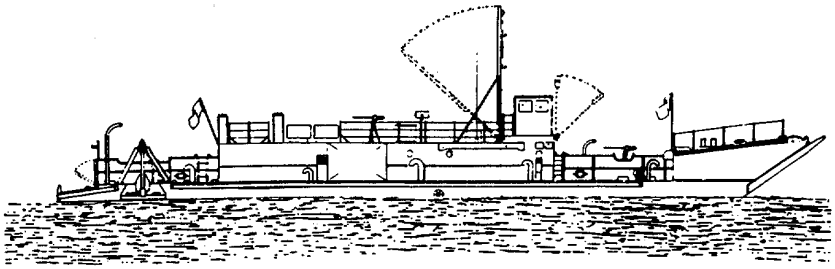
TECHNICAL MANUAL

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

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

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



This manual supersedes TM 55-1905-219-14-10, dated 19 September 1980.

HEADQUARTERS, DEPARTMENT OF THE ARMY

14 FEBRUARY 1985

CHANGE

NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 APRIL 1992

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

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

Approved for public release; distribution is unlimited.

TM 55-1905-219-14-10, 14 February 1985, is changed as follows:

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

Remove pages	Insert pages
5-649 and 5-650	5-649 and 5-650
5-661 and 5-662	5-661 and 5-662
5-665 and 5-666	5-665 and 5-666
5-683 and 5-684	5-683 and 5-684
5-697 through 5-702	5-697 through 5-702
FP-3/FP-4	FP-3/FP-4
FP-5/FP-6	
FP-9/FP-10	FP-9/FP-10
FP-11/FP-12	FP-11/FP-12
FP-21/FP-22	FP-21/FP-22
FP-27/FP-28	FP-27/FP-28
FP-29/FP-30	FP-29/FP-30

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

By Order of the Secretary of the Army:

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

Official:

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
00916

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25E, (qtyrqr block no. 1061)

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 11 April 1988

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

LANDING CRAFT UTILITY
LCU 1667-1670

NSN 1905-00-168-5764

TM 55-1905-219-14-10, 14 February 1985, is changed as follows:

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

Remove pages	Insert pages
5-313 and 5-314	5-313 and 5-314
5-315 and 5-316	5-316

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

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25A, Operator, Unit, Direct Support and General Support Maintenance requirements for Landing Craft, Utility, LCU- 1667-1670.

WARNING

DEATH

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

- Wear safety glasses, safety shoes, and a hard hat to provide adequate protection.
- Death or severe injury may result if personnel fail to use a lifting device that is adequate for the item to be lifted.
- Ear protection must be worn when engines or machinery are in operation.
- Use care when using power tools.
- If cleaning agents are used, be sure area is adequately ventilated, and use protective gloves and goggles, or face shield and apron.
- Avoid excessive injection of ether into an engine during starting attempts. Follow the instructions on the container or by the manufacturer of the starting aid.
- Use the recommended air pressure when using compressed air to clean components. Too much air pressure can rupture, or in some way damage a component and create a hazardous situation that can lead to personal injury.
- When working on an engine that is running, accidental contact with the hot exhaust manifold can cause severe burns.
- Use extreme care when near rotating fans, belts, and pulleys.
- Avoid making contact across the terminals of the batteries, and do not spill the contents of the battery.

WARNING (Continued)

- Keep clear of the Anchor Winch or Bow Ramp Winch while it is in operation.
- During any removal, disassembly, assembly, or installation of an electrical device, make sure all electrical power is disconnected and tagged. (Circuit breaker in the OFF position and tagged).
- Improper functioning of the Engine Exhaust System can cause injury or death.
- Personnel should know the location and operation of all equipment for emergency use.
- Before attempting to operate any equipment, read the instructions completely. Then, return to the appropriate section and follow the instructions.
- Do not enter the Winch Compartment alone.
- If the Halon Fire System is activated (horn sounds), leave the compartment immediately. Check that no one is left, and then close and dog the hatch.
- Use extreme care when handling gasoline for the Salvage Pump.
- Store all flammable material in the Flammable Storage Compartment.
- Prior to cutting or welding on the ramp, remove drain plugs on both sides of the ramp and check if ramp interior is primer coated. If primer coated, flush thoroughly with steam, carbon dioxide, or water. Do not reinstall drain plugs until the cutting and/or welding operation is completed. Failure to take this precaution may result in explosion of accumulated primer vapors.

Technical Manual

No. 55-1905-219-14-10

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *14 February 1985*

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

LANDING CRAFT UTILITY

LCU 1667-1670 NSN 1905-00-168-5764

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-MPS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

TABLE OF CONTENTS

		Page
CHAPTER 5.	DIRECT SUPPORT MAINTENANCE INSTRUCTIONS	5-1
APPENDIX A.	REFERENCES	A-1/A-2
APPENDIX B.	MAINTENANCE ALLOCATION CHART	B-1/B-2

CHAPTER 5

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

OVERVIEW

The direct support maintenance instructions in this chapter apply to the following:

DESCRIPTION	PARAGRAPH
Main Propulsion Engine and Marine Gear	5-3
Electric Power Generation and Distribution	5-28
Bow Ramp and Winch	5-47
Stern Gate	5-53
Anchor Handling System	5-57
Mast	5-84
Ships Hydraulic System	5-85
Steering Systems	5-102
Pump Sets	5-118
Sewage System	5-133
Heating, Ventilation and Air Conditioning System	5-134
Commissary Space	5-143
Fire Fighting System	5-146
Interior Communication System	5-147
Electronic Navigation Systems	5-153
Oil Water Separator	5-155
Piping Systems	5-156
Vents and Sounding Tubes	5-165
Hull and Outfit	5-169

Chapter 3 contains the operator and organizational maintenance instructions for all major equipment.

Chapter 4 contains the operator and organizational maintenance instructions for all auxiliary equipment.

SECTION I. REPAIR PARTS, SPECIAL TOOLS, TMDE,

AND SUPPORT EQUIPMENT

5-1. GENERAL.

Repair parts, special tools, test, maintenance, diagnostic equipment, (TMDE), and support equipment are listed and illustrated in TM 55-1905-219-34P. All fabricated tools are listed in Appendix H.

SECTION II. TROUBLESHOOTING

5-2. GENERAL TROUBLESHOOTING.

a. This table lists the common malfunctions which you may find during the operation and maintenance of the landing craft.

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

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

d. Refer to Chapter 3 or 4 for the crew and organizational maintenance procedures.

Table 5-1. Fuel System-Injector-Incorrect Fuel Output Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Incorrect fuel output.	
Step 1.	Spray tip or orifices partially plugged. Clean the orifices with tool J4298-1 using the proper size wire.
Step 2.	Spray tip orifices enlarged. Replace the spray tip.
Step 3.	Carbon build-up in tip Ream the injector tip with tool J1243.

Table 5-1. Fuel System-Injector-Incorrect Fuel Output Troubleshooting (Cont).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Incorrect fuel output (Cont).	
Step 4.	Worn plunger and bushing. After the possibility of an incorrect or faulty tip has been eliminated and the injector output still does not fall within its specific limits, replace the plunger and bushing with a new assembly. **NOTE** The fuel output of an injector varies with the use of different spray tips of the same size due to manufacturing tolerances in drilling the tips. If the fuel output does not fall within the specified limits of the Fuel Output Check Table, try changing the spray tip. However, use only a tip specified for the injector being tested.
Step 5.	Cracked valve parts. Replace the cracked parts.
Step 6.	Cracked bushing. Replace the plunger and bushing assembly.
Step 7.	Poor lapped surfaces. Re-lap the sealing surfaces.
Step 8.	Foreign material between valve and seat. Disassemble the injector and clean the parts.
Step 9.	Rack and gear not in time. Assemble the gear with the drill spot mark on the tooth engauged between the two marked teeth of the rack.

Table 5-2. Fuel System-Injector-Low or High Valve Opening Pressure Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Low valve opening pressure.	
Step 1.	Worn or eroded needle valve or valve seat in tip.
	Replace the needle valve and tip assembly.
Step 2.	Worn or damaged needle valve quill.
	Replace the needle valve and tip assembly.
Step 3.	Worn or damaged needle valve spring seat.
	Replace the spring seat.
Step 4.	Worn or broken valve spring.
	Replace the valve spring.
Step 5.	Dirt or foreign material in injector.
	Disassemble the injector and clean the parts.
2. High valve opening pressure.	
Step 1.	Carbon or foreign material in spray tip.
	Carbon in the tip should be removed with tip reamer J9464 which is especially designed and ground for this purpose.
Step 2.	Carbon in tip orifices.
	Check the hole size of the spray tip orifices. Then, using tool J4298-1 with the proper size wire, clean the orifices.

Table 5-3. Fuel System-Injector-Insufficient Injector Holding Time Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Insufficient injector holding time troubleshooting.
Step 1. Poor bushing to body fit. Lap the injector body.
Step 2. Injector nut not tightened to specified torque. Tighten the nut to a 75-85 lb-ft torque. Do not exceed the specified torque.
Step 3. Cracked spray tip. Replace the needle valve and spray tip assembly.
Step 4. Worn or eroded needle valve. Replace the needle valve and spray tip assembly.
Step 5. Worn or eroded needle valve seat in spray tip. Replace the needle valve and spray tip assembly.
Step 6. Worn or broken valve spring. Replace the valve spring.
Step 7. Worn or damaged valve spring seat. Replace the valve spring seat.
Step 8. Defective seal ring. Replace the seal ring.
Step 9. Body plug leaks. Install new body plugs.
Step 10. Filter gaskets leak. Replace the filter cap gaskets and tighten the filter caps to 65-75 lb-ft torque.

Table 5-3. Fuel System-Injector-Insufficient Injector Holding Time Troubleshooting (Cont).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. Insufficient injector holding time troubleshooting (Cont).	
Step 11.	Poor sealing surfaces on fuel fittings. Clean up the sealing surfaces or replace the filter caps, if necessary. Replace the filter if a cap is replaced.
Step 12.	Dirt or foreign material in injector. Disassemble the injector and clean the parts.

Table 5-4. Anchor Winch-Slack Puller Fluid Motors Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
1. External Leakage.	
Step 1.	Seal failure. Replace seal.
Step 2.	Defective casting. Replace casting.
2. Leakage from vent port.	
Step 1.	"O" ring failure Replace seal.
Step 2.	Shaft seal failure. Replace shaft seal; check pressure in drain line should not exceed 100 psi.

Table 5-4. Anchor Winch-Slack Puller Fluid Motors Troubleshooting (Cont).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

3. Leakage at fittings.

Step 1. Cracked casting.

Replace.

Step 2. Defective threads.

Replace.

Step 3. Damaged "O" ring.

Replace.

Step 4. Bump on mating surfaces.

Use flat file to make flat surface.

4. Loss in speed under load.

Step 1. Low inlet pressure.

Check pressure.

Step 2. Excessive back-pressure at outlet.

Check pressure.

Step 3. Scored port plate or end cap.

Relap flat to clean up.

Step 4. Worn cam ring and vanes.

Replace.

Step 5. High oil temperature (thins oil).

Use heavier oil; use oil cooler; use open center circuit; adjust relief valve setting.

5. Poor speed control.

Step 1. Excessive pump leakage.

Use more efficient pump. Use flow control valve.

Table 5-4. Anchor Winch-Slack Puller Fluid Motors Troubleshooting (Cont).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
6. Motor fails to start turning.	
Step 1.	Insufficient torque.
	Increase relief valve pressure setting.
Step 2	Excessive motor leakage.
	Check flow from motor outlet if excessive, check shuttle valve in front port plate. Pressure not loading-plate causing plate to move away from rotor.
Step 3.	Defective "O" ring on O.D. of front port plate.
	Cam ring worn; replace "O" ring if damaged.
Step 4.	Insufficient pump delivery.
	Pump worn.
7. Shaft play.	
Step 1.	Worn bearings.
	Replace.
Step 2.	Hammering coupling on shaft.
	Coupling bore should be slip fit on shaft.
8. Burst lines on motor housing.	
Step 1.	Excessive pressure.
	If high inertia load over runs motor, relief valve protection is required in one or possibly both lines between directional valve and motor. Use closed center valve with caution. Relief valve protection probably required as described above.
9. Excessive noise.	
Step 1.	Worn or damaged internal parts.
	Disassemble to remove rotor, vane, cam ring assembly. Inspect for excessive wear. Check condition of faces of port plate and end cap. Rework (lap) or replace if scuffed.

Table 5-5. Stern Gate and Mast Hydraulic Cylinder Troubleshooting.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Excessive side load on piston rod.
Step 1. Misalignment between cylinder and load.
Check alignment of rod with load connection at all points in stroke.
2. Contamination in cylinder.
Step 1. Dirty installation (rust scale, chips, sealant, etc.).
Clean and flush entire system deburr connections, etc.
Step 2. Exceptionally dirty environment.
Shield piston rod/bearing area from direct contact with contaminant.
Step 3. Worn rod scraper.
Replace when rod seals are changed.
3. Impact damage or broken parts.
Step 1. Cushions not properly adjusted.
Reference adjustment instructions in this manual.
Step 2. Lack of or improperly adjusted speed controls.
Add or adjust to reduce piston speed.
Step 3. Excessive system pressure.
Reduce to minimum required to move load.
4. Seal damage (loss of elasticity, shape, etc.).
Step 1. Excessive temperature in environment or system.
Install replacement seals with proper temperature rating.
Step 2. Cylinder stored in horizontal position for extended period.
Replace seals, store vertically with rod up.

SECTION III. MAINTENANCE INSTRUCTIONS

5-3. MAIN PROPULSION ENGINE AND MARINE GEAR-MAINTENANCE INSTRUCTIONS.

The following is an index to the maintenance instructions.

DESCRIPTION	PARAGRAPH
Propulsion Engine/Marine Gear Removal and Run-In Instructions	5-4
Marine Gear	5-5
Engine/Transmission Controls	5-6
Variable Speed Mechanical Governor	5-7
Blower	5-8
Fuel Injector	5-9
Expansion Tank	5-10
Water Manifold	5-11
Thermostat and Housing	5-12
Balance Weight Cover and Accessory Drive	5-13
Engine Supports, Lifter Brackets and Crankshaft Front Cover	5-14
Muffler	5-15
Lube Oil Pump	5-16
Lube Oil Pressure Regulator and Relief Valve	5-17
Flywheel and Housing	5-18
Camshaft and Gear Train	5-19
Cylinder Block	5-20
Hydrostarter	5-21
Accumulator	5-22
Hydrostarter Pump (Engine Driven)	5-23
Hydrostarter Solenoid	5-24
Reservoirs and Filters	5-25
Hydrostarter Piping (FWD Engine Room)	5-26
Hydrostarter Piping (AFT Engine Room)	5-27

5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Installation** **c. Alignment**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Cutting Tools
Welding Tools
Crane (20 ton)
Miscellaneous chains, etc.
Feeler gauge 0.002 inch
straight edge

Material/Parts

Engine Oil

Personnel Required

8

References

FO-1. Machinery-Vehicle Deck Access

Equipment
Condition Condition Description

NONE

Special Environmental Conditions

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

General Safety Instructions

Observe normal precautions when handling heavy equipment.

LOCATION	ITEM	ACTION	REMARKS

NOTE

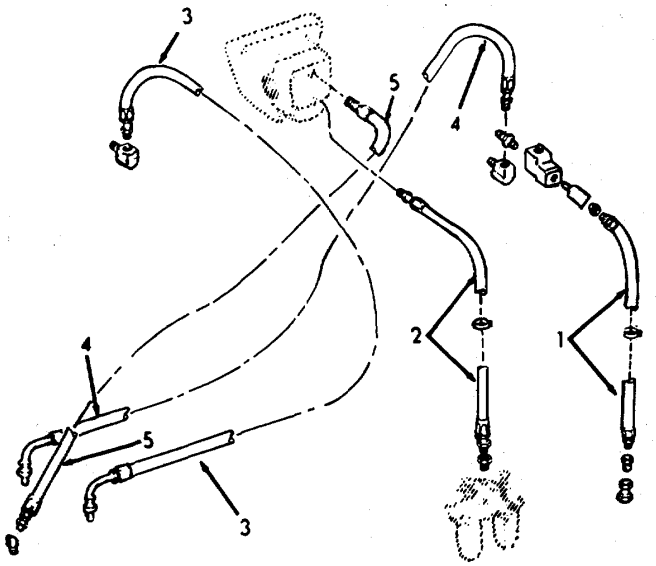
- Propulsion engine weight is 4925 lbs (2145 kg) dry.
- When a heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine gear coupling to prevent bending of the shaft.

WARNING

- To prevent the possibility of a fire when using cutting or welding equipment, place a crewman above and below the deck with a fire extinguisher.
- Keep clear of the area directly below the deck section being removed.

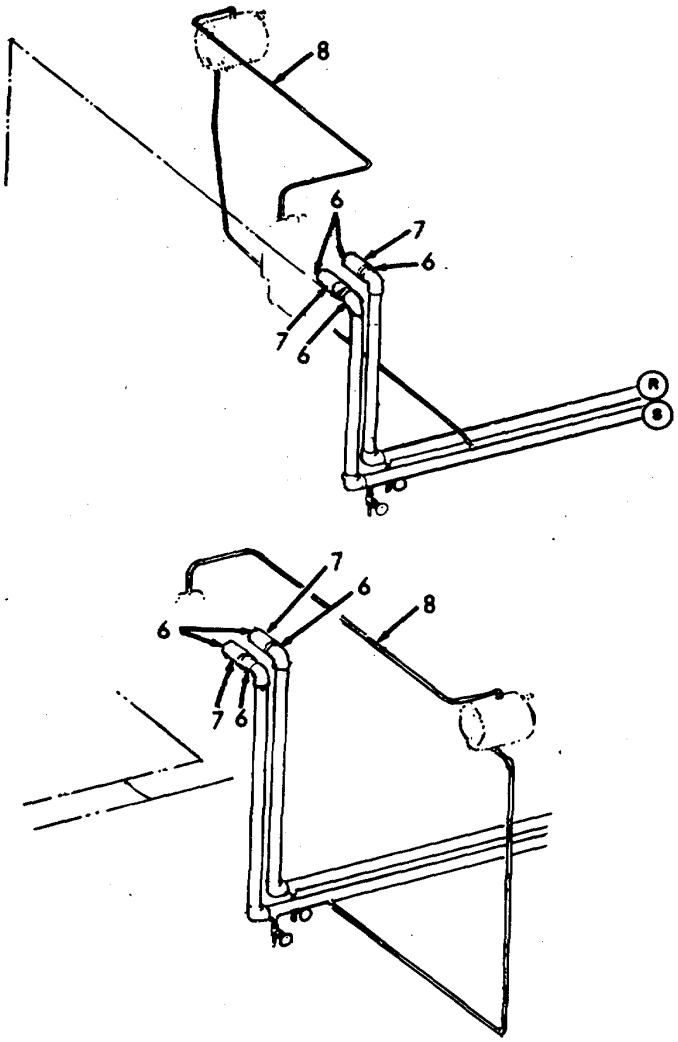
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Fuel Lines	a. Supply valves	Close.	
	b. Drain hose (1)	Drain fuel.	Use a suitable container.
	c. Fuel pump input hose (2)	Disconnect at fuel pump.	
	d. Hose to left bank (3)	Disconnect at cylinder head.	
	e. Hose to right bank (4)	Disconnect at cylinder head.	
	f. Hose to fuel pump (5)	Disconnect at fuel pump.	



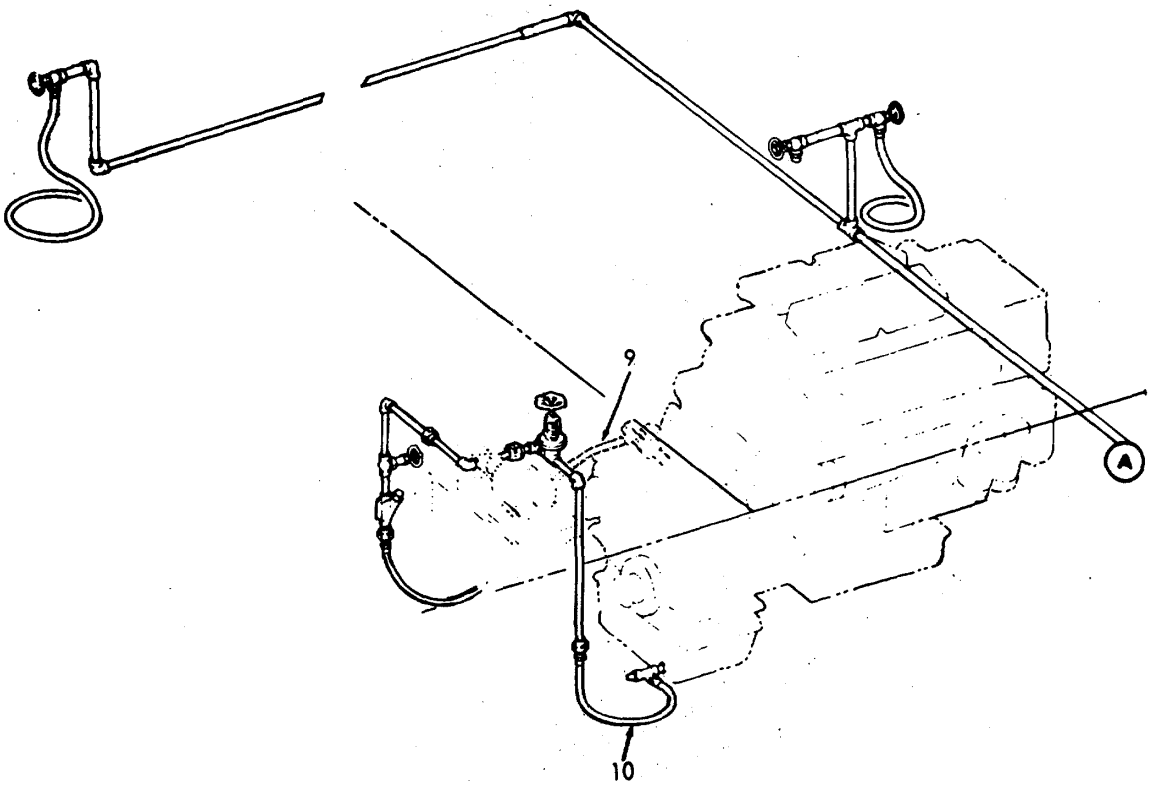
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2. Cooling Lines	a. Hose clamps (6)	Loosen.	
	b. Hoses (7)	Remove.	
	c. Tubing to expansion tank (8)	Remove.	



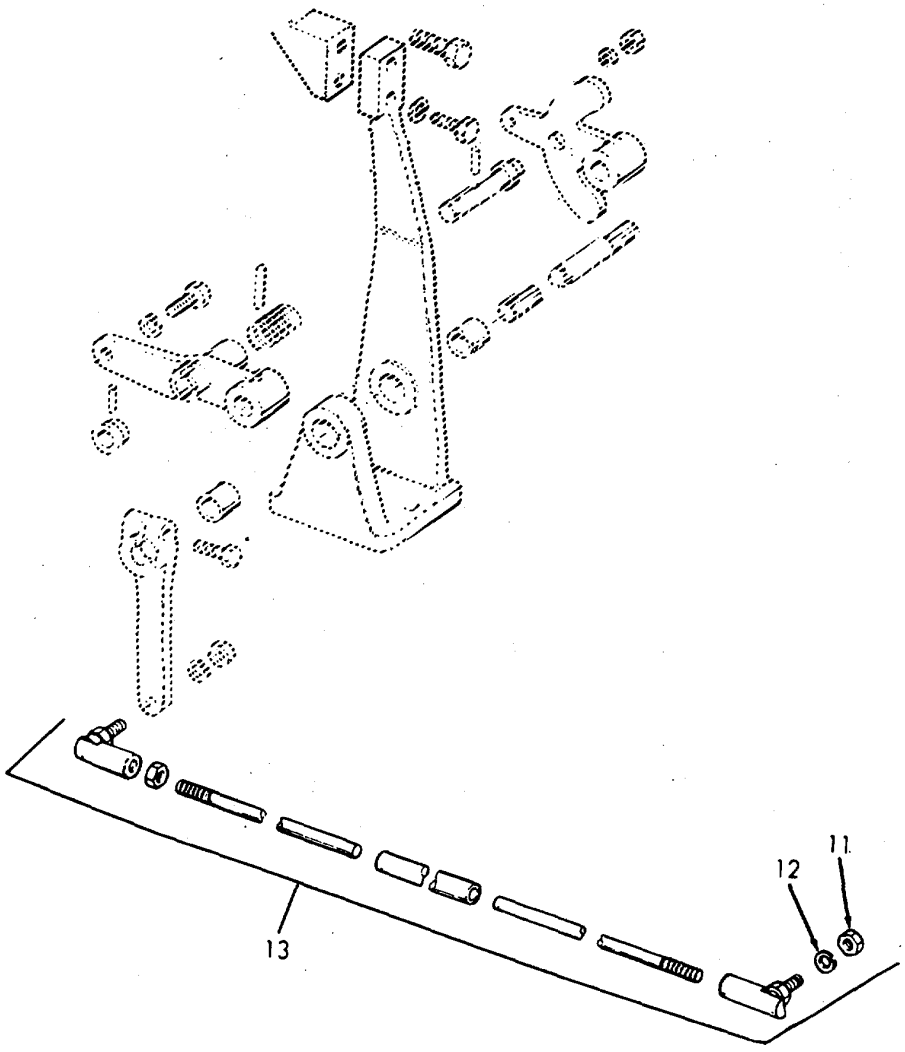
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
3. Marine Gear Lube Oil Piping	a. Hose (9)	Remove.	
	b. Hose (10)	Remove.	



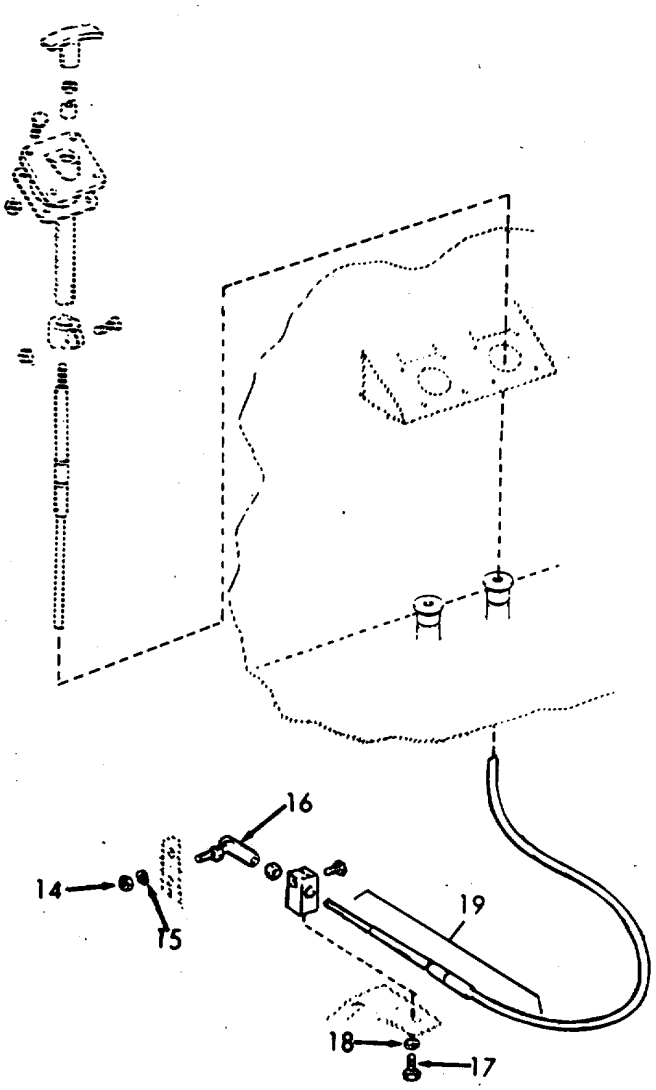
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Clutch Control Levers	a. Nut (11) and lock-washer (12)	Remove.	
	b. Control rod (13)	Remove.	



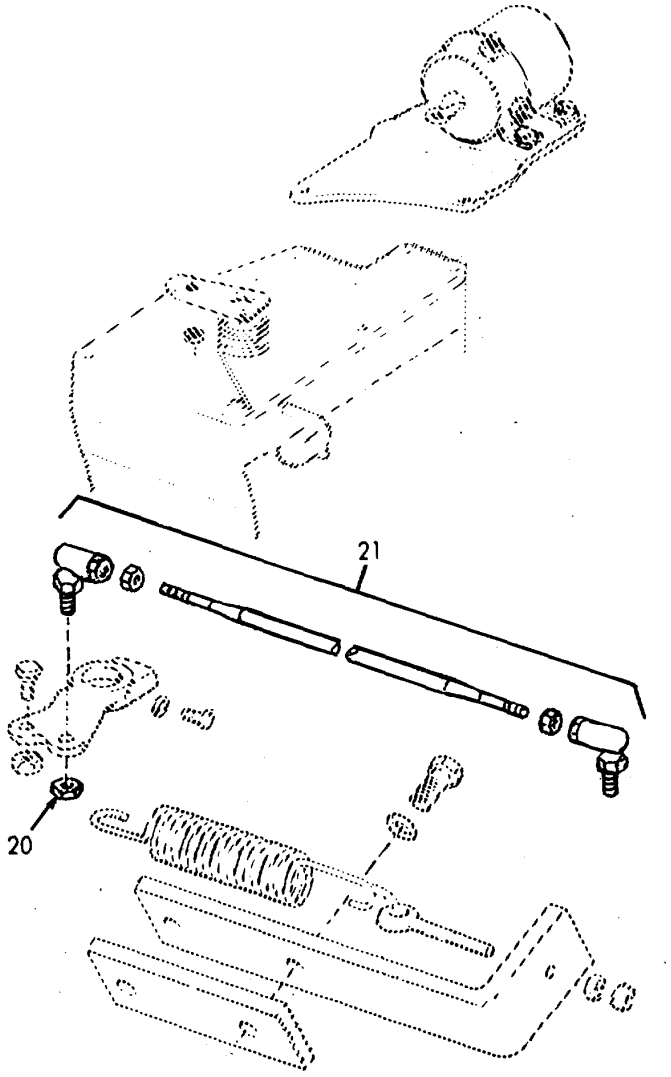
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
5. Shutdown Lever	a. Nut (14) and lock-washer (15)	Remove.	
	b. Ball joint (16)	Remove.	
	c. Screw (17) and lock-washer (18)		
	d. Control cable (19)		



5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
6. Throttle Control Lever	a. Nut (20)	Remove.	
	b. Control lever (21)	Remove.	

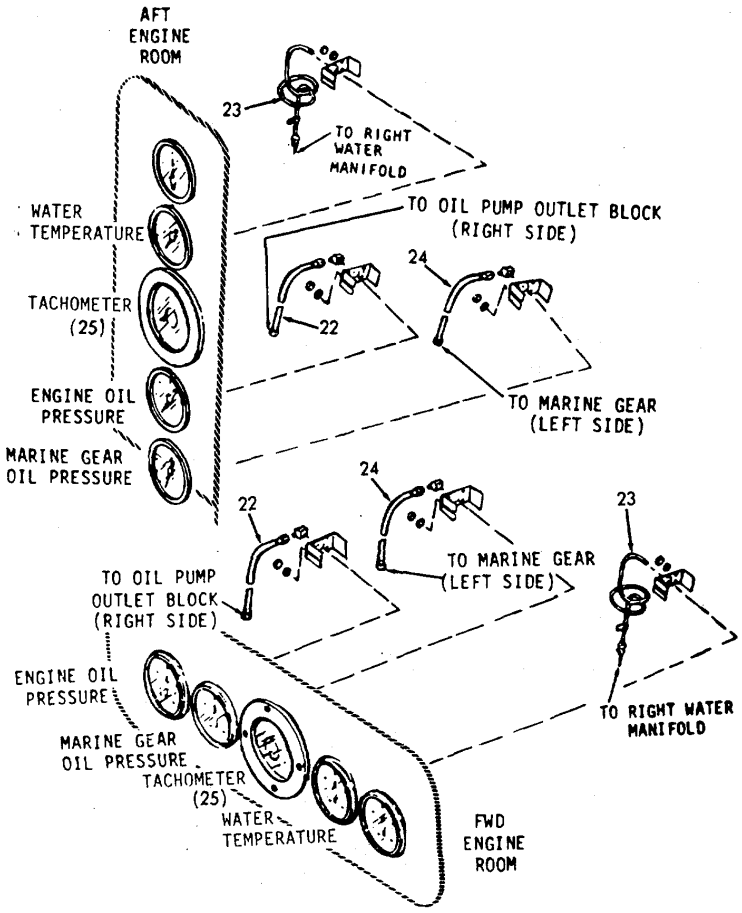


5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

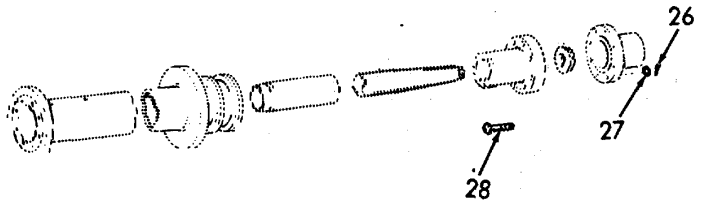
REMOVAL (Cont)|

7.	Instrument Panel	a. Oil pressure gauge line (22)	Remove.
		b. Water temperature gauge line (23)	Remove.
		c. Marine gear oil gauge line (24)	Remove.
		d. Tachometer (25) and motor wiring	Tag and disconnect.

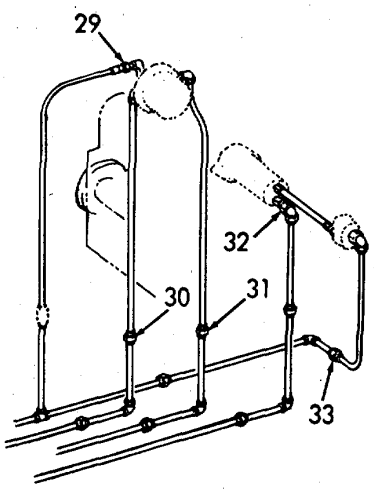


5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
8. Propeller shaft	a. Cotter pins (26)	Remove.	
	b. Nuts (27) and screws (28)	Remove.	

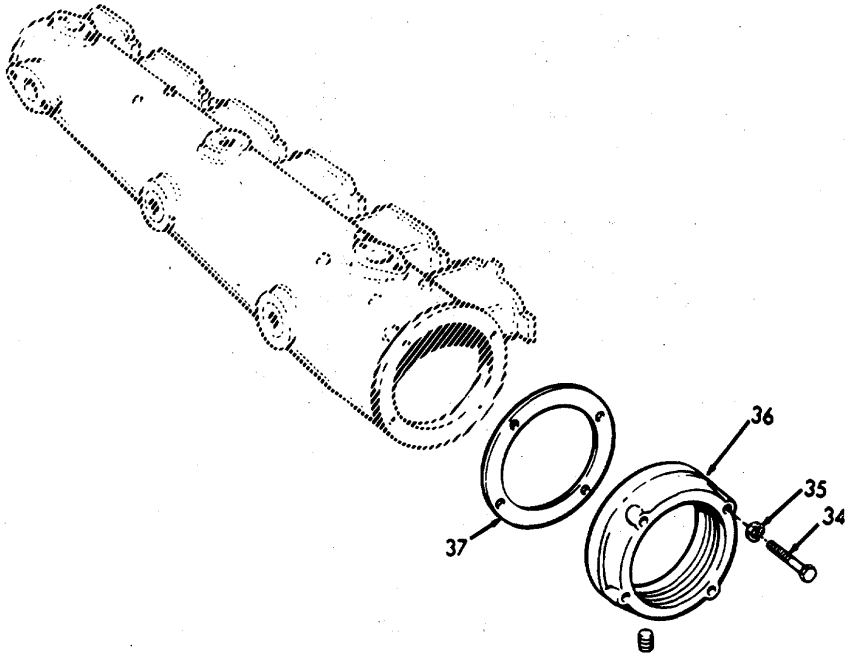


9. Hydro-starter piping	a. Hand pump relief valve	Open to reduce pressure in system.	
	b. Piping unions (29, 30 31, 32 and 33)	Separate.	



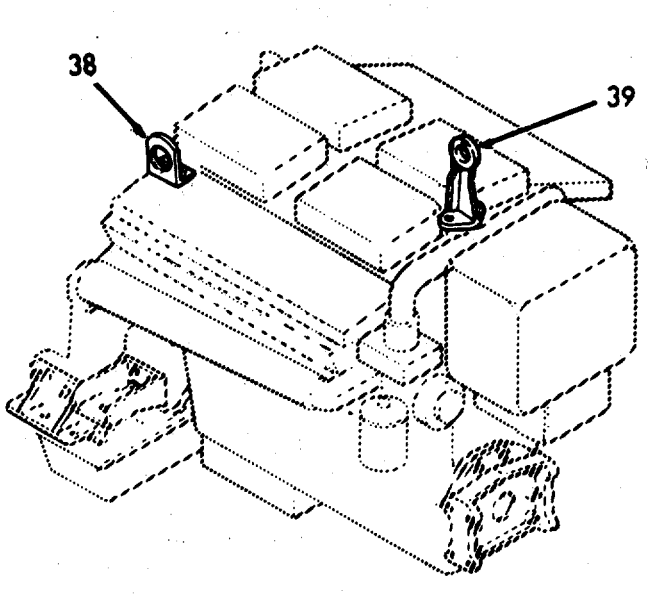
5-4. MAIN PROPULSION ENGINE/MARINE GEAR-REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
10. Exhaust Piping	a. Screws (34) and lock-washers (35)	Remove on both exhaust manifolds.	
	b. Flanges (36)	Slide up exhaust pipes.	
	c. Gasket (37)	Remove.	Discard.



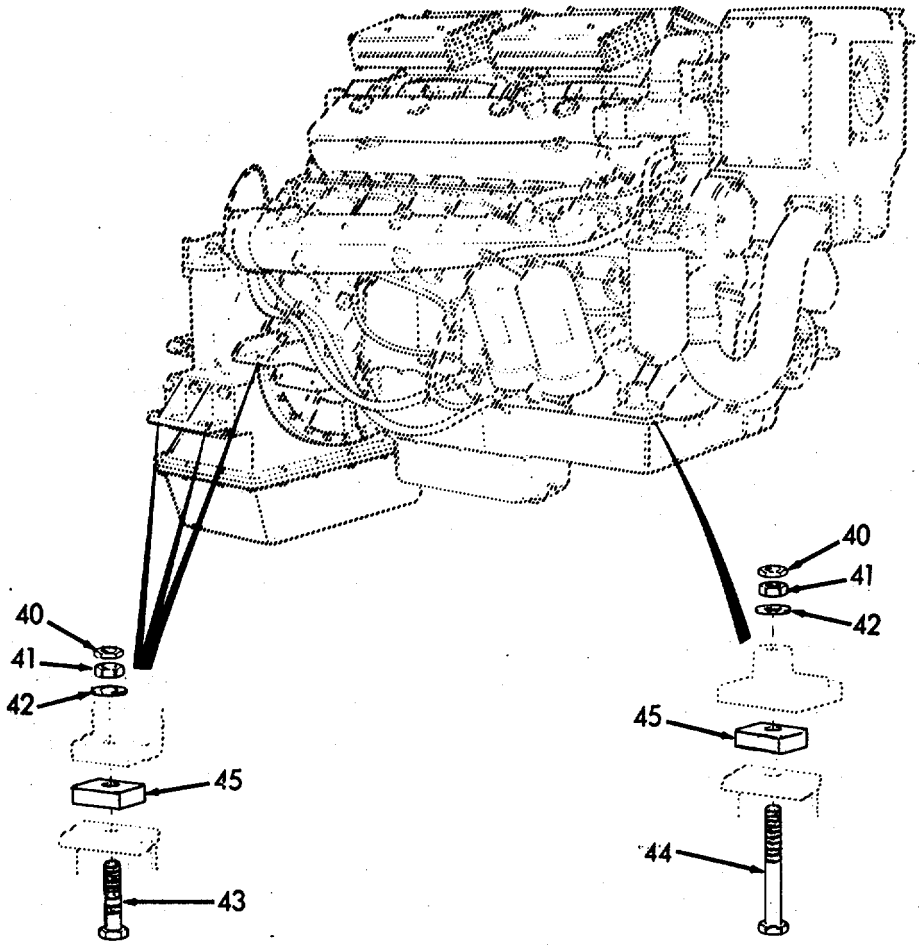
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
11. Alarms	Wiring	Tag and disconnect.	
12 Vehicle Deck	Deck plate	Remove.	Refer to FO-1.
13. Engine Room	a. Lifting brackets (38 and 39)	attach chains.	



5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Nuts (40 and 41) and flat washers (42)	Remove.	
	c. Screws (43) and (44)	Remove.	
	d. Liners (45)	Remove.	



5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
14. Vehicle Deck		Lift engine	
RUN IN			
15. MAIN PROPULSION ENGINE.			

a. Following a complete overhaul or any major repair job involving the installation of piston rings, pistons, cylinder liners or bearings, the engine should be "run-in" on a dynamometer prior to release for service.

b. The dynamometer is a device for applying specific loads to an engine. It permits the serviceman to physically and visually inspect and check the engine while it is operating. It is an excellent method of detecting improper tune-up, misfiring injectors, low compression and other malfunctions and may save an engine from damage at a later date.

c. The operating temperature within the engine affects the operating clearances between the various moving parts of the engine and determines to a degree how the parts will wear. Normal coolant temperature (160° -185° F) should be maintained throughout the run-in.

d. The rate of water circulation through the engine on a dynamometer should be sufficient to avoid having the engine outlet water temperature more than 10°F higher than the water inlet temperature. Though a 10° rise across an engine is recommended, it has been found that a 15° temperature rise maximum can be permitted.

e. Thermostats are used in the engine to control the coolant flow; therefore, be sure they are in place and fully operative or the engine will overheat during the run-in. However, if the dynamometer has a water stand-pipe with a temperature control regulator, such as a Taylor valve or equipment, then engine should be tested without thermostats.

f. The Basic Run-In Horsepower Schedule is shown in the Table. The horsepower shown in the table is at SAE conditions: dry air density .0705 lb/cu.ft., air temperature of 85°F and 500 ft. elevation.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

g. Dynamometer test and run-in procedures.

(1) The Basic Engine

(a) A basic engine includes only those items actually required to run the engine. The addition of any engine driven accessories will result in a brake horsepower figure less than the values shown in the Basic Engine Run-In Horsepower Schedule. The following items are included on the basic engine: blower, fuel pump, fresh water pump and governor.

(b) In situations where other than basic engine equipment is used during this test, proper record of this fact should be made on the Engine Test Report. The effects of this additional equipment on engine performance should then be considered when evaluating test results.

RUN-IN SCHEDULE

(Horsepower at SAE Conditions)
(Air Temperature 85° Elevation 500 ft.)
(Dry Air Density .0705 lb./cu.ft.)

BASIC RUN-IN BRAKE HORSEPOWER SCHEDULE

Time Minutes	Speed rpm	Injectors	12V-71 4-Valve
10	1200	A11	84
30	1800	A11	340
	2300	N-70	428

FINAL FULL POWER RUN-IN

1800	N-70	429
2000	N-70	466
2100	N-70	480
2300	N-70	500

ENGINE TEST REPORT

Date_____ Unit Number_____
Repair Order Number_____ Model Number _____

A Pre-Starting					
Prime Lube 1. Oil System	Prime Fuel 2. System	Adjust Valves 3. And Bridges	Time 4. Injector	Adjust 5. Governor	Adjust 6. Injector Racks

B Basic Engine Run-In						C Basic Run-In Inspection
TIME AT SPEED	TIME START STOP	RPM	BHP	WATER TEMP.	LUBE OIL PRESS.	1. Check oil at rocker mechanism
						2. Inspect for lube oil leaks
						3. Inspect for fuel oil leaks
						4. Inspect for water leaks
						5. Check and tighten all external bolts
						6.

D INSPECTION AFTER BASIC RUN-IN			
1. Tighten Cylinder Head & Rocker Shaft Bolts		4. Adjust Governor Gap	
2. Adjust Valves (Hot)		5. Adjust Injector Racks	
3. Time Injectors		6.	

E FINAL RUN-IN							
TIME		TOP RPM		BHP	AIR BOX PRESSURE FULL LOAD	EXHAUST BACK PRESSURE F/L	CRANKCASE PRESSURE F/L
START	STOP	NO LOAD	FULL LOAD				

BLOWER INTAKE RES. - F/L	FUEL OIL PRESSURE RET. MAN. F/L	WATER TEMP. FULL LOAD	LUBE OIL TEMP. F/L	LUBE OIL PRESSURE		IDLE SPEED
				FULL LOAD	IDLE	

F	INSPECTION AFTER FINAL RUN
1. Inspect Air Box, Pistons Liners, Rings	6. Inspect Oil Pump Drive
2. Inspect Blower	7. Replace Lube Filter Elements
3. Wash Oil Pan, Check Gasket	8. Tighten Flywheel Bolts
4. Clean Oil Pump Screen	9. Rust Proof Cooling System
5. Tighten Oil Pump Bolts	
REMARKS:	
Final Run OK'd_____Dynamometer Operator_____Date _____	
NOTE: Operator must initial each check and sign this report.	

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

(2) Dynamometer

(a) The function of the dynamometer is to absorb and measure the engine output. Its basic components are a frame, engine mounts, the absorption unit, a heat exchanger, and a torque loading and measuring device.

(b) The engine is connected through a universal coupling to the absorption unit. The load on the engine may be varied from zero to maximum by decreasing or increasing the resistance in the unit. The amount of power absorbed in a water brake type dynamometer as an example, is governed by the volume of fluid within the working system. The fluid offers resistance to a rotating motion. By controlling the volume of water in the absorption unit, the load may be increased or decreased as required.

(c) The power absorbed is generally measured in torque (lb-ft) on a suitable scale. This value for a given engine speed will show the brake horsepower developed in the engine by the following formula:

BHP = (T X RPM)/5250
Where:
BHP = brake horsepower
T = torque in lb-ft
RPM = revolutions per minute

(d) Some dynamometers indicate direct brake horsepower readings. Therefore, the use of the formula is not required when using these units.

(e) During the actual operation, all data taken should be recorded immediately on an Engine Test Report (see sample).

(3) Instrumentation

(a) Certain instrumentation is necessary so that data required / to complete the Engine Test Report may be obtained. The following list contains both the minimum amount of instruments and the proper location of the fittings on the engine so that the readings represent a true evaluation of engine conditions.

1 Oil pressure gage installed in one of the engine main oil galleries.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

2 Oil temperature gage installed in the oil pan, or thermometer installed in the dipstick hole in the oil pan.

3 Adaptor for connecting a pressure gage or mercury manometer to the engine air box.

4 Water temperature gage installed in the thermostat housing or water outlet manifold.

5 Adaptor for connecting a pressure gage or water manometer to the crankcase.

6 Adaptor for connecting a pressure gage or mercury manometer to the exhaust manifold at the flange.

7 Adaptor for connecting a vacuum gage or water manometer to the blower inlet.

8 Adaptor for connecting a fuel pressure gage to the fuel manifold inlet passage.

9 Adaptor for connecting a pressure gage or mercury manometer to the turbocharger.

(b) In some cases, gases reading in pounds per square inch are used for determining pressures while standard characteristics are given in inches of mercury or inches of water. It is extremely important that the scale of such a gage be of low range and finely divided if accuracy is desired. This is especially true of a gage reading in psi, the reading of which is to be converted to inches of water. The following conversion factors may be helpful.

Inches of water = psi X 27.7"
Inches of mercury = psi X 2.04"

(4) Run-In Procedure

(a) Pre-Starting

1 Fill the lubrication system.

2 Prime the fuel system.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

3 A preliminary valve clearance adjustment must be made before the engine is started.

4 A preliminary injector timing check must be made before starting the engine.

5 Preliminary governor adjustments must be made.

6 Preliminary injector rack adjustment must be made.

(b) Basic Engine Run-In

1 The operator should be observant at all times, so that any malfunction which may develop wll1 be detected. Since the engine has just been reconditioned, this run-in will be a test of the workmanship of the service- man who performed the overhaul. Minor difficulties should be detected and corrected so that a major problem will not develop.

2 After performing the preliminary steps, be sure all water valves, fuel valves, etc. are open. Also inspect the exhaust system, being sure that it is properly connected to the engine. Always start the engine with minimum dynamometer resi stance.

3 After the engine starts, if using a water brake type dynamometer, allow sufficient water, by means of the control loading valves, into the dynamometer absorption unit to show a reading of approximately 5 lb-ft on the torque gage (or 10-15 HP on a horsepower gage). This is necessary, on some units, to lubricate the absorption unit seals and to protect them from damage.

4 Set the engine throttle at idle speed, check the lubricating oil pressure and check all connections to be sure there are no leaks.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

5 Refer to Engine Test Report sample which establishes the sequence of events for the test and run-in and to the Basic Run-In Horsepower Schedule which indicates the speed (rpm), length of time and the brake horsepower required for each phase of the test. Also, refer to the Operating Conditions in Chapter 3 which presents the engine operating characteristics. These characteristics will be a guide for tracing faulty operation or lack of power.

6 Engine governors in most cases must be reset at the maximum full-load speed designated for the run-in. If a governor is encountered which cannot be adjusted to this speed, a stock governor should be installed for the run-in.

7 After checking the engine performance at idle speed and being certain the engine and dynamometer are operating properly, increase the engine speed to half speed and apply the load indicated on the Basic Run-In Horsepower Schedule.

8 The engine should be run at this speed and load for 10 minutes to allow sufficient time for the coolant temperature to reach the normal operating range. Record length of time, speed, brake horsepower, coolant temperature and lubricating oil pressure on the Engine Test Report.

9 Run the engine at each speed and rating for the length of time indicated in the Basic Run-In Horsepower Schedule. This is the Basic Run-In. During this time engine performance will improve as new parts begin to "seat in". Record all of the required data.

(c) Basic Run-In Inspection

1 While the engine is undergoing the Basic Run-In, check each item indicated in Section "C" of the Engine Test Report. Check for fuel oil or water leaks in the rocker arm compartment.

2 During the final portion of the Basic Run-In, the engine should be inspected for fuel oil, lubricating oil and water leaks.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

3 Upon completion of the Basic Run-In and Inspection, remove the load from the dynamometer and reduce the engine speed gradually to idle and then stop the engine.

(d) Inspection After Basic Run-In

The primary purpose of this inspection is to provide a fine engine tune-up. First, tighten the cylinder head and rocker arm shaft bolts to the proper torque. Next, complete the tune-up procedure.

(e) Final Run-In

1 After all of the tests have been made and the Engine Test Report is completed through Section (d), the engine is ready for final test. This portion of the test and run-in procedure will assure the engine owner that his engine has been rebuilt to deliver factory rated performance at the same maximum speed and load which will be experienced in the installation.

2 If the engine has been shut-down for one hour or longer, it will be necessary to have a warm-up period of 10 minutes at the same speed and load used for warm-up in the Basic Run-In. If piston rings, cylinder liners or bearings have been replaced as a result of findings in the Basic Run-In, the entire Basic Run-In must be repeated as though the run-in and test procedure were started anew.

3 All readings observed during the Final Run-In should fall within the range specified in the Operating Conditions in Chapter and should be taken at full load unless otherwise specified. Following is a brief discussion of each condition to be observed.

4 The engine water temperature should be taken during the last portion of the Basic Run-In at full load. It should be recorded and should be within the specified range.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

5 The lubricating oil temperature reading must be taken while the engine is operating at full load and after it has been operating long enough for the temperature to stabilize. This temperature should be recorded and should be within the specified range.

6 The lubricating oil pressure should be recorded in psi after being taken at engine speeds indicated in the Operating Conditions, Chapter 3.

7 The fuel oil pressure at the fuel manifold inlet passage should be recorded and should fall within the specified range. Fuel pressure should be recorded at maximum engine rpm during the Final Run-In.

8 Check the air box pressure while the engine is operating at maximum speed and load. This check may be made by attaching a suitable gage (0-15 psi) or manometer (15-0-15) to an air box drain or to a hand hole plate prepared for this purpose. If an air box drain is used as a source for this check, it must be clean. The air box pressure should be recorded in inches of mercury.

9 Check the crankcase pressure while the engine is operating at maximum run-in speed. Attach a manometer, calibrated to read in inches of water, to the oil level dipstick opening. Normally, crankcase pressure should decrease during the run-in indicating that new rings are beginning to " seat-i n" .

10 Check the air inlet restriction with a water manometer connected to a fitting in the air inlet ducting located 2" above the air inlet housing. When practicability prevents the insertion of a fitting at this point, the manometer may be connected to a fitting installed in the 1/4" pipe tapped hole in the engine air inlet housing. If a hole is not provided, a stock housing should be drilled, tapped and kept on hand for future use.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

11 The restriction at this point should be checked at a specific engine speed. Then the air cleaner and ducting should be removed from the air inlet housing and the engine again operated at the same speed while noting the manometer reading. On turbocharged engines, take the reading on the inlet side of the turbocharger. The difference between the two readings, with and without the air cleaner and ducting, is the actual restriction caused by the air cleaner and ducting.

12 Check the normal air intake vacuum at various speeds (at no-load) and compare the results with the Engine Operating Conditions in Chapter 3. Record these readings on the Engine Test Report.

13 Check the exhaust back pressure (except turbocharged engines) at the exhaust manifold companion flange or within one inch of this location. This check should be made with a mercury manometer through a tube adaptor installed at the tapped hole. If the exhaust manifold does not provide a 1/8" pipe tapped hole, such a hole can be incorporated by reworking the exhaust manifold. Install a fitting for a pressure gage or manometer in this hole. Care should be exercised so that the fitting does not protrude into the stack. On turbocharged engines, check the exhaust back pressure in the exhaust piping 6" to 12" from the turbine outlet. The tapped hole must be in a comparatively straight area for an accurate measurement. The manometer check should produce a reading in inches that is below the Maximum Exhaust Back Pressure for the engine

14 Turbocharger compressor outlet pressure and turbine inlet pressures are taken at full-load and no-load speeds.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

RUN IN (Cont)

15 Refer to the Basic Run-In Horsepower Schedule and deter- mine the maximum rated brake horsepower and the full-load speed to be used during the Final Run-In. Apply the load thus determined to the dynamometer. If a hydraulic governor is used, the droop may be adjusted at this time by following the prescribed procedure. The engine should be run at this speed and load for 1/2 hour. While making the Final Run-In, the engine should develop, within 5%, the maximum rated brake horsepower indicated for the speed at which it is operating. If this brake horsepower is not developed, the cause should be determined and corrections made.

16 When the above conditions have been met, adjust the maximum no-load speed to conform with that specified for the particular engine. This speed may be either higher or lower than the maximum speed used during the Basic Run-In. This will ordinarily require a governor adjust- ment .

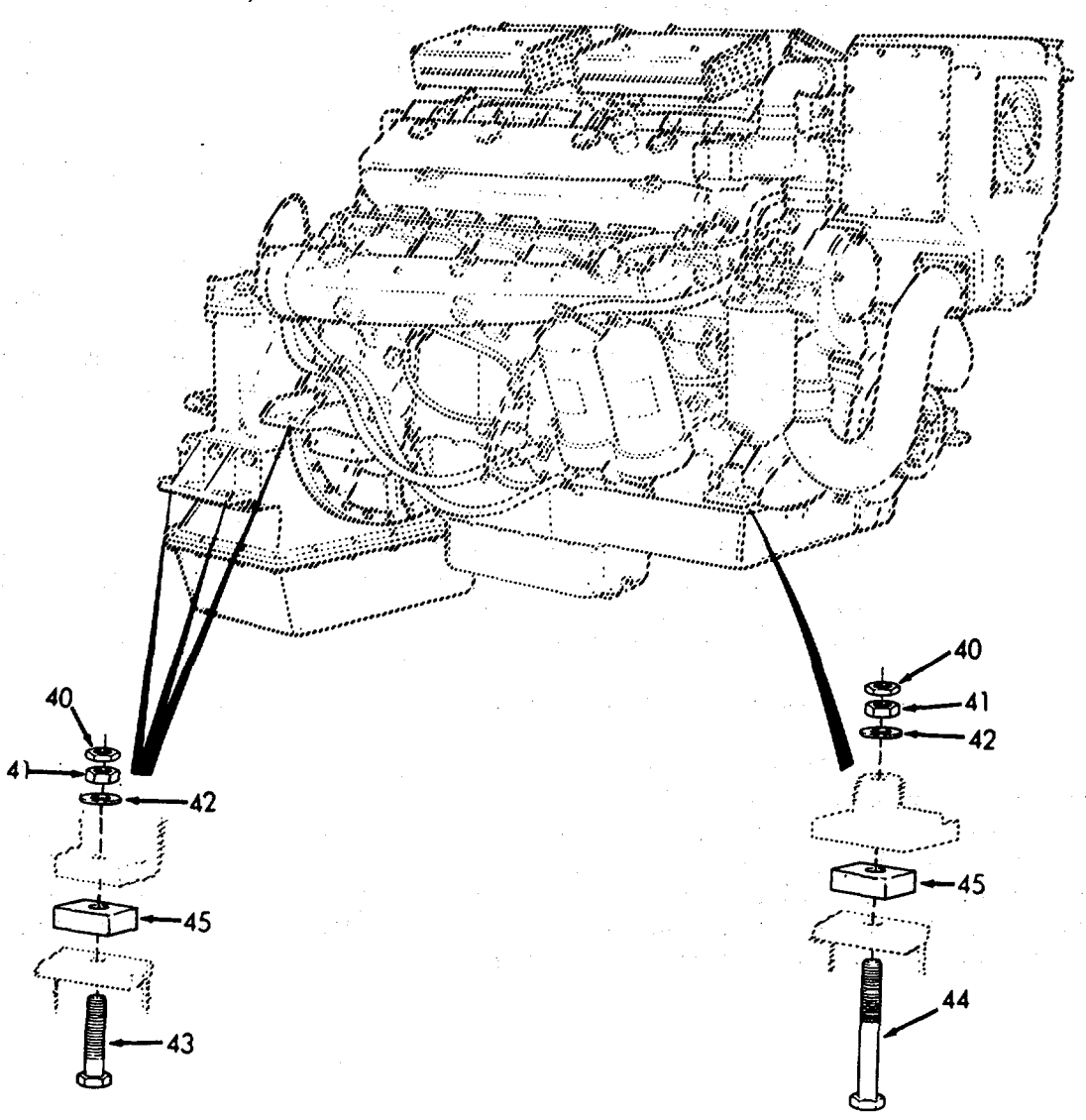
17 All information required in Section "E", Final Run-In, of the Engine Test Report should be determined and filled in. After the prescribed time for the Final Run-In has elapsed, remove the load from the dynamometer and reduce the engine speed gradually to idle speed and then stop the engine. The Final Run-In is complete.

(f) Inspection After Final Run-In.

After the Final Run-In and before the Engine Test Report is completed, a final inspection must be made. This inspection will provide final assurance that the engine is in proper working order. During this inspection, the engine is also made ready for any brief delay in delivery or installation which may occur. This is accomplished by rust-proofing the fuel system. Also, a rust inhibitor should be introduced into the cooling system.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
16. Vehicle Deck	Engine	Lower into position.	
17. Engine Mounts	Liners (45), screws (43 and 44), flatwashers (42) , and nuts (40 and 41)	Install.	



18. Vehicle Deck	Deck plate	Install.	

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

ALIGNMENT

19. Engine and Marine Gear Alignment to Propeller shaft

NOTE

It is important to align the engine and gear only when the boat is afloat and NOT in dry-dock. During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when boat is in service. With the engine and gear in position on the engine bed, arrangements must be made to have a controlled lifting or lowering of each of the four corners of the engine. If threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the jacking screws will not damage the engine bed. Lifting can also be accomplished by the use of properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realign- ment.

(1) It will also be necessary to move the engine and gear from one side or the other on bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges.

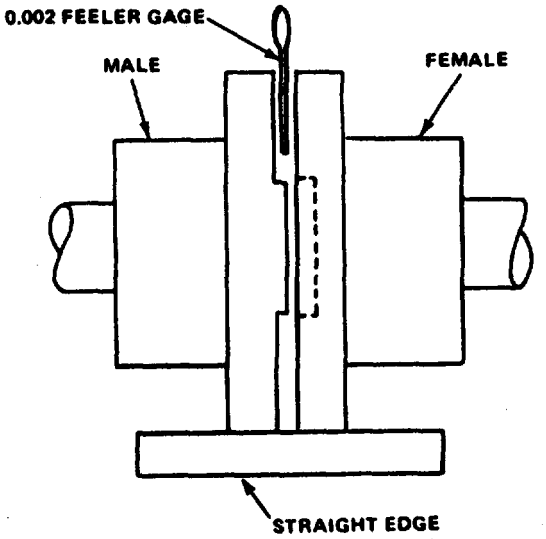
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTI ONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

ALIGNMENT (Cont)

NOTE (Cont)

(2) As the engine and marine gear then comes into its aligned position, it will be possible to match the male and female halves of the output flange and propeller coupling and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. Place a 0.002 inch (0.005 cm) feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.



(3) Then the marine gear flange coupling is rotated 90, 180 and 270 degrees with the feeler blade being moved around the flange again in each successive position. If the alignment is correct, the feeler gauge will fit snugly, with the same tension, all around the flange coupling.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

ALIGNMENT (Cont)

NOTE (Cont)

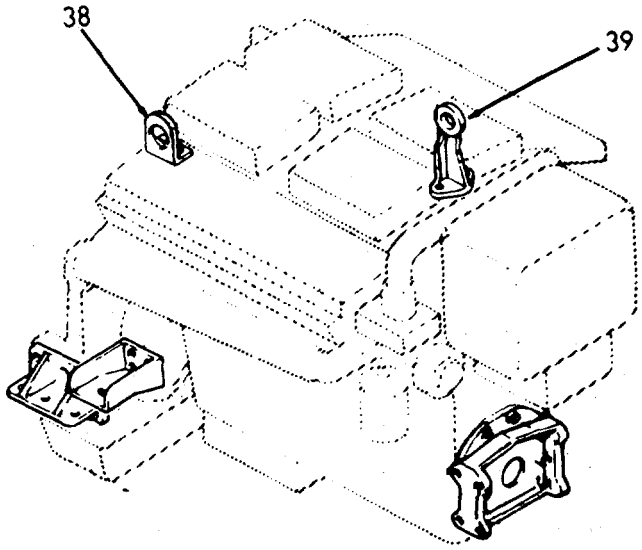
(4) If the alignment varies during rotation, then further alignment is necessary, or the marine gear and shaft couplings could be checked for improper face runout. Face runout on the marine gear output flange can usually be corrected by repositioning the coupling on its spline. Shaft coupling runout is usually due to an inaccuracy of taper fit or key interference.

(5) Some boats are not structurally rigid and some carry their load in such a way that they will "hog" or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine gear output flange and propeller coupling. This clearance might be 0.005 to 0.007 inch (0.013 to 0.018 cm) while the top would maintain the standard 0.002 inch (0.005 cm).

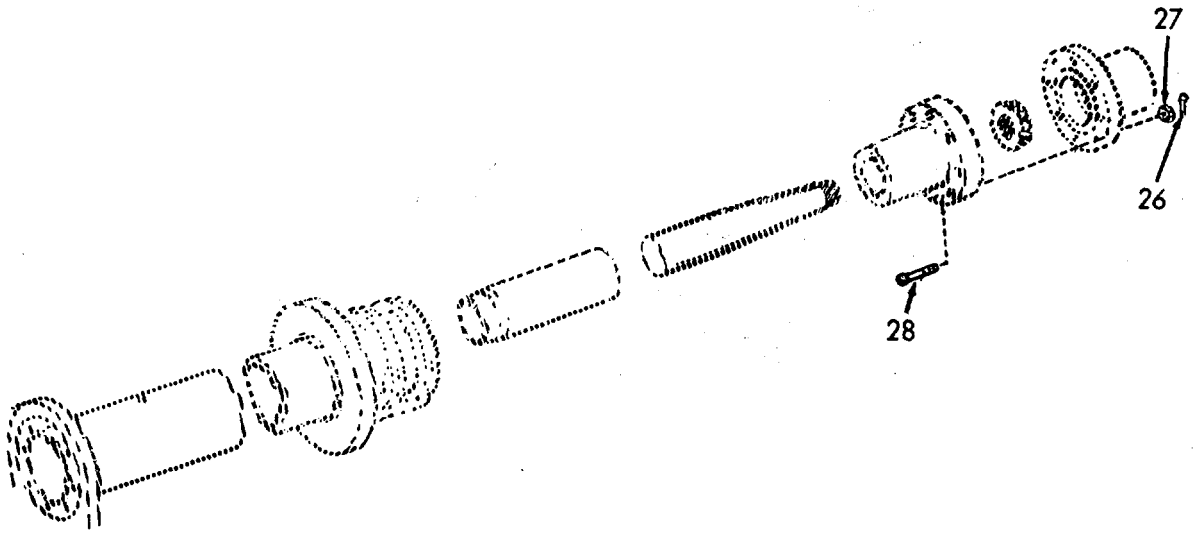
(6) During the process of securing final alignment, it may be necessary to shift the engine many times. When the final alignment is secured, the necessary steel or hardwood shims are made up and the engine and gear is fastened in place. The alignment is then rechecked and if satisfactory, the coupling is bolted together.

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION |			
20. Engine Room	Lifting brackets (38 and 39)	Remove chains.	

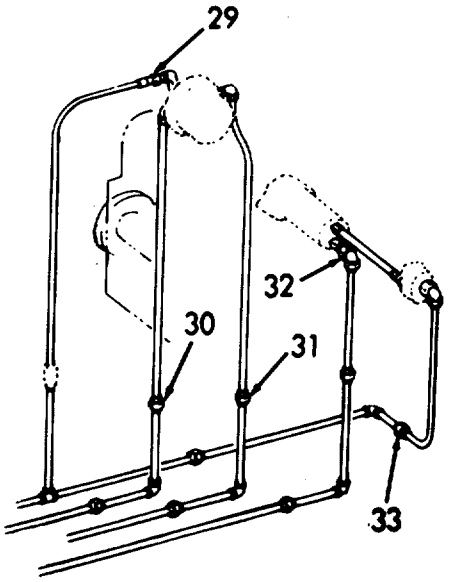


21. Propeller Shaft (27)	a. Screws (28) and nuts	Install.	
	b. Cotter pins (26)	Install.	



5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

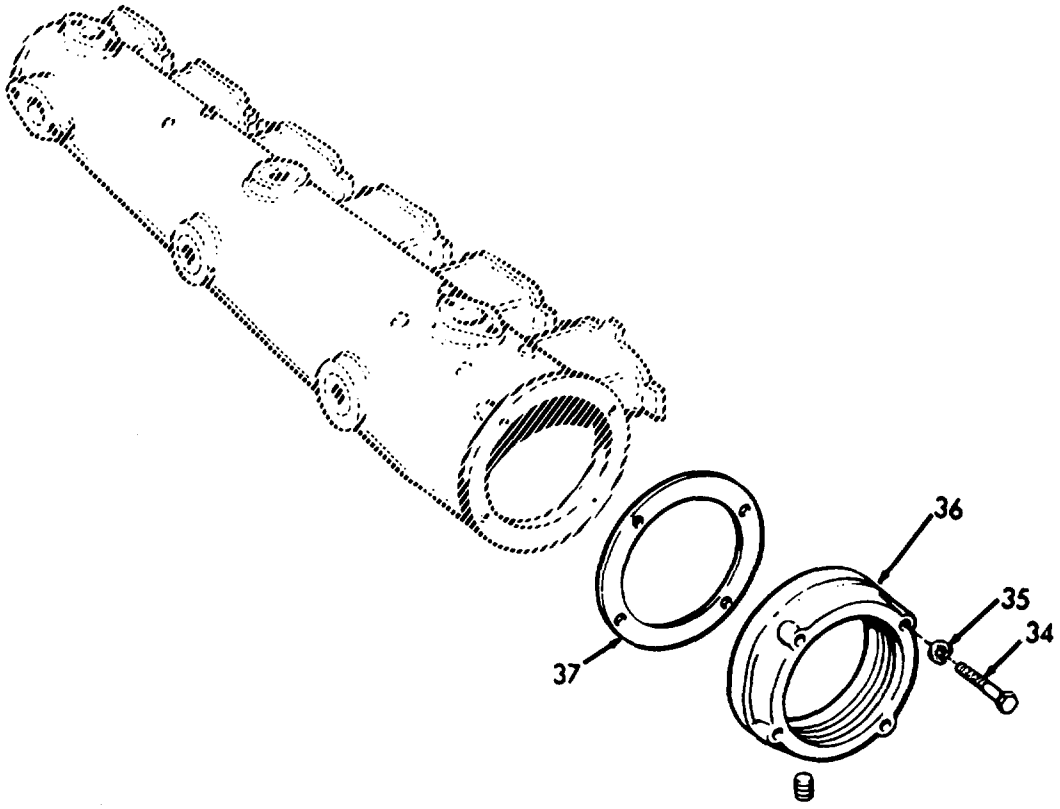
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
22. Hydro-starter Piping	a. Pipe unions (29, 30, 31, 32 and 33)	Reconnect.	



	b. Hand pump	Close relief valve and operate pump to pressurize system.	

5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
23. Exhaust Piping	a. Gasket (37)	Replace.	Use new gasket.
	b. Flange (36)	Orientate to exhaust manifold.	
	c. Screws (34), and lock-washers (35)		

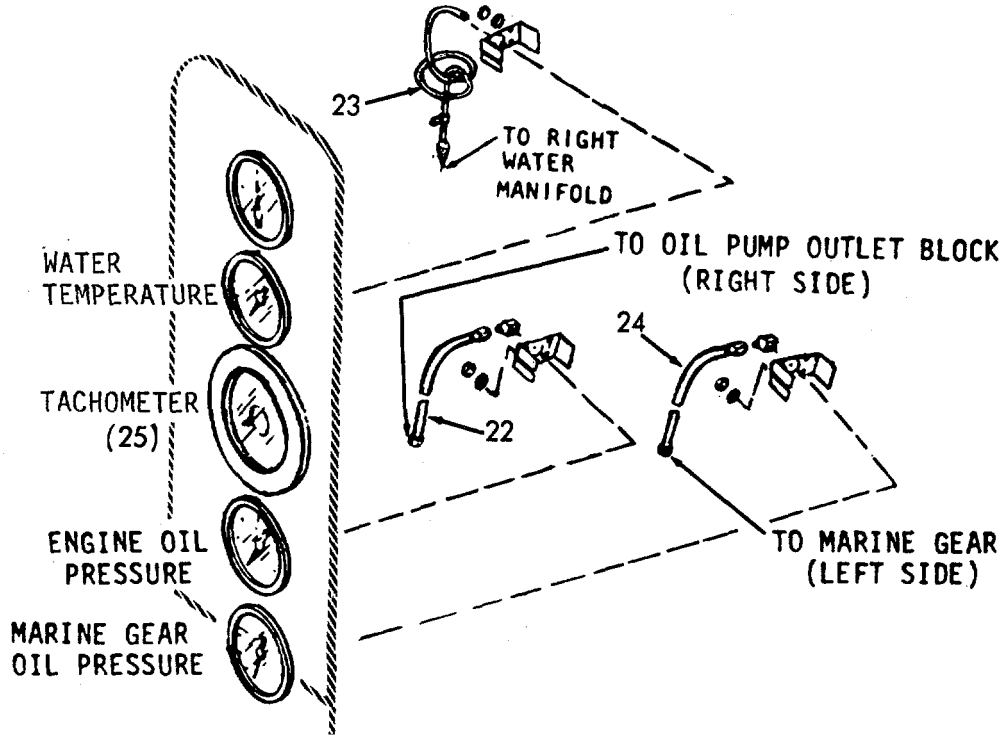


5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

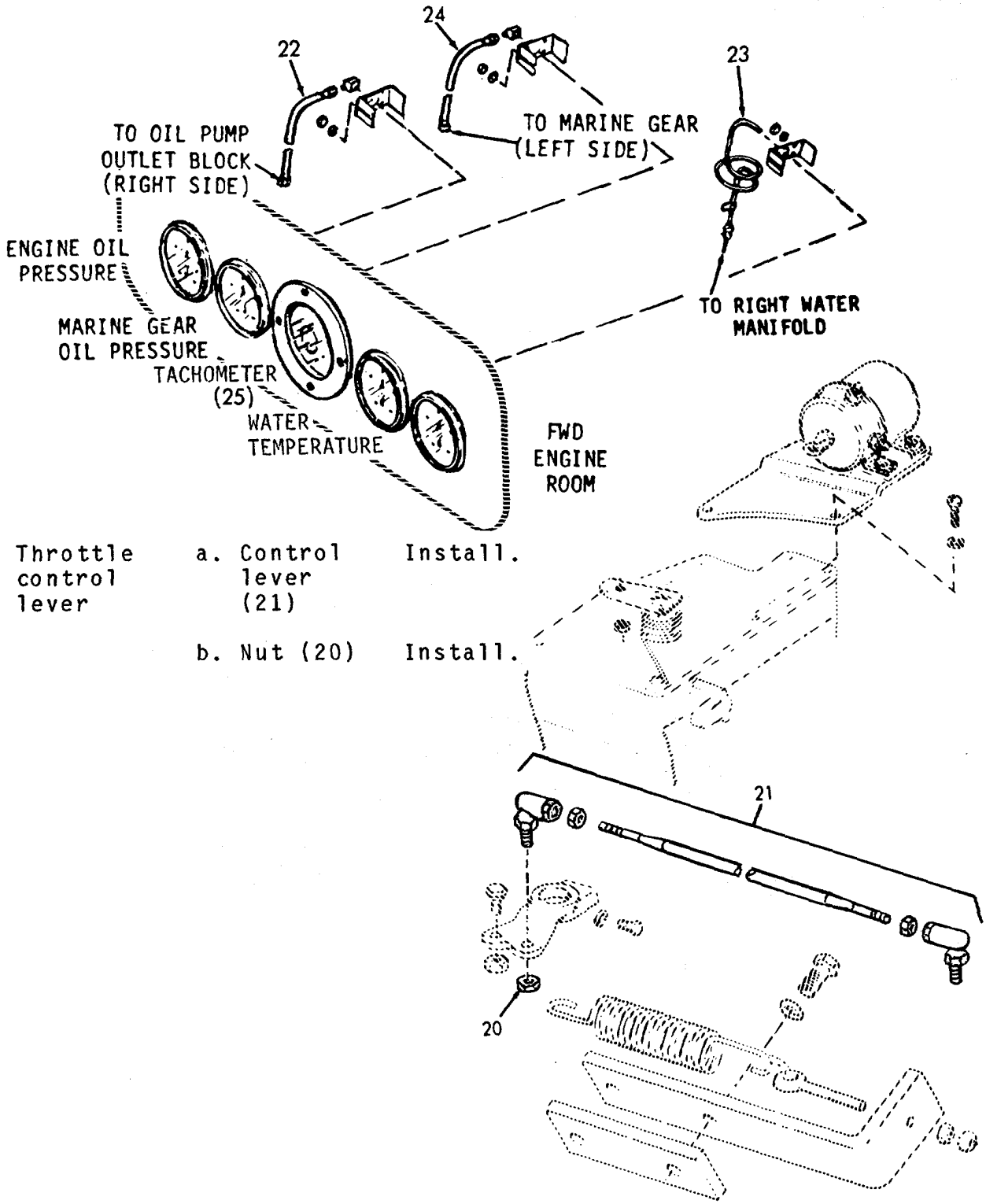
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

24. Instrument Panel	a. Oil pressure gage line (22)	Install.	
	b. Water temperature gage line (23)	Install.	
	c. Marine gear oil gage line (24)	Install.	
	d. Tachometer (25) and motor wiring	Install.	

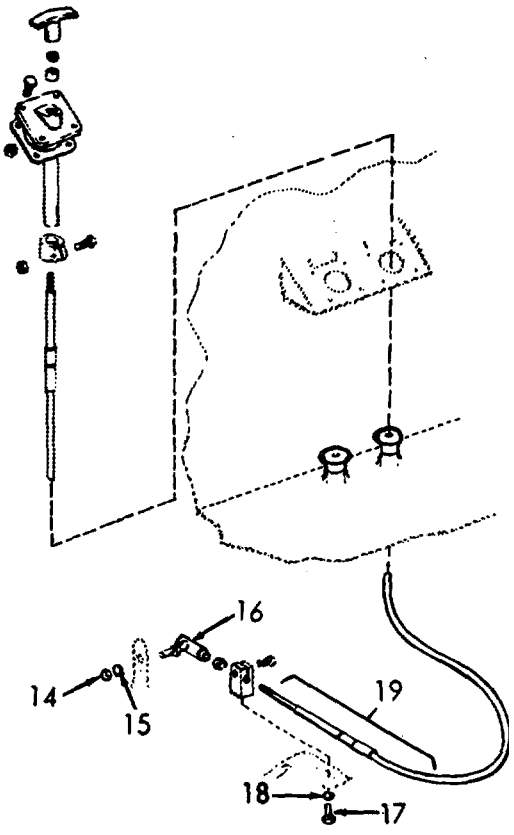


5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
			
25. Throttle control lever	a. Control lever (21)	Install.	
	b. Nut (20)	Install.	

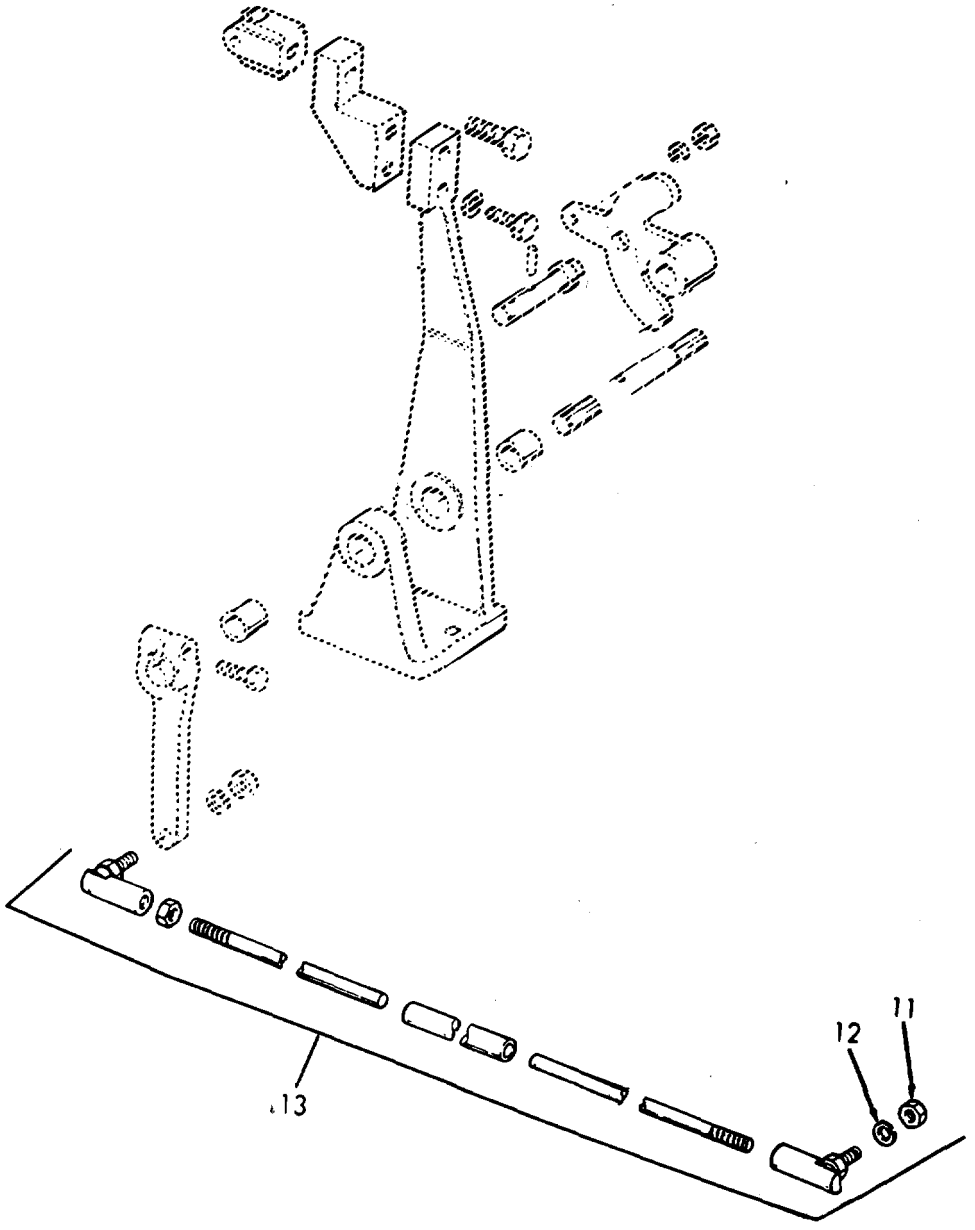
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
26. Shutdown Lever	a. Control cable (19)	Install.	
	b. Screw (17), and lockwasher (18)	Install.	
	c. Ball joint (16)	Install.	
	d. Nut (14) and lock-washer (15)	Install.	



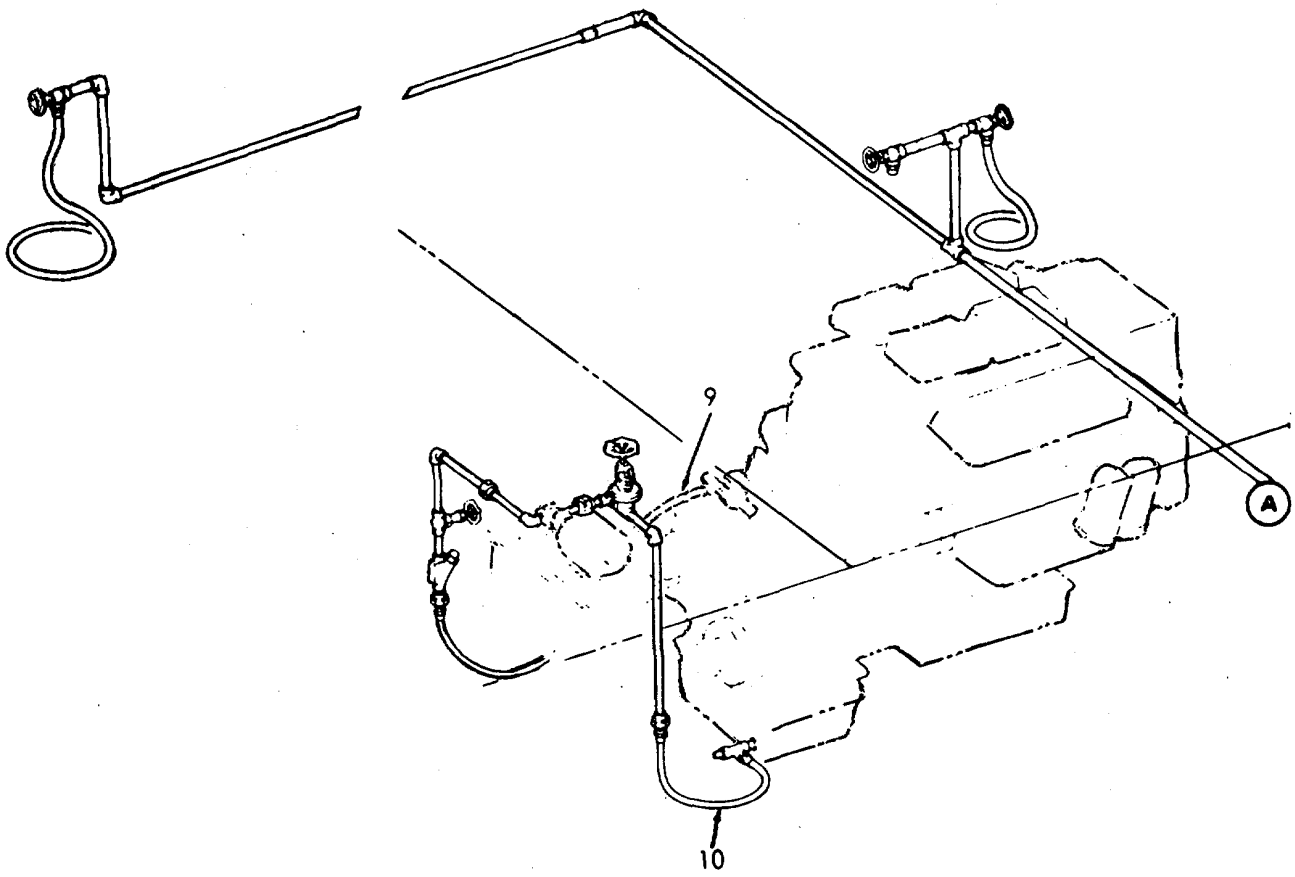
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continu ed).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
27. Clutch Control levers	a. Control rod (13)	Install.	
	b. Nut (11) and lock-washers (12)		



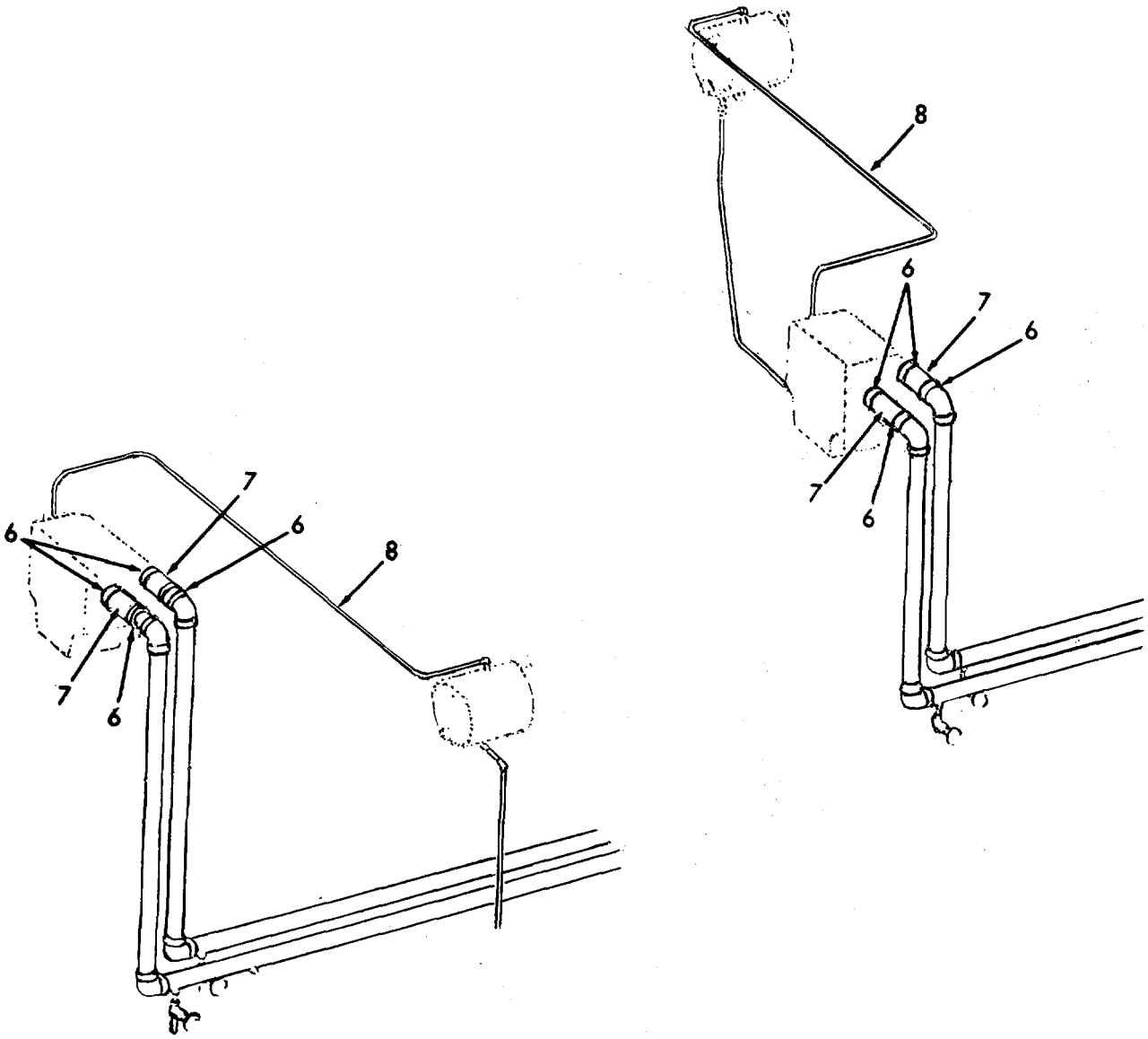
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
28. Marine gear lube oil piping	a. Hose (9)	Install.	
	b. Hose (10)	Install.	
	c. Valves	Open.	



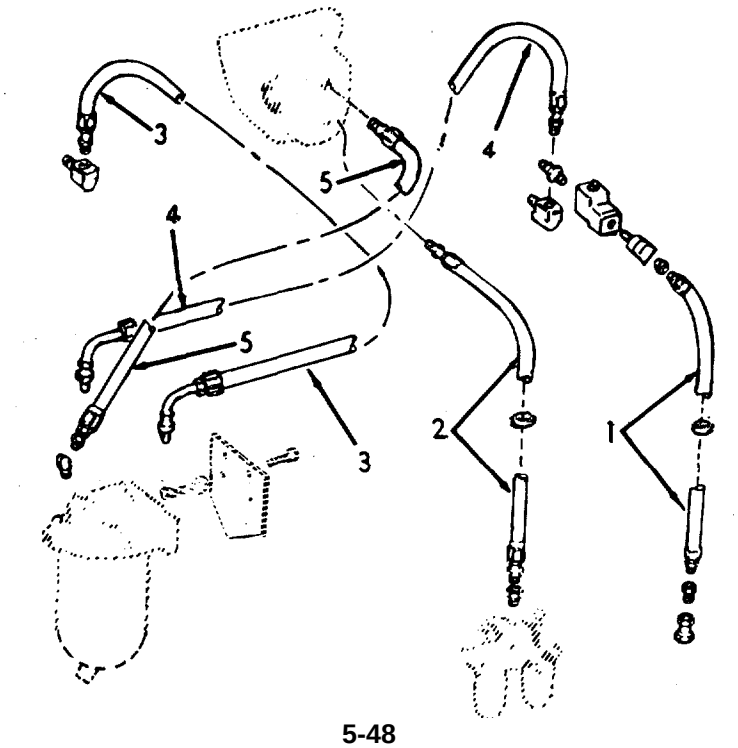
5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
29. Cooling Lines	a. Tubing to expansion tank (8)	Install.	
	b. Hoses (7)	Install.	
	c. Hose clamps (6)	Tighten.	
	d. Valves	Open	



5-4. MAIN PROPULSION ENGINE/MARINE GEAR - REMOVAL AND RUN-IN MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
30. Fuel Lines	a. Hose to fuel pump (5)	Install.	
	b. Hose to right bank (4)	Install.	
	c. Hose to left bank (3)	Install.	
	d. Fuel pump inlet hose (2)	Install.	
	e. Drain hose (1)	Install.	
	f. Supply	Open. valve	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS.

For overhaul procedures that can be done on the marine gear with-out removal, refer to step 30 on page 5-149 and step 31 on page 5-162.

This task covers:

a. Removal
b. Overhaul
c. Cleaning and Inspection
d. Installation
e. Adjustments

INITIAL SETUP

Test Equipment

Depth gage
Dial gage
Feeler gage
Maintenance Instructions

Special Tools

Wheel pullers
Babbett hammer
Hoist
Arbor press
Torque wrench
Eye bolts

Material/Parts

Oil OE-HDO-30
White lead or equivalent
Pipe thread compound

Personnel Required

2

References

Para 5-4.	Engine and Marine Gear Removal
Para 3-8	Marine Gear-Operators
Appendix F	Manufactured Special Tools

Equipment

Condition	Condition Description
	NONE

Special Environmental Conditions

NONE

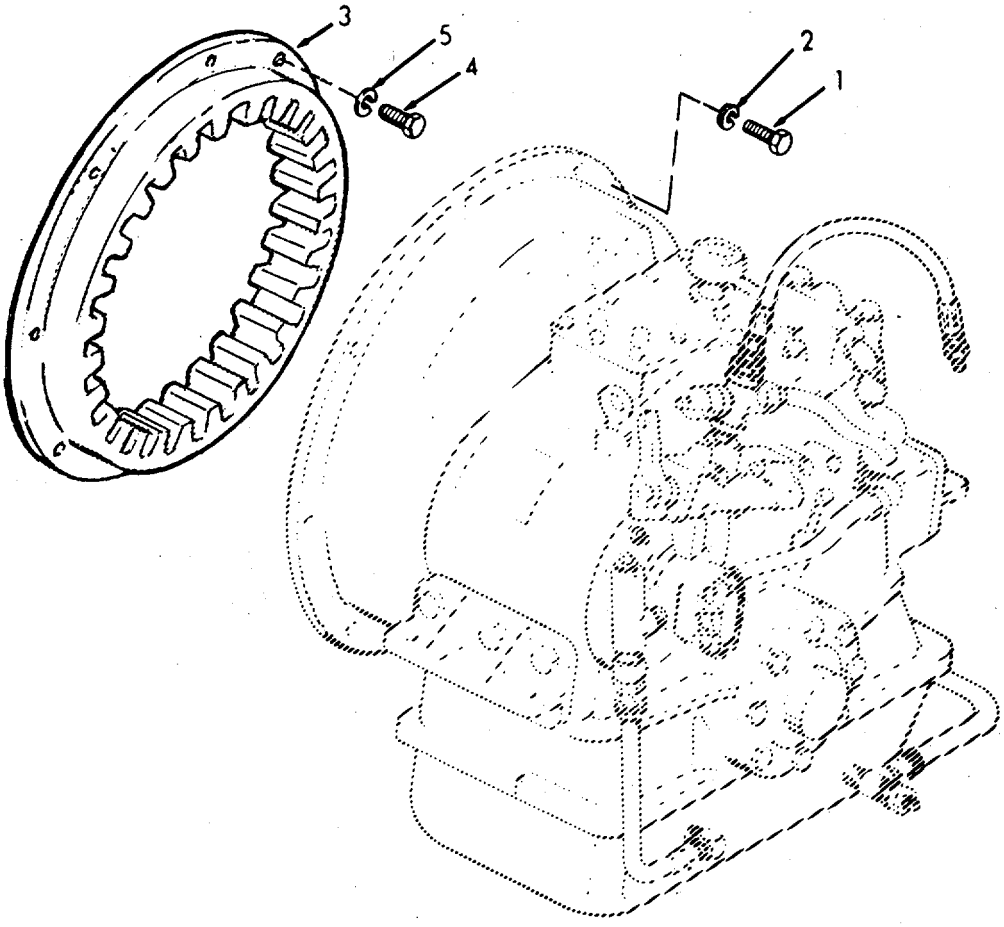
General Safety Instructions

WARNING

Use eye protection when using compressed air.

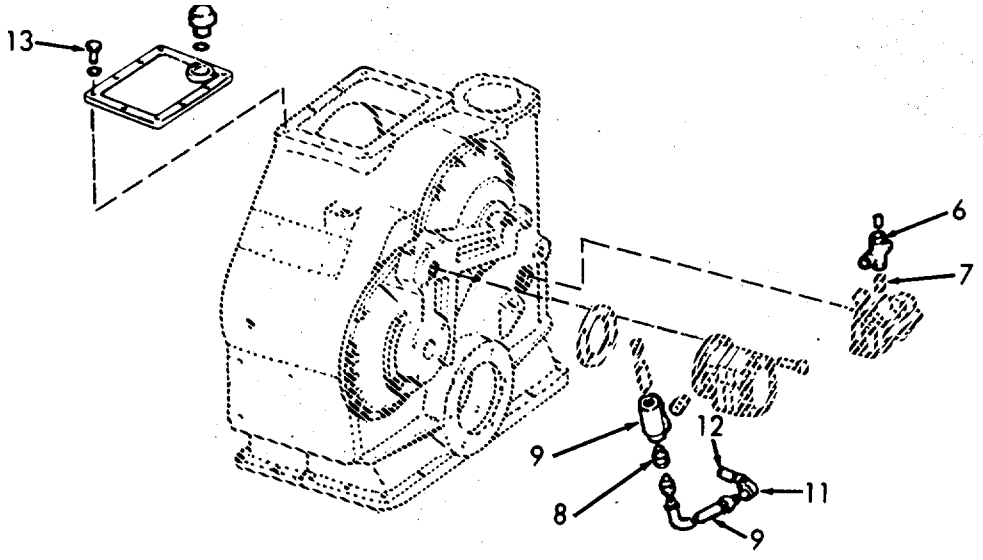
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL,			
1. Marine gear	a. Engine and marine	Remove.	Refer to paragraph 5-4.
	b. Hoses	Remove.	Refer to paragraph 5-4.
	c. Screws (1) and lockwashers (2)	Remove.	
	d. Driving ring (3)	Remove screws (4), and lockwashers (5).	



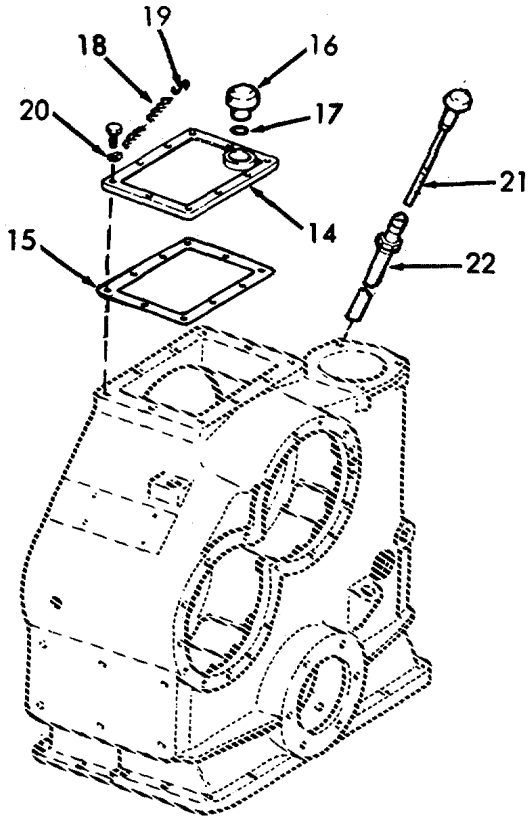
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY			
2. Miscellaneous external parts	a. Reducing tee (6)	Remove.	
	b. Pipe nipple (7)	Remove.	
	c. Male adapter union (8)	1. Disconnect from oil-sump-to-strainer flexible hose (9). 2. Remove from oil strainer housing (10).	
	d. Flexible hose (9)	Remove from elbow (11).	
	e. Elbow (11), and pipe nipple (12)	Remove.	
	f. Screws (13)	Remove	



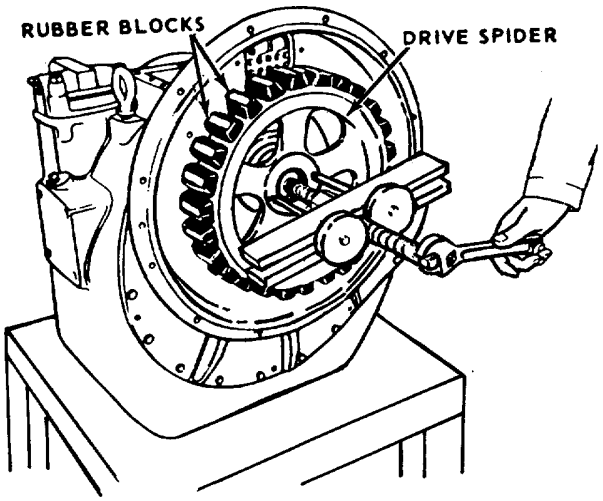
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

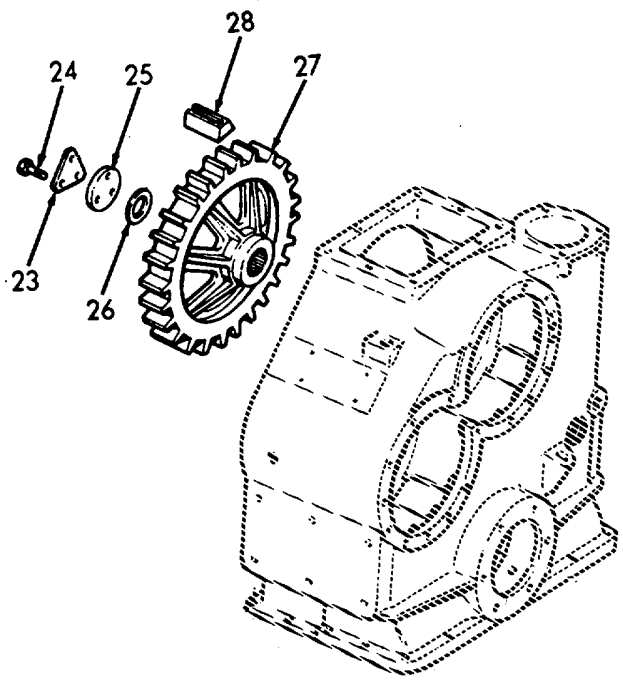
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	g. Top cover (14), and gasket (15)	Remove.	Discard gasket.
	h. Oil breather assembly (16), and preformed packing (17)	Remove.	Discard pre-formed packing.
	i. Breather chain (18), "S"-1ink (19), and clip (20)	Disassemble.	If necessary.
	j. Oil level gage (21), and gage 21 tube (22)	Remove.	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

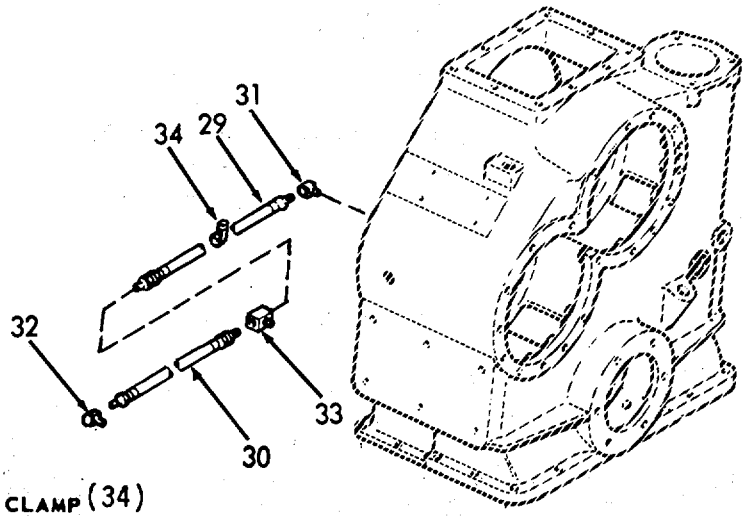
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
3. Spider Drive	a. Lock plate (23)	Bend locking edges back.	
	b. Screws (24)	Remove.	
	c. Lock plate (23), and retaining washer (25)	Remove.	Discard lock plate.
	d. Preformed packing (26)	Remove.	Discard.
	e. Drive spider (27)	Remove.	Install puller in the two 3/8-16 UNC tapped holes.
	f. Rubber blocks (28)	Remove.	If replacement is necessary.

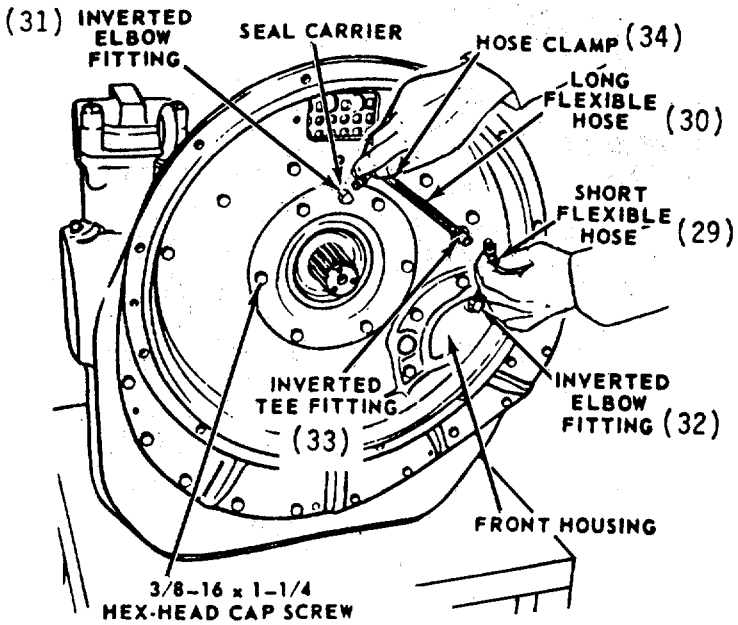




5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

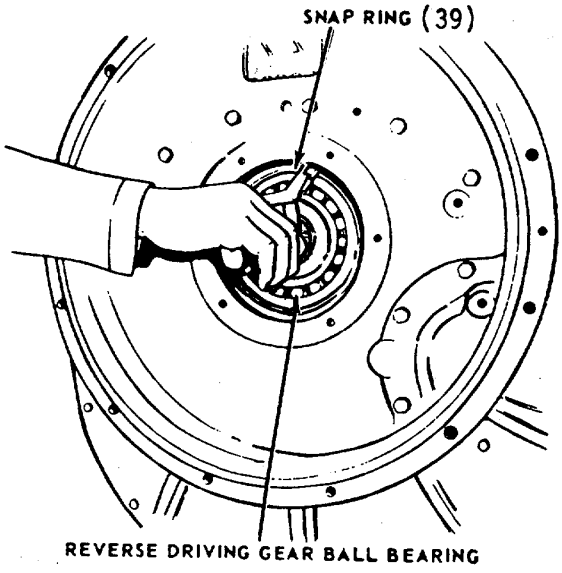
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
4. Front housing	a. Short flexible hose (29), and long flexible hose (30)	1. Disconnect from inverted elbows (31 and 32)	Each hose contains a union for ease of disassembly.
		2. Disconnect from inverted tee (33).	
	b. Hose clamp (34), elbows (31 and 32), and' tee (33)	Remove.	If necessary.

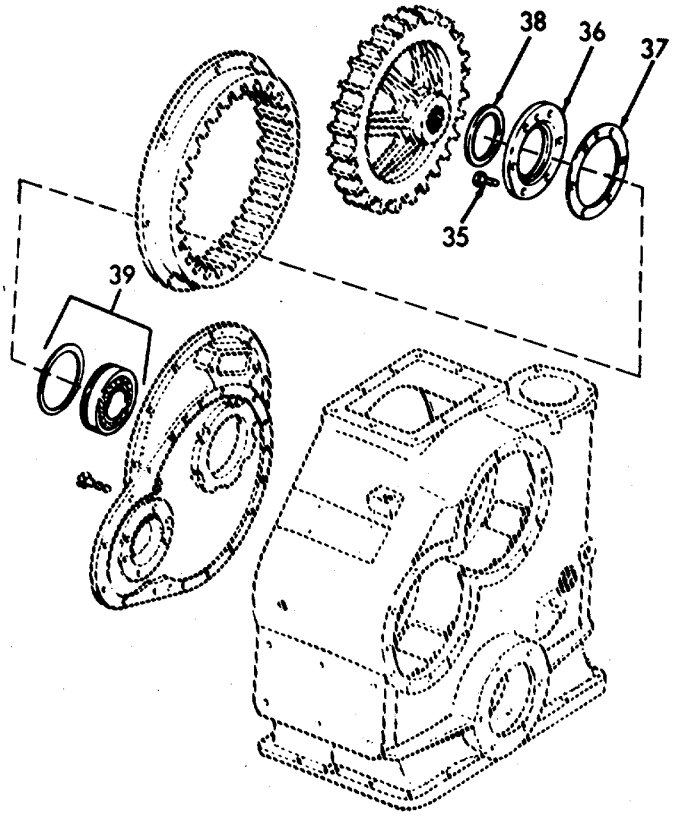




5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

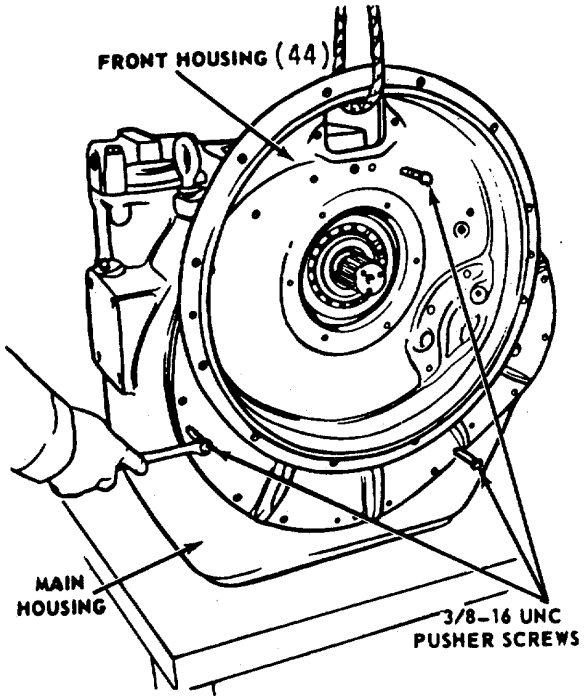
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	c. Screws (35)	Remove.	
	d. Seal carrier (36), and gasket (37)	Remove.	Discard gasket.
	e. Drive spider oil seal (38)	Remove.	Discard.
	f. Snap ring (39)	Remove from outer race of driving gear ball bearing.	

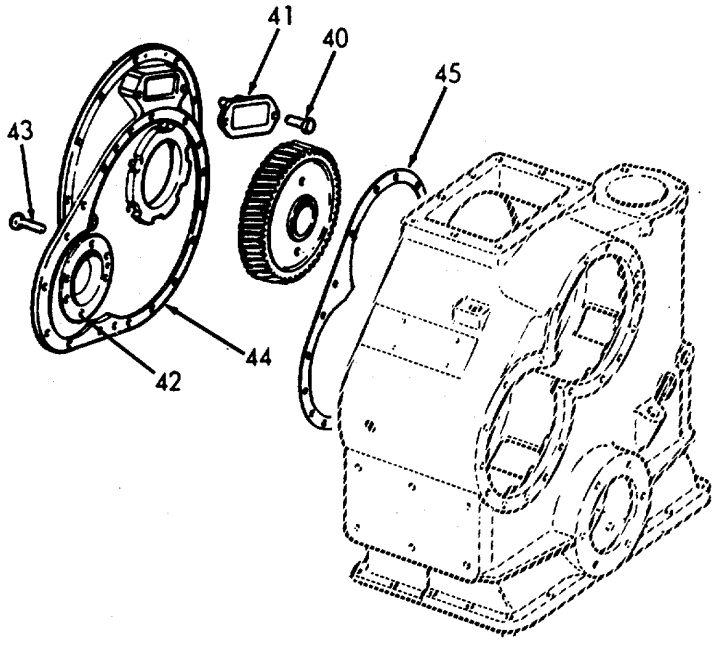




5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

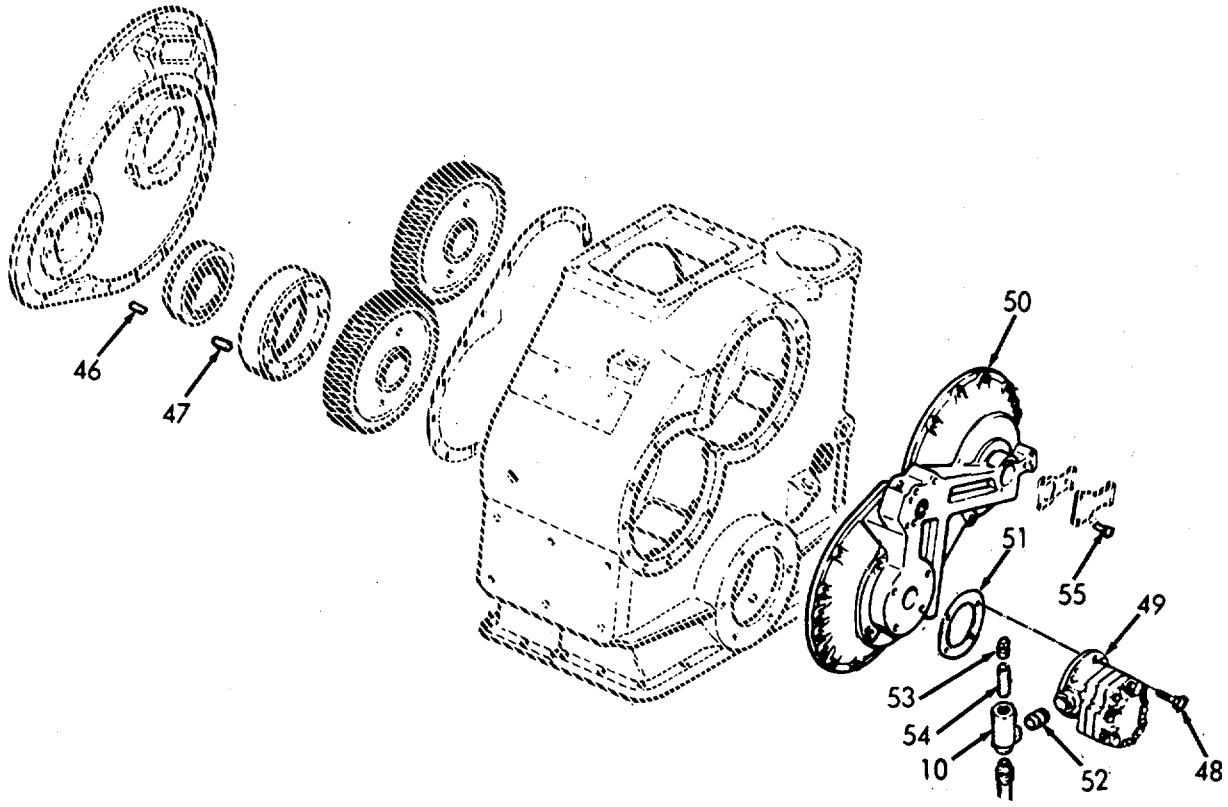
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	g. Screws (40), and front housing cover plate (41)	Remove.	
	h. Screws (42)	Remove six screws.	
	i. Screws (43)	Remove 19 screws.	
	j. Front housing (44), and gasket (45)	Remove by installing three pusher screws in the 3/8-16 UNC tapped holes in front housing.	Discard gasket.





5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	k. Dowel pins (46 and 47)	Remove.	If necessary.
5. Manifold Group	a. Screws (48)	Remove four screws.	
	b. Oil pump (49), and gasket (51)	Remove from manifold (50).	Discard gasket.
	c. Oil strainer housing (10), and short nipple (52)	Remove.	
	d. Pipe plug (53), and oil strainer (54)	Remove.	
	e. Screws (55)	Remove	

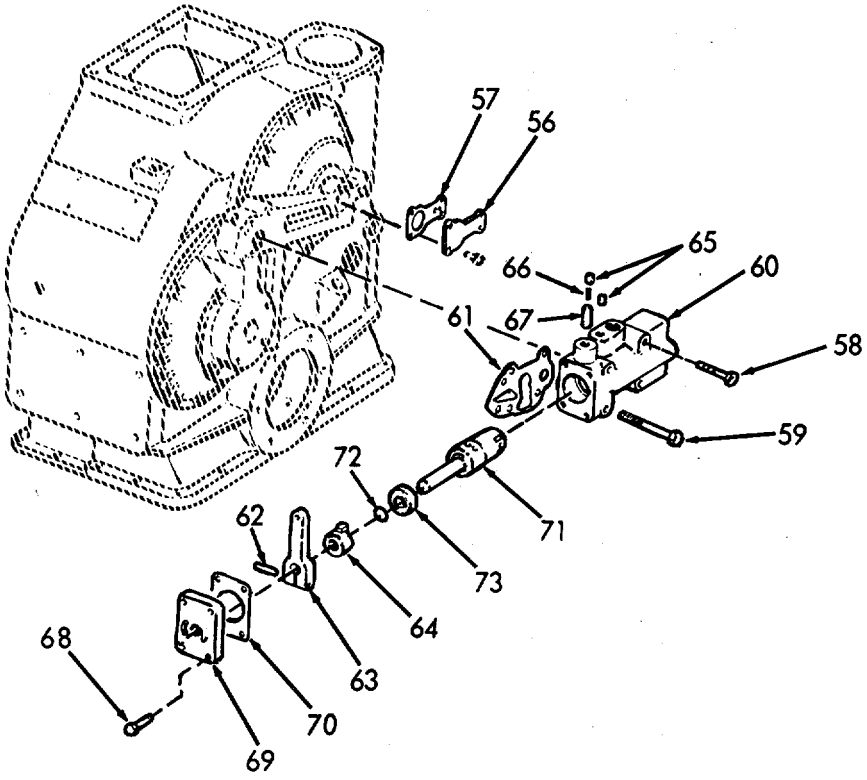


5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	f. Cover plate (56), and gasket (57)	Remove.	Discard gasket.
		CAUTION	
	Exercise care in the handling of the valve stem and the pistons since these parts are ground accurately to fit in the body.		
6. Selector valve	a. Screws (58 and 59)	Remove.	
	b. Selector valve (60), and gasket (61)	Remove.	Discard gasket.
	c. Roll pin (62)	Remove.	
	d. Selector valve lever (63), and stop collar (64)	Remove.	
	e. Pipe plugs (65)	Remove.	
	f. Indexing detent spring (66) and detent (67)	Remove.	
	g. Screws (68)	Remove.	
	h. Cover (69) and gasket (70)	Remove.	Discard gasket.

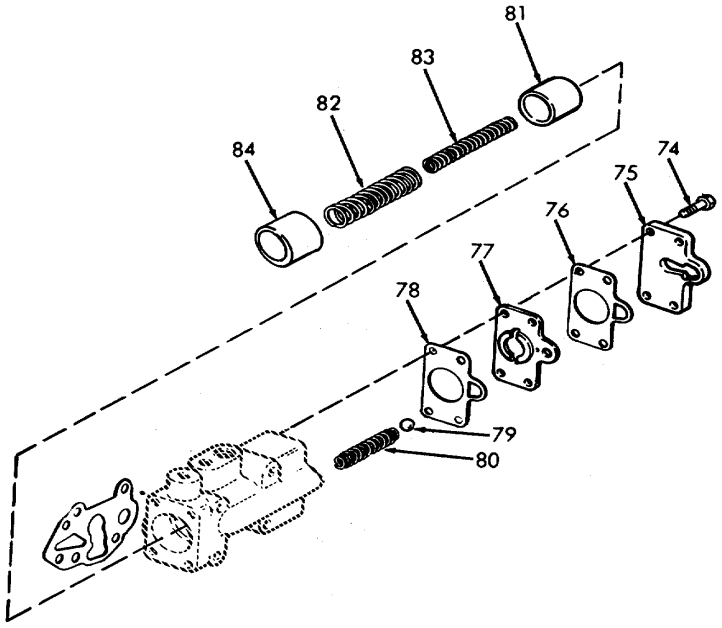
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
i.	Selector valve stem (71)	Remove.	
J.	Ball bearing (73), and O-ring (72)	Remove.	Discard O-ring.



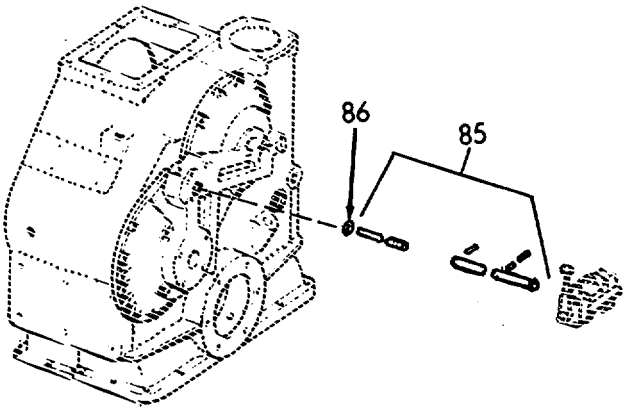
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

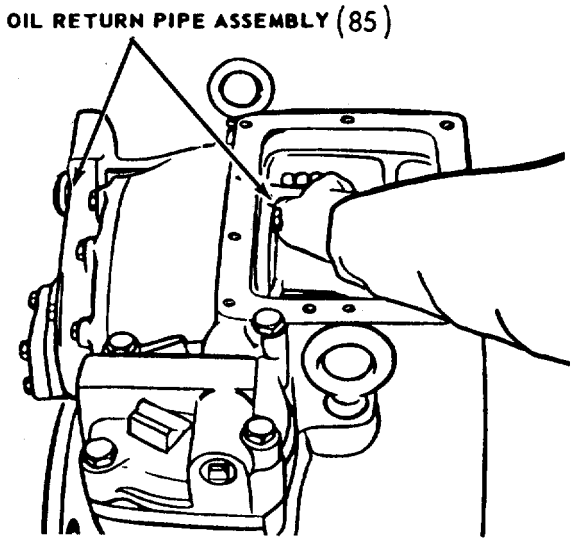
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	k. Screws (74)	Remove.	
	l. Orifice cover (75), gasket (76), orifice plate (77), and gasket (78)	1. Remove. 2. Ball (79) and spring (80) will pop out.	Discard gaskets.
	m. Pressure rate control piston (81), piston outer spring (82), and 8 inner spring (83),and piston (84)	Remove.	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

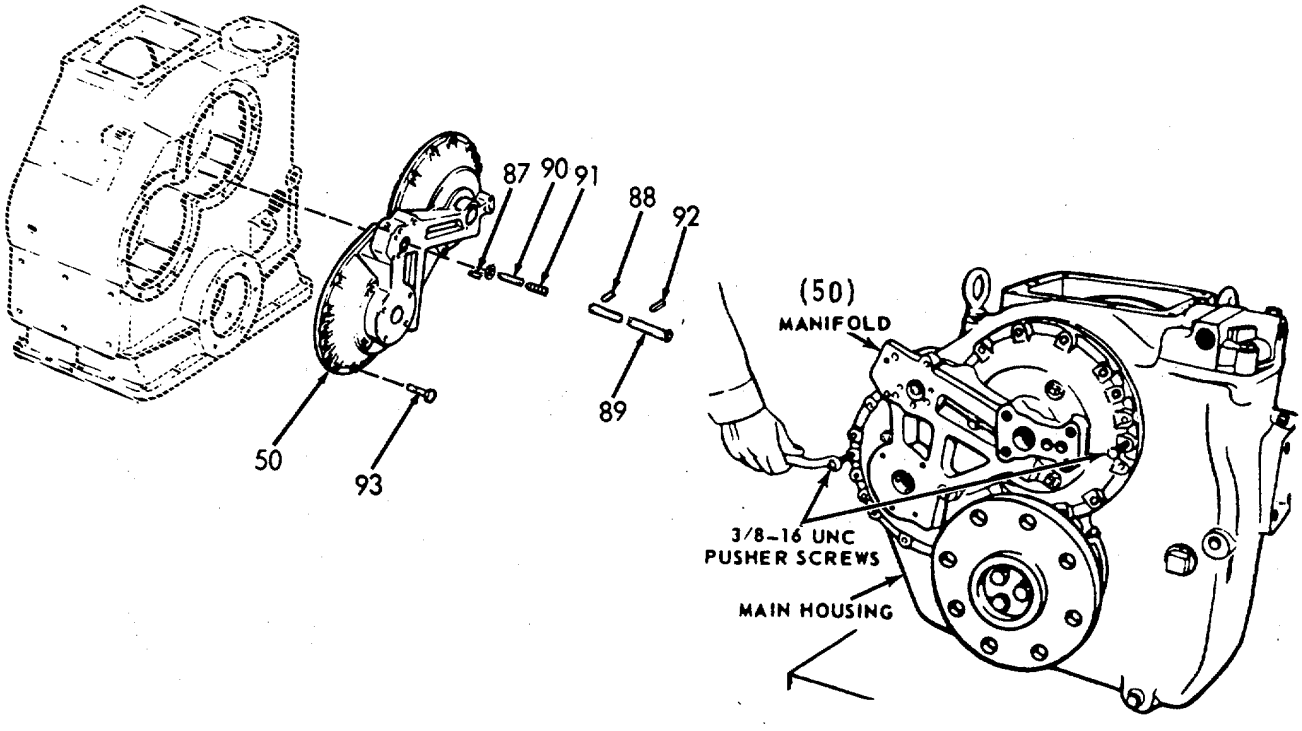
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
7. Manifold group	a. Oil return pipe assembly (85)	1. Reach down through top cover plate opening and firmly grasp.	
		2. Carefully push the assembly rearward through the manifold.	
		3. Remove pipe (85) and gasket (86).	a. Discard gasket. b. It maybe necessary to gently tap the pipe at the front of the gear.





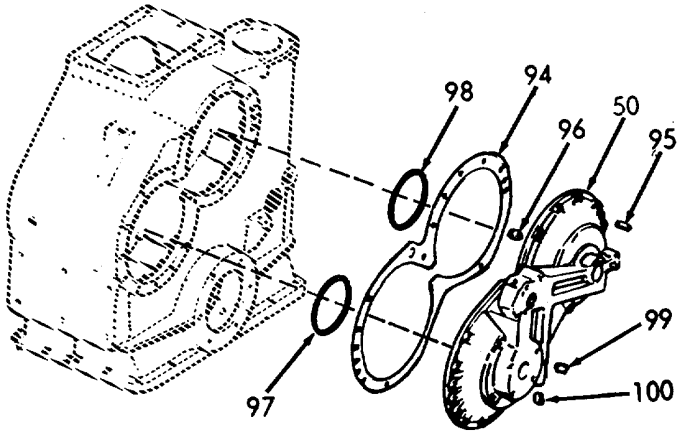
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

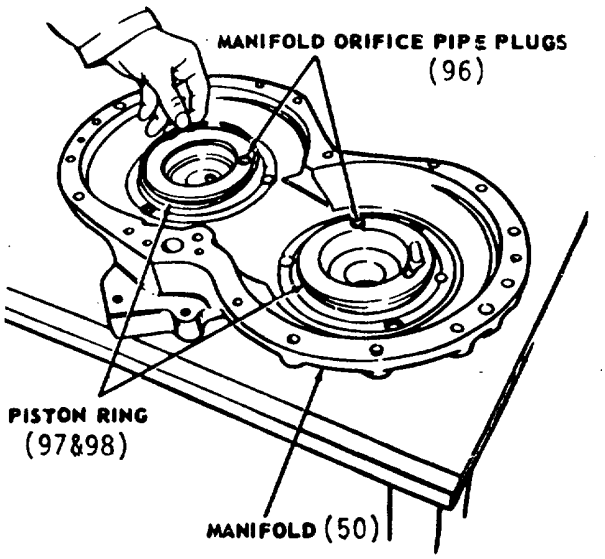
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	b. Roll pin (87)	Remove.	Only if replacement of parts is necessary.
	c. Roll pin (88)	Remove from straight end of pipe (89).	
	d. Spring (90), and piston (91)	Remove.	
	e. Roll pin (92)	Remove.	
	f. Screws (93)	1. Remove 16 screws. 2. Install two pusher screws in the 3/8-16 UNC tapped holes in the manifold (50).	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

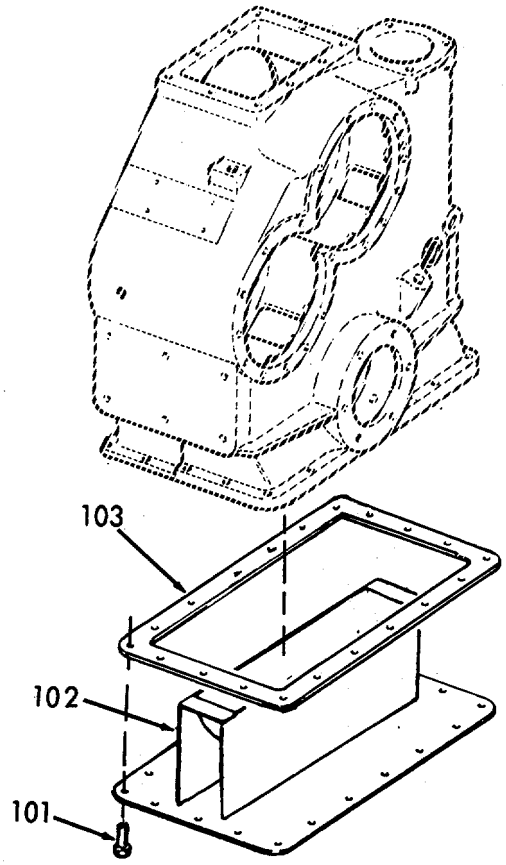
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	g. Manifold (50), and gasket (94)	Remove.	Discard gasket.
	h. Dowel pins (95)	Remove	If necessary.
	i. Manifold orifice pipe plugs (96)	Remove.	
	j. Piston rings (97 and 98)	Remove.	
	k. Pipe plugs (99)	Remove.	Square heads if necessary.
	1. Pipe plugs (100)	Remove.	Hex heads.





5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
8. Oil filter group		Refer to Organizational Maintenance paragraph 3-8.	
9. Sump cover and gear pan group	a. Special screws (101)	Remove 14 screws.	Screws are zinc plated.
	b. Bottom cover (102), and gasket	Remove.	Discard gasket.



10. Counter shaft group

NOTE

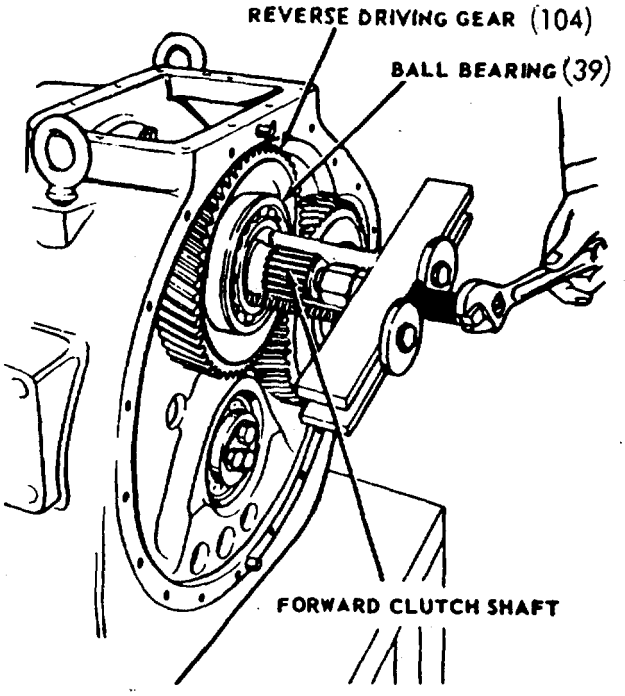
Prior to removing the counter shaft group, the reverse driving and driven gears are removed.

5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

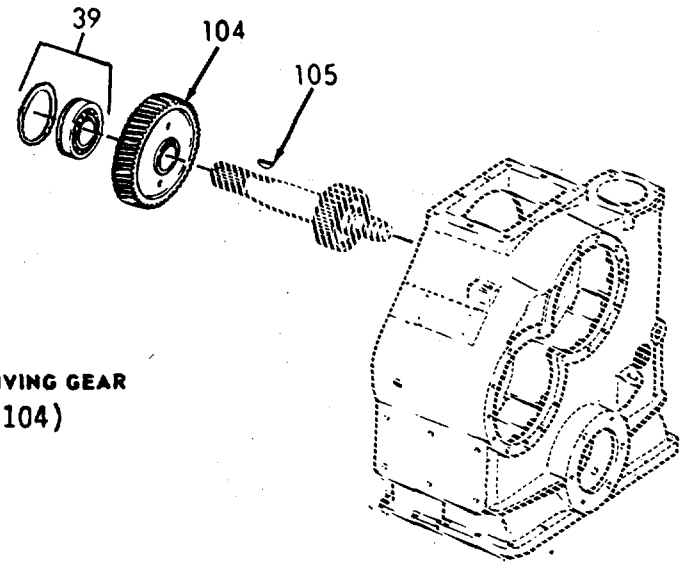
OVERHAUL - DISASSEMBLY (Cont)

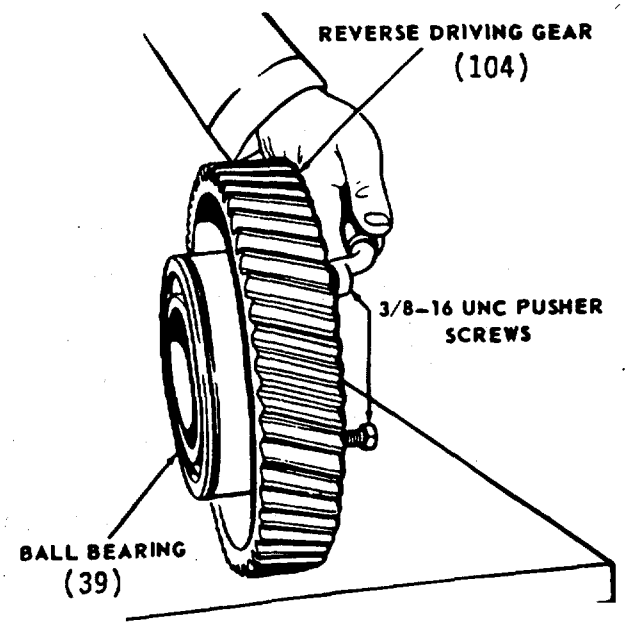
a.	Reverse gear (104), and ball bearing (39)	1. Install gear puller in the two 1/2-13UNC tapped holes.	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

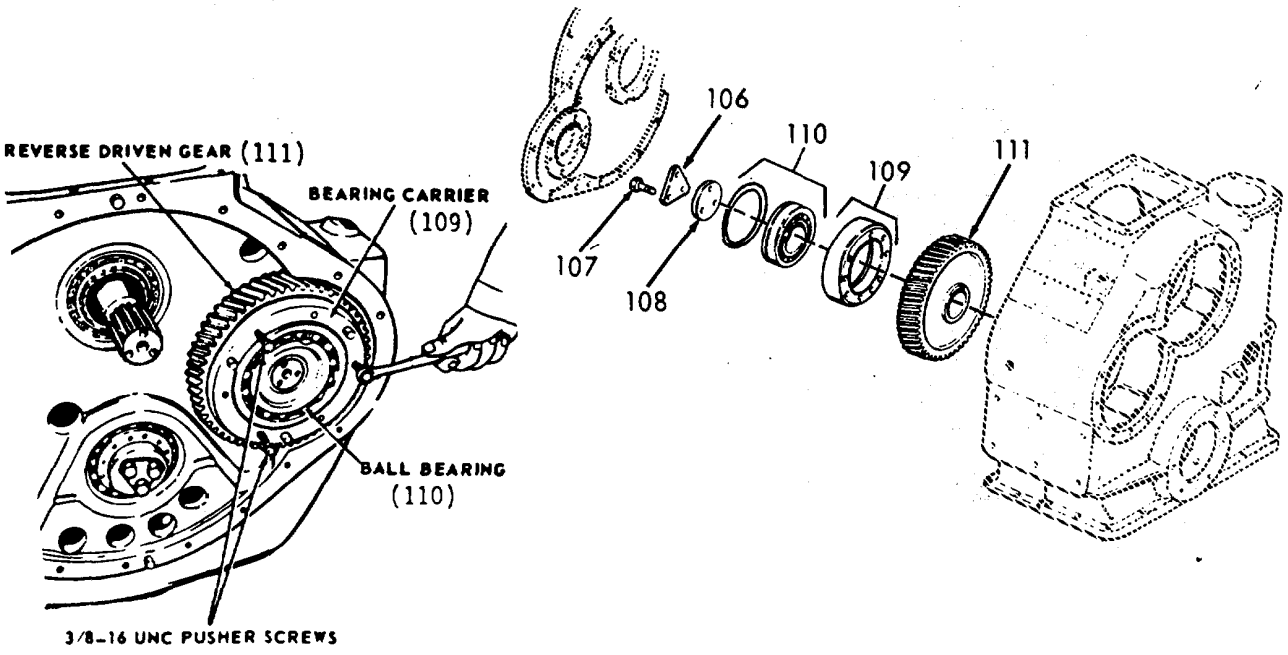
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	b. Key (105)	Remove.	
	c. Ball bearing (39)	1. Use pusher screws in the two 3/8-16UNC tapped holes in the gear (104).	Snap ring was removed in step 4f on page 5-55.
		2. Remove.	





5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	d. Lock plate (106)	Bend back locking edges.	
	e. Screws (107)	Remove.	
	f. Lock plate (106), and retainer washer (108)	Remove. plate.	Discard lock-
	g. Bearing carrier (109)	1. Install 3 pusher screws 3/8-16UNC. 2. Force the carrier (109) and ball bearing (110) from gear (111).	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

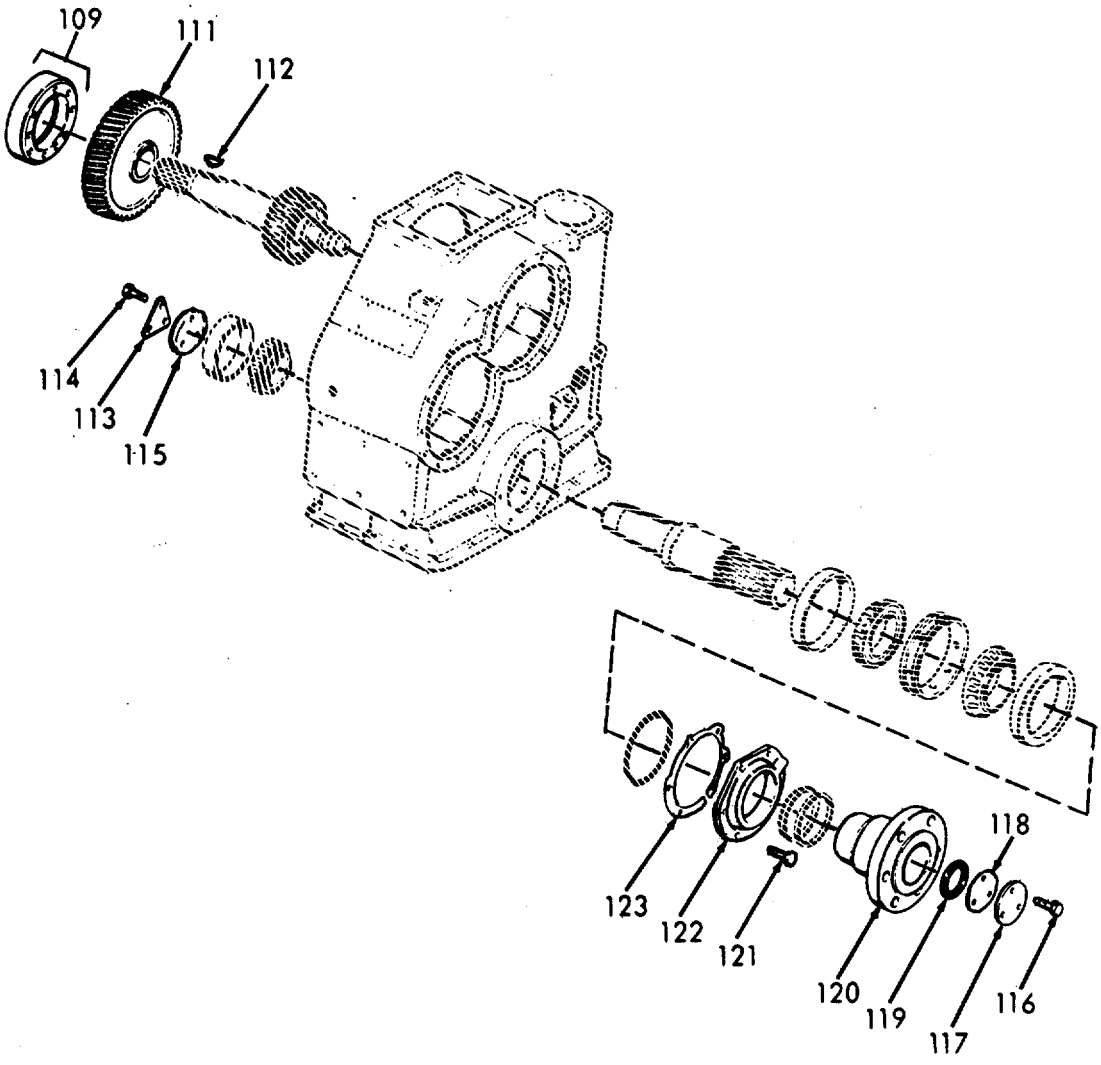
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	h. Carrier (109)	Install gear puller in two 1/2-13UNC tapped holes in gear (111).	
	i. Reverse driven gear (111), and key (112)	Remove.	
	j. Lockplate (113)	Bend back locking edges.	
	k. Screws (114)	Remove.	
	l. Lockplate (113), and retaining washer (115)	Remove. plate.	Discard lock-
	m. Screws (116), and retaining washers (117)	Remove.	
	n. Propeller flange shim (118), and gasket (119)	Remove from propeller flange.	
	o. Propeller flange (120)	Remove.	It may be necessary to tap the flange with a babbitt hammer or brass bar.
	p. Screws (121)	Remove.	

5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

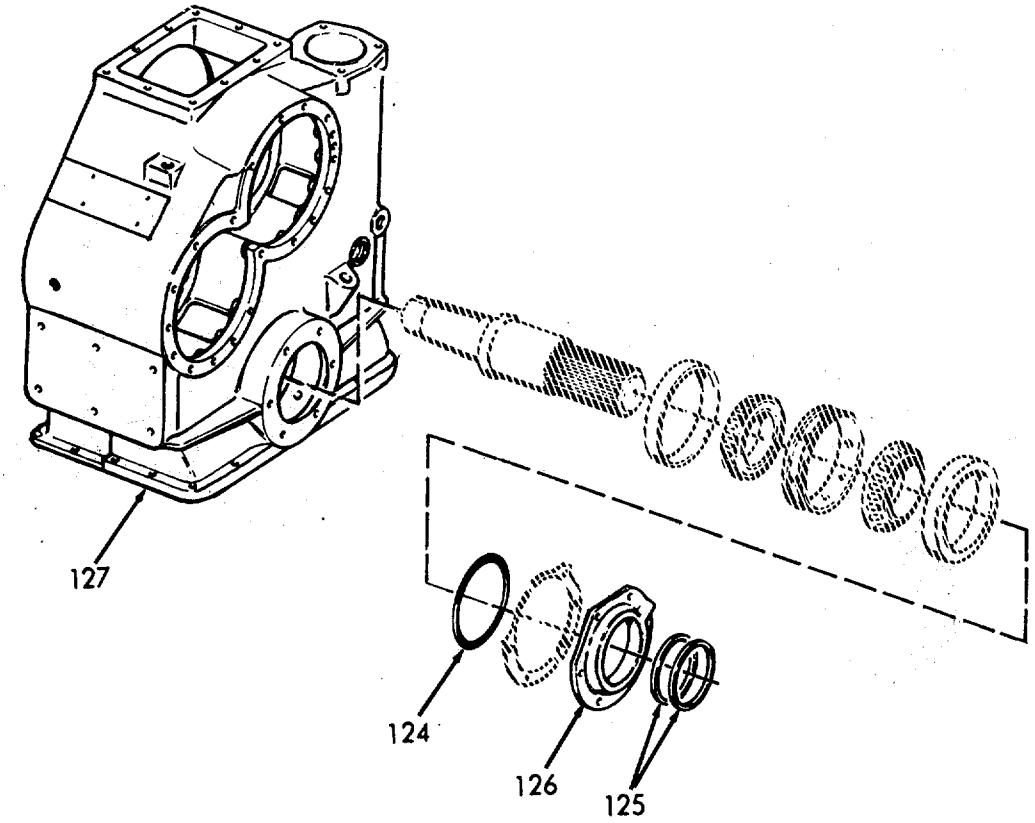
OVERHAUL - DISASSEMBLY (Cont)

q.	Bearing retainer (122), and shims (123)	Remove.	



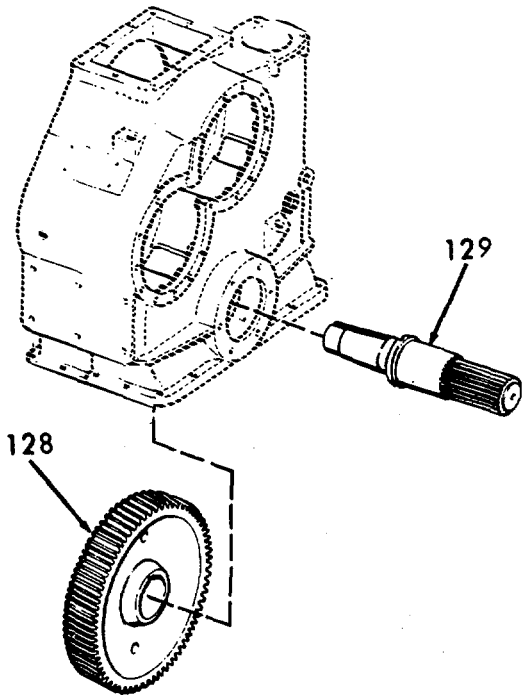
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

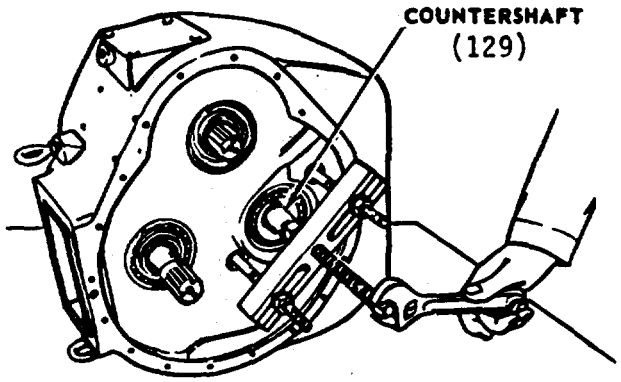
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
r.	Preformed packing (124)	Remove from bearing retainer.	Discard.
s.	Propeller flange oil seals (125)	Remove from bearing retainer.	Discard.
t.	Lubri-cation filling (126)	Replace.	If necessary
u.	Main housing (127)	Place on side with filter cavity down.	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

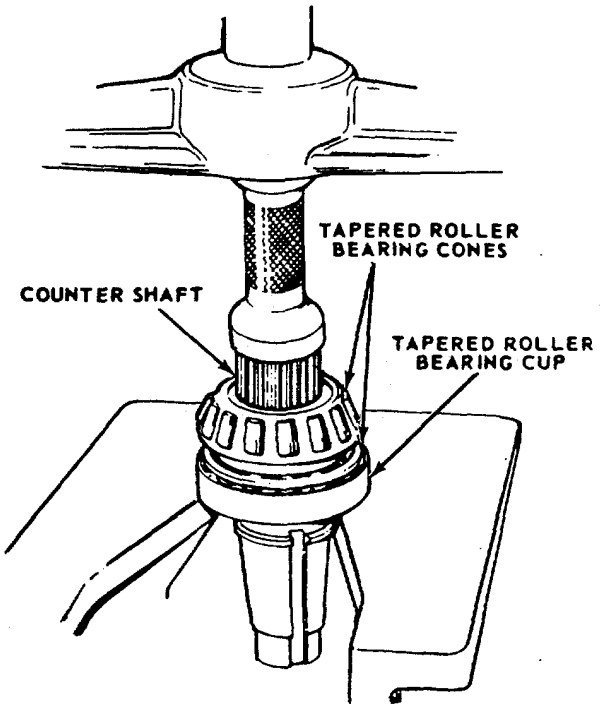
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	v. Counter shaft gear (128)	1. Rotate until puller holes in gear are aligned with the holes in the web of the main housing.	
		2. Place wooden blocks between the gear and the main housing. removed.	Prevents damage to gear when the counter shaft is
		3. Using .puller with 3/4-10NC threads, force counter shaft (129) with attached parts from the gear and main housing.	

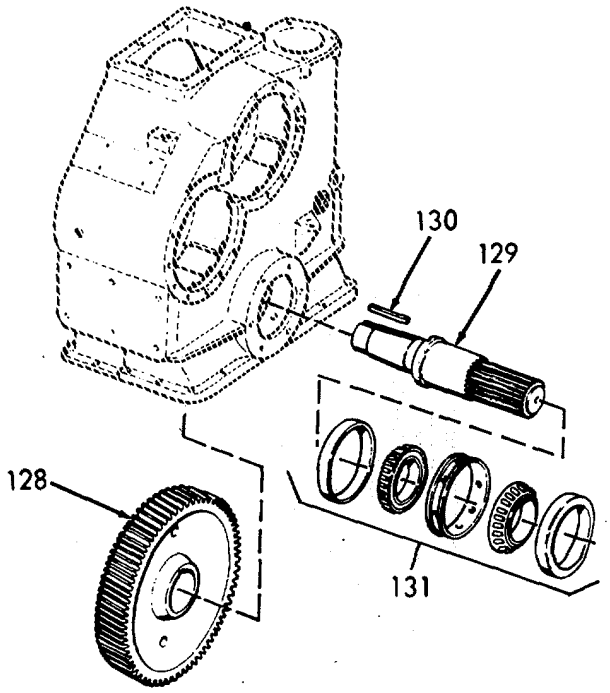




5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

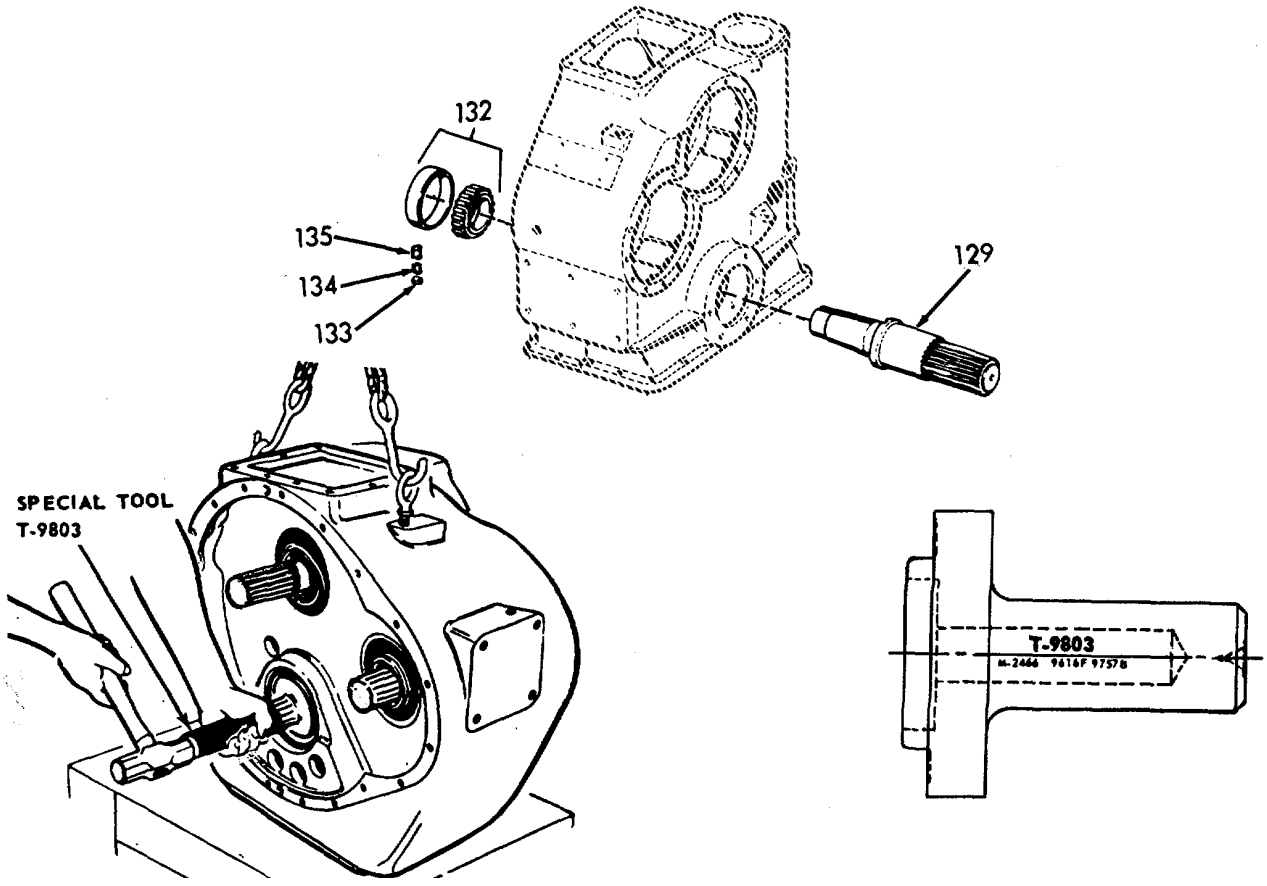
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	w. Key (130), counter shaft (129), and counter shaft gear (128)	Remove.	
	x. Tapered roller bearing (131)	1. Remove cup from cone. is necessary. 2. Use a drift pin and remove cup from main housing. 3. Press the cones of the tapered roller.	Only if replacement of parts





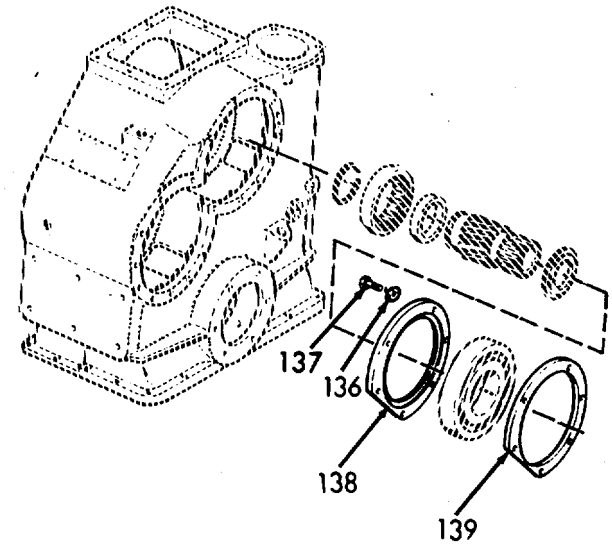
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)l			
	y. Counter shaft roller bearing (132)	Remove inner race from the counter shaft (129).	
	z. Pipe plug (133), retainer pin spring (134), and retainer pin (135)	Secure outer race of bearing (132) to main housing .	
	aa Outer race	Remove. Use tool T9803.	See Appendix F



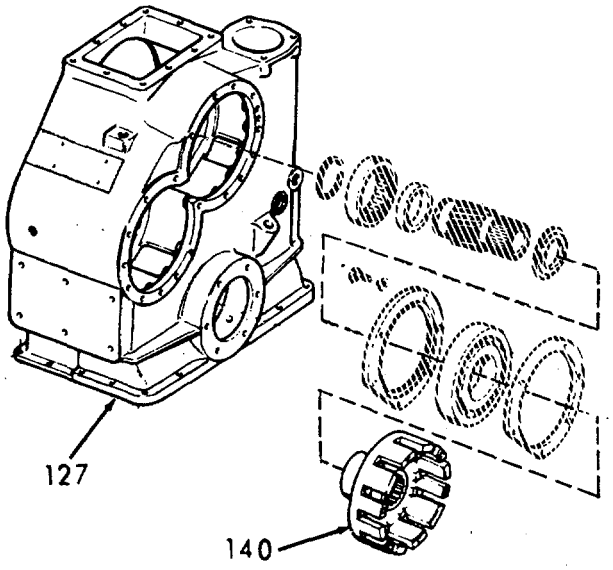
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

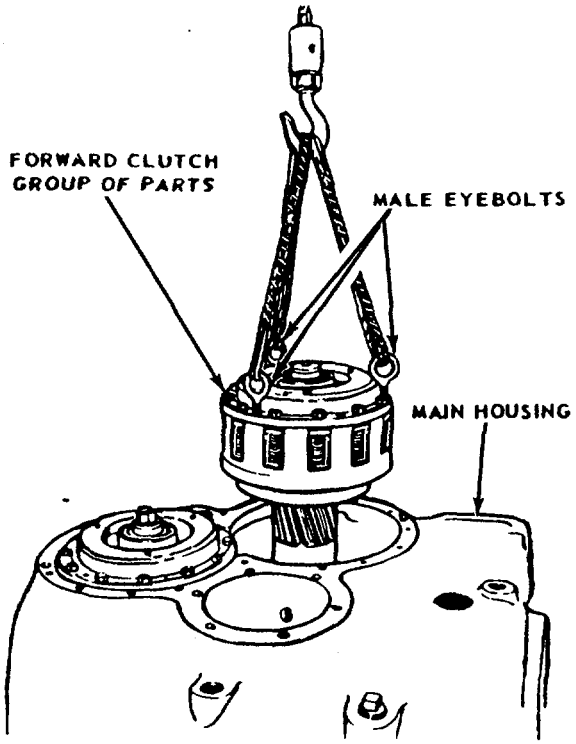
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
11. Forward clutch group	a. Lock-plates (136)	1. Reach through top cover plate.	
		2. Bend back locking edge of six lock-plates.	
	b. Screws (137), and lock-plates (136)	Remove.	
	c. Drilled hole bearing retainer (138)	Separate from hole bearing retainer (139).	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

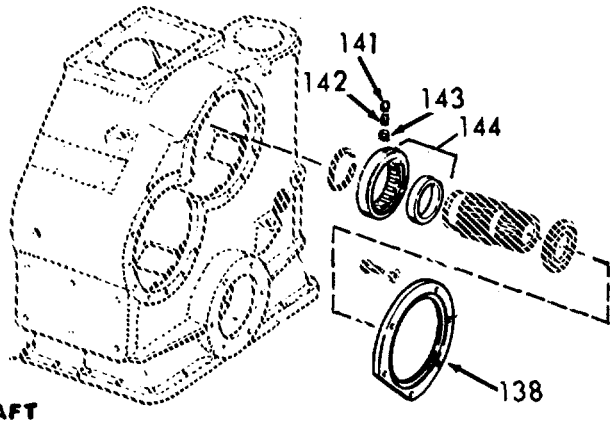
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	d. Main housing (127)	1. Place beneath a hoist. 2. Install male eyebolts in three 3/8-16UNC tapped holes in spider (140). 3. Hold the main housing down. 4. Lift the forward clutch group from the main housing. 5. Place on bench. 6. Remove eye bolts .	

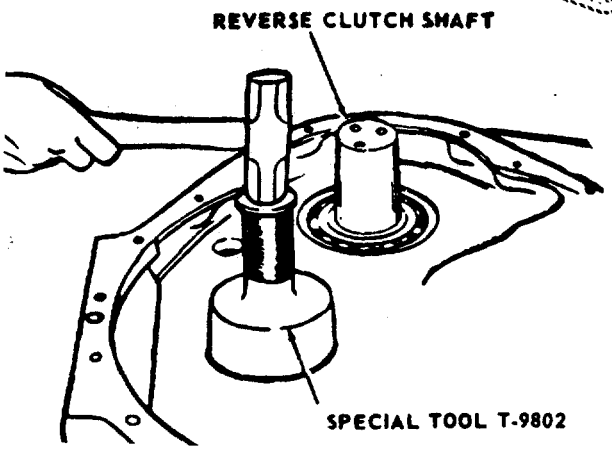


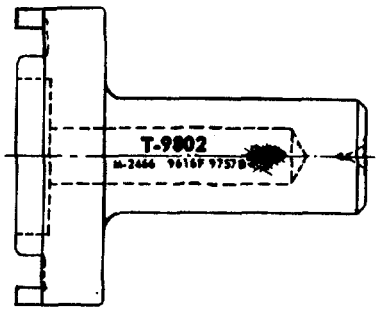


5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	e. Drilled hole bearing retainer (138)	Remove.	
	f. Pipe plug (141), retainer pin spring (142), and retainer pin (143)	Remove.	They secure the outer race of forward pinion roller bearing.
	g. Forward pinion roller bearing (144)	1. Remove outer race. 2. Use tool T9802.	

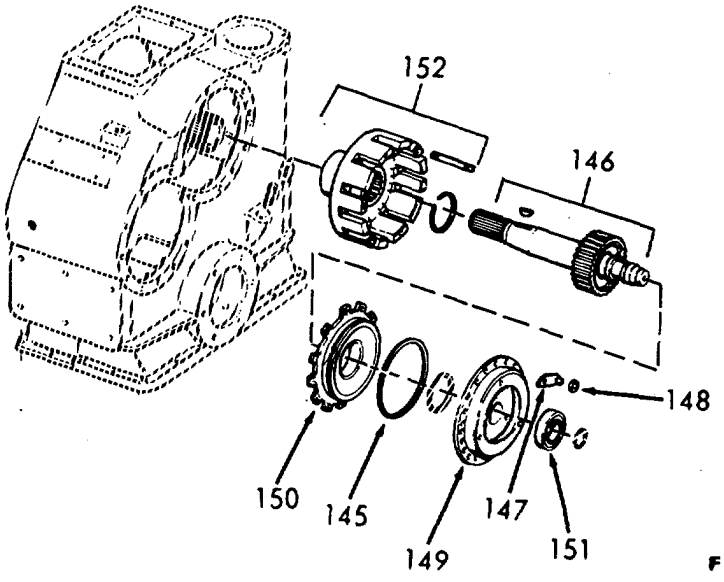


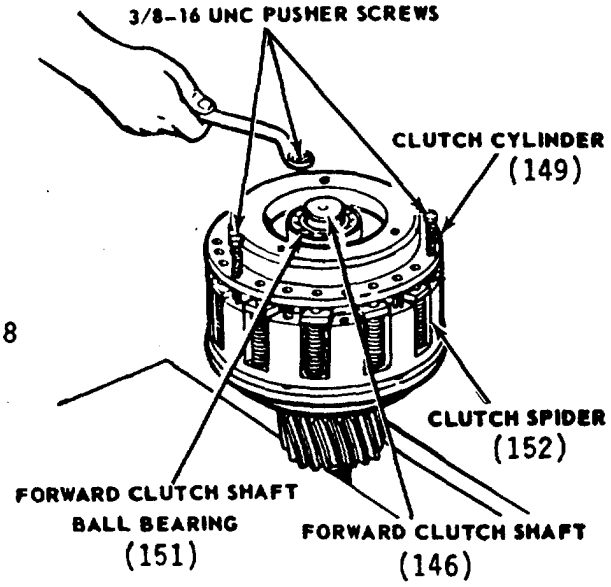




5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

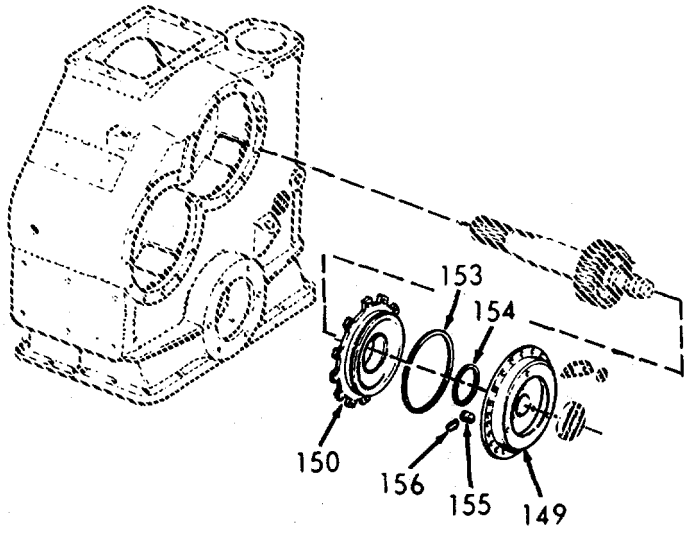
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	h. Piston ring (145)	Remove from forward clutch shaft (146).	
	i. Lockplates (147)	Bend back locking edges of six lockplates.	
	j. Nuts (148), and lockplates (147)	Remove 12 nuts and 6 lockplates.	Discard lockplates.
	k. Clutch cylinder (149)	1. Install three 3/8-16 pusher screws. 2. Alternately turn pusher screws. 3. Remove clutch cylinder (149), clutch piston (150), ball bearing (151) from clutch spider (152). 4. Separate parts in previous step.	





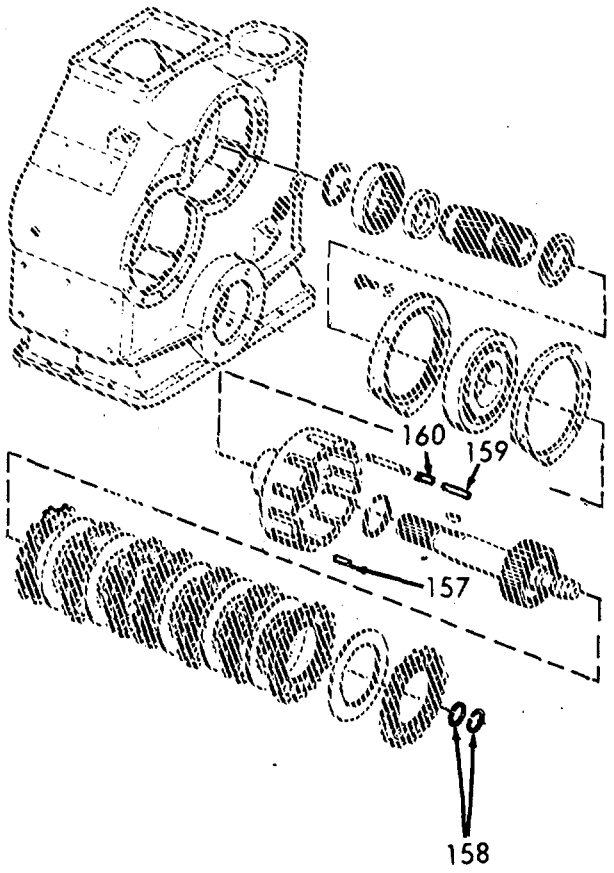
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	l. Piston ring (153)	Remove from piston (150).	
	m. Piston ring (154)	Remove from cylinder (149).	
	n. Roll pins (155), and set screws (156)	Remove 3 pins and 3 setscrews.	If necessary.



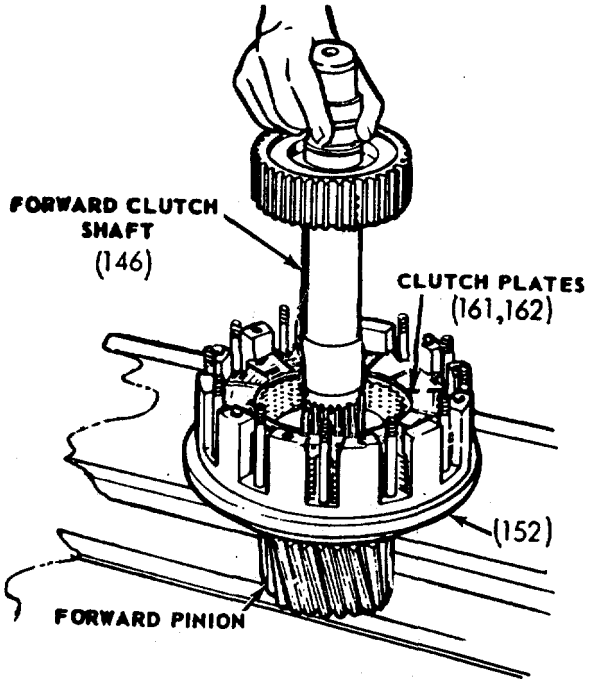
5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	o. Roll pins (157)	Remove six pins.	If necessary.
	p. Piston rings (158)	Remove two places.	
	q. Release springs (159), and split sleeves (160)	Remove 12 places.	



5-5. MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	r. Forward clutch shaft (146)	Remove from spider (152).	
	s. Eight sintered metal clutch plates (161), and seven steel clutch plates (162)	Remove from spider (152).	

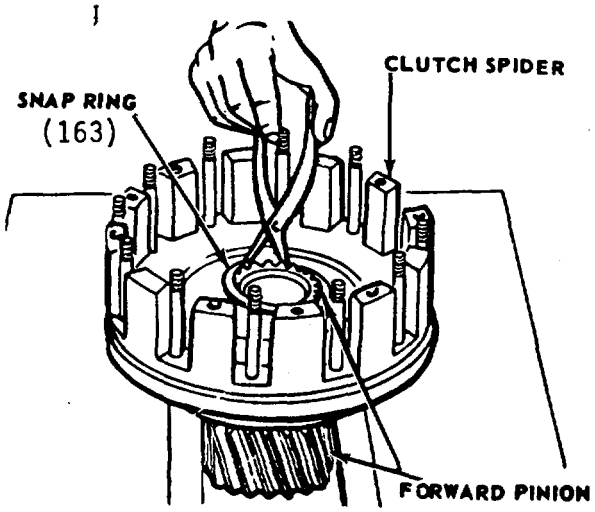


MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

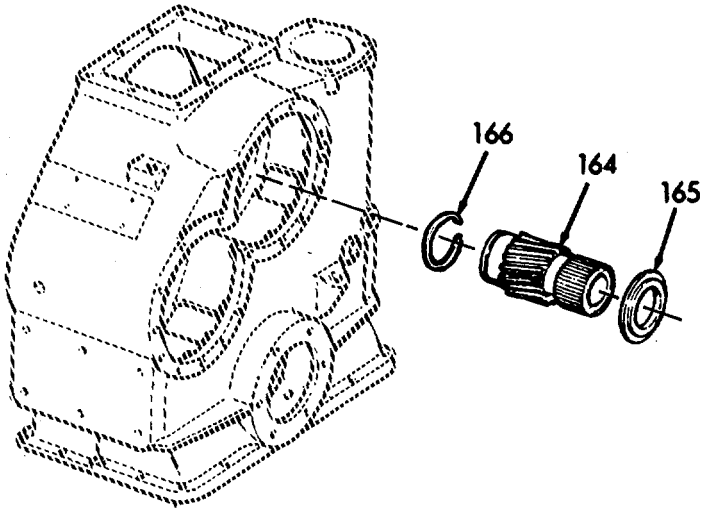
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont))

t.	External snap ring (163)	Remove	

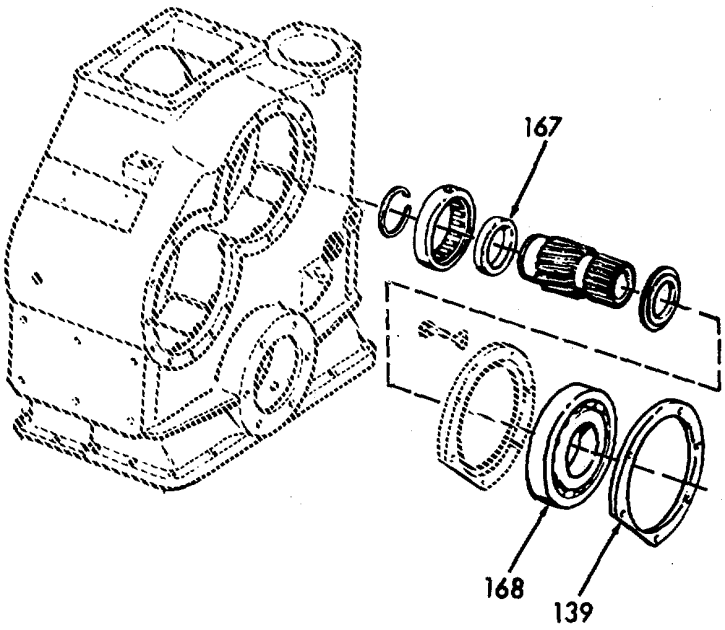


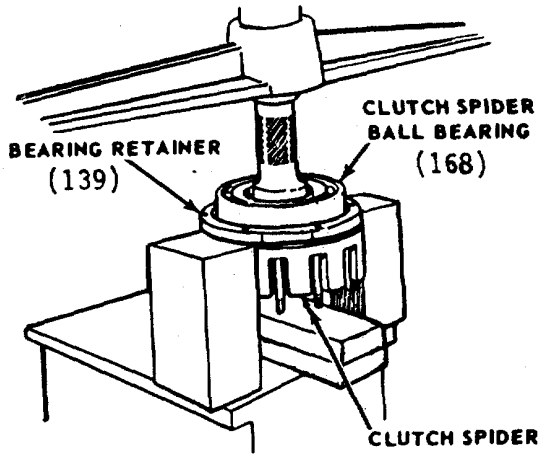
u.	Forward pinion (164)	Press out.	Use an arbor press.
v.	Forward pinion spacer (165), and external snap ring (166)	Remove.	



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

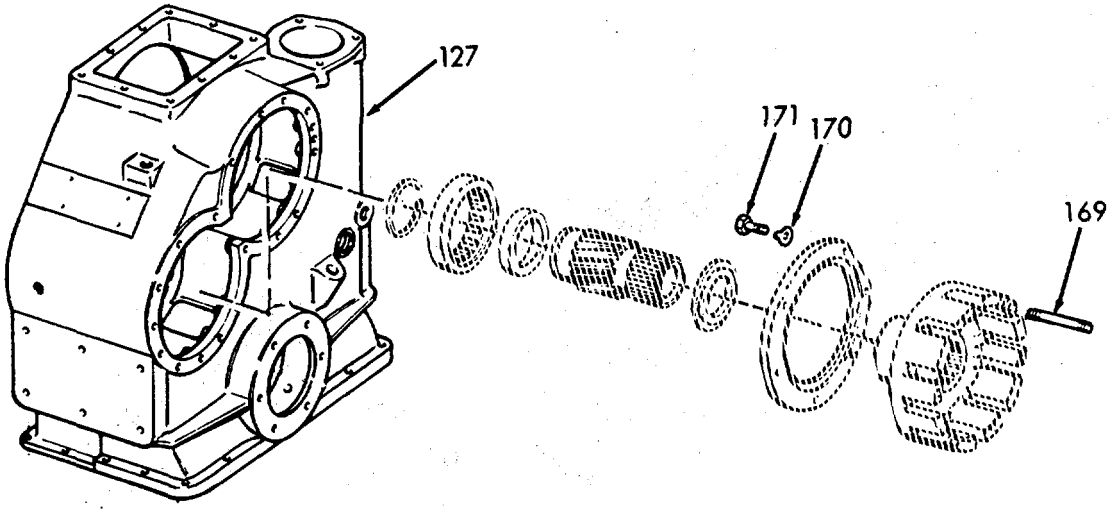
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)|			
	w. Inner race of forward pinion roller bearing (167)	Remove.	Remove only if replacement of parts is necessary.
	x. Clutch spider ball bearing (168)	1. Place on blocks underneath bearing retainer (139) on an arbor press. 2. Press out.	
	y. Bearing retainer (139)	Remove.	





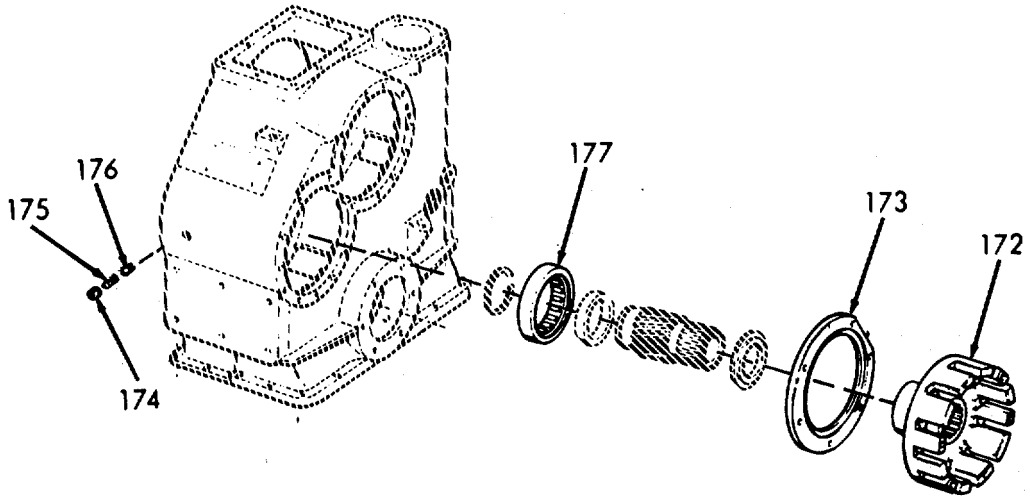
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	z. Studs (169)	Remove 12 studs on spider.	If necessary.
12. Reverse clutch group	a. Lock plates (170)	1. Reach through bottom opening of main housing. 2. Bend back locking edge of six lock plates.	
	b. Screws (171), and lock plates (170)	Remove.	
	c. Main housing (127)	Place beneath a hoist clutch end up.	



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	d. Clutch spider (172)	1. Install three 3/8-16 UNC eye bolts. 2. Hold the main housing down and lift the reverse group of parts up. 3. Place on work bench. 4. Remove eye bolts.	
	e. Outer bearing retainer (173)	Remove.	
	f. Setscrew (174), retainer pin spring (175), and pin (176)	Remove.	Secure outer race of reversion pinion roller bearing (177) to main housing.

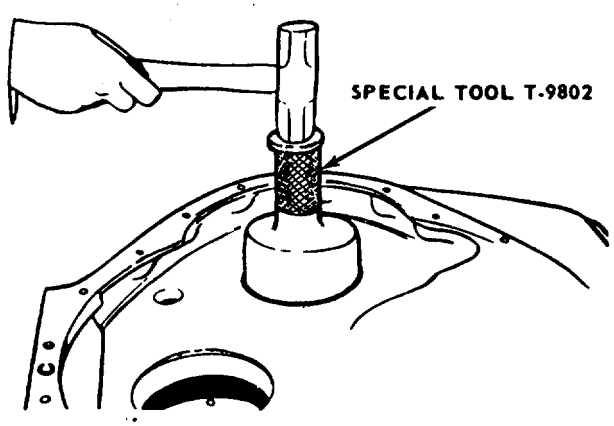


	g. Outer race of bearing (177)	Remove.	Use tool T9802.

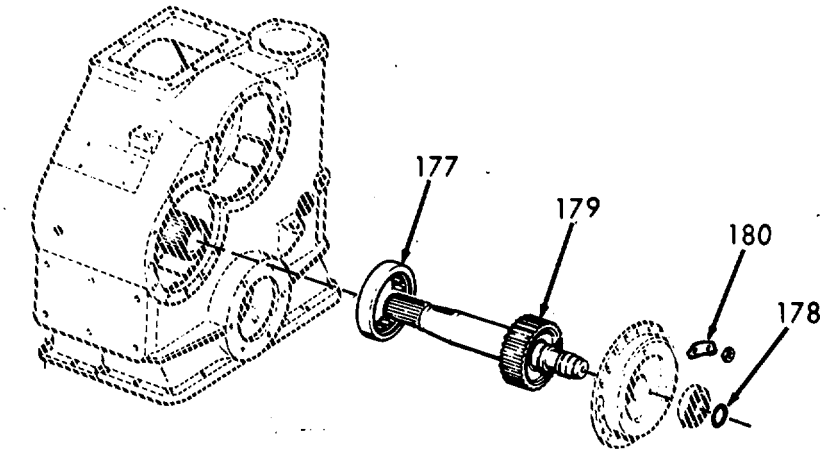
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont)

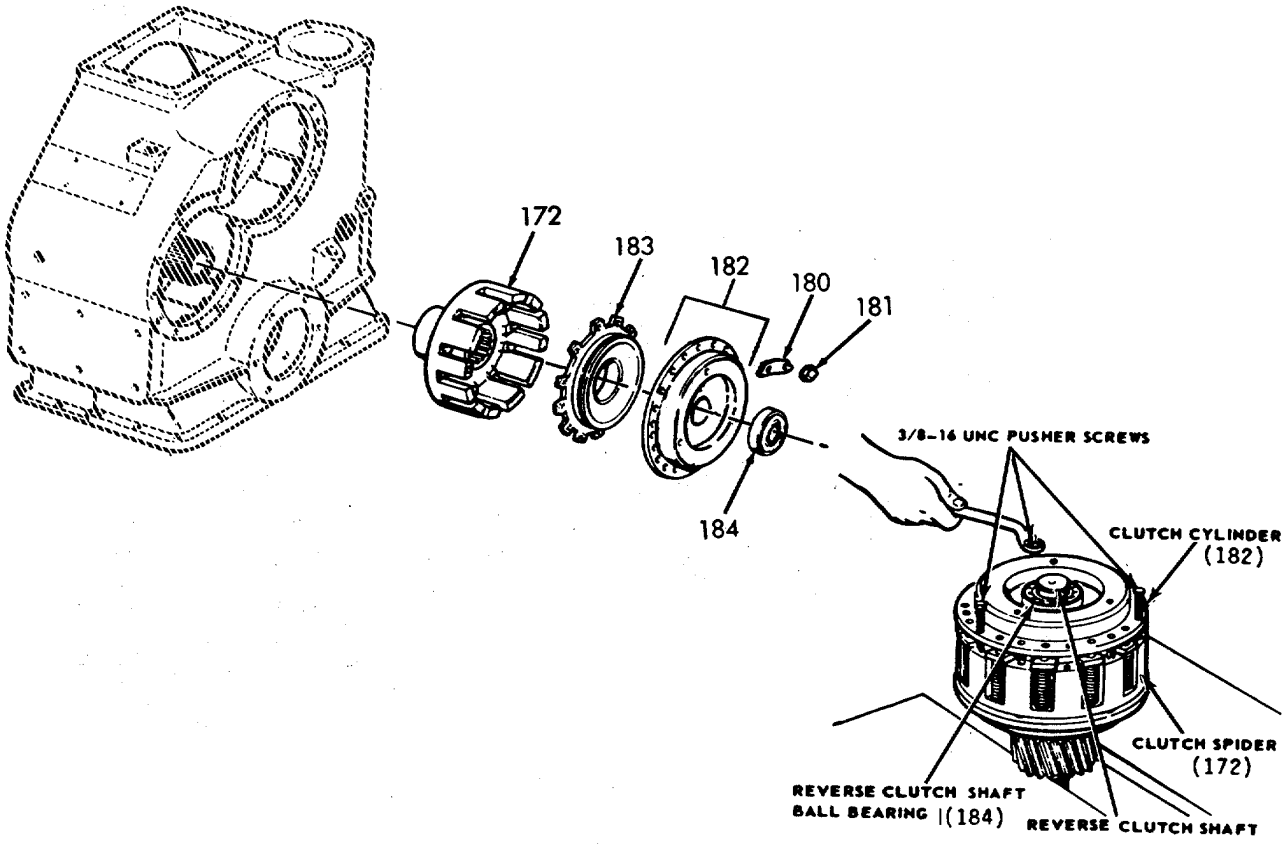


h.	Piston ring (178)	Remove from reverse clutch shaft (179).	
i.	Lock plates (180)	Bend back locking edges of six lockplates.	



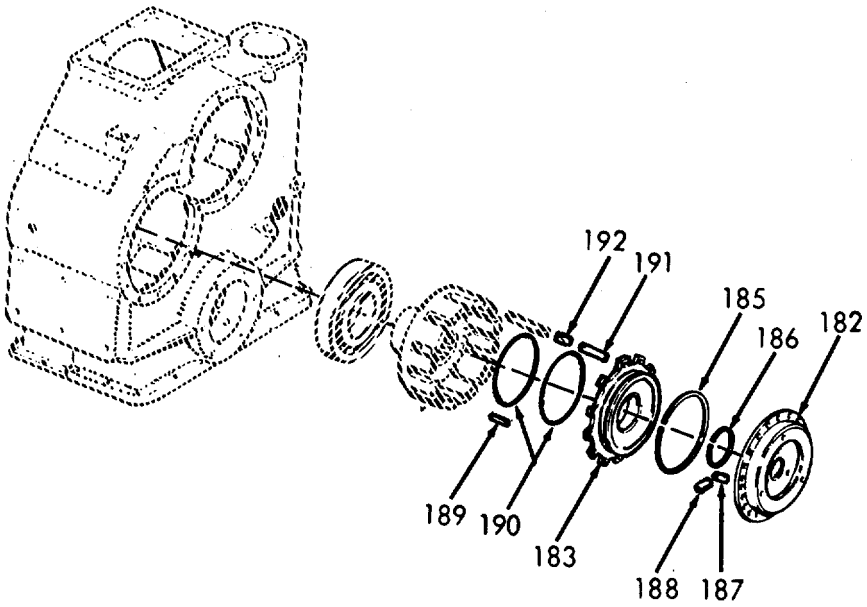
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	j. Nuts (181), and lock plates (180)	Remove 12 nuts and 6 lock plates.	Discard lock plates.
	k. Clutch cylinder (182)	1. Install three 3/8-16 pusher screws. 2. Alternately turn pusher screws. 3. Remove clutch cylinder (182) clutch piston (183), ball bearing (184) from clutch spider (172). 4. Separate parts in previous step.	



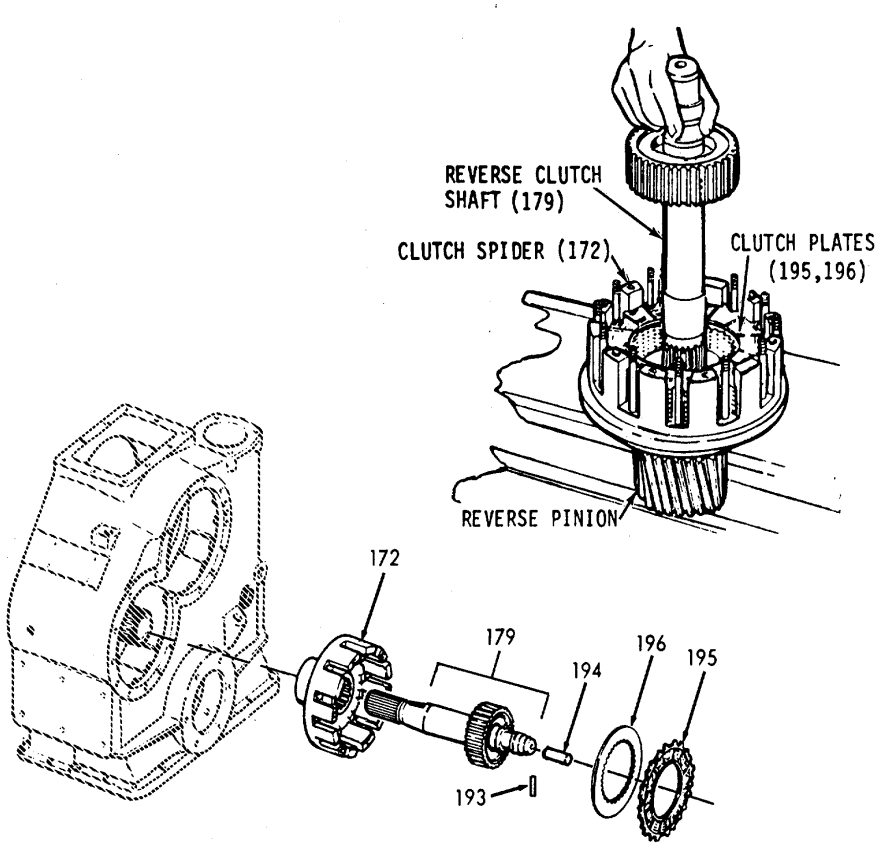
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	l. Piston ring (185)	Remove from piston (183).	
	m. Piston ring (186)	Remove from cylinder (182).	
	n. Roll pins (187) and set screws (188)	Remove 3 pins and 3 setscrews.	If necessary.
	o. Roll pins (189)	Remove six pins.	If necessary.
	p. Piston rings (190)	Remove two places.	
	q. Release springs (191) and split sleeves (192)	Remove 12 places.	



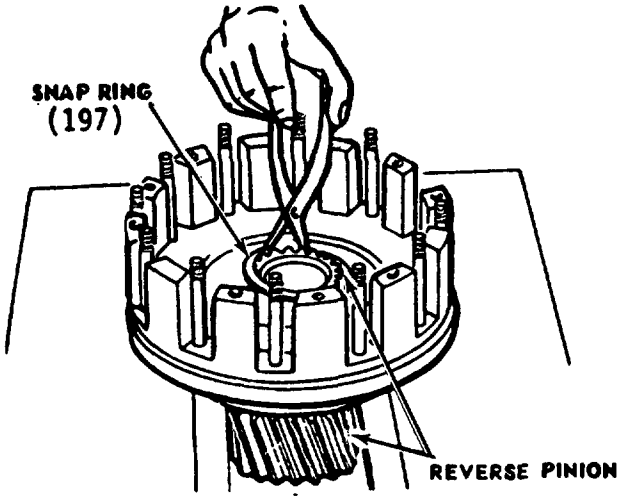
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	r. Reverse clutch shaft (179)	Remove from spider (172).	
	s. Dowel pin (193) and oil pump drive sleeve (194)	Remove.	
	t. Eight sintered metal clutch plates (195) and and seven steel clutch plates (196)	Remove from spider (172).	

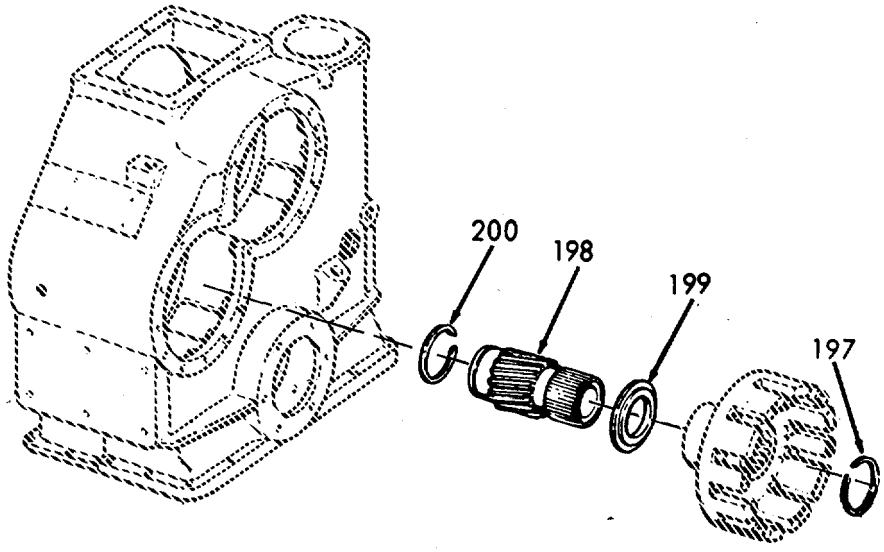


MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)|			
	u. External snap ring (197)	Remove.	

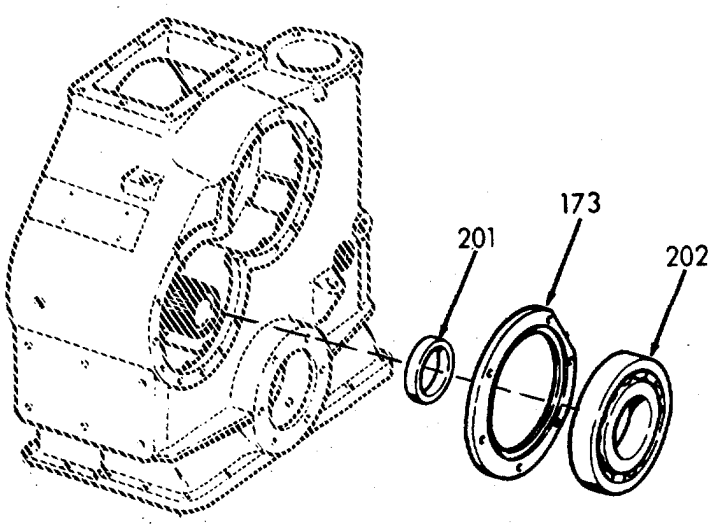


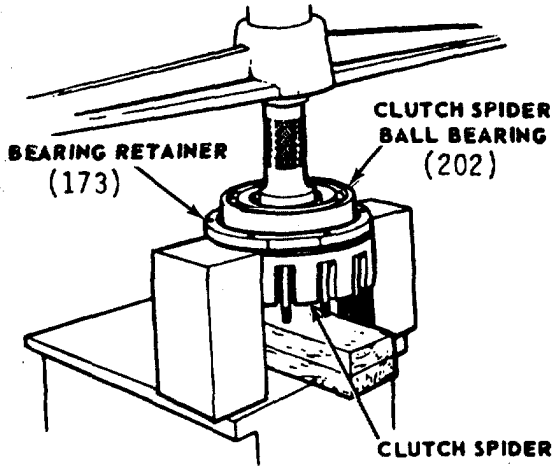
	v. Reverse pinion (198)	Press out.	Use an arbor press.
	w. Reverse pinion spacer (199), and external snap ring (200)'	Remove.	



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

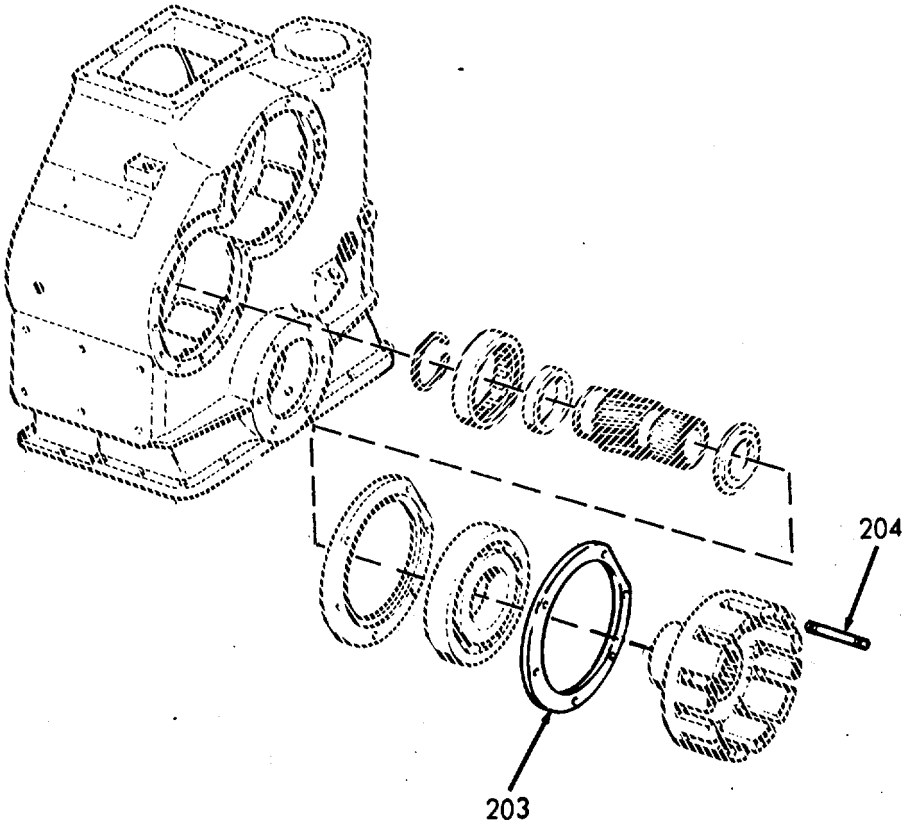
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	x. Inner race of pinion roller bearing (201)	Remove.	Remove only if replacement of parts is necessary.
	y. Clutch spider ball bearing (202)	1. Place on blocks underneath bearing retainer (173) on an arbor press. 2. Press out.	





MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	z. Bearing retainer (203)	Remove.	
	aa. Studs (204)	Remove 12 studs on spider.	Only if necessary.



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
CLEANING AND INSPECTION			
13. General	a. Oil seal s	Replace all oil seals.	
	b. Gaskets	Replace all gaskets.	
	c. Lock plates	Replace all lock plates.	
	d. Piston rings	Replace all piston rings.	
	e. Oil filter element	Replace the oil filter element.	
14. Cleaning	a. Ball and roller bearings	Use standard maintenance procedures to clean all ball and roller bearings.	
	b. Oil pump assembly	Use fresh cleaning agent to flush the oil pump assembly.	
		WARNING Wear eye protection when using compressed air.	
	c. All other parts	Thoroughly clean all other parts with a suitable cleaning agent. After cleaning, dry with compressed air. Lubricate all machined surfaces with clean oil. Examine each part after cleaning to make certain all foreign matter has been removed.	

NOTE

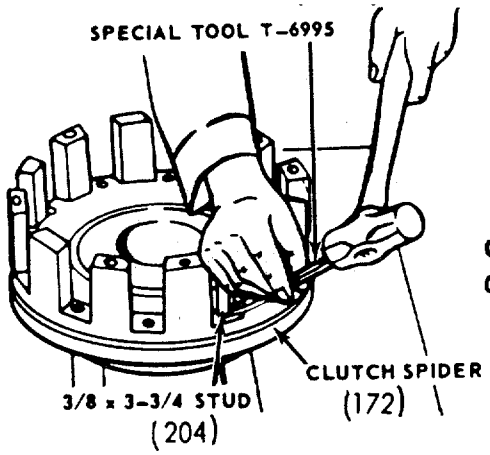
Do not use any abrasive material on selector valve parts as damage will result.

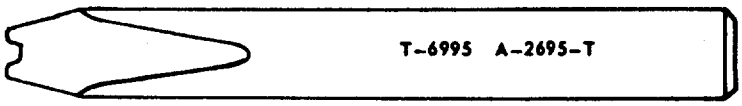
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
CLEANING AND INSPECTION (Cont)			
15. Inspection	a. Ball and roller bearings	Use standard maintenance procedures to inspect all ball and roller bearings.	
	b. Castings	Inspect all castings for cracks. Replace a cracked casting. Inspect all bearing bores and mounting faces for wear, grooves, scratches, etc. Remove burrs and scratches with a crocus clutch. Inspect tapped holes for damaged threads. Chase damaged threads with a used tap of the correct size. Replace all castings that cannot be repaired.	
	c. Splined parts	Inspect all splined parts for worn, twisted, chipped or burred splines. If possible, remove these defects with a soft stone. Replace a splined part that cannot be repaired.	
	d. Threaded parts	Inspect all threaded parts for damaged threads. Repair damaged threads with a thread file or a fine three-cornered file. Replace a threaded part that cannot be repaired.	
	e. Pressure gauge assembly	Inspect the pressure gauge assembly for damage. Replace a damaged pressure gauge assembly.	
	f. Driving ring	Inspect the driving ring for damage or wear. Replace the ring if necessary.	
	g. Drive spider	Inspect the drive spider for broken, cracked or otherwise damaged lugs. Inspect the drive spider for a loose fit on the forward clutch shaft. Replace a drive spider that is damaged, or that fits loosely on the forward clutch shaft.	

MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

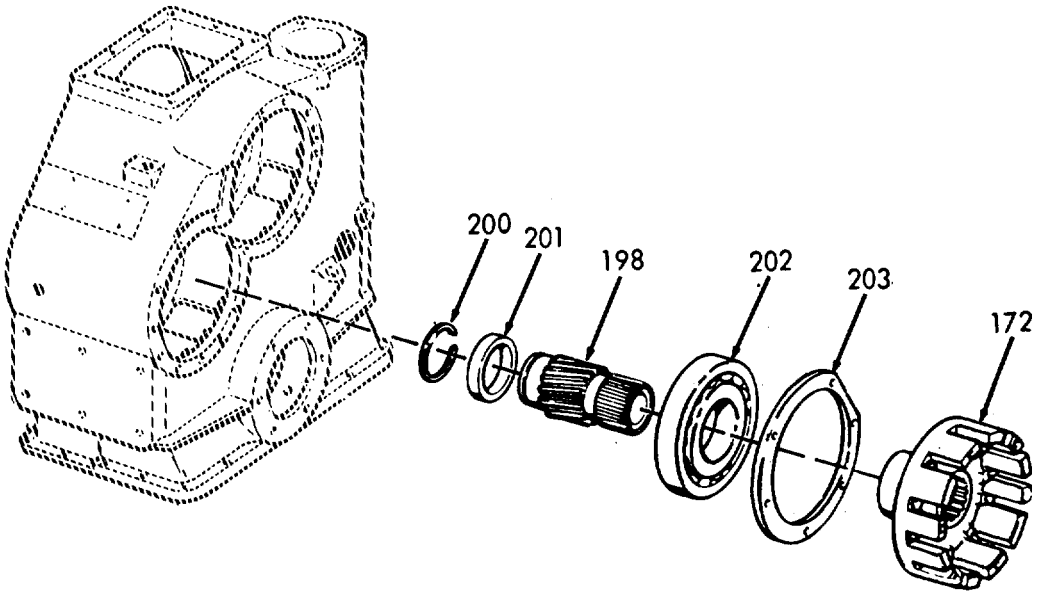
LOCATION	ITEM	ACTION	REMARKS
CLEANING AND INSPECTION (Cont)			
	h. Flexible hose	Inspect all flexible hose for cracks, sponginess or other damage. Replace a damaged hose.	
	i. Gear teeth	Inspect all gear teeth for cleanliness and damage. Foreign particles tend to collect in the root of the gear teeth. Clean thoroughly and repair minor damage with a fine file or crocus cloth. Replace a gear that cannot be repaired.	
	j. Orifices	It is very important that all orifices to -be clean and clear. Inspect the orifices in the orifice plate of the selector valve assembly. Inspect the orifice in the oil return pipe piston. Inspect the orifices in the two manifold orifice pipe plugs. Use a small wire to make certain the orifices are clean and clear.	
OVERHAUL - REASSEMBLY			
16. Reverse clutch group	a. Clutch spider studs (204)	1. Install twelve 3/8 x 3-3/4 studs i n spider (172). 2. Stake studs in place Use tool T6995. on both sides of clutch spider.	





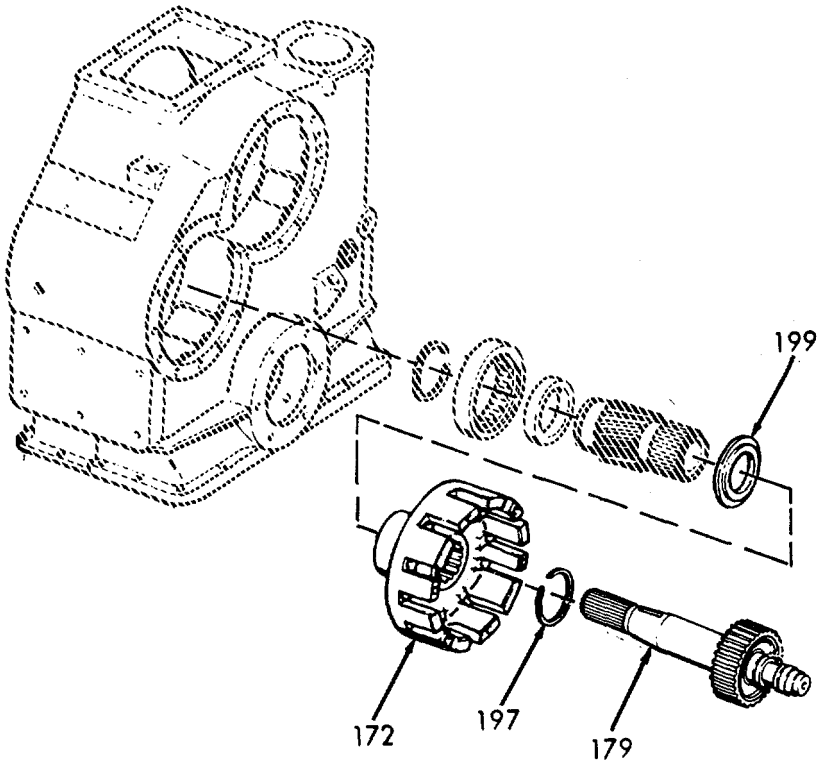
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	b. Clutch spider ball bearing (202) and bearing retainer (203).	Install on clutch spider (172).	User arbor press.
	c. Reverse pinion (198)	Press into inner race of the reverse pinion roller bearing (201).	
	d. Snap ring (200)	Install.	
	e. Reverse pinion (198)	Place in arbor press, splined end up.	



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	f. Reverse pinion spacer (199)	Place on pinion.	
	g. Clutch spider (172)	Press onto the pinion.	
	h. Snap ring (197)	Install.	
	i. Reverse clutch shaft assembly (179)	Install.	



LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

CAUTION:

Sintered-Metal Clutch Plates

- The possibility of clutch pack failure exists on initial start-up after rebuild, due to lack of lubrication until lube pressure builds up.

- All sintered-metal clutch plates must be submerged in oil (use same oil as will be used in unit) for a minimum of one (1) hour prior to assembly. A longer soaking period would be even more beneficial.

- Covering the plates with oil from an oil can during assembly is NOT sufficient!

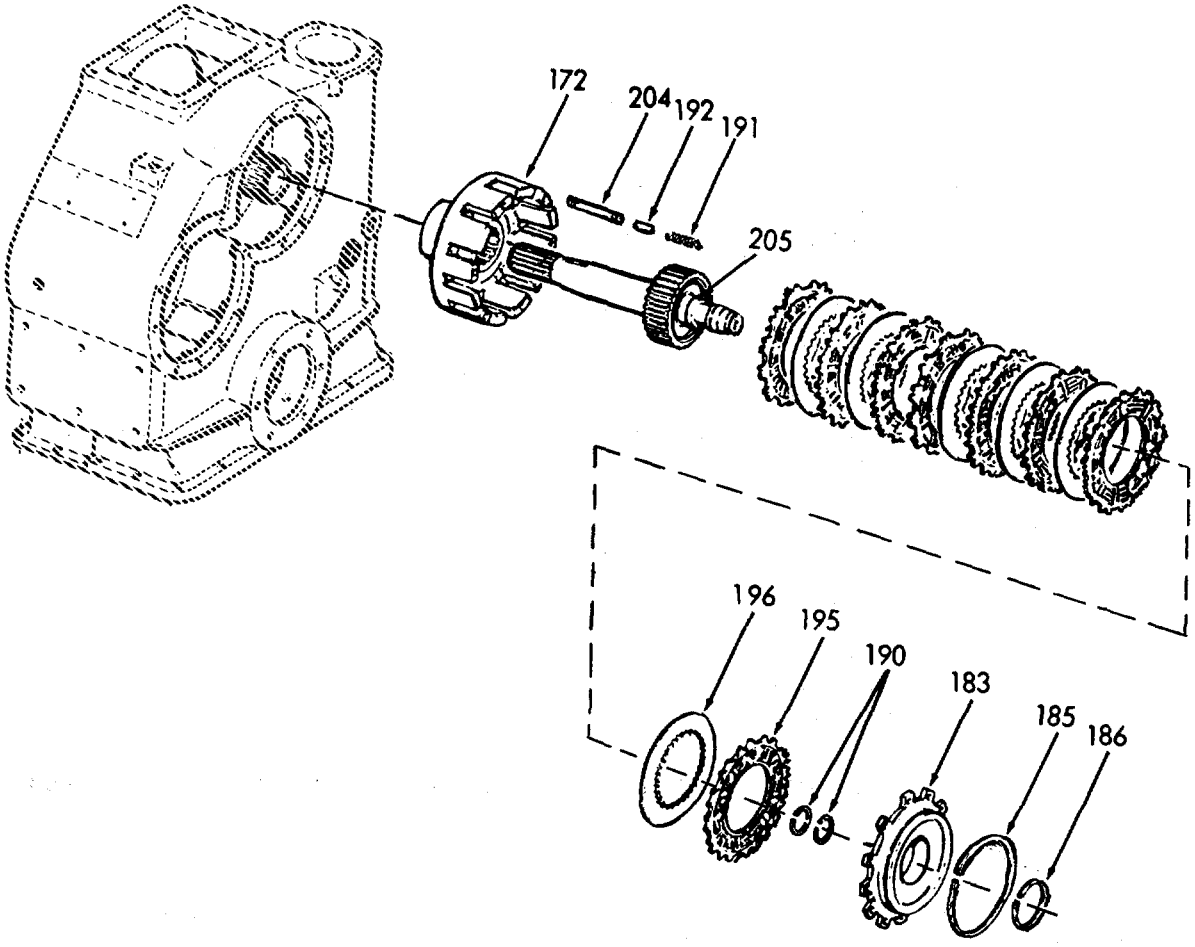
MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	j. Eight sintered-metal clutch plates (195) , and seven steel clutch plates (196)	Install.	Alternate clutch plate stack. Begin and end with a sintered-metal clutch plate.
	k. Split sleeves (192)	Install twelve on clutch spider (172) and studs (204).	
	l. Release springs (191)	Install.	
	m. Piston rings (190)	Install new rings.	Rings are 1-3/4 inch.
	n. Set screws and oil catcher (205)	Install.	
	o. Piston ring (185)	Install in clutch piston 7 inch ring. (183).	
	p. Piston ring (186)	Install in clutch piston 3 inch ring. (183).	

MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

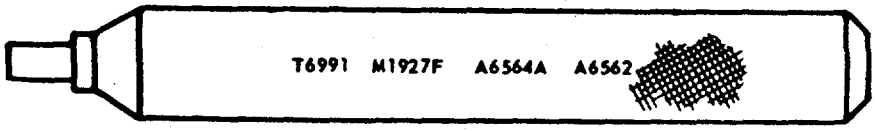
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)



MARINE GEAR - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	q. Clutch piston (183)	1. Carefully install in clutch cylinder (182). 2. Place clutch piston and cylinder against clutch spider (172). 3. Use three full threaded 3/8-16 X 1 inch screws. of springs.	Hold cylinder to spider against tension
	r. Roll pins (189)	Install 6 pins.	Use tool T6991.

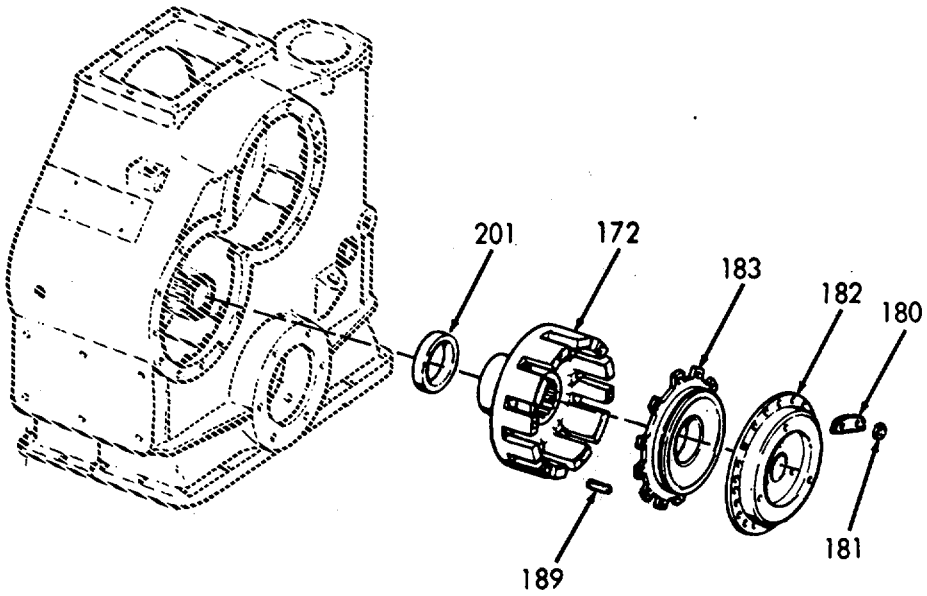


	s. Lock plates (180) and nuts (181)	1. Install. plates. 2. Tighten nuts to 38 lb-ft (51.5 Nm) torque. 3. Bend ends of lock plates against the flats of the nuts. 4. The center of each lock plate must cover a roll pin (189). 5. Remove three screws installed in step 16q.	Use new lock

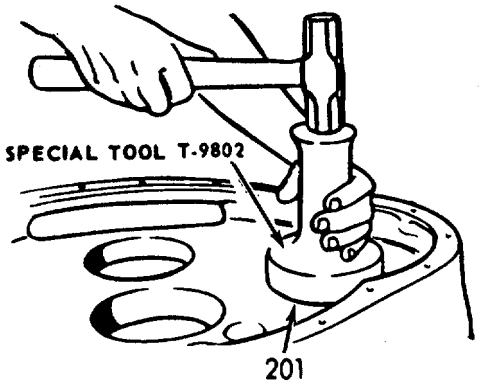
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

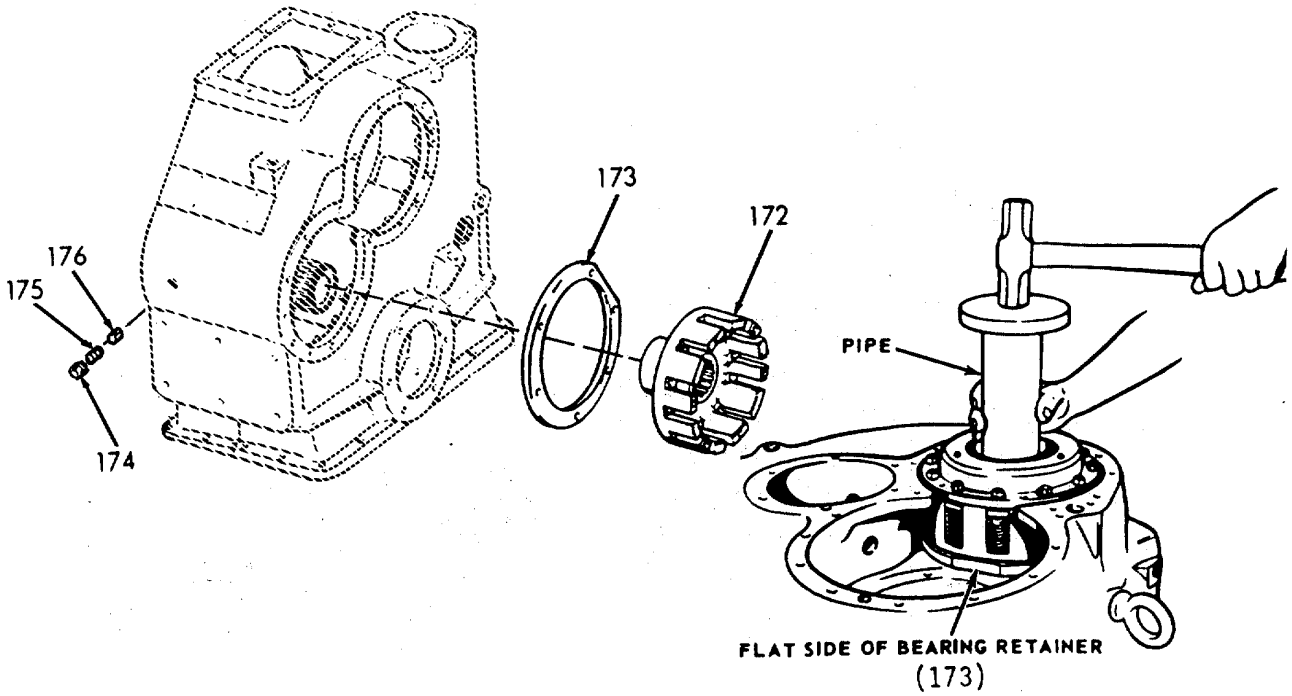


t.	Outer race of reverse pinion roller bearing (201)	1. Install. 2. Carefully align the pin hole in the outer race with the pin hole in the housing.	Use tool T9802.



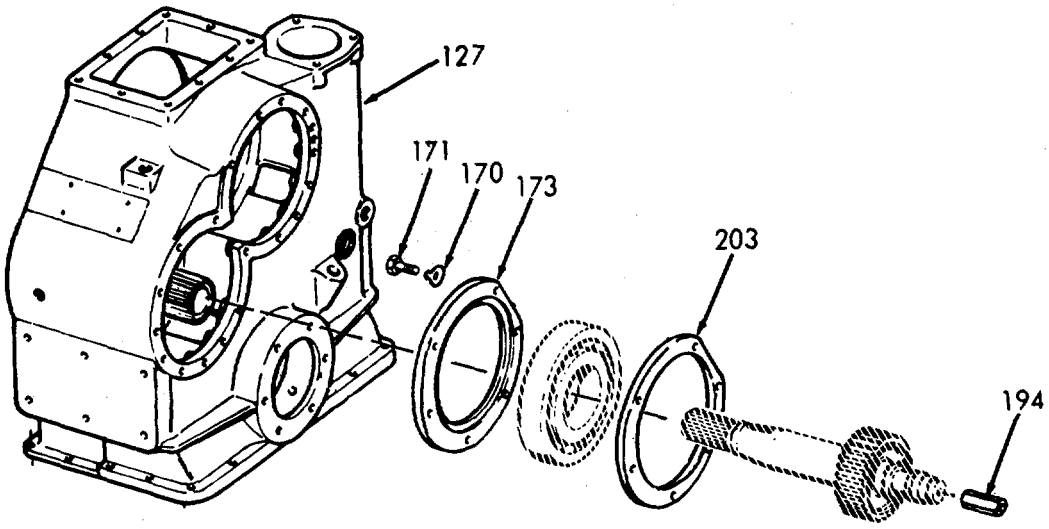
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	u. Retainer pin (176) spring (175) and setscrew (174)	Install.	
	v. Clutch spider (172)	Install three 3/8-16 eye bolts.	
	w. Drilled hole bearing retainer (173)	Hold in place.	
	x. Reverse clutch group	1. Use a hoist.	
		2. Install.	
		3. Seat.	Use a hammer and a piece of pipe.



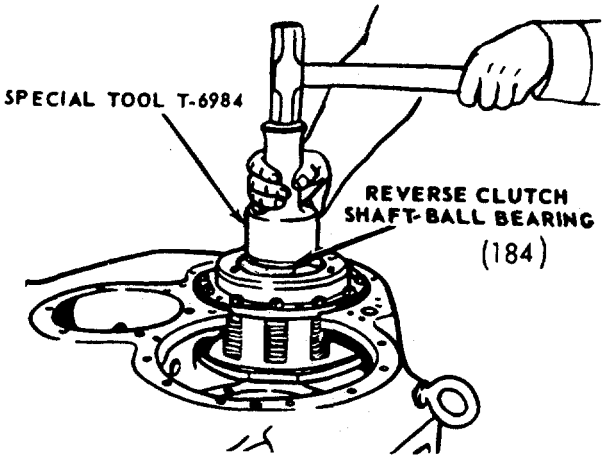
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	y. Lock plates (170)	Bend to facilitate locking.	
	z. Bearing retainers (173 and 203)	Place in position in main housing (127) with the flatside facing the forward clutch position.	
	aa. Lock plates (170), and screws (171)	1. Install. 2. Tighten screws X 1-1/2 inches to 38 lb-ft (51.5 Nm) torque. 3. Bend tabs of lock plates to flats of screws.	Screws are 3/8-16.
	ab. Oil pump drive sleeve (194)	Place in position on reverse clutch shaft.	



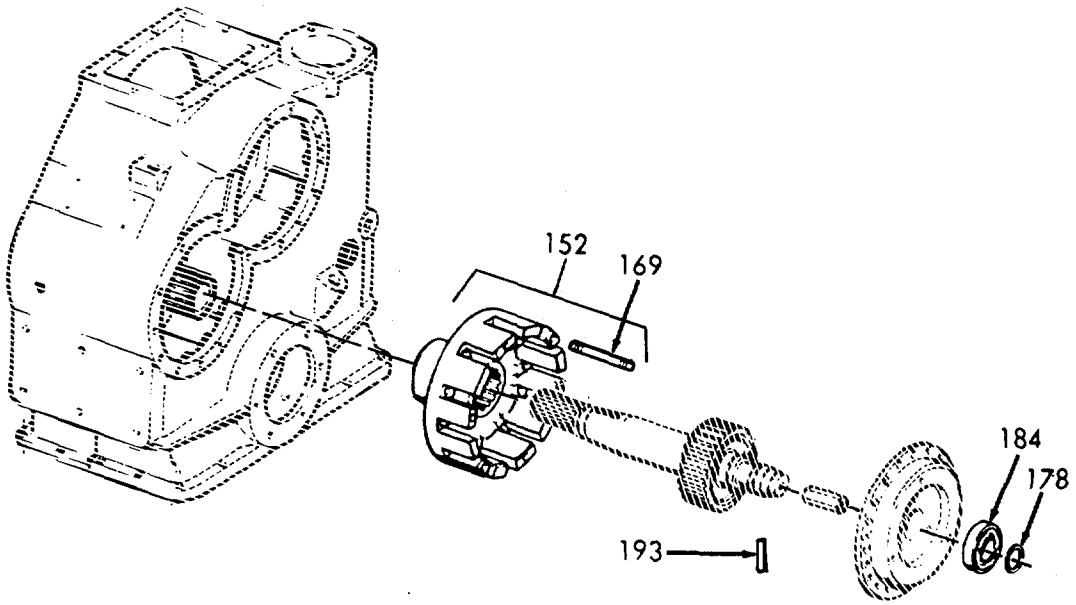
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	ac. Dowell pin (193)	Install.	Pin is 1/4 X 1-1/2 inch.
	ad. Reverse clutch shaft ball bearing (184)	1. Place on shaft. 2. Install.	Use tool T6984.
	ae. Piston ring (178)	Install on end of clutch shaft.	Use new 1.57 inch piston ring.



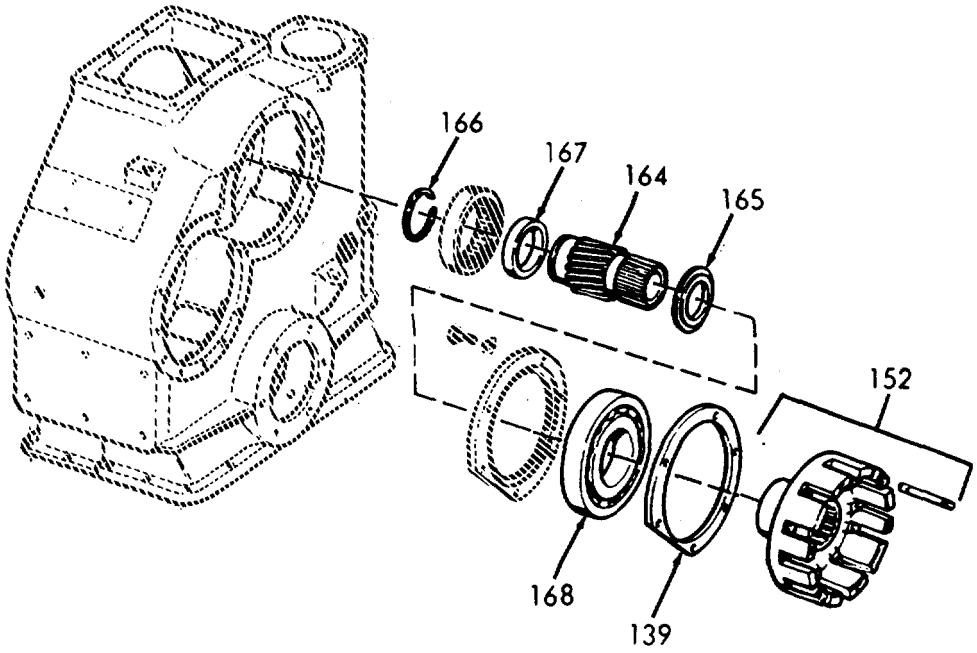
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
17. Forward clutch group (169)	a. Clutch spider studs	1. Install twelve 3/8 x 3-3/4 studs in spider (152).	
		2. Stake studs in place on both sides of clutch spider.	Use tool T6995.



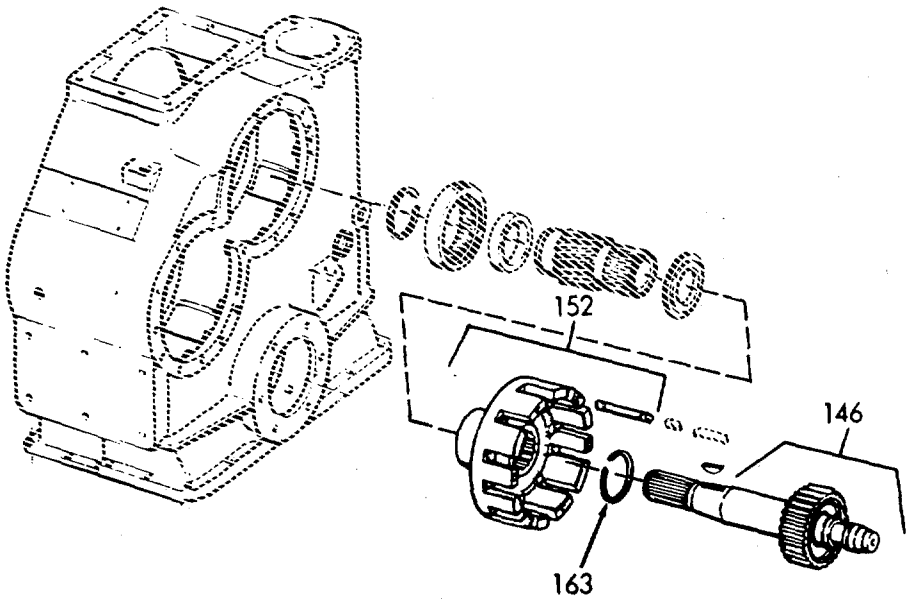
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	b. Clutch spider ball bearing (168), and bearing retainer (139).	Install on clutch spider (152).	User arbor press.
	c. Forward pinion (164)	Press into inner race of the forward pinion roller bearing (167).	
	d. Snap ring (166)	Install.	
	e. Forward pinion (164)	Place in arbor press, splined end up.	
	f. Forward pinion spacer (165)	Place on pinion.	



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	g. Clutch spider (152)	Press onto the pinion.	
	h. Snap ring (163)	Install.	
	i. Forward clutch shaft assembly (146)	Install.	



5-107

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

CAUTION

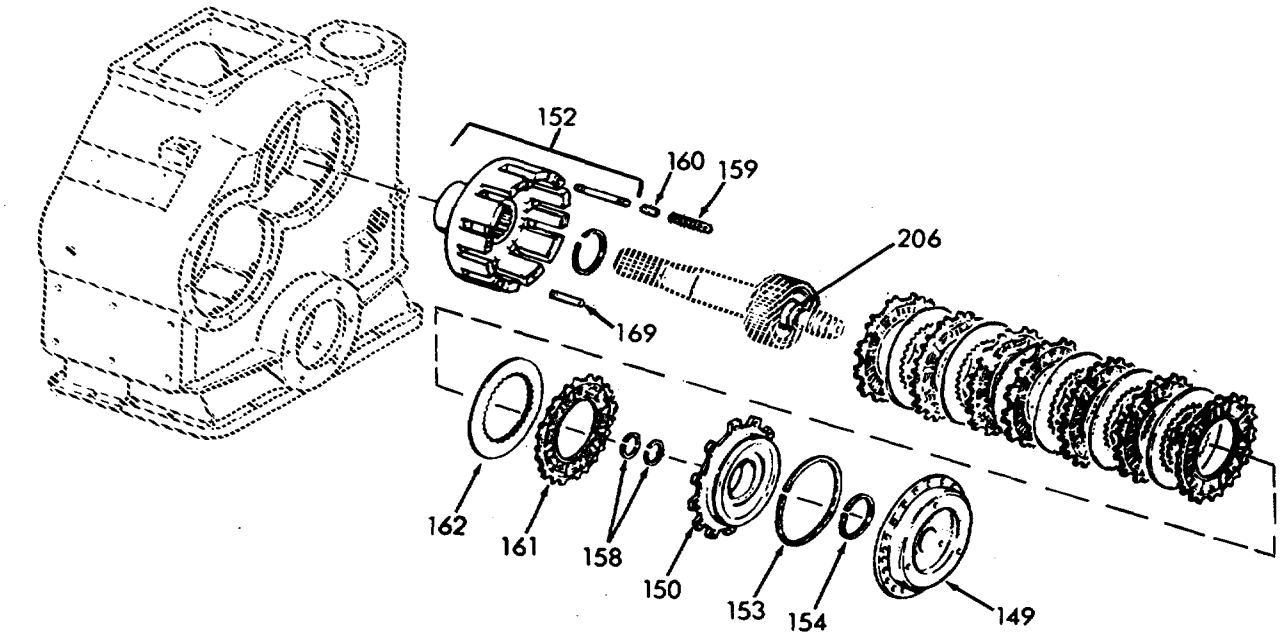
Sintered-Metal Clutch Plates

- The possibility of clutch pack failure exists on initial start-up after rebuild, due to lack of lubrication until lube pressure builds up.
- All sintered-metal clutch plates must be submerged in oil (use same oil as will be used in unit) for minimum of one (1) hour prior to assembly. A longer soaking period would be even more beneficial.
- Covering the plates with oil from an oil can during assembly is NOT sufficient!

j.	Eight sintered-metal clutch plates (161), and seven steel clutch clutch plates (162)	Install.	Alternate clutch plate stack. Begin and end with a sintered-metal clutch plate.
k.	Split sleeves (160)	Install twelve on clutch spider (152) and studs (169).	
l.	Release springs (159)	Install.	
m.	Piston rings (158)	Install new rings.	Rings are 1-3/4 inch.

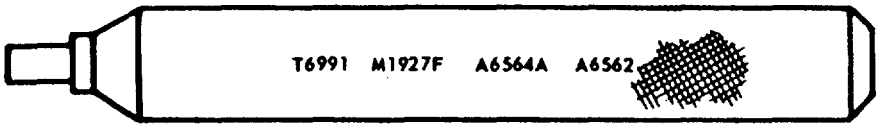
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	n. Set screws and oil catcher (206)	Install.	
	o. Piston ring (153)	Install in clutch piston (150).	7 inch ring.
	p. Piston ring (154)	Install in clutch piston (150).	3 inch ring.
	q. Clutch piston (150)	1. Carefully install in clutch cylinder (149).	
		2. Place clutch piston and cylinder against clutch spider (152).	
		3. Use three full threaded 3/8-16 X 1 inch screws.	Hold cylinder to spider against tension of springs.

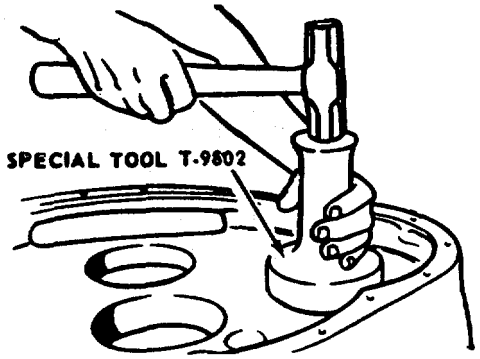


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
r.	Roll pins (157)	Install 6 pins.	Use tool T6991.

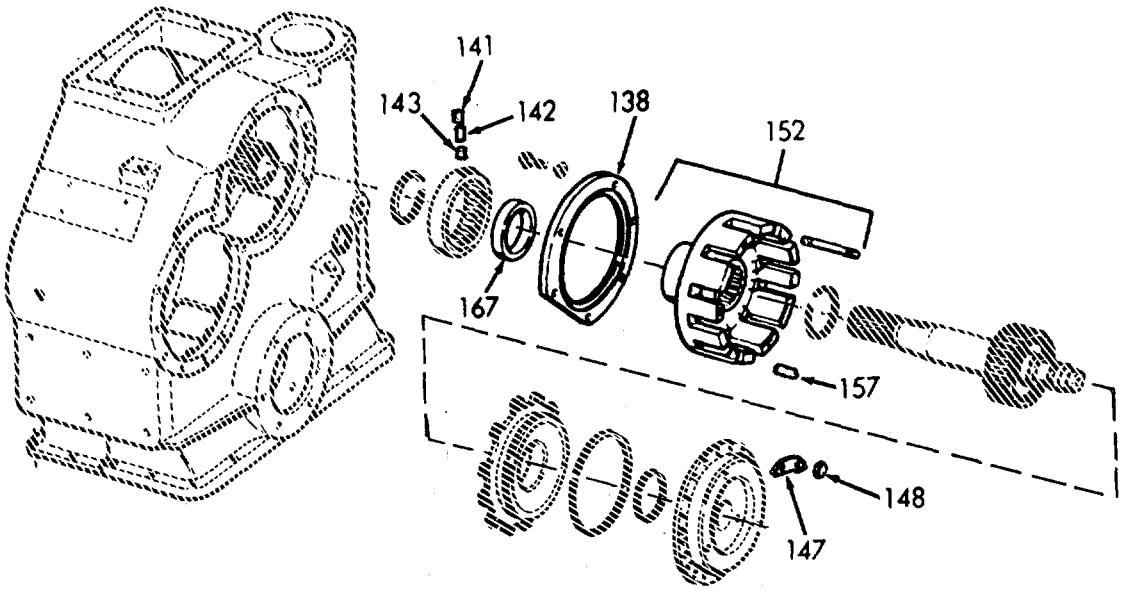


s.	Lock plates (147) and nuts (148)	1. Install. 2. Tighten nuts to 38 lb-ft (51.5 Nm) torque. 3. Bend ends of lock plates against the flats of the nuts. 4. The center of each lock plate must cover a roll pin (157). 5. Remove three screws installed in step 17q.	Use new lock plates.
t.	Outer race of forward pinion roller bearing (167)	1. Install. 2. Carefully align the pin hole in the outer race with the pin hole in the housing.	Use tool T9802.



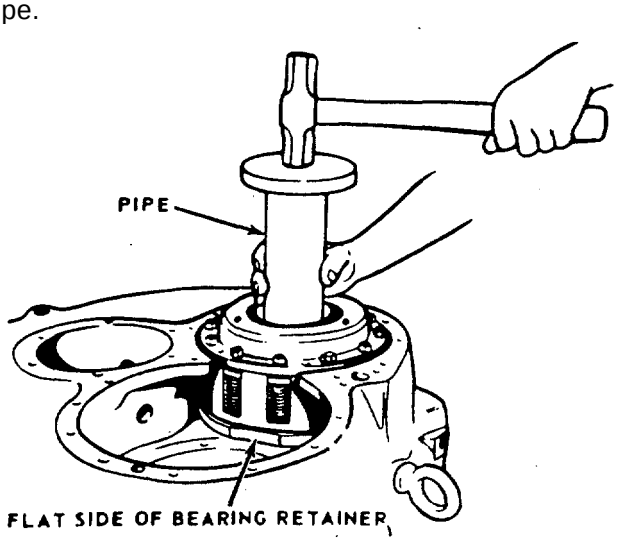
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	u. Retainer pin (143) spring (142) and sets crew (141)	Install.	
	v. Clutch spider (152)	Install three 3/8-16 eye bolts.	
	w. Drilled hole bearing retainer (138)	Hold in place.	



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

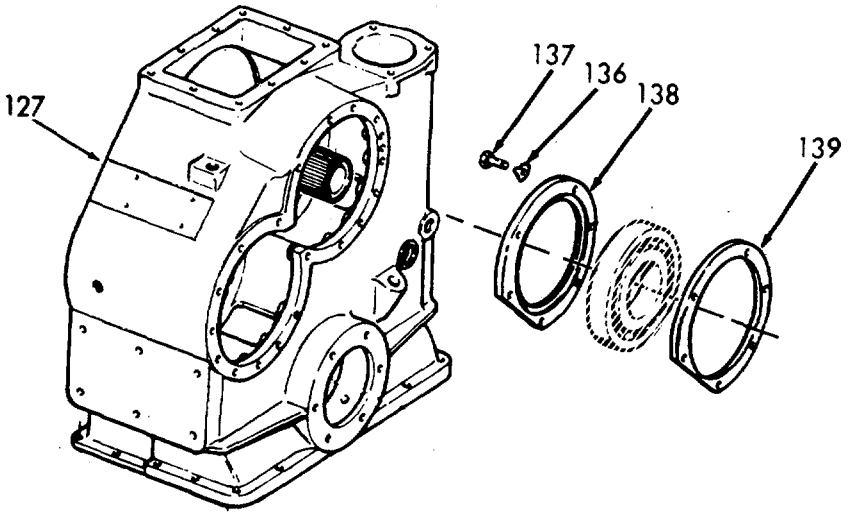
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	x. Forward clutch group and a piece of pipe.	1. Use a hoist. 2. Install and seat.	Use a hammer
	y. Lock plates (136)	Bend to facilitate locking.	
	z. Bearing retainers (138) and (139)	Place in position in main housing (127) with the flatside facing the reverse clutch position.	
	aa. Lock plates (136) and screws (137)	1. Install. 2. Tighten screws X 1-1/2 inches to 38 lb-ft (51.5 Nm) torque. 3. Bend tabs of lock plates to flats of screws.	Screws are 3/8-16.



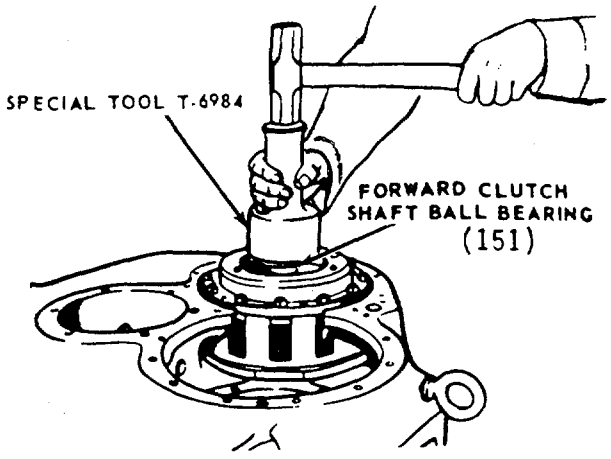
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

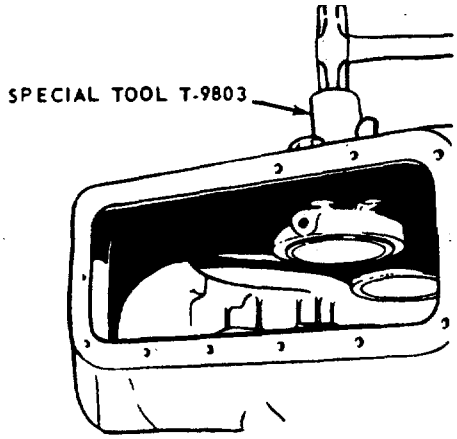


ab. Forward clutch shaft ball bearing (151)	1. Place on shaft.		
	2. Install.		Use tool T6984.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

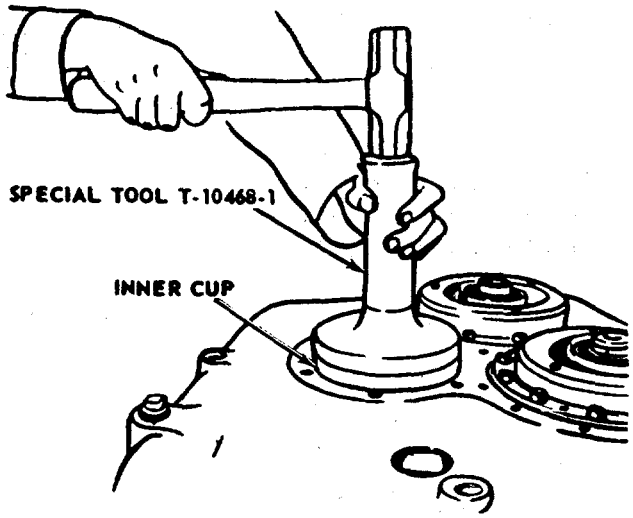
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	ac. Piston ring (145)	Install on end of clutch shaft.	Use new 1.57 inch piston ring.
18. Counter shaft group	a. Counter shaft roller bearing outer race (132)	1. Carefully align the pin hole in the outer race with the pin hole in housing. 2. Install.	Use tool T9803.
	b. Retainer pin (135) spring (134) and pipe plug (133)	Install.	
	c. Tapered roller bearing inner cup (131)	1. Install.	Use tool T10468-1.

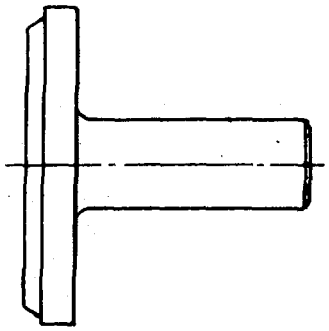


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

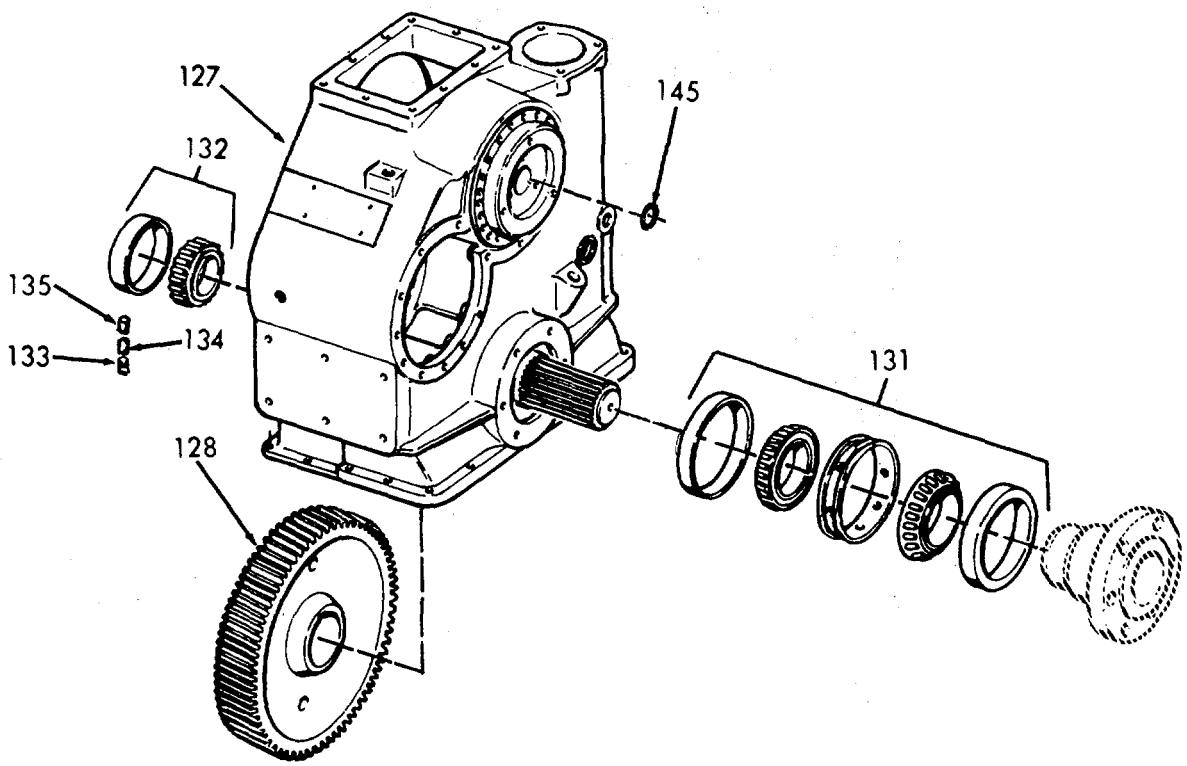
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)



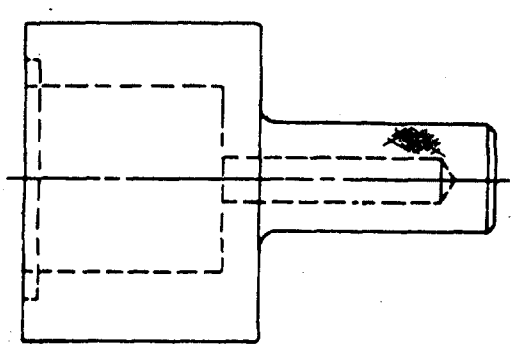


d.	Counter shaft gear (128)	Use wooden blocks and position in main housing (127).	Place large end of the tappered hole in the gear to the rear of the main housing.



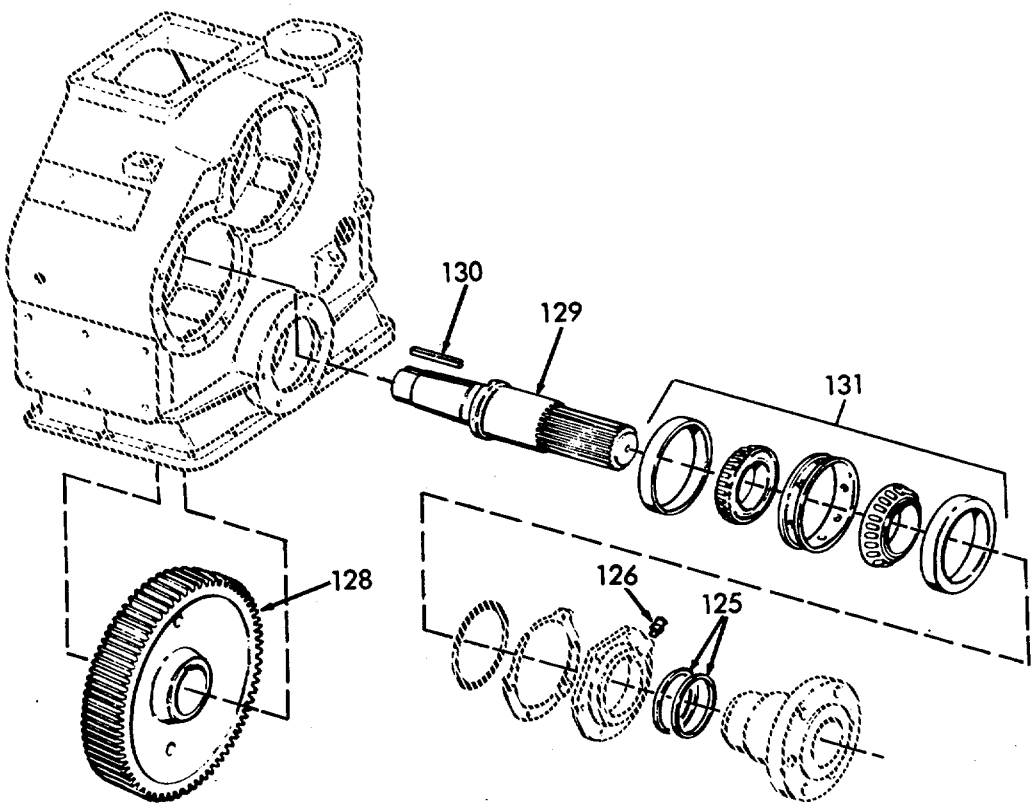
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	e. Tapered roller bearing cone surface on the counter shaft (131)	1. Coat with white lead. 2. Press the counter shaft into the cones of the tapered roller bearings.	Use arbor press.
	f. Key (130)	Install.	Key is 5/8 X 5/8 X 3-3/8.
	g. Counter shaft (129) and counter shaft gear (128).	Assemble.	Make sure key and keyway are aligned.
	h. Tapered roller bearing cup spacer (131)	Install.	
	i. Tapered roller bearing outer cup (131)	Install.	Use tool T10468-2.



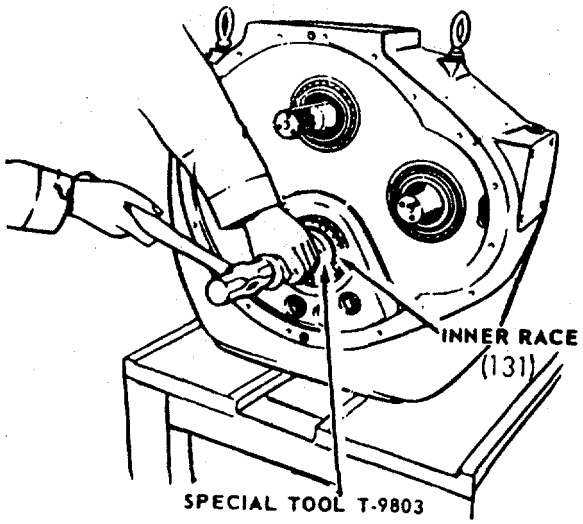
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	j. Lubrication fitting (126)	Install.	1/8 inch 45°.
	k. Propeller flange oil seals (125)	Install.	a. Use new seals. b. Seals must be flush with each side of bearing retainer with a gap between seals. c. Lip of outer seal must point rearward. d. Lip of inner seal must point forward.



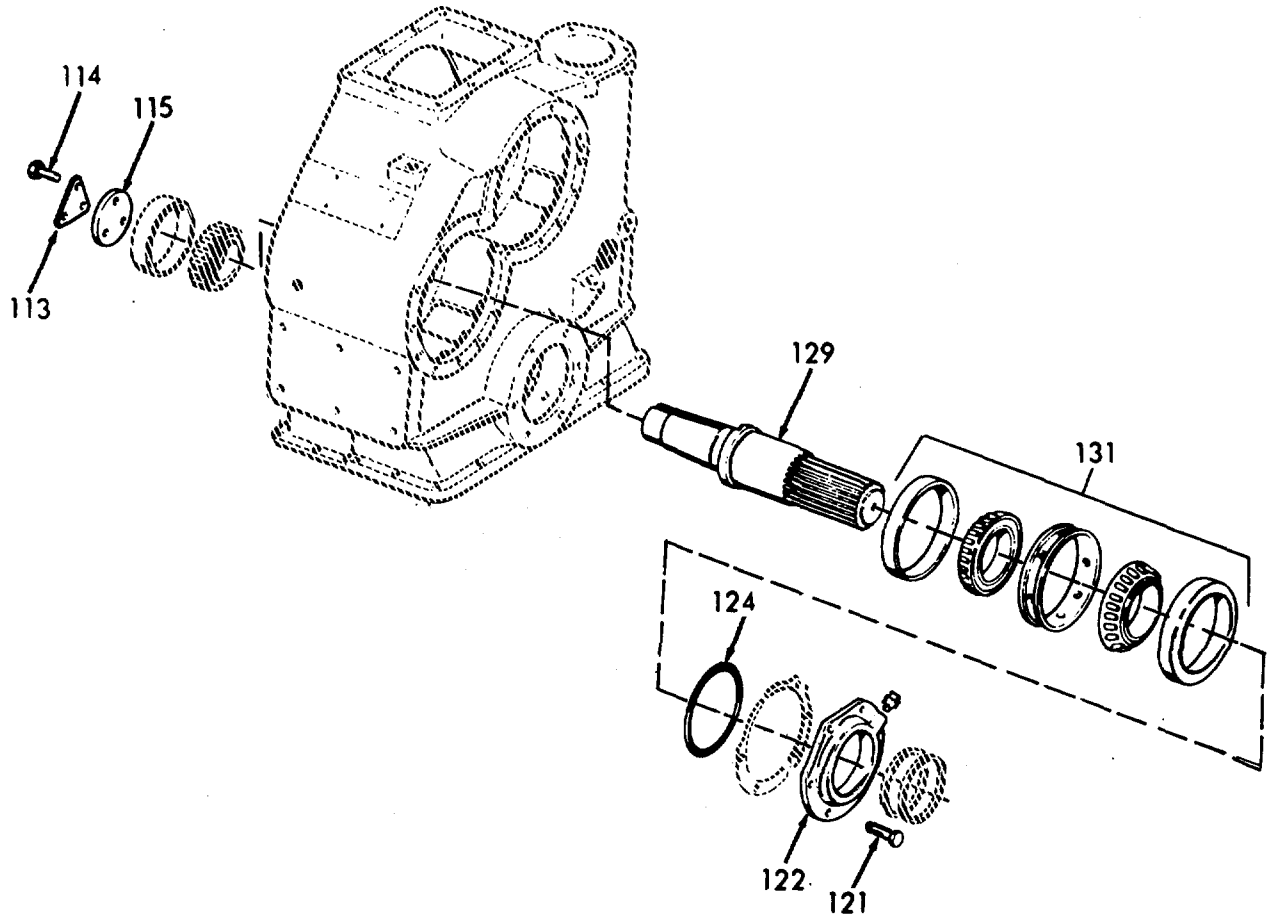
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	l. Pre-formed packing (124)	Install on bearing retainer (122).	
	m. Bearing retainer (122)	1. Attach to main housing with three screws (121). 2. Turn screws finger tight only.	Screws are 1/2-13 X 1-1/2 inch.
	n. Counter shaft roller bearing surface on counter shaft (129)	1. Coat with white lead.	
	o. Inner race of counter shaft roller bearing (131)	Install on counter shaft (129).	a. Use tool T9803. b. Slightly lift the counter shaft to align the bearing.



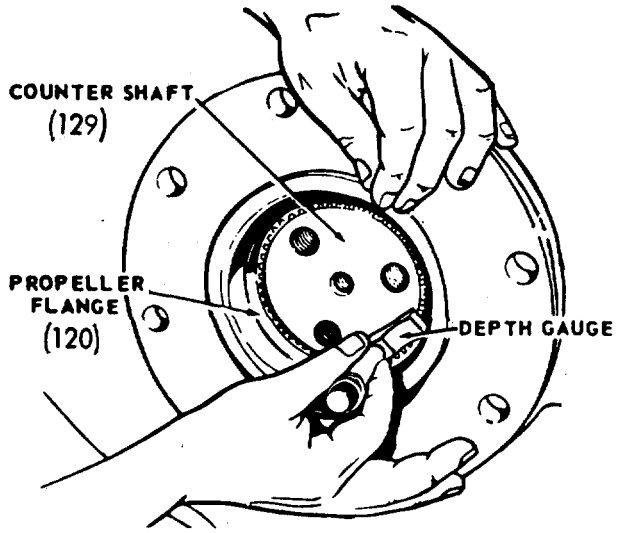
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	p. Retainer washer (115), lock plate (113) and screws (114)	1. Install. 2. Tighten screws to 175 lb-ft (237.3 Nm) torque. 3. Bend lockplate against flats of screws. 4. Remove wooden blocks.	Use new lock plate.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

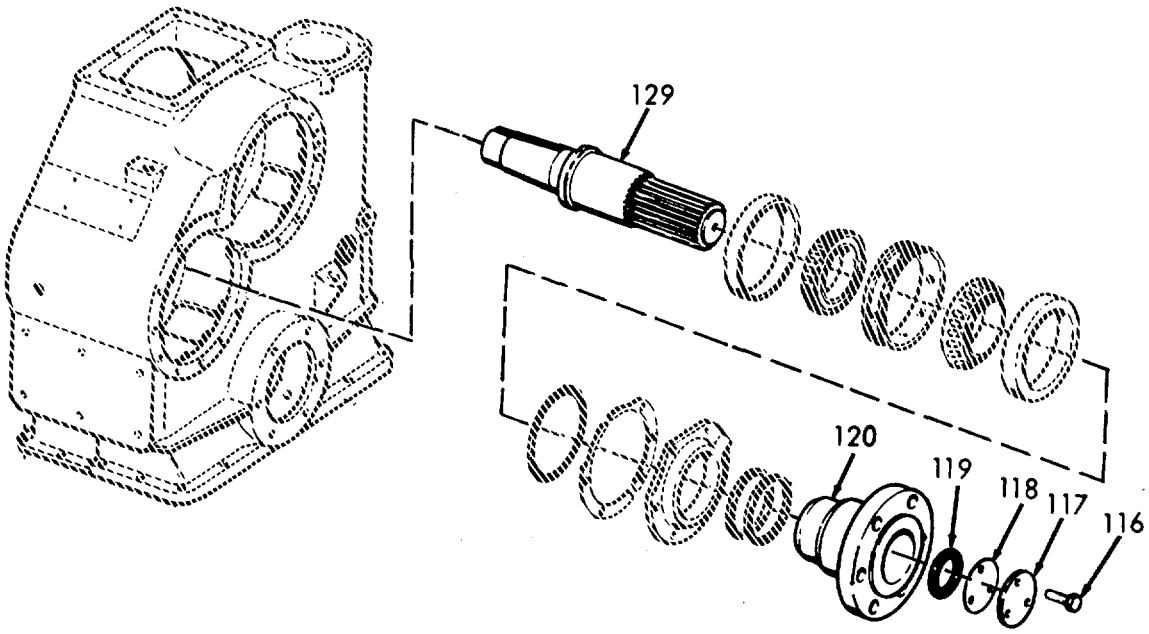
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	q. Propeller flange (120)	1. Apply a light film of oil to the sleeve of the flange.	
		2. Carefully tap the flange onto the counter shaft.	a. Do not damage the oil seals in the bearing retainer. b. Use a block of wood and seat the flange.
		3. Using a depth gage, measure the distance from the end of the counter shaft to the inner lip surface of the flange.	



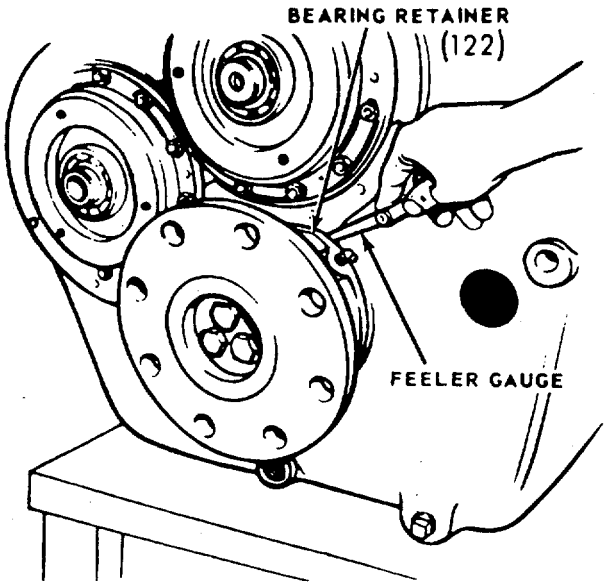
4. Select the appropriate number of flange shims (118) to equal .010 to .015 inch less than the measurement just taken.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	r. Ring gasket (119)	Install.	
	s. Shims (118), retainer washer (117), and screws (116)	1. Install. previously selected.	a. Use shims b. Screws are 5/8-18X1-1/2 inch.
		2. Tighten screws to 175 lb-ft (237.3 Nm) torque.	
	t. Counter shaft (129)	Rotate a few revolutions.	This rolls the bearings causing them to align.

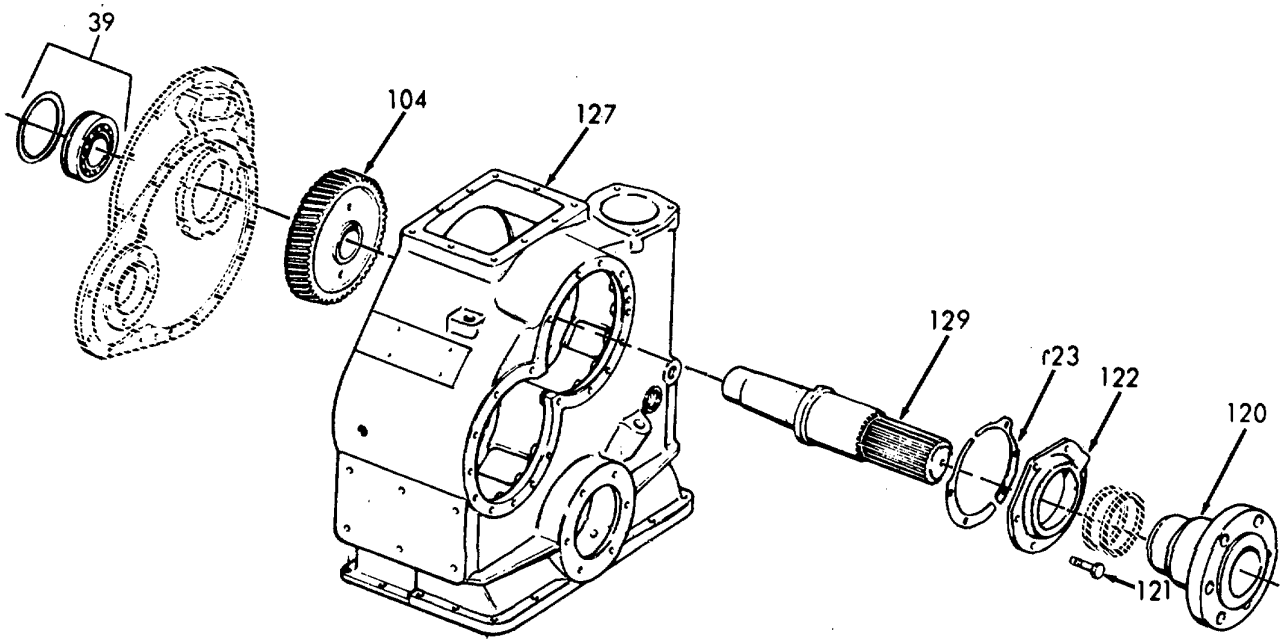


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	u. Bearing retainer (122)	1. Measure the shim space between the bearing retainer and housing (127).	Use feeler gage.
			
		2. Add 0.003 to 0.008 inch to the figure.	
		3. Obtain desired shim pack (123) thickness.	
	v. Screws (121), shim pack (123)	1. Remove three screws installed in step m.	
		2. Add shim pack between retainer (122) and housing (127).	
		3. Install eight screws (121).	Screws are 1/2-13 X 1-1/2 inch.
		4. Tighten screw to 86-95 lb-ft (116.6-128.8 Nm) torque 5.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	w. Propeller flange (120)	1. Check flange run out. 2. Maximum runout should be less than 0.004 inch.	Use a dial gage.
	x. Output shaft (129)	1. Check end play.	a. Use dial gage. b. See step 27.
		2. End play should be between 0.003-0.008 inch.	
		3. Change shims (123) as required.	
	y. Reverse driving gear (104)	Place on arbor press hub end up.	
	z. Reverse driving gear ball bearing (39)	Press onto gear (104).	The snap ring groove in the bearing must be at the upper end of the bearing.

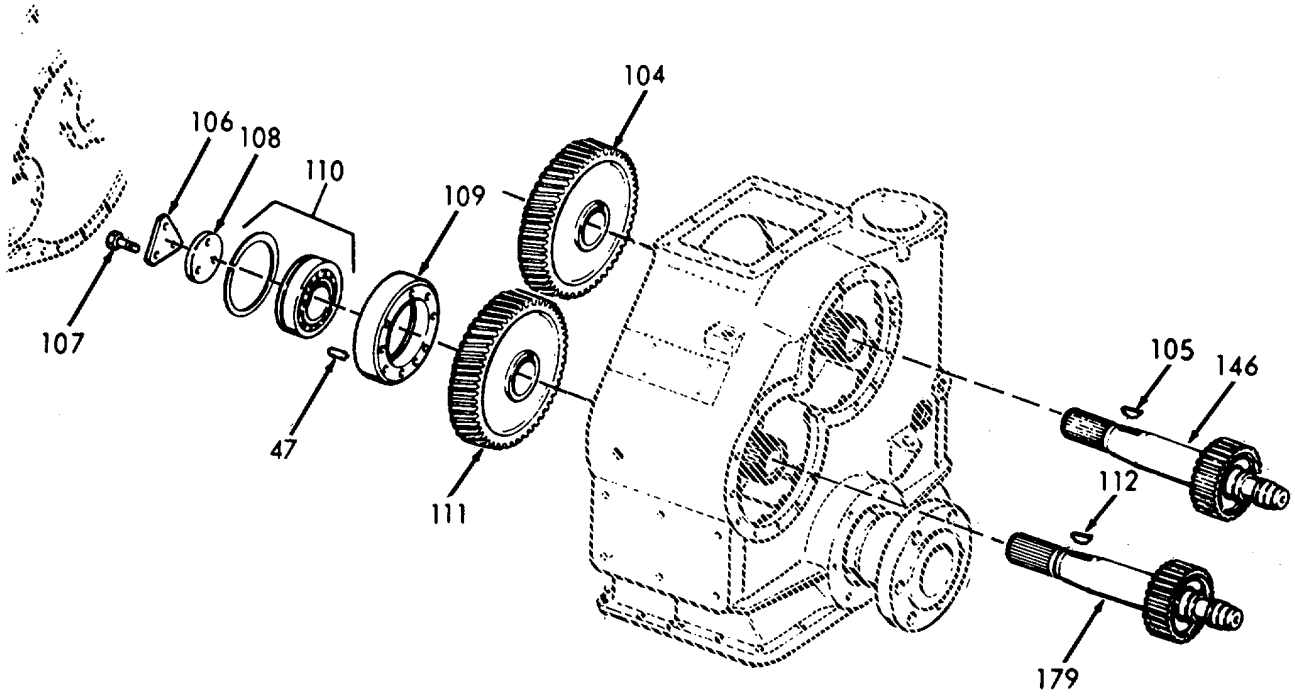


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	aa. Woodruff key (105)	Install in forward clutch shaft (146).	
	ab. Reverse driving gear (104)	1. Align keyway of the gear and installed key.	
		2. Install gear on shaft (146).	
	ac. Dowell pins (47)	Install three in bearing carrier (109).	Pins are 1/2 X 1 inch.
	ad. Reverse driven gear ball bearing and snap ring (110)	Install in bearing carrier (109).	
	ae. Reverse driven gear (104)	Place on arbor press, hub end up.	
	af. Reverse driven gear ball bearing (110) with carrier (109)	Press onto gear.	Chambered edge of the carrier must be down.
	ag. Woodruff key (112), reverse driven gear (111), and reverse clutch shaft (179)	Align keyway of gear with the installed key and install.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	ah. Retainer washer (108), lock plate (106), and screws (107)	1. Install. 2. Tighten screws to 38 lb-ft (51.5 Nm) torque. 3. Bend lock plate against the flats of the screws.	Use new lock plate.

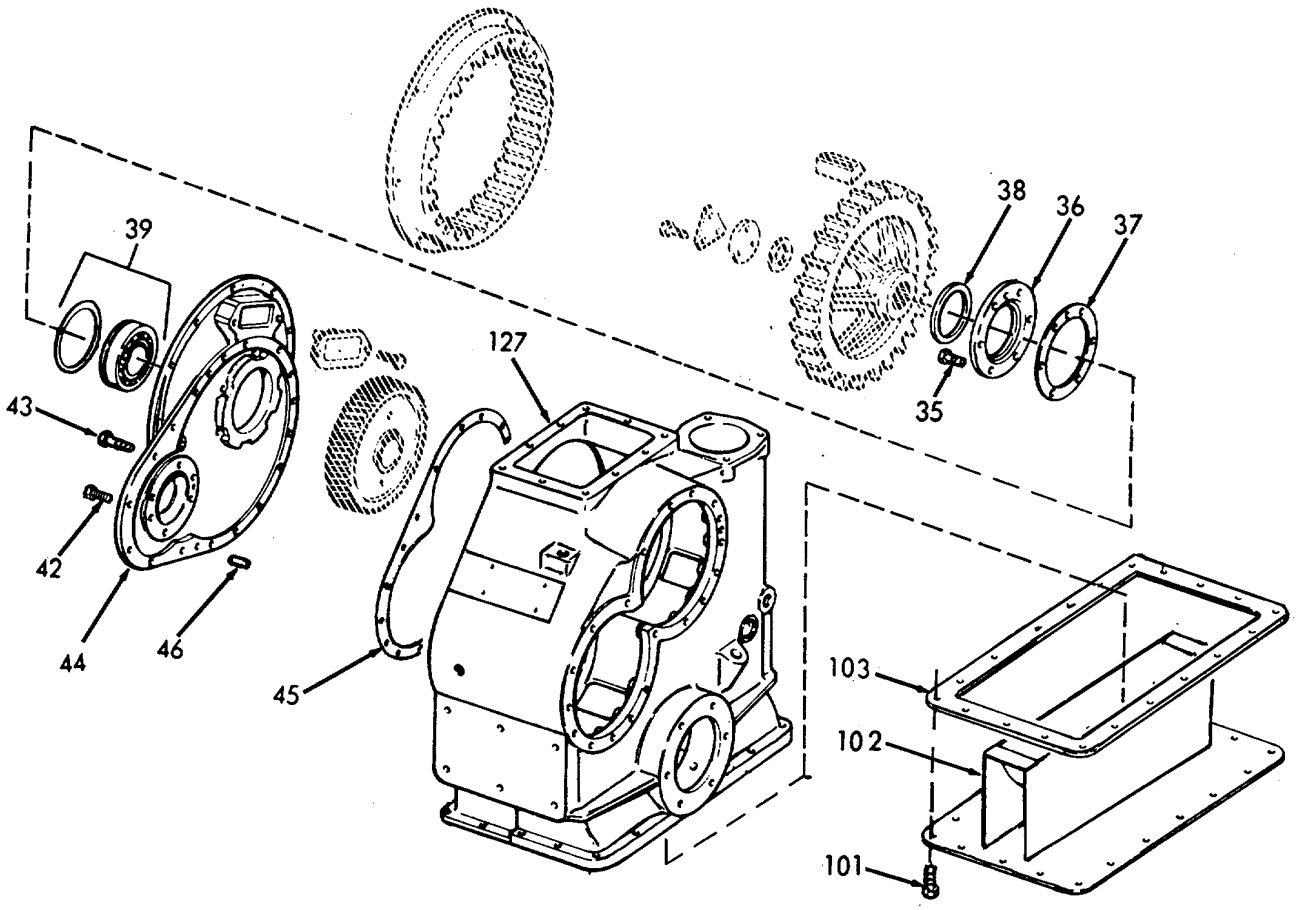


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
19. Sump cover and gear pan	a. Pan (102), and gasket gasket (103)	Align on housing (127).	Use new gasket.
	b. Special zinc-plated screws (101)	1. Install.	
		2. Tighten to 38 lb-ft (51.5 Nm) torque.	Screws are 3/8-16 X 7/8.
20. Oil filter group		Refer to chapter 3.	
21. Front housing group	a. Dowell pins (46)	Install two places. inch.	Pins are 1/2X1
	b. Front housing (44), and gasket (45)	1. Lift housing with hoist.	
		2. Position on main housing (127).	Use new gasket.
		3. Align dowell pins.	
	c. Screws (43)	1. Install 19 screws.	Screws are 3/8-16 X 1-1/4 inch.
		2. Tighten to 38 lb-ft (51.5 Nm) torque.	
	d. Screws (42)	1. Install six screws.	Screws are 3/8-16 X 1-1/4 inch.
		2. Alternately tighten screws to 38 lb-ft (51.5 Nm) torque.	
	e. Snap ring (39)	Install.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	f. Drive spider oil seal (38), seal carrier (36), and gasket (37)	1. Lip of seal must point towards machined face of the carrier. 2. Front side of seal must be flush with carrier bore. 3. The tapped hole in the carrier must be in the top center position.	Use new seal and gasket.
	g. Screws (35)	1. Install six screws. 2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	Screws are 3/8-16 X 1-1/4 inch.

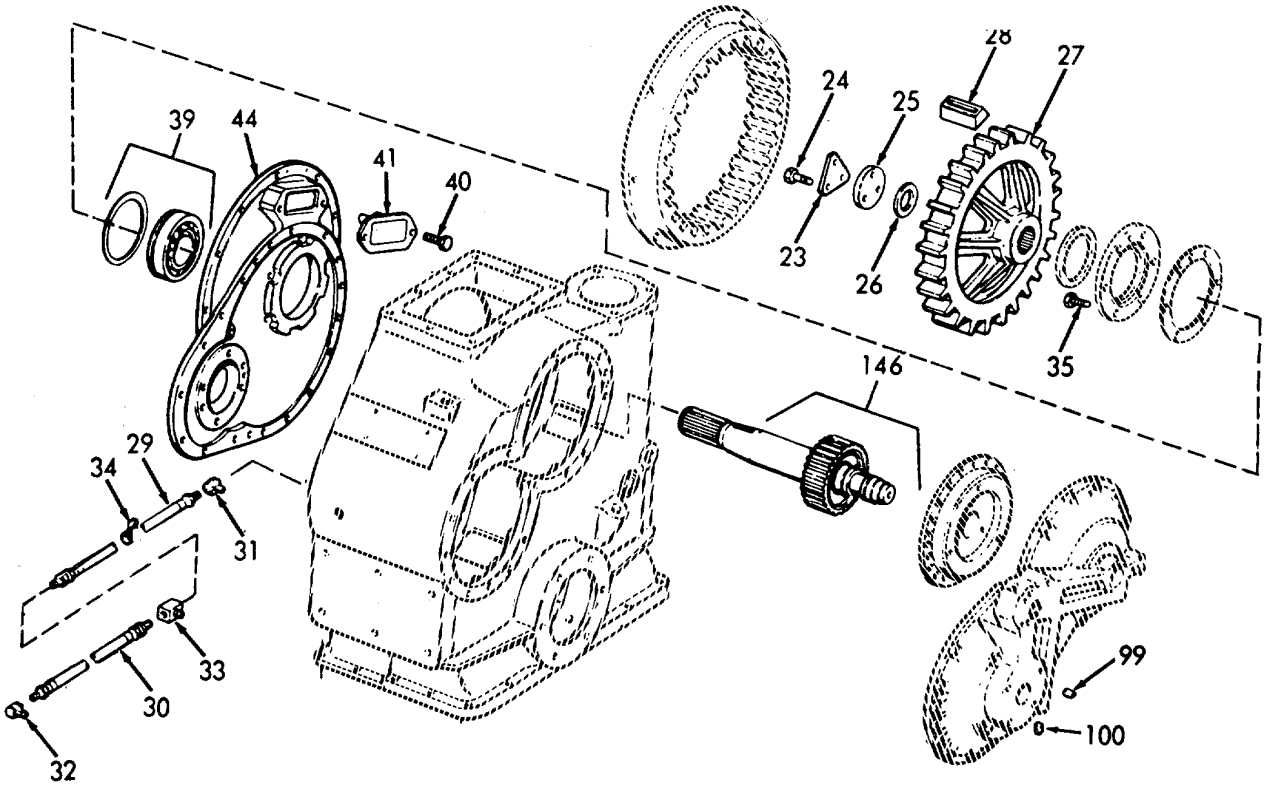


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	h. Elbows (31 and 32), and tee (33)	Install.	
	i. Short flexible hose (29), and long flexible hose (30)	Install.	
	j. Hose clamp (34)	Install.	
	k. Cover plate (41), and screws (40)	1. Install. 2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	Screws are 3/8-16 X 7/8 inch.
22. Drive spider group	a. Rubber blocks (28)	Install 26 places.	
	b. Drive spider (27)	1. Place on forward clutch shaft (146). 2. Install.	a. Use a babbit hammer. b. Make certain to align splines of spider and shaft.
	c. Rubber ring gasket (26)	Install on forward clutch shaft (146).	Use new gasket.

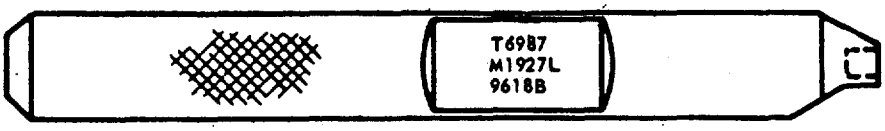
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	d. Retainer washer (25), lock plate (23), and screws (24)	1. Install.	a. Use new lock plate. b. Screws are 3/8-24X1-1/4 inch.
		2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	
		3. Bend lockplate against flats of screws.	
23. Manifold group	a. Pipe plugs (100)	Install four.	Plugs are 1/4 inch.
	b. Pipe plugs	Install six.	Plugs are 3/8 inch.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	c. Roll pin (87)	Install.	Use tool T6987.
	d. Piston rings (97 and 98)	Install in manifold (50).	Use new rings. Rings are 5 inch.
	e. Manifold orifice pipe plugs (96)	Install two.	
	f. Dowell pins (95)	Install in main housing (127).	Pins are 1/2-1 inch.
	g. Manifold (50) and gasket (94)	1. Align. 2. Carefully tap manifold in place.	Use new gasket. Use babbit hammer.



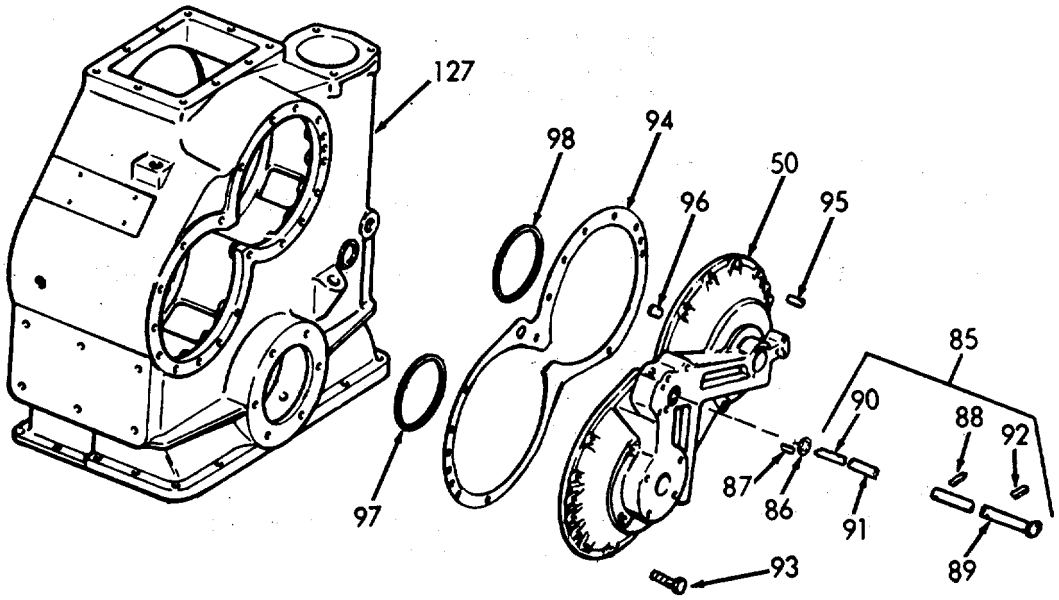
CAUTION

Do not use great force to install the manifold as damage to the piston rings on the shafts will occur.

	h. Screws (93)	1. Install 16 screws.	Screws are 3/8-16 X 1-1/2 inch.
		2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	
	i. Outer roll pin (92)	Install in hole in oil return pipe (89) nearest flanged end of pipe.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	j. Oil return pipe piston (91), spring (90)	1. Install in oil return pipe (89). 2. Partially compress spring through one of the lubrication holes in the pipe.	Use a small drift.
	k. Roll pin (88)	1. Install. 2. Remove drift.	
	l. Ring gasket (86)	Place over roll pin (87).	
	m. Oil return pipe (89)	1. Install through the manifold (50) and the main housing (127) and into the counter bore in the front housing.	



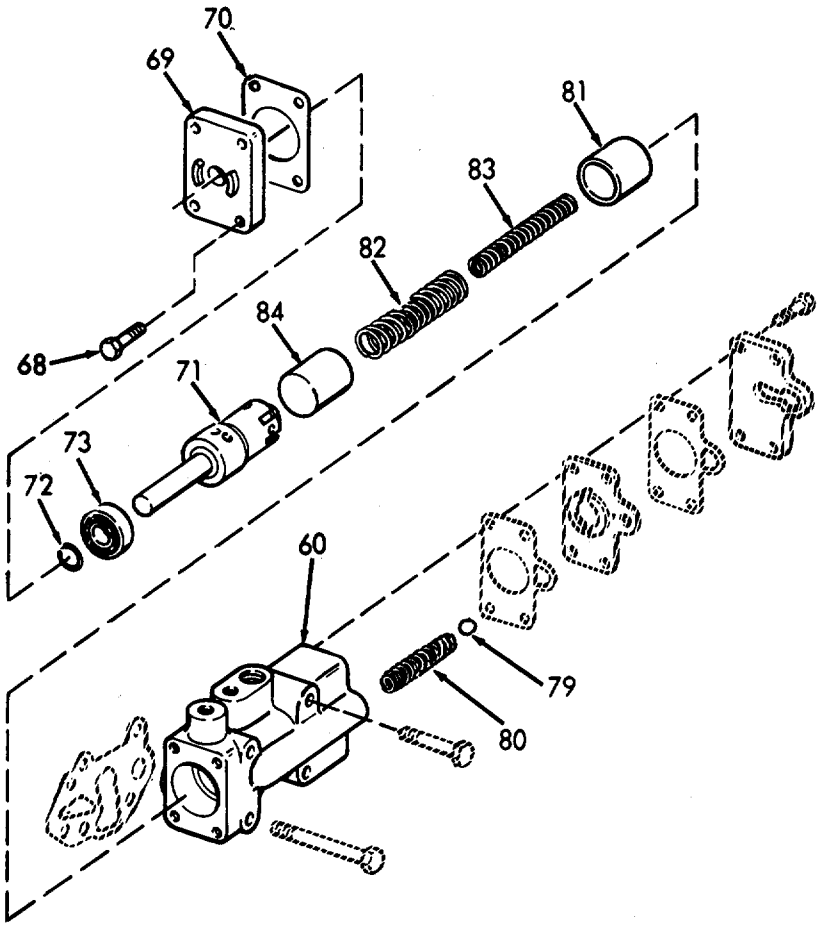
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
		2. The front housing end of the pipe is aligned with the tee fitting installed in the front side of the front housing.	
24. Selector valve	a. Selector valve stem (71), and ball bearing (73)	1. Press into ball bearing. 2. Install in valve body (60).	Use arbor press.
	b. Preformed packing	Insert in cover (69).	
	c. Valve cover (69), and gasket (70)	Align.	
	d. Screws (68)	1. Install. 2. Tighten screws to 21 lb-ft (28.5 Nm) torque.	Screws are 5/16-18 X 1 inch.
	e. Pressure regulation piston (84), outer spring (82), inner spring (83), pressure rate control piston (81), compression spring (80), and steel ball (79)	Install in valve body.	Part (84) is the smaller of the two pistons.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

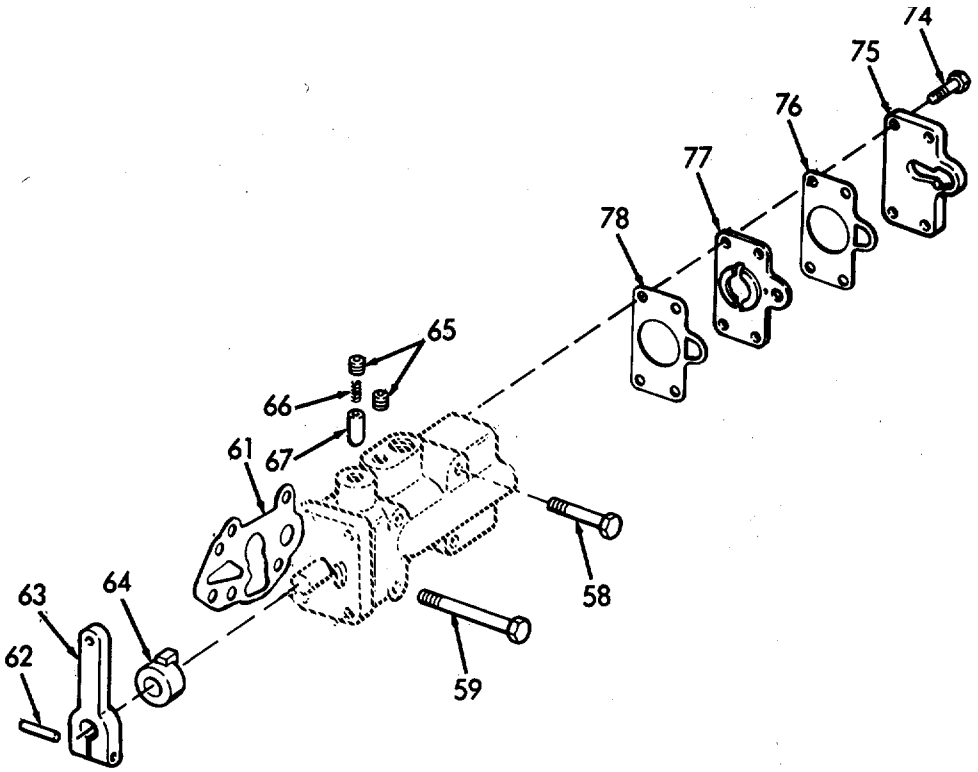


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	f. Orifice plate gasket (78), plate (77), plate cover gasket (76), plate cover (75), and screws (74)	1. Install. 2. Tighten screws to 21 lb-ft (28.5 Nm) torque.	a. Use new gaskets. b. Screws are 5/16-18 X 1 inch.
	g. Indexing detent (67), spring (66), and pipe plug (65)	1. Install. 2. Make certain detent indexes in one of the bores in the stem.	
	h. Pipe plug (65)	Install in adjacent hole.	
	i. Collar stop (64), lever (63), and roll pin (62)	Install.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
25. Manifold group	a. Selector valve and gasket (61), and screws 58 and 59)	1. Install.	a. Screws (58) are 3/8-16 X 2-3/4 inch. b. Screws (59) are 3/8-16 X 5-3/4 inch.
		2. Tighten screws to 21 lb-ft (28.5 Nm) torque.	

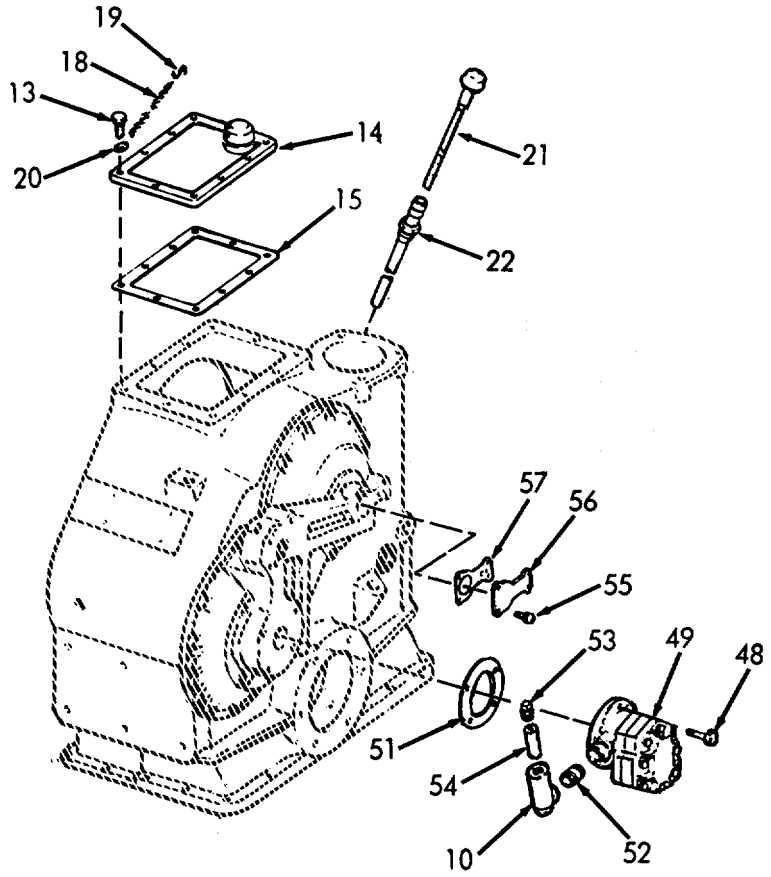


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	b. Cover plate (56), gasket (57), and screws (55)	1. Install.	a. Use new gasket. b. Screws are 3/8-16 X 1 inch.
		2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	
	c. Oil strainer (54), and pipe plug (53)	Install in oil strainer housing (10).	Use pipe thread compound on pipe plug.
	d. Short pipe nipple (52)	1. Install in oil strainer housing.	
		2. Install in oil pump (49).	
	e. Oil pump assembly (49), gasket (51), and screws (48)	1. Install.	a. Use new gasket. b. Screws are 3/8-16 X 1 inch.
		2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	
26. Miscel-laneous external parts	a. Oil lever gage tube (22), and oil level gage (21)	Install.	
	b. Breather chain clip (20), chain (18), and s-hook (19)	Assemble.	

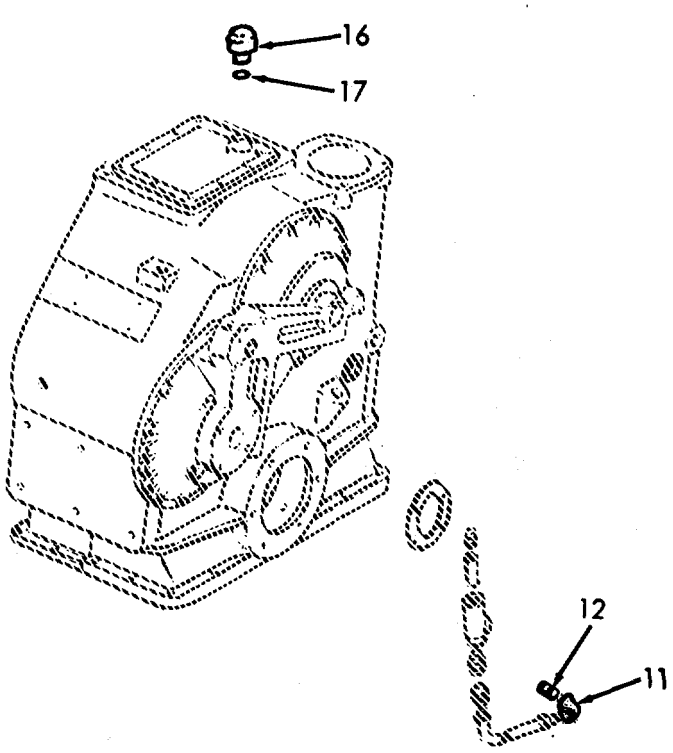
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	c. Top cover (14), and gasket (15)	Install.	Use new gasket.
	d. Screws (13)	1. Install. 2. Tighten screws to 38 lb-ft (51.5 Nm) torque.	Screws are 3/8-16 X 7/8 inch.



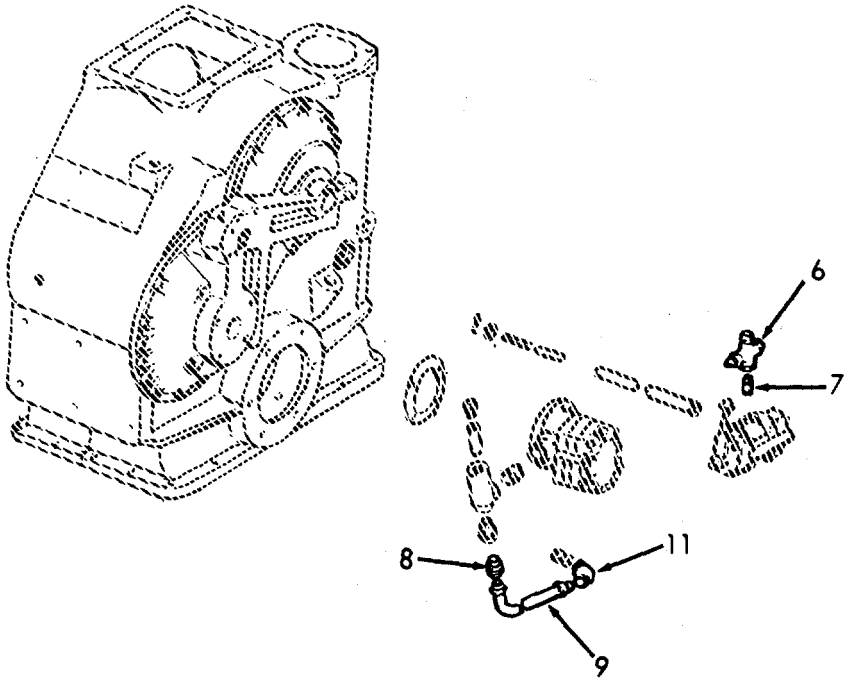
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	e. Oil breather assembly (16), and preformed packing (17)	Install.	Use new pre-formed packing.
	NOTE Use pipe thread compound on the remaining threaded parts.		
	f. Pipe nipple (12)	Install.	
	g. Elbow (11)	Install.	



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - REASSEMBLY (Cont)			
	h. Oil-pump-to-strainer flexible hose (9)	Attach to elbow (11).	
	i. Straight male adapter union (8)	Install.	
	j. Flexible hose (9)	Attach free end.	
	k. Short pipe nipple (7), and reducing tee (6).	Install.	



5-139

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - REASSEMBLY (Cont)

27. Matched tapered roller bearing sets

Twin Disc uses Tapered Roller Bearing sets which are selectively assembled and match marked by the bearing manufacturer. Bearings typical of this construction are Twin Disc part numbers M2427 and M2551 in MG-514 Marine Gears. It is not practical to list all bearings of this type since such a list is difficult to keep current due to additions and changes. Therefore, the following general description and procedure will help you identify and correctly assemble this type of bearing.

This type of bearing, when properly assembled, does not require further adjustment to provide proper bearing end play*. Desired end play is built into the bearing set by the bearing manufacturer. This built in end play is controlled by selectively machining the various bearing parts.

Matched bearings of this type in addition to the usual bearing manufacturer's machine stamped part number also have a hand etched code number and suffix letters.

A typical etched code number is "65-1319". For a given bearing set all the parts of that set will be etched with the same code number. In addition one end of the cone and one end of the cup will have a suffix letter. (In our example above "65-1319A" .) The suffix lettered components must be assembled adjacent to each other. (In our example above, the "65-1319A" cone must be assembled toward the "65-1319A" end of the cup.) Failure to observe this procedure will certainly result in premature bearing failure.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

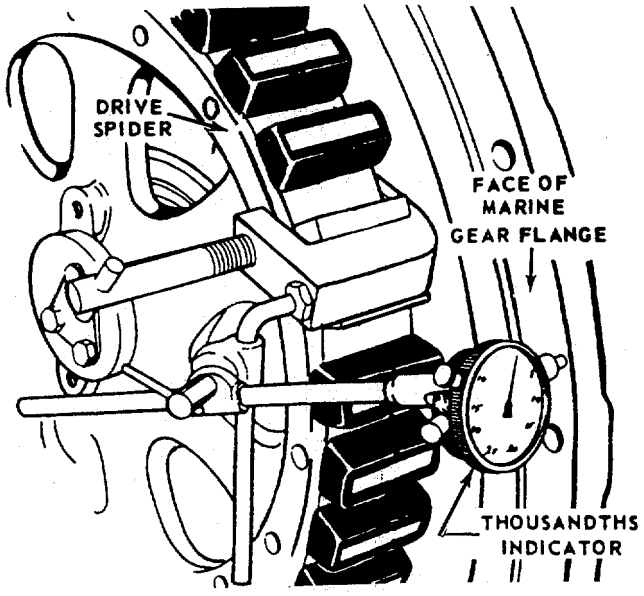
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
		To summarize the following points should be remembered when servicing units that have matched bearing sets: 1. All parts of matched bearing sets are etch marked with the same code number. 2. Do not mix matched bearing assemblies with different code numbers. 3. If one part of a matched assembly has failed the entire assembly must be replaced. 4. The suffix letter components must be assembled adjacent to each other. 5. All new matched bearing assemblies shipped for service are individually boxed and are packed in the correct relative position for assembly into the unit. * When used at the counter shaft location on Marine Gears, the shimming of the bearing retainer is not for bearing end play adjustment. Shims are used at the bearing retainer to control the amount of crush applied to the bearing assembly to avoid collapsing	
INSTALLATION			
28. Marine gear		a. General. The marine gear flange and pilot and the engine flywheel and flywheel housing must be checked for trueness. Make certain the engine flywheel and the flywheel housing are clean prior to making the tests.	

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

b. Checking Marine Gear Flange. Bolt a thousandths indicator or gauge to the drive spider of the marine gear so that the indicator is perpendicular to the face of the marine gear housing and the indicator stem is riding on the face of the flange. Rotate the drive spider and note the face runout of the marine gear flange. The face runout must not exceed .017-inch maximum total indicator reading for the SAE No. 0 flange, or a .013-inch maximum total indicator reading for the SAE No. 1 flange.

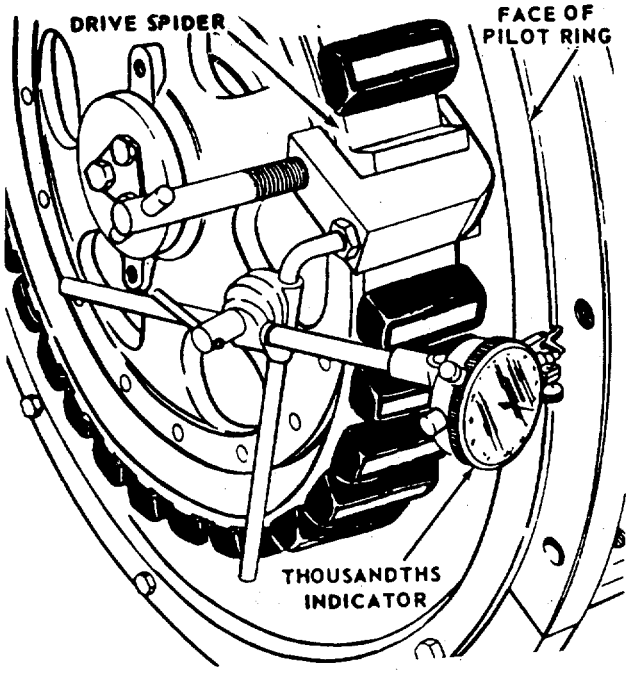


c. Checking Marine Gear Pilot Ring. With the indicator bolted as in Paragraph b above, adjust the indicator stem so that it will ride on the pilot surface of the flange. Rotate the drive spider and note the pilot surface runout must not exceed .010-inch for the SAE No. 0 flange, or .008-inch for the SAE No. 1 flange. This applies to a continuous 270-degree arc if the balance of the pilot surface is negative in reading; otherwise, it means all 360-degrees.

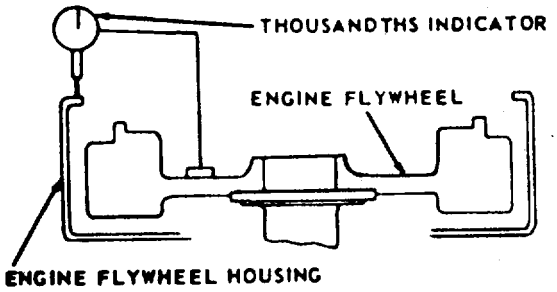
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



d. Checking Face of Engine Flywheel Housing. Bolt a thousandths indicator or gauge to the engine flywheel so that the indicator is perpendicular to the face of the engine flywheel housing and the indicator stem is riding on the face of the flange. Rotate the engine flywheel and note the face deviation of the engine flywheel housing range. The face deviation must not exceed .008-inch maximum total indicator reading.

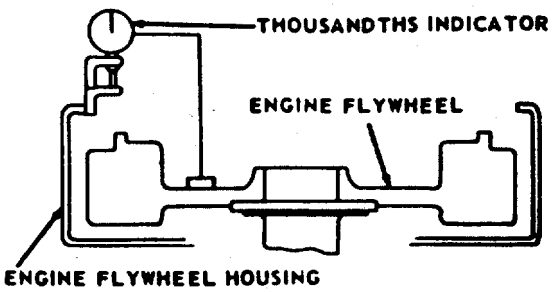


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

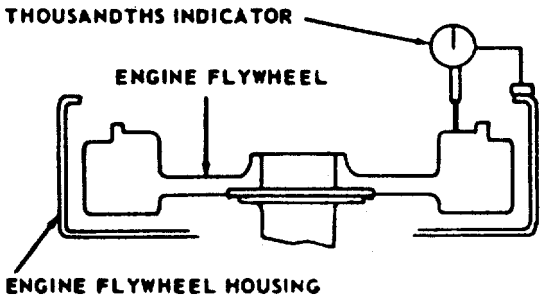
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

e. Checking Bore of Engine Flywheel Housing. With the indicator bolted as in Paragraph d above, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing. Rotate the engine flywheel and note the bore eccentricity of the engine flywheel housing bore. The bore eccentricity must not exceed .008-inch maximum total indicator reading.



f. Checking Driving Ring Surface of Engine Flywheel. Bolt a thousandths indicator or gauge to the engine flywheel housing so that the indicator is perpendicular to the engine flywheel, and the indicator stem is riding on the inner face of the flywheel. The variation of face runout of the surface to which the driving ring is bolted should not exceed .0005-inch maximum total indicator reading per inch of diameter.

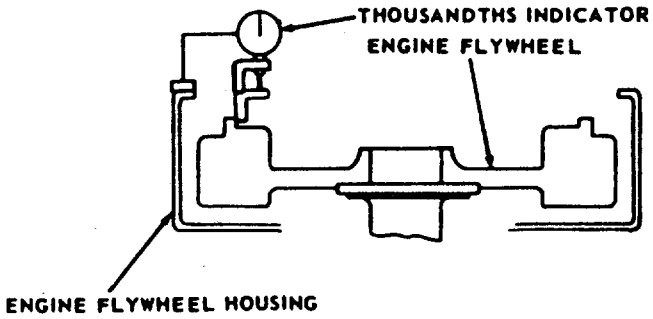


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

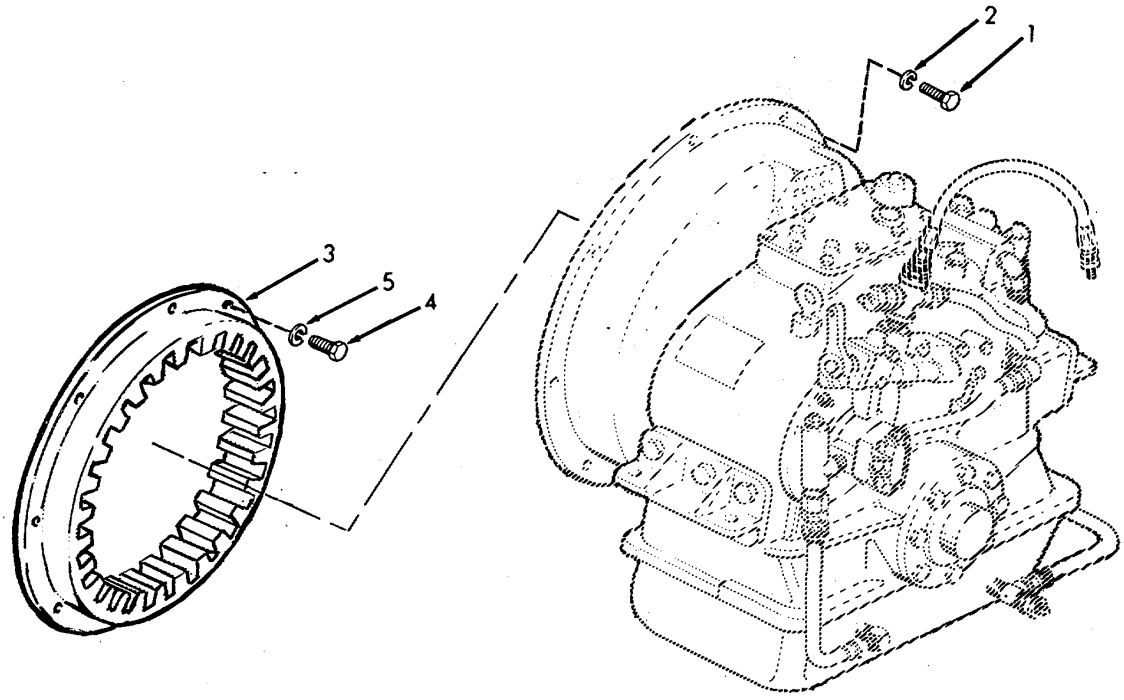
INSTALLATION (Cont)

g. Checking Driving Ring Pilot Bore of Engine Flywheel. With the indicator bolted as in Paragraph f above, adjust the indicator stem so that it will ride on the driving ring pilot bore of the engine flywheel. The driving ring pilot bore eccentricity of the engine flywheel should not exceed .005-inch maximum total indicator reading.



h. Driving ring (3) — Install screws (4) and lockwashers (5).

i. Screws (1), and lockwashers (2) — Install.



j. Hoses — Reconnect.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT IN CRAFT

29. Engine and marine gear alignment to propeller shaft

NOTE

It is important to align the engine and gear only when the boat is afloat, and NOT in dry-dock. During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when boat is in service. With the engine and gear in position on the engine bed, arrangements must be made to have a controlled lifting or lowering of each of the four corners of the engine. If threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the jacking screws will not damage the engine bed. Lifting can also be accomplished by the use of properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realignment.

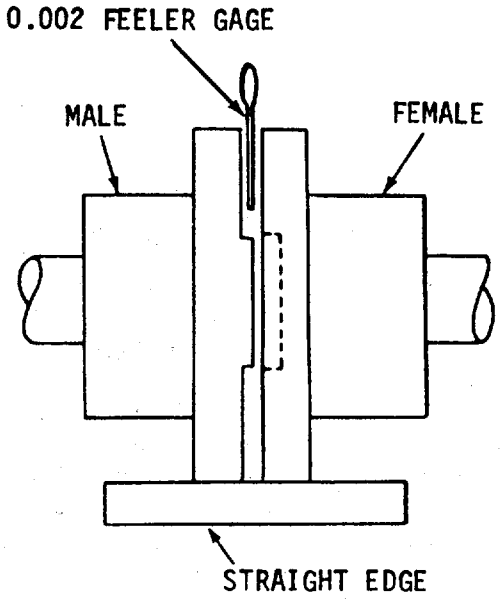
(1) It will also be necessary to move the engine and gear from one side or the other on bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges.

(2) As the engine and marine gear then comes into its aligned position, it will be possible to match the male and female halves of the output flange and propeller coupling and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. Place a 0.002 inch (0.005 cm) feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT IN CRAFT (Cont)



NOTE (Cont)

(3) Then the marine gear flange coupling is rotated 90, 180 and 270 degrees with the feeler blade being moved around the flange again in each successive position. If the alignment is correct, the feeler gauge will fit snugly, with the same tension, all around the flange coupling.

(4) If the alignment varies during rotation, then further alignment is necessary, or the marine gear and shaft couplings could be checked for improper face runout. Face runout on the marine gear output flange can usually be corrected by repositioning the coupling on its spline. Shaft coupling runout is usually due to an inaccuracy of taper fit or key interference.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT IN CRAFT (Cont)

NOTE (Cont)

(5) Some boats are not structurally rigid and some carry their load in such a way that they will "hog" or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine gear output flange and propeller coupling. This clearance might be 0.005 to 0.007 inch (0.013 to 0.018 cm) while the top would maintain the standard 0.002 inch (0.005 cm).

(6) During the process of securing final alignment, it may be necessary to shift the engine many times. When the final alignment is secured, the necessary steel or hardwood shims are made up and the engine and gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

(7) When a heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine gear coupling and prevent bending of the shaft.

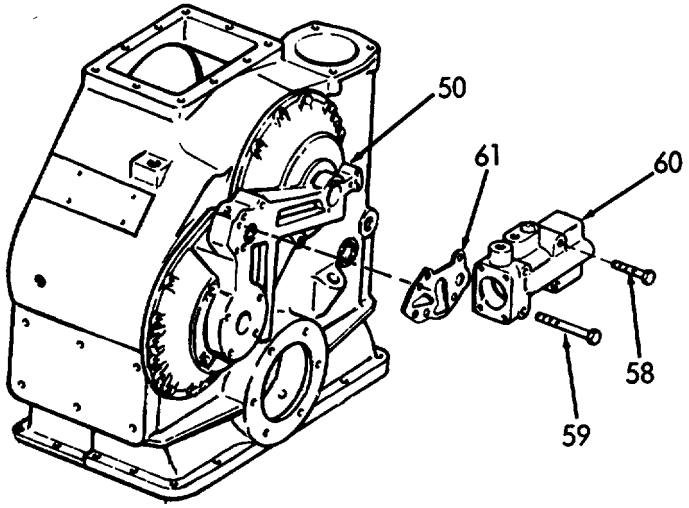
OVERHAUL IN CRAFT

NOTE

Due to the unique design of the Marine Gear, it is possible to service the forward and reverse clutches without disconnecting the gear from the engine or propeller shaft companion flange. With this feature, it is unnecessary to disturb the alignment of the gear, or to accomplish the time-consuming operation of removing the gear from the installation. Other serviceable parts while the gear is installed are the selector valve assembly, the oil pump assembly, the oil filter, and the oil strainer. Also, it is possible to service the propeller flange oil seals by disconnecting the propeller shaft companion flange and moving the shaft rearward approximately 3-1/2 inches.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL IN CRAFT (Cont)			
30. Clutch overhaul	a. Removal	The following procedure can be accomplished while the marine gear is instal1ed in the boat. 1. Disconnect the linkage to the selector valve assembly and the pressure gauge assembly. Disconnect the heat exchanger inlet line. 2. Remove the four hex-head cap screws (58 and 59) that secure the selector valve assembly (60) to the manifold (50). Remove the selector valve assembly, with attached parts, and the selector-valve to manifold gasket (61). Discard the gasket (61).	



5-149

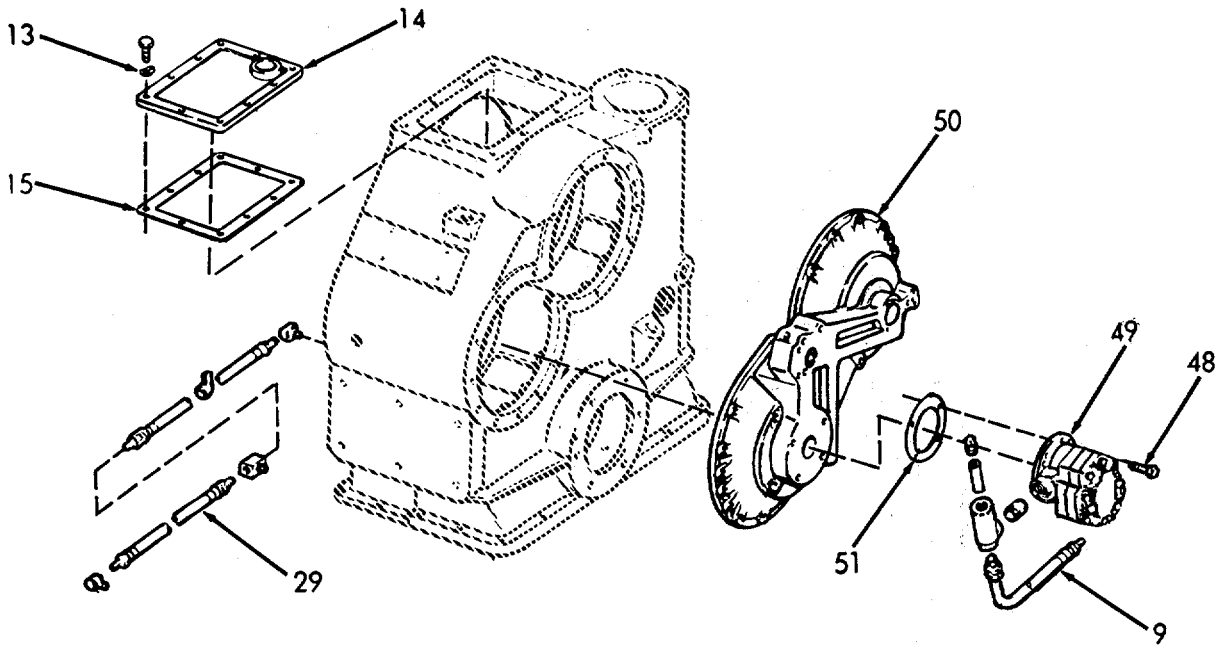
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

3. Disconnect the swivel male adapter union from the oil-sump-to-strainer flexible hose (9). Disconnect the swivel male adaptor union from the oil-pump-to-filter flexible hose. Remove the four hex-head cap screws (48) that secure the oil pump assembly (49) to the manifold (50). Remove the oil pump assembly (49), with attached parts, and the oil-pump-to-manifold gasket (51) from the manifold. Discard the gasket (51). Remove the flexible hose (29) from the pressure discharge side of the oil pump.

4. Remove the ten hex-head cap screws (13) that secure the top cover plate (14) to the main housing. Remove the top cover plate (14), with attached parts and the top cover plate from the main housing. Discard the gasket (15).



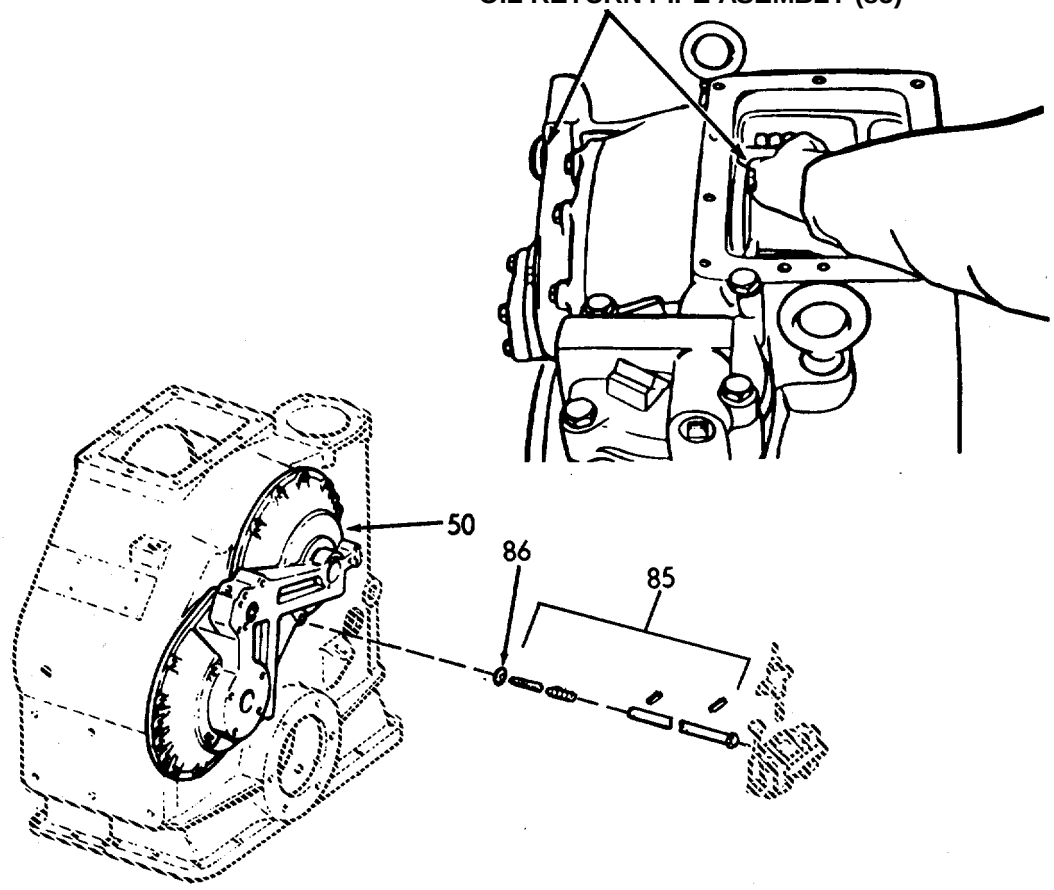
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

5. Reach down through the top cover plate opening in the main housing, and firmly grasp the oil return pipe assembly (85). Carefully push the oil return pipe assembly (85) rearward through the manifold (50) and remove the return pipe and the corprene ring gasket (86) from the manifold. Discard the gasket. As the return pipe is removed from the manifold, it is necessary to hold the tube carrier to prevent the carrier from damage as a result of falling into the gear.

OIL RETURN PIPE ASEMBLY (85)

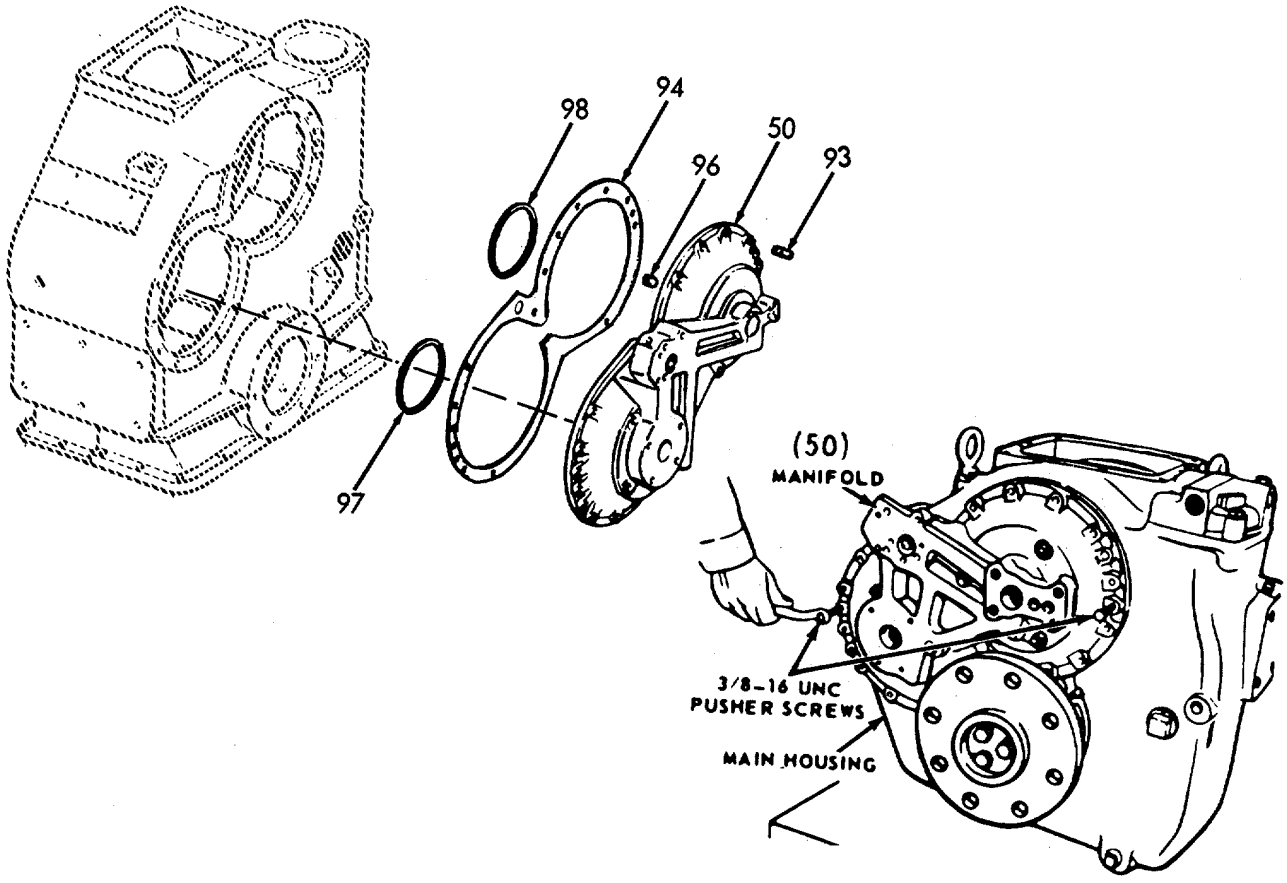


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

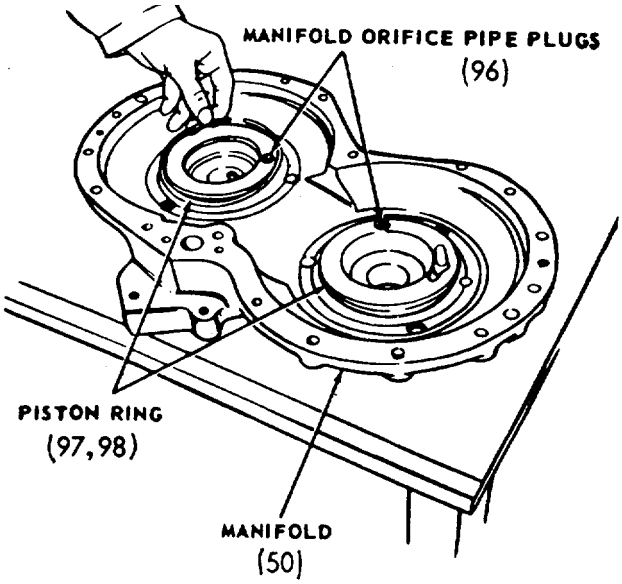
6. Remove three bolts that secure the propeller flange to the companion flange for manifold removal clearance. Remove the 16 hex-head cap screws (93) that secure the manifold (50) to the main housing. Install two pusher screws in the 3/8-16 UNC tapped holes in the manifold. Remove the manifold (50), with attached parts, and the manifold-to-main-housing gasket (94) from the main housing. Discard the gasket (94). Remove the two piston rings (97 and 98) and the manifold orifice pipe plugs (96) from the manifold (50) only if replacement of parts is necessary.



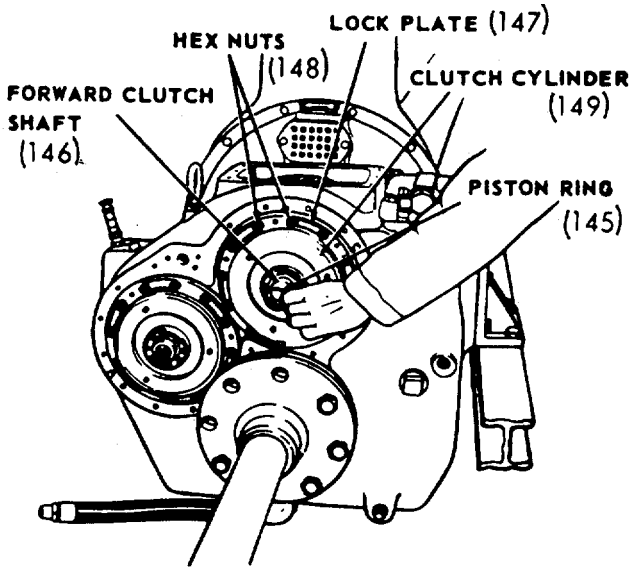
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

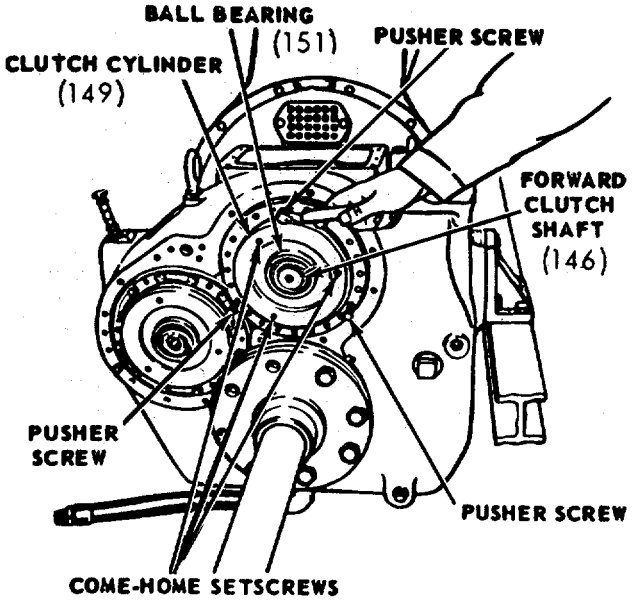


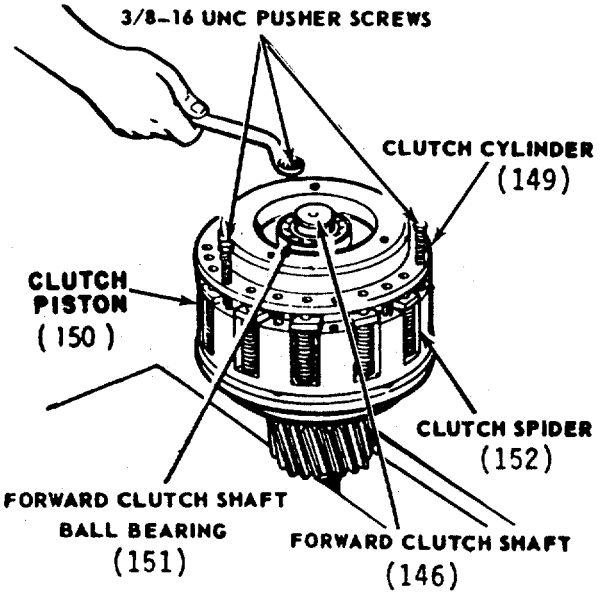
7. Remove the piston ring (145) from the forward clutch shaft (146). Bend back the locking edges of the six lock plates (147). Remove the twelve hex nuts (148) and the six lock plates (147) that secure the clutch cylinder (149) to the clutch spider.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL IN CRAFT (Cont)			
		8. Install pusher screws in the three 3/8-16 UNC tapped holes in the clutch cylinder (149). Alternately screw the pushers and remove the clutch cylinder (149) and the clutch piston (150) from the clutch spider (152) and the ball bearing (151) from the forward clutch shaft (146). Separate the cylinder and piston and remove a piston ring from each part only if replacement of parts is necessary.	





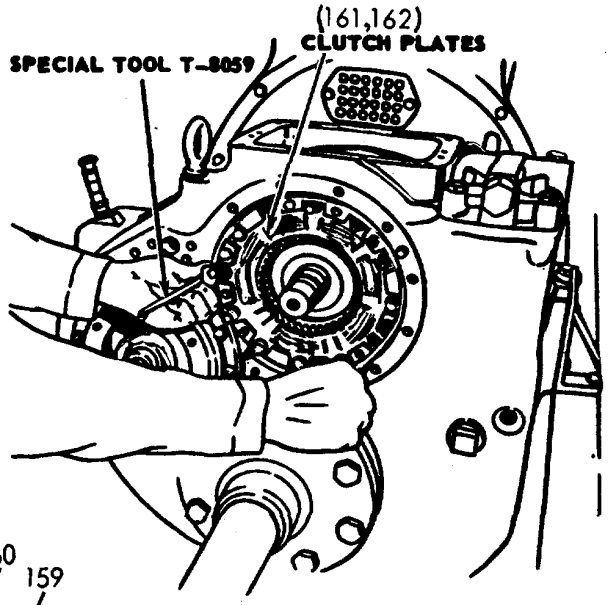
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

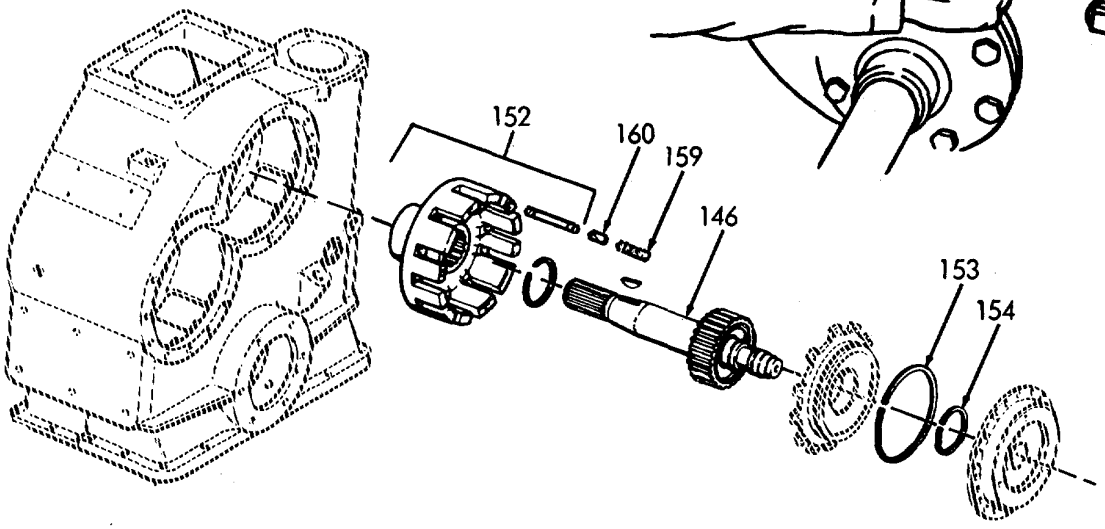
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

9. Remove the two piston rings (153 and 154) from the forward clutch shaft (146) only if replacement of parts is necessary. Remove the twelve release springs (159) from the split sleeves (160) installed on the studs in the clutch spider. Use special tool T8059 and remove the clutch plates (161 and 162) from the clutch spider (152). (161.162)

SPECIAL
TOOL
T8059

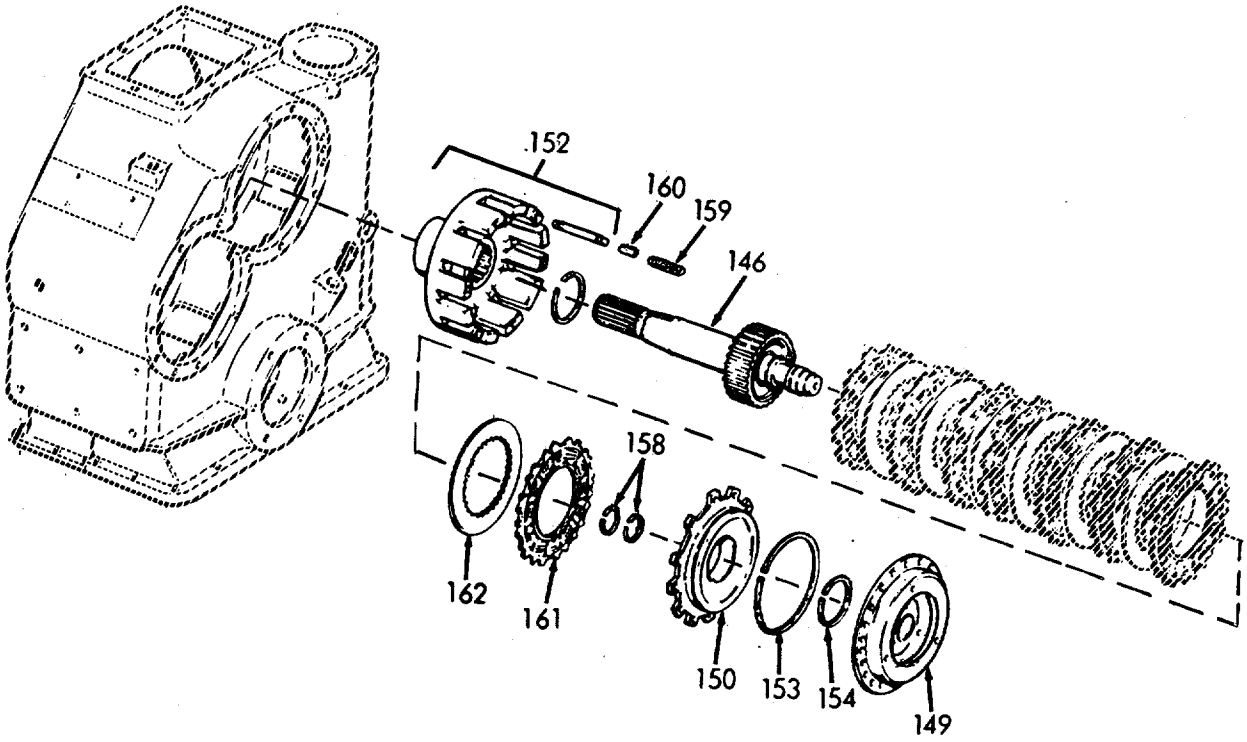




10. Disassemble the reverse clutch by following the procedure described in Paragraphs 7. through 9.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL IN CRAFT (Cont)			
	b. Installation	Both clutches may be installed by the following procedure although only the forward clutch procedure will be described. 1. Place the new clutch plates (161 and 162) in position in the clutch spider (152). Use eight sintered-metal clutch plates and seven steel clutch plates. Alternate the clutch plate stack; begin with a sintered-metal plate and end with a sintered-metal plate. Install the twelve release springs (159) on the split sleeves (160) installed on the studs in the clutch spider (152). Install new piston rings (153 and 154) if necessary, in the clutch shaft (146) clutch piston (150), and clutch cylinder (149). Place the clutch piston (150) in position in the clutch cylinder (149).	

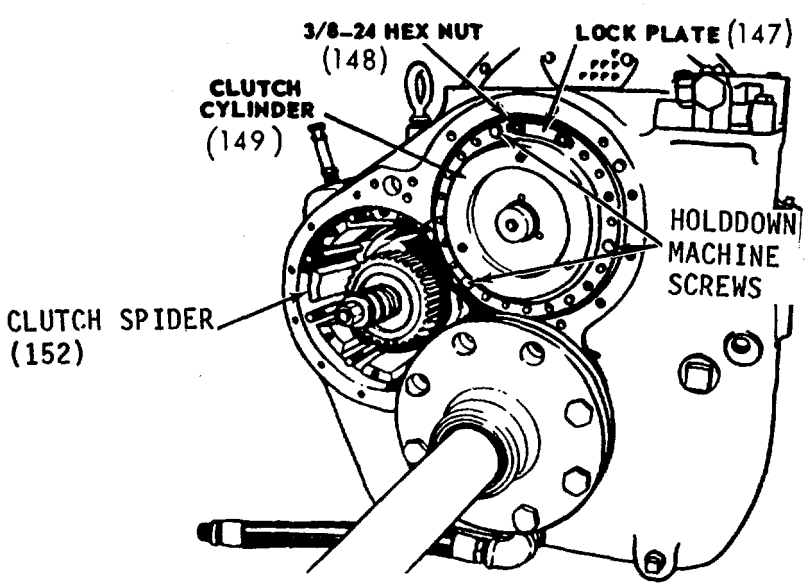


5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

2. Place the clutch cylinder (149) with piston, in position against the clutch spider (152). Use three 3/8-16 NC X 1 fully-threaded machine screws to hold the cylinder to the spider against the tension of the springs. Install six lock plates (147) and twelve 3/8-24 hex nuts (148) on the studs on the clutch spider. The center of each lock plate must cover a roll pin. Tighten the hex nuts to 38 lb-ft (51.5 Nm) torque, and lock in place by bending the lock plates (147). Remove the three hold-down machine screws.



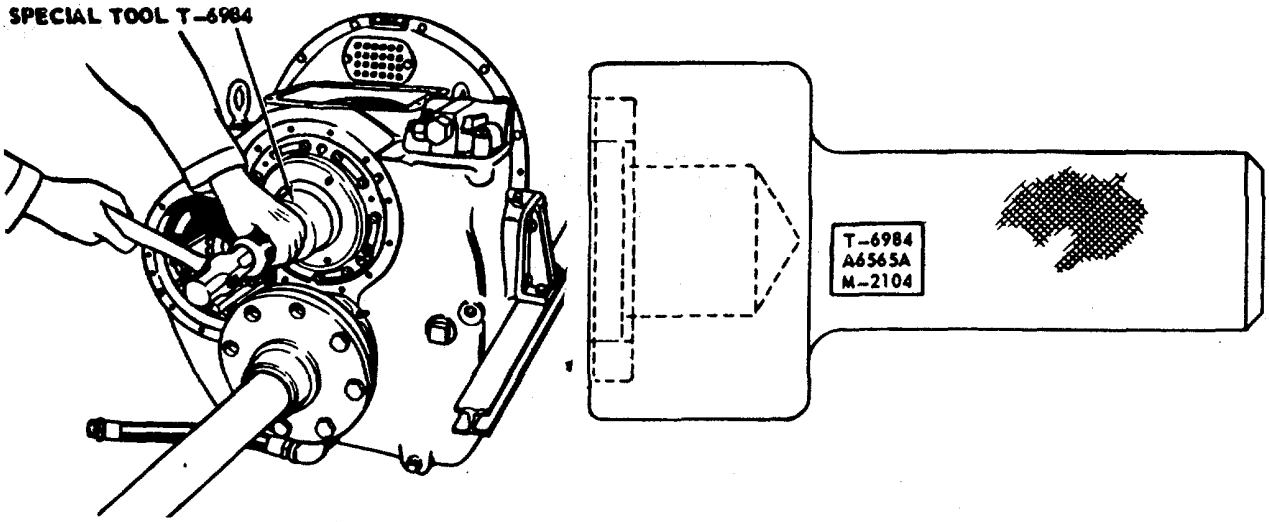
5-157

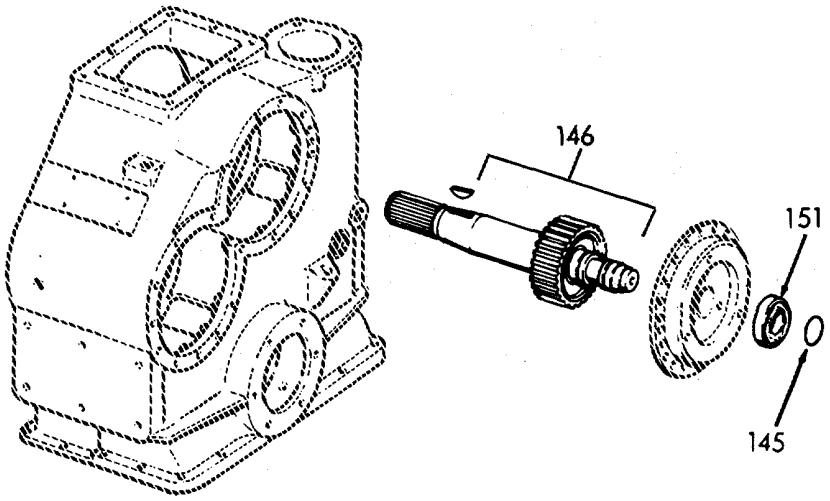
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

3. Place the ball bearing (151) in position on the forward clutch shaft (146). Use Tool T6984 and drive the bearing on the shaft. Install a new piston ring (145), if the old one was damaged, on the end of the shaft.





5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

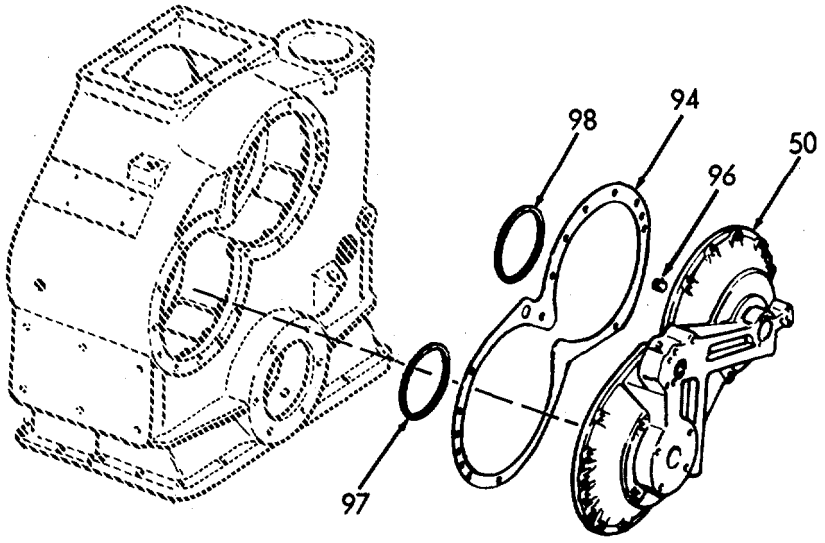
OVERHAUL IN CRAFT (Cont)

4. Install the reverse clutch by following the above procedure.

5. Install the manifold orifice pipe plugs (96) and two new piston rings (97 and 98) in 'the manifold, if removal had been necessary. Place the manifold (50) and a new manifold-to-main-housing gasket (94) , in position on the two dowel pins in the main housing.

CAUTION

Do not use great force to install the manifold as damage to the piston rings in the manifold or the piston rings on the shafts will occur.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

6. Secure the manifold to the main housing with sixteen 3/8-16 X 1-1/2 hex-head cap screws (93). Tighten the cap screws to 38 lb-ft (51.5 Nm) torque. Install the three bolts that were removed from the propeller flange and the companion flange.

7. Install a new corprene ring gasket (86) in the manifold (50). Install the oil return pipe assembly (85) in the manifold (50) and against the gasket by indexing the return pipe on the roll pin in the manifold (50).

8. Place the top cover plate (14) and a new top cover plate gasket (15) in position on the main housing, and secure the cover plate to the housing with ten 3/8-16 X 7/8 hex-head cap screws (13). Secure the breather chain clip in position beneath one of the cap screws. Tighten the cap screws to 38 lb-ft (51.5 Nm) torque.

9. Place the oil pump assembly (49), with attached parts and a new oil-pump-to-manifold gasket (51) in position against the manifold, and secure the oil pump to the manifold with four 3/8-16 X 1 hex-head cap screws (48). Tighten the cap screws to 38 lb-ft (51.5 Nm) torque. Connect the oil-sump-to-strainer flexible hose (9) to the oil strainer housing.

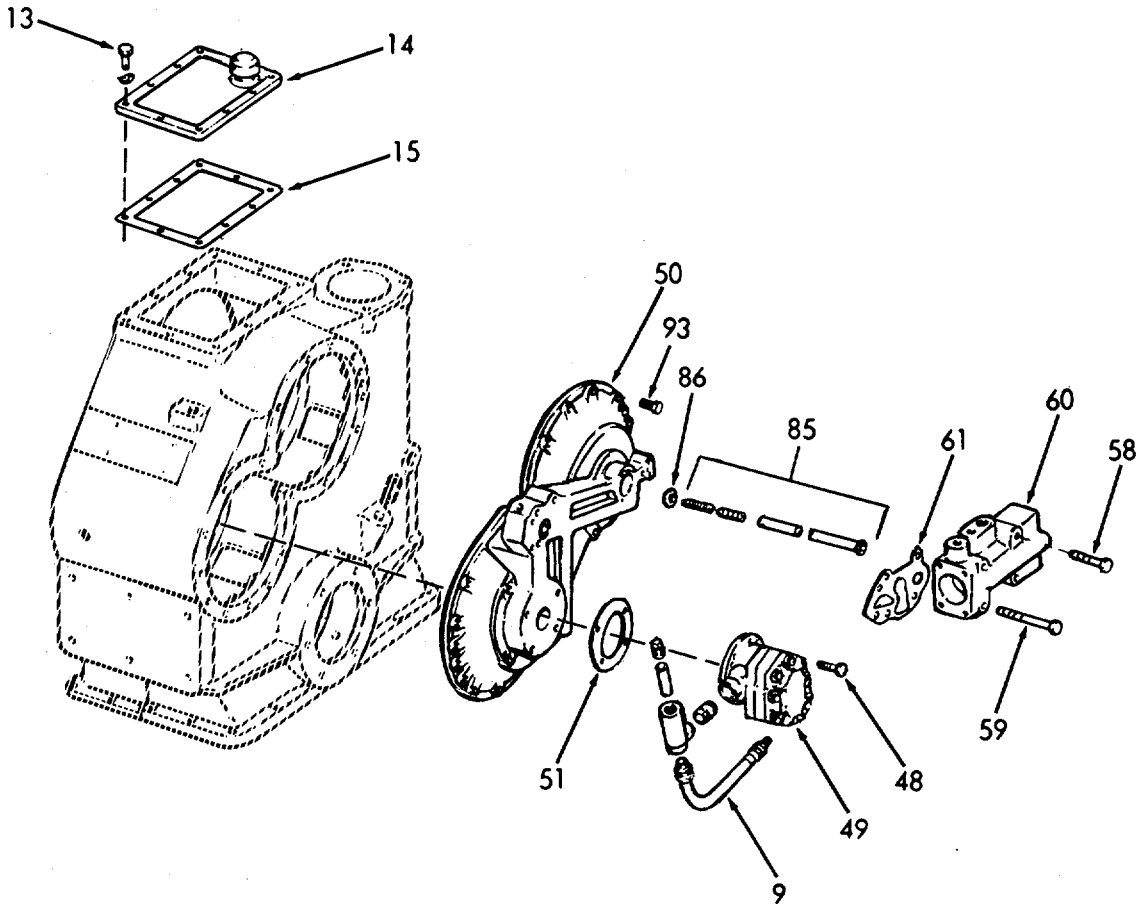
10. Place the selector valve assembly (60) with attached parts and a new selector-valve-to-manifold gasket (61) in position against the manifold (50) and secure the selector valve to the manifold with two 3/8-16 X 2-3/4 hex-head cap screws (58) and two 3/8-16 X 5-3/4 hex-head cap screws (59). Tighten the cap screws to 38 lb-ft (51.5 Nm) torque.

5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

11. Connect the heat exchanger inlet line to the selector valve assembly. Connect the flexible hose from the oil pump discharge port to the oil filter inlet port. Connect the linkage to the selector valve assembly and the pressure gauge assembly.



5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL IN CRAFT (Cont)			
31. Oil seal replacement	a. Removal	1. Prior to replacing the propeller flange oil seals, it is necessary to drain the marine gear sump of oil. Drain the oil from the gear.	
		2. Scribe an aligning mark across the outside diameter of the propeller flange and the companion flange for installation purposes. Remove the bolts that secure the propeller flange to the companion flange. Slide the propeller shaft rearward approximately 3-1/2 inches.	
		3. Remove the three hex-head cap screws (116), the retainer washer (117) and the propeller flange shim (118) that secure the propeller flange on the counter shaft (120). Remove the propeller flange and ring gasket (119) from the counter shaft. Discard the gasket (119). It may be necessary to tap the flange with a babbitt hammer or a brass bar.	
		4. Remove the seven hex-head cap screws (121) that secure the bearing retainer (122) to the main housing. Remove the bearing retainer (122) and the bearing retainer shims (123) from the main housing. Remove the bearing retainer "O" ring gasket (124) from the bearing retainer (122). Discard the gasket (124) . Remove the two propeller flange oil seals (125) from the bearing retainer (122). Discard the oil seals (125).	
	b. Installation	1. Install two new propeller flange oil seals (125) in the bearing retainer (122). The lip of the inner seal must point forward. Install a new bearing retainer "O" ring gasket (124) on the bearing retainer (122). Place the bearing retainer and the bearing	

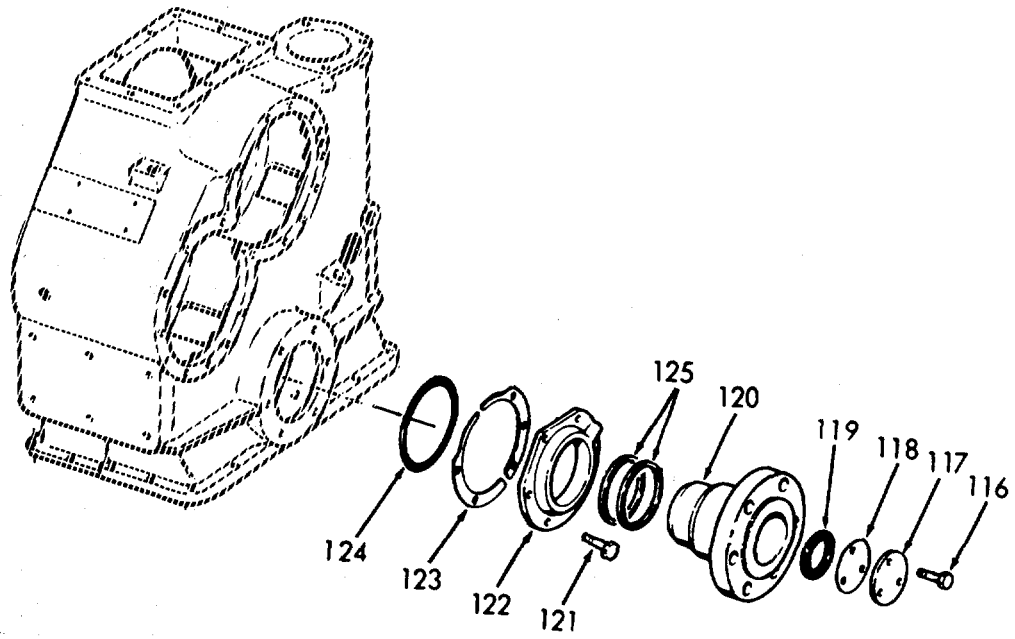
5-5. MARINE GEAR MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL IN CRAFT (Cont)

retainer shims (123) that were removed, against the main housing and secure the retainer to the housing with seven 1/2-13 X 1-1/2 hex-head cap screws (121). Tighten the cap screws to 85 lb-ft (115.2 Nm) torque.

2. Carefully tap the propeller flange on the counter shaft. Do not damage the oil seals! Install a new ring gasket (119) in the propeller flange. Secure the propeller flange to the counter shaft (120) with the propeller flange shim (118), the retainer washer, and three 5/8-18 X 1-1/2 hex-head cap screws (116). Tighten the cap screws to 175 lb-ft (237.3 Nm) torque.



3. Slide the propeller shaft and companion flange forward against the propeller flange. Align the scribed marks on the propeller flange and companion flange. Secure the flanges together with the bolts previously removed.

4. After the installation has been completed, fill the marine gear sump with oil.

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS.

This task covers:

Repair

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

3-9.1. Control Station - Operator Maintenance.

Equipment Condition **Condition Description**

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS

REPAIR

1. Control station

NOTE

Refer to paragraph 3-9.1 for removal procedure.

a. Screws (1) Remove.

b. Cover (2) Remove.

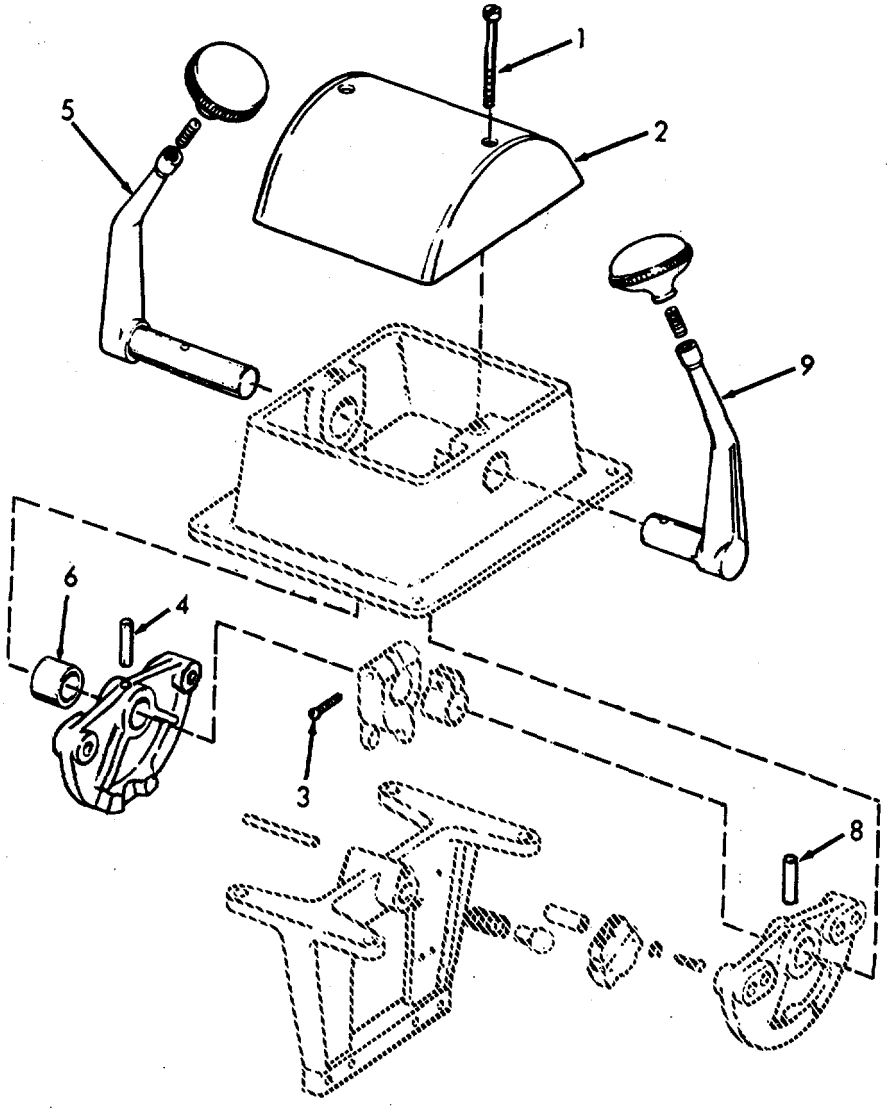
c. Adjustment screw (3) Loosen.

d. Roll pin (4) Remove.

e. Throttle handle (5) Remove.

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Bearing (6)	Remove from quadrant (7).	
	g. Roll pin (8)	Remove.	
	h. Clutch handle (9)	Remove .	

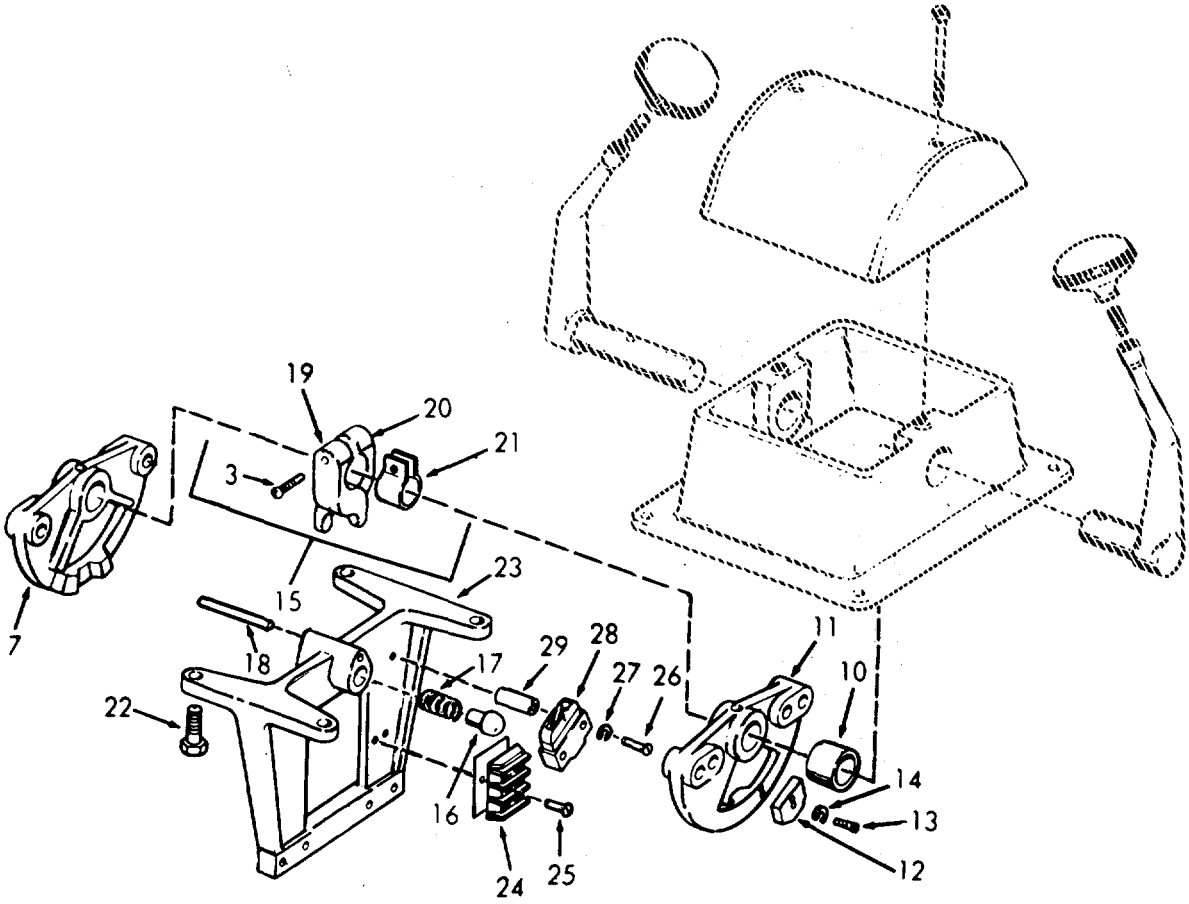


5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Bearing (10)	Remove from quadrant (11).	
	j. Quadrants (7 and 11)	Remove.	
	k. Switch cam (12), screws (13), and lockwashers (14)	Remove.	If necessary
	l. Throttle brake assembly (15)	1. Remove. 2. Interlock pin (16), spring (17) and brass stop pin (18) will come out.	
	m. Screw (3) brake shoe (19), brake shoe (tapped hole) (20), and leather brake pad (21)	Disassemble.	
	n. Screws (22), and cable bracket (23)	Remove.	
	o. Wiring strip (24).	Remove from terminal	
	p. Screws (25), and terminal insulation strip (24)	Disassemble.	If necessary.

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	q. Screws (26), lockwashers (27)a switch (28), and bushing (29)	Disassemble.	If necessary.

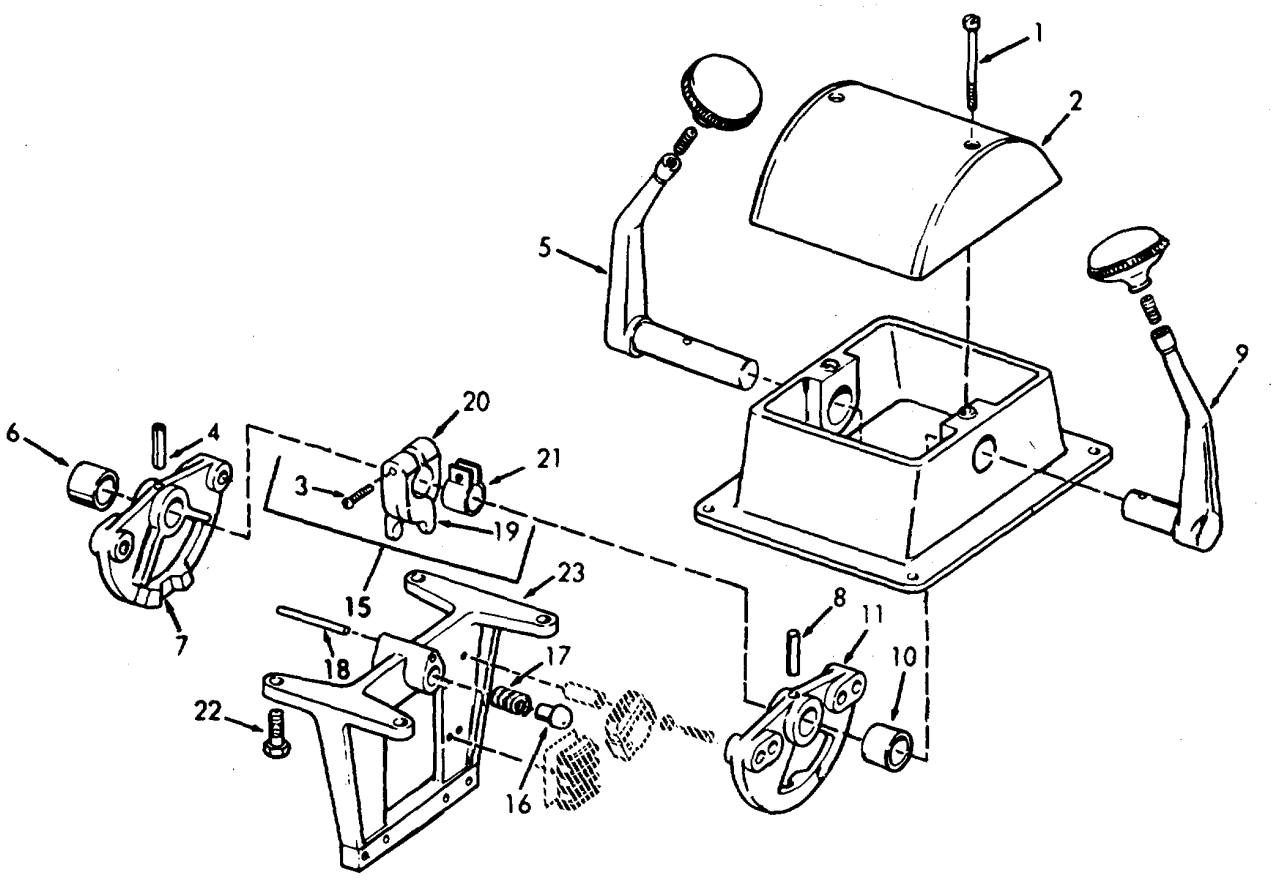


5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	r. Screws (22), and cable bracket (23)	Install.	
	s. Screw (3), brake shoe (19) , brake shoe (tapped hole) (20), and leather brake pad (21)	Reassemble.	
	t. Throttle brake assembly (15), (interlock pin (16), spring (17), and brass stop pin (18))	Reassemble.	
	u. Quadrant (11), clutch handle (9), bearing (10), and roll pin (8)	Install.	

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	v. Quadrant (7), throttle handle (5), bearing (6), and roll pin (4)	Install.	
	w. Adjustment screw (3)	Tighten.	
	x. Screws (1), and cover (2)	Install.	



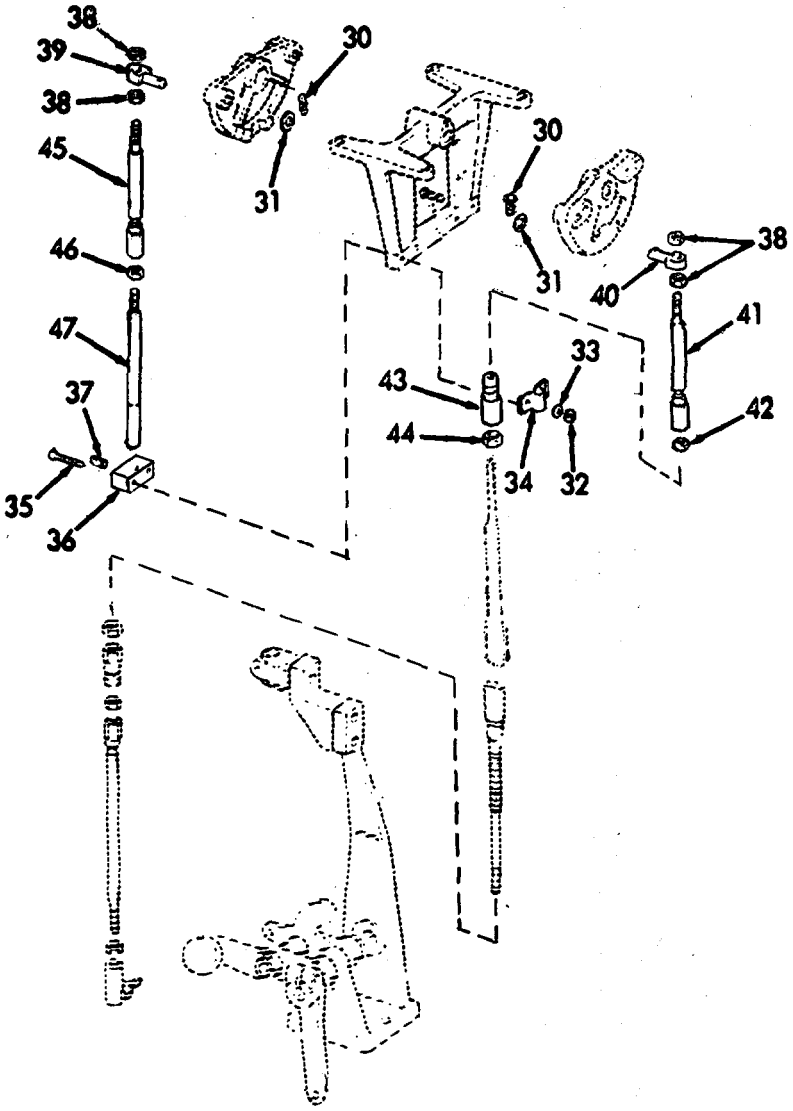
5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
2. Connecting rod and socket assemblies	a. Cotter pins, (30), and flat-washers (31)	Remove.	
	b. Nuts (32), lockwashers (33), clamps (34), and screws (35)	Remove.	
	c. High idle detent (36), and plunger ball (37)	Remove.	
	d. Nuts (38), and swivel joints (39 or 40)	Disassemble.	
	e. Rod and socket assembly (41), nut (42), bushing (43), and nut (44)	Disassemble.	If necessary.
	f. Rod and socket assembly (45), nut (46), and high idle detent rod (47)	Disassemble.	If necessary.

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



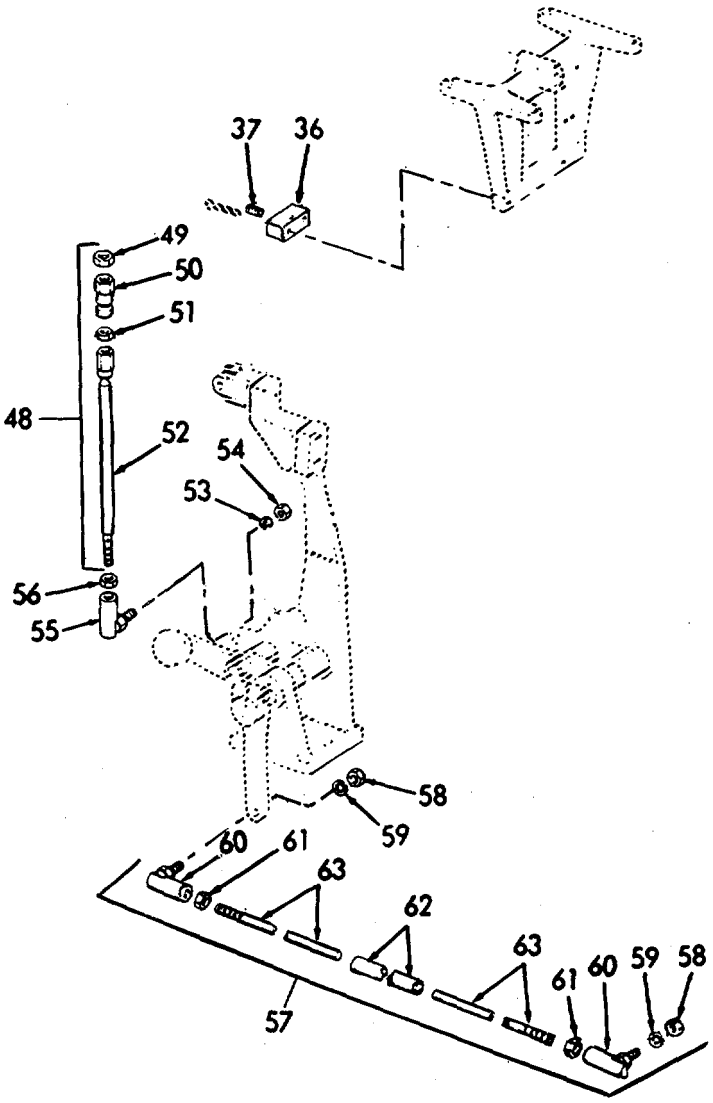
5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Articulator cable engine end (48) (nut (49), adapter bushing (50), nut (51), and rod and socket assembly (52))	Disassemble	If necessary.
	h. Nut (53), lockwasher (54), ball joint (55), and nut (56)	Disassemble.	If necessary
	i. Connecting rod assembly (57), (nuts (58), lockwashers (59), ball joints (60), nuts (61), connecting rod (62) and coupling (63))	Disassemble.	If necessary
	j. High idle detent (36) and plunger ball (37)	Install.	

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

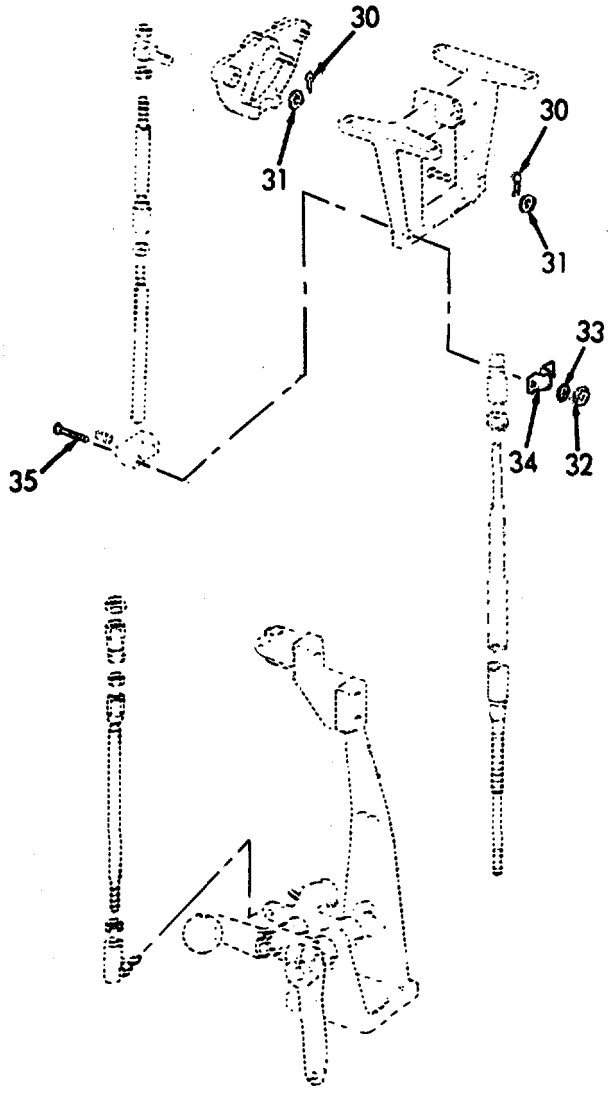
REPAIR (Cont)



5-173

5-6. ENGINE AND TRANSMISSION CONTROLS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Screws (35), clamps (34), lock washers (33) and nuts (32)	Install.	
	l. Flat washers (31) and cotter pins (30)	Install.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS.

This task covers:

Overhaul

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Arbor press
Vice (soft jaws)
9/16 open wrench

Material/Parts

Lactate
Shell Alvania No.2
grease or equivalent

Personnel Required

1

References

3-10. Variable Speed Mechanical Operator Maintenance.

Equipment Condition — **Condition Description**

NONE

Special Environmental Conditions

NONE

General Safety Instructions

WARNING
Wear protective eye goggles when Using compressed air.

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY

1. Governor cover

NOTE

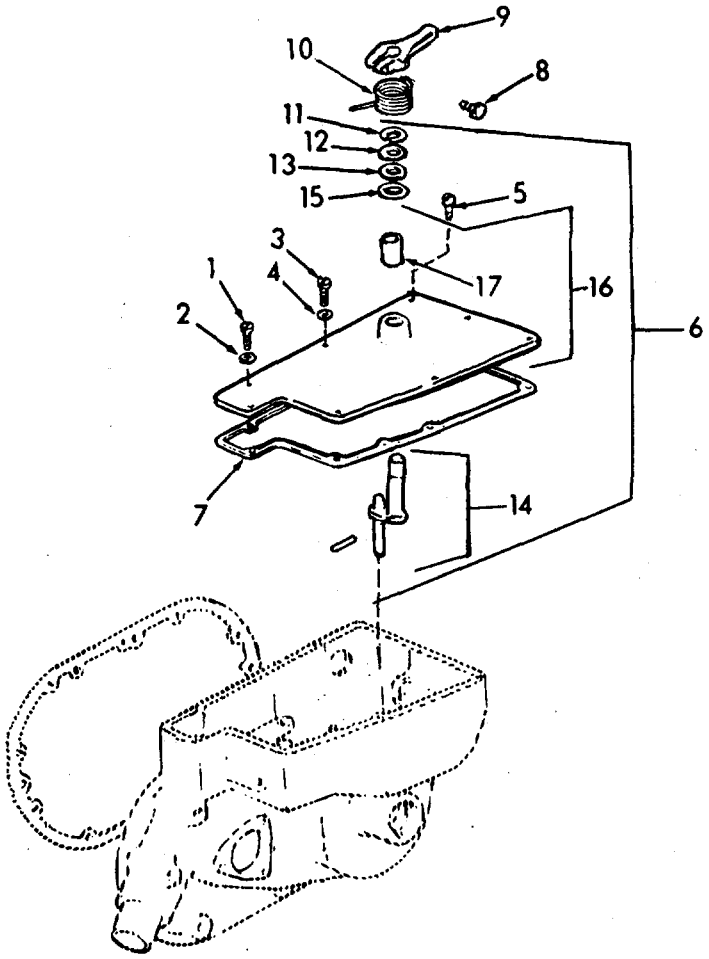
Before removing any of the parts from the governor, wash the entire unit in clean fuel oil, dry it with compressed air and inspect it for worn or damaged parts which may be repaired or replaced without complete disassembly.

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	a. Screws (1, 3 and 5), and lock-washers (2 and 4)	Remove.	
	b. Cover assembly (6), and gasket (7)	Remove	Discard gasket.
	c. Cover assembly (6)	Clamp in vice	Soft jaws.
	d. Stop lever screw (8)	1. Loosen. 2. Remove stop lever (9).	
	e. Return spring (10)	Remove.	
	f. Retaining ring (11), retainers (12), and backup washer (13)	Remove.	
	g. Stop lever shaft (14)	Pull out of cover.	
	h. Seal ring (15)	Remove.	
	i. Cover assembly (16)	1. Wash thoroughly. oil.	Use clean fuel
		2. Inspect bushing (17).	If bushing is not damaged proceed to step 2.

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	j. Cover assembly (16)	1. Place in arbor press.	
		2. Press out bushing.	



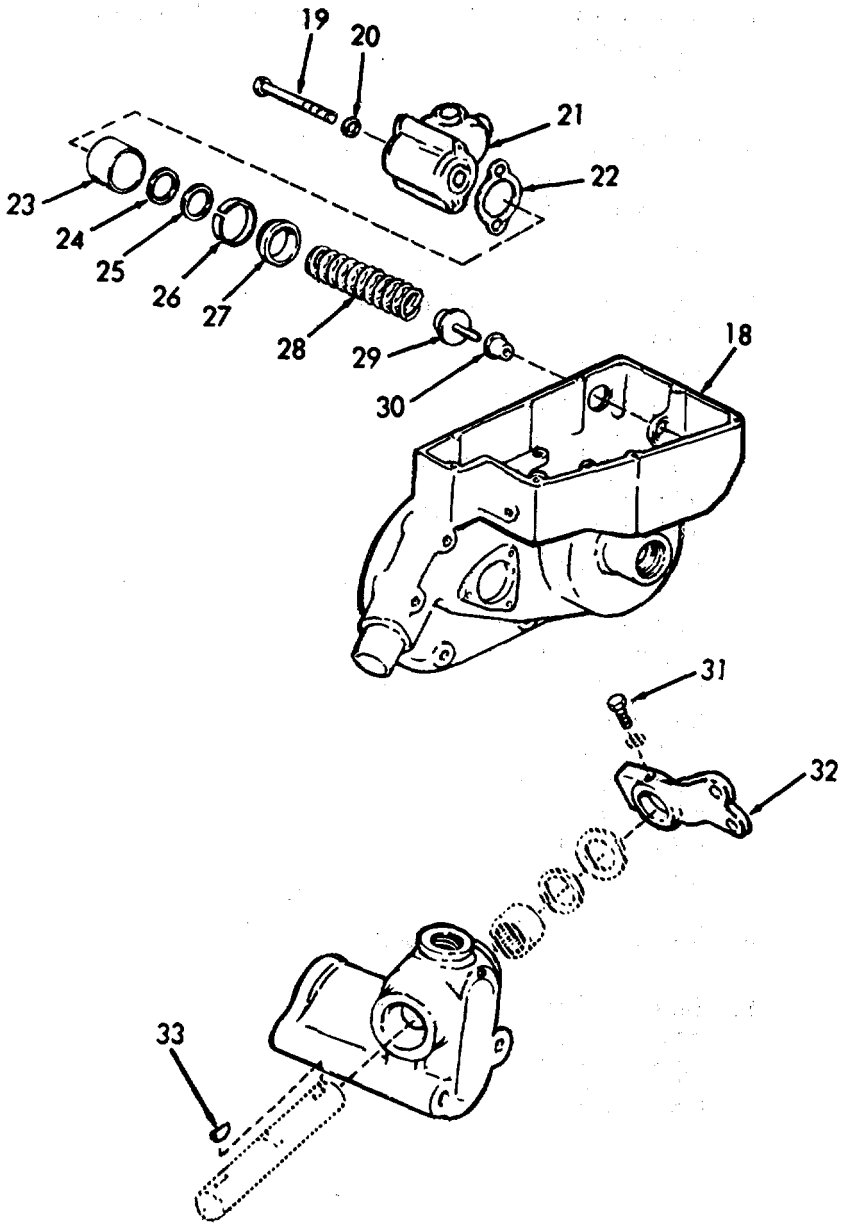
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
2. Governor	a. Governor housing (18)	Clamp flange in vice. housing	Soft jaws
	b. Screws (19), and lockwashers (20)	Remove.	
	c. Spring housing (21), and gasket (22)	Remove	Discard gasket.
	d. Variable speed spring retainer (23), shims (24 and 25), stop with gap (26), stop with seat (27), spring (28), plunger (29), and guide (30)	Remove.	Removal of plunger (29) requires a small brass rod and hammer.
3. Variable speed spring housing (21)	a. Screw (31)	Loosen.	
	b. Speed control lever key (33)	Remove. (32), and	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont)

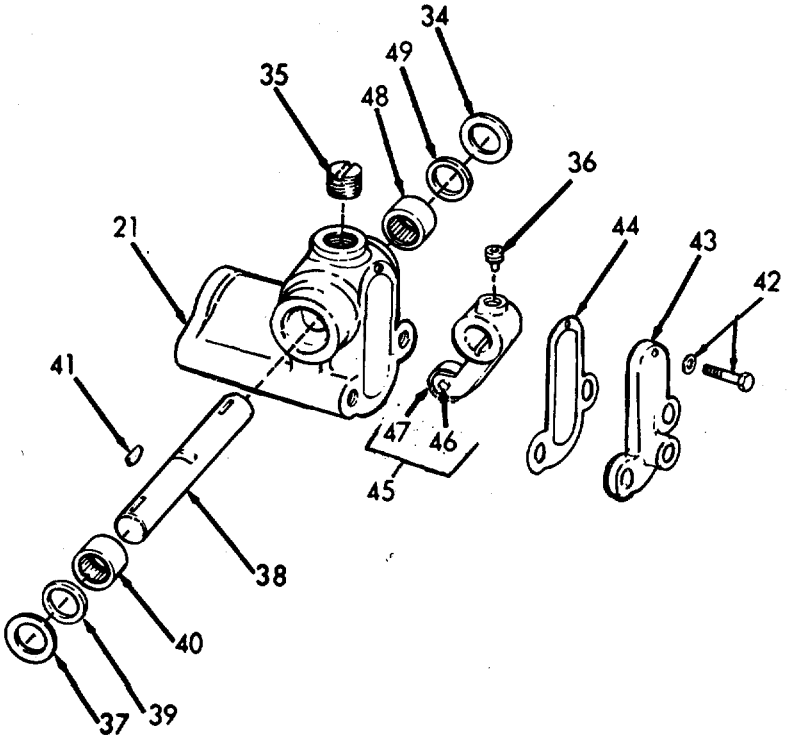


5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	c. Flatwasher (34)	Remove.	
	d. Plug (35), and set screw (36)	Remove.	
	e. Spring housing (21)	1. Place sleeve on bed of arbor press.	Sleeve 3/4 inch ID X 1-1/2 inch long.
		2. Support housing on top of sleeve with cup plug (37) down.	
		3. Place a small brass rod on the end of the shaft.	
		4. Press shaft (38), cup plug (37), seal (39), bearing (40) and from housing and key (41).	
	f. Bearing (40), and seal (39)	Remove from shaft (38).	Discard bearing.
		NOTE	
	Inside end of needle bearing damaged by key. Do not attempt to reuse bearing.		
	g, Screw and flat washer (42)	Remove.	
	h. Cover (43), and gasket (44)	Remove	Discard gasket.

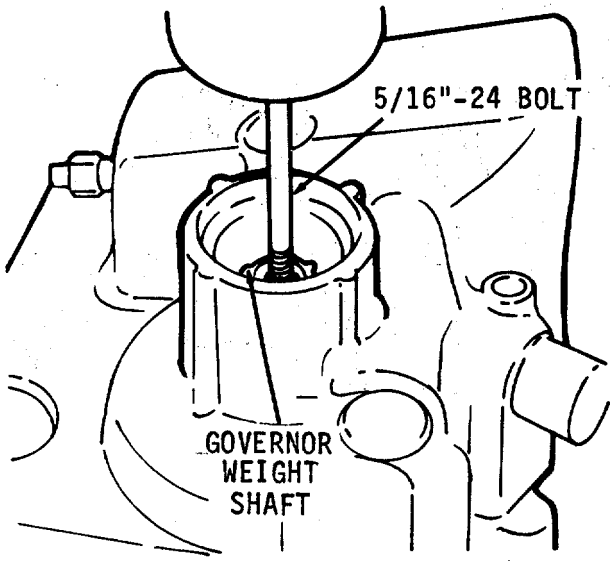
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	i. Spring lever (45)	1. Remove.	
		2. Replace pin (46) and bearing (47).	If necessary.
	j. Spring housing (21)	1. Clean thoroughly.	Use clean diesel oil.
		2. Inspect bearing (48) for wear or damage.	If o.k., proceed to step 4.
	k. Bearing (48) and seal (49)	Press out.	



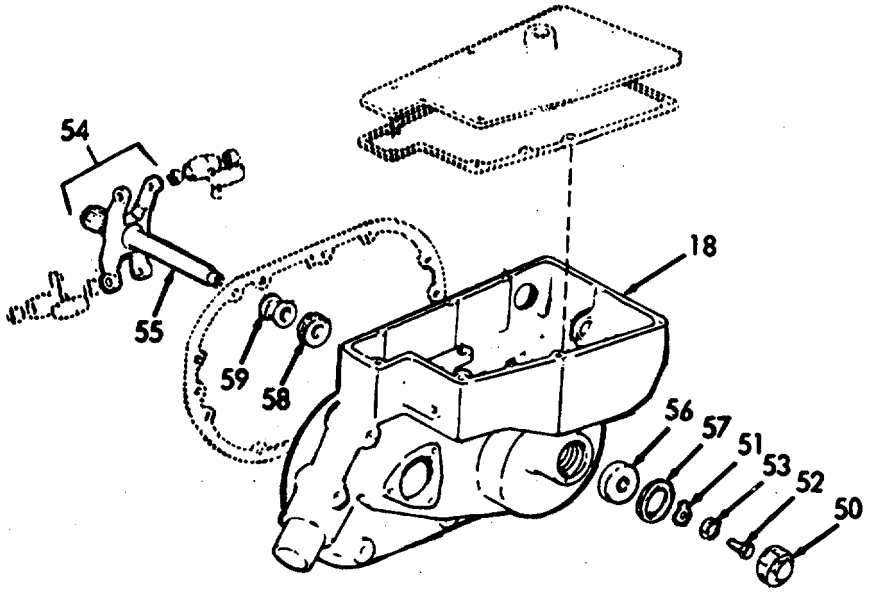
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
4. Governor weight and shaft assembly	a. Governor housing (18)	Clamp in vice flange.	Soft jaws.
	b. Plug (50)	Remove.	
	c. Lockwasher (51)	Bend tang away from screw (52).	
	d. Screw (52), flat washer (53), and lockwasher (51)	1. Hold weight carrier assembly (54). 2. Remove.	
	e. Shaft (55)	Install screw.	Screw is 5/16-24 X 3 inch.
	f. Governor housing (18)	1. Place in arbor press. 2. Press shaft (55) from bearing (56).	
	g. Gasket (57)	Remove.	Discard.



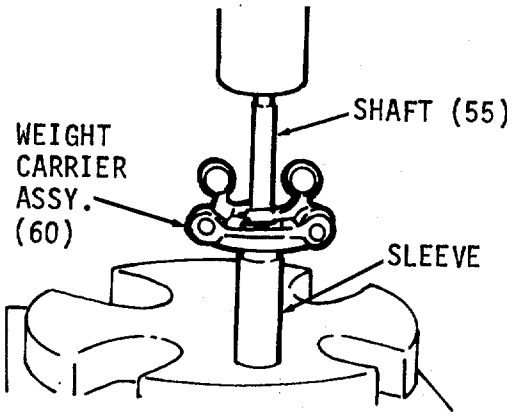
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	h. Governor riser thrust bearing (58), and riser (59)	Slide from shaft.	
		NOTE The thrust bearing is specially designed to absorb thrust load; therefore, looseness between the mating parts does not indicate excessive wear.	
	i. Governor weight shaft bearing (56)	Remove from housing.	Tap the bearing with a small brass rod and hammer.

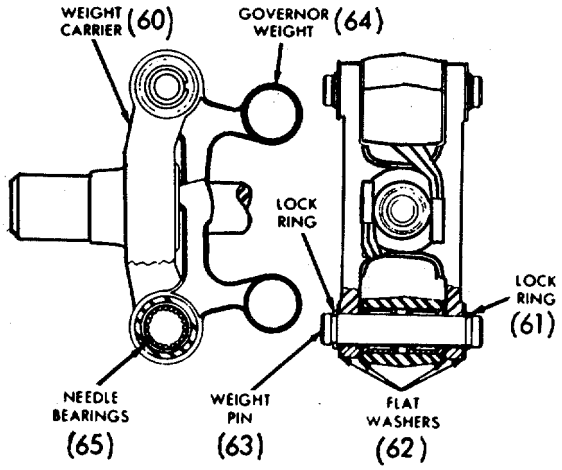


5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
5. Governor weights and shaft	a. Weight carrier assembly (54)	1. Place in arbor press. 2. Press out shaft (55) from carrier (60).	

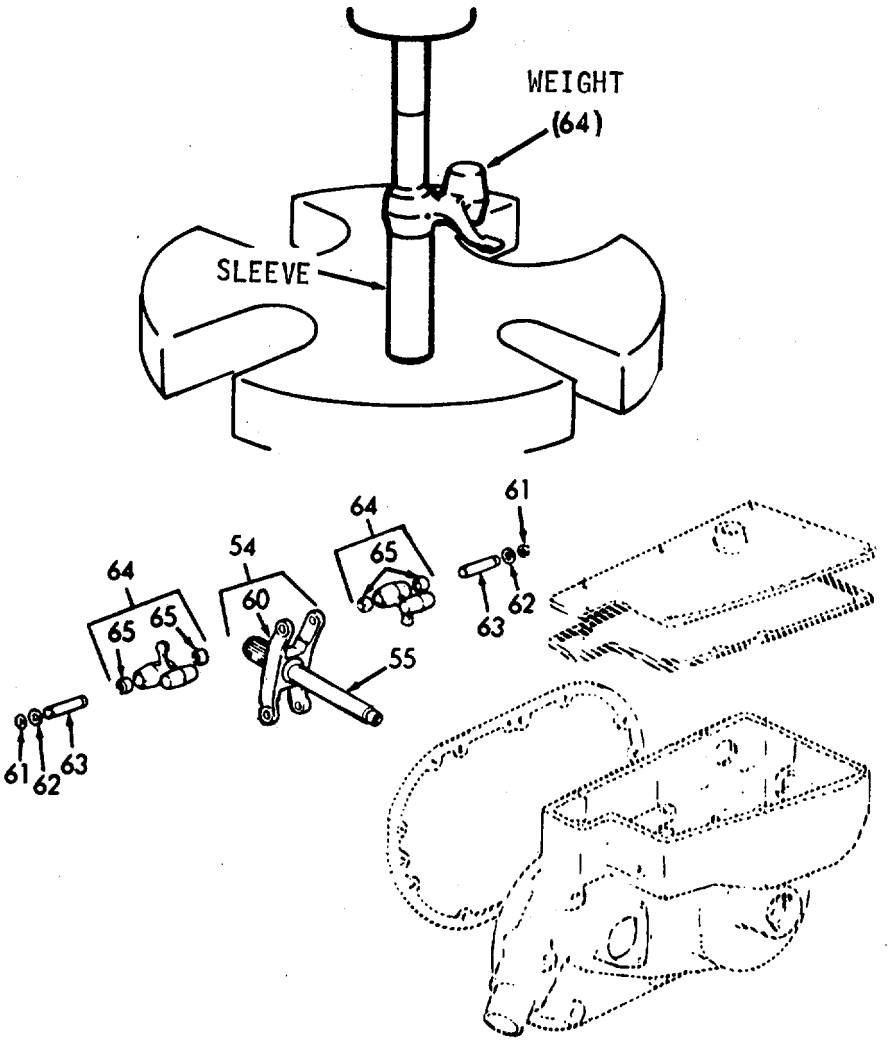


	b. Lock rings (61)	Remove 4 places.	Use snap ring pliers.
	c. Flatwashers (62), and weight pins (63)	Remove.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	d. Weights (64)	1. Wash thoroughly.	Use clean diesel oil.
		2. Inspect needle bearings (65) for wear and damage.	If not damaged, proceed to step 6.
	e. Needle bearings (65)	Press out using arbor press.	

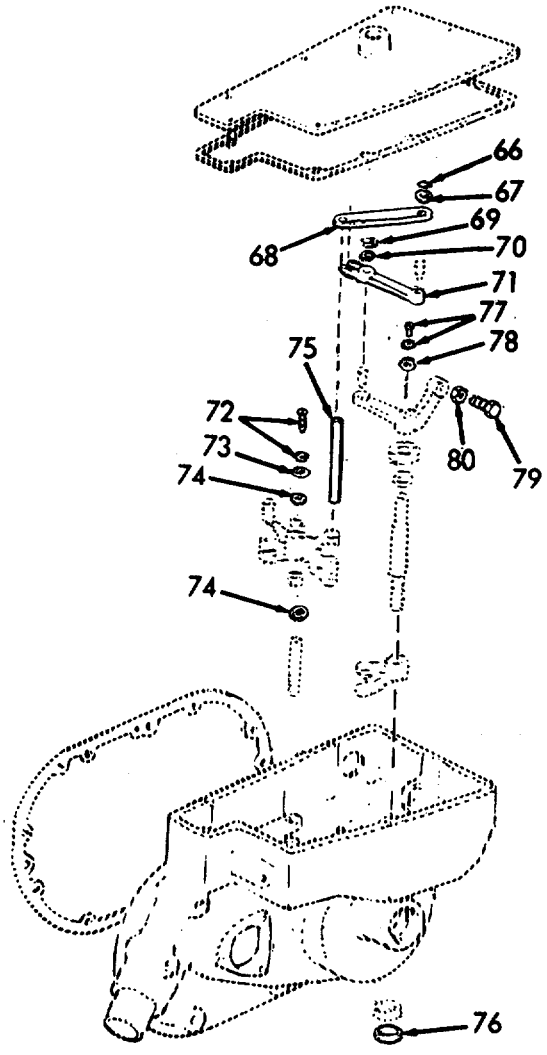


5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
6. Governor linkage and operating shaft	a. Spring retainer (66), and plain washer (67)	Remove.	
	b. Connecting link (68)	Remove.	
	c. Spring retainer (69), and washer (70)	Remove.	
	d. Differential lever (71)	Remove.	
	e. Screw and lockwasher (72) , and lock clip (73)	Remove.	
	f. Flat washers (74)	See note.	
	NOTE Do not loose the two flat washers located between the top and bottom of the lever assembly and the governor housing.		
	g. Operating lever pin (75)	Remove.	
	h. Expansion plug (76)	Remove.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	i. Retaining screw (77), and flat washer (78)	Remove.	
	j. Adjustment screw (79) and locknut (80)	Remove.	If necessary.



5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

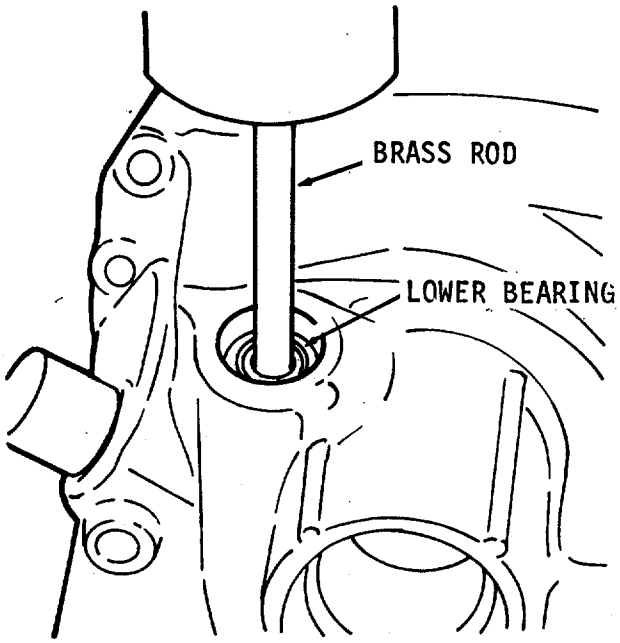
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)

k. Governor housing (18)

1. Support housing bottom side up on bed of arbor press, with the two dowel pins in the top of the housing between the two steel supports.

2. Place a small brass rod on the end of the operating shaft and the ram of the press



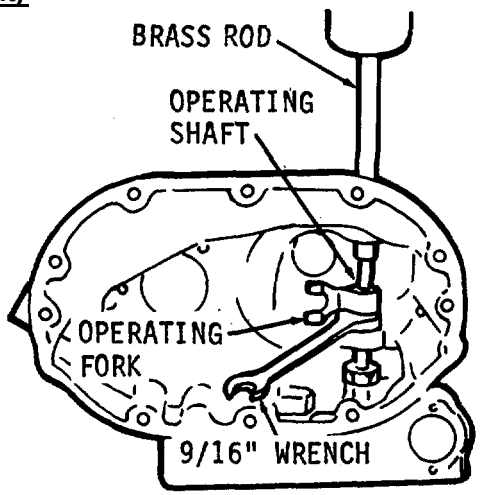
3. Press the shaft (81) out of the bearing.

4. Place a 9/16 open wrench under the operating fork (82).

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

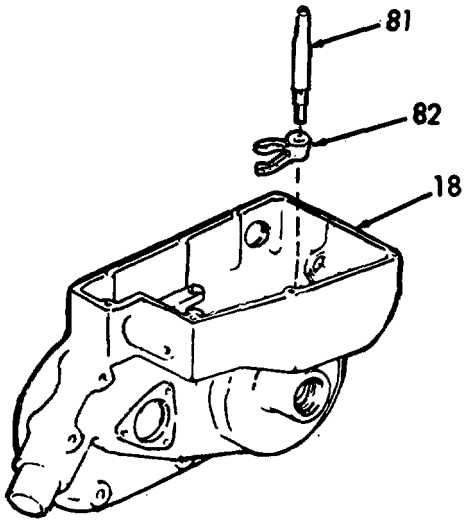
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)



5. Place a brass rod on the end of the shaft and under the ram of the press.

6. Press the fork (82), off the operating shaft (81).



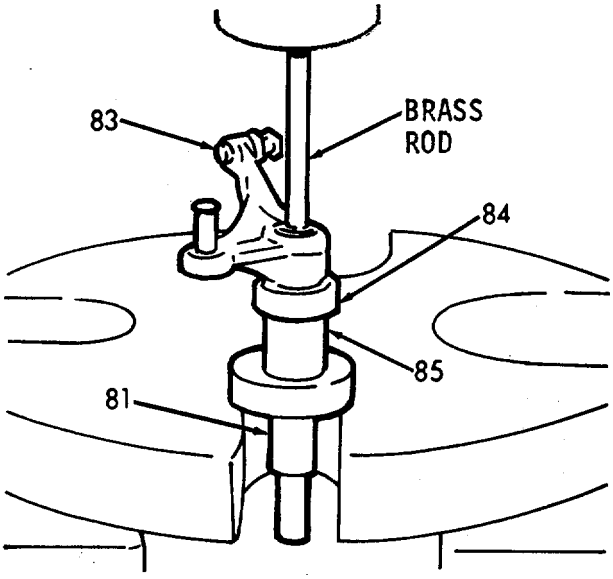
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
		7. Remove the shaft (81), operating lever (83), bearing (84) and spacer (85) as an assembly.	
	l. Lower bearing (86)	Remove from housing.	
	m. Shaft (81), operating lever (83), bearing (84) and spacer (85) as an assembly	1. Place a short 9/16 inside diameter sleeve over the end of the operating shaft and rest it against the inner race of the bearing.	
		2. Place the sleeve and assembly on a large washer or plate, with a 5/8 inch hole, on the bed of an arbor press.	
		3. Place a small brass rod on the end of the shaft and under the ram of the press.	
		4. Press the shaft (81) out of the lever (83) and bearing (84).	Catch the shaft to prevent it from falling and being damaged.
		NOTE Be sure that the bearing inner race is resting on the sleeve or the bearing may be damaged.	

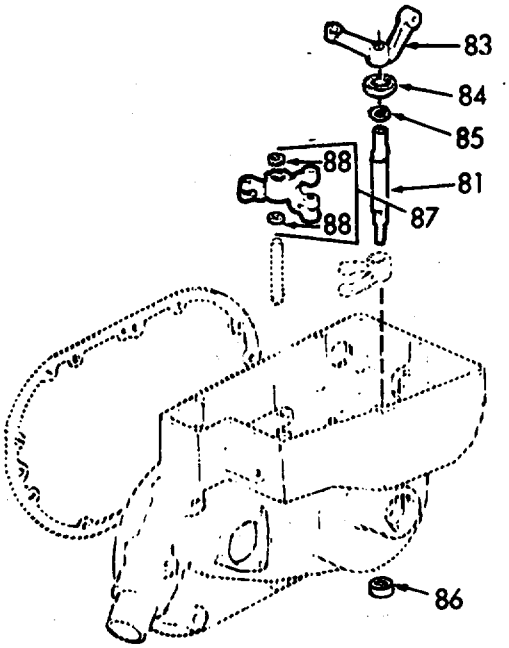
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)

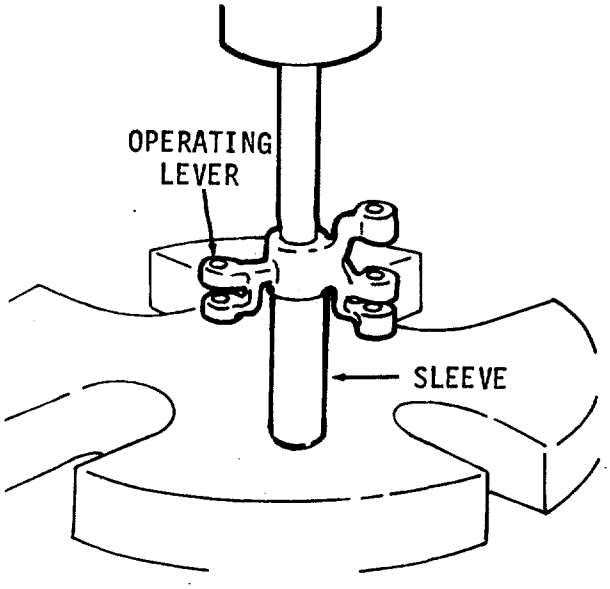


n.	Control link operating lever (87) and needle bearings (88)	1.	Wash thoroughly.	Use clean diesel oil.
		2.	Inspect needle bearings for wear or damage.	If satisfactory, proceed to step p.



5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	o. Needle bearings (88)	1. Support the control link operating lever on a sleeve. 2. Rest the sleeve on the bed of an arbor press. 3. Press both bearings out of the lever.	

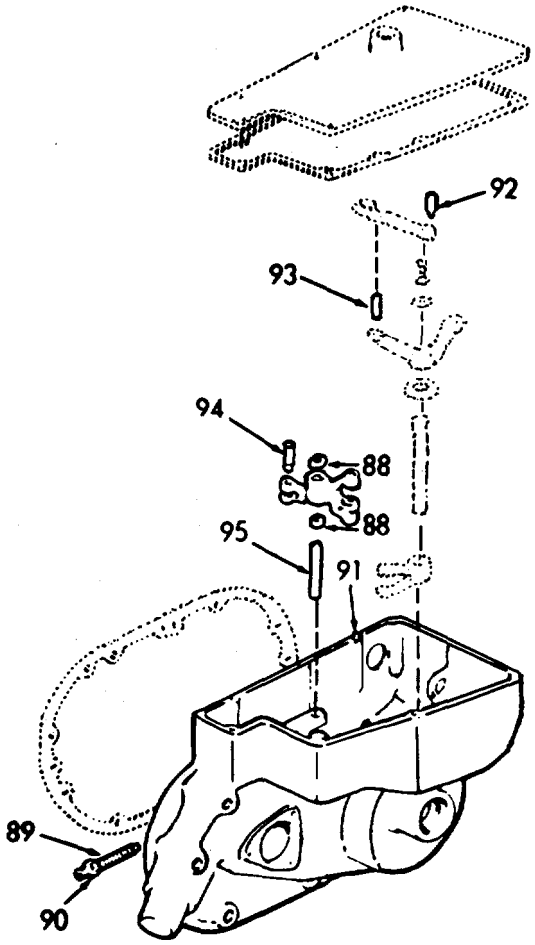


	p. Buffer screw (89) and lock nut (90)	Remove.	If necessary.
	q. Dowel pins (91) and pins (92, 93, 94 and 95)	Remove.	If necessary.

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)



5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-INSPECTION

7. All parts

WARNING

Wear eye protection when using compressed air.

Wash all of the governor parts in clean fuel oil and dry them with compressed air.

Examine the bearings for any indications of corrosion or pitting. Lubricate each bearing with light engine oil; then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots.

Examine the riser thrust bearing for excessive wear, flat spots, or corrosion.

Examine the weight carrier pins and needle bearings in the weights for wear.

Examine the governor weight at the riser contact area for excessive wear. If this condition exists install a new governor weight.

Examine the control link operating lever shaft and needle bearings for wear and damage.

Examine the stop lever shaft and bushing in the governor cover for wear.

NOTE

The stop lever shaft bushing is not serviced. When replacement of the bushing becomes necessary, it must be replaced with two needle bearings.

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-INSPECTION (Cont)			
		Examine the speed control lever shaft and needle bearings in the variable speed spring housing for wear.	
		Examine the variable speed spring lever roller and pin for excessive wear. The roller bearing rides on a hardened bearing pin which is a press fit in the spring lever and is staked at three places on both sides.	
		Examine the variable speed spring plunger, guide, and spring retainer for wear or score marks. If the retainer or plunger are scored slightly, clean them up with crocus cloth. Replace the retainer, plunger, and guide if scored excessively.	
		Inspect the adjusting screw, lock nut, pins, seal rings and any other parts in the governor housing for wear or defects that might affect the governor operation.	
		Replace all of the parts that are worn or damaged.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

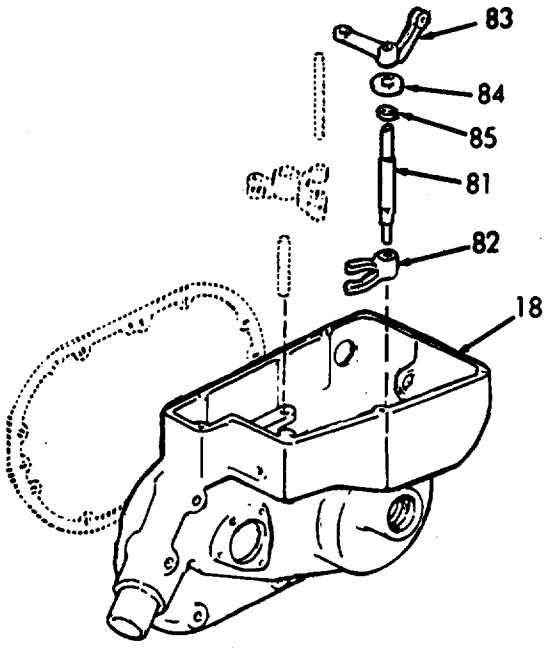
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY			
8. Operating shaft and governor linkage	a. Governor shaft upper bearing (84), spacer (85), and operating shaft (81)	1. Lubricate the inside diameter of the governor operating shaft upper bearing with engine oil. 2. Start the bearing, numbered side up, straight on the large end of the operating shaft. 3. Support the bearing and operating shaft on a 9/16" inside diameter sleeve on the bed of an arbor press, with the inner race of the bearing resting on the sleeve, then press the shaft into the bearing until 1/4" of the shaft protrudes through the bearing.	
	b. Governor operating shaft lever (83)	1. Lubricate the inside diameter of the governor operating shaft lever with engine oil. 2. Start the lever, pivot pin in operating lever facing up, straight on the operating shaft with the flat on the shaft registering with the flat surface in the lever. 3. Support the operating lever, bearing and shaft on the bed of an arbor press with a steel support directly under the center of the lever, then press the operating shaft through the bearing and lever until the end of the shaft contacts the steel support.	
		NOTE The upper end of the shaft must be flush with the top surface of the lever.	
	c. Operating shaft spacer (85)	Place the operating shaft spacer over the lower end of the shaft and slide it against the upper bearing inner race.	

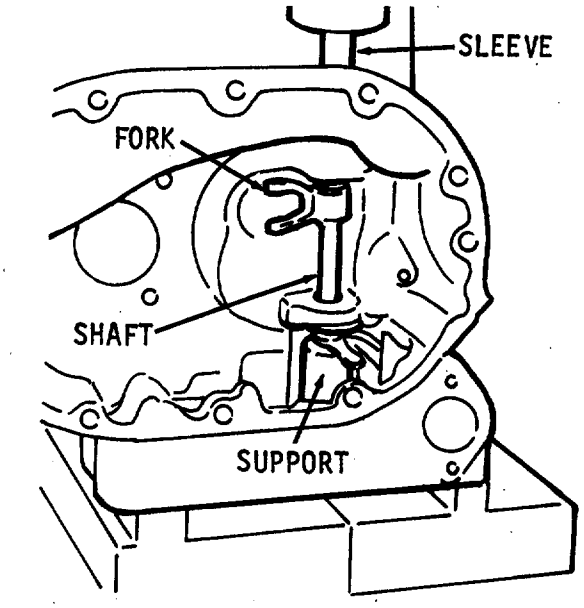
5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-INSPECTION (Cont)

	d. Governor operating shaft (81), bearing (84), spacer (85), and lever (83) assembly	Insert the end of the assembly through the upper bearing bore in the housing with the lever positioned as shown.
	e. Operating shaft fork (82)	Lubricate the inside diameter of the governor operating shaft fork with engine oil, then place the operating fork over the lower end of the shaft with the finish cam surfaces on the fork fingers facing the rear of the governor housing and the flat on the shaft registering with the flat surface in the fork.
	f. Governor housing (18) and operating shaft assembly	1. Support the governor housing and operating shaft assembly on the bed of an arbor press with the upper end of the operating shaft resting on a steel support as shown. 2. Place a 7/16" inside diameter sleeve over the end of the shaft and against the fork; then, press the fork tight against the shaft spacer on the shaft.



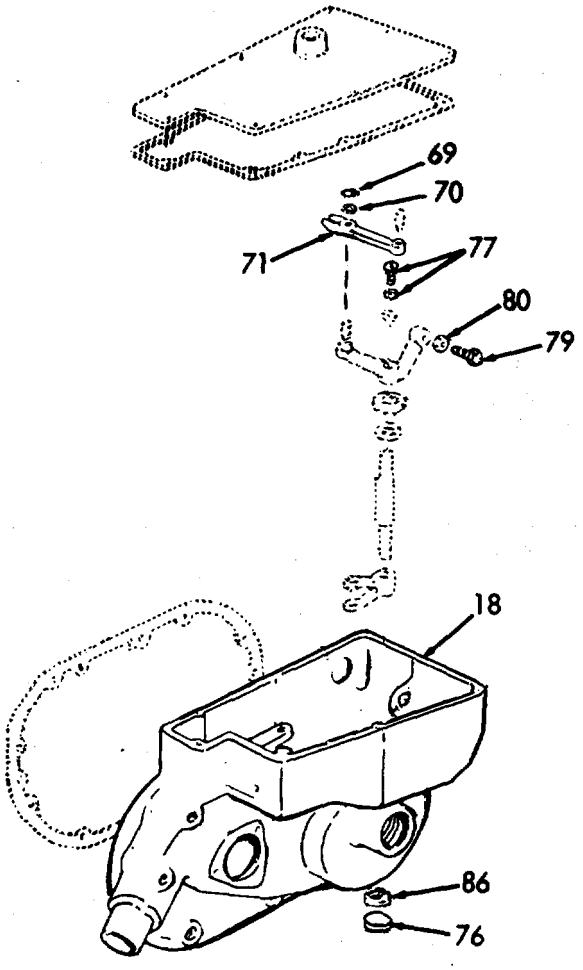


5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
	g. Governor operating shaft lower bearing (86)	1. Lubricate bearing with engine oil. 2. Start the bearing numbered side up, straight in the governor housing and over the end of the operating shaft.	
	h. Governor housing (18) and operating shaft assembly	1. Support the governor housing and operating shaft assembly on the bed of an arbor press with the upper end of the operating shaft resting on a steel support as shown. 2. Place a 7/16" inside diameter sleeve on the inner race of the bearing and under the ram of the press; then, press the bearing on the shaft until it seats on the shoulder in the housing.	
	i. Retaining washer and screw, and lockwasher (77)	Install.	
	j. Expansion plug (76)	1. Apply a thin coat of good quality sealant around the edge of a new expansion plug. 2. Place the plug, concave side up, in the opening in the housing next to the lower operating shaft bearing. 3. Tap the center of the plug with a hammer to secure the plug in the housing.	Use a new plug.

5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
	k. Differential lever (71), washer (70), and spring retainer (69)	Place the differential lever over the pivot pin in the operating lever, with the pin in the lever up, and secure it in place with a plain washer and spring retainer.	
	l. Nut (80), and adjusting screw	Install.	

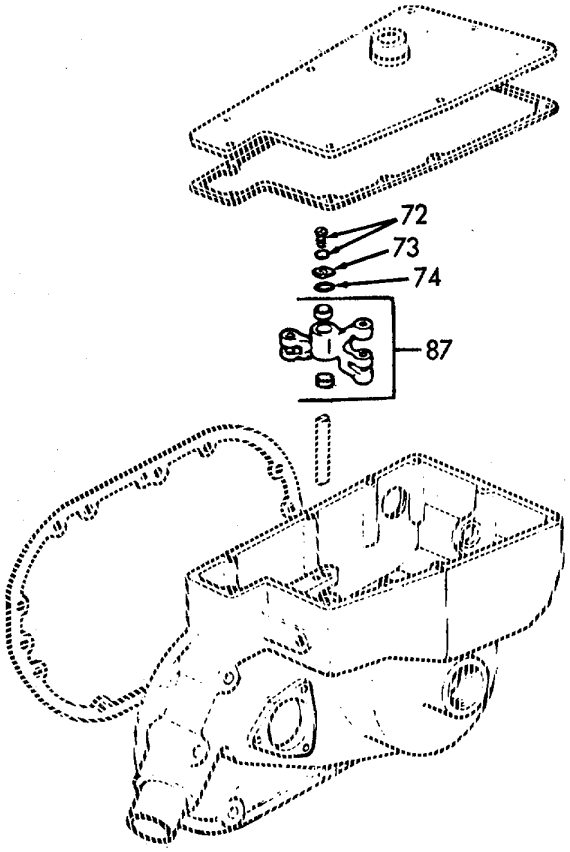


5-7. VARIABLE SPEED MECHANICAL GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
	m. Control link operating lever, and needle bearings (87)	1. If removed, place the control link operating lever on the bed of an arbor press, with a steel-support under the bearing bore. 2. Lubricate the outer surface of the bearing with engine oil and start the bearing, numbered end up, straight into the bore of the lever. Insert the pilot end of installer in the bearing and under the ram of the press. 3. Then, press the bearing into the lever until it is flush with the top surface of the lever. Reverse the lever on the press and install the second bearing in the same manner.	
	n. Control link operating lever (87)	1. Lubricate the control link operating lever needle bearings with Shell Alvania No. 2 grease, or equivalent. 2. Place the lever in position between the two bosses inside the governor housing. 3. Insert a flat washer on each side of the lever.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
		4. Install the control link operating lever shaft with the slot (in the side at one end of the shaft) up.	
	o. Washer (74), lock clip (73), and screw and rooster (72)	1. Align the slot in the control link operating lever shaft with the lock clip screw hole in the boss next to the shaft.	
		2. Install and tighten securely	



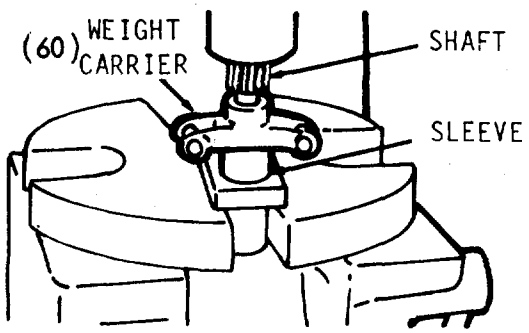
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

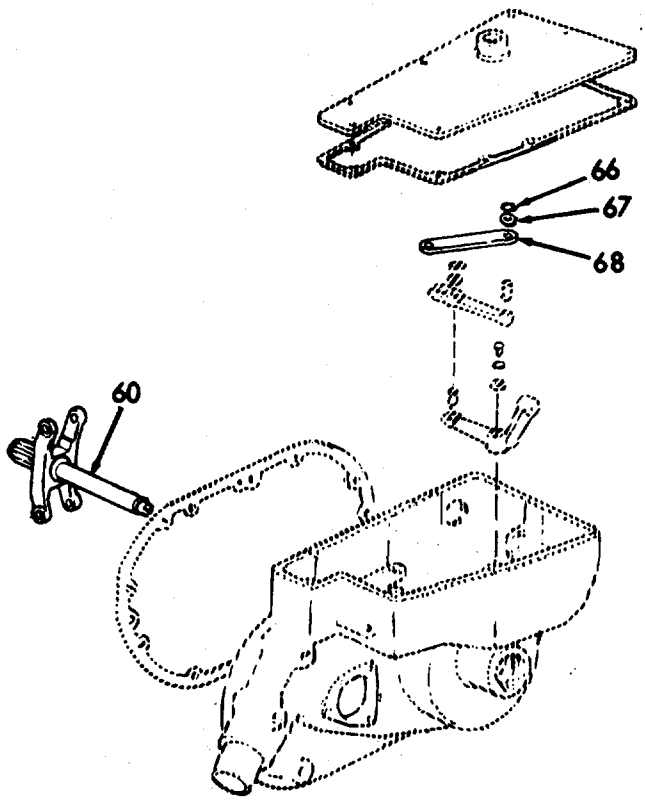
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	p. Connecting link (68), plain washer (67), and spring retainer (66)	1. Install. 2. Place the opposite end of the connecting link on top of the control link operating lever and install the connecting pin.	
9. Governor weight and shaft assembly			
	NOTE If the governor weight carrier assembly was removed from the weight shaft, the weights must be removed from the carrier before attempting to install the carrier on the shaft.		
	a. Weight carrier (60)	1. Support the weight carrier (rear face up) on a sleeve and a steel support (with a 1" hole) over an opening in the bed of an arbor press. 2. Lubricate the weight shaft with engine oil. Then, insert the non-splined end of the shaft through the carrier, sleeve, and hole in the steel support. Bring the ram of the press down on the shaft and press the shaft straight into the carrier until the shoulder on the shaft is tight against the carrier.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

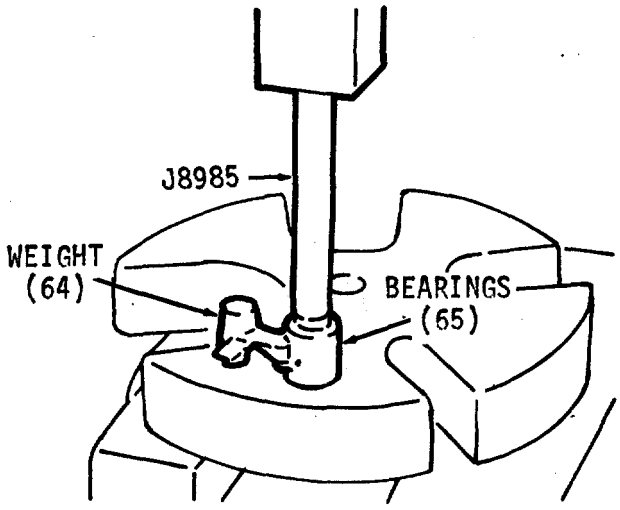
OVERHAUL-REASSEMBLY (Cont.)





