (19).

j. Remove capscrews (20), flatwashers (21), overboard connector (22), and gasket (23). Discard gasket.

k. Remove nuts (24), lockwashers (25), and capscrews (26).

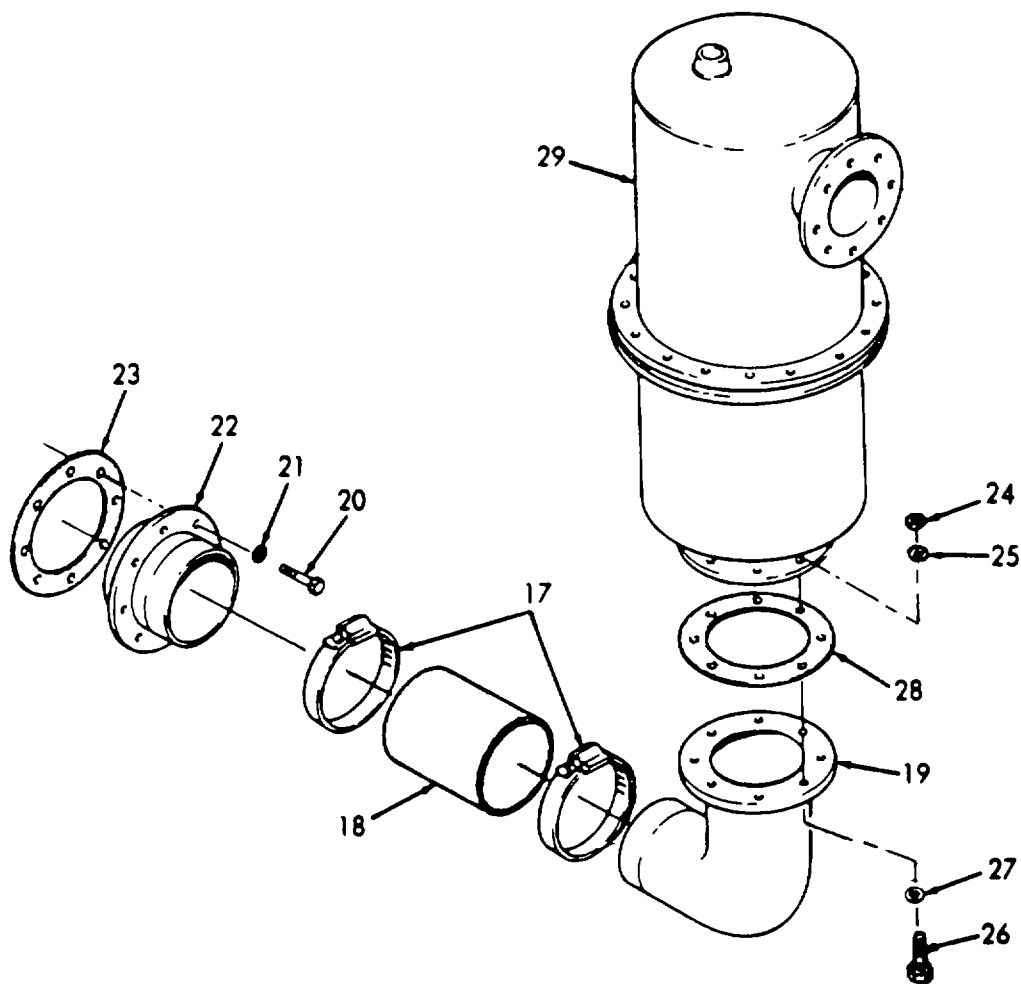
5-24. MUFFLER AND EXHAUST PIPING (Continued).

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

REMOVAL (Cont)

1. Remove flatwashers (27), gas- Discard gasket.
ket (28) and elbow assembly
(19) from muffler (29).

- m. Remove muffler (29).



5-24. MUFFLER AND EXHAUST PIPING (Continued).

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

INSPECTION

- | | | |
|----|---|--|
| 2. | <ul style="list-style-type: none"> a. Inspect muffler assembly for burned out condition, cracks, warpage or other damage. b. Inspect threaded parts for thread damage. c. Inspect hose clamps for cracks or rust. d. Inspect hose for cracks, breaks, or deterioration. e. Inspect flexible connection for cracks, breaks and deterioration. | |
|----|---|--|

REPAIR/REPLACE

3.

WARNINGS

When welding, safety goggles must be worn to prevent eye injury.

NOTE

Welding must be done by a qualified welder only.

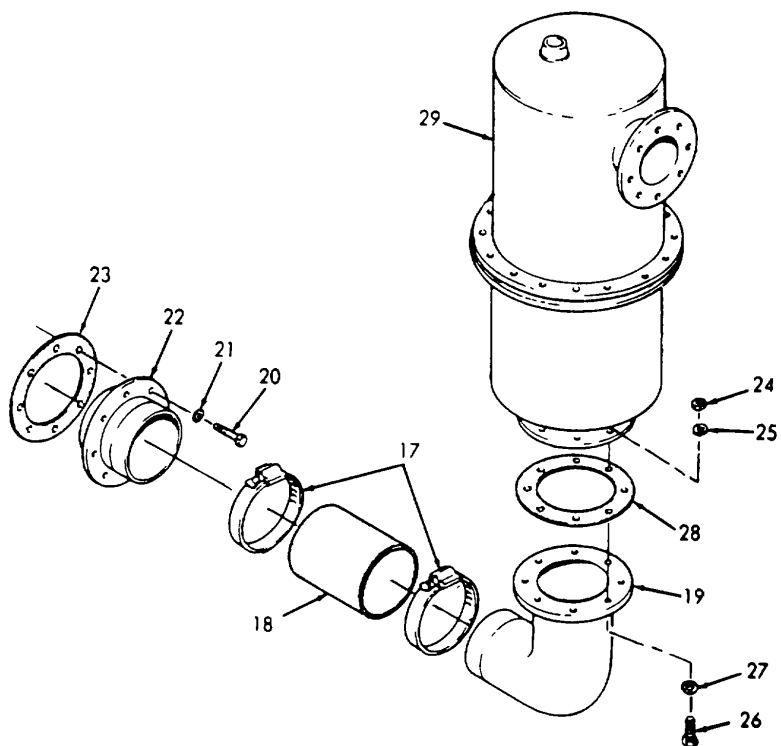
- a. Weld cracks or breaks and grind smooth.
- b. Replace defective hose and hose clamps.
- c. Replace other defective parts as necessary.

5-24. MUFFLER AND EXHAUST PIPING (Continued).

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

INSTALLATION

- | | | |
|----|--|-----------------|
| 4. | <p>a. Install elbow assembly (19) and gasket (28) to muffler assembly (29) using flatwashers (27), capscrews (26), lockwashers (25), and nuts (24).</p> <p>b. Position overboard connector gasket (23) in place.</p> <p>c. Install overboard connector (22) using flatwashers (21), and capscrews (20).</p> <p>d. Slide hose clamps (17) over hose (18).</p> | Use new gasket. |
|----|--|-----------------|

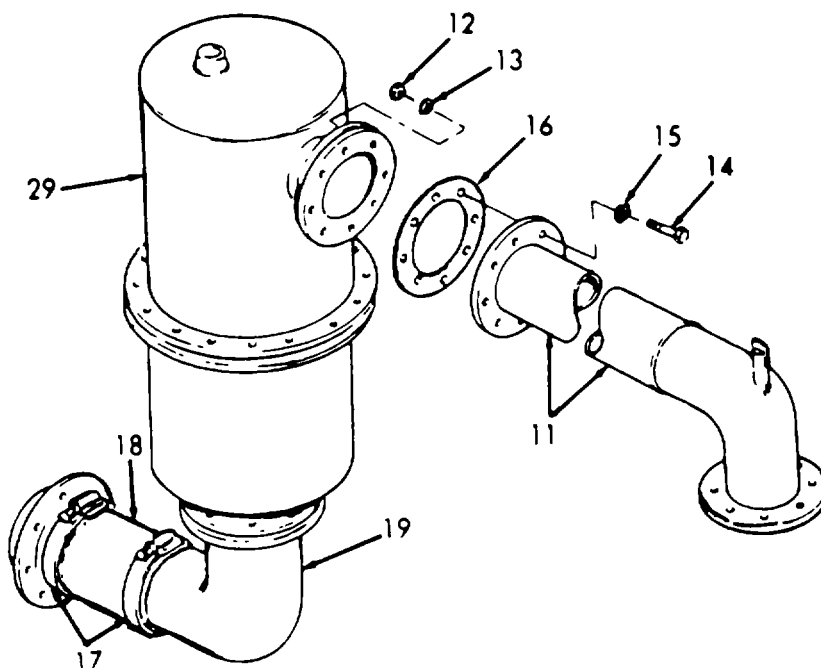


5-24. MUFFLER AND EXHAUST PIPING (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

- e. Install hose (18) to elbow assembly (19).
- f. Tighten hose clamps (17).
- g. Position pipe assembly gasket (16) in place. Use new gasket.
- h. Install pipe assembly (11) to muffler (29) with flatwashers (15), capscrews (14), lockwashers (13), and nuts (12).



- i. Secure pipe assembly (11) to bracket with capscrews (10), lockwashers (9), hex nuts (8).
- j. Install connector assembly (7).

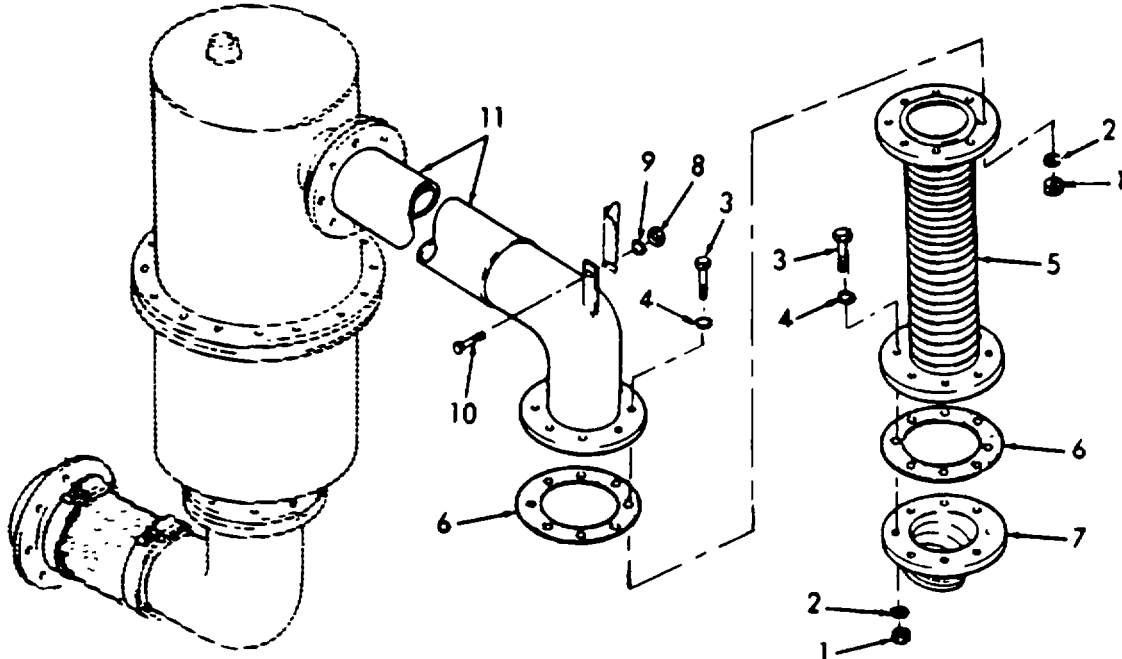
5-24. MUFFLER AND EXHAUST PIPING (Continued).

LOCATION/ITEM	ACTION	REMARKS
INSTALLATION (Cont)	<p>k. Position flexible connection gaskets (6) in place.</p> <p>l. Position flexible connection (5) in place.</p> <p>m. Secure with flatwashers (4), capscrews (3), lockwashers (2), and nuts (1).</p> <p>n. Reconnect piping to mufflers.</p>	Use new gaskets.

WARNING

Treat all piping and exhaust lines as being insulated with asbestos material. Protective clothing and respirators shall be worn at all times when handling asbestos-covered piping and exhaust lines.

- o. Install asbestos covering. If used.



5-25. FRESH WATER PUMP.

The fresh water pump circulates coolant through the cylinder block, cylinder head, heat exchanger (keel cooler), oil coolers, and exhaust manifold. The pump is mounted on the front end of the blower and is driven by the lower blower rotor shaft. The sealed-type ball bearing is filled with lubricant at the time it is assembled to the pump shaft and no further lubrication is required.

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |
-

INITIAL SETUP**Test Equipment**

NONE

References

NONE

Special Tools

Drive Coupling Remover
J1930
Water Pump Wrench J4242

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Arbor press

Equipment**Condition Condition Description**

NONE

Materials/Parts

Liquid soap
Cleaning solvent Fed.
Spec. P-D-680
Sealant
Parts kit 5193605 (72582)
Repair kit 5198307 (72582)

Special Environmental Conditions

NONE

Personnel Required

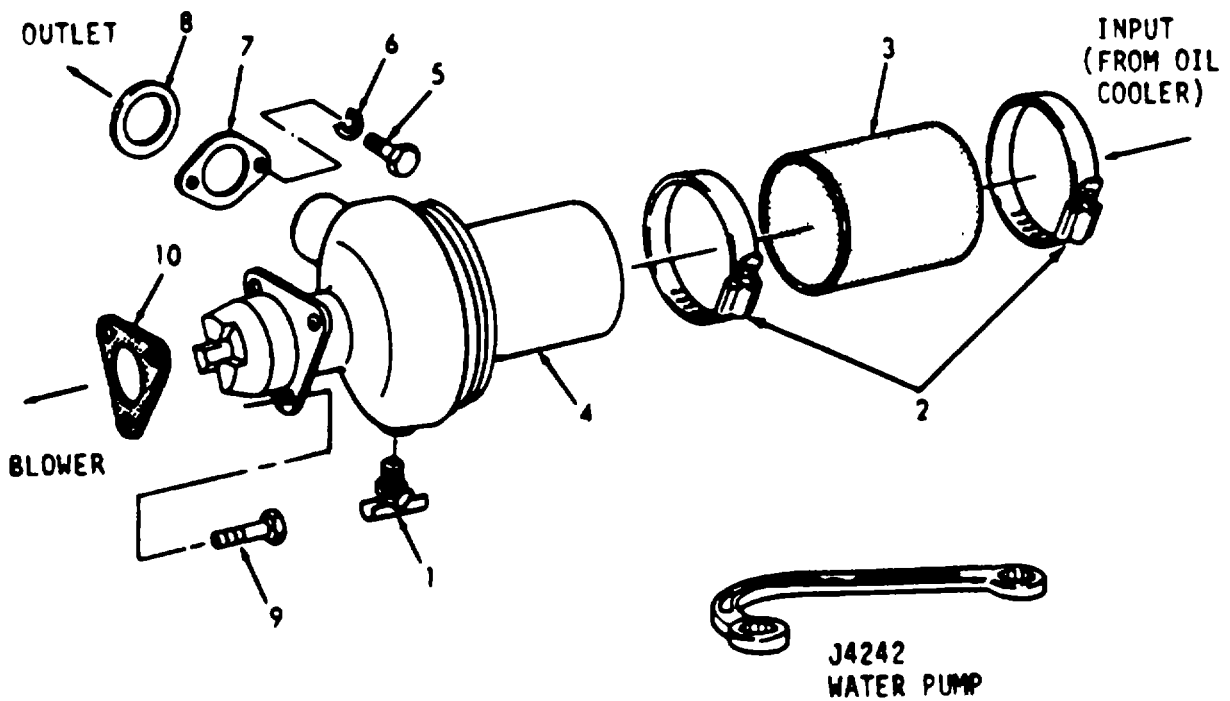
MOS 61C10

General Safety Instructions

Observe WARNINGS and CAUTIONS
in procedure.

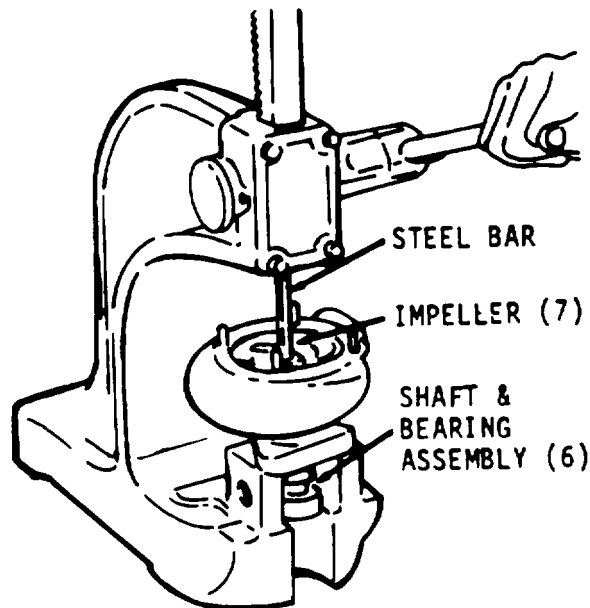
5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
REMOVAL		
1. Water Pump	<p>a. Open drain cock (1) and drain cooling system.</p> <p>b. Loosen hose clamps (2) and slide hose (3) back against pump (4).</p> <p>c. Remove bolts (5), lockwashers (6), outlet flange (7), and preformed packing (8).</p> <p>d. Remove bolt and seal assemblies (9) attaching pump to blower. Use tool J4242.</p> <p>e. Remove water pump (4) and mounting gasket (10).</p>	



5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>		
2. Water Pump	<p>a. Remove hex nuts (1) and lockwashers (2) from pump cover (3).</p> <p>b. Remove pump cover (3) and cover gasket (4) from pump body (5).</p> <p>c. Support pump on its mounting flange in an arbor press. Place a short steel bar on the shaft, and separate the shaft and bearing assembly (6) from the impeller and seal assembly (7) and pump body (5).</p>	<p>Discard gasket.</p> <p>Pin (8) will shear.</p>

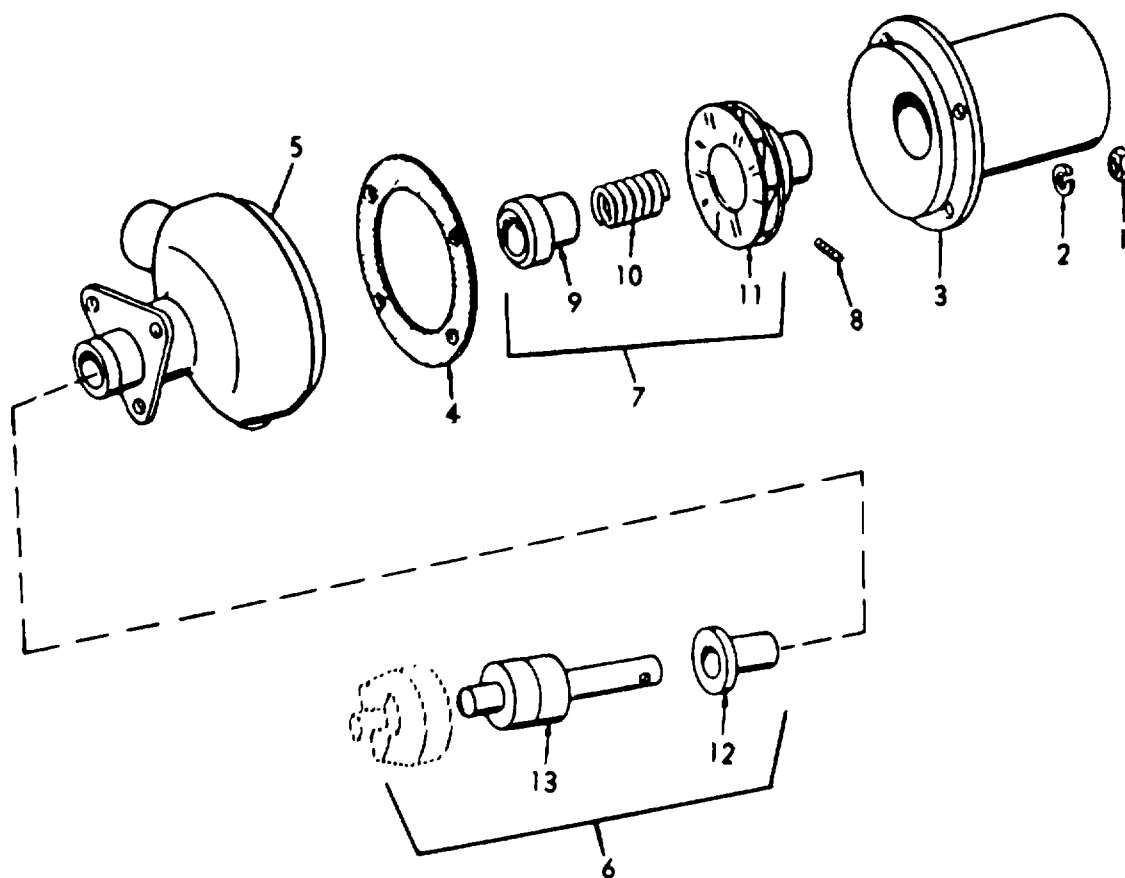


5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- d. Remove impeller and seal assembly (7) from pump body (5).
- e. Remove seal assembly (9) and spring (10) from impeller (11).
- f. Remove sheared pin (8) from impeller (11).
- g. Tap or press slinger (12) off shaft and bearing assembly (13).



