



TM 5-3810-305-24

TECHNICAL MANUAL

UNIT, DIRECT SUPPORT, AND GENERAL SUPPORT
MAINTENANCE

FOR

CRANE, WHEEL MOUNTED,
HYDRAULIC, LIGHT, 7 1/2 TON
(ROUGH TERRAIN CRANE)

MODEL LRT 110

CONSISTS OF:

Type I General Purpose
(3810-01-165-0646)

Type II Airborne/Airmobile
(3810-01-165-0647)

This technical manual is an authentication of the manufacturers commercial literature and does not conform with the format and content specified in AR 25-30, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

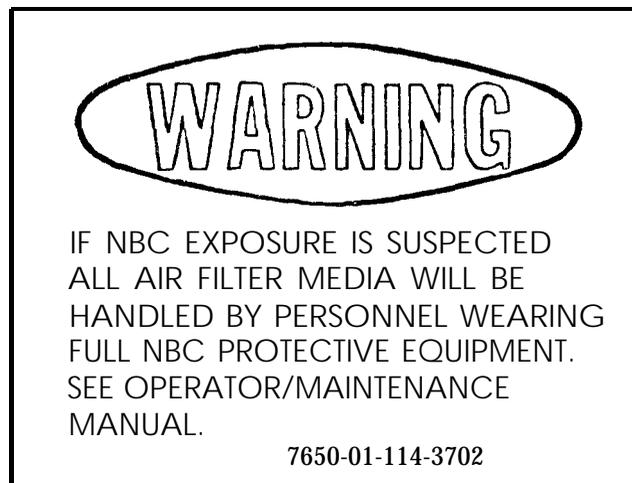
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HEADQUARTERS, DEPARTMENT OF THE ARMY 3 DECEMBER 1991

1. Purpose. This is to alert operators, organizational, direct and general support to the safety hazards involving handling of automotive air filters under Nuclear, Biological and Chemical conditions (NBC).

2. Procedures.

a. If NBC exposure is suspected, all air filters should be handled by personnel wearing protective equipment. Consult your NBC Officer or NBC NCO for appropriate handling or disposal procedures.



b. Position decal in a noticeable place on or near air filter housing. Mounting of this decal is mandatory. Order decal using P/N 12296626, CAGE 19207, NSN 7690-01-114-3702.

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**HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., 3 December 1991**

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CONSISTS OF:
TYPE I GENERAL PURPOSE
(3810-01 -1 65-0646)

TYPE II AIRBORNE/AIRMOBILE
(3810-01-165-0647)

REPORTING OF ERRORS

You can help improve this manual. If you find any mistakes or if you know of away 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 Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

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CHAPTER 1
INTRODUCTION

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The purpose of this manual is to familiarize personnel with the LRT 110 Crane and provide the necessary information and data needed for Troubleshooting, Cleaning/Inspection, Testing, Lubrication and Maintenance of all major components.

GENERAL

The LRT 110 Crane is a wheel-mounted, self-contained, two- and four-wheel drive, two- and four-wheel steering crane. A diesel engine powers the LRT 110 Crane, driving through a

powershift transmission with tandem pump hydraulic power for operation of the crane, outriggers, fully revolving upperstructure and steering system (refer to Figures 1-1 and 1-2).

The LRT 110 Crane design meets all the applicable requirements of OSHA, EPA, PCSA Std. #4, ANSI B30.5 and the specified SAE Standards.

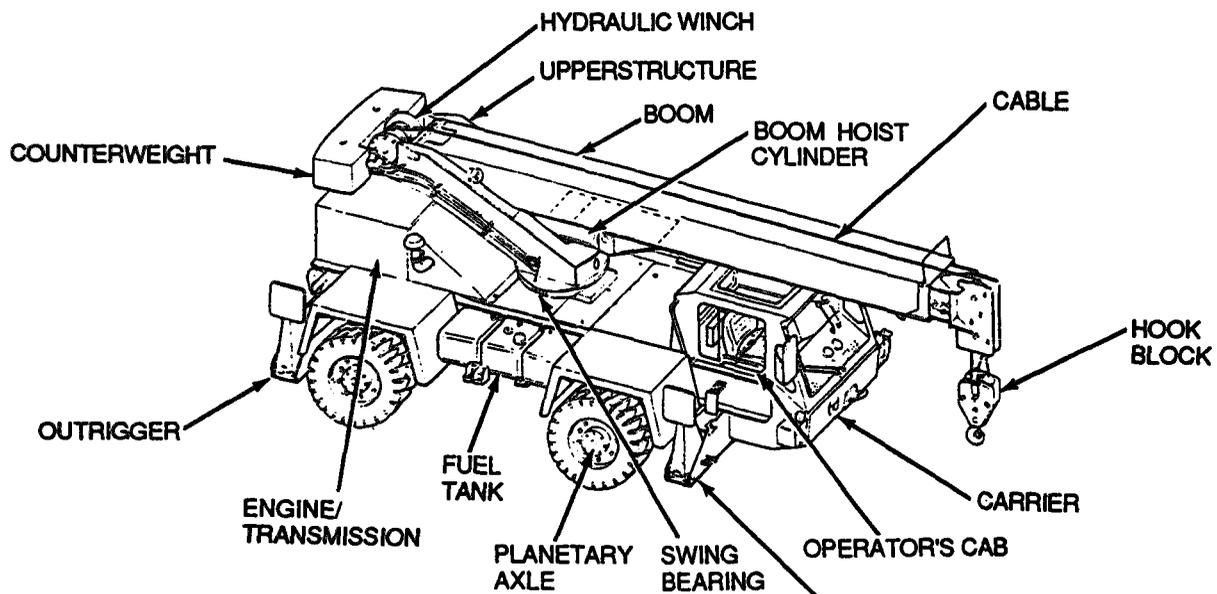


Figure 1-1

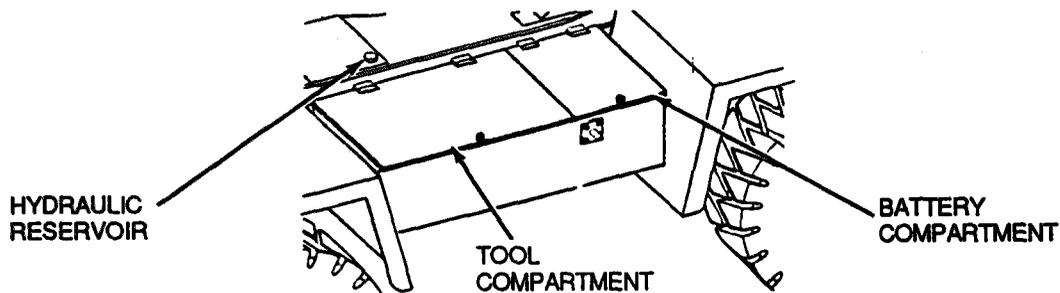


Figure 1-2

MAJOR COMPONENT NOMENCLATURE

NOTE

All directional references in this manual (right or left, front or rear, etc.) correspond to the position of the operator when facing forward in operator's cab.

Upperstructure: The upperstructure includes the counterweight, hydraulic winch and boom hoist cylinder.

Boom Attachment: The boom attachment includes the crane boom, boom extend cylinder and hook block.

Carrier: The carrier includes the frame, engine, transmission, swing bearing, planetary axles, outriggers, operator's cab, fuel tank, hydraulic reservoir, batteries and tool compartment.

Refer to the Koehring Commercial Operation Instructions manual for the following information:

Capabilities
Performance Characteristics
Equipment Specifications
Capacities
Load Rating on Outriggers
Load Rating on Tires
Maximum Permissible Hoist
Line Load
List of Items Required
Storage Data
Tools and Test Equipment
Warranty Information.

SAFETY PRECAUTIONS

INTRODUCTION

The LRT 110 Crane is designed to conform to all applicable SAE, ANSI and OSHA safety requirements.

As a crane operator, your responsibility for safety is not lessened by the operational aids and wining devices provided.

Guard against a fake sense of security. Failure to follow even a single safety precaution can cause **DEATH** or **SERIOUS INJURY**. You are responsible for your own safety as well as others Working around you.

Warning decals are placed conspicuously on the crane warning of hazards including the danger of electrocution if the crane boom or load is swung into power lines.

In addition to this summary list of safety precautions, **WARNINGS**, **CAUTIONS** and **NOTES** appear throughout the manual directly above the procedure to which they apply.

WARNING

indicates a hazard which can result in **DEATH** or serious injury if precautions are not taken.

CAUTION

is a reminder of safety practices or directs attention to unsafe practices that may result in damage to equipment.

NOTE

is a statement containing information that will make the procedure safer or easier to perform.

GENERAL WARNINGS

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause **DEATH** or serious injury.

WARNING

Wear protective gloves when handling hot gear. **SERIOUS INJURY** may result if hot gear contacts skin.

WARNING

Parts are under spring tension. **SERIOUS INJURY** may result from flying parts. Always wear eye protection.

WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

WARNING

Keep fingers from between belt and pulley. **SERIOUS INJURY** may result if tensioner slips.

⚠ WARNING

Keep your body clear of test spray. Fluid can be injected into the bloodstream causing blood poisoning and possible DEATH or serious injury.

⚠ WARNING

Keep all personnel away from winch and hook block area. Failure to follow this procedure could cause DEATH or serious injury.

⚠ WARNING

Heating nut to a temperature of approximately 300 degrees F (149 degrees C) maybe required to break down Loctite. Wear protective equipment while heating and handling parts. Failure to follow this procedure could cause SERIOUS INJURY.

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause SERIOUS INJURY.

⚠ WARNING

- Battery gases can explode. Do not smoke or allow sparks or open flames near batteries. Wear safety glasses or goggles when checking the batteries. Failure to follow this procedure could cause DEATH or serious injury.
- Sulfuric acid contained in batteries can cause serious burns. If battery corrosion or electrolyte makes contact, take immediate action to stop the burning effects:

EYES: Flush eyes with cold water for no less than 15 minutes and seek medical attention immediately.

SKIN: Flush with large amounts of cold water until all acid is removed. Seek medical attention as required.

INTERNAL: If corrosion or electrolyte is ingested, drink large amounts of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Seek medical attention immediately.

CLOTHING/EQUIPMENT: Wash area with large amounts of cold water. Neutralize acid with baking soda or household ammonia.

Failure to follow this procedure could cause DEATH or serious injury.

⚠ WARNING

Water is hot. Do not place hands in container. Failure to follow this procedure could cause **SERIOUS INJURY**.

⚠ WARNING

Do not let harness go as cable reel will pull harness rapidly. Rapidly moving harness could cause **SERIOUS INJURY** if it hits personnel.

⚠ WARNING

Liquid nitrogen is extremely cold, having a temperature of -320 degrees F (-195 degrees C). Skin contact with liquid nitrogen or with an object cooled by liquid nitrogen will result in **SEVERE INJURY**. Wear protective gloves that will not absorb liquid nitrogen. Excess liquid nitrogen must be disposed of promptly since liquid nitrogen will condense oxygen from the atmosphere. The mixture of liquid nitrogen and liquid oxygen is a powerful oxidizer and may react violently with easily oxidizable substances.

⚠ WARNING

Diesel fuel and other combustible materials are used in operation and maintenance of this equipment. Do not smoke or allow open flames in areas where combustible materials are stored or used. Failure to follow this procedure could cause **DEATH** or serious injury.

⚠ WARNING

Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment goggles or safety glasses, face shield and gloves. Do not breath vapors. Do not use near sparks or open flames and do not smoke while using it. Failure to follow these procedures could cause **DEATH** or serious injury.

⚠ WARNING

Cooling system is pressurized. Use extreme caution and proper protection when removing radiator cap after operating temperature is reached. Steam and hot gases will be escaping through the radiator cap; avoid being burned by these escaping gases. When removing cap, loosen it slowly to the left, then pause a moment. Continue to turn cap until it can be removed. Failure to follow this procedure could cause **SERIOUS INJURY**.

 **WARNING**

- When inflating tires, always make certain tires are properly seated. Improperly seated tires can burst with explosive force. Failure to follow this procedure could cause DEATH or serious injury.

- Do not mix one type of wheel with a different type of tire. Improper resting of these components can cause tire and wheel to fly apart with explosive force. Failure to follow this procedure could cause DEATH or serious injury.

- When deflating tires, always make certain tire is completely deflated before removing from rim. Failure to follow this procedure could cause DEATH or serious injury.

- Always use a safety cage to inflate tire and wheel assembly to avoid DEATH or serious injury from exploding parts.

 **WARNING**

Keep hands out of (component). SERIOUS INJURY may result if component slips.

 **WARNING**

(Component) must be properly supported when lowering to ground. Failure to follow this procedure could cause DEATH or serious injury.

 **WARNING**

Weight of (component) is approximately XX lb (XX kg). Use adequate equipment to lift and support (component). Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

 **WARNING**

The brake linings contain asbestos. Wear a protective breather respirator when performing maintenance on the brake assembly and brake drum.

Care must be taken when cleaning the brake assembly. Clean the assembly as a whole by using a solution of hot soapy water. Go over the assembly 3 times or enough to be sure it is completely clean to prevent the asbestos fibers from being released into the air and circulated in the maintenance area.

Do not use compressed air to dry the brake assembly; let it air dry.

Failure to follow this procedure could cause SERIOUS INJURY.

GENERAL CAUTIONS

In addition to personnel hazards, the mechanic is also responsible for avoiding potential damage to the equipment.

CAUTION

- When installing capscrews, always make certain they are replaced in their proper locations.
- When replacing capscrews or nuts, always use a new capscrew or nut of the same size and strength.
- Do not use standard torque chart values if a specific torque is referenced in the procedure.
- All torque values listed in this manual are dry torques. Dry hardware is defined as hardware as received from supply without any additional lubricants being applied.

Failure to follow these procedures could cause damage to equipment.

CAUTION

Copper sealing washers are not reusable. If a previously tightened connection containing copper sealing washer(s) is loosened, the washer(s) must be replaced before retightening. Failure to follow this procedure could cause damage to equipment.

CAUTION

Do not interchange (components). Reload is factory set. Failure to follow this procedure could cause damage to equipment.

CAUTION

Build up of deposits in coolant passages can cause engine overheating. Excessive deposits can be cleaned in an acid tank, but the cam bushing must be removed first. Failure to follow this procedure could cause damage to equipment.

CAUTION

Do not allow temperature to exceed 250 degrees F (121 degrees C). Failure to follow this procedure could cause damage to equipment.

CAUTION

Use webbing or wire mesh slings to prevent damage of boom. If chain or cables are used, boom corners must be protected. Failure to follow this procedure could cause damage to equipment.

CAUTION

Work should be done in a clean, dust-free area as cleanliness is of the utmost importance when servicing hydraulic equipment. Failure to follow this procedure could cause damage to equipment.

CAUTION

(Component) is serviced only as a complete assembly. Do not discard or lose any parts. Failure to follow this procedure could cause damage to equipment.

CAUTION

Use only clean hydraulic oil to lubricate parts. Failure to follow this procedure could cause damage to equipment.

CAUTION

All parts must be clean before installation to prevent damage to (component).

CAUTION

Use care to avoid damaging surfaces while removing assembly. Failure to follow this procedure could cause damage to equipment.

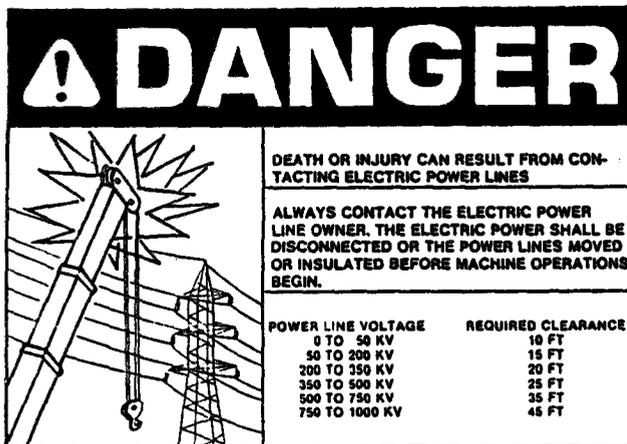
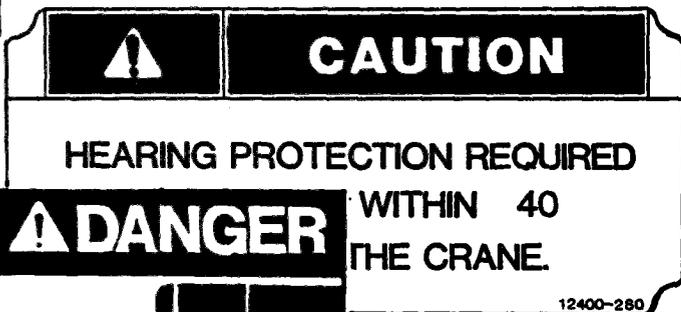
CAUTION

Removal of retainers and bearings may cause destruction of parts. Remove retainers and bearings only if inspection indicates replacement is necessary.

SAFETY DECALS



Read and follow all safety decals. Failure to follow this procedure could cause DEATH or serious injury.



HOW TO USE THIS MANUAL

The Koehring Commercial Maintenance Instructions manual is designed, in conjunction with the Koehring Commercial Operation Instructions manual and the Koehring Commercial Parts Manual, to help the mechanic maintain a LRT 110 Crane.

Maintenance instructions in this manual are divided by Chapter, Section and procedure.

In the first five chapters, general maintenance practices, including cleaning, lubrication, troubleshooting, inspection and performance verification, are discussed.

Chapters 6 through 17 cover maintenance procedures applicable to both the Type I and Type II versions of the LRT 110 Crane.

In Chapter 18, maintenance procedures specific to the Type H version are discussed. Chapter 19 covers preparation instructions for shipment of a LRT 110 Crane and Chapter 20 discusses storage.

An Appendix is included in the back of the manual.

To locate a specific maintenance procedure in the manual, consult the Table of Contents on page i or the Index located at the back of the manual.

CHAPTER 2
CLEANING PROCEDURES

Title	Page
General cleaning	2-1
Electrical cleaning	2-1
Bearing Cleaning	2-2

BEARING CLEANING

WARNING

Dry cleaning solvent P-D-680 used to clean all parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment: goggles or safety glasses, face shield and gloves. Do not breathe vapors. Do not use near sparks or open flames and do not smoke while using it. Failure to follow these procedures could cause **SERIOUS INJURY**.

1. Clean all bearings before inspection. An accurate judgement about the condition of a bearing cannot be made unless it is thoroughly free from dirt. Do not spin dirty bearings. Rotate them slowly while cleaning in dry cleaning solvent P-D-680. Bearings with a shield or seal on one side only should be cleaned and inspected in the same way as other bearings. Bearings with shield or seals on both sides should **NOT** be cleaned in dry cleaning solvent P-D-680. Wipe with a clean cloth to prevent dirt or other contamination.

WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kpa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Dry bearings thoroughly with compressed air. When drying bearing, rotate one race by hand to expose all parts of bearing.

CHAPTER 3
TROUBLESHOOTING AND PREVENTIVE
MAINTENANCE CHECKS AND SERVICES (PMCS)

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Section I. TROUBLESHOOTING**ENGINE****1. ENGINE CRANKS BUT WILL NOT START; NO SMOKE FROM EXHAUST****CAUSE**

Out of fuel

REMEDY

Fill tank

CAUSE

STE/ICE fuel switch OFF

REMEDY

- 1) Turn switch ON
- 2) Replace switch

CAUSE

Less than 22 volts at fuel solenoid

REMEDY

- 1) Tighten wire connection on fuel solenoid
- 2) Check wire for continuity. Replace if faulty

CAUSE

Fuel line plugged

REMEDY

- 1) Change filters
- 2) Clean out line
- 3) Replace line

CAUSE

Lift pump inoperative

REMEDY

Inspect pump. Replace pump if required

CAUSE

Injection pump inoperative

REMEDY

Replace injection pump

2. ENGINE WILL NOT START WHEN COLD START IS USED**CAUSE**

No ether delivered from cylinder

REMEDY

- 1) Check cylinder for tightness and quantity of ether
- 2) If empty, replace

CAUSE

Valve not dispensing ether

REMEDY

- 1) Disconnect tube at valve and actuate valve
- 2) Adjust actuating cable

CAUSE

Obstruction in tube to atomizer

REMEDY

Reconnect tube to valve. Actuate valve; if no ether is present, replace tube

CAUSE

Obstruction in atomizer

REMEDY

Remove atomizer. Reconnect tube to atomizer. Actuate valve; if ether is not discharged from atomizer, it is clogged. Remove atomizer and clean out or replace

3. ENGINE HARD TO START/WILL NOT START; SMOKE FROM EXHAUST

CAUSE

Cranking speed too low

REMEDY

- 1) Tighten battery connection
- 2) Service batteries
- 3) Replace starting motor

CAUSE

Cold start needed

REMEDY

Use cold start device

CAUSE

Engine starting under load

REMEDY

Check for properly positioned valve spools, cables, and levers. Repair or replace as required

4. ENGINE STARTS, BUT WILL NOT KEEP RUNNING

CAUSE

Idle speed too low

REMEDY

Adjust low idle screw

CAUSE

Engine starting under load

REMEDY

Check for properly positioned valve spools, cables, and levers. Repair or replace as required

CAUSE

Contaminated fuel

REMEDY

Drain fuel and clean system

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fittings
- 2) Replace damaged fuel system components

5. ENGINE WILL NOT CRANK**CAUSE**

Ignition switch OFF

REMEDY

Turn ignition switch ON

CAUSE

Transmission shift not in neutral

REMEDY

- 1) Shift into neutral
- 2) Replace neutral safety switch

CAUSE

Battery connections loose

REMEDY

Tighten battery connections

CAUSE

Battery voltage low

REMEDY

Service batteries

6. ENGINE SURGES AT IDLE**CAUSE**

Idle speed set too low

REMEDY

Adjust low idle screw

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fittings
- 2) Replace damaged fuel system components

CAUSE

Low fuel level in tank

REMEDY

Add fuel

CAUSE

Fuel lines restricted

REMEDY

- 1) Clean out lines
- 2) Replace lines

CAUSE

Fuel filters plugged

REMEDY

Replace fuel filters

CAUSE

Injection pump inoperative

REMEDY

Replace injection pump

7. WARM ENGINE IDLES ROUGH**CAUSE**

Idle speed set too low

REMEDY

Adjust low idle screw

CAUSE

Injection nozzles plugged or inoperative

REMEDY

- 1) Replace injection nozzles
- 2) Repair injection nozzles

CAUSE

Fuel contaminated

REMEDY

Drain fuel and clean system

CAUSE

Air cleaner element plugged

REMEDY

- 1) Clear air cleaner element
- 2) Replace air cleaner element

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fittings
- 2) Replace damaged fuel system components

CAUSE

Injection pump timing incorrect

REMEDY

Replace injection pump

CAUSE

Injection pump inoperative

REMEDY

Replace injection pump

CAUSE

Valves incorrectly adjusted

REMEDY

Adjust valve clearance

8. ENGINE MISFIRES

CAUSE

Fuel contaminated

REMEDY

Drain fuel and clean system

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fittings
- 2) Replace damaged fuel system components

CAUSE

Fuel injection lines leaking

REMEDY

- 1) Tighten connections
- 2) Replace lines

CAUSE

injection nozzles plugged or inoperative

REMEDY

- 1) Replace injection nozzle
 - 2) Repair injection nozzle
-

CAUSE

Valves adjusted incorrectly

REMEDY

Adjust valve clearance

9. ENGINE RUNS HOT

CAUSE

Vehicle overloaded

REMEDY

- 1) Reduce load
- 2) Use lower gear

CAUSE

Coolant level low

REMEDY

- 1) Add coolant
- 2) Check for leaks and repair

CAUSE

Engine temperature gauge/sending unit malfunctioning

REMEDY,

Replace engine temperature gauge/sending unit

CAUSE

Fins in radiator plugged

REMEDY

Clean out fins

CAUSE

Thermostat inoperative, incorrect or missing

REMEDY

Test thermostat and replace if required

CAUSE

Collapsed hose

REMEDY

Replace collapsed hose

CAUSE

Loose belt on water pump and fan

REMEDY

Replace belt tensioner

CAUSE

Pressure cap incorrect/malfunctioning

REMEDY

Replace cap

CAUSE

Water pump inoperative

REMEDY

Replace water pump

CAUSE

Injection pump timing incorrect or overfueled

REMEDY

Replace injection pump

10. LOW OIL PRESSURE

CAUSE

CM level low

REMEDY

- 1) Fill to proper level
- 2) Check for leaks and repair

CAUSE

Oil pressure gauge/sending unit malfunctioning

REMEDY

Replace oil pressure gauge/sending unit

CAUSE

Engine oil diluted or improper viscosity

REMEDY

- 1) Change engine oil
- 2) Check for origin of contamination and repair or replace

CAUSE

Engine oil filter plugged

REMEDY

Change engine oil filter

CAUSE

Engine oil relief valve stuck open

REMEDY

Replace engine oil relief valve

CAUSE

Seal on engine oil suction tube inoperative

REMEDY

Replace seal

CAUSE

Engine bearing worn or damaged

REMEDY

- 1) Replace engine
- 2) Repair engine

11. ENGINE RUNNING TOO COLD

CAUSE

Engine temperature gauge/sending unit malfunctioning

REMEDY

Replace engine temperature gauge/sending unit

CAUSE

Thermostat inoperative, incorrect temperature set-point

REMEDY

Test thermostat and replace if required

12. ENGINE RPM WILL NOT REACH RATED SPEED - NO LOAD

CAUSE

Throttle linkage incorrectly adjusted

REMEDY

Adjust throttle linkage

CAUSE

Tachometer malfunctioning

REMEDY

- 1) Adjust tachometer
 - 2) Replace tachometer
-

13. LOW POWER

CAUSE

Vehicle overloaded

REMEDY

- 1) Reduce load
- 2) Use lower gear

CAUSE

Air cleaner element plugged

REMEDY

- 1) Clean air cleaner element
- 2) Replace air cleaner element

CAUSE

Fuel filters plugged

REMEDY

Replace fuel filters

CAUSE

Poor quality fuel

REMEDY

- 1) Drain tank
- 2) Clean out lines

CAUSE

Throttle linkage incorrectly adjusted

REMEDY

Adjust throttle linkage

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fitting
- 2) Replace damaged fuel system components

CAUSE

Fuel lines restricted

REMEDY

- 1) Clean out lines
- 2) Replace lines

CAUSE

Fuel drain manifold restricted

REMEDY

- 1) Clear restriction
- 2) Replace fuel drain manifold

CAUSE

CM level high

REMEDY

Drain to proper level

CAUSE

Valves incorrectly adjusted

REMEDY

Adjust valve clearance

CAUSE

Injection nozzles plugged or inoperative

REMEDY

- 1) Replace injection nozzles
- 2) Repair injection nozzles

CAUSE

Injection pump inoperative

REMEDY

Replace injection pump

14. EXCESSIVE SMOKE UNDER LOAD

CAUSE

Air cleaner element plugged

REMEDY

- 1) Clean air cleaner element
- 2) Replace air cleaner element

CAUSE

Engine running too cold

REMEDY

- 1) Warm up engine
- 2) Test thermostat and replace if required

CAUSE

Injection pump timing incorrect

REMEDY

Replace injection pump

CAUSE

More than one seal washer under injector nozzle

REMEDY

Remove extra washers

CAUSE

Injection nozzles plugged or inoperative

REMEDY

- 1) Replace injection nozzles
- 2) Repair injection nozzles

CAUSE

Injection pump overfueled

REMEDY

Replace injection pump

15. FUEL KNOCK

CAUSE

Poor quality fuel

REMEDY

- 1) Drain tank
- 2) Clean out lines

CAUSE

Air in fuel system

REMEDY

- 1) Tighten fuel fitting
- 2) Replace damaged fuel system components

CAUSE

Injection pump timing incorrect

REMEDY

Replace injection pump

CAUSE

Injection nozzles plugged or inoperative

REMEDY

- 1) Replace injection nozzles
- 2) Repair injection nozzles

HYDRAULICS - GENERAL

NOTE

“Hydraulic function” is the general term used for any of the following five hydraulically controlled operations on the crane: boom hoist, boom telescope, upper-structure swing, winch and outriggers.

Before any troubleshooting is attempted, become fully acquainted with the following two basic fundamental facts of a hydraulic system:

A - SPEED

The speed of a hydraulic function is directly related to the, system flow. A reduction in speed of a cylinder or motor is caused by an insufficient quantity of oil being delivered to the component.

B - POWER

The power or force of a hydraulic function is related to pressure.

If the differences between speed and power of a hydraulic system is understood correctly, then accurate troubleshooting can be accomplished in a minimum of time.

Follow these steps to isolate hydraulic malfunctions:

- a. Identify hydraulic functions that are malfunctioning.
- b. If one function is malfunctioning, check components unique to that function.
- c. If more than one function is malfunctioning, refer to hydraulic schematic. Identify components common to all areas malfunctioning. Check those common components first.
- d. Check for proper hydraulic oil level in hydraulic reservoir and for obvious leaks.

1. CONTROL LEVER STICKS OR BINDS

CAUSE

Control linkage or cable sticking

REMEDY

Starting from the control valve end, disconnect the components one at a time until the malfunction is located, and then repair or replace that component. (Note: Binding push-pull cables may simply have too tight a bend at some point in their length.)

CAUSE

Valve spool sticking

REMEDY

Replace control valve

2. NO MOVEMENT OF HYDRAULIC FUNCTION(S)

CAUSE

Valve spool does not shift fully

REMEDY

- 1) Adjust linkage
- 2) Replace faulty linkage
- 3) Replace control valve

CAUSE

Valve spool shifts fully

REMEDY

- 1) Refer to sections on:
 - A) Relief Valve Troubleshooting
 - B) Motor, Cylinder or Winch Troubleshooting according to circuit being checked
 - C) Pump Troubleshooting
- 2) Replace control valve

SWING CIRCUIT

1. UPPERSTRUCTURE WILL NOT SWING

CAUSE

Swing relief valve stuck in open position

REMEDY

Replace swing relief valve

CAUSE

Swing motor leaks internally

REMEDY

- 1) Replace swing motor
 - 2) Repair swing motor
-

CAUSE Downstream blockage	REMEDY 1) Return additional controls to neutral position 2) Locate and remove blockage
CAUSE Swing valve spool damaged	REMEDY Replace main control valve
CAUSE Mechanical fault in swing reducer gear box	REMEDY 1) Replace swing gearbox 2) Repair swing gear box
CAUSE Mechanical fault in swing bearing	REMEDY Replace swing bearing
CAUSE Main hydraulic pump faulty	REMEDY 1) Replace main hydraulic pump 2) Repair main hydraulic pump

2. SWING MOTION SLUGGISH

CAUSE Swing relief valve set too low	REMEDY Adjust swing relief valve
CAUSE Fault in flow divider valve	REMEDY Replace flow divider
CAUSE Swing motor leaks internally	REMEDY 1) Replace swing motor 2) Repair swing motor
CAUSE Main hydraulic pump faulty	REMEDY 1) Replace main hydraulic pump 2) Repair main hydraulic pump
CAUSE Leakage around swing control valve spool	REMEDY Replace main control valve

3. SWING MOTION ERRATIC

CAUSE Swing bearing not lubricated properly	REMEDY Lubricate swing bearing
---	--

CAUSE

Swing relief valve malfunctioning

REMEDY

- 1) Adjust swing relief valve
- 2) Replace swing relief valve

4. SWING MOTOR TURNS IN WRONG DIRECTION

CAUSE

Hose connections wrong

REMEDY

Reverse hose connections

CAUSE

Swing motor assembled improperly

REMEDY

- 1) Replace swing motor
- 2) Repair swing motor

BOOM HOIST CIRCUIT

1. BOOM HOIST CYLINDER INOPERATIVE OR ERRATIC

CAUSE

Load is too great

REMEDY

Consult capacity chart for maximum loads and reduce as required

CAUSE

Anti-two block system malfunctioning

REMEDY

- 1) Insure proper connection of counterweight
- 2) Replace relay in anti-two block panel
- 3) Repair open circuits in wiring
- 4) Lubricate disconnect assemblies
- 5) Replace disconnect assemblies

CAUSE

Boom hoist hold valve malfunctioning

REMEDY

Replace boom hoist hold valve

CAUSE

Rotary manifold leaking internally

REMEDY

- 1) Replace rotary manifold
- 2) Repair rotary manifold

CAUSE

Downstream blockage

REMEDY

Locate and remove blockage

CAUSE

Boom hoist cylinder binding

REMEDY

- 1) Replace boom hoist cylinder
- 2) Repair boom hoist cylinder

2. BOOM DROPS SLIGHTLY AS RAISE CONTROL IS RELEASED**CAUSE**

Boom hoist hold valve free flow check not seating properly

REMEDY

Replace boom hoist hold valve

3. BOOM HOIST, EXTEND AND OUTRIGGER CYLINDERS INOPERATIVE OR ERRATIC**CAUSE**

Main relief valve malfunctioning

REMEDY

- 1) Adjust main relief valve
- 2) Replace main control valve

CAUSE

Main hydraulic pump faulty

REMEDY

- 1) Replace main hydraulic pump
- 2) Repair main hydraulic pump

4 BOOM DRIFTS DOWN**Testing boom hoist cylinder**

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

With hydraulic oil at a working temperature and boom off to one side, elevate boom to 60-degree angle and suspend a 5-ton (4.54 metric ton) load on a two-part line, 1 ft (305 mm) off ground, Shut engine off. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Disconnect hose from adapter on right side of hold valve. Some hydraulic oil will run out, but will stop. Turn ignition switch ON to energize anti-two block solenoid. Push boom hoist lever to lower position and hold. Boom should hold its position. If boom lowers and no hydraulic oil comes out of adapter, boom hoist hold valve must be replaced. If boom lowers and hydraulic oil comes out of adapter, boom hoist cylinder is by-passing and should be replaced/repaired.

CAUSE

Boom hoist hold valve not seating properly

REMEDY

Replace boom hoist hold valve

CAUSE

Boom hoist cylinder by-passing hydraulic oil

REMEDY

- 1) Replace boom hoist cylinder
- 2) Repair boom hoist cylinder

BOOM EXTEND CIRCUIT

1. BOOM EXTEND FUNCTION WILL NOT OPERATE

CAUSE

Load too great

REMEDY

Consult capacity chart for maximum load and reduce load as required

CAUSE

Anti-two block system malfunctioning

REMEDY

- 1) Insure proper connection of counterweight
- 2) Replace relay in anti-two block panel
- 3) Repair open circuits in wiring
- 4) Lubricate disconnect assemblies (refer to Koehring Commercial Operation Instructions manual for lubrication specifications)
- 5) Replace disconnect assemblies

CAUSE

Rotary manifold leaking internally

REMEDY

- 1) Replace rotary manifold
- 2) Repair rotary manifold

CAUSE

Boom extend cylinder binding

REMEDY

- 1) Replace boom extend cylinder
- 2) Repair boom extend cylinder

2. BOOM EXTEND CYLINDER EXTENDS BUT WILL NOT RETRACT

CAUSE

counterbalance valve malfunctioning

REMEDY

Replace counterbalance valve

CAUSE

Internal leakage in boom extend cylinder

REMEDY

- 1) Replace boom extend cylinder
 - 2) Reseal boom extend cylinder
-

3. BOOM SECTION RETRACTS UNDER LOAD

Test Boom Extend Cylinder

- 1) With boom off to one side and horizontal, extend boom approximately 6 ft (1.83 m). Mark side of the extended section at end of the boom base.
- 2) Elevate boom to maximum angle and suspend a 5-ton (4.54 metric ton) load on a two-part line 1 ft (305 mm) off ground.
- 3) With engine shut off, hold or tie boom extend lever in fully extended position for approximately 15 minutes.
- 4) Return boom extend lever to neutral position. Start engine and lower boom to horizontal. Re-mark extended section as in step 1. Measure distance between marks. The difference is the leak-down: Leak-down must not exceed 0.75 in. (19.1 mm) in 15 minutes with hydraulic oil at a working temperature. If leak-down exceeds 0.75 in. (19.1 mm) in 15 minutes, do step 5.
- 5) With hydraulic oil at a working temperature, elevate boom to a 60-degree angle and suspend a 5-ton (4.54 metric ton) load on a two-part line 1 ft (305 mm) off ground. Extend telescoping section approximately 1/2 of full extension. Shut engine off. Disconnect hose from tube on left side of boom extend cylinder at boom base. Some hydraulic oil should run out, but will stop. Pull boom extend lever to the retract position and hold.

Boom should hold its position. If boom retracts and no hydraulic oil comes out of tube, counterbalance valve must be replaced. If boom retracts and hydraulic oil comes out of tube, boom extend cylinder is by-passing and should be replaced or repaired.

CAUSE
Counterbalance valve not seating properly

REMEDY
Replace counterbalance valve

CAUSE
O-ring around counterbalance valve damaged

REMEDY
Replace counterbalance valve

CAUSE
Boom extend cylinder by-passing

REMEDY
1) Replace boom extend cylinder
2) Repair boom extend cylinder

OUTRIGGER CIRCUIT

1. ALL OUTRIGGERS INOPERATIVE

CAUSE
No electrical power to outrigger solenoid valves

REMEDY
1) Reset circuit breaker
2) Tighten wire harness connection

CAUSE
Main relief valve malfunctioning

REMEDY
1) Adjust main relief valve
2) Replace main control valve

CAUSE
Main hydraulic pump worn or damaged

REMEDY
1) Replace main hydraulic pump
2) Repair main hydraulic pump

2. INDIVIDUAL OUTRIGGER INOPERATIVE

CAUSE

Wire connection at outrigger solenoid valve loose or disconnected

REMEDY

- 1) Connect wire
- 2) Repair wire

CAUSE

Individual outrigger switch malfunction

REMEDY

Replace bad outrigger switch

CAUSE

Outrigger solenoid coil burned out

REMEDY

Replace outrigger solenoid coil

CAUSE

Outrigger hold valve on outrigger cylinder not operating

REMEDY

- 1) Replace outrigger hold valve
- 2) Repair outrigger hold valve

CAUSE

Outrigger cylinder leaking internally

REMEDY

- 1) Replace outrigger cylinder
- 2) Repair outrigger cylinder

CAUSE

Outrigger solenoid valve spool damaged

REMEDY

Replace outrigger solenoid valve

3. OUTRIGGERS WILL NOT LIFT MACHINE

CAUSE

Main relief valve malfunctioning

REMEDY

- 1) Adjust main relief valve
- 2) Replace main control valve

CAUSE

Outrigger cylinder leaking internally

REMEDY

- 1) Replace outrigger cylinder
- 2) Repair outrigger cylinder

4. OUTRIGGER RETRACTS UNDER LOAD

Testing Outrigger Cylinder



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

With hydraulic oil at working temperature, start engine and set vehicle on outriggers. Shut engine off. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Disconnect both hoses from either front or rear outrigger cylinders at tee located by outrigger solenoid valve. Cap tee. Some hydraulic oil will run out, but will stop. Turn ignition switch ON to energize outrigger solenoid valve switches. Pull outrigger control lever to raise position and hold. Actuate outrigger switch corresponding to outrigger cylinder being checked. If outrigger cylinder retracts and no hydraulic oil comes out of hose, outrigger hold valve must be replaced/repared. If outrigger cylinder retracts and hydraulic oil comes out of hose, outrigger cylinder is by-passing and should be replaced/repared.

CAUSE

Outrigger hold valve not seating properly

REMEDY

Replace outrigger hold valve

CAUSE

Outrigger cylinder leaking internally

REMEDY

- 1) Replace outrigger cylinder
- 2) Repair outrigger cylinder

STEERING CIRCUIT

1. SLOW STEERING, HARD STEERING, OR LOSS OF POWER ASSIST

CAUSE

Steer axle overloaded

REMEDY

Consult Capacity Chart for maximum load.
Reduce load as required

CAUSE

Swing relief valve malfunctioning

REMEDY

- 1) Adjust swing relief valve
- 2) Replace swing relief valve

CAUSE

Flow divider sticking

REMEDY

Replace flow divider

CAUSE

Main hydraulic pump worn or malfunctioning

REMEDY

- 1) Replace main hydraulic pump
- 2) Repair main hydraulic pump

2. VEHICLE WANDERS - VEHICLE WILL NOT STAY IN A STRAIGHT LINE

CAUSE

Mechanical linkage worn

REMEDY

- 1) Replace linkage
- 2) Repair linkage

CAUSE

Leaking fitting on steering circuit

REMEDY

- 1) Tighten fitting
- 2) Replace fitting

CAUSE

Air in hydraulic system

REMEDY

Repair leaks in pump suction circuit

CAUSE

Steering cylinder leaking internally

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Steering cylinder piston loose

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Steering selector valve leaking

REMEDY

- 1) Replace steering selector valve
- 2) Repair steering selector valve

CAUSE

Steering control unit worn

REMEDY

Replace steering control unit

3. DRIFT - VEHICLE VEERS SLOWLY IN ONE DIRECTION

CAUSE

Steering linkage worn or damaged

REMEDY

Replace steering linkage

CAUSE

Steering cylinder leaks internally

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Steering selector valve leaking

REMEDY

- 1) Replace steering selector valve
- 2) Repair steering selector valve

4. SLIP - SLOW MOVEMENT OF STEERING WHEEL FAILS TO CAUSE ANY MOVEMENT OF STEERED WHEELS

CAUSE

Steering cylinder leaking internally

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Steering control unit worn

REMEDY

Replace steering control unit

5. TEMPORARY HARD STEERING OR HANG-UP

CAUSE

Main hydraulic pump failure

REMEDY

- 1) Replace main hydraulic pump
- 2) Repair main hydraulic pump

CAUSE

Transmission pump drive failure

REMEDY

- 1) Replace transmission
 - 2) Repair transmission
-

CAUSE

Blockage in supply or output lines to main hydraulic pump

REMEDY

Replace hydraulic hose

CAUSE

Thermal shock

REMEDY

Replace steering control unit

NOTE

“Thermal shock” is an extremely rare condition caused when hydraulic system is operated for some time without turning steering wheel so that fluid in reservoir and system is hot and steering control unit is relatively cool (more than 50 degrees F [27.8 degrees C] temperature differential). When steering wheel is turned quickly, the result is temporary seizure and possible damage to internal parts of steering control unit. The temporary seizure may be followed by total free wheeling.

6. ERRATIC STEERING**CAUSE**

Air in hydraulic system

REMEDY

Repair leak in pump suction circuit

CAUSE

Leaking fitting on steering circuit

REMEDY

- 1) Tighten fitting
- 2) Replace fitting

CAUSE

Hose pinched

REMEDY

Replace hose

CAUSE

Flow divider sticking

REMEDY

Replace flow divider

CAUSE

Steering cylinder piston loose

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Thermal shock

REMEDY

Replace steering control unit

NOTE

“Thermal shock” is an extremely rare condition caused when hydraulic system is operated for some time without turning steering wheel so that fluid in reservoir and system is hot and steering control unit is relatively cool (more than 50 degrees F [27.8 degrees C] temperature differential). When steering wheel is turned quickly, the result is temporary seizure and possible damage to internal parts of steering control unit. The temporary seizure may be followed by total free wheeling.

7. “SPONGY” OR SOFT STEERING

CAUSE

Air in hydraulic steering circuit

REMEDY

Turn steering wheel repeatedly from full left to full right while sitting still

8. FREE WHEELING - STEERING WHEEL TURNS WITH SLIGHT RESISTANCE BUT RESULTS IN LITTLE OR NO STEERED WHEEL ACTION

CAUSE

Steering linkage malfunctioning

REMEDY

- 1) Repair steering linkage
 - 2) Replace steering linkage
-

CAUSE

Steering cylinder internal leakage

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Loose steering cylinder piston

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

CAUSE

Wear in steering control unit

REMEDY

Replace steering control unit

9. EXCESSIVE FREE PLAY AT STEERING WHEEL**CAUSE**

Steering wheel nut loose

REMEDY

Tighten steering wheel nut

CAUSE

Steering column shaft/steering wheel worn or damaged

REMEDY

Replace steering control unit/steering wheel

10. EXCESSIVE FREE PLAY AT STEERED WHEELS**CAUSE**

Steering linkage malfunctioning

REMEDY

- 1) Repair steering linkage
- 2) Replace steering linkage

CAUSE

Loose steering cylinder piston

REMEDY

- 1) Replace steering cylinder
- 2) Repair steering cylinder

11. STEERING UNIT LOCKS UP**CAUSE**

Hydraulic power insufficient

REMEDY

- 1) Adjust steering/swing relief valve
- 2) Replace steering/swing relief valve and/or flow divider

CAUSE

Large particles in steering control unit

REMEDY

- 1) Locate origin of particles and correct
- 2) Drain and flush entire hydraulic system
- 3) Replace steering control unit

CAUSE

Steering control unit worn

REMEDY

Replace steering control unit

CAUSE

Thermal shock

REMEDY

Replace steering control unit

NOTE

“Thermal shock” in an extremely rare condition caused when hydraulic system is operated for some time without turning steering wheel so that fluid in reservoir and system is hot and steering control unit is relatively cool (more than 50 degrees F [27.8 degrees C] temperature differential). When steering wheel is turned quickly, the result is temporary seizure and possible damage to internal parts of steering control unit. The temporary seizure may be followed by total free wheeling,

12. STEERING WHEEL OSCILLATES OR TURNS BY ITSELF

CAUSE

Lines connected to wrong cylinder ports

REMEDY

Reconnect lines correctly

13. STEERED WHEELS TURN IN WRONG DIRECTION WHEN OPERATOR ACTIVATES STEERING WHEEL

CAUSE

Lines connected to wrong cylinder ports

REMEDY

Reconnect lines correctly

PUMPS

1. FAILURE OF HYDRAULIC PUMP(S) TO DELIVER FLUID

CAUSE

Low hydraulic oil level

REMEDY

Add hydraulic oil as required

CAUSE

Hydraulic oil intake suction filter plugged

REMEDY

Clean hydraulic oil intake suction filter

CAUSE

Hydraulic oil viscosity too heavy to pick up prime

REMEDY

Use lighter viscosity hydraulic oil. Consult lube chart

CAUSE

Air leak in suction line, preventing priming or causing noise and irregular action of control circuit

REMEDY

Repair leaks

CAUSE

Shaft or parts broken inside hydraulic pump(s)

REMEDY

- 1) Replace hydraulic pump(s)
- 2) Repair hydraulic pump(s)

CAUSE

Contamination in pump(s)

REMEDY

- 1) Locate origin of contamination and correct
- 2) Drain and flush entire hydraulic system
- 3) Replace hydraulic pump(s)
- 4) Repair hydraulic pump(s)

2. LOW OR NO PRESSURE IN SYSTEM

CAUSE

Engine rpm too low

REMEDY

Adjust low idle rpm

CAUSE

Relief valve set too low

REMEDY

Adjust relief valve setting

CAUSE

Hydraulic oil leaking

REMEDY

- 1) Check hydraulic system for leaks
- 2) Repair leaks

CAUSE

Hydraulic oil viscosity incorrect

REMEDY

Use proper hydraulic oil. Consult lube chart

CAUSE

Air in hydraulic system

REMEDY

Repair leak in pump suction circuit

CAUSE

Internal parts of hydraulic pump(s)
worn

REMEDY

- 1) Replace hydraulic pump(s)
- 2) Repair hydraulic pump(s)

3. PUMP(S) MAKING NOISE

CAUSE

Hydraulic oil viscosity too high

REMEDY

- 1) Warm hydraulic oil
- 2) Use lower viscosity hydraulic oil. Consult lube chart

CAUSE

Air in hydraulic system

REMEDY

Repair leak in pump suction circuit

CAUSE

Partially clogged intake line, intake filter or restricted intake pipe

REMEDY

Clean out intake filter screen or eliminate restriction.

CAUSE

Worn or broken parts in hydraulic pump(s)

REMEDY

- 1) Replace hydraulic pump(s)
- 2) Repair hydraulic pump(s)

4. EXTERNAL OIL LEAKAGE AROUND HYDRAULIC PUMP(S)

CAUSE

Loose fitting on hydraulic pump(s)

REMEDY

Tighten fittings

CAUSE

Damaged O-rings at split flange fittings

REMEDY

Replace O-ring seals

CAUSE

Damaged O-ring seals between hydraulic pump(s) sections

REMEDY

Replace O-ring seals

5. BREAKAGE OF PARTS INSIDE HYDRAULIC PUMP HOUSING(S)

CAUSE

Seizure due to lack of hydraulic oil

REMEDY

Fill hydraulic reservoir to proper level, clean hydraulic oil filter and check for restrictions in suction line. Consult lube chart

CAUSE

Excessive pressure above maximum rating

REMEDY

Adjust relief valve maximum setting(s)

CAUSE

Solid matter being wedged in hydraulic pump(s)

REMEDY

- 1) Locate origin of contamination and correct
- 2) Drain and flush entire hydraulic system
- 3) Replace hydraulic pump(s)
- 4) Repair hydraulic pump(s)

RELIEF VALVES

1. CANNOT GET PRESSURE

CAUSE

Poppet stuck open or dirt under seat

REMEDY

Replace relief valve

2. ERRATIC PRESSURE

CAUSE

Poppet seat damaged

REMEDY

Replace relief valve

3. PRESSURE SETTING NOT CORRECT

CAUSE

Locknut and adjusting screw loose

REMEDY

Adjust relief valve

4. LEAKAGE

CAUSE

Damaged seats or worn O-rings

REMEDY

Replace relief valve

BRAKES

1. BRAKES SLOW TO RELEASE OR DRAG

CAUSE

Brake pedal adjustment improper

REMEDY

Adjust pedal free play

CAUSE

Brake shoe return springs weak or broken

REMEDY

Replace brake shoe return springs

CAUSE

Automatic adjuster improperly assembled

REMEDY

Replace adjuster

CAUSE

Parking brake caliper frozen to mounting pins

REMEDY

Free up and coat with grease. Consult lube chart

CAUSE

Parking brake linkage improperly assembled or adjusted

REMEDY

- 1) Assemble parking brake linkage properly
- 2) Adjust parking brake

2. BRAKES DO NOT RELEASE

CAUSE

Brake pedal sticking

REMEDY

Lubricate clevis and pivot pin with oil

CAUSE

Brake pedal adjustment improper

REMEDY

Adjust pedal free play

CAUSE

Brake booster defective

REMEDY

- 1) Replace brake booster
- 2) Repair brake booster

3. BRAKES SLOW TO APPLY

CAUSE

Piston in brake booster sticking or damaged

REMEDY

- 1) Replace brake booster
- 2) Repair brake booster

CAUSE

Low hydraulic oil flow

REMEDY

- 1) Increase engine rpm
- 2) Replace main hydraulic pump
- 3) Repair main hydraulic pump

4. INSUFFICIENT BRAKES

CAUSE

Low brake fluid level

REMEDY

- 1) Fill to proper level
 - 2) Bleed brake system
-

CAUSE Improper brake pedal adjustment	REMEDY Adjust brake pedal
CAUSE Automatic adjuster(s) inoperative	REMEDY Replace automatic adjuster(s)
CAUSE Hydraulic tubing loose or damaged	REMEDY Tighten or replace hydraulic tubing and fittings
CAUSE Brake hose/tube restricted	REMEDY Replace brake hose/tube
CAUSE Wheel cylinders leaking	REMEDY Replace wheel cylinder
CAUSE Brake lining or drum condition poor	REMEDY 1) Replace brake lining 2) Turn drum
CAUSE Parking brake pads worn	REMEDY 1) Adjust parking brake pad clearance 2) Replace parking brake pad and adjust

ELECTRICAL SYSTEM



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Refer to electrical schematic for aid in troubleshooting electrical system.

1. STARTING MOTOR DOES NOT OPERATE

CAUSE ignition switch OFF	REMEDY Turn ignition switch ON
CAUSE Transmission not in neutral	REMEDY Place transmission in neutral

CAUSE

Defective neutral safety switch

REMEDY

Replace neutral safety switch

CAUSE

Battery weak or dead

REMEDY

- 1) Tighten battery terminals
- 2) Charge or replace battery(s)

CAUSE

No voltage at starter motor

REMEDY

- 1) Reset or replace circuit breaker
- 2) Charge or replace battery(s)
- 3) Repair open circuits

CAUSE

Damaged or loose wiring between starter motor and batteries

REMEDY

- 1) Clean and tighten all connections
- 2) Replace wiring as needed

CAUSE

Solenoid, relay or starting switch defective

REMEDY

Replace failed component

CAUSE

Starter motor defective

REMEDY

- 1) Replace starter motor
- 2) Check pinion gear and flywheel ring gear
- 3) Repair starter motor

2. ALTERNATOR CHARGING LOW OR UNSTEADY

CAUSE

Fan belt loose or worn

REMEDY

- 1) Replace fan belt
- 2) Replace belt tensioner

CAUSE

Alternator terminals loose or corroded

REMEDY

- 1) Tighten alternator terminals
- 2) Clean alternator terminals
- 3) Replace alternator terminals

CAUSE

Brushes worn

REMEDY

- 1) Replace alternator
- 2) Repair alternator

CAUSE

Circuit open

REMEDY

- 1) Repair wire
- 2) Replace alternator
- 3) Repair alternator

CAUSE

Diode panel defective

REMEDY

- 1) Replace alternator
- 2) Repair alternator

CAUSE

Alternator defective

REMEDY

- 1) Replace alternator
- 2) Repair alternator

3. BATTERY VOLTAGE LOW

CAUSE

Batteries weak

REMEDY

- 1) Charge batteries
- 2) Replace batteries

CAUSE

Battery electrolyte level low

REMEDY

Fill battery cells

CAUSE

Battery cables or terminals corroded

REMEDY

Clean battery cables, terminals and battery posts

CAUSE

Alternator defective

REMEDY

- 1) Replace alternator
- 2) Repair alternator

4. EXTERNAL LIGHT(S) NOT OPERATING

CAUSE

Light switch OFF or in blackout mode

REMEDY

Turn on light switch or correct position

CAUSE

Circuit breaker tripped

REMEDY

- 1) Reset circuit breaker
- 2) Replace circuit breaker

CAUSE

Bulb burned out in light assembly

REMEDY

Replace bulb

CAUSE

Connection at light fixture corroded or loose

REMEDY

- 1) Tighten connector
- 2) Clean connector
- 3) Replace connector

CAUSE

Light switch defective

REMEDY

Replace light switch

CAUSE

Lighting circuit shorted

REMEDY

Check for shorts and repair

5. WORK LIGHTS NOT OPERATING

CAUSE

Circuit breaker tripped

REMEDY

- 1) Reset circuit breaker
- 2) Replace circuit breaker

CAUSE

Vehicle lights in blackout mode

REMEDY

Switch to correct mode

CAUSE

Relay faulty

REMEDY

Replace relay

CAUSE

No circuit through electrical collector ring

REMEDY

- 1) Replace electrical collector ring
- 2) Repair electrical collector ring

ANTI-TWO BLOCK SYSTEM

1. PANEL LIGHT AND HORN WILL NOT COME ON WITH ANTI-TWO BLOCK COUNTERWEIGHT LIFTED; CONTROL DISCONNECTS WILL NOT ENGAGE

CAUSE

Ignition switch OFF

REMEDY

Turn ignition switch ON

CAUSE

Circuit breaker tripped

REMEDY

- 1) Reset circuit breaker
 - 2) Replace circuit breaker
-

CAUSE

Wire broken

REMEDY

Check voltage in control panel harness between terminals 0 and 37. If voltage is 0, check between ignition post of ignition switch and ground. If 24 volts available, wire to control panel is bad. Replace wire.

2. HORN WORKS BUT NO LIGHT WITH ANTI-TWO BLOCK COUNTERWEIGHT LIFTED; CONTROL DISCONNECTS WILL NOT ENGAGE

CAUSE

Light bulb burned out

REMEDY

Replace light bulb

3. LIGHT AND HORN ARE ON WITH HOOK BLOCK NOT CONTACTING ANTI-TWO BLOCK COUNTERWEIGHT; CONTROL DISCONNECTS WILL NOT ENGAGE

CAUSE

Anti-two block counterweight chain broken or hung up

REMEDY

Insure counterweight is attached to chain and hanging freely.

CAUSE

Electrical cable broken or bad connection

REMEDY

- 1) Check all cables for visible damage, then check plug terminals 37 and 38 at control panel and check for continuity. If circuit is open, check wires inside cable reel, wires from reel to anti-two block switch and anti-two block switch on boom head. If continuity exists, check relay in panel.
- 2) Replace faulty component

CAUSE

Anti-two block switch defective

REMEDY

Check for correct mechanical operation. If correct, remove cover and wires from terminals #1 and #2. With arm pulled down there should be a closed circuit between terminals. With arm up, circuit should be open. If all conditions are not met, replace anti-two block switch.

CAUSE

Relay in anti-two block panel defective

REMEDY

Check for 24 volts between relay pins #30 (hot) and #86 (ground). If voltage is 0, check for voltage between pin #87a and ground. If 24 volts, replace relay. (With no electrical power to relay, pins #30 and #87a should show continuity. With 24 volts to #85 and #86 grounded, there should be continuity between pins #87 and #30.)

CAUSE

No circuit through electrical collector ring

REMEDY

- 1) Replace electrical collector ring
- 2) Repair electrical collector ring

4. LIGHT AND HORN ARE ON BUT CONTROL DISCONNECTS WILL NOT DISENGAGE

CAUSE

Control disconnect defective

REMEDY

Check voltage across disconnect terminals. If 24 volts, check anti-two block BY-PASS switch in anti-two block panel. If voltage is 0, repair or replace disconnect (check other disconnects for condition). To operate crane, solenoid must have 24 volts supplied to one side and have a good ground on the other side. Under this condition, the disconnect should act as a solid link.

With 24 volts removed, disconnect should allow free motion of control lever in one direction and operate valve spool in other direction.

CAUSE

Anti-two block BY-PASS switch defective

REMEDY

Check to insure that anti-two block BY-PASS switch is in the off position. Check for 24 volts in anti-two block panel. If present, replace anti-two block BY-PASS switch or anti-two block panel.

5. NO LIGHT AND HORN BUT CONTROL DISCONNECTS WILL NOT ENGAGE

CAUSE

Wire broken or bad connection

REMEDY

Check voltage across disconnect terminals. If voltage is 0, check voltage across terminals in the anti-two block panel. If 24 volts, replace wire. If 24 volts across disconnect, disconnect is defective.

CAUSE

Function disconnect defective

REMEDY

Check solenoid for function. Applying 24 volts to disconnect, solenoid should engage with a distinct snap. If not, solenoid must be replaced. If solenoid engages but disconnect "breaks" under load, replace disconnect.

TRANSMISSION

If transmission performance is inadequate, install pressure gauge(s) on the transmission control valve and check pressures, and check for the following symptoms.

1. ERRATIC TRANSMISSION OIL PRESSURE**CAUSE**

Transmission oil level low

REMEDY

Add transmission oil to proper level. Consult lube chart

CAUSE

Oil strainer cover gasket not sealing

REMEDY

Replace oil strainer cover gasket

CAUSE

Oil sump tube cracked

REMEDY

Replace oil sump tube and clean screen

CAUSE

O-ring on sump tube not sealing

REMEDY

Replace O-ring and oil strainer cover gasket

CAUSE

Oil passage cover plate leaking

REMEDY

Replace oil passage cover plate gasket

2. EXCESSIVE TRANSMISSION OIL PRESSURE AT HIGH SPEED (RPM)

CAUSE Main regulator valve sticking	REMEDY Check main regulator for contamination and clean orifice
CAUSE Main regulator valve spring faulty	REMEDY Replace main regulator valve spring
CAUSE Main regulator valve orifice plugged	REMEDY Clean main regulator valve orifice

3. LOW TRANSMISSION OIL PRESSURE IN ALL GEARS

CAUSE Main regulator valve sticking	REMEDY Check main regulator valve spring
CAUSE Transmission oil pressure set too low	REMEDY 1) Repair control valve 2) Replace control valve
CAUSE Main regulator valve spring faulty	REMEDY Replace main regulator valve spring
CAUSE Control valve body cracked	REMEDY Replace control valve body
CAUSE Charge pump defective	REMEDY Replace charge pump
CAUSE O-ring on charge pump mount defective	REMEDY Replace O-ring on charge pump

4. LOW TRANSMISSION OIL PRESSURE IN ONE GEAR BUT ALRIGHT IN OTHER GEARS

CAUSE Broken seal ring on input end of clutch weld assembly piston shaft	REMEDY Replace seal ring
--	------------------------------------

CAUSE
Outer or inner piston seal not sealing

REMEDY
Replace piston seals

5. LOW CONVERTER PRESSURE

CAUSE
Converter bypass valve defective

REMEDY
Inspect converter bypass valve and replace if necessary

CAUSE
Converter hub seal ring not sealing

REMEDY
Replace converter hub seal ring

6. HIGH TRANSMISSION OIL PRESSURE

CAUSE
Hose bends too sharp in routing

REMEDY
Re-route hoses

CAUSE
Hose defective

REMEDY
Replace hose

CAUSE
Hoses not connected correctly

REMEDY
Connect hoses correctly

CAUSE
Main regulator valve orifice plugged

REMEDY
Clean main regulator valve orifice

7. CLUTCH SELECTED PRESSURE DOES NOT RETURN TO NORMAL

CAUSE
Main regulator valve spring weak

REMEDY
Replace main regulator valve spring

CAUSE
Accumulator spring too strong

REMEDY
Replace spring

CAUSE
Charge pump defective

REMEDY
Replace charge pump

CAUSE
Excessive internal leakage to clutch

REMEDY
Replace seals

8. EXCESSIVE NOISE AT ENGINE IDLE

CAUSE

Charge pump defective

REMEDY

Replace charge pump

CAUSE

Excessive backlash in gear train

REMEDY

Replace bearings and inspect for defective gears

9. EXCESSIVE GEAR NOISE AT HIGH SPEED (RPM)

CAUSE

Main regulator valve orifice plugged

REMEDY

Clean main regulator valve orifice

10. TRANSMISSION OIL BLOWS OUT OF BREATHER ON TOP OF TRANSMISSION

CAUSE

Converter seal ring broken

REMDY

Replace converter hub seal ring

11. TRANSMISSION OVERHEATING

CAUSE

Converter stalling

REMEDY

Shift to lower gear

CAUSE

Transmission oil level too high

REMEDY

Drain to proper level. Consult lube chart

CAUSE

Engine overheating

REMEDY

- 1) Add engine coolant if required
- 2) Clean radiator

CAUSE

Transmission oil cooler dirty

REMEDY

Flush and clean transmission oil cooler

CAUSE

Transmission oil level low

REMEDY

Add transmission oil. Consult lube chart

12. TRANSMISSION PRESSURE CHECK ALRIGHT, BUT UNIT HAS NO POWER

CAUSE

Converter sprag clutch jammed

REMEDY

Repair converter

CAUSE

Converter sprag clutch installed wrong

REMEDY

Reinstall clutch correctly

AXLE ASSEMBLY

1. WHEELS PULL TO RIGHT OR LEFT

CAUSE

Tires not properly inflated

REMEDY

Inflate tires properly

CAUSE

Tires worn

REMEDY

Check and replace tires

2. STEERING IS ERRATIC

CAUSE

Tie rods out of adjustment or worn

REMEDY

Adjust or repair tie rods

CAUSE

Tires or wheels damaged

REMEDY

Repair or replace wheels or tires

CAUSE

Wheel bearings worn

REMEDY

Replace wheel bearings

CAUSE

Worn pivot and spindle assembly
trunnion bearings

REMEDY

Replace pivot and spindle assembly
trunnion bearings

3. WHEEL END LEAKS OIL

CAUSE

Hub seal defective

REMEDY

Replace hub seal

CAUSE

Wheel end cover O-ring defective

REMEDY

Replace wheel end cover O-ring

4. WHEELS NOISY WHEN TURNED TO RIGHT OR LEFT

CAUSE

Air pressure low or unevenly worn tires

REMEDY

Service or replace tires

CAUSE

Fluid level low in differential or wheel end

REMEDY

Service wheel end or differential

CAUSE

Constant velocity joint worn

REMEDY

Repair constant velocity joint

5. EXCESSIVE NOISE IN TRANSFER OF POWER FROM ENGINE TO WHEELS

CAUSE

Drive shaft(s) defective

REMEDY

- 1) Replace drive shaft(s)
- 2) Repair drive shaft(s)

CAUSE

Differential defective

REMEDY

Replace ring and pinion gears

WINCH

1. WINCH WILL NOT DEVELOP MAXIMUM LINE PULL

CAUSE

Winch relief valve set too low

REMEDY

- 1) Adjust winch relief valve
- 2) Replace winch control valve

CAUSE

Winch relief valve sticking

REMEDY

Replace winch control valve

CAUSE

Main relief valve set too low

REMEDY

- 1) Adjust main relief valve
- 2) Replace main control valve

CAUSE

Main relief valve sticking

REMEDY

Replace main control valve

CAUSE

Winch motor worn or damaged

REMEDY

- 1) Replace winch motor
 - 2) Repair winch motor
-

CAUSE

Main hydraulic pump worn or damaged

REMEDY

- 1) Replace main hydraulic pump
- 2) Repair main hydraulic pump

CAUSE

Rotary manifold leaking

REMEDY

- 1) Replace rotary manifold
- 2) Repair rotary manifold

2. WINCH WILL LOWER BUT WILL NOT RAISE

CAUSE

Insufficient parts of line for load being lifted

REMEDY

Consult capacity chart for maximum loads.
Reduce load as required

CAUSE

Anti-two block system malfunction

REMEDY

Refer to section on anti-two block troubleshooting

3. WINCH WILL NOT LOWER LOAD OR NOT LOWER LOAD SMOOTHLY

CAUSE

Problem could be plugged or loose pilot orifice. Pilot orifice is a small pipe plug with a hole drilled through it, located behind pilot port fitting on brake valve. If it becomes plugged, it will prevent pilot pressure from opening brake valve. If it becomes loose, it will allow an unregulated amount of oil in to operate brake valve, which causes erratic brake valve operation.

REMEDY

Remove pilot hose and fitting brake valve, then use a 5/32 in. allen wrench to remove pilot orifice. Diameter of orifice is approximately 0.020 in. (0.51 mm). Clean and install pilot orifice tightly in brake valve.

CAUSE

Brake cylinder seal leaking

REMEDY

- 1) Replace winch
- 2) Repair winch

CAUSE

Brake discs damaged

REMEDY

- 1) Replace winch
- 2) Repair winch

4. HYDRAULIC OIL LEAKS FROM VENT PLUG

CAUSE

Brake cylinder seal defective

REMEDY

- 1) Replace winch
- 2) Repair winch

CAUSE

High hydraulic system back pressure

REMEDY

- 1) Clean hydraulic return filter
- 2) Clean out hydraulic return lines
- 3) Repair or replace pinched hydraulic return lines

5. THE BRAKE WILL NOT HOLD A LOAD WITH THE CONTROL LEVER IN NEUTRAL

CAUSE

High hydraulic system back pressure

REMEDY

- 1) Clean hydraulic return filter
- 2) Clean out hydraulic return lines
- 3) Repair or replace pinched hydraulic return lines

CAUSE

Brake discs damaged

REMEDY

- 1) Replace winch
- 2) Repair winch

CAUSE

Brake clutch slipping

REMEDY

- 1) Replace winch
- 2) Repair winch

6. WINCH WILL NOT HOIST RATED LOAD

CAUSE

Winch mounted on an uneven or flexible surface

REMEDY

- 1) Inspect upperstructure for cracks or defects
- 2) First loosen, then evenly retighten all winch mounting bolts to recommended torque

CAUSE

Winch relief valve set too low

REMEDY

- 1) Adjust winch relief valve
- 2) Replace winch control valve

CAUSE

Rigging and sheaves not operating efficiently

REMEDY

Perform rigging service as recommended (refer to Koehring Commercial Operation Instructions manual)

7. THE WINCH RUNS HOT

CAUSE

Winch mounted on an uneven or flexible surface

REMEDY

- 1) Inspect upperstructure for cracks or defects
- 2) First loosen, then evenly retighten all winch mounting bolts to recommended torque

CAUSE

Hydraulic oil cooler plugged

REMEDY

Thoroughly clean exterior and flush interior of hydraulic oil cooler

CAUSE

Internal winch parts excessively worn or damaged

REMEDY

- 1) Replace winch
- 2) Repair winch

8. WINCH “CHATTERS” WHILE RAISING RATED LOAD

CAUSE

Winch relief valve set too low

REMEDY

- 1) Adjust winch relief valve
- 2) Replace winch control valve

9. WIRE ROPE DOES NOT SPOOL SMOOTHLY ON DRUM

CAUSE

Rope damaged or spooled without tension

REMEDY

Consult wire rope section of Koehring Commercial Operation Instructions manual

CAUSE

Winch may have been overloaded, causing permanent set in wire rope

REMEDY

Replace wire rope (consult Capacity Chart for maximum load)

Section II.
**PREVENTIVE MAINTENANCE CHECKS
AND SERVICES (PMCS) SCHEDULE**

The following Preventive Maintenance Checks and Services (PMCS) should be followed regularly to maintain the LRT 110 Crane at peak operating condition. Perform PMCS more often to compensate for continuous operation or under abnormal conditions (i.e. extreme cold or heat; exposure to moisture or salt; operation in dust or sand).

NOTE

Routinely perform operator's PMCS when the operator is not available to assist in maintenance level PMCS or when operator's PMCS has not been performed on schedule (refer to Koehring Commercial Operation Instructions manual).

The PMCS schedule below is provided as information and is not authorization for performance of procedures. Perform only those procedures authorized by your organization.

Two Week Check or Every 80 to 100 Hours of Service

Check swing reducer oil level (refer to page 15-33).

Check Winch Lubrication Level: (Figure 3-1)

1. Remove plug (Figure 3-1).
2. If oil is not visible, fill to level of plug (refer to Koehring Commercial Operation Instructions manual for lubrication specifications).

Check operation of speedometer alarm (refer to page 17-71).

Three Month Check or Every 250 Hours of Service

Service Air Filter:

NOTE

When the air restriction indicator is in the red zone, the air cleaner will need to be serviced.

1. Loosen clamp (1) on air cleaner (6, Figure 3-2) from underneath carrier.
2. Remove cup (2) and baffle (3, Figure 3-3).
3. Separate cup (2) and baffle (3).
4. Remove wing nut (4) and element (5).

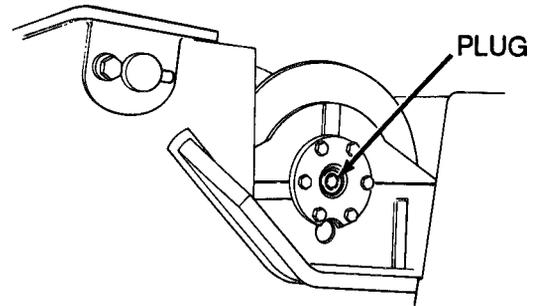


Figure 3-1

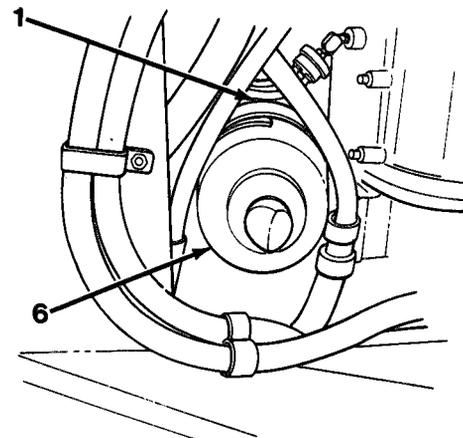


Figure 3-2

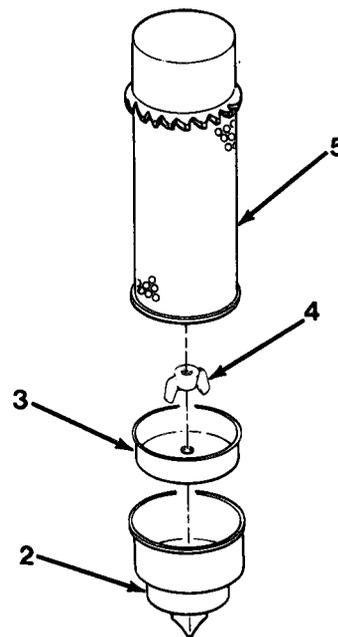


Figure 3-3

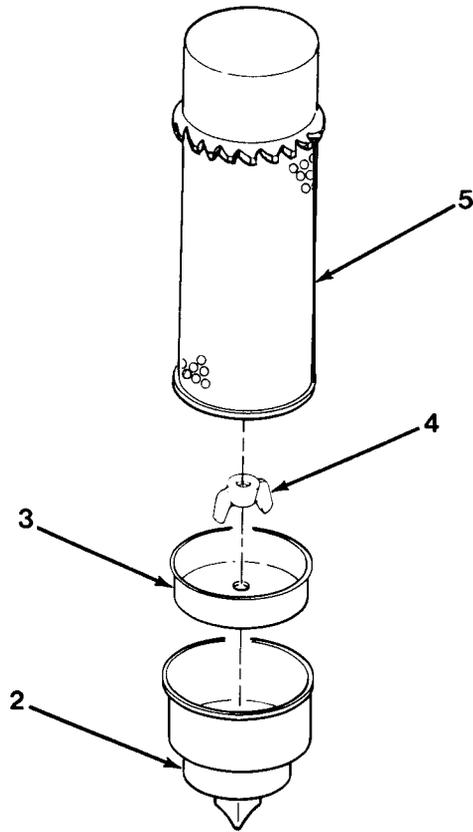


Figure 3-3

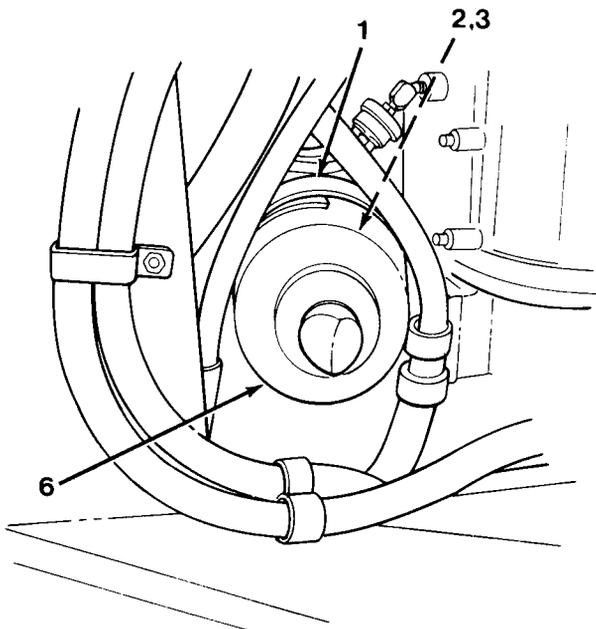


Figure 3-2

Service Air Filter:

⚠ WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

5. Clean cup (2, Figure 3-3) with compressed air.
6. Clean element (5) with compressed air. Keep air nozzle perpendicular to element (5) pleats while rotating element (5).
7. Inspect element (5) by placing a bright light inside element (5). If element (5) has thin spots, pin holes or small ruptures, element (5) must be replaced.
8. Install element (5) and wing nut (4).
9. Install baffle (3) in cup (2).
10. Install baffle (3) and cup (2) on bottom of air cleaner (6, Figure 3-2).
11. Tighten clamp (1).

Change Engine Oil and Oil Filter

1. Warm engine oil prior to draining.
2. Place a suitable container under oil filter (Figure 3-4).
3. Using a strap wrench, remove oil filter.
4. Place a suitable container under engine oil pan and remove drain plug (Figure 3-5). Engine holds 10 qt (9.46 L). Drain engine oil.
5. Install drain plug, torque to 60 lb-ft (81 N•m) and fill with 10 qt (9.46 L) of engine oil (refer to Koehring Operation Instructions manual for lubrication specifications).
6. Coat oil filter seal with clean engine oil, fill oil filter with oil and install hand-tight. Oil filter holds 1 qt (0.95 L).
7. Start engine and run for approximately 5 minutes. Check for leaks.

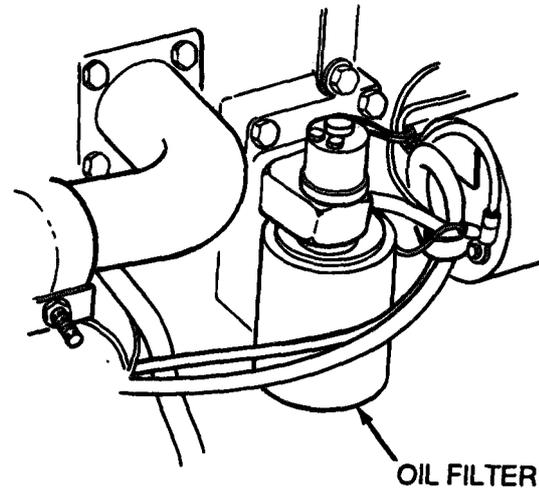


Figure 3-4

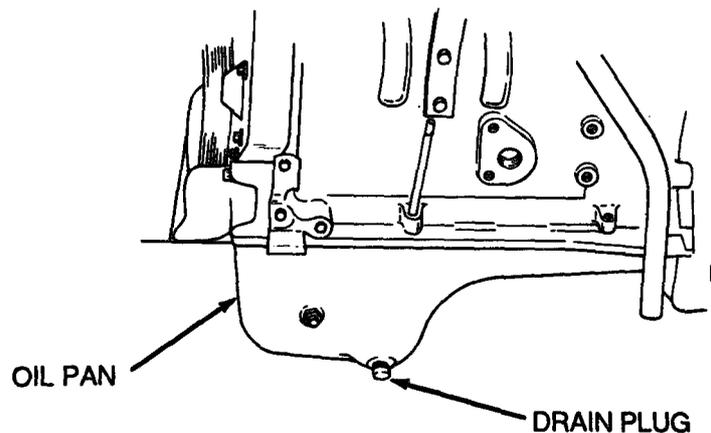


Figure 3-5

Four Month Check or Every 500 Hours of Service

Change fuel filter elements (refer to page 7-30).

Clean hydraulic suction filter (refer to page 3-49).

Change hydraulic return line filter (refer to page 13-70).

Drain Fuel Tank of Water and Sediment:

⚠ WARNING

Diesel fuel and other combustible materials are used in operation and maintenance of this equipment. Do not smoke or allow open flames in areas where combustible materials are stored or used. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Machine must be level and not operated for approximately 1 hour to allow fuel and water to separate.

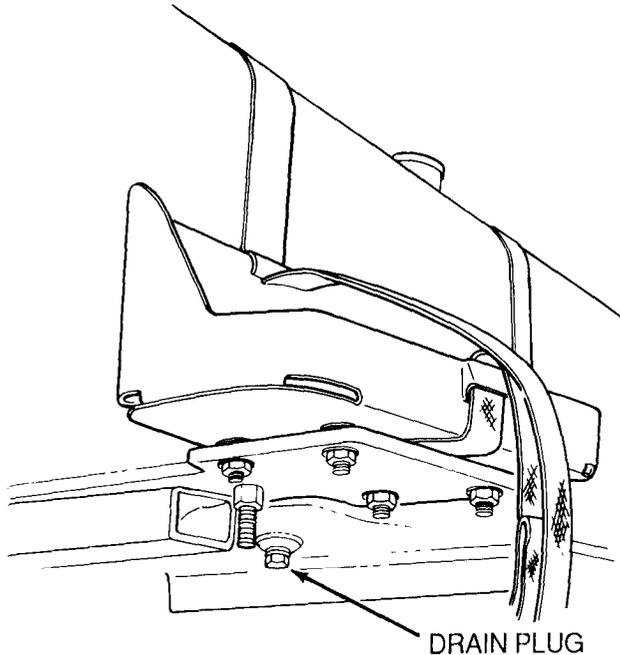


Figure 3-6

1. Place a suitable container under fuel tank. Fuel tank holds 40 gal (151.4 L).
2. Loosen plug located at the bottom of fuel tank and drain until fuel runs clearly and no water remains (Figure 3-6).
3. Install drain plug and refill fuel tank (refer to Koehring Commercial Operation Instructions manual for fuel specifications).

Clean Hydraulic Suction Filter

1. Suction Filter Removal:

- a. Remove deck plate (refer to page 14-9).



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

- b. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
- c. Remove plug (7), O-ring (8), eight nuts (9), washers (10), cover (11) and O-ring (12, Figure 3-7).
- d. Remove filter (13) and O-ring (14) from reservoir.

2. Suction Filter Cleaning/Inspection:

- a. Clean all parts (refer to Chapter 2).
- b. Inspect all parts (refer to Chapter 4).

3. Suction Filter Installation:

- a. Install O-ring (14) and filter (13, Figure 3-7).
- b. Install O-ring (12), cover (11), eight washers (10), nuts (9), O-ring (8) and plug (7).
- c. Close dipstick cap. Operate crane at part throttle to slightly pressurize the reservoir.
- d. Bleed out all air by loosening plug (7). Tighten plug (7).
- e. Install deck plate (refer to page 14-9).

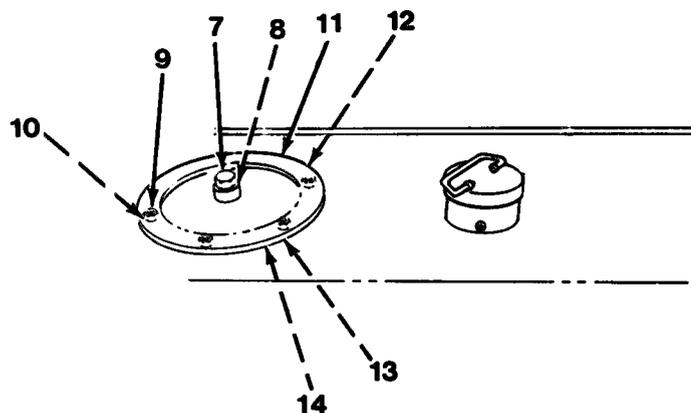


Figure 3-7

Change Transmission Oil and Transmission Oil Filter (Figure 3-8):

1. Warm transmission oil to operating temperature prior to draining.
2. Using a strap wrench, remove transmission oil filter.
3. Place a suitable container under transmission. Transmission holds 12qt(11.36 L).
4. Remove drain plug located on the bottom of transmission and drain.

NOTE

New or rebuilt transmission will require 20.5 qt (19.40 L) of transmission oil.

5. Install drain plug and fill transmission with 12 qt (11.36 L) of transmission oil (refer to Koehring Commercial Operation Instructions manual for lubrication specifications).
6. Coat transmission oil filter seal with clean transmission oil and install hand-tight. Warm transmission oil and check for leaks and proper level.

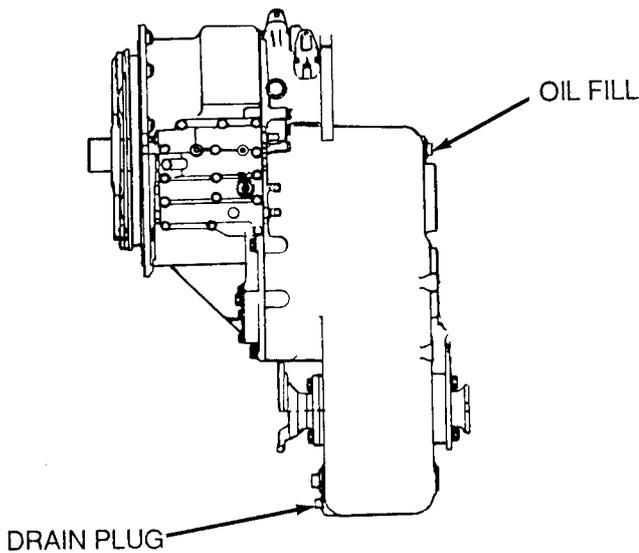


Figure 3-8

Check Antifreeze Concentration:

1. Using an antifreeze tester, test the antifreeze concentration for -34 degrees F (-37 degrees C).
2. Maintain a 50/50 mixture of antifreeze to water (refer to Koehring Commercial Operation Instructions manual for antifreeze specifications).

Six Month Check or Every 1,000 Hours of Service

Adjust engine valve lash clearance (refer to page 6-38).

Change winch oil (refer to page 3-53).

Check relief valve pressure settings (refer to page 3-59).

Tighten swing bearing bolts (refer to page 15-17).

Check Axle Differential and Hub Oil Levels:

NOTE

Vehicle must be level for axle hub and differential oil level checks.

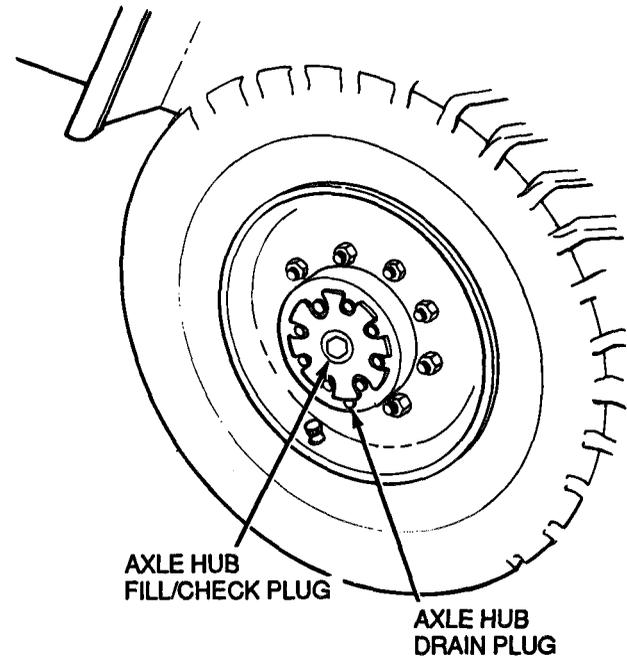


Figure 3-9

1. Remove axle hub fill check plug (Figure 3-9).
2. If oil is not visible, fill to level of fill/check plug (refer to Koehring Commercial Operation Instructions manual for lubrication specifications). Install fill/check plug.
3. Remove fill/check plug (Figure 3-10).
4. If oil is not visible, fill to level of fill/check plug (refer to Koehring Commercial Operations manual). Install fill/check plug.

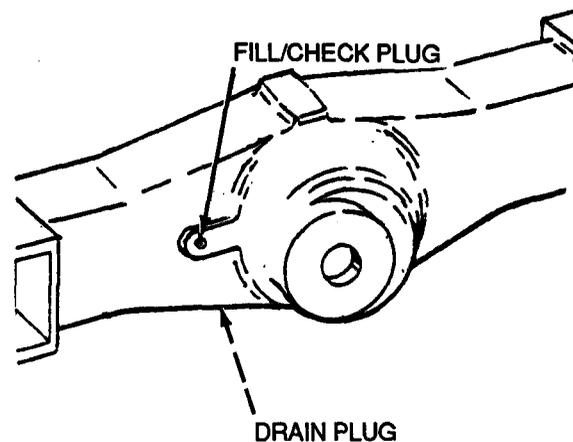


Figure 3-10

Check brake shoes for wear condition (refer to page 12- 12).

Inspect brake shoes for cracks, scoring, grooves or wear. If brake shoe is less than 0.177 in. (4.50 mm) thick, or if inspection indicates damage, replace.

Check Fan Hub Bearing For End Play (Figure 3-11):

⚠ WARNING

Never perform fan hub bearing end play check with the engine running. Failure to follow this procedure could cause **SERIOUS INJURY**.

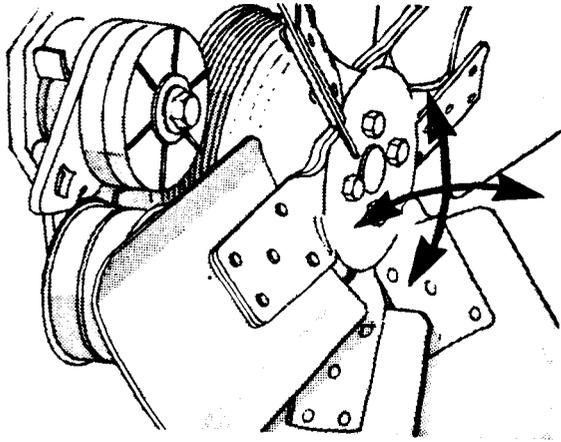


Figure 3-11

1. Release tension of fan belt (refer to page 6-12).
2. Fan should spin freely. Grasp fan blade and alternately push and pull fan to check for end play.

Change Winch Oil:

1. Start engine and rotate winch drum to align drain plug (15, Figure 3-12) and access hole in base.
2. Insert a length of 1 in. (25.4 mm) I.D. pipe and screw into the larger threads of drain hole.
3. Position a suitable container under pipe.
4. Remove drain plug (15) and O-ring (16) and drain.
5. Install drain plug (15) and O-ring (16). Remove pipe and oil level plug (17) and O-ring (18).

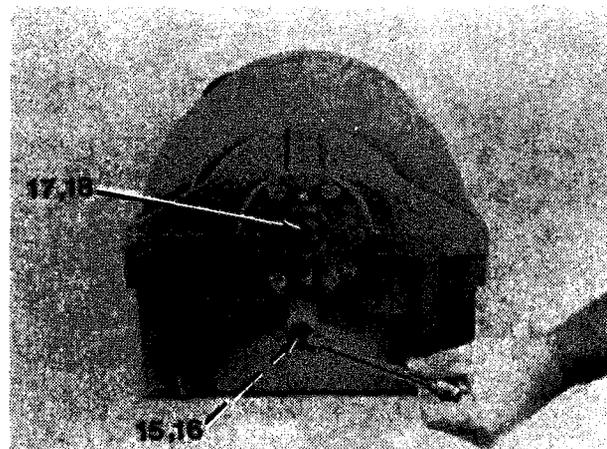


Figure 3-12

Add approximately 2 qt (1.89 L) of lubricant.

Allow time for lubricant to flow through winch and then check that lubricant level is at bottom of oil level plug threads.

8. Install oil level dug (17) and O-ring (18).

Twelve Month Check or Every 1,500-2,000 Hours of Service

Drain and Clean Hydraulic Reservoir (Figure 3-13):

1. Warm hydraulic oil to operating temperature prior to draining.
2. Position a suitable container under hydraulic reservoir. Hydraulic reservoir holds 23.8 gal (90.09 L).

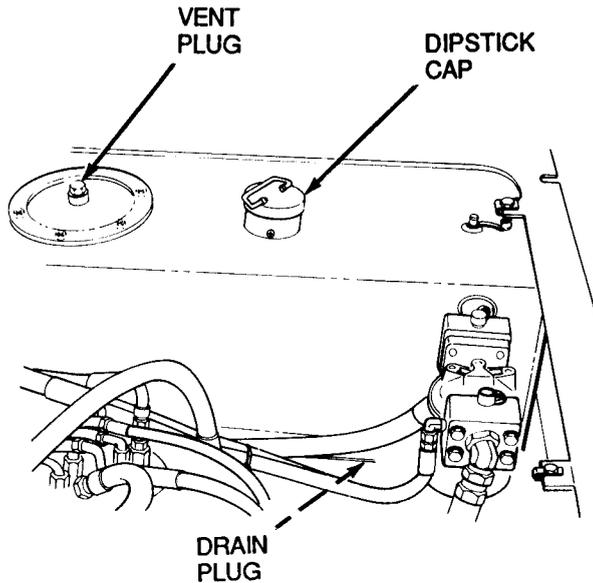


Figure 3-13

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Hydraulic reservoir must be completely drained and flushed to remove any water or sediment.

3. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Remove drain plug at bottom of hydraulic reservoir and drain.
4. Remove suction filter (refer to page 13-68).

⚠ WARNING

Diesel fuel and other combustible materials are used in operation and maintenance of this equipment. Do not smoke or allow open flames in areas where combustible materials are stored or used. Failure to follow this procedure could cause DEATH or serious injury.

5. Replace drain plug and fill hydraulic reservoir with 10 gal (37.9 L) of diesel fuel. Allow fuel to remain in hydraulic reservoir approximately 1 hour to thoroughly clean it.
6. Remove drain plug and drain diesel fuel from hydraulic reservoir.
7. Install drain plug and add 15 gal (56.8 L) of hydraulic oil (refer to Koehring Commercial Operation Instructions manual for hydraulic oil specifications).
8. Remove drain plug and drain hydraulic oil from reservoir.
9. Install drain plug and fill hydraulic reservoir with 23.8 gal (90.09 L) of hydraulic oil (refer to Koehring Commercial Operation Instructions manual for hydraulic oil specifications).
10. After refilling hydraulic reservoir, it will be necessary to bleed air from system. Open vent plug on suction filter cover and vent until filling is complete. Close vent plug and dipstick cap. Operate crane at part throttle to slightly pressurize hydraulic reservoir. Then bleed out all air by loosening vent plug. Tighten vent plug.

Drain and Refill Swing Reduction Unit:

1. Remove deck plate (refer to page 14-9).
2. Position a suitable container under swing reduction unit.
3. Remove drain plugs and fill/check plug (Figure 3-14) to drain oil.
4. Install drain plugs.
5. Fill with gear oil to level of fill/check plug (refer to Koehring Commercial Operation Instructions manual for gear oil specifications).
6. Install fill/check plug.
7. Install deck plate (refer to page 14-9).

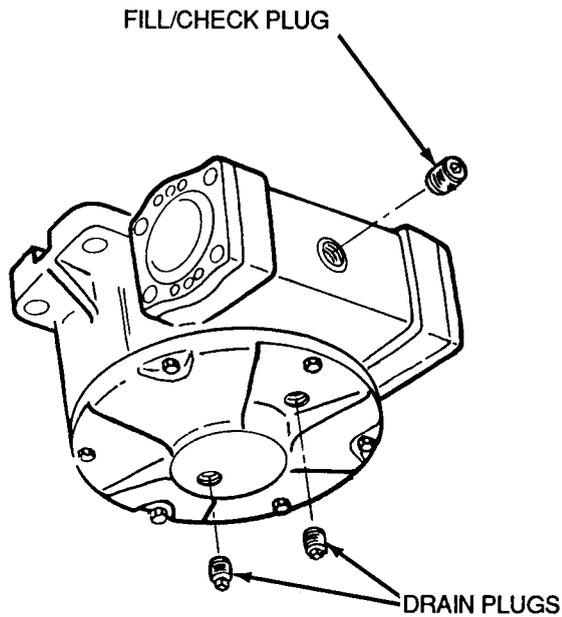


Figure 3-14

Change Axle Hub Oil and Differential Oil:

1. Position axle hub drain plug at "6 o'clock" (Figure 3-9).
2. Position a suitable container under axle hub drain plug. Axle hub holds 3 qt (2.84 L).
3. Remove axle hub drain plug and drain oil completely.
4. Install axle hub drain plug.
5. Remove axle hub fill plug.
6. Fill axle hub with 3 qt (2.84 L) of oil. Oil level should be level of fill plug. If not, add oil to obtain fill plug level (refer to Koehring Commercial Operation Instructions manual for oil specifications). Install new sealing washer and axle hub fill plug.
7. Repeat steps 1 thru 6 for remaining three axle hubs.
8. Position a suitable container under differential housing.
9. Remove drain plug at the bottom of differential housing and drain oil completely (Figure 3-10).
10. Install drain plug and remove fill/check plug on top rear of differential. Fill with oil and install fill/check plug (refer to Koehring Commercial Operation Instructions manual for oil specifications).

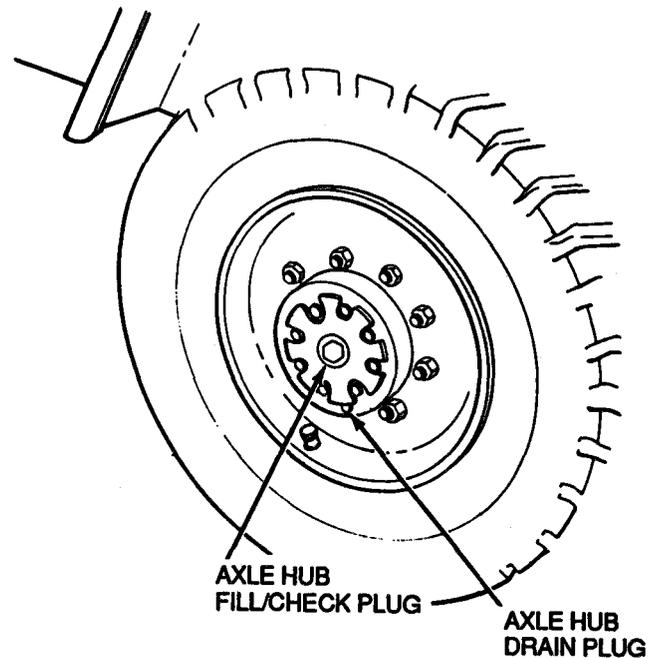


Figure 3-9

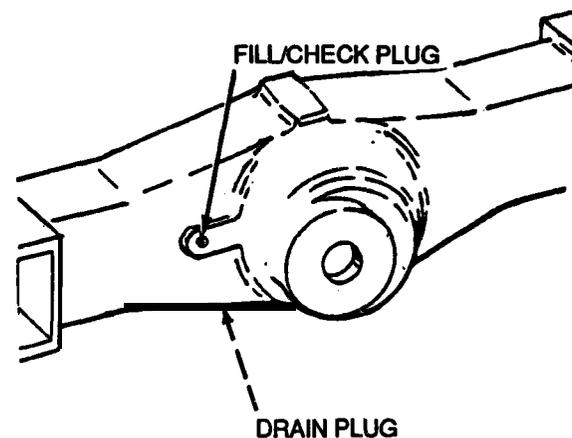


Figure 3-10

Change Engine Coolant:

⚠ WARNING

Cooling system is pressurized. Use extreme caution and proper protection when removing radiator cap after operating temperature is reached. Steam and hot gases will be escaping through the radiator cap; avoid being burned by these escaping gases. When removing cap, loosen it slowly to the left, then pause a moment. Continue to turn cap until it can be removed. Failure to follow this procedure could cause **SERIOUS INJURY**.

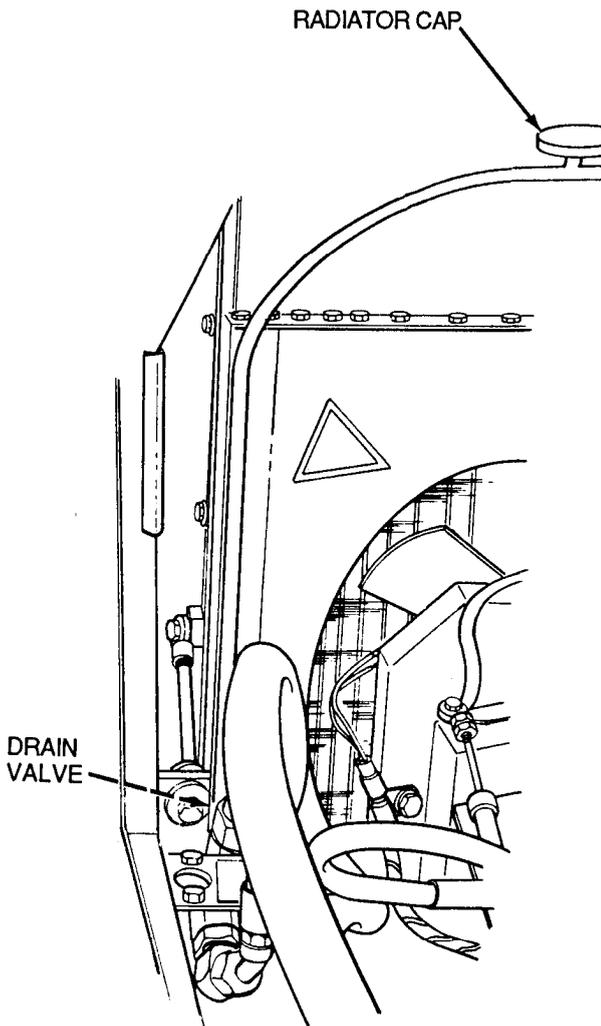


Figure 3-15

1. Remove radiator cap and drain cooling system by opening drain valve on bottom tank of radiator and removing plug in side of engine coolant inlet (Figure 3-15). Drain radiator into a suitable container. Radiator holds 28 qt (26.50 L).
2. Check for damaged coolant hoses and loose or damaged hose clamps. Replace as required.
3. To clean system, flush with clean water. If system shows mineral build-up, scale, rust or oil, use a heavy duty radiator cleaner and follow manufacturers directions.
4. Replace plug, close drain valve and refill cooling system with a 50/50 mixture of water and ethylene-glycol type antifreeze. Adequate venting is provided for a fill rate of 32 qt (30.38 L) per minute, so allow time for air to be expelled in order to get a complete fill.
5. Install radiator cap and start engine. Check for leaks while running engine for 5 minutes.

⚠ WARNING

Cooling system is pressurized. Use extreme caution and proper protection when removing radiator cap after operating temperature is reached. Steam and hot gases will be escaping through the radiator cap; avoid being burned by these escaping gases. When removing cap, loosen it slowly to the left, then pause a moment. Continue to turn cap until it can be removed. Failure to follow this procedure could cause **SERIOUS INJURY**.

6. Remove radiator cap, recheck coolant level and add coolant if necessary.

Check Hydraulic Pressure Relief Valves:

Hydraulic system has three separate pressure circuits that have protective adjustable relief valves (Figure 3-16):

1. Main relief valve - set at $2,750 \pm 50$ psi ($18,960 \pm 345$ kPa) at full flow. Controls outriggers, boom hoist and boom extend.
2. Winch relief valve - set at $2,650 \pm 50$ psi ($18,270 \pm 345$ kPa) at full flow.
3. Swing relief valve - set at $2,500 \pm 50$ psi ($17,240 \pm 345$ kPa) at full flow.

MAIN CONTROL VALVE

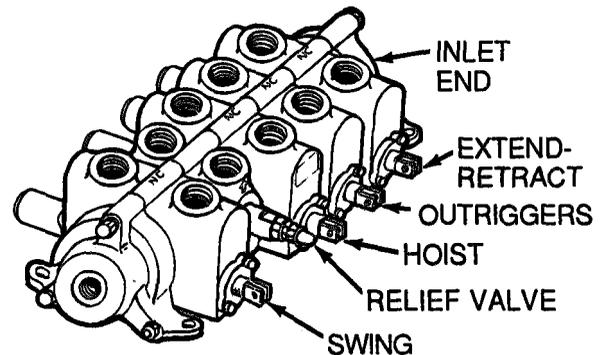


Figure 3-15

WINCH CONTROL VALVE

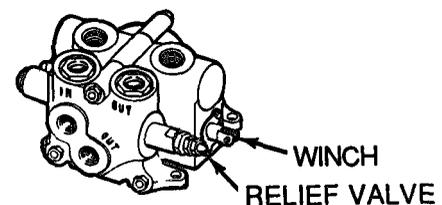


Figure 3-16

Check Relief Valve Adjustments:

Setting hydraulic pressure is an extremely intricate operation and should be performed only after satisfying the following conditions:

1. Warm hydraulic oil to operating temperature.
2. Be sure to operate at full governed engine speed as relief valve setting will vary with flow rate.
3. Use a good quality 4,000 psi (27,580 kPa) gauge equipped with a short pressure hose and 1/4 inch female quick disconnect. Be certain to calibrate pressure gauge used. Gauge calibration can be lost if gauge is subjected to rapidly pulsating pressure for a few seconds. Gauge must have a proper snubber to read center of pump pressure ripple or erroneous readings will result.

NOTE

- Relief valves used on this crane have screw-type adjustments. If it is determined that a relief valve is out of adjustment, follow this general adjustment procedure. Install a 4,000 psi (27,580 kPa) gauge in the designated test port locations and proceed with pressure check and adjustments.

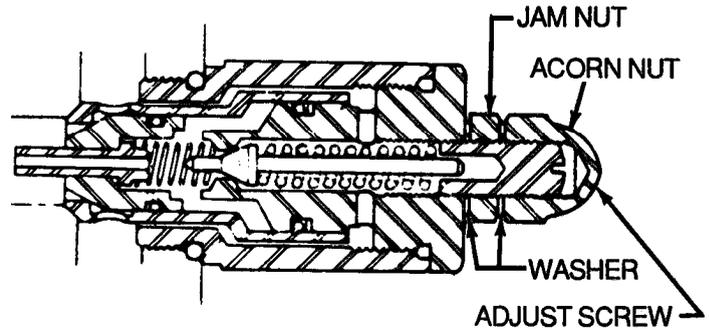
- If STE/ICE R is available, this version contains a 5,000 psi (34,475 kPa) pressure transducer. This may be substituted for the 4,000 psi gauge referenced for checking the hydraulic circuit pressures. By attaching the 1219-879 adapter between the transducer and the 7091272-18 hose the transducers threaded 1/4" pipe connection will adapt to the hose.

4. Remove acorn nut and loosen jam nut (Figure 3-17).
5. Run engine at full rpm so pump will develop required flow.
6. Operate one plunger of control valve at its extreme position long enough to get a pressure reading on the gauge.
7. Turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure until desired pressure setting is obtained.
8. Holding adjusting screw, tighten jam nut. Install and tighten acorn nut.
9. Retest to check pressure setting.

NOTE

Results of the above settings will indicate a relatively constant relief valve setting across full engine rpm.

RELIEF VALVE FOR THE MAIN CONTROL AND WINCH CONTROL VALVES



CARTRIDGE FOR THE STEERING AND SWING RELIEF VALVE

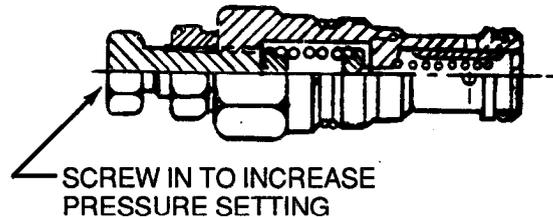


Figure 3-17

Check main relief valve (refer to page 13-73).

Check winch relief valve (refer to page 16-42).

Check steering/swing control relief valve (refer to page 13-88).

CHAPTER 4
INSPECTION PROCEDURES

Title	Page
General Inspection	4-1
Electrical Inspection	4-1
Bearing Inspection	4-1

GENERAL INSPECTION

Proper inspection of parts and operating equipment prevents small problems from becoming major problems. Use the following guidelines when inspecting the LRT 110 Crane

1. Visually check for any broken welds, loose fasteners, damaged threads, bending, cracking, deformity, nicks, cuts, tears, scratches, gouges, distortion, blockage or inoperability.
2. Equipment defects can be discovered by performing preventive maintenance checks at both operator and maintenance levels.
3. Inspect disassembled, cleaned parts for damage listed previously.
4. Check for wear.
5. Replace all seals and gaskets with new seals and gaskets.
6. Inspect all new parts for defects before installation.

ELECTRICAL INSPECTION

1. Make sure all connections are tight.
2. Electrical wires, cables and connections should be checked for cracks due to aging and for exposed wires which could cause an electrical short.

BEARING INSPECTION

Bearings are inspected by holding the inner race so that the axis is vertical (bearing is horizontal). Turn the outer race slowly. Bearing may have a small amount of tarnish, stain or corrosion on the outside surface of the races. Operation of the bearing is not affected and they need not be rejected.

If bearings feel slightly rough or have a tendency to stick at certain points when rotated, reclean. Determine cause of sticking and reject if necessary.

Reject bearings with the following defects: broken or cracked races; dented shields or seals; cracked or broken separators, balls or rollers; flaked areas on balls, rollers or raceways; signs of heating (darkened to brownish-blue or blue-black); and indentations from ball or roller impressions. An anti-friction bearing, properly lubricated, should not wear unless dirt or abrasive foreign matter gets into it. Dirt mixed with grease or oil will lap down balls and rollers. Load-carrying surfaces of anti-friction bearings are finished with extreme care and will sustain very heavy loads unless the surfaces are damaged by abusive handling or by foreign matter.

TM5-3810-305-24

CHAPTER 5
PERFORMANCE VERIFICATION

Title	Page
Vehicle and STE/ICE Troubleshooting	5-1
ST/ICE Test Procedure	5-3

VEHICLE AND SERVICE TROUBLESHOOTING

General. To troubleshoot a vehicle problem, the technician can use STE/ICE (vehicle test meter and transducers).

Data Entry Tests. For information regarding Data Entry, Cylinder Entry, and Data Display Tests, refer to TM 9-4910-571-12&P.

Offset Tests. The STE/ICE VTM performs a test by setting the TEST SELECT switches to the test number and then pressing the TEST button.

For some tests, an offset test is required before the test itself can be performed. This is done by selecting the number of the desired test and holding the TEST button down for several seconds.

The offset test nulls characteristic differences in the vehicle test meter (VTM), test leads, and transducers. It zeros the meter. Once the offset is performed, the VTM automatically corrects for the offset before displaying measured values.

The displayed offset value should be checked against limits given in the test procedure. If the displayed value is outside these limits, either the transducer or the test cable is faulty and must be replaced. This is a form of self-test. Perform the offset test when each transducer is connected.

The offset test is performed with the test probe cable in TK mock or DCA plug connected to the VTM.

Care should be taken to see that no stimulus is applied to the transducer in TK mode. Test probe cable leads should be shorted together. To perform an offset test, dial the test number into the TEST SELECT switches. Press and hold the

TEST button, until the prompting message CAL appears on the display.

