

**TECHNICAL MANUAL**

**UNIT,  
DIRECT SUPPORT  
AND  
GENERAL SUPPORT  
MAINTENANCE MANUAL**

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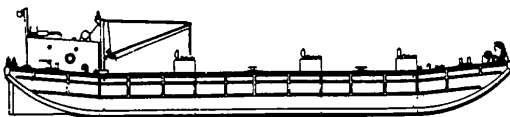
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**BARGE, LIQUID CARGO,  
NON-PROPELLED, STEEL  
120 FEET, DESIGN 231C  
NSN 1930-01-313-9472**

Approved for public release; distribution is unlimited.

**WARNING**

A loading or unloading operation is a fire hazard. No smoking, open flames, open lights, or any repair work requiring the use of tools that could ignite the flammable cargo shall be permitted on the vessel or in the area adjacent to the vessel during cargo transfer operations.

Petroleum vapors are both toxic and explosive. In sufficient concentration petroleum vapor may cause death within five minutes. In lesser concentrations, irritation of the eyes, severe headache, and mild exhilaration may be experienced. Tanks which are not ventilated and have remained empty for a while may be depleted in oxygen due to rusting. The oxygen content may not be enough to support life.

Fight fire from the windward side, allowing the wind to blow heat away from the operator. The wind will also carry the carbon dioxide to the fire.

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

Use caution when welding on or near the fuel tank. Possible explosion could result if heat build-up inside the tank is sufficient.

Make sure all guards are in place.

Do not stick fingers in the ports of a pump. The close running parts will cause injury.

Loose clothing can get easily entangled in moving parts. When operating machines do not wear unbuttoned jackets, loose sleeve cuffs, or neckties. Do not breathe cleaning solvent P-D-680 for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

The pickling acid will cause severe burns if it comes in contact with your skin. Wear eye protection, rubber gloves, and a rubber apron. Use extreme care as not to splash the solution. If the acid does come in contact with your skin or clothing, neutralize the acid immediately with baking soda. Seek prompt medical attention.

**WARNING**

When mixing water and acid, always mix the acid into the water. Failure to do this may cause the acid to splatter on your body with serious burns or even death resulting.

Use the recommended air pressure (under 35 psi line 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 personnel injury.

Take adequate precautions to prevent personal injury in the event that there is a rupture in the pressurized system.

Do not weld at any location on this barge until a safe area has been determined which is gas and fume free. Failure to comply with this warning could result in injury to personnel.

Do not weld a closed fuel tank or container until every precaution has been taken to eliminate all confined gases and fumes from inside and outside the tank or container area. Failure to comply with this warning could result in injury to personnel.

To reduce the risk of injury to personnel, keep fingers out of piston pin hole when disassembling the piston dome from the skirt.

TECHNICAL MANUAL

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HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C. 26 MARCH, 1990

UNIT, DIRECT SUPPORT AND  
GENERAL SUPPORT MAINTENANCE MANUAL

BARGE, LIQUID CARGO,  
NON-PROPELLED, STEEL  
120 FEET, DESIGN 231C  
NSN 1930-01-313-9472

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

**Approved for public release; distribution is unlimited.**

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## CHAPTER 1

## INTRODUCTION

Section I.	GENERAL INFORMATION
Section II.	EQUIPMENT DESCRIPTION

## Section I. GENERAL INFORMATION

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Maintenance Forms and Records, and Reports .....	1-2	Reporting Equipment Improvement Recommendations (EIR).....	1-5
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**1-1. SCOPE.**

- a. Type of Manual. Unit, Direct Support and General Support Maintenance.
- b. Model Number and Equipment Name. Barge, Liquid Cargo, Non-propelled, Steel, 120 Feet, Design 231C.
- c. Purpose of Equipment. Designed to transport bulk petroleum products on rivers and in harbors.

**1-2. MAINTENANCE FORMS AND RECORDS, AND REPORTS.**

a. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System (TAMMS).

b. The following record and report forms are to be used by the operational personnel for recording and reporting operations:

DD Form 314	Preventive Maintenance Schedule and Record
DA Form 2404	Equipment Inspection and Maintenance Worksheet
DA Form 2407	Maintenance Request
DA Form 2407-1	Maintenance Request (Continuation Sheet)
DA Form 2408	Equipment Log Assembly (Record)
DA Form 2408-5	Equipment Modification Record
DA Form 2408-14	Uncorrected Fault Record

1-3. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE.

Refer to TM 750-244-3 for instructions covering the destruction of the barge to prevent enemy use.

1-4. PREPARATION FOR STORAGE OR SHIPMENT.

For storage requirements or for shipment instructions, refer to Chapter 3, Section VII. Administrative storage requirements will be in accordance with the following:

- a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.
- b. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be completed, shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR).

If the barge or associated equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at Commander, U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We'll send you a reply.

Section II. EQUIPMENT DESCRIPTION

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1-6. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

- a. The barge is a large vessel of the nonpropulsion type and must be towed to desired locations.
- b. Designed to transport bulk petroleum products in rivers and harbors.
- c. There are six cargo compartments in the hull with a total cargo capacity of 4,495 bbls. or 576.15 long tons or 645.27 short tons.

- d. Equipped with diesel engine driven rotary pump for transfer of cargo.
- e. Equipped with hand operated bilge pump, cargo boom, two anchors, anchor windlass and davit.
- f. Equipped with running and navigation lights.

#### 1-7. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

- a. HULL. The main body and frame of the barge.
- b. DAVIT. Used to hoist and position anchors on deck.
- c. WINDLASS. Used to hoist anchors.
- d. CARGO HOSE BOOM. Used to hoist and support cargo hoses during loading or unloading operations.
- e. MACHINERY HOUSE. Provides a shelter for cargo pump diesel engine and reduction gear.
- f. FUEL TANK. Stores fuel for cargo pump diesel engine. Located on top of machinery house.
- g. EXHAUST MUFFLER. Suppresses exhaust noise and sparks from cargo pump diesel engine. Located on top of machinery house.
- h. CARGO PIPING SYSTEM. Used in loading and unloading of cargo and controlled by various valves in the system.
- i. DIESEL ENGINE. Drives the cargo pump for unloading cargo. Located in machinery house.
- j. CARGO PUMP. Driven by diesel engine through speed reducer. Used to unload liquid cargo. Located in aft rake compartment below engine.
- k. BILGE PUMP. Hand operated. Used to remove bilge from cargo compartments. Two are located on the main deck.
- l. ANCHORS. Two 300 pound (136 kg) anchors are secured forward on the main deck.
- m. HATCHES. Various hatches providing access to equipment and compartments are located on the main deck. The hatch above the aft rake compartment is illustrated.
- n. FILLING INLET AND DISCHARGE OUTLET VALVES. Filling valve provides connection to shore storage facility. Discharge valve provides connection for cargo unloading. Both are located outside the machinery house on a single riser.
- o. SAFETY SHUT-DOWN CONTROL. Hand operated remote control for stopping the pump engine in the event of any emergency. Located near compartment 3, center tank, port side.

**1-7. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - Continued.**

p. PRESSURE GAGE. Indicates pressure of cargo during loading or unloading operations. Located at speed reducer in machinery house. Discharge pressure is limited to 70 psi by the relief valve on the cargo pump, do not alter the valve setting to exceed 70 psi. Loading pressures are determined by the shore facility.

**1-8. DIESEL ENGINE CONTROLS AND INDICATORS.**

a. WATER TEMPERATURE GAGE. Indicates temperature of engine coolant. Normal temperature is approximately 165°F (73.9°C). Possible trouble is indicated by readings above 180°F (82.2°C or below 155°F (68.4°C)).

b. OIL PRESSURE GAGE. Indicates pressure of engine lubricating oil. Safe pressure is between 30 to 60 psi.

c. THROTTLE CONTROL. Controls engine speed.

d. TACHOMETER. Located above power take off clutch. Indicates engine speed in revolutions per minute.

e. POWER TAKE OFF CLUTCH LEVER. Engages or disengages clutch to start or stop pumping operations. Located between engine and speed reducer.

f. RUNNING LIGHTS. Battery operated. Located at forward corners of deck, green on starboard side and red on port side, and centered on after deck, white 135 degrees.

**1-9. DIFFERENCES BETWEEN MODELS.**

This manual covers only the Barge, Liquid Cargo, Nonpropelled, Steel, 120 feet, design 231C.

**1-10. EQUIPMENT DATA.**

a. Data and Identification Plates.

- (1) The identification plate for the diesel engine is located on the right side of the cylinder block.
- (2) The identification plate for the power take off clutch is located on top of the clutch housing.
- (3) The data plate for the speed reducer is located at the rear of the speed reducer.
- (4) The data plate for the cargo pump is attached to the pump housing.

b. Tabulated Data.

## (1) Barge, nonpropelled, design, 231C.

Length (over-all) .....	120 ft
Beam (molded).....	33 ft
Depth, side .....	12 ft 6 in.
Depth, midships.....	10 ft 6 in.
Displacement, light .....	179 tons
Displacement, loaded .....	685 tons
Draft, loaded (forward).....	7 ft 6 in.
Draft, loaded (aft) .....	7 ft 6 in.
Capacity (diesel oil) .....	
Cargo tank No. 1 Stbd.....	28,312 gal.
Cargo tank No. 2 Port.....	28,327 gal.
Cargo tank No. 3 Stbd.....	37,744 gal.
Cargo tank No. 4 Port.....	37,766 gal.
Cargo tank No. 5 Stbd.....	28,321 gal.
Cargo tank No. 6 Port.....	28,334 gal.
Total capacity.....	188,804 gal. or 4,495 bbl.

## 100 PERCENT CAPACITY

PORT	TANK COMPARTMENT 2	TANK COMPARTMENT 1	STARBOARD
	28,327 GALLONS	28,312 GALLONS	
	TANK COMPARTMENT 4	TANK COMPARTMENT 3	
	37,766 GALLONS	37,744 GALLONS	
	TANK COMPARTMENT 6	TANK COMPARTMENT 5	
	28,334 GALLONS	28,321 GALLONS	

## 85 PERCENT CAPACITY

TANKS		
1/2	25034 Gallons	88.4%
3/4	31922 Gallons	84.6%
5/6	22850 Gallons	80.7%

**1-10. EQUIPMENT DATA - Continued.****(2) Diesel Engine.**

Manufacturer .....	Detroit Diesel Engine Division of General Motors Corp.
Model .....	1043-7000
Number of cylinders .....	4
Displacement .....	283.7 cubic in.
Bore and stroke .....	4 1/4 in by 5 in.
Governor speed .....	1890 rpm
Brake horsepower .....	120 hp
Firing order .....	1-3-4-2
Lubrication system .....	Pressure
Cooling system .....	Fresh water w/radiator
Starting method .....	Hydraulic starting
Fuel system .....	Solid injection
Fuel .....	Diesel oil

**(3) Pump Coupling Assembly.**

Manufacturer .....	The Falk Corporation
Type .....	T10

**(4) Exhaust Fan.**

Manufacturer .....	Fan Engineering Co., Inc.
Model .....	L-07
Capacity .....	750 cfm/1700 rpm

**(5) Cargo Pump.**

Manufacturer .....	Dover Corpora- tion/Blackmer Pump Division
Model .....	HXL8F-N
Type .....	Vertical rotary
Suction .....	8 in.
Discharge .....	8 in.
Fitted .....	Standard
Capacity .....	1050 gpm at 150 rpm

**(6) Bilge Pump.**

Manufacturer .....	Kolstrand Woodward Mark
Model .....	AKPTDP30

**(7) Speed Reducer.**

Manufacturer .....	The Falk Corporation
Type .....	YBX
Series .....	2000

(8) Nut and Bolt Torque Data, Detroit Diesel Engine 7000 C.

Diameter	Tension in pounds
5/16	24-30
3/8	35-40
7/16	55-60
1/2	90-100
9/16	150-160
5/8	165-175
1	180-200
1 1/8	300-325

1-7/(1-8 Blank)

## CHAPTER 2

### UNIT MAINTENANCE

---

#### 2-1. SERVICE UPON RECEIPT.

a. Inspection.

- (1) Inspect barge for damage to machinery house.
- (2) Inspect barge for damage to winch and secure mounting of winch.
- (3) Inspect all lights for damage and check for proper operation.
- (4) Inspect engine assembly for loose or missing parts.
- (5) Inspect pump assembly and drive shaft for loose or missing parts.
- (6) Inspect life preservers for deterioration and light for proper operation.
- (7) Refer to Appendix B, TM 55-1930-208-10 and make sure all authorized items are on board the barge.
- (8) Refer to paragraph 3-1, TM 55-1930-208-10 and service the engine.
- (9) Refer to paragraph 2-17, TM 55-1930-208-10 and service the radiator.
- (10) Refer to paragraph 3-1, TM 55-1930-208-10 and service the speed reducer.
- (11) Refer to paragraph 2-6, TM 55-1930-208-10 and service the fuel tank.

#### NOTE

There are no maintenance functions authorized to be accomplished by unit maintenance.

**2-1/(2-2 Blank)**

## CHAPTER 3

### DIRECT SUPPORT MAINTENANCE

Section I.	REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT
Section II.	MAINTENANCE OF HULL
Section III.	MAINTENANCE OF MACHINERY HOUSE
Section IV.	MAINTENANCE OF BOOM, CARGO
Section V.	MAINTENANCE OF GEAR, DECK
Section VI.	MAINTENANCE OF HYDRAULIC START SYSTEM
Section VII.	MAINTENANCE OF ENGINE
Section VIII.	MAINTENANCE OF CLUTCH
Section IX.	MAINTENANCE OF SPEED REDUCER
Section X.	MAINTENANCE OF PUMP, TRANSFER

#### Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

	Para.		Para.
Common Tools and Equipment .....	3-1	Special Tools, TMDE, and Support	
Repair Parts .....	3-3	Equipment .....	3-2

#### 3-1. COMMON TOOLS AND EQUIPMENT.

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

#### 3-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT.

Refer to the Repair Parts and Special Tools List (TM 55-1930-208-24P) and to the Maintenance Allocation Chart (Appendix B of this manual) for the Special Tools, TMDE, and Support Equipment required at Direct Support Maintenance.

#### 3-3. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools List (TM 55-1930-208-24P) covering Direct Support Maintenance for this manual.

---

## Section II. MAINTENANCE OF HULL

	Para.		Para.
Engine Shutdown .....	3-6	Valve, Pressure Relief .....	3-5
Ullage Assembly .....	3-4		

### 3-4. ULLAGE ASSEMBLY.

---

This task covers:

- |                |               |           |               |
|----------------|---------------|-----------|---------------|
| a. Disassembly | b. Inspection | c. Repair | d. Reassembly |
|----------------|---------------|-----------|---------------|
- 

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Gasket P/N UL-102-15

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Vessel is moored (paragraph 2-7, TM 55-1930-208-10).

Ullage removed (paragraph 3-4, TM 55-1930-208-10).

#### a. Disassembly. (Refer to figure 3-1).

(1) Remove nut (1) and wing nut (2).

(2) Remove screw (3) and plate (4).

(3) Remove stem (5), yoke (6), gasket (7), cover (8), and screen (9). Discard gasket (7).

#### b. Inspection.

(1) Inspect wing nut (2) for damaged threads and cracks.

(2) Inspect yoke (6) for cracks.

(3) Inspect cover (8) for cracks or other damage.

#### c. Repair.

(1) Refer to TM 9-237 for welding of cover (8).

(2) Repair to other parts is limited to replacing damaged parts.

d. Reassembly.

- (1) Install screen (9) into cover (8). Install new gasket (7) on cover (8).
- (2) Install yoke (6), stem (5), plate (4), and screw (3).
- (3) Install wing nut (2) and nut (1).

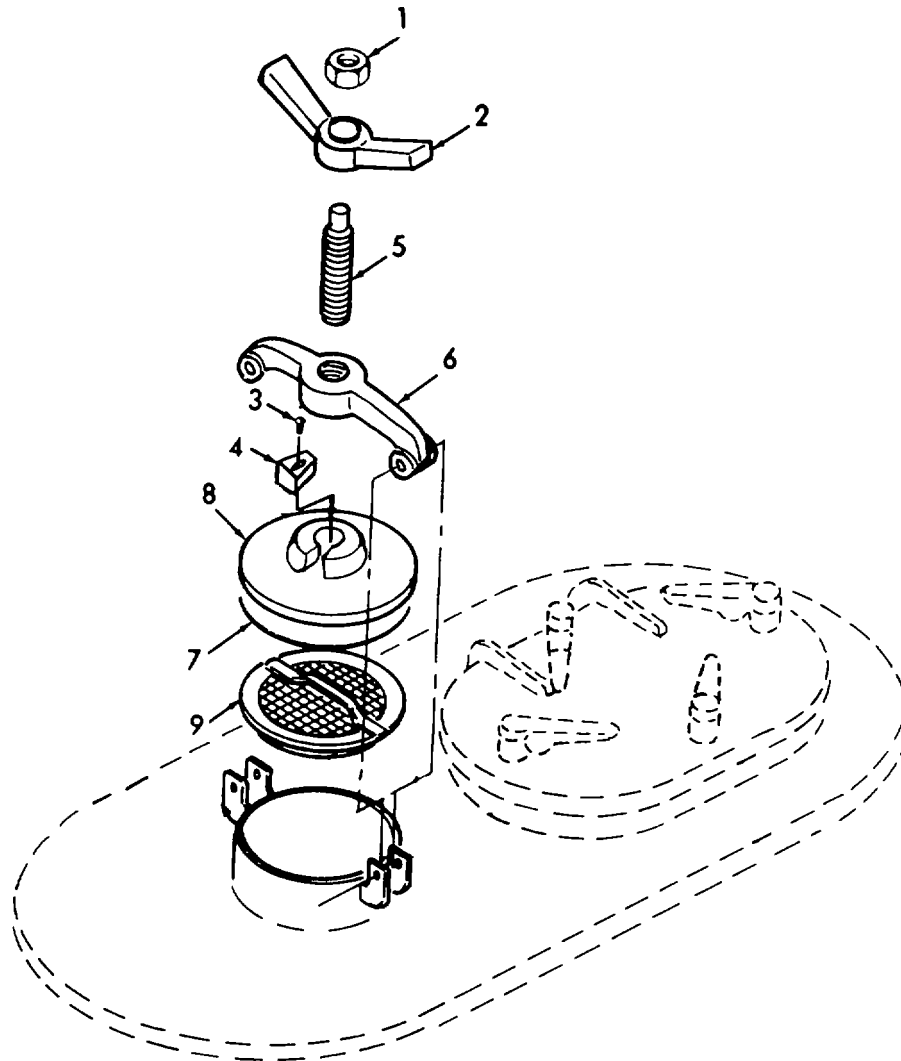


Figure 3-1. Ullage, Disassembly/Reassembly.

### 3-5. VALVE, PRESSURE RELIEF.

This task covers:

- a. Removal
- b. Installation

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Washer, Lock P/N MS35338-146

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Vessel is moored (paragraph 2-7, TM 55-1930-208-10).

a. Removal. (Refer to figure 3-2).

(1) Remove eight nuts (1) and eight lockwashers (2).

(2) Remove relief valve (3).

b. Installation.

(1) Install relief valve (3) on expansion dome.

(2) Install eight lockwashers (2) and eight nuts (1).

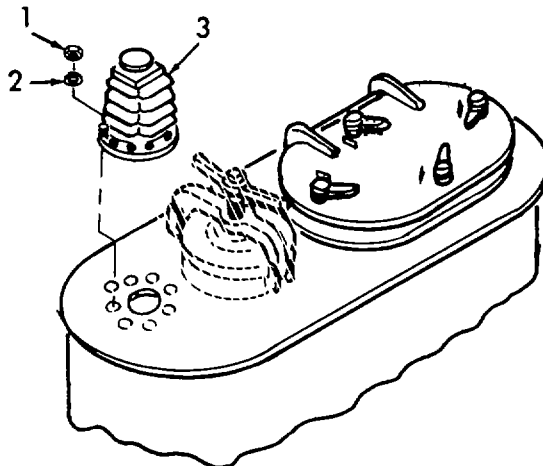


Figure 3-2. Relief Valve, Removal/Installation.

**3-6. ENGINE SHUTDOWN.**

---

This task covers:

- a. Removal                      b. Repair                      c. Installation                      d. Test
- 

INITIAL SET-UP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Washer, Lock P/N 101

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. Removal. (Refer to figure 3-3).

- (1) Disconnect bushing (1) from engine control.
- (2) Remove pipe (2), coupling (3), pulleys (4), pipe (5), and coupling (6).
- (3) Disconnect cable (7) from pull assembly (9) and remove cable.
- (4) Remove four screws (8) and remove pull assembly (9).
- (5) Remove screw (10), lockwasher (11), clamp (12), and hoses (13, 14, and 15).
- (6) Remove three elbows (16) and tee (17). Remove elbow (18), nipple (19), elbow (21), and two adapters (20). Remove valve (22).
- (7) Remove nut (28), lockwasher (24), screw (25), and clamp (26).
- (8) Remove two nuts (27), two lockwashers (28), rod (29), and connector (30).
- (9) Remove two blower bolts and remove control (31).

### 3-6. ENGINE SHUTDOWN - Continued.

b. Repair. Repair is limited to replacing damaged parts.

c. Installation.

- (1) Position control (31) on blower and secure with existing blower bolts.
- (2) Install connector (30), rod (29), two lockwashers (28), and two nuts (27).
- (3) Install clamp (26) and secure with screw (25), lockwasher (24), and nut (23).
- (4) Install valve (23), two adapters (20), and elbow (21).
- (5) Install nipple (19), elbow (18), tee (17), and three elbows (16).
- (6) Install hoses (15, 14, and 13). Install clamp (12) and secure with lockwasher (11) and screw (10).
- (7) Position pull assembly (9) on expansion dome and secure with five screws (8).
- (8) Install cable (7) and connect to pull assembly (9) and control (31).
- (9) Install coupling (6) to pulley (4) and install pipe (5).
- (10) Install pulleys (4), coupling (3), and pipe (2). Connect bushing (1) to engine control.

d. Test. Refer to TM 55-1930-208-10, paragraph 3-8 and test engine shutdown.

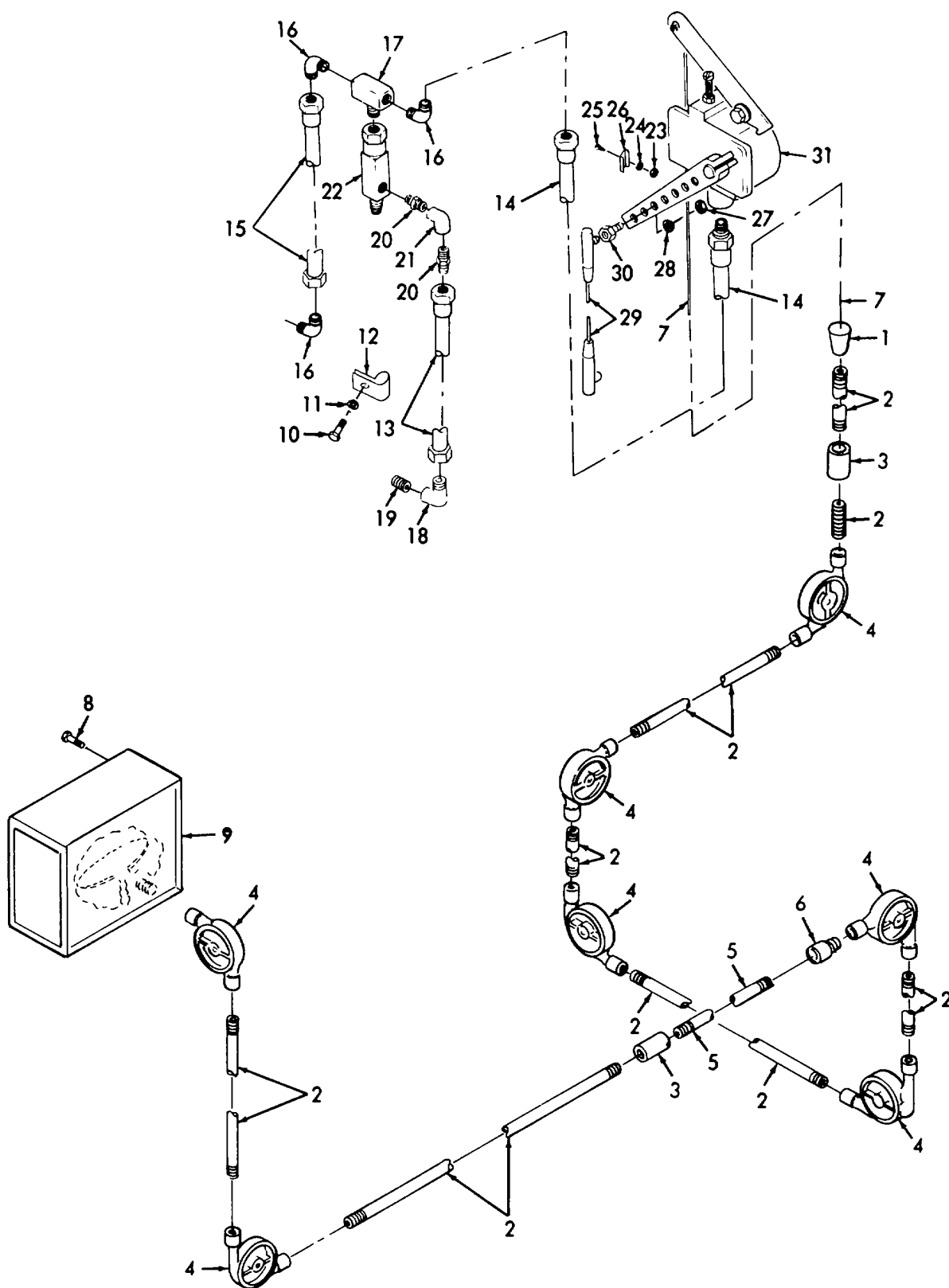


Figure 3-3. Engine Shutdown, Removal/Installation.

### Section III. MAINTENANCE OF MACHINERY HOUSE

Fan Exhaust.....	Para. 3-7	Tank, Fuel Oil.....	Para. 3-8
------------------	--------------	---------------------	--------------

#### 3-7. FAN, EXHAUST.

---

This task covers:

- a. Removal                      b. Installation
- 

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Washer, Lock P/N MS35338-46

Washer, Lock P/N MS35338-48

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

#### a. Removal. (Refer to figure 3-4).

- (1) Remove four nuts (1), four lockwashers (2), and four bolts (3) securing belt guard (4).
- (2) Remove four nuts (5), four lockwashers (6), four flat washers (7), and four bolts (8) to relieve drive belt tension. Then, remove drive belt (9).
- (3) Remove bushing (10) and sheave (11) from the fan (15).
- (4) Remove four hose clamps (12) and disconnect hoses (13 and 14).
- (5) Remove two screws (16) securing the couplings (17). Then, disconnect and remove duct (18), elbow (19), and duct (20).
- (6) Remove nut (21), lockwasher (22), U-bolt (23), and duct (24).

#### b. Installation.

- (1) Install duct (24) and secure with U-bolt (23), lockwasher (22), and nut (21).
- (2) Assemble duct (20), elbow (19), and duct (18). Connect the assembly using couplings (17) secured by two screws (16).

- (3) Connect hoses (14 and 13) and secure with hose clamps (12).
- (4) Install sheave (11) and bushing (10) on the fan (15).
- (5) Install drive belt (9) on the sheave (11). Position the fan to obtain proper belt tension and install four bolts (8), four flat washers (7), four lockwashers (6), and four nuts (5).
- (6) Install belt guard (4) using four bolts (3), four lockwashers (2), and four nuts (1).

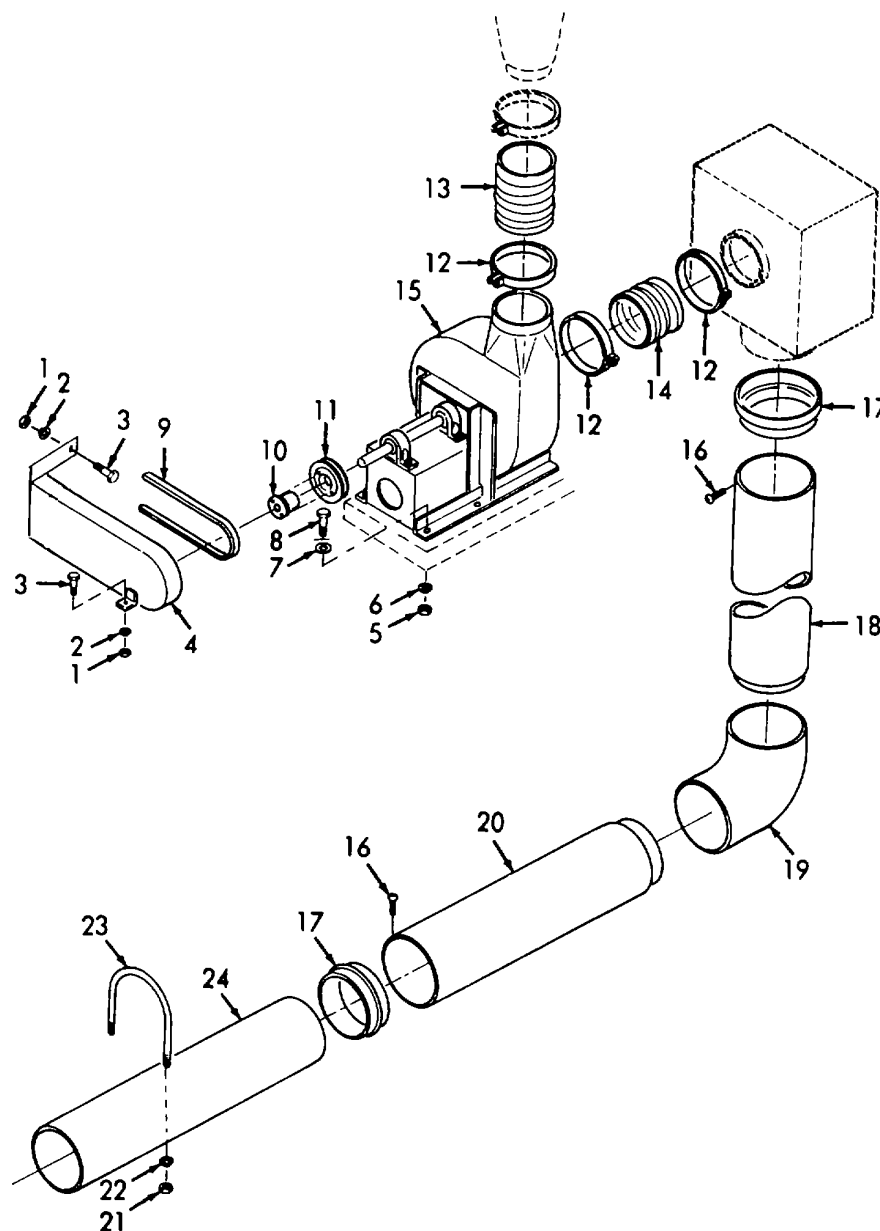


Figure 3-4. Exhaust Fan, Removal/Installation.

### 3-8. TANK, FUEL OIL.

---

This task covers:

- a. Removal
  - b. Installation
- 

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Gasket P/N STYLE 3000

Washer, Lock P/N MS35338-44

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

#### a. Removal. (Refer to figure 3-5).

- (1) Be sure the main fuel line valve has been turned off prior to attempting removal of tank.
- (2) Remove pipe cap (1) from the tank.
- (3) Remove valve (2), screen (3), nipple (4), and elbow (5).
- (4) Remove four bolts (6) and four nuts (7) from both the upper and lower fuel tank flanges. Remove gaskets (8) from the flanges.
- (5) Remove four nuts (9), four lockwashers (10), four bolts (11), four lockwashers (12), and two bar straps (13) securing fuel tank (14).

#### b. Installation.

- (1) Mount fuel tank (14) using two bar straps (13), four lockwashers (12), four bolts (11), four lockwashers (10), and four nuts (9).
- (2) Place gaskets (8) on both the upper and lower tank flanges. Secure each flange with four nuts (7) and bolts (6).
- (3) Install elbow (5) on the tank. Then, install pipe nipple (4), screen (3), and valve (2).
- (4) Install pipe cap (1) on the tank.
- (5) Turn on the main fuel line valve.

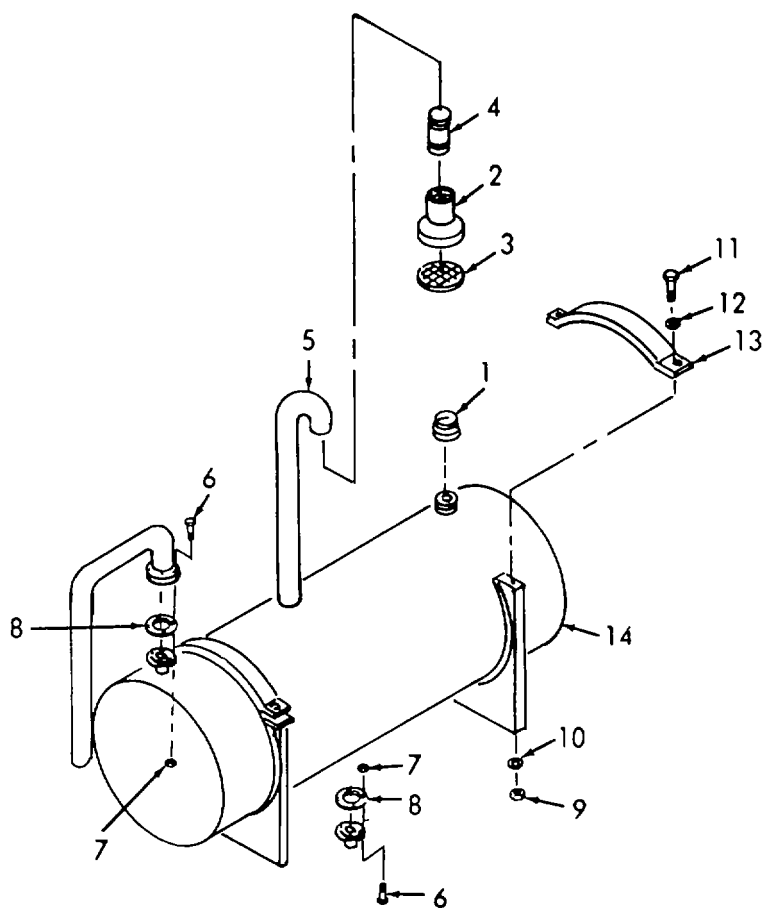


Figure 3-5. Fuel Oil Tank, Removal/Installation.

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**Section IV. MAINTENANCE OF BOOM, CARGO**

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**3-9. BOOM, CARGO.**

---

This task covers:

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

INITIAL SET-UP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Pin, Cotter P/N MS9245-58  
Pin, Cotter P/N MS24665-495  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS27183-13

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. Removal. (Refer to figure 3-6).

- (1) Remove three cotter pins (1) and three pins (2).
- (2) Remove cable swedge and remove cable (3) from sheave blocks (4 and 5). Remove sheave blocks (4 and 5).
- (3) Remove pin (6), nut (7), bolt (8), washer (9), bushing (10), and swivel (11).
- (4) Remove four nuts (12), four bolts (13), and two cable assemblies (14).
- (5) Remove cable swedge and remove cable (15) from sheave blocks (16 and 17). Remove sheave blocks (16 and 17).
- (6) Loosen nut on two hand winches (21) and remove cables (3 and 15).
- (7) Remove eight nuts (18), eight lockwashers (19), eight bolts (20), and two winches (21).
- (8) Remove cotter pin (22), nut (23), two washers (24), and bolt (25). Remove boom assembly (26).
- (9) Remove cotter pin (27), nut (28), two washers (29), pivot (30), and bushing (31).

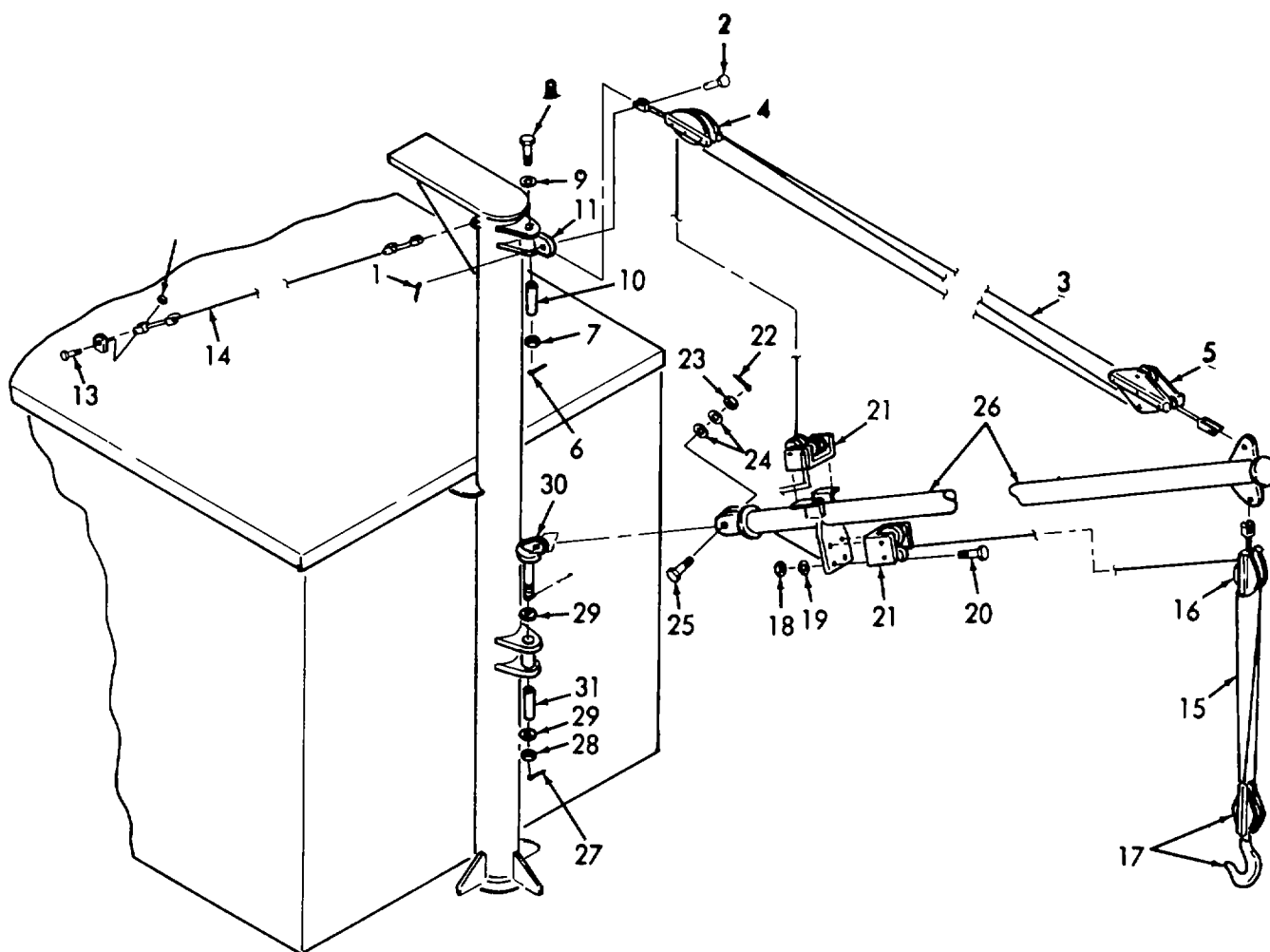


Figure 3-6. Cargo Boom, Removal/Installation.

b. Cleaning.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow all parts to dry.

**3-9. BOOM, CARGO - Continued.****c. Inspection.**

- (1) Inspect cables (3 and 15) for broken strands or signs of fraying.
- (2) Inspect all sheave blocks for worn or damaged sheaves.
- (3) Inspect boom assembly for cracks or broken welds.
- (4) Inspect both winches for brake ease of operation.

**d. Repair.** Repair is limited to replacing defective parts.**e. Installation.**

- (1) Install bushing (31), washers (19), and pivot (30). Secure pivot with washers (29), nut (28), and cotter pin (27).
- (2) Position boom assembly (26) on pivot (30). Secure boom assembly with bolt (25), two washers (24), nut (23), and cotter pin (22).
- (3) Install two winches (21) and secure with eight bolts (20), eight lockwashers (19) and eight nuts (18).
- (4) Connect cables (3 and 15) to winches (21), by looping cable through cable retainer and tighten nut.
- (5) Weave cable (15) through sheave blocks (17 and 16). Install cable swedge on cable at sheave block (17). Secure sheave block (16) to boom assembly with pin (2) and cotter pin (1).
- (6) Install two cables (14) and secure with four bolts (13) and four nuts (12).
- (7) Install swivel (11), bushing (10), and secure with bolt (8), washer (9), nut (7), and cotter pin (6).
- (8) Weave cable (3) through sheave blocks (4 and 5). Install cable swedge on cable at sheave block (5). Secure sheave blocks (4 and 5) with two pins (2) and cotter pin (1).

---

**Section V. MAINTENANCE OF GEAR, DECK****3-10. BILGE PUMP AND PIPING.**

---

**This task covers:**

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

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

Gasket P/N MIL-G-1149

Solvent, Cleaning (Item 4, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. **Removal.** (Refer to figure 3-7).

- (1) Remove two nuts (1) and two bolts (2) and separate bilge pump (3) from the piping. Remove gasket (4) from the pump flange. Discard gasket (4).
- (2) Remove foot valve (5) from the opposite end of the piping.
- (3) Remove remaining piping by disconnecting two pipe unions (6) and separate the five pipes (7) and two elbows (8).

## 3-10. BILGE PUMP AND PIPING-Continued.

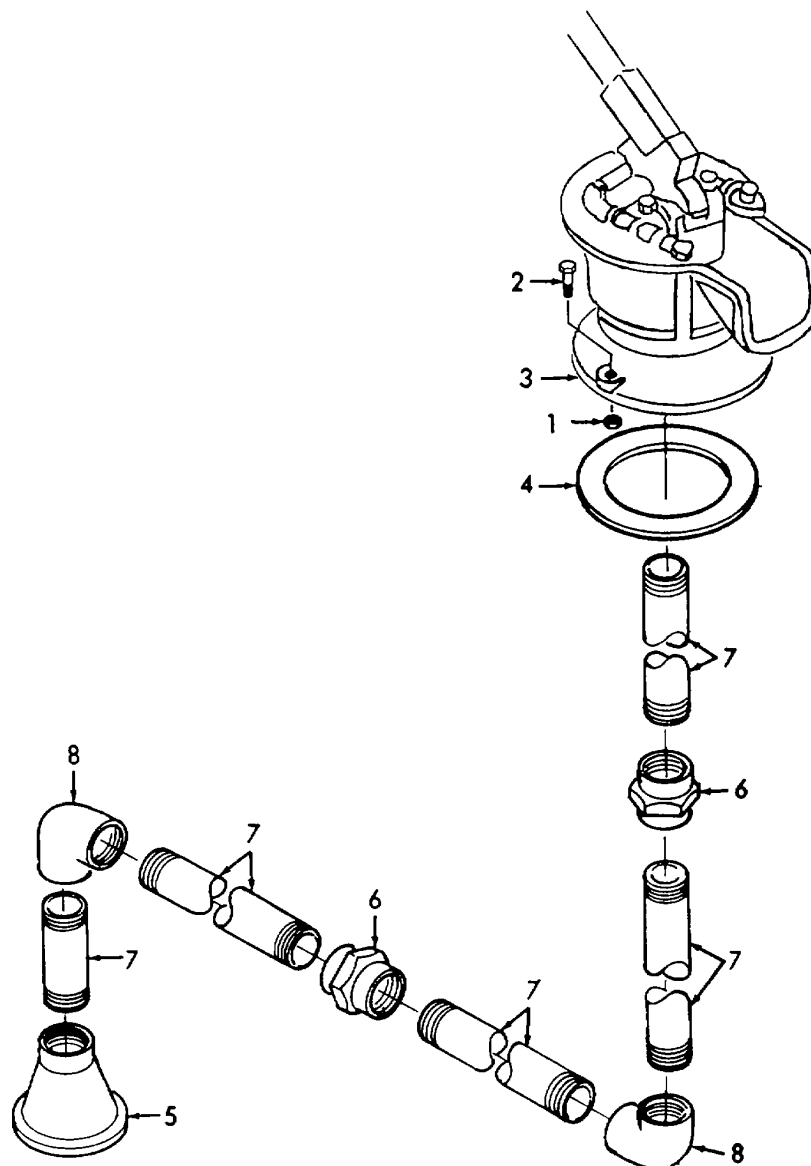
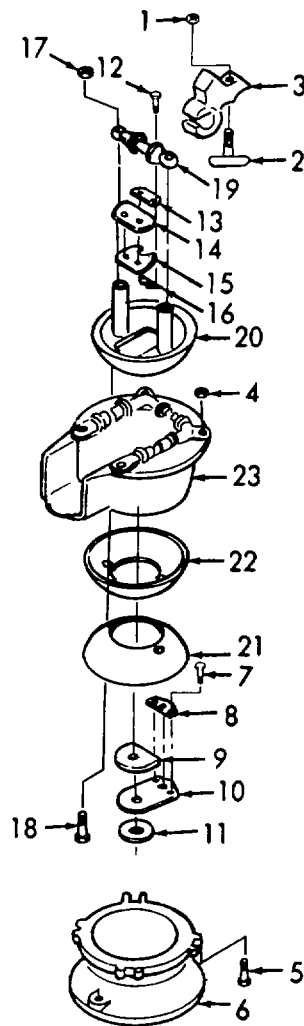


Figure 3-7. Bilge Pump and Piping, Removal/Installation.

b. Disassembly. (Refer to figure 3-8).

- (1) Remove two nuts (1) and bolt (2) and lift lever socket (3) from the pump.
- (2) Remove four nuts (4) and four bolts (5) and remove the pump base (6).
- (3) Remove two screws (7) and separate the lower valve keeper (8), valve weight (9), suction valve (10), and valve washer (11) from the base.
- (4) Remove two screws (12) and separate the upper valve washer (13), valve weight (14), suction valve (15), and valve keeper (16) from the pump.
- (5) Remove two nuts (17) and bolts (18) and remove the cross head (19). Separate top plunger (20), bottom plunger (21), and diaphragm (22) from the pump pot (23).



**Figure 3-8. Bilge Pump, Disassembly/Reassembly.**

**3-10. BILGE PUMP AND PIPING-Continued.**c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

d. Inspection.

- (1) Inspect all parts for evidence of wear or damage.
- (2) Examine the neoprene diaphragm for cracks, breaks, or evidence of wear.

e. Repair. Repair of the bilge pump is accomplished by the replacement of defective parts.f. Reassembly.

- (1) Refer to figure 3-8 and assemble the plunger bottom (21), diaphragm (22), top plunger (20), and cross head (19) in the pump pot (23). Secure with two bolts (18) and two nuts (17).
- (2) Assemble the upper valve keeper (16), suction valve (15), valve weight (14), and valve washer (13). Secure with two screws (12).
- (3) Assemble the lower valve washer (11), suction valve (10), valve weight (9), and valve keeper (8). Install the assembly in the pump base with two screws (7).
- (4) Fasten the upper pump to the base (6) with four bolts (5) and four nuts (4).
- (5) Install lever socket (3) on the pump and secure with bolt (2) and two nuts (1).

g. Installation.

- (1) Refer to figure 3-7 and assemble the two elbows (8), five pipes (7), and two unions (6).
- (2) Install the foot valve (5) on the lower end of the pipe line.
- (3) Affix gasket (4) to the bilge pump mounting flange and secure the pump (3) to the pipe line with two bolts (2) and two nuts (1).

## Section VI. MAINTENANCE OF HYDRAULIC START SYSTEM

	Para.		Para.
Accumulator .....	3-13	Hydraulic Pump.....	3-12
Cranking Motor .....	3-11	Reservoir, Hydraulic.....	3-14

**3-11. CRANKING MOTOR.****This task covers:**

- |                |             |               |           |
|----------------|-------------|---------------|-----------|
| a. Disassembly | b. Cleaning | c. Inspection | d. Repair |
| e. Reassembly  |             |               |           |

**INITIAL SET-UP:**Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

Materials Required:

Cloth, Emery (Item 7, Appendix C)  
Seal P/N GA100104  
Seal P/N GA100088  
Seal P/N RG1136  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N WA6-10BL  
Washer, Lock P/N WA6-8BL

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Cranking motor removed (paragraph 3-11, TM 55-1930-208-10).

### 3-11. CRANKING MOTOR- Continued.

a. Disassembly. (Refer to figure 3-9).

- (1) Clamp cranking motor in a vise.
- (2) Remove four screws (1), four lockwashers (2), and remove housing (3) and flange (4).
- (3) Remove two screws (5) and plate (6).
- (4) Insert a flat tip screwdriver in housing opening and move anchor plate of starting drive (8) toward the pinion gear to uncover setscrew (7). Loosen setscrew (7) and slide starting drive (8) off shaft (21). Remove two keys (9) from shaft.

#### NOTE

Before removing port plate (12), use a small punch and put indexing mark on port plate and housing.

- (5) Remove eight screws (10), eight lockwashers (11), and port plate (12).
- (6) Remove barrel assembly (13) front shaft (21). Remove pistons (14) from barrel assembly (13).
- (7) Using retaining ring pliers, remove retaining ring (15) and spring (16) from barrel assembly (13).
- (8) Using retaining ring pliers, remove retaining ring (17), seal (18), seal (19), and seal (20). Discard all seals.
- (9) Place housing and shaft in an arbor press and press shaft (21) out of housing (22) from port plate end.
- (10) Remove seal holder (23) from shaft (21). Remove spiral ring (24) and press bearing (25) from shaft (21).
- (11) Place housing in an arbor press and press needle bearing (26) from housing (3).

#### CAUTION

Do not apply excessive heat, damage to port plate will occur.

- (12) Apply even heat to port plate (12). Jar port plate (12) against a wooden block, needle bearing (27) will fall out.

#### CAUTION

Do not apply excessive heat, or damage to housing will occur.

- (13) Apply even heat to housing (22), jar housing against a wooden block, bearing (28) will fall out.
- (14) Remove four drive screws (29) and plate (30).

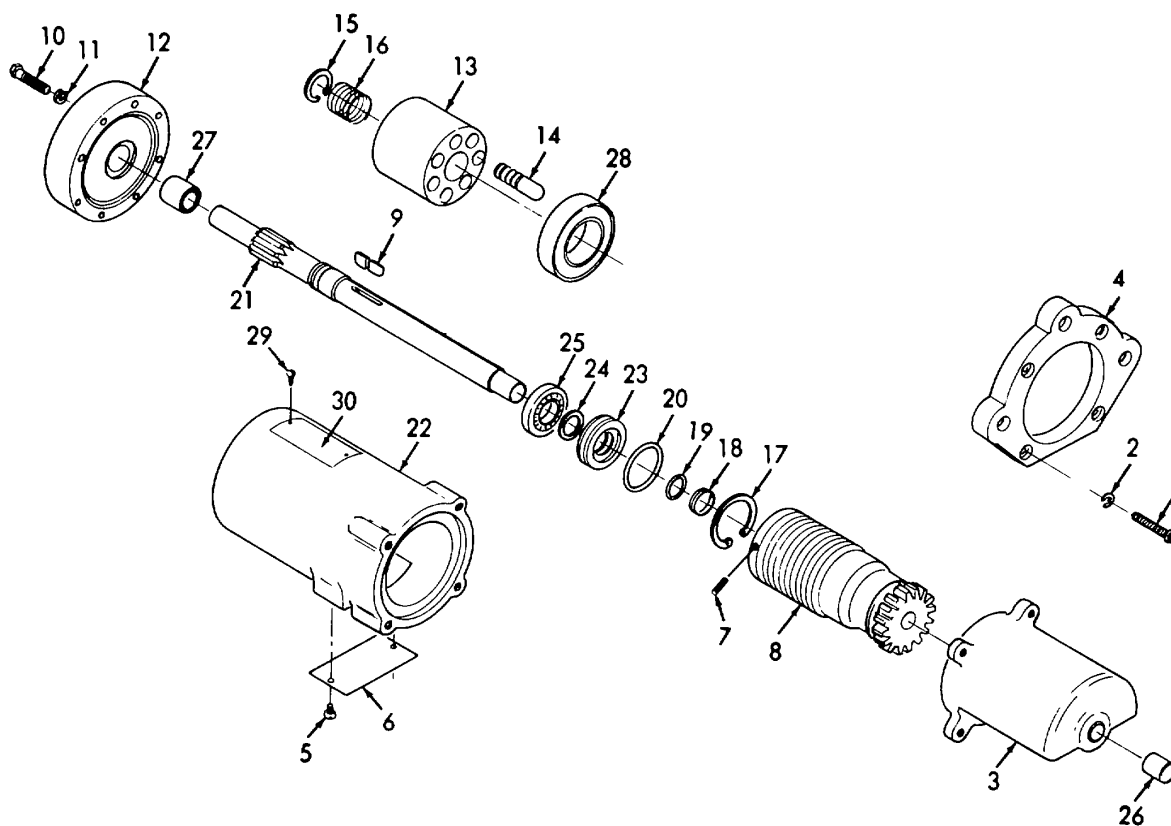


Figure 3-9. Cranking Motor, Disassembly/Reassembly.

**3-11. CRANKING MOTOR-Continued.****b. Cleaning.****WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all metal parts with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

**c. Inspection.**

- (1) Visually check housing for cracks or other damage.
- (2) Examine pinion gear for excessive worn or chipped teeth. Replace a damaged starting drive.
- (3) Inspect port plate face, where barrel rides, to insure it is smooth and free of scoring. Slight scuff marks can be removed by using fine grit emery cloth (item 7, Appendix C).
- (4) Inspect ported face of barrel for scratching or scoring. Slight scuff marks can be removed by using fine grit emery cloth (item 7, Appendix C).
- (5) Inspect seal holder for cracks or damage.

**d. Repair. Repair is limited to replacement of defective parts.****e. Reassembly.**

- (1) Refer to figure 3-9 and install plate (30) and secure with four drive screws (29).
- (2) Using an arbor press, press bearings (28), (27), and (26) in their respective housings.
- (3) Using an arbor press, press bearing (25) on shaft (21). Install spiral ring (24). Press shaft (21) into housing (22).

**NOTE**

Recessed side of seal holder should be next to bearing (25).

- (4) Install seal holder (23) and seals (20) through (18). Using retaining ring pliers, install retaining ring (17).

- (5) Position spring (16) in barrel assembly (13). Using retaining ring pliers, install retaining ring (15). Install pistons (14) in barrel assembly (13).
- (6) Line up splines and install barrel assembly (13) on shaft (21).
- (7) Position port plate (12) on housing (22) and secure with eight lockwashers (11) and eight screws (10). Tighten screws alternately and pull port plate (12) evenly. Torque screws to 150 in-lbs (16.94 Nm).
- (8) Install key (9) and starting drive (8) on shaft (21). Tighten screw (7).
- (9) Install plate (6) and secure with two screws (5).
- (10) Install flange (4) and housing (3) and secure with four lockwashers (2) and four screws (1).

### 3-12. HYDRAULIC PUMP.

---

#### **This task covers:**

- |                |             |               |           |
|----------------|-------------|---------------|-----------|
| a. Disassembly | b. Cleaning | c. Inspection | d. Repair |
| e. Reassembly  |             |               |           |
- 

#### **INITIAL SET-UP:**

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Gasket P/N GA1129-1  
 Gasket P/N GA1129-2  
 Gasket P/N GA1129-4  
 Gasket P/N GA1129-5  
 Gasket P/N GA1129-7  
 Gasket P/N GA202082  
 Ring P/N RG1138  
 Ring P/N RG100157  
 Seal, Oil P/N SE100082  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock P/N WA5-10CA  
 Washer, Lock P/N WA6-10CA

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Hydraulic pump removed (paragraph 3-12, TM 55-1930-208-10).

---

**3-12. HYDRAULIC PUMP -Continued.**a. Disassembly. (Refer to figure 3-10).

- (1) Remove key (1) from shaft (33).
- (2) Remove plug (2), O-ring (3), spring (4), and ball (5) from housing (6).
- (3) Remove cap (7), adjusting screw (8), spring (9), valve seat (10), ball (11), and valve seat (12) from housing (6).
- (4) Remove adapter (13), O-ring (14), O-ring (15), inlet valve (16), and spring (17) from housing (6).
- (5) Remove plug (18) and O-ring (19) from housing (6). Using a ¼ inch diameter brass rod inserted in opposite side, push plunger valve (20) from housing (6). Remove and discard back-up ring (21), O-ring (22), and back-up ring (23) from plunger valve (20).
- (6) Remove plug (24), O-ring (25), spring (26), ball (27), and valve seat (28) from housing (6).
- (7) Remove two screws (29), two lockwashers (30), and mounting flange assembly (31) from housing (6). Remove and discard O-ring (32).
- (8) Remove shaft (33), bearing (34), and washer (35). Remove piston (36) and ring (37) as an assembly.
- (9) Remove washer (38). Press oil seal (39) and bearing (40) front mounting flange assembly (31) using an arbor press.

**NOTE**

The carrier bearing (41) should only be removed if it is damaged.

- (10) Using a puller, remove bearing (41) from housing (6).

**NOTE**

Sleeve (42) has been shrink fitted into the housing. It is not replaceable.

- (11) Remove four screws (43), four lockwashers (44), setscrew (45), shaft (46), seal (47), and gasket (48) from housing (49).
- (12) Remove four screws (50) and four lockwashers (51). Remove balance shaft nut and remove flange (52).

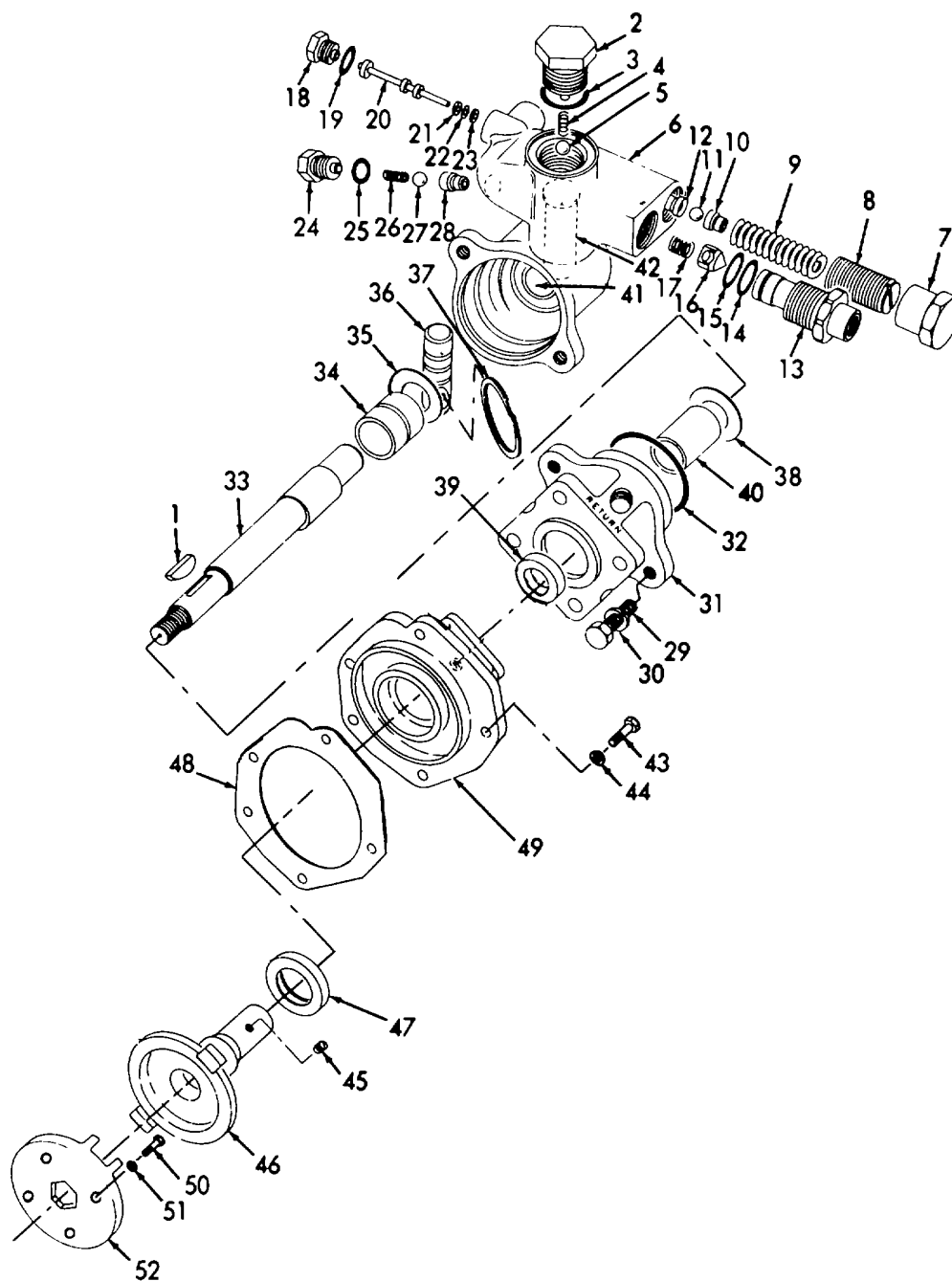


Figure 3-10. Hydraulic Pump, Disassembly/Reassembly.

**3-12. HYDRAULIC PUMP-Continued.**b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all metal parts with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

c. Inspection.

- (1) Inspect housing (6) for cracks or other visual damage. Check threads for damage. Check valve seats (12 and 28) for damage or scores. The bore of the sleeve (42) must be smooth with no scratches or scoring.
- (2) Inspect bearings (34, 40, and 41) to be sure that they are free and turn smoothly. Check throw bearing (34) to be sure O. D. is not galled or has not picked up metal from end of piston (36).
- (3) Inspect shaft (33) to be sure that it is free of burrs. There should be no indications of wear at bearing journals. Check to be sure that keyway is not broken out or rounded over, due to coupling having been loose or an improper fit.
- (4) Inspect piston (36) to be sure it fits freely in bore of sleeve and be free of scratches or scoring. Also, the bleed hole must be free of all contamination.
- (5) Inspect balls (5, 11, and 27) and their seats for damage or scoring.
- (6) Inspect springs (4, 9, 17, and 26) to be sure that they are not bent or deformed. Check for signs of chaffing.
- (7) Replace O-rings (3, 15, 19, 22, 25, and 32) and oil seal (39).

d. Repair. Repair is limited to replacement of defective parts found during inspection.e. Reassembly.

- (1) Refer to figure 3-10 and position flange (52) on camshaft gear and secure with four lockwashers (51) and four screws (50).
- (2) Install seal (47) and shaft (46) in housing (49). Install setscrew (45). Position assembled housing (49) and gasket (48) on the engine and secure with four lockwashers (44) and four screws (43).

- (3) Press bearing (41), into housing (6), using an arbor press.
- (4) Place mounting flange assembly on a pair of parallel blocks, on an arbor press with bearing side up. Apply a light coat of grease (item 11, Appendix C) on the outside diameter of the bearing. Making certain that the bearing (40) is squarely started in the bore, proceed to press the bearing into the bore until it is flush with the mounting flange assembly surface.
- (5) Turn the flange over. Start the oil seal (39) into the bore making certain that it enters squarely. Note should be taken at this time that the garter spring in the seal is facing in the direction of the bearing. Press the seal into the bore to a depth of  $\frac{1}{4}$  inch below the surface of the flange.
- (6) Install two retaining rings (37) on piston (36). Be sure retaining rings do not overlap each other. Coat piston (36) with oil (item 8, Appendix C) and slide piston (36) with retaining rings into sleeve (42).

#### NOTE

Bleed hole in piston must be facing the inlet port.

- (7) Install bearing (34) and washer (35) on shaft (33). Install assembled shaft (33) into housing (6), making sure shaft (33) has entered bearing (41) freely.
- (8) Install washer (38) on shaft (33). Place the pump on a bench with the drive shaft facing upward. Be certain that the woodruff key and any nuts and washers are not attached to the drive shaft at this time. At this point check to see that washer (38) is in place. Next, insert the mounting flange assembly (31) and O-ring gasket (32) over the drive shaft. Install lockwasher (30) and screw (19) and tighten.
- (9) Install valve seat (28), ball (27), spring (26), O-ring (25), and plug (24) in housing (6).
- (10) Install back-up ring (23), O-ring (22), and back-up ring (21) on plunger valve (20). Install plunger valve (20) into housing (6). Install O-ring (19) and plug (18).
- (11) Install spring (17), inlet valve (16), O-ring (15), O-ring (14), and adapter (13) into housing (6).
- (12) Install valve seat (12), ball (11), valve seat (10), spring (9), and adjusting screw (8) into housing (6). Install cap (7) loosely until final pressure adjustment is obtained.
- (13) Install ball (5), spring (4), O-ring (3), and plug (2) into housing (6).
- (14) Install key (4) on shaft (23).

**3-12. HYDRAULIC PUMP-Continued.**

e. Reassembly-Continued.

(15) Refer to TM 55-1930-208-10, paragraph 3-12 and install the pump.

**3-13. ACCUMULATOR.****This task covers:**

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

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Cloth, Crocus (Item 5, Appendix C)  
Gasket P/N GA100117  
Gasket P/N GA100475  
Oil, Lubricating (Item 12, Appendix C)  
Ring P/N RG100155  
Ring P/N RG203187-1  
Seal P/N GA1128-9  
Seal P/N SE202992-27  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46  
Washer, Lock P/N WA6-16

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

a. Removal. (Refer to figure 3-11).

- (1) Remove cap (1) and loosen locknut (2) on valve assembly until all gas escapes.
- (2) Remove hoses (3 and 4). Remove adapter (5), elbow (6), tee (7), and adapter (8).
- (3) Remove four screws (9), four clamps (10), and accumulator (11).
- (4) Remove four nuts (12), four lockwashers (13), four screws (14), and bracket (15).

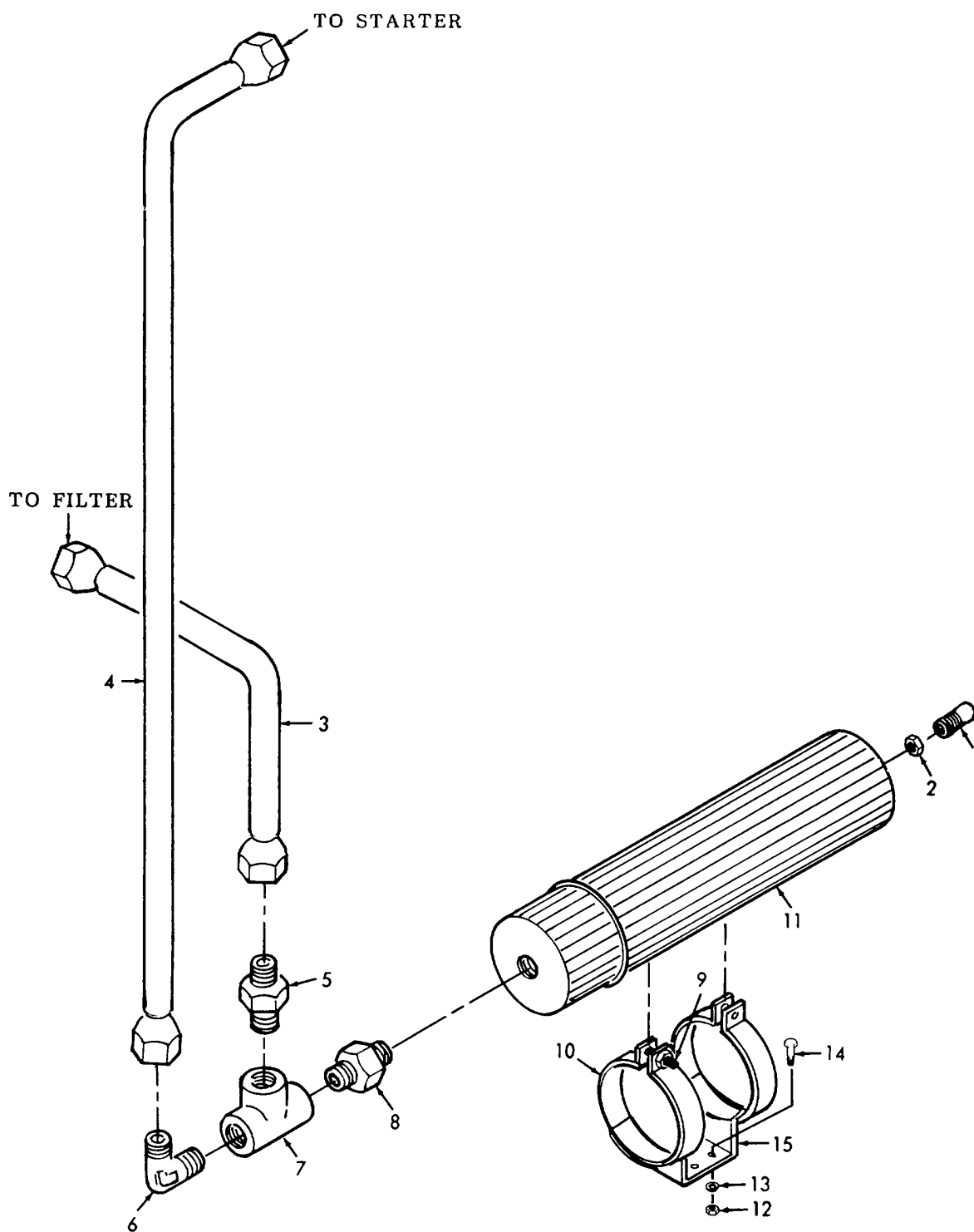
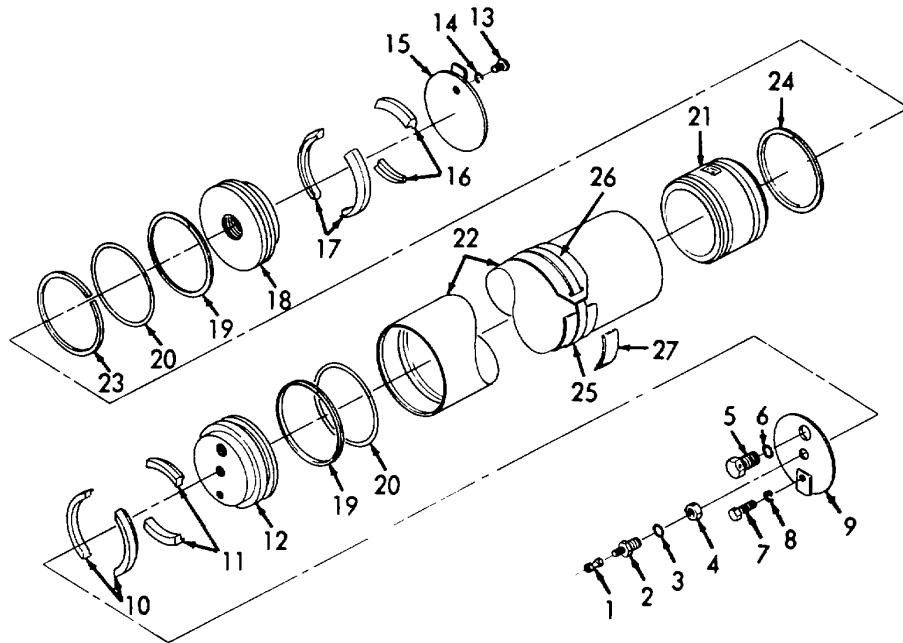


Figure 3-11. Accumulator, Removal/Installation.

**3-13. ACCUMULATOR-Continued.****b. Disassembly.** (Refer to figure 3-12).

- (1) Remove cap (1), valve assembly (2), gasket (3), and nut (4).
- (2) Remove fuse assembly (5) and gasket (6).
- (3) Place accumulator in a pipe vise and remove screw (7), lockwasher (8), and plate (9).
- (4) Screw ½-20 screw into air valve port and push end cap (12) away from ring segments (10 and 11). Remove ring segments (10 and 11) and pull out end cap (12). Leave screw in end cap for reassembly.
- (5) Remove screw (13), lockwasher (14), and plate (15).
- (6) Screw ½-20 screw into air valve port and push end cap (18) away from ring segments (16 and 17). Remove ring segments (16 and 17) and pull out end cap (18).
- (7) Remove two packings (19) and two seals (20) from end caps (12 and 18).
- (8) Use a wooden dowel and push piston (21) from housing (22).
- (9) Remove ring (23) and seal (24).
- (10) Remove clip (25), strap (26), and name plate (27).

**Figure 3-12. Accumulator, Disassembly/Reassembly.**

c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean end caps and piston with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

d. Inspection.

- (1) Inspect bore of housing for scratches. The bore must be free of scratches. Minor scratches may be polished out with fine crocus cloth (item 5, Appendix C).
- (2) Inspect piston for scratches or scoring. Replace a damaged piston.
- (3) Inspect threads and valve seat on valve assembly, replace if damaged.

e. Repair. Repair is limited to replacing damaged components.f. Reassembly.

- (1) Refer to figure 3-12 and install name plate (27) on housing (22) and secure with strap (26) and clip (25).
- (2) Lubricate seal (24) with oil (item 12, Appendix C) and install seal (24) and ring (23) on piston (21).
- (3) Lubricate inside of housing (22) with a light coat of oil (item 12, Appendix C). Carefully insert the piston (21) into the housing bore with the closed end first. Once piston has entered housing, push it half way down.
- (4) Install two packings (19) and two seals (20) on end caps (18 and 12). Slide oil end cap (18) into the housing.
- (5) Install ring segments (17 and 16) and hold in place. Push piston (21) against oil end cap (18). Install plate (15) and secure with lockwashers (14) and screw (13).
- (6) Install gas end cap (12). Install ring segments (11 and 10) and hold in place. Push end cap (12) into position, by using a wooden dowel through the oil end cap (18). Install plate (9) and secure with lockwasher (8) and screw (7).
- (7) Install gasket (6) and fuse assembly (5). Torque to 20-25 ft-lb (2.26 - 2.83 N).

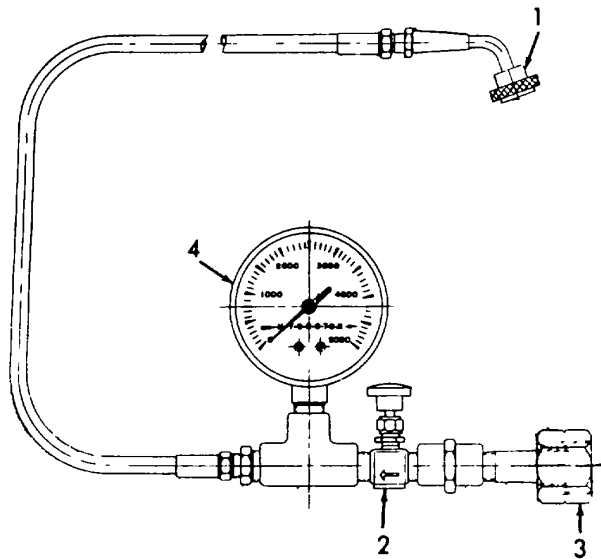
**3-13. ACCUMULATOR-Continued.**f. Reassembly-Continued.

- (8) Install nut (4), gasket (3), valve assembly (2), and cap (1). Torque to 45-50 ft-lb (5.08-5.65 N).
- (9) Before attaching chuck (1, figure 3-13) to valve assembly on accumulator, be sure valve (2) is in the closed position. Valve is closed when handle is turned clockwise.

**WARNING**

Nitrogen is flammable and can burn skin and irritate eyes. Eye and skin protection are required. Use only in a well-ventilated area, away from open flames.

- (10) Connect nut (3) to nitrogen tank and tighten.
- (11) Open valve (2) and slowly open valve on nitrogen tank to allow gas to flow into the accumulator, closing occasionally to allow needle on gauge (4) to settle in position. The accumulator is fully charged when 1500 psi is indicated on gauge (4).



**Figure 3-13. Accumulator Charging Set-Up.**

g. Installation.

- (1) Refer to figure 3-11 and install accumulator (11) with four clamps (10) and four screws (9).

(2) Install adapter (8), tee (7), elbow (6), and adapter (5). Install two hoses (4 and 3).

(3) Install cap (1) and tighten locknut (2).

### 3-14. RESERVOIR, HYDRAULIC.

---

**This task covers:**

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

**INITIAL SET-UP:**

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Washer, Lock P/N MS35338-46

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Lines and fitting disconnected (paragraph 3-13).

---

a. Removal. (Refer to figure 3-14).

(1) Remove reducer (1) and filter element (2).

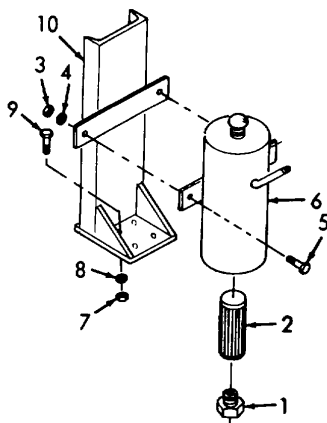
(2) Remove two nuts (3), two lockwashers (4), and two bolts (5) and remove the reservoir (6) from the mounting bracket.

(3) Remove four nuts (7), four lockwashers (8), and four bolts (9) securing the mounting bracket (10).

b. Service. Service is limited to replacing filter element (2).