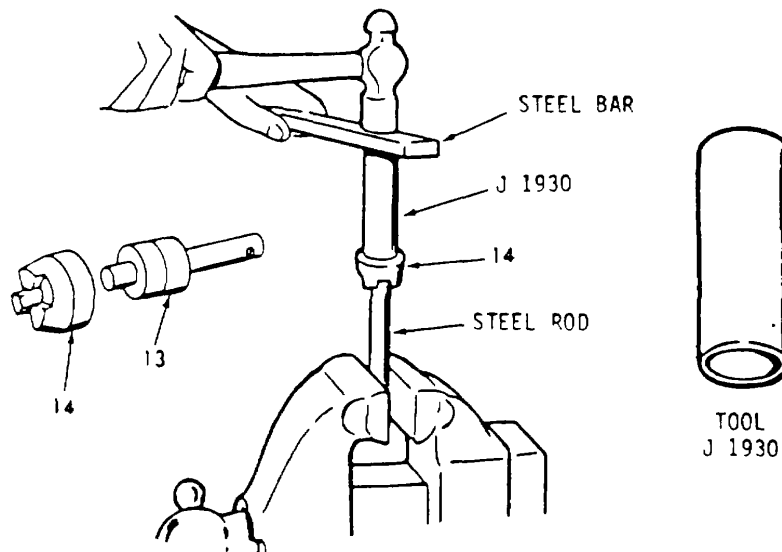
5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- h. Remove drive coupling (14) from shaft and bearing assembly (13) using a steel rod clamped in a vise and tool J1930.

If necessary.
Use tool J1930.

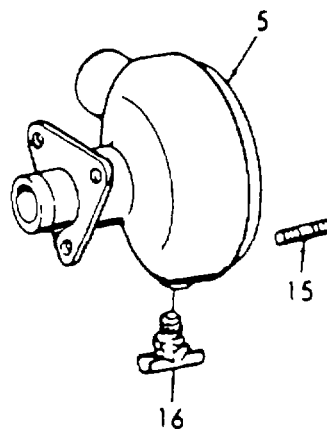


- i. Remove studs (15) from pump body (5).

If damaged.

- j. Remove draincock (16).

If damaged.



5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING

4.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° - 138°F (38° - 59° C).

CAUTION

The sealed-type pump shaft and bearing must not be immersed in cleaning solvent since dirt may be washed in, and the fluid cannot be entirely removed.

Clean parts in cleaning solvent
P-D-680 and dry thoroughly.

INSPECTION

5.

- a. Inspect impeller for nicks, chips, cracks or breaks.
- b. Inspect threaded parts for crossed or stripped threads.
- c. Inspect body for cracks or breaks.
- d. Inspect cover for cracks or breaks.
- e. Inspect spring for cracks or loss of tension.
- f. Inspect pump shaft bearing for rough spots by rotating by hand.
- g. Inspect coupling for burrs, nicks, or cracks.

5-25. FRESH WATER PUMP (Continued).

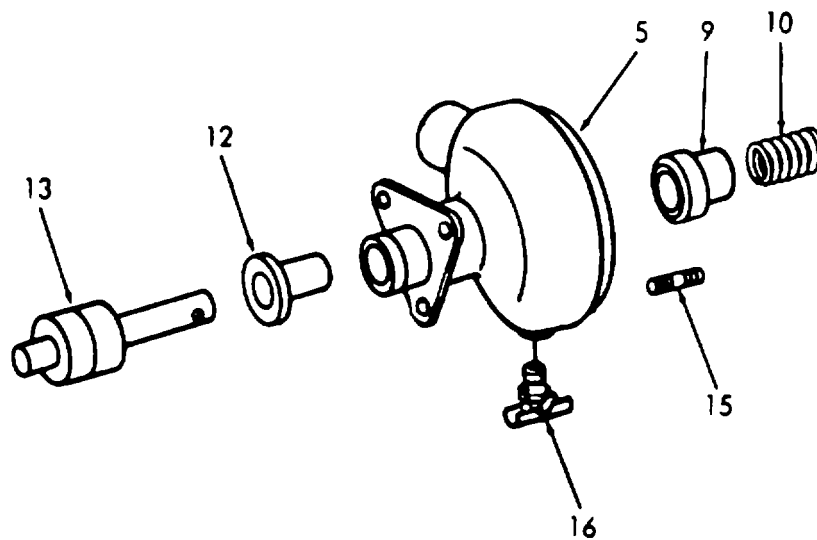
LOCATION/ITEM	ACTION	REMARKS
<u>REPAIR</u>		
6.	<ul style="list-style-type: none"> a. Replace gaskets. b. Replace damaged or defective parts as required. c. Replace a water pump damaged beyond repair. 	
<u>ASSEMBLY</u>		
7. Water Pump	<ul style="list-style-type: none"> a. Install draincock (16). b. Install studs (15). Apply a coat of sealant to lower portion of threads. c. Install slinger (12) onto shaft and bearing assembly (13). d. Support the impeller end of the pump body on an arbor press, and insert the coupling end of the shaft and bearing assembly (13) into the pump body (5). Then, press against the outer race of the bearing until the bearing contacts the shoulder in the pump body. Stake the end of the pump body in three places to prevent the bearing from moving endwise. 	<p>If removed.</p> <p>Torque to 10-12 lb. ft. (13.6-16.3 Nm).</p> <p>Install with flange of sleeve approximately 3/16 inch from end of outer race of bearing assembly.</p>

5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- e. With the surface of the water pump seal (9) clean and free from dirt and metallic particles, apply a thin coat of liquid soap on the inside diameter of the rubber seal. Do not scratch or mar the surface of the carbon seal washer. Slide the seal assembly on the pump shaft until the carbon seal washer is seated firmly against the pump body insert. Then, install the spring (10) with the small end toward the seal.



5-25. FRESH WATER PUMP (Continued).

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

ASSEMBLY (Cont)

- f. Support the bearing end of the shaft (not the drive coupling) on the bed of an arbor press. Then, press the impeller (11) onto the shaft. The end of the shaft must be flush with the face of the impeller hub with the bearing being held against the shoulder in the water pump body.
- g. Install pin (8).
- h. Support the impeller end of the pump shaft on a suitable arbor and press the drive coupling (14) onto the shaft. The drive coupling must be flush with the end of the shaft. Make sure the drive coupling is tight on the shaft.

NOTE

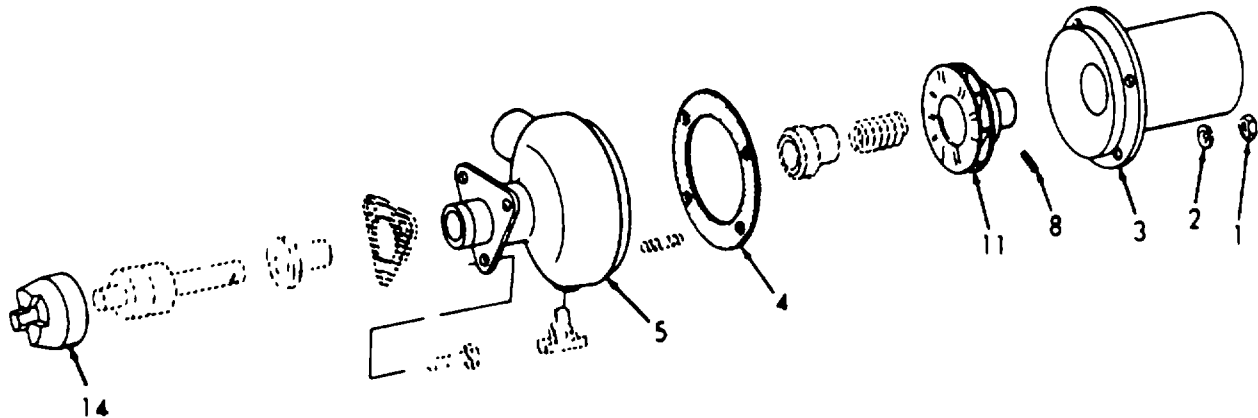
Rotate shaft and bearing assembly by hand to be sure rear face of impeller blades do not rub pump body.

- i. Position pump cover gasket (4) against bolting flange of pump body (5). Use new gasket.
- j. Install cover (3) using lock-washers (2), and nuts (1).

5-25. FRESH WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

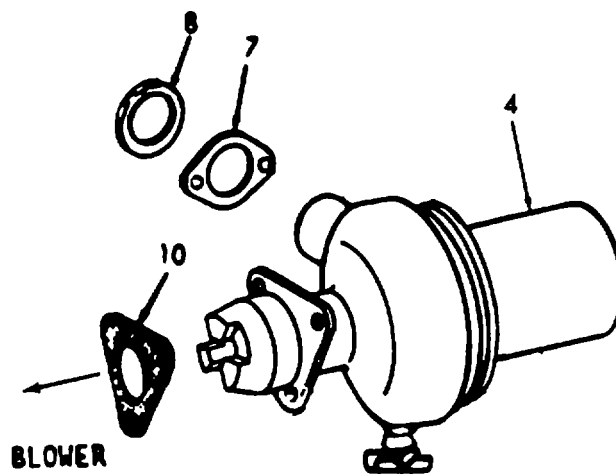


INSTALLATION

8. Water Pump

- a. Place preformed packing (8) over pump outlet flange (7).
- b. Position pump mounting gasket (10) in place on blower.

Place flat side of packing facing pump body (4).



5-25. FRESH WATER PUMP (Continued).

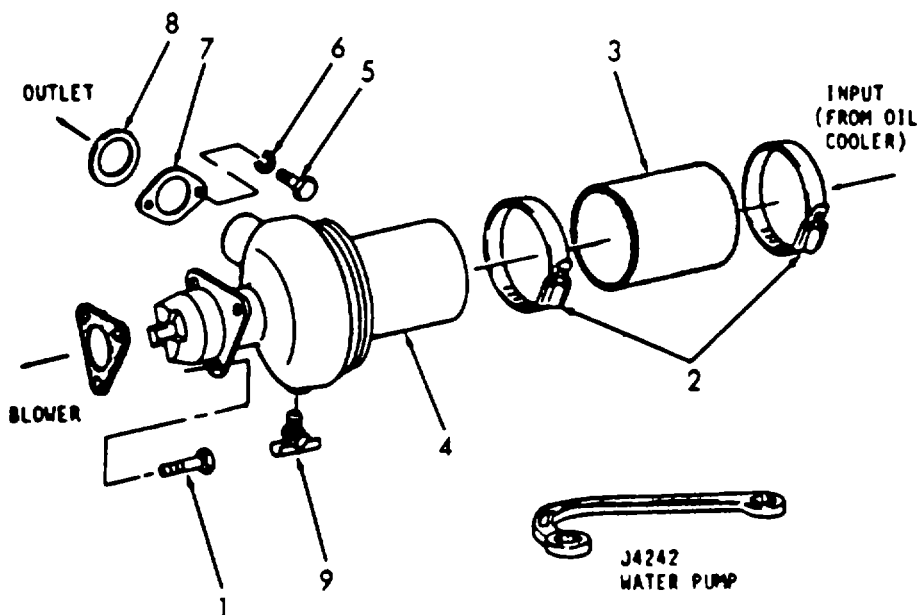
LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION (Cont)

NOTE

Place pump assembly against blower cover so that lugs on drive coupling mesh with lugs on intermediate shaft coupling.

- | | |
|---|---|
| <ul style="list-style-type: none"> c. Secure pump assembly (4) to blower with bolt and seal assemblies (9). d. Slide packing (8), and retainer (7) against the cylinder block. e. Secure with lockwashers (6), and bolts (5). f. Install hose clamps (2), and hose (3). g. Close draincock (1). h. Refill cooling system. | <p>Use tool J4242 to tighten bolts.</p> |
|---|---|



5-26. FRESH WATER EXPANSION TANK

This task covers:

- a. Inspection
- b. Removal
- c. Disassembly
- d. Repair/Replace
- e. Assembly
- f. Installation

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Welding set
Safety goggles

Equipment Condition Description

NONE

Materials/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10, 44B

General Safety Instructions

Observe WARNINGS and CAUTIONS in procedure.

LOCATION/ITEM

ACTION

REMARKS

INSPECTION

- | | |
|---|---|
| <p>1. Fresh Water Expansion Tank Assembly</p> | <ul style="list-style-type: none"> a. Inspect sight glass assembly for evidence of leaking. b. Inspect sight glass for discoloration or cracks. c. Inspect mounting brackets for rust, corrosion, cracks, or distortion. |
|---|---|

5-26. FRESH WATER EXPANSION TANK (Continued)..

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

INSPECTION (Cont)

- d. Inspect tank for evidence of leaking or insecure mounting, cracks or breaks.
- e. Inspect hoses for deterioration, cracks, or leaks.
- f. Inspect valves for cracks and breaks, and for proper operation.
- g. Inspect threaded parts for thread damage.

REMOVAL

2. Piping
and
Hoses

- a. Drain system.
- b. Loosen hose clamps (1), and slide back on hose. Then, remove hose (2) from elbow (3), and pipe (4).
- c. Remove pipe (4), elbow (5), pipe (6), elbow (7), pipe (8), and swing check valve (9).
- d. Remove pipe (10), elbow (11), pipe (12), and elbow (13).
- e. Loosen collar (14) and slide back on union (15).
- f. Remove union (15) from pipe (16).
- g. Loosen hose clamps (17), and slide back on hose (18).
- h. Remove hose (18) from fill pipes (19).

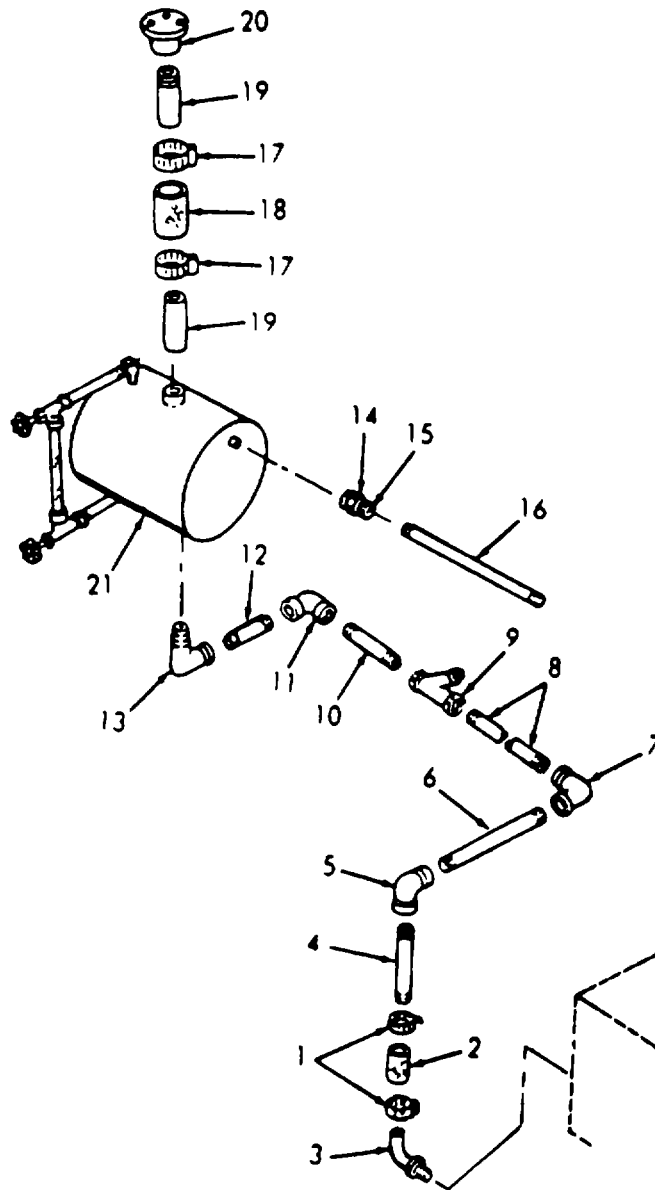
5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- i. Remove fill pipes (19) from top of expansion tank (21), and deck plate pipe (20).

If necessary.



5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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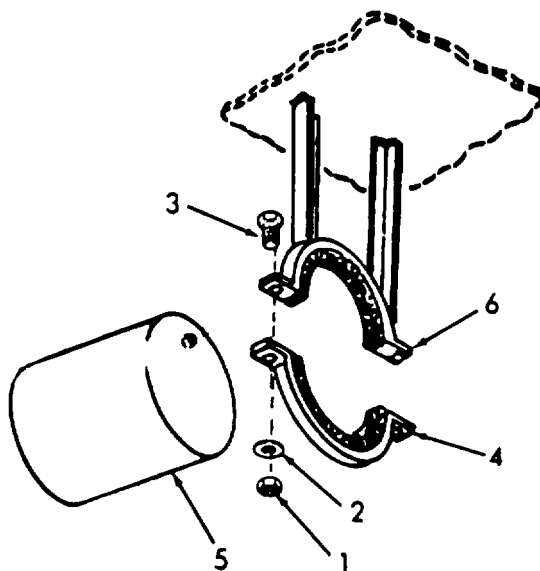
REMOVAL (Cont)

- | | | |
|--|---|--|
| 3. Expansion Tank With Sight Glass Assembly Attached | a. Remove four hex nuts (1), lockwashers (2), and cap-screws (3) from brackets (4). | |
|--|---|--|

NOTE

Two personnel are required to lift expansion tank from mounting brackets.

- | | |
|---|--|
| b. Lift expansion tank (5) from mounting bracket (6), and place on a suitable work bench. | |
|---|--|



5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY

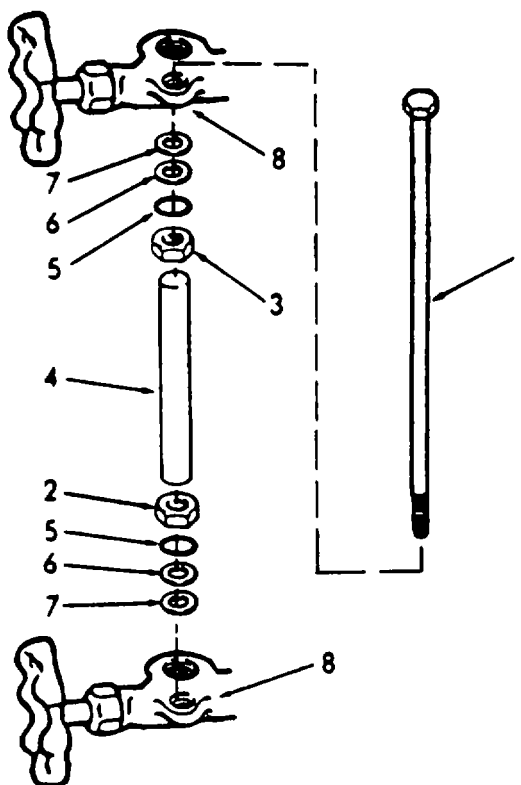
4. Sight Glass and Fittings

CAUTION

Use extreme care when handling sightglass to avoid breakage.

- a. Remove rods (1).
- b. Unscrew collars (2 and 3) from valves.
- c. Remove sightglass (4). Slide sightglass upward, and then down and out.
- d. Remove "O" rings (5, 6, and 7) from valves (8).

If used.
Discard if
defective or
damaged.

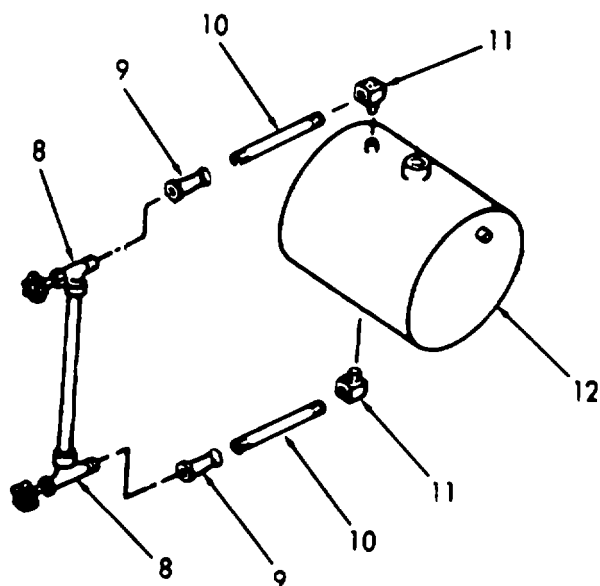


5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- e. Remove valves (8) from reducing couplings (9).
- f. Remove pipe nipples (10), and street elbows (11) from expansion tank (12).



REPAIR/REPLACE

- 5. Fresh Water Expansion Tank Assembly

WARNING

When welding, safety goggles must be worn to prevent eye injury.

NOTE

Welding must be done by a qualified welder only.

5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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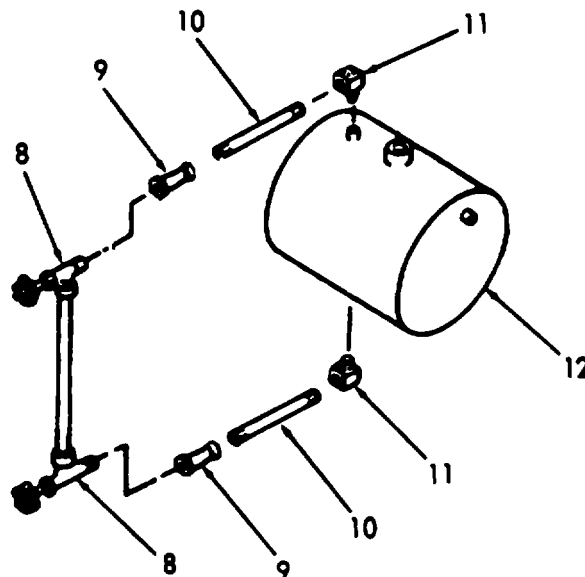
REPAIR/REPLACE (Cont)

- a. Weld cracks or breaks in expansion tank.
- b. Replace defective hoses and hose clamps, and other defective threaded parts and valves.
- c. Replace "O" rings in sight glass assembly.
- d. Replace defective sight glass.
- e. Replace expansion tank if damaged beyond repair.

ASSEMBLY

6. Sight Glass and Fittings to Expansion Tank

- a. Install steel elbows (11) in expansion tank (12).
- b. Install pipe nipples (10), reducing couplings (9), and valves (8).