In a few seconds after release of the TEST button, a number will appear. This is the measured offset value associated with the test probe cable or transducer and cable.

d. Control Tests. These tests are used to change (or control) the way a vehicle test is displayed, or the way it is run. There are four control tests:

01 Interleave (displays rpm with next test).

02 Minimum Value (displays minimum value for next test).

03 Maximum Value (displays maximum value for next test).

04 Peak to Peak Value (displays peak-to-peak value for next test).

NOTE

Control tests 01,02,03, and 04 specify the action to be taken by the next test only. A subsequent test will reset the control.

1. Interleave (Test 01).

This test alternately measures engine speed and a second parameter-such as fuel pressure or alternator voltage.

To initiate interleave, dial 01 into the TEST SELECT switches and press and release the TEST button.

The prompting message PASS is the signal to dial in the second test number and again press and release the TEST button.

2. Minimum Value (Test 02).

This test displays the minimum value measured during a test.

To initiate a minimum value display, dial 02 into the TEST SELECT switches and press and release the TEST button.

The prompting message PASS is the signal to dial in the desired test number and again press and release the TEST button.

The minimum value is displayed and updated whenever a lower minimum value is measured. Entering 02 and the test number again will reset the process and a new minimum value will be displayed.

3. Maximum Value (Test 03).

This test displays the maximum value measured during a test.

To initiate a maximum value display, dial 03 into the TEST SELECT switches and press and release the TEST button.

The prompting message PASS is the signal to dial in the desired test number and again press and release the TEST button.

The maximum value is displayed and updated whenever a higher maximum value is measured. Entering 03 and the test number again will reset the process and a new maximum value will be displayed.

4. Peak-to-Peak Value (Test 04).

This test displays the peak-to-peak value of alternator/generator output volts (82), 45 volts DC (89), 1500 amps DC (90) and battery volts (67).

To start a peak-to-peak measurement, dial 04 into the TEST SELECT switches and press the TEST button.

The prompting message PASS is the signal to dial in one of the four numbers (82, 89,90, 67) and again press the TEST button.

STE/ICE TEST PROCEDURE (Test Card Is on page 5-7)

1. Verify that engine oil, transmission oil, engine coolant fuel and batteries are at proper level. Check fan belt installation.
 2. Born VTM/XDCR Kit Assembly, STE/ICE, remove top tray containing TM 9-4910-571 - 12&P, Simplified Test Equipment For Internal Combustion Engines, and temporarily set aside.
 3. Remove DCA cap from DCA receptacle located in right rear of cab. Remove cable W1 from STE/ICE kit. Attach cable W 1 to DCA receptacle.
 4. Make sure VTM is OFF. Attach other end of cable W1 to J1 plug on VIM.
 5. Turn VTM ON. Change TEST SELECT switches to read 66. Push TEST button. Change TEST SELECT swiches to read 99. Push TEST button. VTM will display a series of numbers and then PASS. If display does not read PASS or C, or an incorrect display appears, refer to TM 9-4910-571-12&P.
 6. Change TEST SELECT switches to read 60. Push TEST button. VTM will display VEH. Refer to vehicle test card for vehicle identification (VID) number. Change TEST SELECT switches to read VID number. Push TEST button. VTM will display 28. Change TEST SELECT switches to read 61. Push TEST button. VTM will flash VII) number. Change TEST SELECT switches to read 58. Push TEST button. VTM will display CYL. Change TEST SELECT switches to read 04. Push TEST button. Change TEST SELECT switches to read 62. Push TEST button. VTM will flash 04. Change TEST SELECT switches to read 67. Push TEST button. VTM will flash battery voltage. Refer to test card for battery voltage test limits. If battery voltage falls outside test limits, service batteries (refer to page 10-16).
 7. Start engine. Operate engine at 1,000 to 1,200 rpm. Change TEST SELECT switches to read 01. Push TEST button. VIM will display PASS. Change TEST SELECT switches to read 67. Push TEST button. VTM will alternately flash battery charge voltage and engine rpm. During this test engine speed must be maintained between 1,000 to 1,200 rpm. Refer to test card for battery charge voltage test limits. If battery charge voltage falls outside test limits, troubleshoot alternator/charging system.
 8. With engine speed at idle, change TEST SELECT switches to read 10. Push TEST button. VTM will display engine rpm Refer to test card for engine rpm idle test limits. If engine rpm idle falls outside test limits, adjust throttle idle speed (refer to page 17-14). Accelerate engine to full governed speed, no load. Refer to test card for engine rpm governed speed, no load, test limits. If engine rpm falls outside test limits, refer to page 3-6.
 9. Check vehicle engine oil pressure gauge reading. Perform TK engine oil pressure test to verify gage (refer to test card and TM 9-4910-571-12&P). If vehicle engine oil pressure gauge readings fall outside test limits but TK test is within limits, replace vehicle engine oil pressure gauge (refer to page 17-61).
 10. If TK test falls outside test limits, inspect vehicle for oil leaks, change oil filter (refer to page 3-47). Replace lube oil pump (refer to page 6-24).
-

11. Check air cleaner filter restriction gauge. Maximum reading is 25in. of water. If reading is above 25 in. of water, service air cleaner (refer to page 3-46).

12. Shut engine off. Wait 1 minute to allow fuel pressure to bleed off. Change TEST SELECT switches to read 24. Push TEST button until VTM displays CAL, then release button. Refer to test card for fuel supply pressure test offset limit. If CAL reading is high, break fuel supply line at tee to release line pressure and retest. Start engine. Accelerate engine to full governed speed. Push TEST button. VTM will display fuel supply pressure. Refer to test card for fuel supply pressure test limits. If fuel supply pressure falls outside test limits, inspect fuel supply lines for leaks or pinched tubes. Service fuel filters (refer to page 7-30). Replace fuel pressure transducer (refer to page 10-39). Replace fuel lift pump (refer to page 7-24).

13. Change TEST SELECT switches to read 26. Push TEST button. Accelerate engine to full governed speed. VTM will display either PASS or FAIL. If VTM displays FAIL, service fuel filters (refer to page 7-30).

14. With engine at idle, change TEST SELECT switches to read 27. Push TEST button. Refer to test card for fuel solenoid voltage test limits. If fuel solenoid voltage falls outside test limits, check wiring at fuel solenoid (refer to page 10-39), If fuel solenoid still falls outside test limits, replace fuel solenoid (refer to page 7-7, step 4 and 7-14, step 18).

15. Operate engine between 1,000 to 1,200 rpm. Change TEST SELECT switches to read 01. Push TEST button. VTM will display PASS. Change TEST SELECT switches to read 82. Push TEST button. Refer to test card for alternator voltage test limits. If alternator voltage falls

outside test limits, replace or repair alternator (refer to page 10-1).

16. Engine must be within the normal temperature range. With engine at idle, change TEST SELECT switches to read 12. Push TEST button. When VTM displays CIP, push accelerator pedal to floor and hold until VTM displays power test percent full power value. Return engine to idle. Refer to test card for power test percent full power test limits.

17. Shut engine off. Turn fuel switch OFF. Change TEST SELECT switches to read 14. Push TEST button. When VTM displays GO, crank engine. Stop cranking engine when VTM displays OFF or E013. If for some reason the cranking is incorrect, VTM will display EO13. If E013 is displayed, batteries could be discharged, cranking speed could be low or cranking was interrupted during test. Correct problem and repeat test. After VTM displays OFF, it will then display either FAIL or the compression unbalance test value. If FAIL appears, the compression unbalance value is too far unbalanced for VTM to measure. Refer to test card for compression unbalance test limits. If compression unbalance test falls outside test limits, replace engine (refer to page 6-1).

18. Change TEST SELECT switches to read 72. Push TEST button until VTM displays CAL, then release button. Refer to test card for current first peak test offset limits. Push TEST button again. VTM will display GO. Crank engine. When VTM displays OFF, stop cranking engine. VTM will display amperage value. Refer to test card for current first peak test limits. If amperage falls outside test limits, service batteries (refer to page 10-16).

19. Start engine. Check vehicle engine temperature gauge. Refer to test card for engine temperature test limits. If temperature falls outside test limits, replace thermostat (refer to page 9-1). If temperature is still outside test limits, replace water pump (refer to page 9-3).

20. Shut engine off. Turn fuel switch ON. Change TEST SELECT switches to read 01. Push TEST button. VTM will display PASS. Operate engine between 1,000 to 1,200 rpm. Change TEST SELECT switches to read 84. Push TEST button. Refer to test card for alternator negative cable voltage drop test limits. If voltage falls outside test limits, clean and inspect battery and ground connections.

21. Turn fuel switch OFF. Change TEST SELECT switches to read 80. Push TEST button until VTM displays CAL then release button. Refer to TEST card for starter motor current average offset hits. Push TEST button again. Crank engine. Stop cranking engine. VTM will display amperage value. Refer to test card for starter motor current average test limits. If amperage falls outside test limits, clean and inspect battery, starter and ground connections.

22. Change TEST SELECT switches to read 73. Push TEST button until VTM displays CAL, then release button. Refer to TEST card for battery internal resistance offset limits. Push TEST button again. VTM will display GO. Crank engine. When VTM displays OFF, stop cranking engine. VTM will display milliohm value. Refer to test card for battery internal resistance test limits. If milliohms fall outside test limits, service batteries (refer to page 10-16).

23. Change TEST SELECT switches to read 74. Push TEST button until VTM displays CAL, then release button. Refer to TEST card for starter current resistance offset limits. Push

TEST button again. VTM will display GO. Crank engine. When VTM displays OFF, stop cranking engine. VTM will display milliohm value. Refer to test card for starter current resistance test limits. If milliohms fall outside test limits, check starter connections. If test limits are still exceeded, replace or repair starter (refer to page 10-8).

24. Change TEST SELECT switches to read 75. Push TEST button until VTM displays CAL, then release button. Refer to TEST card for battery resistance charge offset limits. Push TEST button again. VTM will display GO. Crank engine. When VTM displays OFT, stop cranking engine. VTM will display milliohm value. Refer to test card for battery resistance charge test limits. If milliohms fall outside test limits, service batteries (refer to page 10-16).

25. Change TEST SELECT switches to read 70. Push TEST button. Crank engine. VTM will display voltage value while engine is cranking. Stop cranking engine. Refer to test card for starter solenoid voltage test limits. If voltage falls outside test limits, replace or repair starter (refer to page 10-8).

26. Change TEST SELECT switches to read 69. Push TEST button. Crank engine. VTM will display voltage value while engine is cranking. Stop cranking engine. Refer to test card for starter negative cable drop test limits. If voltage falls outside test limits, clean and inspect battery and starter cable connections.

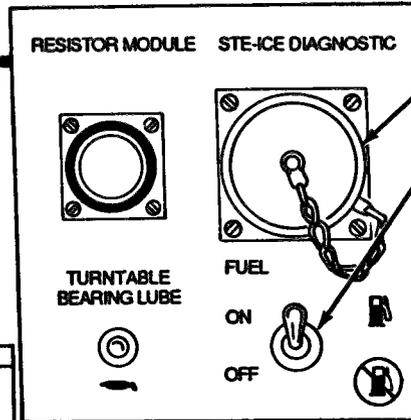
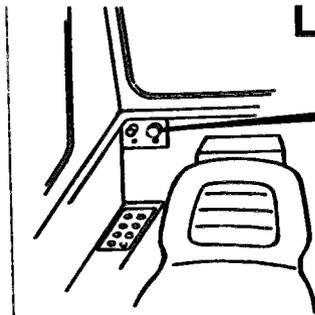
27. Change TEST SELECT switches to read 68. Push TEST button. Crank engine. VTM will display voltage value while engine is cranking. Stop cranking engine. Refer to test card for starter motor voltage test limits. If voltage falls outside test limits, service batteries (refer to page 10-16).

28. Turn fuel switch ON. Start engine. Operate vehicle at proper road speeds. Check vehicle transmission temperature gauge. Refer to test card for vehicle transmission temperature limits. If temperature reading falls outside limits, service transmission oil filter.

29. Perform TK return fuel pressure test (refer to test card and TM 9-4910-571-12&P). If pressure value falls outside test limits, inspect fuel return hoses for kinks or damage.

30. Turn ignition switch OFF. Turn VTM off. Disconnect cable W 1 from DCA receptacle. Disconnect cable W 1 from J1 plug on VTM. Stow VTM in case (refer to TM 9-4910-571 - 12&P).

LRT-110 7-1/2 TON CRANE TEST CARD-VID 28



STE-ICE DCA RECEPTACLE

FUEL SHUTOFF

(VID SUBSTITUTE UNTIL STE-ICE R IS FIELDIED)

ERROR MESSAGES

E000	INFORMATION NOT AVAILABLE
E001	TEST NON-EXISTENT
E002	TRANSDUCER NOT CONNECTED
E003	TEST NOT VALID IN THIS DCA
E004	VID OR NUMBER OF CYL NOT ENTERED
E005	CAL NOT PERFORMED
E007	NUMBER OF CYL CONFLICTS WITH VID
E008	TEST PROBE NOT CONNECTED
E009	ENGINE NOT RUNNING
E010	BAD VID
E011	ACCEL/DECEL TIME TOO LARGE
E012	TACH PICKUP MISSING
E013	BAD DATA
E014	BAD NUMBER OF CYLINDERS
E018	TEST DISCONTINUED EXCESSIVE TIME
9999	OVERLOAD OR NUMBER EXCEEDS DISPLAY CAPABILITY

OPERATOR MESSAGES

PASS	TEST SUCCESSFULLY COMPLETED
CAL	OFFSET TEST IN PROGRESS RELEASE TEST BUTTON
CIP	INITIATE CI POWER SIMULATION
CYL	ENTER NUMBER OF CYLINDERS OR CYLINDER PAIRS
FAIL	TEST FAILED
GO	CRANK ENGINE
OFF	IF CRANKING, STOP IF CI POWER, DECELERATE
VEH	ENTER VEHICLE IDENTIFICATION NUMBER
....	VTM ACCEPTING DATA OR INITIAL TURN ON
0065	DIAL 99 PUSH TEST BUTTON
8888	CHECK DISPLAY

POWER AND COMPRESSION TEST

POWER TEST 13 AND COMPRESSION UNBALANCE TEST 14 AND 15 CANNOT BE RUN ON THIS VEHICLE AT THIS TIME (AUG. '86). TEST 12 CAN BE SET WITH THIS ENGINE. A RECORD ON EACH VEHICLE MAY BE KEPT USING POWER TEST 12. A CHANGE FROM THE NORMAL VALUE FOR THE VEHICLE INDICATES FAILURE OF THE POWER TEST.

Figure 1

VEHICLE READINESS TEST

PRE-TEST INSPECTION

1. FAN BELT
2. OIL LEVEL ENGINE
3. COOLANT LEVEL
4. FUEL LEVEL
5. BATTERIES
6. OIL LEVEL TRANSMISSION IN NEUTRAL AT IDLE

CONTROL OF NEXT TEST

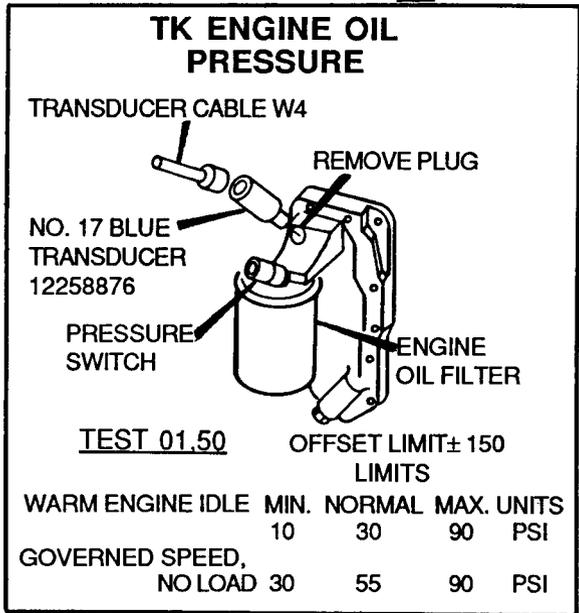
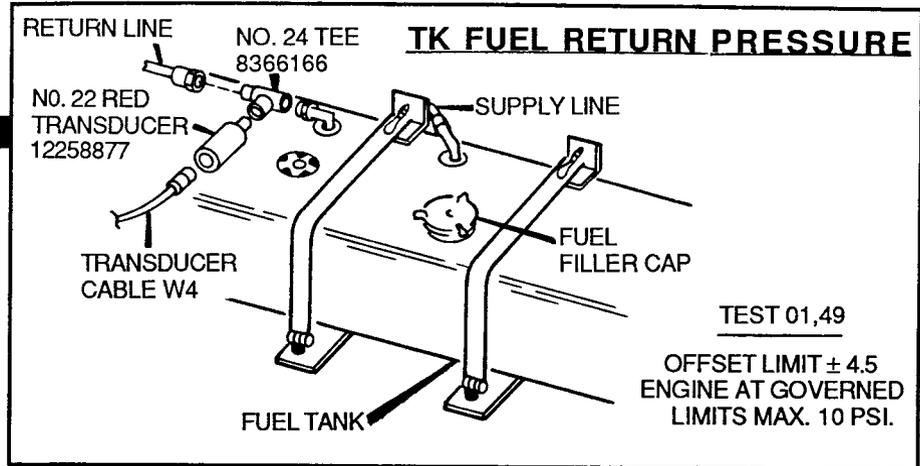
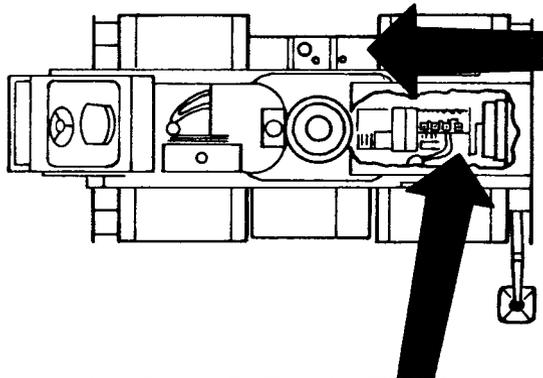
- 01 INTERWEAVE WITH SPEED
- 02 DISPLAY MIN. VALUE
- 03 DISPLAY MAX. VALUE
- 04 DISPLAY PEAK TO PEAK VALUE

POWER UP INITIAL ENTRY

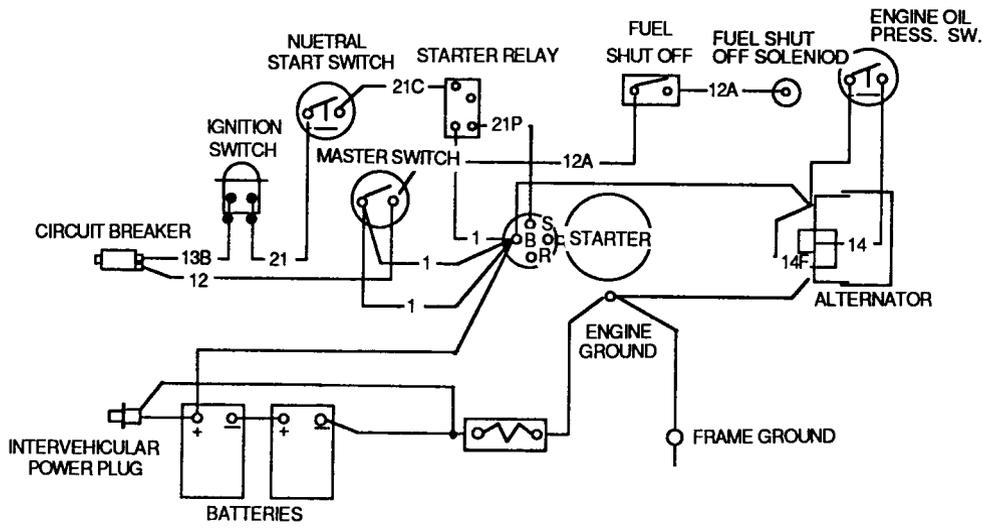
- 1) CONNECT VTM TO W1 CABLE. W1 CABLE ATTACHES (SEE FIGURE 1) TO VEHICLE DCA PLUG. (VTM MUST BE OFF WHEN MAKING CONNECTIONS.)
- 2) TEST 66 CONFIDENCE TEST (SECOND ENTRY 99)
- 3) TEST 80 VID ENTRY 28
- 4) TEST 61 VID (DISPLAY 28)
- 5) TEST 58 CYL ENTRY 4
- 6) TEST 62 DCA ID (DISPLAY 4)

OPTIONAL VEHICLE TESTS

TEST NAME	TEST NO.	OFFSET LIMIT	OPERATING CONDITION	LIMITS			UNITS
				MIN.	NORMAL	MAX.	
BATTERY VOLTAGE	67	-	ENGINE OFF	22	24	27	VOLTS
BATTERY CHARGE VOLTAGE	01, 67	-	LIGHTS ON 1000-1200 RPM	24	27-28.6	28.6	VOLTS
ENGINE RPM	10	-	IDLE NO LOAD	720	800	880	RPM
	10	-	GOVERNED SPEED, NO LOAD	2800	2950	3050	RPM
VEHICLE ENGINE OIL PRESSURE GAGE	-	-	WARM ENGINE IDLE	10	30	90	PSI
			GOVERNED SPEED, NO LOAD	30	55	90	PSI
TK ENGINE OIL PRESSURE	01, 50	-	(SEE REVERSE SIDE)				
VEHICLE AIR CLEANER FILTER RESTRICTION GAGE	-	-	ENGINE OFF (RIGHT SIDE ENGINE HOUSING)	-	-	25	IN. H2O
FUEL SUPPLY PRESSURE	24	±4.5	ENGINE AT GOVERNED	3	6	10	PSI
FUEL FILTER RESTRICTION	26	-	ENGINE AT GOVERNED	-	-	-	PASS/FAIL
FUEL SOLENOID VOLTAGE	27	-	IDLE	22	24	28.6	VOLTS
ALTERNATOR VOLTAGE	01, 82	-	LIGHTS ON 1000-1200 RPM	27.5	27.5-28.6	28.6	
POWER TEST % FULL POWER	12	-	LIMIT (TBD)	-	-	-	RPM/SEC
COMPRESSION UNBALANCE	14	-	WARM ENGINE (FUEL SHUTOFF)	-	2	10	%
CURRENT FIRST PEAK	72	±150	CRANK ON GO	750	800	900	AMPS
VEHICLE GAGE COOLANT TEMP	-	-	PROPER ENGINE WARM-UP	140	190	210	°F
ALTERNATOR NEGATIVE CABLE VOLTAGE DROP	01, 84	-	1000-1200 RPM	-	.04	.09	VOLTS
STARTER MOTOR CURRENT AVERAGE	80	±150	CRANKING	160	175	190	AMPS
BATTERY INTERNAL RESISTANCE	73	±150	CRANK ON GO	-	9.3	25	MILLIOHMS
STARTER CURRENT RESISTANCE	74	±150	CRANK ON GO	-	22	25	MILLIOHMS
BATTERY RESISTANCE CHARGE	75	±150	CRANK ON GO	-	16.6	50	MILLIOHMS/SEC
STARTER SOLENOID VOLTAGE	70	-	CRANKING	20	22	27	VOLTS
STARTER NEGATIVE CABLE DROP	69	-	CRANKING	-	.5	.7	VOLTS
STARTER MOTOR VOLTAGE	66	-	CRANKING	20	22	28	VOLTS
TRANSMISSION TEMP GAGE	-	-	PROPER WARM-UP ROADING	-	190-200	250	°F
TK RETURN FUEL PRESSURE	01, 49	-	(SEE REVERSE SIDE)				



STARTING/CHARGING CIRCUIT DIAGRAM



CHAPTER 6

ENGINE

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ENGINE AND TRANSMISSION ASSEMBLY

ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

1. Rotate upperstructure and boom to an attitude of 90 degrees to carrier frame.
2. Remove sliding engine hood (refer to page 14-22).
3. Remove nut (1), capscrew (2), plate (3), spacer (4) and two clamps (5) from hoses (6) and (7). Remove two nuts (8) and lockwashers (9). Loosen nuts (10) on T-clamps (11) and remove 90-degree elbow (12) and stack cap (13). Disconnect restriction indicator hose (14) from restriction indicator (15, Figure 6-1).
4. Remove six nuts (16), washers (17) and hood support (18).

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

5. Disconnect battery negative ground cable.

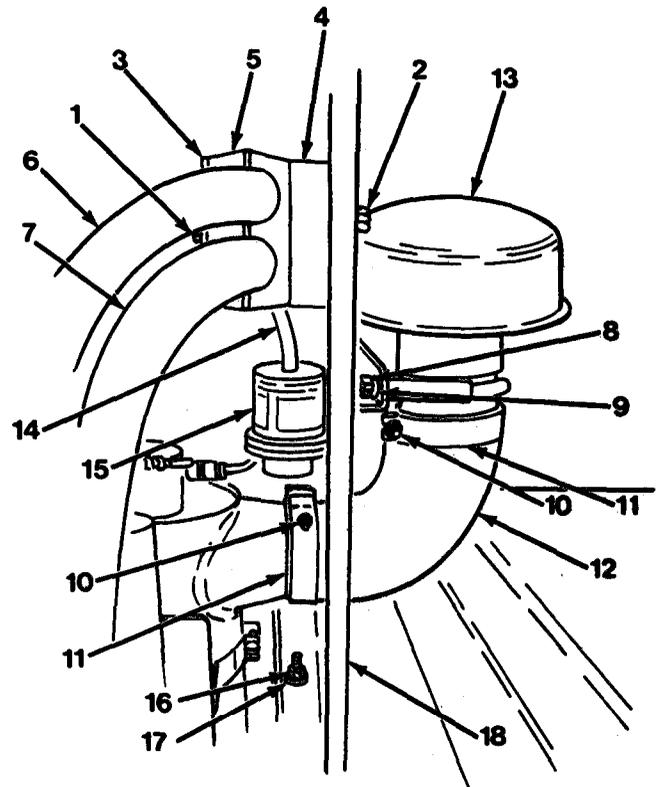


Figure 6-1

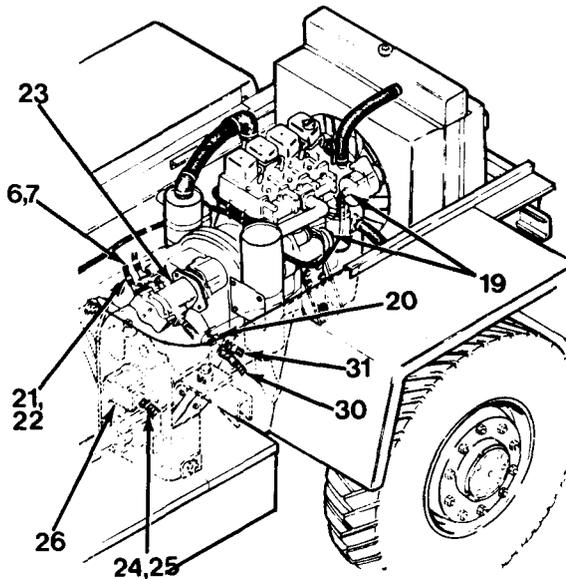


Figure 6-2

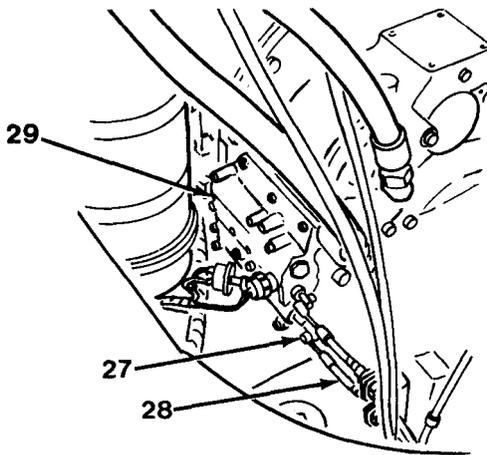


Figure 6-3

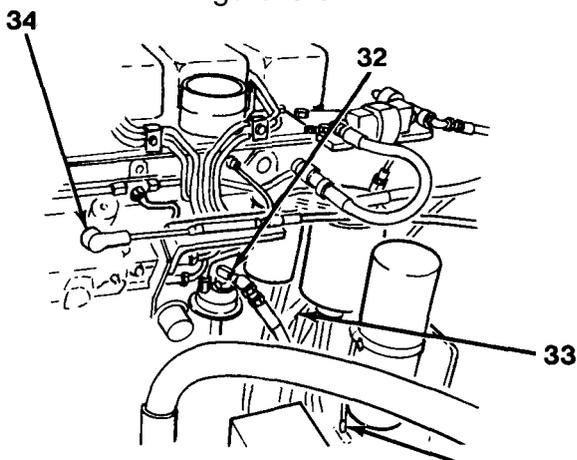


Figure 6-4

ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

6. Remove radiator and oil cooler (refer to page 9-5).
7. Disconnect all electrical connections (19, Figure 6-2) from alternator, starter and temperature and pressure sending units. Remove all mounting hardware from wiring harness.

NOTE

- Drain fluids from engine (refer to page 3-47) and transmission (refer to page 3-50).
 - Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.
8. Disconnect two hoses (6) and (7) from charge pump on top right hand side of transmission. Secure hoses out of the way for removal.
 9. Disconnect hoses (20), (21) and (22) from main hydraulic pump (23), and two hoses (24) and (25) from ground driven steering pump (26) (refer to pages 13-37 and 13-44).
 10. Remove two cotter pins (27) to disconnect two control cables (28) from transmission control valve (29). Loosen two jam nuts on each cable and remove cables (28, Figure 6-3) from mounting bracket. Remove two oil cooler hoses (30) and (31, Figure 6-2) from left-hand side of transmission.

11. Disconnect fuel hoses (32) and (33), injector pump throttle cable (34) and cold start cable (35, Figure 6-4).
12. Remove shift bracket (36, Figure 6-5) as an assembly from transmission (refer to page 11-80).
13. Remove four capscrews (37) and disconnect front drive shaft (38) from transmission. Support front drive shaft (38) on suitable blocks.
14. Remove eight capscrews (39) and rear drive shaft (40) from transmission and rear axle.

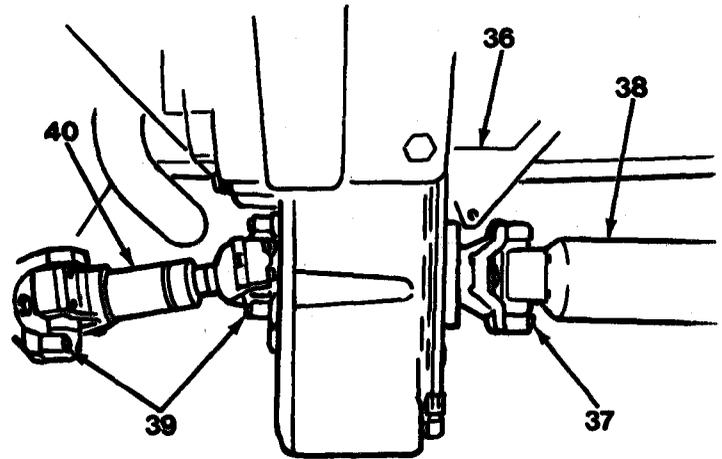


Figure 6-5

15. Engine/transmission assembly is mounted at three points with rubber shock mounts, one at front of engine and two on sides of transmission. Remove two nuts (41), capscrews (42) and spacers (43) from sides of transmission. Remove capscrew (44), washer (45) and spacer (46, Figure 6-6) from front of engine. Check to make sure path up and out of frame is clear of hoses, wires and brackets.

⚠ WARNING

Weight of engine and transmission assembly is approximately 1,800 lb (816 kg). Use adequate lifting equipment to lift and support engine/transmission assembly. Do not lift over personnel or let personnel walk Underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

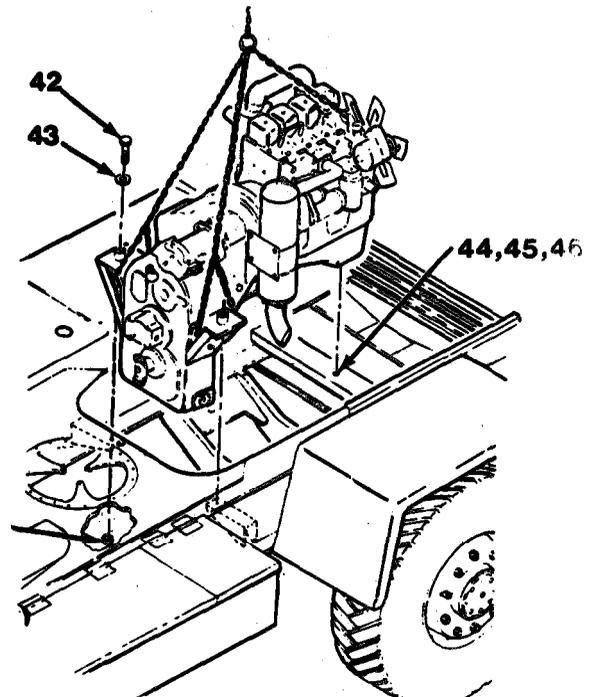


Figure 6-6

ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

16. Attach hoist and chains to front engine lift eye and rear transmission mounts. Gradually hoist engine/transmission assembly up, guiding it slightly forward to clear main hydraulic pump on rear of transmission. Move engine/transmission assembly away from carrier.

17. Lower engine/transmission assembly on to suitable support stand.

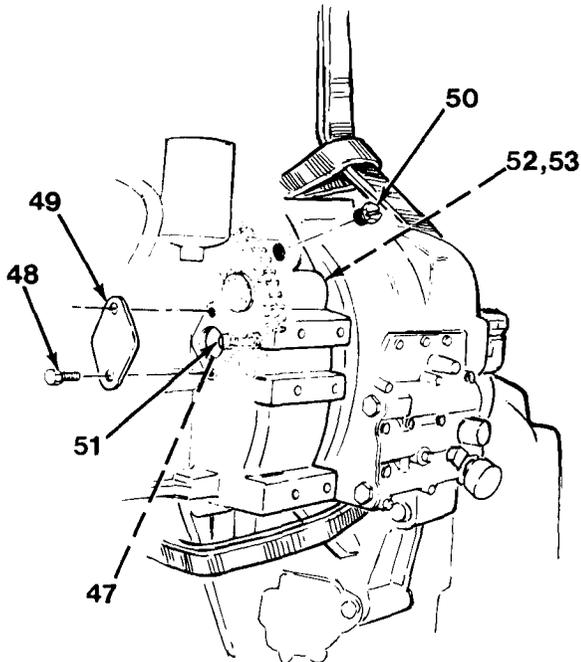


Figure 6-7

REMOVE TRANSMISSION FROM ENGINE

1. Engine flywheel is bolted to transmission converter drive plate with 12 capscrews (47). Access to 12 capscrews (47) is through engine side of flywheel housing. Remove two capscrews (48), cover plate (49) and plug (50, Figure 6-7) on right-hand side of flywheel housing.
2. With a barring tool or large screwdriver, rotate ring gear through plug (50) access hole until each capscrew (47) is lined up with access hole (51). Use a 9/16 in. socket and remove 12 capscrews (47).

⚠ WARNING

Weight of transmission is approximately 1,100 lb (499 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Attach hoist and sling around converter housing on transmission.
4. With transmission supported, remove 12 capscrews (52) and lockwashers (53) from transmission and flywheel housing.
5. Pull transmission straight out of flywheel housing and support it on a suitable work stand.
6. Repairs to or replacement of transmission can now be made. If changing to a new transmission, remove and transfer all adapters and mounting brackets. The capscrews that fasten mounting brackets to transmission require a torque of 260 lb-ft (352 Nom). Plug openings in replaced transmission before sending to repair.
7. If necessary for repair of transmission, remove main hydraulic pump and ground driven steering pump (refer to pages 13-37 and 13-44).
4. Rotate flywheel until one of the holes in flywheel is aligned with flywheel access hole (51, Figure 6-7).

 **WARNING**

Weight of transmission is approximately 1,100 lb (499 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Support and align transmission to flywheel. Align protruding stud from drive plate face with mounting hole in flywheel.

INSTALL TRANSMISSION TO ENGINE

1. Examine capscrews for damaged threads. Check flywheel ring gear for condition before attaching transmission.
2. Using a dial indicator, check engine crankshaft end play. It should be from 0.005 to 0.010 in. (0.13 to 0.25 mm). Crankshaft end play should be the same after attaching the transmission.
3. Install 3/8-24 x 2-1/4 threaded guide stud, with a screwdriver slot in end, into one of the threaded inserts on converter drive plate from engine side.

INSTALL TRANSMISSION TO ENGINE

CAUTION

DO NOT FORCE TRANSMISSION AT ANY TIME. Forcing transmission into pilot sleeve of flywheel can preload crankshaft and cause engine and transmission damage.

6. Push transmission into engine.
7. Install 12 lockwashers (53) and M10-1.50 x 35 mm capscrews (52, Figure 6-7) to transmission and flywheel housing.
8. Check crankshaft end play and compare measurement with what was observed in step 2. No end play can mean crankshaft has been preloaded. Do not proceed until the reason for preload has been determined and corrected.
9. Remove guide stud. Install 12 capscrews (47) through access hole (51) through flywheel into drive plate. Hand tighten all the way around. Torque capscrews (47) to 31 ± 2 lb-ft (42 ± 3 N•m).
10. Recheck crankshaft end play and compare measurement with what was observed in step 2. No end play can mean crankshaft has been preloaded. Do not proceed until the reason for preload has been determined and corrected. When satisfactory, replace cover plate (49), two capscrews (48) and plug (50).
11. If hydraulic pumps have been removed, install ground driven steering pump and main hydraulic pump (refer to pages 13-45 and 13-38).

The engine/transmission assembly is ready to return to carrier frame.

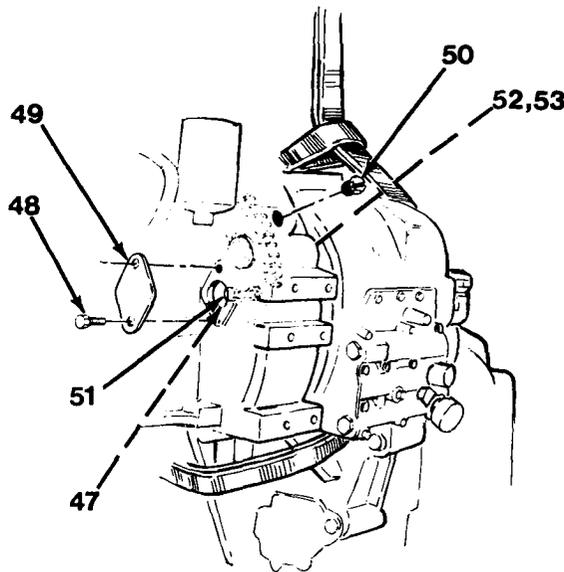


Figure 6-7

ENGINE AND TRANSMISSION INSTALLATION

When reassembled engine and transmission is ready for installation, check rubber shock mounts for deterioration and distortion. Replace if condition warrants. Examine all connecting components to make sure they are in position to install.

WARNING

Weight of engine and transmission assembly is approximately 1,800 lb (816 kg). Use adequate lifting equipment to lift and support engine/transmission assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Using hoist and chains, lower engine/transmission assembly into position over frame. Slowly lower and guide engine/transmission assembly back into its location in frame. In front of engine install spacer (46), washer (45) and capscrew (44). In side of transmission install two spacers (43), capscrews (42) and nuts (41, Figure 6-6).
2. Install rear drive shaft (40) and eight cap screws (39, Figure 6-5) to transmission and rear axle. Torque eight cap screws (39) to 50 lb-ft (68 N•m).
3. Connect front drive shaft (38) and install four cap screws (37) to transmission. Torque four cap screws (37) to 50 lb-ft (68 N•m).
4. Install shift bracket (36) as an assembly (refer to page 11-81 and adjust per page 17-49).
5. Connect cold start cable (35), injector pump throttle cable (34) and fuel hoses (33) and (32, Figure 6-4).

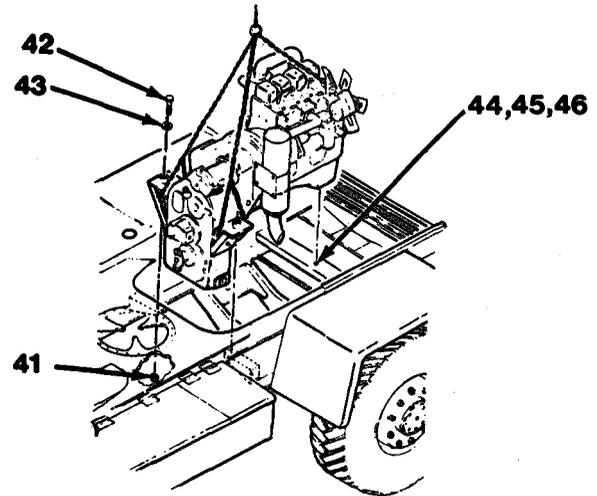


Figure 6-6

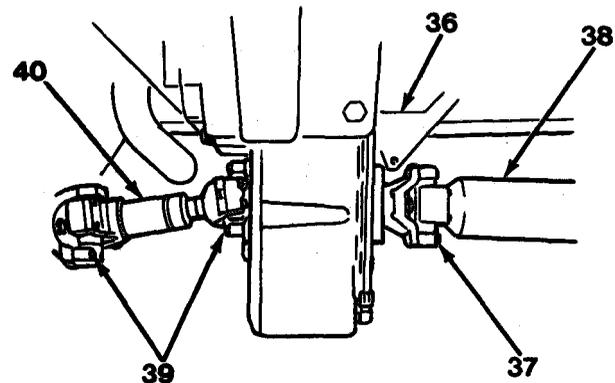


Figure 6-5

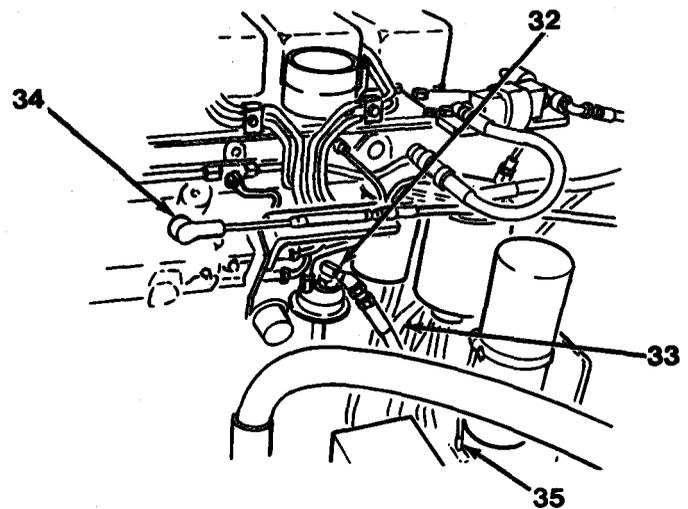


Figure 6-4

ENGINE AND TRANSMISSION INSTALLATION

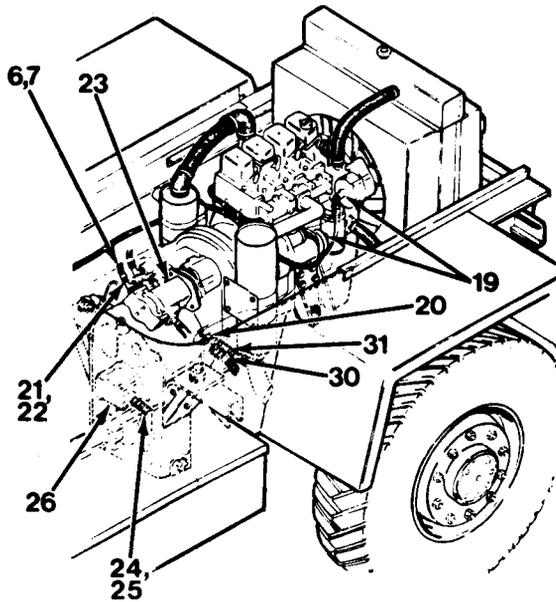


Figure 6-2

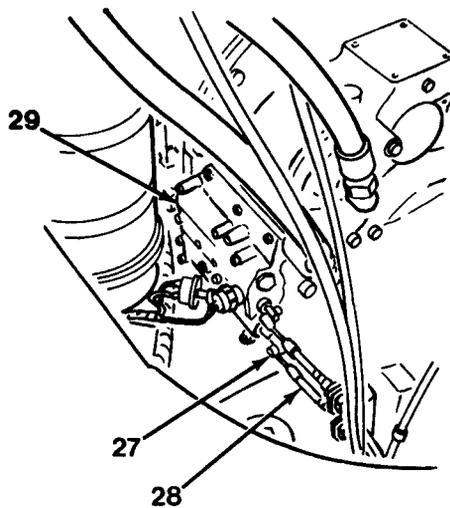


Figure 6-3

6. Connect transmission oil cooler hoses (30) and (31, Figure 6-2). Using two cotter pins (27), connect two control cables (28) to control valve (29, Figure 6-3) on right-hand side of transmission.
7. Connect two control cables (28) in their mounting bracket and tighten two jam nuts on each cable (28). Check and adjust cable (refer to page 17-49).
8. Connect hoses (24) and (25) to ground driven steering pump (26) and hoses (20), (21) and (22) to main hydraulic pump (23, Figure 6-2) (refer to pages 13-45 and 13-38).
9. Connect hoses (7) and (6) to charge pump on top right-hand side of transmission.
10. Connect all electrical connections (19) to temperature and pressure sending units, alternator and starter. Secure all harness assemblies with mounting hardware.
11. Install radiator and oil cooler (refer to page 9-10).

12. Connect battery negative ground cable.
13. Install hood support (18), six washers (17) and nuts (16, Figure 6-1) on frame.
14. Connect restriction indicator hose (14) to restriction indicator (15).
15. Install stack cap (13), 90-degree elbow (12) and T-clamps (11) as an assembly and tighten nuts (10). Install two lockwashers (9) and nuts (8). Install two clamps (5), spacer (4), plate (3), capscrew (2) and nut (1) on hoses (6) and (7).
16. Fill engine and transmission with proper fluids to proper levels (refer to pages 3-47 and 3-50).
17. Check that everything has been connected and installed, all connections are tight and no leaks are evident.
18. Install sliding engine hood (refer to page 14-22).
19. Conduct a start-up to check operation of unit.

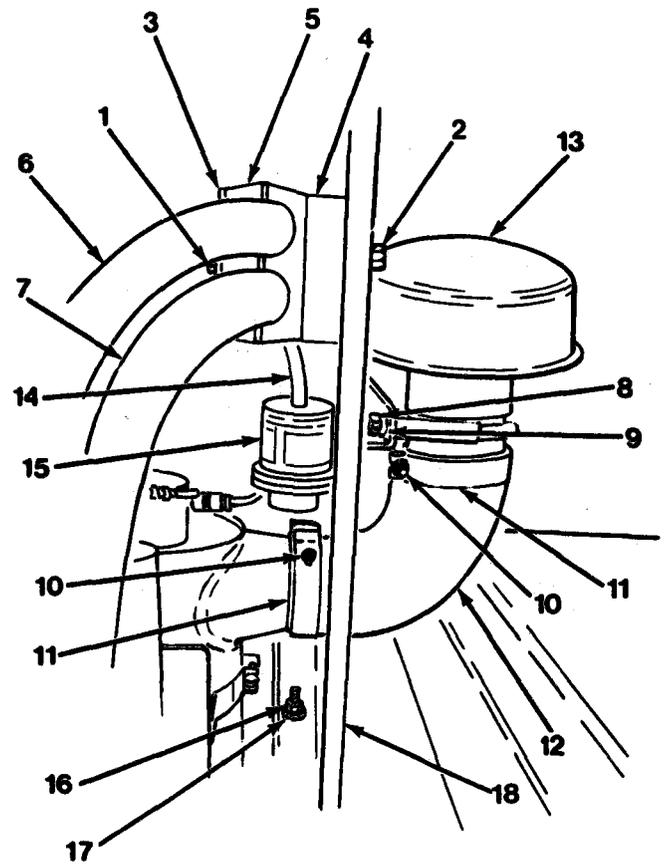


Figure 6-1

MOUNTING THE ENGINE ON A ROLLOVER STAND

1. Remove engine/transmission assembly (refer to page (6-1).
2. Remove transmission from engine (refer to page 6-4).
3. Remove oil filter (refer to page 3-47).
4. Using a 17 mm socket, remove drain plug (1) and drain oil from oil pan (2, Figure 6-1) into a suitable 11 quart (10.40 L) (or larger) container.
5. Remove starter (refer to page 10-8).
6. Align side of engine (3) to mounting bracket (4) of rollover stand (5).
7. Using a 19 mm socket, install four capscrews (6) and secure engine (3) to rollover stand (5). Torque four capscrews (6) to 57 lb-ft (77 N•m).

REMOVING THE ENGINE FROM THE ROLLOVER STAND

1. Install drain plug (1) to oil pan (2, Figure 6-1).

WARNING

Weight of engine is approximately 700 lb (318 kg). Use adequate lifting equipment to lift and support engine. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Install a suitable hoist and sling to lifting brackets (7).
3. Remove four capscrews (6) from rollover stand mounting bracket (4) and remove engine (3) from rollover stand (5).
4. Install transmission to engine (refer to page 6-5).
5. Install starter (refer to page 10-9).
6. Install oil filter (refer to page 3-47).
7. Install engine and transmission (refer to page 6-7).

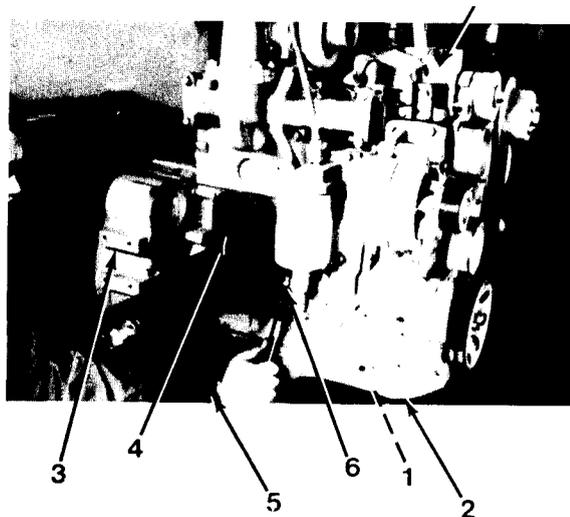


Figure 6-1

ENGINE MOUNT

ENGINE MOUNT REMOVAL

1. Remove engine/transmission assembly (refer to page 6-1).
2. Using a 18 mm socket, remove four cap-screws (1) and engine mount (2, Figure 6-1) from engine.

ENGINE MOUNT CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

ENGINE MOUNT INSTALLATION

1. Using a 18 mm socket, install engine mount (2) and four capscrews (1, Figure 6- 1) to engine. Torque to 57 lb-ft (77 N•m).
2. Install engine/transmission assembly (refer to page 6-7).

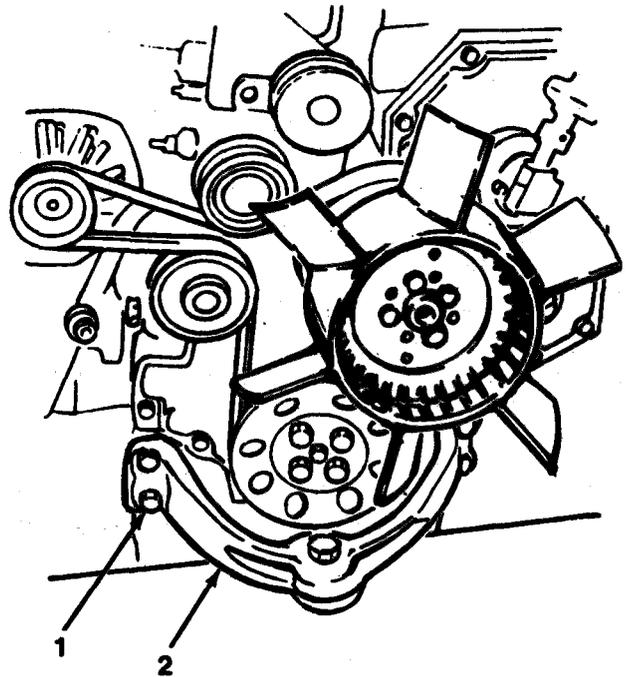


Figure 6-1

DRIVE BELT, PULLEYS AND FAN

**DRIVE BELT, PULLEYS AND FAN
REMOVAL**

1. Remove four capscrews and lockwashers (1) and fan (2, Figure 6-1).

3. Remove belt (3).

4. Relax tension in bracket (7) by rotating breaker bar counterclockwise.

5. Remove capscrew (4) and belt tensioner (5) from bracket (7),

⚠ WARNING

Keep hands out of path of spring-loaded tensioner. **SERIOUS INJURY** may result if tensioner slips.

2. Using a 1/2 in. drive breaker bar, insert in square hole in bracket (7). Rotate breaker bar clockwise to release tension on belt (3).

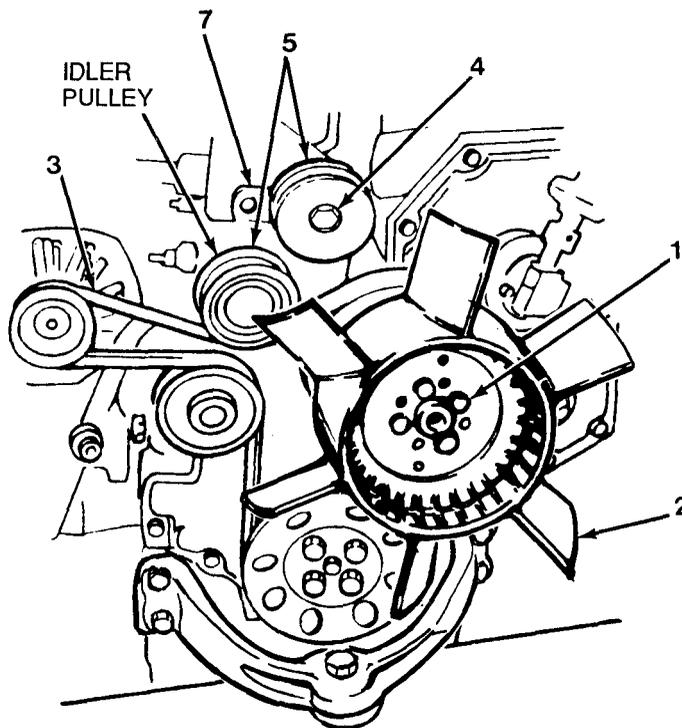


Figure 6-1

6. Using a 5 mm allen wrench, remove two allen head capscrews (6) and bracket (7, Figure 6-2).
7. Remove spacer (8) and fan pulley (9).
8. Remove four capscrews (10) and fan hub(11, Figure 6-3).
9. Remove plug A located at top, right of bell housing and use a suitable prybar wedged between flywheel and bell housing to lock flywheel before removing crankshaft pulley.
10. Remove four capscrews (12) and crankshaft pulley (13, Figure 6-4).

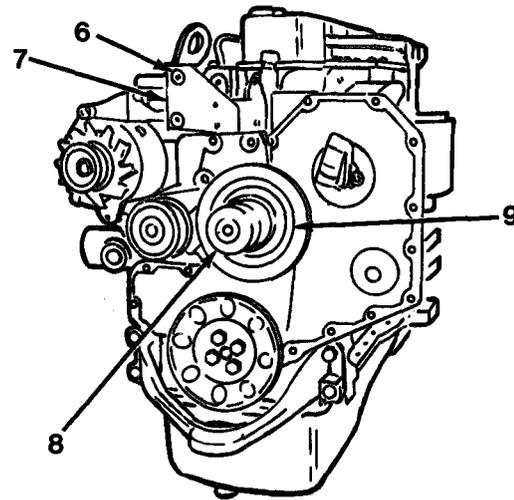


Figure 6-2

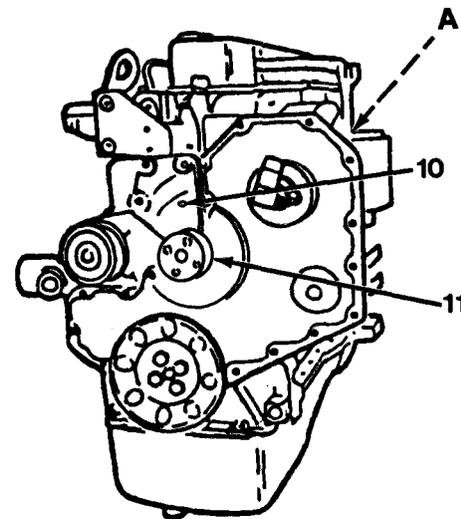


Figure 6-3

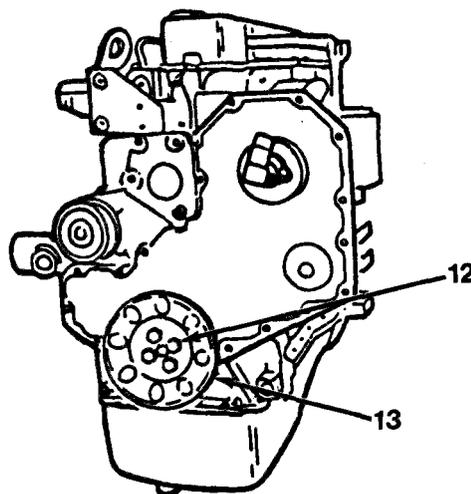


Figure 6-4

FAN HUB DISASSEMBLY

1. Secure fan hub in suitable vise. Using a 10 mm allen wrench, remove center bolt (14) and washer (15, Figure 6-5).

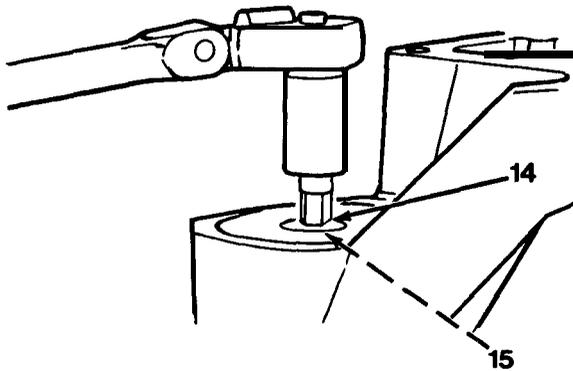


Figure 6-5

NOTE

Approximately 6 tons (5.44 metric tons) of pressure are required for the following step.

2. Press roller bearing (16, Figure 6-6) out of fan hub housing.

DRIVE BELT, PULLEYS AND FAN CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect fan hub bearing for leakage of lubricant and make sure hub rotates freely.
3. Inspect all other parts (refer to Chapter 4).

FAN HUB ASSEMBLY

1. Pack roller bearing (16, Figure 6-6) with grease. Press fan hub into fan hub housing, flush with front of housing.
2. Install washer (15) and center bolt (14, Figure 6-5). Torque center bolt (14) to 57 lb-ft (77 N•m).

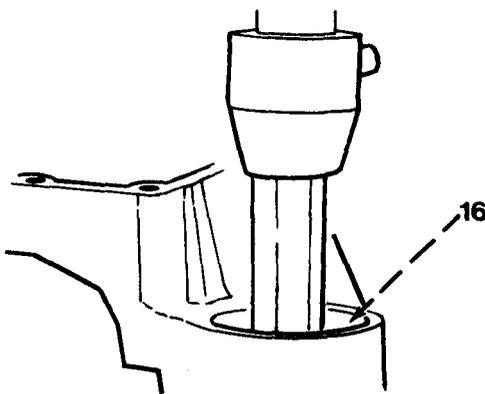


Figure 6-6

DRIVE BELT, PULLEYS AND FAN INSTALLATION

1. Use a suitable prybar in hole of plug A (Figure 6-3) wedged between flywheel and bell housing to lock flywheel before installing crankshaft pulley.
2. Install crankshaft pulley (13) and four cap-screws (12, Figure 6-4). Torque four cap-screws (12) to 44 lb-ft (60 N•m).
3. Install plug A, fan hub (11) and four cap-screws (10, Figure 6-3). Torque four cap-screws (10) to 18 lb-ft (24 N•m).
4. Install fan pulley (9) and spacer (8, Figure 6-2).
5. Install bracket (7) and two allen head cap-screws (6). Torque capscrews (6) to 18 lb ft (24 N•m).

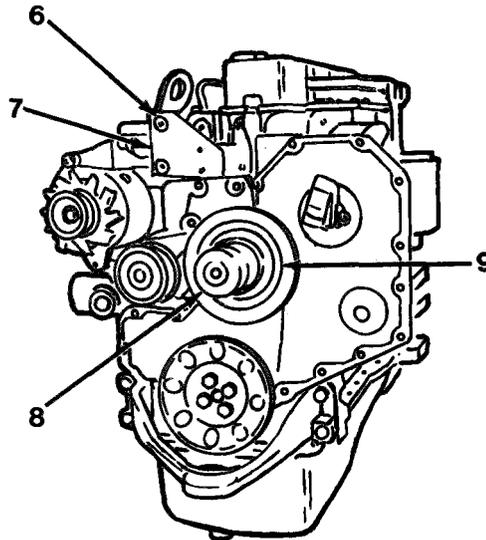


Figure 6-2

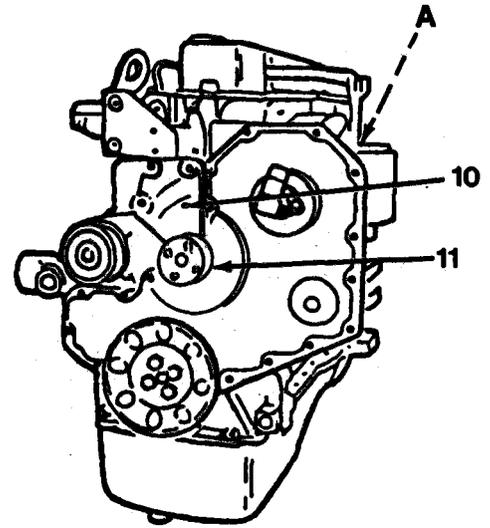


Figure 6-3

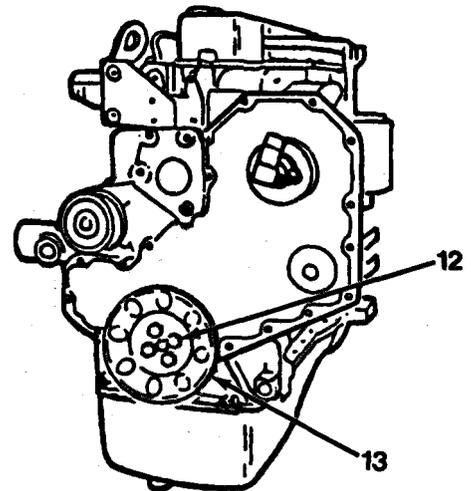


Figure 6-4

DRIVE BELT, PULLEYS AND FAN INSTALLATION

6. Install belt tensioner (5) and capscrew (4, Figure 6-1) with idler pulley hanging directly below capscrew (4). Torque capscrew (4) to 32 lb-ft (43 N•m).

⚠ WARNING

Keep fingers from between belt and pulley. **SERIOUS INJURY** may result if tensioner slips.

7. Insert 1/2 in. drive breaker bar in square hole on bracket (7). Rotate belt tensioner (5) clockwise to permit installation of belt (3).

8. Install belt (3) around pulleys and under belt tensioner (5).

9. Relax tension in bracket (7) to tension belt (3).

10. Install fan (2) and four capscrews (1). Torque four capscrews (1) to 18 lb-ft (24 N•m).

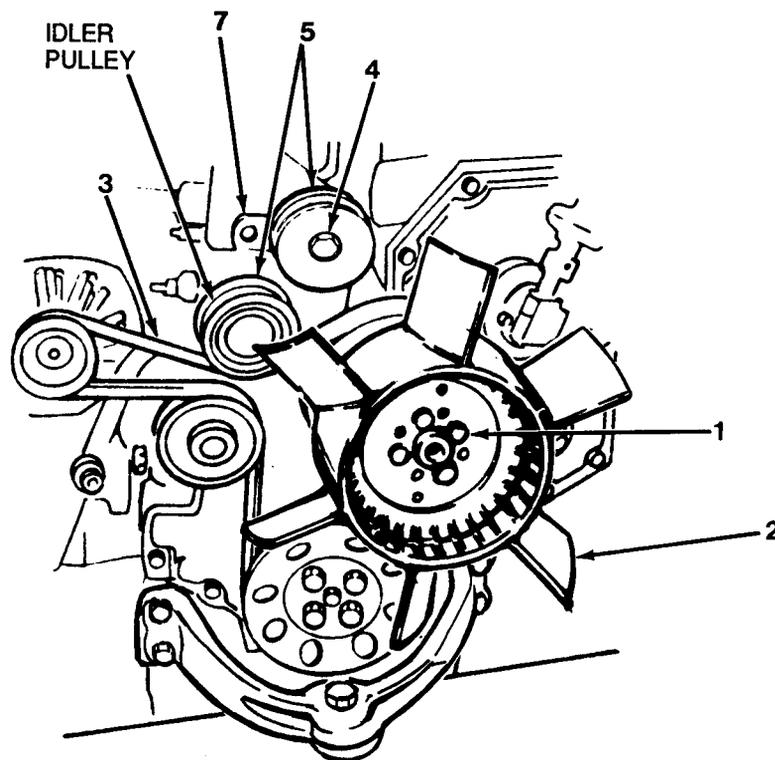


Figure 6-1

FRONT GEAR TRAIN ACCESSORY DRIVE AND FRONT COVER

FRONT GEAR TRAIN ACCESSORY DRIVE AND FRONT COVER REMOVAL

1. Remove radiator and oil cooler assembly if engine is still in carrier (refer to page 9-5).
2. Remove drive belt pulleys and fan (refer to page 6-12).
3. Remove two capscrews (1), washers (2) and tachometer drive (3) from front cover (6, Figure 6-1).
4. Using a strap wrench, remove access hole cover (4) from front cover (6).
5. Remove 20 capscrews (5), front cover (6) and gasket (7, Figure 6-2). Remove all gasket material from mounting surfaces.
6. Remove seal (8) by driving out of front cover (6).

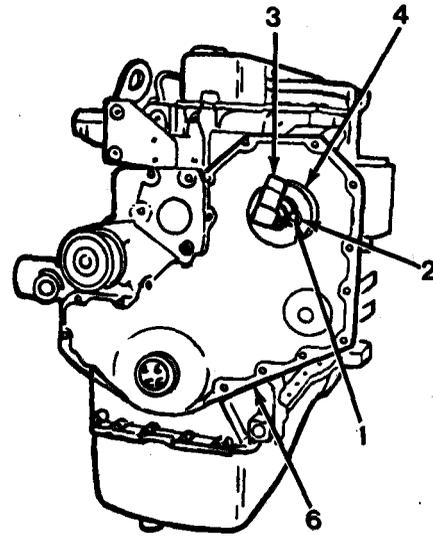


Figure 6-1

FRONT GEAR TRAIN ACCESSORY DRIVE AND FRONT COVER CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

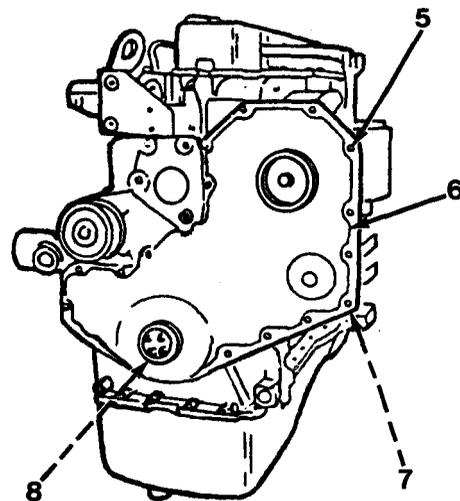


Figure 6-2

FRONT GEAR TRAIN ACCESSORY DRIVE AND FRONT COVER INSTALLATION

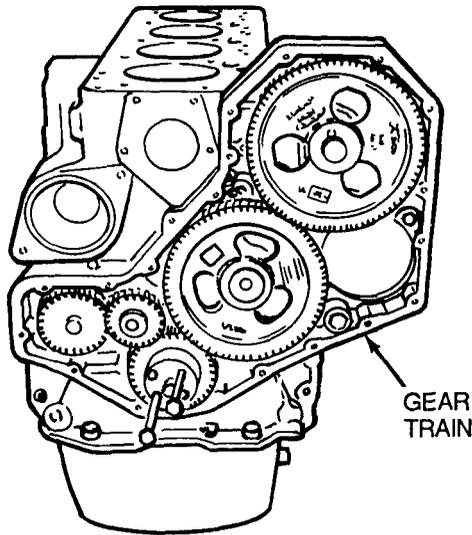


Figure 6-3

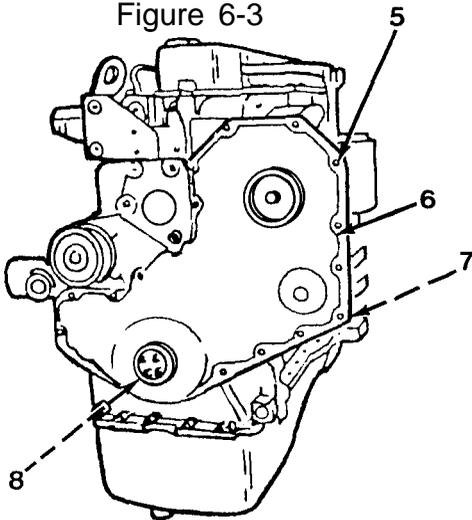


Figure 6-2

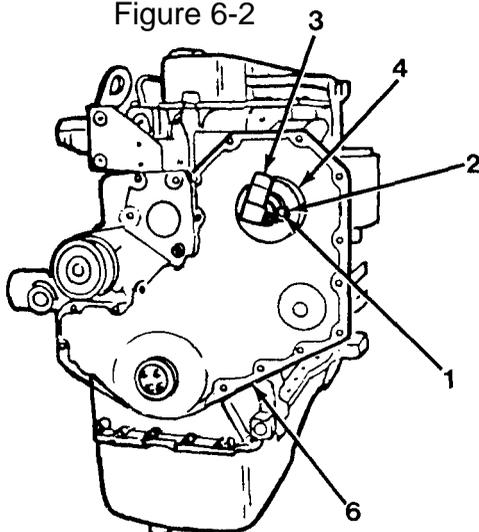


Figure 6-1

1. Using clean oil, lubricate front gear train (Figure 6-3).

CAUTION

Seal lip and sealing surface on crankshaft must be free from all oil residue to prevent seal leaks. Teflon seals must be installed on dry, clean surfaces.

2. Thoroughly clean and dry front seal area of crankshaft.
3. Apply sealant MIL-S-4613 to outside diameter of front seal (8, Figure 6-2).
4. Install seal (8) in front cover (6). Make sure seal (8) and sealing surface is free of oil residue to prevent leaks.
5. Apply sealant MIL-S-7916 to front cover (6) and gear housing.
6. Install gasket (7) on gear housing.
7. Install front cover (6) and 20 capscrews (5). Torque 20 capscrews (5) to 18 lb-ft (24 N•m).
8. Install access hole cover (4), tachometer drive (3), two washers (2) and capscrews (1) in front cover (6, Figure 6-1). Torque two capscrews (1) to 7 lb-ft (9.5 N•m)
9. Install drive belt, pulleys and fan (refer to page 6-15).
10. Install radiator and oil cooler assembly if engine is still in carrier (refer to page 9-10).

TIMING PIN ASSEMBLY

TIMING PIN ASSEMBLY REMOVAL

1. Using a T-25 Torx tool, remove two screws (1, Figure 6-1).
2. Remove timing pin housing (2).
3. Remove gasket (3). Remove all gasket material from mounting surfaces.

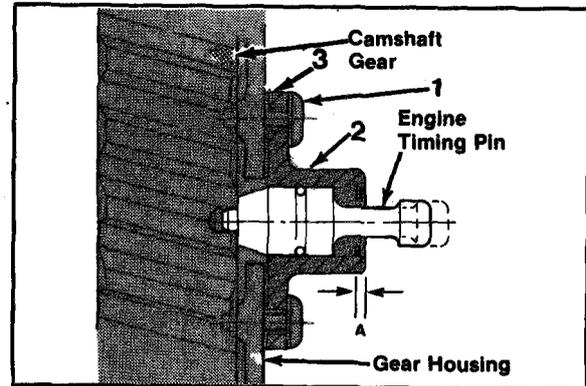


Figure 6-1

TIMING PIN ASSEMBLY INSTALLATION

1. Remove cylinder head (refer to page 6-42).
2. Remove front gear cover (refer to page 6-17).
3. Using four 18 mm capscrews, install crankshaft pulley (4, Figure 6-2).
4. Fabricate a wire pointer by bending a piece of wire into approximately the shape shown in Figure 6-2.
5. Install flat washer (5), fabricated wire pointer (6) and 13 mm capscrew (7) to gear housing above crankshaft pulley (4).

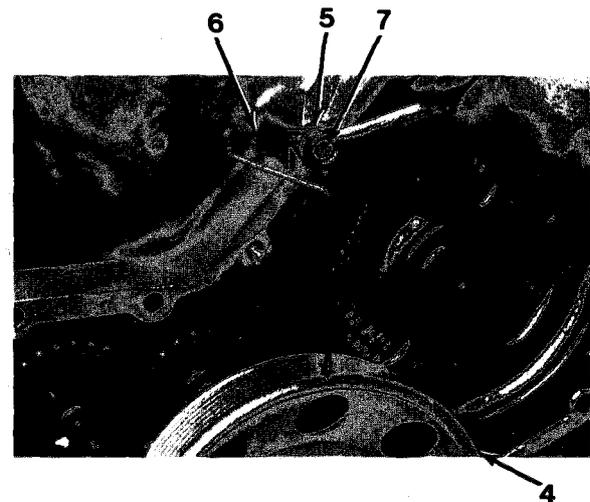


Figure 6-2

6. Fabricate a steel plate (8, Figure 6-3).

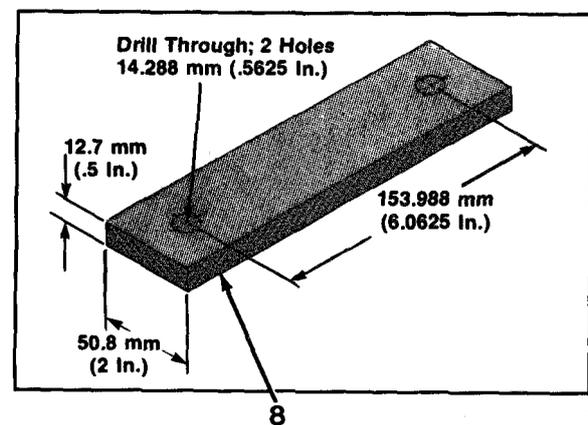


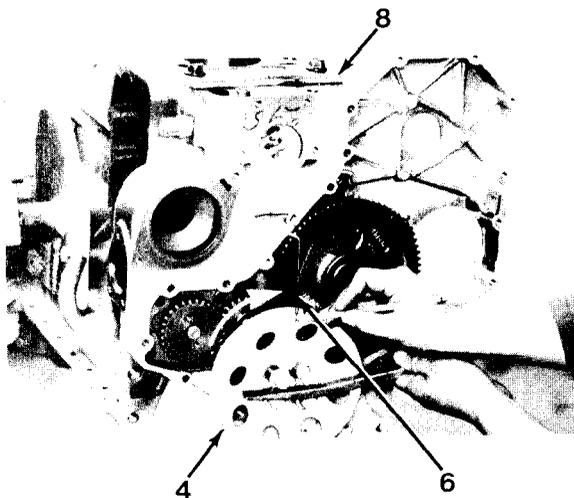
Figure 6-3



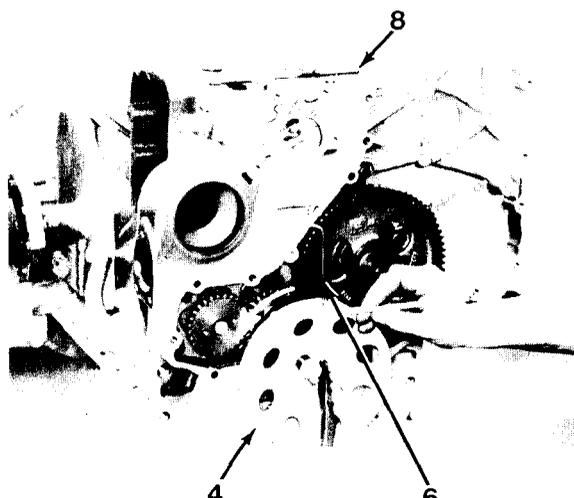
8 9
Figure 6-4

TIMING PIN ASSEMBLY INSTALLATION

7. Use two 18 mm capscrews (9) to install fabricated plate (8, Figure 6-4) over cylinder number 1.
8. Rotate crankshaft pulley (4) until piston contacts fabricated plate (8). Mark pointer (6, Figure 6-5) position on crankshaft pulley (4).
9. Rotate crankshaft pulley (4) in opposite direction until piston contacts fabricated plate (8, Figure 6-6).
10. Mark pointer (6) position on crankshaft pulley (4).



4 6 8
Figure 6-5



4 6 8
Figure 6-6

11. Mark pulley (4, Figure 6-7) half distance between first two marks.
12. The middle mark is the Top Dead Center (TDC) mark.
13. Remove two 18 mm capscrews (9) and fabricated plate (8, Figure 6-4).
14. Rotate crankshaft pulley (4) until pointer (6, Figure 6-5) aligns with TDC mark.

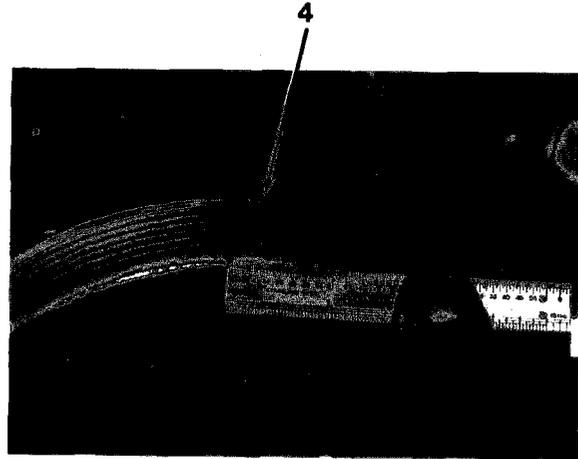


Figure 6-7

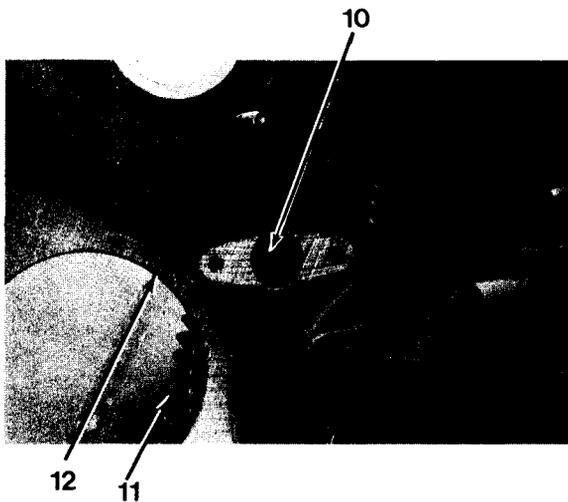


Figure 6-8

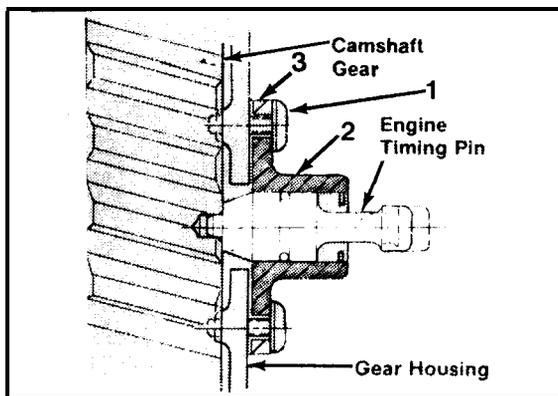


Figure 6-1

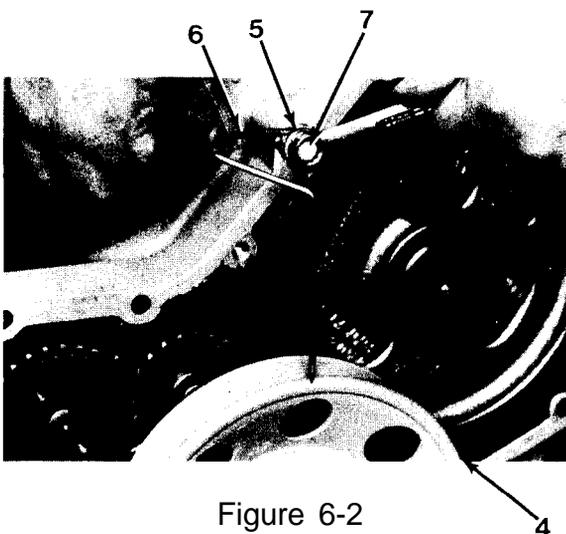


Figure 6-2

TIMING PIN ASSEMBLY INSTALLATION

15. The timing pin hole (10) in camshaft gear (11) should be visible through timing pin assembly hole in gear housing (12, Figure 6-8).
16. If timing pin hole (10) is not visible, rotate crankshaft pulley one complete turn.
17. Timing pin hole (10) should be visible.
18. Apply Loctite 592 to screws (1). Install gasket (3), housing (2) and two screws (1, Figure 6-1).
19. Push timing pin in to engage hole in gear. Using a T-25 Torx tool, torque two screws (1) to 4 lb-ft (5 N•m).
20. Remove 13 mm cap screw (7), fabricated wire pointer (6) and flat washer (5, Figure 6-2).
21. Remove four 18 mm cap screws and crankshaft pulley (4).
22. Install front gear cover (refer to page 6- 18).
23. Install cylinder head (refer to page 6-43).

TIMING PIN ASSEMBLY DISASSEMBLY

1. Using small, flat-blade screwdriver, remove retaining ring (13, Figure 6-9).
2. Remove timing pin (14).
3. Remove O-ring (15).

TIMING PIN ASSEMBLY CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to chapter 4).

TIMING PIN ASSEMBLY ASSEMBLY

1. Install O-ring (15, Figure 6-9).
2. Install timing pin (14).
3. Install retaining ring (13).

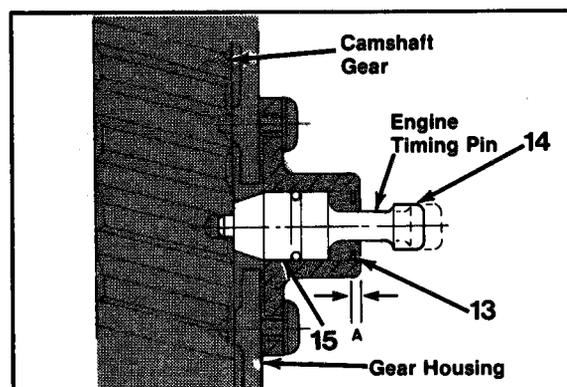


Figure 6-9

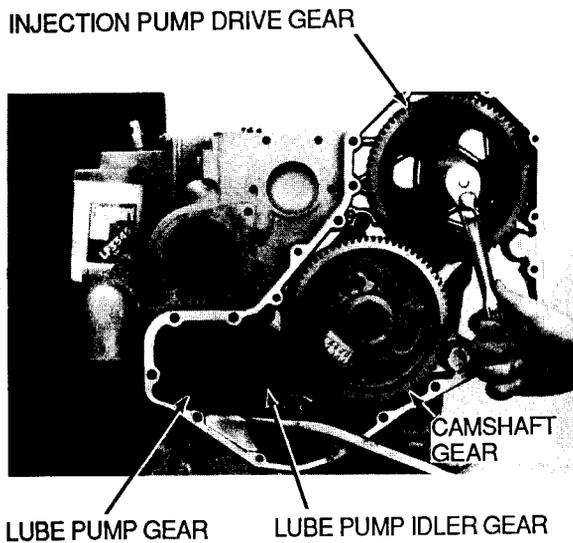


Figure 6-1

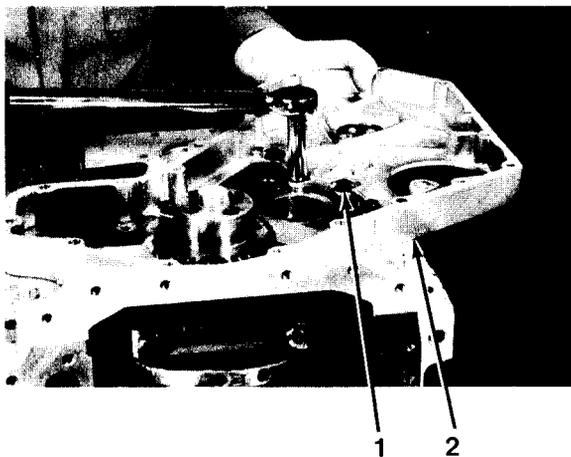


Figure 6-2

FRONT GEAR HOUSING

FRONT GEAR HOUSING REMOVAL

1. Remove engine/transmission assembly from carrier (refer to page 6- 1).
2. Remove front cover (refer to page 6-17).

NOTE

Check backlash of all gears before removing them.

3. Check backlash of injection pump drive gear (Figure 6-1) (refer to page 7-1).
4. Check camshaft gear backlash (refer to page 6-55).
5. Check lube pump gear backlash (refer to page 6-28).
6. Check lube pump idler gear backlash (refer to page 6-28).
7. Remove injection pump drive gear (refer to page 7-1, steps 5 thru 16).
8. Remove camshaft (refer to page 6-55).
9. Remove lube pump (refer to page 6-28).
10. Remove lube pump idler gear (refer to page 6-28).
11. Using a 10 mm socket wrench, remove seven cap screws (1, Figure 6-2).
12. Remove front gear housing (2).

13. Remove front gear housing gasket (3, Figure 6-3). Remove all gasket material from mounting surfaces.
14. Remove injection pump gasket (4, Figure 6-4). Remove all gasket material from mounting surfaces.
15. Install two 13 mm nuts on each of three injection pump mounting studs (5, Figure 6-5). Using a 13 mm socket wrench on nuts, remove three injection pump mounting studs (5).
16. Remove two 13 mm nuts from each of three injection pump mounting studs (5).
17. Using a 15 m socket wrench, remove two capscrews (6) and accessory drive cover (7, Figure 6-6).
18. Remove gasket (8). Remove all gasket material from mounting surfaces.

NOTE

Do not remove timing pin assembly unless gear housing is being replaced.

19. Remove timing pin assembly, if necessary (refer to page 6-19).

FRONT GEAR HOUSING CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

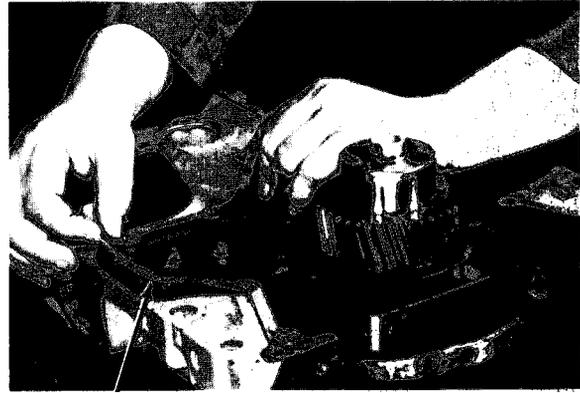


Figure 6-3

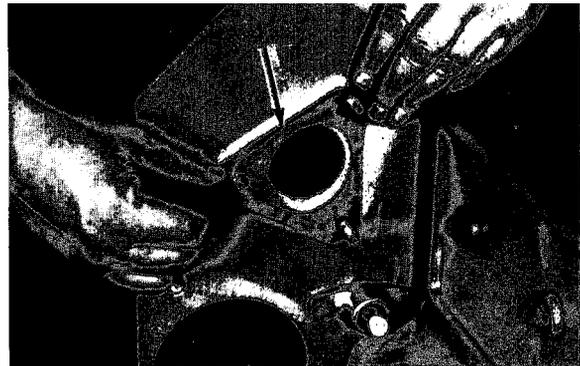


Figure 6-4



Figure 6-5

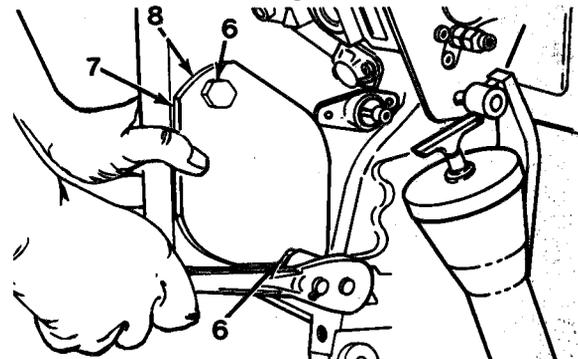


Figure 6-6

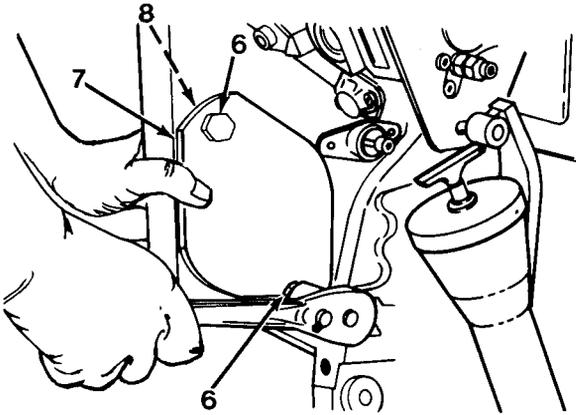


Figure 6-6

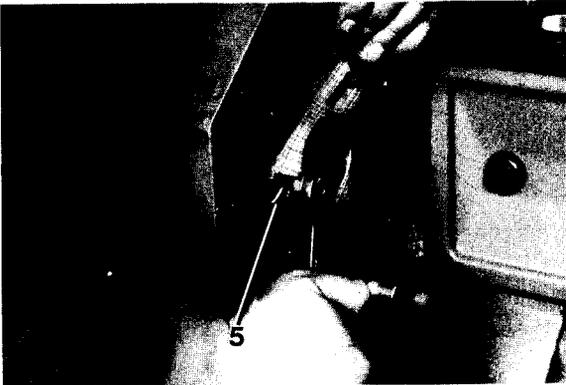


Figure 6-5

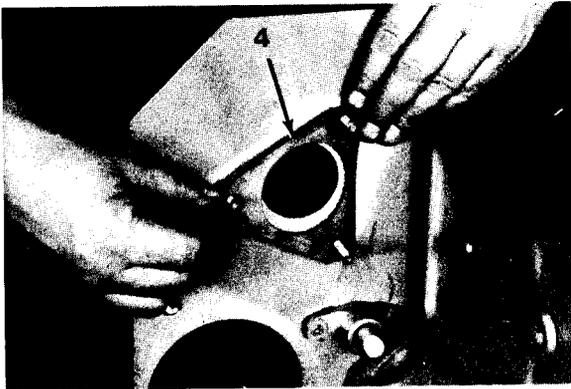
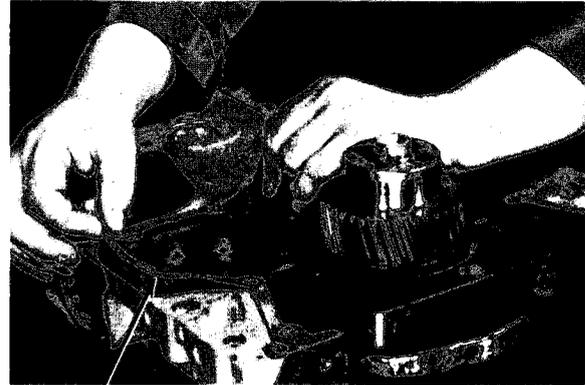


Figure 6-4

FRONT GEAR HOUSING INSTALLATION

1. Install gasket (8), accessory drive cover (7) and two capscrews (6, Figure 6-6).
2. Install two 13 mm nuts on each of three injection pump mounting studs (5, Figure 6-5).
3. Apply Loctite 609 on threads of three injection pump mounting studs (5).
4. Using a 13 mm socket wrench, install three injection pump mounting studs (5).
5. Remove two nuts from each of three injection pump mounting studs (5).
6. Install injection pump gasket (4, Figure 6-4).

7. Install new front gear housing gasket (3, Figure 6-3).
8. Install front gear housing (2, Figure 6-2).
9. Using a 10 mm socket wrench, install seven capscrews (1). Torque seven capscrews (1) to 18 lb-ft (24 N•m).
10. Install lube pump idler gear (Figure 6-1) (refer to page 6-30).
11. Install lube pump (refer to page 6-30).
12. Install camshaft (refer to page 6-58).
13. Install injection pump drive gear (refer to page 7-4, steps 7 thru 12).
14. Check lube pump idler gear backlash (refer to page 6-28).
15. Check lube pump gear backlash (refer to page 6-28).
16. Check camshaft gear backlash (refer to page 6-55).
17. Check injection pump drive gear backlash (refer to page 7-1).
18. Install timing pin assembly, if removed (refer to page 6-19).
19. Install front cover (refer to page 6-18).
20. Install engine/transmission assembly in carrier (refer to page 6-7).



3 Figure 6-3

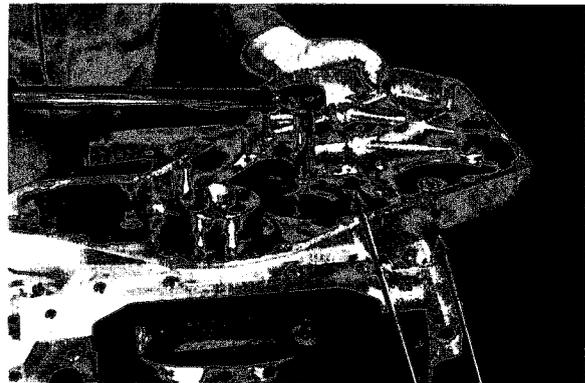


Figure 6-2 1 2

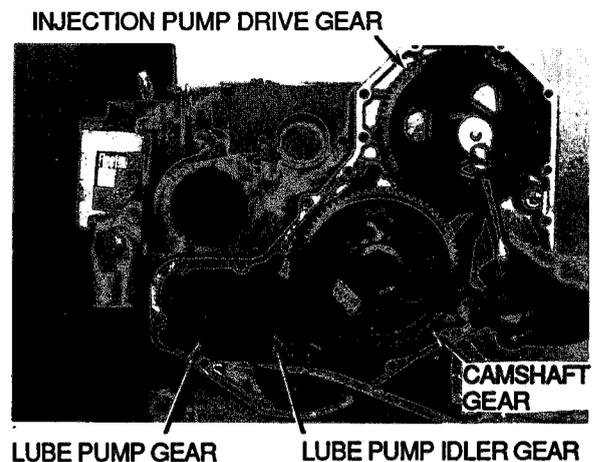


Figure 6-1

LUBE OIL PUMP

LUBE OIL PUMP REMOVAL

NOTE

- Before removing lube oil pump, check backlash of lube oil pump gears.
- Hold adjoining gear to keep from moving, when checking backlash.
- Lube oil pump gear and idler gear backlash limit is 0.003 to 0.013 in. (0.08 to 0.33 mm).



Figure 6-1

1. Using dial indicator on tooth of lube oil pump gear, check for excessive backlash.
2. Using dial indicator on tooth of idler gear, check backlash of lube oil pump idler gear (Figure 6-1).

3. Using a 13 mm socket wrench, remove four capscrews (1, Figure 6-2).
4. Remove lube oil pump (2, Figure 6-3).
5. If backlash exceeds limits, replace lube oil pump (2).

LUBE OIL PUMP CLEANING/INSPECTIOIN

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

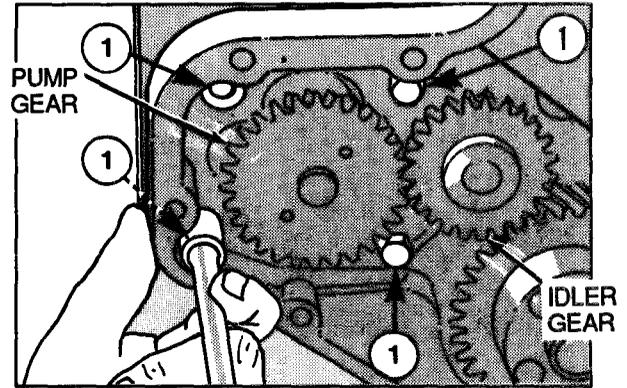


Figure 6-2

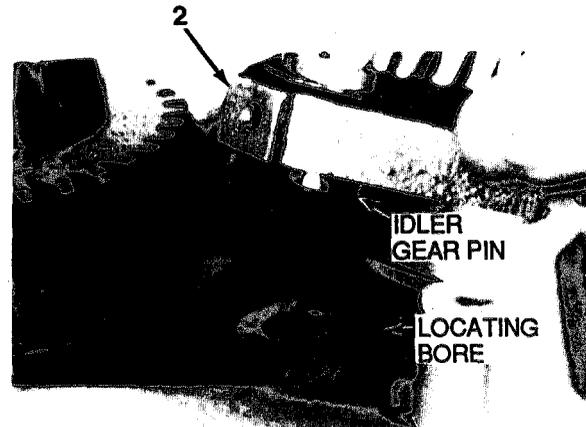


Figure 6-3

LUBE OIL PUMP INSTALLATION

1. Lubricate lube oil pump (2, Figure 6-3) with clean engine oil.

NOTE

Filling lube oil pump before installing will aid in priming during engine start up.

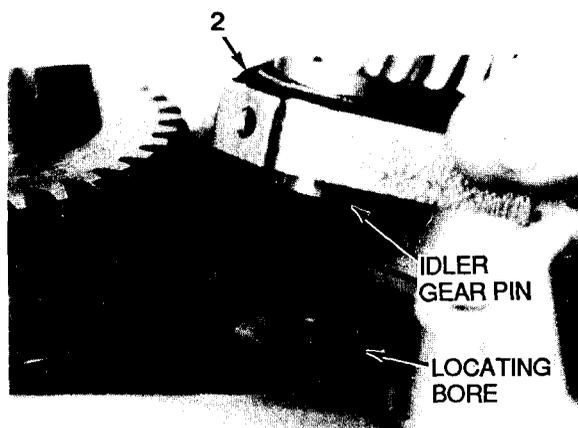


Figure 6-3

2. Install lube oil pump (2). Be sure idler gear pin fits into locating bore in cylinder block.
3. Using a 13 mm socket wrench, install four capscrews (1, Figure 6-2). Torque four capscrews (1) to 18 lb-ft (24 N•m).

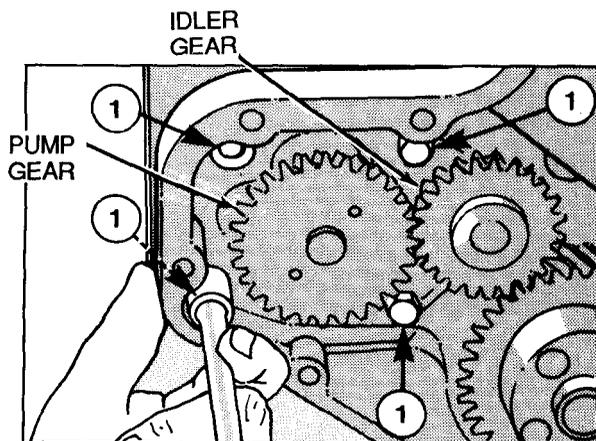


Figure 6-2

AIR CLEANER

AIR CLEANER REMOVAL

NOTE

Tag all hose and tube assemblies before disconnecting to aid in identification. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Remove hood support (refer to page 14-25).
2. Remove cold start cylinder, if so equipped (refer to Koehring Commercial Operation Instructions manual).
3. Loosen four clamps (1, Figure 6-1).
4. Remove elbows (2) and (3), four clamps (1) and tube (4).

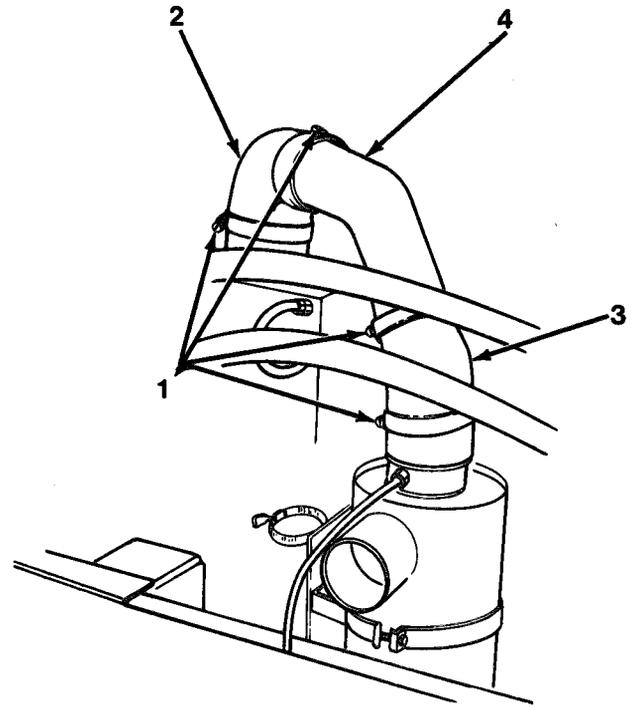


Figure 6-1

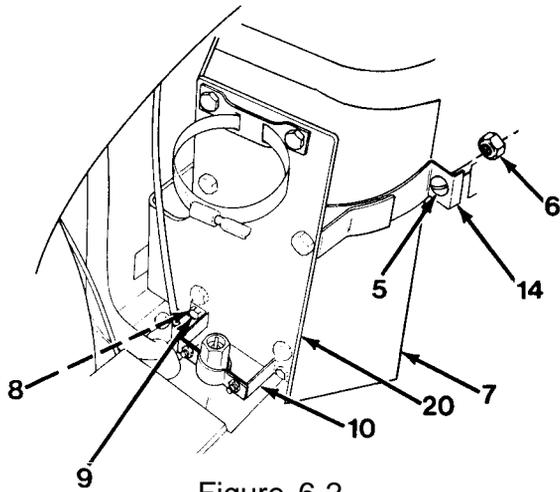


Figure 6-2

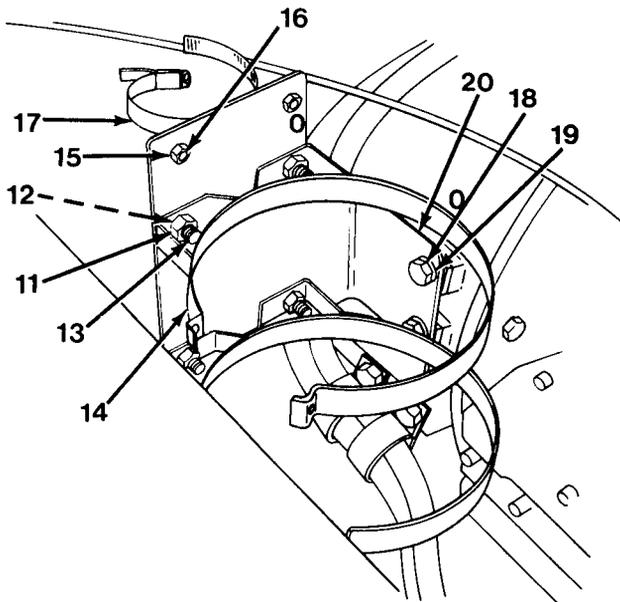


Figure 6-3

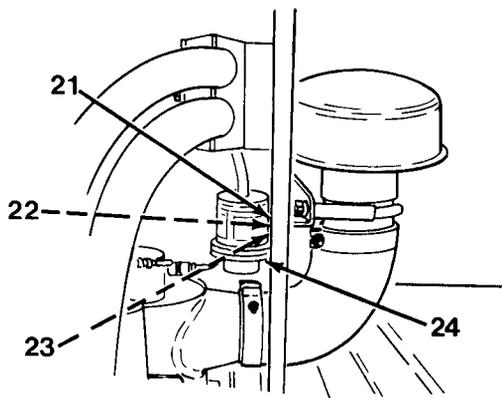


Figure 6-4

AIR CLEANER REMOVAL

5. Remove two screws (5) and nuts (6) to loosen two mounting bands (14, Figure 6-2).
6. Remove air cleaner (7).
7. Remove two nuts (8) and cap screws (9) to disconnect bracket (10) from bracket (20).
8. Remove four nuts (11), washers (12), cap screws (13) and two mounting bands (14) from bracket (20, Figure 6-3).
9. Remove two nuts (15), cap screws (16) and bracket (17).
10. Remove two cap screws (18), washers (19) and bracket (20).
11. Remove two nuts (21), lockwashers (22), machine screws (23) and restriction indicator (24, Figure 6-4) from hood support.

AIR CLEANER INSTALLATION

1. Install restriction indicator (24), two machine screws (23), lockwashers (22) and nuts (21, Figure 6-4) on hood support.
2. Install bracket (20), two washers (19) and capscrews (18, Figure 6-3).
3. Install bracket (17), two capscrews (16) and nuts (15).
4. Install two mounting bands (14), four capscrews (13), washers (12) and nuts (11) to bracket (20).
5. Install two capscrews (9) and nuts (8) to connect bracket (10) on bracket (20, Figure 6-2).
6. Install air cleaner (7) and tighten two mounting bands (14) by installing two nuts (6) and screws (5).
7. Install tube (4), four clamps (1) and elbows (3) and (2, Figure 6-1).
8. Tighten four clamps (1).
9. Install cold start cylinder, if so equipped (refer to Koehring Commercial Operation Instructions manual).
10. Install hood support (refer to page 14-25).

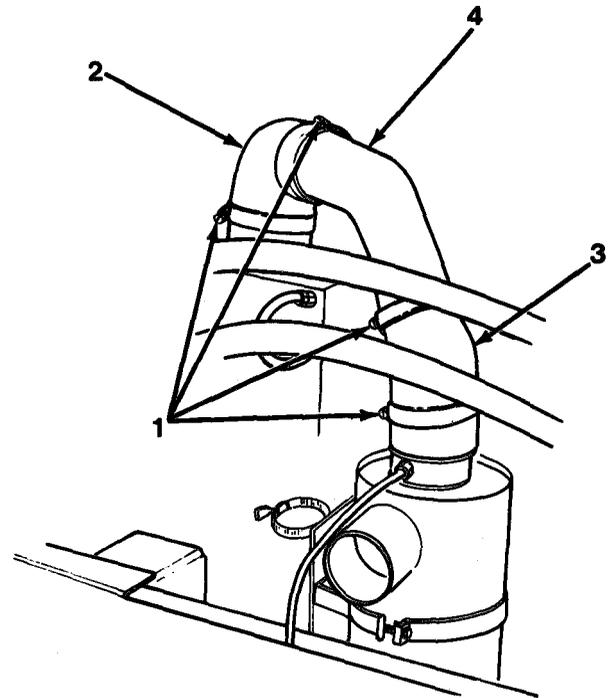


Figure 6-1

AIR CLEANER DISASSEMBLY

1. Remove clamp (1) and cup (2, Figure 6-5).
2. Remove valve (3) and baffle (4) from cup (2).
3. Remove nut (5) and element (6) from body (7).
4. Remove hose (8) and coupling (9) from body (7).

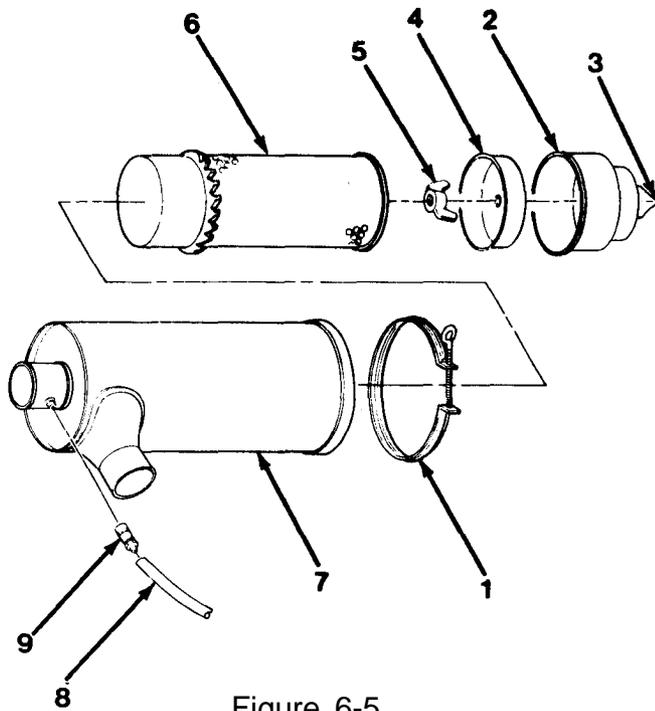


Figure 6-5

AIR CLEANER CLEANING/inspection

1. Clean element (refer to page 3-46).
2. Clean all other parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

AIR CLEANER ASSEMBLY

1. Install coupling (9) and hose (8) to body (7, Figure 6-5).
2. Install element (6) and nut (5) to body (7).
3. Install baffle (4) and valve (3) to cup (2).
4. Install cup (2) and clamp (1).