**3-14. RESERVOIR, HYDRAULIC-Continued.****c. Installation.**

- (1) Refer to figure 3-14 and secure the reservoir mounting bracket (10) to the frame with four bolts (9), four lockwashers (8), and four nuts (7).
- (2) Install reservoir (6) on the mounting bracket using two bolts (5), two lockwashers (4), and two nuts (3).
- (3) Install the filter element (2) and reducer (1) in the reservoir.
- (4) Attach the hydraulic line and fittings (paragraph 3-13) and fill the reservoir.



**Figure 3-14. Hydraulic Reservoir, Removal/Installation.**

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**Section VII. MAINTENANCE OF ENGINE**

	<b>Para.</b>		<b>Para.</b>
Balance Weights .....	3-41	Head, Cylinder .....	3-39
Blower .....	3-19	Injector, Fuel .....	3-22
Blower Drive .....	3-20	Intake, Air Cleaner Assembly .....	3-18
Camshaft and Balance Shaft .....	3-33	Manifold, Exhaust .....	3-42
Controls, Fuel Injector .....	3-35	Manifold, Water .....	3-27
Controls, Rocker Arm .....	3-3	Oil Pressure Regulator .....	3-466
Cooler, Lubrication Oil .....	3-23	Oil Pump .....	3-47
Cover, Balance Weight .....	3-	Panel, Instrument .....	3-4831
Cover, Rocker Arm .....	3-3	Pan, Oil .....	3-384
Crankshaft Pulley and Damper .....	3-21	Pump, Fuel .....	3-30
Engine, Diesel .....	3-15	Pump, Water .....	3-24
Engine Lifting Brackets .....	3-3	Radiator .....	3-262
Fan Belts .....	3-25	Tachometer .....	3-29
Flywheel .....	3-44	Thermostat and Housing .....	3-28
Flywheel Housing .....	3-45	Throttle Controls .....	3-16
Gear Train Idler Gear .....	3-4	Valve Operating Mechanism .....	3-373
Governor .....	3-17	Valves, Intake and Exhaust .....	3-40

**3-15. ENGINE, DIESEL.****This task covers:****a. Removal****b. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

Washer, Lock P/N MS35338-48

Washer, Lock P/N MS35338-145

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Coupler disconnected (paragraph 3-52).

Fan guard removed; radiator drained; hoses disconnected (paragraph 3-26).

Exhaust fan belt removed (paragraph 3-7).

Engine shutdown cable disconnected (paragraph 3-6).

Exhaust pipe removed (paragraph 3-9).

Hydraulic reservoir lines and fittings removed (paragraph 3-14).

Fuel lines disconnect (paragraph 3-16, TM 55-1930-208-10).

Ether starting aid disconnected (paragraph 3-23, TM 55-1930-208-10).

**3-15. ENGINE, DIESEL - Continued.****a. Removal.** (Refer to figure 3-15).

- (1) The size of the machinery house door will allow entry of a suitable lifting device to aid in the removal of the engine.
- (2) Keeping in mind that the engine will have to be rotated to remove it through the door, connect a spreader bar with a suitable sling and adequate chain hoist to the engine lifter brackets. To prevent binding of the engine lifter brackets the lifting device should be adjusted so the lifting hooks are vertical. To ensure proper weight distribution, all engine lifter brackets should be used to lift the engine.
- (3) Remove two front engine mounting nuts (1), two lockwashers (2), two bolts (3), and two spacers (4).
- (4) Remove four nuts (5), four lockwashers (6), four bolts (7), and four flat washers (8) securing the rear engine support to the frame.
- (5) Remove eight screws (9) and eight lockwashers (10) securing the two rear engine supports (11) to engine (12).
- (6) Lift the engine off the frame and remove from the machinery house.

**b. Installation.**

- (1) Keeping in mind that the engine must be rotated after entering the machinery house, connect a suitable sling and adequate chain hoist to the engine lifter bracket.
- (2) Move the engine into the machinery house and position it over the frame. Attach the rear engine supports (11) to engine (12) with eight lockwashers (10) and eight screws (9).
- (3) Lower the engine onto the frame. Secure the rear engine supports to the frame using four bolts (7), four flat washers (8), four lockwashers (6), and four nuts (5).
- (4) Secure the front of the engine to the frame using two spacers (4), two bolts (3), two lockwashers (2), and two nuts (1).
- (5) Connect ether starting aid (paragraph 3-23, TM 55-1930-208-10) and fuel lines (paragraph 3-16, TM 55-1930-208-10).
- (6) Connect hydraulic reservoir lines and fittings (paragraph 3-14).
- (7) Install exhaust pipe (paragraph 3-9), attach engine shutdown cable (paragraph 3-6), and install exhaust fan belt (paragraph 3-7).
- (8) Connect radiator hoses; install fan guard; and fill radiator with coolant (paragraph 3-26).
- (9) Connect coupler (paragraph 3-52).

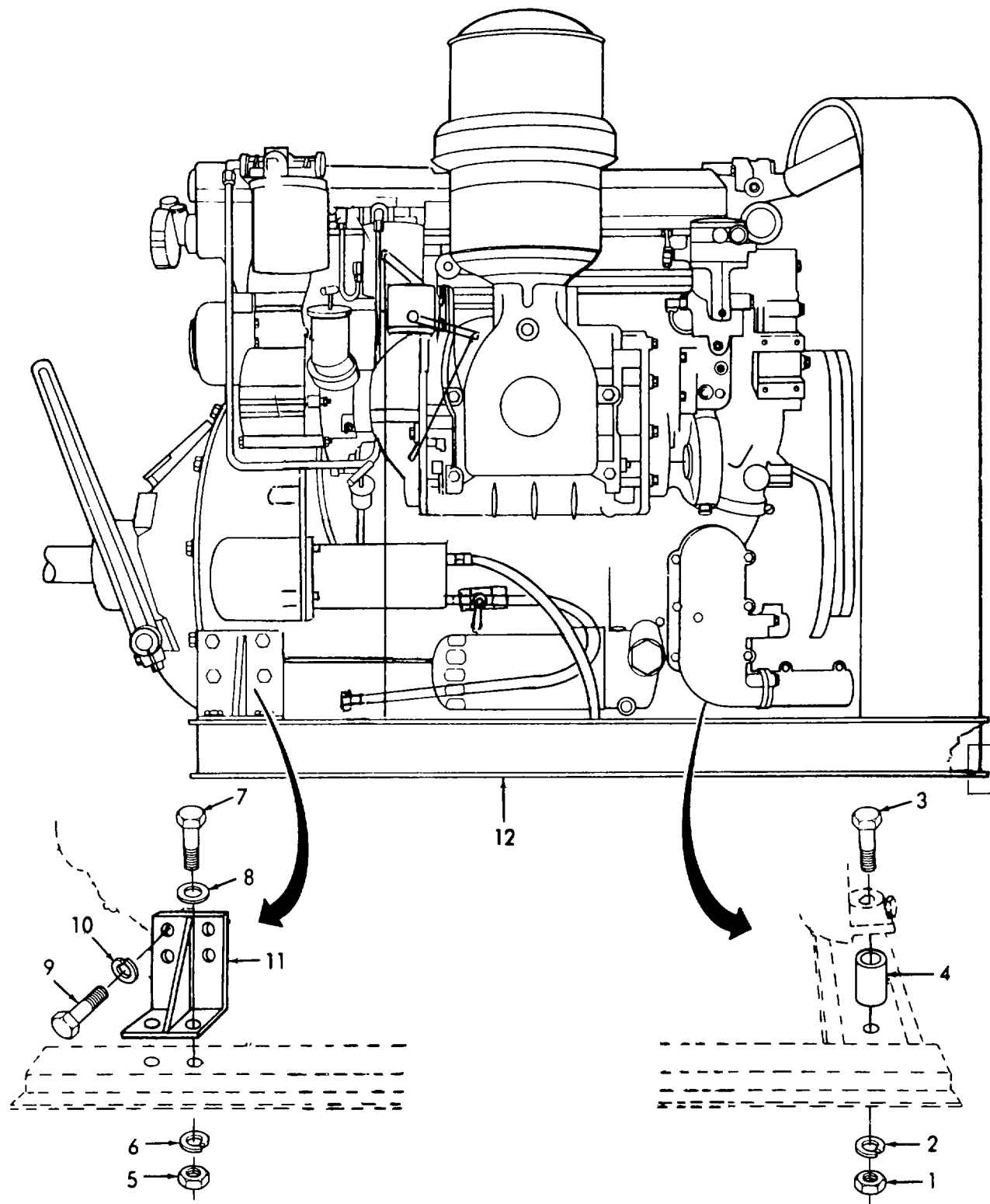


Figure 3-15. Diesel Engine, Removal/Installation.

**3-16. THROTTLE CONTROLS.****This task covers:****a. Removal****b. Repair****d. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

Pin, Cotter P/N MS24665-170

Washer, Lock P/N 120380

Washer, Lock P/N MS35338-44

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

**a. Removal. (Refer to figure 3-16).**

- (1) Remove bolt (1) and lockwasher (2) securing lever (3).
- (2) Remove pin (4), washer (5), spring (6), and control knob (7) from shaft (8).
- (3) Loosen two set-screws (9) and remove the shaft coupling (10).
- (4) Remove nut (11), lockwasher (12), and screw (13) securing control lever (14) to the governor shaft.
- (5) Remove two cotter pins (15) and remove two clevis pins (16) securing control link (17).
- (6) Remove nut (18), lockwasher (19), and screw (20) securing control lever (21) to control shaft (22).

**b. Repair. Throttle control repairs are limited to the replacement of defective parts.****c. Installation.**

- (1) Secure the control lever (21) to control shaft (22) using screw (20), lockwasher (19), and nut (18).
- (2) Attach control link (17) between the control levers with two clevis pins (16). Secure the clevis pins with two cotter pins (15).
- (3) Attach control lever (14) to the governor shaft with screw (13), lockwasher (12), and nut (11).

- (4) Install the shaft coupling (10) and tighten set-screws (9).
- (5) Attach control knob (7) to shaft (8) using spring (6), flat washer (5), and pin (4).
- (6) Secure lever (3) to the shaft with lockwasher (2) and bolt (1).

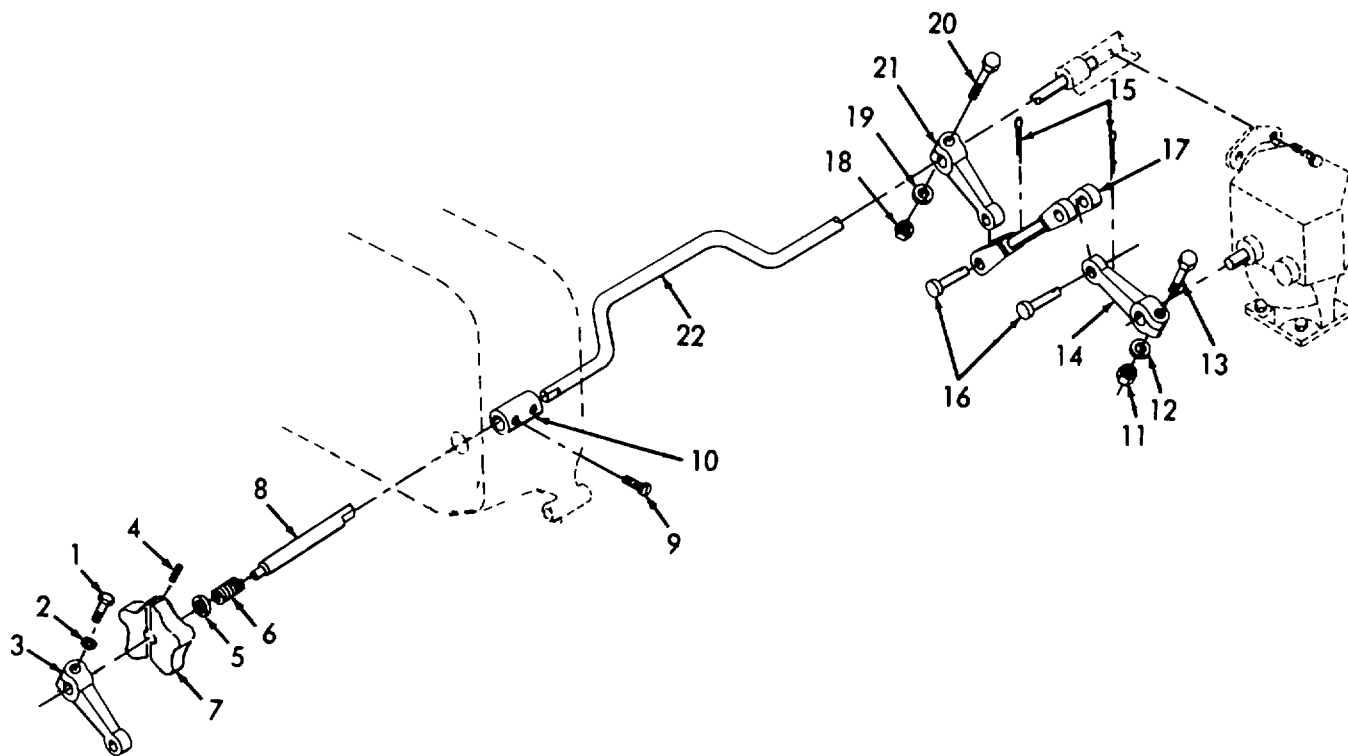


Figure 3-16. Throttle Controls, Removal/Installation.

**3-17. GOVERNOR.**


---

**This task covers:**

- |                        |                       |                      |
|------------------------|-----------------------|----------------------|
| <b>a. Removal</b>      | <b>b. Disassembly</b> | <b>c. Cleaning</b>   |
| <b>d. Inspection</b>   | <b>e. Repair</b>      | <b>f. Reassembly</b> |
| <b>g. Installation</b> | <b>h. Adjustment</b>  |                      |
- 

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Compound, Sealing (International Compound No. 2, Item 13, Appendix C)  
 Gasket P/N 3224773  
 Gasket P/N 3249110  
 Gasket P/N 5150246  
 Gasket P/N 5169866  
 Gasket P/N 5197066  
 Oil, Lubricating (Item 12, Appendix C)  
 Pin, Cotter P/N 103373  
 Seal P/N 249112  
 Seal P/N 3307753  
 Seal P/N 5197065  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock P/N MS35333-39  
 Washer, Lock P/N MS35338-44  
 Washer, Lock P/N MS35338-45  
 Washer, Lock P/N 120217

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Valve rocker cover removed (paragraph 3-36).  
 Fuel rod disconnected from fuel injector control tube (paragraph 3-39).  
 Throttle control lever disconnected (paragraph 3-16).

---

**a. Removal. (Refer to figure 3-17).**

- (1) Disconnect the oil inlet tube assembly (1) from the governor oil inlet plug.
- (2) Remove five cover screws (2), then lift the governor cover (3) and gasket (4) from the governor housing. Remove the two sub-caps to cylinder head bolts (5).
- (3) Refer to figure 3-18 and remove the two sub-cap retaining screws and lockwashers.

- (4) Lift up on the sub-cap assembly until a definite snap indicates that the fuel rod and collar have been freed from the terminal lever cross pin. Then, remove the sub-cap assembly, pulling the fuel rod out of the hole in cylinder head and throttle control rod mounting bracket.
- (5) Remove four bolts (6, figure 3-17) and four lockwashers (7) and lift the governor housing (8) away from the drive housing. Remove governor housing gasket (9).
- (6) Remove six drive housing bolts (10) and six flat washers (11) and separate the drive housing (12) from the blower. Remove drive housing gasket (13).

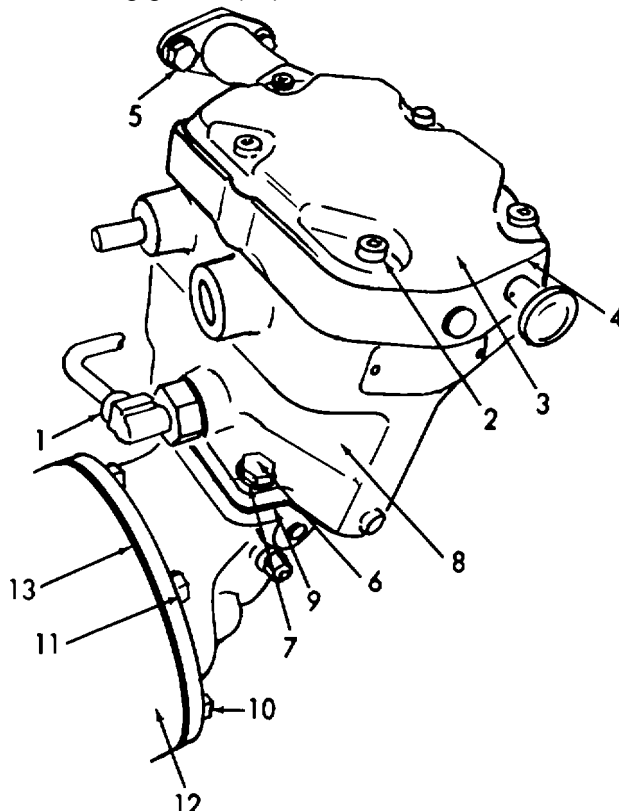


Figure 3-17. Governor, Removal/Installation

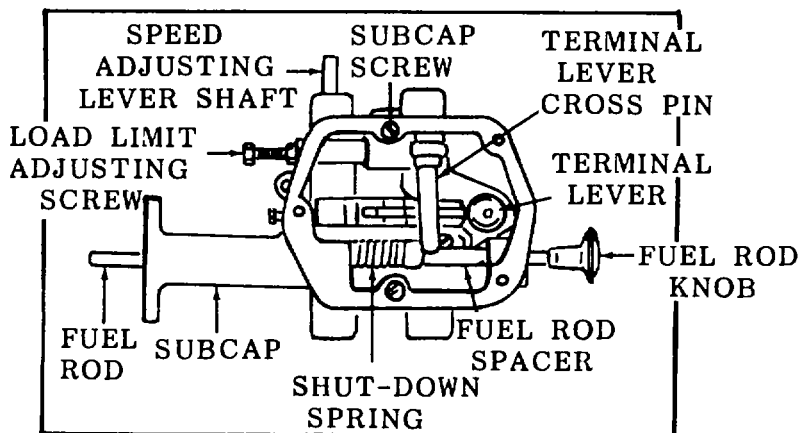


Figure 3-18. Top View of Governor with Cover Removed.

**3-17. GOVERNOR - Continued.**

- b. Disassembly. (Refer to figure 3-19).

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Before removing any parts from the governor, wash the unit thoroughly in cleaning solvent (item 4, Appendix C), and allow unit to dry. Inspect unit for worn or damaged parts that may be repaired or re-placed without completely disassembling the governor.
- (2) Disassemble the governor sub-cap as follows:
  - (a) Loosen the fuel rod knob locknut (1) and remove knob (2) and nut from fuel rod (3).
  - (b) Pull the spacer (4) out of the sub-cap and off the fuel rod.
  - (c) Pull the fuel rod out of the sub-cap and remove the fuel rod collar (5), shutdown spring (6), fuel rod disc (7), and the fuel rod spring (8) from the sub-cap.
  - (d) Loosen the load limit adjusting screw locknut (9) and remove the load limit screw (10) and washer (11) from the sub-cap.
  - (e) If necessary, remove the fuel rod oil seal (12) and the sub-cap plug (13) from the sub-cap.
  - (f) Examine the fuel rod bushing (14) in the sub-cap (15). If worn or damaged, press it out of the sub-cap with an arbor press.
- (3) Clamp the governor housing and base assembly (figure 3-20) in a bench vise equipped with soft jaws.
  - (a) Remove sub-cap to housing gasket (1).
  - (b) Loosen the maximum speed adjusting screw locknut (2) and remove the adjusting screw (3) and flat washer (4) from the governor housing.
  - (c) Remove the speed adjusting lever roll spring pin (5) from the speed adjusting lever and the lever shaft using a small punch and hammer.

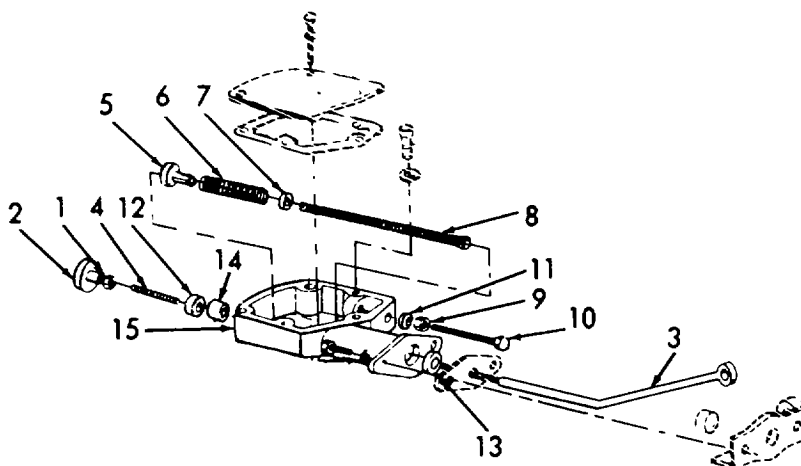


Figure 3-19. Governor Sub-cap, Disassembly/Reassembly.

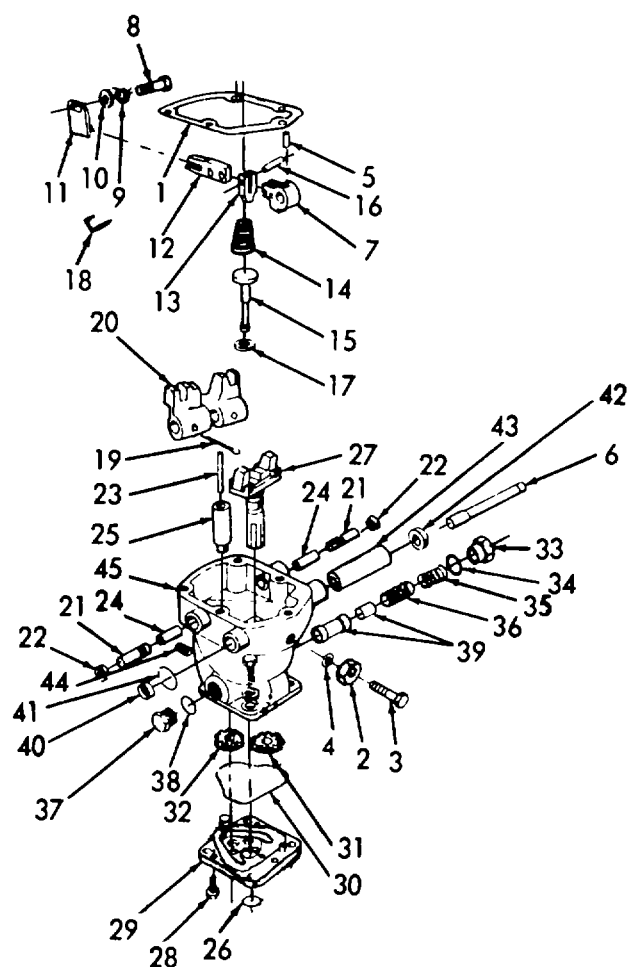


Figure 3-20. Governor Housing and Base, Disassembly/Reassembly.

**3-17. GOVERNOR- Continued.**b. Disassembly - Continued.**NOTE**

Record the position of the groove in the outside diameter of the speed adjusting lever shaft (6) to ensure the groove will be installed in the same position at the time of assembly.

- (d) Pull the speed adjusting lever shaft (6) out of the speed adjusting lever (7) and governor housing.
- (e) Remove the speed droop adjusting bracket screw (8), lockwasher (9), and flat washer (10). Remove the droop adjusting bracket (11) from the speed adjusting floating lever (12).
- (f) Lift the speed adjusting lever, floating lever spring fork (13), spring fork speeder spring (14) and pilot valve plunger (15) as an assembly from the governor housing.
- (g) Remove the pilot valve plunger thrust bearing (17) and the roll spring pin (16) from the governor housing.
- (h) If necessary, the speed adjusting lever (7), floating lever (12), spring fork (13), speeder spring (14), and pilot valve plunger and spring seat assembly may be disassembled as follows:
  - (1) Straighten the bent end of the wire pin (18) securing the speed adjusting lever and spring fork to the speed adjusting floating lever.
  - (2) Pull the pin out of the speed adjusting lever, floating lever and spring fork, with a pair of pliers.
  - (3) Insert a small screw driver between the spring and fork and pry the speeder spring from the spring fork.
  - (4) Work a small screw driver around under the speeder spring, and remove the spring from the pilot valve plunger and spring seat assembly.
    - (i) Remove the two cotter pins (19) securing the terminal lever (20) to the terminal lever shafts (21).
    - (j) Place a 1/4 inch brass rod approximately 5 inches long against the inner end of the terminal lever shaft; then drive the governor housing cup plug (22) out of the boss at each side of the housing.

**CAUTION**

Use care when removing the cup plugs; do not damage the serration inside the terminal lever with the brass rod.

- (k) Push the terminal lever shafts out of the terminal lever and housing with the brass rod. Then, lift the terminal lever out of the housing.
- (l) Remove the terminal lever to power piston pin (23) from the piston.
- (m) Remove the two terminal lever shaft bushings (24) from the housing.
- (4) Remove the governor housing from the bench vise. Turn the governor upside down and remove the power piston (25) from the housing.

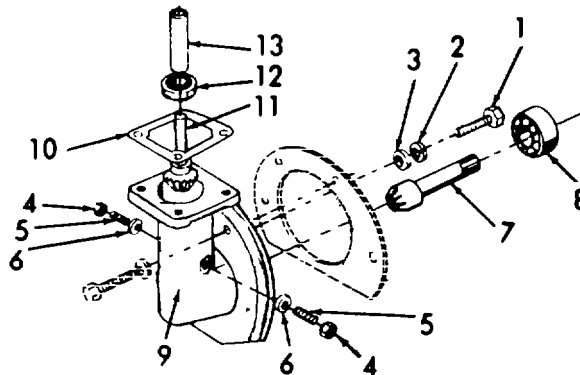
**NOTE**

It may be necessary to tap the face of the governor housing lightly against a wood block to jar the piston out of the housing.

- (5) Place the housing, bottom side up, on a bench.
  - (a) Remove the lock ring (26) from the groove in the shaft of the governor weight (27) with a pair of snap ring pliers; then remove the weight from the housing.
  - (b) Remove the three screws (28) securing the governor base (29) to the governor housing. Tap the edge of the base lightly with a plastic hammer to loosen it; then, remove the base and seal ring (30) from the governor housing.
  - (c) Remove the oil pump drive gear (31) and driven gear (32) from the housing.
- (6) Clamp the bottom (square portion) of the governor housing between the soft jaws of a vise.
  - (a) Remove the oil inlet plug (33), gasket (34), relief valve plunger sleeve retaining spring (35), and relief valve plunger spring (36) from the governor housing.
  - (b) Remove the dummy hole plug (37) and gasket (38) from the opposite side of the governor housing. Insert a small brass rod through the dummy hole opening, and push the relief valve plunger and sleeve (39) out of the housing.
  - (c) If necessary, remove the speed adjusting lever shaft hole plug (40) in the governor housing by inserting a 1/4 inch diameter brass rod through the shaft opening and tap the cup plug out of the housing with a hammer. Remove gasket (41) from the housing.
  - (d) Remove governor speed adjusting lever shaft seal (42) and bushing (43).

**3-17. GOVERNOR - Continued.****b. Disassembly - Continued.**

- (7) Refer to figure 3-21 and disassemble the governor drive assembly.
  - (a) Remove two bearing retaining bolts (1), two lockwashers (2), and two flat washers (3).
  - (b) Remove two nuts (4), two set-screws (5), and two flat washers (6).
  - (c) Withdraw the horizontal drive shaft (7) and bearing (8) as an assembly from the drive housing (9).
  - (d) Separate the housing gasket (10) from the housing.
  - (e) Withdraw driven shaft (11), bearing (12), and sleeve (13) as an assembly from the drive housing.
  - (f) If inspection of bearings (8 and 12) indicates they should be replaced, rest bearing on bed of arbor press and press shaft from bearing, using a brass bar between ram of press and shaft.



**Figure 3-21. Governor Drive Assembly, Disassembly/Reassembly.**

**c. Cleaning.****WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean the governor parts with cleaning solvent (item 4, Appendix C).

- (2) Allow all parts to dry.

d. Inspection.

- (1) Examine the pilot valve plunger and its bore in the ball head for scoring and burrs. If slightly scored, the area may be cleaned up with a fine India stone. Care must be used to prevent rounding off the edges of the plunger.
- (2) Examine the oil pump gears and driven gear bushing for excessive wear and damage.
- (3) Examine the power piston and its cylinder (bore) in the governor housing for scoring and burrs. If slightly scored, the areas may be cleaned up with a fine India stone. Care must be taken to prevent stoning flat areas and round off edges of the piston.
- (4) Examine the ends of the power piston-to-terminal lever pin for wear and scoring. Also, check the pin seats in the terminal lever and power piston for wear and scoring.
- (5) Inspect the ends of the terminal lever cross pin and holes in the terminal lever for wear and scoring.
- (6) Inspect the finished radius (thrust bearing contact surfaces) of the flyweights for excessive wear or flat spots. The flyweights must operate freely on their support pins for satisfactory governor operation.
- (7) Inspect the terminal lever and speed adjusting lever shaft bushings in the governor housing. If scored or worn excessively, the bushings should be replaced.
- (8) Check the speed adjusting lever retracting spring and the shut down and fuel rod springs for fractured coils.
- (9) Examine gear teeth of the drive and driven shafts in the governor drive for chipping or scoring.
- (10) Revolve bearings by hand to check for excessive wear, bind, or rough spots.

e. Repair. Governor repairs are accomplished by the replacement of defective parts.

f. Reassembly.

- (1) After inspection and the necessary replacement parts have been obtained, refer to figure 3-21 and assemble the governor drive assembly.
  - (a) With bearing (8) properly supported on bed of arbor press, press drive shaft (7) into bearing and against shoulder of shaft.

**3-17. GOVERNOR- Continued.**f. Reassembly - Continued.

- (b) Start bearing (12) on driven shaft (11) followed by sleeve (13); then, with sleeve properly supported on bed of arbor press, and using a brass bar between ram and gear, press shaft into bearing and sleeve.
  - (c) Lower driven shaft assembly into governor drive housing from top with bearing resting on shoulder in housing.
  - (d) Start a nut (4) and flat washer (6) on each setscrew (5) and thread screws into the governor housing until they bottom on outer race of bearing.
  - (e) Install the horizontal drive shaft assembly in governor housing with bearing (8) resting in counter-bore provided and with teeth of the horizontal drive gear in mesh with the teeth on the vertical driven gear.
  - (f) Place a lockwasher (2) and flat washer (3) over each bearing retaining bolt (1) and thread bolts into the drive housing to secure bearing.
  - (g) Affix a new gasket (10) to the drive housing (9).
- (2) Refer to figure 3-20 and reassemble the governor housing and base assembly.
- (a) Install pipe plug (44) in housing (45). Install the terminal speed adjusting lever shaft bushing (43) in the housing.
  - (b) Lubricate the two oil pump gears (31 and 32) with engine oil and place them in their respective positions in the governor base (29).
  - (c) Place a new seal ring (30) in the groove in the governor base, with the wide side of the seal down in the groove.
  - (d) Set the governor housing on the base with the dowels in the base registering with the holes in the housing and the idler gear stud in the housing registering with the hole in the idler gear. Press the housing down against the seal ring in the base.

**NOTE**

It is important when installing the driven gear stud that it be installed with the arrow on the stud pointing towards the relief valve side of the governor. Also, that the shaft of the arrow is parallel to a line through the center of the governor and the relief valve.

- (e) Lubricate the outside diameter of the governor weight (27) with engine oil; then insert the end of the weight straight into and through the bore of the governor housing, drive gear, and base.
- (f) Insert the three screws (28) through the base and thread them into the governor housing. Turn the governor weight while tightening the screws to make sure the weight revolves freely. If a bind exists, loosen the screws, tap the sides of the base lightly with a plastic hammer, and tighten the screws again. Revolve the weight again and check for binding. Repeat, if necessary, until all parts rotate freely.
- (g) Install the lock ring (26) in the groove in the shaft of the governor weight with a pair of snap ring pliers.
- (h) Lubricate the outside diameter of the relief valve plunger and sleeve (39) with engine oil. Then, insert the plunger inside the plunger sleeve.
- (i) Place the relief valve plunger spring (36) and the plunger sleeve retaining spring (35) in the housing and against the plunger and sleeve.
- (j) Place a gasket (34) on the oil inlet plug (33), then place the plug over the ends of the springs and thread it into the governor housing.
- (k) Place a gasket (38) on the dummy hole plug (37) and thread it into the opening in the opposite side of the housing.
- (1) Clamp the bottom (square portion) of the governor housing between the soft jaws of a bench vise. Tighten the oil inlet plug and dummy hole plug securely.
- (m) Lubricate the power piston (25) with engine oil; then insert the piston, small end down, straight into the piston bore in the governor housing, and push it in until it bottoms.
- (n) Install the two terminal lever shaft bushings (24) in the housing.
- (o) Lubricate one of the terminal lever shafts (21) with engine oil (item 8, Appendix C). Place the terminal lever (20) in between the ends of the two bushings inside the governor housing; then insert the serrated end of the shaft into the bushing in the housing with the cotter pin holes in the shaft and terminal lever in alignment. Install a cotter pin (19) and bend the ends over against the side of the terminal lever.
- (p) Install the second terminal lever shaft at the opposite side of the governor housing in the same manner.

**3-17. GOVERNOR - Continued.****f. Reassembly - Continued.**

- (q) Apply a thin coat of sealant (item 21, Appendix C) to the outside diameter of new governor housing cup plugs (22). Start the plugs, open end out, straight into the shaft openings; then press the plugs in flush with the outside face of the housing boss.
- (r) Lubricate the terminal lever to power piston pin (23) with engine oil (item 8, Appendix C). Raise the edge of the terminal lever and insert the pin in the hole in the power piston; then lower the terminal lever down on the pin.
- (s) Place the non-slotted end of the speed adjusting floating lever (12) in the slot on the speed adjusting lever shaft (6) so that the pin holes are in alignment. Insert the long end of the speed adjusting lever-to-floating lever wire pin (16) through the pin hole in the speed adjusting lever and floating lever.
- (t) Place the speed adjusting floating lever in the slot of the speed adjusting lever fork (7) with the pin holes in alignment; then insert the short end of the wire pin (18) through the hole in the spring fork and floating lever.
- (u) Push the wire pin in against the speed adjusting lever and spring fork and bend the protruding end of the pin over toward the slotted end of the floating lever.
- (v) Press the lower end of the spring fork (13) into the small end of the speeder spring (14); then insert the opposite end of the spring in the spring seat of the pilot valve plunger (15).
- (w) Lubricate the pilot valve plunger thrust bearing (17) with engine oil (item 8, Appendix C) and place it over the end of the pilot valve plunger with the smallest, outside diameter, bearing race next to the spring seat.
- (x) Lubricate the pilot valve plunger with engine oil (item 8, Appendix C). Hold the thrust bearing against the spring seat and insert the assembly in the governor housing with the speed adjusting lever facing the two bushings inside the housing. Start the pilot valve plunger straight into the bore of the governor weight and push the assembly in until the speed adjusting lever is in position between the two bushings and the thrust bearing is resting on the lip of the flyweights.
- (y) Lubricate the governor speed adjusting shaft (6) with engine oil (item 8, Appendix C). Rotate the shaft so the machined slot in the outside diameter of the shaft is in the same position it was in at the time of removal. Then, insert the shaft in the shaft bushing in the housing, from the oil inlet plug side, with the roll pin hole in the shaft and lever in alignment.

- (z) Start the speed adjusting lever roll (spring) pin (5) straight into the pin hole in the lever; then tap the pin through the lever and shaft until it is flush with the top of the lever.
- (aa) Apply a thin coat of sealant (item 21, Appendix C) to the outside diameter of the speed adjusting lever shaft cup plug (40). Insert the plug, with gasket (41), straight into the boss in the opposite side of governor housing.
- (ab) Apply a thin coat of sealant (item 21, Appendix C) to the outside diameter of the speed adjusting shaft oil seal (42). Place the oil seal, lip of seal facing in, over the end of the speed adjusting shaft and start it in the bore in the housing, then press the seal in flush with the edge of the boss.
- (ac) Place the flat side of the speed droop adjusting bracket (11) against the top (bolting) surface of the terminal lever, with the pin in the bracket in the slot of the speed adjusting floating lever. Secure the bracket to the lever with a flat washer (10), lockwasher (9), and screw (8).
- (ad) Thread lock nut (2) on the maximum speed adjusting screw (3). Place the washer (4) on the adjusting screw, then thread the screw approximately half way in the governor housing.
- (ae) Affix a new gasket (1) to the governor housing.
- (3) Refer to figure 3-19 and reassemble the governor sub-cap.
  - (a) Press a new fuel rod bushing (14) in the sub-cap flush with the bottom of the counter-bore. Then, press a new fuel rod oil seal (12), with the lip of the seal facing out, straight in and against the bottom of the counter-bore in the sub-cap (15).
  - (b) Apply a thin coat of sealant (item 21, Appendix C) to outside diameter of a new governor sub-cap cup plug (13). Start the plug, open end out, straight into the plug opening; then press the plug in against the shoulder in the bore of the sub-cap.
  - (c) Insert the threaded end of the fuel rod (3) through the hole in the cup plug in the projecting end of the sub-cap.
  - (d) Place the large end of the fuel rod spring (8) over the threaded end of the fuel rod and push it in against the cup plug in the sub-cap.
  - (e) Place the fuel rod disc (7), large outside diameter end first, over the threaded end of the fuel rod and against the fuel rod spring.
  - (f) Place the shut down spring (6) over the end of the fuel rod and over the end of the fuel rod disc.
  - (g) Place the fuel rod collar (5), small outside diameter end first, over the end of the fuel rod and inside the shut down spring.

**3-17. GOVERNOR - Continued.**f. Reassembly - Continued.

- (h) Push the fuel rod through the bushing in the sub-cap, then slide the fuel rod spacer (4) over the end of the fuel rod and through the bushing in the sub-cap.
- (i) Push the fuel rod through the spacer until the threads on the end of the fuel rod are through the spacer. Then, install the lock nut (1) and fuel rod knob (2) on the end of the fuel rod.
- (j) Thread the lock nut (9) on the load limit screw (10). Place the washer (11) over the end of the load limit screw, then thread the screw into the sub-cap until the end protrudes approximately 1/8 inch through the second boss inside the sub-cap.

## g. Installation.

- (1) Refer to figure 3-17 and affix a new gasket (13) to the bolting flange of the governor drive housing (12); then start serrations of horizontal drive shaft into mesh with serrations of upper blower rotor shaft.
- (2) Set drive housing in position against blower end cover and attach the drive housing with six drive housing bolts (10) and six flat washers (11). Do not tighten bolts until the governor has been attached securely to the drive housing and cylinder head.
- (3) Affix a new gasket (9) to the top of the governor drive housing. Position the governor housing (8) over the drive housing with the maximum speed adjusting screw facing the cylinder head. Align the splines of the ball head shaft with the splines in the driven shaft sleeve; then enter the shaft straight in the sleeve and rest the governor housing on the gasket.
- (4) Install the four governor to drive housing bolts (6) and six lock washers (7). Tighten the bolts to 13-17 lb.-ft (18-23 Nm).
- (5) Start the fuel rod through the opening in the cylinder head. Push in on the fuel rod knob and at the same time lower the sub-cap down on the governor housing so that the fuel rod enters the slot in the terminal lever cross pin and the fuel rod collar rests in the front side of the terminal lever cross pin with the flat side of the collar adjacent to the side of the terminal lever. Refer to figure 3-18 and install the two sub-caps to governor housing screws and lockwashers.
- (6) Insert the two bolts (5, figure 3-17) through the sub-cap bolting flange and thread them into the cylinder head. Tighten the bolts to 7-9 lb.-ft (9.6-12.3 Nm). Tighten the governor drive housing to blower cover bolts (10) to 13-17 lb.-ft (18-23 Nm).
- (7) Connect the oil inlet tube assembly (1) to the governor oil inlet plug.

- (8) Pour approximately one pint of engine lubricating oil (item 8, Appendix C) in the top of the governor to provide initial governor lubrication.
- (9) Affix a new gasket (4) to the top of the governor sub-cap. Place governor cover (3) on top of the gasket and install cover screws (2). Tighten the screws securely.

h. Adjustment.

**NOTE**

Refer to paragraph 3-34 and adjust injector rack before adjusting the governor. (1) Refer to figure 3-22 and loosen the load limit adjusting screw locknut and adjust the screw to obtain a distance of approximately 2 inches from the outside face of the boss on the governor sub-cap to the end of the screw.

- (2) Place the fuel rod and terminal lever in the full-fuel position.
- (3) Turn the load limit screw until a .020 inch space exists between the fuel rod collar and the terminal lever, then hold the screw and tighten the locknut.
- (4) Start the engine and operate at approximately one-half the rated no-load speed until the lubricating oil has had an opportunity to warm up.

**NOTE**

When the engine lubricating oil is cold, the governor regulation may be erratic. The regulation should become increasingly stable as the temperature of the lubricating oil increases. (5) Stop the engine and remove the governor cover.

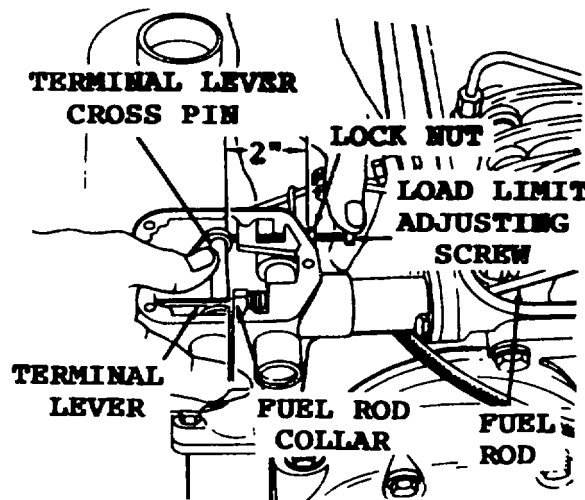


Figure 3-22. Adjusting Load Limit

**3-17. GOVERNOR - Continued.**h. Adjustment - Continued.

- (6) Loosen the locknut and back off the maximum speed adjusting screw approximately 5/8 inch (figure 3-24).
- (7) Refer to figure 3-23 and loosen the speed droop adjusting screw. Move the bracket so the screw is midway between the ends of the slot in the bracket. Tighten the screw.

**NOTE**

Be sure the bracket remains on the shoulder of the terminal lever.

- (8) With the throttle in the run position, adjust the engine speed until the engine is operating at 5% above the recommended full load speed.
- (9) Apply the full rated load on the engine and readjust the engine speed to the correct full-load speed.
- (10) Remove the rated load and note the engine speed after the speed has stabilized under no load. If the speed droop is correct, the engine speed will be approximately 5% higher than the full-load speed.

**NOTE**

•If the speed droop is too high, stop the engine, loosen the bolt again and move the speed droop adjusting bracket in (toward the engine). Tighten the screw. To increase the speed droop, move the droop adjusting bracket out (away from the engine).

•After the speed droop is properly adjusted, set the maximum no-load speed as follows:

- (11) Loosen the maximum speed adjusting screw locknut and back the adjusting screw out three times.
- (12) With the engine operating at no load, adjust the engine speed until the engine is operating approximately 8% higher than the rated full-load speed.
- (13) Turn the maximum speed adjusting screw in lightly until contact is felt with the linkage in the governor (figure 3-24).
- (14) Hold the adjusting screw and tighten the locknut.
- (15) Install the governor cover.

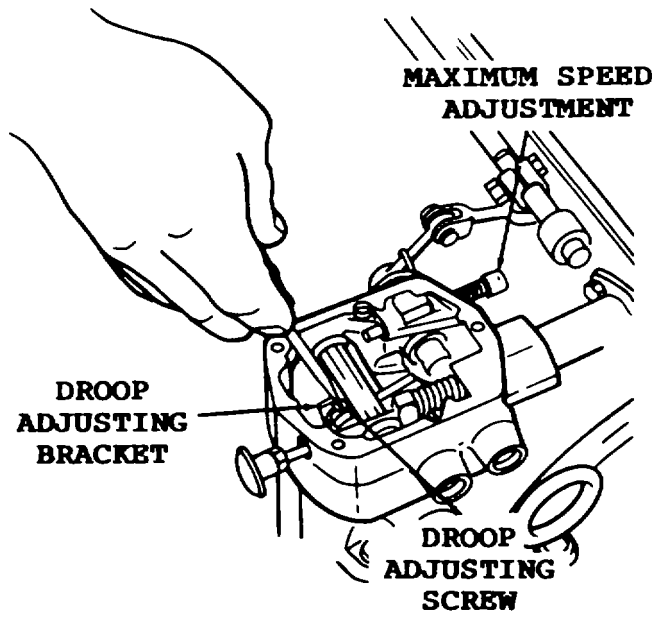


Figure 3-23. Adjusting Speed Droop.

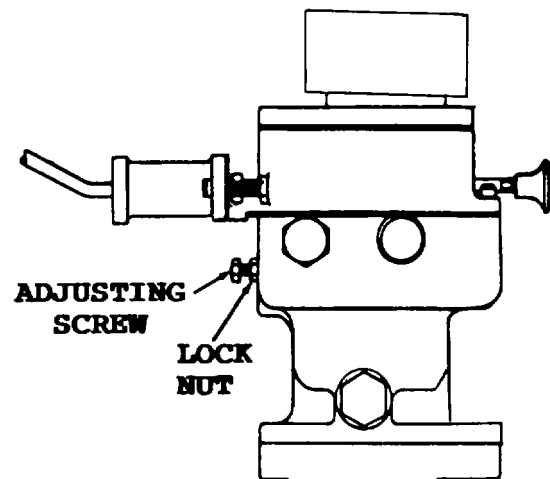


Figure 3-24. Adjusting Maximum No-Load Speed.

**3-18 INTAKE, AIR CLEANER ASSEMBLY.**

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**This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 3290612  
Ring P/N 5182977  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Air cleaner removed (paragraph 3-15, TM 55-1930-208-10).  
Air shutoff cable disconnected (paragraph 3-6).  
Ether starting aid disconnected (paragraph 3-23, TM 55-1930-208-10).  
Engine shutdown removed (paragraph 3-6).

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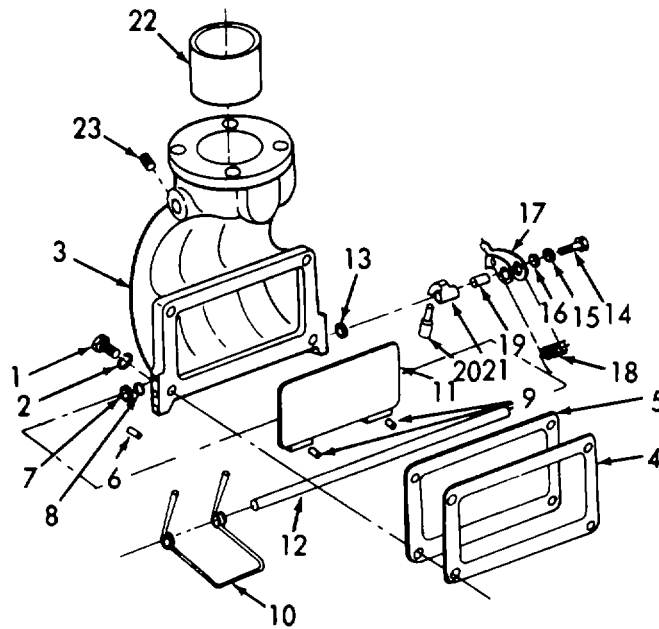
**a. Removal.** (Refer to figure 3-25).

- (1) Remove four screws (1) and four lockwashers (2) and remove the air inlet housing (3) from the side of the blower.
- (2) Remove striker plate gasket (4) and striker plate (5).

**b. Disassembly.**

- (1) Use a small punch to remove pin (6) and flat washer (7) from the air shutoff valve shaft. Remove and discard the seal ring (8) from the housing.
- (2) Remove two pins (9) that secure the air shutoff valve to the shaft.
- (3) Note the position of the air shutoff valve spring (10) and valve (11). Then, withdraw the shaft (12) from the housing to release the valve and spring in the housing. Remove and discard the seal ring (13) from the housing.
- (4) Remove the screw (14), lockwasher (15), and flat washer (16) from the housing and remove the latch (17), latch spring (18), and bushing (19).
- (5) Remove lever handle (20) and lever control cam (21) from the housing.

- (6) Remove air cleaner mounting tube (22) and two pipe plugs (23) from the housing (3).



**Figure 3-25. Air Intake, Removal, Disassembly, Reassembly, and Installation.**

c. Cleaning.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

d. Inspection.

- (1) Inspect all parts for wear or damage.
- (2) Be sure the face of the air shutoff valve is perfectly flat to assure a tight seal when it is in the shutdown position.

e. Repair. Air intake assembly repairs are accomplished by the replacement of defective parts.

**3-18. INTAKE, AIR CLEANER ASSEMBLY - Continued.**

f. Reassembly.

- (1) Install two pipe plugs (23) and air cleaner mounting tube (22) in the housing.
- (2) Place the valve (11) and spring (10) in position in the housing and lip shaft (12) in place. Then, install two pins (9) which retain the valve to the shaft.
- (3) Lubricate with engine oil (item 8, Appendix C) and install new seal rings (8 and 13) at ends of the shaft.
- (4) Install the lever control cam (21) and lever handle (20).
- (5) Install washer (7) and pin (6) at the other end of the shaft.
- (6) Assemble bushing (19) and spring (18) on latch (17). Then, slip the attaching screw (14) through the lockwasher (15), flat washer (16), and latch and bushing. Attach the latch assembly to the housing and tighten the screw.

g. Installation.

- (1) Before attaching the air intake assembly to the blower, place a steel straight-edge lengthwise on the face of the housing bolting flange and close the valve against the straight-edge. The finished pads at each end of the valve must be flush against the straight-edge when it is moved from top to bottom of the intake housing flange.
- (2) Mount air intake housing (3) together with striker plate (5) and striker plate gasket (4) on the blower with four lockwashers (2) and four screws (1). Tighten the screws to 16-20 lb-ft (22-27 Nm).
- (3) Connect the air shutoff cable (paragraph 3-6). Start and run the engine at idle speed and no load. Trip the air shutdown. If engine does not stop, check for air leakage between the valve and the striker plate. If necessary, reposition the valve.
- (4) Connect the ether starting aid (paragraph 3-23, TM 55-1930-208-10) and install the air cleaner (paragraph 3-15, TM 55-1930-208-10).

**3-18 INTAKE, AIR CLEANER ASSEMBLY.**

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**This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Puller (Item 25, Appendix B)  
 Oil Seal Remover (Item 26, Appendix B)  
 Tool Set, Blower Service (Item 27, Appendix B)  
 Bearing Driver (Item 28, Appendix B)  
 Oil Seal Pilot (Item 29, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Adhesive (Item 1, Appendix C)  
 Cloth, Soft (Item 23, Appendix C)  
 Compound, Sealing (Item 22, Appendix C)  
 Gasket P/N 5115657  
 Gasket P/N 5172865  
 Oil, Fuel (Item 9, Appendix C)  
 Oil, Lubricating (Item 12, Appendix C)  
 Seal P/N 5192438  
 Washer, Lock P/N MS35338-44  
 Washer, Lock P/N MS35338-45  
 Washer, Lock P/N MS35338-46  
 Washer, Lock P/N MS35338-48

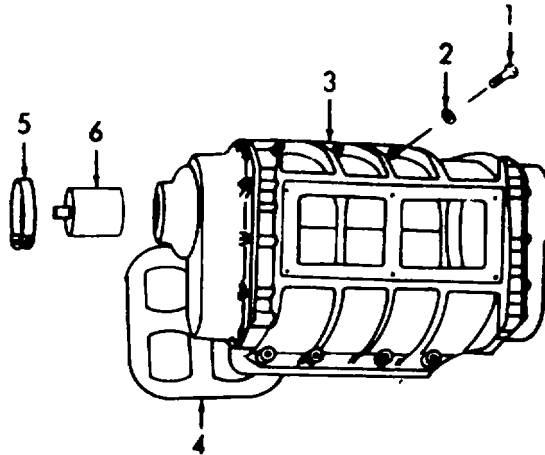
**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Coolant system drained of coolant (paragraph 2-17, TM 55-1930-208-10).  
 Hydraulic speed control governor removed (paragraph 3-17).  
 Blower drive shaft removed (paragraph 4-11).  
 Air cleaners removed (paragraph 3-15, TM 55-1930-208-10).  
 Air inlet housing removed (paragraph 3-18).  
 Fuel pump removed (paragraph 3-21).  
 Fresh water pump removed (paragraph 3-24).

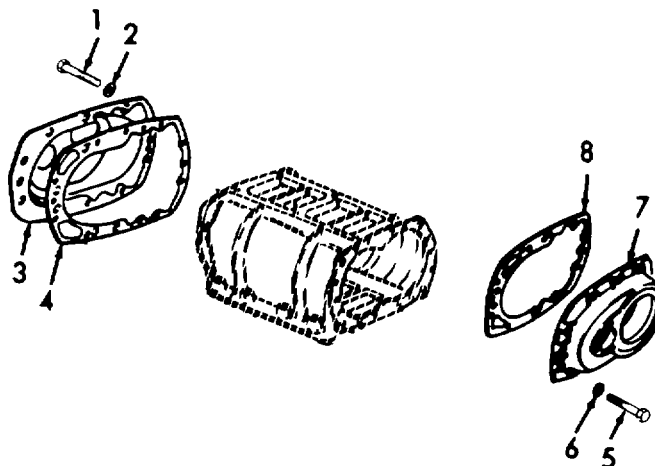
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**3-19. BLOWER - Continued.**a. Removal. (Refer to figure 3-26).

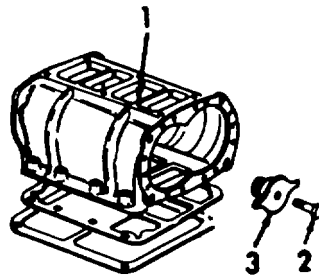
- (1) Remove four bolts (1), four flat washers (2), and blower (3).
- (2) Remove and discard gasket (4).
- (3) Loosen and remove clamp (5).
- (4) Remove blower drive shaft cover (6).

**Figure 3-26. Blower, Removal/Installation.**b. Disassembly. (Refer to figures 3-27 through 3-33).

- (1) Refer to figure 3-27 and remove ten bolts (1), ten flat washers (2), rear end cover (3), and gasket (4). Discard gasket (4).
- (2) Remove ten screws (5), ten flat washers (6), front end cover (7), and gasket (8). Discard gasket (8).

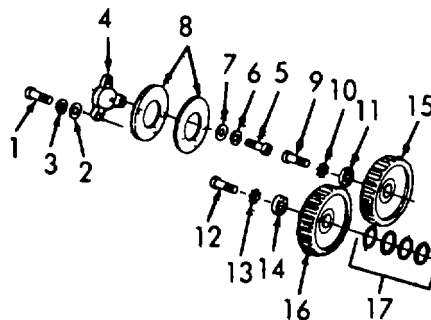
**Figure 3-27. Blower End Cover, Removal.**

- (3) Refer to figure 3-28 and place a clean, folder cloth (item 23, Appendix C) between both rotors and another between the rotor and housing (1).
- (4) Remove bolt (2).
- (5) Thread screw into the water pump drive coupling, then attach slide hammer and remove coupling (3).



**Figure 3-28. Water Pump Drive Coupling, Removal.**

- (6) Refer to figure 3-29 and remove bolts (1), three flat washers (2), three lockwashers (3), and rotor and drive hub (4).
- (7) Remove three bolts (5), three lockwashers (6), three flat washers (7), and two plates and spacers (8).
- (8) Remove bolt (9), washer (10), and retainer (11).
- (9) Remove two bolts (12), washer (13), and fuel pump coupling disc (14).

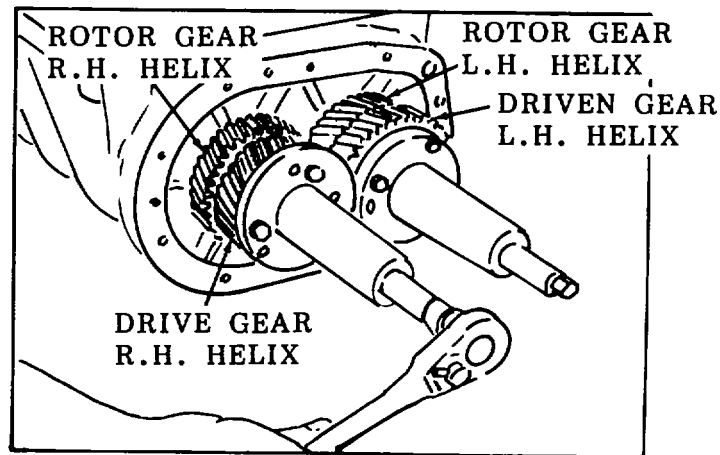


**Figure 3-29. Drive Gears, Removal.**

**3-19. BLOWER - Continued.**

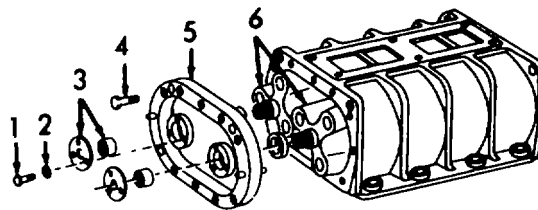
b. Disassembly - Continued.

- (10) Refer to figure 3-30 and install two gear pullers J6270F to the gears.



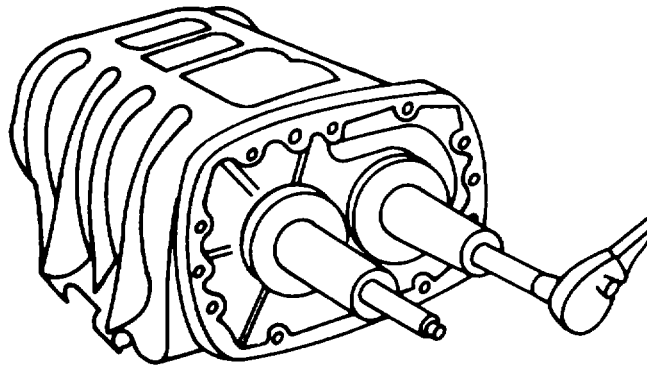
**Figure 3-30. Installation of Gear Pullers.**

- (11) Remove drive gear (15, figure 3-29 and rotor gear (16) simultaneously.
- (12) Remove shims (17, figure 3-29) from the rotor shafts or inner face of the gears and note the number and thickness of shims used with each gear.
- (13) Refer to figure 3-31 and remove three bolts (1), three flat washers (2), and bearing retainer (3). Repeat for other bearing retainer.
- (14) Remove two screws (4).



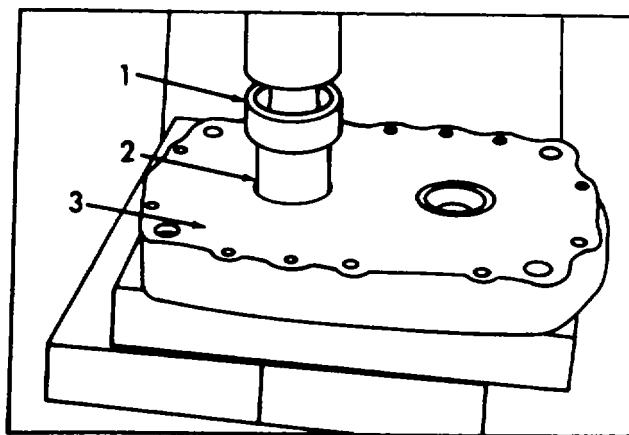
**Figure 3-31. End Plate and Rotor, Removal.**

- (15) Refer to figure 3-32 and install both pullers and remove the end plate.



**Figure 3-32. End Plate Removal Using Tool Set J6270F.**

- (16) After removing one end plate (5, figure 3-31), repeat steps (13) through (15), for the other end plate.
- (17) Remove both rotors (6, figure 3-31).
- (18) Support outer face of end plate on wood blocks on the bed of the arbor press.
- (19) Refer to figure 3-33 and place the long end of oil seal remover and installer tool (1) down through oil seal (2) and into bearing.
- (20) Press bearing and oil seal out of the end plate (3).
- (21) Repeat for other bearing and oil seal and then for other end plate.



**Figure 3-33. Bearing and Oil Seal Removal Using Tool J6270-3.**

**3-19 BLOWER- Continued.**c. Cleaning.

- (1) Clean all parts in clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess oil and dry.

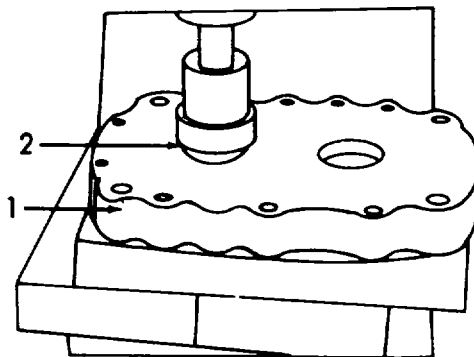
d. Inspection.

- (1) Inspect for missing or damaged hardware.
- (2) Inspect bearings for signs of corrosion and pitting.
- (3) Inspect seals for scoring and lack of pliability.
- (4) Inspect rotor lobes for scoring, burrs, and cracks.
- (5) Inspect rotor shafts for burrs, wear, peeling, and cracks.
- (6) Inspect housing and end plates for burrs, scoring, rust, corrosion, and cracks.
- (7) Inspect gears for damage, wear, and chipped teeth.

e. Repair. Repair of blower is limited to the replacement of defective parts and to the removal of small burrs and light scoring with emery cloth.

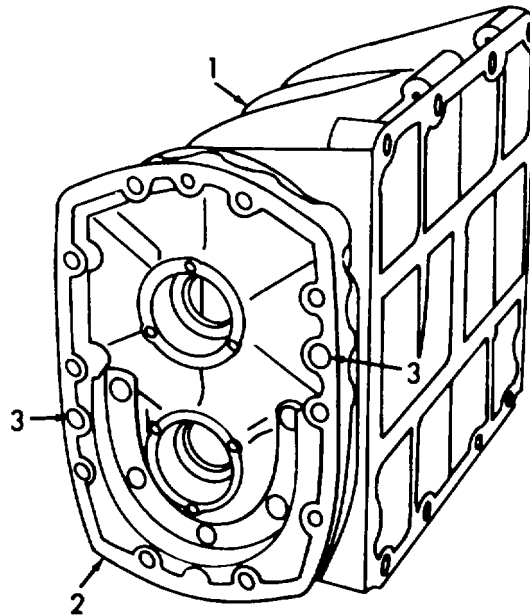
f. Assembly. (Refer to figures 3-34 through 3-43).

- (1) Refer to figure 3-34 and use wooden blocks to support the end plate (1) finished side up on arbor press.
- (2) Start the oil seal (2) straight into the bore with sealing edge facing down.
- (3) Place the short end of oil seal remover and installer into the oil seal (2) and press seal into the plate.
- (4) Repeat steps (1) through (3) for the rest of the oil seals on both plates.



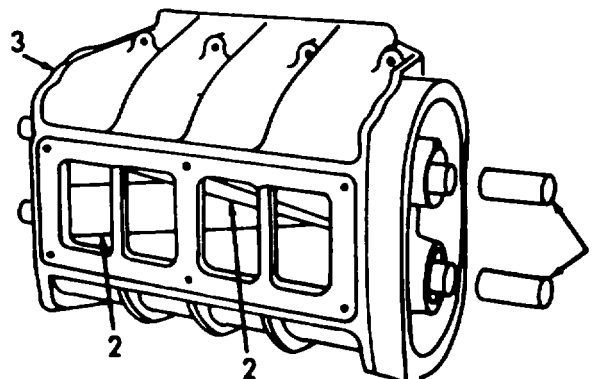
**Figure 3-34. Oil Seals, Installation.**

- (5) Refer to figure 3-35 and apply sealing compound (item 22, Appendix C) to front of housing (1).
- (6) Install blower front end plate (2) using a soft mallet to drive the plate over the dowel pins.
- (7) Install two screws (3) to secure end plate (2) to housing (3). Torque screws to 5-10 lb-ft (7-14 Nm).



**Figure 3-35. Front End Plate, Installation.**

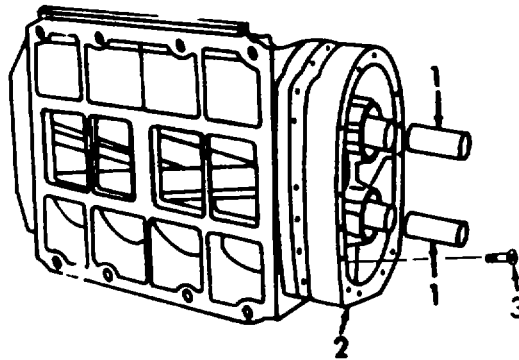
- (8) Refer to figure 3-36 and place an oil seal pilot (1) on the short (non-splined) end of each rotor shaft (2).
- (9) Place the rotors (2) in mesh with the missing serrations of the splines aligned. Insert the rotors (2) into the housing (3) with the right hand helix rotor at the top.



**Figure 3-36. Rotor, Installation.**

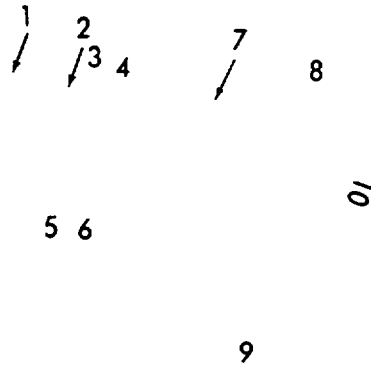
**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (10) Push rotor shafts and oil pilots on through oil seals.
- (11) Remove oil seal pilots J6270-5 (1, figure 3-36).
- (12) Refer to figure 3-37 and place an oil seal pilot (1) on end of rotor shaft.
- (13) Place rear plate (2) in position after lightly coating housing mating surface with sealing compound (item 22, Appendix C).
- (14) Place rear plate (2) over pilot (1) and gently tap the plate with a soft mallet to drive the plate over the dowel pins.
- (15) Install two screws (3) and torque them to 5-10 lb-ft (7-14 Nm).
- (16) Remove both pilots (1).

**Figure 3-37. Rear End Plate, Installation.**

- (17) Refer to figure 3-38 and lubricate bearings with engine oil (item 8, Appendix C).
- (18) Place bearing (1) numbered side out, into position in the front end plate. Use a bearing driver J6270-4 and tap the bearing onto the shaft and into the plate.
- (19) Repeat steps (17) and (18) for the other bearing.
- (20) Install two bearing retainers (2) and secure with six washers (3) and six bolts (4). Torque bolts to 7-9 lb-ft (9-12 Nm).
- (21) Start the end of water pump coupling (5) straight into the left hand rotor shaft.
- (22) Place clean, soft cloths (item 23, Appendix C) between the rotors and the rotor and housing to prevent them from turning.

- (23) Install retaining bolt (6) and torque bolt to 18 lb-ft (24 Nm).
- (24) Install gasket (7) and front cover (8) into position.
- (25) Install ten washers (9) and ten bolts (10). Torque bolts to 13-17 lb-ft (18-23 Nm).



**Figure 3-38. Bearings, Retainers, and Front Cover, Installation.**

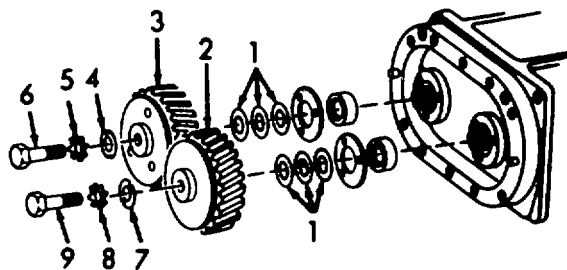
- (26) Refer to figure 3-39 and lubricate bearings (1) with lubricating oil (item 12, Appendix C).
- (27) Place bearing (1) number side up on the shaft. Seat the bearing with a bearing driver J6270-4.
- (28) Install retainer (2), three washers (3), and three screws (4). Torque screws to 7-9 lb-ft (9-12 Nm).
- (29) Repeat steps (20) through (28) for the outer bearing.

4

**Figure 3-39. Bearing, Installation.**

**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (30) Refer to figure 3-40 and rotate the rotors so that missing serrations face the tip of the blower.
- (31) Install the same number of shims (1) on each rotor as they were removed.
- (32) Lubricate the serrations on the rotor shaft with lubricating oil (item 12, Appendix C).
- (33) Place the teeth of the gears (2 and 3) in mesh so that the missing serrations inside the gears are in alignment and facing the same direction as the missing serrations on the shafts.
- (34) Start both rotor gears (2 and 3) on the rotor shafts with the right hand helix on the upper rotor and the left hand helix gear on the lower rotor.
- (35) Install the gear installers to both gears.
- (36) Place a clean, soft cloth (item 23, Appendix C) between the rotors and between the rotors and housing.
- (37) Alternately tighten installers and press on the shaft at the same time until the gears are firmly seated against the shims.

**Figure 3-40. Blower Gears, Installation.**

- (38) Remove the gear installers.
- (39) Install retainer (4), lockwasher (5), and bolt (6). Torque bolt to 55-65 lb-ft (75-88 Nm).
- (40) Install drive coupling disc (7), lockwasher (8), and bolt (9). Torque bolt to 55-65 lb-ft (75-88 Nm).
- (41) Remove the cloths from the blower.
- (42) Refer to figure 3-41 and use a feeler gage and check dimensions "A" and "B" on both rotors and all lobes.

- (43) Take measurements "C", "CC", "D", and "E". Measurements should be taken 1 inch from the end of the rotor.
- (44) To change dimensions "C" or "CC", add or subtract shims (1, figure 3-40) as shown in figure 3-41. A shim change of 0.003 inch will cause a change of 0.001 inch in rotor spacing.
- (45) After each change of shims, recheck all measurements.

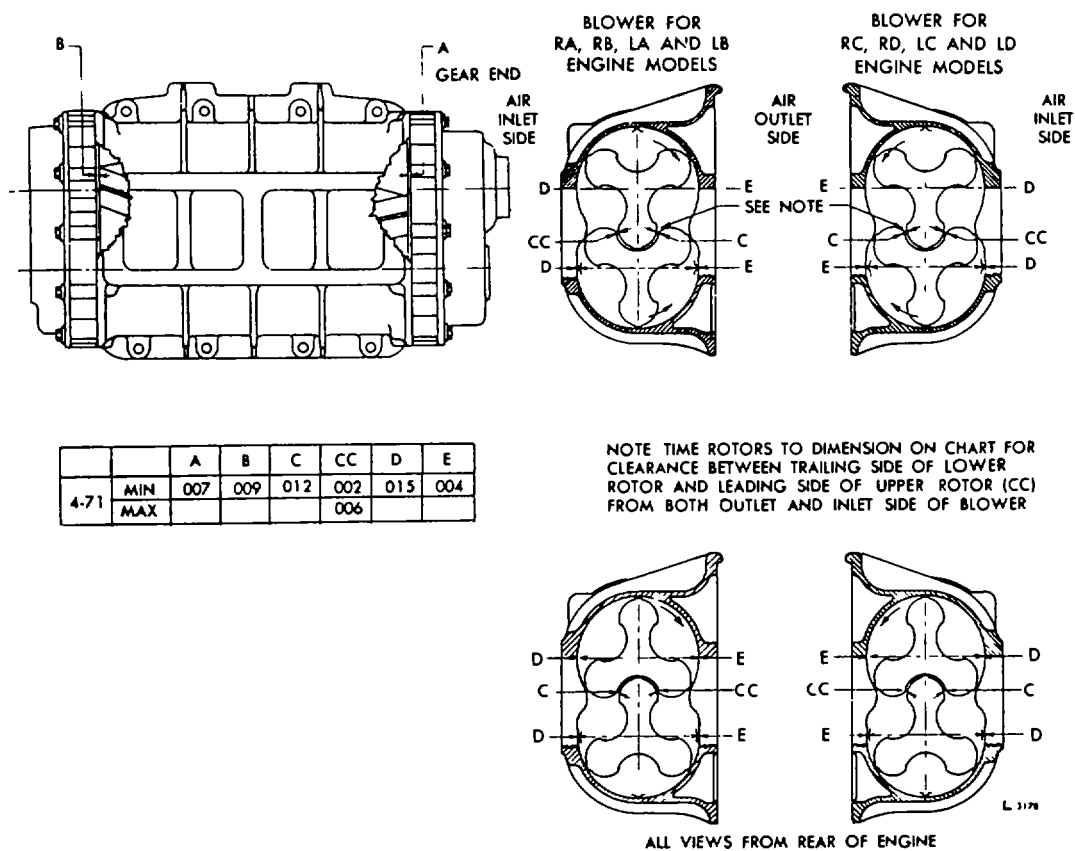
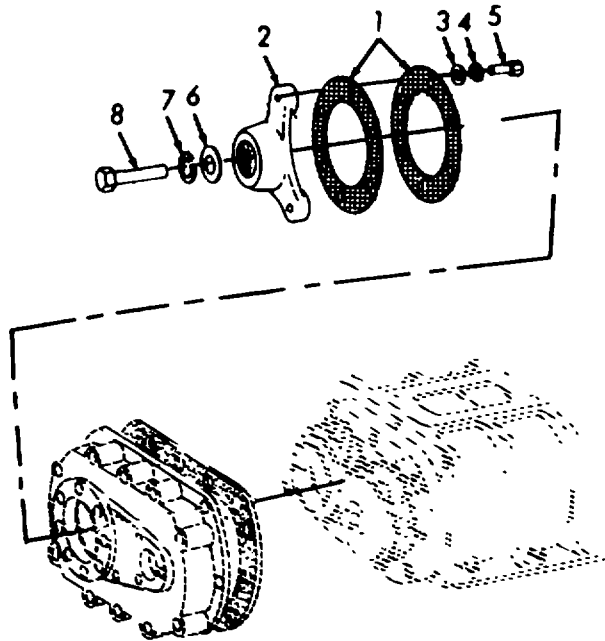


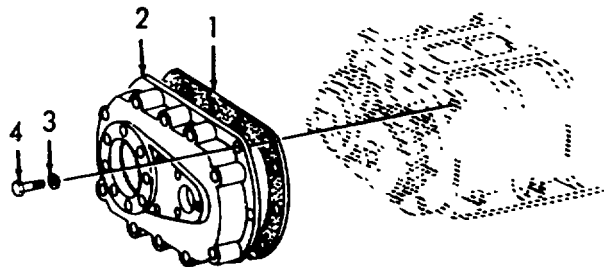
Figure 3-41. Rotor Timing.

**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (46) Refer to figure 3-42 and install plates (1) to hub (2). Secure with three washers (3), three lockwashers (4), and three bolts (5). Torque bolts to 25-30 lb-ft (34-41 Nm).
- (47) Install hub (2) and secure with three washers (6), three lockwashers (7), and three bolts (8). Torque bolts to 25-30 lb-ft (34-41 Nm).

**Figure 3-42. Drive Hub, Installation.**

- (48) Refer to figure 3-43 and install gasket (1) and cover (2).
- (49) Install ten washers (3) and ten bolts (4). Torque bolts to 13-17 lb-ft (18-23 Nm).

**Figure 3-43. End Covers, Installation.**

g. Installation. (Refer to figure 3-26).

- (1) Use adhesive (item 1, Appendix C) and install gasket (4) to the engine block.
- (2) Install blower drive shaft cover (6) and secure with clamp (5).
- (3) Place blower (3) into position against the cylinder block, being careful not to dislodge the blower gasket.
- (4) Install eight blower mounting bolts (1) and eight flat washers (2).
- (5) Install fresh water pump (paragraph 3-25).
- (6) Install fuel pump (paragraph 3-22).
- (7) Install air inlet housing (paragraph 3-18).
- (8) Install air cleaners (paragraph 3-15, TM 55-1930-208-10).
- (9) Install blower drive shaft (paragraph 3-21).
- (10) Install hydraulic speed control governor (paragraph 3-17).
- (11) Fill cooling system with coolant per paragraph 3-20, TM 55-1930-208-10, start engine and check operation.

### 3-20. BLOWER DRIVE.

---

**This task covers:**

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

**INITIAL SETUP:**

Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

Materials Required:

Gasket P/N 5148810  
Oil, Engine (Item 8, Appendix C)  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

**3-20. BLOWER DRIVE - Continued.**a. Removal. (Refer to figure 3-44).

- (1) Remove the six bolts that secure the flywheel housing small hole cover.
- (2) Remove snap ring (1). Pull blower drive shaft (2) out of the drive assembly.
- (3) Disconnect blower drive oil line (3) from blower drive support.
- (4) Loosen hose clamps (4) and remove gaskets (5) and bushing (6).
- (5) Straighten the ears on lockwasher (7) and loosen drive gear hub nut (8).
- (6) Remove blower drive support attaching bolt (9) and lockwashers (10).
- (7) Loosen blower drive support (11) by tapping it lightly and withdraw the support from the cylinder block rear end plate. Take care to prevent damage to blower drive gear teeth. Discard gasket (12).

b. Disassembly.