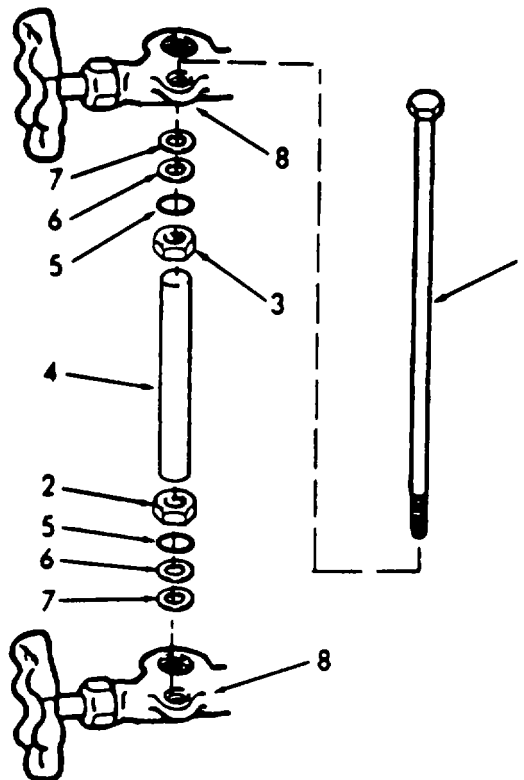


5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- c. Install washers (7), washers (6), and packings (5) into valves (8).
- d. Slide sight glass (4) into collars (3) and tighten to secure.
- e. Slide collars (3 and 2) onto valves (8), and tighten to secure.
- f. Install rods (1).



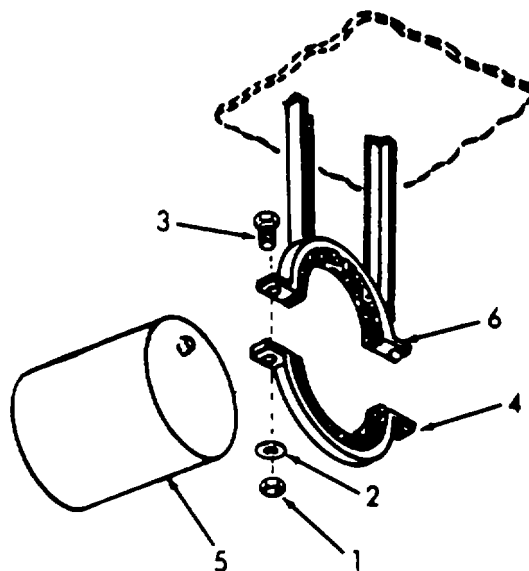
5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
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INSTALLATION7. Expansion
Tank**NOTE**

Two personnel are required to lift expansion tank into mounting brackets.

- a. Position expansion tank (5) in place in mounting brackets (6).
- b. Install brackets (4) to tank with four capscrews (3), lock-washers (2), and hex nuts (1).



5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION (Cont)</u>		
8. Tank Piping and Hoses	a. Install fill pipes (19) in deck plate pipe (20), and top of expansion tank (21).	
	b. Slide hose (18) over fill pipes and secure with hose clamps (17). install hose.	Place clamps (7) over hose, if removed, and
	c. Install union (15), to tank (21), and pipe (16).	
	d. Tighten collar (14) on union (15) to secure.	
	e. Install elbow (13), pipe (12), elbow (11), and pipe (10).	
	f. Install swing check valve (9), pipe (8), elbow (7), pipe (6), elbow (5), and pipe (4). hose.	Place hose clamps over hose if removed. Then, install
	g. Slide hose (2) over elbow (3), and pipe (4), and secure with hose clamps (1).	
	h. Refill system.	

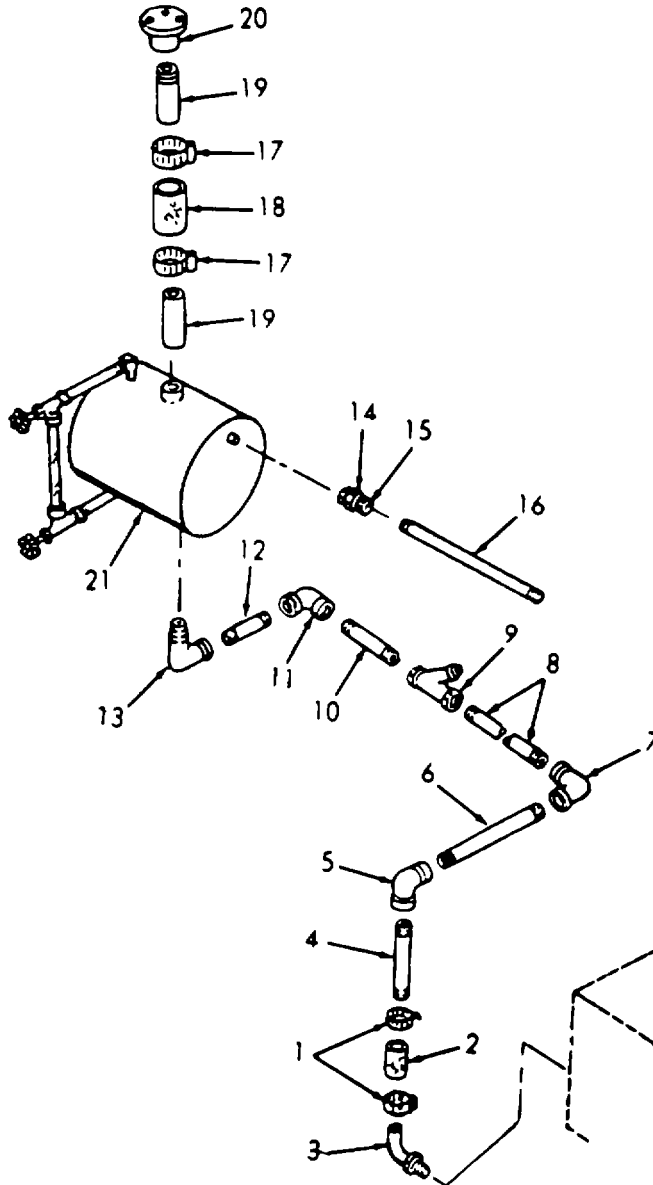
5-26. FRESH WATER EXPANSION TANK (Continued).

LOCATION/ITEM

ACTION

REMARKS

INSTALLATION (Cont)



5-27. RAW WATER PUMP.

The raw water pumps are mounted on the flywheel housing of each engine, and driven by a coupling from the end of the camshaft. The impeller is self-lubricated by the water pumped, and should not be run dry for longer than normally required for the pump to prime itself. A rotary-type seal, seals against leakage along the shaft.

This task covers:

Repair on Engine

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment
Condition Condition Description

NONE

Materials/Parts

Kit 5197227 (72582)

Special Environmental Conditions

NONE

Personnel Required

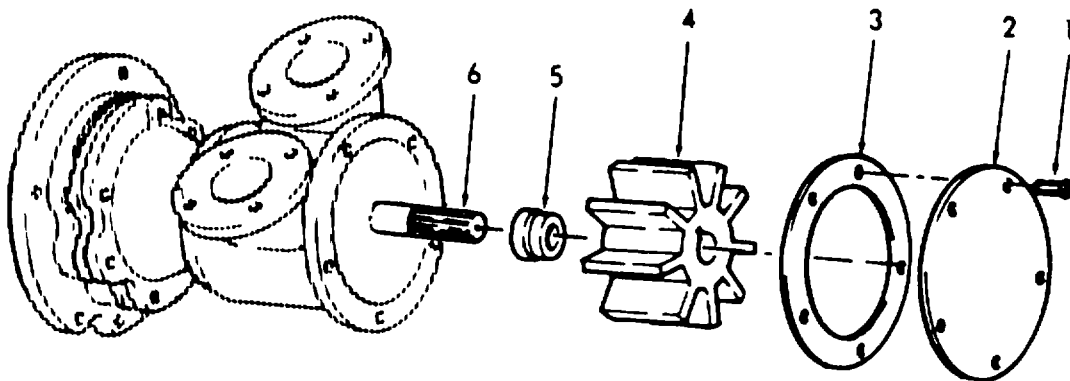
MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

5-27. RAW WATER PUMP (Continued).

LOCATION/ITEM	ACTION	REMARKS
REPAIR ON ENGINE		
1. Water Pump	a. Remove cover screws (1), cover (2), and cover gasket (3).	Discard screws and gasket.
	b. Using two pliers, grasp a blade at each side of impeller and pull impeller (4) from shaft.	Discard impeller.
	c. Insert two wires, each with hook at one end, between housing and seal with hook over edge of seal (5).	
	d. Pull seal assembly (5) from shaft (6).	Discard seal.



5-27. RAW WATER PUMP (Continued)

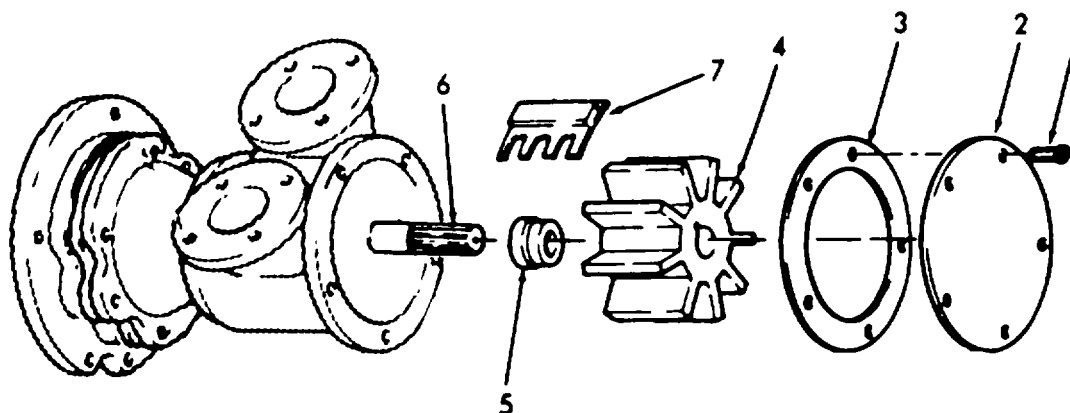
LOCATION/ITEM	ACTION	REMARKS
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REPAIR ON ENGINE (Cont)

WARNING

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (38° -59° C).

- e. Clean all parts with cleaning solvent P-D-680 and dry thoroughly.
- f. Install seal assembly (5) on pump drive shaft (6). Use new seal assembly.
- g. Compress impeller blades enough to clear offset cam (7) and press impeller (4) onto splined end of drive shaft (6). Use new impeller.
- h. Position cover plate gasket (3) in place on pump body. Use new gasket.
- i. Install cover (2) onto body with screws (1). Use new screws.



5-28. SEA WATER DUPLEX STRAINER

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |
-

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783

Equipment
Condition Condition Description

NONE

Materials/Parts

Detergent
Clean, soft lint-free cloths
Cleaning solvent P-D-680

Special Environmental Conditions

NONE

Personnel Required

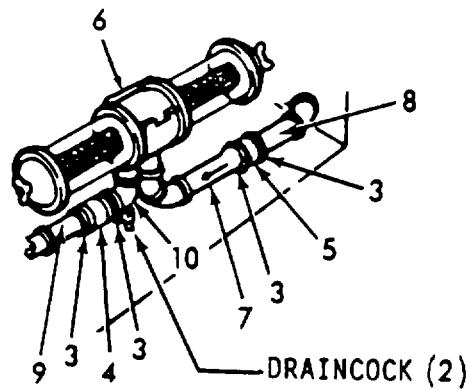
MOS 61C10

General Safety Instructions

Observe WARNING in procedure.

5-28. SEA WATER DUPLEX STRAINER (Continued).

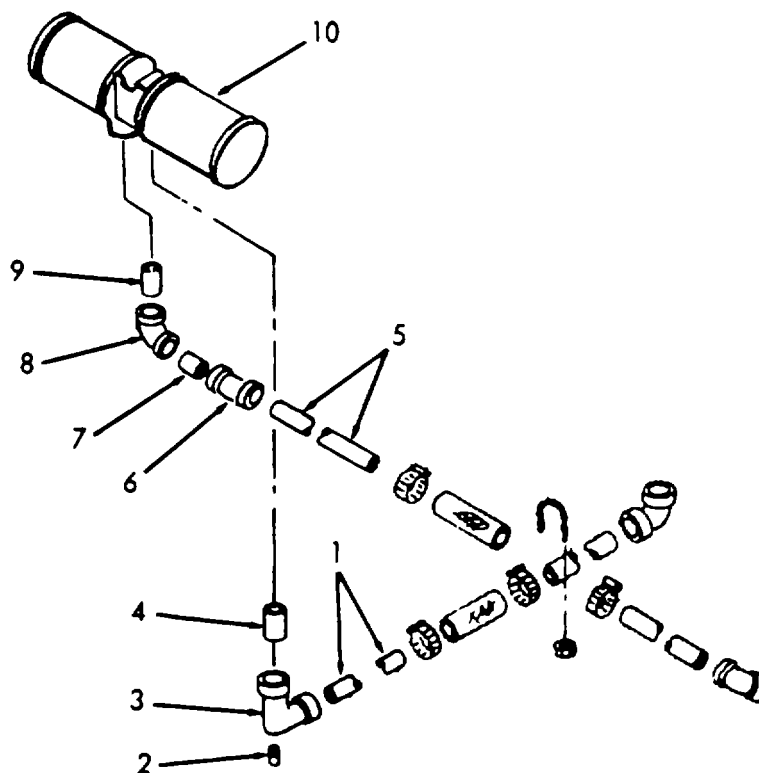
LOCATION/ITEM	ACTION	REMARKS
REMOVAL		
1. Strainer, Hose, and Associated Piping	<ol style="list-style-type: none"> a. Close sea water seacock b. Open draincock (2) to drain system. c. Loosen hose clamps (3) and slide back over hoses (4 and 5). d. Remove hose (5) from pipes (7 and 8). e. Remove hose (4) from pipes (9 and 10). f. Remove strainer (6) with associated piping attached. 	



NOTE: PORT ENGINE INSTALLATION SHOWN
STARBOARD OPPOSITE, EXCEPT AS NOTED.

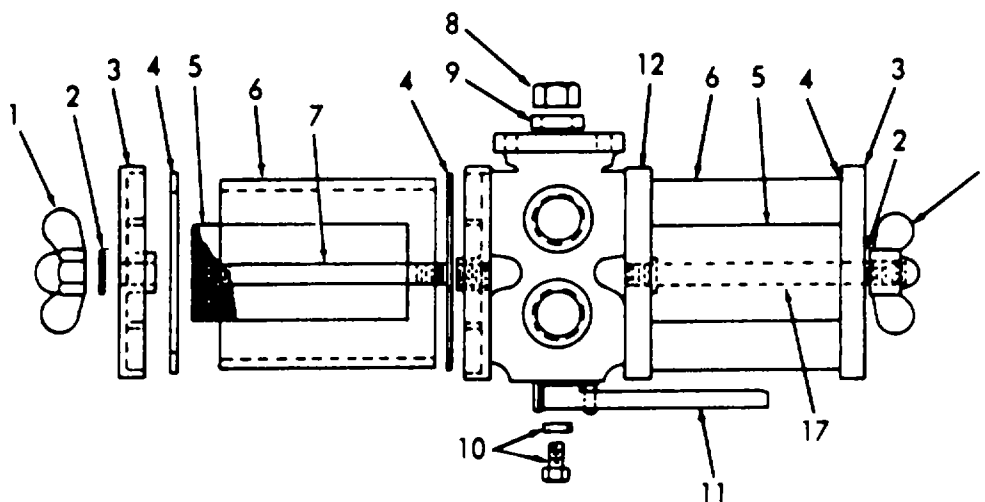
5-28. SEA WATER DUPLEX STRAINER (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
2. Strainer Piping tee (3).	<p>a. Remove brass tube (1), and draincock (2), from reducing</p> <p>b. Remove reducing tee (3), brass tube (4), brass pipe (5), and elbow (6).</p> <p>c. Remove brass tube (7), elbow (8), and close nipple (9) from duplex strainer (10).</p>	



5-28. SEA WATER DUPLEX STRAINER (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
3. Duplex Strainer	a. Loosen and remove wing nut (1), lockwasher (2), end cap (3), and cylinder gasket (4) from cylinder (6).	Discard gasket.
	b. Lift strainer screen (5) off of threaded rod (7).	
	c. Remove lucite cylinder (6), and cylinder gasket (4) from body (12).	Discard gasket.
	d. Remove threaded rod (7).	If damaged.
	e. Disassemble other end of strainer in the same manner.	
	f. Remove nut (8), washer (9), and screw and washer assembly (10) from body plug assembly (12).	
	g. Remove handle (11) from body plug assembly (12).	



5-28. SEA WATER DUPLEX STRAINER (Continued).

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

CLEANING

4. Strainer



Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°-138°F (380-59°C).

- | | |
|--|--------------------------|
| <p>a.
of strainer
with cleaning solvent P-D-680
and dry thoroughly. Agitate
to loosen trapped material.</p> | <p>Clean metal parts</p> |
| <p>b.
cylinders using
detergent and clean, lint-
free cloths. Rinse cylinders
with fresh water and dry with
clean, lint-free cloths.</p> | <p>Clean lucite</p> |

INSPECTION

- | | |
|-----------|--|
| <p>5.</p> | <p>a. Inspect threaded parts for
thread damage.</p> <p>b. Inspect body for cracks or
breaks.</p> <p>c. Inspect strainer screen for
rips, tears or clogged con-
dition.</p> <p>d. Inspect lucite cylinders for
breaks, scratches, discolo-
ration, or cracks.</p> |
|-----------|--|

5-28. SEA WATER DUPLEX STRAINER (Continued).

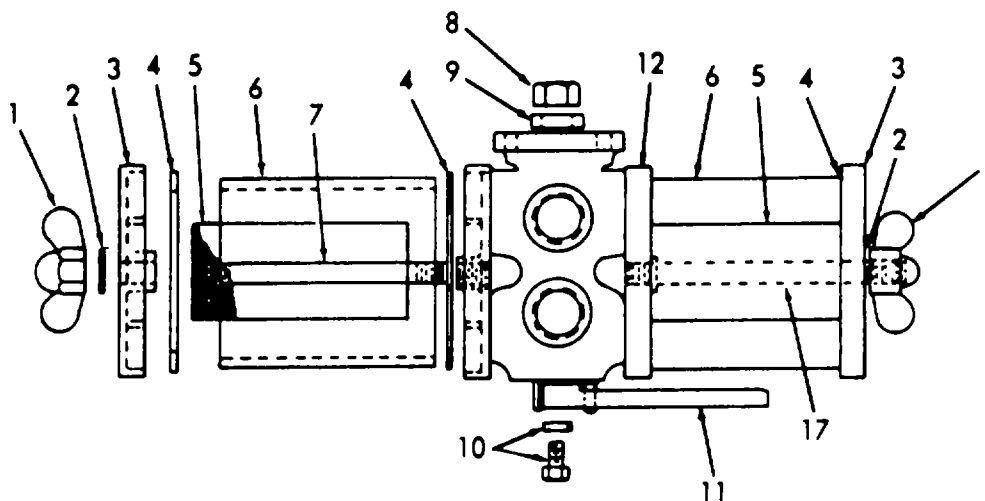
LOCATION/ITEM	ACTION	REMARKS
---------------	--------	---------

REPAIR

- | | | |
|--------------------|---|--|
| 6. Duplex Strainer | <ul style="list-style-type: none"> a. Replace gaskets. b. Straighten distorted threaded rods. | |
|--------------------|---|--|

ASSEMBLY

- | | | |
|-----------------|---|--|
| 7. Strainer (5) | <ul style="list-style-type: none"> a. Install threaded rod (7). b. Position gasket (4) in place on body (12) and insert strainer (5) over rod (7). c. Place lucite cylinder (6) on body (12). d. Place gasket (4) over end of cylinder (6). e. Install end cap (3) onto cylinder (6) with washer (2), and wing nut (1). f. Assemble other end of strainer in the same manner. | <p>If removed.</p> <p>Use new gasket.</p> <p>Use new gasket.</p> |
|-----------------|---|--|

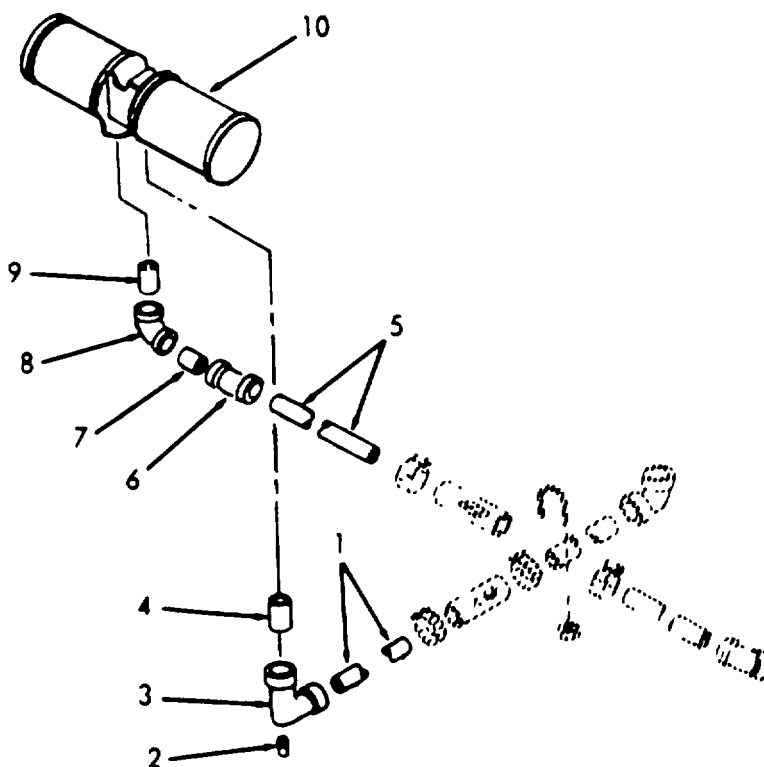


5-28. SEA WATER DUPLEX STRAINER (Continued).