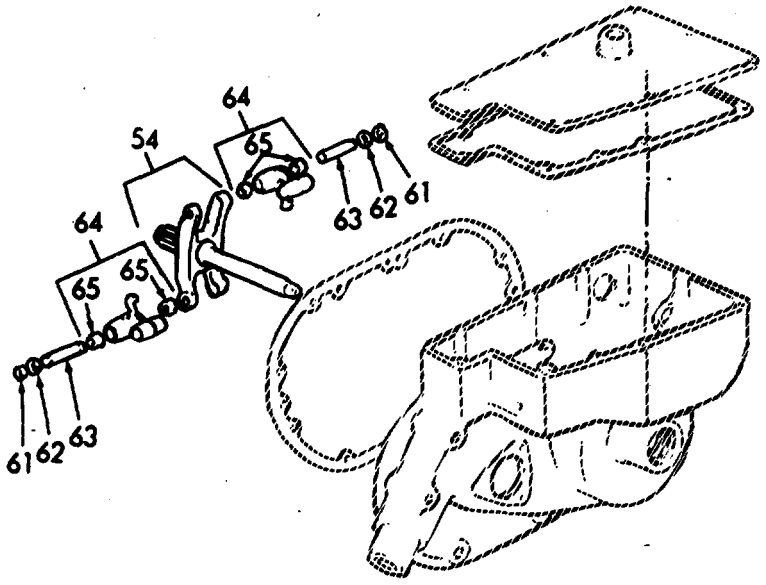
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	b. Governor weight (64) and bearings (65)	1. Place the governor weight, either end up, on the bed of an arbor press. 2. Lubricate the outer surface of the bearing with engine oil and start the bearing, numbered end up, straight into the bore of the weight. 3. Insert the pilot end of installer in the bearing and under the ram of the press. 4. Press the bearing straight in the weight until it is flush with the top of the weight. 5. Reverse the weight on the press and install the second bearing in the same manner.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
		6. Install the bearings in the second weight in the same manner as described above. 7. Lubricate the needle bearings with Shell Alvania No. 2 grease, or equivalent.	
	c. Weight carrier (54)	Position the weight carrier and shaft assembly on a bench with one pair of the weight pin arms facing up.	
	d. Weight pin (63), flat washer (62), and lock ring (61)	1. Install on end of pin. 2. Insert the pin through the bearing in the carrier arm and place a second flat washer over the pin and against the carrier arm.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

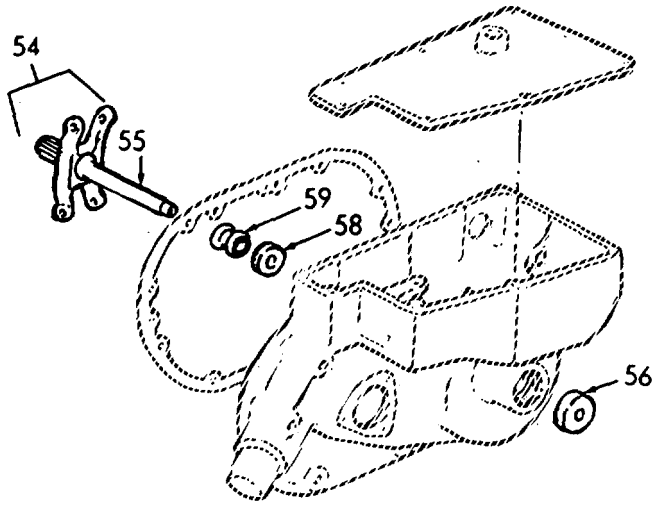
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
		3. Position the governor weight and bearing assembly between the arms of the weight carrier. 4. Push the weight pin just through the weight. 5. Insert a third flat washer between the inner face of the carrier arm and the weight and push the pin through the washer and the carrier arm. 6. Install the fourth flat washer over the pin and against the outside of the carrier arm. 7. Install the second lock ring in the groove of the weight pin. 8. Install the second governor weight and bearing assembly in the carrier in the same manner as described above.	
	e. Governor riser (59)	Slide on weight shaft (55) and against the fingers of the high speed weight.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont.)

f.	Thrust bearing (58)	Place the bearing over the weight shaft with the bearing race having the smaller inside diameter against the riser.	
g.	Weight carrier (54)	1. Insert in the governor housing. 2. Support the splined end of the shaft and the governor housing on the bed of an arbor press with the upper end of the shaft under the ram of the press .	
h.	Weight shaft bearing (56)	1. Place the weight shaft bearing in the governor housing (numbered side up) and start it straight on the end of the weight carrier shaft.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
		2. Place a sleeve with a 1/2" inside diameter on top of the bearing inner race.	
		3. Bring the ram of the press down on the sleeve and press the bearing into the housing and against the shoulder on the shaft.	
	i. Lockwasher (51)	Place the lock washer on the end of the weight carrier shaft with the tang on the inner diameter of the washer in the notch in the end of the shaft.	
	j. Flatwasher (53) and screw (52)	1. Place the flat washer on the bearing retainer screw and thread the screw into the shaft.	
		2. Clamp the splined end of the weight carrier shaft in the soft jaws of a bench vise and tighten the bearing retainer bolt to 15-19 lb-ft (20.3-25.7 N.m) torque. Bend the tang on the lock washer against the head of the bolt.	
	k. Gasket (57) and plug (50)	1. Place gasket in the housing and against the bearing.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

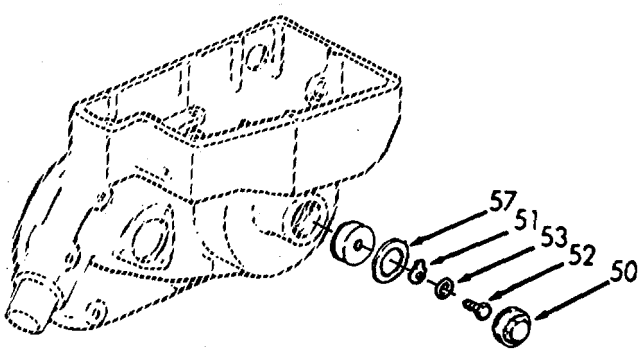
OVERHAUL-REASSEMBLY (Cont.)

2. Apply a loctite sealant grade HV or equivalent to the full 360° circumference of the plug and thread the plug into the tapped end of the governor weight housing.

3. Tighten the plug to 45 lb-ft (61.0 N.m) torque.

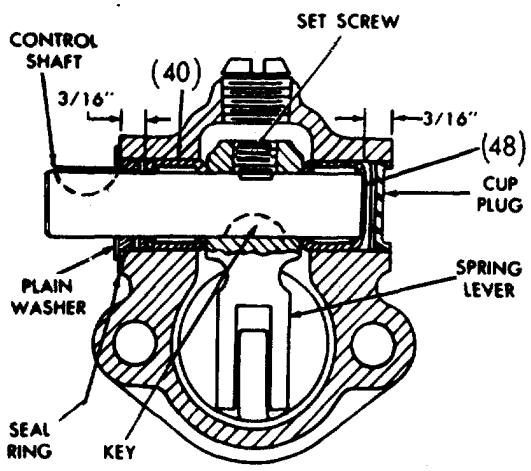
NOTE

Rotate the governor weight assembly. If a bind exists, remove the housing plug and check to see if the weight shaft bearing is fully seated in the governor housing.



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
10. Variable speed spring housing	a. Speed control lever shaft needle bearing (40 and 48)	1. Lubricate the needle bearings with Shell Alvania No. 2 grease, or equivalent.	
		2. Start one of the bearings, numbered end up, straight in the bearing bore in the right hand side of the spring housing as shown below.	



		3. Place the pilot rod end of the bearing installer assembly in the bearing.	Use tool J9196.
		4. Support the spring housing, bearing and installer on a short sleeve on the bed of an arbor press as shown below, then press the bearing in the housing until the shoulder on the installer contacts the housing.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

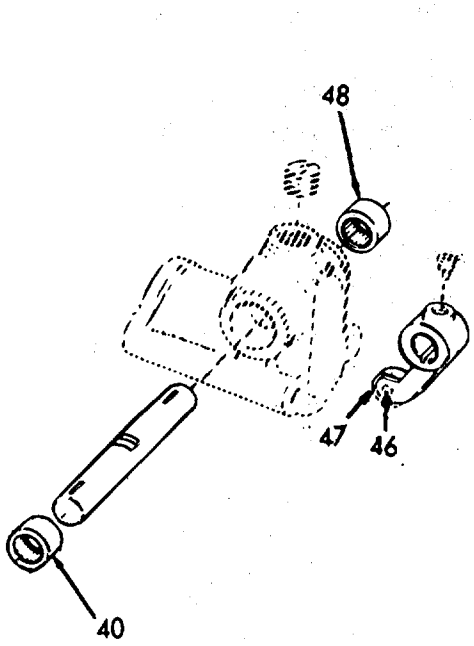
LOCATION	ITEM	ACTION	REMARKS

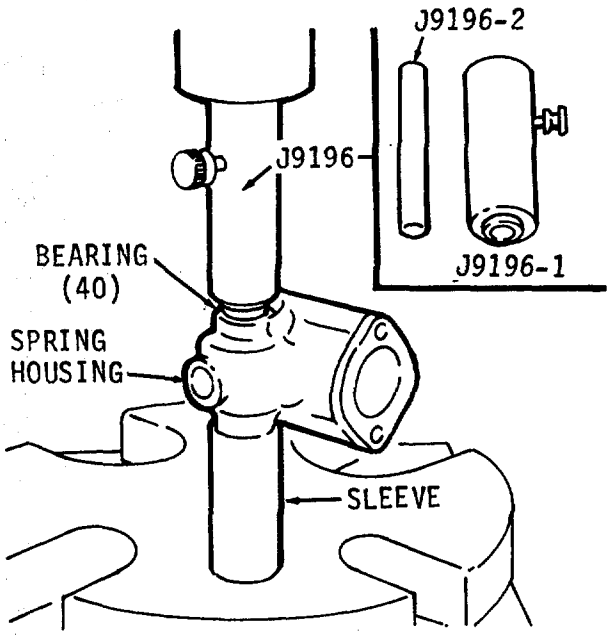
OVERHAUL-REASSEMBLY (Cont.)

NOTE

When the shoulder on the installer body contacts the housing, the bearings (40 and 48) will be properly positioned in the housing.

b.	Roller bearing (47) and pin (46)	1. Insert in spring lever. 2. Press the pin below the surface of the lever and stake at three places on both sides of the lever.	





5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

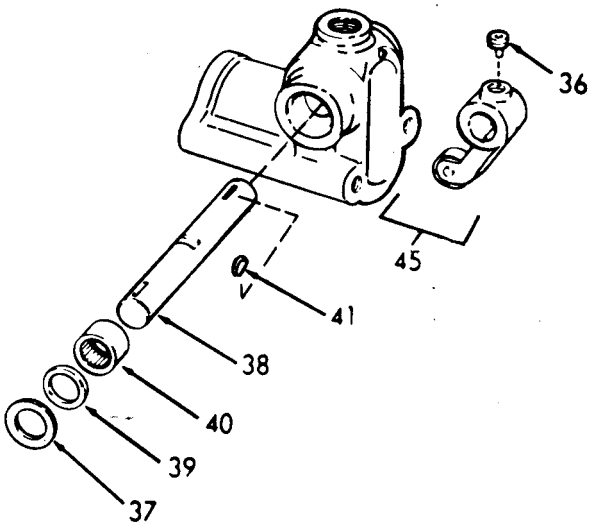
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	c. Key (41)	Install in center keyway of shaft (38).	
	d. Spring lever assembly (45)	1. Place the spring lever assembly between the bearing bores inside the spring housing with the arm (roller end) of the lever facing out. 2. Insert the correct end of the speed control lever shaft of the spring housing, opposite the bearing previously installed. 3. Align the key in the shaft with the keyway in the spring lever and push the shaft through the lever and in the bearing until the flat on the top of the shaft is centered under the set screw hole in the lever.	
	e. Set screw (36)	Thread the set screw into the spring lever, making sure the point of the screw is seated in the flat on the shaft.	
	f. Needle bearing (40)	1. Place the second speed control lever shaft needle bearing, numbered end up, over the protruding end of the shaft and start it straight in the bore of the housing.	

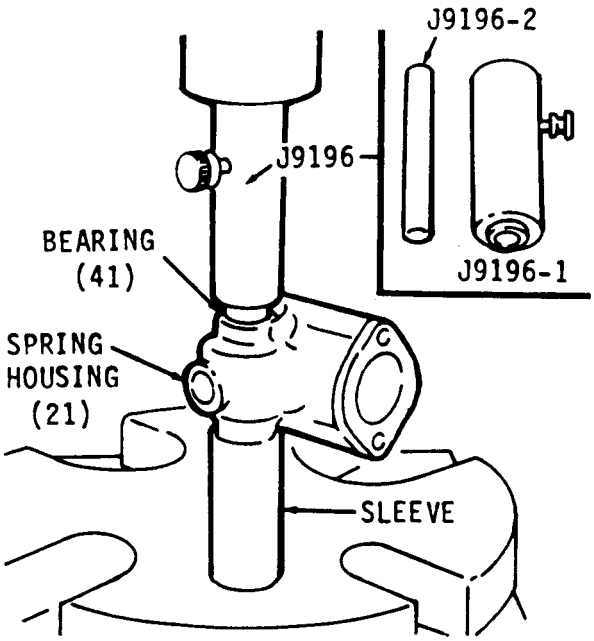
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont.)

		2. Remove the bearing pilot rod from the installer body and place the installer body over the end of the shaft and against the bearing.	
		3. Support the spring housing, bearings and installer on a short sleeve on the bed of an arbor press as shown, then press the bearing in the housing until the shoulder on the installer contacts the housing.	
	g. Seal (39)	Install	Use new seal.
	h. Cup plug (37)	1. Apply a thin coat of sealing compound to the outside diameter of the cup plug.	



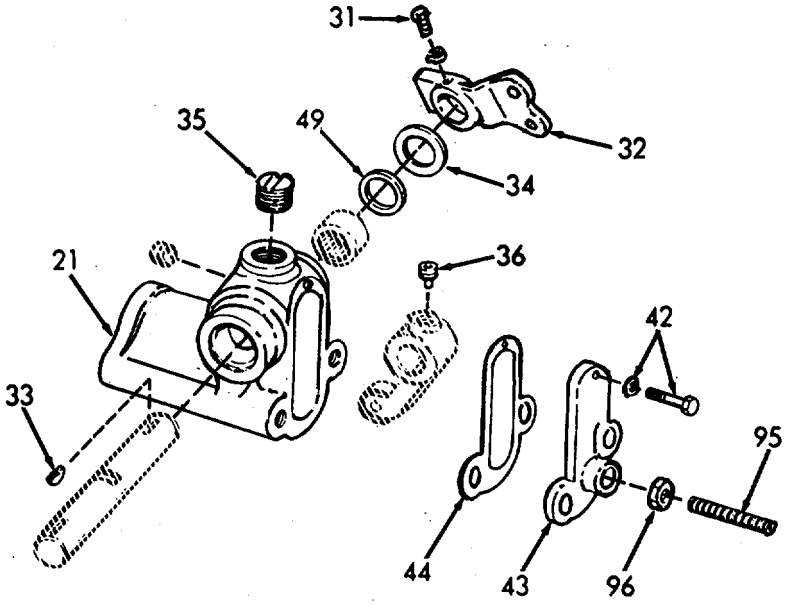


5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
		2. Start the cup plug straight in the bearing bore in the housing, then support the spring housing, bearings and shaft assembly on a sleeve on the bed of an arbor press and press the cup plug in flush with the outside face of the housing.	
	i. Spring housing (21)	Place in vice.	Use soft jaws.
	j. Set screw (36)	1. Tighten to 12-15 lb-ft (16.3-20.3 N.m) torque. 2. Stake the edge of the spring lever set screw hole with a small center punch and hammer to retain the set screw in the lever.	
	k. Plug (35)	Install.	
	l. Seal ring (49), and plain washer (34)	Install.	
	m. Key (33), speed control lever (32), and screw (31)	1. Install 2. Tighten screw.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	n. Cover (43), gasket (44), and screw assembly (42)	Install.	Use new gasket.
	o. Adjusting screw (95), and locknut (96)	Thread screw into housing approximately 1 inch (2.54 cm).	

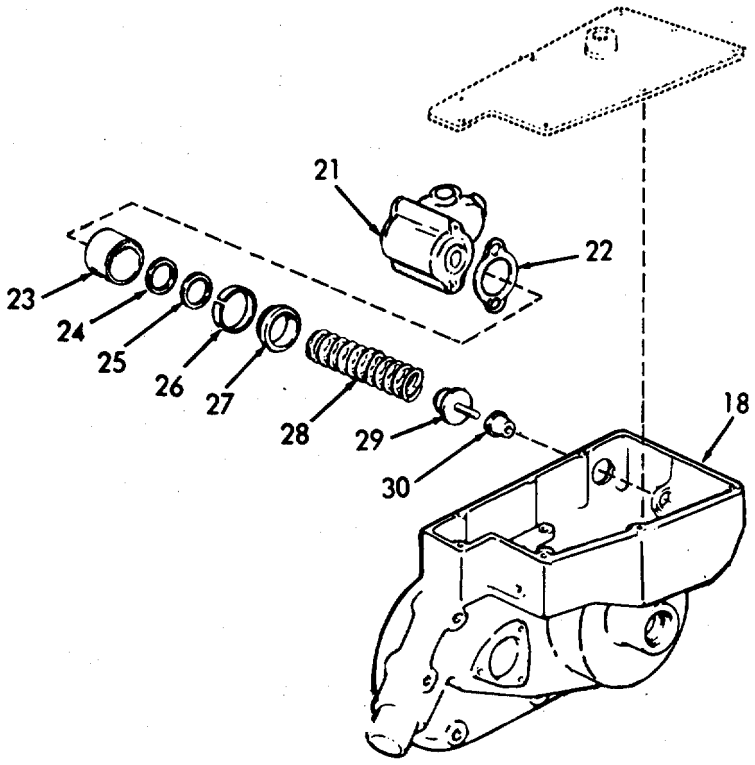


5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
11. Variable speed plunger	a. Governor housing (18)	Clamp in vise.	Use soft jaws.
	b. Plunger guide (30)	1. Start straight into boss inside housing.	
		2. Tap in place with a small brass rod and hammer.	
	c. Variable speed spring plunger (29)	1. Lubricate the small end of the variable speed spring plunger with engine oil .	
		2. Insert the plunger in the plunger guide inside the governor housing .	
	d. Spring retainer stop (27)	Install in counterbore of housing.	
	e. Spring retainer (23)	1. Lubricate outside diameter with engine oil.	
		2. Insert the spring retainer, solid end first, into the spring housing (21) and against the spring lever.	
	f. Shims (24 and 25)	Place the same amount of shims,that were removed, in the spring retainer (23). Use thin shims first.	

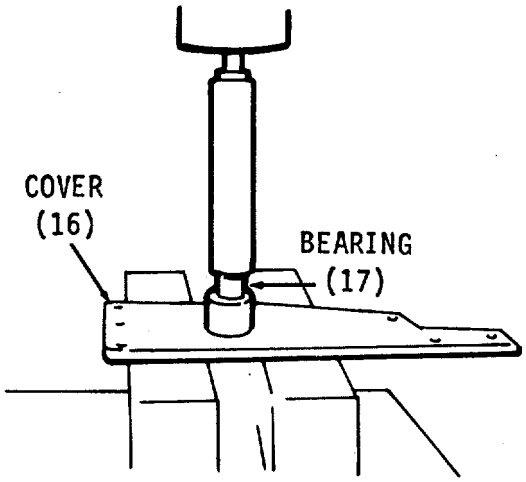
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	g. Spring retainer split stop (26)	Install in spring housing approximately 1/16 inch from the finished face of the housing.	
	h. Variable speed spring housing (21), gasket (22), and spring (28)	1. Affix gasket to housing. 2. Insert the variable speed spring into the spring housing and spring retainer with the tightly wound end of the spring against the shims in the retainer.	Use a new gasket.



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	i. Variable speed spring housing (21), screws (19), and lockwashers (20)	1. Install. 2. Make sure the end of the spring is over the end of the spring plunger (29). 3. Tighten screws to 13-17 lb-ft (17.6-23.0 N.m) torque.	
12. Governor cover	a. Cover and bearings (17)	1. Place the cover, inner face down, on two steel supports on the bed of an arbor press as shown below. - 2. Refer to "NOTE" under "Inspection"; then, lubricate the new needle bearing with engine oil and start the bearing, numbered end up, straight in the bearing bore in the cover boss.	



5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

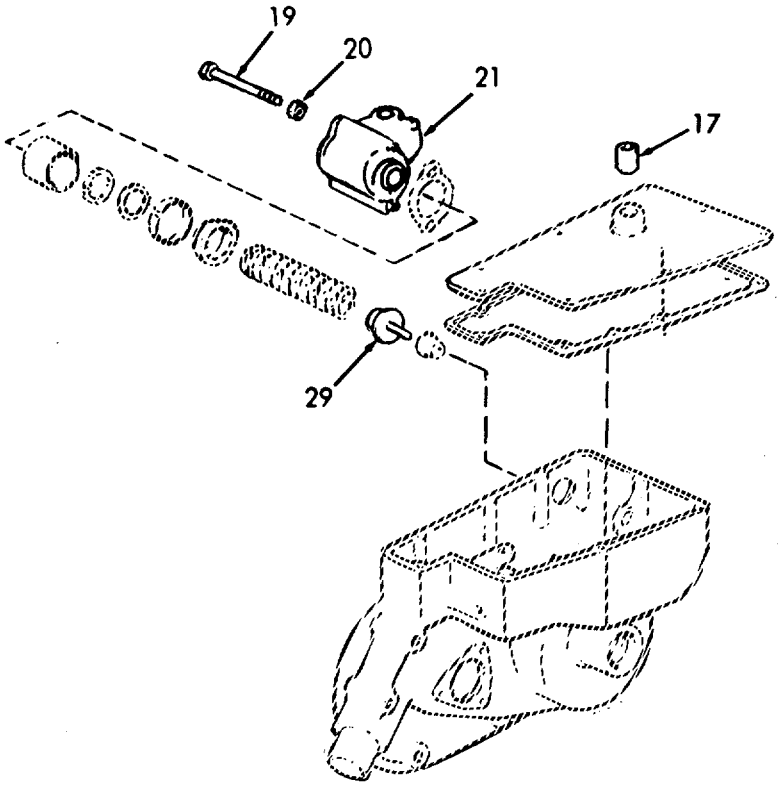
OVERHAUL-REASSEMBLY (Cont.)

3. Place the correct end of the installer in the bearing and under the ram of the press.

4. Press the bearing into the cover until the stop on the installer contacts the boss on the cover.

5. Reverse the cover, inner face up, on the bed of an arbor press.

6. Lubricate the second bearing with engine oil and start the bearing, numbered end up, straight in the bore until it is flush with the face of the boss.



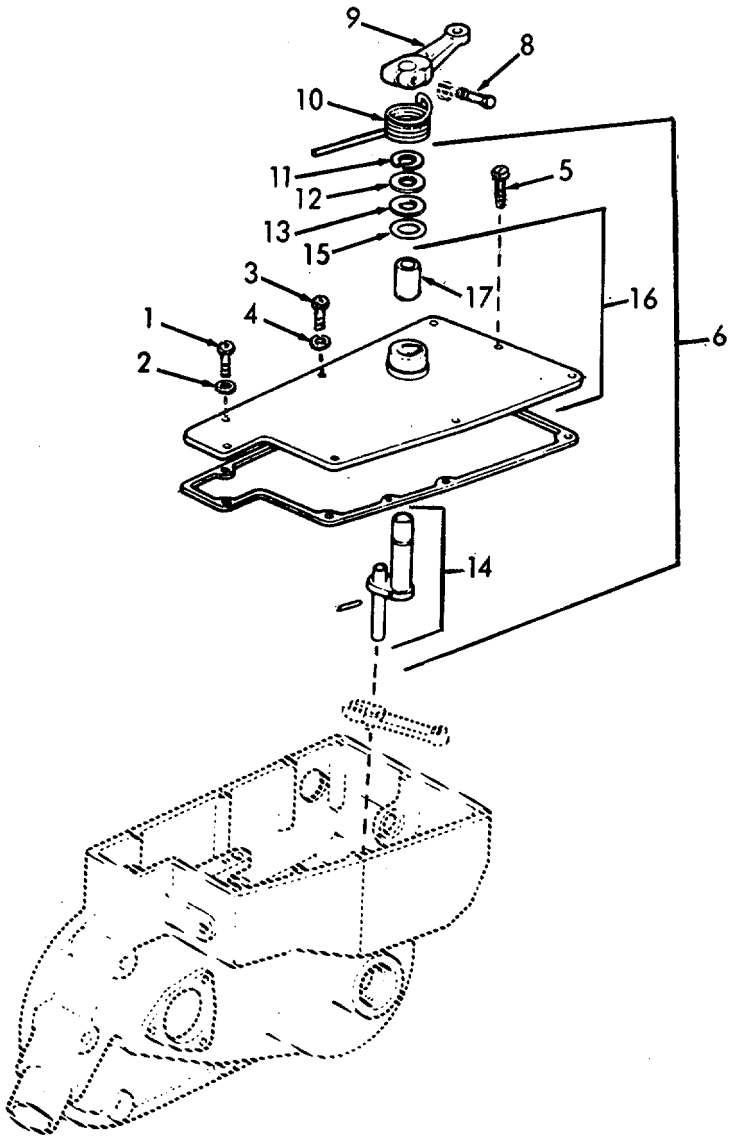
5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont.)			
	b. Stop level shaft (14), and needle bearings (17)	1. Lubricate bearings with Shell Alvania No. 2 grease or equivalent. 2. Insert shaft through bearings.	
	c. Seal ring (15)	Install into bearing bore and against bearing.	
	d. Seal ring retainer washers (13), retainer (12) and retaining ring (11)	Install.	
	e. Cover assembly (16), screws (1 and 3), lockwashers (2 and 4) and gasket (6)	Install.	Use new gasket.
	f. Screw (5), and return spring (10)	1. Place spring over shaft with hooked end of spring facing up. 2. Install.	
	g. Stop lever (9), and screw (8)	Install and tighten screw.	

5-7. VARIABLE SPEED MECHANICAL GOVERNOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont.)



5-8. BLOWER-MAINTENANCE INSTRUCTIONS.

This task covers:

a. Overhaul

INITIAL SETUP

Test Equipment
- Micrometer
- Feeler gage (1/2 inch wide)

Special Tools
- Clamp set blower alignment (J21834)
- Tool J6270 (set)
- Vice-soft jaws
- Arbor press

Material/Parts
- Blower kit P/N 5192796
- Teflon pipe tape

Personnel Required
1

References

Para 3-12	Blower Organizational Maintenance

Equipment Condition — Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

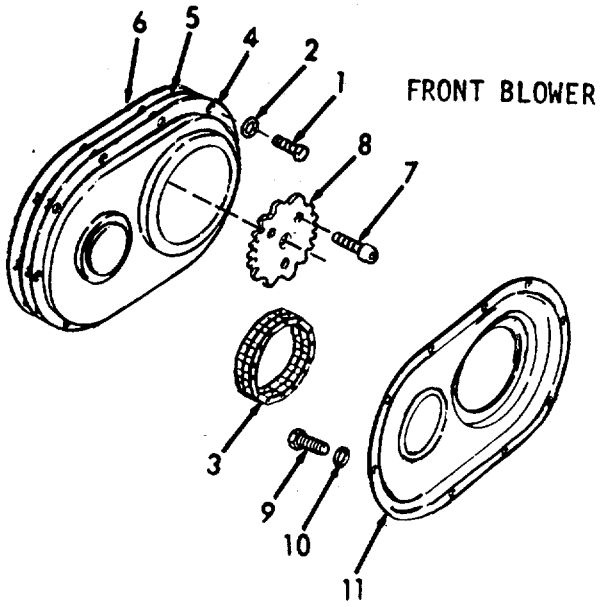
WARNING

Wear protective eye goggles when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY			
1. Blower coupling front blower	a. Screws (1) and washers (2)	Remove.	
	b. Chain (3)	Remove.	If attached.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	c. End plate cover (4), reinforcement plate (5) ,and gasket (6)	Remove.	
	d. Capscrews (7), and sprocket (8)	Remove.	
2. Blower coupling rear blower	a. Screws (9), and washers (10)	Remove.	
	b. Chain (3)	Remove.	If attached
	c. End plate cover (11), reinforcement plate (5), and gasket (6)	Remove.	

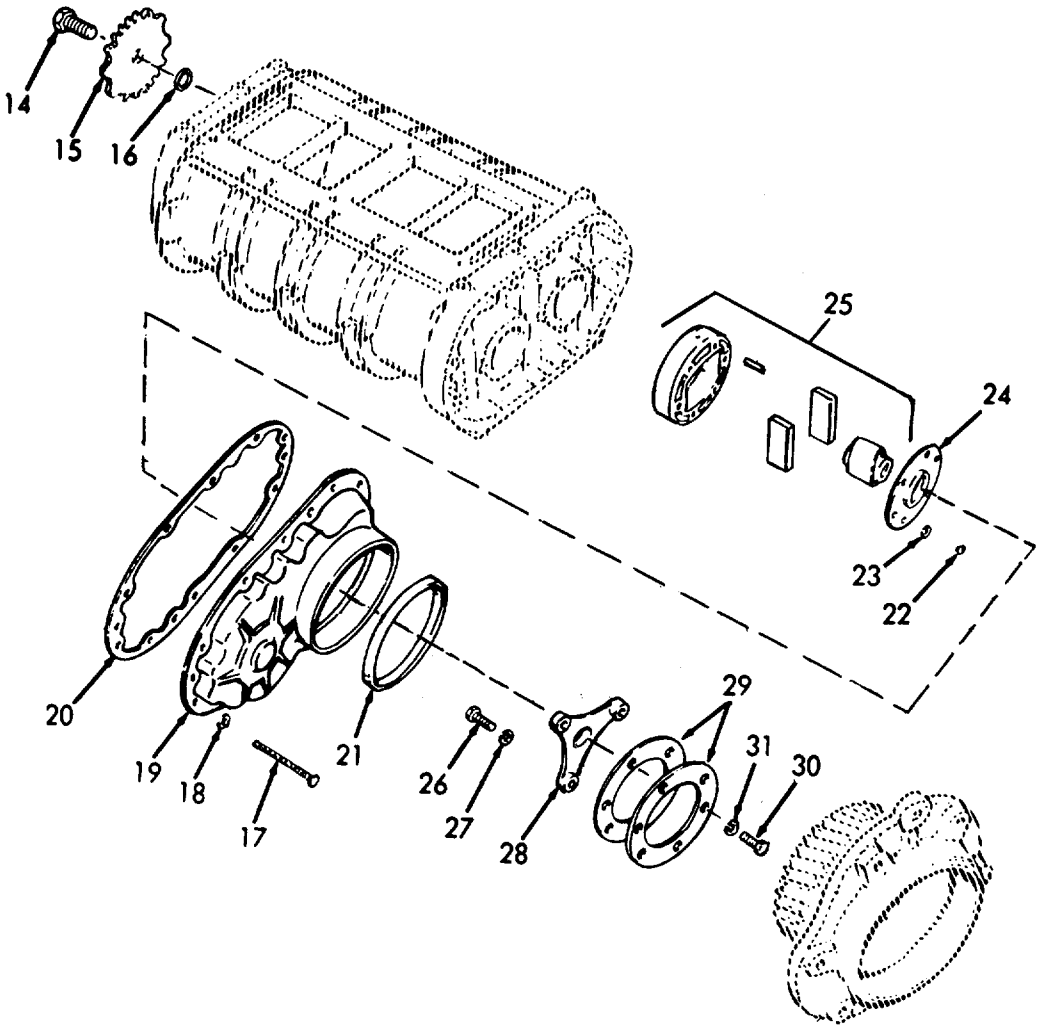


5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	d. Screw (14), sprocket (15), and spacer (16)	Remove.	
3. Rear blower cover and coupling	a. Machine bolts (17), and washers (18)	Remove.	
	b. End plate cover (19), and gasket (20)	Remove.	
	c. Blower drive cover seal (21)	Remove.	
	d. Drive coupling machine bolts (22), and lockwashers (23)	Remove.	
	e. Retainer (24) and rear blower coupling (25)	Remove from right hand blower rotor gear.	
4. Blower Drive	a. Screws (26) and lockwashers (27)	Remove.	
	b. Hub (28), and spring plates (29)	Remove.	

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	c. Screws (30), and lockwashers (31)	Remove.	



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	d. Hub nut (32), and lockwasher (33)	Remove.	
	e. Thrust washer (34), and thrust bearing (35)	Remove.	
	f. Gear (36)	Remove.	Gear is left hand helix.
	g. Bushing (37), and thrust bearing (38)	Remove.	
	h. Dowels (39), and spring pin (40)	Remove.	If necessary.
5. Rear blower coupling (25)	Coupling cam (41), coupling spring pack (42) ,spring seats (43), and coupling support (44)	Disassemble.	
6. Blower	a. Screws (45) and spacers (46)	1. Place a folded cloth between the rotors.	
		2. Remove.	
	b. Timing gears (47)	1. Remove both gears at the same time.	Use two pullersJ6270-1.

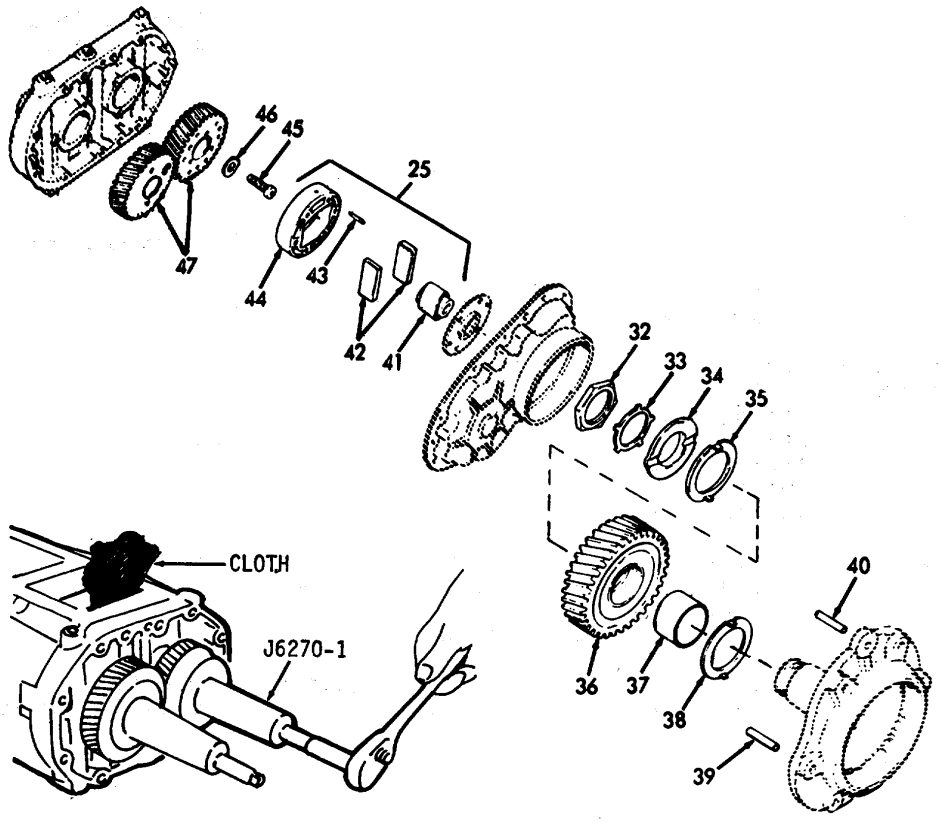
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

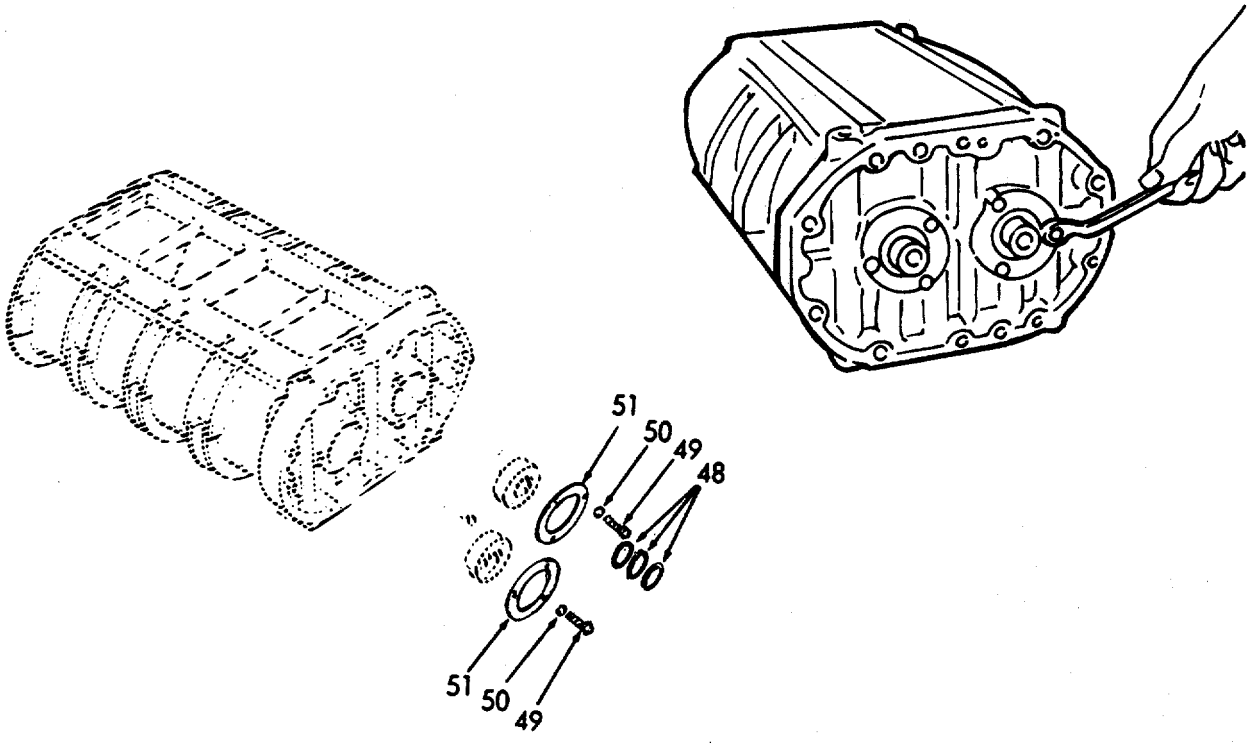
2. Back out the center screws of both pullers and place the flanges against the gear faces, aligning the flange holes with the tapped holes in the gears. Secure the pullers to the gears with 5/16"-24 X 1-1/2" bolts (two bolts on the L.H. helix gear and three bolts on the R.H. helix gear).

3. With a clean cloth placed between the rotors to prevent their turning, turn the two puller screws uniformly clockwise and withdraw the gears from the rotor shafts as shown below.



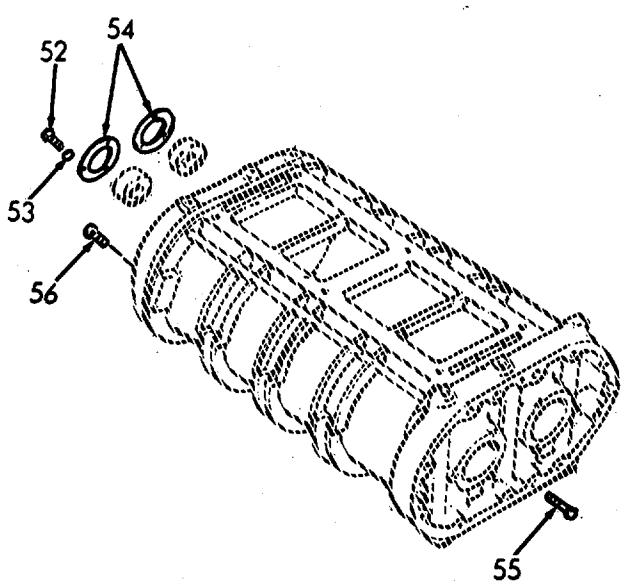
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	c. Shims (48)	1. Note the number and thickness of shims on each rotor shaft to ensure identical replacement when assembling blower.	
		2. Remove.	
	d. Screws (49), and lockwashers (50)	Remove six places.	
	e. Bearing retainers (51)	Remove two places.	



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	f. Screws (52), and lockwashers (53)	Remove six places.	
	g. Bearing retainer (54)	Remove two places.	
	h. Screws (55)	Remove.	
	i. Screws (56)	Loosen.	Approximately three turns.



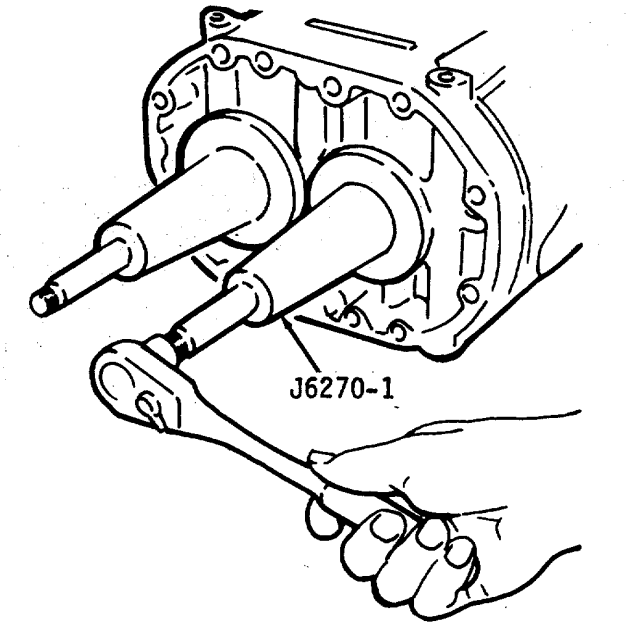
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	j. Rear end plate (57)	1. Back out the center screws of pullers far enough to permit the flange of each puller to lay flat on the face of the end plate.	Use two pullers J6270-1.
		2. Align the holes in each puller flange with the tapped holes in the end plate and secure the pullers to the end plate and secure the pullers to the end plate with six 1/4"-20 X 1-1/4" or longer screws.	

NOTE

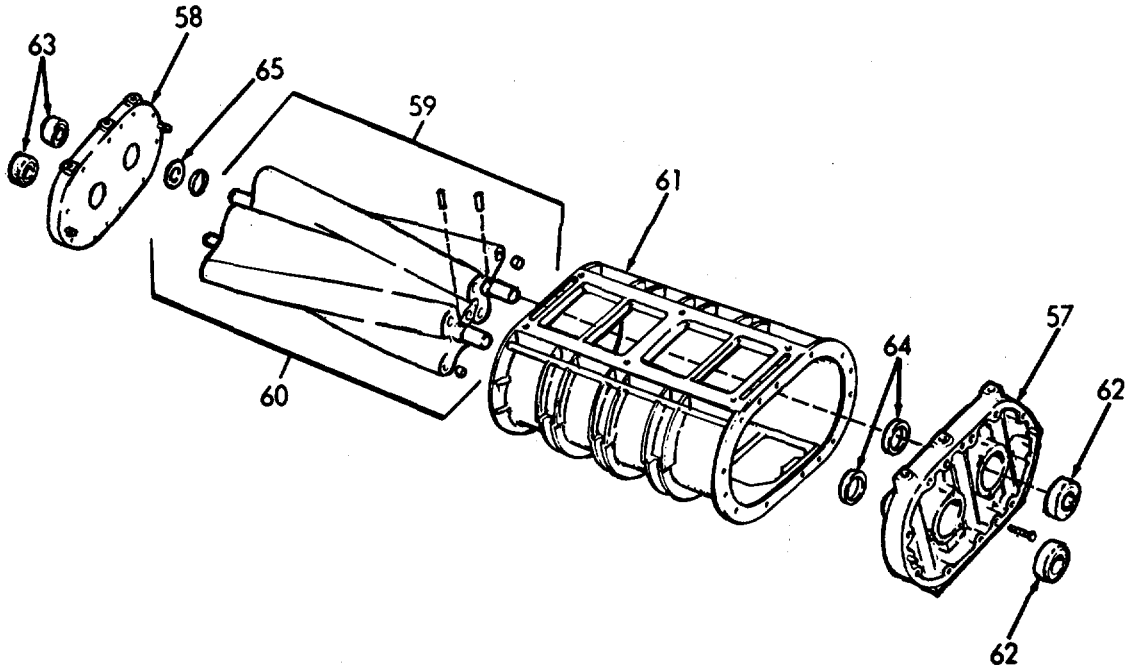
Be sure that the 1/4"-20 screws are threaded all the way into the tapped holes in the end plate to provide maximum anchorage for the pullers and to eliminate possible damage to the end plate.

3. Turn the two puller screws uniformly clockwise and withdraw the end plate and bearings from the blower housing and rotors as shown below.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	k. Front end plate (58)	Remove.	Refer to step j above.
	l. Rotors (59 and 60)	Remove from blower housing (61).	
	m. Bearings (62 and 63), and seals (64) and 65)	1. Inspect the oil seals. If the seals are scored, charred or hardened so that a tight seal around the shafts is impossible, new seals should be installed. If necessary, the seals may be removed from the end plates at the same time the individual bearings are removed.	



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

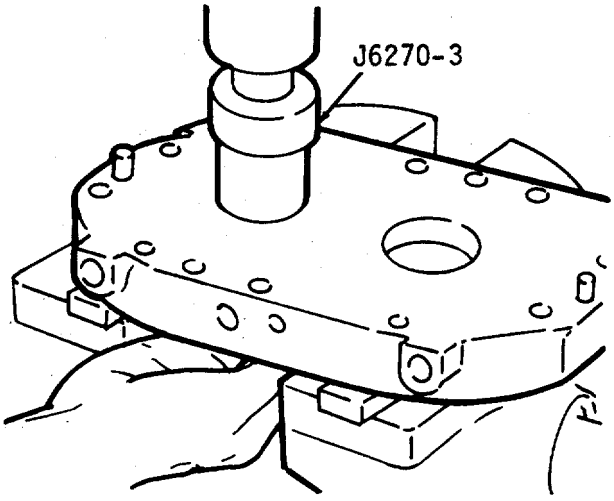
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

2. Support the outer face of the end plate on wood blocks on the bed of an arbor press.

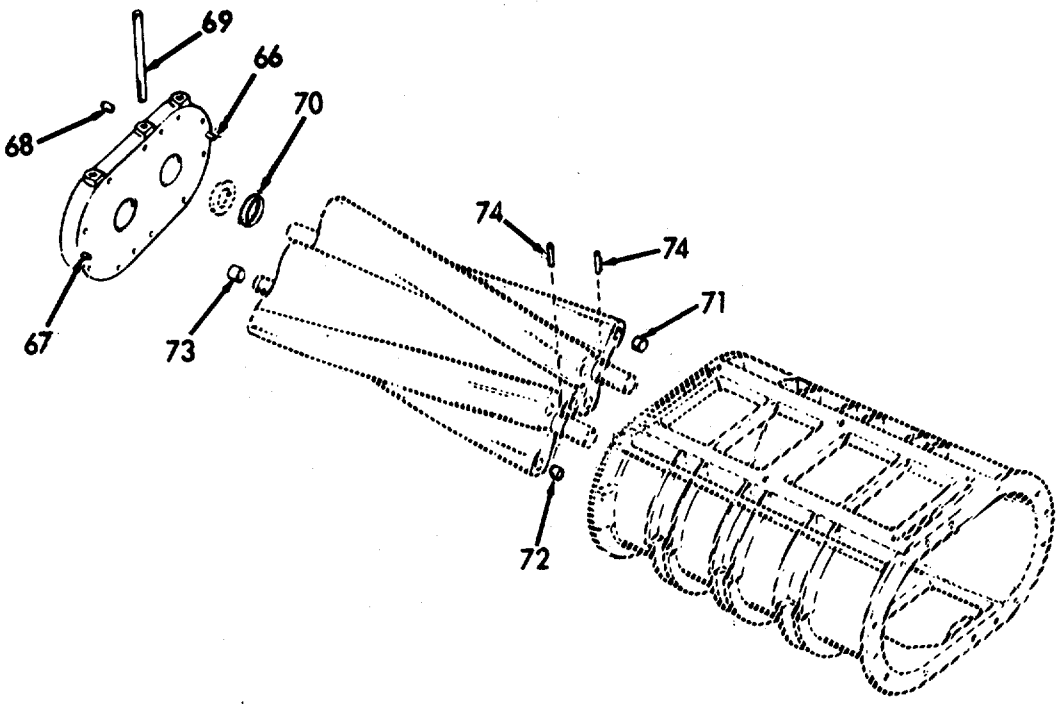
3. Place the long end of the oil seal remover and installer J6270-3 down through the oil seal and into the bearing, with the opposite end of the remover under the ram of the press. Then, press the bearing and oil seal out of the end plate.

Remove the remaining bearings and oil seal is from the end plates in the same manner.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
	n. Dowel pins (66 and 67)	Remove.	If necessary.
	o. Pipe plug (68), and sleeve (69)	Remove.	If necessary.
	p. Collars (70), plugs (71, 72 and 73), and pins (74)	Remove.	If necessary.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

7. Blower

WARNING

Wear protective eye goggles when using compressed air.

a. Wash all of the blower parts in clean fuel oil and dry them with compressed air.

b. Examine the bearings for any indications of corrosion or pitting. Lubricate each bearing with light engine oil; then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots.

c. The double-row ball bearings are pre-loaded and have no end play. A new double-row bearing will seem to have considerable resistance to motion when revolved by hand.

d. Check the oil seal rings, carriers and collars for wear and scoring. If worn excessively, they must be replaced. Inspection of the lip type oil seal is covered in step 6 m.

e. Inspect the blower rotor lobes, especially the sealing ribs, for burrs and scoring. Rotors must be smooth for efficient operation of the blower. If the rotors are lightly scored or burred, they may be cleaned up with emery cloth.

f. Examine the rotor shaft serrations for wear, burrs or peening. Also, inspect the bearing and oil seal contact surfaces of the shafts for wear and scoring.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

g. Inspect the inside surface of the blower housing for burrs and scoring. The inside surface must be smooth for efficient operation of the blower. If the inside surface of the housing is slightly scored or burred, it may be cleaned up with emery cloth.

h. Check the finished ends of the blower housing for flatness and burrs. The end plates must set flat against the blower housing.

i. The finished inside face of each end plate must be smooth and flat. If the finished face is slightly scored or burred, it may be cleaned up with emery cloth.

j. Examine the serrations in the blower timing gears for wear and peening; also check the teeth for wear, chipping or damage. If the gears are worn to the point where the backlash between the gear teeth exceeds .004", or damaged sufficiently to require replacement, both bearings must be replaced as a set.

k. Check the blower drive shaft serrations for wear or peening. Replace the shaft if it is bent.

l. Inspect the blower drive coupling springs (pack) and the cam for wear.

m. Replace all worn or excessively damaged blower parts.

n. Clean the oil strainer in the vertical oil passage at the bottom of each blower end plate and blow out all oil passages with compressed air.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

8. Blower

NOTE

Several precautions are given below to assure the proper assembly of the rotors and gears for correct blower timing.

1. The lobes on the driving blower rotor and the teeth on its gear form a right hand helix while the lobes and teeth of the driven rotor and gear form a left hand helix. Hence, a rotor with right-hand helix lobes must be used with a gear having right-hand helix teeth and vice versa.

2. One serration is omitted on the drive end of each blower rotor shaft and a corresponding serration is omitted in each gear. Assemble the gears on the rotor shafts with the serrations in alignment.

3. The rotors must be assembled in the blower housing with the omitted serrations in the rotor shafts aligned as shown in step f below.

a.	Blower end plates (57 and 58), and oil seals (64 and 65)	1. Support the blower end plate, finished surface facing up, on wood blocks on the bed of an arbor press.	Use new oil seals.

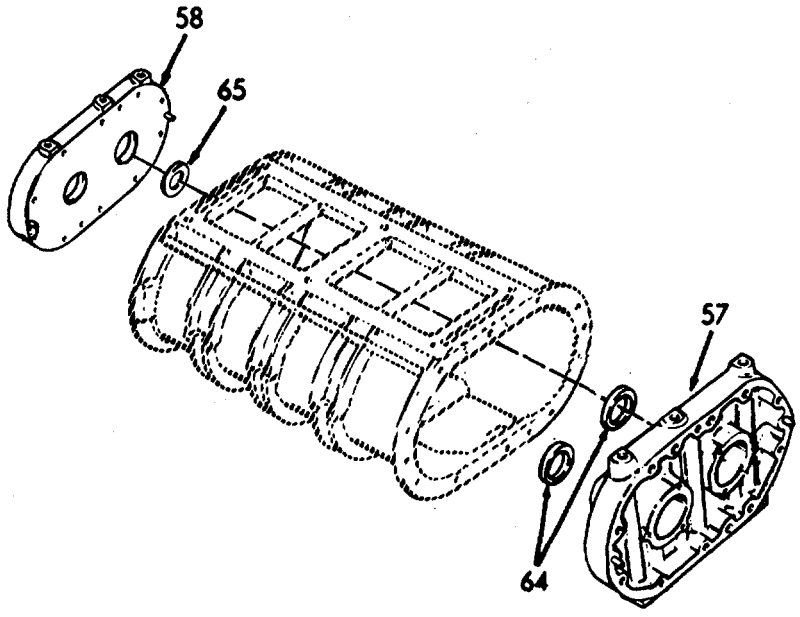
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

2. Start the oil seal straight into the bore in the end plate with the sealing edge facing down (toward the bearing bore) .

3. Place the short end of all oil seal remover and installer J6270-3 in the oil seal and under the ram of the press. Then, press the oil seal into the end plate until the shoulder on the installer contacts the end plate.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

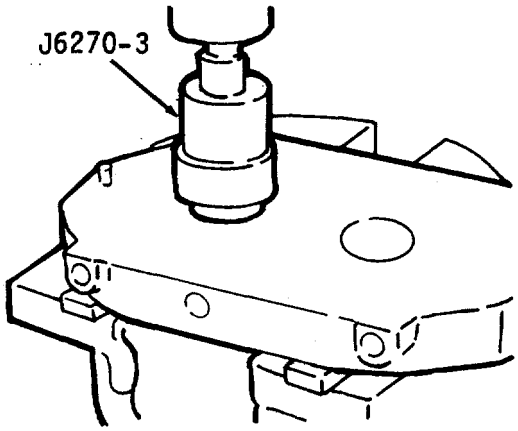
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

NOTE

A step under the shoulder of the installer will position the oil seal approximately .005" below the finished face of the end plate. This is within the .002" to .008" specified.

4. Install the remaining oil seals in the end plates in the same manner.



b. Blower front end plate (58)

1. The top of the end plate is readily identified by the three bolt holes and one oil hole, whereas the bottom side of the end plate has three bolt holes and three oil holes. Also, the dowel pins (66 and 67) extend on both sides of the front end plate.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

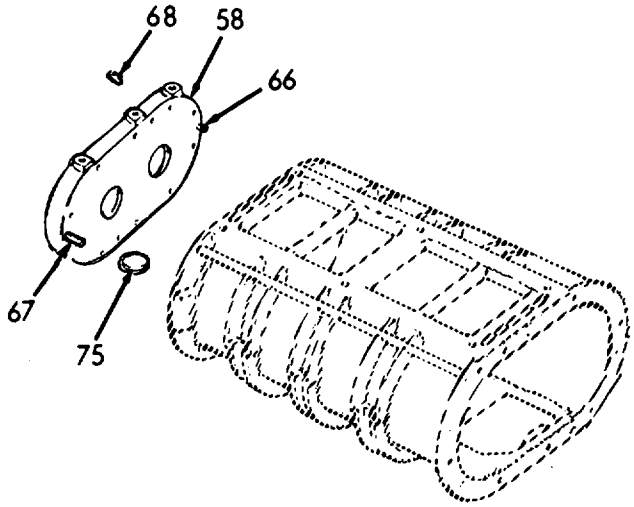
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont.)

CAUTION

The horizontal oil passage in the top front face of the front end plate that intersects the vertical oil passage is plugged. Do not install this end plate on the rear end of the blower housing.

		2. The front end plate should be attached to the front end of the blower housing first. The rear end plate is attached to the blower housing after the rotors are in place. Attach the front end plate to the blower housing as follows:	
c.	Pipe plug (68), and oil strainer (75)	1. If removed, press a new oil strainer into the vertical oil passage at the bottom side of the end plate from flush to .015" below bottom surface.	Use teflon tape on pipe plug threads on front blower only.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont.)			
		2. Install the pipe plug in the vertical oil passage at the top of the end plate.	
	d. Dowel pins (66 and 67)	Check the dowel pins. The dowel pins must project .380" from the flat inner face of the front end plate to assure proper alignment of the end plate with the housing.	
	e. Blower housing (61) and front end plate (58)	1. Place the blower housing on a bench with the top side of the housing up and the front end of the housing facing the outside of the bench.	
		2. Position the end plate (58) in front of the blower housing with the top side of the end plate facing up. Then, start the dowel pins straight into the dowel pin holes in the housing. Push or tap the end plate against the housing .	

NOTE

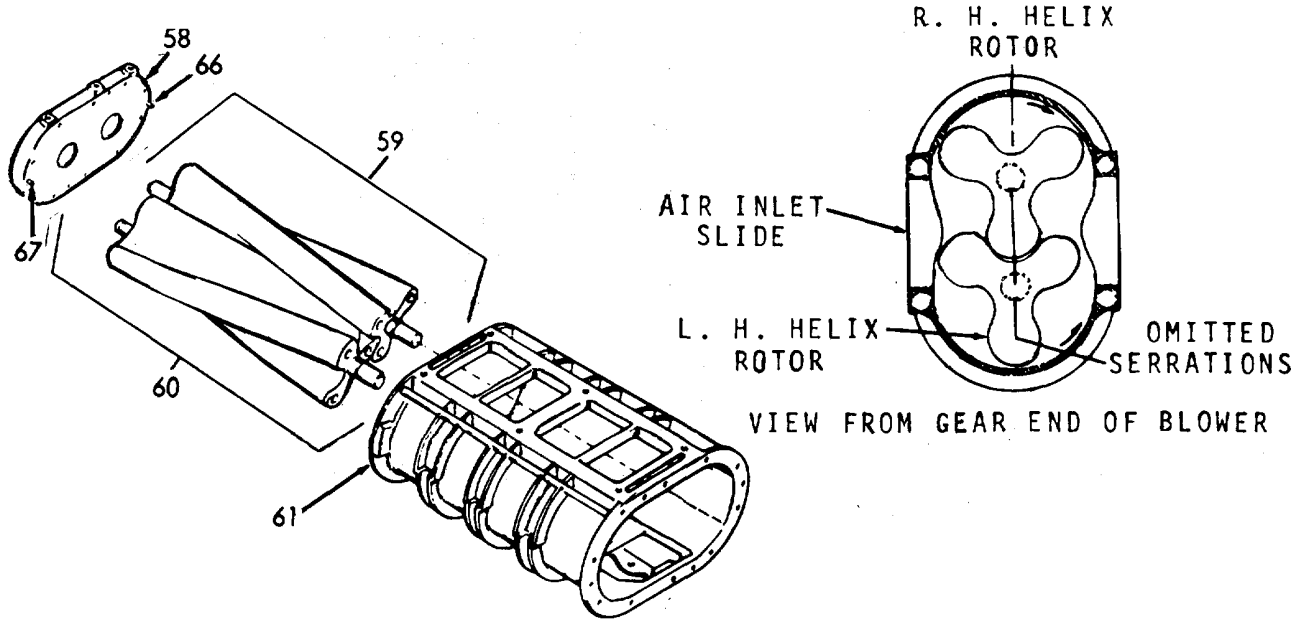
Gaskets are not used between the end plates and the housing; therefore, the mating surfaces must be perfectly flat and smooth.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
		3. Insert the two screws through the end plate and thread them into the housing. Tighten the screws securely. Do not use lock washers on these screws.	
	f. Blower housing (61) and rotors (59 and 60)	1. Reverse the blower housing on the bench (rear end of housing facing the outside of the bench).	
		2. Place the rotors in mesh with the omitted serrations in the rotor shafts in a horizontal position and facing to the left as viewed from the gear end.	

NOTE

The right-hand helix rotor is marked "GEAR END" on one end. The gear end of the left-hand rotor is that end which has the serrated shaft.

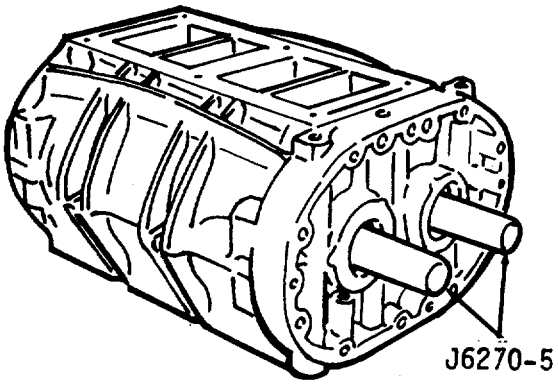


5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

3. Install an oil seal pilot J6270-5 over the opposite end of each rotor shaft.



4. Insert the rotors straight into the housing and through the front blower end plate.

5. Remove the oil seal pilots from the rotor shafts.

g. Blower rear end plate (57)

1. Install an oil seal pilot J6270-5 over the serrated end of each rotor shaft.

2. Check the dowel pins. The dowel pins must project .270" from the flat inner face of the rear end plate to assure proper alignment of end plate with the housing.

3. With the top of the end plate identified as in Step 8 a and its flat finished face towards the blower housing, slide the end plate straight over the oil seal pilots and start

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

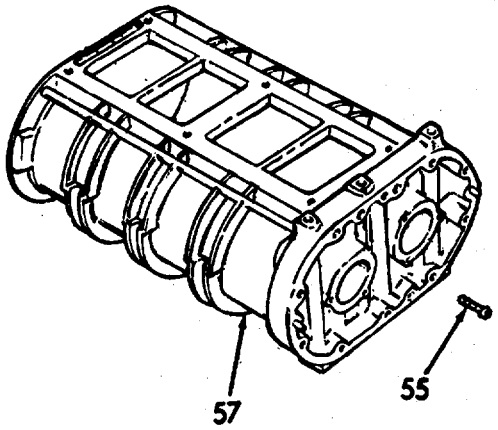
LOCATION	ITEM	ACTION	REMARKS

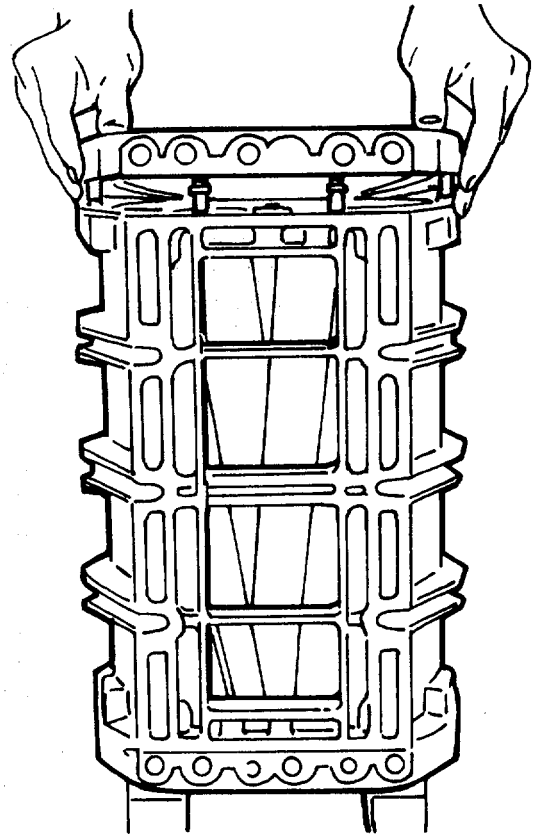
OVERHAUL - ASSEMBLY (Cont)

the dowel pins straight into the dowel pin holes in the housing. Then, push or tap the end plate against the housing .

4. Insert two screws (55) through the end plate and thread them into the housing. Tighten the screws securely. Do not use lockwashers on these screws.

5. Remove the oil seal pilots from the rotor shafts.





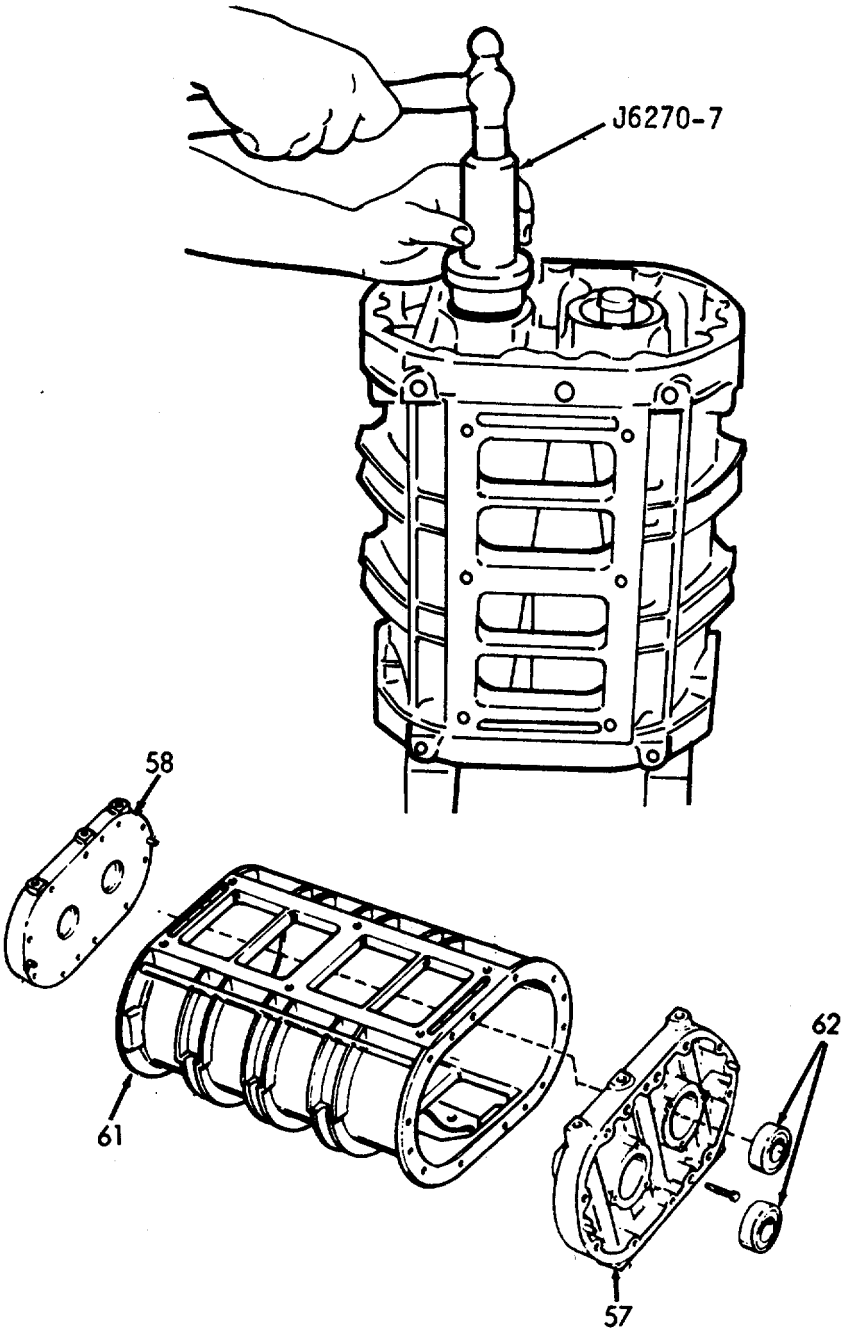
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	h. Blower housing (61) and end plates (57 and 58)	Check the relationship of the blower end plates to the housing at the cylinder block side of the blower assembly. The protrusion of the housing with respect to the end plates should not be more than .0015". Excessive protrusion could distort the housing when the end plate to cylinder block bolts are tightened and cause rotor to housing interference.	
	i. Bearings (62)	1. With the blower housing, rotors and end plates still supported in a vertical position on the two wood blocks, install the ball bearings on the rotor shafts and in the rear end plate as follows: 2. Lubricate one of the ball bearings with light engine oil. Start the bearing, numbered end up, straight on one of the rotor shafts. 3. Place installer J6270-7 on top of the bearing and tap the bearing straight on the shaft and into the rear end plate as shown. 4. Install the second ball bearing on the remaining rotor shaft in the same manner.	

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

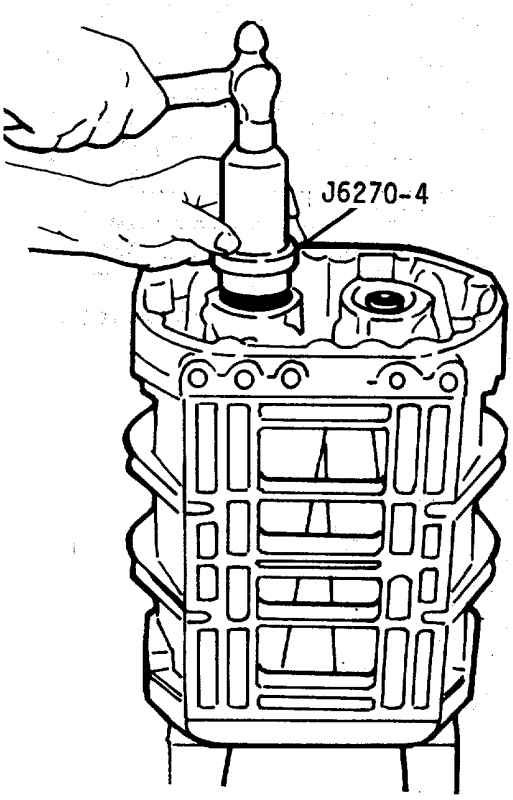
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)



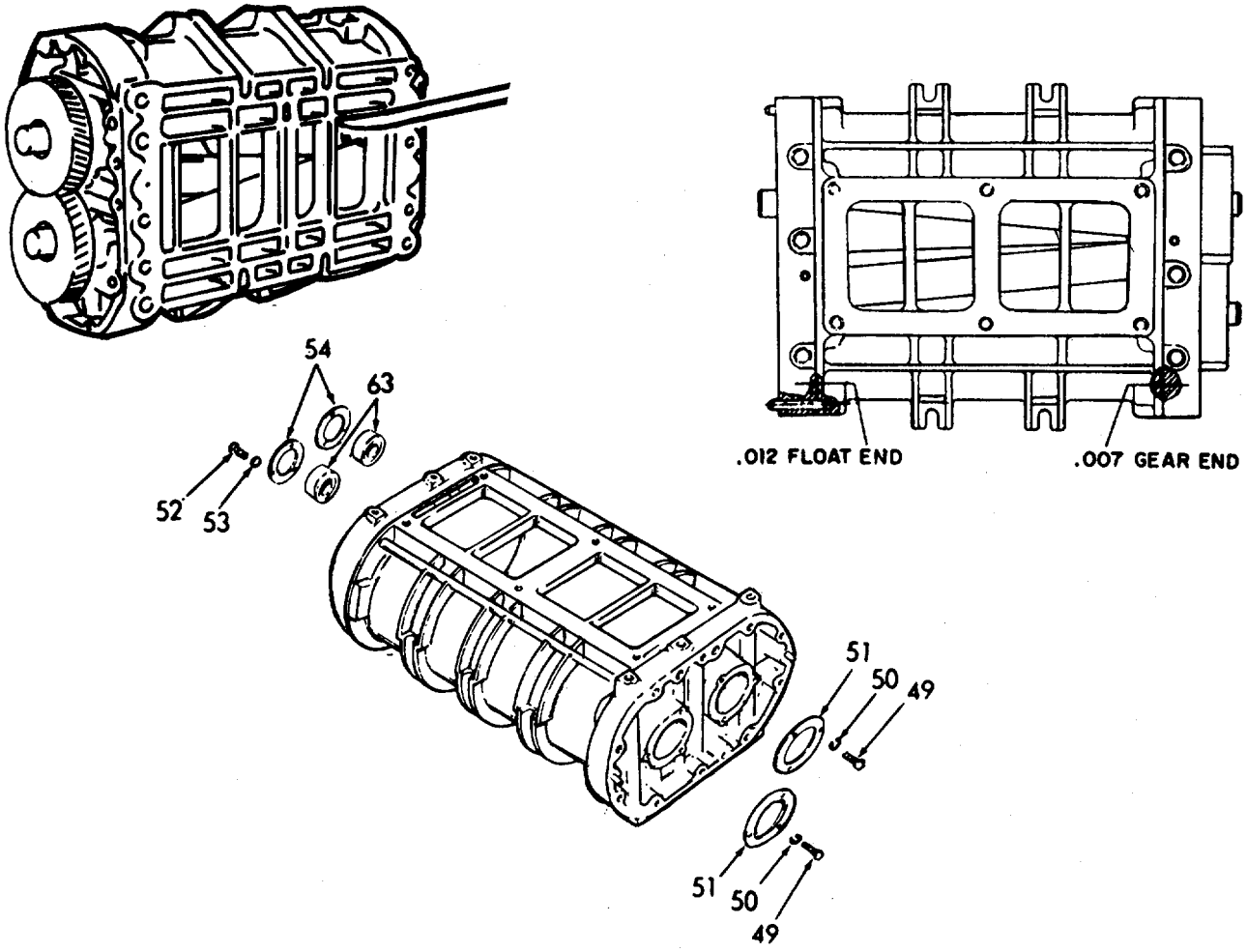
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	j. Bearing retainers (51), screws (49) and lock-washers (50)	1. Install. 2. Tighten screws to 7-9 lb-ft (9.5 - 12.2 Nm) torque.	
	k. Bearings (63)	1. Reverse the position of the blower housing on the two wood blocks. 2. Lubricate one of the roller bearings with light engine oil. Start the bearing, numbered end up, straight on one of the rotor shafts. 3. Place installer J6270-4 on top of the bearing and tap the bearing straight on the shaft and into the front end plate as shown. 4. Install the second roller bearing on the remaining rotor shaft in the same manner.	



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	l. Bearing retainers (54), screws (52) and lock-washers (53)	1. Install. 2. Tighten screws to 7-9 lb-ft (9.5 - 12.2 Nm) torque.	
	m. Blower housing assembled	Make a preliminary check of the rotor-to-end plate and rotor-to-housing clearances at this time with a feeler gage for minimum blower clearances.	



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	n. Shims (48)	Replace shims in their original positions.	Refer to Step 6 c.
	o. Blower housing assembly and gears (47)	1. Before installing the blower rotor timing gears on the rotor shafts, observe precautions in Step 8.a.2 and 3 relative to the rotor shaft and timing gear alignment. 2. The center punch mark in the end of each rotor shaft at the omitted serration will assist in aligning the gears on the shafts. 3. Place the blower assembly on the bench, with the top of the housing up and the rear end (serrated end of rotor shafts) on the blower facing the outside of the bench. 4. Rotate the rotors to bring the omitted serrations on the shafts in alignment and facing to the left. 5. Lubricate the serrations of the rotor shafts with light engine oil.	

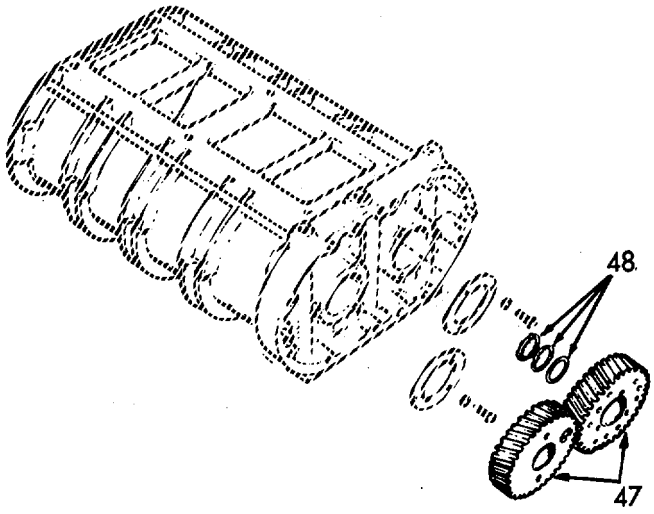
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

6. Place the teeth of the rotor gears in mesh so that the omitted serrations inside the gears are in alignment and facing the same direction' as the serrations on the shafts.

7. Start both rotor gears straight on the rotor shafts with the right hand helix gear on the right hand helix rotor and the left hand helix gear on the left hand helix rotor, with the omitted serrations in the gears in line with the omitted serrations on the rotor shafts.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
		8. Thread a 1/2"-20 X 1-1/4" bolt with a large plain washer into the end of each rotor shaft. Place a clean folded cloth between the lobes of the rotors to prevent the gears from turning. Draw the gears into position tight against the shims and the bearing inner races.	
		9. Remove the two bolts and washers that were used to draw the gears into position on the rotor shafts.	
	p. Screws (45) and spacers (46)	1. Lubricate the threads of screws with engine oil.	
		2. Place a spacer on each of the screws and thread them into the rotor shafts.	
		3. Tighten the bolts to 55-65 lb-ft (74.6 - 88.1 Nm) torque.	

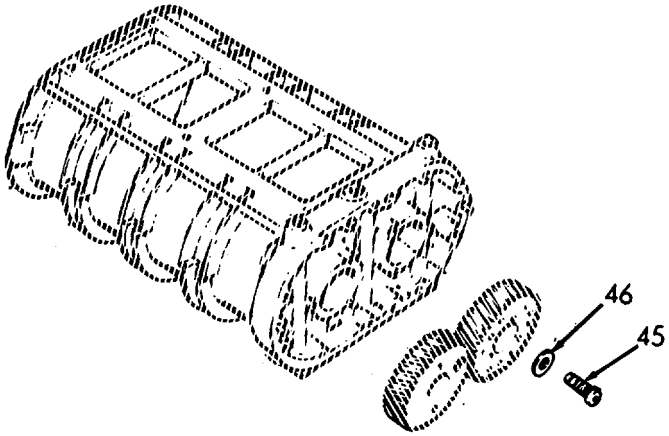
NOTE

The blower timing gear retaining screws incorporate a special nylon insert and must be lubricated before installing them in the rotor shafts.

5-7. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)



OVERHAUL - TIMING BLOWER ROTORS

9. Blower

a. After the blower rotors and timing gears are installed, the blower rotors must be timed.

NOTE

Before timing the blower, install four 5/16"-18 X 1-7/8" bolts with flat washers through four bolt holes in each end plate (top and bottom) and thread them into the blower housing. Tighten the bolts to 13-17 lb-ft (17.6 - 23.0 Nm) torque. This will hold the end plates against the blower housing so the proper clearance between the rotors and the end plate can be obtained.

b. The blower rotors, when properly positioned in the housing, run with a slight clearance between the lobes. This clearance may be varied by moving one of the helical gears in or out on the shaft relative to the other gear.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

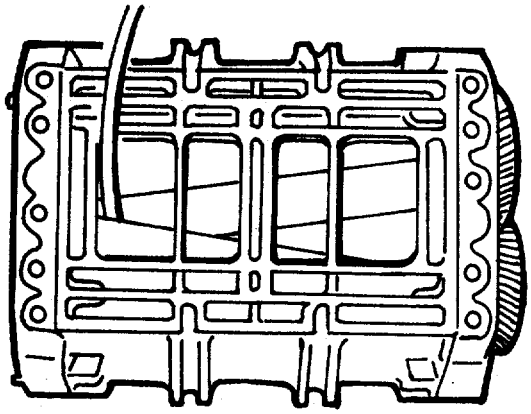
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS (Cont)

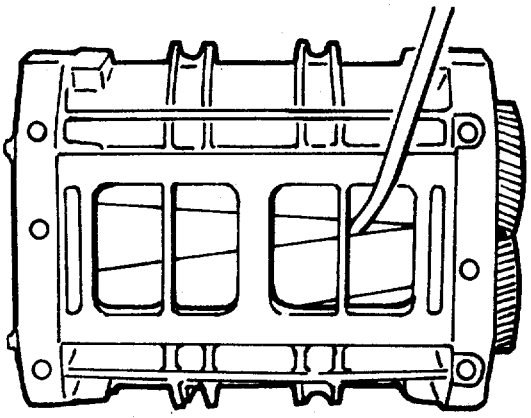
c. If the right hand helix gear is moved out, the right hand helix rotor will turn counterclockwise when viewed from the gear end. If the left hand helix gear is moved out, the left-hand helix rotor will turn clockwise when viewed from the gear end. This positioning of the gear, to obtain the proper clearance between the rotor lobes, is known as blower timing.

d. Moving the gears out or in on the rotor shafts is accomplished by adding or removing shims between the gears and the bearings.

e. The clearance between the rotor lobes may be checked with 1/2" wide feeler gages in the manner shown below. When measuring clearances of more than .005", laminated feeler gages that are made up of .002", .0035" or .005" feeler stock are more practical and suitable than a single feeler gage. Clearances should be measured from both the inlet and outlet sides of the blower.



AIR OUTLET SIDE SHOWN



AIR INLET SIDE SHOWN

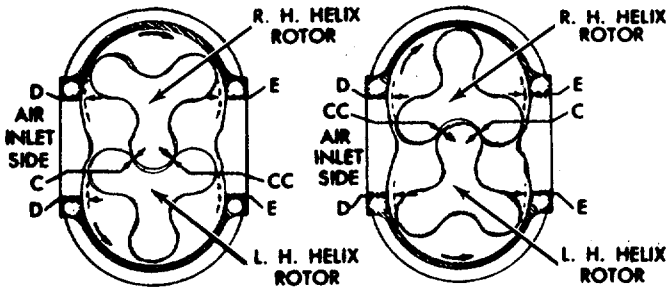
5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS (Cont)

f. Time the rotors as follows:

Time the rotors to have from .002" to .006" clearance between the trailing edge of the right hand 'helix rotor and the leading edge of the left hand helix rotor ("C" or "CC" clearance) measured from both the inlet and outlet sides as shown above and below. If possible, keep this clearance to the minimum (.002"). Then, check the clearance between the leading edge of the right hand helix rotor and the trailing edge of the left hand helix rotor ("C" clearance) for the minimum clearance of (.012"). Rotor-to-rotor measurements should be taken 1" from each end and at the center of the blower.



NOTE

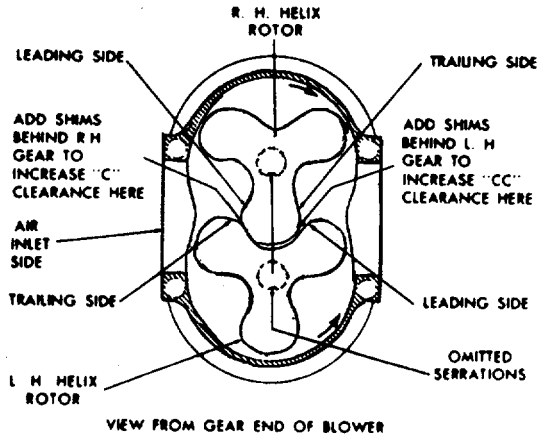
If the proper clearances cannot be obtained between the rotors, a mix of the former and current rotors, which have a different helix angle, may have occurred.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS (Cont)

g. After determining the amount one rotor must be revolved to obtain the proper clearance, add shims back of the proper gear as shown below to produce the desired result. When more or less shims are required, both gears must be removed from the rotors. Placing a .003" shim in back of a rotor gear will revolve the rotor .001".



VIEW FROM GEAR END OF BLOWER

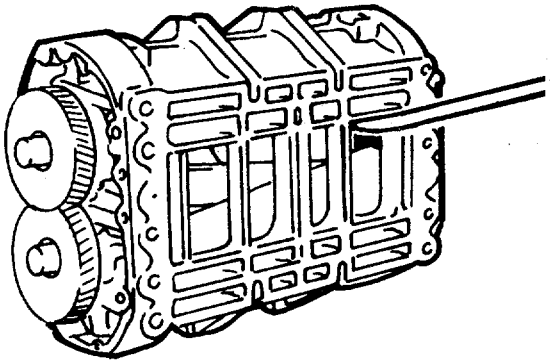
h. Install the required thickness of shims back of the proper gear and next to the bearing inner race and install both gears. Recheck the clearances between the rotor lobes.

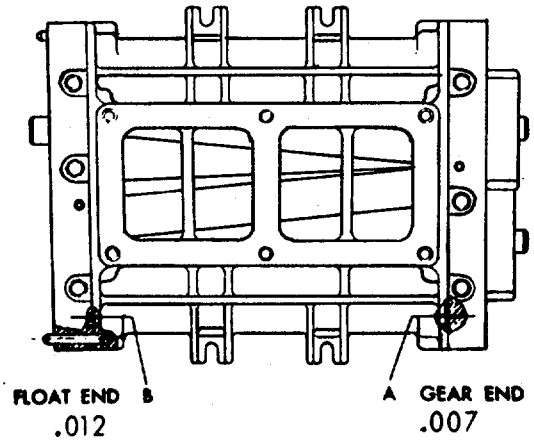
i. Determine the minimum clearances at points "A" and "B". Insert the feeler gages, between the end plates and the ends of the rotors. This operation must be. performed at the ends of each lobe, making 12 measurements in all. See below for the minimum clearances.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

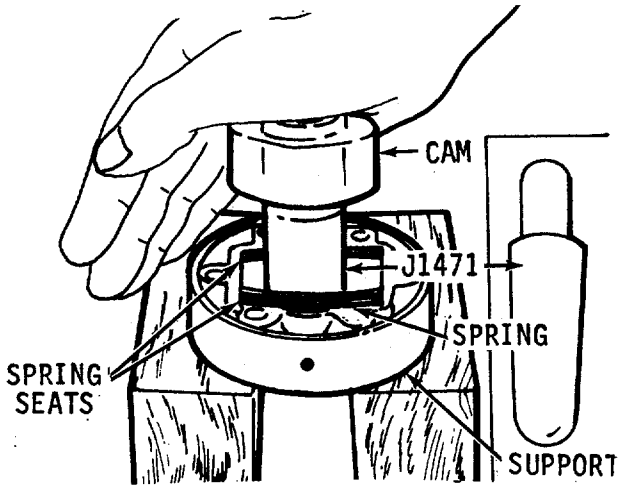
OVERHAUL - TIMING BLOWER ROTORS (Cont)





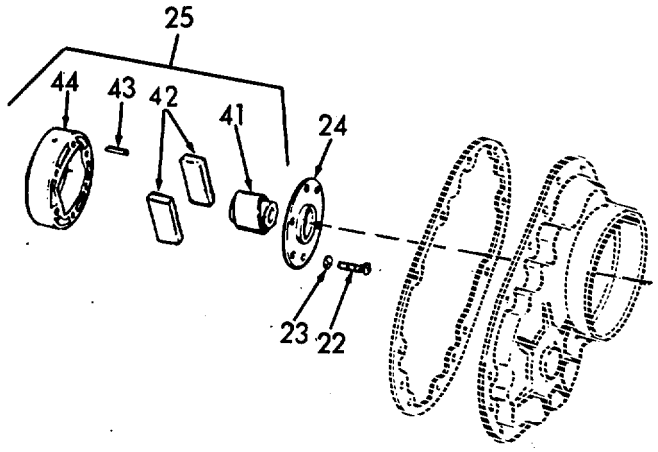
j. Check the clearance between each rotor lobe and the blower housing at both the inlet and outlet side - 12 measurements in all. See above for the minimum clearances.

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY			
10. Rear blower coupling	a. Support (44), spring seats (43), springs (42), and coupling cam (41)	1. Place on two wooden blocks. 2. Apply a light coat of grease to the back of the spring seats. Place the half round spring seats in the grooves inside the support at each end of the opening.  3. Lubricate the springs with light engine oil . Then, place the spring packs, consisting of 21 leaves per pack, into the support with the spring seats in position as shown. 4. Place the blower drive cam over the end of the installer J1471, with the large chamfered inside diameter end of the cam facing up.	

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
		Insert the tapered end of the installer between the spring packs until the drive cam is centered between the spring packs. Remove the installer from the drive cam.	
	b. Blower assembly	Place the blower assembly on end on two wood blocks with the rotor gears up.	
	c. Rear blower coupling (25), retainer (24), bolts (22), and lock-washers (23)	1. Place the blower coupling assembly and retainer on the right hand helix gear, align the bolt holes and start the six bolts and lock washers. 2. Tap the drive coupling cam with a plastic hammer to seat it on the rotor gear.	



5-257

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

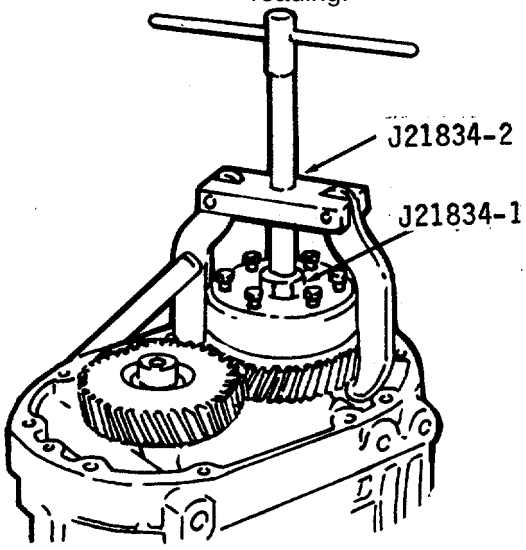
OVERHAUL - ASSEMBLY (Cont)

3. Place the alignment clamp adapter J21834-1, in the coupling cam. Then, install the alignment clamp J21834-2 and tighten it only enough to prevent any misalignment during the assembly of the coupling to the gear.

CAUTION

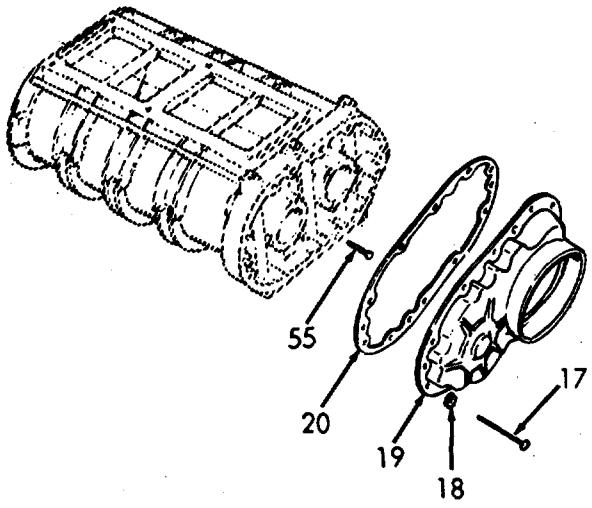
Insert a rag between the rotor gears to keep them from turning.

4. Tighten two bolts that are opposite to one another to 20-25 lb-ft (27.1 - 33.9 Nm) torque and then remove the alignment clamp and tighten the remaining bolts to the same torque. The cam spline runout should not exceed 020" total indicator reading.



5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	d. Screws (55)	Remove.	
	e. End plate cover (19), gasket (20), bolts (17), and washers (18)	1. Affix gasket to cover. 2. Place the cover over the gears and against end plate, with the opening in the cover over the blower drive coupling attached to the right hand helix gear. 3. Tighten bolts to 13-17 lb-ft (17.6 - 23.0 Nm) torque.	a. Use a new gasket. b. Bolts are 5/16-18 X 2-1/16 long.



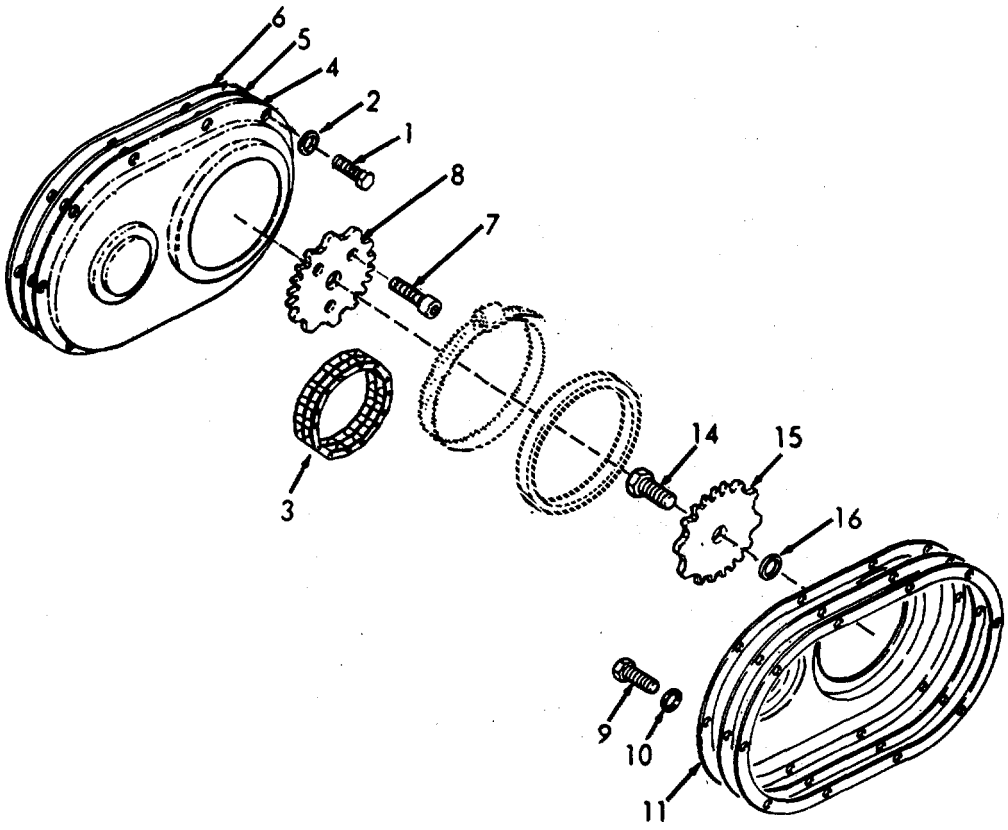
5-259

5-8. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
11. Blower coupling rear blower	a. Screw (14), sprocket (15) and spacer (16)	Install.	
	b. End plate cover (11), rein-forcement plate (5), and gasket (6)	Install.	Use new gasket.
	c. Chain (3)	Install.	
	d. Screws (9), and washers (10)	Install.	
12. Blower coupling front blower	a. Cap screws (7) and sprocket (8)	Install.	
	b. End plate cover (4), rein-forcement plate (5), and gasket (6)	Install.	

5-8. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	c. Chain (3)	Install.	
	d. Screws (1), and washers (2)	Install.	



5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS.

This task covers:
Overhaul

INITIAL SETUP:

Test Equipment

NONE

Special Tools
Injector body reamer J21089
Injector service set J23435
Lapping block J22090
Magnifying glass

Material/Parts

Service kit 522 8701
Parts kit 522 8769
Methyl ethyl ketone (MEK)

Personnel Required
1

References

Para 3-15. Fuel Injector - Organizational Maintenance.

Equipment Condition: NONE — Condition Description

Special Environmental Conditions

NONE

General Safety Instructions

WARNING

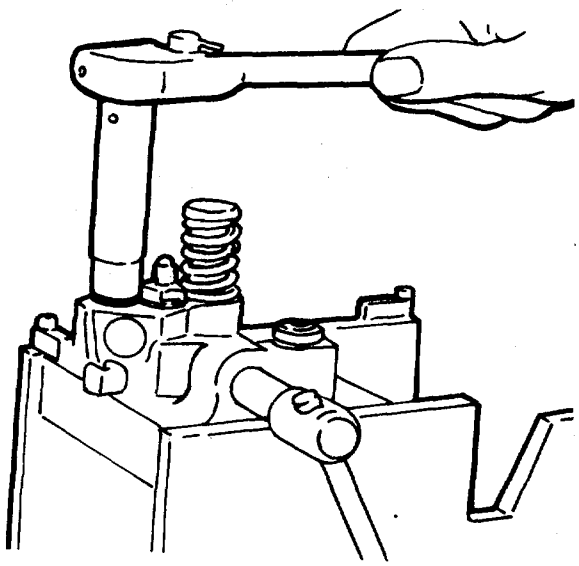
Wear protective eye goggles when using compressed air.

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY			
1. Injector	a. Filter cap (1), gasket (2), and filter element (3)	1. Place in holding fixture. 2. Remove two places.	Discard gasket and element.

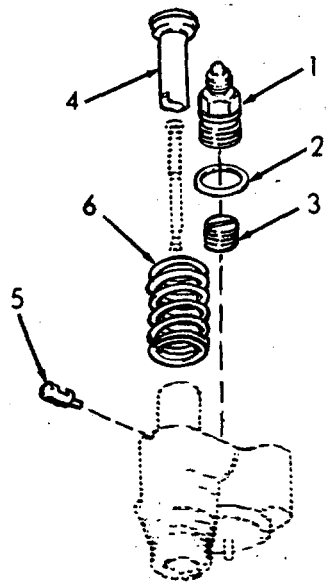
5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

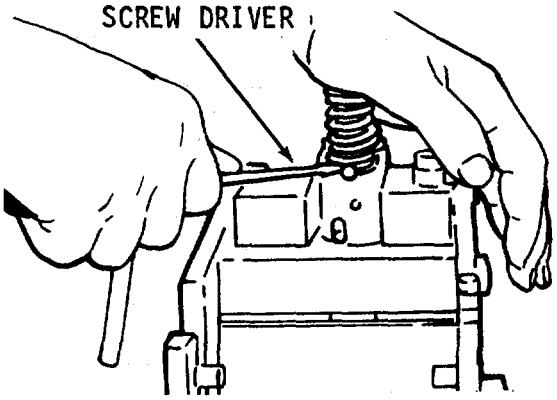
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont)



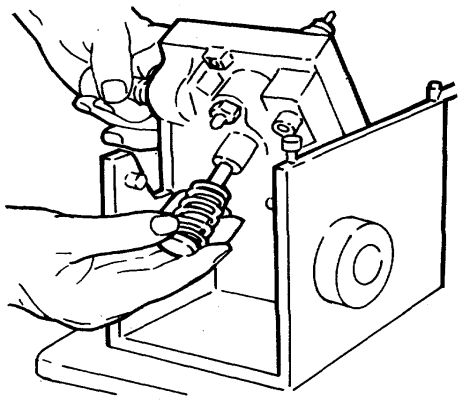
b.	Injector follower (4), stop pin (5)	1. Compress the follower spring (6). 2. Raise the spring above the stop pin (5) with a screw driver and withdraw the pin. Allow the spring to rise



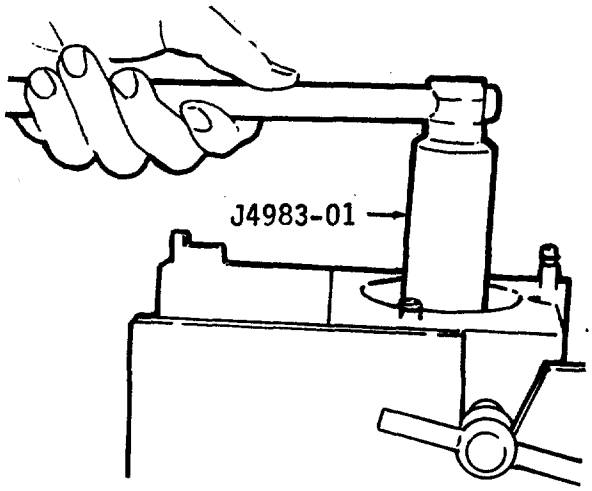


5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
c.	Injector Remove. follower (4), plunger (7) and spring (6)		



d.	Injector valve nut (8)	1. Loosen.	Use tool J4983-01.
		2. Lift the injector nut straight up, being careful not to dislodge the spray tip and valve parts.	



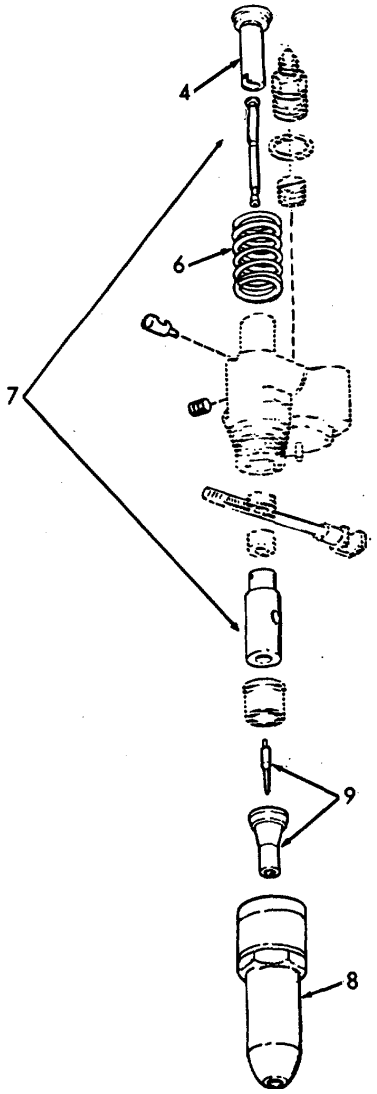
5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

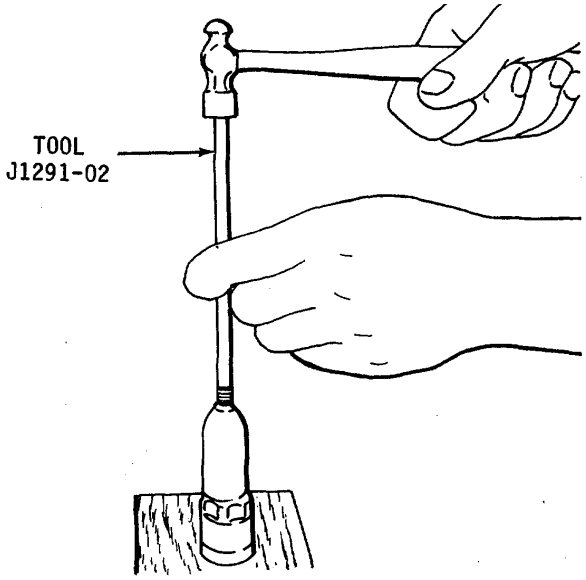
OVERHAUL - DISASSEMBLY (Cont)

e. Spray tip (9) and valve parts

1. Remove the spray tip and valve parts from the bushing and place them in a clean receptacle until ready for assembly.

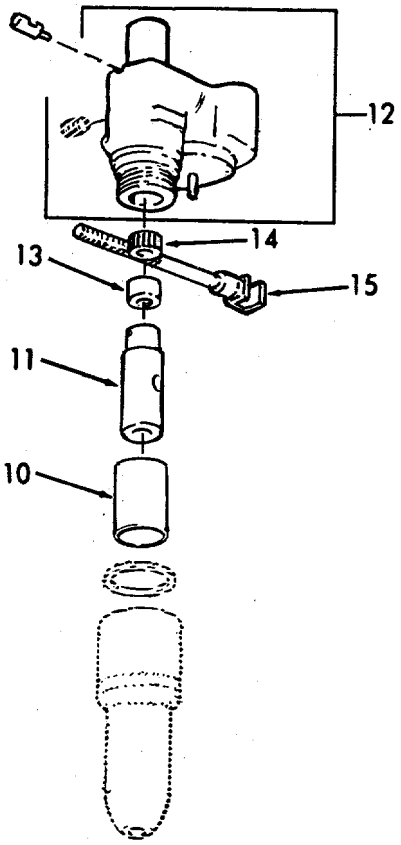


2. When an injector has been in use for some time, the spray tip, even though clean on the outside, may not be pushed readily from the nut with the fingers. In this event, support the nut on a wood block and drive the tip down through the nut, using tool J1291-02.



5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	f. Spill deflector (10), and bushing (11)	1. Remove spill detector. 2. Lift bushing straight out of injector body (12).	
	g. Injector body (12)	1. Remove from holding fixture. 2. Turn over and catch gear retainer (13) and gear (14) in your hand as they fall out of the body.	
	h. Injector control rack (15)	Remove from body.	



5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - CLEANING

2. Injector

a. Since most injector difficulties are the result of dirt particles, it is essential that a clean area be provided on which to place the injector parts after cleaning and inspection.

WARNING

Wear protective eye goggles when using compressed air.

b. Wash all of the parts. with clean fuel oil or a suitable cleaning solvent and dry them with clean, filtered compressed air. Do not use waste or rags for cleaning purposes. Clean out all of the passages, drilled holes and slots in all of the injector parts.

c. Carbon on the inside of the spray tip may be loosened for easy removal by soaking for approximately 15 minutes in a suitable solution prior to the external cleaning and buffing operation. Methyl Ethyl Ketone solution is recommended for this purpose.

CAUTION

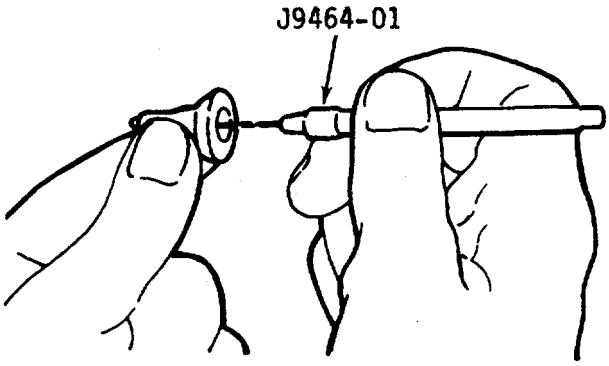
Care must be exercised when inserting the carbon remover J9464-01 in the spray tip to avoid contacting the needle valve seat in the tip.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - CLEANING (Cont)

d. Clean the spray tip with tool J9464-01.

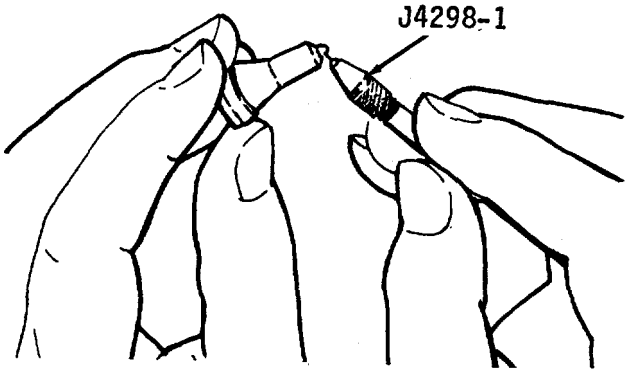


WARNING

Use eye protection when using compressed air.

e. Wash the tip in fuel oil and dry it with compressed air. Clean the spray tip orifices with pin vise J4298-1 and the proper size spray tip cleaning wire. Use wire J21460 to clean .0055" diameter holes and wire J21461 to clean .006" diameter holes.

f. Before using the wire, hone the end until it is smooth and free of burrs and taper the end a distance of 1/16" with stone J8170. Allow the wire to extend 1/8" from tool J4298-1.



5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - CLEANING (Cont)

CAUTION

Do not buff excessively. Do not use a steel wire buffing wheel or the spray tip holes may be distorted.

g. The exterior surface of an injector spray tip may be cleaned by using a brass wire buffing wheel. To obtain a good polishing effect and longer brush life, the buffing wheel should be installed on a motor that turns the wheel at approximately 3000 rpm. A convenient method of holding the spray tip while cleaning and polishing is to place the tip over the drill end of the spray tip cleaner tool J1243 and hold the body of the tip against the buffing wheel. In this way, the spray tip is rotated while being buffed.

h. When the body of the spray tip is clean, lightly buff the tip end in the same manner. This cleans the spray tip orifice area and will not plug the orifices.

WARNING

Use eye protection when using compressed air.

i. Wash the spray tip in clean fuel oil and dry it with compressed air.

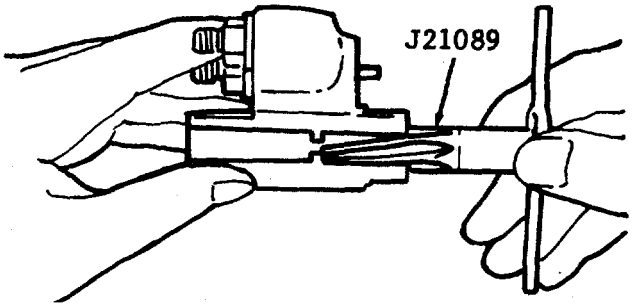
j. Clean and brush all of the passages in the injector body, using fuel hole cleaning brush J8152 and rack hole cleaning brush J8150. Blow out the passages and dry them with compressed air.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - CLEANING (Cont)

k. Carefully insert reamer J21089 in the injector body. Turn it in a clockwise direction a few turns, then remove the reamer and check the face of the ring for reamer contact over the entire face of the ring. If necessary, repeat the remaining procedure until the reamer does make contact with the entire face of the ring. Clean up the opposite side of the ring in the same manner.



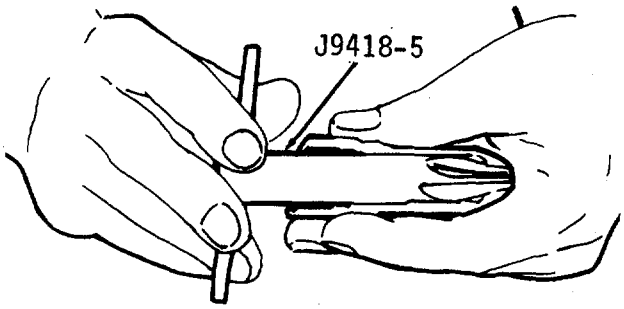
l. Carefully insert a .375" diameter straight fluted reamer inside the ring bore in the injector body. Turn the reamer in a clockwise direction and remove any burrs inside the ring bore. Then wash the injector body in clean fuel oil and dry it with compressed air.

m. Carefully insert carbon remover tool J9418-1 in the injector nut. Turn it in a clockwise direction to remove the carbon deposits on the flat spray tip seat as shown below. Remove the carbon deposits from the lower end of the injector nut with carbon remover J9418-5, in the same manner. Use care to prevent removing any metal or setting up burrs on the spray tip seat.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-CLEANING (Cont)



n. Wash the injector nut in clean fuel oil and dry it with compressed air. Carbon deposits on the spray tip seating surfaces of the injector nut will result in poor sealing and consequent fuel leakage around the spray tip.

o. When handling the injector plunger, do not touch the finished plunger surfaces with your fingers. Wash the plunger and bushing with clean fuel oil and dry them with compressed air. Be sure the high pressure bleed hole is not plugged. If this hole is plugged, fuel leakage will occur at the upper end of the bushing where it will drain out of the injector body vent and rack holes, during engine operation, causing a serious oil dilution problem. Keep the plunger and bushing together as they are mated parts.

p. After washing, submerge the parts in a clean receptacle containing clean fuel oil. Keep the parts of each injector assembly together.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - INSPECTION			
3.	Injector	a. Inspect the teeth on the control rack gear for excessive wear or damage. Also check for excessive wear in the bore of the gear and inspect the gear retainer. Replace damaged or worn parts.	
		b. Inspect the injector follower and pin for wear.	
		c. Inspect both ends of the spill deflector for sharp edges or burrs which could create burrs on the injector body or injector nut and cause particles of metal to be introduced into the spray tip and valve parts. Remove burrs with a 500 grit stone.	
		d. Inspect the follower spring for visual defects. Then check the spring with spring tester and an accurate torque wrench.	
		e. The injector follower spring (.142" diameter wire) has a free length of approximately 1.504" and should be replaced when a load of less than 70 lbs. will compress it to 1.028".	
		f. It is recommended that at the time of overhaul, all injectors in an engine be converted to spring (.142" diameter wire) which will provide improved cam roller to shaft follow. However, in the event that one or two injectors are changed, the remaining injectors need not be reworked-to incorporate the current spring.	

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - INSPECTION (Cont)

g. Check the seal ring area on the injector body for burrs or scratches. Also check the surface which contacts the injector bushing for scratches, scuff marks or 'other damage. If necessary, lap this surface. A faulty sealing surface at this point will result in high fuel consumption and contamination of the lubricating oil. Replace any loose injector body plugs or a loose dowel pin. Install the proper number tag on a service replacement injector body.

h. Inspect the injector plunger and bushing for scoring, erosion, chipping or wear. Check for sharp edges on that portion of the plunger which rides in the gear. Remove any sharp edges with a 500 grit stone. Wash the plunger after stoning it. Injector Bushing Inspectalite can be used to check the port holes in the inner diameter of the bushing for cracks or chipping. Slip the plunger into the bushing and check for free movement. Replace the plunger and bushing as an assembly if any of the above damage is noted, since they are mated parts. Use new mated factory parts to assure the best performance from the injector.

i. Injector plungers cannot be reworked to change the output. Grinding will destroy the hardened case at the helix and result in chipping and seizure or scoring of the plunger.

j. Examine the spray tip seating surface of the injector nut and spray tip for nicks, burrs, erosion or brinelling. Reseat the surface

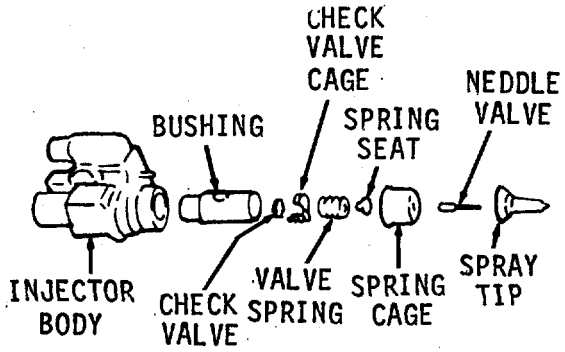
5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

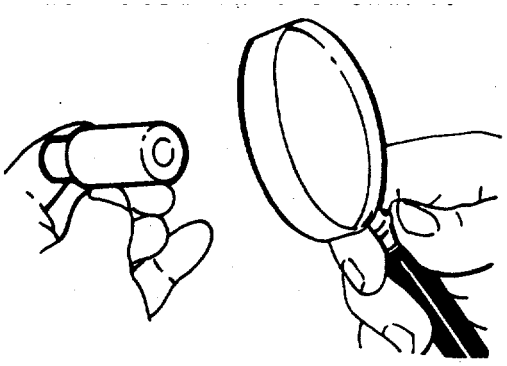
OVERHAUL -I NSPECTION (Cont)

k. The injector valve spring plays an important part in establishing the valve opening pressure of the injector assembly. Replace the worn or broken spring.

Inspect the sealing surfaces of the injector parts indicated by arrows below.



l. Examine the sealing surfaces with a magnifying glass as shown below for even the slightest imperfections will prevent the injector from operating properly. Check for burrs, nicks, erosion, cracks, chipping and excessive wear. Also check for enlarged orifices in the spray tip. Replace damaged or excessively worn parts. Check the minimum thickness of the lapped parts as noted in the chart.



5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-INSPECTION (Cont)

m. Examine the seating area of the needle valve for wear or damage. Also examine the needle quill and its contact point with the valve spring seat. Replace damaged or excessively worn parts.

n. Examine the needle valve seat area in the spray tip for foreign material. The smallest particle of such material can prevent the needle valve from seating properly-. Polish the seat area with polishing stick. Coat only the tapered end of the stick with polishing compound and insert it directly into the center of the spray tip until it bottoms. Rotate the stick 6 to 12 times, applying a light pressure with the thumb and forefinger.

CAUTION

Be sure that no compound is accidentally placed on the lapped surfaces located higher up in the spray tip. The slightest lapping action on these surfaces can alter the near-perfect fit between the needle valve and tip.

o. Before reinstalling used injector parts, lap all of the sealing surfaces indicated by the arrows in the figure in step k. It is also good practice to lightly lap the sealing surfaces of new injector parts which may become burred or nicked during handling.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-LAPPING

4. Injector

Lap the sealing surfaces indicated in the figure in step 3 k and the chart as follows:

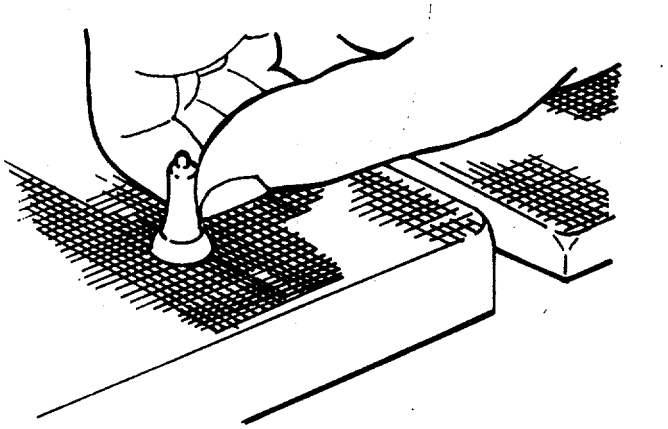
WARNING

Use eye protection when using compressed air.

a. Clean the lapping blocks J22090 with compressed air. Do not use a cloth or any other material for this purpose.

b. Spread a good quality 600 grit dry lapping powder on one of the lapping blocks.

c. Place the part to be lapped flat on the block as shown below and, using a figure eight motion, move it back and forth across the block. Do not press on the part, but use just enough pressure to keep the part flat on the block. It is important that the part be kept fl at on the block at all times.



5-276

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-LAPPING (Cont)

d. After each four or five passes, clean the lapping powder from the part by drawing it across a clean piece of tissue placed on a flat surface and inspect the part. Do not lap excessively (refer to the chart on minimum thickness).

PART NAME	MINIMUM THICKNESS
Tip, Spray (Shoulder)	.199
Cage, Check Valve	.165 -.163
Valve, Check	.022
Cage, Valve Spring	.602

e. When the part is flat, wash it in cleaning solvent and dry it with compressed air.

f. Place the dry part on the second block. After applying lapping powder, move the part lightly across the block in a figure eight motion several times to give it a smooth finish. Do not lap excessively. Again wash the part in cleaning solvent and dry it with compressed air.

g. Place the dry part on the third block. Do not use lapping powder on this block. Keep the part flat and move it across the block several times, using the figure eight motion. Lapping the dry part in this manner gives it the "mirror" finish required for perfect sealing.

h. Wash all of the lapped parts in clean fuel oil and dry them with compressed air.

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-ASSEMBLY (Cont)			
5. Injector filters		**NOTE** Use an extremely clean bench to work on and to place the parts when assembling an injector. Also be sure all of the injector parts, both new and used, are clean.	
	a. Filters (3)	1. Insert a new filter, dimple end down, slotted end up, in each of the fuel cavities in the top of the injector body (8).	Use a new filter.
	b. Gaskets (2), and filter caps (1)	1. Install gasket on each filter cap.	Use new gaskets.
		2. Lubricate cap threads and install.	
		3. Tighten caps to 65-75 lb-ft (88.1 - 101.7 Nm) torque.	Use 9/16 inch deep socket.
		WEARING Wear protective eye goggles when using compressed air.	
	c. Filters	1. Purge the filters after installation by directing compressed air or fuel through the filter caps.	
		2. Install clean shipping caps on the filter caps to prevent dirt from entering the injector.	

5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-ASSEMBLY (Cont)

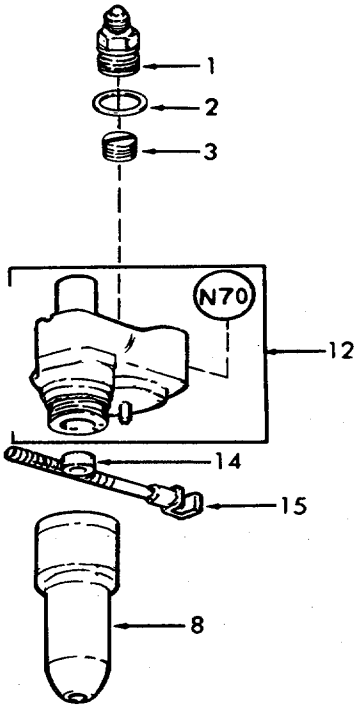
6. Rack and gear

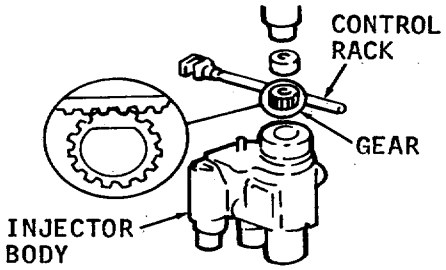
NOTE

Note the drill spot marks on the control rack and gear.

a. Injector body (12) and rack (15) — Hold the injector body, bottom end up and slide the rack through the hole in the body. Look into the body bore and move the rack until you can see the drill marks. Hold the rack in this position.

b. Gear (14) — Place the gear in the injector body so that the marked tooth is engaged between the two marked teeth on the rack.





5-9. FUEL INJECTOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-ASSEMBLY (Cont)			
	c. Gear retainer (13)	Place on top of gear.	
	d. Bushing (11)	Align the locating pin in the bushing with the slot in the injector body, then slide the end of the bushing into place.	
7. Spray tip, spring cage, check valve	a. Injector body (12)	Support bottom end up in holding fixture.	
	b. Seal ring (16)	Place on shoulder of body.	
	c. Spill deflector (10)	Place over barrel of body.	
	d. Check valve (17), and check valve cage (18)	1. Place the check valve (without the .010" hole) centrally on the top of the bushing. 2. Then place the check valve cage over the check valve and against the bushing.	
	e. Spring seat (19), spring (20), and spring cage (21)	1. Insert the spring seat in the valve spring, then insert the assembly into the spring cage, spring seat first.	
		CAUTION	
	Install a new spring seat in a former injector if a new design spray tip assembly is used.		

5-9. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Continued).

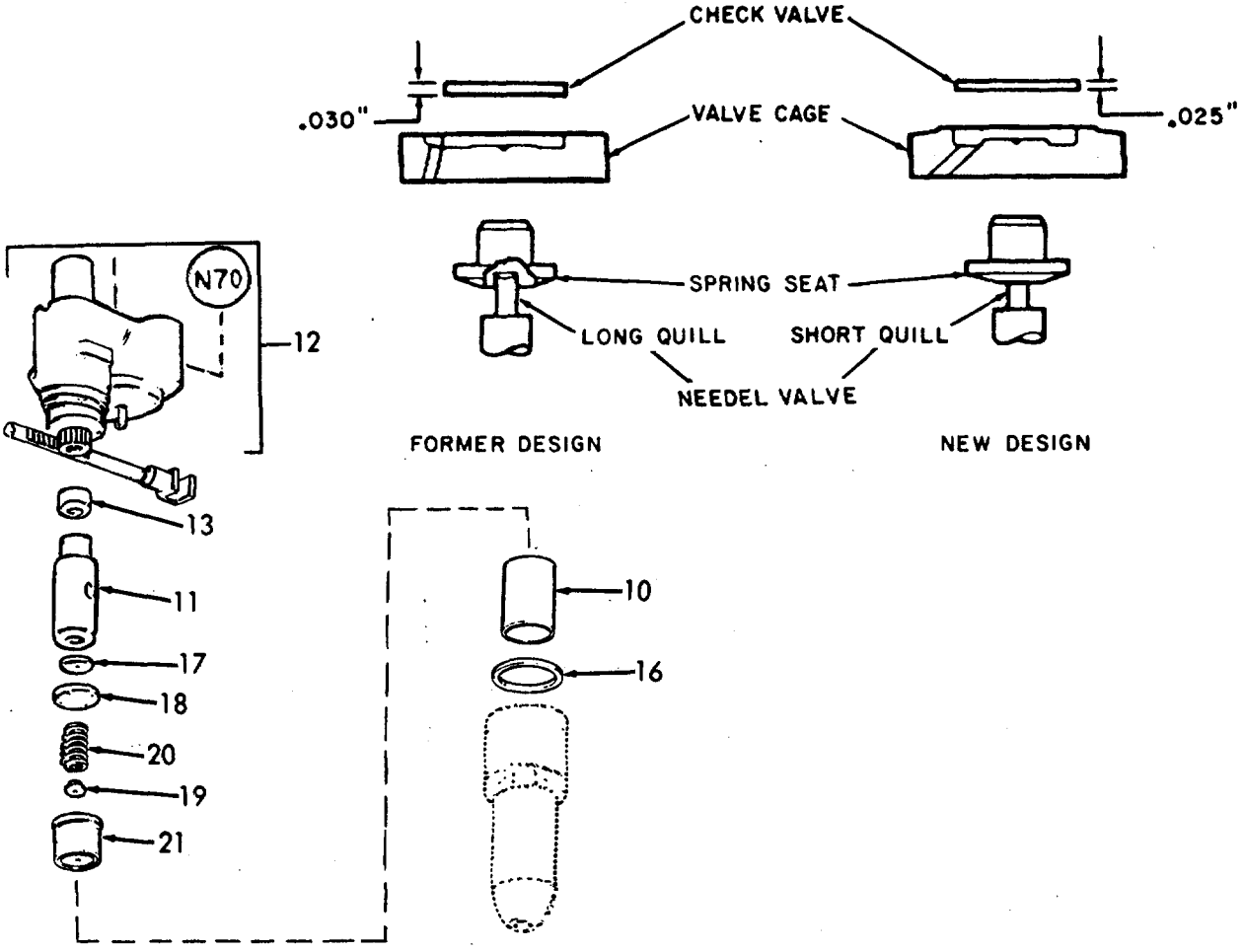
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

2. Place the spring cage, spring seat and valve spring assembly (valve spring down) on top of the check valve cage.

CAUTION

When installing a new spray tip assembly in a former injector, a new valve spring seat must also be installed. The current needle valve has a shorter quill.



5-9. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Continued).

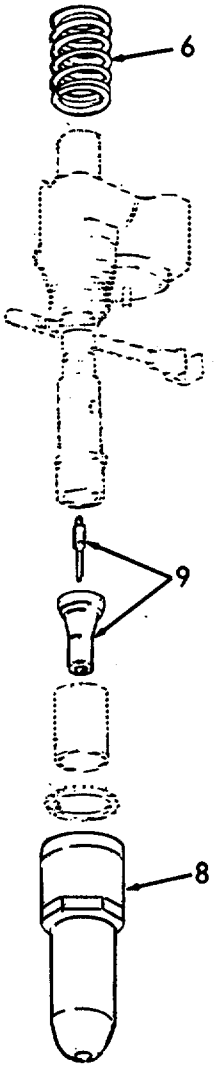
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	f. Needle valve (9)	1. Insert the needle valve, tapered end down, inside of the spray tip.	
		2. Then place the spray tip and needle valve on top of the spring cage with the quill end of the needle valve in the hole in the spring cage.	
	g. Injector nut (8)	1. Lubricate the threads in the injector nut and carefully thread the nut on the injector body by hand. Rotate the spray tip between your thumb and first finger while threading the nut on the injector body. Tighten the nut as tight as possible by hand. At this point there should be sufficient force on the spray tip to make it impossible to turn with your fingers.	
		2. Use socket J4983-01 and a torque wrench to tighten the injector nut to 75-85 lb-ft (101.7 - 115.2 Nm) torque.	

NOTE

Do not exceed the specified torque. Otherwise, the nut may be stretched and result in improper sealing of the lapped surfaces in a subsequent injector overhaul.

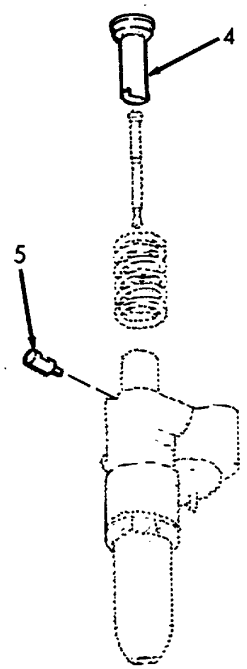
5-9. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Continued).

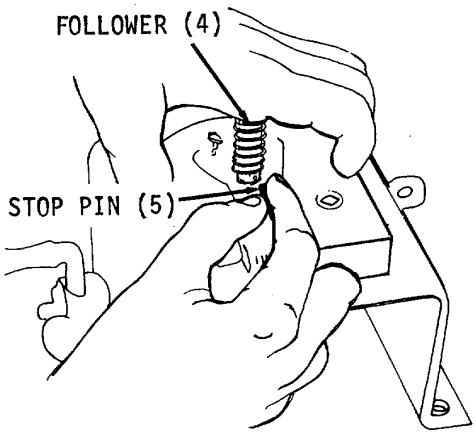
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)j			
8. Plunger and follower	a. Injector and spring (6)	Invert the injector in the assembly fixture (filter cap end up) and push the rack all the way in. Then place the follower spring on the injector body.	



5-9. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	b. Stop pin (5) and follower (4)	1. Place stop pin on injector body so that the follower spring rests on the narrow flange of the stop pin. 2. Align the slot in the follower with the stop pin hole in the injector body. 3. Align the flat side of the plunger with the slot in the follower. 4. Insert the free end of the plunger in the injector body. 5. Press down on the follower and at the same time press the stop pin into position. When in place, the spring will hold the stop pin in position.	





5-9. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
9.	Injector	Before placing an overhauled injector in service, perform those tests that can be performed at the Direct Support Maintenance Level.	

5-10. EXPANSION TANK - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Welding

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment

Condition Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS

WELDING

The only maintenance at this level is welding. Weld in accordance with existing procedures.

5-11. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Welding

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
NONE

Equipment Condition
NONE

Condition Description

Material/Parts
NONE .

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS

WELDING

The only maintenance at this level is welding. Weld in accordance with existing procedures.

5-12. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS.

This task covers:

a. INSERT FUNCTION **b. INSERT FUNCTION** **d. INSERT FUNCTION**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

References
NONE

Equipment
Condition **Condition Description**
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS
WELDINGI			
		The only maintenance at this level is welding. Weld in accordance with existing procedures.	

5-13. BALANCE WEIGHT COVER AND ACCESSORY DRIVE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Gasket kit 5196375

Personnel Required
1

References
Para 3-18 Water Pump - Removal

Equipment Condition **Condition Description**
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

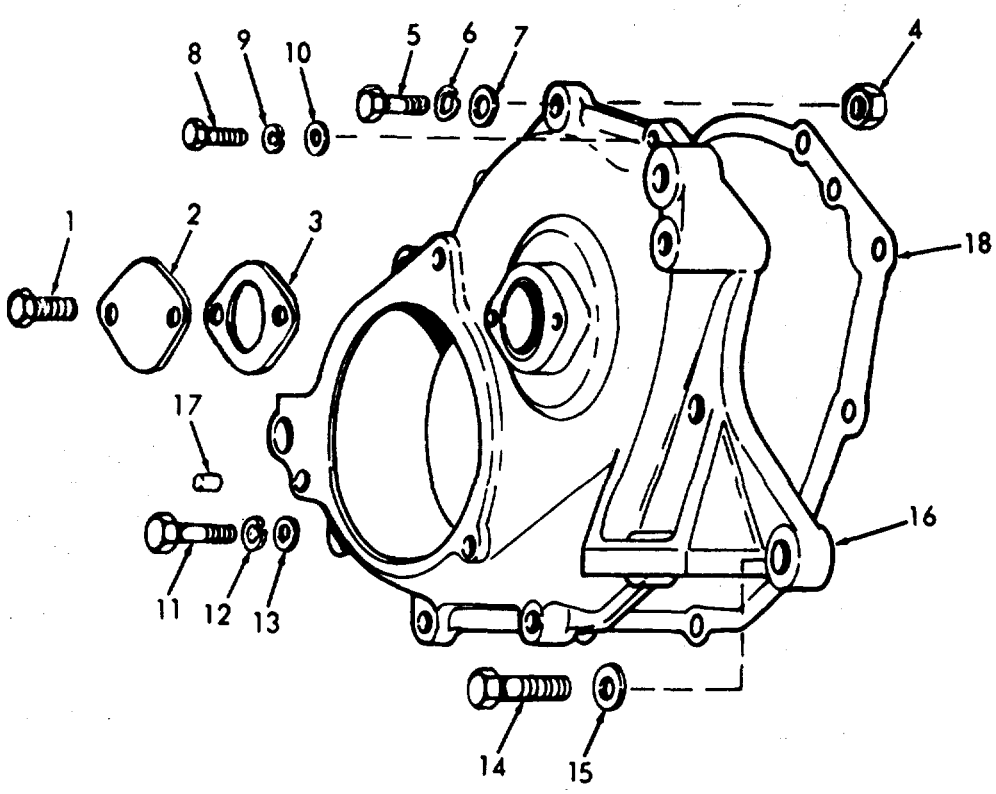
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Balance weight cover	a. Cooling system	Drain.	
	b. Water pump	Remove.	Refer to paragraph 3-18.

5-13. BALANCE WEIGHT COVER AND ACCESSORY DRIVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Screws (1), drive hole cover (2) , and gasket (3)	Remove.	Discard gasket.
	d. Nuts (4), screws (5), lock-washers (6), and flatwashers (7)	Remove.	
	e. Screw (8), lockwashers (9), and flatwasher (10)	Remove.	
	f. Bolt (11), lockwasher (12), and flatwasher (13)	Remove.	
	g. Screws (14), and flat washers (15)	Remove.	
	h. Cover (16)	Remove.	Tap the ends of the cover with a soft hammer to loosen.
	i. Dowel pins (17)	Remove.	If necessary.
	j. Gasket (18)	Remove.	Discard.

5-13. BALANCE WEIGHT COVER AND ACCESSORY DRIVE - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
2. Balance weight cover	a. Gasket (18)	Affix to cover (16).	
	b. Cover (16)	Install.	
	c. Screws (14), and flatwashers (15)	1. Install. 2. Torque.	See below.
	d. Bolt (11), lockwasher (12), and flatwasher (13)	orque.	See below.



5-13. BALANCE WEIGHT COVER AND ACCESSORY DRIVE - MAINTENANCE INSTRUCTIONS

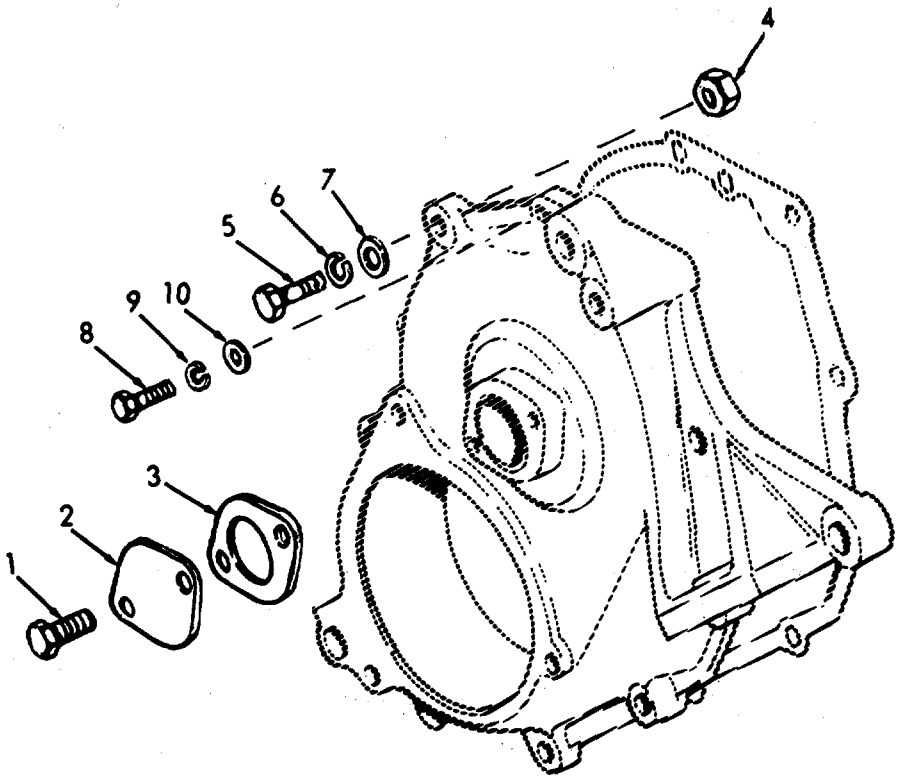
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	e. Screws (8), Torque. lockwashers (9), and fatwashers (10)		See below.
	f . Screws (5), Torque . lockwashers (6), fl at washers (7) , and nuts (4)		See below.
	g. Gasket (3), drive hole cover (2), and screws (1)	1. Install. 2. Torque.	Use new gasket. See below.C,,

SCREW	lb-ft	TORQUE - Nm
3/8-16	30-35	40.7 - 47.5
3/8-24	35-39	47.5 - 52.9
1/2-13	71-75	96.3 - 101.7
5/8-11	137-147	186.0 - 199.5

5-13. BALANCE WEIGHT COVER AND ACCESSORY DRIVE -MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



h.	Water pump	Install.	Refer to paragraph 3-18.
i.	Cooling system	Fill.	

5-14. ENGINE SUPPORTS, LIFTER BRACKETS AND CRANKSHAFT FRONT COVER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Repair

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
Gasket kit P/N5196375

Personnel Required
1

References
NONE

Equipment Condition **Condition Description**
NONE

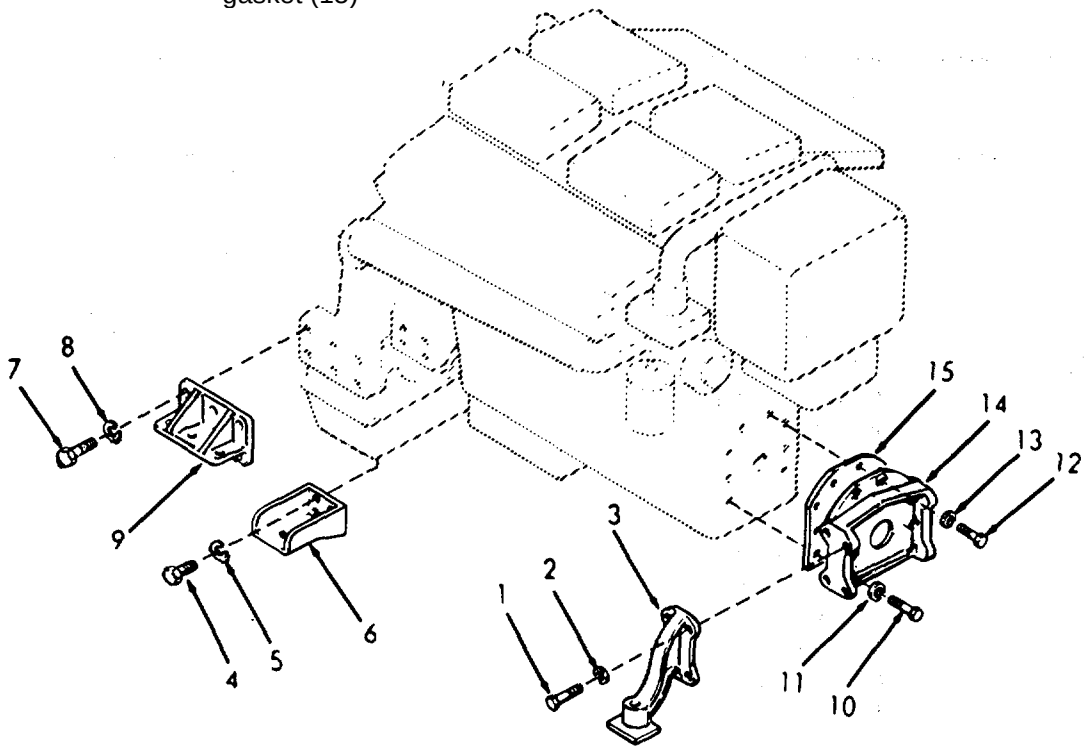
Special Environmental Conditions
NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
1. Engine supports, crankshaft front cover	a. Screws (1), lockwashers (2), and front support (3)	Replace.	If necessary.
	b. Screws (4), lockwashers (5), and rear support bracket (6)	Replace.	If necessary.
	c. Screws (7), lockwashers (8), and mari ne gear support (9)	Replace.	If necessary.

5-14. ENGINE SUPPORTS, LIFTER BRACKETS AND CRANKSHAFT FRONT COVER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Screws (10), lockwashers (11), bolts (12), lock-washers (13), crankshaft front cover (14), and gasket (15)	Replace.	If necessary, use a new gasket.



5-15. MUFFLER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Replace and Repair

INITIAL SETUP:

Test Equipment
NONE

Special Tools
Lifting tools

Material/Parts
NONE

Personnel Required
2

References
NONE

Equipment Condition **Condition Description**
NONE

Special Environmental Conditions

WARNING

The insulation contains asbestos. Prolonged exposure is hazardous to your health.

General Safety Instructions

WARNING
The weight of the muffler (150 lb.) requires two persons to remove.

LOCATION	ITEM	ACTION	REMARKS

REPAIR OR REPLACEI

1.	Muffler	Repair or replace the following items as required: a. Reducing flange (1) b. Muffler (2) c. Flange (3) d. Flexible connector (4) e. Nut (5)	

5-15. MUFFLER - MAINTENANCE INSTRUCTIONS (Continued).

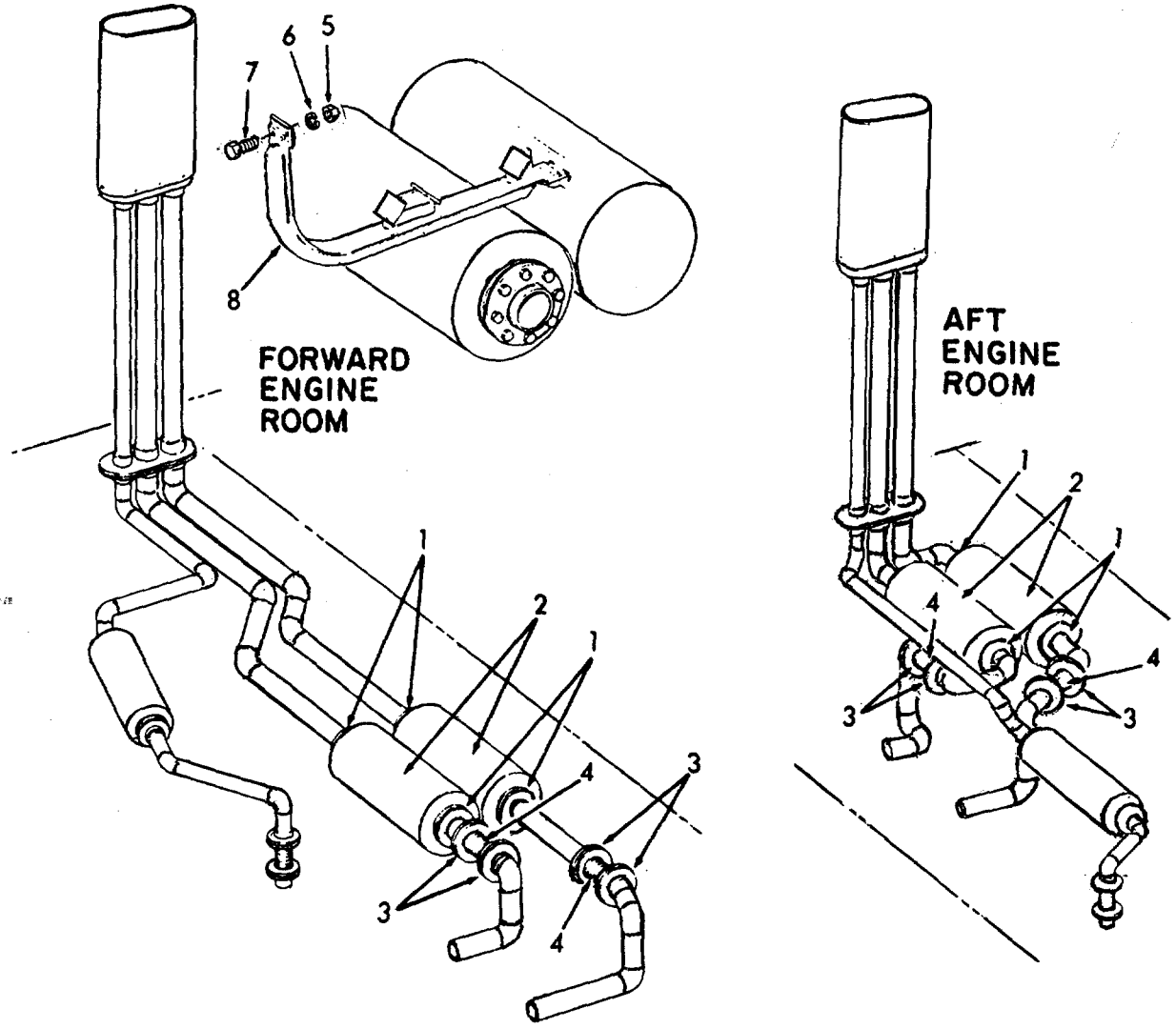
LOCATION	ITEM	ACTION	REMARKS

REPAIR OR REPLACE (Cont)

f. Lockwasher (6)

g. Screw (7)

h. Muffler hanger (8)



5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Disassembly **b. Inspection** **d. Reassembly**

INITIAL SETUP:

Test Equipment
NONE

References
NONE

Special Tools
Gear puller
Oil pump gear instalJer tool J8509
Arbor press
Feeler ribbon .010 inch

Equipment Condition **Condition Description**
NONE

Material/Parts
Gasket kit (part)
P/N 5196375

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
NONE

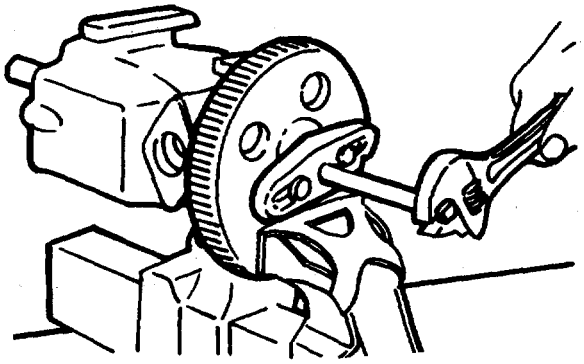
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Lube oil pump	a. Screws (1), and lockwashers (2)	Remove.	
	b. Cover (3)	Remove.	
	c. Gear (4)	1. Attach gear puller with two screws in tapped holes in gear.	a. Screws are 5/16-24. b. Do not damage end of shaft - use a small spacer.

5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

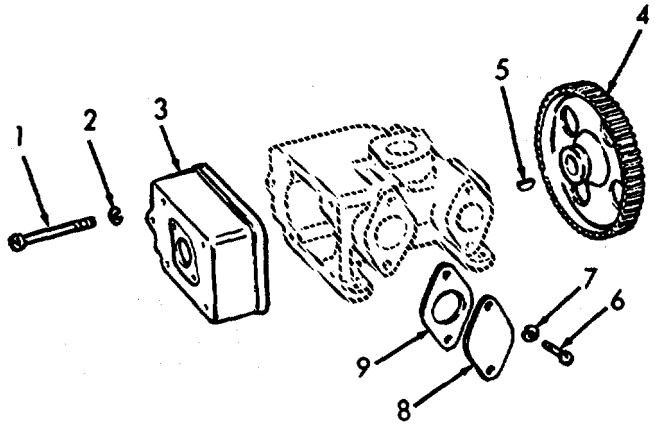
LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

2. Rotate puller screw clockwise to remove gear.



d.	Key (5)	1. Remove. 2. Make sure the shaft is not burred.	
e.	Screws (6), lockwashers (7), pad cover (8), and gasket (9)	Remove.	Discard gasket.



5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

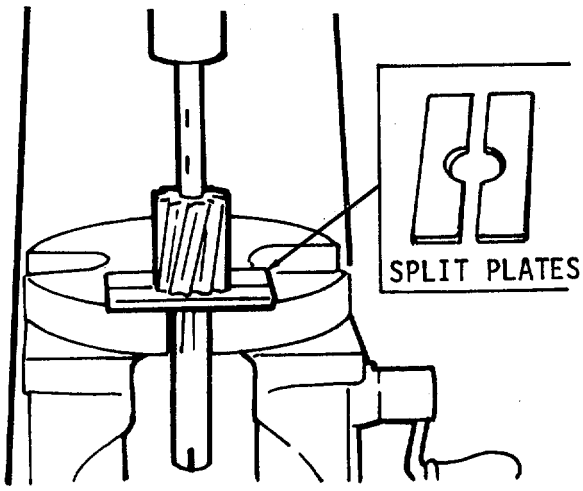
This task covers:
a. INSERT FUNCTION **b. INSERT FUNCTION** **d. INSERT FUNCTION**

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	f. Screws (10), lockwashers (11), pad cover (12), and gasket (13)	Remove.	Discard gasket.
	g. Screws (14), lockwashers (15), pad cover (16), and gasket (17)	Remove from cover (3).	Discard gasket.
	h. Bushings (18)	Remove from cover (3).	
	i. Pump drive and driven gears and, shaft assembly (19)	Remove from body (20).	
	j. Right hand helix gear (21), driven gear shaft (22), and key (23)	Press the gear from the shaft.	Use an arbor press and sleeve.
	k. Left hand helix gear (24), drive gear shaft (25), and key (23)	Press the gear from the shaft.	Use an arbor press and sleeve.

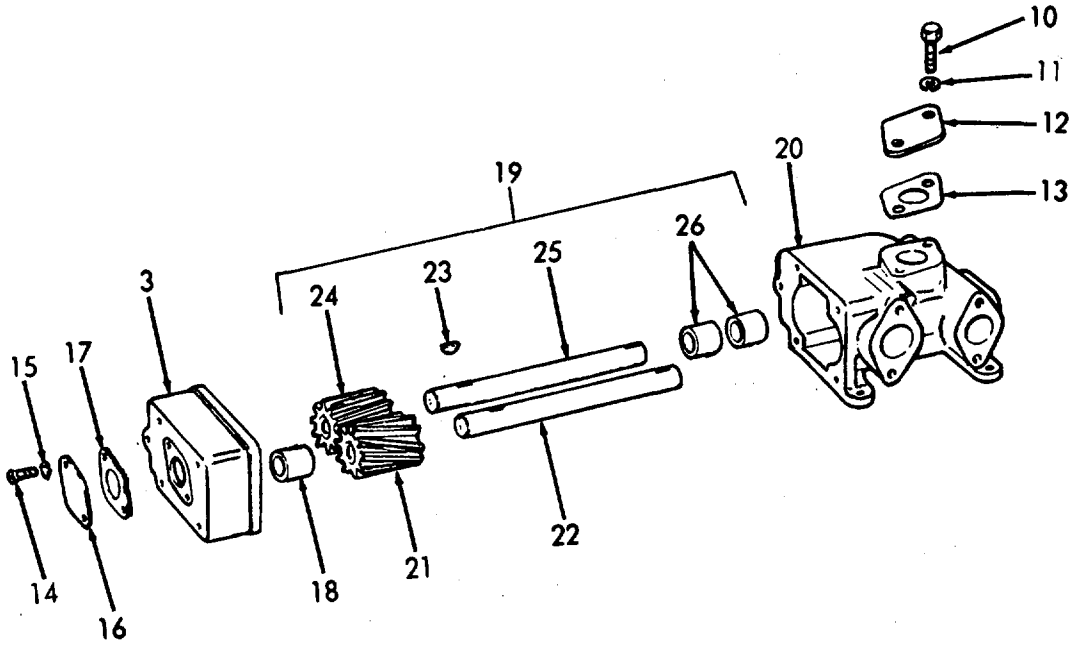
5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



1.	Bushing (26)	Remove.	



5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION

2. **WARNING**

Wear protective eye goggles when using compressed air.

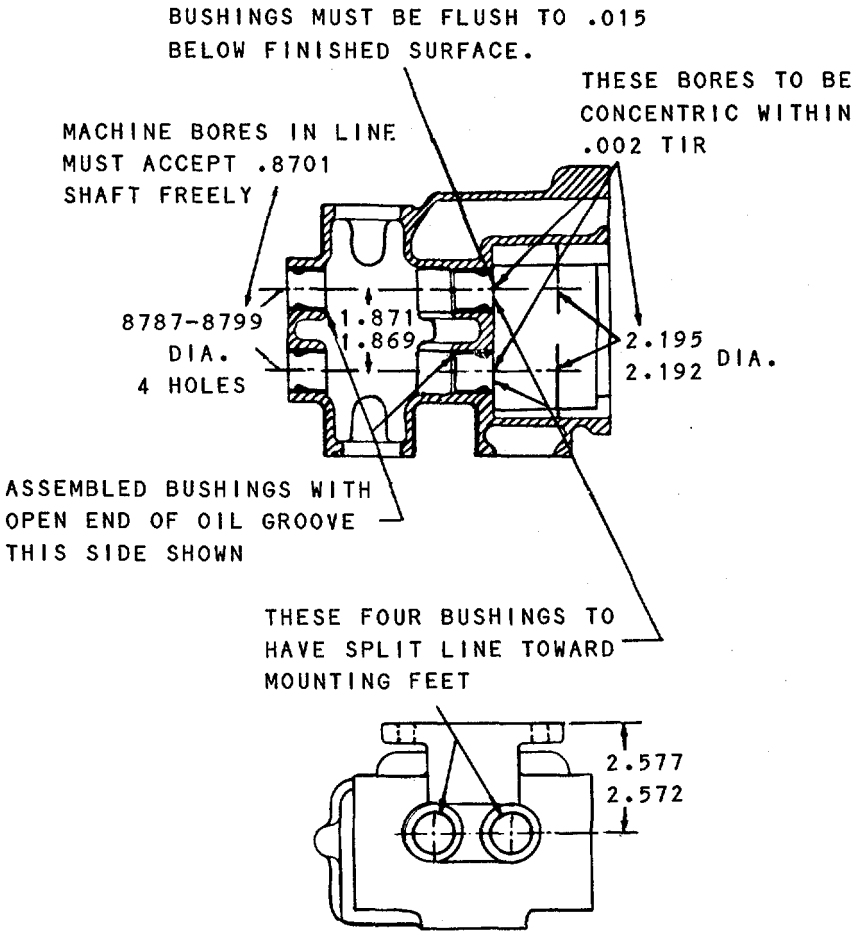
a. Wash all of the parts in clean fuel oil and dry them with compressed air.
b. The greatest amount of wear in the oil pump is imposed on the internal drive and driven gears. This wear may be kept to a minimum by keeping the lubricating oil clean and acid-free. If dirt and sludge are allowed to accumulate in the lubricating system, pronounced gear wear may occur in a comparatively short period of time. Proper servicing of oil filters will increase the life of the gears.

c. Examine the internal gear cavity of the pump body for wear or scoring. Also inspect the pump cover for wear. Replace the parts if necessary.
d. Inspect the bushings in the pump body and cover. If the bushings are worn excessively, replace the pump body and cover unless suitable boring equipment is available for finishing the new bushings. When installing new bushings, replace all of the bushings in the pump. The bushings must be located and positioned as shown below. The gear bore and the bushing bore must be concentric within .002" total indicator reading. The shaft-to-bushing clearance with new parts is .0015" to .0032".

5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



e. If the gear teeth are scored or worn, install new gears. The use of excessively worn gears will result in low engine oil pressure which, in turn, may lead to serious damage throughout the engine.

f. Inspect the pump shafts for wear and check the keyways. Replace the shafts if necessary.

g. Inspect the external pump drive-driven gear for wear and replace it if necessary.

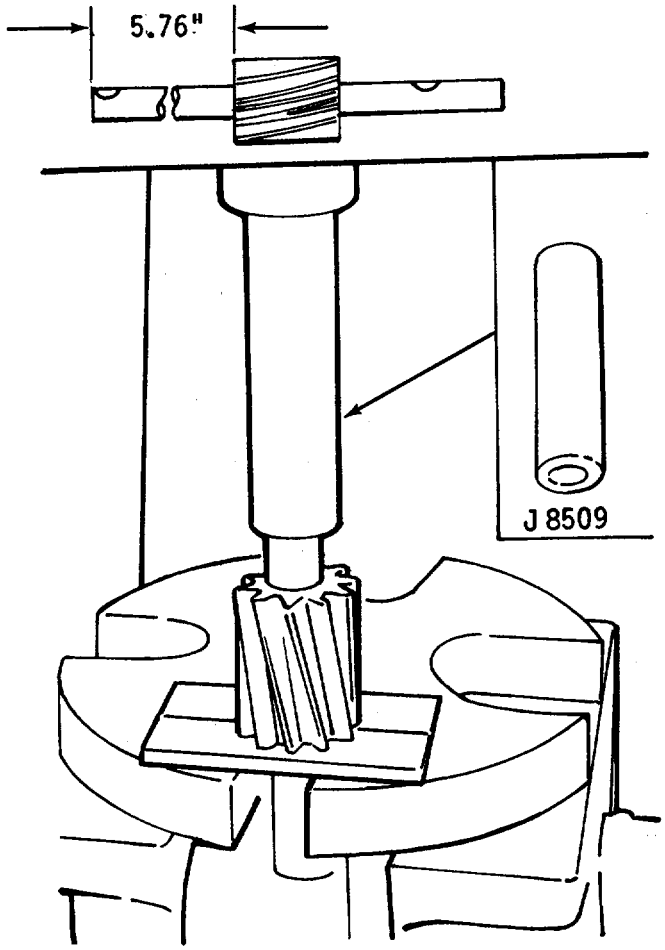
5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Key (23), drive gear shaft (25), and left hand helix gear (24)	1. Place key in slot in shaft. 2. Apply a light coat of engine oil to shaft. 3. Start the gear squarely on the key. 4. Place tool over drive gear (or opposite) end of the shaft and press the gear on the shaft.	a. Use tool J8509. b. Use arbor press. c. The tool will position the gear 5.76 inch from the end of the shaft. d. The tool will prevent the shaft from bending .
	b. Key (23), driven gear shaft (22), and right hand helix gear (21)	Perform action in step a. above.	

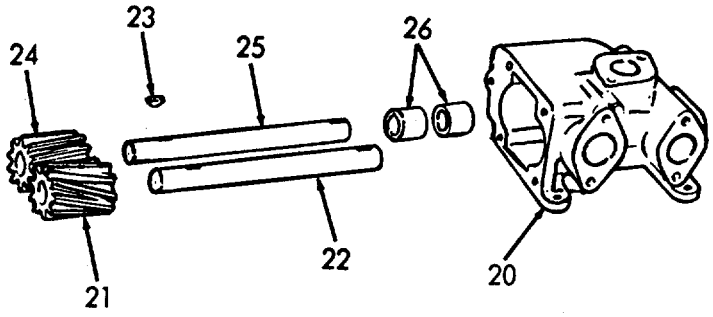
5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



c. Bushings (26) — Install in body (20).



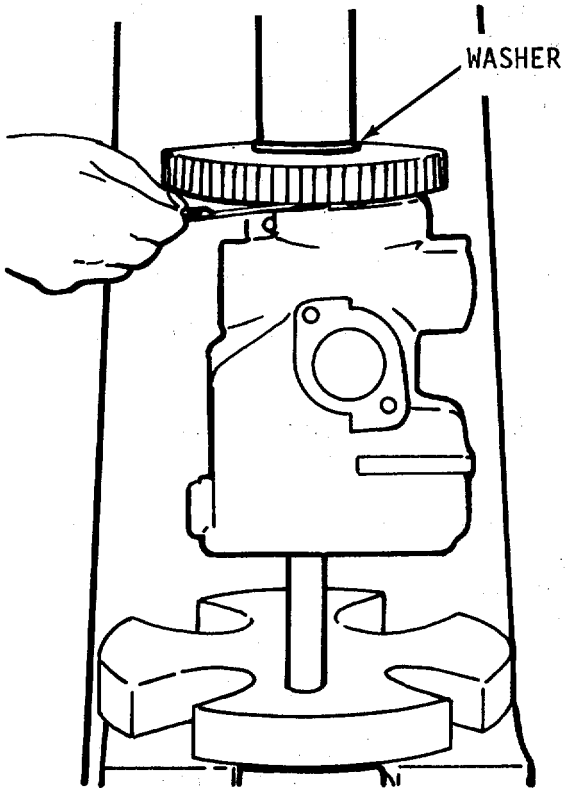
5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

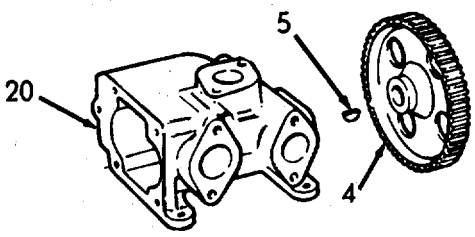
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Left hand helix gear and shaft	Install the drive gear and shaft assembly in the pump body with left hand helix gear is the drive shaft for a right hand rotation engine. The right hand helix gear must be on the right hand side (viewing pump from cover end and mounting flanges facing up).	
	e. Key (5)	Insert in end of drive shaft.	
	f. Pump body (20) including gears	1. Place in arbor press with the gear end down.	
		2. Start gear (4) (with extended hub side facing the pump) straight on the shaft, aligning the key in the shaft with the keyway in the gear.	Use a large flat washer with a center hole slightly larger than the OD of the pump drive shaft on the gear hub.
		3. Insert a .010" feeler ribbon between the drive gear and the pump body to properly position the gear on the shaft. Press the gear up to the pump body just far enough to allow .010" feeler' to be readily slipped from place.	

5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)





5-307

5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Driven gear shaft (22), and right hand helix gear (21) assembled	Install in body (20).	
	h. Pad cover (12), gasket (13), screws (10), and lockwashers (11)	Install.	Use new gasket.
	i. Pad cover (8), gasket (13), screws (6), and lock-washers (7)	Install.	Use new gasket.
	j. Pad cover (16), gasket (17), screws (14), and lockwashers (15)	Install in cover (3).	Use new gasket.
	k. Bushings (18)	Install in cover (3).	
	1. Cover (3), screws (1), and lock-washers (2)	Install on body (20).	

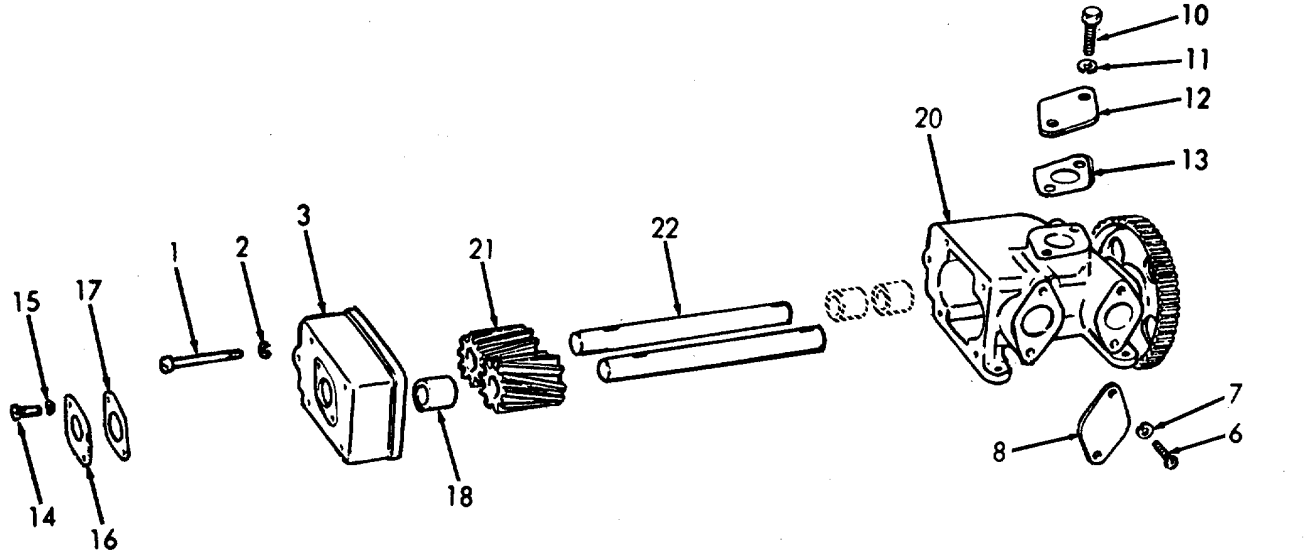
5-16. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

NOTE

The oil pump must turn freely after assembly. Any binding must be eliminated before the oil pump is installed on the engine by loosening the bolts and tapping the cover, then retightening the bolts.



5-17. LUBE OIL PRESSURE REGULATOR AND RELIEF VALVES - MAINTENANCE INSTRUCTIONS.

This task covers:

a. INSERT FUNCTION **b. INSERT FUNCTION** **d. INSERT FUNCTION**

INITIAL SETUP:

Test Equipment
NONE

References
Para 3-36 Lubricating Oil Pressure Relief Valve
Para 3-37 Lubricating Oil Pressure Regulator

Special Tools
Vice (Soft jaws)

Equipment Condition **Condition Description**
NONE

Material/Parts
NONE

Special Environmental Conditions
NONE

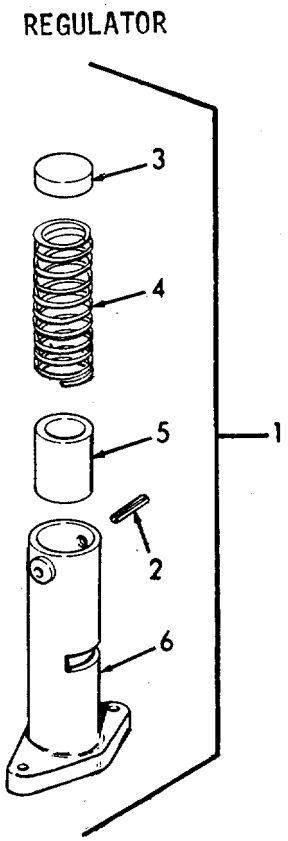
Personnel Required
1

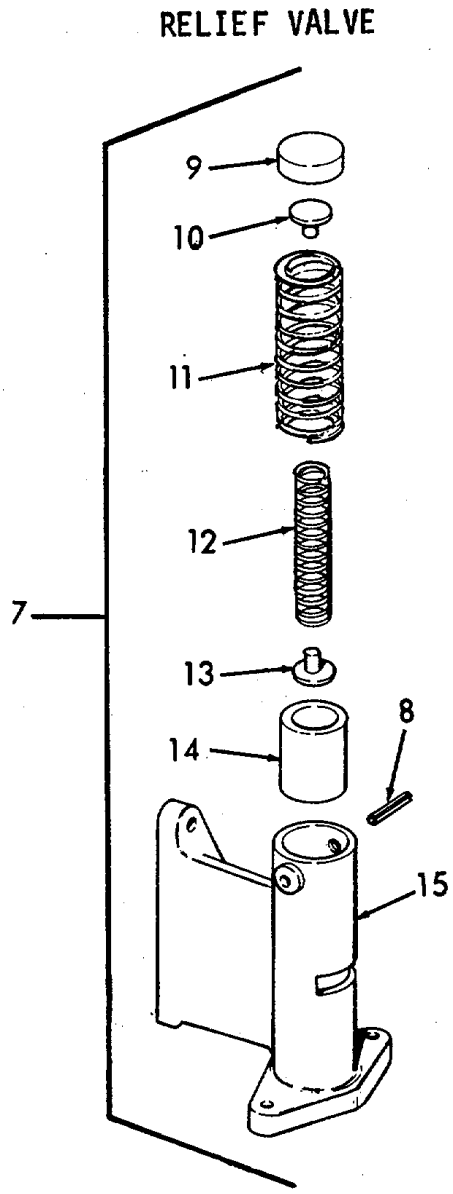
General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Regulator assembly	a. Regulator jaws. (1)	Clamp in vice with soft	
	b. Spring pin (2)	Remove.	
	c. Seat (3), spring (4) and valve (5)	Remove from body (6).	

5-17. LUBE OIL PRESSURE REGULATOR AND RELIEF VALVES - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
2. Relief valve	a. Relief valve assembly (7)	Clamp in vice with soft jaws.	
	b. Spring pin (8)	Remove.	
	c. Seat (9), spring seat (10), springs (11 and 12), spring seat (13), and valve (14)	Remove from body (15).	





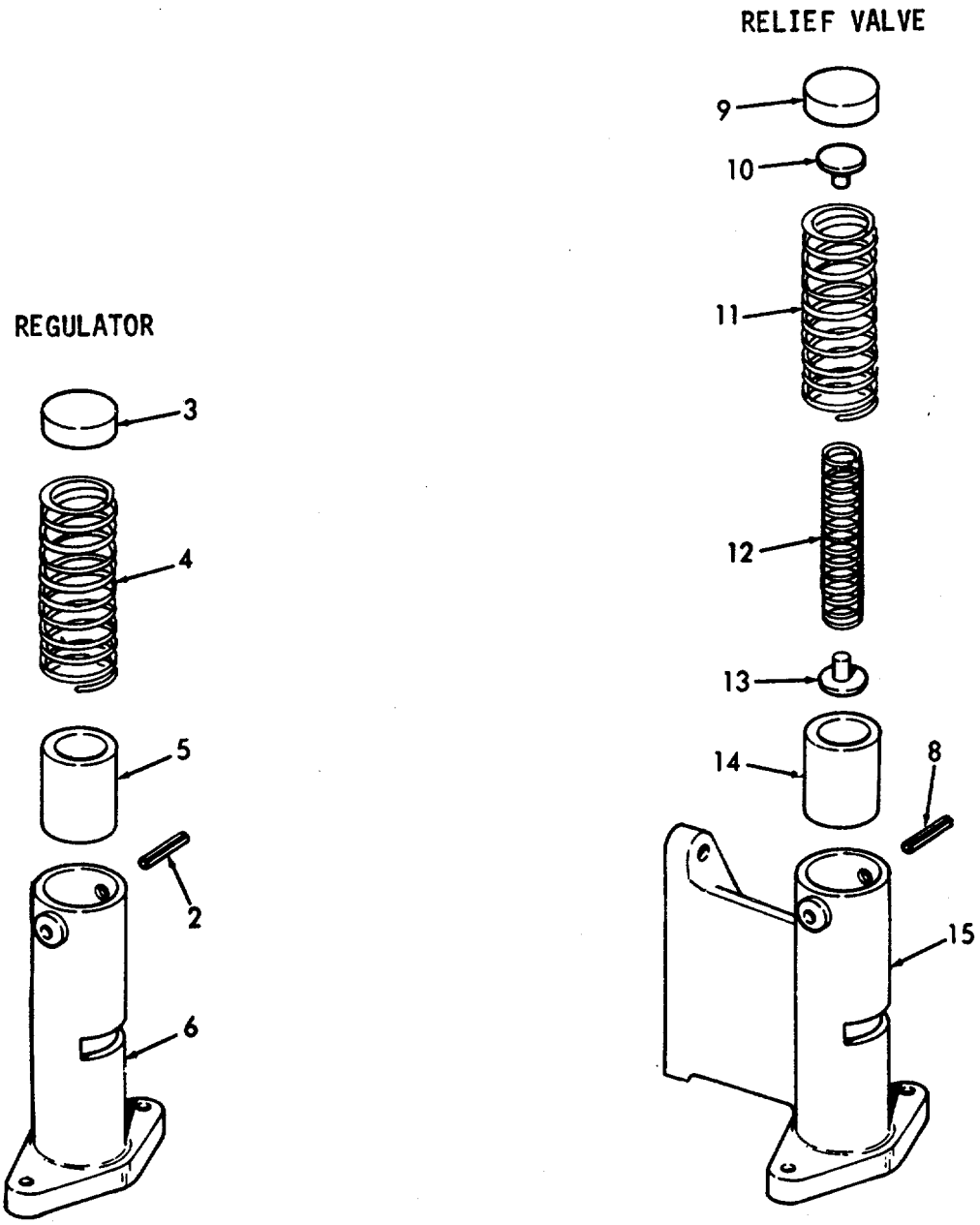
5-17. LUBE OIL PRESSURE REGULATOR AND RELIEF VALVES - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
3. Regulator and relief valve		**WARNING** Wear protective eye goggles when using compressed air. a. Clean all parts in fuel oil, dry them with compressed air. b. Inspect valves or valve bodies for scoring. Clean with crocus cloth. c. If the valves or valve bodies cannot be cleaned - discard. d. Inspect for pitted or fractured springs.	
REASSEMBLY			
4. Regulator	a. Valve (5), spring (4), and seat (3)	Insert in valve body (6).	
	b. Spring pin (2)	Insert.	
5. Relief valve	a. Valve (.14), spring seat (13), springs (11 and 12), spring seat (10), and seat (9)	Insert in valve body (15).	
	b. Spring pin (8)	Install.	

5-17. LUBE OIL PRESSURE REGULATOR AND RELIEF VALVES - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



5-18. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS.

Refer to TM 5-2815-251-14, Detroit Diesel Engines, V-71, Section 1.4 for Flywheel and Housing Maintenance Instructions.

All data on page 5-315 is deleted.

5-18. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:
a. INSERT FUNCTION **b. INSERT FUNCTION** **d. INSERT FUNCTION**

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

2. Flywheel ring gear

a. Support the flywheel - ring gear side up - on a solid flat surface.

b. Rest ring gear on a flat, metal surface and heat the gear uniformly with an acetylene torch, keeping the torch moving around the gear to avoid hot spots.

CAUTION

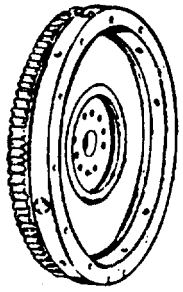
Do not, under any circumstances, heat the gear over 400°F (204°C), as excessive heat may destroy the original heat treatment.

NOTE

Heat indicating "crayons", which are placed on the ring gear and melt at a predetermined temperature, may be obtained from most tool vendors. Use of these "crayons" will ensure against over-heating the gear.

c. Use a pair of tongs to place the gear on the flywheel with the chamfer facing the same direction as on the gear just removed.

d. Tap the gear in place against the shoulder on the flywheel. If the gear cannot be tapped into place readily, remove it and apply additional heat, noting the above caution.



5-19. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS.

a. Camshaft

1. The contrarotating camshafts are located near the top of the cylinder block. A left cylinder bank and a right cylinder bank camshaft is provided to actuate the exhaust valve and injector operating mechanism.

2. The accurately ground cams ensure efficient, quiet, cam follower roller action, and are heat treated to provide a hard wear surface.

3. The engine is equipped with a low velocity, low lift injector cam lobe and a long closing ramp exhaust cam lobe design camshaft. Former engines were equipped with a high lift injector cam lobe camshaft. The two camshafts are interchangeable and only the current camshaft, which can be identified by the numeral "7" stamped on one end of the camshaft, is serviced.

4. Both ends of each camshaft are supported by a bearing assembly which consists of a flanged housing and two bushings. In addition, intermediate two-piece bearings support the camshafts at uniform intervals throughout their length. The intermediate bearings are secured to the camshaft by lock rings, thus permitting them to be inserted in the cylinder block with the shafts. Each intermediate bearing is secured in place, after the camshafts are installed, with a lock screw threaded into a counter-bored hole in the top of the cylinder block.

5. The camshaft gear thrust load is absorbed by two thrust washers, one on each end of the rear camshaft end bearing, on each shaft.

5-19. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS.

a. Camshaft

1. The contrarotating camshafts are located near the top of the cylinder block. A left cylinder bank and a right cylinder bank camshaft is provided to actuate the exhaust valve and injector operating mechanism.

2. The accurately ground cams ensure efficient, quiet, cam follower roller action, and are heat treated to provide a hard wear surface.

3. The engine is equipped. with a low velocity, low lift injector cam lobe and a long- closing ramp exhaust cam lobe design camshaft. Former engines were equipped with a high lift injector cam lobe camshaft. The two camshafts are interchangeable and only the current camshaft, which can be identified by the numeral "7" stamped on one end of the camshaft, is serviced.

4. Both ends of each camshaft are supported by a bearing assembly which consists of a flanged housing and two bushings. In addition, intermediate two-piece bearings support the camshafts at uniform intervals throughout their length. The intermediate bearings are secured to the camshaft by lock rings, thus permitting them to be inserted in the cylinder block with the shafts. Each intermediate bearing is secured in place, after the camshafts are installed, with a lock screw threaded into a counter-bored hole in the top of the cylinder block.

5. The camshaft gear thrust load is absorbed by two thrust washers, one on each end of the rear camshaft end bearing, on each shaft.

*U.S. GOVERNMENT PRINTING OFFICE: 1988 - 554030/80202

5-19. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS.

6. Lubricating oil is supplied under pressure to the bearings via angular drilled passages in the rear of the cylinder block, which lead from the main oil gallery to each rear end bearing. From the rear end bearings, the oil passages through the drilled oil passages in the camshafts to the intermediate bearings and to the front end bearings.

7. A camshaft front pulley (integral weight) is attached to the front end of the left bank camshaft and a water pump drive gear (bolt-on weight) is attached to the front end of the right bank camshaft. A camshaft gear is attached to the rear end of each camshaft. The pulley and the gears are retained on the camshafts with a retaining nut.

b. Camshaft gears

1. The camshaft gears, located at the flywheel end of the engine, mesh with each other and run at the same speed as the crankshaft. Either one of the gears may be driven by the crankshaft timing gear through an idler gear, depending upon engine rotation. Viewing the engine from the gear train end, the right hand camshaft gear has right hand helical teeth and the left hand camshaft gear has left hand helical teeth. The idler gear mates with the right hand camshaft gear on right hand rotation engines.

2. Since the two camshaft gears must be in time with each other, timing marks are stamped on the rim of both gears. Also, since these two gears as a unit must be in time with the crankshaft, timing marks are located on the idler gear and the crankshaft gear.

5-19. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS.

3. Each camshaft gear on the right hand rotation engines are keyed to the shaft and held securely by a nut, nut retainer, retainer bolts and lockwashers.
4. Camshaft gears used on 12V engines are not interchangeable.

c. Idler gear

1. The idler gear is mounted on a double row, tapered roller bearing, which in turn is supported on a stationary hub. This hub is secured directly to the cylinder block by a bolt which passes through the hub and rear end plate. A dowel in the hub correctly positions the hub and prevents it from rotating.

2. The idler gear bearing consists of two cups, two cones and an outer and inner spacer ring.

3. The idler gear bearing cup(s) is a light press fit in the gear and is held in place by a retainer which is secured by six bolts. The bearing cones are pressed onto the gear hub and do not rotate. The spacer(s) separates the bearing cones .

4. The idler gear is pressure lubricated by oil from the cylinder block rear cross oil gallery. Oil enters an opening between the cylinder block and the idler gear hub and circulates around the idler gear hub bolt which has a smaller outside diameter than the inside diameter of the gear hub bolt hole. The oil is forced through a drilled passage in the gear hub to the roller bearing.

5-19. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS (Continued) .

LOCATION	ITEM	ACTION	REMARKS

5. A left hand helix gear is provided for right hand rotation engines.

6. An idler gear hole spacer (dummy hub) is used on the side opposite the idler gear.

The following is an index to the maintenance instructions:

DESCRIPTION	PARAGRAPH
Camshaft assembly and gear train	5-19.1
Idler gear	5-19.2
Idler gear hole spacer	5-19.3

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment

Micrometers
Feeler gages

References

Para 3-18 Water Pump Removal
3-26 Front Balance Weight Cover Removal
3-32 Flywheel And Housing Removal
3-34 Cylinder Head Removal

Special Tools

Puller J4558-01
Torque wrench
Puller J1902-01

Equipment Condition: Condition Description

NONE

Material/Parts

Gasket kit P/N5196375

Special Environmental Conditions

NONE

Personnel Required

2

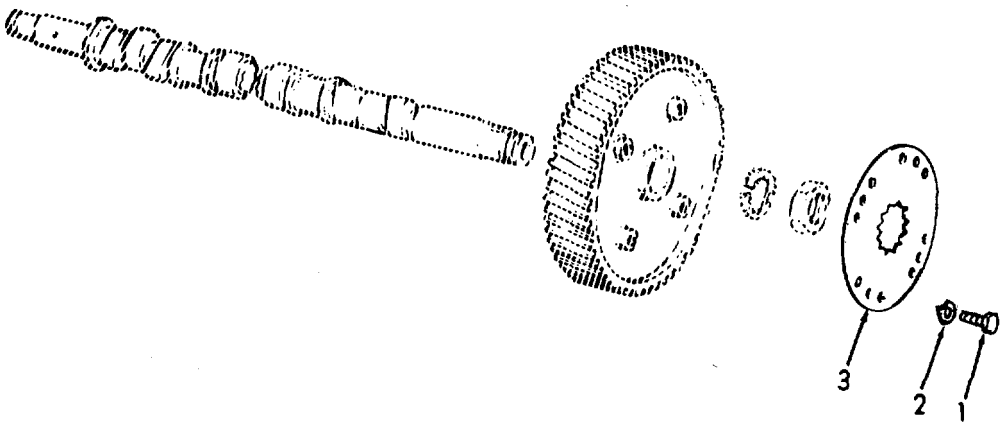
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Camshaft Assembly	a. Cooling system	Drain.	
	b. Cylinder heads	Remove.	Refer to paragraph 3-34.
	c. Flywheel and flywheel housing	Remove.	Refer to paragraph 3-32.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Water pump	Remove.	Refer to paragraph 3-18.
	e. Front balance weight cover	Remove.	Refer to paragraph 3-26.
	f. Screws (1), lockwashers (2) , and nut retaining plate (3)	Remove.	

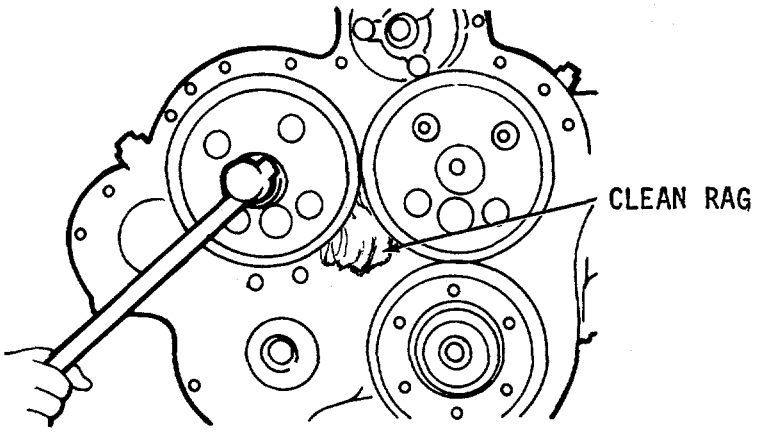


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

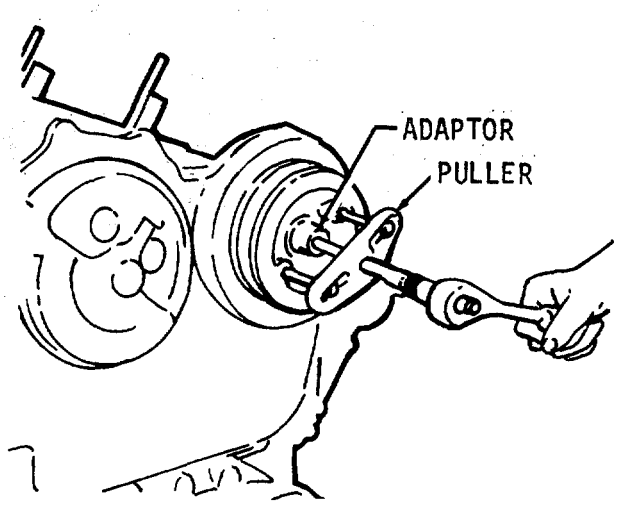
LOCATION	ITEM	ACTION	REMARKS

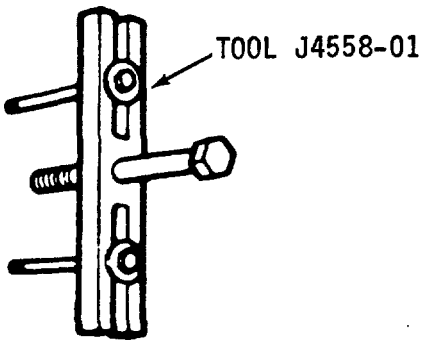
REMOVAL (Cont)

g.	Nuts (4) and lock-washers (5)	1. Wedge a clean rag between gears. 2. Remove nut from both ends of each cam shaft.	



h.	Camshaft pulley (6)	1. Install puller. 2. Protect the end of the camshaft with an adapter. 3. Remove.	Use tool J4558-01.



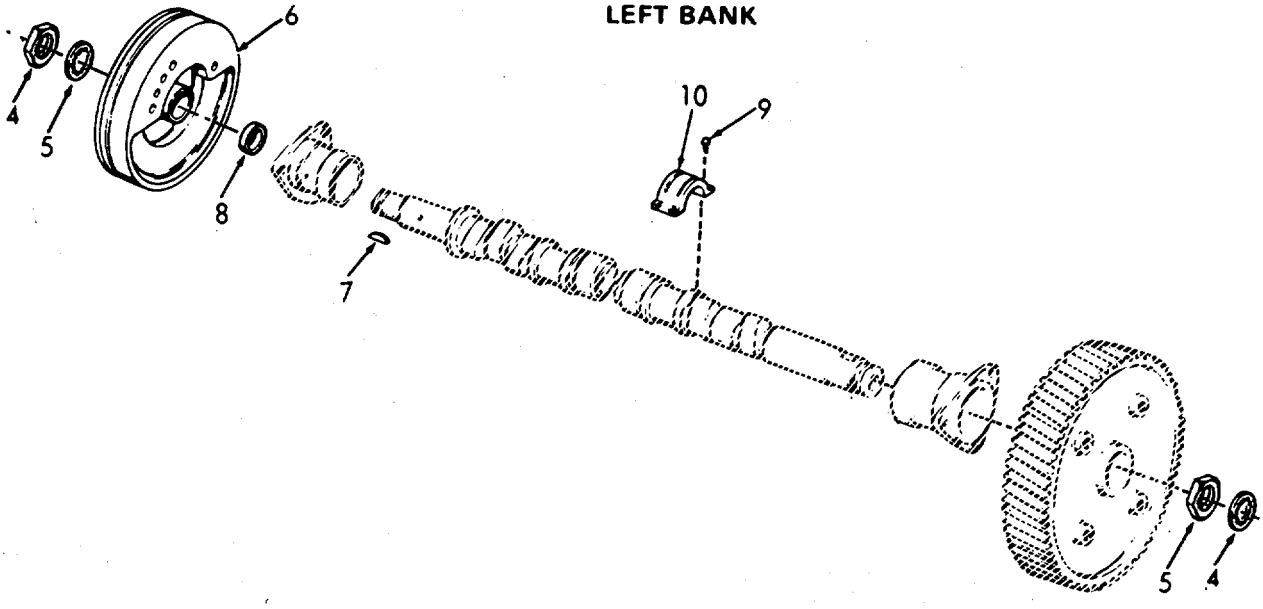


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

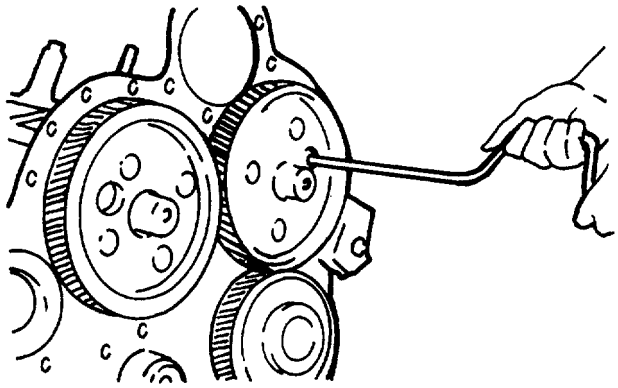
REMOVAL (Cont)

	i. Key (7), and spacer (8)	Remove.	
	j. Bolts (9), and lower bearing (10)	Remove.	

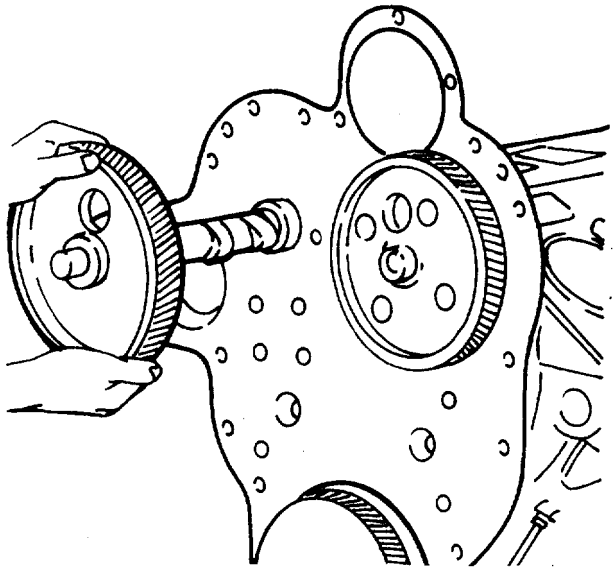


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
k.	Camshaft gears (11 and 12), screws (13), and lockwashers (14)	1. Rotate gears as required. 2. Remove screws and lockwashers.	

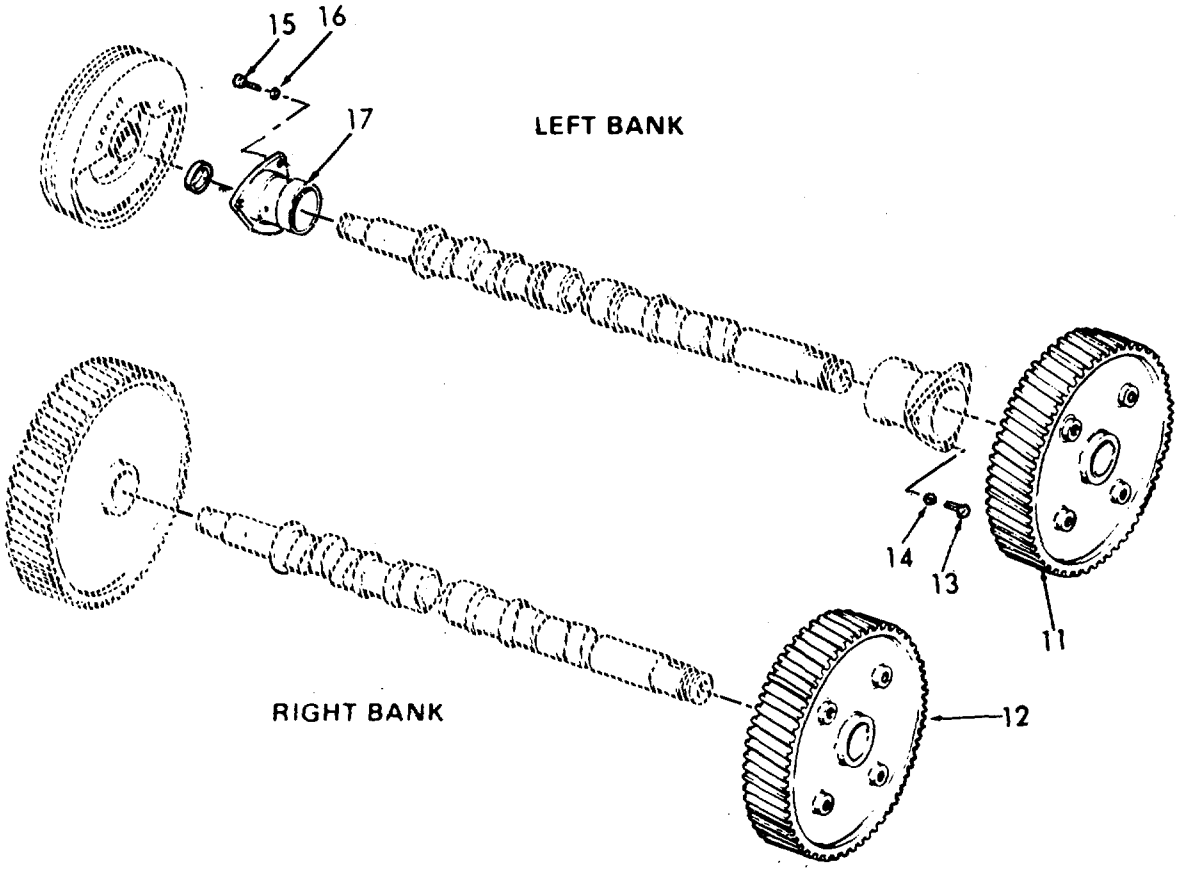


l.	Camshaft, bearing and gear assembly	Remove from cylinder block .	



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	m. Screws (15), lock-washers (16), and bearings (17)	Remove.	If necessary, use a pry bar under the bearing flange.
2. Camshaft gears	Camshaft, gears and bearing assembly	1. Place in arbor press. 2. Place a wooden block under the lower end of the camshaft to protect the threads when the shaft is pressed from the gear.	



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

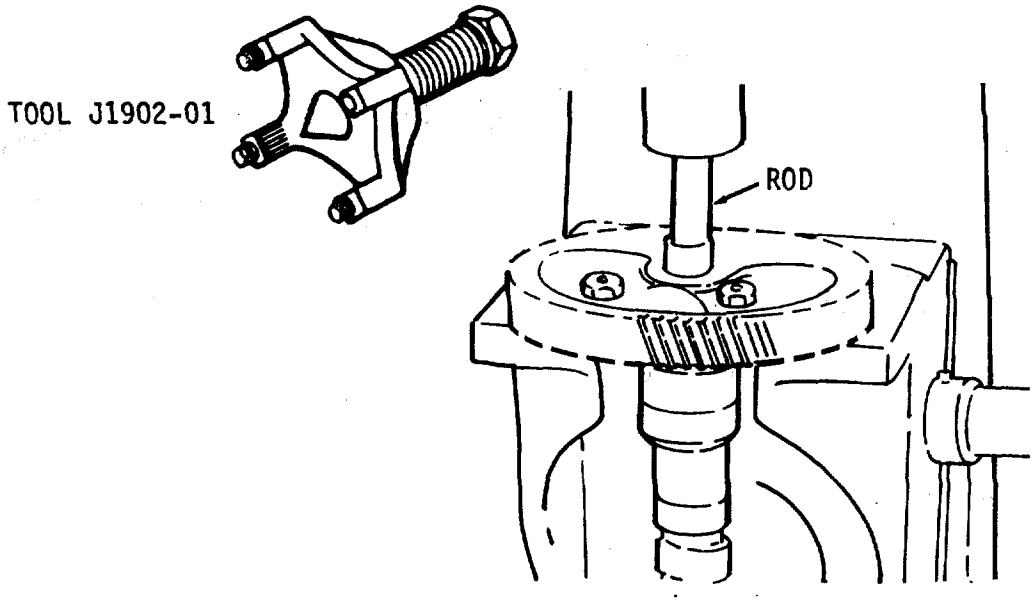
3. Place a short one-inch diameter brass rod on the end of the camshaft and press the shaft (18 or 19) out of the gear (11 or 12).

NOTE

If an arbor press is not available, tool J1902-01 may be used to remove the gear from the camshaft.

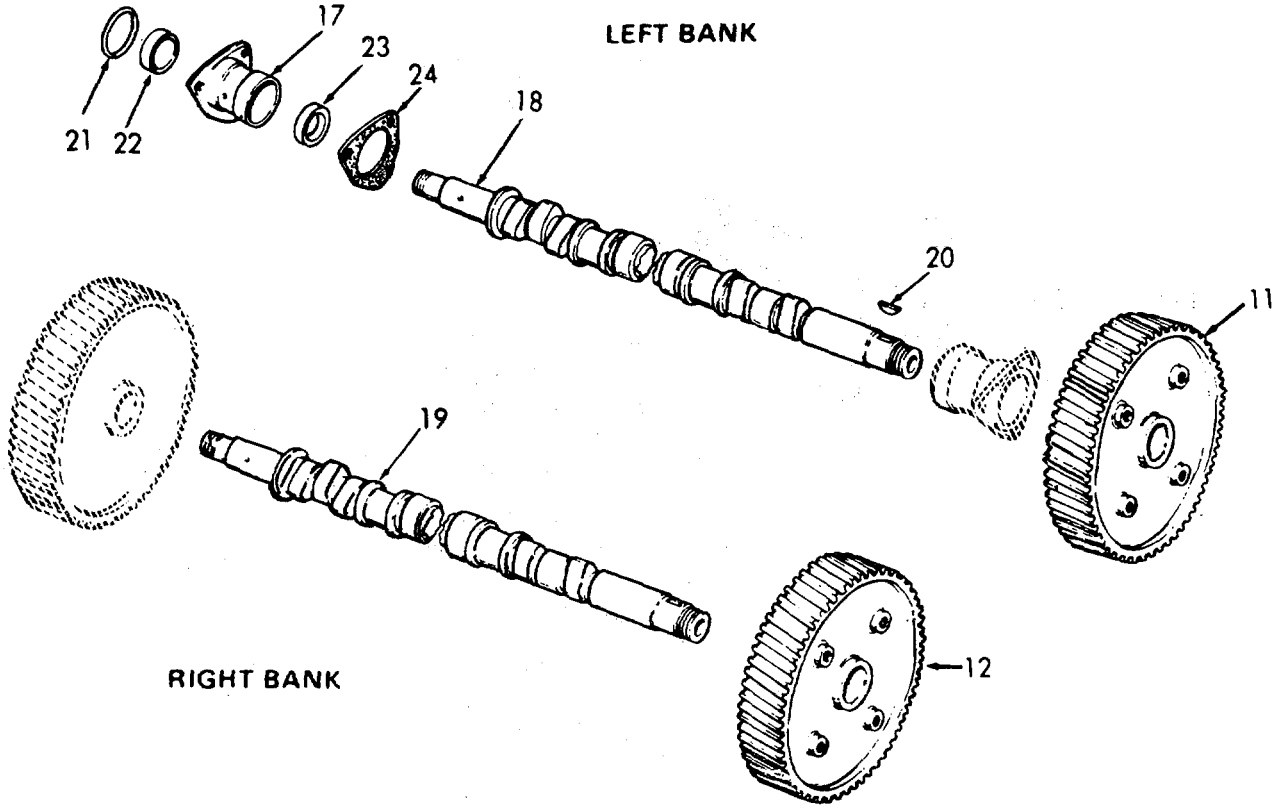
4. If necessary, remove the key (20) from the camshaft.

5. Remove the gear from the other camshaft in a similar manner.



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
3. Camshaft left bank forward	a. Oil seal (21), and bushing (22)	Remove.	
	b. Bearing (17), bushing (23), and gasket (24)	Remove.	Discard gasket.



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Thrust washer (25), bushing (26), rear end bearing (27), bushing (28), and thrust washer (29)	Slide off of each camshaft.	
	d. Lockrings (30), and intermediate bearings halves (10 and 31)	Remove.	
	e. Plugs (32 and 33)	Remove the end plugs from each camshaft, to facilitate the removal of any foreign material lodged behind the plugs, as follows: 1. Clamp the camshaft in a vise equipped with soft jaws, being careful not to damage the cam lobes or machined surfaces of the shaft. 2. Make an indentation in the center of the camshaft end plug with a 31/64" drill (carboloy tip.	Discard plugs.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

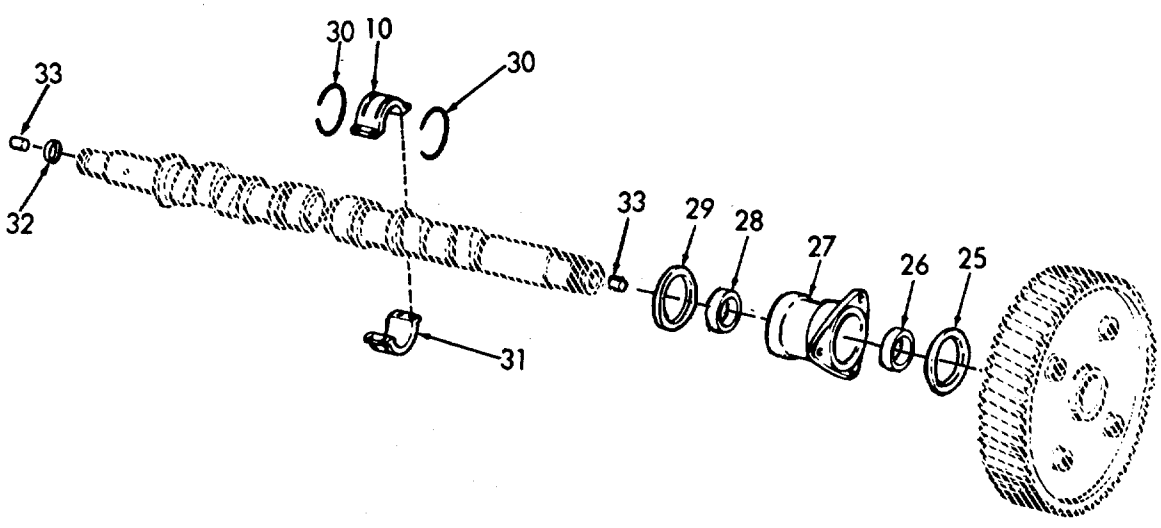
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

3. Punch a hole as deeply as possible with a center punch, to aid in breaking through the hardened surface of the plug.

4. Then, drill a hole straight through the center of the plug with a 1/4" drill (carboloy tip).

5. Use the 1/4" drilled hole as a guide and re-drill the plug with a 5/16" drill (carboloy tip).



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

6. Tap the drilled hole with a 3/8"-16 tap.

7. Thread a 3/8"-16 adaptor J8183 into the plug. Then attach a slide hammer to the adaptor and remove the plug by striking the weight against the handle .

8. Insert a length of 3/8" steel rod in the camshaft oil gallery and drive the remaining plug out.

NOTE

If a steel rod is not available, remove the remaining plug as outlined in Steps 1 through 7.

INSPECTION

4. Camshaft

WARNING

Wear protective eye goggles when using compressed air.

a. Soak the camshaft in clean fuel oil. Then, run a wire brush through the oil gallery to remove any foreign material or sludge. Clean the exterior of the camshaft and blow out the oil gallery and the oil holes with compressed air. Clean the gears, camshaft bearings and related parts with fuel oil and dry them with compressed air.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

b. Inspect the cams and journals for wear or scoring. If the cams are scored, inspect the cam followers. Also, inspect the camshaft keyways and threads for damage.

c. Runout at the center bearing, when mounted on end bearing surfaces, should not exceed .002" maximum.

d. Examine both faces of each camshaft rear end bearing and thrust washer. Also, examine the surfaces of each camshaft and camshaft gear which contact the thrust washers. Replace excessively worn or scored parts. Camshaft or camshaft gear thrust surfaces that are not scratched too severely may be smoothed down with an oil stone.

NOTE

If a new camshaft is to be installed, steam clean it to remove the rust preventive and blow out the oil passages with compressed air.

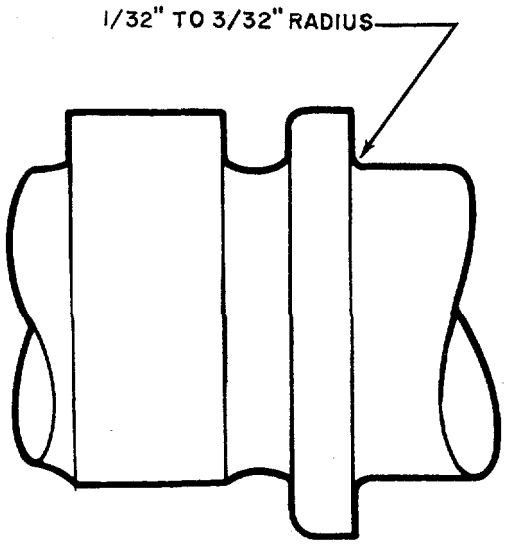
e. New standard size thrust washers are .120" to .122" thick. The clearance between the thrust washer and the thrust shoulder of the camshaft is .004" to .012" with new parts, or a maximum of .018" with used parts. Excessive clearance may be reduced by using thrust washers which are .005" or .010" oversize.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

f. When the thrust surfaces of a camshaft are ground undersize, a radius of 1/32" to 3/32" must be maintained between the bearing surface of the thrust collar shoulder and the bearing surface of the camshaft. A fillet radius gage may be used to measure the specified radii.



g. Inspect the bushings in the front and rear camshaft end bearings. Replace the bushings if they are worn excessively or have turned in the bearing. New bushings must be finish bored to a 20 R.M.S. finish after installation and checked for the proper press fit, which is indicated if the bushings will not move when a 2000 pound end load is applied. Also, the inside diameter of the bushings must be square with the rear face of the bearing within .0015" total indicator reading and concentric with the outside diameter of the bearing housing within .002" total indicator reading. The bushings must project .045" to .055" from each end of the rear camshaft end bearings. The bushings in the front camshaft end bearings must be flush with the ends of the bushing bore.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

h. The clearance between the camshaft end journals and the camshaft end bearing bushings is .0025" to .004" or a maximum of .006" with used parts. Undersize and oversize camshaft end bearings are available for service.

i. Inspect the oil seal in the left bank camshaft front end bearing for wear or damage. Replace the seal if necessary. Also, examine the spacer used at the front end of each camshaft. The outside diameter of the spacer used in the left bank front end bearing must provide a smooth oil seal contact surface. The outside diameter is not ground and polished on the original spacer used on the right bank camshaft in current engines. Only the polished spacer is available for service and may be used in either position.

j. Replace excessively scored or worn camshaft intermediate bearings. The clearance between the camshaft journals and the intermediate bearings is .0025" to .005" with new parts, or a maximum of .009" with worn parts. Undersize and oversize camshaft intermediate bearings are available for service. Also, examine the intermediate bearing lock screws and the tapped holes in the cylinder block for damaged threads.

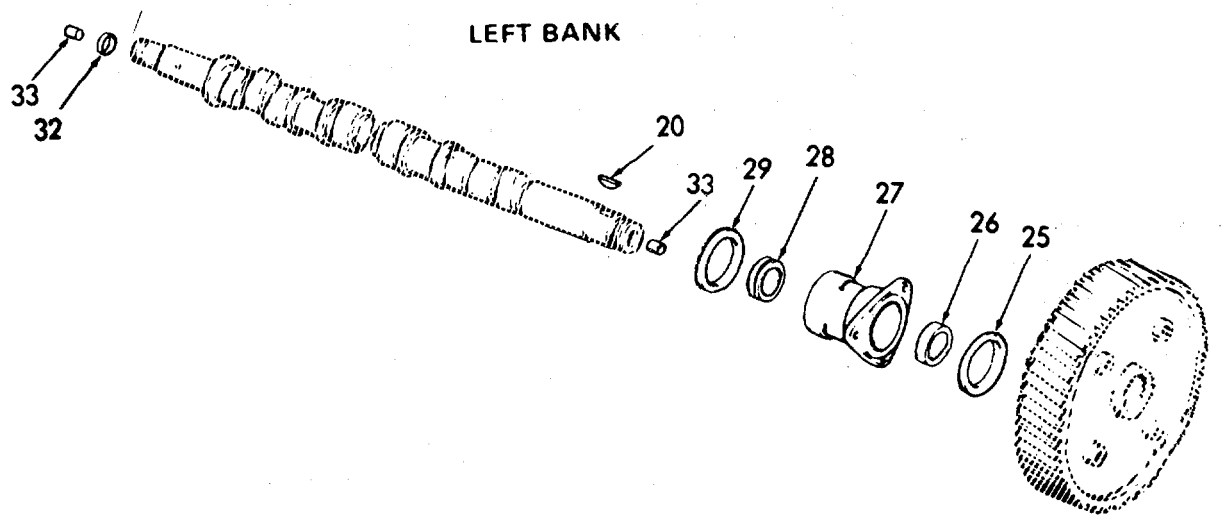
k. Examine the teeth on the water pump drive gear and the camshaft gears for scoring, pitting or wear. Replace the gears if necessary. Also, examine the keyways and tapped holes in the gears and the camshaft pulley for damage.

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	l. Inspect the vibration damper, if used, for dents, nicks or bulges in the outer casing of damper. Replace damper if necessary. Regardless of condition, the damper must be replaced at time of normal overhaul.		
	m. Effective with engines 12VA-458, a front camshaft gear with 66 teeth replaced the former gear which had 92 teeth to correspond with a change in the water pump drive gear.		
6. Camshaft gears		**WARNING** Wear protective eye goggles when using compressed air. Clean the gears with fuel oil and dry them with compressed air. Then, examine the gear teeth for scoring, pitting, or wear. Replace the gears if necessary. Also, check the other gears in the gear train.	
INSTALLATION			
7. Camshaft gears and parts	a. Plugs (32 and 33)	Install.	Use new plugs.
	b. Thrust washers (29)	Apply grease to the steel face of each thrust washer. Then, place a thrust washer against each end of the two camshaft rear end bearings. Be sure the steel face of each washer is next to the bearing.	

5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Bushing (28)	Install.	
	d. Rear end bearings (27)	Lubricate the rear camshaft bearing journal and slide a rear end bearing on each camshaft, with the bolting flange of the bearing toward the outer (camshaft gear) end of the shaft.	
	e. Bushings (26) , and lockring (25)	Install.	
	f. Keys (20)	Install.	



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

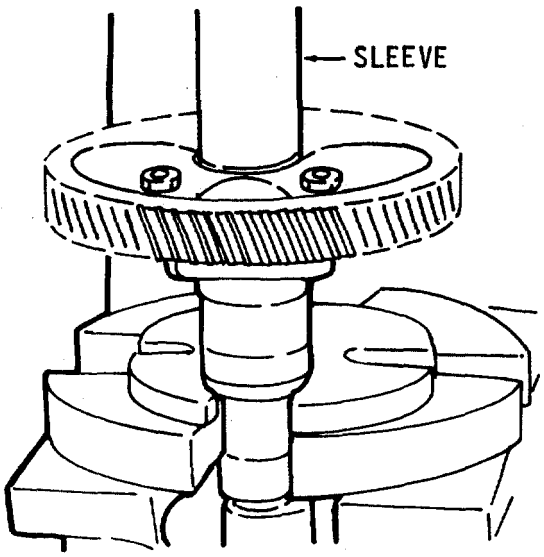
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

	g. Gears (11 and 12)	1. Start the gear over the end of the camshaft, with the key in the shaft aligned with the keyway in the gear. 2. Then, with the camshaft support in an arbor press, place a sleeve on top of the gear and press the gear tight against the shoulder on the shaft.	