MANIFOLD COVERPLATE

MANIFOLD COVERPLATE REMOVAL

1. Remove high-pressure fuel injection lines (refer to page 7-34).
2. Using a 13 mm socket remove eight cap-screws (1), coverplate (2) and gasket (3, Figure 6-1). Clean all gasket material from mounting surfaces.

MANIFOLD COVERPLATE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

MANIFOLD COVERPLATE INSTALLATION

NOTE

CoverPlate must be installed with air inlet on flywheel end. Air inlet must be directly above cold start atomizer inlet.

1. Install gasket (3) and coverplate (2, Figure 6-1).
2. Lubricate eight capscrews (1) with Loctite 592 and install on coverplate (2).
3. Install high-pressure fuel injection lines (refer to page 7-38).
4. Torque 10 capscrews (1) to 18 lb-ft (24 N•m) after high-pressure fuel injection lines are installed.

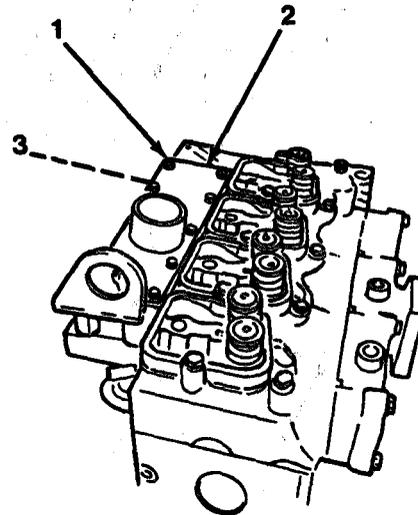


Figure 6-1

VALVE COVERS

VALVE COVERS REMOVAL

Using a 15 mm socket, remove four capscrews (1), O-rings (2), valve covers (3) and gaskets (4, Figure 6-1). Remove all gasket material from mounting surfaces.

VALVE COVERS CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

VALVE COVERS INSTALLATION

Install four gaskets (4), valve covers (3), O-rings (2) and capscrews (1, Figure 6-1). Torque four capscrews (1) to 18 lb-ft (24 N•m).

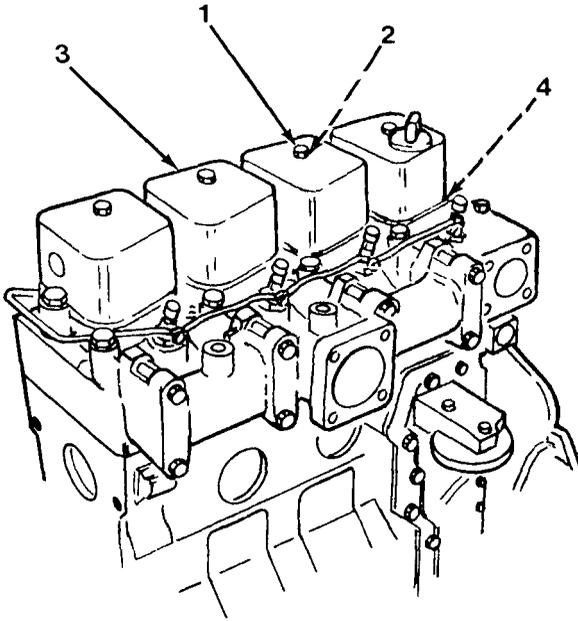


Figure 6-1

ROCKER LEVERS AND PUSH RODS

ROCKER LEVERS AND PUSH RODS REMOVAL

1. Remove high-pressure tubes (refer to page 7-34).
2. Remove valve covers (refer to page 6-36).
3. Loosen four adjusting nuts (1) and rocker adjustment screws (2) to release spring tension from rocker shaft support assemblies (5, Figure 6-1).
4. Using a 13 mm socket, remove four cap-screws (3) from rocker shaft support assemblies (5).
5. Using an 18 mm socket, remove four cap-screws (4) and rocker shaft support assemblies (5) from cylinder head.
6. Remove eight push rods (6, Figure 6-2).

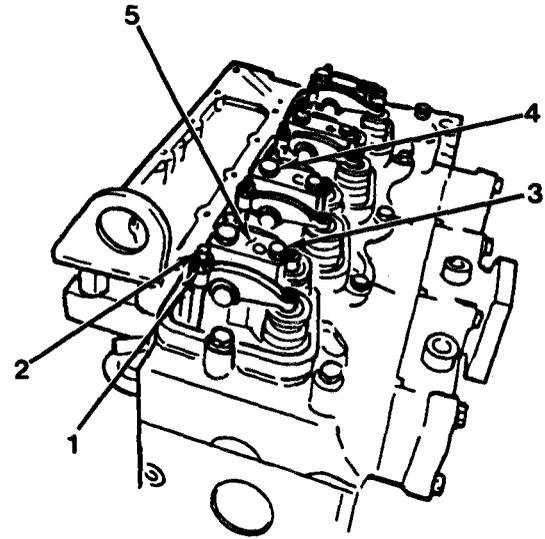


Figure 6-1

ROCKER LEVERS AND PUSH RODS INSTALLATION

1. Lubricate with engine oil and install eight push rods (6, Figure 6-2) in engine.
2. Install four rocker shaft support assemblies (5, Figure 6-1).
3. Lubricate with engine oil and install four capscrews (4) to cylinder head. Torque four capscrews (4) to 92 lb-ft (125 N•m).
4. Lubricate with engine oil and install four capscrews (3) to rocker shaft support assemblies (5). Torque four capscrews (3) to 18 lb-ft (24 N•m).

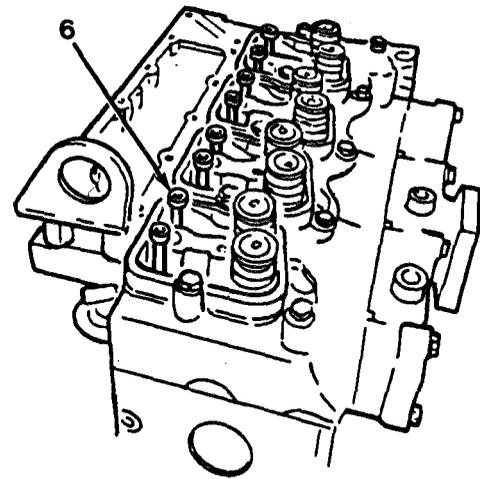


Figure 6-2

ROCKER LEVERS AND PUSH RODS INSTALLATION

5. To set valve clearance, turn valve adjustment screws in until they touch push rod sockets. Loosen valve adjustment screws one full turn.
6. Timing pin is designed only to locate Top Dead Center (TDC) for cylinder number 1 and not to lock engine.
7. Locate TDC for cylinder number 1 (refer to page 7-1, steps 5 and 6).
8. Disengage timing pin.
9. Valve stem to rocker lever clearances for intake should measure 0.010 in. (0.25 mm); for exhaust 0.020 in. (0.5 1 mm). To adjust, loosen jam nut turn adjusting screw to obtain correct clearance and hold. Torque jam nut to 18 lb-ft (24 N•m).
10. Perform valve set procedure with cylinder number 1 at TDC, timing pin will engage.
11. Adjust intake and exhaust valves at cylinder number 1, intake at cylinder 2 and exhaust at cylinder 3.
12. Mark crankshaft and front cover and rotate crankshaft 360 degrees. Timing pin will not engage this time.
13. Adjust exhaust and intake valves at cylinder 4, intake at cylinder 3 and exhaust at cylinder 2.

14. Install valve covers (refer to page 6-36).
15. Install high-pressure tubes (refer to page 7-38).

ROCKER LEVERS AND PUSH RODS DISASSEMBLY

NOTE

The following is a maintenance procedure for one rocker shaft support assembly. Maintenance procedure for remaining three rocker shaft support assemblies is identical.

Before disassembly of rocker shaft support assemblies, mark on each side of rocker shaft support and rocker levers (I) or (E) for intake or exhaust to aid in assembly.

1. Remove two retaining rings (7), thrust washers (8) and intake and exhaust rocker levers (9) from reeker shaft support assemblies (5, Figure 6-3).

NOTE

Do not disassemble reeker shaft support. They are serviced as an assembly.

2. If inspection shows adjusting nuts (1) and rocker adjusting screws (2) are defective, remove and discard from intake and exhaust rocker levers (9, Figure 6-4).

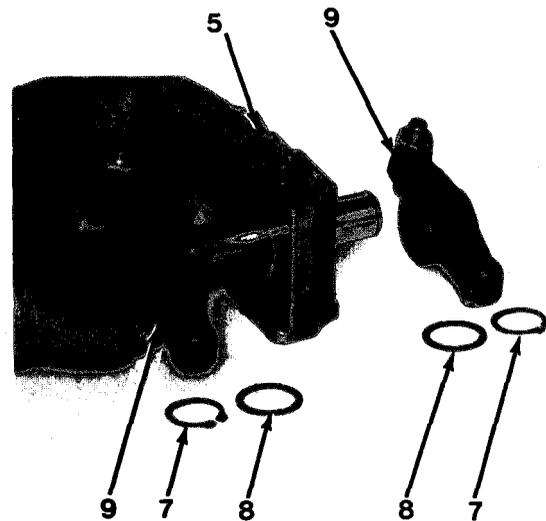


Figure 6-3

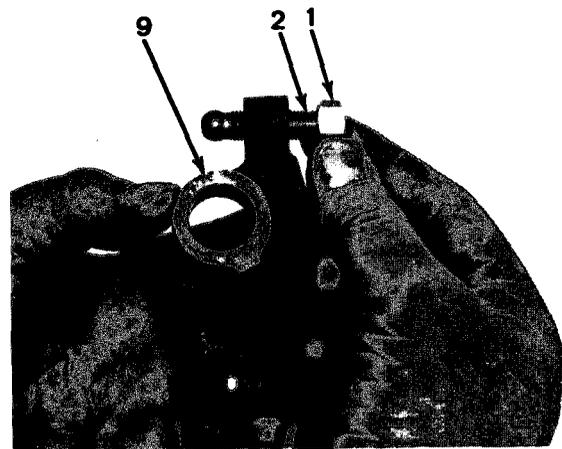


Figure 6-4

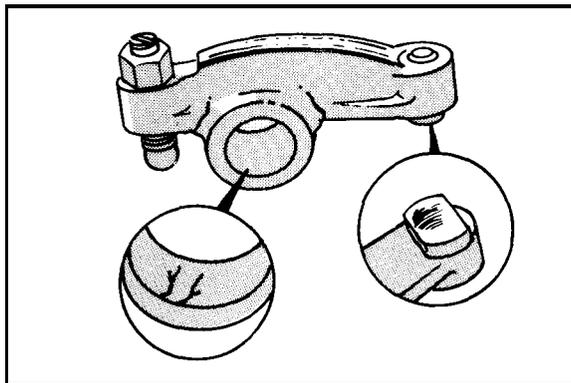


Figure 6-5

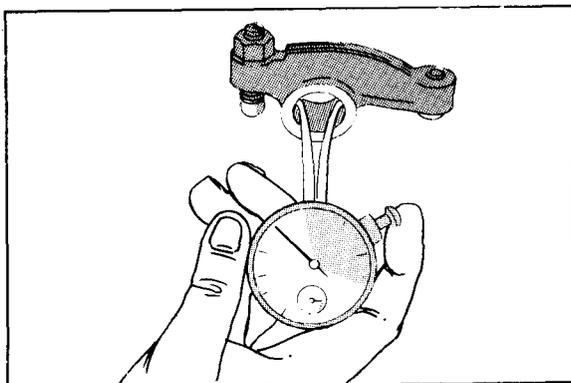


Figure 6-6

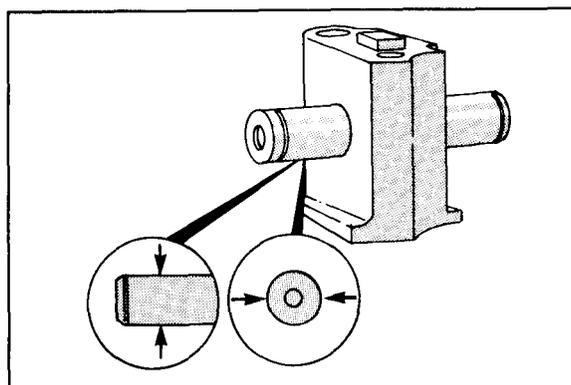


Figure 6-7

ROCKER LEVERS AND PUSH RODS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect rocker levers for cracks and wear in bore and contact surface of valve stem (Figure 6-5).
3. Using a dial indicator, measure diameter of rocker lever bore. Diameter of bore should measure 0.7480 in. (18.999 mm) minimum and 0.7500 in. (19.050 mm) maximum (Figure 6-6).
4. Inspect rocker shaft support assembly for wear on shaft.
5. Using a micrometer, measure diameter of shaft. Diameter of shaft should measure 0.7456 in. (18.938 mm) minimum and 0.7470 in. (18.974 mm) maximum. Replace rocker shaft support assembly when shaft measurement is not within minimum/maximum tolerance (Figure 6-7).
6. Inspect all other parts (refer to Chapter 4).

ROCKER LEVERS AND PUSH RODS ASSEMBLY

1. If removed, install four rocker adjustment screws (2) and adjusting nuts (1) to rocker intake and exhaust recker levers (9, Figure 6-4).

NOTE

Be sure to assemble intake and exhaust rocker levers in the correct location.

2. Lubricate rocker shaft support assemblies (5) with engine oil and install intake and exhaust rocker levers (9), two thrust washers (8) and retaining rings (7, Figure 6-3).

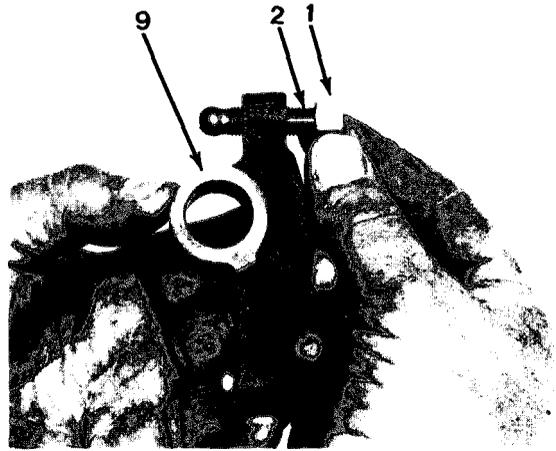


Figure 6-4

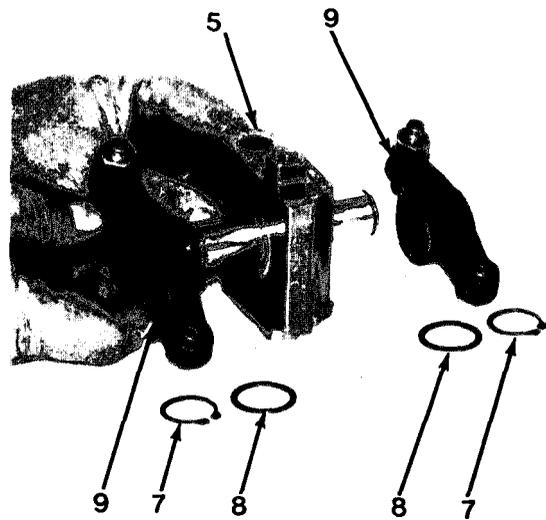


Figure 6-3

CYLINDER HEAD

CYLINDER HEAD REMOVAL

1. Remove exhaust manifold (refer to page 8-1).
2. Remove fuel injection tubes (refer to page 7-34).
3. Remove valve covers (refer to page 6-36).
4. Remove rocker levers and push rods (refer to page 6-37).
5. Remove manifold coverplate (refer to page 6-35).
6. Using an 18 mm socket, remove 14 capscrews (1) from cylinder head (2, Figure 6-1).

⚠ WARNING

Weight of cylinder head is approximately 80 lb (36 kg). Use adequate lifting equipment to lift and support cylinder head. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

7. Using a suitable hoist and sling, remove cylinder head (2) from block (3) and place on a suitable work table.
8. Remove gasket (4). Remove all gasket material from cylinder head (2) and block (3).

CYLINDER HEAD INSTALLATION

NOTE

Make sure cylinder head and block surfaces are clean and not nicked or gouged.

1. Install gasket (4) in block (3) aligning gasket (4) up with holes in block (3, Figure 6-2).

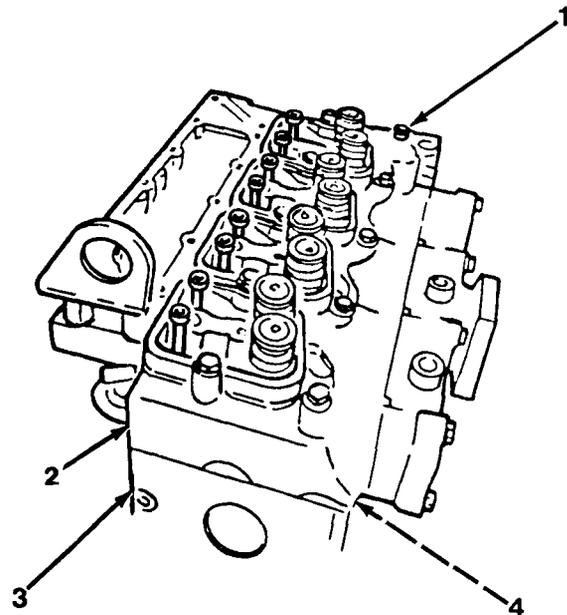


Figure 6-1

⚠ WARNING

Weight of cylinder head is approximately 80 lb (36 kg). Use adequate lifting equipment to lift and support cylinder head. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.



Figure 6-2

2. Using suitable hoist and sling, install cylinder head (2) carefully on block (3) making sum gasket (4, Figure 6-1) stays in place.
3. Install rocker levers and push rods, (refer to page 6-37).
4. Lubricate and install 14 capscrews (1, Figure 6-3) on cylinder head (2). Torque 18 capscrews in Sequence shown three separate times. First time, tighten capscrews (1) to 29 lb-ft (39 N•m). Second time, tighten capscrews (1) to 62 lb-ft (84 N•m). Third time, tighten capscrews (1) to 92 lb-ft (125 N•m).
5. Torque four 13 mm capscrews on rocker lever support assembly to 18 lb-ft (24 N•m).
6. Install manifold coverplate (refer to page 6-35).
7. Install valve covers (refer to page 6-36).
8. Install fuel injection tubes (refer to page 7-37).
9. Install exhaust manifold (refer to page 8-1).

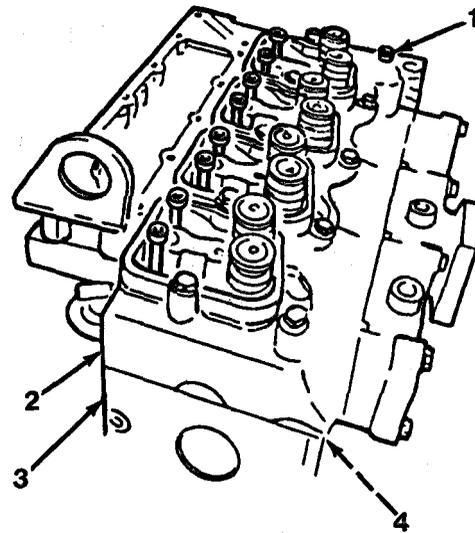


Figure 6-1

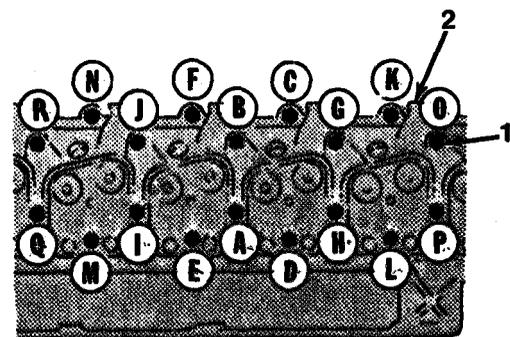


Figure 6-3

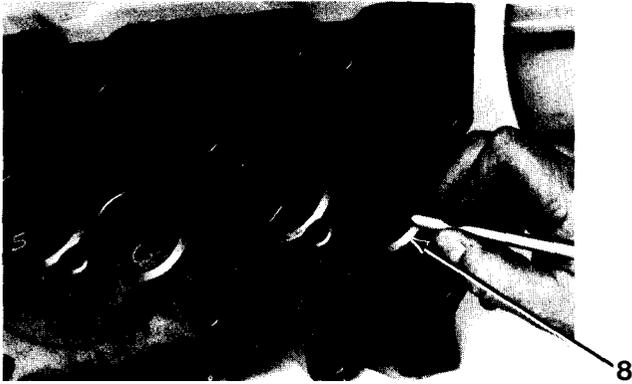


Figure 6-3

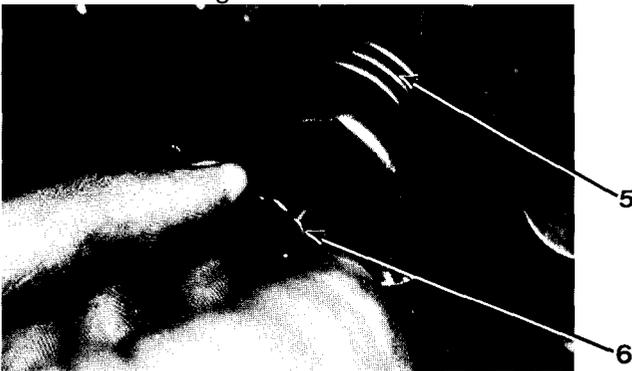


Figure 6-4

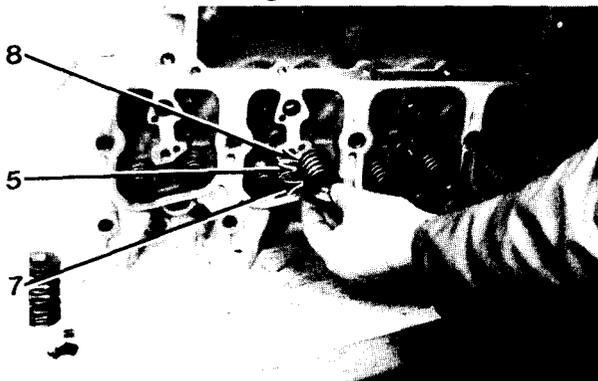


Figure 6-5

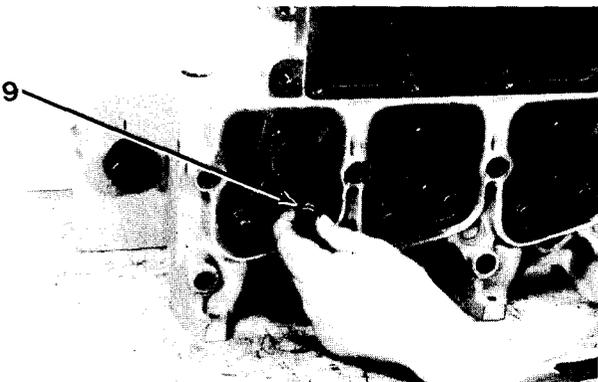


Figure 6-6

CYLINDER HEAD DISASSEMBLY

NOTE

- Cylinder head has integral valve guides and valve seats. The seats can be re-ground. Seats that have been previously re-ground can be replaced with service seats. Service valve guides are also available to replace worn guides.

- The following is a maintenance procedure for one valve spring, two valve collets and valve. The maintenance procedure for the remaining seven valve springs, valve collets and valve is identical.

1. Mark valve (8, Figure 6-3) to identify position and to aid in assembly.
2. Compress valve spring (5). Remove valve collets (6, Figure 6-4).
3. Release valve spring (5) slowly and remove retainer (7), valve spring (5) and valve (8, Figure 6-5). Keep valve (8) in a labeled rack.
4. Remove valve seal (9, Figure 6-6).

CYLINDER HEAD CLEANING/ INSPECTION

1. Clean carbon from injector nozzle seat with a nylon or brass brush (Figure 6-7).

WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Wash cylinder head in hot soapy water solution and dry with compressed air.
3. Polish gasket surfaces with 400-grit paper. Use an orbital sander or sanding block to maintain a flat surface.
4. Inspect valve guides for scuffing or scoring.
5. Inspect cylinder head surface for nicks and erosion.
6. Using a feeler gage and straight edge, check cylinder head for distortion.

LIMIT

Variation: 0.0039 in. (0.099 mm) within 2.00 in. (50.8 mm) diameter area. 0.003 in. (0.08 mm) overall end to end or side to side.



Figure 6-7

CYLINDER HEAD VALVES CLEANING/INSPECTION

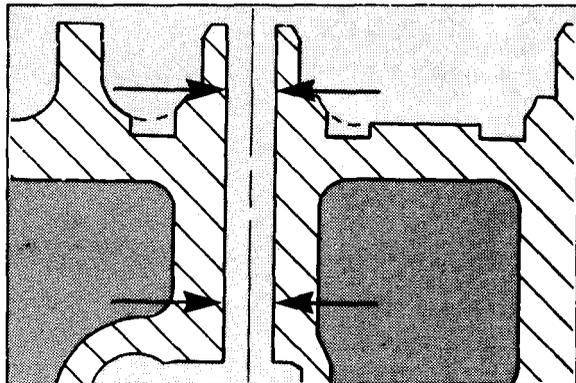


Figure 6-8

7. Measure valve guide bore. Minimum diameter is 0.3157 in. (8.019 mm) and maximum diameter is 0.3185 in. (8.090 mm) (Figure 6-8).
8. If valve guide bores are found to be worn during inspection, cylinder head must be machined for service valve guides. Valve guides must be finish-reamed after installation into head.

NOTE

If, after inspection, it is determined that service valve guides and valve inserts are required, install service valve guides first.

Valve Guide Part No.

- 3904408- Intake (Thick wall)
- 3904409- Exhaust (Thick wall)
- 3906206- Intake & Exhaust (Thin wall)

NOTE

The following dimensions are for (Thin wall) valve guides.

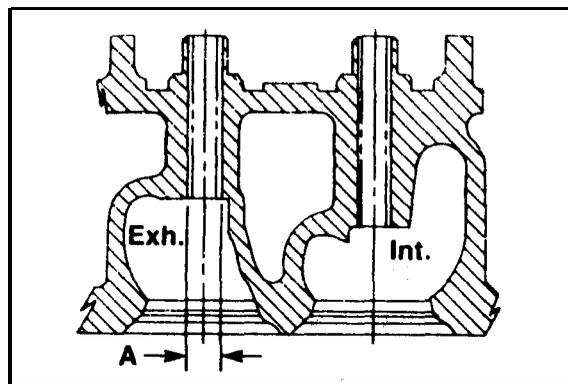


Figure 6-9

9. Machine cylinder head parent metal valve guide bores to dimension A (Figure 6-9).

$$A = 0.4380 + 0.0005 \text{ in. (11.125 0.013 mm) diameter.}$$

Bore is to be centered with valve seats within 0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.

10. Install valve guides to dimensions A thru D (Figure 6-10).

A= Lubricate with oil and press guides flush to bottom of bosses.

B= 0.4724 ± 0.0295 in. (12.00 ± 0.75 mm) diameter.

C= Trim off flush to top of guide bosses, if necessary.

D= 0.3161 ± 0.0004 in. (8.029 ± 0.010 mm).

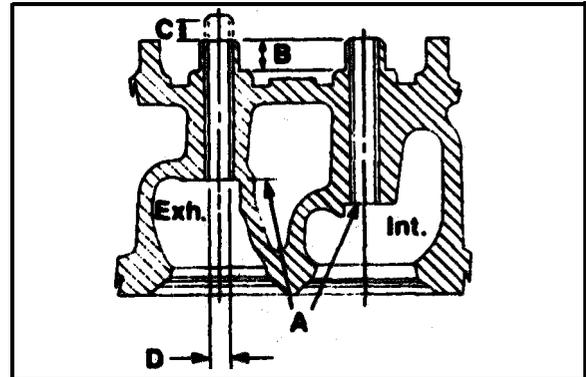


Figure 6-10

Final bore after assembly is to be centered with valve seats within 0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.

NOTE

The following dimensions are for (Thick wall) valve guides.

11. Machine cylinder head parent metal valve guide bores to dimension A (Figure 6-9).

A = 0.5512 ± 0.0005 in. (14.000 ± 0.013 mm).

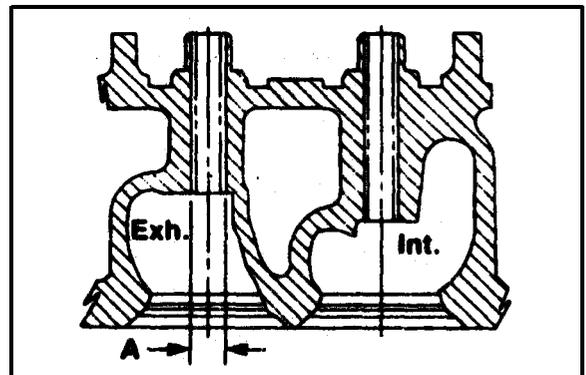


Figure 6-9

Bore is to be centered with valve seats within 0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.

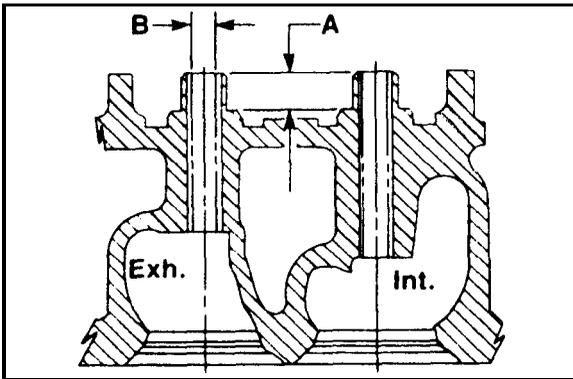


Figure 6-11

CYLINDER HEAD VALVES CLEANING/INSPECTION

12. Install valve guides. Lubricate with oil and press guides to dimension A protrusion above cylinder head. Finish ream bores to dimension B (Figure 6-11).

A = 0.4823 ± 0.020 in. (12.250 ± 0.51 mm).

B = 0.3161 ± 0.0004 in. (8.029 ± 0.010 mm)

CYLINDER HEAD CLEANING/INSPECTION

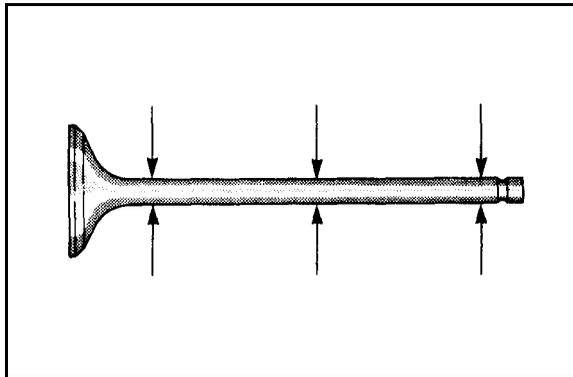


Figure 6-12

1. Clean valve heads with soft wire wheel.
2. Polish valve stem with crocus cloth.
3. Using a 0-1 in. (0-25 mm) micrometer, inspect valve heads and stems for abnormal wear.
4. Measure valve stem diameter. Minimum diameter is 0.3126 in. (7.940 mm) and maximum is 0.3142 in. (7.981 mm) (Figure 6-12).
5. Mark new valves, if required, for replacement location.
6. Grind face of valves being reused. Check and replace bent valves.
7. Check seat angle of valves. Intake is 30 degrees and exhaust is 45 degrees (Figure 6-13).

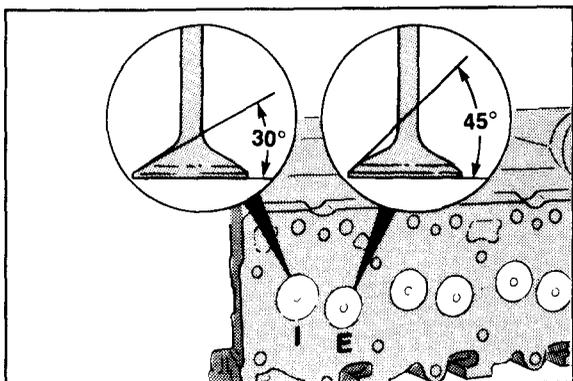


Figure 6-13

8. Measure thickness of rim. The minimum (T) is 0.031 in. (0.79 mm) (Figure 6-14).
9. Check valve stem tip for flatness (Figure 6-15).
10. Using grinding wheel, re-surface valve tip if inspection indicates it is necessary.
11. The illustrated marks indicate valve seats have been ground previously. Previously re-ground seats can be replaced with service seats (Figure 6-16).
12. Install valves in their designated location and measure valve depth.
13. The valve depth is the distance from valve face to head deck. Record depth of each valve as A (Figure 6-17). The valve depth minimum is 0.039 in. (0.99 mm) and maximum is 0.060 in. (1.52 mm).
14. Grind valve seats to remove scores, scratches and burns.

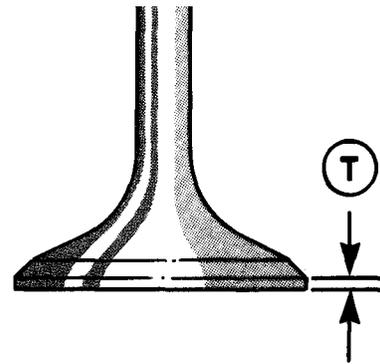


Figure 6-14

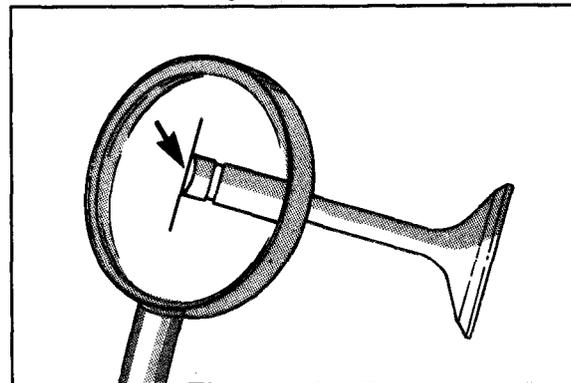


Figure 6-15

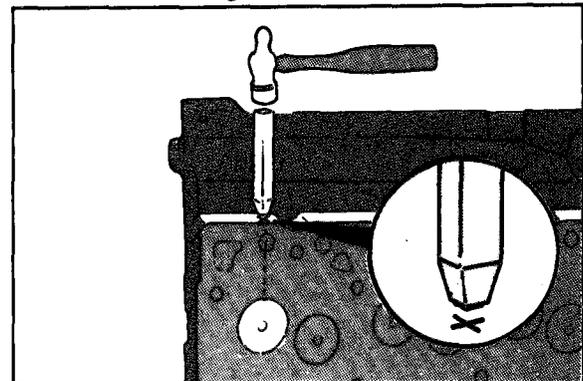


Figure 6-16

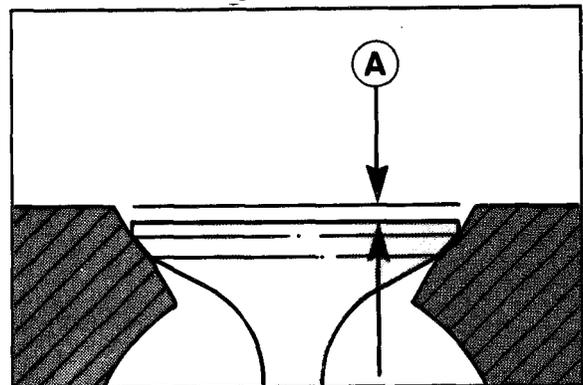


Figure 6-17

CYLINDER HEAD CLEANING/ INSPECTION

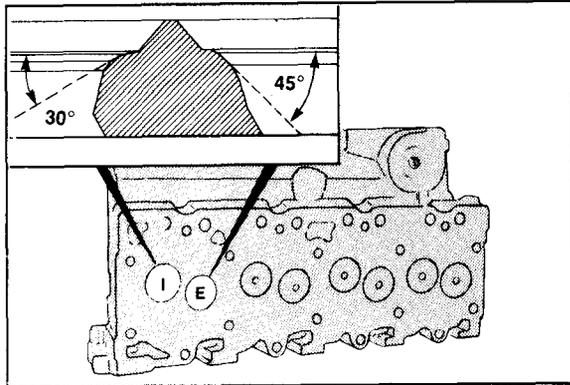


Figure 6-18

15. Check seat angle of cylinder head. Intake is 30 degrees and exhaust is 45 degrees (Figure 6-18).
16. Install valves in their respective bores and measure depth again.
17. Record depth of each valve as B, and calculate grinding depth GD as $GD = B - A$ (Figure 6-19). The grinding depth limit is 0.010 in. (0.25 mm).

NOTE

The service valve seats are available for over the limit seats.

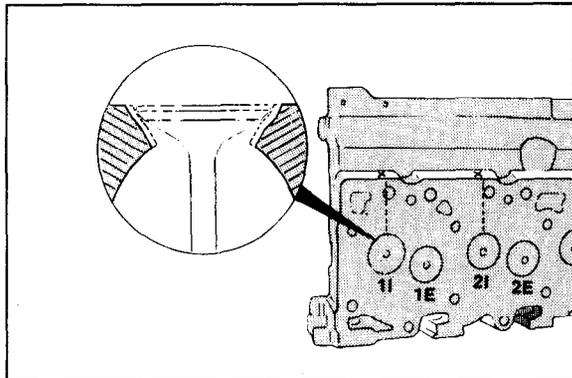


Figure 6-19

18. Mark cylinder head to identify re-ground valve seats.
19. If removed, install valves in their designated location and measure depth again. Refer to step 13 above for correct valve depth. Replace valve if depth is over limit.
20. Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.

CAUTION

Make sure all lapping compound is cleaned from valves and seats. Failure to do so will cause serious damage to cylinder head and valves.

21. Remove valves and clean lapping compound from valves and seats.
22. Measure valve seat width indicated by lapped surface. Valve seat minimum width (1) limit is 0.060 in. (1.5 mm) and maximum width (2) is 0.080 in. (2.03 mm) (Figure 6-20).
23. If required, grind area (A) with a 60-degree stone and (B) with a 15-degree stone to center seat on valve face (Figure 6-21). Maintain valve seat width limits referred to in step 22.

VALVE SPRINGS INSPECTION

1. Measure valve springs. The approximate limit for free length is 2.190 in. (55.63 mm). The maximum inclination is 0.039 in. (0.99 mm) (Figure 6-22).
2. Inspect valve spring tension. A minimum load of 65.0 to 72.2 lb (289 to 321 N) is required to compress spring to a height of 1.94 in. (49.3 mm).

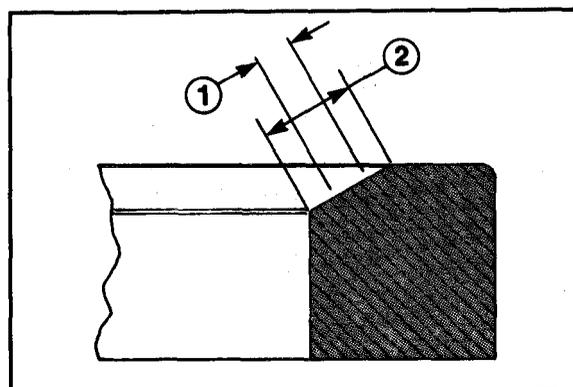


Figure 6-20

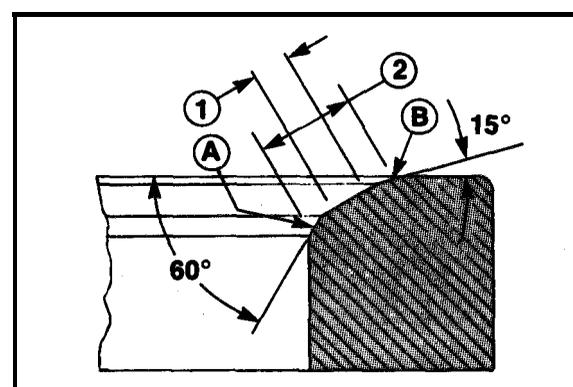


Figure 6-21



Figure 6-22

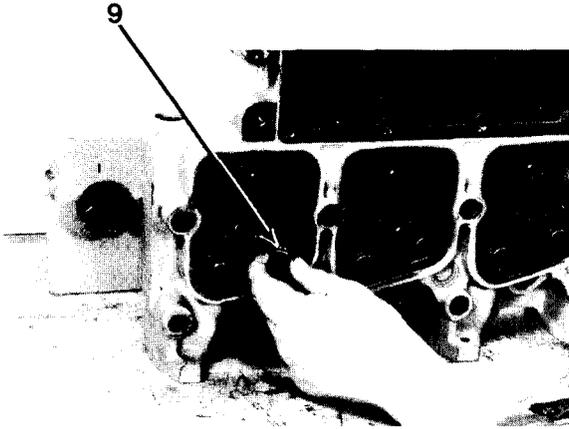


Figure 6-6

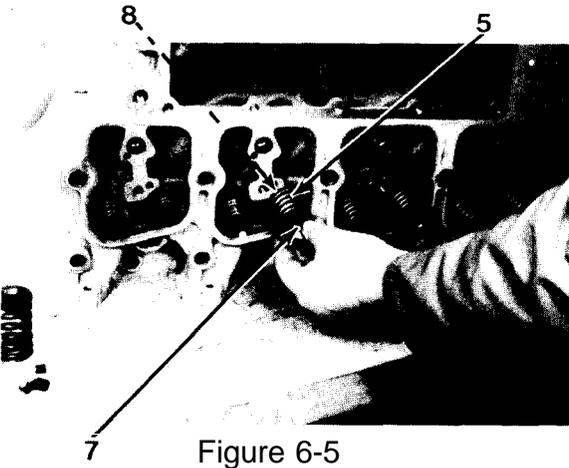


Figure 6-5

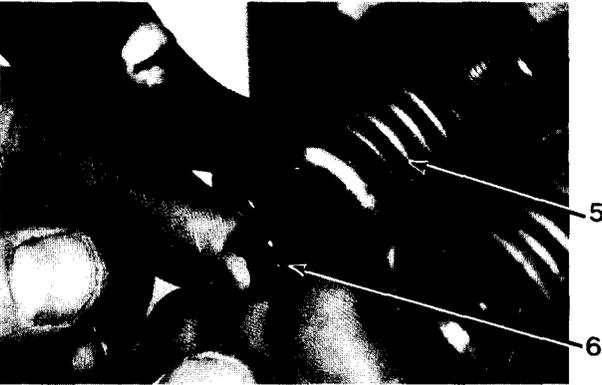


Figure 6-4

CYLINDER HEAD ASSEMBLY

1. Install valve seal (9, Figure 6-6).

NOTE

Make sure marks made on valves match up with marks on cylinder head made during disassembly.

2. Lubricate and install valve (8), valve spring (5) and retainer (7, Figure 6-5).
3. Compress valve spring (5), install valve collets (6, Figure 6-4) and release spring tension.
4. After assembly, tap valve stems (8) to verify collets (6, Figure 6-23) are seated.

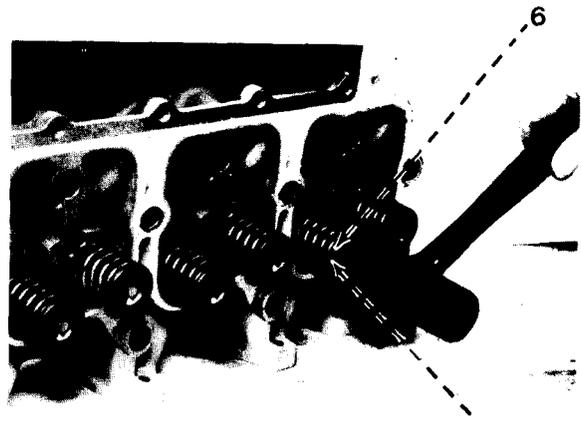


Figure 6-23

TAPPET COVER

TAPPET COVER REMOVAL

1. Remove fuel filters and head assembly (refer to page 7-30).
2. Remove injection pump (refer to page 7-1).
3. Remove lift pump and fuel drain tube (refer to pages 7-24 and 7-36).
4. Remove spring hose clamp (1) and hose (2) from tappet cover (5, Figure 6-1).
5. Using a 10 m socket, remove two capscrews (3), capscrew seals (4), tappet cover (5) and tappet cover gasket (6) from block. Remove all gasket material from mounting surfaces.

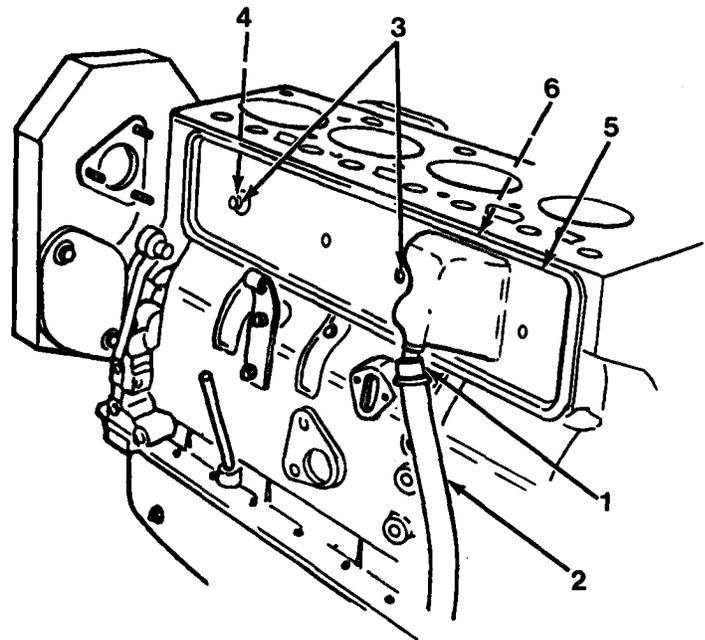


Figure 6-1

TAPPET COVER CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

TAPPET COVER INSTALLATION

NOTE

Tappet cover gasket has an adhesive back. Pull off protective cover on gasket to expose adhesive surface.

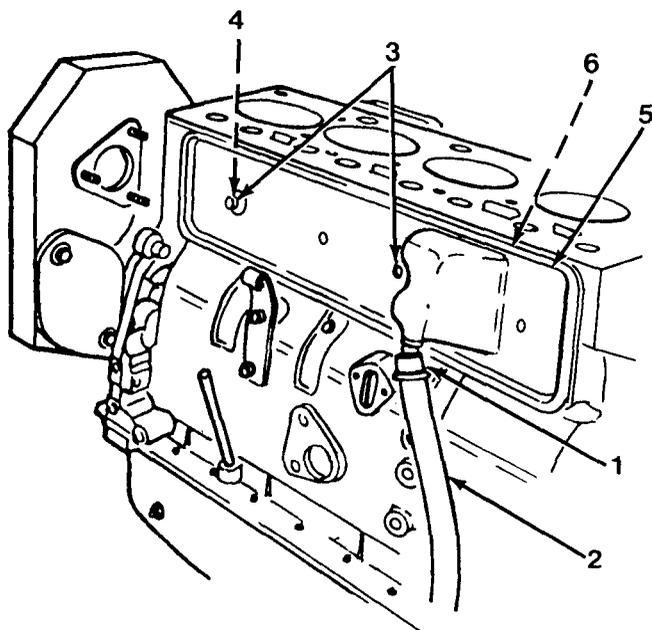


Figure 6-1

1. Install tappet cover gasket (6) with adhesive side down on tappet cover (5, Figure 6-1). Apply sealant ML-S-79 16 to top of gasket and block.
2. Install tappet cover (5), two capscrew seals (4), and capscrews (3) on block. Torque two capscrews (3) to 18 lb-ft (24 N•m).
3. Install hose (2) and spring hose clamp (1) on tappet cover (5).
4. Install lift pump and fuel drain tube (refer to page 7-24 and 7-37).
5. Install injection pump (refer to page 7-3).
6. Install fuel filters and head assembly (refer to page 7-30).

CAMSHAFT AND VALVE TAPPETS

CAMSHAFT AND VALVE TAPPETS REMOVAL

1. Position dial indicator on tooth of camshaft gear (4, Figure 6-1).
2. Using dial indicator, measure camshaft gear (4, Figure 6-2) backlash. Camshaft gear (4) backlash limits (A) are 0.003 to 0.013 in. (0.08 to 0.33 mm).
3. Using a 13 mm socket, remove two capscrews (1, Figure 6-3).

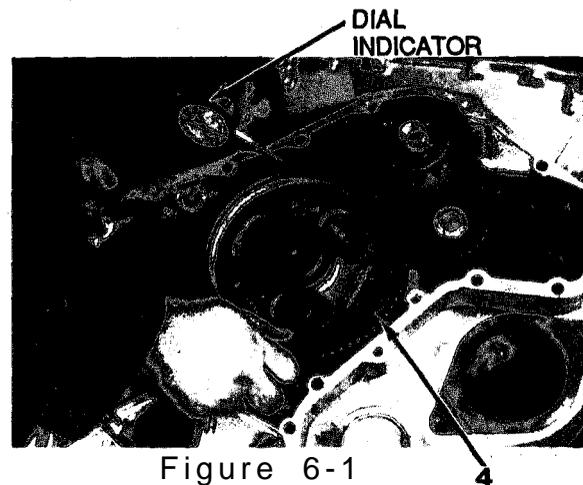


Figure 6-1

NOTE

Thrust support will fall free from camshaft upon removal of camshaft.

4. Remove camshaft assembly (2) and thrust support (3, Figure 6-4).

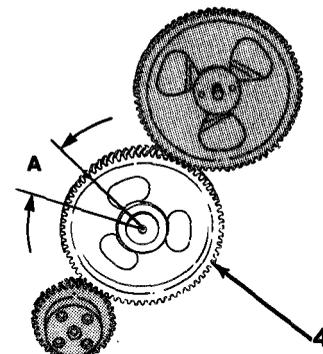


Figure 6-2

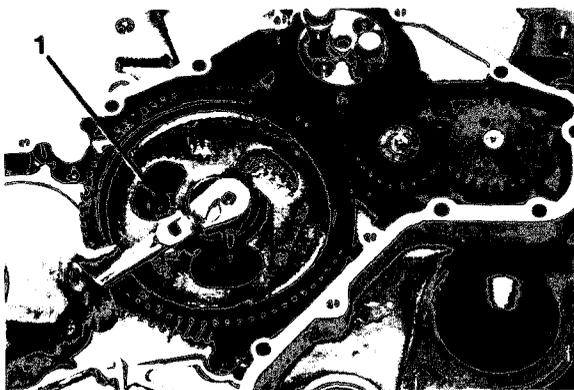
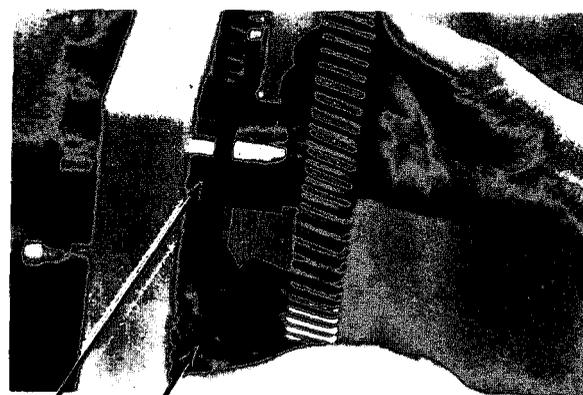


Figure 6-3



2 3 Figure 6-4

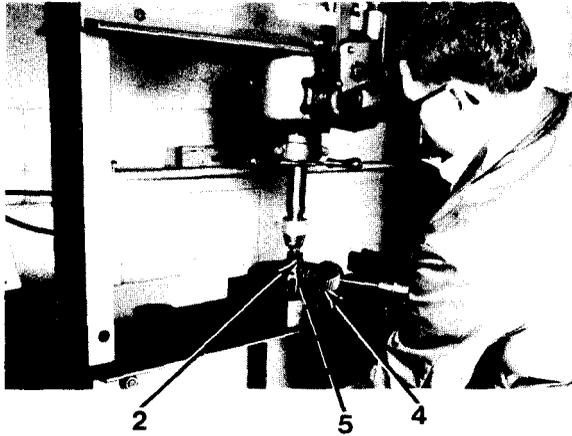


Figure 6-5

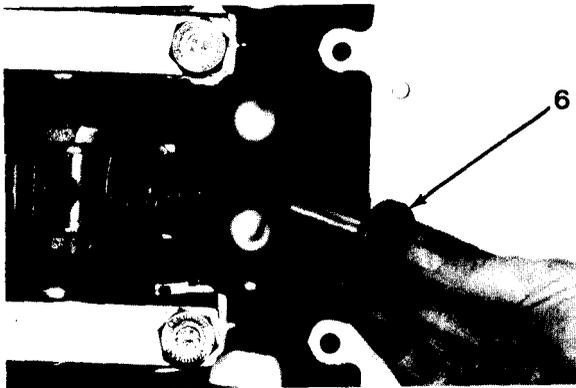


Figure 6-6

CAMSHAFT AND VALVE TAPPETS REMOVAL

5. Using a press, remove camshaft gear (4) from camshaft (2, Figure 6-5).
6. Remove woodruff key (5) from camshaft (2).
7. Remove eight valve tappets (6, Figure 6-6) from cylinder block.

CAMSHAFT AND VALVE TAPPETS CLEANING/inspection

⚠ WARNING

Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment: goggles or safety glasses, face shield and gloves. Do not breathe vapors. Do not use near sparks or open flames and do not smoke while using it. Failure to follow these procedures could cause SERIOUS INJURY.

1. Clean camshaft and camshaft gear with dry cleaning solvent P-D-680 and lint-free cloth.
2. Check camshaft fuel lift pump lobes, valve lobes and bearing journals for cracks, pitting and scoring.
3. Check camshaft gear teeth for pitting and cracks at roots of teeth.

4. Measure camshaft bearing journals and valve lobes at locations as shown (Figure 6-7).

DIAMETER AT PEAK OF LOBE

Intake

MIN 1.861 in. (47.27 mm)
 MAX 1.866 in. (47.40 mm)

Exhaust

MIN 1.850 in. (46.99 mm)
 MAX 1.855 in. (47.12 mm)

Fuel lift pump

MIN 1.410 in. (35.81 mm)
 MAX 1.422 in. (36.12 mm)

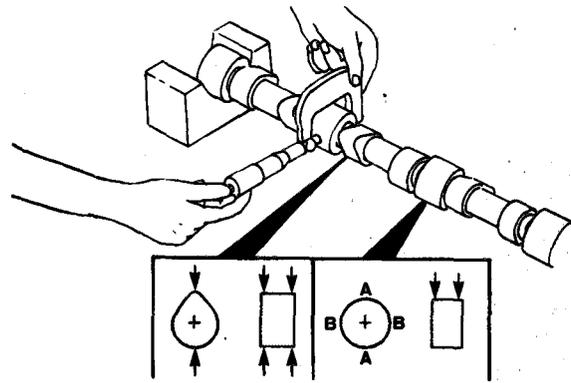


Figure 6-7

JOURNAL DIAMETER

MIN 2.1245 in. (53.962 mm)
 MAX 2.1265 in. (54.013 mm)

5. Check eight valve tappets for pitting and cracks (Figure 6-8).
6. Inspect contact surfaces on faces of eight valve tappets.

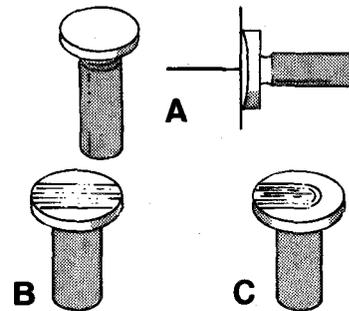


Figure 6-8

LIMITS

(A) - Normal contact
 (B) and (C) - Poor contact, discard.

7. Using micrometer, measure eight valve tappet stems at locations shown (Figure 6-9).

DIAMETER

MIN 0.627 in. (15.93 mm)
 MAX 0.629 in. (15.98 mm)

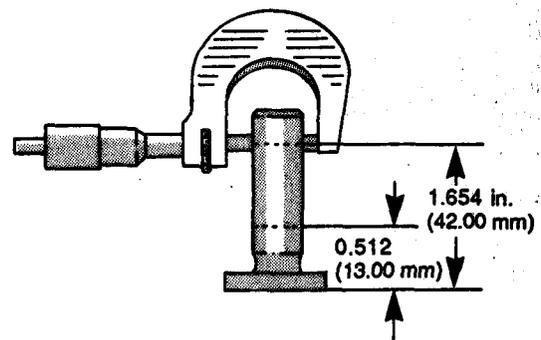


Figure 6-9

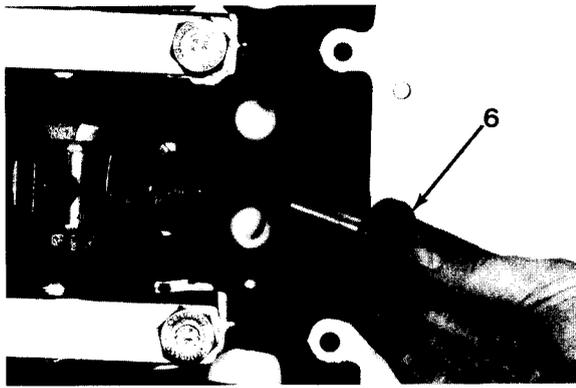


Figure 6-6

CAMSHAFT AND VALVE TAPPETS INSTALLATION

1. Lubricate eight valve tappets (6, Figure 6-6) with lubricating oil DOD-L-2568 1.
2. Install eight valve tappets (6).
3. Using hammer, install woodruff key (5) on camshaft (2, Figure 6-10).
4. Lubricate camshaft (2) ends, journals and lobes with lubricating oil DOD-L-2568 1.

WARNING

Wear protective gloves when handling hot gear. **SERIOUS INJURY** may result if hot gear contacts skin.

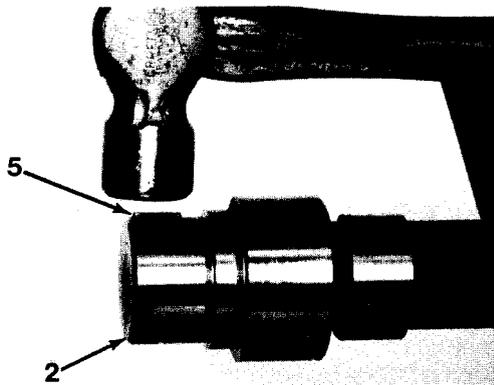


Figure 6-10

5. Heat camshaft gear (4, Figure 6-11) in oven at 250 degrees F (121 degrees C) for 45 minutes.
6. Install camshaft gear (4) on camshaft (2) with timing marks away from camshaft (2). Camshaft gear (4) must seat against shoulder on camshaft (2).

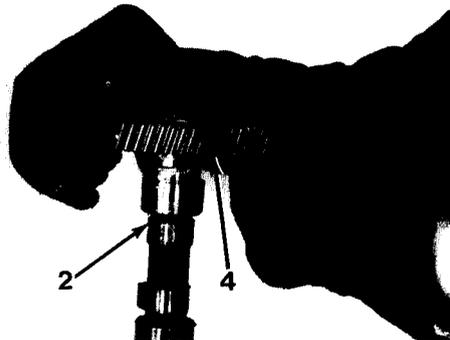


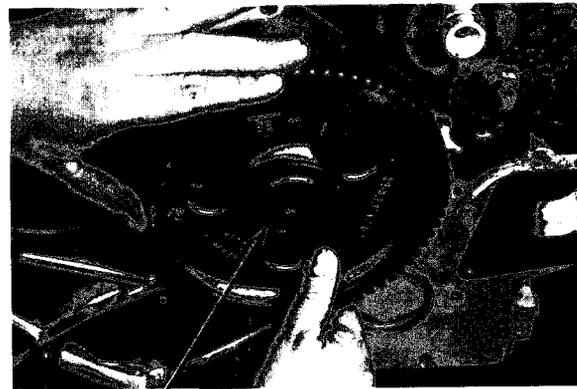
Figure 6-11

7. Lubricate camshaft bores with lubricating oil DQD-L-25681 (Figure 6-12).
8. Position camshaft (2, Figure 6-13) into cylinder block up to last journal.
9. Make sure timing marks are aligned (Figure 6-14).
10. Lubricate thrust support (3) with lubricating Oil DOD-L-25681.
11. Position thrust support (3).



CAMSHAFT
BORE

Figure 6-12



2 Figure 6-13



Figure 6-14

3

CAMSHAFT AND VALVE TAPPETS INSTALLATION

12. Push camshaft (2) into cylinder block and install two capscrews (1, Figure 6-15). Using a 13 mm socket, torque capscrews (1) to 18 lb-ft (24 N•m).

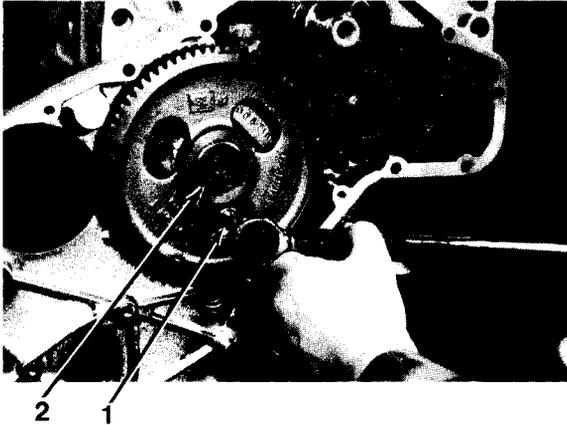


Figure 6-15

NOTE

Camshaft end play is controlled by thickness of thrust support and groove in camshaft.

13. Position dial indicator on camshaft gear (4, Figure 6-16),
14. Using dial indicator, measure camshaft end play. Camshaft end play limits (A) are 0.007 to 0.011 in. (0.18 to 0.28 mm).
15. Measure camshaft gear backlash (refer to page 6-55, step 2).

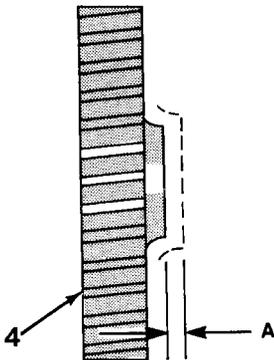


Figure 6-16

FLYWHEEL AND FLYWHEEL HOUSING

FLYWHEEL AND FLYWHEEL HOUSING REMOVAL

1. Remove engine/transmission assembly (refer to page 6-1).

CAUTION

Do not use timing pinto lock engine. This will damage timing pin.

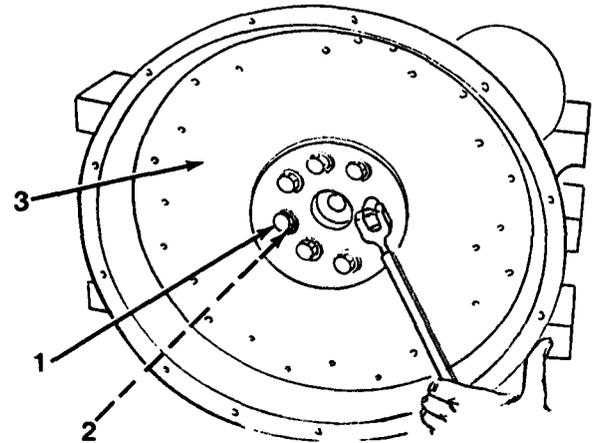


Figure 6-1

2. Install two capscrews in front of crankshaft and hold crankshaft by placing breaker bar or similar object between capscrews.
3. Using a 19 mm socket, remove eight capscrews (1), washers (2) and flywheel (3, Figure 6-1) from engine.
4. Using a 15 mm socket, remove eight capscrews (4), flywheel housing (5) and O-ring (6, Figure 6-2).

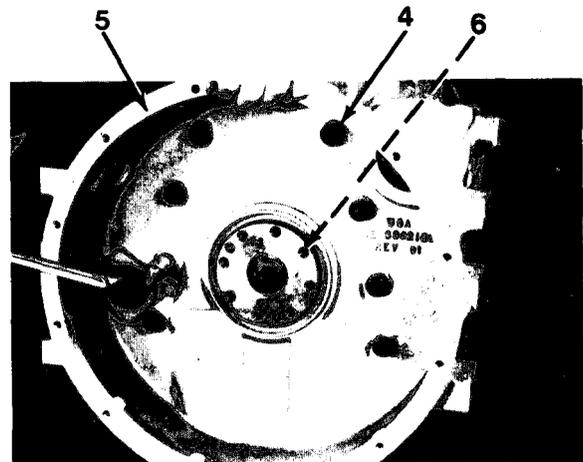


Figure 6-2

FLYWHEEL AND FLYWHEEL HOUSING INSTALLATION

1. Install O-ring (6), flywheel housing (5) and eight capscrews (4, Figure 6-2).
2. Torque eight capscrews (4, Figure 6-3) in sequence to 57 lb-ft (77 N•m).

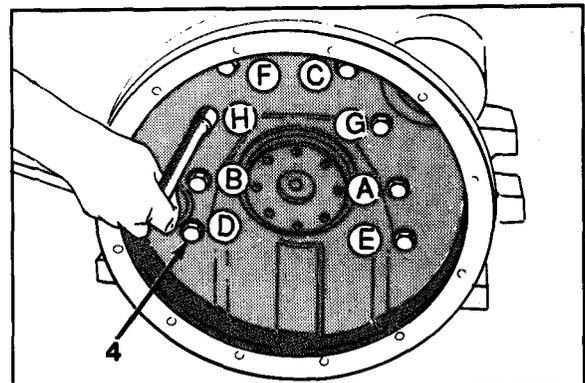


Figure 6-3

FLYWHEEL AND FLYWHEEL HOUSING INSTALLATION

- Attaching a dial indicator to crankshaft, measure vertical and horizontal runout of flywheel housing (Figure 6-4).

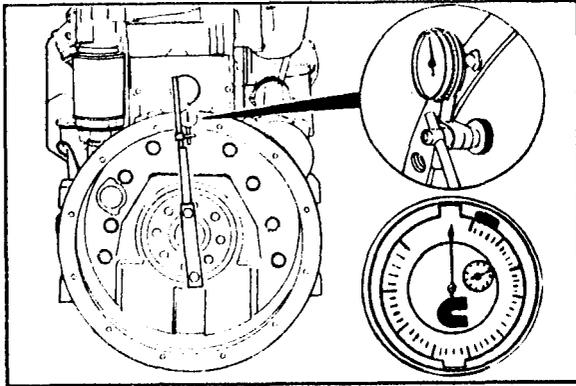


Figure 6-4

CAUTION

Dial indicator tip must not enter capscrew holes or gauge will be damaged.

NOTE

Extension bar for dial indicator must be rigid for an accurate reading. It must not sag.

- Position dial indicator at 12 o'clock position. Adjust dial until needle points to zero.
- Slowly rotate crankshaft. Record readings obtained at 3 o'clock, 6 o'clock and 9 o'clock positions (Figure 6-5).
- Continue to rotate crankshaft back to 12 o'clock position. Check dial indicator to make sure needle points to zero. Determine Total Indicator Reading (TIR).

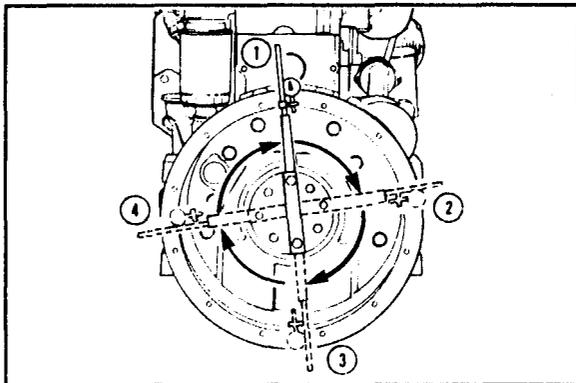


Figure 6-5

EXAMPLE:

12 o'clock = 0.000 in. (0.00 mm)
 3 o'clock = +0.003 in. (0.08 mm)
 6 o'clock = -0.002 in. (0.05 mm)
 9 o'clock = +0.003 in. (0.08 mm)

Equals TIR = 0.005 in. (0.13 mm)

NOTE

Maximum TIR is determined by diameter of housing bore. Replace housing if out of specification.

7. Specification of bore diameter is 17.625 to 17.630 in. (447.68 to 447.80 mm). TIR maximum is 0.008 in. (0.20 mm).

CAUTION

Do not force crankshaft beyond point where bearing clearance has been removed. Do not use flywheel housing as a fulcrum. Failure to follow this procedure could cause damage to equipment.

8. Determine adjustment for main bearing clearance by raising rear of crankshaft to its upper hit. Use a floor-mounted support with padded pry bar to raise crankshaft and record reading (Figure 6-6).
9. Calculate bearing clearance adjustment by subtracting one-half of reading obtained in step 8 from reading obtained at 6 o'clock position.

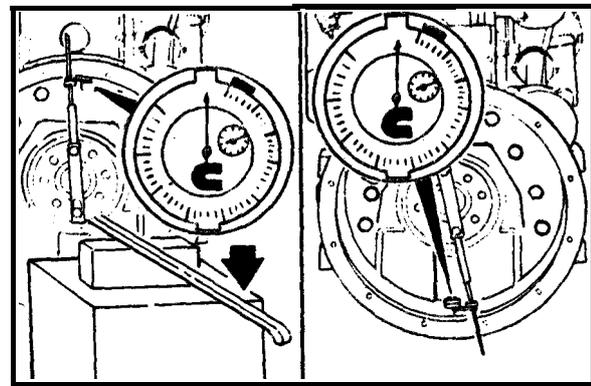


Figure 6-6

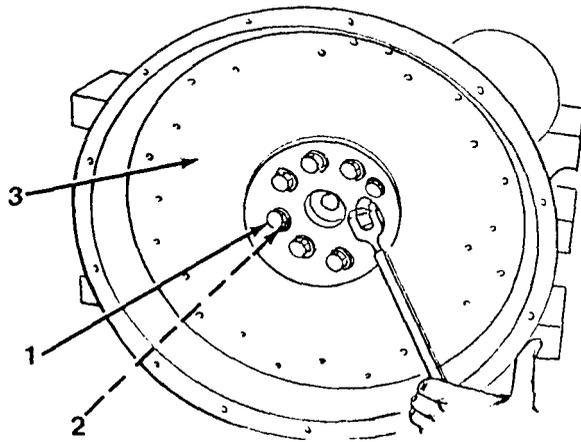


Figure 6-1

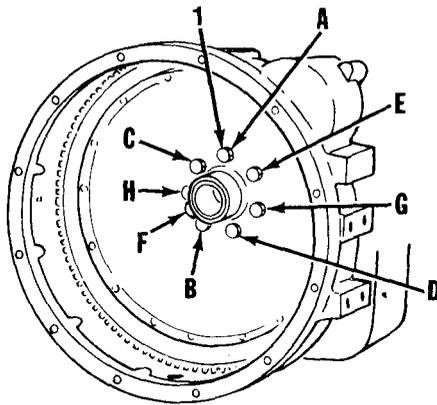


Figure 6-7

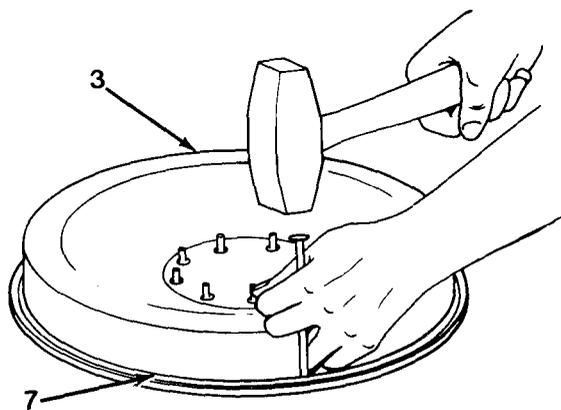


Figure 6-8

FLYWHEEL AND FLYWHEEL HOUSING INSTALLATION

EXAMPLE:

Total bearing clearance = +0.003 in. (+0.08 mm)

One-half bearing clearance = +0.0016 in.
(+0.040 mm)

6 o'clock position reading = +0.008 in. (+0.20 mm)

Adjusted 6 o'clock reading = +0.0064 in. (+0.162 mm)

10. Lock crankshaft (refer to page 6-61, step 2).

11. Install flywheel (3), eight washers (2) and capscrews (1, Figure 6-1).

12. Torque eight capscrews (1, Figure 6-7) in sequence to 101 lb-ft (137 N•m).

FLYWHEEL AND FLYWHEEL HOUSING DISASSEMBLY

! WARNING

Wear eye protection when driving ring gear from flywheel. **SERIOUS INJURY** may result from flying metal fragments. Do not use a steel drift pin.

Using a brass drift pin, drive ring gear (7) from flywheel (3, Figure 6-8).

FLYWHEEL AND FLYWHEEL HOUSING CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).

2. Inspect all parts (refer to Chapter 4).

FLYWHEEL AND FLYWHEEL HOUSING ASSEMBLY

WARNING

Wear protective gloves when installing ring gear. **SERIOUS INJURY** may result if hot gear contacts skin.

1. Heat ring gear (7, Figure 6-9) for 20 minutes in oven preheated to 260 degrees F (127 degrees C).

NOTE

Ring gear must be installed with bevel on teeth facing toward crankshaft side on flywheel.

2. Install hot ring gear (7) on flywheel (3).

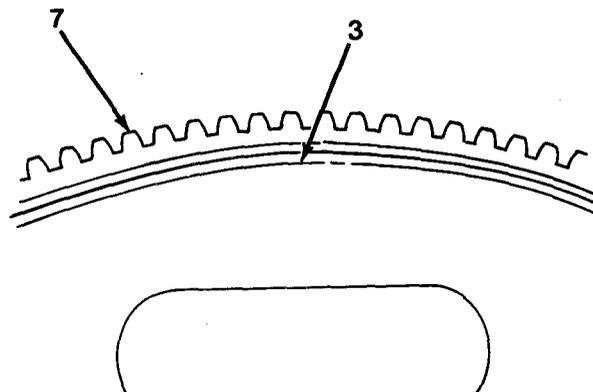


Figure 6-9

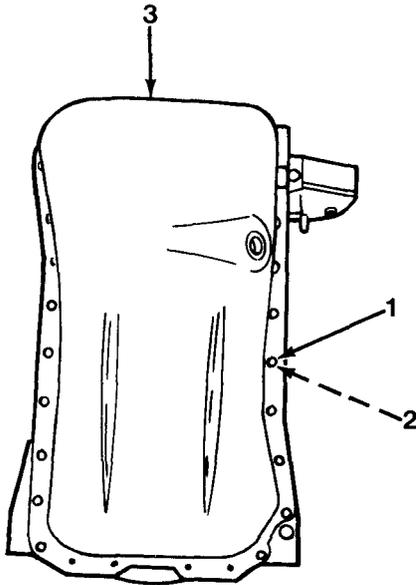


Figure 6-1

OIL PAN AND SUCTION TUBE

OIL PAN AND SUCTION TUBE REMOVAL

1. Drain oil pan (3, Figure 6-1) (refer to page 3-47).
2. Using a 10 mm socket, remove 24 capscrews (1), washers (2) and oil pan (3, Figure 6-1).
3. Remove gasket (4, Figure 6-2). Remove all gasket material from mounting surfaces.
4. Using a 10 mm socket, remove two capscrews (5), capscrew (6), suction tube (7) and gasket (8). Remove all gasket material from mounting surfaces.

OIL PAN AND SUCTION TUBE CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

OIL PAN AND SUCTION TUBE INSTALLATION

1. Install new gasket (8), suction tube (7), capscrew (6) and two capscrews (5, Figure 6-2). Torque capscrew (6) and two capscrews (5) to 18 lb-ft (24 N•m).
2. Apply sealant MIL-S- 15204 to fill joints between oil pan rail, gear housing and rear cover.

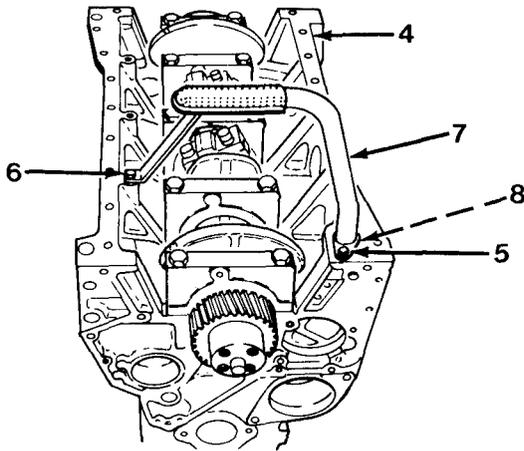


Figure 6-2

NOTE

Oil pan gasket has a print-a-seal surface on one side.

3. Apply sealant MIL-S-7916 to both sides of new gasket (4) and position it with print-a-seal surface toward engine block.
4. Install oil pan (3), 24 washers (2) and cap-screws (1, Figure 6-1). Torque 24 capscrews (1) to 18 lb-ft (24 N•m).
5. Refill oil pan (3) (refer to page 3-47).

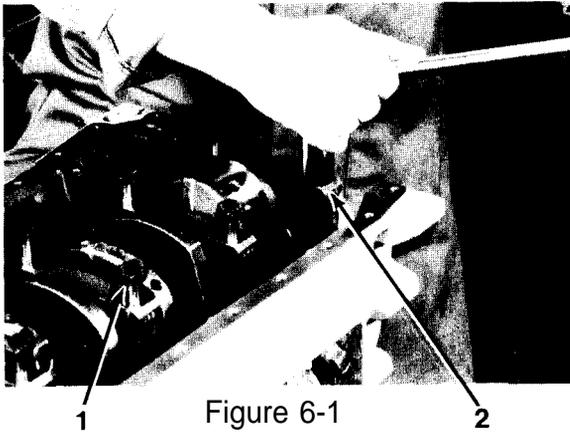


Figure 6-1

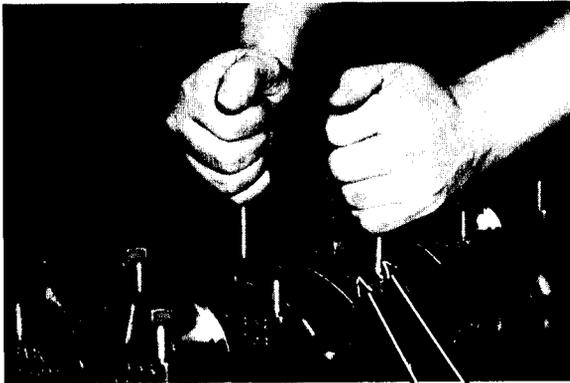


Figure 6-2

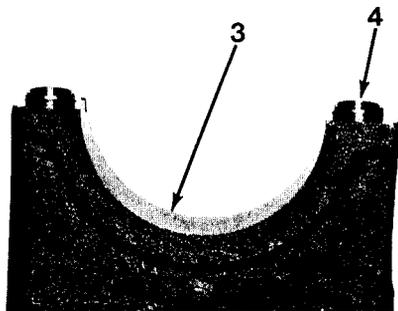


Figure 6-3

CRANKSHAFT AND BEARINGS

CRANKSHAFT AND BEARINGS REMOVAL

1. Remove flywheel and housing (refer to page 6-61).
2. Remove front gear cover (refer to page 6-17).
3. Remove pistons, connecting rods and bearings (refer to page 6-79).
4. Using a 23 mm socket, remove 10 cap screws (1, Figure 6-1).
5. Using a die, number five main bearing caps (2), if not already numbered.

CAUTION

Do not pry on main bearing caps to free them. Failure to follow this procedure could cause damage to equipment.

6. Remove five main bearing caps (2) by using two cap screws (1, Figure 6-2) to loosen, being careful not to damage cap screw threads.
7. Remove five lower bearings (3, Figure 6-3).
8. Remove 10 ring dowels (4).

⚠ WARNING

Weight of crankshaft is approximately 801b(36 kg). Use adequate lifting equipment to lift and support crankshaft. Keep hands out of (component). Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

9. Remove crankshaft (5, Figure 6-4).
10. Remove four upper main bearings (6) and thrust bearing (7, Figure 6-5).
11. Remove four piston cooling nozzles (8, Figure 6-6).

CRANKSHAFT AND BEARINGS INSTALLATION

1. Using drift pin, install four piston coding nozzles (8, Figure 6-7).

NOTE

Thrust bearing is installed in second journal from rear.

2. Install thrust bearing (7) and four upper main bearings (6, Figure 6-5).
3. Lubricate thrust bearing (7) and four upper main bearings (6) with lubricating oil DOD-L-25681.

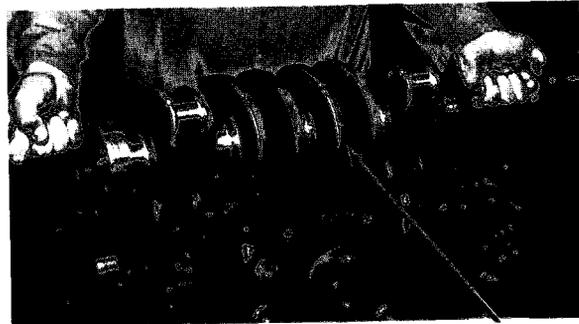


Figure 6-4

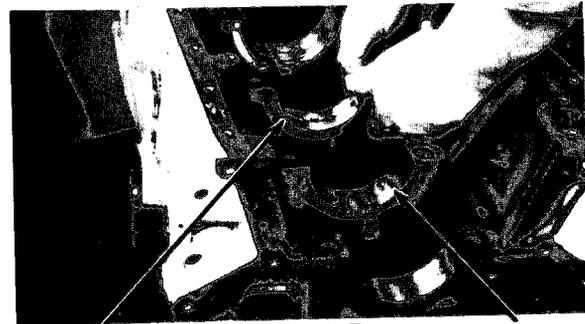


Figure 6-5

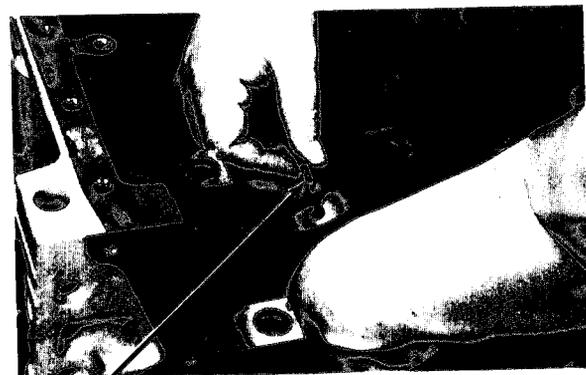


Figure 6-6



DRIFT
PIN

Figure 6-7

CRANKSHAFT AND BEARINGS INSTALLATION

⚠ WARNING

Weight of crankshaft is approximately 80 lb (36 kg). Use adequate lifting equipment to lift and support crankshaft. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

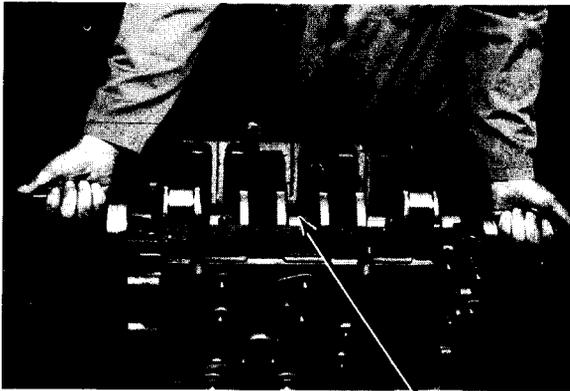


Figure 6-8 5

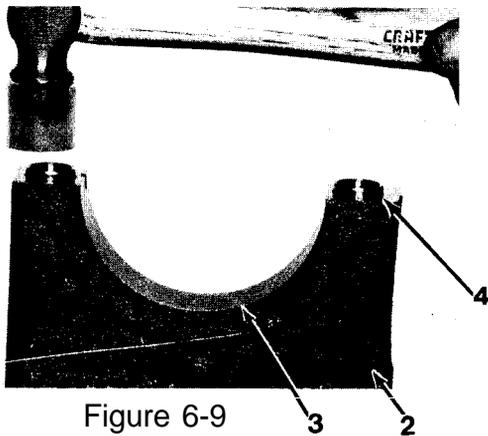


Figure 6-9 3 2 4

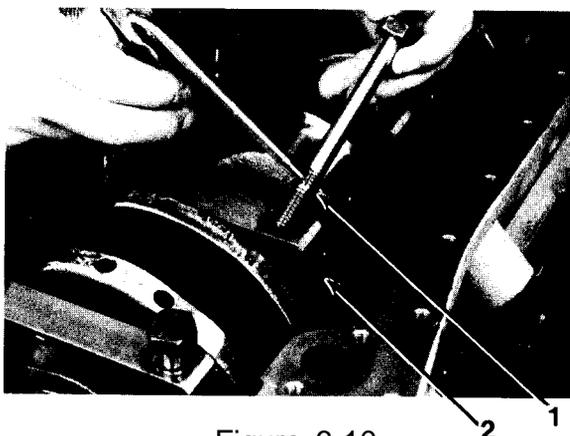


Figure 6-10 2 1

4. Install crankshaft (5, Figure 6-8).
5. Install 10 ring dowels (4) on 5 main bearing caps (2, Figure 6-9).
6. Install five lower bearings (3).
7. Lubricate 5 lower bearings (3) with lubricating oil DOD-L-25681.
8. Lubricate threads and undersides of heads of 10 capscrews (1, Figure 6-10) with engine oil.
9. Install 5 main bearing caps (2) and 10 cap-screws (1).

10. Torque 10 capscrews (1, Figure 6-11) in sequence shown three separate times. First time, torque 10 capscrews (1) to 44 lb-ft (60 N•m). Second time, torque 10 capscrews (1) to 88 lb-ft(119 N•m). Third time, torque 10 capscrews (1) to 129 lb-ft (175 N•m).

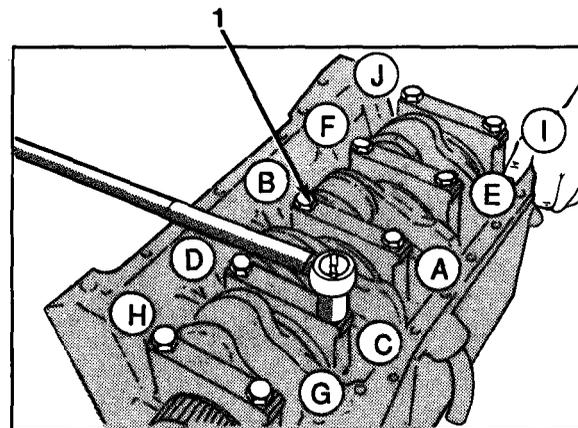


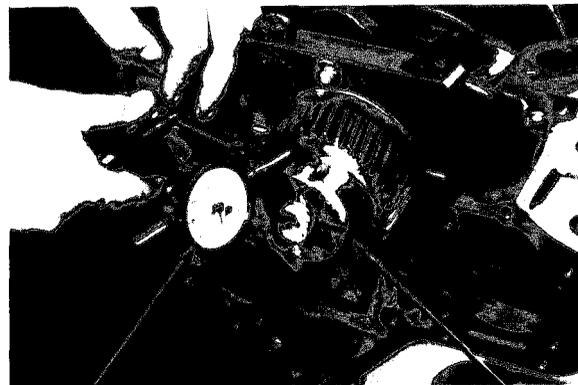
Figure 6-11

11. Rotate crankshaft. Crankshaft must rotate freely. If crankshaft does not rotate freely, check for proper installation of upper main bearings (step 2) and lower bearings (step 6) and check sizes of upper main and lower bearings.

12. Position dial indicator on crankshaft (5, Figure 6-12).

NOTE

Dimensions of thrust bearing and crankshaft journals determine end play.



DIAL INDICATOR Figure 6-12

13. Using dial indicator, measure end play. End play limits (A, Figure 6-14) are 0.005 to 0.010 in. (0.13 to 0.25 mm).

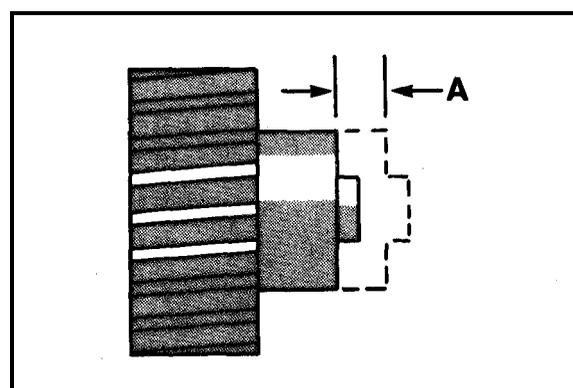


Figure 6-13

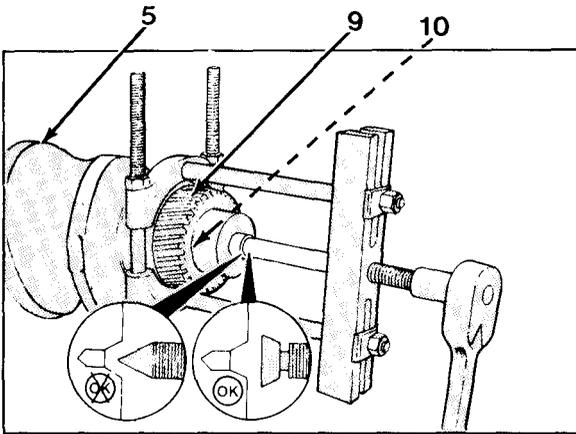


Figure 6-14

CRANKSHAFT AND BEARINGS DISASSEMBLY

1. Using heavy-duty puller, remove gear (9) from crankshaft (5, Figure 6-14).
2. Using locking pliers, remove dowel pin (10).

CRANKSHAFT AND BEARINGS CLEANING/inspection

1. Clean crankshaft oil holes with a nylon brush (Figure 6-15).
2. Clean all other parts (refer to Chapter 2).
3. Check crankshaft seal surfaces for scratches and grooves.

NOTE

Sleeves can be put over worn seal surfaces.

4. Check connecting rod and main bearing journals for deep scoring and over heating.

NOTE

Step 5 determines main bearing clearance.

5. Measure crankshaft main journal diameters at locations shown by arrows (Figure 6-16).

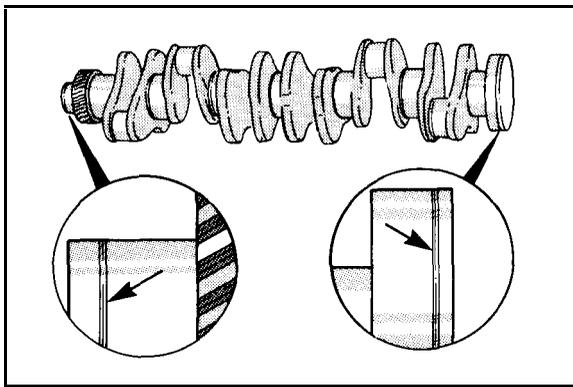


Figure 6-15

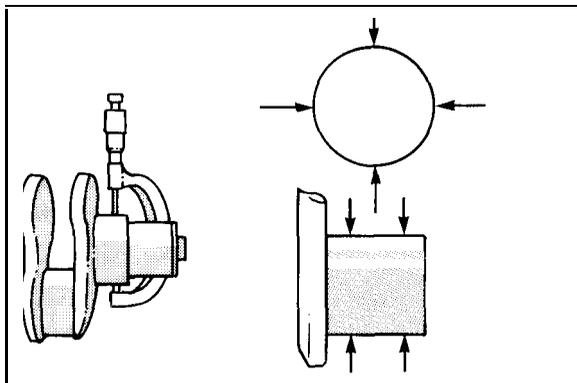


Figure 6-16

DIAMETER

MIN 3.2662 in. (82.961 mm)

MAX 3.2682 in. (83.012 mm)

OUT-OF-ROUNDNESS

0.002 in. (0.05 mm)

TAPER

0.0005 in. (0.013 mm)

Main bearing clearance =

Main bore diameter with bearing installed
minus crankshaft main journal diameter.

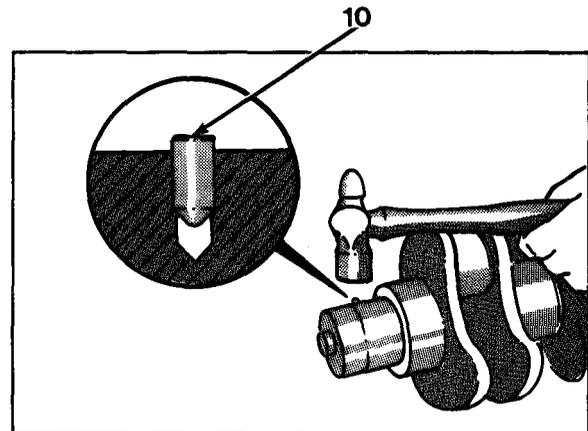


Figure 6-17

MAIN BEARING CLEARANCE MAX

in. (0.1206 mm)

CRANKSHAFT AND BEARINGS ASSEMBLY

1. Using hammer, install dowel pin (10, Figure 6-17) until it bottoms out.



Wear protective gloves when handling hot gear. **SERIOUS INJURY** may result if skin contacts hot gear.

Gear will be permanently distorted if heated for longer than 45 minutes. Failure to follow this procedure could cause damage to equipment.

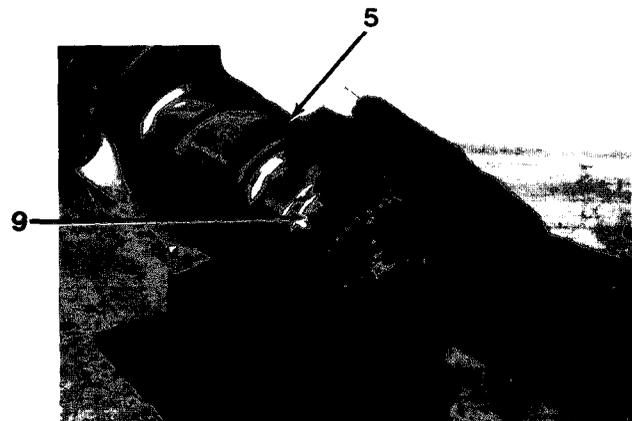


Figure 6-18

2. Heat gear (9, Figure 6-18) for 45 minutes at 250 degrees F (121 degrees C).
3. Install gear (9) on crankshaft (5).

CRANKSHAFT SEALS, FRONT AND REAR

FRONT CRANKSHAFT SEALS REMOVAL

NOTE

- There are two separate procedures for removing front seal. One is with front cover removed and one is with front cover installed.
- Step 1 is the procedure for removing front seal with front cover removed.

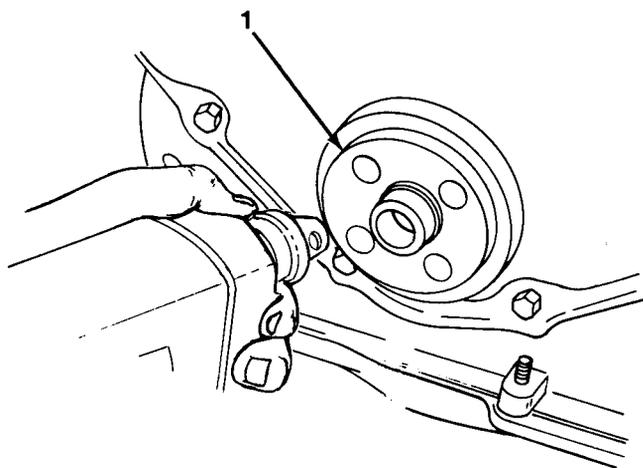


Figure 6-1

1. Remove front seal (1, Figure 6-1) with front cover removed (refer to page 6-17).

NOTE

Steps 2 thru 4 is procedure for removal of front seal with front cover installed.

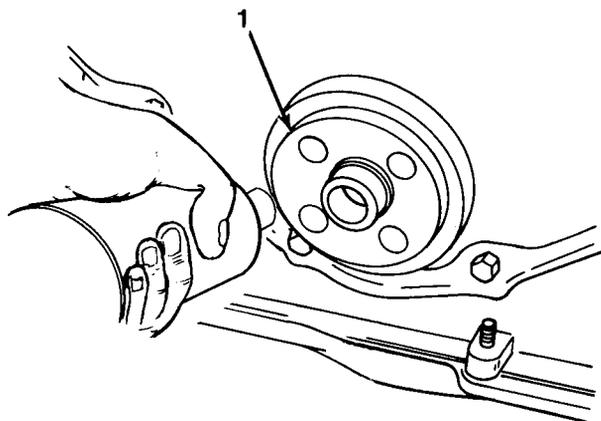


Figure 6-2

2. Remove crankshaft pulley (refer to page 6-12).
3. Drill two holes 180 degrees apart to relieve tension on front seal (1).
4. Using a slide hammer fitted with a sheet metal screw, remove and discard front seal (1, Figure 6-2).

FRONT AND REAR CRANKSHAFT SEALS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FRONT CRANKSHAFT SEALS INSTALLATION

CAUTION

Seal lip and sealing surface on crankshaft must be free from all oil residue to prevent seal leaks. Teflon seals must be installed on dry, clean surfaces.

NOTE

Steps 1 and 2 is the procedure for installation of new front seal with front cover installed.

1. Apply sealant MIL-S-4613 to outside diameter of front seal (1, Figure 6-3).
2. Using a seal starter ring, install new front seal (1) on crankshaft.

CAUTION

Drive front seal alternately at the 12,3,6 and 9 o'clock positions to prevent damage to seal carrier.

3. Using a seal driver, drive new front seal (1) on crankshaft until seal driver bottoms.

NOTE

Step 3 is the procedure for installation of new front seal with front cover removed.

4. Install new front seal (1) with front cover removed (refer to page 6-18).

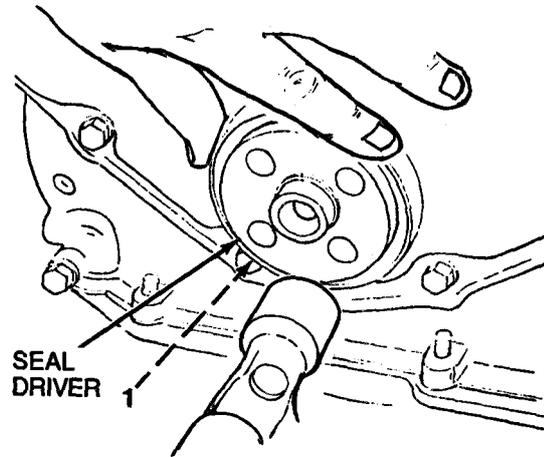


Figure 6-3

REAR CRANKSHAFT SEALS REMOVAL

NOTE

- There are two separate procedures for removing rear seal. One is with flywheel housing installed and one is with flywheel housing removed.

- Steps 1 thru 3 is the procedure for removal of rear seal with flywheel housing installed.

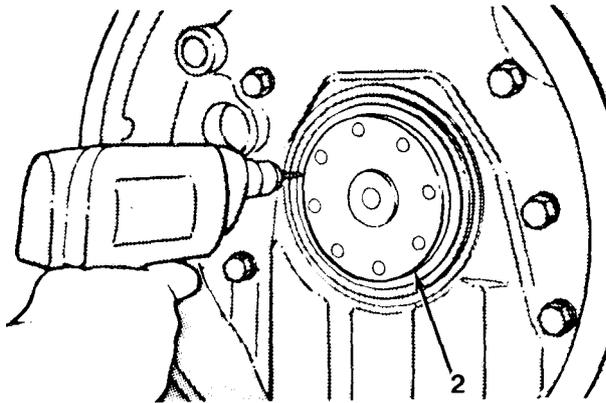


Figure 6-4

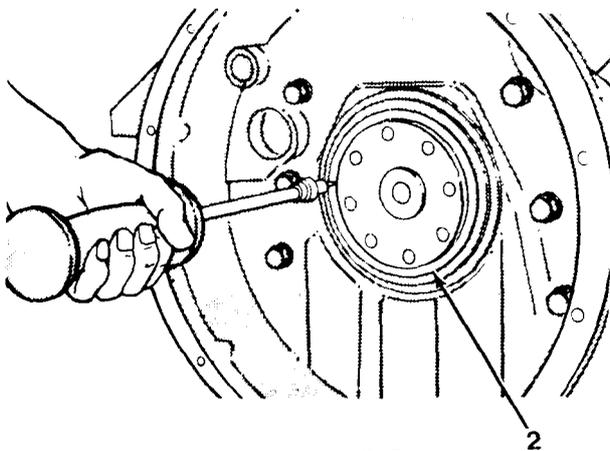


Figure 6-5

1. Remove flywheel (refer to page 6-61).
2. Drill two holes 180 degrees apart to relieve tension on rear seal (2, Figure 6-4).
3. Using a slide hammer fitted with a sheet metal screw, remove rear seal (2, Figure 6-5).

NOTE

Steps 4 thru 7 is the procedure for removal of rear seal with flywheel housing removed.

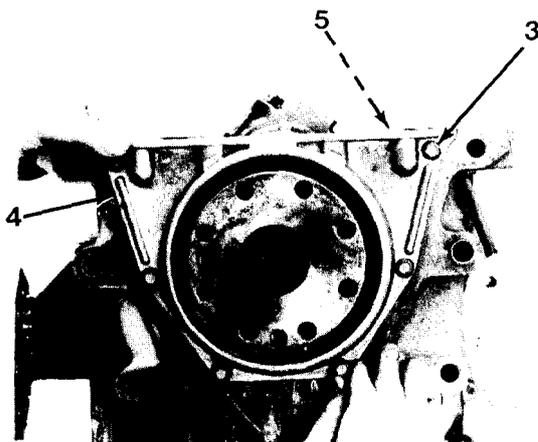


Figure 6-6

4. Remove flywheel housing (refer to page 6-61).
5. Using an 8 mm socket, remove six cap screws (3), rear cover (4) and gasket (5, Figure 6-6) from block. Remove all gasket material from mounting surfaces.
6. Support rear cover (4) on a suitable work stand.
7. Using a flat drift punch, remove and discard rear seal (6, Figure 6-7).

REAR CRANKSHAFT SEALS INSTALLATION

CAUTION

Seal lip and sealing surface on crankshaft must be free from all oil residue to prevent seal leaks. Teflon seals must be installed on dry clean surfaces.

NOTE

Steps 1 thru 4 is the procedure for installation of rear seal with flywheel housing removed.

1. Install gasket (5), rear cover (4) and six capscrews (3, Figure 6-6) to block. Torque six capscrews (3) to 7 lb-ft (9 N•m).

NOTE

Use a mild soap on inside diameter of rear seal for easier installation. Do not use any kind of sealant on rear seal.

2. Using a seal starter ring, install rear seal (6, Figure 6-8) on crankshaft.

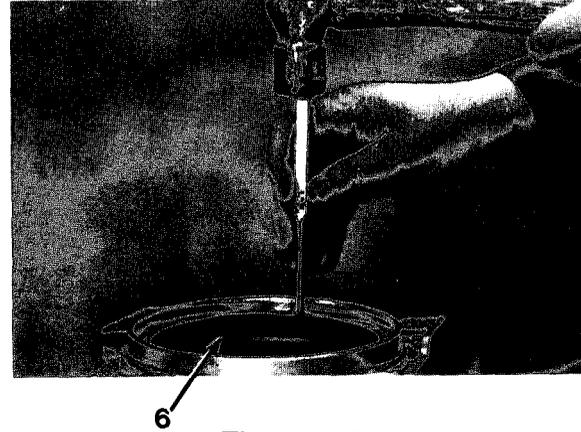


Figure 6-7



Figure 6-8

REAR CRANKSHAFT SEALS INSTALLATION

CAUTION

Drive rear seal alternately at the 12,3,6 and 9 o'clock positions to prevent bending rear cover.

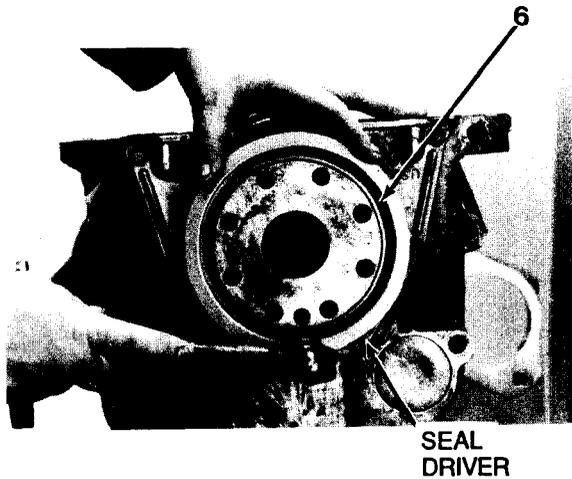


Figure 6-9

3. Using a seal driver, drive rear seal (6, Figure 6-9) on crankshaft until seal driver bottoms.
4. Install flywheel housing (refer to page 6-61).

NOTE

- Steps 5 and 6 is the procedure for installation of rear seal with flywheel housing installed.
- Use a mild soap on inside diameter of rear seal for easier installation. Do not use any kind of sealant on rear seal.

5. Using a seal starter ring, install rear seal (2, Figure 6-10) on crankshaft.

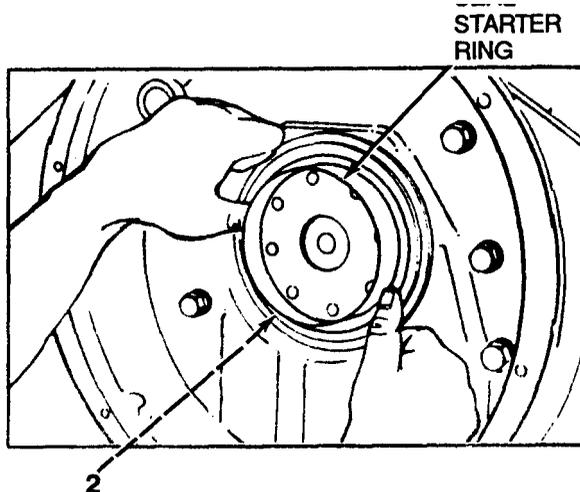


Figure 6-10

Alternately, drive rear seal at the 12, 3,6 and 9 o'clock positions to prevent bending rear cover.

6. Using a seal driver, drive rear seal (2) on crankshaft until seal driver bottoms.

PISTONS, CONNECTING RODS AND BEARINGS

PISTONS, CONNECTING RODS AND BEARINGS REMOVAL

1. Remove engine/transmission assembly (refer to page 6-1).
2. Remove oil pan and suction tube (refer to page 6-66).
3. Remove cylinder head and gasket (refer to page 6-42).

CAUTION

Be careful not to gouge cylinder bore with ridge reamer. Failure to follow this procedure could cause damage to equipment.

NOTE

The following is a maintenance procedure for one piston and connecting rod. The maintenance procedure for remaining pistons and connecting rods is identical.

4. Using a ridge reamer, remove ridge from top of cylinder bore (Figure 6-1).
5. Using a die, mark each connecting rod cap (2, Figure 6-2) according to cylinder.
6. Using a die, mark each piston (8, Figure 6-3) according to cylinder.

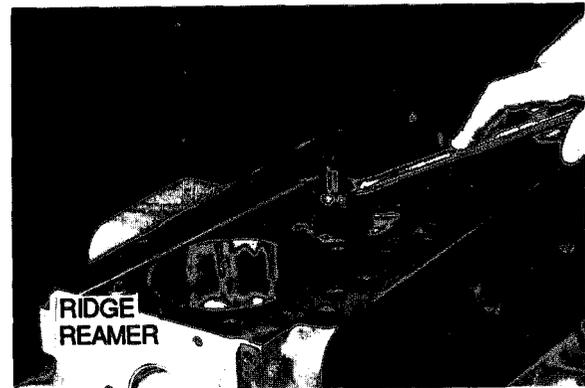


Figure 6-1

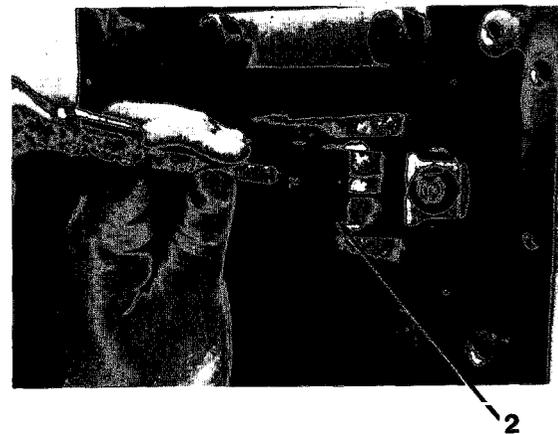


Figure 6-2



Figure 6-3

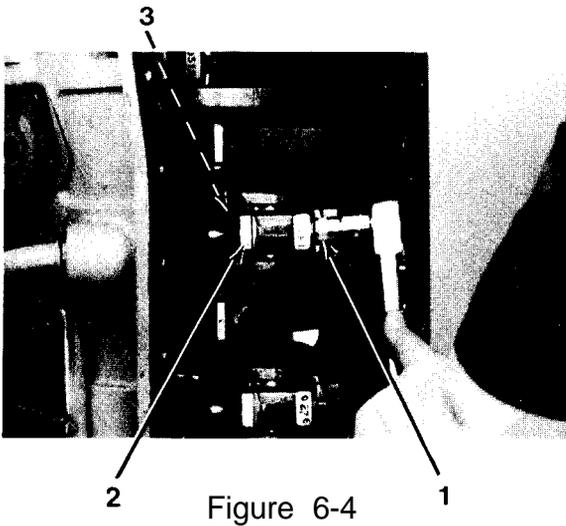


Figure 6-4

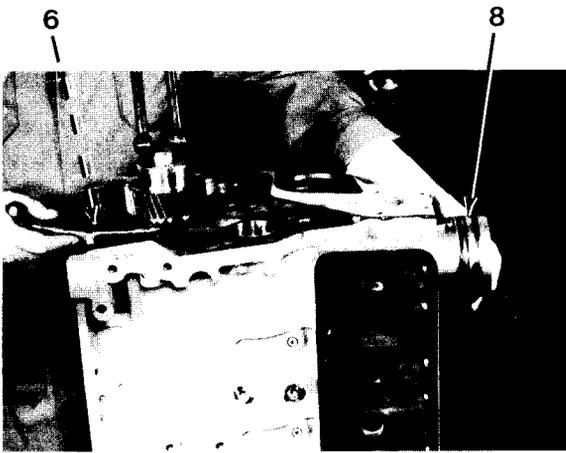


Figure 6-5



Figure 6-6

PISTONS, CONNECTING RODS AND BEARINGS REMOVAL

7. Using a 12 mm socket, remove two connecting rod capscrews (1), connecting rod cap (2) and two bearing halves (3, Figure 6-4).
8. Catch piston (8) in one hand while pushing connecting rod (6, Figure 6-5) out of cylinder bore with other hand.
9. Using snap ring pliers, remove two retaining rings (4, Figure 6-6).