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

ASSEMBLY (Cont)

- | | | |
|-----------------------|---|--|
| 8. Strainer
Piping | <p>a. Install close nipple (9) in duplex strainer (10).</p> <p>b. Install elbow (8), brass tube (7), elbow (6), brass pipe (5), brass tube (4), and reducing tee (3).</p> <p>c. Install draincock (2) and brass tube (1).</p> | |
|-----------------------|---|--|

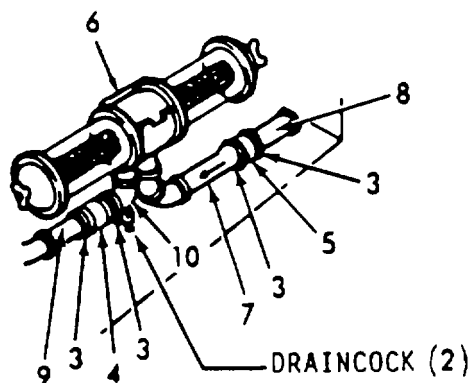


5-28. SEA WATER DUPLEX STRAINER (Continued).

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

INSTALLATION

- | | | |
|--|---|--|
| 9. Strainer, Hose, and Associated Piping | <ul style="list-style-type: none"> a. Position strainer (6) in place. b. Slide hose (5) over ends of pipes (7 and 8). c. Secure with hose clamps (3). d. Slide hose (4) over ends of pipes (9 and 10). e. Secure with hose clamps (3). f. Open draincock (2) and sea water seacock. | |
|--|---|--|



NOTE: PORT ENGINE INSTALLATION SHOWN
STARBOARD OPPOSITE, EXCEPT AS NOTED.

5-29. ENGINE SPEED GOVERNOR.

GENERAL

a. The limiting speed mechanical governor illustrated is a single weight-type governor, and performs the following functions:

- (1) Controls the engine idling speed.
- (2) Limits the maximum operating speed of the engine.

b. The governor is mounted on the front end of the blower, and is driven by the upper blower rotor. The governor consists of three subassemblies:

1. Control Housing Cover
2. Control Housing
3. Weights and Housing

c. The governor provides full fuel for starting when the speed control lever is in the idle position. Immediately after starting, the governor moves the injector racks to the position required for idling.

d. Operation.

(1) The centrifugal force of the revolving governor weights (1) is converted into linear motion which is transmitted through the riser (2), and operating shaft (3) to the operating shaft lever (4). One end of lever (4) operates against the high and low speed springs (5 and 6), through the spring cap (7), while the other end provides a moving fulcrum on which the differential lever (8) pivots. (2) When the centrifugal force of the revolving governor weights balances out the tension on the high or low speed spring (depending on the speed range), the governor stabilizes the engine speed for a given setting of the governor control lever.

(3) In the low speed range, the centrifugal force transmitted operates the low speed spring. As the engine speed is increased, the centrifugal force compresses the low speed spring (5) until the spring cap (7) is tight against the high speed plunger (8). This removes the low speed spring from operation and the governor is then in the intermediate speed range. In this range the centrifugal force is operating against the high speed spring and thus the engine speed is manually controlled.

(4) As the engine speed is increased to a point where the centrifugal force overcomes the pre-load of the high speed spring, the governor will move the injector racks out to the position required for maximum no-load speed.

5-29. SEA WATER DUPLEX STRAINER (Continued).

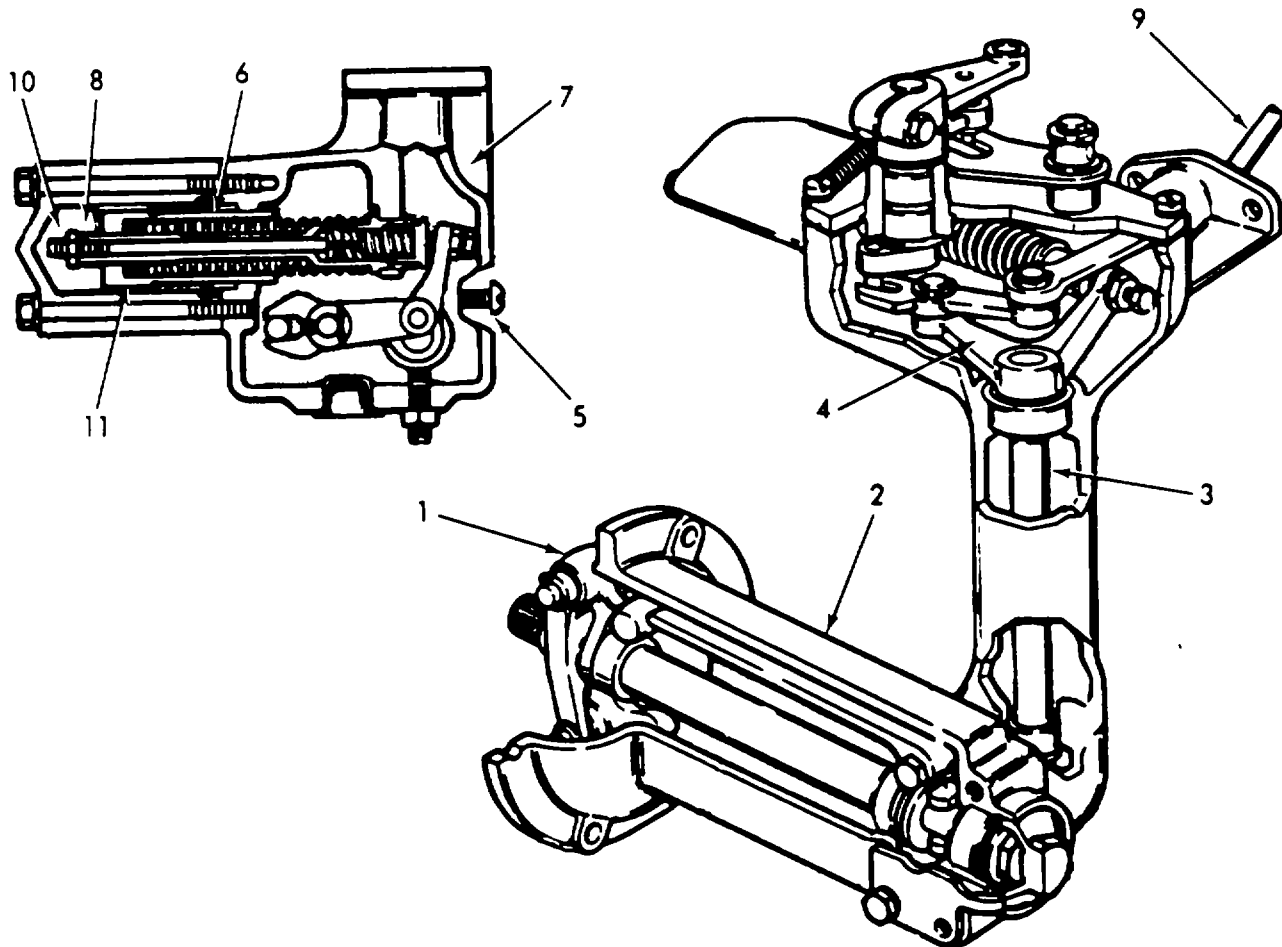
(5) A fuel rod (9), connected to the differential lever and injector control tube lever, provides a means for the governor to change the fuel settings of the injector control racks.

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

(7) Adjustment of the engine idle speed is accomplished by changing the tension on the low speed spring by means of the idle adjusting screw (10).

(8) The maximum no-load speed is determined by the centrifugal force required to balance out tension on the high speed spring.

(9) Adjustment of the maximum no-load speed is accomplished by the high speed spring retainer (11). Movement of the high speed spring retainer nut will increase or decrease the tension on the high speed spring.



5-29. ENGINE SPEED GOVERNOR (Continued).

e. Lubrication.

(1) Surplus oil returning from the cylinder head provides lubrication for the parts in the governor control housing, the riser thrust bearings, and the weight shaft end bearing. Oil, picked up from a reservoir in the blower front end plate by a slinger attached to the lower rotor shaft provides lubrication for the governor weights and weight carrier.

(2) Pressure lubrication has been provided for the weight housing bearings. An oil tube is attached between the oil gallery in the cylinder block, and the governor weight housing.

5-29. ENGINE SPEED GOVERNOR (Continued).

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Installation |

INITIAL SETUP

Test Equipment

NONE

References

NONE

Special Tools

Bearing Remover (J21967)
 Bearing Installer (J21068)

Tools

General Mechanic's Tool Kit
 NSN 5180-00-629-9783
 Arbor press
 Safety goggles

Equipment

<u>Condition</u>	<u>Condition Description</u>
Para 5-14	Governor Removed.

Materials/Parts

Loctite sealant
 Clean fuel oil, (Grade HV
 or equivalent)
 Clean, lint-free cloths

Special Environmental Conditions

NONE

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING and CAUTION in procedure.

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>		
1. Governor Cover	<ul style="list-style-type: none"> a. Release spring (1) from special screw (2). b. Remove screws (2 and 3) and lockwashers (4). c. Remove cover (5) and gasket (6). d. Remove plug (7) from throttle shaft (8). e. Remove capscrew (9) and lockwasher (10) from speed control lever (11). f. Remove speed control lever (11) from throttle shaft (8). g. Remove tapered pin (12) from throttle shaft lever (13). h. Lift throttle shaft lever assembly (13) and flatwasher (14) from throttle shaft (8). i. Withdraw throttle shaft (8) from cover assembly (5). j. Remove spring (1) from cam (15). k. Remove retaining ring (16) and flatwasher (17) from cam pin (18). 1. Remove cam (15) from cam pin (18) and packing (19) from cover assembly (5). 	<p>If necessary for replacement.</p> <p>Remove cam pin (18) from cover if worn or damaged.</p>

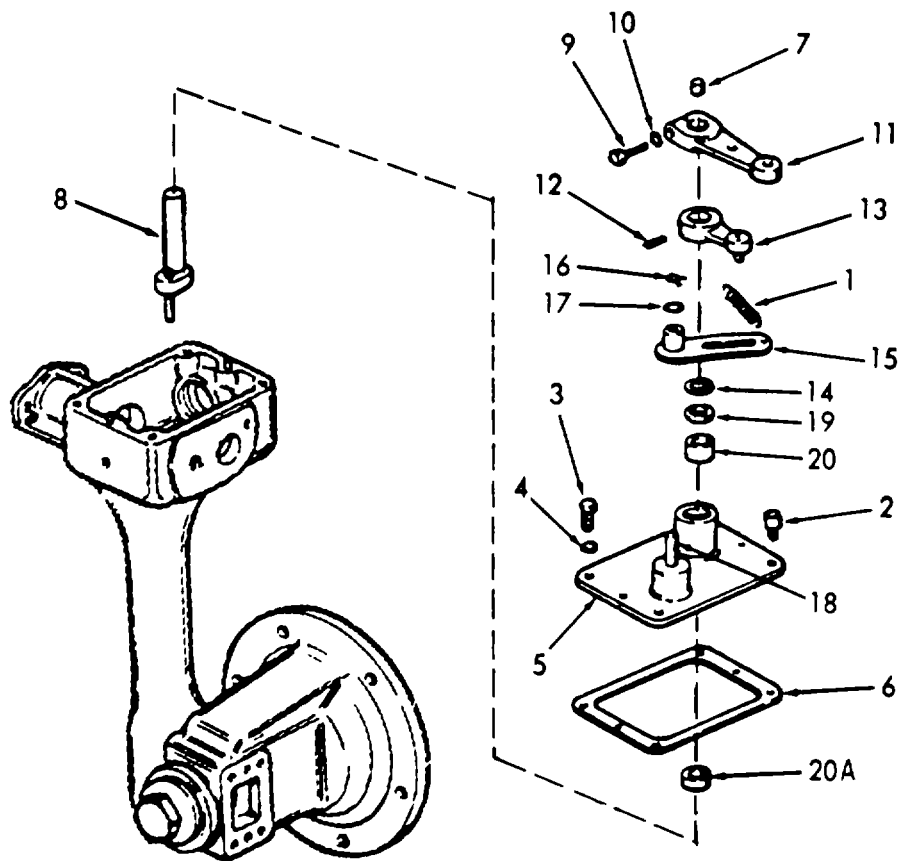
5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

m. Wash the cover (5) assembly (containing needle bearings 20, and 20A) thoroughly in clean fuel oil and inspect the needle bearings for wear or damage.

If bearings are satisfactory for further use, do not remove.



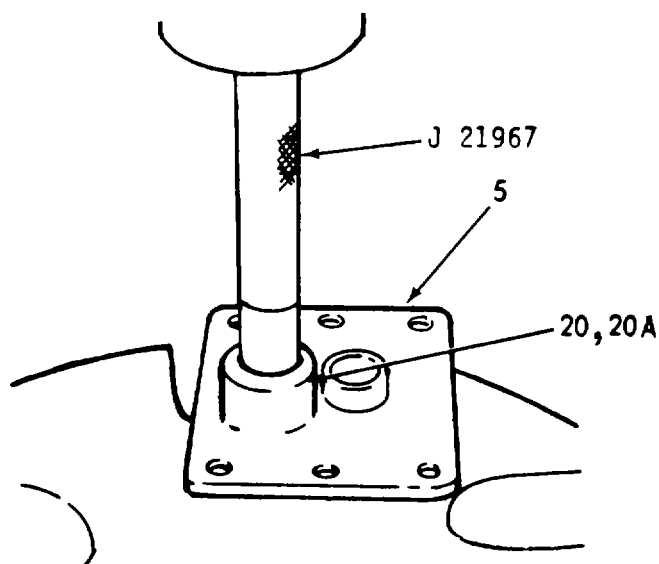
5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- n. If needle bearing removal is necessary, place the inner face of the cover (5) over the opening in the bed of the press. Place remover on top of the bearing (20) and under the ram of the press; then press both bearings (20 and 20A) out of the cover.

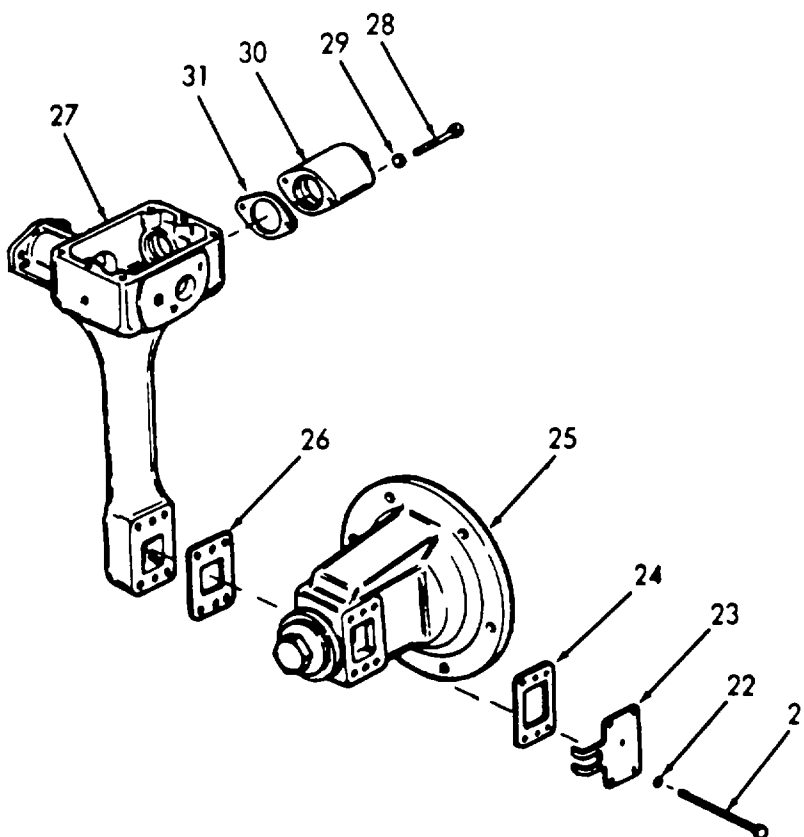
Use tool J21967.



5-518

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
2. Governor Control Housing	<p>a. Remove screws (21) and lock-washers (22).</p> <p>b. Remove weight housing cover (23) and gasket (24).</p> <p>c. Remove weight housing (25) and gasket (26) from governor control housing (27).</p> <p>d. Place governor control housing (27) in a soft-jawed vise.</p> <p>e. Remove capscrews (28), lock-washers (29), high speed spring housing (30), and gasket (31) from control housing (27).</p>	



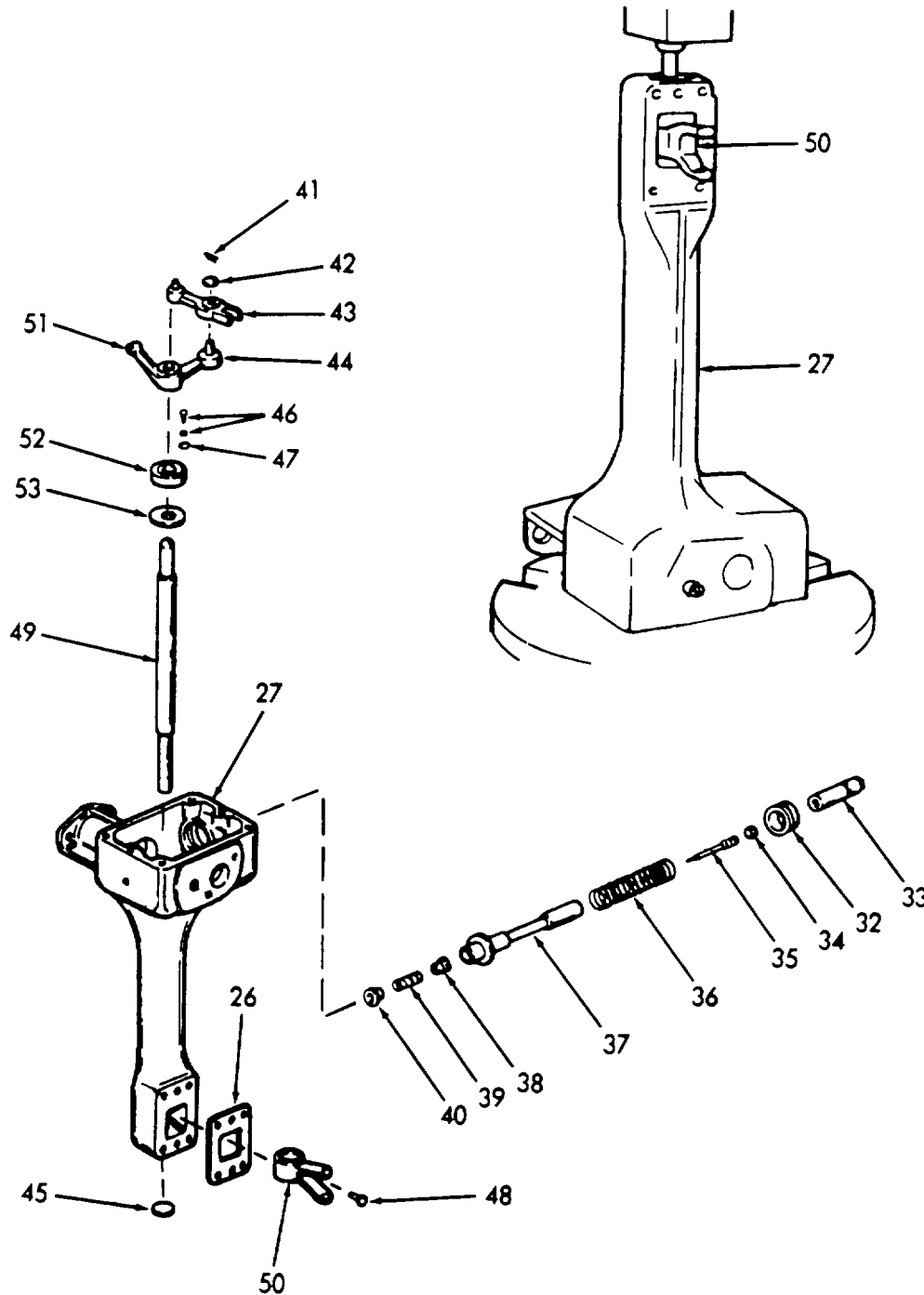
5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
	f. Loosen locknut (32). Then remove high speed spring retainer (33), hex nut (34), adjusting screw (35), high speed adjusting spring (36), plunger (37), low speed spring seat (38), low speed spring (39), and retainer (40).	
	g. Remove retainer (41) and flatwasher (42) from differential lever.	
	h. Remove differential lever (43).	Remove pin (44) from differential lever if damaged.
	i. Remove expansion plug (45) from housing (27).	
	j. Remove bearing retaining screw and lockwasher assembly (46) and flatwasher (47).	
	k. Loosen operating fork set-screw (48).	If used.
	1. Support control housing in bed of arbor press.	
	m. Press operating shaft (49) from governor shaft fork (50) with bellcrank (51), bearing (52), and flatwasher (53) attached.	Use a brass rod in press to remove shaft and associated parts.

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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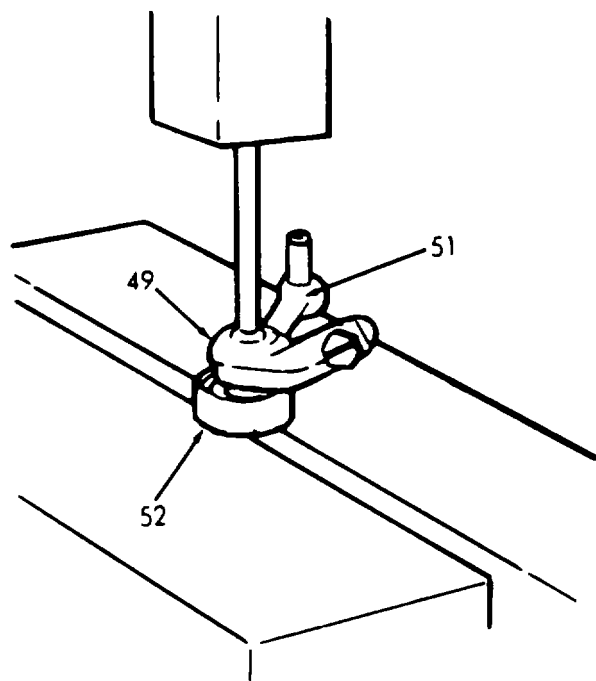
DISASSEMBLY (Cont)

n. Remove governor shaft fork (50) from housing (27), and press bushing (54) from housing.