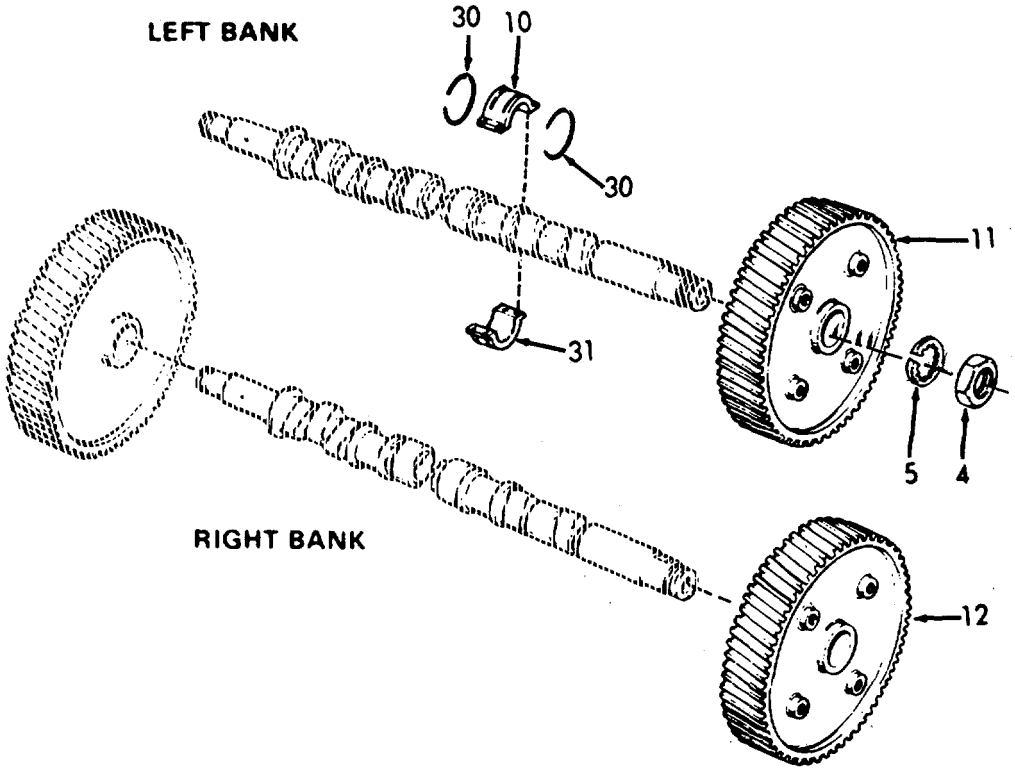
NOTE

If an arbor press is not available, use tool J1903 to install the gear on the camshaft.



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	h. Lockwasher (5), and nut (4) is installed.	Thread on camshaft.	The nut is tightened when the camshaft
	i. Inter-mediate bearings halves (10 and 31), and lockring (30) LEFT BANK	Lubricate the camshaft intermediate bearing journals. Then, place the two halves of each intermediate bearing on a camshaft journal and lock the halves together with two lock rings. Assemble each lock ring with the gap over the upper bearing and the ends an equal distance above the split line of the bearing.	

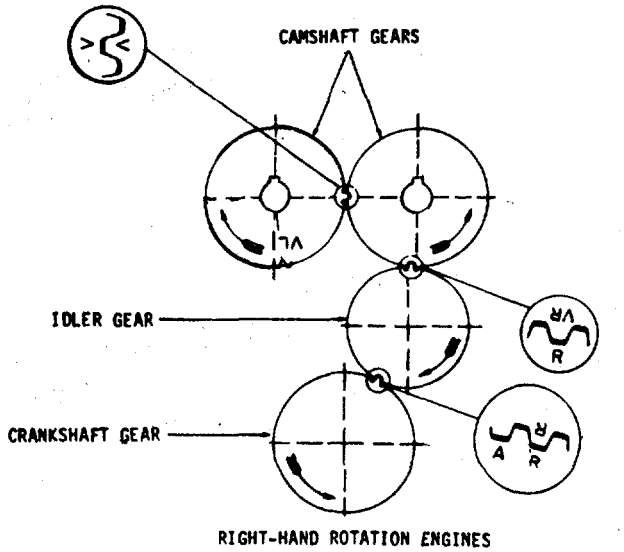


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

8. Camshaft	a. Camshaft (19)	1. Insert the front end of the camshaft with the right hand helix gear through the opening on the right bank side in the rear end plate until the first intermediate bearing enters the bore. Continue to work the camshaft and bearings into the cylinder block until the camshaft gear teeth are about to engage the teeth of the mating gear. Use care not to damage the cam lobes when installing the camshaft.	
		2. Align the timing marks on the mating gears as shown below and slide the camshaft gear in place.	

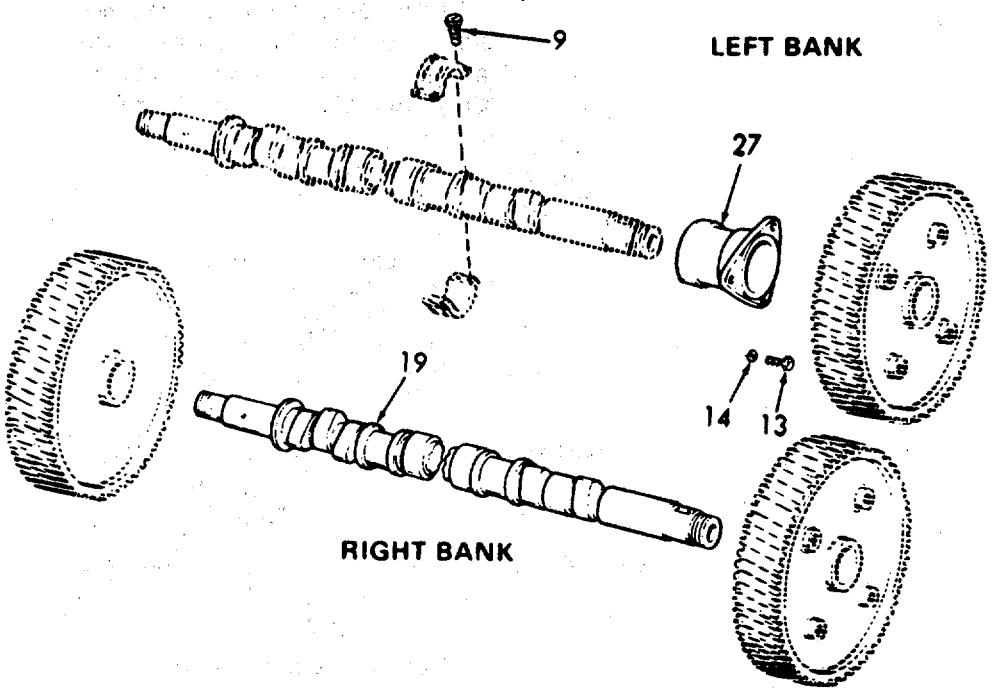


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

	b. Camshaft rear end bearing (27), screws (13), and lockwashers (14)	1. Rotate camshaft as required to install screws. 2. Tighten screws to 35-40 lb-ft (47.5 - 54.2 Nm) torque.	
	c. Inter-mediate bearings and lock screws (9)	1. Revolve the camshaft intermediate bearings to align the locking holes in the bearings with the tapped holes in the top of the cylinder block. 2. Install the lock screws. 3. Tighten screws to 15-20 lb-ft (20.3 - 27.1 Nm) torque.	

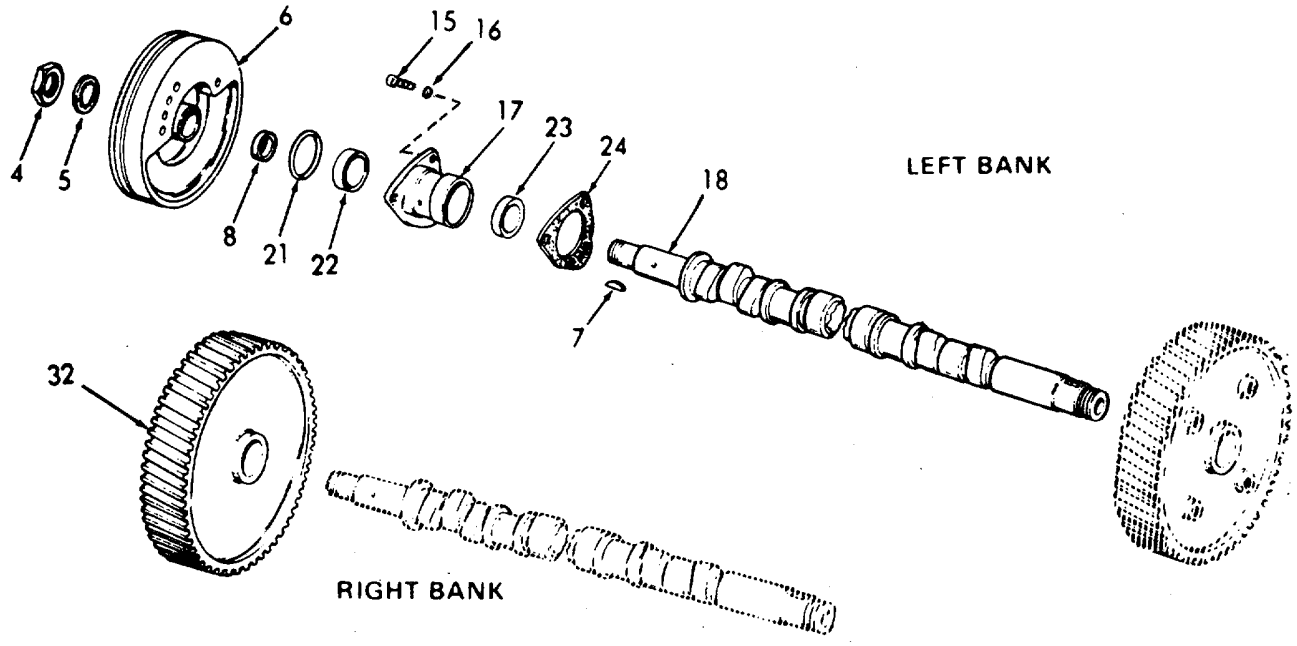


5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Camshaft (18)	Perform steps a thru c.	
	e. Gasket (24), bushing (23), front end bearing (17)	1. Install. 2. Lubricate bearing. 3. Slide bearing on left bank camshaft with the bolting flange towards the outer end of the shaft.	Use new gasket.
	f. Bushing (22), and left bank oil seal (21)	Install.	
	g. Bolts (15), and lockwashers (16)	1. Install. 2. Tighten bolts to 35-40 lb-ft (47.5 - 54.2 Nm) torque.	
	h. Front end bearing (17)	Install on right bank.	Perform steps e thru g above.
		NOTE There is no oil seal (21) on the right bank.	
	i. Spacer (8)	1. Lubricate. 2. Slide on left bank. 3. Install another spacer on right bank.	Spacer has polished outside diameter.
	j. Keys (7)	Install.	

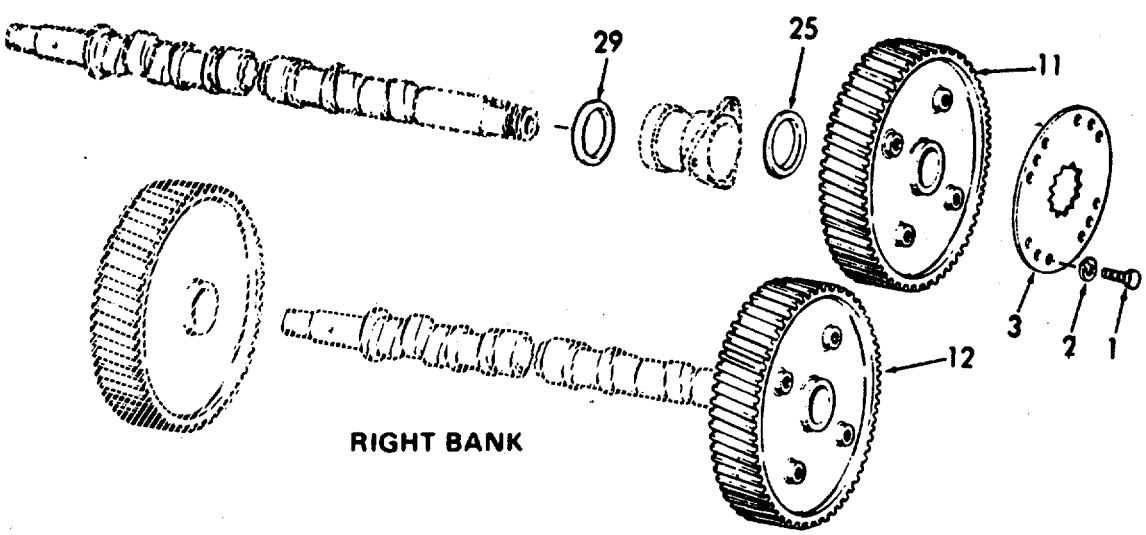
5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	k. Front balance pulley (6)	Install on left bank.	
	l. Right bank gear (32)	Install.	
	m. Internal tooth lockwashers (5), and nuts (4)	1 Install on both ends of each camshaft. 2. Wedge a clean cloth between the camshaft gears to prevent rotation. 3. Tighten nut to 300-325 lb-ft (406.8 - 440.7 Nm) torque.	



5-19.1. CAMSHAFT ASSEMBLY AND GEAR TRAIN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	n. Retainer nuts (3), screws (1), and lockwasher (2)	1. Install. 2. Tighten screws to 35-39 lb-ft (47.5 52.9 Nm) torque. 3. Remove clean cloth.	
	o. Thrust washers (25 and 29)	Check the clearance between the thrust washer and the thrust shoulder of each camshaft. The specified clearance is .004" to .012" with new parts or a maximum of .018" with used parts.	
	p. Gears (11 and 12)	Check the backlash between the mating gears. The specified backlash between new gears is .003" to .008" or a maximum of .010" between worn gears.	



5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **c. Reassembly** **e. Installation**
b. Disassembly **d. Test**

INITIAL SETUP:

Test Equipment
Spring gage

References
NONE

Special Tools

Arbor press

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

5-18 Flywheel Housing - Removal

Material/Parts
NONE

Special Environmental Conditions
NONE

Personnel Required
1

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

NOTE

Flywheel housing removed.

1.	Idler gear	a. Screw (1), and flat-washer (2)	Remove.
		b. Gear, hub and bearing assembly	Remove.

5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

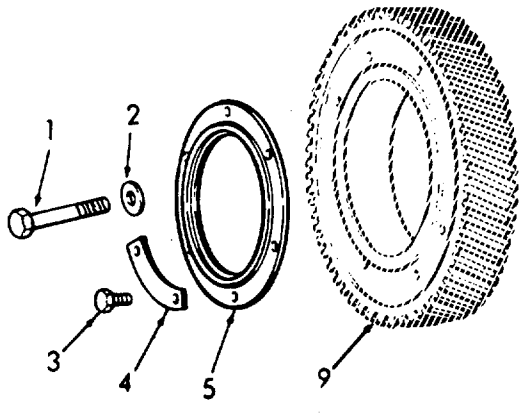
REMOVAL (Cont)

NOTE

Before removing the idler gear assembly, check the bearing by grasping the rim of the gear with both hands and rocking it. If the gear wobbles or shakes, the bearing must be replaced. If there is no perceptible wobble, it is only necessary to check the bearing pre-load before reinstalling the idler gear and bearing assembly.

DISASSEMBLY

2.	a.	Screws (3), bearing retainer locks (4), and bearing retainer (5)	Remove.



5-345

5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

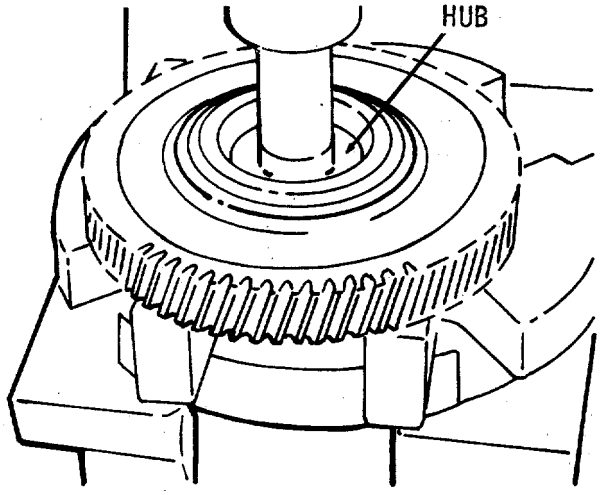
LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

NOTE

The component parts of the idler gear bearing are matched; therefore, matchmark the parts during disassembly to ensure reassembly of the parts in their original positions.

	b. Idler gear assembly (6), and hub (7)	Place the idler gear assembly in an arbor press, with the inner bearing cone supported on steel blocks as shown. While rotating the idler gear to prevent brinelling of the bearing, press the hub out of the bearing.	



	c. Bearing assembly (8)	Use a brass drift alternately at the four notches provided in the shoulder of the gear to tap the bearing cup(s) from the idler gear.	

5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION

3. a. Wash all parts thoroughly in clean fuel oil and dry with compressed air.

b. Examine the gear teeth for evidence of scoring, pitting, or wear. Also, examine the idler gear hub for wear or damage.

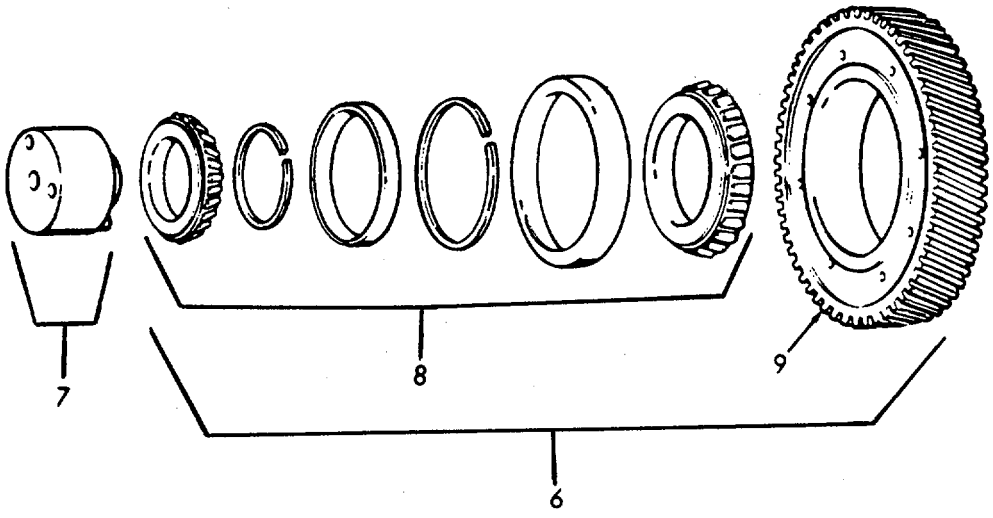
c. Inspect the bearing carefully for wear, pitting, scoring, or flat spots on the rollers or cups.

REASSEMBLY

NOTE

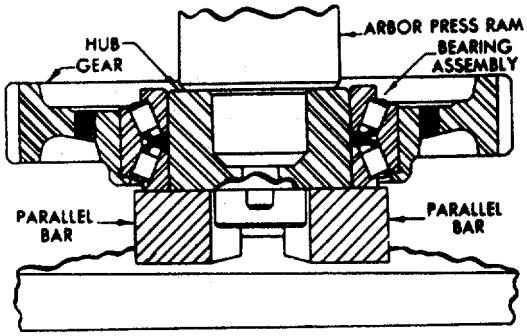
Use the match marks previously made to ensure assembly of the parts in the same positions from which they were removed. Then proceed as follows:

a. Idler gear (9) — Support gear, shoulder down, on the bed of an arbor press.



5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Bearing cup inner (10)	1. Start into gear numbered side up.	
		2. Press flat against the shoulder of gear.	Use a flat steel plate between the ram of the press and the bearing cup.
	c. Outer spacer ring (11)	Lay on the face of the bearing cup.	
	d. Bearing cup outer (12)	1. Start into gear numbered side up.	Use a flat steel plate between the ram of the press and the bearing cup.
		2. Press flat against the spacer ring.	
	e. Inner bearing cone (13), and idler gear hub (7)	Press cone on hub until flush with inner hub mounting face.	



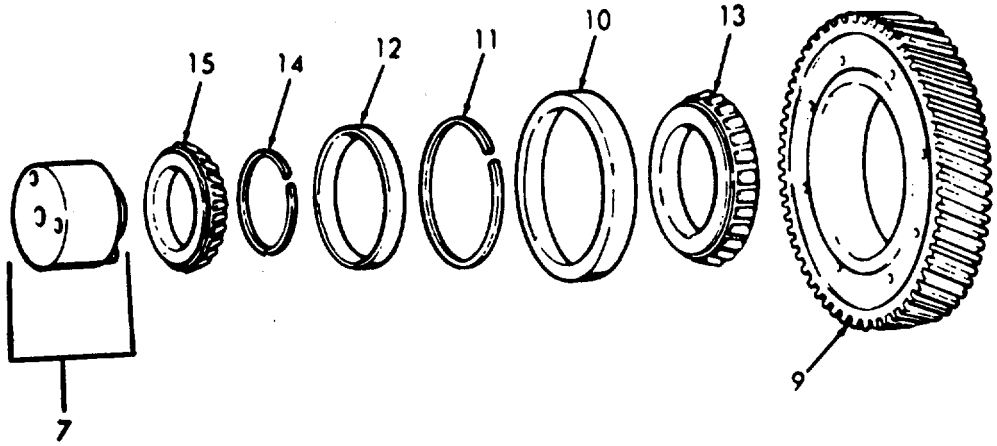
5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	f. Inner spacer ring (14), and idler hub (7) spacer ring.	Install the inner spacer ring on the idler gear hub so that the oil hole in the hub is 180° from the gap in the inner	
	g. Idler gear (9)	Position the gear with both cups over the hub and inner bearing cone.	

CAUTION

The bearing cones must be supported so as not to load the bearing rollers during this operation.

	h. Outer bearing cone (15)	Press the bearing cone over the hub, while rotating the gear to seat the rollers properly between the cones.	



5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
TEST			
5.	a.	Prior to installing and securing the bearing retainer, check the pre-load of the bearing assembly.	
	b.	The rollers in the bearing are loaded between the bearing cup and the bearing cones in accordance with design requirements to provide a rigid idler gear and bearing assembly. As the bearing cones are moved toward each other in a tapered roller bearing assembly, the rollers will be more tightly held between the cones and the cup. In the idler gear bearing, a slight pre-load is applied by means of a selected spacer ring between the bearing cones, to provide rigidity of the gear and bearing assembly when it is mounted on its hub. This method of pre-loading is measured, in terms of "pounds-pull", by the effort required at the outer diameter of the gear to turn the bearing cup in relation to the bearing cones.	
	c.	Check the bearing pre-load whenever the idler gear assembly is removed from the engine for service or for an engine overhaul.	
	d.	The idler gear bearing must be clean and lubricated with engine oil before checking the pre-load. If a new bearing has been installed, "work in" the bearing by rotating the gear back and forth several times.	

5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

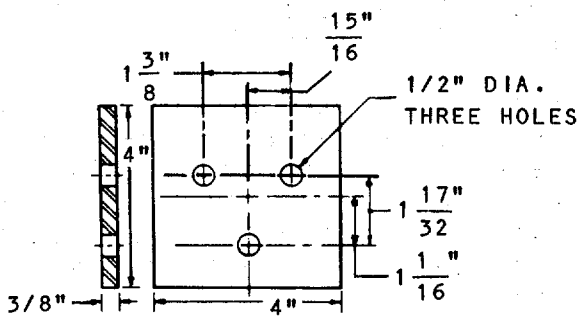
TEST (Cont)

e. If the crankshaft and camshaft gears are not mounted on the engine, the torque required to rotate the idler gear may be checked by mounting the idler gear in position on the engine, using a 4" square, 3/8" thick steel plate against the hub and cone as outlined below.

1. Mount the idler gear assembly on the engine.

2. Install the idler gear hub retaining bolt and washer and tighten the bolt to 80-90 lb-ft (108.5 - 122.0 Nm) torque.

3. Place the steel plate (lower plate shown below) against the hub and bearing. Insert three 3/8"-16 bolts through the plate and thread them into the hub. Tighten the bolts to 25-40 lb-ft (33.9 - 54.2 Nm) torque.

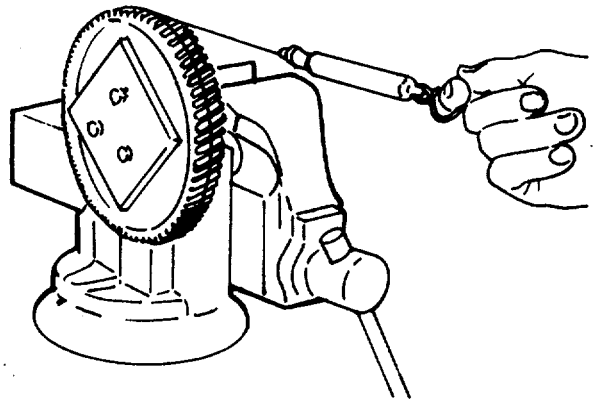


5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

TEST (Cont)

4. Tie one end of a piece of lintless 1/8" cord around a 1/8" round piece of wood (or soft metal stock). Place wood between two of the gear teeth and wrap the cord around the the gear several times as shown. Attach the other end of the cord to a spring scale. Maintain a steady pull on the cord and scale, 90° to the axis of the hub, and note the pull , in pounds and ounces, required to start the gear rotating. Make several checks to obtain an average reading. If the pull is within 1-1/4 lb (5.56 N) minimum to 6 lbs. 12 oz. (30.03 N) maximum, and does not fluctuate more than 2 lbs 11 oz. (11.98 N), the idler gear and bearing assembly is satisfactory for use.



5-352

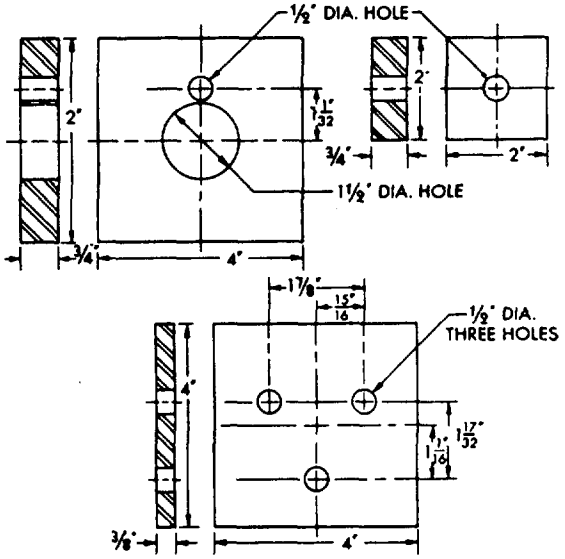
5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

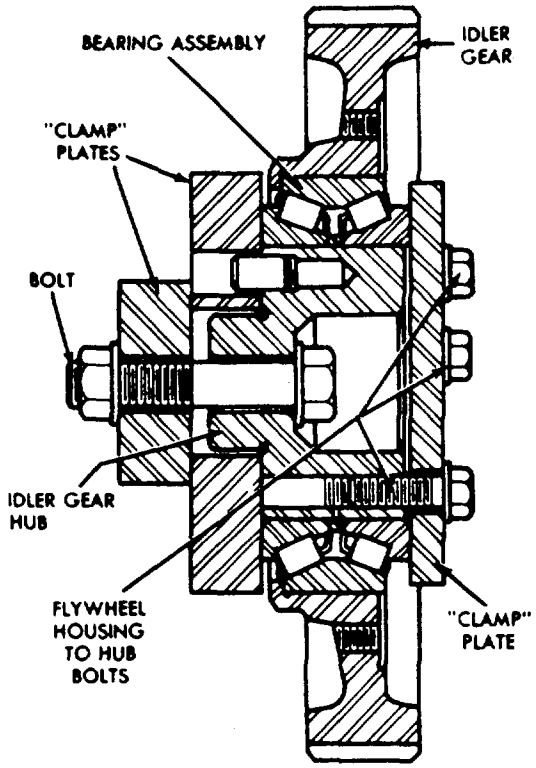
LOCATION	ITEM	ACTION	REMARKS

TEST (Cont)

f. If the crankshaft and camshaft gears are mounted on the engine, a suitable fixture, which may be held in a vise, can be made as shown. Three plates, a 1/2"-13 X 2-3/4" bolt, 1/2"-13 nut, and two 1/2" plain washers are required. The plates are made from steel stock. Check the pre-load on the bearings as follows:

1. Attach two of the steel plates (two upper plates) to the idler gear hub with the 1/2"-13 bolt, washers and nut as shown. Tighten the bolt to 80-90 lb.-ft (108.5 - 122.0 Nm) torque.



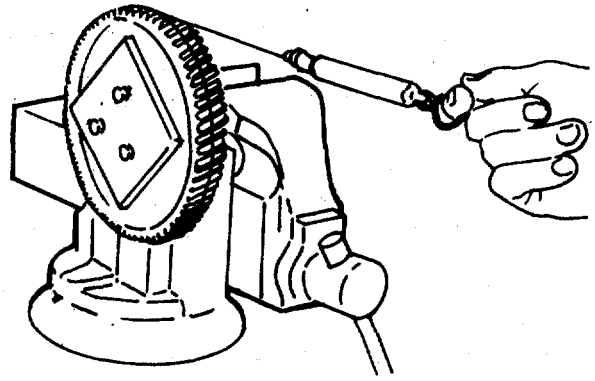


5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

TEST (Cont)

2. Attach the third plate to the idler gear hub with three 3/8"-16 bolts. Tighten the bolts to 25-40 lb.-ft (33.9 - 54.2 Nm) torque.
3. Clamp the idler gear assembly and fixture in a vise.



4. Attach a cord to the idler gear and spring scale and check the bearing pre-load as outlined in step e 4.

g. If the scale reading is within the specified 1-1/4 to 6-3/4 lbs (5.56 N to 30.03 N) specified but fluctuates more than 2 lbs. 11 ounces (11.98 N) the idler gear and bearing assembly must not be installed on the engine. Fluctuations in scale reading may be caused by the races not being concentric to each other, damaged races or rollers, or dirt or foreign material within the bearings. In these cases, the bearing should be inspected for the cause of fluctuation in the scale readings and corrected or a new bearing installed.

5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

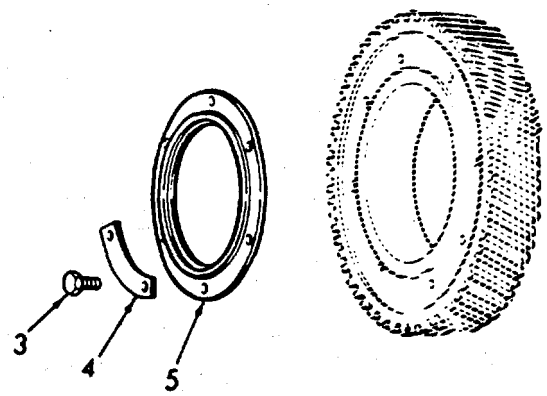
TEST(Cont

h. A scale reading which exceeds the specified maximum indicates binding of the bearing rollers, or rollers improperly installed. When the scale reading is less than the specified minimum, the bearing is more likely worn and the bearing should be replaced.

i. After pre-load check is completed, remove the steel plates and install the bearing retainer (5) as follows:

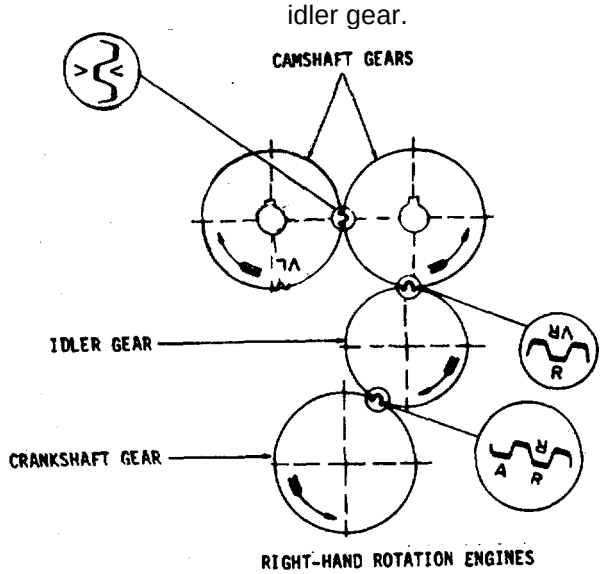
1. Attach the bearing retainer to the idler gear with six screws (3) and three screw locks (4). Tighten the screws to 24-29 lb.-ft (32.5 - 39.3 Nm) torque.

2. Bend the ears of each screw lock against the flat side of the attaching screw heads to secure the screws.

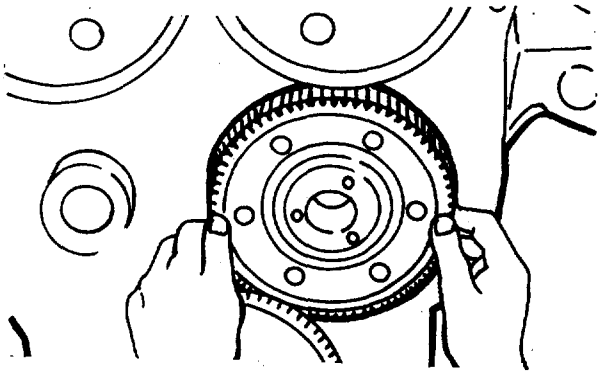


5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Idler gear	a. Idler gear assembly	1. Position the crankshaft gear and camshaft gear so the timing marks will align with those on the idler gear.	

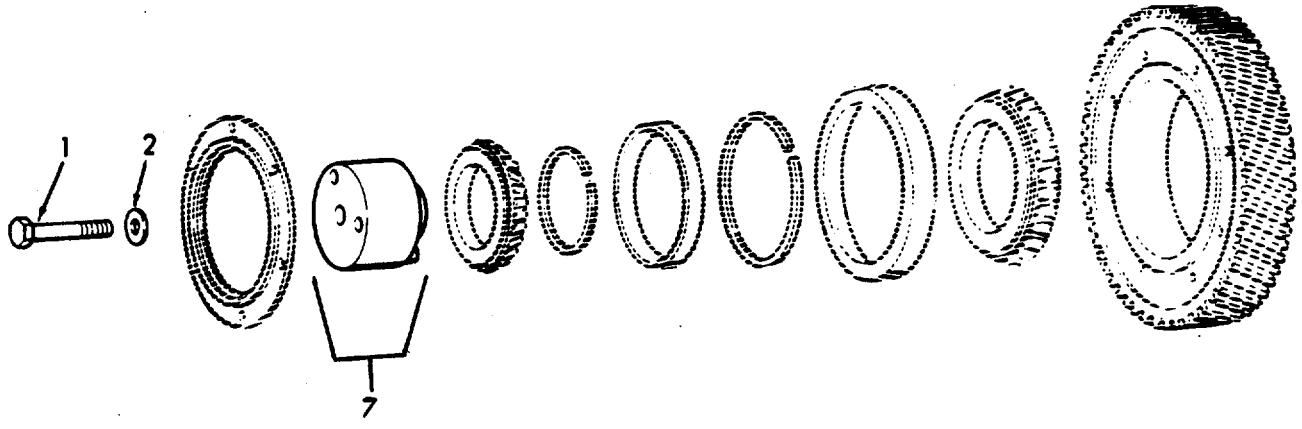


2. With the timing marks in alignment, start the idler gear in mesh with the crankshaft gear and camshaft gear, and simultaneously rotate the gear so the pin in the hub registers with the hole in the end plate.



5-19.2. IDLER GEAR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		3. Roll the idler gear into position and align the hollow pin with the hole in the end plate. Then, gently tap the hub until it seats against the end plate.	
	b. Screw (1), and flat washer (2)	1. After making sure the hub (7) is tight against the end plate 2. Tighten screw to 80-90 lb.-ft (108.5 - 122.0 Nm) torque.	
	c. Idler gear hole spacer (dummy hub)	1. Install. 2. Tighten screw to 80-90 lb.-ft (108.5 - 122.0 Nm) torque.	
	d. Idler gear bearing	1. Lubricate the idler gear bearing and gear teeth liberally with clean engine oil. 2. Check the backlash between the mating gears. The backlash must be .003" to .008" between new gears and must not exceed .010" between worn gears.	



5-19.3. IDLER GEAR HOLE SPACER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Repair

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
1

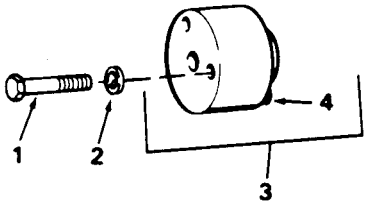
References
NONE

Equipment Condition **Condition Description**
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
1. Spacer	a. Screw (1) b. Flat washer (2) c. Spacer (3) d. Dowel (4)	Repair.	As Required



5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS.

This task covers:

a. Repair
a. Cleaning
c. Pressure Test
d. Inspect

INITIAL SETUP

Test Equipment

Feeler gauge
Straight edge
Depth gauge

References

Chapter 3 (volume 4) Removal of all parts
Chapter 5 Removal of all parts

Special Tools

Drift ¾ inch
Hammer 1 pound
Hone
120 grit stone

Equipment Condition: NONE

Material/Parts

Pickling Acid
Alkaline Solution (heavy duty)
Permatex
International Compound #2 or equivalent
Rust preventive

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
1. Cylinder Block	All components	Remove.	Refer to Chapter 3 and 5.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING

2. a. Scrape all gasket material from the cylinder block. Then remove all oil gallery plugs and core hole plugs (except cup plugs) to allow the cleaning solution to contact the inside of the oil and water passages. This permits more efficient cleaning and eliminates the possibility of the cleaning solution attacking the aluminum core hole plug gaskets (if used).

b. If a core hole plug is difficult to remove, hold a ¾ inch drift against the plug and give it a few sharp blows with a one pound hammer. With a ½ 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.

c. Clean the cylinder block as follows:

(1) Remove the grease by agitating the cylinder block in a hot bath of commercial heavy-duty alkaline solution.

(2) Wash the block in hot water or steam clean it to remove the alkaline solution.

(3) If the water jackets are heavily scaled, proceed as follows:

(a) Agitate the block in a bath of inhibited commercial pickling acid.

(b) Allow the block to remain in the acid bath until the bubbling stops (approximately 30 minutes).

(c) Lift the block, drain it and reimmerse it in the same acid solution for 10 minutes.

(d) Repeat Step "(c)" until all scale is removed.

(e) Rinse the block in clear hot water to remove the acid solution.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING (Cont)

(f) Neutralize the acid that may cling to the casting by immersing the block in an alkaline bath.

(g) Wash the block in clean water or steam clean it.

WARNING

Wear protective eye goggles when using compressed air.

(4) Dry the cylinder block with compressed air.

(5) Make certain that all water passages, oil galleries and air box drain openings have been thoroughly cleaned.

NOTE

The above cleaning procedure may be used on all ordinary cast iron and steel parts of the engine. Mention will be made of special cleaning procedures whenever necessary.

(6) After the block has been cleaned and dried, coat the threads of the plugs with sealant and, using new gaskets, reinstall the core hole plugs. Tighten the 1 ¾ inch-16 plugs to 150-180 lb-ft (203.4-244.0 N·m) torque and the 2 ½ inch-16 plugs to 230-270 lb-ft (311.8-366.1 N·m) torque.

CAUTION

Excessive torque applied to the core hole plugs may result in cracks in the water jacket.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING (Cont)

d. If for any reason the cup plugs in the water jackets were removed, install new plugs as follows:

(1) Clean the cup plug holes and apply Permatex No. 1 sealant, or equivalent, to the outer diameter of the plugs.

(2) Drive the plugs in place with handle and adaptor.

PRESSURE TEST

3. After the cylinder block has been cleaned, it must be pressure tested for cracks or leaks by either one of two methods.

a. This method may be used when a large enough water tank is available and the cylinder block is completely stripped of all parts.

(1) Seal off the water inlet and outlet holes air tight. This can be done by using steel plates and suitable rubber gaskets held in place by bolts. Drill and tap one cover plate to provide a connection for an air line.

(2) Immerse the block for twenty minutes in a tank of water heated to 180° -200° F (82.2-93.3° C).

(3) Apply 40 psi (275.8 kPa) air pressure to the water jacket and observe the water in the tank for bubbles which indicate the presence of cracks or leaks in the block. A cracked cylinder block must be replaced by a new block. (4) After the pressure test is completed, remove the block from the water tank. Then remove the plates and gaskets and dry the block with compressed air.

b. This method may be used when a large water tank is unavailable, or when it is desired to check the

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

PRESSURE TEST (Continued)

block for cracks without removing the engine from the equipment which it powers. However, it is necessary to remove the cylinder heads, blower, oil cooler, air box covers and oil pan.

(1) Attach sealing plates and gaskets as in method a. However, before attaching the last sealing plate, fill the water jacket with a mixture of water and one gallon of antifreeze. The antifreeze will penetrate small cracks and its color will aid in detecting their presence.

(2) Install the remaining sealing plate and tighten it securely.

(3) Apply 40 psi (275.8 kPa) air pressure to the water jacket and maintain this pressure for at least two hours to give the water and antifreeze mixture ample time to work its way through any cracks which may exist.

(4) At the end of the test period, examine the cylinder bores, air box, oil passages, crankcase and exterior of the block for presence of the water and antifreeze mixture which will indicate the presence of cracks. A cracked cylinder block must be replaced by a new block.

(5) After the test is completed, remove the plates, drain the water jacket and blow out all of the passages in the block with compressed air.

INSPECT

4. a. After cleaning and pressure/testing, inspect the cylinder block.

b. Since most of the engine cooling is accomplished by heat transfer through the cylinder liners to the water jacket, a good liner-to-block contact must exist when the engine is operating. Whenever the cylinder liners are removed from an engine the block bores must be inspected.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

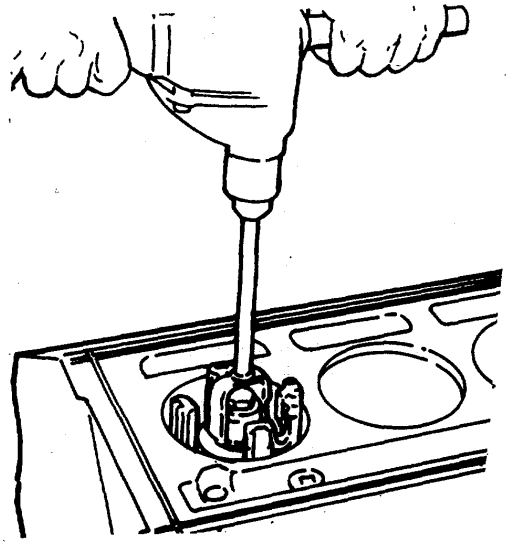
NOTE

Before attempting to check the block bores, hone them throughout their entire length until about 75% of the area above the ports has been "cleaned-up".

c. Hone the block bores as follows:

(1) Use a hone in which the cutting radius of the stones can be set in a fixed position to remove irregularities in the bore rather than following the irregularities as with a spring-loaded hone. Clean the stones frequently with a wire brush to prevent stone loading. Follow the hone manufacturer's instructions regarding the use of oil or kerosene on the stones. Do not use such cutting agents with a dry hone. Use 120 grit stones.

(2) Insert the hone in the bore and adjust the stones snugly to the narrowest section. When correctly adjusted, the hone will not shake in the bore, but will drag freely up and down the bore when the hone is not running.



5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

(3) Start the hone and "feel out" the bore for high spots which will cause an increased drag on the stones. Move the hone up and down the bore with short overlapping strokes about 1 inch (2.54 cm) long. Concentrate on the high spots in the first cut. As these are removed, the drag on the hone will become lighter and smoother. Do not hone as long at the air inlet port area as in the rest of the bore because this area, as a rule, cuts away more rapidly. Feed lightly to avoid an excessive increase in the bore diameter. Some stones cut rapidly even under low tension.

(4) When the bore is fairly clean, remove the hone, inspect the stones and measure the bore. Determine which spots must be honed most. Moving the hone from the top to the bottom of the bore will not correct an out-of-round condition. To remain in one spot too long will cause the bore to become irregular. Where and how much to hone can be judged by feel. A heavy cut in a distorted bore produces a steady drag on the hone and makes it difficult to feel the high spots. Therefore, use a light cut with frequent stone adjustments.

(5) Wash the cylinder block thoroughly after the boring operation.

d. Check the cylinder block bores:

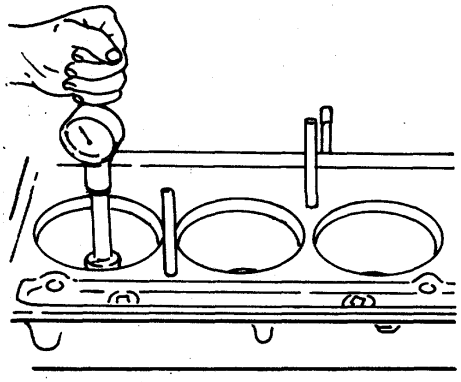
(1) Visually check the contact area as revealed by the honed surface. There must not be any low spots which are larger in area than a half dollar.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

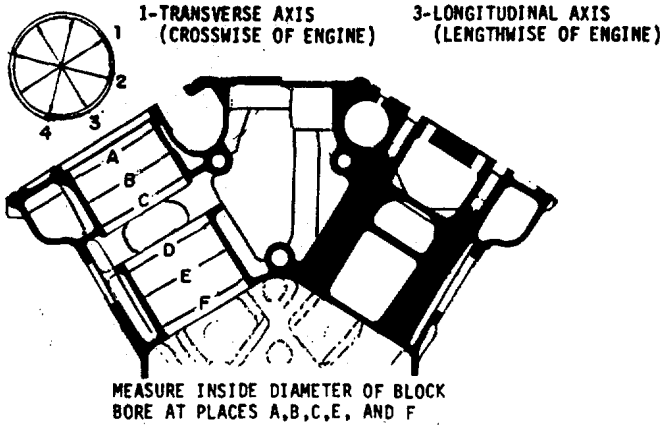
LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

(2) Measure the entire bore of each cylinder with cylinder bore gauge J5347 which has a dial indicator calibrated in .0001 inch increments. The standard block bore is 4.6260 inch to 4.6270 inch.



(3) First, place the bore gauge in the master ring gauge J8386-01 which has anI.D. of 4.6270 inch and set the dial to zero. Next, rotate the dial clockwise .0005 inch to give a zero dial indicator setting of 4.6265 inch. Take measurements on the cleaned-up surface only at positions A, B, C, D, E and F in the bore on axes 45° apart. Read the measurements from the zero mark on the gauge. The readings may be recorded on a form similar to the on, illustrated.



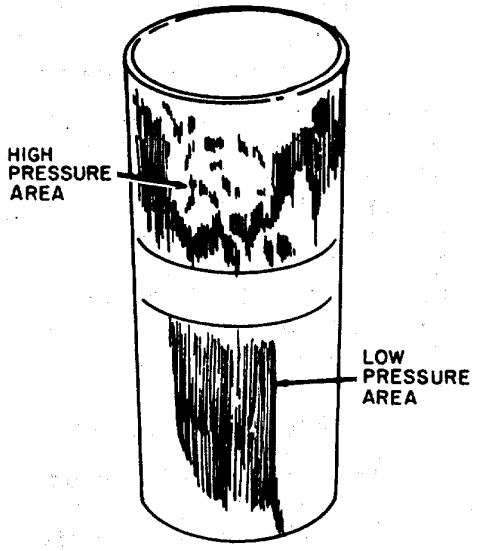
5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

	Trans.	45°	Long.	45°
	1	2	3	4
A				
B				
C				
Port Belt	X	X	X	X
D				
E				
F				

(4) The cylinder liner is alternately expanding and contracting, during engine operation, due to temperature variations. This may result in irregularities in the block bores (out-of-round and taper), the effects of which will be seen as high pressure areas on the outside of the cylinder liner.



(5) If a new liner and piston is installed in the block without properly fitting the liner, galling and seizing of the piston may result. This is caused by the new piston having to travel over the irregularities without time to conform to the particular shape of the block bore.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

e. Fit the liner to the cylinder block:

The liner-to-block clearance with new parts is zero to .002 inch. With used parts, the maximum liner-to-block clearance is .0025 inch. Examine the block bore measurements to determine if standard or .001 inch oversize O.D. liners can be used, or if the cylinder block should be bored oversize. A light push fit between the liner and the block is desirable. However, a good fit between the cylinder liner and block may be obtained by comparing the average bore sizes in table below.

For Average Block Bore I.D. Size of	Use Liner O.D. Size	To Give A Liner-to-Block Clearance of
4.6260 inch 4.6275 inch	Standard	.000 inch to .0025 inch
4.6270 inch 4.6285 inch	.001 inch Oversize	.000 inch to .0025 inch

f. If necessary, bore the cylinder block as follows:

(1) Each bore in a used block must not be out-of-round or tapered more than .002 inch. If the average block bore is over 4.6285 inch, the block should be bored oversize as shown below.

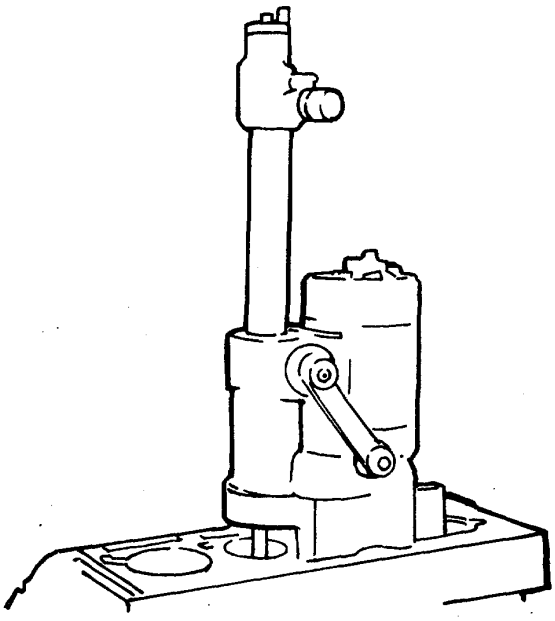
Block Boring Dimensions	Liner O.D. Size	Maximum Block Bore I.D. on a Used Block
4.631 inch 4.632 inch	.005 inch Oversize	4.6325 inch
4.636 inch 4.637 i7nch	.010 inch Oversize	4.6375 inch
4.646 inch 4.647 inch	.020 inch Oversize	4.6475 inch
4.656 inch 4.657 inch	.030 inch Oversize	4.6575 inch

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

(2) A typical commercially available portable boring bar is illustrated. Instructions on correct use of the boring bar are provided by the manufacturer.



(3) After boring the block for an oversize cylinder liner, check the bore finish to be sure it is smooth (120 RMS). Heat transfer from the cylinder liner to the block will be adversely affected if the block isn't smooth.

(4) Wash the block thoroughly after the boring operation.

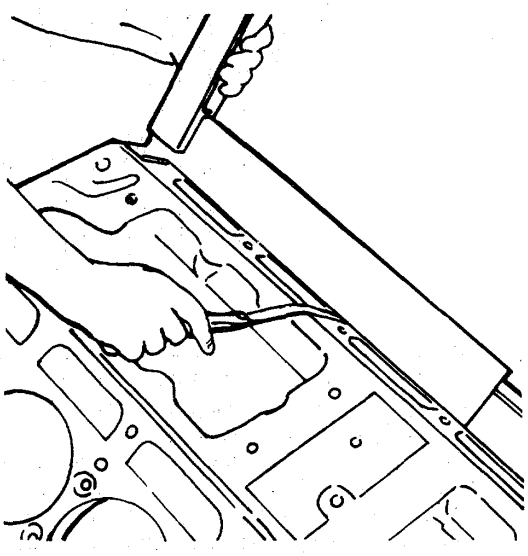
(5) When an oversize liner is used, stamp the size of the liner on the top deck of the block adjacent to the liner counterbore. An oversize liner insert must be installed whenever an oversize liner is used.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

g. Check the top of the block (cylinder head contact surfaces) for flatness with an accurate straight edge and a feeler gauge.



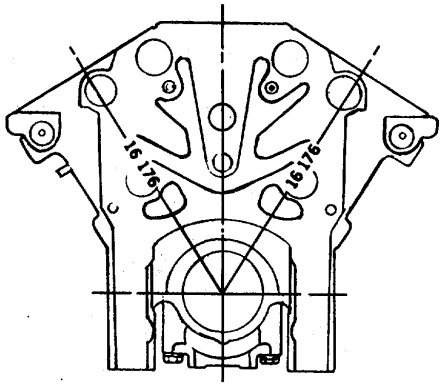
(1) The cylinder head contact surfaces of the block must not vary more than .003 inch transversely and' not over .009 inch longitudinally. It will be difficult to prevent water, oil and compression leaks if these surfaces exceed these tolerances.

(2) If it is necessary to machine these surfaces to correct for the above conditions, do not remove more than .008 inch of metal. Stamp the amount of stock removed on the face of the block. The distance from the centerline of the crankshaft to the top of the cylinder head surface of the block must not be less than 16.176 inch.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)



(3) If stock is removed from the cylinder head contact surfaces of the block, check the depth of the seal ring grooves and counterbores. The cylinder head seal strip grooves must be .092-.107 inch deep. The large water hole counterbores (between the cylinders) must be .109-.120 inch deep, and the combination water and oil hole counterbores and small water hole counterbores must be .087-.098 inch deep. If necessary, deepen the grooves or counterbores to the specified limits to retain the proper "crush" on the seal rings. It is not necessary to deepen the counterbores for the cylinder liners since .004 inch and .008 inch undersize thickness inserts are available for adjusting the liner position as outlined in Chapter 3 paragraph 3-40 under Fitting Cylinder Liner in Block Bore.

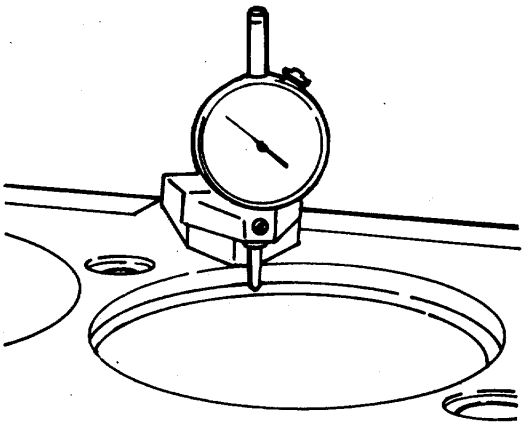
h. Make sure the cylinder liner counterbores in the block are clean and free of dirt. Then check the depth. The depth must be .4770 inch to .4795 inch and must not vary more than .0015 inch throughout the entire circumference. The counterbored surfaces must be smooth and square with the cylinder

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

bore within .001 inch total indicator reading. There must not be over .001 inch difference between any two adjacent cylinder counterbores when measured along the cylinder longitudinal centerline of the cylinder block.



i. Check the main bearing bores as follows:

(1) Check the bore diameters with the main bearing caps in their original positions. Lubricate the bolt threads and bolt head contact areas with a small quantity of International Compound No. 2, or equivalent. Then install and tighten the bolts to 165-175 lb-ft (223.7-237.3 Nm) torque. When making this check, do not install the main bearing cap stabl1izers. The specified bore diameter is 4.812 inch to 4.813 inch. If the bores do not fall within these limits, the cylinder block must be rejected.

CAUTION

Main bearing cap bolts are especially designed for this purpose and must not be replaced by ordinary bolts.

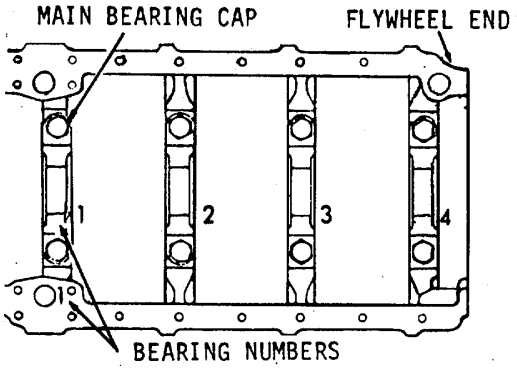
5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

NOTE

Bearing caps are numbered to correspond with their respective positions in the cylinder block. It is imperative that the bearing caps are reinstalled in their original positions to maintain the main bearing bore alignment. The number of the front main bearing cap is also stamped on the face of the oil pan mounting flange of the cylinder block, adjacent to its permanent location in the engine as established at the time of manufacture. The No.1 main bearing cap is always located at the end opposite the fly-wheel end of the cylinder block.



(2) Finished and unfinished main bearing caps are available for replacing broken or damaged caps. When fitting a finished replacement bearing cap, it may be necessary to try several caps before one will be found to provide the correct bore diameter and bore alignment. If a replacement bearing cap is installed, be sure to stamp the correct bearing position number on the cap.

NOTE

Use the unfinished bearing caps for the front and intermediate bearing positions. The finished bearing caps, machined for the crankshaft thrust washers, are to be used in the rear bearing position.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

(3) Main bearing bores are line-bored with the bearing caps in place and thus are in longitudinal alignment. Bearing bores may be considered properly aligned with one another if the crankshaft can be rotated freely by hand after new bearing shells have been installed and lubricated and the bearing caps have been secured in place and the bolts tightened to 180-190 lb-ft (244.0-257.6 N·m) torque. If a main bearing bore is more than .001 inch out of alignment, the block must be line-bored or scrapped. Misalignment may be caused by a broken crankshaft, excessive heat or other damage.

(4) If the main bearing bores are not in alignment or a replacement bearing cap is used, the block must be line-bored. Install the bearing caps in their original positions (without the bearing cap stabilizers) and tighten the bolts to 165-175 lb-ft (223.7-237.3 Nm) torque. Line-bore the block, but do not remove more than .001 inch stock. After boring, all bores must be within the specified limits of 4.812 inch to 4.813 inch.

j. Replace loose or damaged dowel pins. The dowels at the ends of the cylinder block extend .630 inch from cylinder blocks.

The dowels used to retain the crankshaft thrust washers on the rear main bearing cap must extend .110 inch to .120 inch from the surface of the bearing cap.

k. If used, replace damaged or broken cylinder head studs. Drive new studs to a height of 4 3/8 inches ± 1/32 inch above the block at a minimum of 75 lb-ft (101.7 N·m) torque. Also examine the cylinder head retaining bolt holes. If the threads are damaged, use a tap to "cleanup" the threads or install a helical thread insert.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

l. The tapped holes in the cylinder blocks may be tapped with a 5/8 inch-11 UNC3B thread tap. The stud holes and unplugged bolt holes must have the thread extending 1.85 inch below the block surface. If the bolt hole in the block is plugged, the plug must be a minimum of 1.92 inch below the surface of the block and threaded the full distance. When replacing a bolt hole plug in the current water-below-port block.

m. Check the remaining cylinder block surfaces and threaded holes. Check all of the mating surfaces, or mounting pads, for flatness, nicks and burrs. Clean-up damaged threads in tapped holes with a tap or install helical thread inserts, if necessary.

n. After inspection, if the cylinder block is not to be used immediately, spray the machined surfaces with engine oil. If the block is to be stored for an extended period of time, spray or dip it in a polar type rust preventive such as Valvoline Oil Company's "Tectyl 502-C", or equivalent. Castings free of grease or oil will rust when exposed to the atmosphere.

WARNING

Wear protective goggles when using compressed air.

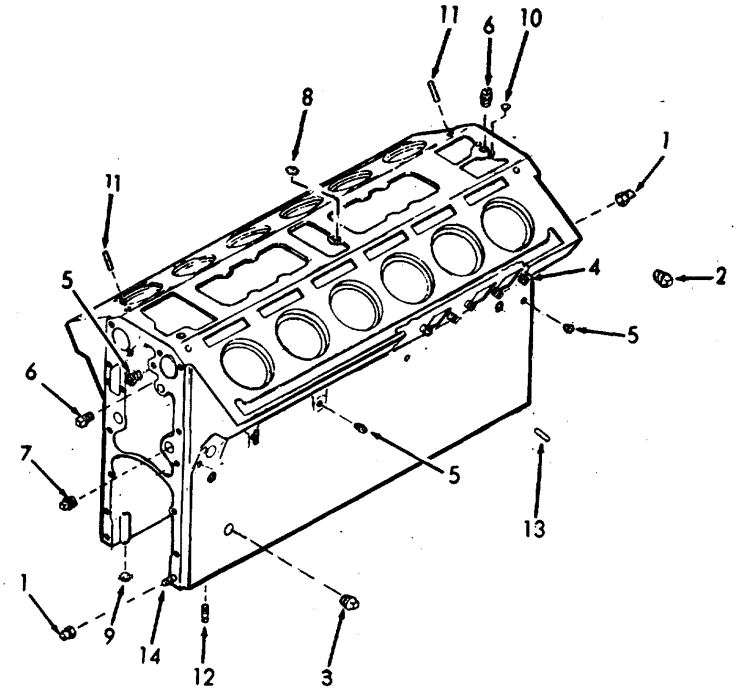
NOTE

Before a reconditioned or new service replacement cylinder block is used, steam clean it to remove the rust preventive and blow out the oil galleries with compressed air.

5-20. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)



MISCELLANEOUS PARTS ON CYLINDER BLOCK

Item	Description	Item	Description
1	Nut plug 3/8-24	8	Plug
2	Pipe plug	9	Plug
3	Pipe plug	10	Plug
4	Stud	11	Pin
5	Pipe plug	12	Stud 3/8 x 1-13/16 long
6	Pipe plug headless	13	Pin 3/16 x ½
7	Pipe plug	14	Pin ½ x 1-5/8 long

5-21. HYDROSTARTER-MAINTENANCE INSTRUCTIONS.

This task covers:

a. Disassembly **b. Inspection** **d. Reassembly**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Arbor Press

Material/Parts

Oil SAE5

Personnel Required

1

References

NONE

Equipment Condition: Condition Description — NONE

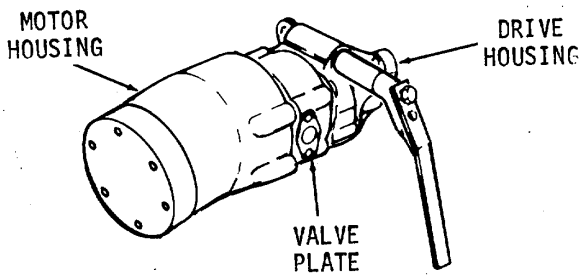
Special Environmental Conditions

NONE

General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Hydro-starter	a. Hydro-starter	1. Clean the exterior thoroughly.	
		2. Scribe marks on the drive housing, clutch housing, valve plate, and motor housing.	To be done prior to disassembly to ensure correct reassembly.

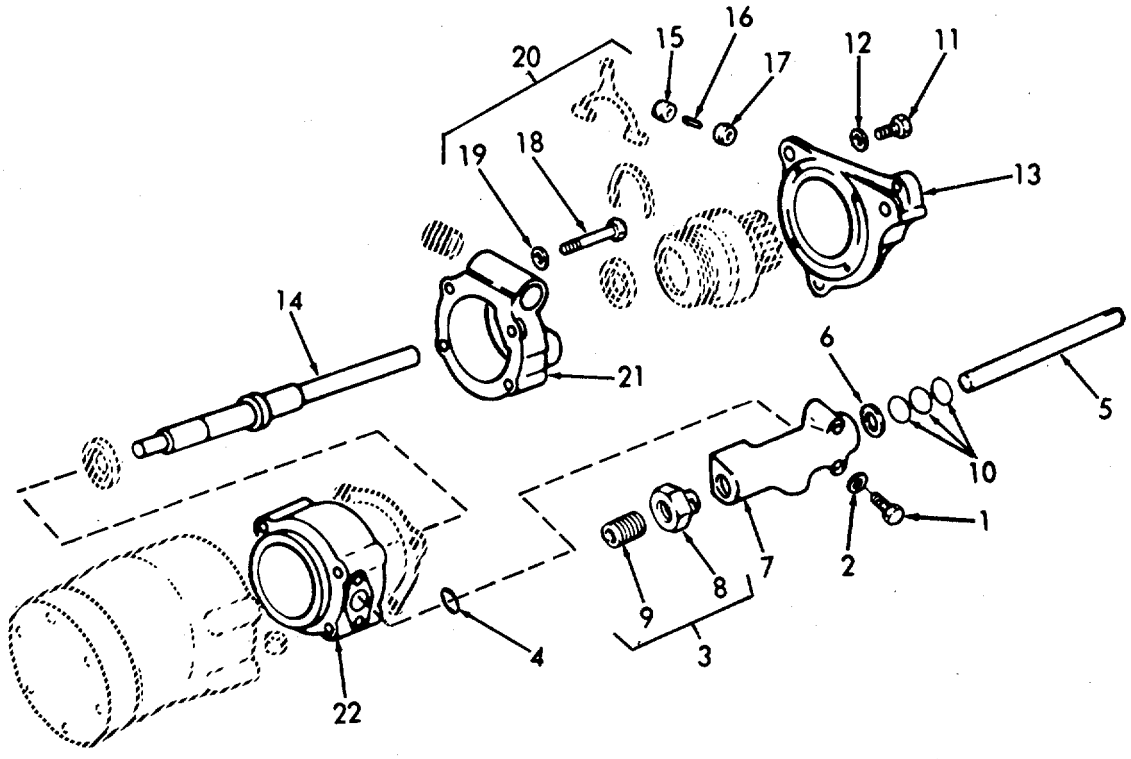


5-21. HYDROSTARTER-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	b. Screws (1), and lockwashers (2)	Remove	
	c. Control valve assembly (3), and preformed packing (4)	Remove	
	d. Control valve (5), and gasket (6)	Remove from control valve body (7).	
	e. Control valve plug (8), and breather valve plug (9)	Remove from control valve body (7).	Be careful not to scratch or damage body.
	f. Seal rings (10)	Remove.	
	g. Screws (11), and lockwashers (12)	Remove.	
	h. Drive housing (13)	Slide off the shaft (14).	
	i. Pipe plug (15), and oil wick (16)	Remove.	
	j. Bushing (17)	Remove.	If necessary.

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	k. Screws (18), and lockwashers (19)	Remove.	
	l. Clutch assembly (20), and clutch housing (21)	Separate from valve plate (22)	



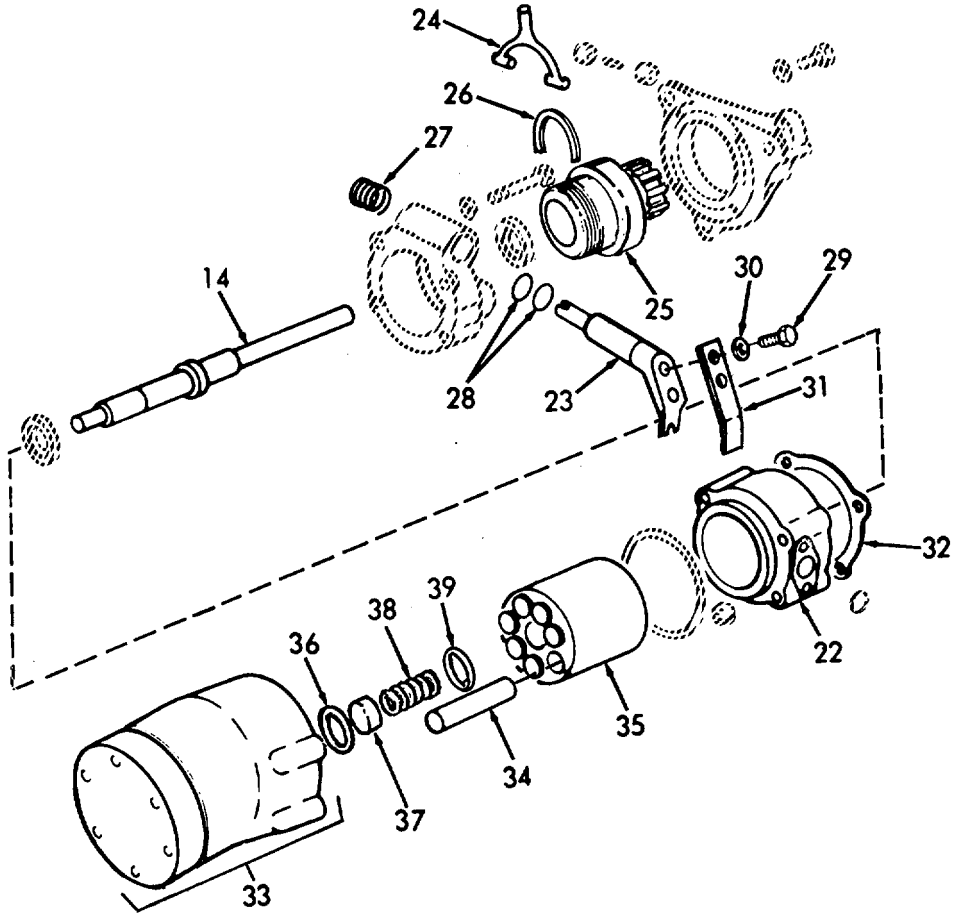
5-379

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	m. Control shaft (23), clutch fork (24), and clutch (25)	Rotate shaft and disengage clutch from fork.	
	n. Clutch yoke (26)	Remove by lifting from clutch (25).	
	o. Fork (24)	Remove from shaft (14).	
	p. Torsion spring (27)	Remove from control shaft (23).	
	q. Control shaft (23)	Remove.	
	r. Seal rings (28)	Remove from control shaft (23).	Discard seal rings.
	s. Screws (29), lockwashers (30), and control handle (31)	Disassemble if broken or damaged.	
	t. Gasket (32)	Remove.	
	u. Motor-housing and needle bearing assembly including end cover and bearing as an assemble (33)	1. Withdraw from valve plate (22). 2. Be careful not to drop the pistons (34) from the rotor (35).	
	v. Pistons (34)	Remove from rotor (35).	

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	w. Shaft assembly and snap retaining ring (36)	1. Place in arbor press. 2. Remove snap ring.	
	x. Retaining ring (37), compression spring (38), and special washer (39)	Remove.	



5-381

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	y. Rotor (35), gasket (40), and valve plate (22)	S1lide off shaft.	
	z. Oil seal (41)	Remove valve plate only it is leaking.	Discard seal.
	aa. Retaining ring (42)	Remove.	If necessary.
	ab. Pipe plug (43)	Remove.	If necessary.
	ac. Screws (44), and lockwashers (45)	Remove.	
	ad. End cover (46), gasket (47), and bearing (48)	Separate from motor housing (49).	Discard gasket
INSPECTION			
2.		**WARNING**	

Wear protective eye goggles when using compressed air.

a. Wash all of the parts in clean fuel oil and dry them with compressed air, with the exception of the drive clutch assembly.

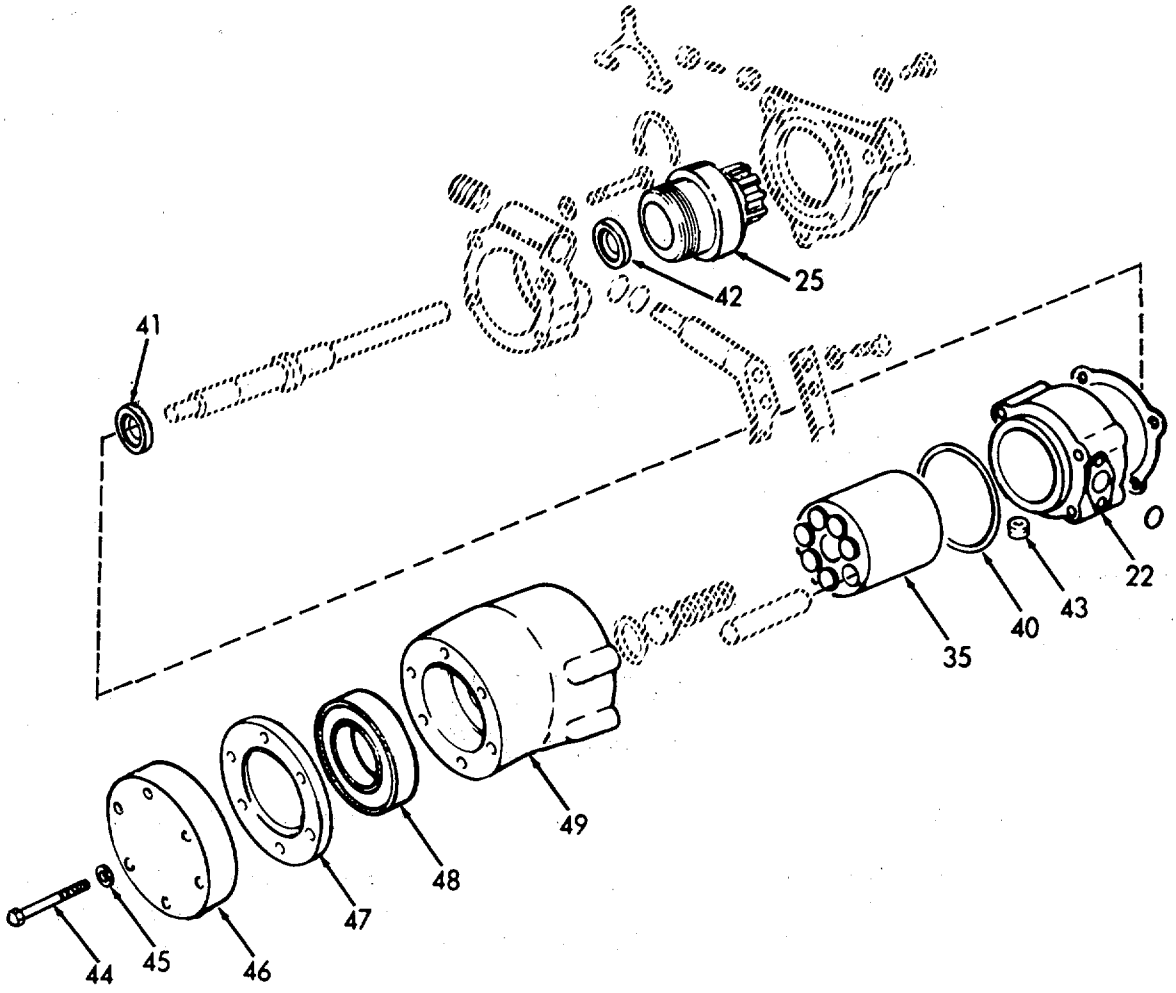
b. Examine the teeth and internal splines of the drive clutch assembly (25) for excessive wear and replace if necessary.

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

c. If the overrunning clutch slips, preventing positive pinion engagement, replace it unless the slippage is due to extremely cold weather which would cause the grease to set up and prevent the clutch from operating. Then wash it thoroughly in clean fuel oil to free the rollers in the clutch shell and lubricate with SAE 5W oil. Attach a tag to the starter, noting the lubricant used in the clutch assembly.



5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

NOTE

When replacing the drive clutch assembly, only the Delco Remy drive clutch assemblies are available for service and, if the unit did not incorporate a Delco Remy drive clutch before, it will be necessary to replace the drive housing also.

d. Check the rotor (35) and pistons (34) for scoring or other damage.

e. Replace the yoke (26) if it is cracked or worn on the faces near slots.

f. Replace the clutch fork (24) if the trunnions or machined shank of the fork is bent, or are worn out of alignment.

g. Replace the starter shaft oil seal (41) if the lip is rough or hard.

h. The rotor bearings located inside motor housing should not require replacement; however, if they are worn excessively, a new motor housing and bearing assembly (33) must be installed.

i. Apply light engine oil to the end bearing (46). Then hold the inner race and revolve the outer race slowly by hand to check for rough spots.

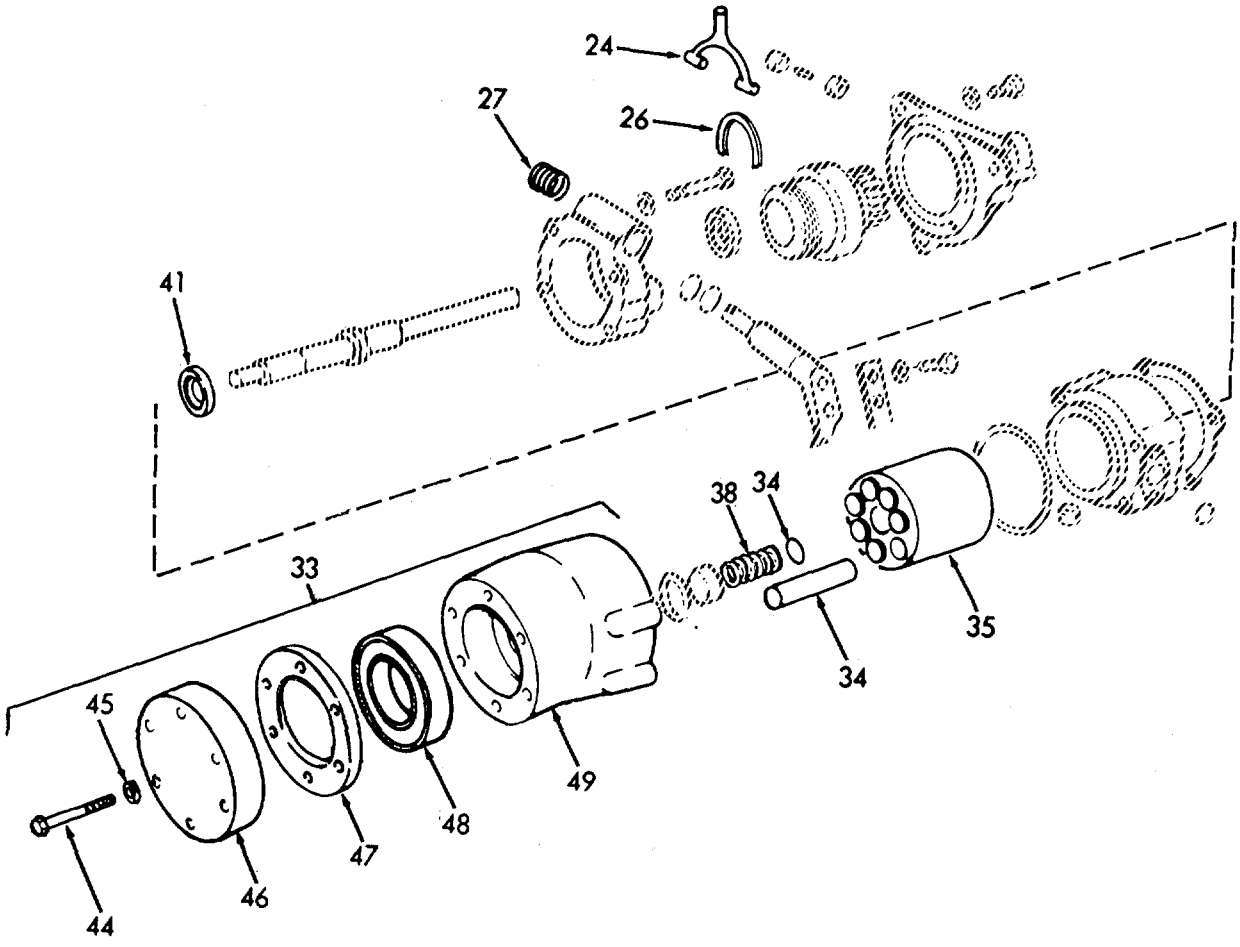
j. Replace the control shaft torsion spring (27) or compression spring (38) if either is broken or damaged in any way.

REASSEMBLY

3.	a.	Bearing (48), and end cap (46)	Install bearing numbered end up.

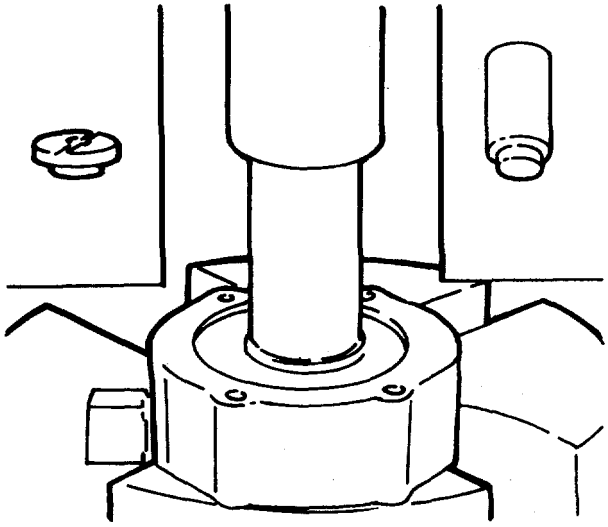
5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. End cap (46), gasket (47), motor housing (49), screws (44), and lockwashers (45)	Assemble.	Use a new gasket.



5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

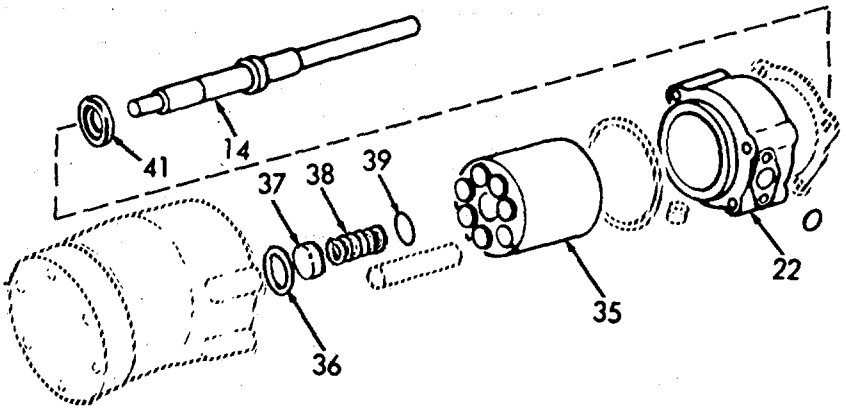
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Shaft oil seal (41), and valve plate (22)	1. Install seal with lip facing in.	Use new seal.
		2. Use an arbor press.	The seal is properly positioned when the installer bottoms in the valve plate.
		3. Stake the seal in place in at least six places.	



d. Starter shaft (14)	Apply a thin coat of grease on forward face of starter shaft collar.	
e. Valve plate (22)	1. Place seal side first over the splined end of the starter shaft (14).	

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		2. Place valve plate and starter shaft assembly in arbor press.	
	f. Rotor (35), special washer (39), compression spring (38), retaining ring (37), retaining snap ring (36)	1. Assemble in arbor press. 2. Use a spring compresser and install snap ring.	



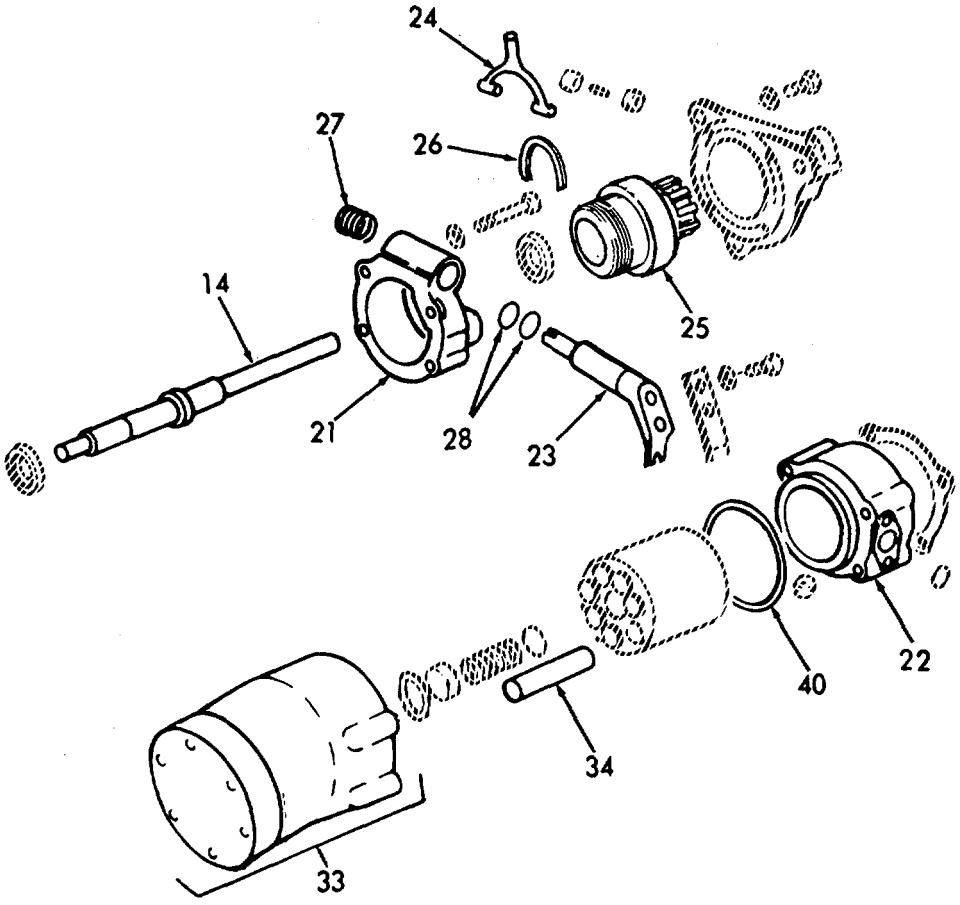
5-387

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Pistons (34)	Insert in rotor open end first.	
	h. Seal ring (40)	Install on valve plate.	
	i. Motor housing (33), and valve plate (22)	Assemble.	Align scribe marks.
	j. Seal rings (28)	1. Lubricate.	
		2. Install on control shaft (23).	
	k. Control shaft (23)	Guide the shaft gently into the clutch housing (21) so as not to damage the seal rings (28).	
	l. Torsion spring (27)	Install.	
	m. Clutch fork (24)	1. Apply grease to fingers of clutch fork.	
		2. Insert into fork of control shaft.	
	n. Yoke (26), and clutch (25)	1. Apply grease to slots in yoke.	
		2. Apply grease to spool of clutch assembly.	
		3. Set yoke in collar of clutch assembly.	

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	o. Clutch (25), and shaft (14)	1. Grease internal splines of clutch. 2. Grease external splines of shaft. 3. Rotate shaft and insert clutch fork (24) trunnions into the slots of the yoke.	



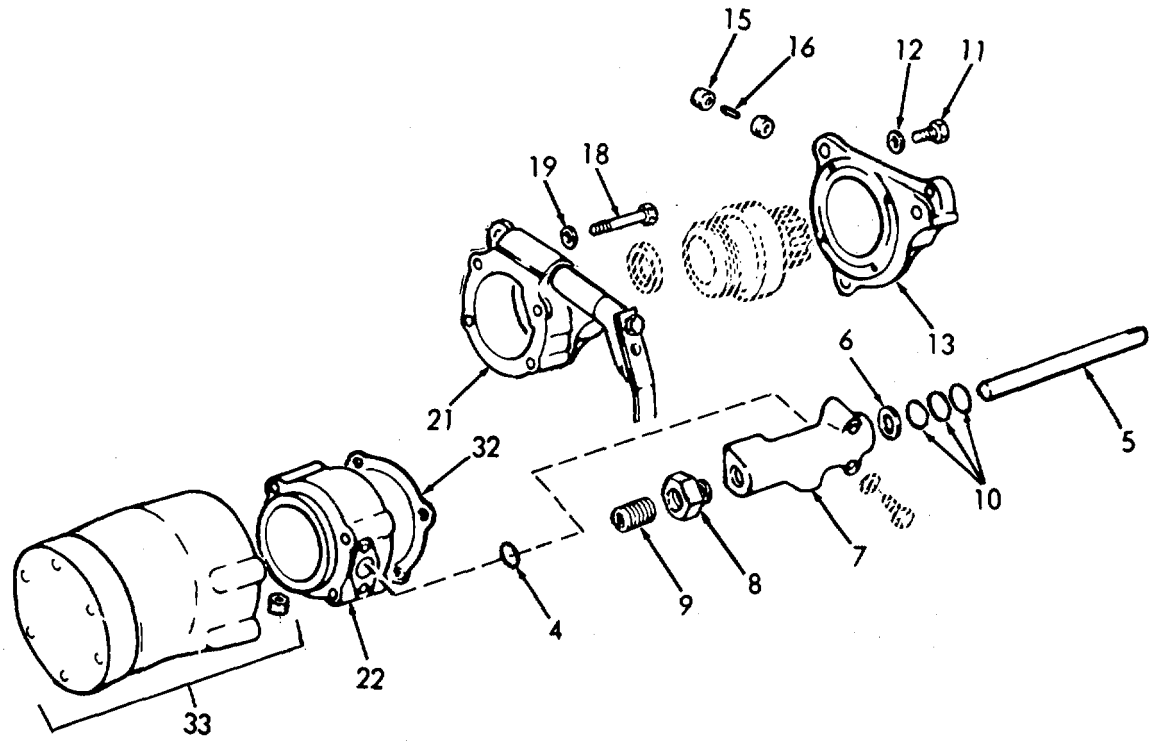
5-389

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	p. Valve plate (22), motor housing (33), clutch housing (21), and gasket (32)	Align scribe marks.	Use new gasket.
	q. Screws (18), and lockwashers (19)	Install.	
	r. Oil wick (16), and pipe plug (15)	1. Dip wick in engine oil and insert in drive housing (13). 2. Install pipe plug.	
	s. Drive housing (13), and clutch housing (21)	Align scribe marks.	
	t. Screws (11), and lockwashers (12)	Install.	
	u. Seal rings (10)	Install in control valve body (7).	Use new seal rings.
	v. Control valve plug (8), and breather valve plug (9)	Install.	

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

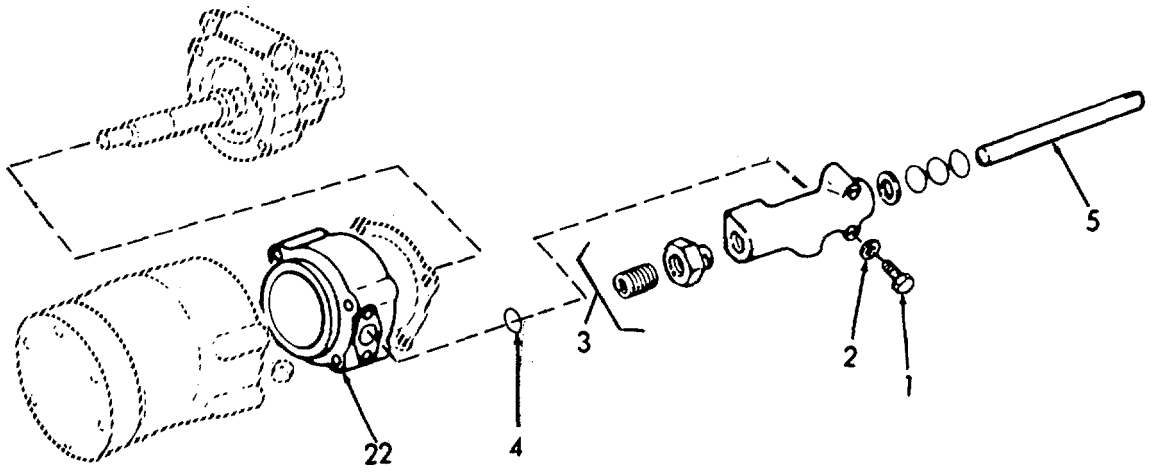
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	w. Control valve (5)	1. Lubricate	
		2. Start the control valve, slotted end out, straight in the control valve body and push it through the three seal rings in the body.	
	x. Preformed packing (6)	Install.	
	y. Seal ring (4)	Install in counter-bore of the valve plate (22).	



5-391

5-21. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	y. Seal ring (4)	Install in counter-bore of the valve plate (22).	
	z. Control valve assembly (3)	1. Align with valve plate and 2. Insert control handle in slot of control valve (5).	
	aa. Screws (1), and lockwashers (2)	Install.	



5-392

5-22. ACCUMULATOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Service **b. Disassembly** **d. Reassembly**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Charging kit J6714-02
Strap wrench
Piston ring compressor
3 1/2 to 7 inches

Material/Parts

Nitrogen

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS

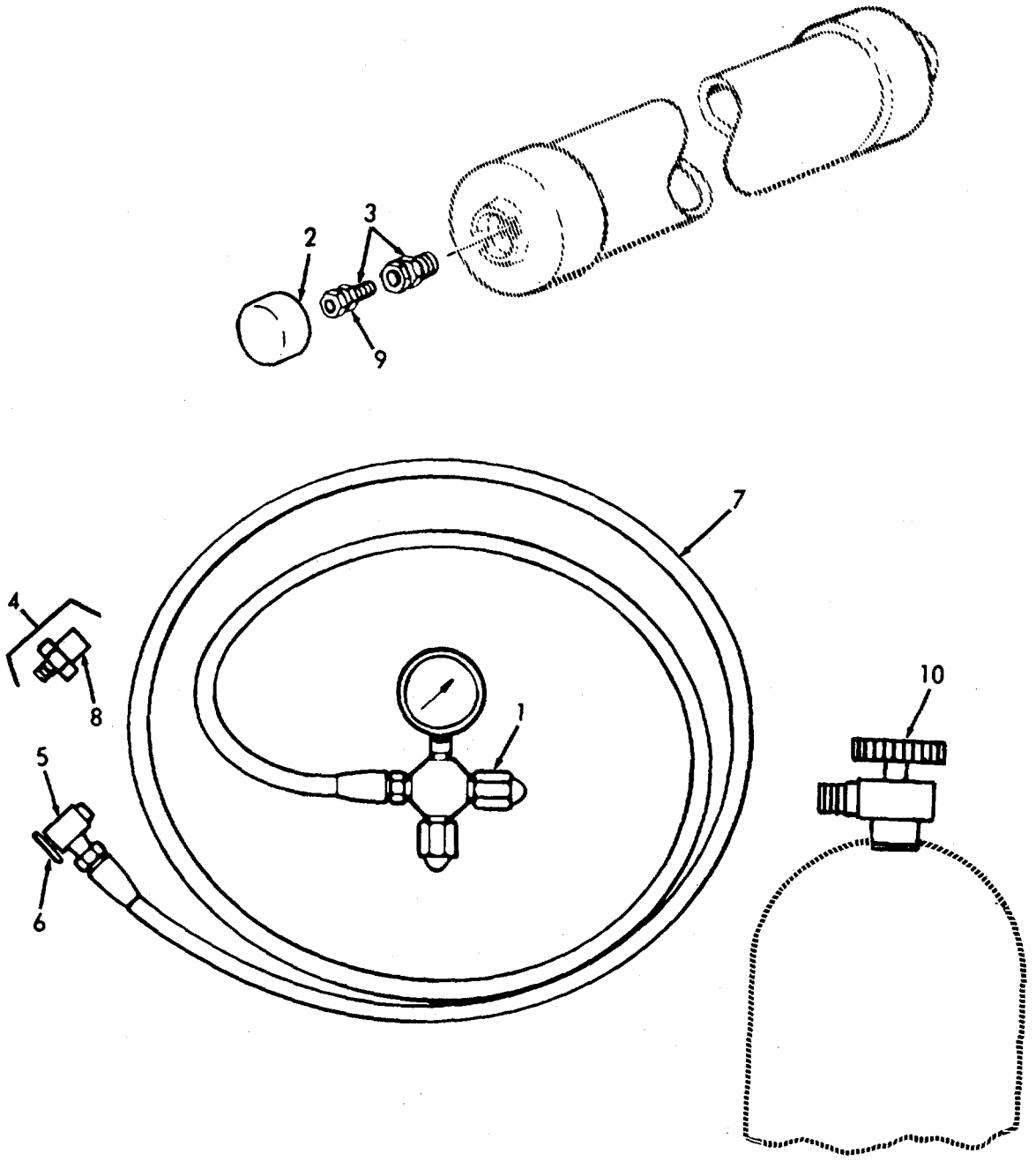
SERVICE

1.	Recharging the accumulator	a. Attach gage (1) end of the charging kit to nitrogen tank. b. Remove air check valve cover from accumulator cap (2) and the cap from the air check valve (3). c. Install air valve stem extension (4) on the air valve (5). d. Completely back off shaft pin in the air check valve connector (6) on the charging kit hose (7).	

5-22. ACCUMULATOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)



5-22. ACCUMULATOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)

(1) Install the connectors (2) on the air valve stem extension (4).

(2) Draw swivel nut (8) uptight.

e. Loosen hex locknut (9) on the accumulator air valve stem.

(1) Turn counter-clock-wise.

(2) Turn locknut 1-1/2 turns only.

f. Turn clockwise the shaft pin in the air check valve

(3) connector until the valve core air valve is de-pressed.

g. Open the valve (10) on nitrogen tank and allow small flow of nitrogen to enter the accumulator until the charging kit gage register 1300 psi (8964 kPa). Close nitrogen tank valves (10).

(1) Check the precharge pressure during charging.

(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.

h. Back off the shaft pin in air check valve (3).

(1) Tighten hex locknut (9) on accumulator valve stem.

i. Disconnect the accumulator charging kit.

(1) From accumulator.

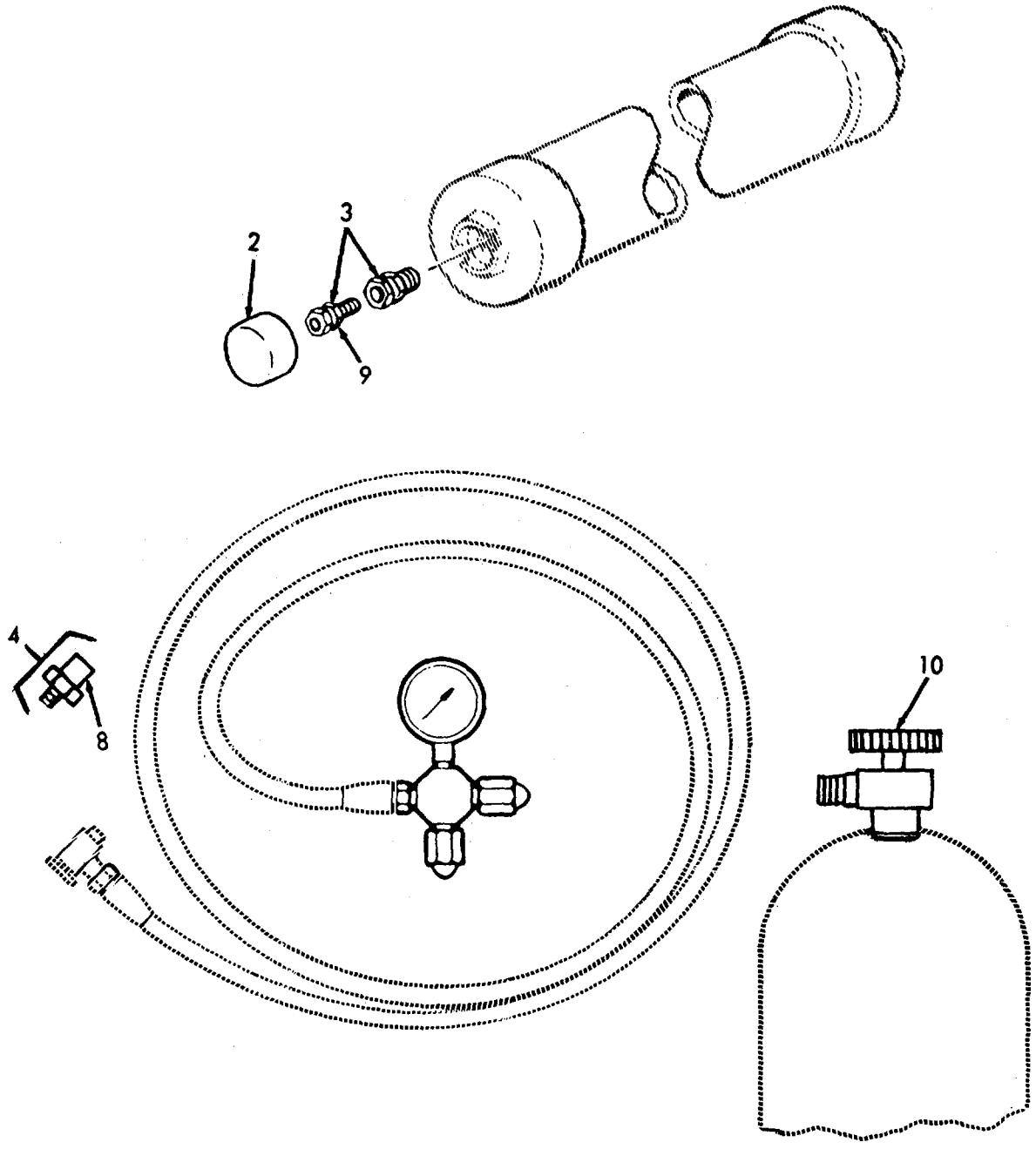
(2) From nitrogen tank.

j. Replace the cap on the air valve (3) and accumulator cap (2).

5-22. ACCUMULATOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)



5-22. ACCUMULATOR - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY

2. Accumulator

NOTE

Normally, no maintenance of the accumulator is required other than painting to resist external corrosion. However, if there is a loss of the nitrogen precharge pressure due to a leaky air valve, indicated by bubbles in a soap solution applied around the valve, or due to leakage past the piston, indicated by bubbles and foaming in the reservoir, replace either the air valve or the piston seal rings as required. Seal rings between the end cap and the shell will rarely require replacement, unless the accumulator is disassembled.

a. If a defective air valve was the cause of leakage, remove the air valve cover (2) from the accumulator cap (11), and the air valve cap (12) from the air valve. Loosen the 5/8 inch hex swivel nut on the air valve stem (13) approximately 1-1/2 turns and then depress the valve core to release any remaining nitrogen pressure before removing the air valve. Remove the valve (13) and replace it with a new part.

   However, if damaged piston and cap seal rings are surmised, continue with the disassembly.

b. Remove the accumulator caps (11) and (14) from the shell with a strap wrench, then push the piston (15) out of the shell (16) by hand.

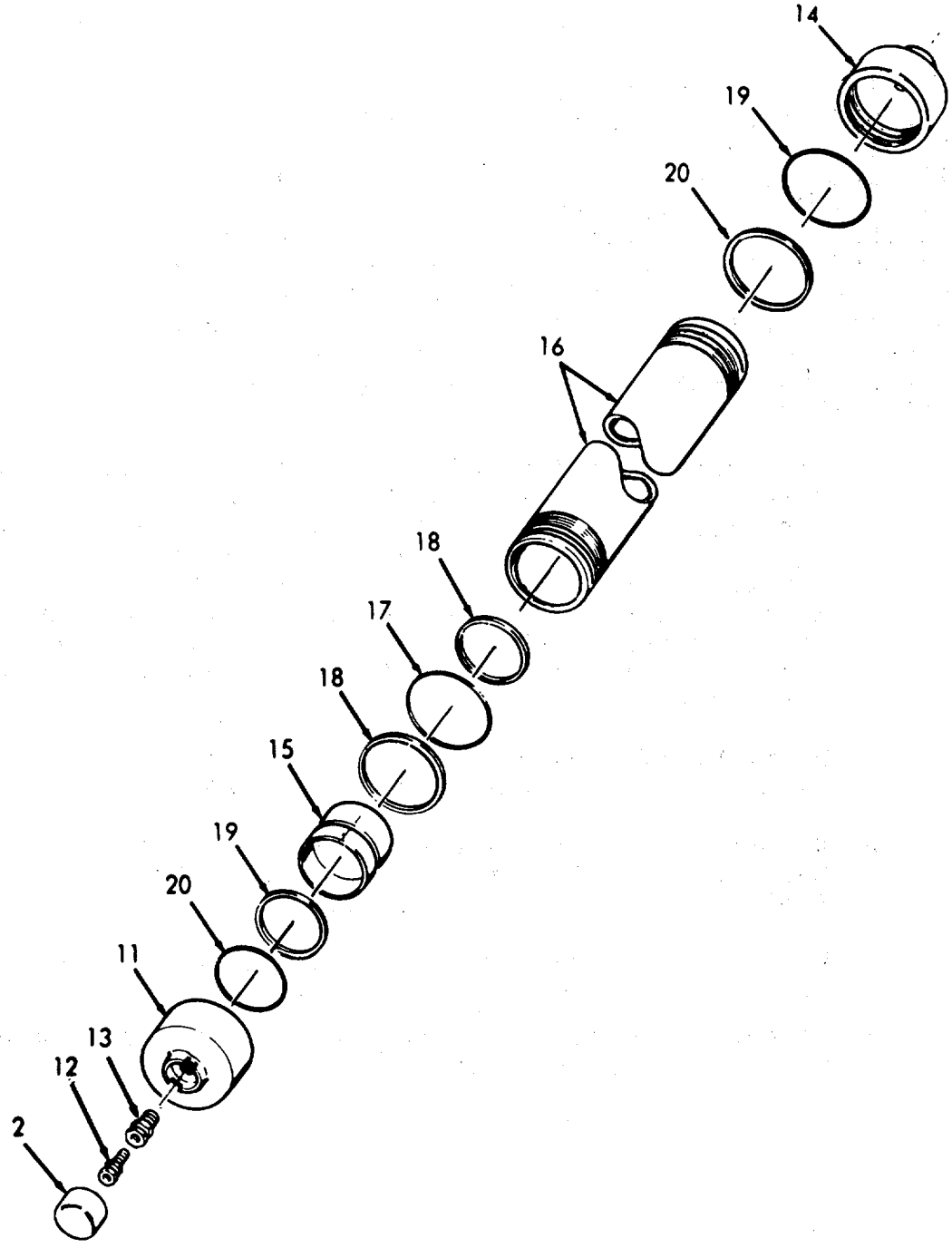
c. Remove and discard the seal ring (17) and the back-up rings (18) from the piston (15).

d. Remove and discard the seal rings (19) and the back-up rings (20) from the shell.

5-22. ACCUMULATOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



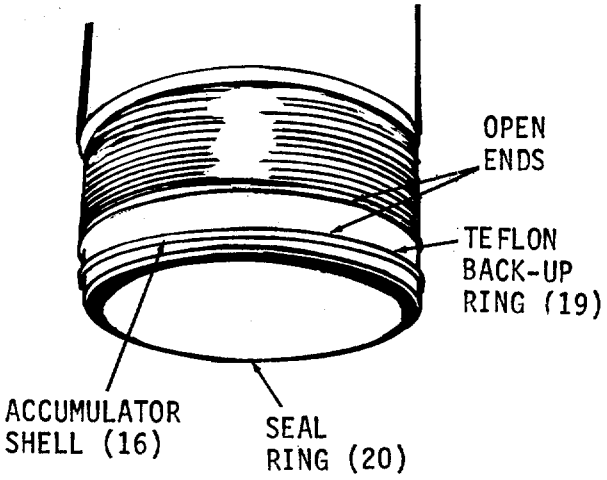
5-22. ACCUMULATOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY

3. After cleaning the shell, piston, and cap thoroughly, assemble the accumulator as follows:

   a. Install new teflon back-up rings (19) and new seal rings (20) in the grooves of the shell, with the seal ring nearest the open end of the shell (16). It is important that the teflon seal be installed in the ring groove of the shell so that the open ends do not catch on the threads of the steel cap when it is threaded into 'the end of the shell. Lubricate the seal ring and the sealing surface of the end cap with engine oil before installing the cap. Reverse positioning of the open ends of the back-up ring can cause contact between the ends and the cap itself. This can cause the back-up ring to buckle and result in an improper seal ring seal when the cap is threaded on the shell.



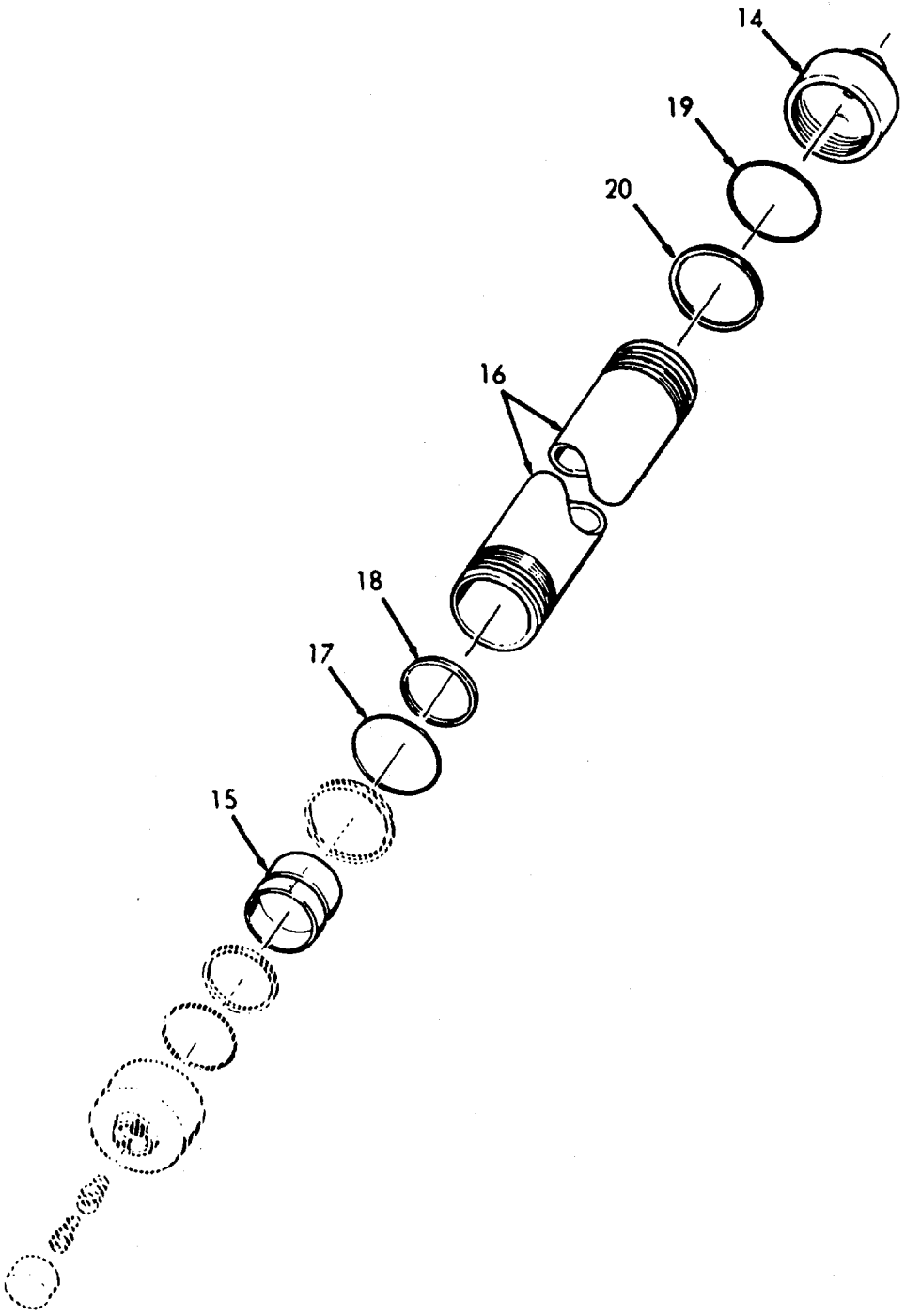
   b. Install the fluid end cap (14) on the shell, being careful not to damage the seal ring.

   c. Assemble a new seal ring (17) between the two new teflon back-up rings (18), in the piston (15) ring groove. To insure correct positioning of the seal ring and the two teflon back up rings, it is recommended that a suitable ring compressor with a diameter capacity of 3-1/2 inches to 7 inches and 3-1/2 inches high compression band be used.

5-22. ACCUMULATOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

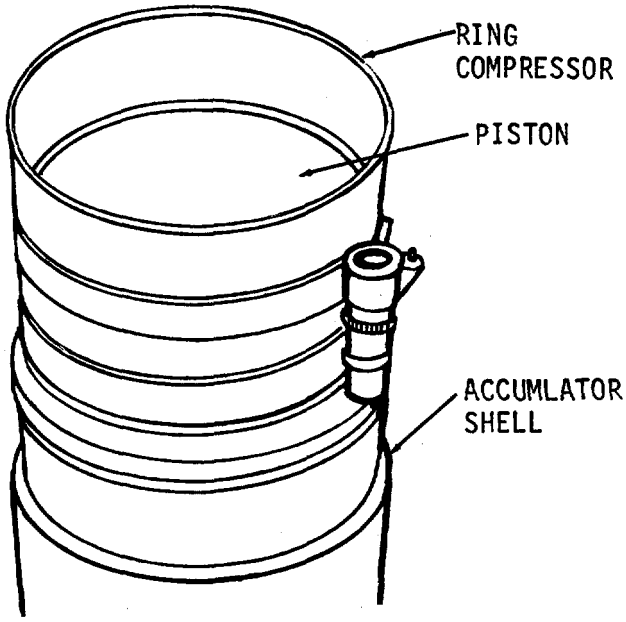


5-22. ACCUMULATOR-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

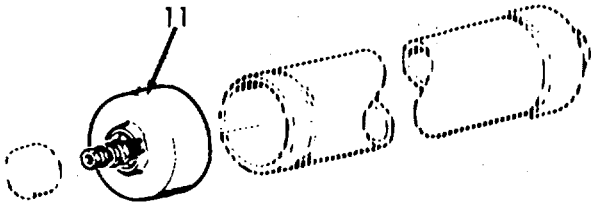
d. Install the ring compressor on the piston and rings and place the entire assembly on the open end of the shell. Lubricate the inner surface of the ring compressor and the beginning inner region of the shell with engine oil to reduce friction between the piston .and the shell.



e. Carefully drive the piston, crown side first, into the shell with a hammer and block of wood, tapping gently to slowly move the seal ring and back-up rings across the chamfered edge of the shell.

f. Install the nitrogen end cap (11).

g. Pressurize accumulator-Refer to Step 1.



5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS.

This task covers:

Overhaul

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Repair Kit KT202788

Personnel Required

1

References

Para 3-48 Pump-Removed

Equipment Condition	Condition Description
Paragraph	
3-48	Pump-Removal

Special Environmental Conditions

NONE

General Safety Instructions

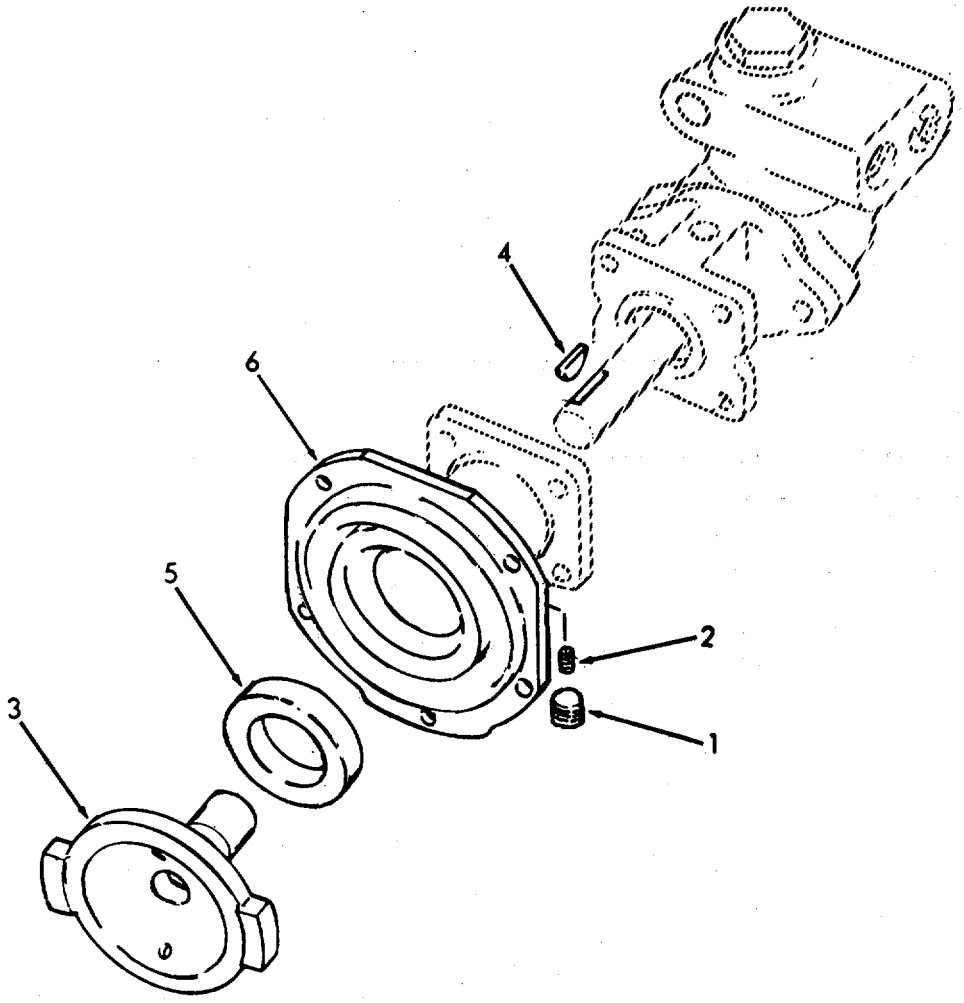
NONE

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLYI			
1. Engine driven pump	a. Drive pump	1. Remove pipe plug (1).	
		2. Remove setscrew (2).	
		3. Remove drive pump (3).	
		4. Remove woodruff key (4).	
		5. Remove oil seal (5).	
		6. Remove mounting flange (6).	Withdraw drive pump from shaft.

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)



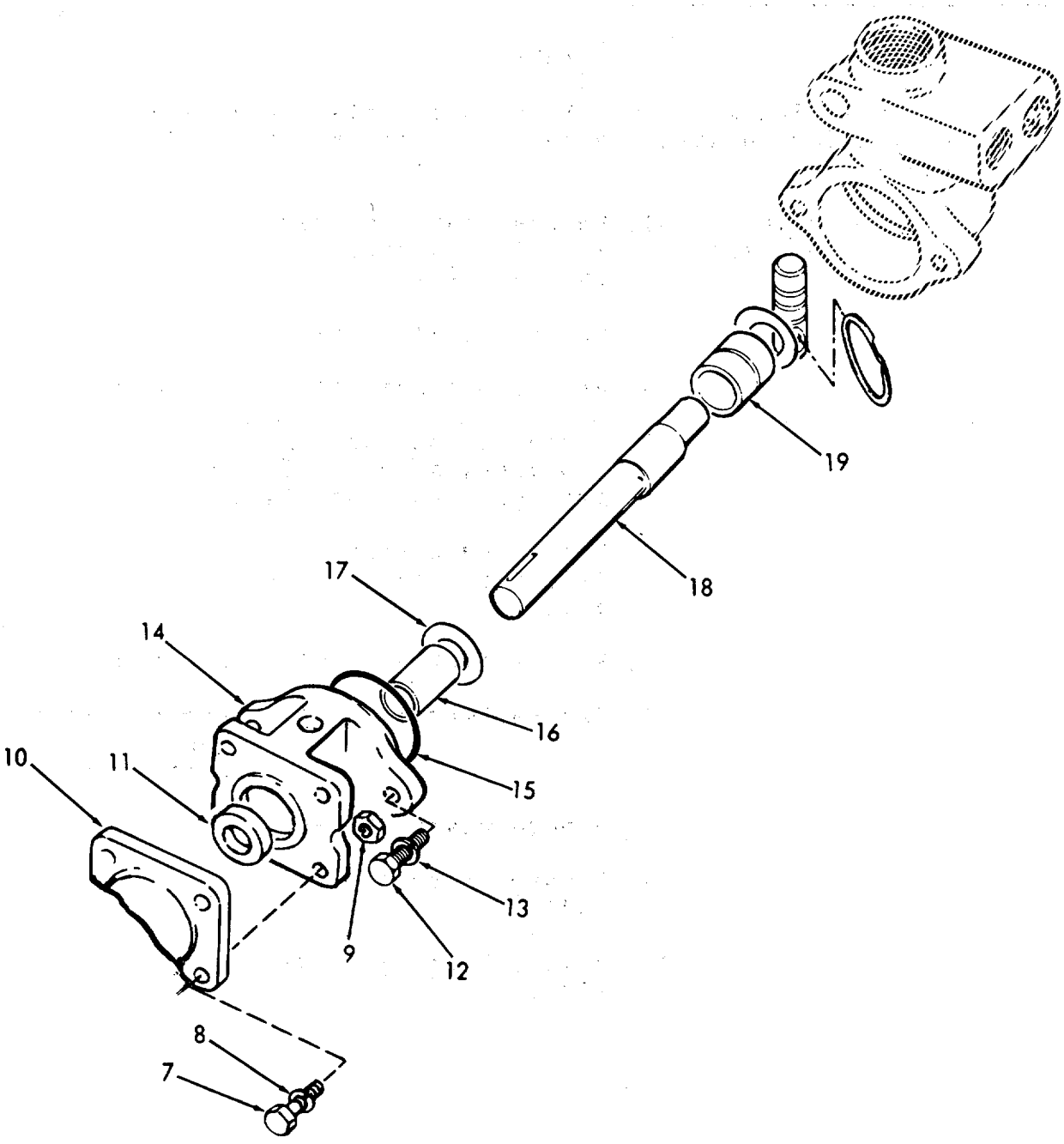
5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
		NOTE Place scribe marks on the mounting plate and pump body prior to disassembly to ensure their correct reassembly.	
	b. Pump housing	1. Remove four capscrews (7), lockwashers (8), and nuts (9).	
		2. Remove retainer (10).	
		3. Remove oil seal (11). Discard.	
		4. Remove capscrews (12), and lockwashers (13) from pump housing (14).	
		5. Remove pump housing (14) from valve housing.	
		6. Remove packing (15).	Discard.
		7. Remove bearing (16).	Check bearing for wear, if worn replace.
		8. Remove washer (17).	
		9. Remove drive shaft (18).	
		10. Remove bushing shaft (19).	

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

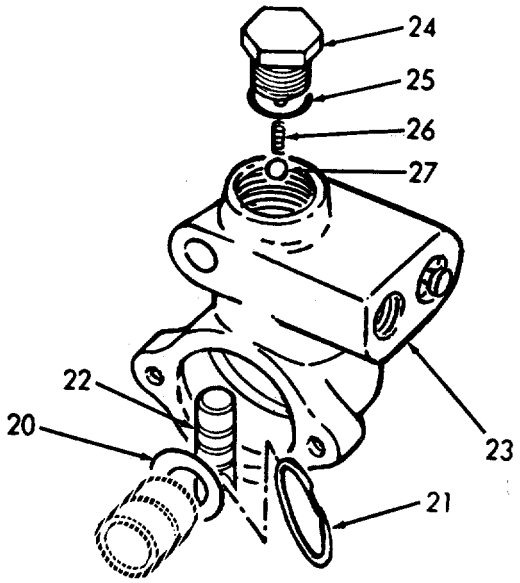
OVERHAUL-DISASSEMBLY (Cont)



5-407

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

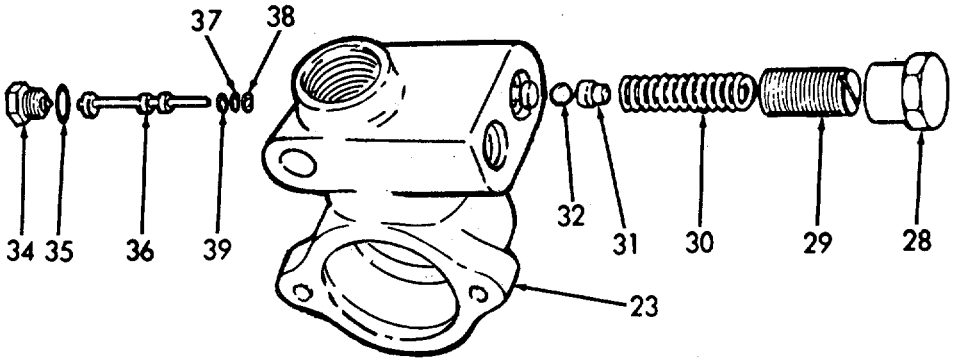
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
		11. Remove washer (20).	
		12. Remove retaining ring (21).	Discard.
		13. Remove piston plunger (22) from valve housing (23).	
	c. Plug valve	1. Remove plug (24).	
		2. Remove packing (25).	Discard.
		3. Remove spring valve (26).	Discard.
		4. Remove ball bearing (27) from valve housing (23) .	Check bearing for wear, if worn replace.



5-408

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	d. Pressure relief valve	1. Remove valve cap (28).	
		2. Remove adjusting spring screw (29).	
		3. Remove valve spring (30).	
		4. Remove valve seat (31).	
		5. Remove ball bearing (32).	Check bearing for wear, if worn replace.
		6. Remove valve seat (33).	
		7. Remove plug (34).	
		8. Remove packing (35).	Discard.
		9. Remove plunger valve (36).	
		10. Remove back-up ring (37).	Discard.
		11. Remove packing (38).	Discard.
		12. Remove back-up ring (39) from valve housing (23).	Discard.



5-409

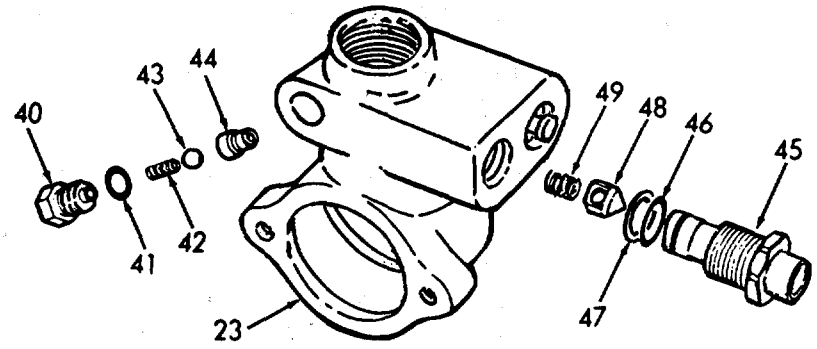
5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY (Cont)			
	e. Seat valve	1. Remove plug (40).	
		2. Remove packing (41).	Discard.
		3. Remove spring valve (42).	Discard.
		4. Remove ball bearing (43).	Check bearing for wear, if worn replace.
		5. Remove seat valve (44) from valve housing (23).	
	f. Inlet valve	1. Remove adapter fitting (45).	
		2. Remove packing (46).	Discard.
		3. Remove back-up ring (47).	Discard.
		4. Remove inlet valve (48).	
		5. Remove inlet spring valve (49) from valve housing (23).	Discard.

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-DISASSEMBLY (Cont)



OVERHAUL-REPAIR

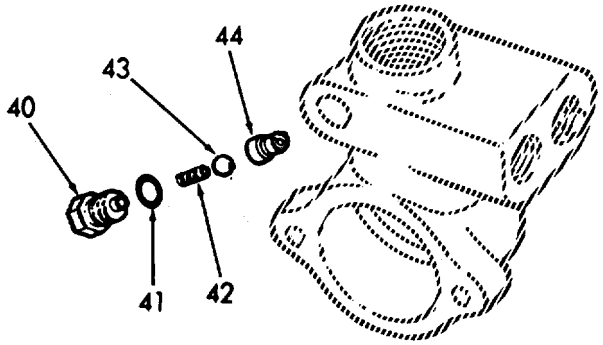
2. Replace all defective parts with serviceable-like items.

OVERHAUL-REASSEMBLYI

3.	a. Inlet valve (48)	1. Install new inlet spring valve (49).	Use repair kit.
		2. Install inlet valve (48).	
		3. Install back-up ring (47).	Use repair kit.
		4. Install packing (46).	Use repair kit.
		5. Install adapter fitting (45) into valve housing (23).	

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
	b. Seat valve (44)	1. Install seat valve (44).	
		2. Install ball bearing (43).	
		3. Install spring valve (42).	Use repair kit.
		4. Install packing (41).	Use repair kit.
		5. Install plug (40).	



	c. Pressure relief valve	1. Install back-up ring (37), packing (38), and back-up ring (39) onto plunger valve (36).	For back-up rings and packing, use repair kit.

NOTE

Coat back-up rings and packing liberally with hydraulic fluid.

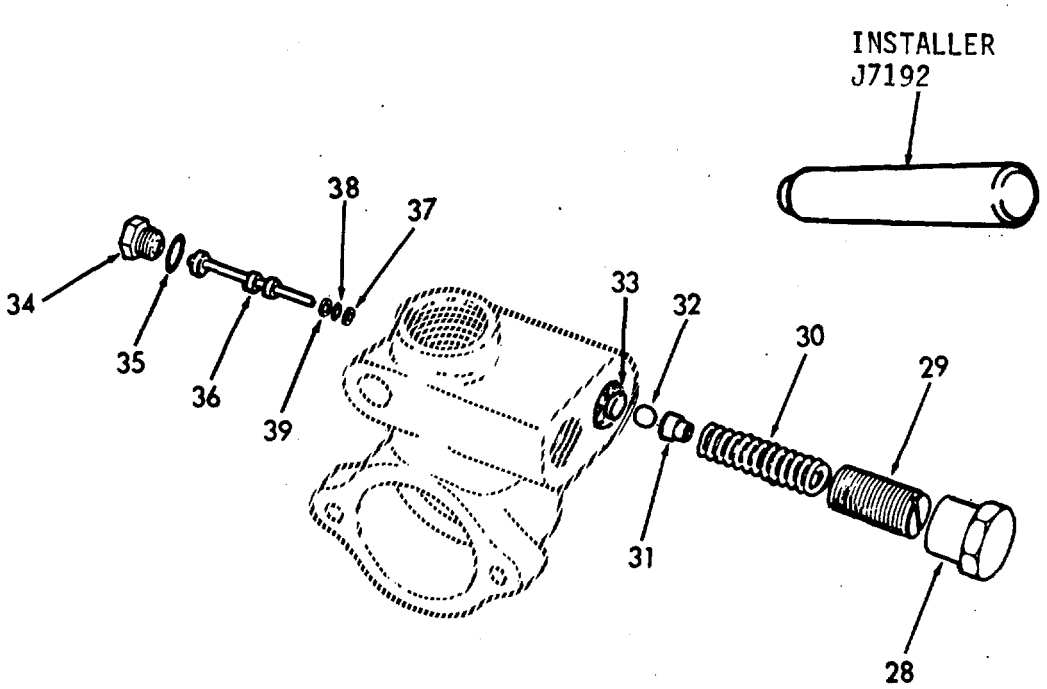
		2. Install plunger valve (36).	Use installer J7192.

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

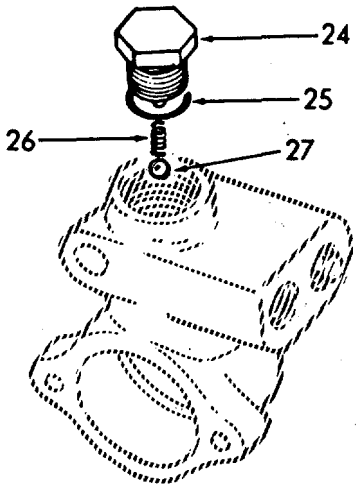
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont)

3. Install packing (35). Use repair kit.
4. Install plug (34).
5. Install valve seat (33).
6. Install ball bearing (32).
7. Install valve seat (31).
8. Install valve spring (30).
9. Install adjusting spring screw (29).
10. Install valve cap (28).

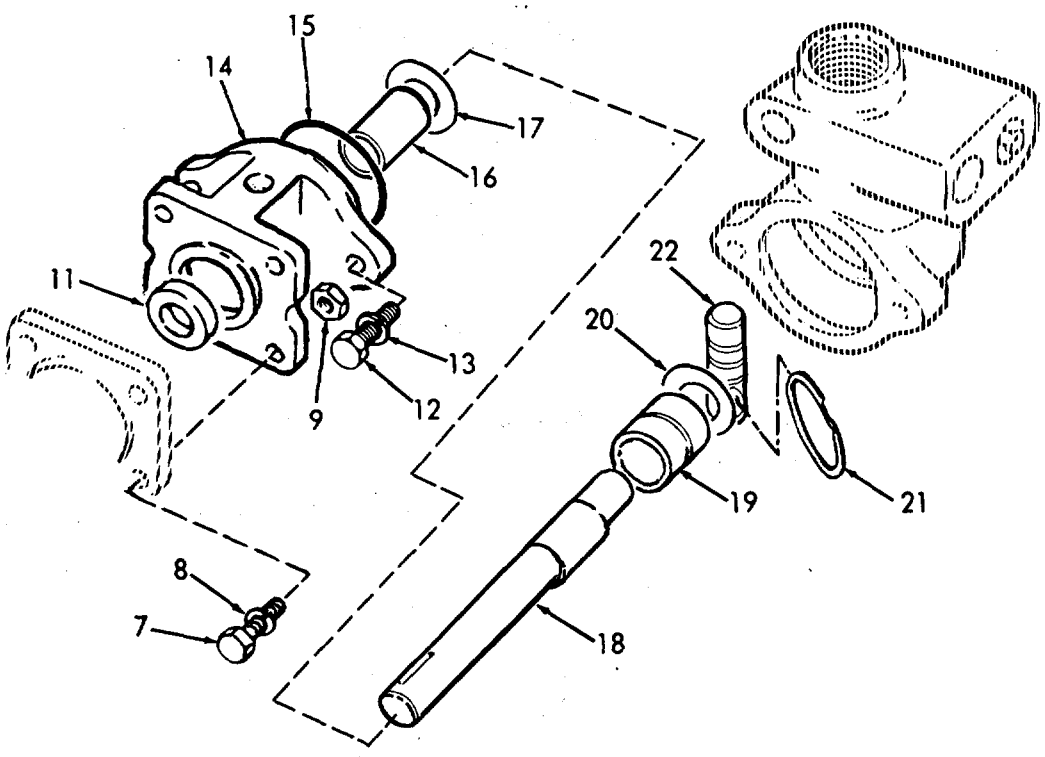


5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
	d. Plug valve	1. Install ball bearing (27).	
		2. Install spring valve (26).	Use repair kit.
		3. Install packing (25).	Use repair kit.
		4. Install plug (24).	
			
	e. Pump housing	1. Install piston plunger (22).	
		2. Install retaining ring (21)	Use repair kit.
		3. Install washer (20).	
		4. Install bushing shaft (19).	
		5. Install drive shaft (18).	
		6. Install washer (17).	
		7. Install bearing (16).	

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-REASSEMBLY (Cont)			
		8. Install packing (15).	Use repair kit.
		9. Replace pump housing (14).	
		10. Install lockwashers (13) and capscrews (12).	
		11. Install oil seal (11).	
		12. Install four lock-washers (8), capscrews (7) and nuts (9).	



5-415

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont)

NOTE

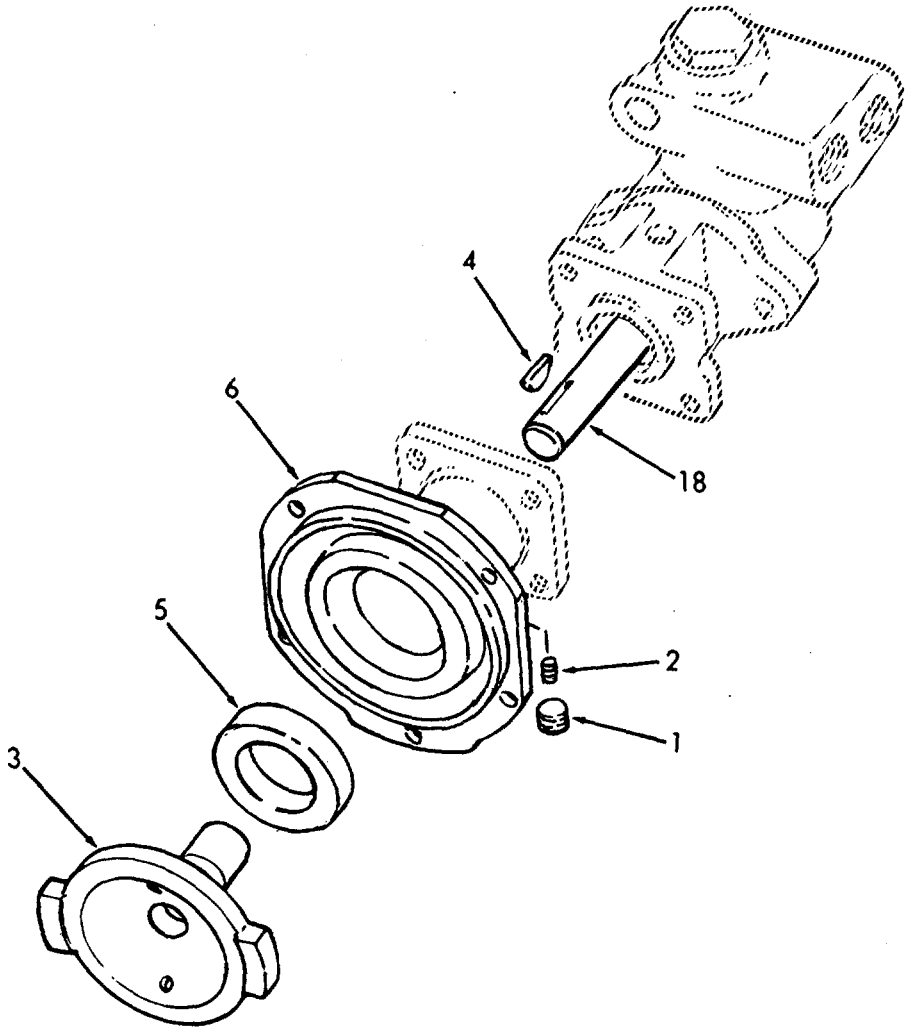
Line up scribe marks of the mounting plate and the pump body to ensure correct reassembly.

f.	Drive pump	1. Install mounting flange (6) onto shaft (18).	
		2. Install oil seal (5).	
		3. Install drive pump (3).	
		4. Install woodruff key (4).	
		5. Install setscrew (2).	
		6. Install pipe plug (1).	

5-23. HYDROSTARTER-ENGINE DRIVEN PUMP-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL-REASSEMBLY (Cont)



5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS.

This task covers:

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

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

Gasket kit P/N 919428

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS

WARNING

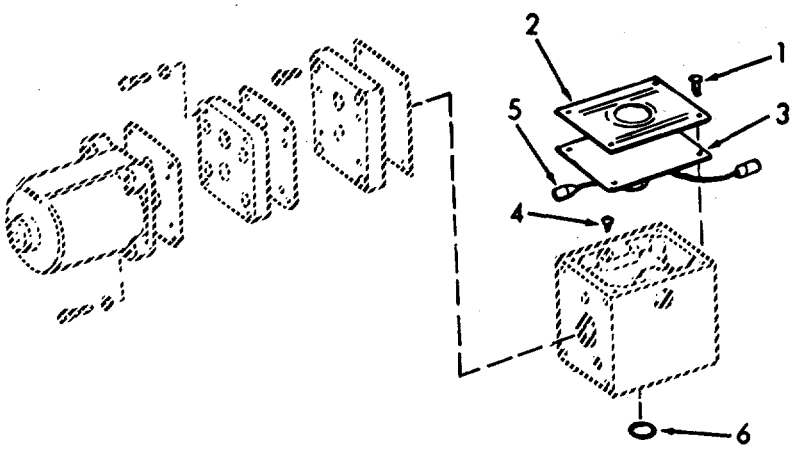
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Hydro-starter solenoid	a. Tubing	Inspect for breaks, bends, cracks, and leaking.
		b. Wiring	Inspect for breaks, cracks and worn insulation.
		c. Valve	Inspect for cracks and leaking and that hardware is tight.

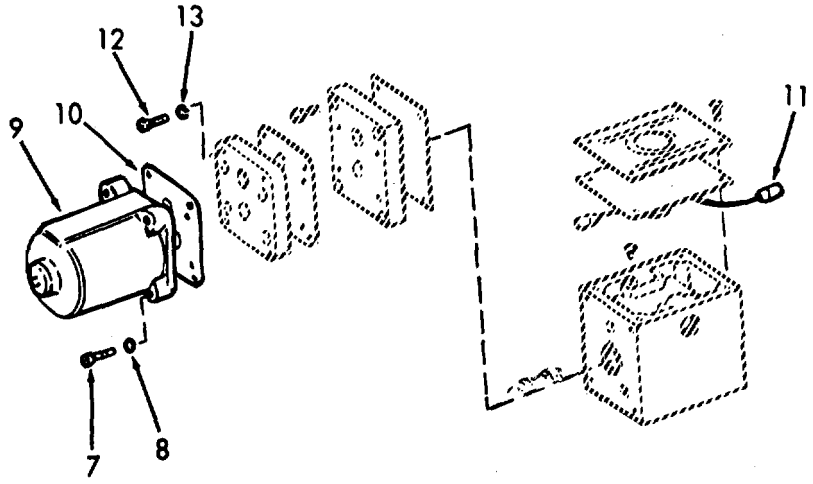
5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screw (1), and identification plate (2)	Remove.	
	b. Gasket and wire subassembly (3)	1. Lift to disconnect ground screw (4). 2. Tag and disconnect external wiring. 3. Remove gasket and wire subassembly (3).	
	c. Piping	Disconnect piping at union.	
	d. Wire receptacle (5)	Remove.	
	e. Valve, and O-ring (6)	Remove from mounting.	Discard O-ring.



5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3.	a. Screw (7), and lock-washers (8)	Remove.	
	b. Solenoid (9), and gasket (10)	1. Remove. 2. Disconnect wire receptacle (11).	Discard gasket.
	c. Screws (12), and lockwashers (13)	Remove.	



5-421

5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

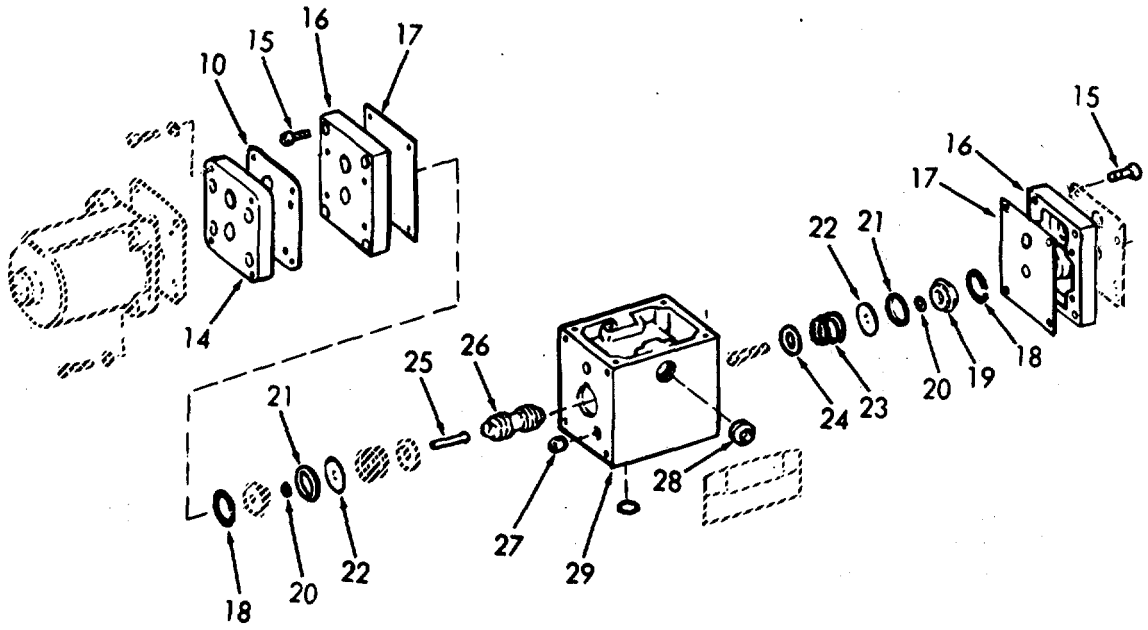
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Solenoid mounting plate (14), and gasket (10)	Remove.	Discard gasket.
	e. Screw (15)	Remove.	
	f. Adapter plate (16), and gasket (17)	Remove.	Discard gasket.
	g. Retaining ring (18), spring guide (19), O-rings (20 and 21), washers (22), spring (23), and spring washer (24)	Remove.	Discard O-rings.

NOTE

To help remove retaining ring (18), apply force to the end of the push pin (25) located in the opposite end of the valve.

5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	h. Push pin (25), and spool (26)	Remove and disassemble.	
	i. Plugs (27 and 28)	Remove from body (29).	If necessary.



5-423

5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING

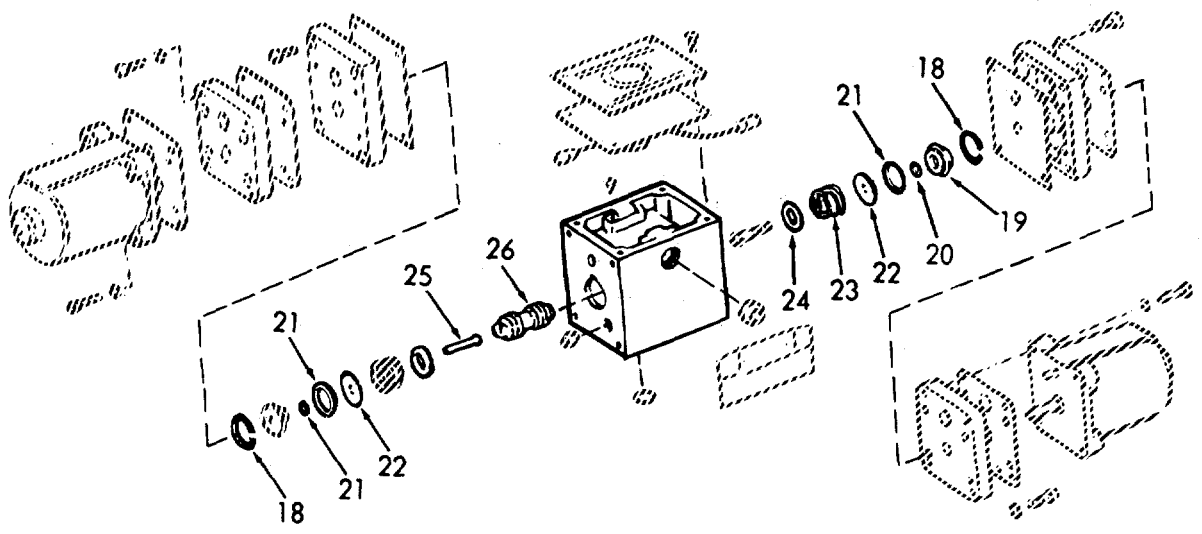
4. All parts must be thoroughly cleaned and kept clean duringinspection and assembly. Contamination in the unit will cause excessive wear, leakage and decreased service life. Clean in accordance with standard procedures for hydraulic parts. Do not usecompressed air to dry parts unless the air is completely filtered in order to remove water and contaminants.

REASSEMBLY

5. **NOTE**

Coat all internal parts lightly with lubricating oil.

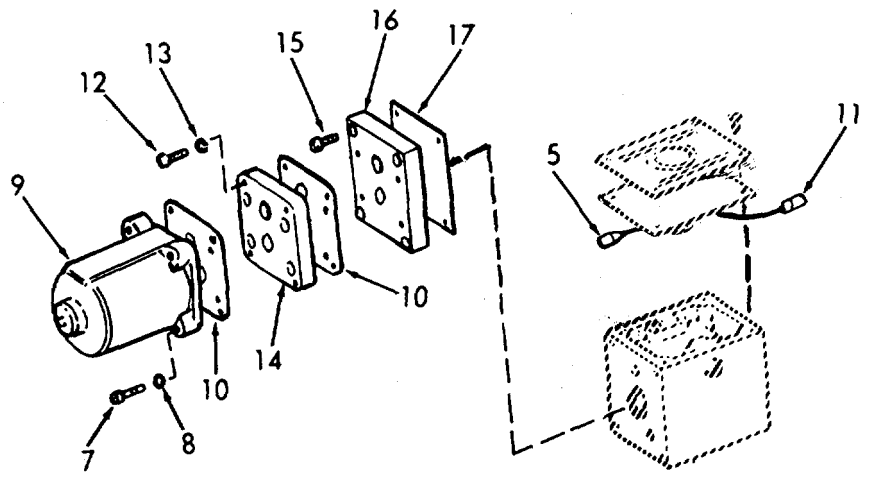
a.	Push pin (25), and spool (26)	Reassemble and insert into body (29).	
b.	Spring washer (24), spring (23), washer (22), O-rings (21 and 20), spring guide (19), and retaining ring (18)	Install in body (29).	Use new O-rings.



5-424

5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

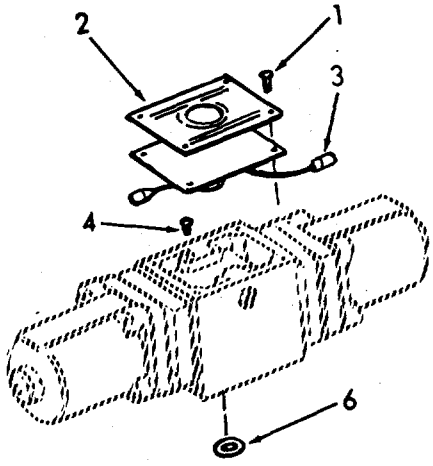
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Gasket (17), adapter plate, (16), and screws (15)	Reassemble.	Use new gasket.
	d. Gasket (10), solenoid mounting plate (14), screws (12), and lockwashers (13)	Reassemble.	Use new gasket.
	e. Wire recepta-cles (5 and 11)	Feed thru holes in gasket (17), adapter plate (16), gasket (10), and solenoid mounting plate (14). Attach wire receptacles (5 and 11) to solenoid (9).	
	f. Gasket (10), solenoid (9), screws (7), and lockwashers (8)	Reassemble.	Use new gasket.



5-425

5-24. HYDROSTARTER SOLENOID-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6.	a. O-rings (6)	Lubricate and install.	Use new O-rings.
	b. Wiring and piping	Install.	
	c. Gasket and wire sub-assembly (3), identi-fication plate (2), and screw (1)	1. Install wire sub-assembly to ground screw (4). 2. Install remaining parts.	



5-426

5-25. HYDRAULIC RESERVOIR-MAINTENANCE INSTRUCTIONS.

This task covers:

Repair or Replace

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools

NONE

Equipment Condition: NONE

Condition Description

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

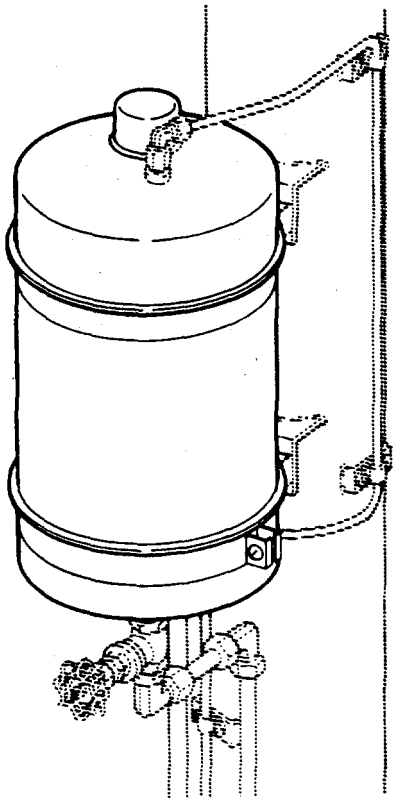
1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS

Remove and repair as necessary.



5-427

5-26. HYDRAULIC STARTING SYSTEM PIPING-FORWARD ENGINE ROOM- MAINTENANCE INSTRUCTIONS.

This task covers:

Replace

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
		Repair or Replace as necessary.	
1. Forward engine room, port engine	a.	Male connector (1)	
	b.	Hydraulic tubing (2)	
	c.	3000 pounds ball valve (3)	
	d.	Pressure gage (4)	
	e.	Male run tee (5)	
	f.	Nipple (6)	
	g.	90° male elbow (7)	
	h.	90° union elbow (8)	
	i.	Hydraulic tubing (9)	

5-26. HYDRAULIC STARTING SYSTEM PIPING-FORWARD ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)

j. 90° male elbow (10)

k. 90° male elbow (11)

l. 90° male elbow (12)

m. 45° male elbow (13)

n. 90° male elbow (14)

o. 90° male elbow (15)

p. Female connector (16)

q. Two wire braid rubber hose (17)

r. Two wire braid rubber hose (18)

s. Two wire braid rubber hose (19)

t. JIC swivel hose fitting (20)

u. Hose fitting (21)

v. JIC swivel hose fitting (22)

w. 90° male elbow (23)

x. 90° male elbow (24)

y. Female tee (25)

z. Reducing bushing (26)

aa. 90° female elbow (27)

ab. Solenoid valve (28)

ac. Male connector (29)

ad. 90° male elbow (30)

ae. Male elbow (31)

5-26. HYDRAULIC STARTING SYSTEM PIPING-FORWARD ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)

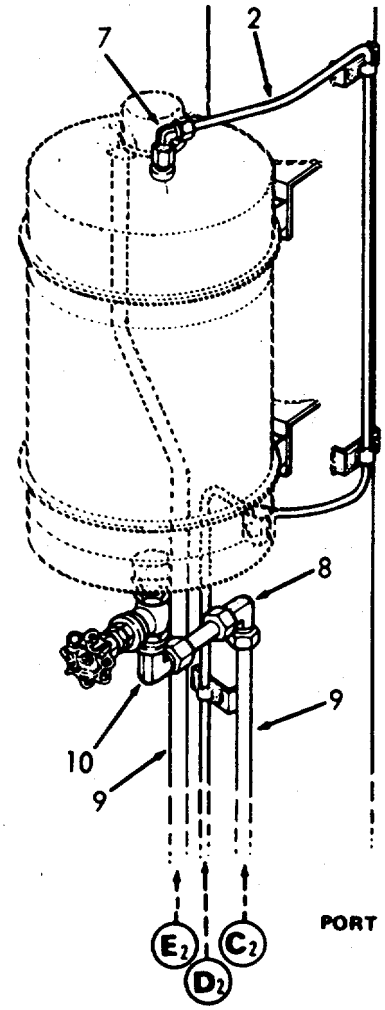
af. Male connector (32)

ag. Female pipe cross (33)

ah. Male connector (34)

ai. Female run tee (35)

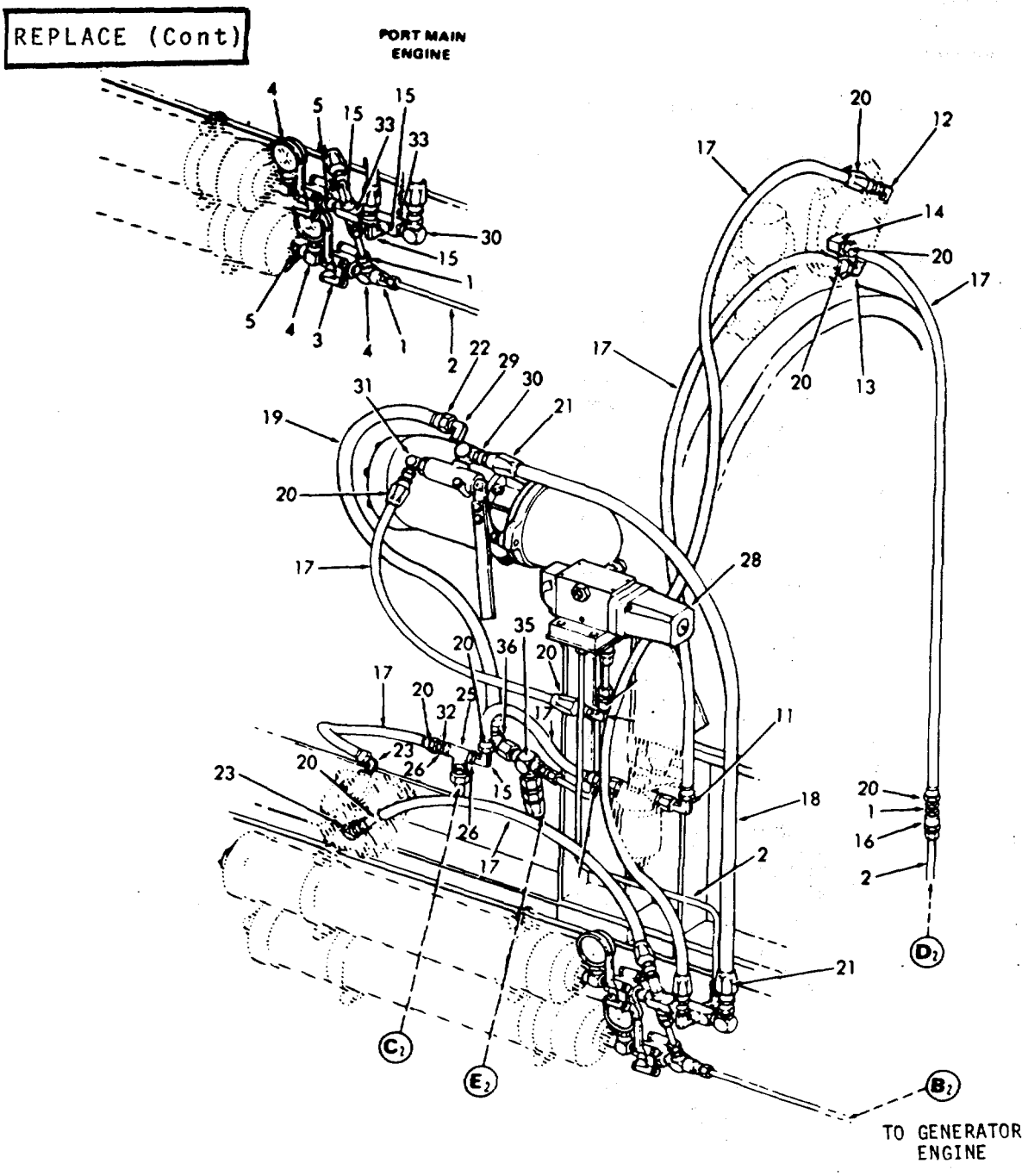
aj. 90° female elbow (36)



5-26. HYDRAULIC STARTING SYSTEM PIPING-FORWARD ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



5-27. HYDRAULIC STARTING SYSTEM PIPING-AFT ENGINE ROOM-MAINTENANCE INSTRUCTIONS.

This task covers:

Replace

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
		Repair or Replace as necessary.	
1. Aft engine room, starboard engine		a. Male connector (1)	
		b. Male branch tee (2)	
		c. Hydraulic tubing (3)	
		d. 90° male elbow (4)	
		e. 3000 pounds ball valve (5)	
		f. Pressure gage (6)	
		g. Male run tee (7)	
		h. Nipple (8)	
		i. 90° male elbow (9)	

5-27. HYDRAULIC STARTING SYSTEM PIPING-AFT ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)

j. 90° union elbow (10)

k. Hydraulic tubing (11)

l. 90° male elbow (12)

m. Union tee (13)

n. Female branch tee (14)

o. Female run tee (15)

p. Male run tee (16)

q. 90° male elbow (17)

r. 90° male elbow (18)

s. 90° male elbow (19)

t. 45° male elbow (20)

u. 90° male elbow (21)

v. Female branch tee (22)

w. Male connector (23)

x. Bushing (24)

y. Hydraulic tubing (25)

z. 90° male elbow (26)

aa. Female connector (27)

ab. Two wire braid hose (28)

ac. Two wire braid hose (29)

ad. Two wire braid hose (30)

ae. JIC swivel hose fitting (31)

5-27. HYDRAULIC STARTING SYSTEM PIPING-AFT ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)

af. Hose fitting (32)

ag. JIC swivel hose fitting (33)

ah. 90° male elbow (34)

ai. 90° male elbow (35)

aj. Female tee (36)

ak. Reducing bushing (37)

al. 90° female elbow (38)

am. Solenoid valve (39)

an. Male connector (40)

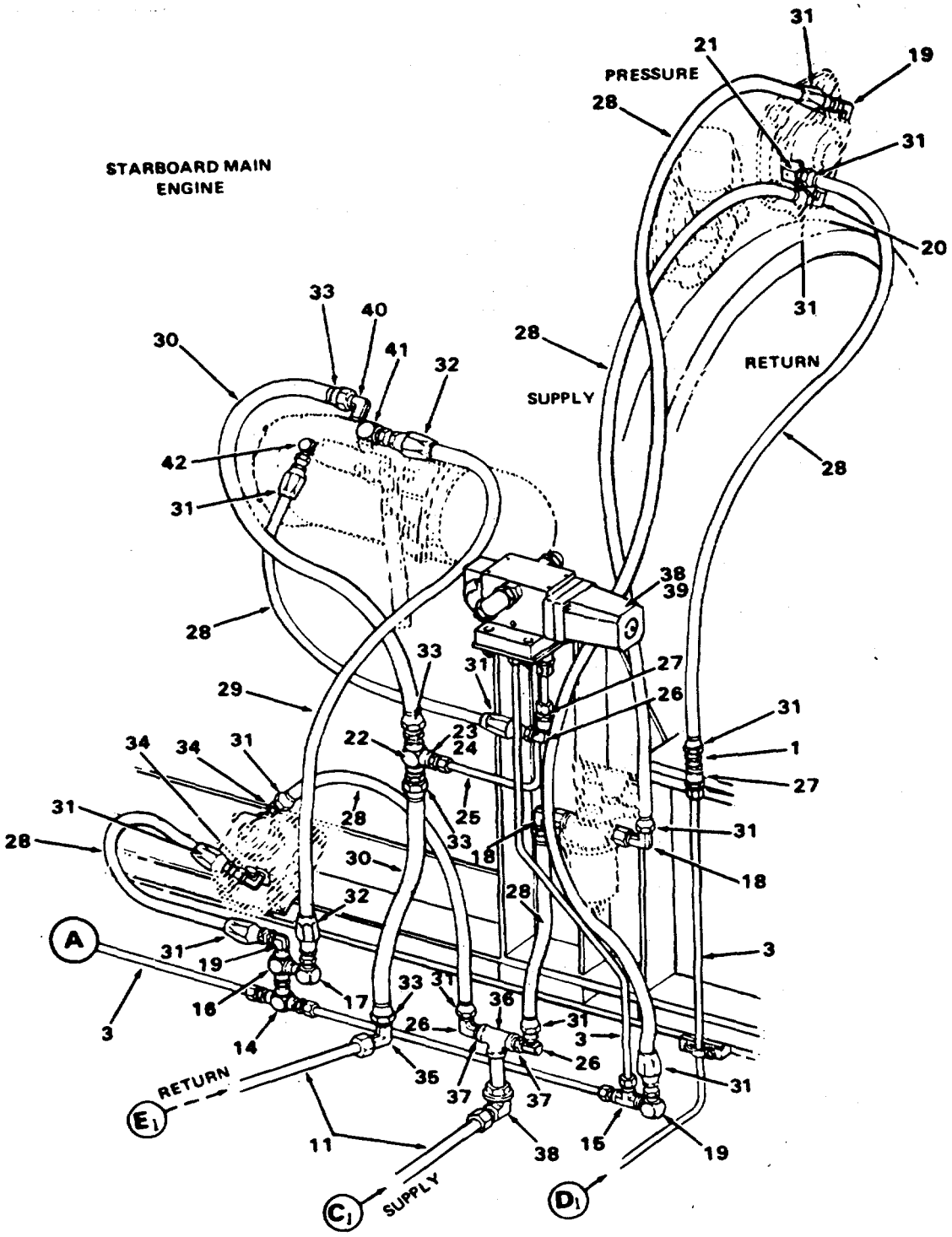
ao. 90° male elbow (41)

ap. Male elbow (42)

5-27. HYDRAULIC STARTING SYSTEM PIPING-AFT ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

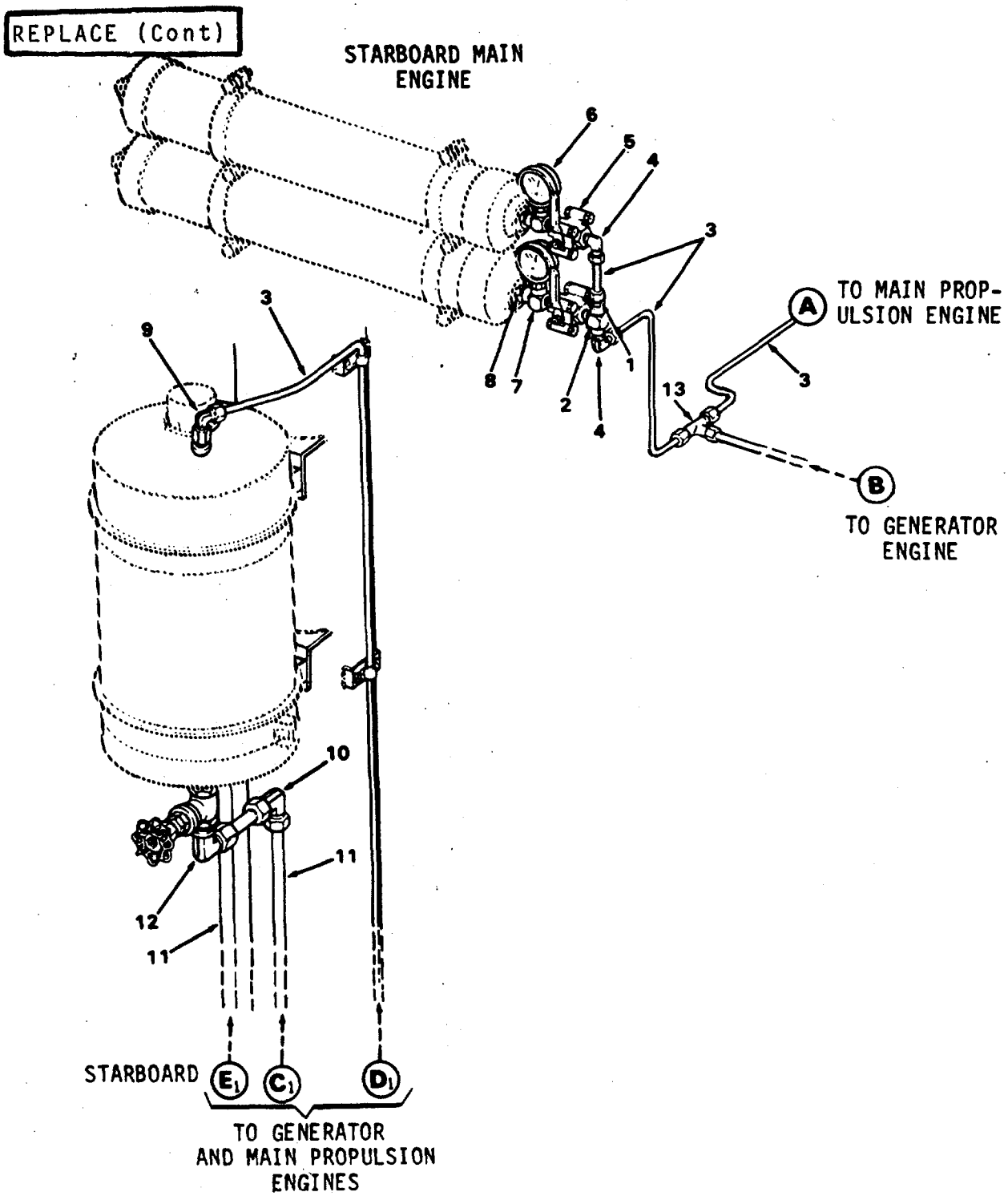
REPLACE (Cont)



5-27. HYDRAULIC STARTING SYSTEM PIPING-AFT ENGINE ROOM-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



5-28. ELECTRIC POWER GENERATION AND DISTRIBUTION-MAINTENANCE INSTRUCTIONS.

The following is an index to the maintenance instructions.

Description	Paragraph
Main Switchboard	5-29
Transformers	5-30
Power Panel Boards	5-31
Generator	5-32
Engine Assembly	5-33
Governor	5-34
Blower	5-35
Fuel Injector	5-36
Fresh Water Pump	5-37
Water Manifold	5-38
Thermostat and Housing	5-39
Exhaust Manifold	5-40
Flywheel and Housing	5-41
Lube Oil Pump	5-42
Cylinder Block	5-43
24-Volt Rectifier	5-44
Distribution Lighting Panel	5-45
Running Light Control Panel	5-46

NOTE

For the hydrostarter maintenance procedures refer to the following:

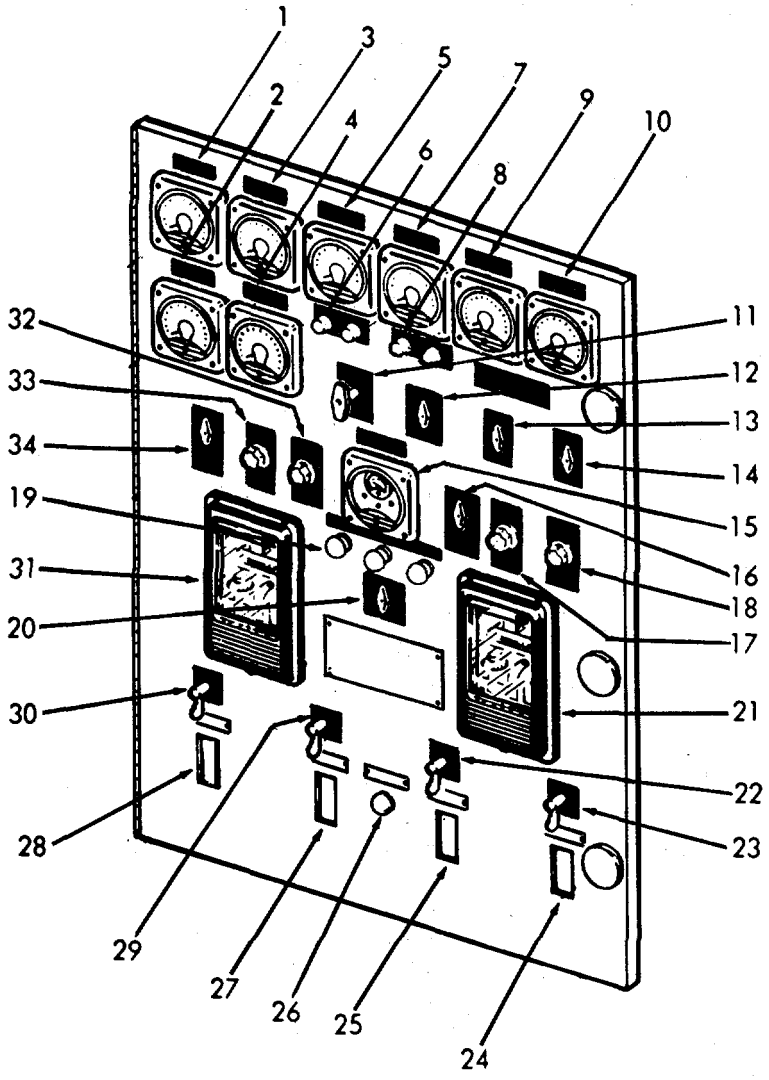
Hydrostarter	5-21
Accumulator	5-22
Engine Driven Pump	5-23
Solenoid	5-24
Reservoir	5-25
Piping (FWD Engine Room)	5-26
Piping (AFT Engine Room)	5-27

5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS.

a. Refer to the following figure for orientation and the function of the parts.

1. GENERATOR #1 VOLTMETER.
2. GENERATOR #1 AMMETER.
3. GENERATOR #2/SHORE POWER VOLTMETER.
4. GENERATOR #2/SHORE POWER AMMETER.
5. GENERATOR #1 WATTMETER.
6. FUSES-WATTMETER.
7. GENERATOR #2 WATTMETER.
8. FUSES-WATTMETER.
9. SYNCROSCOPE.
10. FREQUENCY METER.
11. GENERATOR #2/SHORE POWER AMMETER SWITCH.
12. GENERATOR #2/SHORE POWER VOLTMETER SWITCH.
13. SYNCROSCOPE SWITCH.
14. FREQUENCY SWITCH.
15. SHORE POWER PHASE SEQUENCE INDICATOR.
16. GENERATOR #2 UNIT PARALLEL SWITCH.
17. GENERATOR #2 VOLTAGE ADJUST RHEOSTAT.
18. GENERATOR #2 DROOP RHEOSTAT.
19. GROUND BUS INDICATORS.
20. GROUND TEST SWITCH.
21. GENERATOR #2 REVERSE POWER RELAY.
22. GENERATOR #2 AUTOMATIC/MANUAL SWITCH.
23. GENERATOR #2 GOVERNOR SWITCH.
24. CIRCUIT BREAKER 150 AMP-Main power to Ship's Distribution Panels.
25. CIRCUIT BREAKER 100 AMP-Shore Connection.
26. SHORE POWER INDICATOR LIGHT.
27. CIRCUIT BREAKER 70 AMP-Generator #1.
28. CIRCUIT BREAKER 70 AMP-Generator #2.
29. GENERATOR #1 GOVERNOR SWITCH.
30. GENERATOR #1 AUTOMATIC/MANUAL SWITCH.
31. GENERATOR #1 REVERSE POWER RELAY.
32. GENERATOR #1 DROOP RHEOSTAT.
33. GENERATOR #1 VOLTAGE ADJUST RHEOSTAT.
34. GENERATOR #1 UNIT PARALLEL SWITCH.

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).



b. Refer to FO-2 for schematic and to FO-3 for wiring orientation.

c. Refer to para 5-29.1 for general information and testing of the voltage regulator.

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Repair **b. Replace.**

INITIAL SETUP:

Test Equipment

NONE

References

FO-2 Main switchboard schematic
FO-3 Main switchboard component orientation

Special Tools

Ground Rod

Equipment Condition: NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1 Repair
4 Replace

General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

- In order to avoid severe shock and possible death, make sure all electricity (shore power and generators) is disconnected and tagged.
- Ground all components to prevent shock hazard in the case of component failure. The current-carrying capacity of the grounding circuit must be greater than the capacity of the largest lead to the component to be grounded.

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

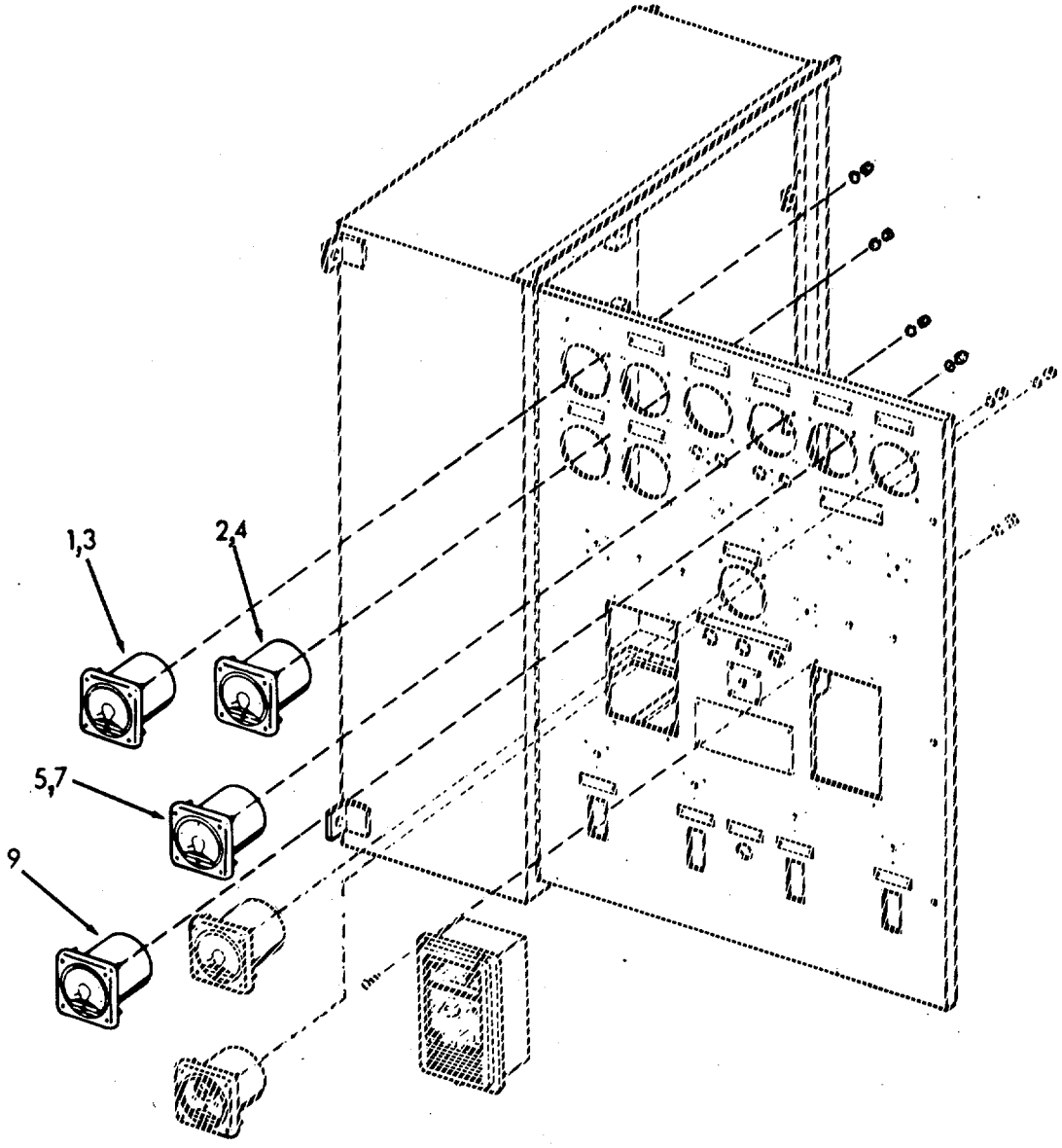
LOCATION	ITEM	ACTION	REMARKS
REPAIR			
		NOTE All wiring is numbered, refer to schematic (FO-2) for location.	
1. Gages	a. Voltmeters (1 and 3)	1. Disconnect wiring.	
		2. Remove nuts and lockwashers.	
		3. Replace meter.	
		4. Install lockwashers and nuts.	
		5. Reconnect wiring.	
	b. Ammeter (2 and 4)	1. Disconnect wiring.	
		2. Remove nuts and lockwashers.	
		3. Replace meter.	
		4. Install lockwashers and nuts.	
		5. Reconnect wiring.	
	c. Wattmeter (5 and 7)	1. Disconnect wiring.	
		2. Remove nuts and lockwashers.	
		3. Replace meter.	
		4. Install lockwashers and nuts.	
		5. Reconnect wiring.	
	d. Synchro-scope (9)	1. Disconnect wiring.	
		2. Remove nuts and lockwashers.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

3. Replace meter.
4. Install lockwashers and nuts.
5. Reconnect wiring.



5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Frequency meter (10)	1. Disconnect wiring. 2. Remove nuts and lockwashers. 3. Replace meter. 4. Install lockwashers and nuts. 5. Reconnect wiring.	
	f. Shore power phase indicator (15)	1. Disconnect wiring. 2. Remove nuts and lockwashers. 3. Replace meter. 4. Install lockwashers and nuts. 5. Reconnect wiring.	
	g. Reverse power relay (21 and 31)	1. Disconnect wiring. 2. Remove nuts, lockwashers and screws. 3. Replace relay. 4. Install screws, lockwashers, and nuts. 5. Reconnect wiring.	
2. Switches and rheostats	a. Generator shore power ammeter switch (11)	1. Disconnect wiring. 2. Remove knob, screws, lockwashers, and identification plate. 3. Replace switch.	

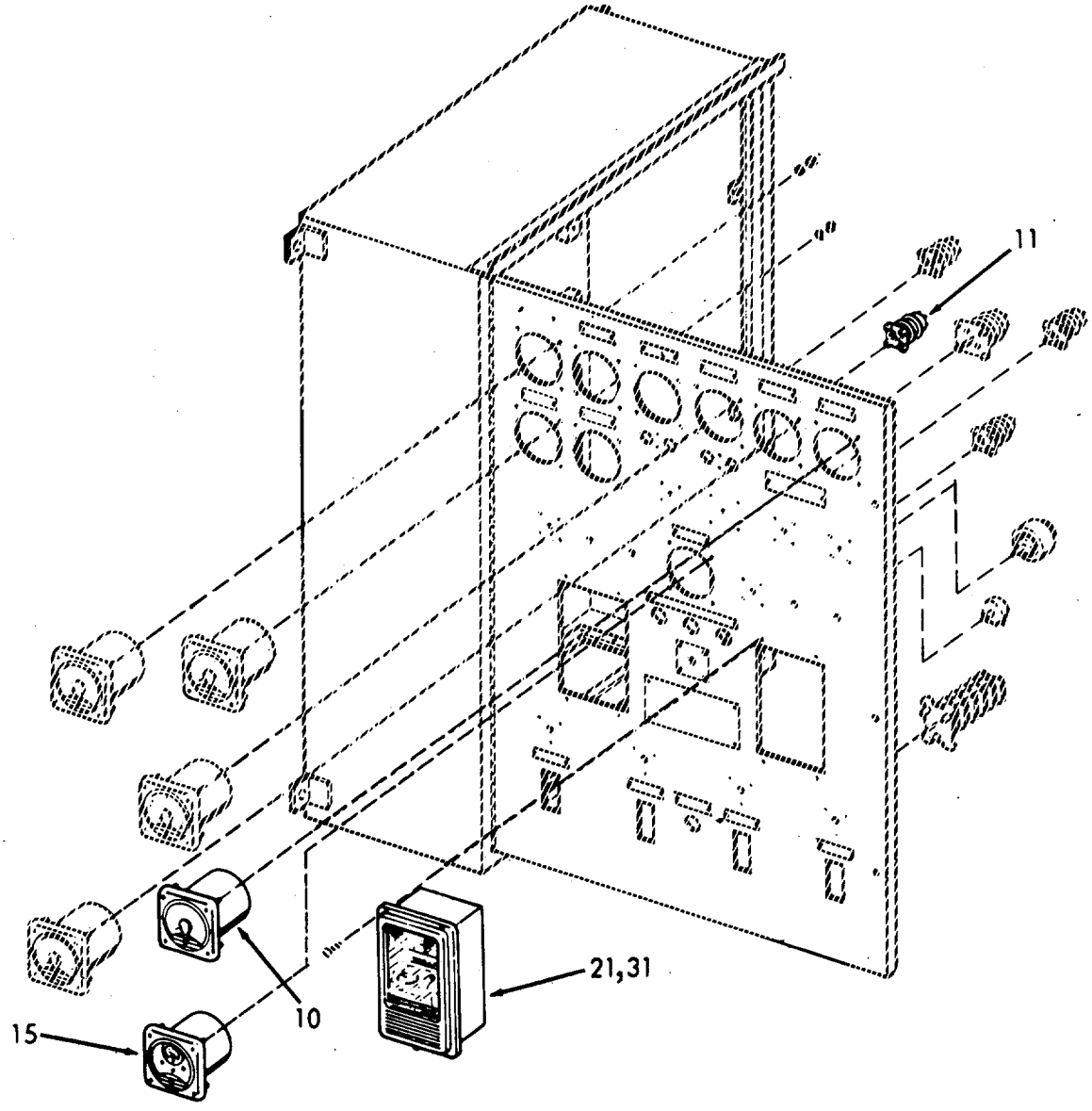
5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

4. Install identification plate, screws, lockwashers, and knob.

5. Reconnect wiring.



5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

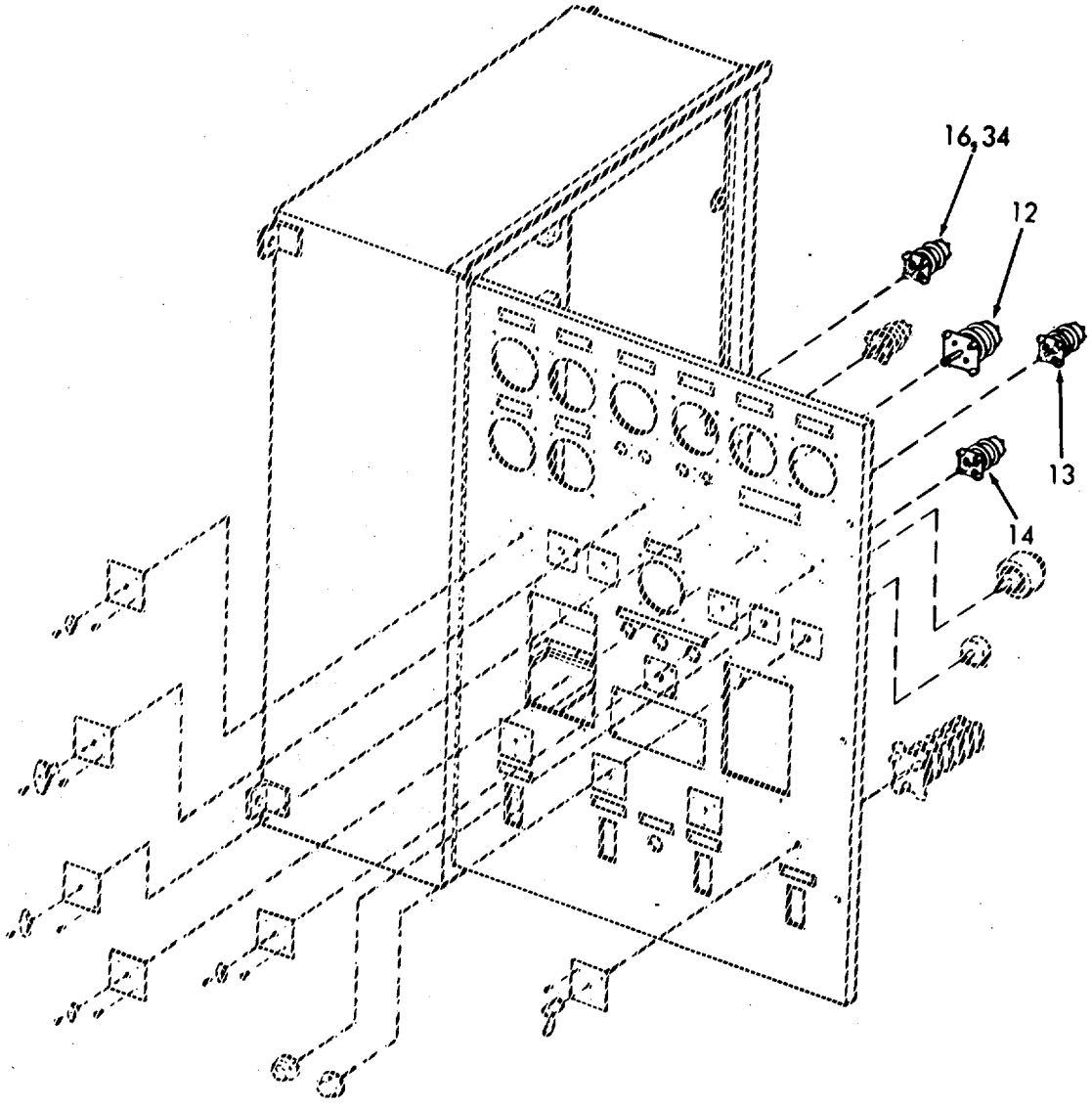
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	b. Generator bus/shore power voltmeter switch (12) plate.	1. Disconnect wiring. 2. Remove knob, screws, lockwashers, and identification 3. Replace switch. 4. Install identification plate, screws and lockwashers, and knob. 5. Reconnect wiring.	
	c. Synchroscope switch (13)	1. Disconnect wiring. 2. Remove knob, screws, lockwashers, and identification plate. 3. Replace switch. 4. Install identification plate, screws and lockwashers, and knob. 5. Reconnect wiring.	
	d. Frequency switch (14)	1. Disconnect wiring. 2. Remove knob, screws, lockwashers, and identification plate 3. Replace switch. 4. Install identification plate, screws, lockwashers, and knob. 5. Reconnect wiring.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

e.	Generator 1 or 2 unit parallel switch (16 and 34)	1. Disconnect wiring. 2. Remove knob, screws, lockwashers, and identification plate. 3. Replace switch.



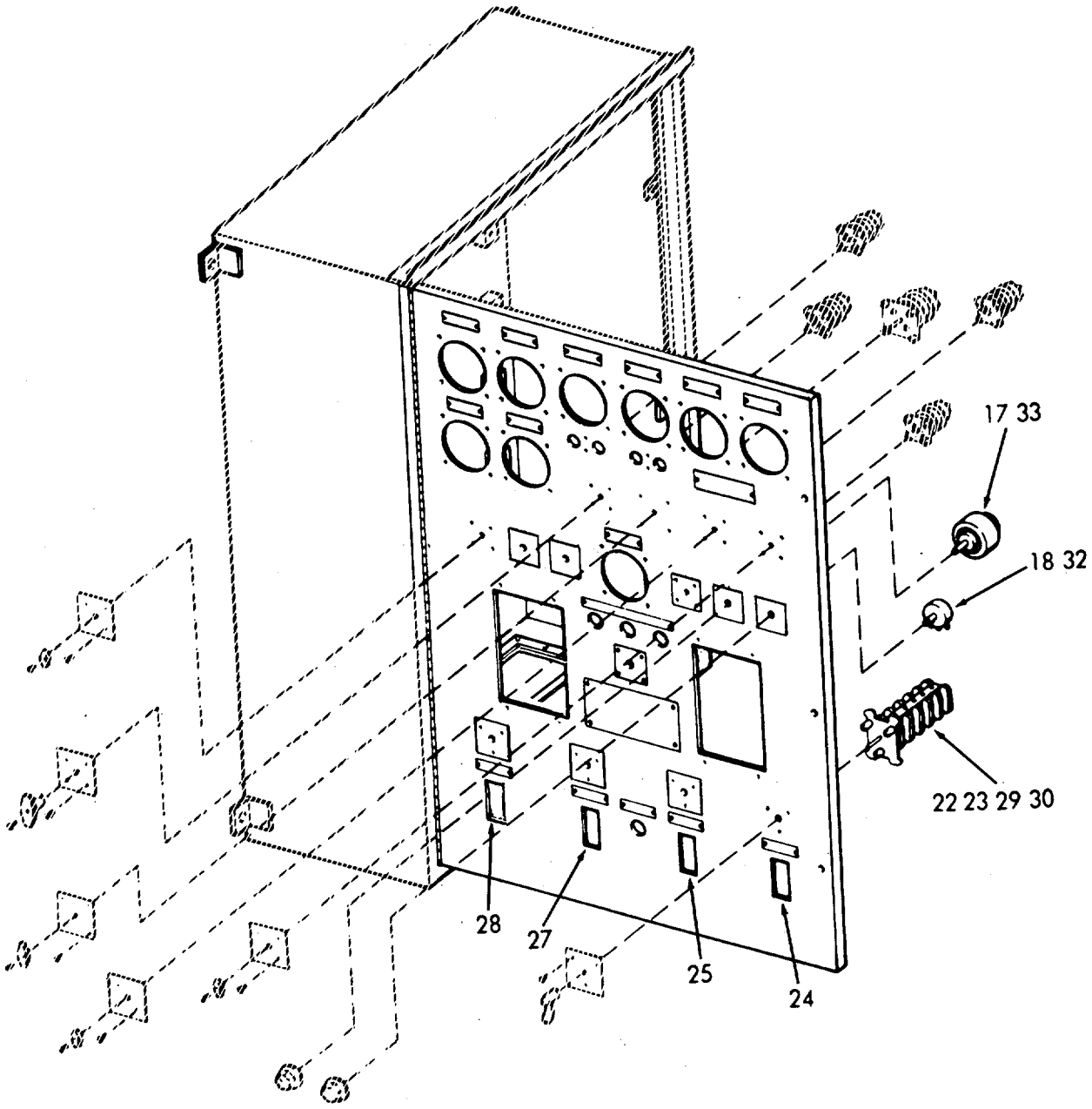
5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Generator 1 or droop reheostat, generator 1 or 2 voltage adjust reheostat (17, 18, 32, and 33)	1. Disconnect wiring. 2. Remove knob and mounting hardware. 3. Replace rheostat. 4. Install mounting hardware and knob. 5. Reconnect wiring.	
	g. Generator 1 or 2 governor switch, and generator 1 or 2 auto manual (22, 23, 29, and 30)	1. Remove cover nut and cover. 2. Disconnect wiring. 3. Remove knob, screw and lockwasher, and identification plate. 4. Replace switch. 5. Install identification plate, screw, lockwasher, and knob.	
3. Circuit breakers (24, 25, 27, and 28)	a. Nuts, and lockwashers	Remove.	
	b. Circuit breakers (24, 25, 27 , 28)	Remove.	
	c. Wiring	Disconnect.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



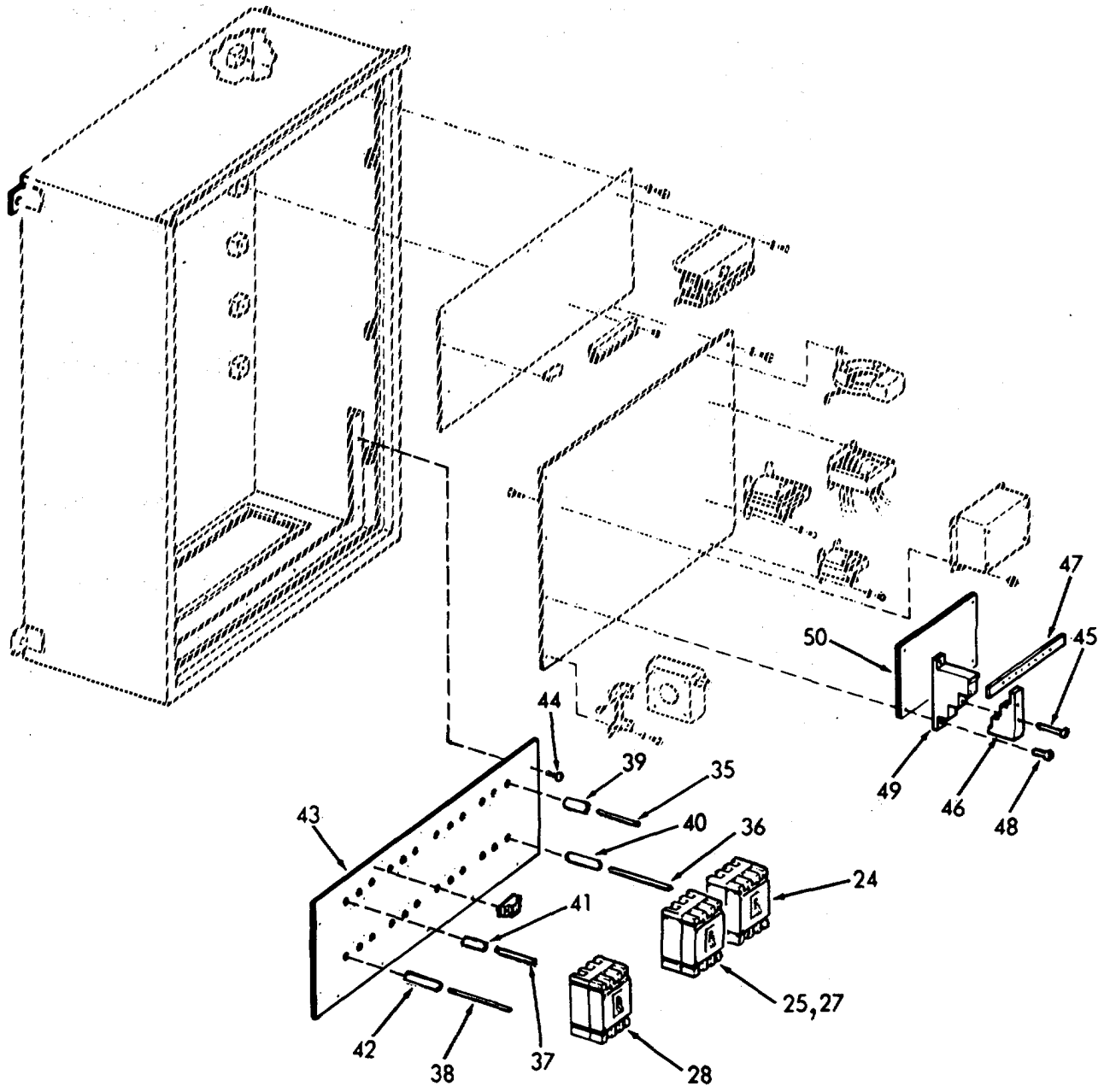
5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. Studs (35, (36, 37, or 38), and insulating tubes (39, 40, 41, or 42)	Replace on mounting pad (43).	If necessary.
	e. Screws (44), and mounting pad (43)	Replace.	If necessary..
	f. Screws (45) buss-bar clamps (46)	Replace.	If necessary.
	g. Buss-bars (47)	Replace.	If necessary.
	h. Screws (48), buss-bar bases (49), and, insulating pad (50)	Replace.	f necessary.
	i. Wiring	Reconnect.	
	j. Circuit breakers (24, 25, 27, and 28)	Install.	
	k. Nuts and lockwashers	Install.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-451

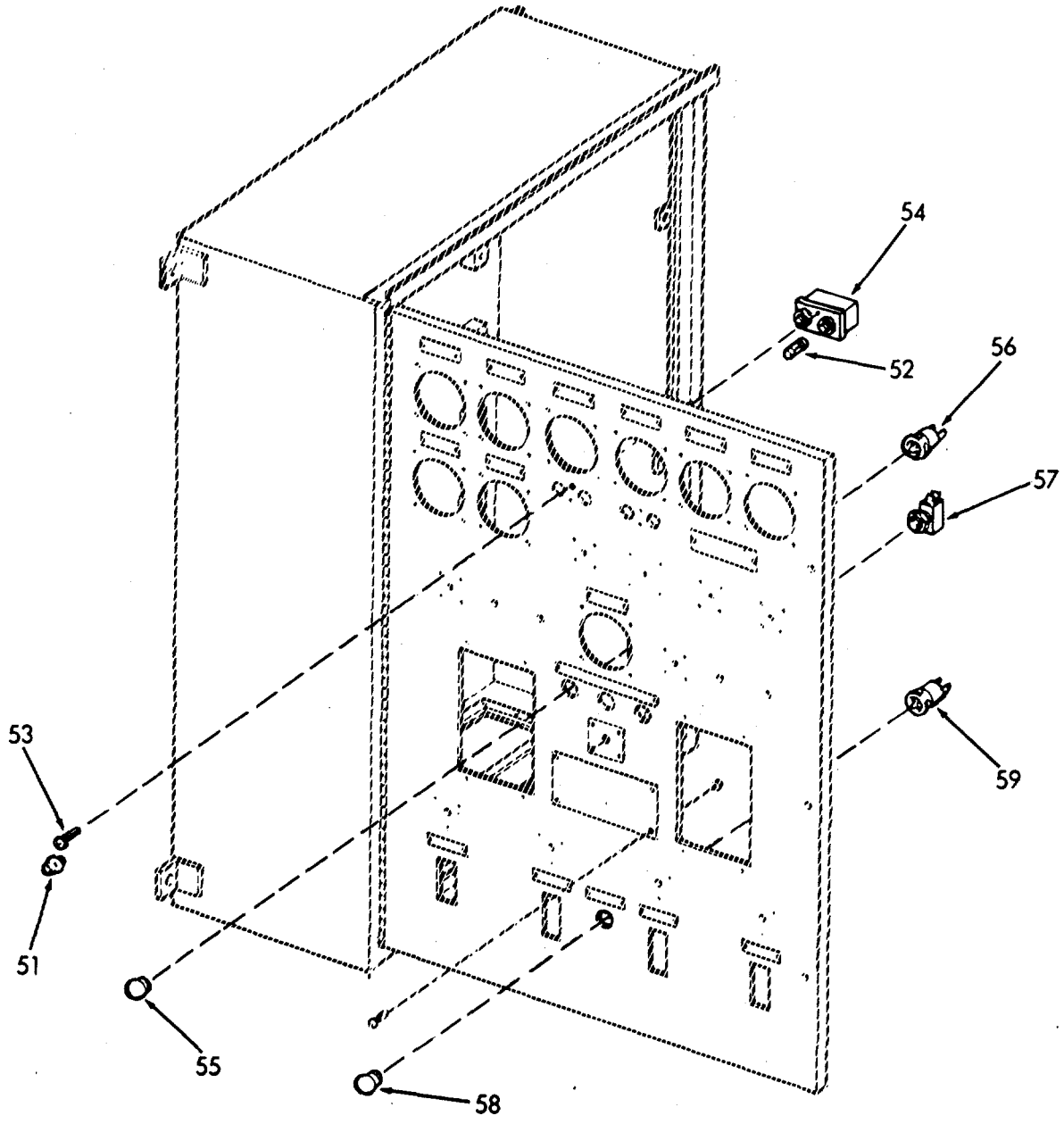
5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Fuses for Wattmeter	a. Fuse cap (51), and fuse (52)	Remove.	
	b. Screw (53)	Remove.	
	c. Fuseholder (54)	Replace.	
	d. Screw (53)	Install.	
	e. Fuse (52), and fuse cap (51)	Install.	
5. Ground Bus fault indicators and switch	a. Indicator lamp (55)	Remove.	
	b. Wiring	Remove.	
	c. Light holder (56), or switch (57)	Replace.	
	d. Wiring	Reconnect.	
	e. Indicator lamp (55)	Install	
6. Shore power indicator	a. Indicator lamp (58)	Remove.	
	b. Wiring	Remove.	
	c. Light holder (59)	Replace.	
	d. Wiring	Reconnect.	
	e. Indicator lamp (58)	Install.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

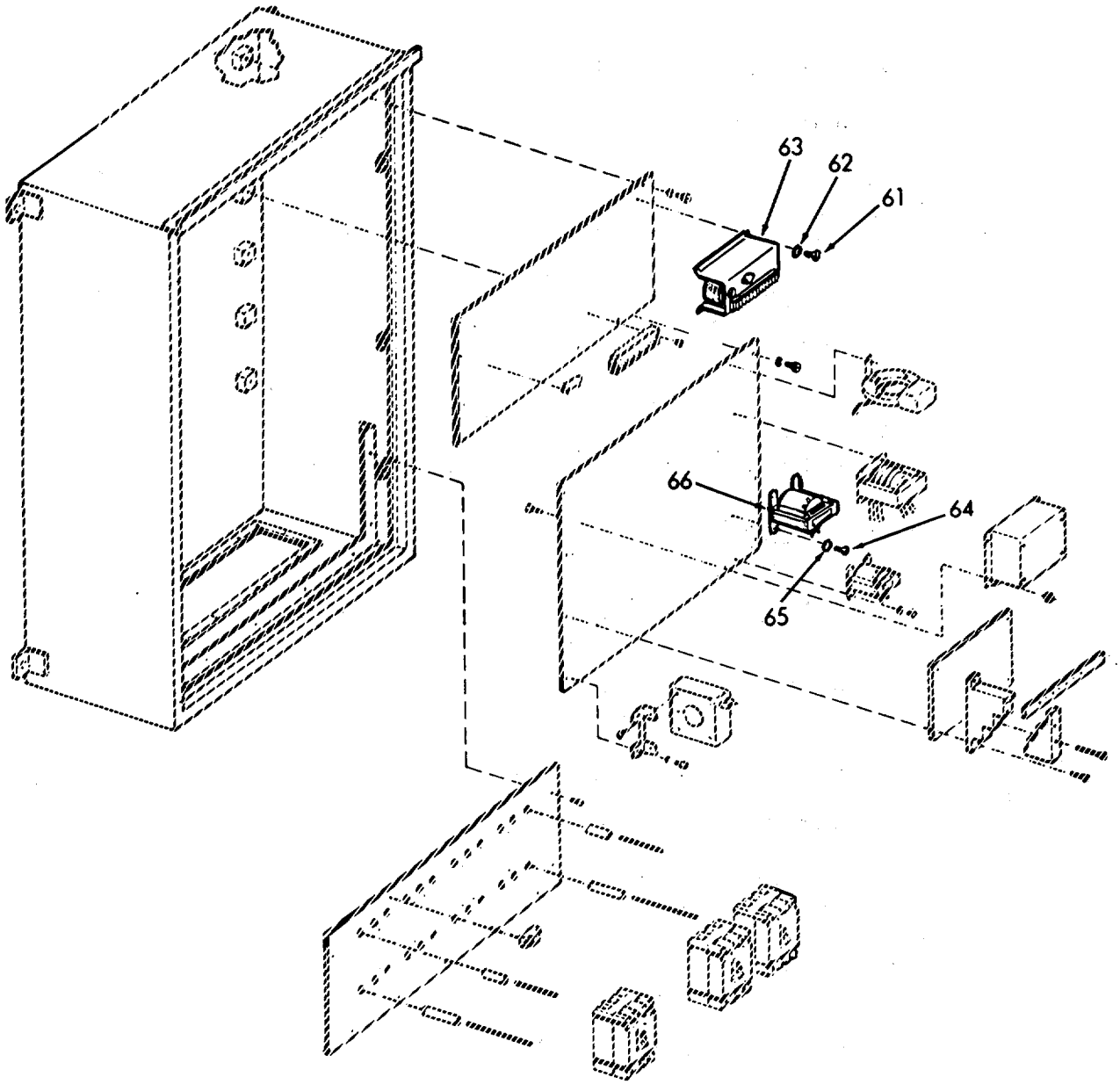
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Light resistors	a. Wiring	Remove.	
	b. Screws and lockwashers	Remove.	
	c. Resistors (60)	Replace.	
	d. Screws, and lock-washers	Install.	
	e. Wiring	Reconnect.	
8. Voltage regula-tors	a. Wiring	Tag and disconnect.	
	b. Screw (61), and lockwashers (62)	Remove.	
	c. Voltage regulators (63)	Replace.	
	d. Screws (61), and lockwashers (62)	Install.	
	e. Wiring	Reconnect and remove tags.	
9. Control trans-formers	a. Wiring	Disconnect.	
	b. Screws (64), and lockwashers (65)	Remove.	
	c. Control trans-formers (66)	Replace.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

d.	Screws (64), and lockwashers (65)	Install.
e.	Wiring	Reconnect.

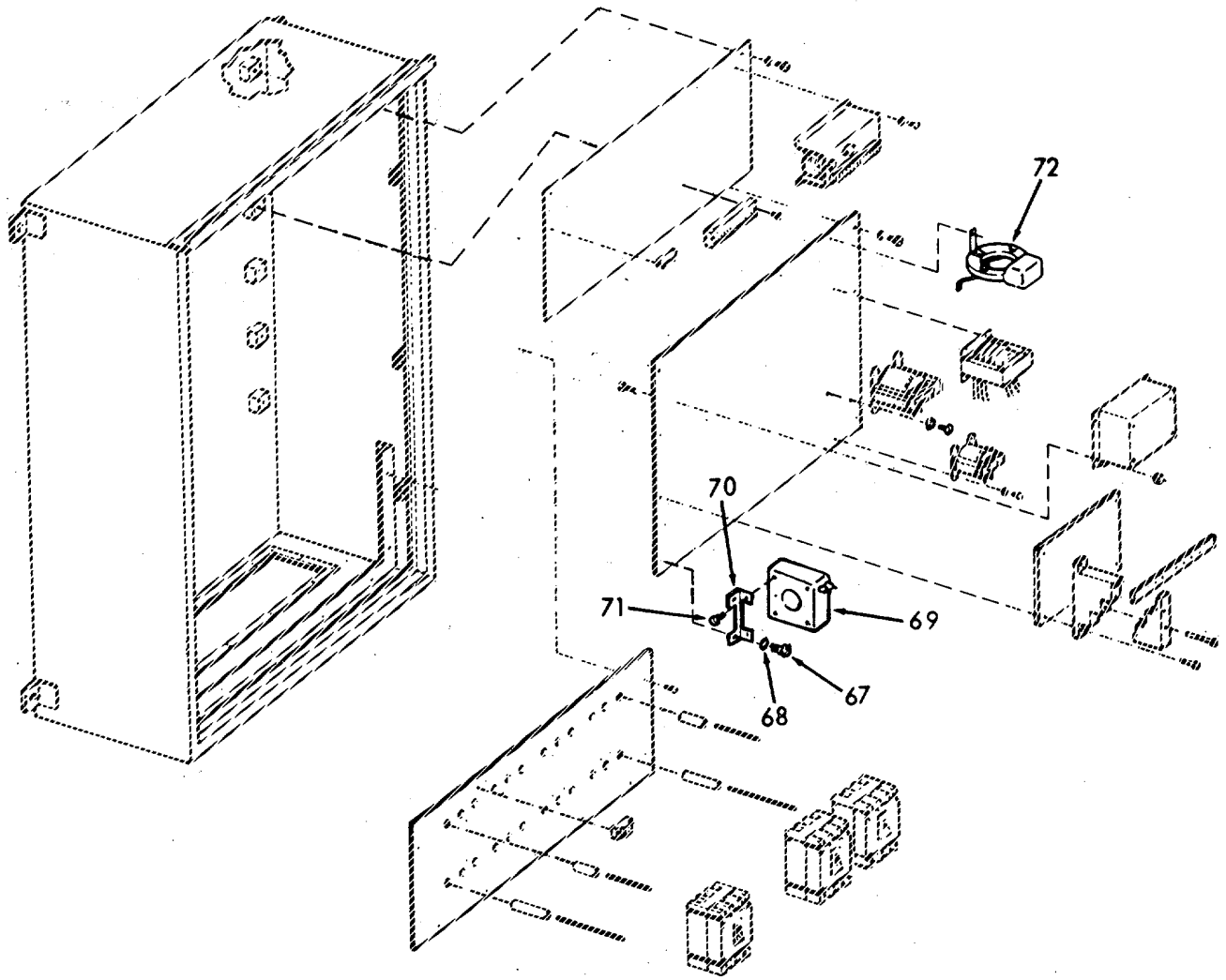


5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Current transformers	a. Wiring at top	Disconnect.	
	b. Screws (67), and lockwashers (68)	Remove.	
	c. Current transformer (69)	Remove.	
	d. Screws (70), and mounting feet (71)	Remove.	If necessary.
	e. Loop wiring	1. Cut tie wraps and remove loop. 2. Replace loop.	Refer to schematic for loop routing.
	f. Current transformers (69)	Install.	
	g. Screws (67) , and lockwashers (68)	Install.	
	h. Wiring at top	Reconnect.	
11. Droop transformers	a. Wiring and loop wiring	Cut tie wraps and disconnect.	
	b. Screws, and lockwashers	Remove.	