NOTE

Heating piston is not required to remove piston pin.

10. Remove piston pin (5) and connecting rod (6, Figure 6-7).

- Using a piston ring expander, remove three piston rings (7) from piston (8, Figure 6-8).

PISTONS, CONNECTING RODS AND BEARINGS CLEANING/INSPECTION

- Soak piston in cold parts cleaner overnight.

CAUTION

Do not bead blast piston to clean, or clean connecting rod or piston in acid tank. Failure to follow this procedure could cause damage to equipment.

- Clean piston and connecting rod with soap and water.
- Clean deposits from ring groove of piston with square end of a broken piston ring.

WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

CAUTION

Do not use a ring groove cleaner or scratch ring sealing surface in piston groove. Failure to follow this procedure could cause damage to equipment.

- Wash piston again with soap and water. Rinse and dry with compressed air.

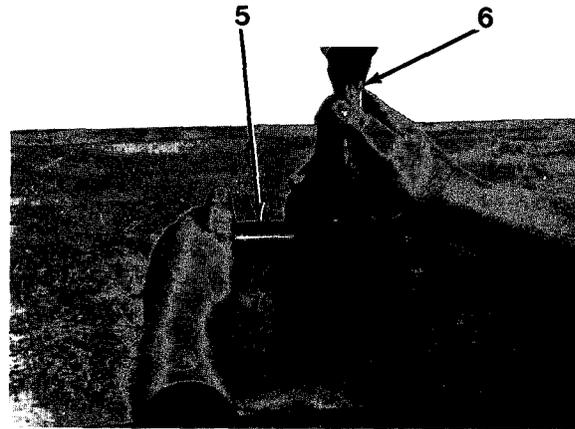


Figure 6-7

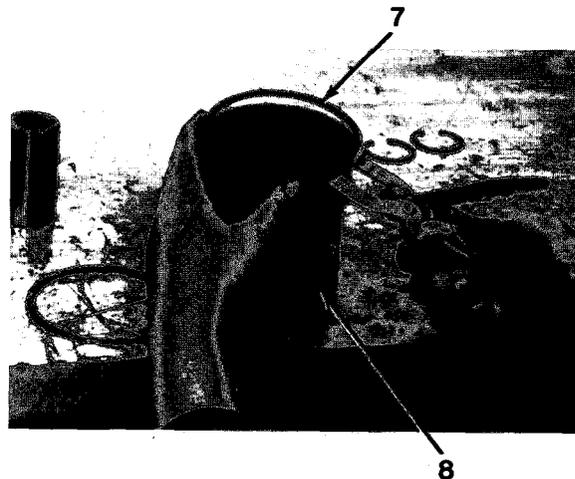


Figure 6-8

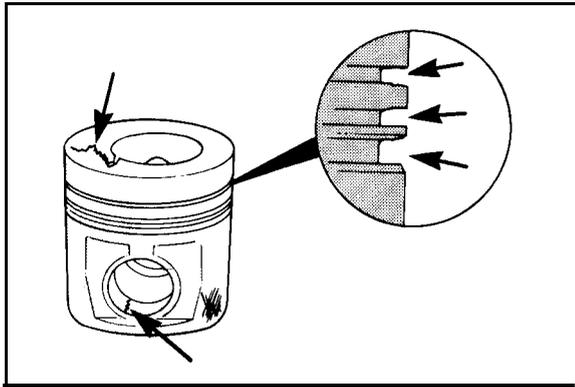


Figure 6-9

PISTONS, CONECTING RODS AND BEARINGS CLEANING/inspection

5. Inspect piston for damage and excessive wear at locations shown by arrows (Figure 6-9).
6. Using a micrometer, measure piston (Figure 6-10).

DIAMETER

MIN 4.0088 in. (101.824 mm)
 MAX 4.0117 in. (101.897 mm)

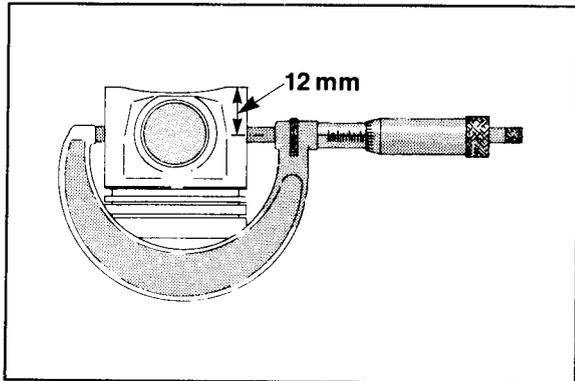


Figure 6-10

7. Using one of three new piston rings and feeler gage, measure ring groove clearance (Figure 6-11).

RING CLEARANCE

Top:

MIN 0.0030 in. (0.076 mm)
 MAX 0.0059in. (0. 150 mm)

Intermediate:

MIN 0.0030 in. (0.076 mm)
 MAX 0.0059 in. (0.150 mm)

Oil control:

MIN 0.0016 in. (0.041 mm)
 MAX 0.0051 in. (0.130 mm)



Figure 6-11

8. Using an inside micrometer, measure piston pin bore at locations shown by arrows (Figure 6-12).

DIAMETER

MIN 1.5750 in. (40.005 mm)
 MAX 1.5758 in. (40.025 mm)

9. Inspect piston pin for nicks, gouges and excessive wear (Figure 6-13).
10. Using a micrometer, measure piston pin at locations shown by arrows.

DIAMETER

MIN 1.5744 in. (39.990 mm)
 MAX 1.5749 in. (40.002 mm)

CAUTION

I-beam section of connecting rod must be free of dents or other damage. Damage to this part can cause stress risers which will progress to breakage.

11. Inspect connecting rod for damage and wear (Figure 6-14).
12. Using an inside micrometer, measure pin bore of connecting rod at locations shown by arrows.

DIAMETER

MIN 1.5769 in. (40.053 mm)
 MAX 1.5784 in. (40.091 mm)

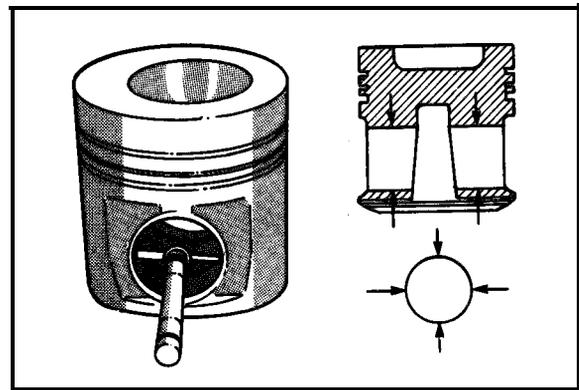


Figure 6-12

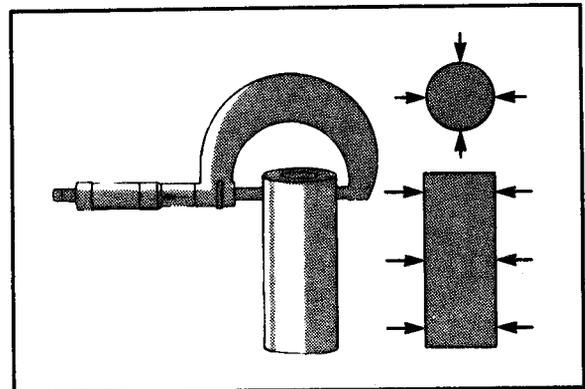


Figure 6-13

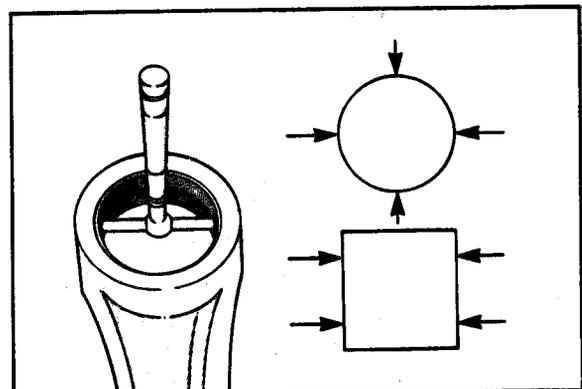


Figure 6-14

PISTONS, CONECTING RODS AND BEARINGS CLEANING/inspection

NOTE

Steps 13 thru 15 determine connecting rod bearing clearance.

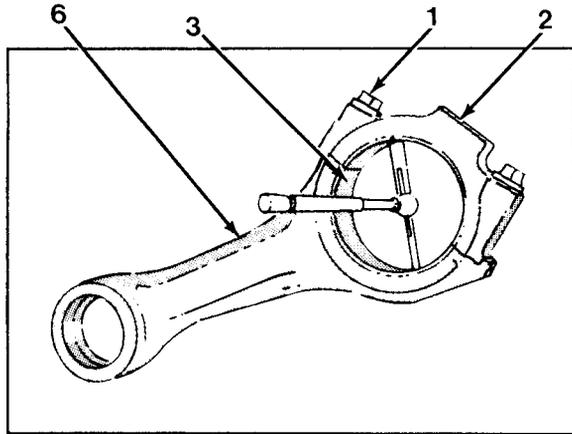


Figure 6-15

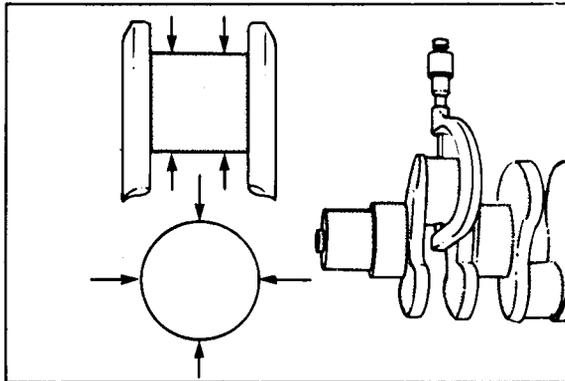


Figure 6-16

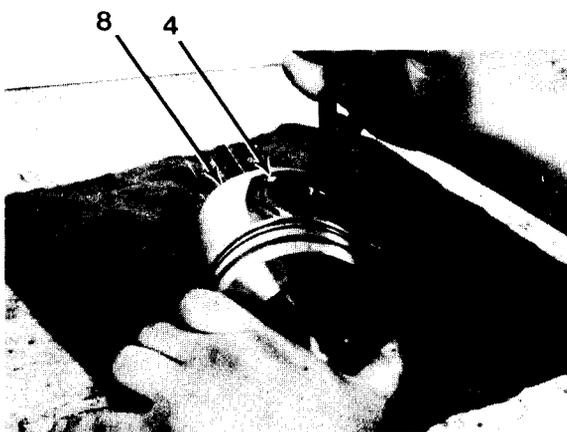


Figure 6-17

13. Install two bearing halves (3), connecting rod cap (2) and two connecting rod capscrews (1: on connecting rod (6, Figure 6-15). Torque two connecting rod capscrews (1) to 73 lb-ft (99 N•m).

14. Using an inside micrometer, measure crankshaft bore of connecting rod (6) and record smallest diameter.

15. Using a micrometer, measure and record average diameter of crankshaft connecting rod journal (Figure 6-16).

DIAMETER

MIN 2.7150 in. (68.961 mm)
MAX 2.7170 in. (69.012 mm)

OUT-OF-ROUNDNESS

0.002 in. (0.05 mm)

TAPER

0.0005 in. (0.013 mm)

Bearing clearance = connecting rod inside diameter minus crankshaft connecting rod journal diameter.

BEARING CLEARANCE

0.0035 in. (0.089 mm)

16. Clean all other parts (refer to Chapter 2).

17. Inspect all other parts (refer to Chapter 4).

PISTONS, CONNECTING RODS AND BEARINGS INSTALLATION

1. Using snap ring pliers, install one of two retaining rings (4) on side of piston (8, Figure 6-17) marked FRONT.
2. Lubricate piston (8) pin bore with engine oil.
3. Install piston (8) on connecting rod (6, Figure 6-18), positioning FRONT marking on piston (8) with numbers on connecting rod (6).

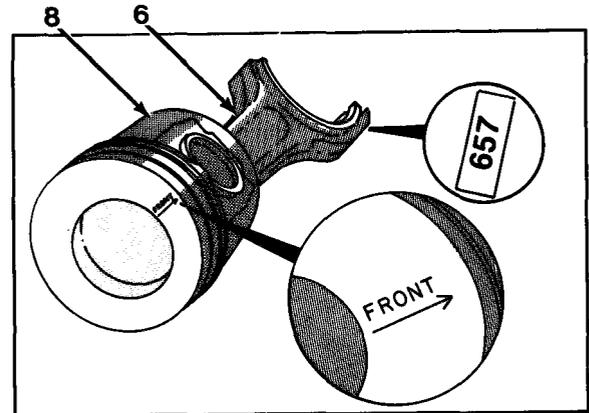


Figure 6-18

NOTE

Heating piston is not required to install piston pin.

4. Lubricate piston pin (5, Figure 6-19) with engine oil and install.
5. Install second of two retaining rings (4).
6. Position one of three new piston rings (7, Figure 6-20) in cylinder and use a piston to square it in cylinder bore. A = 3.5 in. (89 mm)
7. Using a feeler gage, measure piston ring (7) gap and remove from cylinder.

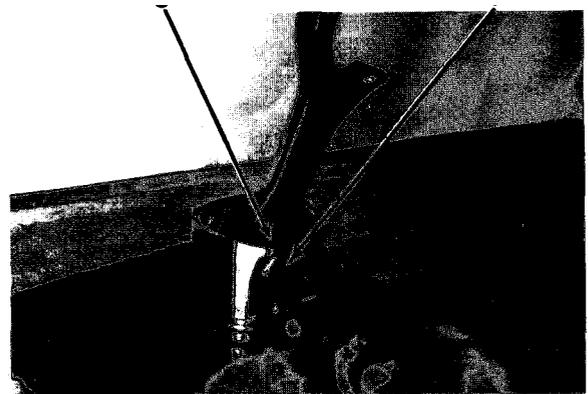


Figure 6-19

PISTON RING GAP

MIN 0.0100 in. (0.254 mm)
MAX 0.0215 in. (0.546 mm)

8. Repeat steps 6 and 7 for remaining two of three piston rings (7).

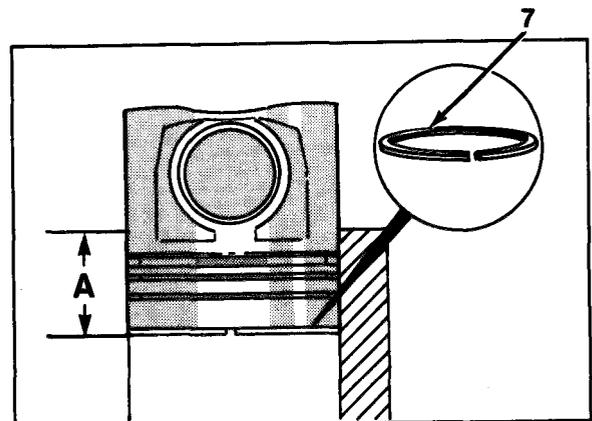


Figure 6-20

PISTONS, CONECTING RODS AND BEARINGS INSTALLATION

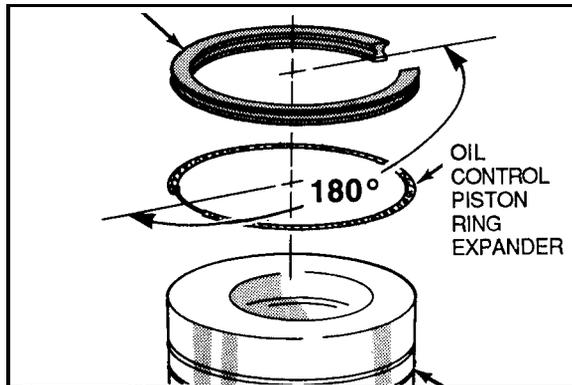


Figure 6-21 8

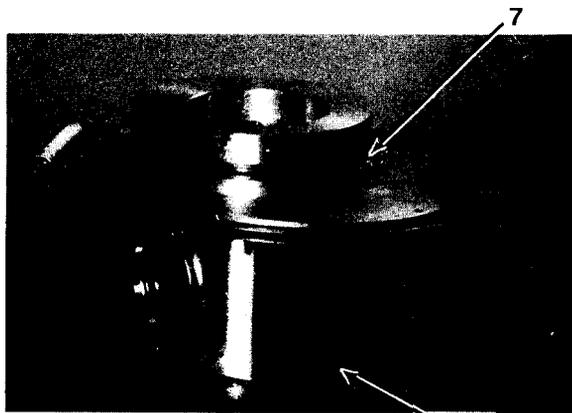


Figure 6-22 8

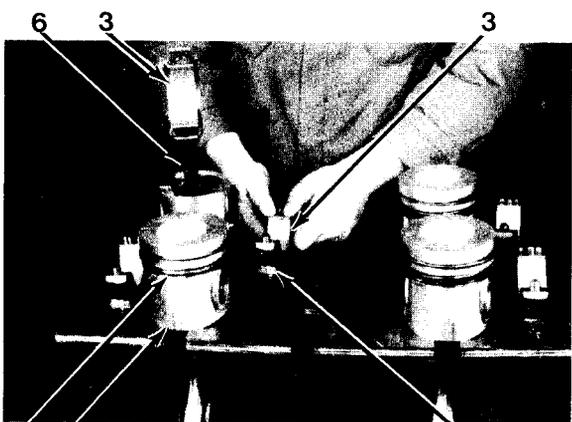


Figure 6-23 2

CAUTION

Top surfaces of all piston rings are marked with the word TOP. Piston rings must be assembled with the word TOP facing up. Failure to follow this procedure could cause damage to equipment.

9. Position oil control piston ring expander in inner groove of one of three piston rings (7, Figure 6-21).
10. Install one of three piston rings (7) on piston (8) with end gap 180 degrees from end of oil control ring piston expander,
11. Install intermediate one of three piston rings (7) on piston (8, Figure 6-22).
12. Install top remaining one of three piston rings (7) on piston (8).
13. Install one of two bearing halves (3) in connecting rod (6) and remaining bearing half (3) in connecting rod cap (2, Figure 6-23). Make sure tang on two bearing halves (3) is in slot of connecting rod (6) and connecting rod cap (2).
14. Lubricate two bearing halves (3) with light film of lubricating oil DOD-L-25681.

15. Lubricate three piston rings (7) and piston (8) with engine oil.
16. Position gaps of three piston rings (7) on piston (8, Figure 6-24) as shown.

CAUTION

If using strap type ring compressor, make sure inside of strap does not hook on a ring gap and break the ring. Failure to follow this procedure could cause damage to equipment

17. Using a ring compressor, compress three piston rings (7, Figure 6-25).
18. Lubricate cylinder bore with clean engine oil.
19. Position crankshaft journal so piston, when installed, will bottom dead center (BDC).

CAUTION

Do not damage cylinder wall when inserting connecting rod. Failure to follow this procedure could cause damage to equipment.

20. Position piston (8) and connecting rod (6, Figure 6-26) into cylinder bore with the word FRONT on piston (8) towards front of cylinder block.
21. Push piston (8) into bore while guiding connecting rod (6) to crankshaft journal.
22. Lubricate threads and two connecting rod capscrews (1, Figure 6-27).

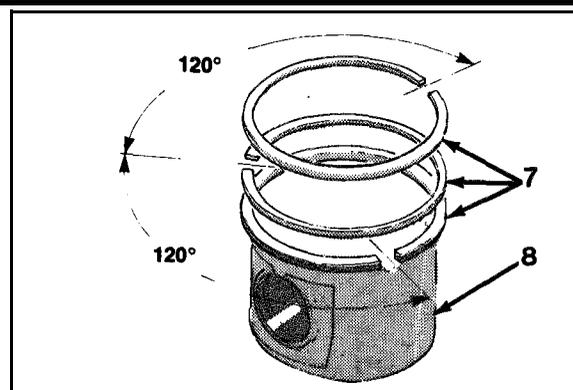


Figure 6-24

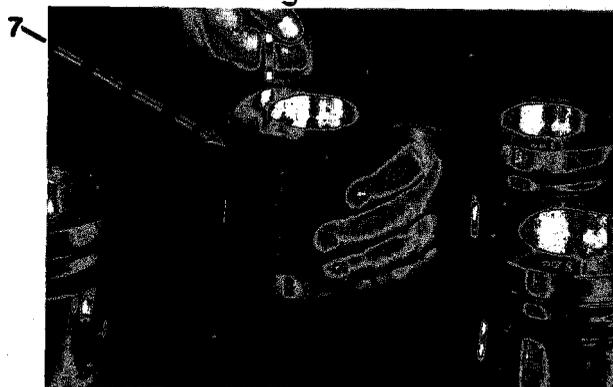


Figure 6-25

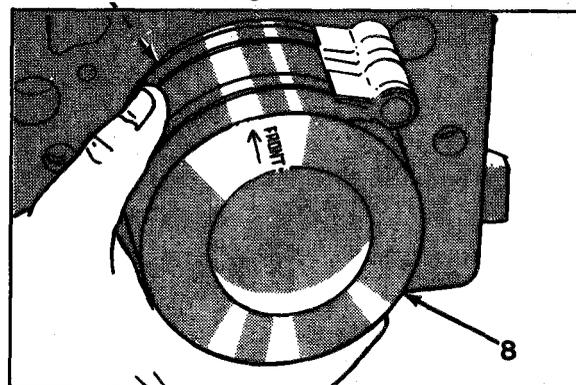


Figure 6-26



Figure 6-27

PISTONS, CONNECTING RODS AND BEARINGS INSTALLATION

CAUTION

Four digit number stamped on connecting rod and connecting rod cap must match and be installed on oil cooler side of engine. Failure to follow this procedure could cause damage to equipment.

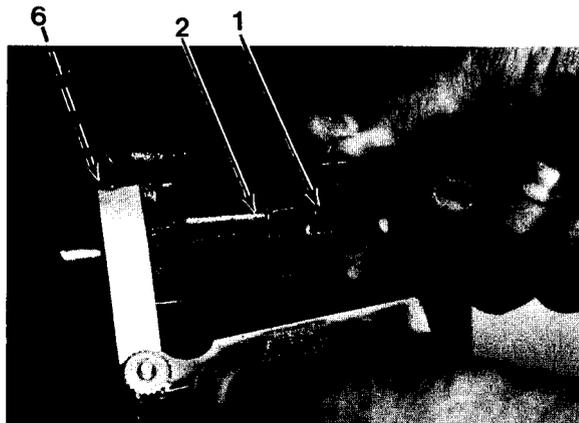


Figure 6-28

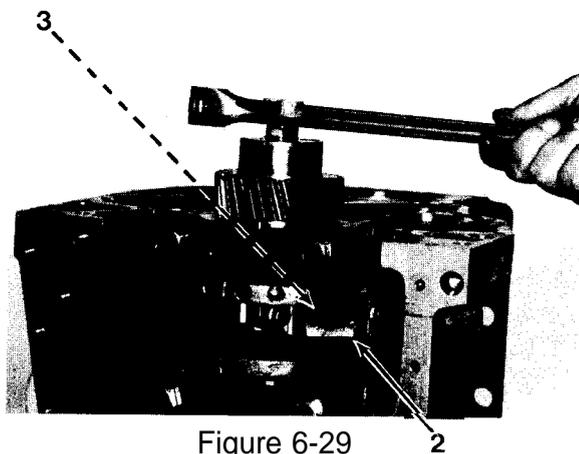


Figure 6-29

23. Install connecting rod cap (2) and two connecting rod capscrews (1, Figure 6-28).
24. Using a 12 mm socket and torque wrench, torque two connecting rod capscrews (1) alternately to 26 lb-ft (35 N•m), then to 51 lb-ft (69 N•m) and then to 73 lb-ft (99 N•m).
25. Using feeler gage, measure side clearance between connecting rod (6) and crankshaft. Side clearance limits are 0.004 to 0.012 in. (0.10 to 0.30 mm).

NOTE

Do not measure clearance between connecting rod cap and crankshaft.

26. Rotate crankshaft after each connecting rod cap (2) is installed. Crankshaft must rotate freely. If crankshaft does not rotate freely, check bearing halves (3, Figure 6-29) (refer to step 13).
27. Install cylinder head and gasket (refer to page 6-43).
28. Install oil pan and suction tube (refer to page 6-66).
29. Install engine/transmission assembly (refer to page 6-7).

OIL LEVEL GAUGE

OIL LEVEL GAUGE REMOVAL

1. Remove dipstick (1, Figure 6-1).
2. Do not remove oil gauge tube (2, Figure 6-2) unless damaged. If damaged, use a pair of pliers to remove oil gauge tube (2).

OIL LEVEL GAUGE CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

OIL LEVEL GAUGE INSTALLATION

1. If oil gauge tube (2, Figure 6-2) was removed, apply sealant to the base of oil gauge tube (2).
2. Insert a capscrew into top of oil gauge tube (2) and drive oil gauge tube (2) into block. Remove capscrew.
3. Install dipstick (1, Figure 6-1).

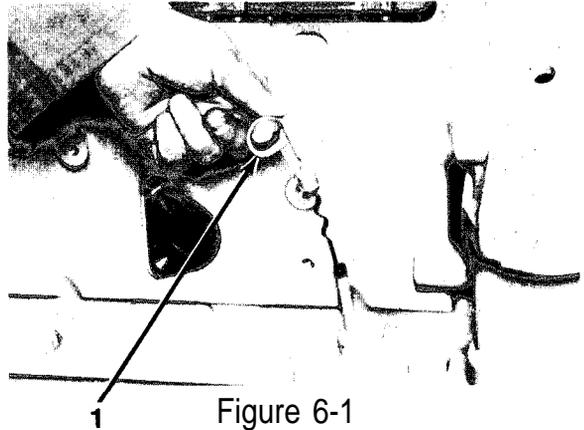


Figure 6-1

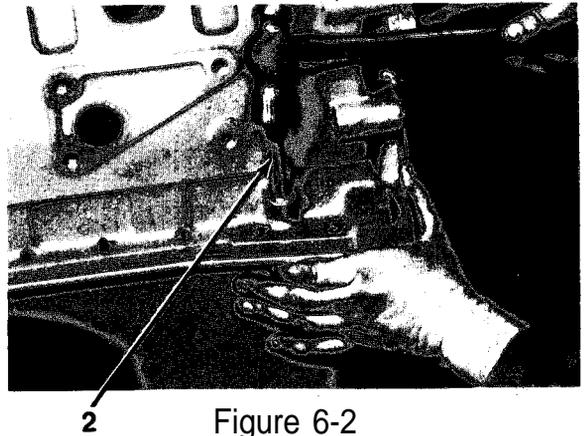


Figure 6-2

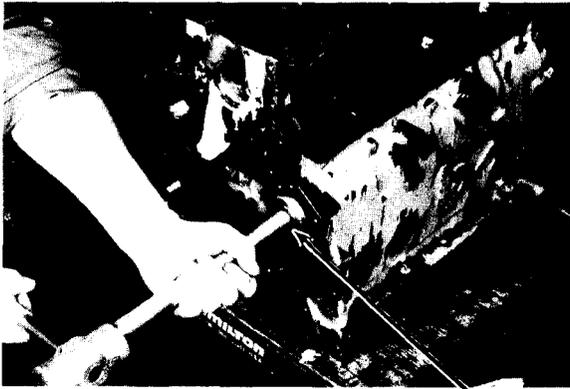


Figure 6-1 1

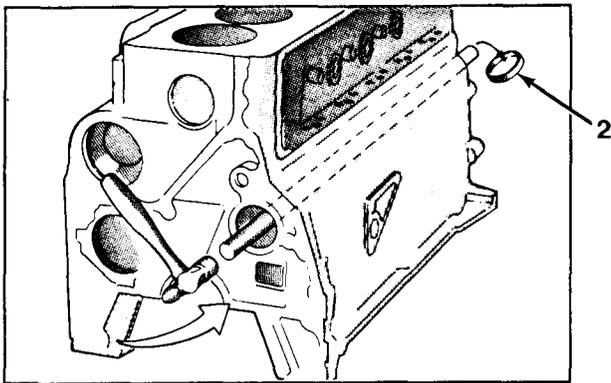


Figure 6-2

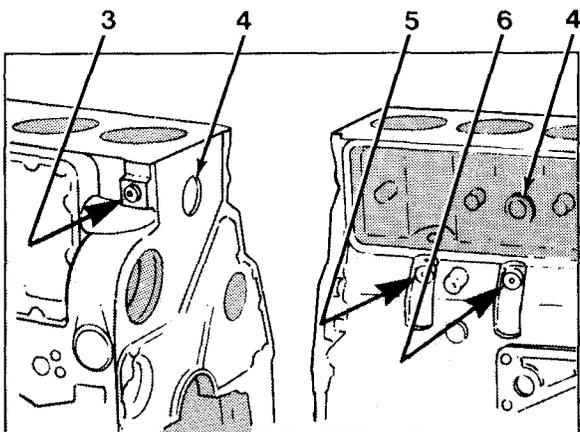


Figure 6-3

CYLINDER BLOCK

CYLINDER BLOCK DISASSEMBLY

CAUTION

Be careful not to damage camshaft bore.

NOTE

Before removing expansion plugs, pipe plugs and cam bushing, refer to cleaning and inspection section. Do not remove expansion plugs, pipe plugs and cam bushing unless damaged.

1. Using a universal bushing installation tool, remove cam bushing (1, Figure 6-1) from cylinder block.
2. Drive camshaft expansion plug (2, Figure 6-2) from block.
3. Remove pipe plug (3, Figure 6-3) from oil passage.
4. Using a center punch, make a hole in center of water passage expansion plugs (4).
5. Using a suitable prybar, remove water passage expansion plugs (4) from water passages.
6. Remove oil sampling valve (5).
7. Remove oil pressure sending unit (6).

CYLINDER BLOCK CLEANING/ INSPECTION

⚠ WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Clean cylinder block bores with a solution of hot water and strong detergent. Rinse with hot water and dry with compressed air.

CAUTION

Build up of deposits in coolant passages can cause engine overheating. Excessive deposits can be cleaned in an acid tank, but the cam bushing must be removed first. Failure to follow this procedure could cause damage to equipment.

2. Make sure coolant passages are clean (Figure 6-4).
3. Clean block in a hot tank with a solution of hot water and strong detergent. Cam bushing does not have to be removed for this procedure.
4. Using a white, lint-free, lightly oiled cloth, wipe the bores and check for cleanliness. If grit residue is present, reclean cylinder block bores (Figure 6-5).
5. Clean block in solvent. Use a nylon brush to clean all oil passages.

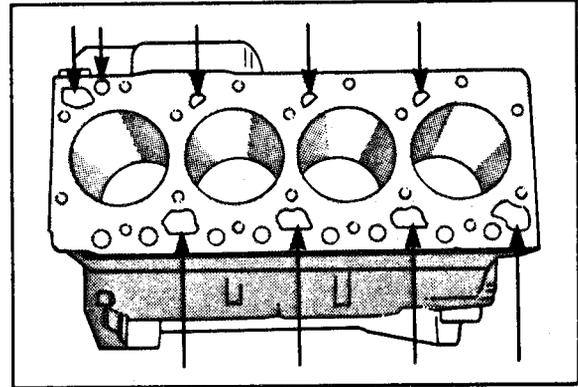


Figure 6-4



Figure 6-5

CYLINDER BLOCK CLEANING/ INSPECTION

6. Polish gasket surfaces with 400 grit paper. Use an orbital sander or sanding block to maintain a flat surface.
7. Clean all other parts (refer to Chapter 2).
8. Inspect cylinder bores for damage or excessive wear.
9. Using a straight edge and feeler gauge, check top surface for flatness between each cylinder (Figure 6-6). Variation limit is 0.002 in. (0.05 mm).

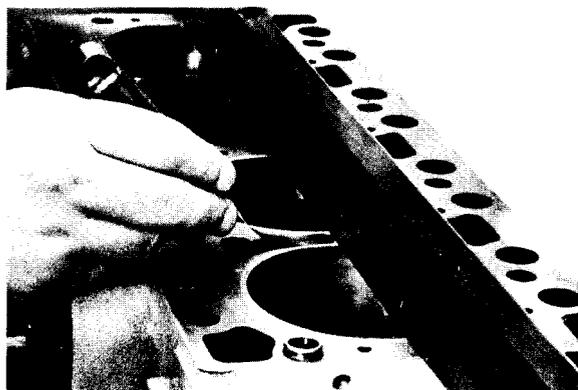


Figure 6-6

10. Measure cylinder bores. Minimum diameter should be 4.0157 in. (101.999 mm) and maximum should be 4.0203 in. (102.116 mm).
11. Check out-of-roundness and taper of bore. Tolerance for out-of-roundness is 0.0015 in. (0.038 mm) measured in 1.00 in. (25.4 mm) distance and tolerance for taper is 0.003 in. (0.76 mm) measured in 4.50 in. (144.3 mm) distance (Figure 6-7).

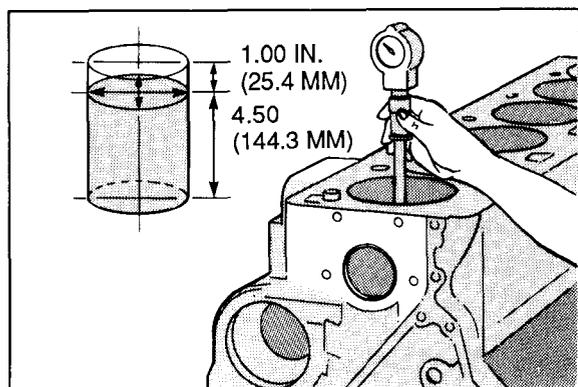


Figure 6-7

NOTE

Oversize pistons and rings are available for re-bored cylinder blocks.

12. If tolerances exceed limits block must be bored or replaced. Refer to de-glazing and honing section.
13. Inspect main bearing bores for damage or abnormal wear.

14. Install main bearings and measure main bearing bore diameter with bolts tightened to 130 lb-ft torque (176 N•m). Maximum diameter should be 2.2720 in. (57.709 mm) (Figure 6-8).
15. Inspect tappet bores for scoring or excessive wear. Minimum diameter should be 0.630 in. (16.00 mm) and maximum should be 0.632 in. (16.05 mm) (Figure 6-9).

CYLINDER BLOCK DE-GLAZING AND HONING

NOTE

New piston rings may not seat in glazed cylinder bores.

1. De-glazing makes the bore rough to help seat rings. Size of bore is not changed with proper de-glazing (Figure 6-10).

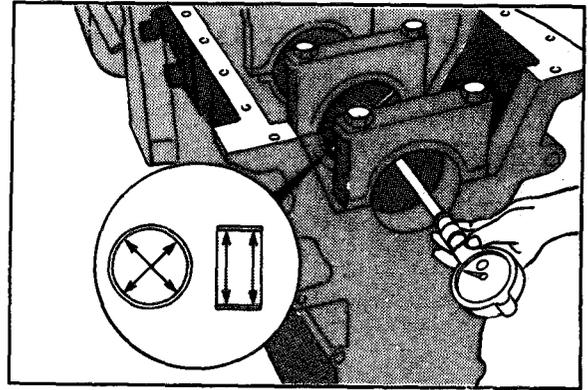


Figure 6-8

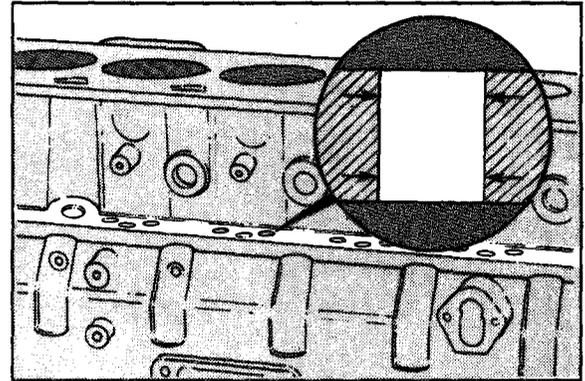


Figure 6-9

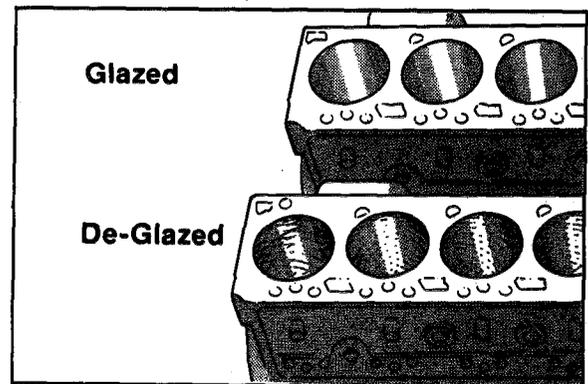


Figure 6-10

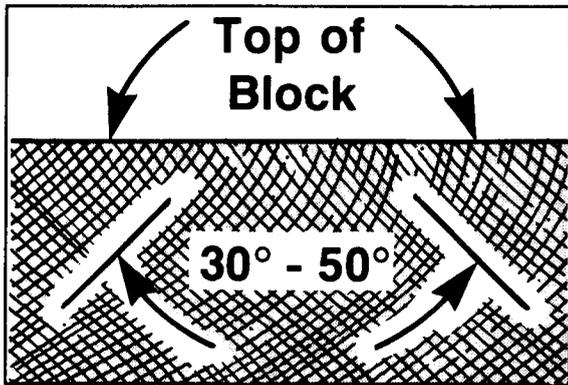


Figure 6-11

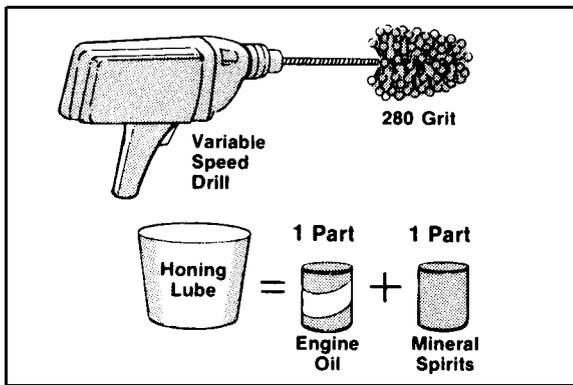


Figure 6-12

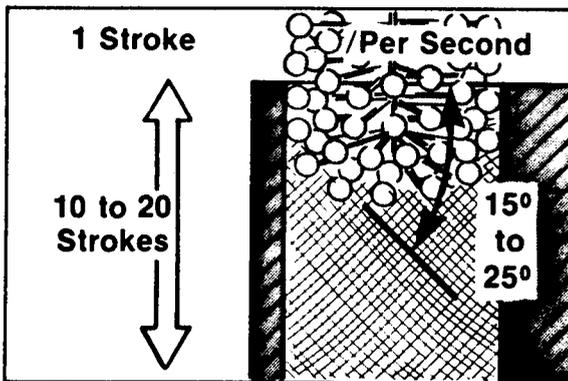


Figure 6-13

CYLINDER BLOCK DE-GLAZING AND HONING

2. A correctly de-glazed surface will have a crosshatched appearance with lines at 15- to 25-degree angles with top of cylinder block, and 30- to 50-degree included angles on crosshatch (Figure 6-11).
3. Using a drill, fine grit Flexi-Hone and a mixture of equal parts of diesel fuel and SAE 30W engine oil, de-glaze bores (Figure 6-12).

Crosshatch angle is a function of drill speed and how fast hone is moved vertically. Drill speed should be 300 to 400 rpm. Failure to follow this procedure could cause damage to equipment.

4. Vertical strokes must be smooth, continuous passes along full length of bore. Inspect bore after 10 strokes (Figure 6-13).
5. If drill speed is too slow or vertical stroke is too fast, crosshatch angle lines will show a 70-degree angle (Figure 6-14).

6. If drill speed is too fast or vertical stroke is too slow, crosshatch angle lines will show a 10 degree angle (Figure 6-15).

CAUTION

Be extremely careful not to hone the bore out of specification. Refer to step 4 of inspection for proper specifications. Failure to follow this procedure could cause damage to equipment.

7. A sizing hone can be used to remove minor grooves or to correct minor out of taper (Figure 6-16).

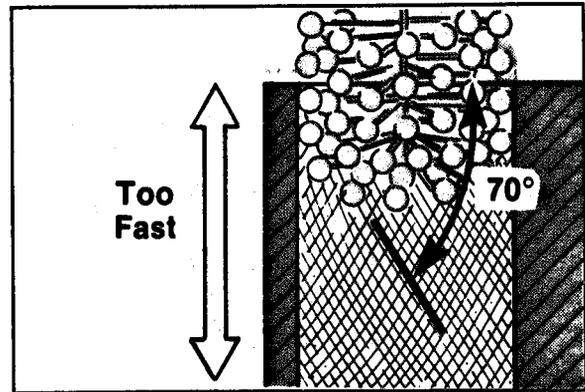


Figure 6-14

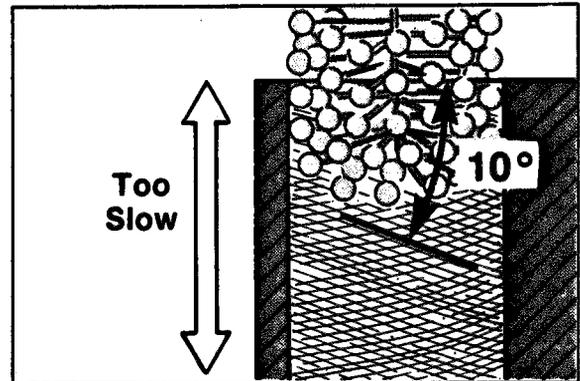


Figure 6-15

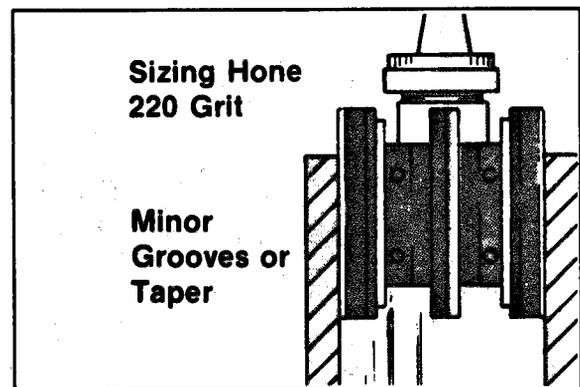


Figure 6-16

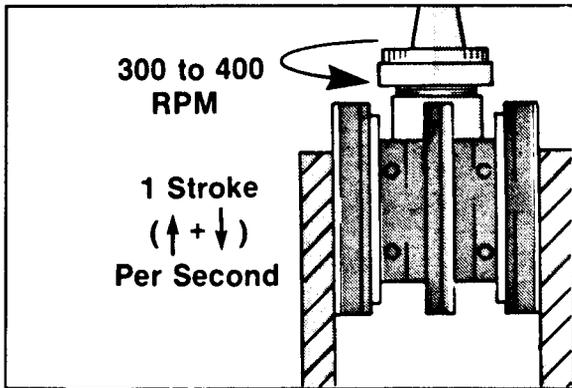


Figure 6-17

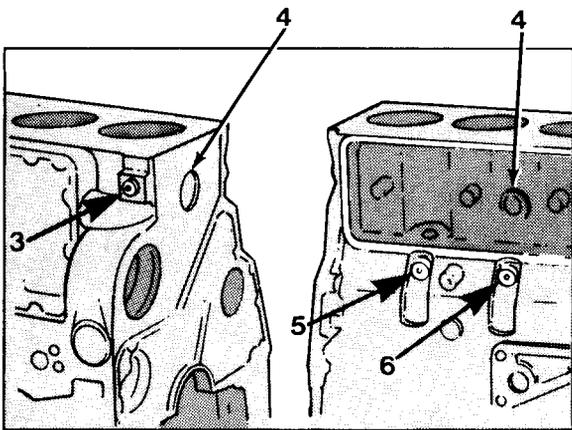


Figure 6-3



Figure 6-18

CYLINDER BLOCK DE-GLAZING AND HONING

8. Operate sizing hone similar to Flexi-Hone. Inspect bore after 10 strokes (Figure 6-17).

CYLINDER BLOCK ASSEMBLY

1. Apply sealant MIL-S-46163 to water passage expansion plugs (4, Figure 6-3).
2. Using a suitable driver, drive water passage expansion plugs (4) into water passages until flush with countersink in block.
3. Apply sealant MIL-S-46163 around outside diameter of pipe plug (3), oil sampling valve (5) and oil pressure sending unit (6).

NOTE

Position oil sampling valve with discharge port down.

4. Install pipe plug (3), oil sampling valve (5) and oil pressure sending unit (6) into oil passages of block. Tighten pipe plug (3), oil sampling valve (5) and oil pressure sending unit (6).
5. Apply sealant MIL-S-46163 around outside diameter of camshaft expansion plug (2, Figure 6-18) and position it with convex side out on block.

6. Using a large drift and hammer, expand camshaft expansion plug (2, Figure 6-19) and drive it flush with block.

CAUTION

Make sure oil holes are clean. A 0.128 in. (3.25 mm) diameter rod must be able to pass through the oil holes. Failure to follow this procedure could cause damage to equipment.

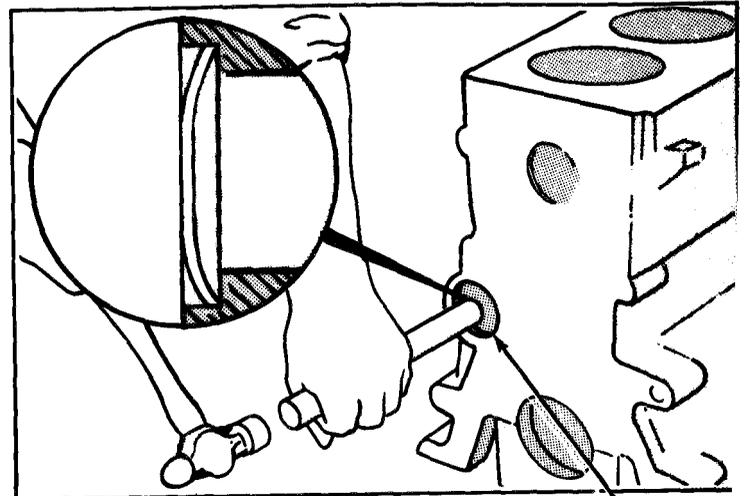


Figure 6-19

7. Mark oil holes on cam bushing (1) and on block (7, Figure 6-20).
8. Using a universal bushing installation tool, install cam bushing (1) flush with block (7, Figure 6-1) making sure oil holes are aligned.
9. Measure cam bushing (1). The minimum diameter should be 2.1295 in. (54.089 mm) and maximum should be 2.1314 in. (54.138 mm).



Figure 6-20

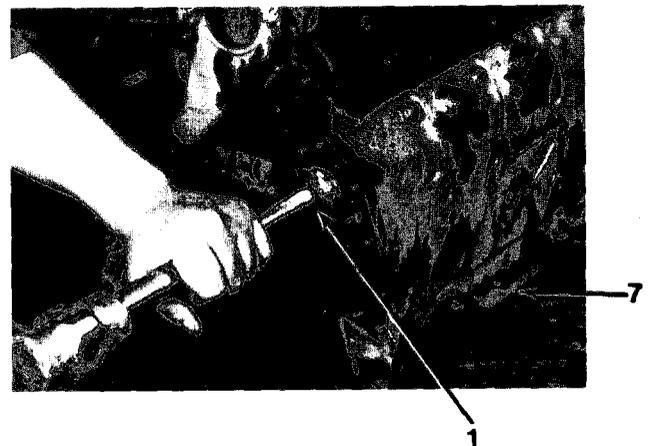


Figure 6-1

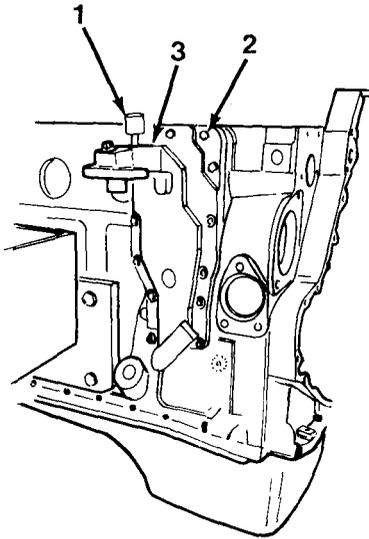


Figure 6-1

LUBE OIL COOLER

LUBE OIL COOLER REMOVAL

1. Remove oil filter (refer to page 3-47). If required, drain coolant (refer to page 3-58).

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

2. Disconnect wires to oil pressure switch (1, Figure 6-1) and remove oil pressure switch (1).
3. Using a 10 mm socket, remove 14 capscrews (2) and cover (3) from engine.
4. Remove cooler core (4) and cooler core gasket (5, Figure 6-2).

LUBE OIL COOLER INSTALLATION

1. Install cooler core gasket (5) and cooler core (4, Figure 6-2) to engine.
2. Install cover (3) and 14 capscrews (2, Figure 6-1). Torque 14 capscrews (2) to 18 lb-ft (24 N•m).
3. Install oil filter (refer to page 3-47).
4. Fill with coolant, if required (refer to page 3-58).
5. Connect wires to oil pressure switch (1).

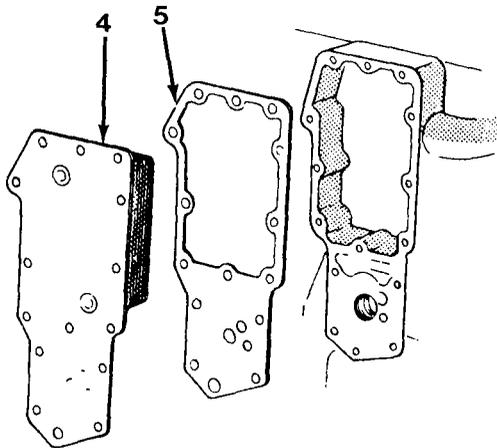


Figure 6-2

LUBE OIL COOLER COVER DISASSEMBLY

1. Remove plug (6), sealing washer (7), spring (8) and pressure regulator plunger (9, Figure 6-3).
2. Remove oil pressure switch (1, Figure 6-1).
3. Inspect pressure regulator plunger (9) bore for nicks or scratches. Pressure regulator plunger (9) must move freely in bore. If pressure regulator plunger (9) does not move freely, replace lube oil cooler assembly.
4. Check spring (8, Figure 6-4). If spring (8) is out of tolerance, replace spring (8).

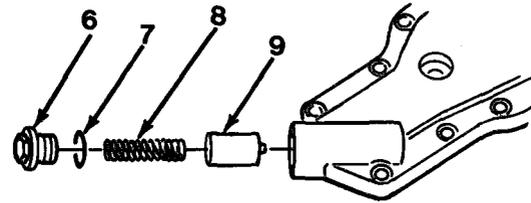


Figure 6-3

LIMIT

Valve Open:
Height 1.57 in. (39.9 mm)
Load: 20.5 lb (91 N)

Valve Assembled:
Height 1.77 in. (44.9 mm)
Load: 13.5 lb (60 N)

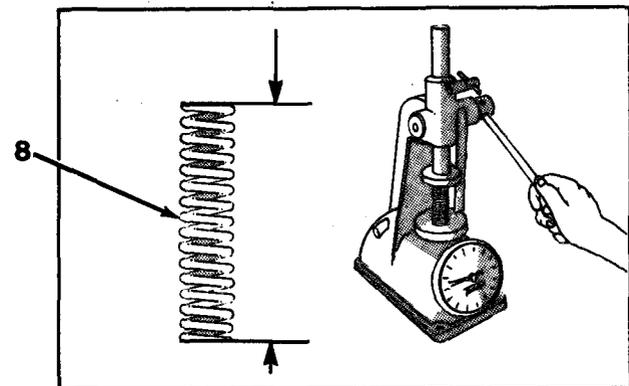


Figure 6-4

**LUBE OIL COOLER CLEANING/
INSPECTION**

⚠ WARNING

Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment: goggles or safety glasses, face shield and gloves. Do not use near sparks or open flames and do not smoke while using it. Failure to follow these procedures could cause **SERIOUS INJURY**.

1. Plug cooler core and soak it in cleaning solvent to remove coolant deposits.

⚠ WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kpa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

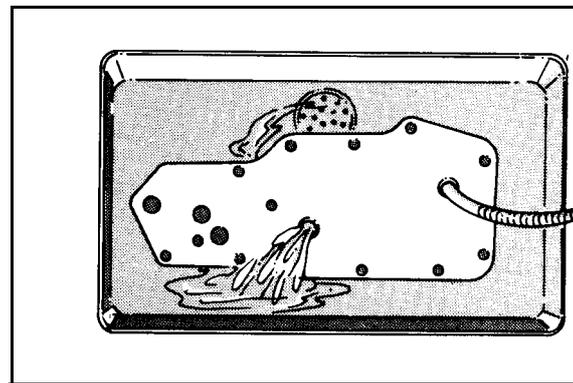


Figure 6-5

2. Remove plugs and soak cooler core in solvent. Back flush oil passages and dry with compressed air (Figure 6-5).
3. Clean all other parts (refer to Chapter 2).
4. Inspect soldered joints for corrosion or cracks.
5. Pressurize cooler core to 70 psi (483 kPa), submerge in water and check for leaks.
6. Inspect all other parts (refer to Chapter 4).

LUBE OIL COOLER COVER ASSEMBLY

1. Install pressure regulator plunger (9), spring (8), sealing washer (7) and plug (6, Figure 6-3). Torque plug (6) to 74 lb-ft (100 N•m).
2. Install oil pressure switch (1, Figure 6-1).

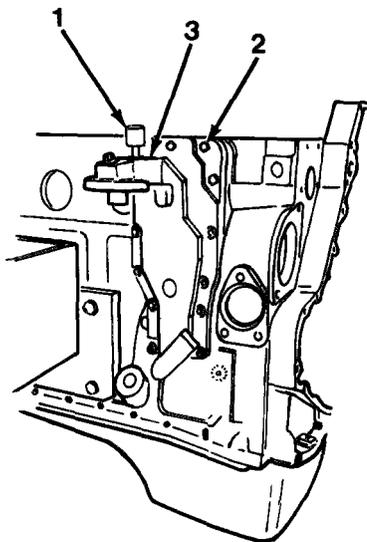


Figure 6-1

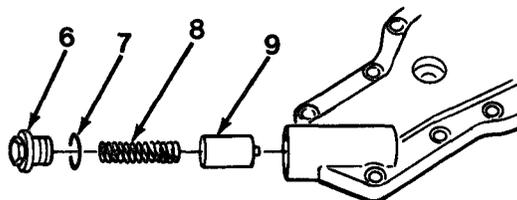


Figure 6-3

CHAPTER 7
FUEL SYSTEM

Title	Page
Injection Pump	7-1
Injector Nozzles	7-16
Lift Pump	7-24
Fuel Tank	7-25
Fuel Lines	7-28
Fuel Filters and Head Assembly	7-30
Cold Start Device	7-31
Fuel Injection Tubes	7-34
Fuel Pressure Switch and Transducer	7-39

INJECTION PUMP

INJECTION PUMP REMOVAL

1. Remove front cover (refer to page 6-17).
2. Remove all fuel injection tubes (refer to page 7-34).

NOTE

- Hold camshaft gear from moving when checking injection pump drive gear backlash.
 - Gear backlash limit is 0.003 to 0.013 in. (0.08 to 0.33 mm).
3. Use dial indicator on tooth of injection pump drive gear (Figure 7-1) and check for excessive gear backlash.
 4. If gear backlash exceeds limit, replace gear and/or camshaft gear.

NOTE

Number 1 cylinder must be at top dead center (TDC) before removing pump.

5. Barring engine slowly, push on engine timing pin (Figure 7-2) until pin engages.
6. Number 1 cylinder is now at TDC.
7. Disengage engine timing pin (Figure 7-3).

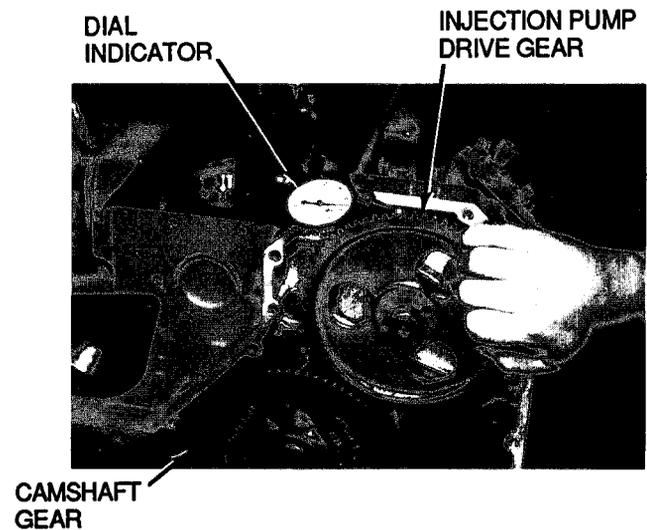


Figure 7-1

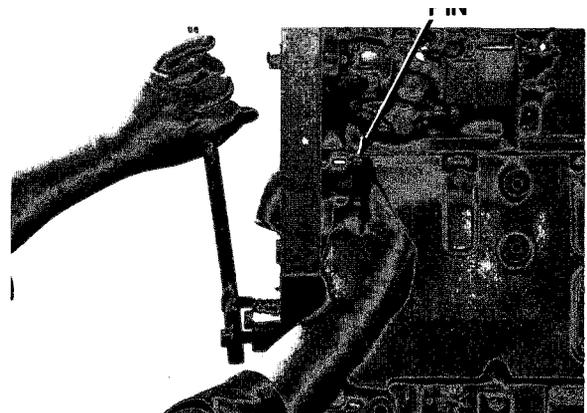


Figure 7-2

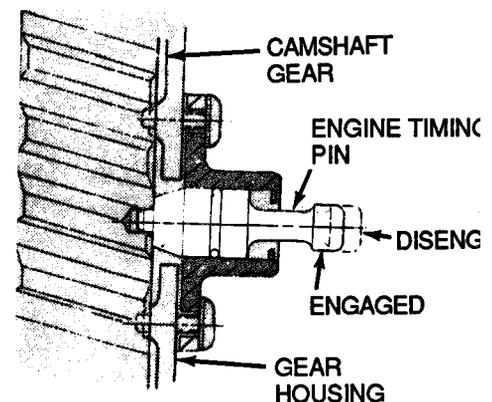


Figure 7-3

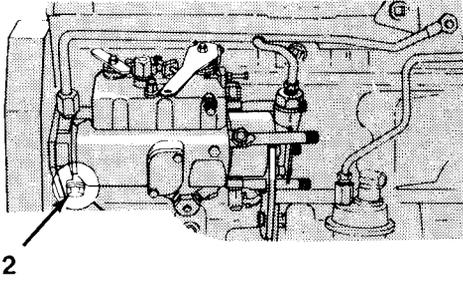


Figure 7-4

INJECTION PUMP REMOVAL

NOTE

Injection pump driveshaft must be locked before removing injection pump.

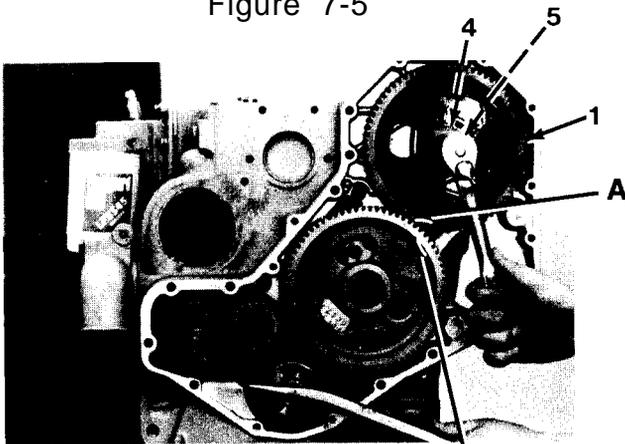
8. Loosen injection pump driveshaft lockscrew (2, Figure 7-4).
9. Reposition locked timing seal (3, Figure 7-5).
10. Torque injection pump lockscrew (2) to 22 lb-ft (30 N•m).

NOTE

Hold drive gear steady to prevent locked injection pump from rotating during drive gear removal.

11. Using 22 mm wrench, remove drive gear mounting nut (4) and washer (5) off of injection pump drive gear (1, Figure 7-6).
12. Using T-bar puller with 8 mm x 1.25 cap-screw, remove drive gear (1, Figure 7-7).

Figure 7-5



CAMSHAFT
TIMING MARK

Figure 7-6

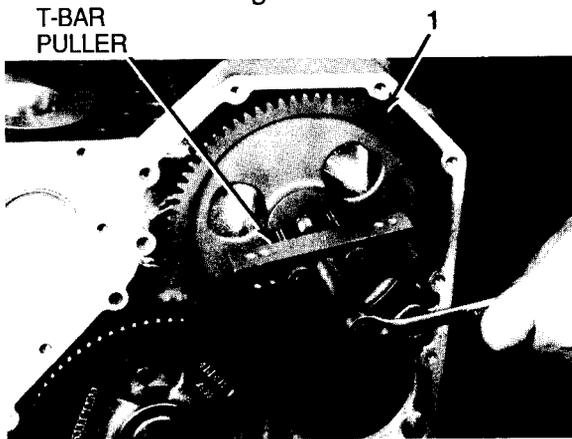


Figure 7-7

13. Using 13 mm wrench, remove capscrew (6, Figure 7-8) from rear brake.
14. Matchmark (A, Figure 7-9) injection pump mounting flange with gear housing.
15. Using 13 mm wrench, remove three flange nuts (7) from mounting studs.
16. Remove injection pump (8) with drive gear key (9, Figure 7-10) in place.
17. Remove gasket (10),

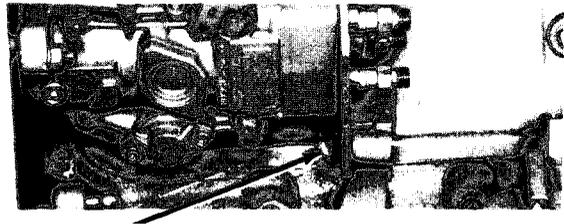


Figure 7-8

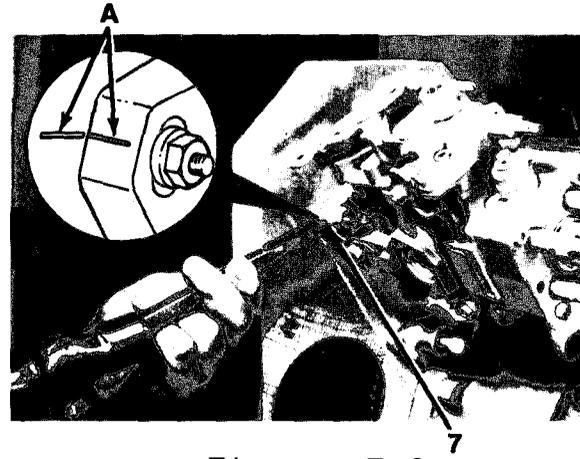


Figure 7-9

INJECTION PUMP CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

INJECTION PUMP INSTALLATION

NOTE

Number 1 cylinder must be at top dead center (TDC) before installing injection pump.

1. Barring engine slowly, push in engine timing pin until pin engages (Figure 7-2).
2. Number 1 cylinder is now at TDC.

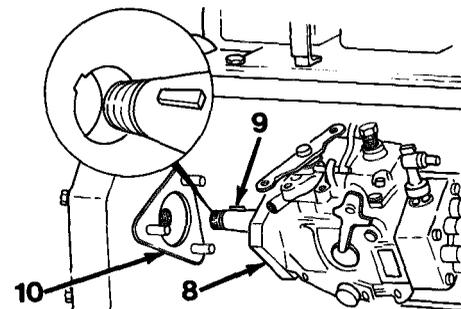


Figure 7-10

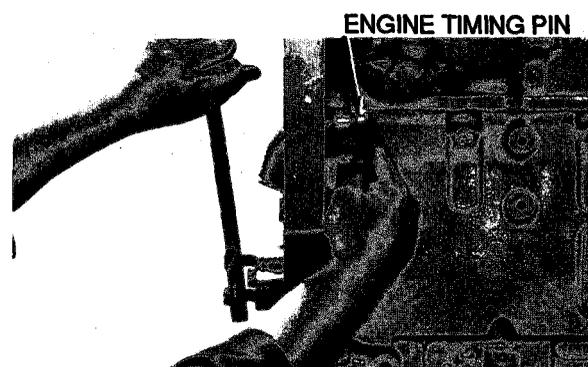


Figure 7-2

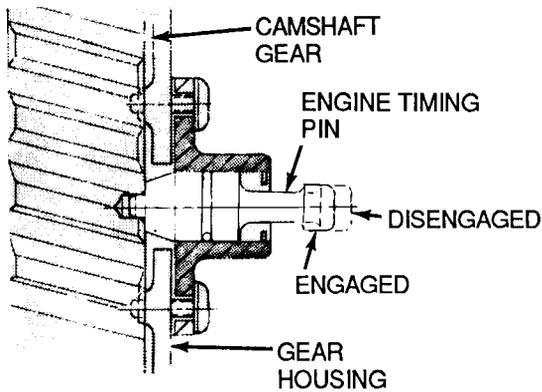


Figure 7-3

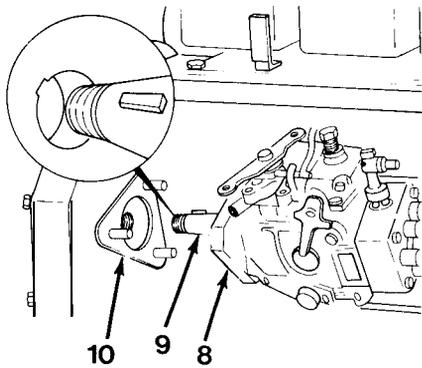


Figure 7-10

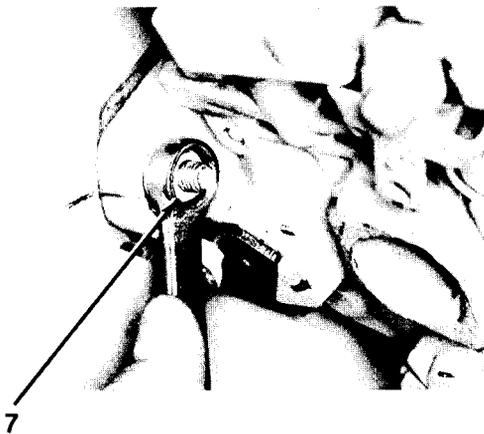


Figure 7-11

INJECTION PUMP INSTALLATION

3. Disengage engine timing pin (Figure 7-3).
4. Install gasket (10, Figure 7-10),
5. Install timed and locked injection pump (8) with drive gear key (9) in place.
6. Install three flange nuts (7, Figure 7-11) finger tight.
7. Install injection pump drive gear (1, Figure 7-6) onto driveshaft, aligning keyway in injection pump drive gear with key in shaft and aligning letter A on injection pump drive gear with timing mark on camshaft gear.
8. Using 22 mm wrench, install lockwasher (5) and nut (4).
9. Torque nut (4) to 11 to 15 lb-ft (15 to 20 N•m).

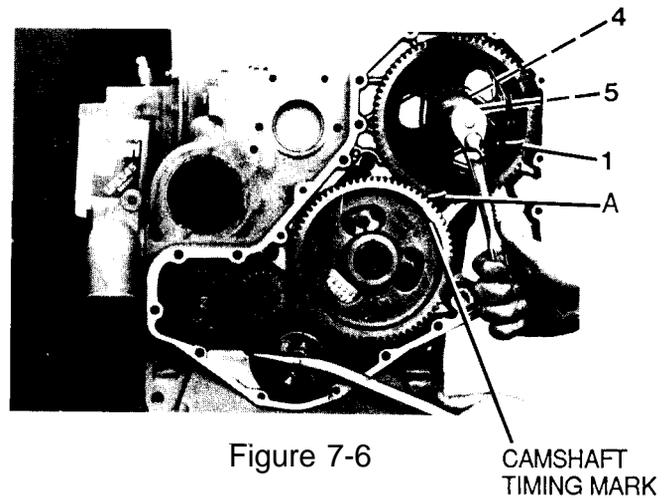


Figure 7-6

CAMSHAFT
TIMING MARK

10. When installing previously removed injection pump, align matchmarks (A, Figure 7-9).
11. When new or rebuilt injection pump is installed, matchmark injection pump mounting flange to match matchmark on gear housing.
12. Using 13 mm wrench, torque three flange nuts (7) to 18 lb-ft (24 N•m).
13. Using 13 mm wrench, torque rear bracket capscrew (6, Figure 7-8) to 18 lb-ft (24 N•m).
14. Loosen injection pump driveshaft lockscrew (2, Figure 7-4).
15. Reposition locked timing seal (3, Figure 7-12) to unlocked position.
16. Torque injection pump driveshaft lockscrew (2) to 7 lb-ft (10 N•m).

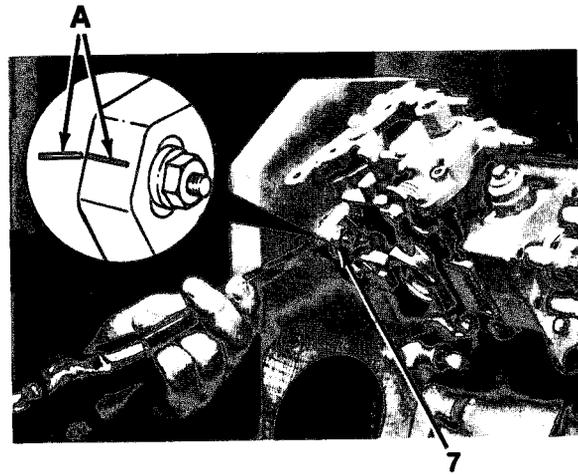


Figure 7-9

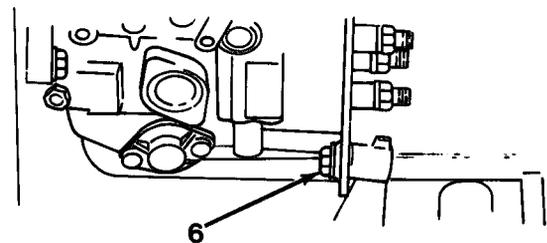


Figure 7-8

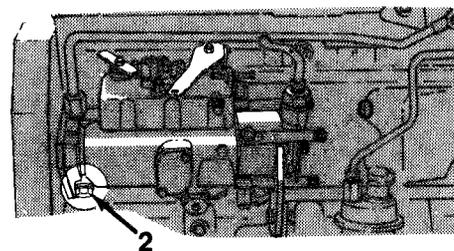


Figure 7-4

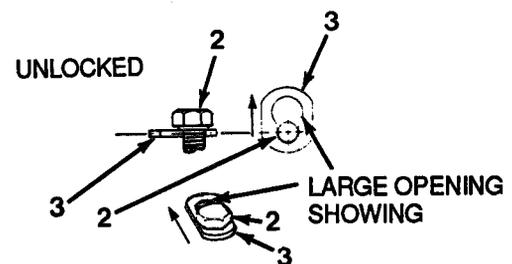


Figure 7-12

INJECTION PUMP DISASSEMBLY

CAUTION

Rebuild and calibration of pumps must be performed by qualified personnel using the appropriate special equipment. However, there are a number of external repairs that can be performed on injection pump without affecting calibration. Failure to follow this procedure could cause damage to equipment.

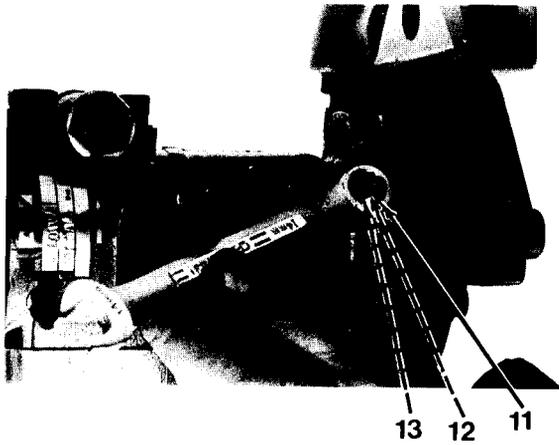


Figure 7-14

NOTE

Matchmark shaft position to housing.

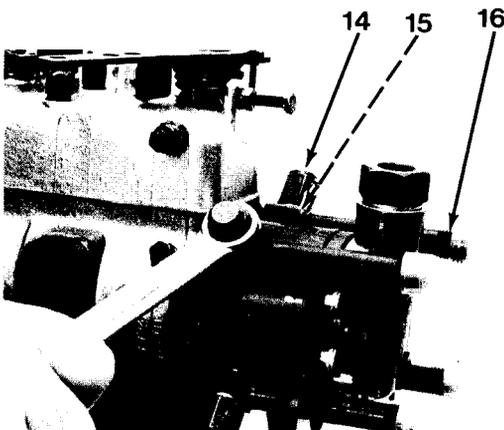


Figure 7-15

1. Remove cap screw (11) and washer (12, Figure 7-14).
2. Remove O-ring (13) from cap screw(11).
3. Remove four banjo bolts (14), eight copper washers (15) and four fittings (16, Figure 7-15).

4. Remove solenoid with plunger (17), spring (18) and O-ring (19, Figure 7-16).
5. Remove screw assembly (20) and washer (21, Figure 7-17).
6. Remove orifice bleed fitting (22) and washer (23, Figure 7-18).
7. Remove inlet fitting (24), washer (25) and filter (26).

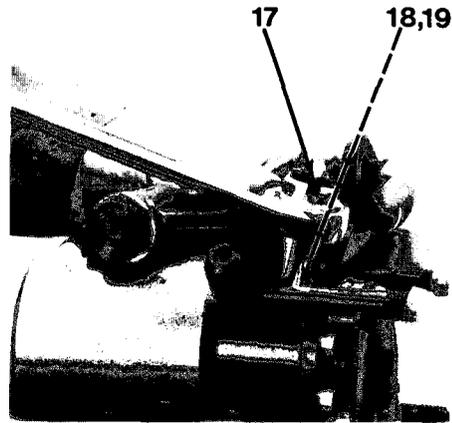


Figure 7-16

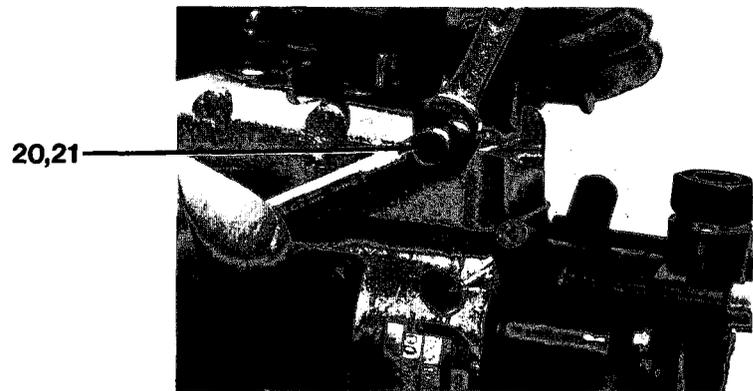


Figure 7-17

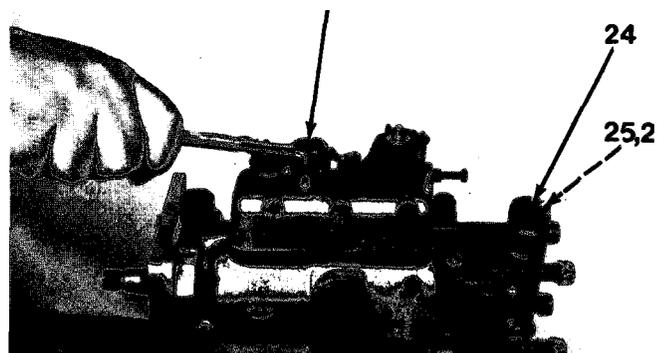


Figure 7-18

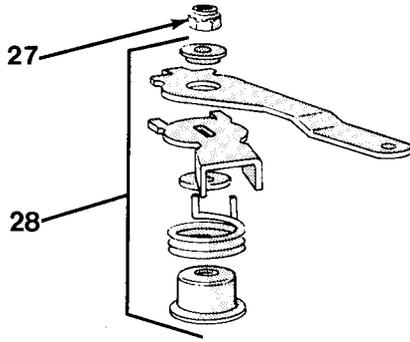


Figure 7-19

INJECTION PUMP DISASSEMBLY

8. Remove lock nut (27) and throttle lever kit (28, Figure 7-19).
9. Remove lock nut (29), washer (30), lever (31), spring (32) and guide (33, Figure 7-20).
10. Remove plug and washer (34) from spring cap (35, Figure 7-21).

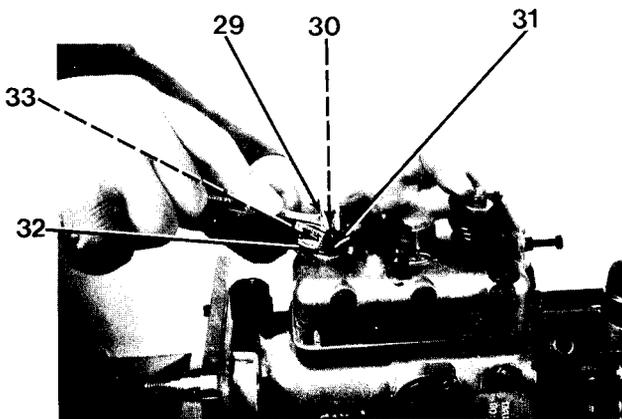


Figure 7-20

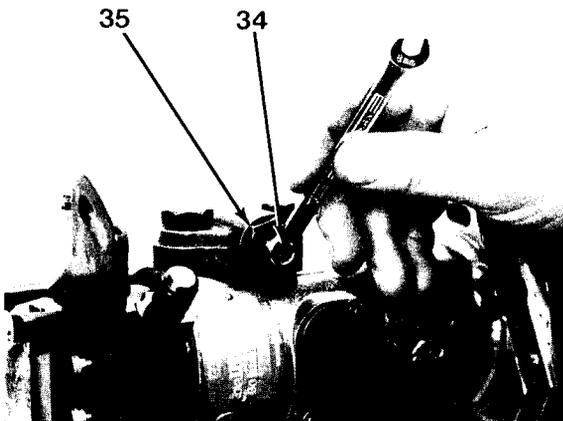


Figure 7-21

CAUTION

Remove cap slowly; cap is under spring tension. Failure to follow this procedure could cause damage to equipment

NOTE

Record the number of shims for use in assembly.

11. Remove spring cap and O-ring (35) slowly and remove spring and shims (36, Figure 7-22).
12. Remove pressure end cap (37) and O-ring (38, Figure 7-23) from timing housing.
13. Remove cap nut and sealing washer (39, Figure 7-24).

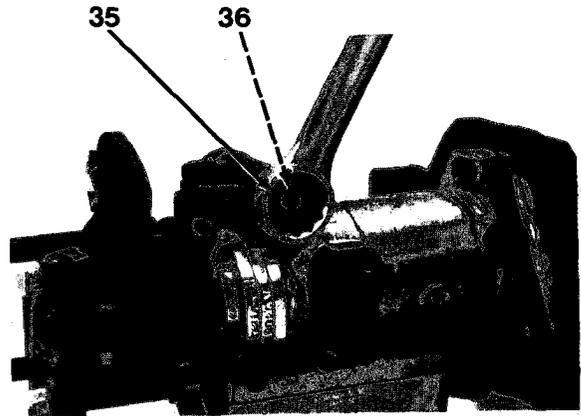


Figure 7-22

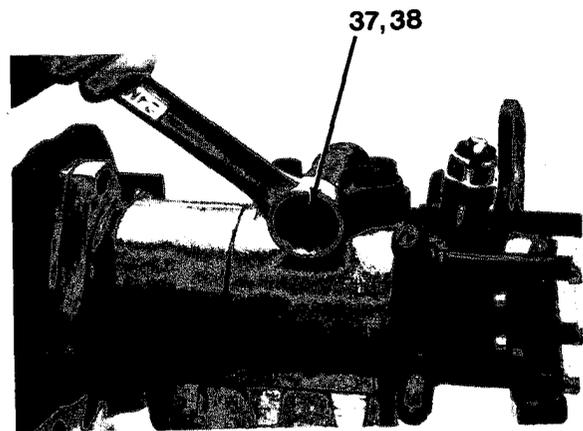


Figure 7-23

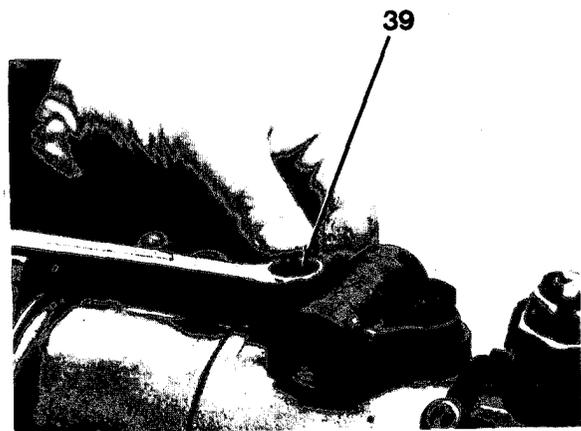


Figure 7-24

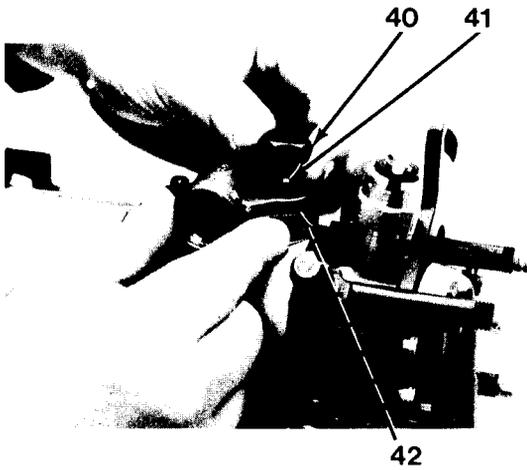


Figure 7-25

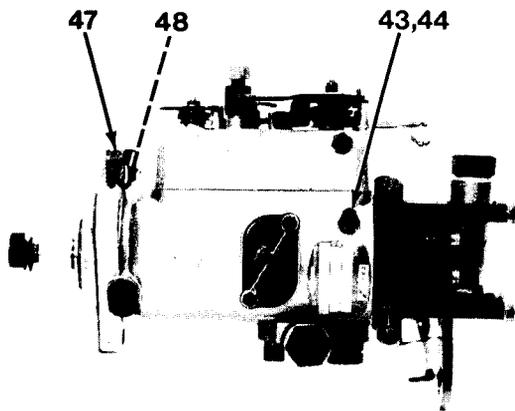


Figure 7-26

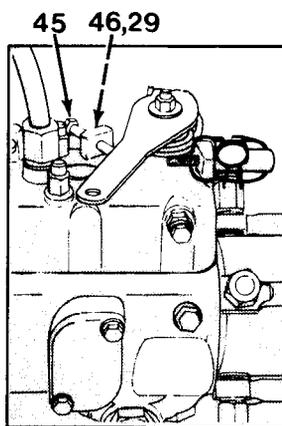


Figure 7-27

INJECTION PUMP DISASSEMBLY

14. Remove locating fitting and O-rings (40) and ball (41, Figure 7-25).
15. Remove timing housing and gasket (42).
16. Remove assembly screw (43) and washer (44, Figure 7-26).

NOTE

Matchmark position of lock nut on idle screw to aid in assembly.

17. Remove low idle screw (45), washer (46) and lock nut (29, Figure 7-27).

18. Remove return fitting (47) and washer (48, Figure 7-26).

INJECTION PUMP CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

INJECTION PUMP ASSEMBLY

1. Install return fitting (47) and washer (48, Figure 7-26).
2. Install lock nut (29), washer (46) and idle screw (45, Figure 7-27). Align matchmarks made during disassembly.
3. Install assembly screw (43) and washer (44, Figure 7-26). Torque assembly screw (43) to 65 lb-in. (7.3 N•m).
4. Assemble locating fitting and O-rings (40) and ball (41, Figure 7-28).

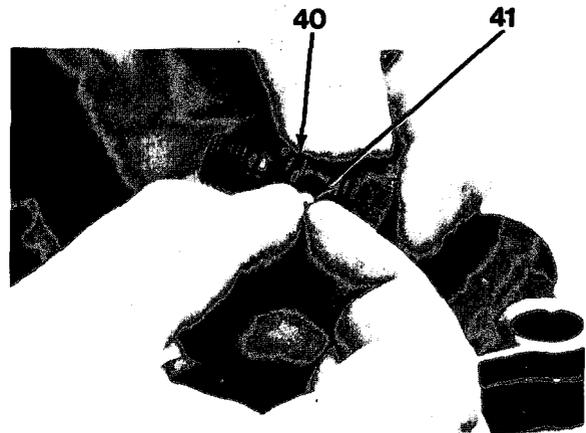


Figure 7-28

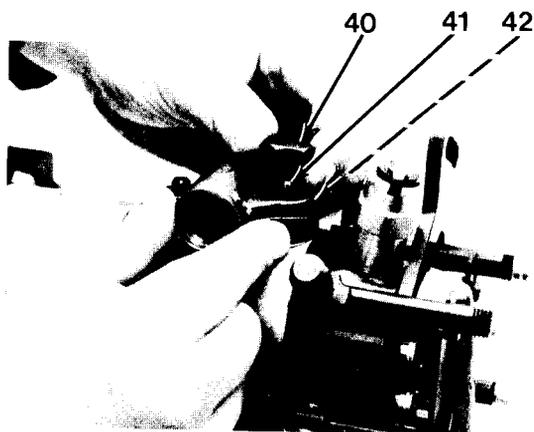


Figure 7-25

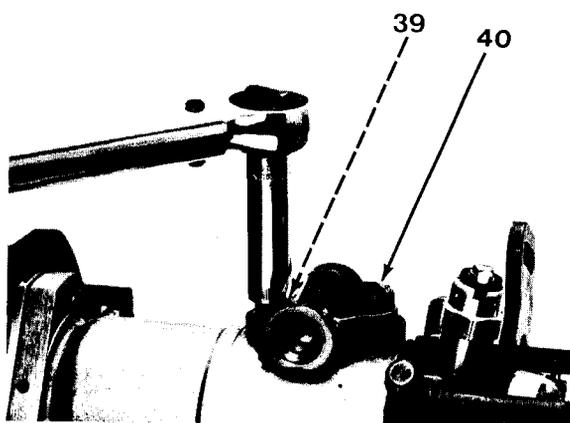


Figure 7-29

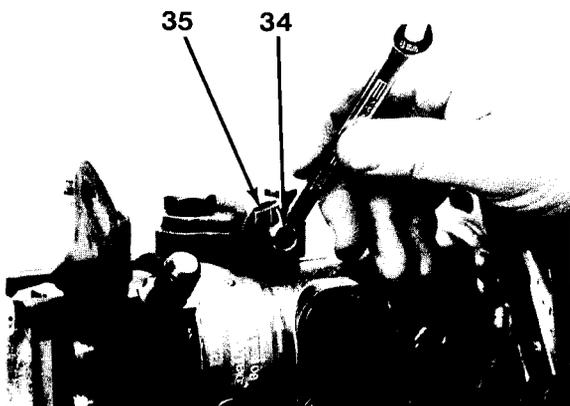


Figure 7-21

INJECTION PUMP ASSEMBLY

5. Install gasket (42) in timing housing with locating fitting and O-ring (40) and ball (41, figure 7-25), and hand tighten.
6. Install cap nut and sealing washer (39, Figure 7-29) onto timing housing.
7. Tighten cap nut (39) and locating fitting (40) alternately and evenly until a torque of 22 lb-ft (30 N•m) is obtained on cap nut (39) and a torque of 29 lb-ft (39 N•m) is obtained on locating fitting (40).
8. Install plug and washer (34) into spring cap (35, Figure 7-21).
9. Install spring cap and O-ring (35) with spring and shims (36, Figure 7-22) into timing housing, using the number of shims recorded during disassembly. Torque spring cap (35) to 17.5 lb-ft (23.7 N•m).

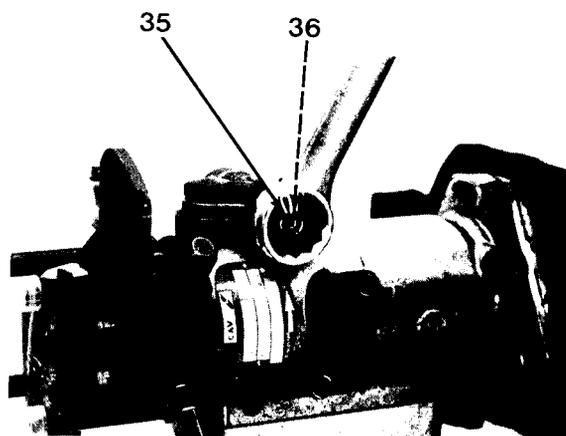


Figure 7-22

10. Install O-ring (38) and pressure end cap (37, Figure 7-23) into timing housing. Torque pressure end cap (37) to 17.5 lb-ft (23.7 N•m)

11. Install guide (33), spring (32) and shutdown lever (31, Figure 7-20).

12. Position return spring (32) with one end contacting boss on governor cover. Hook free end around shutoff lever. Rotate lever clockwise until it engages flats on shutoff shaft.

13. Install washer (30) and lock nut (29). Torque locknut (29) to 30 lb-in. (3.4 N•m).

14. Install lever kit (28) and lock nut (27, Figure 7-19). Stop arm in lever kit (28) must slide over flats of shaft. Torque locknut (27) to 30 lb-in. (3.4 N•m).

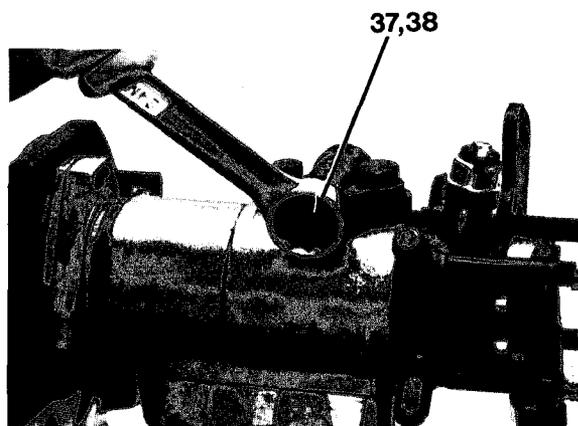


Figure 7-23

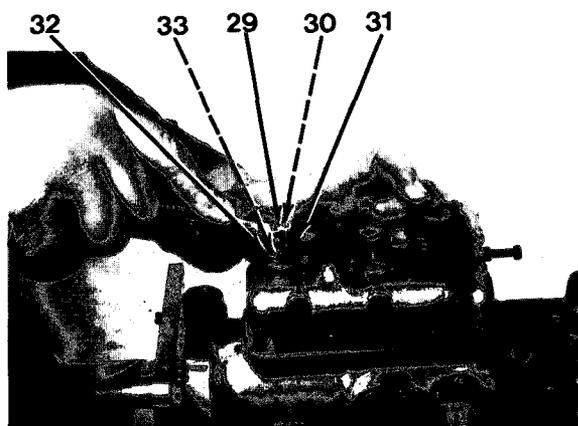


Figure 7-20

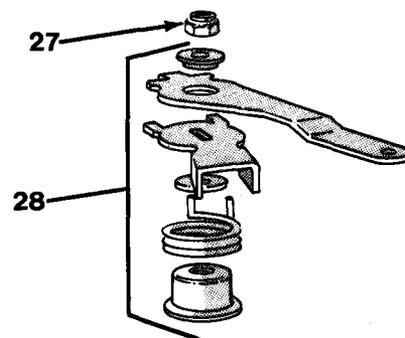


Figure 7-19

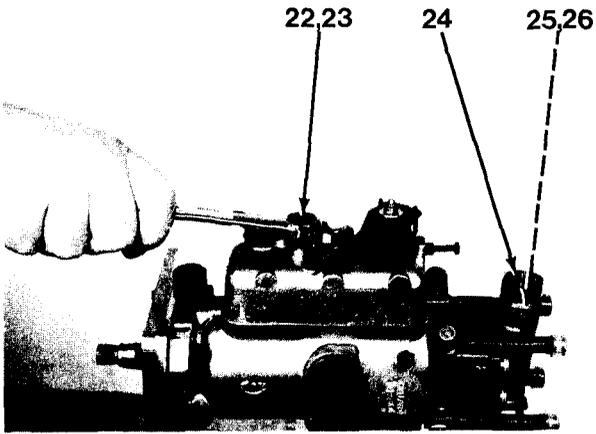


Figure 7-18

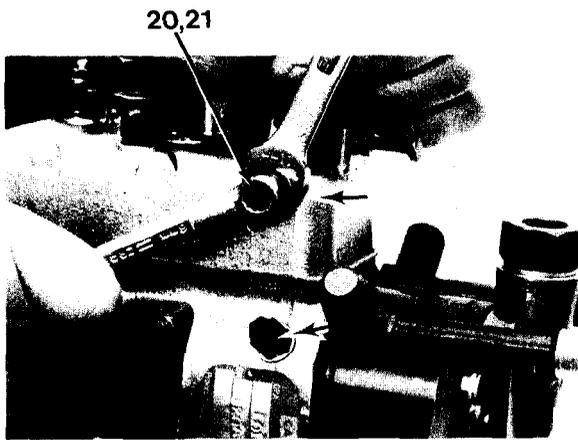


Figure 7-17

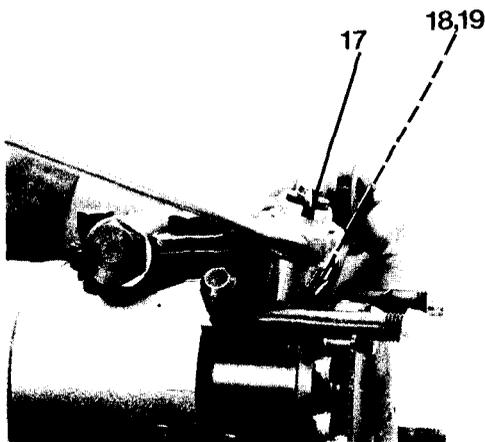


Figure 7-16

INJECTION PUMP ASSEMBLY

15. Install filter (26), washer (25) and inlet fitting (24, Figure 7-18). Torque inlet fitting (24) to 38 lb-ft (52 N•m).
16. Install washer (23) and orifice bleed fitting (22). Torque orifice bleed fitting (22) to 15 lb-ft (20 N•m).
17. Install washer (21) and screw assembly (20, Figure 7-17). Torque screw assembly (20) to 40 lb-in. (4.5 N•m).
18. Install O-ring (19), spring (18) and solenoid with plunger (17, Figure 7-16). Torque solenoid (17) to 11 lb-ft (15 N•m).

19. Install four fittings (16), eight copper washers (15) and four banjo bolts (14, Figure 7-15). Torque four banjo bolts (14) to 23lb-ft (31 N•m).
20. Install O-ring (13) and special washer (12) on capscrew(11, Figure 7-14).
21. Position shaft as marked during disassembly and install screw assembly (11) into injection pump to lock.

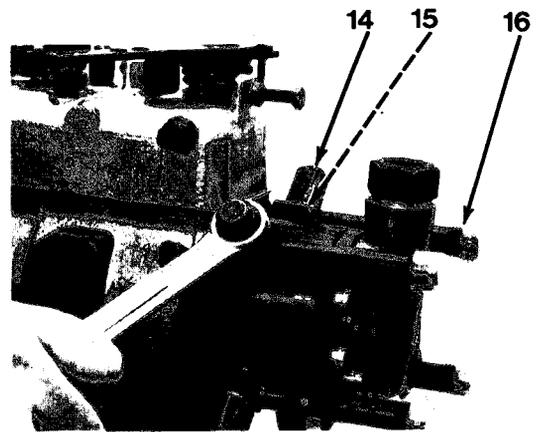


Figure 7-15

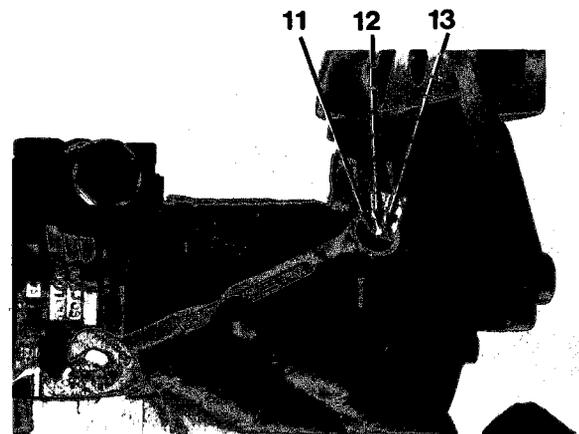


Figure 7-14

INJECTOR NOZZLES

INJECTOR NOZZLES REMOVAL

1. Remove exhaust manifold (refer to page 8-1).
2. Remove fuel injection tubes (refer to page 7-34).

CAUTION

If rust has formed on hold-down nut, the injector nozzle can turn in bore when nut is loosened. This will cause injector locating ball to cut a groove in bore, severely damaging head.

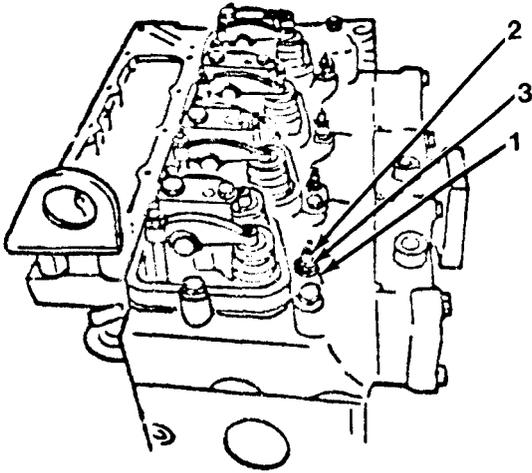


Figure 7-1

3. If injectors are rusty, soak hold-down nut with a rust-penetrating solvent for a minimum of 3 minutes and loosen rust by carefully hitting injector body with drift pin.
4. Hold injector body with adjustable wrench and, using a 24 mm box wrench, loosen hold-down nut (1) and remove four injector nozzles (2, Figure 7-1) from cylinder head.
5. Remove four copper injector washers (3).

INJECTOR NOZZLES INSTALLATION

1. Apply antiseize compound MIL-A-907 to threads between injector nozzle hold-down nut (1, Figure 7-1) and injector body.

NOTE

Protrusion on side of nozzle fits into a notch in head to orient injector.

2. Install four new copper injector washers (3).
3. Install four injector nozzles (2) in cylinder head.
4. Hold injector body with adjustable wrench and tighten hold-down nut (1), making sure injector nozzle (2) does not rotate. Torque hold-down nut (1) to 44 lb-ft (60 N•m).
5. Install exhaust manifold (refer to page 8- 1).
6. Install fuel injection tubes (refer to page 7-38).

INJECTOR NOZZLES DISASSEMBLY

1. Using a brass wire brush and a piece of hardwood dipped in diesel fuel, clean carbon residue from injector nozzle (2, Figure 7-2).
2. Position injector nozzle (2) in a soft-jawed vise and remove nozzle retainer (4).
3. Remove nozzle tip (5) and intermediate plate (6, Figure 7-3).

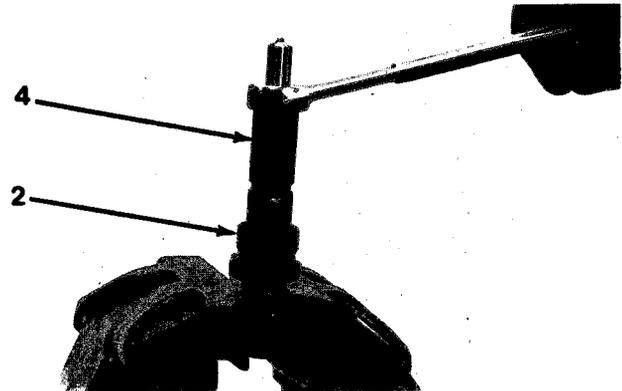


Figure 7-2

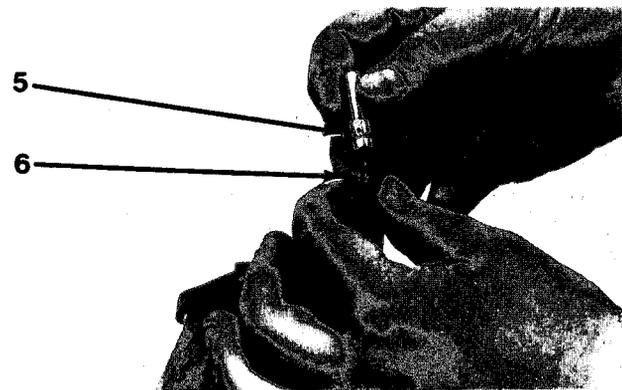


Figure 7-3

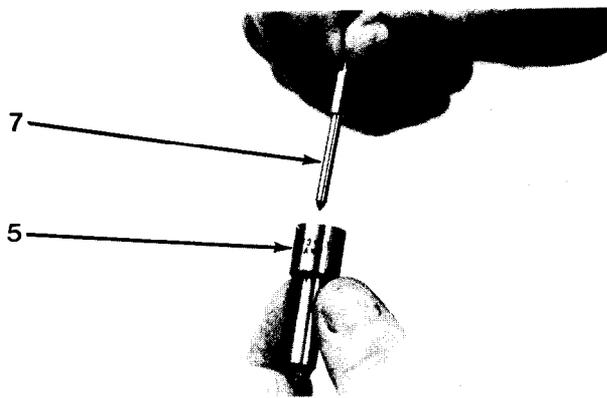


Figure 7-4

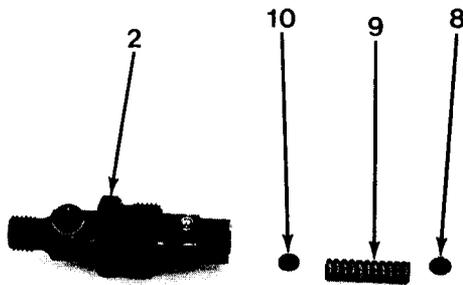


Figure 7-5

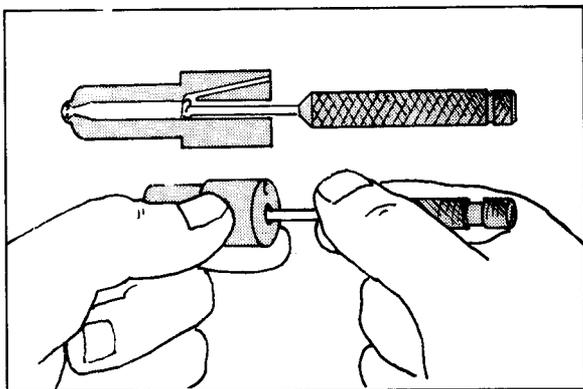


Figure 7-6

INJECTOR NOZZLES DISASSEMBLY

CAUTION

Hold the needle valve by the stem only. Natural skin oils will corrode the finely lapped surfaces of the needle valve.

4. Submerge nozzle tip (5) in container of clean diesel fuel and remove needle valve (7, Figure 7-4) from nozzle tip (5). Needle valve (7) and nozzle tip (5) are matched for fit. They must not be intermixed.
5. Remove injector nozzle (2, Figure 7-5) from vise.
6. Turn injector nozzle (2) upside down and remove pressure spindle (8), pressure spring (9) and shims (10).

INJECTOR NOZZLES CLEANING/INSPECTION

NOTE

When doing the following steps, make sure fingers, needle valve, nozzle tip, scraper and hardwood are saturated with clean diesel fuel.

1. Polish needle valve on hardwood.
2. Clean nozzle tip with a scraper (Figure 7-6).

! WARNING

Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment: goggles or safety glasses, face shield and gloves. Do not breathe vapors. Do not use near sparks or open flames and do not smoke while using it. Failure to follow these procedures could cause **SERIOUS INJURY**.

3. Clean interior ring groove of nozzle tip with a scraper (Figure 7-7). Rinse in dry cleaning solvent P-D-680 to remove all dirt and carbon residue and dip in clean diesel fuel.
4. Clean spray holes with appropriate size cleaning needle (Figure 7-8). Remove burned-on combustion deposits on nozzle tip with dry cleaning solvent P-D-680. Rinse in clean diesel fuel.
5. Clean nozzle up with brass brush (Figure 7-9).
6. Clean all other parts (refer to Chapter 2).
7. Inspect nozzle tip for rough surfaces or corrosion. The pressure shoulder will normally have a rough machined appearance. If nozzle tip is deteriorated, replace with compatible nozzle body.

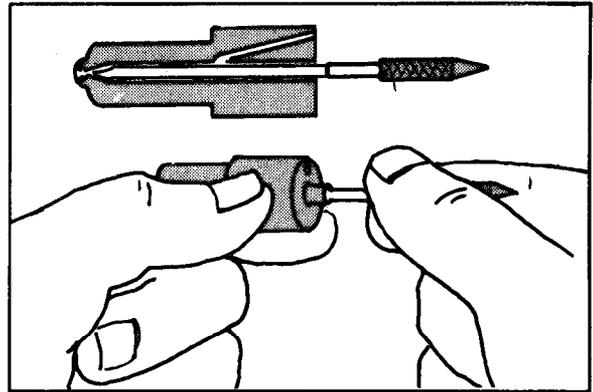


Figure 7-7

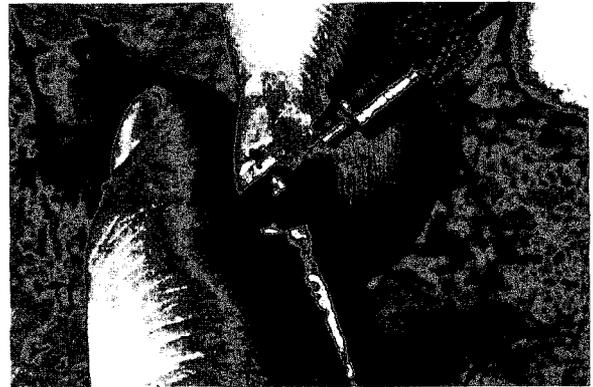


Figure 7-8

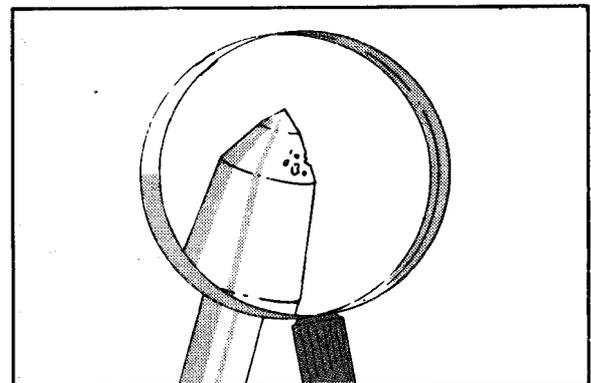


Figure 7-9

INJECTOR NOZZLES CLEANING/INSPECTION

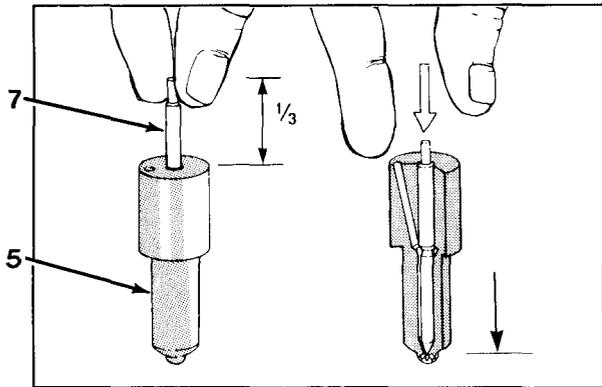


Figure 7-10

8. Dip needle valve in diesel fuel. Install needle valve into nozzle tip. Pull needle valve out of nozzle tip about one-third of the way. Release needle valve and let it slide back down into nozzle tip under its own weight (Figure 7-10). If needle valve fails the slide test, replace it.
9. Inspect all other parts (refer to Chapter 4).