Remove bushing only if defective.

o. Support operating shaft and bellcrank in arbor press as shown.

Use a brass rod to press shaft from bellcrank and bearing.



5-522

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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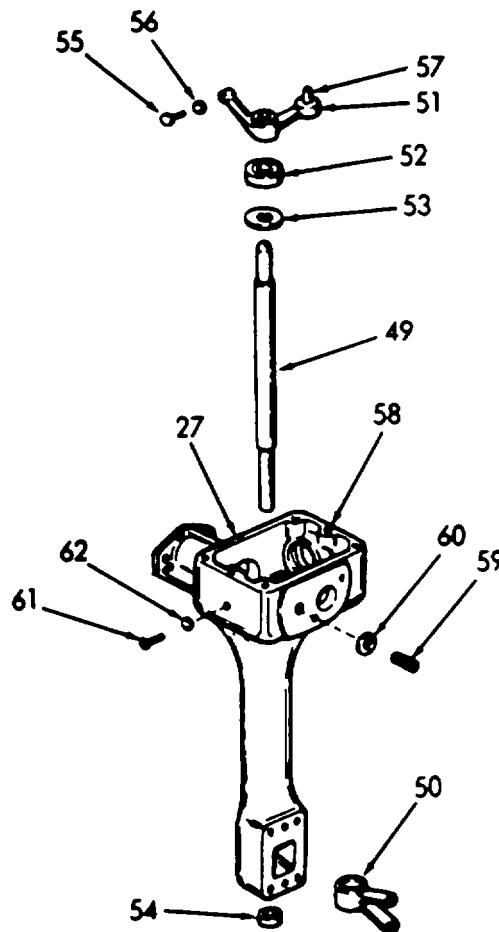
DISASSEMBLY (Cont)

p. Press shaft (49) from the bellcrank (51), bearing (52), and flatwasher (53).

q. Remove gap adjusting setscrew (55), hex nut (56), and pin (57) from the bellcrank (51).

If necessary.

r. Remove pins (58), buffer screw with spring (59), hex nut (60), screw (61), and copper gasket (62) from housing (27).



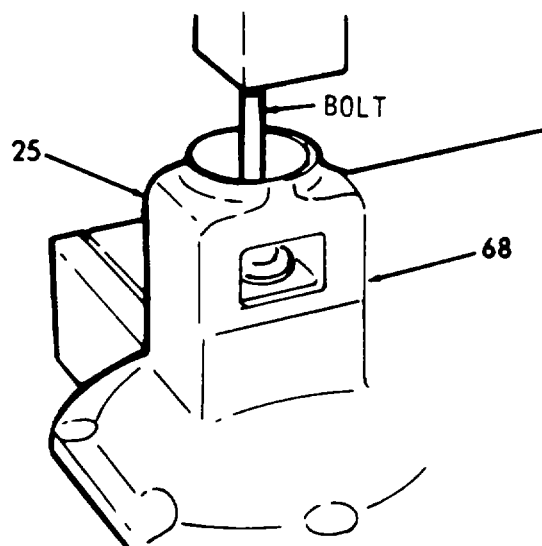
5-523

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|----------------------------|---|--|
| 3. Governor Weight Housing | <ul style="list-style-type: none"> a. Place weight housing (25) in a soft-jawed vise. b. Remove cap (63), and flat-washer (64) from housing. c. Straighten tangs on key washer and remove machine bolt (65) and key washer (66). d. Thread a 5/16 inch - 24 x 3 inch bolt into tapped end of weight shaft (67). e. Support weight housing (25) on bed of arbor press as shown. | |
|----------------------------|---|--|



- f. Press shaft and carrier assembly (68) from the ball bearing (69).

5-29. ENGINE SPEED GOVERNOR (Continued).

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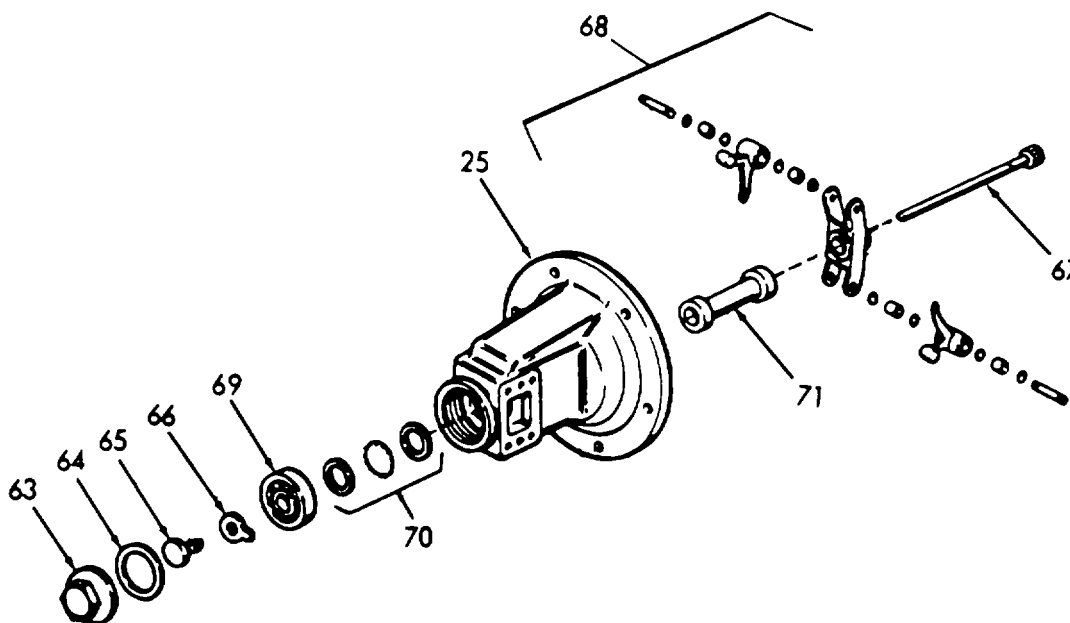
DISASSEMBLY (Cont)**NOTE**

The thrust bearing is especially designed to absorb thrust loads; therefore, looseness between mating parts does not indicate excessive wear.

- g. Slide thrust bearing (70) and riser (71) from shaft (67).
- h. Remove ball bearing (69) from weight housing.

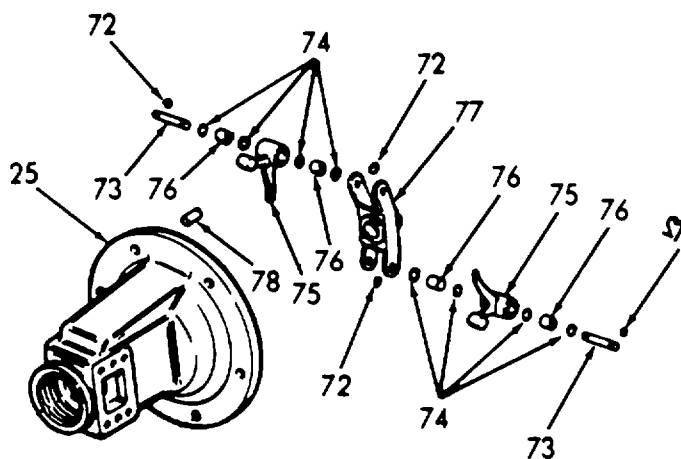
NOTE

Mark weights and carrier with a center punch for identification. Note position of thin washers between weights so that parts can be replaced in their original position.



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)		
	i. Remove retaining rings (72) from grooved pins (73).	
	j. Remove pins (73), flatwashers (74), and weights (75) from carrier (77) if necessary.	Remove roller bearings (76) from weights
	k. Remove dowel pins (78) from housing (25).	If necessary.



CLEANING

4.

WARNING

Wear safety goggles when using compressed air to avoid possible eye injury. Air pressure should not exceed 30 PSI.

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>INSPECTION</u>		
5.	<ul style="list-style-type: none"> a. Rotate ball bearings slowly by hand to detect rough or flat spots, corrosion or pitting. b. Inspect riser thrust bearings for corrosion, flat spots or wear. c. Inspect bushings in weights for wear. d. Inspect operating shaft and bushing for wear. e. Inspect weight carriers, weights and retaining pins for wear. f. Inspect threaded parts for crossed or stripped threads. 	
<u>REPAIR</u>		
6.	<ul style="list-style-type: none"> a. Replace governor assembly. b. Replace any ball bearings that are corroded or pitted. c. Replace defective riser thrust bearings. d. Replace other damaged or defective parts as required. 	If damaged.

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY</u>		
7. Governor Weight Housing	a. Install dowel pins (78) in housing (25).	If removed.
	b. Install roller bearings (76) in weights (75).	If removed.
	c. Install retaining ring (72) in groove of grooved pin (73).	
	d. Place a flatwasher (74) over grooved pin.	
	e. Start pin (73) through opening of carrier (77).	
	f. Place another flatwasher (72) over pin (73).	
	g. Insert weight (75) between arms of carrier (77) and push pin (73) through weight (75).	
	h. Place another flatwasher (74) over pin, and against weight (75).	
	i. Push pin (73) completely through carrier (77) and place fourth flatwasher (74) against carrier (77).	
	j. Install locking ring (72) to secure pin (73).	
	k. Install other weight in the same manner.	

5-29. ENGINE SPEED GOVERNOR (Continued).

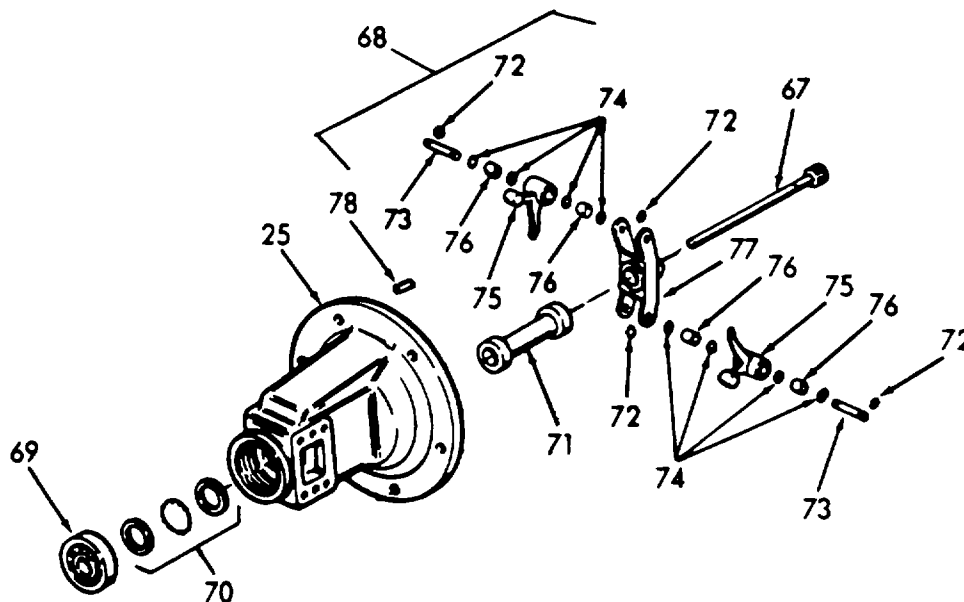
LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- l. Insert shaft (67) through assembled carrier assembly (68).
- m. Slide riser (71) and thrust bearing (70) onto shaft assembly with bearing race having the smallest inside diameter against riser (71).
- n. Insert carrier and shaft assembly (68) into housing (25).

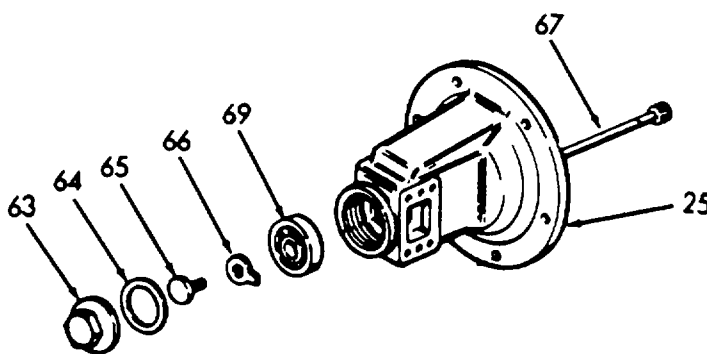
CAUTION

Ball bearing (69) has thrust capacity in one direction only. Be sure to install the bearing so that the thrust shoulder is toward the governor weights as shown. Otherwise, the force exerted by the weights will pull the inner race and ball assembly away from the outer race and result in damage to bearing and erratic governor operation.



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>	<p>o. Support the splined end of the shaft on the bed of an arbor press. Start the shaft end bearing (69) in the housing and over the end of the shaft with the numbered side of the bearing facing away from the shaft. Press bearing in place with a sleeve that bears against inner race.</p> <p>p. Place key washer (66) over shaft (67).</p> <p>q. Thread bearing retainer bolt (65) into tapped end of shaft and tighten.</p> <p>r. Bend tang on the key washer (66) against head of bolt (65).</p> <p>s. Place flatwasher (64) in housing (25) against ball bearing (69).</p> <p>t. Coat threads of weight cap (63) with Loctite sealant, grade HV or equivalent, and install in housing.</p>	<p>Torque cap to 30-60 lb. ft. (40 - 81 Nm).</p>

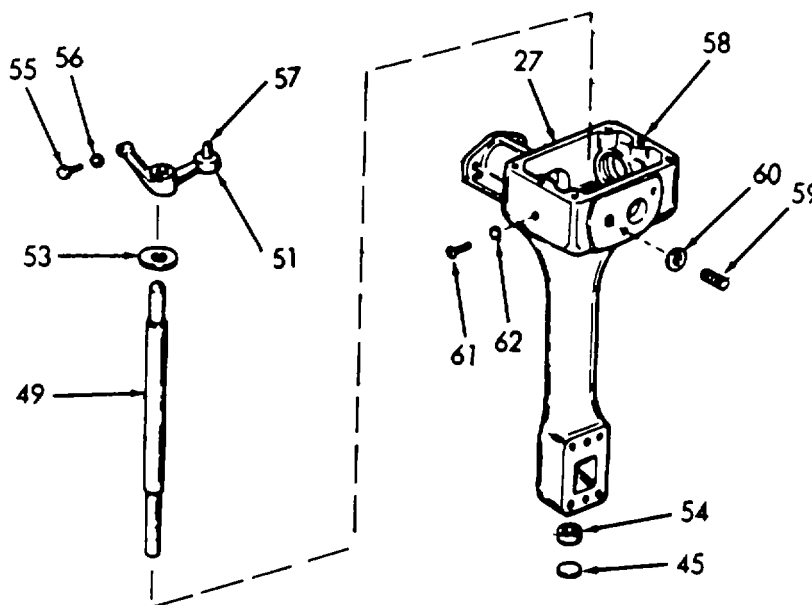


5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- | | | |
|-----------------------------|---|-------------|
| 8. Governor Control Housing | a. Install copper gasket (62), and screw (61) into housing (27). | If removed. |
| | b. Thread hex nut (60) onto buffer screw with spring (59) and thread screw into housing (27). | If removed. |
| | c. Install pins (58). | If removed. |
| | d. Install pin (57), gap adjusting hex nut (56), and setscrew (55) in bellcrank (51). | If removed. |
| | e. Press bushing (54) into housing (27). | |
| | f. Place flatwasher (53) over short finished end of governor shaft (49). | |



5-531

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>		
	g. Place bearing (52) over end of shaft (49).	
	h. Support opposite end of shaft on bed of a press, and press bearing (52) on the shaft against washer (53).	Use a sleeve which has the same diameter as bearing inner race.
	i. Place bellcrank (51) over end of shaft with pin (57) up with flat on shaft registering with flat surface in bellcrank.	
	j. Press bellcrank onto shaft (49) tight against bearing (52).	
	k. Lubricate bearing (52) on shaft and bushing (54) in governor shaft fork (50) with <u>clean</u> engine oil.	
	l. Insert bellcrank and shaft into housing (27).	
	m. Position governor shaft fork (50) over lower end of shaft so finished side of fork will rest against thrust bearing when governor is assembled.	
	n. Support the operating shaft and control housing (27) in an arbor press with the upper end of the operating shaft resting on a steel block. Align the flat in the fork (50) with the flat on the operating shaft. Then, place a sleeve over the end of the shaft, and rest it on the fork. Bring the ram of	

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

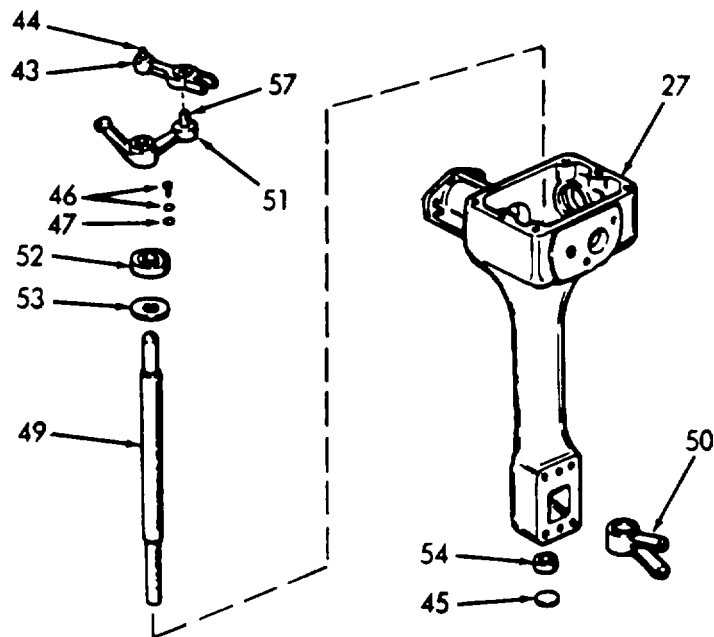
the press down on the sleeve and press the fork straight down and tight against the shoulder on the shaft.

- o. Install setscrew (48) in governor shaft fork (45). If used.

- p. Coat outer edges of expansion plug with sealant and press plug (45) into the housing (27).

- q. Install flatwasher (47) and the bearing retaining lock-washer assembly (46) to secure bearing (52).

- r. pin (44) in differential lever (43). If removed.



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

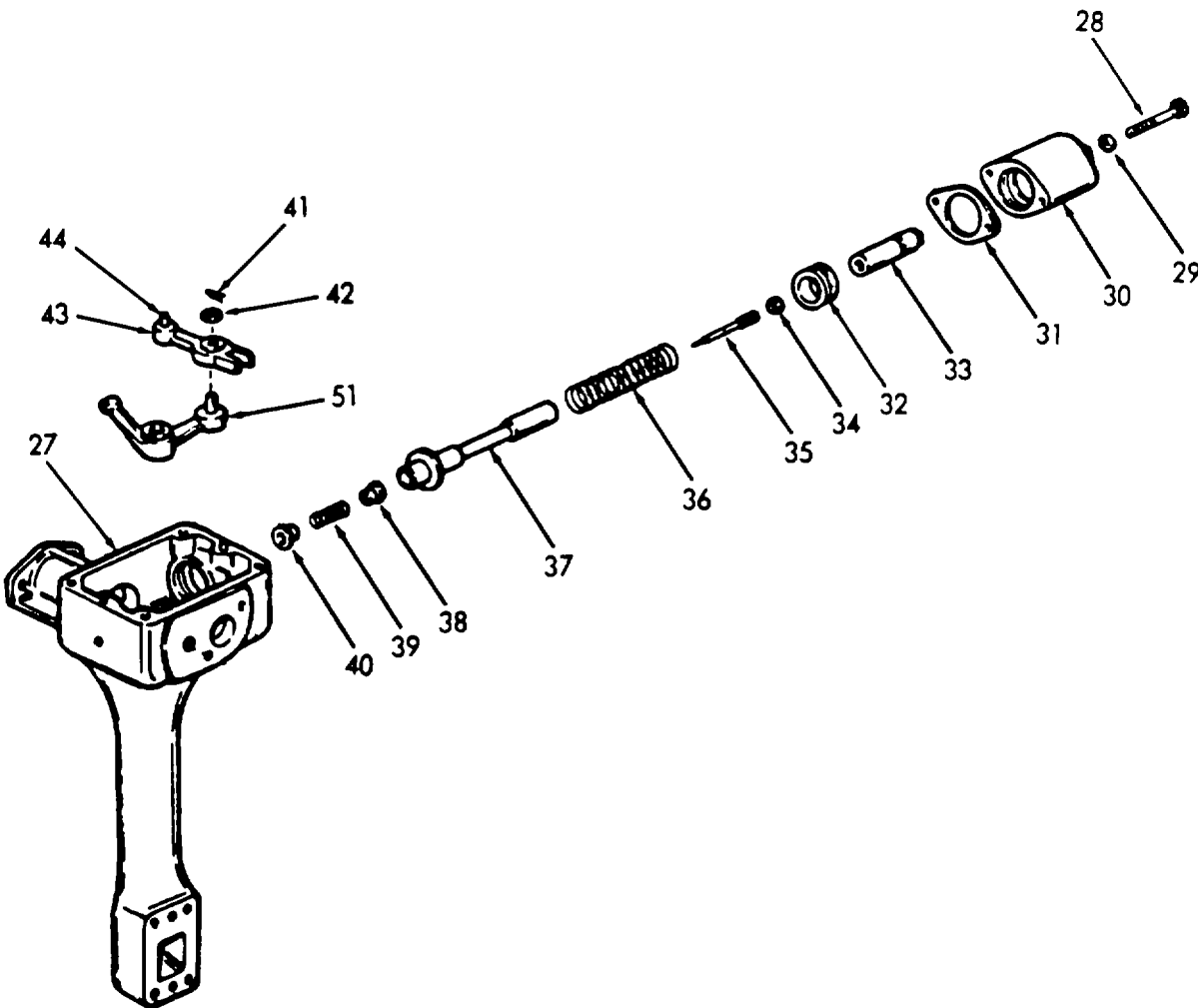
- s. Place differential lever (43) over pin of bellcrank (51).
- t. Secure with flatwasher (42), and retainer (41).
- u. Thread locknut (32) on the high speed spring retainer (33) approximately 1-1/2 inch (3.81 cm). Place the high speed spring (36) over the high speed spring plunger (37), with the tightly wound end of spring against the shoulder of the plunger.
- v. Insert plunger and spring assembly in the high speed spring retainer. Thread the idle screw (35) approximately 1 inch (2.54 cm) into the tapped end of the plunger. Thread the locknut (34) over the idle screw.
- w. Insert the low speed spring (39) in the low speed spring cap (40) and the small end of the spring seat (38) in the opposite end of the low speed spring (39).
- x. Insert low speed spring seat and low speed spring and cap assembly in the high speed spring plunger (37) with the spring seat (38) against the shoulder of idle screw (35).