5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Droop transformer (72)	Replace .	
	d. Screws, and lockwashers	Install.	
	e. Wiring	Reconnect.	



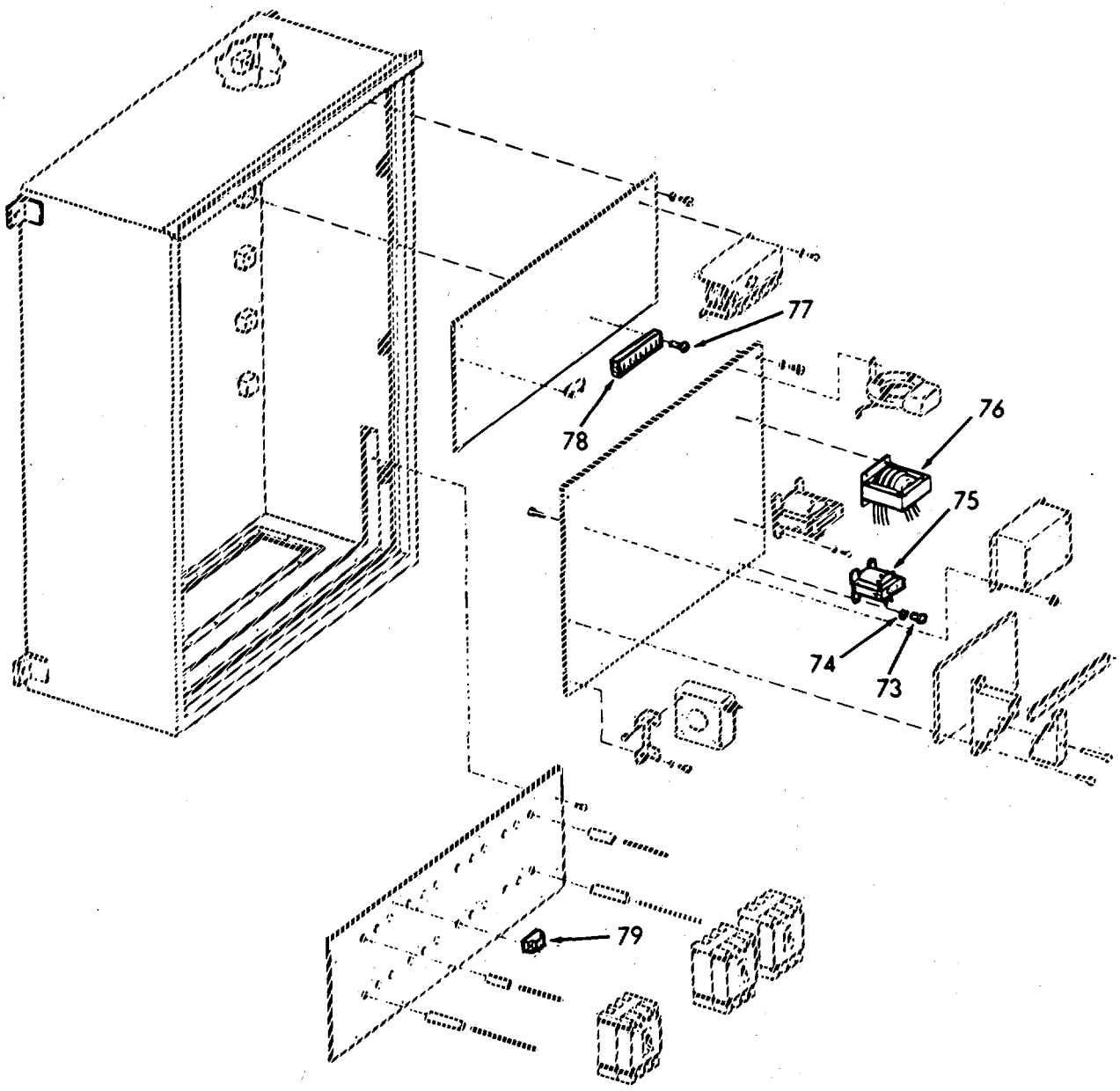
5-29. MAIN SWITCHBOARD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
12. Power transformer	a. Wiring	Disconnect.	
	b. Screws (73) ,and lockwashers (74)	Remove.	
	c. Power transformer (75)	Replace.	
	d. Screws (73), and lockwashers (74)	Install.	
	e. Wiring	Reconnect.	
13. Voltage regulating current transformer	a. Wiring	Disconnect.	
	b. Screws, and lockwashers	Remove.	
	c. Transformer (76)	Replace.	
	d. Screws, and lockwashers	Install.	
	e. Wiring.	Reconnect.	
14. Terminal strips	a. Wiring.	Tag and disconnect.	
	b. Screws (77), and terminal strip (78) or (79)	Replace.	
	c. Wiring	Reconnect and remove tags.	

5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont.)



5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Continued).

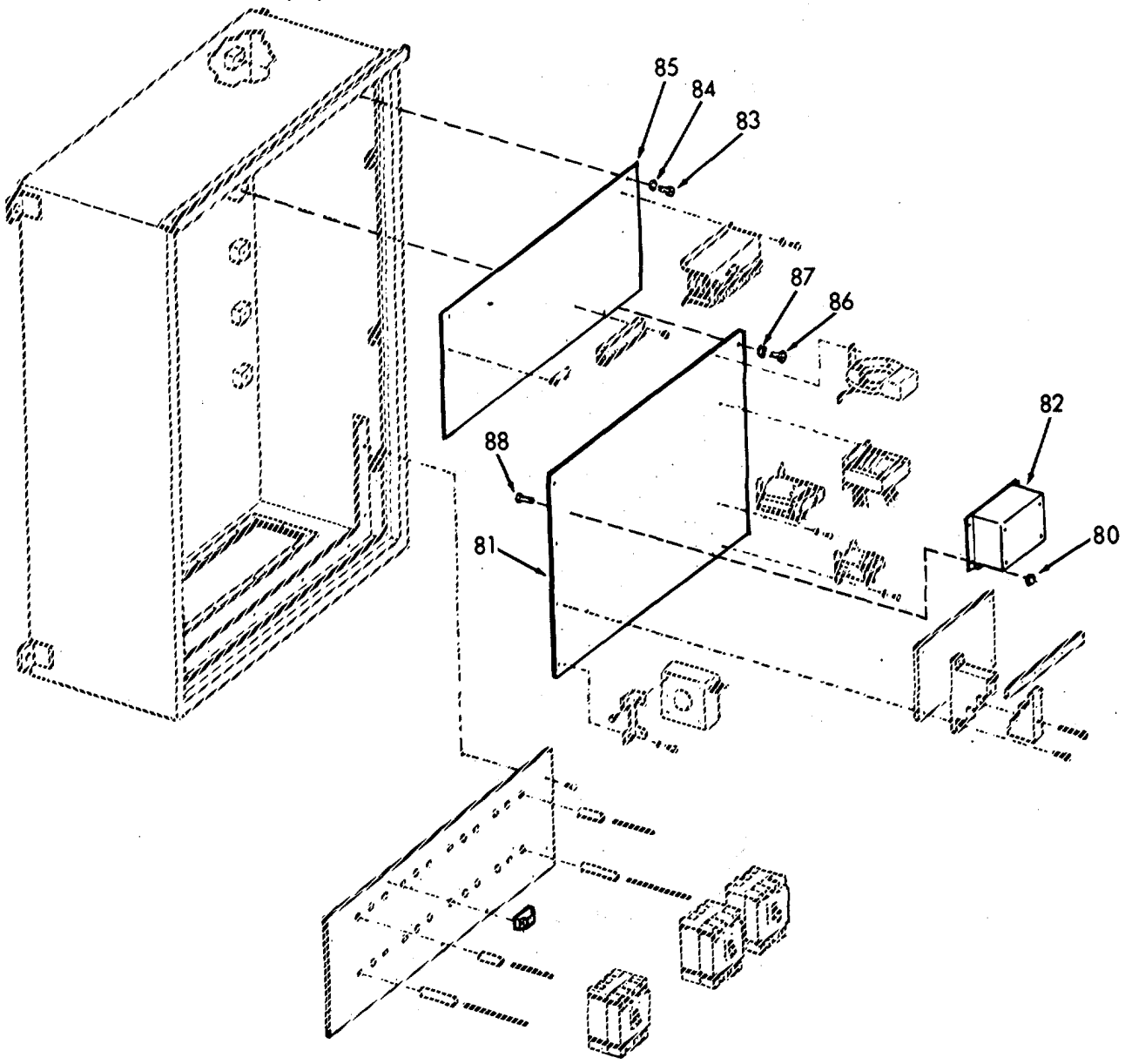
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
15. Transducer	a. Wiring	Disconnect.	
	b. Nuts (80), and screws (81)	Remove.	
	c. Transducer (82)	Replace.	
	d. Screws (81), and nuts (80)	Install.	
	e. Wiring	Reconnect.	
REPLACE			
16. Main switchboard	a. Wiring	Tag and disconnect all external wiring.	Refer to schematic (FO-2).
	b. Switchboard	Remove all mounting hardware.	
17. Regulator Plate	a. Screws (83), and lockwashers (84)	Remove.	
	b. Regulator plate (85)	Replace.	
	c. Screws (83) ,and lockwashers (84)	Install.	
18. Mounting Plate	a. Screws (86), and lockwashers (87)	Remove.	

5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

Replace (Cont.)

b.	Mounting plate (88)	Replace.
c.	Screws (86) , and lockwashers (87)	Install.



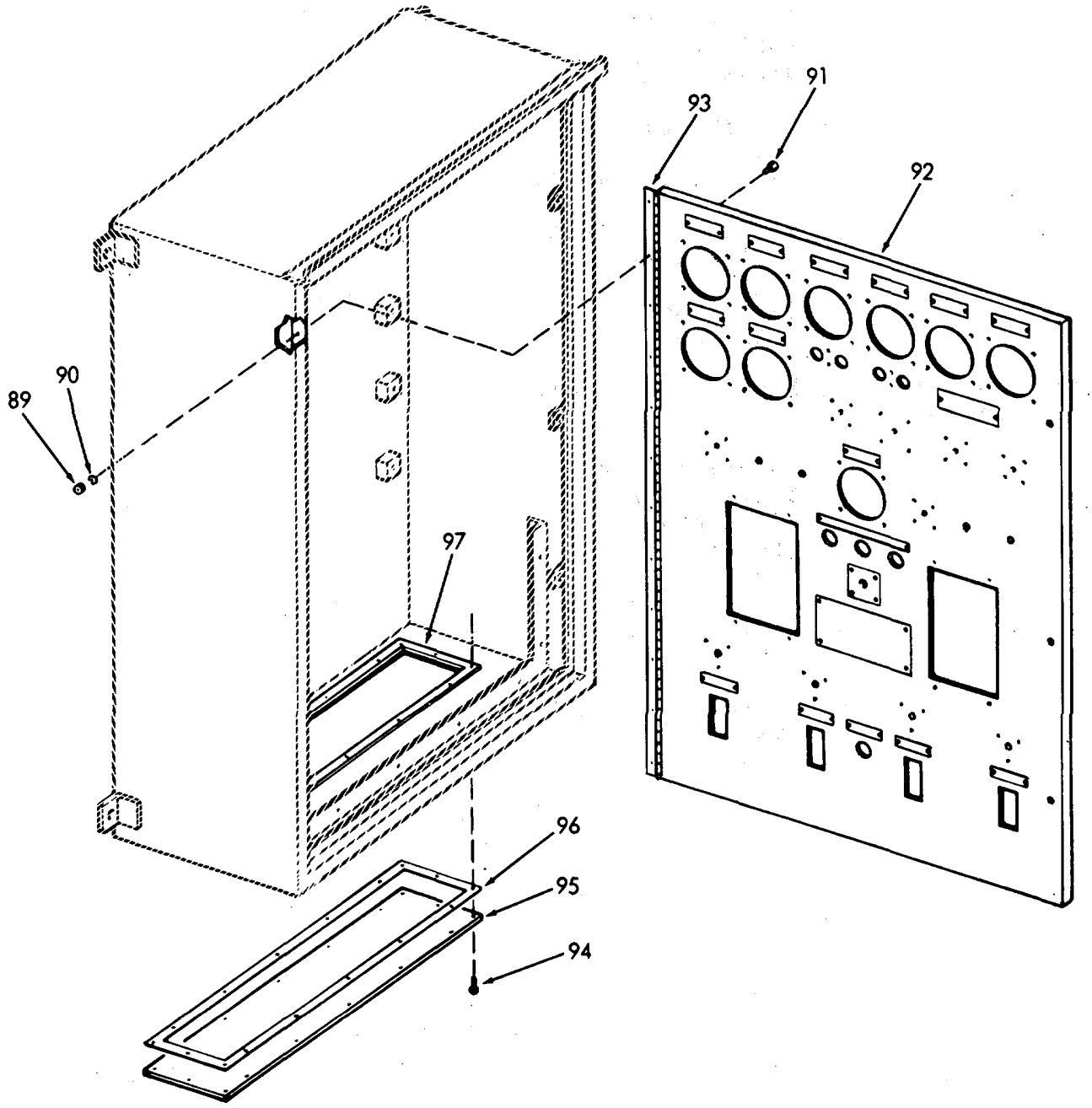
5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
Replace (Cont.)			
19. Door	a. Nuts (89), lockwashers (90), and screws (91)	Remove.	
	b. Door (92)	Replace.	
	c. Hinge (93)	Replace.	
	d. Screws (91), lock-washers (90), and nuts (89)	Install.	
20. Mounting plate	a. Screws (94)	Remove.	
	b. Mounting plate (95), and gasket (96)	Replace.	
	c. Tapped pad (97)	Replace.	
	d. Screws (94)	Install.	

5-29. MAIN SWITCHBOARD-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

Replace (Cont.)



5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS

a. General

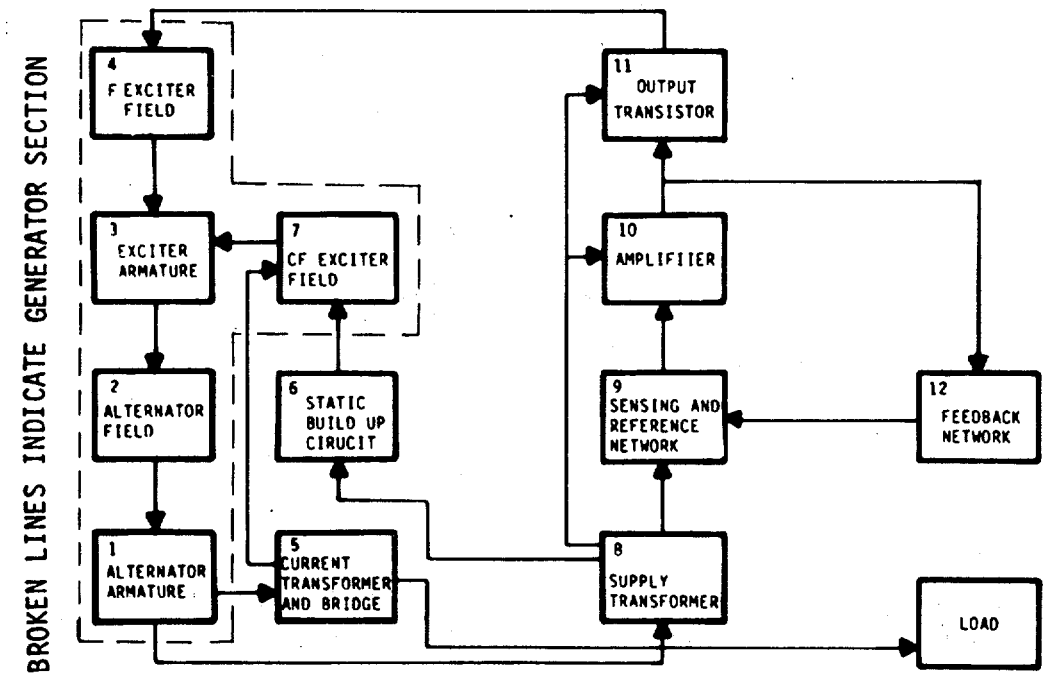
The voltage regulator is designed for voltage control of AC three-phase generators.

b. Circuit Description

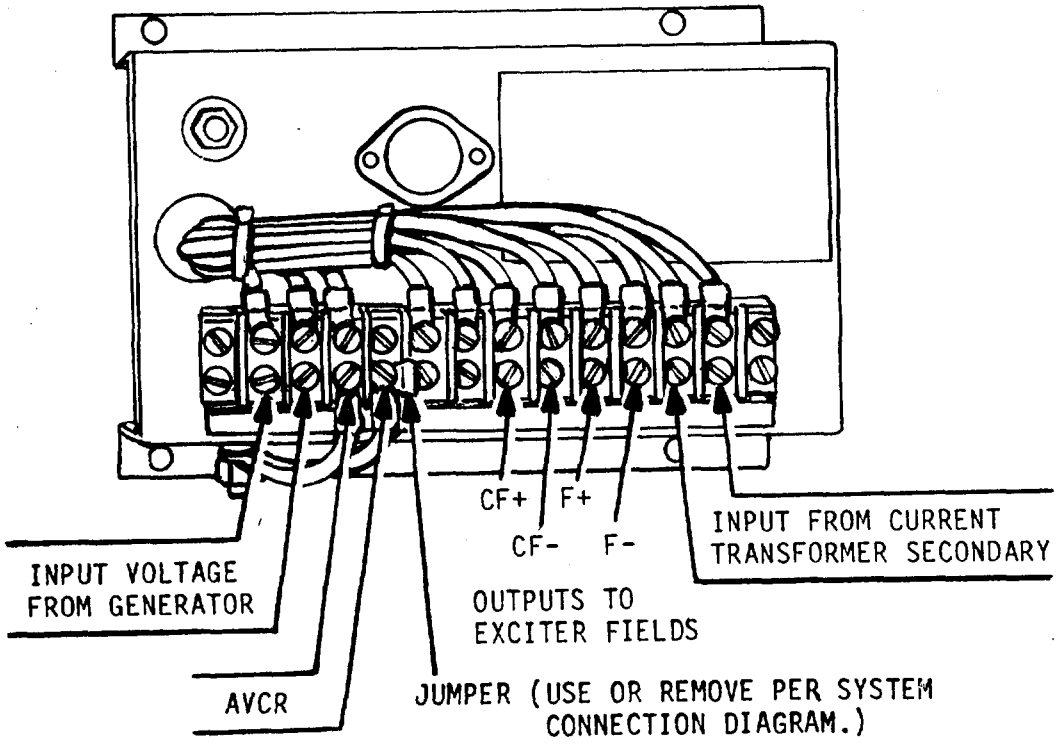
The numbers in parentheses refer to block diagram. The generator voltage output (1) is applied to the supply transformer (8) which supplies voltage to the static build-up circuit (6). During the build up period, the static build-up circuit supplies current to the CF exciter field (7). During normal operation, and under short circuit conditions, the current transformer and bridge (5) also supply current to the CF exciter field. The supply transformer (8) supplies a sample voltage to the sensing and reference network (9). This net- work rectifies the voltage and compares it to a reference. The difference, or error signal, is fed to an amplifier (10) which in turn controls the output transistor (11). The output transistor acts as a switch and varies the current in the F exciter field (4) in order to maintain the proper generator output voltage.

The supply transformer (8) also supplies power to the amplifier (10) and output transistor (11). The feedback network (12) provides for stable operation.

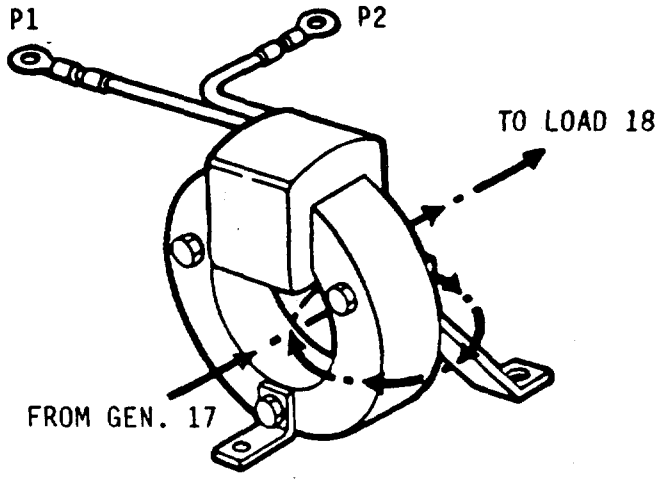
Power flow from the exciter fields (4 and 7) to the exciter armature (3), to the alternator field (2), to the alternator armature (1) is conventional for ac generators.



5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Continued).



TERMINAL STRIP CONNECTIONS



WHEN TWO TURNS ARE REQUIRED

ANY REVERSAL OF CONNECTIONS OR INSTALLATION OF THE PRIMARY WIRE THROUGH THE DROOP TRANSFORMER WILL CAUSE A VOLTAGE RISE RATHER THAN A VOLTAGE DROOP.

5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Continued).

c. Testing

(1) If troubleshooting tests have not corrected fault in regulator, remove unit for bench testing and conduct tests indicated below. Replace the regulator if it fails to pass any of the tests in this section, unless otherwise instructed. The following equipment is needed:

(a) A 0-1 amp dc ammeter

(b) A 0-10 amp dc ammeter

(c) A 50 ohm, 100 watt resistor

NOTE

CF Exciter Field of generator can be used.

(d) A 1 ohm, 100 watt resistor

NOTE

F Exciter Field of generator can be used.

(e) A 3500 ohm AVCR

NOTE

The AVCR may be installed and already connected.

(f) An ac voltmeter

(g) A single-phase, 50 or 60 hz, variable voltage power supply with 1.5 amp output capability.

(h) A 0-100 volt dc voltmeter.

(2) Ground Test. With the regulator completely disconnected from the generator, ground test between regulator terminals 3, 7 and 9 to regulator chassis with an ohmmeter or "Megger". If a ground can be located and easily repaired, this should be done.

5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Continued).

(3) F Field Circuit Test.

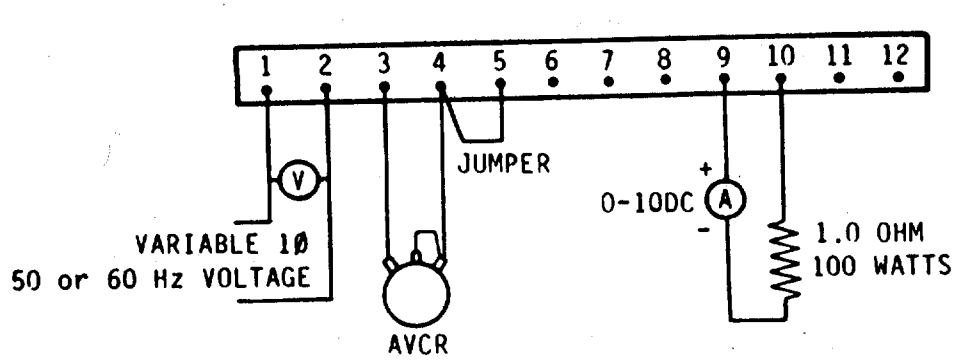
CAUTION

Do not allow the F field output to exceed 10 amps for more than several seconds or the output transistor may be damaged.

(a) Connect the regulator as shown and turn the AVCR ccw for minimum output. Adjust the single-phase input to the nominal operating voltage for the regulator-V1 in the following table:

TEST VOLTAGE TABLE

MODEL SERIES	V1	V2	V3	V4
H60	240	200	15	140



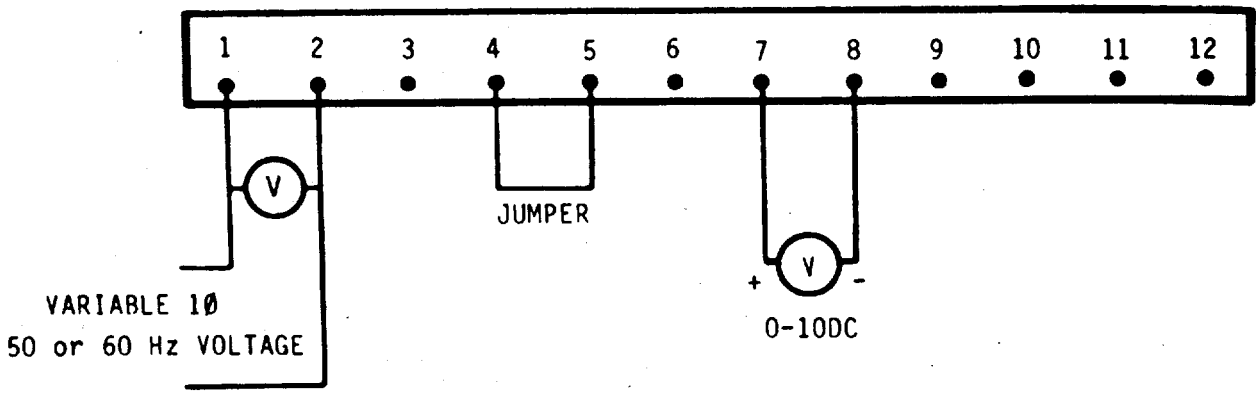
(b) At this point the ammeter should read close to zero.

(c) Turn the AVCR fully cw and adjust the single-phase input to V2 in the Test Voltage Table. The output should read not less than 5 amps.

5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Continued).

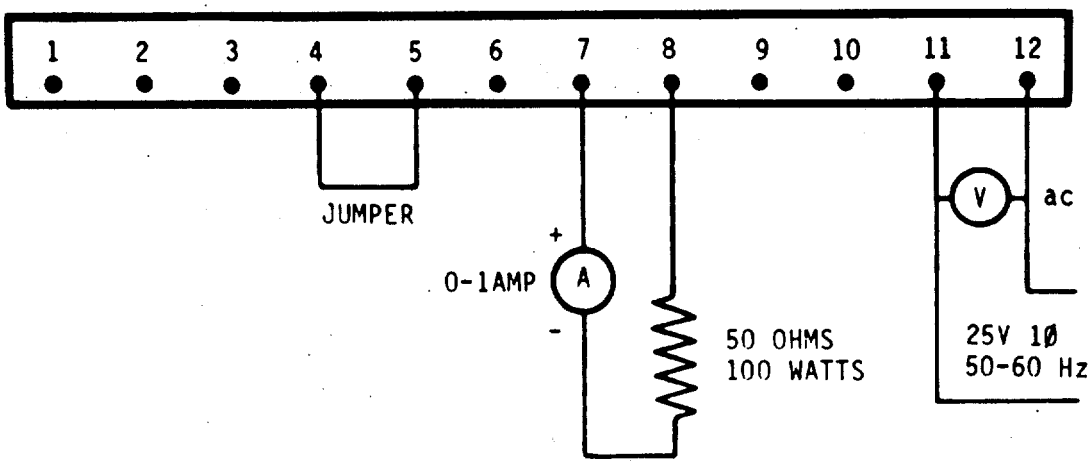
(4) Build-up Circuit Test.

(a) Connect the regulator as shown below, and adjust the single-phase input to V3ni the Test Voltage Table. The output voltage should not be less than 0.5 volt.



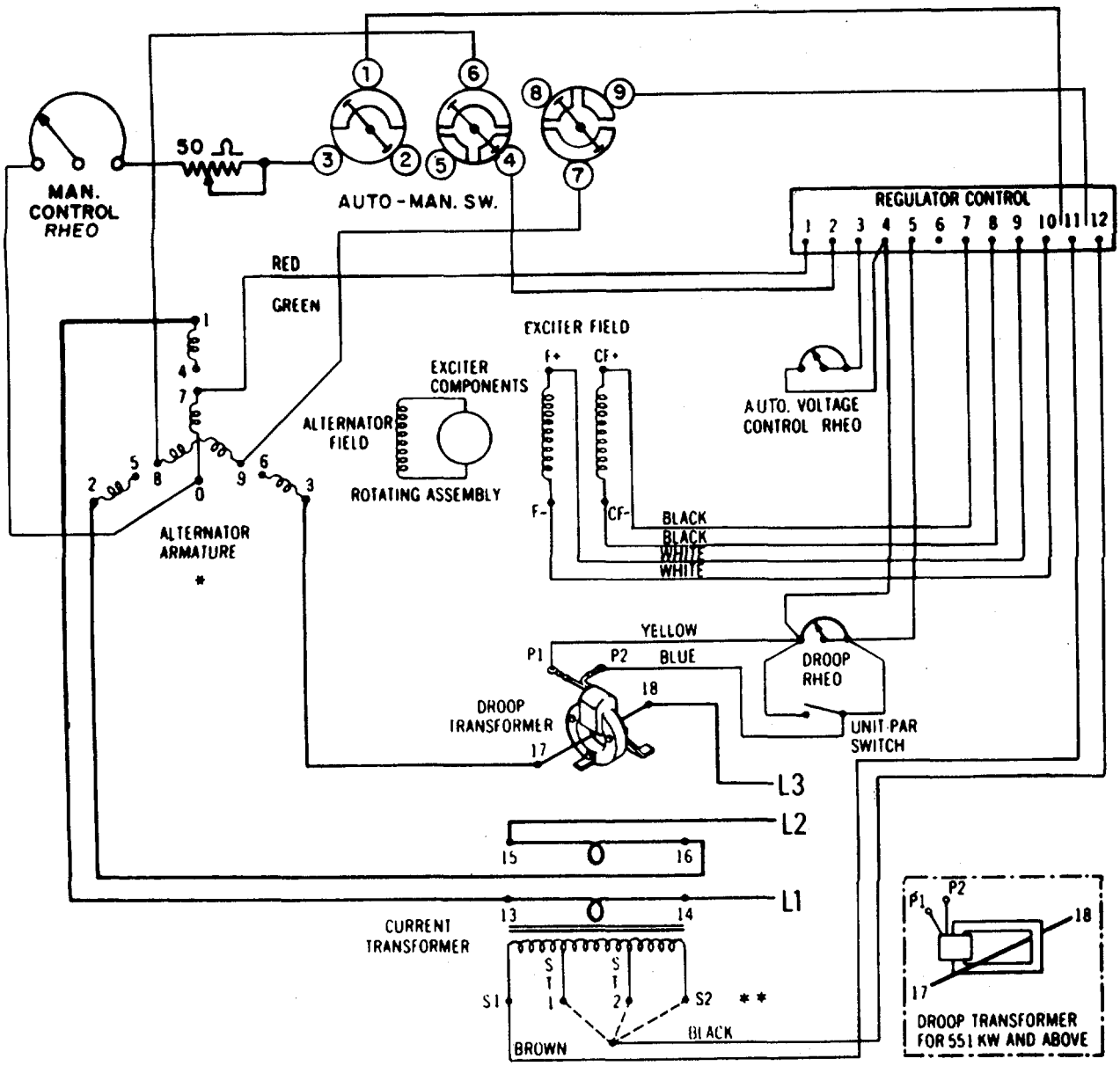
(b) Increase the input to V4 in the Test Voltage Table. The output voltage should rise to a peak and then drop to approximately zero as the input voltage is increased to the test limit.

(5) CF field Circuit Test. Connect the regulator as shown below and apply 25 volts ac to terminals 11 and 12. The output current should not be less than 0.35 amp.



5-29.1. VOLTAGE REGULATOR-MAINTENANCE INSTRUCTIONS (Continued).

d. Printed circuit boards and schematic.



* 1 FOR ALTERNATORS HAVING TWO OR MORE POWER LEADS IN PARALLEL FROM THE END OF EACH PHASE WINDING TREAT ALL LEADS WITH THE SAVE NUMBERS AS THOUGH THEY WERE A SINGLE CONDUCTOR AND CONNECT PER CHART
2 THE NEUTRAL LEAD MAY BE USED GROUNDED OR UNGROUNDED AS PER APPLICATION

** SELECTION OF SECONDARY TAP ON CURRENT TRANSFORMER DEPENDS UPON GENERATOR USED INSULATE UNUSED TAPS

5-30. TRANSFORMERS-MAINTENANCE INSTRUCTIONS.

This task covers:
a. Replace

INITIAL SETUP

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition / Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
2	Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

In order to avoid severe shock and possible death, make sure all electricity (shore power and generators) are disconnected and tagged.

REPLACE

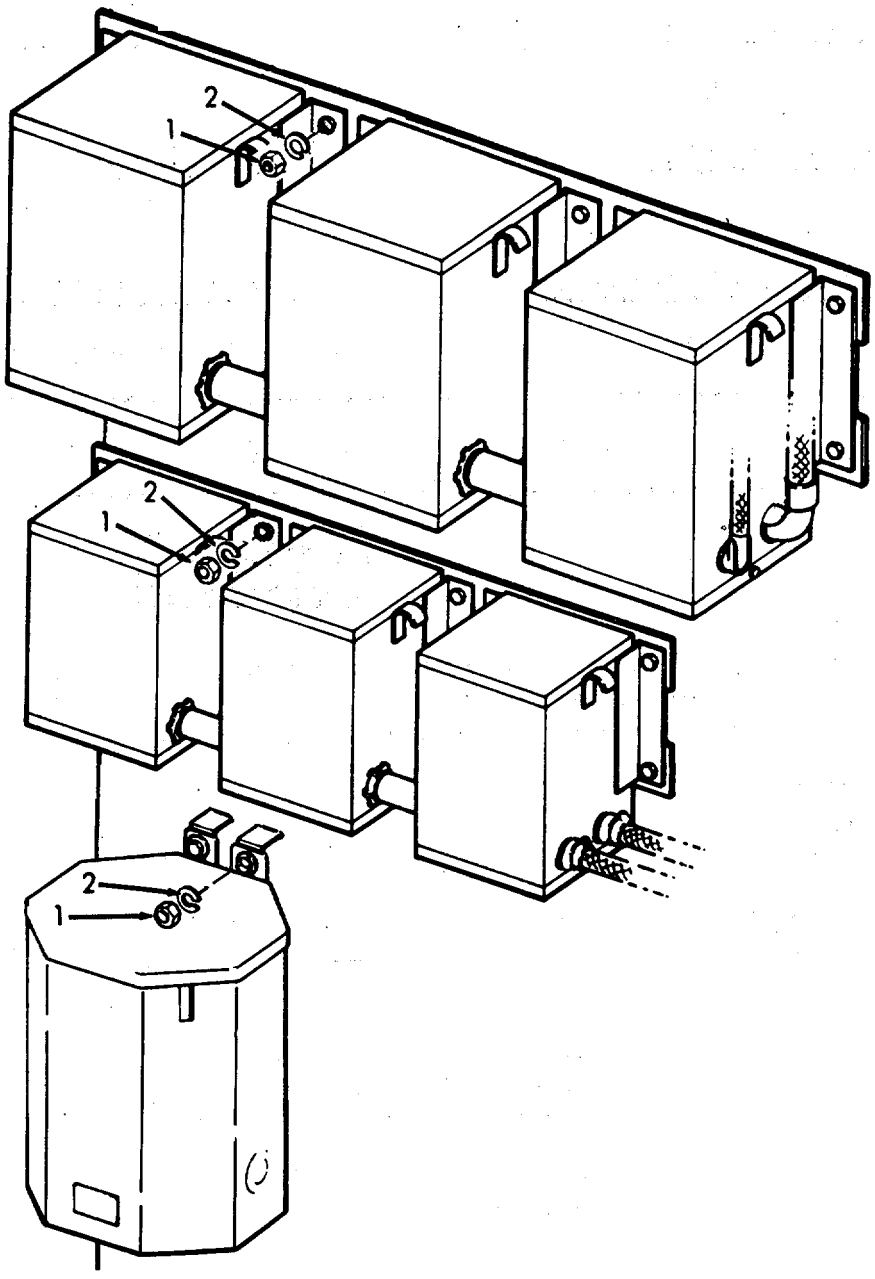
1.	Transformers	a. Wiring	Disconnect.	Refer to schematic and orientation.
		b. Nuts (1), and lockwashers (2)	Remove.	
		c. Transformer	Replace.	

5-30. TRANSFORMERS-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont.)

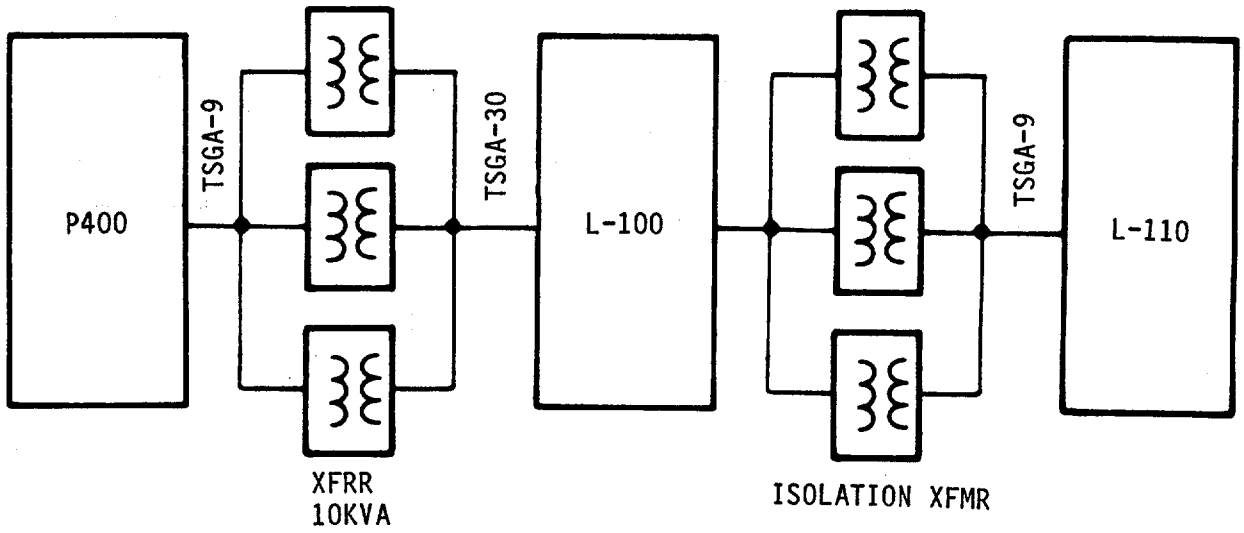
d.	Nuts (1), and lock-washer (2)	Install.
e.	Wiring	Reconnect.



5-30. TRANSFORMERS-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

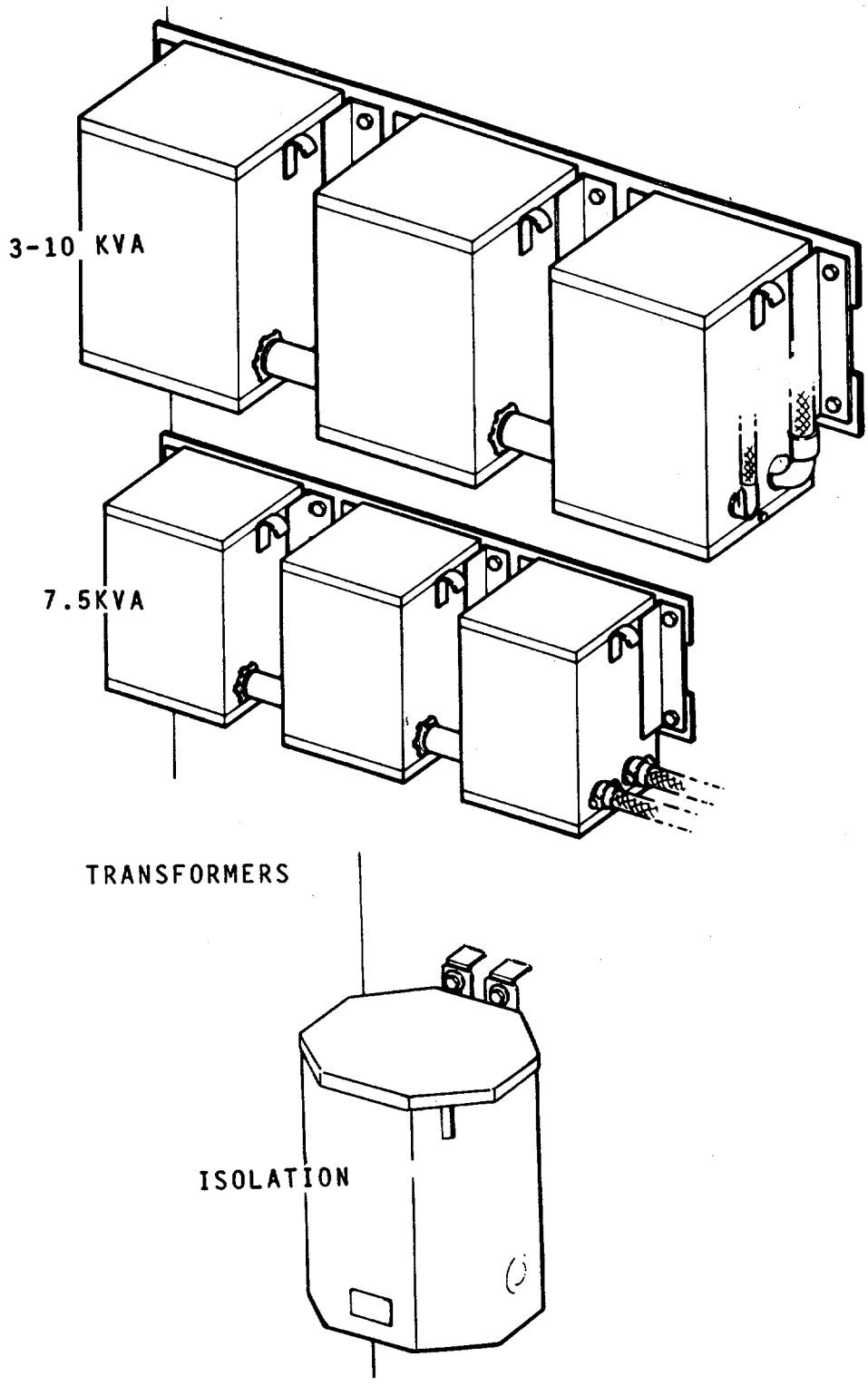
REPLACE (Cont.)



5-30. TRANSFORMERS-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont.)



5-31. POWER DISTRIBUTION PANEL BOARDS-MAINTENANCE INSTRUCTIONS.

This task covers:
a. Replace b. Overhaul

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

2

References

FO-4 Power Distribution Schematic
FO-5 Wireways
FO-6 Power Distribution System
FO-7 List of Feeders and Mains

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

- In order to avoid severe shock and possible death, make sure all electricity (shore power and generators) is disconnected and tagged.
- Ground all components to prevent shock hazard in the case of component failure. The current carrying capacity of the grounding circuit must be greater than the capacity of the largest lead to the component to be grounded.

5-31. POWER DISTRIBUTION PANEL BOARDS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE OVERHAUL			
		NOTE All wiring is tagged.	
1. Power distribution panel boards	a. Wiring	Disconnect.	See references.
	b. Panel	1. Remove hardware then panel.	
		2. Replace.	
	c. Wiring	Reconnect.	
2. Wiring		Replace as necessary.	See references.

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

This task covers:
a. Test **b. Disassembly** **c. Reassembly**

INITIAL SETUP

Test Equipment

Volt Ohmmeter
Megohmmeter (500V)

Special Tools

Pipe (6 ft long) and flange
Chain hoist
Torque wrench
Gear or bearing puller
Soldering (25 Watt max)

Material/Parts

Electrical tape
Varnish (Insulating)
Rust inhibiting grease

Personnel Required

2

References

Para 3-63 Generator-Removal.

Equipment Condition — Condition Description

NONE

Special Environmental Conditions

NONE

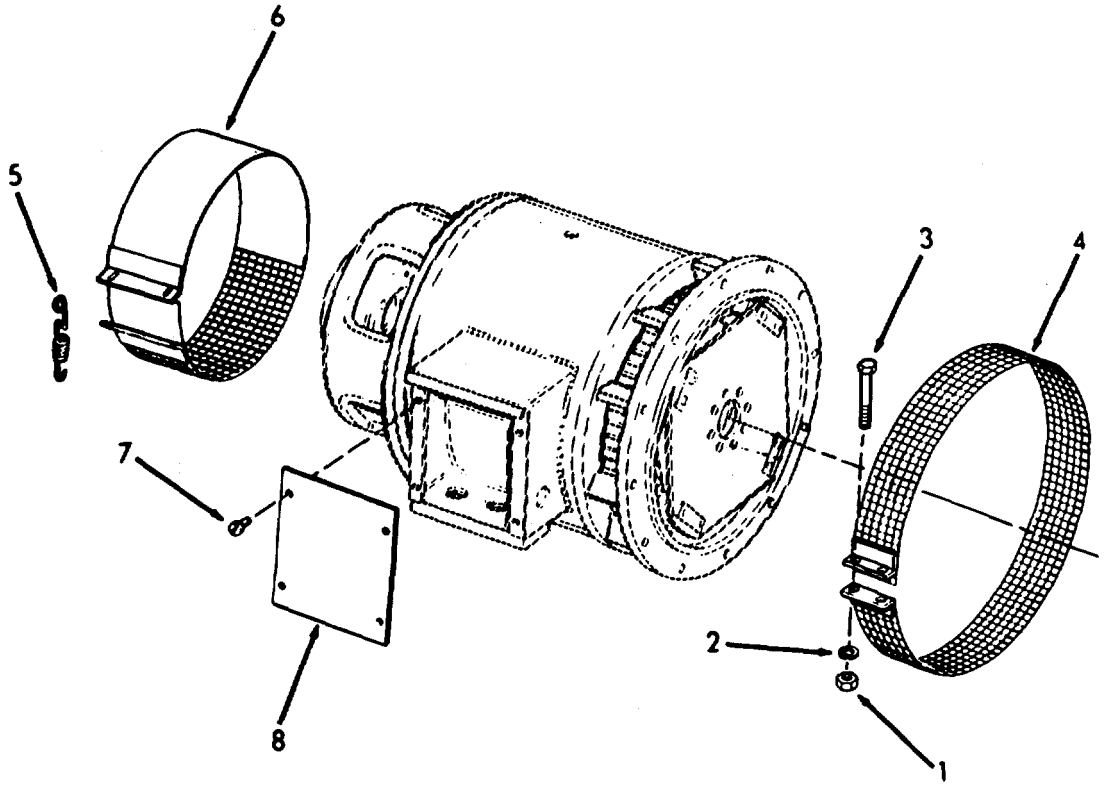
General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
TESTS			
1. Prelim-inary set-up	a. Nuts (1) lockwashers (2), and screws (3)	Remove.	
	b. Fan cover (4)	Remove.	
	c. Springs (5), and end frame cover (6)	Remove.	

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	d. Screws (7) , and cover plate(8)	Remove.	Remove on both sides.



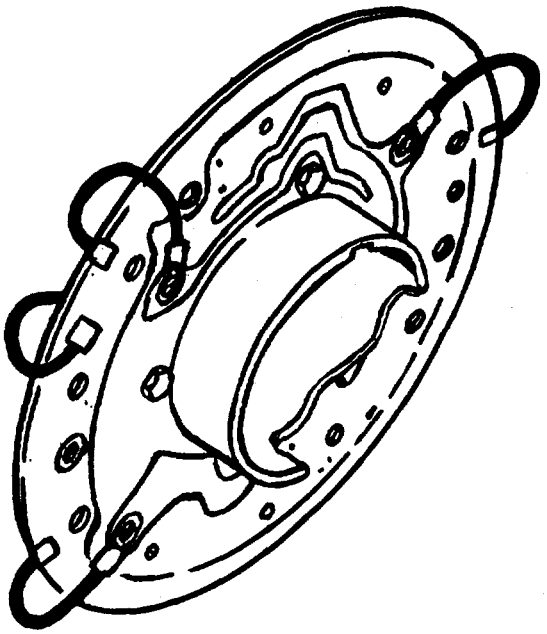
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
2.	Insulation		
		CAUTION To prevent possible damage to the regulator and rotating rectifiers during this test, they must be isolated as follows:	
	a. Jumper across the printed circuits as shown.	1. Place a jumper	
		NOTE Place jumper near outer edge which is free of coating.	
		2. Place additional jumpers from printed circuits to all three exciter armature leads at their termination on the rotating rectifier assembly.	

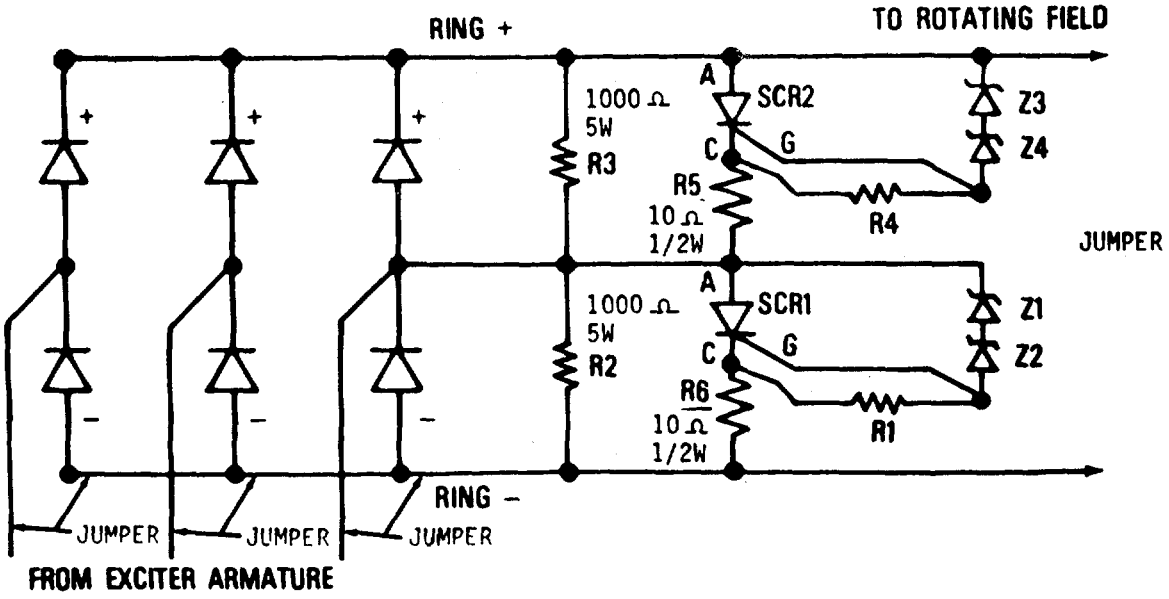
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

TESTS (Cont.)



LOCATION OF JUMPERS

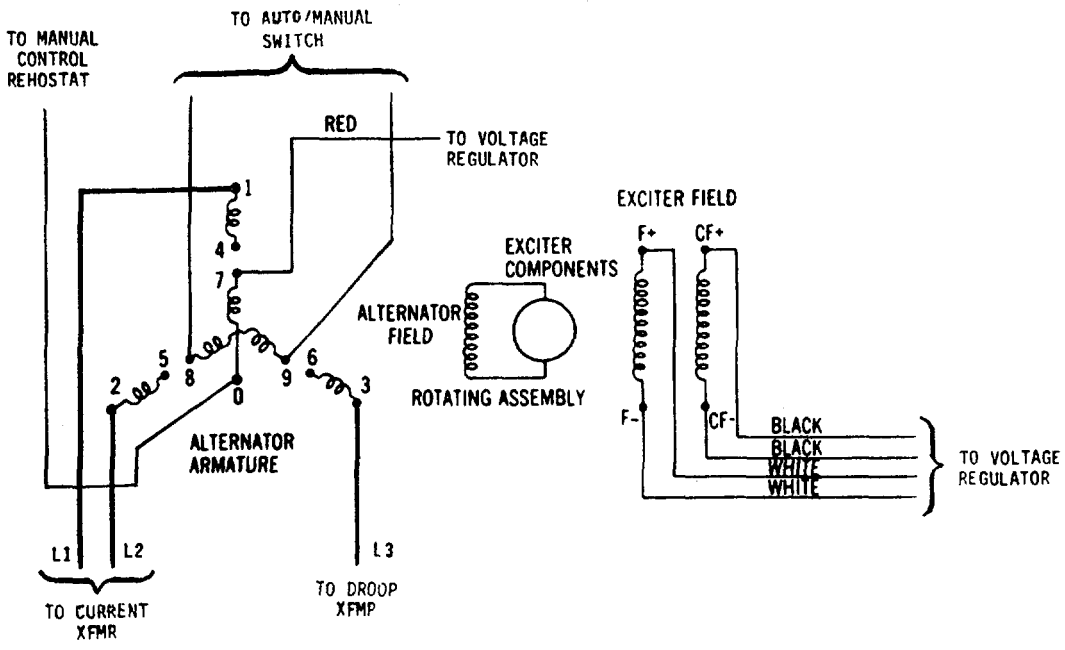


5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	b. Megohm-meter	1. Attach one lead to frame and the other to L1, L2, or L3.	a. Use a 500V megohmmeter. b. The minimum insulation should be 1.3 meg.
		2. Attach one lead to frame and the other to F(+ or -).	a. The minimum insulation should be 1.3 meg. b. If the resist-ance is lower the generator requires main-tenance.
		3. Attach one lead to frame and the other to CF (+ or -).	a. The minimum insulation should be 1.3 meg. b. If the resist-ance is lower the generator requires main-tenance. c. If it shows a short (grounded), locate and repair.
	c. Jumpers	Remove all jumpers.	

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
3. Resistance tests	a. Exciter field coil assembly		
		NOTE If the exciter field coil assembly is suspected of being open or shorted, check resistance.	
		1. Detach F+ lead, and measure resistance between F+ and F-.	See table for resistance limits on page 5-493.
		2. Detach CF+ lead, and measure resistance between CF+ and CF-.	
		3. Examine the insulation carefully.	Tape and varnish all breaks.



NOTE ALL OUTPUTS OF THE GENERATOR GO TO THE MAIN SWITCHBOARD.

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

TESTS (Cont.)

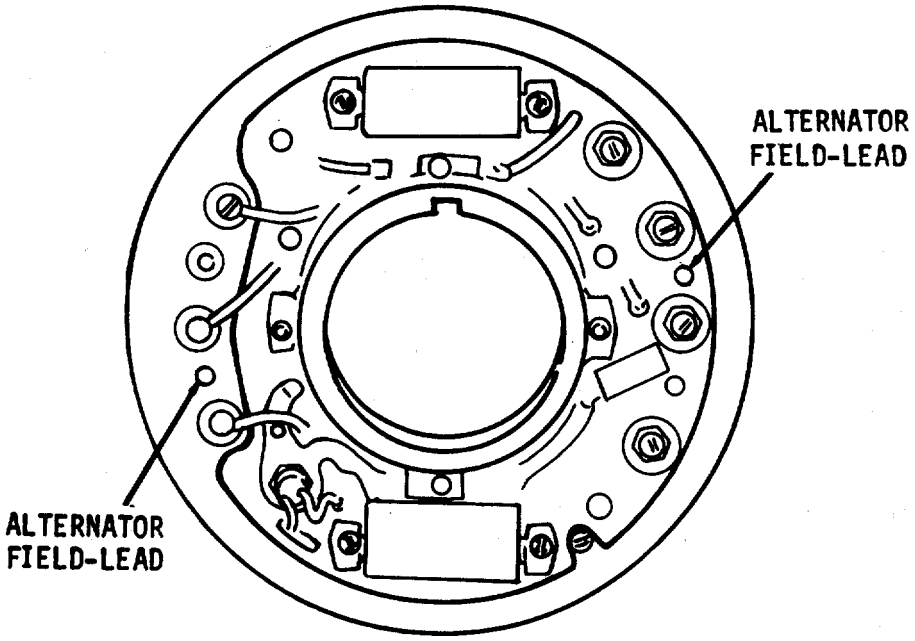
b. Rotating field coils

NOTE

A short or open circuit in the rotating field coils may be detected by measuring the total resistance of the field.

1. Detach both alternator field leads on the rotating rectifier assembly, and measure resistance. — See table for resistance limits on page 5-493.

2. Check insulation resistance between the shaft and one of the detached leads.



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	c. Alternator armature	1. Check insulation resistance.	See table for resistance limits on page 5-485.
		2. Inspect for loose coils and insulators.	
		3. Inspect for breaks or worn spots in leads.	Tape and varnish all breaks.
	d. Exciter armature		
		NOTE	
		An open or shorted armature may be detected by measuring the phase to phase resistance at the armature terminals.	
		1. Detach all three armature leads at the rotating rectifier assembly, check resistance.	See table for resistance limits on page 5-485.
		NOTE	
		An open armature may indicate an overload condition or a defective rotating rectifier assembly.	
		CAUTION	
		The insulation test must be done with three exciter armature leads disconnected from the rotating rectifier assembly, otherwise, the rectifiers could be damaged.	

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
		2. Check insulation resistance for winding to armature sleeve or laminations.	If a ground is indicated and not located and repaired. Replace the armature.

RESISTANCE LIMITS

(Corrected for 25°C. or 77°F.)

*Alternator Armature (Slator)	.200	-	.220	Ohms
Alternator Field (Rotor)	2.55	-	2.85	Ohms
Exciter Armature	.27	-	.30	Ohms
Exciter Field CF	48.5	-	54.0	Ohms
Exciter Field F	1.08	-	1.2	Ohms

*High Voltage Connection

4. Rotating rectifiers assembly

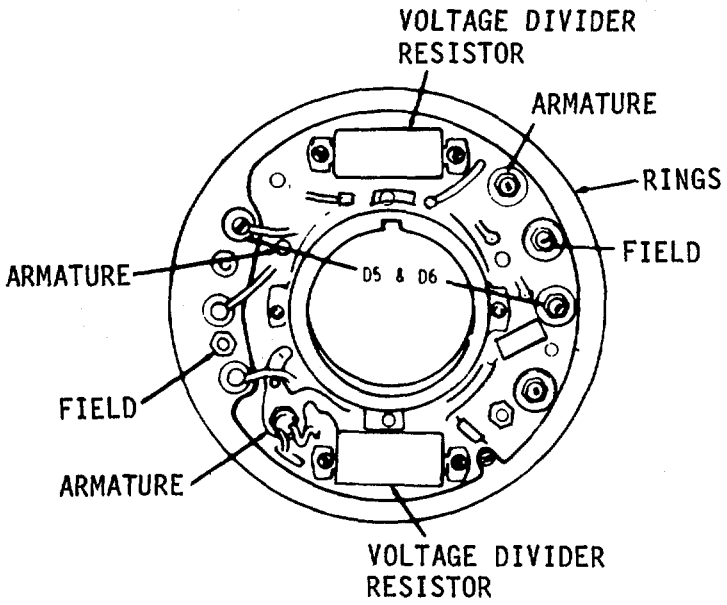
NOTE

The following tests are made with a VOM. Complete the entire series of checks before performing any repair. Replace any components which do not have the resistance readings indicated.

a. Armature leads, and field leads	Disconnect and identify.	Identification should insure that the leads can be reconnected to the same point from which they were removed.

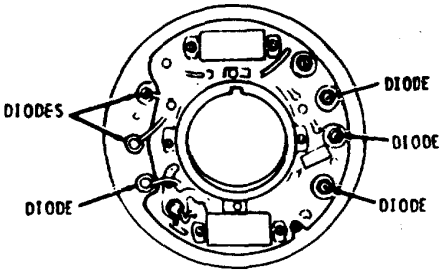
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

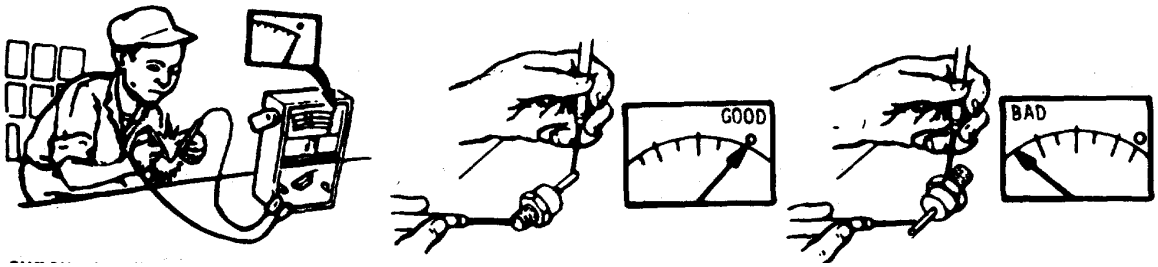
LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	b. Nuts on diodes D5 and D6	1. Remove nuts. 2. Pull diodes away from printed circuit board.	Do not unsolder solder connections.
	c. Voltage divides resistors	Inspect for visable damage or discoloration.	
	d. Assembly	Inspect for visable damage or discoloration.	
	e. Printed circuit board rings	Inspect for discoloration or burning.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

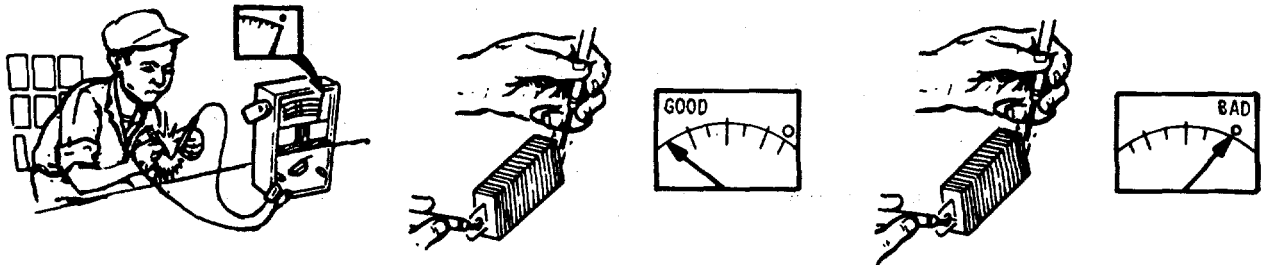
LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
f. Diodes across diodes.	Check resistances on the RX1 scale.	Use an ohmmeter	





CHECK MULTIMETER FOR CONTINUITY DIODE

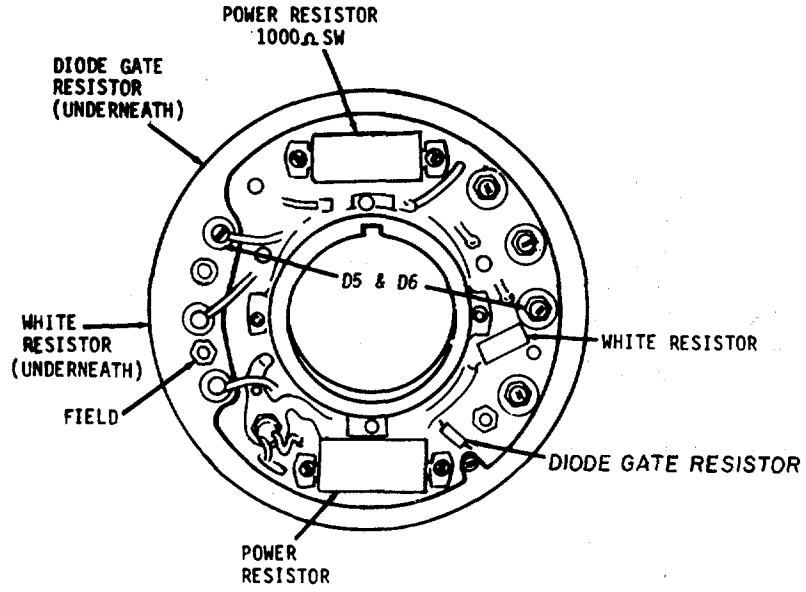
g. White resistors 10 ohm 1/2w	1. Check for resistance.		Use ohmmeter on RX1 scale.
	2. If open, discard.		
h. Power resistors 1000 ohm 5w	1. Check for resistance.		Use ohmmeter on RX1 scale.
	2. If open, discard.		

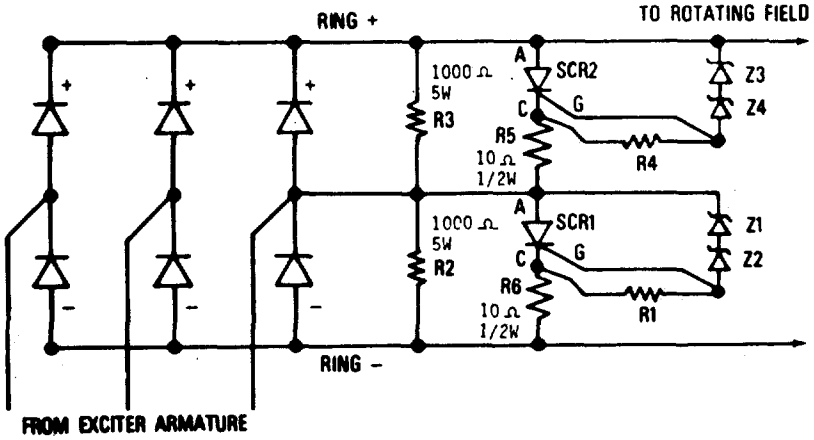


CHECK MULTIMETER FOR CONTINUITY RESISTOR

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

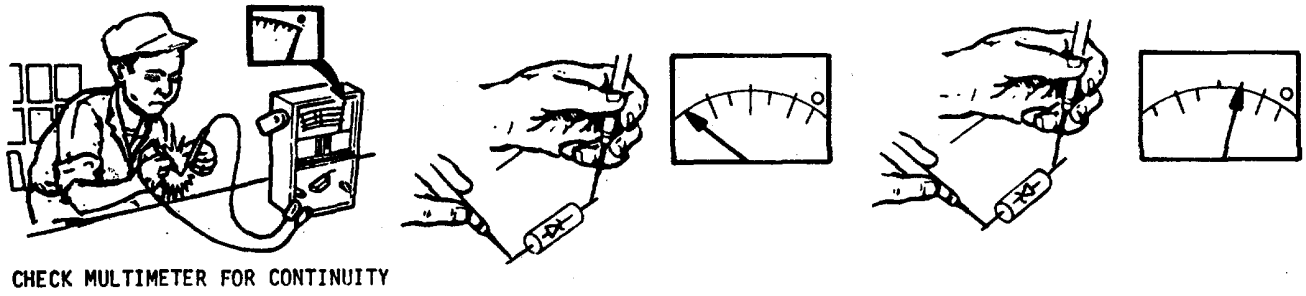
LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	i. Diode gate resistor If open, discard.	1. Check for resistance. RX1 scale.	Use ohmmeter on



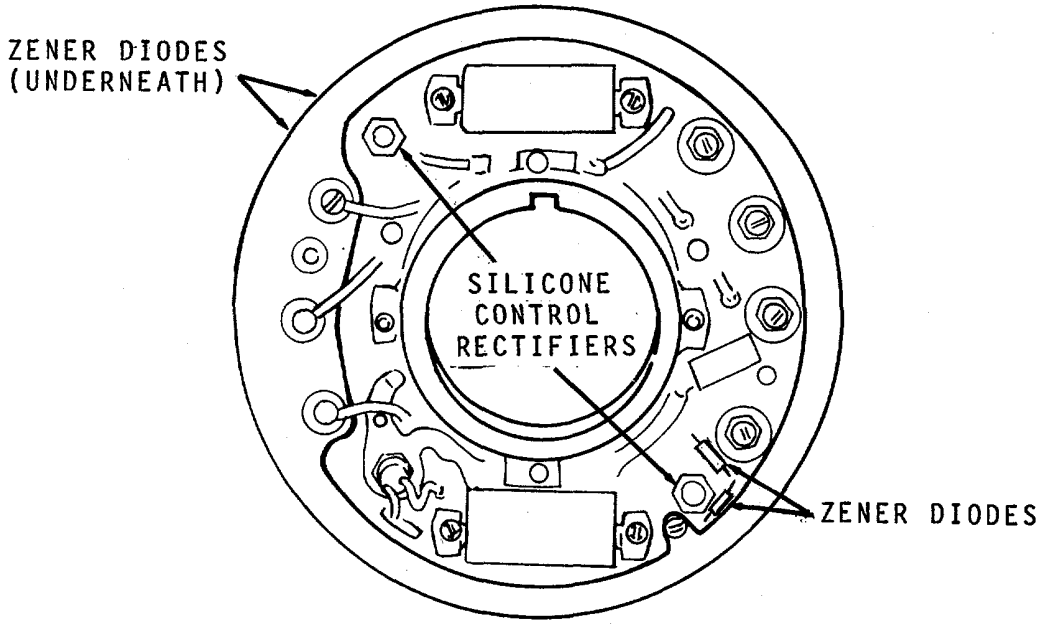


5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	j. Zener diodes	1. Check for resistance.	Use ohmmeter on RX1 scale.
		2. Mid scale in one direction.	
		3. Very high in the opposite direction.	

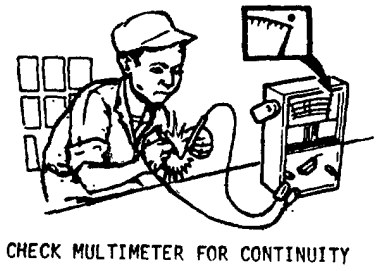


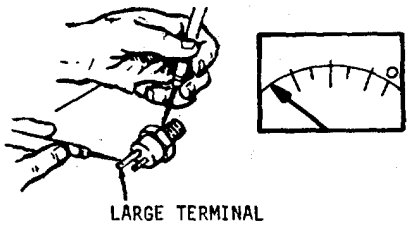
CHECK MULTIMETER FOR CONTINUITY

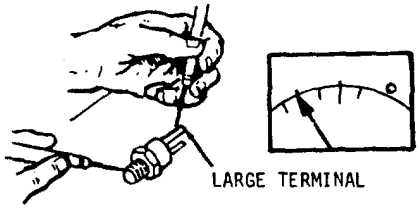


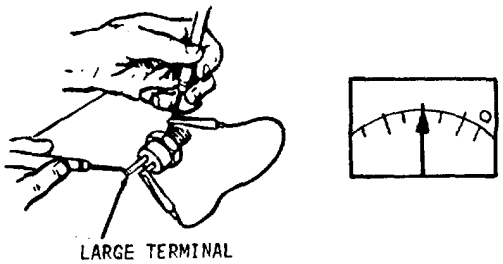
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
TESTS (Cont.)			
	k. Silicon controlled rectifiers	1. Place meter lead on large soldered lead of the SCR, the other lead on the threaded section of the SCR on the other side of the PC board. 2. Meter should read very high in one direction, and slightly lower in the other direction. 3. Place leads in the high direction connect a jumper from the positive (+) lead of the meter to the small soldered SCR lead on the other side of the board. 4. The meter should read mid-scale.	Use ohmmeter on RX1 scale.


CHECK MULTIMETER FOR CONTINUITY

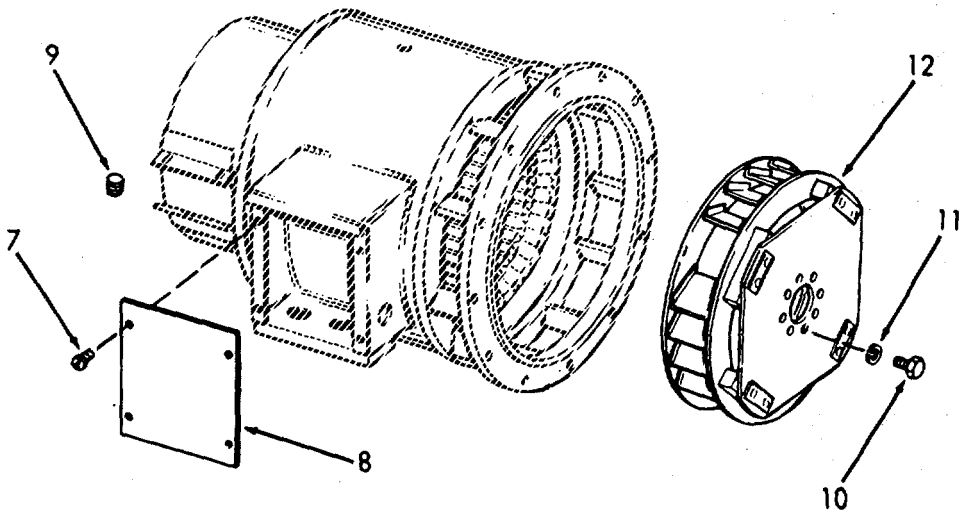

LARGE TERMINAL


LARGE TERMINAL


LARGE TERMINAL

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
5. Generator	a. Pipe plug (9)	Remove.	
	b. Screws (10), and lockwashers (11)	Remove.	
	c. Fan and driving disc (12)	Remove.	
	NOTE Check for fan spacer. Make sure to include spacer during reassembly.		
	d. Screws (7), and terminal box covers (8)	Remove.	Remove on both sides.
	e. Wiring	1. Identify and disconnect in terminal box. 2. Make sure they can be withdrawn through the frame.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont.)

NOTE

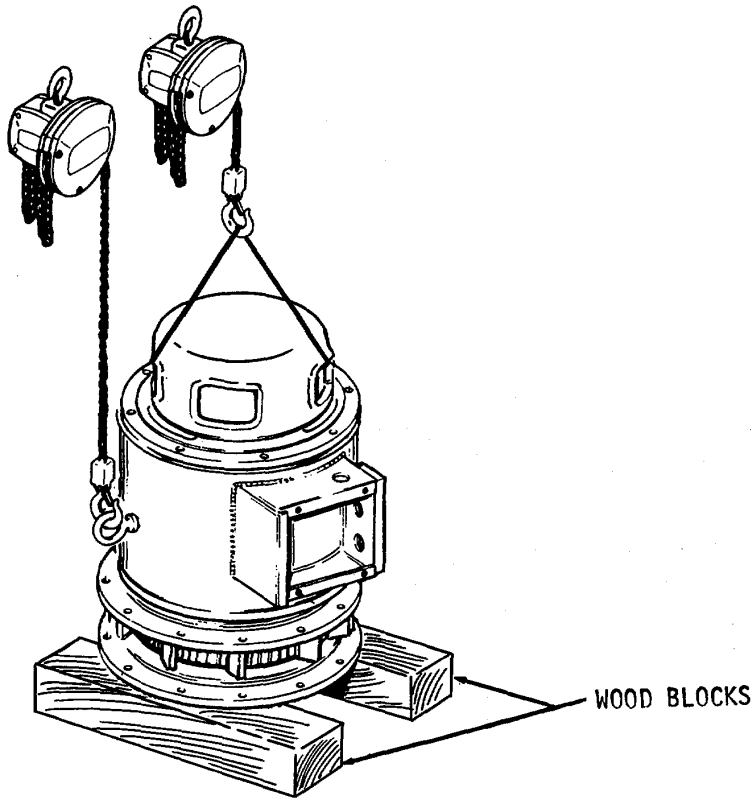
For the vertical method of disassembly continue. For the horizontal method proceed to step k.

f.	Hoist	Attach to eyebolt.	
g.	Steel cable and second hoist	Insert cable through windows in end frame.	

WARNING

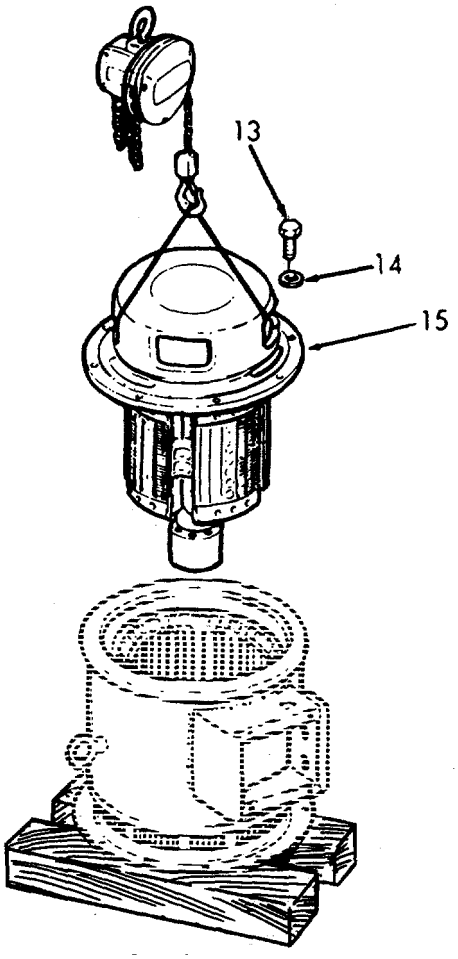
The generator can "whip" or snap sideways as it shifts to a vertical position. Keep personnel away from generator.

h.	Generator	1. Lift carefully to vertical position. 2. Lower so that frame rests on wooden blocks. 3. Remove hoist from eye bolt.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	i. Screws (13), and lockwashers (14)	Remove.	
	j. End frame (15) and assembled parts	1. Realign cable. 2. Lift and remove.	

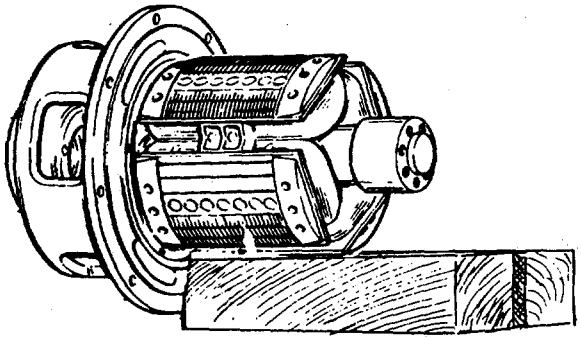


3. Lower assembly into horizontal position and place on blocks so that end frame will extend beyond blocks .

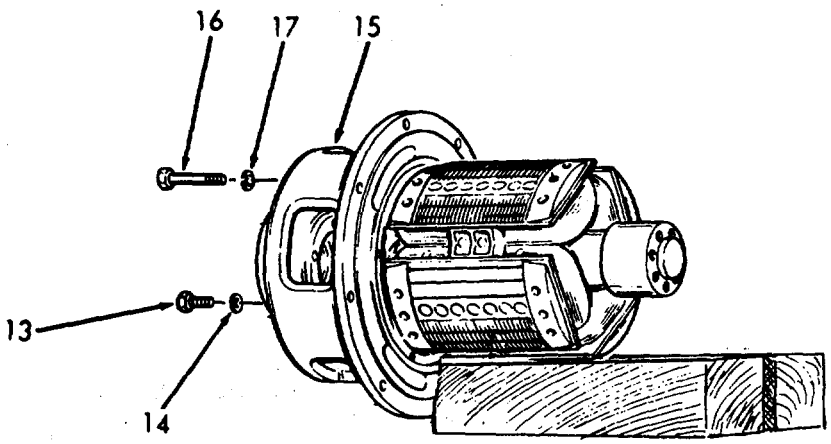
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont.)



k.	Screws (16), and lockwashers (17) end frame.	1. Attach hoist to cable in windows in end frame (15). 2. Tighten hoist to support 3. Remove screws and lockwashers.	
l.	Screws (13), and lockwashers (14)	Remove.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	m. End frame (15)	Pry straight out.	

CAUTION

The exciter field is attached to the end frame, and the rotating rectifier assembly is attached to the shaft. Protect the rotating rectifier assembly.

n. Screws (18) and lockwashers (19)	Remove.	
o. Exciter field assembly (20)	Remove.	

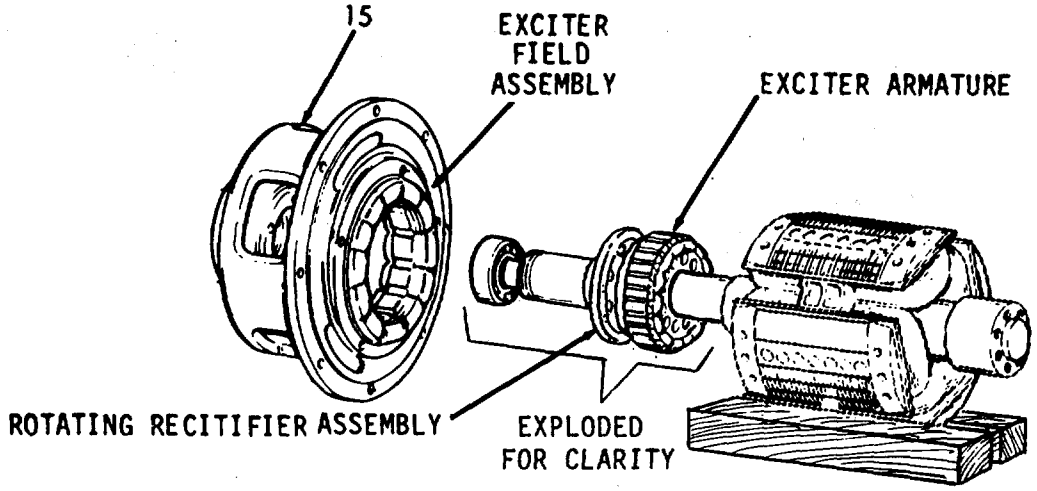
NOTE

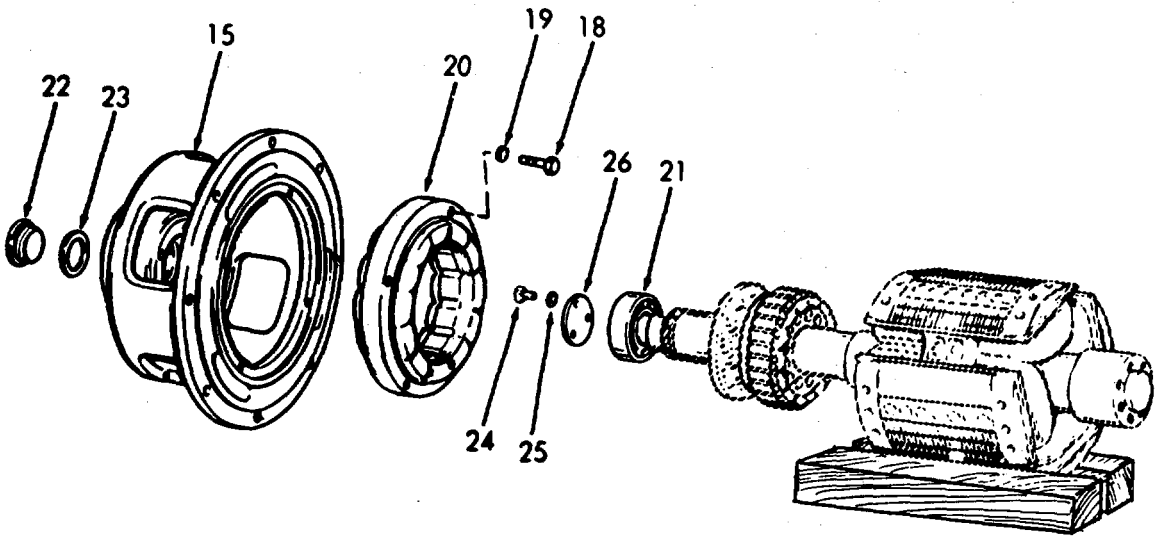
Check bearing (21) by turning the outer race with the fingers. If the bearing feels rough, turns hard, or sticks in spots, replace the bearing. If the bearing needs replacement proceed. If the bearing is good go to steps.

p. End frame center plug (22), and flatwashers (23)	Remove.	
q. Screws (24), lock-washers (25), and bearing retainer (26)	Remove.	

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

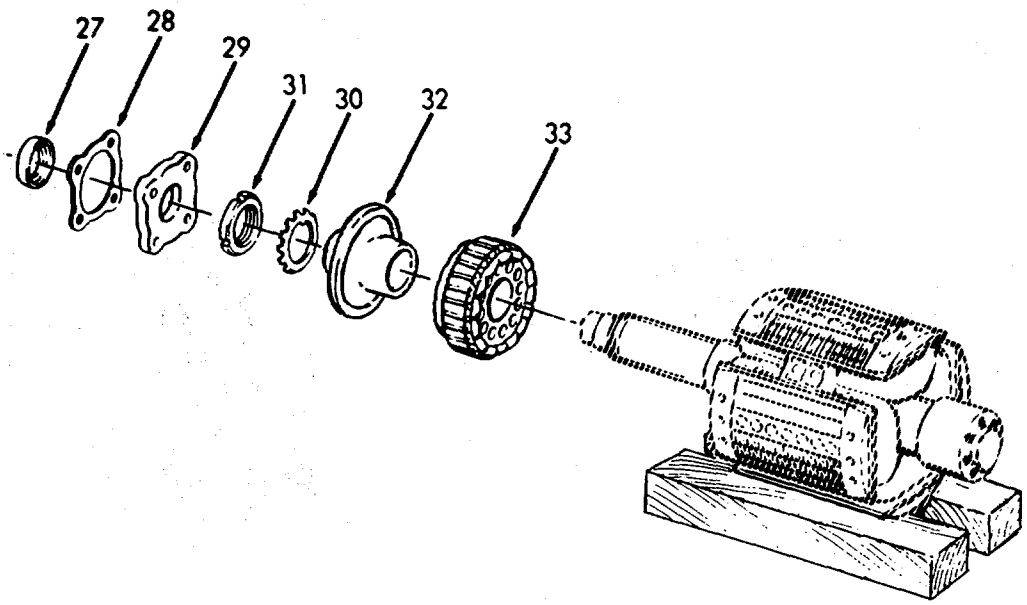
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	r. Bearing (21)	Remove.	a. Use gear or bearing puller. b. Discard bearing.





5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	s. Bearing collar (27)	Unscrew.	
	t. Gasket (28), and bearing retainer (29)	Remove.	
	NOTE To remove the rotating rectifier assembly and the exciter armature proceed.		
	u. Retaining lockwasher (30), and locknut (31)	1. Bend tangs on lockwasher. 2. Remove locknut. Pull each off of shaft.	
	v. Rotating rectifier assembly (32), and exciter armature (33)	Pull each off of shaft.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont.)

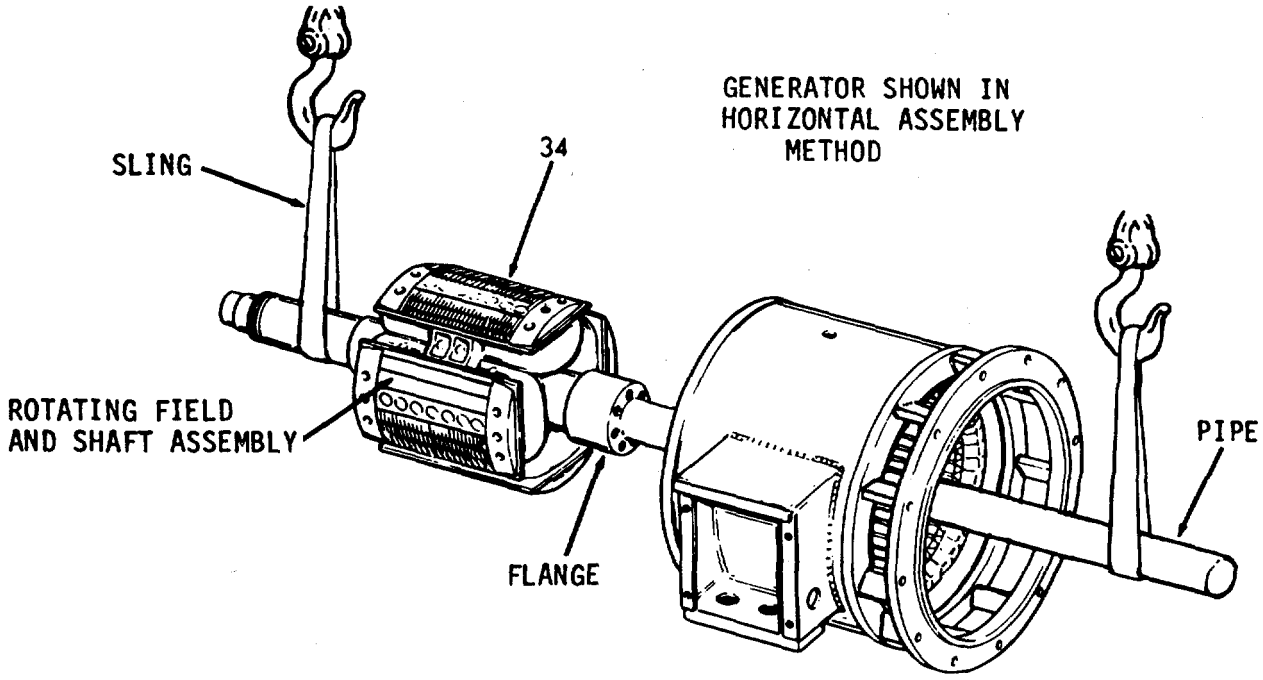
NOTE

To remove the rotating field and shaft assembly from the coil and stator frame in the horizontal method proceed as follows:

w.	Rotating field, and shaft assembly (34)	1. Fabricate a 6 ft. pipe with a flange to mate with the holes in end of shaft. 2. Using two hoists and leather or canvas slings, slide the shaft assembly out of the coil and stator frame.

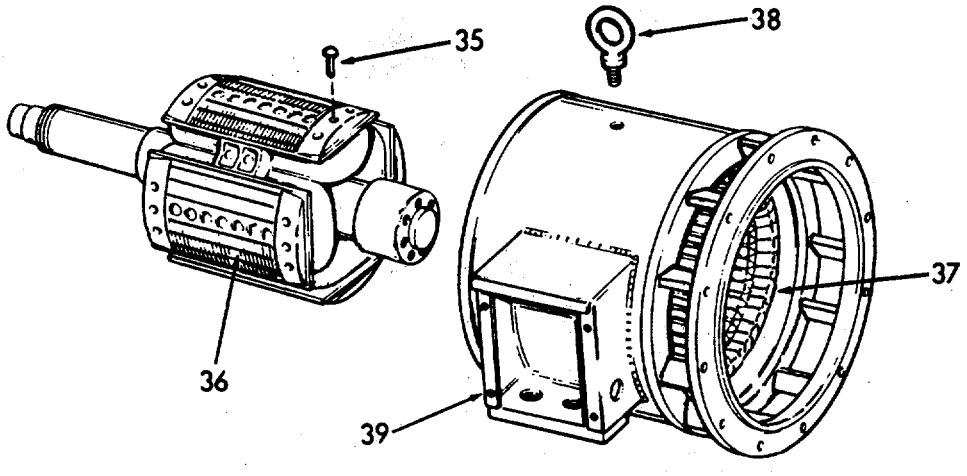
CAUTION

Exercise care, in lifting and moving, not to damage the windings.



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont.)			
	x. Bolts (35)	Unstake and remove.	Remove insulating varnish.
	y. Rotating coil (36)	Remove.	
	z. Stator and coil assembly (37)	Remove eyebolt (38) and other mounting hardware from stator and coil frame assembly (39).	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont.)

6. Rotating rectifier assembly — Repair or replace the following parts as required:

CAUTION

In order not to damage electronic components use a soldering iron with a maximum rating of 25 Watts.

a. Rectifier locknut (1)

b. Diode rectifier (2)

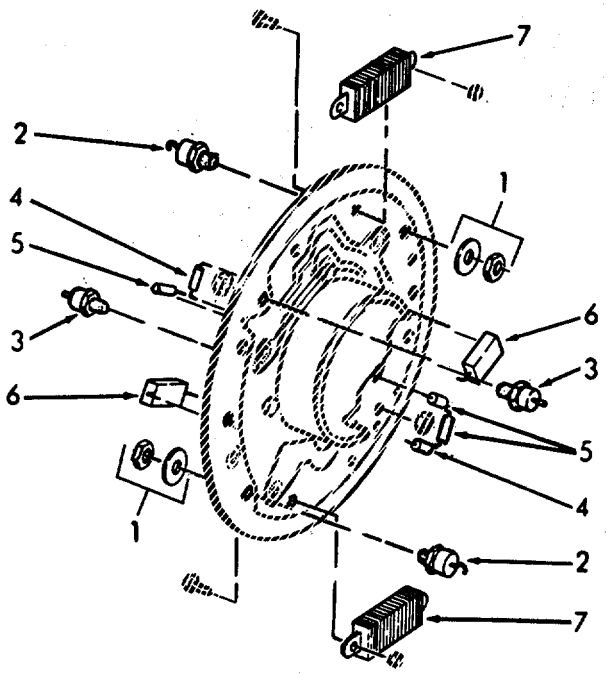
c. Silicone controlled rectifier (3)

d. Diode gate circuit (4)

e. Zener diode (5)

f. Resistor 10 ohms 1/2 watt (6)

g. Resistor 1000 ohms 5 watt (7)



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
7. Generator	a. Stator and coil assembly (37)	Install eyebolt (38) and other mounting hardware in stator and coil frame assembly (39).	
	b. Rotating coils (36), and bolts (35)	1. Install.	
		2. Torque bolts as follows:	

Bolt	Torque lb ft	N.m
3/8	35	47.5
7/16	80	108.5
1/2	110	149.1
5/8	250	339.0
3/4	350	474.5

3. Balance

CAUTION

If new rotating coil assemblies are installed, rebalance the rotating field and exciter armature assembly to less than 1 ounce-inch.

4. Stake bolts.

5. Insulate. — Use insulating varnish.

NOTE

The next step is when the horizontal reassembly method is used.

c. Rotating field, and shaft assembly (34)	1. Install.	
	2. Use two hoists and leather or canvas slings, and pipe.	

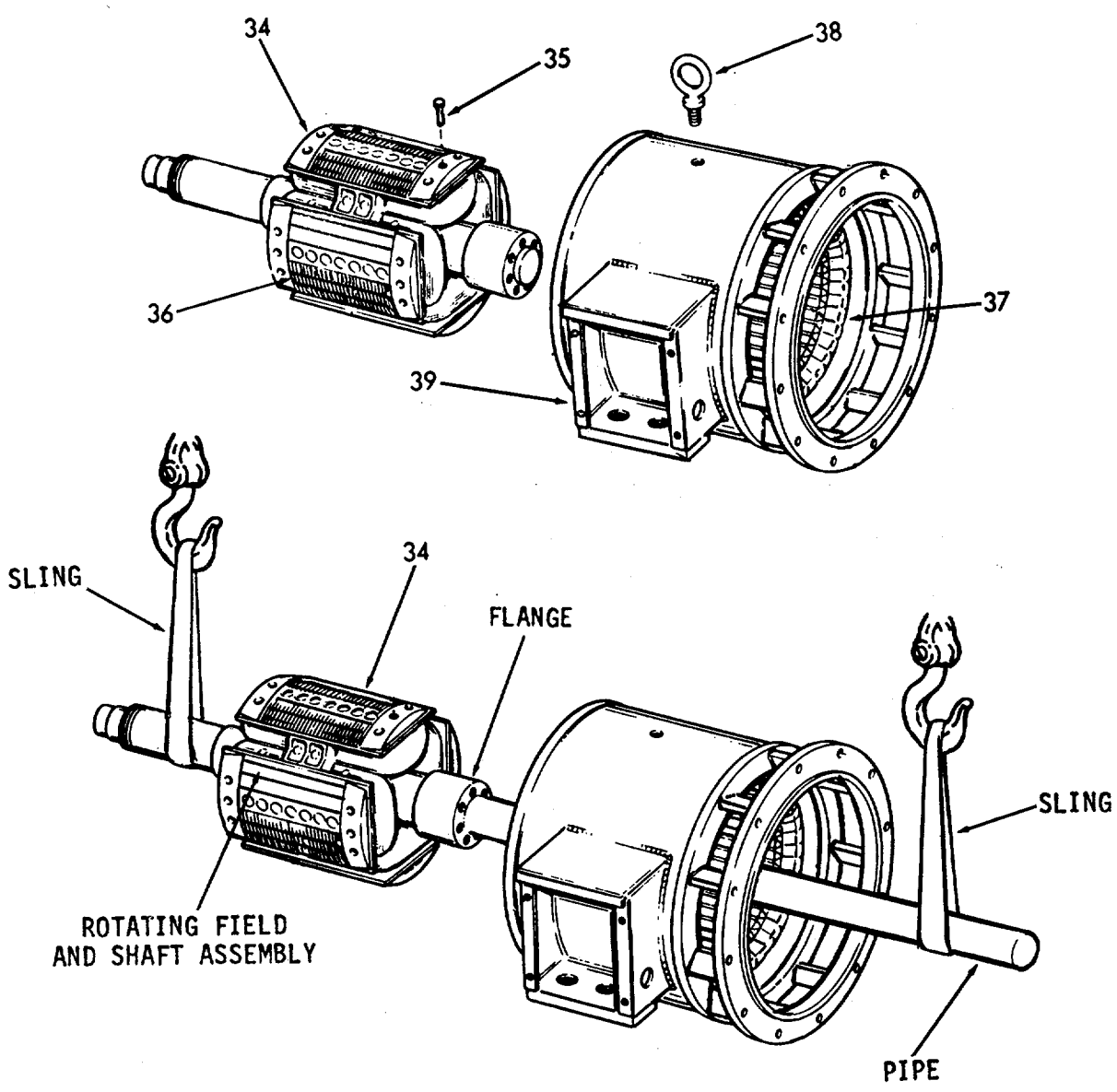
5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont.)

CAUTION

Exercise care, in lifting and moving, not to damage the windings.



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

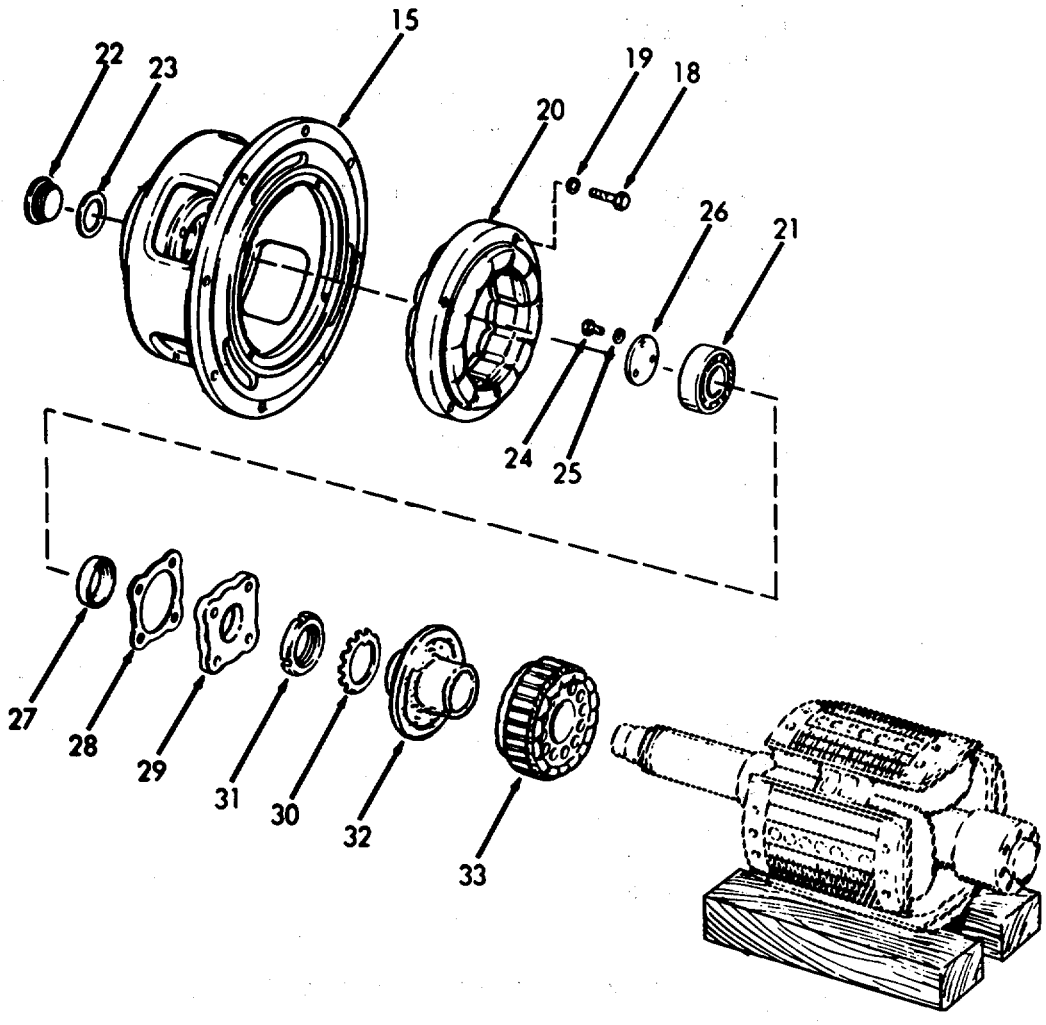
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont.)			
	d. Exciter armature (33), and rotating rectifier assembly (32)	1. Coat shaft with a light application of rust inhibiting grease. 2. Push on shaft.	
	e. Retaining lockwasher (30), and locknut (31) washer.	1. Install. 2. Tighten nut. 3. Bend tangs on lock-	
	f. Bearing retainer (29) gasket (28), and bearing collar (27)	Install on the shaft.	Use a new gasket.
	g. Bearing (21)	Install.	Apply pressure on inner race until bearing seats against bearing collar. Do not apply pressure to outer race.
	h. Bearing retainer (26), screws (24), and lockwashers (25)	Install.	
	i. Flatwasher (23), and end frame center plug (22)	Install in end frame (15).	

5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont.)

j.	Exciter field (20)	Place in end frame (15).
k.	Screws (18), and lockwashers (19)	Install.



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

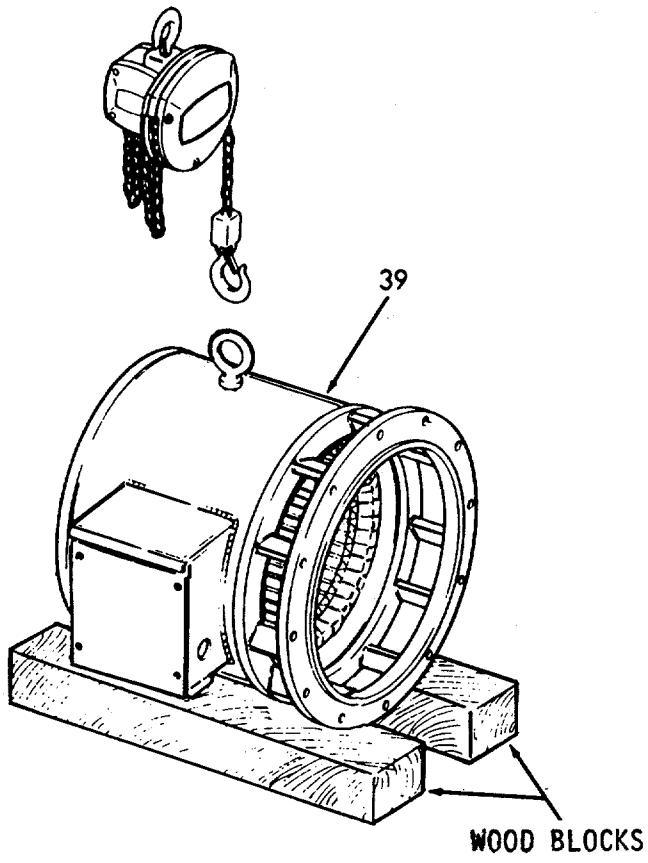
REASSEMBLY (Cont.)

l.	Coil and stator frame (39)	1. Install chain hoist.	
		2. Lift to vertical position.	
		3. Lower so that frame rests on wooden blocks.	

NOTE

Before removing hoists make sure there is room for the shaft.

4. Remove chain hoist.

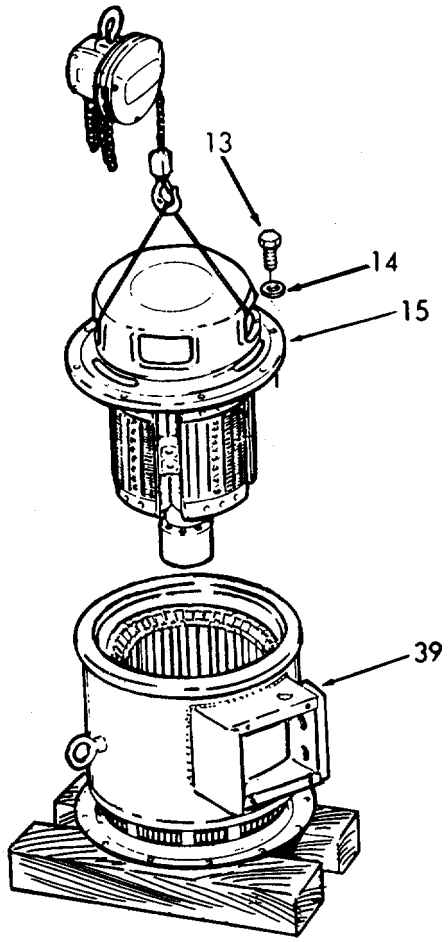


5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont.)

m.	End frame (15), screws (13), and lockwashers (14)	1. Attach hoist to cable in windows in end frame. 2. Tighten hoist to support end frame. 3. Lower into coil and stator frame (39). 4. Align holes. 5. Install screws (13), and lockwashers (14).



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

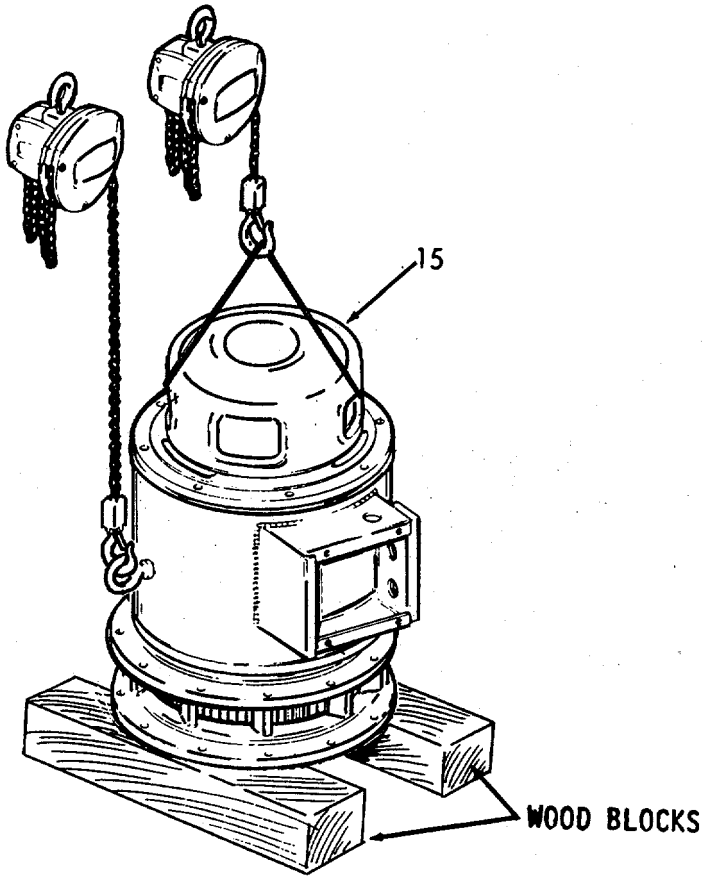
LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont.)

WARNING

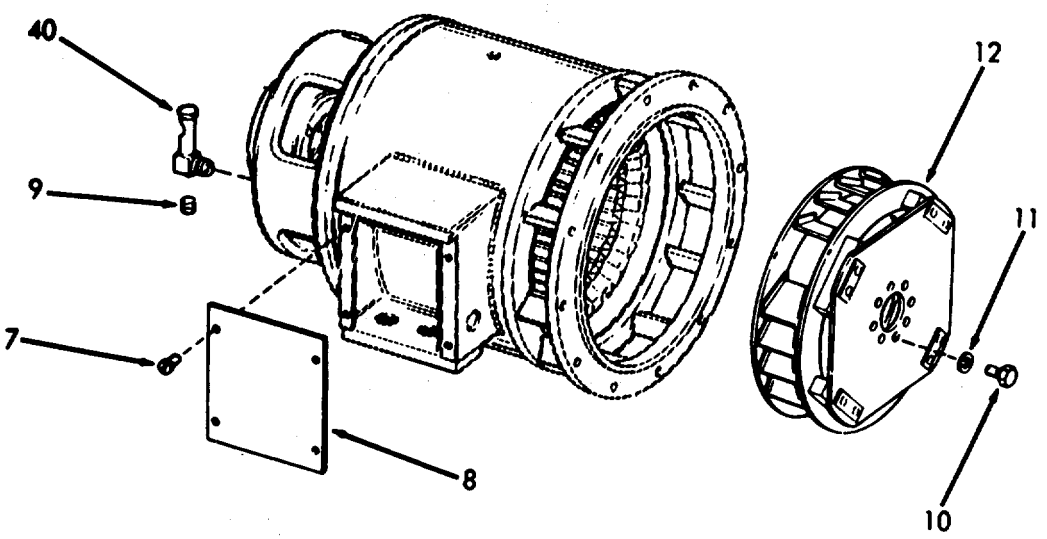
The generator can "whip" or snap sideways as it shifts to a horizontal position. Keep personnel away from the generator.

n.	Generator	1. Reposition cable in window of end frame (15). 2. Attach hoist to eye-bolt. 3. Carefully lower to horizontal position.	



5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont.)			
	o. Wiring	1. Route wiring through frame and reconnect.	
	p. Terminal box covers (8), and screws (7)	Install.	On both sides.
	q. Fan and driving disc (12)	Install.	
	NOTE If spacers were removed during disassembly. Make sure they are reinstalled.		
	r. Screws (10), and lockwashers (11)	Install.	
	s. Pipe plug (9)	Install.	
	t. Oil level sight gage (40)	Fill with oil.	Use type OE/HDO.

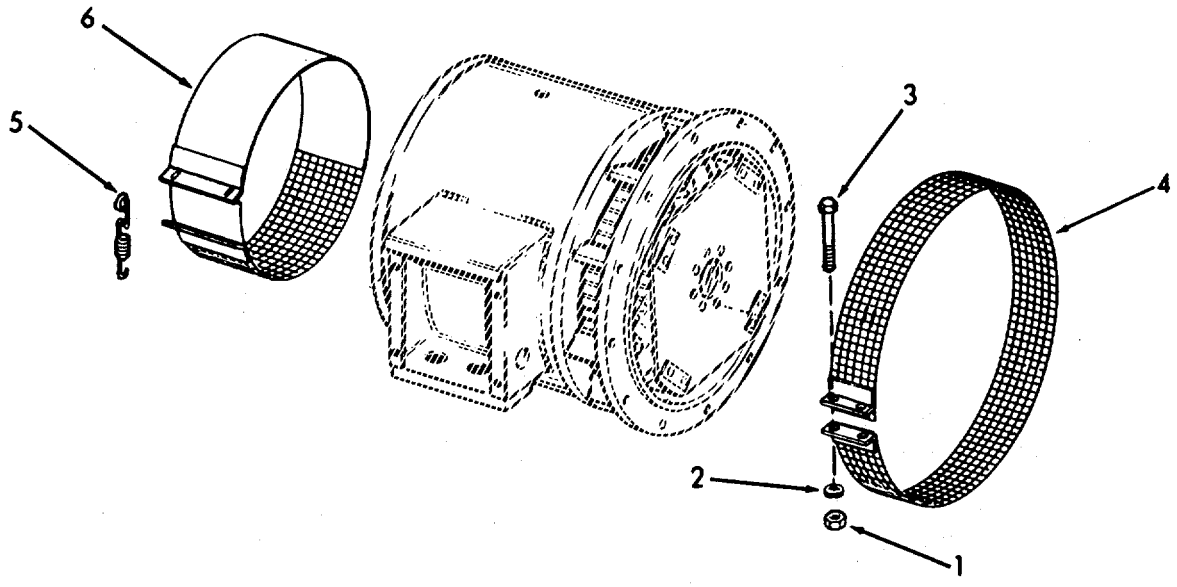


5-32. GENERATOR (40 KW)-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont.)

	u. End frame cover (6), and springs (5)	Install.	
	v. Fan cover (4), screws (3), lockwashers (2), and nuts (1)	Install.	



5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Engine Run-In Instruction** **d. Installation**

INITIAL SETUP

Test Equipment
NONE

Special Tools
Cutting Tools
Welding Tools
Crane (10 ton)
Miscellaneous chains etc.

Material/Parts
NONE

Personnel Required
6

References
F0-1 Machinery - Vehicle Disk Access

Equipment Condition: Condition Description
NONE

Special Environmental Conditions
Do not drain out into bilges. Use oil separation and recovery system to collect oil.

General Safety Instructions
Observe normal precautions when handling heavy equipment.

LOCATION	ITEM	ACTION	REMARKS

NOTE

Generator engine weight 5850 lbs. (2654 kg) dry.

WARNING

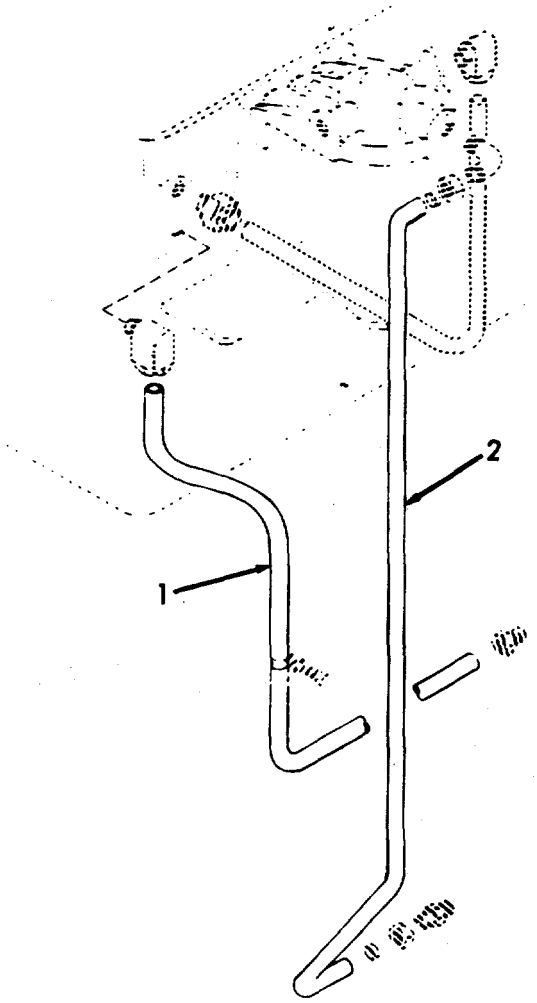
- To prevent the possibility of a fire: When using cutting or welding equipment, place a crewman above and below deck with fire extinguisher.
- Keep clear of the area directly below the deck section being removed.

5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

1. Fuel lines	a. Drain hose (1)	Drain fuel.	Use a suitable container.
	b. Fuel pump input base (2)	Disconnect at fuel pump.	Use a suitable container.

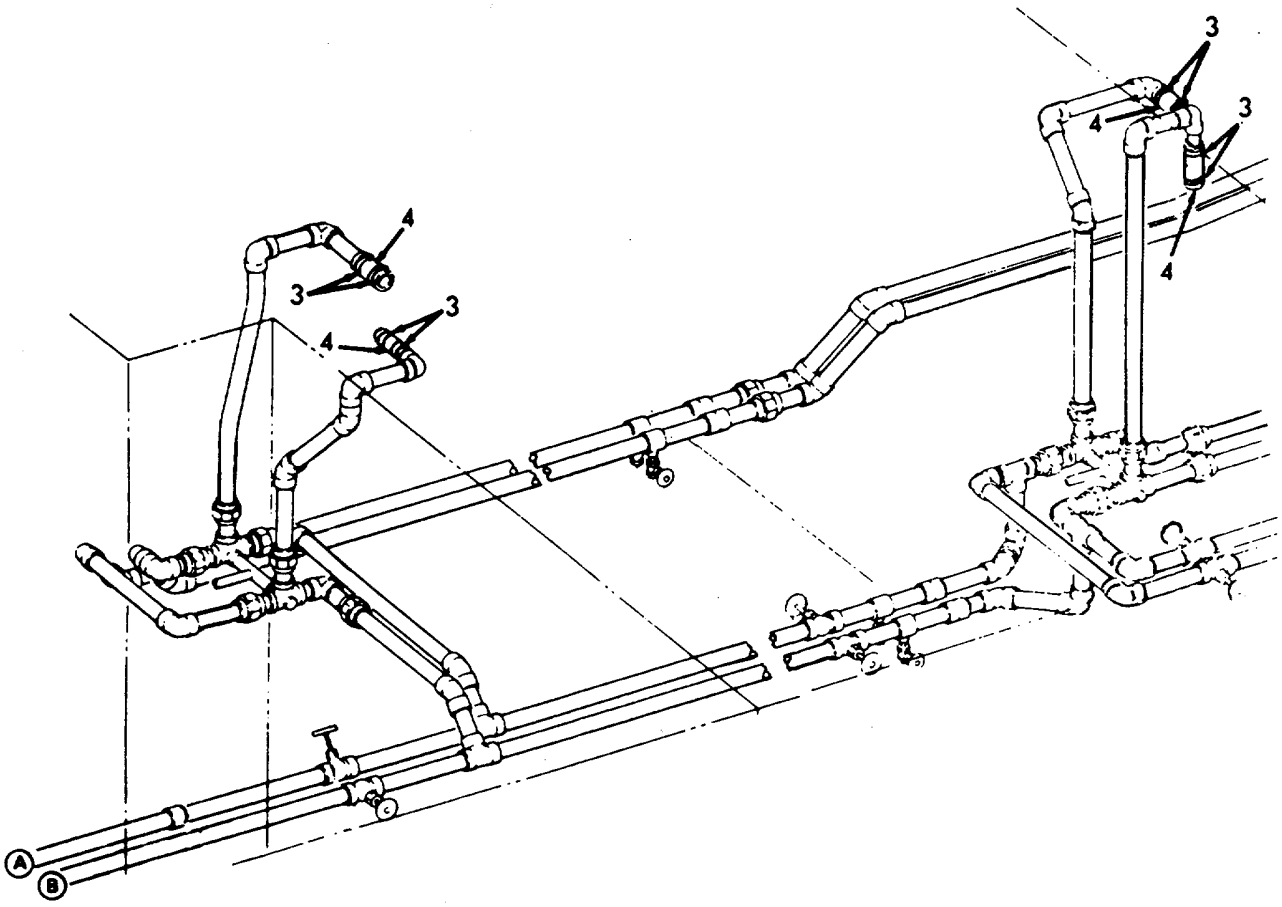


5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

2.	Cooling lines	a. Hose clamps (3)	Loosen.
		b. Hoses (4)	Remove.

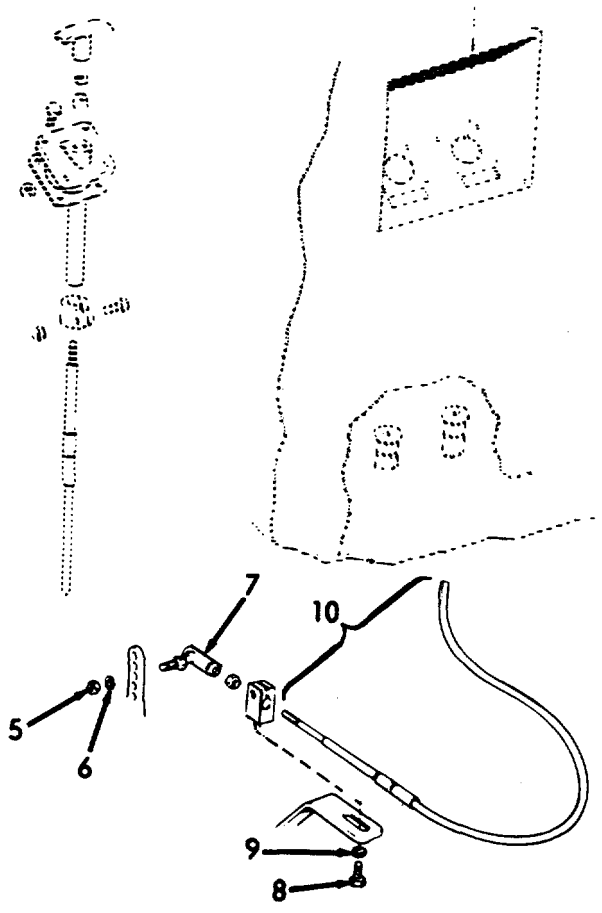


5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

3. Shut-down lever	a. Nut (5), and lock-washer (6)	Remove.	
	b. Ball joint (7)	Remove.	
	c. Screw (8), and lock-washer (9)	Remove.	
	d. Control cable (10)	Remove.	

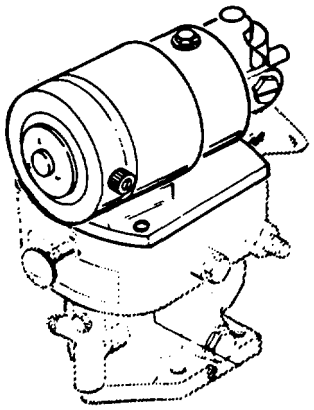


5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

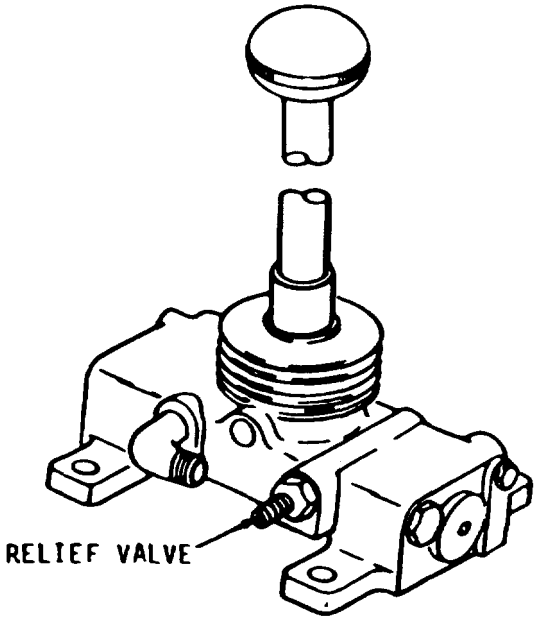
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

4.	Synchronizing motor	Disconnect wiring.	



5.	Hydrostarter piping valve	a. Hand pump relief	Open to reduce pressure in system.

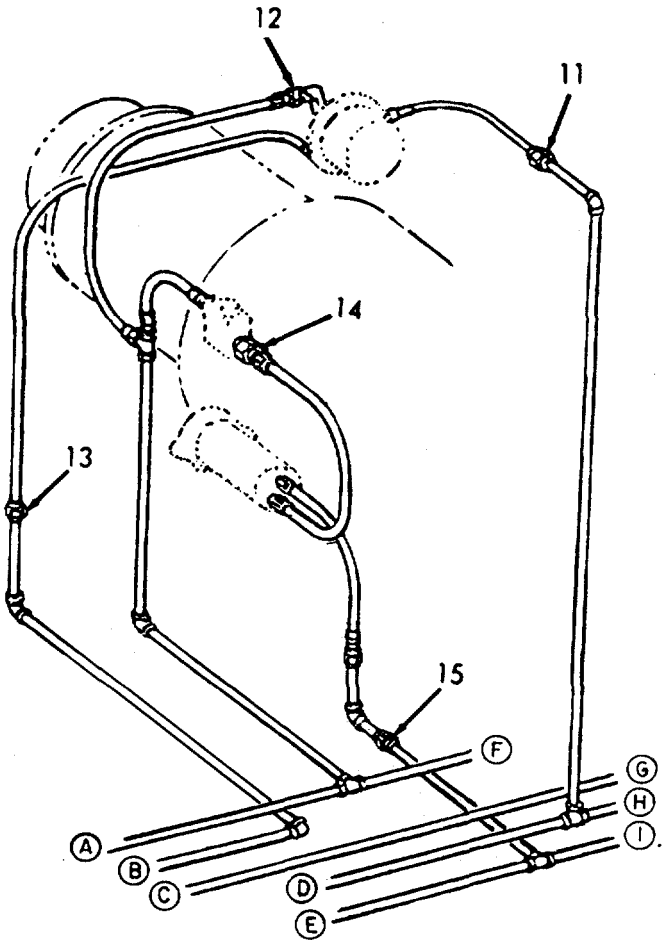


5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

	b. Piping unions (11, 12, 13, 14, and 15)	Separate to collect oil.	

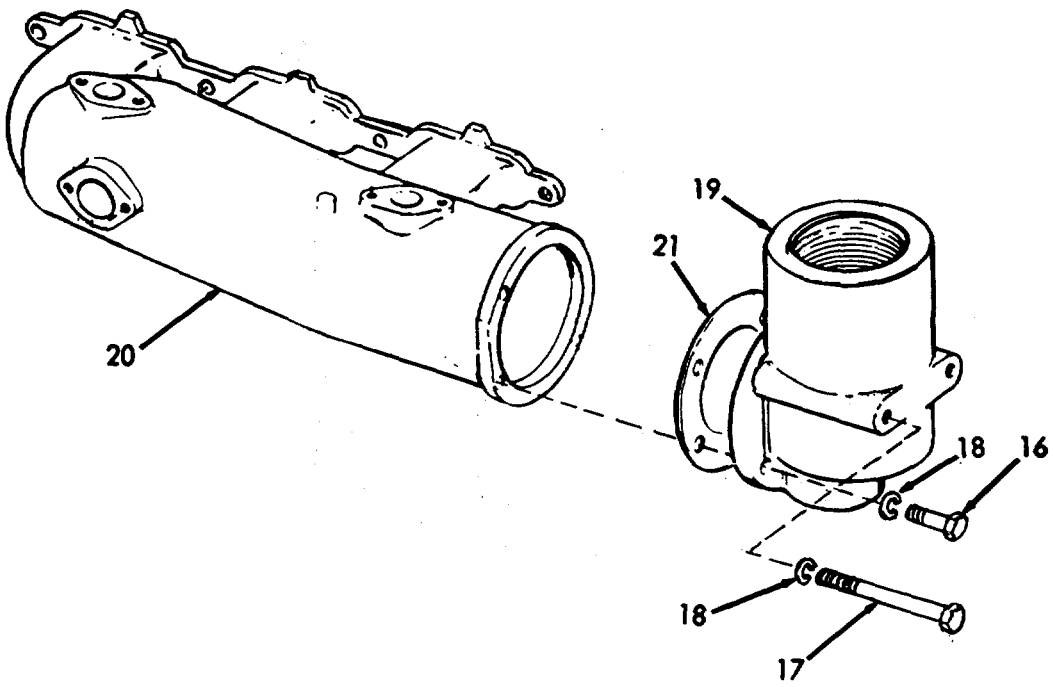


5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

6. Exhaust Piping	a. Screws (16 and 17), and lock-washers (18)	Remove.	
	b. Exhaust elbow (19), and mani - fold (20)	Separate.	
	c. Gasket (21)	Remove.	



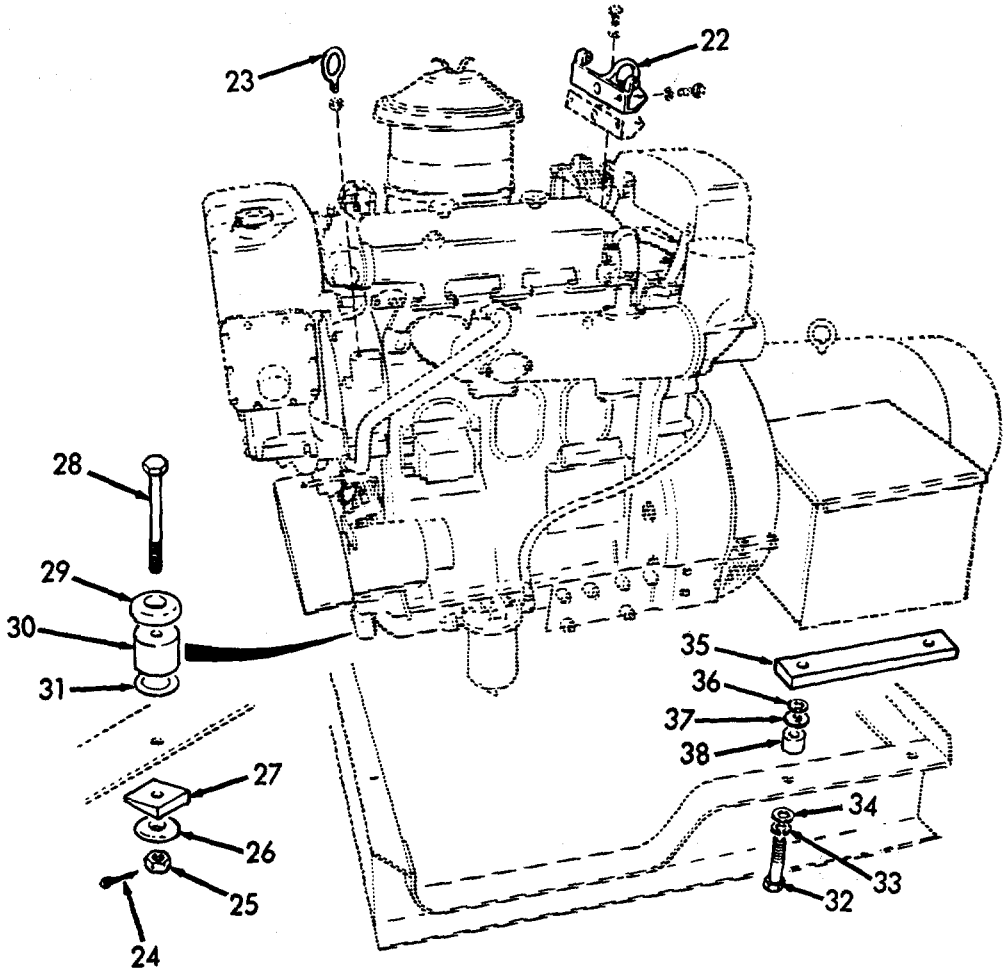
5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
7. Generator	Wiring	Tag and disconnect.	
8. Alarms	Wiring	Tag and disconnect.	
9. Vehicle deck	Deck plate	Remove.	Refer to F0-1.
10. Engine Room	a. Lifting brackets (22), and eyebolt (23)	Attach chains.	
	b. Cotter pins (24), castle nuts (25), mounting cushions (26), bevel washers (27), bolts (28), cushion washers (29) , support spacers (30), and shims (31)	Remove.	
	c. Screws (32), lockwashers (33), flatwashers (34), insulators (35), washers (36), spacers (37), and bushings (38)	Remove.	

5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)



11. Vehicle deck	Engine	Lift	

5-33. ENGINE ASSEMBLY - REMOVAL AND RUN IN - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS

12. Generator engine

a. Following a complete overhaul or any major repair job involving the installation of piston rings, pistons, cylinder liners or bearings, the engine should be "run-in" on a dynamometer prior to release for service.

b. The dynamometer is a device for applying specific loads to an engine. It permits the serviceman to physically and visually inspect and check the engine while it is operating. It is an excellent method of detecting improper tune-up, misfiring injectors, low compression and other malfunctions, and may save an engine from damage at a later date.

c. The operating temperature within the engine affects the operating clearances between the various moving parts of the engine and determines to a degree how the parts will wear. Normal coolant temperature (160° - 185°F.) should be maintained throughout the run-in.

d. The rate of water circulation through the engine on a dynamometer should be sufficient to avoid having the engine outlet water temperature more than 10°F. higher than the water inlet temperature. Though a 10° rise across an engine is recommended, it has been found that 15° temperature rise maximum can be permitted.

e. A thermostat is used in the engine to control the coolant flow; therefore, be sure it is in place and fully operative or the engine will overheat during the run-in. However, if the dynamometer has a water stand-pipe with a temperature control regulator, such as a Taylor valve or equivalent, the engine should be tested without. Thermostats.

f. The Basic Run-in Horsepower Schedule is shown below The horsepower shown in the table is at SAE conditions: dry air density .0705 lb/cu .ft., air temperature of 85°F., and 500 ft. elevation.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

g. Dynamometer test and run-in procedures

(1) The Basic Engine

(a) A basic engine includes only those items actually required to run the engine. The addition of any engine driven accessories will result in a brake horsepower figure less than the values shown in the Basic Engine Run-In Horsepower Schedule The following items are included on the basic engine: blower, fuel pump, fresh water pump and governor.

BASIC RUN-IN HORSEPOWER SCHEDULE

Speed RPM	Time Minutes	Horsepower
1200	10	21
1800	30	67
*1800	30	82
*2100	30	85
*2300	30	92

*Run at only one of the speeds shown, whichever is at or nearest to the governed speed and reset governor after final run, if necessary.

(b) In situations where other than basic engine equipment is used during the test, proper record of this fact should be made on the Engine Test Report. The effects of this additional equipment on engine performance should then be considered when evaluating test results.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

(2) Dynamometer

(a) The function of the dynamometer is to absorb and measure the engine output. Its basic components are a frame, engine mounts, the absorption unit, a heat exchanger, and a torque loading and measuring device.

(b) The engine is connected through a universal coupling to the absorption unit. The load on the engine may be varied from zero to maximum by decreasing or increasing the resistance in the unit. The amount of power absorbed in a water brake type dynamometer, as an example, is governed by the volume of fluid within the working system. The fluid offers resistance to a rotating motion. By controlling the volume of water in the absorption unit, the load may be increased or decreased as required.

(c) The power absorbed is generally measured in torque (lb-ft) on a suitable scale. This value for a given engine speed will show the brake horsepower developed in the engine by the following formula:

BHP = (T x RPM)/5250

Where:

BHP = brake horsepower
T = torque in lb-ft
RPM = revolutions per minute

(d) Some dynamometers indicate direct brake horsepower readings. Therefore, the use of the formula is not required when using these units.

(e) During the actual operation, all data taken should be recorded immediately on an Engine Test Report (see sample) on page 5-522'

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

(3) Instrumentation

(a) Certain instrumentation is necessary so that data required to complete the Engine Test Report may be obtained. The following list contains both the minimum amount of instruments and the proper location of the fittings on the engine so that the readings represent a true evaluation of engine conditions.

1. Oil pressure gage installed in one of the engine main oil galleries.

2. Oil temperature gage installed in the oil pan, or thermometer installed in the dipstick hole the oil pan.

3. Adaptor for connecting a pressure gage or mercury manometer to the engine air box.

4. Water temperature gage installed in the water outlet manifold.

5. Adaptor for connecting a pressure gage or water manometer to the crankcase.

6. Adaptor for connecting a pressure gage or mercury manometer to the exhaust manifold at the flange.

7. Adaptor for connecting a vacuum gage or water manometer to the blower inlet.

8. Adaptor for connecting a fuel pressure gage to the fuel manifold inlet passage.

ENGINE TEST REPORT

Date_____ Unit Number_____
Repair Order Number_____ Model Number _____

A	Pre-Starting				
Prime Lube 1. Oil System	Prime Fuel 2. System	Adjust Valves 3. And Bridges	Time 4. Injector	Adjust 5. Governor	Adjust 6. Injector Racks

B Basic Engine Run-In						C Basic Run-In Inspection
TIME AT SPEED	TIME START STOP	RPM	BHP	WATER TEMP.	LUBE OIL PRESS.	1. Check oil at rocker mechanism
						2. Inspect for lube oil leaks
						3. Inspect for fuel oil leaks
						4. Inspect for water leaks
						5. Check and tighten all external bolts
						6.

D INSPECTION AFTER BASIC RUN-IN			
1. Tighten Cylinder Head & Rocker Shaft Bolts		4. Adjust Governor Gap	
2. Adjust Valves (Hot)		5. Adjust Injector Racks	
3. Time Injectors		6.	

E FINAL RUN-IN							
TIME		TOP RPM		BHP	AIR BOX PRESSURE FULL LOAD	EXHAUST BACK PRESSURE F/L	CRANKCASE PRESSURE F/L
START	STOP	NO LOAD	FULL LOAD				

BLOWER INTAKE RES. - F/L	FUEL OIL PRESSURE RET. MAN. F/L	WATER TEMP. FULL LOAD	LUBE OIL TEMP. F/L	LUBE OIL PRESSURE		IDLE SPEED
				FULL LOAD	IDLE	

F	INSPECTION AFTER FINAL RUN
1. Inspect Air Box, Pistons Liners, Rings	6. Inspect Oil Pump Drive
2. Inspect Blower	7. Replace Lube Filter Elements
3. Wash Oil Pan, Check Gasket	8. Tighten Flywheel Bolts
4. Clean Oil Pump Screen	9. Rust Proof Cooling System
5. Tighten Oil Pump Bolts	
REMARKS:	
Final Run OK'd_____Dynamometer Operator_____Date _____	
NOTE: Operator must initial each check and sign this report.	

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

(b) In some cases, gages reading in pounds per square inch are used for determining pressures while standard characteristics are given in inches of mercury or inches of water. It is extremely important that the scale of such a gage be of low range and finely divided if accuracy is desired. This is especially true of a gage reading in psi, the reading of which is to be converted to inches of water. The following conversion factors may be helpful.

Inches of water = psi x 27.7 inches
Inches of mercury = psi x 2.04 inches

(4) Run-In Procedure

The procedure outlined below will follow the order of the sample Engine Test Report on page 5-522.

(a) Pre-Starting

1. Fill the lubrication system.

2. Prime the fuel system.

3. A preliminary valve clearance adjustment must be made before the engine is started.

4. A preliminary injector timing check must be made before starting the engine.

5. Preliminary governor adjustments must be made.

6. Preliminary injector rack adjustment must be made.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

(b) Basic Engine Run-In

1. The operator should be observant at all times, so that any malfunction which may develop be detected. Since the engine has just been reconditioned, this run-in will be a test of the workmanship of the serviceman who performed the overhaul. Minor difficulties should be detected and corrected so that a major problem will not develop.

2. After performing the preliminary steps, be sure all water valves, fuel valves, etc. are open. Also inspect the exhaust system, being sure that it is properly connected to the engine. Always start the engine with minimum dynamometer resistance.

3. After the engine starts, if using a water brake type dynamometer, allow sufficient water, by means of the control loading valves, into the dynamometer absorption unit to show a reading of approximately 5 lb.-ft. on the torque gage (or 10-15 HP on a horsepower gage). This is necessary, on some units, to lubricate the absorption unit seals and to protect them from damage.

4. Set the engine throttle at idle speed, check the lubricating oil pressure and check all connections to be sure there are no leaks

5. Refer to the Engine Test Report sample on page 5-522 which establishes the sequence of events for the test and run-in, and to the Basic Run-In Horsepower Schedule on page 5-519 which indicates the speed (rpm), length of time and the brake horsepower required for each phase of the test. Also, refer to the Operating Conditions in Chapter 3 which presents the engine operating characteristics. These characteristics will be a guide for tracing faulty operation or lack of power.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

6. Engine governors in most cases must be reset at the maximum full-load speed designated for the run-in. If a governor is encountered which cannot be adjusted to this speed, a stock governor should be installed for the run-in.

7. After checking the engine performance at idle speed and being certain the engine and dynamometer are operating properly, increase the engine speed to half speed and apply the load indicated on the Basic Run-In Horsepower Schedule on page 5-527.

8. The engine should be run at this speed and load for 10 minutes to allow sufficient time for the coolant temperature to reach the normal operating range. Record length of time, speed, brake horsepower, coolant temperature and lubricating oil pressure on the Engine Test Report

9. Run the engine at each speed and rating for the length of time indicated in the Basic Run-In Horsepower Schedule. This is the Basic Run-In. During this time engine performance will improve as new parts begin to "seat in". Record all of the required data.

(c) Basic Run-In Inspection

1. While the engine is undergoing the Basic Run-In, check each item indicated in Section "C" of the Engine Test Report. Check for fuel oil or water leaks in the rocker arm compartment.

2. During the final portion of the Basic Run-In, the engine should be inspected for fuel oil, lubricating oil, and water leaks.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

3. Upon completion of the Basic Run-In and Inspection, remove the load from the dynamometer and reduce the engine speed gradually to idle and then stop the engine.

(d) Inspection after basic run-in

The primary purpose of this inspection is to provide a fine engine tune-up. First, tighten the cylinder head and rocker arm shaft bolts to the proper torque (refer to Chapter 3). Next, complete the applicable tune-up procedure.

(e) Final Run-In

1. After all of the tests have been made and the Engine Test Report is completed through Section (d), the engine is ready for final test. This portion of the test and run-in procedure will assure the engine owner that his engine has been rebuilt to deliver factory rated performance at the same maximum speed and load which will be experienced in the installation.

2. If the engine has been shut-down for one hour or longer, it will be necessary to have a warm-up period of 10 minutes at the same speed and load used for warm-up in the Basic Run-In. If piston rings, cylinder liners or bearings have been replaced as a result of findings in the Basic Run-In, the entire Basic Run-In must be repeated asthough the run-in and test procedures were started anew.

3. All readings observed during the Final Run-In should fall within the range specified in the Operating Conditions (refer to chapter 3), and should be taken at full load unless otherwise specified. Following is a brief discussion of each condition to be observed.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

4. The engine water temperature should be taken during the last portion of the Basic Run-In at full load. It should be recorded and within the specified range.

5. The lubricating oil temperature reading must be taken while the engine is operating at full load and after it has been operating long enough for the temperature to stabilize. This temperature should be recorded and should be within the specified range.

6. The lubricating oil pressure should be recorded in psi after being taken at engine speeds indicated in the Operating Conditions, Chapter 3.

7. The fuel oil pressure at the fuel manifold inlet passage should be recorded and should fall within the specified range. Fuel pressure should be recorded at maximum engine rpm during the Final Run-In.

8. Check the air box pressure while the engine is operating at maximum speed and load. This check may be made be attaching a suitable gage (0-15 psi) or manometer (15-0-15) to an air box drain or to a hand hole plate prepared for this purpose. If an air box drain is used as a source for this check, it must be clean. The air box pressure should be recorded in inches of mercury.

9. Check the crankcase pressure while the engine is operating at maximum run-in speed. Attach a manometer, calibrated to read in inches of water, to the oil level dipstick opening. Normally, crankcase pressure should decrease during the run-in indicating that new rings are beginning to " seat-in".

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

10. Check the air inlet restriction with a water manometer connected to a fitting in the air inlet ducting located 2 inches above the air inlet housing. When practicability prevents the insertion of a fitting at this point, the manometer may be connected to a fitting installed in the 1/4 inch pipe tapped hole in the engine air inlet housing. If a hole is not provided, a stock housing should be drilled, tapped, and kept on hand for future use .

11. The restriction at this point should be checked at a specific engine speed. Then the air cleaner and ducting should be removed from the air inlet housing and the engine again operated at the same speed while noting the manometer reading. The difference between the two readings, with and without the aircleaner and ducting, is the actual restriction caused by the air cleaner and ducting.

12. Check the normal air intake vacuum at various speeds (at no-load),and compare the results with the Engine Operating Conditions in Chapter 3. Record these readings on the Engine Test Report.

13. Check the exhaust back pressure at the exhaust manifold companion flange or within one inch of this location. This check should be made with a mercury manometer through a tube adaptor installed at the tapped hole. If the exhaust manifold does not provide a 1/8 inch pipe tapped hole, such a hole can be incorporated by reworking the exhaust manifold. Install a fitting for a pressure gage or manometer in this hole. Care should be exercised so that the fitting does not protrude into the stack. The manometer check should produce a reading in inches that is below the Maximum Exhaust Back Pressure for the engine.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

ENGINE RUN-IN INSTRUCTIONS (Cont)

14. Refer to the Basic Run-In Horsepower Schedule and determine the maximum rated brake horsepower and the full-load speed to be used during the Final Run-In. Apply the load thus determined to the dynamometer. If a hydraulic governor is used, the droop may be adjusted at this time by following the prescribed procedure. The engine should be run at this speed and load for 1/2 hour. While making the Final Run-In, the engine should develop, within 5%, the maximum rated brake horsepower indicated for the speed at which it is operating. If this brake horsepower is not developed, the cause should be determined and corrections made.

15. When the above conditions have been met, adjust the maximum no-load speed to conform with that specified for the particular engine. This speed may be either higher or lower than the maximum speed used during the Basic Run-In. This will ordinarily require a governor adjustment.

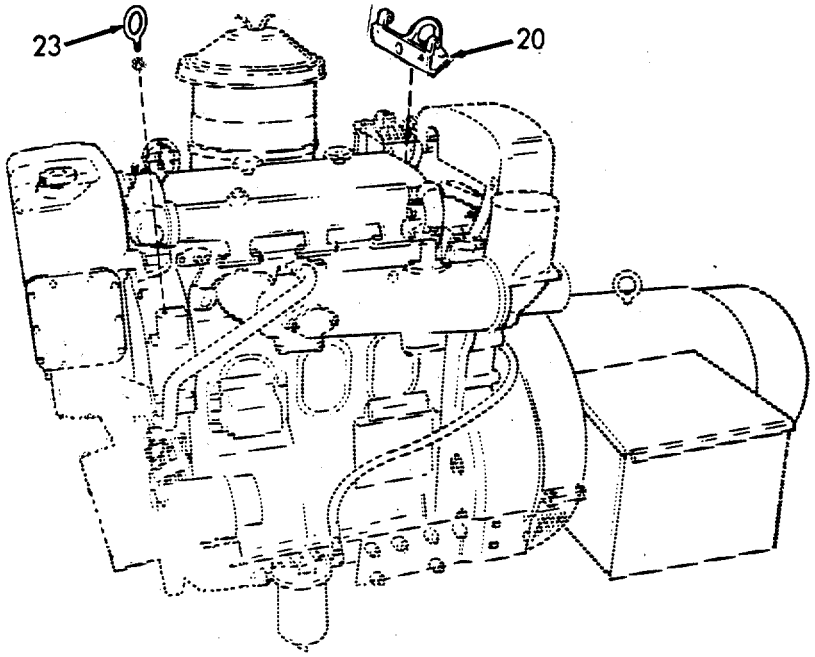
16. All information required in Section "E", Final Run-In, of the Engine Test Report should be determined and filled in. After the prescribed time for the Final Run-In has elapsed, remove the load from the dynamometer and reduce the engine speed gradually to idle speed and then stop the engine. The Final Run-In is complete.

(f) Inspection After Final Run-In

After the Final Run-In and before the Engine Test Report is completed, a final inspection must be made. This inspection will provide final assurance that the engine is in proper working order. During this inspection the engine is also made ready for any brief delay in delivery or installation which may occur. This is accomplished by rust-proofing the fuel system. Also, a rust inhibitor should be introduced into the cooling system.

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
13. Vehicle deck	Engine	Lower engine.	
14. Engine Room	a. Lifting bracket (22), and eyebolt (23)	Remove chains.	



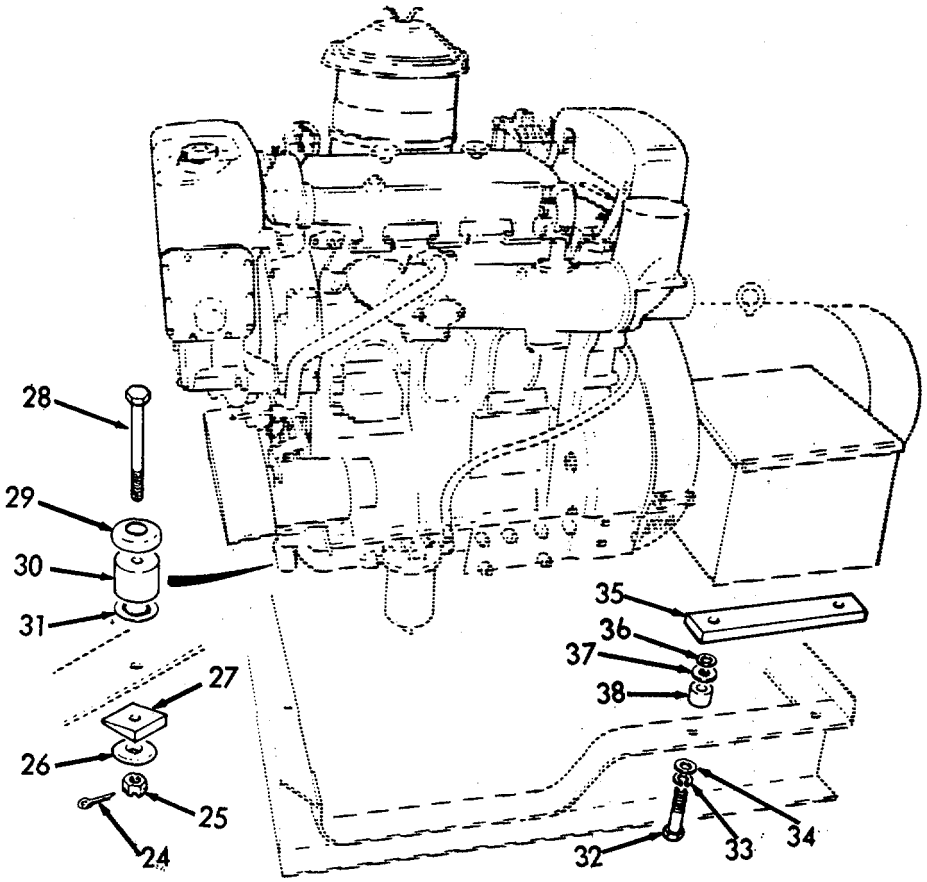
5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
	b. Shims (31), support spacers (30), cushion washers (29), bolts (28), bevel washers (27), mounting cushions (26), castle- nuts (25), and cotter pins (24)	1. Install. 2. Align holes and install cotter pins.	
	c. Bushings (38) spacers (37), washers (36), insulators (35), screws (32), lockwashers (33), and flatwashers (34)	Install.	

5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

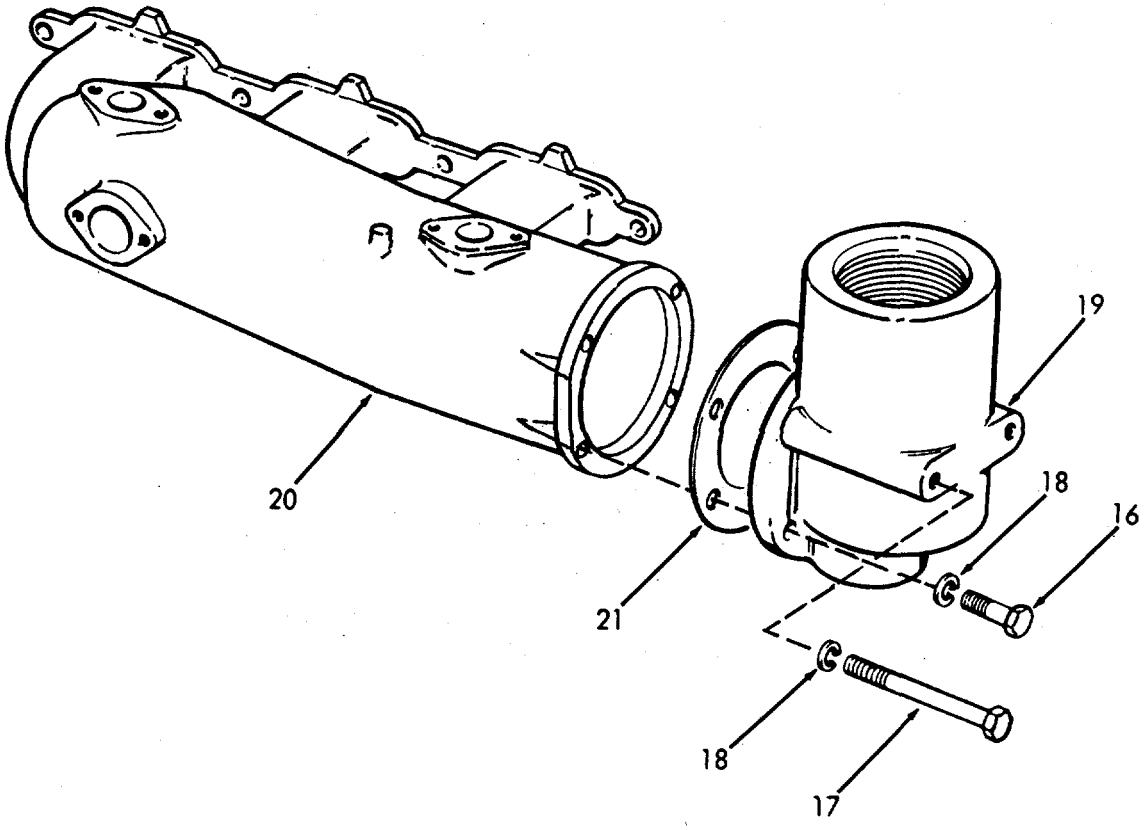
INSTALLATION



15. Vehicle deck	Deck plate	Install.	

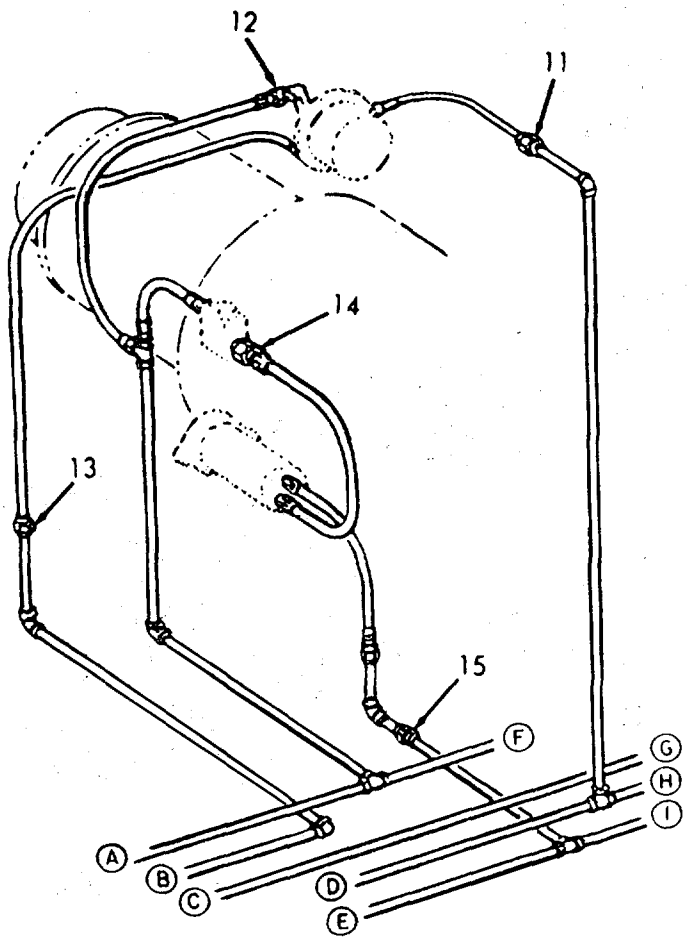
5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
16. Alarms	Wiring	Reconnect.	
17. Generator	Wiring	Reconnect.	
18. Exhaust piping	a. Gasket (21)	Install between exhaust elbow (19), and manifold (20).	Use new gasket.
	b. Screws (16 and 17), and lockwashers (18)	Install.	



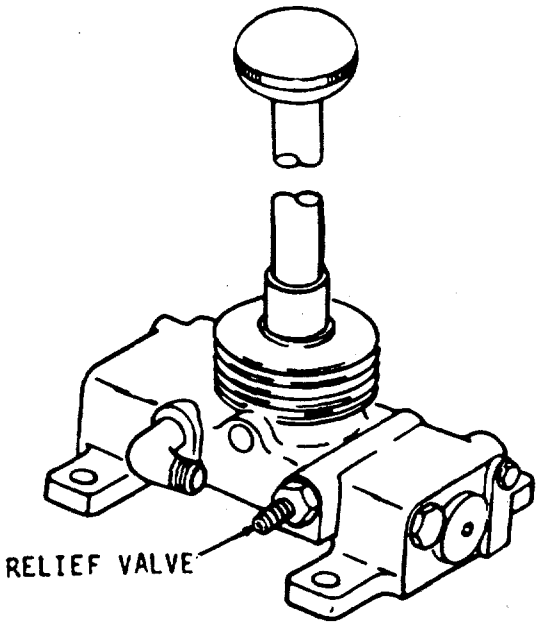
5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
19. Hydro-starter piping	a. Piping unions (11, 12, 13, 14, and 15)	Reconnect.	

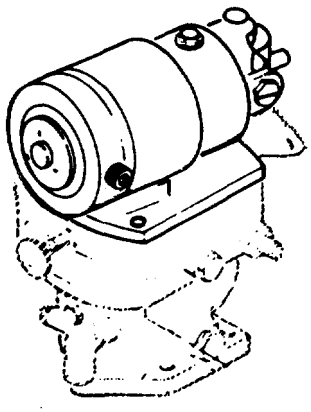


5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
	b. Hand pump	1. Close pressure relief valve. 2. Pressurize system.	

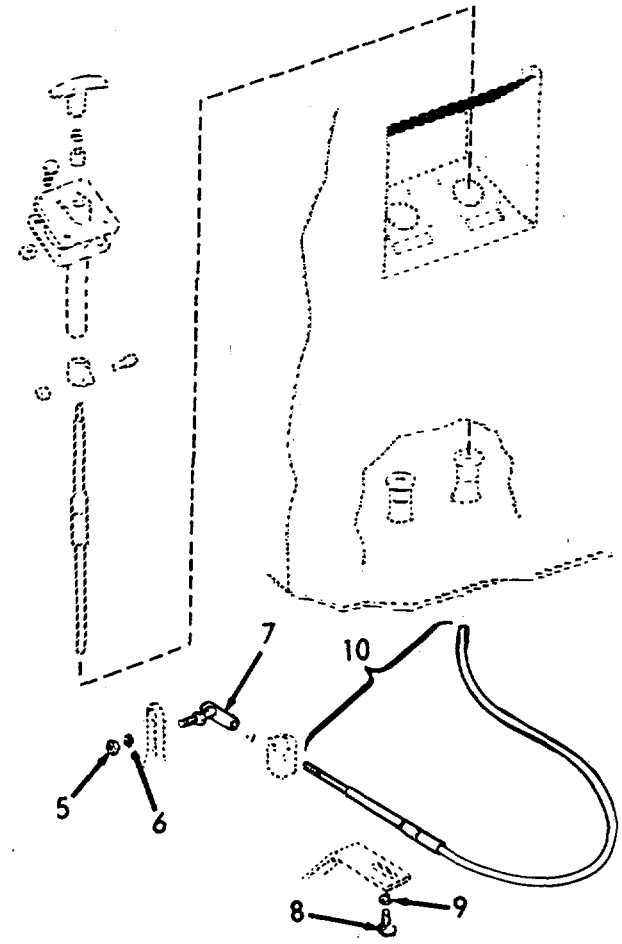


20. Synchro-nizing motor	Wiring	Reconnect.	



5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

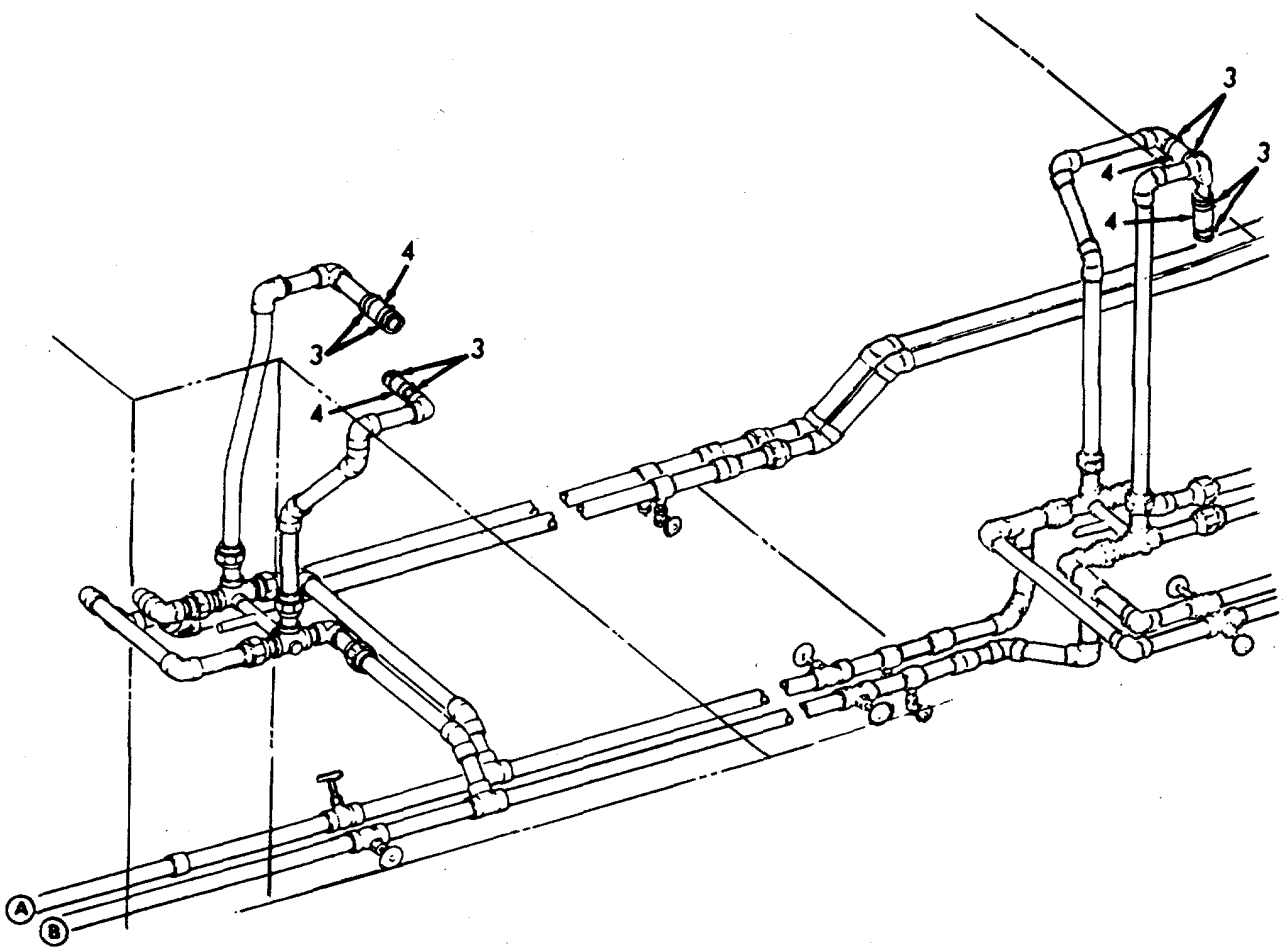
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
21. Shutdown lever	a. Control cable (10), screw (8), and lock-washer (9)	Install.	
	b. Ball joint (7), lock-washer (6), and nut (5)	Install.	



5-537

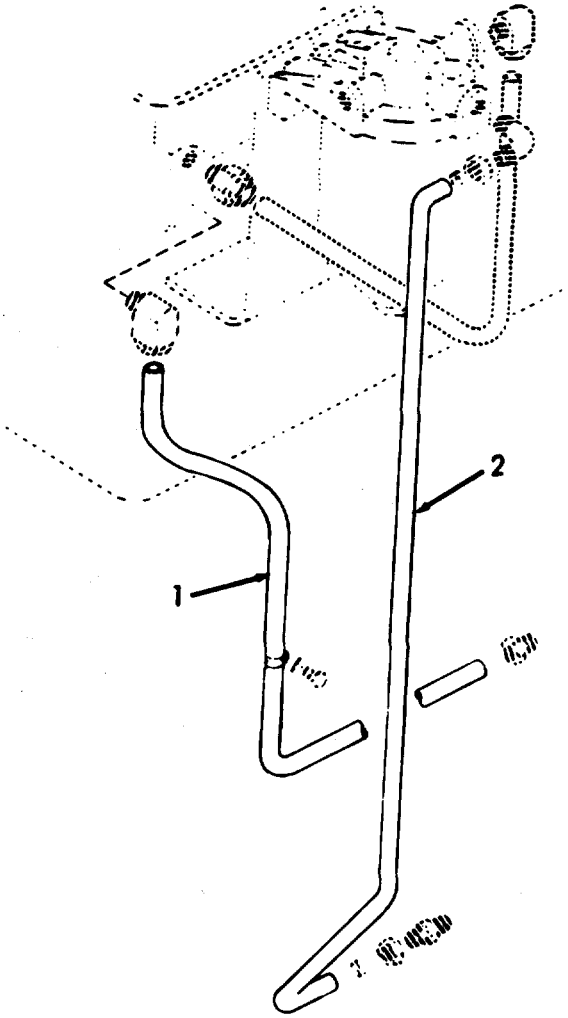
5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
22. Cooling lines	Hoses (4), and hose clamps (3)	Install and tighten clamps.	



5-33. ENGINE ASSEMBLY-REMOVAL AND RUN IN-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
23. Fuel lines	a. Fuel input hose (2)	Reconnect.	
	b. Drain hose (1)	Reconnect.	



5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS.

a. The governor maintenance at this level of maintenance is limited to the hydraulic governor drive and the synchronizing motor.

b. Description

(1) The governor drive assembly, consists of an integral horizontal drive shaft and bevel gear and an integral vertical driven shaft and bevel gear, both mounted on ball bearings and contained in a governor drive housing.

(2) Drive to the horizontal shaft is through serrations on shaft engaging with serrations in the upper blower rotor shaft. The governor proper is driven through splines on the lower end of the ball head registering with splines in upper end f the driven shaft sleeve.

(3) The bearing on the horizontal shaft is retained by two bolts, flatwashers, and lockwashers and on the vertical shaft by two set screws, flatwashers, and lockwashers. The drive housing flange at the drive shaft is gasketed and bolted to the blower front end cover, while the governor is gasketed and bolted to the drive housing at the driven shaft opening.

c. Lubrication

(1) Gears and bearings f the governor drive assembly are lubricated by surplus oil from the governor which spills over the moving parts and then returns to the engine crankcase through connecting drilled passages in the blower front end plate and cylinder block.

(2) If the governor fails to control the engine speed properly, the fault may lie in the governor drive. To function properly, the clearance between the bevel gears f the drive and driven shafts should not be less than .001 inch or exceed .003 inch.

5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

This task covers:

a. Disassembly **b. Inspection** **c. Reassembly**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Arbor Press

Material/Parts

NONE

Personnel Required

1

References

Para 3-66 Governor

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

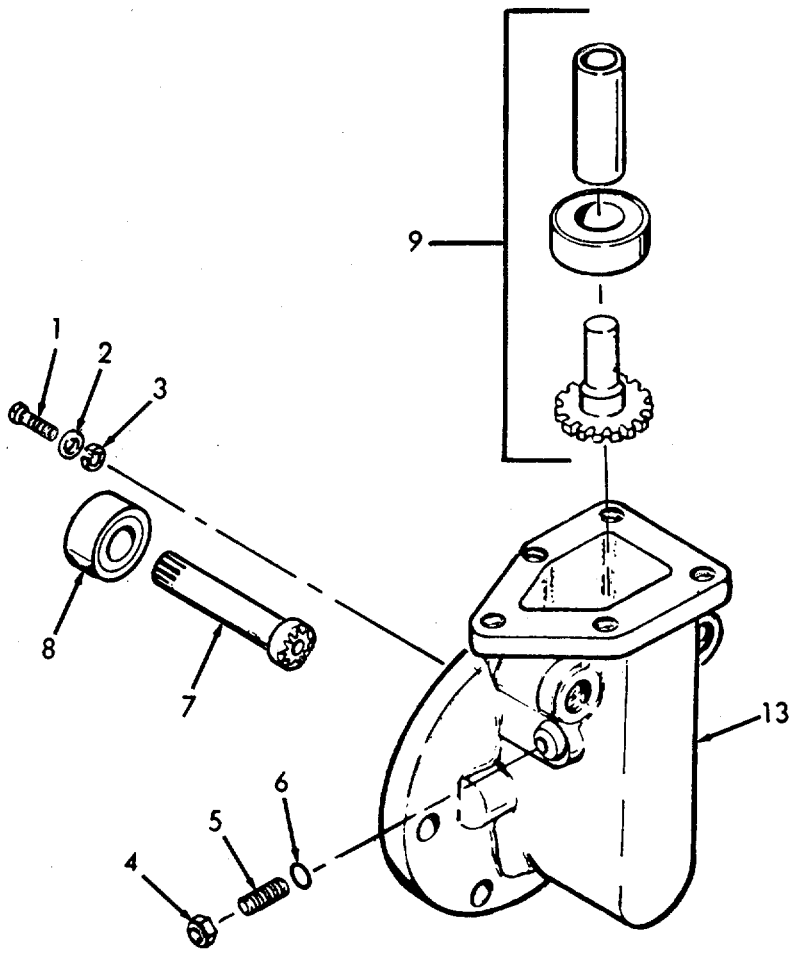
General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Hydraulic governor drive	a. Screws (1), special flatwashers (2), and lockwashers (3)	Remove.	
	b. Nuts (4), sets crew s (5), and gaskets (6)	Remove.	
	c. Horizontal drive shaft (7), and bearing (8)	Remove as an assembly.	

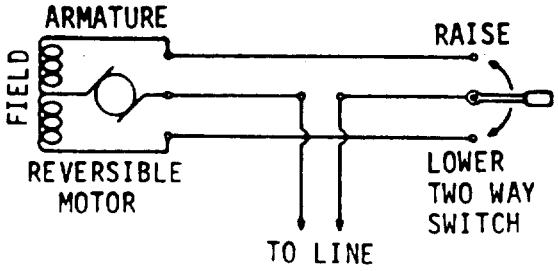
5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Driven shaft assembly (9)	Remove from housing (13).	



5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
2. Synchronizing motor	a. Wiring	Tag and disconnect.	

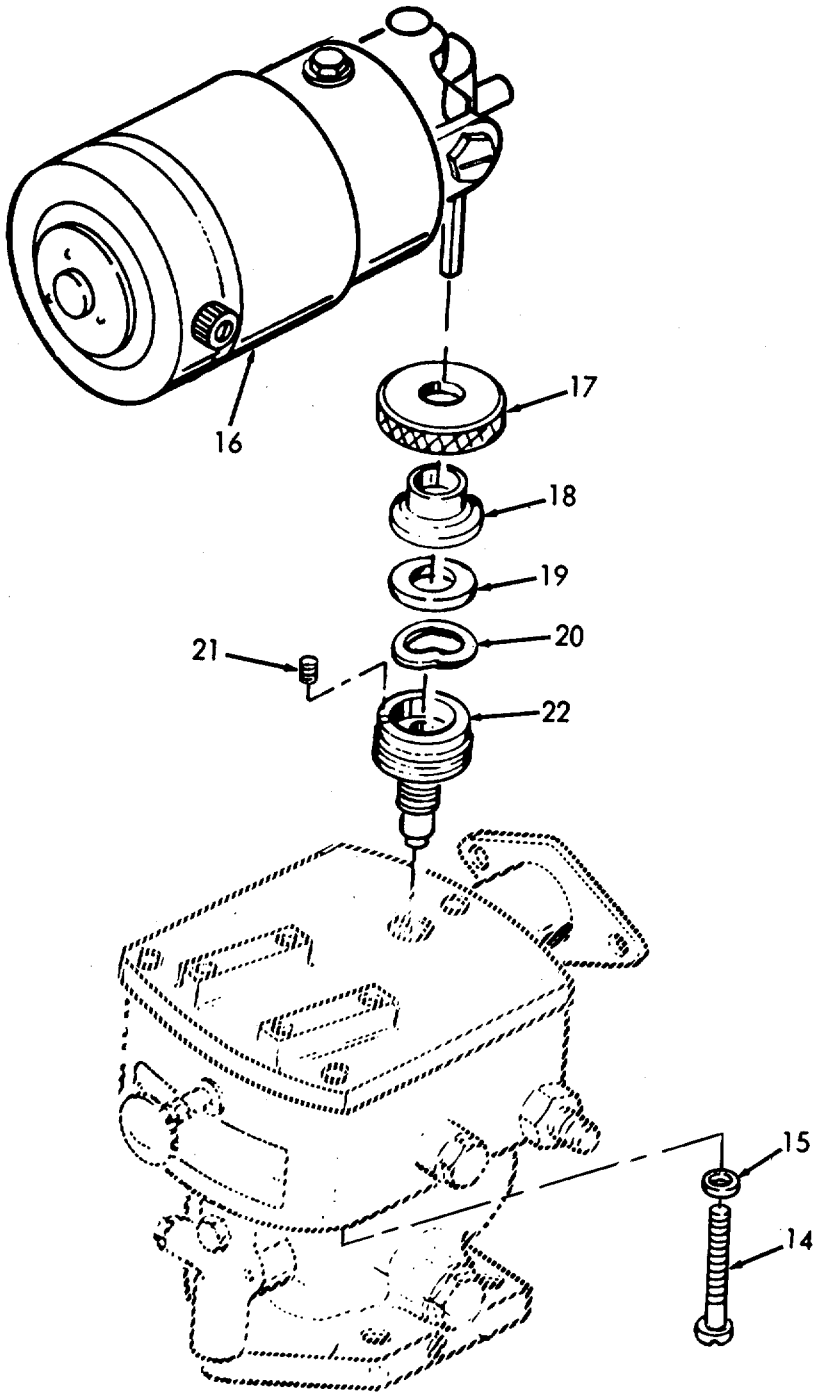


	b. Screws (14), and flatwashers (15)	Remove.	
	c. Motor (16)	Lift out.	
	d. Friction cover (17), friction disc (18), micarta washer (19), friction spring (20), setscrew (21), and speed adjusting screw (22)	Remove.	

5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



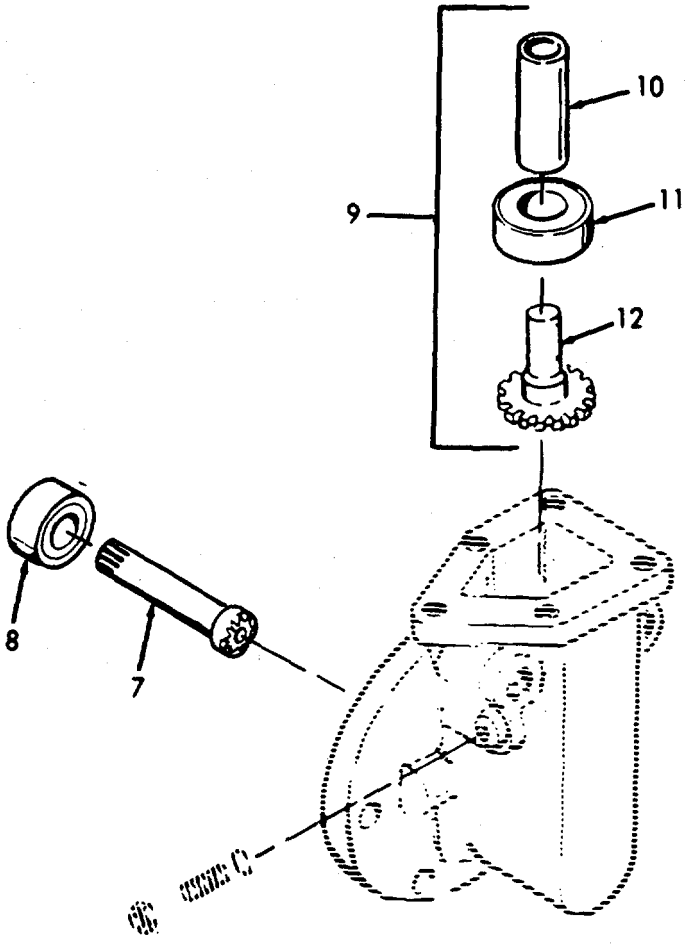
5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		WARNING Wear eye protection when using compressed air.	
3.	Hydraulic drive	a. After the governor drive has been disassembled, wash all parts in clean fuel oil and dry them with compressed air.	
		b. Examine gear teeth of drive and driven shafts for chipping or scoring and, if either of these conditions exist, replace shafts.	
		c. Revolve bearings by hand to check for excessive wear, bind, or rough spots. If any of these conditions exist, install new bearings.	
		d. Slight end play is not objectionable in single row annular ball bearings, since they are built with that characteristic.	
		e. If inspection reveals the bearings are in good condition, lubricate them with clean engine oil prior to using.	
		f. If inspection reveals defects:	
		(1) Horizontal drive shaft (7), and bearing (8)	(a) Rest bearing on bed of arbor press.
			(b) Press shaft from bearing. — Use a brass rod between ram of press and shaft.
		(2) Driven shaft assembly (9) consisting of the following: shaft sleeve (10), bearing (11), and driven shaft (12)	(a) Rest bearing on bed of arbor press.
			(b) Press shaft from bearing. — Use a brass rod between ram of press and shaft.

5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

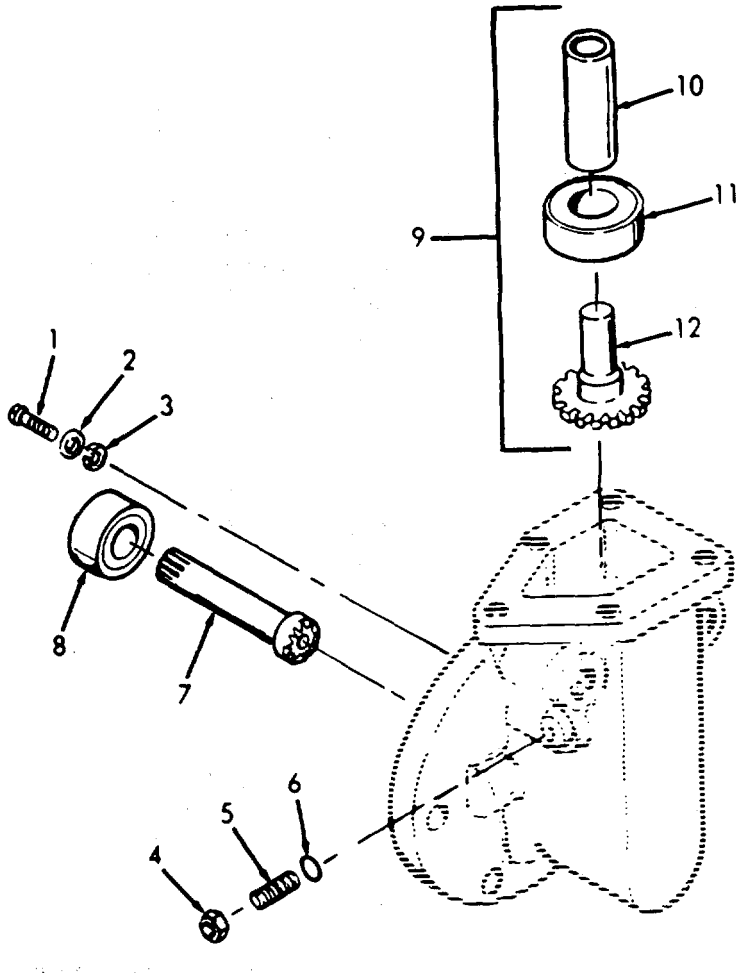


5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
4. Hydraulic governor drive	a. Bearing (8), and shaft (7)	1. Support bearing on arbor press.	
		2. Press shaft into bearing and against shoulder on shaft.	
	b. Bearing (11), sleeve (10), and shaft (12)	1. Start bearing on shaft.	
		2. Support sleeve on bed of arbor press.	
		3. Using a brass bar between ram and gear, press shaft into bearing and sleeve.	
	c. Driven shaft assembly (9)	1. Lower into housing (13).	
		2. Bearing will rest on shoulder in housing.	
	d. Nuts (4), and set-screw (5)	Start nuts onto set-screws.	
	e. Setscrews (5), and gaskets (6)	1. Thread screw into housing until it bottoms on outer race of bearing.	
		2. Tighten nut (4).	
	f. Horizon-tal drive shaft (7), shaft and bearing (8),	1. Install with bearing resting in counter bore provided.	
		2. Teeth will mesh with teeth in driven gear assembly (9).	

5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Screws (1), special flatwashers (2), and lockwashers (3)	Install.	



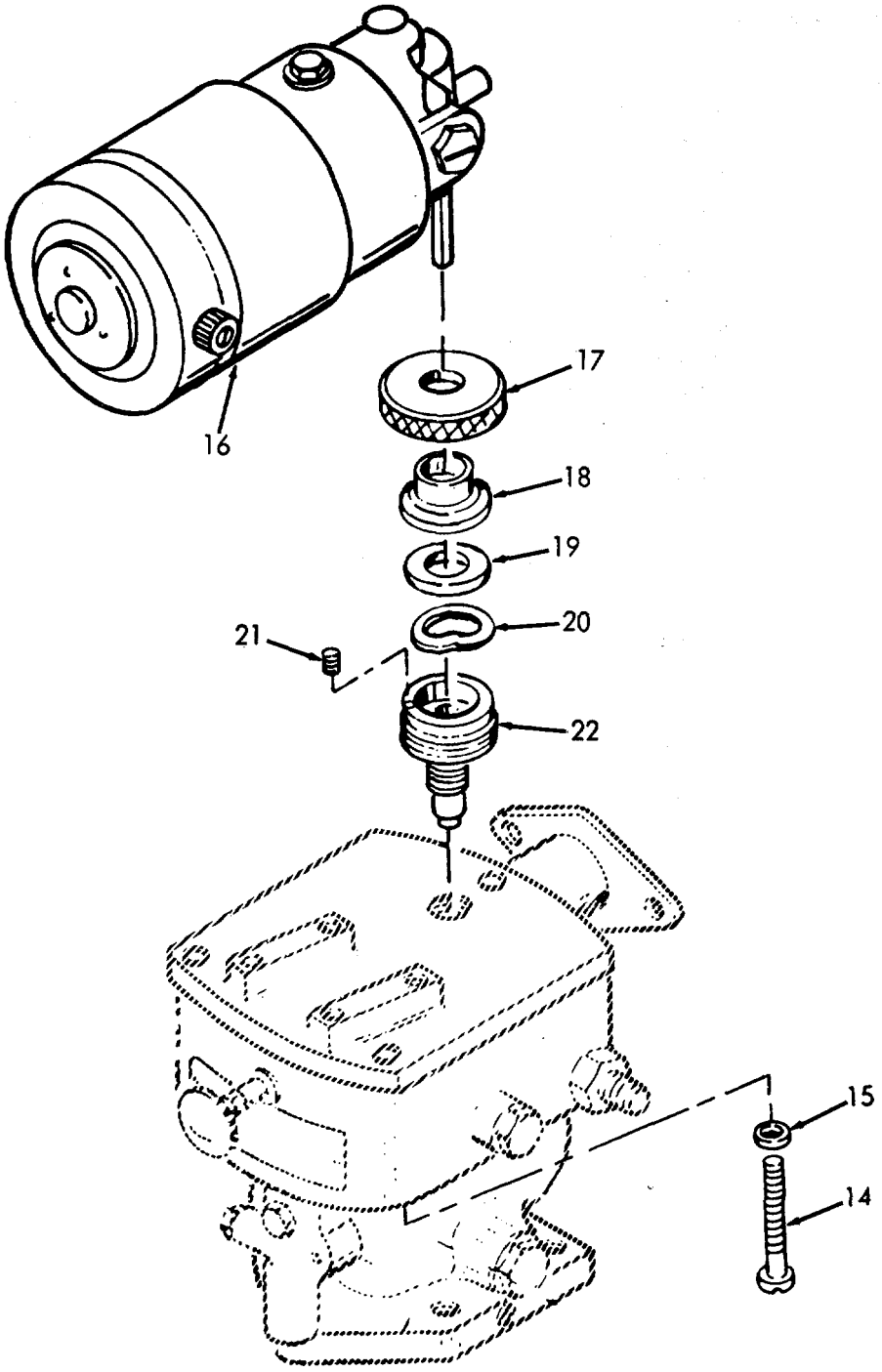
5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
5. Synchronizing motor	a. Speed adjusting screw (22), sets crew (21), friction spring (20), micarta washer (19), friction disc (18), and friction cover (17)	Install.	
	b. Motor (16)	Install.	
	c. Screws (14), and flatwashers (15)	Install.	
	d. Wiring	Reconnect.	

5-34. GOVERNOR-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

This task covers:

Overhaul

INITIAL SETUP:

Test Equipment

Micrometer
Feeler gage (1/2 inch wide)

Special Tools

Vice-soft jaws
Tool J6270 (Set)
Arbor press
Slide hammer

Material/Parts

Hub blower kit
P/N5192751

Personnel Required

1

References

Para 3-68 Blower Organizational Maintenance

Equipment Condition: NONE

Special Environmental Conditions

NONE

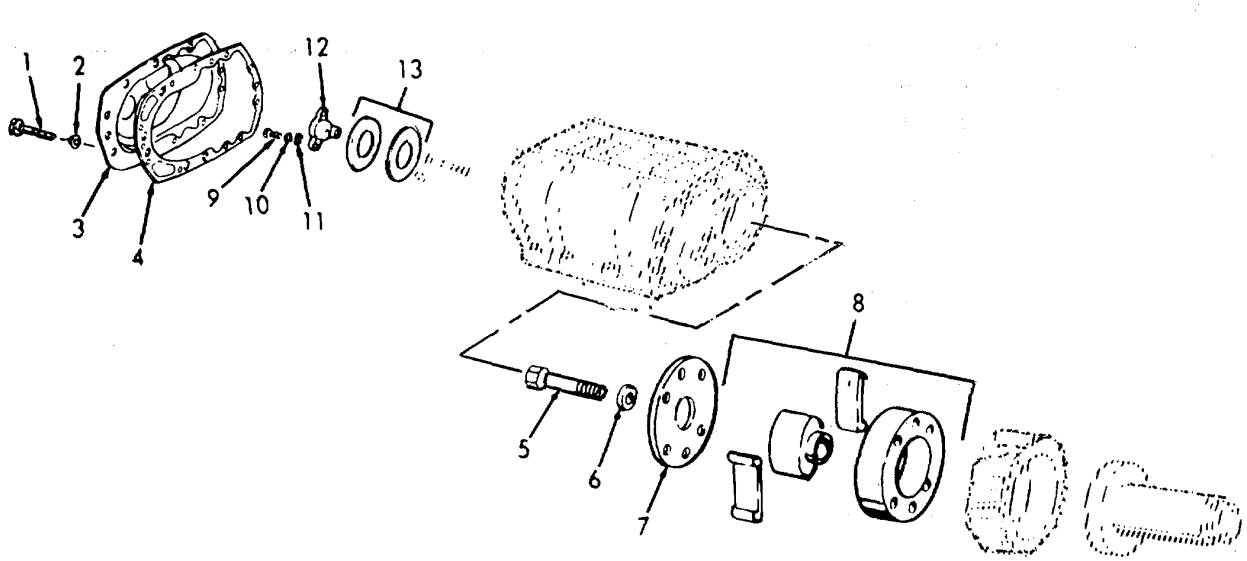
General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL-DISASSEMBLY			
1. Rear blower cover and drive coupling	a. Machine bolts (1), and lock-washers (2)	Remove.	
	b. End plate cover (3), and gasket (4)	Remove.	

5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	c. Drive coupling machine bolts (5), and lockwashers (6)	Remove.	
	d. Retainer (7), and rear blower coupling (8)	Remove from right hand blower rotor gear.	
2. Blower Drive	a. Screws (9), flatwasher (10),and lockwashers (11)	Remove.	
	b. Hub (12), and spring plates (13)	Remove.	



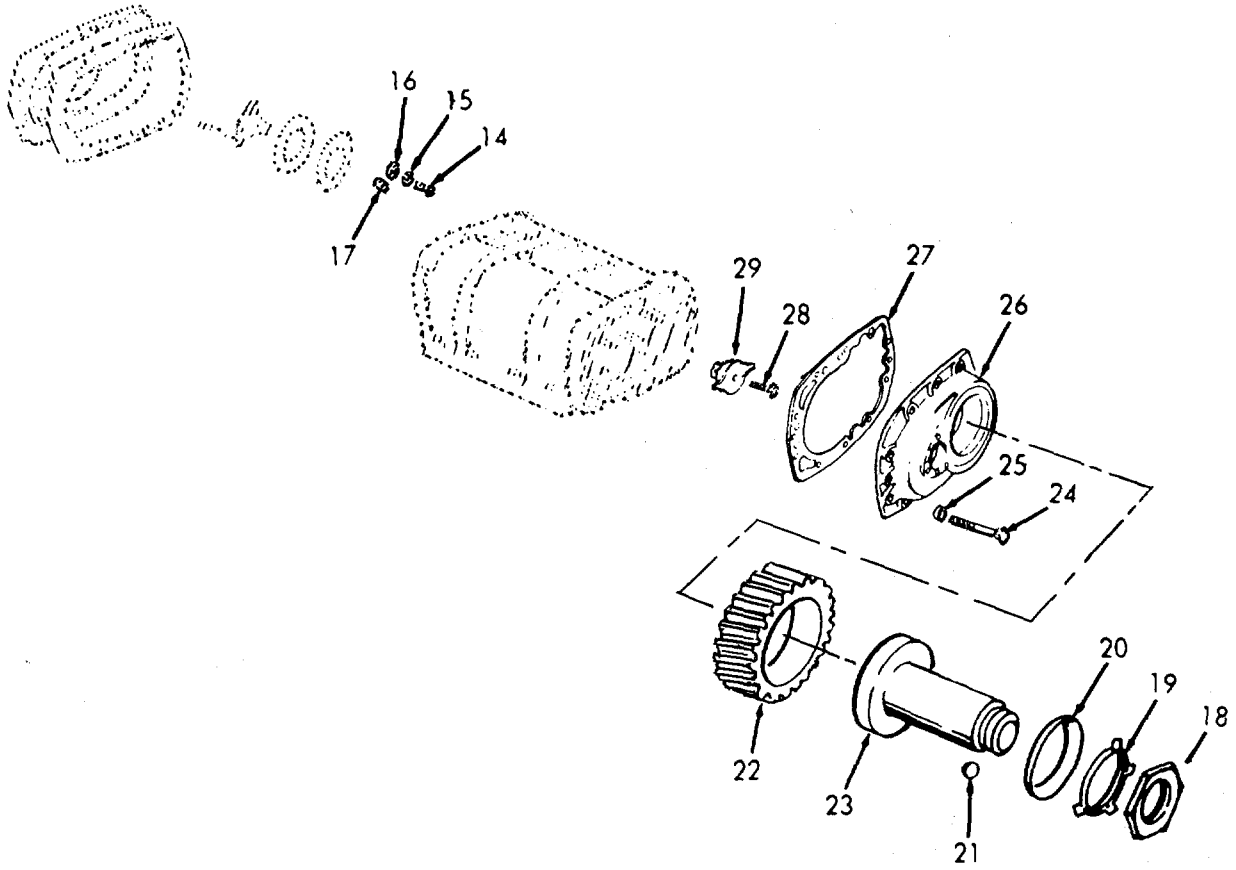
5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

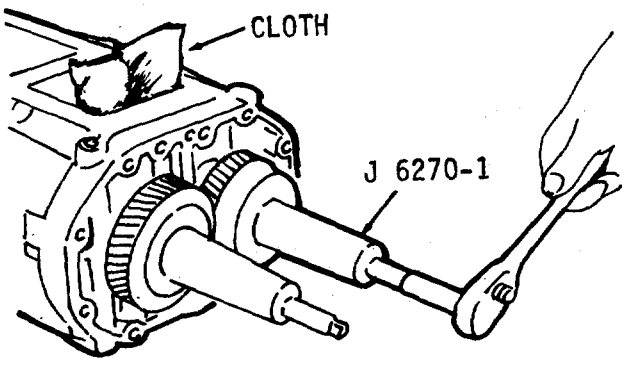
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	c. Screws (14), flat-washers (15), and lockwashers (16)	Remove.	
	d. Spacers (17), hubnut (18), and lockwasher (19)	Remove.	
	f. Thrust washer (20), and ball bearing (21)	Remove.	
	g. Gear (22), and drive shaft (23)	Remove.	Gear is left-hand helix.
3. Front blower cover and water pump drive coupling	a. Machine bolts (24), and lockwashers (25)	Remove.	
	b. Front cover (26), and gasket (27)	Remove.	
	c. Screw (28), and water pump coupling (29)	1. Place a clean folded cloth between the rotors.	
		2. Pull the drive coupling from the blower rotor shaft.	Use a slide-hammer.

5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont)



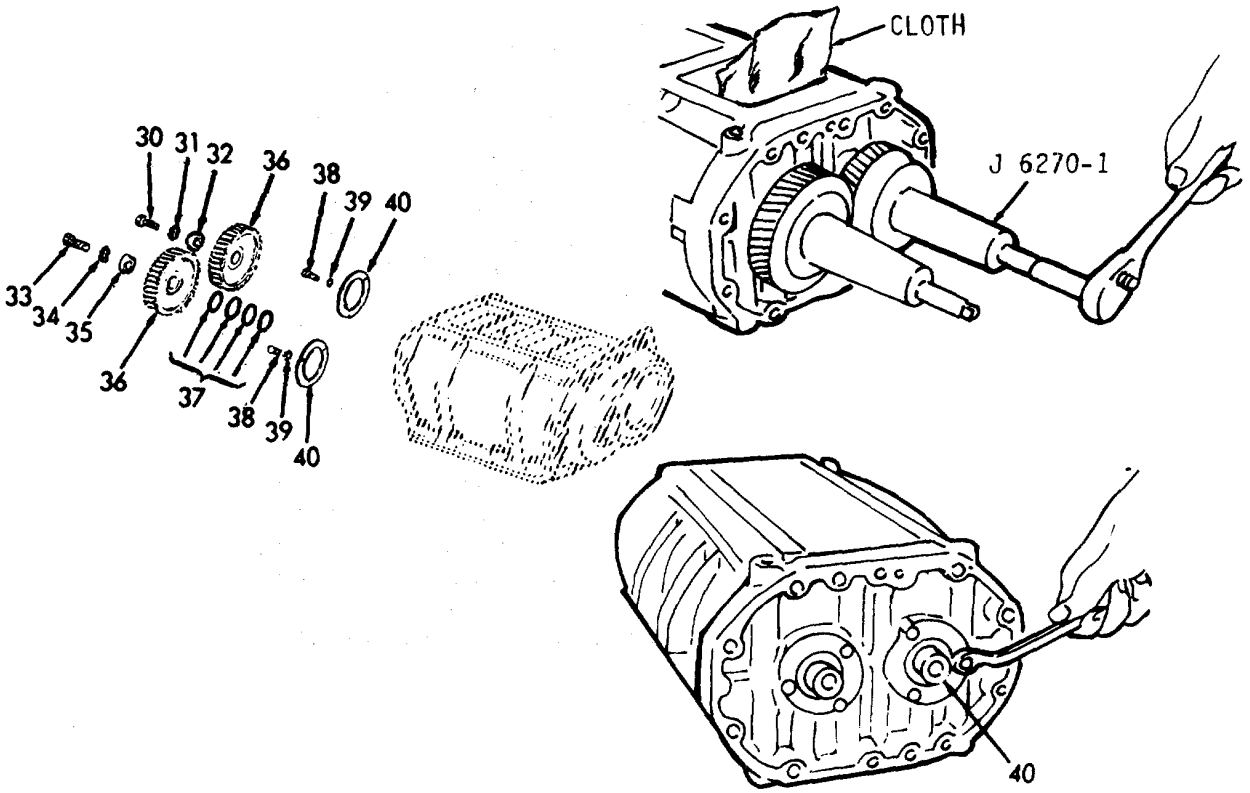


5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
4. Blower	a. Screw (30), lockwasher (31), and coupling disc (32)	1. Place a clean folded cloth between the rotors. 2. Remove.	
	b. Screw (33), lockwasher (34), and retaining washer (35)	Remove.	
	c. Timing gears (36)	1. Remove both gears at the same time. 2. Back out the center screws of both pullers and place the flanges against the gear faces, aligning the flange holes with the tapped holes in the gears. Secure the pullers to the gears with 5/16 inch-24 x 1-1/2 inch bolts (two bolts on the L.H. helix gear and three bolts on the R.H. helix gear). 3. With a clean cloth placed between the rotors to prevent their turning, turn the two puller screws uniformly clockwise and withdraw the gears from the rotor shafts as shown below.	Use two pullers J6270-1.

5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	d. Shims (37)	1. Note the number and thickness of shims on each rotor shaft to ensure identical replacement when assembling blower.	
		2. Remove.	
	e. Screws (38), and lockwashers (39)	Remove six places.	
	f. Bearing retainers (40)	Remove two places.	

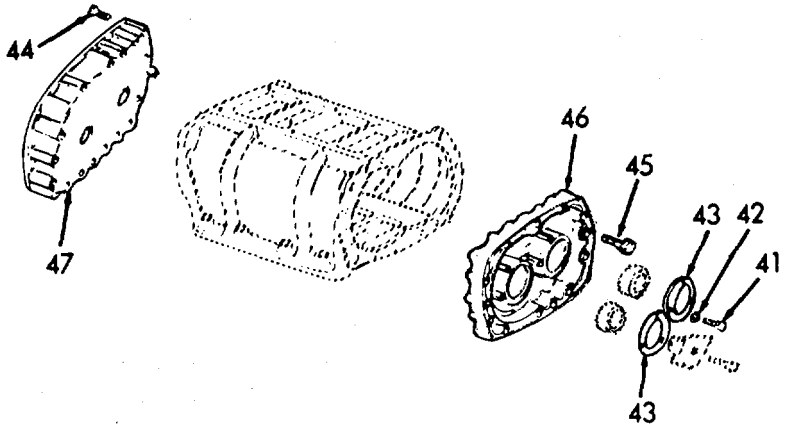


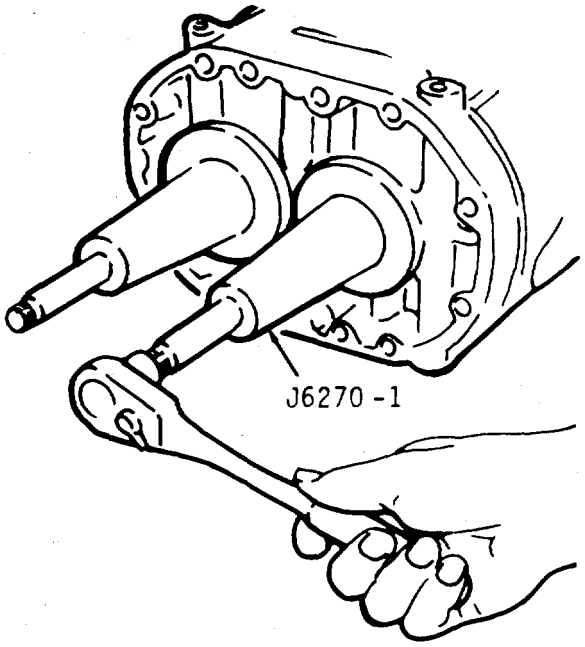
5-35. BLOWER-MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	g. Screws (41), and lockwashers (42)	Remove six places.	
	h. Bearing retainers (43)	Remove two places.	
	i. Screws (44)	Remove.	
	j. Screws (45)	Loosen.	Approximately three turns.
	k. Rear end plate (46)	1. Back out the center screws of pullers far enough to permit the flange of each puller to lay flat on the end plate.	Use two pullers J6270-1.
		2. Align the holes in each puller flange with the tapped holes in the end plate and secure the pullers to the end plate with six 1/4 inch -20 x 1-1/4 inch or longer screws.	
		NOTE Be sure that the 1/4 inch -20 screws are threaded all the way into the tapped holes in the end plate to provide maximum anchorage for the pullers and to eliminate possible damage to the end plate.	
		3. Turn the two puller screws uniformly clockwise and withdraw the end plate and bearings from the blower housing and rotors as shown below.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	1. Front end plate (47)	Remove.	Refer to step k above.





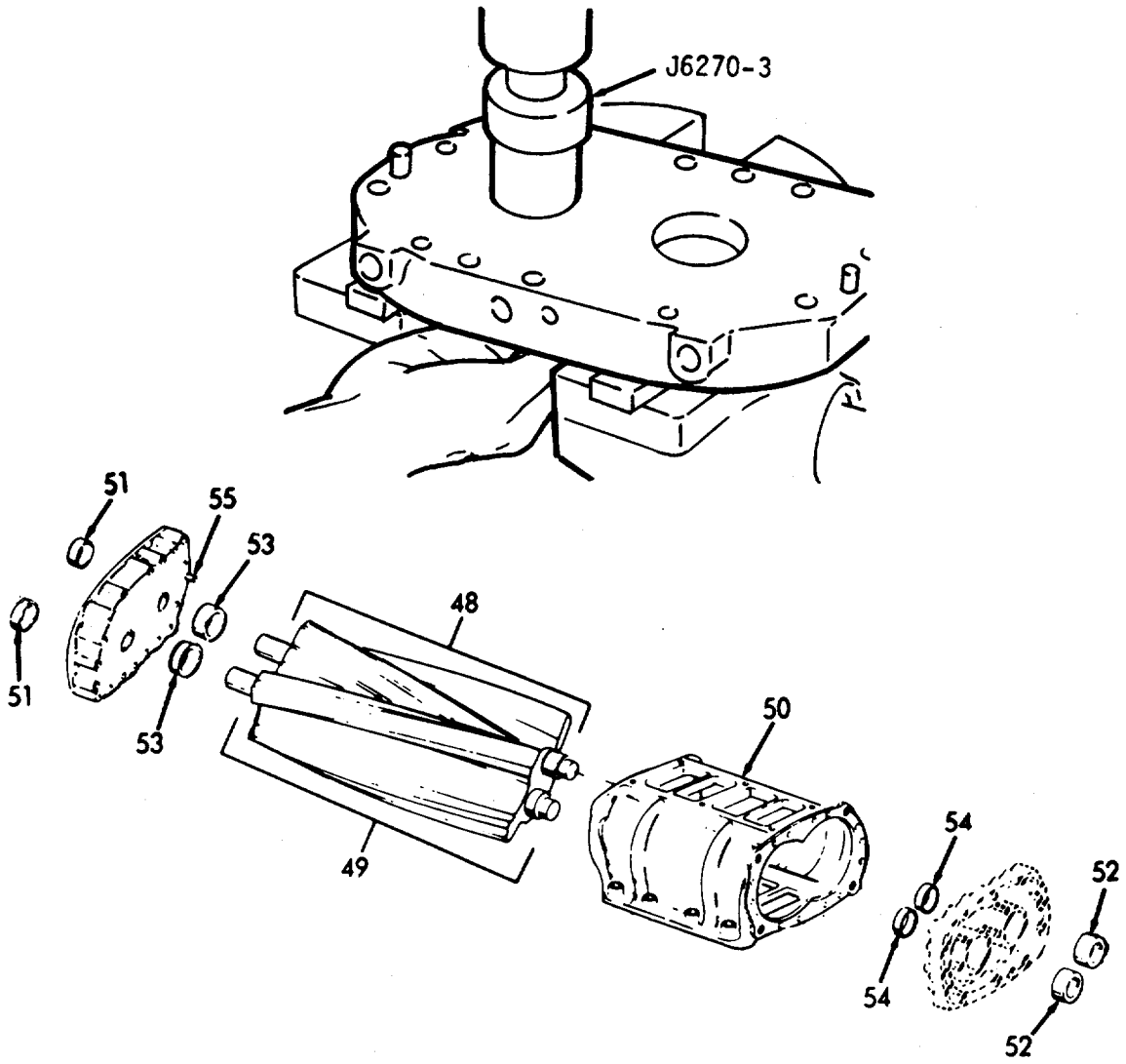
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - DISASSEMBLY (Cont)			
	m. Rotors (48 and 49)	Remove from blower housing (50).	
	n. Bearings (51 and 52), and seals (53 and 54)	1. Inspect the oil seals. seals. If the seals are scored, charred or hardened so that a tight seal around the shafts is impossible, new seals should be installed. If necessary, the seals may be removed from the end plates at the same time the individual bearings are removed. 2. Support the outer face of the end plate on wood blocks on the bed of an arbor press. 3. Place the long end of the oil seal remover and installer J6270-3 down through the oil seal and into the bearing, with the opposite end of the remover under the ram of the press. Then, press the bearing and oil seal out of the end plate. 4. Remove the remaining bearings and oil seals from the end plates in the same manner.	
	o. Dowel pins (55)	Remove.	If necessary.

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - DISASSEMBLY (Cont)



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - INSPECTION

5. Blower

WARNING

Wear eye protection when using compressed air.

a. Wash all of the blower parts in clean fuel oil and dry them with compressed air.

b. Examine the bearings for any indications of corrosion or pitting. Lubricate each bearing with light engine oil; then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots.

c. The double-row ball bearings are pre-loaded and have no end play. A new double-row bearing will seem to have considerable resistance to motion when revolved by hand.

d. Check the oil seal rings, carriers and collars for wear and scoring. If worn excessively, they must be replaced. Inspection of the lip type oil seal is covered in item step 4n.

e. Inspect the blower rotor lobes, especially the sealing ribs, for burrs and scoring. Rotors must be smooth for efficient operation of the blower. If the rotors are slightly scored or burred, they may be cleaned up with emery cloth.

f. Examine the rotor shaft serrations for wear, burrs or peening. Also, inspect the bearing and oil seal contact surfaces of the shafts for wear and scoring.

g. Inspect the inside surface of the blower housing for burrs and scoring. The inside surface must be smooth for efficient operation of the blower. If the inside surface of the housing is slightly scored or burred, it may be cleaned up with emery cloth.

h. Check the finished ends of the blower housing for flatness and burrs. The end plates must set flat against the blower housing.

i. The finished inside face of each end plate must be smooth and flat. If the finished face is slightly scored or burred, it may be cleaned up with emery cloth.

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - INSPECTION (Cont)

j. Examine the serrations in the blower timing gears for wear and peening; also check the teeth for wear, chipping or damage. If the gears are worn to the point where the backlash between the gear teeth exceeds .004 inch, or damaged sufficiently to require replacement, both gears must be replaced as a set.

k. Check the blower drive shaft serrations for wear or peening. Replace the shaft if it is bent.

l. Inspect the blower drive coupling springs (pack) and the cam for wear.

m. Replace all worn or excessively damaged blower parts.

n. Clean the oil strainer in the vertical oil passage at the bottom of each blower end plate, and blow out all oil passages with compressed air.

OVERHAUL - ASSEMBLY

6. Blower

a. Several precautions are given below to assure the proper assembly of the rotors and gears for correct blower timing.

1. The lobes on the DRIVING blower rotor and the teeth on its gear form a right-hand helix while the lobes and teeth of the DRIVEN rotor and gear form a left-hand helix. Hence, a rotor with right-hand helix lobes must be used with a gear having right-hand helix teeth and vice versa.

2. One serration is omitted on the drive end of each blower rotor shaft and a corresponding serration is omitted in each gear. Assemble the gears on the rotor shafts with the serrations in alignment.

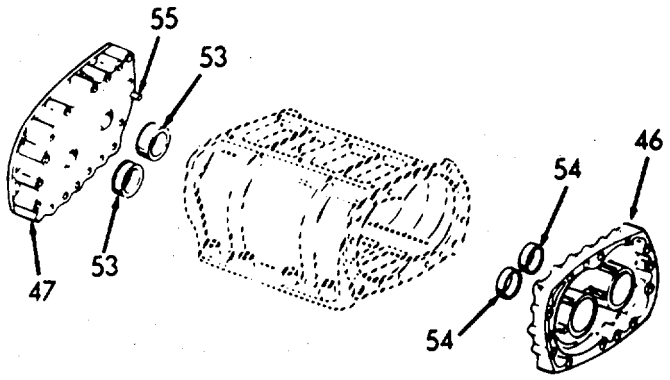
3. The rotors must be assembled in the blower housing with the omitted serrations in the rotor shafts aligned as shown in step 6f.