- (1) Refer to figure 3-44 and secure blower drive gear and support assembly in a vise with soft jaws.
- (2) Take out drive coupling bolts (13) and lockwashers (14) and remove retainer (15) and coupling support (16).
- (3) Remove drive gear hub nut (8), lockwasher (7), thrust washer (17), and lock ball (18).
- (4) Press gear hub (19) out of gear (20).
- (5) Remove cam follower (21), springs (22), and seats (23) from coupling support (16).
- (6) Remove thrust washer (24) and bearing (25) from housing.
- (7) Remove oil filler cap (26), oil filler tube (27), and strainer (28) from housing.
- (8) Disconnect chain (29) from filler cap and tube.
- (9) Remove plug (30) from housing.

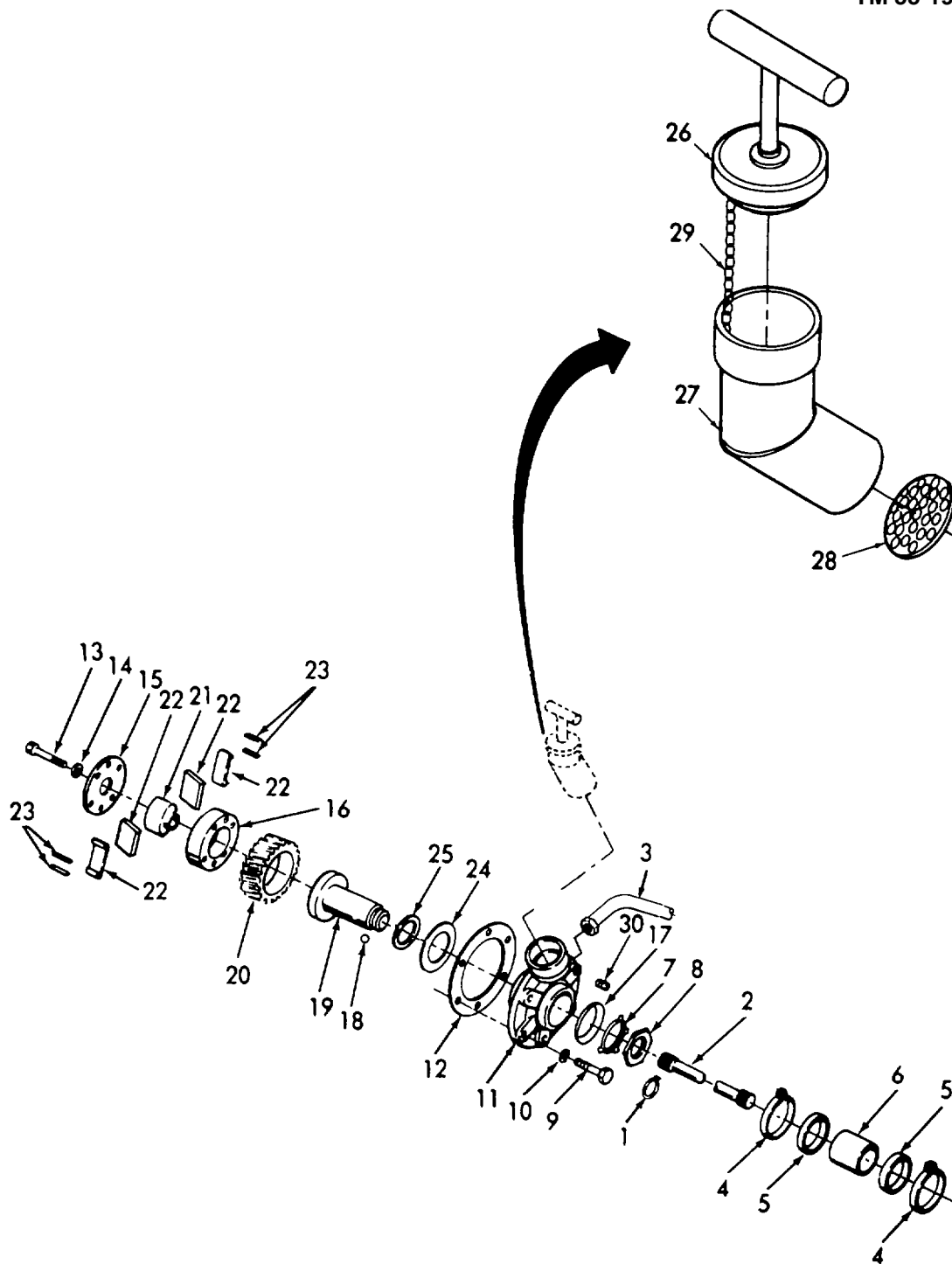


Figure 3-44. Blower Drive, Removal, Disassembly, Reassembly, and Installation.

**3-20. BLOWER DRIVE - Continued.**c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts thoroughly with cleaning solvent (item 4, Appendix C) and dry thoroughly.
- (2) Make sure that oil grooves, oil holes, and cavities are free of dirt.

d. Inspection.

- (1) Check for worn or scored thrust washers.
- (2) Inspect blower drive coupling support, cam, spring seats, and spring packs for worn or damaged parts.
- (3) Check for worn or damaged serrations on blower drive shaft.
- (4) Examine blower drive gear for worn, scored, or pitted teeth.

e. Repair. Repair of the blower drive consists of the replacement of defective parts.f. Reassembly.

- (1) Refer to figure 3-44 and install plug (30) in housing.
- (2) Attach chain (29) between oil filler cap (26) and oil filler tube (27). Install filler cap and filler tube with strainer (28) in housing.
- (3) Press drive gear hub (19) into drive gear (20).
- (4) Lubricate drive gear hub, bearing (25) in the housing, thrust surfaces, and thrust washer with engine oil (item 8, Appendix C).
- (5) Place thrust washer (24) on the protruding bearing in gear side of housing and insert drive gear and hub assembly.
- (6) Locate lock ball (18) in its place on drive gear hub and slide thrust washer (17) into position over lock ball. Thrust washer must be installed with tapered face toward the threads on the hub.
- (7) Install new lockwasher (7) and finger tighten hub nut (8). Install two bolts into threaded holes in drive gear hub. Place a suitable holding bar across bolts to keep hub from rotating and tighten hub nut to 50-60 lb-ft (68-81 Nm). Bend the ears of lockwasher against the nut, to lock the nut in place. Remove two bolts from gear hub.

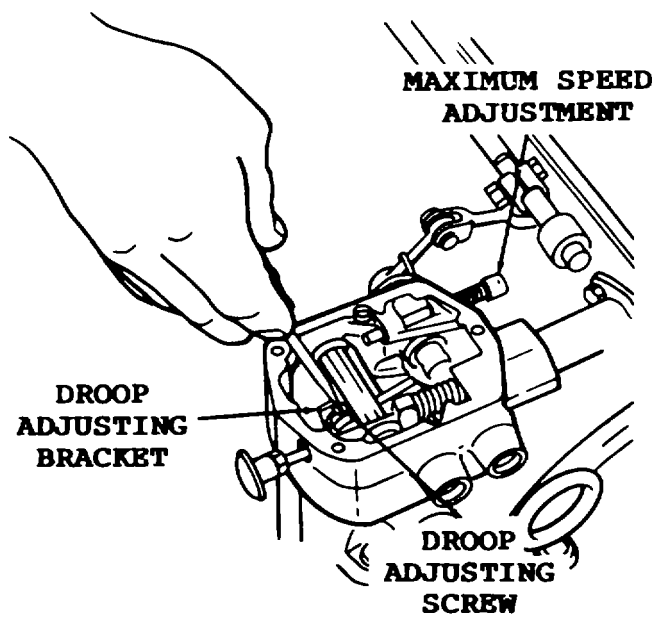


Figure 3-23. Adjusting Speed Droop.

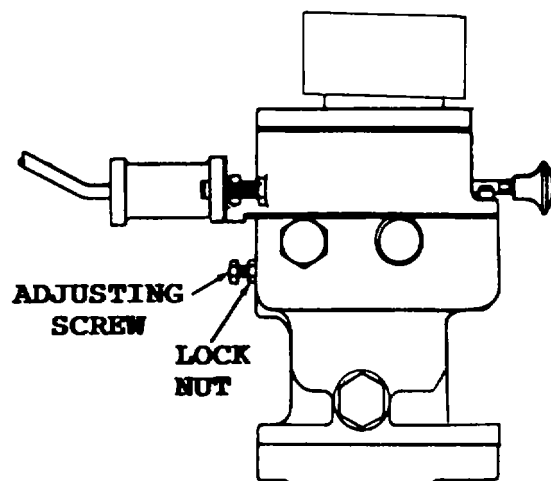


Figure 3-24. Adjusting Maximum No-Load Speed.

**3-18 INTAKE, AIR CLEANER ASSEMBLY.**

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**This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 3290612  
Ring P/N 5182977  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Air cleaner removed (paragraph 3-15, TM 55-1930-208-10).  
Air shutoff cable disconnected (paragraph 3-6).  
Ether starting aid disconnected (paragraph 3-23, TM 55-1930-208-10).  
Engine shutdown removed (paragraph 3-6).

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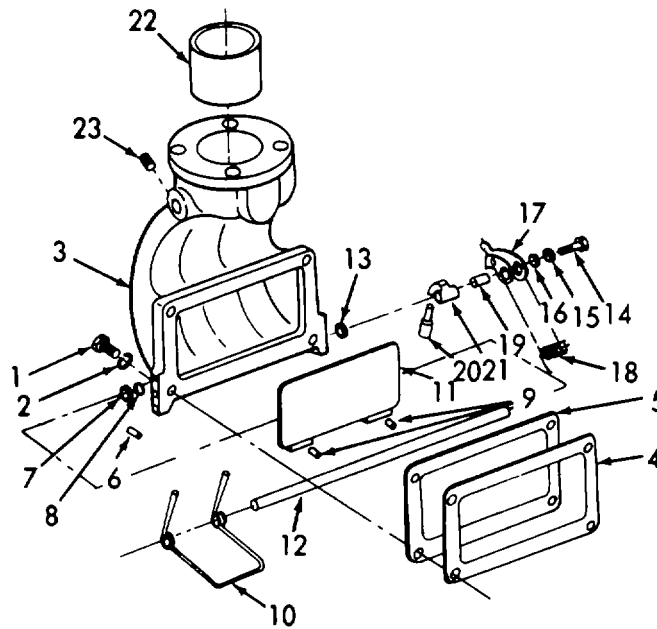
a. **Removal.** (Refer to figure 3-25).

- (1) Remove four screws (1) and four lockwashers (2) and remove the air inlet housing (3) from the side of the blower.
- (2) Remove striker plate gasket (4) and striker plate (5).

b. **Disassembly.**

- (1) Use a small punch to remove pin (6) and flat washer (7) from the air shutoff valve shaft. Remove and discard the seal ring (8) from the housing.
- (2) Remove two pins (9) that secure the air shutoff valve to the shaft.
- (3) Note the position of the air shutoff valve spring (10) and valve (11). Then, withdraw the shaft (12) from the housing to release the valve and spring in the housing. Remove and discard the seal ring (13) from the housing.
- (4) Remove the screw (14), lockwasher (15), and flat washer (16) from the housing and remove the latch (17), latch spring (18), and bushing (19).
- (5) Remove lever handle (20) and lever control cam (21) from the housing.

- (6) Remove air cleaner mounting tube (22) and two pipe plugs (23) from the housing (3).



**Figure 3-25. Air Intake, Removal, Disassembly, Reassembly, and Installation.**

c. Cleaning.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

d. Inspection.

- (1) Inspect all parts for wear or damage.
- (2) Be sure the face of the air shutoff valve is perfectly flat to assure a tight seal when it is in the shutdown position.

e. Repair. Air intake assembly repairs are accomplished by the replacement of defective parts.

**3-18. INTAKE, AIR CLEANER ASSEMBLY - Continued.**f. Reassembly.

- (1) Install two pipe plugs (23) and air cleaner mounting tube (22) in the housing.
- (2) Place the valve (11) and spring (10) in position in the housing and lip shaft (12) in place. Then, install two pins (9) which retain the valve to the shaft.
- (3) Lubricate with engine oil (item 8, Appendix C) and install new seal rings (8 and 13) at ends of the shaft.
- (4) Install the lever control cam (21) and lever handle (20).
- (5) Install washer (7) and pin (6) at the other end of the shaft.
- (6) Assemble bushing (19) and spring (18) on latch (17). Then, slip the attaching screw (14) through the lockwasher (15), flat washer (16), and latch and bushing. Attach the latch assembly to the housing and tighten the screw.

g. Installation.

- (1) Before attaching the air intake assembly to the blower, place a steel straight-edge lengthwise on the face of the housing bolting flange and close the valve against the straight-edge. The finished pads at each end of the valve must be flush against the straight-edge when it is moved from top to bottom of the intake housing flange.
- (2) Mount air intake housing (3) together with striker plate (5) and striker plate gasket (4) on the blower with four lockwashers (2) and four screws (1). Tighten the screws to 16-20 lb-ft (22-27 Nm).
- (3) Connect the air shutoff cable (paragraph 3-6). Start and run the engine at idle speed and no load. Trip the air shutdown. If engine does not stop, check for air leakage between the valve and the striker plate. If necessary, reposition the valve.
- (4) Connect the ether starting aid (paragraph 3-23, TM 55-1930-208-10) and install the air cleaner (paragraph 3-15, TM 55-1930-208-10).

**3-18 INTAKE, AIR CLEANER ASSEMBLY.**

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**This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Puller (Item 25, Appendix B)  
 Oil Seal Remover (Item 26, Appendix B)  
 Tool Set, Blower Service (Item 27, Appendix B)  
 Bearing Driver (Item 28, Appendix B)  
 Oil Seal Pilot (Item 29, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Adhesive (Item 1, Appendix C)  
 Cloth, Soft (Item 23, Appendix C)  
 Compound, Sealing (Item 22, Appendix C)  
 Gasket P/N 5115657  
 Gasket P/N 5172865  
 Oil, Fuel (Item 9, Appendix C)  
 Oil, Lubricating (Item 12, Appendix C)  
 Seal P/N 5192438  
 Washer, Lock P/N MS35338-44  
 Washer, Lock P/N MS35338-45  
 Washer, Lock P/N MS35338-46  
 Washer, Lock P/N MS35338-48

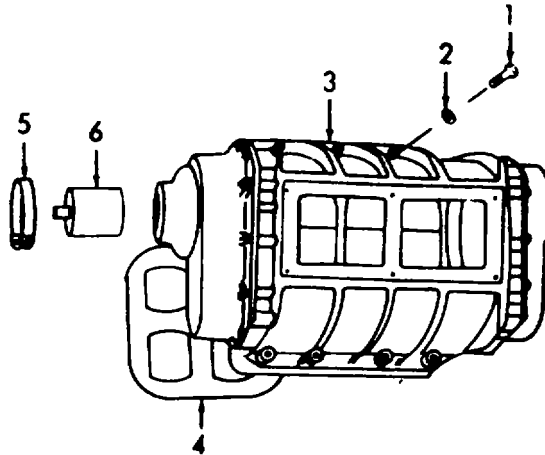
**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Coolant system drained of coolant (paragraph 2-17, TM 55-1930-208-10).  
 Hydraulic speed control governor removed (paragraph 3-17).  
 Blower drive shaft removed (paragraph 4-11).  
 Air cleaners removed (paragraph 3-15, TM 55-1930-208-10).  
 Air inlet housing removed (paragraph 3-18).  
 Fuel pump removed (paragraph 3-21).  
 Fresh water pump removed (paragraph 3-24).

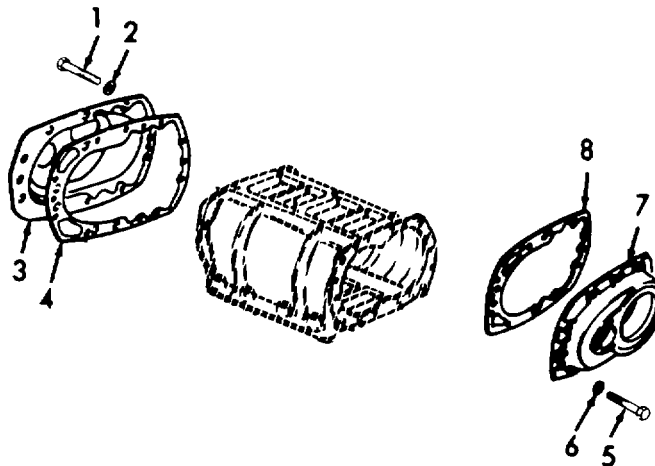
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**3-19. BLOWER - Continued.**a. Removal. (Refer to figure 3-26).

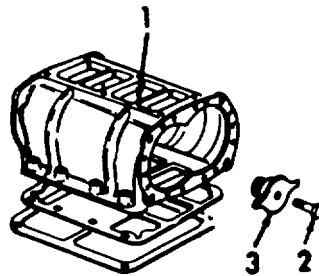
- (1) Remove four bolts (1), four flat washers (2), and blower (3).
- (2) Remove and discard gasket (4).
- (3) Loosen and remove clamp (5).
- (4) Remove blower drive shaft cover (6).

**Figure 3-26. Blower, Removal/Installation.**b. Disassembly. (Refer to figures 3-27 through 3-33).

- (1) Refer to figure 3-27 and remove ten bolts (1), ten flat washers (2), rear end cover (3), and gasket (4). Discard gasket (4).
- (2) Remove ten screws (5), ten flat washers (6), front end cover (7), and gasket (8). Discard gasket (8).

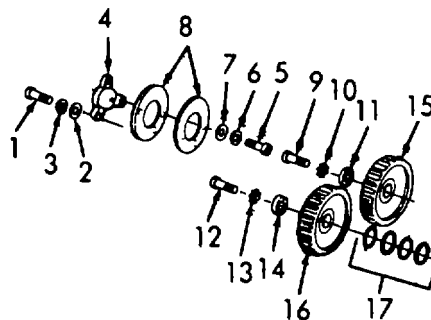
**Figure 3-27. Blower End Cover, Removal.**

- (3) Refer to figure 3-28 and place a clean, folded cloth (item 23, Appendix C) between both rotors and another between the rotor and housing (1).
- (4) Remove bolt (2).
- (5) Thread screw into the water pump drive coupling, then attach slide hammer and remove coupling (3).



**Figure 3-28. Water Pump Drive Coupling, Removal.**

- (6) Refer to figure 3-29 and remove bolts (1), three flat washers (2), three lockwashers (3), and rotor and drive hub (4).
- (7) Remove three bolts (5), three lockwashers (6), three flat washers (7), and two plates and spacers (8).
- (8) Remove bolt (9), washer (10), and retainer (11).
- (9) Remove two bolts (12), washer (13), and fuel pump coupling disc (14).

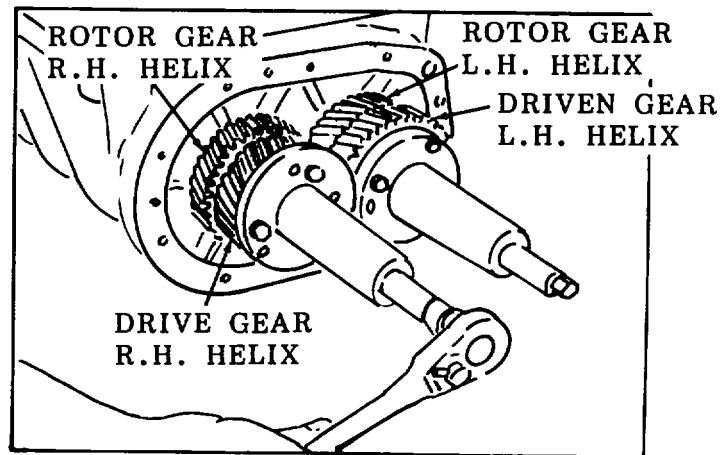


**Figure 3-29. Drive Gears, Removal.**

**3-19. BLOWER - Continued.**

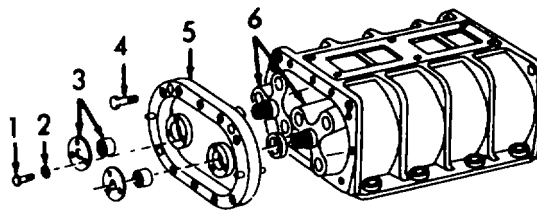
b. Disassembly - Continued.

- (10) Refer to figure 3-30 and install two gear pullers J6270F to the gears.



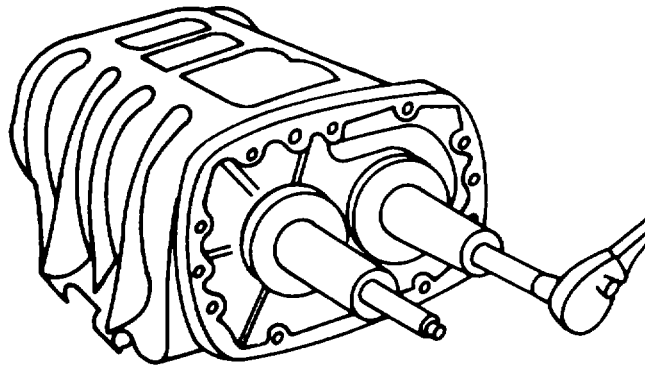
**Figure 3-30. Installation of Gear Pullers.**

- (11) Remove drive gear (15, figure 3-29 and rotor gear (16) simultaneously.
- (12) Remove shims (17, figure 3-29) from the rotor shafts or inner face of the gears and note the number and thickness of shims used with each gear.
- (13) Refer to figure 3-31 and remove three bolts (1), three flat washers (2), and bearing retainer (3). Repeat for other bearing retainer.
- (14) Remove two screws (4).



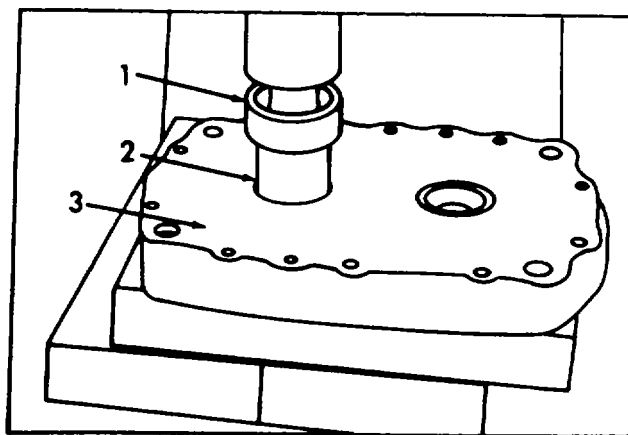
**Figure 3-31. End Plate and Rotor, Removal.**

- (15) Refer to figure 3-32 and install both pullers and remove the end plate.



**Figure 3-32. End Plate Removal Using Tool Set J6270F.**

- (16) After removing one end plate (5, figure 3-31), repeat steps (13) through (15), for the other end plate.
- (17) Remove both rotors (6, figure 3-31).
- (18) Support outer face of end plate on wood blocks on the bed of the arbor press.
- (19) Refer to figure 3-33 and place the long end of oil seal remover and installer tool (1) down through oil seal (2) and into bearing.
- (20) Press bearing and oil seal out of the end plate (3).
- (21) Repeat for other bearing and oil seal and then for other end plate.



**Figure 3-33. Bearing and Oil Seal Removal Using Tool J6270-3.**

### 3-19 BLOWER- Continued.

c. Cleaning.

- (1) Clean all parts in clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess oil and dry.

d. Inspection.

- (1) Inspect for missing or damaged hardware.
- (2) Inspect bearings for signs of corrosion and pitting.
- (3) Inspect seals for scoring and lack of pliability.
- (4) Inspect rotor lobes for scoring, burrs, and cracks.
- (5) Inspect rotor shafts for burrs, wear, peeling, and cracks.
- (6) Inspect housing and end plates for burrs, scoring, rust, corrosion, and cracks.
- (7) Inspect gears for damage, wear, and chipped teeth.

e. Repair. Repair of blower is limited to the replacement of defective parts and to the removal of small burrs and light scoring with emery cloth.

f. Assembly. (Refer to figures 3-34 through 3-43).

- (1) Refer to figure 3-34 and use wooden blocks to support the end plate (1) finished side up on arbor press.
- (2) Start the oil seal (2) straight into the bore with sealing edge facing down.
- (3) Place the short end of oil seal remover and installer into the oil seal (2) and press seal into the plate.
- (4) Repeat steps (1) through (3) for the rest of the oil seals on both plates.

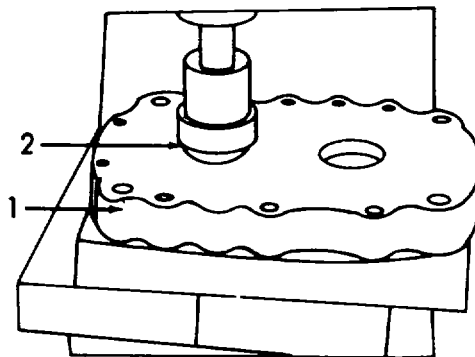
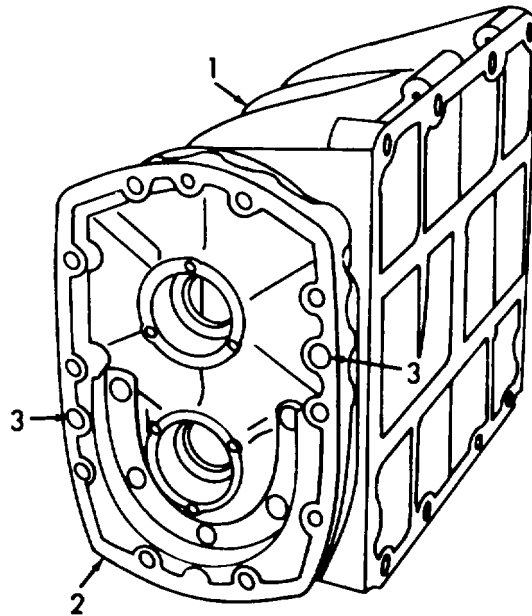


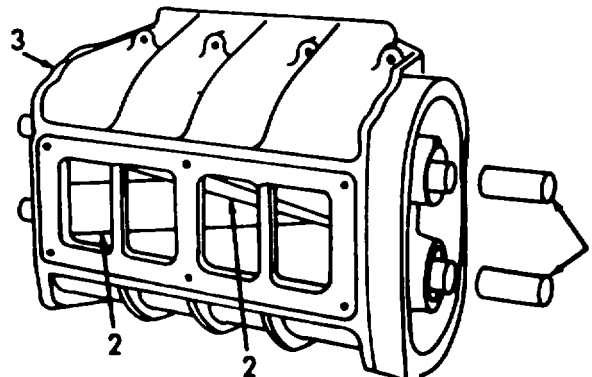
Figure 3-34. Oil Seals, Installation.

- (5) Refer to figure 3-35 and apply sealing compound (item 22, Appendix C) to front of housing (1).
- (6) Install blower front end plate (2) using a soft mallet to drive the plate over the dowel pins.
- (7) Install two screws (3) to secure end plate (2) to housing (3). Torque screws to 5-10 lb-ft (7-14 Nm).



**Figure 3-35. Front End Plate, Installation.**

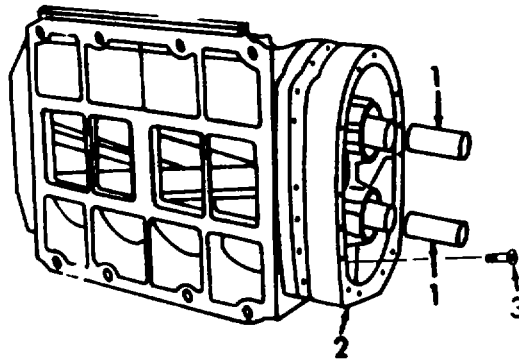
- (8) Refer to figure 3-36 and place an oil seal pilot (1) on the short (non-splined) end of each rotor shaft (2).
- (9) Place the rotors (2) in mesh with the missing serrations of the splines aligned. Insert the rotors (2) into the housing (3) with the right hand helix rotor at the top.



**Figure 3-36. Rotor, Installation.**

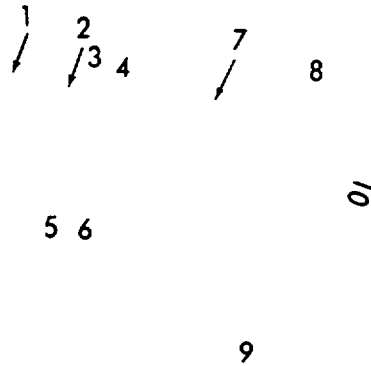
**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (10) Push rotor shafts and oil pilots on through oil seals.
- (11) Remove oil seal pilots J6270-5 (1, figure 3-36).
- (12) Refer to figure 3-37 and place an oil seal pilot (1) on end of rotor shaft.
- (13) Place rear plate (2) in position after lightly coating housing mating surface with sealing compound (item 22, Appendix C).
- (14) Place rear plate (2) over pilot (1) and gently tap the plate with a soft mallet to drive the plate over the dowel pins.
- (15) Install two screws (3) and torque them to 5-10 lb-ft (7-14 Nm).
- (16) Remove both pilots (1).

**Figure 3-37. Rear End Plate, Installation.**

- (17) Refer to figure 3-38 and lubricate bearings with engine oil (item 8, Appendix C).
- (18) Place bearing (1) numbered side out, into position in the front end plate. Use a bearing driver J6270-4 and tap the bearing onto the shaft and into the plate.
- (19) Repeat steps (17) and (18) for the other bearing.
- (20) Install two bearing retainers (2) and secure with six washers (3) and six bolts (4). Torque bolts to 7-9 lb-ft (9-12 Nm).
- (21) Start the end of water pump coupling (5) straight into the left hand rotor shaft.
- (22) Place clean, soft cloths (item 23, Appendix C) between the rotors and the rotor and housing to prevent them from turning.

- (23) Install retaining bolt (6) and torque bolt to 18 lb-ft (24 Nm).
- (24) Install gasket (7) and front cover (8) into position.
- (25) Install ten washers (9) and ten bolts (10). Torque bolts to 13-17 lb-ft (18-23 Nm).



**Figure 3-38. Bearings, Retainers, and Front Cover, Installation.**

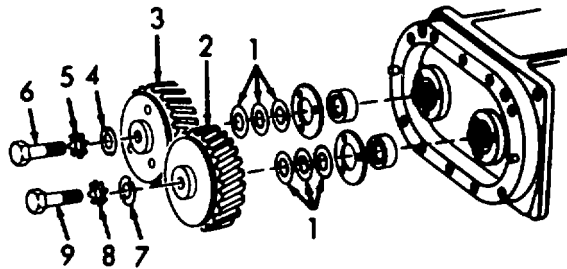
- (26) Refer to figure 3-39 and lubricate bearings (1) with lubricating oil (item 12, Appendix C).
- (27) Place bearing (1) number side up on the shaft. Seat the bearing with a bearing driver J6270-4.
- (28) Install retainer (2), three washers (3), and three screws (4). Torque screws to 7-9 lb-ft (9-12 Nm).
- (29) Repeat steps (20) through (28) for the outer bearing.

4

**Figure 3-39. Bearing, Installation.**

**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (30) Refer to figure 3-40 and rotate the rotors so that missing serrations face the tip of the blower.
- (31) Install the same number of shims (1) on each rotor as they were removed.
- (32) Lubricate the serrations on the rotor shaft with lubricating oil (item 12, Appendix C).
- (33) Place the teeth of the gears (2 and 3) in mesh so that the missing serrations inside the gears are in alignment and facing the same direction as the missing serrations on the shafts.
- (34) Start both rotor gears (2 and 3) on the rotor shafts with the right hand helix on the upper rotor and the left hand helix gear on the lower rotor.
- (35) Install the gear installers to both gears.
- (36) Place a clean, soft cloth (item 23, Appendix C) between the rotors and between the rotors and housing.
- (37) Alternately tighten installers and press on the shaft at the same time until the gears are firmly seated against the shims.

**Figure 3-40. Blower Gears, Installation.**

- (38) Remove the gear installers.
- (39) Install retainer (4), lockwasher (5), and bolt (6). Torque bolt to 55-65 lb-ft (75-88 Nm).
- (40) Install drive coupling disc (7), lockwasher (8), and bolt (9). Torque bolt to 55-65 lb-ft (75-88 Nm).
- (41) Remove the cloths from the blower.
- (42) Refer to figure 3-41 and use a feeler gage and check dimensions "A" and "B" on both rotors and all lobes.

- (43) Take measurements "C", "CC", "D", and "E". Measurements should be taken 1 inch from the end of the rotor.
- (44) To change dimensions "C" or "CC", add or subtract shims (1, figure 3-40) as shown in figure 3-41. A shim change of 0.003 inch will cause a change of 0.001 inch in rotor spacing.
- (45) After each change of shims, recheck all measurements.

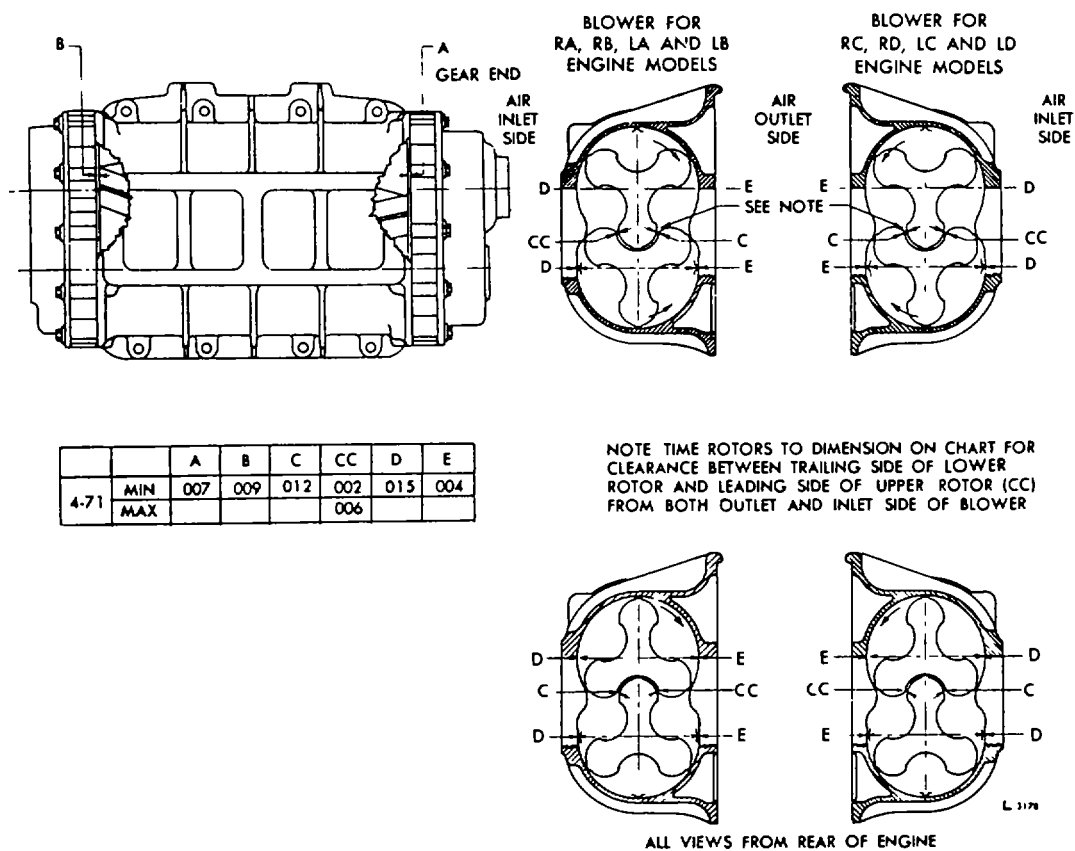
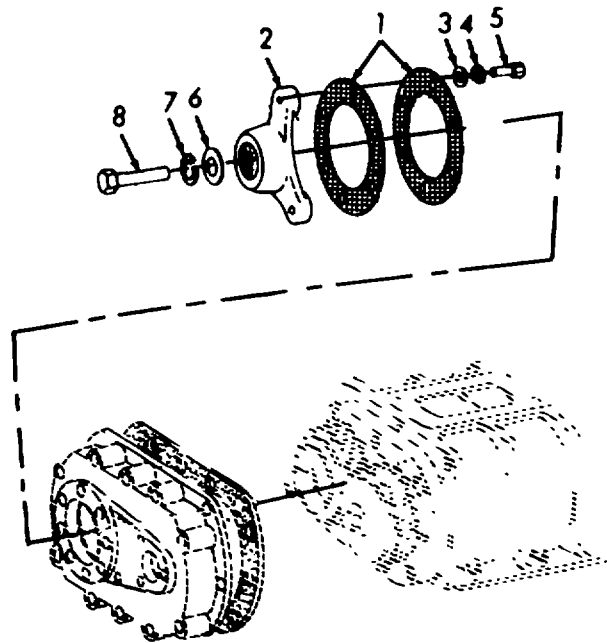


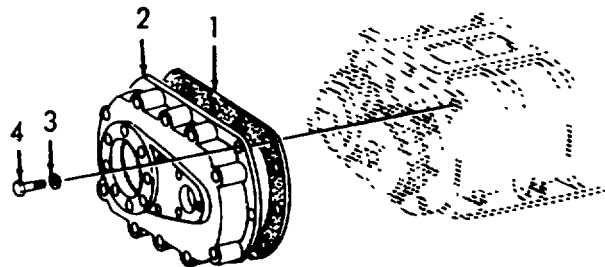
Figure 3-41. Rotor Timing.

**3-19. BLOWER - Continued.**f. Assembly - Continued.

- (46) Refer to figure 3-42 and install plates (1) to hub (2). Secure with three washers (3), three lockwashers (4), and three bolts (5). Torque bolts to 25-30 lb-ft (34-41 Nm).
- (47) Install hub (2) and secure with three washers (6), three lockwashers (7), and three bolts (8). Torque bolts to 25-30 lb-ft (34-41 Nm).

**Figure 3-42. Drive Hub, Installation.**

- (48) Refer to figure 3-43 and install gasket (1) and cover (2).
- (49) Install ten washers (3) and ten bolts (4). Torque bolts to 13-17 lb-ft (18-23 Nm).

**Figure 3-43. End Covers, Installation.**

g. Installation. (Refer to figure 3-26).

- (1) Use adhesive (item 1, Appendix C) and install gasket (4) to the engine block.
- (2) Install blower drive shaft cover (6) and secure with clamp (5).
- (3) Place blower (3) into position against the cylinder block, being careful not to dislodge the blower gasket.
- (4) Install eight blower mounting bolts (1) and eight flat washers (2).
- (5) Install fresh water pump (paragraph 3-25).
- (6) Install fuel pump (paragraph 3-22).
- (7) Install air inlet housing (paragraph 3-18).
- (8) Install air cleaners (paragraph 3-15, TM 55-1930-208-10).
- (9) Install blower drive shaft (paragraph 3-21).
- (10) Install hydraulic speed control governor (paragraph 3-17).
- (11) Fill cooling system with coolant per paragraph 3-20, TM 55-1930-208-10, start engine and check operation.

### 3-20. BLOWER DRIVE.

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**This task covers:**

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

**INITIAL SETUP:**

Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

Materials Required:

Gasket P/N 5148810  
Oil, Engine (Item 8, Appendix C)  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

**3-20. BLOWER DRIVE - Continued.**a. Removal. (Refer to figure 3-44).

- (1) Remove the six bolts that secure the flywheel housing small hole cover.
- (2) Remove snap ring (1). Pull blower drive shaft (2) out of the drive assembly.
- (3) Disconnect blower drive oil line (3) from blower drive support.
- (4) Loosen hose clamps (4) and remove gaskets (5) and bushing (6).
- (5) Straighten the ears on lockwasher (7) and loosen drive gear hub nut (8).
- (6) Remove blower drive support attaching bolt (9) and lockwashers (10).
- (7) Loosen blower drive support (11) by tapping it lightly and withdraw the support from the cylinder block rear end plate. Take care to prevent damage to blower drive gear teeth. Discard gasket (12).

b. Disassembly.

- (1) Refer to figure 3-44 and secure blower drive gear and support assembly in a vise with soft jaws.
- (2) Take out drive coupling bolts (13) and lockwashers (14) and remove retainer (15) and coupling support (16).
- (3) Remove drive gear hub nut (8), lockwasher (7), thrust washer (17), and lock ball (18).
- (4) Press gear hub (19) out of gear (20).
- (5) Remove cam follower (21), springs (22), and seats (23) from coupling support (16).
- (6) Remove thrust washer (24) and bearing (25) from housing.
- (7) Remove oil filler cap (26), oil filler tube (27), and strainer (28) from housing.
- (8) Disconnect chain (29) from filler cap and tube.
- (9) Remove plug (30) from housing.

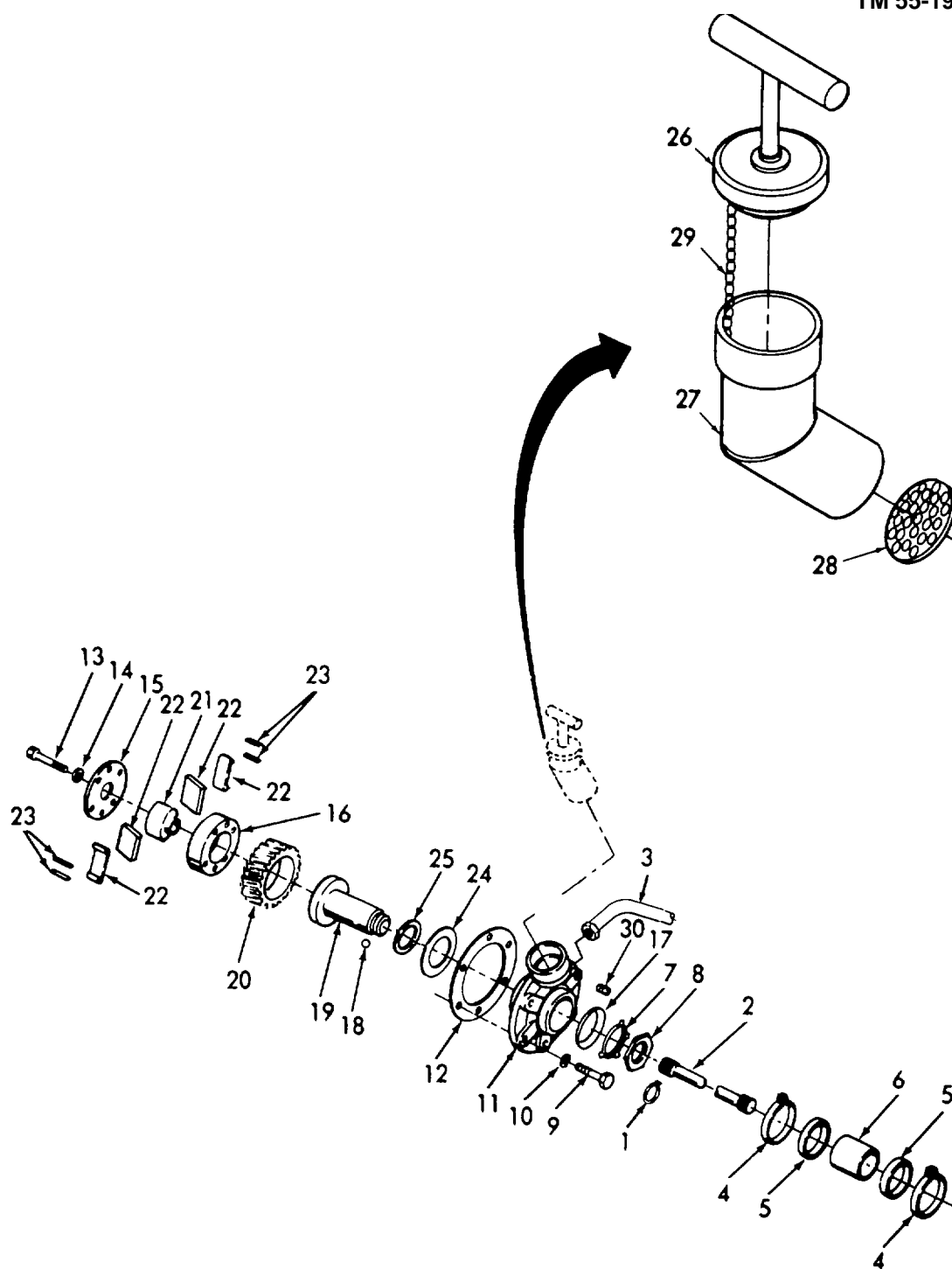


Figure 3-44. Blower Drive, Removal, Disassembly, Reassembly, and Installation.

**3-20. BLOWER DRIVE - Continued.**c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts thoroughly with cleaning solvent (item 4, Appendix C) and dry thoroughly.
- (2) Make sure that oil grooves, oil holes, and cavities are free of dirt.

d. Inspection.

- (1) Check for worn or scored thrust washers.
- (2) Inspect blower drive coupling support, cam, spring seats, and spring packs for worn or damaged parts.
- (3) Check for worn or damaged serrations on blower drive shaft.
- (4) Examine blower drive gear for worn, scored, or pitted teeth.

e. Repair. Repair of the blower drive consists of the replacement of defective parts.f. Reassembly.

- (1) Refer to figure 3-44 and install plug (30) in housing.
- (2) Attach chain (29) between oil filler cap (26) and oil filler tube (27). Install filler cap and filler tube with strainer (28) in housing.
- (3) Press drive gear hub (19) into drive gear (20).
- (4) Lubricate drive gear hub, bearing (25) in the housing, thrust surfaces, and thrust washer with engine oil (item 8, Appendix C).
- (5) Place thrust washer (24) on the protruding bearing in gear side of housing and insert drive gear and hub assembly.
- (6) Locate lock ball (18) in its place on drive gear hub and slide thrust washer (17) into position over lock ball. Thrust washer must be installed with tapered face toward the threads on the hub.
- (7) Install new lockwasher (7) and finger tighten hub nut (8). Install two bolts into threaded holes in drive gear hub. Place a suitable holding bar across bolts to keep hub from rotating and tighten hub nut to 50-60 lb-ft (68-81 Nm). Bend the ears of lockwasher against the nut, to lock the nut in place. Remove two bolts from gear hub.

- (8) Place blower drive coupling support (16) on wood blocks. Install call] (21), springs (22), and seats (23) in coupling support.
- (9) Place coupling support against the drive gear with blower drive shaft ring groove in the cam facing away from drive gear. Then, place drive coupling retainer (15) against the coupling support with the flared edge away from the support.
- (10) Revolve coupling assembly on hub flange until cam lobes are in line with oil grooves in the gear hub. Then, install drive coupling bolts (13) and lockwashers (14).

g. Installation.

- (1) Refer to figure 3-44 and place a new gasket (12) on mounting face of blower drive support (11).
- (2) Attach blower drive support assembly to cylinder block end plate with bolts (9) and lockwashers (10).
- (3) Install bushing (6) and gaskets (5). Tighten hose clamps (4).
- (4) Connect blower drive oil line (3) to drive support.
- (5) Insert blower drive shaft (2) into rotor gear hub. The end without the groove for the retaining ring must be inserted first.
- (6) Lock drive shaft in place by installing snap ring (1) in groove provided in coupling cam.
- (7) Replace flywheel housing small hole cover and secure with six bolts.

**3-21. PUMP, FUEL.**


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This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Tool Set, Fuel Pump (Item 2, Appendix B)  
 Oil Seal Remover (Item 3, Appendix B)  
 Oil Seal Installer (Item 4, Appendix B)  
 Oil Seal Installer (Item 5, Appendix B)  
 Fuel Pump Holding Fixture (Item 6, Appendix B)  
 Fuel System Primer (Item 7, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 5150193  
 Gasket P/N 5161003  
 Grease, Light (Item 11, Appendix C)  
 Seal P/N 5107223  
 Solvent, Cleaning (Item 4, Appendix C)

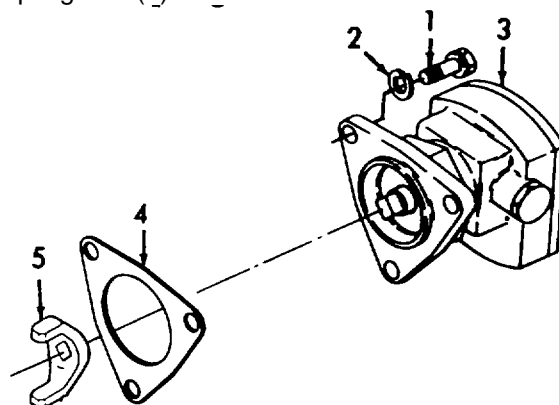
**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Fuel lines removed.

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**a. Removal.** (Refer to figure 3-45).

- (1) Remove three screws (1) and three lockwashers (2).
- (2) Remove fuel pump (3) and gasket (4). Discard gasket (4).
- (3) Remove drive coupling fork (5).

**Figure 3-45. Fuel Pump, Removal/Installation.**

b. Disassembly. (Refer to figure 3-46).

- (1) Mount the fuel pump in the fuel pump holding fixture.
- (2) Remove eight bolts (1), eight lockwashers (2), and cover (3). Take care not to damage the finished surfaces on the cover (3) and the body (4).
- (3) Remove the drive shaft, drive gear as an assembly.
- (4) Using an arbor press, press the drive shaft just far enough to remove ball (7). Then, invert shaft and gear assembly in press and press shaft (5) from gear (6).

**NOTE**

Do not press square end of shaft through the gear, as light score marks will damage the oil seal contact surface.

- (5) Remove the driven gear and shaft assembly (8).
- (6) Remove plug (9), gasket (10), spring (11), pin (12), and valve (13). Discard gasket (10).

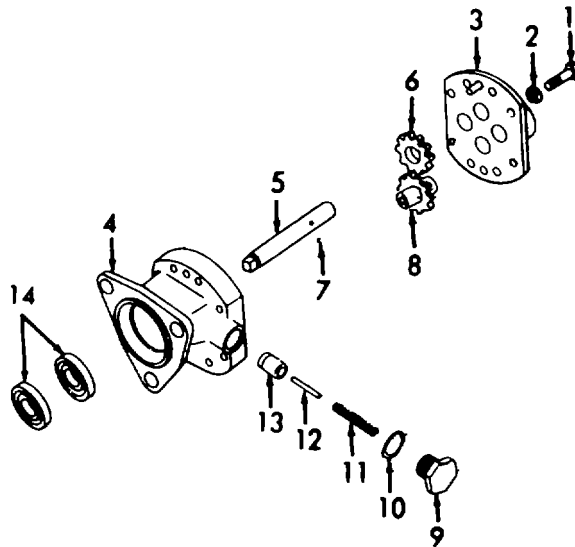


Figure 3-46. Fuel Pump, Disassembly/Reassembly.

### 3-21. PUMP, FUEL - Continued.

#### b. Disassembly - Continued.

- (7) Clamp the pump body in a vise. Use oil seal remover tool (figure 3-47) and remove inner and outer oil seals (14, figure 3-46).

GRAPHIC OMITTED

**Figure 3-47. Oil Seal Remover Tool.**

#### c. Cleaning.

- (1) Clean the fuel pump with fuel oil (item 9, Appendix C).
- (2) Allow to dry.

#### d. Inspection.

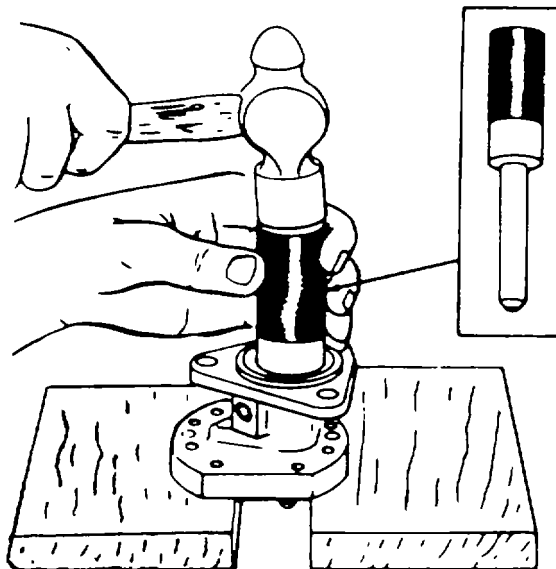
- (1) Inspect for cracks, dents and obvious damage.
- (2) Inspect for damaged or missing hardware.
- (3) Inspect gear teeth for wear, scoring, and chipping.
- (4) Inspect shafts for wear, scoring, and burrs.
- (5) Inspect cover and body for wear at gear and shaft contact points. Check mating surfaces for nicks, scratches, and burring.
- (6) Inspect relief valve for scoring and burrs. Valve should fit in body with little or no play.

#### e. Repair. Repair is limited to the replacement of defective components.

#### f. Assembly. (Refer to figures 3-48 through 3-50).

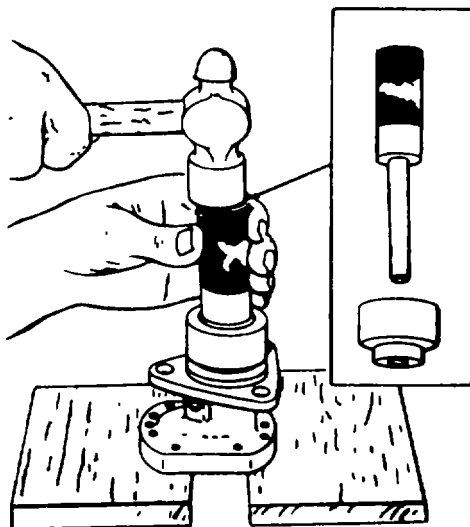
- (1) Lubricate the lips of the oil seals with light grease (item 11, Appendix C).
- (2) Refer to figure 3-48. Support the body with wooden blocks.
- (3) Place the seal over the pilot of the seal installation tool.

- (4) Start the seal straight into the body.
- (5) Drive the seal into the body until it bottoms.



**Figure 3-48. Inner Oil Seal, Installation.**

- (6) Refer to figure 3-49. Place the shorter end of the adapter over the installation tool pilot and against the tool handle.
- (7) Place the outer oil seal over the pilot with the lip facing the adapter.
- (8) Start the seal straight into the body.
- (9) Drive in the seal until the shoulder of the adapter contacts the pump body.

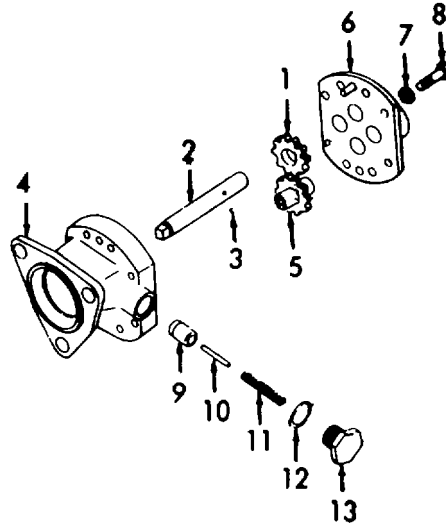


**Figure 3-49. Outer Oil Seal, Installation.**

### 3-21. PUMP, FUEL- Continued.

f. Assembly - Continued.

- (10) Refer to figure 3-50. Press the gear (1) onto the shaft (2) and beyond the ball slot.
- (11) Install the steel ball (3) then press the gear back until the slot contacts the ball (3).
- (12) Lubricate the pump shaft (2) with light grease (item 11, Appendix C) and install shaft to body (4).



**Figure 3-50. Fuel Pump, Assembly.**

- (13) Lubricate the driven gear shaft (5) with light grease (item 11, Appendix C) and install.

**CAUTION**

Use care that sealant is not squeezed into the gear compartment, otherwise damage to the gears and shaft may result.

- (14) Apply a thin coat of sealant (item 21, Appendix C) to the cover mating surface. Install cover (6) and secure with eight lockwashers (7) and eight bolts (8).

**NOTE**

The coating of sealant must be extremely thin since the pump clearances have been set up on the basis of metal-to-metal contact. Too much sealant could increase the clearances and affect the efficiency of the pump.

- (15) Install valve (9), pin (10), spring (11), gasket (12), and plug (13). Torque plug (13) to 18-22 lb-ft (24-30 Nm).
- (16) Turn pump shaft by hand to ensure the gears rotate freely.

g. Installation.

- (1) Refer to figure 3-45 and install new gasket (4) to pump mounting flange. Install drive coupling fork (5) on shaft.
- (2) Place the fuel pump (3) against the blower, being certain that the drive coupling fork registers with the slots in the drive disc on the blower rotor shaft.
- (3) Install and tighten three lockwashers (2) and three screws (1).

### 3-22. INJECTOR, FUEL.

---

This task covers:

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

#### INITIAL SETUP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Socket, Injector Nut (Item 8, Appendix B)  
 Remover, Injector (Item 9, Appendix B)  
 Reamer, Hand (Item 10, Appendix B)  
 Socket, Injector Nut (Item 11, Appendix B)  
 Driver, Spray Tip (Item 12, Appendix B)  
 Spray Tip Orifices Cleaning Tool (Item 13, Appendix B)  
 Spray Tip, Cleaning Tool (Item 14, Appendix B)  
 Wire, Orifice Cleaning .005 In. Diameter (Item 15, Appendix B)  
 Wire, Orifice Cleaning .006 In. Diameter (Item 16, Appendix B)  
 Stone (Item 17, Appendix B)  
 Brush, Fuel Hole (Item 18, Appendix B)  
 Brush, Rock Hole (Item 19, Appendix B)  
 Reamer (Item 20, Appendix B)  
 Tester, Fuel Injector (Item 21, Appendix B)  
 Fuel Output Tester (Item 22, Appendix B)  
 Tester, Rack (Item 23, Appendix B)  
 Reamer (Item 24, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

##### Materials Required:

Caps, Line (for fuel lines)  
 Filter Element P/N 5228587  
 Gasket P/N 5229167  
 Solvent, Cleaning (Item 4, Appendix C)

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Rocker cover removed (paragraph 3-34).

---

### 3-22. INJECTOR, FUEL- Continued.

a. Removal. (Refer to figure 3-51).

- (1) Remove both fuel pipes (1 and 2) from the injector. Cap both the injector ports and the fuel port on the head.
- (2) Remove the rocker arms per paragraph 3-63.
- (3) Remove bolt (3), flat washer (4), and clamp (5).
- (4) Loosen both adjustment screws on the injector rack control lever and remove the lever out of the injector rack. (Refer to paragraph 3-35).
- (5) Remove the injector (6).
- (6) Cover the injector hole in the head to keep dirt out.

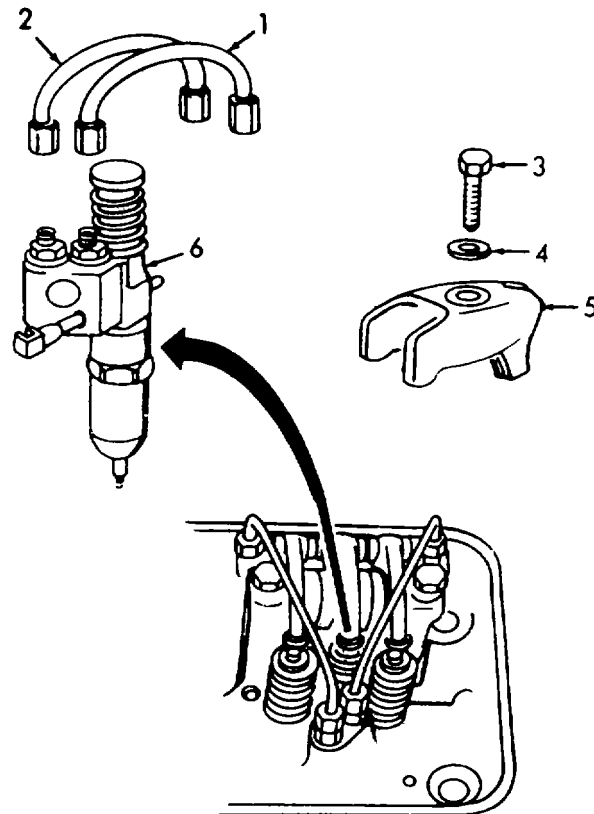


Figure 3-51. Fuel Injector, Removal/Installation.

b. Test. (Refer to figure 3-52).

- (1) Install injector into tester J29584.
- (2) With the injector control rack, held in the no-fuel position, operate the handle to depress the follower to the bottom of its stroke.
- (3) Slowly release pressure on the handle while moving the injector rack up and down until the follower reaches the top of its travel.

- (4) If the rack falls freely the injector passes the test. If the injector fails the rack freeness test, either the plunger is scored or there is a misalignment of the body, bushing, or nut due to irregular or dirty parts.
- (5) Remove injector from tester.

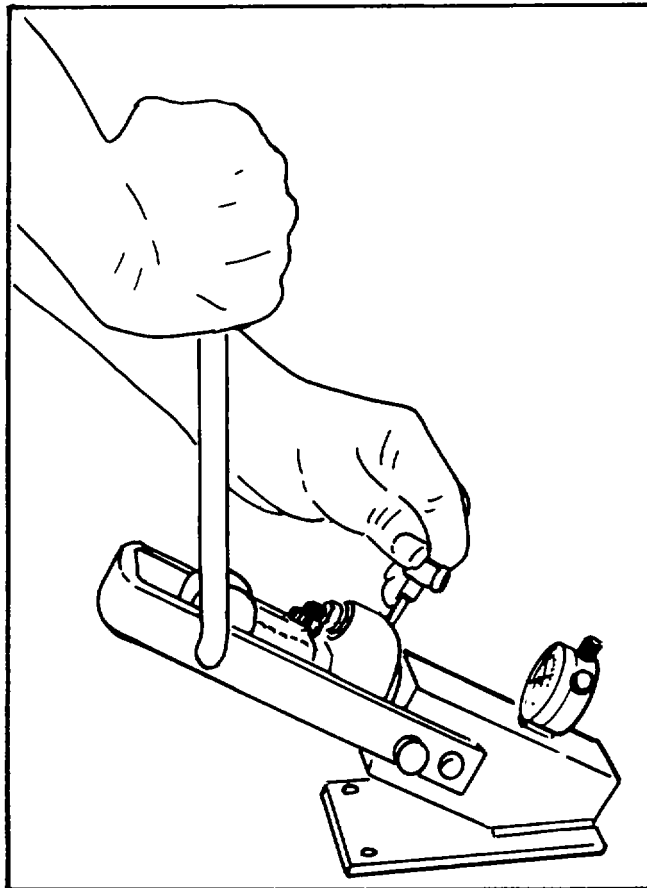
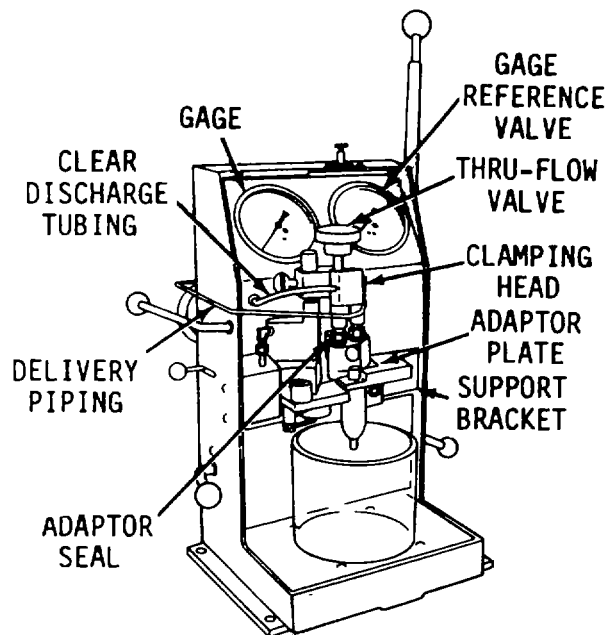


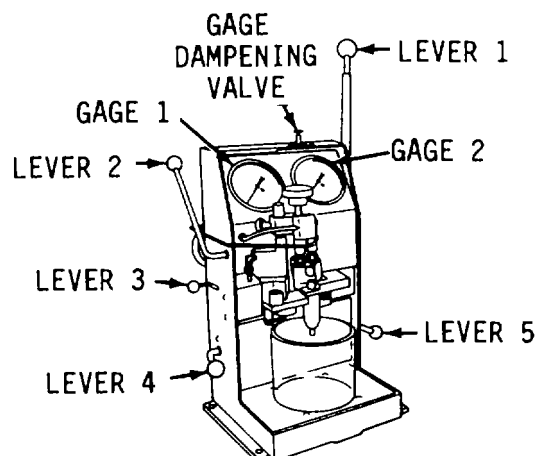
Figure 3-52. Checking Rack for Freeness in Tester J29584.

**3-22. INJECTOR, FUEL - Continued.**b. Test Continued.

- (6) Refer to figure 3-53. Install the clamping head on the clamping post and tighten the setscrew into the lower detent position.
- (7) Connect the oil delivery piping to the clamping head.
- (8) Connect the discharge tubing to the pipe on the clamping head.
- (9) Install the injector to the adaptor plate.
- (10) Swing the mounted injector and adaptor plate rearward and adapter plate rearward until they contact the support bracket stop pin.

**Figure 3-53. Injector Installed in Tester J23010.**

- (11) Refer to figure 3-54 and position injector tester levels as follows:
  - (a) Lever 2 up and to the rear.
  - (b) Lever 3 in the rear detent.
  - (c) Lever 4 up (horizontal).
  - (d) Lever 5 up (horizontal).
- (12) Aline the clamping head seals over the injector filter caps.



**Figure 3-54. Injector in Position for Testing.**

- (13) Refer to figure 3-53. Back off the Thru-Flow Valve halfway.
- (14) Hold the clamping head in position over the filter caps and, with the left hand, operate pump lever 1 evenly to move the clamping head down to seal the filter caps. Be sure the Thru-Flow Valve moves freely.
- (15) Move lever 4 down and operate pump lever 1 to produce a test oil flow through the injector.
- (16) Continue pumping lever 1 until air bubbles no longer pass through the discharge tubing.
- (17) Be sure lever 4 is down and set the injector rack in the full-fuel position.
- (18) Place pump lever 1 in vertical position.
- (19) Move lever 3 to forward detent position.
- (20) Pump injector lever 40 to 80 strokes per minute. Observe the spray pattern and check that all spray orifices are open and dispersing the test oil evenly. The beginning and ending of injection should be sharp and the test oil should be finely atomized.
- (21) Note the highest reference gage pressure or Gage No. 2. It should be between 127 and 146.
- (22) Stop pumping and close the Thru-Flow Valve. Be sure lever 4 is down.
- (23) Operate pump lever 1 to build pressure up to 1600 to 2000 psi (11,024 to 13,078 kPa) on Gage No. 1.
- (24) Check for leakage at the filter cap gaskets, body plugs, and nut seal ring. Open the Thru-Flow Valve and allow the pressure to bleed off.

### 3-22. INJECTOR, FUEL - Continued.

b. Test Continued.

- (25) Close the Flow-Thru Valve.
- (26) Move lever 2 to the rear horizontal position.
- (27) Operate pump lever 1 until Gage No. 1 reads 700 psi (4,823 kPa).
- (28) Move lever 4 to the up position.
- (29) Time the pressure drop between 450 to 250 psi (3,100 to 1,723 kPa). If the pressure drop occurs in less than 15 seconds, leakage is excessive.

**NOTE**

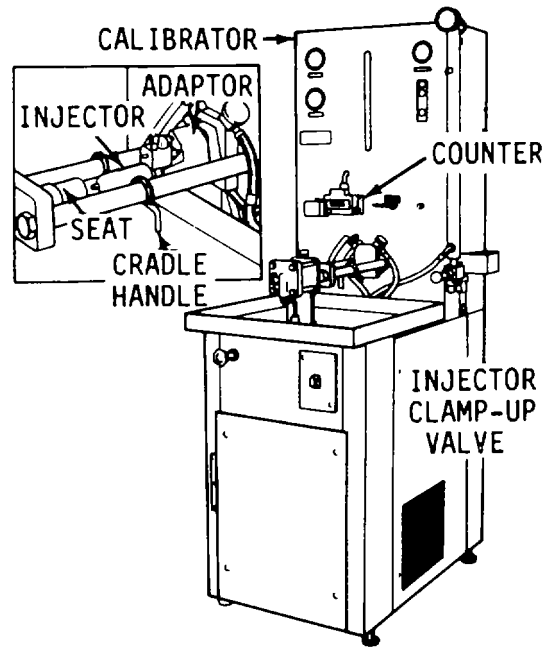
- If the injector has failed any of the above testing, disassemble, clean and inspect the injector.
- If the injector has passed all the above test, proceed with step (30).

- (30) Refer to figure 3-55. Install the injector to the calibrator test.
- (31) Be sure the camshaft index wheel and the fuel flow lever are set.
- (32) Turn on the test fuel oil heater switch and preheat the oil to 95-105°F (35-40°C).
- (33) Slide the adapter forward and up against the fuel block face.
- (34) With the cradle handle in the vertical position, install the injector seat into the seal.
- (35) Clamp the injector into position by operating the air valve.
- (36) Check that the counter is set for 1000 strokes.
- (37) Pull the injector rack out to the no-fuel position.
- (38) Turn on the main power control switch.

**NOTE**

The low oil pressure warning buzzer will sound until the lubricating oil reaches the proper pressure.

- (39) Turn on the motor starter switch.
- (40) After the calibrator has started, set the injector rack to full-fuel position.

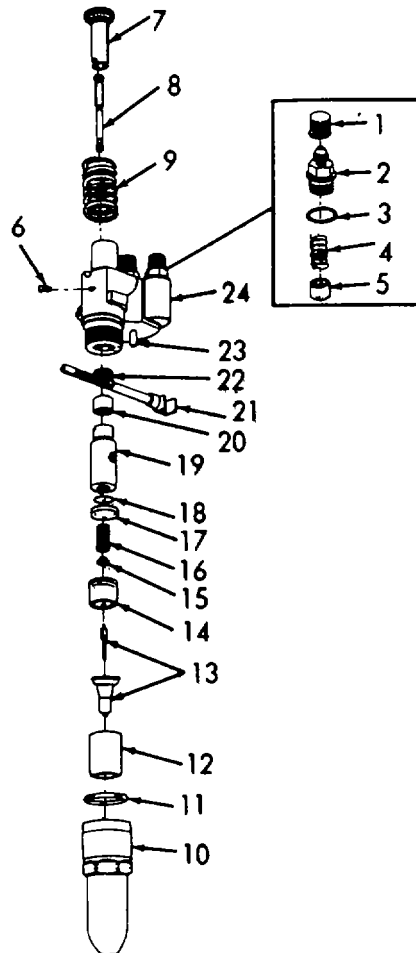


**Figure 3-55. Injector in Calibrator J22410.**

- (41) Allow the injector to be operated for 30 seconds to purge any air.
- (42) Press the red fuel flow start button to start the flow of fuel into the vial. The fuel flow will stop after 1000 strokes.
- (43) Set all switches (motor and power control) to off.
- (44) The amount of fuel in the vial should be between 57 and 62.
- (45) If the injector does not meet the above steps, repair the injector.

**3-22. INJECTOR, FUEL - Continued.**c. Disassembly. (Refer to figure 3-56).

- (1) Remove cup (1), adapter (2), spacer (3), spring (4), and filter element (5).
- (2) Raise spring (4) above stop pin (6) by prying with a screw driver.
- (3) Remove stop pin (6). Slowly allow spring (9) to expand.
- (4) Remove follower (7), plunger (8), and spring (9).
- (5) Remove nut (10), packing (11), spacer (12), and spray tip (13). Discard packing (11).
- (6) Remove seats (14 and 15), spring (16), gage (17), and disk (18).
- (7) Remove bushing (19), spacer (20), rack (21), and gear (22). Remove pin (23) from body (24) if damaged.

**Figure 3-56. Fuel Injector, Disassembly/Reassembly.**

d. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all injector parts with cleaning solvent (item 4, Appendix C). Allow to dry.
- (2) Use spray tip cleaning tool J4298-1 and clean the spray tip.
- (3) Clean the tip orifices with tool J1243 and tip cleaning wires J21459-01 or J2146-01.
- (4) Hone the end of the spray tip with stone J8170.
- (5) The exterior may be cleaned with a brass wire buffing wheel.
- (6) Clean and brush all passages in the injector body using fuel hole cleaning brush J8152 and rack hole cleaning brush J8150. Wash body in cleaning solvent (item 4, Appendix C) and allow to dry.
- (7) Carefully insert reamer J21089 in the injector body. Turn reamer 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 reaming procedure until the reamer makes contact with the entire face of the ring. Clean up the opposite side of the ring in the same manner.
- (8) Carefully insert reamer J4986-01 in the injector nut. Turn the reamer in a clockwise direction a few turns, then remove the reamer and check the face of the seat for reamer contact over the entire surface. Repeat the reaming procedure until the reamer makes contact with the entire face of the seat.
- (9) Wash injector nut in cleaning solvent (item 4, Appendix C) and allow to dry.

e. Inspection.

- (1) Inspect the teeth on the control rack and gear for wear or damage. Check the gear bore for wear.
- (2) Inspect the follower and stop pin for damage or wear.
- (3) Inspect the spill deflector for damage or burrs.
- (4) Inspect the springs for deformations or other damage.
- (5) Inspect the injector body for loose pins and plugs. Check the interior for scratches, scuff marks, or other damage.

**3-22. INJECTOR, FUEL - Continued.**e. Inspection Continued.

- (6) Inspect the plunger and bushing for scoring, erosion, chipping, or wear. Check for sharp edges on the gear mating surface. Check the plunger and bushing for free movement.
- (7) Inspect the nut and spray tip for cracks, nicks, burrs, erosion, or brinelling.
- (8) Inspect the needle valve for wear and damage.

f. Repair. Repair is limited to the removal of burrs, the lapping of sealing surfaces, and the replacement of defective parts.

g. Reassembly.

- (1) Refer to figure 3-56 and install pin (23) in body (24), if removed.
- (2) Install the rack (21) through the hole in the body. Slide the rack until you can see the drill marks on the rack.
- (3) Install gear (22) into the body, so that the drill mark on the gear is between the drill marks on the rack (21).
- (4) Place bushing (20) on top of gear. Align the locating pin on bushing (19) with the slot in the injector body and slide the bushing (19) into place.
- (5) Install disk (18), gage (17), spring (16), and seats (14 and 15).
- (6) Install spray tip (13), spacer (12), new packing (11), and nut (10). Torque nut (10) to 75-85 lb-ft (102-115 Nm).
- (7) Install spring (9), plunger (8), and follower (7).
- (8) Place pin (6) into position so the spring (9) rests on the flange of pin (6).
- (9) Aline the slot in the follower (3) with the stop pin hole in the body (24).
- (10) Aline the flat spot on the plunger with the slot in the follower.
- (11) Insert the free end of the plunger (8) into the body (24). Press down on the follower (7) and at the same time press the stop pin (6) into position. When in place, the spring (9) will hold the stop pin (6) in position.
- (12) Install the injector into the concentricity gage and check for total runout.
- (13) If runout exceeds 0.008 inches, loosen injector nut and reposition spray tip. Retorque nut and recheck runout.

(14) Perform all tests contained in paragraph 3-22b.

h. Installation.

- (1) Refer to figure 3-51 and remove caps on injector body and fill with fuel oil (item 9, Appendix C).
- (2) Install injector (6) into the cylinder head. Be sure the pin on the injector body goes into the hole provided in the cylinder head.
- (3) Slide the injector rack control lever into the injector rack and tighten the adjustment screws.
- (4) Install clamp (5), flat washer (4), and screw (3). Torque screw to 20-25 lb-ft (27-34 Nm).
- (5) Install the rocker arm cover per paragraph 3-34.
- (6) Install both fuel pipes (1 and 2) to the injector and fuel ports in the head. Torque fuel pipe connections to 12-15 lb-ft (16-20 Nm).

### 3-23. COOLER, LUBRICATION OIL.

---

This task covers:

- |               |             |                 |
|---------------|-------------|-----------------|
| a. Removal    | b. Cleaning | c. Testing      |
| d. Inspection | e. Repair   | f. Installation |
- 

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Gasket P/N 5150154  
 Gasket P/N 5150155  
 Gasket P/N 5175882  
 Gasket P/N 8923223  
 Hydroxide, Sodium (Item 16, Appendix C)  
 Primer Coating (Item 18, Appendix C)  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock P/N MS35338-46

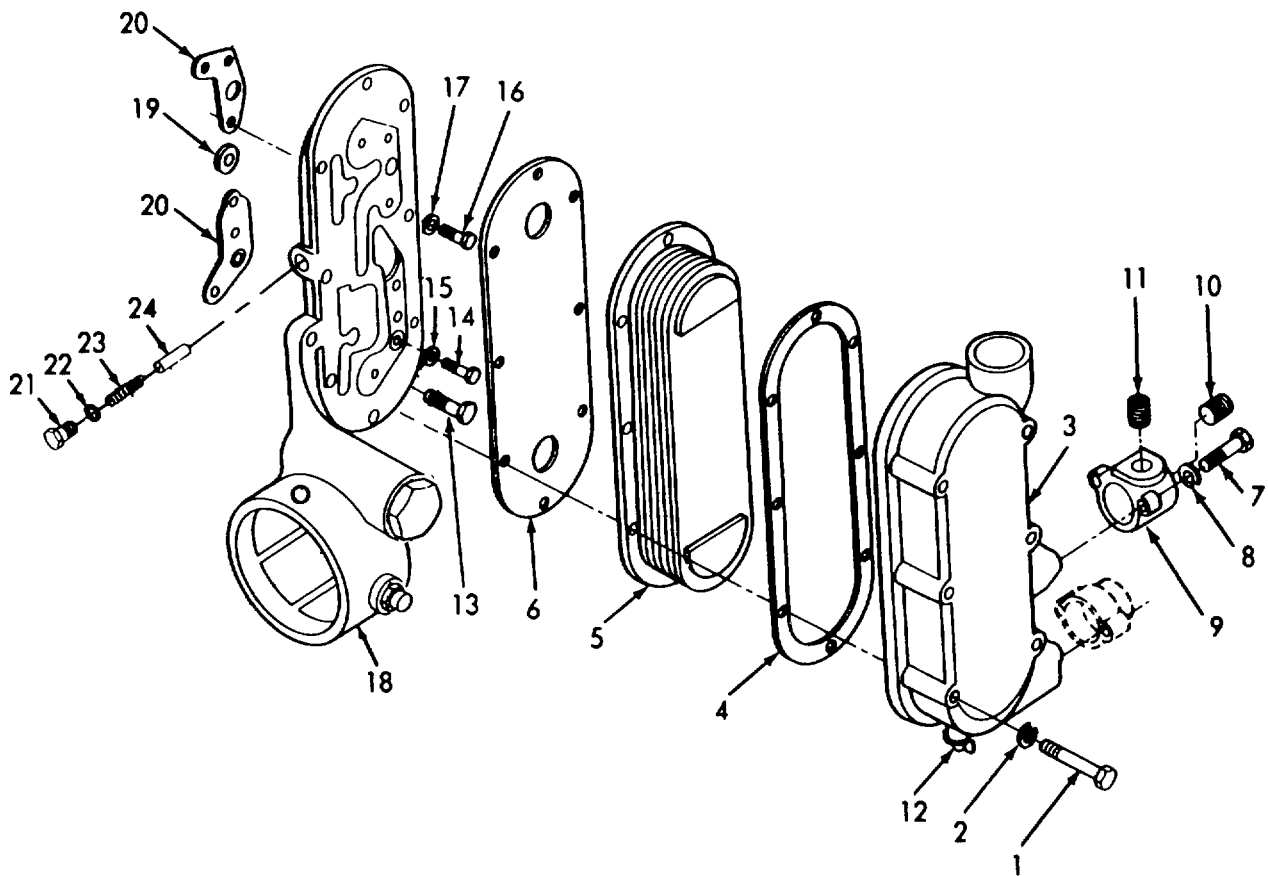
Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Coolant drained (paragraph 2-17, TM 55-1930-208-10).