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)

- y. Start the governor high speed spring assembly into the opening of the control housing (27) and thread the high speed spring retainer (33) in the housing approximately 1 inch (2.54 cm).
- z. Install high speed spring cover gasket (31), housing (30), mounting lockwashers (29), and capscrews (28).



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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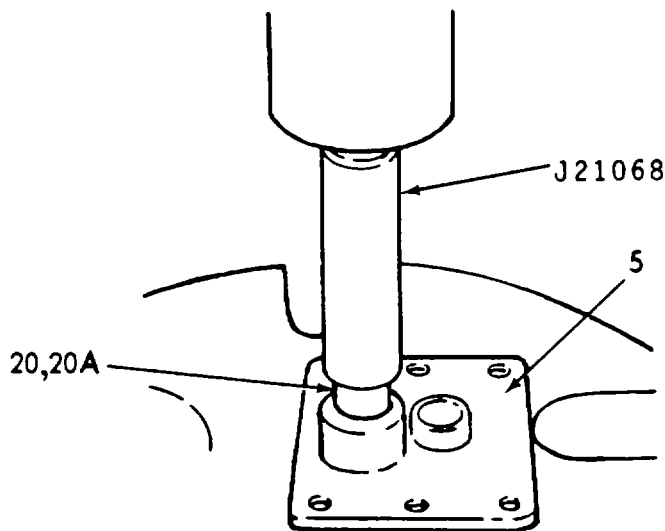
ASSEMBLY (Cont)

9. Governor Cover	<p>a. Place governor cover (5) on bed of an arbor press with inner face of cover <u>down</u>.</p> <p>b. Start upper bearing (20) straight into bearing bore of cover <u>with number on bearing up</u>.</p>	If removed.
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NOTE

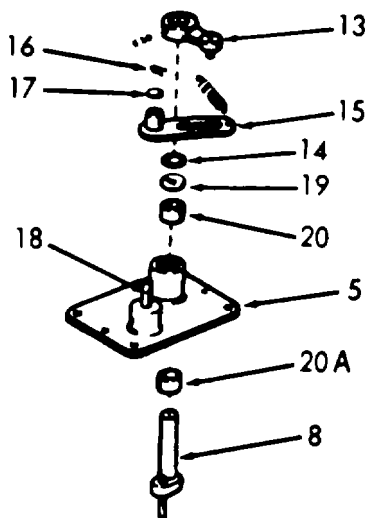
Do not use impact tools to install needle bearings.

- c. Insert bearing installer J21068 in bearing and press bearing in until shoulder on tool contacts cover (5).
- d. Turn cover over and start lower bearing (20A), number side up, in bearing bore. Press bearing in flush with cover, using tool J21068.



5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
ASSEMBLY (Cont)		
e.	Install dowel pin (18).	If removed.
f.	Install packing (19) in cover assembly (5).	
g.	Apply lubricant to dowel pin (18) and place cam (15) over dowel pin with boss of cam up.	
h.	Place washer (17) over pin and secure with retaining ring (16).	
i.	Pack needle bearings (20 and 20A) with grease. Then, slide throttle shaft (8) through bearings.	Install pin in throttle shaft if removed.
j.	Place flatwasher (14) over shaft.	
k.	Start lever assembly (13) over throttle shaft (8) with holes in lever and shaft in alignment for installation of the straight pin.	Install pin in lever assembly (13), if removed.



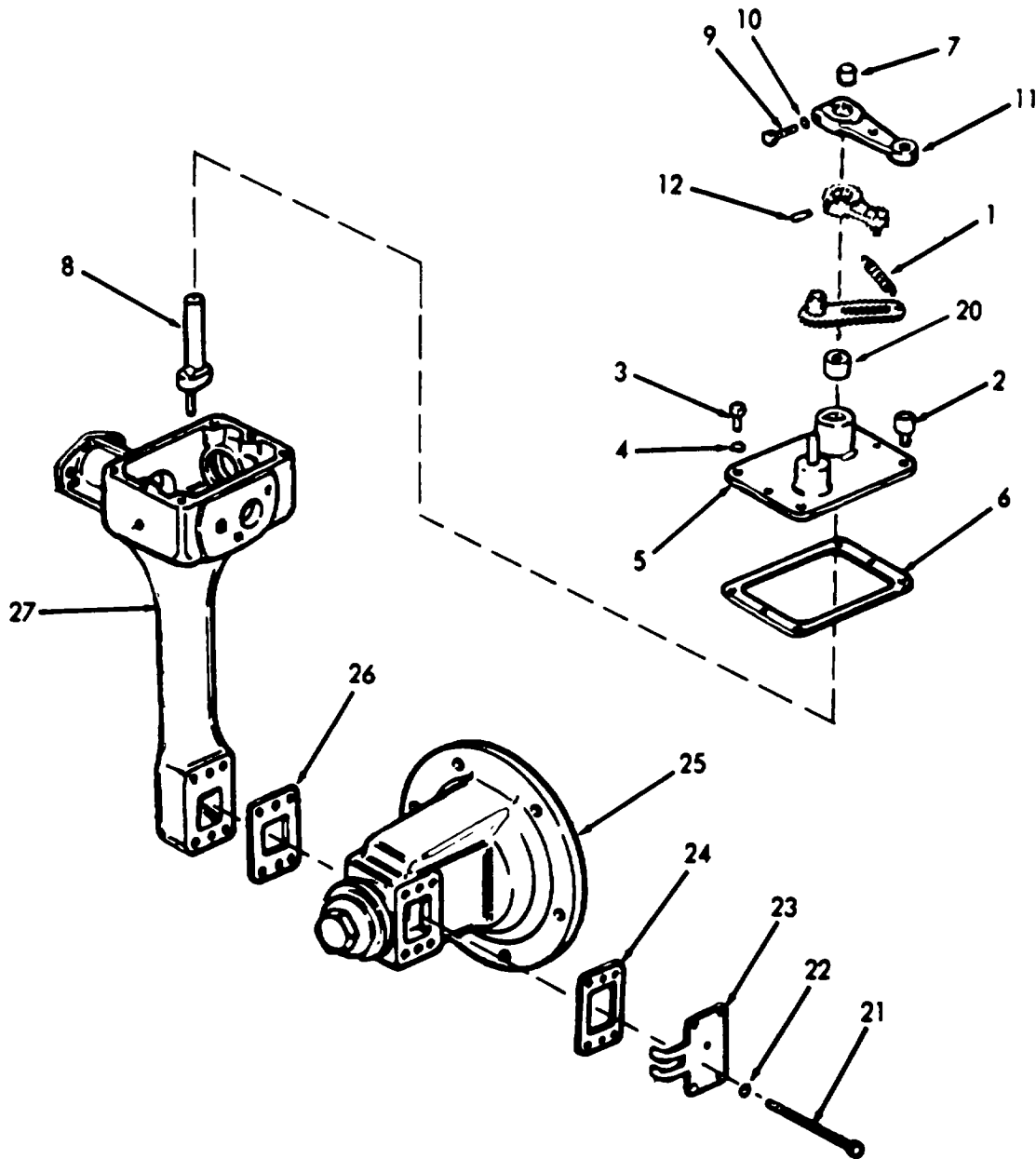
5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>ASSEMBLY (Cont)</u>		
10. Governor	<ul style="list-style-type: none"> <li>i. Support the lower end of throttle shaft on the bed of arbor press. Then, place a sleeve on throttle lever and under ram of press. Align the slot in cam with pin in throttle lever; then press the lever down on the shaft until hole in the lever is in line with the hole in the shaft. <li>m. Insert straight pin (12) in the hole of the lever. Support the lever and cover assembly on a steel block and drive the pin into place. <li>n. Position speed control lever (11) on throttle shaft (8), and tighten capscrew (9). <li>o. Install plug (7) in throttle shaft. <li>a. Assemble weight housing (25), gasket (26), and control housing (27). <li>b. Install gasket (24), weight housing cover (23) using screws (21) and lockwashers (22). <li>c. Install gasket (6) and cover (5) assembled on control housing (27). <li>d. Install three screws (3) and lockwashers (4). <li>e. Install special screw (2) and spring (1). 	Install lock-washer (10), and capscrew (9), if removed.

5-29. ENGINE SPEED GOVERNOR (Continued).

LOCATION/ITEM	ACTION	REMARKS
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ASSEMBLY (Cont)



INSTALLATION

11. Refer to paragraph 5-14 and install and adjust governor.

5-30. TRANSMISSION CONTROL VALVE.

LOCATION/ITEM	ACTION	REMARKS
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GENERAL

The control valve assembly consists of a master selector valve for controlling both engines of the power unit simultaneously and separate shutoff control valves for controlling the flow of the oil to each individual engine marine gear. Three oil passages, for forward drive, for reverse drive, and for neutral and lubrication, are provided in each reverse gear housing. Oil grooves and passages are machined in the selector control valve so that, when it is rotated to the forward position by the lever, oil is admitted to the forward oil passage in the gear housing. When the selector control valve is rotated to the reverse position, oil is admitted to the reverse oil passage. The neutral (lubricating) oil passage is never cut off regardless of the position of the selector control valve.

This task covers:

- | | | |
|----------------|-----------------------|-----------------|
| a. Inspection | d. Cleaning | g. Reassembly |
| b. Removal | e. Inspection | h. Installation |
| c. Disassembly | f. Repair/Replacement | |

INITIAL SETUP

Test Equipment
NONE

References
NONE

Special Tools

NONE

Equipment
Condition Condition Description
Paragraph
NONE

Tools

General Mechanic's Tool Kit
NSN 5180-00-629-9783
Safety goggles

Special Environmental Conditions
NONE

Material/Parts

Cleaning solvent P-D-680
Sealing compound

Personnel Required

MOS 61C10

General Safety Instructions

Observe WARNING in procedure.
in procedure.

5-30. TRANSMISSION CONTROL VALVE (Continued).

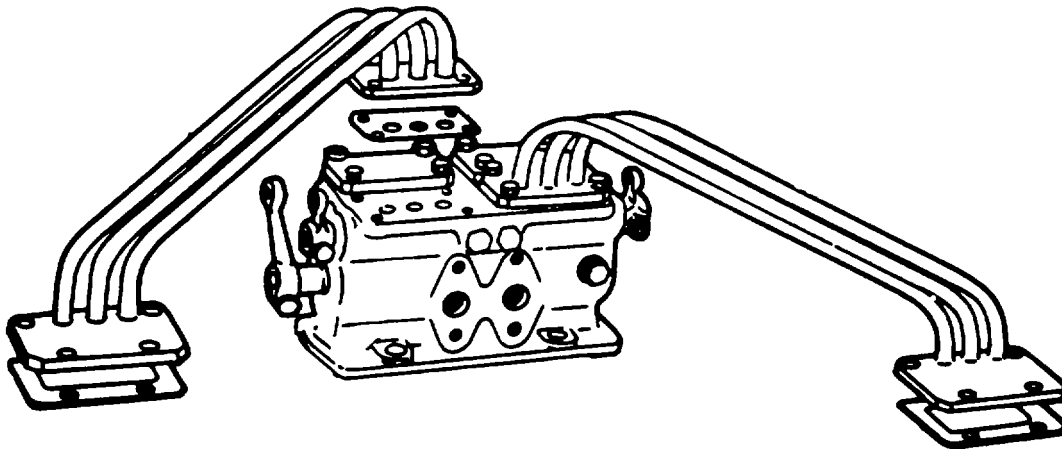
LOCATION/ITEM	ACTION	REMARKS
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NOTE

The transmission control valve is mounted on the reduction gear housing at the rear of the engine.

INSPECTION

1. Transmission Control Valve	<p>a. Inspect oil supply hoses and inlet tubes for loose mountings, leaking, cracks, or deterioration.</p> <p>b. Inspect control valve for loose mounting or evidence of leaking.</p> <p>c. Inspect oil cooler-to-control valve oil tubes for cracks, leaks, distortion, or other damage.</p>	<p>Located on back of control valve housing.</p>
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5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL

2. Transmission
Control
valve

NOTE

The transmission control valve is mounted on the reduction gear housing at rear of engine.

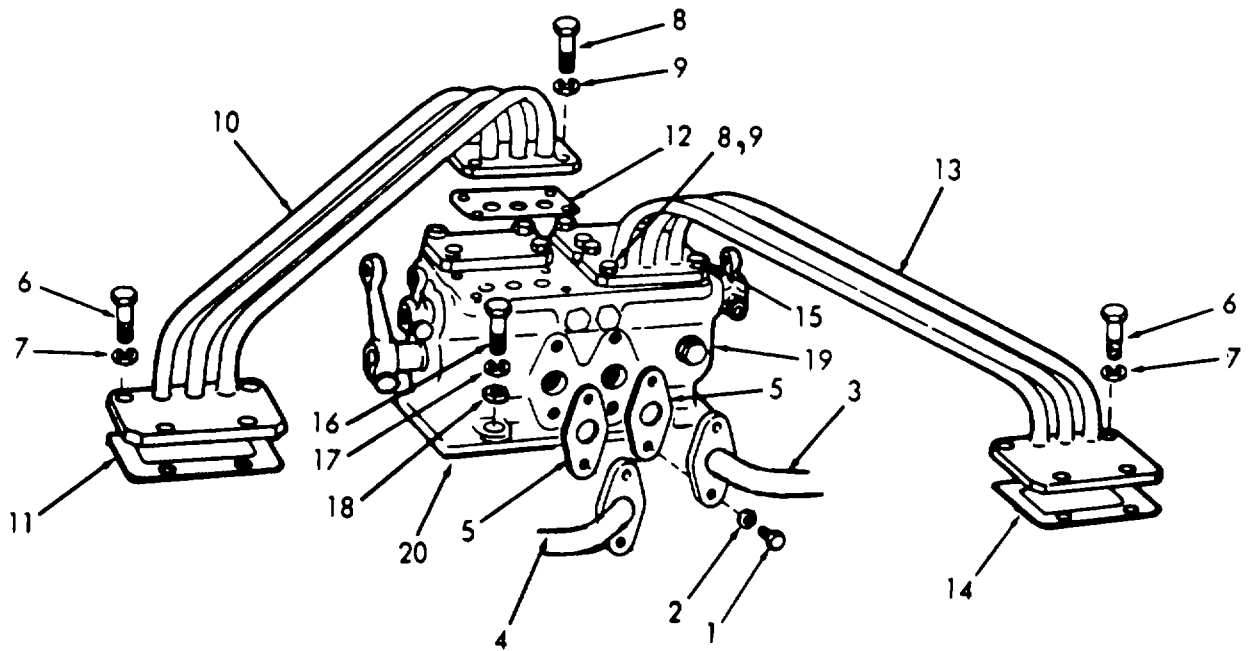
- | | | |
|----|---|-------------------------------|
| a. | Disconnect operating linkage from control valve. | |
| b. | Remove bolts (1) and lock-washers (2) from oil supply hoses. | |
| c. | Remove hose assemblies (3 and 4), and gaskets (5) from control valve (19). | Discard gaskets. |
| d. | Remove bolts (6) and lock-washers (7) securing each tube assembly to reverse gear housings. | |
| e. | Remove capscrews (8) and non-metallic washers (9) securing tube assemblies to top of the control valve. | Discard non-metallic washers. |
| f. | Remove tube assembly (10), and gaskets (11 and 12). | Discard gaskets. |
| g. | Remove tube assembly (13) and gaskets (14 and 15). | Discard gaskets. |
| h. | Remove capscrews (16), lock-washers (17), and flatwashers (18) securing control valve (19) to reduction gear housing cover. | |

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REMOVAL (Cont)

- | | | |
|----|---|----------|
| i. | Lift control valve assembly (19) from reduction gear housing cover. | |
| j. | Remove mounting gasket (20). | Discard. |

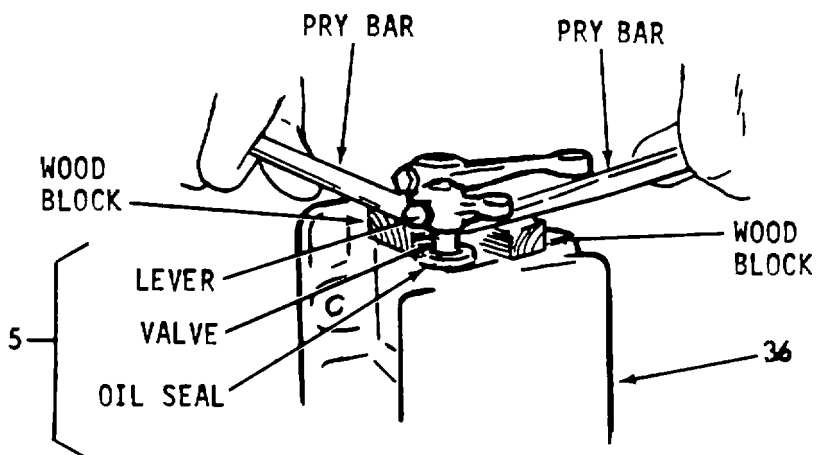


5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- | | | |
|------------------|--|-----------------------------|
| 3. Control Valve | <p>a. Remove screw assemblies (1) and flatwashers (2) from shutoff valve.</p> <p>b. Remove capscrew (3), and washer (4).</p> <p>c. With control valve housing (36) supported in a vertical position, place two small wood blocks on the end of the housing and, using pry bars spaced 180° apart under the shutoff valve lever as shown, pry shutoff valve and oil seal assembly (5) out of the housing.</p> | One for each shutoff valve. |
|------------------|--|-----------------------------|



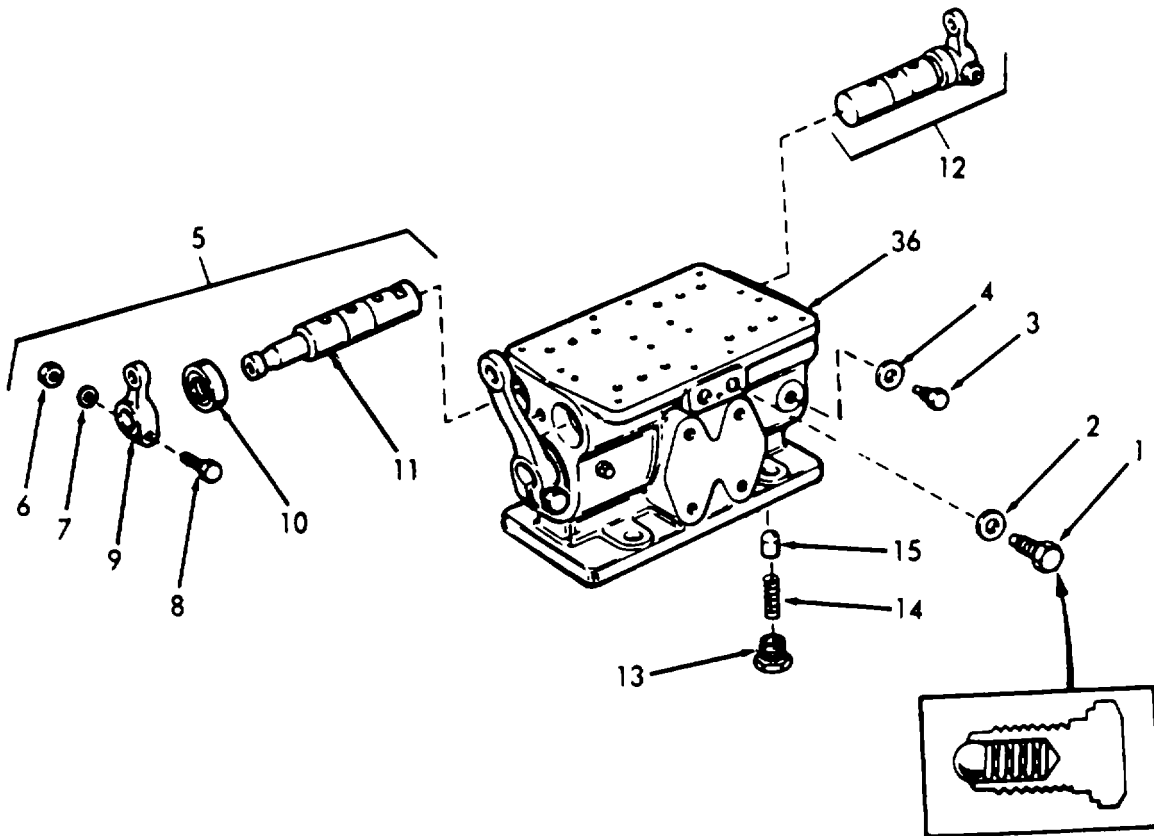
- d. Remove hex nut (6), lock-washer (7), and capscrew (8) from shutoff valve lever (9).

5-30. TRANSMISSION CONTROL VALVE (Continued).