INJECTOR NOZZLES ASSEMBLY

NOTE

Make sure all mating surfaces are clean and lubricated with diesel fuel before assembly.

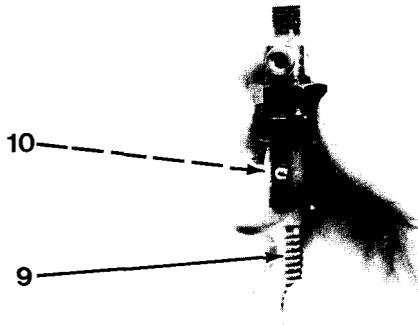


Figure 7-11

1. Install same thickness of shim(s) (10) that were removed in disassembly. Use pressure spring (9, Figure 7-11) to make sure shim(s) (10) are installed flat.
2. Position injector nozzle (2) in a soft-jawed vise. Install pressure spring (9) and pressure spindle (8, Figure 7-12) in injector nozzle (2).

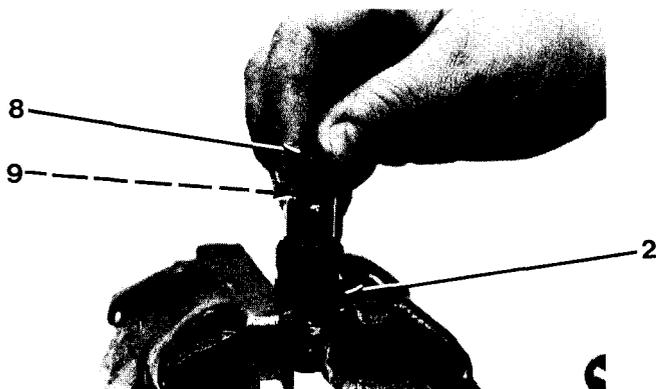


Figure 7-12

3. Install intermediate plate (6) and nozzle tip (5, Figure 7-3).

4. Install nozzle retainer (4) into injection nozzle (2, Figure 7-2). Torque nozzle retainer (4) to 22 lb-ft (30 N•m).

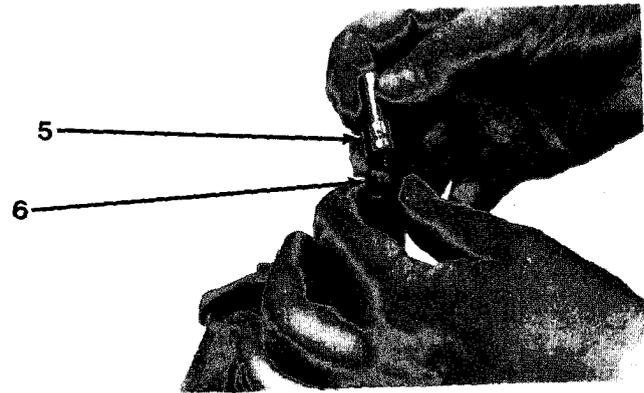


Figure 7-3

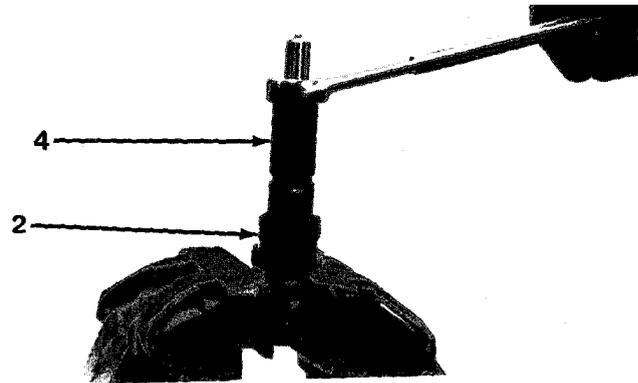


Figure 7-2

INJECTOR NOZZLES TESTING

⚠ WARNING

Keep your body clear of test spray. Fluid can be injected into the bloodstream causing blood poisoning and possible DEATH or serious injury.

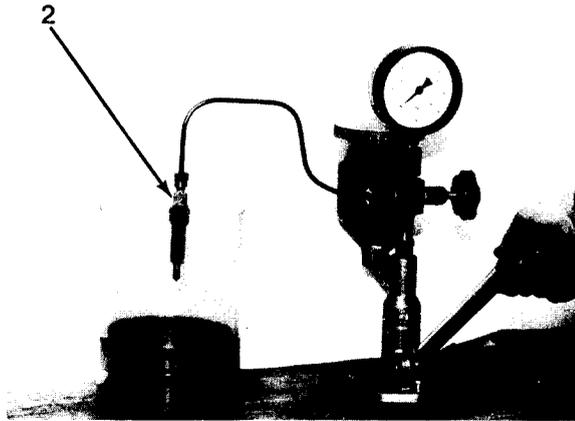


Figure 7-13

NOTE

- All nozzles must be tested for opening pressure, chatter and spray pattern.
- Chatter test indicates ability of needle valve to move freely and correctly atomize fuel. You should hear valve open and see a well atomized spray pattern.
- Used nozzles should not be evaluated for chatter at lower speeds. A used nozzle can generally be used if it passes leakage test, chatters audibly at high lever speeds and uniformly atomizes the fuel.

1. Install nozzle tester to injector nozzle (2, Figure 7-13).
2. Test opening pressure by opening valve and operate lever one stroke per second.

3. Read pressure indicated when spray begins. Spray should start between 3,160 to 3,307 psi (21,788 to 22,802 kPa) (Figure 7-14).
4. If opening pressure is out of specification, change shim pack. Adding shims will increase pressure (Figure 7-15).
5. To test leakage, open valve and operate lever to hold pressure 290 psi (2,000 kPa) below opening pressure. No drops should fall from tip within 10 seconds (Figure 7-16).

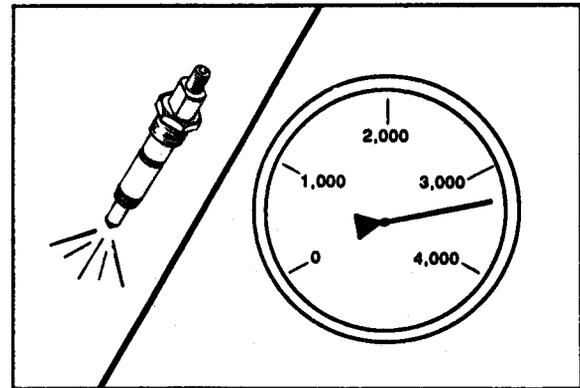


Figure 7-14

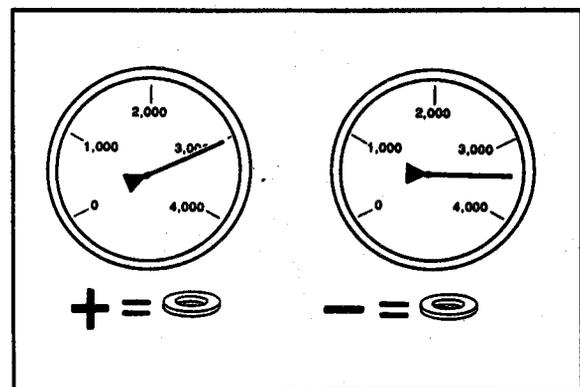


Figure 7-15

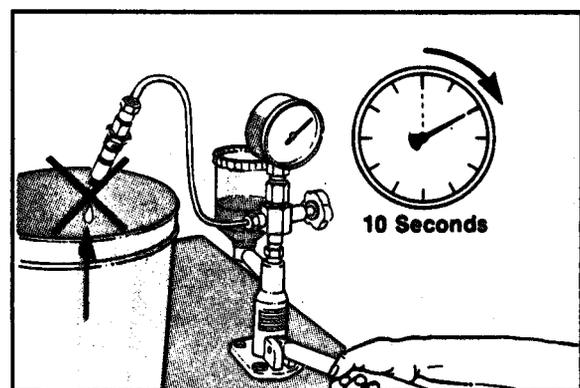


Figure 7-16

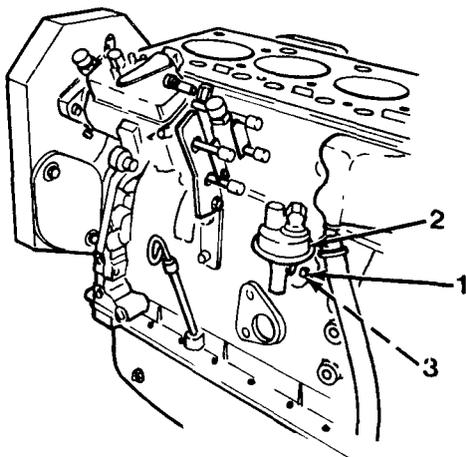


Figure 7-1

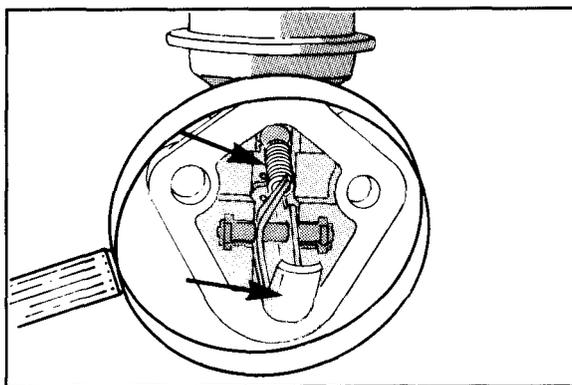


Figure 7-2

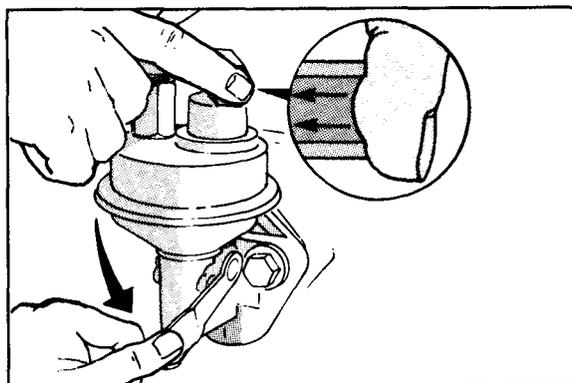


Figure 7-3

LIFT PUMP

LIFT PUMP REMOVAL

1. Disconnect fuel lines (refer to page 7-28).
2. Disconnect fuel injection tubes (refer to page 7-34).
3. Using a 13 mm wrench, remove two cap-screws (1), lift pump (2) and gasket (3, Figure 7-1) from engine. Discard gasket (3). Remove all gasket material from mounting surfaces.

LIFT PUMP CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect camshaft lever and return spring for wear (Figure 7-2).
3. Inspect diaphragm by blocking fuel inlet line with finger and operating priming lever (Figure 7-3). A properly operating pump will have suction that will not bleed down until finger is removed from inlet.
4. Inspect all other parts (refer to Chapter 4).

LIFT PUMP INSTALLATION

1. Install new gasket (3), lift pump (2) and two cap-screws (1, Figure 7-1). Torque two cap-screws (1) to 18 lb-ft (24 N•m).
2. Connect fuel injection tubes (refer to page 7-37).
3. Connect fuel lines (refer to page 7-29).

FUEL TANK

FUEL TANK REMOVAL

1. Remove drain plug (1) and drain fuel tank (16, Figure 7-1).
2. Remove four nuts (2), washers (3), capscrews (4) and bracket (5).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

3. Disconnect fuel lines (6) and (7, Figure 7-2).

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

4. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid installation. Remove tags following maintenance.

5. Remove nut (8), lockwasher (9), screw (10), lockwasher (11) and disconnect sending unit harness (12).
6. Install lockwasher (11) and screw (10).
7. Remove four nuts (13), washers (14), two strain (15) and fuel tank (16).

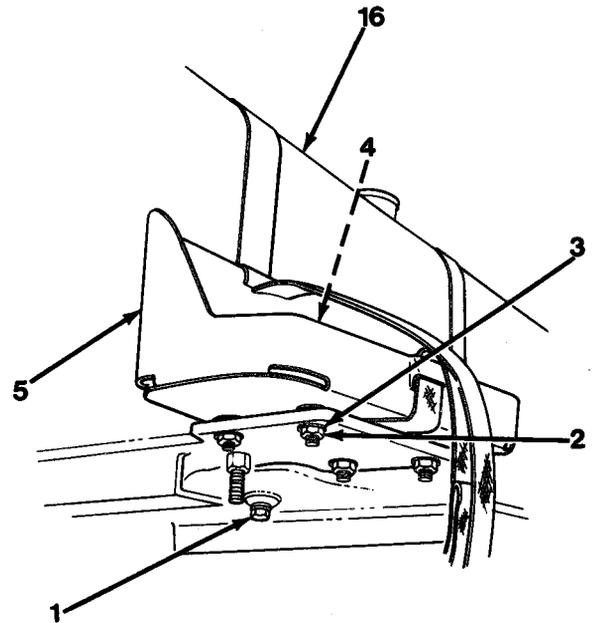


Figure 7-1

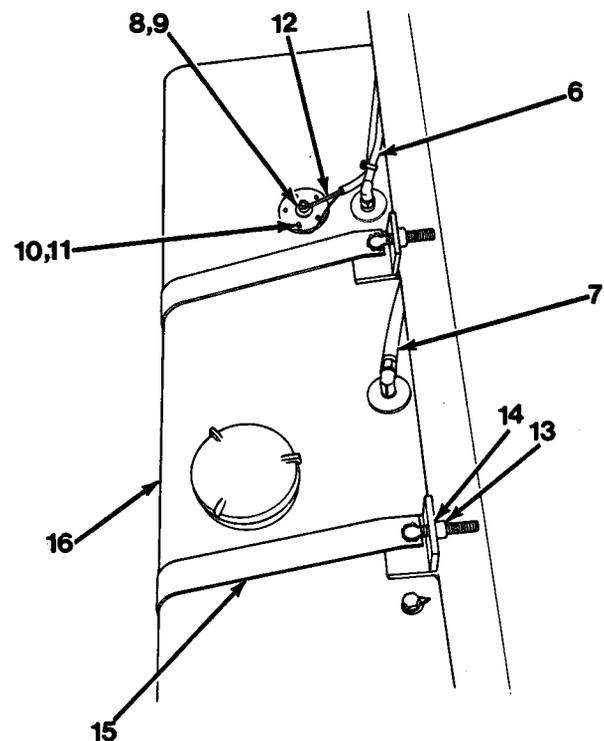


Figure 7-2

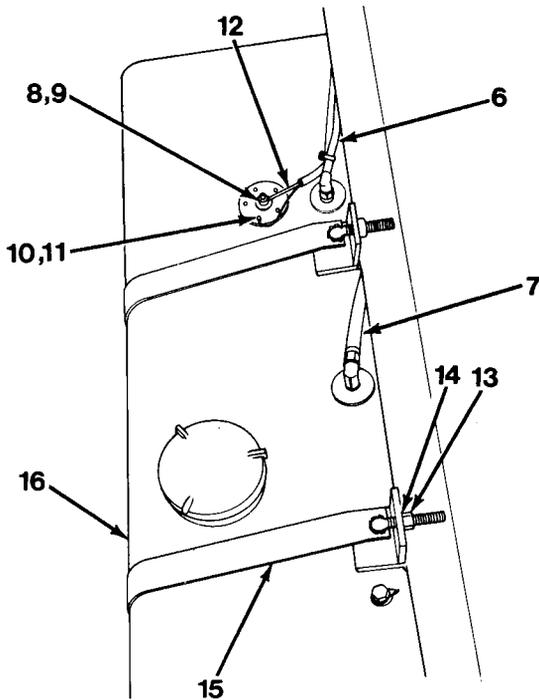


Figure 7-2

FUEL TANK INSTALLATION

1. Position fuel tank (16) and install two straps (15), four washers (14) and nuts (13, Figure 7-2).
2. Remove screw (10) and lockwasher (11). Position ground wire and install lock-washer (11) and screw (10).
3. Connect sending unit harness (12) and install lockwasher (9) and nut (8),
4. Connect fuel lines (7) and (6).
5. Install bracket (5), four capscrews (4), washers (3) and nuts (2, Figure 7-1).
6. Install drain plug (1) and fill fuel tank (16).

FUEL TANK DISASSEMBLY

1. Remove elbows (17) and (18), bushing (19) and check valve (20, Figure 7-3).
2. Remove four machine screws (21), lockwashers (22) and sending unit (23).
3. Unscrew cap (27) and remove fill screen (24, Figure 7-4).
4. Unhook chain (25) at clip (26) and remove cap (27).

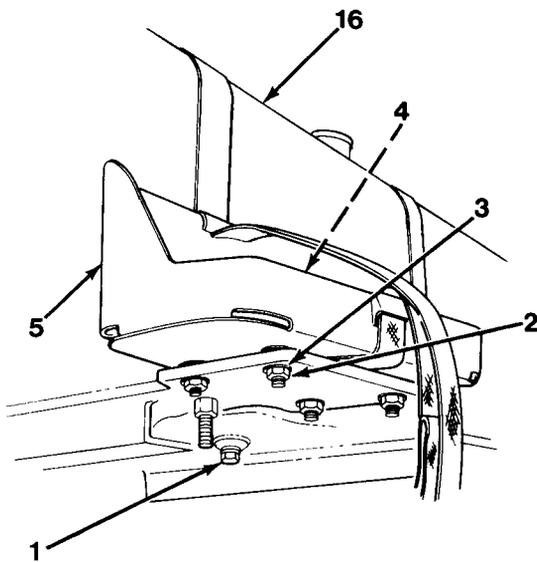


Figure 7-1

FUEL TANK CLEANING/INSPECTION

WARNING

compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Clean fuel screen with compressed air.
2. Clean all other parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

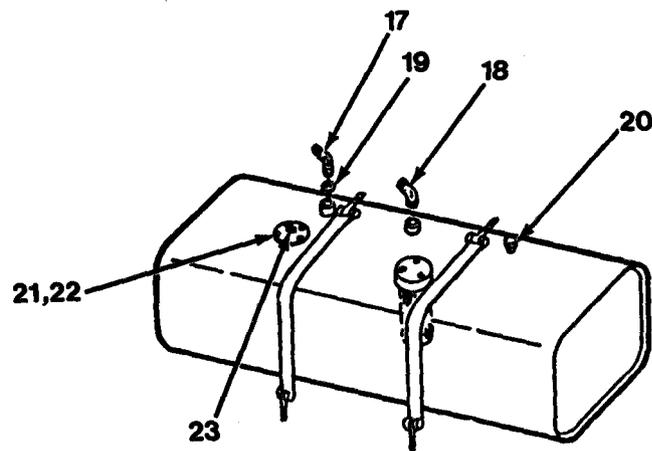


Figure 7-3

FUEL TANK ASSEMBLY

1. Hook chain (25) at clip (26, Figure 7-4).
2. Install fill screen (24) and cap (27).
3. Install sending unit (23), four lockwashers (22) and machine screws (21, Figure 7-3).
4. Install check valve (20), bushing (19) and elbows (18) and (17).

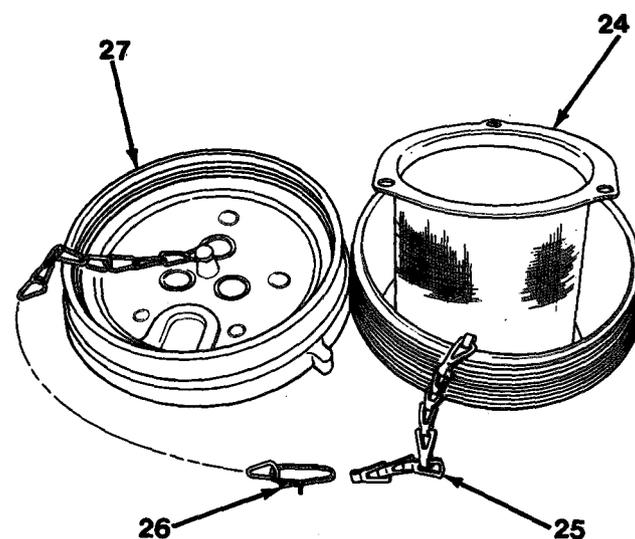


Figure 7-4

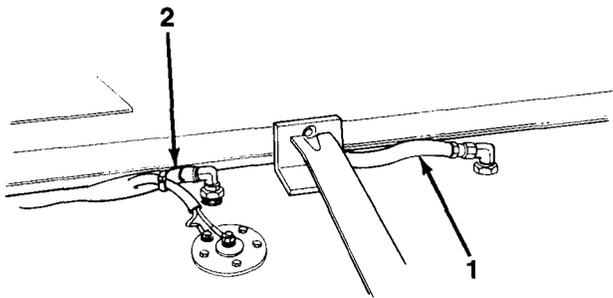


Figure 7-1

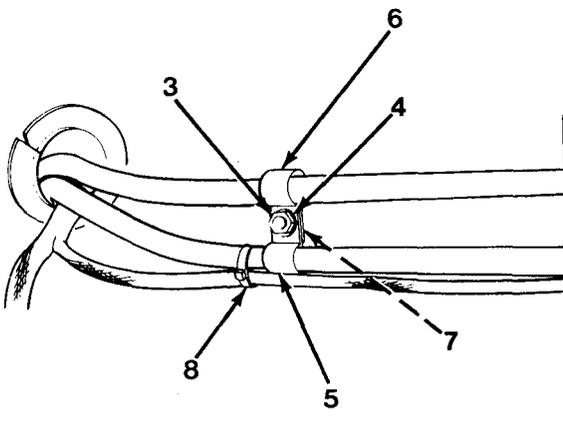


Figure 7-2

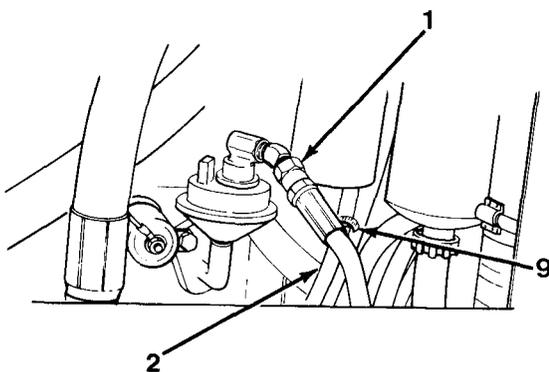


Figure 7-3

FUEL LINES

FUEL LINES REMOVAL

1. Slide open engine cover.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Disconnect fuel lines (1) and (2, Figure 7-1) at elbows on top of fuel tank.
3. Remove two nuts (3), washers (4), clamps (5) and (6), two washers (7) and three plastic ties (8, Figure 7-2).
4. Remove fuel line (1, Figure 7-3) from fuel lift pump.
5. Remove clamp (9) and fuel line (2) from fuel return line.

FUEL LINES CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FUEL LINES INSTALLATION

1. Install fuel line (2) and clamp (9, Figure 7-3) to fuel return line.
2. Install fuel line (1) to fuel lift pump.
3. Install two washers (7), clamps (6) and (5), two washers (4) and nuts (3, Figure 7-2).
4. Connect fuel lines (2) and (1, Figure 7-1) to elbows on top of fuel tank.
5. Install three plastic ties (8, Figure 7-2) and slide engine cover closed.

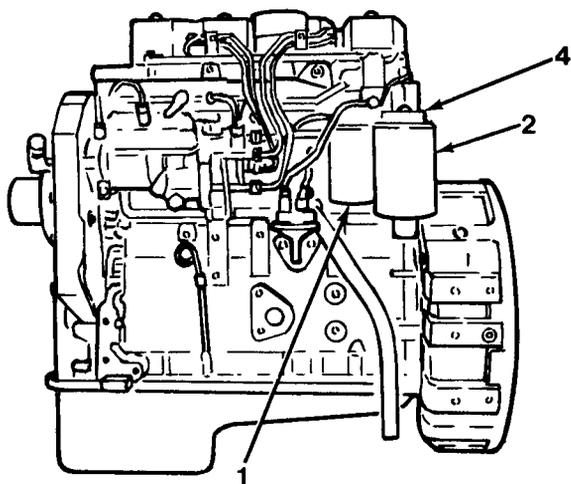


Figure 7-1

FUEL FILTERS AND HEAD ASSEMBLY

FUEL FILTERS AND HEAD ASSEMBLY REMOVAL

1. Disconnect fuel injection tubes (refer to page 7-35).
2. Using a strap wrench, remove secondary fuel filter (1) and primary fuel filter (2) from fuel filter head (4, Figure 7-1).
3. Using a 24 mm socket, remove hexagon nut (3), fuel filter head (4), O-ring seal (5) and rectangular seal (6, Figure 7-2).

FUEL FILTERS AND HEAD ASSEMBLY CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FUEL FILTERS AND HEAD ASSEMBLY INSTALLATION

1. Install rectangular seal (6), O-ring seal (5), fuel filter head (4) and hexagon nut (3, Figure 7-2) to engine. Torque hexagon nut (3) to 24 lb-ft (33 N•m).
2. Fill fuel filters with clean fuel and lubricate seal with clean oil. Install primary fuel filter (2) and secondary fuel filter (1) to fuel filter head (3, Figure 7-1).
3. Connect fuel injection tube (refer to page 7-37).

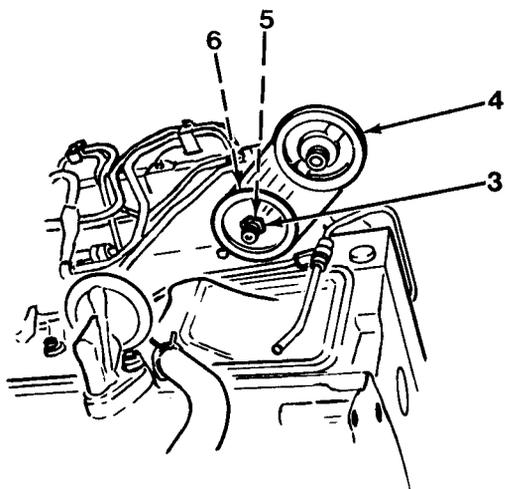


Figure 7-2

COLD START DEVICE

COLD START DEVICE REMOVAL

1. Remove cold start cylinder, if so equipped (refer to Koehring Commercial Operation Instructions manual).
2. Loosen screw (1, Figure 7-1) securing cable end.
3. Remove screw (2), clamp (3) and disconnect cable (4).
4. Disconnect tube (5) from elbow (6).
5. Remove elbow (6) from valve (9).
6. Remove two nuts (7), bracket (8), valve (9) and two capscrews (10) from bracket (11).
7. Remove tube (5) and fitting (12, Figure 7-2) from cylinder head.
8. Remove two nuts (13), capscrews (14) and bracket (11, Figure 7-3).
9. Remove two nuts (15), capscrews (16), bracket (17) and clamp (18).

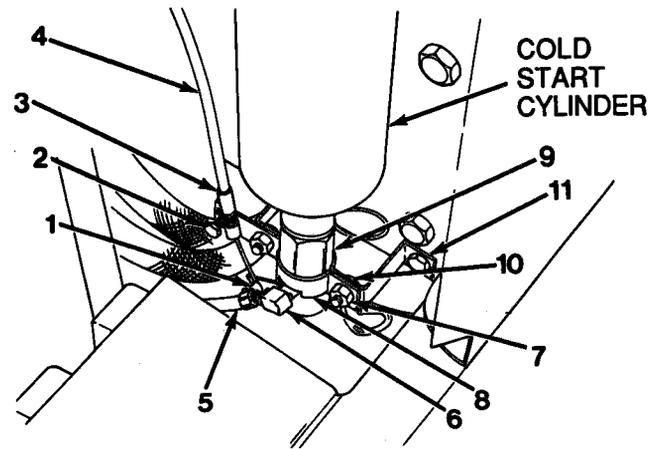


Figure 7-1

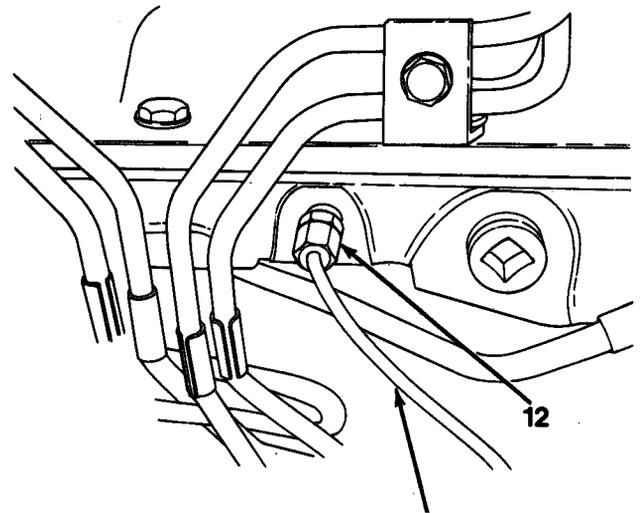


Figure 7-2

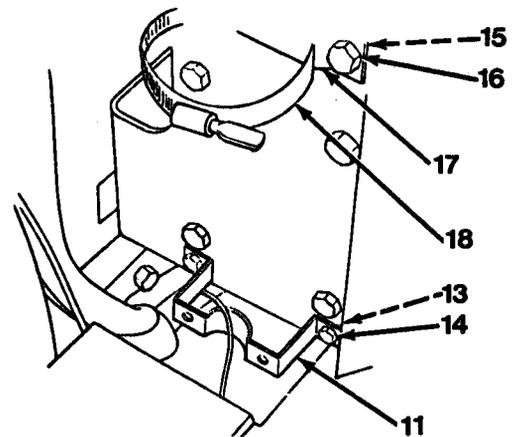


Figure 7-3

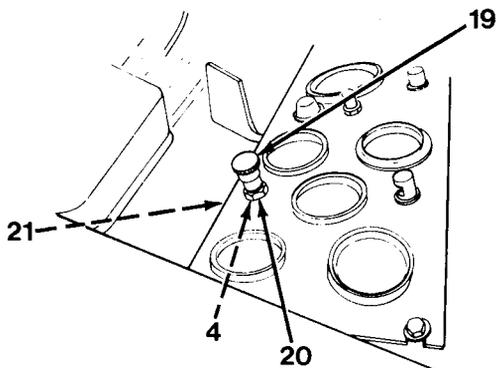


Figure 7-4

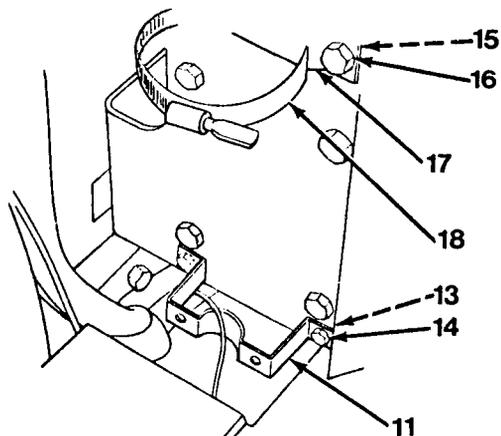


Figure 7-3

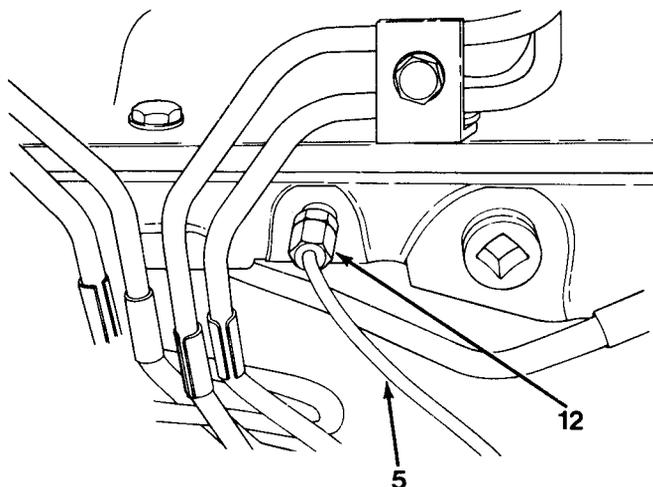


Figure 7-2

COLD START DEVICE REMOVAL

10. Remove knob (19), lock nut (20), nut (21) and cable (4, Figure 7-4).

COLD START DEVICE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

COLD START DEVICE INSTALLATION

1. Install cable (4, Figure 7-4) by positioning through opening on back wall of operator's compartment and through opening on instrument panel
2. Install nut (21), lock nut (20) and knob (19) to cable (4).
3. Install clamp (18), bracket (17), two cap screws (16) and nuts (15, Figure 7-3).
4. Install bracket (11), two capscrews (14) and nuts (13).

NOTE

Atomizer opening at end of fitting must point straight up when installed in cylinder head.

5. Install fitting (12) and tube (5, Figure 7-2) to cylinder head.

6. Install valve (9), bracket (8), two capscrews (10) and nuts (7) to bracket (11, Figure 7-1).

7. Install elbow (6) to valve (9).

8. Connect tube (5) to elbow (6).

NOTE

Cable knob inside cab must be down when connecting cable to valve.

9. Insert cable end into lever opening on valve (9).

10. Install clamp (3) and screw (2) to secure cable (4).

11. Position lever on valve (9) to up position until just before lever springs back.

12. Tighten screw (1) to secure cable end. Check to be sure valve lever can perform full operating stroke.

13. Install cold start cylinder, if so equipped (refer to Koehring Commercial Operation Instructions manual).

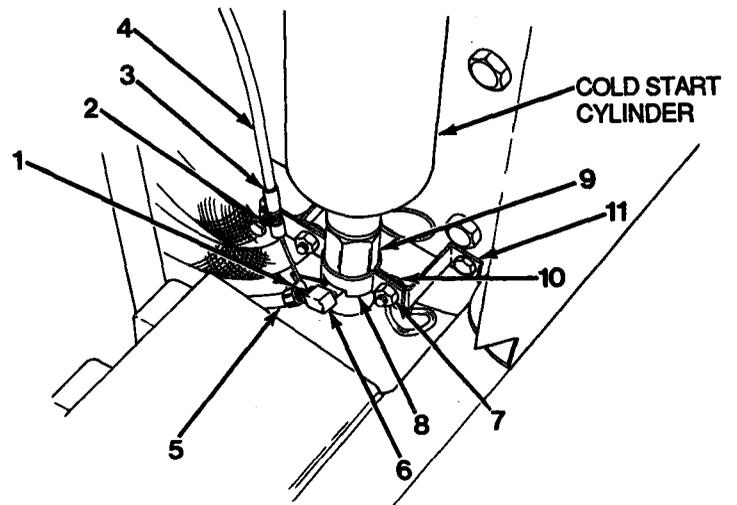


Figure 7-1

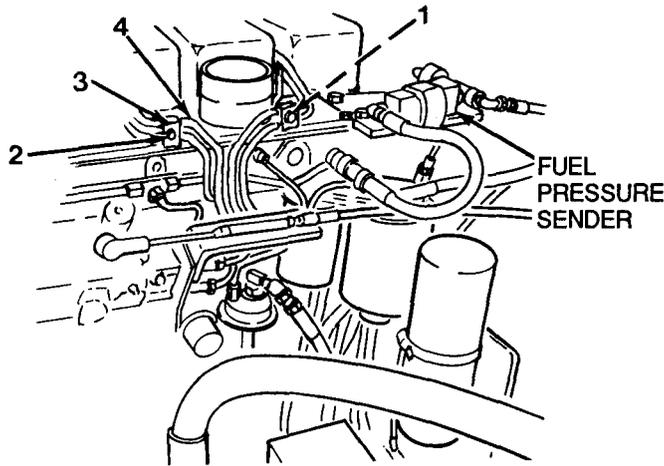


Figure 1-1

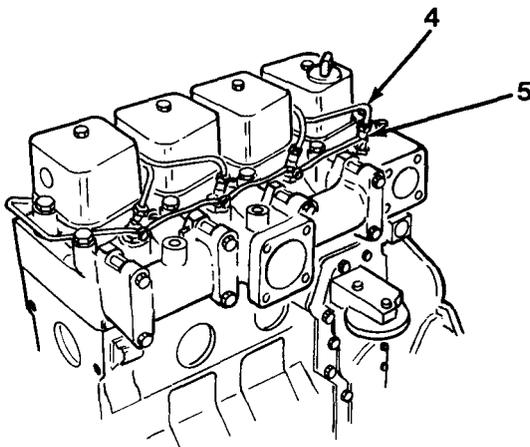


Figure 7-2

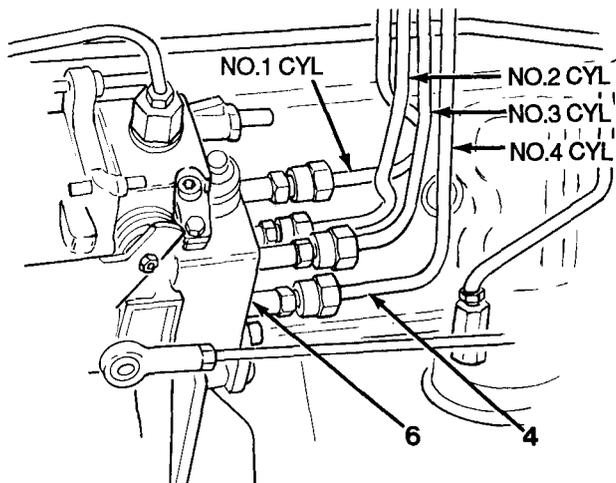


Figure 7-3

FUEL INJECTION TUBES

HIGH-PRESSURE TUBES REMOVAL

1. Disconnect injector throttle cable (refer to page 17-10).

NOTE

- Before removal of fuel injection tubes, have suitable container available.
- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Using a 13 mm wrench, remove two cap-screws (1) and (2) and tube braces (3) from manifold coverplate and high-pressure tubes (4, Figure 7-1).

NOTE

Mark on four tags, No. 1 cylinder thru No.4 cylinder, to aid in installation.

3. Using a 17 mm wrench, disconnect four high-pressure tubes (4) from injectors (5, Figure 7-2). Make sure marked tags match proper cylinders.

CAUTION

Use a 14 mm wrench on injection pump delivery valves when removing high-pressure tubes to prevent damage to injection pump delivery valves.

4. Remove No. 3 and No. 4 cylinder high-pressure tubes (4) from injection pump (6, Figure 7-3).
5. Remove No. 1 and No. 2 cylinder high-pressure tubes (4) from injection pump (6).

CAUTION

Make sure injection pump connection is held securely when loosening low-pressure tubes. Failure to follow this procedure could cause damage to equipment.

LOW-PRESSURE TUBES REMOVAL

NOTE

- Before removal of fuel injection tubes, have suitable container available.
- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Using 14 mm and 16 mm wrenches, loosen two nuts (12) and remove low-pressure tube (13) from injection pump (14) and tee fitting (15).
5. Using 14 mm and 19 mm wrenches, loosen nut (16) and remove low-pressure tube assembly (17) from injection pump (14).

1. Disconnect two fuel pressure sender hoses from banjo fittings (refer to page 7-39).
2. Using a 17 mm wrench, remove two banjo screws (7) and four copper seals (8, Figure 7-4) from filter head. Discard four copper seals (8).

CAUTION

Use a 17 mm wrench on lift pump connection while removing low-pressure tube to prevent damage to lift pump connection.

3. Using a 14 mm wrench, loosen nut (9) and remove low-pressure tube (10) from lift pump (11).

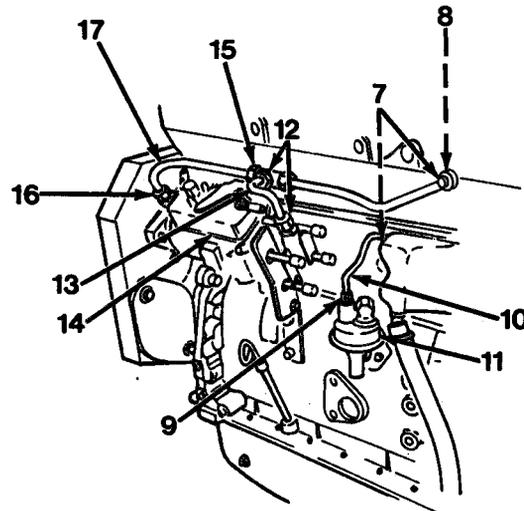


Figure 7-4

FUEL DRAIN TUBES REMOVAL

NOTE

- Before removal of fuel injection tubes, have suitable container available.
- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

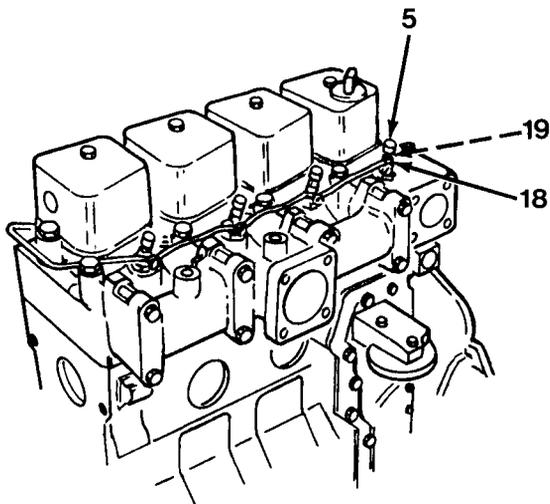


Figure 7-5

1. Using a 10 mm wrench, remove four banjo connector screws (18) and banjo connector seals (19) from injectors (5, Figure 7-5). Discard four banjo connector seals (19).
2. Using a 13 mm wrench, remove fuel manifold tube (20) from male union tee (21, Figure 7-6).
3. Using a 10 mm wrench, remove two cap-screws (22) and fuel drain tube (23) from engine and injection pump (14).

FUEL INJECTION TUBES CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2),
2. Inspect all parts (refer to Chapter 4).

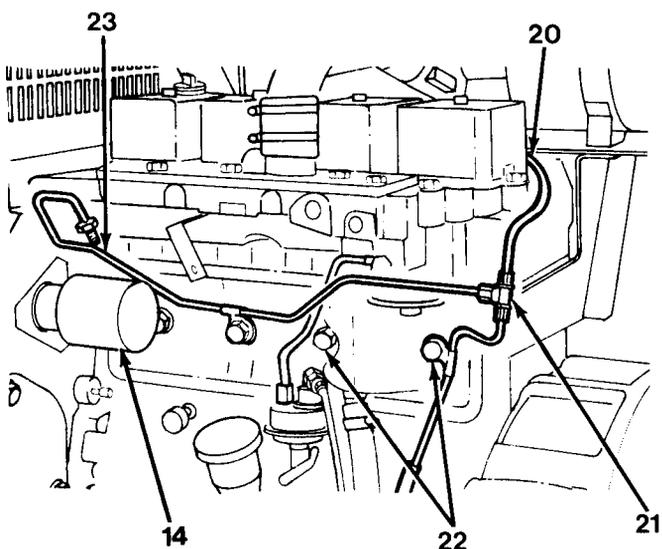


Figure 7-6

FUEL DRAIN TUBES INSTALLATION

1. Install fuel drain tube (23) and two capscrews (22) to engine and injection pump (14, Figure 7-6). Torque two capscrews (22) to 18 lb-ft (24 N•m).
2. Install fuel manifold tube (20) to male union tee (21).
3. Install four new banjo connector seals (19) and banjo connector screws (18) to injectors (5, Figure 7-5). Torque four banjo connector screws (18) to 6.5 lb-ft (8.8 N•m).

4. Install four new copper seals (8) and two capscrews (7) to filter head. Torque two capscrews (7) to 18 lb-ft (24 N•m).

LOW PRESSURE TUBES INSTALLATION

CAUTION

Make sure injection pump connection is held securely when tightening low-pressure tubes. Failure to follow this procedure could cause damage to equipment.

1. Install low-pressure tube assembly (17) to injection pump (14) and tighten nut (16, Figure 7-4).
2. Install low-pressure tube (13) to injection pump (14) and tee fitting (15) and tighten two nuts (12).

CAUTION

Make sure lift pump connection is held securely when tightening low-pressure tubes. Failure to follow this procedure could cause damage to equipment

3. Install low-pressure tube (10) to lift pump (11) and tighten nut (9).

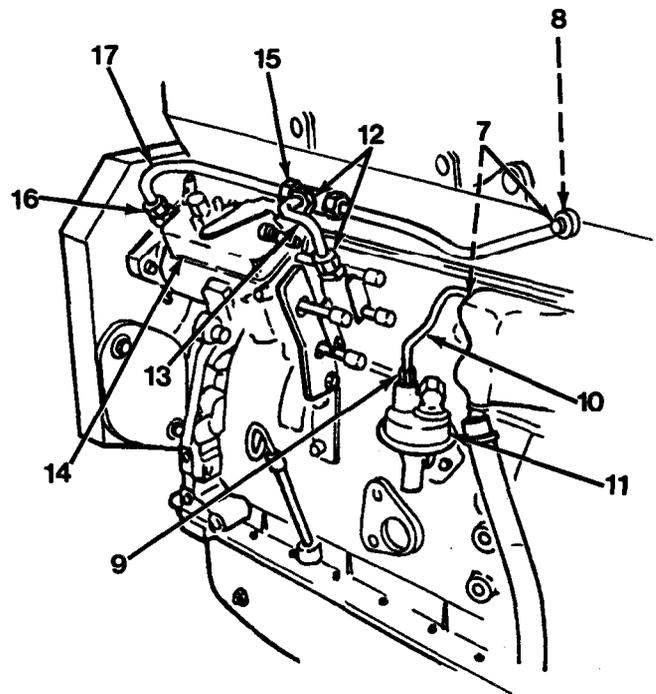


Figure 7-4

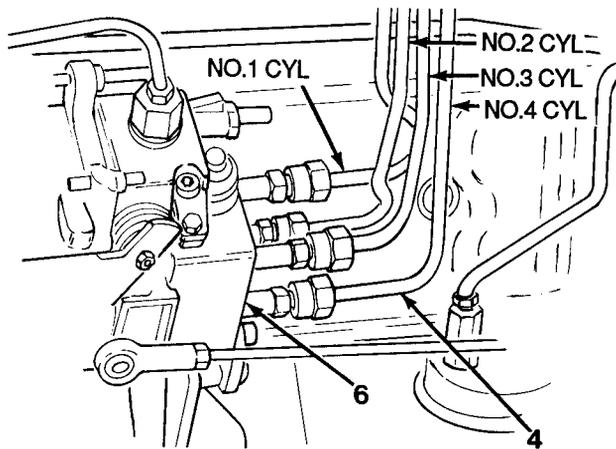


Figure 7-3

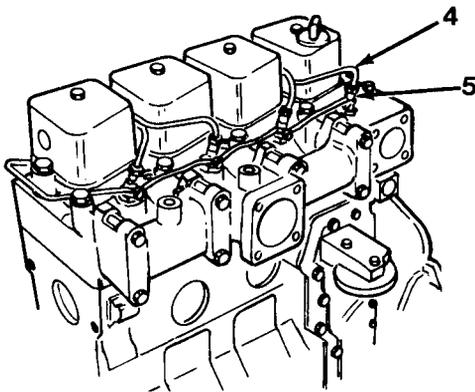


Figure 7-2

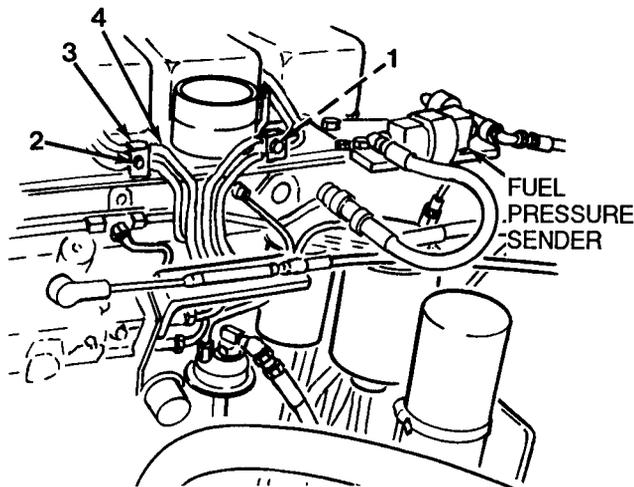


Figure 7-1

LOW-PRESSURE TUBES INSTALLATION

5. Connect two fuel pressure sender hoses to banjo fittings (refer to page 7-40).

HIGH-PRESSURE TUBES INSTALLATION

CAUTION

Make sure injection pump connections are held securely when tightening high-pressure tubes. Failure to follow this procedure could cause damage to equipment.

NOTE

Make sure high pressure lines are correct for engine. Check part number tag on tubes.

1. Install No. 2 and No. 1 cylinder high-pressure tubes (4) to injection pump (6, Figure 7-3).
2. Install No. 4 and No. 3 cylinder high-pressure tubes (4) to injection pump (6).
3. Connect four high-pressure tubes (4) to injectors (5, Figure 7-2).
4. Install two brackets (3), capscrews (2) and (1) to high-pressure tubes (4, Figure 7-1) and manifold coverplate. Torque two capscrews (1) to 18 lb-ft (24 N•m).
5. Connect throttle cable (refer to page 17-12).

**FUEL PRESSURE SWITCH AND
TRANSDUCER**

**FUEL PRESSURE SWITCH AND
TRANSDUCER REMOVAL**



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid installation. Remove tags following maintenance.

2. Disconnect pressure switch (1) wire and transducer (2, Figure 7-1) wire.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

3. Remove two hoses (3).

4. Remove straight adapter (4).

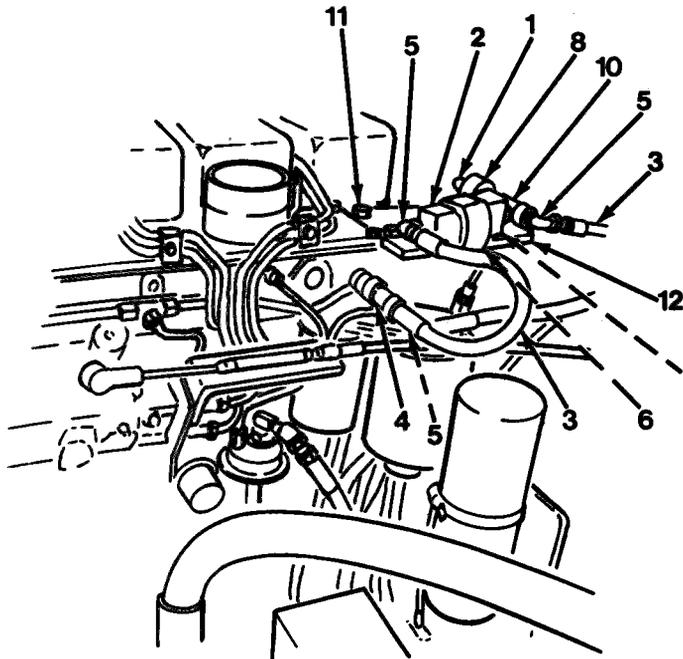


Figure 7-1

**FUEL PRESSURE SWITCH AND
TRANSDUCER REMOVAL**

5. Remove three elbow adapters (5, Figure 7-1).
6. Remove two nuts (6), capscrews (7), clamps (8) and (9) and transducer (2).
7. Remove pressure switch (1) from tee (10).
8. Remove tee (10) from transducer (2).
9. Remove two capscrews (11) and plate (12).

**FUEL PRESSURE SWITCH AND
TRANSDUCER CLEANING/inspection**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**FUEL PRESSURE SWITCH AND
TRANSDUCER INSTALLATION**

1. Install plate (12) and two capscrews (11, Figure 7-1).
2. Install tee (10) to transducer (2).
3. Install pressure switch (1) to tee (10).
4. Install clamps (9) and (8), two capscrews (7) and nuts (6).
5. Install three elbow adapters (5).
6. Install straight adapter (4).
7. Install two hoses (3).
8. Connect pressure switch (1) and transducer (2) wires.
9. Connect battery negative ground cable.

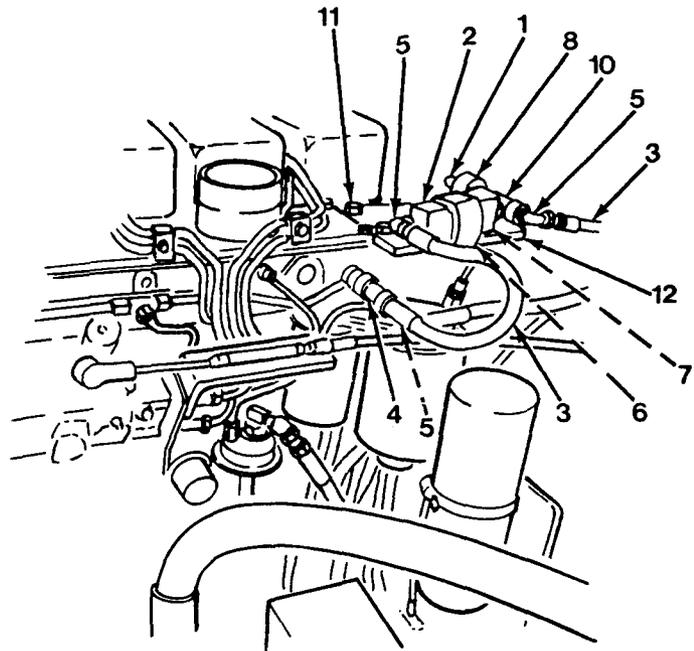


Figure 7-1

TM5-3810-305-24

CHAPTER 8
EXHAUST SYSTEM

Title	Page
Exhaust Manifold	8-1
Exhaust System	8-2

EXHAUST MANIFOLD

EXHAUST MANIFOLD REMOVAL

1. Disconnect exhaust pipe (refer to page 8-2).
2. Using a 13 mm socket, remove eight cap-screws (1), manifold (2) and four gaskets (3, Figure 8-1). Remove all gasket material from mounting surfaces.

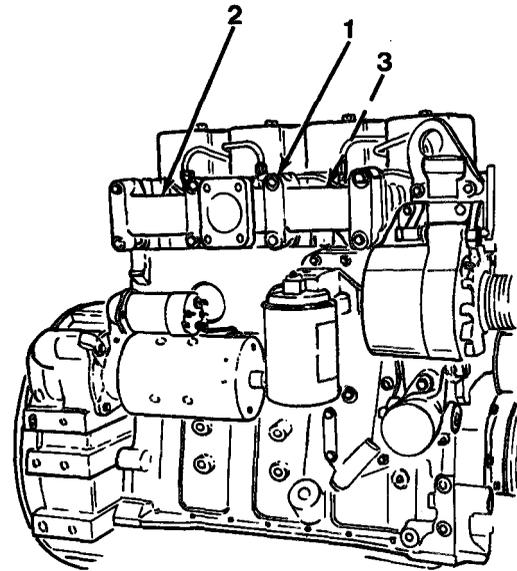


Figure 8-1

EXHAUST MANIFOLD CLEANING/
INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

EXHAUST MANIFOLD INSTALLATION

1. Install four gaskets (3), manifold (2) and eight cap-screws (1, Figure 8-1) to block.
2. Torque eight capscrews (1, Figure 8-2) to 32 lb-ft (43 N•m) in sequence shown.
3. Install exhaust pipe (refer to page 8-3).

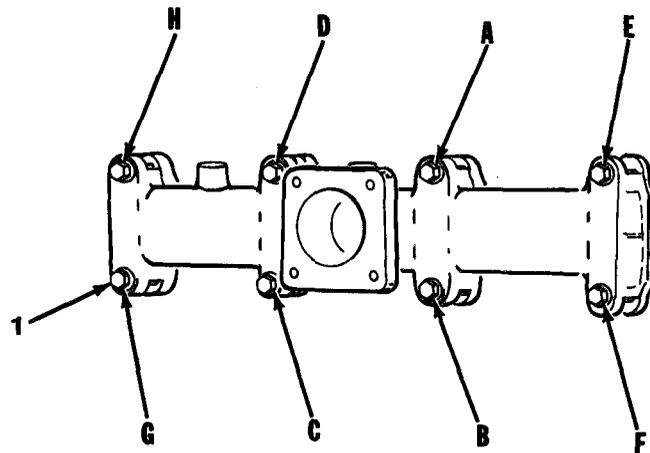


Figure 8-2

EXHAUST SYSTEM

EXHAUST SYSTEM REMOVAL

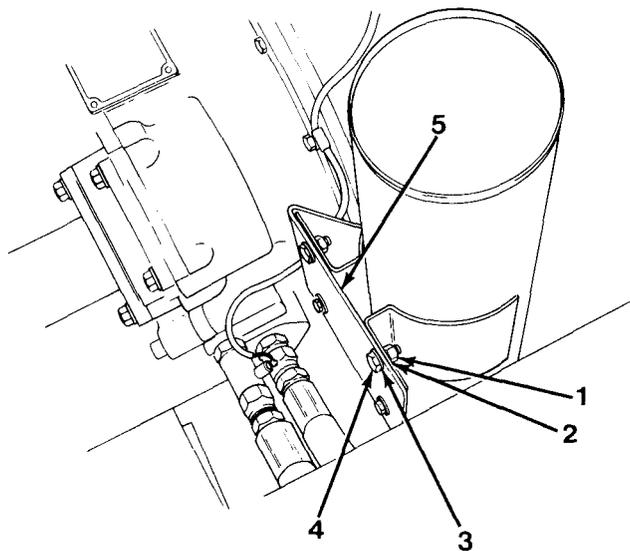


Figure 8-1

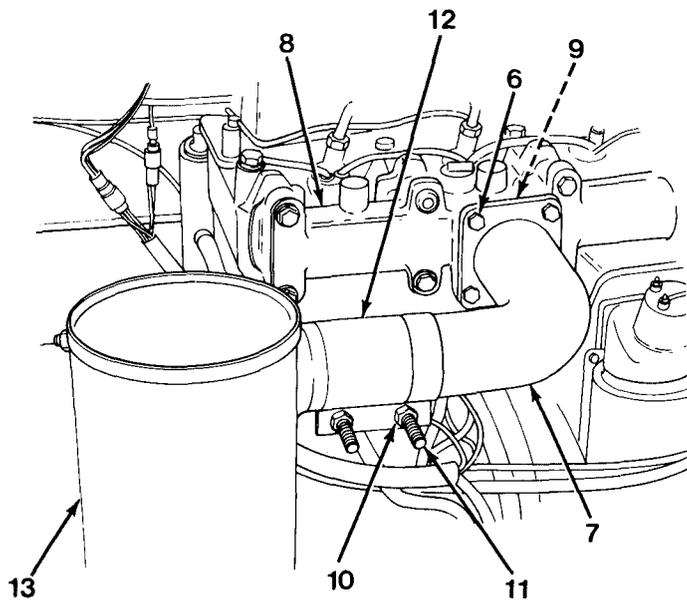


Figure 8-2

1. Remove engine hood support (refer to page 14-25).
2. Remove four nuts (1), lockwashers (2), washers (3) and capscrews (4) from bracket (5, Figure 8-1).
3. Remove four capscrews (6) securing exhaust tube (7) to exhaust manifold (8, Figure 8-2).
4. Remove gasket (9). Remove all gasket material from mounting surfaces.
5. Remove complete exhaust system from vehicle.
6. Remove two nuts (10), capscrews (11) and clamp (12) from muffler (13) and exhaust tube (7).
7. Remove two nuts (14), washers (15), clamp (16) and exhaust tube (17) from end of muffler (13, Figure 8-3).

- Remove two capscrews (18), washers (19) and bracket (5) from side of flywheel housing (20, Figure 8-4).

EXHAUST SYSTEM CLEANING/ INSPECTION

- Clean all parts (refer to Chapter 2).
- Inspect all parts (refer to Chapter 4).

EXHAUST SYSTEM INSTALLATION

- Install bracket (5) to side of flywheel housing (20) with two washers (19) and capscrews (18, Figure 8-4).
- Install exhaust tube (17) to end of muffler (13) with clamp (16), two washers (15) and nuts (14, Figure 8-3). Do not tighten at this time.
- Install exhaust tube (7) to muffler (13) with clamp (12), two capscrews (11) and nuts (10, Figure 8-2).
- Position complete exhaust system in vehicle. Tighten two nuts (14, Figure 8-3).
- Install gasket (9) between exhaust manifold (8) and exhaust tube (7). Secure with four capscrews (6, Figure 8-2). Torque capscrews (6) to 32 lb-ft (43 N•m).

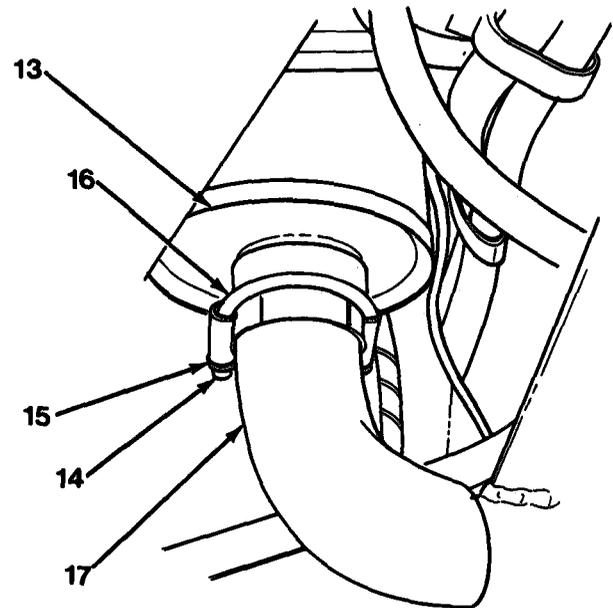


Figure 8-3

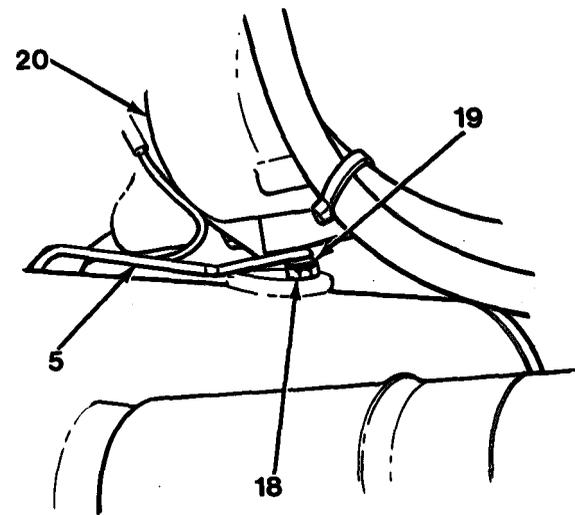


Figure 8-4

EXHAUST SYSTEM INSTALLATION

6. Install four capscrews (4), washers (3), lock-washers (2) and nuts (1) to bracket (5, Figure 8-1).
7. Install engine hood support (refer to page 14-25).

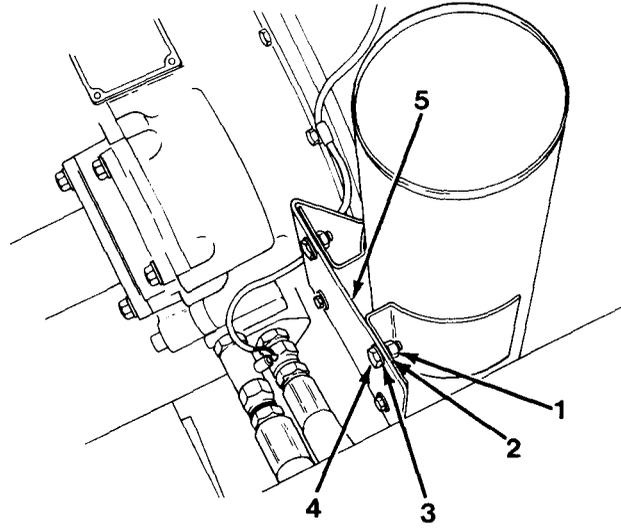


Figure 8-1

TM5-3810-305-24

CHAPTER 9

COOLING SYSTEM

Title	Page
Thermostat	9-1
Water Pump	9-3
Water Inlet Connection	9-4
Radiator and Oil Cooler	9-5

THERMOSTAT

THERMOSTAT REMOVAL

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

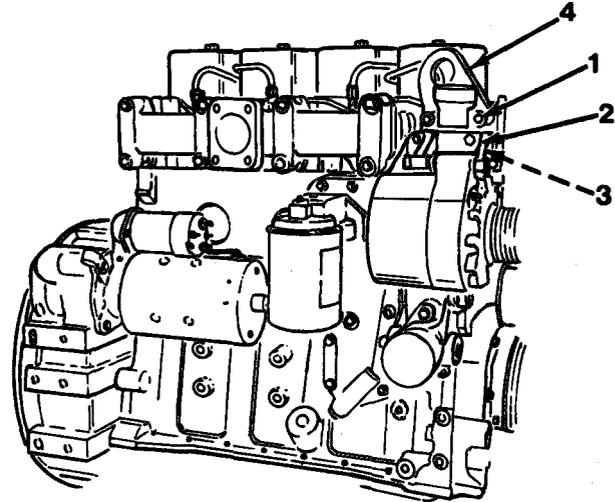


Figure 9-1

1. Disconnect battery negative ground cable.
2. Drain coolant (refer to page 3-58).
3. Remove drive belt (refer to page 6-12).
4. Remove alternator (refer to page 10-1).
5. Remove radiator hose (refer to page 9-7, step 6).
6. Using a 10 mm socket, remove three cap-screws (1), thermostat housing (2), gasket (3) and lifting bracket (4, Figure 9-1).
7. Remove thermostat (5) from thermostat housing (2, Figure 9-2).

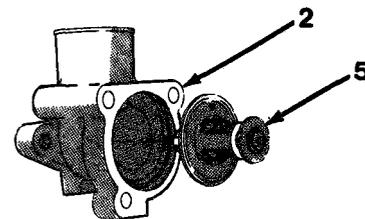


Figure 9-2

THERMOSTAT CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Make sure vent notch is open and free from corrosion.

THERMOSTAT CLEANING/INSPECTION

⚠ WARNING

Water is hot. Do not place hands in container. Failure to follow this procedure could cause **SERIOUS INJURY**.

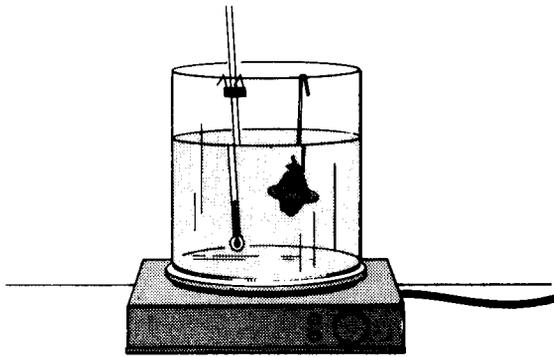


Figure 9-3

- Heat thermostat in hot water to check for correct operation. Thermostat should start to open at 181 degrees F (83 degrees C) and fully open at 203 degrees F (95 degrees C) (Figure 9-3).

- Inspect all other parts (refer to Chapter 4).

THERMOSTAT INSTALLATION

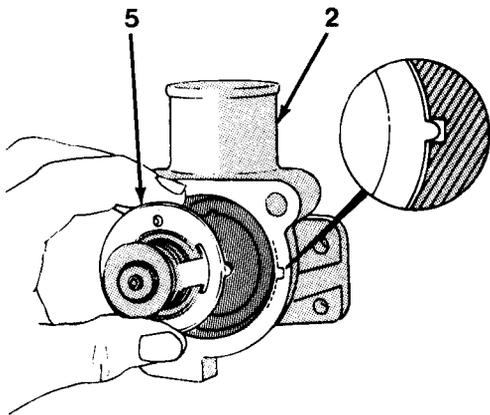


Figure 9-4

- Install thermostat (5) in thermostat housing (2, Figure 9-4) aligning tang up with notch.
- Install lifting bracket (4), gasket (3), thermostat housing (2) and three capscrews (1, Figure 9-1). Torque three capscrews (1) to 18 lb-ft (24 N•m).

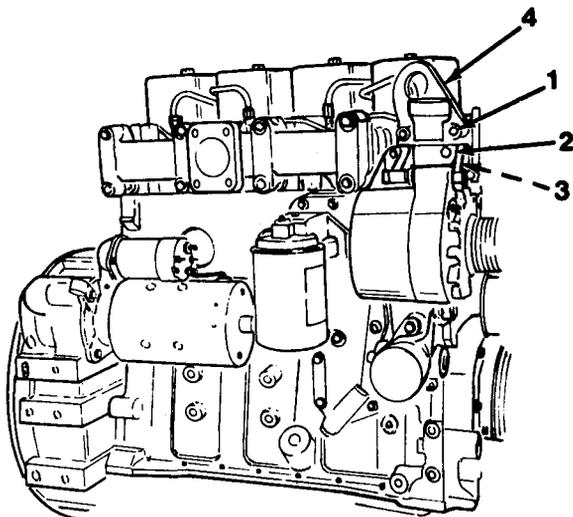


Figure 9-1

- Install alternator (refer to page 10-1).
- Install drive belt (refer to page 6-15).
- Install radiator hose (refer to page 9-12, step 9).
- Fill with coolant (refer to page 3-58).
- Connect battery negative ground cable.

WATER PUMP

WATER PUMP REMOVAL

1. Remove drive belt (refer to page 6-12).
2. Using a 13 mm socket, remove two capscrews (1) and water pump (2, Figure 9-1) from engine.
3. Remove O-ring (3) from groove on inside of water pump (2) housing.

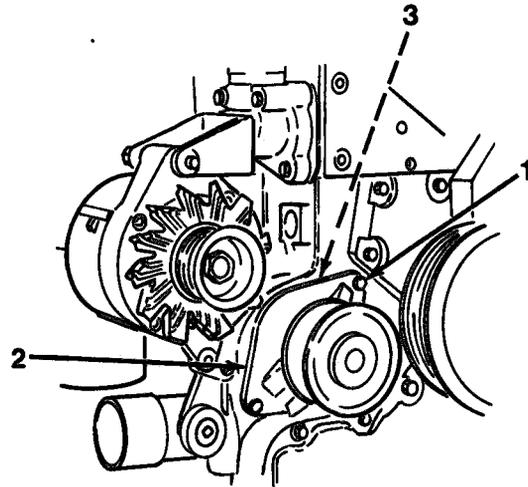


Figure 9-1

WATER PUMP CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect impeller blades for wear or corrosion.
3. Inspect for free rotation of water pump (2, Figure 9-2).
4. Check weep hole (4, Figure 9-3) for evidence of a leaky seal. If seal is bad, replace water pump (2).
5. Inspect all other parts (refer to Chapter 4).

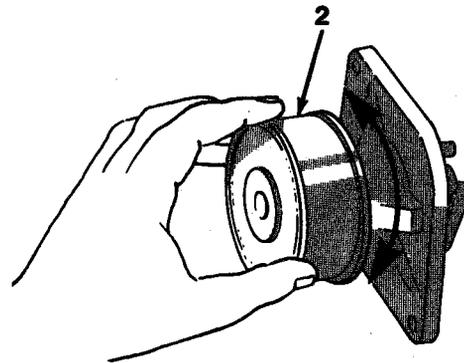


Figure 9-2

WATER PUMP INSTALLATION

1. Install O-ring (3) in groove on water pump (2, Figure 9-1) housing.
2. Install water pump (2) and two capscrews (1) on engine. Torque two capscrews (1) to 18 lb-ft (24 N•m).
3. Install drive belt (refer to page 6-15).

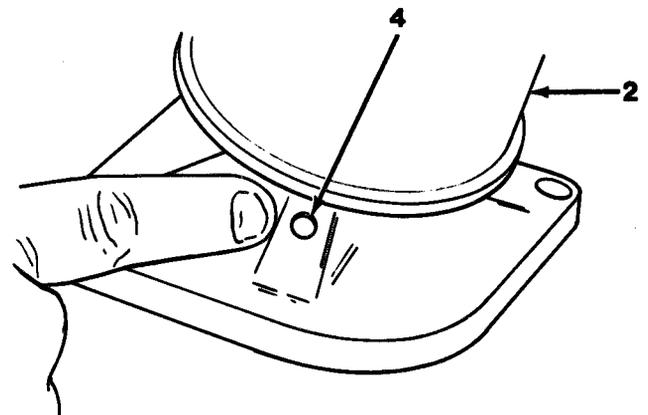


Figure 9-3

WATER INLET CONNECTION

NOTE

WATER INLET CONNECTION REMOVAL



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

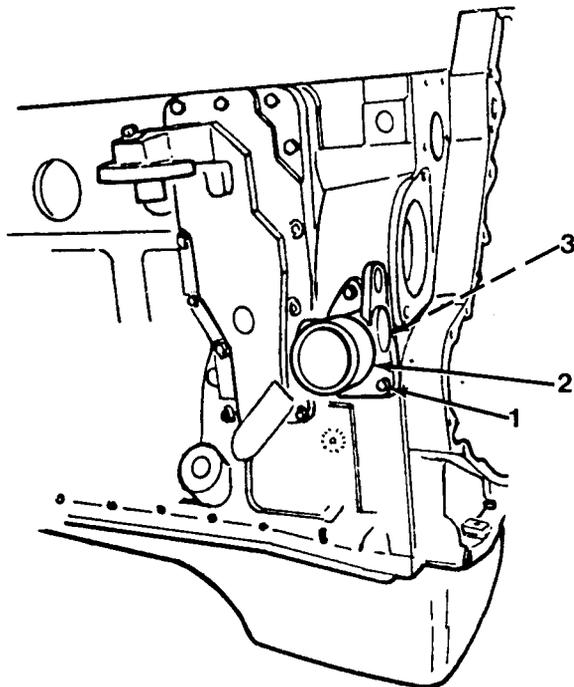


Figure 9-1

1. Disconnect battery negative ground cable.
2. Drain coolant (refer to page 3-58).
3. Remove drive belt (refer to page 6-12).
4. Remove alternator (refer to page 10-1).
5. Remove hoses (refer to page 9-7).
3. Using a 15 mm socket, remove three cap-screws (1), water inlet connection (2) and O-ring (3, Figure 9-1).

WATER INLET CONNECTION CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

WATER INLET CONNECTION INSTALLATION

1. Install O-ring (3), water inlet connection (2) and three capscrews (1, Figure 9-1).
2. Install alternator (refer to page 10-1).
3. Install drive belt (refer to page 6-15).
4. Install hoses (refer to page 9- 12).
5. Fill with coolant (refer to page 3-58).
6. Connect battery negative ground cable.

RADIATOR AND OIL COOLER

RADIATOR AND OIL COOLER REMOVAL

1. Remove engine sliding hood from crane (refer to page 14-22).
2. Rotate upperstructure 90 degrees out of way.

⚠ WARNING

Cooling system is pressurized. Use extreme caution and proper protection when removing radiator cap after operating temperature is reached. Steam and hot gases will be escaping through the radiator cap; avoid being burned by these escaping gases. When removing cap, loosen it slowly to the left, then pause a moment. Continue to turn cap until it can be removed. Failure to follow this procedure could cause **SERIOUS INJURY**.

3. Remove radiator cap (1) and open drain valve (2, Figure 9-1). Drain coolant into a container large enough to hold 28 qt (26.50 L).

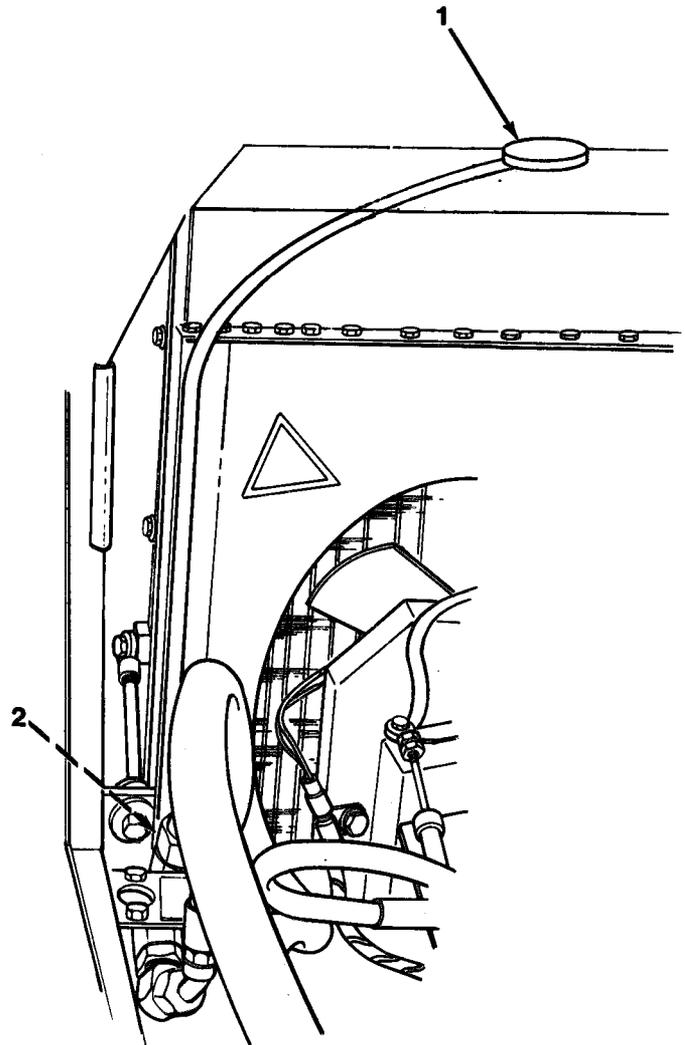


Figure 9-1

RADIATOR AND OIL COOLER REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

4. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

5. Disconnect and cap hydraulic cooling hose (3, Figure 9-2) and hydraulic cooling hose (4) on front of oil cooler (5, Figure 9-3).

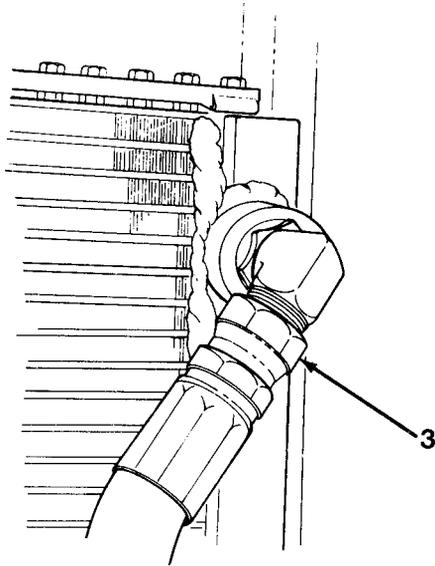


Figure 9-2

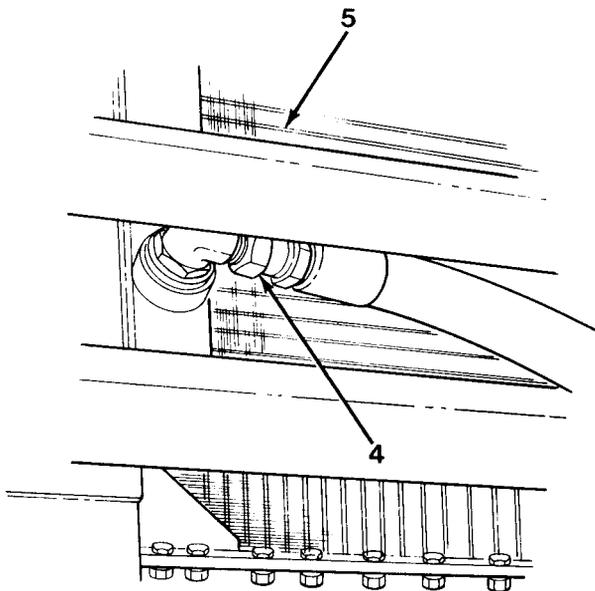


Figure 9-3

6. Remove two clamps (6), upper hose (7, Figure 9-4), two clamps (8) and lower hose (9, Figure 9-5) from radiator and engine.
7. Remove overflow hose (10) from clips on shroud (11, Figure 9-6).
8. Remove eight capscrews (12), lockwashers (13) and washers (14) from shroud (11). Remove and support shroud (11) on engine.

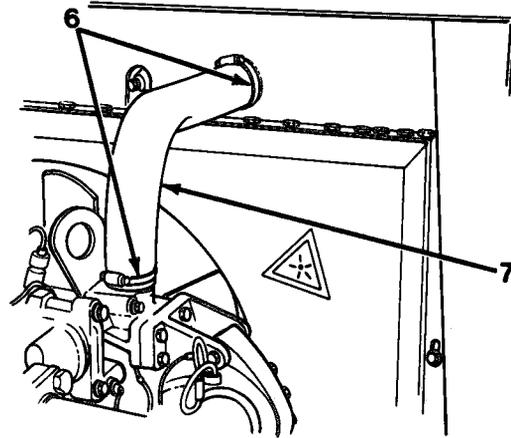


Figure 9-4

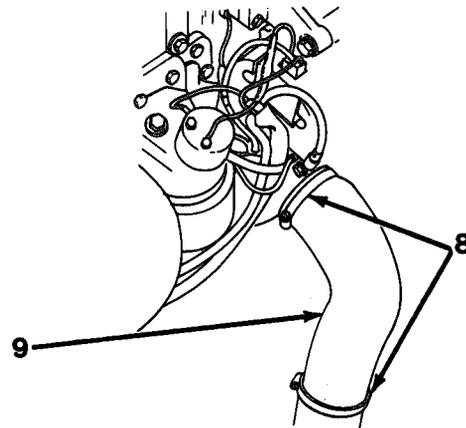


Figure 9-5

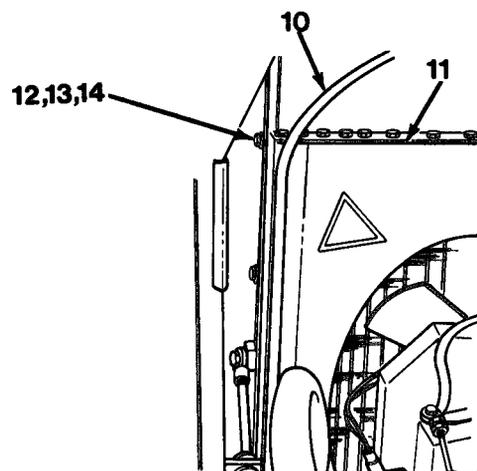


Figure 9-6

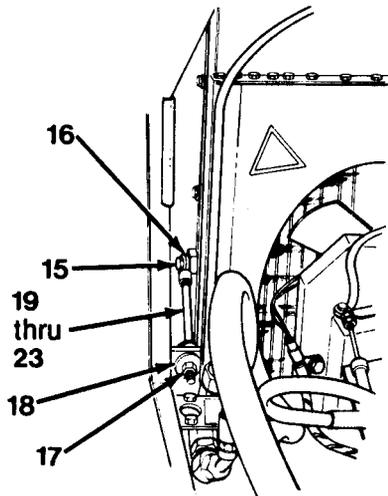


Figure 9-7

RADIATOR AND OIL COOLER REMOVAL

9. Remove two capscrews (15) that attach rod ends (16, Figure 9-7) on each side of radiator.
10. Remove two nuts (17), spacers (18) and rod assembly (19 thru 23).
11. Remove two mounts (19), retainers (20), nuts (21), studs (22) and nuts (23) from rod ends (16, Figure 9-8).
12. Remove two nuts (24) and spacers (25, Figure 9-9) from studs on bottom of radiator under frame.

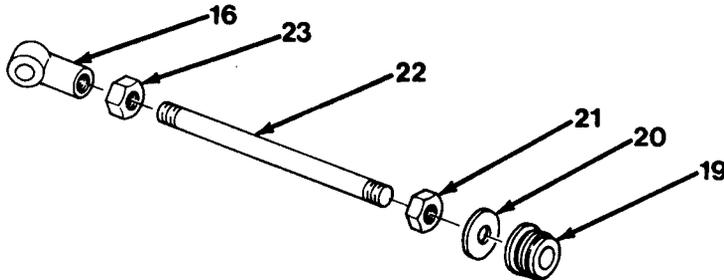


Figure 9-8

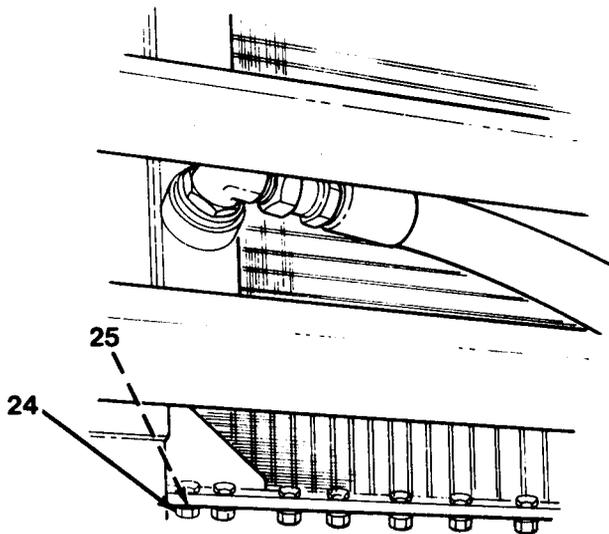


Figure 9-9

⚠ WARNING

Weight of radiator and oil cooler assembly is approximately 300 lb (136 kg). Use adequate lifting equipment to lift and support radiator and oil cooler. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

13. Install two capscrews (15) in radiator and oil cooler assembly (26, Figure 9-10). Attach suitable sling to two capscrews (15) and using hoist, carefully lift forward and up away from crane.
14. Remove shroud (11) and two mounts (27, Figure 9-11) from engine and frame.

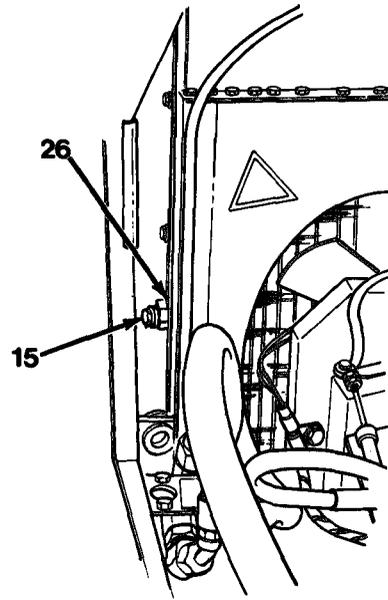


Figure 9-10

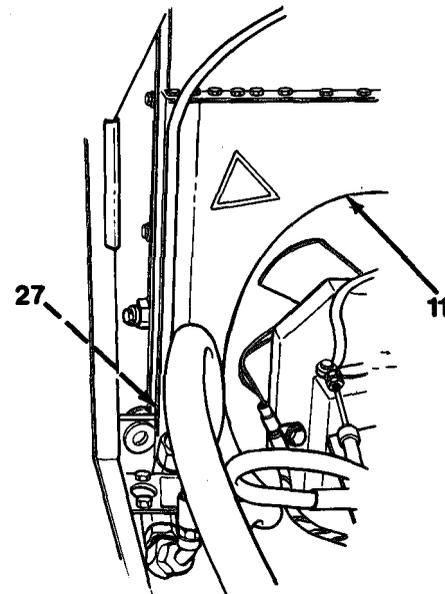


Figure 9-11

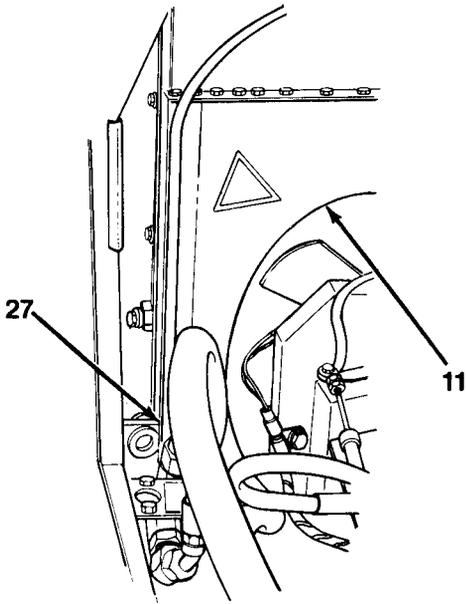


Figure 9-11

RADIATOR AND OIL COOLER INSTALLATION

1. Support shroud (11) on engine and install two mounts (27, Figure 9-11) to frame.

⚠ WARNING

Weight of radiator and oil cooler assembly is approximately 300 lb (136 kg). Use adequate lifting equipment to lift and support radiator and oil cooler. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Install two capscrews (15) into radiator and oil cooler assembly (26, Figure 9-10). Using suitable hoist and sling on two capscrews (15), carefully position radiator and cooler assembly in frame.

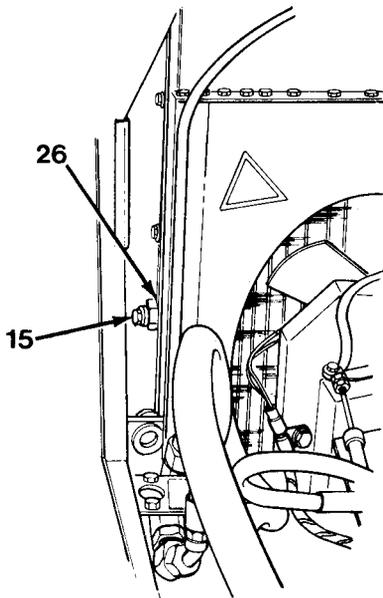


Figure 9-10

3. Install two spacers (25) and nuts (24, Figure 9-9) to studs on bottom of radiator. Remove sling and two capscrews (15) from radiator and oil cook assembly (26, Figure 9-10).
4. Install two nuts (21), retainers (20) and mounts (19) on one end of studs (22), and nuts (23) and rod ends (16, Figure 9-8) on other end of studs (22).
5. Install rod assembly (19 thru 23) and secure with two spacers (18) and nuts (17, Figure 9-7).
6. Scam two rod ends (16) to radiator with cap screws (15).
7. Install shroud (11), eight washers (14), lock-washers (13) and capscrews (12) to radiator. Secure overflow hose (10, Figure 9-6) in clips on shroud (11).

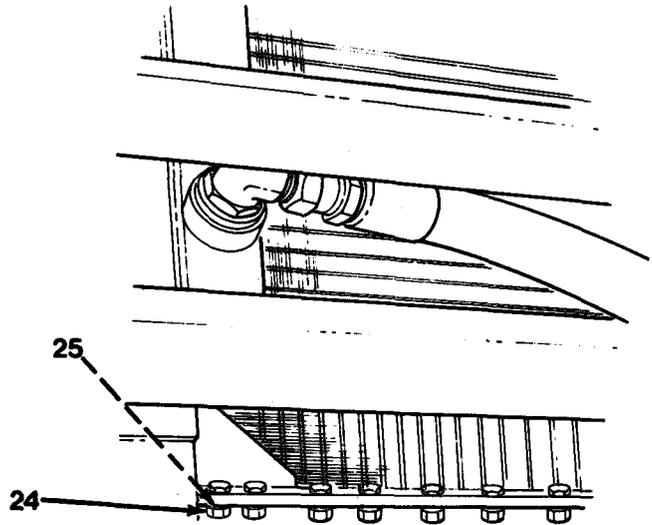


Figure 9-9

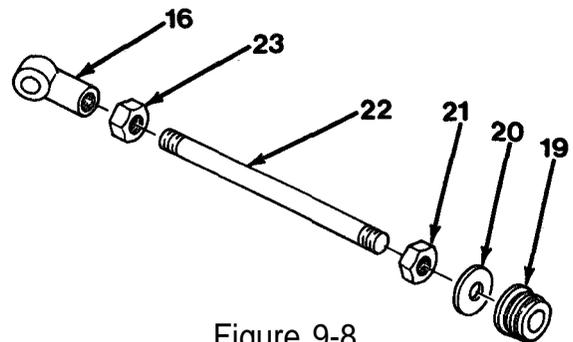


Figure 9-8

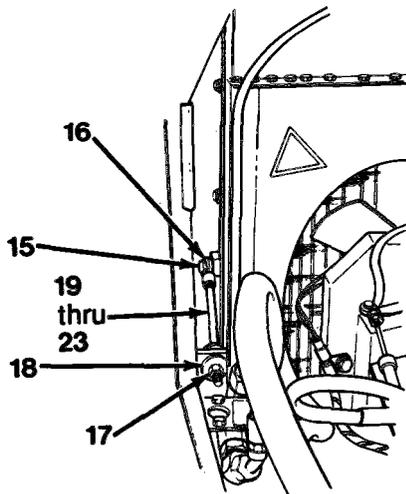


Figure 9-7

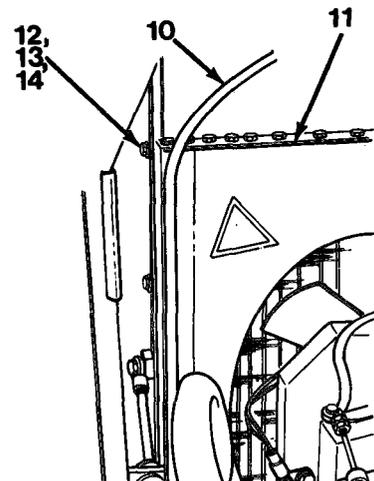


Figure 9-6

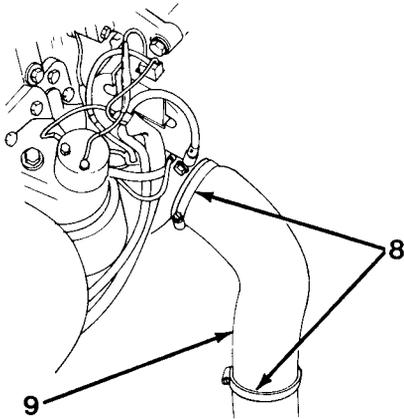


Figure 9-5

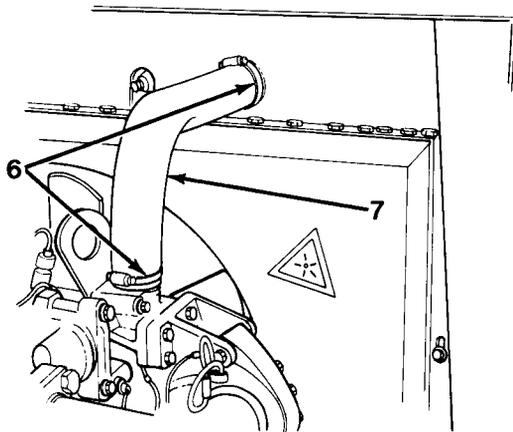


Figure 9-4

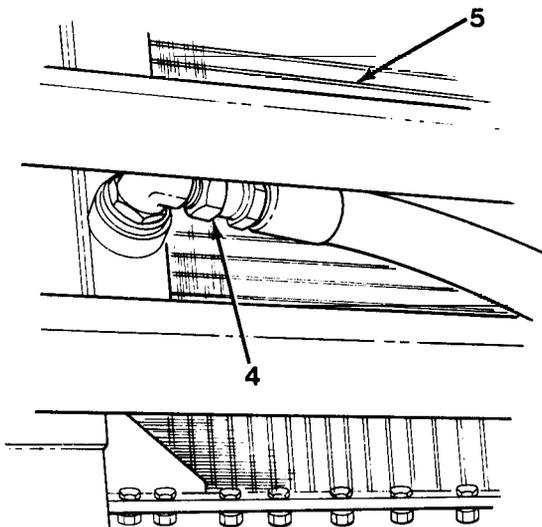


Figure 9-3

RADIATOR AND OIL COOLER INSTALLATION

8. Install lower hose (9) and secure with two clamps (8, Figure 9-5).
9. Install upper hose (7) and secure with two clamps (6, Figure 9-4).
10. Connect hydraulic cooling hose (4, Figure 9-3) and hydraulic cooling hose (3, Figure 9-2) to front of oil cooler (5, Figure 9-3).
11. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
12. Close dipstick cap.

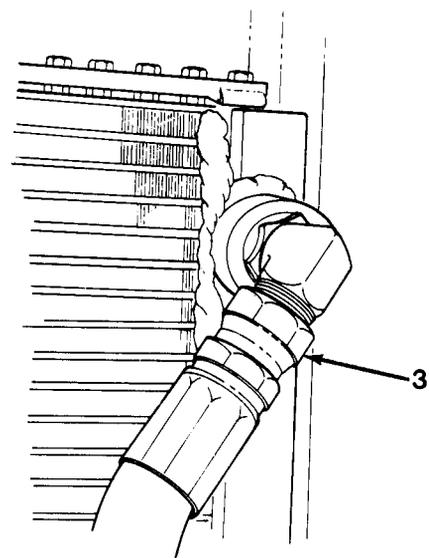


Figure 9-2

13. Make sure drain valve (2) is closed. Fill radiator with recommended antifreeze solution to proper level and install cap (1, Figure 9-1).
14. Start engine. Check for leaks and recheck fluid levels.
15. Install engine sliding hood (refer to page 14-23).

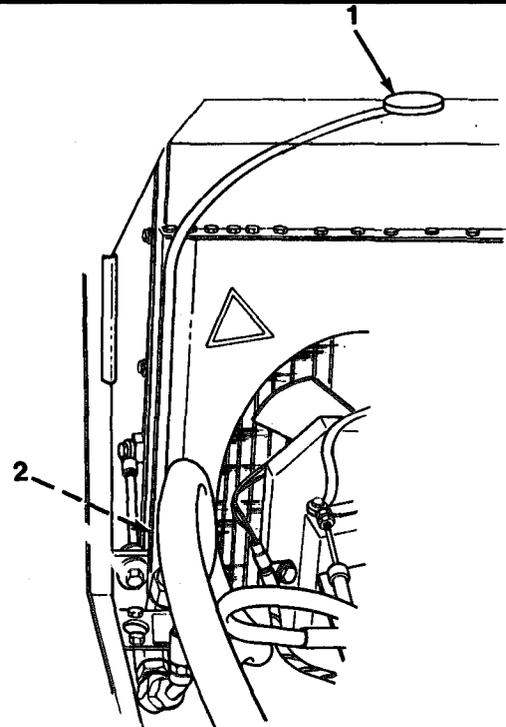


Figure 9-1

RADIATOR AND OIL COOLER DISASSEMBLY

1. Position radiator on suitable work surface and remove two capscrews (15), drain valve (2), eight capscrews (28), washers (29), brackets (30) and (31) and oil cooler (32, Figure 9-12) from radiator.
2. Remove plug (33) and overflow tube (10), if necessary, for repair of radiator.

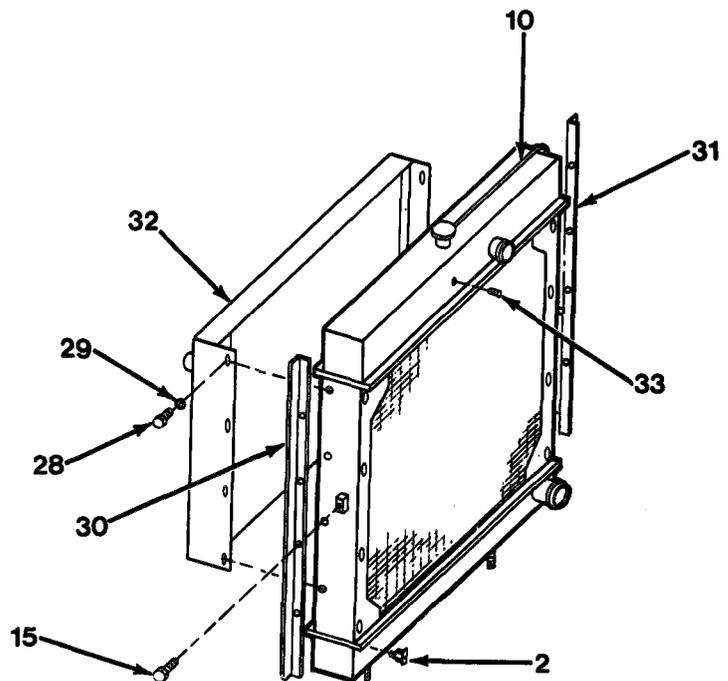


Figure 9-12

RADIATOR AND OIL COOLER CLEANING/INSPECTION

⚠ WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

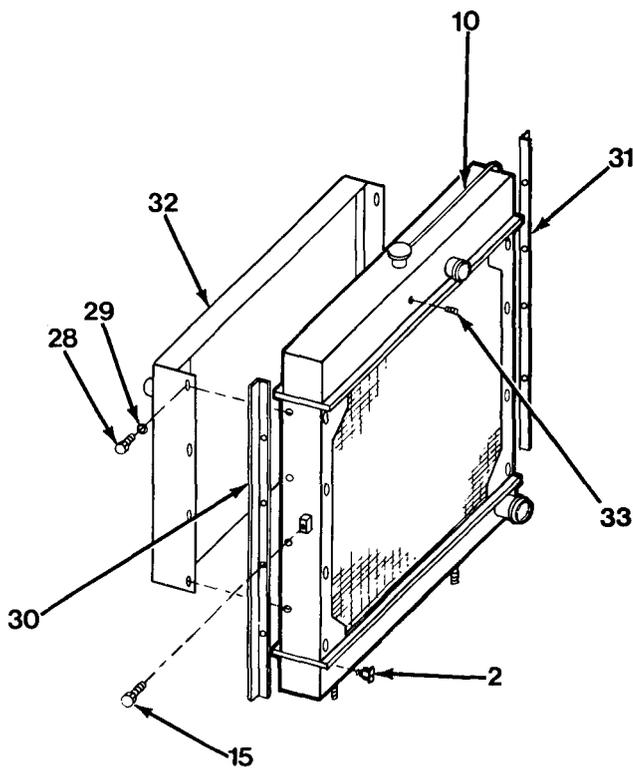


Figure 9-12

1. Clean radiator interior and exterior with water and dry with compressed air.
2. Cap oil cooler ports to prevent contamination. Clean exterior with water and dry with compressed air.
3. Clean all other parts (refer to Chapter 2).
4. Inspect hoses for deterioration.
5. Inspect radiator for leaks in seams and tubes.
6. Inspect all other parts (refer to Chapter 4).

RADIATOR AND OIL COOLER ASSEMBLY

1. If removed, install overflow tube (10) and plug (33, Figure 9-12).
2. Install oil cooler (32), brackets (31) and (30), eight washers (29), capscrews (28), drain valve (2) and two capscrews (15) to radiator.

CHAPTER 10
ELECTRICAL SYSTEM

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ALTERNATOR

ALTERNATOR REMOVAL

1. Release tension and remove belt (refer to page 6-12).

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid installation. Remove tags following maintenance.

2. Disconnect battery negative ground cable.
3. Disconnect wires (1) from alternator (5, Figure 10-1).
4. Using a 13 mm open-end wrench, remove two capscrews (2) and brace (3) from lower end of alternator (5).
5. Using a 17 mm open-end wrench, remove mounting capscrew (4), alternator (5) and spacer (6, Figure 10-2).
6. Using a 13 mm open-end wrench, remove three capscrews (7) and support (8).

ALTERNATOR INSTALLATION

1. Install support (8) and three capscrews (7, Figure 10-2) on thermostat housing.
2. Install spacer (6), alternator (5) and mounting capscrew (4). Do not tighten capscrew (4) at this time.

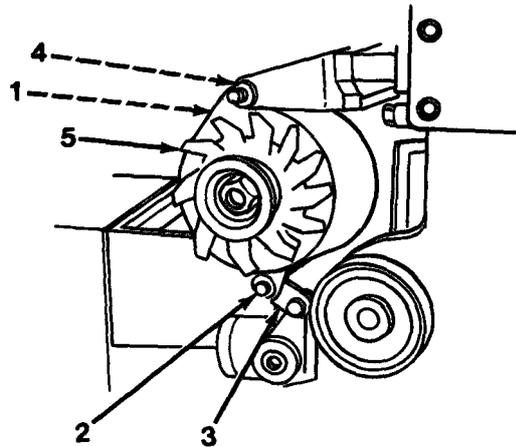


Figure 10-1

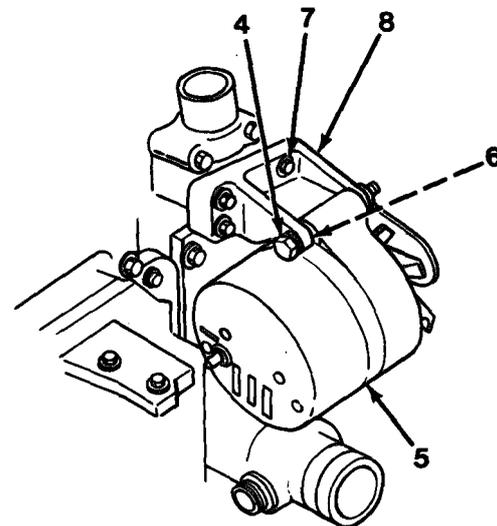


Figure 10-2

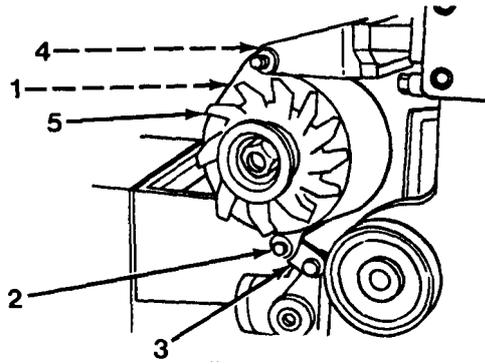


Figure 10-1

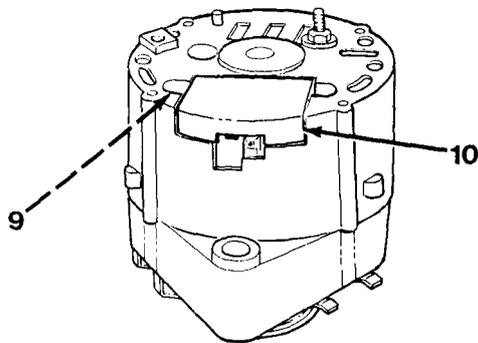


Figure 10-3

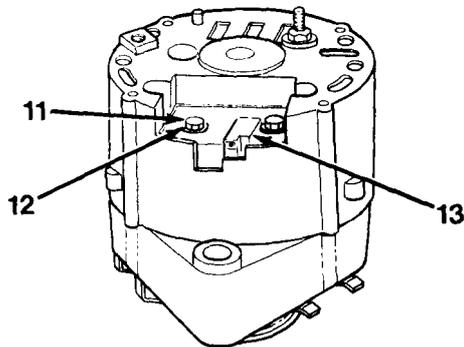


Figure 10-4

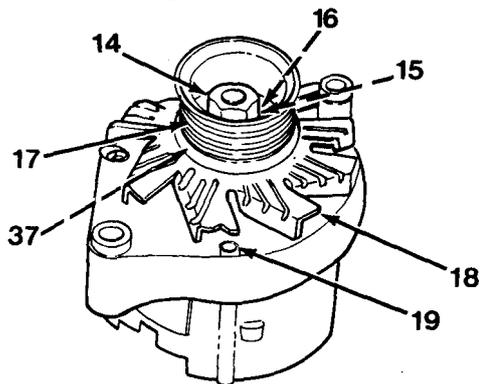


Figure 10-5

ALTERNATOR INSTALLATION

3. Install brace (3) and two capscrews (2) at lower end of alternator (5, Figure 10-1). Torque two capscrews (2) to 18 lb-ft (24 N•m).
4. Torque mounting capscrew (4) to 32 lb-ft (43 N•m).
5. Connect wire harness (1) to alternator (5).
6. Connect battery negative ground cable.
7. Install belt (refer to page 6-15).

ALTERNATOR DISASSEMBLY

NOTE

It may be necessary to insert a screwdriver between voltage regulator and rear housing for removal.

1. Remove two self-tapping screws (9) and pull voltage regulator (10, Figure 10-3) straight back. Unplug and remove voltage regulator (10).
2. Remove two self-tapping screws (11), washer (12) and brush assembly (13, Figure 10-4).

NOTE

Using scribe, matchmark front and rear housing. It may be necessary to use a screwdriver for separation of housings.

3. Remove four thru bolts (19, Figure 10-5) and separate front and rear housings (Figure 10-6). The rotor assembly will be in front housing and stator assembly will be in rear housing.

4. Secure rotor in a vise.
5. Remove nut (14), split lockwasher (15), cone (16), pulley (17) and fan (18) and spacer (37, Figure 10-5).
6. Remove nut (20), washer (21) and two insulator washers (22, Figure 10-7) from back of rear housing.
7. Pull stator assembly (28, Figure 10-8) away from rear housing

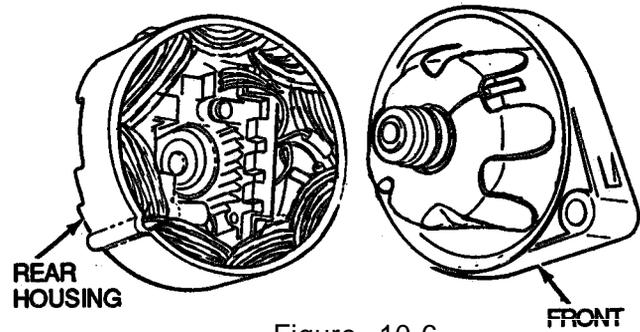


Figure 10-6

NOTE

Discharge capacitor by grounding capacitor lead to alternator housing.