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**3-23. COOLER, LUBRICATION OIL - Continued.**a. Removal. (Refer to figure 3-57).

- (1) Remove upper and lower hoses.
- (2) Remove six bolts (1), six lockwashers (2), and housing (3).
- (3) Remove and discard gasket (4).
- (4) Remove core assembly (5), remove and discard gasket (6).
- (5) Remove two bolts (7), two lockwashers (8), and connector (9). Remove plugs (10 and 11) from connector.
- (6) Remove drain cock (12) from housing (3).
- (7) Remove two screws (13), bolt (14), flat washer (15), three screws (16), three lockwashers (17), and adapter (18).
- (8) Remove and discard gasket (19) and two gaskets (20).
- (9) Remove plug (21), flat washer (22), spring (23), and valve (24) from adapter (18).

**Figure 3-57. Lube Oil Cooler, Removal/Installation.**

b. Cleaning.

(1) Clean oil side of core as follows:

(a) Drain any oil remaining in oil cooler core.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

(b) Force cleaning solvent (item 4, Appendix C) through the passages to remove carbon and sludge build-up.

**NOTE**

If the core is exceptionally dirty, consider "hot tanking" the core.

(2) Clean the coolant side of the core as follows:

**NOTE**

Do not attempt to clean an oil cooler core when an engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil. Replace the core.

**WARNING**

The sodium hydroxide will cause severe burns if it comes in contact with your skin. Wear eye protection, rubber gloves, and a rubber apron. Use extreme care as not to splash the solution. If the solution does come in contact with your skin or clothing, neutralize the solution immediately with baking soda. Seek prompt medical attention.

(a) Carefully immerse the oil cooler core into the solution and allow the core to remain in the solution until the bubbling and foaming stops (normally, thirty to sixty seconds).

(b) Remove the core and flush thoroughly with clean, hot water under pressure.

**WARNING**

Use the recommended air pressure (under 35 psi line 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 a personal injury.

**3-23. COOLER, LUBRICATION OIL - Continued.**b. Cleaning Continued.

(2) Clean the coolant side of the core as follows Continued:

(c) Dry the core with low pressure, compressed air.

(d) Apply primer coating to core after drying.

**NOTE**

Do not attempt to clean an oil cooler core when an engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil. Replace the core.

c. Testing.

(1) Make a suitable plate and attached to the flanged side of the oil cooler core.

(2) Make a rubber gasket to insure a tight seal between the plate and core.

(3) Drill and tap the plate to permit an air hose fitting to be attached at the inlet side of the oil cooler core.

**WARNING**

Wear eye protection to prevent personal injury in the event that there is a rupture in the pressurized system.

(4) Attach an air hose and apply 75-150 psi (517-1034 kPa) air pressure. Then submerge the oil cooler core and plate assembly in a tank of heated water (180°F or 82°C). Any leaks will be indicated by air bubbles in the water.

(5) After the pressure check is completed, remove the plate and air hose and dry the oil cooler core with compressed air. Replace the oil cooler core if leaks were indicated.

d. Inspection.

(1) Inspect for missing or damaged hardware.

(2) Inspect cover for cracks or warping.

(3) Inspect core for cracks or signs of leakage.

e. Repair. Repair is limited to replacement of defective parts.

f. Installation.

- (1) Refer to figure 3-57 and apply a light coat of engine oil (item 8, Appendix C) to valve (24) and install in adapter (18).
- (2) Install spring (23), flat washer (22), and plug (21).
- (3) Install new gaskets (20 and 19) and adapter (18) and secure with three lockwashers (17), three screws (16), three flat washers (15), bolt (14), and two screws (13).
- (4) Install drain cock (12) in adapter (3).
- (5) Install plugs (11 and 10) in connector (9).
- (6) Install connector (9) on adapter (3) and secure with two lockwashers (8) and two screws (7).
- (7) Install gasket (6), core assembly (5), gasket (4), adapter (3), and secure with six lockwashers (2) and six bolts (1).
- (8) Install upper and lower hoses and tighten clamps.

**3-24. PUMP, WATER****This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Drive Coupling Removal Tool (Item 70, Appendix B)

**Materials Required:**

Gasket P/N 5150188  
 Gasket P/N 5150193  
 Packing P/N 5150191  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock P/N MS35338-44  
 Washer, Lock P/N MS35338-45

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

**a. Removal.** (Refer to figure 3-58).

- (1) Open the drain cock in the pump body and draining the cooling system.
- (2) Loosen hose clamps (1) and remove hose (2).
- (3) Loosen hose clamp (3) and remove packing (4).
- (4) Remove two bolts (5), two lockwashers (6), outlet flange (7), and packing ring (8).
- (5) Remove three bolts (9), three lockwashers (10), and withdraw the pump and gasket (11).
- (6) Remove water pump connector (12) from the pump cover.

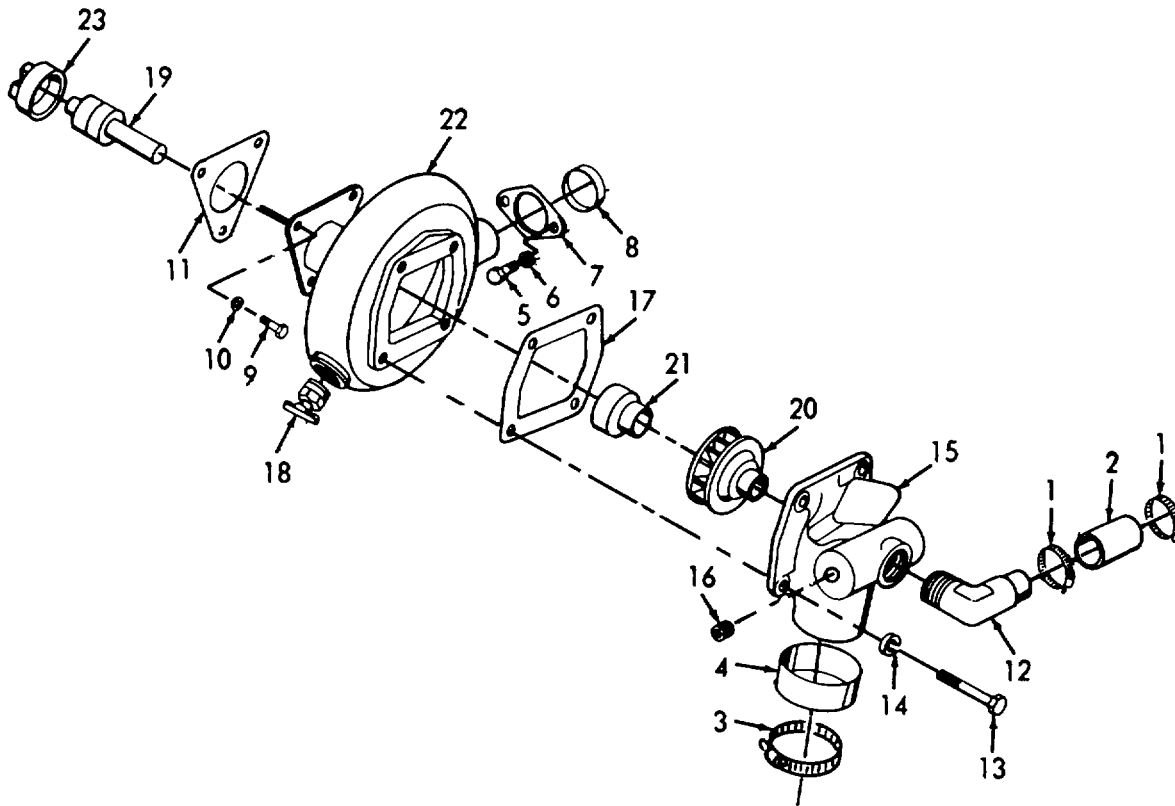
**b. Disassembly.**

- (1) Refer to figure 3-58 and remove four bolts (13) and four lockwashers (14). Separate the pump cover (15) and gasket (17) from the pump body. Remove plug (16).

**NOTE**

Clean the corrosion from around the impeller and shaft before separating the shaft and bearing assembly from the impeller, seal, and pump body.

- (2) Remove drain cock (18) from pump body.
- (3) Support the pump on its mounting flange in an arbor press. Place a short steel rod on the end of the shaft and press the shaft bearing assembly (19) from the impeller (20), seal (21), and pump body (22).



**Figure 3-58. Water Pump, Removal, Disassembly, Reassembly, and Installation.**

- (4) If necessary, remove the shaft drive coupling (23) from the shaft using the drive coupling remover tool.

c. Cleaning

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts, except the shaft and bearing assembly, with cleaning solvent (item 4, Appendix C) and dry thoroughly.
- (2) The sealed type shaft bearing must not be immersed in solvent since dirt may be washed in and the fluid cannot be entirely removed.

**3-24. PUMP, WATER - Continued****d. Inspection.**

- (1) Revolve the pump shaft bearing slowly by hand. Check for any rough spots. If rough spots are detected, replace the shaft and bearing assembly and the seal.
- (2) Examine the impeller and seal components for evidence of wear. If worn, replace them.

**e. Repair.** Water pump repairs are accomplished by replacement of defective parts.**f. Reassembly.**

- (1) Refer to figure 3-58 and support the impeller end of the pump body (22) on an arbor press and insert the coupling end of the shaft and bearing assembly (19) into the pump body. Then press against the outer race of the bearing until the bearing contacts the shoulder in the pump body.
- (2) With the surface of the pump seal (21) clean and free from dirt and metallic particles, apply a thin coat of liquid soap on the inside diameter of the seal. Slide the seal on the pump shaft until it is seated against the insert in the pump body.
- (3) Support the bearing end of the shaft on the bed of an arbor press and press the impeller (20) on the shaft. Do not press against the outer race of the bearing. The end of the shaft must be flush with the face of the impeller hub with the bearing held against the shoulder in the pump body.
- (4) Support the impeller end of the pump shaft on an arbor press and press the shaft drive coupling (23) on the shaft. The coupling must be flush with the end of the shaft. Make sure the coupling is tight on the shaft.
- (5) Rotate the shaft by hand to be sure the rear face of the impeller blades does not rub the pump body.
- (6) Install drain cock (18) in the pump body and install plug (16) in pump cover (15).
- (7) Attach pump cover (15) and new cover gasket (17) to pump body with four bolts (13) and four lockwashers (14).
- (8) Install water pump connector (12) in the pump cover.

**g. Installation.**

- (1) Refer to figure 3-58 and place the pump outlet flange (7) over the pump outlet with the flat side of flange facing the pump body. Slip the packing ring (8) over the pump outlet and next to the flange.

- (2) Use a new gasket (11) at the bolting flange and place the pump against the blower end plate cover so that the lugs on the drive coupling mesh with the lugs on the intermediate shaft coupling. Secure the pump to the blower with three lockwashers (10) and three bolts (9).
- (3) Slide the pump outlet packing ring (8) and packing flange (7) against the cylinder block and secure the flange with two bolts (5) and lockwashers (6).
- (4) Secure packing (4) to pump cover with hose clamp (3).
- (5) Attach hose (2) to pump cover and tighten hose clamps (1).
- (6) Close water pump drain cock and fill the engine cooling system.

### 3-25. FAN BELTS.

---

**This task covers:**

**a. Removal**

**b. Installation**

**c. Adjust**

---

#### **INITIAL SETUP:**

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Washer, Lock P/N MS35338-45

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

#### a. Removal. (Refer to figure 3-59).

- (1) Remove six nuts (1), six lockwashers (2), and six screws (3), and fan guard (4).
- (2) Loosen four bolts (5) securing the fan pulley.
- (3) Loosen adjusting bolt (6) to relieve tension on the fan belts (7).
- (4) Slip the fan belts off the pulleys and over the fan blade.

**3-24. FAN BELTS - Continued**b. Installation.**NOTE**

Replace all belts in the set when one is worn.

- (1) Refer to figure 3-59 and slip the matched belt set (7) over the fan blades and into the grooves of the pulleys.
- (2) Tighten bolt (6) to place sufficient tension on the belts so they are held in place in the grooves of the pulleys.
- (3) Install the fan guard using six screws (3), six lockwashers (2), and six nuts (1).
- (4) Adjust fan belt tension per the following paragraph.

c. Adjust.

- (1) New belts.
  - (a) Refer to figure 3-59 and tighten bolt (6) so that a firm push with the thumb, at a point midway between the two pulleys, will depress the belt 1/2 to 3/4 inch.
  - (b) When proper tension is obtained, tighten four bolts (5) securing the fan pulley.
  - (c) New standard V-belts will stretch after the first few hours of operation. Run the engine for 15 seconds to seat the belts, then readjust the tension. Check the belts again after 1/2 hour and again after 8 hours. If necessary, readjust the belts per the following instructions.
- (2) Belt readjustment.
  - (a) Refer to figure 3-59 and loosen four bolts (5) securing fan pulley.
  - (b) Adjust bolt (6) so that a firm push with the thumb, at a point between the two pulleys, will depress the belt 1/2 to 3/4 inch.
  - (c) When proper tension is obtained, tighten the four bolts (5) securing the fan pulley.

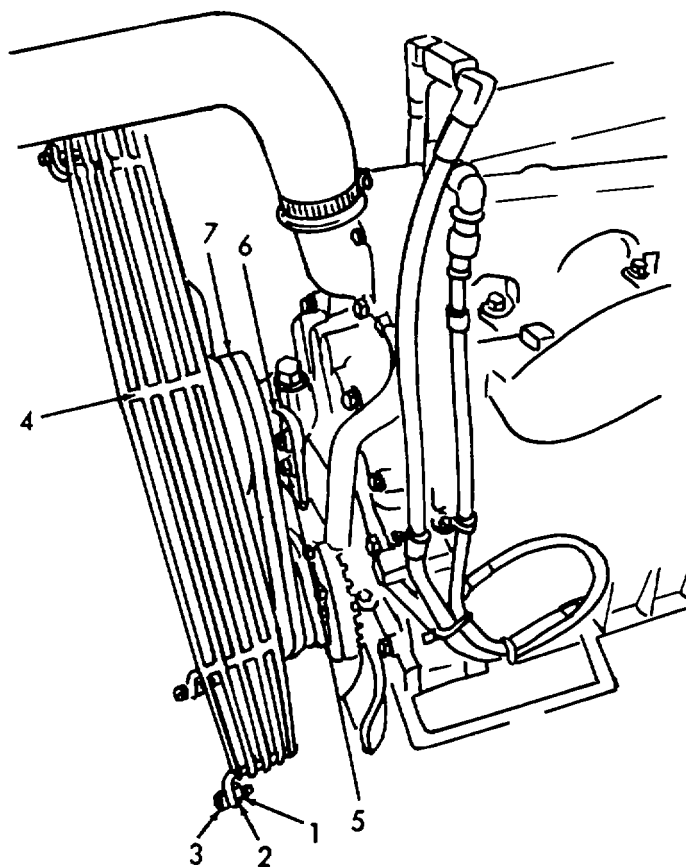


Figure 3-59. Fan Belts, Removal, Installation, and Adjustment.

**3-24. RADIATOR.****This task covers:**

**a. Removal**  
**d. Test**

**b. Cleaning**  
**e. Repair**

**c. Inspection**  
**f. Installation**

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

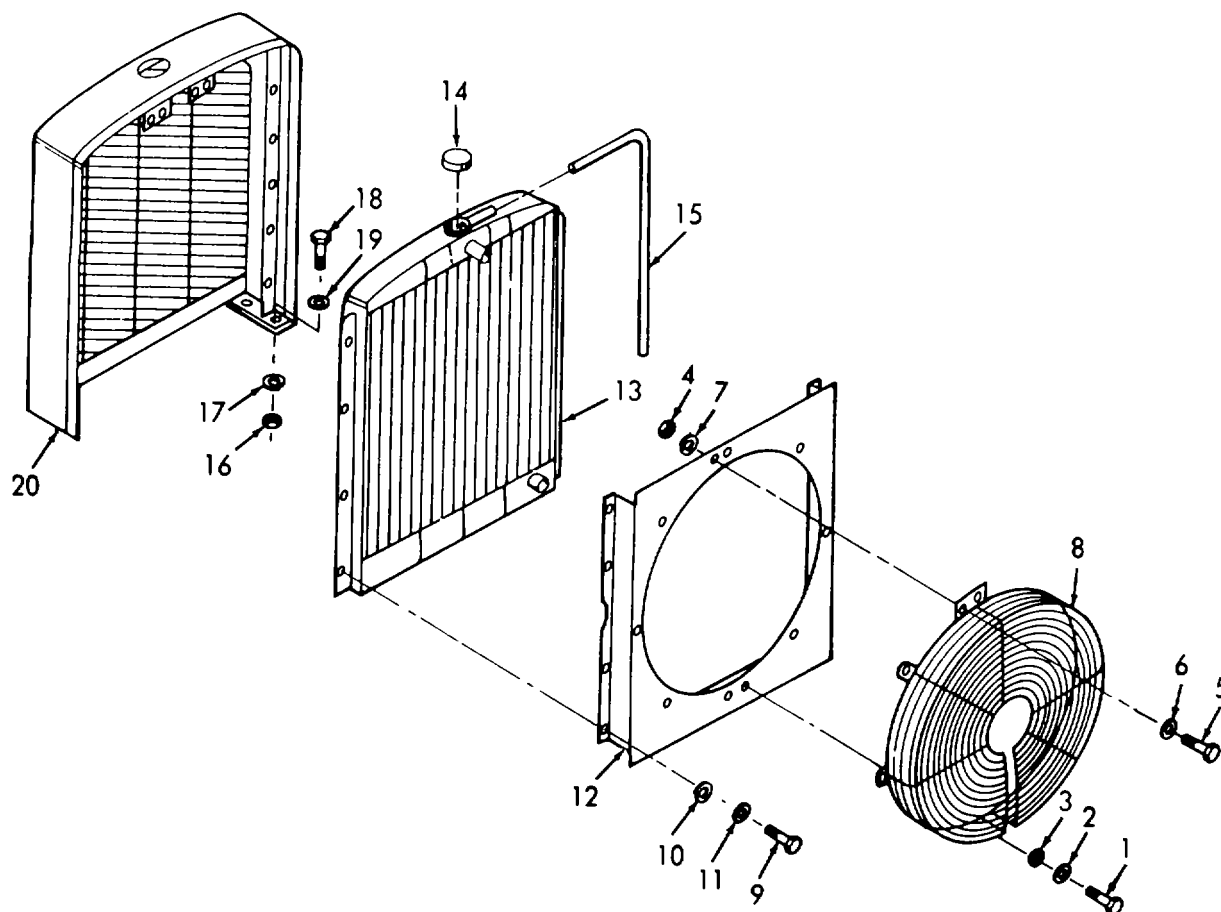
Number 00 Grit Abrasive Paper (Item 17, Appendix C)  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock MS35338-45

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Radiator drained and hoses removed (paragraph 3-20, TM 55-1930-208-10).

**a. Removal.** (Refer to figure 3-60).

- (1) Remove six bolts (1), six lockwashers (2), six flat washers (3), six nuts (4), six screws (5), six lockwashers (6), and six flat washers (7) securing the fan guard (8).
- (2) Remove ten bolts (9), ten lockwashers (10), and ten flat washers (11) securing the fan shroud (12) and radiator (13). Remove filler cap (14) and overflow hose (15) from the radiator.
- (3) Remove four nuts (16), four lockwashers (17), four screws (18), and four flat washers (19) securing the radiator shell (20).



**Figure 3-60. Radiator, Removal/Installation.**

**b. Cleaning.**

- (1) Clean foreign particles from radiator core air passages with filtered compressed air.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (2) Clean exterior surface of radiator with cleaning solvent (item 4, Appendix C).

**c. Inspection.**

- (1) Visually inspect radiator for excessive corrosion, cracked, or broken brazing, and bent cooling fins.
- (2) Check interior of radiator for rust and scale deposits.

### 3-24. RADIATOR - Continued

d. Test.

- (1) Provide an air line fitting at one of the radiator openings.
- (2) Attach an air line to the fitting and submerge the radiator in a container of water.
- (3) Pressurize the radiator to 10-15 psig and check for air bubbles which indicate leakage.

e. Repair.

- (1) Straighten bent cooling fins.
- (2) Remove light corrosion with number 00 grit abrasive paper (item 17, Appendix C).
- (3) Repair leaks and cracked or broken seams by brazing or soldering.
- (4) Replace radiator if damaged beyond repair.

f. Installation.

- (1) Refer to figure 3-60 and attach radiator shell (20) to the frame using four screws (18), four flat washers (19), four lockwashers (17), and four nuts (16).
- (2) Install overflow hose (15) and filler cap (14) on radiator (13).
- (3) Attach radiator and fan shroud (12) to the radiator shell using ten bolts (9), ten lockwashers (10), and ten flat washers (11).
- (4) Install the fan guard (8) and secure with six screws (5), six lockwashers (6), six flat washers (7), six nuts (4), six bolts (1), six lockwashers (2), and six flat washers (3).
- (5) Connect radiator hoses and fill radiator with coolant (paragraph 2-17, TM 55-1930-208-10).

**3-27. MANIFOLD, WATER.****This task covers:****a. Removal****b. Inspection****c. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

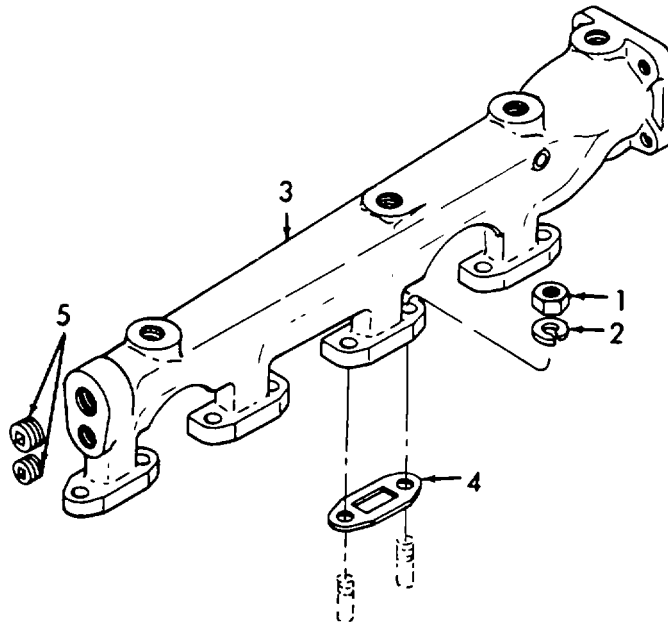
Gasket P/N 5150361  
Washer, Lock MS35338-46

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Coolant drained (paragraph 2-17, TM 55-1930-208-10).  
Thermostat removed (paragraph 3-28).  
Engine shutdown removed (paragraph 3-6).

a. Removal. (Refer to figure 3-61).

- (1) Remove eight nuts (1), eight lockwashers (2), water manifold (3), and four gaskets (4). Discard gaskets (4).
- (2) Remove two plugs (5) from manifold (3).



**Figure 3-61. Water Manifold, Removal/Installation.**

3-27. MANIFLD, WATER - Continued

---

- b. Inspection.
- (1) Inspect for damaged or missing hardware.
  - (2) Inspect manifold for cracks, deformed mating surfaces, rust, and corrosion.
- c. Installation.
- (1) Refer to figure 3-61 and install four new gaskets (4) and place manifold (3) into position.
  - (2) Install eight lockwashers (2) and eight nuts (1). Torque nuts (1) to 25-30 lb-ft (34-41 Nm).
  - (3) Install two plugs (5).
  - (4) Refer to paragraph 2-17, TM 55-1930-208-10 and fill radiator with coolant.
  - (5) Refer to paragraph 3-28 and install the thermostat.

3-28. THERMOSTAT AND HOUSING

---

This task covers:				
a. Removal	b. Cleaning	c. Inspection	d.	Test
e. Installation				

---

INITIAL SETUP:

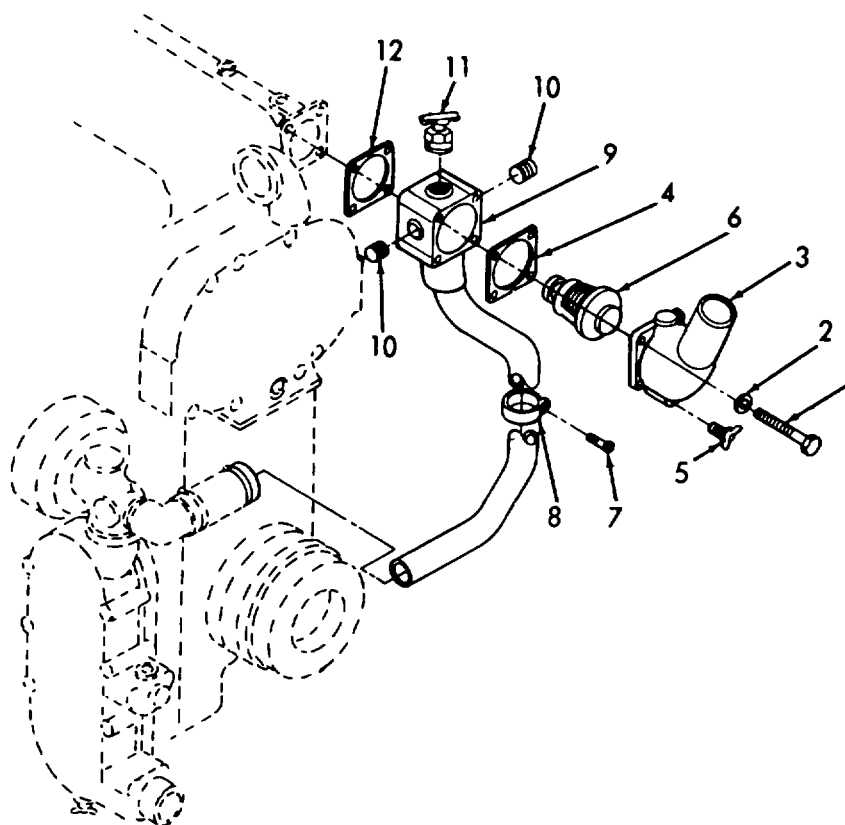
Tools Required:  
Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:  
Cloth, Soft (Item 23, Appendix C)  
Gasket P/N 5169478  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-45

Equipment Conditions:  
Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Coolant drained (paragraph 2-17, TM 55-1930-208-10).

a. Removal. (Refer to figure 3-62).

- (1) Remove radiator upper hose.
- (2) Remove four bolts (1), four lockwashers (2), elbow (3), and gasket (4). Discard gasket (4).
- (3) Remove drain cock (5) and thermostat (6).
- (4) Loosen oil cooler upper hose clamp.
- (5) Remove screw (7), clamp (8), and tube assembly (9). Remove plugs (10). Remove drain cock (11).
- (6) Remove and discard gasket (12).



**Figure 3-62. Thermostat and Housing, Removal/Installation.**

b. Cleaning.

- (1) Remove all buildup of dirt, grease, etc. by wiping with a clean, soft cloth (item 4, Appendix C).

### 3-28. THERMOSTAT AND HOUSING - Continued.

#### b. Cleaning - Continued.

#### **WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (2) Clean all parts using a soft cloth (item 23, Appendix C) and cleaning solvent (item 4, Appendix C).
- (3) Allow to dry.

#### c. Inspection.

- (1) Inspect for damaged or missing hardware.
- (2) Inspect thermostat housing for cracks, deformed mating surfaces, rust, or corrosion.

#### d. Test. Check thermostat operation as follows:

- (1) Put the thermostat in a container of water.
- (2) Place a thermometer in the water. Do not allow the thermometer to touch the bottom or sides of the container.
- (3) While slowly agitating the water to maintain an even temperature, apply heat to the water.
- (4) The thermostat should be fully open at approximately 185-195°F (85-91°C). Allow at least 10 minutes for the thermostat to react.
- (5) Upon completion of the check, remove the thermostat from the water and turn off the heat.

#### e. Installation.

- (1) Refer to figure 3-62 and install drain cock (11) and plugs (10) in tube assembly (9).
- (2) Position a new gasket (12) on water manifold. Install tube assembly (9), clamp (8), and screw (7).
- (3) Tighten oil cooler upper hose clamp.
- (4) Install drain cock (5) in elbow (3).
- (5) Position a new gasket (4) on tube assembly (9).

- (6) Install thermostat (6), elbow (3), and secure with four lockwashers (2) and four bolts (1).
- (7) Install upper radiator hose and tighten clamps.
- (8) Refer to paragraph 2-17, TM 55-1930-208-10, and fill radiator with coolant.

### 3-29. TACHOMETER.

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**This task covers:**

**a. Removal**

**b. Installation**

---

#### **INITIAL SETUP:**

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Seal P/N 3202615

Washer, Lock P/N MS35338-47

Washer, Lock P/N MS35338-48

Washer, Lock P/N 120217

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

**3-29. TACHOMETER - Continued.****a. Removal.** (Refer to figure 3-63).

- (1) Loosen nut (1) and disconnect the drive shaft (2).
- (2) Remove four screws (3) and four lockwashers (4) securing the tachometer mounting adapter.
- (3) Remove the cover seal (5), drive cover (6), and cover adapter (7).
- (4) Remove three nuts (8), three screws (9), and three lockwashers (10). Separate the resilient mount (11) and mounting adapter (12) from the tachometer. Remove screw (13) and lockwasher (14) from the adapter.
- (5) Remove two nuts (15), two lockwashers (16), two flat washers (17), two flat washers (18), and separate the retainer (19) from tachometer (20).

**b. Installation.**

- (1) Refer to figure 3-63 and place two flat washers (18) over the mounting studs of tachometer (20).
- (2) Attach retainer (19) to the tachometer using two washers (17), two lockwashers (16) and two nuts (15).
- (3) Install screw (13) and lockwasher (14) in the tachometer adapter (12). Then, mount the assembled tachometer in the adapter with resilient mount (11), three screws (9), three lockwashers (10), and three nuts (8).
- (4) Mount the assembled tachometer to the housing using four screws (3) and four lockwashers (4).
- (5) Install cover adapter (7), drive cover (6), and seal (5). Attach drive shaft (2) and tighten nut (1).

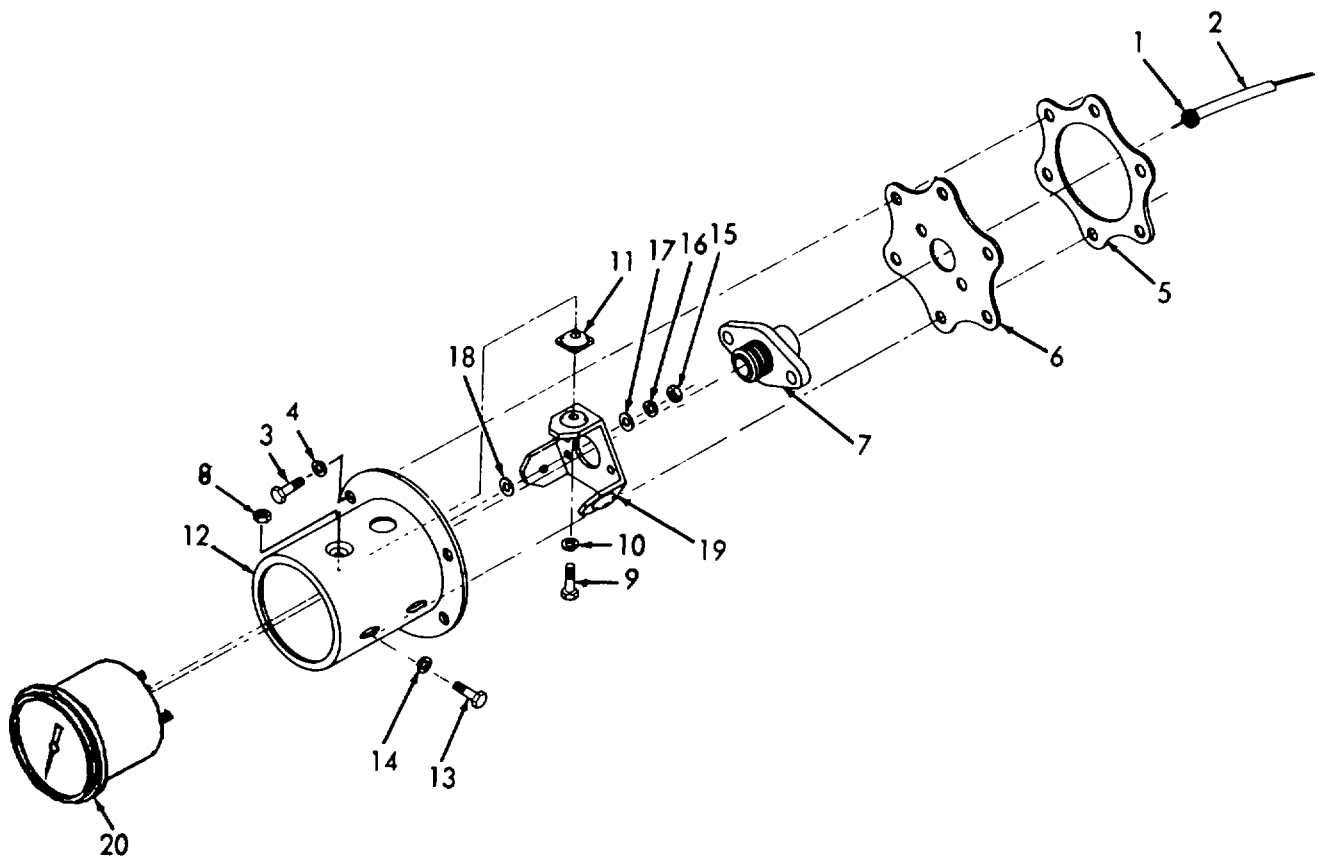


Figure 3-63. Tachometer, Removal/Installation.

**3-30. CRANKSHAFT PULLEY AND DAMPER**

---

**This task covers:**

- a. Removal
- d. Installation

- b. Cleaning

- c. Inspection
- 

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Puller Gear (Item 52, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Oil, Lubricating (Item 12, Appendix C)  
 Solvent, Cleaning (Item 4, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Fan belts removed (paragraph 3-25).

---

a. **Removal.** (Refer to figure 3-64).

- (1) Remove pulley retaining bolt (1) and flat washer (2).
- (2) Use the gear puller and remove the pulley (3) and two keys (4).
- (3) Remove six screws (5) and six lockwashers (6).
- (4) Reinstall flat washer (2) and bolt (1) to use with gear puller.
- (5) Use the gear puller and ease the damper (7) and hub (9) toward end of crankshaft.
- (6) Remove bolt (1) and flat washer (2).
- (7) Remove outer cone (8).
- (8) Remove damper (7) and hub (9) as an assembly.
- (9) Remove inner cone (10).

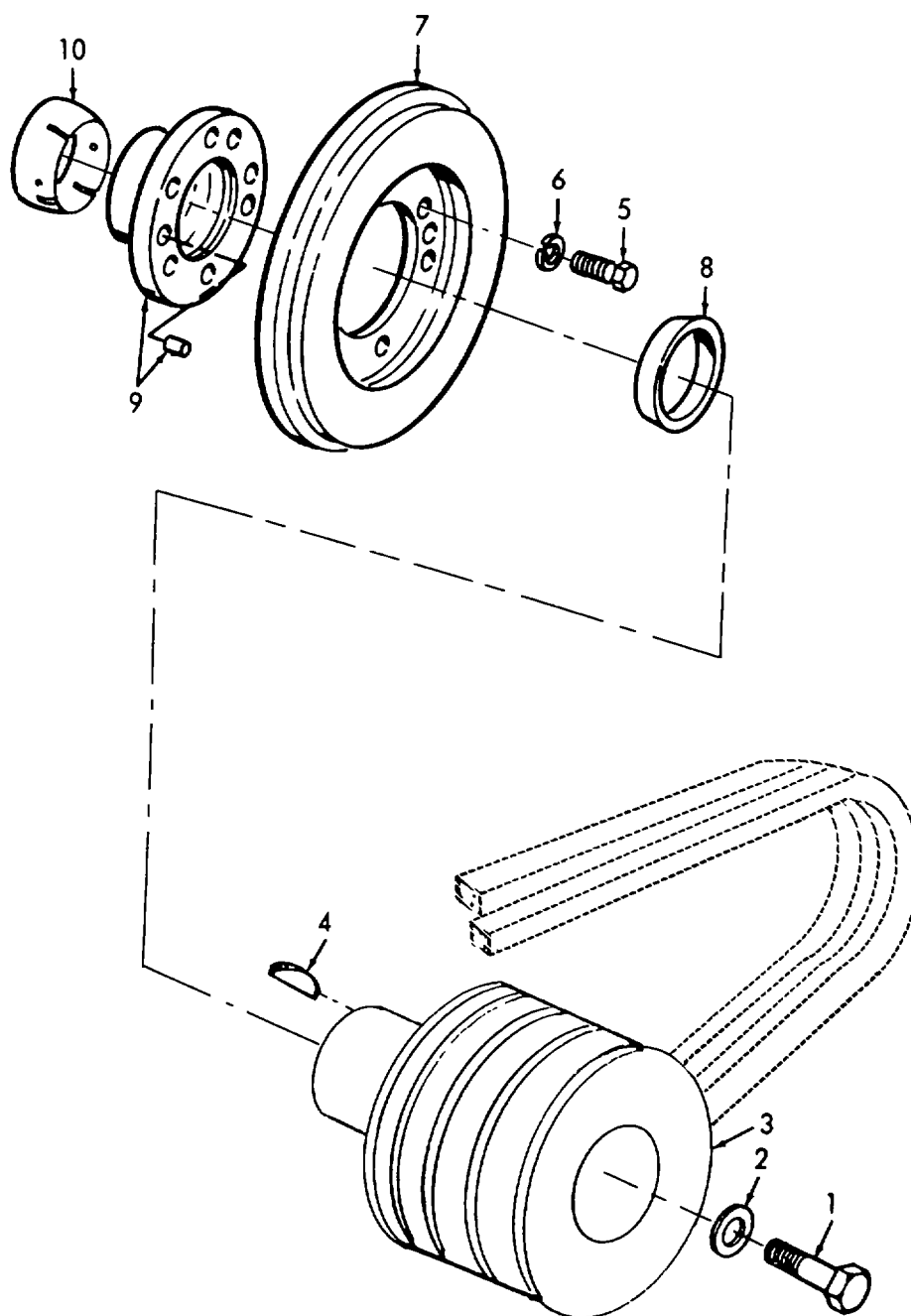


Figure 3-64. Crankshaft Pulley and Damper, Removal/Installation.

**3-30. CRANKSHAFT PULLEY AND DAMPER - Continued****b. Cleaning.****WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts in cleaning solvent (item 4, Appendix C).
- (2) Wipe off excess and dry all parts thoroughly.

**c. Inspection.**

- (1) Inspect pulley for cracks and burring in keyways.
- (2) Inspect damper for separation of rubber and metal. Check that rubber is not deteriorated and that metal plates are not bent.
- (3) Inspect cones and hub for cracks and burring.
- (4) Check for missing or damaged hardware.
- (5) Inspect the end of the crankshaft for cracks and burring.

**d. Installation.**

- (1) Coat the lip of the oil seal in the front cover with lubricating oil.
- (2) Slide the inner cone (10) onto the crankshaft.
- (3) Assemble hub (9) to damper (7) and secure with six lockwashers (6) and six bolts (5).
- (4) Slide assembled damper onto the crankshaft.
- (5) Install outer cone (8), two keys (4), and pulley (3). Secure pulley with flat washer (2) and bolt (1). Torque to 180 lb-ft (244 Nm).
- (6) Strike the end of bolt (1) a sharp blow with a 2 to 3 pound lead hammer, then torque the bolt to 300 lb-ft (407 Nm).
- (7) Strike the bolt again with the hammer.
- (8) Torque the bolt to 290-310 lb-ft (393-421 Nm).

**3-31. COVER, BALANCE WEIGHT**

---

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 5121753

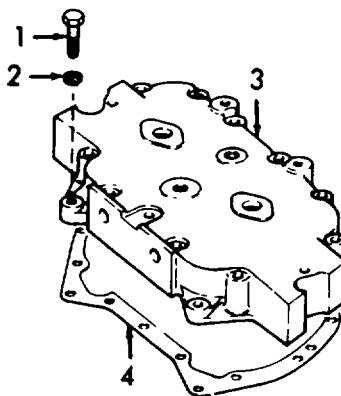
**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Coolant drained (paragraph 2-17, TM 55-1930-208-10).

---

a. **Removal.** (Refer to figure 3-65).

- (1) Remove thirteen bolts (1) and thirteen lockwashers (2).
- (2) Remove cover (3).
- (3) Remove and discard gasket (4).



**Figure 3-65. Balance Weight Cover, Removal/Installation.**

b. **Cleaning.**

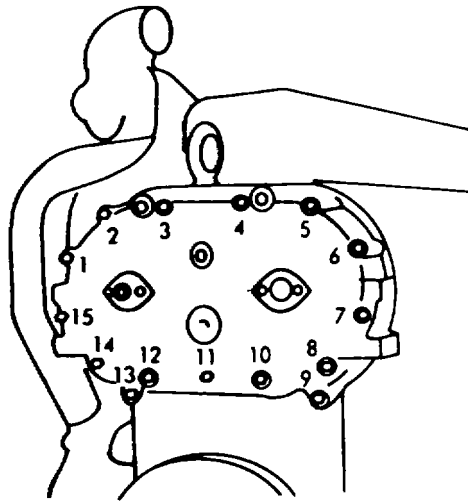
- (1) Clean the balance cover with clean fuel oil.
- (2) Wipe off excess and allow to dry.

**3-31. COVER, BALANCE WEIGHT - Continued.****c. Inspection.**

- (1) Inspect for missing or damaged hardware.
- (2) Inspect for cracks, warps, and dents.
- (3) Inspect for rust and corrosion.
- (4) Replace a damaged cover.

**d. Installation.**

- (1) Refer to figure 3-65 and install new gasket (4) into position.
- (2) Install cover (3) into position.
- (3) Install thirteen lockwashers (2) and thirteen bolts (1).
- (4) Refer to figure 3-66 and torque bolts (1) to 25-30 lb-ft (34-41 Nm) in sequence shown.
- (5) Refill cooling system.
- (6) Start engine and check for leaks.



**Figure 3-66. Balance Weight Cover, Bolt Tightening Sequence.**

**3-32. ENGINE LIFTING BRACKETS.**

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

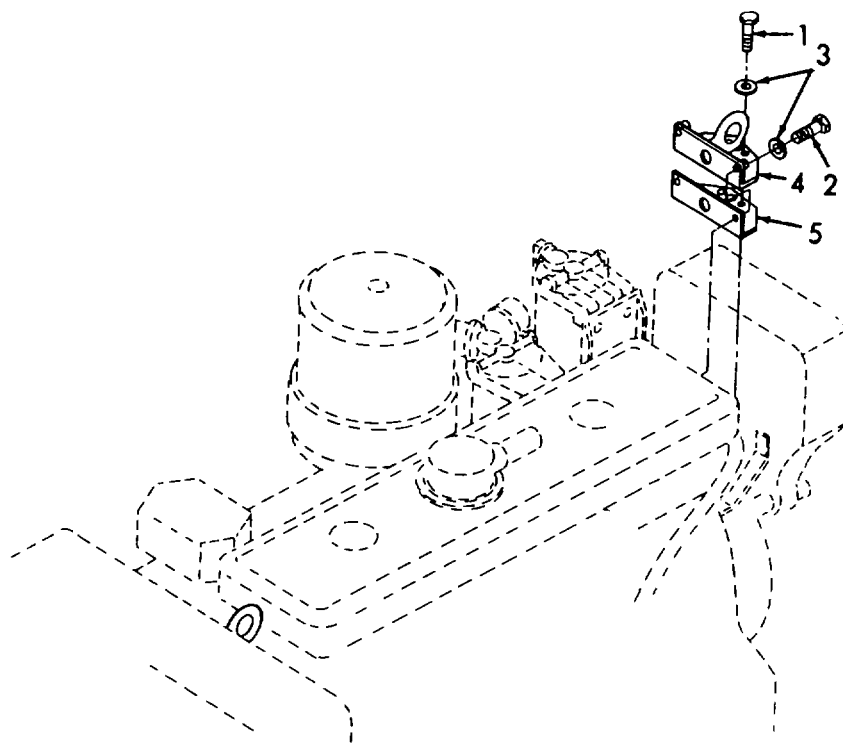
Gasket P/N 5150052  
Solvent, Cleaning (Item 4, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

a. **Removal.** (Refer to figure 3-67).

- (1) Remove two bolts (1), two bolts (2), and four flat washers (3).
- (2) Remove from lifting bracket (4) and gasket (5). Discard gasket (5).
- (3) Remove rear lifting bracket in the same manner.



**Figure 3-67. Engine Lifting Brackets, Removal/Installation.**

**3-32. ENGINE LIFTING BRACKETS - Continued.**b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean lifting brackets with cleaning solvent (item 4, Appendix C).
- (2) Allow lifting brackets to dry.

c. Inspection.

- (1) Inspect lifting brackets for cracks. Replace a damaged lifting bracket.
- (2) Inspect mounting hardware for damaged threads. Replace all damaged hardware.

d. Installation.

- (1) Refer to figure 3-67 and install gasket (5) and lifting bracket (4) on engine.
- (2) Secure lifting brackets with four flat washers (3), two bolts (2), and two bolts (1). Torque all bolts to 55-60 lb-ft (75-81 Nm).

**3-33. MANIFOLD, EXHAUST.**

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

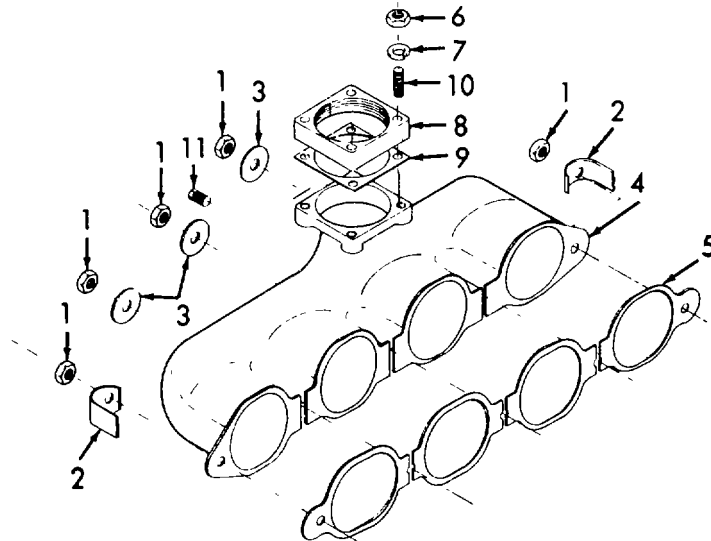
Cloth, Soft (Item 23, Appendix C)  
Gasket P/N 5145238  
Gasket P/N 5150196  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-46

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Exhaust muffler removed (paragraph 3-9, TM 55-1930-208-10).

**a. Removal.** (Refer to figure 3-68).

- (1) Remove five nuts (1), two crabs (2), three flat washers (3), manifold (4), and gasket (5). Discard gasket (5).
- (2) Remove four nuts (6), four lockwashers (7), flange (8), and gasket (9). Discard gasket (9).
- (3) Remove four studs (10) and plug (11) from manifold.



**Figure 3-68. Exhaust Manifold, Removal/Installation.**

**3-33. MANIFOLD, EXHAUST- Continued.****b. Cleaning.**

- (1) Remove all buildup of dirt, grease, etc. by wiping with a clean, soft cloth (item 23, Appendix C).

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (2) Clean using a clean, soft cloth (item 23, Appendix C) or a medium bristle brush (item 14, Appendix C) and cleaning solvent (item 4, Appendix C).
- (3) Allow to dry.

**c. Inspection.**

- (1) Inspect manifold for cracks or obvious damage.
- (2) Inspect all hardware for damaged threads.
- (3) Replace a damaged manifold or hardware.

**d. Installation.**

- (1) Refer to figure 3-68 and install plug (11) and four studs (10) in manifold (4).
- (2) Install new gasket (9) and flange (8) on manifold (4) and secure with four lockwashers (7) and four nuts (6). Tighten nuts to 20-25 lb-ft (27-34 Nm).
- (3) Install new gasket (5) and manifold (4) on cylinder head. Secure manifold to cylinder head with three flat washers (3), two crabs (2), and five nuts (1).
- (4) Starting with the center nut and working alternately toward each end, tighten the nuts to 30-35 lb-ft (41-47 Nm).
- (5) Install exhaust muffler per paragraph 3-9, TM 55-1930-208-10.

**3-34. COVER, ROCKER ARM.**

---

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Brush, Medium Bristle (Item 14, Appendix C)  
Cloth, Soft (Item 23, Appendix C)  
Gasket P/N 5103646  
Gasket P/N 5104081  
Solvent, Cleaning (Item 4, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. **Removal.** (Refer to figure 3-69).

- (1) Disconnect breather hose (1).
- (2) Remove two bolts (2), two flat washers (3), and two isolators (4).
- (3) Remove cover assembly (5) and gasket (6). Discard gasket (6).
- (4) Remove screw (7), retainer (8), disk (9), retainer (10), cover (11), and seal (12) from cover (5).

**3-34. COVER, ROCKER ARM - Continued.****b. Cleaning.**

- (1) Remove all buildup of dirt, grease, etc. by wiping with a clean, soft cloth (item 23, Appendix C).

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (2) Clean using a clean, soft cloth (item 23, Appendix C) or a medium bristle brush (item 14, Appendix C) and cleaning solvent (item 4, Appendix C).
- (3) Allow to dry.

**c. Inspection.**

- (1) Inspect for cracks, dents, and signs of obvious damage.
- (2) Inspect for missing or damaged hardware.

**d. Installation.**

- (1) Refer to figure 3-69 and install seal (12), cover (11), retainer (10), disk (9), retainer (8), and secure with screw (7).
- (2) Install new gasket (6) and cover assembly (5) on cylinder head.
- (3) Install two isolators (4), two flat washers (3), and two bolts (2). Torque bolts (2) to 15-20 lb-ft (20-27 Nm).

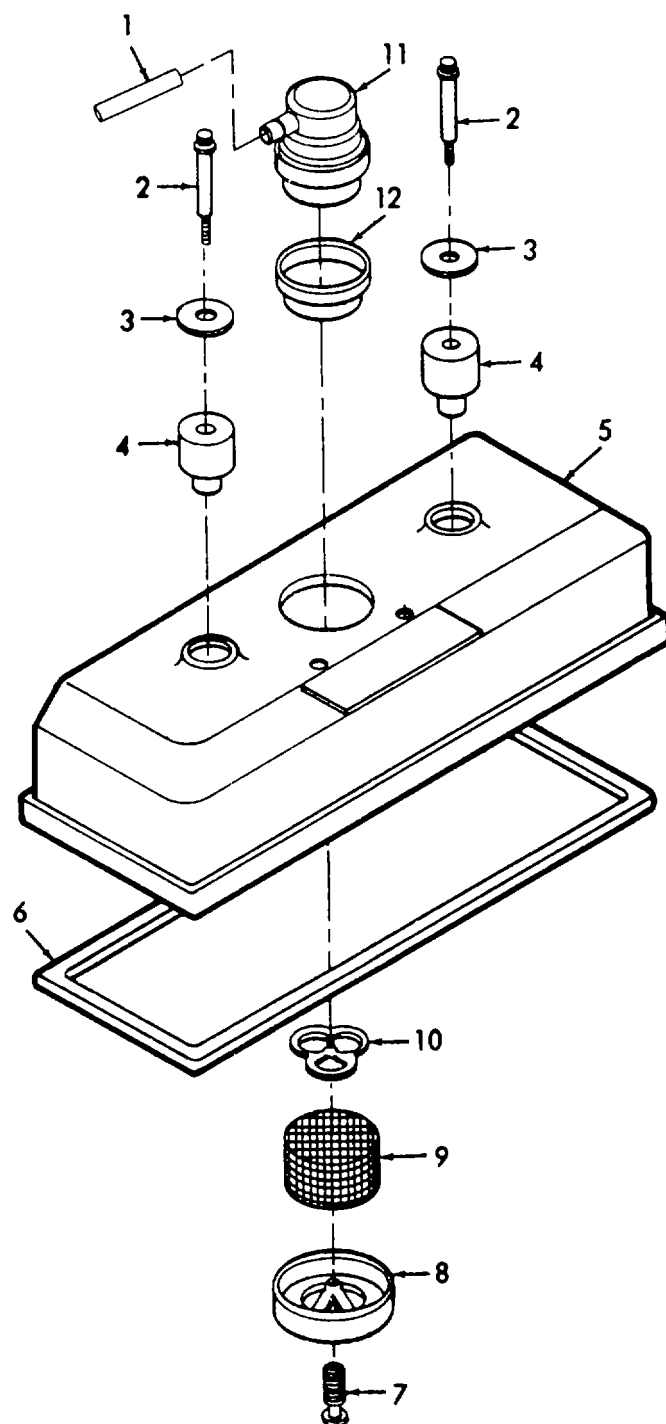


Figure 3-69. Rocker Arm Cover, Removal/Installation.

**3-31. COVER, BALANCE WEIGHT**

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

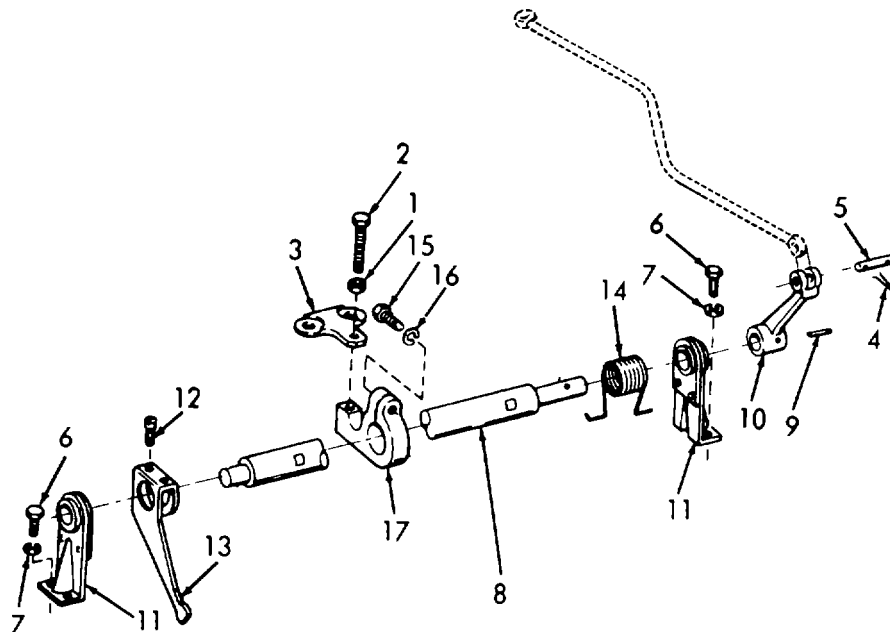
Pin, Cotter P/N MS24665-170  
Washer, Lock P/N MS35338-44

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Rocker cover removed (paragraph 3-34).

a. Removal. (Refer to figure 3-70).

- (1) Loosen nut (1), bolt (2), and plate (3).
- (2) Remove cotter pin (4) and pin (5).
- (3) Remove four screws (6), four lockwashers (7), and shaft and lever assembly (8) from the cylinder head.



**Figure 3-70. Injector Controls, Removal, Disassembly, Reassembly, and Installation.**

b. Disassembly.

- (1) Refer to figure 3-70 and remove pin (9), lever (10) and two brackets (11).
- (2) Loosen eight adjusting screws (12) and remove four control levers (13) and spring (14).
- (3) Remove screw (15), lockwasher (16), and rocker arm (17).

c. Cleaning.

- (1) Clean all parts in fuel oil.
- (2) Wipe off excess oil and allow to dry.

d. Inspection.

- (1) Inspect all parts for cracks, wear, bends, rust, or corrosion.
- (2) Inspect spring for loss of resilience.

e. Repair. Repair is limited to the replacement of defective parts.

f. Reassembly.

- (1) Refer to figure 3-70 and install rocker arm (17) on shaft and lever assembly (8) and secure with lockwasher (16) and screw (15).
- (2) Install four levers (13) and tighten eight adjusting screws (12).
- (3) Install spring (14) and two brackets (11) on shaft and lever assembly.
- (4) Install lever (10) and pin (9).

g. Installation.

- (1) Refer to figure 3-70 and position shaft and lever assembly into position. Be sure all levers fit into injector racks.
- (2) Install four lockwashers (7) and four screws (6). Torque the screws (6) to 10-12 lb-ft (14-16 Nm).
- (3) Position fuel control rod into lever (10) and secure with pin (5) and cotter pin (4).
- (4) Install plate (3), nut (1), and bolt (2). Tighten nut (1).

**3-35. CONTROLS, FUEL INJECTOR - Continued.**h. Adjustment.**NOTE**

Always adjust the No. 1 injector rack control lever first.

- (1) Disconnect linkage attached to the governor speed control lever.
- (2) Turn the idle speed adjusting screw (figure 3-71) until 1/2 inch of the threads project from the locknut, when the nut is against the high speed plunger.

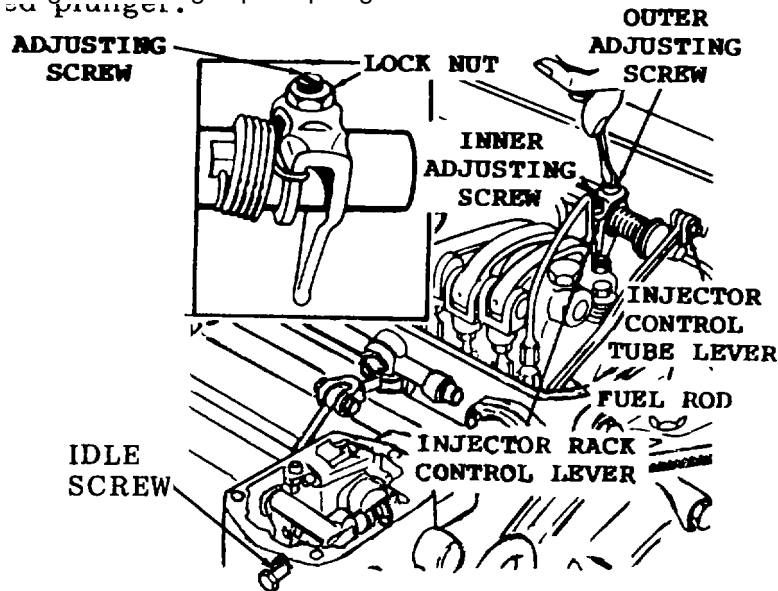


Figure 3-71. Control Rack Lever Adjustment.

- (3) Back out the buffer screw (figure 3-72) approximately 5/8 inch.

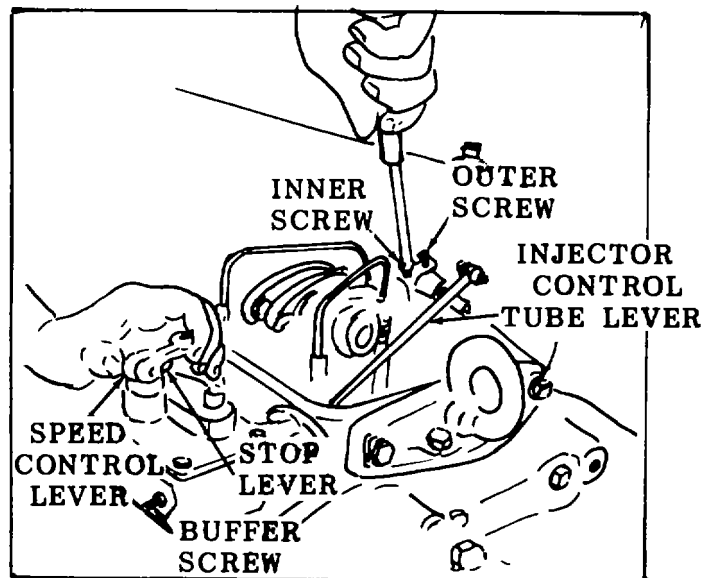


Figure 3-72. Positioning No. 1 Injector Rack Control Lever.

- (4) Loosen all inner and outer injector rack control lever adjusting screws and locknuts. Be sure all of the control levers are free on the injector control tube.
- (5) Move the speed control lever to the maximum speed position (figure 3-72). Hold the lever in that position with light finger pressure.
- (6) Turn the inner adjusting screw on No. 1 injector rack control lever down until a slight movement of the control tube is observed or a step-up in effort is noted. This will place the No. 1 injector rack in the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then, alternately tighten both the inner and outer adjusting screw. Torque adjusting screws to 24-36 lb-in (3-4 Nm).
- (7) To be sure of the proper rack adjustment, hold the speed control lever in maximum speed position and press down on the injector rack with a screwdriver or finger tip and note "rotating" movement of the injector control rack when speed control lever is in maximum speed position (figure 3-73). Hold the speed control lever in maximum speed position and, using a screwdriver, press downward on the injector control rack. The rack should tilt downward and when pressure of the screwdriver is released, the control rack should "spring back upward" (figure 3-74).

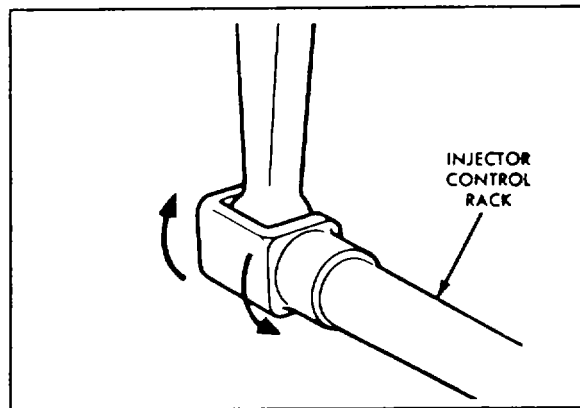


Figure 3-73. Checking Rotating Movement of Injector Control Rack

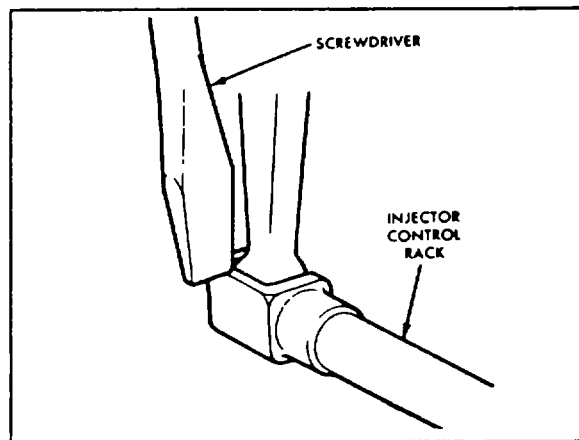


Figure 3-74. Checking Injector Control Rack "Spring"

**3-35. CONTROLS, FUEL INJECTOR - Continued.****h. Adjustment - Continued.**

- (8) If the rack does not return to its original position, it is too loose. Back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly, this will correct this condition.
- (9) The setting is too tight if, when moving the speed position to maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (as determined by the stop under the governor cover). This will result in a step-up in effort required to move speed control lever to end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly. Torque the adjusting screws to 24-36 lb-in (3-4 Nm).
- (10) Hold the button screw (figure 3-72) and tighten the locknut.
- (11) Manually hold the No. 1 control lever in the fuel position and turn No. 2 control lever inner adjusting screw until injector rack has moved to fuel position and inner adjusting screw is bottomed on control tube. Turn outer adjusting screw down until it bottoms lightly on the injector control tube. Alternately tighten both the inner and outer adjusting screws until they are tight.
- (12) Recheck lever and rack No. 1 to make sure that it has remained snug on ball end of injector control rack. If the rack of No. 1 is loose, back off inner adjusting screw and tighten outer screws.
- (13) Position remaining control levers per steps (7) and (9). When properly adjusted, all levers will be snug on injector control racks.
- (14) Reconnect fuel rod to control tube.
- (15) Turn idle speed adjusting screw (figure 3-71) until it projects 3/16 inch from the locknut to permit starting the engine.
- (16) Refer to paragraph 3-34 and install rocker arm cover.

**3-31. CONTROLS,ROCKER ARM.**

---

This task covers:

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

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

Materials Required:

Fuel line caps.  
Oil, Fuel (Item 9, Appendix C)  
Oil, Lubricating (Item 12, Appendix C)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Rocker cover removed (paragraph 3-34).  
Injector fuel pipes removed and ports capped (paragraph 3-22).

---

a. Removal. (Refer to figure 3-75).

- (1) Crank engine or turn crankshaft to bring injector and valve rocker arms in line horizontally on the cylinder being worked on.

**NOTE**

Do not bar the crankshaft in a counterclockwise direction of rotation with a wrench or barring tool on the crankshaft bolt, or the bolt may be loosened.

- (2) Remove two bolts (1) which secure brackets (2) to cylinder head (3).
- (3) Fold rocker arms (4) back and remove brackets (2) and shaft (5).
- (4) Loosen the locknuts (6) and unscrew rocker arms from push rods (7).

**3-36. CONTROLS, ROCKER ARM - Continued.****b. Cleaning.**

- (1) Wash all parts (except the cam followers) in fuel oil.
- (2) Allow to dry.
- (3) Clean the cam followers in clean lubricating oil (item 12, Appendix C) and then wipe dry.

**c. Inspection.**

- (1) Inspect shaft and bushings for scoring or worn spots.
- (2) Inspect rocker arms for wear and galling on contact surfaces.

**d. Repair.** Repair of the rocker arm controls are limited to the replacement of defective components.**e. Installation.**

- (1) Refer to figure 3-75 and thread the rocker arms (4) onto push rods (7) and tighten locknuts (6).
- (2) Apply clean lubricating oil (item 12, Appendix C) to the shaft (5) and install shaft (5) through rocker arms (1).
- (3) Install brackets (2) and two bolts (1) to cylinder head (3). Torque bolts (1) to 90-100 lb-ft (122-136 Nm).
- (4) Install the fuel pipes to the injector per paragraph 3-22.
- (5) Start engine and adjust valves per paragraph 3-39.
- (6) Install rocker arm cover per paragraph 3-33.

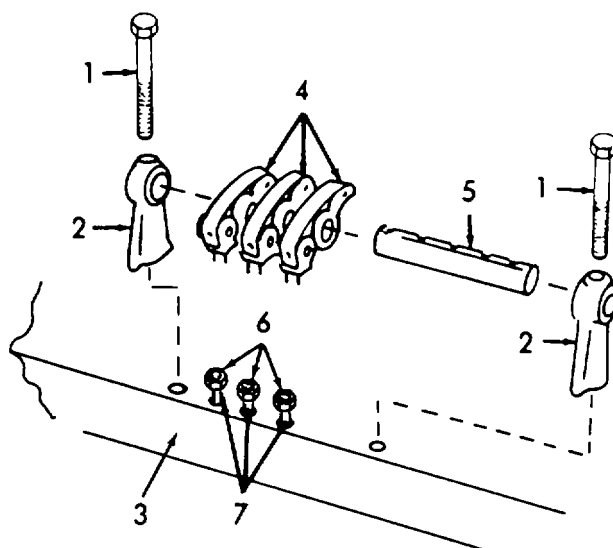


Figure 3-75. Rocker Arms, Removal/Installation.

**3-37. PAN OIL**

---

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 5150116  
Gasket P/N 840277

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Oil drained from crankcase (paragraph 3-1, TM 55-1930-208-10).

---

a. **Removal.** (Refer to figure 3-76).

- (1) Remove thirty-four bolts (1) and oil pan (2).
- (2) Remove and discard gasket (3).
- (3) Remove drain plug (4) and gasket (5).

b. **Cleaning.**

- (1) Clean with clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess oil and dry.

c. **Inspection.**

- (1) Inspect oil pan for dents and cracks.
- (2) Inspect oil pan for warps by placing the oil pan upside-down on a flat surface.
- (3) Inspect drain plug and oil pan for damaged threads.
- (4) Replace a damaged oil pan.

d. **Installation.**

- (1) Install gasket (5) and drain plug (4).
- (2) Install new gasket (3), oil pan (2), and secure with thirty-four bolts (1).

- (3) Starting with center bolt on each side of oil pan, tighten bolts to 10-20 lb-ft (14-27 Nm).

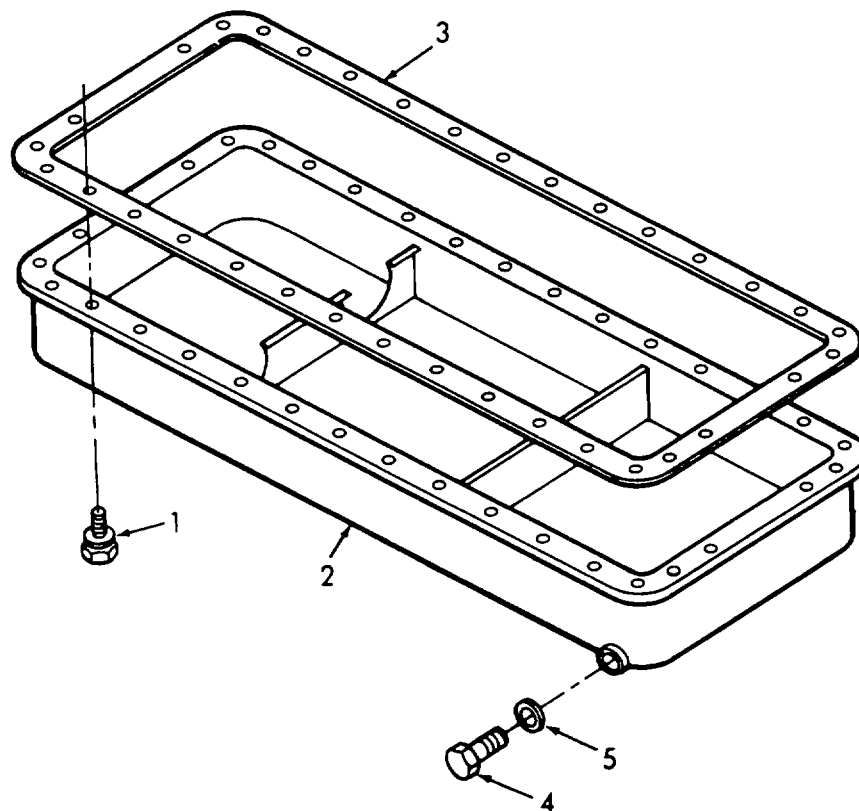


Figure 3-76. Oil Pan, Removal/Installation.

### 3-38. HEAD, CYLINDER

---

This task covers:

- a. Removal
  - b. Installation
- 

#### INITIAL SETUP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

##### Materials Required:

Adhesive (Item 1, Appendix C)  
Compound, Sealing (Item 22, Appendix C)  
Gasket P/N 5103659  
Gasket P/N 519973

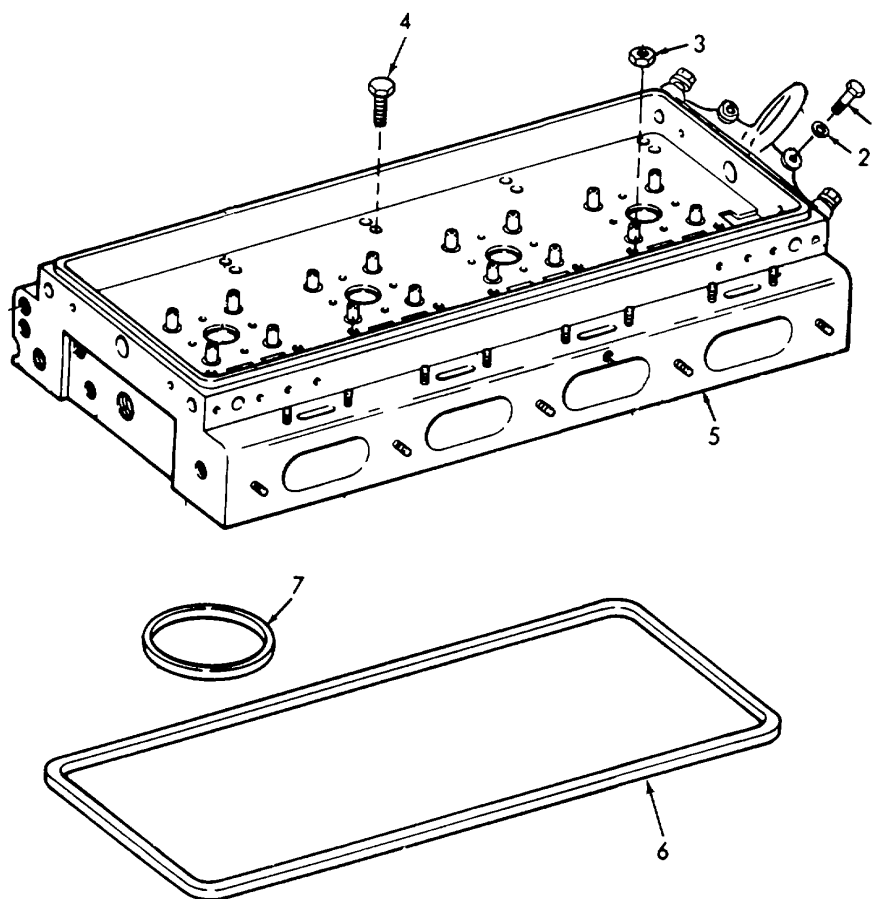
##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Coolant drained (paragraph 2-17, TM 55-1930-208-10)  
Exhaust manifold removed (paragraph 3-33).  
Air cleaners removed (paragraph 3-18).  
Inlet housing removed (paragraph 3-18).  
Thermostat and housing removed (paragraph 3-28).  
Water manifold removed (paragraph 3-27).  
Rocker cover removed (paragraph 3-31).  
Fuel injectors and fuel piping removed (paragraph 3-35).  
Fuel lines removed (paragraph 3-35).  
Fuel strainer removed (paragraph 3-21).  
Fuel filter removed (paragraph 3-8).  
Fuel injector control rack removed (paragraph 3-22).

---

#### a. Removal. (Refer to figure 3-77).

- (1) Remove four lower bolts (1) and four lockwashers (2) from lifting brackets.
- (2) Remove two nuts (3) and ten bolts (4).
- (3) Attach a sling to the cylinder head lifting bracket and a chain hoist, lift cylinder head (5) away from the engine.
- (4) Remove and discard gasket (6) and seal rings (7).



**Figure 3-77. Cylinder Head, Removal/Installation.**

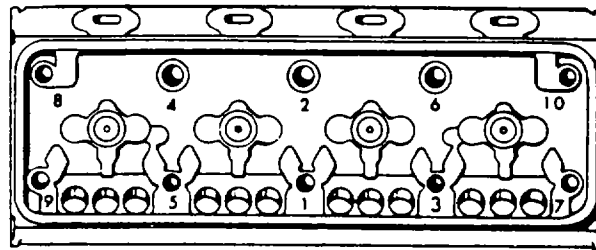
**b. Installation.**

- (1) Refer to figure 3-77 and check that cylinder head and block mating surfaces are clean and free from any debris.
- (2) Check that piston crowns are free from foreign material.
- (3) Clean out all threaded holes in top of block with thread chaser.
- (4) Install new head gasket (6).
- (5) Use adhesive (item 1, Appendix C) and install new seals (7).
- (6) Connect hoist to lifting brackets.
- (7) Place cylinder head (5) over engine block. Make a final visual inspection to ensure that all gaskets and seal rings are in position.
- (8) Wipe the bottom of the cylinder head clean and lower to within  $\frac{1}{2}$  inch of gaskets.