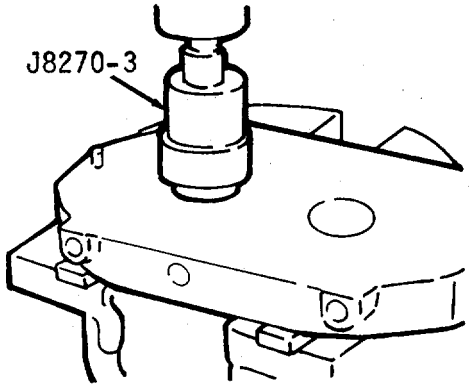
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	b. Blower end plates (46 and 47), and oil seals (53 and 54)	1. Support the blower end plate, finished surface facing up, on wood blocks on the bed of an arbor press.	Use new oil seals.
		2. Start the oil seal straight into the bore in the end plate with the sealing edge facing down (toward the bearing bore).	
		3. Place the short end of oil seal remover and installer J6270-3 in the oil seal and under the ram of the press. Then, press the oil seal into the end plate until the shoulder on the installer contacts the end plate.	
		NOTE A step under the shoulder of the installer will position the oil seal approximately .005 inch below the finished face of the end plate. This is within the .002 inch to .008 inch specified.	
		4. Install the remaining oil seals in the end plates in the same manner.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	c. Blower front end plate (47)	1. The top of the end plate is readily identified by the three bolt holes and one oil hole, whereas the bottom side of the end plate has three bolt holes and three oil holes. Also, the dowel pins (55) extend on both sides of the front end plate.	





5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

CAUTION

The horizontal oil passage in the top front face of the front end plate that intersects the vertical oil passage is plugged. Do not install this end plate on the rear end of the blower housing.

2. The front end plate should be attached to the front end of the blower housing first. The rear end plate is attached to the blower housing after the rotors are in place. Attach the front end plate to the blower housing as follows:

d. Dowel pins (55)

Check the dowel pins. The dowel pins must project .380 inch from the flat inner face of the front end plate to assure proper alignment of the end plate with the housing.

e. Blower housing (50), and front end plate (47)

1. Place the blower housing on a bench with the top side of the housing up, and the front end of the housing facing the outside of the bench.

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

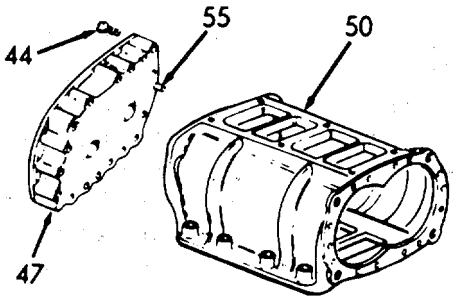
OVERHAUL - ASSEMBLY (Cont)

2. Position the end plate (47) in front of the blower housing with the top side of the end plate facing up. Then, start the dowel pins (55) straight into the dowel pin holes in the housing. Push or tap the end plate against the housing.

NOTE

Gaskets are not used between the end plates and the housing; therefore, the mating surfaces must be perfectly flat and smooth.

3. Insert the two screws (44) through the end plate and thread them into the housing. Tighten the screws securely. Do not use lockwashers on these screws.



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

f. Blower housing (50), and rotors (48 and 49)

1. Reverse the blower housing on the bench (rear end of housing facing the outside of the bench).

2. Place the rotors in mesh with the omitted serrations in the rotor shafts in a horizontal position and facing to the left as viewed from the gear end.

NOTE

The right-hand helix rotor is marked "GEAR END" on one end. The gear end of the left-hand rotor is that end which has the serrated shaft.

3. Install an oil seal pilot J6270-5 over the opposite end of each rotor shaft.

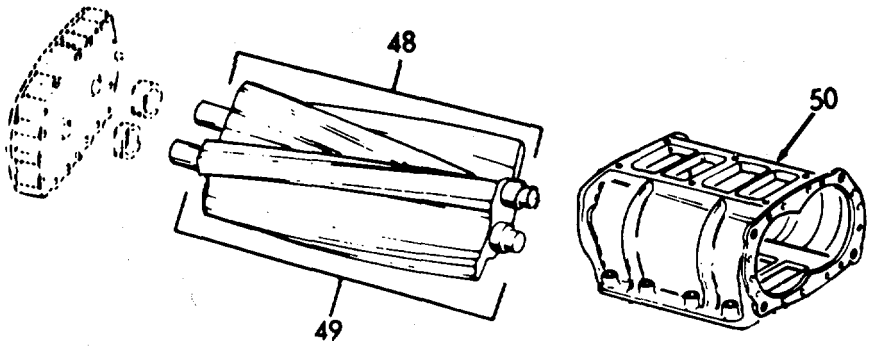
4. Insert the rotors straight into the housing and through the front blower end plate.

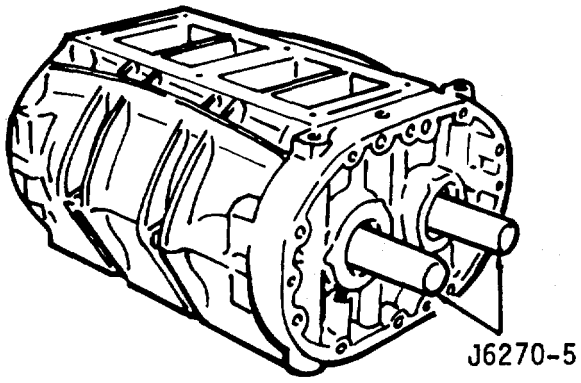
5. Remove the oil seal pilots from the rotor shafts.

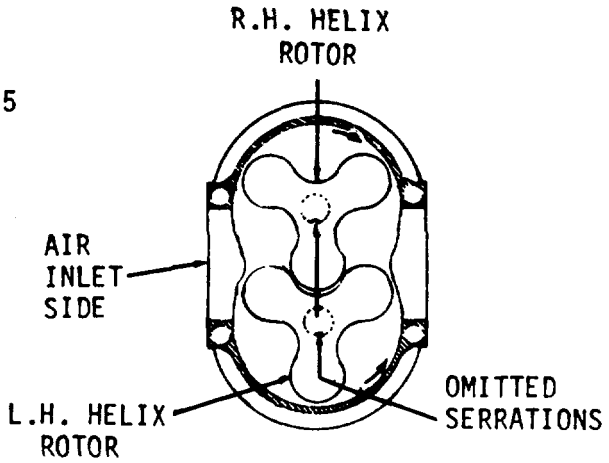
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)







VIEW FROM GEAR END OF BLOWER

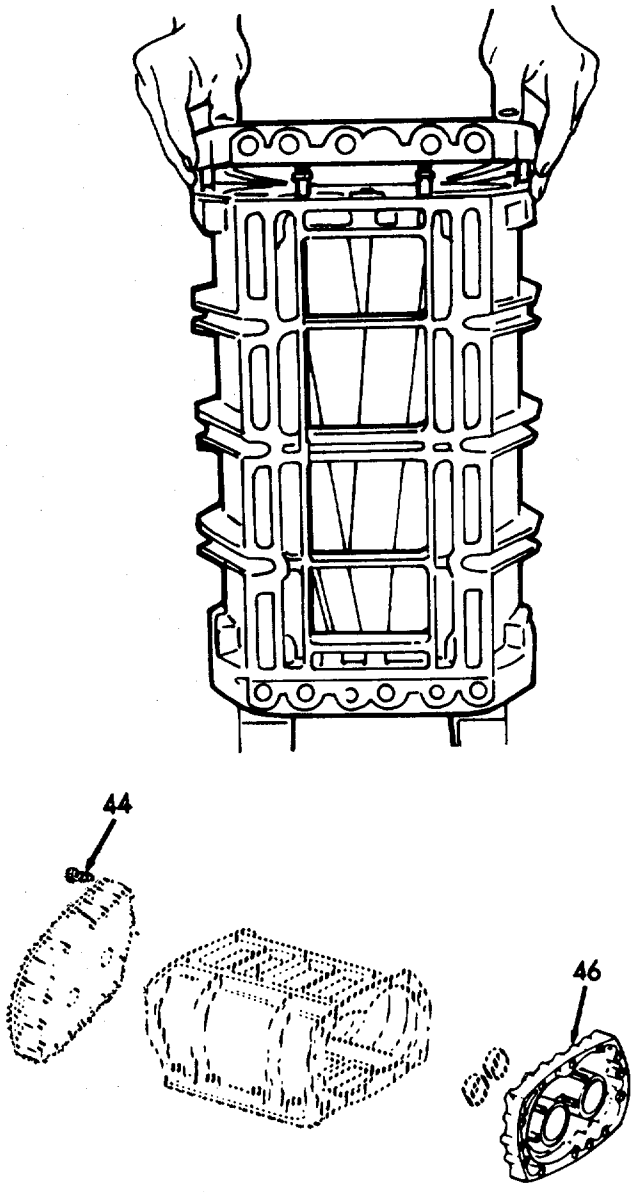
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	g. Blower rear end plate (46)	1. Install an oil seal pilot J6270-5 over the serrated end of each rotor shaft. 2. Check the dowel pins. The dowel pins must project .270 inch from the flat inner face of the rear end plate to assure proper alignment of the end plate with the housing . 3. With the top of the end plate identified as in Step 6a and its flat finished face towards the blower housing, slide the end plate straight over the oil seal pilots and start the dowel pins straight into the dowel pin holes in the housing. Then, push or tap the end plate against the housing. 4. Insert the two screws (44) through the end plate and thread them into the housing. Tighten the screws securely. Do not use lockwashers on these screws. 5. Remove the oil seal pilots from the rotor shafts.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

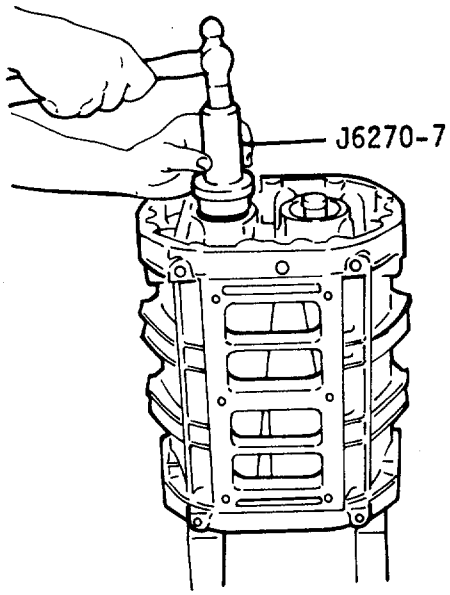
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	h. Blower housing (50), and end plates (46 and 47)	Check the relationship of the blower end plates to the housing at the cylinder block side of the blower assembly. The protrusion of the housing with respect to the end plates should not be more than .0015 inch. Excessive protrusion could distort the housing when the end plate to cylinder block bolts are tightened and cause rotor to housing interference.	
	i. Bearings (51)	1. With the blower housing, rotors and end plates still supported in a vertical position on the two wood blocks, install the ball bearings on the rotor shafts and in the rear end plate as follows: 2. Lubricate one of the ball bearings with light engine oil. Start the bearing, numbered end up, straight on one of the rotor shafts. 3. Place installer J6270-7 on top of the bearing and tap the bearing straight on the shaft and into the rear end plate as shown.	

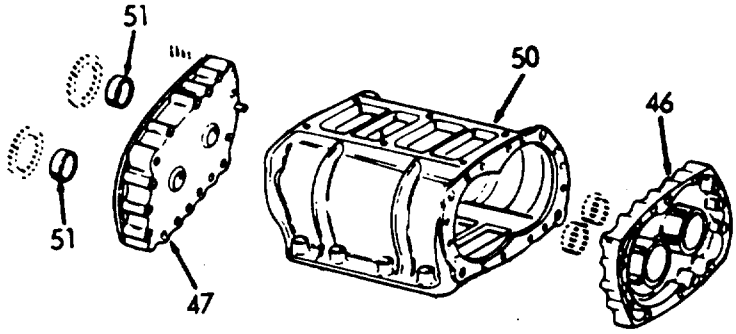
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

4. Install the second ball bearing on the remaining rotor shaft in the same manner.





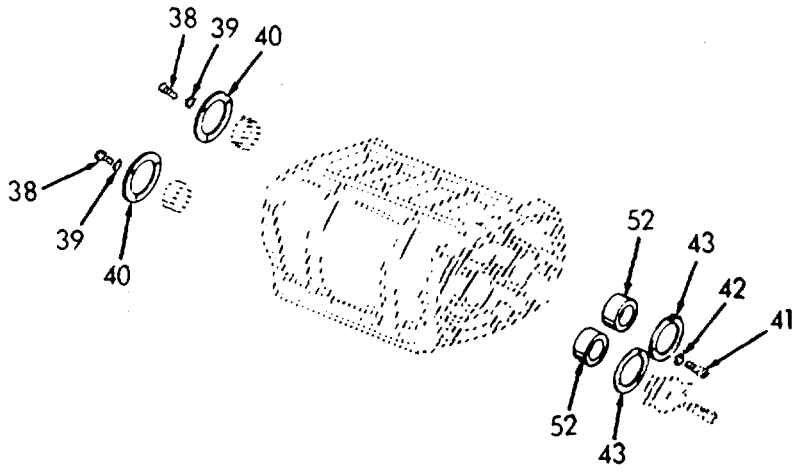
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

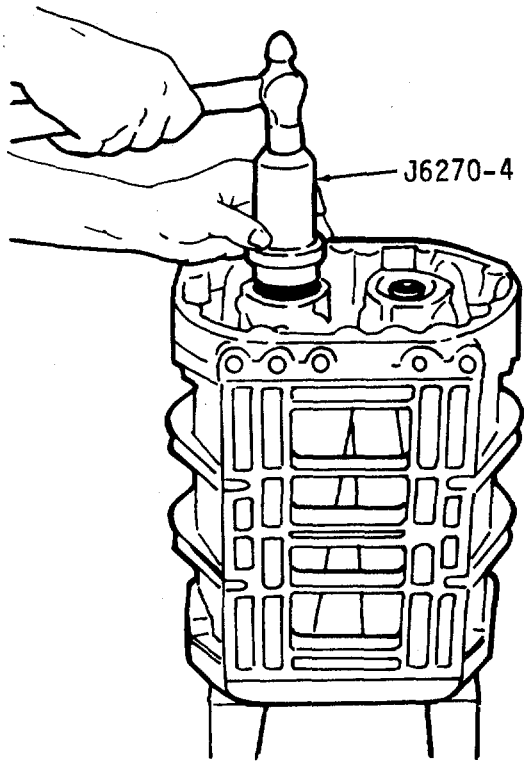
LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	j. Bearing retainers (40), screws (38), and lockwashers (39)	1. Install. 2. Tighten screws to 7-9 lb-ft (9.5-12.2 Nm) torque.	
	k. Bearings (52)	1. Reverse the position of the blower housing on the two wood blocks. 2. Lubricate one of the roller bearings with light engine oil. Start the bearing, numbered end up, straight on one of the rotor shafts. 3. Place installer J6270-4 on top of the bearing and tap the bearing straight on the shaft and into the front end plate as shown. 4. Install the second roller bearing on the remaining rotor shaft in the same manner.	
	l. Bearing retainers (43), screws (41), and lockwashers (42)	1. Install. 2. Tighten screws to 7-9 lb-ft (9.5-12.2 Nm) torque.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)



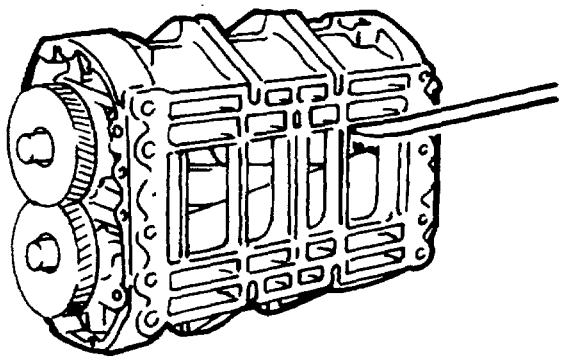


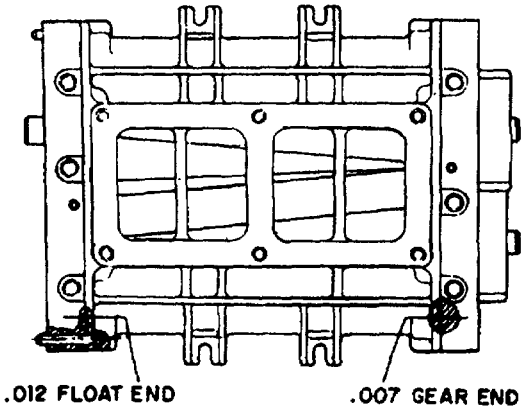
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

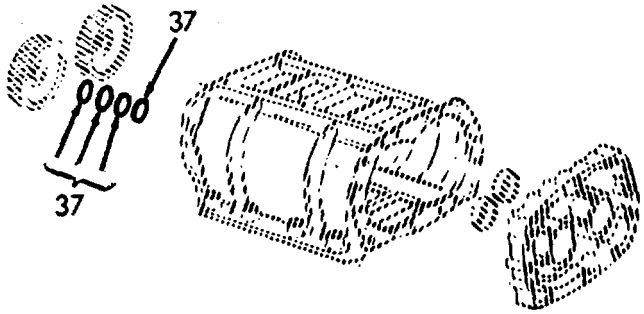
OVERHAUL - ASSEMBLY (Cont)

m.	Blower housing assembled	Make a preliminary check of the rotor-to-end plate and rotor-to-housing clearances at this time with a feeler gage for minimum blower clearances.	





n.	Shims (37)	Replace shims in their original positions.	Refer to step 4c.



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
	o. Blower housing assembly and gears	1. Before installing the blower rotor timing gears on the rotor shafts, observe precautions in step 6a2 and 3 relative to the rotor shaft and timing gear alignment. 2. The center punch mark in the end of each rotor shaft at the omitted serration will assist in aligning the gears on the shafts. 3. Place the blower assembly on the bench, with the top of the housing up and the rear end (serrated end of rotor shafts) of the blower facing the outside of the bench. 4. Rotate the rotors to bring the omitted serrations on the shafts in alignment and facing to the left. 5. Lubricate the serrations of the rotor shafts with light engine oil. 6. Place the teeth of the rotor gears in mesh so that the omitted serrations inside the gears are in alignment and facing the same direction as the serrations on the shafts.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY (Cont)			
		7. Start both rotor gears straight on the rotor shafts with the right-hand helix gear on the right-hand helix rotor and the left-hand helix gear on the left- hand helix rotor, with the omitted serrations in the gears in line with the omitted serrations on the rotor shafts.	
		8. Thread 1/2 inch-20X1-1/4 inches bolt with a large plain washer into the end of each rotor shaft. Place a clean folded cloth between the lobes of the rotors to prevent the gears from turning. Draw the gears into position tight against the shims and the bearing inner races.	
		9. Remove the two bolts and washers that were used to draw the gears into position on the rotor shafts.	
	p. Screw (30), lockwasher (31), and coupling disc (32)	1. Lubricate the threads of screws with engine oil.	
		2. Thread them into the rotor shafts.	
		3. Tighten the bolts to 55-65 lb-ft (74.6-88.1 Nm) torque.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

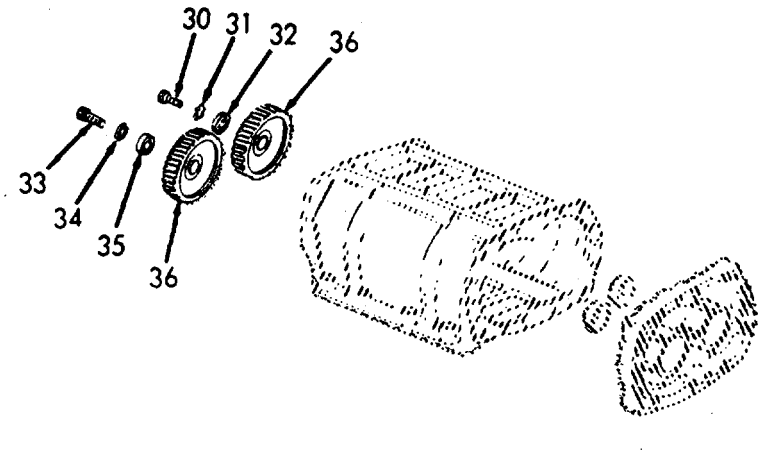
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY (Cont)

q.	(33) lockwasher (34), and retaining washers (35)	1. Lubricate the threads of screws with engine oil. 2. Thread them into the rotor shafts. 3. Tighten the bolts to 55-65 lb-ft (74.6-88.1 Nm) torque.	

NOTE

The blower timing gear retaining screws incorporate a special nylon insert and must be lubricated before



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS

7. Blower

a. After the blower rotors and timing gears are installed, the blower rotors must be timed.

NOTE

Before timing the blower, install four 5/16 inch - 18 x 1-7/8 inch bolts with flatwashers through four bolt holes in each end plate (top and bottom) and thread them into the blower housing. Tighten the bolts to 13-17 lb-ft (17.6 - 23.0 Nm) torque. This will hold the end plates against the blower housing so the proper clearance between the rotors and the end plate can be obtained.

b. The blower rotors, when properly positioned in the housing, run with a slight clearance between the lobes. This clearance may be varied by moving one of the helical gears in or out on the shaft rela- tive to the other gear.

c. If the right-hand helix gear is moved out, the right-hand helix rotor will turn counterclockwise when viewed from the gear end. If the left-hand helix gear is moved out, the left-hand helix rotor will turn clockwise when viewed from the gear end. This positioning of the gear, to obtain the proper clearance between the rotor lobes, is know as blower timing.

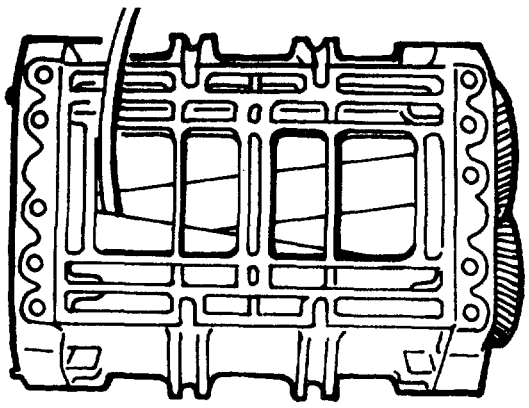
d. Moving the gears OUT or IN on the rotor shafts is accomplished by adding or removing shims between the gears and the bearings.

e. The clearance between the rotor lobes may be checked with 1/2 inch wide feeler gages in the manner shown below. When measuring clearances of more than .005 inch, laminated feeler gages that are made up of .002 inch, .003 inch, or .005 inch feeler stock are more practical and suitable than a single feeler gage. Clearances should be measured from both the inlet and out- let sides of the blower.

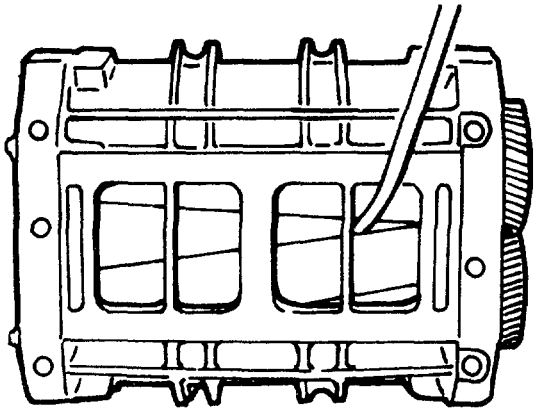
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS

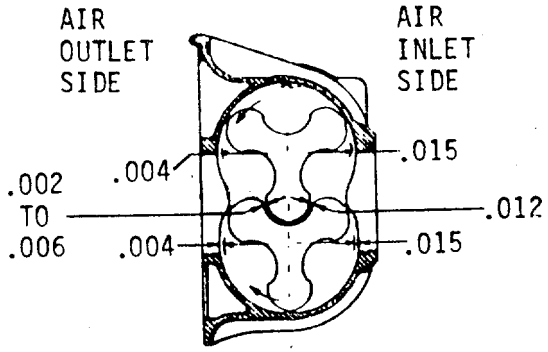


AIR OUTLET SIDE SHOWN



AIR INLET SIDE SHOWN

f. Time the rotors as follows: Time the rotors to have from .002 inch to .006 inch clearance between the TRAILING edge of the right- hand helix rotor and the LEADING edge of the left- hand helix rotor measured from both the inlet and outlet sides as shown above and below. If possible, keep this clearance to the minimum (.002 inch). Then, check the clearance between the LEADING edge of the right-hand helix rotor and the TRAILING edge of the left-hand helix rotor ("C" clearance) for the minimum clearance of (.012 inch). Rotor- to-rotor mesurements should be taken 1 inch from each end, and at the center of the blower.



5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

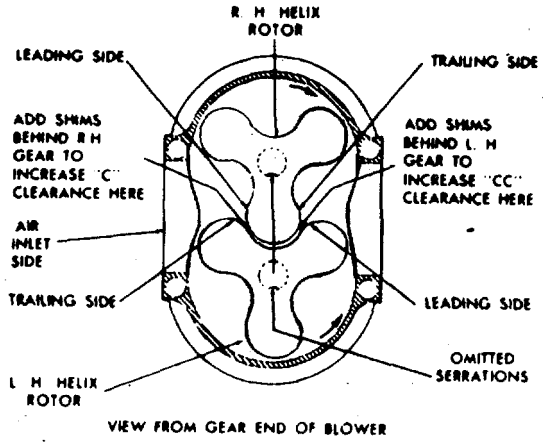
LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS (Cont)

NOTE

If the proper clearances cannot be obtained between the rotors, a mix of the former and current rotors, which have a different helix angle, may have occurred.

g. After determining the amount one rotor must be re- volved to obtain the proper clearance, add shims back of the proper gear as shown below to pro- duce the desired result. When more or less shims are required, both gears must be removed from the rotors. Placing a .003 inch shim in back of a rotor gear will revolve the rotor .001 inch.



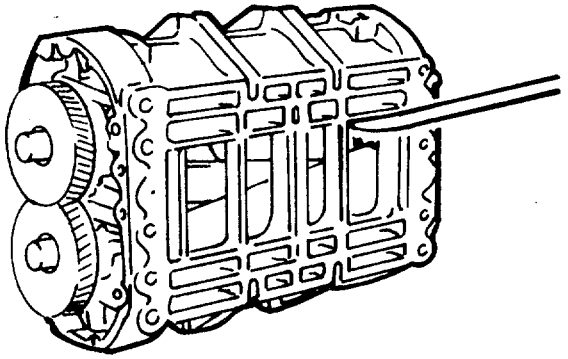
h. Install the required thickness of shims in back of the proper gear and next to the bearing inner race and reinstall both gears. Recheck the clearances between the rotor lobes.

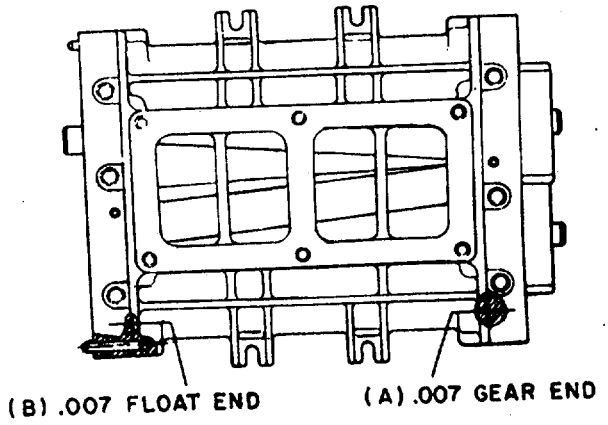
i. Determine the minimum clearances at points "A" and "B". Insert the feeler gages, between the end plates and the ends of the rotors. This operation must be performed at the ends of each lobe, making 12 measurements in all. See below for the mini- mum clearances.

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - TIMING BLOWER ROTORS (Cont)





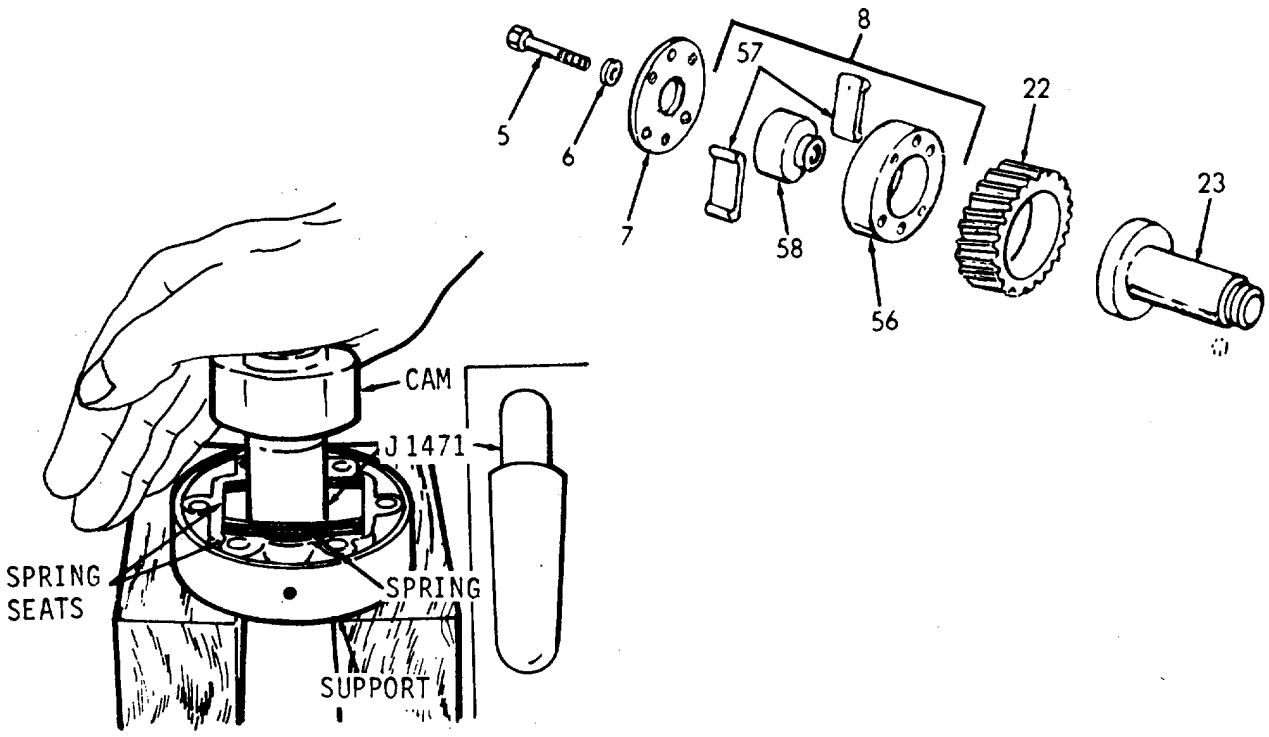
j. Check the clearance between each rotor lobe and the blower housing at both the inlet and outlet side-- 12 measurements in all. See above for the minimum clearances.

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY CONTINUED			
8. Rear blower coupling	a. Support (56), spring pack (57), anc coupling cam (58)	1. Place on two wooden blocks. 2. Apply a light coat of grease to the back of the spring seats. Place the half round spring seats in the grooves inside the support, and the flat spring seats inside the support at each end of the opening. 3. Lubricate the springs with light engine oil. Then, place the spring packs, consisting of 21 leaves per pack, into the support with the spring seats in position as shown. 4. Place the blower drive cam over the end of the installer J1471, with the large chamfered inside diameter end of the cam facing up. Insert the tapered end of the installer between the spring packs until the drive cam is centered between the spring packs. Remove the installer from the drive cam.	
	b. Blower assembly	Place the blower assembly on end on two wood blocks with the rotor gears up.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY CONTINUED (Cont)			
	c. Rear blower coupling (8), retainer (7), bolts (5), and lockwashers (6)	1. Place the blower coupling assembly and retainer on the right-hand helix gear, align the bolt holes and start the six bolts and lockwashers. 2. Tap the drive coupling cam with a plastic hammer to seat it on the rotor gear (22).	
	d. Gear (22), and hub (23)	Assemble.	



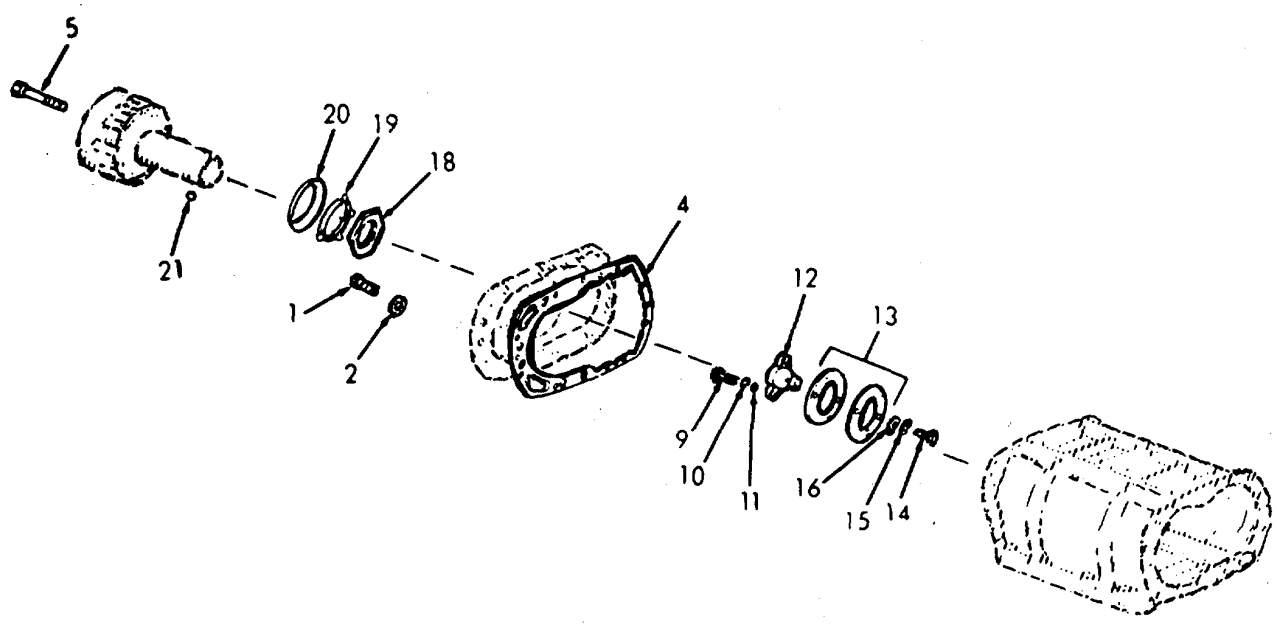
5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
OVERHAUL - ASSEMBLY CONTINUED (Cont)			
	e. Ball (21), thrust washer (20), lock-washer (19), and hub nut (18)	Install.	
9. Blower Hub	a. Screws (14), lockwashers (15), and flatwashers (16)	Install in hub (13).	
	b. Screws (9), lockwashers (10), and flatwashers (11)	Install gear hub (12) to hub (13).	
10. End Cover	a. Gasket (4) end cover (5)	Install.	
	b. Bolts (1), and lock-washers (2)	Install.	

5-35. BLOWER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

OVERHAUL - ASSEMBLY CONTINUED (Cont)



5-36. FUEL INJECTOR - MAINTENANCE INSTRUCTIONS.

For fuel injector maintenance, refer to paragraph 5-9.

5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Disassembly **b. Inspection** **c. Reassembly**

INITIAL SETUP:

Test Equipment
NONE

References
Para 3-75 Fresh Water Pump

Special Tools
Arbor press
Coupling and oil seal remover J 1930
Torque wrench

Equipment Condition
Condition Description
NONE

Material/Parts
Cleaning Fluid
Reconditioning Kit - P/N 5198307 or
Replacement Kit - P/N 5193605

Special Environmental Conditions
NONE

Personnel Required
1

General Safetv Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Fresh water pump (2)	a. Nuts (1), and lock-washers	Remove.	
	b. Pump cover (3), and gasket (4)	Remove.	Discard gasket.

5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

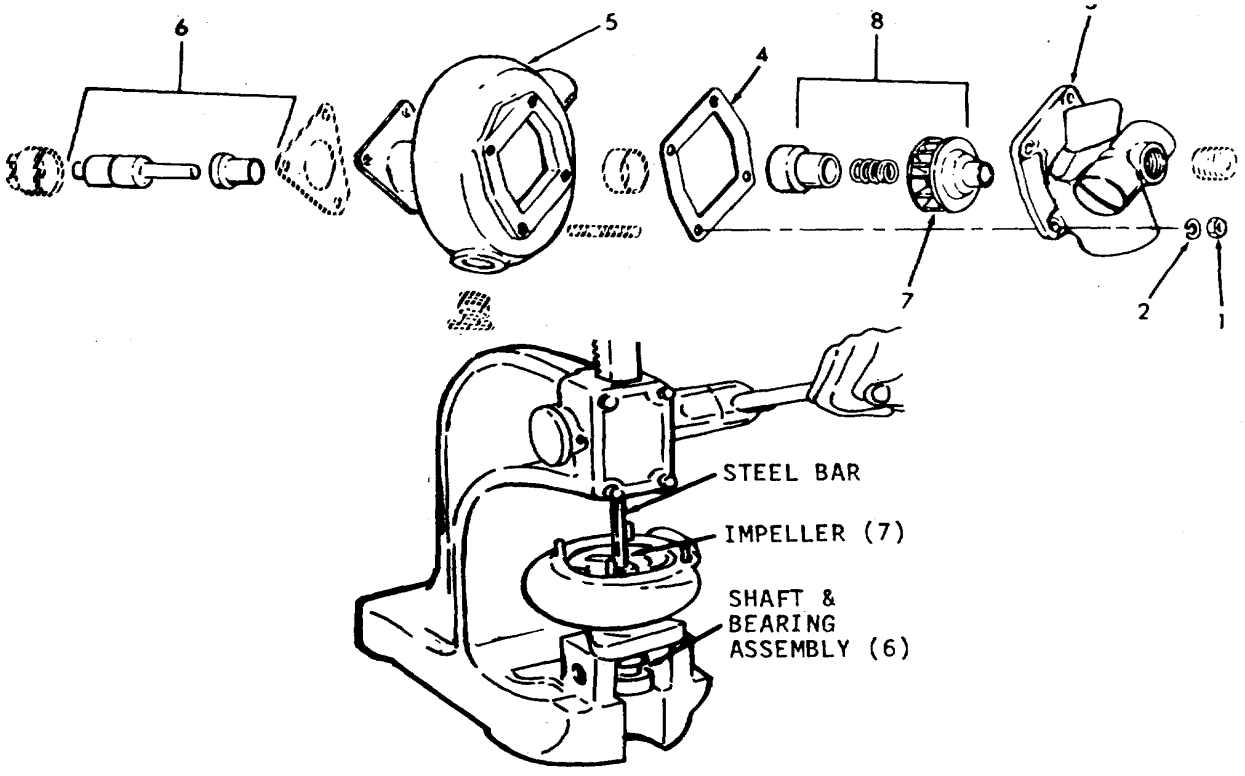
LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

NOTE

Clean the corrosion from around the impeller and shaft before separating the shaft and bearing as- sembly from the impeller, seal and water pump body.

c.	Pump body (5)	1. Support on mounting flange in an arbor press .	
		2. Place a short steel rod on the shaft.	
		3. Press out the shaft and bearing assembly (6) from the impeller (7) and seal assembly (8).	Discard shaft and bearing assembly



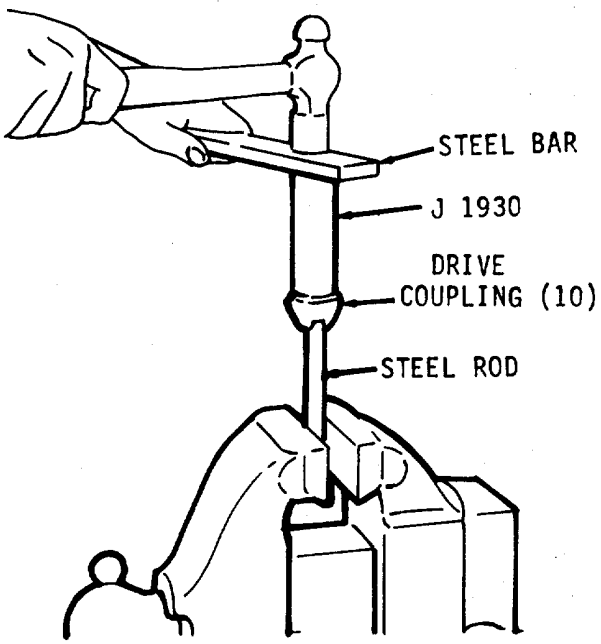
5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

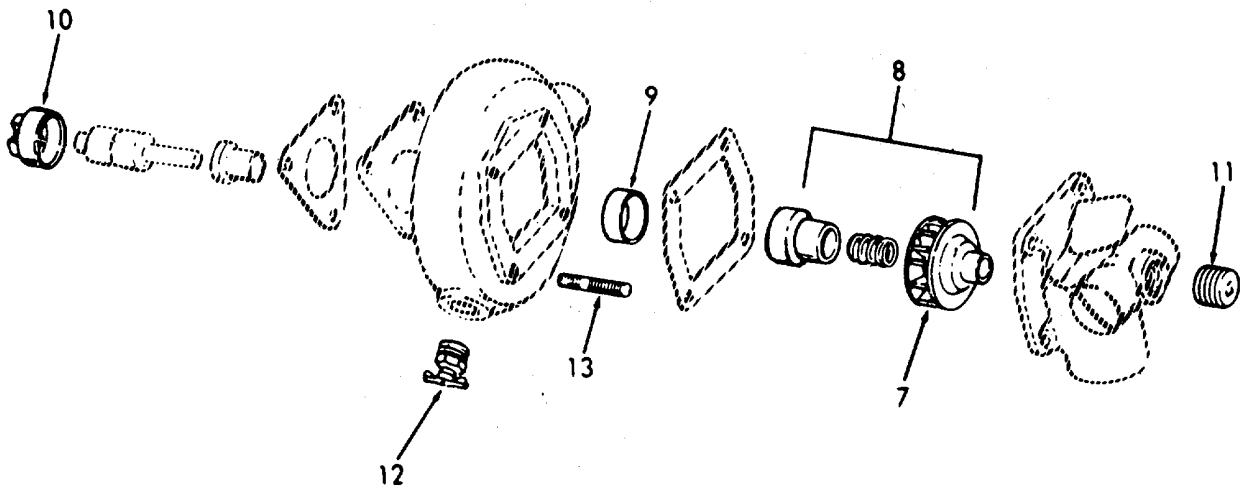
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Impeller (7), and seal assembly (8)	Remove from pump body.	a. Discard impeller if reconditioning pump. b. Discard seal assembly.
	e. Steel insert (9)	1. Inspect for scratches or excessive wear. 2. Tap or press it out.	Discard, if necessary.
		NOTE Perform the following step only if reconditioning the pump.	
	f. Pump drive coupling (thrower) (10)	1. Place steel rod in a vice. 2. Place drive coupling (10) on steel rod. 3. Using tool J1930 and a steel bar, remove coupling (10)	
	g. Pipe plug (11)	Remove.	If necessary.
	h. Drain cock (12)	Remove.	If necessary.
	i. Studs (13)	1. Remove. 2. Examine the studs in the pump body. If it is necessary to replace a stud, use a good grade of sealant on the threads and drive the stud in to 6-8 lb-ft (8.1-10.8 Nm) torque.	

5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)





5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION

2. a. Clean all of the parts except the shaft and bearing assembly. The sealed-type pump shaft bearing must not be immersed in a cleaning fluid since dirt may be washed in and the fluid cannot be entirely removed.

b. Revolve the pump shaft bearing slowly by hand. If rough spots are detected, replace the shaft and bearing assembly and the seal assembly. A seal replacement kit includes a shaft and bearing assem- bly, cover and mounting gaskets, packing and seal assembly.

c. Examine the impeller for wear, and replace it if necessary.

REASSEMBLY

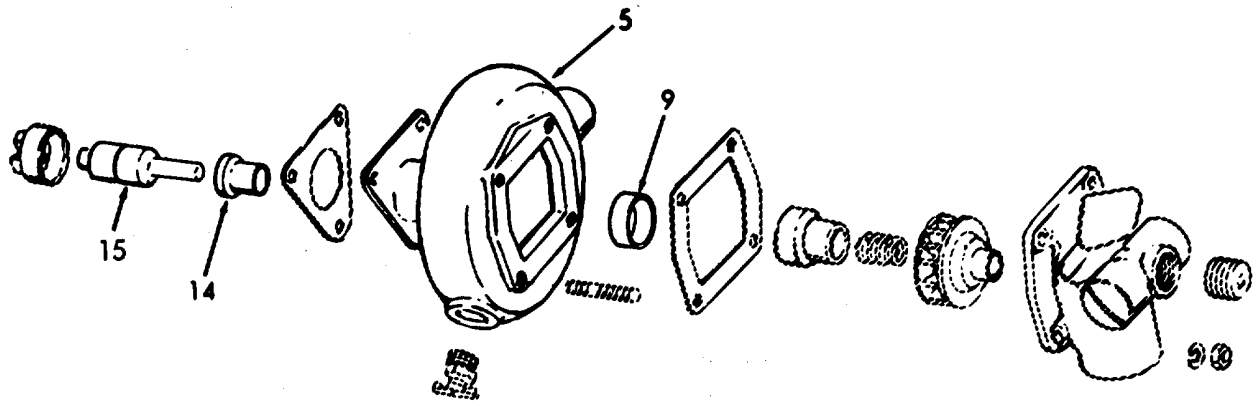
3. a. Steel insert (9) — If a new steel insert is to be used in the pump body, make sure the counter-bore in the pump body is thoroughly clean before installing a new insert. Dirt in the counterbore can cause mis-alignment between the insert and the carbon washer and result in a leak at this point. Start the counterbored end of the insert into the pump body. Then, press the insert in until it contacts the shoulder in the pump body. The insert has a .0015 inch - .0035 inch press fit in the pump body.

CAUTION

Do not mar the highly finished seal contact surface of the insert when pressing it into the pump body.

5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Slinger (14), and shaft (15)	Install the slinger on the pump shaft with the flange of the slinger approximately 3/16 inch from the end of the outer race of the bearing.	
	c. Pump body (5)	1. Support the impeller end of the pump body on an arbor press, and inset the coupling end of the new shaft and bearing assembly (9) into the pump body. 2. Press against the outer race of the bearing until the bearing contacts the shoulder in the pump body. 3. Stake the end of the pump body in three places to prevent the bearing from moving endwise.	

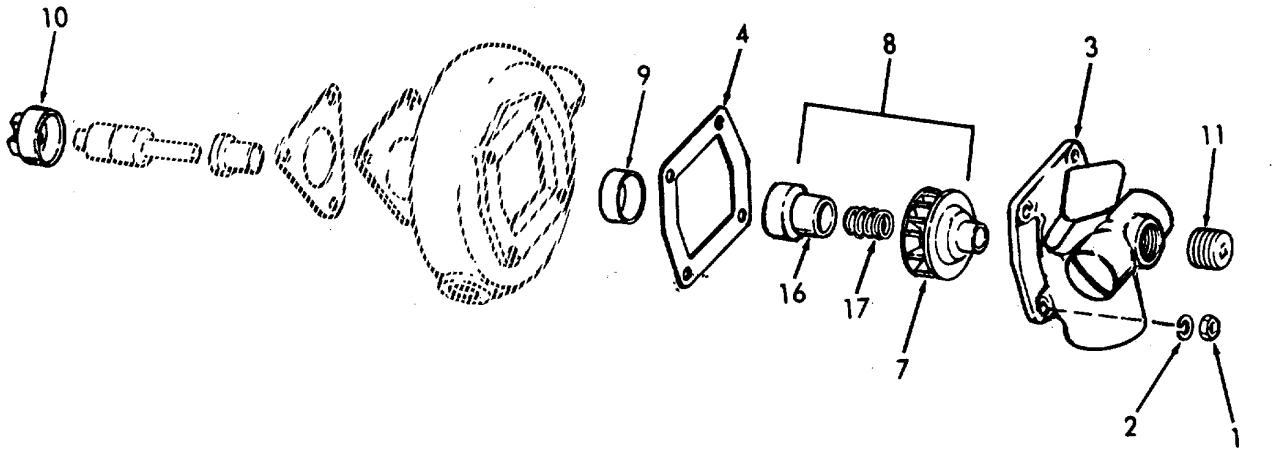


5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Seal assembly (8)	1. With the surface of the water pump seal clean and free from dirt and metallic particles, apply a thin coat of liquid soap on the inside diameter of the rubber carbon washer seal (16). Do not scratch or mar the surface of the carbon seal washer. 2. Slide the new seal assembly on the pump shaft until the carbon seal washer is seated firmly against the pump body insert. 3. Install the spring (17) with the small end toward the seal.	
	e. Impeller (7)	1. Support the bearing end of the shaft (not the drive coupling) on the bed of an arbor press. 2. Then press the impeller on 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.	
	f. Drive coupling (thrower) (10)	Support the impeller end of the pump shaft on a suitable arbor press and, press the coupling 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.	

5-37. FRESH WATER PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Pump assembly	Rotate the shaft by hand to be sure the rear face of the impeller blades do not rub the pump body.	
	h. Cover (3), and gasket (4)	Install.	Use a new gasket.
	i. Nuts (1), and lock-washers (2)	Install.	



5-38. WATER MANIFOLD - MAINTENANCE INSTRUCTIONS.

This task covers:

Welding

INITIAL SETUP:

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition / Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
1	Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS

WELDING

The only maintenance at this level is welding. Weld in accordance with existing procedures.

5-39. THERMOSTAT AND HOUSING - MAINTENANCE INSTRUCTIONS.

This task covers:

Welding

INITIAL SETUP:

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition** / **Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
1	Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS

WELDING

The only maintenance at this level is welding. Weld in accordance with existing procedures.

5-40. EXHAUST MANIFOLD - MAINTENANCE INSTRUCTIONS.

This task covers:

Welding

INITIAL SETUP:

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition** / **Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
1	Observe precautions when welding.

LOCATION	ITEM	ACTION	REMARKS

WELDING

The only maintenance at this level is welding. Weld in accordance with existing procedures.

5-41. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Installation**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Drift
Hammer
Acetylene torch

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe precautions when using acetylene torch.

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

1. Flywheel ring gear — Check whether or not the ring gear teeth are chamfered. The replacement gear must be installed so that the chamfer on the teeth facesthe same direction with relationship to the flywheel as on the gear that is to be removed. Then remove the ring gear as follows:

   a. Support the flywheel, crankshaft side down, on a solid flat surface or hardwood block which is slightly smaller than the inside diameter of the ring gear.

   b. Drive the ring gear off the flywheel with a suitable drift and hammer. Work around the circumference of the gear to avoid binding the gear on the flywheel.

5-41. FLYWHEEL AND HOUSING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION

2. Flywheel ring gear

a. Support the flywheel - ring gear side up - on a solid flat surface.

b. Rest ring gear on a flat, metal surface and heat the gear uniformly with an acetylene torch, keeping the torch moving around the gear to avoid hot spots.

CAUTION

Do not, under any circumstances, heat the gear over 400°F (204°C), as excessive heat may destroy the original heat treatment.

NOTE

Heat indicating "crayons", which are placed on the ring gear and melt at a predetermined temperature, may be obtained from most tool vendors. Use of these crayons" will ensure against over-heating the gear.

c. Use a pair of tongs to place the gear on the flywheel with the chamfer facing the same direction as on the gear just removed.

d. Tap the gear in place against the shoulder on the flywheel. If the gear cannot be tapped into place readily, remove it and apply additional heat, notingthe above caution.

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Disassembly **b. Inspection** **c. Reassembly**

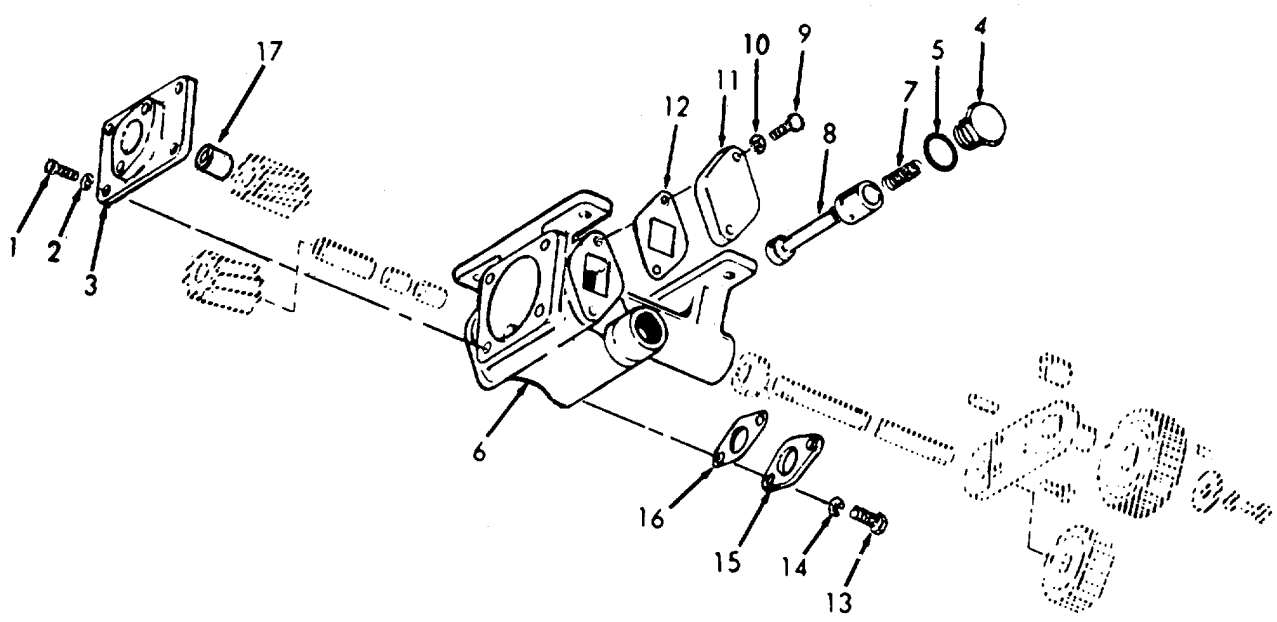
INITIAL SETUP:

Test Equipment	References
Micrometer Feeler ribbon	Para 3-94 Lube Oil Pump - Removal
Special Tools	**Equipment Condition** / **Condition Description**
Gear puller Arbor press	NONE
Material/Parts	**Special Environmental Conditions**
Overhaul kit P/N 5194800	NONE
Personnel Required	**General Safety Instructions**
1	Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Lube oil Pump	a. Screws (1), and lock-washers (2)	Remove.	
	b. Cover (3)	Remove.	
	c. Valve plug (4), and copper gasket (5)	Remove from both sides.	Discard gaskets.
	d. Pump body (6)	Jar body to loosen spring (7) and valve (8).	Discard spring.

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Screws (9), and lock-washers (10)	Remove.	
	f. Pad cover (11), and gasket (12)	Remove.	Discard gasket.
	g. Screws (13), and lockwashers (14)	Remove.	
	h. Pad cover (15), and gasket (16)	Remove.	Discard gasket.
	i. Bushing (17)	Remove from cover (3).	Discard.



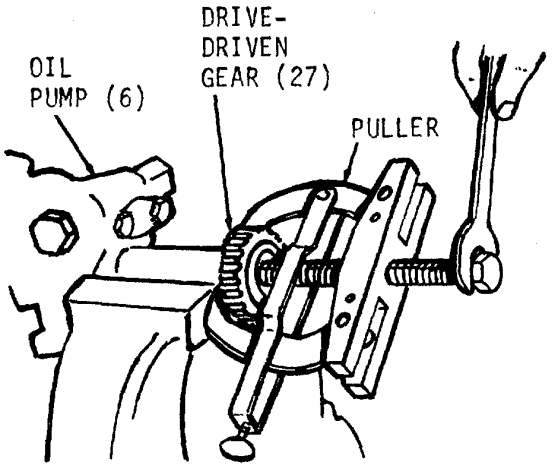
5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

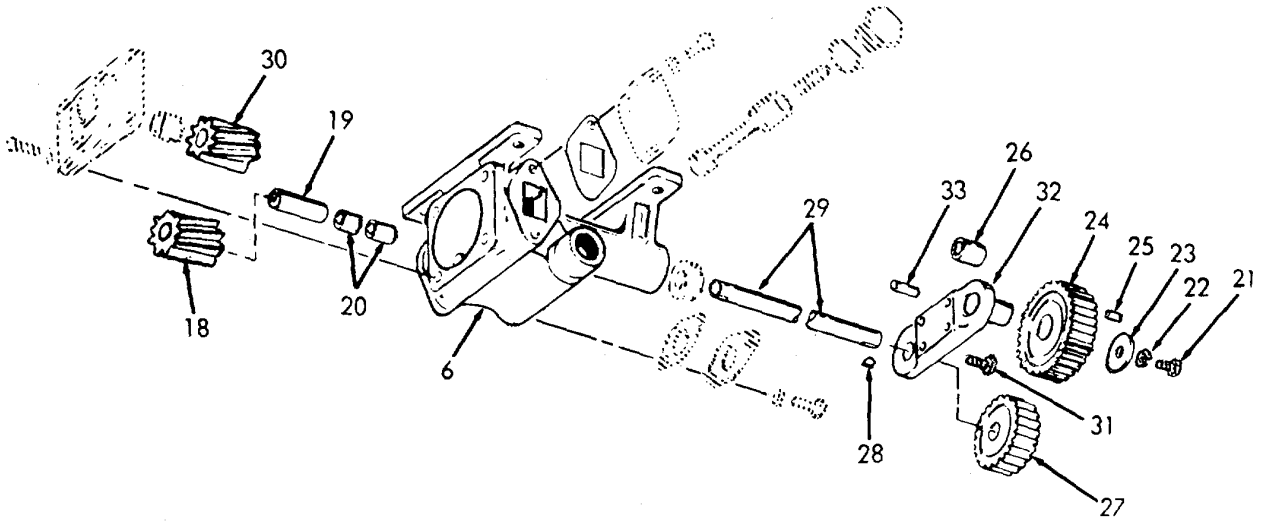
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	j. Driven gear (18)	Remove from shaft (19).	Discard, if damaged.
	k. Shaft (19), and bushings (20)	Remove.	Discard, if damaged.
	l. Screw (21), lockwasher (22), and idler gear washer (23)	Remove.	
	m. Idler gear (24)	Remove.	Discard, if damaged.
	n. Headless pin (25)	Remove.	If necessary.
	o. Bushing (26)	Remove.	Discard.
	p. Pump body (6)	1. Clamp in vice.	
		2 Pull drive-driven gear (27), and woodruff key (28), and shaft (29).	Use gear puller.
	q. Shaft (29), and drive gear (30)	Remove from body (6) as an assembly.	Refer to step "t" for disassembly.
	r. Screw (31), and idler gear support (32)	Remove.	
	s Dowel pin (33)	Remove.	

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

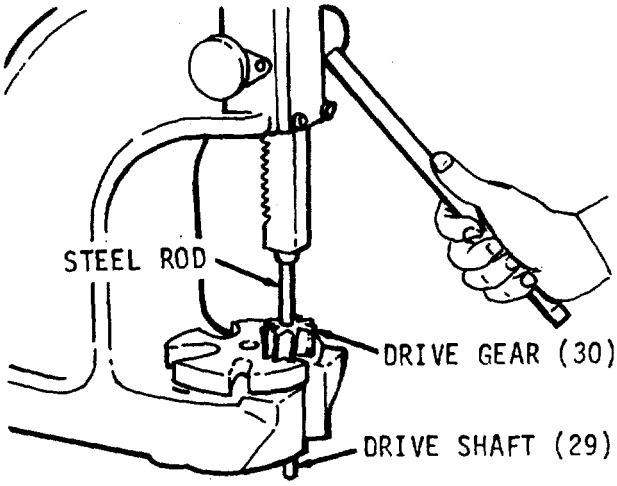
DISASSEMBLY (Cont)





5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

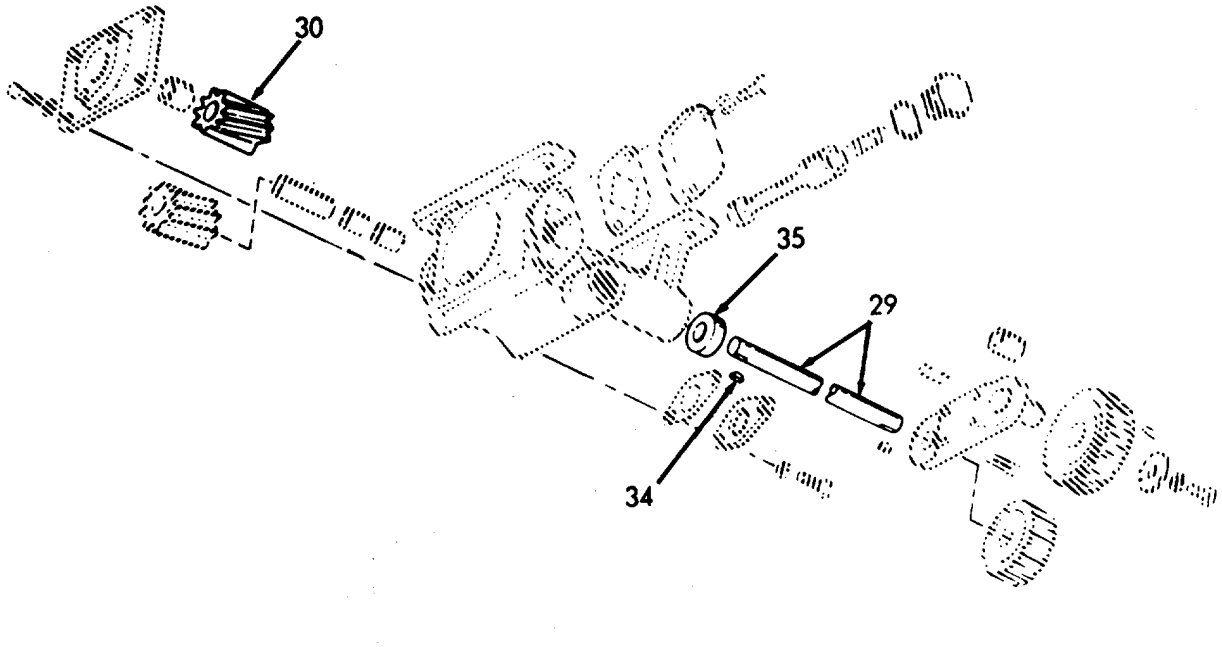
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	t. Drive gear (30), shaft (29), and woodruff key (34)	1. Position on bed of arbor press with long end of shaft extending down through slot in bed plate and with the face of the gear resting on the plate. 2. Place a short 1/2 inch round steel rod on end of the shaft. 3. Press the shaft from the gear.	The drive gear or the shaft are part of the overhaul kit.
	u. Bushings (35)	Remove.	Discard.



5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



5-609

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION

WARNING

Wear eye goggles for protection when using compressed air.

2. a. Wash all parts in clean fuel oil and dry them with compressed air.

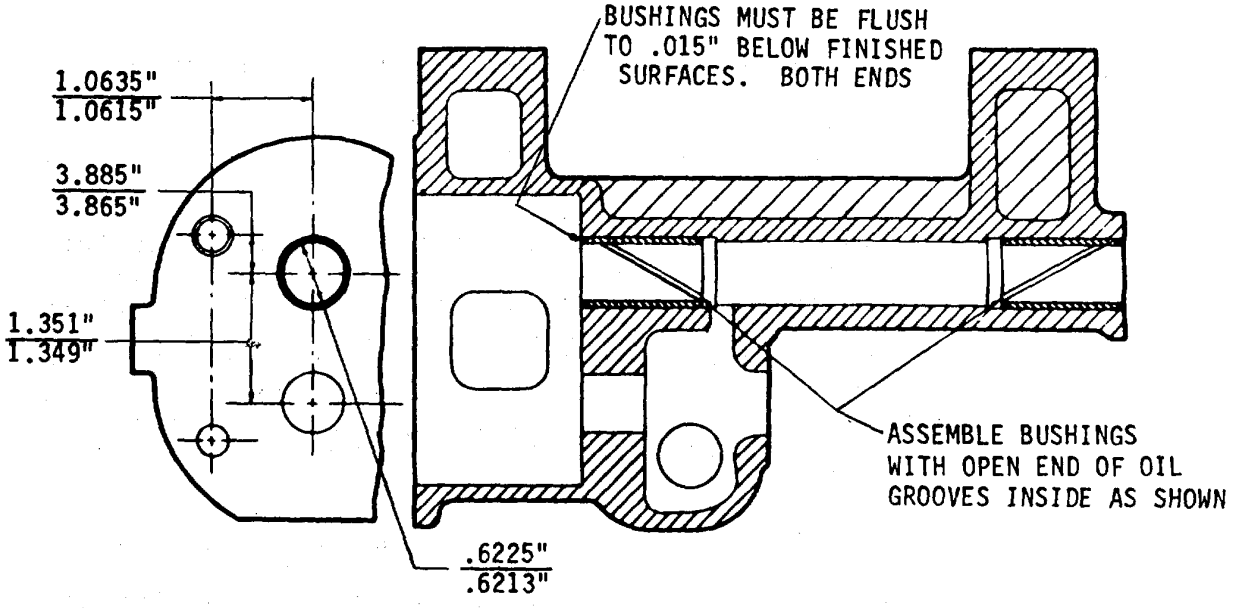
b. Examine the gear cavity in the pump body and the drive shaft bushings. If the driven gear bushings are worn, replace the bushings. Service replacement bushings in the driven gears must be reamed after assembly. Bushings used with the .499 inch diameter driven gear shaft must be reamed to .500 inch ± .0005 inch and bushings used with the .623 inch diameter shaft must be reamed to .625 inch ± .0005 inch.

c. Inspect the bushings in the pump body and cover. If the bushings are worn excessively, replace the pump and cover assemblies unless suitable boring equipment is available for finishing the new bushings. When installing new bushings, replace all of the bushings. The bushings must be located and positioned as shown. Also, the gear bore and the bushing bore in both the pump body and cover must be concentric within .001 inch. The shaft- to-pump body-bushing clearance with new parts is .0008 inch to .0025 inch. The shaft-to-pump cover bushing clearance with new parts is .0010 inch to .0027 inch.

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



d. In an efficient oil pump, the gears should have a free-running fit (with no perceptible looseness) in the pump housing. If the gear teeth are scored or worn, install new gears. The use of excessively worn gears will result in low engine oil pressure which in turn, may lead to serious damage throughout the engine.

e. Inspect the pressure relief valve and its seat in the pump body. If necessary, install new parts.

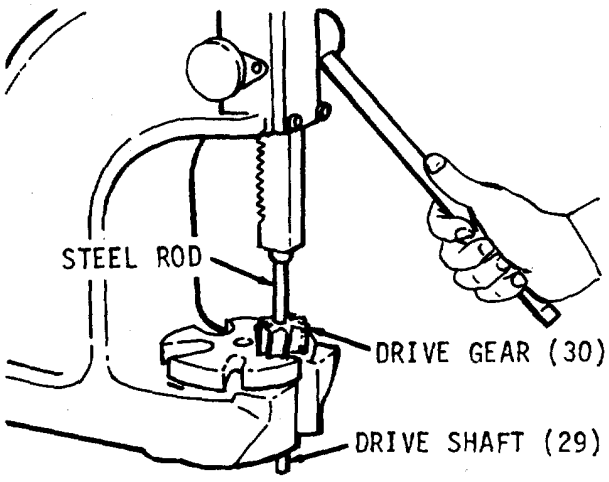
5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

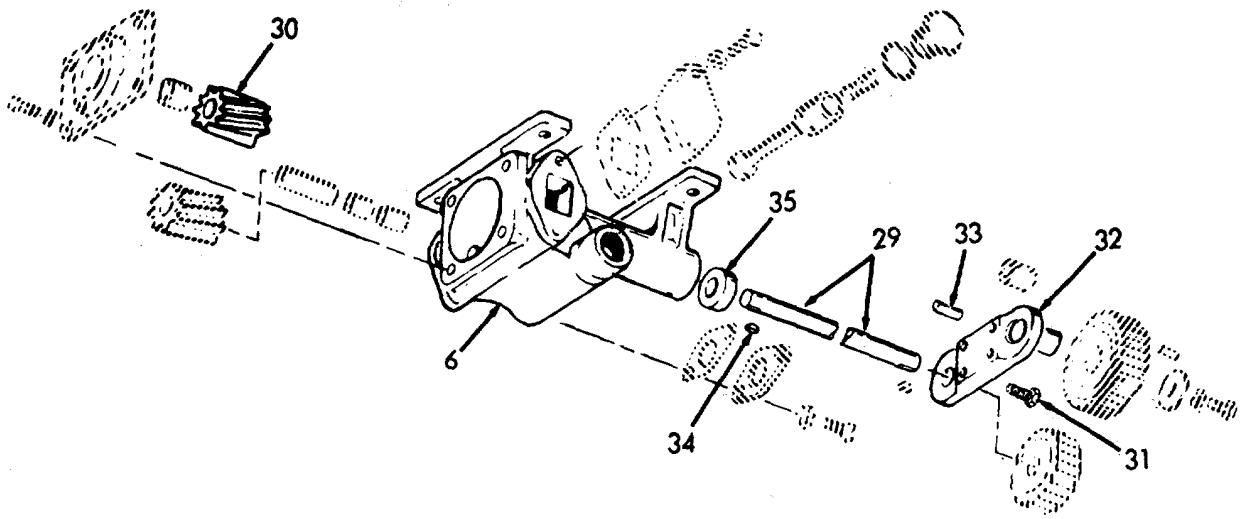
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Bushings (35)	Press into body (6).	Use new bushing, if removed previously.
	b. Drive gear (30), shaft (29), and woodruff key (34)	1. Insert key in shaft.	Use new gear and shaft, if removed previously.
		2. Apply a light coat of engine oil to the shaft.	
		3. Start the shaft squarely into the bore of the gear.	Use an arbor press.
		4. Press shaft into gear.	
		5. The gear must be 6-15/16 inches from the keyway end of the shaft.	
	c. Dowel pin (33)	Install.	
	d. Idler gear support (32), and screw (31)	Install.	
	e. Drive gear (30), and shaft (29) assembly	Install in body.	

5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



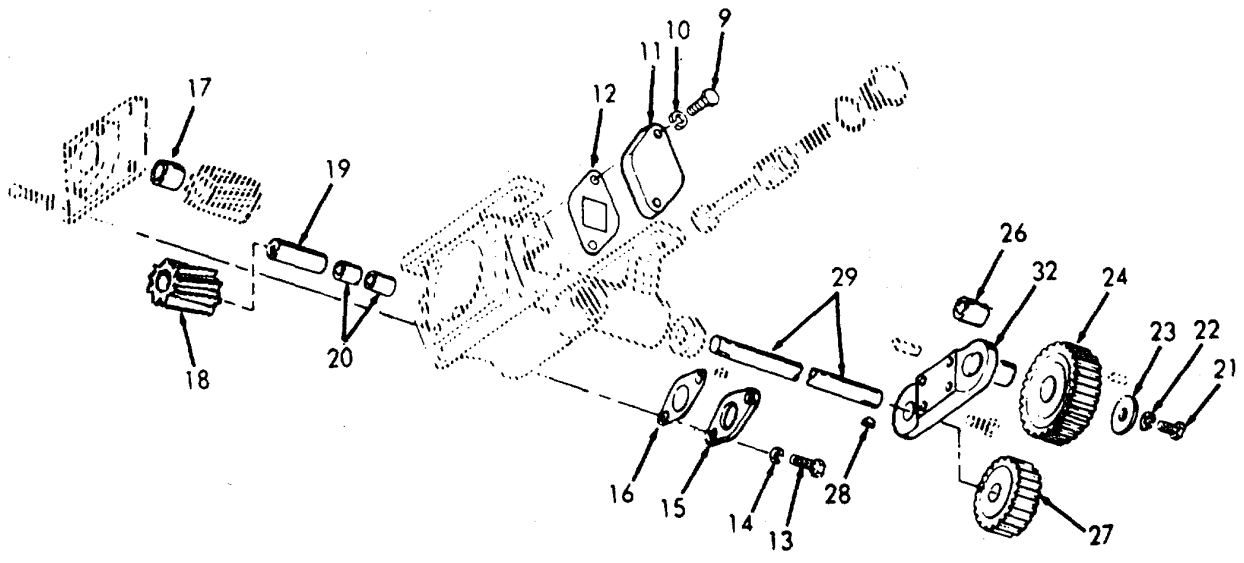


5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	f. Shaft (29), woodruff key (28), and drive-driven gear (27)	1. Position gear no the end of the shaft with the extended hub side up away from the body.	Use new shaft and gear, if previously replaced.
		2. Insert a .005 feeler ribbon between the gear and the body.	
		3. Press the gear on the shaft until the clearance is .005 between the body and the gear.	
	g. Bushings (26)	Install.	Use a new bushing.
	h. Idler gear (24)	1. Lubricate with engine oil.	Use a new gear, if replaced
		2. Install with flat side facing the support (32).	
	i. Idler gear washer (23), lockwasher (22), and screw (21)	1. Rotate washer and lockwasher so that the slot in each washer engages the headless pin.	
		2. Install.	
	j. Bushings (20), and shaft (19)	Install.	Use new bushing and shaft, if necessary.
	k. Driven gear (18)	Install.	Use a new gear, if replaced.
	l. Bushing (17)	Install.	Use a new bushing.

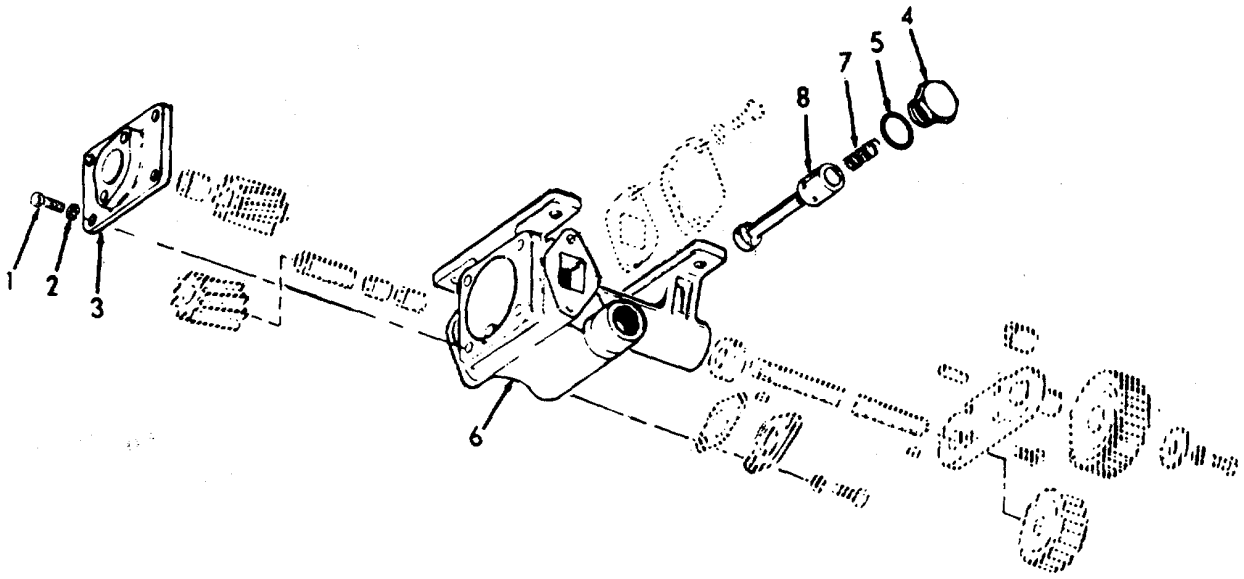
5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	m. Pad cover (15), and gasket (16)	Install.	Use a new gasket.
	n. Screws (13), and lockwashers (14)	Install.	
	o. Pad cover (11), and gasket (12)	Install.	Use a new gasket.
	p. Screws (9), and lock-washers (10)	Install.	



5-42. LUBE OIL PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	q. Valve plug (4), and copper gasket (5)	Install in body on side opposite the inlet opening.	Use a new gasket.
	r. Valve (8), and spring (7)	1. Place in body (6). gasket. 2. Install second valve plug (4), and copper gasket (5).	Use a new
	s. Cover (3), screws (1), and lockwashers (2)	Install.	
	t. Pump	1. The oil pump must trun freely after assembly. 2. Any bind in the pump must be removed prior to installation.	



5-43. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Repair
b. Cleaning
c. Pressure Test
d. Inspect

INITIAL SETUP:

Test Equipment

Feeler gage
Straight edge
Depth gage

References

Chapter 3 (volume 4) - Removal of all parts
Chapter 5 - Removal of all parts

Special Tools

Drift 3/4 inch
Hammer, 1 pound
Hone
120 grit hones

Equipment Condition: NONE

Material/Parts

Pickling Acid
Alkaline Solution (Heavy duty)
Permatex International Compound #2 or equivalent
Rust Preventive

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe all WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
1. Cylinder block	All components	Remove.	Refer to Chapter 3 and 5.

5-43. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING

2. a. Scrape all gasket material from the cylinder block. Then remove all oil gallery plugs and core hole plugs (except cup plugs) to allow the cleaning solution to contact the inside of the oil and water passages. This permits more efficient cleaning and eliminates the possibility of the cleaning solution attacking the aluminum core hole plug gaskets (if used).

b. If a core hole plug is difficult to remove, hold a 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. To remove the special plugs in the water-below-port cylinder block:

c. Clean the cylinder block as follows:

(1) Remove the grease by agitating the cylinder block in a hot bath of commercial heavy-duty alkaline solution.

(2) Wash the block in hot water or steam clean it to remove the alkaline solution.

(3) If the water jackets are heavily scaled, proceed as follows:

(a) Agitate the block in a bath of inhibited commercial pickling acid.

(b) Allow the block to remain in the acid bath until the bubbling stops (approximately 30 minutes).

(c) Lift the block, drain it and re-immerse it in the same acid solution for 10 minutes.

(d) Repeat Step (c) until all scale is removed.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING (Cont.)

(e) Rinse the block in clear hot water to remove the acid solution.

(f) Neutralize the acid that may cling to the casting by immersing the block in an alkaline bath.

(g) Wash the block in clean water or steam clean it.

WARNING

Wear eye protective when using compressed air.

(4) Dry the cylinder block with compressed air.

(5) Make certain that all water passages, oil galleries and air box drain openings have been thoroughly cleaned.

NOTE

The above cleaning procedure may be used on all ordinary cast iron and steel parts of the engine. Mention will be made of special cleaning procedures whenever necessary.

(6) After the block has been cleaned and dried, coat the threads of the plugs with sealant and, using new gaskets, reinstall the core hole plugs. Tighten the 1-3/4 inch - 16 plugs to 150-180 lb- ft (203.4-244.0Nm) torque and the 2-1/2 inch-16 plugs to 230-270 lb-ft (311.8-366.1Nm) torque .

CAUTION

Excessive torque applied to the core hole plugs may result in cracks in the water jacket.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

PRESSURE TEST

3. After the cylinder block has been cleaned, it must be pressure tested for cracks or leaks by either one of two methods.

(a) This method may be used when a large enough water tank is available and the cylinder block is completely stripped of all parts.

(1) Seal off the water inlet and outlet holes air tight. This can be done by using steel plates and suitable rubber gaskets held in place by bolts. Drill and tap one cover plate to provide a connection for an air line.

(2) Immerse the block for twenty minutes in a tank of water heated to 180° -200° F (82.2-93.3º C.).

(3) Apply 40 psi (275.8 kPa) air pressure to the water jacket and observe the water in the tank for bubbles which indicate the presence of cracks or leaks in the block. A cracked cylinder block must be replaced by a new block.

WARNING

Wear protective eye goggles when using compressed air.

(4) After the pressure test is completed, remove the block from the water tank. Then remove the plates and gaskets and dry the block with com- pressed air.

b. This method may be used when a large tank is unavailable, or when it is desired to check the block for cracks without removing the engine from the equipment which it powers. However, it is necessary to remove the cylinder heads, blower, oil cooler, air box covers and oil pan.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

PRESSURE TEST (Cont.)

(1) Attach sealing plates and gaskets as in method "a". Before attaching the last sealing plate, fill the water jacket with a mixture of water and one gallon of antifreeze. The antifreeze will penetrate small cracks and its color will aid in detecting their presence.

(2) Install the remaining sealing plate and tighten it securely.

(3) Apply 40 psi (275.8 kPa) air pressure to the water jacket and maintain this pressure for at least two hours to give the water and anti- freeze mixture ample time to work its way through any cracks which may exist.

(4) At the end of the test period, examine the cylinder bores, air box, oil passages, crank- case and exterior of the block for presence of the water and antifreeze mixture which will indicate the presence of cracks. A cracked cylinder block must be replaced by a new block.

(5) After the test is completed, remove the plates, drain the water jacket and blow out all of the passages in the block with compressed air.

INSPECT

4. a. After cleaning and pressure testing, inspect the cylinder block.

b. Since most of the engine cooling is accomplished by heat transfer through the cylinder liners to the water jacket, a good liner-to-block contact must exist when the engine is operating. Whenever the cylinder liners are removed from an engine, the block bores must be inspected.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

NOTE

Before attempting to check the block bores, hone them throughout their entire length until about 75% of the area above the ports has been cleaned-up.

c. Hone the block bores as follows:

(1) Use a hone in which the cutting radius of the stones can be set in a fixed position to remove irregularities in the bore rather than following the irregularities as with a spring-loaded hone. Clean the stones frequently with a wire brush to prevent stone loading. Follow the hone manufacturer' s instructionsregarding the use of oil or kerosene on the stones. Do not use such cutting agents with a dry hone. Use 120 grit stones.

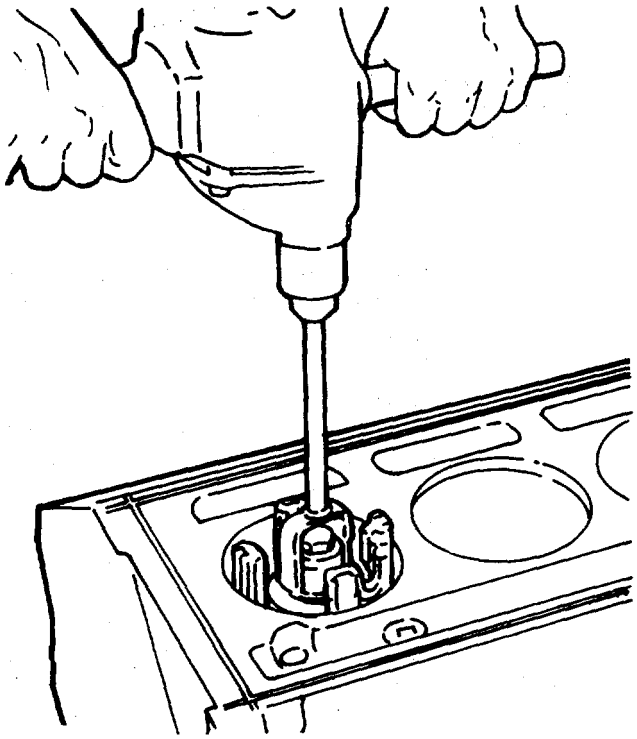
(2) Insert the hone in the bore and adjust the stones snugly to the narrowest section. When correctly adjusted, the hone will not shake in the bore, but will drag freely up and down the bore when the hone is not running.

(3) Start the hone and '"feel out" the bore for high spots which will cause an increased drag on the stones. Move the hone up and down the bore with short, overlapping strokes about 1 inch (2.54 cm) long. Concentrate on the high spots in the first cut. As these are removed, the drag on the hone will become lighter and smoother. Do not hone as long at the air inlet port area as in the rest of the bore because this area, as a rule, cuts away more rapidly. Feed lightly to avoid an excessive increase in the bore diameter. Some stones cut rapidly even under low tension.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)



(4) When the bore is fairly clean, remove the hone, inspect the stones, and measure the bore. Determine which spots must be honed most. Moving the hone from the top to the bottom of the bore will not correct an out-of-round condition. To remain in one spot too long will cause the bore to become irregular. Where and how much to hone can be judged by feel. A heavy cut in a distorted bore produces a steady drag on the hone and makes it difficult to feel the high spots. Therefore, use a light cut with frequent stone adjustments.

(5) Wash the cylinder block thoroughly after the honing operation is completed.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

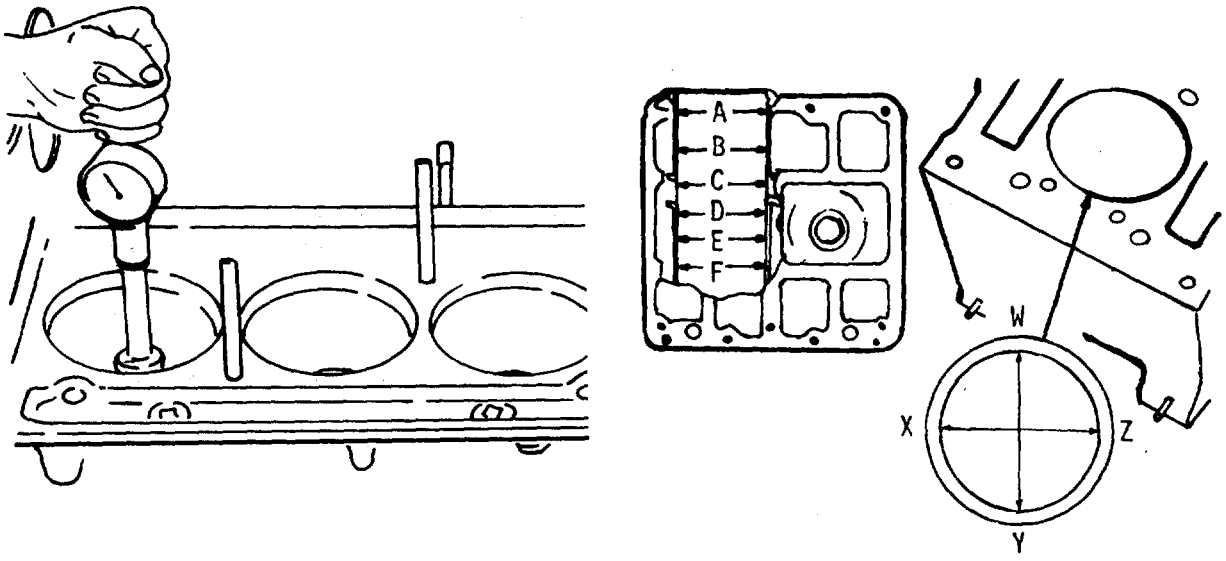
INSPECT (Cont.)

d. Check the cylinder block bores:

(1) Visually check the contact area as revealed by the honed surface. There must not be any low spots which are larger in area than a half dollar.

(2) Measure the entire bore of each cylinder with cylinder bore gage J5347 which has a dial indi- cator calibrated in .0001 inch increments. The standard block bore is 4.6260 inch to 4.6270 inch.

(3) First, place the bore gage in the master ring gage J8386-01 which has an I.D. of 4.6270 inch and set the dial to zero. Next, rotate the dial clockwise .0005 inch to give a zero dial indicator setting of 4.6265 inch. Take measurements on the cleaned-up surface only at positions A, B, C, D, E, and F in-the bore on axes 45° apart. Read the measurements from the zero mark on the gage.

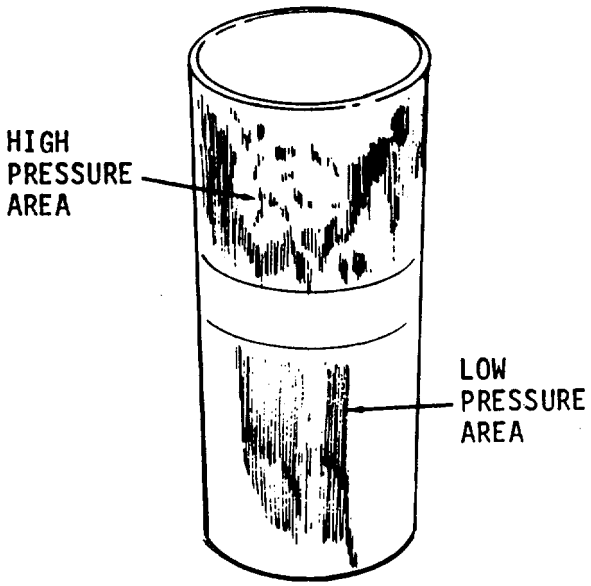


5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

(4) The cylinder liner is alternately expanding and contracting during engine operation, due to temperature variations. This may result in irregularities in the block bores (out-of-round and taper), the effects of which will be seen as high pressure areas on the outside of the cylinder liner.



(5) If a new liner and piston is installed in the block without properly fitting the liner, galling and seizing of the piston may result. This is caused by the new piston having to travel over the irregularities without time to conform to the particular shape of the block bore.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

e. Fit the liner to the cylinder block: The liner-to-block clearance with new parts is zero to .002 inch. With used parts, the maximum liner- to-block clearance is .0025 inch. Examine the block bore measurements to determine if standard or .001 inch oversize O.D. liners can be used, or if the cylinder block should be bored oversize. A light push fit between the liner and the block is desirable. However, a good fit between the cylinder liner and block may be obtained by comparing the average bore sizes in Table below.

For Average Block Bore I.D. Size of	Use Liner O.D. Size	To Give A Liner-to-Block Clearance of
4.6260 inches 4.6275 inches	Standard	.000 inch to .0025 inch
4.6270 inches 4.6285 inches	.001 inch Oversize	.000 inch to .0025 inch

f. If necessary, bore the cylinder block as follows: (1) Each bore in a used block must not be out-of- round or tapered more than .002 inch. If the average block bore is over 4.6285 inches, the block should be bored oversize as shown below.

Block Boring Dimensions	Liner O.D. Size	Maximum Block Bore I.D. on a Used Block
4.631 inches 4.632 inches	.005 inch Oversize	4.6325 inches
4.636 inches 4.637 inches	.010 inch Oversize	4.6375 inches
4.646 inches 4.647 inches	.020 inch Oversize	4.6475 inches
4.656 inches 4.657 inches	.030 inch Oversize	4.6575 inches

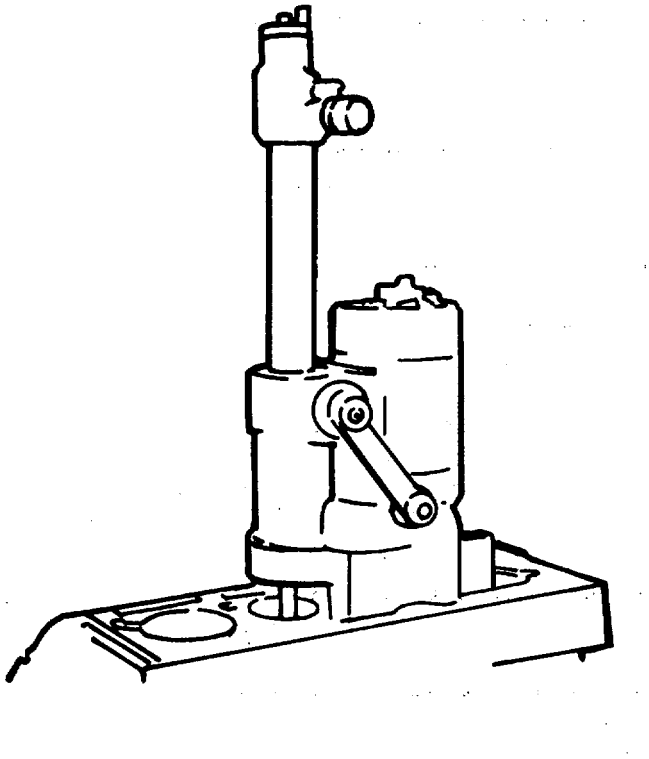
5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

(2) A typical commercially available portable boring bar is illustrated below. Instructions on correct use of the boring bar are provided by the manufacturer.

(3) After boring the block for an oversize cylinder liner, check the bore finish to be sure it is smooth (120 RMS). Heat transfer from the cylinder liner to the block will be adversely affected if the block isn't smooth.



(4) Wash the block thoroughly after the boring operation.

(5) When an oversize liner is used, stamp the size of the liner on the top deck of the block adjacent to the liner counterbore. An oversize liner insert must be installed whenever an oversize liner is used.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

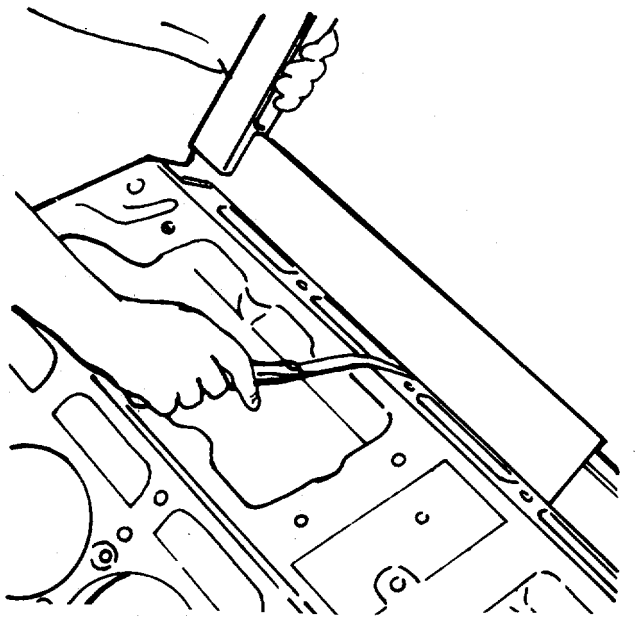
LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

g. Check the top; of the block (cylinder head contact surfaces) for flatness with an accurate straight edge and a feeler gage.

(1) The top surface of the block must not vary more than .003 inch transversely and not over .006 inch, .007 inch or .009 inch longitudinally on the 3, 4 and 6 cylinder blocks respectively. It will be difficult to prevent water, oil, and compression leaks if the top surface of the block exceeds these tolerances.

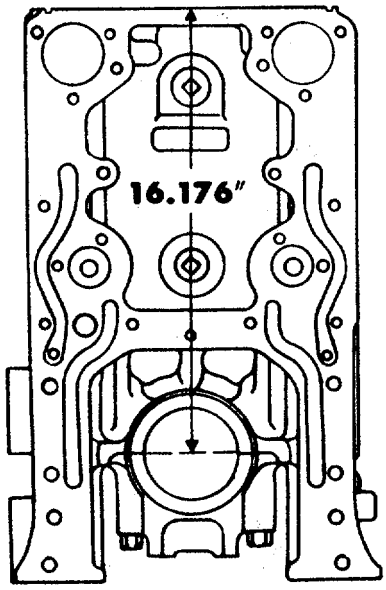
(2) If it is necessary to machine these surfaces to correct for the above conditions, do not remove more than .008 inch of metal. Stamp the amount of stock removed on the face of the block. The distance from the centerline of the crankshaft to the top of the cylinder head surface of the block must not be less than 16.176 inches.



5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)



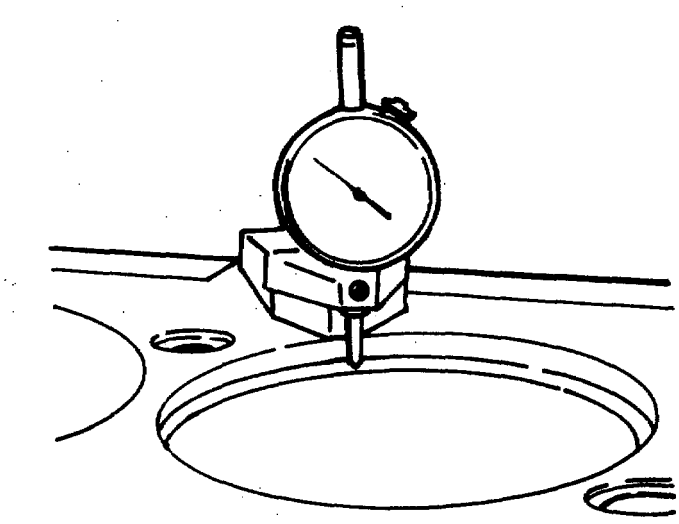
(3) If stock is removed from the cylinder head contact surfaces of the block, check the depth of the seal ring grooves and counterbores. The cylinder head seal strip grooves must be .092 inch-.107 inch deep. The large water hole counterbores (between the cylinders) must be .109 inches-.120 inches deep; and the combination water and oil hole counterbores and small waterhole counterbores must be .087 inches-.098 inches deep. If necessary, deepen the grooves or counterbores to the specified limits to retain the proper "crush" on the seal rings. It is not necessary to deepen the counterbores for the cylinder liners since .004 inch and .008 inch under- size thickness inserts are available for adjusting the liner position as outlined in Chapter 3, paragraph 3-98, under Fitting Cylinder Liner in Block Bore.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

h. Make sure the cylinder liner counterbores in the block are clean and free of dirt. Then check the depth. The depth must be .4770 inch to .4795 inch and must not vary more than .0015 inch throughout the entire circumference. Thecounterbored surfaces must be smooth and square with the cylinder bore within .001 inch total indicator reading. There must not be over .001 inch difference between any two adjacent cylinder counterbores when measured along the cylinder longitudinal center- line of the cylinder block.



i. Check the main bearing bores as follows:

(1) Check the bore diameters with the main bearing caps in their original positions. Lubricate the bolt threads and bolt head contact areas with a small quantity of International Compound No. 2, or equivalent. Then install and tighten the bolts to 165-175 lb-ft (223.7-237.3 Nm) torque. When making this check, do not install the main bearing cap stabilizers. The specified bore diameter is 4.812 inch to 4.813 inch. If the bores do not fall within these limits, the cylinder block must be rejected.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont)

CAUTION

Main bearing cap bolts are especially designed for this purpose and must not be replaced by ordinary bolts.

NOTE

Bearing caps are numbered to correspond with their respective positions in the cylinder block. It is imperative that the bearing caps are reinstalled in their original positions to maintain the main bearing bore alignment. The number of the front main bearing cap is also stamped on the face of the oil pan mounting flange of the cylinder block, adjacent to its permanent location in the engine as established at the time of manufacture. The No. 1 main bearing cap is always located at the end opposite the flywheel end of the cylinder block.

(2) Finished and unfinished main bearing caps are available for replacing broken or damaged caps. When fitting a finished replacement bearing cap, it may be necessary to try several caps before one will be found to provide the correct bore diameter and bore alignment. If a replacement bearing cap is installed, be sure to stamp the correct bearing position number onthe cap.

NOTE

Use the unfinished bearing caps for the front and intermediate bearing positions. The finished bearing caps, machined for the crankshaft thrust washers, are to be used in the rear bearing position.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

(3) Main bearing bores are line-bored with the bearing caps in place and thus are in longitudinal alignment. Bearing bores may be considered properlyaligned with one another if the crankshaft can be rotated freely by hand after new bearing shells have been installed and lubricated and the bearing caps have been secured in place and the bolts tightened to 180-190 lb-ft (244.0- 257.6 Nm) torque. If a main bearing bore is more than .001 inch out of alignment, the block must be line-bored or scrapped. Misalignment may be caused by a broken crankshaft, excessive heat or other damage.

(4) If the main bearing bores are not in alignment or a replacement bearing cap is used, the block must be line-bored. Install the bearing caps in their original positions (without the bearing cap stabilizers) and tighten the bolts to 165-175 lb-ft (223.7-237.3 Nm) torque. Line-bore the block, but do not remove more than .001 inch stock. After boring, all bores must be within the specified limits 3.812 inch to 3.813 inch.

j. Replace loose or damaged dowel pins. The dowels at the ends of. the cylinder block must extend .630 inch from cylinder blocks. The dowels used to retain the crankshaft thrust washers on the rear main bearing cap must extend .110 inch to 120 inch from the surface of the bearing cap.

k. If used, replace damaged or broken cylinder head studs. Drive new studs to a height of 4 3/8 inch $\pm$ 1/32 inch above the block at a minimum of 75 lb-ft (101.7 Nm) torque. Also, examine the cylinder head retaining bolt holes. If the threads are damaged, use a tap to "clean-up" the threads or install an helical threadinsert.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)

l. The tapped holes in the cylinder blocks may be tapped with a 5/8 inch-11 UNC3B thread tap. The stud holes and unplugged bolt holes must have the thread extending 1.84 inches below the block surface.

m. Check the remaining cylinder block surfaces and threaded holes. Check all of the mating surfaces, or mounting pads, for flatness, nicks andburrs. Clean-up damaged threads in tapped holes with a tap or install helical thread inserts if necessary.

n. After inspection, if the cylinder block is not to be used immediately, spray the machined surfaces with engine oil. If the block is to be stored for an extended period of time, spray or dip it in a polar-type rust preventive such as Valvoline Oil Company's "Tectyl 502-C", or equivalent. Castings free of grease or oil will rust when exposed to the atmosphere.

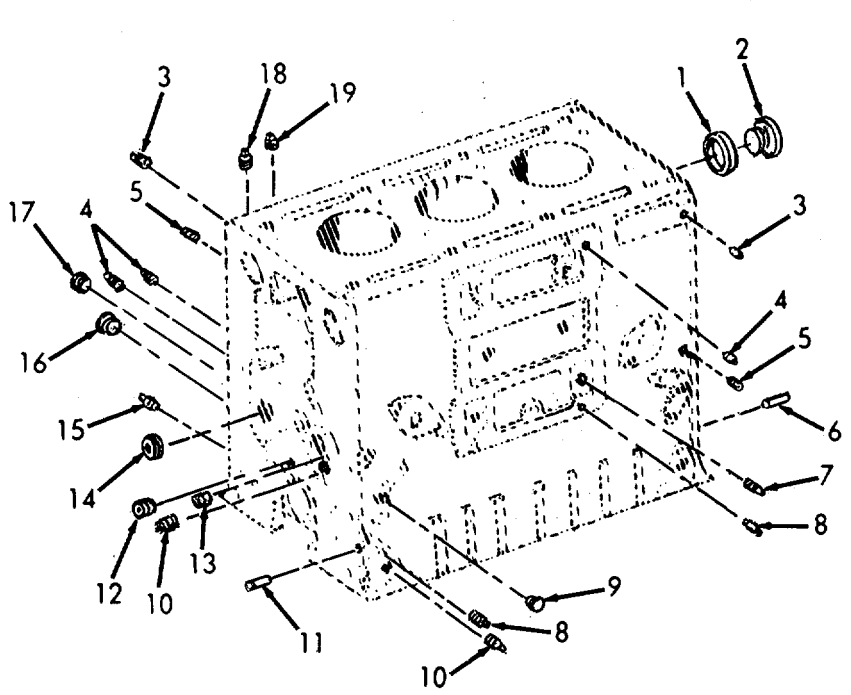
NOTE

Before a reconditioned or new service replacement cylinder block is used, steam clean it to remove the rust preventive and blow out the oil galleries with compressed air.

5-43. CYLINDER BLOCK-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECT (Cont.)



1. Gasket 1 3/4-16 plug
2. Plug
3. Pipe plug 1/8 steel
4. Plug 0.346 diameter x 7/32 long
5. Headless pipe plug
6. Dowel pin
7. Pipe plug 3/8 steel
8. Pipe plug
9. Plug cup 5/8
10. Pipe plug headless 1/2-14 NPTF
11. Dowel pin
12. Plug special 1/4 x 5/16
13. Plug cup
14. Pipe plug
15. Pipe plug 3/4 steel
16. Plug cup
17. Plug cup
18. Special plug
19. Pipe plug headless 3/8 - 18 NPTF

5-44. 24 VOLT RECTIFIER-MAINTENANCE INSTRUCTIONS

This task covers:

Repair

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

1

References

Para 3-108 24 VDC Rectifier

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe all WARNINGS in procedure.

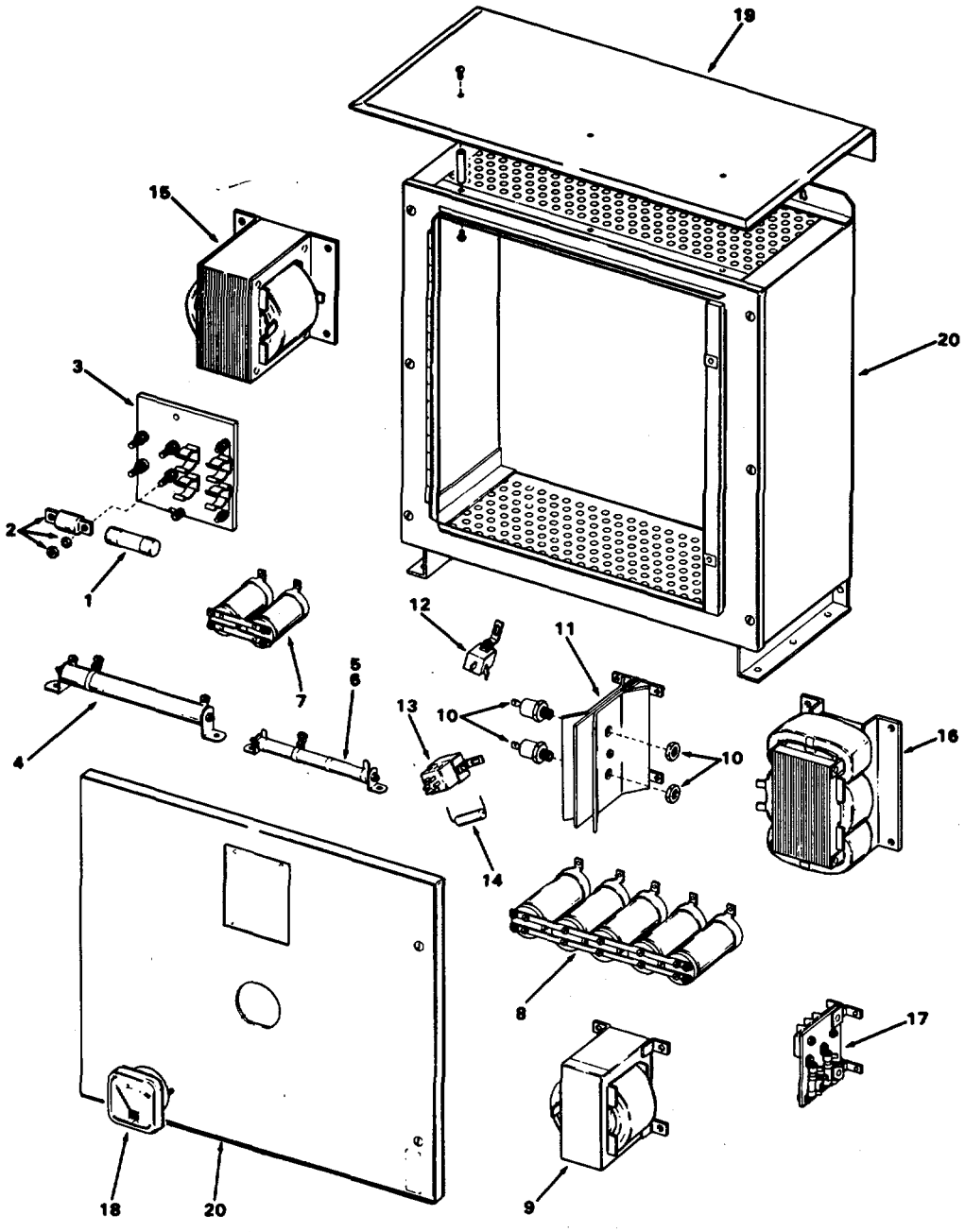
REPAIR

ITEM NO.	DESCRIPTION
1	FUSE INPUT 45 AMPERE 250 VOLT AC
2	FUSE OUTPUT 100 AMPERE 130 VOLT DC
3	BOARD ASSEMBLY TERMINAL
4	RESISTOR FIXED 25 OHMS 200 WATT COLLECTOR
5	RESISTOR FIXED VOLTAGE DIVIDER 75 OHMS 50 WATT
6	RESISTOR FIXED VOLTAGE DIVIDER 100 OHMS 25 WATT
7	CAPACITOR ELECTROLYTIC 10000 UF 50 WVDC
8	CAPACITOR ELECTROLYTIC 9800 UF 50 WVDC
9	CHOKE INPUT
10	DIODE SILICON POSITIVE
11	HEATSINK SILICON DIODE
12	PROTECTOR SURGE AC
13	RELAY CUTOUT 115 VOLT AC
14	CAPACITOR FIXED CUTOUT RELAY
15	TRANSFORMER ASSEMBLY RECTIFIER
16	REACTOR ASSEMBLY RECTIFIER
17	CONTROL UNIT ASSEMBLY RECTIFIER
18	AMMETER
19	DRIPSHIELD RECTIFIER
20	ENCLOSURE CASE NO. 6 RECTIFIER

5-44. 24 VOLT RECIFIER-MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont.)



5-44. 24 VOLT RECIFIER-MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont.)

TROUBLE SHOOTING AND REPLACING SILICON DIODES

The silicon diode may be a source of trouble. The function of the diode is to allow the flow of current through in one direction only. If the polarity of the conducting current is reversed, the diode will block the current flow. Thus, the diode has a low resistance to current flow in the other direction, and a high resistance to current flow in the other direction. Therefore, a simple ohmmeter may be used to test the diode. The procedure for checking the silicon diode is as follows:

1. Isolate one end of the diode by disconnecting the wires attached to the nipple (or pig-tail) end of the diode (only one end of the diode must be disconnected).

2. Clip one lead of the ohmmeter to the nipple (or pig-tail) lead of the diode. Clip the other ohmmeter lead to the aluminum heat sink. (If a portable multimeter is used, set the switches on Ohms, DC and scale RX100).

3. Note the ohmmeter reading. Then reverse the leads to the diode. Again, note the ohmmeter reading. If the diode is good, the meter will indicate a high resistance in one direction, and a low resistance with the leads reversed. If the diode is shorted, the meter will read full scale, or "O" resistance with the leads in either direction. If the diode is "open", the ohmmeter needle will not indicate or show infinite resistance, indicating an open circuit with the ohmmeter leads in either direction.

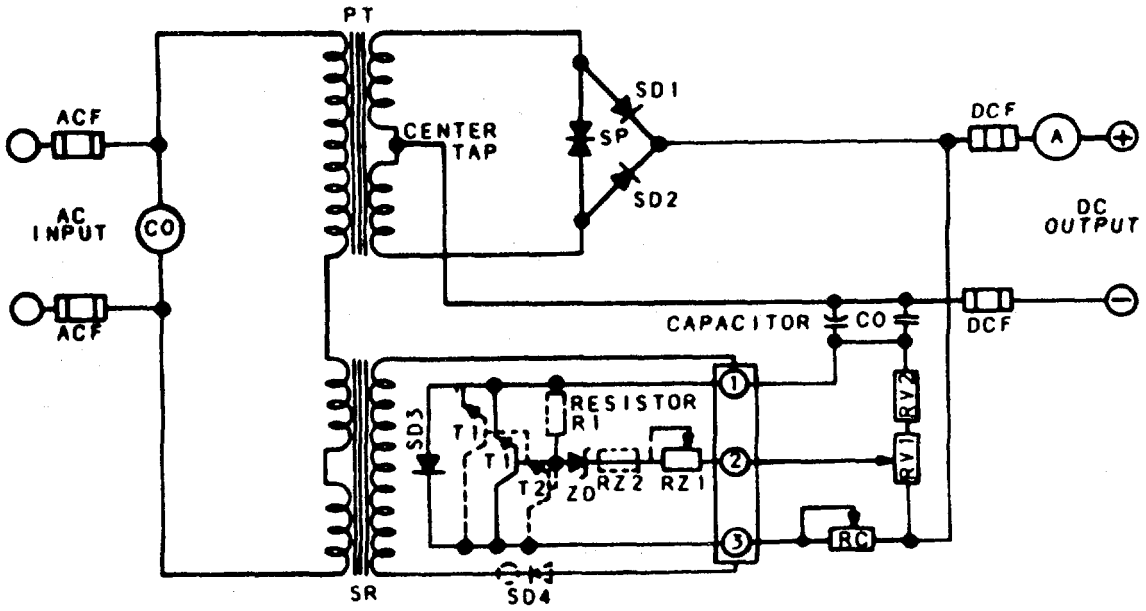
4. All diodes must be checked in the event that more than one diode is defective.

5. If the diode is defective, remove the defective diode from the heat sink and replace with a new diode. When installing a new diode, be sure to note if the old diode was insulated from the heat sink. If the diode should be insulated from the heat sink, care should be taken so that the mica insulating washer is placed properly on each side of the heat sink with the insulating bush- ing between the diode mounting stud and the aluminum heat sink.

5-44. 24 VOLT RECTIFIER-MAINTENANCE INSTRUCTIONS .

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont.)



5-45. DISTRIBUTION LIGHTING PANELS-MAINTENANCE INSTRUCTIONS.

This task covers:

Replace

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

2

References

FO-4 Power Distribution Schematic
FO-5 Wireways
FO-8 Lighting Distribution System

Equipment Condition — Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe WARNING in this procedure.

REPLACE

WARNING

- In order to avoid severe shock and possible death, make sure that all electricity (Shore power and Generators) is disconnected and tagged.
- Ground all components to prevent shock hazard in the case of component failure. The current carrying capacity of the grounding circuit must be greater than the capacity of the largest lead to the component to be grounded.

5-45. DISTRIBUTION LIGHTING PANELS-MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
		NOTE Make sure that all wiring is tagged.	
1. Lighting Distribution Panels	a. Wiring	Disconnect.	See References.
	b. Panel	1. Remove hardware. Then, remove panel.	
	c. Wiring	2. Replace and reconnect.	
2. Wiring	Replace as necessary.		See references.

5-46. RUNNING LIGHT CONTROL PANEL-MAINTENANCE INSTRUCTIONS.

This task covers:

Replace

INITIAL SETUP:

Test Equipment	References
NONE	NONE
Special Tools	**Equipment Condition** / **Condition Description**
NONE	NONE
Material/Parts	**Special Environmental Conditions**
NONE	NONE
Personnel Required	**General Safety Instructions**
2	NONE

REPLACE

WARNING

- In order to avoid severe shock and possible death, make sure all electricity (shore power and generators) is disconnected and tagged.
- Ground all components to prevent shock hazard in the case of component failure. The current carry- ing capacity of the grounding circuit must be greater than the capacity of the largest lead to the component to be grounded.

5-46. RUNNING LIGHT CONTROL PANEL-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
	NOTE Make sure that all wiring is tagged.		
1. Running Lights Control Panels	a. Wiring	Disconnect.	See References.
	b. Panel	1. Remove hardware. Then, remove panel.	
	c. Wiring	2. Replace and reconnect.	
2. Wiring	Replace as necessary.		See references.

5-47. BOW RAMP-MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

The following is an index to the bow ramp maintenance procedures:

DESCRIPTION	PARAGRAPH
Bow Ramp, Sheaves and Fairleads	5-48
Winch Assembly	5-49
Speed Reducer	5-50
Winch Motor	5-51
Controller	5-52

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS.

This task covers:

Replace

INITIAL SETUP

Test Equipment

NONE

Special Tools

Crane
Slings and Cables

Material/Parts

Engine Oil

Personnel Required

4

References

Para 3-116	Bow Ramp, Sheaves, and Fairleads Organizational Maintenance

Equipment Condition	Condition Description
	NONE

Special Environmental Conditions

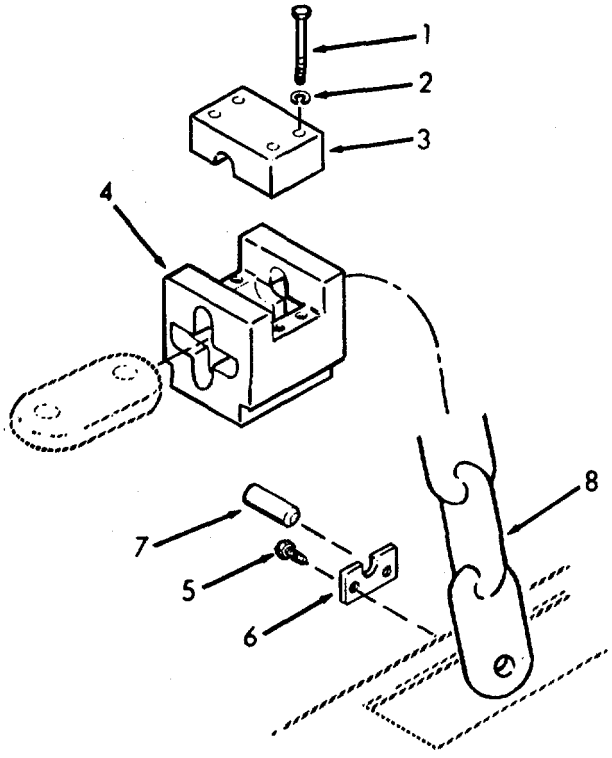
NONE

General Safety Instructions

Observe standard precautions when moving heavy objects.

5-48. BOW RAMP, SHEAVES, AND FAIRLANDS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
1. Chain(s) and Associated Hardware	a. Bow ramp	Lower.	The chain must be slack.
	b. Chain stop	1. Remove screw (1), and lockwashers (2).	
		2. Remove chain stop top (3).	Remove lower half (4) if necessary.
	c. Chain end link	1. Remove screws (5), and pin keeper (6). 2. Remove pin (7). 3. Remove chain (8) from ramp.	

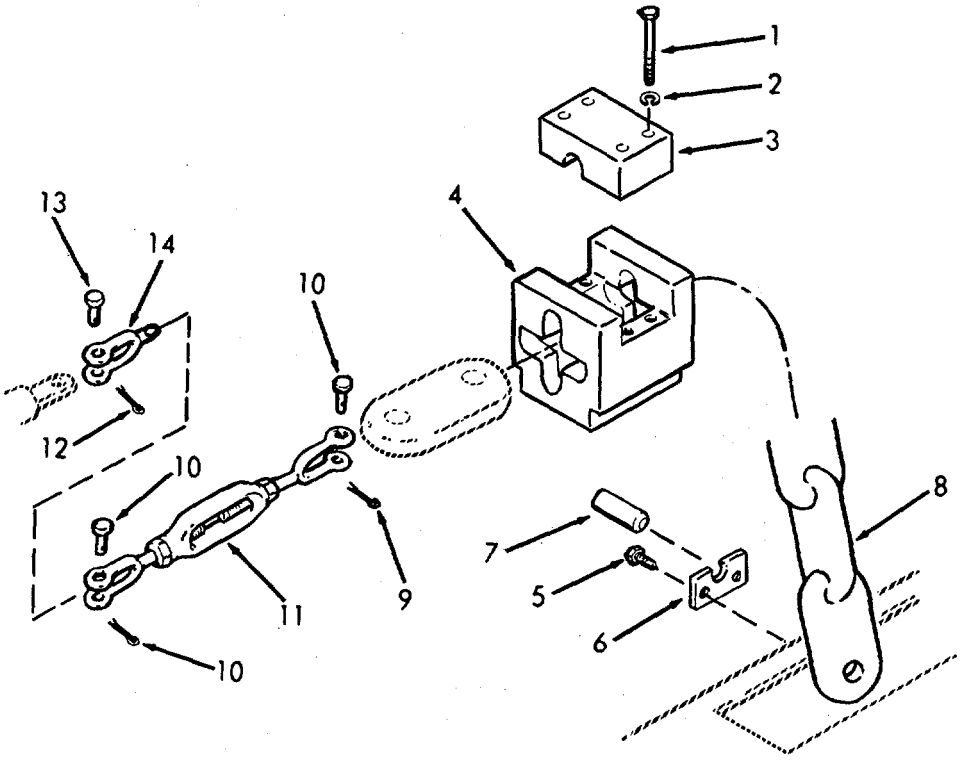


5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
		3. Remove chain (8) from ramp.	
	d. Turnbuckle	1. Remove cotter pin (9), and pins (10).	Secure chain to prevent movement.
		2. Remove turnbuckle (11).	
	e. Swivel	1. Attach keeper to cable.	Prevent cable from running through upper fairlead sheave.
		2. Remove cotter pin (12), and pin (13).	
		3. Remove swivel (14).	
	f. Chain	1. Remove chain (8).	Use crane if necessary.
		2. Remove chain link (15).	
		3. Replace chain (8), and chain link (15).	Secure chain to prevent movement.
	g. Swivel	1. Attach swivel (14), using pin (13), and cotter pin (12).	
		2. Remove keeper on cable.	
	h. Turnbuckle	1. Install turnbuckle (11). 2. Install pins (10), and cotter pins (9).	
	i. Chain end link	1. Install pin (7) in chain and ramp.	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
		2. Install keeper (6), and screws (5).	
	j. Turnbuckle	Adjust turnbuckle to reduce slack on chain.	
	k. Chain stop	1. Install and adjust lower chain half (4).	
		2. Install chain stop top half (3).	
		3. Install screws (1), and lockwashers (2).	
	l. Bow ramp	1. Operate and adjust turnbuckle (11).	
		2. Adjust chain stop.	

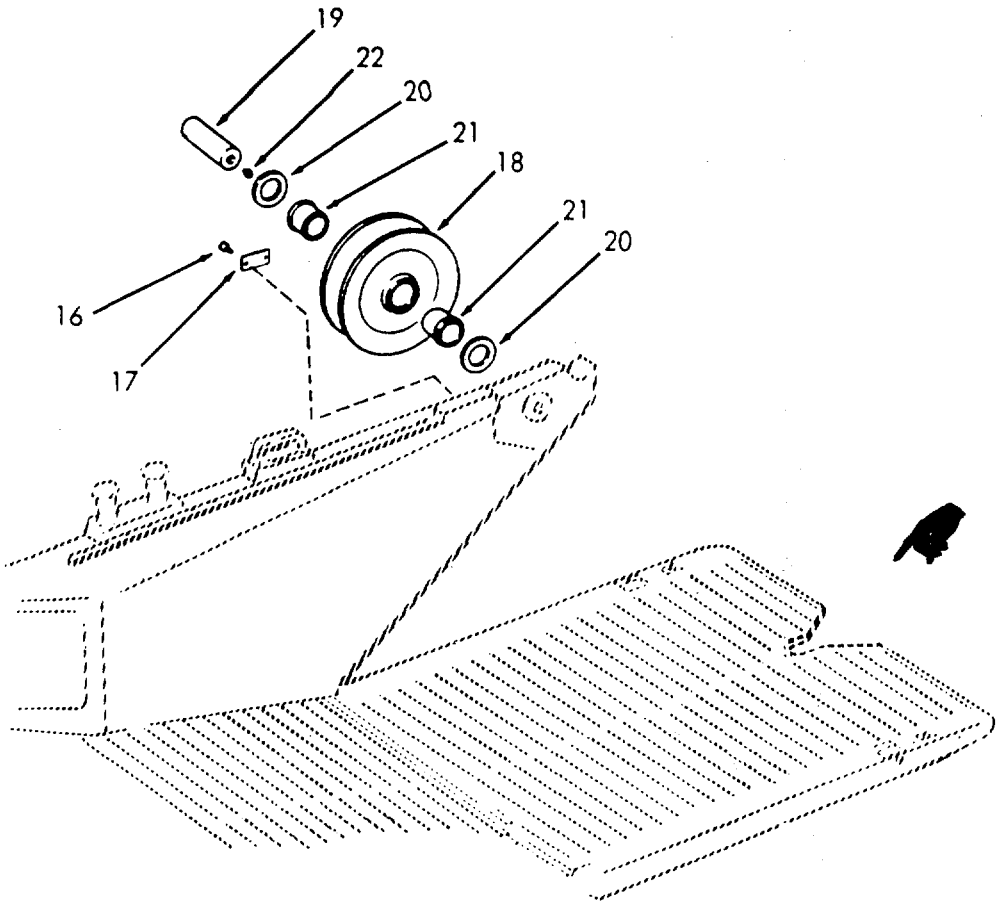


5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
2. Wildcat	a. Bow ramp	Lower.	
	b. Chain	Disconnect.	See step 1 above.
	c. Screws (16), and keeper (17)	Remove.	
	d. Wildcat (18)	Attach lifting cable.	
	e. Pin (19), bronze washers (20), and bushings (21)	Remove.	
	f. Wildcat (18)	Lift and remove.	
	g. Lubrication fitting (22)	Replace.	If necessary.
	h. Wildcat (18), bushings (21), bronze was hers (20), and pin (19)	Install.	
	i. Keeper (17), and screws (16)	Install.	
	j. Wildcat (18)	Remove lifting devices.	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
	k. Chain	Reconnect.	See step 1 above.
	l. Lubrication fitting (22) Grease.		



4951-098

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

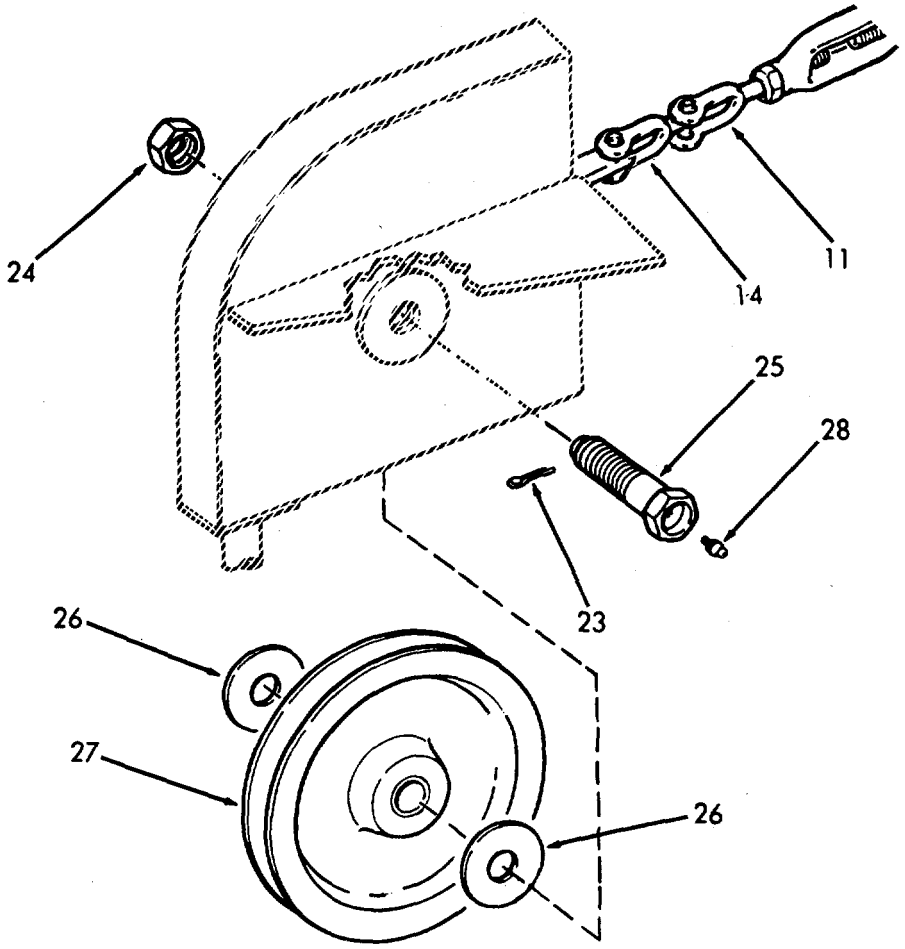
LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
3. Upper Fairlead Sheave	a. Bow ramp	Lower.	
	b. Swivel (14)	1. Disconnect from turnbuckle (11}.	
		2. Let cable go slack.	
	c. Cotter pin (23)	Remove.	
	d. Nut (24)	Remove.	
	e. Sheave pin (25), brass washers (26), and sheave (27)	Remove.	
	f. Lubrication fitting (28)	Replace.	If necessary.
	g. Sheave pin (25) , brass washers (26), and sheave (27)	install.	
	h. Nut (24), and cotter pin (23)	Install.	
	i. Swivel (14)	Attach to turnbuckle.	
	j. Lubrication fitting (28)	Grease,	
4. Lower Fairlead Sheave	a. Bow Ramp	Lower.	
	b. Swivel (14)	1. Disconnect from turnbuckle (11).	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont.)

2. Let cable go slack.



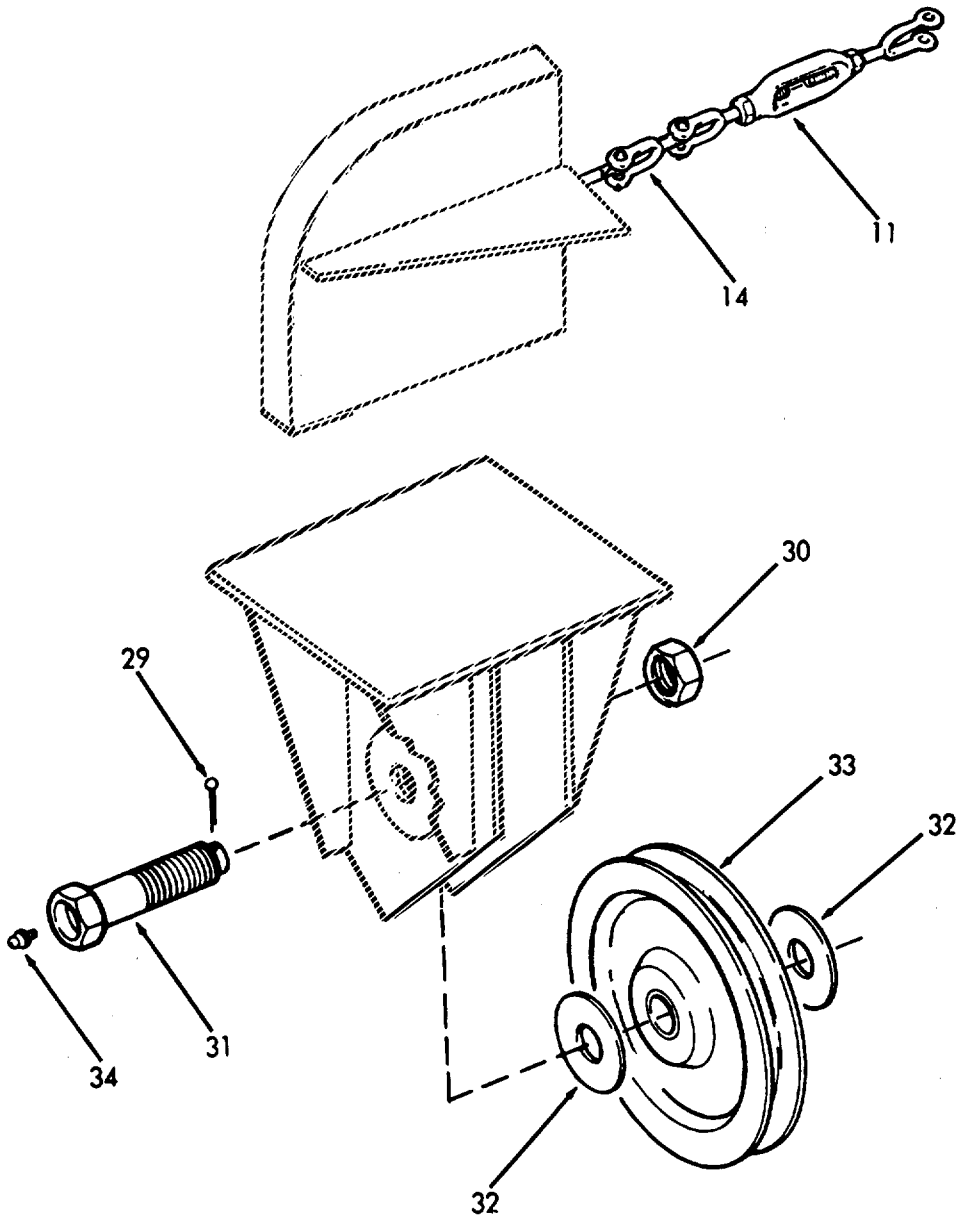
5-651

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
	c Cotter pin (29)	Remove.	
	d. Nut (30)	Remove.	
	e. Sheave pin (31), brass washers (32), and sheave (33)	Remove.	
	f. Lubri-cation fitting (34)	Replace.	If necessary.
	g. Sheave pin (31), brass washers (32), and sheave (33)	Install.	
	h. Nut (30), and cotter pin (29)	Install.	
	i. Swivel (14)	Attach to turnbuckle (11).	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
	j. Lubrication fitting (34)	Grease.	

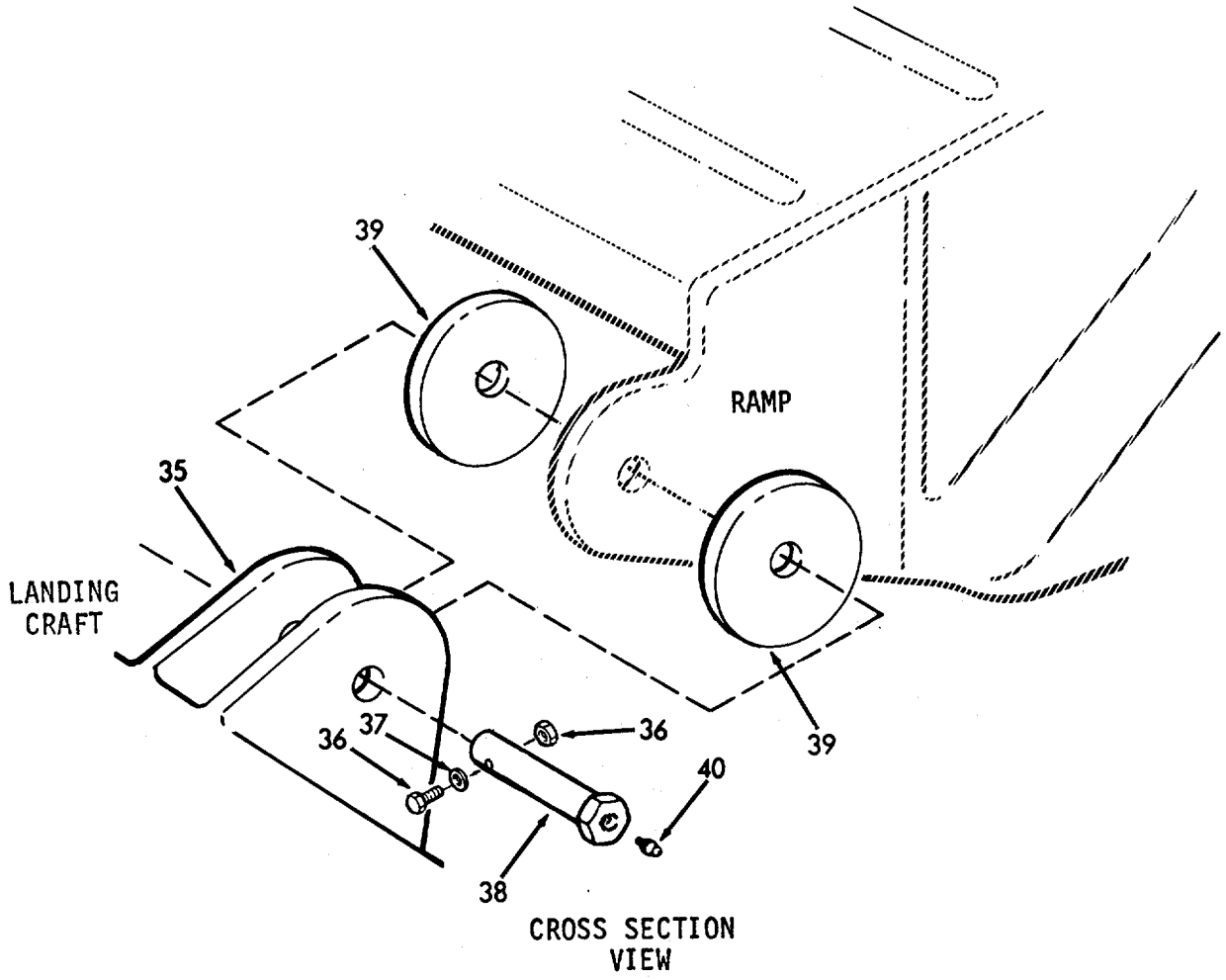


5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
5. Ramp Seal Gasket	Gasket (35)	Replace.	If necessary.
6. Hinge Pin	a. Nut and bolt assembly (36), and washer (37)	Remove.	
	b. Pin (38), and bronze washers (39)	Remove.	
	c. Lubrication fitting (40)	Replace.	If necessary.
	d. Pin (38), and bronze washers (39)	Replace.	
	e. Nut and bolt assembly (36) and washer (37)	Replace.	
	f. Lubrication fitting (40)	Grease.	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
7. Cable	a. Ramp	Lower.	Let chain go slack.



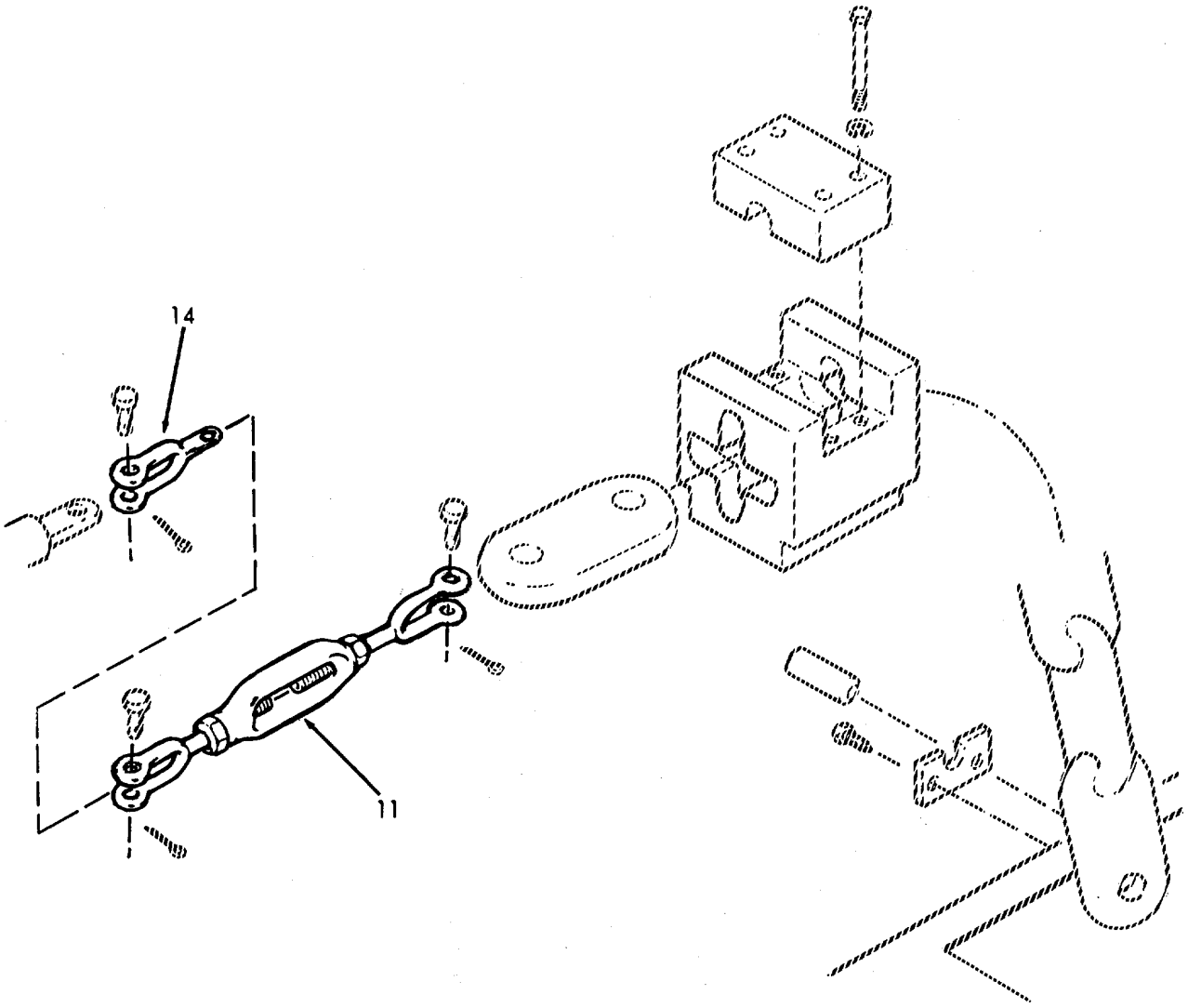
5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont.)			
	b. Cable	Disconnect from winch drum.	
	c. Swivel (14)	Disconnect.	
	d. Cable	1. Pull from upper fair-lead sheave.	
		2. Replace.	
	e. Swivel (14)	Reconnect.	
	f. Cable	Reconnect to winch drum.	
	g. Turnbuckle (11)	Readjust.	
8. Ramp	a. Ramp	1. Lower.	Let chain go slack.
		2. Install crane.	
	b. Chain end link	Disconnect.	See step 1c.
	c. Hinge pins	Remove from 10 places.	See step 6.
	d. Ramp	Replace.	
	e. Hinge pins	Install.	See step 6.
	f. Chain end link	Install.	See step 1i.
	g. Ramp	1. Remove crane.	
		2. Operate and adjust-turnbuckles (11).	

5-48. BOW RAMP, SHEAVES, AND FAIRLEADS-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont.)



5-49. WINCH ASSEMBLY-MAINTENANCE INSTRUCTIONS .

This task covers:

a. Removal **b. Installation** **d. Repair**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Cutting tools
Welding tools
Crane
Misc. chains (etc.)

Material/Parts

NONE

Personnel Required

4

References

F0-1	Machinery Vehicle Deck Access
Para 3-117	Winch Assembly
Para 3-120	Winch Brake and Motor

Equipment Condition Paragraph	Condition Description
5-48	Cable removed.

Special Environmental Conditions

NONE

General Safety Instructions

Observe normal precautions when handling heavy equipment.

LOCATION	ITEM	ACTION	REMARKS

WARNING

- Keep clear while winch is in operation.
- When lowering the ramp manually be sure the hand crank is not mounted on the high speed shaft, as injury may be caused by the spinning crank.
- Be sure the pawl is against a ratchet tooth before releasing the crank handle.
- Keep clear of the area directly below the deck section being removed.

5-49. WINCH ASSEMBLY-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

WARNING (Continued)

- Verify that all power has been shut off, and that the power source has been properly tagged before proceeding.
- To prevent the possibility of fire when using cutting or welding equipment, place a crewman above and below the deck with fire extinguishers.
- In order to avoid possible serious injury, place the circuit breaker in the OFF position and tag. Place the disconnect switch in the OFF position and tag.
- DEATH

  or severe injury may result if personnel move around in the winch compartment with the winch running.
- Do not enter the winch compartment alone.
- Disconnect power to the winch whenever working on the ramp gate, the wire rope, or in the vicinity of the winch in the winch room.
- Improper selection and installation of a brake and/or lack of maintenance, may cause brake failure which could result in injury to personnel.

REMOVAL

1.	Bow Ramp Winch	a.	Electric brake wiring	Tag and disconnect.	Refer to wiring diagram on page 5-661.
		b.	Motor wiring	Tag and disconnect.	
		c.	Cable	Disconnect and remove.	Refer to paragraph 5-48.

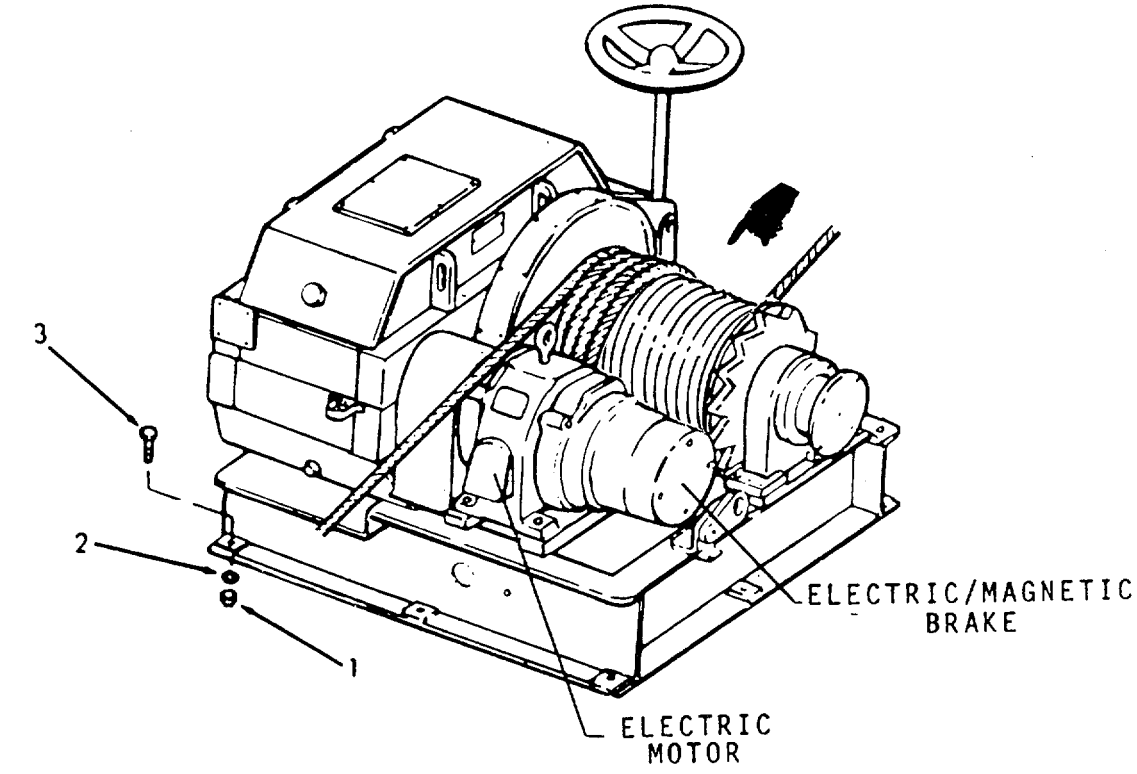
5-49. WINCH ASSEMBLY-MAINTENANCE INSTRUCTIONS (Continued).

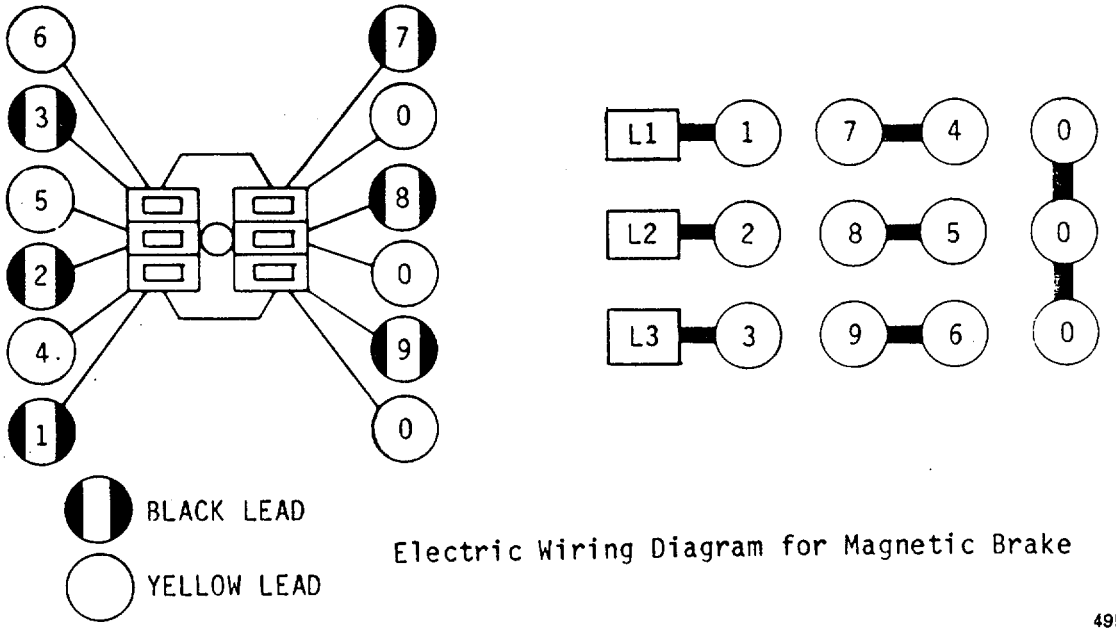
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.) I			
	d. Nuts (1 and 2), and screws (3)	Remove.	
2. Vehicle Deck	Deck Plate	Remove.	Refer to FO-1.
3. Bow Ramp Winch		Attach chain.	
4. Vehicle Deck	Bow Ramp Winch	Remove.	
INSALLATION			
5. Bow Ramp Winch	a. Winch	1. Replace. 2. Align mounting holes.	
	b. Screws (3), and nuts (1 and 2)	Install.	
6. Vehicle Deck	Deck Plate	Replace.	
7. Bow Ramp Winch	a. Cable	Reconnect.	Refer to paragraph 5-48.
	b. Motor wiring	Reconnect.	
	c. Electric brake wiring	Reconnect.	Refer to schematic on page 5-662.

5-49. WINCH ASSEMBLY-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont.)





Electric Wiring Diagram for Magnetic Brake

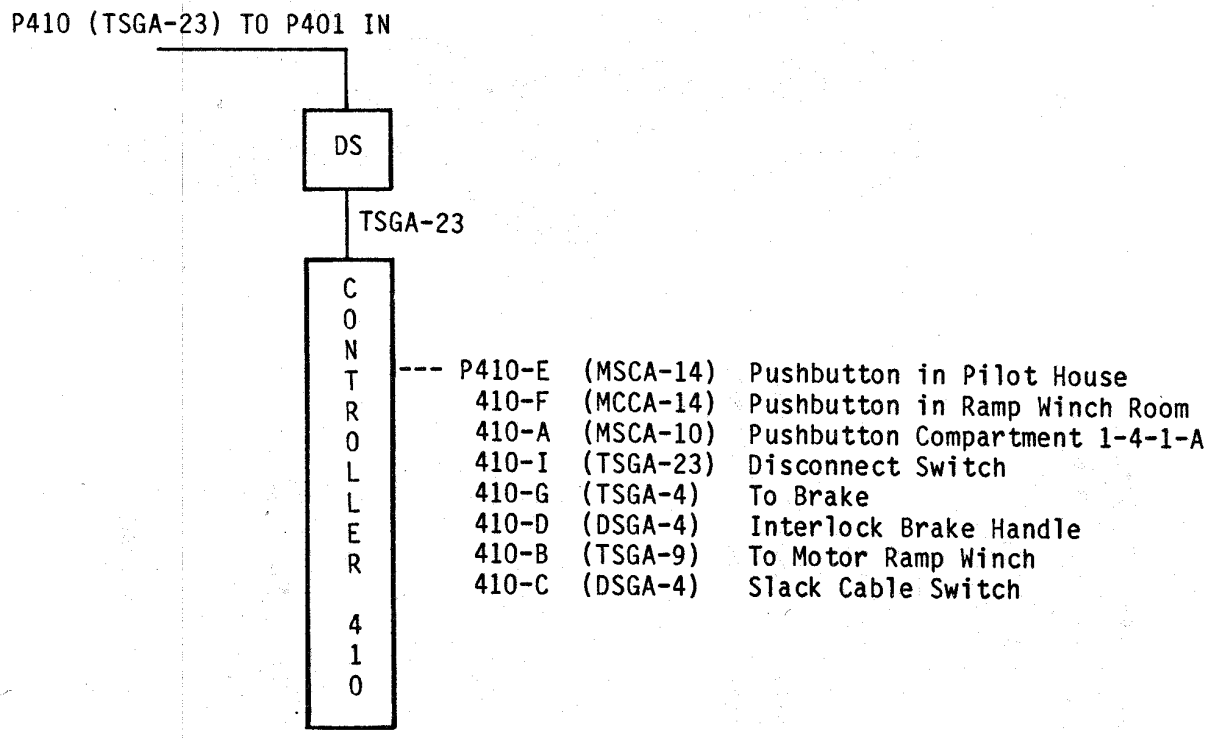
4954-212

5-49. WINCH ASSEMBLY-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR

8. Drum — To remove the drum from the winch, it is necessary to remove the reducer, drum, and bearing housing as an assembly. Refer to paragraph 5-50-Speed Reducer Removal.



5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS .

This task covers:

a. Removal **b. Repair** **d. Installation**

INITIAL SETUP:

Test Equipment
NONE

Special Tools

Slings
Chain hoist
Puller
Arbor press

Material/Parts

Oil MIL-L-2105 type G090
[1 gallon (3.78 liters)]
Lubricant MIL-G-10924
type GAA

Personnel Required
2

References
NONE

Equipment Condition Paragraph | Condition Description

5-49	Winch assembly removal
3-118	Torque coupling replace.

Special Environmental Conditions

NONE

General Safety Instructions
Observe WARNINGS in paragraph 5-49.

5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Speed Reducer, Drum, and Bearing Housing Assembly	a. Coupling guard	1. Remove screws (1) and lockwashers (2). 2. Remove coupling guard (3).	
	b. Torque coupling	Disconnect by unbolting flanges, and removing grid.	1. Refer to paragraph 3-118. 2. Do not remove spring-loaded torque setting nuts.
	c. Brake band	Remove cotter pin (4), nut (5), and screw (6).	
	d. Bearing housing	Remove screws (7), and lockwashers (8).	
	e. Speed reducer	Remove screws (9), and lockwashers (1O).	
	f. Speed reducer, and assembled parts	1. Install slings on speed reducer, and drum.	

CAUTION

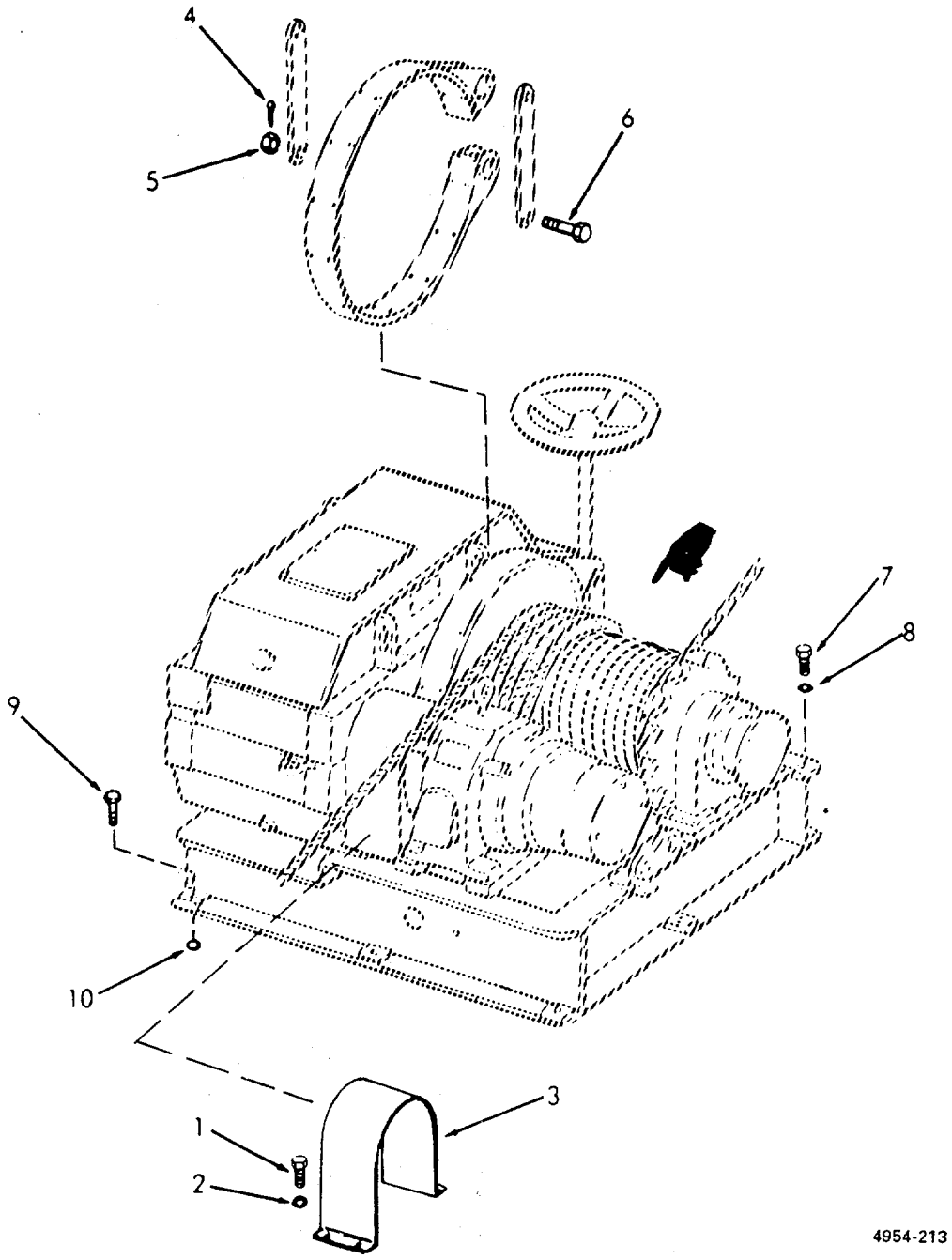
When lifting the speed reducer assembly, take care not to hit the electric motor or brake.

2. Carefully lift the assembly straight up.

5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)

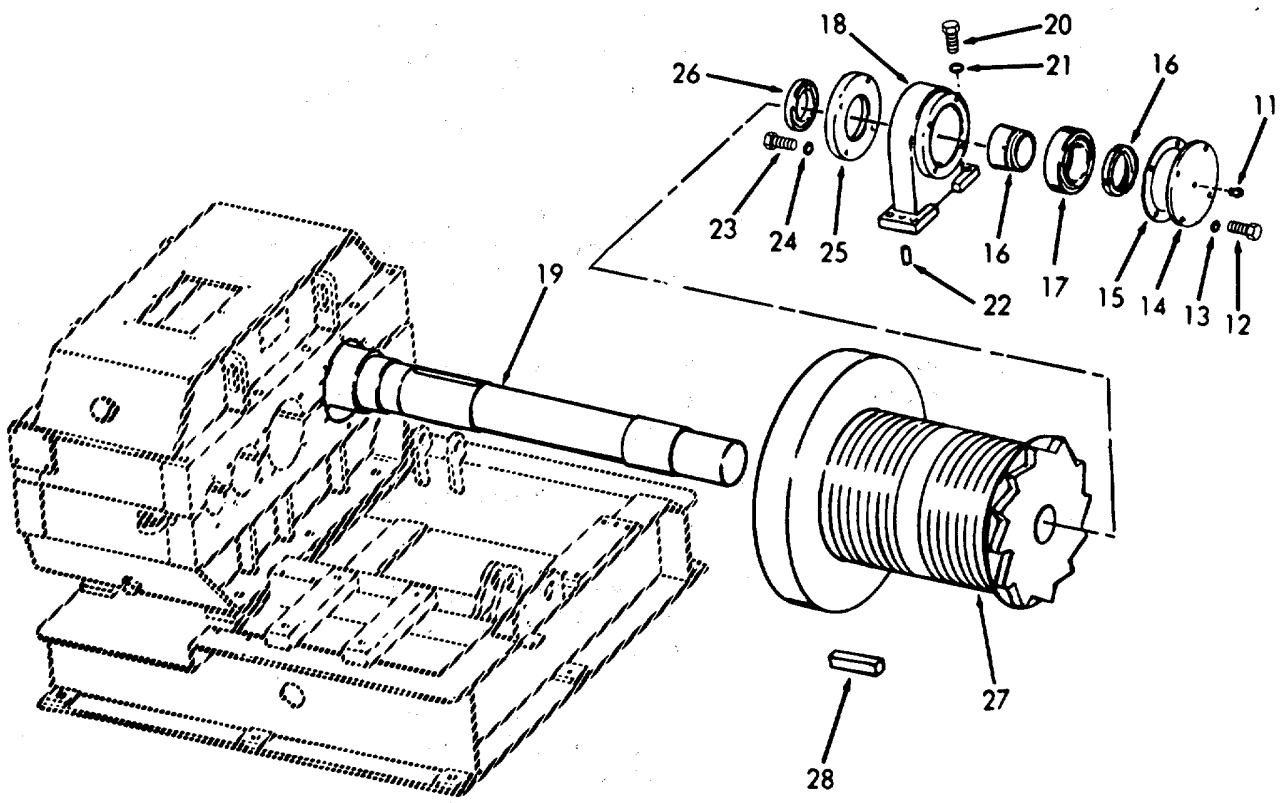


5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
2. Bearing Housing	a. Bearing housing cover	1. Remove lubricating fitting (11).	If necessary.
		2. Remove screws (12), and lockwashers (13).	
		3. Remove bearing housing cover (14).	
		4. Remove ring cover (15).	
	b. Bearing roller	1. Loosen bearing adapter (16).	
		2. Remove bearing roller (17), and bearing adapter (16) from bearing housing (18), and speed reducer shaft (19).	
		3. Remove bearing adapter (16) from bearing roller (17).	Check bearing roller for wear. Replace if necessary.
	c. Bearing housing	1. Remove capscrews (20), and lock-washers (21).	
		2. Remove dowel pins (22).	
		3. Remove bearing housing (18) from speed reducer shaft (19).	
		4. Remove capscrews (23), and lock-washers (24) from seal plate holder (25).	

5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS (Continued).

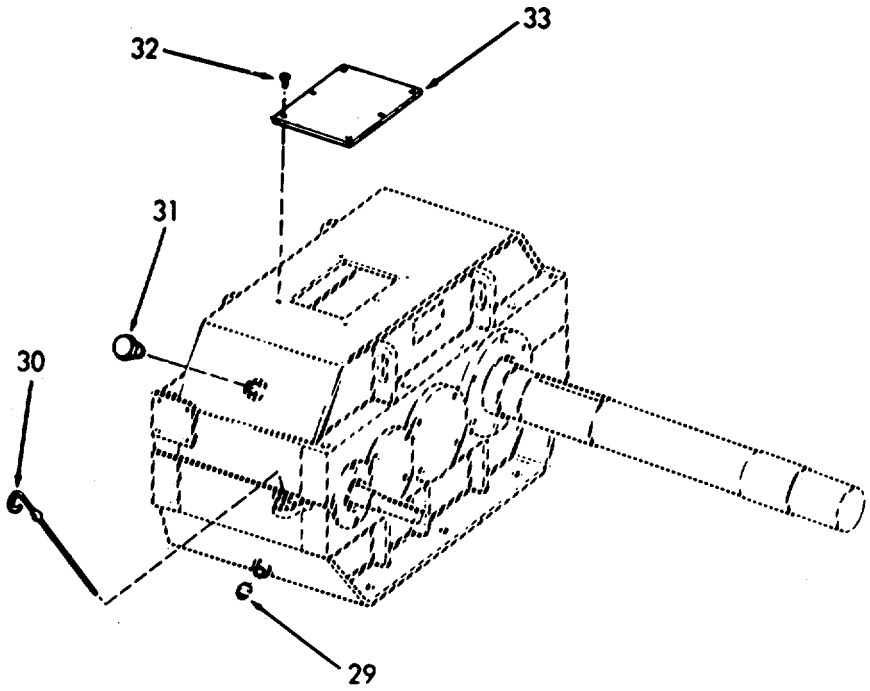
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
		5. Remove seal plate holder (25) from bearing housing (18).	
		6. Remove oil seal bearing (26).	
3. Drum	a. Drum (27)	Remove.	It may be necessary to use a puller.
	b. Key (28)	Remove.	



5-667

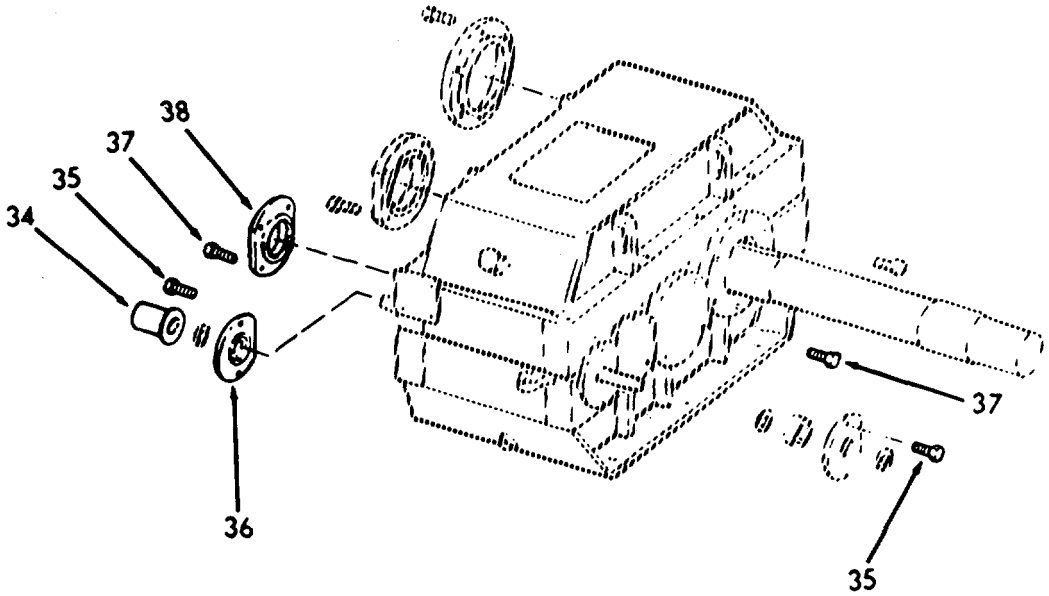
5-50. SPEED REDUCER-BOW RAMP WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
4. Speed Reducer Cover	a. Drain plug (29)	Remove.	Drain oil into a suitable container.
	b Dipstick (30)	Remove.	
	c. Vent plug (31)	Remove.	
	d. Screws (32), and inspection plate (33) .	Remove.	



5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL(Cont)			
	e. Input shaft cover (34)	Remove.	
	f. Screws (35), and input shaft bearing retaining plate (36)	Remove two upper screws, and loosen two lower screws.	
	g. Screws (37), and third shaft bearing retaining plate (38)	Remove.	

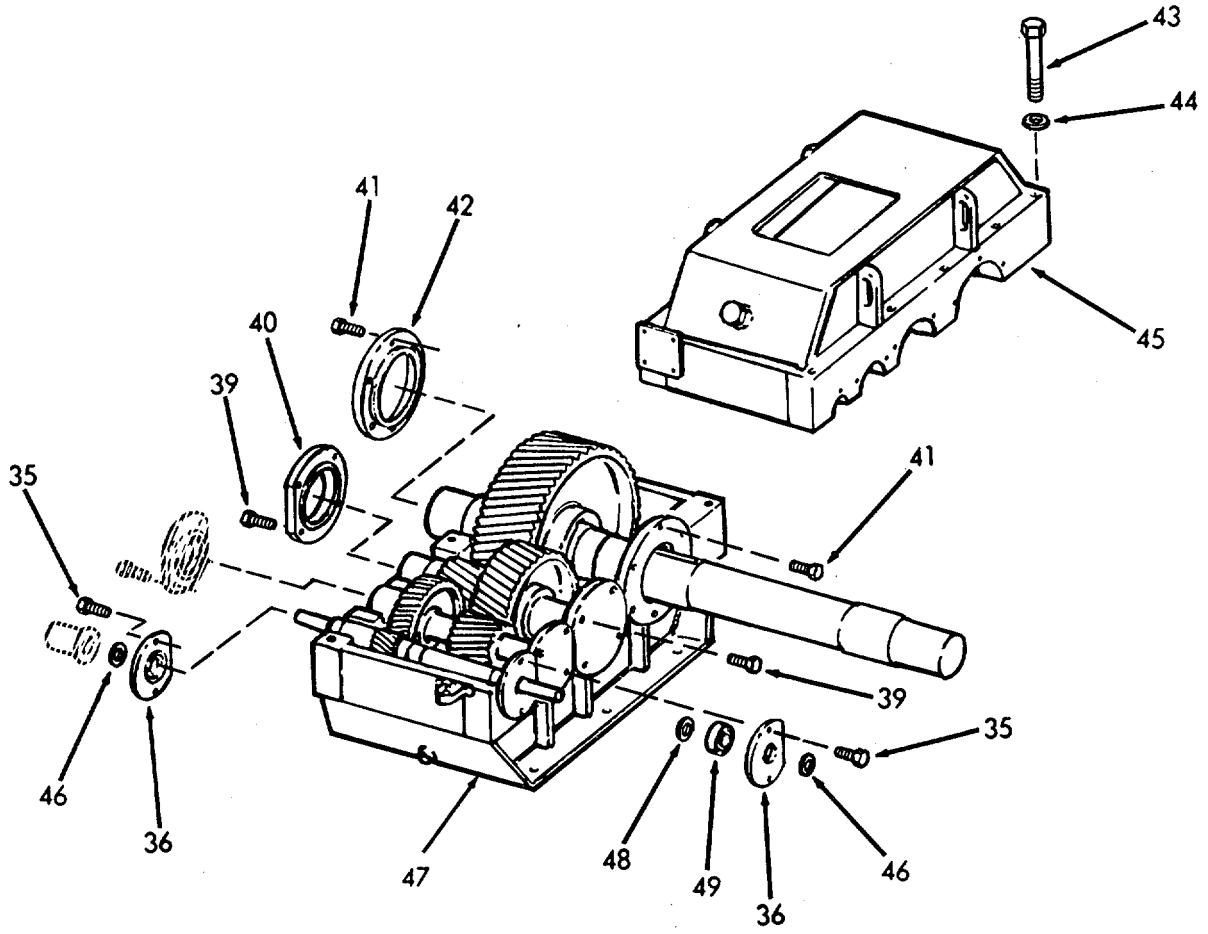


5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Screws (39), and second shaft bearing retaining plate (40)	Remove.	
	i. Screws (41), and low speed shaft bearing retaining plate (42)	Remove three upper screws, and loosen three lower screws.	
	j. Screws (43), and lock washers (44)	Remove.	
	k. Cover (45)	Carefully lift off.	
REPAIR			
5. High Speed Input Pinion Shaft	a. Screws (35), and bearing retainers (36)	Remove retaining screws.	
	b. Torque coupling and key	Remove.	Refer to paragraph 3-118.
	c. Oil seal (46)	Remove from bearing retainers (36).	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	d. High speed input shaft assembly	Lift out of housing (47).	
	e. Bearing retaining ring (48), and bearing (49)	Remove.	Use bearing puller.

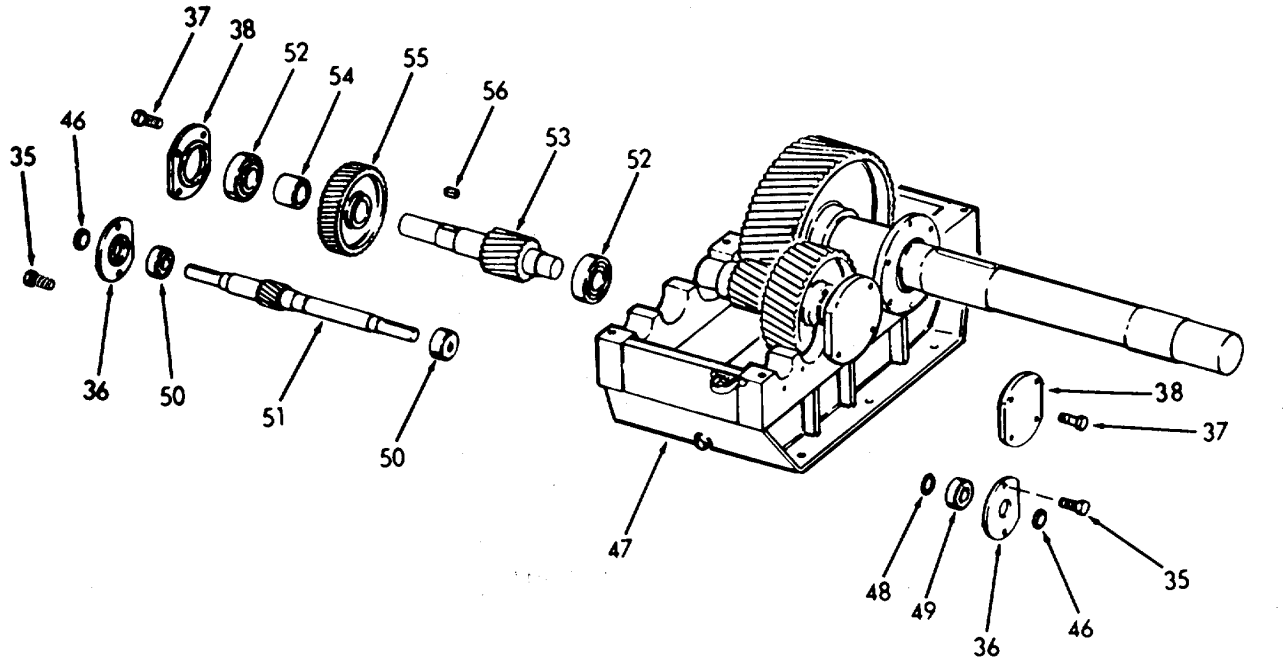


5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Bearing cups and cones (50)	1. Remove from shaft (51).	Use an arbor press to remove cups.
		2. Lightly oil shaft.	
		3. Install new bearing cups and cones.	
	g. Bearing (49), and retaining ring (48)	1. Install bearing. press.	Use an arbor
		2. Install retaining ring.	
	h. High speed input shaft assembly	Install in housing (47).	
	i. Oil seals (46)	Install in bearing retainers (36).	
	j. Torque coupling and key	Install.	Refer to paragraph 3-118.
	k. Bearing retainers (36), and screws (35)	Install bottom two screws.	Do not tighten.
6. Third Pinion Shaft	a. Screws (37), and bearing retainers (38)	1. Remove remaining screws.	
		2. Remove bearing retainer.	
	b. Third pinion shaft	Lift out of housing (47).	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	c. Bearing cups and cones (52)	Remove from shaft (53).	Use an arbor press to remove cups.
	d. Spacer (54)	Remove.	
	e. Gear (55), and key (56)	1. Remove from shaft (25). 2. Oil the shaft. 3. Replace.	Use an arbor press to remove and install.
	f. Spacer (54)	Install.	
	g. Bearing cups and cones (52)	1. Oil the shaft. 2. Install.	Use an arbor press.

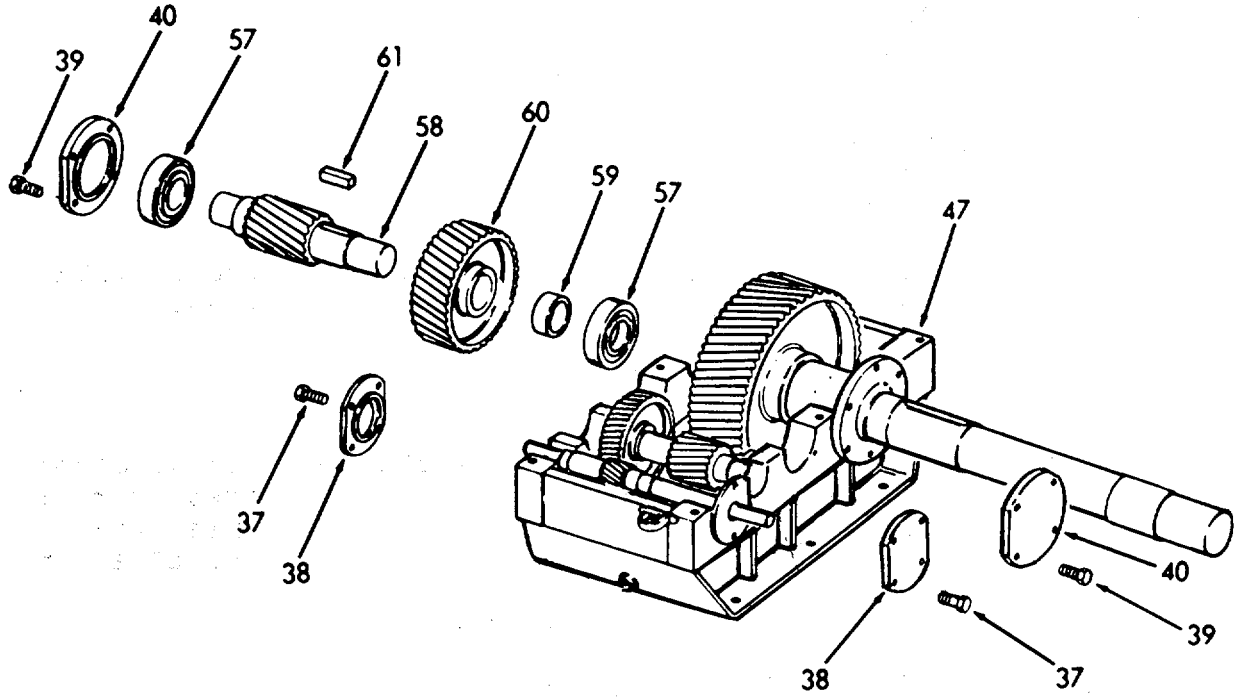


5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Third pinion shaft	Install in housing (47).	
	i. Bearing retainers (38), and screws (37)	Install the bottom two screws.	Do not tighten.
7. Second Pinion Shaft	a. Screws (39), and bearing retainers (40)	1. Remove remaining screws. 2. Remove bearing retainer.	
	b. Second pinion shaft	Lift out of housing (47).	
	c. Bearings (57)	Remove from shaft (58).	Use an arbor press.
	d. Spacer (59)	Remove.	
	e. Gear (60), and key (61)	1. Remove from shaft (30). 2. Oil the shaft. 3. Replace.	Use an arbor press for removal and installation.
	f. Spacer (59)	Install.	
	g. Bearings (57)	1. Oil the shaft. 2. Install.	Use an arbor press.

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Second pinion shaft	Install in housing (47).	
	i. Bearing retainers (40), and screws (39)	Install bottom two screws.	Do not tighten.

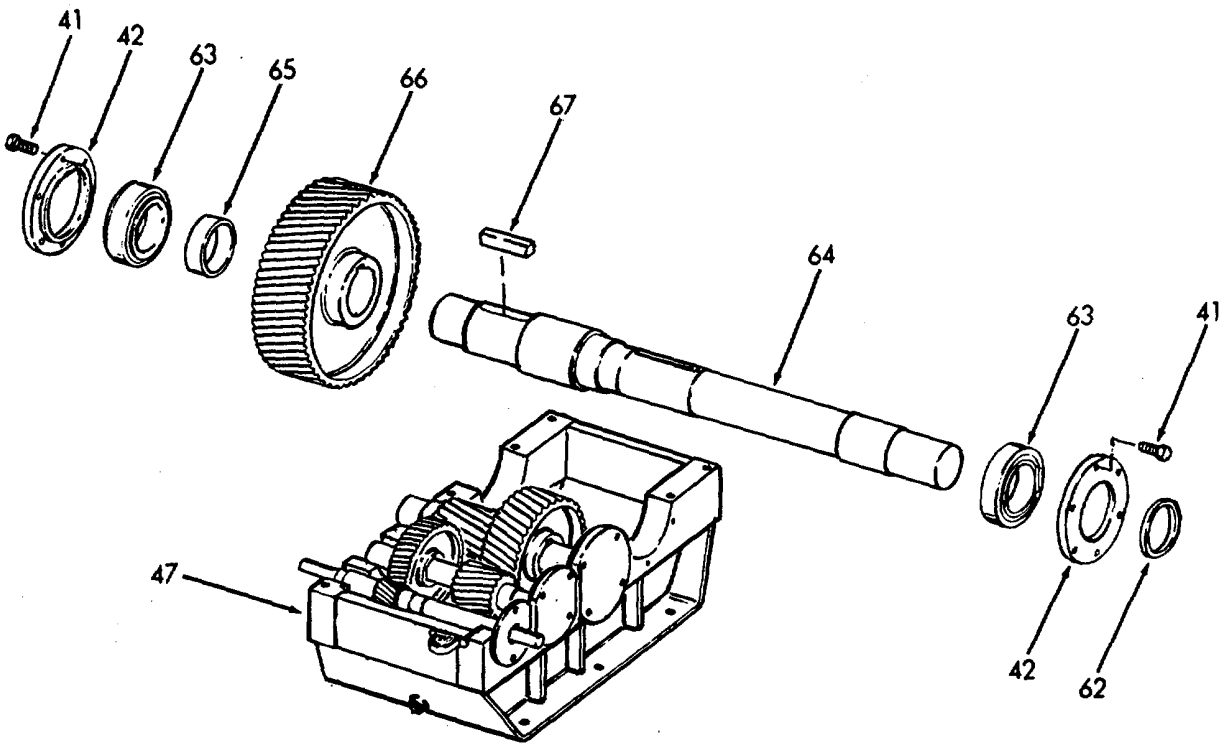


5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Low Speed Shaft	a. Screws (41), and bearing retainers (42)	1. Remove remaining screws. 2. Remove bearing retainer.	
	b. Oil seal (62)	Remove.	
	c. Low speed shaft	Lift out of housing (47).	
	d. Bearing cups and cones (63)	Remove from shaft (64).	Use an arbor press.
	e. Spacer (65)	Remove.	
	f. Gear (66), and key (67)	1. Remove from shaft. 2. Oil the shaft. 3. Replace.	Use an arbor press for removal and installation.
	g. Spacer (65)	Install.	
	h. Bearing cups and cones (63)	1. Oil shaft. 2. Install.	Use an arbor press.
	i. Low speed shaft	Install in housing (47).	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Bearing retainers (42), and screws (41)	Install bottom three screws.	Do not tighten.
	k. Oil seal (62)	Install.	



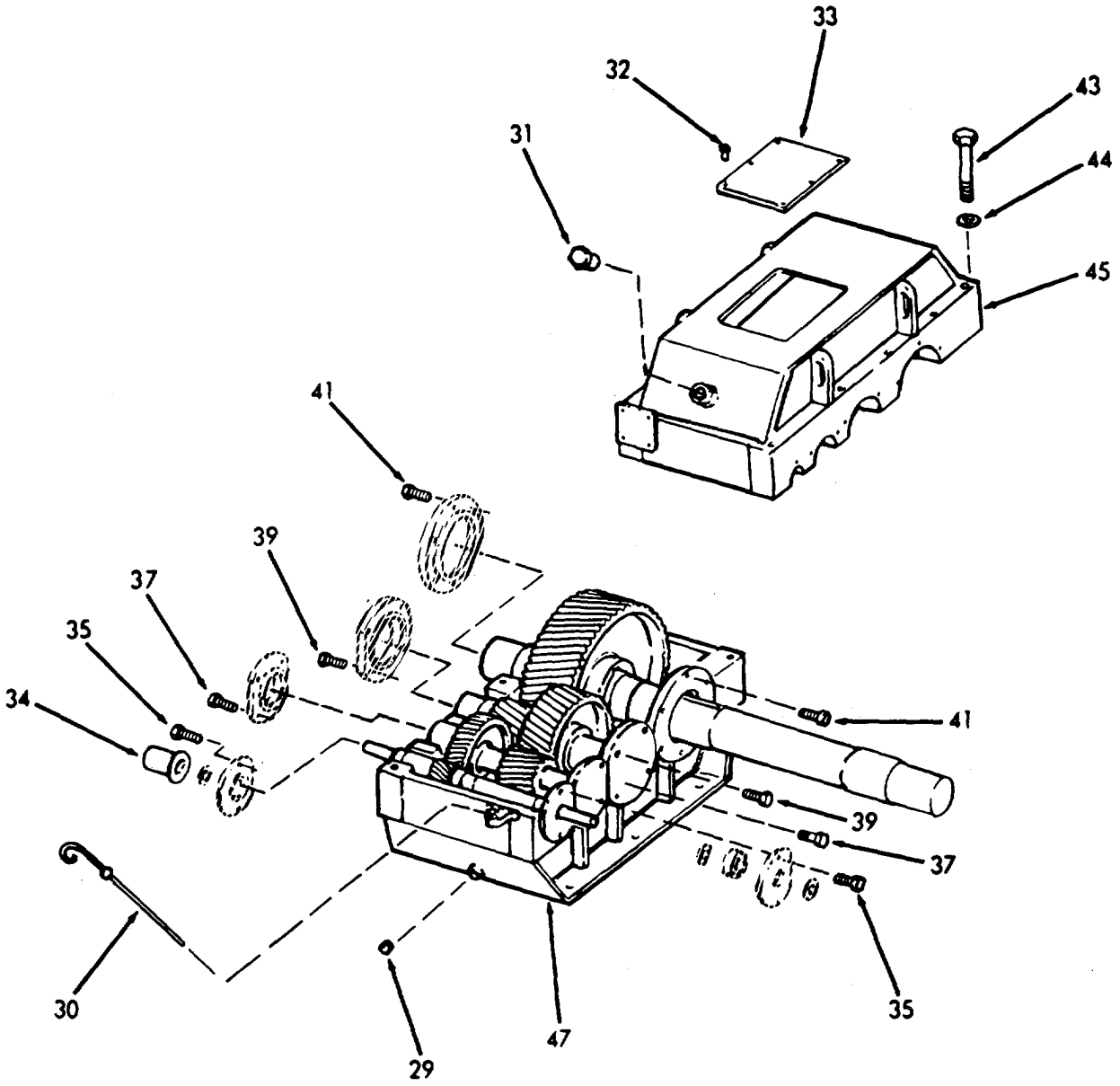
5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
9. Speed Reducer Cover	a Cover (45)	Carefully lower onto housing (47).	
	b. Screws (43) ,and lockwashers (44)	Install.	
	c. Screws (35, 37, 39, and 41)	1. Install remaining screws. 2. Tighten all screws.	
	d. Input shaft cover (34)	Install.	
	e. Inspection plate (33), and screws (32)	Install	
	f. Drain plug (29)	Install.	
	g. Housing	Fill with oil.	Use oil MIL-G-2105 type G090.
	h. Dipstick (30)	Install.	
	i. Vent plug (31)	Install.	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



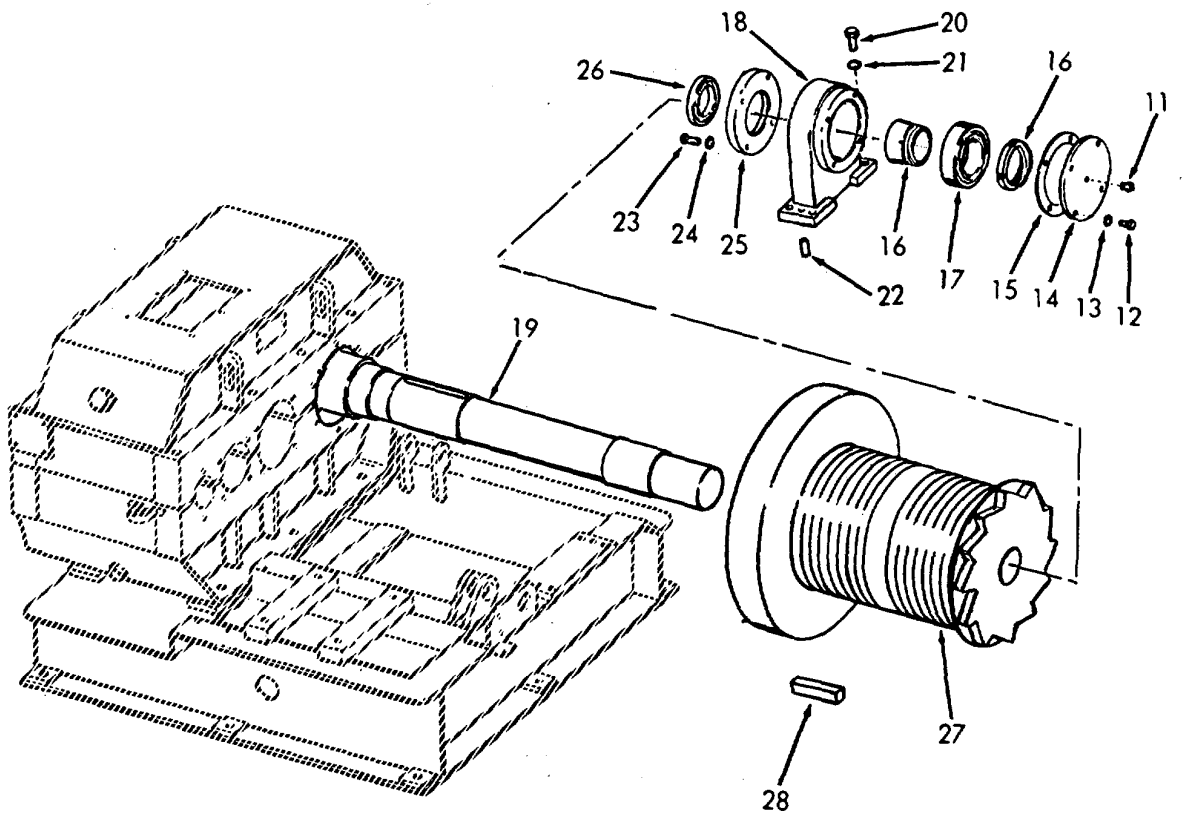
5-679

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
10. Drum	a. Shaft (19)	Oil the shaft.	
	b. Key (28)	Install.	
	c. Drum (27)	Install.	
11. Bearing Housing	a. Bearing housing	1. Install oil seal bearing (26), and seal plate holder (25) onto speed reducer shaft (19). 2. Install bearing housing (18) onto speed reducer shaft (19). 3. Install lockwashers (24), and capscrews (23), onto seal plate holder (25), and bearing housing (18). 4. Install dowel pins (22), lockwashers (21), and capscrews (20) onto bearing housing (18).	
	b. Bearing roller	1. Install bearing-adapter (16), onto bearing roller (17). 2. Install bearing roller (17), and bearing adapter (16) onto speed reducer shaft (19), and into bearing housing (18).	
	c. Bearing housing cover	1. Install ring cover (15).	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		2. Install bearing housing cover (14), lockwashers (13), and screws (12) .	
		3. Install lubricating fitting (11).	Apply GAA lubricant.



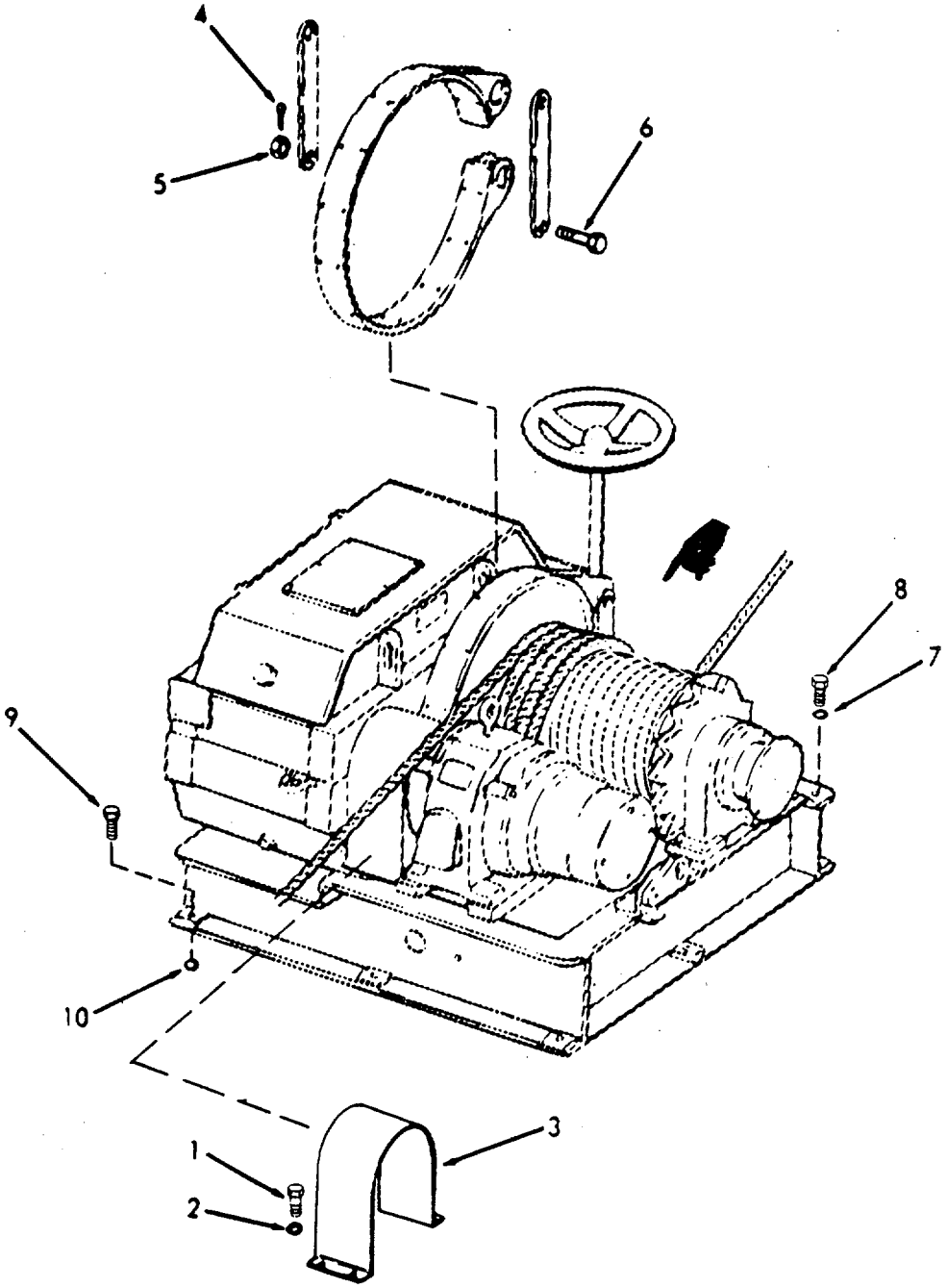
5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
12. Speed Reducer, Drum, and Bearing Housing Assembly			
		CAUTION When lowering the speed reducer assembly, take care not to hit the electric motor or brake.	
	a. Speed reducer and assembled parts	1. Attach slings on speed reducer and drum.	
		2. Install bearing housing cover (14), lockwashers (13), and screws (12) .	
	b. Screws (9), and lockwashers (10)	Install into speed reducer.	
	c. Screws (7), and lockwashers (8)	Install in bearing housing.	
	d. Screw (6), nut (5) , and cotter pin (4)	Install in brake band.	
	e. Torque coupling	Reconnect.	Refer to paragraph 3-118.
	f. Coupling guard (3)	Install.	
	g. Screws (1), and lock-washers (2)	Install in coupling guard.	

5-50. SPEED REDUCER - BOW RAMP WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



5-51. WINCH MOTOR - BOW RAMP - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Repair** **c. Installation**

INITIAL SETUP:

Test Equipment

NONE

References

NONE

Special Tools
Paragraph
Bearing puller
Arbor press
Chain hoist

Equipment Condition: 3-118
Condition Description: Torque Coupling Replace

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

2

General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

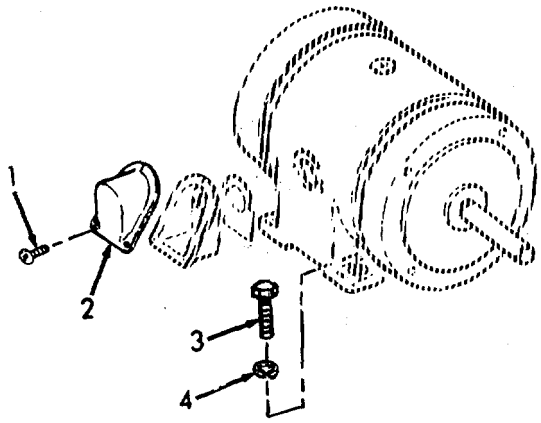
In order to avoid shock and possible injury, tag and place disconnect switches and circuit breakers in the OFF position.

REMOVAL

1.	Motor	a. Screws (1), and terminal box cover (2)	Remove.

5-51. WINCH MOTOR - BOW RAMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL(Cont)			
	b. Wiring	Tag and disconnect.	
	c. Torque coupling	Remove.	Refer to paragraph 3-118.
	d. Screws (3), and lockwashers (4)	Remove.	
	e. Motor	Lift with chain hoist.	



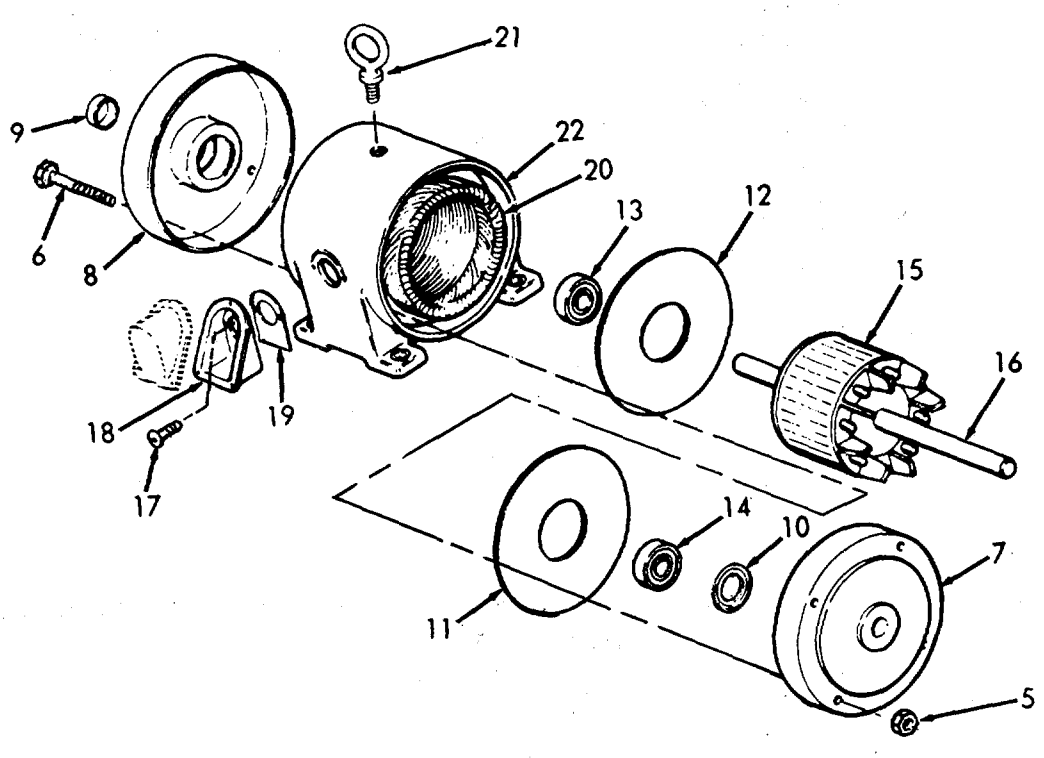
5-685

5-51. WINCH MOTOR - BOW RAMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
2.	a. Nuts (5), and three bolts (6)	Remove.	
	b. Bearing brackets (7 and 8)	Remove.	
	c. Dust cap (9)	Remove.	If necessary.
	d. Labyrinth seal (10)	Remove.	
	e. Baffles (11 and 12)	Remove.	
	f. Front end bearing (13), and rear end bearing (14)	Remove.	Use bearing puller or arbor press.
	g. Rotor (15), shaft, and key (16)	Separate, if necessary.	Use an arbor press.
	h. Screws (17), terminal box (18), and gasket (19)	Remove.	If necessary.
	i. Stator coils (20) from frame (22).	Remove lifting eye (21), and other attaching hardware	If necessary.

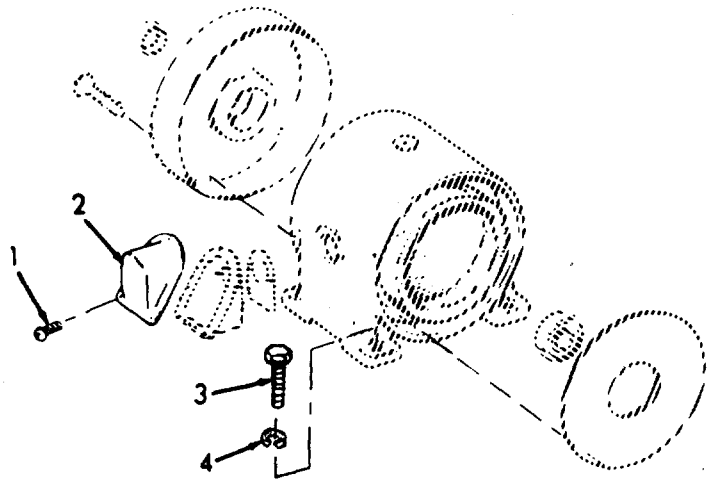
5-51. WINCH MOTOR - BOW RAMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Front end bearing (13), and rear end bearing (14)	Install.	Use an arbor press.
	k. Baffles (11 and 12)	Install.	
	l. Seal (10)	Install.	
	m. Bearing brackets (7 and 8)	Install.	
	n. Three bolts (6), and nuts (5)	Install.	



5-51. WINCH MOTOR - BOW RAMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Motor	Lift with chain hoist and lower into position.	
	b. Screws (3), and lockwashers (4)	Install.	
	c. Torque coupling	Install.	Refer to paragraph 3-118.
	d. Wiring	Install.	
	e. Terminal box cover (2), and screws (1)	Install.	



5-52. CONTROLLER - BOW RAMP - MAINTENANCE INSTRUCTIONS.

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

INITIAL SETUP:

Test Equipment
NONE

Special Tools
NONE

Material/Parts
NONE

Personnel Required
2

References
NONE

Equipment Condition
Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

In order to avoid shock and possible injury, tag and place disconnect switches and circuit breakers in the OFF position.

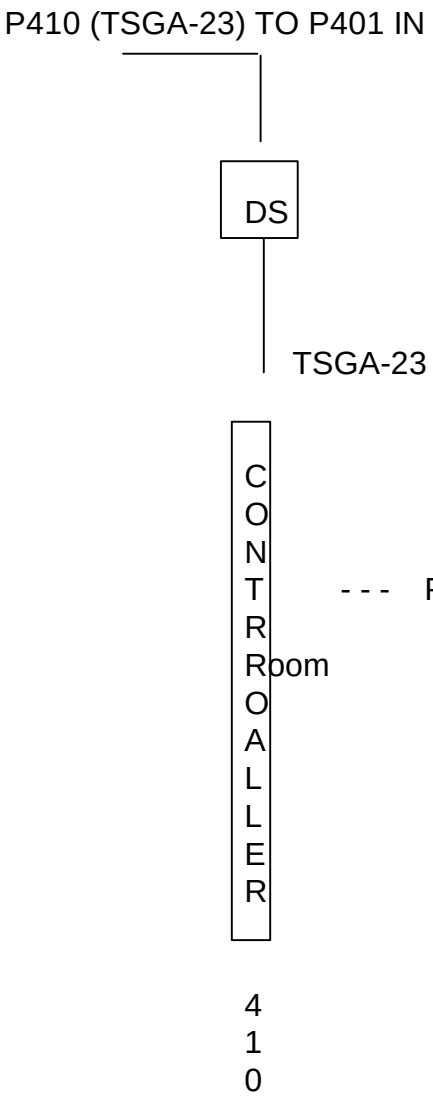
REPLACE

1. Controller	a. Wiring	Tag and disconnect.	Refer to wiring diagram.
	b. Mounting hardware	Remove.	
	c. Controller	Replace.	
	d. Mounting hardware	Install.	
	e. Wiring	Reconnect.	Refer to wiring diagram.

5-52. CONTROLLER - BOW RAMP - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



- - -	P410-E	(MSCA-14)	Pushbutton in Pilot House
	410-F	(MCCA-14)	Pushbutton in Ramp Winch
	410-A	(MSCA-10)	Pushbutton Compartment 1-4-1-
	410-I	(TSGA-23)	Disconnect Switch
	410-G	(TSGA-4)	To Brake
	410-D	(DSGA-4)	Interlock Brake Handle
	410-B	(TSGA-9)	To Motor Ramp Winch
	410-C	(DSGA-4)	Slack Cable Switch

5-52. CONTROLLER - BOW RAMP - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPAIR

2. Repair the following parts as required:

ITEM	DESCRIPTION
1	Enclosure Assembly
2	Reset Assembly
3	Fuse Holder
4	Terminal Board
5	Bracket Mounting
6	Heater Thermal
7	Relay Assembly
8	Interlock Mechanical
9	Bracket Mounting
10	Terminal Board
11	Adapter
12	Bracket Mounting
13	Contactor Magnetic Size 2 440 Volt 3 Phase
14	Coil
15	Contact Electrical Movable
16	Contact Electrical Stationary
17	Spring Helical Compression
18	Spring Return
19	Contact Interlock Movable
20	Contact Interlock Stationary
21	Fascia Assembly

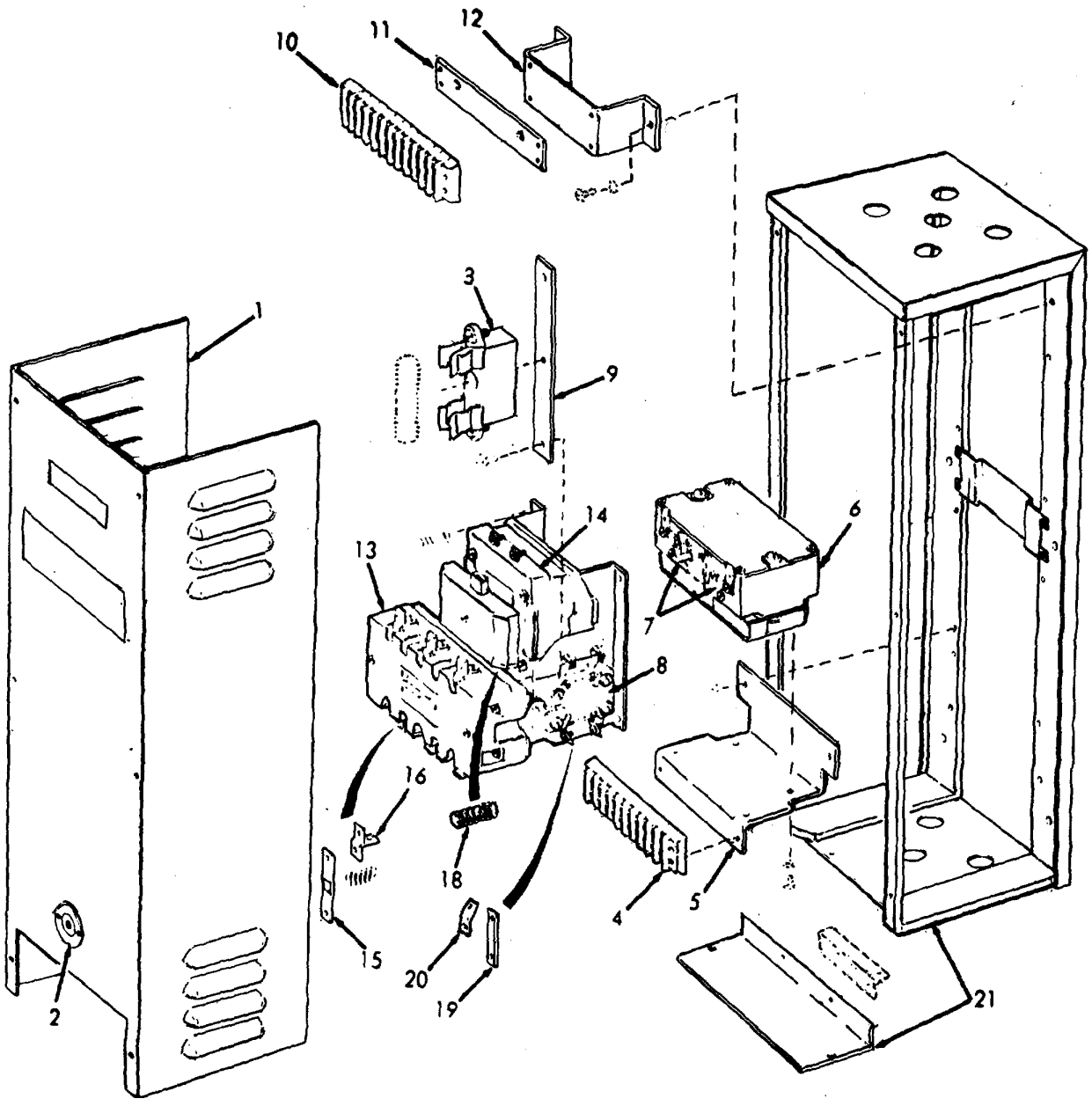
NOTE

There is no schematic available.

5-52. CONTROLLER - BOW RAMP - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-693

5-53. STERN GATE - OVERALL - MAINTENANCE INSTRUCTIONS.

The following is an index to the maintenance procedures:

DESCRIPTION	PARAGRAPH
Stern Gate	5-54
Gate Hinges and Springs	5-55
Portable Davit	5-56

5-54. STERN GATE - MAINTENANCE INSTRUCTIONS.

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

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Crane
Slings

Material/Parts

Grease MIL-G-10924
Type GAA

Personnel Required

2

References
Paragraph

5-55 Gate Hinges and Springs

Equipment
Condition Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

Observe standard safety precautions when lifting heavy items.