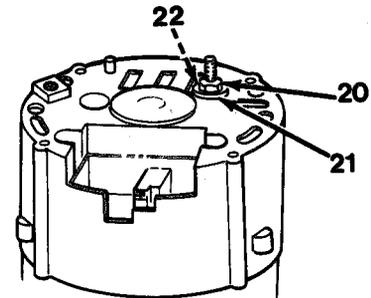


Figure 10-7

8. Remove self-tapping screw (23) and capacitor (24).
9. Remove carriage bolt (25) and two self-tapping screws (26) from diode bridge rectifier (29) inside rear housing.
10. Remove four self-tapping screws (27) from two terminals.

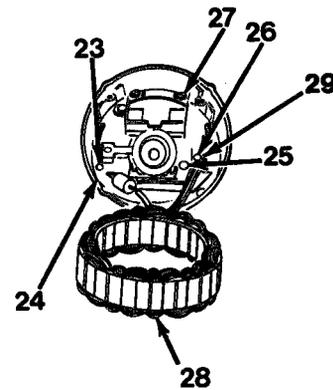


Figure 10-8

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

11. Remove stator assembly (28), diode bridge rectifier (29), AC terminal (30) and terminal (31, Figure 10-9) as an assembly from rear housing.

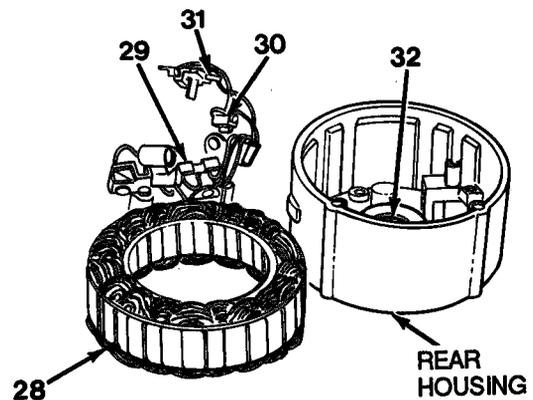


Figure 10-9

ALTERNATOR DISASSEMBLY

CAUTION

Removal of retainers and bearings may cause destruction of parts. Remove retainers and bearings only if inspection indicates replacement is necessary.

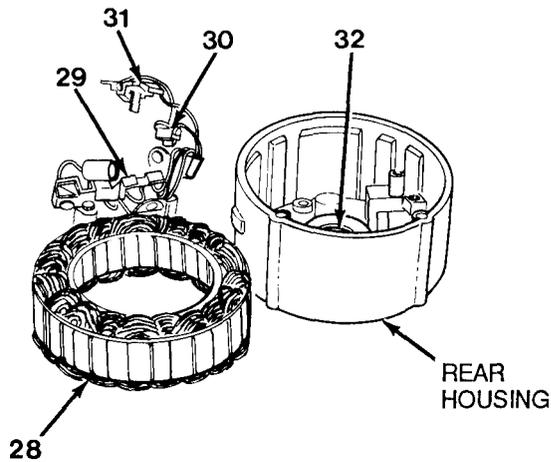


Figure 10-9

12. Remove rear bearing retainer (32, Figure 10-9), if necessary, from rear housing.

13. Remove rear bearing (33), if necessary, from rotor assembly (34, Figure 10-10) secured in a vice.

14. Compress ears of front bearing retainer (35) and lift bearing retainer (35) free of recess.

15. Place rotor assembly (34) on an arbor press and push rotor assembly (34) from front housing.

16. Using a split collar puller, remove front bearing (36, Figure 10-11), if necessary, from rotor shaft. Use a thick washer between bearing puller shaft and thread end of rotor to prevent damage to rotor.

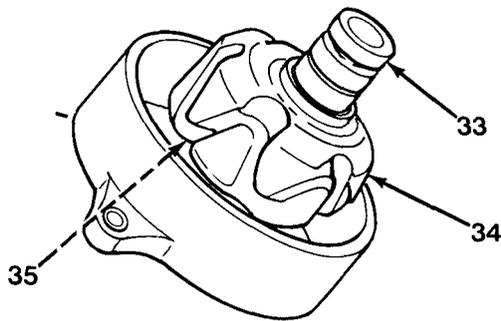


Figure 10-10

ALTERNATOR CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

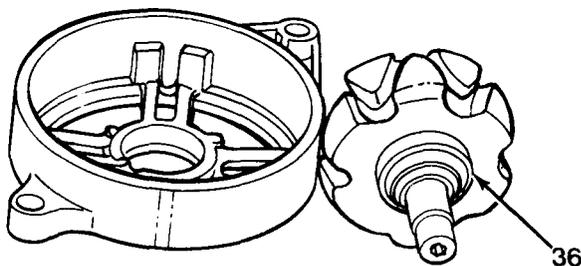


Figure 10-11

ALTERNATOR ASSEMBLY

1. Using a press, install front bearing (36, Figure 10-11), if removed, on rotor shaft.
2. Using a press, install rotor assembly (34, Figure 10-10) into front housing.
3. Secure front bearing retainer (35) into recess.
4. Using a press, install rear bearing (33), if removed, to rotor assembly (34).
5. Using a press, install rear bearing retainer (32, Figure 10-9), if removed, to rear housing.
6. Install terminal (31), AC terminal (30), diode bridge rectifier (29) and stator assembly (28, Figure 10-9) as an assembly to rear housing. Leave stator assembly (28) pulled away from rear housing.

ALTERNATOR ASSEMBLY

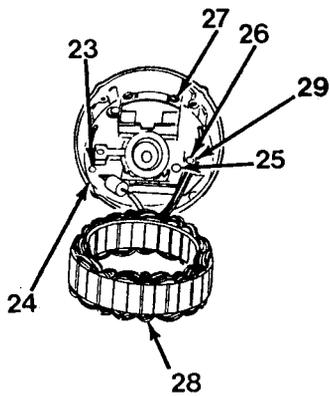


Figure 10-8

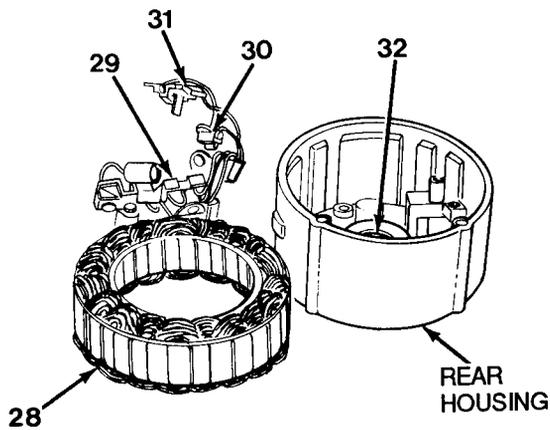


Figure 10-9

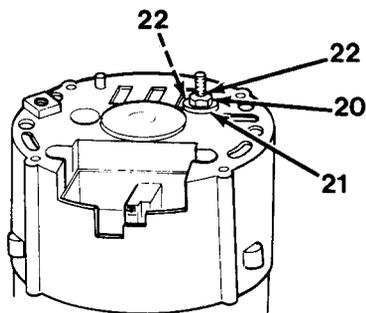


Figure 10-7

7. Install four self-tapping screws (27, Figure 10-8) to two terminals.
8. Install two self-tapping screws (26) and carriage bolt (25) to diode bridge rectifier (29, Figure 10-9) inside rear housing.
9. Install self-tapping screw (23) and capacitor (24, Figure 10-8).
10. Position stator assembly (28) back into rear housing.
11. Install two insulator washers (22), washer (21) and nut (20, Figure 10-7) to back of rear housing.
12. Secure rotor in a vise.

13. Install spacer (37), fan (18), pulley (17), cone (16), split lockwasher (15) and nut (14).
Torque nut (14) to 59 lb-ft (80 N•m).
14. Using matchmarks, position front and rear housings and install four thru bolts (19, Figure 10-5).
15. Install brush assembly (13), flat washer (12) and two self-tapping screws (11, Figure 10-4) to rear side of alternator.
16. Plug in and install voltage regulator (10) and two self-tapping screws (9, Figure 10-3).

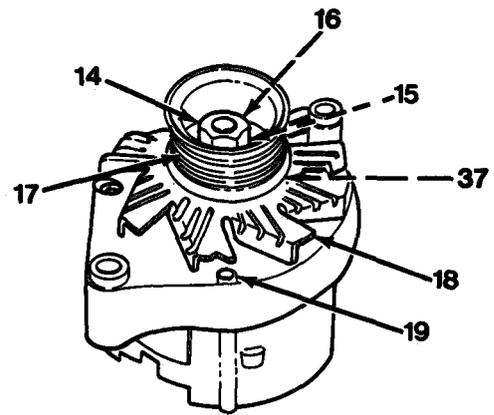


Figure 10-5

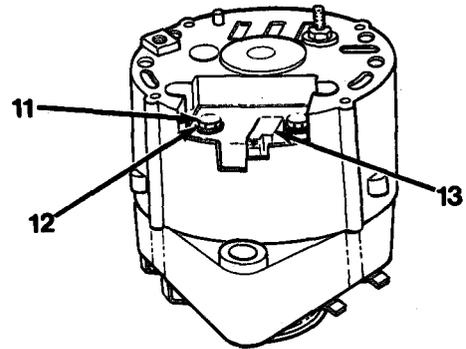


Figure 10-4

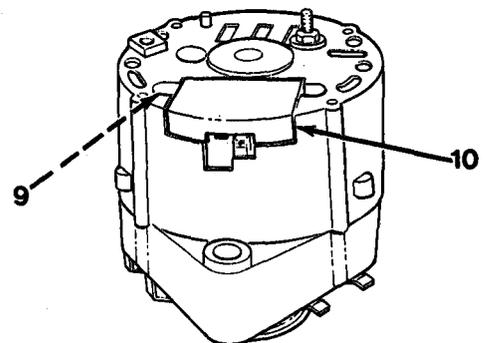


Figure 10-3

STARTING MOTOR

STARTING MOTOR REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

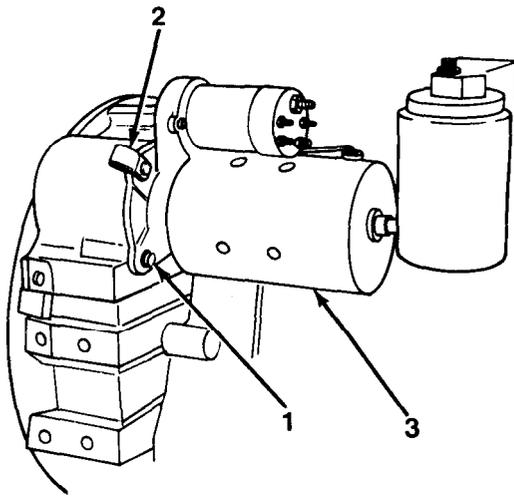


Figure 10-1

1. Disconnect battery negative ground cable.
2. Disconnect cables and wires from starting motor solenoid.
3. Remove three capscrews (1), clip (2) and starting motor (3, Figure 10-1) from engine.

STARTING MOTOR INSTALLATION

1. Position starting motor (3) cm engine and install clip (2) and three capscrews (1, Figure 10-1). Torque three capscrews (1) to 32 lb-ft (43 N•m).
2. Connect wires and cables to starting motor solenoid.
3. Connect battery negative ground cable to battery.

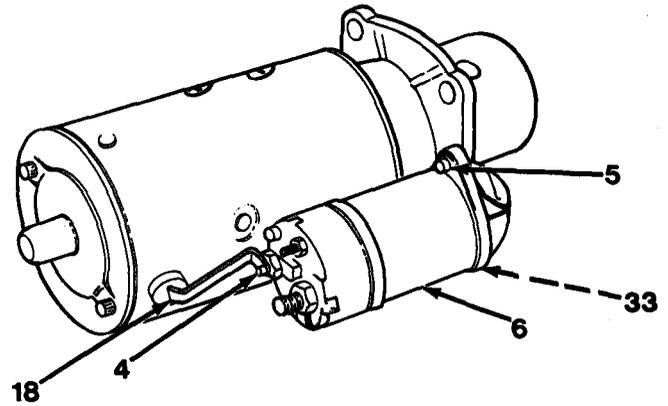


Figure 10-2

STARTING MOTOR DISASSEMBLY

1. Remove switch screw (4) and disconnect field coil solenoid connector (18, Figure 10-2).
2. Remove two screws (5), starting motor solenoid (6) and spring (33).
3. Remove two thru bolts (7), commutator end frame (8) and washer (9, Figure 10-3).
4. Remove housing (10) from armature (11, Figure 10-4).

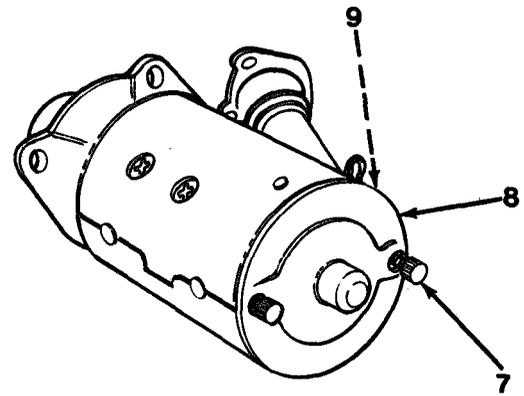


Figure 10-3

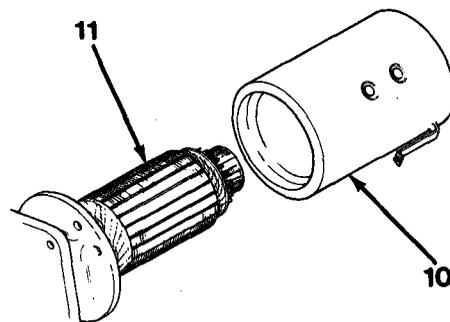


Figure 10-4

STARTER MOTOR DISASSEMBLY

5. Remove two pins (12), brush springs (13), four brush screws (14), brushes (15) and brush holders (16, Figure 10-5).

6. Remove connecting field screw (17) and field coil solenoid connector (18) from housing (10, Figure 10-6).

Remove eight screws (19), pole shoes (34) and field coil assembly (20).

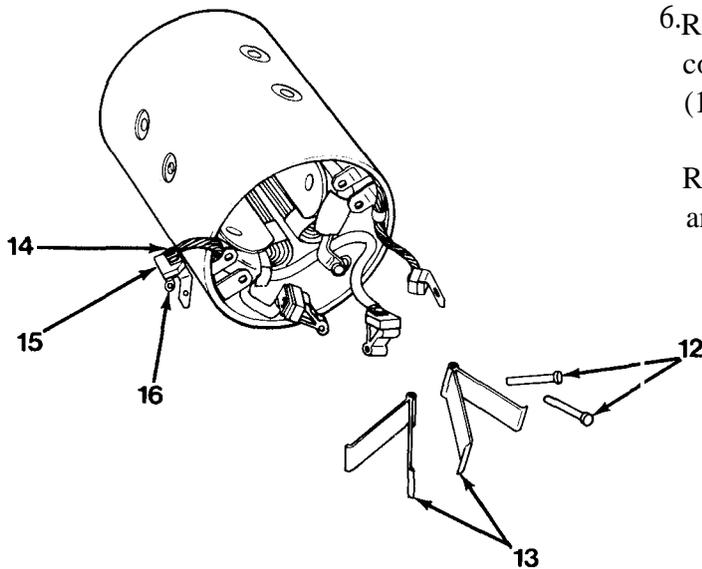


Figure 10-5

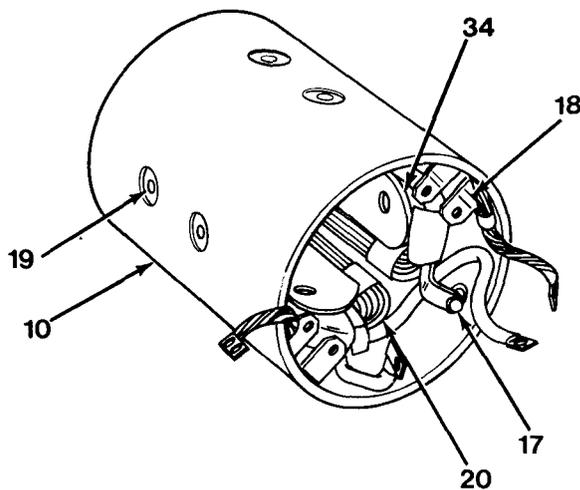


Figure 10-6

8. Remove nut (21), stud lever and washers (33) and four screws (22) from drive housing (23, Figure 10-7).
9. Separate armature (11) and plunger (24) with shift lever attached from drive housing (23, Figure 10-8).

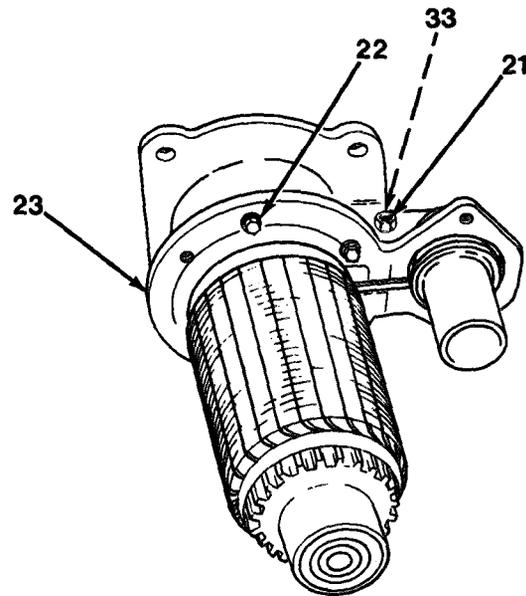


Figure 10-7

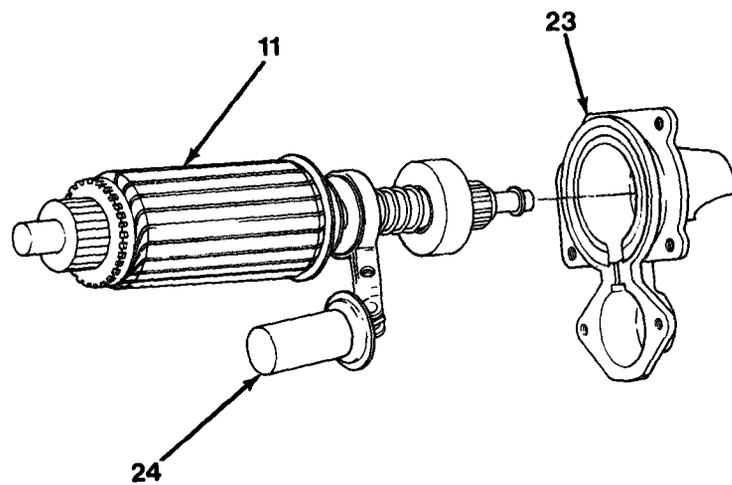


Figure 10-8

STARTER MOTOR DISASSEMBLY

10. Remove thrust collar (25), retainer ring (26) and stop collar (27) from armature (11), Figure 10-9).
11. Remove drive assembly (28), drive washer (29) and bearing plate (30).

Removal of center bearing bushing and bearing oil seal may cause destruction of parts. Remove center bearing bushing and bearing oil seal only if inspection indicates replacement is necessary.

12. Using bearing press, remove center bearing bushing (31) and bearing oil seal (32), if necessary, from bearing plate (30).

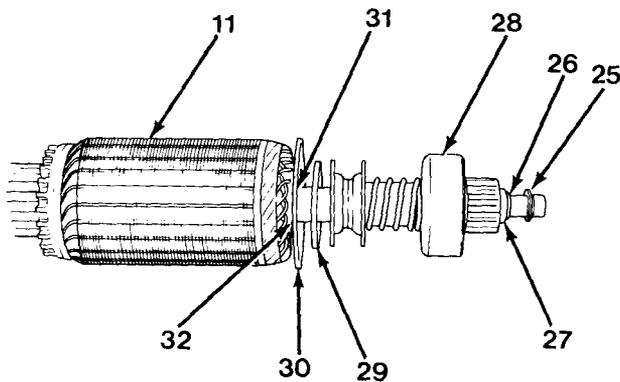


Figure 10-9

STARTING MOTOR CLEANING/INSPECTION

1. Clean brushes with a dry cloth only. Do not permit dry cleaning solvent to contact brushes.

WARNING

- Dry cleaning solvent P-D-680 used to clean all parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment: goggles or safety glasses, face shield and gloves. Do not breathe vapors. Do not use near sparks or open flames and do not smoke while using it. Failure to follow this procedure could cause **SERIOUS INJURY**.

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Remove loose particles from armature with compressed air and wipe with a clean cloth dampened with dry cleaning solvent P-D-680. Clean commutator end frame lightly with sandpaper and remove all traces of dust with low-pressure compressed air.
3. Clean all other parts (refer to Chapter 2).
4. Inspect brushes for wear. Replace worn brushes.
5. Inspect field coils using a voltmeter and check for grounds and opens. Replace field coils if grounded or open.
6. Inspect armature for short circuits, opens or grounds. Replace armature if it short circuits, opens or grounds.
7. Inspect all other parts (refer to Chapter 4).

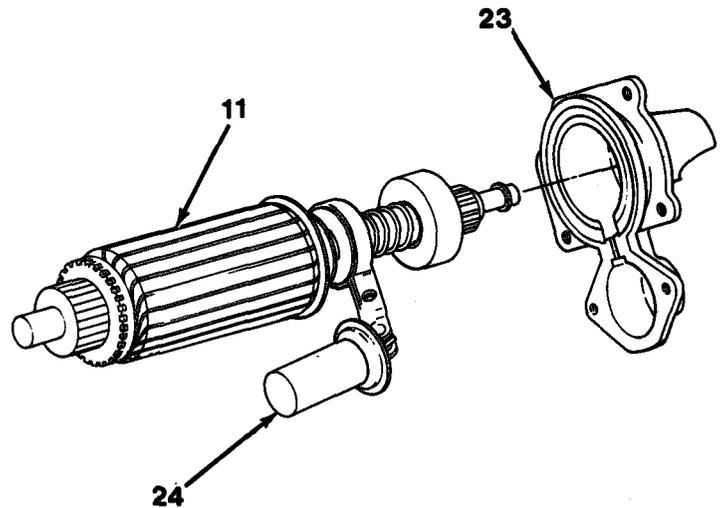


Figure 10-8

STARTING MOTOR ASSEMBLY

1. Using bearing press, install bearing oil seal (32) and center bearing bushing (31), if removal, to bearing plate (30, Figure 10-9).
2. Install bearing plate (30) drive washer (29) and drive assembly (28) to armature (11).
3. Install stop collar (27), retainer ring (26) and thrust collar (25).
4. Install plunger (24) with shift lever attached and armature (11) to drive housing (23, Figure 10-8).

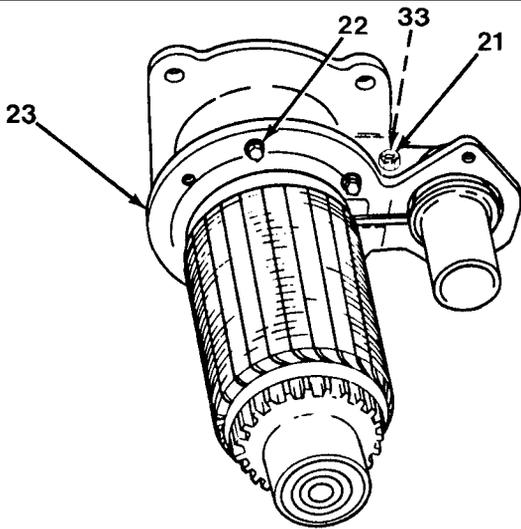


Figure 10-7

STARTER MOTOR ASSEMBLY

5. Install four screws (22), stud lever and washers (33) and nut (21) to drive housing (23, Figure 10-7).
6. Install field coil assembly (20), pole shoes (34) and eight screws (19) to housing (10, Figure 10-6).
7. Install field coil solenoid connector (18) and connecting field screw (17) to housing (10).
8. Install four brush holders (16), brushes (15), brush screws (14), two brush springs (13) and pins (12) to housing (10, Figure 10-5).

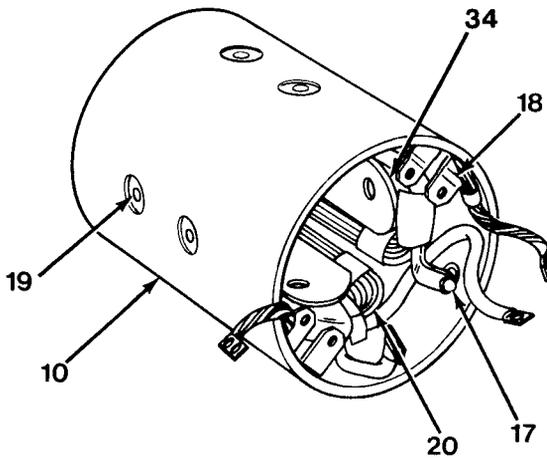


Figure 10-6

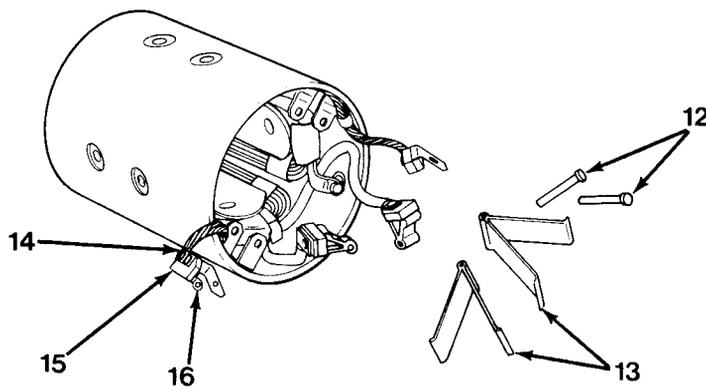


Figure 10-5

9. Install armature (11) into housing (10, Figure 10-4).

10. Install washer (9), commutator end frame (8) and two thru bolts (7, Figure 10-3).

11. Install spring (33), starting motor solenoid (6) and two screws (5, Figure 10-2).

12. Connect field coil solenoid connector (18) and install switch screw (4).

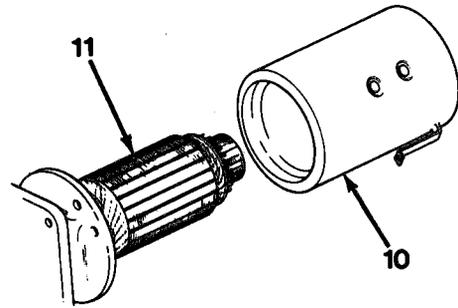


Figure 10-4

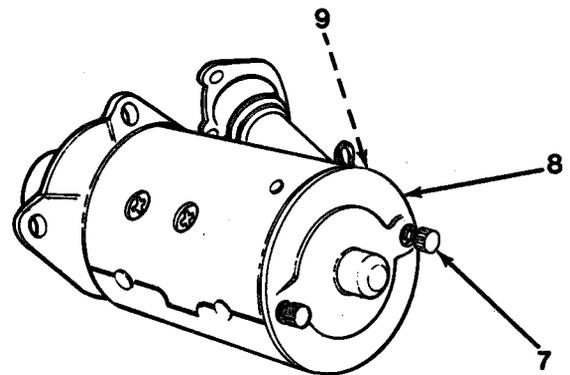


Figure 10-3

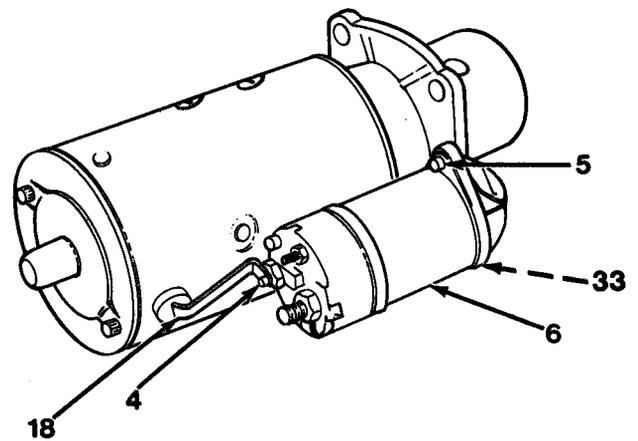


Figure 10-2

BATTERY ASSEMBLY

BATTERY ASSEMBLY REMOVAL

 **WARNING**

- Battery gases can explode. Do not smoke or allow sparks or open flames near batteries. Wear safety glasses or goggles when checking the batteries. Failure to follow this procedure could cause DEATH or serious injury.
- Sulfuric acid contained in batteries can cause serious burns. If battery corrosion or electrolyte makes contact, take immediate action to stop the burning effects:

EYES: Flush eyes with cold water for no less than 15 minutes and seek medical attention immediately.

SKIN: Flush with large amounts of cold water until all acid is removed. Seek medical attention as required.

INTERNAL: If corrosion or electrolyte is ingested, drink large amounts of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Seek medical attention immediately.

CLOTHING/EQUIPMENT: Wash area with large amounts of cold water. Neutralize acid with baking soda or household ammonia.

Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Before disconnecting cables and removing batteries, determine condition of batteries. Check specific gravity of each cell with a hydrometer. With temperature of electrolyte at 80 degrees F (26.7 degrees C), specific gravity for each cell of a fully charged battery should be between 1.280 and 1.275. If specific gravity between highest and lowest cells exceeds 50 points (0.050), or highest cell is below 1.200, refer to TM 9-6140-200-14 for further testing.

1. Open battery compartment cover,



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

2. Disconnect ground cable (1) from battery (2), Figure 10-1).
3. Disconnect black wire from ground cable (1).
4. Disconnect positive cable (3) from battery (4).

5. Disconnect two white wires and cable (5) from cable (3).
6. Remove jumper cable (6) from batteries (2) and (4).
7. Remove four nuts (7), washers (8) and two battery clamps (9).

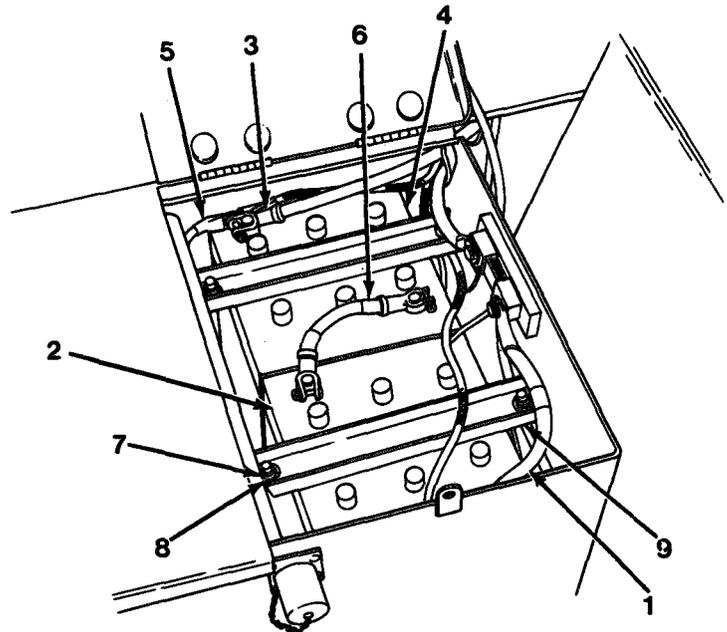


Figure 10-1

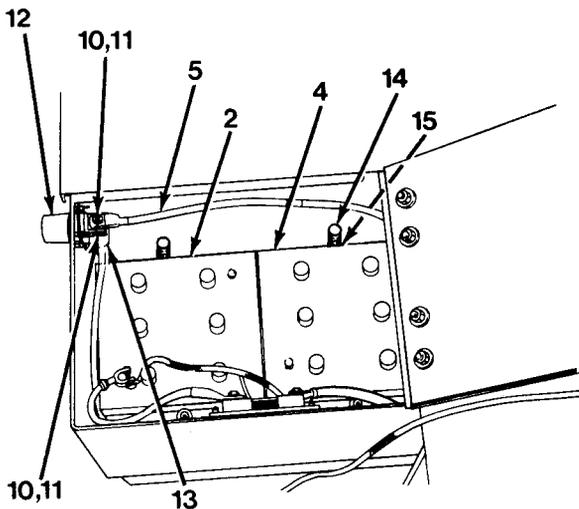


Figure 10-2

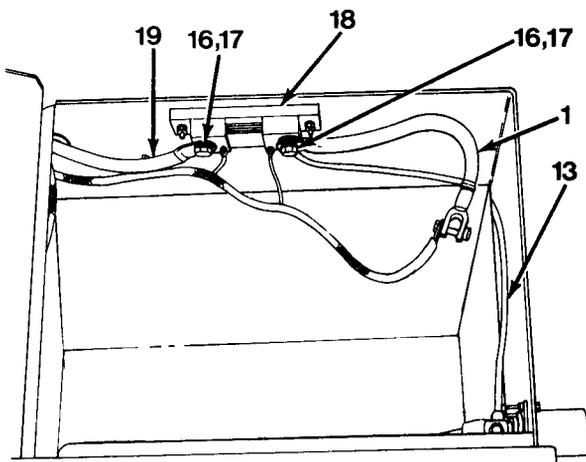


Figure 10-3

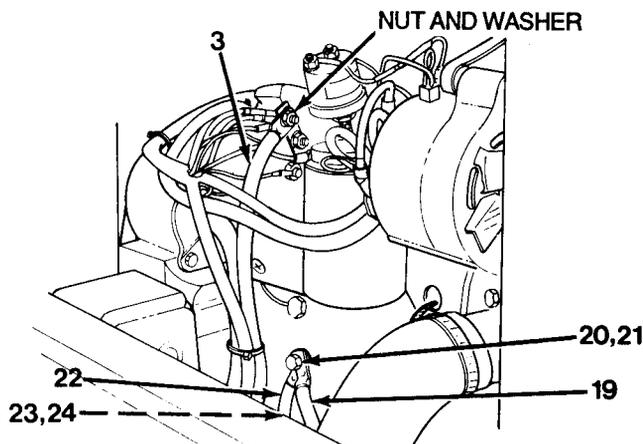


Figure 10-4

BATTERY ASSEMBLY REMOVAL

8. Remove capscrew (10), two washers (11) and disconnect cable (5) from slave receptacle (12, Figure 10-2).
9. Remove capscrew (10), washer (11) and disconnect cable (13) from slave receptacle (12).
10. Remove batteries (2) and (4) from battery compartment.
11. Remove four bolts (14) and O-rings (15).
12. Remove capscrew (16), washer (17) and disconnect cables (1) and (13) from shunt (18, Figure 10-3).
13. Remove capscrews (16), washers (17) and disconnect cable (19) from shunt (18).
14. Remove bolt (20), lockwasher (21) and disconnect cables (19) and (22, Figure 10-4).
15. Follow cable (22) down to frame and remove nut (23), washer (24) and cable (22).

16. Remove two nuts (25), two washers (26) and four clamps (27, Figure 10-5).
17. Cut and remove all tie straps securing cables (3) and (19, Figure 10-4).
18. Remove nut and washer securing cable (3) to starting motor.
19. Disconnect cable (3) from starting motor and remove cables (3) and (19) from vehicle. Reinstall nut and washer on starting motor.
20. Remove grommet (28) and flexible trim (29, Figure 10-6).
21. Remove two screws (30) and lockwashers (31) and disconnect red and blue wires from shunt (18, Figure 10-7).
22. Remove two nuts (32), lockwashers (33), bolts (34) and shunt (18).
23. Remove four nuts (35), lockwashers (36), bolts (37) and slave receptacle (12).
24. Remove two pads from inside of battery case.

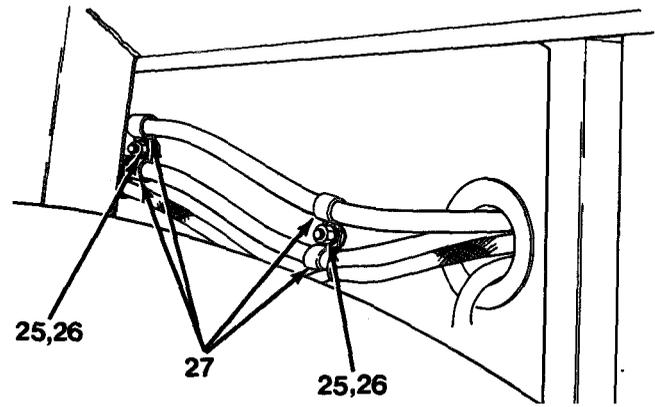


Figure 10-5

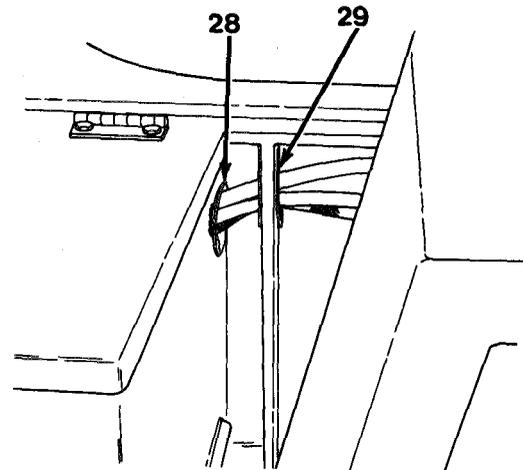


Figure 10-6

BATTERY ASSEMBLY CLEANING/ INSPECTION

1. Clean cable terminals with a solution of baking soda and water. Rinse with clean water and wire brush.
2. Clean batteries with a solution of baking soda and water. Rinse with clean water. Clean negative and positive terminal posts with a wire brush.

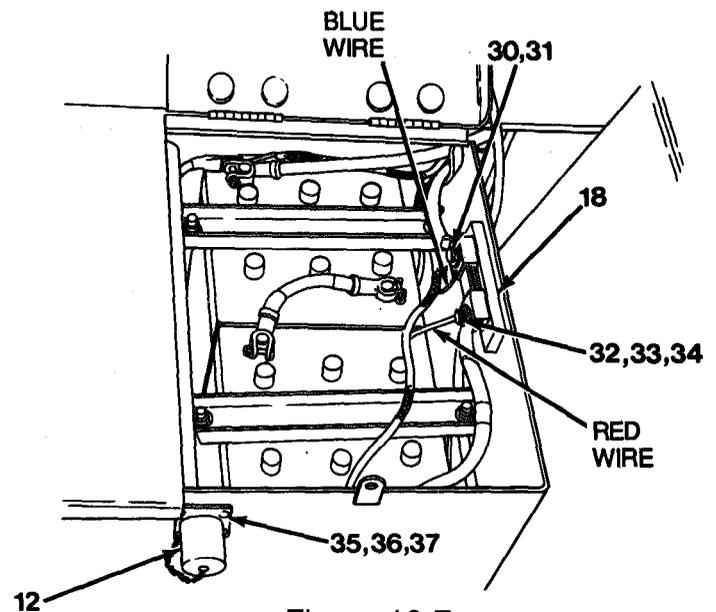


Figure 10-7

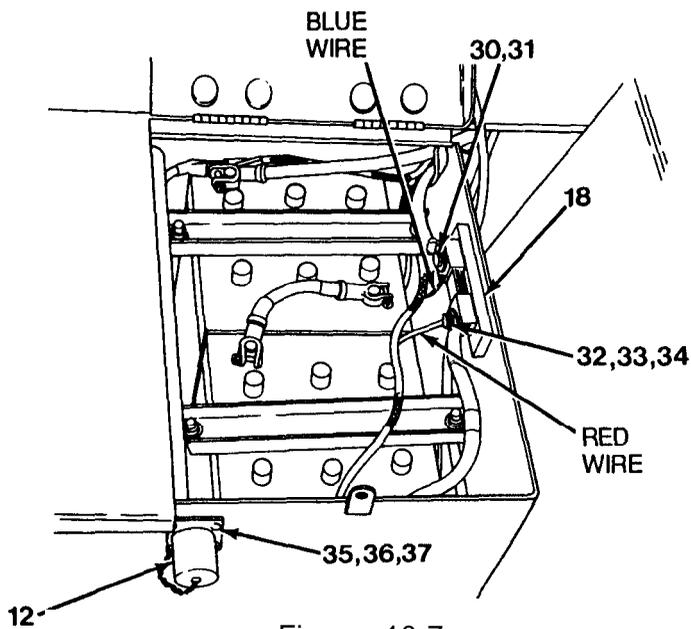


Figure 10-7

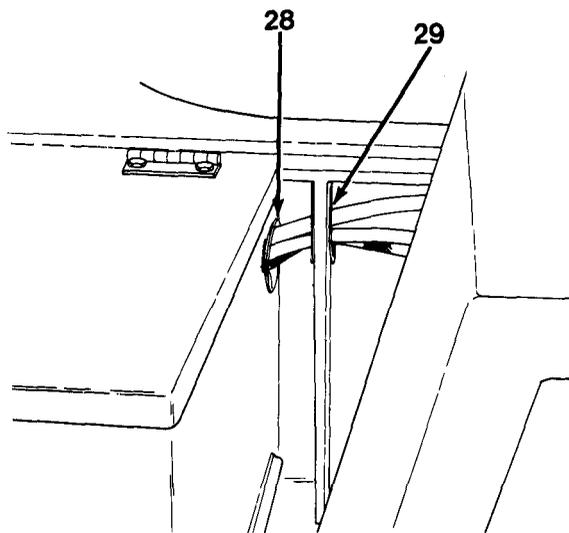


Figure 10-6

BATTERY ASSEMBLY CLEANING/ INSPECTION

3. Clean all other parts (refer to Chapter 2).
4. Inspect battery cables for broken, cracked or deteriorated insulation.
5. Inspect battery cable terminal for corroded or damaged condition.
6. Inspect battery case for signs of cracks or electrolyte leakage.
7. Insure terminal posts are solid.
8. Replace battery cables that have broken wires or damaged insulation.
9. If battery is to be charged, observe all safety precautions. Charge batteries (refer to TM 9-6140-200-14).
10. Inspect all other parts (refer to Chapter 4).

BATTERY ASSEMBLY INSTALLATION

1. Install two pads inside bottom of battery case.
2. Install slave receptacle (12), four bolts (37), lockwashers (36) and nuts (35, Figure 10-7).
3. Install shunt (18), two bolts (34), lockwashers (33) and nuts (32).
4. Connect blue and red wires to shunt (18) and install two lockwashers (31) and screws (30).
5. Install flexible trim (29) and grommet (28, Figure 10-6).

6. Thread cables (19) and (3) through flexible trim (29) and grommet (28, Figure 10-8).
7. Remove nut and washer from starting motor (Figure 10-4).
8. Connect cable (3) to starting motor and install nut and washer.
9. Install cable (22), washer (24) and nut (23).
10. Connect cables (22) and (19) and install lock-washer (21) and bolt (20).
11. Connect cable (19) to shunt (18) and install washer (17) and capscrew (16, Figure 10-3)

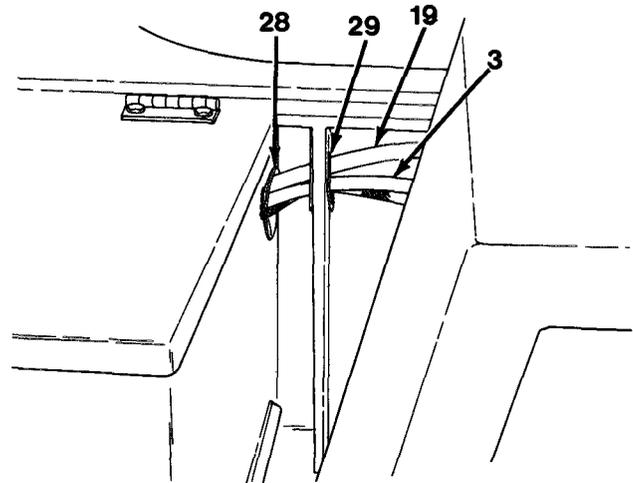


Figure 10-8

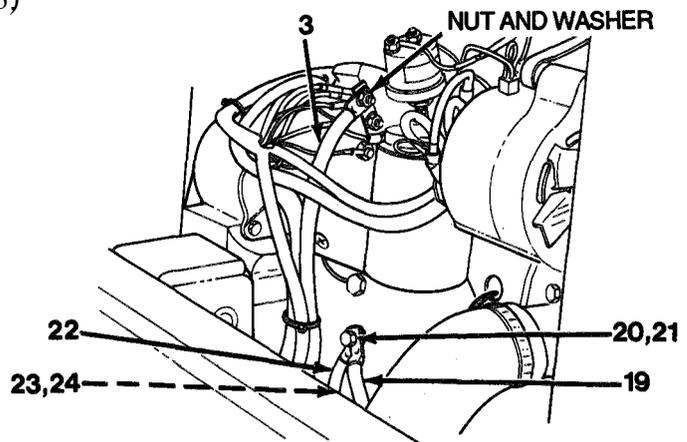


Figure 10-4

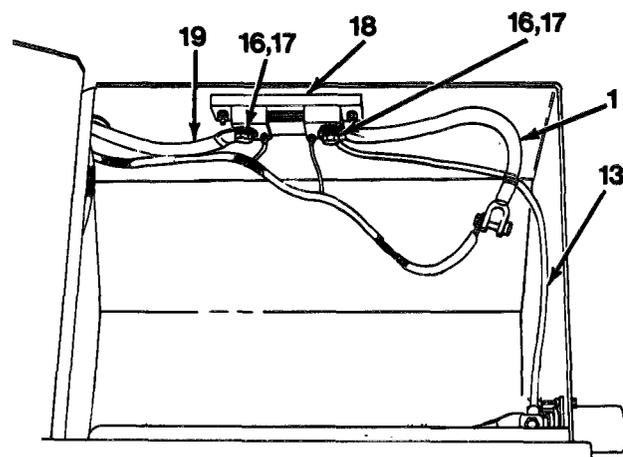


Figure 10-3

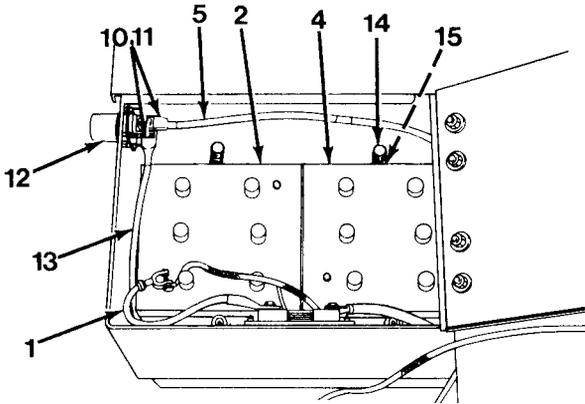


Figure 10-9

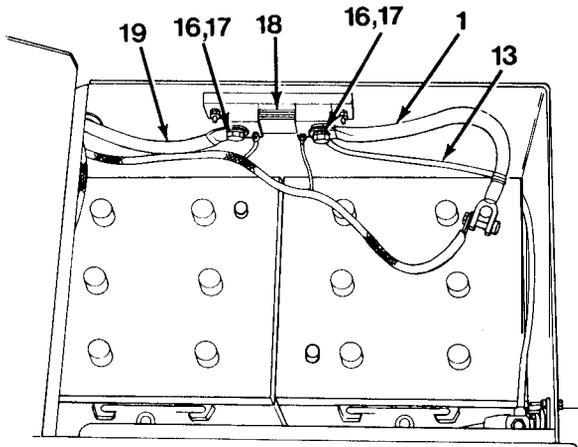


Figure 10-10

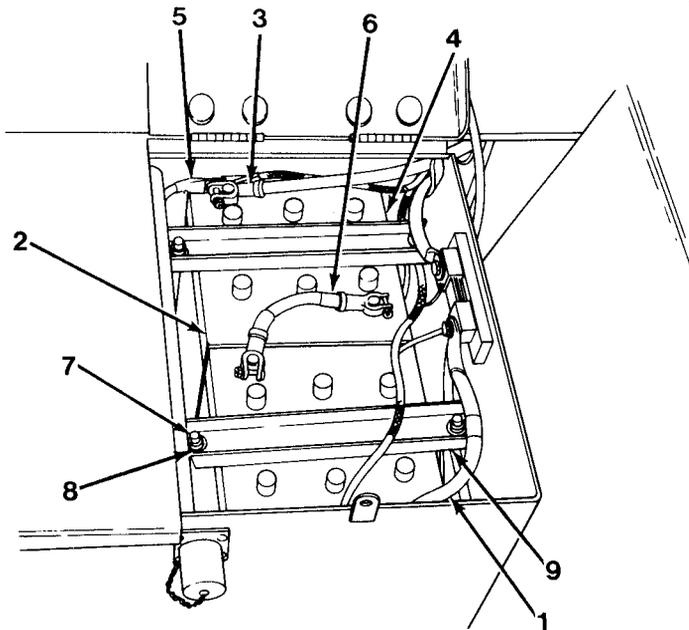


Figure 10-1

BATTERY ASSEMBLY INSTALLATION

12. Install four bolts (14) and O-rings (15, Figure 10-9).
13. Install batteries (4) and (2) into battery compartment.
14. Install cables (13) and (1), washer (17) and capscrew (16) to shunt (18, Figure 10-10).
15. Connect cable (13) and install two washers (11) and capscrew (10) to slave receptacle (12, Figure 10-9).
16. Connect cable (5) and install two washers (11) and capscrew (10) to slave receptacle (12).
17. Install two battery clamps (9), four washers (8) and nuts (7, Figure 10-1).
18. Install jumper cable (6) to batteries (4) and (2).
19. Connect cable (5) and two white wires to cable (3).

20. Install cable (3) to battery (4).
21. Install four clamps (27), two washers (26) and nuts (25, Figure 10-5).
22. Connect black wire to ground cable (1) and connect ground cable (1) to battery (2, Figure 10-1).
23. Install tie straps as needed.

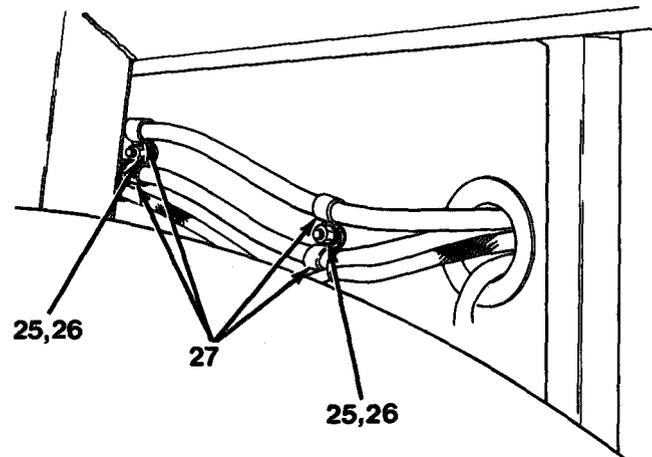


Figure 10-5

ELECTRICAL WIRING HARNESS REPAIR

CABLE/WIRE AND PIN/SOCKET IDENTIFICATION

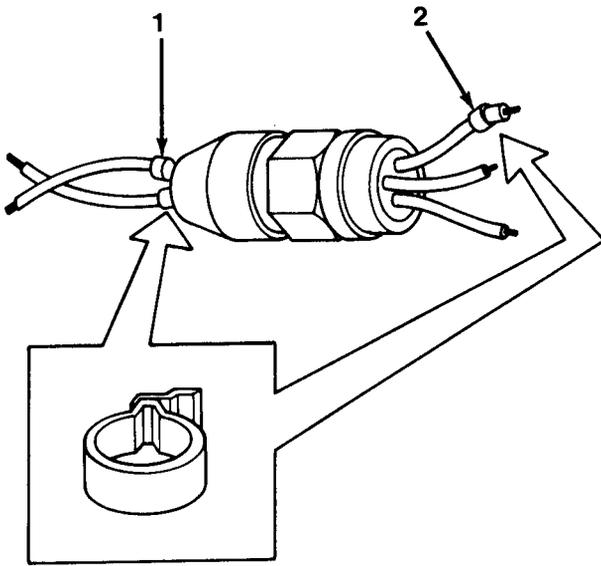


Figure 10-1

NOTE

When removing more than one wire from a multiple wire harness, record which line was removed from which pin hole.

1. Cable identifiers (1, Figure 10-1) are aluminum tags attached to cables. These tags are embossed with cable identification number.
2. Wire identifiers (2) are embossed with same individual wire number. Wire identifier numbers are shown on wiring diagram.
3. If cables or wires are replaced, remove tags from old wire and place them on new wire.
4. All pins (male connectors) and sockets (female connectors) in receptacles and plugs are identified by alphabetical code. Coded identification starts at the connector key (3) or groove (4, Figure 10-2). Male connectors identifying letters run clockwise and female connectors identifying letters run counter-clockwise.

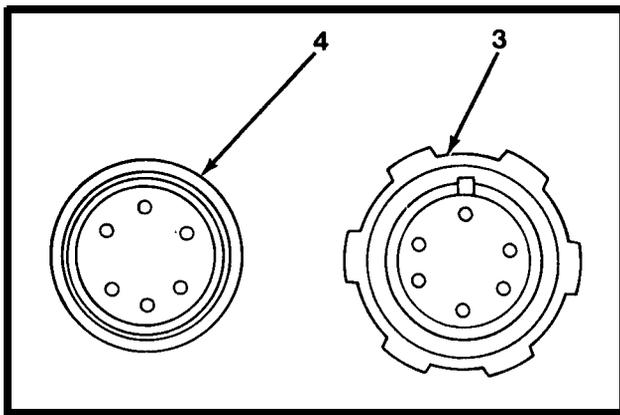


Figure 10-2

FEMALE-TYPE PANEL MOUNTING RECEPTACLE DISASSEMBLY

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Push socket contacts (5) out through rear of insert (6, Figure 10-3) with pin extractor.
3. Unsolder cable leads (7) from solder wells on socket contacts (5).
4. Slide insert (6) out through rear of shell (8).

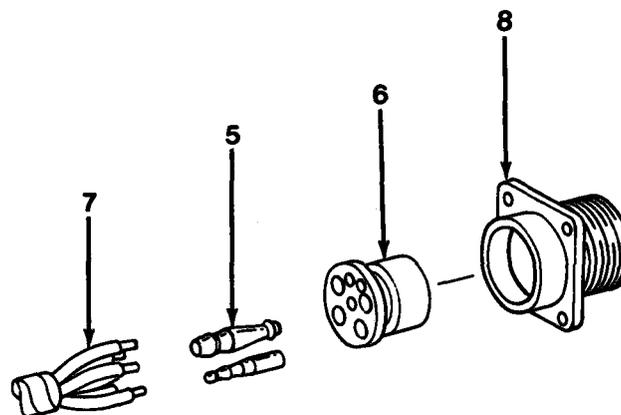


Figure 10-3

MALE-TYPE PANEL MOUNTING RECEPTACLE DISASSEMBLY

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Push pin contacts (9) out through rear of insert (10, Figure 10-4) with pin extractor.
3. Unsolder cable leads (11) from solder wells on pin contacts (9).
4. Slide insert (10) out through rear of shell (12).

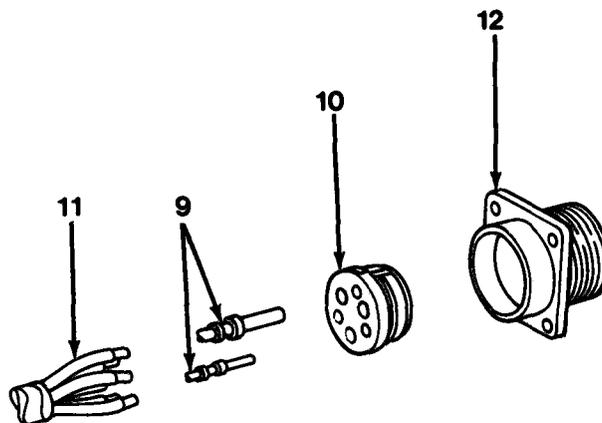


Figure 10-4

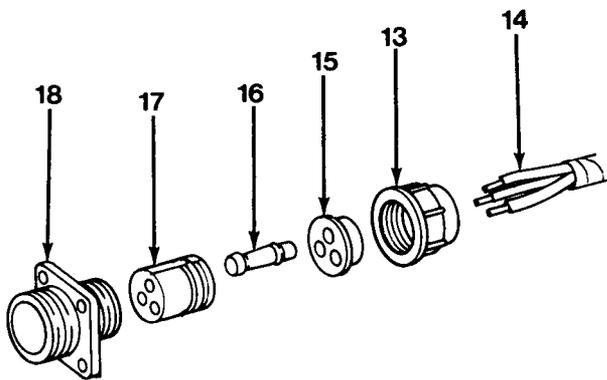


Figure 10-5

FEMALE-TYPE PANEL MOUNTING RECEPTACLE WITH RIDGED LOCKING NUT DISASSEMBLY

! WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Unscrew nut (13, Figure 10-5) from shell assembly and slide back on cable.
3. Slide grommet (15) back on cable leads (14).
4. Push socket contacts (16) out through front of insert (17) with pin extractor.
5. Push insert (17) out through rear of shell (18).
6. Unsolder cable leads (14) from pin contacts (16).

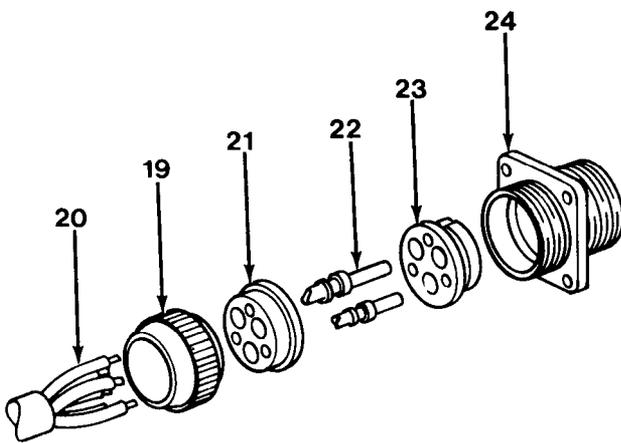


Figure 10-6

MALE-TYPE PANEL MOUNTING RECEPTACLE WITH RIDGED LOCKING NUT DISASSEMBLY

! WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Unscrew nut (19, Figure 10-6) from shell assembly and slide back on cable.

3. Push grommet (21) back on cable leads (20).
4. Push pin contacts (22) out through rear of insert (23) with pin extractor.
5. Push insert (23) out through rear of shell (24).
6. Unsolder leads (20) from pin contacts (22).

FEMALE-TYPE PLUG WITH RIDGED LOCKING NUT DISASSEMBLY



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

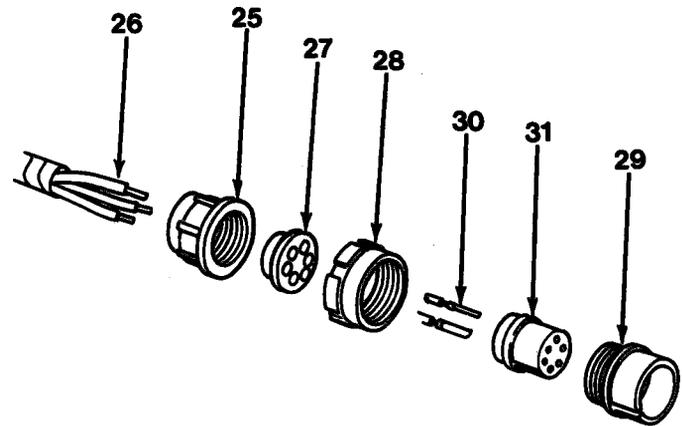


Figure 10-7

1. Disconnect battery negative ground cable.
2. Unscrew nut (25, Figure 10-7) from shell assembly and slide back on cable.
3. Slide grommet (27) back on cable leads (26).
4. Slide coupling nut (28) off shell (29).
5. Push socket contacts (30) out through rear of insert (31) with pin extractor.
6. Push insert (31) out through rear of shell (29).
7. Unsolder leads (26) from socket contacts (30).

MALE-TYPE PLUG WITH RIDGED LOCKING NUT DISASSEMBLY

! WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Unscrew nut (32, Figure 10-8) from shell assembly and slide back on cable.
3. Slide grommet (34) back on cable leads (33).
4. Slide coupling nut (35) off shell assembly,
5. Drive pin contacts (36) out through rear of insert (37) with pin extractor.
6. Push insert (37) out through rear of shell (38).
7. Unsolder cable leads (33) from pin contacts (36).

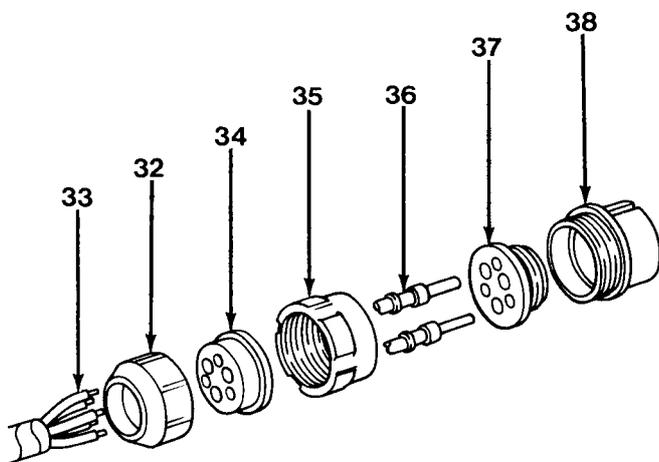


Figure 10-8

CABLE CONNECTORS DISASSEMBLY

! WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cables,
2. Cut and discard connectors for terminal-type cables, female cables with washers or sleeves and male cables with washers.

TERMINAL-TYPE CABLE CONNECTOR ASSEMBLY

1. Strip cable insulation equal to depth of terminal well.
2. Slide insulator (40) over cable (41, Figure 10-9).

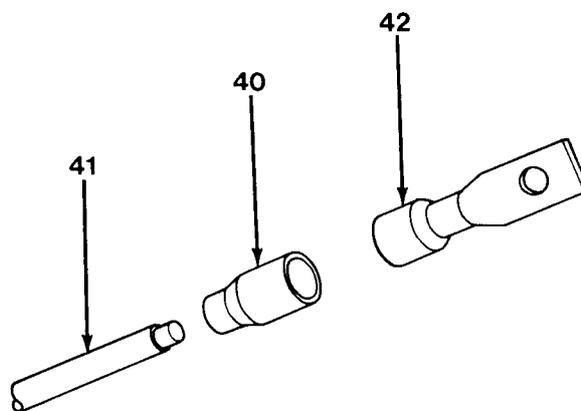


Figure 10-9

3. Insert cable (41) into terminal (42) well and crimp.
4. Slide insulator (40) over crimped end of terminal (42).
5. Connect battery negative ground cable.

FEMALE CABLE CONNECTOR WITH WASHER ASSEMBLY

1. Strip cable insulation approximately 0.125 in. (3.2 mm).
2. Slide shell (43) and washer (44) over cable (45, Figure 10-10).
3. Place cable (45) in cylinder end of terminal (46) and crimp.
4. Slide shell (43) and washer (44) over terminal (46).
5. Connect battery negative ground cable.

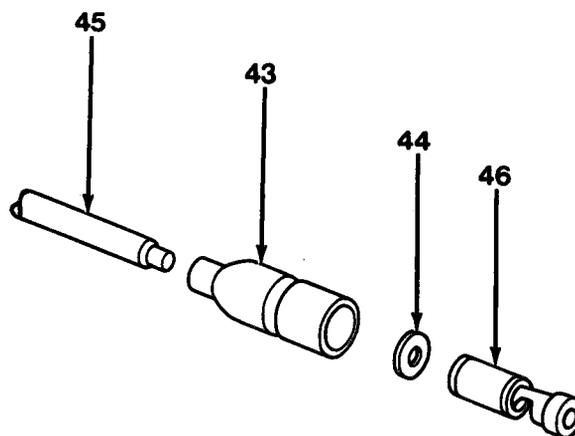


Figure 10-10

MALE CABLE CONNECTOR WITH WASHER ASSEMBLY

1. Strip cable insulation equal to depth of ferrule well.
2. Slide shell (49) over cable (48, Figure 10-11).
3. Insert cable (48) into terminal (47) well and crimp.
4. Place C-washer (50) over cable (48) at crimped junction and slide shell (49) over C-washer (50) and terminal (47).
5. Connect battery negative ground cable.

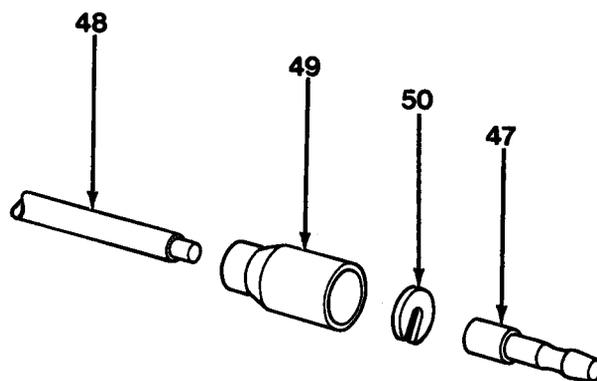


Figure 10-11

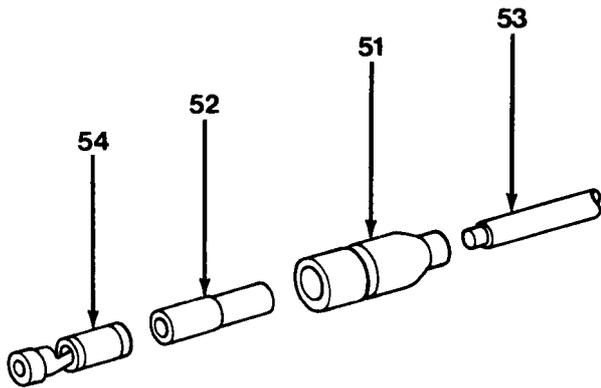


Figure 10-12

FEMALE CABLE CONNECTOR WITH SLEEVE ASSEMBLY

1. Strip cable insulation approximately 0.125 in. (3.2 mm).
2. Slide shell (51) and sleeve (52) over cable (53, Figure 10-12).
3. Place cable (53) in cylinder end of terminal (54) and crimp.
4. Slide shell (51) and sleeve (52) over terminal (54).
5. Connect battery negative ground cable.

MALE-TYPE PLUG WITH RIDGED LOCKING NUT ASSEMBLY

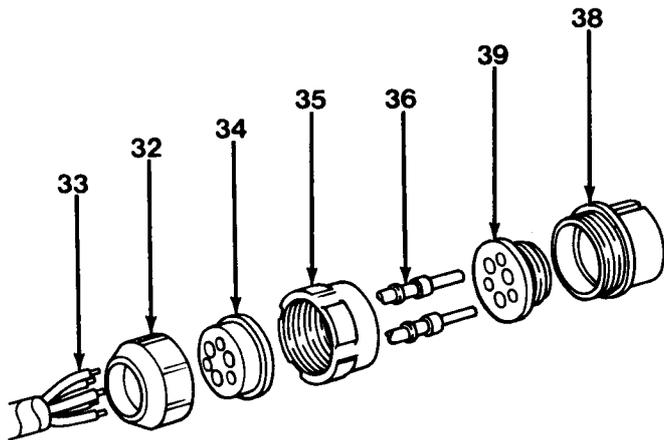


Figure 10-8

1. Strip cable of insulation equal to depth of solder wells of pin contacts (36, Figure 10-8).
2. Slide nut (32) over cable.
3. Slide grommet (34) over cable leads (33).
4. Insert cable leads (33) into solder wells of pin contacts (36) and solder (use rosin core solder only).
5. Push insert (39) into shell (38) from rear until seated. Groove in insert (39) must be aligned with guide in shell (38) to insure proper fit.
6. Push pin contacts (36) into insert (39) from rear until seated.
7. Slide coupling nut (35) onto shell assembly.
8. Push grommet (34) down cable leads (33) and over solder wells of pin contacts (36).

9. Screw nut (32) onto shell assembly.
10. Tape cable leads as required.
11. Connect battery negative ground cable.

FEMALE-TYPE PLUG WITH RIDGED LOCKING NUT ASSEMBLY

1. Strip cable insulation equal to depth of solder wells of socket contacts (30, Figure 10-7).
2. Slide nut (25) over cable.
3. Slide grommet (27) over cable leads (26).
4. Insert cable leads (26) into solder wells of socket contacts (30) and solder (use rosin core solder only).
5. Push insert (31) into shell (29) from rear until seated. Groove in insert (31) must be aligned with guide in shell (29) to insure proper fit.
6. Push socket contacts (30) into insert (31) from rear until seated.
7. Slide coupling nut (28) onto shell assembly.
8. Push grommet (27) down cable leads (26) and over spider wells of socket contacts (30).
9. Screw nut (25) onto shell assembly.
10. Tap cable leads as required.
11. Connect battery negative ground cable.

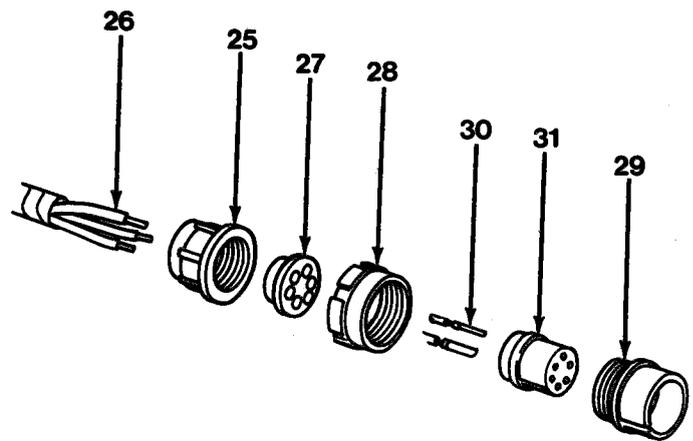


Figure 10-7

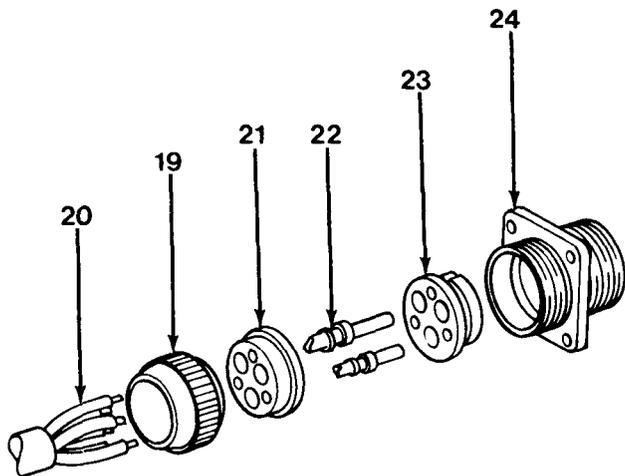


Figure 10-6

MALE-TYPE PANEL MOUNTING RECEPTACLE WITH RIDGED LOCKING NUT ASSEMBLY

1. Strip cable insulation equal to depth of solder wells of pin contacts (22, Figure 10-6).
2. Slide nut (19) over cable.
3. Slide grommet (21) over cable leads (20).
4. Insert cable leads (20) into solder wells of pin contacts (22) and solder (use rosin core solder only).
5. Push insert (23) into shell (24) from rear until seated. Groove in insert (23) must be aligned with guide in shell (24) to insure proper fit.
6. Push pin contacts (22) into insert (23) from rear until seated.
7. Push grommet (21) down cable leads (20) and over solder wells of pin contacts.
8. Screw nut (19) onto shell assembly.
9. Tape cable leads as required.
10. Connect battery negative ground cable.

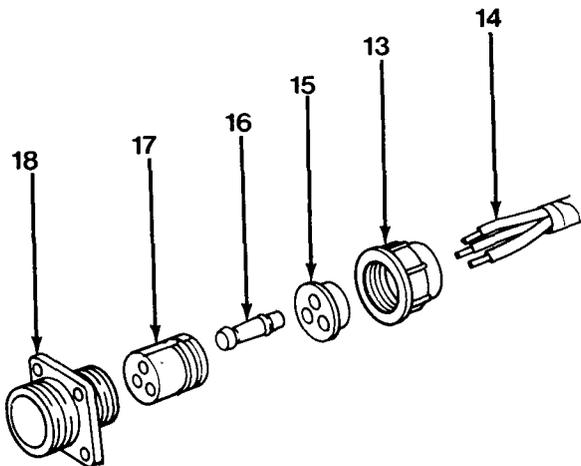


Figure 10-5

FEMALE-TYPE PANEL MOUNTING RECEPTACLE WITH RIDGED LOCKING NUT ASSEMBLY

1. Strip cable insulation to depth of solder wells of socket contacts (16, Figure 10-5).
2. Slide nut (13) over cable.
3. Slide grommet (15) over cable leads (14).
4. Insert cable leads (14) into solder wells of socket contacts (16) and solder (use rosin core solder only).

5. Push insert (17) into shell (18) from rear until seated. Groove in insert (17) must be aligned with guide in shell (18) to insure proper fit.
6. Push socket contacts (16) into insert (17) from rear until seated.
7. Push grommet (15) down cable leads (14) and over solder wells of socket contacts (16).
8. Screw nut (13) onto shell assembly.
9. Tape cable leads as required.
10. Connect battery negative ground cable.

2. Insert cable leads (7) into solder wells of socket contacts (5) and solder (use rosin core solder only).
3. Push insert (6) into shell (8) from rear until seated. Groove in insert (6) must be aligned with guide in shell (8) to insure proper fit.
4. Push socket contacts (5) into insert (6) from rear until seated,
5. Tape cable leads as required.
6. Connect battery negative ground cable.

MALE-TYPE PANEL MOUNTING RECEPTACLE ASSEMBLY

1. Strip cable insulation equal to depth of solder wells of pin contacts (9, Figure 10-4).
2. Insert cable leads (11) into solder wells of pin contacts (9) and solder (use rosin core solder only).
3. Push insert (10) into shell (12) from rear until seated. Groove in insert (10) must be aligned with guide in shell (12) to insure proper fit.
4. Push pin contacts (9) into insert (10) from rear until seated.
5. Tape cable leads as required.
6. Connect battery negative ground cable.

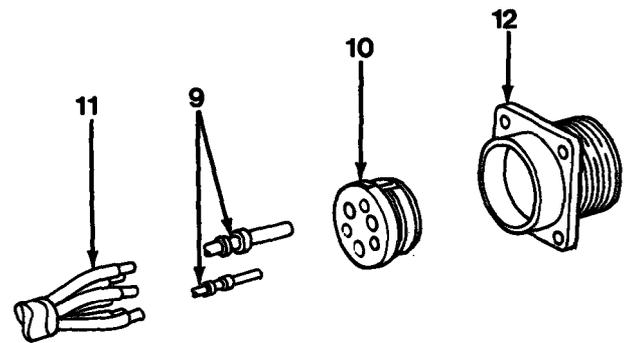


Figure 10-4

FEMALE-TYPE PANEL MOUNTING RECEPTACLE ASSEMBLY

1. Strip cable insulation equal to depth of solder wells of socket contacts (5, Figure 10-3).

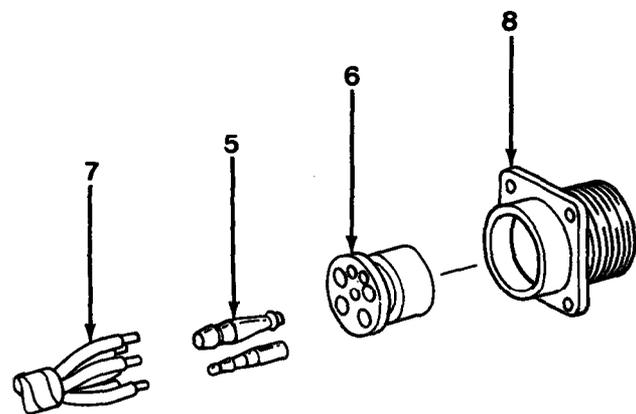


Figure 10-3

MAIN ENGINE WIRING HARNESS

**MAIN ENGINE WIRING HARNESS
REMOVAL**

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Disconnect main engine wiring harness (Figure 10-1) from hydraulic valve bank, winch valve, fuel shut-off toggle switch, front outrigger solenoid valve, collector ring, fuel sender, transmission temperature sender, axle centering light switch, oil pressure sender, travel alarm, rear outrigger solenoid valve, water temperature sender, oil pressure sender, alternator, starting motor solenoid, starting motor relay, speedometer sender, taillights, fuel solenoid and turn signals.
3. Remove main engine wiring harness mounting clamps and tie wraps. Discard tie wraps.
4. Remove main engine wiring harness.

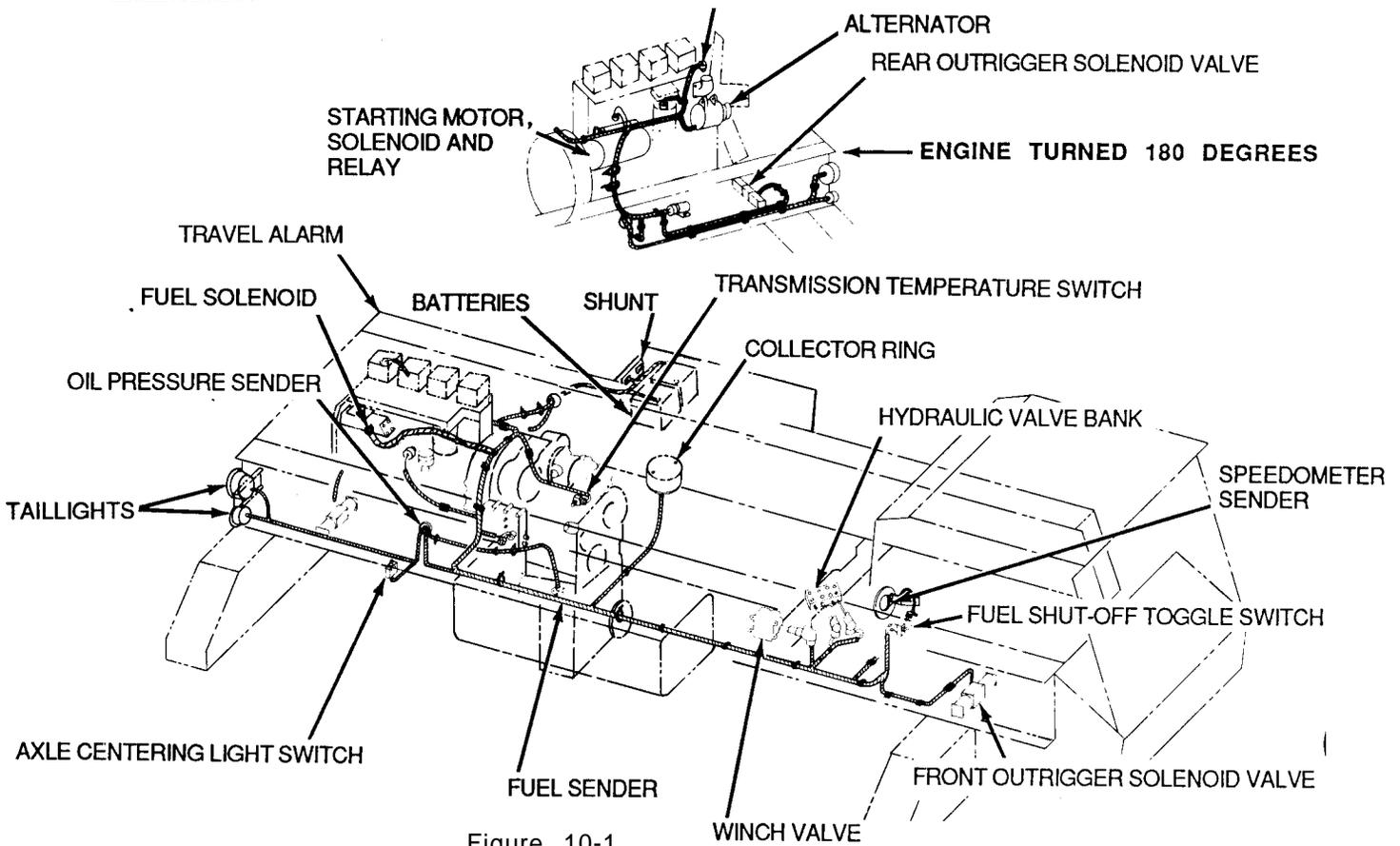


Figure 10-1

MAIN ENGINE WIRING HARNESS INSPECTION

1. Inspect all parts (refer to Chapter 4).
2. Repair wire harness, if necessary (refer to page 10-24).

MAIN ENGINE WIRING HARNESS INSTALLATION

1. Position main engine wiring harness in vehicle.
2. Connect main engine wiring harness (Figure 10-1) at hydraulic valve bank, winch valve, fuel shut off toggle switch, front outrigger solenoid valve, collector ring, fuel sender, transmission temperature sender, axle centering light switch, oil pressure sender, travel alarm, rear outrigger solenoid valve, water temperature sender, oil pressure sender, alternator, starting motor solenoid, starting motor relay, speedometer sender, taillights, fuel solenoid and turn signals.
3. Install new tie wraps and clamps to secure main engine wiring harness.
4. Connect battery negative ground cable.

CAB MAIN HARNESS

CAB MAIN HARNESS REMOVAL



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Disconnect circuit breaker panel and wire assemblies (refer to page 17-64).
3. Disconnect wire harness plugs from receptacles on back wall of cab.
4. Disconnect side sloping dash panel and wire assemblies (refer to page 17-63).
5. Disconnect anti-two block panel and wire assemblies (refer to page 10-66).
6. Disconnect dash panel and wire assemblies (refer to page 17-61).
7. Remove two clamps (1) and wire (2, Figure 10-1) from heater and circuit breaker.

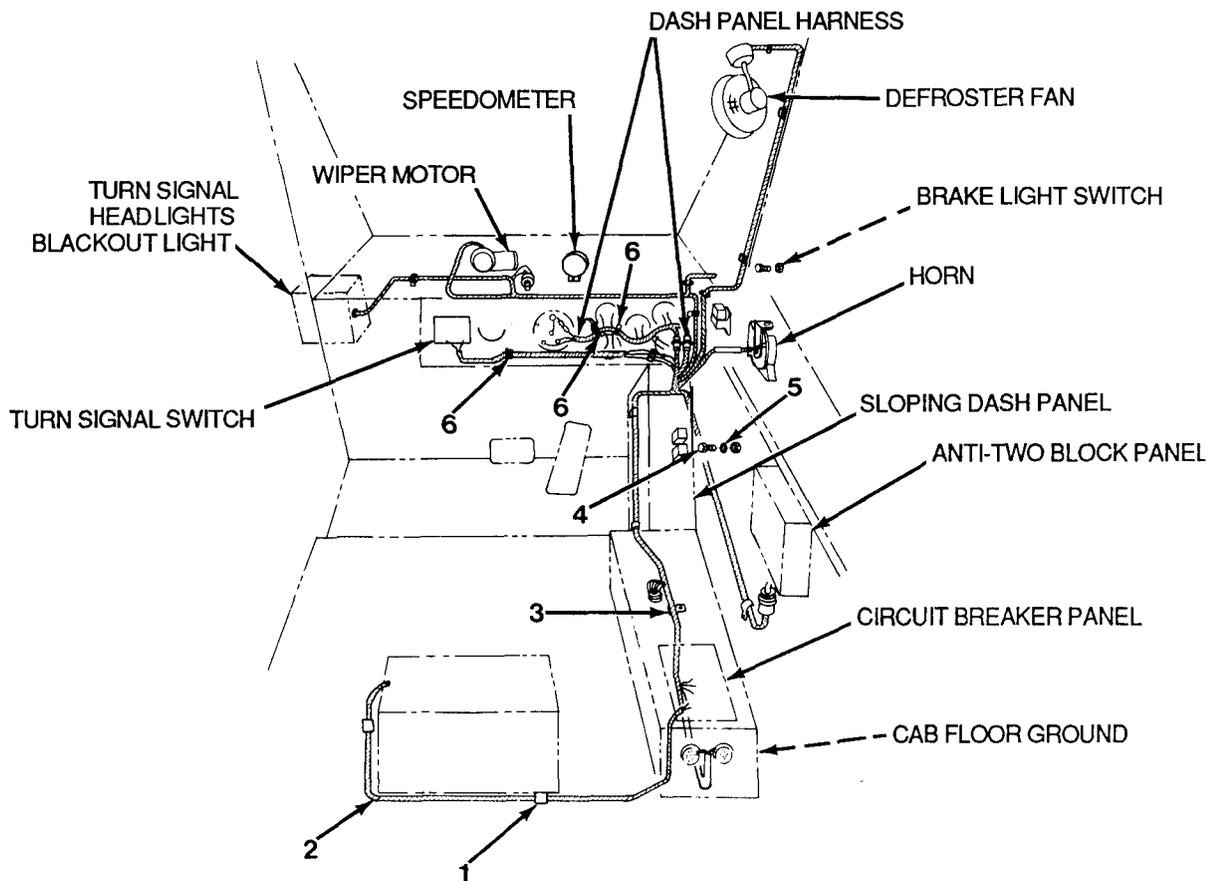


Figure 10-1

8. Disconnect cab main harness from cab floor ground, circuit breaker, anti-two block warning panel, sloping dash panel, horn, defroster fan, brake light switch, wiper motor, turn signal switch, speedometer, head-lights, blackout light, turn signal and speedometer alarm.
9. Remove cab main harness mounting clamps (3), capscrews (4), nuts (5) and plastic ties (6).
10. Remove cab main harness.

CAB MAIN HARNESS INSPECTION

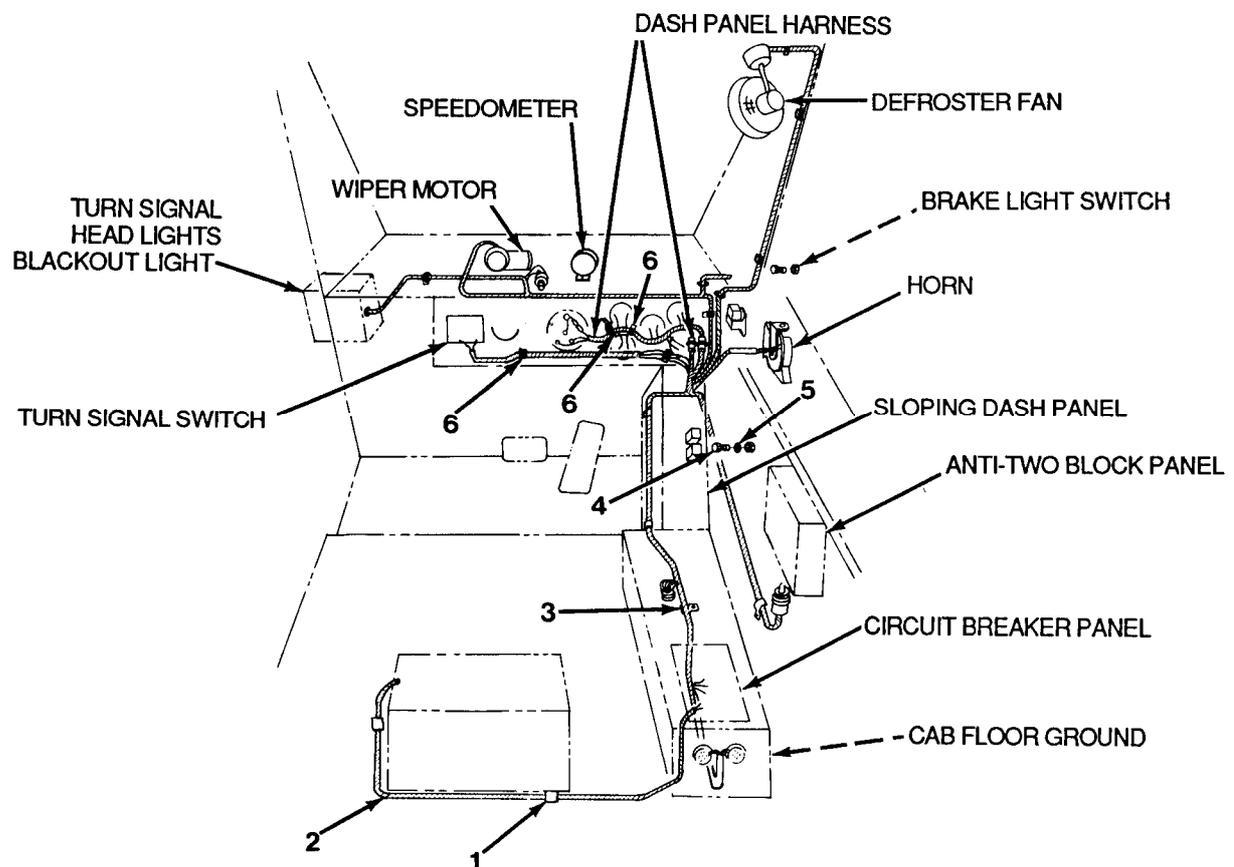
1. Inspect all parts (refer to Chapter 4).
2. Repair cab main harness, if necessary (refer to page 10-24).

CAB MAIN HARNESS INSTALLATION

1. Position cab main harness in vehicle.
2. Install new plastic ties (6), nuts (5), capscrews (4) and cab main harness mounting clamps (3, Figure 10-1) to secure cab main harness.

CAB MAIN HARNESS INSTALLATION

3. Connect cab main harness from cab floor ground, circuit breaker, anti-two block warning panel, sloping dash panel, horn, defroster fan, brake light switch, wiper motor, turn signal switch, speedometer, headlights, blackout light, turn signal and speedometer alarm.
4. Install wire (2) and two clamps (1, Figure 10-1) to heater and circuit breaker.
5. Connect dash panel and wire assemblies (refer to page 17-66).
6. Connect circuit breaker panel and wire assemblies (refer to page 17-65).
7. Connect sloping dash panel and wire assemblies (refer to page 17-65).
8. Connect anti-two block panel and wire assemblies (refer to page 10-67).
9. Connect battery negative ground cable.



MAIN STE/ICE HARNESS

MAIN STE/ICE HARNESS REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.

2. Remove DCA and resistor module connectors from rear wall of cab (refer to page 10-69).

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

3. Disconnect main STE/ICE harness (Figure 10-1) horn resistor module, tachometer sender, fuel pressure transducer, alternator, starting motor solenoid, fuel differential pressure switch, shunt, batteries, starting motor and fuel solenoid.

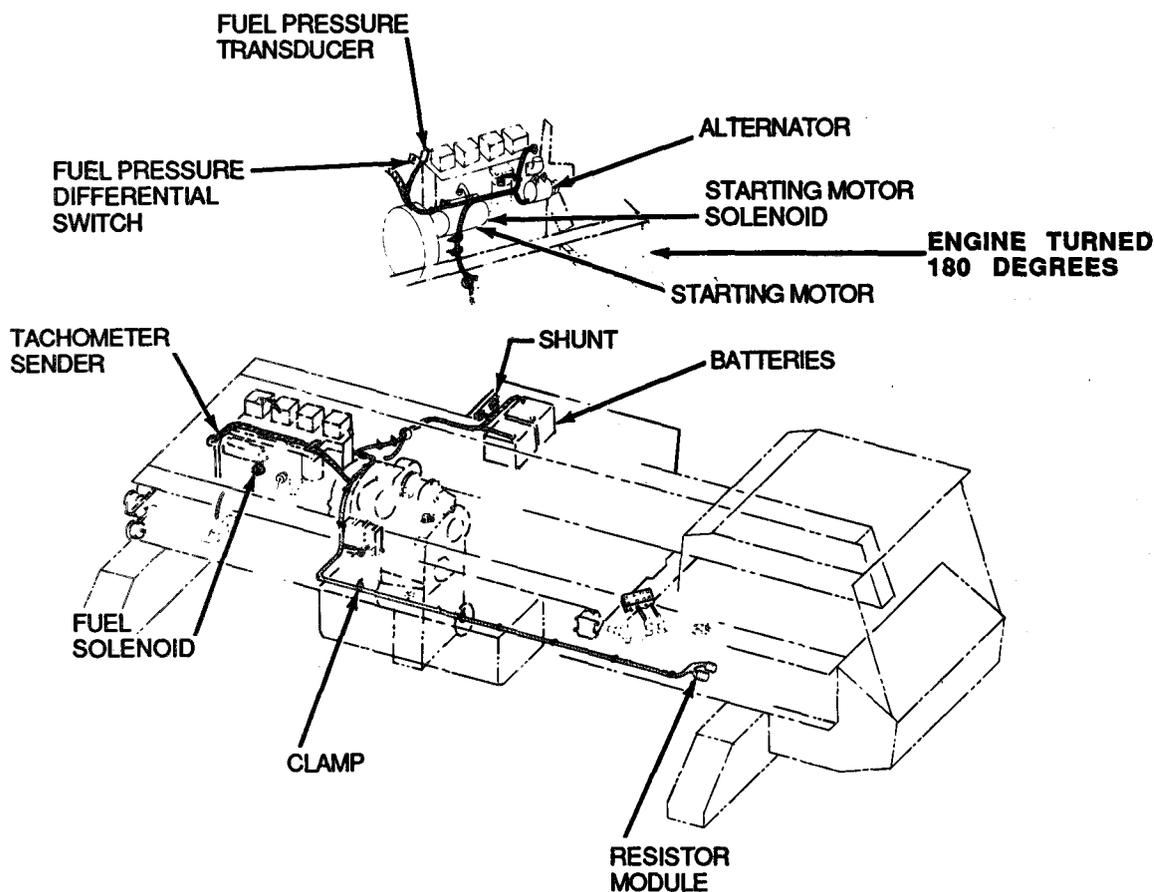


Figure 10-1

MAIN STE/ICE HARNESS REMOVAL

4. Remove main STE/ICE harness mounting clamps and hardware.
5. Remove STE/ICE harness.

MAIN STE/ICE HARNESS INSPECTION

1. Inspect all parts (refer to Chapter 4).
2. Repair STE/ICE wire harness, if necessary (refer to page 10-24).

MAIN STE/ICE HARNESS INSTALLATION

1. Position main STE/ICE harness (Figure 10-1) in vehicle.
2. Connect main STE/ICE harness to resistor module, tachometer sender, fuel pressure transducer, alternator, starter solenoid, fuel pressure differential switch, shunt, batteries, starting motor and fuel solenoid.
3. Install DCA and resistor module connectors on rear wall of cab.
4. Install clamps and hardware to secure main STE/ICE wire harness.
5. Connect battery negative ground cable.

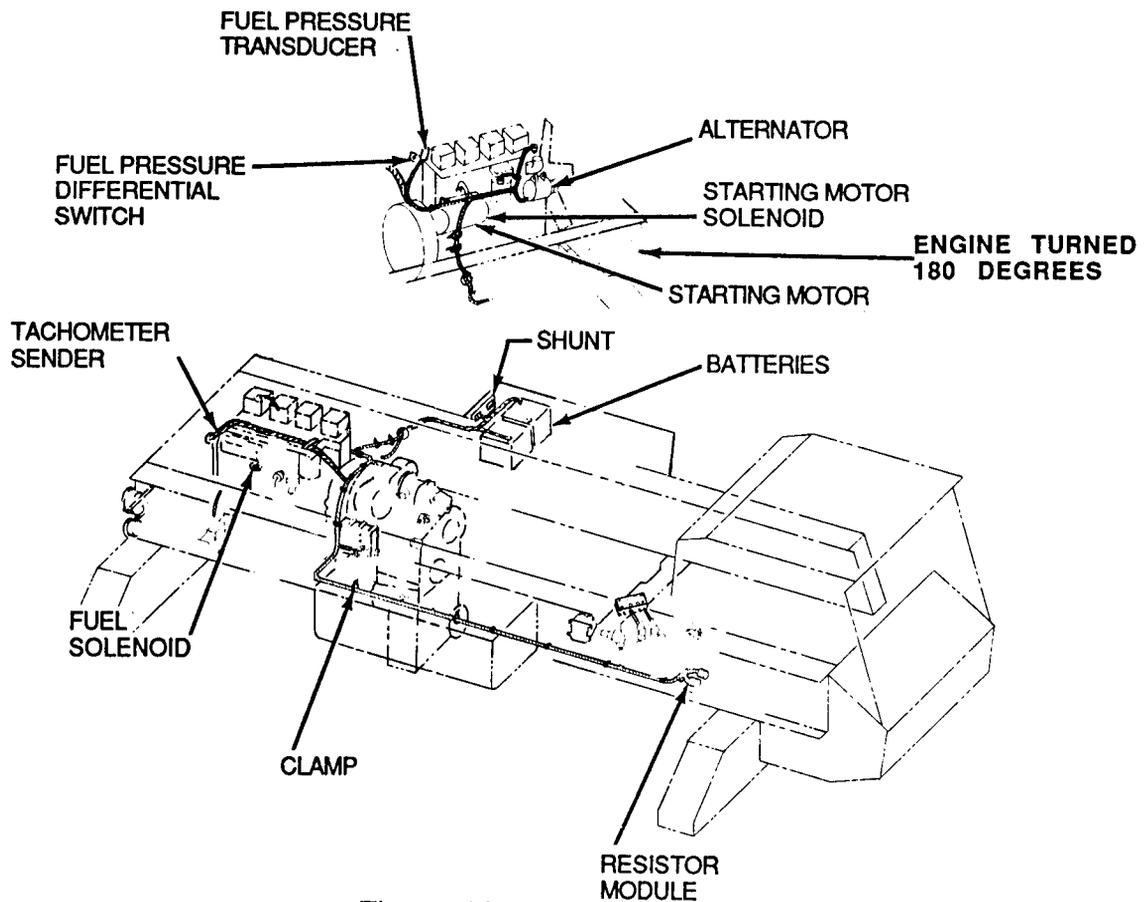


Figure 10-1

LEFT FRONT LIGHTS AND BRACKET

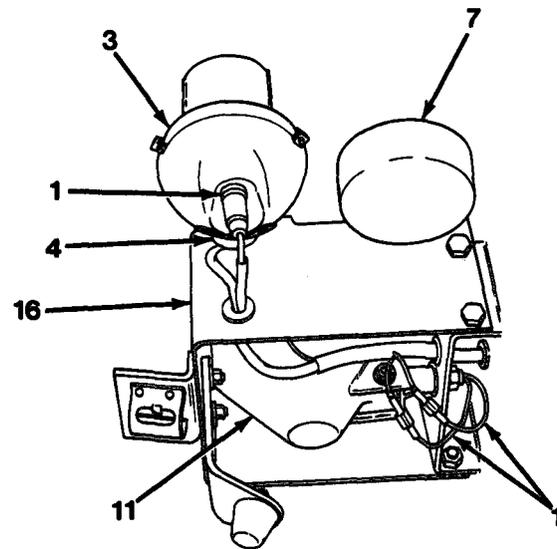
LEFT FRONT LIGHTS AND BRACKET REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

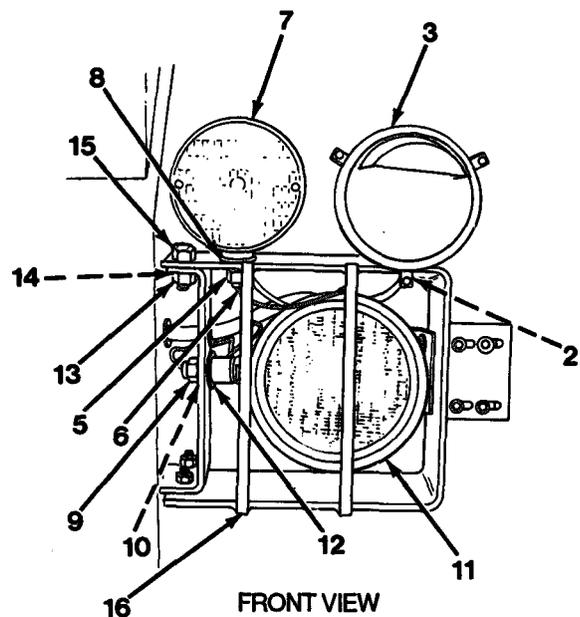
NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.



REAR VIEW

1. Disconnect battery negative ground cable.
2. Disconnect electrical wires (1, Figure 10-1).
3. Remove nut (2), blackout lamp (3) and washer (4).
4. Remove nut (5), ground wire (6), turn signal (7) and washer (8).
5. Remove nut (9) and lockwasher (10) from headlight (11) base.
6. Remove headlight (11) and washer (12).
7. Remove four nuts (13), lockwashers (14), capscrews (15) anti left front bracket (16).



FRONT VIEW

Figure 10-1

LEFT FRONT LIGHTS AND BRACKET INSPECTION

Inspect all parts (refer to Chapter 4).

LEFT FRONT LIGHTS AND BRACKET INSTALLATION

1. Install left front bracket (16), four capscrews (15), lockwashers (14) and nuts (13 Figure 10-1).
2. Install washer (12), headlight (11), lock-washer (10) and nut (9).
3. Install washer (8), turn signal (7), ground wire (6) and nut (5).
4. Install washer (4), blackout lamp (3) and nut (2).
5. Connect electrical wires (1).
6. Connect battery negative ground cable.

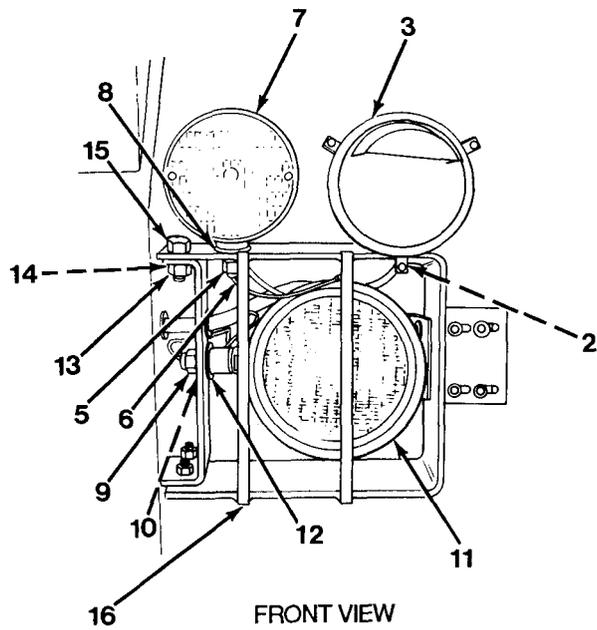
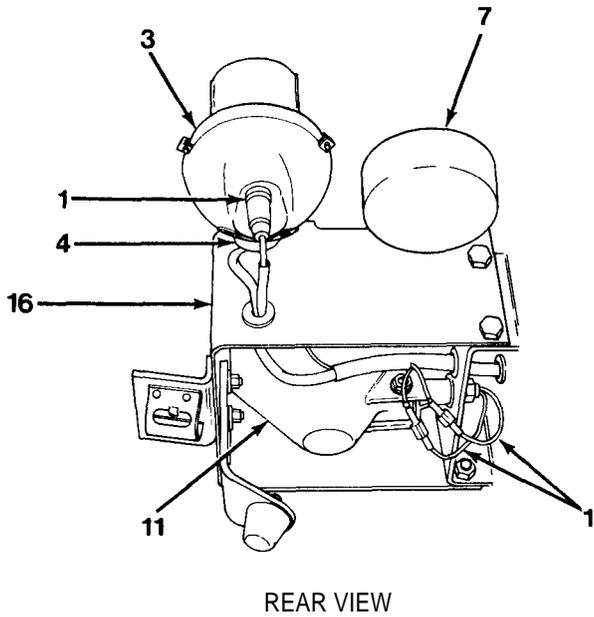


Figure 10-1

RIGHT FRONT LIGHTS AND BRACKET

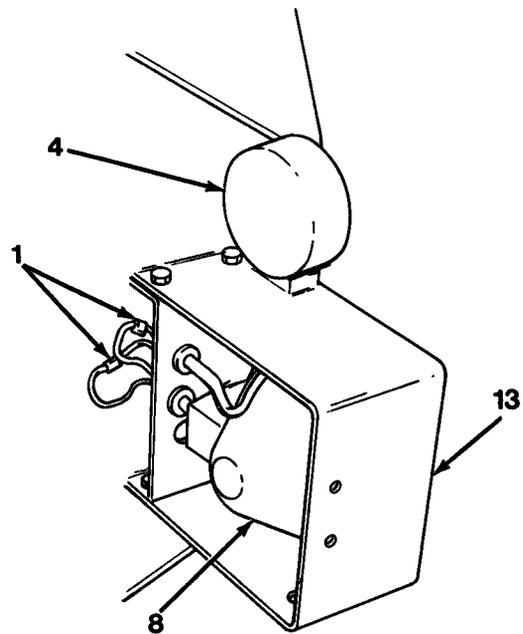
**RIGHT FRONT LIGHTS AND BRACKET
REMOVAL**



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

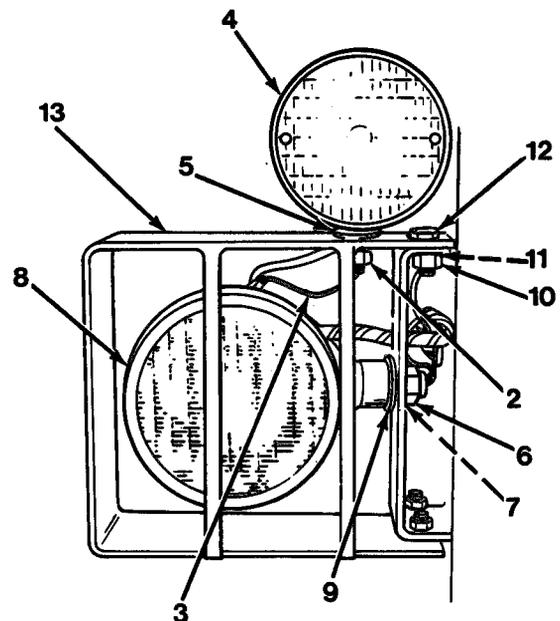
NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.



REAR VIEW

1. Disconnect battery negative ground cable.
2. Disconnect electrical wires (1, Figure 10-1).
3. Remove nut (2), ground wire (3), turn signal (4) and washer (5).
4. Remove nut (6) and lockwasher (7) from headlight (8) base.
5. Remove headlight (8) and washer (9).
6. Remove four nuts (10), lockwashers (11), capscrews (12) and right front bracket (13).



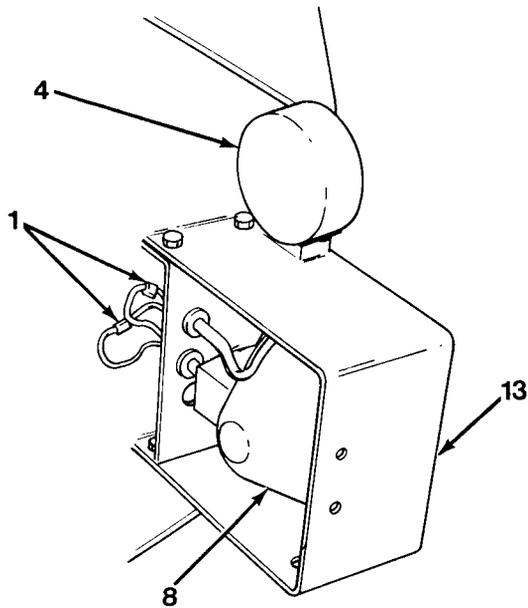
FRONT VIEW

**RIGHT FRONT LIGHTS AND BRACKET
INSPECTION**

Inspect all parts (refer to Chapter 4).

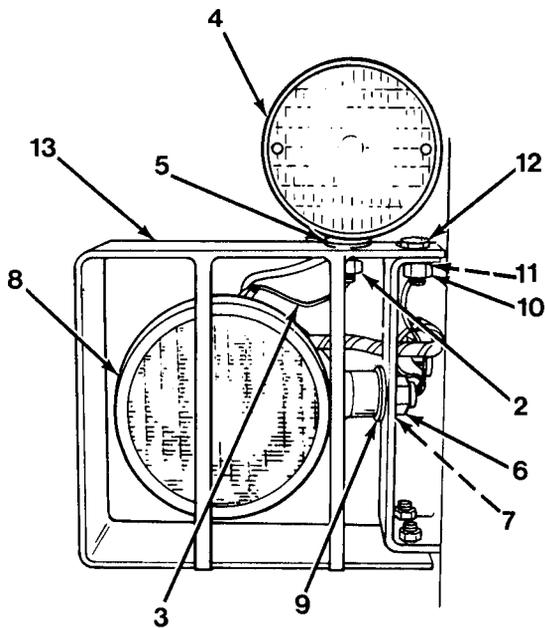
Figure 10-1

RIGHT FRONT LIGHTS AND BRACKET INSTALLATION



REAR VIEW

1. Install right front bracket (13), four capscrews (12), lockwashers (11) and nuts (10, Figure 10-1).
2. Install washer (9), headlight (8), lockwasher (7) and nut (6).
3. Install washer (5), turn signal (4), ground wire (3) and nut (2).
4. Connect electrical wires (1),
5. Connect battery negative ground cable.



FRONT VIEW

Figure 10-1

REAR LIGHTS**FEAR LIGHTS REMOVAL****⚠ WARNING**

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Disconnect electrical wires.
3. Remove nut (1, Figure 10-1), washer (2), wire (3), turn signal (4) and washer (5).
4. Remove two capscrews (6), lockwashers (7), wires (8) and rear taillight (9).
5. Repeat steps 1 thru 3 for other side, if necessary.

3. Connect electrical wires.
4. Repeat steps 1 thru 3 for other side, if necessary.
5. Connect battery negative ground cable.