### 3-38. HEAD, CYLINDER - Continued.

b. Installation - Continued.

- (9) Slowly lower the cylinder head (5) into position.
- (10) Apply sealing compound (item 22, Appendix C) to all cylinder head bolts (4) and nuts (3).
- (11) Install ten bolts (4) and two nuts (3). Remove hoist.
- (12) Remove sling from cylinder head.
- (13) Torque bolts and nuts to 175-185 lb-ft (238-251 Nm) in 50 lb-ft (68 Nm) increments per figure 3-78.



**Figure 3-78. Cylinder Head Bolt Tightening Sequence.**

- (14) Install four lockwashers (2) and four bolts (1).
- (15) Install fuel injector control rack (paragraph 3-35).
- (16) Install fuel injectors (paragraph 3-35), rocker cover (paragraph 3-31), water manifold (paragraph 3-27), and thermostat (paragraph 3-28).
- (17) Install air inlet housing (paragraph 3-18), air cleaners (paragraph 3-18), and exhaust manifold (paragraph 3-33).
- (18) Refer to TM 55-1930-208-10, paragraph 2-17 and add coolant to radiator.

**3-39. VALVE OPERATING MECHANISM.**

---

This task covers:

- |            |                 |               |
|------------|-----------------|---------------|
| a. Removal | b. Cleaning     | c. Inspection |
| d. Repair  | e. Installation | f. Adjustment |
- 

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Remover, Spring (Item 44, Appendix B)  
Tester, Spring (Item 45, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Oil, Lubricating (Item 12, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Cylinder head removed (paragraph 3-38).  
Rocker arms removed (paragraph 3-36).

---

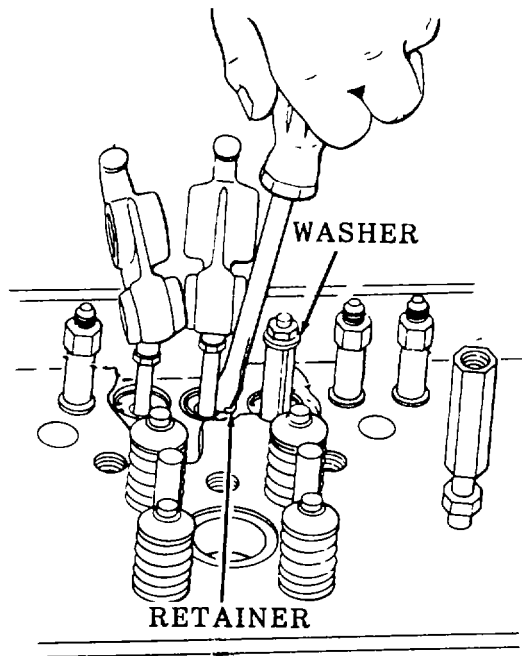
**3-39. VALVE OPERATING MECHANISM - Continued.**

- a. Removal. (Refer to figure 3-79).

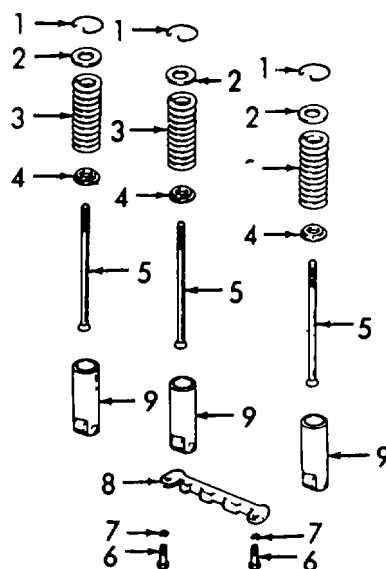
**NOTE**

When removing cam followers and associated parts, tag them so they can be installed in their original location.

- (1) Remove push rod locknut.
- (2) Install remover J3092-01, a flat washer, and push rod locknut, with the lower end of the tool resting on the upper seat.
- (3) Thread nut down to compress spring.
- (4) Refer to figure 3-80 and remove three spring retainers (1).
- (5) Remove locknut, flat washer, and remover.
- (6) Remove three upper spring seats (2), three springs (3), three lower spring seats (4), and three push rods (5).
- (7) Remove two screws (6), two lockwashers (7), and cam follower guide (8).
- (8) Remove three cam followers (9).



**Figure 3-79. Removing Push Rod from Upper Side of Cylinder Head Using Tool J3092-01.**



**Figure 3-80. Cam Followers, Push Rods, and Springs, Removal/Installation.**

b. Cleaning.

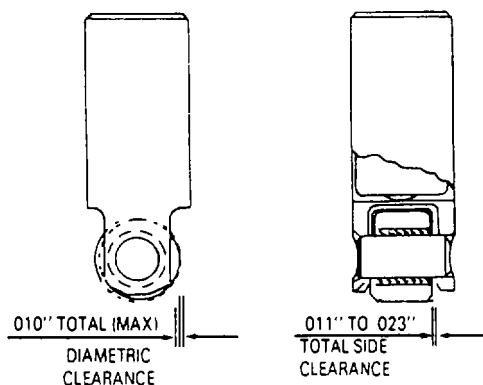
**NOTE**

Do not wash cam follower with diesel fuel oil.

- (1) Clean cam follower with clean lubricating oil (item 12, Appendix C).
- (2) Clean push rods, springs, and spring seats with clean diesel fuel oil.
- (3) Allow parts to dry.

c. Inspection.

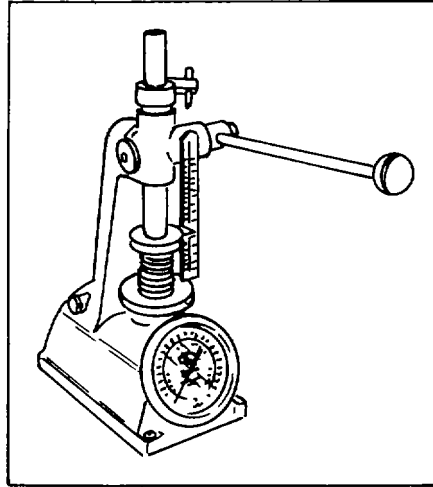
- (1) Inspect cam followers for scoring, pitting, or flat spots.
- (2) Refer to figure 3-81 and inspect cam follower rollers for proper clearance.



**Figure 3-81. Cam Roller Clearance.**

**3-39. VALVE OPERATING MECHANISM - Continued.**c. Inspection Continued.

- (3) Inspect push rods for distortion and excessive wear.
- (4) Install cam follower spring in spring tester J22738-02 (figure 3-82) and check the spring load. Replace a spring when a load of less than 172 lbs (72.98 kg) will compress it to a length of 2.125 inch.

**Figure 3-82. Testing Cam Follower Spring.**

- d. Repair. Repair is limited to replacing cam roller, roller pin, and other defective parts.
- e. Installation.

**NOTE**

If new cam follower assemblies are to be installed, remove the preservative by washing with clean lubricating oil (item 12, Appendix C) and wipe dry. Do not use fuel oil.

**WARNING**

Wear asbestos gloves to avoid serious burns when handling heated part.

- (1) Refer to figure 3-80. Before cam followers are installed, immerse them in clean lubricating oil (item 12, Appendix C) (heated to 100-125°F or 38-52°C) for at least one hour to ensure initial lubrication of the cam roller pins and bushings. Rotate cam rollers during the soaking period to purge any air from bushing-roller area.

- (2) Assemble three lower spring seats (4), three springs (3), three upper spring seats (2), and locknut on three push rods (5). Slide the three push rod assemblies in position from the bottom of the head. Install three spring retainers (1).
- (3) Note the oil hole in the bottom of the cam follower. With the oil hole directed away from the exhaust valves, slide the cam follower (9) in position from the bottom of the head.
- (4) Install cam follower guide (8) and secure with two lockwashers (7) and two screws (6). Torque screws to 12-15 lb-ft (16-20 Nm).
- (5) Install rocker arms per paragraph 3-36.
- (6) Install cylinder head per paragraph 3-38.

f. Adjustment. (Refer to figures 3-83 and 3-84).

- (1) Check that there is at least .005 inch clearance between the cam follower legs and cam follower guide (figure 3-83).

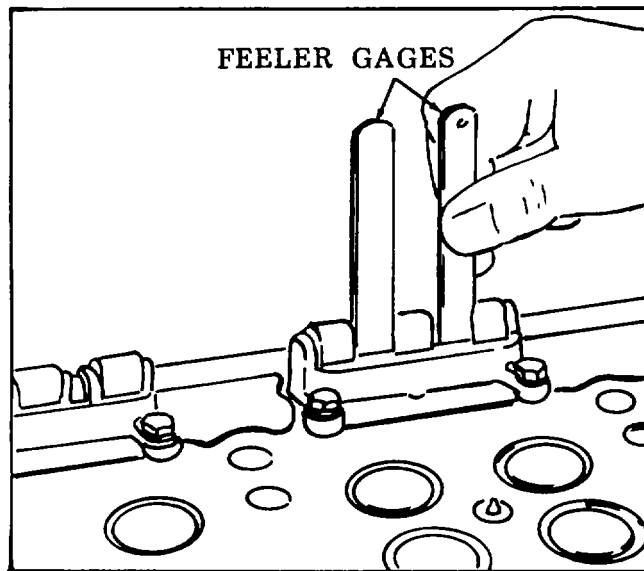
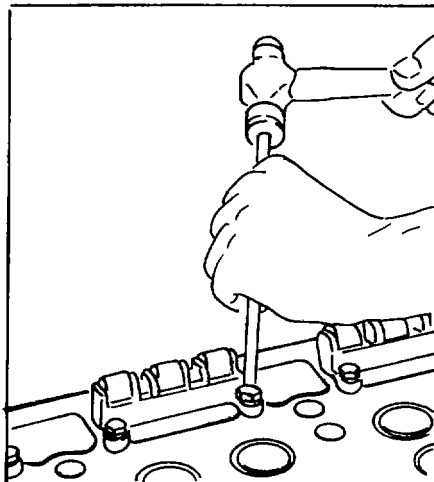


Figure 3-83. Checking Cam Follower to Guide Clearance.

**3-39. VALVE OPERATING MECHANISM - Continued.**f. Adjustment - Continued.

- (2) If there is insufficient clearance, loosen guide bolts slightly and tap each corner of the guide with a brass rod (figure 3-84). Then, retighten bolts to specified torque 12-15 lb-ft (16-20 Nm).



**Figure 3-84. Adjusting Cam Follower Guide.**

**3-40. VALVES, INTAKE AND EXHAUST.**

**This task covers:**

- a. Removal  
d. Repair

- b. Cleaning  
e. Installation

- c. Inspection

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Remover, Spring, P/N J3092-01 (Item 44, Appendix B)  
Valve Spring Compressor (Item 46, Appendix B)

**Materials Required:**

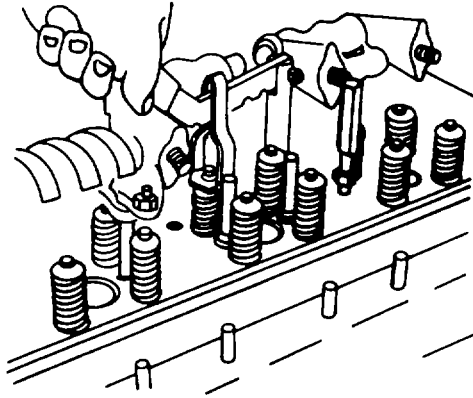
Oil, Lubricating (Item 12, Appendix C)  
Wood Block (2" X 3" X 30")

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Fuel pipes and injectors removed (paragraph 3-35).  
Rocker arms shafts removed (paragraph 3-36).  
Exhaust valve bridges removed (paragraph 3-39).

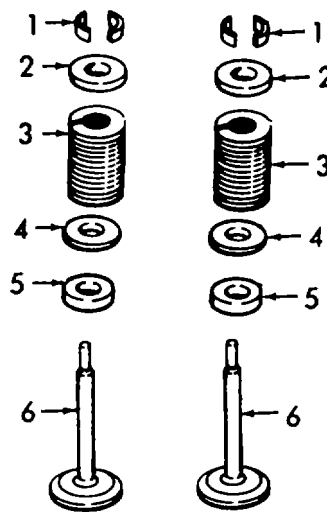
a. Removal. (Refer to figures 3-85 and 3-86).

- (1) Support the head on the block of wood.
- (2) Refer to figure 3-85 and thread valve spring compressor into rocker arm bracket bolt holes.
- (3) Compress the valve spring.



**Figure 3-85. Valve Spring Compressor Use.**

- (4) Refer to figure 3-86 and remove two piece valve lock (1).
- (5) Slowly release the spring compressor.
- (6) Remove valve cap (2), valve spring (3), and spring seat (4).
- (7) Remove the spring compressor.
- (8) Remove and discard valve guide seal (5).
- (9) Turn the cylinder head over and remove valve (6) from the bottom.



**Figure 3-86. Valves, Removal/Installation.**

### 3-40. VALVES, INTAKE AND EXHAUST-Continued.

b. Cleaning.

- (1) Clean all parts in clean fuel oil.
- (2) Wipe off excess and allow to dry.

c. Inspection.

- (1) Inspect springs for pits and fractures. Place spring in spring tester and check spring compression. Spring is bad if a load of less than 25 lbs (111 N) will compress spring to 1.80 inch.
- (2) Inspect for worn, pitted valve spring seats, and caps.
- (3) Inspect valve seats for cracks, pitting, scratches, or scuff marks.
- (4) Inspect valve face for ridges, cracks, pitting, and warping.

d. Repair. Repair is limited to the replacement of defective parts or refacing of valves to 30° angle.

e. Installation.

- (1) Be sure that valve guides and valve seats are clean.
- (2) Refer to figure 3-86 and lubricate valve stem (1) with lubricating oil (item 12, Appendix C).
- (3) Use a piece of masking tape to hold valve (6) into place.
- (4) Rotate the head over onto the block of wood.
- (5) Install valve spring seat (5).
- (6) Install valve guide oil seals (4).
- (7) Install springs (3) and caps (2) into position.
- (8) Refer to figure 3-85 and install spring compressor into one of the rocker arm bracket bolt holes.
- (9) Compress spring (3) and install both halves of valve lock (1).
- (10) Remove spring compressor.
- (11) Refer to figure 3-87 and check the valve position.
- (12) Give the end of the valve stems a sharp tap with the end of a plastic mallet to aid in seating the valve locks.

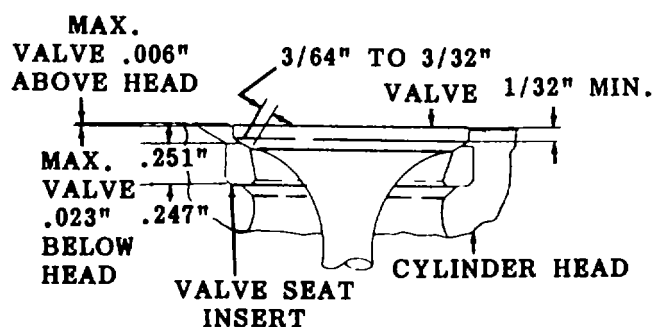


Figure 3-87. Exhaust Valve Positioning.

**3-41. BALANCE WEIGHTS.**

This task covers:

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

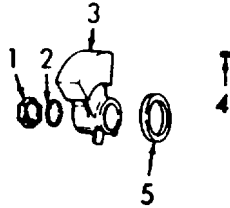
Grease, Heavy (Item 10, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Balance weight cover removed (paragraph 3-31).

**3-41. BALANCE WEIGHTS - Continued.**a. Removal. (Refer to figure 3-88).

- (1) Place a block of wood between the balance weights to prevent rotation.
- (2) Remove nut (1) and lockwasher (2).
- (3) Remove balance weight (3), key (4), and washer (5).

**Figure 3-88. Balance Weight, Removal/Installation.**b. Cleaning.

- (1) Clean all parts with clean fuel oil.
- (2) Wipe all parts dry.

c. Inspection.

- (1) Inspect for wear, burns, or damage to balance weight and washers.
- (2) Inspect nut for damage.

d. Installation.

- (1) Refer to figure 3-88 and coat washer (5) with heavy grease (item 10, Appendix C).
- (2) Install washer (5).
- (3) Install key (4) and balance weight (3).
- (4) Install lockwasher (2) and nut (1). Torque nut (1) to 300-325 lb-ft (407-441 Nm).
- (5) Refer to paragraph 3-31 and install balance weight cover.

**3-42. CAMSHAFT AND BALANCE SHAFT.****This task covers:**

a. Removal  
d. Repair

b. Cleaning  
e. Installation

c. Inspection

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Grease, Light (Item 11, Appendix C)  
Oil, Lubricating (Item 12, Appendix C)  
Washer, Lock P/N MS35338-46  
Washer, Lock P/N 517769

**Equipment Conditions:**

Engine removed (paragraph 3-15).

Flywheel and flywheel housing removed (paragraphs 3-44 and 3-45).

Balance weight cover and balance weights removed (paragraph 3-31 and 3-41).

a. **Removal.** (Refer to figure 3-89).

- (1) Remove four bolts (1) and retainer (2).
- (2) Remove four bolts (3) and retainer (4).
- (3) Remove nut (5) and nut (6).
- (4) Rotate gear (20) so that hole in gear lines up with bearing retaining bolt (7).
- (5) Remove bolt (7) and lockwasher (8).
- (6) Rotate gear (22) so that hole in gear lines up with bearing retaining bolts (9). (7) Remove bolt (9) and lockwasher (10).
- (8) Remove bolt (11), lockwasher (12), bolt (13), and lockwasher (14).
- (9) Remove bearing (15), bearing (16), washer (17), and washer (18).
- (10) Remove both screws (19) that secure the intermediate bearings.
- (11) Remove gear (20) and camshaft (21) as a unit.
- (12) Remove gear (22) and balance shaft (23) as a unit.

### 3-42. CAMSHAFT AND BALANCE SHAFT - Continued.

a. Removal - Continued.

- (13) Press off gear (20) from camshaft (21). Remove key (24).
- (14) Press off gear (22) from balance shaft (23). Remove key (25).
- (15) Remove two bolts (26) and weight (27).
- (16) Remove two bolts (28) and weights (29).
- (17) Remove bearing (30) and bearing (31).
- (18) Remove four lock rings (32) and two bearings (33) from camshaft (21).

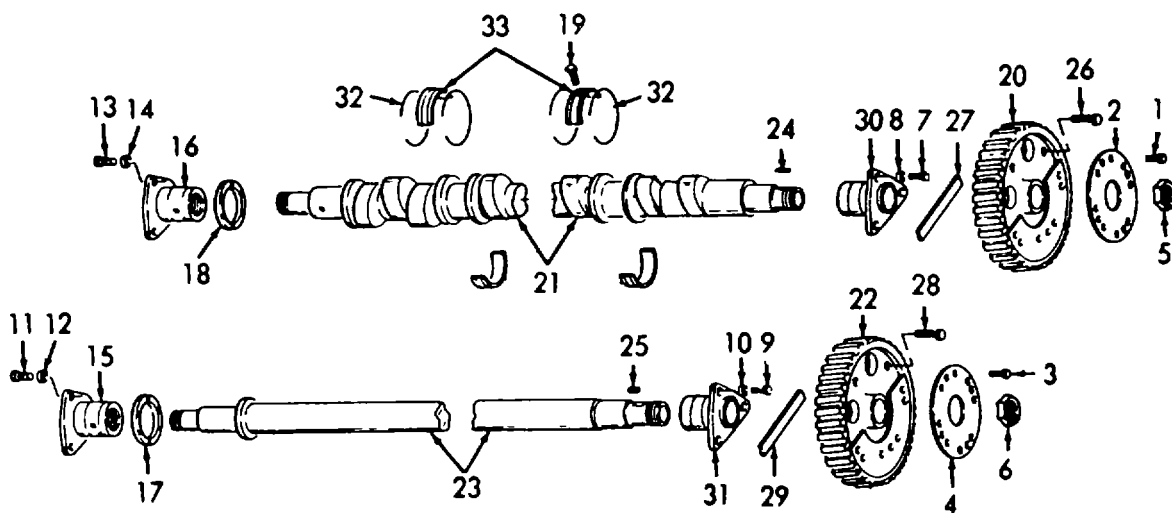


Figure 3-89. Camshaft and Balance Shaft, Removal/Installation.

b. Cleaning.

- (1) Clean all parts thoroughly with clean fuel oil.
- (2) Wipe off excess oil and dry.

c. Inspection.

- (1) Inspect camshaft cams and journals for wear and scoring.
- (2) Inspect all parts for burrs, scratches, wear, scoring, and damage.

- d. Repair. Repair is limited to the replacement of defective components and to the removal of light scratches with crocus cloth.

e. Installation.

- (1) Refer to figure 3-89 and lubricate the camshaft end bearing (30) and balance shaft end bearing (31) with lubricating oil (item 12, Appendix C).
- (2) Install the camshaft end bearing (30) and the balance shaft end bearing (31).
- (3) Press the gear (20) and key (24) on the camshaft (21).
- (4) Press the gear (22) and key (25) on balance shaft (23).
- (5) Lubricate the intermediate bearing journals and the intermediate bearing (33) with lubricating oil (item 12, Appendix D).
- (6) Install the intermediate bearings (33) and lock into place with the lock rings (32). Be sure the lock ring gap is centered on the upper bearing.
- (7) Install the balance weight (27) to the gear (20) and secure with two screws (26).
- (8) Install the balance weight (29) on the gear (22) and secure with two screws (28).
- (9) Install the camshaft (21) with attached gear (20).
- (10) Secure the bearing (30) to the block with three screws (7) and three lockwashers (8).
- (11) Install the balance shaft (23) with the attached gear (22) and make sure that the timing marks on the gear align with the timing marks on the camshaft gear and idler gear.
- (12) Secure the bearing (31) to the block with three lockwashers (10) and three screws (9).
- (13) Tighten bolts (7 and 9) to 35-40 lb-ft (47-54 Nm).
- (14) Lubricate the thrust washers (18 and 17) and the bearing (16 and 15) with lubricating oil (item 12, Appendix D).
- (15) Install thrust washer (18) and front bearing (16). Secure with three lockwashers (14) and three screws (13). Tighten screws to 35-40 lb-ft (47-54 Nm).
- (16) Install thrust washer (17) and front bearing (15). Secure with three lockwashers (12) and three screws (11). Tighten screws to 35-40 lb-ft (47-54 Nm).
- (17) Install front balance weights per paragraph 3-41.

**3-42. CAMSHAFT AND BALANCE SHAFT - Continued.**e. Installation Continued.

- (18) Install nut (5) and tighten to 300-325 lb-ft (407-441 Nm). Install nut retainer (2) and four screws (1). Tighten screws (1) to 35-39 lb-ft (47-53 Nm).
- (19) Install nut (6) and tighten to 300-325 lb-ft (407-441 Nm). Install nut retainer (4) and four screws (3). Tighten screws (3) to 35-39 lb-ft (47-53 Nm).
- (20) Turn intermediate bearings (33) until the tapped holes in the bearings are in alignment with the tapped holes in the block. Install screws (19) and tighten to 15-20 lb-ft (20-27 Nm).
- (21) Refer to paragraphs 3-41 and 3-31 and install balance weights and balance cover.
- (22) Refer to paragraphs 3-44 and 3-45 and install flywheel and flywheel housing.

**3-43. GEAR TRAIN AND IDLER GEAR.****This task covers:**

- a. Removal
- d. Installation

b. Cleaning

c. Inspection

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

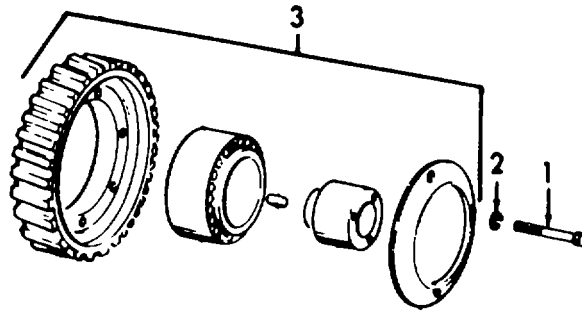
**Materials Required:**

Oil, Fuel (Item 9, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Flywheel housing removed (paragraph 3-45).

- a. **Removal.** (Refer to figure 3-90). Remove bolt (1), washer (2), and gear (3).



**Figure 3-90. Gear Train Idler Gear, Removal/Installation.**

- b. **Cleaning.**

- (1) Clean all parts in clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess oil and dry.

- c. **Inspection.**

- (1) Inspect bearings and cups for wear, pitting, scoring, or flat spots.
- (2) Inspect gear for scoring, pitting, cracking, chipping, and wear.

**3-43. GEAR TRAIN AND IDLER GEAR - Continued.**d. Installation.

- (1) Refer to figure 3-90 and align timing marks and hub hole with the dowel pin.
- (2) Place gear (3) into position and tap hub gently to seat the dowel pin.
- (3) Install washer (2) and bolt (1). Torque bolt to 80-90 lb-ft (108-122 Nm).

**3-44. FLYWHEEL.****This task covers:****a. Removal****b. Cleaning****c. Inspection****d. Repair****INITIAL SETUP:**Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Flywheel Lifting Tool (Item 47, Appendix B)  
 Acetylene Torch  
 Wrench, Torque (Item 71, Appendix B)

Materials Required:

Brush, Medium Bristle (Item 14, Appendix C)  
 Cloth, Soft (Item 23, Appendix C)  
 Solvent, Cleaning (Item 4, Appendix C)

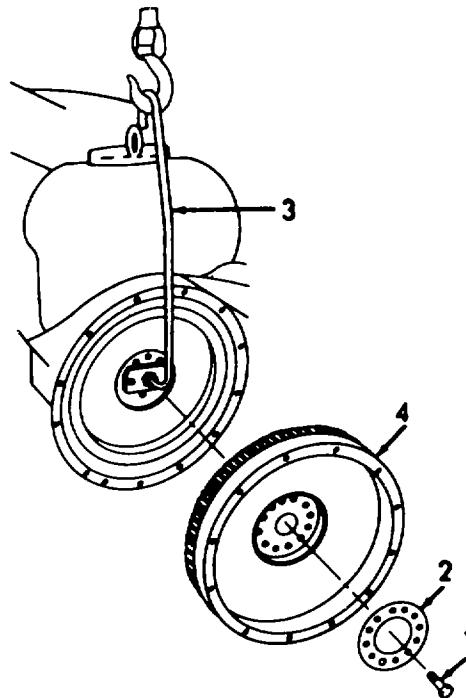
Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Clutch removed (paragraph 3-50).

a. Removal. (Refer to figure 3-91).

- (1) Remove six bolts (1) and scuff plate (2).
- (2) Attach flywheel lifting tool (3) to flywheel (4) with two 7/16 inch-14 bolts.
- (3) Attach a chain hoist to the lifting tool to support the flywheel.
- (4) Move upper end of lifting tool in and out to loosen the flywheel from the crankshaft.
- (5) Remove the flywheel from the crankshaft.

- (6) Set the flywheel down and remove flywheel lifting tool.



**Figure 3-91. Flywheel, Removal/Installation.**

b. Cleaning.

- (1) Remove all buildup of dirt, grease, etc. by wiping with a clean, soft cloth (item 23, Appendix C).

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (2) Clean all parts using a medium bristle brush (item 14, Appendix C) or a soft cloth (Item 23, Appendix C) and cleaning solvent (item 4, Appendix C).
- (3) Allow all parts to dry.

c. Inspection.

- (1) Inspect for damaged or worn ring gear teeth.
- (2) Inspect flywheel for cracks.

**3-44. FLYWHEEL - Continued.**

- d. Repair. Repair is limited to the replacement of the ring gear as follows:
- (1) Support the flywheel, crankshaft side down, on a solid flat surface.
  - (2) 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.
  - (3) Turn the flywheel ring gear side up.
  - (4) Rest the ring gear on a flat metal surface.
  - (5) Heat ring gear uniformly with an acetylene torch, keeping the torch moving around the gear to avoid hot spots.
  - (6) Use a pair of tongs to place the ring gear on the flywheel.
  - (7) Tap the gear into place against the shoulder of the flywheel. If the gear cannot be tapped into place readily, remove it and reheat.
- e. Installation.
- (1) Refer to figure 3-91 and attach flywheel lifting tool (3) to flywheel (4) with two 7/16 inch-14 bolts.
  - (2) Lift flywheel into position and align with crankshaft bolt holes.
  - (3) Remove flywheel lifting tool.
  - (4) Install scuff plate (2) and six bolts (1). Apply international Compound No. 2 to the threads of the bolts. Wipe off excess.
  - (5) Torque six bolts (1) to 50 ft-lb (68 Nni), then tighten six bolts (1) an additional 1/4 turn.

**3-45. FLYWHEEL HOUSING.**

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**This task covers:****a. Removal****b. Cleaning****c. Inspection****d. Installation**

---

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Hoist, Chain  
 Tool, Oil Seal (Item 48, Appendix B)  
 Pilot Studs (Item 49, Appendix B)  
 Oil Seal Expander (Item 50, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 5104506  
 Gasket P/N 5113061  
 Gasket P/N 5150054  
 Oil, Fuel (Item 9, Appendix C)  
 Oil, Lubricating (Item 12, Appendix C)  
 Washer, Lock P/N MS35338-46  
 Washer, Lock P/N MS35338-47  
 Washer, Lock P/N MS35338-48  
 Wire, Lock P/N 5187323

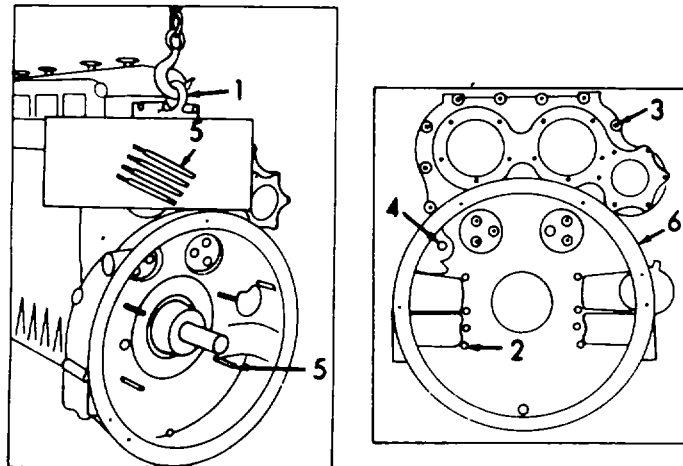
**Equipment Conditions:**

Engine removed (paragraph 3-15).  
 Starter removed (paragraph 3-11).  
 Oil pan removed (paragraph 3-37).  
 Flywheel removed (paragraph 3-44).  
 Tachometer removed (paragraph 3-29).  
 Blower drive removed (paragraph 3-20).

---

**3-45. FLYWHEEL HOUSING - Continued.**a. Removal. (Refer to figure 3-92).

- (1) Remove two bolts securing lifting bracket (1) to cylinder head.
- (2) Remove twelve bolts (2) from inside housing bell.
- (3) Remove twelve bolts (3) from around upper portion of housing (6).
- (4) Remove two bolts (4) that secure the housing from the front of the rear end plate.
- (5) Install four pilot studs (5) to block.
- (6) Attach chain hoist to lifter bracket.
- (7) Strike the housing on the front face with a soft hammer on both sides to work the housing off the dowels and away from the cylinder block.
- (8) Remove and discard gasket.

**Figure 3-92. Flywheel Housing, Removal.**b. Cleaning.

- (1) Clean housing with clean fuel oil (item 9, Appendix C). Be sure to remove all traces of gasket from both the housing and the block mating surfaces.
- (2) Wipe off excess oil and dry.

c. Inspection.

- (1) Inspect for cracks and other damage.
- (2) Inspect for damaged or missing mounting hardware.

d. Installation.

- (1) Refer to figure 3-93 and install new crankshaft oil seal.
- (2) Install new housing gasket to housing (1).
- (3) Coat the crankshaft oil seal with lubricating oil (item 12, Appendix C).
- (4) Install four pilot studs (2) into block.
- (5) Install oil expander (3) to end of crankshaft.
- (6) Attach hoist to the flywheel housing and lift into position.
- (7) Remove the oil seal expander.

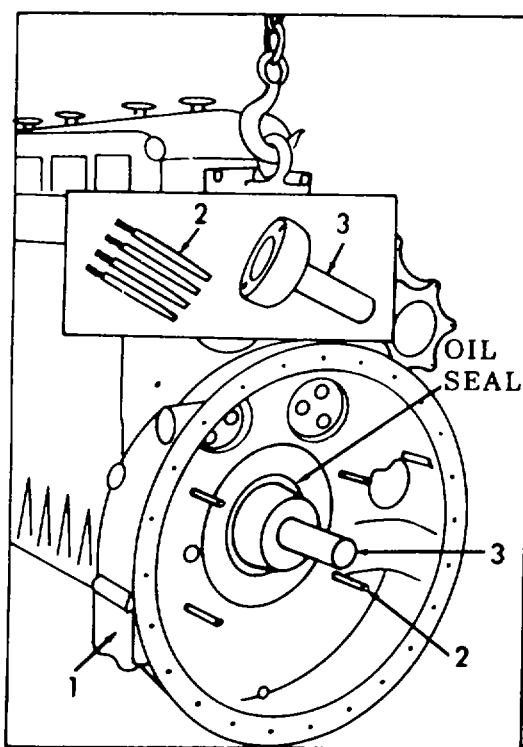
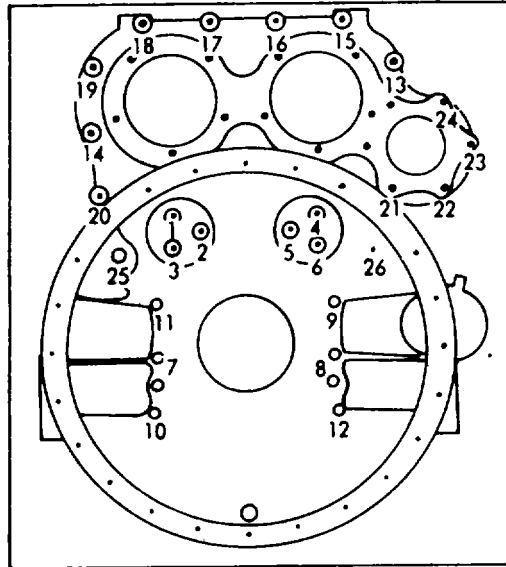


Figure 3-93. Flywheel Housing, Installation.

**3-45. FLYWHEEL HOUSING- Continued.****d. Installation - Continued.**

(8) Refer to figure 3-94 and install mounting bolts and tighten finger tight.

(9) Torque bolts (1) through (26) to 30 lb-ft (30 Nm).

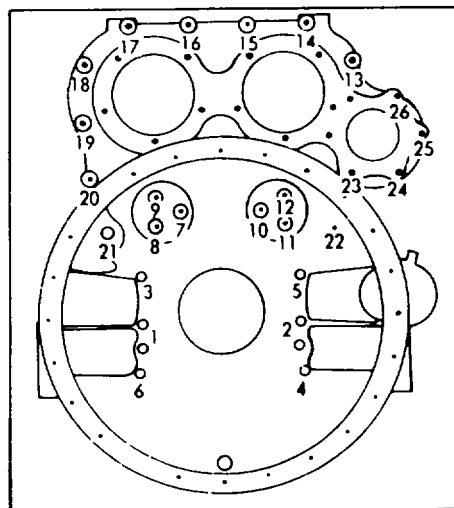


**Figure 3-94. Flywheel Housing, First Torque.**

(10) Refer to figure 3-95 and torque bolts (1) through (6) to 90-100 lb-ft (122-136 Nm).

(11) Torque bolts (7) through (12) to 40-45 lb-ft (54-61 Nm).

(12) Torque bolts (13) through (26) to 25-30 lb-ft (43-41 Nm).



**Figure 3-95. Flywheel Housing, Final Torque.**

**3-46. OIL PRESSURE REGULATOR.****This task covers:****a. Removal****b. Cleaning****c. Inspection****d. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

Gasket P/N 5104381

Gasket P/N 515376

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Engine removed from mounting frame (paragraph 3-15).

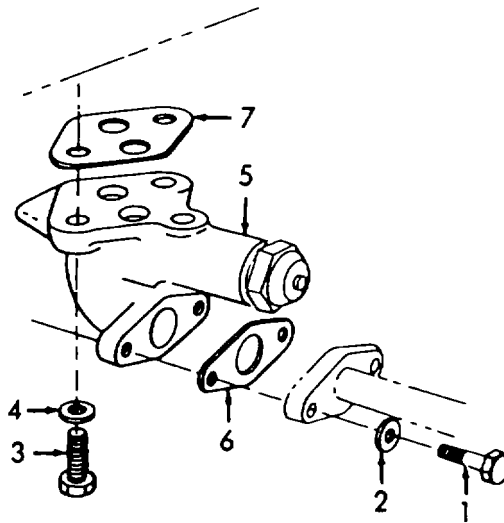
Oil pan removed (paragraph 3-37).

**a. Removal.** (Refer to figure 3-96).

(1) Remove two screws (1), two washers (2), two screws (3), and two washers (4).

(2) Remove pressure regulator (5).

(3) Remove and discard gasket (6) and gasket (7).

**Figure 3-96. Oil Pressure Regulator, Removal/Installation.**

**3-46. OIL PRESSURE REGULATOR - Continued.**

- b. Cleaning.
  - (1) Clean all parts in clean fuel oil (item 9, Appendix C).
  - (2) Wipe off excess oil and dry.
- c. Inspection.
  - (1) Inspect body for obvious damage.
  - (2) Inspect for missing or damaged hardware.
- d. Installation.
  - (1) Refer to figure 3-96 and install gasket (7) into position.
  - (2) Install regulator (5) and gasket (6).
  - (3) Install two washers (4), two screws (3), two washers (2), and two screws (1).

**3-47. OIL PUMP.****This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Puller, Gear (Item 52, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 105456  
 Gasket P/N 5151370  
 Gasket P/N 5151370  
 Washer, Lock P/N MS35338-46  
 Washer, Lock P/N 103320

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Engine removed from mounting frame (paragraph 3-15).  
 Oil pan removed (paragraph 3-37).

a. Removal. (Refer to figure 3-97).

- (1) Remove two screws (1), two washers (2), two screws (3), two lockwashers (4), and outlet tube (5).
- (2) Remove and discard two gaskets (6 and 7).
- (3) Remove retainer (8) and screen (9).
- (4) Remove two nuts (10), two lockwashers (11), two screws (12), and cover (13).
- (5) Remove four screws (14), four lockwashers (15), and two brackets (16).
- (6) Remove two screws (17), two lockwashers (18), inlet tube (19), and gasket (20). Discard gasket (20).
- (7) Remove two screws (21) and two lockwashers (22).

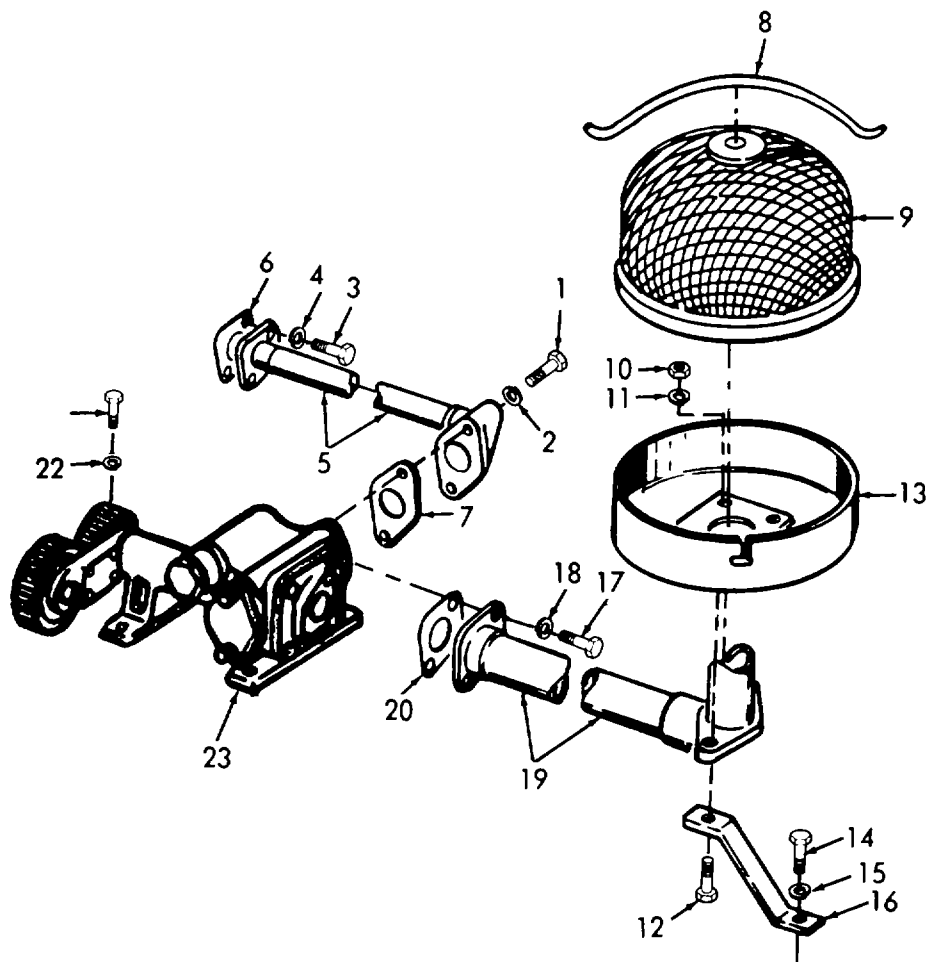
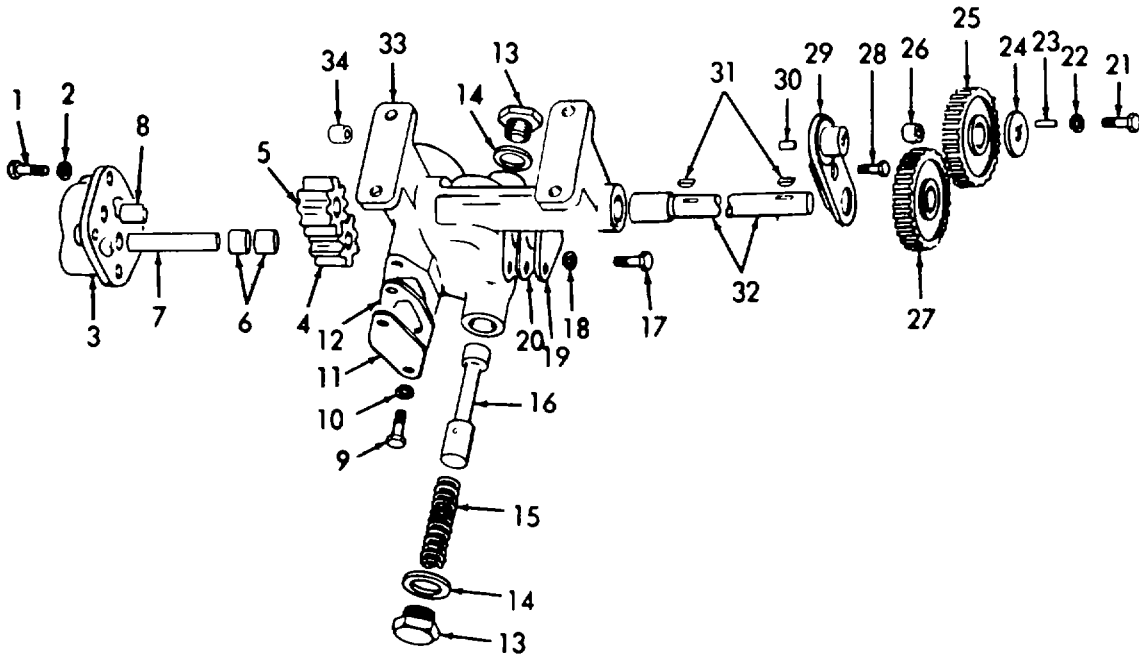


Figure 3-97. Oil Pump, Removal/Installation.

### 3-47. OIL PUMP - Continued.

b. Disassembly. (Refer to figure 3-98).

- (1) Remove four screws (1), four lockwashers (2), and cover (3) from oil pump body.
- (2) Remove drive gear (4), driven gear (5) bushing (6), and shaft (7).
- (3) Position cover (3) in an arbor press and press out bushings (8).
- (4) Remove two screws (9), two lockwashers (10), cover (11), and gasket (12). Discard gasket (12).
- (5) Remove two plugs (13), two gaskets (14), spring (15), and relief valve (16).
- (6) Remove two screws (17), two lockwashers (18), cover (19), and gasket (20). Discard gasket (20).
- (7) Straighten the tab of lockwasher (22) and remove bolt (21), lockwasher (22), pin (23), washer (24) and idler gear (25). Press bushing (26) from gear (25).
- (8) Clamp pump body in a vise, use a puller and remove drive gear (27).
- (9) Remove bolt (28) and idler gear support (29) from pump body (33). Remove pin (30) from idler gear support (29).
- (10) Remove two keys (31) and shaft (32) from pump body (33). Press bushing (34) from pump body (33).



**Figure 3-98. Oil Pump, Disassembly/Reassembly.**

c. Cleaning.

- (1) Wash all parts in clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess oil and dry.

d. Inspection.

- (1) Inspect gear cavity in the pump body and the drive shaft bushings. If the driven gear bushings are worn, replace the bushings.
- (2) Inspect all gear teeth for scoring or signs of wear. Replace a bad gear.
- (3) Inspect pressure relief valve and its seat in the pump body for signs of wear. Replace a bad relief valve.

e. Repair. Repair of the oil pump is limited to replacing defective parts.

f. Reassembly.

- (1) Refer to figure 3-98 and press bushing (34) into pump body (33). Install pin (30) into idler gear support (29).
- (2) Install idler gear support (29) on pump body (33) and secure with bolt (28). Tighten bolt to 45-50 lb-ft (61-68 Nm) torque.
- (3) Apply a light coat of engine oil on shaft (32). Insert woodruff key (31) in the keyways. Using an arbor press drive gear (4) on shaft.
- (4) Install the drive gear and shaft assembly into pump body (33) and slide the driven gear (5) onto the shaft.
- (5) Place drive shaft (32) on the bed of an arbor press and insert woodruff key (31) in keyway of shaft. Position drive gear (27) on shaft (32), with the extended hub side up away from the pump body.
- (6) Insert a .004 inch to .006 inch feeler gage between the driven gear and the pump body. Press the gear on the shaft, until the clearance between the gear and the body is .004 inch to .006 inch.
- (7) Install pin (23) in idler gear support (29). Position idler gear (25) on support, with the flat side of gear facing the support. Install washer (24), washer (22), and bolt (21). Tighten bolt to 21-26 lb-ft (28-35 Nm) so the bolt head is over the end of pin (23). Bend tab of washer (22) against on flat of bolt head.
- (8) Position a new gasket (20) and cover (19) on pump body and secure with two lockwashers (18) and two screws (17).
- (9) Install relief valve (16), spring (15), two gaskets (14), and two plugs (13). Tighten plugs to 25-35 lb-ft (34-47 Nm) torque.

### 3-47. OIL PUMP - Continued.

#### f. Reassembly - Continued.

- (10) Position a new gasket (12) and cover (11) on pump body and secure with two lockwashers (10) and two screws (9).

#### NOTE

If bushing (8) and (6) are replaced, they must be reamed after assembly.

- (11) Press new bushings (8 and 6) into place. Bushing used with .499 inch diameter driven gear shaft must be reamed to .500 inch + .0005 inch and bushings used with .623 inch diameter shaft must be reamed to .625 inch + .0005 inch.

#### NOTE

If suitable boring equipment is not available, replace the pump.

- (12) Install shaft (7) into cover (3).
- (13) Position cover (3) on pump body and secure with four lockwashers (2) and four screws (1).

#### g. Installation.

- (1) Refer to figure 3-97 and install pump (23) and secure with two lock-washers (22) and two screws (21).
- (2) Install new gasket (20), inlet tube (19), two lockwashers (18), and two screws (17).
- (3) Install two brackets (16), four lockwashers (15), and four screws (14).
- (4) Install cover (13), two screws (12), two lockwashers (11), and two nuts (10).
- (5) Install screen (9) and retainer (8).
- (6) Install two new gaskets (7 and 6).
- (7) Install outlet tube (5) and place oil pump (23) into position and secure with two lockwashers (4), two screws (3), two washers (2), and two screws (1).
- (8) Reinstall oil pan (paragraph 3-37).
- (9) Reinstall engine (paragraph 3-15).

**3-48. PANEL, INSTRUMENT.**

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**This task covers:****a. Removal****b. Cleaning****c. Inspection****d. Installation**

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**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

**Materials Required:**

Solvent, Cleaning (Item 4, Appendix C)

Washer, Lock P/N MS35338-42

Washer, Lock P/N MS35338-44

Washer, Lock P/N MS35338-46

Washer, Lock P/N MS35338-48

Washer, Lock P/N 120217

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Throttle control removed (paragraph 3-16).

Water temperature gage removed (paragraph 3-21, TM 55-1930-208-10).

Oil pressure gage removed (paragraph 3-22, TM 55-1930-208-10).

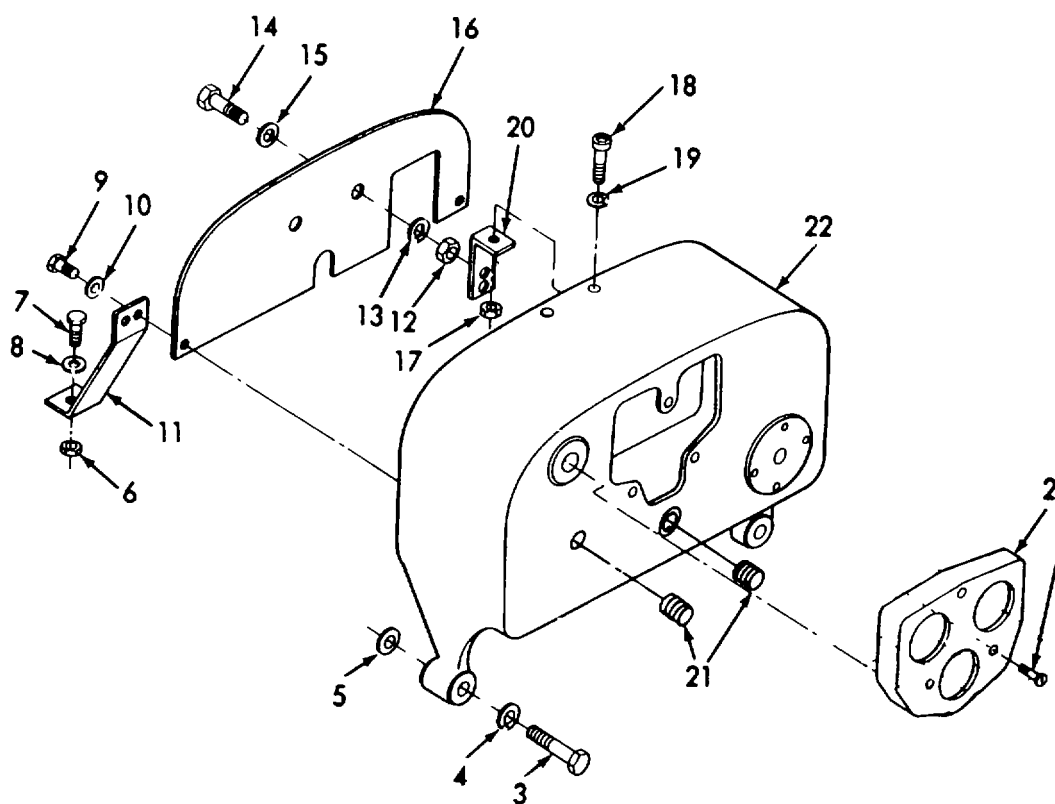
Cold weather starting aid control removed (paragraph 3-23, TM 55-1930-208-10).

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**3-48. PANEL, INSTRUMENT- Continued.**

a. Removal. (Refer to figure 3-99).

- (1) Remove three screws (1) and panel cluster (2).
- (2) Remove two screws (3), two lockwashers (4), and two spacers (5).
- (3) Remove nut (6), screw (7), lockwasher (8), screw (9), lockwasher (10), and bracket (11).
- (4) Remove nut (12), lockwasher (13), screw (14), flat washer (15), and cover (16).
- (5) Remove nut (17), screw (18), lockwasher (19), and bracket (20).
- (6) Remove three plugs (21) and panel (22).



**Figure 3-99. Instrument Panel, Removal/Installation.**

b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean panel and panel cluster with cleaning solvent (item 4, Appendix C).
- (2) Allow parts to dry.

c. Inspection. Inspect panel and panel cluster for dents, rust, and broken welds. Replace a damaged panel or panel cluster.

d. Installation.

- (1) Refer to figure 3-99 and install three plugs (21) into panel (22).
- (2) Install bracket (20) and secure with lockwasher (19), screw (18), and nut (17).
- (3) Install cover (16) and secure with flat washer (15), screw (14), lockwasher (13), and nut (12).
- (4) Install bracket (11) and secure with lockwasher (10) and screw (9).
- (5) Position panel (22) on engine and secure with lockwasher (8), screw (7), nut (6), two spacers (5), two lockwashers (4), and two screws (3).
- (6) Position panel cluster (2) on panel (22) and secure with three screws (1).
- (7) Install cold weather starting aid control per paragraph 3-23, TM 55-1930-208-10.
- (8) Install oil pressure gage per paragraph 3-22, TM 55-1930-208-10.
- (9) Install water temperature gage per paragraph 3-21, TM 55-1930-208-10.
- (10) Install throttle control per paragraph 3-16.

## Section VIII. MAINTENANCE OF CLUTCH

	Para.		Para.
Clutch Adjustment .....	3-49	Clutch Replacement .....	3-50

### 3-49. CLUTCH ADJUSTMENT.

This task covers:

- |                                  |                      |
|----------------------------------|----------------------|
| a. Inspection Hole Cover Removal | b. Clutch Adjustment |
|----------------------------------|----------------------|

#### INITIAL SETUP:

#### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

#### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Clutch disengaged.

- a. Inspection Hole Cover Removal. (Refer to figure 3-100).

(1) Remove two screws (1) and inspection hole cover (2) to expose clutch adjusting rings.

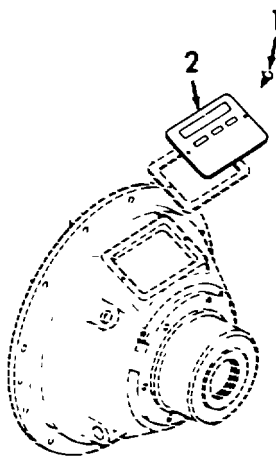
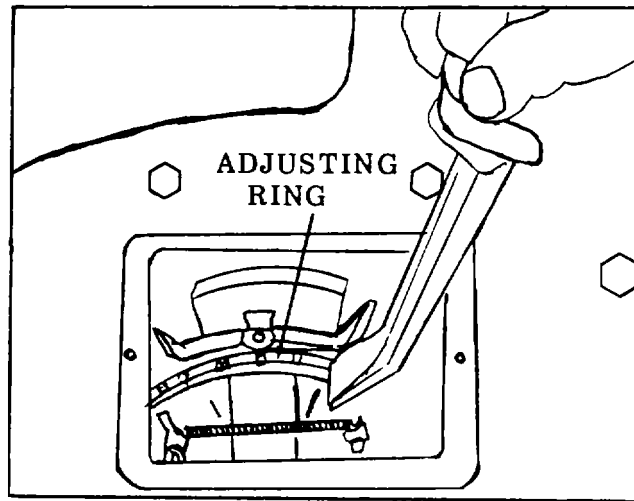


Figure 3-100. Inspection Hole Cover Removal.

b. Clutch Adjustment. (Refer to figure 3-101).

(1) Rotate the clutch, if necessary, to bring the clutch adjusting ring lock within reach.

(2) Raise the end of the adjusting ring lock up out of the splined groove in the hub of the outer clutch pressure plate. Then, while holding the clutch drive shaft to prevent the clutch from turning, turn the clutch adjusting ring clockwise and tighten the clutch until the desired pressure on the outer end of the hand lever is obtained. When the clutch is properly adjusted, heavy pressure is required at the outer end of the hand lever to move the throwout linkage to the "over center" or locked position.



**Figure 3-101. Clutch Adjustment.**

(3) After the clutch is properly adjusted, reinstall the end of the clutch adjusting ring lock in one of the splined grooves in the hub of the outer clutch pressure plate.

(4) Install inspection hole cover (figure 3-100).

**3-50. CLUTCH REPLACEMENT.**

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**This task covers:****a. Removal****b. Installation**

---

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)

Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Washer, Lock P/N MS35338-47

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Coupling removed (paragraph 3-52).

**a. Removal.** (Refer to figure 3-102).

- (1) Support the weight of power take-off assembly with a rope sling and chain hoist.
- (2) Engage the clutch with the hand lever to hold the clutch facings in place.
- (3) Remove twelve bolts (1) and twelve lockwashers (2) securing the power take-off (3) assembly to the engine flywheel housing.
- (4) Screw two of clutch housing attaching bolts into the tapped holes provided in the flange of the clutch housing and push power take-off assembly away from flywheel housing. Pull power take-off assembly straight back away from the engine.

**CAUTION**

Do not permit the outer end of the unit to tip down when being removed from the engine or the clutch pilot bearing may be damaged.

- (5) Remove sixteen bolts (4), sixteen lockwashers (5), and clutch driving ring (6).

**b. Installation.**

- (1) Refer to figure 3-102 and install clutch driving ring (6) and secure to the flywheel with sixteen bolts (4) and sixteen lockwashers (5). Tighten bolts to 71-75 lb-ft (96.9-10.24 Nm).

- (2) Support power take-off assembly with a rope sling and chain hoist. Position power take-off assembly at the rear of the flywheel housing with clutch drive shaft in line with pilot bearing in the flywheel.
- (3) Push power take-off forward and guide forward end of drive shaft straight into the clutch pilot bearing and engage the teeth on the outer diameter of clutch facings with the teeth in the inner diameter of clutch driving ring.
- (4) Install power take-off (3) on flywheel housing and secure with twelve bolts (1) and twelve lockwashers (2). Tighten bolts to 46-50 lb-ft (62.8-68.3 Nm).
- (5) Remove chain hoist and rope sling.
- (6) Before applying a load and with clutch released, rotate drive shaft by hand to be sure it rotates freely.
- (7) Adjust the clutch per paragraph 3-49.

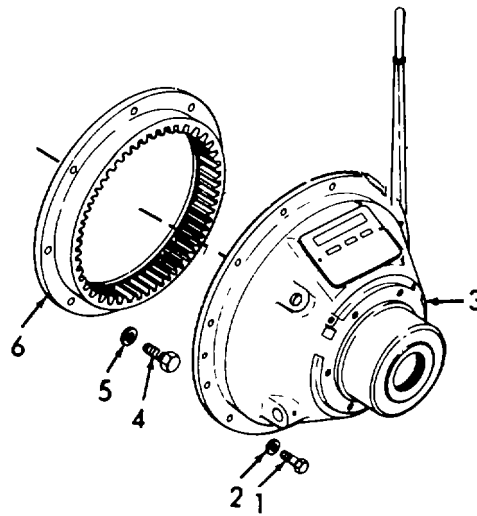


Figure 3-102. Clutch Replacement, Removal/Installation.

**Section IX. MAINTENANCE OF SPEED REDUCER**

	Para.		Para.
Coupler Assembly .....	3-52	Speed Reducer .....	3-51
Shaft Assembly .....	3-53		

**3-51. SPEED REDUCER.****This task covers:**

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

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket Kit P/N M02966240-100  
Gloves, Asbestos (Item 34, Appendix C)  
Permatex #3 (Item 19, Appendix C)  
Seal P/N M02966240-35  
Seal P/N M02966240-45  
Solvent, Cleaning (Item 4, Appendix C)  
Washer, Lock P/N MS35338-44  
Washer, Lock P/N MS35338-46  
Washer, Lock P/N MS35338-48  
Washer, Lock P/N MS35338-50

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Coupling removed (paragraph 3-52).  
Shaft assembly removed (paragraph 3-53).

- a. Removal. (Refer to figure 3-103).
  - (1) Remove four nuts (1), four lockwashers (2), and four bolts (3).
  - (2) Attach a sling to four lifting eyes on the speed reducer. Attach a lifting device, capable of lifting 750 lbs (340.50 Kg) to sling.
  - (3) Slowly raise speed reducer until bottom shaft clears mounting base. Rotate speed reducer and remove from machinery house through the door.

- (4) Position wood blocks under speed reducer, lower lifting device and remove sling.
- (5) Refer to TM 55-1930-208-10, paragraph 3-1 and drain oil.

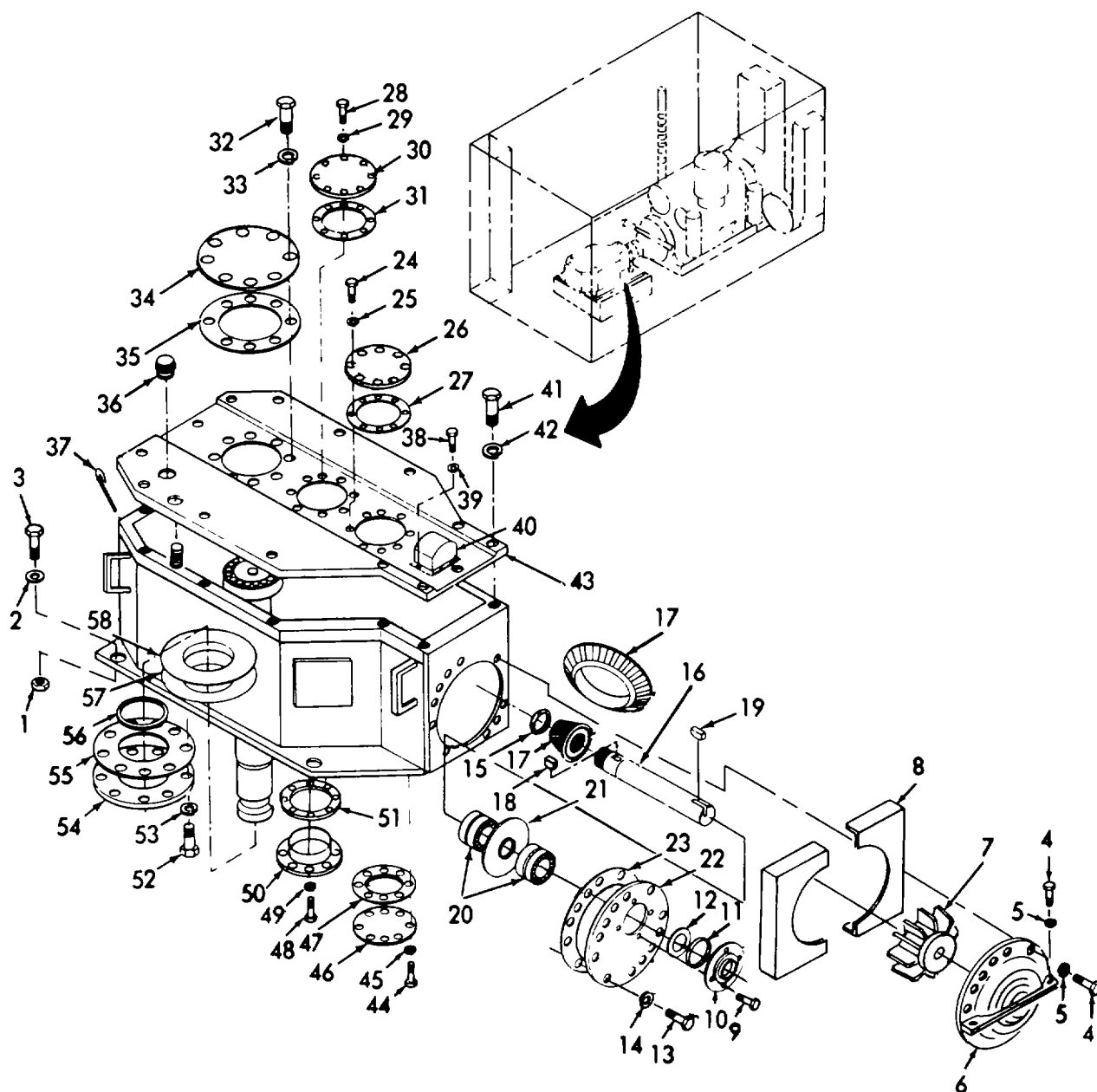


Figure 3-103. Speed Reducer Cover and High Speed Shaft.

### 3-51. SPEED REDUCER - Continued.

#### b. Disassembly.

- (1) Refer to figure 3-103 and remove ten screws (4), ten lockwashers (5), and cover (6).
- (2) Remove fan (7) and baffle (8).
- (3) Remove four bolts (9) and cage (10). Remove seal (11) and ring (12).
- (4) Remove thirteen bolts (13), thirteen lockwashers (14), and remove high speed head assembly.
- (5) Mount head assembly in an arbor press with the bevel pinion up. Wrap shim stock around shaft extension and key to prevent damage to shaft.
- (6) Hold shaft with a wrench and remove nut (15).
- (7) Apply heat to bevel pinion ; press shaft (16) from pinion gear (17) and remove keys (18 and 19).
- (8) Press bearings (20) and slinger (21) from shaft. Remove head (22) and shim (23).

#### **NOTE**

Wire shims to head for reference when reassembling speed reducer.

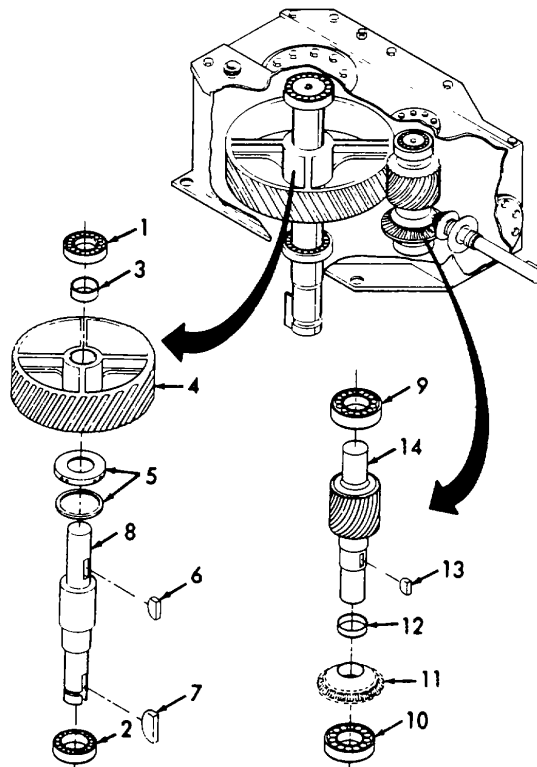
- (9) Remove eight bolts (24), eight lockwashers (25), cover (26), and shim gasket (27).
- (10) Remove eight bolts (28), eight lockwashers (29), cover (30), and shim gasket (31).
- (11) Remove eight bolts (32), eight lockwashers (33), cover (34), and shim gasket (35).
- (12) Remove breather (36) and dipstick (37).
- (13) Remove six bolts (38), six lockwashers (39), and oil distributor (40).
- (14) Remove thirteen bolts (41) and thirteen lockwashers (42). Attach two eye bolts to cover. Attach a sling to the eye bolts. Attach a lifting device capable of lifting 150 lbs (68.20 Kg) and remove cover (43).
- (15) Remove eight bolts (44), eight lockwashers (45), cover (46), and shim gasket (47).
- (16) Remove eight bolts (48), eight lockwashers (49), cover (50), and shim gasket (51).

- (17) Remove eight bolts (52), eight lockwashers (53), cover (54), shim gasket (55), seal (56), gasket (57), and seal (58).
- (18) Refer to figure 3-104 and attach a sling to the low speed gear. Attach a lifting device capable of lifting 150 lbs (68.10 Kg) and remove assembled low speed shaft assembly.
- (19) Press bearing (1 and 2) off of shaft (8).

**NOTE**

To ease removal, heat may be applied to bearing cone or inner race.

- (20) Press gear (4) off of shaft (8) and remove spacer (3).
- (21) Remove seal ring (5) and keys (6 and 7) from shaft (8).
- (22) Remove assembled intermediate shaft from housing.
- (23) Press bearings (9 and 10) and bevel pinion (11) off of shaft (14).
- (24) Remove spacer (12) and key (13) from shaft (14).



**Figure 3-104. Speed Reducer Low Speed and Intermediate Shafts.**

**3-51. SPEED REDUCER - Continued.**c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow all parts to dry.
- (3) Remove gasket material from all surfaces.

d. Inspection.

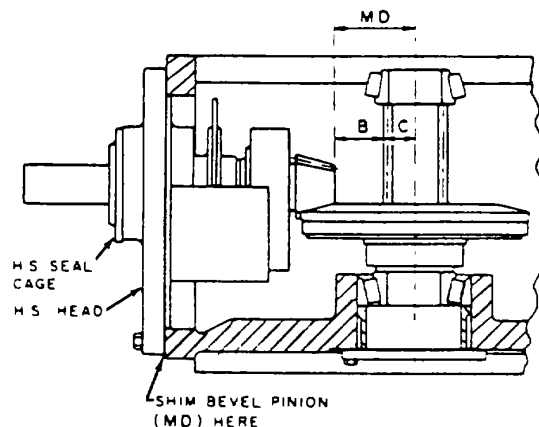
- (1) Inspect all bearings for pitting or scoring. Replace a damaged bearing.
- (2) Inspect all gears for chipped or missing teeth. Replace a damaged gear.
- (3) Inspect all covers for cracks or signs of damage. Replace a damaged cover.

e. Repair. Repair is limited to replacing damaged parts.f. Reassembly.**WARNING**

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (1) Refer to figure 3-104 and install key (13) and spacer (12) on shaft (14).
- (2) Preheat bevel pinion (11) in an oil bath or an oven to a maximum of 375°F (191°C), press bevel pinion (11) onto shaft (14).
- (3) Preheat bearings (10 and 9) in an oil bath or an oven to a maximum of 275°F (135°C), press bearings (10 and 9) onto shaft (14).
- (4) Install assembled intermediate shaft in housing.
- (5) Install keys (7 and 6), seal ring (5), and spacer (3) on shaft (8).
- (6) Preheat gear (4) in an oil bath or an oven to a maximum of 375°F (191°C), press gear (4) on shaft (8).

- (7) Preheat bearings (2 and 1) in an oil bath or an oven to a maximum of 275°F (135°C), press bearings (2 and 1) on shaft (8).
- (8) Attach a sling and lifting device capable of lifting 150 lbs (68.10 Kg) and install assembled low speed shaft in housing, making sure gears (14 and 4) teeth mesh.
- (9) Install shim gasket (51) and cover (50) and secure with eight lockwashers (49) and eight bolts (48). Torque bolts to 255 lb-in (29.02 Nm).
- (10) Install shim gasket (47) and cover (46) and secure with eight lockwashers (45) and eight bolts (44). Torque bolts to 255 lb-in (29.02 Nm).
- (11) Install key (18) on shaft (16). Wrap shim stock around shaft and mount in vise.
- (12) Preheat bevel pinion (17) in an oil bath or oven to a maximum of 275°F (135°C), press bevel on shaft (16) and secure with nut (15).
- (13) Preheat bearings (20) in an oil bath or oven to a maximum of 275°F (135°C), press bearings (20) and slinger (21) on shaft (16).
- (14) Install assembled high speed shaft in housing. Install shim gasket (23) and cover (22) and secure with thirteen lockwashers (14) and thirteen bolts (18). Torque bolts to 640 lb-in (62.80 Nm).
- (15) Install ring (12), seal (11), and cage (10) and secure with four bolts (9). Torque bolts to 255 lb-in (29.01 Nm).
- (16) Refer to figure 3-105 and measure the dimension from the toe of bevel pinion to the outside diameter of the intermediate helical pinion or shaft. Record this value as (B).



**Figure 3-105. Bevel Pinion Measurement.**

**3-51. SPEED REDUCER- Continued.**f. Reassembly - Continued.**CAUTION**

The lower intermediate bearing rollers must be seated when measuring dimension (B). Also exercise care not to displace the intermediate shaft subassembly cross axially.

- (17) Measure the intermediate helical pinion or shaft outside diameter with a micrometer, divide by 2 and record as dimension (C).

**NOTE**

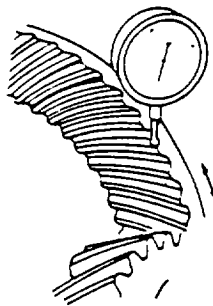
When measuring helical pinions with odd numbers of teeth, tightly wrap shim stock (.010 inch minimum thickness) around pinion and measure the diameter. Subtract twice the shim stock thickness from this value for the pinion outside diameter.

- (18) Add (B) + (C) and subtract total value from the pinion (MD) previously recorded. The difference is the required high speed compressed shim pack. Select shims which total in thickness within + .000 inch to .004 inch of the calculated shim pack.
- (19) Remove the high speed head, add the calculated amount of shims and install head. Tighten head bolts to 640 lb-in (62.80 Nm).
- (20) Place a dial indicator (figure 3-106) against a bevel gear tooth at the gear outside diameter perpendicular to the tooth surface.
- (21) Rotate the bevel gear back and forth while holding the bevel pinion shaft immobile. Read the backlash (tooth clearance) on the indicator. Required backlash is etched on the outer diameter of bevel gear.

**NOTE**

Final backlash at the mesh must equal etched backlash within .000 inch to + .004 inch.

- (22) To increase backlash, increase thickness of lower intermediate shim pack.



**Figure 3-106. Measuring Pinion Backlash.**

- (23) Refer to figure 3-103. Coat housing cover base with permatex (item 19, Appendix C). Install two eye bolts to cover (43). Attach a sling to eye bolts. Use a lifting device capable of lifting 150 lbs (68.10 Kg) and install cover (43). Secure cover with thirteen lockwashers (42) and thirteen bolts (41). Torque bolts to 1100 lb-in (125.12 Nm).
- (24) Install oil distributor (40) and secure with six lockwashers (39) and six bolts (38). Torque bolts to 255 lb-in (29.02 Nm).
- (25) Install dipstick (37) and breather (36).
- (26) Install shim gasket (35) and cover (34) and secure with eight lockwashers (33) and eight bolts (32). Torque bolts to 640 lb-in (62.80 Nm).
- (27) Install shim gasket (31) and cover (30) and secure with eight lockwashers (29) and eight bolts (28). Torque bolts to 255 lb-in (29.02 Nm).
- (28) Install shim gasket (27) and cover (26) and secure with eight lockwashers (25) and eight bolts (24). Torque bolts to 255 lb-in (29.02 Nm).
- (29) Install key (19) and fan (7) on shaft (16). Install baffle (8) and cover (6). Secure cover with two lockwashers (5) and eight screws (4).
- (30) Attach a sling to the four lifting eyes on the speed reducer. Attach a lifting device, capable of lifting 750 lbs (340.50 Kg) to sling.
- (31) Slowly raise speed reducer until bottom shaft clears bottom of machinery house door. Move speed reducer into machinery house. Rotate speed reducer and lower it on the mounting base, making sure the mounting holes are aligned.
- (32) Install four bolts (3), four lockwashers (2), and four nuts (1).
- (33) Refer to TM 55-1930-208-10, paragraph 3-1 and fill speed reducer with oil.
- (34) Install shaft assembly per paragraph 3-53.
- (35) Install coupling per paragraph 3-52.

**3-52. COUPLING ASSEMBLY.**


---

This task covers:

- a. Removal                      b. Installation
- 

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanic's (Item 1, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Gasket P/N 1090710-5

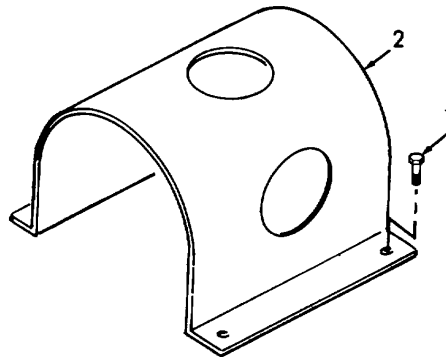
**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

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- a. **Removal.** (Refer to figure 3-107).

- (1) Remove four bolts (1) securing the coupling guard (2).



**Figure 3-107. Coupling Guard, Removal/Installation.**

- (2) Refer to figure 3-108 and remove four fasteners (1) securing coupling cover halves (2) and gaskets(3).
- (3) Using a round rod or screw driver that will conveniently fit into open loop ends of the grid (4), remove the grid. Begin at the open end of the grid section and insert the rod or screw driver into the loop ends. Use the teeth adjacent to each loop as a fulcrum and pry the grid out radially in even, gradual stage, proceeding alternately from side to side.
- (4) Remove hubs (5) and seals (6).