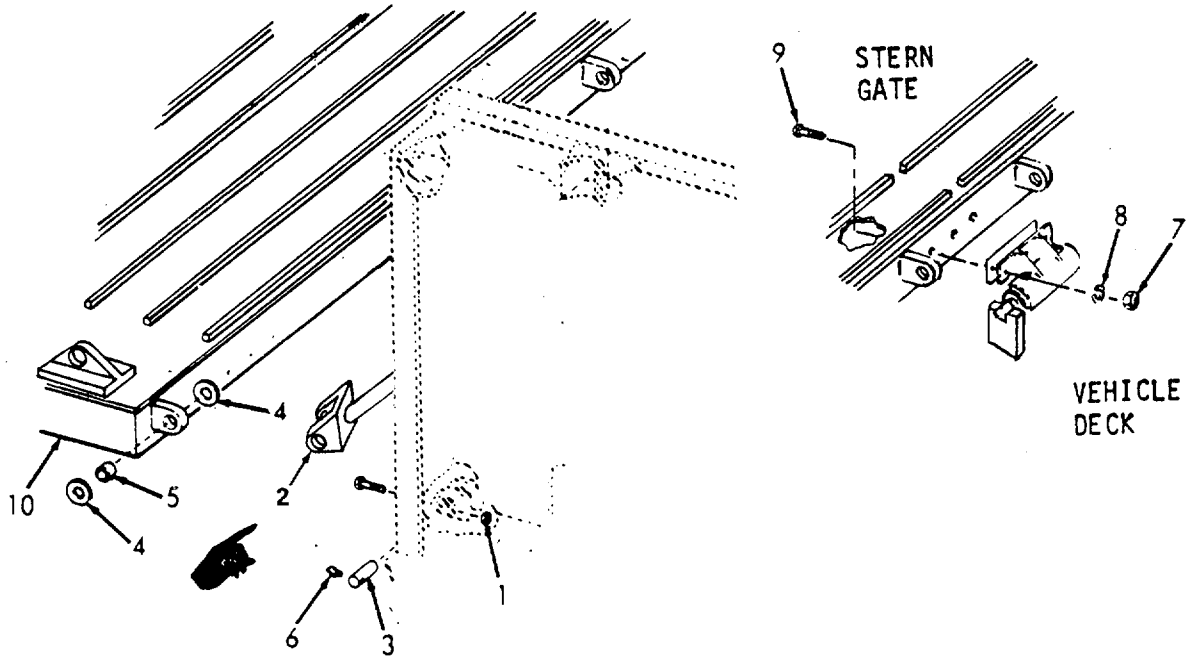
5-54. STERN GATE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
1. Stern Gate clevis	a. Hydraulic cylinder	Remove hardware that attaches cylinder to stern gate.	
	b. Hinge assembly	1. Remove nuts (1), and screws (2).	Four places.
		2. Remove pin (3), two washers (4), and bushing (5).	Four places.
		3. Remove lubrication fitting (6).	If necessary.
	c. Spring assembly	Remove nuts (7), lockwashers (8), and screws (9)	1. Seven places. 2. Wedge spring in the open position.
	d. Stern gate (10)	1. Attach slings.	
		2. Lift gate with crane.	
		3. Replace gate.	
	e. Spring assembly and nuts (7).	Install screws (9), lockwashers (8),	Wedge spring in the open position.
	f. Hinge Assembly	1. Install bushing (5), two washers (4), and pin (3).	
		2. Install screw (2), and nuts (1).	
	g. Hydraulic cylinder clevis	Install hardware that attaches cylinder to stern gate.	
	h. Lubrication fitting (6)	Grease.	Use grease MIL-G-10924 type GAA.

5-54. STERN GATE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



4951-184

REPAIR

2. Repair Stern Gate in accordance with existing procedures.

5-55. GATE HINGES AND SPRINGS - STERN GATE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Replace **b. Repair**

INITIAL SETUP:

Test Equipment

NONE

References
Paragraph

5-54 Stern Gate

Special Tools

NONE

Equipment
Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

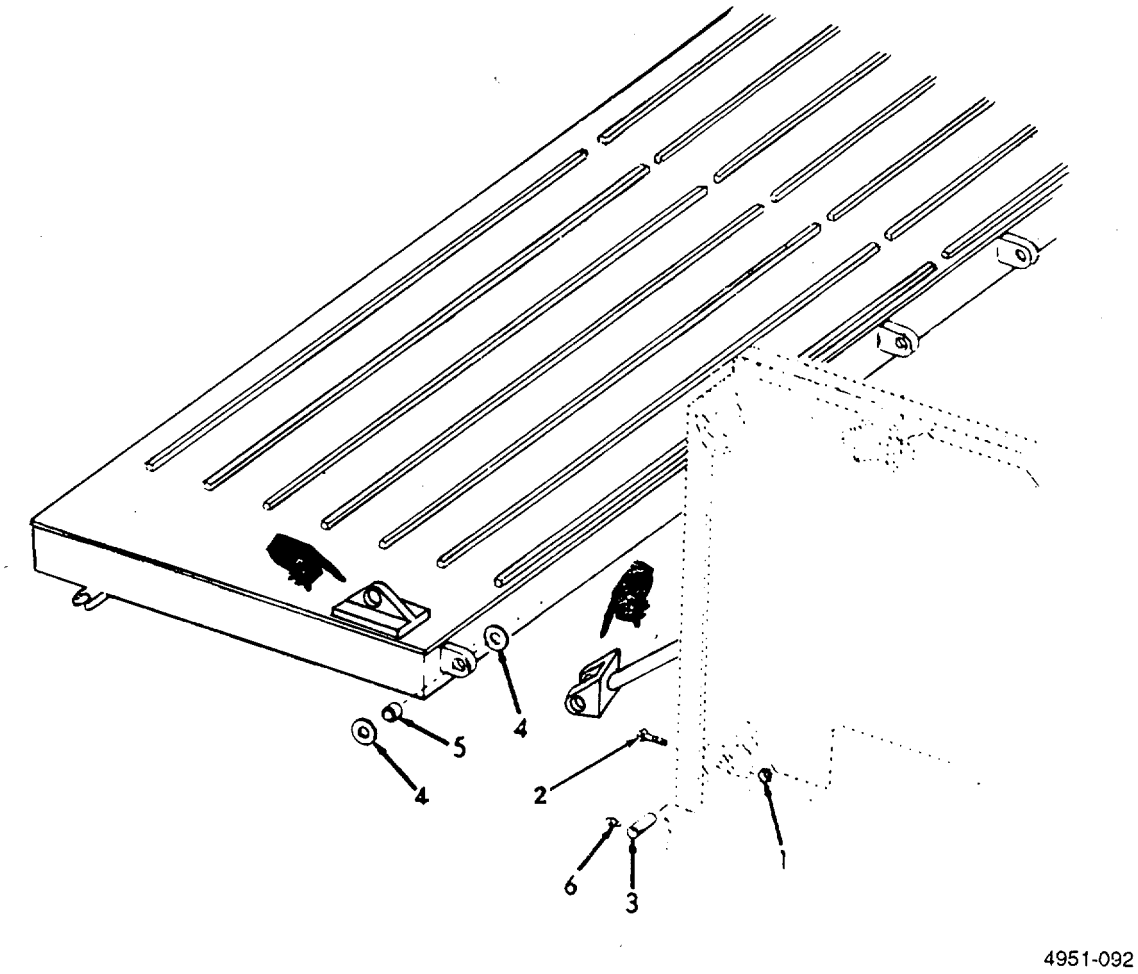
NONE

LOCATION	ITEM	ACTION	REMARKS
REPAIR OR REPLACE			
1. Gate Hinges	a. Nuts (1), and screws (2)	Remove.	
	b. Pin (3), two washers (4), and bushing (5)	Remove.	
	c. Lubri-cation fitting (6)	Remove.	If necessary.

5-55. GATE HINGES AND SPRINGS - STERN GATE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR OR REPLACE (Cont)



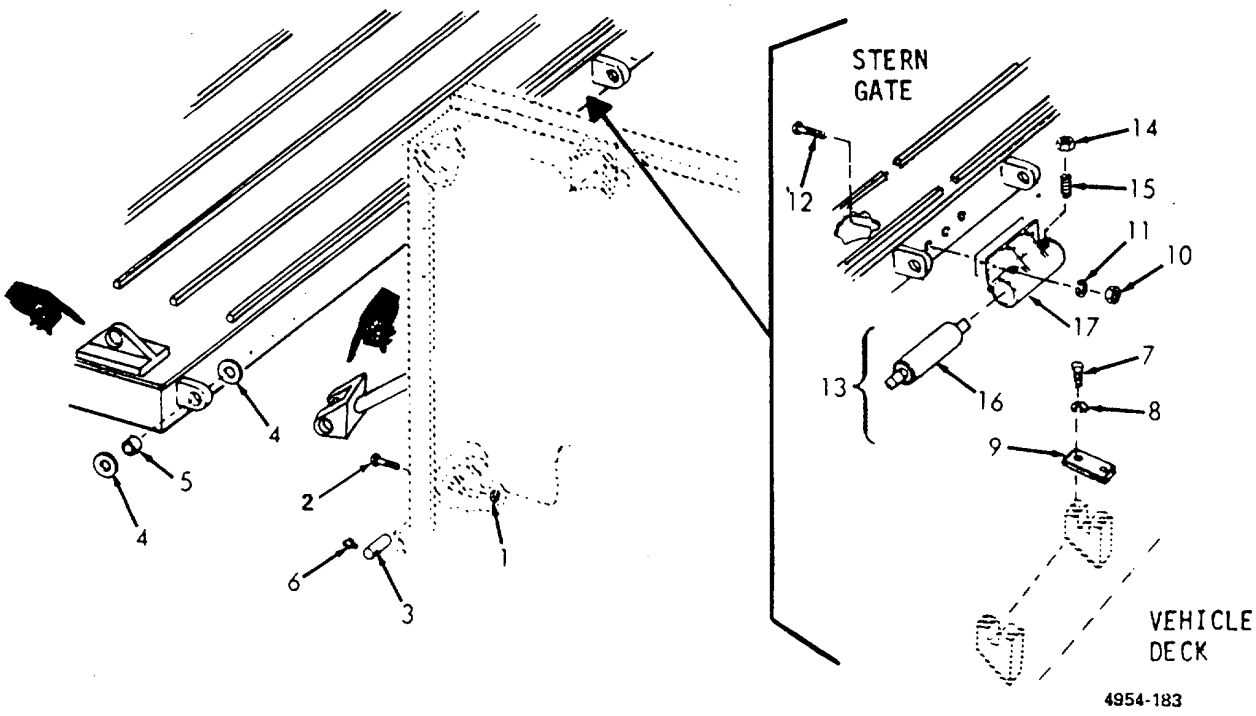
4951-092

5-55. GATE HINGES AND SPRINGS - STERN GATE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR OR REPLACE (Cont)			
	d. Bushing (5), washers (4), and pin (3)	Install.	
	e. Screws (2), and nuts (1)	Install.	
	f. Lubrication fitting (6)	Grease.	Use grease MIL-G-10924 type GAA.
2. Gate Springs	a. Screws (7), and lockwashers (8)	Remove.	
	b. Cover plates (9)	Remove.	
	c. Nuts (10), lockwashers (11), and screws (12)	Remove.	
	d. Spring assembly (13)	Remove.	
	e. Locknuts (14), and setscrews (15)	Remove.	Four places.
	f. Spring (16)	Remove from bracket (17).	

5-55. GATE HINGES AND SPRINGS - STERN GATE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR OR REPLACE (Cont)			
	g. Spring (16)	Install in bracket (17).	
	h. Setscrews (15), and locknuts (14)	Install.	Four places.
	i. Spring assembly (13)	Install.	
	j. Screws (12), lockwashers (11), and nuts (10)	Install.	
	k. Cover plates (9), lock-washers (8), and screws- (7)	Install.	



5-56. PORTABLE DAVIT - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Repair

INITIAL SETUP:

Test Equipment

NONE

References
Paragraph

5-54 Stern Gate

Special Tools

NONE

Equipment
Condition Condition Description

NONE

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
1.	Portable Davits	Repair davits in accordance with standard procedures.	

*U.S. GOVERNMENT PRINTING OFFICE: 1992 - 654-028160075

5-57. ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

The following is an index to the Anchor Winch maintenance instructions:

DESCRIPTION	PARAGRAPH
Winch Assembly	5-58
Universal Joint Assembly	5-59
Drive Brake Assembly	5-60
Drive Gear Assembly	5-61
Level Wind Assembly	5-62
Frame and Drum Assembly	5-63
Slack Puller and Motor Assembly	5-64
Disconnect Clutch Assembly	5-65
Torque Converter	5-66
Hydraulic Tank	5-67

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal **b. Installation**

INITIAL SETUP:

Test Equipment

NONE

References

FO-1 Machinery - Vehicle Deck Access

Special Tools

Cutting tools
Welding tools
Crane (20 ton)
Misc. chains

Equipment Condition: NONE

Condition Description

Material/Parts

NONE

Special Environmental Conditions

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

Personnel Required

8

General Safety Instructions

Observe normal precautions when handling heavy equipment.

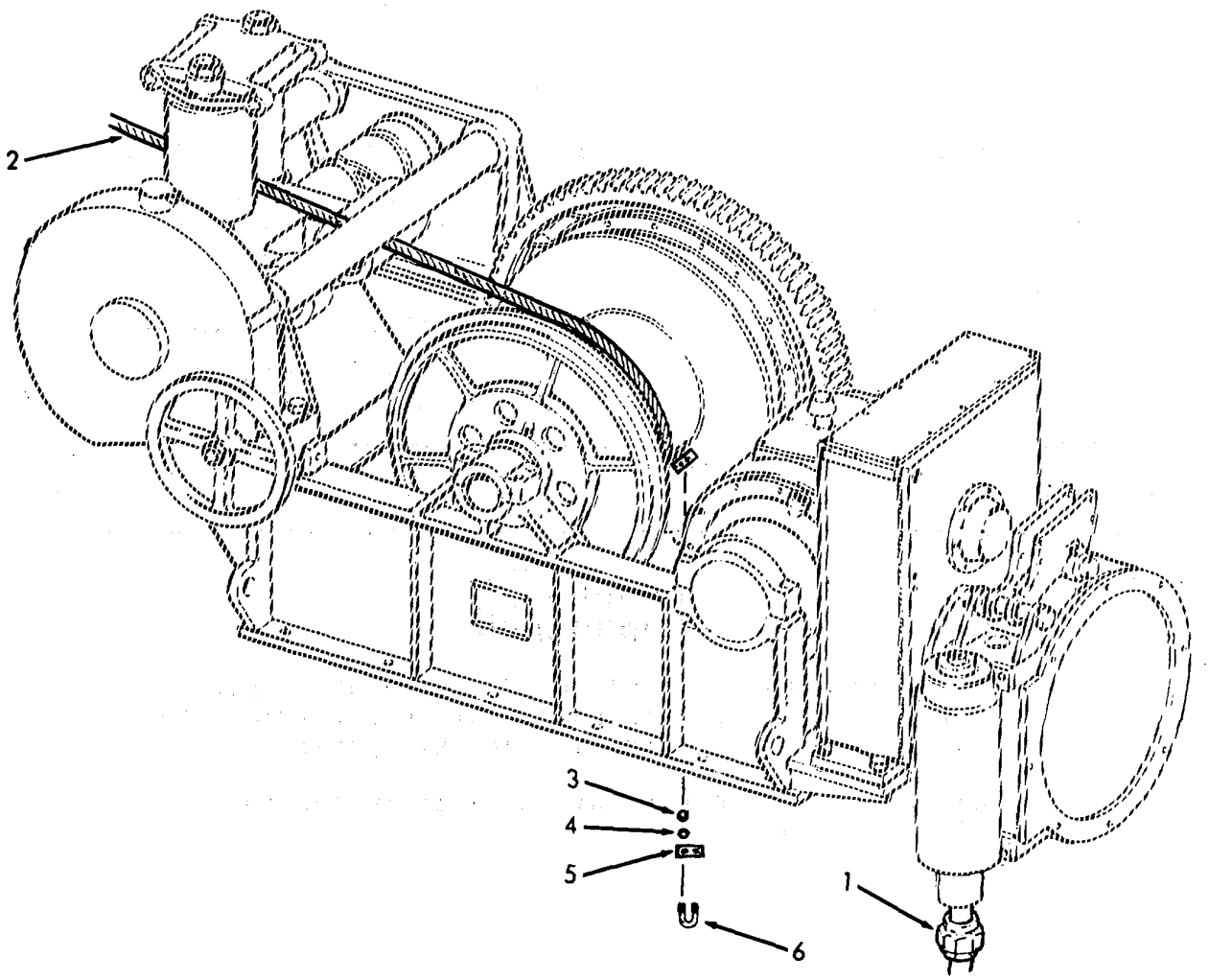
LOCATION	ITEM	ACTION	REMARKS

WARNING

- To prevent the possibility of a fire when using cutting or welding equipment, place a crewman above and below the deck with a fire extinguisher.
- Keep clear of the area directly below the deck section being removed.

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Anchor Winch Compartment	a. Hydraulic lines	1. Loosen union (1).	
		2. Drain fluid.	Drain fluid into a suitable container.
		3. Disconnect.	
	b. Cable	1. Remove all cable (2) from drum. 2. Remove nuts (3), lockwashers (4), and U-bolt (6).	



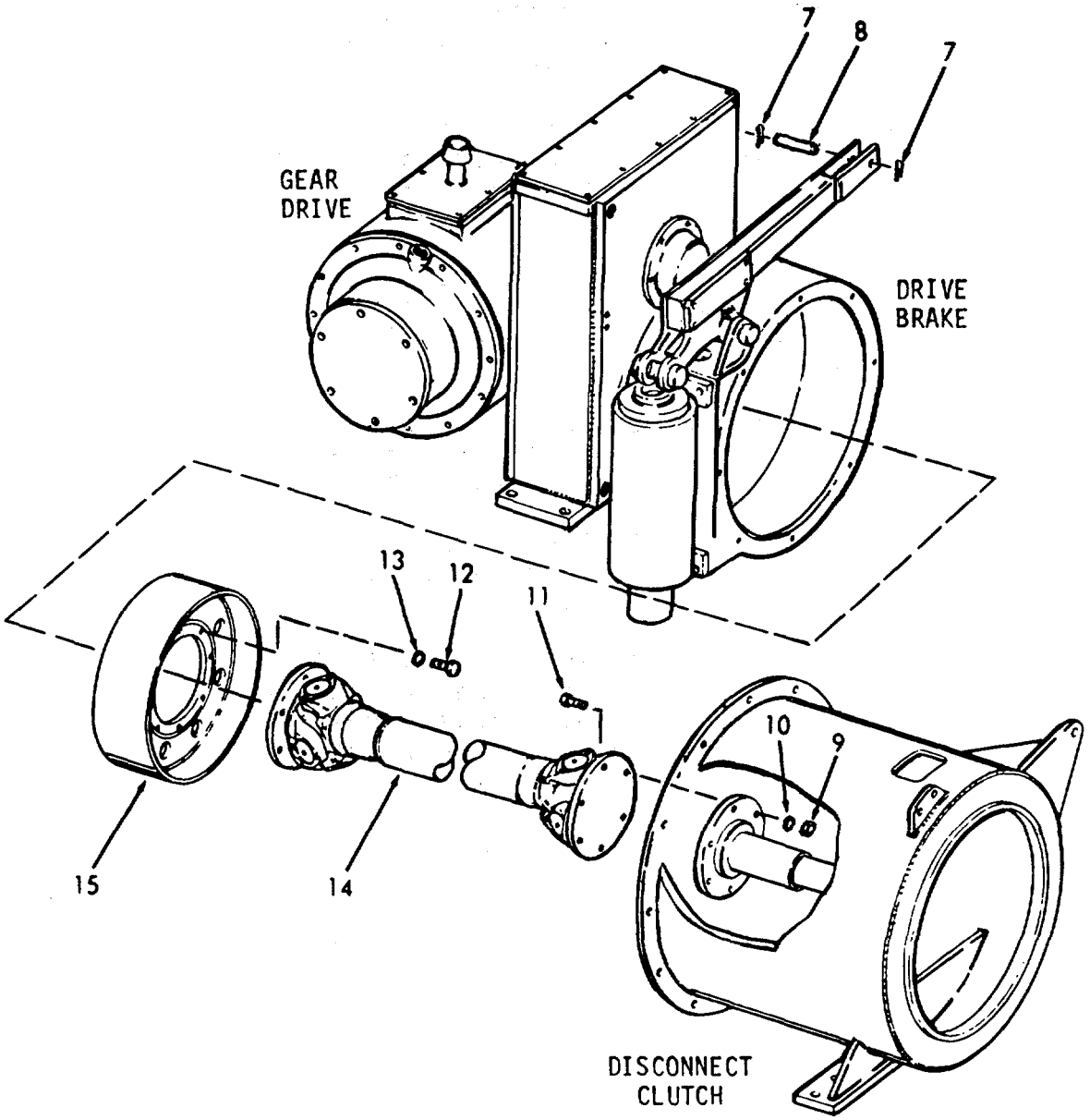
5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Brake lever pin (8).	1. Remove cotter pins (7), and	
	d. Deck plates	Remove as needed for access to the universal joint assembly.	
	e. Universal joint at disconnect clutch	Remove nuts (9), lockwashers (10), and screws (11).	
	f. Universal joint	1. Remove screws (12), and lock-washers (13). 2. Remove universal joint assembly (14). 3. Brake wheel (15) is loose and should be removed from the drive brake.	

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

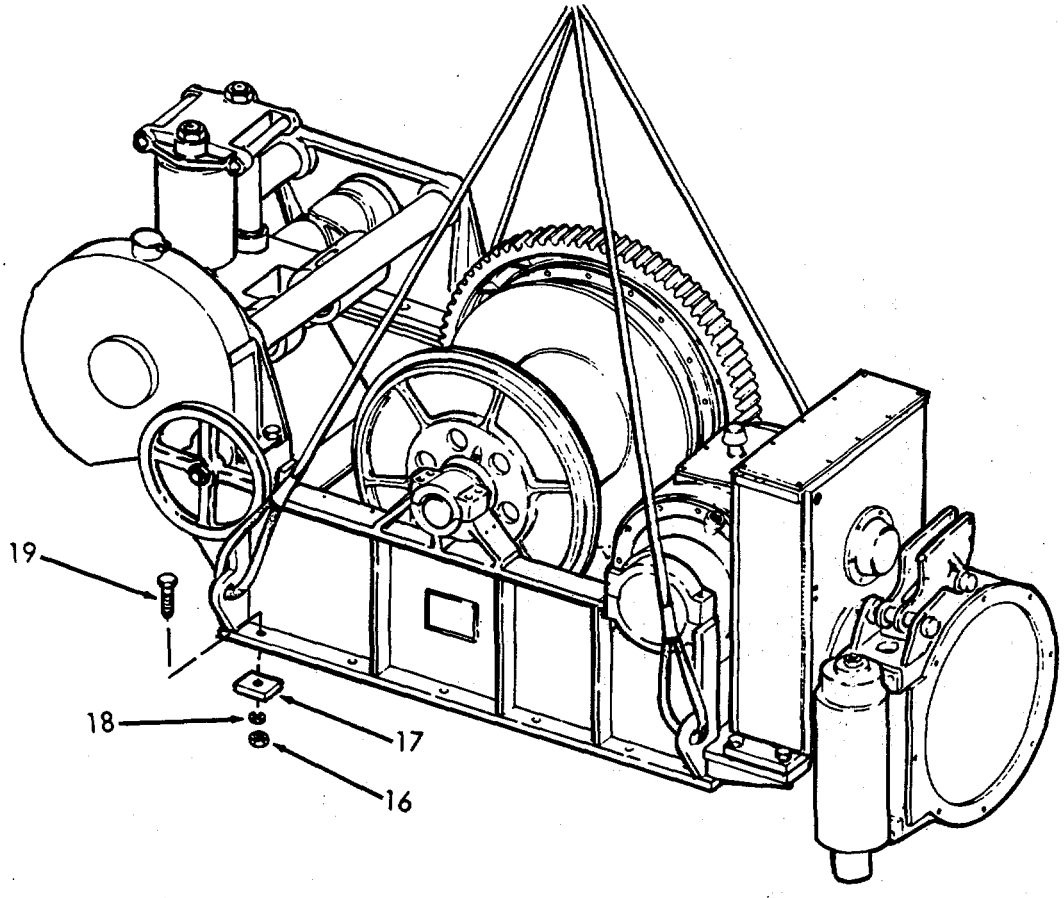
REMOVAL (Cont)



5-707

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

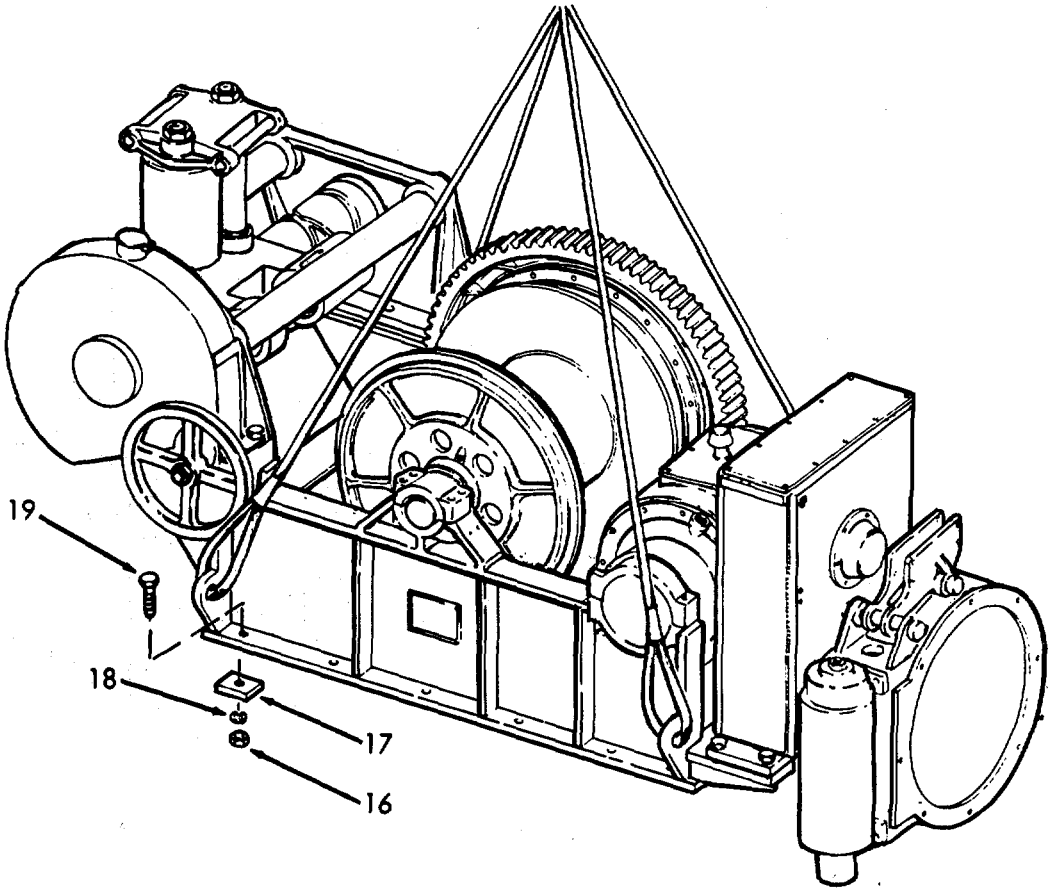
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	g. Frame	1. Remove nuts (16), lockwashers (17), steel chocks (18), and screws (19). 2. Attach cables to winch at lifting points.	



2. Vehicle Deck	a. Deck plate	Remove.	Refer to FO-1.
	b. Anchor winch	Remove.	

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3. Anchor Winch	a. Winch	1. Replace. 2. Align mounting holes.	
	b. Screws (19), steel chocks (18), lockwashers (17), and nuts (16)	Install.	



4. Vehicle Deck	Deck plate	Replace.	

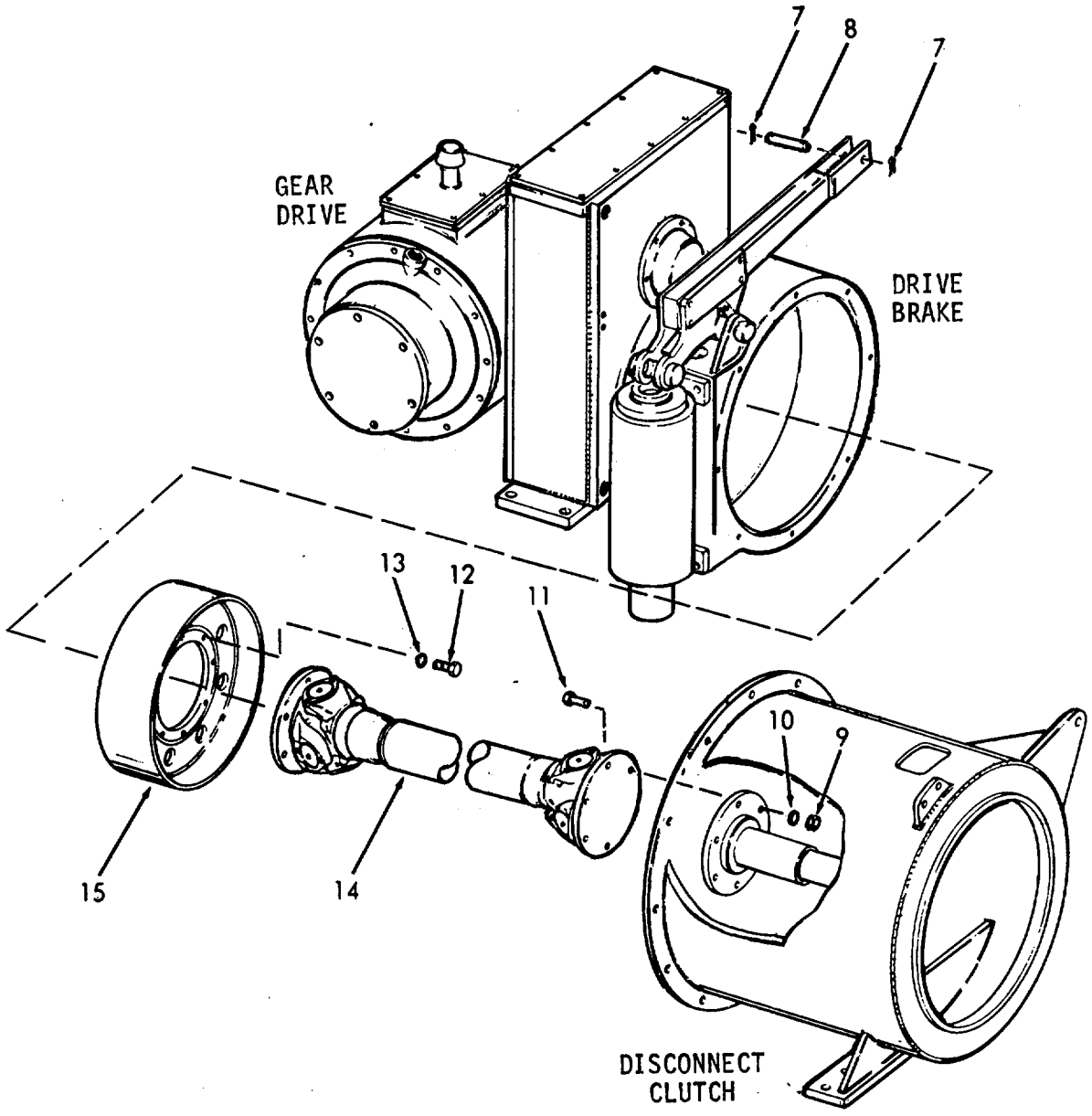
5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
5. Anchor Winch Compartment	a. Brake wheel (15), and universal joint assembly (14)	Align holes.	
	b. Screws (12), and lock-washers (13)	Install through brake wheel into drive brake.	
	c. Screws (11), lock-washers (10), and nuts (9)	Install onto disconnect clutch.	
	d. Deck plates	Replace.	
	e. Pin (8), and cotter pins (7)	Install into brake lever.	

5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

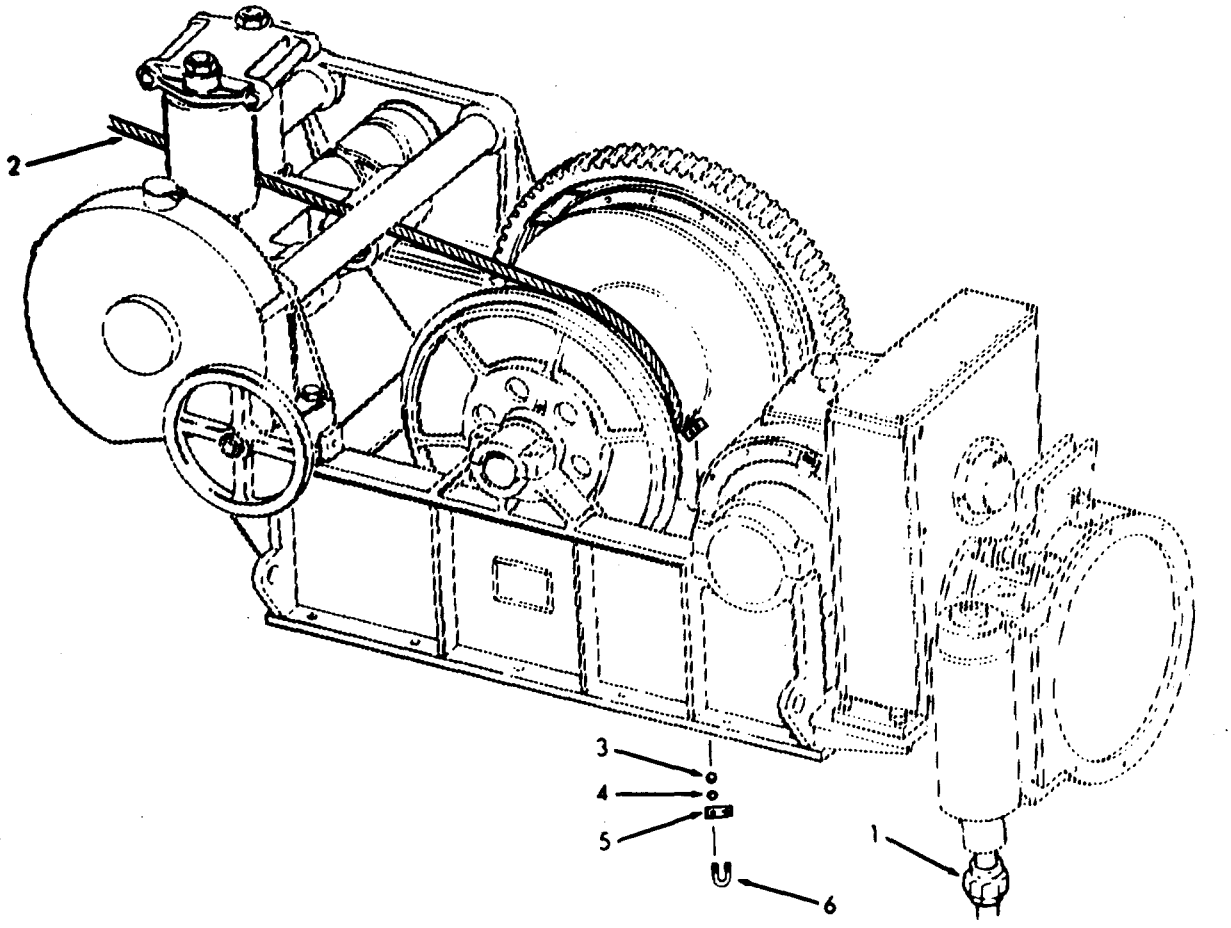
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



5-58. ANCHOR WINCH ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	f. Cable (2) U-bolt (6), clamp-plate (5), lockwashers (4), and nuts (3)	Install onto drum.	
	g. Union (1)	Reconnect.	



6. Anchor Winch Engine	a. Operate engine.		
	b. Observe level in hydraulic tank, and add hydraulic fluid if necessary.		
	c. Operate winch to rewind cable onto drum.		

5-59. UNIVERSAL JOINT ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

This task covers: Repair

INITIAL SETUP

Test Equipment

NONE

Special Tools
Arbor press

Material/Parts

Grease MIL-G-81322 type GH
Repair kit P/N 5-280X

Personnel Required

2

References

Para 5-58 Universal Joint Removal

Equipment Condition: NONE

Special Environmental Conditions

NONE

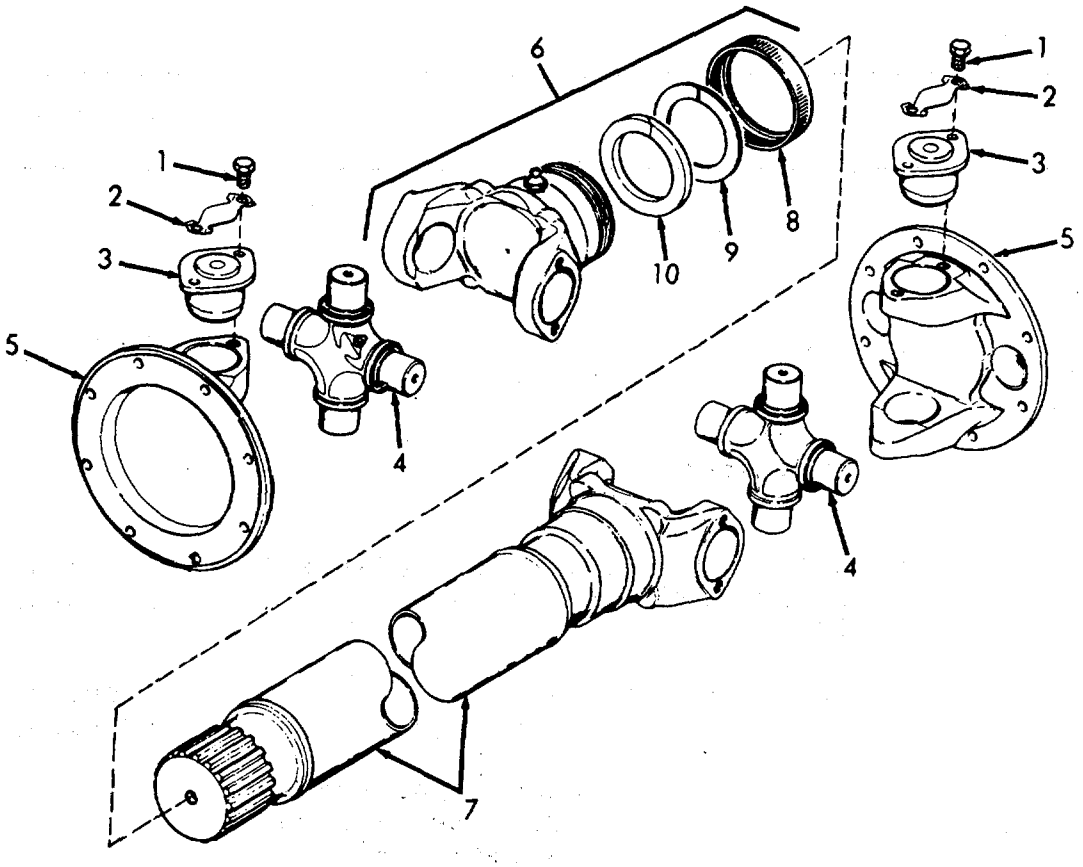
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
1. Universal Joint	a. Screws (1), and cross bearing lock strap (2)	Remove four places for each cross.	Discard.
	b. Bearing assemblies (3)	Remove four places for each cross.	Discard, if necessary.
	c. Cross (4)	1. Remove from yoke flange (5). 2. Remove one cross from the slip yoke assembly (6).	Discard crosses,' if necessary.

5-59. UNIVERSAL JOINT ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		3. Remove the other cross from the drive shaft (7).	
	d. Slip joint dust cap (8)	Loosen.	
	e. Drive shaft (7)	Remove from slip yoke (6).	
	f. Dust cap (8), split flatwasher (9), and cork washer (10)	Remove from slip yoke (11).	



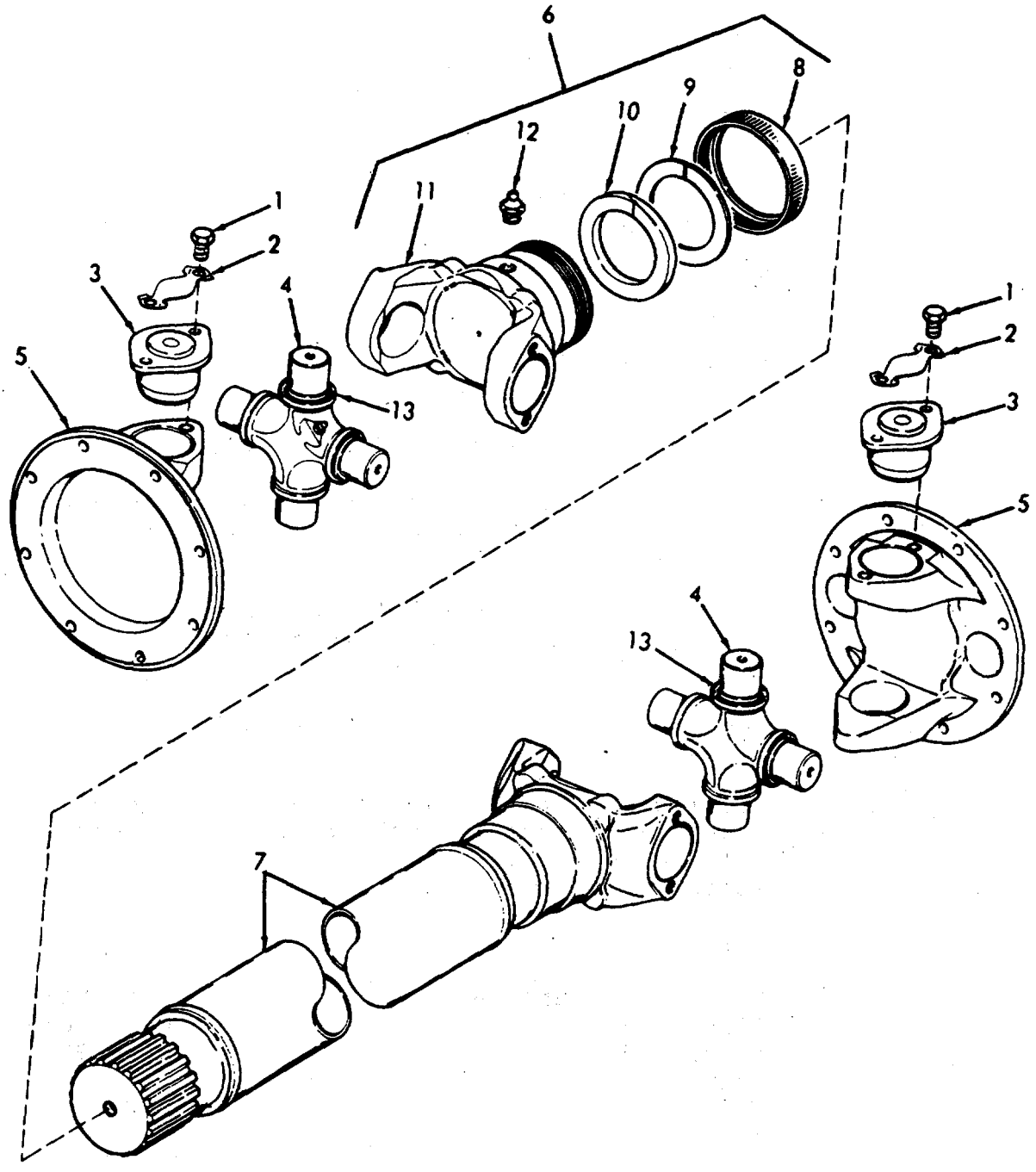
5-59. UNIVERSAL JOINT ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Lubrication fitting (12)	Replace.	If necessary.
	h. Dust cap (8), split flatwasher (9), and cork washer (10)	Slide onto drive shaft (7).	
	i. Drive shaft (7), and	1. Install in slip yoke (11). Parts 2. Tighten dustcap (8).	
	j. Crosses (4)	1. Install one in the slip yoke assembly (6). 2. Install the other in the drive shaft (7)-	Use new crosses, if necessary
	k. Yoke flange (5)	Install on crosses (4).	
	1. Bearing assemblies (3), lockstraps (2), and screws (1)	Install in all four ends of each cross.	Use new parts, if necessary.
	m. Lubrication fittings (12 and 13)	Grease.	Use grease MIL-G-81322, type GH.

5-59. UNIVERSAL JOINT ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-59. UNIVERSAL JOINT ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

This task covers: **Repair**

LOCATION	ITEM	ACTION	REMARKS

INITIAL SETUP

Test Equipment

NONE

Special Tools

NONE

Material/Parts

NONE

Personnel Required

2

References

NONE

Equipment Condition — Condition Description

Paragraph	
3-130	Drive Brake
5-58	Winch Assembly

Special Environmental Conditions

NONE

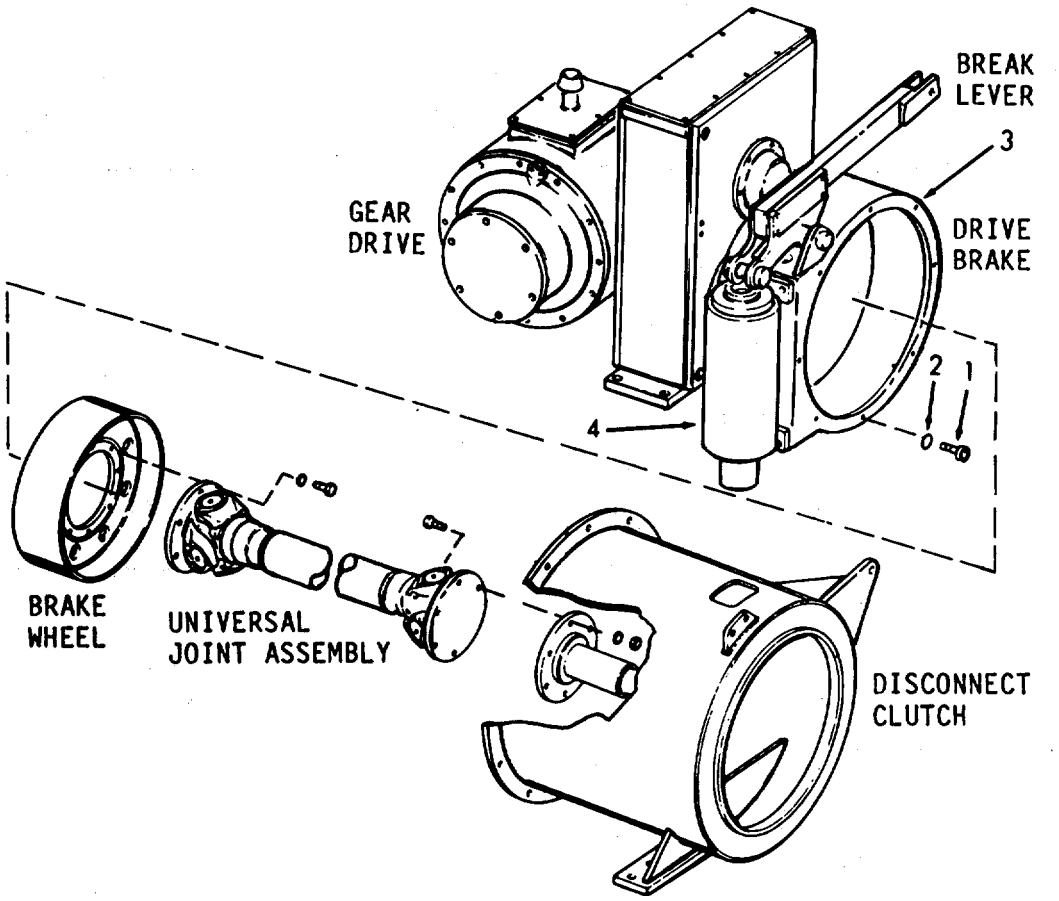
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
REPAIR.			
1. Drive Brake	a. Universal joint assembly	Remove.	Refer to paragraph 5-58.
	b. Brake wheel	Remove.	Refer to paragraph 5-58.
	c. Drive brake	Disassemble.	Refer to paragraph 5-130.
	d. Brake lever	Remove.	Refer to paragraph 5-58.
	e. Screws (1), and lockwashers (2)	Remove.	

5-60. DRIVE BRAKE ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Housing (3)	Repair and replace.	
	g. Cylinder (4)	Repair and replace.	
	h. Brake 1ever	Install.	Refer to paragraph 5-58.
	i. Drive brake	Reassemble	Refer to paragraph 5-130.
	j. Brake wheel and universal joint y	Install.	Refer to paragraph 5-58.



5-60. DRIVE BRAKE ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:
a. Removal **b. Disassembly** **c. Reassembly**
d. Installation

LOCATION	ITEM	ACTION	REMARKS

INITIAL SETUP

Test Equipment

NONE

Special Tools
Chain hoist
Sling
Bearing puller
Gear puller

Material/Parts

Oil MIL-L-2105 type G090
[10 gallon (37.85 liters)]

Personnel Required

2

References

NONE

Equipment

Condition	Condition Description
5-60	Drive Brake Removed

Special Environmental Conditions

NONE

General Safety Instructions

Observe standard safety precautions when lifting heavy equipment.

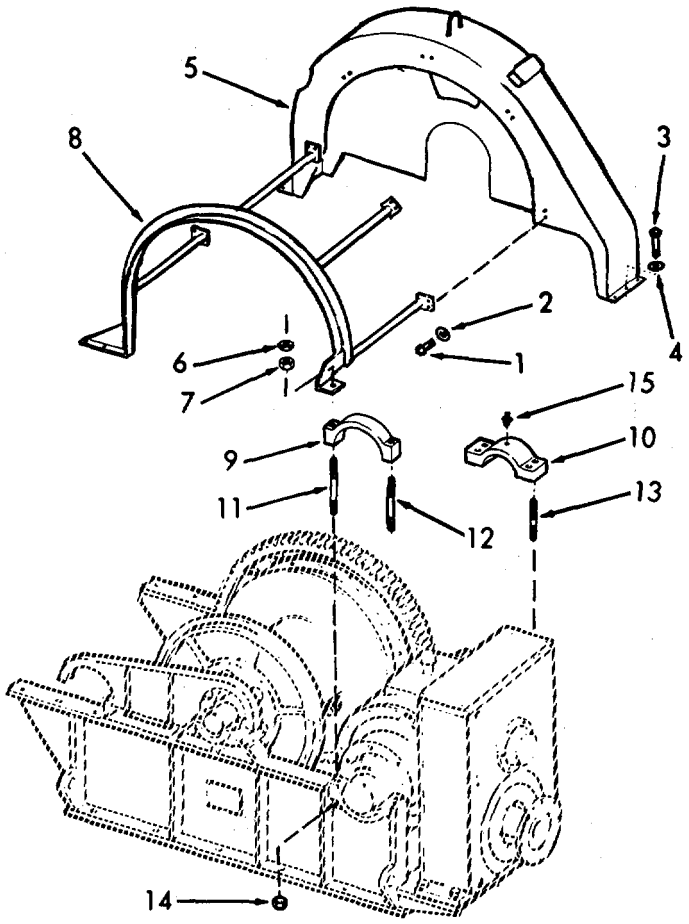
LOCATION	ITEM	ACTION	REMARKS

REMOVAL

1.	Gear Guards	a. Screws (1), and lockwashers (2)	Remove ten places.
		b. Screws (3), and lockwashers (4)	Remove six places.
		c. Gear guard (5)	Remove.
		d. Plain nuts (6), and jam nuts (7)	Remove six places.

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Drum guard (8)	Remove.	
	f. Pedestal caps (9 and 10)	Remove.	
	g. Studs (11, 12, or 13) and stop nuts (14)	Remove.	If necessary.
	h. Lubrication fitting (15)	Remove.	If necessary.



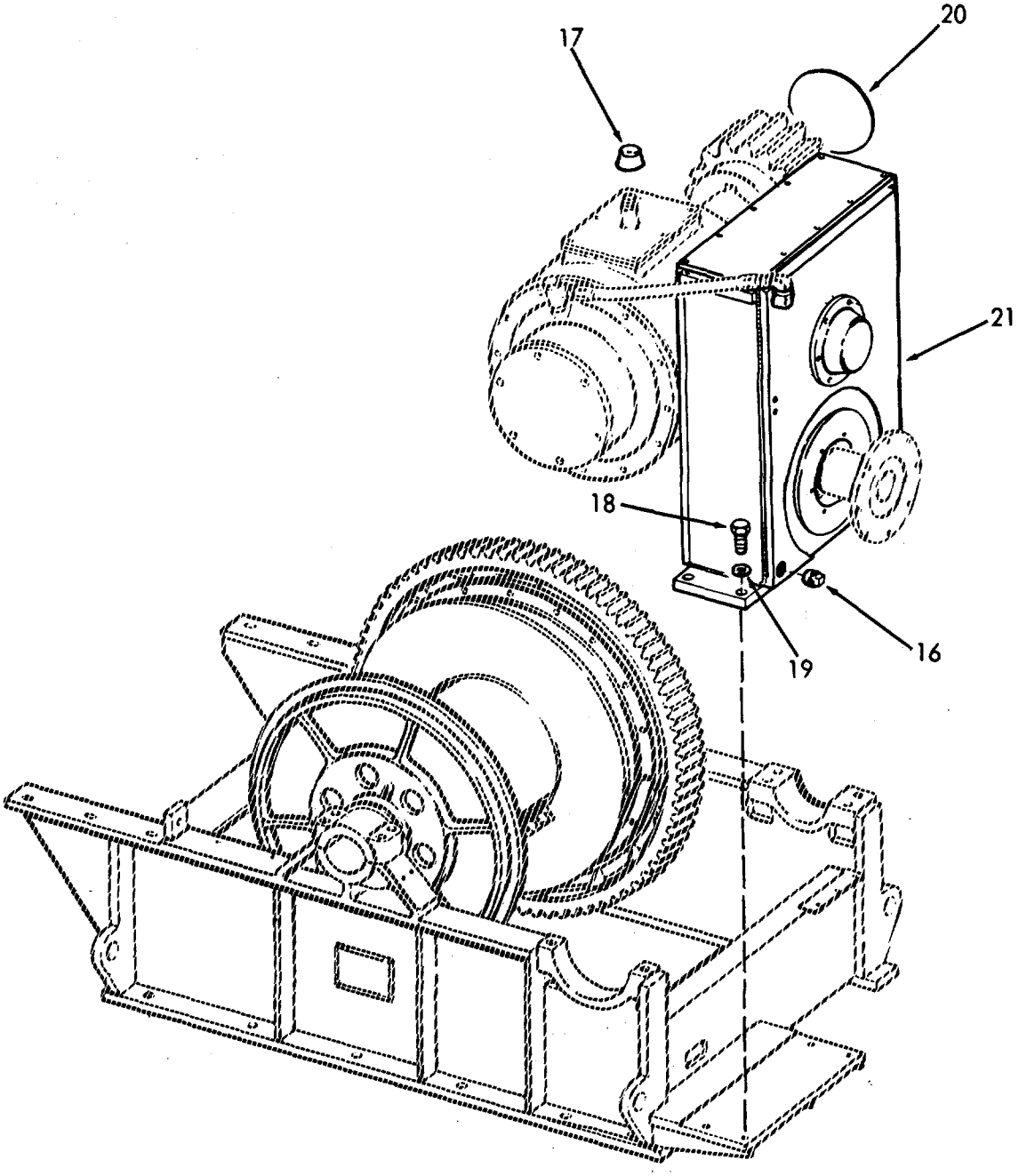
5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2. Drive Gear	a. Drive brake	Remove.	Refer to paragraph 5-60.
	b. Pipe plug (16)	1. Remove.	
		2. Drain oil.	Use a suitable container and dispose oil of properly.
	c. Breather (17)	Remove.	Clean.
	d. Screws (18), and lockwashers (19)	Remove.	
	e. Bearing seal cover (20)	Remove.	
	f. Drive gear (21)	1. Attach slings and chain hoist.	
		2. Lift up and remove.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

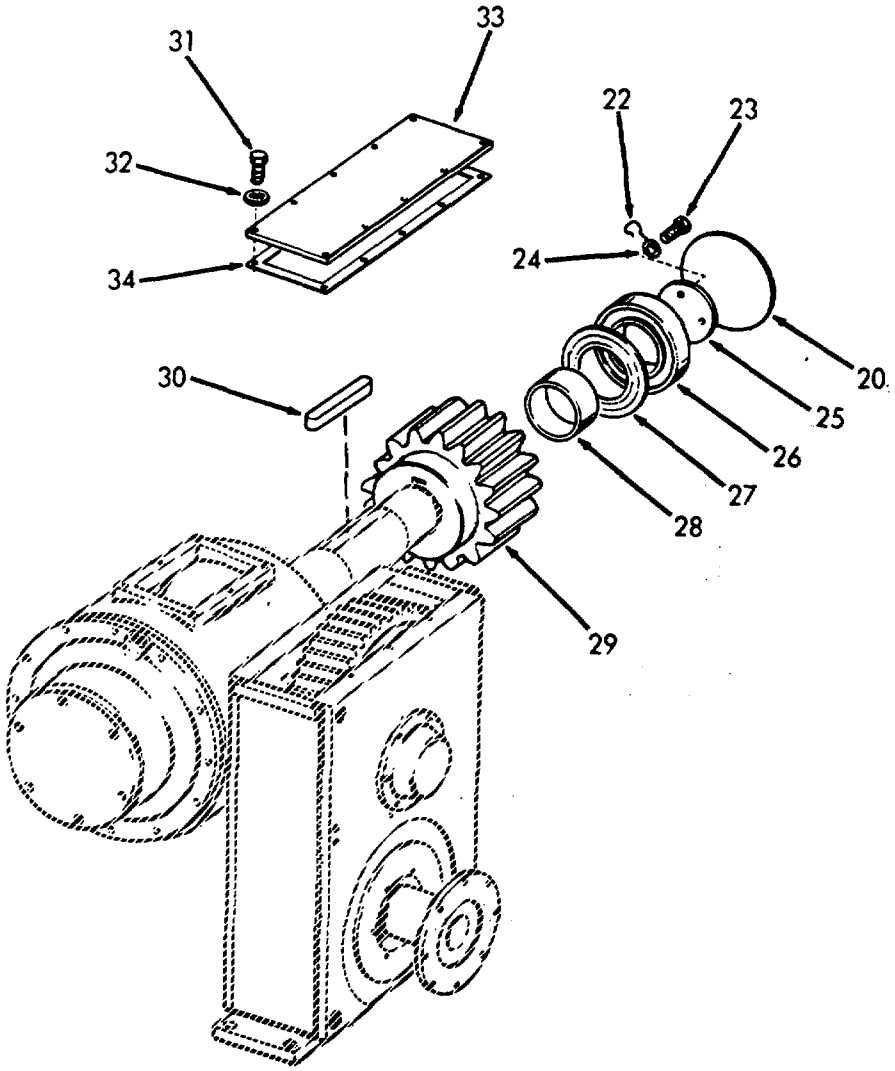


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Drive Gear Assembly	a. Safety wire (22)	Cut and remove.	
	b. Screws (23), and lock-washers (24)	Remove.	
	c. Bearing retaining cover (25)	Remove.	
	d. Bearing (26)	Remove.	Use bearing puller.
	e. Bearing cap seal (27), and spacer (28)	Remove.	
	f. Drive pinion (29)	Remove.	Use gear puller.
	g. Key (30)	Remove.	Tag for identification in reassembly.
	h. Screws (31), and lock-washers (32)	Remove.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	i. Cover (33), and gasket (34)	Remove.	Discard gasket.

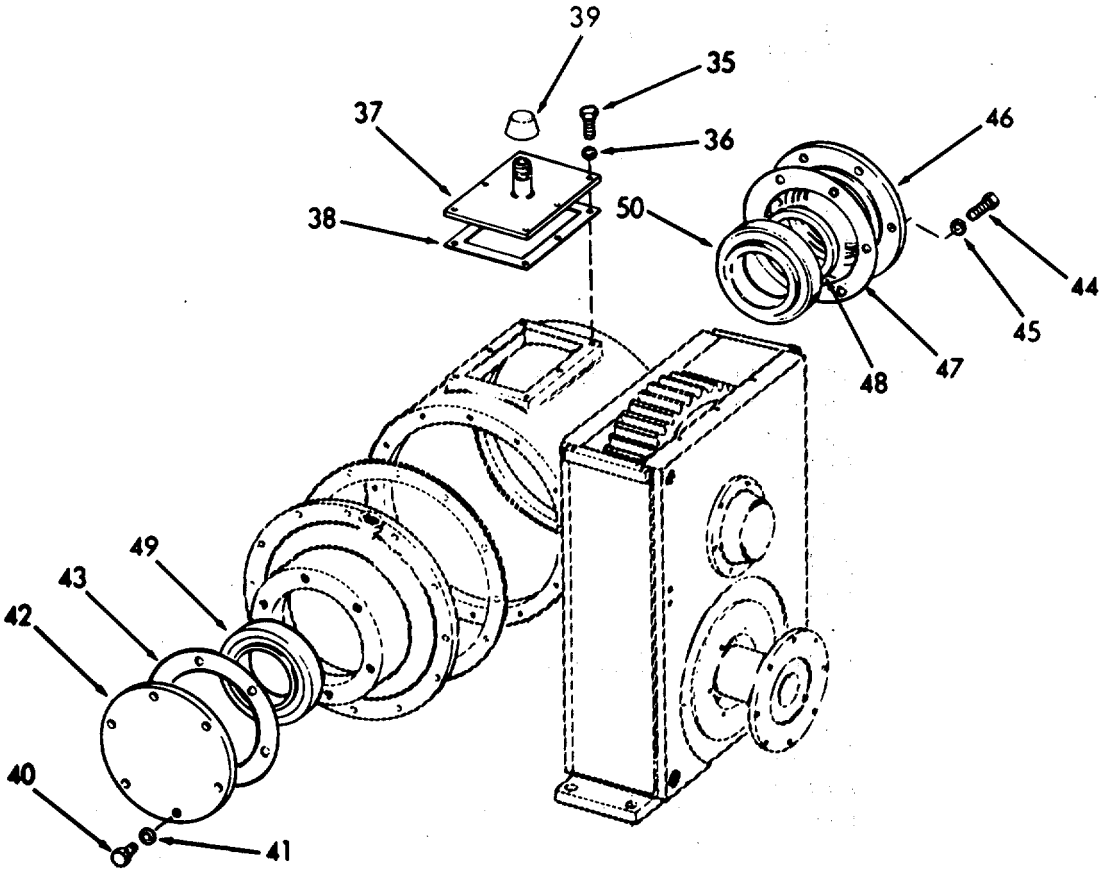


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	j. Screws (35), and lock-washers (36)	Remove.	
	k. Cover (37), and gasket (38)	Remove.	Discard gasket.
	1. Pipe nipple (39)	Replace.	If necessary.
	m. Screws (40), and lock-washers (41)	Remove.	
	n. Bearing carrier cover (42), and cover shim (43)	Remove.	
	o. Screws (44), and lock-washers (45)	Remove.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	p. Bearing carrier cover (46), cover shim (47), and seal (48)	Remove.	Discard seal.
	q. Bearings (49 and 50)	Remove.	Use bearing puller.

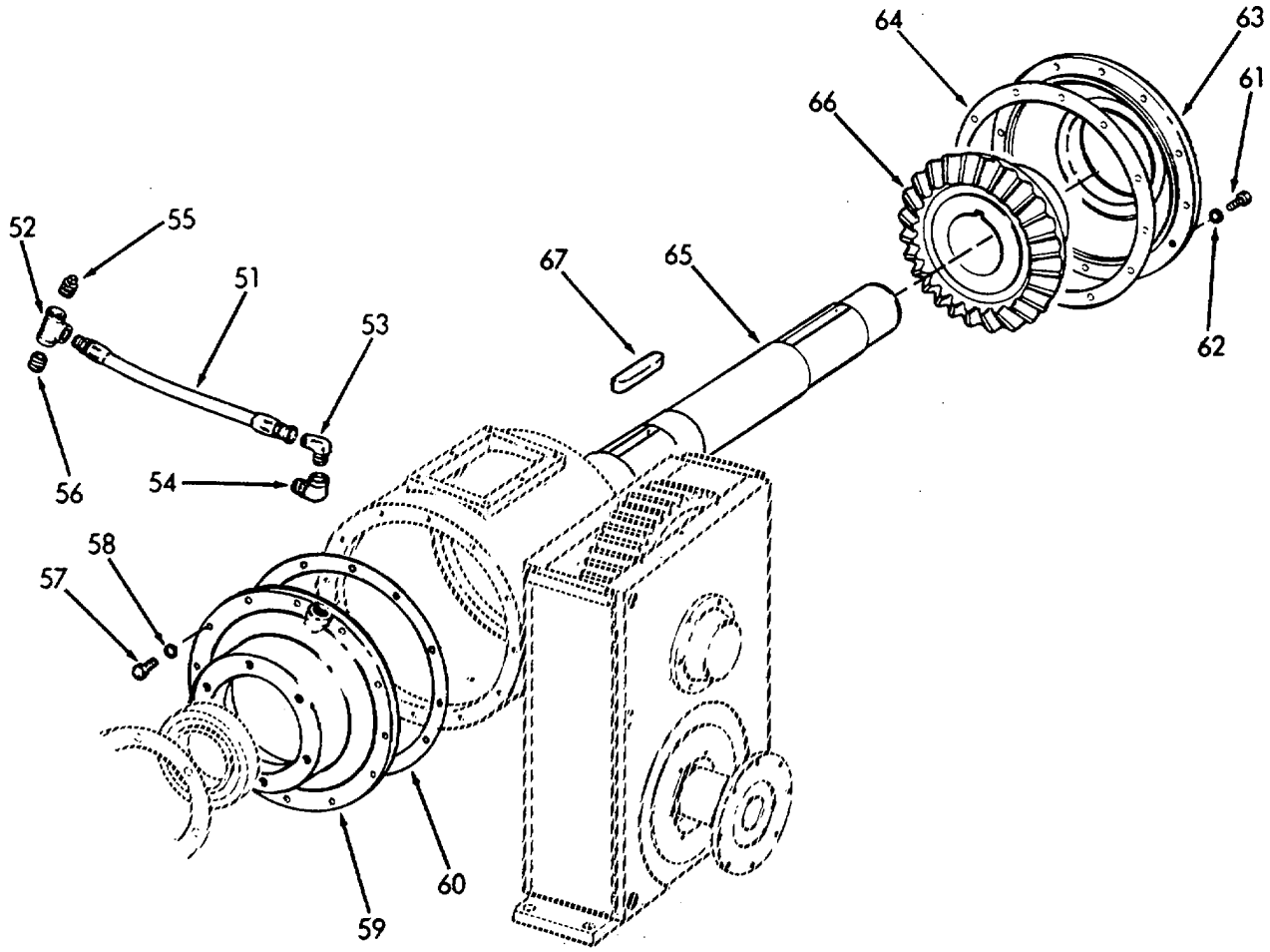


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	r. Flexible hose (51), tee (52), and elbows (53 and 54)	Remove.	
	s. Pipe plug (55)	Remove from tee (52).	If necessary.
	t. Pipe nipple (56)	Remove.	
	u. Screws (57), and lockwashers (58)	Remove.	
	v. Gear box carrier (59) , and gasket (60)	Remove.	Discard gasket.
	w. Screws (61), and lockwashers (62)	Remove.	
	x. Gear box carrier (63) , and gasket (64)	Remove.	Discard gasket.
	y. Shaft (65), and pinion gear (66)	1. Remove as an assembly. 2. Separate.	 Use arbor press.

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	z. Key (67)	Remove.	Tag for identification reassembly.

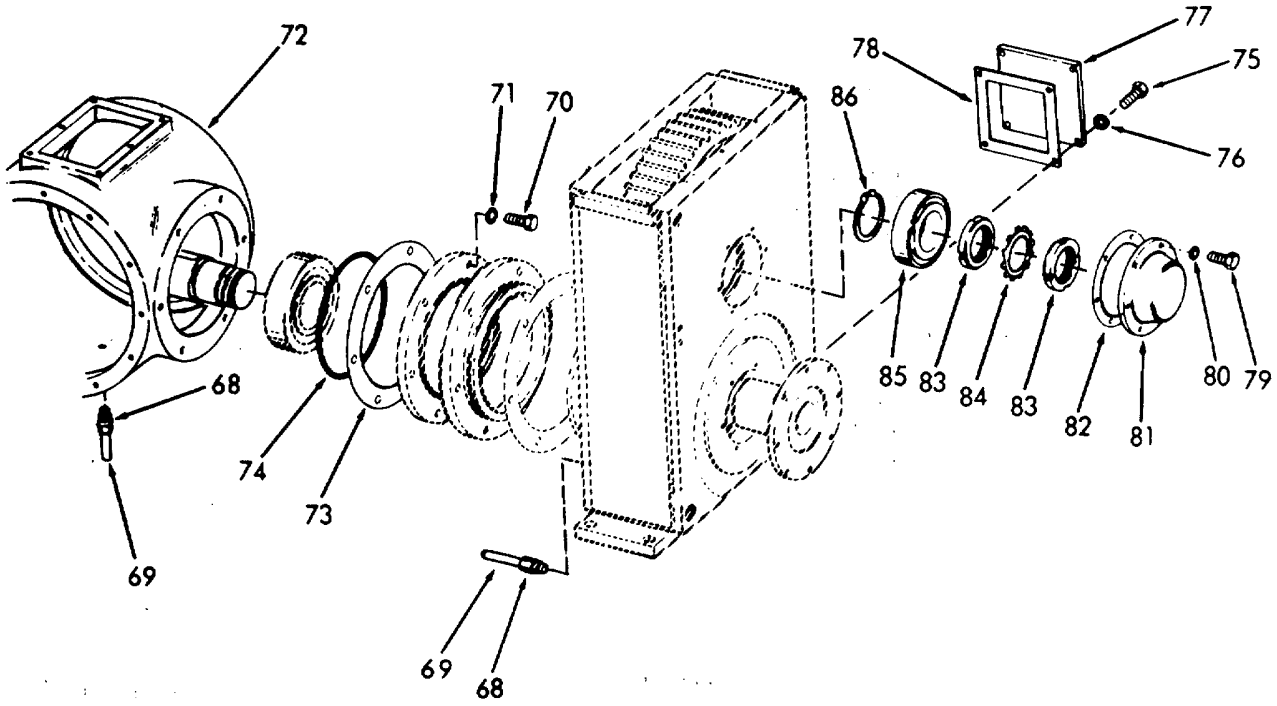


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	aa. Adapter (68), and tube (69)	Loosen and remove.	
	ab. Screws (70), and lockwashers (71)	Remove.	
	ac. Gear housing (72), gasket (73), and preformed packing (74)	Remove.	Discard gasket and preformed packing.
	ad Screws (75), and lockwashers (76)	Remove.	
	ae. Side cover (77), and gasket (78)	Remove.	Discard gasket.
	af. Screws (79), and lockwashers (80)	Remove.	
	ag. Bearing cover (81), and gasket (82)	Remove.	Discard gasket.
	ah. Locknuts (83), and lockwashers (84)	Remove.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	ai. Bearing (85), and snap ring (86)	Remove.	

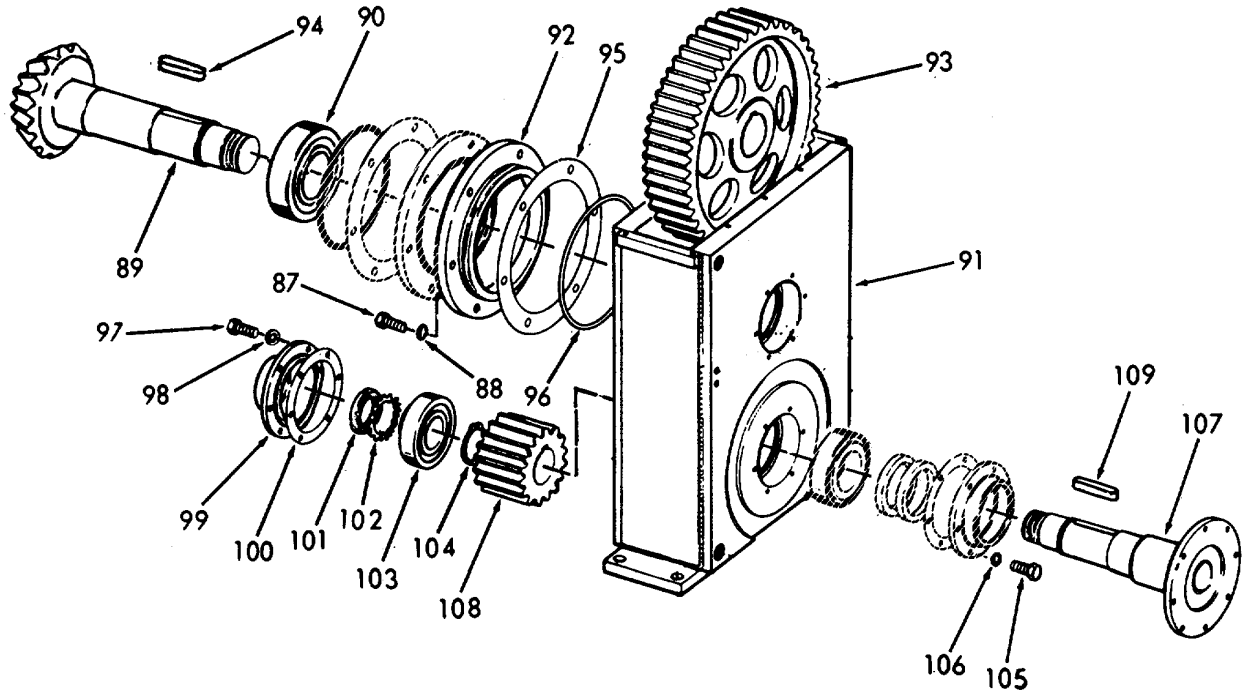


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	aj. Screws (87), and lockwashers (88)	Remove.	
	ak. Bevel pinion (89), bearing '(90), and bearing carrier (92)	1. Remove as an assembly. 2. Disassemble.	
	al. Pinion bevel gear (93), and key (94)	Remove from gear housing (91).	Tag key for identification during reassembly.
	am. Gasket (95), and preformed packing (96)	Remove.	
	an. Screws (97) and lockwashers (98)	Remove.	
	ao. Cover (99), and gasket (100)	Remove.	Discard gasket.
	ap. Locknuts (101), and lockwasher (102)	Remove.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	aq. Bearing (103), and snap ring (104)	Remove.	
	ar. Screws (105), and lockwashers (106)	Remove.	
	as. Shaft (107) , pinion (108), and associated parts	Remove from housing (91).	
	at. Pinion (108), shaft (107), and key (109)	Separate.	Tag key for identification during reassembly.

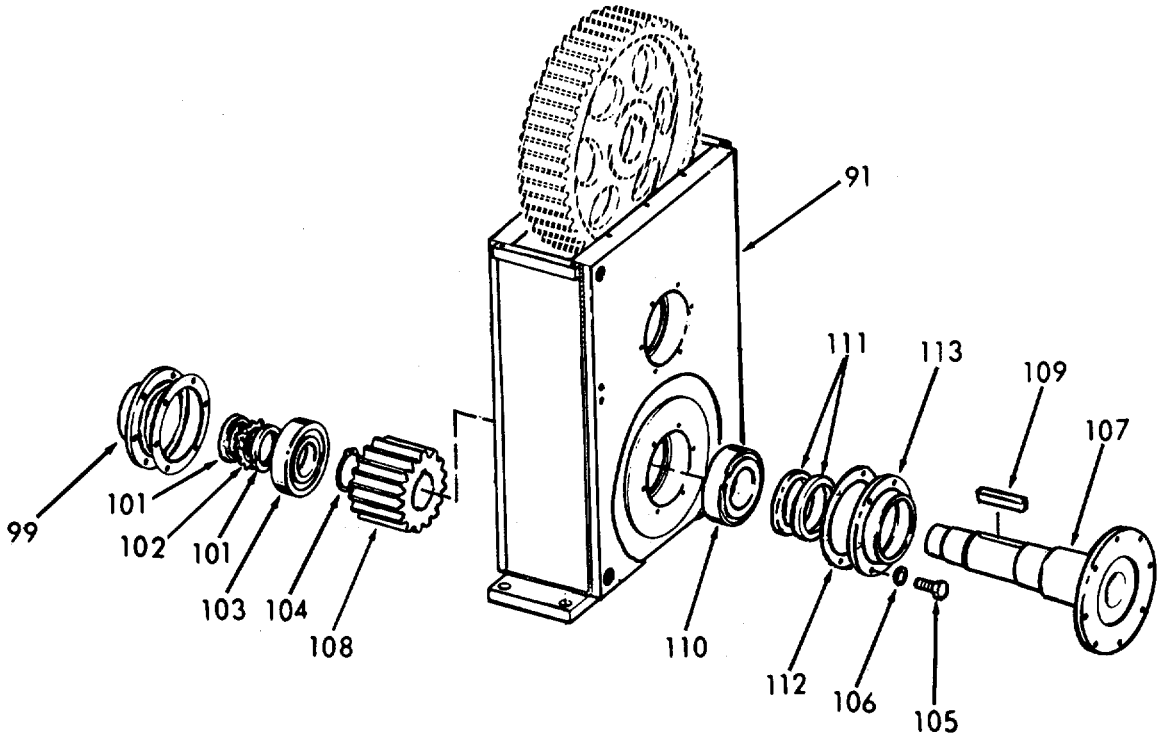


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	au. Bearing (110)	Remove from shaft (107).	
	av. Seals (111.), gasket (112), and cover (113)	Remove shaft (107).	Discard seals and gasket.
	aw. All parts	Inspect for wear and damage.	Discard all defective parts.
REASEMBLY			
4.	a. Cover (113), gasket (112), and seals (111)	Place on shaft (107). and seals.	Use new gasket
	b. Bearing (110)	Install on shaft (107).	
	c. Key (109), and pinion (108)	Install on shaft (107).	
	d. Shaft (107), pinion (108), and associated parts	Insert into housing (91).	
	e. Screws (105), and lockwashers (106)'	Install.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEM1BLY (Cont)			
	f. Bearing (103), and snap ring (104)	Install.	
	g. Locknuts (101), and lockwasher (102)	Install.	
	h. Cover (99), and gasket (100)	Install.	Use new gasket.

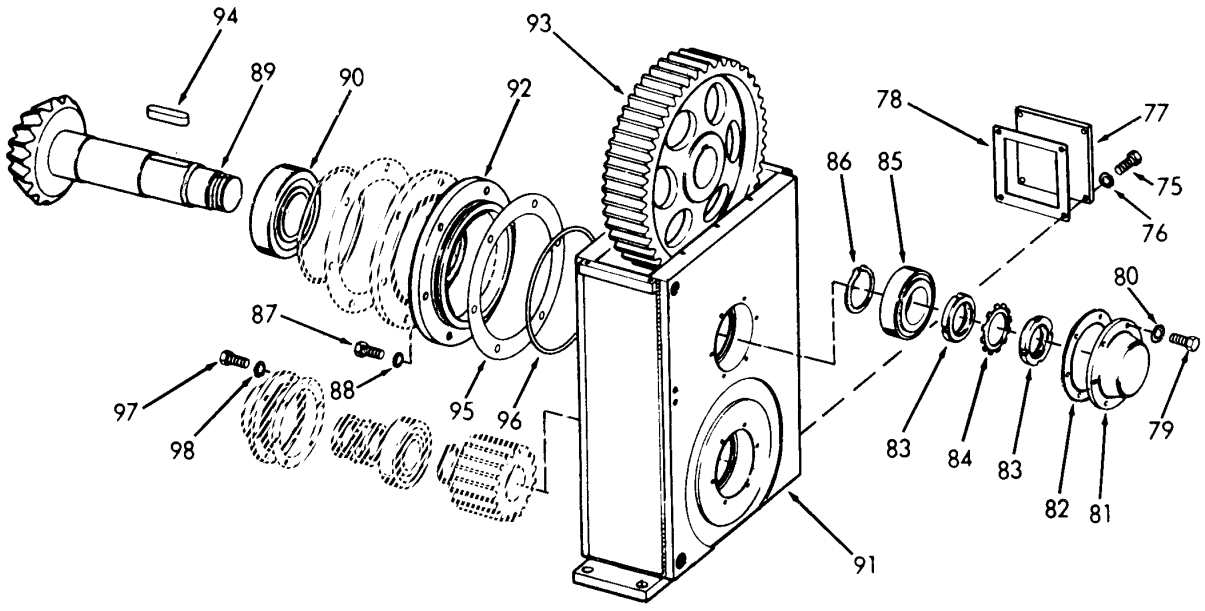


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	i. Screws (97), and lockwashers (98)	Install.	
	j. Bevel pinion (89), bearing (90), and bearing carrier (92)	Assemble.	
	k. Preformed packing (96)	Install.	Use new packing.
	1. Bevel pinion (89), bearing (90), and bearing carrier (92) (assembled), gasket (95), pinion bevel gear (93), and key (94)	Install in housing (91).	Use new gasket.
	m. Screw (87), and lockwashers (88)	Install.	
	n. Snapring (86), and bearing (85)	Install.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	o. Locknuts (83), and lockwashers (84)	Install.	
	p. Bearing cover (81), and gasket (82)	Install.	Use new gasket.
	q. Screws (79) and lockwashers (80)	Instal1.	
	r. Side cover (77), and gasket (78)	Install.	Use new gasket.
	s. Screws (75) ,and lockwashers (76)	Install.	



5-737

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:
a. INSERT FUNCTION b. INSERT FUNCTION d. INSERT FUNCTION

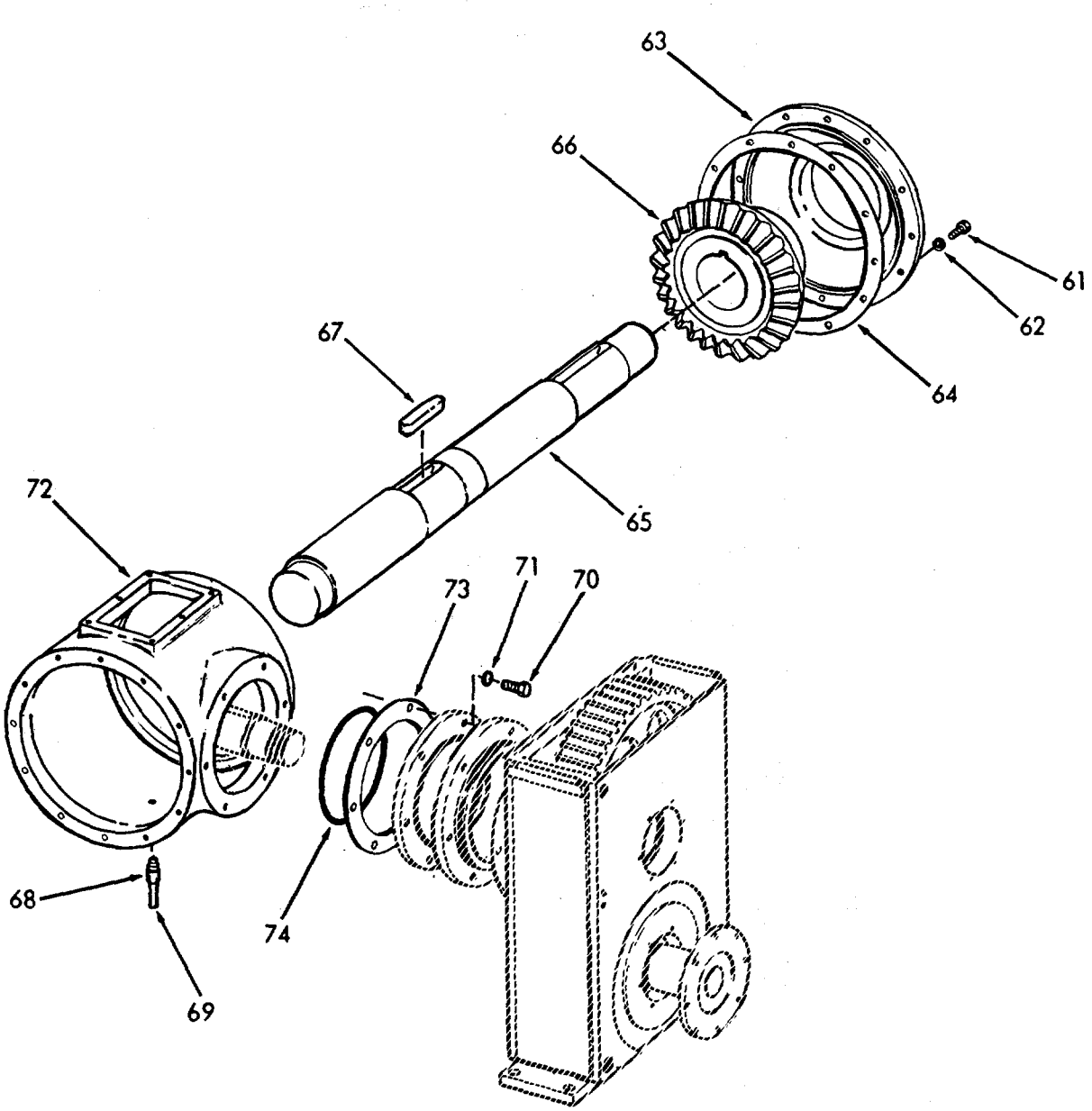
INITIAL SETUP:

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	t. Preformed packing (74)	Install in gear housing (72).	Use new packing.
	u. Gear housing (72), and gasket (73)	Install.	Use new gasket.
	v. Screws (70) , and lockwashers (71)	Install.	
	w. Adaptor (68), and tube (69)	Install.	
	x. Shaft (65), key (67), and pinion gear (66)	1. Assemble. 2. Install.	
	y. Gear box carrier (63), and gasket (64)	Install.	Use new gasket.
	z. Screws (61), and lockwashers (62)	Install.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

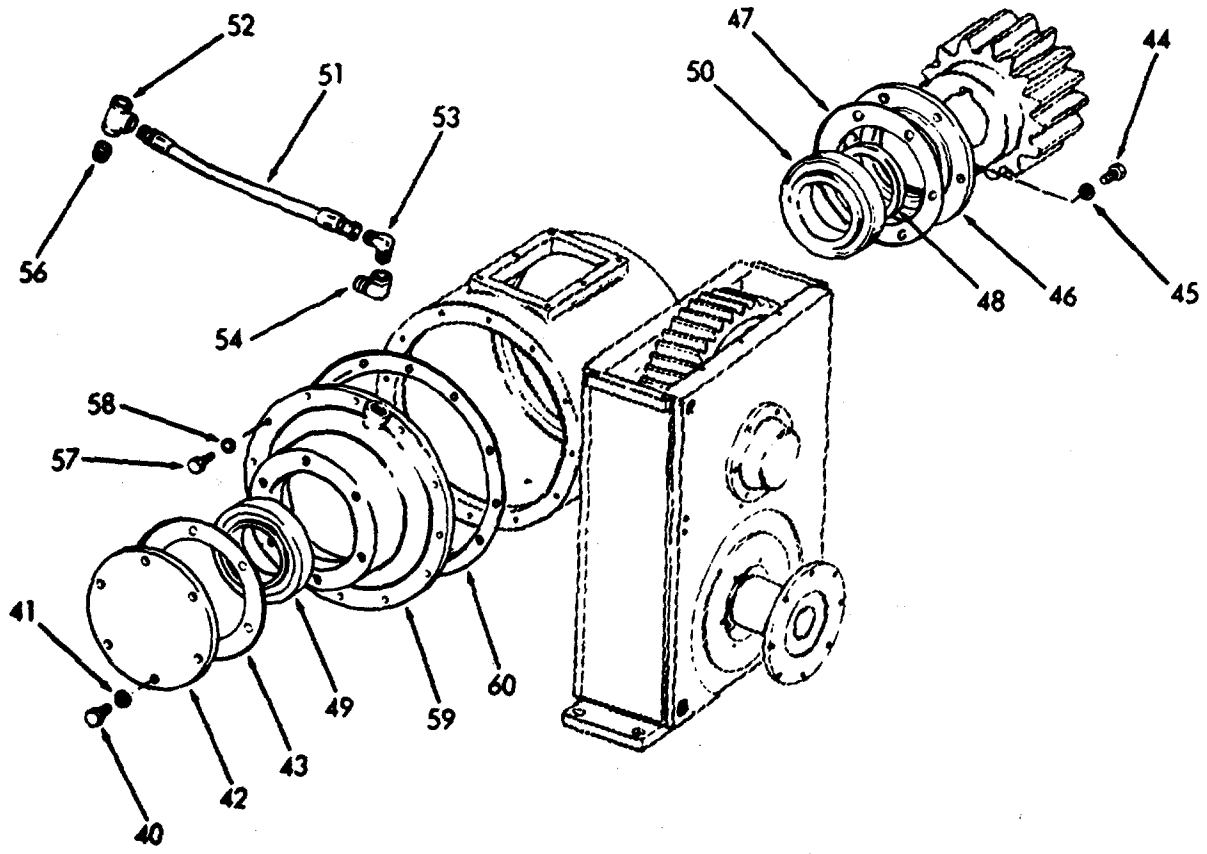


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	aa. Gear box carrier (59), and gasket (60)	Install.	Use new gasket.
	ab. Screws (57), and lockwashers (58)	Install.	
	ac. Pipe nipple (56)	Install.	
	ad. Flexible hose (51), tee (52), and elbows (53 and 54)	Install.	
	ae. Bearings (49 and 50)	Install.	
	af. Bearing cover (46), cover shim (47), and seal (48)	Install.	Use new seal.
	ag. Screws (44), and lockwashers (45)	Install.	
	ah. Bearing carrier cover (42), and cover shim (43)	Install.	

5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	ai. Screws (40), and lockwashers (41)	Install.	

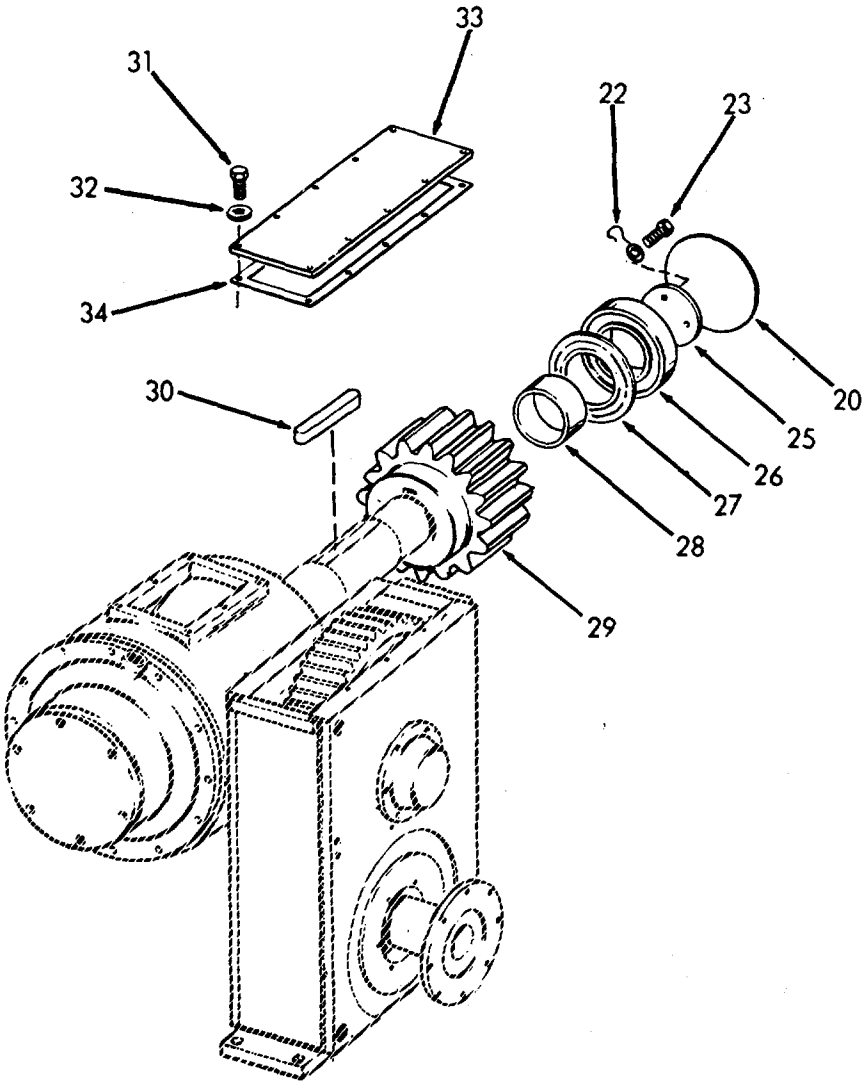


5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	aj. Cover (37), and gasket (38)	Install.	Use new gasket.
	ak. Screws (35), and lockwashers (36)	Install.	
	al. Cover (33) , and gasket (34)	Install.	Use new gasket.
	am. Screws (31), and lockwashers (32)	Install.	
	an. Drive pinion (29), and key (30)	Install.	
	ao. Bearing cap seal (27), and spacer (28)	Install.	
	ap. Bearing (26)	Install.	
	aq. Bearing retainer cover (25)	Install.	
	ar. Screws (23), and lockwashers (24)	Install.	

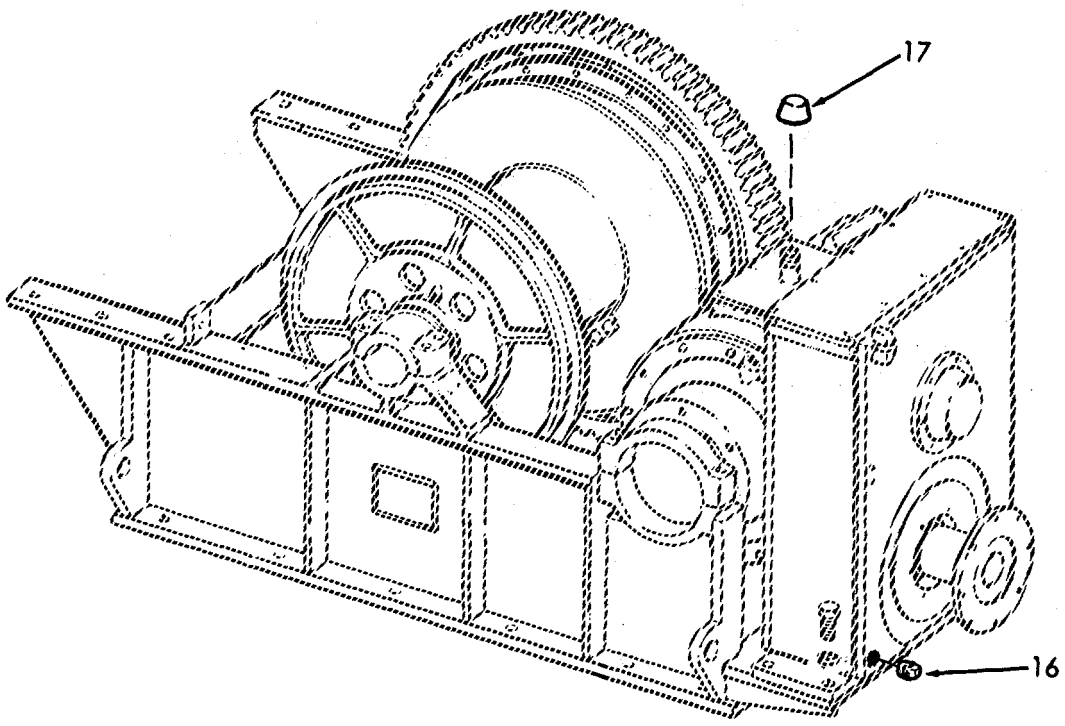
5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)j			
	as. Safety wire (22)	Install.	
	at. Bearing seal cover (20)	Install.	



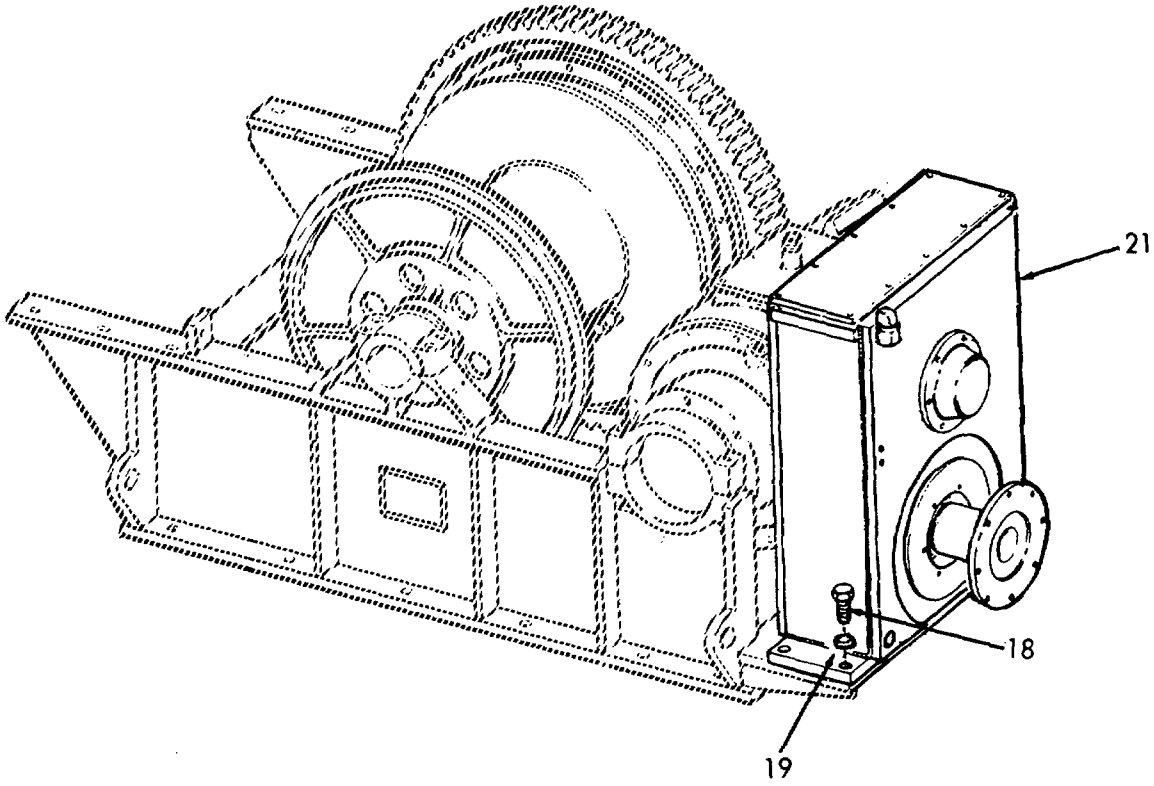
5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	au. Pipe plug (16)	Install.	
	av. Lubrication	Add oil	1. Use oil MIL-L-2105 type Gp90. 2. Use 10 gallons (37.85 liters)
	aw. Breather (17)	1. Lubricate.	a. Use oil MIL-L-2105 type G090. b. Use 1 pint (47 liter). 2. Install
		2. Install.	



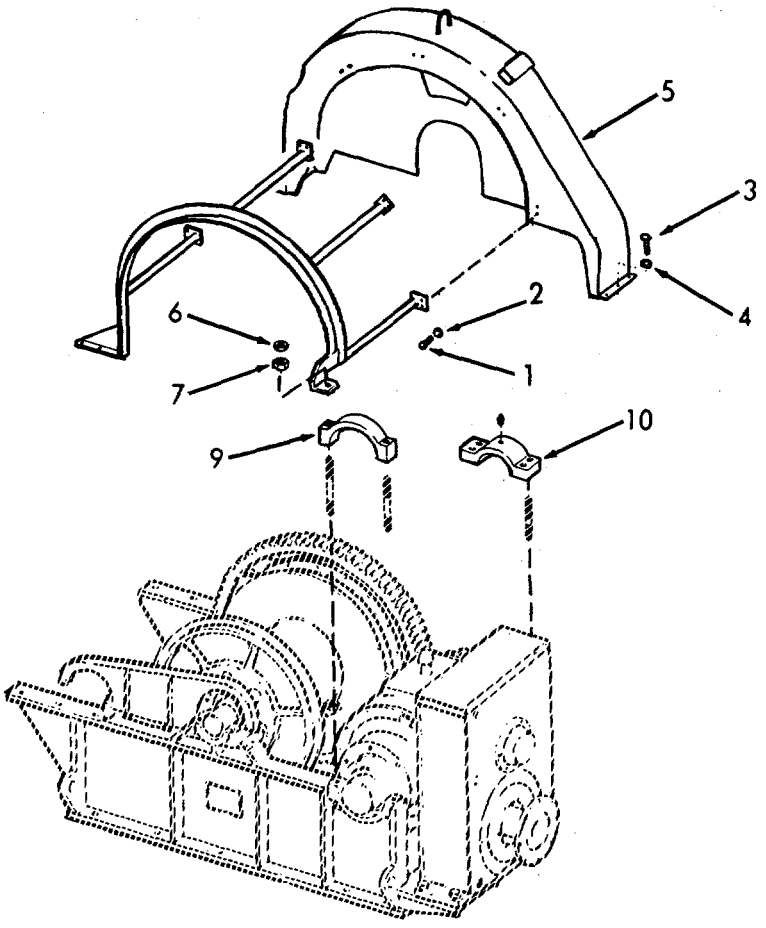
5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Drive gear (21)	1. Attach slings. 2. Install.	
	b. Screws (18), and lock-washers (19)	Instal1.	



5-61. DRIVE GEAR ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Pedestal caps (9 and 10)	Install.	
	d. Drum guard (8)	Install.	
	e. Jam nuts (7), and plain nuts (6)	Install.	
	f. Gear guard (5)	Install.	
	g. Screws (3), and lockwashers (4)	Install.	
	h. Screws (1), and lockwashers (2)	Install.	



5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

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

INITIAL SETUP

Test Equipment
NONE

Special Tools
Bearing and gear pullers

Material/Parts
Grease MIL-G-81322 type GH
Grease MIL-G-10924 type GAA
Oil UV-L-751 type CW

Personnel Required
2

References
NONE

Equipment Condition / Condition Description
NONE

Special Environmental Conditions
NONE

General Safety Instructions
NONE

LOCATION	ITEM	ACTION	REMARKS

NOTE

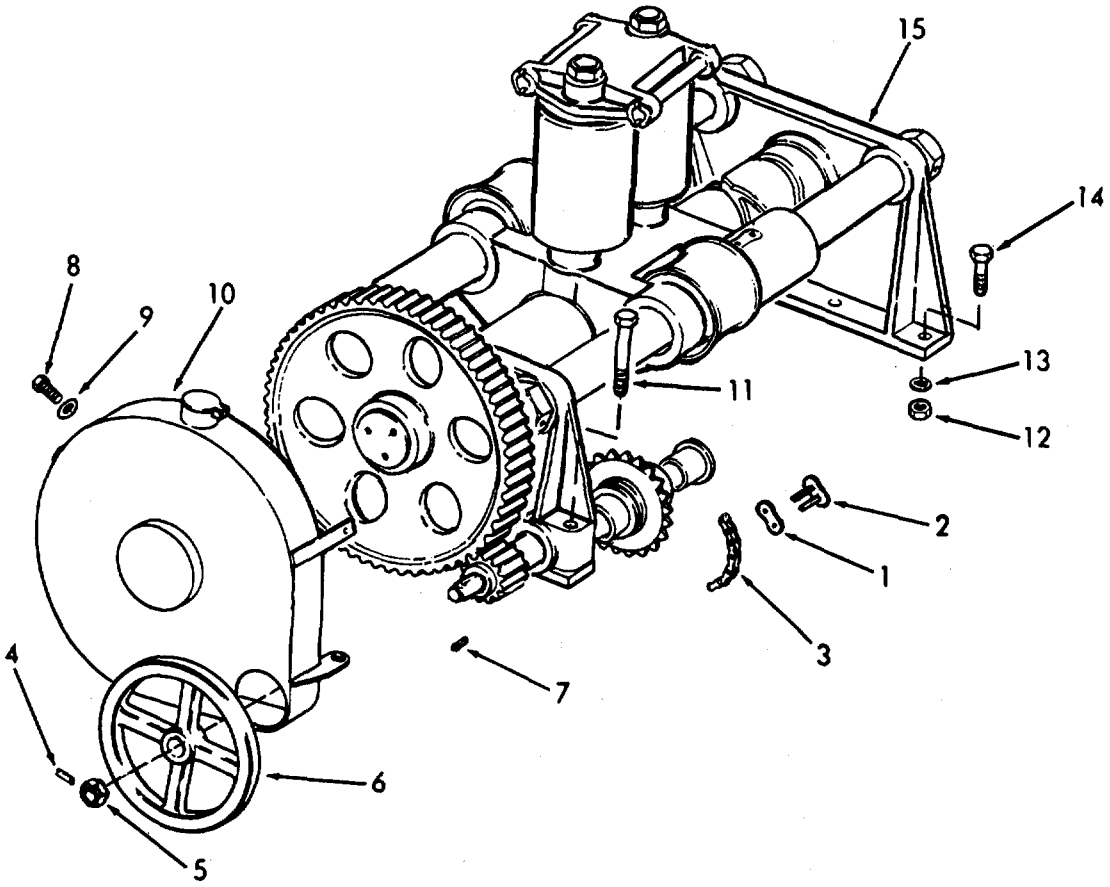
The level wind assembly can be completely overhauled without removal from the winch - see Repair.

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
1. Level Wind	a. Keeper (1), and link (2)	Separate.	
	b. Chain (3)	Remove.	
	c. Headless straight pin (4)	Remove.	
	d. Jam nut (5), handwheel (6), and key (7)	Remove.	
	e. Screws (8), and lock-washers (9)	Remove.	
	f. Guard (10)	Remove.	
	g. Screws (11)	Remove five places.	
	h. Nut (12), lockwasher (13), and screw (14)	Remove.	
	i. Level wind assembly (15)	1. Lift off. 2. Replace.	
	j. Screws (11)	Install.	
	k. Screw (14), lockwasher (13), and nut (12)	Install.	
	l. Guard (10)	Install.	
	m. Screws (8), and lock-washers (9)	Install.	

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	n. Handwheel (6), jam nut (5), and key (7)	1. Install. 2. Align holes in wheel and jam nut.	
	o. Pin (4)	Install.	
	p. Chain (3), link (2), keeper (1)	Install. and	



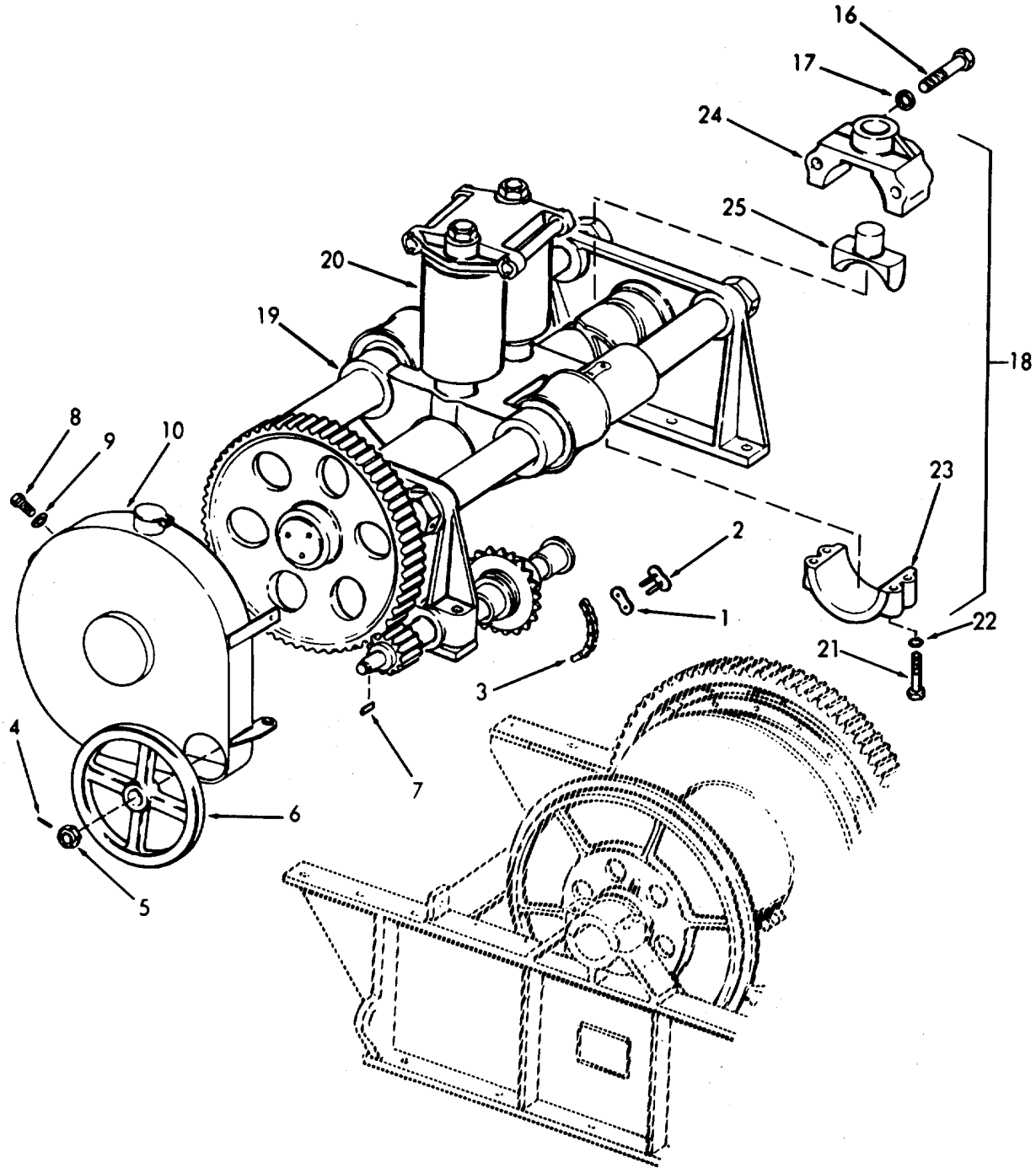
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2.	a. Keeper (1), and link (2)	Separate.	
	b. Chain (3)	Remove.	
	c. Headless pin (4)	Remove.	
	d. Nut (5), handwheel (6), and key (7)	Remove.	
	e. Screws (8), and lock-washers (9)	Remove.	
	f. Guard (10)	Remove.	
	g. Screws (16), and lockwashers (17)	Remove.	Disengage drive shuttle assembly (18).
	h. Carriage body (19)	Slide away from dowel shuttle (18), until vertical roller (20) can be cleared.	
	i. Screws (21), and lockwashers (22)	Remove.	
	j. Shuttle guide cap (23), shuttle guide (24), and shuttle (25)	Remove.	

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



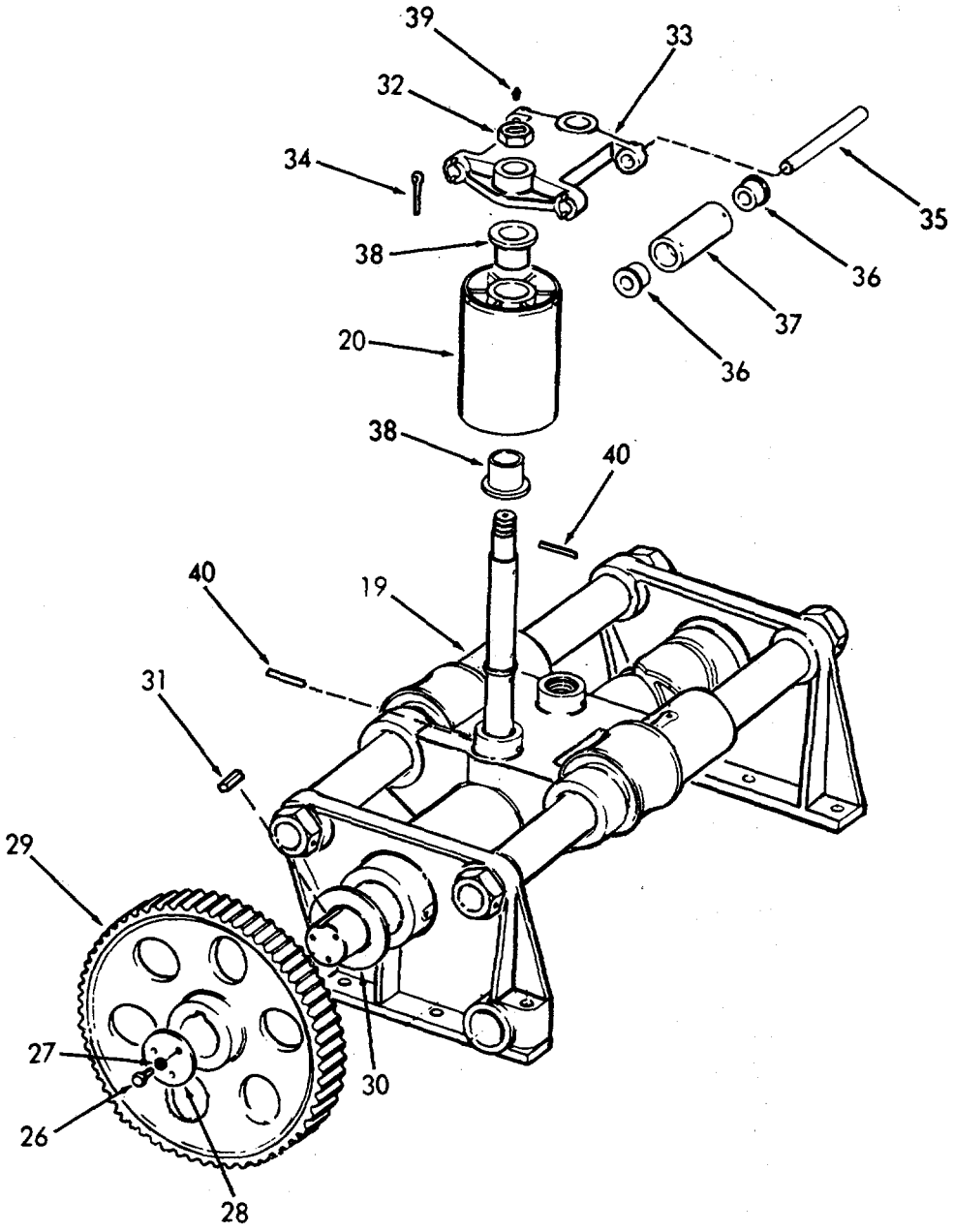
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	k. Screws (26), and lock-washers (27)	Remove.	
	1. Clamp plate (28)	Remove.	
	m. Gear (29)	Remove.	
	n. Thrust washer (30), and key (31)	Remove.	
	o. Nuts (32)	Remove.	
	p. Top roller bracket (33)	Remove.	
	q. Cotter pins (34), shafts (35), (33). hubs (36), and barrels (37)	Remove from top roller bracket	If necessary.
	r. Bushings (38), and vertical rollers (20)	Remove.	
	s. Lubrication fittings (39)	Remove.	If necessary.
	t. Carriage body (19)	Slide to end of shaft away from driven sprocket.	
	u. Spiral pins (40)	Remove from four places.	Pins are 1/4 x 3 inches long.

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



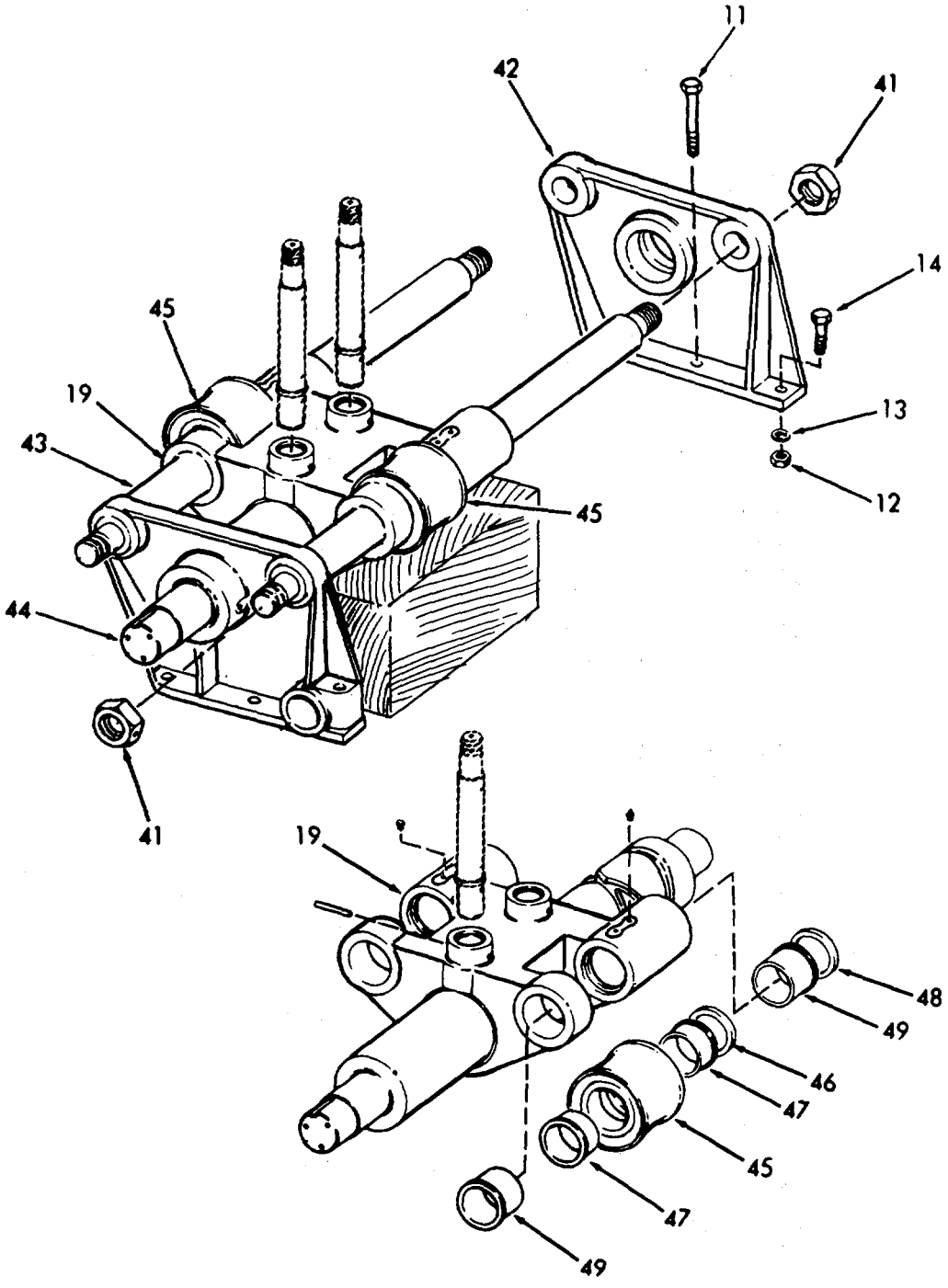
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	v. Jam nuts (41)	Remove four places.	
	w. Nut (12), lockwasher (13), and screw (14)	Remove.	
	x. Screws (11)	Remove from non-driven end pedestal (42).	
	y. Carriage body (19)	Support on blocks.	
	z. Nondriven end pedestal (42)	Drive off the carriage guide shafts (43).	
	aa. Worm shaft (44)	Remove from carriage body (19).	
	ab. Carriage body (19), carriage guide shafts (43), and horizontal rollers (45)	Remove.	
	ac. Felt seals (46), and bushings (47)	Remove from rollers (45).	
	ad. Felt seals (48), and bushings (49)	Remove from carriage body (19).	

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



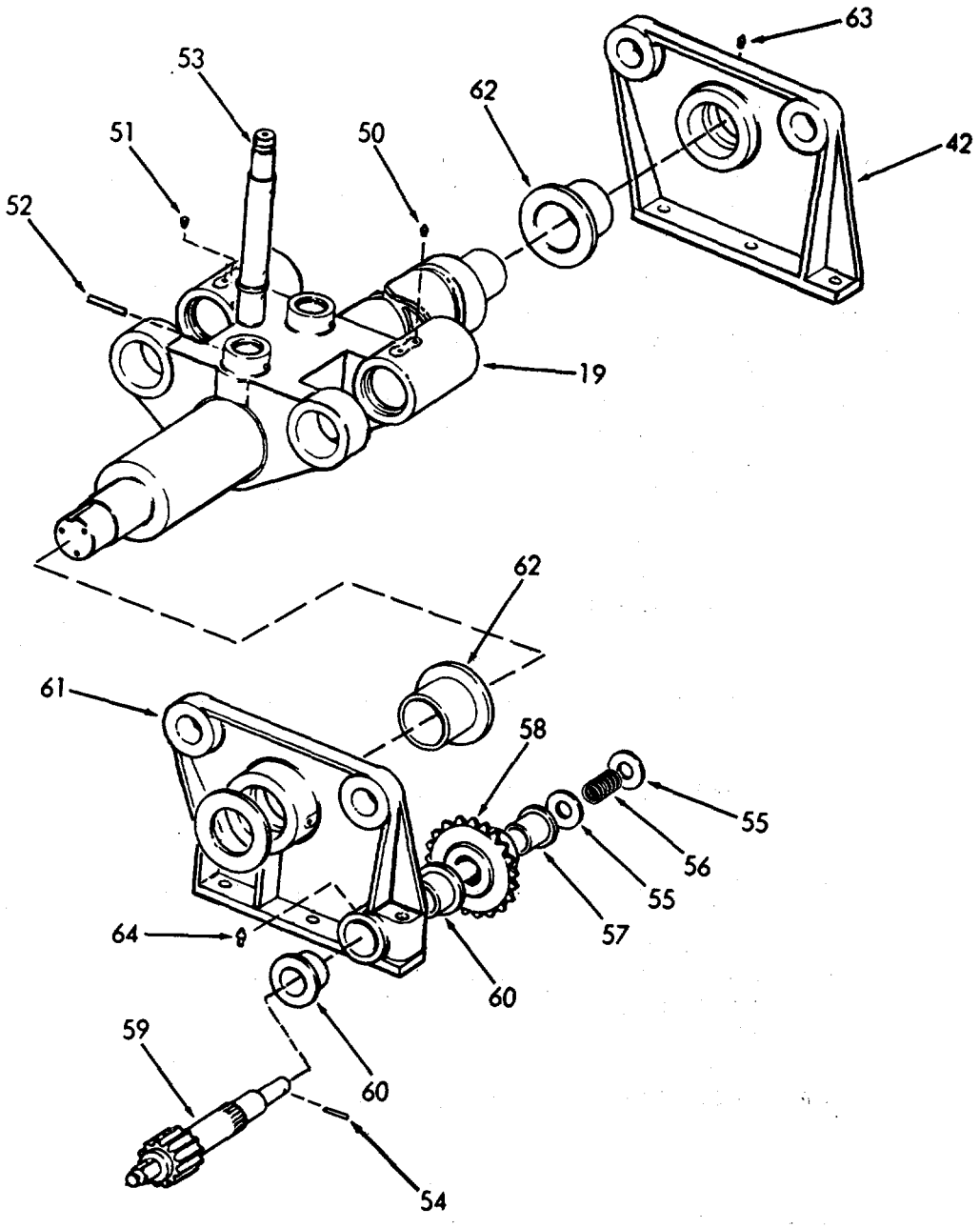
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ae. Lubrication fitting (50), and relief fittings (51)	Remove.	If necessary.
	af. Spiral pins (52), and vertical shafts (53)	Disassemble.	Pins are 3/8 x 3 inch.
	ag. Spiral pin (54)	Remove.	Pin is 3/16 x 1 3/16 inches.
	ah. Flatwashers (55), spring (56)$ bushing (57), and sprocket (58)	Remove from shaft (59).	
	ai. Shaft (59)	Remove from driven-end pedestal (61).	
	aj. Bushings (60)	Remove.	
	ak. Bushings (62)	Remove from pedestals (42 and 61).	
	al. Lubrication fittings (63 and 64)	Remove from pedestals (42 and 61).	If necessary.
	am. Bushings	Inspect.	Discard worn and unserviceable bushings.
	an. Felt seals	Inspect.	Discard if worn or badly glazed.

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

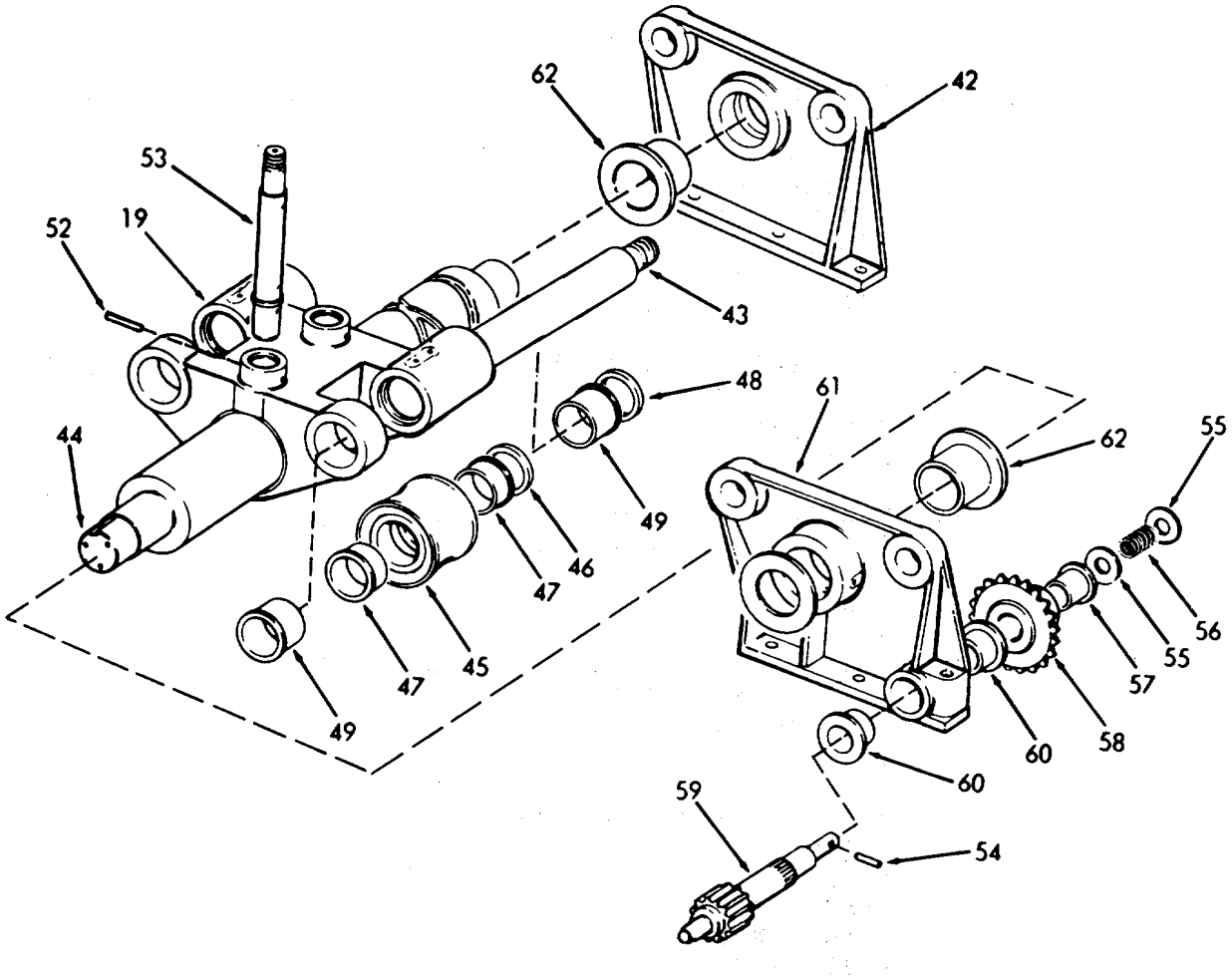


5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ao. Bushings (62)	Install in pedestals (42 and 61).	
	ap. Bushings (60)	Install in pedestal (61).	
	aq. Shaft (59)	Install in pedestal (61).	
	ar. Sprocket (58), bushing (57), spring (56), flatwashers (55), and spiral pin (54)	Install.	
	as. Vertical shafts (53), and spiral pins (52)	Install.	Pins are 3/8 x 3 inch.
	at. Bushings (49), and felt seals (48)	Install in carriage body (19).	
	au. Bushings (47), and felt seals (46)	Install in rollers (45).	
	av. Horizontal rollers (45), carriage guide shafts (43), and carriage body (19)	Assemble.	

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	aw. Worm shaft (44)	Install in carriage body (19).	
	ax. Nondriven end pedestal (42)	Install.	



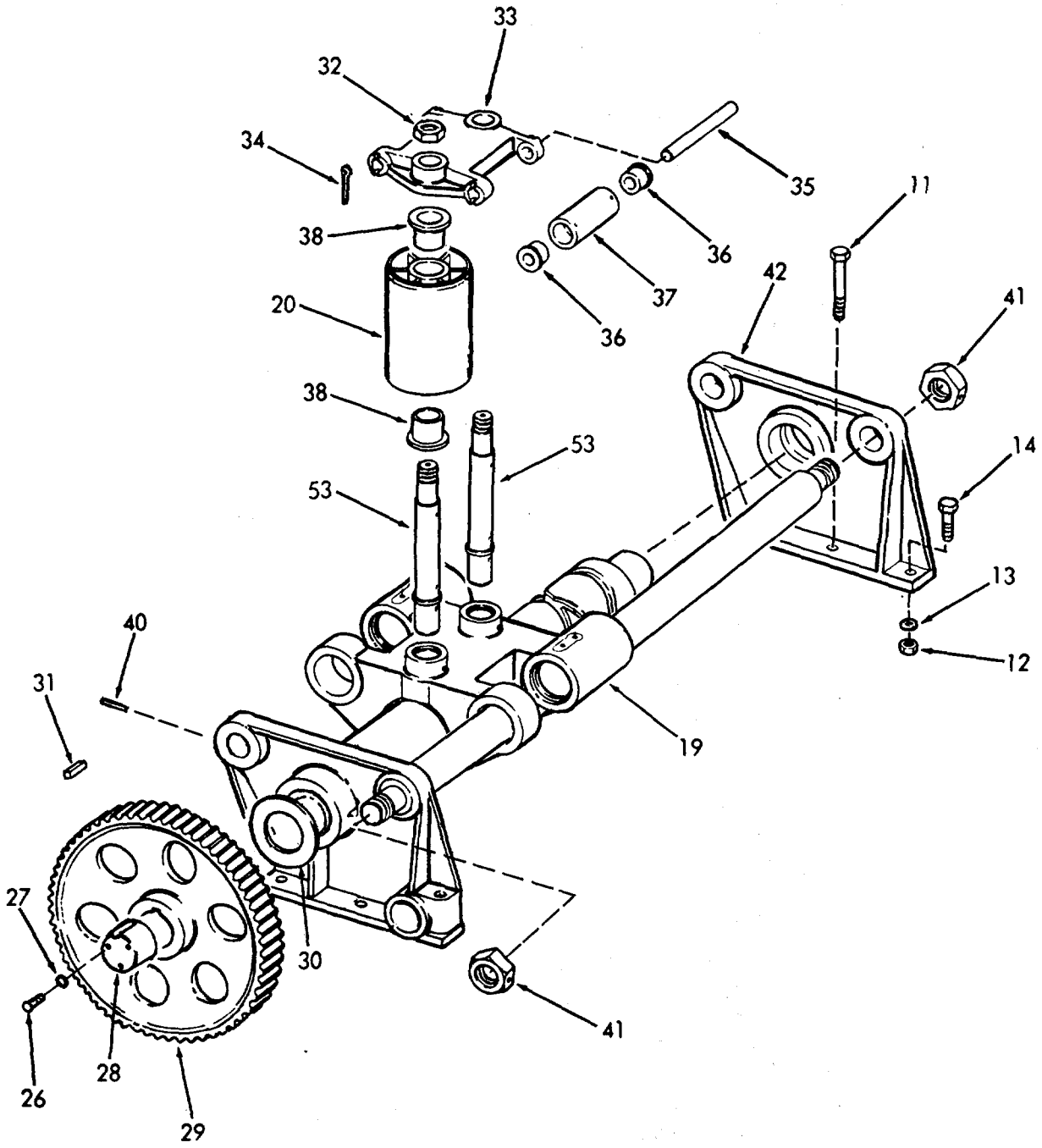
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ay. Carriage body (19)	Remove wooden blocks.	
	az. Screws (11)	Install	
	ba. Screw (14), lockwasher (13), and nut (12)	Install.	
	bb. Jam nuts (41)	Install.	
	bc. Spiral pins (40)	Install.	
	bd. Vertical rollers (20), and bushings (38)	Install on vertical shafts (53).	
	be. Barrels (37), hubs (36), shafts (35), and cotter pins (34)	Install in top roller bracket (33).	
	bf. Top roller bracket (33)	Install.	
	bg. Nuts (32)	Install.	
	bh. Thrust washer (30)	Install.	
	bi. Key (31), and gear (29)	Install.	
	bj. Clamp plate (28), screws (26), and lockwashers (27)	Install.	
	bk. Carriage body (19)	Slide towards gear.	

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



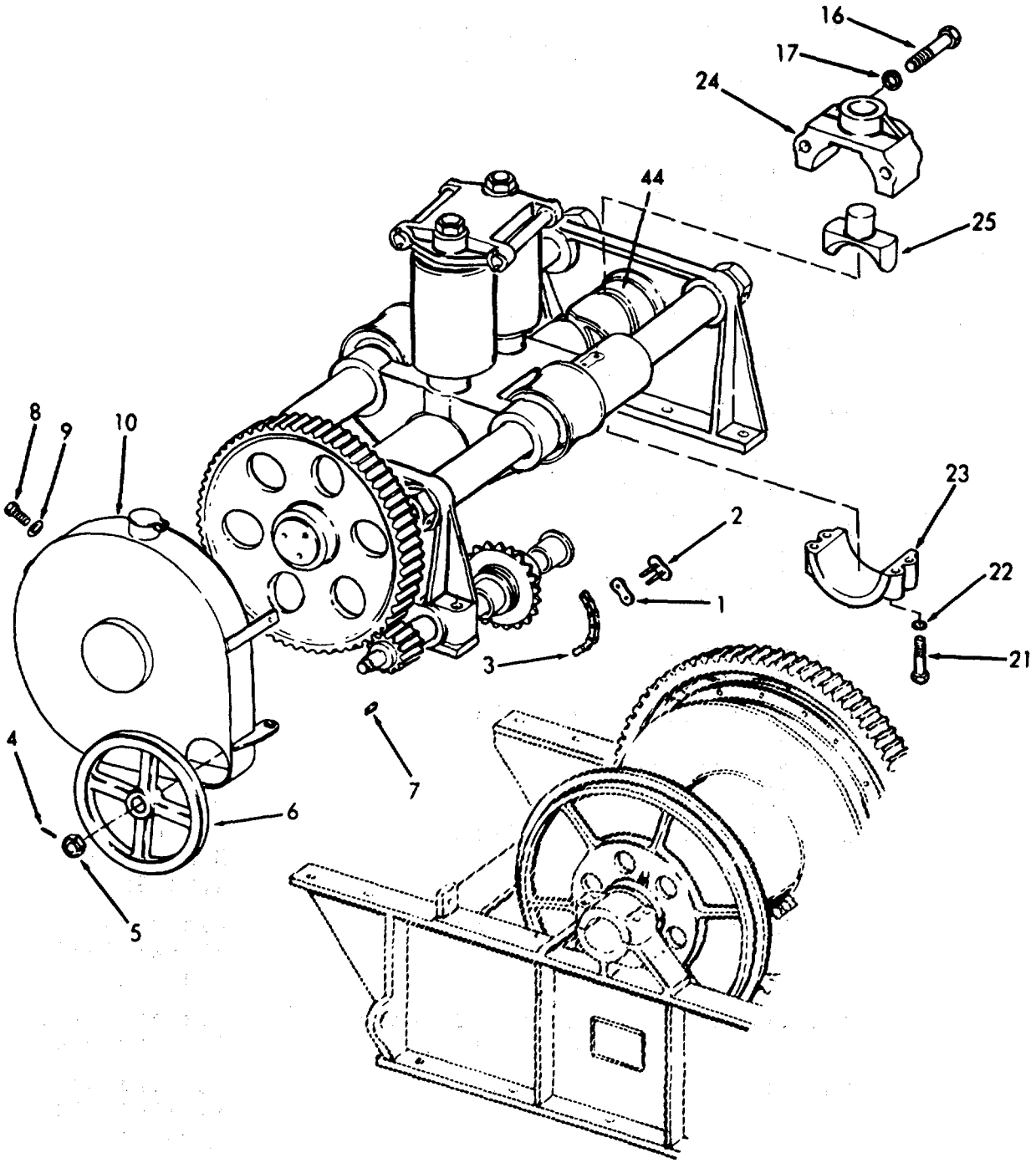
5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	bl. Shuttle (25), shuttle guide cap (23), shuttle guide (24), screws (21), and lock-washers (22)	Assemble on worm gear (44).	
	bm. Screws (16), and lock-washers (17)	Install.	
	bn. Guard (10), screws (8), and lock-washers (9)	Install.	
	bo. Key (7), handwheel (6), and nut (5)	Install.	
	bp. Headless pin (4)	Install.	
	bq. Chain (3), link (2), and keeper (1)	Install.	
	br. Lubrication fittings	Lubricate.	Use grease MIL-G-81322 type GH.
	bs. Worm shaft	Lubricate.	Use grease MI L-G-10924 type GAA.
	bt. Gears	Lubricate when operating.-	Use oil VV-L-751, type CW.
	bu. Handle	Lubricate.	Use grease MIL-G-10924, type GAA.

5-62. LEVEL WIND ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE

INSTRUCTIONS

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

INITIAL SETUP

Test Equipment

NONE

Special Tools

Chain hoist
S1ings

Material/Parts

Lubricating oil
VV-L-751 type CW
Grease MIL-G-81322 type GH

Personnel Required

2

References

NONE

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

General Safety Instructions

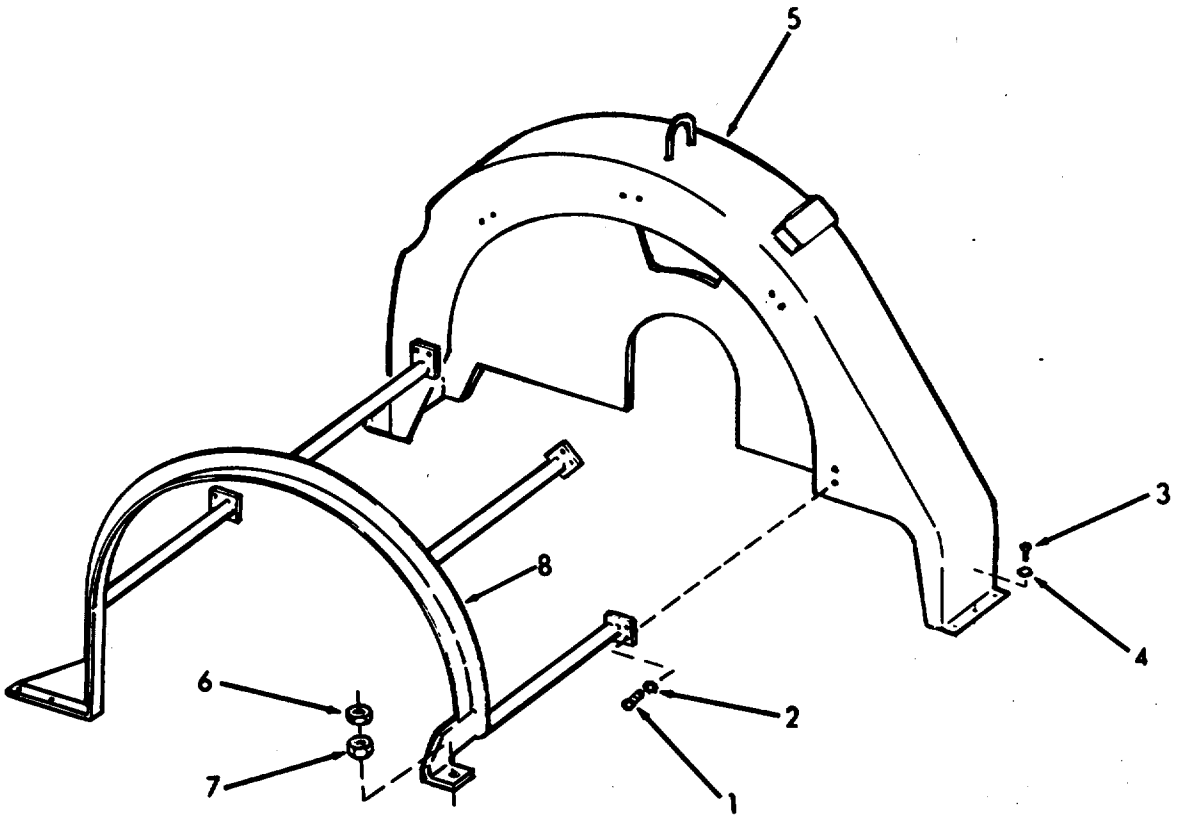
Observe precautions when lifting heavy parts.

LOCATION	ITEM	ACTION	REMARKS
REPLACE			
1. Drum Assembly	a. Screws (1), and lock-washers (2)	Remove.	
	b. Screws (3), and lock-washers (4)	Remove.	

5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE

INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	c. Guard (5)	Remove.	
	d. Nut (6), and jam nut (7)	Remove.	
	e. Drum guard (8)	Remove.	



5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE

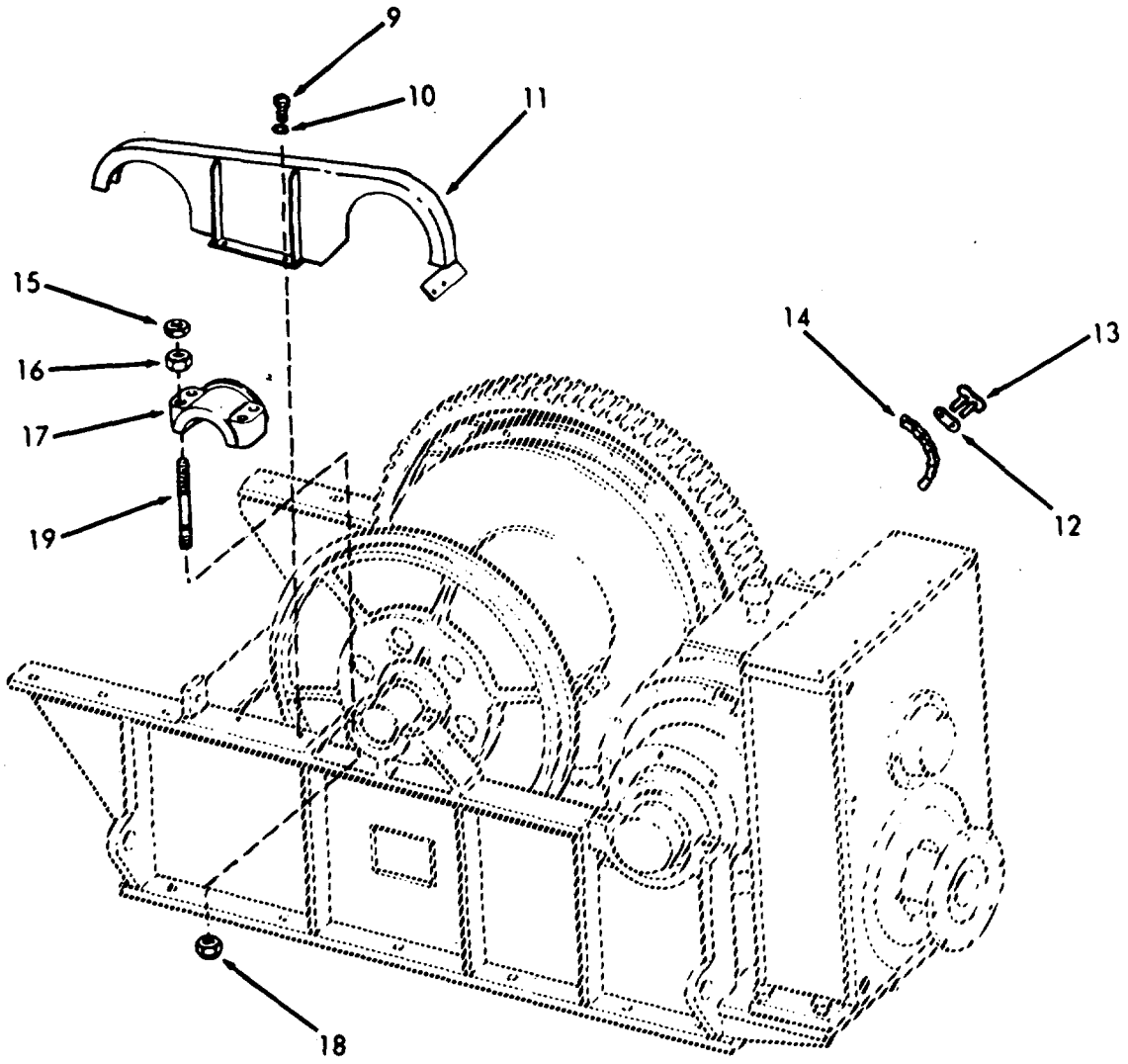
		INSTRUCTIONS	
LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	f. Screws (9), and lock-washers (10)	Remove.	
	g. Chain guard (11)	Remove.	
	h. Keeper (12), link (13), and chain (14)	Remove.	
	i. Nut (!5), and jam nuts (16)	Remove.	
	j. Pedestal caps (17)	Remove.	
	k. Stop nuts (18), and studs (19)	Remove.	If necessary.

5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE

INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



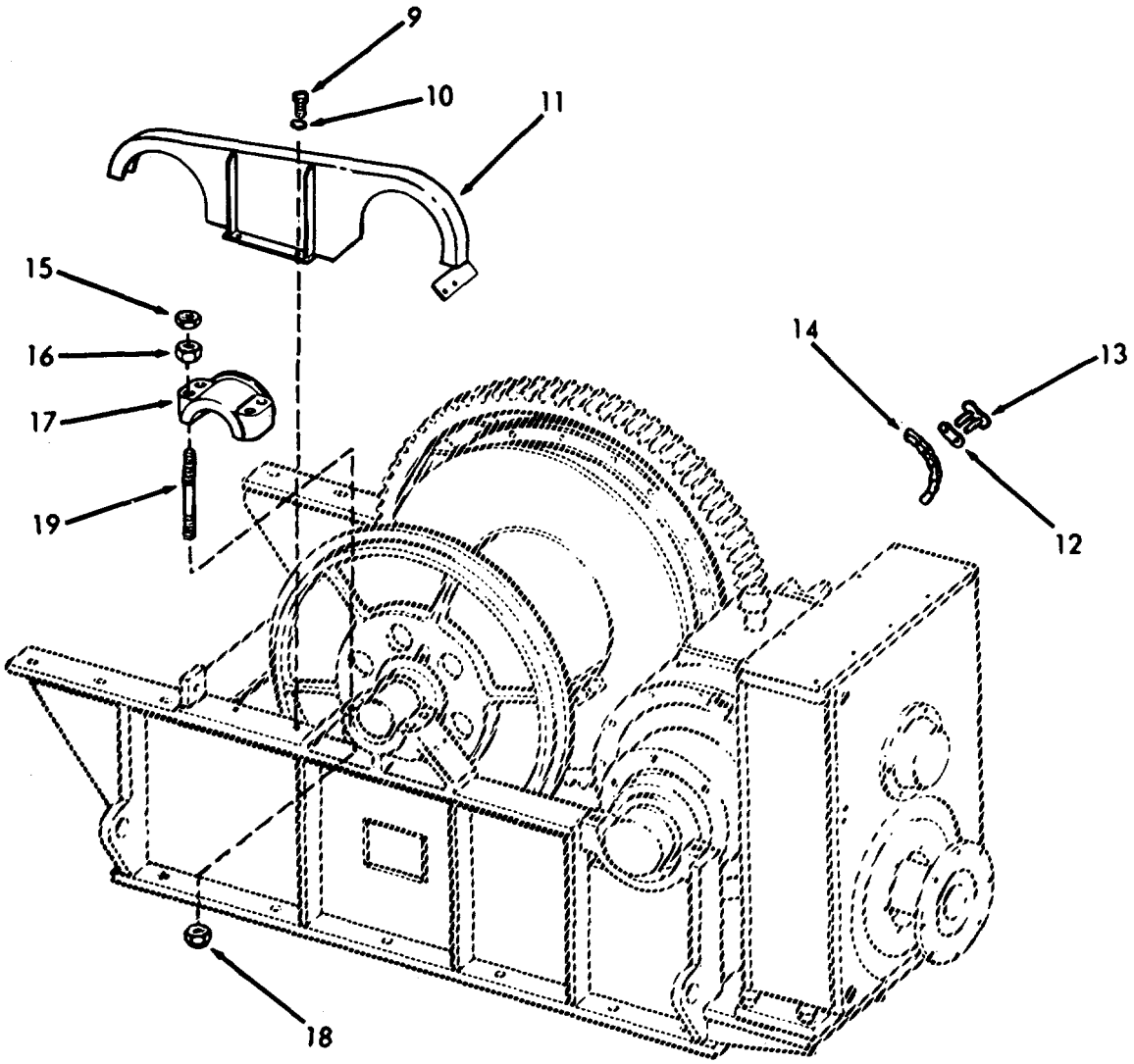
5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	1. Drum Assembly	1. Attach slings. 2. Attach chain hoist. 3. Replace drum assembly.	
	m. Pedestal caps (17)	Install.	
	n. Jam nuts (16), and nuts (15)	Install.	
	o. Chain (14), link (13), and keeper (12)	Install.	
	p. Chain guard (11)	Install.	
	q. Screws (9), and lock-was hers (10)	Install.	

5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



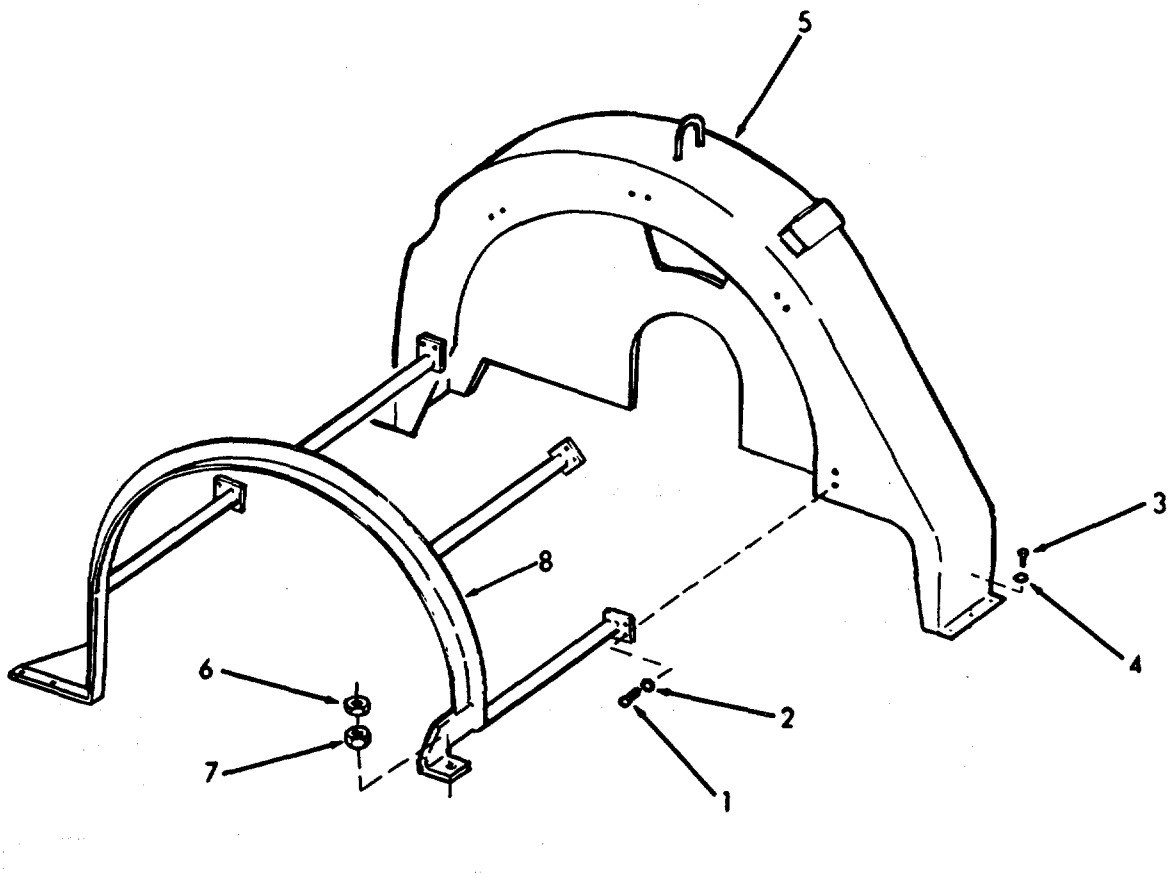
5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACE (Cont)			
	r. Drum guard (8)	Install.	
	s. Jam nut (7). and nut (6)	Install.	
	t. Guard (5)	Install.	
	u. Screws (3), lock-washers (4)	Install.	
	v. Screws (1), and lock washer (2)	Install.	
	w. Gear	Lubricate.	1. Use oil VV-L-751 type CW. 2. Pour on gear with winch operating.

5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACE (Cont)



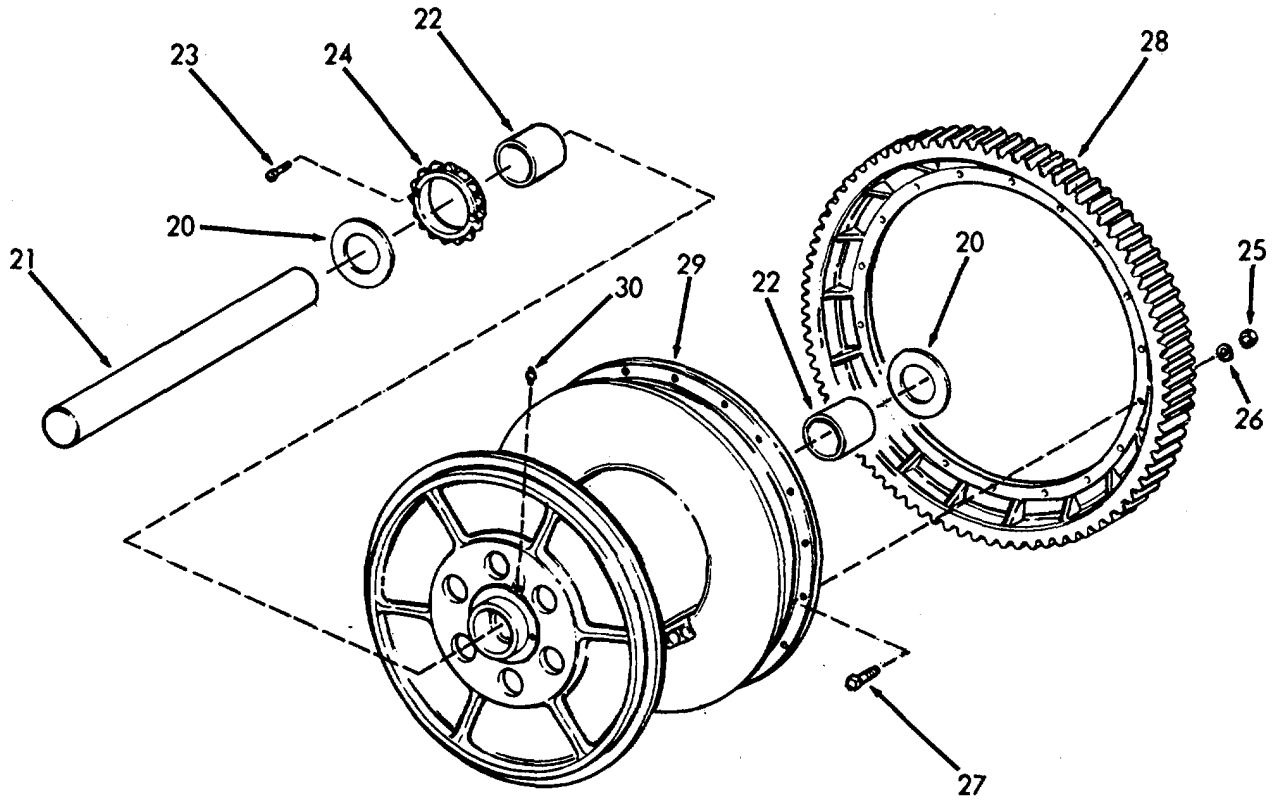
5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2. Drum Assembly	a. Washers (20), shaft (21), and bushings (22)	Remove.	
	b Screws (23), and sprocket (24)	Remove.	
	c. Nuts (25), lockwashers (26), and screws (27)	Remove.	
	d. Gear (28)	Remove from drum (29).	
	e. Lubrication fittings (30)	Replace.	If necessary.
	f. Drum (29), and gear (28)	Assemble.	
	g. Screws (27), lockwashers (26), and nuts (25)	Install.	
	h. Sprocket (24), and screws (23)	Install.	
	i. Bushings (22), shaft (21), and washers (20)	Install.	
	j. Lubrication fittings	Grease.	Use grease MIL-G-81322, type GH.

5-63. FRAME AND DRUM ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS

This task covers:

a. Removal **b. Repair** **c. Installation**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Bearing puller
Ring compressor
Torque wrench

Material/Parts

Grease MIL-G-81322 type GH
Lubricating oil MIL-L-2105 type G090
Hydraulic "O" ring and seal kit P/N 514-18564 or
Overhaul kit P/N 514-08889

Personnel Required

2

References

NONE

Equipment Condition — Condition Description

NONE

Special Environmental Conditions

Do not drain oil into bilges. Use the oil/water separation/recovery system to collect used oil.

General Safety Instructions

Observe WARNINGS in this procedure.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

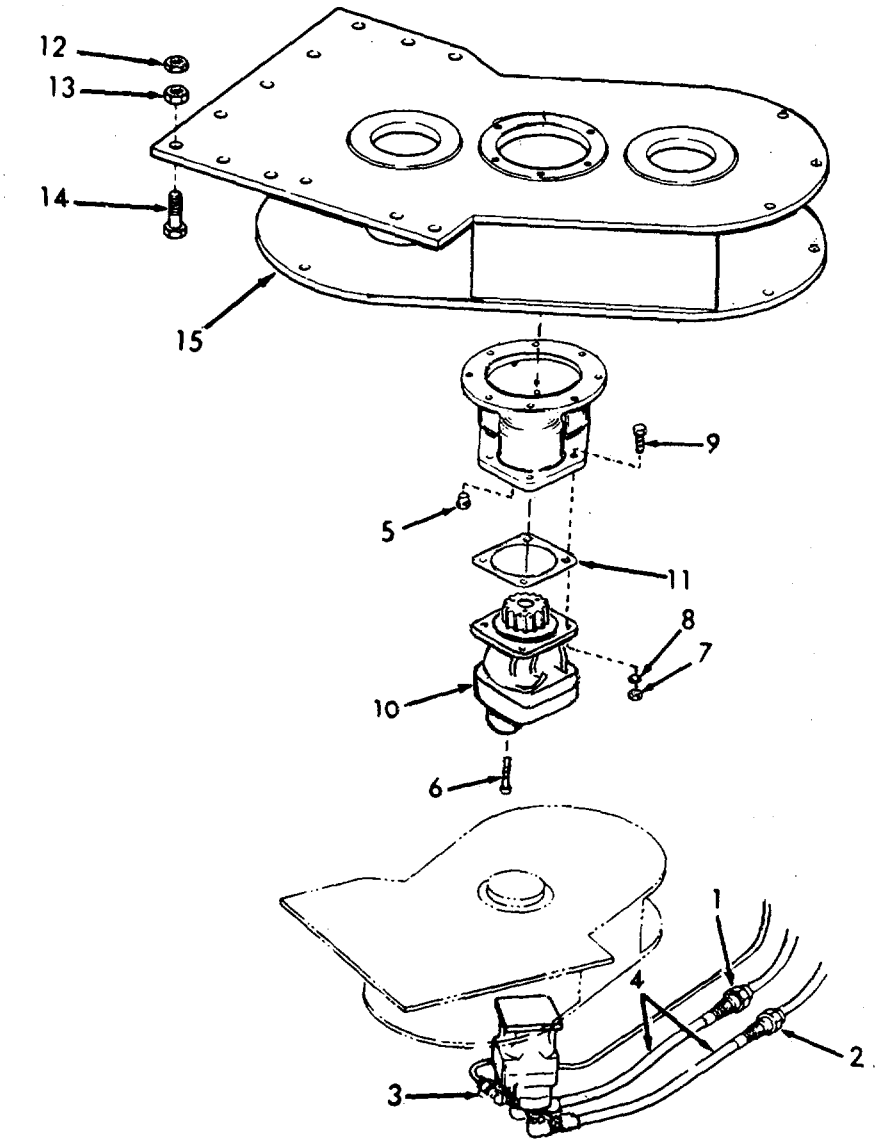
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Slack Puller Motor	a. Unions (1, 2, and 3)	1. Loosen. 2. Drain. 3. Separate.	Drain oil into a suitable container.
	b. Flexible hoses (4)	Remove.	Drain oil into a suitable container.
	c. Pipe plug (5)	Remove.	
	d. Screw (6)	Remove.	
	e. Nut (7) lock-washers (8), and screws (9)	Remove.	
	f. Hydraulic motor (10), and gasket (11)	Remove.	Discard gasket.
2. Slack Puller	a. Jam nuts (12), nuts (13), and screws (14)	Remove.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

b.	Slack puller (15)	Remove.	

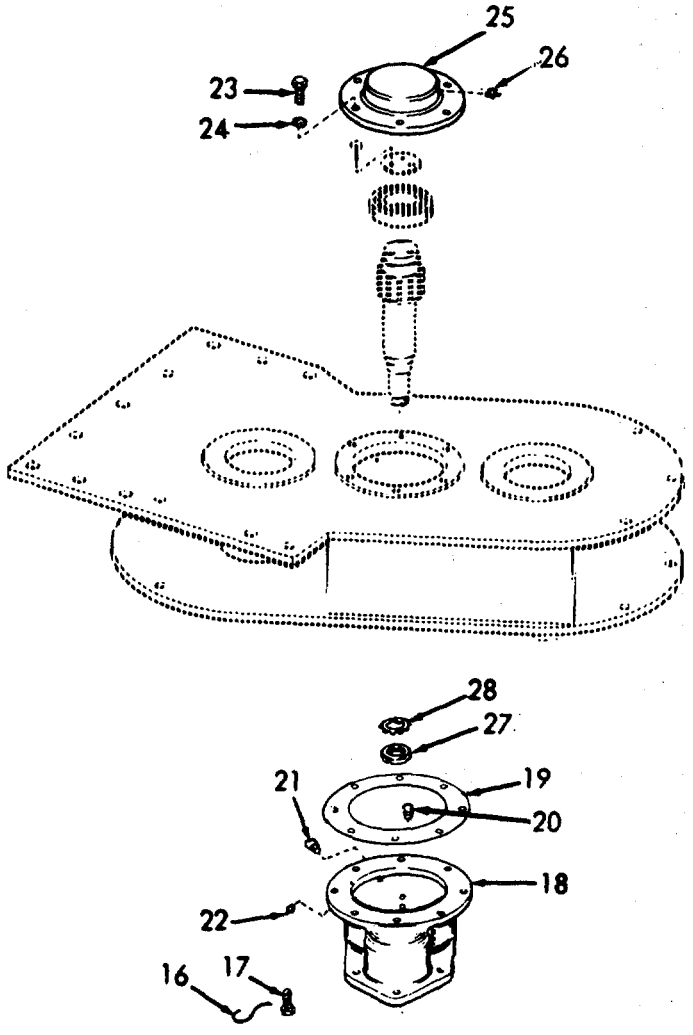


5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Slack Puller	a. Lock-wire (16)	Cut and remove.	
	b. Screws (17)	Cut and remove.	
	c. Housing (18), and gasket (19)	Remove.	Discard gasket.
	d. Pipe plug (20) breather (21), and lubri-cation fitting (22)	Remove.	If necessary.
	e. Screws (23), and lock-washers (24)	Remove.	
	f. Bearing cover (25)	Remove.	
	g. Lubri-cation fitting (26)	Remove.	If necessary.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Locknut (27), and lock-washer (28)	Remove.	

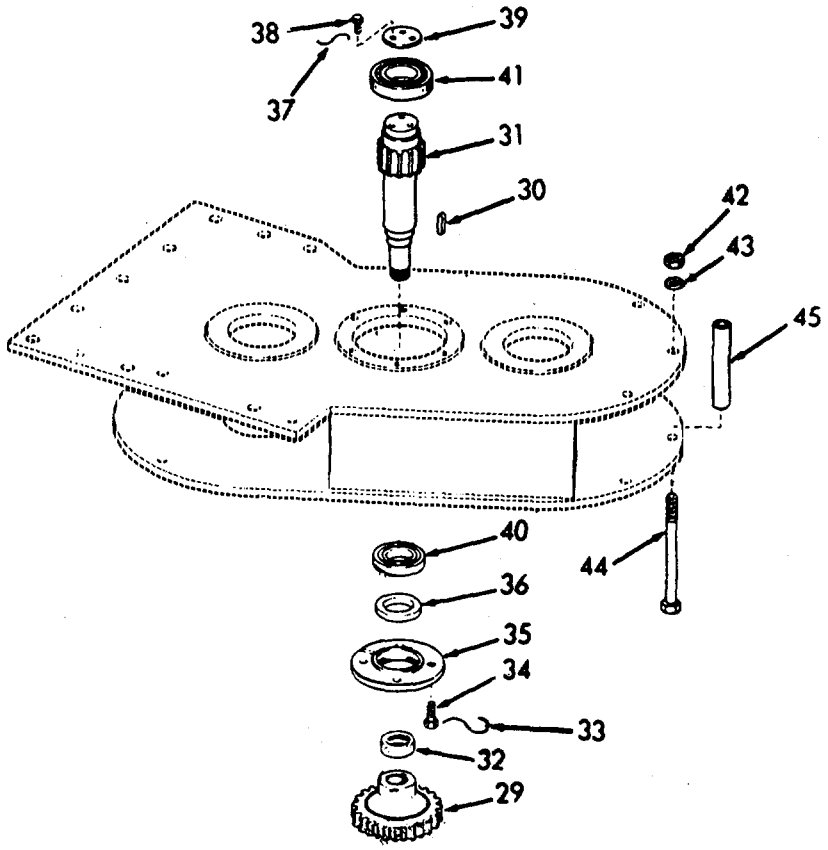


5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Gear (29), and key (30)	Remove from pinion shaft (31).	
	j. Shaft retainer (32)	Remove.	
	k. Lockwire (33)	Cut and remove.	
	l. Screws (34)	Remove.	
	m. Shaft retainer (35)	Remove.	
	n. Bearing seal (36)	Remove.	Discard seal.
	o. Pinion shaft (31), and bearings	Remove as an assembly.	
	p. Lockwire (37)	Cut and remove.	
	q. Screws (38)	Remove.	
	r. Clamp plate (39)	Remove.	
	s. Bearings (40 and 41)	Remove from pinion shaft (31).	Use a bearing puller.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	t. Nuts, (42), lock washers (43), screws (44), and spacers (45)	Remove.	



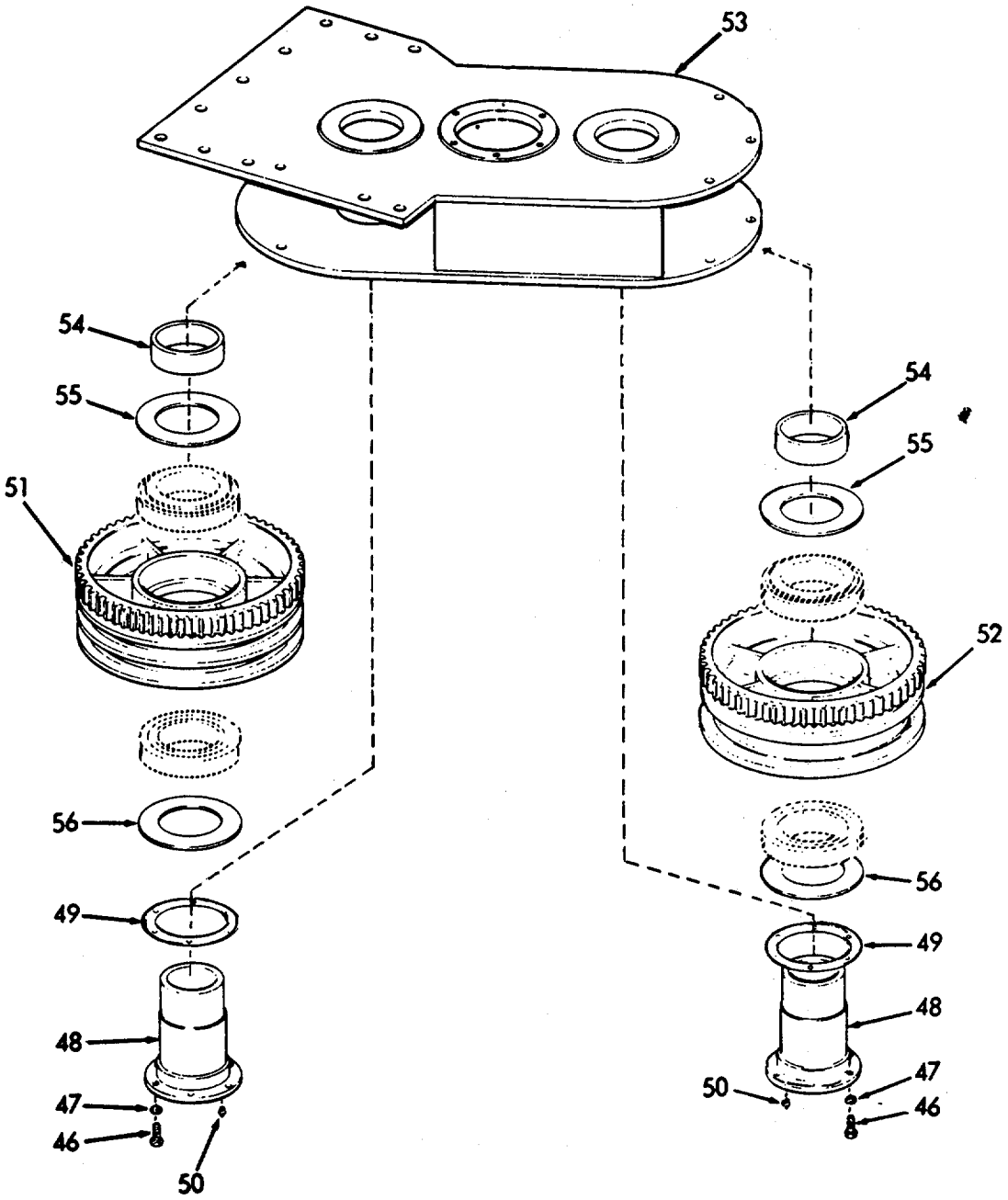
5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	u. Screws (46), and lock-washers-(47)-	Remove on both sides.	
	v. Tube shafts (48), and shims (49)	Remove on both sides.	
	w. Lubri-cation fittings (50)	Remove.	If necessary.
	x. Sheaves (51, and 52), and associated parts	Slide from frame (53).	
	y. Spacers (54), lower bearing plate (55), and upper bearing plate (56)	Remove.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



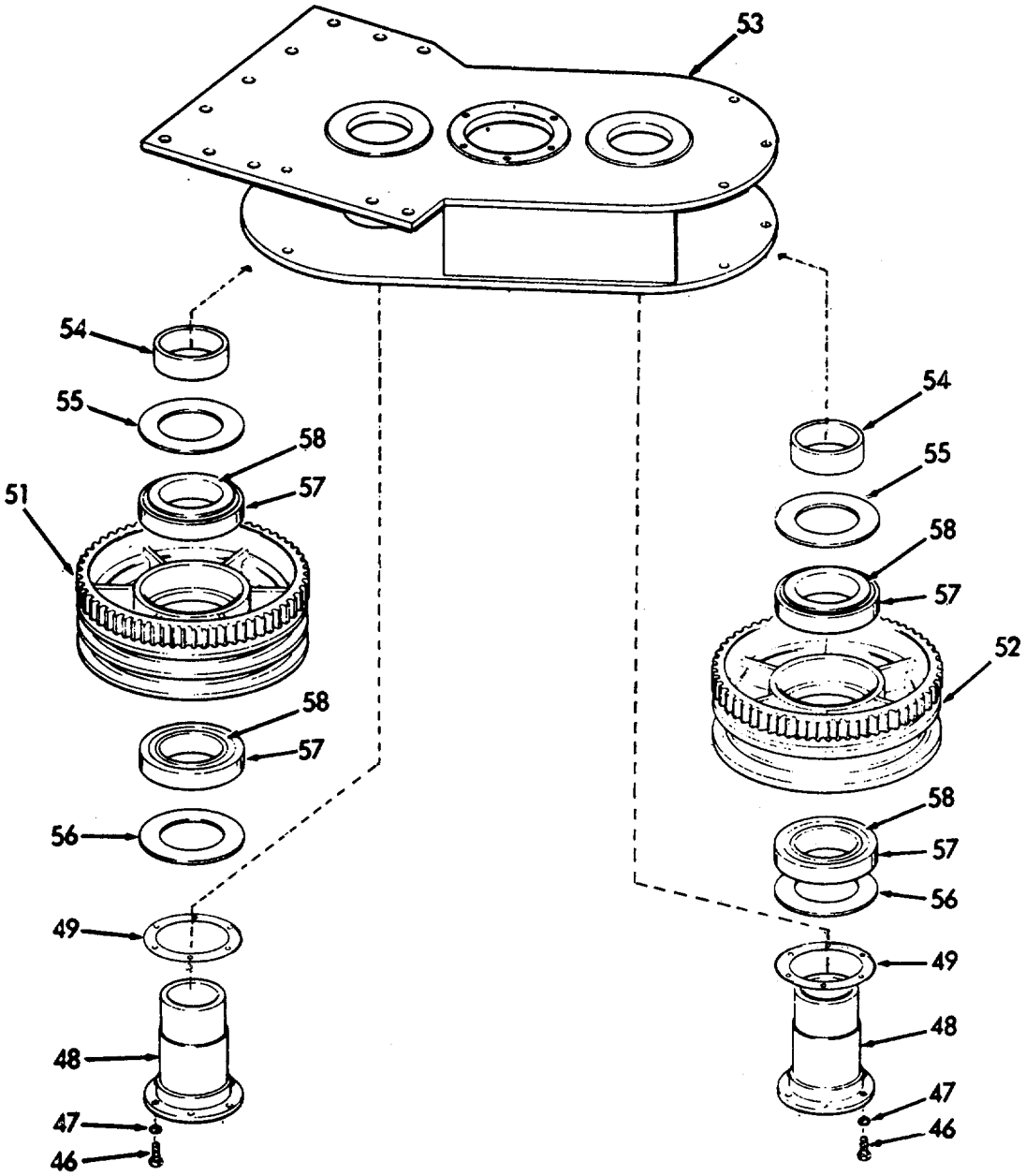
5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	z. Bearing cups (57), and bearing cones (58)	1. Remove. 2. Inspect for wear or damage. 3. Replace.	
	aa. Upper bearing plate (56), lower bearing plate (55), and spacers (54)	Assemble.	
	ab. Sheaves (51 and 52), and associated parts	Slide in frame (53).	
	ac. Shims (49), and tube shafts (48)	Install on both sides.	
	ad. Screws (46), and lock washers (47)	Install on both sides.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

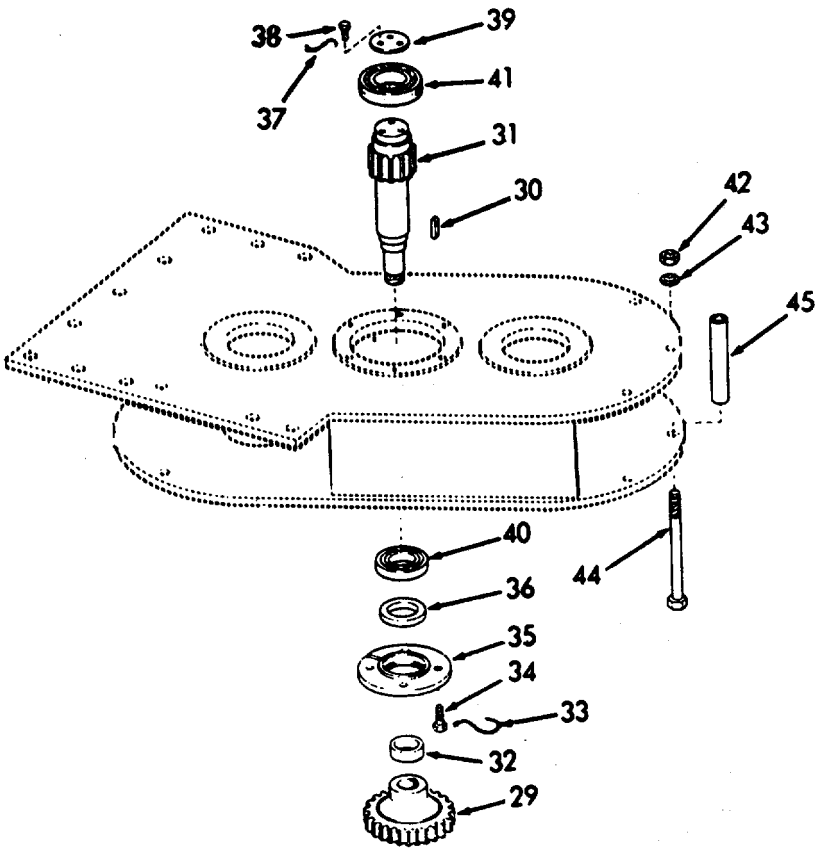


5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ae. Spacers (45), screws (46), lock-washers (43), and nuts (42)	Install.	
	af Bearings (40 and 41)	Press onto pinion shaft.	Use an arbor press.
	ag. Clamp plate (39), and screws (38)	Install.	
	ah. Lockwire (37)	Install.	
	ai. Pinion shaft (31), and bearings	Install.	
	aj. Bearing seal (36)	Install.	Use new seal.
	ak. Shaft retainer (35). and screws (34)	Install.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	al. Lockwire (33)	Install.	
	am. Shaft retainer (32)	Install.	
	an. Key (30), and gear (29)	Install on pinion shaft (31).	



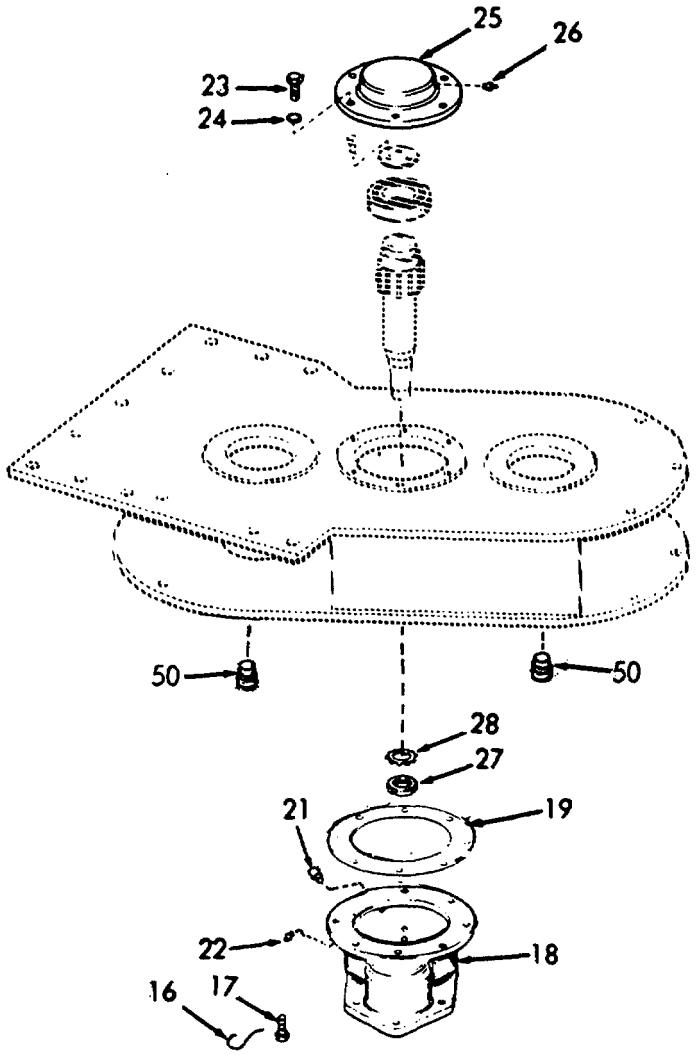
5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ao. Lock-washer (28), and locknut (27)	Install.	
	ap. Bearing cover (25)	Install.	
	aq. Screws (23), and lock washers (24)	Install.	
	ar. Gasket (19), and housing (18)	Install.	
	as. Screw (17), and lockwire (16)	Install.	
	at. Lubri-cation fittings (21, 26, and 50)	Grease.	Use grease MIL-G-81322, type GH.
	au.	Proceed to Installation of Slack Puller (step 5).	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

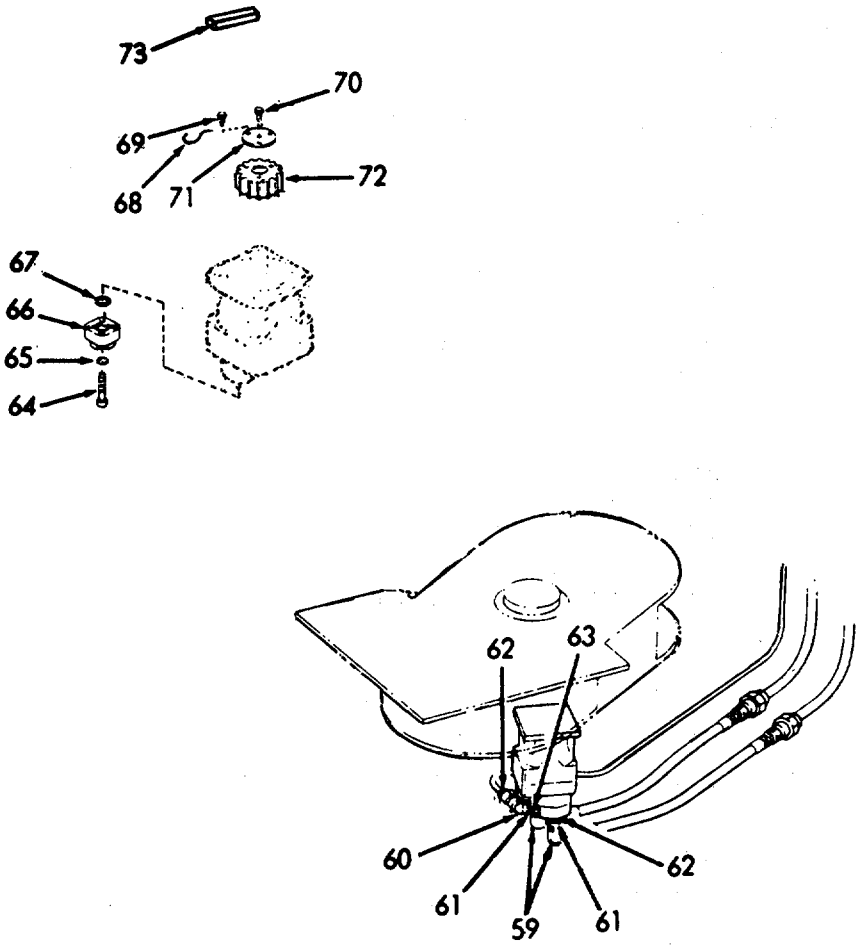
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Slack Puller Motor	a. Elbows (59 and 60), adaptors (61), and reducers (62 and 63)	Remove.	
	b. Screws (64), and lock-washers (65)	Remove.	
	c. Flange connectors (66), and preformed packings (67)	Remove.	Discard packing.
	d. Lockwire (68)	Cut and remove.	
	e. Screws (69)	Remove.	
	f. Screw (70), and clamp plate (71)	Remove.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

g.	Gear (72), and key (73)	Remove.	



5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Pipe plug (74)	1. Remove. 2. Drain.	Drain oil into a suitable container.
	i. Screws (75)	Remove.	
	j. End cap (76)	Remove.	
	k. Dowel pin (77)	Remove from cam ring (78).	
	l. Pre-formed packing (79), and bearing (80)	Remove from end cap (76).	Discard.
	m. Cam ring (78)	Install screws in top two holes provided as puller holes.	Screws are 10-24.
	n. Cam ring (78), Vanes (81), springs (82), spring guides (83), and) rotor (84)	1. Read warning. 2. Install ring compressor.	Discard vanes, springs, and spring guides.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

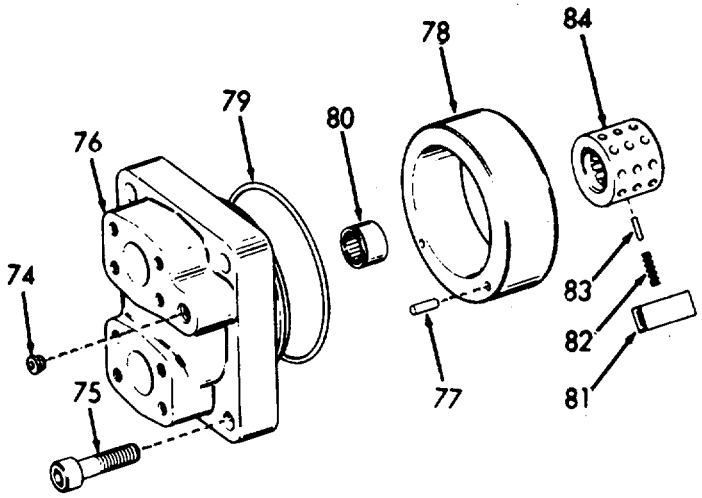
LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

WARNING

The vanes are held against the cam ring by tension from the springs in the rotor. If the rotor is pulled from the cam ring with no protection, compression from the springs will cause the vanes to be thrown forcibly out from the rotor in all directions. Serious injury can occur to the maintenance personnel since the vanes have fine, sharp edges.

Place the cartridge (cam ring, rotor, springs, and vanes) on a clean, flat surface. Push the rotor and vanes simultaneously out of the cam ring far enough so that a ring compressor can be securely fastened around the vanes. Once the ring compressor is in place, push the rotor and vanes the remainder of the way out of the cam ring. Ease the tension of the ring compressor slowly so that the vanes do not fly out of the rotor.



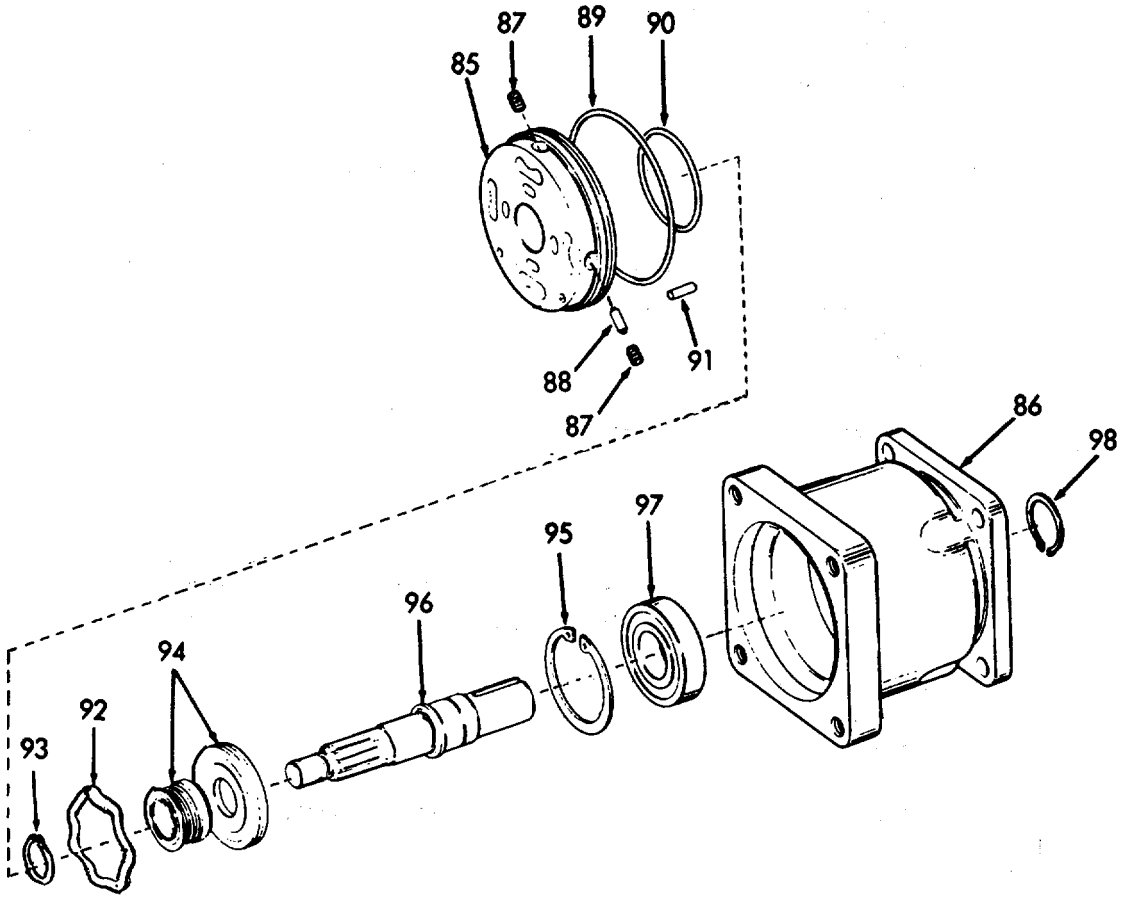
5-793

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	o. Port Plate (85)	1. Insert two screws in tapped holes.	Screws are 10-24.
		2. Remove plate from housing (86).	
	p. Setscrews (87), and spool (88)	Remove.	
	q. Pre-formed packing (89 and 90)	Remove from port plate (85).	Discard.
	r. Dowel pin (91)	Remove from housing (86).	
	s. Wavy spring washer (92)	Remove from housing (86)	Discard.
	t. External retaining ring (93)	Remove.	
	u. Seals (94)	Remove from port plate (85).	Discard.
	v. Retaining ring (95)	Remove.	
	w. Shaft (96) and bearing (97)	Remove as an assembly.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	x. Snap ring (98)	Remove.	
	y. Bearing (97)	Remove from shaft (96).	



5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

WARNING

Wear protective eye goggles when using compressed air.

z.	Cleaning	Wash all metal parts in cleaning solvent, and blow dry with clean, compressed air.	

CAUTION

Dirt is a major cause of wear and pump failure. Cover all parts after cleaning to prevent dust and dirt from settling on them. All surfaces should be coated with a film of hydraulic lubricating oil, Military Specification MIL-H-5606 after they have been cleaned.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

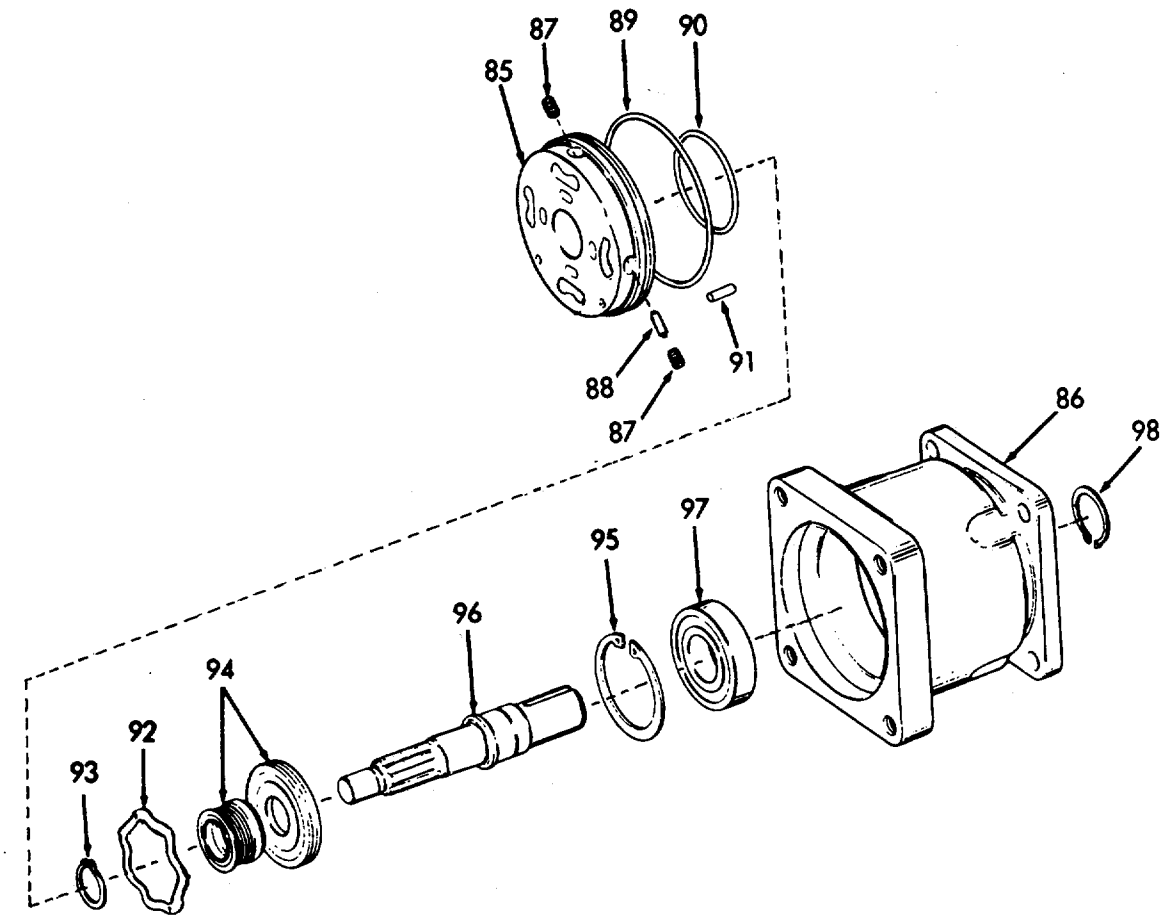
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	aa. Inspection	1. Inspect the seal for wear and breaks. Replace a defective seal . 2. Inspect springs for cracks or permanent set. Replace all defective springs. 3. Inspect bearings for wear or flat spots and replace if defective. 4. Inspect cam ring for wear and replace if defective. 5. Inspect rotor for scores or marring and replace if defective. 6. Inspect housing for cracks or other possible casting damage and replace if needed.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ab. Bearing (97)	Install on shaft (96).	
	ac. Retaining ring (98)	Install.	
	ad. Shaft (96), bearing (97), and retaining ring (98)	Install in housing (86).	
	ae. Retaining ring (95)	Install.	
	af. Seals (94)	Install on port plate (85).	Use new seals.
	ag. Retaining ring (93)	Install.	
	ah. Wavy spring washer (92)	Install in housing (86).	
	ai. Dowel pin (91)	Install in housing (86).	
	aj. Pre-formed packings (89 and 90)	Install in port plate (85).	Use new packings.

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	ak. Setscrews (87), and spool (88)	Install on port plate (85).	Use new packings.



5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

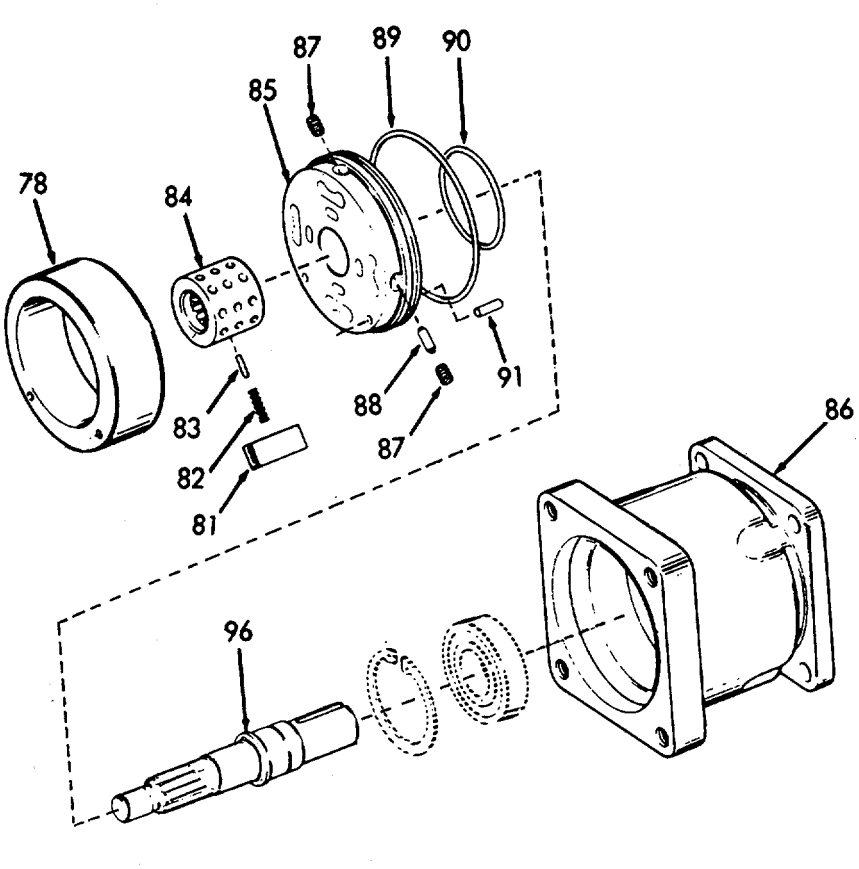
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	al. Port plate (85)	1. Install in housing (86).	
		2. Push it over splined end of shaft (96).	
		3. Do not damage pre-formed packings (89 and 90).	
		4. Allow dowel pin (91) to engage in proper hole.	
	am. Cam ring (78), rotor (84) springs (82), spring guides (83), and vanes (81)	1. Place on clean, flat surface.	
		2. Install spring guides and vanes into rotor.	
		3. Place ring compressor around the vanes and tighten compressor gradually until springs and vanes are in the position they will occupy while in the cam.	
		4. install the rotor in the cam ring using a back-up plate to prevent the vanes from sliding end-wise in the slots and damaging the springs.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

5. If the vanes slide end-wise, inspect and replace damaged springs.



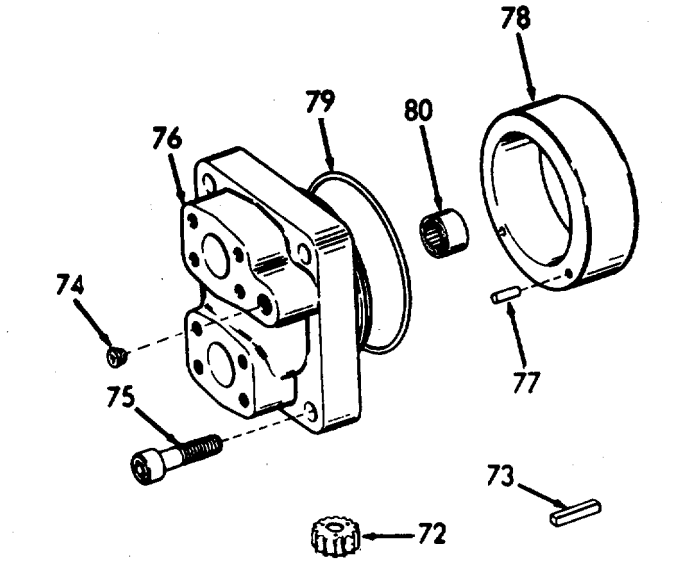
5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		WARNING Be certain that the assembly is inserted far enough in the cam ring so that when the ring compressor is removed, the vanes do not fly out of position.	
	an. Pre-formed packing (79), and bearing (80)	Insert in end cap (76).	
	ao. Dowel pin (77)	Insert in cam ring (78).	
	ap. End cap (76)	Install.	
	aq. Screws (75)	1. Install. 2. Torque screws to 130 lb-ft (176.3 Nm).	
	ar. Pipe plug (74)	Install.	
	as. Gear (72), and key (73)	Install.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



5-803

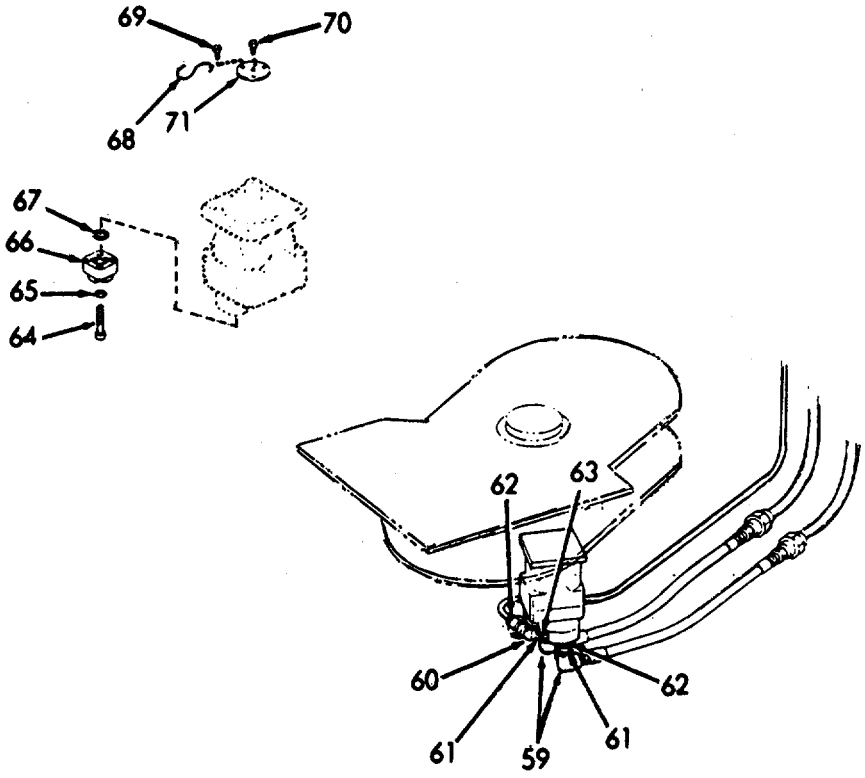
5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	at. Screw (70)	Install.	
	au. Clamp plate (71), and screws (69)	Install.	
	av. Lockwire (68)	Install.	
	aw. Flange connectors (66), and preformed packings (67)	Install.	Use new packings.
	ax. Screws (64), and lock-washers (65)	Install.	
	ay. Reducers (62 and 63), adaptors (61), and elbows (59 and 60)	Install.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

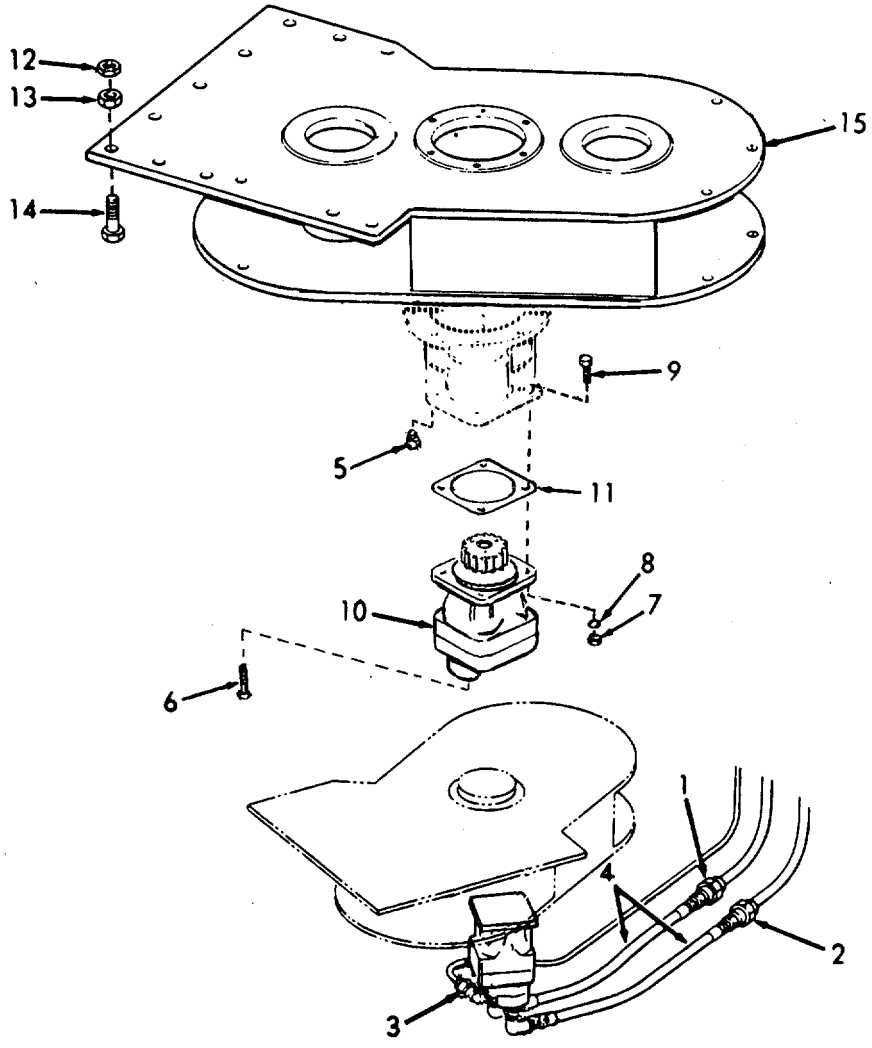


5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Slack Puller	a. Slack puller (15)	Align holes.	
	b. Screws (14), nuts (13), and jam nuts (12)	Install.	
6. Slack Puller Motor	a. Gasket (11), and hydraulic motor (10)	Align holes.	Use new gasket.
	b. Screws (9), lock-washers (8), and nuts (7)	Install.	
	c. Screws (6)	Install.	
	d. Pipe plug (5)	Install.	
	e. Flexible hoses (4)	Install.	
	f. Unions (1, 2, and 3)	Tighten.	

5-64. SLACK PULLER AND MOTOR - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Motor drive housing	Add oil. 2105 type G090.	Use oil MIL-L-
	h. System	Operate and check fluid levels.	Add hydraulic fluid as needed.



5-65. DISCONNECT CLUTCH - MAINTENANCE INSTRUCTIONS

The following is an index to the Disconnect Clutch maintenance instructions:

DESCRIPTION	Paragraph
Disconnect Clutch Assembly	5-65.1
Disconnect Clutch	5-65.2
Clutch Hydraulic Cylinder	5-65.3

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Removal b. Repair c. Installation

INITIAL SETUP:

Test Equipment

Depth gage

Special Tools

Arbor press
Clutch aligning arbor

Material/Parts

NONE

Personnel Required

2

References

Para 5-65.2 Disconnect Clutch Repair

Equipment Condition: NONE

Condition Description

Special Environmental Conditions

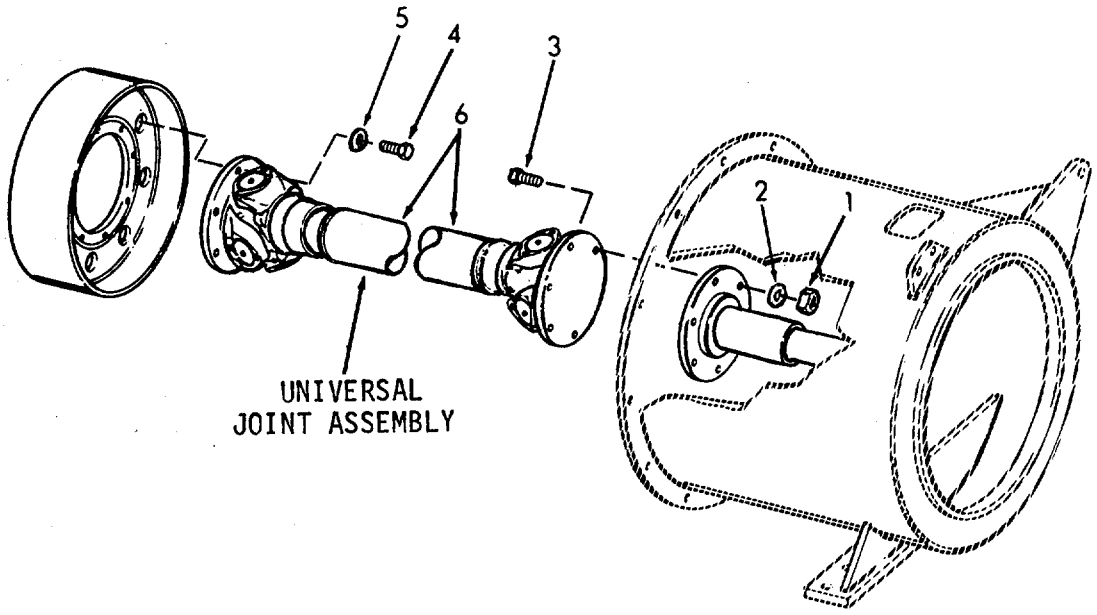
Do not drain oil into bilges. Use oil separation and recovery system to collect drained oil.