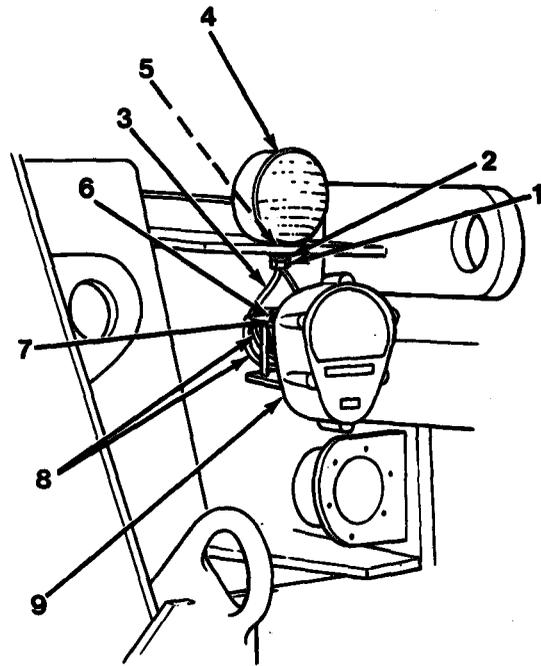


Figure 10-1

REAR LIGHTS INSTALLATION

1. Install taillight (9), two wires (8), lockwashers (7) and capscrews (6, Figure 10-1).
2. Install washer (5), turn signal (4), wire (3), washer (2) and nut (1).

TRAVEL ALARM

TRAVEL ALARM REMOVAL



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

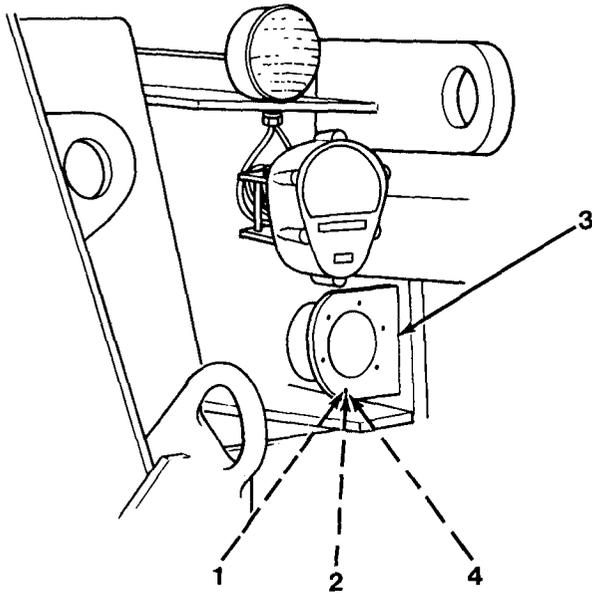


Figure 10-1

1. Disconnect battery negative ground cable.
2. Disconnect electrical wires.
3. Remove two nuts (1), two lockwashers (2), travel alarm (3) and two washers (4, Figure 10-1).

TRAVEL ALARM INSPECTION

Inspect all parts (refer to Chapter 4).

TRAVEL ALARM INSTALLATION

1. Install two washers (4), travel alarm (3), two lockwashers (2) and nuts (1, Figure 10-1).
2. Connect electrical wires.
3. Connect battery negative ground cable.

HORN

HORN REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Disconnect electrical wires (1, Figure 10-1).
3. Remove nut (2), horn (3), and washer (4).

HORN INSPECTION

Inspect all parts (refer to Chapter 4).

HORN INSTALLATION

1. Install washer (4), horn (3) and nut (2, Figure 10-1).
2. Connect electrical wires (1).
3. Connect battery negative ground cable.

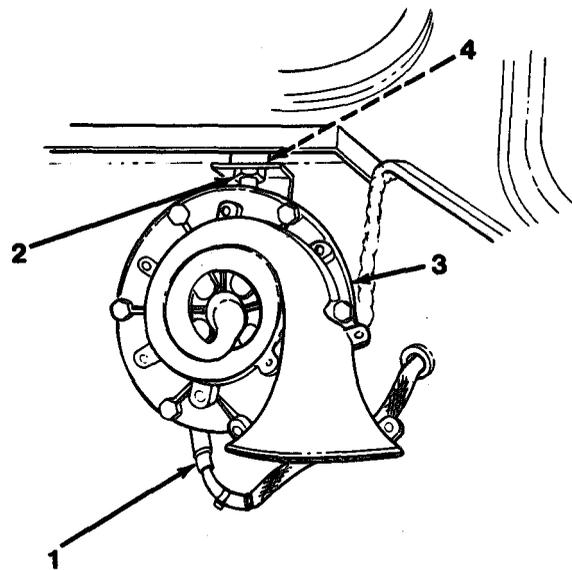


Figure 10-1

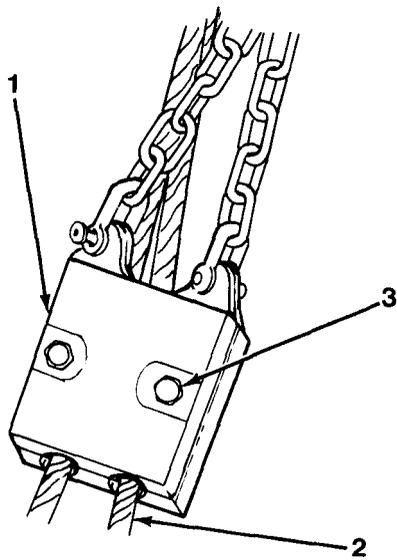


Figure 10-1

BOOM ELECTRICAL

BOOM ELECTRICAL REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Remove counterweight (1) from cable (2) by removing two sockethead cap screws (3, Figure 10-1) from counterweight (1). Split counterweight (1) and move from around cable (2).
3. Install two sockethead cap screws (3) back into counterweight (1).
4. Remove threaded pin (4) from clevis (5) on top of counterweight chain (6, Figure 10-2).

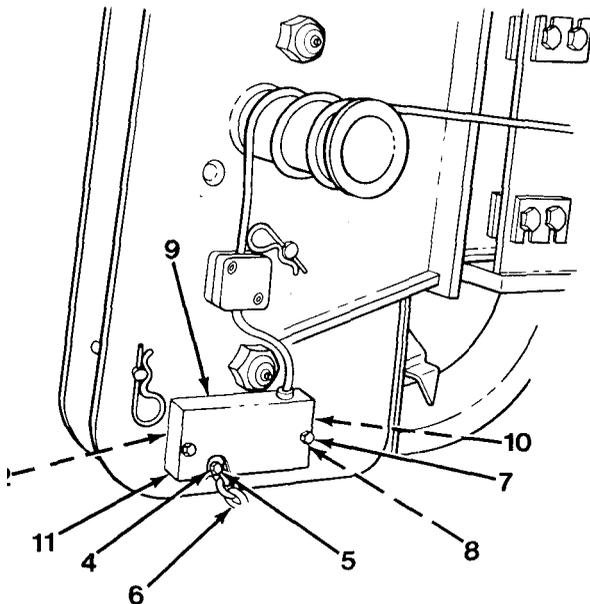


Figure 10-2

4. Remove counterweight chain (6) and install threaded pin (4) on clevis (5).
5. Remove two capscrews (7), lockwashers (8) and anti-two block switch assembly (9).

CAUTION

Anti-two block switch is serviced only as a complete assembly. Do not discard or lose any parts. Failure to follow this procedure could cause damage to equipment.

6. Remove screw (10), front cover (11) and rear cover (12) of anti-two block switch assembly (9) exposing electrical switch.
7. Slide electrical switch from anti-two block switch assembly (9), if necessary.
8. Remove three screws (13), electrical switch cover (14), three O-ring type gaskets (15) and cover gasket (16, Figure 10-3).
9. Loosen two screws (17) inside switch to disconnect cord (18, Figure 10-4).

WARNING

Do not let cord go as cable reel will pull harness rapidly. Rapidly moving harness could cause **SERIOUS INJURY** if it hits personnel.

10. Remove two capscrews (20) and clamping block (21). Slowly allow cable reel to take up cord (18).

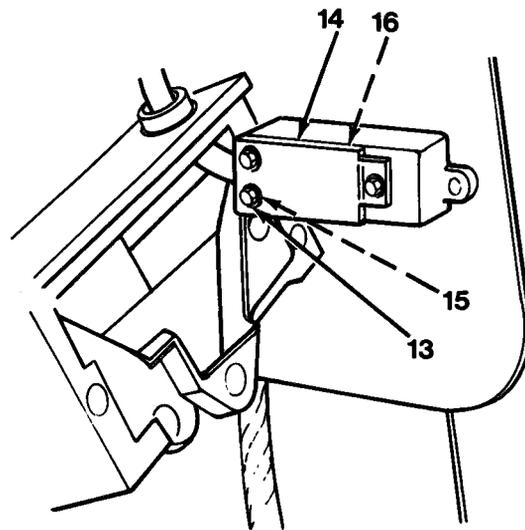


Figure 10-3

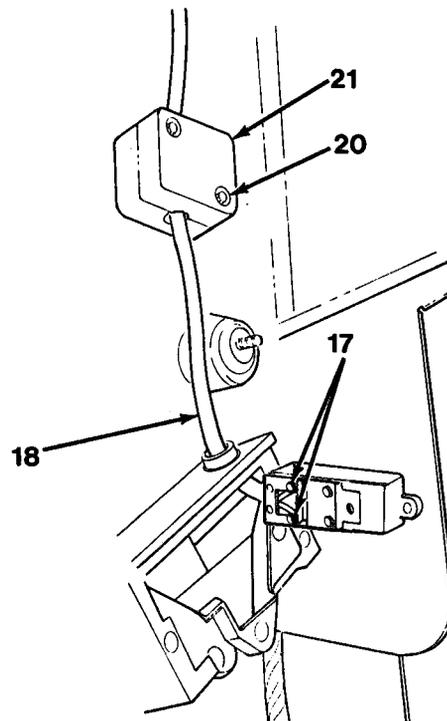


Figure 10-4

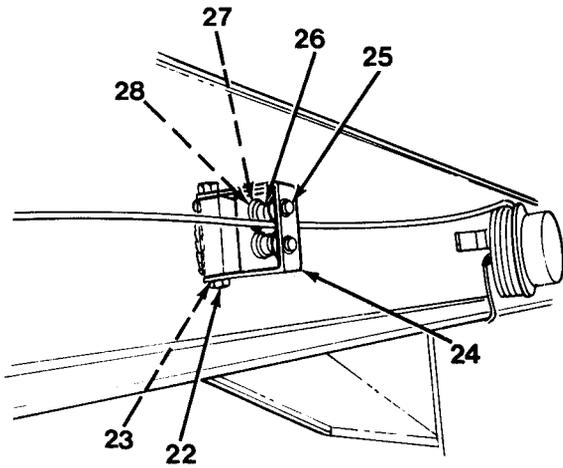


Figure 10-5

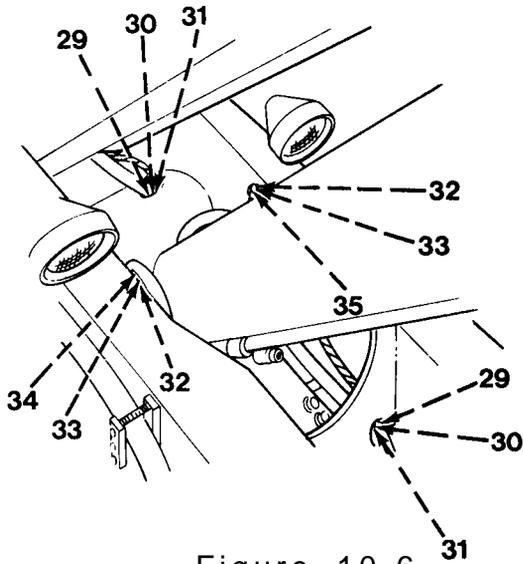


Figure 10-6

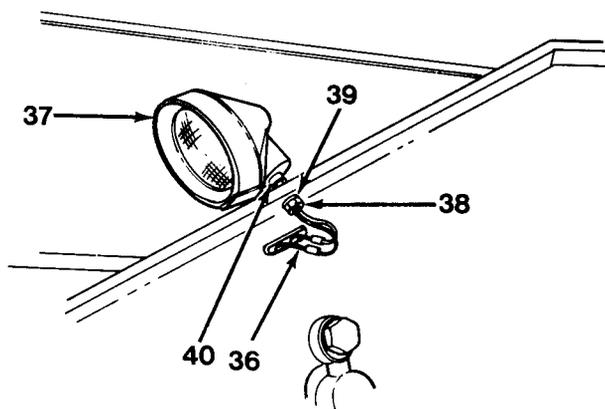


Figure 10-7

BOOM ELECTRICAL REMOVAL

11. Remove two capscrews (22), lockwashers (23) and roller bracket (24, Figure 10-5).
12. Disassemble roller bracket (24) by removing nut (25), roller (26), washer (27) and shoulder screw (28). Repeat for other roller.

NOTE

Boom must be raised to highest position to aid in removing wire harness clamps.

13. Connect battery negative ground cable.
14. Start engine. Raise boom to highest position.
15. Remove two nuts (29), washers (30) and clamps (31, Figure 10-6).
16. Install two washers (30) and nuts (29).
17. Remove nut (32), washer (33) and clamp (34).
18. Remove nut (32), washer (33) and clamp (35).
19. Hold anti-two block BY-PASS switch and lower boom. Shut engine off.
20. Disconnect battery negative ground cable.
21. Disconnect two work light wires (36) from each of the three work lights (37, Figure 10-7).
22. Remove three nuts (38), washers (39), work lights (37) and spacers (40).

23. Disconnect wire harness (41) from wire harnesses (42) and (43, Figure 10-8).
24. Remove nut (32), washer (33) and clamp (44).
25. Disconnect wire harness (41) from collector ring wire harness (45, Figure 10-9).
26. Remove wire harness (41).

CAUTION

Cable reel is serviced only as a complete assembly. Do not discard any parts. Failure to follow this procedure could cause damage to equipment.

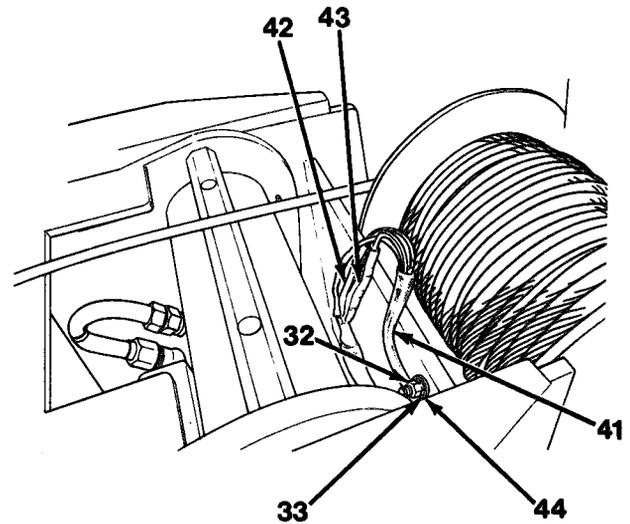


Figure 10-8

27. Remove six acorn nuts (46), washers (47) and reel cover (48, Figure 10-10).
28. Disconnect wire harness (42, Figure 10-11).
29. Install reel cover (48), six washers (47) and acorn nuts (46, Figure 10-10).

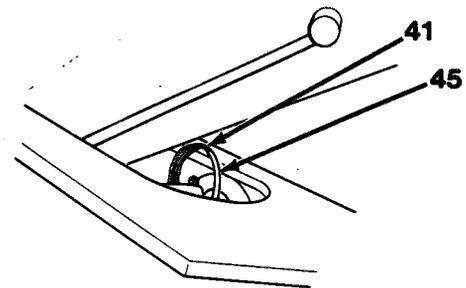


Figure 10-9

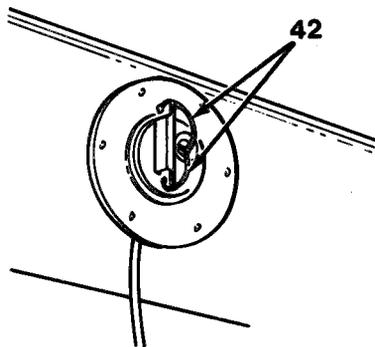


Figure 10-11

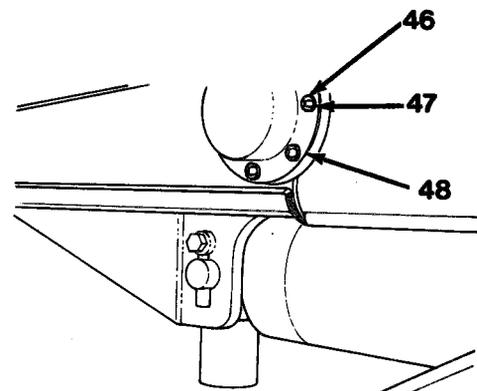


Figure 10-10

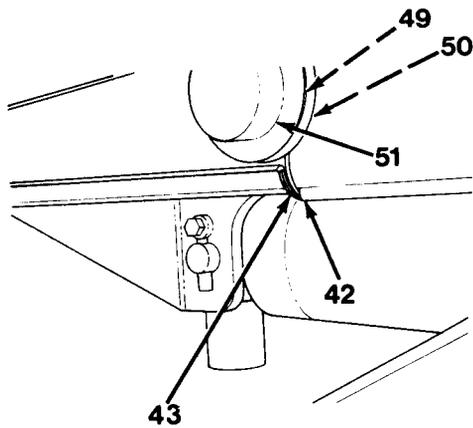


Figure 10-12

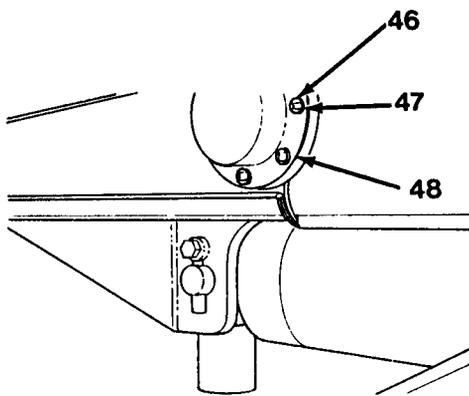


Figure 10-10

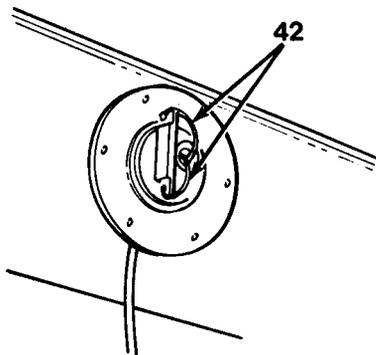


Figure 10-11

BOOM ELECTRICAL REMOVAL

30. Remove capscrew (49), lockwasher (50) and cable reel (51, Figure 10-12).
31. Remove wire harnesses (42) and (43).

BOOM ELECTRICAL INSPECTION

Inspect all parts (refer to Chapter 4).

BOOM ELECTRICAL INSTALLATION

1. Install wire harnesses (43) and (42, Figure 10-12).
2. Install cable reel (51), lockwasher (50) and capscrew (49).

Cable reel is serviced only as a complete assembly. Do not discard any parts. Failure to follow this procedure could cause damage to equipment.

3. Remove six acorn nuts (46), washers (47) and reel cover (48, Figure 10-10).
4. Connect wire harness (42, Figure 10-11).
5. Install reel cover (48), six washers (47) and acorn nuts (46, Figure 10-10).

6. Install wire harness (41) to collector ring wire harness (45, Figure 10-9).
7. Connect wire harnesses (43) and (42) to wire harness (41, Figure 10-8).
8. Install clamp (44), washer (33) and nut (32).
9. Install three spacers (40), work lights (37), washers (39) and nuts (38, Figure 10-7).
10. Connect two work light wires (36) to each of three work lights (37).

NOTE

Boom must be raised to highest position to aid in installing wire harness clamps.

11. Connect battery negative ground cable.
12. Start engine. Raise boom to highest position.

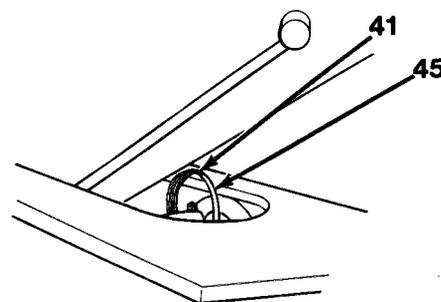


Figure 10-9

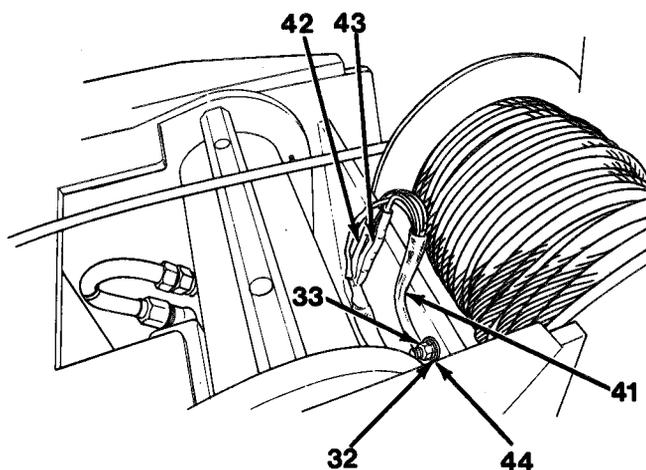


Figure 10-8

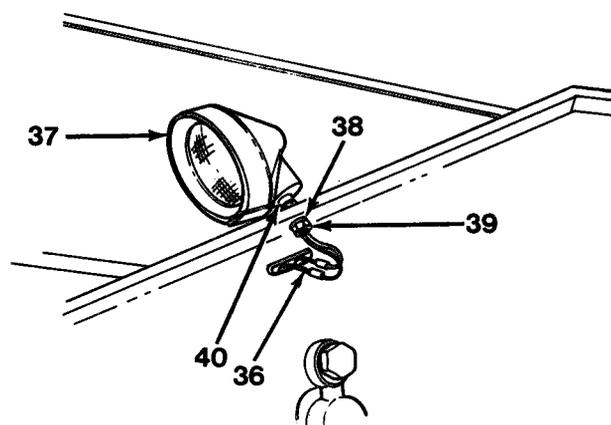


Figure 10-7

BOOM ELECTRICAL INSTALLATION

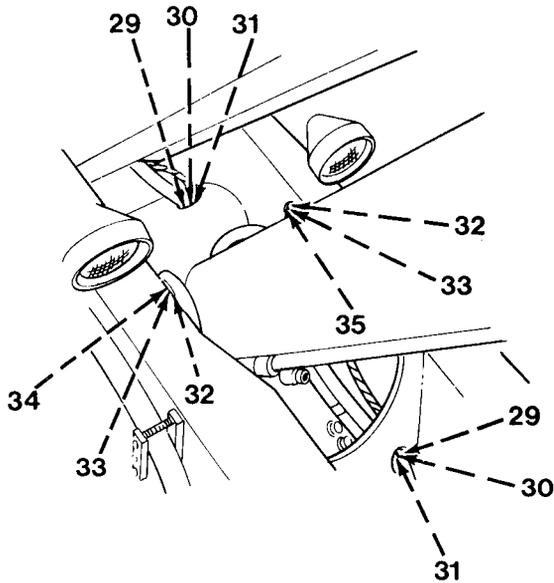


Figure 10-6

13. Install clamp (35), washer (33) and nut (32, Figure 10-6).
14. Install clamp (34), washer (33) and nut (32).
15. Remove two nuts (29) and washers (30).
16. Install two clamps (31), washers (30) and nuts (29).
17. Hold anti-two block BY-PASS switch and lower boom. Shut engine off.
18. Disconnect battery negative ground cable.
19. Assemble roller bracket (24) by installing shoulder screw (28), washer (27), roller (26) and nut (25, Figure 10-5). Repeat for other roller.
20. Install roller bracket (24), two lockwashers (23) and capscrews (22).

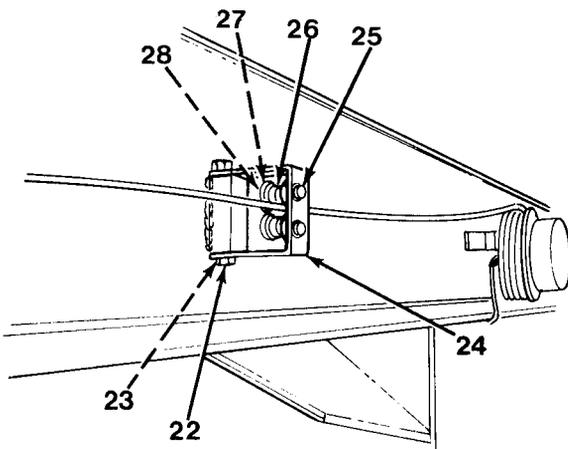


Figure 10-5

⚠ WARNING

Do not let harness go as cable reel will pull harness rapidly. Rapidly moving harness could cause **SERIOUS INJURY** if it hits personnel.

21. Spool cord (18) off of cable reel, thread through roller brackets, wrap 3 to 4 times around strain relief tube and install clamping block (21) and two capscrews (20) to secure harness (18, Figure 10-4) in place.
22. Connect cord (18) to electrical switch by tightening two screws (17) on electrical switch. Slide electrical switch in place in anti-two blink switch assembly (9).
23. Install cover gasket (16), three O-ring type gaskets (15), switch cover (14) and tie screws (13, Figure 10-3).

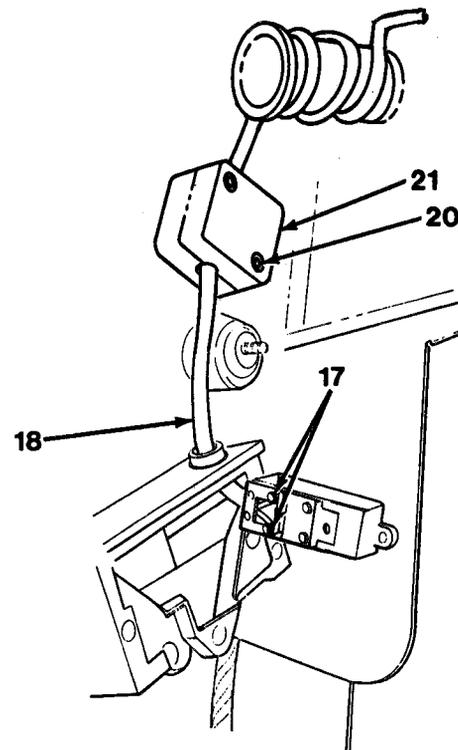


Figure 10-4

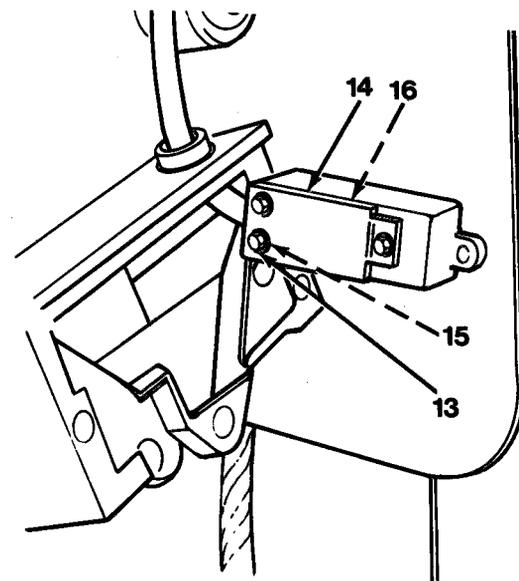


Figure 10-3

BOOM ELECTRICAL INSTALLATION

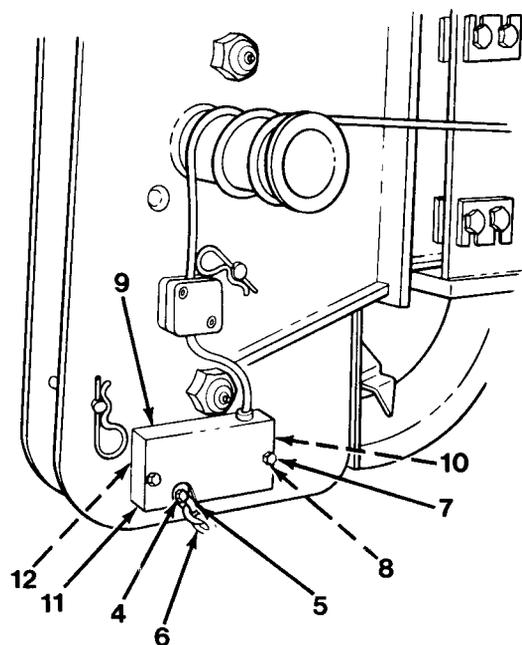


Figure 10-2

24. Install front cover (11) and rear cover (12) on anti-two block switch assembly (9) with screw (10, Figure 10-2).
25. Install anti-two block switch assembly (9), two lockwashers (8) and capscrews (7).
26. Install counterweight (1, Figure 10-1) and chain (6) by removing threaded pin (4) from clevis (5) on anti-two block switch assembly (9, Figure 10-2) and secure with threaded pin (4).
27. Place counterweight (1) around cable (2) by removing two sockethead capscrews (3) and splitting counterweight (1, Figure 10-1). Place cable (2) in counterweight (1).
28. Install two capscrews (3) back in counterweight (1).
29. Connect battery negative ground cable.

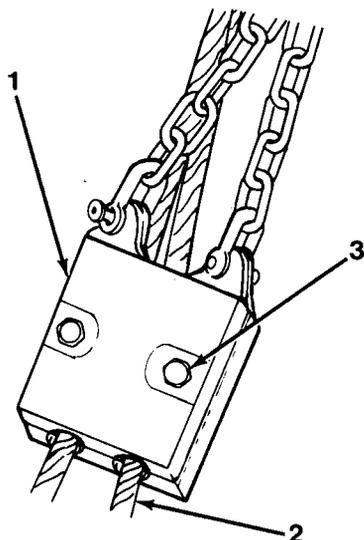


Figure 10-1

ELECTRICAL COLLECTOR RING

ELECTRICAL COLLECTOR RING REMOVAL

1. Start engine. Raise boom to 15 degrees elevation. Shut engine off.

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

2. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

3. Disconnect four knife connectors (1) from under carrier at bottom of rotary manifold (2, Figure 10- 1).
4. Disconnect four knife connectors (3) from inside upperstructure near top of collector ring (4).
5. Remove two nuts (5) and washers (6) from cover (7) of collector ring (4). Remove cover (7).

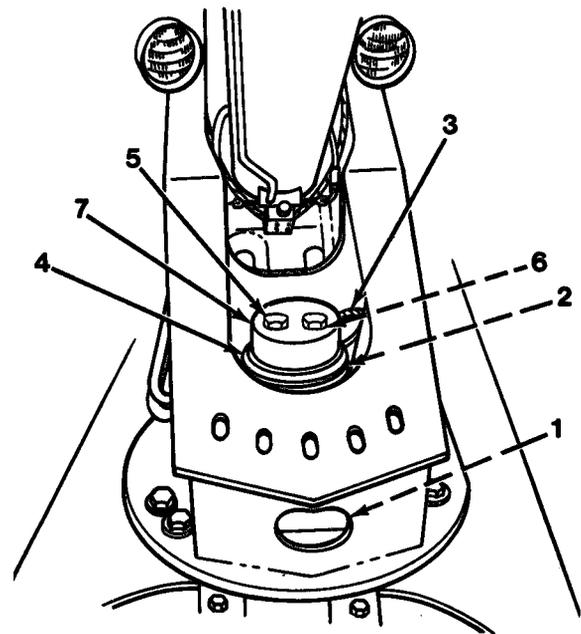


Figure 10-1

ELECTRICAL COLLECTOR RING REMOVAL

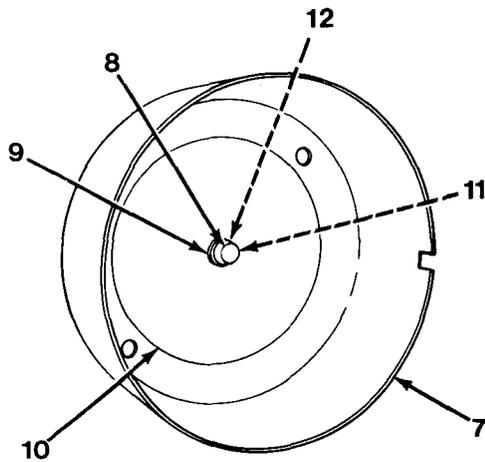


Figure 10-2

6. Remove cap nut (8), nylon washer (9), nylon plate (10), capscrew (11) and washer (12) from cover (7, Figure 10-2).
7. Loosen three setscrews (13) on bottom of collector ring core (14). Lift collector ring base (15) and brushes (16) off as an assembly from mounting column (17, Figure 10-3). Remove setscrews (13), if necessary.
8. Remove two of four set collars (18), bearing (19) and remaining two set collars (18) from two studs (20).
9. Push upon lower harness (21) to create slack. Slide collector ring core (14) to one side and remove collector ring core (14) from brush assemblies (16).
10. Remove lower harness (21) from collector ring core (14).

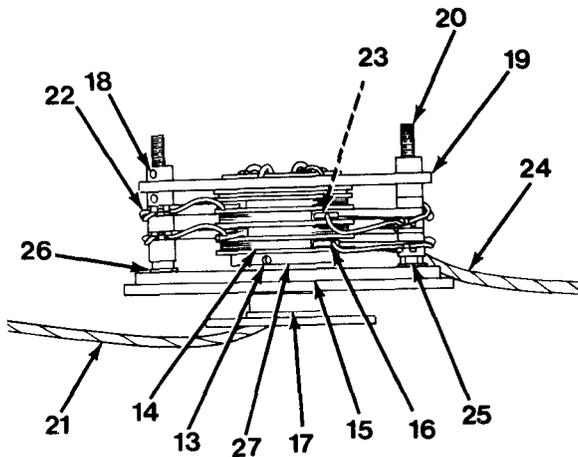


Figure 10-3

NOTE

Record number of nylon shims used when removing brush assemblies. Also note position of color coded wires when removing brush assemblies.

11. Remove nylon shim(s) (22) and four brush assemblies (16) from two studs (20).
12. Remove four springs (23) from brush assemblies (16).
13. Remove upper harness (24) from brush assemblies (16).

14. Loosen two nuts (25). Remove two studs (20), washers (26) and nuts (25) from collector ring base (15).
15. Remove bearing (27) from collector ring base (15).
16. Remove three capscrews (28) and mounting column (17, Figure 10-4).
17. Remove two capscrews (29), washers (30) and bracket (31) from rotary manifold (2).

ELECTRICAL COLLECTOR RING INSPECTION

Inspect all parts (refer to Chapter 4).

ELECTRICAL COLLECTOR RING INSTALLATION

1. Connect battery negative ground cable.
2. Start engine. Raise boom to 15 degrees elevation. Shut engine off.

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

3. Disconnect battery negative ground cable.
4. Place ignition switch in OFF position.
5. Install bracket (31), two washers (30) and capscrews (29) on rotary manifold (2, Figure 10-4).
6. Install mounting column (17) and tie capscrews (28).

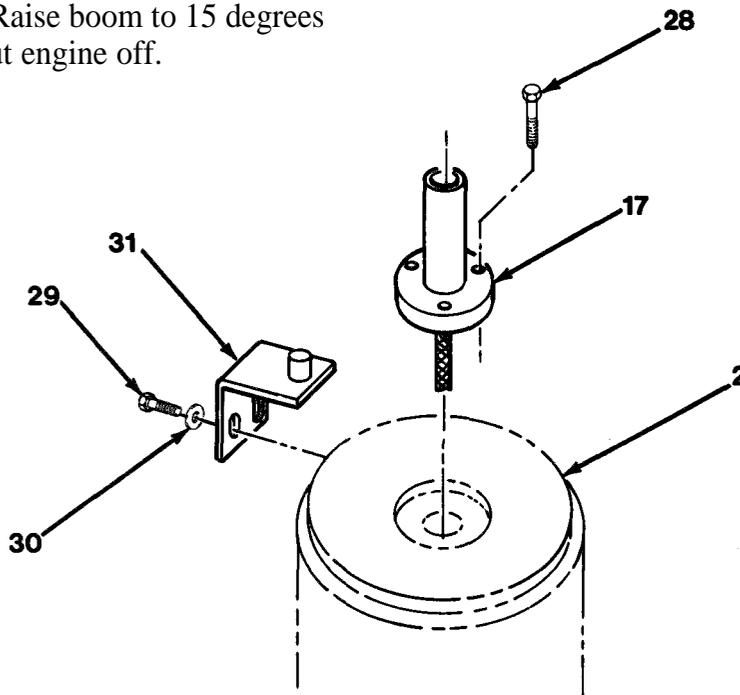


Figure 10-4

ELECTRICAL COLLECTOR RING INSTALLATION

7. Install bearing (27) in collector ring base (15, Figure 10-3) .
8. Install two nuts (25) and washers (26) on two studs (20). Install two studs (20) in collector ring base (15). Secure two nuts (25).
9. Connect upper harness (24) to brush assemblies (16).
10. Install four springs (23) in four brush assemblies (16).

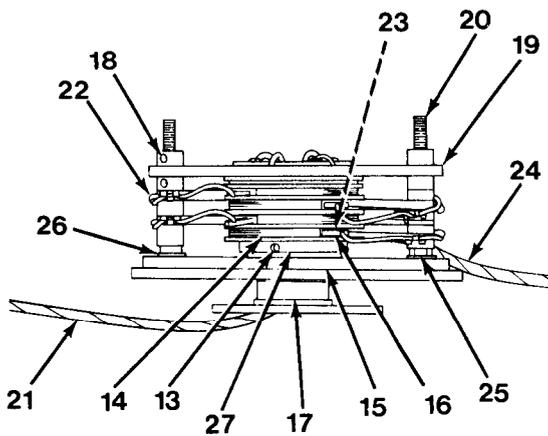


Figure 10-3

NOTE

Use number of nylon shims recorded in removal for assembling collector ring core. Also, use the placement of color coded wires noted during removal for assembling collector ring core.

11. Install nylon shim(s) (22) and brush assembly (16) on two studs (20).
12. Connect lower harness (21) to collector ring core (14).
13. Install lower harness (21) and collector ring core (14) through collector ring base (15). Slide collector ring core (14) into brush assemblies (16). Make sure brush assemblies (16) are on correct ring.
14. Install two of four set collars (18), bearing (19) and remaining two set collars (18) on studs (20).

15. Install three setscrews (13), if removed.
Install collector ring core (14) and collector ring base (15) as an assembly on mounting column (17). Align hole in collector ring base (15, Figure 10-3) with bracket (31) on rotary manifold (2, Figure 10-4). Torque three setscrews (13, Figure 10-3) to 45 to 55 lb-in (5.1 to 6.2 N•m).
16. Install washer (12), capscrew (11), nylon plate (10), nylon washer (9) and cap nut (8) on cover (7, Figure 10-2).

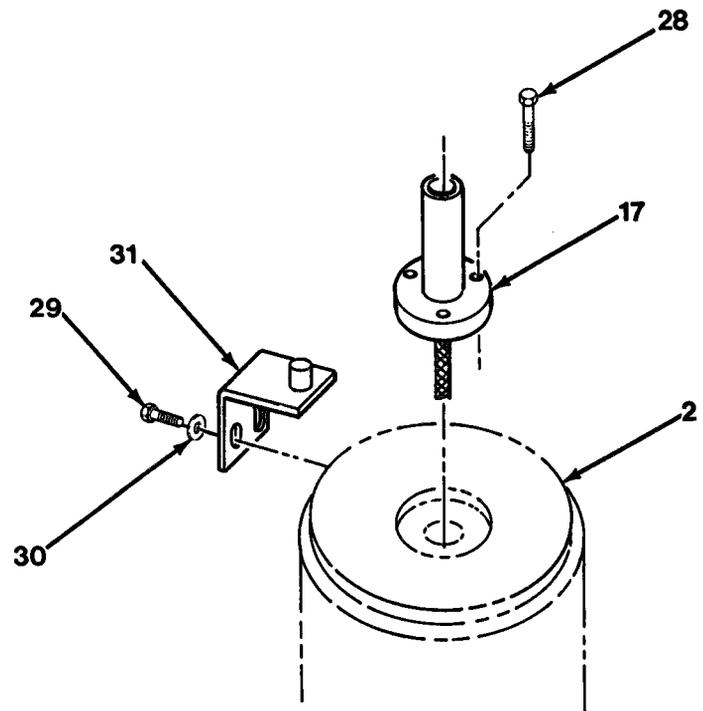


Figure 10-4

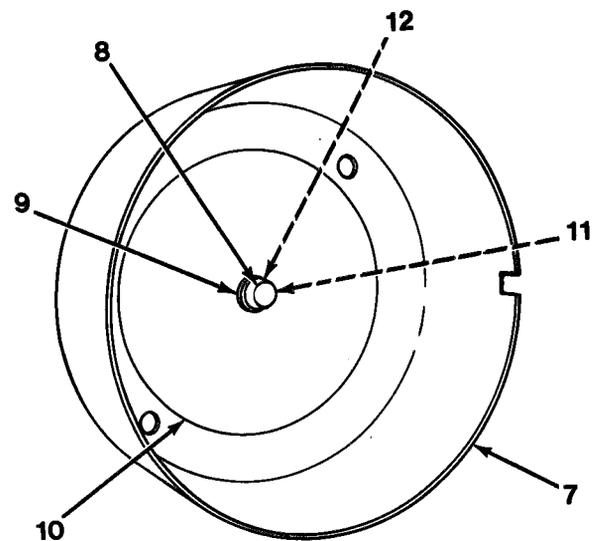


Figure 10-2

ELECTRICAL COLLECTOR RING INSTALLATION

17. Install cover (7). Make sure upper harness grommet fits in slot on side of cover (7). Install two washers (6) and nuts (5, Figure 10-1).

CAUTION

Secure harness so that it does not drop down around electrical collector ring. Damage to harness may result.

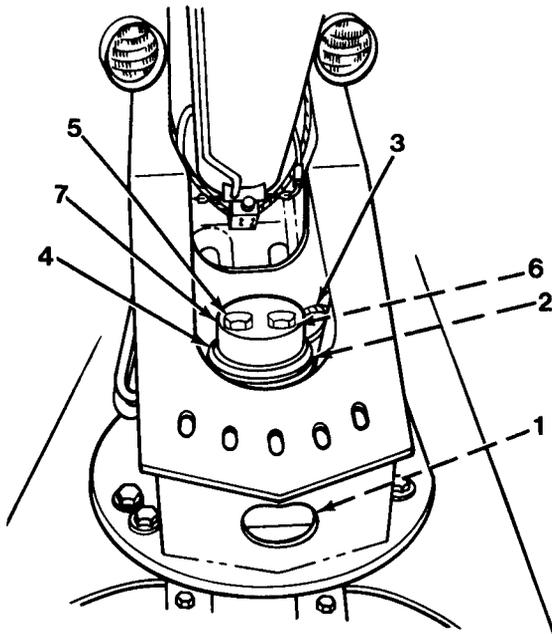


Figure 10-1

18. Connect four knife connectors (3) inside upperstructure. Protect connectors (3) with shrink tubing or electrical tape. Secure harnesses together with tie wraps.
19. Connect four knife connectors (1) under carrier near rotary manifold (2). Protect connectors with shrink tubing or electrical tape. Secure harnesses together with tie wraps.
20. Connect battery negative ground cable.

AXLE CENTERING LIGHT SWITCH ASSEMBLY

AXLE CENTERING LIGHT SWITCH ASSEMBLY REMOVAL

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Disconnect cam switch electrical lead (1, Figure 10-1).
3. Remove two sockethead capscrews (2), nuts (3) and washers (4, Figure 10-2).
4. Remove switch (5).
5. Remove jam nut (6) and washer (7).
6. Remove two nuts (8), washers (9), capscrews (10), washers (11), block (12) and rod (13).
7. Remove rod (13) from block (12).

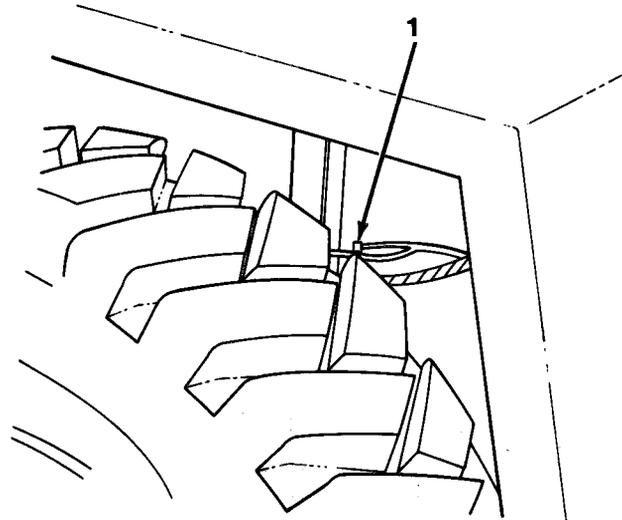


Figure 10-1

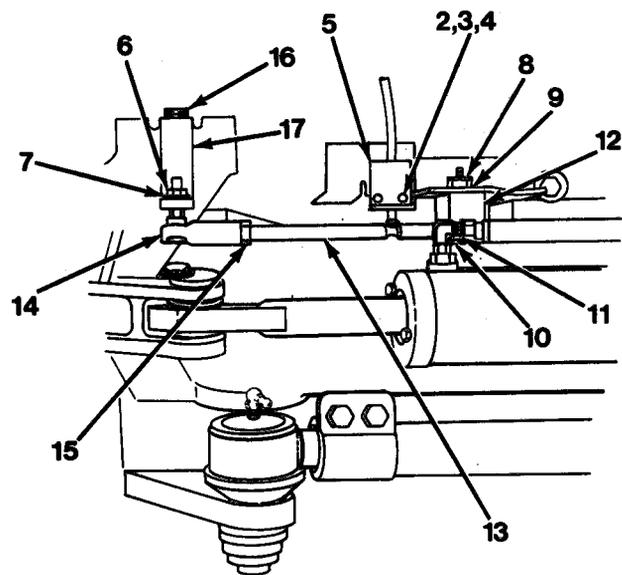


Figure 10-2

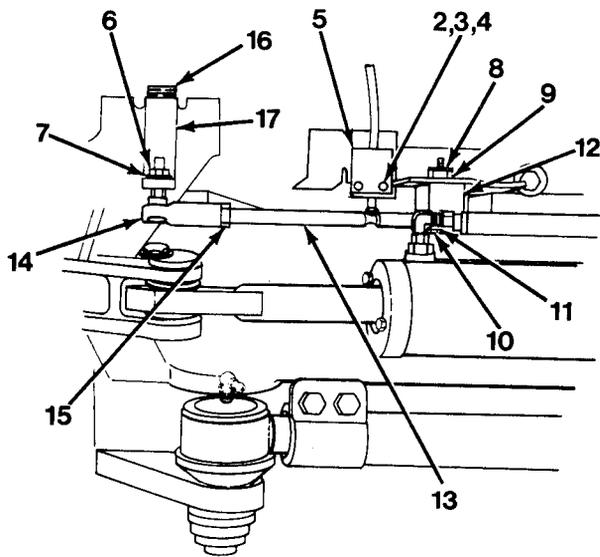


Figure 10-2

AXLE CENTERING LIGHT SWITCH ASSEMBLY REMOVAL

8. Loosen jam nut (15) and remove rod (13) from rod end (14).
9. Remove jam nut (15) from rod (13).
10. Remove two capscrews (16) and plate (17).

AXLE CENTERING LIGHT SWITCH ASSEMBLY INSPECTION

Inspect all parts (refer to Chapter 4).

AXLE CENTERING LIGHT SWITCH ASSEMBLY INSTALLATION

1. Install plate (17) and two capscrews (16, Figure 10-2).
2. Install jam nut (15) on rod (13).
3. Install rod (13) into rod end (14).
4. Install rod (13) into the large diameter hole side of block (12).
5. Install block (12) with rod (13), two washers (11), capscrews (10), washers (9) and nuts (8).
6. Install rod end (14), washer (7) and jam nut (6).
7. Install switch (5), two sockethead capscrews (2), washers (4) and nuts (3).
8. Connect cam switch electrical lead (1, Figure 10-1).
9. Connect battery negative ground cable.

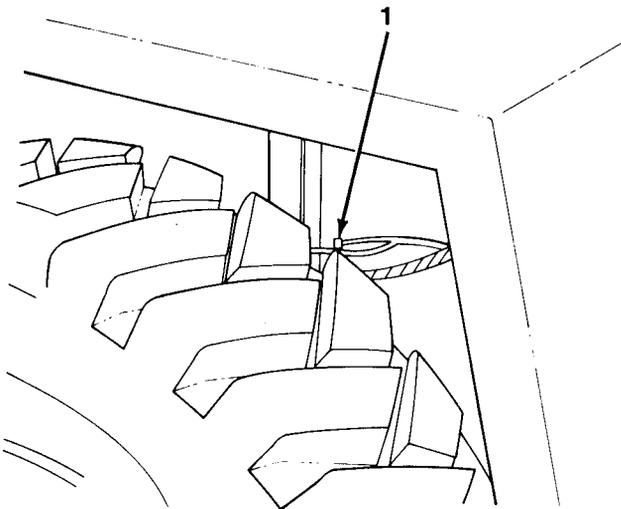


Figure 10-1

AXLE CENTERING LIGHT SWITCH ASSEMBLY ADJUSTMENT

1. Rear wheels must be parallel to carrier frame when making any adjustments.
2. Loosen jam nut (15) on rod (13, Figure 10-3).
3. Thread rod (13) in or out of rod end (14) until switch cam is in the center of groove on rod (13).
4. Tighten jam nut (15) against rod end (14).
5. Loosen two sockethead capscrews (2). Slide cam switch down until roller is centered in groove and just rests on rod (13). Tighten two sockethead capscrews (2).
6. Red indicator light should be on while rear axle is being turned right or left. Light should be off when axle is centered.

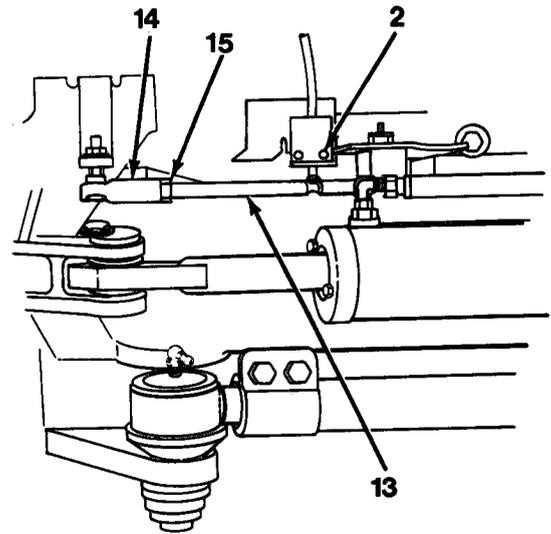


Figure 10-3

ANTI-TWO BLOCK CONTROL PANEL

ANTI-TWO BLOCK CONTROL PANEL REMOVAL



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

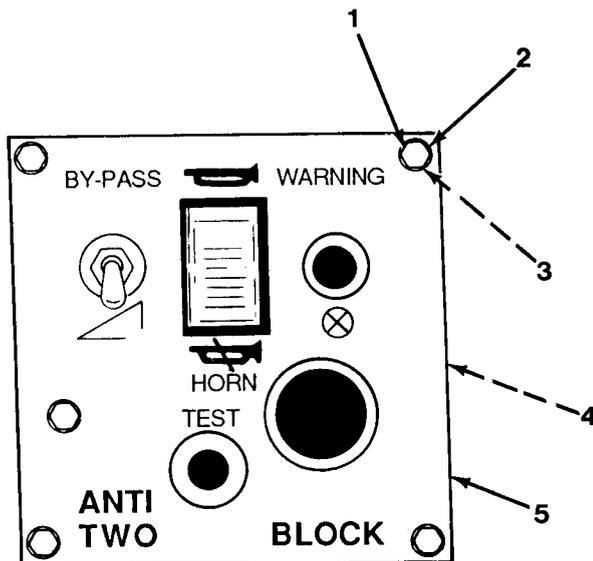


Figure 10-1

1. Disconnect battery negative ground cable.
2. Remove four bolts (1), washers (2) and tubes (3, Figure 10-1).
3. Disconnect plug (4) from connector in cab at rear of control panel (5).
4. Remove control panel (5).

ANTI-TWO BLOCK CONTROL PANEL INSTALLATION

1. Connect plug (4) at rear of control panel (5, Figure 10- 1) to connector in cab.
2. Install four tubes (3), washers (2) and bolts (1).
3. Connect battery negative ground cable.

ANTI-TWO BLOCK CONTROL PANEL DISASSEMBLY

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Remove BY-PASS toggle switch (6) by disconnecting two wires from switch (6). Remove nut, washer and switch (6, Figure 10-2).
2. Remove relay (10) by disconnecting five connectors and removing screw (7), washer (8), nut (9) and relay (10).
3. Remove horn (11) by disconnecting two wires and removing plastic nut and horn (11).
4. Remove TEST switch (12) by disconnecting two wires and removing nut, washer and test switch (12).
5. Remove HORN switch (13) by disconnecting two wires and pressing in on spring clips while pushing horn switch (13) out.

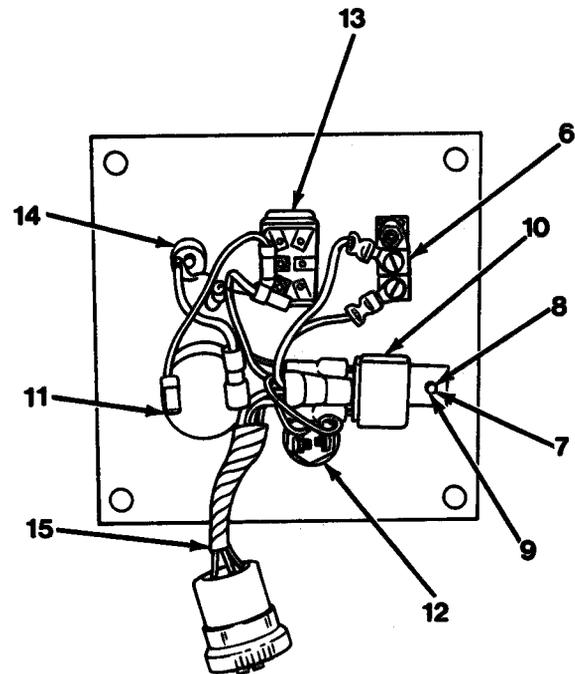


Figure 10-2

NOTE

Do not unsolder connections unless necessary.

6. Remove WARNING light (14) by removing nut and washer. Panel harness (15) and resistor are attached to light by solder. Remove bulb from light by unthreading bulb from socket.

ANTI-TWO BLOCK CONTROL PANEL ASSEMBLY

CAUTION

Excess heat will damage WARNING light and/or resistor.

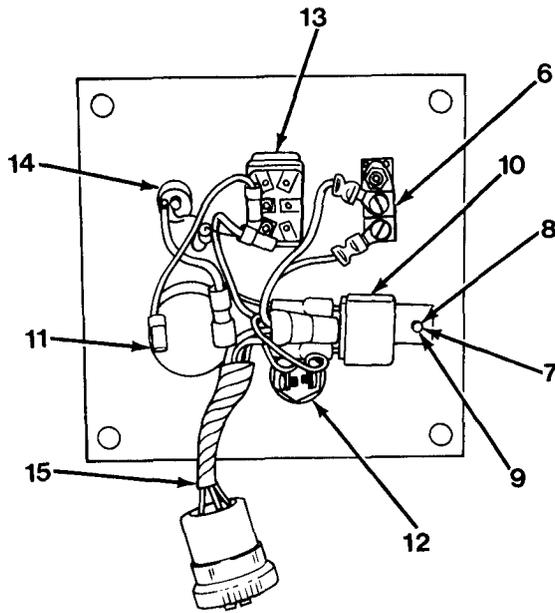


Figure 10-2

1. Solder panel harness (15) and resistor to warning light. Install warning light on control panel (5) and secure with washer and nut. Install bulb in WARNING light (14, Figure 10-2) socket.
2. Install HORN switch (13) by pushing horn switch (13) in hole until spring clips lock. Attach two red wires.
3. Install TEST switch (12) and secure with washer and nut. Install red wire and grey wire.
4. Install horn (11) and secure with plastic nut. Install red wire and black wire.
5. Install screw (7), washer (8) and nut (9) to secure relay (10). Connect wires from connector to relay tabs.
6. Install BY-PASS toggle switch (6) and secure with washer and nut. Install white wire and grey wire.

ANTI-TWO BLOCK CONTROL PANEL CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**STE/ICE DCA CONNECTOR/
RESISTOR-MODULE**

**STE/ICE DCA CONNECTOR/ RESISTOR
MODULE REMOVAL**



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

1. Disconnect battery negative ground cable.
2. Remove deck plate (refer to page 14-9).
3. Remove four screws (1) and STE/ICE plug (2) Figure 10-1) from inside rear wall of cab.

4. Remove four screws (3) and resistor module (4) from inside rear wall of cab.
5. Remove nut, washer and toggle switch (5).

**STE/ICE DCA CONNECTOR/ RESISTOR
MODULE INSPECTION**

Inspect all parts (refer to Chapter 4).

**STE/ICE DCA CONNECTOR/RESISTOR
MODULE INSTALLATION**

1. Install toggle switch (5, Figure 10-1) with washer and nut.
2. Install STE/ICE plug (2) and four screws (1) to inside rear wall of cab.
3. Install resistor module (4) and four screws (3) to inside rear wall of cab.
4. Install deck plate (refer to page 14-9).
5. Connect battery negative ground cable.

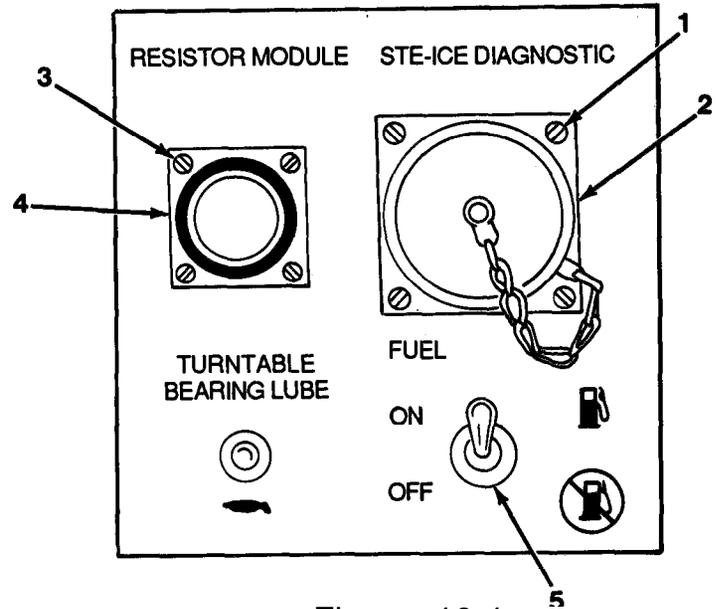


Figure 10-1

WORK LIGHTS

WORK LIGHTS REMOVAL



Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

- The following is a maintenance procedure for one work light, Maintenance procedure for remaining two work lights is identical.
- Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

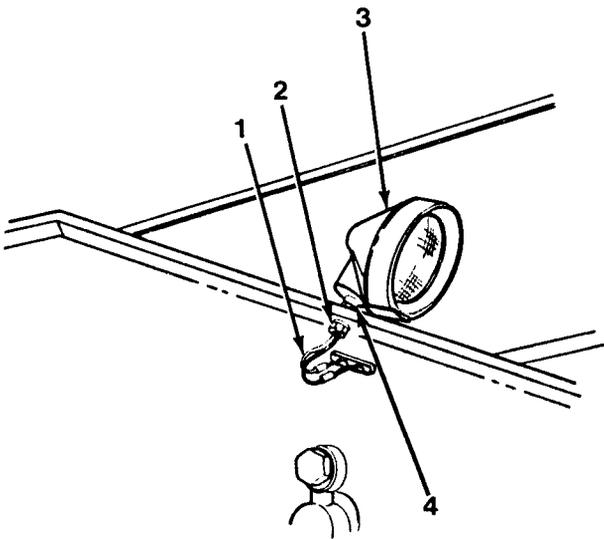


Figure 10-1

1. Disconnect battery negative ground cable.
2. Disconnect two wires (1) from work light (3, Figure 10-1).
3. Remove nut (2), work light (3) and spacer (4) from boom.

WORK LIGHTS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

WORK LIGHTS INSTALLATION

1. Install spacer (4), work light (3) and nut (2, Figure 10-1) to boom.
2. Connect two wires (1) to work light (3).
3. Connect battery negative ground cable.

CHAPTER 11
TRANSMISSION

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FRONT COVER AND MAIN CASE

FRONT COVER AND MAIN CASE DISASSEMBLY

1. Remove engine/transmission assembly (refer to page 6-1).
2. Remove transmission from engine (refer to page 6-4).
3. Remove main hydraulic pump (refer to page 13-37).
4. Position drain pan under converter assembly (1, Figure 11-1).

▲ WARNING

Weight of converter assembly is approximately 60 lb (27 kg). Use adequate lifting equipment to lift and support converter assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Remove converter assembly (1) by pulling straight out. Drain converter assembly (1).

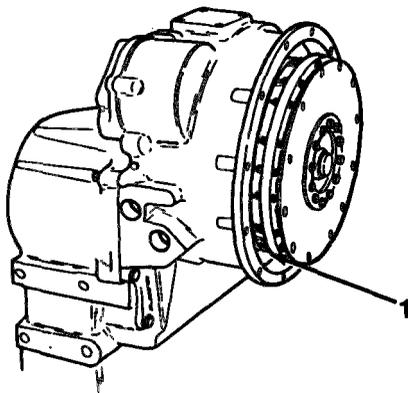


Figure 11-1

NOTE

All fittings should be tagged with case location to aid in installation.

6. Remove elbows (2) and (3) from charge pump assembly (4, Figure 11-2).
7. Remove two plugs (5) and elbow (6) from transmission.

NOTE

Matchmark main pump adapter assembly and charge pump assembly to transmission to aid in installation.

8. Remove four capscrews (7), lockwashers (8) and main hydraulic pump adapter assembly (9) from transmission.
9. Remove four capscrews (10), starwashers(11) and charge pump assembly (4) from transmission.

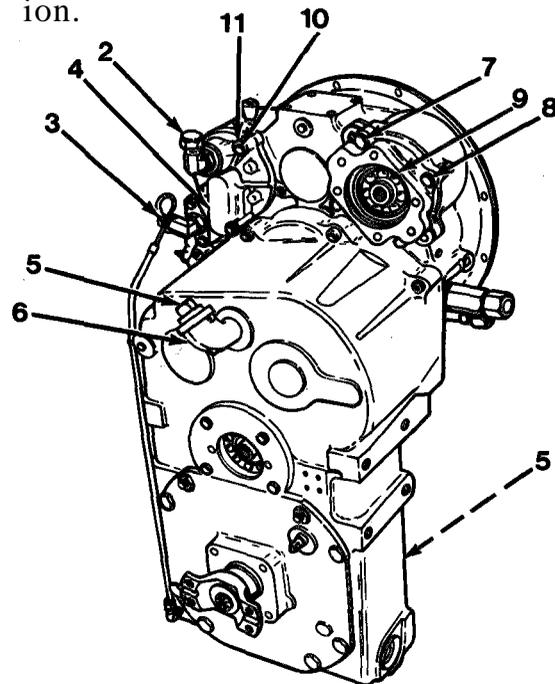


Figure 11-2

**FRONT COVER AND MAIN CASE
DISASSEMBLY**

NOTE

Matchmark top position of bearing retainer and transmission casing to aid in installation.

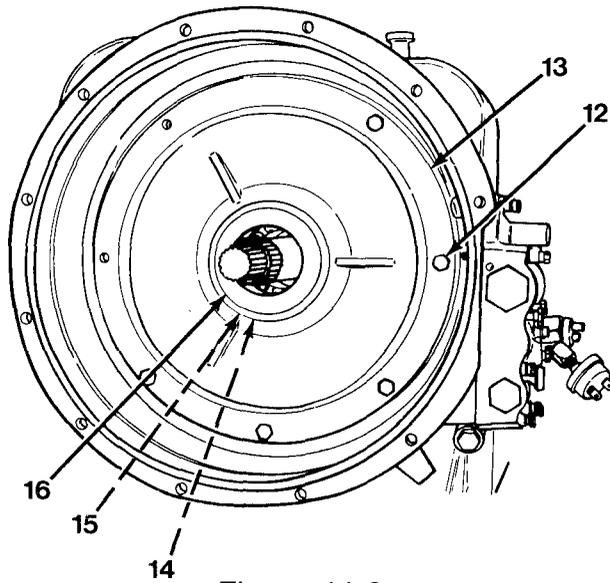


Figure 11-3

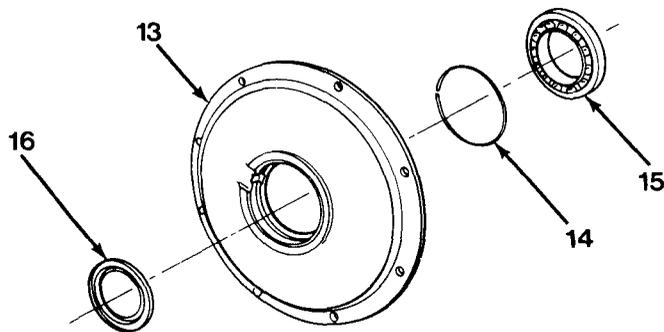


Figure 11-4

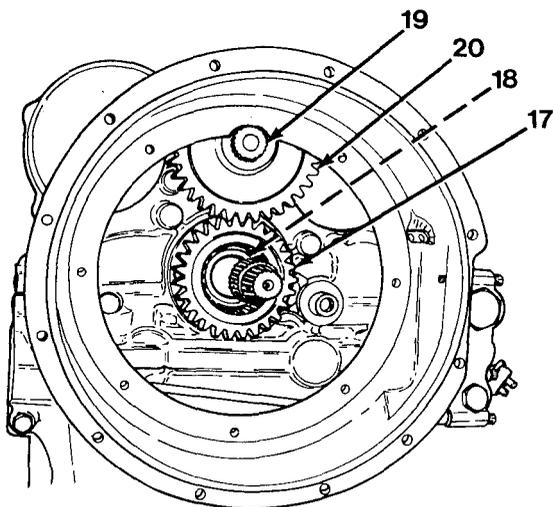


Figure 11-5

10. Remove seven capscrews (12) securing bearing retainer (13, Figure 11-3).
11. Remove bearing retainer (13) with snap ring (14), drive bearing (15) and oil seal (16) together as an assembly.
12. Using snap ring pliers, expand snap ring (14, Figure 11-4).
13. Using a hammer and punch, remove drive bearing (15) and oil seal (16), by driving out of bearing retainer (13).
14. Remove snap ring (14) from bearing retainer (13).
15. Remove hub impeller gear (17) and thrust washer (18, Figure 11-5).
16. Remove snap ring (19) securing ground driven pump gear (20).

17. Using a bearing driver and hammer, remove ground driven pump shaft (21), outside bearing (22), cover (23) and ground driven pump gear (20, Figure 11-6).

18. Remove two snap rings (24). Drive out inside bearing. (22, Figure 11-7).

19. Using a press, remove ground driven pump shaft (21) from outside bearing (22, Figure 11-8).

20. Remove six capscrews (25), cover plate (26) and stator support tube (27, Figure 11-9).

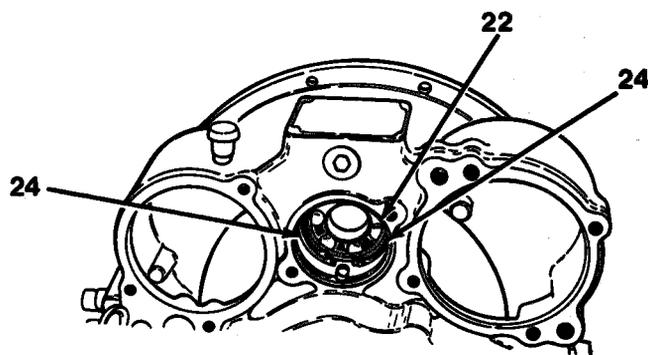


Figure 11-7

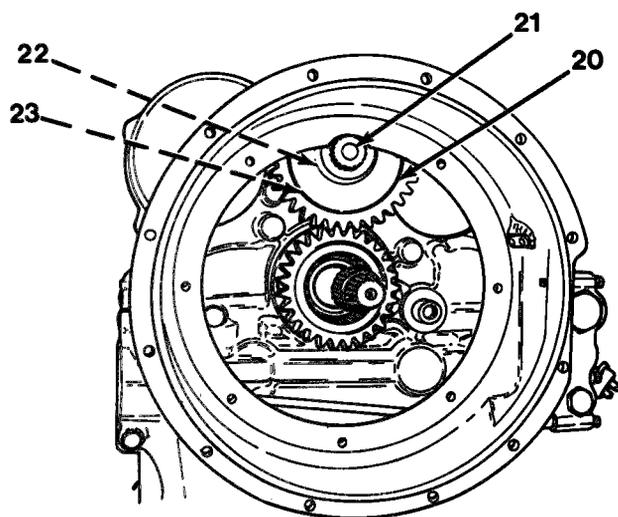


Figure 11-6

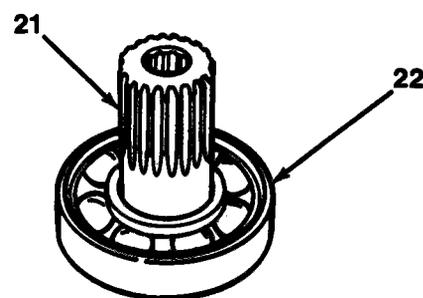


Figure 11-8

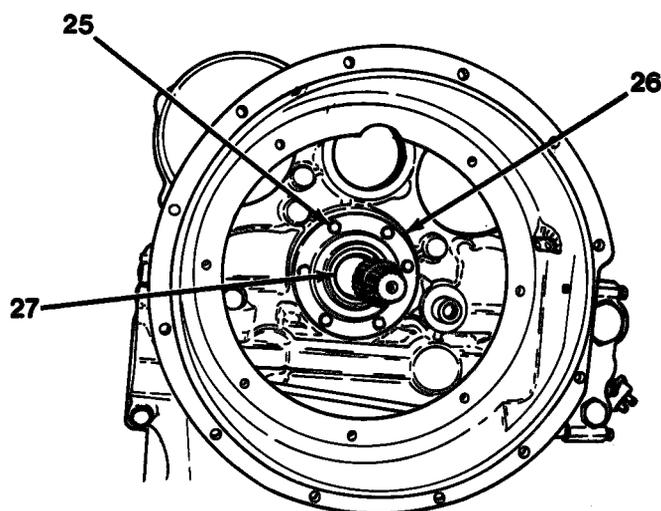


Figure 11-9

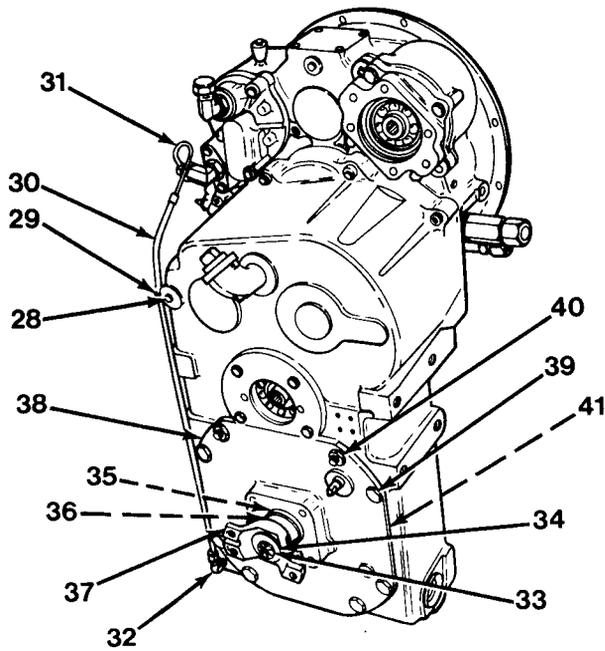


Figure 11-10

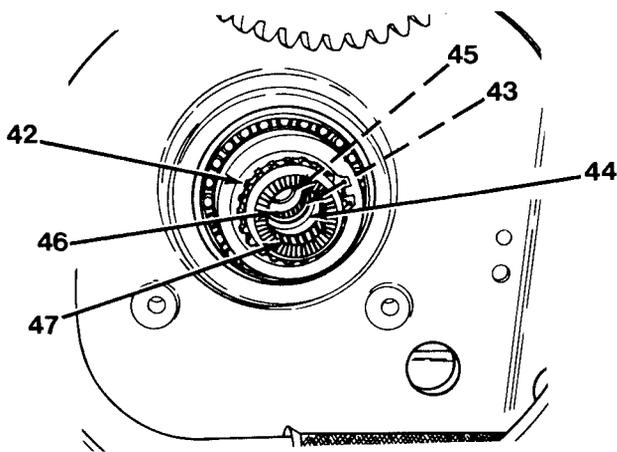


Figure 11-11

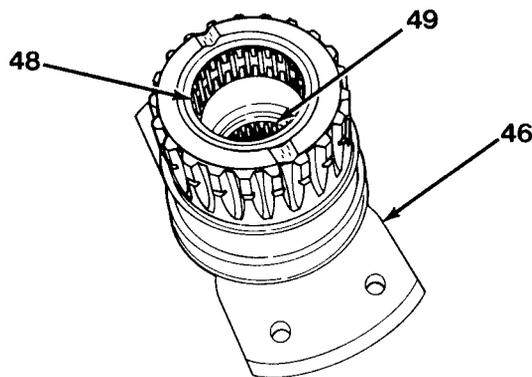


Figure 11-12

FRONT COVER AND MAIN CASE DISASSEMBLY

21. Remove capscrew (28), dipstick clamp (29), dipstick tube (30), dipstick (31) and elbow (32, Figure 11-10) from transmission.

NOTE

Record shim pack thickness to aid in assembly.

22. Remove capscrew (33), washer (34), shim pack (35), O-ring (36) and yoke (37) from output shaft. Matchmark position of output cap (38) and transmission.

⚠ WARNING

Weight of output disconnect group is approximately 67 lb (30 kg). Use adequate lifting equipment to lift and support output disconnect group. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

23. Remove six capscrews (39), two nuts (40) and output disconnect group (41).
24. Remove front thrust bearing (42) and thrust washer (43, Figure 11-11).
25. Remove snap ring (44) and spacer (45).
26. Using hammer and brass punch, remove front output shaft (46) from bearing (47).
27. Using bearing puller, remove and discard bearings (48) and (49) from inside of output shaft (46, Figure 11-12).

28. Remove cone of bearing (47, Figure 11-13) from transmission case.
29. Remove oil seal (50) and cup of bearing (47) from transmission case.
30. Remove two threaded studs (51) from transmission case, if inspection proves necessary.
31. Remove four capscrews (52) from adapter (53).
32. Remove adapter (53) and O-rings (54) and (55).

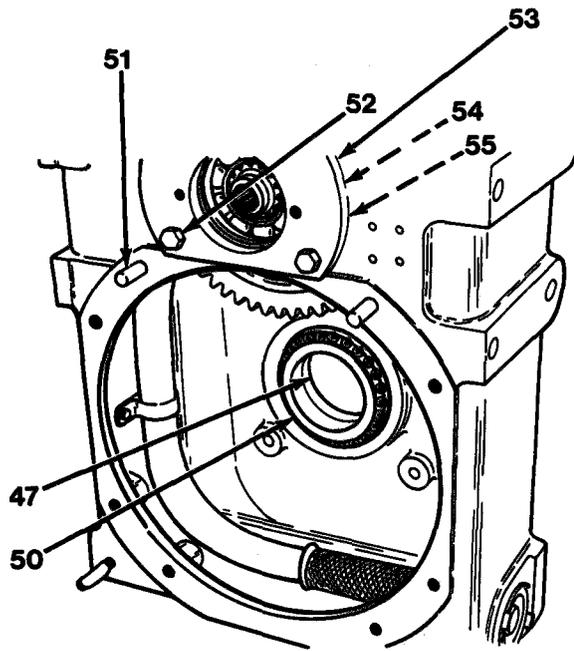


Figure 11-13

Care must be taken not to lose two detent springs and balls located between control valve and transmission main case. Failure to follow this procedure could cause damage to equipment.

NOTE

Control valve must only be removed or installed as transmission sits in normal mounted position, otherwise balls and springs may fall inside transmission.

33. Remove 10 capscrews (56), 3 capscrews (57), 13 plain washers (58), control valve assembly (59) and gasket (60, Figure 11-14). Remove all gasket material from mounting surfaces.

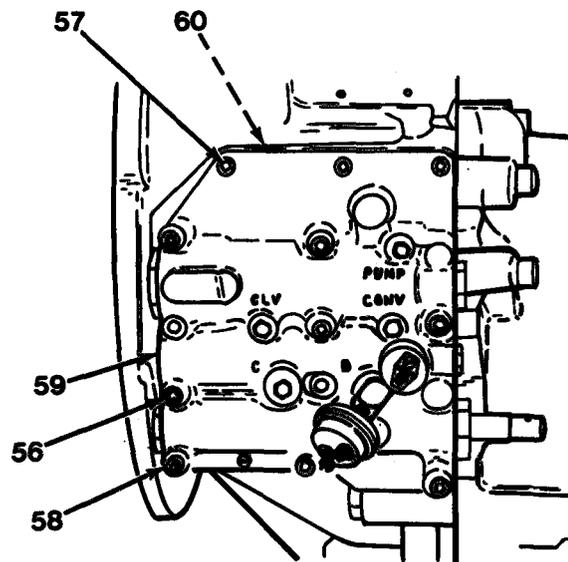


Figure 11-14

**FRONT CASE AND MAIN CASE
DISASSEMBLY**

34. Remove three capscrews (61) and capscrew (62, Figure 11-15) holding transmission main case to front cover.

⚠ WARNING

Weight of transmission is approximately 408 lb (185 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

35. Invert transmission and remove three capscrews (63) and capscrews (64), (65) and (66) holding front cover (67, Figure 11-16) to transmission main case.

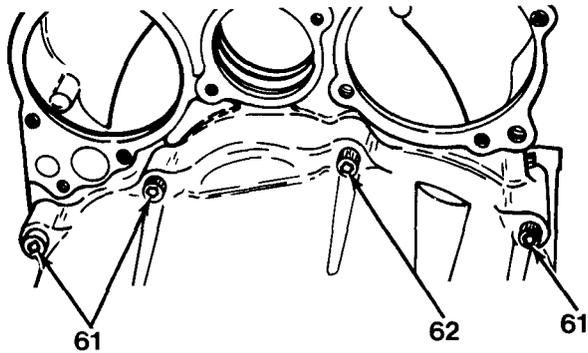


Figure 11-15

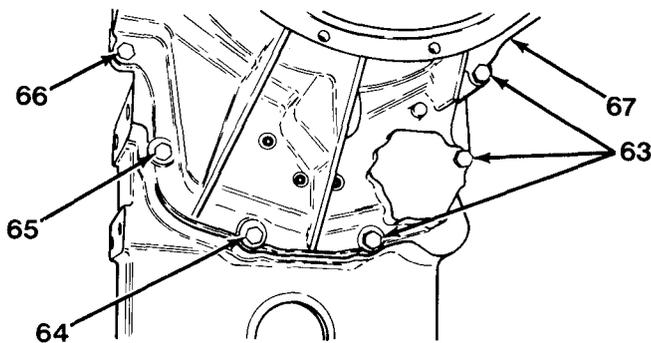


Figure 11-16

⚠ WARNING

Weight of front cover is approximately 226 lb (103 kg). Use adequate lifting equipment to lift and support front cover. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

36. Remove front cover (67, Figure 11-17) by carefully using hoist and sling with eye bolts and pry bars to lift front cover from transmission main case.
37. Remove gasket (68). Remove all gasket material from mounting surfaces.
38. Remove three capscrews (70), oil passage cover (71) and seal ring (72) from front cover (67, Figure 11-18).
39. Remove three capscrews (73) and input shaft group (74).

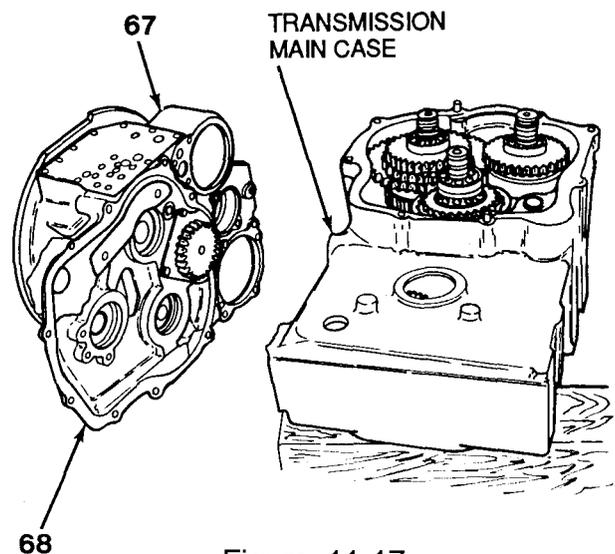


Figure 11-17

40. Remove pipe plugs (75) and (76).
41. Remove relief valve assembly (77) and breather (78) from front cover (67). Drive out relief valve assembly (77) by using driver. Discard relief valve assembly (77).
42. Install clutch pack lifting tool on clutch group (79, Figure 11-19).

⚠ WARNING

Weight of clutch group is approximately 139 lb (63 kg). Use adequate lifting equipment to lift and support clutch group. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Use of pry bar maybe necessary to loosen clutch group.

43. Remove clutch groups (79), consisting of three clutch pack assemblies, from transmission main case, by using clutch pack lifting tool with a hoist and sling.

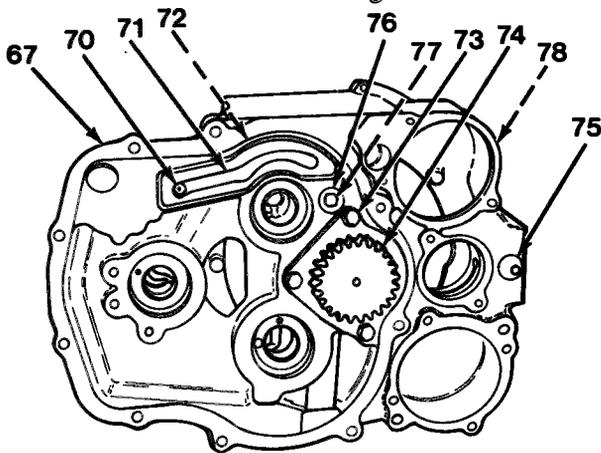


Figure 11-18

44. Remove and discard expansion plug (80, Figure 11-20).
45. Remove suction screen (81) and gasket (82) from transmission main case. Remove capscrew (83), clamp (84), suction tube (85) and O-ring (86). Remove all gasket material from mounting surface.
46. Remove two pipe plugs (87).

NOTE

Do not remove high-pressure lines in front cover. If lines are damaged, replace entire front cover.

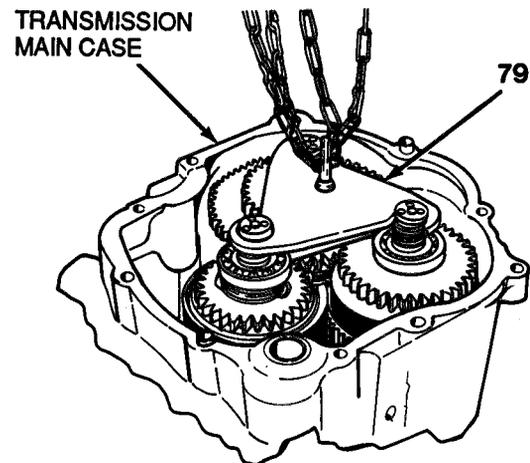


Figure 11-19

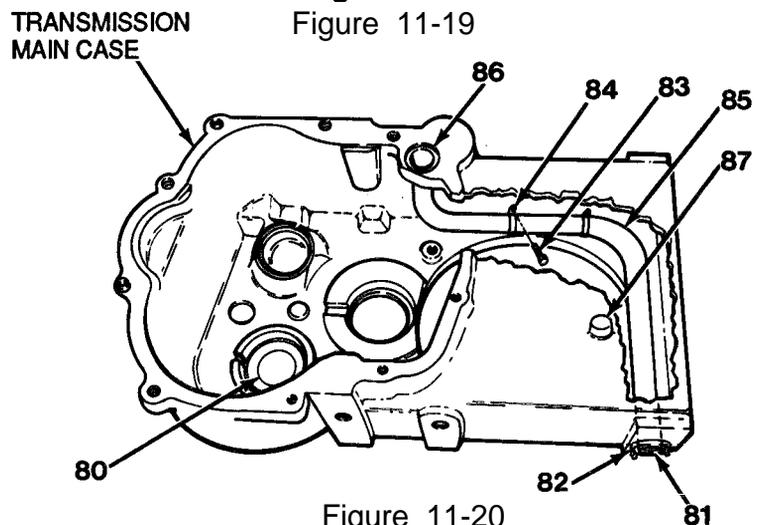


Figure 11-20

FRONT COVER AND MAIN CASE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).



Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Close one end of oil passage and use compressed air, used for cleaning, and inspect oil passages for leakage.
3. Inspect sleeves for wear grooves. If groove is worn 0.003 in. (0.08 mm) or deeper, press out and replace front bore sleeve from front cover.
4. Soak all parts in lubricating oil MIL-L-2104, grade 10, prior to installing.
5. Inspect all other parts (refer to Chapter 4).

FRONT COVER AND MAIN CASE ASSEMBLY

5. Using a hoist and sling, install clutch group (79) into transmission main case.

NOTE

Use pipe sealant when installing pipe plugs.

1. Install two pipe plugs (87, Figure 11-20).
2. Install O-ring (86), suction tube (85), clamp (84) and capscrew (83). Install gasket (82) and suction screen (81) to transmission main case.
3. Install new expansion plug (80).
4. Install clutch pack lifting tool on clutch group (79, Figure 11-19).

TRANSMISSION MAIN CASE

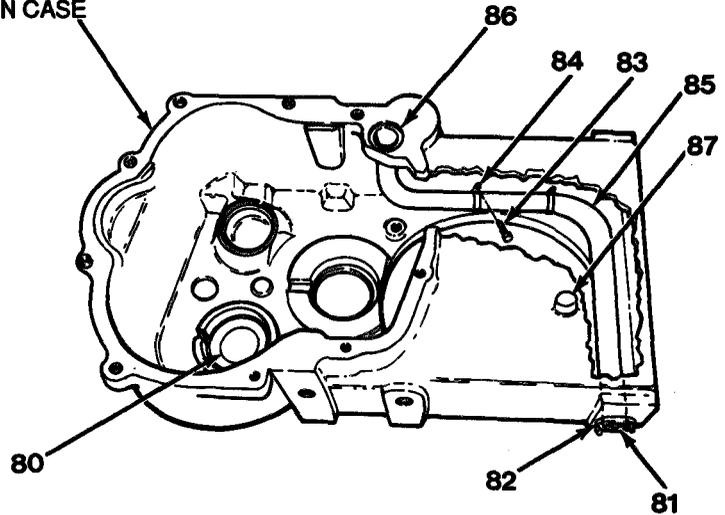


Figure 11-20

⚠ WARNING

Weight of clutch group is approximately 139 lb (63 kg). Use adequate lifting equipment to lift and support clutch group. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

CAUTION

Care must be taken not to damage seal rings on clutch shaft while installing clutch groups. Replace seal rings if damaged.

NOTE

It maybe necessary to tap clutch groups into place with a mallet to seat in transmission main case.

TRANSMISSION MAIN CASE

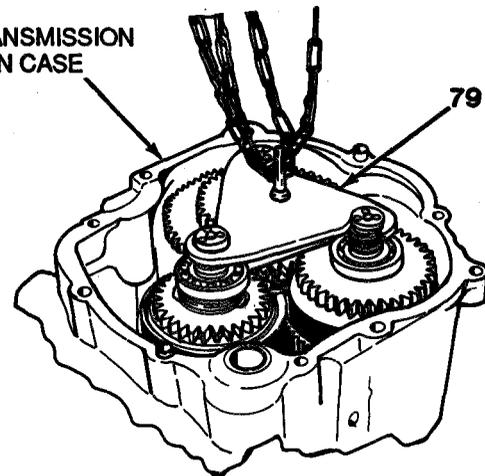


Figure 11-19

FRONT COVER AND MAIN CASE ASSEMBLY

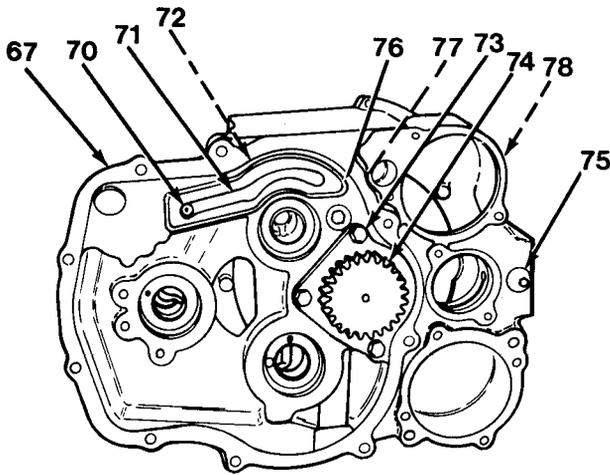


Figure 11-18

CAUTION

Relief valve should be installed with bearing driver of the same diameter as shoulder of relief valve to avoid damaging relief valve.

6. Install breather (78) and new relief valve assembly (77) to front cover (67, Figure 11-18). Tap new relief valve assembly (77) into place.
7. Install pipe plugs (76) and (75).
8. Install input shaft group (74) and three cap screws (73).
9. Install seal ring (72), oil passage cover (71) and three capscrews (70) to front cover (67).

NOTE

Use sealant when installing gasket to main case.

10. Install gasket (68, Figure 11-17).

WARNING

Weight of front cover is approximately 226 lb (103 kg). Use adequate lifting equipment to lift and support front cover. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

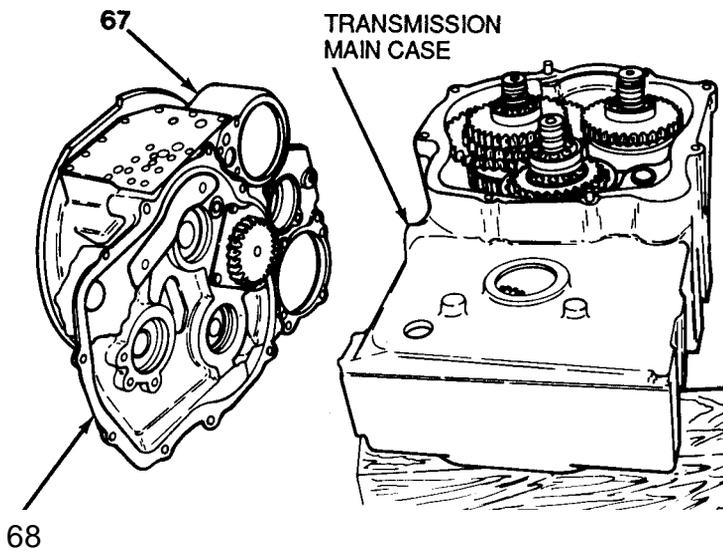


Figure 11-17

CAUTION

Extreme care must be taken not to damage seal rings on clutch shaft while installing front cover. Failure to follow this procedure will cause damage to seal rings.

11. Install front cover (67) to transmission main case, by carefully using hoist and sling with eye bolts.
12. Install capscrews (66), (65), and (64) and three capscrews (63) to secure front cover (67, Figure 11-16) to transmission main case.

WARNING

Weight of transmission is approximately 408 lb (185 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

13. Invert transmission and install capscrew (62) and three capscrews (61, Figure 11-15) to secure front cover to transmission main case.
14. Install O-rings (55) and (54) and adapter (53, Figure 11-13).

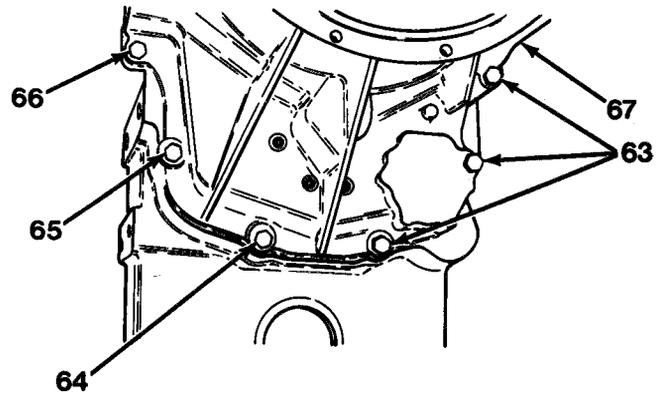


Figure 11-16

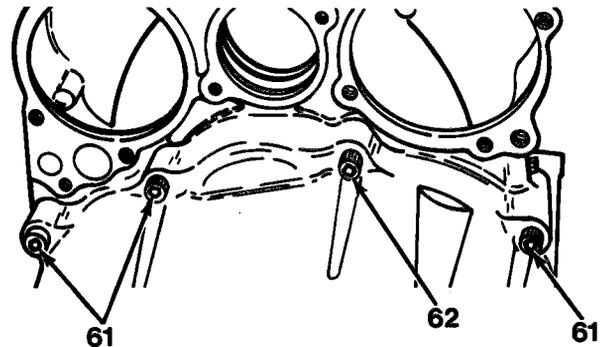


Figure 11-15

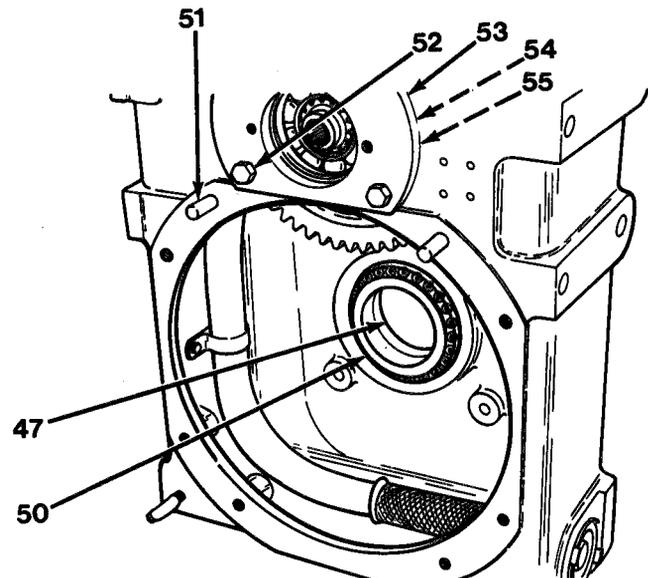


Figure 11-13

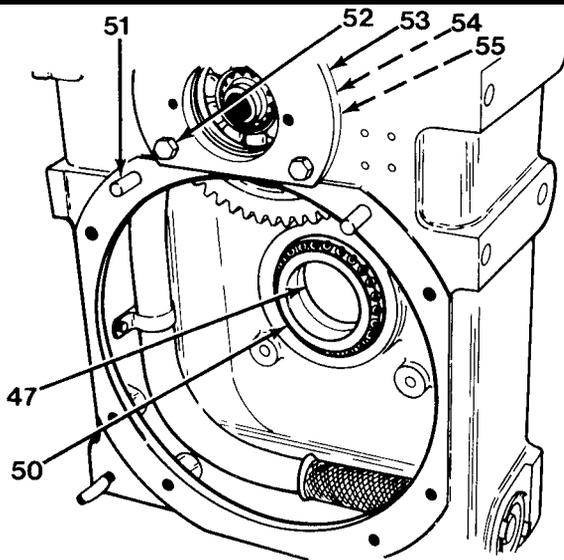


Figure 11-13

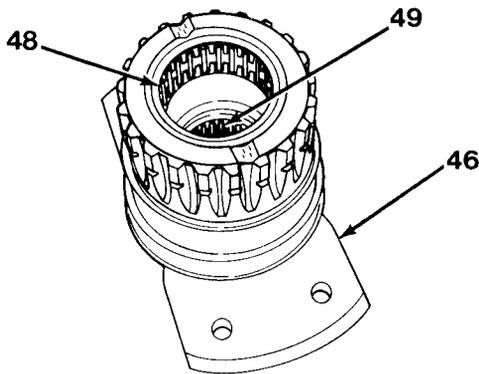


Figure 11-12

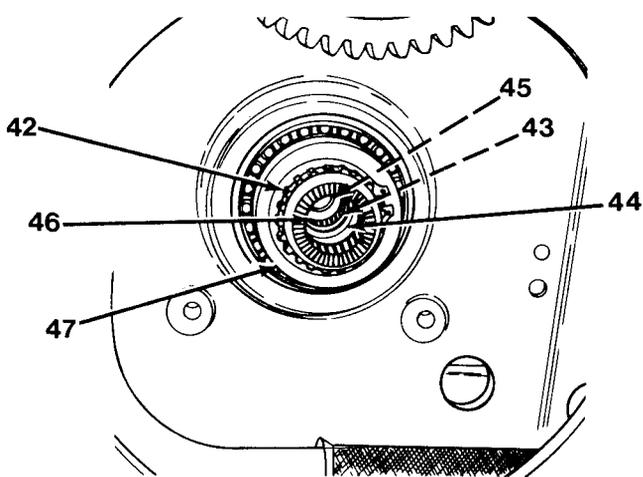


Figure 11-11

FRONT COVER AND MAIN CASE ASSEMBLY

15. Install four capscrews (52) to adapter (53, Figure 11-13).
16. Install two threaded studs (51) in transmission case, if removed.
17. Install bearing cup of bearing (47) and oil seal (50). Install oil seal (50) with lip facing inward.
18. Using proper drivers, install new bearings (49) and (48) to inside of output shaft (46, Figure 11-12).
19. Install shaft (46, Figure 11- 11). Support shaft (46) to keep against transmission main case.

WARNING

Wear protective gloves when handling hot bearing. **SERIOUS INJURY** may result if hot bearing contacts skin.

20. Heat bearing cone of bearing (47) to 350 degrees F (177 degrees C).
21. Install bearing cone of bearing (47) over shaft (46) into transmission case.
22. Install spacer (45) and snap ring (44).
23. Install thrust washer (43) and thrust bearing (42).

NOTE

Output disconnect group must have a total shim thickness of 0.10 to 0.80 in. (2.5 and 20.3 mm) with new shims.

⚠ WARNING

Weight of output disconnect group is approximately 67 lb (30 kg). Use adequate equipment to lift and support output disconnect group. Do not lift over personnel or let personnel walk underneath suspended. Failure to follow this pmdm could cause DEATH or serious injury.

24. Install shim(s) and output disconnect group (41) and align machmarks, made during disassembly, on output cap (38, Figure 11-10) and transmission.
25. Install two nuts (40) and six capscrews (39) and torque to specifications.
26. Install capscrew (33, Figure 11-21) and tighten down halfway.
27. Install dial indicator and base.
28. Pull up on output disconnect group shaft.
29. Measure endplay of shaft.
30. If endplay is greater than 0.004 in. (0.10 mm), remove shim(s) accordingly and repeat steps 24 through 29 to reach 0.000 to 0.004 in. (0.00 to 0.10 mm) endplay.
31. After correct endplay is reached, remove capscrew (33) and dial indicator.

32. Install yoke (37), new O-ring (36), shim(s) pack (35), washer (34) and capscrew (33, Figure 11-10).
33. Install elbow (32), dipstick tube (30), dipstick (31), dipstick clamp (29) and capscrew (28).
34. Install stator support tube (27), cover plate and sleeve (26) and six capscrews (25, Figure 11-9).

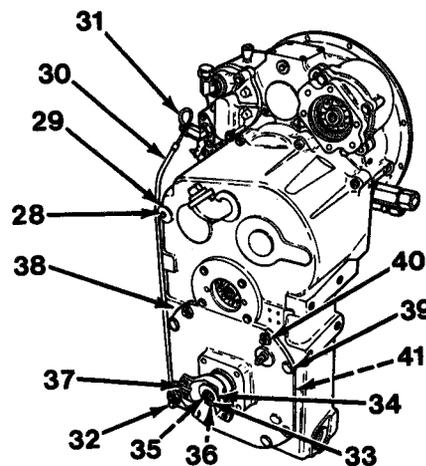


Figure 11-10

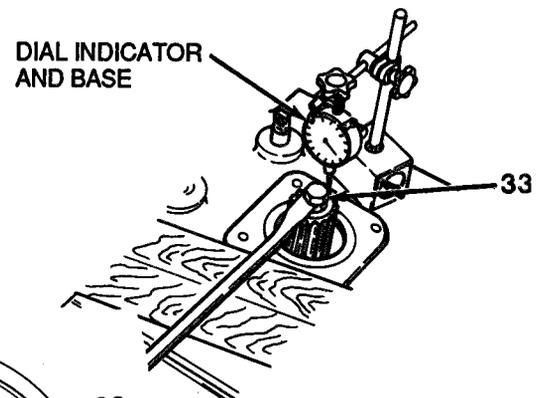


Figure 11-21

NOTE

Use recorded shim(s) pack thickness from disassembly. If new yoke is used, adjust shim(s) pack thickness to obtain 0.005 in. (0.13 mm) gap between yoke face and washer.

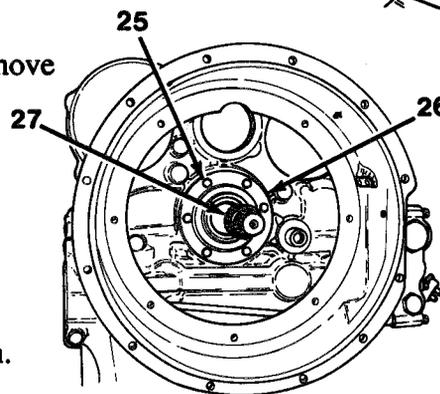


Figure 11-9

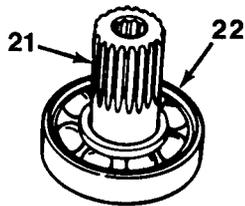


Figure 11-8

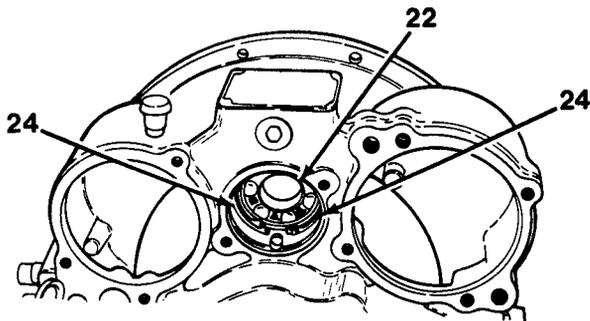


Figure 11-7

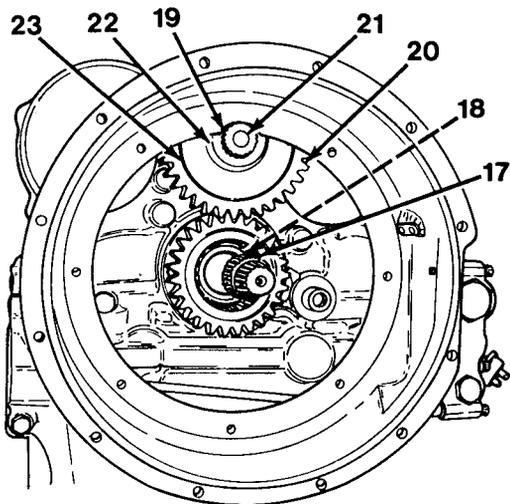


Figure 11-22

FRONT COVER AND MAIN CASE ASSEMBLY

35. Using a press, install outside bearing (22) on ground driven pump shaft (21, Figure 11-8).
36. Install inside bearing (22) and two snap rings (24, Figure 11-7).
37. Install ground driven pump gear (20, Figure 11-22) and hold in place.
38. Using a hammer and bearing driver, install outside bearing (22) with ground driven pump shaft (21), together as an assembly, through ground driven pump gear (20).
39. Install snap ring (19) to secure ground driven pump gear (20).
40. Install cover (23).
41. Install thrust washer (18) and hub impeller gear (17).
42. Install oil seal (16) in bearing retainer (13, Figure 11-4).
43. Install snap ring (14) and expand with snap ring pliers until snap ring (14) is opened far enough to allow installation of bearing (15).
44. Install bearing (15) in bearing retainer (13). Snap ring must seat in bearing.

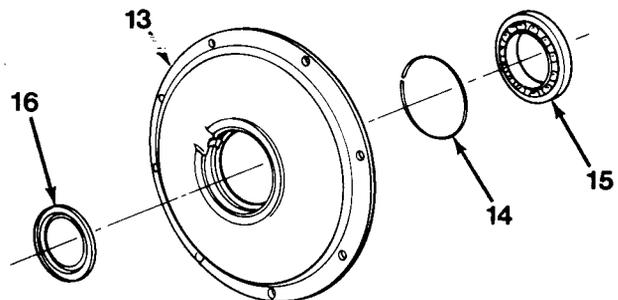


Figure 11-4

45. Install bearing retainer (13) with snap ring (14), bearing (15) and oil seal (16, Figure 11-3), together as an assembly on front cover, noting matchmarks made during disassembly.
46. Install seven capscrews (12) to secure bearing retainer (13).
47. Install charge pump assembly (4), noting marks made during disassembly, and secure with four starwashers (11) and capscrews (10, Figure 11-2).
48. Install main pump adapter assembly (9) and secure with four lockwashers (8) and capscrews (7). Note matchmarks made during disassembly.
49. Install elbow (6) and two plugs (5) in transmission.
50. Install elbows (3) and (2) to charge pump assembly (4).

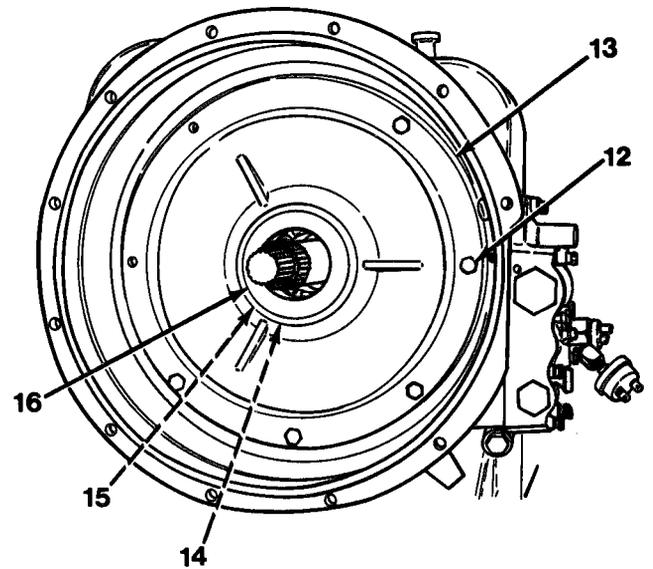


Figure 11-3

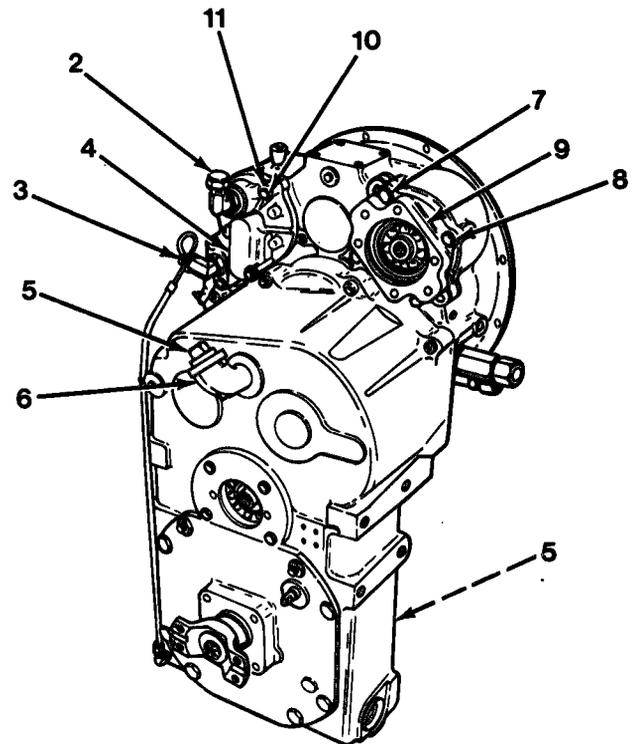


Figure 11-2

FRONT COVER AND MAIN CASE ASSEMBLY

NOTE

- Control valve must only be removed or installed when transmission is in normal mounted position otherwise balls and springs may fall inside transmission.
- Location of two detent springs and balls inside control valve assembly must be noted during control valve assembly to transmission main case (see page 11-71 for location of springs and balls).
- Use sealant when installing new gasket.