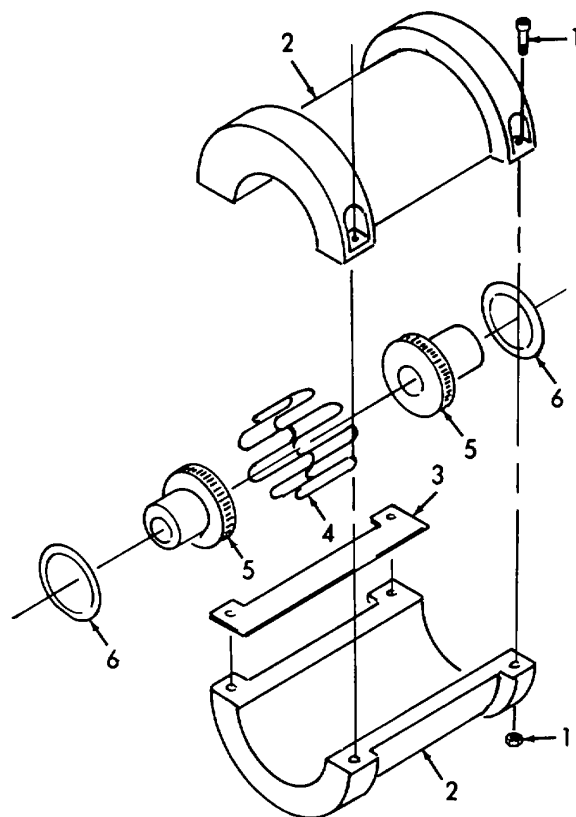
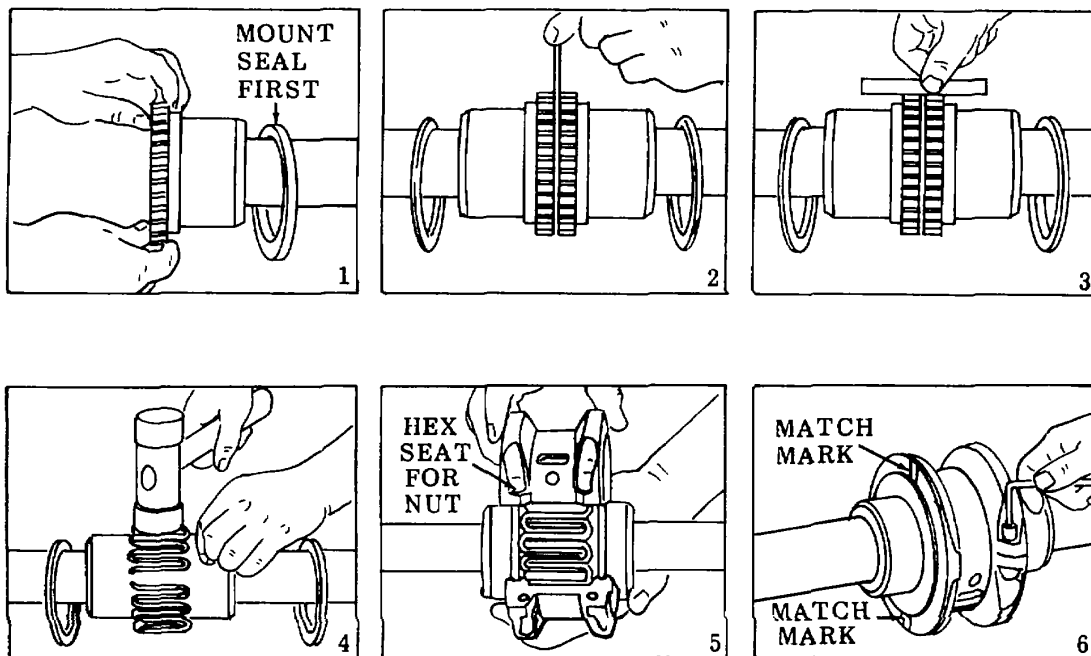


Figure 3-108. Coupling Assembly, Removal.

**3-52. COUPLING ASSEMBLY - Continued.****b. Installation.** (Refer to figure 3-109).

- (1) Lightly coat seals with grease and place on shafts before mounting hubs (Step 1). Mount hubs on their respective shafts so the hub face is flush with the end of its shaft.
- (2) Using a 0.125 inch thick spacer bar, insert the base as shown in Step 2. Insert the bar to the same depth at 90° intervals and measure the clearance between bar and hub face with feelers. The difference in minimum and maximum measurements must not exceed 0.007 inch.
- (3) Align so that a straight edges rests squarely on both hubs as shown in Step 3. Also check at 90° intervals. Check with feelers. The clearance must not exceed 0.008 inch. Tighten all foundation bolts and repeat Steps 2 and 3. Realign coupling, if necessary.
- (4) Pack gap and grooves with lubricant (TM 55-1930-208-10, paragraph 3-1) before inserting grid. When grids are furnished in two or more segments, install them so that all cut ends extend in the same direction; this will assure correct grid contact with non-rotating pin in cover halves. Spread the grid slightly to pass over the coupling teeth and seat with a soft mallet as shown in Step 4.

**Figure 3-109. Coupling Assembly, Installation.**

- (5) Refer to figure 3-108 and pack the spacers between and around the grid (4) with as much lubricant as possible and wipe off excess flush with top of grid. Position seals (6) on hubs (5) to line up with grooves in cover. Position gaskets (3) on flange of lower cover half and assemble covers (2) so that the match marks are on the same side.
- (6) Secure cover halves (2) with fasteners (1) and torque fasteners to 200 lb-in (22.75 Nm).
- (7) Refer to figure 3-107 and install cover (2) and secure with four bolts (1).

### 3-53. SHAFT ASSEMBLY.

---

This task covers:

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

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

##### Materials Required:

Gasket P/N HH-P-151

Joint P/N 5-281X

Solvent, Cleaning (Item 4, Appendix C)

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

**3-53. SHAFT ASSEMBLY - Continued.****a. Removal.** (Refer to figure 3-110).

- (1) Remove four nuts (1), four screws (2), and clamp (3).
- (2) Remove eight nuts (4), sixteen flat washers (5), and eight screws (6). Remove eight screws (7) and two brackets (8).
- (3) Remove five screws (9), five flat washers (10), and guard (11).
- (4) Remove three screws (12), three thumbscrews (13), and guard (14).
- (5) Remove twenty-four nuts (15), twenty-four washers (16), and twenty-four bolts (17) securing upper and lower companion flanges (18) to flange yokes (19).
- (6) Refer to paragraph 3-52 and remove speed reducer.
- (7) Remove eight screws (20) securing four dust caps (21) and four lock straps (22) to the upper flange yoke and slip yoke.
- (8) Remove the dust caps and lock straps from lower flange yoke and tube yoke in the same manner.
- (9) Remove universal joints (23).
- (10) Separate tube yoke (24) and pull remaining shaft components up through stuffing box.

**b. Disassembly.**

- (1) Refer to figure 3-110 and loosen dust cap (25) and separate slip yoke (26) from slip tube (27).
- (2) Remove eight bolts (28) and remove stuffing box (29) and gasket (30) from insert plate (31).

**c. Cleaning.****WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow all parts to dry.

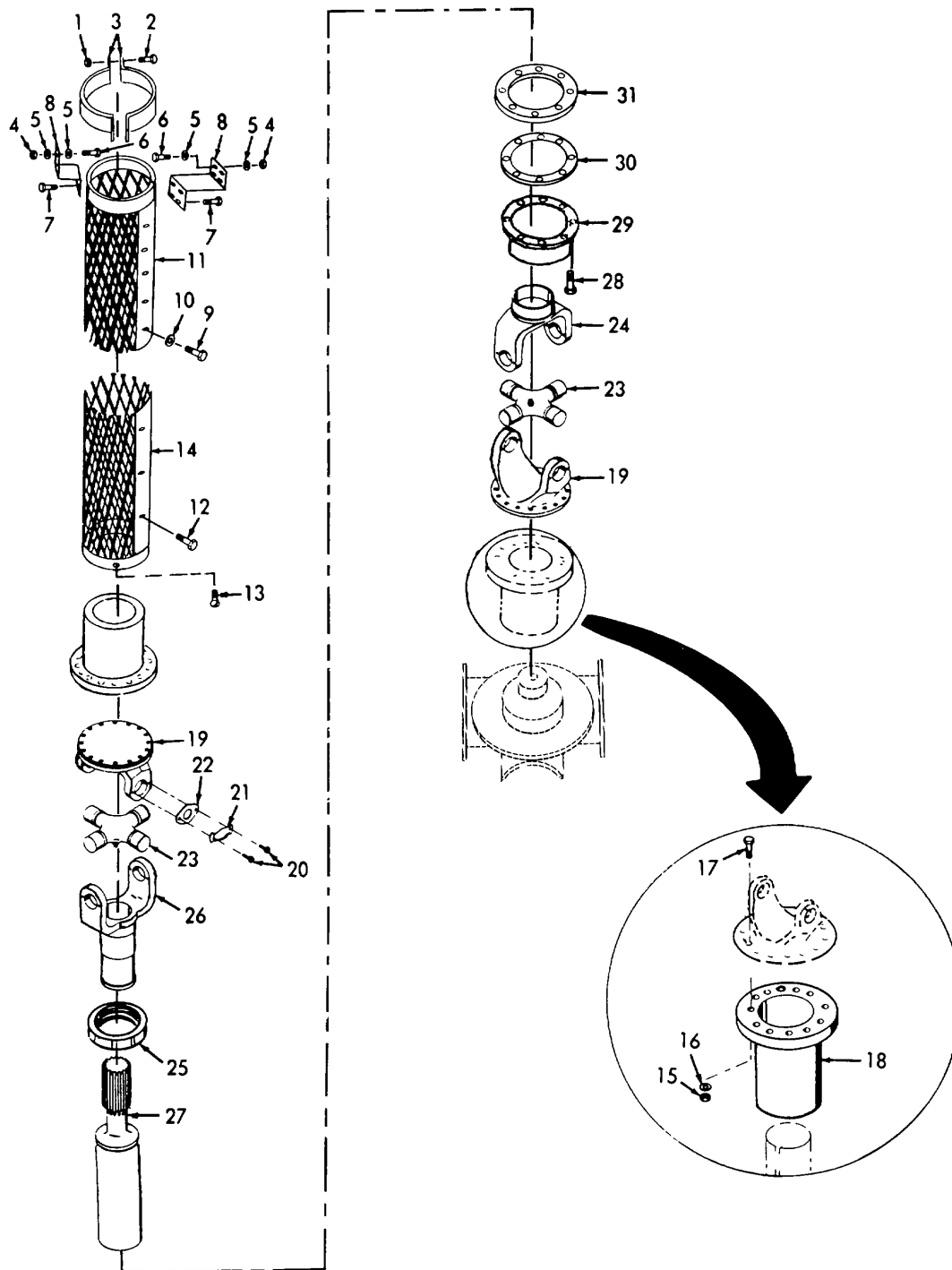


Figure 3-110. Shaft Assembly, Removal, Disassembly, Reassembly, and Installation.

**3-53. SHAFT ASSEMBLY - Continued.**

d. Inspection.

- (1) Examine all parts for signs of excessive wear and damage.
- (2) Check slip yoke and tube yoke for wear and scoring.
- (3) Inspect stuffing box for excessive wear.

e. Repair. Repair of the shaft assembly is limited to the replacement of defective parts.

f. Reassembly.

- (1) Refer to figure 3-110 and assemble stuffing box (29) and gasket (30) to insert plate (31) using eight bolts (28).
- (2) Attach slip yoke (26) to slip tube (27) and tighten dust cap (25).

g. Installation.

- (1) Refer to figure 3-110 and slide slip tube down through stuffing box and install tube yoke (24).
- (2) Assemble universal joints (23), lock straps (22), and dust caps (21). Install eight screws (20) in upper yokes and eight screws in lower yokes.
- (3) Refer to paragraph 3-52 and install speed reducer.
- (4) Install twenty-four bolts (17), twenty-four washers (16), and twenty-four nuts (15) securing upper and lower companion flanges (18) to flange yokes (19).
- (5) Install guard (14) and secure with three thumbscrews (13) and three screws (12).
- (6) Install guard (11) and secure with five flat washers (10) and five screws (9).
- (7) Install two brackets (8) and secure with eight screws (7), eight screws (6), sixteen flat washers (5), and eight nuts (4).
- (8) Install clamp (3) and secure with four screws (2) and four nuts (1).

**Section X. MAINTENANCE OF PUMP, TRANSFER**

	Para.		Para.
Pump, Transfer .....	3-54	Valve, Pressure Relief.....	3-55

**3-54. PUMP, TRANSFER.**


---

This task covers:

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

**INITIAL SET-UP:**Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Gasket P/N HH-P-151  
 Gasket P/N STYLE 3000-8  
 Gasket P/N 387221  
 Gasket P/N 537752  
 O-Ring P/N 701944  
 Seal P/N 904180  
 Seal P/N 904193  
 Solvent, Cleaning (Item 4, Appendix C)  
 Washer, Lock P/N 903528

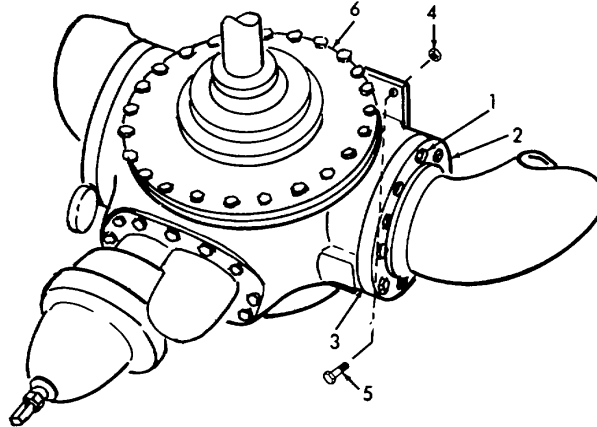
Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Pressure relief valve removed (paragraph 3-55).  
 Shaft assembly removed (paragraph 3-53).

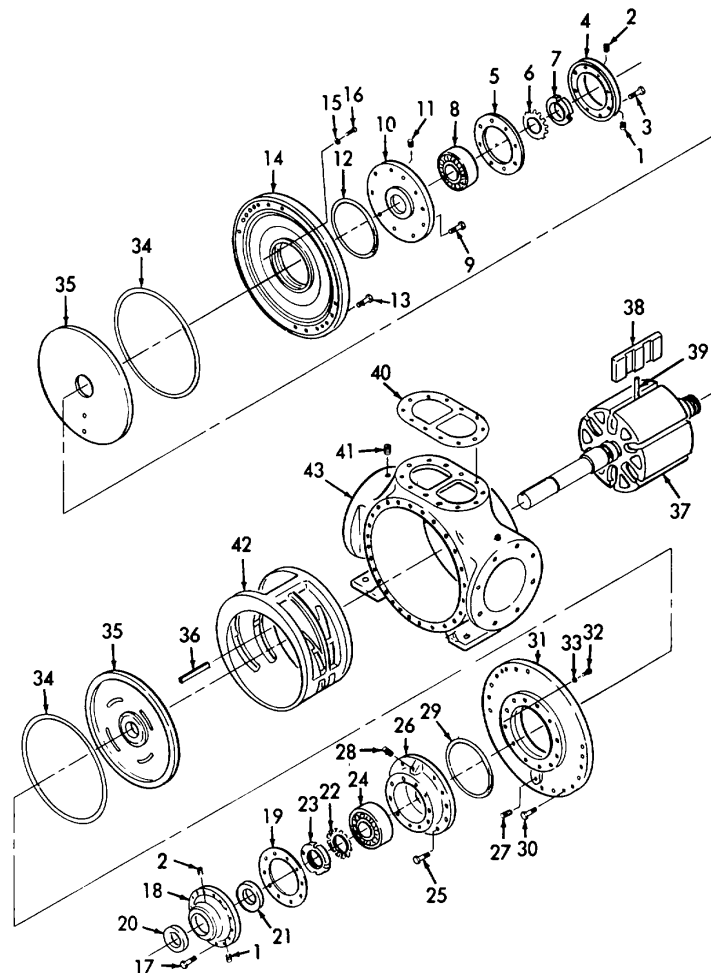
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**3-54. PUMP, TRANSFER- Continued.**a. Removal. (Refer to figure 3-111).

- (1) Remove sixteen screws (1) securing two flanges (2) and two gaskets (3) to pump casing.
- (2) Attach a sling and lifting device, capable of lifting 250 lbs (113.50 Kg) to pump assembly. Apply tension to lifting device and remove four nuts (4) and four screws (5). Remove pump (6) from mounting base.

**Figure 3-111. Transfer Pump, Removal / Installation.**b. Disassembly. (Refer to figure 3-112).

- (1) Remove one grease fitting (1) and one plug (2) from each bearing cover.
- (2) Remove eight screws (3), bearing cover (4) and gasket (5).
- (3) Bend the tabs of lockwasher (6) out of slot in locknut (7) and remove locknut with a hammer and punch. Remove lockwasher (6) and bearing (8).
- (4) Remove twelve screws (9) and hub (10). Remove grease fitting (11) and ring (12) from hub.
- (5) Remove two head retaining screws (13) and screw them into the holes near the outer rim of head (14). Insert an eye bolt in top of head and use a hoist for support. Remove remaining screws and tighten the two in the tapped holes until the head separates from the casing. Remove the head, being careful not to scrape or nick the shaft. Remove two screws (15) and two washers (16).



**Figure 3-112. Transfer Pump, Disassembly/Reassembly.**

- (6) Remove eight screws (17), bearing cover (18), and gasket (19). Remove grease seals (20 and 21).
- (7) Bend the tabs of lockwasher (22) out of the slot in locknut (23) and remove locknut with a hammer and punch. Remove lockwasher (22) and bearing (24).
- (8) Remove twelve screws (25) and hub (26). Remove drain plug (27), grease fitting (28), and ring (29) from hub (26).

**3-54. PUMP, TRANSFER - Continued.**b. Disassembly - Continued.

- (9) Remove two of the head retaining screws (30) and screw them into the holes near the outer rim of head (31). Insert an eye bolt in the top of the head and use a hoist for support. Remove remaining screws and tighten the two in the tapped holes until the head separates from the casing. Remove the head being careful not to scrape or nick the shaft. Remove two screws (32) and two washers (33).
- (10) Remove two O-rings (34) and two discs (35). If discs are stuck in the casing, they may be forced out by running screws down in the threaded holes provided near the outside diameter.
- (11) Remove key (36) and rotor and shaft (37). Remove vanes (38) and push rods (39) from the rotor.
- (12) Remove gasket (40), plug (41), and liner (42) from the casing (43).

c. Cleaning and Inspection**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts thoroughly with cleaning solvent (item 4, Appendix C). Wash out the seal and bearing recess.
- (2) Inspect all parts for scrapes, nicks, or any damage. Remove any burrs and smooth all rough spots on the rotor and liner with a file.

d. Repair. Repair is limited to replacing defective parts.e. Reassembly.**NOTE**

Use eye bolts with the aid of a hoist to install the liner, rotor and shaft, disc, and head assemblies. Tapped holes have been provided in each part for this purpose.

- (1) Refer to figure 3-112. With the aid of a little grease, install liner (42) in casing (43). The keyway in the top of the liner should be lined up with the pin in the top of the casing. Install plug (41) and gasket (40) on the casing.
- (2) Install push rods (39), vanes (38), and key (36) on rotor and shaft (37).

- (3) Install discs (35) in casing with smooth side of disc towards casing. Place O-rings (34) in heads.

**CAUTION**

When placing heads or hubs on the shaft, avoid striking the end of the shaft against the seal face.

- (4) Install head (31) and fasten with two screws (32) and two washers (33). Install head (31) on casing with screws (30).
- (5) Install ring (29), grease fitting (28), and drain plug (27) on hub (26). Install hub using twelve screws (25).
- (6) Slide bearing (24) on shaft. Slide lockwasher (22) on shaft with tangs facing outward. Start the locknut (23) on the threads with the tapered face inward.
- (7) Install grease seals (21 and 20) on the bearing cover (18). Install bearing cover and gasket (19) using eight screws (17).
- (8) Install head (14) with two screws (15) and two washers (16). Install head on casing with screws (13).
- (9) Install ring (12) and grease fitting (11) on hub (10). Install hub with twelve screws (9).
- (10) Slide bearing (8) on the shaft. Slide lockwasher (6) on the shaft with the tangs facing outward. Start the locknut (7) on the shaft with the tapered face inward.
  - (a) With one locknut backed off, tighten the other until the shaft begins to bind or turn hard.
  - (b) Back off the nut about  $1/32$  to  $1/16$  turn (about the width of a tang on the lockwasher) and secure it by bending over a tang on the lockwasher into the slot of the locknut. Pump shaft must now turn freely.
  - (c) Tighten the other locknut until it is snug against the bearing with the bearing seated firmly in its recess. Then tighten the nut about  $1/16$  turn and lock it in place with the tang of the lockwasher.
- (11) Install bearing cover (4) and gasket (5) with eight screws (3).
- (12) Install one plug (2) and one grease fitting (1) in each bearing cover.

f. **Installation.**

- (1) Refer to figure 3-111 and attach a sling and lifting device capable of lifting 250 lbs (113.50 Kg) to pump. Lift pump and install it on the mounting base.

**3-54. PUMP, TRANSFER - Continued.**f. Installation - Continued.

- (2) Secure pump (6) to base with four screws (5) and four nuts (4).
- (3) Install two gaskets (3) and two flanges (2) and secure with sixteen screws (1).
- (4) Install shaft assembly per paragraph 3-53.
- (5) Install pressure relief valve per paragraph 3-55.

**3-55. VALVE, PRESSURE RELIEF.**


---

This task covers:

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

## INITIAL SET-UP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Materials Required:

Gasket P/N 536606  
 Gasket P/N 536652  
 Solvent, Cleaning (Item 4, Appendix C)

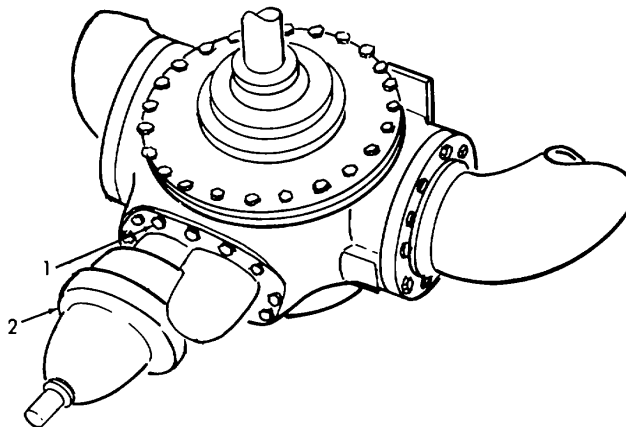
Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. Removal. (Refer to figure 3-113).

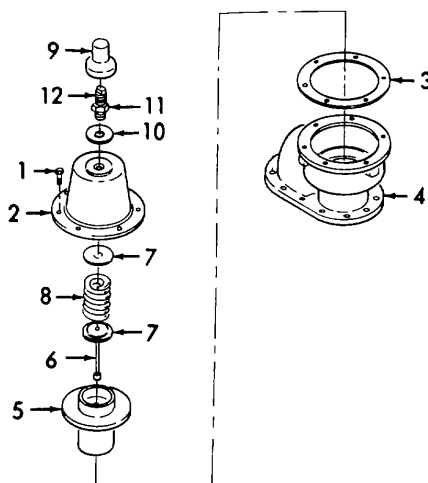
- (1) Remove twelve screws (1) securing relief valve (2) to transfer pump.



**Figure 3-113. Pressure Relief Valve, Removal/Installation.**

b. Disassembly. (Refer to figure 3-114).

- (1) Remove six screws (1) and separate the valve cover (2) and cover gasket (3) from valve body (4).
- (2) Remove valve (5), guide rod (6), spring guide (7), and spring (8).
- (3) Remove cap (9) and cap gasket (10).
- (4) Remove locknut (11) and adjusting screws (12).



**Figure 3-114. Pressure Relief Valve, Disassembly/Reassembly.**

### 3-55. VALVE, PRESSURE RELIEF - Continued.

c. Cleaning and Inspection

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts in cleaning solvent (item 4, Appendix C).
- (2) Allow all parts to dry.
- (3) Examine all parts for wear, damage, cracks, or pitting.
- (4) Replace any defective parts.

d. Repair. Repair is limited to replacing defective parts.

e. Reassembly.

- (1) Refer to figure 3-114 and install adjusting screw (12) and locknut (11) in valve cover.
- (2) Install cap gasket (10) and cap (9) on the cover.
- (3) Assemble spring (8), spring guide (7), guide rod (6), and valve (5).
- (4) Install cover gasket (3) and valve cover (2) on valve body (4) using six screws (1).

f. Installation. Refer to figure 3-113 and install relief valve (2) on pump assembly and secure with twelve screws (1).

### 3-56. PRESSURE GAUGES.

---

This task covers:

a. Removal

b. Installation

c. Installation

---

INITIAL SET-UP:

Tools Required:

Tool Kit, General Mechanic's (Item 1, Appendix B)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

a. Removal. (Refer to figure 3-115).

- (1) Remove ten nuts (1), ten screws (2), and ten clamps (3). Remove tube (4) and adapter (5).
- (2) Remove two screws (6), gauge (7), valve (8), tee (9), tube (10), adapter (11), valve (12), nipple (13), and elbow (14).
- (3) Remove tube (15), adapters (16 and 17), two screws (18), gauge (19), and valve (20).

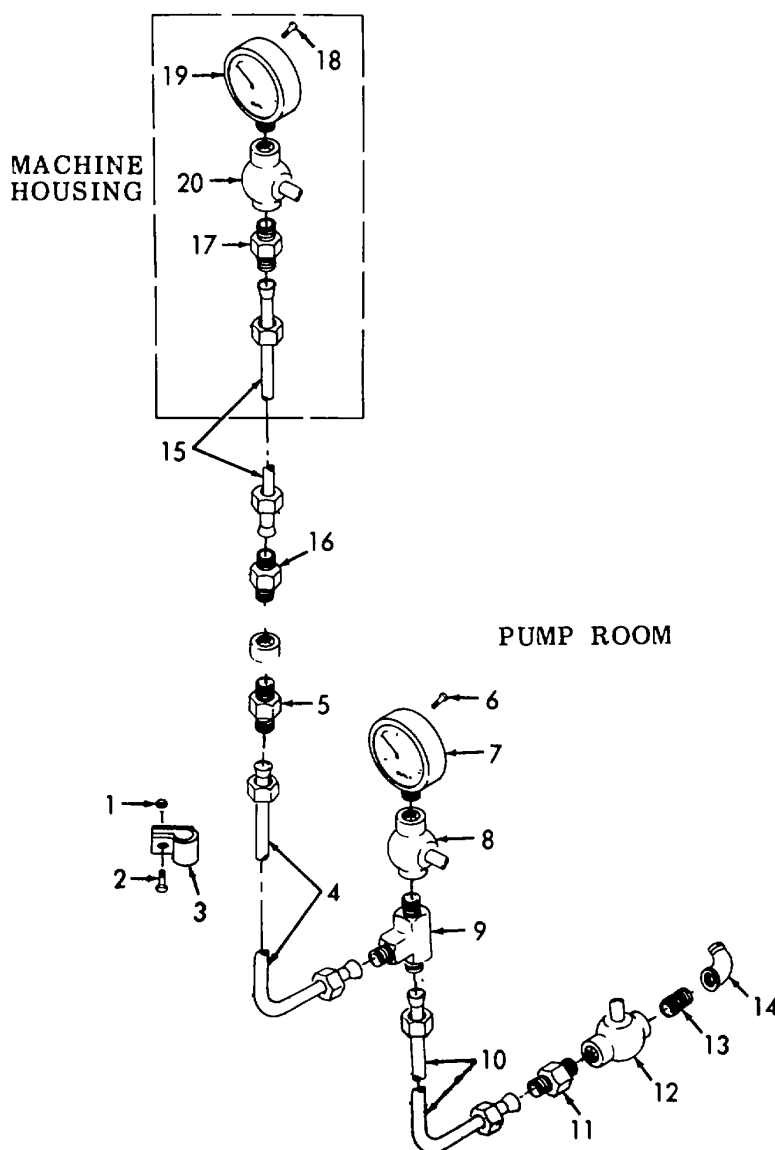


Figure 3-115. Pressure Gauges, Removal/Installation.

**3-56. PRESSURE GAUGES - Continued.****b. Inspection.**

- (1) Inspect gauges for broken or cracked glass.
- (2) Inspect tubes for bends or kinks.

**c. Installation.**

- (1) Refer to figure 3-115 and install gauge (19) and secure with two screws (18). Install valve (20), adapters (17 and 16), and tube (15).
- (2) Install elbow (14), nipple (13), valve (12), adapter (11) and tube (10).
- (3) Install tee (9), elbow (8), gauge (7), and secure with two screws (6).
- (4) Install adapter (5) and tube (4). Install ten clamps (3) and secure with ten screws (2) and ten nuts (1).

CHAPTER 4

GENERAL SUPPORT MAINTENANCE

Section I	REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT
Section II	MAINTENANCE OF HULL
Section III	MAINTENANCE OF MACHINERY HOUSE
Section IV	MAINTENANCE OF DAVIT, ANCHOR
Section V	MAINTENANCE OF ENGINE
Section VI	MAINTENANCE OF CLUTCH

---

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

	Para.		Para.
Common Tools and Equipment.....	4-1	Special Tools, TMDE, and Support	
Repair Parts .....	4-3	Equipment.....	4-2

4-1. COMMON TOOLS AND EQUIPMENT.

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

4-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT.

Refer to the Repair Parts and Special Tools List (TM 55-1930-208-24P) and to the Maintenance Allocation Chart (Appendix B of this manual) for the Special Tools, TMDE, and Support Equipment required at General Support Maintenance.

4-3. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools List (TM 55-1930-208-24P) covering General Support Maintenance for this manual.

---

## Section II. MAINTENANCE OF HULL

### 4-4. HULL.

---

This task covers:

- a. Repair
- 

#### INITIAL SET-UP:

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

- a. Repair.

#### **WARNING**

Do not weld at any location on this barge until a safe area has been determined which is gas and fume free. Failure to comply with this warning could result in injury to personnel.

- (1) Repair of the hull is limited to welding and painting.
- (2) Refer to TM 9-237 for welding and TM 55-503 for hull repair.
- (3) Refer to TM 43-0139 for painting.

#### **WARNING**

Do not weld a closed fuel tank or container until every precaution has been taken to eliminate all confined gases and fumes from inside and outside the tank or container area. Failure to comply with this warning could result in injury to personnel.

---

**Section III. MAINTENANCE OF MACHINERY HOUSE**

	Para.		Para.
Doors.....	4-6	Tank, Fuel Oil .....	4-7
Frame and Exterior Covering.....	4-5		

---

**4-5. FRAME AND EXTERIOR COVERING.**

---

This task covers:

- a. Removal      b. Repair      c. Installation
- 

INITIAL SET-UP:

Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)

Materials Required:

Washer, Lock P/N MS35338-143

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

**4-5. FRAME AND EXTERIOR COVERING - Continued.****a. Removal.** (Refer to figure 4-1).

- (1) Remove two nuts (1), two lockwashers (2), two bolts (3), and grounding reel (4).
- (2) Remove thirty-six nuts (5), thirty-six lockwashers (6), thirty-six bolts (7), and three port lights (8).
- (3) Remove life ring (9), marker light (10), and axe (11) from bracket.
- (4) Remove four nuts (12) and bracket (13).

b. **Repair.** Repair to housing frame and exterior covering is limited to welding and painting. Refer to TM 9-237 and TM 55-503 for welding procedures and TM 43-0139 for painting instructions. Repair to items removed in paragraph a. above is limited to replacing damaged parts.

**c. Installation.**

- (1) Install bracket (13) on mounting studs and secure with four nuts (12).
- (2) Install axe (11), marker light (10), and life ring (9) on their respective brackets.
- (3) Install three port lights (8) and secure with thirty-six bolts (7), thirty-six lockwashers (6), and thirty-six bolts (5).
- (4) Install grounding reel (4) and secure with two bolts (3), two lock-washers (2), and two nuts (1).

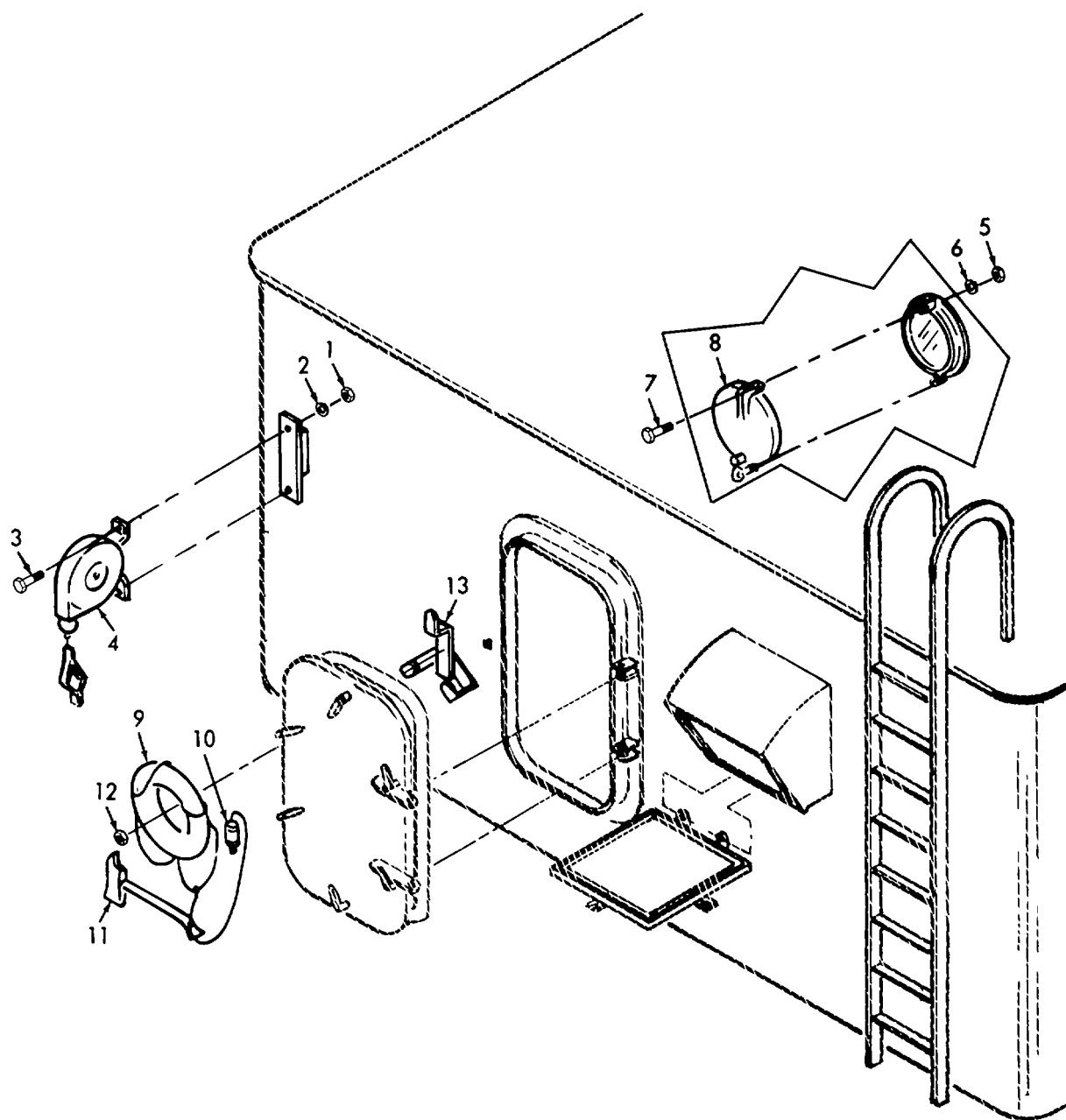


Figure 4-1. Frame and Exterior Covering, Removal/Installation.

**4-6. DOORS.**


---

This task covers:

- a. Removal                      b. Repair                      c. Installation
- 

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)

**Materials Required:**

Gasket P/N MIL-G-23652  
 Pin, Cotter P/N MS24665-387  
 Pin, Cotter P/N MS24665-389  
 Washer, Lock P/N MS35338-143

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

---

a. **Removal.** (Refer to figure 4-2).

- (1) Remove two cotter pins (1), two pins (2), and four washers (3).
- (2) Remove toggle bolt (4) and remove door (5), gasket (6), wing nut (7), and support (8).
- (3) Remove two cotter pins (9), two washers (10), two pins (11), door (12), and gasket (13).
- (4) Remove two cotter pins (14), four washers (15), two pins (16), door (17), and gasket (18).

b. **Repair.** Repair is limited to replacing defective parts.

c. **Installation.**

- (1) Install gasket (18) on door (17). Install door (17) and secure with two pins (16), four washers (15), and two cotter pins (14).
- (2) Install gasket (13) on door (12). Install door (12) and secure with two pins (11), two washers (10), and two cotter pins (9).
- (3) Install support (8) and secure one end with toggle bolt (4).
- (4) Install gasket (6) on door (5). Install door (5) and secure with four washers (3), two pins (2), and two cotter pins (1).
- (5) Install other end of support (8), to door (5) and secure with toggle bolt (4). Install wing nut (7).

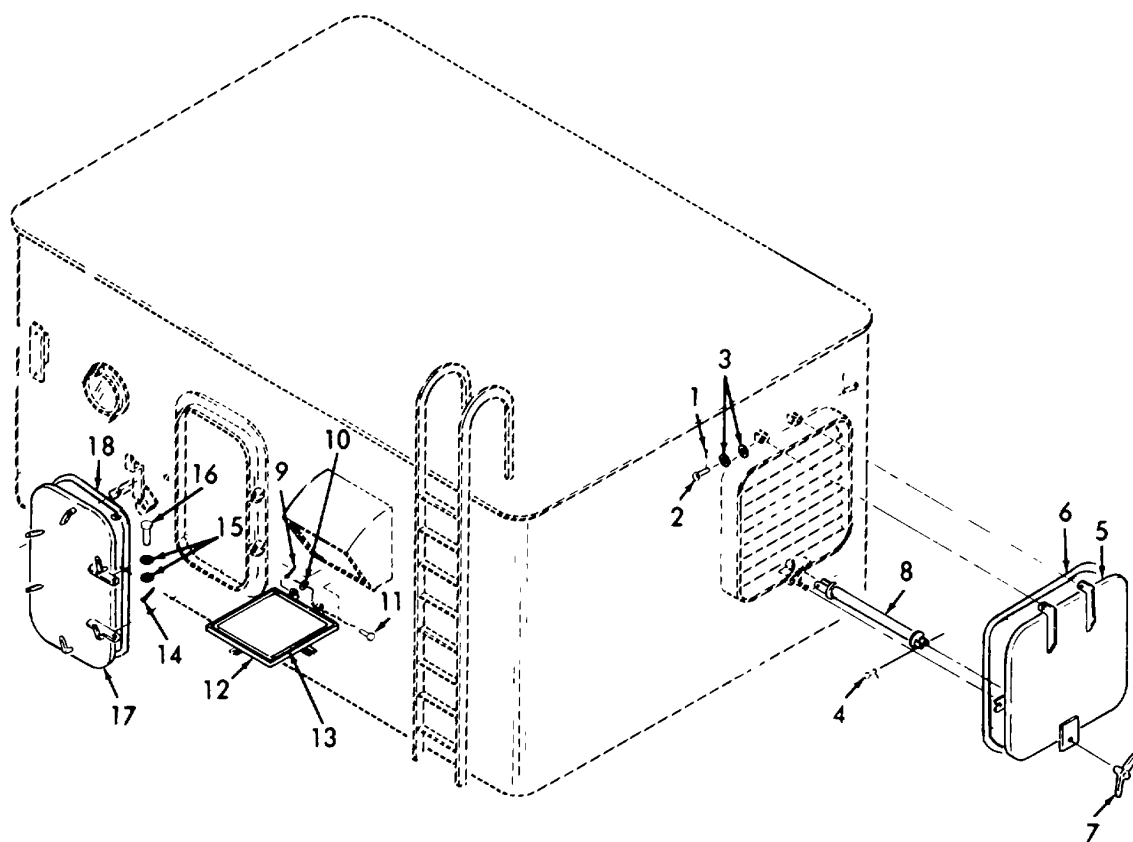


Figure 4-2. Doors, Removal/Installation.

#### 4-7. TANK, FUEL OIL.

---

This task covers:

- a. Repair
- 

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)

##### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Fuel tank removed (paragraph 3-8).

---

- a. Repair.

#### **WARNING**

- Do not weld at any location on this vessel until a safe area has been determined which is gas and fume free. Failure to comply with this warning could result in injury to personnel.
- Do not weld a closed fuel tank or container until every precaution has been taken to eliminate all confined gases, fumes, and dust from inside and outside the tank or container area. Failure to comply with this warning could result in injury to personnel.

- (1) Weld the tank in accordance with TM 9-237, Welding Theory and Applications.
- (2) Paint the tank in accordance with TM 43-0139, Painting Instructions for Army Material.
- (3) Install the tank per paragraph 3-8.

Section IV. MAINTENANCE OF DAVIT, ANCHOR

	Para.		Para.
Davit, Anchor .....	4-8	Winch, Anchor.....	4-9

4-8. DAVIT, ANCHOR.

This task covers:

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

INITIAL SET-UP:

Tools Required:

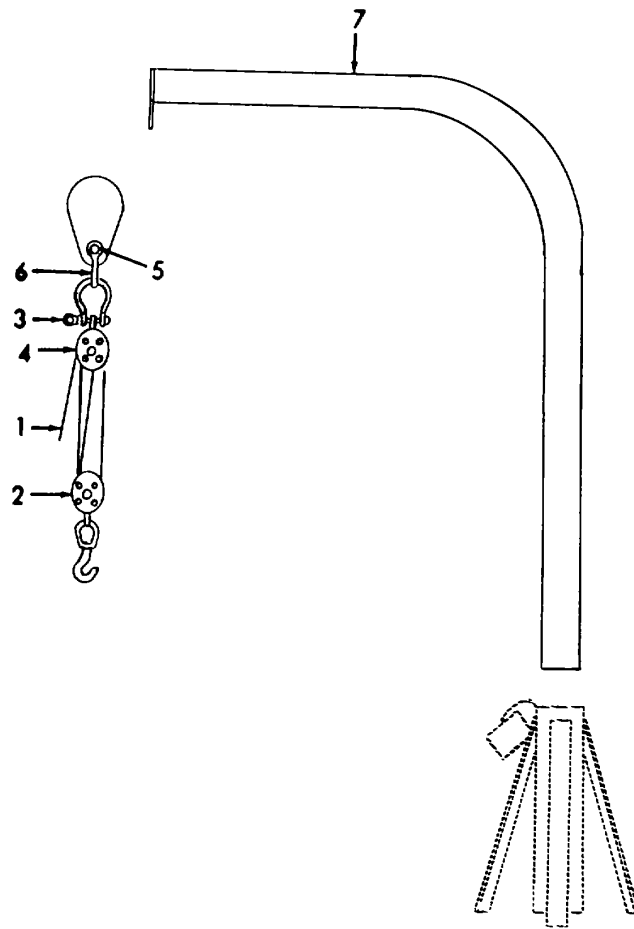
Tool Kit, General Mechanics (Item 1, Appendix B)

Equipment Conditions:

- Engine shut down (paragraph 2-11, TM 55-1930-208-10).
- Barge is moored (paragraph 2-7, TM 55-1930-208-10).

**4-8. DAVIT, ANCHOR - Continued.**

- a. Removal. (Refer to figure 4-3).
  - (1) Remove rope (1) and block and hook (2).
  - (2) Remove shackle bolt (3) and remove block (4).
  - (3) Remove shackle bolt (5), shackle (6), and davit (7).
  
- b. Inspection.
  - (1) Inspect rope for fraying.
  - (2) Inspect shackle for cracks or signs of wear.
  - (3) Inspect shackle block for cracks.
  
- c. Repair. Repair is limited to replacing defective parts.
  
- d. Installation.
  - (1) Install davit (7), shackle (6), and secure shackle with bolt (5).
  - (2) Install block (4) and secure with bolt (3).
  - (3) Install rope (1) onto block (4) and block and hook (2).



**Figure 4-3. Anchor Davit, Removal/Installation.**

**4-9. WINCH, ANCHOR.**


---

This task covers:

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

**INITIAL SET-UP:**Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)

Materials Required:

Pin, Cotter P/N 7900-61  
Solvent, Cleaning (Item 4, Appendix C)

Equipment Conditions:

Barge is moored (paragraph 2-7, TM 55-1930-208-10).

---

a. Removal. (Refer to figure 4-4).

- (1) Attach a sling to drum of winch. Attach a suitable lifting device to sling.
- (2) Remove ten nuts (1), ten bolts (2), and two deck brackets (3). Raise lifting device and remove winch.

b. Disassembly.

- (1) Refer to figure 4-4 and remove setscrew (4) from handwheel. Remove two cotter pins (5), pin (6), block (7), shoe (8), pedal (9), strut (10), and shaft (11).
- (2) Remove handwheel (12) and key (13). Remove pin (14), knob (15), and washer (16).
- (3) Remove two bolts (17), shaft (18), and gear (19). Press bearing (20) out of gear (19). Remove grease fitting (21).
- (4) Install blocking under drum and remove drum shaft (22) by driving out with a rod and maul. Remove wedge (23) and drum (24). Press bearing (25) out of drum (24).
- (5) Remove lever extender (26), two bolts (27), and two brackets (28). Remove four nuts (29), two studs (30), two tubes (31), cover (32), and two shafts (33).
- (6) Remove bolt (34), stop (35), frame (36), shaft (37), washer (38), gusset (39), and frame (40). Press bearings (41) from each frame.
- (7) Remove pin (42) from frame. Remove wheel (43) and key (44).



**4-9. WINCH, ANCHOR - Continued.**c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with cleaning solvent (item 4, Appendix C).
- (2) Allow all parts to dry.

d. Inspection.

- (1) Inspect all shafts for nicks, burns, or signs of wear.
- (2) Inspect drum gear for chipped or broken teeth.
- (3) Inspect all hardware for damaged threads.
- (4) Inspect bearings for pitting and signs of wear.

e. Repair. Repair is limited to replacing defective parts.f. Reassembly.

- (1) Refer to figure 4-4 and install lever (56), holding dog (55), and two washers (54).
- (2) Install ratchet lever (53), ratchet dog (52), two washers (51), shaft (50), two retaining rings (49), guide (48), spring (47), washer (46), and pin (45).
- (3) Press bearings (41) into side frames (36 and 40). Position side frames (36 and 40) into position and install gusset (39), washer (38), and shaft (37).
- (4) Install key (44) and wheel (43). Install pin (42) into side frame (36). Install stop (25) and secure with bolt (24).
- (5) Install two shafts (33), cover (32), two tubes (31), two studs (30), and four nuts (29).
- (6) Install two brackets (28) and secure with two bolts (27). Install lever extender (26).
- (7) Press bearing (25) into drum (34). Position drum (24) into place and install blocking under drum. Install shaft (22) by driving in with a rod and maul. Remove blocking and install wedge (23).

- (8) Press bearing (19) into gear (20). Install gear (20), shaft (28) and grease fitting (21). Secure shafts (22 and 18) with two bolts (17).
- (9) Install washer (16), knob (15), and pin (14). Install key (13) and handwheel (12).
- (10) Install shaft (11), strut (10), pedal (9), shoe (8), block (7), pin (6), two cotter pins (5), and setscrew (4).

g. Installation.

- (1) Refer to figure 4-4 and attach a sling to drum of winch. Attach a suitable lifting device to sling and raise the winch. Move lifting device and position the winch over its mounting brackets. Lower the lifting device and remove the sling.
- (2) Install two deck brackets (3) and secure with ten bolts (2) and ten nuts (1).
- (3) Lubricate in accordance with paragraph 3-1, TM 55-1930-208-10.

## Section V. MAINTENANCE OF ENGINE

	Para.		Para.
Block, Cylinder.....	4-16	Cylinder Liners.....	4-12
Crankshaft and Seals.....	5-15	Head, Cylinder.....	4-10
Crankshaft Front Cover.....	4-14	Main Bearings.....	4-13
		Pistons and Connecting Rods.....	4-11

### 4-10. HEAD, CYLINDER.

This task covers:

- |                |             |               |           |
|----------------|-------------|---------------|-----------|
| a. Disassembly | b. Cleaning | c. Inspection | d. Repair |
| e. Assembly    |             |               |           |

INITIAL SET-UP:

#### Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)  
 Valve Guide Removal (Item 30, Appendix B)  
 Valve Seat Removal Tool (Item 31, Appendix B)  
 Injector Tube Installer (Item 32, Appendix B)  
 Injector Tube Installer Pilot (Item 33, Appendix B)  
 Pressure Checking Tool P/N 28454 (Item 34, Appendix B)  
 Injector Tube Swaging Tool P/N J28611 (Item 35, Appendix B)  
 Die, Flaring J5286-6 (Item 36, Appendix B)  
 Reamer P/N J22525-1 (Item 37, Appendix B)  
 Injector Tube Cutting Tool P/N J5286-8 (Item 38, Appendix B)  
 Injector Tube Nut Seat Reamer P/N J5286-9 (Item 39, Appendix B)  
 Valve Guide Installer P/N J4144 (Item 40, Appendix B)  
 Valve Seat Insert Installing Tool P/N J1736 (Item 41, Appendix B)  
 Grinder Set, Valve Seat P/N J7040 (Item 42, Appendix B)  
 Adapter Set, Valve Seat P/N J8165-8 (Item 43, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

#### Materials Required:

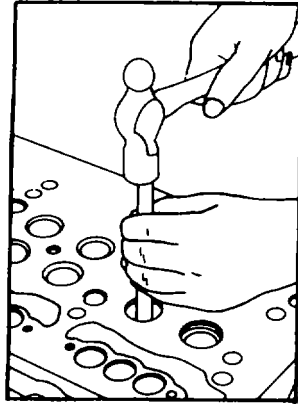
Cloth, Crocus (Item 5, Appendix C)  
 Compound, Sealing (Item 22, Appendix C)  
 Oil, Cutting (Item 6, Appendix C)  
 Oil, Fuel (Item 9, Appendix C)  
 Solution, Alkaline (Item 2, Appendix C)

#### Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Cylinder head removed (paragraph 3-38).

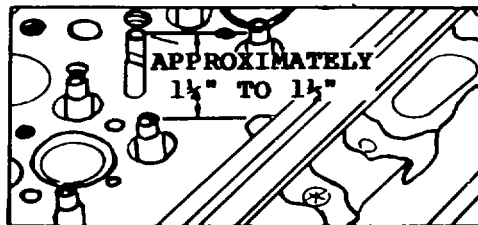
a. Disassembly. (Refer to figures 4-5 through 4-10).

- (1) Refer to figure 4-5 and support head on wood blocks with the bottom of the head up.
- (2) Drive out valve guide with a hammer and valve guide removal tool.



**Figure 4-5. Valve Guide, Removal.**

- (3) Refer to figure 4-6 and file or grind two diametrically opposite notches 1/16 inch deep in the side of the guide, approximately 1-1/4 inch to 1-1/2 inch from the upper end.



**Figure 4-6. Bridge Guide Notch Grinding.**

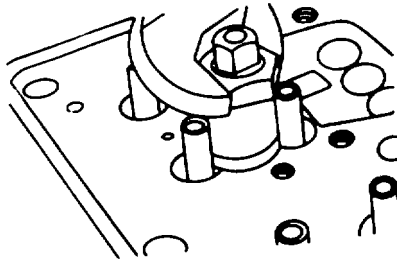
- (4) Refer to figure 4-7 and place the spacer over the guide.
- (5) Slide the guide remover over the guide and align setscrews with the notches ground into the guide.
- (6) Tighten the setscrews to hold the tool securely.



**Figure 4-7. Bridge Guide Removal Tool, Installation.**

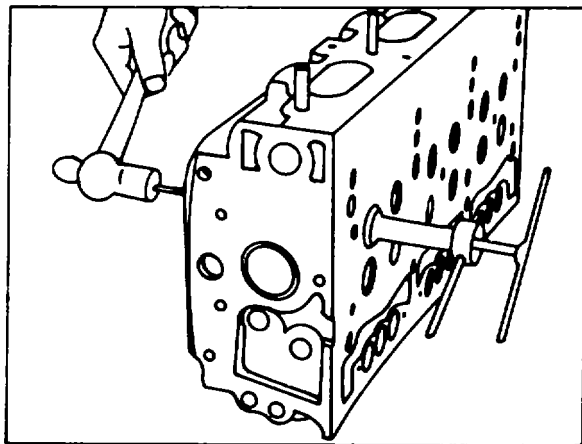
**4-10. HEAD, CYLINDER - Continued.****a. Disassembly - Continued.**

- (7) Refer to figure 4-8 and place the spacer over the guide remover.
- (8) Thread the nut onto the guide remover.
- (9) Turn the nut clockwise until the guide is withdrawn from the cylinder head.



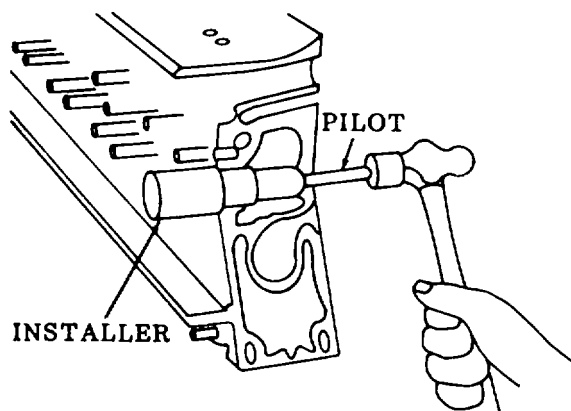
**Figure 4-8. Bridge Guide, Removal.**

- (10) Refer to figure 4-9 and set the head on its side.
- (11) Place the collet of valve seat removal tool inside of valve seat insert so that bottom of collet is flush with bottom of insert.
- (12) Hold collet handle and turn T-handle to expand collet cone until insert is held securely by the tool.
- (13) Insert the drive bar of tool through valve guide.
- (14) Tap drive bar to move insert about 1/16 inch away from its seat in cylinder head.
- (15) Turn T-handle to loosen collet cone and reposition tool so that the narrow flange is below valve seat insert.
- (16) Tighten T-handle and drive insert out of cylinder head.



**Figure 4-9. Valve Seat Insert, Removal.**

- (17) Refer to figure 4-10 and place injectortube installer tool in injector tube.
- (18) Insert pilot through small opening of injector tube and thread pilot into the tapped hole in the end of installer.
- (19) Tap on the end of the pilot to loosen injector tube.
- (20) Remove injector tube, installer, and pilot.



**Figure 4-10. Injector Tube, Removal.**

**4-10. HEAD, CYLINDER - Continued.****b. Cleaning.**

- (1) Remove all screw-in type plugs.
- (2) Scrape off any gasket material.
- (3) Agitate the cylinder head in hot-tank containing an alkaline solution (item 2, Appendix C).
- (4) Wash cylinder head in hot water to remove all alkaline.
- (5) Agitate cylinder head in a bath of pickling acid (item 20, Appendix C).
- (6) Allow cylinder head to remain immersed until bubbling action stops.
- (7) Lift cylinder head and allow it to drain.
- (8) Reimmerse cylinder head in the same acid for 10 minutes.
- (9) Repeat steps (7) and (8) until the head is free of scale.
- (10) Rinse the head with clear hot water to remove the acid.
- (11) Neutralize any acid clinging to the head by immersing it in a tank containing alkaline solution (item 2, Appendix C).

**c. Inspection.**

- (1) Magnetize cylinder head. Cover with a fine magnetic powder or solution. Magnetic particles will gather in cracks, revealing and locating cracks. Demagnetize cylinder head after completion of inspection.
- (2) Inspect cylinder head by applying fluorescent penetrant to area of cylinder head suspected of being cracked. Wipe off excess penetrant, then apply developing powder, which will drain penetrant from cracks. Penetrant will glow under an ultraviolet light.
- (3) Refer to figure 4-11 and pressure test cylinder head.
  - (a) Assemble tool set J28454 to cylinder head.
  - (b) Install rubber stoppers on bridges.
    - (1) Large stoppers are installed on long center bridge feet opposite notch and on long end bridge feet closest together.
    - (2) Small stoppers are installed opposite large stoppers on center bridge and end bridge feet and on all short bridges.
  - (c) Install all parts loosely on cylinder head.

- (d) Tighten the hold down bolts until stopper start to distort. A 5 lb-ft (7 Nm) torque is sufficient. Do not overtighten.
- (e) Install air supply plate.
- (f) Install scrap or dummy injector. Tighten clamp bolts to a torque of 20-25 lb-ft (27-34 Nm).

**NOTE**

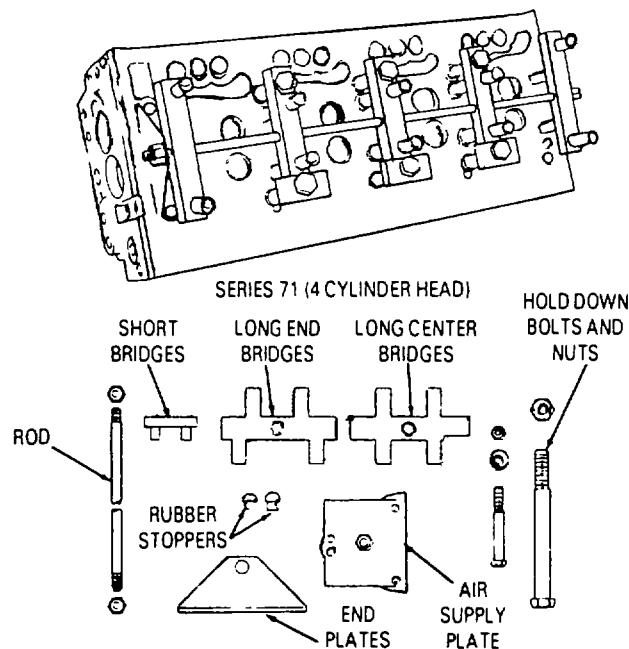
Dummy injectors may be made from old injector nuts and bodies, the injector spray tips are not necessary.

- (g) Connect air supply line to air supply plate.
- (h) Immerse cylinder head in water preheated to 180° to 200°F (82-93°C) for approximately 20 minutes.

**WARNING**

Wear eye protection when using compressed air. Failure to comply with this warning can result in injury to personnel.

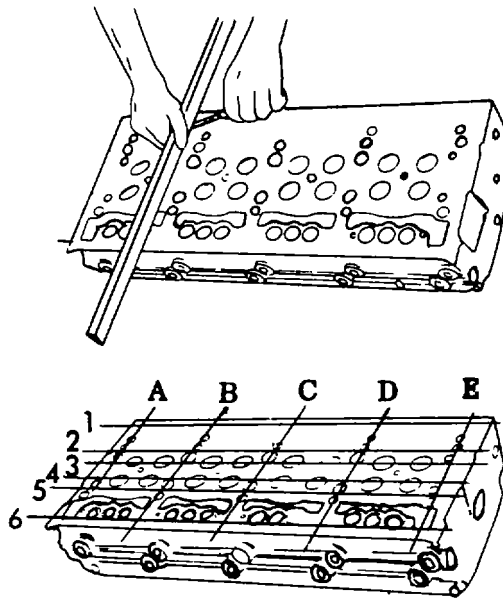
- (i) Apply 40 psi (276 kPa) air pressure.
- (j) Check for leaks at top and bottom of injector tubes, oil gallery, exhaust ports, fuel manifolds, and top and bottom of cylinder head.
- (k) Relieve air pressure and remove head from water. Remove testing equipment. Dry thoroughly.



**Figure 4-11. Pressure Test of Cylinder Head Using Tool J28454.**

**4-10. HEAD, CYLINDER - Continued.****c. Inspection - Continued.**

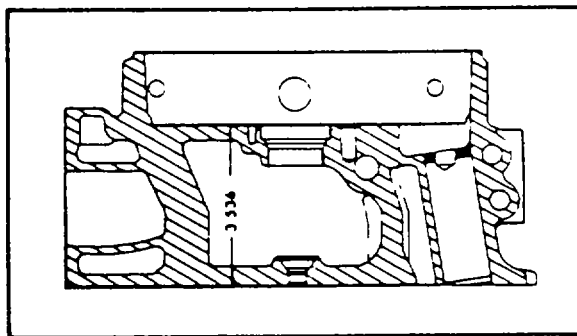
- (4) Refer to figure 4-12 and inspect cylinder head fire deck for flatness.
  - (a) Inspect for flatness. Use a heavy, accurate straight-edge and feeler gages.
  - (b) Check for transverse warpage at points A thru E. Maximum allowable warpage is .004 inch.
  - (c) Check for longitudinal warpage at points 1 thru 6. Maximum allowable warpage is .008 inch.

**Figure 4-12. Checking Fire Deck of Cylinder Head.**

- (5) Inspect the cam follower bores for wear and scoring. Repair light scoring with crocus cloth (item 5, Appendix C) wet with fuel oil (item 9, Appendix C).
- (6) Check that water nozzles are securely mounted. Inspect nozzles for damage. Replace if damaged.

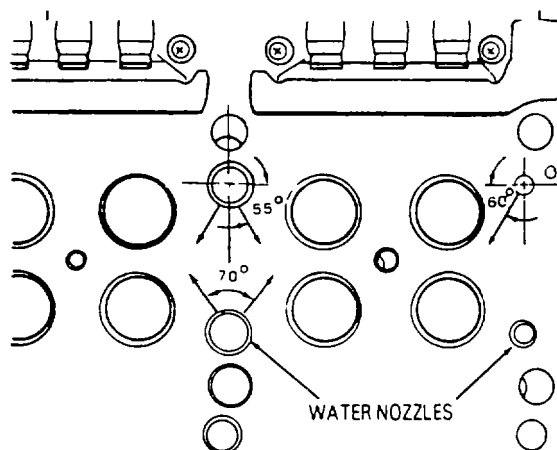
**d. Repair.**

- (1) Refer to figure 4-13 and reface warped head provided that removal of metal will not bring the indicated dimensions less than 3.536 inch minimum.



**Figure 4-13. Minimum Distance Between Top and Bottom Faces.**

- (2) Refer to figure 4-14 and replace water nozzles.
  - (a) Press in place with nozzle openings parallel to longitudinal centerline.



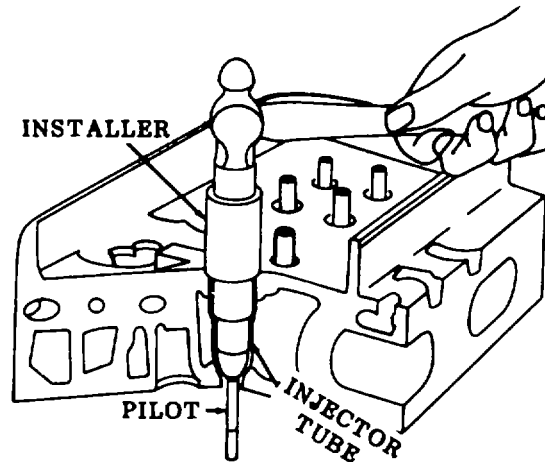
**Figure 4-14. Correct Installation of Water Nozzles.**

- (b) If nozzles do not fit tightly, a suitable wood plug or other suitable tool can be used to expand the nozzle.
  - (c) Loose nozzles can be tinned with solder on the outside diameter being carefully not to allow solder to flow into nozzle orifices.
- (3) Replace all damaged studs. Apply sealing compound (item 22, Appendix C) to threads of new studs before installing. Torque exhaust manifold studs to 25-40 lb-ft (35-54 Nm) and water manifold cover studs to 10-25 lb-ft (14-34 Nm).

**4-10. HEAD, CYLINDER - Continued.**

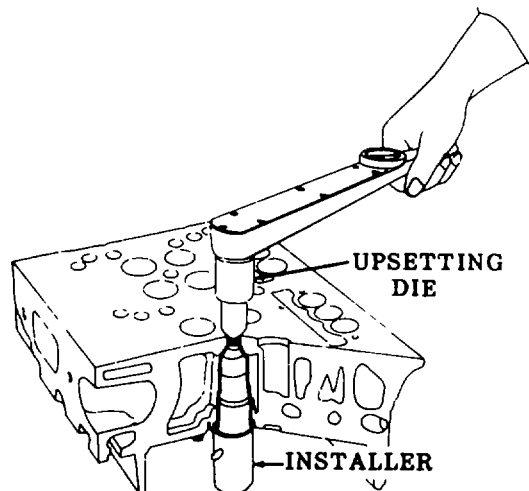
e. Assembly. (Refer to figures 4-15 through 4-21).

- (1) Refer to figure 4-15 and place a new injector tube seal ring in cylinder head counter-bore.
- (2) Place the installer in the injector tube.
- (3) Insert pilot through the small opening in the tube and thread it into the tapped end of the installation.
- (4) Slip the injector tube into the injector bore and drive it into place.



**Figure 4-15. Injector Tube, Installation.**

- (5) Refer to figure 4-16 and turn the cylinder head bottom side up and remove the pilot.
- (6) Thread the upsetting die into the tapped end of the installer.
- (7) Tighten the upsetting die to 30 lb-ft (41 Nm). Then remove the die and installer.



**Figure 4-16. Injector Tube, Upsetting.**

- (8) Refer to figure 4-17 and set the cylinder head right side up.
- (9) Place a few drops of cutting oil (item 6, Appendix C) on the reamer flutes.
- (10) Carefully position the reamer into the injector tube.
- (11) Turn the reamer in clockwise direction and withdrawing the reamer frequently to clean off the metal chips until the lower shoulder of the reamer contacts the injector tube.
- (12) Turn the cylinder head over and insert the pilot to the cutting tool in the small hole of the injector tube.
- (13) Place a few drops of cutting oil (item 6, Appendix C) on the cutter and remove excess stock until the lower end of the injector tube is from flush to .005 inch below the fire deck.

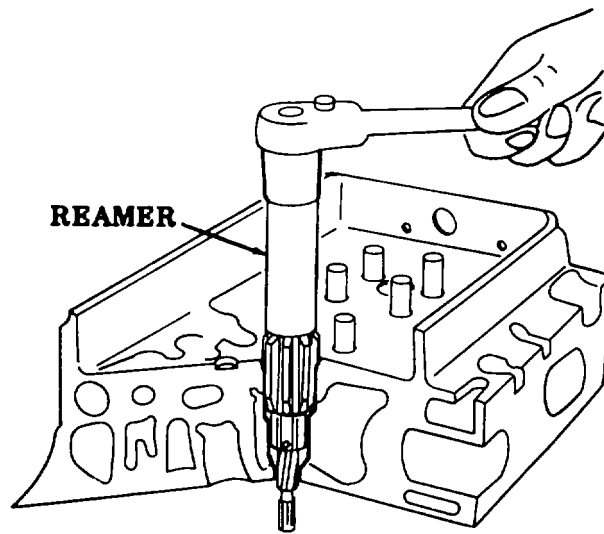
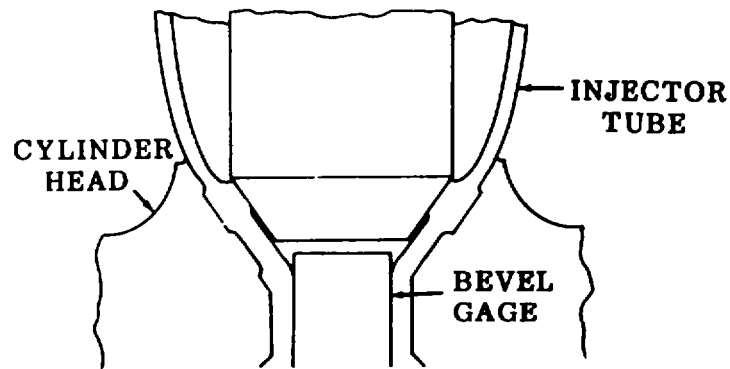


Figure 4-17. Injector Tube, Reaming.

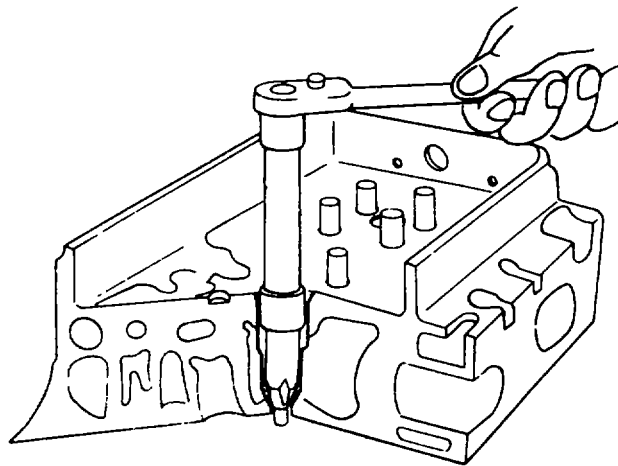
**4-10. HEAD, CYLINDER - Continued.**e. Assembly - Continued.

- (14) Refer to figure 4-18 and install bevel gage into injector tube.
- (15) Measure the gage to fire deck. The measurement should be flush to  $\pm .014$  inch.



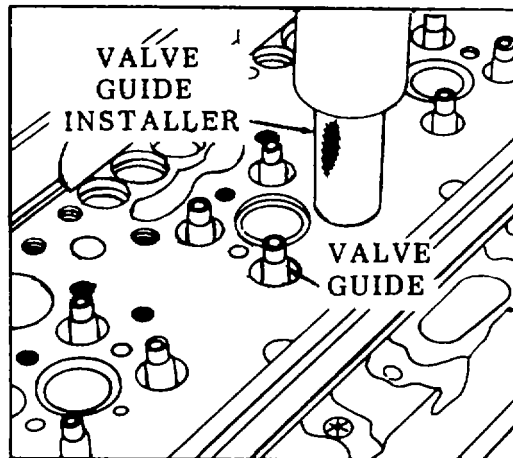
**Figure 4-18. Bevel Gage Measurement.**

- (16) If the injector tube requires further reaming, refer to figure 4-19.
- (17) Place a few drops of cutting oil (item 6, Appendix C) on the bevel seat of the tube.
- (18) Carefully lower the reamer until it contacts the bevel seat.
- (19) Carefully ream and recheck the bevel cut until the measurement contained in steps (14) and (15) is reached.



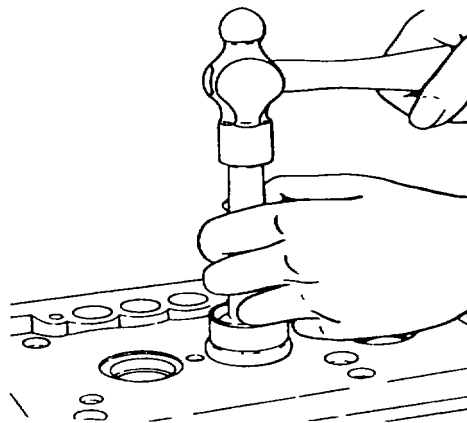
**Figure 4-19. Injector Tube, Finish Ream.**

- (20) Refer to figure 4-20 and position the valve guide squarely into the bore.
- (21) Use the installing tool to start the guide into the bore.
- (22) Press on the installation tool until the tool contacts the cylinder head.
- (23) Use the valve bridge installation tool and perform steps (20) through (22) for the valve bridge guide.



**Figure 4-20. Valve Guide Installation.**

- (24) Refer to figure 4-21 and make sure the valve seat counterbore is clean.
- (25) Immerse the cylinder head for at least thirty minutes in water heated to 180-200°F (82-93°C).
- (26) Place the cylinder head bottom side up.
- (27) Place an insert in the counterbore valve seat side up.
- (28) Drive the seat into the cylinder head with the valve seat installation tool until it seats solidly in the cylinder head.



**Figure 4-21. Valve Seat Insert, Installation.**

**4-10. HEAD, CYLINDER- Continued.**e. Assembly - Continued.

(29) Grind the inserts as follows:

- (a) First apply the 31° grinding wheel on the valve seat insert.
- (b) Use the 60° grinding wheel to open the throat of the insert.
- (c) Grind the top surface of the insert with the 15° wheel to narrow the width of the seat to the dimensions shown in figure 3-95. The 31° face of the insert may be adjusted relative to the center of the valve face with the 15° and 60° grinding wheels.

**NOTE**

Do not permit the grinding wheel to contact the cylinder head when grinding the insert. When an insert has been ground to the extent that the grinding wheel will contact the cylinder head, install a new insert.

- (d) The maximum amount the exhaust valve should protrude beyond the cylinder head (when the valve is closed) and still maintain the proper piston-to-valve clearance is shown in figure 3-95. Grinding will reduce the thickness of the valve seat insert and cause the valve to recede into the cylinder head. If, after several grinding operations, the valve recedes beyond the specified limits, replace the valve seat insert.
- (e) After grinding has been completed, clean the valve seat insert thoroughly with fuel oil (item 9, Appendix C) and dry the insert.
- (f) After the valve seat insert has been ground, determine the position of the contact area between the valve and the valve seat insert as follows:
  - (1) Apply a light coat of Prussian blue, or a similar paste, to the valve seat insert.
  - (2) Lower the stem of the valve in the valve guide and "bounce" the valve on the seat. Do not rotate the valve. This procedure will show the area of contact on the valve face. The most desirable area of contact is at the center of the valve face.

**NOTE**

The use of valve lapping compounds is not recommended.

- (g) After the valve seat inserts have been ground and checked, clean the cylinder head before installing the valves.

**4-11. PISTONS AND CONNECTING RODS.**

---

This task covers:

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

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)  
Piston Ring Remover and Installer (Item 54, Appendix B)  
Seal Ring Compressor (Item 55, Appendix B)  
Piston Pin Leak Detector (Item 56, Appendix B)  
Feeler Gage Set (Item 57, Appendix B)  
Gage, Fire Ring Groove (Item 58, Appendix B)  
Piston Disassembly Tool (Item 59, Appendix B)  
Reamer Connect Rod Bolt Hole (Item 60, Appendix B)  
Piston Ring Compressor (Item 67, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Oil, Engine (Item 8, Appendix C)  
International Compound No. 2 (Item 13, Appendix C)  
Ring, Seal P/N 892221  
Ring Set P/N 5199827

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
Oil pan removed (paragraph 3-37).  
Cylinder head removed (paragraph 3-38).

**4-11. PISTONS AND CONNECTING RODS - Continued.**a. Removal. (Refer to figure 4-22).

- (1) Use a ridge reamer and remove the carbon deposits from the upper inner surface of the cylinder liner.
- (2) Remove two nuts (1) and bearing cap (2).
- (3) Push piston and connecting rod (3) out through top of cylinder block.
- (4) Install bearing cap (2) on connecting rod and secure with two nuts (1).
- (5) Remove remaining three connecting rods and pistons in accordance with step (1) thru (4).

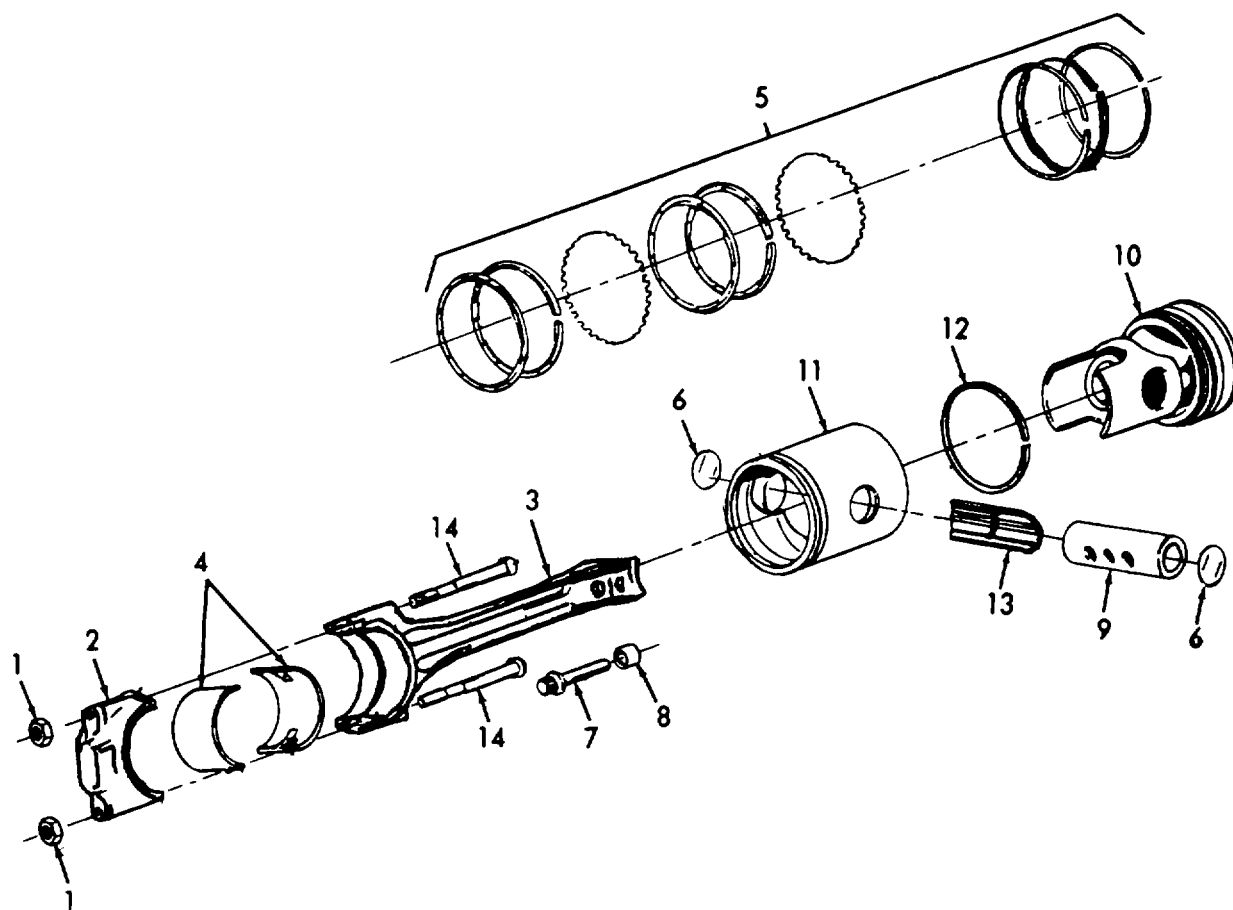
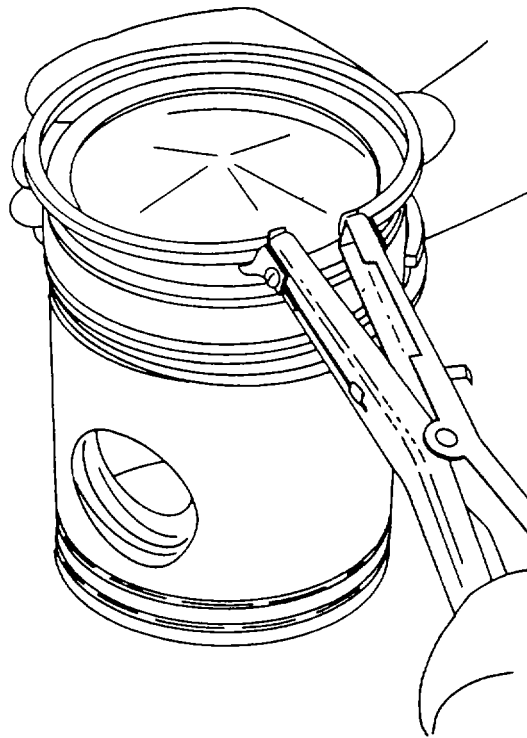


Figure 4-22. Pistons and Connecting Rods, Removal/Installation.