General Safety Instructions

NONE

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Universal Joint Assembly	a. Nuts (1), lock-washers (2), and s crews (3)	Remove.	
	b. Screws (4), and lock-washers (5)	Remove.	
	c. Universal joint assembly (6)	Remove.	



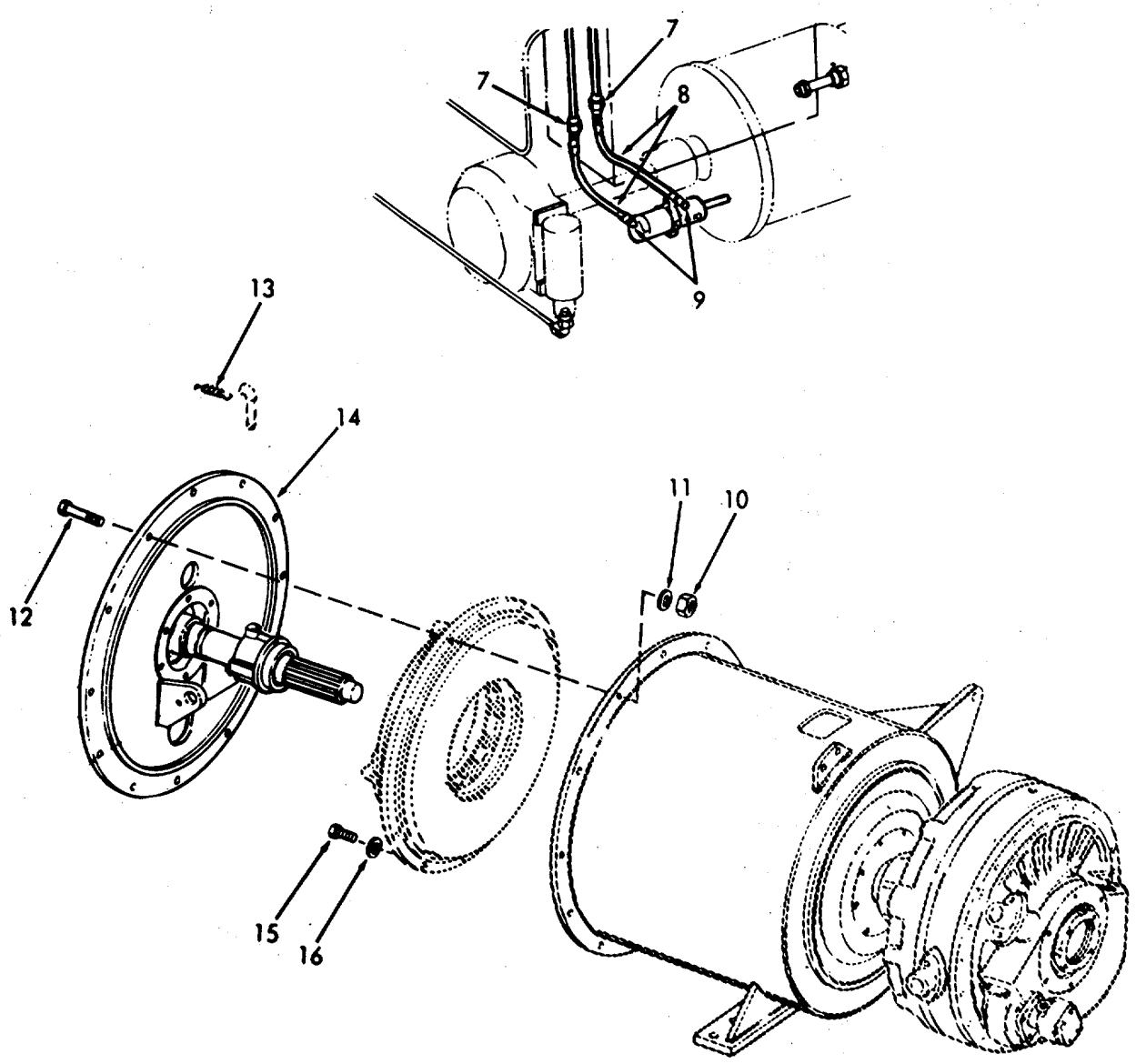
5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)|			
2. Disconnect Clutch	a. Unions (7)	1. Loosen. 2. Drain. 3. Disconnect.	Use suitable container.
	b. Hydraulic hoses (8)	Remove.	
	c. Bushing reducers (9)	Remove.	If necessary.
	d. Nuts (10) lockwashers (11), and screws (12)	Remove.	
	e. Spring (13)	Remove.	
	f. Cover plate and shaft assembly (14)	Remove.	
	g. Screws (15), and lockwashers (16)	Remove.	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

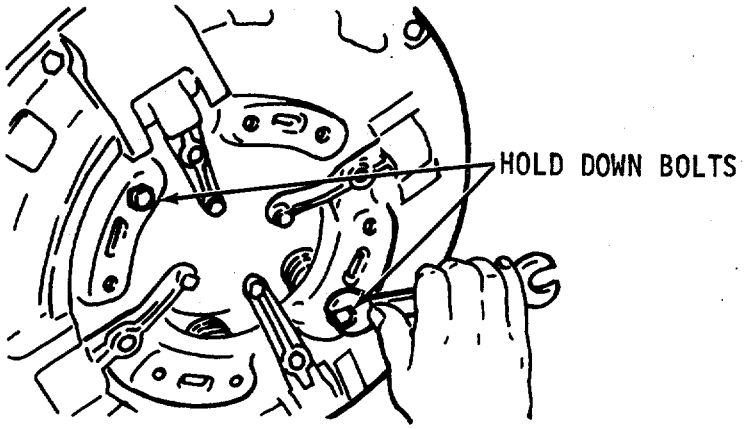
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

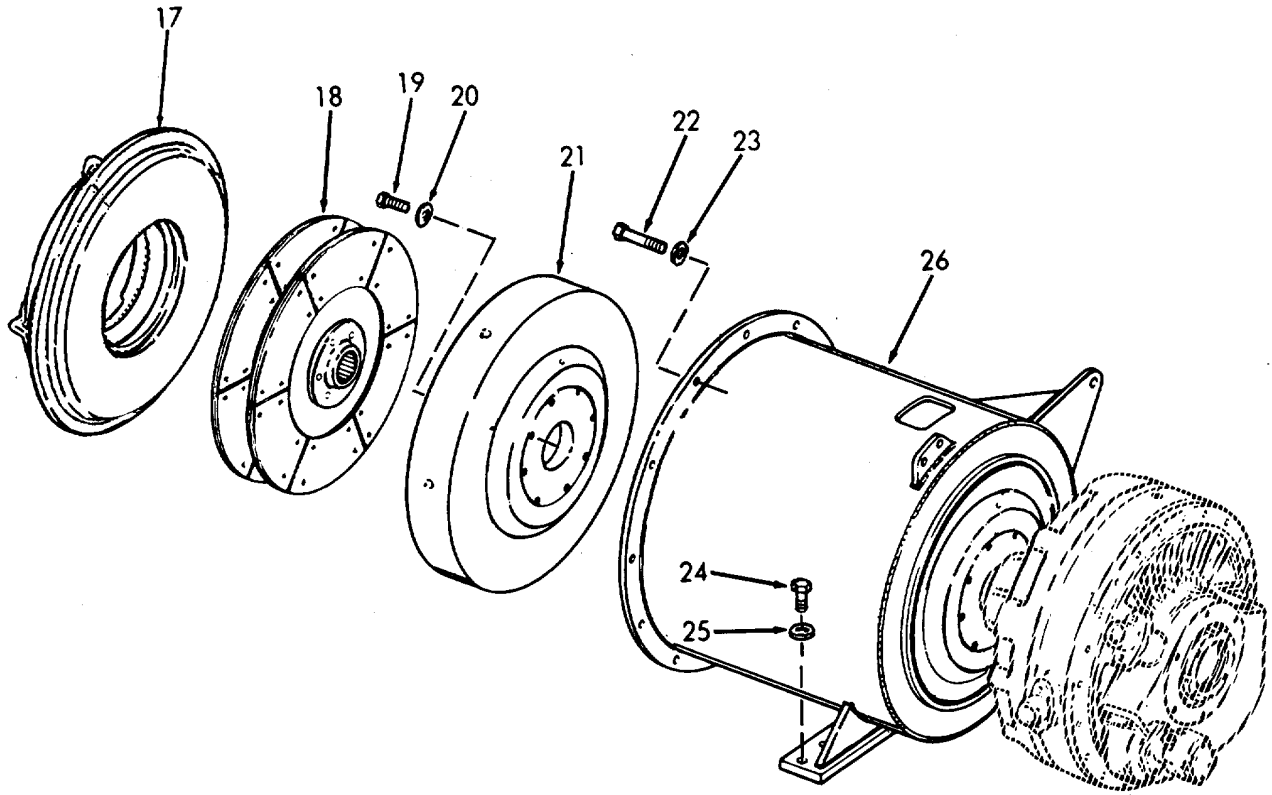
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont) I			
	h. Pressure ring (17), and clutch disc (18)	1. Install two hold-down screws opposite one another through the holes in the spring retainer, and thread these bolts into the tapped holes in the pressure plate provided for this purpose. Tighten sufficiently to compress the springs and free the levers.	Screws are 3/8 16 x 3 inches.
		2. Remove.	



	i. Screws (19) ,and lockwashers (20)	Remove.	
	j. Clutch flywheel (21)	Remove.	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	k. Screws (22), and lockwashers (23)	Remove.	
	l. Screws (24) and lockwashers (25)	Remove.	
	m. Clutch housing (26)	Remove.	

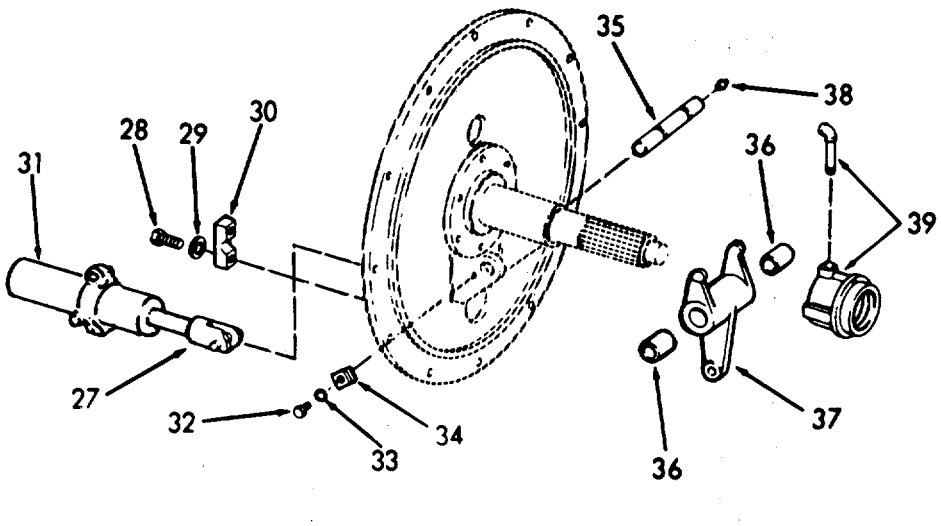


5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Disconnect Clutch	a. Rod clevis pin, and clevis (27)	Remove.	
	b. Screws (28),' and lockwashers (29)	Remove.	
	c. Outside cap brackets (30)	Remove.	
	d. Hydraulic cylinder (31)	Remove.	
	e. Screw (32), lockwasher (33), and pin lock (34)	Remove.	
	f. Pin (35)	Remove.	
	g. Bushings (36), and throwout yoke (37)	Remove.	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	h. Lubrication fitting (38)	Replace.	If necessary.
	i. Bearing carrier (39)	Remove.	

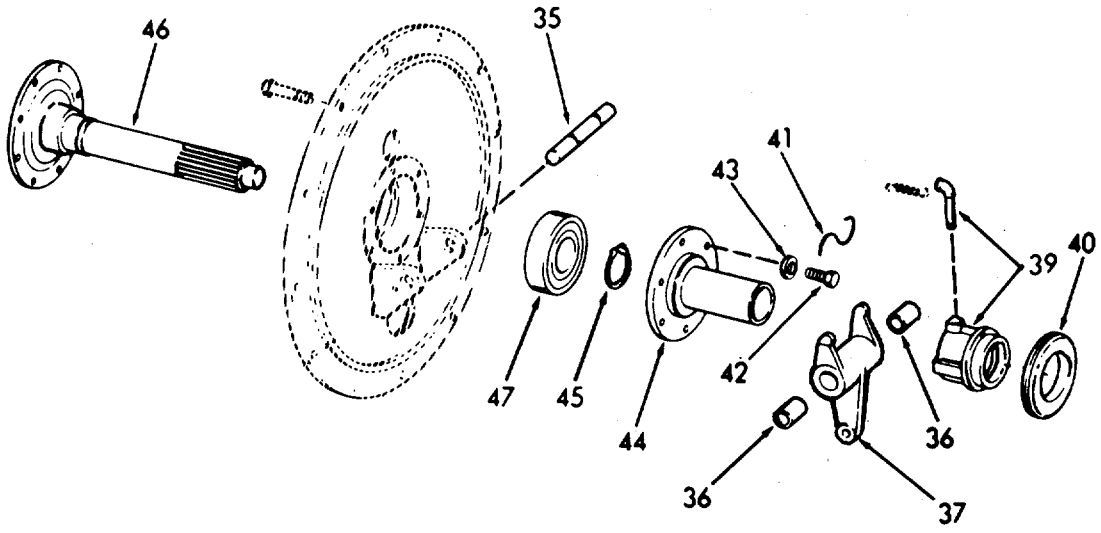


5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Clutch release bearing (40)	Remove from bearing carrier (39).	
	k. Lockwire (41)	Cut and remove.	
	l. Screws (42), and lockwashers (43)	Remove.	
	m. Bearing cover (44)	Remove.	
	n. Snap ring (45)	Remove.	
	o. Shaft (46)	Remove.	
	p. Bearing (47)	Replace.	
	q. Shaft (46)	Install.	
	r. Snap ring (45)	Install.	
	s. Bearing cover (44)	Install.	
	t. Screws (42), and lockwashers (43)	Install.	
	u. Lockwire (41)	Install.	
	v. Clutch release bearing (40)	Install on bearing carrier (39).	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont) I			
	w. Bearing carrier (39)	Install.	
	x. Throwout yoke (37)E bushings (36), and pin (35)	Install.	



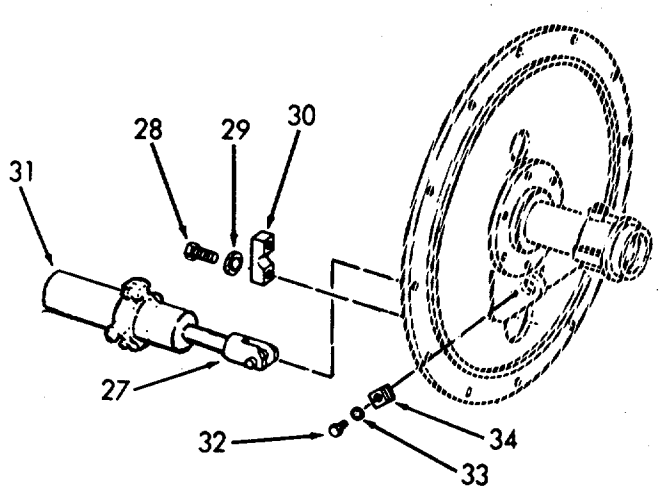
5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	y. Pin lock (34), lock-washer (33), and screw (32)	Install.	
	z. Hydraulic cylinder (31), and outside cap bearings (30)	Install.	
	aa. Screws (28), and lock-washers (29)	Install.	
	ab. Rod clevis pin, and clevis (27)	Install.	

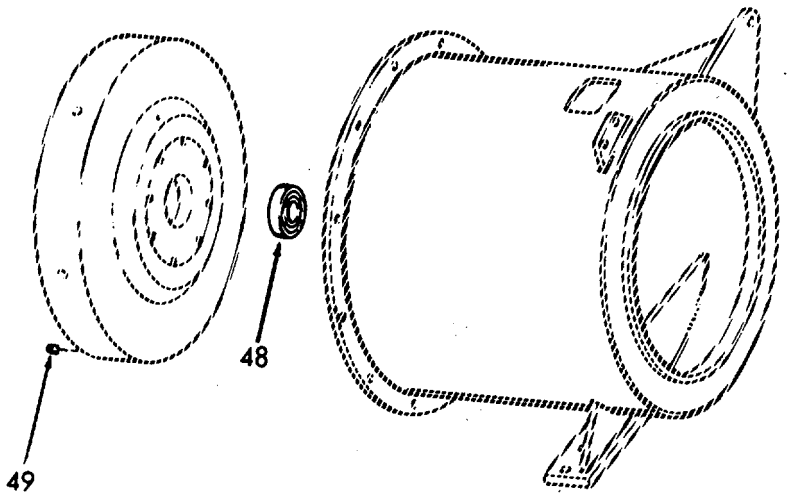
5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



4.	Flywheel (clutch)	a.	Bearing (48)	Remove.
		b.	Setscrews (49)	Remove. If necessary.
		c.	Bearing (48)	Replace.

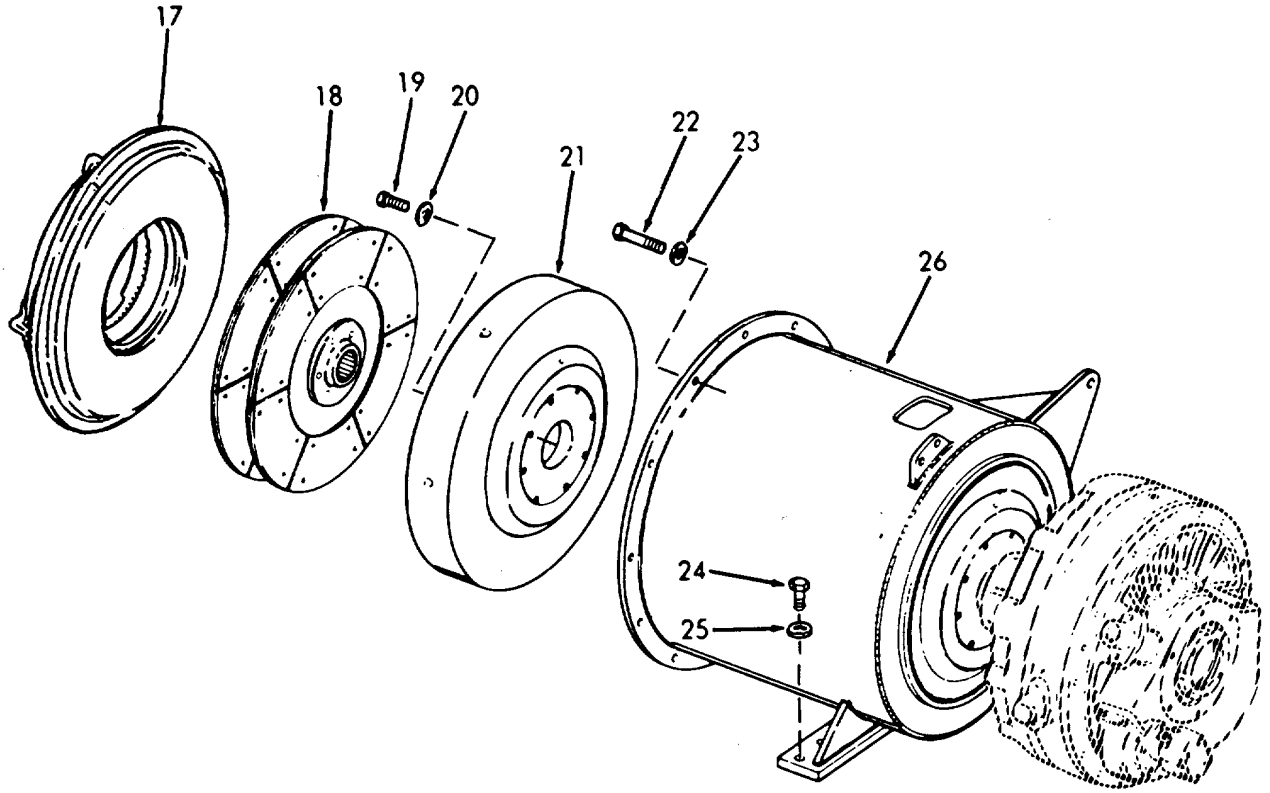


5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5. Dis connect Clutch	a. Clutch housing (26)	Install.	
	b. Screws (24), and lock-washers (25)	Install.	
	c. Screws (22), and lock-washers (23)	Install.	
	d. Clutch flywheel (21)	1. Check for depth of 2.321 +.007-.000 inches. 2. Align holes with flange.	
	e. Screws (19), and lock-washers (20)	Install.	
	f. Pressure ring (17), and assembly	Try assembly in fly-wheel (21) before in-serting disc assembly (18) so as to make certain the clutch pilot diameter fits freely in the flywheel.	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Clutch disc (18)	Install in clutch flywheel.	
	h. Pressure ring assembly (17)	Install in clutch flywheel.	Use clutch aligning arbor.



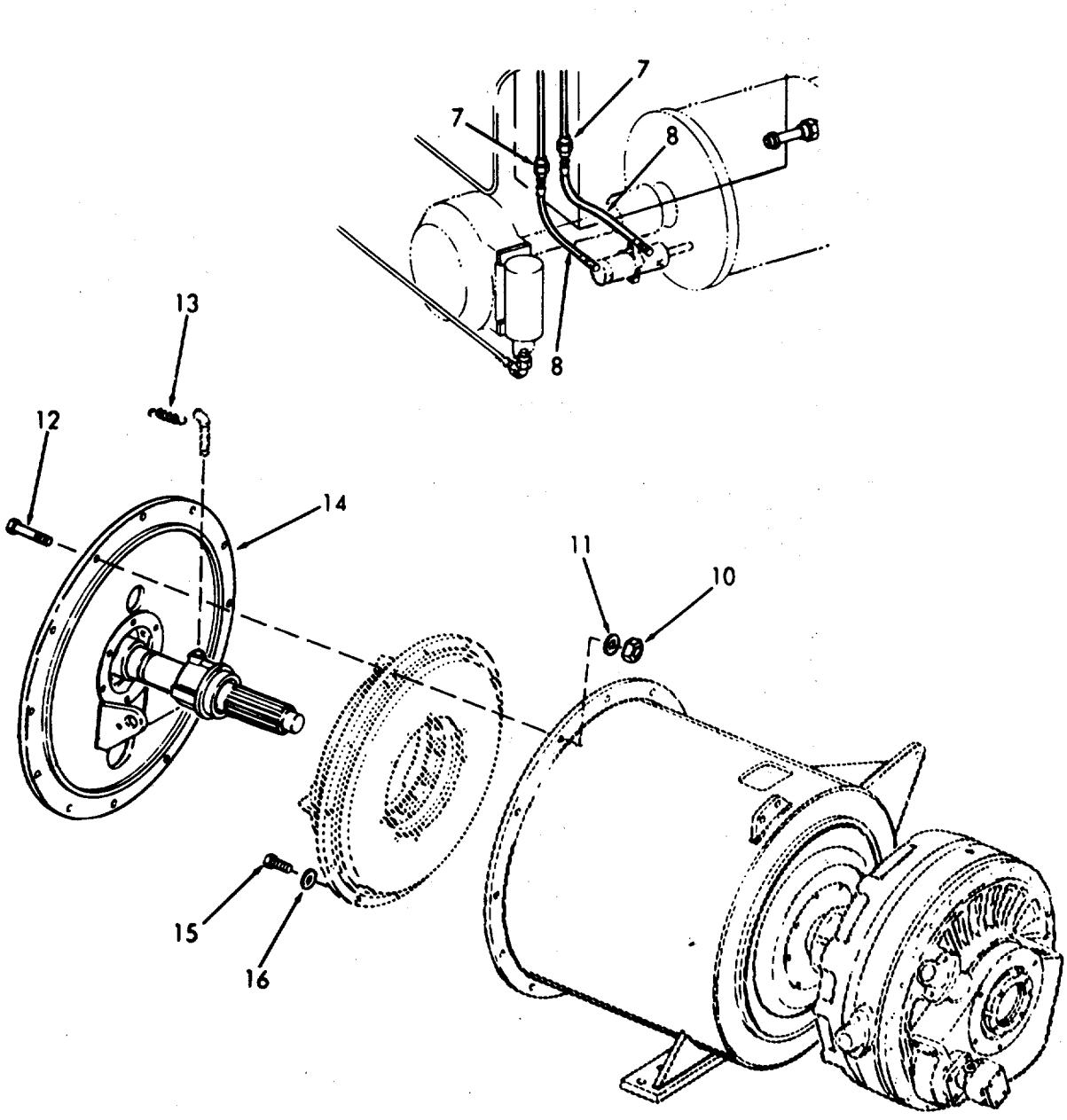
5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	i. Screws (15), and lock-washers (16)	Install.	
	j. Cover plate and shaft assembly (14)	Install.	Do not force assembly onto pressure ring assembly.
	k. Spring (13)	Attach.	
	l. Screws (12), lock-washers (11), and nuts (10)	Install.	
	m. Hydraulic hoses (8)	Install.	
	n. Unions (7)	Reconnect.	

5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

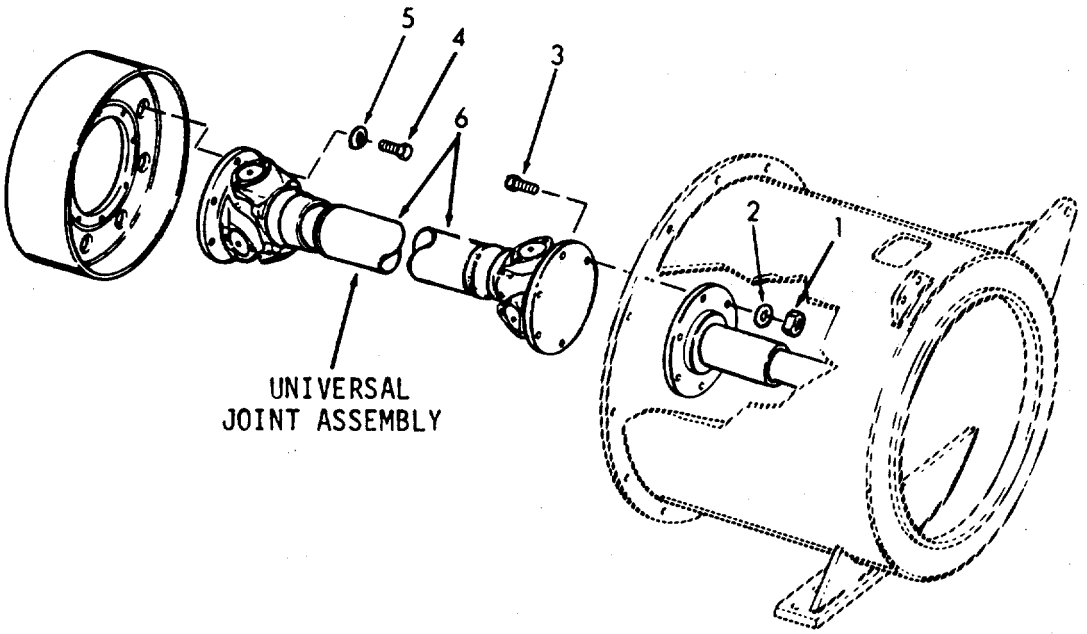
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



5-65.1 DISCONNECT CLUTCH ASSEMBLY - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
6. Universal Joint Assembly	a. Universal joint assembly (6)	Install.	
	b. Screws (4), and lock-washers (5)	Install.	
	c. Screws (3), lock-washers (2), and nuts (1)	Install.	



7. System		a. Operate..	
		b. Check for leaks.	
		c. Refill reservoir if necessary.	
		d. Check for proper operation.	

5-65.2 DISCONNECT CLUTCH - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Disassembly **c. Reconditioning** **e. Adjustment**
b. Inspection **d. Reassembly**

INITIAL SETUP:

Test Equipment

Machinist square
Scale

Special Tools

Arbor press

Material/Parts

NONE

Personnel Required

1

References

None

Equipment Condition: Condition Description

NONE

Special Environmental Conditions

NONE

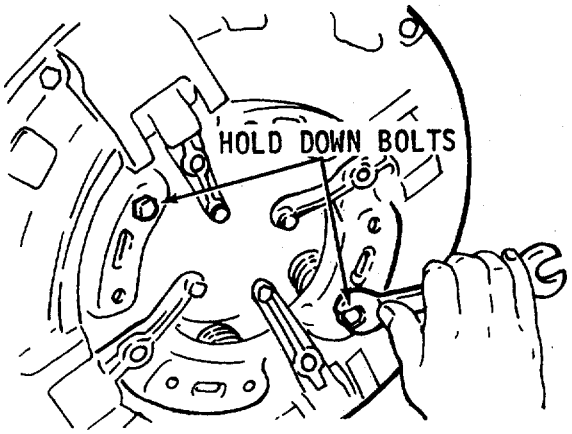
General Safety Instructions

NONE

5-65.2 DISCONNECT CLUTCH - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

(Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Clutch	a. Clutch assembly	Install two holddown screws opposite one another through the holes in the spring retainer and thread these bolts into the tapped holes in the pressure plate provided for this purpose. Tighten sufficiently to compress the springs and free the levers.	Screws are 3/8 16 x 3 inches.
	b. Screws (1), and lockwashers (2)	Remove.	
	c. Cotter pins (3)	Remove.	



5-65.2 DISCONNECT CLUTCH - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

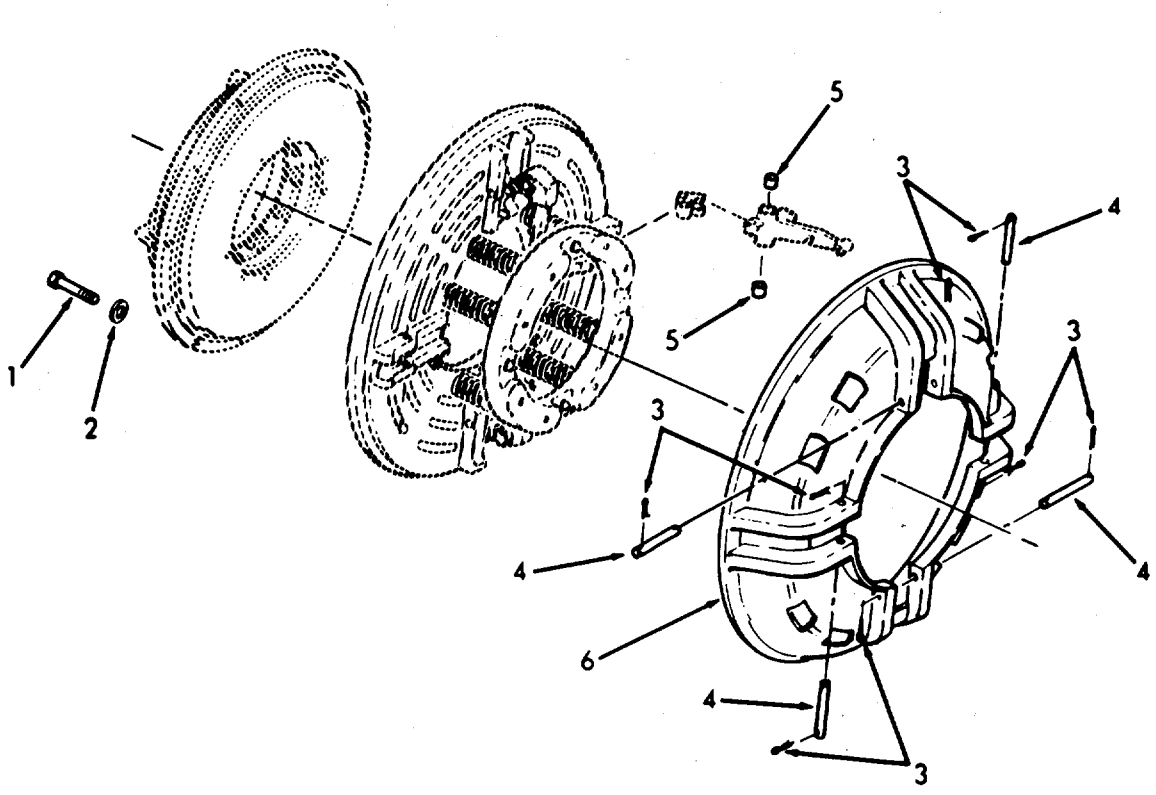
LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY(Cont)

CAUTION

Use care when driving out the lever release pins. Avoid damage to the needle bearings (5).

d.	Lever release pins (4)	Drive out.	
e.	Flywheel ring cover (6)	Lift off.	

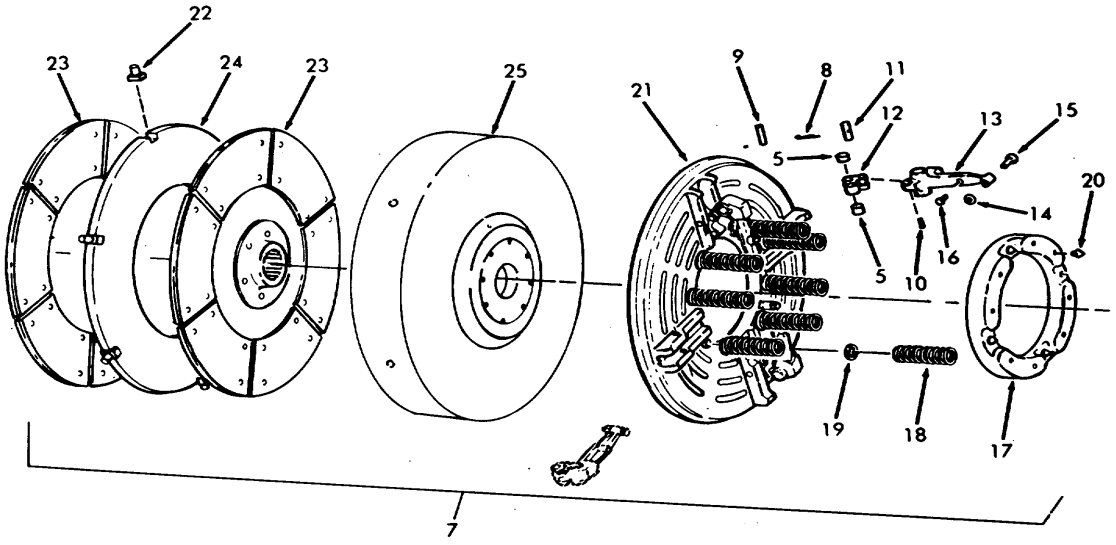


5-65.2 DISCONNECT CLUTCH - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	f. Pressure plate assembly (7)	1. Place on the table of the arbor or drill press. 2. Place block across the spring retainer and hold the springs in a compressed position so that the two hold-down screws can be removed and then slowly release the spring tension.	
	g. Cotter pins (8)	Remove.	
	h. Link pins (9)	Remove.	
	i. Needle bearings (5)	Drive out.	Use an arbor press.
	j. Pressure plate lock-pins (10)	Drive out with pin punch or other suitable tool.	
	k. Link pin (11)	Remove.	
	l. Release lever link (12), and release lever (13)	Separate.	
	m. Nut (14), and adjusting screw (15)	Remove.	If necessary.
	n. Lever guide (16)	Remove.	If necessary.

5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	o. Spring retainer (17), springs (18), and spring washers (19)	Remove.	
	p. Studs (20)	Remove.	Use arbor press.
	q. Pressure plate (21)	Lift off.	
	r. Driving pins (22), clutch disc assembly (23), and intermediate plate (24)	Separate from flywheel (25).	



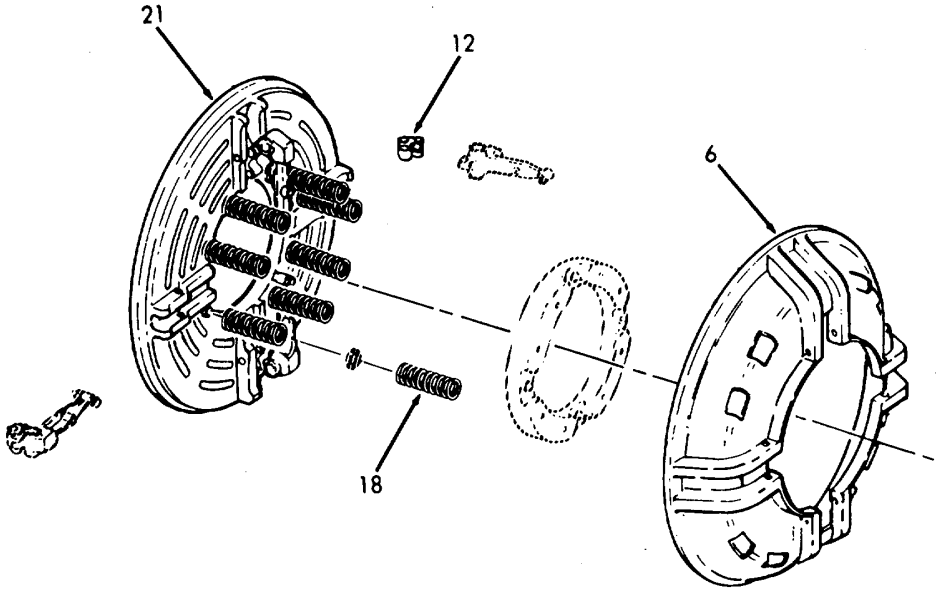
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
2.	a. All parts	Clean thoroughly.	
	b. Springs (18)	Check for color and weight/height.	Color yellow Weight/height minimum 170 lbs. @ 2 ¼ inches.
	c. Pressure plate (21)	Inspected for warp, heat checks, and score marks on the friction surface as well as the condition of the driving slots and pin holes. If excessive wear at the driving slots or elongation of the pin holes is present, the pressure plate should be replaced.	
	d. Flywheel ring (6)	Inspect for wear of the driving lugs and cover pin holes. The cover should fit freely in the slots of the pressure plate with approximately .006 inch clearance between the lugs, and mating slots in the pressure plate. The cover should be checked for distortion by placing it with the flange face down on the surface plate. Replace if distorted.	
	e. Toggle link (12)	Inspect. If any elongation in the holes is shown, replace.	
	f. Pins (all)	Inspect and replace if worn.	

5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



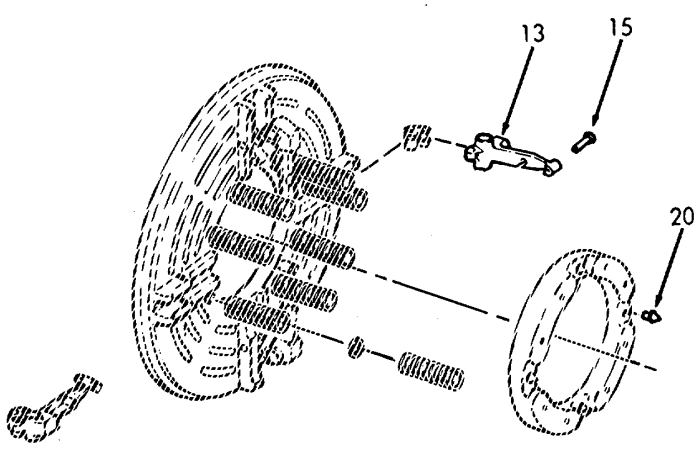
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		CAUTION Use correct grease and do not overlubricate.	
	g. Release lever (13) and associated parts	Inspect the lever for the condition of the toggle link hole; if elongated or worn, replace the lever. Also check the milled slot in the underside of the lever; if excessively worn by fulcrum studs, replace lever. A removable fulcrum guide button can be replaced if worn. Needle bearings must rotate freely; otherwise replace. When installing new needle bearings, use suitable tool and press in flush with lever. Make certain they are installed in the lever so that the part number stamped on the end of the needle bearing cage faces outward as pressing on the other end of the bearing cage to install will damage the bearing. Pack needle bearing with a small amount of high melting point grease.	
	h. ever adjusting screws (15)	Notice the condition of the lever adjusting screws. If they are worn where contacted by the release bearing, install new screws in the levers.	

5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

(Continued)

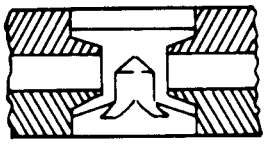
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	i. Studs (20)	Inspect the fulcrum studs in the spring retainer for wear, and replace if necessary.	



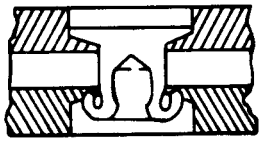
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	j. Disassembly (23)	Inspect the disc assembly for worn, loose, or oil-soaked facings. Check the assembly for distortion or dished condition and for excessive wear at the splines in the hub. If the inspection reveals it is practical to reface the disc assembly the correct facing thickness is 5/32 inch. Do not use a distorted disc assembly. It is very important to use only the genuine original equipment facings and to set the rivets properly-see below. Check the disc assembly for runout. The disc should be true to within .015 inch at a point midway between the bore and the outside diameter of the facing.	



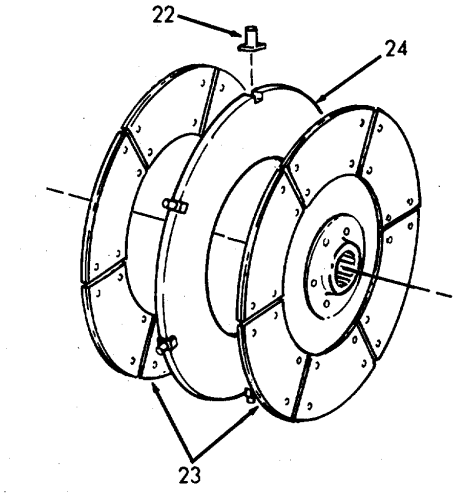
CORRECT RIVETING FOR FABRIC OR SEMI-METALLIC FACINGS



CORRECT RIVETING FOR METALLIC FACINGS

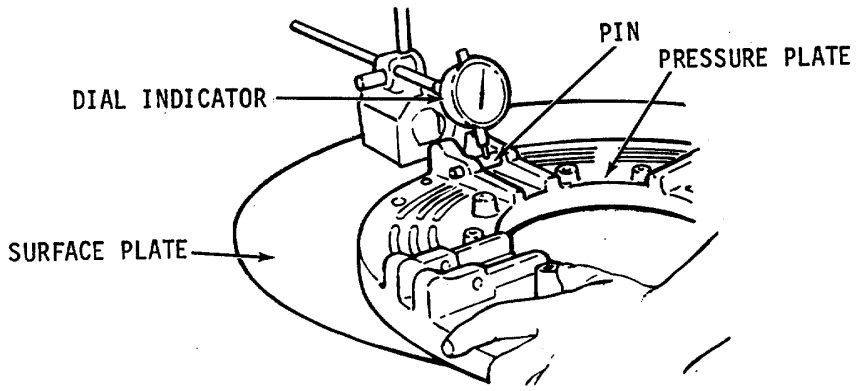
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

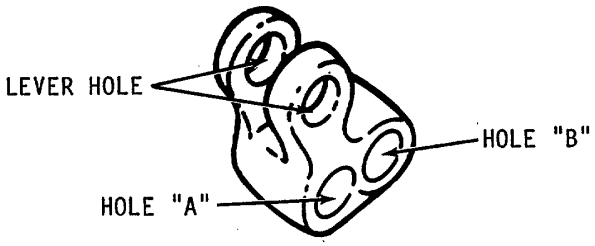
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	k. Driving pins (22) and inter-mediate plate (24)	Check for wear.	



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
RECONDITIONING			
3.	Pressure plate	It is recommended that not more than 1/32 inch be machined from the pressure plate friction surface. If more than this amount or any portion thereof is removed, clutch should be reassembled using hole "A" of toggle link. IMPORTANT: when machining amounts in excess of .0312 inch it is absolutely essential that the resurfaced dimension "B" 1.470 inch be obtained and clutch be reassembled using hole "B" of toggle link. "Dimension B" is the dimension from the top of the pin to the friction surface of the pressure plate as shown below. It is important that these instructions be followed, otherwise short clutch life or incomplete clutch release (drag) will result.	





5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS

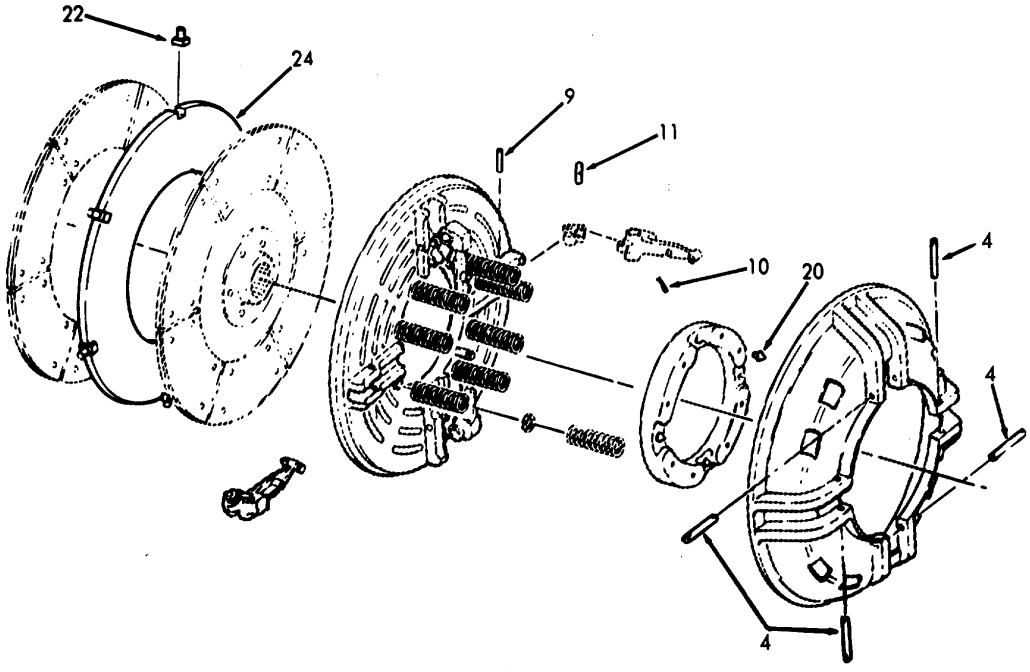
REASSEMBLY

4. Clutch

CAUTION

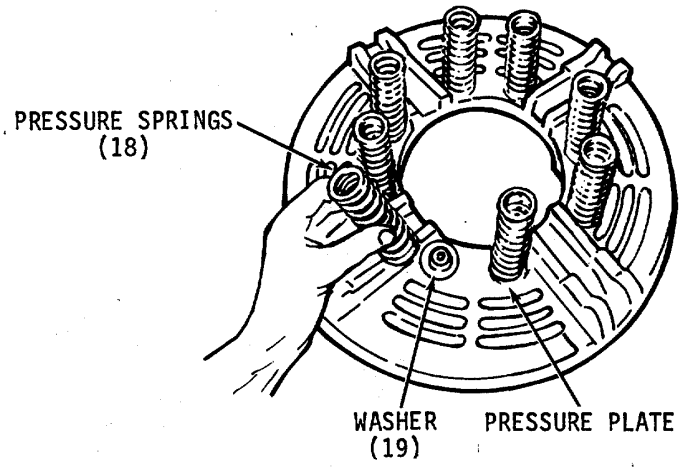
Do not over-lubricate or get lubricant on the facings of disc assembly. This will cause clutch to grab or slip.

a.	Studs (20), driving pins (22), mating slots in pressure plate (24), and pins (4, 9, 10 and 11)	Lubricate.	Use a grease with a high melting point.



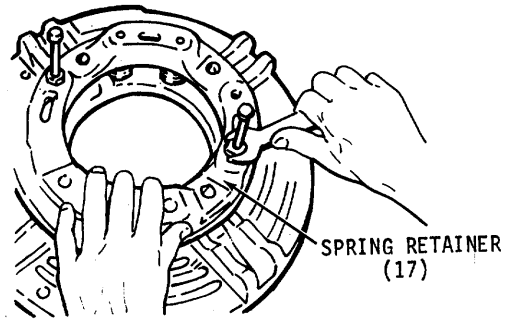
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	b. Washers (19)	Place over the spring locating bosses on the pressure plate. (Use two washers under each spring if a re-faced pressure plate is installed, to compensate for material ground off. Do not use two insulating washers under each pressure spring unless pressure plate has been been refaced to 1.470.	
	c. Springs (18)	Place over washers (19)	



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Spring retainer (17)	1. Install spring retainer into position over the pressure springs and compress springs with the use of two 3/8 inch 16 x 5 ½ inches long, fully-threaded screws and nuts. Insert them through the holes in the spring retainer and into the aligning tapped holes in the pressure plate provided for this purpose. 2. Make certain to tighten the bolts securely in the pressure plate. 3. Draw nuts down against the top of the spring retainer to compress the springs to overall height of approximately 2 inches.	



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

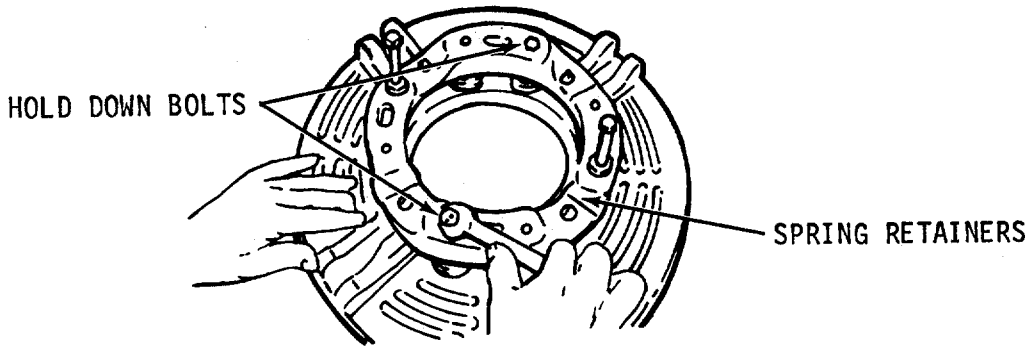
REASSEMBLY (Cont)

e. ALTERNATE METHOD.

An arbor or drill press may be used to compress the springs if preferred. Place block across the top of the spring retainer for this operation. Install two 3/8 inch x 16 x 3 inches hold-down screws opposite one another through the holes in the spring retainer and thread into aligning tapped holes in the pressure plate provided for this purpose to hold the springs fully compressed.

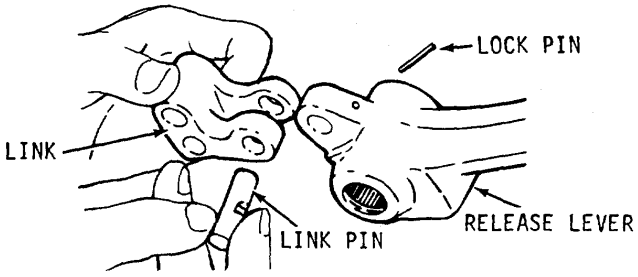
NOTE

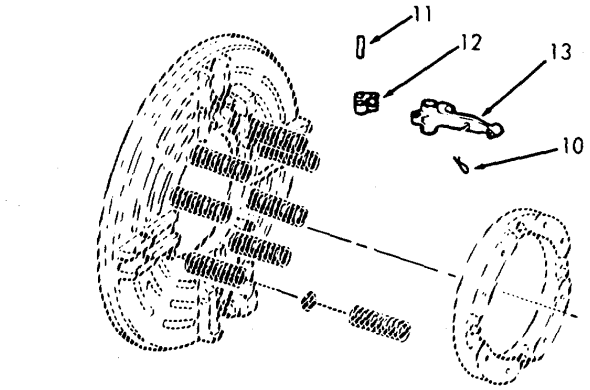
Screws 3/8 inch by 16 x 5 ½ inches long may be left in place until after the clutch in installed in the engine flywheel, or two standard 3/8 inch by 16 x 3 inch bolts installed at right angles to 5 ½ inch screws to hold the springs compressed,and remove long screws. IMPORTANT: The 5 ½ inch screws or hold-down screws must remain in place until the clutch has been bolted into the engine flywheel.



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	f. Link (12), link pin (10), lock-pin (11), and release lever (13)	Assemble toggle link to release lever as shown below placing lever in slot of toggle link and insert link pin.' Align milled notch of link pin with lock pin hole in lever with use of suitable tool before driving in lock pin. Lock pin should be driven in until it is flush with lever surface.	





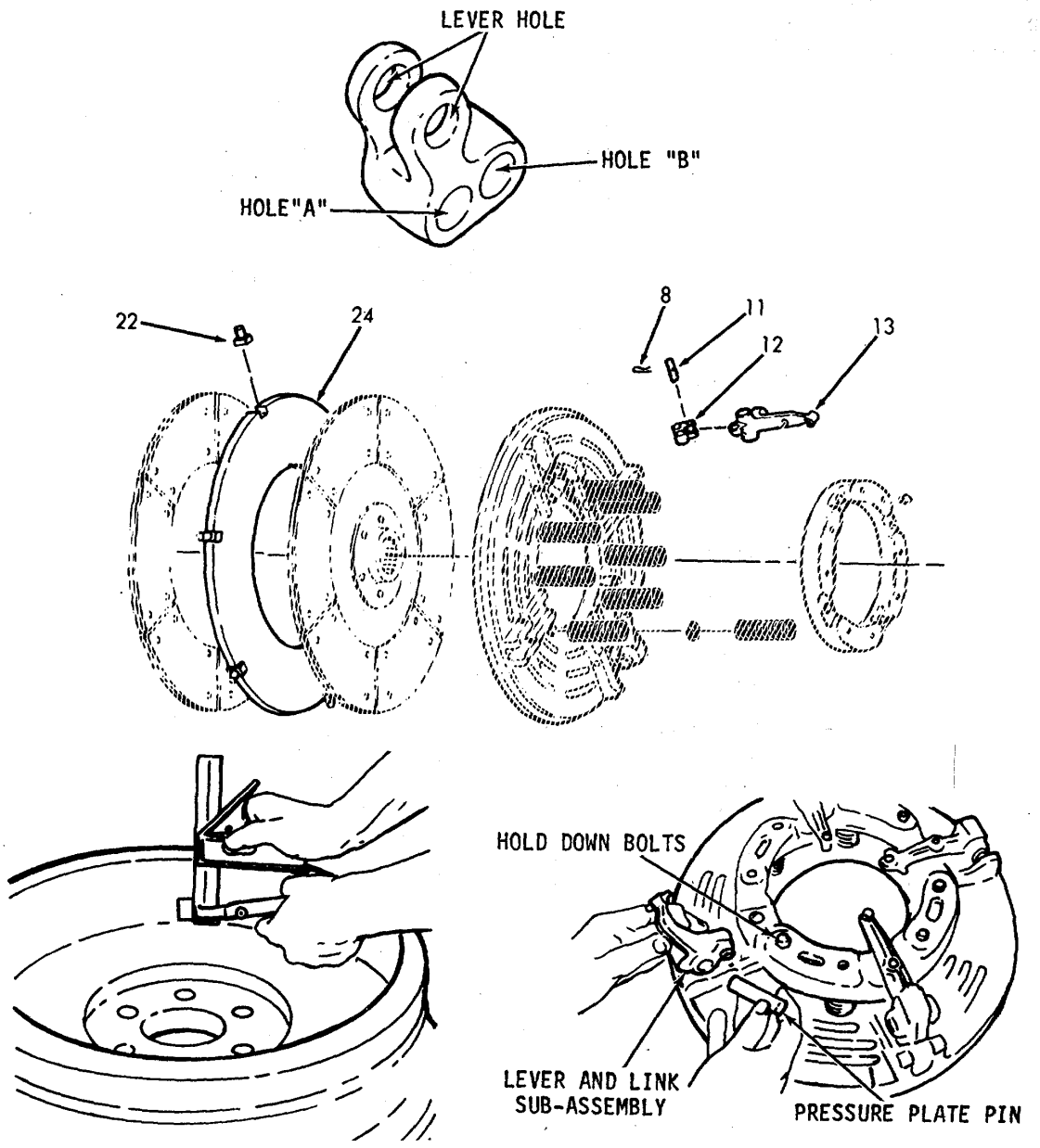
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	g. Link (12)	The proper link hole to use will depend on whether or not the pressure plate has been refaced. Toggle link hole "A" is assembled to the pressure plate if new pressure plate is used. Hole "B" is assembled only if the pressure plate has been been refaced.	
	h. Release lever (13), and link (12), assembled pins (11), and cotter pins (8)	Assemble sub-assembly consisting of lever and link to the pressure plate by placing toggle link in milled slot of pressure plate and inserting pressure plate pin as shown. Drive the pin in far enough so cotter pins can be inserted.	
	i. Driving pins (22), and intermediate plate (24)	1. The driving pins should be installed in the engine flywheel (press fit), and squarely aligned with the friction face of the flywheel. Place a machinist square firmly against rim of the flywheel and make sure the contact face of the driving pins have even contact with the square.	

5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

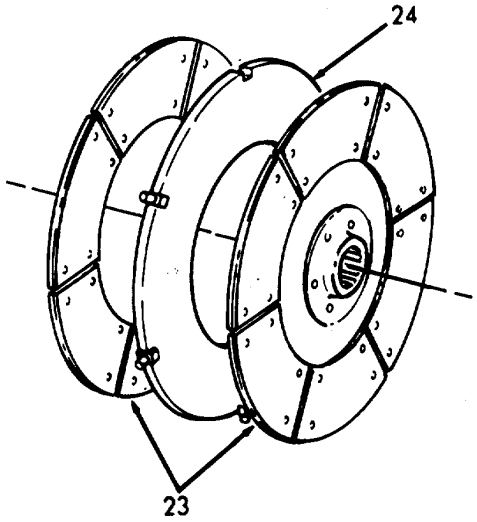


5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	2. Check clearances between the heads of the driving pins and the driving slots in the mating intermediate plate by placing the intermediate plate over the pins, making certain the plate fits freely before the clutch is assembled tothe engine. If excessive clearance between the slots of the intermediate plate and the driving pins exists, new parts should be installed.		
	3. Try the clutch in the engine flywheel before installing driven discs and intermediate plate to make certain clutch pilot diameter is a free fit in the bore of the flywheel.		
j.	Inter-mediate plate (24)	Install.	When installing the intermediate plate, be certain its rotation will be in the direc-tion, of the arrows appearing on one side of the plate near the bore.

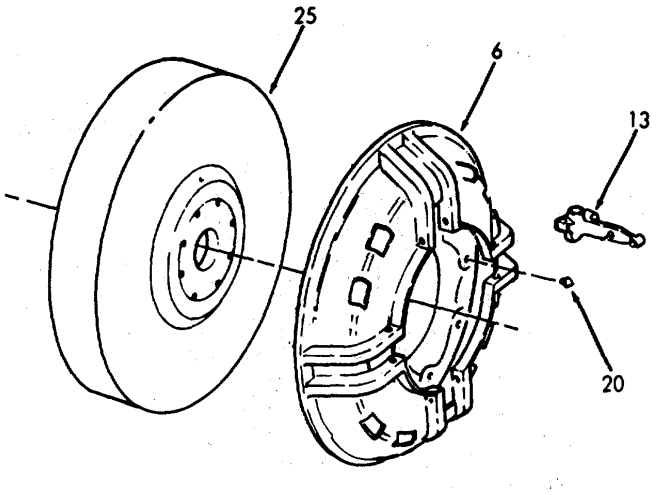
5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	k. Disc assemblies (23)	Install.	When installing disc assemblies, note that the one marked "Flywheel Side" should be installed with this marking next to the friction face of the flywheel. The disc assembly marked "Pressure Plate Side" should be installed with this marking next to the pressure plate friction surface of the clutch. This is important so as to prevent hub interference.



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

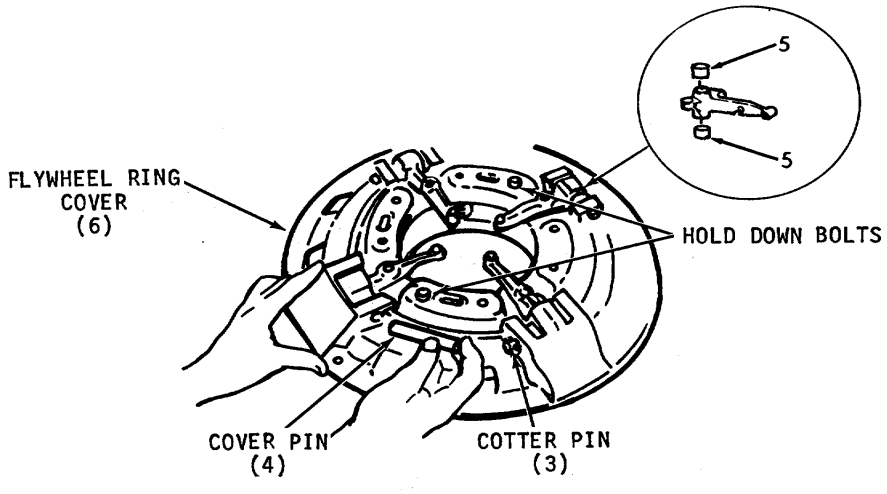
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	1. Fly-wheel (25)	With the four release levers (13) in position so that studs (20) in the spring retainer are entered in the milled slots in the underside of the levers, place the flywheel ring (cover) (6) into position, aligning the lugs in the underside of the cover with the mating slots in the pressure plate. Be sure, if original pressure plate is used, that the cover registers with the aligning "0" mark stamped on the outside diameter of both the cover and the pressure plate.	



	m. Needle bearings (5)	Install in release lever.	

5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	n. Release lever pins (4)	Start cover pins through the flywheel ring (6), while lifting or placing a small block of proper thickness between the top of the workbench and the underside of cover flange to align two opposite levers, and drive cover pins thru the needle bearings (5) in the levers into into place in the flywheel ring. Do not force cover pins into place as this will damage the needle bearings or other component parts. Be sure that the opposite cover holes are squarely aligned with the lever holes before driving the cover pins into place. Drive cover pins in far enough to install cotter pin.	
	o. Cotter pins (3)	Install.	



5-65.2 DISCONNECT CLUTCH-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

(Continued)

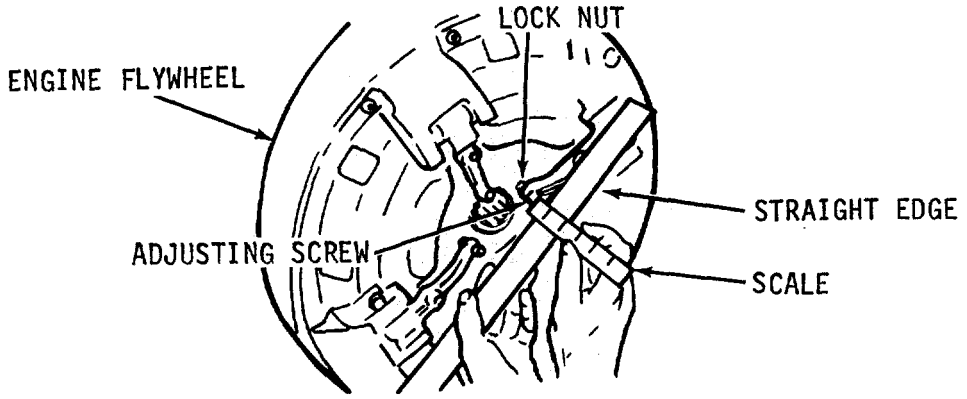
LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT

CAUTION

Be sure hold-down screws are used to hold the springs compressed and free the release levers before clutch is assembled to the engine flywheel.

	5. Release levers	Using straight edge and scale or suitable tool, set adjusting screws in the endsof the release levers to (3/4 inch) "Dimension A" . "Dimension A" is the distance from the ground surface on the raised lever bosses of the clutch flywheel ring (cover) to the heads of the lever adjusting screws when clutch is bolted in engine flywheel and in the engaged position. The contact points of these adjusting screws should be set at a uniform distance from the underside of the straight edge. The adjusting screws must be in the same plane within 1/32 inch. To change the position of the screws, loosen the locknuts and turn the screw as required to obtain "Dimension A". Be sure to tighten locks securely after making screw adjustment.	



5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Disassembly **b. Reassembly**

INITIAL SETUP:

Test Equipment

NONE

Special Tools

NONE

References

NONE

Equipment Condition Paragraph | Condition Description

5-65.1 Disconnect Clutch Assembly Removal
5-65.2 Disconnect Clutch Removal

Material/Parts

NONE

Special Environmental Conditions

NONE

Personnel Required

1

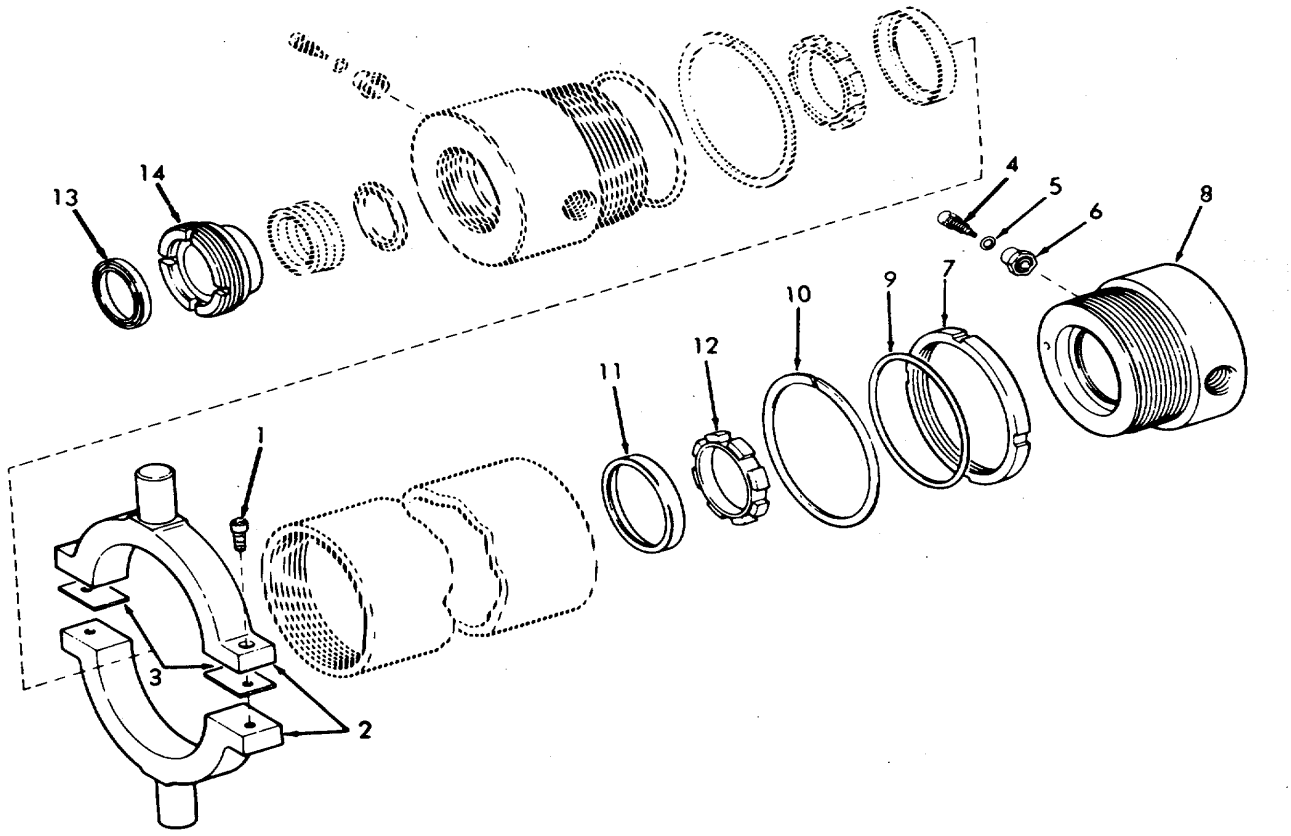
General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
1. Clutch hydraulic cylinder	a. Screws (1)	Remove.	
	b. Trunnions (2), and spacers (3)	Remove.	
	c. Adjusting screws (4), locknuts (5), and preformed packings (6)	Remove.	If necessary.
	d. Locknut (7), and cylinder head (8)	Loosen locknut and remove head.	

5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Gasket (9), and lockwasher (10)	Remove.	
	f. Sleeve (11) and retainer (12)	Remove from head (8).	
	g. Scraper (13), and packing nut (14)	Remove.	



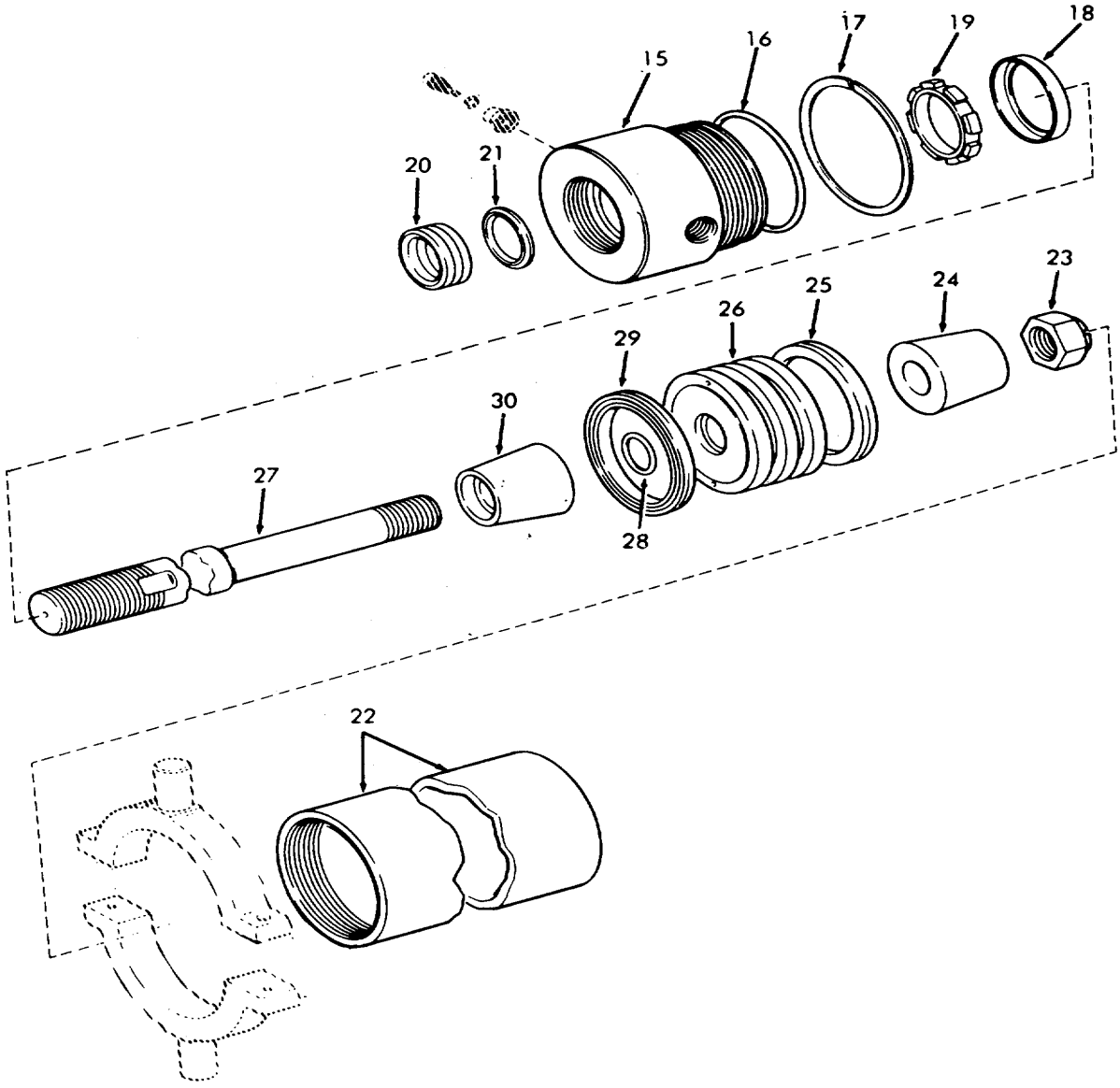
5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	h. Rod head (15), gasket (16), and lockwasher (17)	Remove.	
	i. Sleeve (18), and retainer (19)	Remove from rod head (15).	
	j. Packing (20), and packing adapter (21)	Remove from rod head (15).	
	k. Piston and rod assembly	Remove from cylinder (22).	
	l. Locknut (23)	Remove.	
	m. Collar (24), and packing (25)	Remove.	
	n. Piston (26)	Remove from piston rod (27).	
	o. Preformed packing (28), piston packing (29), and collar (30)	Remove from piston rod (27).	

5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY

NOTE

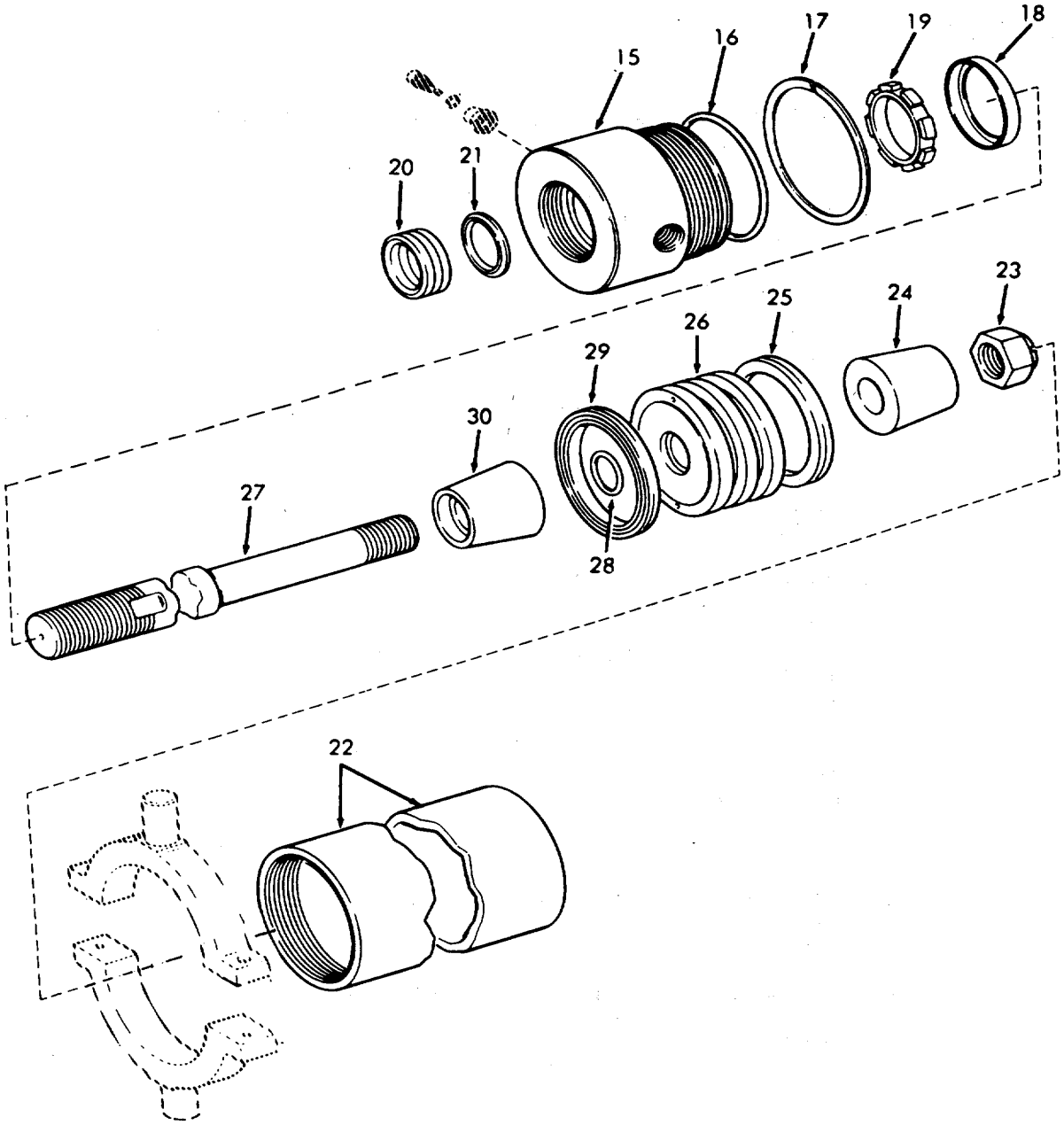
Discard all preformed packing, gaskets, and all worn or damaged parts.

2.	a. Collar (30), piston packing (29), and preformed packing (28)	Install on piston rod (27).	
	b. Piston (26)	Install on piston rod (27).	
	c. Packing (25), and collar (24)	Install.	
	d. Locknut (23)	Install.	
	e. Piston and rod assembly	Install in cylinder (22).	
	f. Packing adaptor (21), and packing (20)	Install in rod head (15)	
	g. Retainer (19), and sleeve (18)	Install in rod head (15).	
	h. Lockwasher (17), gasket (16), and rod head (15)	Install on cylinder (22).	

5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



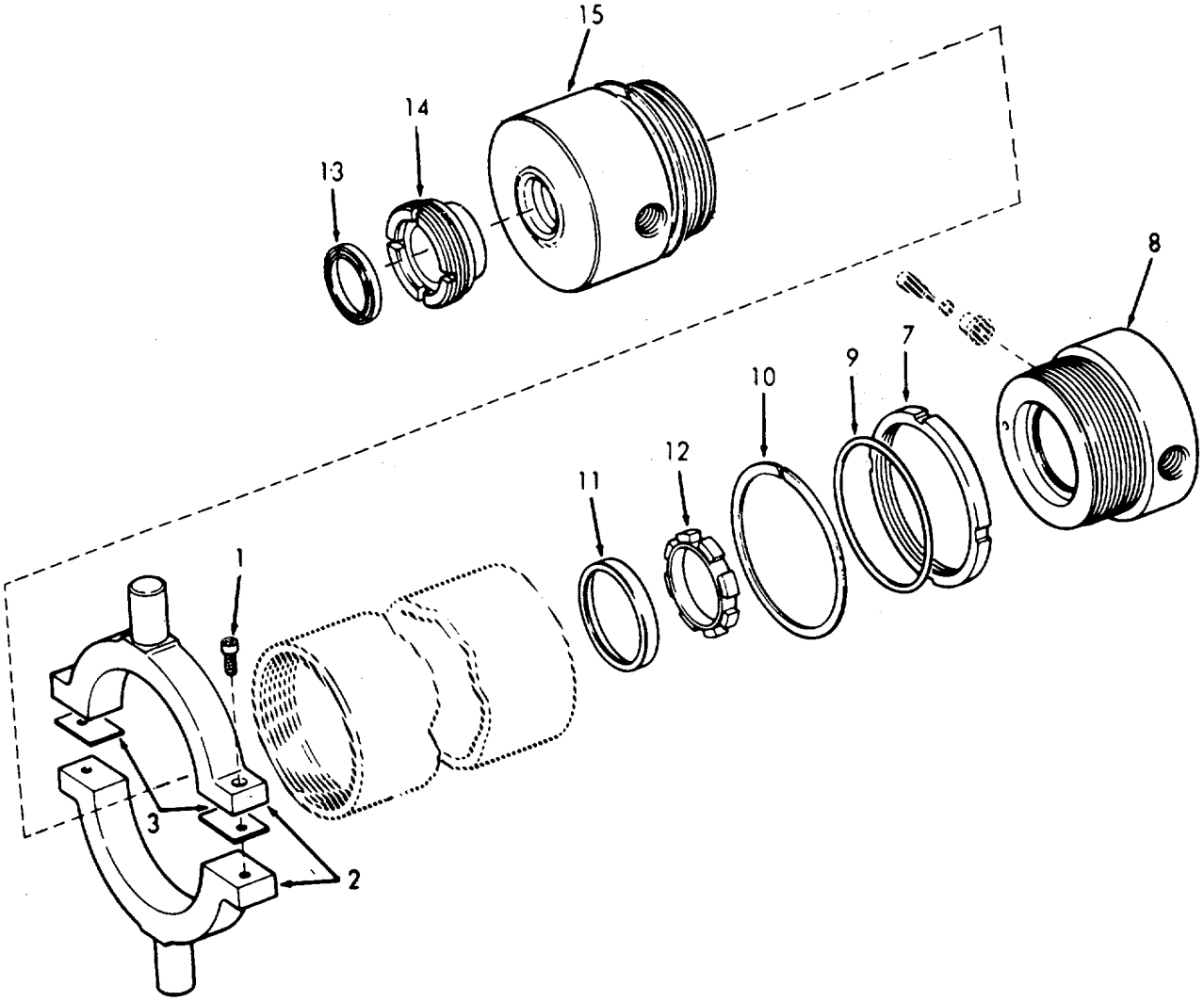
5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	i. Packing nut (14), and scraper (13)	Install in rod head (15).	
	j. Retainer (12), and sleeve (11)	Install in head (8).	
	k. Lockwasher (10), and gasket (9)	Install.	
	l. Cylinder head (8), and lock-nut (7)	Install.	
	m. Spacers (3), trunnions (2), and screws (1)	Install on cylinder.	

5-65.3 CLUTCH HYDRAULIC CYLINDER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS

This task covers:

a. Removal
b. Disassembly
c. Reassembly
d. Installation

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Chain hoist
Arbor press

Material/Parts

2 each Seal kit
P/N 205161-8
10 gallons (29.5 L)
Lubricating oil
MIL-L-2104
Type 0E-HD0 30

Personnel Required

2

References

Para 3-136 Torque Converter - Maintenance Instructions

Equipment Condition Paragraph	Condition Description
5-65.1	Disconnect Clutch Assembly - Removal

Special Environmental Conditions

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

General Safety Instructions

Observe standard safety precautions when handling heavy equipment.

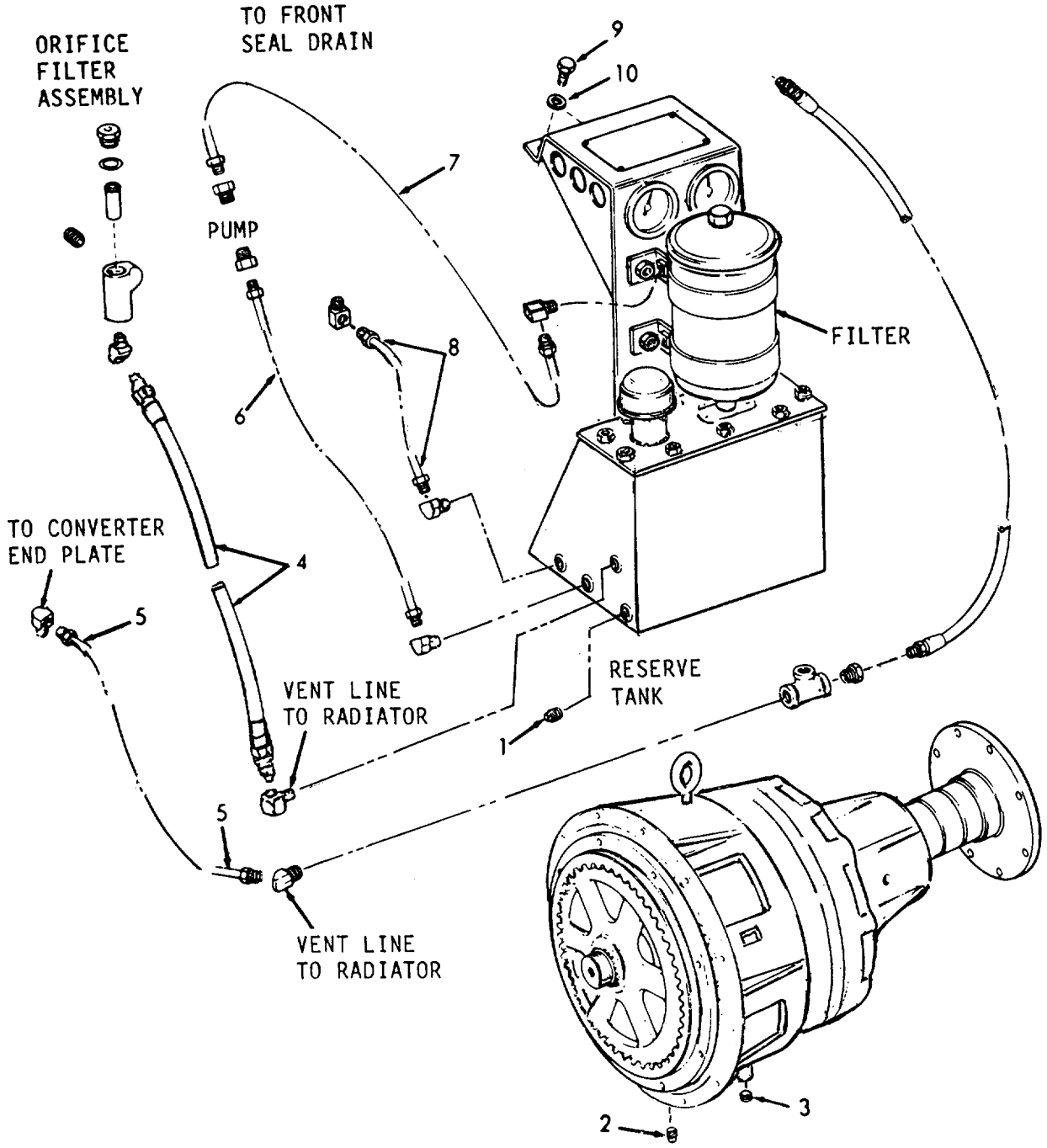
5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Torque converter	a. Drain plugs (1, 2, and 3)	Remove.	Drain oil into a suitable container.
	b. Fluid line to radiator (4)	Remove.	Drain oil into a suitable container.
	c. Fluid line to converter end plate (5)	Remove.	Drain oil into a suitable container.
	d. Fluid lines to pumps (6 and 7)	Remove.	Drain oil into a suitable container.
	e. Fluid line to front seal drain (8)	Remove.	Drain oil into a suitable container.
	f. Screws (9), and lock-washers (10)	Remove.	Drain oil into a suitable container.

5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



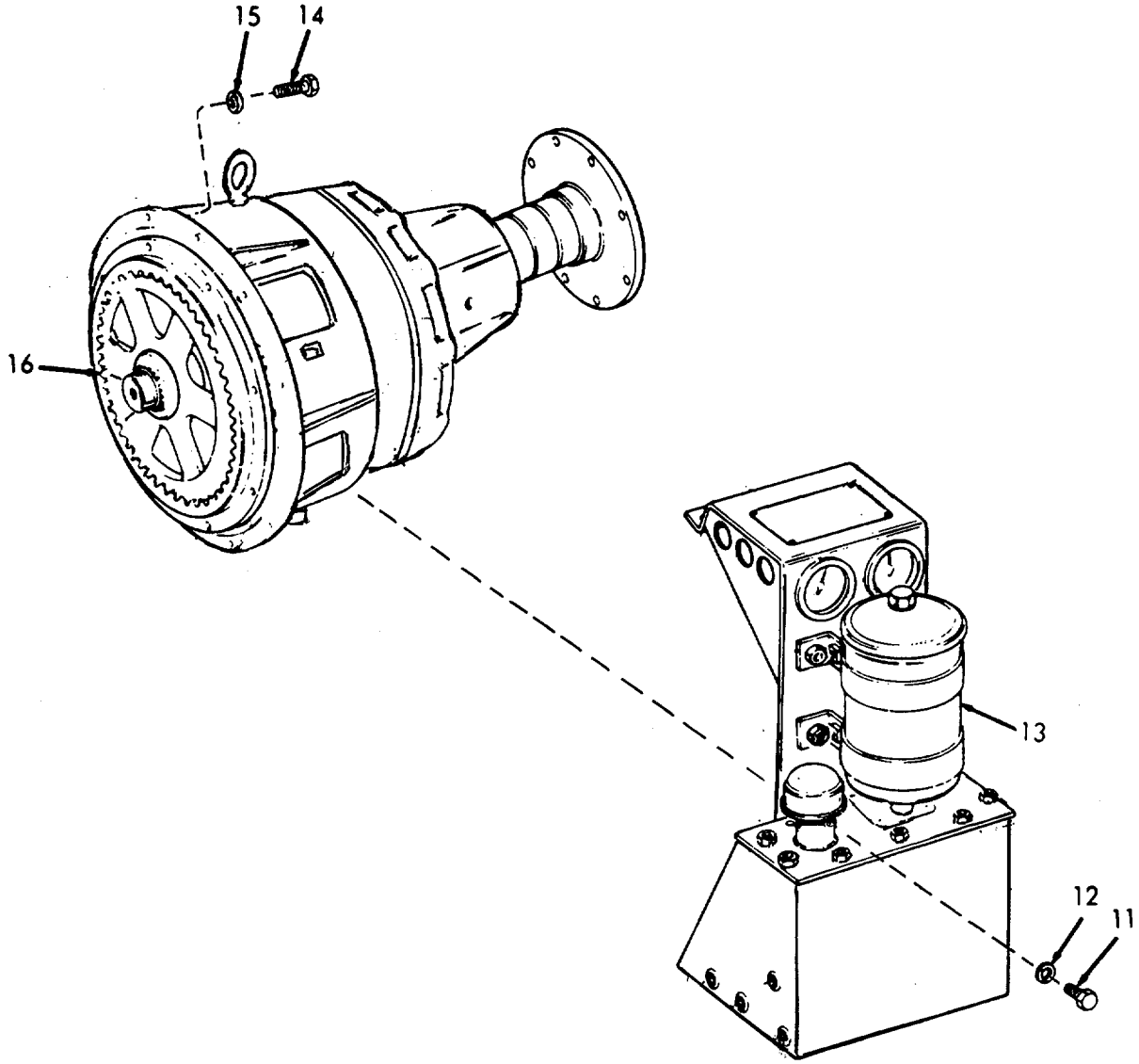
5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	g. Screws (11), and lockwashers (12)	Remove.	Drain oil into a suitable container.
	h. Fluid group (13)	Remove.	
	i. Disconnect clutch	Disassemble and remove.	Refer to paragraph 5-65.1.
	j. Torque converter	Attach chain hoist.	
	k. Screws (14), and lockwashers (15)	Remove.	
	l Disconnect clutch	1. Slide back to disengage drive. spider (16). 2. Remove.	

5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

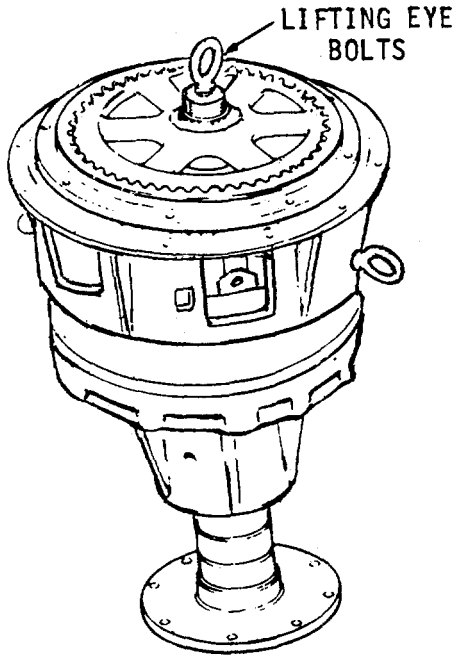
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

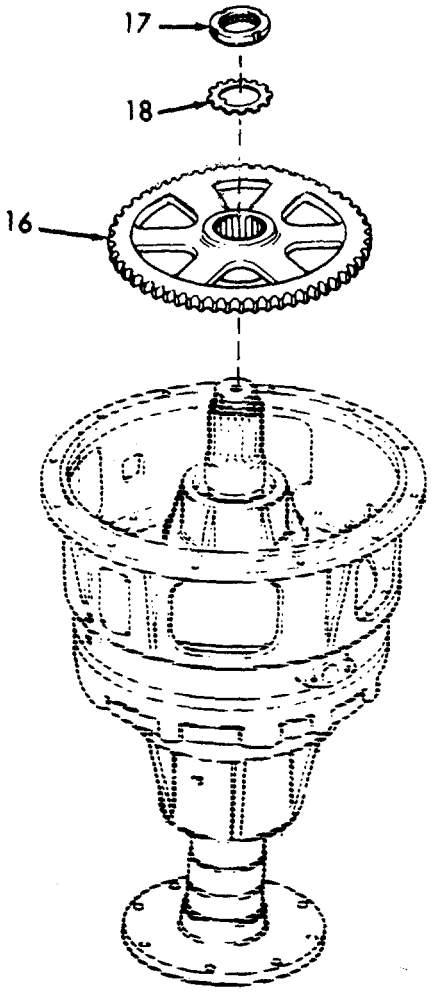
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	m. Lifting eye bolt	1. Install in shaft. 2. Install chain hoist. 3. Lift to vertical position.	



DIASSEMBLY				
2	Input group	a. Bearing locknut (17) , and lock-washer (18)	1. Bend back tangs on lockwasher. 2. Remove nut and lock-washer.	

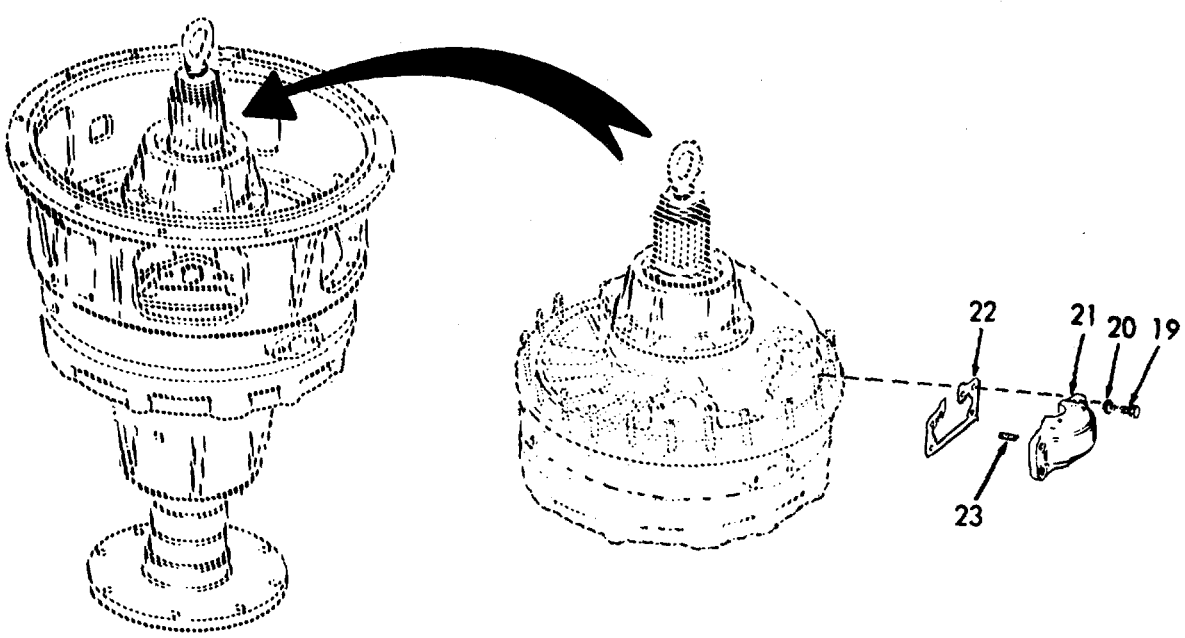
5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	b. Drive spider (16)	Remove.	



5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

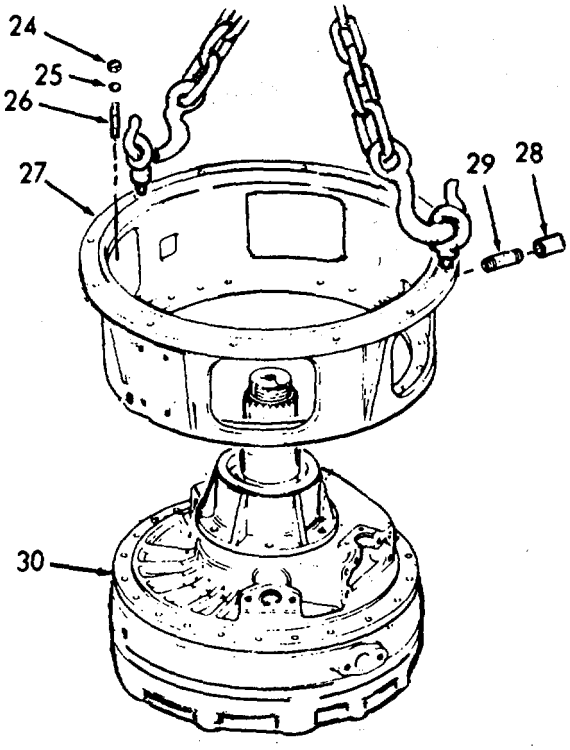
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
3. Basic Group	a. crews (19), lockwashers (20)	Remove.	
	b. Sprocket cover (21), and gasket (22)	Remove.	Discard gasket if damaged.
	c. Dowel pin (23)	Remove.	If necessary.



4. Input Group	a. Nuts (24), and lock-washers (25)	Remove 24 places.	
	b. Studs (26)	Remove.	If necessary.

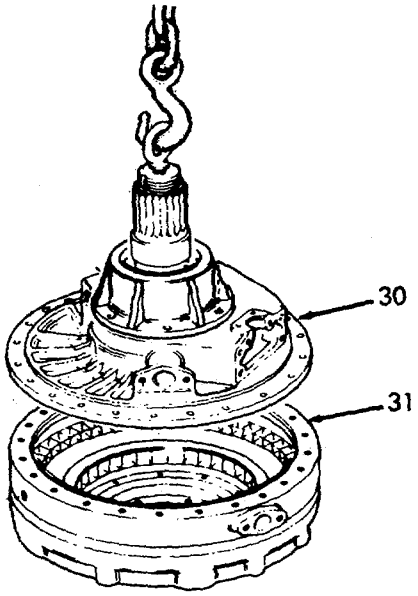
5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	c. Front housing (27)	1. Attach chain hoist. 2. Remove.	
	d. Pipe coupling (28), and nipple (29)	Remove.	If necessary.



5-66. TORQUE CONVERTER - ANCHOR WINCH - MAINTENANCE INSTRUCTIONS (Continued).

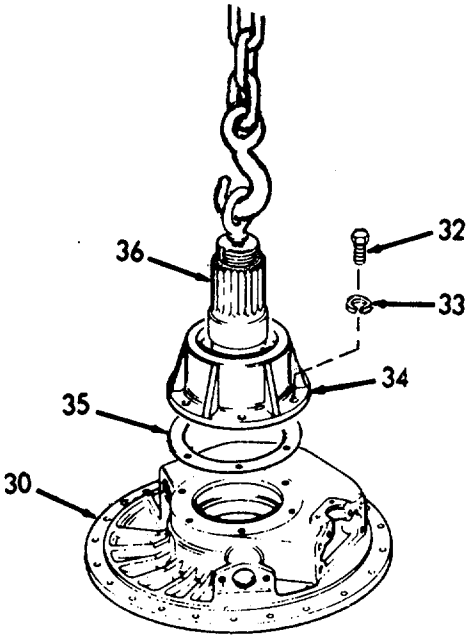
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
5. Basic Group	a. End plate (30)	1. Attach chain hoist. 2. Install jack screws in the three tapped holes. 3. Separate end plate and turbine housing (31). 4. Lift off end plate.	
6. Input Group	a. Screws (32), and lockwashers (33)	Remove.	
	b. Input shaft carrier (34)	1. Install two jack screws in holes provided. 2. Separate carrier with input shaft from end plate (30). 3. Lift off using chain hoist.	
	c. Gasket (35)	Remove.	



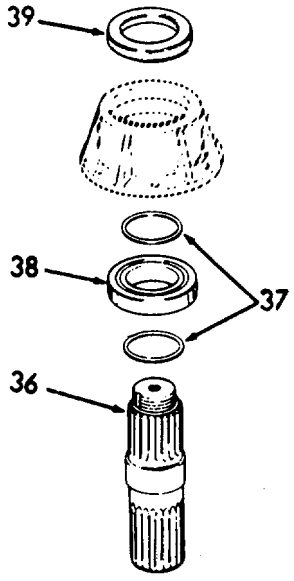
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)

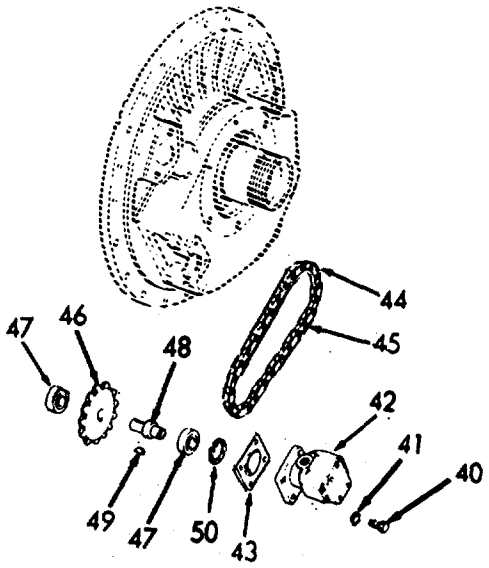


d.	Input shaft (36)	Press out.	
e.	Gaskets (37) , bearing (38), and oil seal (39) 39	Press out.	



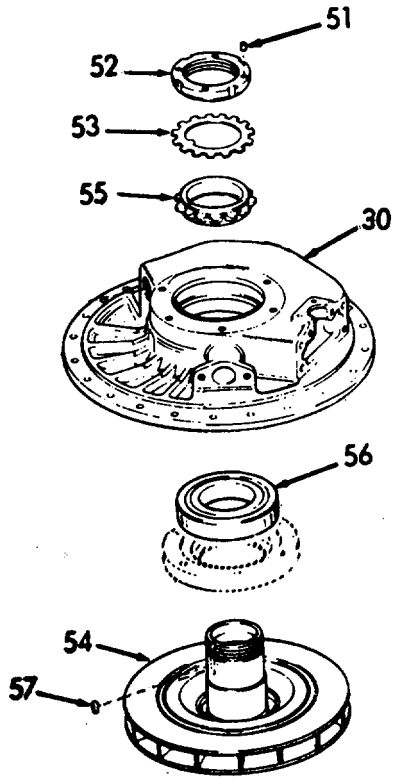
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
7. Basic group	a. Screws (40), and lockwashers (41)	Remove.	
	b. Charging pump (42), and gasket (43)	Remove.	Discard gasket.
	c. Coupler link (44), and chain (45)	Separate and remove.	
	d. Drive sprocket (46), bearings (47), shaft (48), key (49), and retaining ring (50)	1. Remove as an assembly.	If necessary.
		2. Disassemble.	If necessary.



5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Setscrews (51)	Loosen.	
	f. Bearing locknut (52), and lockwasher (53)	Remove.	
	g. Impeller (54)	Press out of endplate (30) through chain sprocket (55), and bearing race (56).	
	h. Impeller (54), chain sprocket (55), and key (57)D, 5 52.	Remove.	

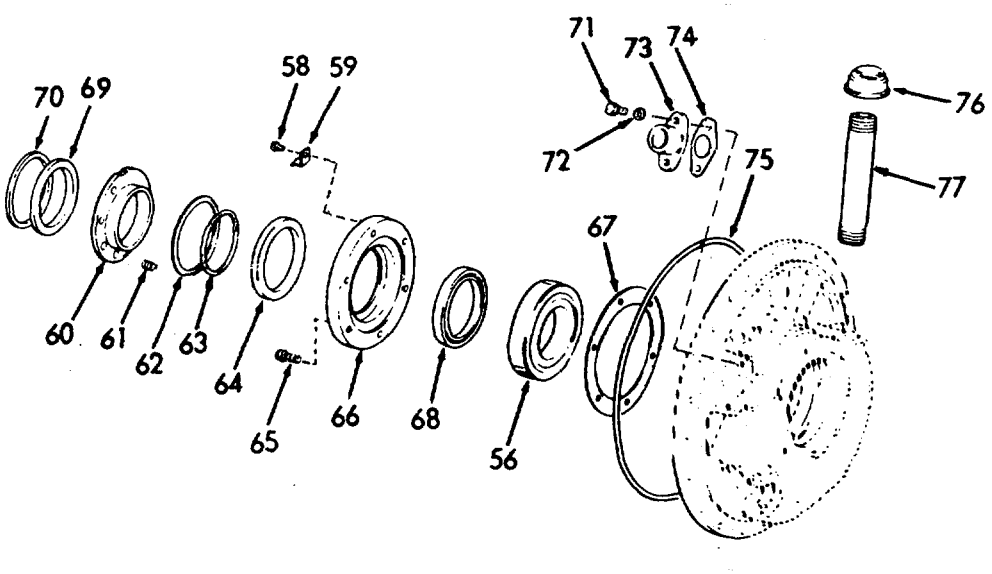


5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	NOTE If the converter is being disassembled for reasons other than seal repair, and it is intended to reassemble the converter using the same seal assemblies and carbon mating rings, extreme care must be taken to keep the sealing surfaces of the steel nose piece and carbon mating ring free from all dirt and scratches.		
	i. Round head screws (58), and seal retaining clips (59)	Remove.	Discard.
	j. Seal nose piece (60), springs (61), retaining washer (62), seal garter spring (63), and rubber element (64)	Remove.	Discard all parts.
	k. Screws (65)	Remove.	
	l. Seal carrier (66)	Remove by tapping on the opposite side of the bearing (56) race.	
	m. Gasket (67)	Remove.	Discard.
	n. Shaft seal (68), and bearing (56)	Remove.	Discard seal.
	o. Mating ring washer (69), and carbon mating ring (70)	Remove.	Discard.

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	p. Screws (71), and lock-washers (72)	Remove.	
	q. Pipe flange (73), and gasket (74)	Remove.	Discard gasket.
	r. O-ring gasket (75)	Remove.	Discard.
	s. Fluid level gage (76), and breather nipple (77)	Remove.	If necessary.



5-873

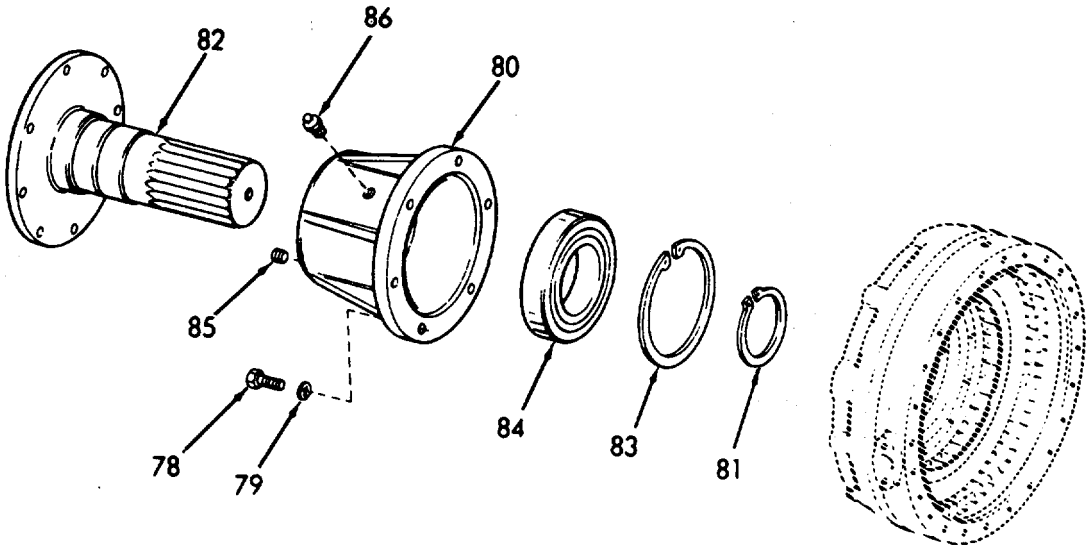
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
8. Output group	a. Screws (78), and lock-washers (79)	Remove.	
	b. Bearing carrier (80), and assembled parts	1. Install jack screws in the three tapped holes. 2. Remove as an assembly.	
	c. External retaining ring (81)	Remove.	
	d. Output shaft (82)	Remove.	Press out.
	e. Internal retaining ring (83)	Remove.	
	f. Bearing (84)	Remove.	Press out.
	g. Pipe plug (85), and lubri-cation fitting (86)	Remove.	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



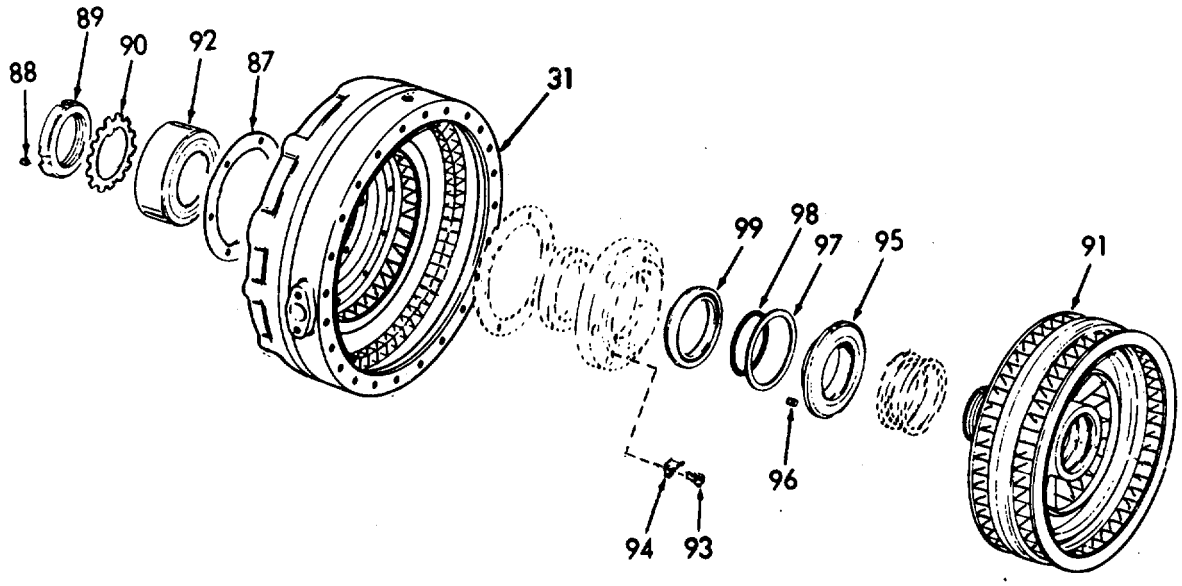
5-875

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
9. Basic group	a. Gasket (87)	Remove.	Discard.
	b. Setscrew (88)	Loosen.	
	c . Locknut (89), and lock-washer (90)	Remove.	
	d. Turbine wheel (91)	1. Press turbine wheel out of turbine housing (31) through bearing (92).	
		2. Remove.	
	NOTE If the converter is being disassembled for reasons other than seal repair, and it is intended to reassemble the converter using the same seal assemblies and carbon mating rings, extreme care must be taken to keep the sealing surfaces of the steel nose piece and carbon mating ring free from all dirt and scratches.		
	e. Round head screws (93), and seal retaining clips (94)	Remove.	Discard.

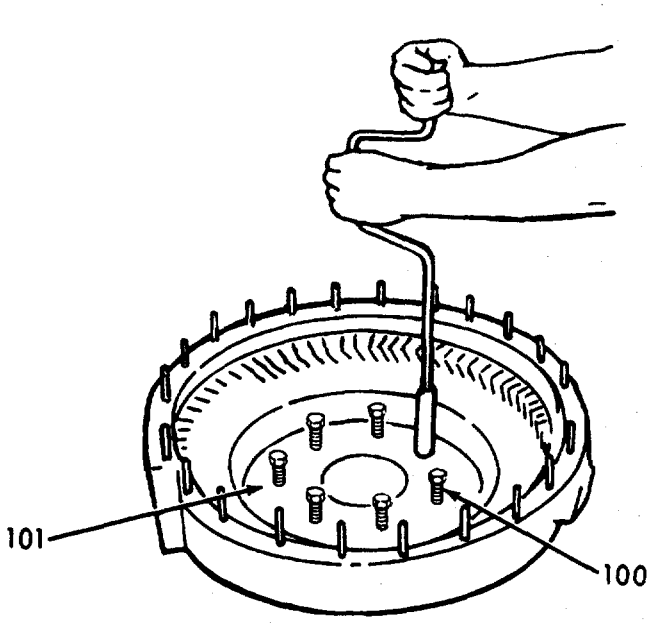
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	f. Seal nose piece (95), springs (96), retaining washer (97), seal garter spring (98), and rubber element (99)	Remove.	Discard all parts.



5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

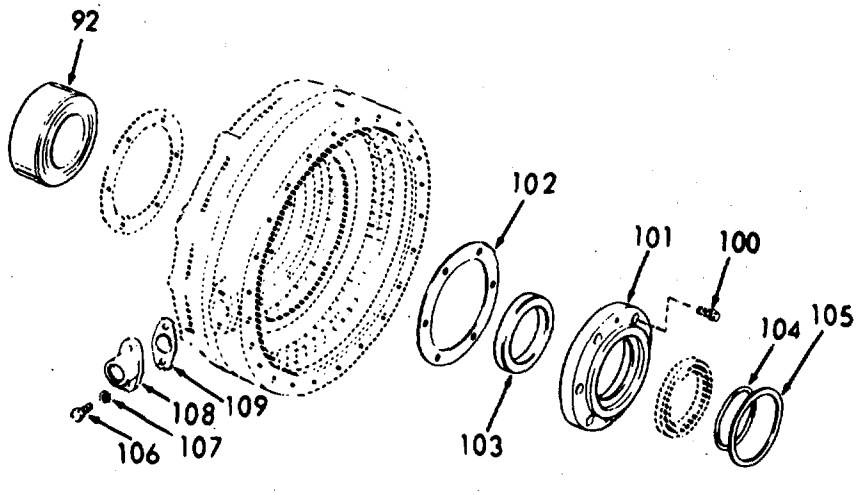
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	g. Screws (100)	Remove.	



	h. Seal carrier (101)	Remove by tapping on the opposite side of the bearing (92) race.	
	i. Gasket (102)	Remove.	
	j. Shaft seal (103), and bearing (92)	Remove.	Discard seal.

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	k. Carbon mating ring (104), and mating ring washer 105)	Remove.	Discard.
	l. Screws (106), and lock-washers (107)	Remove.	
	m. Pipe flange (108), and gasket (109)	Remove.	



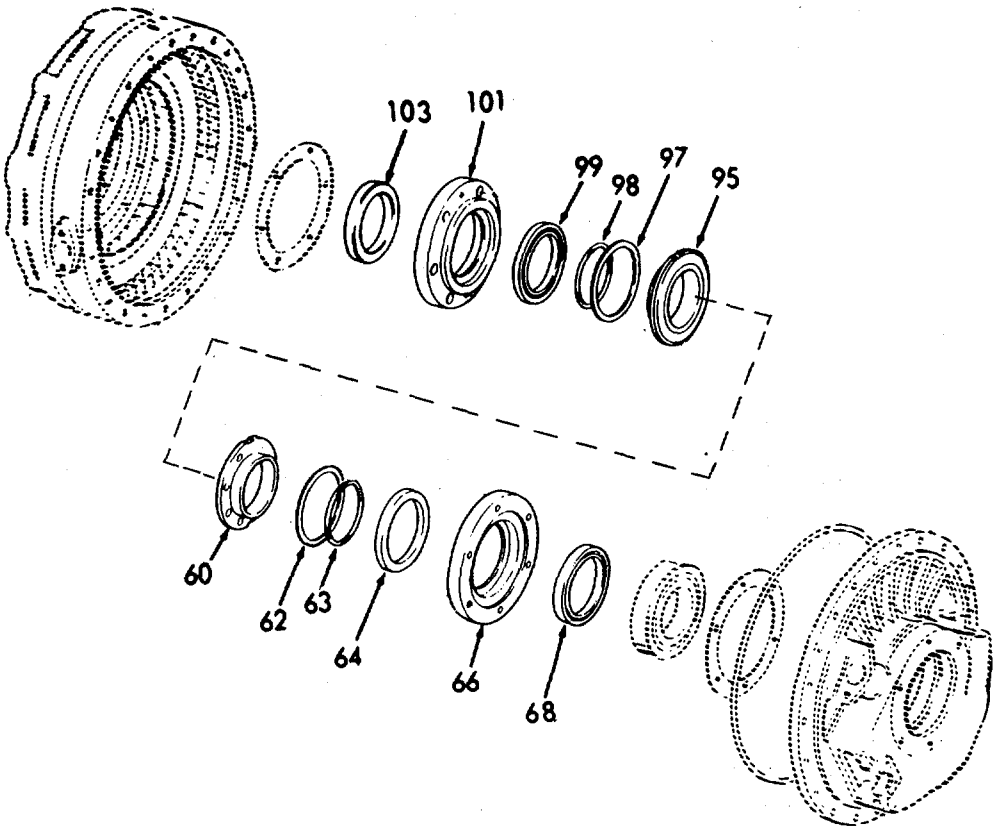
5-879

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
10. Torque converter seal kit (basic group)	NOTE In the following procedure both torque converter seals will be rebuilt with new parts from seal kits.		
	a. Shaft seals (68 and 103), and fluid seal carriers (66 and 101)	1. Install oil seal in its bore on the bearing side of the seal carrier. 2. The lip of the seal will face away from the carrier. 3. Lay seal carrier on a clean surface, shaft seal side down.	
	b. Garter seal springs (63 and 98), and rubber elements (64 and 99)	1. Place garter spring inside of rubber element. 2. Install rubber element in its bore in seal carrier (66 and 101) with garter spring side up. 3. Lubricate with clean oil.	
	c. Retaining washer (62 and 97)	Install shoulder side down in the mating bore of the rubber element..	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Nose pieces (60 and 95)	Fill the spring counter-bores with grease.	

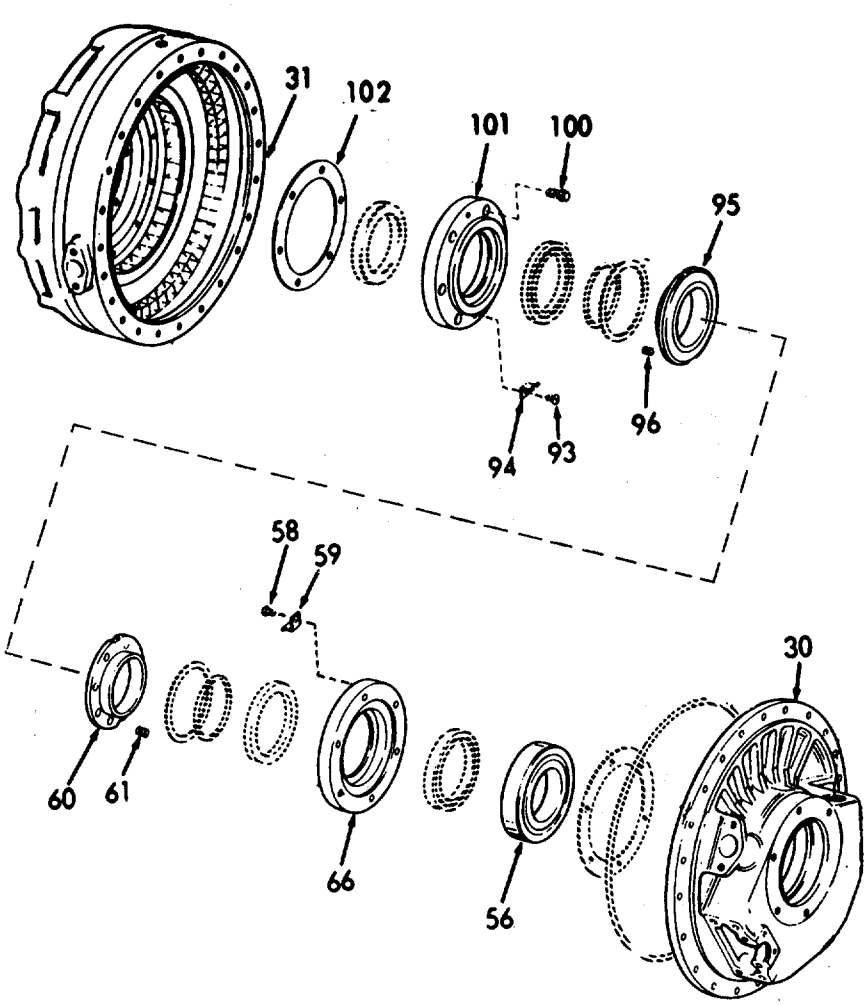


5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	e. Compression springs (61 and 96)	Place in grease filled counterbores.	
	f. Nose pieces (60 and 95)	1. Lubricate the skirt with clean oil.	
		2. Invert and install in seal carriers (66 and 101).	Exercise care in entering the skirt of the nose piece into the lip of the rubber element.
		3. Line up the clip slots in the nose piece with the clip slots in the seal carrier.	
	g. Clips (59 and 94), and round head screws (58 and 93)	Compress the nose piece to the carrier and install the two clips and screws retaining nose piece to the seal carrier (66 and 101). Check for ree movement of the noise piece (60 and 95) .	
	h. Seal carrier (101), assembled gasket seal (102), and turbine housing (31)	1. Soak gasket briefly in clean converter fluid.	Use new gasket.
		2. Install. Make sure holes line up properly with the grease and seal drain passages.	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	i. Screws (100)	Install.	
	j. Bearing (56)	1. Hand pack with grease. 2. Press into end plate (30).	



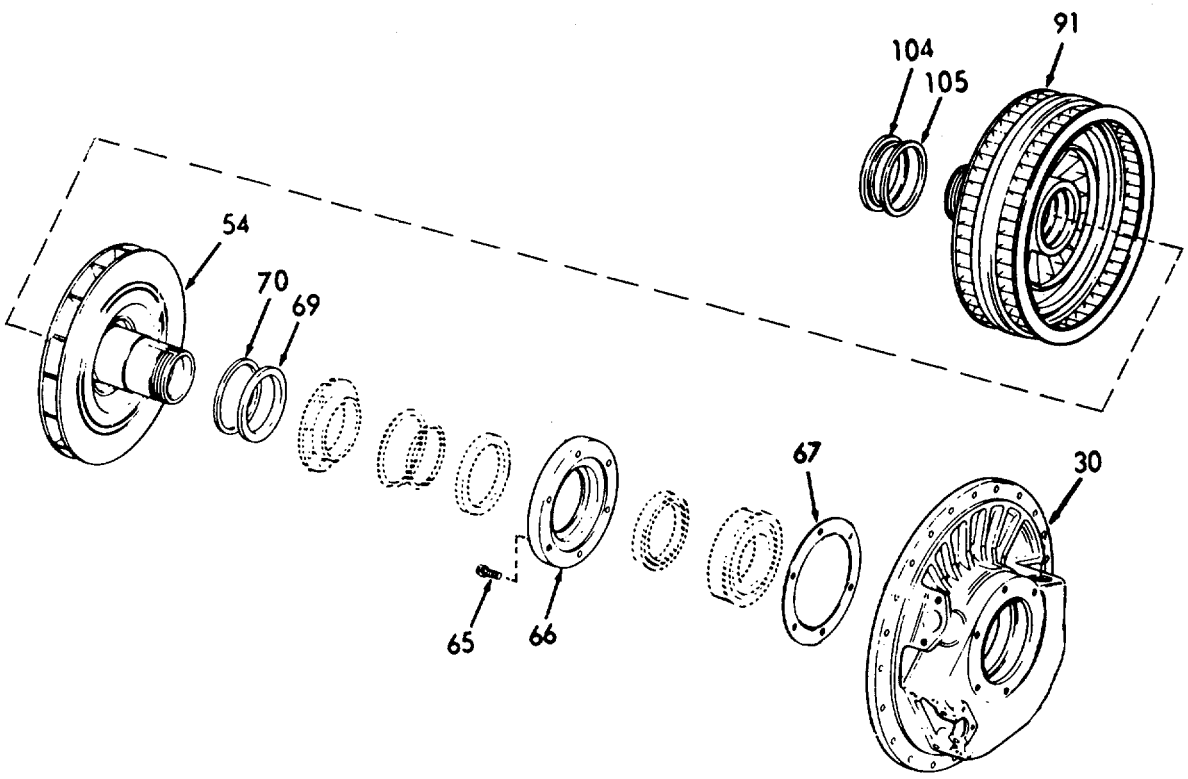
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	k. Seal carrier (66) assembled, gasket seal (67), and end plate (30)	1. Soak gasket briefly in clean converter fluid. 2. Install, make sure holes line up properly with the grease and seal drain passages.	Use new gasket.
	l. Screws (65)	Install.	
	m. Mating washers (69 and 104), and carbon mating ring (70 and 105)	Place the flat side of the washer against the solder of the carbon mating ring.	
	n. Turbine (91), and impeller (54)	1. Lubricate bore with clean oil. 2. Hand press the mating ring and washer into this bore.	Make sure they are properly seated.

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

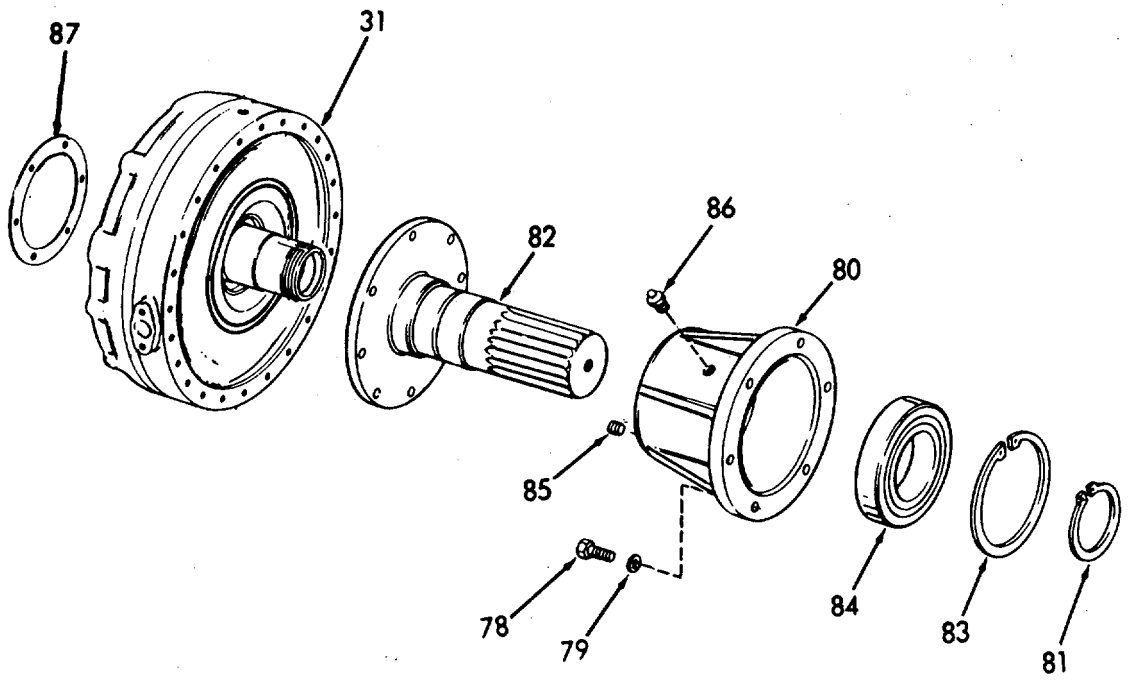


5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
11. Basic group			
		CAUTION	
		Extreme care must be exercised in assembly to make certain that the lapped surfaces of the carbon mating ring and steel nosepiece are free from all particles of dust or grit as this will result in scratches on the lapped surfaces and cause fluid leakage. These surfaces are originally lapped smooth within twelve millionths of an inch.	
	a. Bearing (92)	1. Hand pack with grease.	
		2. Press into turbine housing (31).	
		3. Block bearing on press.	
	b. Turbine wheel (91)	1. Check for proper positioning of the carbon mating ring (105), and washer (104).	
		2. Press into turbine housing (31).	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Lockwasher (90), locknut (89), and setscrews (88)	1. Install. 2. Lock into place. 3. Tighten setscrews.	



5-887

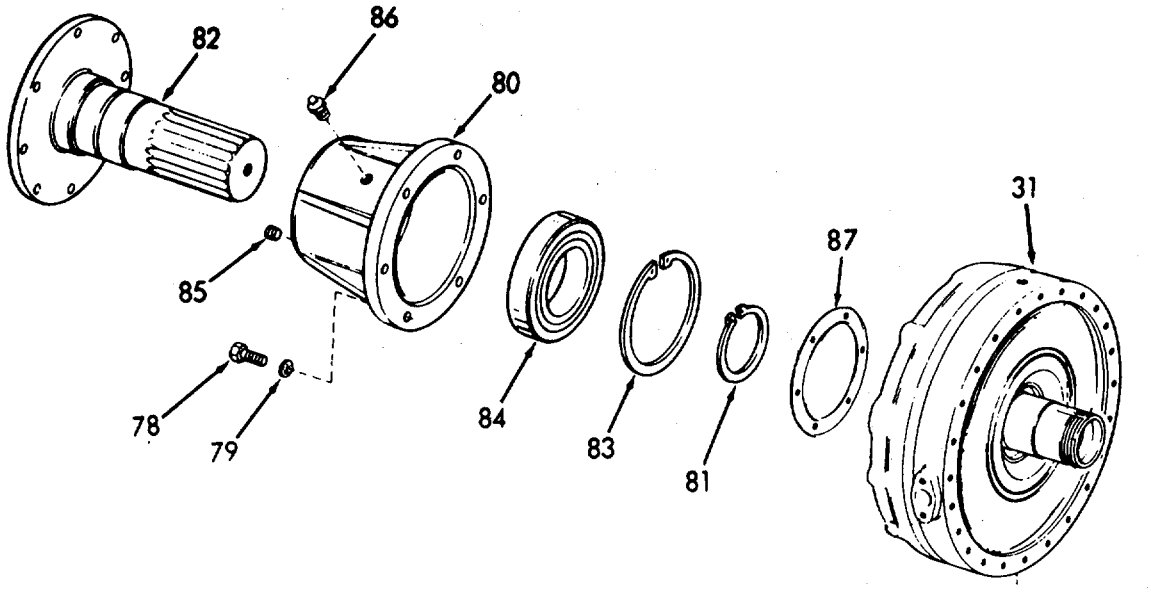
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
12. Output group	a. Bearing (84)	1. Hand pack with grease.	
		2. Press into bearing carrier (80).	
	b. Retaining ring (83)	Install.	
	c. Shaft (82)	1. Coat lightly with clean oil.	
		2. Install into bearing carrier (80).	
	d. Retaining ring (81)	Install.	
	e. Bearing carrier (80), and gasket (87)	Align and install into turbine housing (31).	
	f. Screws (78), and lock-washers (79)	Install.	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

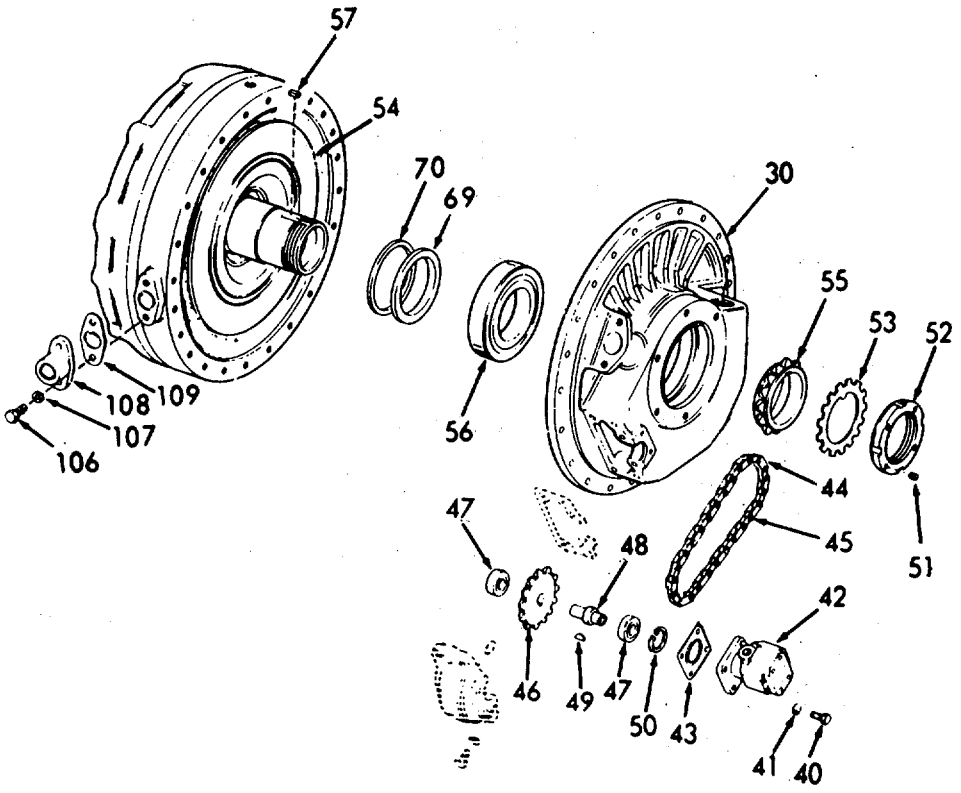


5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
13. Basic Group	a. Gasket (109), and pipe flange (108)	Install.	
	b. Screws (106), and lock-washers (107)	Install.	
	c. Impeller (54)	1. Check for proper positioning of the carbon mating ring (70), and washer (69). 2. Press into end plate (30) through bearing (56).'	
	d. Chain drive sprocket (55), and key (57)	Install.	
	e. Lockwasher (53), locknut (52), and sets crews (51)	1. Install. 2. Lock in place. 3. Tighten-set screws.	
	f. Drive sprocket (46), bearings (47), shaft (48), key (49) ,and retaining ring (50)	Reassemble.	If necessary.
	g. Chain (45), and coupler link (44)	1. Install. 2. Reconnect link.	

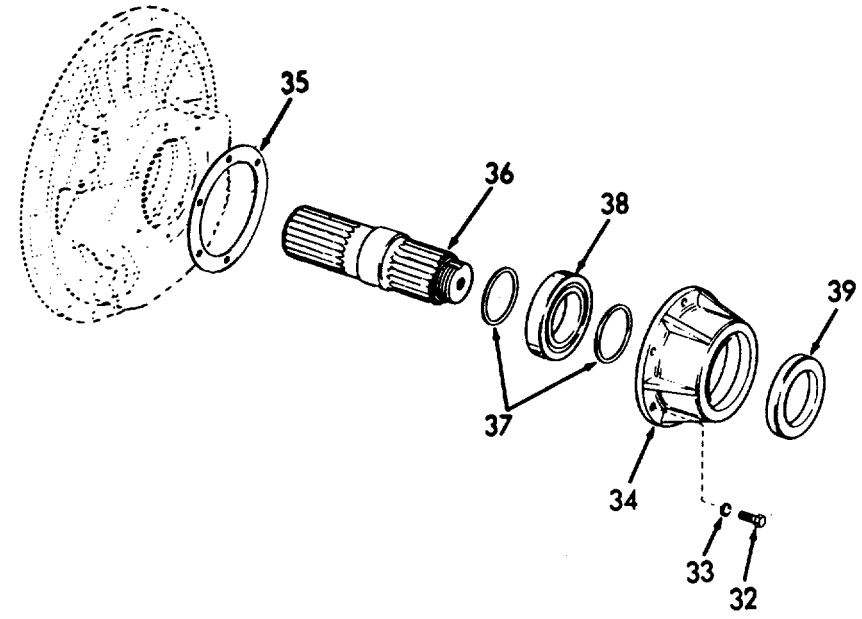
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	h. Gasket (43), and charging pump (42)	Install.	
	i. Screws (40), and lock-washers (41)	Install.	



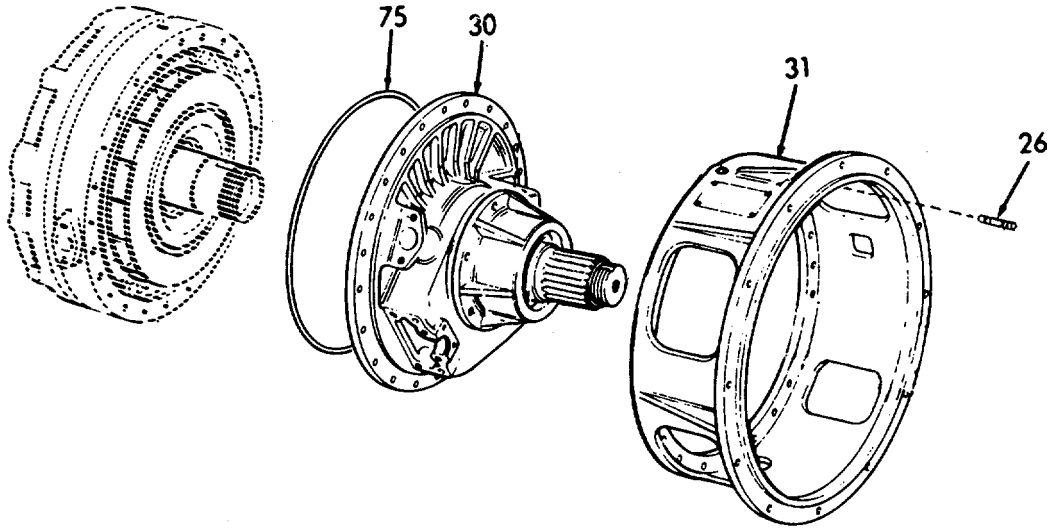
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
14. Input group	a. Gaskets (37), and bearing (38)	Install in bearing carrier (34).	
	b. Oil seal (39)	Install in bearing carrier (34).	The lip of the seal faces the bearing.
	c. Input shaft (36)	Press into bearing carrier (34).	
	d. Bearing carrier (34) assembled, and gasket (35)	Install.	Use new gasket.
	e. Screws (32), and lockwashers (33)	Install.	



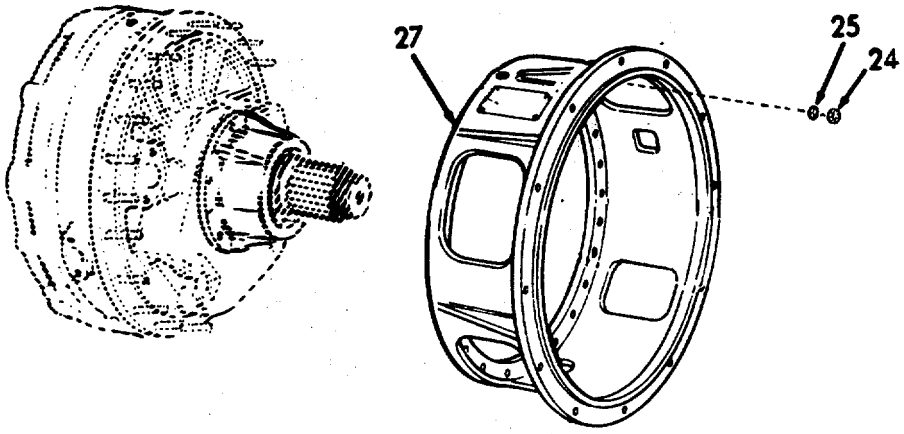
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
15. Basic group	a. Turbine housing (31)	Place on firm blocking open end up.	
	b. End plate O-ring gasket (75)	Install in pilot flange of the end plate (30).	Use new gasket.
	c. Studs (26)	Install .	If necessary.
	d. End plate (30)	Install on turbine housing.	



5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

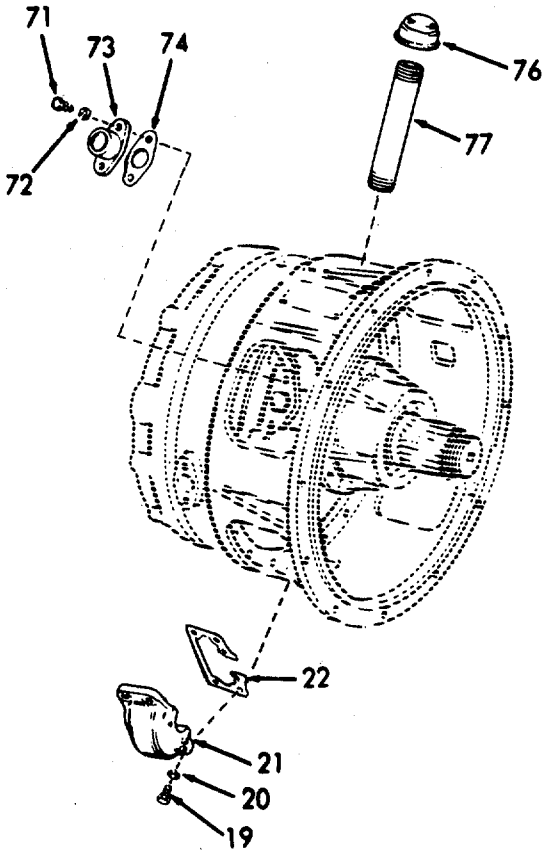
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
16. Input Group	a. Input housing (27)	Install.	
	b. Lock-washers (25) and nuts (24)	Install in 24 places.	



17. Basic Group	a. Sprocket housing (21), and gasket (22)	Install.	
	b. Screws (19), and lockwashers (20)	Install.	
	c. Flange (73) , and gasket (74)	Install.	

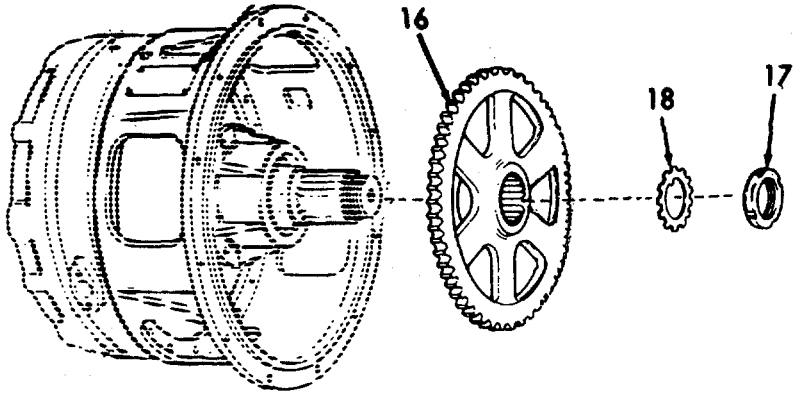
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	d. Screws (71), and lockwashers (72)	Install.	
	e. Breather nipple (77) , and fluid level gage (76)	Install.	



5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
18. Input Group	a. Inspect shaft drive spider (16)	Install.	
	b. Lock-washer (18), and locknut (17)	1. Install. 2. Lock in place.	

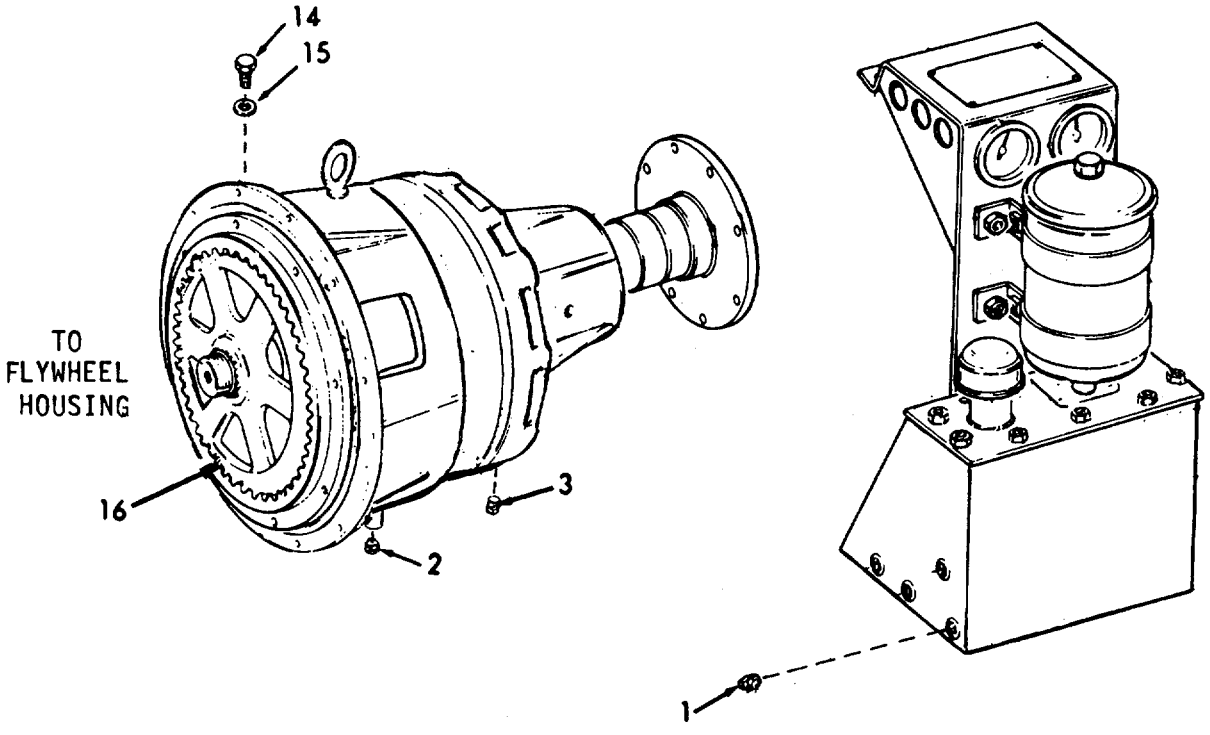


INSTALLATION

19. Torque con-verter	a. Drain plugs (1, 2, and 3)	Install.	
	b. Torque converter	1. Install chain hoist. 2. Lower into place. 3. Slide forward and engage drive spider (16) into gear on engine flywheel.	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		NOTE Before mounting the torque converter to the engine, a dial indicator should be fastened to the engine so as to register the amount of deflection in the engine flywheel housing when the converter is bolted to the housing. After bolting the converter to the engine, a jack should be placed under the converter turbine housing and raised until the indicator at the engine flywheel housing again reads zero to show that there is no longer any deflection in the housing.	
	c. Screws (14), and lockwashers (15)	Install.	
	d. Disconnect clutch	Install and reassemble.	Refer to paragraph 5-65.1.
	e. Fluid group	Align holes.	



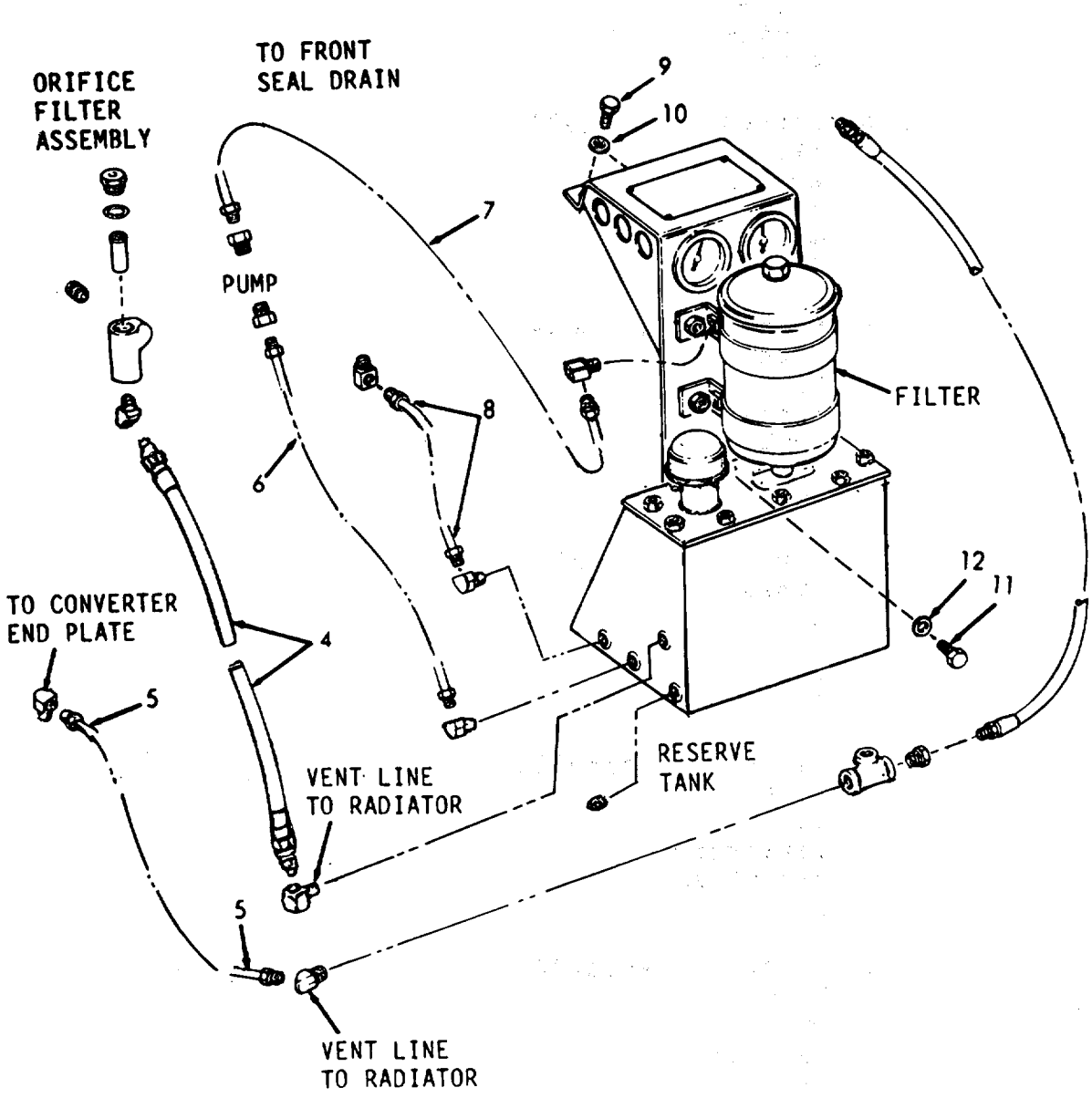
5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	f. Screws (11), and lock-washers (12)	Install.	
	g. Screws (9), and lock-washers (10)	Install.	
	h. Fluid line to front seal drain (8)	Install.	
	i. Fluid lines to pump (6 and 7)	Install.	
	j. Fluid line to converter end plate (5)	Install.	
	k. Fluid line to radiator (4)	Install.	

5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



5-66. TORQUE CONVERTER-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		1. Preparation for test:	
		1. Install a new filter element.	
		2. Make sure reserve tank, reserve tank screen element, and orifice assembly are clean.	
		3. Open vent valve on top of the turbine housing and bleed valve on top of the radiator. Remove radiator filler cap. Add approximately 7 gallons (26.5 liters) of oil (OE/HDO) through the radiator filler opening until fluid flows from the vent on top of the turbine housing. Close vent valve and continue filling, until the oil level reaches the filler opening. Then close bleed valve. Tightly install filler cap to prevent leakage when operating. Remove filler cap from reserve tank. Fill tank with oil (OE HDO) approximately 3 qts. (2.84 liters) to one inch below the full mark on dip stick. Install filler cap, start engine, and operate at half throttle. Check all fittings for leaks.	
		4. Check pressure gage for operating pressure. Normal operating pressure is 45 to 65 PSI and fluid temperature under 200°F when converter is properly filled and vented. The pressure gage responds instantly to full pressure upon starting the engine and zero pressure upon stopping. Sluggishness indicates air trapped within unit requiring further venting at the high point bleed valve. At part-throttle operation, check reserve tank oil level frequently to assure adequate fluid level. Add fluid as required.	

5-67. HYDRAULIC TANK-ANCHOR WINCH-MAINTENANCE INSTRUCTIONS

This task covers:

a. Welding

INITIAL SETUP:

Test Equipment

NONE

Special Tools

Welding equipment

Material/Parts

NONE

Personnel Required

1

References

Para 3-137 Hydraulic Tank Assembly - Maintenance Instructions

Equipment Condition: NONE

Condition Description

Special Environmental Conditions

NONE

General Safety Instructions

NONE

LOCATION	ITEM	ACTION	REMARKS

The only maintenance at this level is welding.

APPENDIX A
REFERENCES

REFER TO VOLUME 12

APPENDIX B
MAINTENANCE ALLOCATION CHART

REFER TO VOLUME 12

INDEX

Paragraph

A

Accumulator 5-22
Anchor Winch ssembly 5-58
Anchor Winch 5-57
- Disconnect Clutch Assembly 5-65
- Dirve Brake Assembly 5-60
- Drive Gear Assembly 5-61
- Frame and Drum Assembly 5-63
- Hydraulic Tank 5-67
- Level Wind Assembly 5-62
- Slack Puller and Motor Assembly 5-64
- Torque Converter 5-66
- Universal Joint Assembly 5-59
- Winch Assembly 5-58

B

Balance Weight Cover and Accessory Drive 5-13
Blower 5-8, 5-35
Bow Ramp 5-47
- Bow Ramp, Sheaves, and Fairleads 5-48
- Controller 5-52
- Speed Reducer 5-50
- Winch Assembly 5-49
- Winch Motor 5-51

Bow Ramp, Sheaves, and Fairleads 5-48

C

Camshaft Assembly and Gear Train 5-19
- Camshaft Assembly and Gear Train 5-19.1
- Idler Gear 5-19.2
- Idler Gear Hole Spacer 5-19.3

Camshaft Assembly and Gear Train 5-19.1
Clutch Hydraulic Cylinder 5-65.3
Controller 5-52
Cylinder Block 5-20, 5-43

INDEX (CONTINUED)

Paragraph

D

Disconnect Clutch 5-65
Clutch Hydraulic Cylinder 5-65.3
Disconnect Clutch Assembly 5-65.1
Disconnect Clutch 5-65.2
Disconnect Clutch Assembly 5-65.1
Disconnect Clutch 5-65.2
Distribution Lighting Panels 5-45
Drive Brake Assembly 5-60
Drive Gear Assembly 5-61

E

Electric Power Generation and Distribution 5-28
Blower 5-35
Cylinder Block 5-43
Distribution Lighting Panels 5-45
Engine Assembly 5-33
Exhaust Manifold 5-40
Flywheel and Housing 5-41
Fresh Water Pump 5-37
Fuel Injector 5-36
Generator 5-32
Governor 5-34
Lube Oil Pump 5-42
Main Switchboard 5-29
Power Panel Boards 5-31
Running Light Control Panel 5-46
Thermostat and Housing 5-39
Transformers 5-30
24-Volt Rectifier 5-44
Water Manifold 5-38
Engine Assembly-Removal and Run-In 5-33
Engine Supports, Lifter Bracket, and Crankshaft Front Cover 5-14
Engine and Transmission Controls 5-6
Exhaust Manifold 5-40
Expansion Tank 5-10

F

Flywheel and Housing 5-18, 5-41
Frame and Drum Assembly 5-63
Fresh Water Pump 5-37
Fuel Injector 5-9, 5-36

INDEX (CONTINUED)

Paragraph

G

Gate Hinges and Springs 5-55
General-Repair Parts, Special Tools, TMDE and Support Equipment 5-1
General Troub1eshootlng 5-2
Generator (40KW) 5-32
Governor 5-34

H

Hydraulic Reservoir 5-25
Hydraulic Starting System Piping (Aft Engine Room) 5-27
Hydraulic Starting System Piping (Forward Engine Room) 5-26
Hydrostarter 5-21
Hydrostarter-Engine Driven Pump 5-23
Hydrostarter Solenoid 5-24

I

Idler Gear 5-19.2
Idler Gear Hole Spacer 5-19.3

L

Level Wind Assembly 5-62
Lube Oil Pressure Regulator and Relief Valve 5-17
Lube Oil Pump 5-16, 5-42

M

Main Propulsion Engine and Marine Gear 5-3
- Accumulator 5-22
- Balance Weight Cover and Accessory Drive 5-13
- Blower 5-8
- Camshaft and Gear Train 5-19
- Cylinder Block 5-20
- Engine Supports, Lifter Brackets and Crankshaft Front Cover 5-14

Engine and Transmission Controls 5-6

INDEX (CONTINUED)

Paragraph

M (continued)

Main Propulsion Engine and Marine Gear Continued)
- Expansion Tank 5-10
- Flywheel and Housing 5-18
- Fuel Injector 5-9
- Hydrostarter 5-21
- Hydrostarter Piping (Aft Engine Room) 5-27
- Hydrostarter Piping (Forward Engine Room) 5-26
- Hydrostarter Pump (Engine Driven) 5-23
- Hydrostarter Solenoid 5-24
- Lube Oil Pressure Regulator and Relief Valve 5-17
- Lube Oil Pump 5-16
- Marine Gear 5-5
- Muffler 5-15
- Propulsion/Marine Gear-Removal and Run-In Instructions 5-4
- Reservoirs and Filters 5-25
- Thermostat and Housing 5-12
- Variable Speed Mechanical Governor 5-7
- Water Manifold 5-11

Main Propulsion Engine/Marine Gear-Removal and Run-In Instructions 5-4
Main Switchboard 5-29
Marine Gear 5-5
Muffler 5-15

P

Portable Davit 5-56
Power Distribution Panel Boards 5-31

R

Running Light Control Panel 5-46

S

Slack Puller and Motor 5-64
Speed Reducer 5-50
Stern Gate 5-54

INDEX (CONTINUED)

Paragraph

S (continued)

Stern Gate-Overall 5-53
Gate Hinges and Springs 5-55
Portable Davit 5-56
Stern Gate 5-54

T

Thermostat and Housing 5-12, 5-39
Torque Converter 5-66
Transformers 5-30
24-Vol t Rectifier 5-44

U

Universal Joint Assembly 5-59

V

Variable Speed Mechanical Governor 5-7
Voltage Regulator 5-29.1

W

Water Manifold 5-11, 5-38
Winch Assembly 5-49
Winch Motor 5 1

By Order of the Secretary of the Army:

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

Official:

DONALD J. DELANDRO
Brigadier General, United States Army
The Adjutant General

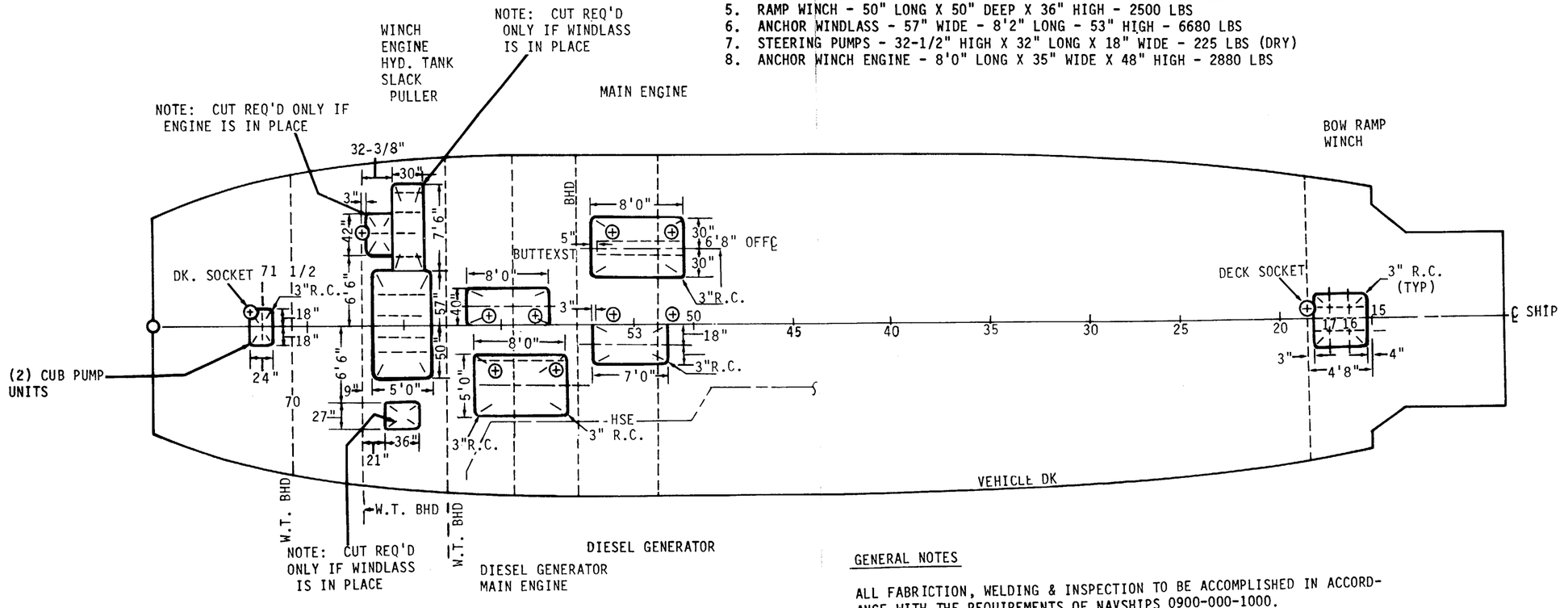
Distribution:

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

☆U.S. GOVERNMENT PRINTING OFFICE: 1985-564-030/20032

APPROXIMATE MACHINERY PRINCIPLES

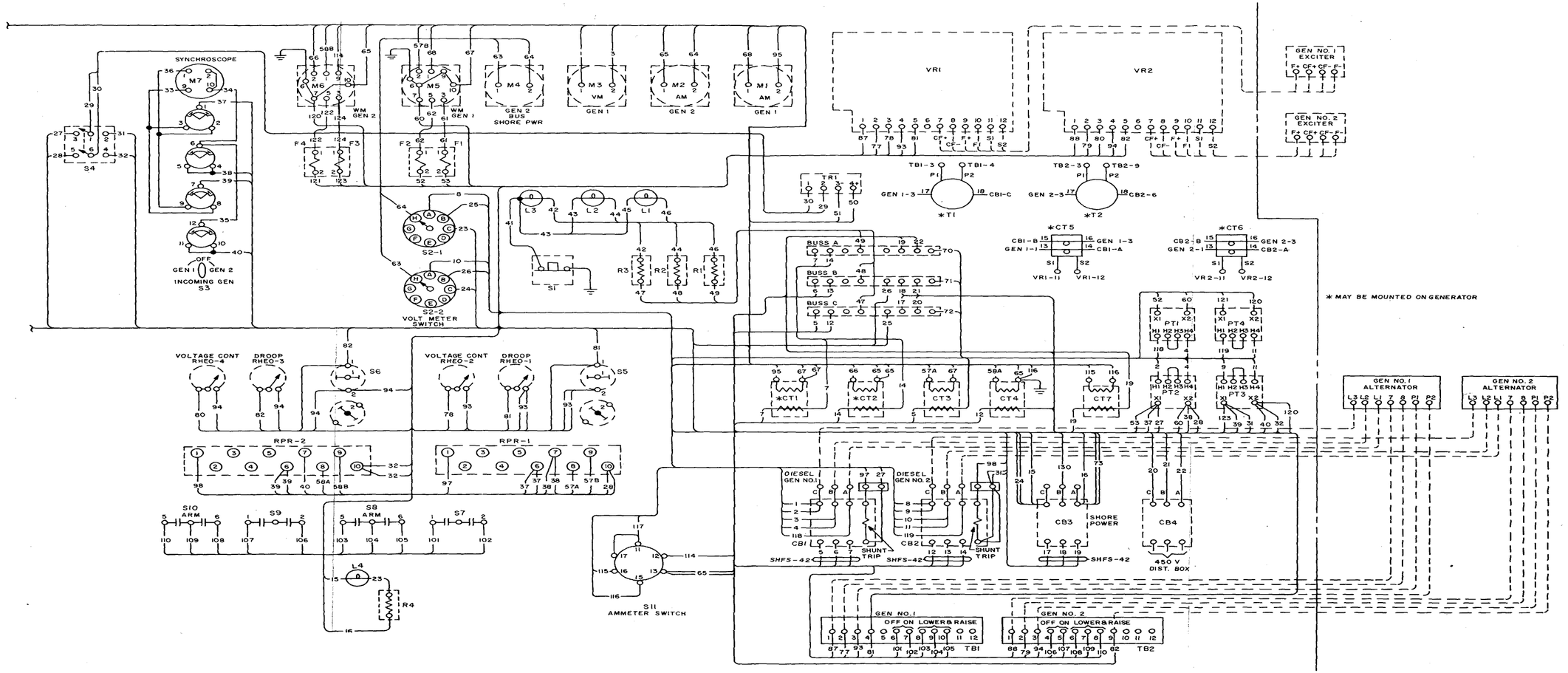
1. HYD. TANK - 41" LONG X 48" HIGH X 20" WIDE - 1070 LBS
2. DIESEL GENERATOR - 73" LONG X 35" WIDE X 44 " HIGH - 5850 LBS
3. MAIN ENGINES - 8'3" LONG X 57" HIGH X 48" WIDE - 4925 LBS
4. SLACK PULLER - 52" LONG X 35" WIDE X 22-1/2" HIGH - 680 LBS
5. RAMP WINCH - 50" LONG X 50" DEEP X 36" HIGH - 2500 LBS
6. ANCHOR WINDLASS - 57" WIDE - 8'2" LONG - 53" HIGH - 6680 LBS
7. STEERING PUMPS - 32-1/2" HIGH X 32" LONG X 18" WIDE - 225 LBS (DRY)
8. ANCHOR WINCH ENGINE - 8'0" LONG X 35" WIDE X 48" HIGH - 2880 LBS



GENERAL NOTES

ALL FABRICTION, WELDING & INSPECTION TO BE ACCOMPLISHED IN ACCORDANCE WITH THE REQUIREMENTS OF NAVSHIPS 0900-000-1000.

FO-1. Machinery Vehicle Deck Access

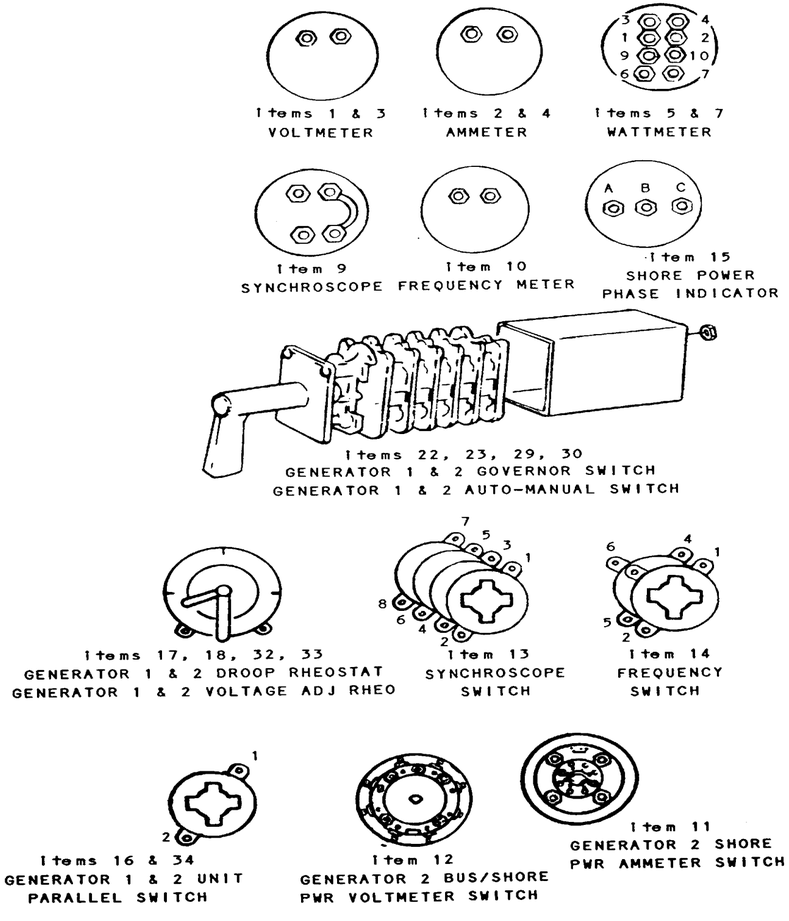


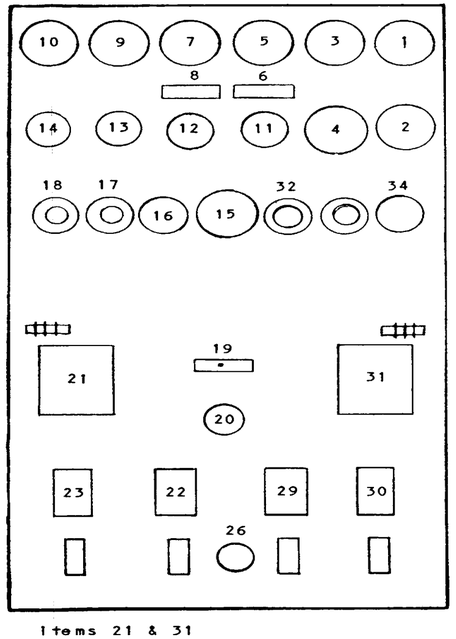
FO-2. Main Switchboard/Schematic

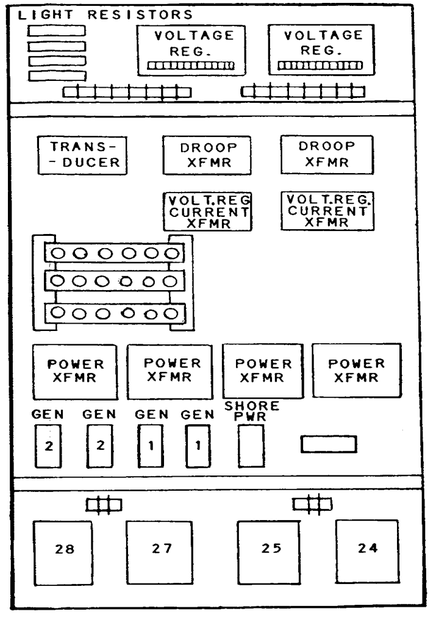
FO-2. Main fo-fo-FO-

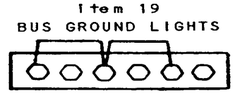
FP-5/(FP-6 blank) Sheet 2 of 2 has been deleted.

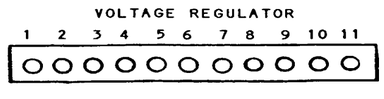
Change 2 (FP-4 blank)/FP-3



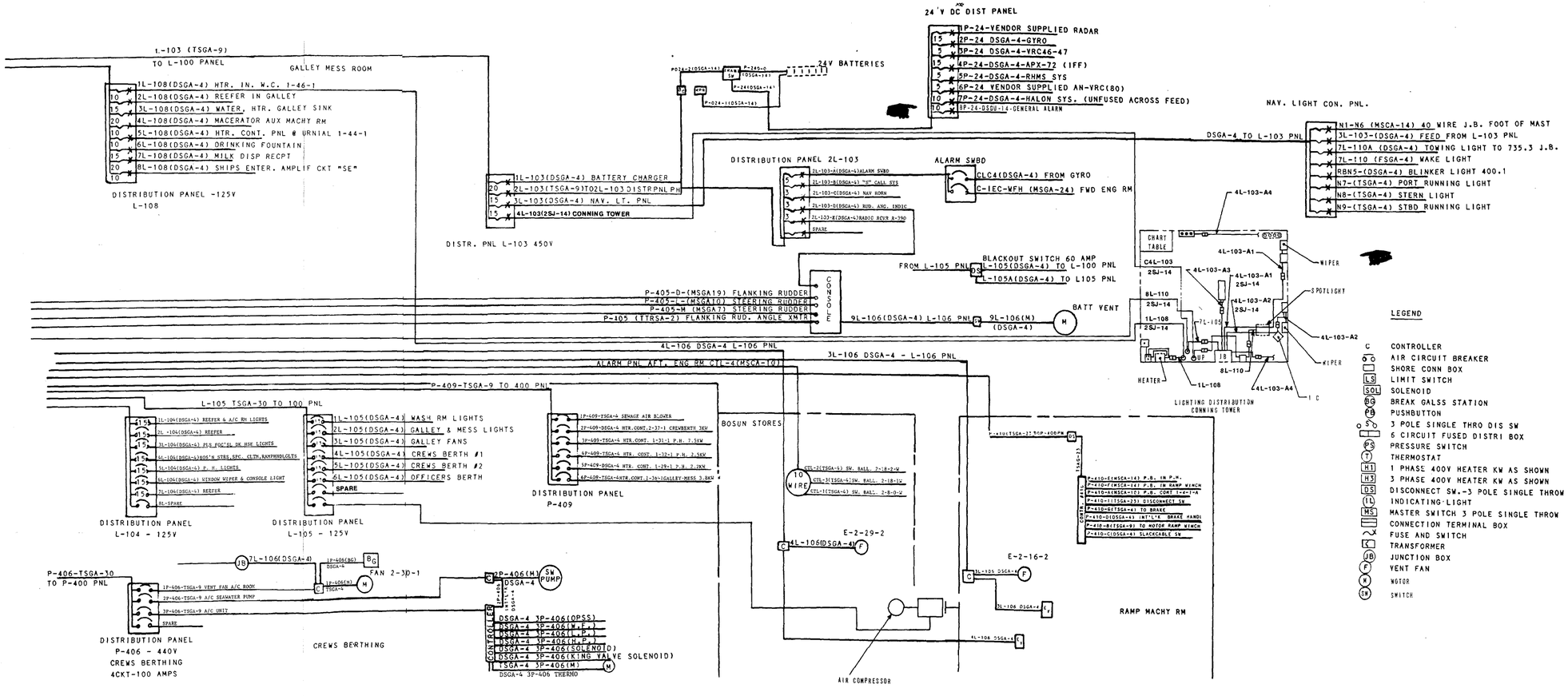






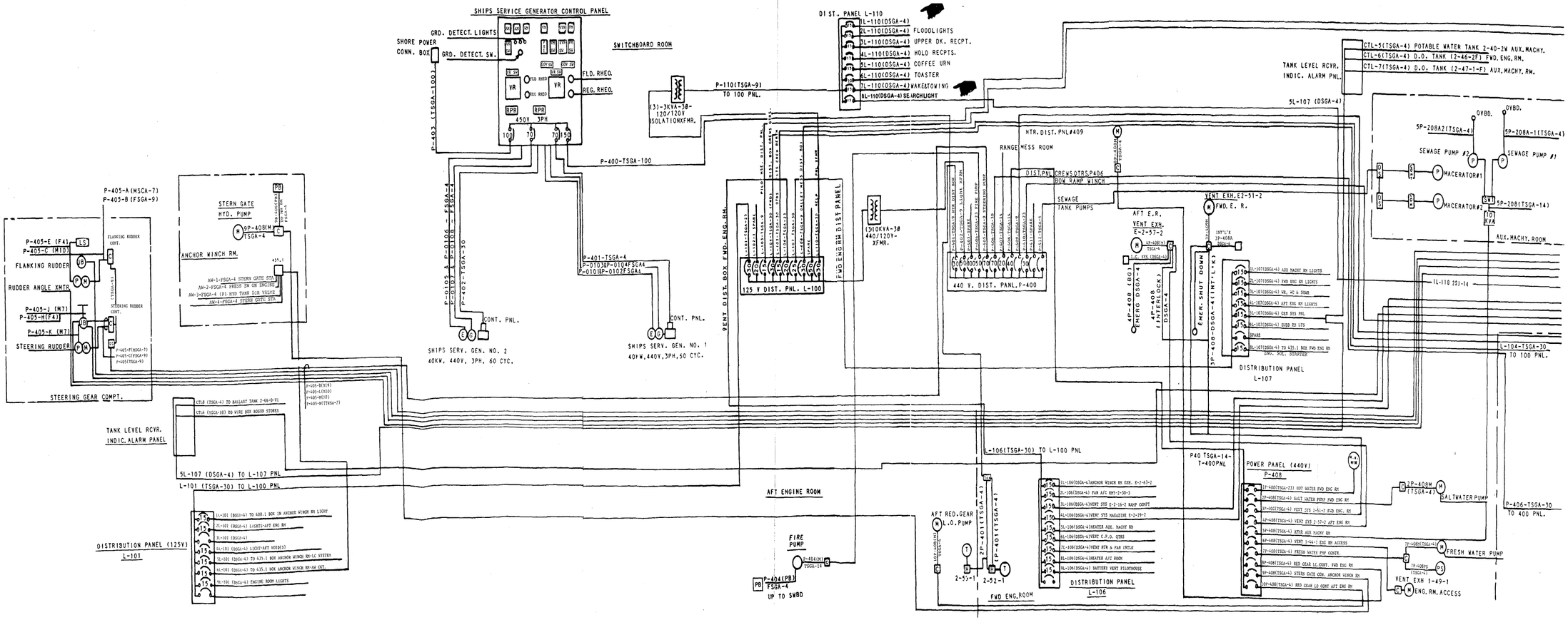


FO-3. Main Switchboard Component/Operation



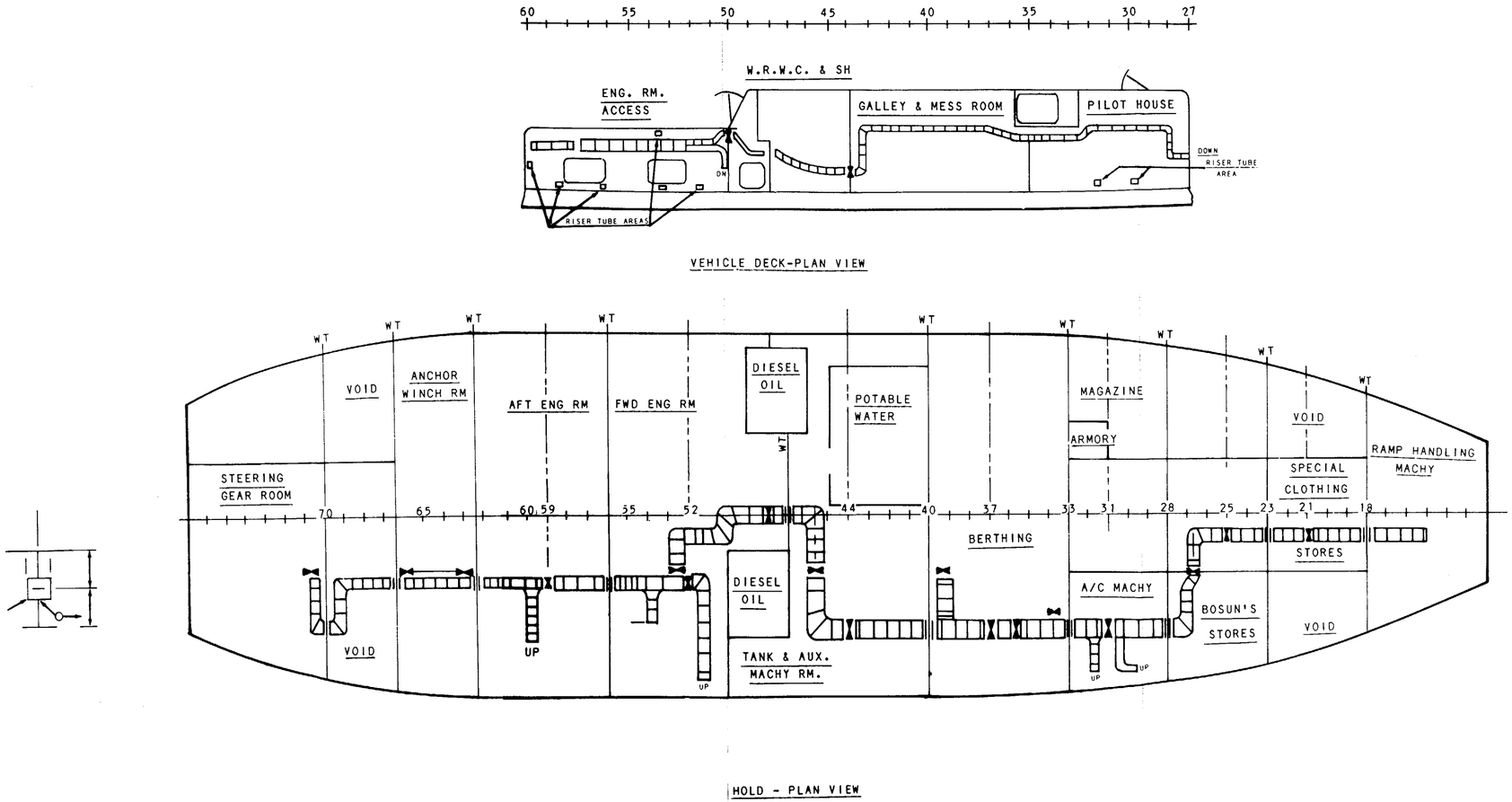
FO-4. Power Distribution Schematic (Sheet 1 of 2)

4954-002

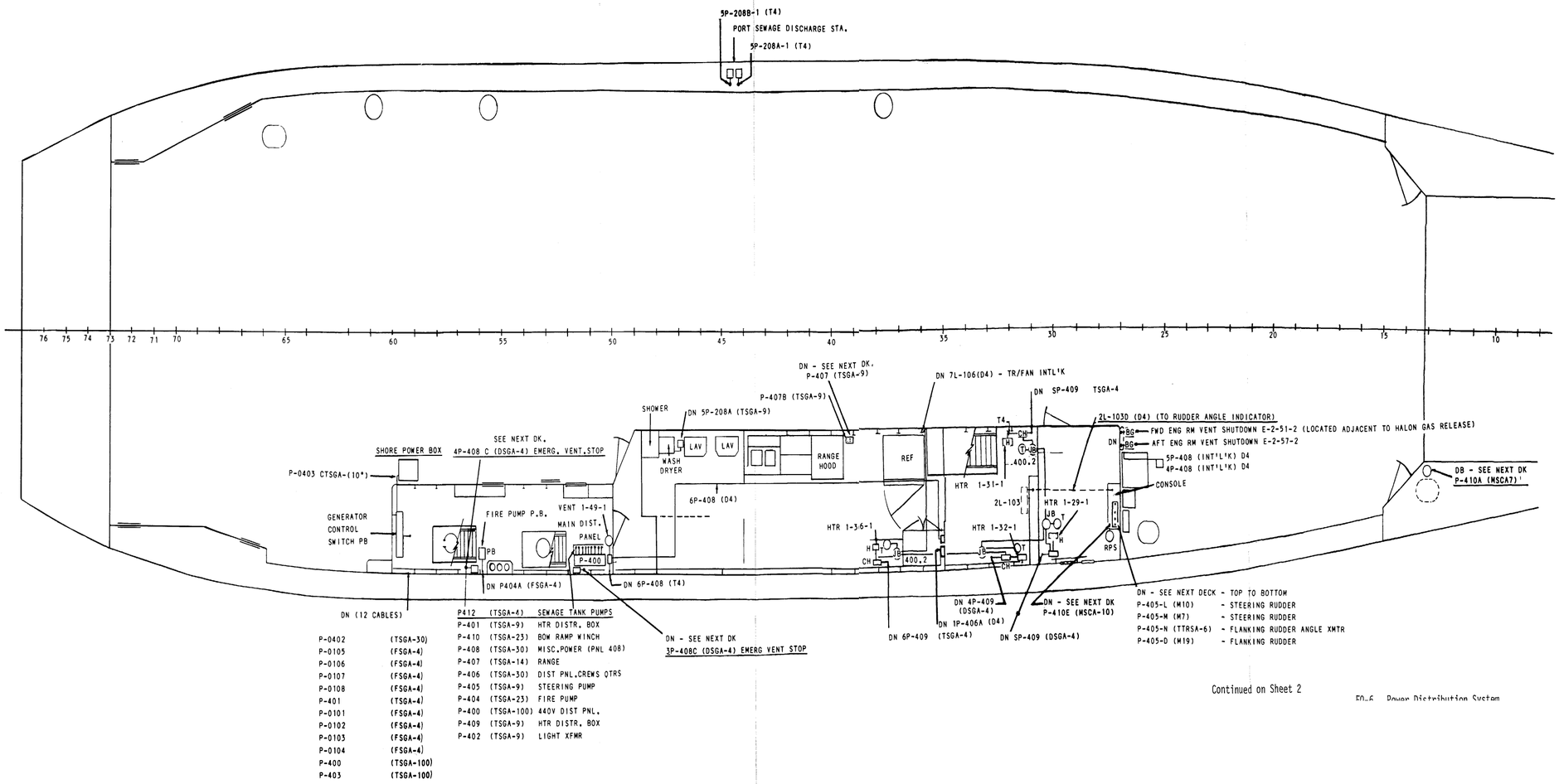


FO-4. Power Distribution Schematic (Sheet 2 of 2)

4954-003



FO-5. Wireways



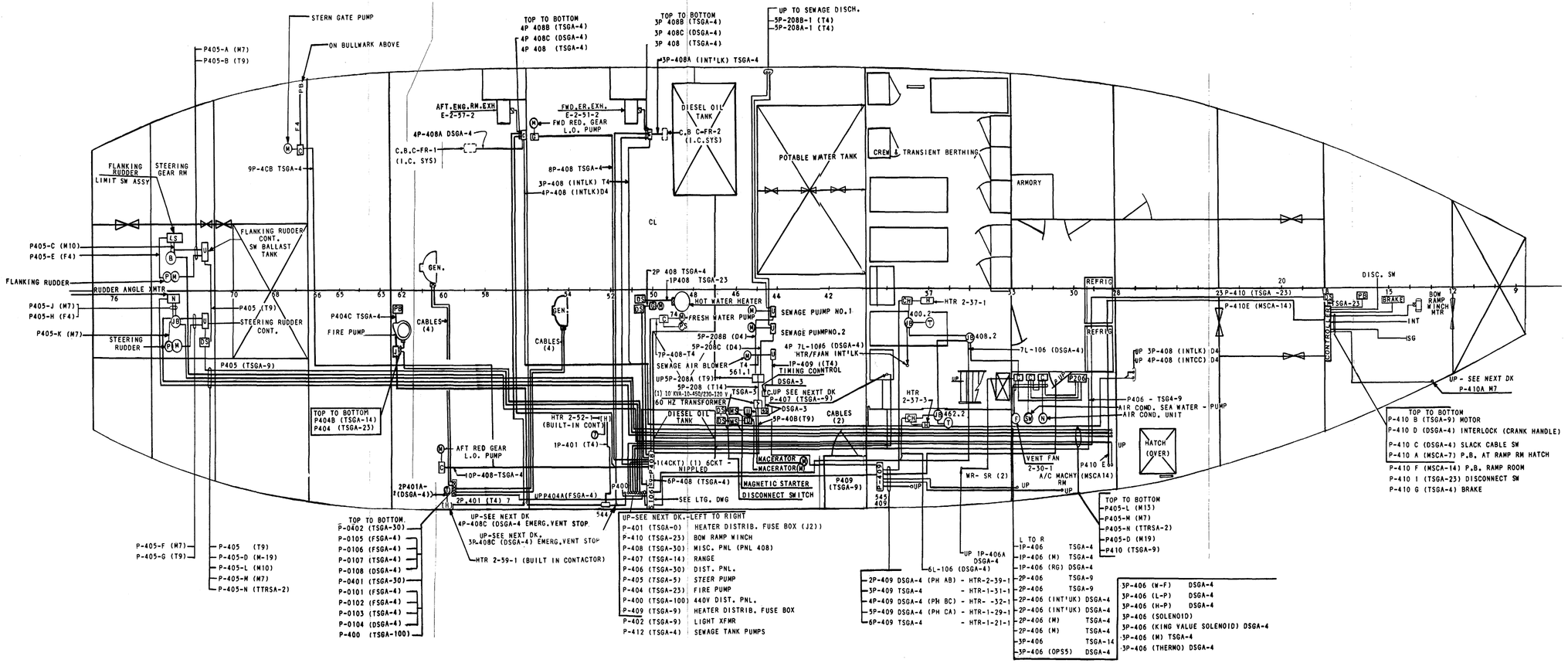
FO-6. Power Distribution System (Sheet 1 of 3)

SYMBOL	DESCRIPTION
[1]	6 CIRCUIT FUSED DISTRIBUTION BOX
[1]	4 CIRCUIT FUSED DISTRIBUTION BOX
CH	CONTACTOR (FOR HEATERS) 30A -3HP-120 VOLT COIL
H	HEATER
T	HEATER THERMOSTAT
LS	FLANKING RUDDER LIMIT SWITCH
N	RUDDER ANGLE TRANSMITTER
C	CONTROLLER FLANKING AND STEERING
PM	POWER UNIT
D6	HOT WATER HEATER DISC. SW - 3P-30A-440V
	RUDDER ANGLE INDICATOR
	STEERING
	20 TERMINAL CONNECTION BOX
JB	4 TERMINAL CONNECTION BOX
	4 CKT DIST. BOX - 30 BUS 30 BRANCH - O -10A FUSE
—	WASHER/DRYER 230/120V 10 - 60HZ
3	TRANSFORMER -440/230-120V-10-60HZ-10KVA
DS	DISCONNECT SWITCH - 3PM - 30A - 450V - UNFUSED
PB	PUSHBUTTON - START/STOP/IND. LT - N.W.T. (FIRE PUMP)
M	MACERATOR PUMP MOTOR 2HP 360/460V - 30 - 60HZ
MS	MAGNETIC MOTOR STARTER - 230 VAC - 30 - 60HZ - UNFUSED
DS	FUSED DISCONNECT SWITCH - 230VAC - 30 - 60HZ - FUSED
TC	TIMING CONTROL - 120 VAC - 10 - 60HZ
SS	SELECTOR SWITCH - 120VAC - 10 - 60HZ (PUMP,

SYMBOL	DESCRIPTION
P-400	PANEL P-400, 440V, DIST. PANEL-10CKT
	SWITCHBOARD
P-406	PANEL P-406, 440V, DIST. PANEL-DP 100A FR CKT BRKS
P-408	PANEL P-408, 440V, DIST. PANEL-DP 160A FR CKT BRKS
SP	SHORE POWER 110A - 30- 440V
	RANGE 12KW - 4-OV-30
DS	RANGE DISC SW. - SP - 30A - 440V
	HOT WATER HEATER
D6	HOT WATER HEATER DISC. SW - 3P-30A-440V
	BOW RAMP MOTOR
	BOW RAMP MOTOR CONTROLLER
RPE	PUSHBUTTON STATION HOUSE
PB	FWD PUSHBUTTON STATION
INT	INTERLOCK CRANK HANDLE
SC	SLAVE CABLE SWITCH
F	VENT FAN
C	VENT FAN CONTROLLER
C	SEWAGE PUMP MOTOR 2 HP 360-460V - 30 - 60HP
PB	PUSHBUTTON WT - ST/STOR
M	AIR PUMP - 4HP - 440V-30
M	SEA WATER PUMP MOTOR
A/C	AIR CONDITIONING UNIT 2HP - 440V - 30 - 60HZ
BG	VENT BREAK GLASS STATION

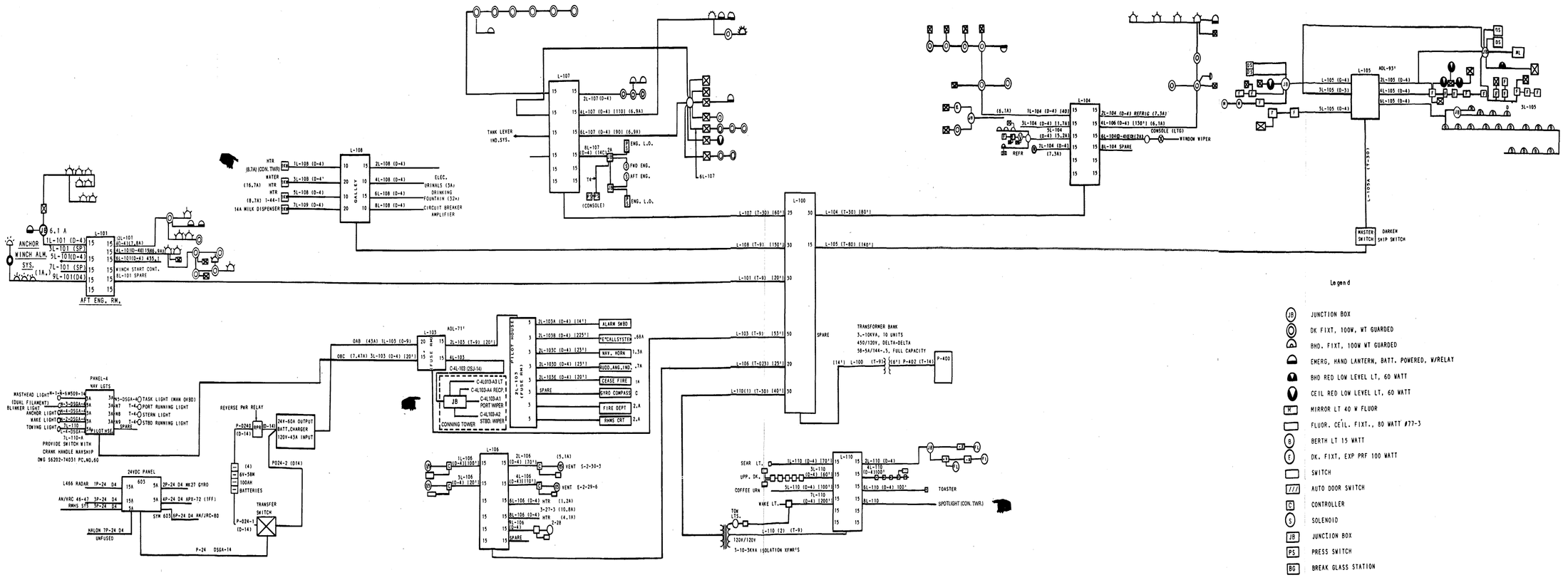
Continued from Sheet 1

FO-6. Power Distribution System (Sheet 2 of 3)Wireways

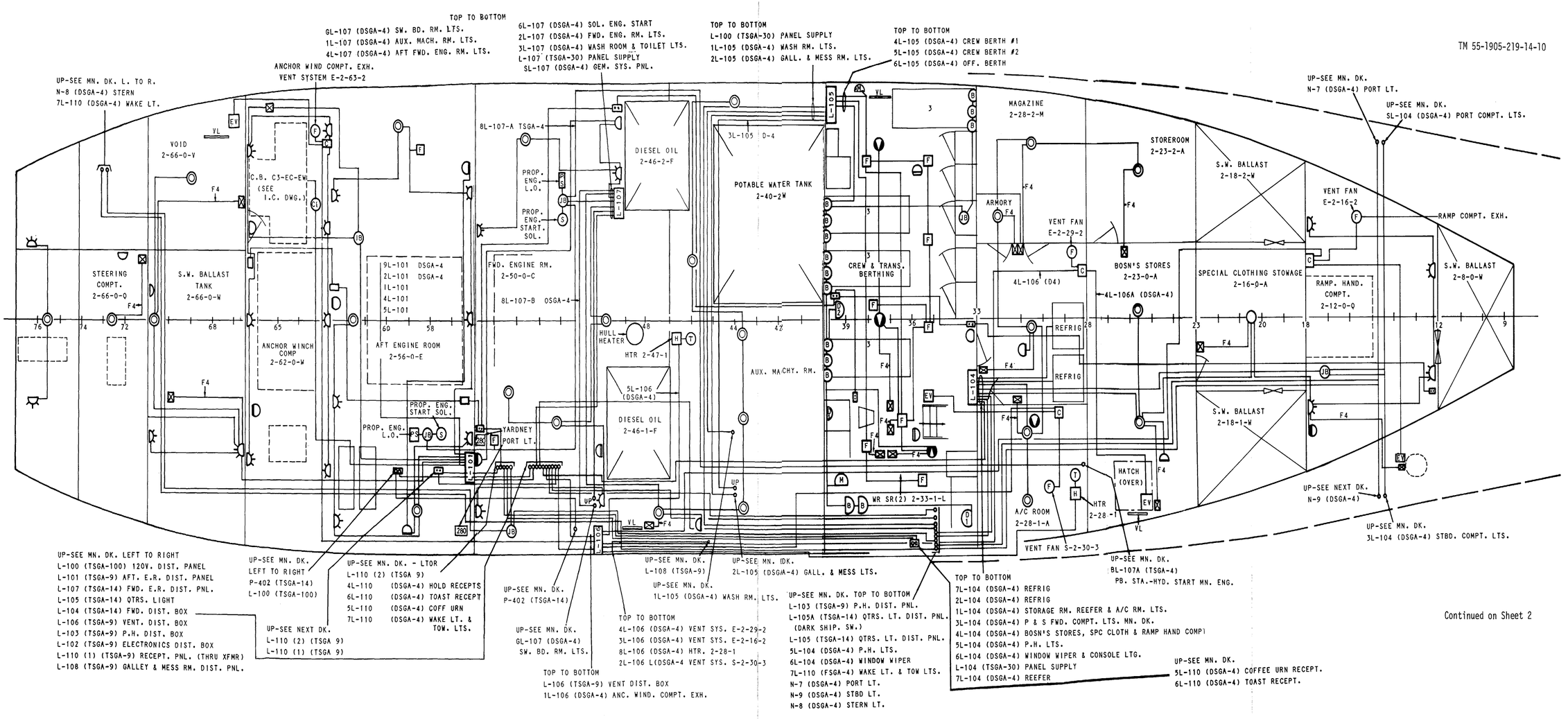


FO-6. Power Distribution System (Sheet 3 of 3)

(FP-20 blank) FP-19



FO-7. List of Feeders and Mains.

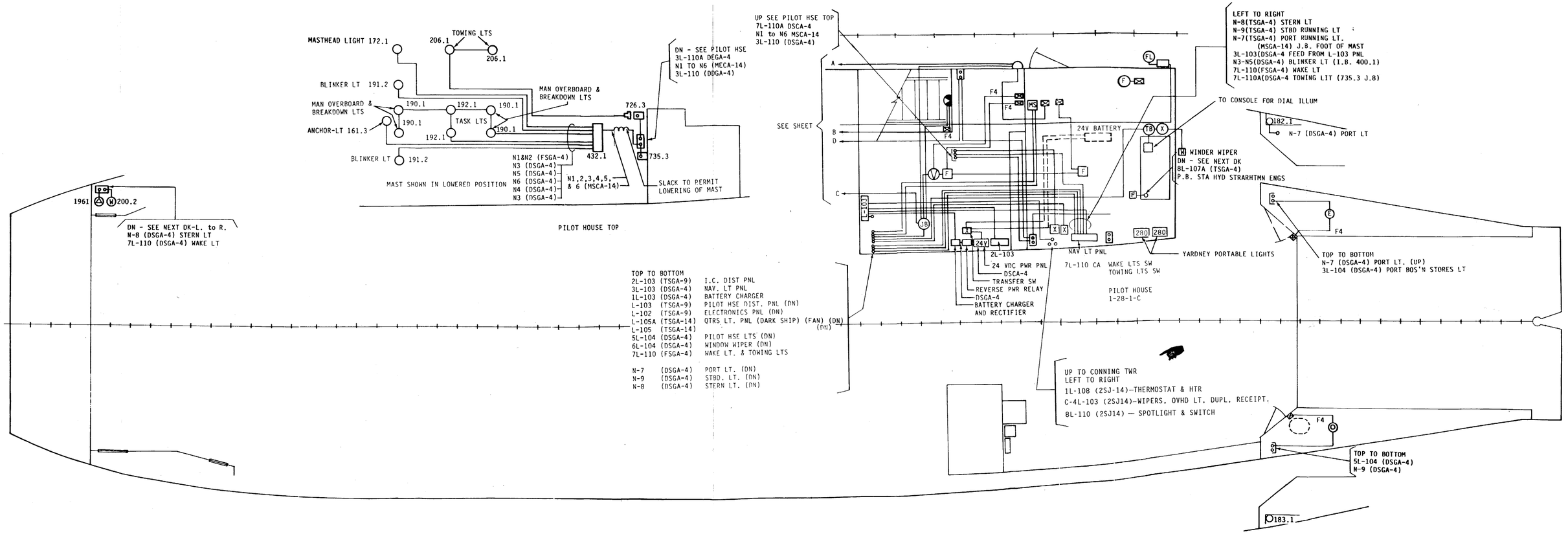


FO-8. Lighting Distribution System (Sheet 1 of 4)

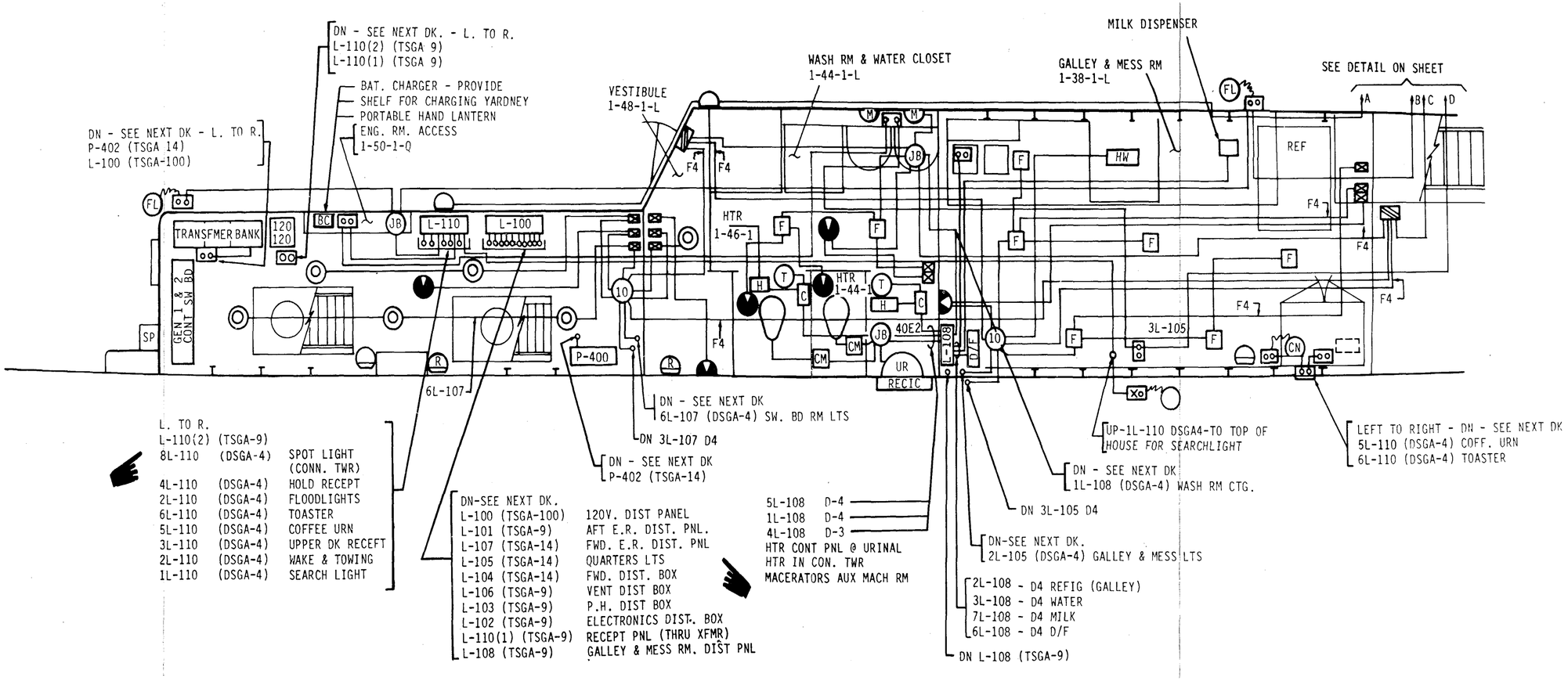
SYMBOL	DESCRIPTION
	CEIL. FIXT., WT. GUARDED, 100W
	BULKHEAD FIXTURE W.T., 100W
B	BERTH. LT., FLOOR, 8 WATT
D1	DESK LT. (FOR SECRETARY BUREAU)
JB	4 TERM. CONN. BOX - 4"
	CEIL. FIXT.
	BULKHEAD FIXTURE
D2	DESK LT. (FOR WRITING TABLE)
F	FLUOR. CEIL. FIXT., 2-20W TUBES, SPRAYTIGHT
SL	SEARCH LT. - 1000W-120V-AC
FL	FLOODLIGHT
	SWITCH, N.W.T. (BREAKS BOTH SIDES)
7353	RECEPT. SING. GANG., DP., 10A, GROUNDING - SBM
	RECEPT., DUPLEX-CONVENIENCE-GRD.
	SWITCH & RECEPT.
M	MIRROR LT., FLUOR., 15 WATT
	TERMINAL BOX
	DOOR SWITCH, 5 CIR.
MS	MASTER SW., 3P.-60A-120V
L-100	DISTR. PNL. - 12 CKT. - CKT BREAKER - 30 FOR - 30BR
L-101	DISTR. PNL. - 12 CKT. - CKT. BREAKER - 30 FOR - 10BR
L-102	DISTR. PNL. - 8 CKT. - SW. & FUSE - 30 FOR - 10BR
L-103	DISTR. PNL. - 4 CKT. - FUSED - 30 FOR - 30BR
L-104	DISTR. PNL. - 12 CKT. - CKT. BREAKER - 30 FOR - 10BR
L-105	DISTR. PNL. - 12 CKT. - CKT. BREAKER - 30 FOR - 10BR
L-108	DISTR. PNL. - 8 CKT. - SW. & FUSE - 30 FOR - 10BR
L-110	DISTR. PNL. - 12 CKT. - CKT. BREAKER - 30 FOR - 10BR
L-106	DISTR. PNL. - 6 CKT. - CKT. BREAKER - 30 FOR - 10BR
L-107	DISTR. PNL. - 12 CKT. - CKT. BREAKER - 30 FOR - 10BR
2L-103	DISTR. PNL. - 8 CKT. - SW. & FUSE - 30 FOR - 10BR
S	SOLENOIDS (HYDRAULIC ENG. START SYSTEM)
10	10 WIRE CONN. BOX
PBS	PUSHBUTTON STA., 4 GANG
CU	COFFEE URN
D/F	DRINKING FOUNTAIN
	TOASTER
	WINDOW WIPER
	WINDOW WIPER SWITCH
	TRANSFORMER 450/120V, 10KVA, 1Ø
	TRANSFORMER, 120/120V, 3KVA, 1Ø
CM	COMMODE MICROSWITCH-120V-1Ø-60HZ
M	MOTOR
C	CONTROLLER
F	FAN
PS	PRESS. SW. - PROP. ENG. START SYS. - L.O.
EV	EMERG. VENT STOP BREAK GLASS STATION
	THRU.-BHD. FIXT.-W.T.-W/GLOBE GUARD & HALF SHIELD
	EMERG. HAND LANTERN WITHOUT RELAY
R	EMERG. HAND LANTERN WITHOUT RELAY W/RED LENS
	EMERG. HAND LANTERN W/RELAY
HL	HOOD LIGHT
	PLUG (FOR TOWING LIGHTS)
280	PORTABLE/RECHARGABLE HAND LANTERN
BC	BATTERY CHARGER
E	EXPLOSION PROOF OVHD. FIXT. 100W
	BATTERY-TYPE 6V-SBM-100AH
RC	RECTIFIER-CONSTAVOLT-MOD. A28-10-24V
	TRANSFER SWITCH-DPDT.-60A-24V
RPR	REVERSE POWER RELAY-60A-24VDC
24V	PWR. PNL.-20VDC-4 CKT.
UF	URINAL FLOWSWITCH-120V-1Ø-60HZ

Continued from Sheet 1

F0-8. Lighting Distribution System
(Sheet 2 of 4)



FO-8. Lighting Distribution System
(Sheet 3 of 4)
Change 2 FP-27/(FP-28 Blank)



4954-005

FO-8. Lighting Distribution System (Sheet 4 of 4)

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 **2028-2**

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.