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

DISASSEMBLY (Cont)

- | | | |
|----|---|------------------------------------|
| e. | Tap lever (9) and remove from end of shutoff valve (11). | Use soft hammer. |
| f. | Remove oil seal (10) from valve (11). | |
| g. | Remove other shutoff valve (12) as detailed in steps c through f above. | |
| h. | Remove pipe plug (13), helical spring (14), and plunger (15). | Located on bottom side of housing. |

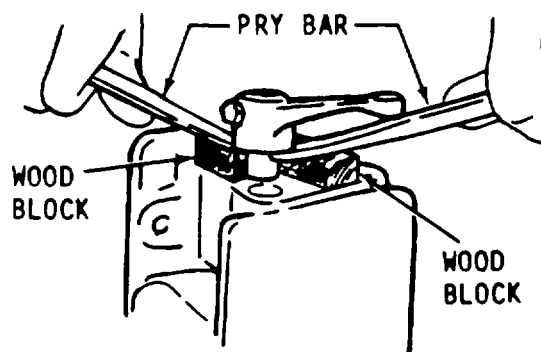


5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- i. Support housing in a vertical position with operating lever (19) end up. Place two small wood blocks on end of housing and, using pry bars spaced 180° apart under selector valve lever, pry selector valve oil seal out of housing as shown. Then, remove master selector valve and oil seal as an assembly (16) from housing.



- j. Remove capscrew (17), and lockwasher (18) from operating lever (19).
- k. Tap lever (19) and remove from end of master valve (21).

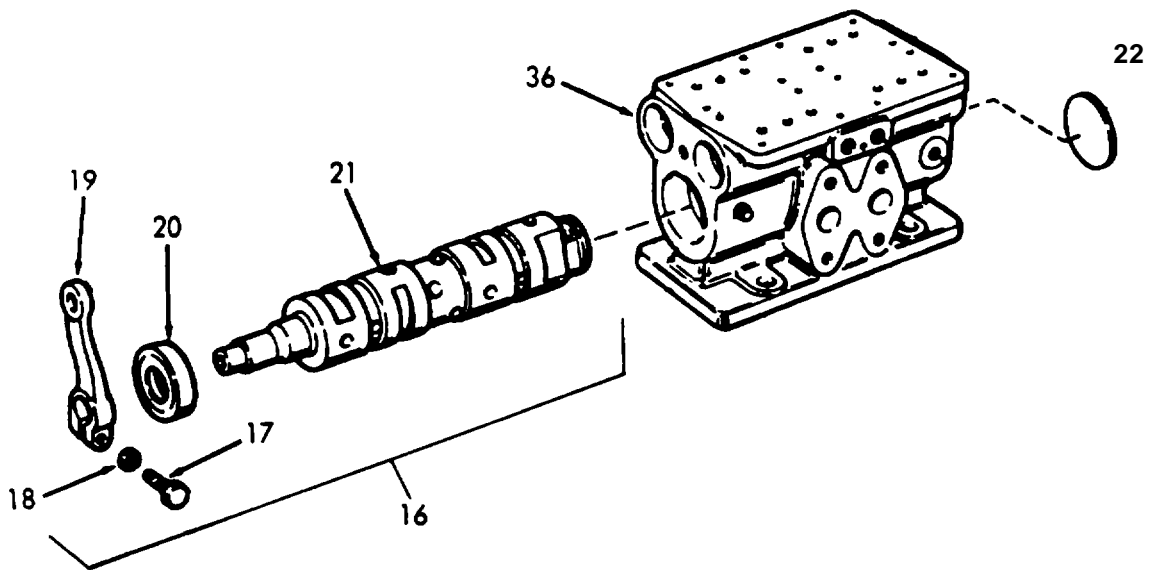
Use a soft hammer.

5-30. TRANSMISSION CONTROL VALVE (Continued).

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

DISASSEMBLY (Cont)

- l. Remove oil seal (20) from master valve (21).
- m. Remove expansion plug (22) from housing (36). Insert a 1/2 inch (12.7mm) diameter steel rod approximately 10 inches (254.mm) long, through the selector valve opening in the housing and rest it against the plug. Tap the end of the rod with a hammer and drive the plug out of the housing.



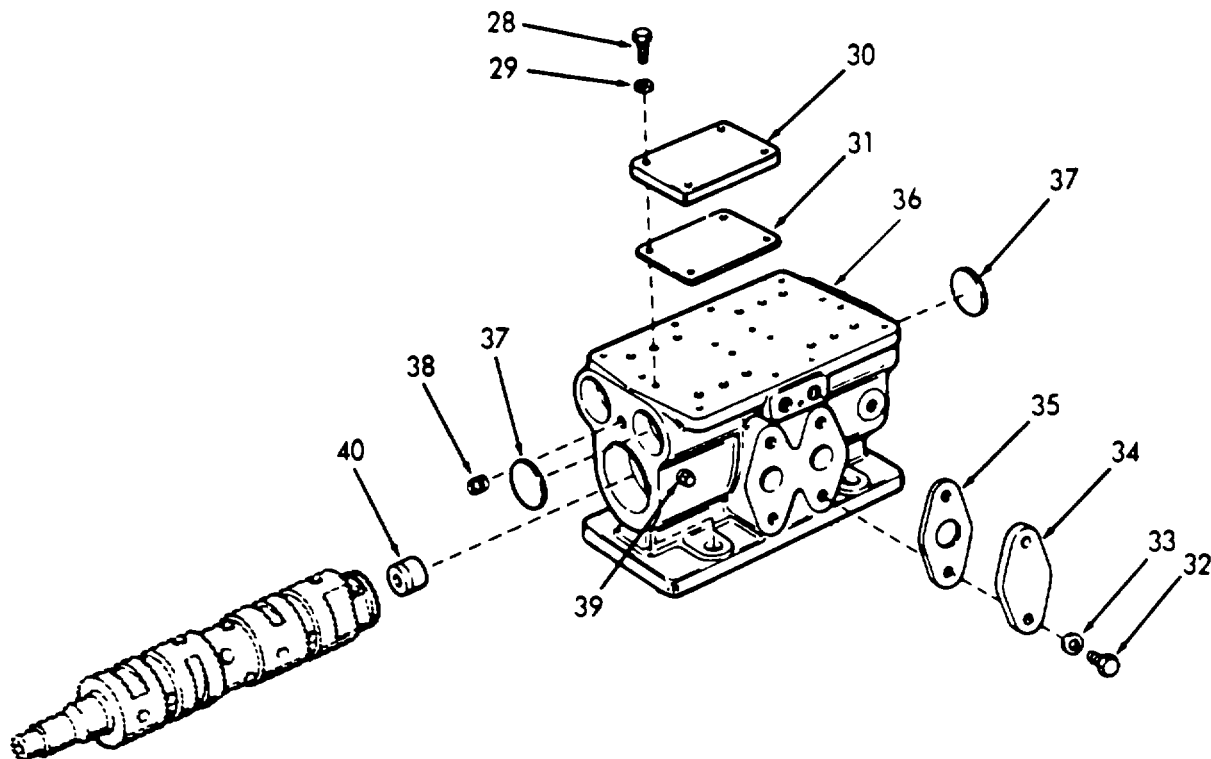
5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>DISASSEMBLY (Cont)</u>		
n.	Remove machine bolts (28), and lockwashers (29), from housing (36).	
o.	Remove oil line flange covers (30), and cover gaskets (31) from housing (36).	Discard gaskets.
p.	Remove expansion plugs (37), and pipe plugs (38 and 39).	If necessary.
q.	Remove plug (40), cap-screws (32), and non-metallic washers (33), from housing (36).	Discard gaskets.
r.	Remove covers (34) and cover gaskets (35) from housing (36).	

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)



CLEANING

4. **WARNING**

Dry cleaning solvent, P-D-680, used to clean parts, is potentially dangerous to personnel and property. Avoid repeated or prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100[±] - 138°F (38[±] - 59°C).

- a. Clean all metal parts of control valve in cleaning solvent P-D-680 and dry thoroughly.

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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CLEANING (Cont)**WARNING**

Wear safety goggles when using compressed air to avoid possible eye injury.

- b. Clean all oil passages with compressed air.

INSPECTION

- 5.
 - a. Inspect lips of oil seals for rough or charred spots.
 - b. Inspect selector valve and shutoff valves for score marks or roughness.
 - c. Inspect selector valve and shutoff valve locating screw balls for scoring or wear.
 - d. Inspect housing for cracks, or breaks, and threaded parts for thread damage.
 - e. Inspect operating levers for cracks, breaks, or burrs.

REPAIR/REPLACEMENT

- 6.
 - a. Replace damaged or defective threaded parts as required.
 - b. Replace all oil seals.
 - c. Replace all gaskets.

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REPAIR/REPLACEMENT (Cont)**NOTE**

The selector valve, shutoff valves and control valve housing are not serviced separately.

- d. Replace defective selector valve.
- e. Replace damaged or defective housing.
- f. Replace other damaged or defective parts as required.
- g. Remove all traces of gasket material from housing, oil hole covers, and flanges of oil tube assemblies.

REASSEMBLY

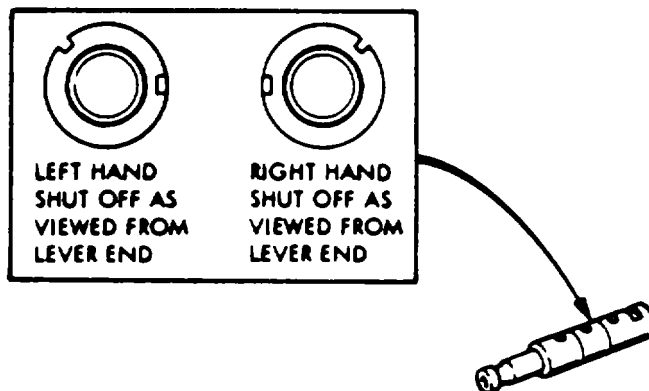
- 7. Shutoff Valve

NOTE

The right-hand and left-hand shutoff valves must be assembled in the correct bores in the control valve housing; therefore, viewing the control valve housing from the end, the right-hand shutoff valve must be assembled into the upper right-hand opening in the housing, and the left-hand shutoff valve into the upper left-hand opening in the housing. Right-hand and left-hand shutoff valves may be identified from the two end views of the valves as shown on the following page.

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- a. Install plugs (39, 38, and 37) in housing.
- b. Place housing (36) on work bench with top of housing facing up.
- c. Lubricate shutoff valve (11) with clean engine oil.
- d. Start valve straight into bore of housing with locating screw slot in alignment with locating screw hole in side of housing.
- e. Slide valve into housing until slot in valve is in line with locating screw hole.
- f. Place flatwasher (2) over end of locating screw assembly (1). Install screw in housing with steel ball (41) in end of screw registering with slot in shutoff valve.

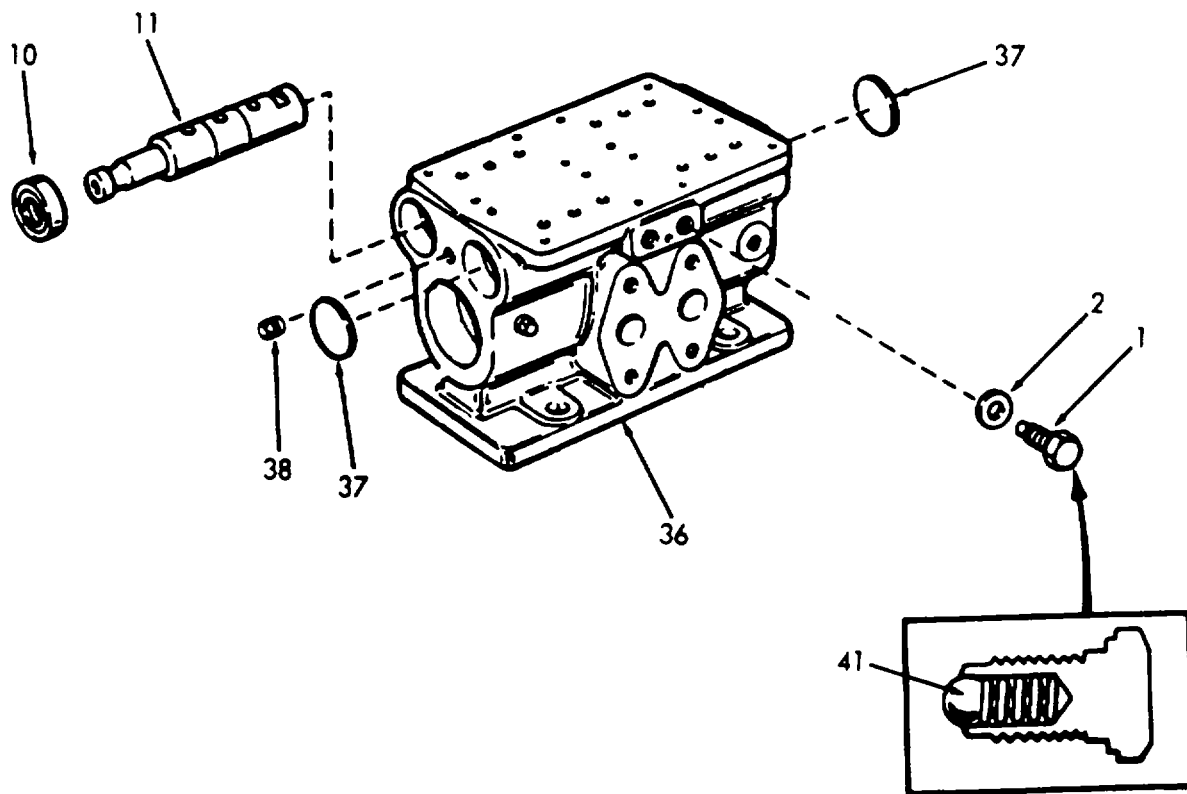
Torque screw to
35-39 lb. ft.
(47.5-52.9 Nm).

5-30. TRANSMISSION CONTROL VALVE (Continued).

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

REASSEMBLY (Cont)

- g. Place housing in a vertical position with outer end of shutoff valve facing up.
- h. Apply a thin coat of sealing compound to outside diameter of oil seal (10).

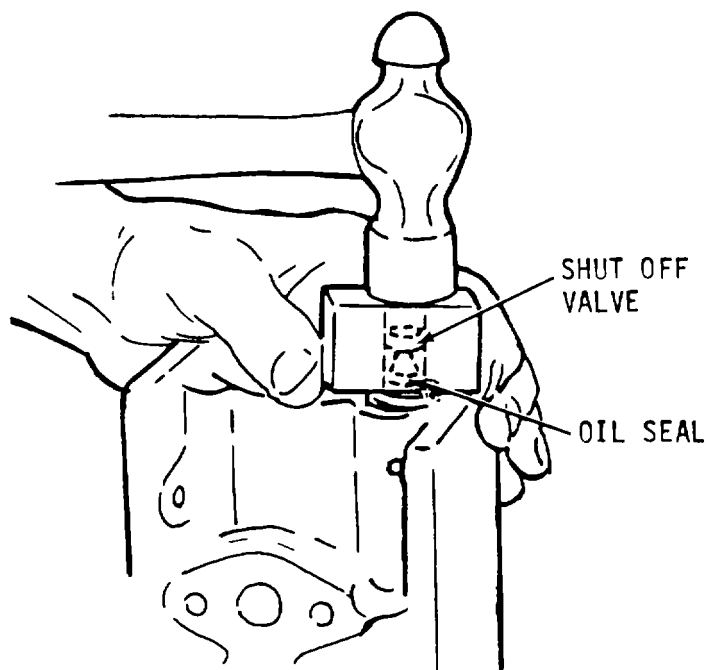


5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM**ACTION****REMARKS**

REASSEMBLY (Cont)

- i. Place oil seal (10) over end of valve with lip of seal facing housing. Then, start seal straight into housing.

**CAUTION**

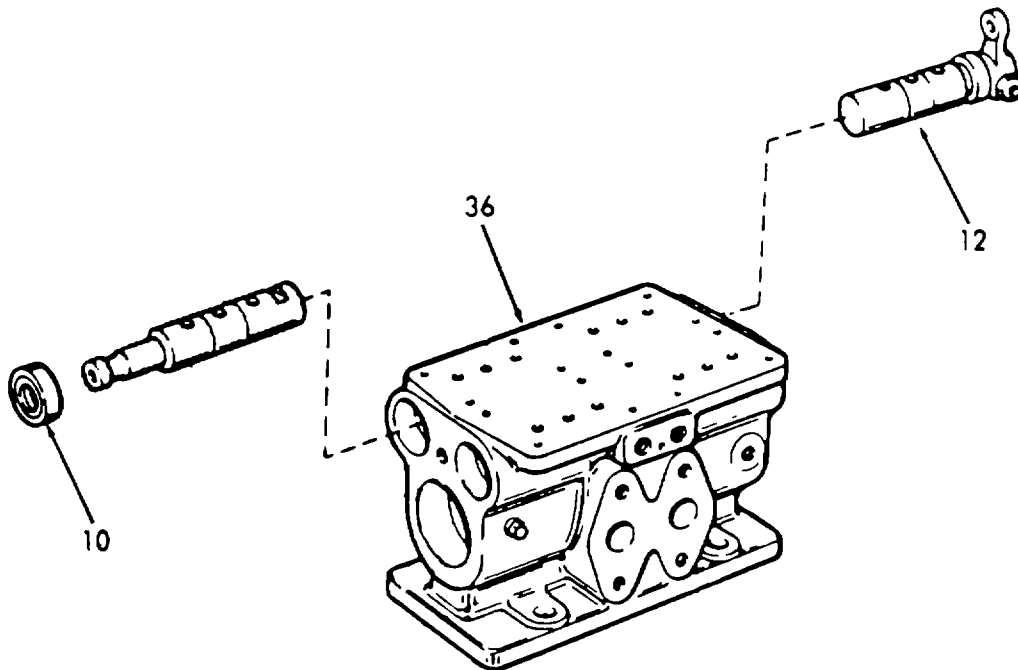
Do not damage lip when installing the oil seal over the end of the shutoff valve.

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- j. Place a small wood block 1 inch thick (25.4mm) with a 1/2 inch (12.7mm) hole drilled through its center over the end of the shutoff valve and against the oil seal as shown. Then, tap the oil seal (10) straight into the housing (36) until it is flush with the outside face of the housing.
- k. Install other shutoff valve (12) and oil seal (10) in the same manner.



5-555

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>REASSEMBLY (Cont)</u>		
8. Selector Valve	<ul style="list-style-type: none"> a. Lubricate selector valve (21) with <u>clean</u> engine oil. b. Start locating screw slot end of selector valve (21) straight into housing (36) with locating screw hole in right-hand side of housing. c. Slide selector valve (21) in housing (36) until slot in valve is in line with locating screw hole. d. Place washer (4) over end of locating screw (3), and install screw in housing with end of screw registering with slot in valve. e. Place housing in a vertical position with lever end of valve facing up. f. Apply a thin coat of sealing compound to outside diameter of oil seal (20). g. Place oil seal over end of selector valve (21) with lip of seal facing housing. h. Start oil seal (20) straight into housing (36). 	<p>Torque screw to 13-17 lb. ft. (17.6-23.0 Nm).</p>

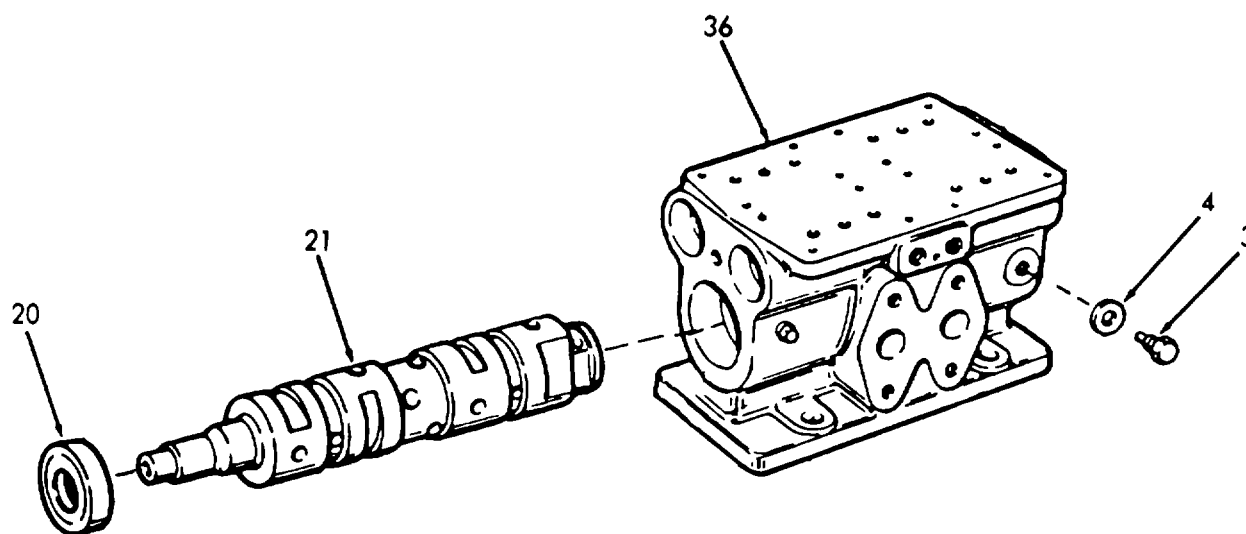
5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM**ACTION****REMARKS**

REASSEMBLY (Cont)**CAUTION**

Use care not to damage the lip when installing oil seal over the end and shoulder of the selector valve.

- i. Place a small wood block 1 1/2 inch (38.1mm) thick with a 7/8 inch (22.23mm) hole drilled through its center over the end of selector valve (21) and against oil seal (20). Tap the oil seal straight into the housing until it is flush with the outside face of housing.



5-30. TRANSMISSION CONTROL VALVE (Continued).