**b. Disassembly.****NOTE**

Piston and connecting rod components should be matched-marked during disassembly to ensure they are reassembled in the same position.

- (1) Refer to figure 4-22 and remove two nuts (1) and bearing cap (2) from connecting rod (3).
- (2) Remove upper and lower bearing shells (4).
- (3) Secure connecting rod in a vise equipped with soft jaws and remove piston rings (5, figure 4-23) with tool J8128, figure 4-41.



**Figure 4-23 . Removing or Installing Piston Rings Using Tool J8128 .**

- (4) Use a punch or chisel and punch a hole through the center of one of the piston pin retainers (6, figure 4-22) and pry the retainer from the piston. Remove the opposite retainer in the same manner.
- (5) Loosen two bolts (7). Remove piston and connecting rod from vise and place on a work bench.
- (6) Remove two bolts (7), two bushings (8), and connecting rod (3).
- (7) Remove piston pin (9).

**4-11. PISTONS AND CONNECTING RODS - Continued.**b. Disassembly - Continued.**WARNING**

To reduce the risk of injury to personnel, keep fingers out of piston pin hole when disassembling the piston dome from the skirt.

(8) Use special tool J33048 and grasp the piston assembly by the skirt and pin area of the dome. Bring piston assembly down onto the neoprene head of the tool with sufficient force to separate the dome (10) and skirt (11).

(9) Remove seal ring (12) and piston pin bearing (13). Remove two bolts (14) from connecting rod.

c. Cleaning.

(1) Clean piston components with fuel oil and dry with compressed air.

(2) Remove hard carbon on piston crown with wire brush. Do not wire brush piston skirt.

(3) Clean ring grooves with suitable tool or piece of an old compression ring ground to a bevel edge.

(4) Clean inside surfaces of piston crown and skirt and oil drain holes in lower half of piston skirt.

(5) Glass beading can be used to clean piston crown. Allowable air pressure is 80-100 psi (552-689 kPa). Do not leave glass beads in the piston crown.

**NOTE**

Do not attempt to clean piston skirt by glass beading, as it will remove the tin plating.

**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

(6) Clean connecting rod and piston pin with solvent (item 4, Appendix C) and dry.

(7) Blow compressed air through the drilled oil passage in the connecting rod, to be sure orifice, oil passage, and spray holes are not clogged.

d. Inspection.

- (1) Check tapered fire ring groove width in the current piston crown with tool J24599 as shown in figure 4-24. Slide the "NO-GO" wire (.106 inch diameter) of the tool completely around fire ring groove. Should the wire be below flush at any one area, the piston crown must be replaced. The "GO" wire (.100 inch diameter) should be flush or protrude slightly from fire ring groove.
- (2) Check cylinder liner and block bore for excessive out-of-round, taper or high spots which could cause failure of piston (refer to paragraph 4-12 for specifications).

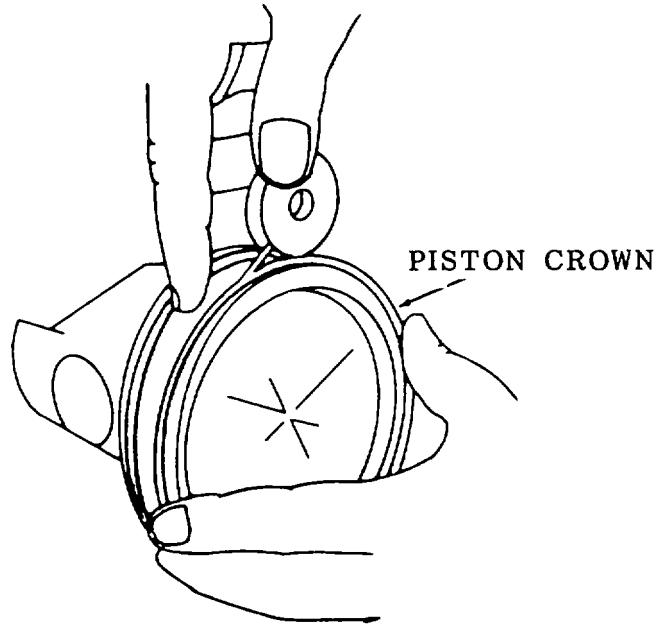


Figure 4-24 . Checking Fire Ring Groove in Piston Crown Using Tool J24599 .

## 4-11. PISTONS AND CONNECTING RODS - Continued.

## d. Inspection - Continued

- (3) Visually check connecting rod for twist or bending.
- (4) Check connecting rod for cracks by the magnetic particle method as shown in figure 4-25.

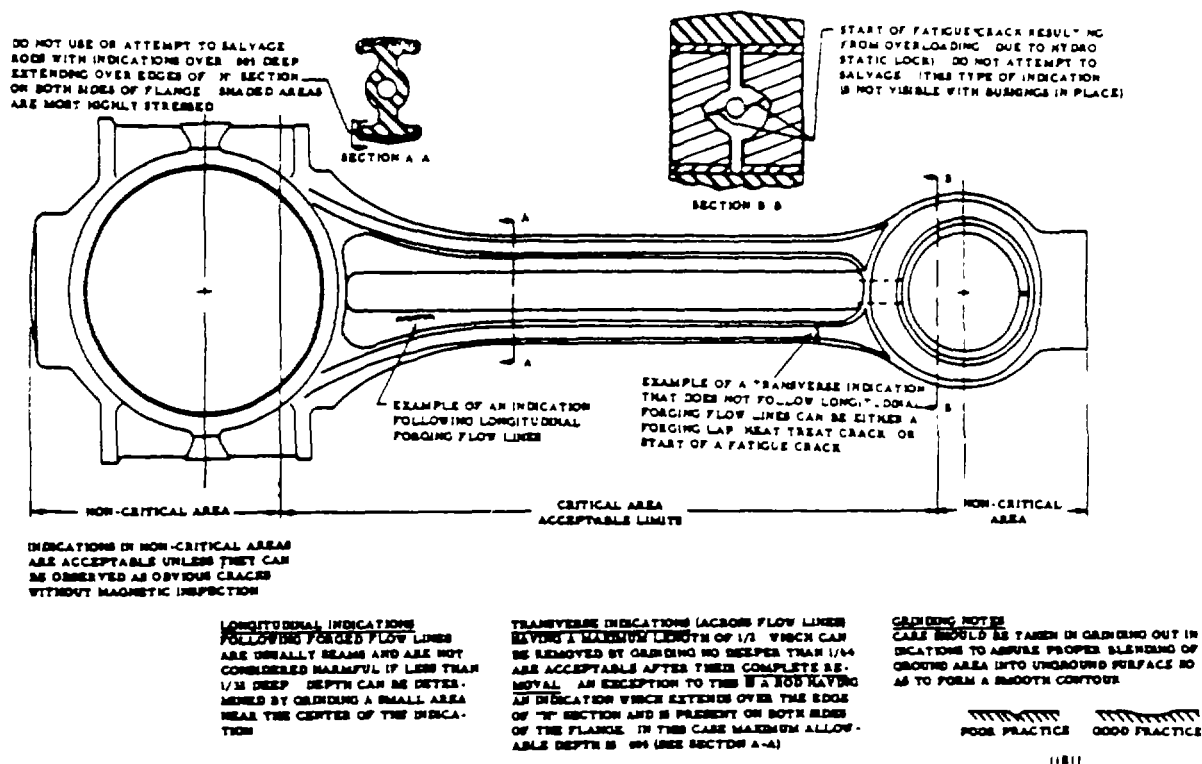


Figure 4-25 . Magnetic Particle Inspection Limits for Connecting Rod .

- (5) Remove any nicks or burrs from connecting rod bolt holes with reamer J28460 (figure 4-26). The reamer includes a 60° angle to clean up the chamfer at the bolt hole to ensure proper seating of the underside of the bolt head.

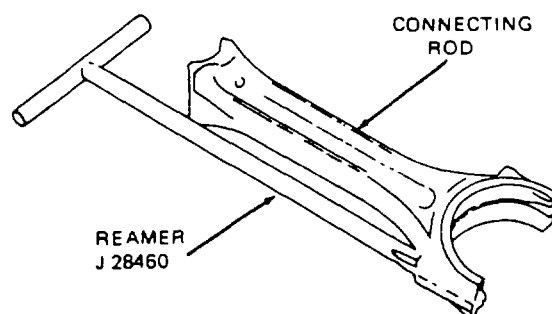
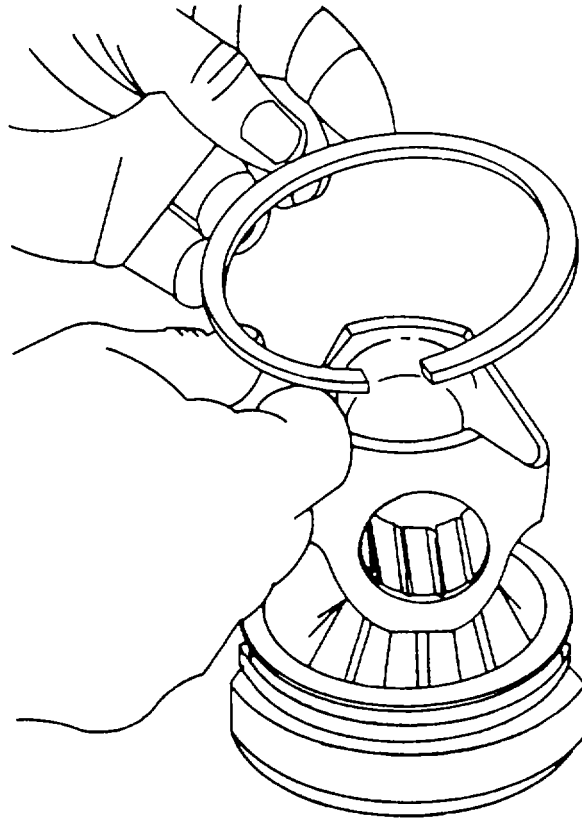


Figure 4-26 . Connecting Rod Bolt Hole Reamer .

- (6) Inspect connecting rod bearings for indications of scoring, overheating, or other damage. Replace a damaged bearing.
  - (7) Inspect piston pin for signs of fretting. Replace a damaged piston pin.
- e. Repair. Repair of the pistons and connecting rods is limited to the replacement of defective components.
- f. Reassembly.
- (1) Refer to figure 4-22 and install bearing (13) in piston skirt (11). With new parts, there is .0005 to .0105 inch clearance between the edge of the bushing and the groove in the piston crown.
  - (2) Lubricate seal ring (12) with engine oil (item 8, Appendix C). Install seal ring (12) on piston crown (10), with the chamfer or counterbore directed toward bottom of the piston crown as shown in figure 4-27.



**Figure 4-27 . Installing Seal Ring .**

**NOTE**

The current seal rings are made of cast iron and are identified by the tin-plating on the outside diameter, a black oxide finish, or a dull cast iron color. These rings can be mixed in an engine. The former steel ring, identified by a very shiny appearance, must not be used for service.

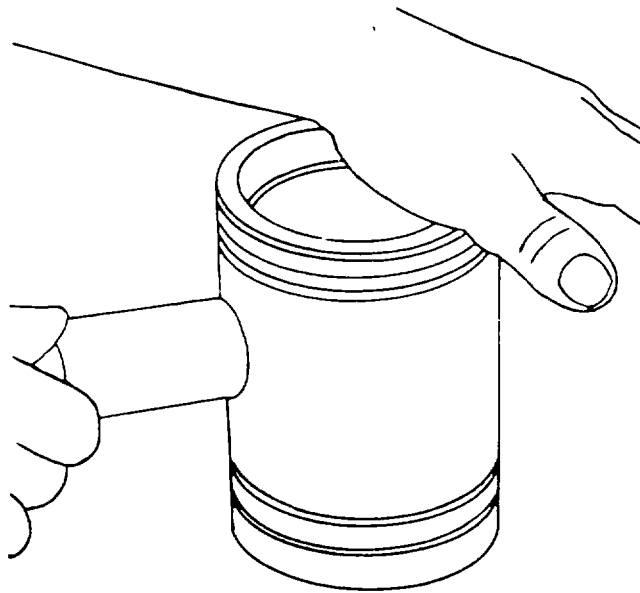
**4-11. PISTONS AND CONNECTING RODS - Continued.****f. Reassembly - Continued**

- (3) Compress the seal ring with ring compressor J23453 and push the skirt into position on the piston crown.

**NOTE**

Before completely assembling the piston, check to make sure the seal ring does not stick in the ring groove. It is imperative for satisfactory engine operation that the seal ring is free in the piston crown groove. Check the full 360° circumference of the groove to be sure there are no tight spots. When the piston crown, seal ring, and piston skirt are assembled, the skirt should spin freely on the crown (crown top down on the bench). If the seal ring sticks, remove high spots or nicks in the groove with a flat file. If this does not relieve sticking, replace the piston crown.

- (4) Lubricate piston pin with clean engine oil (item 8, Appendix C) and install as shown in figure 4-28.

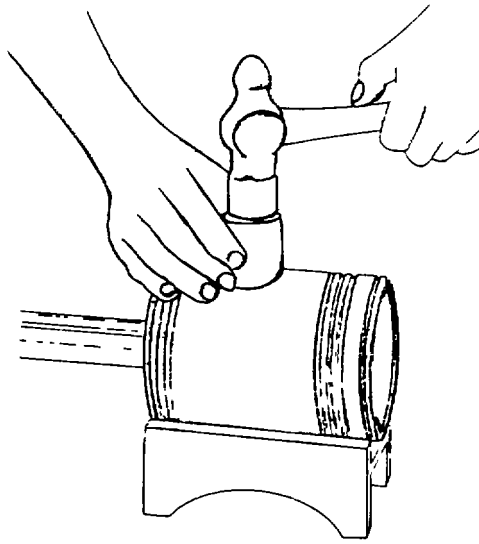


**Figure 4-28 . Installing Piston Pin .**

**NOTE**

Line up the piston pin opening in the piston skirt with the bearing (bushing opening in the piston crown to prevent damage to the pin or bushing.

- (5) Install bushings (8, figure 4-22) on bolts (7). Apply a small amount of International Compound No. 2 (item 13, Appendix C) or equivalent, to the bolt threads and bolt head contact surface.
- (6) Install and tighten the bolts finger tight. Clamp the connecting rod in a vise and tighten the bolts to 55-60 lb-ft (75-81 Nm) torque. Do not exceed the torque.
- (7) Place a new piston pin retainer in position as shown in figure 4-29. Then place crowned end of installer J23762 against retainer and strike tool just hard enough to deflect retainer and seat it evenly in the piston.
- (8) Install second piston pin retainer in the same manner.



**Figure 4-29 . Installing Piston Pin Retainer Using Tool J23762 .**

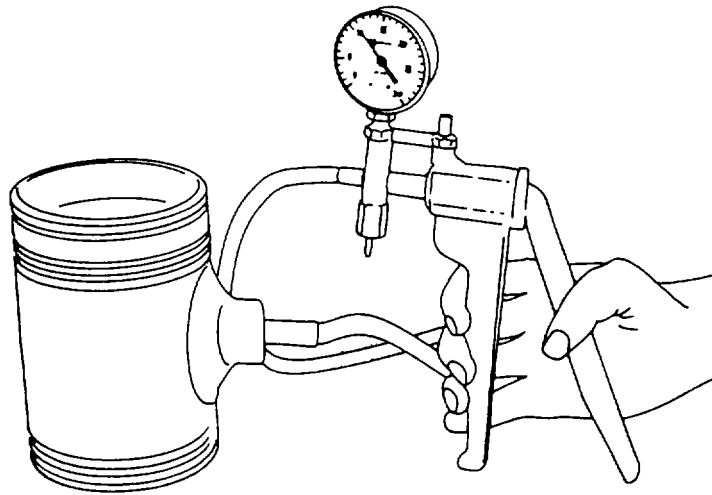
**NOTE**

Due to the size of the counterbore in the piston skirt, be careful when installing the piston pin retainers. Inspect them to be sure they are not buckled and that they are fully seated in the counterbore. The width of the land should be even around the retainer.

**4-11. PISTONS AND CONNECTING RODS - Continued.**

## f. Reassembly - Continued.

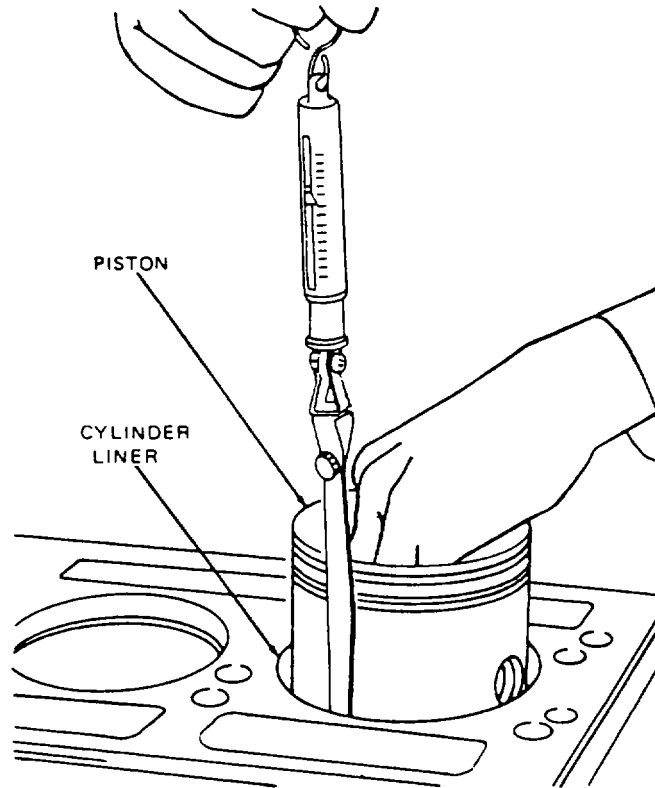
- (9) Refer to figure 4-30 and check each retainer for proper seating with leak detector J23987-01. Place the suction cup over the retainer and hand operate the lever to pull a vacuum of ten inches on the gage.
- (10) Measure piston skirt diameter lengthwise and crosswise of piston pin bore. Measurements should be taken at room temperature (70°F or 21°C).
- (11) The piston-to-liner clearance, with new parts, will vary with the particular piston and cylinder liner. A maximum clearance of .012 inch is allowable with used parts.



**Figure 4-30 . Checking Piston Pin Retainer for Proper Sealing Using Tool J23987-01 .**

- (12) With cylinder liner installed in cylinder block, hold piston skirt upside down in the liner and check clearance in four places 90° apart.
- (13) Refer to figure 4-31 and use feeler gage set J5438-01 to check the clearance. The spring scale attached to the proper feeler gage, is used to measure the force in pounds required to withdraw feeler gage.

- (14) Select a feeler gage with a thickness that will require a pull of six pounds to remove. The clearance will be .001 inch greater than the thickness of the feeler gage used, i.e., a .004 inch feeler gage will indicate a clearance of .005 inch when it is withdrawn with a pull of six pounds. The feeler gage must be perfectly flat and free of nicks and bends.
- (15) If any bind occurs between piston and liner, examine the piston and liner for burrs. Remove burrs with a fine hone (a flat one is preferable) and recheck clearance.



**Figure 4-31 . Measuring Piston-to-Liner Clearance Using Tool J5438-01 .**

**NOTE**

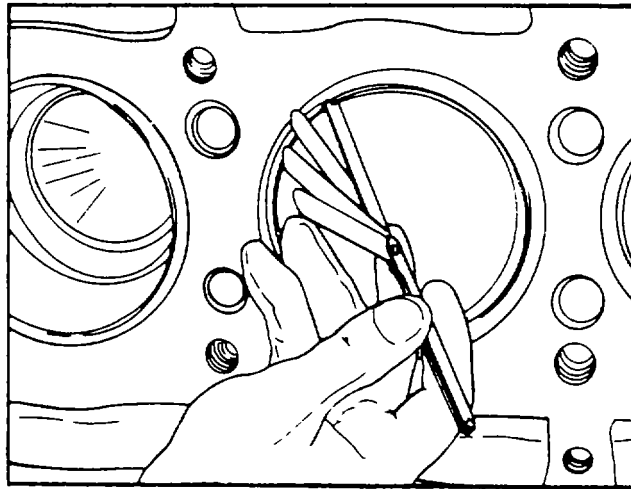
All new piston rings must be installed whenever a piston is removed, regardless of whether a new or used piston or cylinder liner is attached.

**4-11. PISTONS AND CONNECTING RODS - Continued.****f. Reassembly - Continued**

(16) Refer to figure 4-32. If the gap on a compression ring is insufficient, it may be increased by filing or stoning the ends of the ring. File or stone both ends of the ring so the cutting action is from the outer surface to the inner surface. The ends of the ring must remain square and the chamfer on the outer edge must be approximately .015 inch.

(17) Each piston is fitted with a fire ring, two compression rings, and two oil control rings.

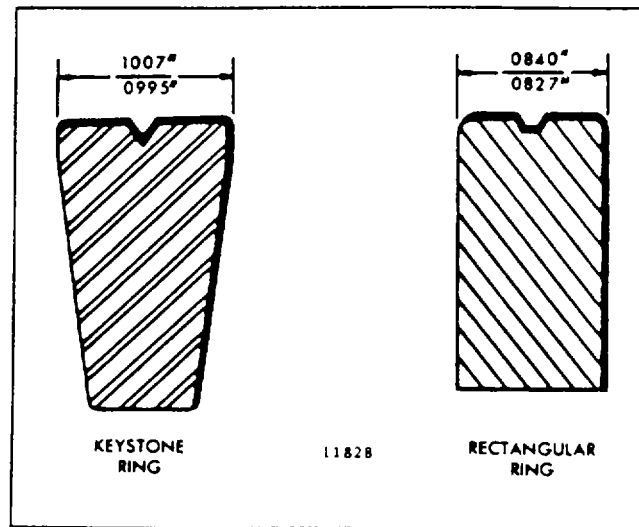
(18) The top (fire) ring and the upper compression ring (second groove) are prestressed. Both are identified by a small indentation mark on the top side.



**Figure 4-32 . Measuring Piston Ring Gap .**

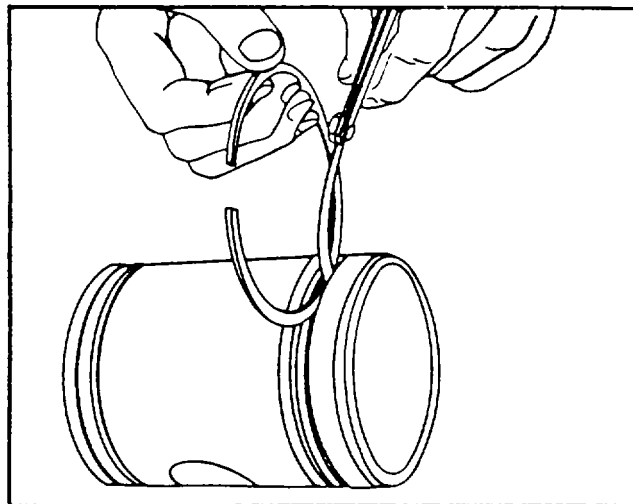
**NOTE**

The current piston crowns (18.7:1 and 17:1 compression ratio) have a tapered fire ring groove. To conform with this change, a tapered fire ring (figure 4-33) must be used. The former piston crown (17:1 compression ratio) had a rectangular fire ring groove. Only pistons with the tapered fire ring groove are available for service.



**Figure 4-33 . Comparison of Fire Rings .**

- (19) Insert one ring at a time inside of cylinder liner and far enough down to be within the normal area of ring travel. Use a piston skirt to push ring down to be sure it is parallel with top of liner. Measure ring gap with a feeler gage as shown in figure 4-32.
- (20) Refer to figure 4-34 and check ring side clearance.



**Figure 4-34 . Measuring Piston Ring Side Clearance .**

**NOTE**

Lubricate piston rings and piston with engine oil (item 8, Appendix C) before installing rings.

**4-11. PISTONS AND CONNECTING RODS- Continued.****f. Reassembly - Continued**

(21) Starting with the bottom ring, install compression rings with tool J8128. To avoid breaking or overstressing rings, do not spread them any more than necessary to slip them over the piston. Refer to figure 4-35 for ring identification and location.

(22) Stagger the ring gaps around the piston.

(23) Install ring expanders in oil control ring grooves in piston skirt. When installing oil control rings, use care to prevent overlapping ends of ring expanders. An overlapped expander will cause the oil ring to protrude beyond allowable limits and will result in breakage when piston is inserted in ring compressor during installation in cylinder liner. Do not cut or grind ends of expanders to prevent overlapping. Cutting or grinding the ends will decrease the expanding force on the oil control rings and result in high lubricating oil consumption.

**NOTE**

When peripheral abutment type ring expanders are used, install them with the legs of the free ends toward the top of the piston. With free ends pointing up, a noticeable resistance will be encountered during installation of the piston if ends of the expander are overlapped and corrective action can be taken before ring breakage occurs.

(24) Install oil control rings by hand. Start with the upper half of the top oil ring and align the gaps as indicated in figure 4-35.

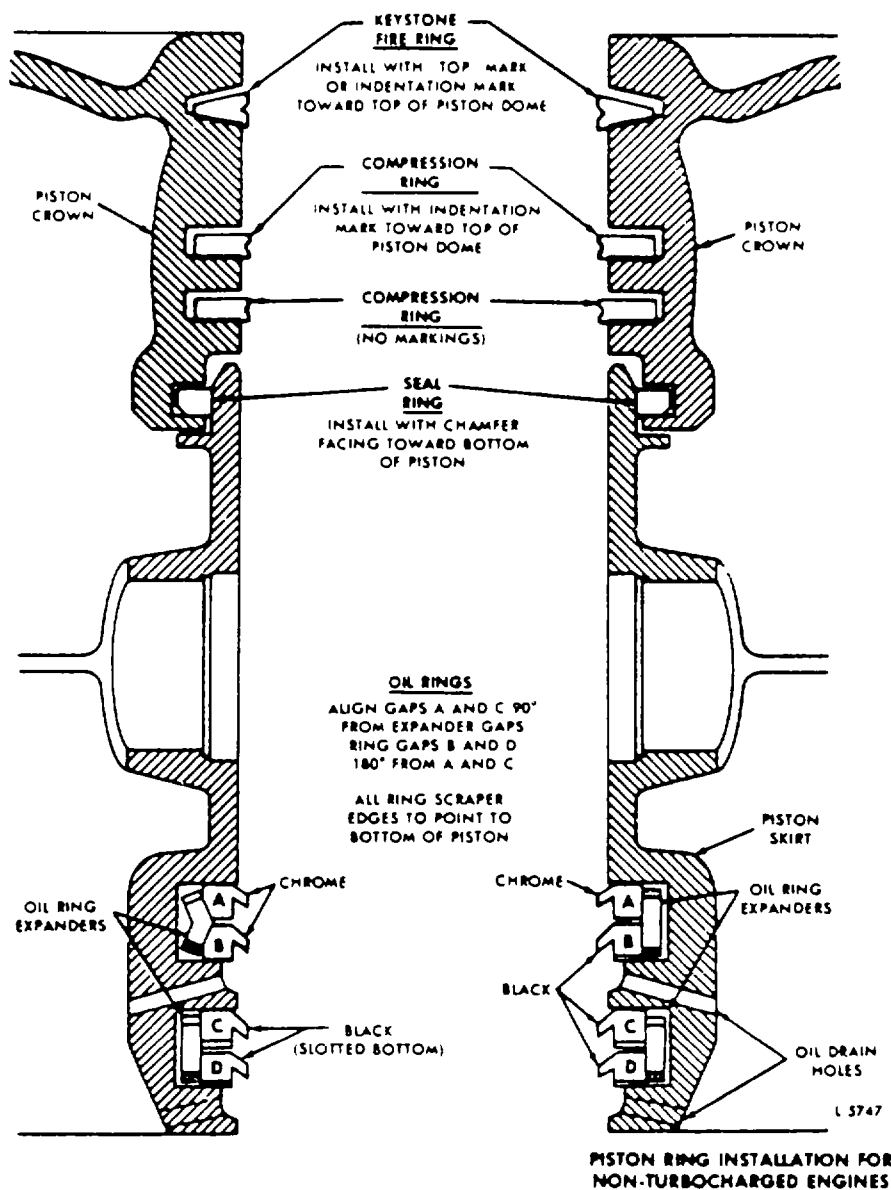


Figure 4-35 . Piston Ring Installation Instructions .

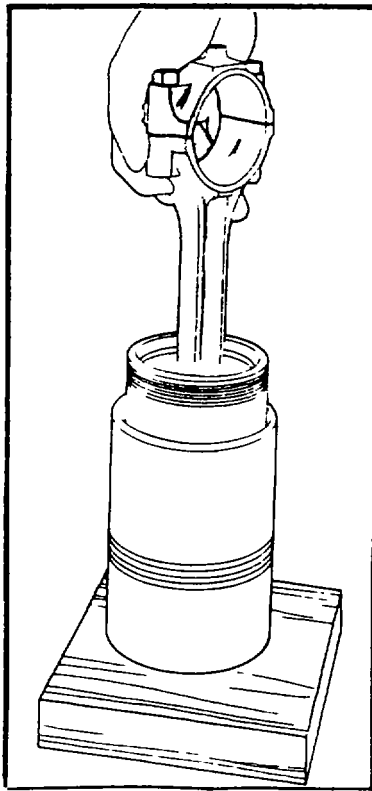
**4-11. PISTONS AND CONNECTING RODS- Continued.****g. Installation.**

- (1) Apply clean engine oil (item 8, Appendix C) to the piston, rings, and inside of ring compressor.

**NOTE**

Inspect ring compressor for nicks or burrs, especially at the non-tapered inside diameter end. Nicks or burrs on the inside diameter of the compressor will result in damage to piston rings.

- (2) Refer to figure 4-36. Place piston ring compressor on a wood block, with tapered end of ring compressor facing up.
- (3) Position (stagger) the piston ring gaps properly on the piston. Make sure ends of the oil control ring expanders are not overlapped.
- (4) Start top of the piston straight into ring compressor. Then push piston down until it contacts the wood block.



**Figure 4-36 . Installing Piston and Connecting Rod Assembly in Ring Co mpressor and Cylinder Liner .**

- (5) Remove connecting rod cap (2, figure 4-22).
- (6) Place ring compressor, piston, and connecting rod assembly on liner so the numbers on the rod and cap are aligned with the matchmark on the liner.

**NOTE**

The numbers on the side of the connecting rod and cap identify the rod with the cap and indicate the particular cylinder in which they are used. If a new service connecting rod is to be installed, the same identification numbers must be stamped in the same location as on the connecting rod that was replaced.

- (7) Push piston and connecting rod assembly down into liner until piston is free of the ring compressor.

**NOTE**

Do not force piston into liner. The peripheral abutment type expanders apply considerably more force on the oil ring than the standard expander. Therefore, extra care must be taken during loading operation to prevent ring breakage.

- (8) If any of the pistons and liners are already in the engine, use hold-down clamps to retain liners in place when crankshaft is rotated.
- (9) Rotate crankshaft until the connecting rod journal of the particular cylinder being worked on is at the bottom of its travel. Wipe journal clean and lubricate with clean engine oil (item 8, Appendix C).
- (10) Install upper bearing shell, the one with a short oil groove at each parting line, in connecting rod. Lubricate bearing shell with clean engine oil (item 8, Appendix C).
- (11) Place lower bearing shell, the one with the continuous oil groove from one parting line to the other, in the connecting rod cap, with the tang on bearing shell in the notch in the connecting rod bearing cap. Lubricate bearing shell with clean engine oil.

**NOTE**

Be sure connecting rod bolt has not turned in the connecting rod before torque is applied to the nut.

- (12) Install bearing cap (2, figure 4-22) and bearing shell on connecting rod with the identification numbers on cap and the rod adjacent to each other. Tighten connecting rod bolt nuts to 60-70 lb-ft (81-95 Nm) torque (lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (castellated nut).

**NOTE**

The current connecting rod bolt is .200 inch longer than the former bolt. After the oil pump piping is installed, bar the engine over for a clearance check. In the event interference occurs, loosen the pipe or item involved and retighten it while holding it away from the point of interference.

**4-11. PISTONS AND CONNECTING RODS - Continued.**g. Installation - Continued.

- (13) Check connecting rod side clearance. The clearance must be .006 inch to .012 inch.
- (14) Install the remaining piston and rod assemblies in the same manner. Use hold-down clamps to hold each liner in place.
- (15) After all of the liners and pistons have been installed, remove the hold-down clamps.
- (16) Refer to paragraph 3-37 and install oil pan.
- (17) Refer to paragraph 3-38 and install cylinder head.

**4-12. CYLINDER LINERS.****This task covers:**

- |                   |                    |                      |                           |
|-------------------|--------------------|----------------------|---------------------------|
| <b>a. Removal</b> | <b>b. Cleaning</b> | <b>c. Inspection</b> | <b>d. INSERT FUNCTION</b> |
|-------------------|--------------------|----------------------|---------------------------|

**INITIAL SETUP:**Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)  
 Cylinder Liner Remover Set (Item 61, Appendix B)  
 Cylinder Hone Set (Item 62, Appendix B)  
 Stones and Wipers (Item 63, Appendix B)  
 Gage, Bore, Dial (Item 64, Appendix B)  
 Master Ring Gage (Item 65, Appendix B)  
 Cylinder Set, Master Range (Item 66, Appendix B)  
 Clamp (Item 68, Appendix B)  
 Fixture, Bore Ring Master Set (Item 69, Appendix B)

Materials Required:

Oil, Fuel (Item 9, Appendix C)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Oil pan removed (paragraph 3-37).  
 Cylinder head removed (paragraph 3-38).  
 Pistons and connecting rods removed (paragraph 4-11).

a. Removal.

- (1) Remove cylinder liner with tool J1918-02 as follows.

- (2) Slip lower puller clamp up on the puller rod and off the tapered seat. Cock the clamp so it will slide down through the liner. The clamp will drop back on the tapered seat after it clears the bottom of the liner. Then slide the upper puller clamp down against top edge of the liner.
- (3) With tool in place, refer to figure 3-37 and strike the upset head on the upper end of the puller rod a sharp blow with the puller weight, thus releasing the liner.
- (4) Remove tool from liner. Then remove liner from block.
- (5) Remove liner insert and shims (if used) from the counterbore in the block.
- (6) Tag liner, insert, and shims.

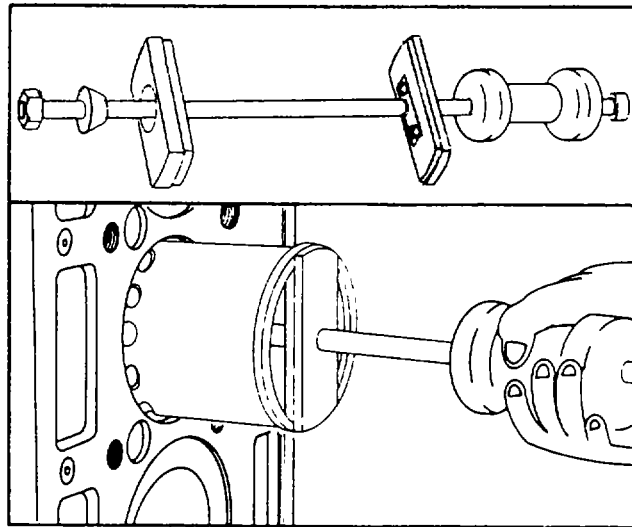


Figure 4-37 . Removing Cylinder Liner Using Tool J1918-02 .

**NOTE**

If tool J1918-02 is unavailable, tap liner out with a hardwood block and hammer.

b. Cleaning.

- (1) Clean the liner with clean fuel oil (item 9, Appendix C).
- (2) Wipe off excess fuel oil and allow liner to dry.

c. Inspection.

- (1) Examine outside diameter of liner for fretting. Fretting is the result of a slight movement of the liner in the block bore during engine operation, which causes material from the block to adhere to the liner. These metal particles may be removed from the surface of liner with a coarse, flat stone.

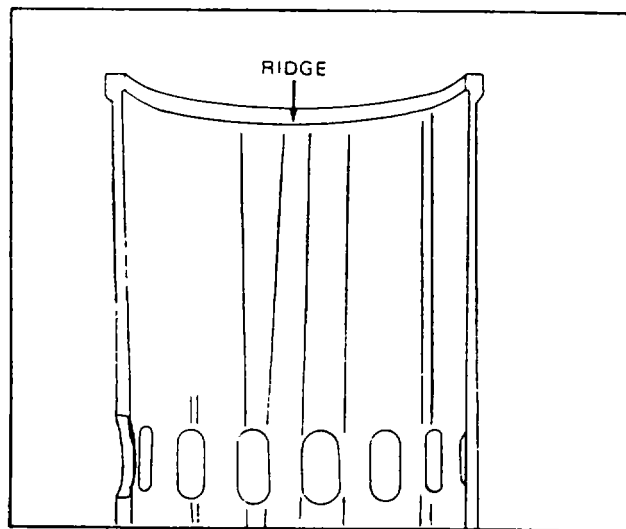
**4-12. CYLINDER LINERS- Continued.****c. Inspection - Continued**

- (2) The liner flange must be smooth and flat on both the top and bottom surfaces. Check for cracks at the flange. The liner insert must also be smooth and flat on the top and bottom surfaces. Replace liner if there is evidence of brinelling.
- (3) A used cylinder liner must be honed for the following reasons

**NOTE**

Do not modify the surface finish in a new service liner. Since the liner is properly finished at the factory, any change will adversely affect the seating of the piston rings.

- (a) Break the glaze due to the rubbing action of the piston rings which results after long periods of operation. Unless this glaze is removed, the time required to seat new piston rings will be lengthened.
- (b) Remove the ridge (figure 4-38) formed at the top by piston ring travel. Otherwise, interference with the travel of the new compression rings may result in ring breakage.
- (c) The hone J5902-01, equipped with 120 grit stones J5902-14, should be worked up and down the full length of liner a few times in a criss-cross pattern that produces hone marks on a 45° axis.



**Figure 4-38 . Cylinder Liner Ridge Due to Wear .**

- (d) After liner has been honed, remove it from the fixture and clean it thoroughly. Then dry it with compressed air and check the entire surface for burrs.

- (e) After honing, the liner must conform to the same limits oil taper and out-of-round as a new liner and the piston-to-liner clearance must be within the specified limits.
- (4) Measure the block bore (figure 4-39) and the outside diameter of the liner. If the liner-to-block clearance (with used parts) exceeds .0025 inch, it will be necessary to bore the block for an oversize liner.

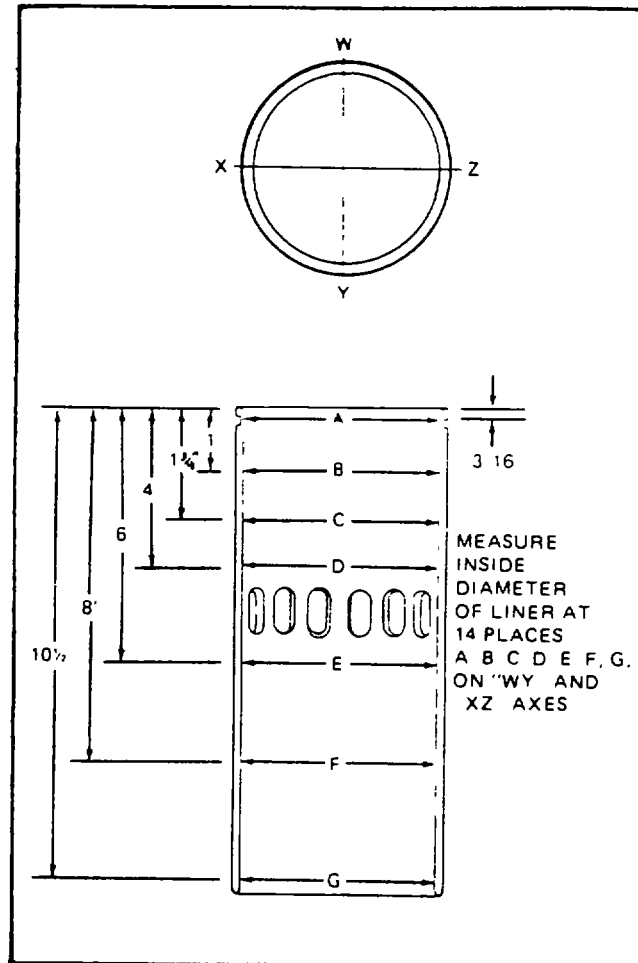
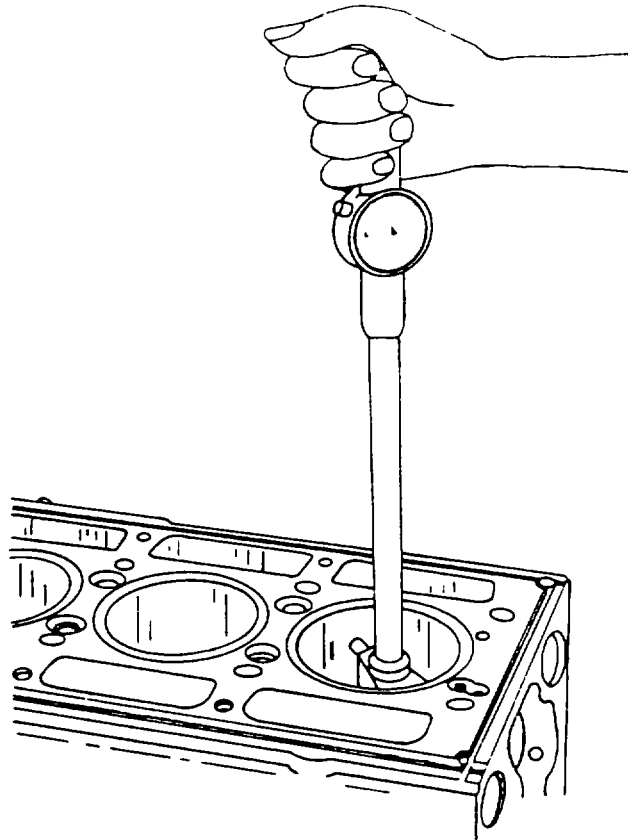


Figure 4-39 . Cylinder Liner Measurement Diagram .

**4-12. CYLINDER LINERS - Continued.**c. Inspection - Continued

- (5) Install liner in the proper bore of the cylinder block. Measure inside diameter of the liner at the various points. Use cylinder bore gage J5347-01 (figure 4-40), which has a dial indicator calibrated in .0001 inch increments. Set cylinder bore gage on zero in master ring gage J5580-1. Also check liner for taper and out-of-round. It is not necessary to measure the inside diameter or taper of a new liner.



**Figure 4-40 . Checking Bore of Cylinder Liner Using Tool J5347-01 .**

**NOTE**

Dial bore gage master setting fixture J23059-01 may be used in place of the master ring gage.

- (6) The piston-liner clearance must be within the specified limits. Also, the taper must not exceed .002 inch and the out-of-round must not exceed .0025 inch on a used liner. If the out-of-round exceeds .0025 inch, rotate the liner 90° in the block bore and recheck.
- (7) New service liners, standard and oversize, have an inside diameter of 4.2495 inch to 4.2511 inch (long port liner) or 4.2495 inch to 4.2516 inch (short port liner).

(8) Cylinder liners are available in .001 inch, .005 inch, 0.10 inch, 0.20 inch, and .030 inch oversize on the outside diameter. When an oversize liner is installed, stamp the amount of the oversize on top of the cylinder bore adjacent to the liner counterbore.

(9) The cylinder bores in a new cylinder block are classified as #1, #2, or #3 (table 4-1) designating the specific size range for each bore and appropriate cylinder liner that may be fitted to each bore.

(10) A new standard size cylinder liner is also classified as #1, #2, or #3.

(11) Although the block bores and liners should be measured to determine the liner-to-block clearance, the selection of a liner is narrowed down to only those in the appropriate classifications or possibly a .001 inch oversize liner.

(12) Before installing a liner in a used cylinder block, always lightly hone the block bore.

(13) After honing block bore, check the bore measurements to determine if a standard liner (classification #1, #2, or #3) or possibly a .001 inch oversize liner can be used (refer to table 4-1). A push fit between the liner and the block is desirable. If an adequate push fit cannot be obtained. It may be necessary to bore the block to receive an oversize liner.

(14) When it becomes necessary to install an oversize liner, the same care in selective tolerance fitting must be adhered to. However, it may be more difficult to select an oversize liner since the size range is not broken down into classifications.

(15) In deciding whether boring is necessary or not, keep in mind that 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 cylinder block should be bored oversize.

(16) To determine what size to re-bore the cylinder block for an oversize liner, each service liner used must be measured on the outside diameter for size in three places (under the flange, between the flange and the ports, and above the ports). The cylinder bore size will be determined by the average liner measurement taken at the three positions.

#### EXAMPLE:

Service line O.D. measures 4.6280"

O.D. size = 4.6280"  
plus clearance = .0005"  
bore size = 4.6285"

Then,  $4.6235" + .001"$  boring tolerance will allow a bore size of 4.6285" to 4.6295" and a possible liner-to-block clearance of .0005" to .0015". The clearance tolerance is the dimensional difference between the liner O.D. and the block bore I.D.

## 4-12. CYLINDER LINERS - Continued.

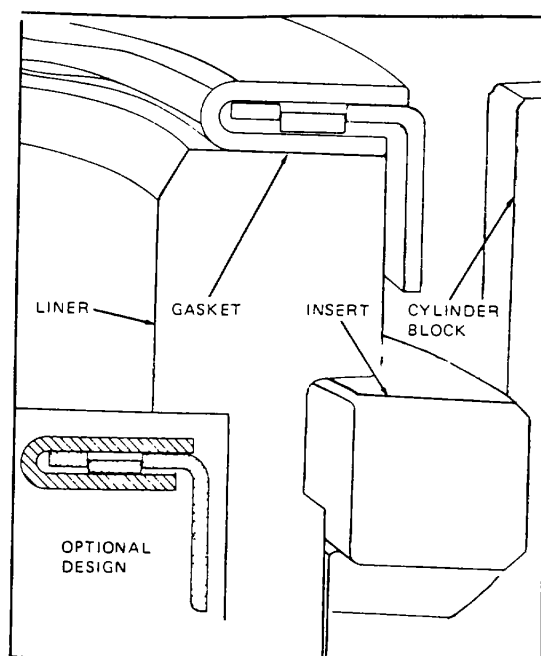
c. Inspection - Continued

Table 4-1. Cylinder Liner Tolerances

NEW CYLINDER LINER TO NEW CYLINDER BLOCK BORE FITS				
Classification Number Stamped Adjacent to Each Cyl. Bore	Cylinder Bore Classification Diameter (I.D.)	Standard Cylinder Liner Diameters and Liner-to-Block Clearances When Properly Matched		
		Liner (O.D.) Classification	Liner (O.D.) Diameter	Liner/Block Diameter
CAST IRON BLOCK				
#0	4.6256"/4.6259"	#1	4.6250"/4.6255"	.0001"/.0009"
#1	4.6260"/4.6265"	#1	4.6250"/4.6255"	.0005"/.0015"
		#2	4.6256"/4.6260"	.0000"/.0009"
#2	4.6266"/4.6270"	#2	4.6256"/4.6260"	.0006"/.0014"
		#3	4.6261"/4.6265"	.0001"/.0009"
#3	4.6271"/4.6275"	#3	4.6261"/4.6265"	.0006"/.0014"
METRIC				
#0	117.490/117.498 mm	#1	117.475/117.488 mm	.002/.023 mm
#1	117.500/117.513 mm	#1	117.475/117.488 mm	.012/0.38 mm
		#2	117.490/117.500 mm	.000/.023 mm
#2	117.516/117.526 mm	#2	117.490/117.500 mm	.016/.036 mm
		#3	117.503/117.513 mm	.003/.023 mm
#3	117.528/117.539 mm	#3	117.503/117.513 mm	.015/.036 mm

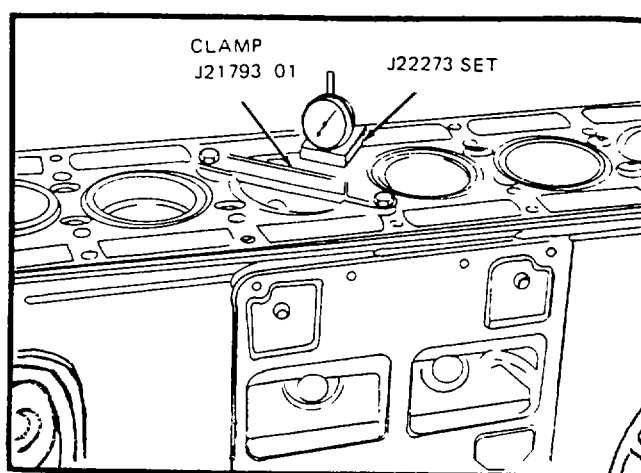
d. Installation.

- (1) Wipe the inside and outside of the liner clean and make sure the block bore and counterbore are clean.
- (2) Place a standard size cylinder liner in the cylinder block as shown in figure 4-41.
- (3) Push cylinder liner into the cylinder block until the liner flange rests on the insert. Do not use excessive force to install liner. The liner should slide smoothly in place with hand pressure. If a new liner cannot be pushed in place, light honing of the block bore may be necessary to obtain the desired fit for best heat transfer.



**Figure 4-41. Cylinder Liner Mounting in Block.**

- (4) Install a cylinder liner hold-down clamp as shown in figure 4-42.



**Figure 4-42. Checking Distance of Liner Flange Below Top Face of Block.**

- (5) Measure distance from top of liner to top of block with a dial indicator. The liner flange must be .045 inch to .050 inch below the surface of the block. However, even though all of the liners are within these specifications, there must not be over .002 inch difference in depth between any two adjacent liners when measured along the cylinder longitudinal center line.

**4-12. CYLINDER LINERS - Continued.**d. Installation - Continued.**NOTE**

A .002 inch thick shim is available for adjusting the liner height. The shim must be installed underneath the liner insert. Do not cut the shim for installation. Liner inserts which are .0015 inch thicker or thinner than standard are also available for service. In addition, the .004 inch and .008 inch thinner inserts, which are provided for use with resurfaced cylinder blocks, can also be used to adjust the liner height.

- (6) Matchmark the liner and the cylinder block with a felt pen so the liner may be reinstalled in the same position in the same block bore. The matchmarks should be toward the blower side of the engine.
- (7) Remove the hold-down clamp and the cylinder liner.

**NOTE**

**Do not remove the liner insert.**

- (8) Refer to paragraph 4-11 and install piston and connecting rod.
- (9) Refer to paragraph 3-38 and install cylinder head.
- (10) Refer to paragraph 3-37 and install oil pan.

**4-13. MAIN BEARINGS.****This task covers:****a. Removal****b. Cleaning****c. Inspection****d. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)  
 Micrometer Ball Attachment (Item 51, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

International Compound No. 2 (Item 13, Appendix C)  
 Oil, Engine (Item 8, Appendix C)  
 Oil, Fuel (Item 9, Appendix C)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).  
 Engine removed (paragraph 3-6).

a. Removal. (Refer to figures 4-43 and 4-44).

(1) Remove oil pan in accordance with paragraph 3-37.

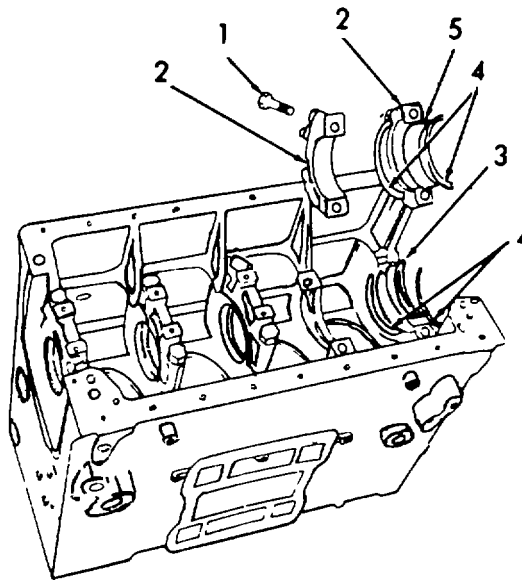
(2) Remove oil pump in accordance with paragraph 3-47.

(3) Refer to figure 4-43 and remove two bolts (1) and bearing cap (2).

#### NOTE

**Remove one bearing cap at a time.**

(4) Insert a 1/4 inch by 1 inch bolt with a 1/2 inch diameter and 1/16 inch thick head (make from a standard bolt) into crankshaft journal oil hole. Revolve crankshaft to the right (clockwise) and roll bearing shell (3) out of position.



**Figure 4-43. Main Bearing Shells, Bearing Caps, and Crankshaft Thrust Washers, Removal/Installation.**

## 4-13. MAIN BEARINGS - Continued.

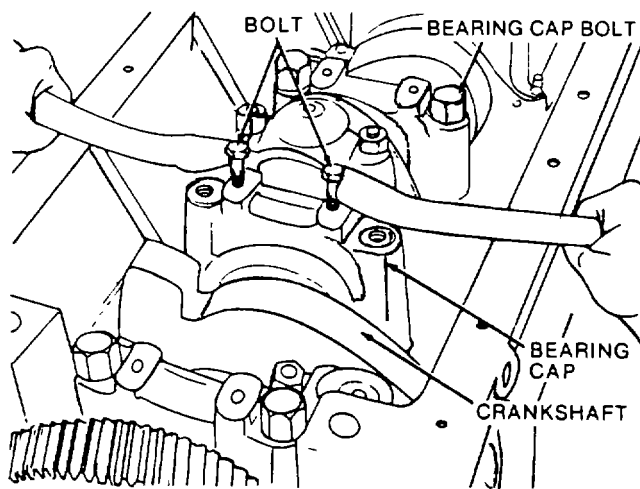
### a. Removal - Continued.

- (5) To remove rear bearing upper shell, tap shell of the edge of the bearing with a small curved rod (figure 4-44), revolving the crankshaft at the same time to roll bearing shell out.
- (6) Remove upper halves of thrust washers (4, figure 4-43) by pushing on the ends of the washers with a small rod, forcing them around and out of the main bearing support.

### NOTE

**The lower halves of the crankshaft thrust washers (4) will be removed along with rear bearing cap .**

- (7) Remove lower bearing shell (5) from bearing cap (2).



**Figure 4-44. Main Bearing Cap, Removal/Installation.**

### b. Cleaning.

- (1) Clean bearing caps and bearing shells with clean fuel oil (item 9, Appendix C). (2) Wipe off excess fuel oil and allow to dry.

### c. Inspection.

- (1) Inspect bearing shells for scoring pitting, flaking, etching, loss of babbitt or signs of overheating.
- (2) Inspect back side of bearing shells for bright spots. If such spots are present, discard bearing shells.

- (3) Measure thickness of bearing shells at point "C", 90° from the parting line as shown in figure 4-45. Place tool J4757 between bearing shell and micrometer to obtain measurement. Bearing shell thickness will be total thickness of steel ball in the tool and bearing shell, less diameter of the ball.
- (4) Replace all bearing shells if any are thinner than .1530 inch. Figure 4-45. Measuring Thickness of Bearing Shell.

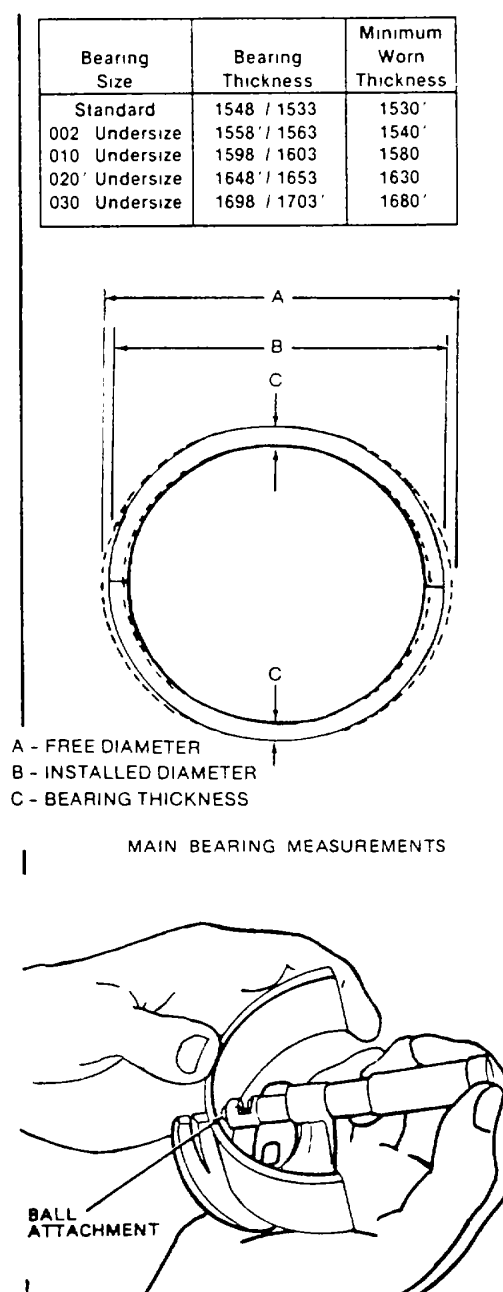


Figure 4-45. Measuring Thickness of bearing Shell.

## 4-13. MAIN BEARINGS - Continued.

### c. Inspection - Continued

#### NOTE

**Do not replace one main bearing shell alone. Always install all new upper and lower bearing shells. If a replacement crankshaft is being installed, install all new bearing shells.**

- (5) Use soft plastic measuring strip squeezed between journal and bearing, check for proper clearance. Clearance should be .0014 inch to .0044 inch with new parts.

#### NOTE

**If clearance between any crankshaft journal and its bearing shell exceeds .0060 inch, all bearing shells must be discarded and replaced.**

- (6) Inspect crankshaft thrust washers for signs of scoring or wear. Replace damaged thrust washers.

#### NOTE

**Before installing new replacement bearings, it is very important to thoroughly inspect the crankshaft journals. Refer to paragraph 4-15 for inspection of crankshaft and removal of ridges.**

### d. Installation.

- (1) Refer to figures 4-44 and 4-43 and apply clean engine oil (item 8, Appendix C) to each crankshaft journal.
- (2) Install upper main bearing shells first. Start the plain end of bearing shell around crankshaft journal so that, when the bearing is in place, the tang will fit into the groove in the bearing support.

#### NOTE

**The upper bearing shell is grooved and drilled for lubrication and the lower bearing shell is not. Be sure to install the grooved and drilled bearing shells in the cylinder block and the plain bearing shells in the bearing caps.**

- (3) Install lower bearing shell so that the tang on the bearing fits into the groove in the bearing cap.
- (4) Assemble the crankshaft thrust washers (4) before installing the rear main bearing cap. Slide the upper halves of the thrust washers into place. Then, assemble the lower halves over the dowel pins in the bearing cap.

**NOTE**

**The main bearing caps are bored in position and stamped 1, 2, 3, etc. They must be installed in their original positions with the marked side of each cap toward the blower side of the cylinder block.**

- (5) Install all bearing caps. Apply a small quantity of International Compound No. 2 (item 13, Appendix C) to the bolt threads. Install bearing cap bolts (1) and draw the bolts up snug. Rap the caps with a soft hammer to seat them properly and tighten all bolts to 44-45 lb-ft (61-75 Nm) torque.
- (6) Turn all bolts (except rear main) an additional 110°-130° of bolt head rotation. Start with center bearing cap bolts and work alternately towards both ends of the block.
- (7) Strike both ends of the crankshaft two or three sharp blows with a soft hammer to insure proper positioning of the rear main bearing cap in the block saddle. Turn the rear main bearing cap bolts an additional 110°-130° of bolt head rotation.

**NOTE**

**If the bearings have been installed properly, the crankshaft will turn freely with all of the main bearing cap bolts or nuts drawn to the specified torque.**

- (8) Check the crankshaft end play as outlined under paragraph 4-15.
- (9) Refer to paragraph 3-47 and install oil pump.
- (10) Refer to paragraph 3-37 and install oil pan.

**4-14. CRANKSHAFT FRONT COVER.**

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**This task covers:****a. Removal****b. Installation**

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**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

Crankshaft pulley removed (paragraph 3-30).

---

**a. Removal.** (Refer to figure 4-46).

(1) Remove four screws (1), three screws (2), and three lockwashers (3).

(2) Remove front cover (4) and gasket (5). Discard gasket (5).

**b. Installation.**

(1) Refer to figure 4-46 and install a new gasket (5) and cover (4).

(2) Secure cover (4) with three lockwashers (3), three screws (2), and four screws (1).

(3) Install crankshaft pulley per paragraph 3-30.

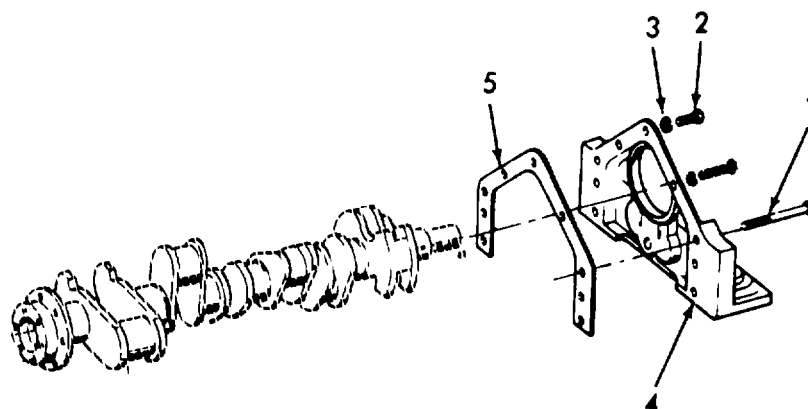


Figure 4-46. Crankshaft Front Cover, Removal/Installation.

#### 4-15. CRANKSHAFT AND SEALS.

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This task covers:

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

#### INITIAL SET-UP:

##### Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)  
 Wrench, Torque (Item 71, Appendix B)  
 Materials Required:  
 Cloth, Crocus (Item 5, Appendix C)  
 Cloth, Emery (Item 7, Appendix C)  
 Oil, Fuel (Item 9, Appendix C)

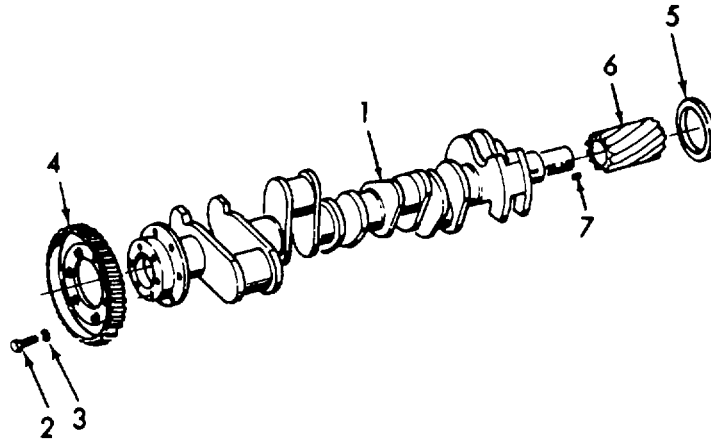
##### Equipment Conditions:

Engine removed (paragraph 3-15).  
 Cylinder head removed (paragraph 3-38).  
 Flywheel removed (paragraph 3-15).  
 Oil pan removed (paragraph 3-37).  
 Main bearing caps removed (paragraph 4-13).  
 Crankshaft front cover removed (paragraph 4-14).

##### a. Removal. (Refer to figure 4-47).

- (1) Refer to paragraph 3-38 and remove the cylinder head.
- (2) Refer to paragraph 3-44 and remove the flywheel.
- (3) Refer to paragraph 4-14 and remove crankshaft front cover.
- (4) Refer to paragraph 3-37 and remove the oil pan.
- (5) Refer to paragraph 4-13 and remove main bearing caps.
- (6) Remove four connecting rod nuts and caps. Push pistons into cylinders as far as they will go.
- (7) Remove crankshaft (1) from the cylinder block.
- (8) Remove six bolts (2) and six lockwashers (3) securing gear (4) to the crankshaft (1).
- (9) Provide a base for the puller screw by placing a steel plate across the cavity on end of the crankshaft. Use a suitable puller and remove gear (4).

(10) Remove oil slinger (5) and then use a gear puller and remove gear (6) and key (7).



**Figure 4-47. Crankshaft, Removal/Installation.**

**b. Cleaning.**

- (1) After the crankshaft has been removed, clean and inspect it thoroughly before reinstalling it in the engine.
- (2) Remove the plugs and clean out the oil passages thoroughly with a stiff wire brush. Clean the crankshaft with fuel oil (item 9, Appendix C) and allow it to dry. Then reinstall the plugs.

**c. Inspection.**

- (1) Inspect keyways for evidence of cracks or wear. Replace the crankshaft, if necessary.
- (2) If the crankshaft shows evidence of excessive overheating, replace the crankshaft since the heat treatment has probably been destroyed.
- (3) Used crankshafts will sometimes show a certain amount of ridging caused by the groove in the upper main bearing shell or lower connecting rod bearing shell. Ridges exceeding .0002 inch must be removed. If the ridges are not removed, localized high unit pressure on new bearing shells will result during engine operation.
- (4) The ridges may be removed by working crocus cloth, wet with fuel oil, around the circumference of the crankshaft journal. If the ridges are greater than .0005 inch, first use 120 grit emery cloth (item 7, Appendix C) to clean up the ridge, 240 grit emery cloth (item 7, Appendix C) for finishing and wet crocus cloth (item 5, Appendix C) for polishing. Use of a piece of rawhide or other suitable rope wrapped around the emery cloth (item 7, Appendix C) or crocus cloth (item 5, Appendix C) and drawn back and forth will minimize the possibility of an out-of-round condition developing (keep the strands of rawhide apart to avoid bind). If rawhide or rope is not used, the crankshaft should be rotated at intervals. If the ridges are greater than .001 inch, the crankshaft must be replaced.

## 4-15. CRANKSHAFT AND SEALS - Continued.

### c. Inspection Continued

- (5) Carefully inspect the rear end of the crankshaft in the area of the oil seal contact surface for evidence of a rough or grooved condition. Any imperfections of the oil seal contact surface will result in oil leakage at this point.
- (6) Slight ridges on the crankshaft oil seal contact surface may be cleaned up with emerycloth (item 7, Appendix C) and crocus cloth (item 5, Appendix C) in the same manner as detailed for the crankshaft journals. If the crankshaft cannot be cleaned up satisfactorily, replace the crankshaft.
- (7) Check the crankshaft thrust surfaces for excessive wear or grooving. If only slightly worn, the surfaces may be dressed with a stone. Otherwise it will be necessary to replace the crankshaft.
- (8) Check the oil pump drive gear and the crankshaft timing gear for worn or chipped teeth. Replace the gears, if necessary.
- (9) Check the crankshaft dowel extension. Current dowels extend 1/2 inch from the crankshaft while former dowels extend 5/8 inch.
- (10) Carefully check the crankshaft for cracks which start at an oil hole at an angle of 45° and follow the journal surface at axis. Any crankshaft with such cracks must be rejected. Several methods of determining the presence of minute cracks not visible to the eye are magnetic particle, fluorescent magnetic particle, and fluorescent penetrant.
- (11) Inspection of the crankshaft using magnetic particle method, magnetize the crankshaft, then cover the crankshaft with a fine magnetic powder or solution. Flaws, such as cracks, form a small local magnetic which causes the magnetic particles to gather there, effectively marking the crack. The crankshaft must be demagnetized after completion of test.
- (12) Inspection of crankshaft using fluorescent magnetic particle method. This method is similar to magnetic particle method, but it is more sensitive since it employs magnetic particles which are fluorescent and glow under "black light". Very fine cracks that may be missed under the first method, especially on discolored or dark surfaces, will be disclosed under "black light".
- (13) Support the crankshaft on its front and rear journals on V-blocks or in a lathe and check the alignment at the adjacent intermediate main journals with a dial indicator.

- (14) When the runout on the adjacent journals is in opposite directions, the sum must not exceed .003 inch total indicator reading. When the runout on the adjacent journals of the four and six cylinder crankshaft is in the same direction, the difference must not exceed .003 inch total indicator reading. When high spots of runout on the adjacent journals of the three cylinder crankshaft are at right angles to each other, the sum must not exceed .004 inch total indicator reading, or .002 inch on each journal. If the runout limit is greater, the crankshaft must be replaced.
- (15) Measure all of the main connecting rod bearing journals as shown in figure 4-48. Measure journals at several places on the circumference so that taper, out-of-round and bearing clearances can be determined. If the crankshaft is worn so that the maximum journal-to-bearing shell clearance (with new shells) exceeds .0044 inch, the crankshaft must be replaced. Measurements of the crankshaft should be accurate to the nearest .0002 inch. Also, if the journal taper of a used crankshaft exceeds .0015 inch or the out-of-round is greater than .001 inch the crankshaft must be replaced.

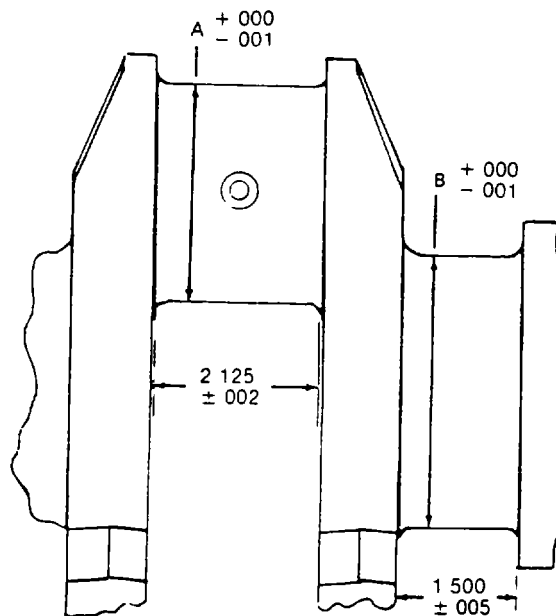
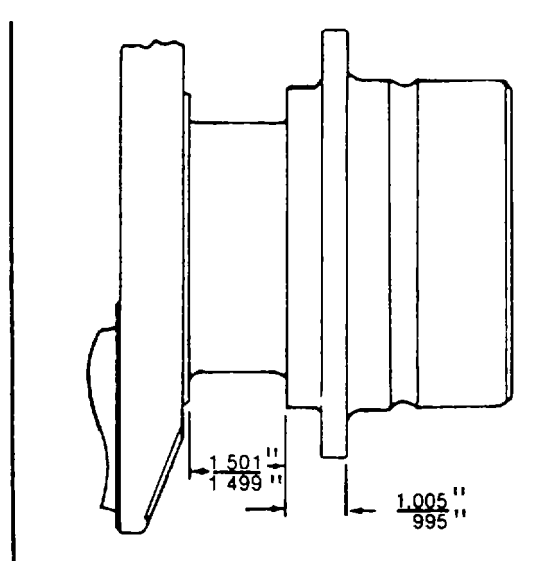


Figure 4-48. Measuring of Main and Connecting Rod Bearing Journals.

## 4-15. CRANKSHAFT AND SEALS - Continued.

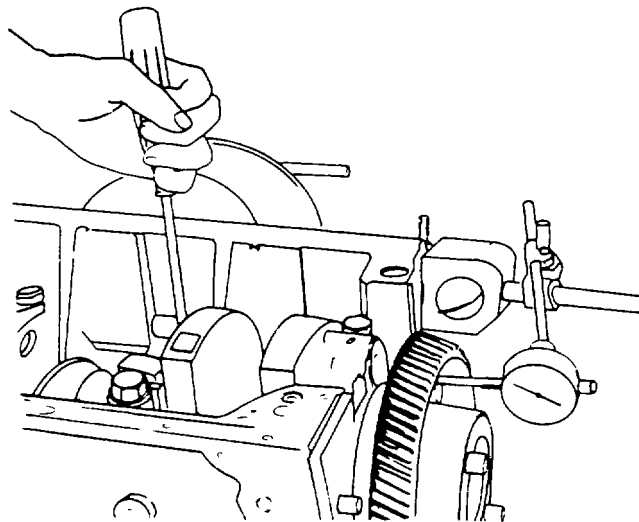
### c. Inspection - Continued

- (16) Measure the crankshaft thrust surfaces as shown in figure 4-49. If worn or grooved, the crankshaft must be replaced.



**Figure 4-49. Measuring Crankshaft Thrust Surfaces.**

- (17) Check the crankshaft end play as shown in figure 4-50, by moving the crankshaft toward the gage with a pry bar. Keep a constant pressure on the pry bar and set the dial indicator to zero. Then, remove and insert the pry bar on the other side of the bearing cap. Force the crankshaft in the opposite direction and note the amount of end play on the dial. The end play should be .004 inch to .011 inch with new parts or a maximum of .018 inch with used parts. Insufficient end play can be the result of a misaligned rear main bearing or a burr or dirt on the inner face of one or more of the thrust washers.



**Figure 4-50. Checking Crankshaft End Play.**

d. Repair. Repair of the crankshaft is limited to replacing the oil pump drive gear and crankshaft timing gear.

e. Installation.

- (1) Refer to figure 4-43 and install the upper grooved main bearing shells in the block. Apply a light coat of engine oil to each bearing shell.
- (2) Position crankshaft (1) into place in the cylinder block.
- (3) Refer to paragraph 4-13 and install main bearing caps.
- (4) Refer to paragraph 4-11 and install connecting rod caps.
- (5) Refer to paragraph 3-37 and install the oil pan.
- (6) Refer to paragraph 4-14 and install the crankshaft front cover.
- (7) Refer to paragraph 3-44 and install the flywheel.
- (8) Refer to paragraph 3-38 and install the cylinder head.
- (9) Secure gear (4) to crankshaft (1) with six lockwashers (3), and six bolts (2). Torque bolts to 35-39 ft-lb (47-53 Nm).
- (10) Install crankshaft (1) in cylinder block.

**4-16. BLOCK, CYLINDER.**


---

**This task covers:**

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


---

**INITIAL SET-UP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)  
 Master Ring Gage Set (Item 53, Appendix B)  
 Cylinder Hone Set (Item 62, Appendix B)  
 Stones and Wipers (Item 63, Appendix B)  
 Gage, Bore Dial (Item 64, Appendix B)  
 Cylinder Set, Master Range (Item 66, Appendix B)  
 Master Ring Gage Set (Item 69, Appendix B)

**Materials Required:**

Primer Coating (Item 18, Appendix C)  
 Solution, Alkaline (Item 2, Appendix C)

**Equipment Conditions:**

Engine removed (paragraph 3-15).  
 Engine accessories and internal components removed from cylinder block  
 (paragraphs 3-17 thru 4-15).

---

**a. Cleaning.****NOTE**

**Scrape all gasket material from cylinder block. Remove all oil gallery  
 plugs and core hole plugs, except cup plugs.**

- (1) Remove grease by agitating block in hot bath of commercial heavy-duty alkaline solution (item 2, Appendix C).
- (2) Wash block in hot water or steam clean to remove alkaline solution (item 2, Appendix C).
- (3) Apply a coat of primer coating to the block after drying.

## b. Test.

- (1) Seal water openings in top of block with metal plates made according to figure 4-51.
- (2) Use main bearing caps to secure plates to block with cylinder head bolts or studs and nuts. Use cylinder head seal rings as gaskets between plates and block.
- (3) Use water hole cover plates and gaskets to cover water pump inlet openings.
- (4) Drill and tap one cover plate to provide a connection for an air line.