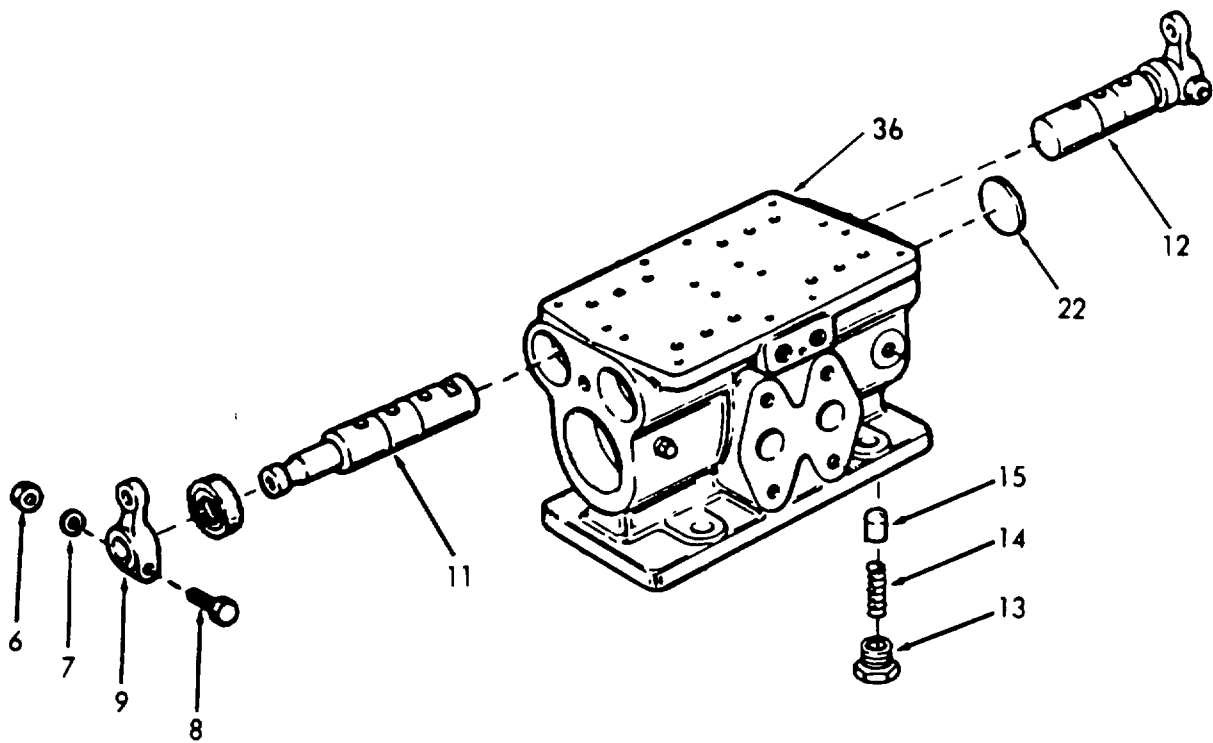
LOCATION/ITEM	ACTION	REMARKS
<u>REASSEMBLY (Cont)</u>		
9. Operating Lever, Pressure Regulating Valve, and Covers	a. If removed, apply a thin coat of sealing compound to the outside diameter of control valve housing plug (22). Place the plug in the opening in the end of the housing with the convex side of the plug facing out. Place a 1/2 inch (12.7mm) diameter drift against the center of plug; then, tap the drift with a hammer securing the plug in the housing.	
	b. Lubricate plunger (15) with <u>clean</u> engine oil.	
	c. Place pointed end of plunger (15) in housing.	Hole is in bottom side of housing.
	d. Insert spring (14) inside plunger and secure with pipe plug (13).	Torque pipe plug to 107-117 lb. ft. (145.1-158.6 Nm).
	e. Align oil passages in each shutoff valve (11 and 12) with oil passages in top of housing.	

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)

- | | | |
|----|---|--|
| f. | Place shutoff valve lever (9) on each valve with arm of lever pointing straight up. | |
| g. | Secure lever (9) to valve with screw (8), lockwasher (7), and nut (6). | Torque nut to 8-10 lb. ft. (10.8-13.6 Nm). |
| h. | Operate each shutoff valve for ease of operation. | |
| i. | Check alignment of the oil passages when levers are positioned straight up. | |



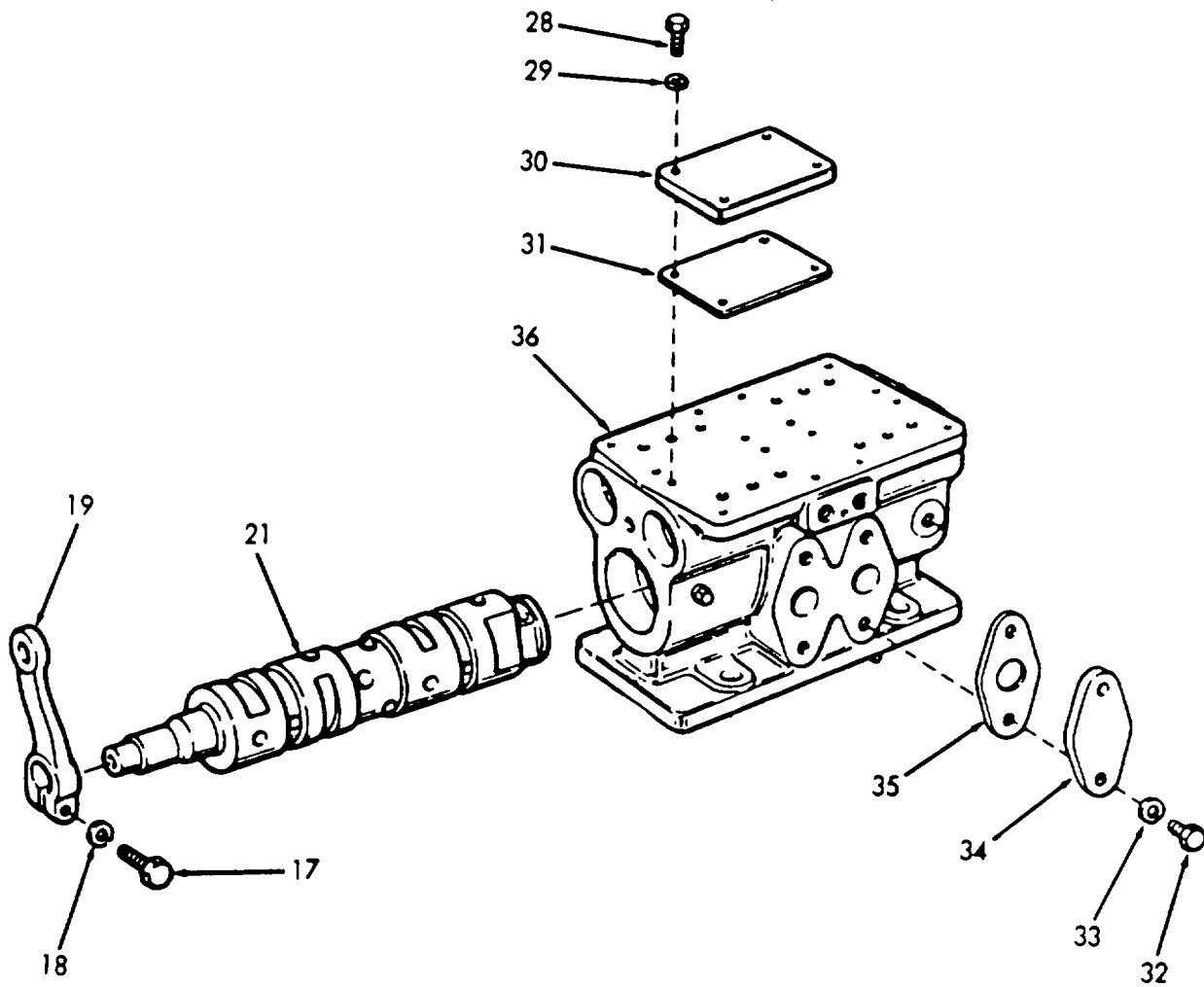
5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
<u>REASSEMBLY (Cont)</u>		
j.	Place selector valve (21) to neutral position midway between forward and reverse positions. Place operating lever (19) over end of valve (21) with arm of lever pointing straight up.	
k.	Place lockwasher (18) over capscrew (17) and install capscrew in lever (19).	Torque capscrew to 7-9 lb. ft. (9.5-12.2 Nm).
l.	Position cover gasket (31) in place on housing (36) and install cover (30) with lockwashers (29) and machine bolts (28).	Use new gasket. Torque bolts to 13-17 lb. ft. (17.6-23.0 Nm).
m.	Position cover gaskets (35) in place on housing, and install covers (34) with non-metallic washers (33) and capscrews (32).	Use new gaskets. Torque capscrews to 7-9 lb. ft. (9.5-12.2 Nm).

5-30. TRANSMISSION CONTROL VALVE (Continued).

LOCATION/ITEM	ACTION	REMARKS
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REASSEMBLY (Cont)



5-30. TRANSMISSION CONTROL VALVE (Continued).

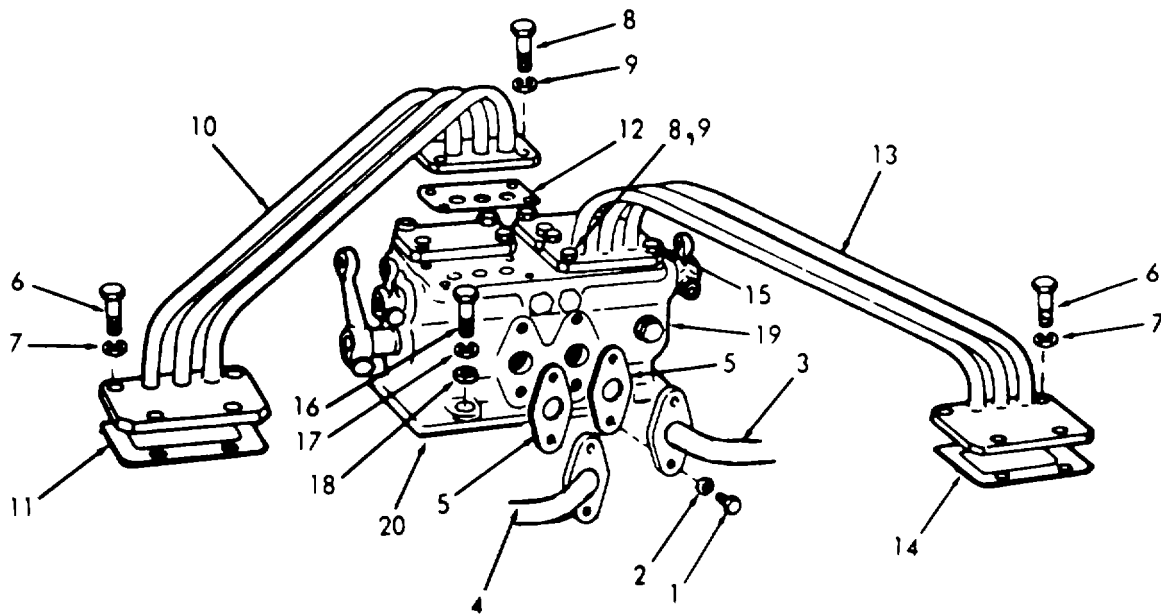
LOCATION/ITEM	ACTION	REMARKS
<u>INSTALLATION</u>		
10. Control Valve Assembly	a. Position <u>new</u> mounting gasket (20) in place over opening in top of reduction gear housing cover.	
	b. Place control valve assembly (19) over gasket with mounting capscrew holes in alignment, and end lever attaching end of selector valve facing control side of unit.	
	c. Secure with flatwashers (18), lockwashers (17), and capscrews (16).	Torque capscrews to 35-39 lb.ft. (47.5-52.9 Nm).
	d. Position oil cooler to control valve oil tube gaskets (5) in place on back of control valve housing (19).	Use new gaskets.
	e. Secure oil supply hoses (4 and 3) to housing with lockwashers (2) and bolts (1).	
	f. Position reverse gear inlet tube gaskets (15 and 14) in place.	Use new gaskets.
	g. Install inlet tube assembly (13) using lockwashers (7), non-metallic washers (9), capscrews (8), and bolts (6).	Torque capscrews to 7-9 lb. ft. (9.5-12.2 Nm), and bolts to 13-17 lb. ft. (17.6-23.0 Nm).
	h. Position reverse gear inlet tube gaskets (11 and 12) in place.	Use new gaskets.

5-30. TRANSMISSION CONTROL VALVE (Continued).

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

INSTALLATION (Cont)

- | | | |
|----|--|--|
| i. | Install inlet tube (10) using lockwashers (7), non-metallic washers (9), cap-screws (8), and bolts (6).
(9.5 - 12.2 Nm)
and bolts to
13-17 lb. ft.
(17.6-23.1 Nm). | Use new non-metallic washers.
Torque capscrews to 7-9 lb. ft. |
| j. | Reconnect operating linkage. | |



5-31. PILOTHOUSE CANOPY.

This task covers:

- a. Disassembly
- b. Reassembly

INITIAL SETUP

Test Equipment
NONE

References
Canopy Removal
(paragraph 4-14)

Special Tools

NONE

Equipment
Condition Condition Description
Paragraph NONE

Tools
General Mechanic's Tool Kit
NSN 5180-00-629-9783
Safety goggles

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required

MOS 61C
This task covers:

General Safety Instructions

NONE

LOCATION/ITEM

ACTION

REMARKS

DISASSEMBLY

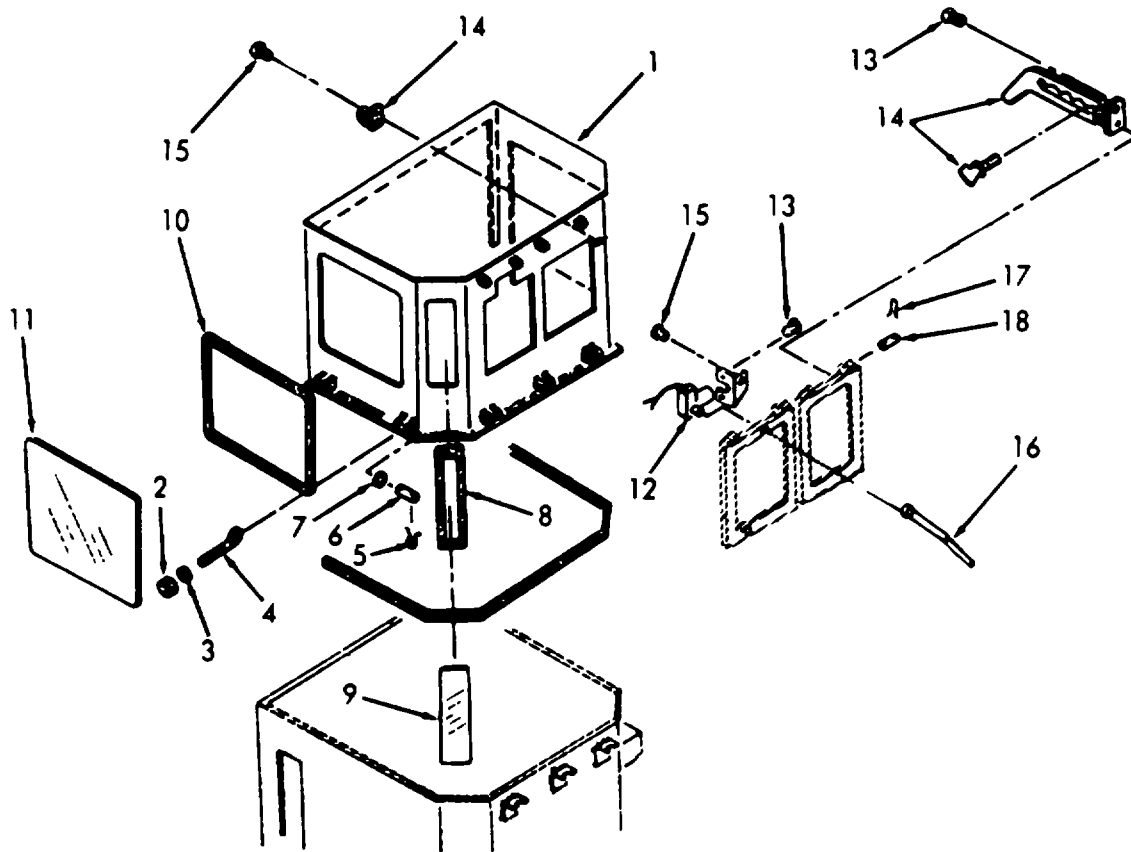
- | | |
|---------------|--|
| 1. Canopy (1) | <ul style="list-style-type: none"> a. Loosen and remove seven nuts (2), washers (3) from eyebolt (4). b. Remove seven cotter pins (5), hinge pins (6), washers (7) and remove eye bolts. c. Remove window lock (8) and glass (9). d. Remove window lock (10) and glass (11). |
|---------------|--|

5-31. PILOTHOUSE CANOPY (Continued).

LOCATION/ITEM	ACTION	REMARKS
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DISASSEMBLY (Cont)

- e. Disconnect lead on windshield wiper motor (12).
- f. Remove fasteners (13) and windshield adjuster assembly (14).
- g. Remove fastener (15) and remove windshield wiper motor and windshield wiper blades (16).



5-31. PILOTHOUSE CANOPY (Continued).

DISASSEMBLY (Cont)

- h. Remove cotter pin (17) and hinge pin (18) and remove windshield assembly (19).
- i. Remove window locks (20) and glass (21) from windshield assembly.
- j. Remove jam nut (22), plain nut (23), washer (24), and dog (25) from windshield assembly.

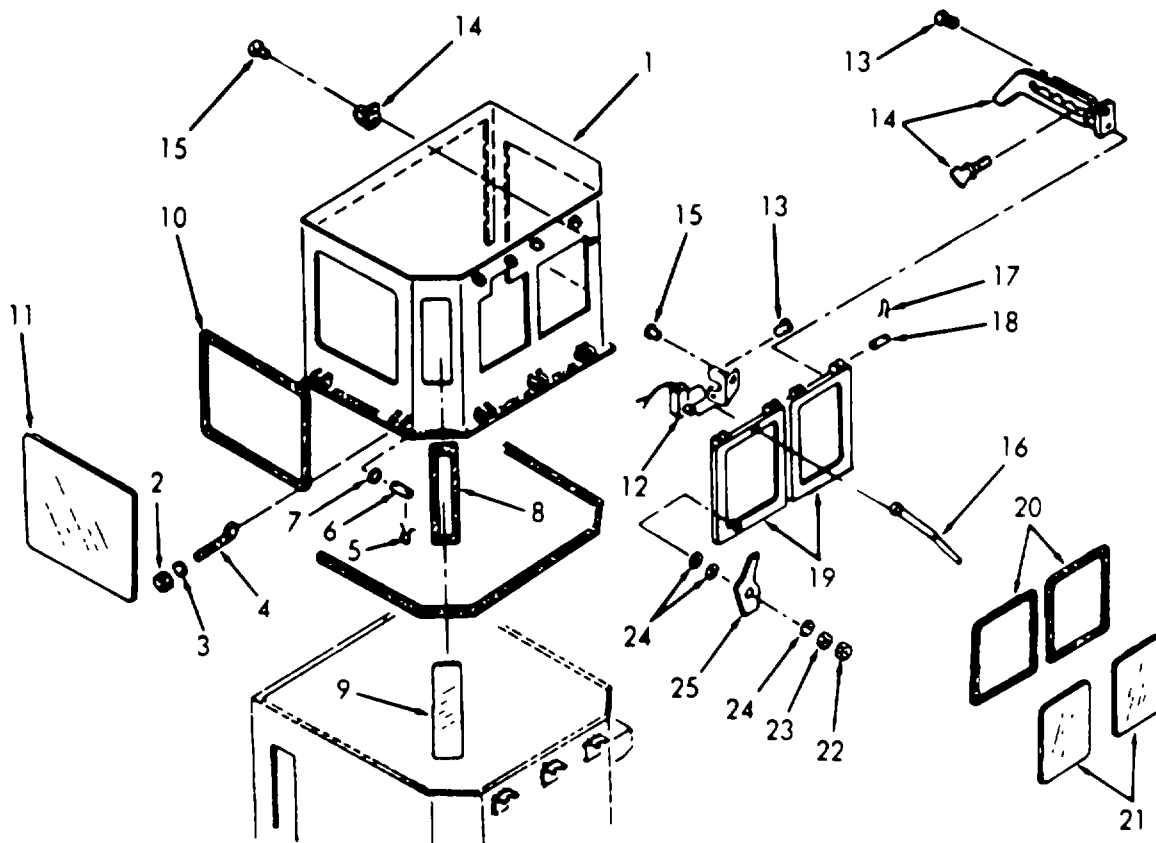
REASSEMBLY

- 2. Canopy (1)
 - a. Assemble dog (25) onto windshield assembly using washer (24), plain nut (23) and jam nut (22).
 - b. Install glass (21) into window locks (20) and install in windshield assembly (19).
 - c. Install windshield assembly onto canopy and secure with hinge pins (18) and cotter pin (17).
 - d. Install windshield wiper blades (16) and windshield motor and secure with fastener (15).
 - e. Install windshield adjuster assembly (14) and secure with fastener (13).
 - f. Connect lead on windshield wiper motor (12).
 - g. Install glass (11) into window lock (10) and insert into canopy.

5-31. PILOTHOUSE CANOPY (Continued).

REASSEMBLY (Cont)

- h. Install glass (9) into window lock (8) and insert into canopy.
- i. Install eye-bolts (4) and secure to canopy with washers (7), hinge pins (6) and cotter pins (5).
- j. Install washers (3), nuts (2) onto eye-bolt.



5-567/(5-568 blank)

By Order of the Secretary of the Army:

CARL E. VUONO
General United States Army
Chief of Staff


Official:

WILLIAM J. MEEHAN, II
Brigadier General, United States Army
The Adjutant General

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PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER			SIGN HERE	

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
 feet
 1 gram = 10 decigram = .035 ounce
 1 decagram = 10 grams = .35 ounce
 acres
 1 hectogram = 10 decagrams = 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

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
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	5/9 (after	Celsius	°C
	temperature	subtracting 32)	temperature	

PIN: 066243-000