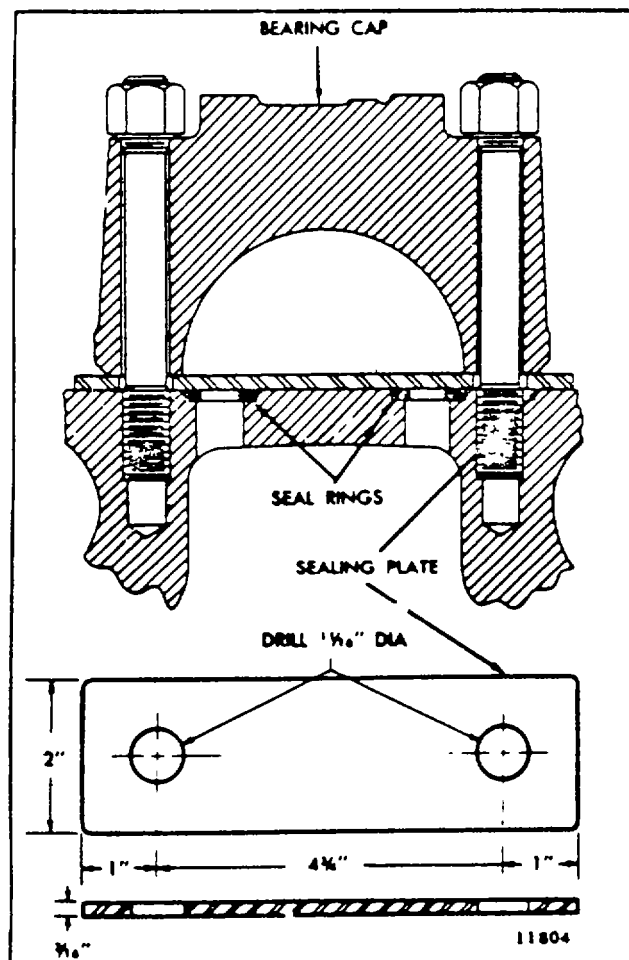


Figure 4-51. Sealing Plate Details for Pressure Testing Cylinder Block.

**4-16. BLOCK, CYLINDER - Continued.****b. Test - Continued.**

- (5) With the cylinder block prepared as shown in figure 4-52, the core hole plugs installed and the plugs removed from the oil passages, test the block as follows:

**METHOD "A".**

- (a) This method may be used when a large enough water tank is available and the cylinder block is completely stripped of all parts.
- (b) Immerse the block for twenty minutes in a tank of water heated to 180-200°F (82-93°C).
- (c) Apply 40 psi (276 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.
- (d) 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.

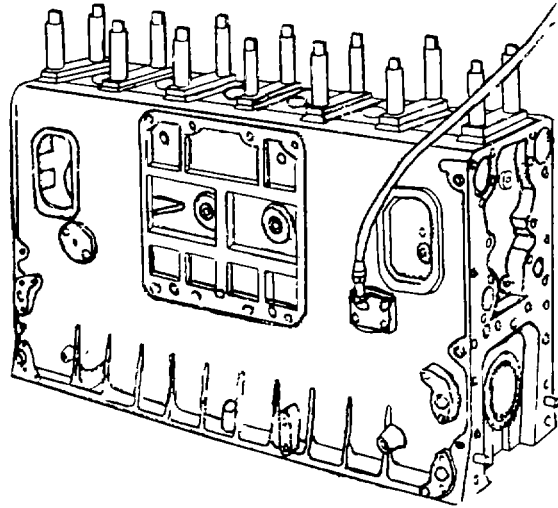
**METHOD "B"**

- (a) This method may be used when a large water tank is unavailable, or when it is desired to check the block for cracks without removing the engine from the equipment which it powers.
- (b) 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 permanent type antifreeze. The antifreeze will penetrate small cracks and its color will aid in detecting their presence.
- (c) Install the remaining sealing plate and tighten it securely.
- (d) Apply 40 psi (276 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.
- (e) 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.

**WARNING**

Use air pressure under 35 psi, when using compressed air to clean and dry components. Wear eye protection when using compressed air. Failure to comply with this warning can result in injury to personnel.

- (f) After the test is completed, remove the plates. Drain water jacket and blow out all passages with compressed air.



**Figure 4-52. Cylinder Block Prepared for Pressure Test.**

c. Repair.

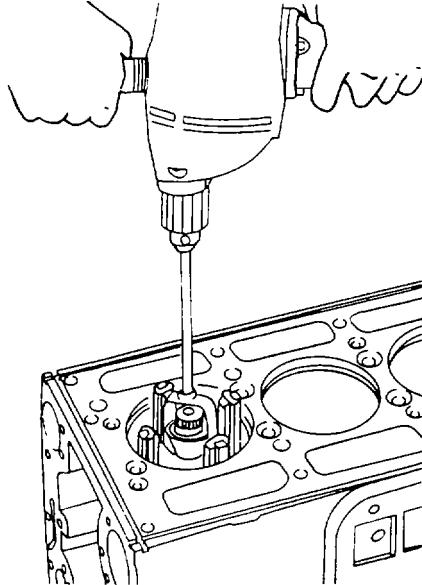
**NOTE**

Whenever cylinder liners are removed from an engine, the block bores must be inspected. Before attempting to check block bores, hone them throughout their entire length until about 75% of the area above the ports has been cleaned up.

- (1) Use a hone in which the cutting radius of the stones can be set in a fixed position rather than a spring-loaded hone.

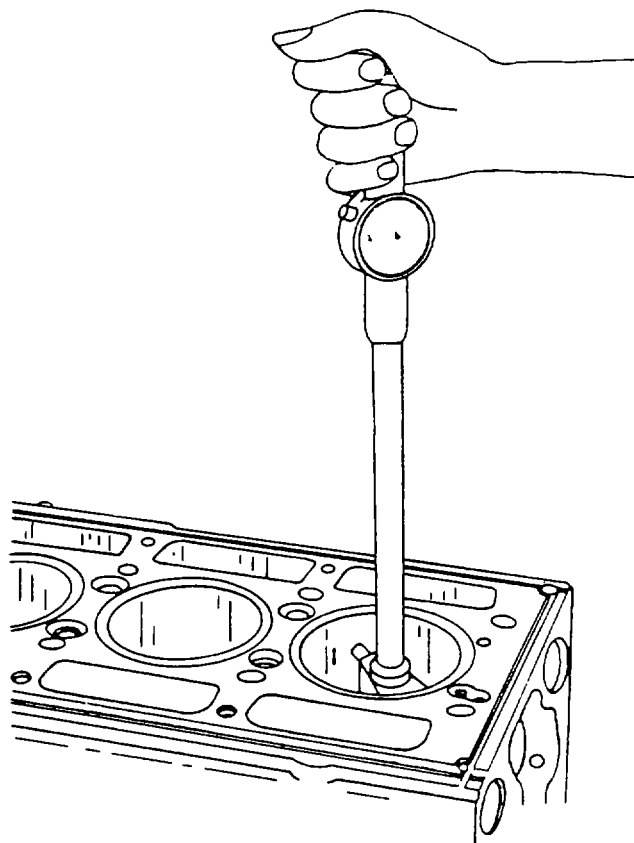
**4-16. BLOCK, CYLINDER-Continued.****c. Repair-Continued.**

- (2) Insert hone (figure 4-53) in bore and adjust stones snugly to the narrowest section. When correctly adjusted, the hone will not shake in the bore, but will drag freely up and down when the hone is not running. Use 120 grit stones J5902-14.



**Figure 4-53. Honing Bore of Cylinder Block.**

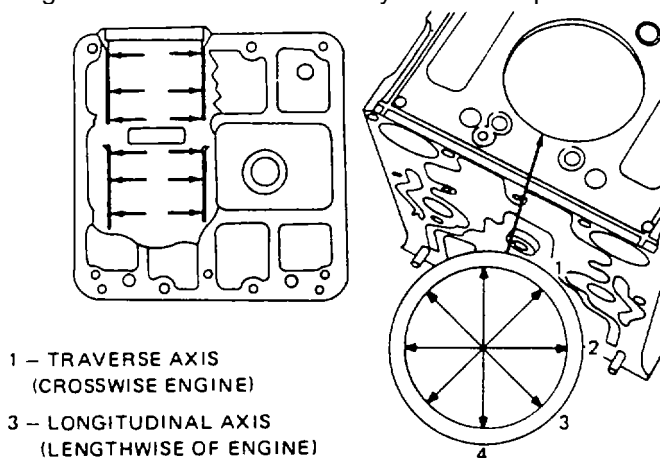
- (3) Remove hone when bore is fairly clean. Measure bore. Determine which spots must be honed most. Where and how much to hone can be judged by feel.
- (4) Wash cylinder block thoroughly after honing operation is completed.
- (5) Measure the entire bore of each cylinder with cylinder bore gage J5347-01 (figure 4-54) which has a dial indicator calibrated in .0001 inch increments. The standard block bore is 4.6260 inch to 4.6275 inch. 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. Take measurements on the cleaned-up surface only at positions A, B, C, D, E, and F in the bore on axis 450 apart. Read the measurements from the zero mark on the gage.



**Figure 4-54. Checking Bore of Cylinder Block.**

**NOTE**

Dial bore gage setting master tool J23059-01 may be used in place of the master ring gage.

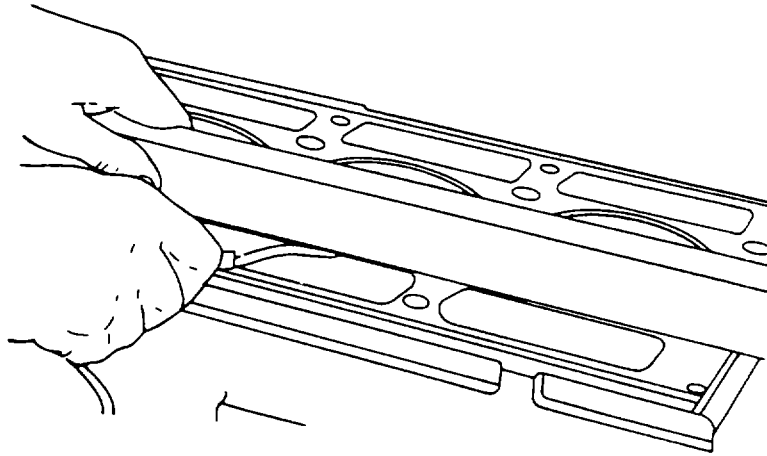


**Figure 4-55. Cylinder Bore Measurement Diagram.**

- (6) The liner-to-block clearance with new parts is zero to .0015 inch. With used parts, the maximum clearance is .0025 inch. After measuring the block bores, measure the outside diameter of the cylinder liners. Then determine the block-to-liner clearances. Replace cylinder block if clearance is not correct.

**4-16. BLOCK, CYLINDER-Continued.****d. Inspection.**

- (1) Check the top of the block for flatness with an accurate straight edge and a feeler gage as shown in figure 4-56.



**Figure 4-56. Checking Top Face of Cylinder Block.**

- (2) The top surface of the block must not vary more than .003 inch transversely and not over .007 inch longitudinally. Cylinder block must be replaced if the top surface exceeds these tolerances.
- (3) Check the main bearing bore diameters with the main bearing caps in their original positions. Apply a small quantity of International Compound No. 2 or equivalent, to the threads on the bolts and to the bolt head contact area. Then install and tighten the bolts to 165-175 lb-ft (224-238 Nm) torque. The specified bore diameter is 3.812 inch to 3.813 inch. If the bores do not fall within these limits, the cylinder block must be replaced.

**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. Main bearing cap bolts are especially designed for this purpose and must not be replaced by ordinary bolts.

- (4) Finished and unfinished main bearing caps are available for replacing broken or damaged caps. When fitting a finished replacement 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) 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 as specified. If a main bearing bore is more than .001 inch out of alignment, the block must be replaced.
- (6) Replace loose or damaged dowel pins.
- (7) Replace damaged or broken cylinder head studs. Install and drive a new stud to a height of 4 3/8 inch  $\pm 1/32$  inch at a minimum of 75 lb-ft (102 Nm).
- (8) Examine the tapped bolt holes for the cylinder head or main bearing cap bolts and, if the threads are damaged, "clean-up" the threads or install a helical thread insert. The topped holes may be tapped with a 5/8 inch-11 UNC3B tap. All cylinder head bolt or stud holes must have the threads extending 1.84 inch below the block surface.
- (9) Check the drive pins (which plug vertical oil galleries) in the corners of the block to be sure they are flush with or below the top surface of the block.
- (10) Check the remaining cylinder block surfaces and threaded holes. Check all of the mating surfaces, or mounting pads, for flatness, nicks, and burrs. The flatness of the blower mounting pad must not vary more than .004 inch. Clean-up damaged threads in, tapped holes with a tap or install helical thread inserts, if necessary.
- (11) Install all internal engine components and engine accessories in accordance with paragraph 4-15 through paragraph 3-17.
- (12) Install engine per paragraph 3-15.

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## Section VI. MAINTENANCE OF CLUTCH

### 4-17. CLUTCH REPAIR.

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**This task covers:**

- a. Disassembly                      b. Cleaning, Inspection and Repair                      c. Reassembly
- 

**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)  
Wrench, Torque (Item 71, Appendix B)

**Materials Required:**

Grease, Heavy (Item 10, Appendix C)  
Oil, Engine (Item 8, Appendix C)  
Solvent, Cleaning (Item 4, Appendix C)

**Equipment Conditions:**

Clutch removed (paragraph 3-50).

---

a. Clutch Disassembly. (Refer to figure 4-57).

- (1) Remove two screws (1), inspection hole cover (2), and gasket (3).
- (2) Hold outer end of the flexible grease tube (4) from turning (inside of clutch housing) and remove the flexible tube retaining nut (5).
- (3) Pull the outer end of the flexible grease tube inside of the clutch housing and remove the opposite end from the release sleeve collar. (4) Support the power take-off assembly on wood blocks with the clutch drive shaft in a horizontal position. Then, bend the edge of the lockwasher (7) up off the flat side of the clutch drive shaft nut (6).
- (5) Disengage the clutch with the hand lever and the clutch facings will drop down against the inside face of the clutch housing; however, they cannot be removed at this time.
- (6) Remove retaining rings (8) from the pins (9); then remove the pins from the links (10).
- (7) Install key in keyway of the clutch drive shaft. Attach a chain wrench to the drive shaft to prevent the drive shaft from turning. Then, remove nut (6) and lockwasher (7) from the shaft.

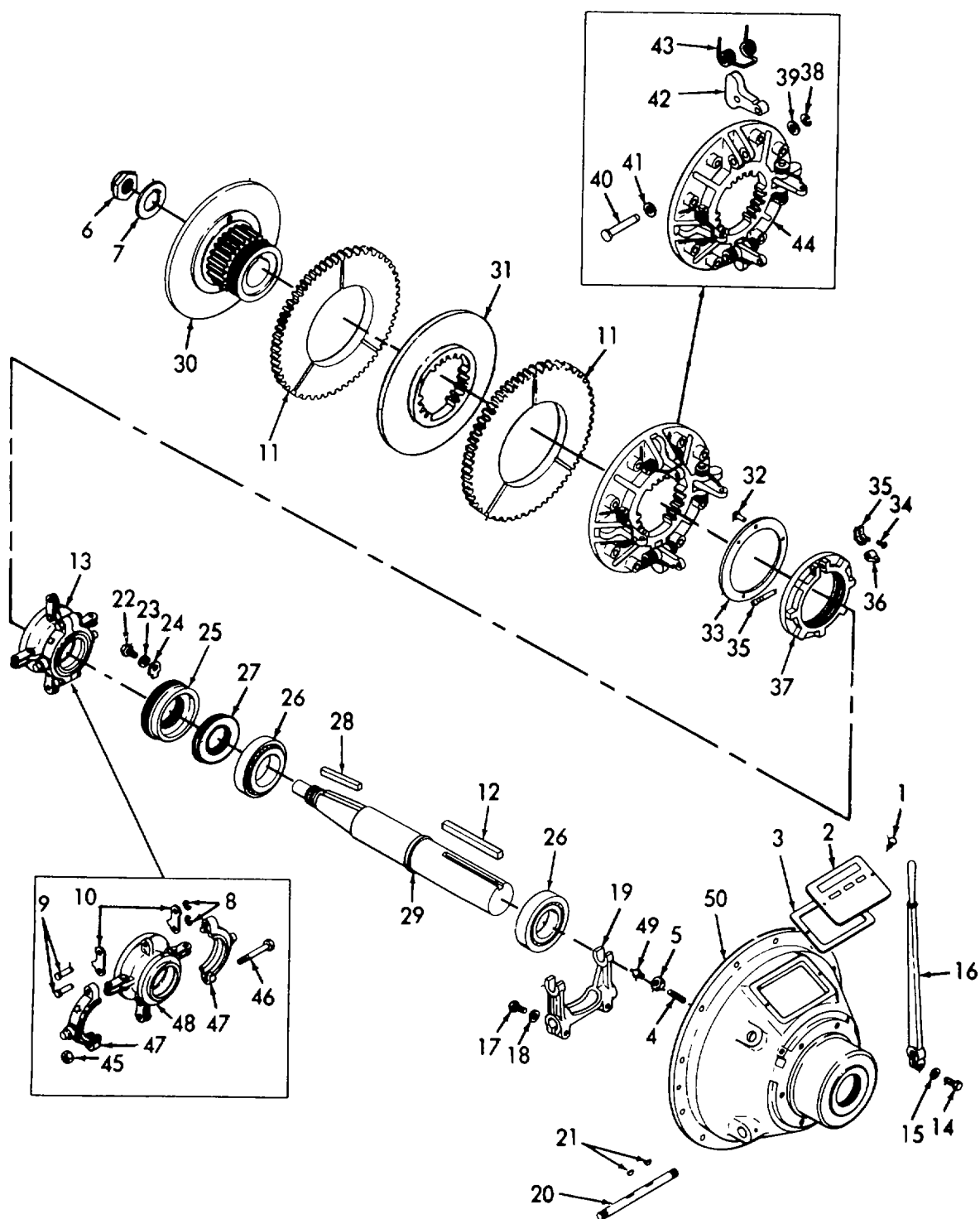
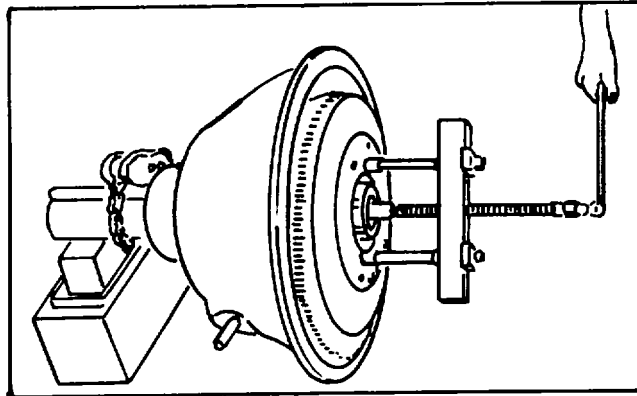


Figure 4-57. Clutch Repair, Disassembly/Reassembly.

**4-17. CLUTCH REPAIR-Continued.****a. Clutch Disassembly-Continued.**

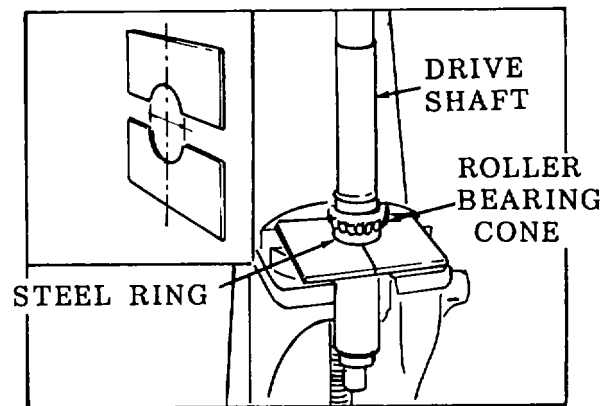
- (8) Attach puller bar J8190, puller legs J8180 and adapters J6471-5 to the forward face of the clutch assembly as shown in figure 4-58. Turn the puller screw to loosen the clutch assembly. Remove the clutch facings (11, figure 4-57) when they clear the clutch housing.



**Figure 4-58. Loosening 14 Inch Diameter Clutch Assembly from Clutch Drive Shaft.**

- (9) Remove the clutch assembly from the clutch drive shaft and place it on a bench with the forward face down.
- (10) Remove the chain wrench and the clutch retaining key (12, figure 4-57) from the clutch drive shaft.
- (11) Slide the clutch release sleeve and release sleeve collar assembly (13) off the clutch drive shaft.
- (12) Remove hand lever attaching bolt (14), lockwasher (15), then slide the hand lever (16) off the shaft.
- (13) Remove two yoke clamping bolts (17) and two lockwashers (18) from clutch release yoke.
- (14) Slide clutch release yoke (19) to the right or left and the clutch release shaft (20) in the opposite direction until the two woodruff keys (21) are free from the yoke.
- (15) Remove two woodruff keys from shaft and withdraw the shaft from the housing and yoke.
- (16) With the clutch assembly removed from the clutch drive shaft, remove the drive shaft from the housing as follows:
- (a) Remove bearing retainer lock plate bolt (22), lockwasher (23), and bearing retainer lock plate (24) from inside clutch housing.

- (b) Remove bearing retainer (25) from clutch housing by turning retainer counterclockwise.
  - (c) Pull clutch drive shaft and roller bearing cones (26) and one bearing cup (27) from the clutch housing. If bearing cones or cup tend to stick in housing, tap on the outer end of clutch drive shaft (29) lightly with a plastic hammer to loosen the bearing cup. Remove key (28) from shaft (29).
  - (d) The bearing cup of the rear roller bearing cone will remain in the clutch housing when the clutch drive shaft is removed. It may be removed by inserting a punch in the holes provided at the rear of the clutch housing and tapping the punch alternately at the three points. Do not cock the bearing cup when removing it.
- (17) Remove the bearing cones from the clutch drive shaft as follows:
- (a) Place two split plates (see insert in figure 4-60) between the bearing cones; then, support the clutch drive shaft and split plates on two steel supports on the bed of the arbor press, as shown in figure 4-59.



**Figure 4-59. Supports on the Bed of Arbor Press.**

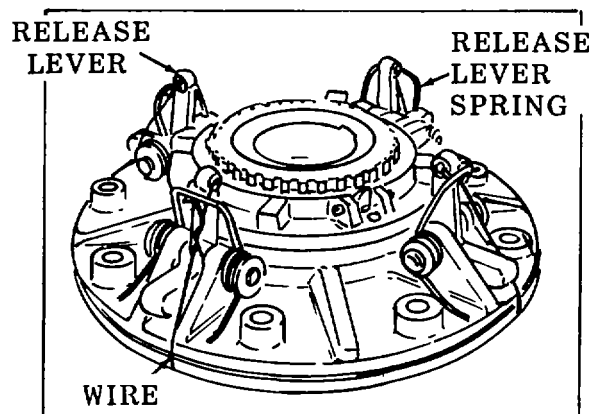
- (b) Place wood blocks under the lower end of the clutch drive shaft to prevent the shaft from falling and being damaged when it is pressed from the bearing.
- (c) With the ram of the press resting on the end of the drive shaft, press the shaft out of the roller bearing cone.

#### **CAUTION**

If the roller bearing inner race was not removed, place a short brass bar between the end of the drive shaft and the ram of the press to prevent damage to the end of the roller bearing inner race.

**4-17. CLUTCH REPAIR-Continued.****a. Clutch Disassembly-Continued.**

- (d) Reverse the clutch drive shaft on the bed of the press and remove the second bearing in the same manner.
- (18) With the clutch assembly removed from the clutch drive shaft, proceed with the disassembly of the clutch as follows:
  - (a) Refer to figure 4-60 and hold the clutch release levers away from the clutch adjusting ring with wire.

**Figure 4-60. Clutch Release Levers.**

- (b) Raise the end of the clutch adjusting ring lockup out of the groove in the hub of the outer clutch pressure plate. Then, remove the clutch adjusting ring by turning it counterclockwise off the hub of the outer clutch pressure plate.
- (c) Remove the wire from the clutch release levers.
- (d) Separate the outer clutch pressure plate (30, figure 3-58), and center clutch pressure plate (31) from the assembly.
- (e) Remove screws (32) and separate the adjusting ring lock plate (33) from the adjusting ring.
- (f) Remove screw (34), adjusting ring lock (35), and adjusting ring lock spring (36) front clutch adjusting ring (37).
- (g) Remove retaining rings (38), plain washers (39), pins (40), and plain washers (41). Remove clutch release levers (42) and springs (43) from the inner clutch pressure plate (44).

- (19) Matchmark both halves of the release sleeve collar (47) to assure that they will be assembled in the same position.
- (20) Remove two nuts (45) from bolts (46) securing the two halves of the collar (47) together, then remove the collar from the release sleeve (48). Remove lubrication fitting (49).

b. Cleaning, Inspection, and Repair.

- (1) Wash all of the power take-off parts (except the clutch facings or shielded bearings) in cleaning solvent (item 4, Appendix C), then dry them with compressed air.

**WARNING**

- Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.
  - Use the recommended air pressure (under 35 psi line 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 personnel injury.
- (2) Examine the ball and roller bearings for corrosion and pitting. Lubricate each bearing with light engine oil (item 8, Appendix C); then, while holding the inner race or cone from turning, revolve the outer race or cup slowly by hand and check for rough spots.
  - (3) Examine clutch facing for wear, burning, or scoring. Also, check the teeth for wear or damage. Replace clutch facing if the teeth are worn or damaged, or if the facing is badly burned or worn.
  - (4) Inspect the friction surfaces of the inner, center, and outer clutch pressure plates for being flat, smooth, and free from cracks or heat checks. Also, examine the drive bosses, the keyway in the outer pressure plate, the adjusting ring threads, and the notches in the inner pressure plate.
  - (5) Examine all of the release levers, link pins and pin holes in the links, release levers, release sleeve, and pressure plate for wear.
  - (6) Inspect the clutch adjusting ring wear plate and threads for wear. If the wear plate is worn excessively, reverse the plate. If both sides of the plate are worn excessively, replace the plate.
  - (7) Examine the wear surface of the clutch release sleeve collar and the mating surface on the release sleeve for wear and scoring.
  - (8) Inspect the mating surface of the clutch release yoke fingers and mating trunnions on the release sleeve collar for wear.

**4-17. CLUTCH REPAIR-Continued.****b. Cleaning, Inspection, and Repair-Continued.**

- (9) Inspect the keyways in the clutch drive shaft and if the shaft is excessively peened or damaged so that the keys have a tendency to "roll", the shaft must be replaced.
- (10) Check for weak or broken pressure plate separator springs.

**c. Reassembly.**

- (1) Place the inner clutch pressure plate (44, figure 4-57) on a bench. Be careful to avoid damage to the finished face of the pressure plate.
- (2) Attach clutch release levers to the inner clutch pressure plate as follows:
  - (a) Place a clutch release lever spring (43) over one of the lever bosses on the inner pressure plate with the open ends of the spring against the outside face of the pressure plate.
  - (b) Place a clutch release lever (42) in the slot in the boss with the end of the lever under the closed end of the spring.
  - (c) Place a plain washer (41) over one of the lever pins (40). Insert the pin through the spring, lever boss, and lever. Secure the pin in place with washer (39) and retaining ring (38).
  - (d) Install the three remaining clutch lever springs and levers in the same manner.
- (3) Place the outer pressure plate (30) on a bench with the hub end of the pressure plate up.
- (4) Place the center clutch pressure plate (31) over the hub of the outer pressure plate with the teeth of the center plate in mesh with the splined grooves in the hub of the outer plate.
- (5) Place the assembled inner clutch pressure plate, inner face down, over the hub of the outer clutch pressure plate with the teeth of the inner plate in mesh with the splined grooves of the outer plate.
- (6) Install the clutch adjusting ring (37) as follows:
  - (a) Attach the adjusting ring wear plate (33) to the clutch adjusting ring (37) with screws (32).
  - (b) Attach the adjusting ring lock (35) and adjusting ring lock spring (36) to the adjusting ring with screw (34).
  - (c) Hold the levers of the inner clutch pressure plate away from the hub of the outer clutch pressure plate with wire.

- (d) Lubricate the threads of the clutch adjusting ring lightly with engine oil; then thread the adjusting ring on the hub of the outer pressure plate until the top of the ring is flush with the top of the outer plate hub.
- (e) Remove the wires holding the clutch release levers.
- (7) Lubricate the inside diameter of the clutch release sleeve collar (47) sparingly. Note the matchmarks previously placed on the collar, then place the two halves of the collar over the shoulder on the clutch release sleeve (48) and secure it in place with bolts (46) and nuts (45). Rotate the collar on the sleeve to be sure it rotates freely. If necessary, loosen the retaining bolt nuts and tap the edge of the collar lightly with a plastic hammer to free it up. Retighten the bolt nuts.
- (8) Note the position of the stop on the clutch release lever links. Then, attach a pair of the release lever links (10) to each ear on the clutch release sleeve with link pins (9) and retaining rings (8).

#### NOTE

Be sure the retaining rings (8) are securely locked in the groove in the link pins (9).

- (9) Place the assembled clutch release sleeve on top of the clutch pressure plates with each pair of release lever links (10) astride the release levers (42). Connect the lever links to the levers with pins (9) and retaining rings (8). Be sure the retaining rings are securely locked in the groove in the link pins.
- (10) Insert two sets of clutch facings (11) (three segments) in between the pressure plates and center, with the teeth of both sets of clutch facings in alignment.
- (11) Lock the clutch facings between the pressure plates as follows:
  - (a) With the clutch assembly resting on the bench, forward face down, turn the clutch adjusting ring clockwise until the inner pressure plate almost contacts the clutch facing.
  - (b) Place the clutch driving ring (3) over the clutch facing with the teeth in the driving ring in mesh with the teeth on the clutch facing. Position the driving ring centrally relative to the pressure plates.

#### NOTE

If the driving ring is not positioned centrally relative to the pressure plates, the clutch cannot be assembled to the flywheel because the teeth of the clutch facing will not enter the teeth of the driving ring even though the clutch drive shaft enters the pilot bearing.

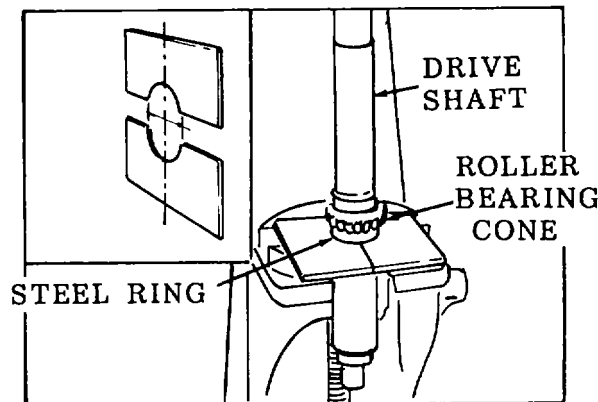
**4-17. CLUTCH REPAIR-Continued.****c. Reassembly-Continued.**

- (c) Lock the clutch facing between the pressure plates by applying pressure on the outer end of the clutch release sleeve and collar assembly. If the clutch facing is still free to move, disengage the clutch and turn the adjusting ring clockwise just enough to lock the clutch facing in place when the clutch is engaged.

**NOTE**

The clutch must now be kept engaged until the power take-off is attached to the engine.

- (d) Remove the clutch driving ring from the clutch facing.
- (12) Install the roller bearing cones on the drive shaft as follows:
- (a) Lubricate the inside diameter of the roller bearing cone (26, figure 4-57) with engine oil; then start the bearing cone straight on the drive shaft (29) with the wide face of the race facing the shoulder on the drive shaft. Install key (28).
- (b) Place a steel ring approximately 1/4 inch thick over the end of the shaft and rest it on the inner race of the bearing cone (figure 4-61).



**Figure 4-61. Placing Steel Ring Over End of the Shaft.**

- (c) Make sure the steel ring bears against the inner race of the bearing cone. Do not allow any pressure to be applied against the roller bearing cage or the bearing cone will be damaged.

- (d) Support the clutch drive shaft, bearing cone, and steel ring on the bed of an arbor press with the split plates under the steel ring as shown in figure 4-61. Press the drive shaft straight into the bearing cone until the inner race is tight against the shoulder on the shaft.
  - (e) Install the second roller bearing cone on the clutch drive shaft in the same manner.
- (13) With the roller bearing cones installed on the clutch drive shaft install it in the clutch housing as follows:
- (a) Support the clutch housing on a wood block with the forward (bell) side of the housing up.
  - (b) Lubricate the outside diameter of the rear roller bearing cup with engine oil (item 8, Appendix C); then start it straight into the bearing bore in the clutch housing with the tapered inner diameter of the cup facing up.
  - (c) Place a (1 inch O.D. x 15 inch long) hard wood block on the top edge of the bearing cup, then use a hammer to tap the bearing cup down in the clutch housing by tapping alternately at several places.
  - (d) Support the clutch housing on wood blocks in a horizontal position.
  - (e) Lubricate the roller bearing cones with light engine oil (item 8, Appendix C); then insert the outer end of the clutch drive shaft through the bearing bore from the forward side of the housing until the bearing cone contacts the bearing cup.
  - (f) Lubricate the outside diameter of the front roller bearing cup with light engine oil (item 8, Appendix C). Place the cup over the forward end of the clutch drive shaft with the tapered inner diameter of the cup facing the bearing cone.
  - (g) Start the roller bearing cup straight in the bearing bore of the clutch housing. Tap the cup in against the rollers of the bearing cone by tapping alternately around the cup with a hard wood block and hammer.
  - (h) Lubricate the threads of the roller bearing retainer (25, figure 4-57) with light engine oil (item 8, Appendix C). Place the retainer over the forward end of the drive shaft with the notches in the end of the retainer facing the forward end of the shaft.
  - (i) Thread the bearing retainer into the bearing bore until it is against the bearing cup. Tighten the bearing retainer while rotating the drive shaft until the bearing retainer is tight and the bearing cups are seated. When the bearing cups are seated it will be noted by the increased effort required to rotate the drive shaft.

**4-17. CLUTCH REPAIR-Continued.**c. Reassembly-Continued.

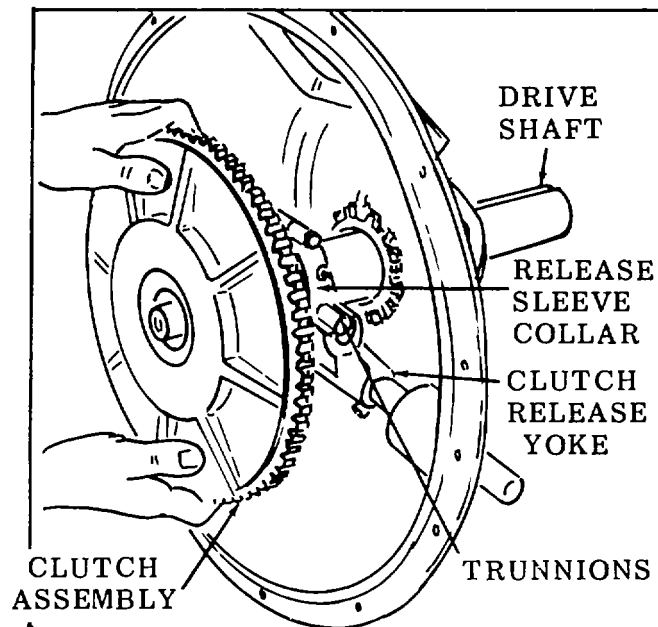
- (j) Back the bearing retainer out two or three notches.
  - (k) Support the clutch housing and shaft assembly on wood blocks with the outer end of the clutch drive shaft up. Tap on the outer end of the drive shaft with a plastic hammer to force the roller bearing cup down until the bearing cup seats on the bearing retainer.
- (14) Support the clutch housing and drive shaft assembly on wood blocks in a horizontal position.
- (15) Install the grease fitting (49, figure 4-57) above the bearing in the clutch housing. Refer to TM 55-1930-208-10, paragraph 3-1 and fill the bearing cavity with grease (item 10, Appendix C) using a grease gun, until the grease just starts to seep out around the clutch drive shaft at the bearing retainer, or at the rear of the clutch housing.

**NOTE**

Rotate the clutch drive shaft when filling the bearing cavity to be sure the bearing cavity is full of grease.

- (16) With the clutch drive shaft and bearings installed in the clutch housing, install the clutch release shaft and yoke in the housing as follows:
- (a) Squirt engine oil (item 8, Appendix C) in the clutch release shaft holes in the clutch housing.
  - (b) Slide the clutch release shaft (20, figure 4-57) through one of the holes in the side of the clutch housing. Position the clutch release yoke (19) in front of the release shaft inside of the clutch housing, so that the heads of the clamping bolts will face the forward end of the clutch housing. Slide the release shaft through the release yoke and through the hole in the opposite side of the clutch housing.
  - (c) Move the release yoke to one side of the clutch housing to expose the two keyways in the shaft. Then install the two woodruff keys (21) in the shaft.
  - (d) Align the keyways in the release yoke with the woodruff keys in the release shaft; then move the release yoke over the keys until it is centrally located in the clutch housing and each end of the release shaft extends an equal distance outside of the clutch housing.
  - (e) Install two clamp bolts (17, figure 4-57) and lockwashers (18). Tighten the bolts to 30-35 lb-ft (40.9 to 47.8 Nm).

- (17) With the clutch drive shaft, clutch release shaft, and yoke assembled in the housing, install the clutch assembly on the drive shaft as follow s:
- Support clutch housing and drive shaft assembly on wood blocks with the drive shaft in a horizontal position and inspection hole in the clutch housing facing up.
  - Lubricate the inside diameter of the clutch release sleeve with engine oil (item 8, Appendix C). Start the clutch assembly over the tapered end of the clutch drive shaft with the keyway in the hub of the outer pressure plate in line with the keyway in the clutch drive shaft. Position the clutch release sleeve collar so the tapped hole in the side of the collar is in proper relation to the flexible tube hole in the side of the clutch housing, so that the flexible grease tube can be connected at each point; then guide the fingers of the release yoke over the trunnions on the release sleeve collar as shown in figure 4-62.



**Figure 4-62. Guiding Fingers of Release Yoke over Release Sleeve Collar.**

- Slide the clutch assembly back on the clutch drive shaft until it is tight against the taper on the drive shaft, then insert key (28, figure 4-57) in the keyway and tap it into place with a punch and hammer.
- Place lockwasher (7) on the drive shaft against the outer pressure plate with the tang on the inner diameter of the lockwasher in the keyway in the pressure plate.
- Install clutch drive shaft nut (6).

**4-17. CLUTCH REPAIR-Continued.**c. Reassembly-Continued.

- (f) Install key (12) in the keyway of the clutch drive shaft. Attach a chain wrench to the drive shaft to prevent the drive shaft from turning.
- (g) Tighten the clutch drive shaft nut (6) to 225-230 lb-ft (307-314 Nm).
- (h) Thread the small end of the flexible grease tube (4) in the hole in the side of the clutch release sleeve collar. Insert the opposite end of the tube through the hole in the side of the clutch housing and install the tube retaining nut (5). Tighten the retaining nut while holding the tube nut inside the clutch housing from turning. Install the grease fitting (49) in the tube.
- (i) Attach the inspection hole cover (2) and gaskets (3) to the clutch housing with screws (1).

**4-18. REMOTE VALVE CONTROL.****This task covers:****a. Removal****b. Repair****c. Installation****INITIAL SETUP:**Tools Required:

Tool Kit, General Mechanics (Item 1, Appendix B)

Equipment Conditions:

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

a. Removal. (Refer to figure 4-63).

- (1) Remove nut (1) and handwheel (2).
- (2) Remove two nuts (3), two bolts (4), reach rod (5), pipe (6), and coupling (7).
- (3) Remove two nuts (8), two bolts (9), reach rod (10), and coupling (11).
- (4) Remove nut (12), bolt (13), and swivel (14).
- (5) Remove four nuts (15), four lockwashers (16), two U-bolts (17), and coupling (18).

b. Repair. Repair is limited to replacing defective parts.

c. Installation.

- (1) Refer to figure 4-63 and install coupling (18) and secure with two U-bolts (17), four lockwashers (16), and four nuts (15).
- (2) Install swivel (14) and secure with bolt (13) and nut (12).
- (3) Install reach rod (10), coupling (11) and secure with two bolts (9) and two nuts (8).
- (4) Install coupling (7), pipe (6), reach rod (5) and secure with two bolts (4) and two nuts (3).
- (5) Install handwheel (2) and secure with nut (1).

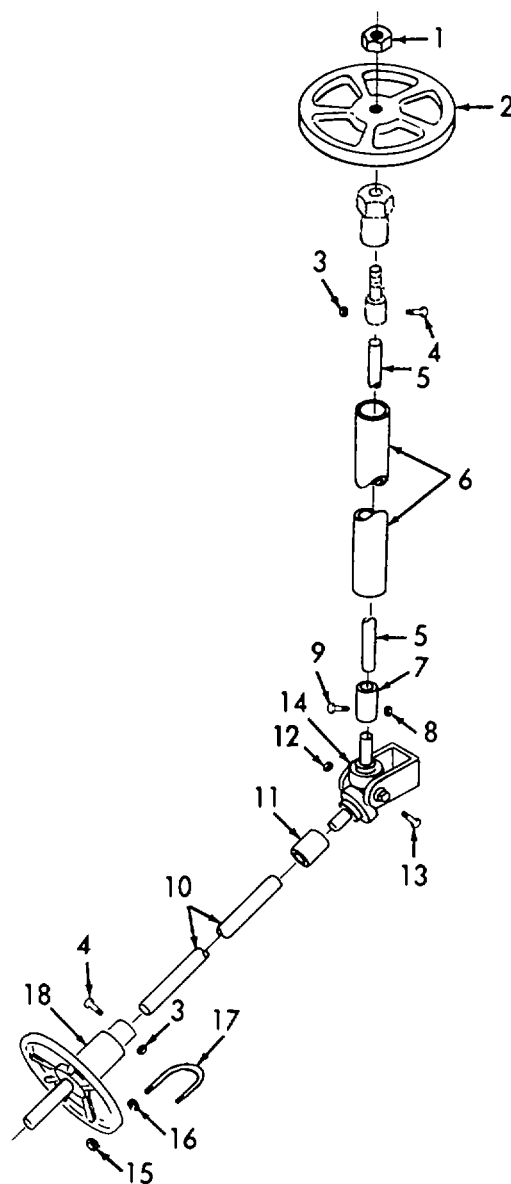


Figure 4-63. Remote Valve Control, Removal/Installation.

**4-19. PIPING, TRANSFER AND VALVES.**

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**This task covers:****a. Removal****b. Repair****c. Installation**

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**INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)

**Equipment Conditions:**Engine shut down (paragraph 2-11, TM 55-1930-208-10).

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**a. Removal.** (Refer to figure 4-64).

- (1) Remove eight nuts (1), eight bolts (2), cover (3), and gasket (4).

**NOTE**

All nuts and bolts used to mount the pipes and valves are the same size. There are 136 nuts and 136 bolts used on this system. Only one nut and bolt will be illustrated and called out in this procedure.

- (2) Remove reducer (5), and gasket (6) and valve (7) and gasket (6). Remove other side of manifold as outlined in steps (1) and (2).

- (3) Remove valve (8) and two gaskets (6).

- (4) Remove two valves (9), four gaskets (6), two expansion joints (10), and two gaskets (6).

**b. Repair.** Repair is limited to replacing defective parts.**c. Installation.**

- (1) Refer to figure 4-64 and install two gaskets (6), two expansion joints (10), four gaskets (6), and two valves (9). Secure with bolts (2) and nuts (1).
- (2) Install two gaskets (6) and valve (8). Secure valve with bolts (1) and nuts (2).
- (3) Install two gaskets (6), two valves (7), two gaskets (6), two reducers (5), two gaskets (4), and two covers (3). Secure all parts with bolts (2) and nuts (1).

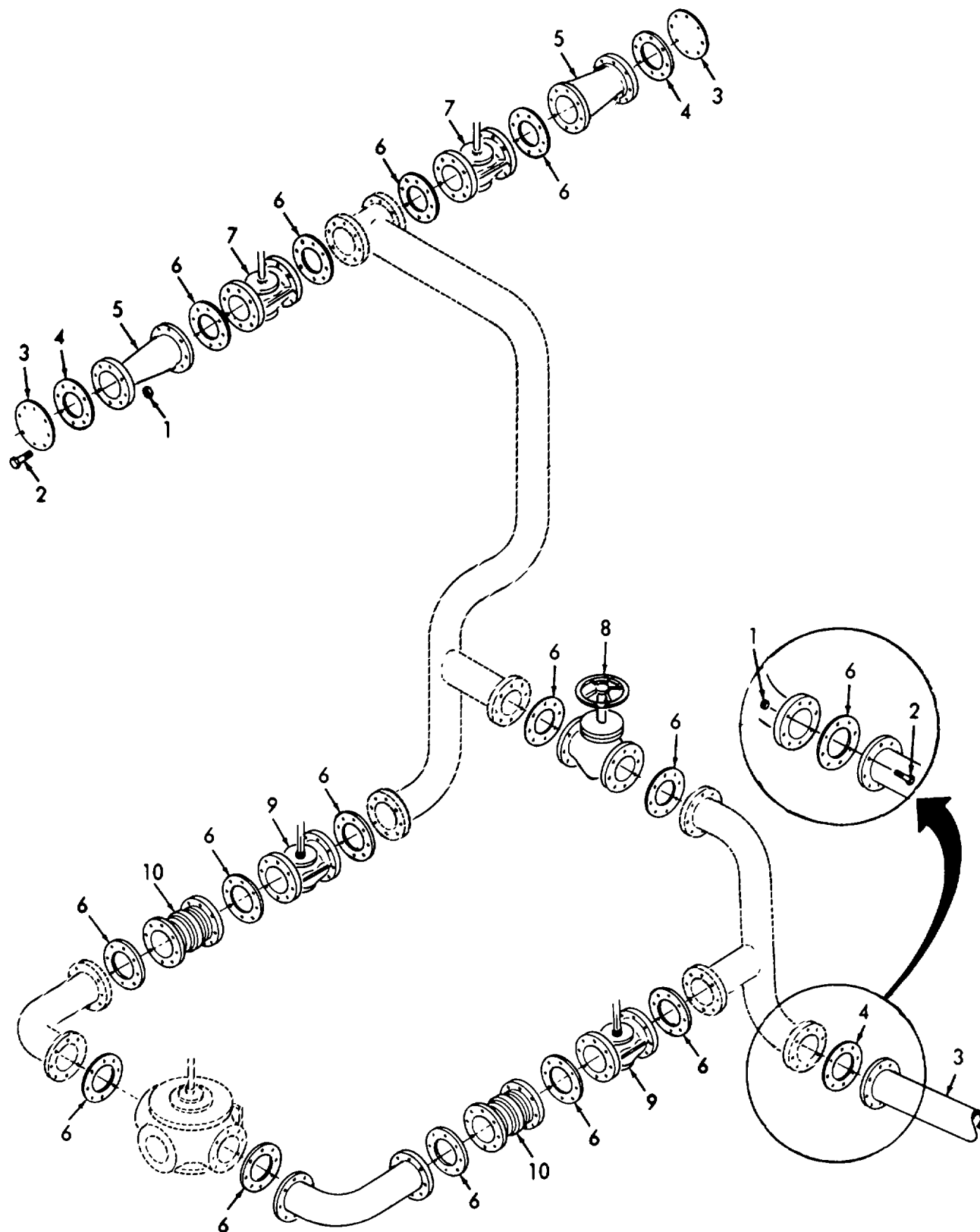


Figure 4-64. Transfer and Valves Piping, Removal/Installation.

**4-20. PIPING, TRANSFER.****This task covers:****a. Removal****b. Repair****c. Installation****INITIAL SETUP:****Tools Required:**

Tool Kit, General Mechanics (Item 1, Appendix B)

**Equipment Conditions:**

Engine shut down (paragraph 2-11, TM 55-1930-208-10).

**a. Removal.** (Refer to figure 4-65).

- (1) Remove nuts (1), bolts (2), six valves (3), and twelve gaskets (4).

**NOTE**

All nuts and bolts used to mount the pipes and valves are the same size. There are 184 nuts and 184 bolts used on this system. Only one nut and bolt will be illustrated and called out in this procedure.

- (2) Remove nuts (1), bolts (2), five expansion joints (5) and ten gaskets (6).

**b. Repair.** Repair is limited to replacing defective parts.**c. Installation.**

- (1) Refer to figure 4-65 and install ten gaskets (6) and five expansion joints (5) and secure with bolts (2) and nuts (1).
- (2) Install twelve gaskets (4) and six valves (3) and secure with bolts (2) and nuts (1).

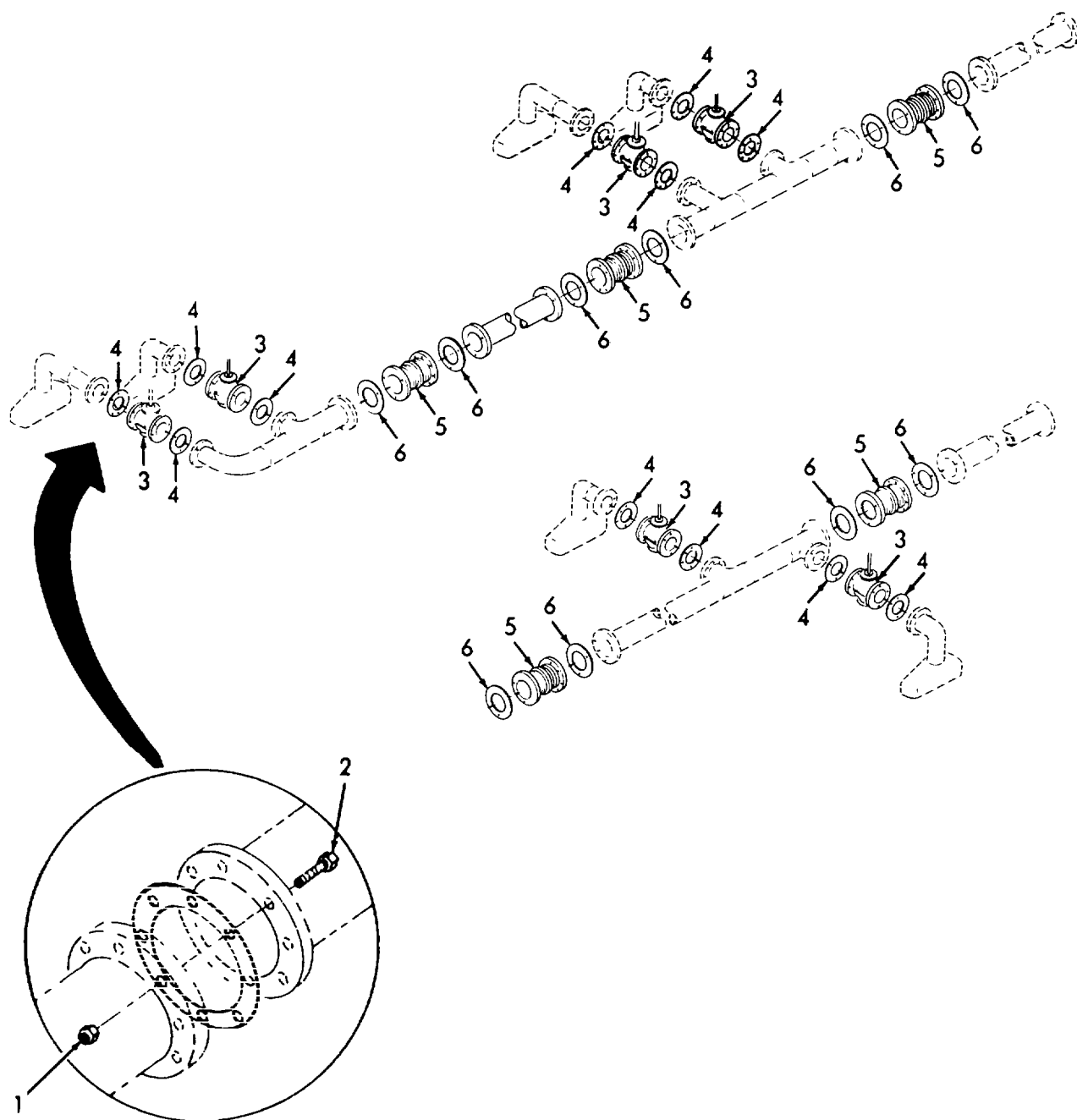


Figure 4-65. Transfer Piping, Removal/Installation.

4-93/(4-94 Blank)

APPENDIX A

REFERENCES

A- 1. SCOPE

This appendix lists all forms, technical manuals, and miscellaneous publications referenced in this manual.

A-2. FORMS.

Preventive Maintenance Schedule and Record.....	DD Form 314
Recommended Changes to Publications and Blank Forms.....	DA Form 2028
Recommended Changes to DA Publications.....	DA Form 2028-2
Equipment Inspection and Maintenance Worksheet.....	DA Form 2404
Maintenance Request.....	DA Form 2407
Maintenance Request (Continuation Sheet).....	DA Form 2407-1
Equipment Log Assembly (Record).....	DA Form 2408
Uncorrected Fault Record.....	DA Foreign 2408-14
Quality Deficiency Report.....	SF Form 368

A-3. TECHNICAL MANUALS.

Administrative Storage.....	TM 740-90-1
Destruction of Army Materiel.....	TM 750-244-3
Painting Instructions for Army Materiel.....	TM 43-0139
The Army Maintenance Management System (TAMMS).....	DA PAM 738-750
Vessel Salvage and Hull Repair.....	TM 55-503
Welding Theory of Application .....	TM 9-237

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## APPENDIX B

### MAINTENANCE ALLOCATION CHART

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#### Section I. INTRODUCTION

##### B-1. GENERAL.

- a. This section provides a general explanation of all maintenance and repair functions authorized at the various maintenance levels.
- b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.
- c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.
- d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

##### B-2. MAINTENANCE FUNCTIONS.

Maintenance functions will be limited to and defined as follows:

- a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., sight, sound, or feel).
- b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.
- c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.
- d. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.
- e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.
- f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

**B-2. MAINTENANCE FUNCTIONS - Continued.**

- g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.
- h. Replace. To remove an unserviceable item and install a serviceable counter- part in its place. "Replace" is authorized by the MAC and is shown as the 3rd position code of the SMR code.
- i. Repair. The application of maintenance services<sup>1</sup>, including fault location troubleshooting<sup>2</sup>, removal/installation, and disassembly/assembly<sup>3</sup> procedures, and maintenance actions<sup>4</sup> to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

**B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.**

- a. Column 1, Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be "00".
- b. Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies and modules for which maintenance is authorized.
- c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in Column 2. (For detailed explanation of these func- tions, see paragraph B-2.)

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<sup>1</sup>Services - inspect, test, service, adjust, align, calibrate, and/or replace.

<sup>2</sup>Fault locate/troubleshoot - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

<sup>3</sup>Disassemble/assemble - encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least component identified as maintenance significant (i.e., assigned an SMR code) for the category of maintenance under consideration.

<sup>4</sup>Actions - welding, grinding, riveting, straightening, facing, remachinery, and/or resurfacing.

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d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

C..... Operator or crew  
 O..... Organizational maintenance  
 F..... Direct Support Maintenance  
 H..... General Support Maintenance  
 D..... Depot Maintenance

e. Column 5, Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. Column 6, Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

#### **B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.**

a. Column 1, Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3, Nomenclature. Name or identification of the tool or test equipment.

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<sup>5</sup>This maintenance category is not included in Section II, column (4) of the Maintenance Allocation Chart. To identify functions to this category of maintenance, enter a work time figure in the "H" column of Section II, column (4), and use an associated reference code in the Remarks column (6). Key the code to Section IV, Remarks, and explain the SRA complete repair application there. The explanatory remark(s) shall reference the specific Repair Parts and Special Tool List (RPSTL) TM which contains additional SRA criteria and the additional spare/repair parts.

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**B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III - Continued.**

- d. Column 4, National Stock Number. The National stock number of the tool or test equipment.
- e. Column 5, Tool Number. The manufacturer's part number.

**B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.**

- a. Column 1, Reference Code. The code recorded in column 6, Section II.
- b. Column 2, Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

## Section II. MAINTENANCE ALLOCATION CHART

FOR  
LIQUID CARGO BARGE  
DESIGN 231C

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
00	BARGE, DECK OR LIQUID CARGO								
01	HULL	Inspect Service Repair	3.0 8.0			50.0			A
	Ullage Assembly	Inspect Replace Repair Service	.5 .5 .8		4.0			1 1	
	Hatches	Replace Service	1.0 1.0					1	
	Valve, Pressure Relief	Replace			1.0			1	
	Screens, Flame	Inspect Service Replace	.1 .2 .2					1	
	Ladders	Replace	4.0					1	
	Engine Shutdown	Inspect Service Test Replace Repair	.1 .2 .1		2.0 2.0			1 1	
02	HOUSE, MACHINERY								
	Frame and Exterior Covering	Inspect Repair	.2			6.0		1	A
	Doors	Inspect Replace Repair Service	1.0   .5			1.5 .5		1 1	A

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
02	HOUSE, MACHINERY - Continued								
		Muffler, Exhaust	Inspect Replace	.1 3.0				1	
		Fan, Exhaust	Inspect Service Replace	.1 .8	1.5			1	
		Tank, Fuel Oil	Inspect Replace Repair Service	.2 4.0 .5	4.0	4.0		1 1	A
03	BOOM, CARGO	Inspect Replace Repair Service	.2 3.5 4.0 .5					1 1	A
04	GEAR, DECK								
		Davit, Anchor	Inspect Replace Repair	.1 1.2 1.5		.1 1.2 1.5		1 1	A
		Pump, Bilge Hand and Piping	Inspect Service Replace Repair	.1 .2	1.0 2.0			1 1	
		Winch, Anchor	Service Inspect Replace Repair	.2 .2		2.0 4.2		1 1	
		Anchor	Inspect Replace	.1 .2					
05	HYDRAULIC START SYSTEM								
		Hand Pump	Replace Repair	.2 1.0				1 1	
		Cranking Motor	Replace Repair	.5	2.0			1 1, 71	

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
05	HYDRAULIC START SYSTEM - Continued								
	Hydraulic Pump and Drive	Replace	.5					1	
		Repair			2.0			1	
	Control Valve	Inspect	.1						
		Replace	.2					1	
	Filter	Inspect	.1						
		Replace	.2					1	
		Repair	.2					1	
	Accumulator	Inspect	.1						
		Replace			1.0			1	
		Repair			1.5			1, 71	
	Reservoir	Inspect	.1						
		Service			.6				
		Replace			.6			1	
	Hoses and Fittings	Inspect	.1						
		Replace	.2					1	
06	ENGINE, DIESEL	Inspect	.2						
		Service	1.5						
		Replace			2.5			1	B
	Controls, Throttle	Replace			2.5			1	B
		Repair			3.0			1	B
	Governor	Repair			4.5			1, 71	B
		Replace			1.0			1	B
		Adjust			1.0				
	Intakes, Air Cleaner Assembly	Replace			1.5			1, 71	B
		Repair			3.0			1	B
	Air Cleaner As- sembly	Inspect	.2						
		Service	.4						
		Replace	1.1						
	Blower	Replace			4.0			1	B
		Repair			5.5			25, 26, 27, 28, 29, 71	B

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
06	ENGINE, DIESEL - Continued								
	Blower Drive	Inspect			.5				
		Replace			2.0			1	
		Repair			3.0			1, 71	
	Pump, Fuel	Replace			1.0			1	B
		Repair			2.5			2, 3, 4, 5, 6, 7, 71	B
	Lines and Fittings, Fuel	Inspect	.5						
		Replace	2.3					1	B
		Repair	2.3						
	Filter Assembly, Fuel/Strainer	Inspect	.2						
		Replace	1.0					1	
	Injector, Fuel	Test			.5			21, 22, 23	B
		Replace			1.5			1	B
		Repair			1.5			8 thru 20, 71	B
	Filter, Lube Oil	Inspect	.2						
		Replace	1.5					1	
	Cooler, Lube Oil	Inspect	.2						
		Replace			1.2			1	B
		Repair			1.0			1	B
	Pump, Fresh Water	Inspect	.1						
		Replace			1.2			1	B
		Repair			2.5			1, 70	B
	Drive, Fan and Belts	Inspect	.1						
		Adjust	.2		.2			1	
		Replace			1.5			1	B
	Radiator	Inspect	.1						
		Test			1.0				B
		Service	.2						
		Replace			2.0			1	B
	Hoses, Water	Repair			3.0				B
		Inspect	.2						
		Replace	.8					1	

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
06	ENGINE, DIESEL - Continued								
	Manifold, Water	Inspect Replace	.2		1.5			1, 71	
	Thermostat	Inspect Replace Test			.2 1.0 .6			1	B B
	Housing	Inspect Replace	.2		.5			1	
	Tachometer	Inspect Replace	.2		1.0			1	B
	Pulley, Crankshaft	Inspect Replace	.2		8.0			1, 52, 71	B
	Cover, Balance Weight	Inspect Replace	.2		2.5			1, 71	B
	Engine Lifting Brackets	Inspect Replace	.4		1.0			1, 71	B
	Manifold, Exhaust	Inspect Replace	.2		2.5			1, 71	B
	Cover, Rocker Arm	Inspect Replace	.1		1.0			1, 71	B
	Controls, Rocker Arm, Injector	Inspect Adjust Replace Repair			.8 1.5 2.5 1.5			1, 71 1	B B B
	Pan, Oil	Inspect Replace	.2		1.0			1, 71	B
	Head, Cylinder	Replace Repair			8.0	8.0		1, 71 30 thru 43	B B
	Valve, Operating Mechanism	Adjust Replace Repair			1.0 3.0 2.5			1, 71 44, 45	B B

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
06	ENGINE, DIESEL - Continued								
	Valves, Intake/Ex- haust Arrangement	Adjust			.5			44, 46	B
		Replace			4.0				B
		Repair			4.0				
	Balance Weight	Inspect			.5			1, 72	
		Replace			1.5				
	Camshaft and Balance Shaft	Replace			18.5			1, 71	B
		Repair			3.0				B
	Idler Gear	Inspect			.5			1, 71	
		Replace			1.0				B
	Flywheel	Inspect			.5			1, 47, 71	
		Replace			5.0				B
		Repair			5.0				B
	Flywheel Housing	Inspect			.2			1, 48, 49, 50	B
		Replace			3.5				B

(MAINTENANCE BASED ON ENGINE HAVING DRIVE COMPONENTS REMOVED FROM FLYWHEEL HOUSING).

06	Valve, Lube Oil Pressure Regulat- ing	Inspect			4.0			1	B
		Replace			5.5				B
	Pump, Lube Oil and Distribution System	Repair			5.0			1, 52, 71	B
		Replace			5.0				B
	Pistons, Connecting Rods and Liners	Replace				10.0		1, 54, 71	B
		Repair				16.0			B
	Rods and Lines							55 thru 68	
	Bearing, Main	Inspect			.5			1, 51	B
		Replace			8.0				B
	Crankshaft	Replace				8.0		1	B
		Repair				1.2			B

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
06	ENGINE, DIESEL - Continued								
	Block, Cylinder	Test Replace Repair				2.0 8.0 16.0		53, 62, 63, 64, 65, 69	B B B
(MAINTENANCE BASED ON BLOCK HAVING ACCESSORIES AND INTERNALS REMOVED).									
	Panel, Instrument	Inspect Replace	.1		1.5			1	B
	Gages	Inspect Service Replace	.1 .2 .8						
	Ether Starting Aid	Replace	.8						
07	PTO/CLUTCH	Inspect Service Adjust Replace Repair	.1 .2		1.0 8.0	8.0		1 1, 71 1, 71	
08	REDUCER, SPEED	Inspect Service Replace Repair	.1 .2		3.0 3.5			1 1, 71	
	Coupling Assembly	Inspect Service Replace Aline	.1 .2		3.0 2.0			1, 71	
	Shaft Assembly	Inspect Service Replace Repair	.1 .2		1.0 1.0			1 1	
09	PUMP, TRANSFER	Inspect Service Replace Repair	.2 .5		16.0 3.0			1 1	

## SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			C	O	F	H	D		
09	PUMP, TRANSFER - Continued								
	Valve, Relief, Pressure	Inspect Test Adjust Replace Repair	.1 .2 .2		1.0 1.5			1 1	
10	LIGHTING	Inspect Repair Replace	.1 .2 .2						
11	PIPING, TRANSFER	Inspect Repair Replace	.2			10.0 8.0			
	Valves, Cargo	Inspect Replace	.1		4.0			1	
	Gages, Pressure and Lines	Inspect Replace	.1		1.4			1	
	Remote Valve Control	Replace Repair				.5 2.5		1 1	
	Piping, Tank	Replace Repair				40.0 10.0		1	

## Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) REFERENCE CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER (NSN)	(5) TOOL NUMBER
1	O, F	Tool Kit, General Mechanic's	5180-00-629-9783	SC 5180- 90-CL-N55
2	F	Tool Set, Fuel Pump	5180-00-219-8407	J1508-E
3	F	Remover, Oil Seal	5120-01-048-1385	J1508-13
4	F	Handle, Oil Seal Insert	5120-00-970-9030	J1508-8
5	F	Adapter, Oil Seal Insert	5120-00-970-9031	J1508-9

## TOOL AND TEST EQUIPMENT REQUIREMENTS (CONTINUATION)

(1) REFERENCE CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER (NSN)	(5) TOOL NUMBER
6	F	Holding Fixture	5120-00-494-1770	J1508-10A
7	F	Fuel System Primer	4910-00-402-9623	J5956
8	F	Socket, Fuel Line Nut	5120-00-019-5232	J8932-01
9	F	Remover, Injector	5120-00-219-8400	J1227-01
10	F	Reamer, Hand	5110-00-294-4606	J5286-9C
11	F	Socket, Injector Nut	5120-00-219-8409	J4983-01
12	F	Driver, Spray Tip	5120-00-355-6167	J1291-02
13	F	Injector Cleaning Pin Vise	5120-00-909-5706	J4298-1
14	F	Injector Tip Reamer	5110-00-219-8399	J1243-01
15	F	Wire, .0052 in. dia.	4901-01-163-7893	J21460-01
16	F	Wire, .0059 in. dia.	5120-00-140-7547	J21461-01
17	F	Stone, Sharpening	5120-01-132-5463	J8170
18	F	Brush, Injector Cleaning	7920-00238-1906	J8152
19	F	Brush, Rack Hole	5120-01-132-5464	J8150
20	F	Reamer, Body	5110-00-937-7628	J21089
21	F	Tester, Fuel Injector	4940-01-148-7876	J23010
22	F	Tester, Fuel Output	4910-01-143-4362	J22410
23	F	Tester, Rack	5210-00-990-3327	J29584
24	F	Reamer	5110-00-019-5240	J4986-01
25	F	Installer, Blower Service	5120-00-936-4376	J6270-F
26	F	Oil Seal Remover	5120-01-048-1388	J6270-3
27	F	Tool Set, Blower Service	5120-01-048-1387	J6270-2
28	F	Installer Seal Ring	5120-00-070-1016	J6270-4
29	F	Pilot, Blower Shaft	5120-00-070-1017	J6270-5
30	H	Remover, Valve Guide	5120-00-473-7392	J267

## TOOL AND TEST EQUIPMENT REQUIREMENTS (CONTINUATION)

(1) REFERENCE CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER (NSN)	(5) TOOL NUMBER
31	H	Tool Valve Seat	5120-00-494-1836	J4824-03
32	H	Injector, Tube Installer	4940-01-199-5441	J5286-4
33	H	Injector, Tube Pilot		J5286-5
34	H	Tool, Pressure Check	4910-01-158-3985	J28454
35	H	Tool, Swaging	5120-01-166-5165	J28611-A
36	H	Die, Flaring	4940-00-711-1920	J5286-6
37	H	Reamer, Hand	5110-01-048-2198	J22525-1
38	H	Injector Tube Cutting Tool		J5286-8
39	H	Injector Tube Nut Seat Reamer		J5286-9
40	H	Installer, Valve Guide	5120-00-706-5588	J4144
41	H	Tool, Installing Valve Seat	5120-00-423-6723	J1736
42	H	Grinder Set, Valve Seat	4910-00-254-5048	J7040
43	H	Adapter Set, Valve Seat	4910-01-238-3959	J8165-8
44	F	Remover, Push Rod	5120-00-494-1843	J3092-01
45	F	Tester, Spring	4940-01-138-8259	J22738-02
46	F	Compressor, Spring	4910-01-157-6166	J7455-7
47	F	Tool, Lift, Flywheel	4910-00-722-3877	J6361-01
48	F	Tool, Oil Seal Installer	4940-00-671-4483	J3154-04
49	H	Stud, Flywheel Aligning	5120-00-629-9781	J1927-01
50	H	Expander, Oil Seal	5120-00-443-2508	J22425-A
51	H	Micrometer Ball Attach- ment	5210-00-494-1738	J4757
52	H	Puller, Gear	5180-00-99-4053	J2174
53	H	Master Ring Set Gage	5210-00-987-7631	J8386-01

## TOOL AND TEST EQUIPMENT REQUIREMENTS (CONTINUATION)

(1) REFERENCE CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER (NSN)	(5) TOOL NUMBER
54	H	Piston Ring Remover and Installer	5120-00-494-1846	J8128
55	H	Seal Ring Compressor	5120-00-127-7662	J23453
56	H	Piston Pin Leak Detector	5210-01-061-4253	J23987-01
57	H	Feeler Gage Set	5210-00-116-1631	J5438-01
58	H	Fire Ring Groove Gage	5220-01-028-1109	J24599
59	H	Piston Disassembly Tool	5120-01-254-1489	J33048
60	H	Reamer Connecting Rod Bolt Hole	5120-01-232-0006	J28460
61	H	Cylinder Liner Remover Set	5120-00-387-9615	J1918-02
62	H	Cylinder Hone Set	5130-00-629-9782	J5902-01
63	H	Stones and Wipers	5130-00-937-7280	J5902-14
64	H	Cylinder Dial Bore Gage	5210-01-070-4543	J5347-B
65	H	Master Ring Gage Size 4.2500	5210-00-937-7282	J5580-1
66	H	Setting Master Range	5120-00-367-7378	J23059-01
67	H	Piston Ring Compressor Size 4.250	5120-00-859-6259	J3272-03
68	H	Cylinder Liner Hold-Down Clamp	5120-00-999-8618	J21793-01
69	H	Cylinder Liner Depth Gage ting Fixture	5210-00-023-4798	J22273
70	F	Drive Coupling Removal Tool		J1930
71	H	Wrench, Torque	5120-00-640-6364	

## SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	TM 55-503, Marine Salvage and Hull Repair. Also TM 9-237, Welding Theory and Application. Manuals to be referenced as an additional source.
B	General Mechanic Tool Kit to be used at all maintenance levels for any maintenance function.

## APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

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## Section I. INTRODUCTION

**C-1. SCOPE.**

This appendix lists expendable/durable supplies and materials you will need to operate and maintain the Liquid Cargo Barge. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

**C-2. EXPLANATION OF COLUMNS.**

a. Column 1 - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, item 5, App. C").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew

O - Organizational Maintenance

F - Direct Support Maintenance

H - General Support Maintenance

c. Column 3 National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column 4 Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column 5 Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

## SECTION II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	F	8040-00-273-8717	Adhesive, Scotch Grip, No. 4300 (76381) EC1357	pt
2	F	7930-01-107-2551	Alkaline Solution (44389) OAK1TE31	gal
3	F	9150-01-086-4166	Cindol, 1705 (73277) CINDOL	gal
4	F,H	6850-00-264-9038	Cleaning Solvent (81348) P-D-680	gal
5	H	5350-00-192-5066	Crocus Cloth (81348) P-C-458	sh
6	H	9150-00-825-9161	Cutting Oil (77247) 22F	gal
7	H	5350-00-071-5950	Emery Cloth (81348) P-C-541	sh
8	F,H	9150-00-186-6681	Engine Oil (81348) MIL-L-2104	gal
9	F,H	9140-01-686-903	Fuel Oil (81348) VVF815GRADEFS2-6	gal
10	H	9150-00-190-0907	Heavy Grease (81349) MIL-G-0010924E-5	cn
11	H	9150-00-445-7819	Light Grease (81349) B46886-I	cn
12	F,H	9150-01-152-4117	Lubricating Oil (81349) MIL-L-2104	qt
13	H	8030-00-616-7694	International Compound, No. 2 (81348) MIL-T-83683	lb
14	H	8020-00-559-0389	Medium Bristle Brush (81348) H-B-491	ea
15	H		Micro Bead Glass Shot, MS-M	lb
16	H	6810-00-270-8177	Sodium Hydroxide (81349) MIL-H-13528	dr
17	H	5350-00-192-5051	Number 00 Grit Abrasive Paper (81348) P-C-451	sh
18	H	8010-00-161-7419	Primer Coating (81348) P/N 00690	dr
19	H	8030-00-251-5048	Permatex No. 3 (81349) MIL-C-10382	tb
20	H	6810-00-174-6581	Pickling Acid (58536) A-A-895	dr
21	H	8030-01-076-0911	Sealant (83574) PR1436G-A2	tb
22	H	8030-00-874-5875	Sealing Compound (71984) DC4 Compound	tb

## EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST (CONTINUED)

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
23	H	8305-00-267-3015	Chesse Cloth (81348) CCC-C-440	rl
24	H	7920-00-205-1711	Rag, Wiping; 50 lb bale (81348) DDD-R-30	bx
25	H	6230-00-264-8261	Flashlight, 2-Cell (21108) MX981	ea
26	H	6135-00-930-0030	Battery, Dry; Flashlight (80057) BA3030U	ea
27	H	7920-00-291-5815	Brush, Wire (81348) H-B-178	ea
28	H	4240-00-174-1365	Canister, OBA (55799) 92908	ea
29	H	6545-00-922-1200	First Aid Kit (21108) MX-981/U	ea
30	H	8030-00-889-3534	Tape, Antisieze (81349) MIL-T-22730	rl
31	H	8030-00-616-7694	Thread Sealant (81349) MIL-T-83483	lb
32	H	6140-01-025-6052	Battery, Running Light (28763) 4065-0101	ea
33	H		Lamp, Running Light (28763) 4060-0085	ea
34	F	8415-01-092-0039	Gloves, Asbestos	ea

C-3/(C-4 Blank)

## APPENDIX D

## STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

THREAD SIZE	260M BOLTS TORQUE		THREAD SIZE	280 M OR BETTER TORQUE	
	(lb-ft)	Nm		(lb-ft)	Nm
1/4 - 20	5 - 7	7 - 9	1/4 - 20	7 - 9	10 - 12
1/4 - 28	6 - 8	8 - 11	1/4 - 28	8 - 10	11 - 14
5/16 - 18	10 - 13	14 - 18	5/16 - 18	13 - 17	18 - 23
5/16 - 24	11 - 14	15 - 19	5/16 - 24	15 - 19	20 - 26
3/8 - 16	23 - 26	31 - 35	3/8 - 16	30 - 35	41 - 47
3/8 - 24	26 - 29	35 - 40	3/8 - 24	35 - 39	47 - 53
7/16 - 14	35 - 38	47 - 51	7/16 - 14	46 - 50	62 - 68
7/16 - 20	43 - 46	58 - 62	7/16 - 20	57 - 61	77 - 83
1/2 - 13	53 - 56	72 - 76	1/2 - 13	71 - 75	96 - 102
1/2 - 20	62 - 70	84 - 95	1/2 - 20	83 - 93	113 - 126
9/16 - 12	68 - 75	92 - 102	9/16 - 12	90 - 100	122 - 136
9/16 - 18	80 - 88	109 - 119	9/16 - 18	107 - 117	146 - 159
5/8 - 11	103 - 110	140 - 149	5/8 - 11	137 - 147	186 - 200
5/8 - 18	126 - 134	171 - 181	5/8 - 18	168 - 178	228 - 242
3/4 - 10	180 - 188	244 - 254	3/4 - 10	240 - 250	325 - 339
3/4 - 16	218 - 225	295 - 305	3/4 - 16	290 - 300	393 - 407
7/8 - 9	308 - 315	417 - 427	7/8 - 9	410 - 420	556 - 569
7/8 - 14	356 - 364	483 - 494	7/8 - 14	475 - 485	644 - 657
1 - 8	435 - 443	590 - 600	1 - 8	580 - 590	786 - 800
1 - 14	514 - 521	697 - 705	1 - 14	685 - 695	928 - 942

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

Grade Identification Marking on Bolt Head	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None	1	No. 6 thru 1 1/2	60,000
None	2	No. 6 thru 3/4 over 3/4 to 1 1/2	74,000 60,000
⌢ Bolts and Screws	5	No. 6 thru 1 over 1 to 1 1/2	120,000 105,000
⌢ Hex Head Sems Only	5.1	No. 6 thru 3/8	120,000
⌢ Bolts and Screws	7	1/4 thru 1 1/2	133,000
⌢ Bolts and Screws	8	1/4 thru 1 1/2	150,000
⌢ Bolts and Screws	None	No. 6 thru 1 1/2	55,000

BOLT IDENTIFICATION CHART

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By Order of the Secretary of the Army:

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PAGE NO.	PARA- GRAPH	FIGURE NO.	TABLE NO.					
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# The Metric System and Equivalents

## Linear Measure

1 centimeter = 10 millimeters = .39 inch  
 1 decimeter = 10 centimeters = 3.94 inches  
 1 meter = 10 decimeters = 39.37 inches  
 1 dekameter = 10 meters = 32.8 feet  
 1 hectometer = 10 dekameters = 328.08 feet  
 1 kilometer = 10 hectometers = 3,280.8 feet

## Weights

1 centigram = 10 milligrams = .15 grain  
 1 decigram = 10 centigrams = 1.54 grains  
 1 gram = 10 decigrams = .035 ounce  
 1 decagram = 10 grams = .35 ounce  
 1 hectogram = 10 decagrams = 3.52 ounces  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

## Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

## Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

## Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch  
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches  
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

## Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
----	------------------------	----------------------------	---------------------	----



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