51. Install gasket (60), control valve assembly (59), 13 washers (58), three capscrews (57) and 10 capscrews (56, Figure 11-14).

⚠ WARNING

Weight of converter assembly is approximately 60 lb (27 kg). Use adequate equipment to lift and support converter assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

52. Install converter assembly (1, Figure 11- 1), by pushing converter assembly (1) inward on input shaft and aligning splines.
53. Install main hydraulic pump (refer to page 13-38),
54. Install transmission to engine (refer to page 6-5).
55. Install engine/transmission assembly (refer to page 6-7).

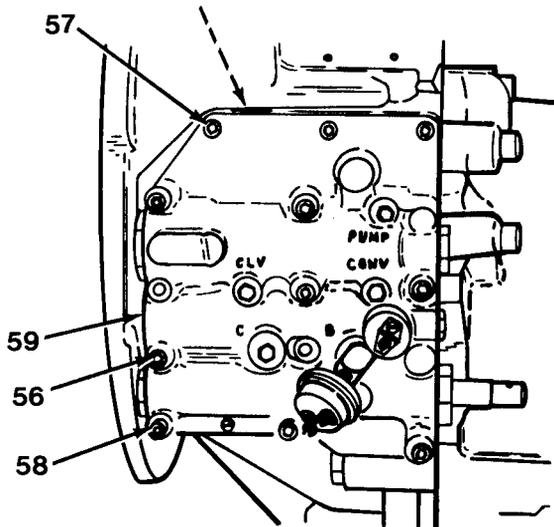


Figure 11-14

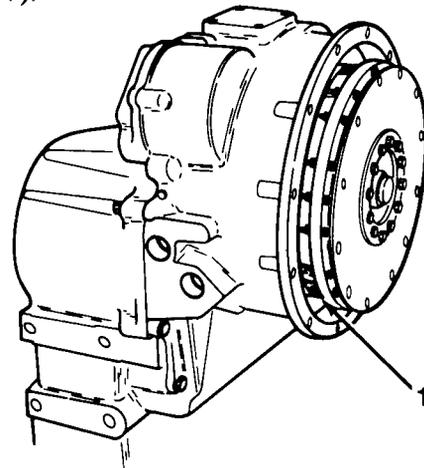


Figure 11-1

OUTPUT DISCONNECT GROUP

OUTPUT DISCONNECT GROUP DISASSEMBLY

1. Remove O-ring (1, Figure 11-1).
2. Remove shim pack (2) from output cap (3).
3. Remove two capscrews (4) and pan baffle (5).
4. Remove two roll pins (6) from output cap (3) and fork (7).
5. Remove output shaft (8) with fork (7), shift collar (9), three detent balls (10), springs (11), snap ring (12), gear (13) and cone of bearing (14, Figure 11-2) as an assembly.
6. Remove cup of bearing (14) from output cap (3, Figure 11-3).
7. Remove oil seal (15) from output shaft bore.
8. Remove seal (16) from fork shaft bore.

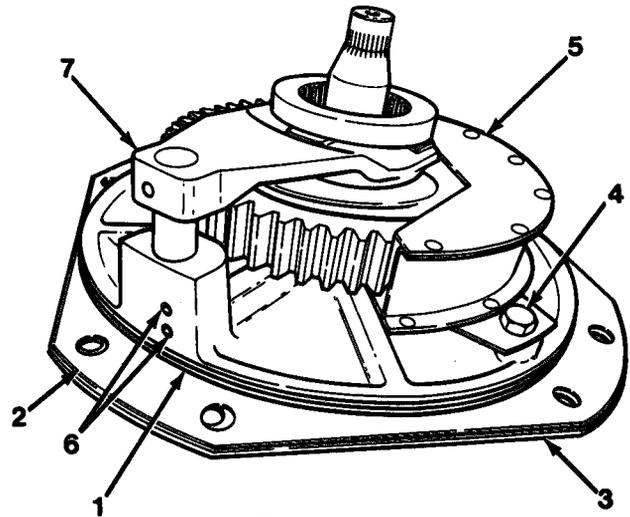


Figure 11-1

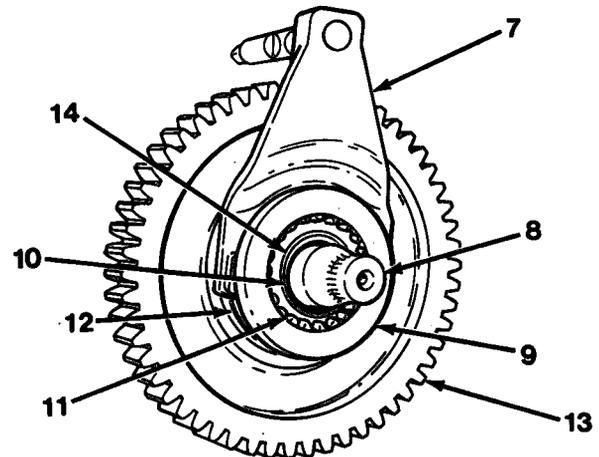


Figure 11-2

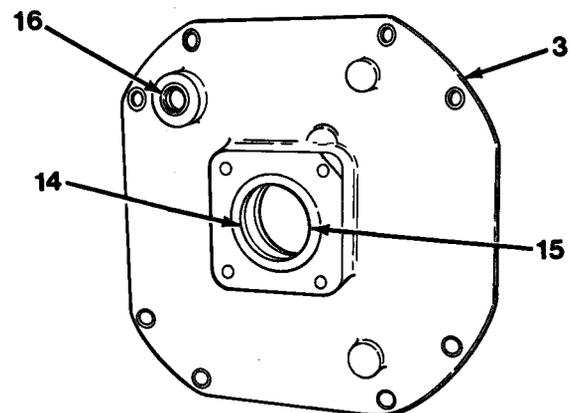


Figure 11-3

OUTPUT DISCONNECT GROUP DISASSEMBLY

9. Remove fork (7) from shift collar (9, Figure 11-4).

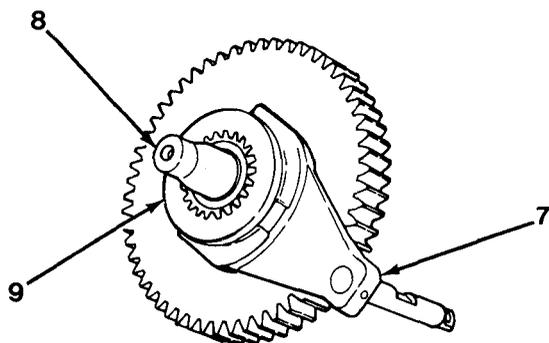


Figure 11-4

⚠ WARNING

Parts are under spring tension. **SERIOUS INJURY** may result from flying parts. Always wear eye protection.

CAUTION

Care must be taken not to lose three detent springs and balls located in output shaft under shift collar. Failure to follow this procedure could cause damage to equipment.

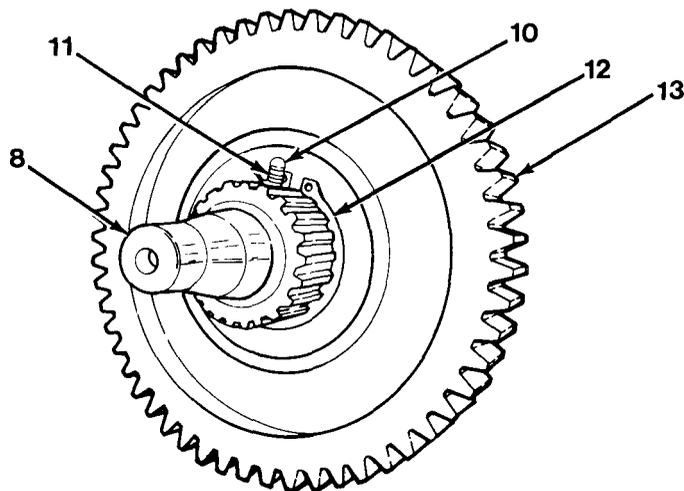


Figure 11-5

10. Remove shift collar (9) from output shaft (8).
11. Remove three detent balls (10) and springs (11, Figure 11-5).
12. Remove snap ring (12) from output shaft (8).
13. Matchmark top of gear (13) to output shaft (8) to aid in installation.
14. Remove gear (13) from output shaft (8).
15. Using a press, remove cone of bearing (14) from output shaft (8, Figure 11-6).

OUTPUT DISCONNECT GROUP CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).

WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Close one end of oil passage and use compressed air, used for cleaning, and inspect oil passages for leakage.
3. Soak all parts in lubricating oil MIL-L-2104, grade 10W, prior to installing.
4. Inspect all other parts (refer to Chapter 4).

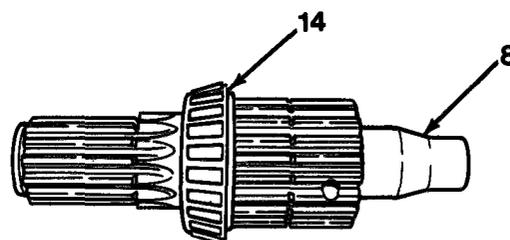


Figure 11-6

OUTPUT DISCONNECT GROUP ASSEMBLY

WARNING

Wear protective gloves when handling hot bearing. **SERIOUS INJURY** may result if hot bearing contacts skin.

1. Heat cone of bearing (14, Figure 11-6) to 350 degrees F (177 degrees C).

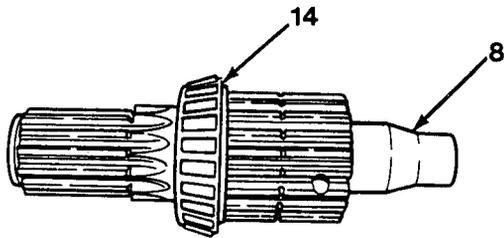


Figure 11-6

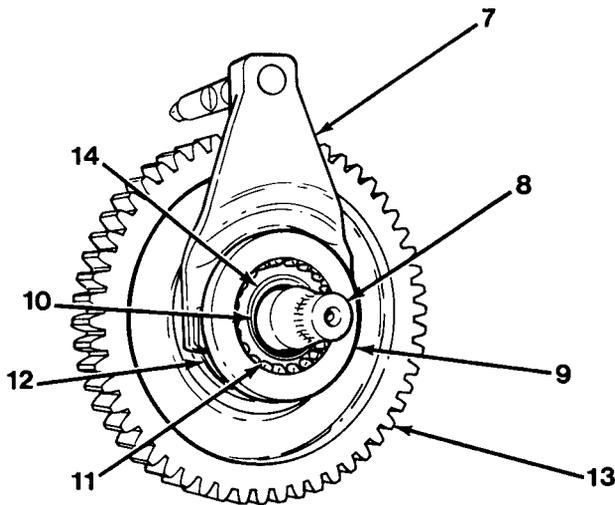


Figure 11-2

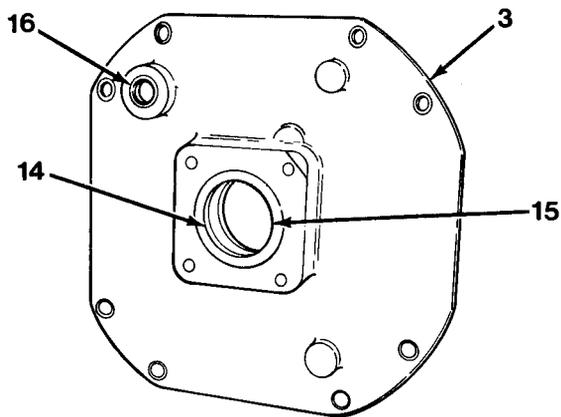


Figure 11-3

OUTPUT DISCONNECT GROUP ASSEMBLY

2. Install cone of bearing (14) on output shaft (8, Figure 11-6).
3. Install gear (13) on output shaft (8, Figure 11-2). Note position of marks made during disassembly.
4. Install snap ring (12) on output shaft (8).

⚠ WARNING

Parts are under spring tension. **SERIOUS INJURY** may result from flying parts. Always wear eye protection.

5. Install three springs (11) and detent balls (10).
6. Compress three springs (11) and detent balls (10) into output shaft (8) and hold in place until shift collar (9) is installed.
7. Install shift collar (9).
8. Install fork (7) on shift collar (9).
9. Install oil seal (16, Figure 11-3) in fork shaft bore.

10. Install oil seal (15) in output shaft bore.
11. Apply a thin coat of lubricating oil MIL-L-2104, grade 10W, to lips of oil seals (15) and (16).
12. Install bearing cup of bearing (14) in output cap (3).

NOTE

Fork shaft must align with fork shaft bore during assembly.

13. Install output shaft (8) with fork (7), shift collar (9), three detent balls (10), springs (11), snap ring (12), gear (13) and bearing cone (14, Figure 11-2) as an assembly.

NOTE

Roll pins must be installed flush in output cap.

14. Install two roll pins (6) through output cap (3) and fork (7, Figure 11-1).
15. Install pan baffle (5) over gear (13) on output cap (3).
16. Install two capscrews (4).
17. Install O-ring (1).
18. Install new shim pack (2) on output cap (3).

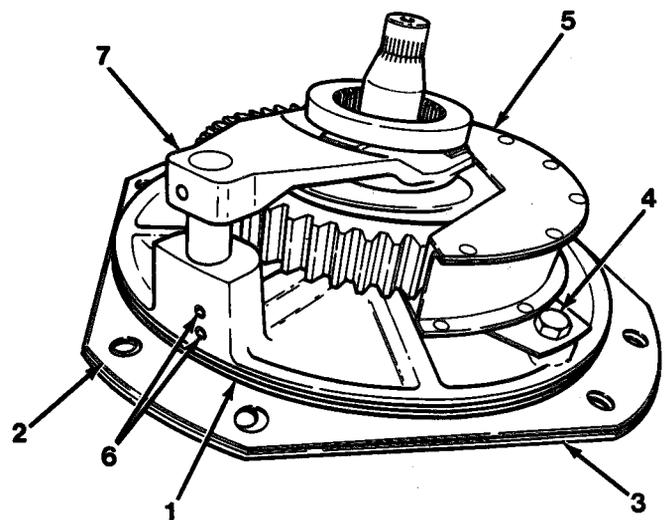


Figure 11-1

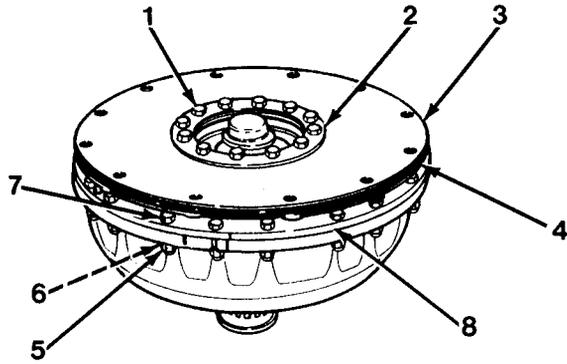


Figure 11-1

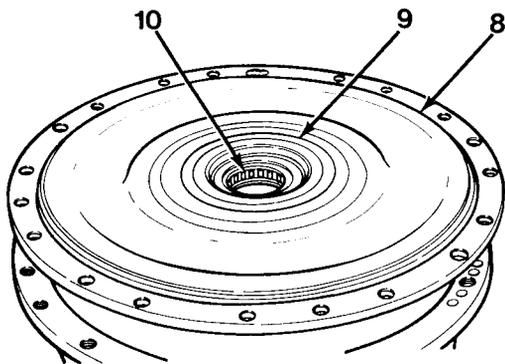


Figure 11-2

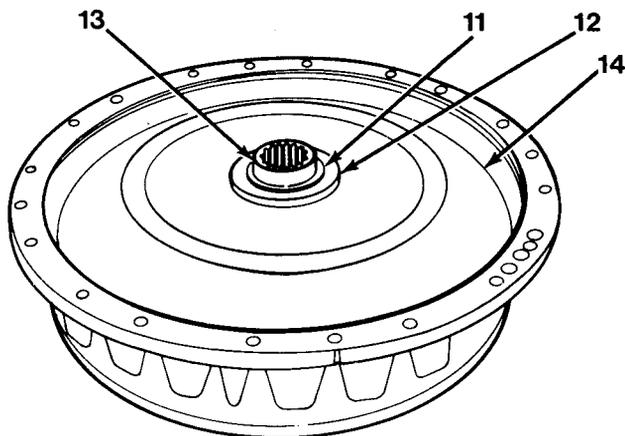


Figure 11-3

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY DISASSEMBLY

NOTE

Matchmark all drive plates and front cover to converter housing.

1. Remove 12 capscrews (1), drive plate ring (2), drive plate assembly (3) and drive plate (4, Figure 11-1) from converter assembly.
2. Remove 20 nuts (5), washers (6), capscrews (7) and front cover (8).
3. Remove seal (9) and bearing (10) from front cover (8, Figure 11-2),
4. Remove thrust race (11), thrust bearing (12) and thrust race (11, Figure 11-3).
5. Remove turbine hub (13) and turbine (14).

6. Remove thrust race (15), thrust bearing (16) and thrust race (15, Figure 11-4).
7. Remove stator assembly (17).
8. Remove two snap rings (18, Figure 11-35).
9. Remove two clutch retainers (19), inner clutch race (20), outer clutch race (21) and sprag clutch assembly (22) as an assembly from stator (23).
10. Remove two clutch retainers (19), inner clutch race (20) and outer clutch race (21) from sprag clutch assembly (22, Figure 11-6).

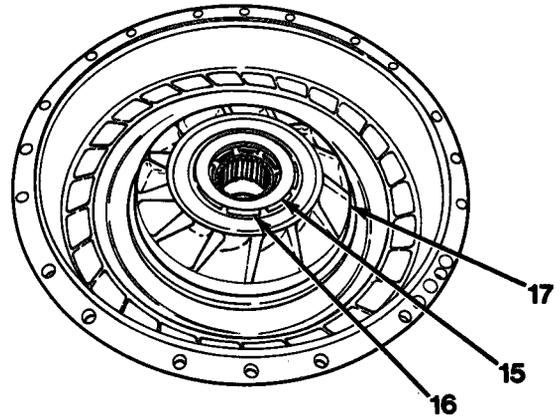


Figure 11-4

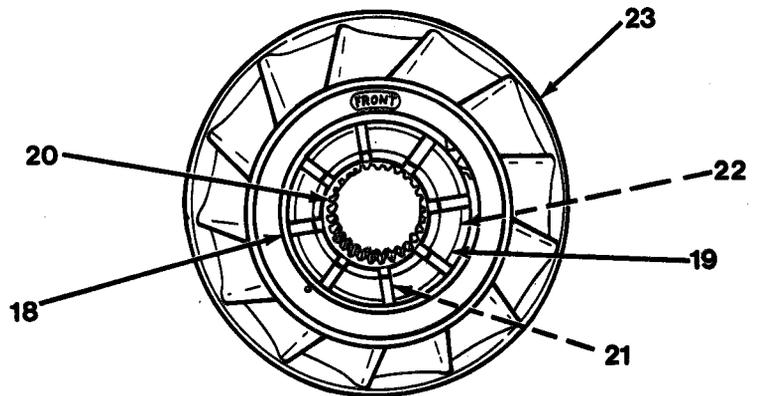


Figure 11-5

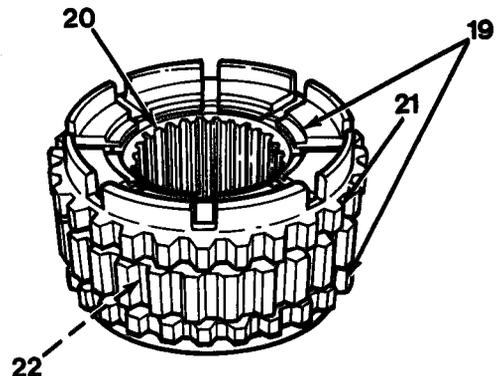


Figure 11-6

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY DISASSEMBLY

11. Remove thrust race (15), thrust bearing (16) and thrust race (15, Figure 11-7).
12. Remove seal ring (24) from impeller hub (25, Figure 11-8).
13. Remove eight bolts (26), washers (27), impeller hub (25) and O-ring (28) from impeller (29).

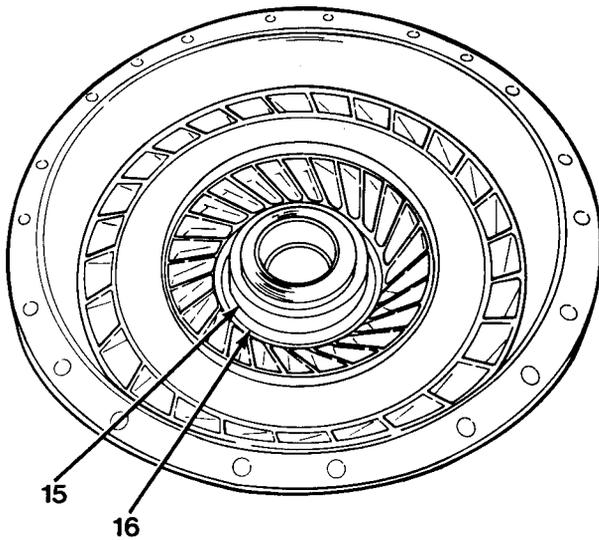


Figure 11-7

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect fins for cracking or flaking.
3. Inspect drive plates for cracking.
4. Inspect all other parts (refer to Chapter 4).

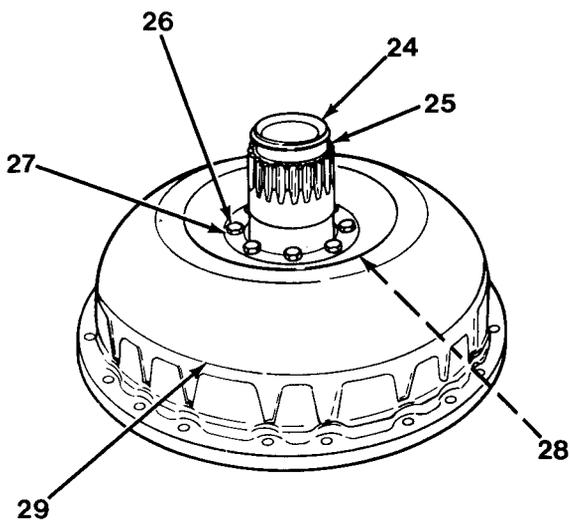


Figure 11-8

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY ASSEMBLY

1. Install O-ring (28), impeller hub (25), eight washers (27) and bolts (26) on impeller (29, Figure 11-8).
2. Install thrust race (15), thrust bearing (16) and thrust race (15, Figure 11-7).
3. Install outer clutch race (21), inner clutch race (20) and two clutch retainers (19) to sprag clutch assembly (22, Figure 11-6).

NOTE

Sprag clutch assembly must be installed in stator with spring side facing down and shoulder side facing up, along with the word FRONT stamped on stator. Inner race should turn in a counterclockwise direction with stator held solid against the bench.

4. Install outer clutch race (21), inner clutch race (20), two clutch retainers (19) and sprag clutch assembly (22) as an assembly in stator (23, Figure 11-5).
5. Install two snap rings (18).

NOTE

The word FRONT must face turbine when installed.

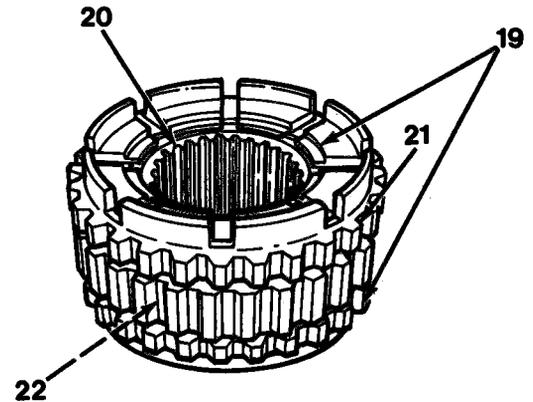


Figure 11-6

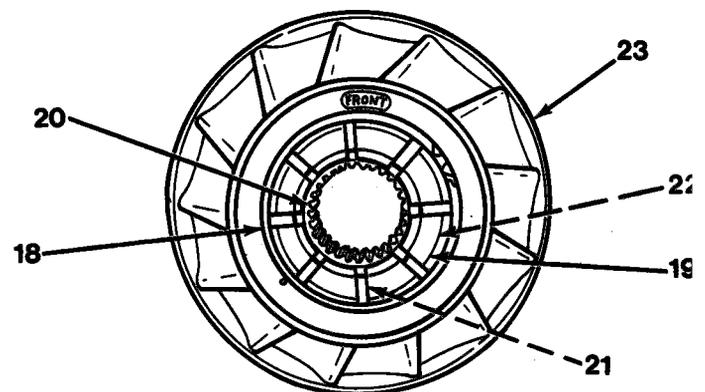


Figure 11-5

DRIVE PLATE GROUP AND CONVERTER ASSEMBLY ASSEMBLY

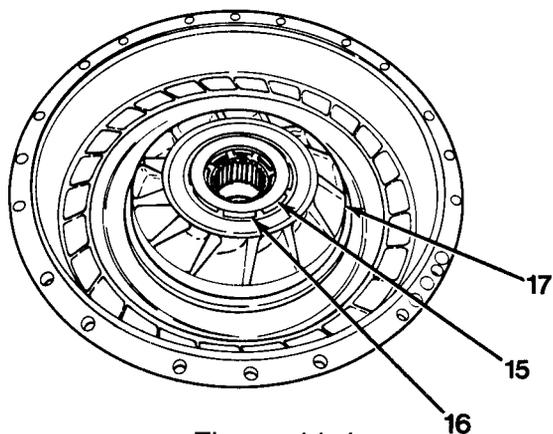


Figure 11-4

6. Install stator assembly (17, Figure 11-4).
7. Install thrust race (15), thrust bearing (16) and thrust race (15).
8. Install turbine (14) and turbine hub (13, Figure 11-3).
9. Install thrust race (11), thrust bearing (12) and thrust race (11).

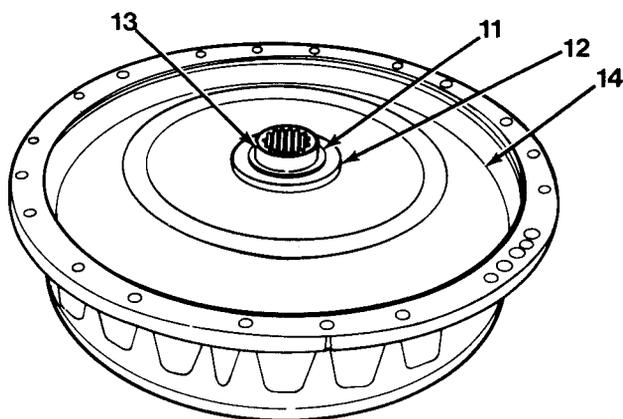


Figure 11-3

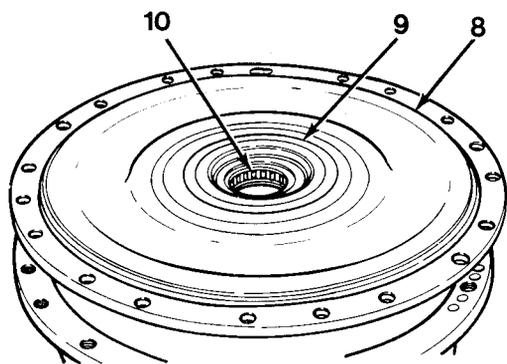


Figure 11-2

10. Install bearing (10) and seal (9) in front cover (8, Figure 11-2).
11. Install front cover (8), 20 capscrews (7), washers (6) and nuts (5, Figure 11-1), noting matchmarks made during disassembly. Torque 20 capscrews (7) to 30 lb-ft (41 N•m).

NOTE

Use Loctite 242 when installing 12 Capscrews.

12. Install drive plate (4), drive plate assembly (3), drive plate ring (2), and 12 capscrews (1) to converter assembly. Torque 12 capscrews (1) to 30 lb-ft (41 N•m).
13. Install seal ring (24) on impeller hub (25, Figure 11-9).

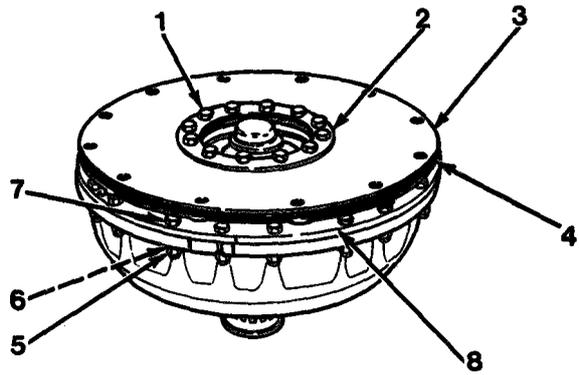


Figure 11-1

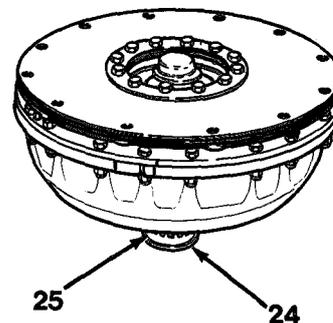


Figure 11-9

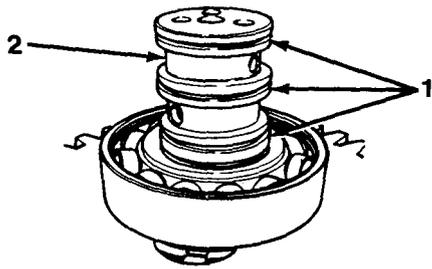


Figure 11-1

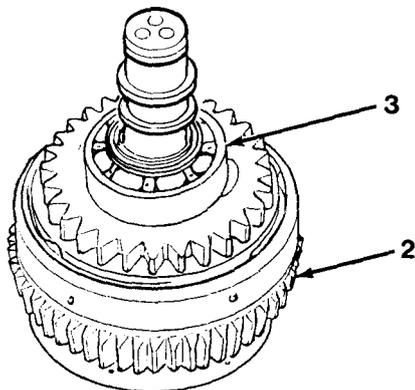


Figure 11-2

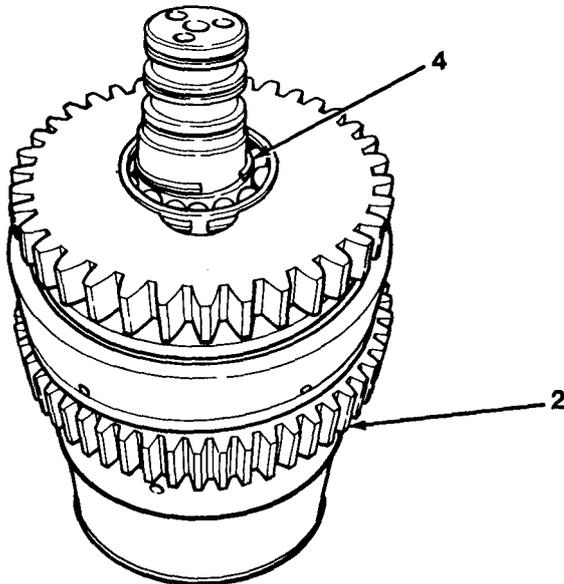


Figure 11-3

FIRST STAGE CLUTCH GROUP

FIRST STAGE CLUTCH GROUP DISASSEMBLY

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft.

1. Remove three seal rings (1) from clutch shaft assembly (2, Figure 11- 1).
2. Remove bearing (3) from clutch shaft assembly (2, Figure 11-2) by using a puller.
3. Remove snap ring (4) from clutch shaft assembly (2, Figure 11-3).

4. Remove forward and rear welded assembly (5) and bearing (6) as an assembly from clutch shaft assembly (2, Figure 11-4) by using a puller.
5. Open snap ring (7) to remove bearing (6) from forward and rear welded assembly (5, Figure 11-5).
6. Remove bearing (6) from forward and rear welded assembly (5) by using a driver.
7. Remove map ring (7), if inspection proves necessary, from forward and rear welded assembly (5, Figure 11-6).

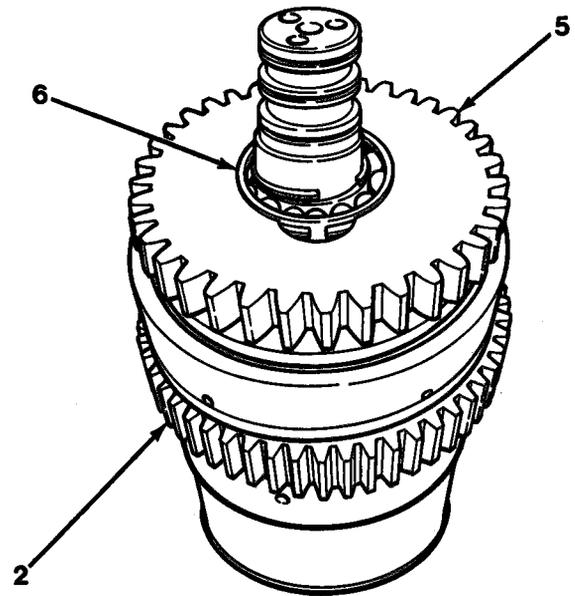


Figure 11-4

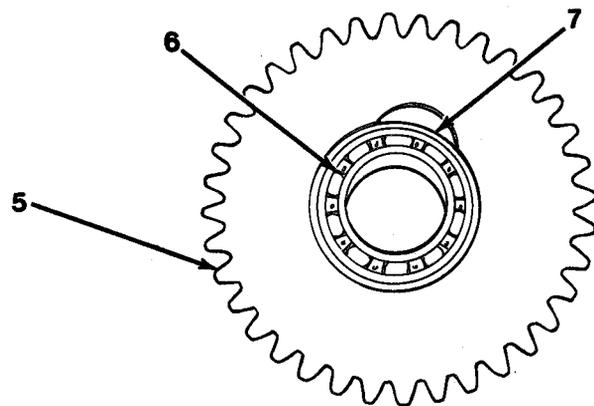


Figure 11-5

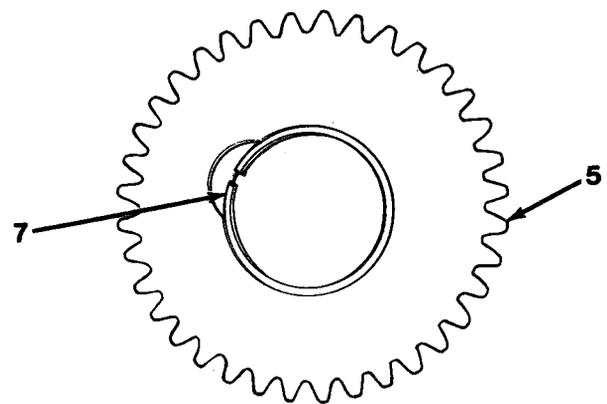


Figure 11-6

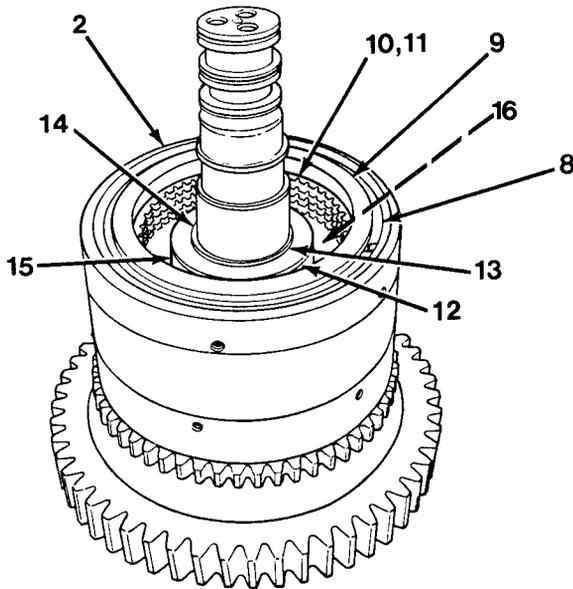


Figure 11-7

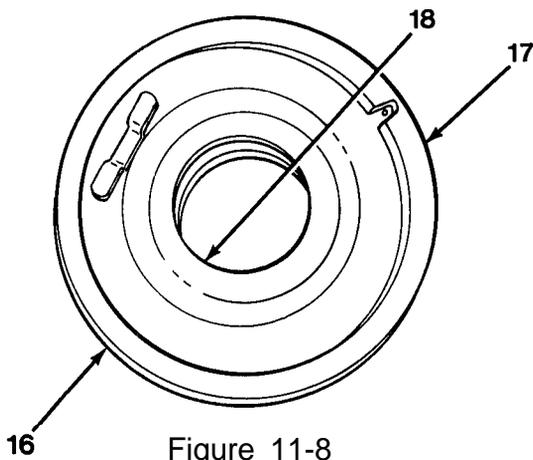


Figure 11-8

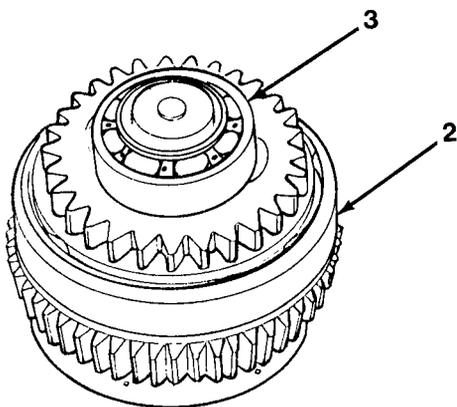


Figure 11-9

FIRST STAGE CLUTCH GROUP DISASSEMBLY

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

8. Remove snap ring (8), clutch plate retainer (9), six clutch plates (10) and clutch separator plates (11, Figure 11-7).
9. Compress four springs (12) and hold down to remove snap ring (13).
10. Remove snap ring (13) from clutch shaft assembly (2).

NOTE

Record positions of four springs before disassembly to aid in assembly.

11. Remove snap ring retainer (14), four springs (12) and thrust washer (15).
12. Remove clutch piston (16) from clutch shaft assembly (2) by applying short bursts of air to oil port of clutch shaft.
13. Remove outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-8).
14. Invert clutch group (Figure 11-9).

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft.

15. Remove bearing (3) from clutch shaft assembly (2) by using a puller.
16. Remove snap ring (4) from clutch shaft assembly (2, Figure 11-10).
17. Remove gear and hub welded assembly (19) and bearing (6) as an assembly from clutch shaft assembly (2) by using a puller.
18. Open snap ring (7) to remove bearing (6) from gear and hub welded assembly (19, Figure 11-11).
19. Remove bearing (6) from gear and hub welded assembly (19) by using a driver.
20. Remove snap ring (7), if inspection proves necessary, from gear and hub welded assembly (19).

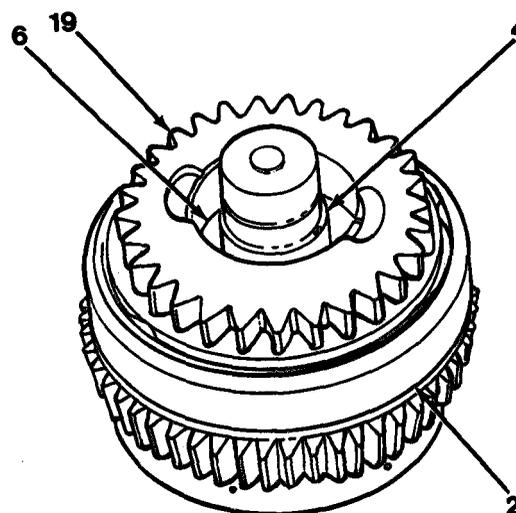


Figure 11-10

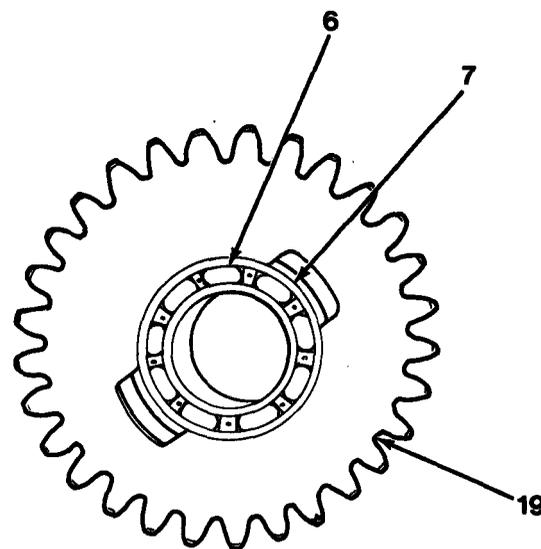


Figure 11-11

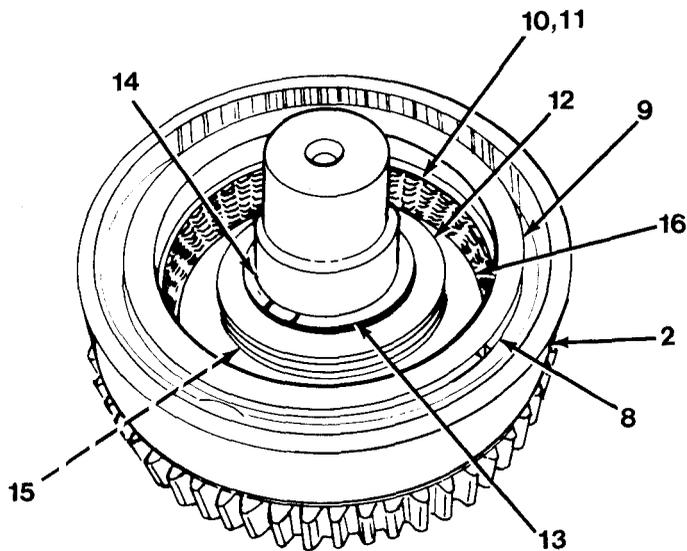


Figure 11-12

FIRST STAGE CLUTCH GROUP DISASSEMBLY

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

21. Remove snap ring (8), clutch plate retainer (9), six clutch plates (10) and clutch separator plates (11, Figure 11-12).
22. Compress four springs (12) and hold down to remove snap ring (13).
23. Remove snap ring (13) from clutch shaft assembly (2).

NOTE

Record positions of four springs before disassembly to aid in assembly.

24. Remove snap ring retainer (14) four springs (12) and thrust washer (15).
25. Remove clutch piston (16) from clutch shaft assembly (2).
26. Remove outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-8).

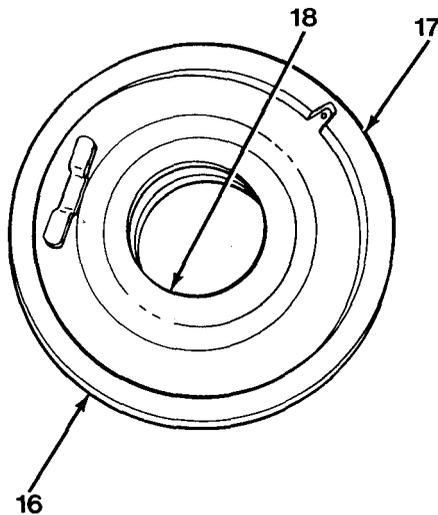


Figure 11-8

**FIRST STAGE CLUTCH GROUP
CLEANING/INSPECTION****CAUTION**

- Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.
 - Do not use compressed air to dry clutch plates. Drip dry only. Using compressed air may cause graphite clutch plates to flake.
1. Clean all parts (refer to Chapter 2).
 2. Inspect sealing surfaces on clutch shaft assemblies for any scratches and score marks.

 WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Safety glasses must be used when cleaning parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

3. Close one end of oil passage and apply compressed air, used for cleaning, and inspect oil passage in clutch shaft assemblies for leakage.
4. Inspect all inner and outer gears on gear and hub welded assemblies for chips, flaking and uneven wear.
5. Inspect clutch plates in four places by using a micrometer. Thickness should be 0.065 to 0.071 in. (1.65 to 1.80 mm).
6. Using a flat plate, visually check clutch plates and separator plates for warpage. If warpage exists, replace all warped clutch plates and separator plates.
7. Check separator plates with a micrometer. Thickness should be 0.0665 to 0.0710 in. (1.689 to 1.803 mm).
8. Check inner and outer seal grooves on clutch pistons for cracks, chips, scratches and flaking.
9. Inspect teeth on the clutch shaft assemblies for chips, flaking and uneven wear.

FIRST STAGE CLUTCH GROUP CLEANING/INSPECTION

10. Inspect retaining plates for flatness, chipping of teeth and flaking.
11. Check thrust washers for wear, flaking, scratches and discoloration. Thickness should be 0.060 to 0.065 in. (1.52 to 1.65 mm).
12. Inspect tensile strength of springs. Spring free height should be 0.125 to 0.139 in. (3.18 to 3.53 mm). Compressed to 0.092 in. (2.34 mm), load should be 170 to 327 lb (77.1 to 148.3 kg).
13. If new clutch plates are used, inspect new clutch plates, in four places, by using a micrometer. Thickness should be 0.065 to 0.071 in. (1.65 to 1.80 mm).
14. Inspect clutch plates for flaking.
15. Soak all parts in lubricating oil MIL-L-2104, grade 10, prior to installing.
16. Inspect all other parts (refer to Chapter 4).

FIRST STAGE CLUTCH GROUP ASSEMBLY

1. Install O-ring (38) and outer piston seal (17) to clutch piston (16, Figure 11-8).

CAUTION

Use care when installing clutch piston or seal damage may result.

2. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-12).

NOTE

Install springs as recorded during disassembly.

3. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2).
4. Compress four springs (12) and hold down to install snap ring (13).
5. Install snap ring (13) on clutch shaft assembly (2).

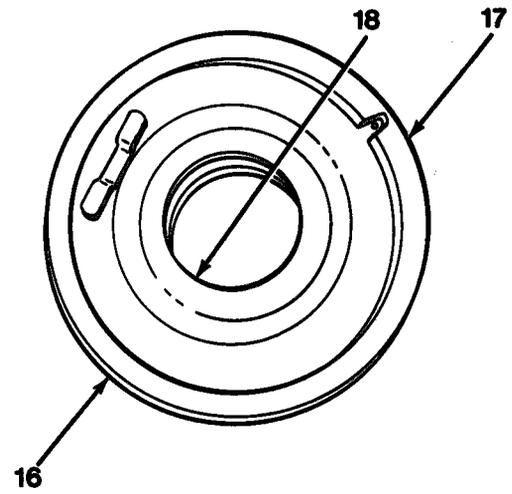


Figure 11-8

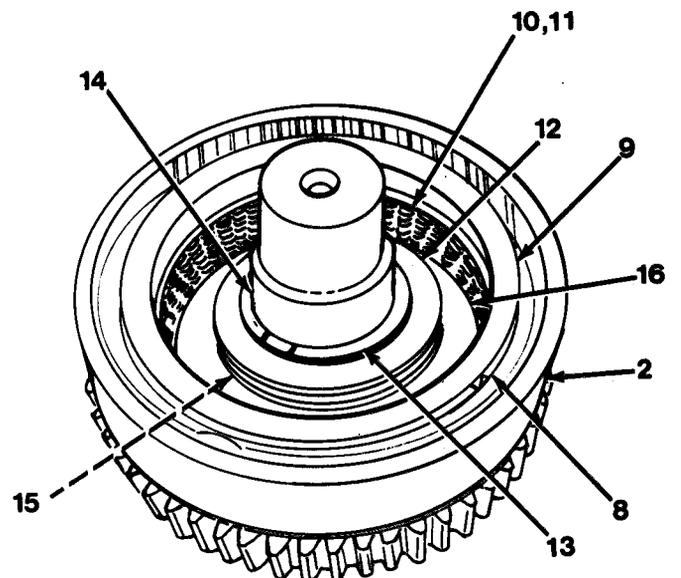


Figure 11-12

FIRST STAGE CLUTCH GROUP ASSEMBLY

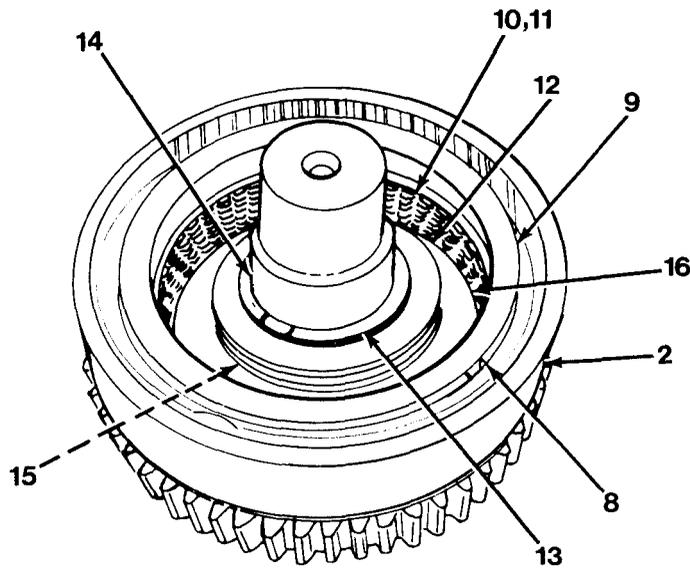


Figure 11-12

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.
- Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.

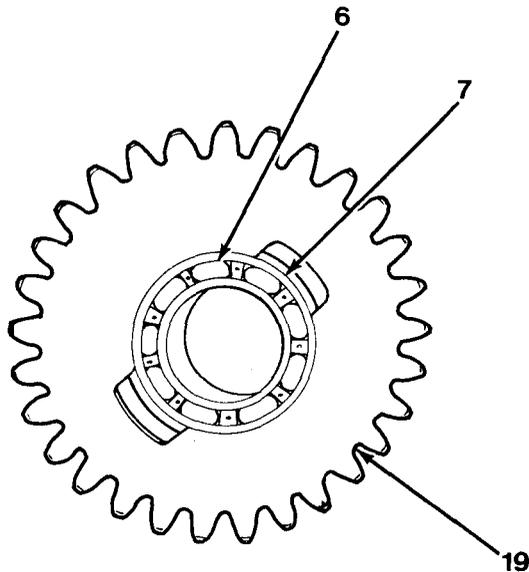


Figure 11-11

6. Install six clutch separator plates (11), clutch plates (10) and clutch plate retainer (9, Figure 11-12).
7. Install snap ring (8).
8. Install snap ring (7) into gear and hub welded assembly (19, Figure 11-11).

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

9. Install gear and hub welded assembly (19) onto clutch shaft assembly (2, Figure 11-10) and turn in both directions, alternately, while installing in order to align clutch plates. Measure height between shaft assembly (2) and face of gear on gear and hub welded assembly (19).
10. Remove gear and hub welded assembly (19) to check for alignment of all clutch plate teeth and any possible damage to teeth. If all clutch plate teeth were aligned to same height as measured in step 10, reinstall gear and hub welded assembly (19) onto clutch shaft assembly (2). If not, repeat step 10.

NOTE

It maybe necessary to prop up gear and hub welded assembly by using two 0.25 in. (6.4 mm) thick alignment bars to allow snap ring to seat in bearing.

11. Open snap ring (7) to install bearing (6) into gear and hub welded assembly (19, Figure 11-13).
12. Install bearing (6) into gear and hub welded assembly (19) and on clutch shaft assembly (2).
13. Remove alignment bars, if used, and seat bearing (6) and gear hub welded assembly (19).

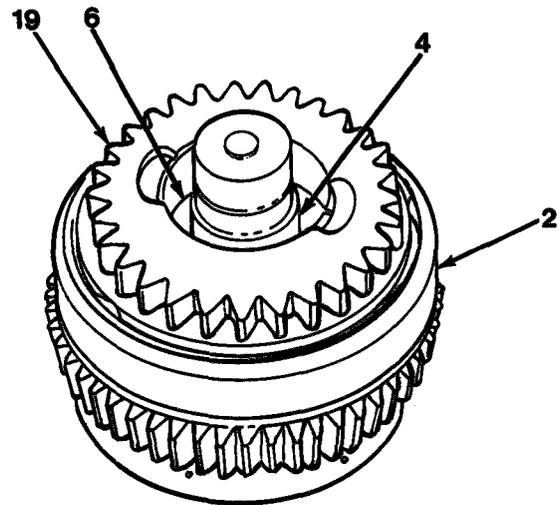


Figure 11-10

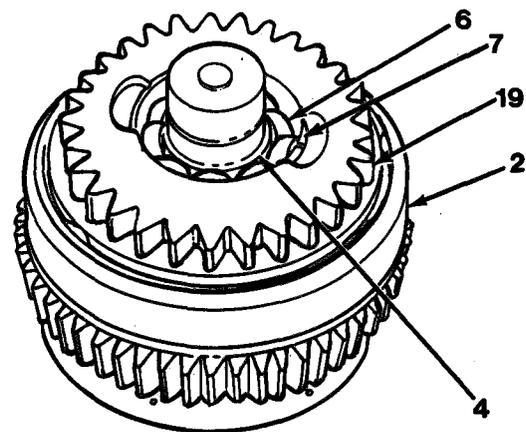


Figure 11-13

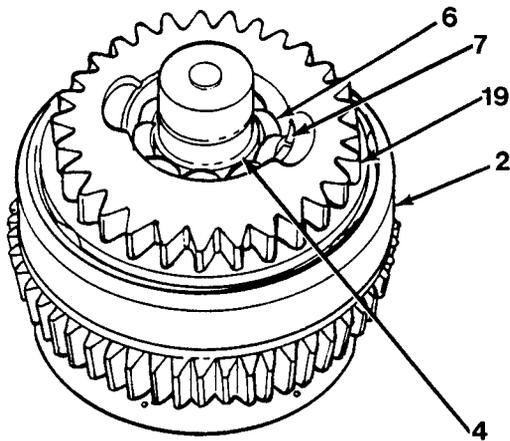


Figure 11-13

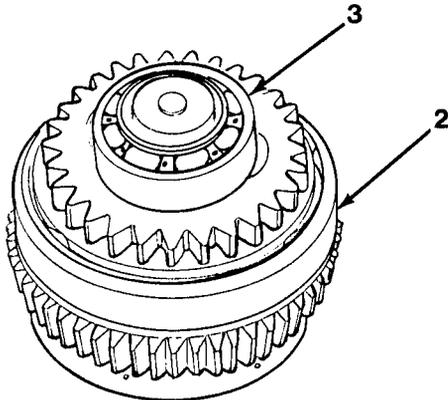


Figure 11-9

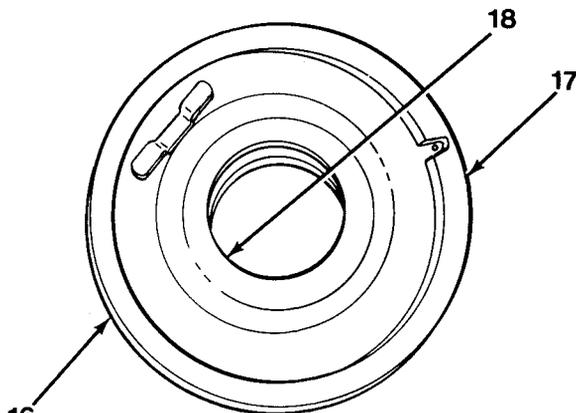


Figure 11-8

FIRST STAGE CLUTCH GROUP ASSEMBLY

14. Install snap ring (4) on clutch shaft assembly (2, Figure 11-13).
15. Install bearing (3) on clutch shaft assembly (2, Figure 11-9) by using a press.
16. Invert clutch group.
17. Install O-ring (18) and outer piston seal (17) to clutch piston (16, Figure 11-8).

CAUTION

Use care when installing clutch piston or seal damage may result.

18. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-7).

NOTE

Install springs as recorded during disassembly.

19. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2).
20. Compress four springs (12) and hold down to install snap ring (13).
21. Install snap ring (13) on clutch shaft assembly (2).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.
- Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.

22. Install six clutch separator plates (11), clutch plates (10) and clutch plate retainer (9).
23. Install snap ring (8).
24. Install snap ring (7) into forward and rear welded assembly (5, Figure 11-6).

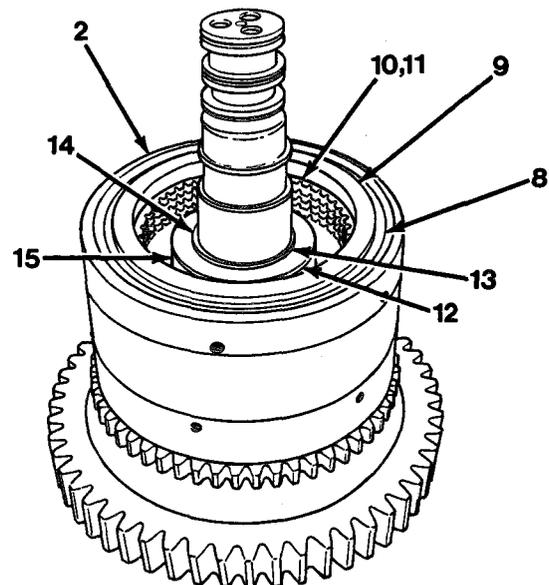


Figure 11-7

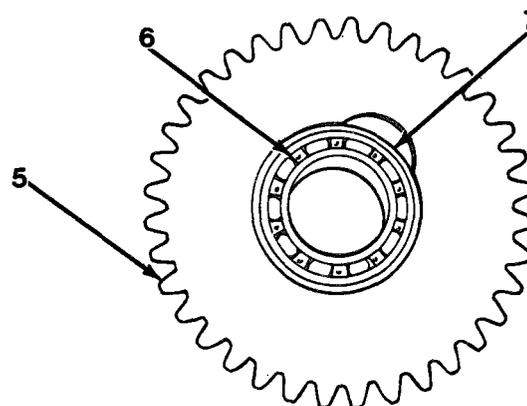


Figure 11-6

FIRST STAGE CLUTCH GROUP ASSEMBLY

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

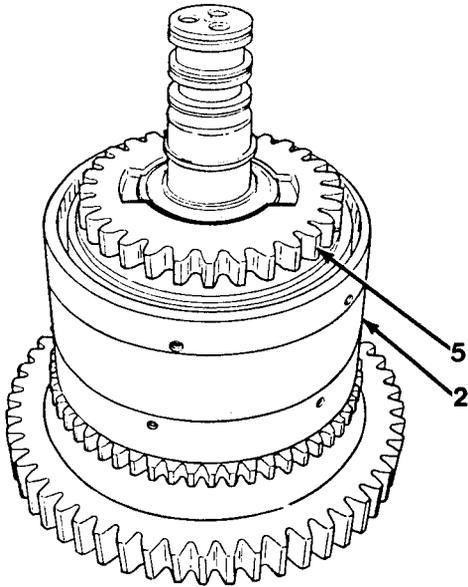


Figure 11-14

25. Install forward and rear welded assembly (5) onto clutch shaft assembly (2, Figure 11-14) and turn in both directions, alternately, while installing in order to align clutch plates. Measure height between shaft assembly (2) and face of gear on gear and hub welded assembly (5).

26. Remove forward and rear welded assembly (5) to check for alignment of all clutch plate teeth and any possible damage to teeth. If all clutch plate teeth were aligned, reinstall forward and rear welded assembly (5) onto clutch shaft assembly (2) to same height as measured in step 27. If not, repeat step 27.

NOTE

It may be necessary to prop up forward and rear welded assembly by using two 0.62 in. (15.8 mm) thick alignment bars to allow snap ring to seat in bearing.

27. Open snap ring (7) to install bearing (6) into forward and rear welded assembly (5, Figure 11-15).

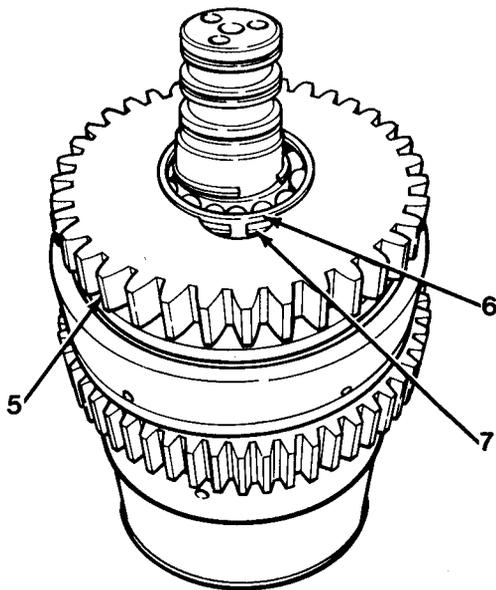


Figure 11-15

28. Install bearing (6) into forward and rear welded assembly (5).
29. Remove alignment bars, if used, and seat bearing (6) and forward and rear welded assembly (5).
30. Install snap ring (4) on clutch shaft assembly (2, Figure 11-3).
31. Install bearing (3) on clutch shaft assembly (2, Figure 11-2) by using a press.

NOTE

Use grease to lubricate the manifold seal rings.

32. Install three seal rings (1) on clutch shaft assembly (2, Figure 11-1).

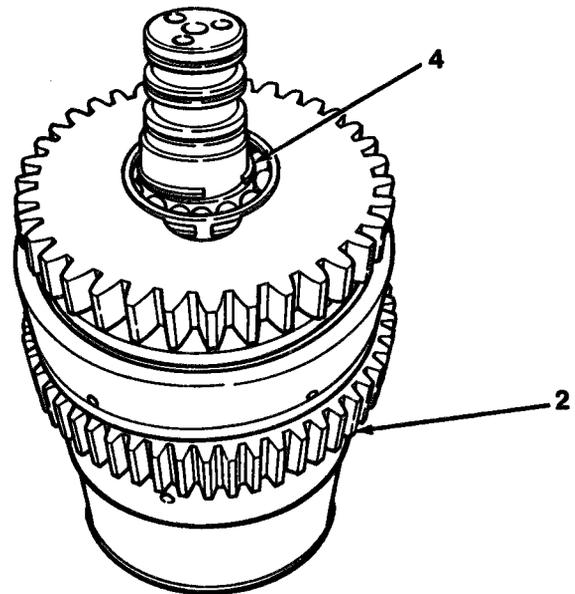


Figure 11-3

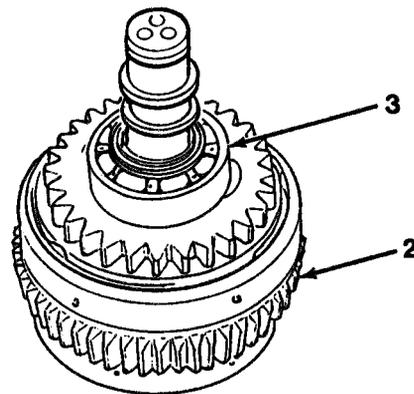


Figure 11-2

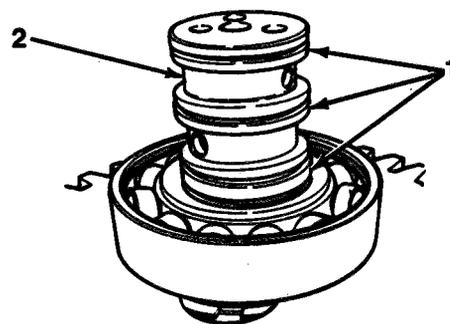


Figure 11-1

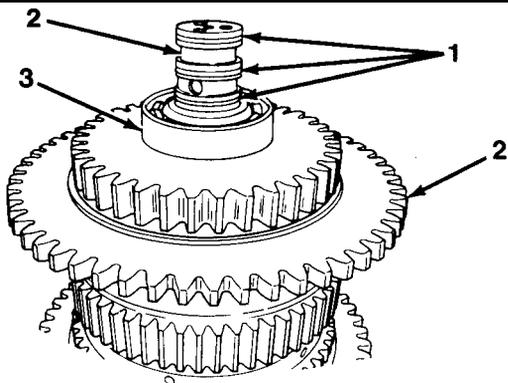


Figure 11-1

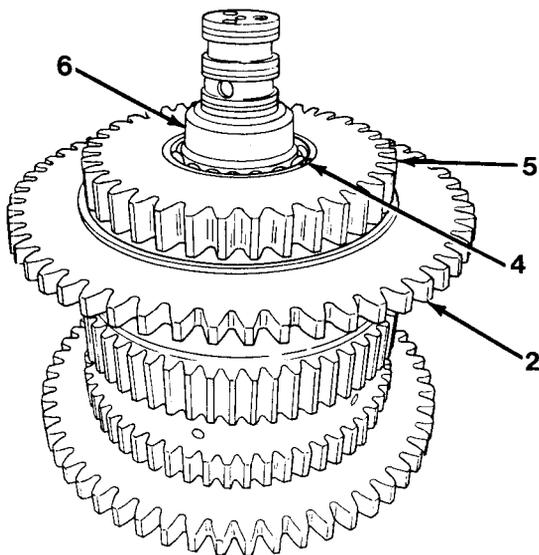


Figure 11-2

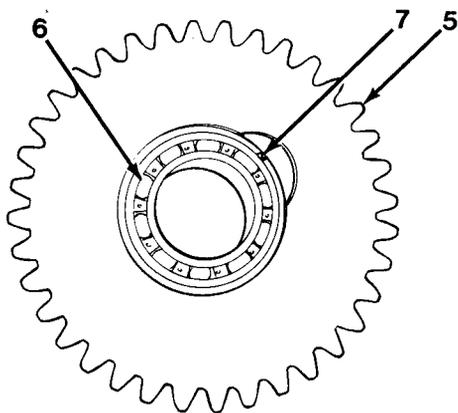


Figure 11-3

SECOND STAGE CLUTCH GROUP

SECOND STAGE CLUTCH GROUP DISASSEMBLY

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

1. Remove and discard three seal rings (1) from clutch shaft assembly (2, Figure 11-1).
2. Remove bearing (3) from clutch shaft assembly (2) by using a puller.
3. Remove snap ring (4) from clutch shaft assembly (2, Figure 11-2).
4. Remove forward and rear welded assembly (5) and bearing (6) as an assembly from clutch shaft assembly (2), by using a puller.
5. Open snap ring (7), to remove bearing (6) from forward and rear welded assembly (5, Figure 11-3).
6. Remove bearing (6) from forward and rear welded assembly (5).
7. Remove snap ring (7), if inspection proves necessary, from forward and rear welded assembly (5).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

8. Remove snap ring (8), clutch plate retainer (9), six clutch plates (10) and clutch separator plates (11, Figure 11-4).
9. Compress four springs (12) and hold down to remove snap ring (13).
10. Remove snap ring (13) from clutch shaft assembly (2).

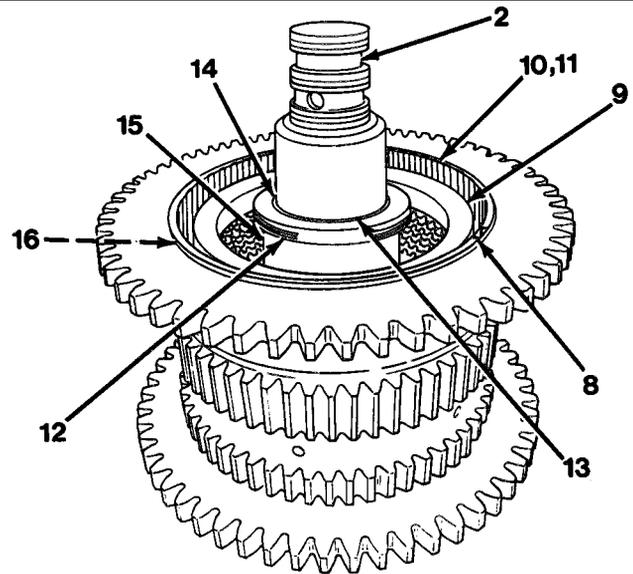


Figure 11-4

NOTE

Record positions of four springs before disassembly to aid in assembly.

11. Remove snap ring retainer (14) four springs (12) and thrust washer (15).
12. Remove clutch piston (16) from clutch shaft assembly (2).
13. Remove and discard outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-5).
14. Invert clutch group.

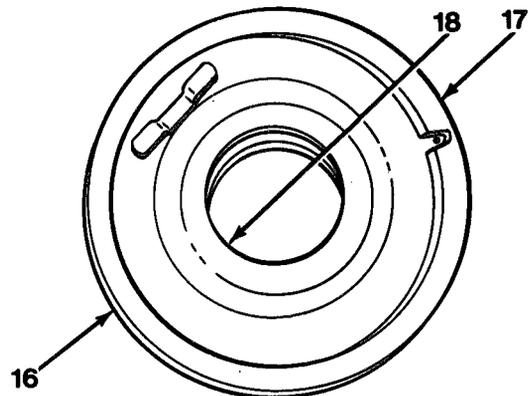


Figure 11-5

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

15. Using a puller, remove bearing (19, Figure 11-6).

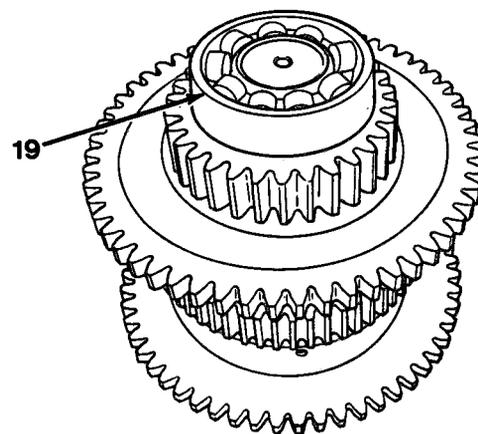


Figure 11-6

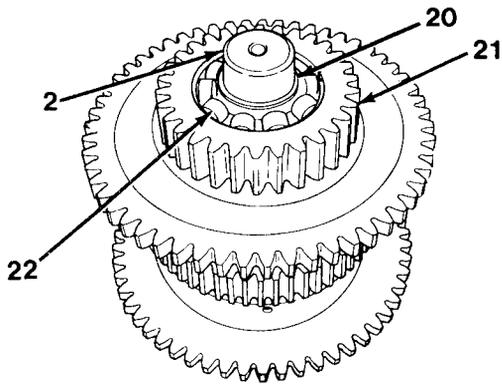


Figure 11-7

SECOND STAGE CLUTCH GROUP DISASSEMBLY

16. Remove snap ring (20) from clutch shaft assembly (2, Figure 11-7).
17. Remove gear and hub welded assembly (21) with one bearing (22) as an assembly from clutch shaft assembly (2) by using a puller.
18. Drive bearing (22) out of gear and hub welded assembly (21, Figure 11-8).
19. Remove snap ring (23) from bearing (22, Figure 11-9).

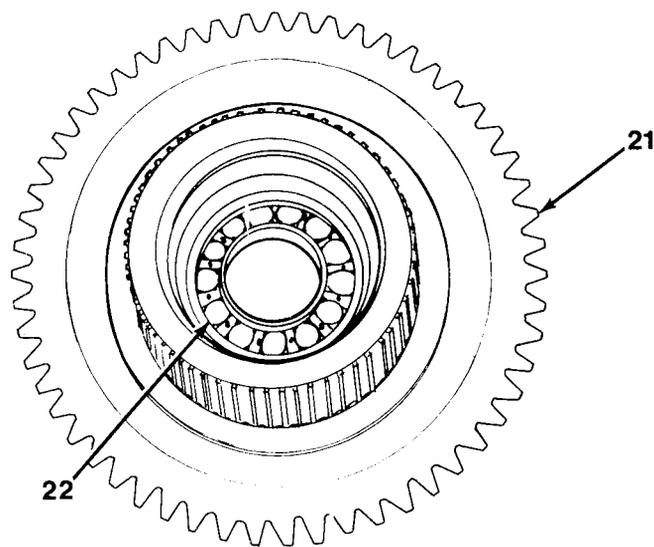


Figure 11-8

NOTE

Record position of bearing before disassembly to aid in assembly.

20. Remove bearing (22) from clutch shaft assembly (2, Figure 11-7).

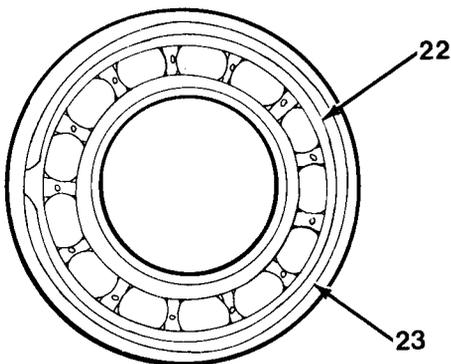


Figure 11-9

21. Remove snap ring (20) from clutch shaft assembly (2, Figure 11-10).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

22. Remove snap ring (8), clutch plate retainer (9), six clutch plates (10) and clutch separator plates (11).
23. Compress four springs (12) and hold down to remove snap ring (13).
24. Remove snap ring (13) from clutch shaft assembly (2).

NOTE

Record positions of four springs before removal to aid in installation.

25. Remove snap ring retainer (14) four springs (12) and thrust washer (15).
26. Remove clutch piston (16) from clutch shaft assembly (2).
27. Remove outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-5).

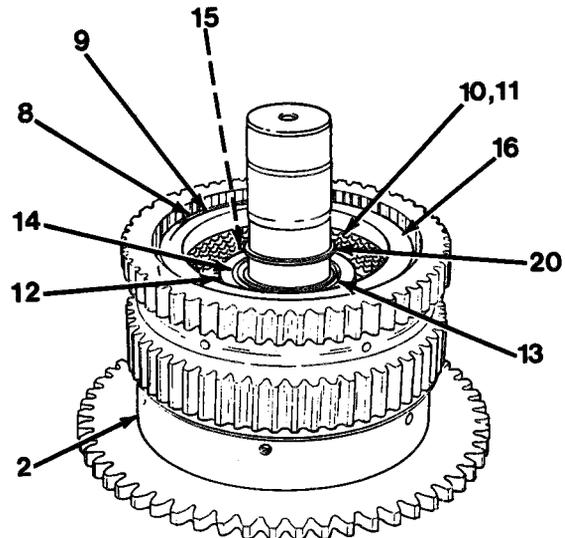


Figure 11-10

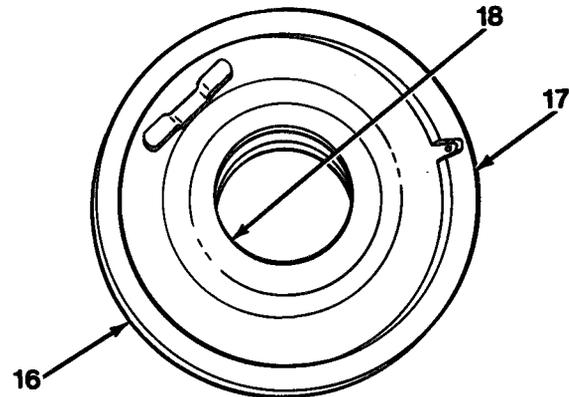


Figure 11-5

SECOND STAGE CLUTCH GROUP CLEANING/INSPECTION

Repeat the cleaning and inspection procedures from the first stage clutch group (refer to page 11-33).

SECOND STAGE CLUTCH GROUP ASSEMBLY

1. Install O-ring (18) and new outer piston seal (17) to clutch piston (16, Figure 11-5).

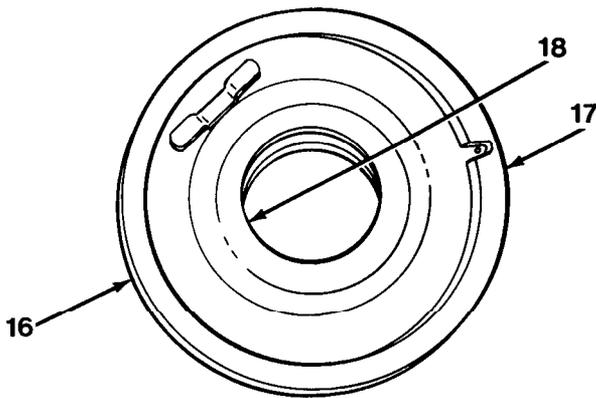


Figure 11-5

CAUTION

Use care when installing clutch piston or seal damage may result.

2. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-10).

NOTE

Install springs as recorded during disassembly.

3. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2).
4. Compress four springs (12) and hold down to install snap ring (13).

5. Install snap ring (13) on clutch shaft assembly (2).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.
- Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.

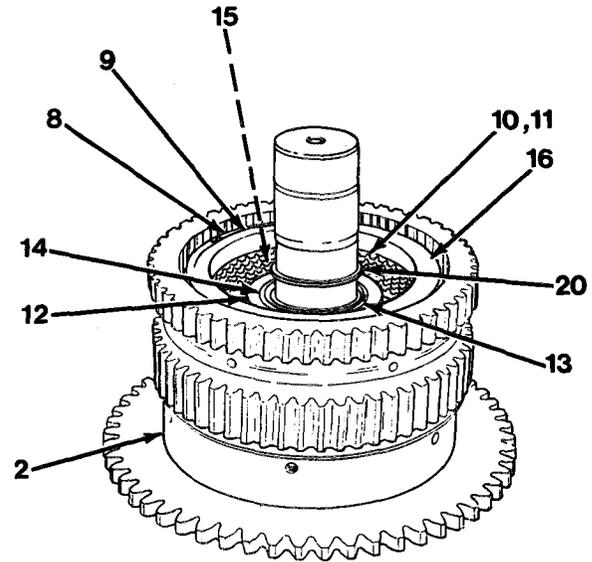


Figure 11-10

6. Install six clutch separator plates (11), clutch plates (10) and clutch plate retainer (9).
7. Install snap ring (8).
8. Install snap ring (20) on clutch shaft assembly (2).

SECOND STAGE CLUTCH GROUP ASSEMBLY

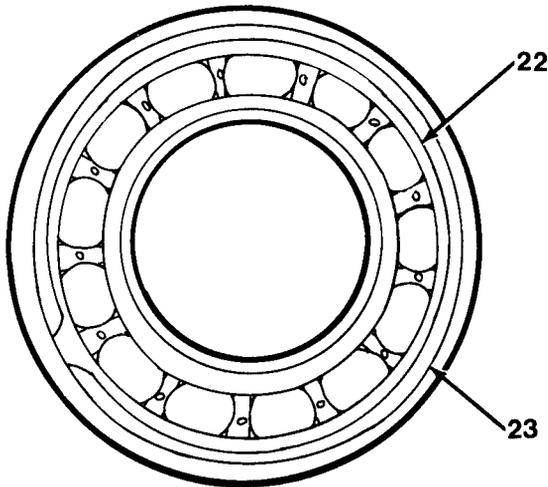


Figure 11-9

9. Install snap ring (23) onto bearing (22, Figure 11-9).

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

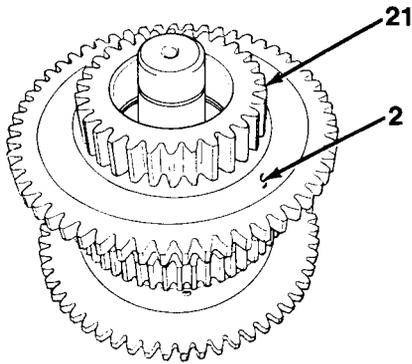


Figure 11-11

10. Install gear and hub welded assembly (21) onto clutch shaft assembly (2, Figure 11-11) and turn in both directions, alternately, while installing in order to align clutch plates.

11. Remove gear and hub welded assembly (21) to check alignment and any possible damage to teeth.

12. Install bearing (22) onto shaft assembly (2, Figure 11-12).

NOTE

It may be necessary to rotate gear and hub welded assembly while tapping with a soft-faced mallet to align clutch teeth.

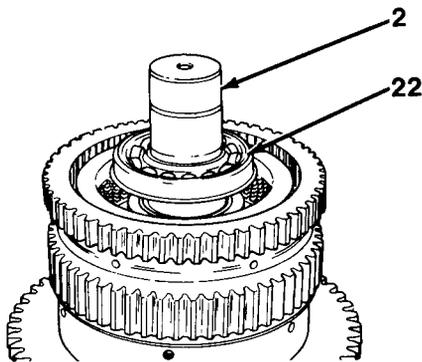


Figure 11-12

13. Install gear and hub welded assembly (21) over bearing (22) on clutch shaft assembly (2, Figure 11-13) by tapping lightly on gear and hub welded assembly (21) with a soft-faced mallet.

14. Install remaining bearing (22) into gear and hub welded assembly (21, Figure 11-7).
15. Install snap ring (20) on clutch shaft assembly (2).
16. Install bearing (19) on clutch shaft assembly (2, Figure 11-6).
17. Invert clutch group.
18. Install O-ring (18) and new outer piston seal (17) to clutch piston (16, Figure 11-5).

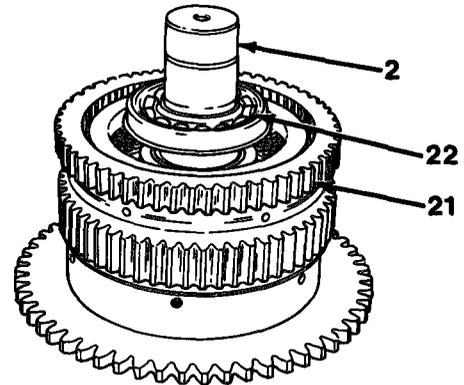


Figure 11-13

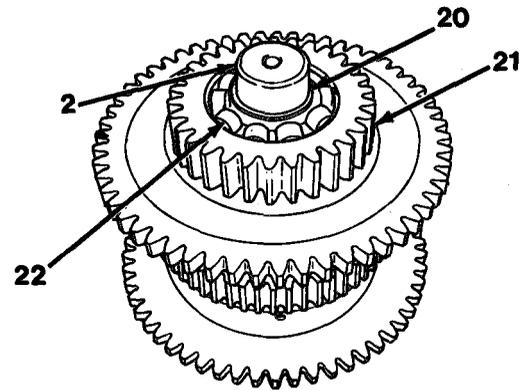


Figure 11-7

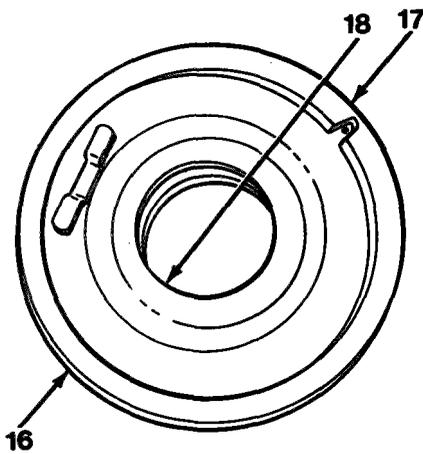


Figure 11-5

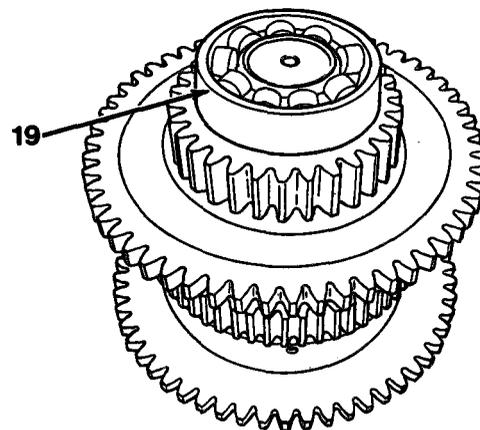


Figure 11-6

SECOND STAGE CLUTCH GROUP ASSEMBLY

CAUTION

Use care when installing clutch piston or seal damage may result.

19. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-10).

NOTE

Install springs as recorded during disassembly.

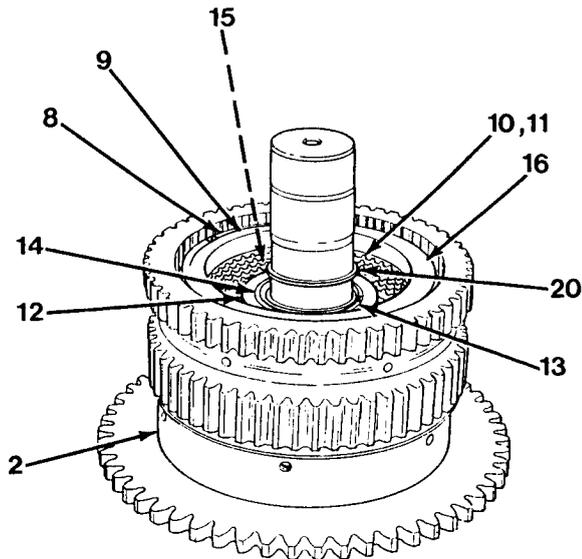


Figure 11-10

20. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2).
21. Compress four springs (12) and hold down to install snap ring (13).
22. Install snap ring (13) on clutch shaft assembly (2).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.

- Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.

23. Install six clutch separator plates (11), clutch plates (10) and clutch plate retainer (9).
24. Install snap ring (8).
25. Install snap ring (7), if removed, into forward and rear welded assembly (5, Figure 11-15).

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft.

26. Install forward and rear welded assembly (5) onto clutch shaft assembly (2, Figure 11-2) and turn in both directions, alternately, while installing in order to align clutch plates. Measure height between shaft assembly (2) and face of gear on forward and rear welded assembly (5).

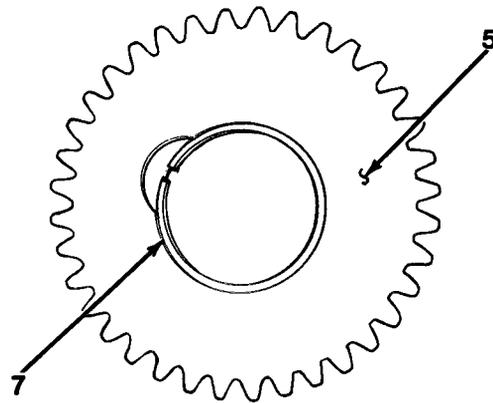


Figure 11-15

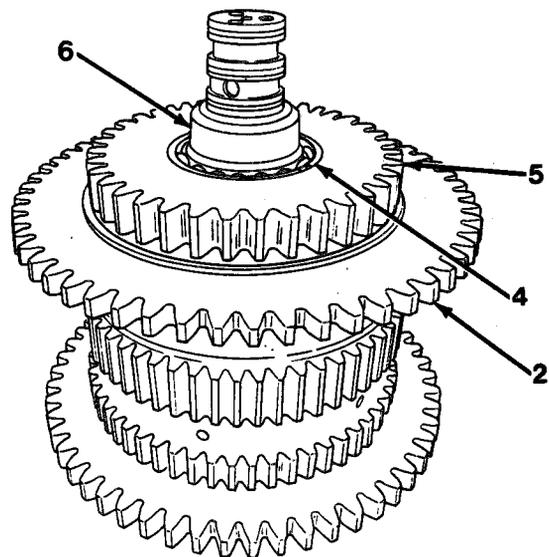


Figure 11-2

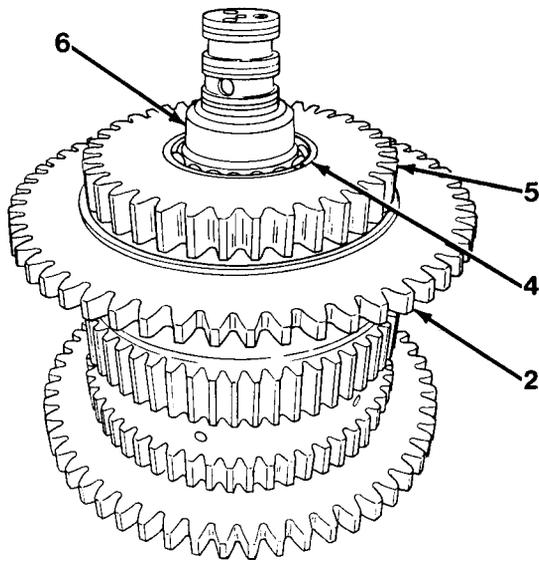


Figure 11-2

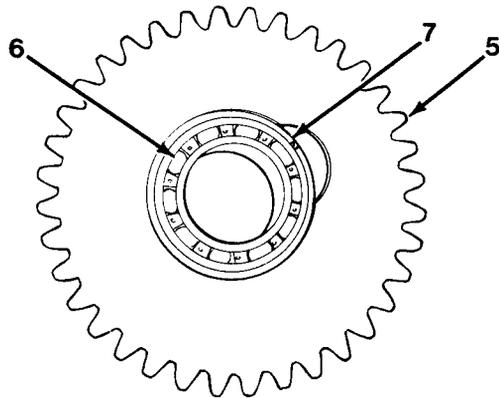


Figure 11-3

SECOND STAGE CLUTCH GROUP ASSEMBLY

27. Remove forward and rear welded assembly (5) to check for alignment of clutch plate teeth and any possible damage to teeth. If all clutch plate teeth were aligned, install forward and rear welded assembly (5) onto clutch shaft assembly (2, Figure 11-2) to same height as measured in step 29. If not, repeat step 29.

NOTE

It may be necessary to prop up forward and rear welded assembly by using two 0.19 in. (4.8 mm) thick alignment bars to allow snap ring to seat in bearing.

28. Open snap ring (7), to install bearing (6) into forward and rear welded assembly (5, Figure 11-3).

29. Install bearing (6) into forward and rear welded assembly (5). Snap ring (7) must seat in bearing assembly.
30. Remove alignment bars, if used, and seat bearing (6) and forward and rear welded assembly (5).
31. Install snap ring (4) on clutch shaft assembly (2, Figure 11-2).
32. Install bearing (3) on clutch shaft assembly (2, Figure 1-11).

NOTE

Use grease to lubricate the manifold seal rings.

33. Install three seal rings (1) on clutch shaft assembly (2).

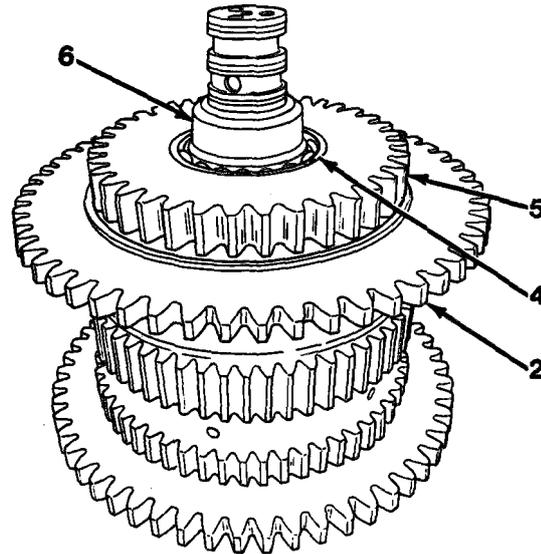


Figure 11-2

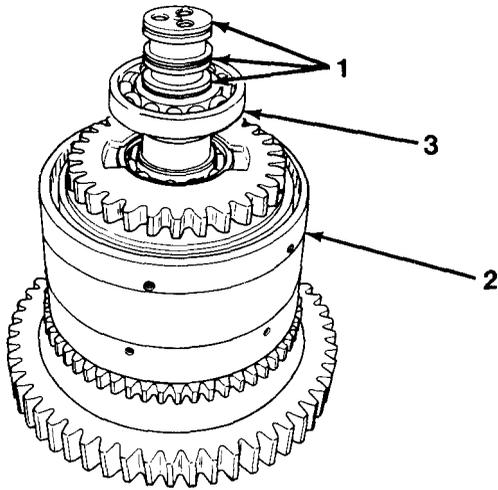


Figure 11-1

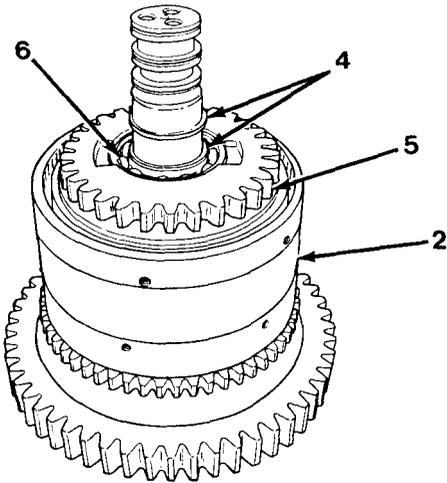


Figure 11-2

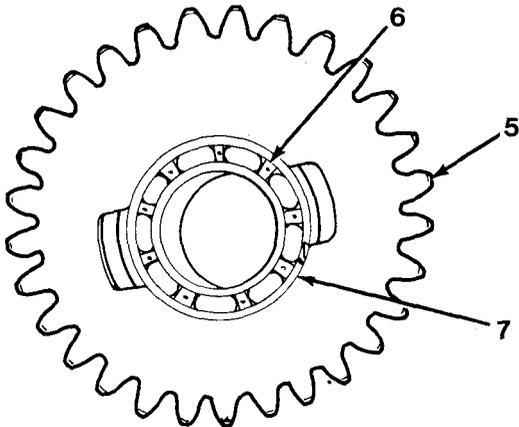


Figure 11-3

THIRD STAGE CLUTCH GROUP

THIRD STAGE CLUTCH GROUP DISASSEMBLY

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

1. Remove three seal rings (1) from clutch shaft assembly (2, Figure 11-1).
2. Using a puller, remove bearing (3) from clutch shaft assembly (2).
3. Remove two snap rings (4) from clutch shaft assembly (2, Figure 11-2).
4. Using a puller, remove high gear welded assembly (5) and bearing (6) as an assembly from clutch shaft assembly (2).
5. Open snap ring (7), to remove bearing (6) from high gear welded assembly (5, Figure 11-3).
6. Remove bearing (6) from high gear welded assembly (5).
7. Remove snap ring (7), if inspection proves necessary, from high gear welded assembly (5).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

8. Remove snap ring (8), clutch plate retainer (9), four clutch plates (10) and clutch separator plates (11, Figure 11-4).
9. Compress four springs (12) and hold down to remove snap ring (13).
10. Remove snap ring (13) from clutch shaft assembly (2).

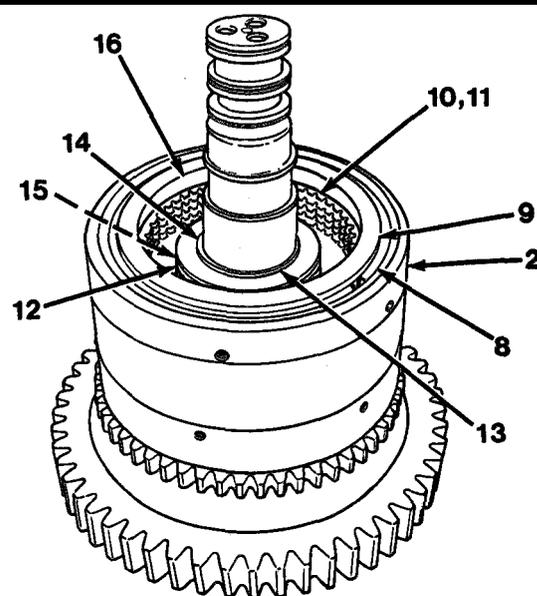


Figure 11-4

NOTE

Record positions of four springs before disassembly to aid in assembly.

11. Remove snap ring retainer (14), four springs (12) and thrust washer (15).
12. Remove clutch piston (16) from clutch shaft assembly (2).
13. Remove outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-5).
14. Invert clutch group.
15. Using a puller, remove bearing (19) from clutch shaft assembly (2, Figure 11-6).

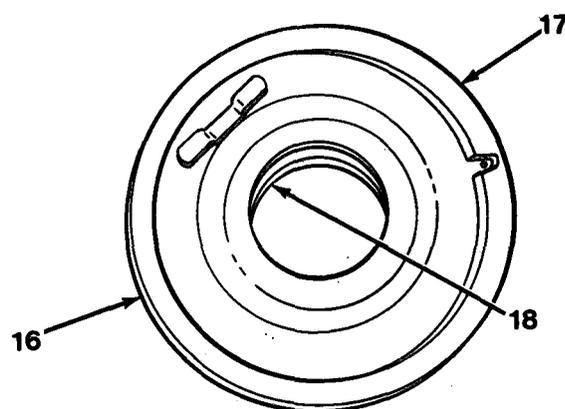


Figure 11-5

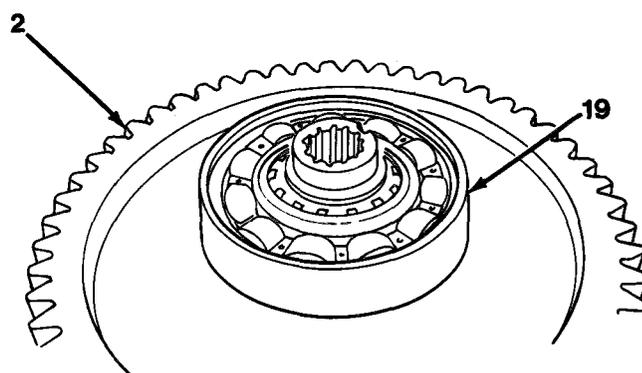


Figure 11-6

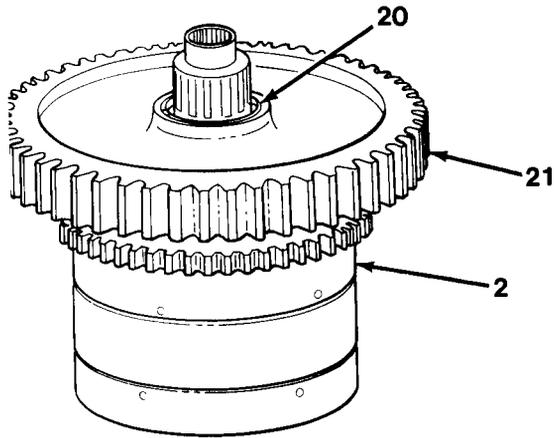


Figure 11-7

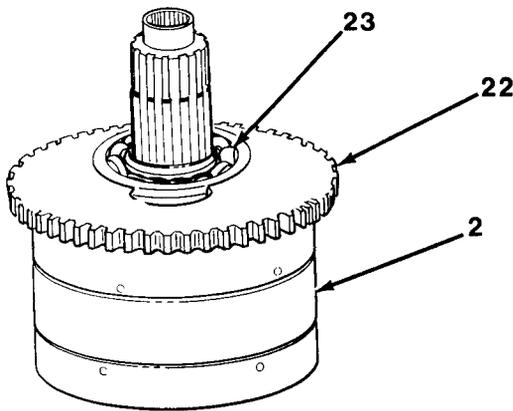


Figure 11-8

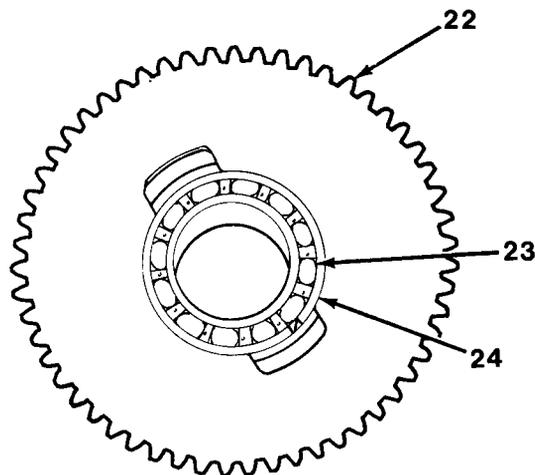


Figure 11-9

THIRD STAGE CLUTCH GROUP DISASSEMBLY

16. Remove snap ring (20) from clutch shaft assembly (2, Figure 11-7)
17. Remove third stage (21) from clutch shaft assembly (2).
18. Mark side of third stage gear (21) which is facing opposite clutch shaft assembly (2) to aid in assembly.
19. Using a puller, remove gear and hub welded assembly (22) and bearing (23) as an assembly from clutch shaft assembly (2, Figure 11-8).
20. Open snap ring (24) to remove bearing (23) from gear and hub welded assembly (22, Figure 11-9).
21. Remove bearing (23) from gear and hub welded assembly (22).
22. Remove snap ring (24), if inspection proves necessary, from gear and hub welded assembly (22).
23. Remove snap ring (20) from clutch shaft assembly (2, Figure 11-10).

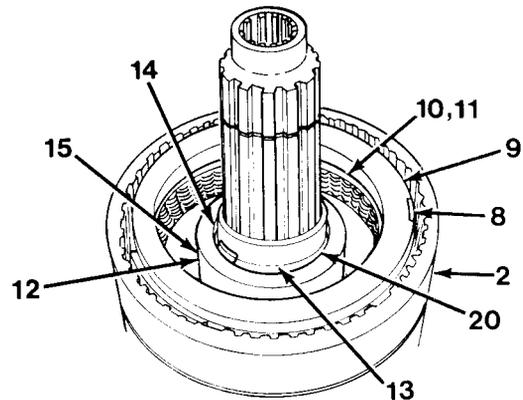


Figure 11-10

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

24. Remove snap ring (8), clutch plate retainer (9), six clutch plates (10) and clutch separator plates (11).
25. Compress four springs (12) and hold down to remove snap ring (13).
26. Remove snap ring (13) from clutch shaft assembly (2).

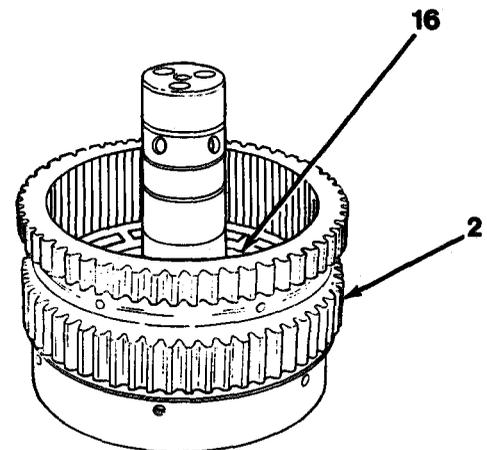


Figure 11-11

NOTE

Record positions of four springs before disassembly to aid assembly.

27. Remove snap ring retainer (14), four springs (12) and thrust washer (15).
28. Remove clutch piston (16) from clutch shaft assembly (2, Figure 11-11).
29. Remove outer piston seal (17) and inner O-ring (18) from clutch piston (16, Figure 11-5).

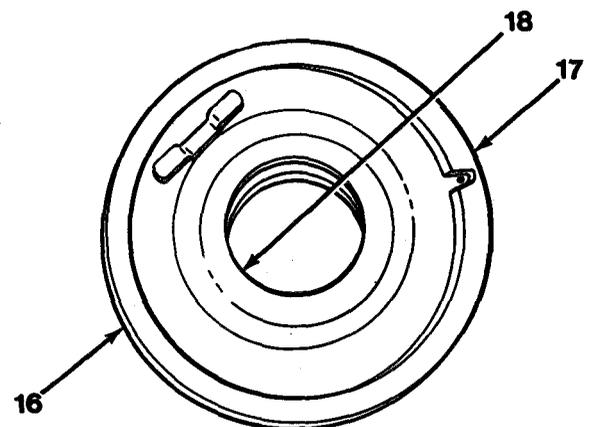


Figure 11-5

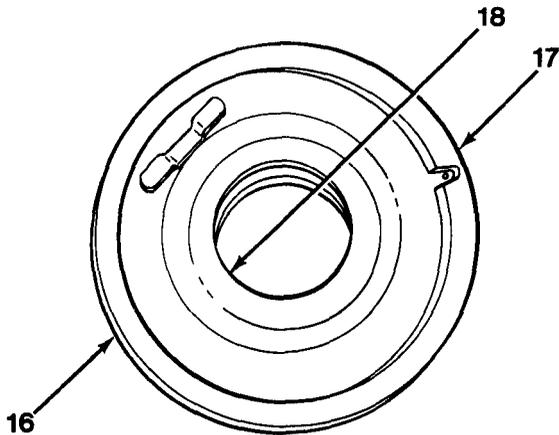


Figure 11-5

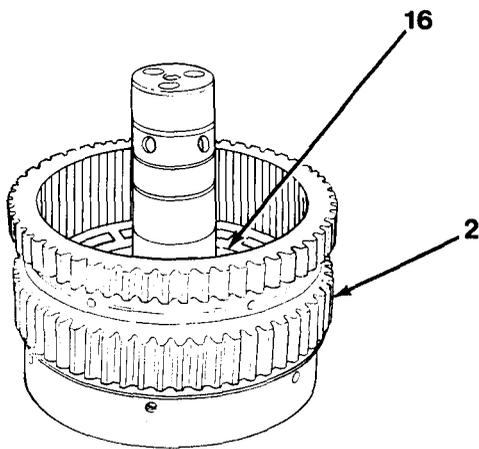


Figure 11-11

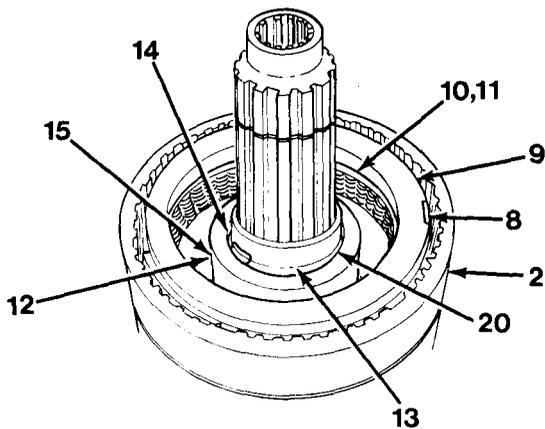


Figure 11-12

THIRD STAGE CLUTCH GROUP CLEANING/inspection

Repeat cleaning and inspection procedures for the first stage clutch group (refer to page 11-33).

THIRD STAGE CLUTCH GROUP ASSEMBLY

1. Install O-ring (18) and new outer piston seal (17) to clutch piston (16, Figure 11-5).

CAUTION

Use care when installing clutch piston or seal damage may result.

2. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-11).

NOTE

Install springs as recorded during disassembly.

3. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2, Figure 11-12).

-
4. Compress foursprings (12) and hold down to install snap ring (13).
 5. Install snap ring (13) on clutch shaft assembly (2).

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.
 - Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.
6. Install six clutch separator plates (11), clutch plates (10) and clutch plate retainer (9).
 7. Install snap ring (8).

THIRD STAGE CLUTCH GROUP ASSEMBLY

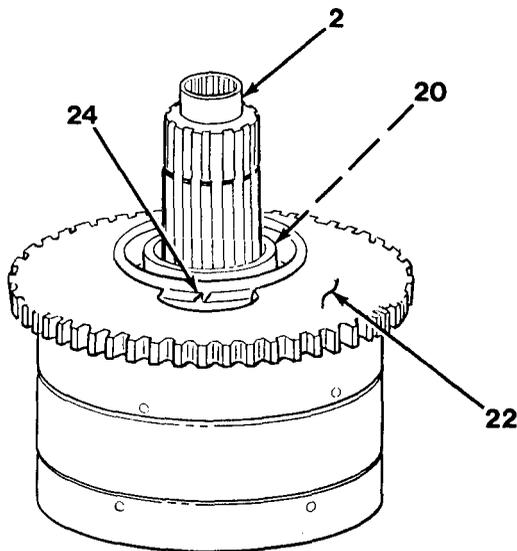


Figure 11-13

8. Install snap ring (20) on clutch shaft assembly (2, Figure 11-13).
9. Install snap ring (24), if removed, into gear and hub welded assembly (22).

CAUTION

Care must be taken not to damage seal ring surfaces on clutch shaft. Failure to follow this procedure could cause damage to equipment.

10. Install gear and hub welded assembly (22) and turn in both directions, alternately, while installing in order to align clutch plates. Measure height between shaft assembly (2) and face of gear on gear and hub welded assembly (22).
11. Remove gear and hub welded assembly (22) to check for alignment of all clutch plate teeth and any possible damage to teeth install gear and hub welded assembly (22) onto clutch shaft assembly (2) to same height as measured in step 10. If not, repeat step 10.

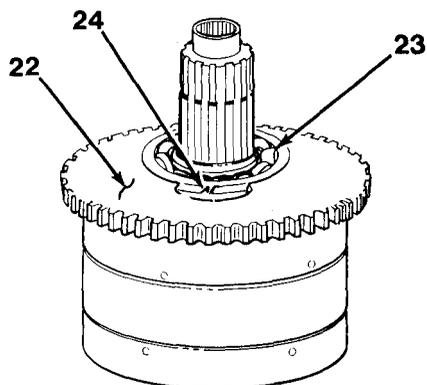


Figure 11-14

12. Open snap ring (24) to install bearing (23) into gear and hub welded assembly (22, Figure 11-14).
13. Install bearing (23) into gear and hub welded assembly (22).
14. Install third stage gear (21) on clutch shaft assembly (2, Figure 11-7). Note marking made during disassembly.
15. Install snap ring (20) on clutch shaft assembly (2).
16. Install bearing (19) on clutch shaft assembly (2, Figure 11-6) by using a press.
17. Invert clutch group.
18. Install O-ring (18) and new outer piston seal (17) to clutch piston (16, Figure 11-5).

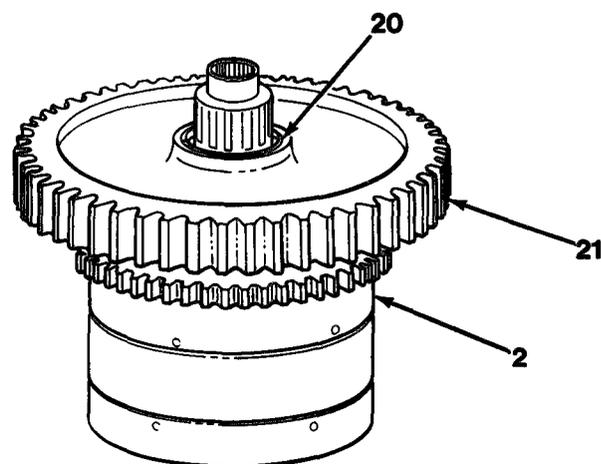


Figure 11-7

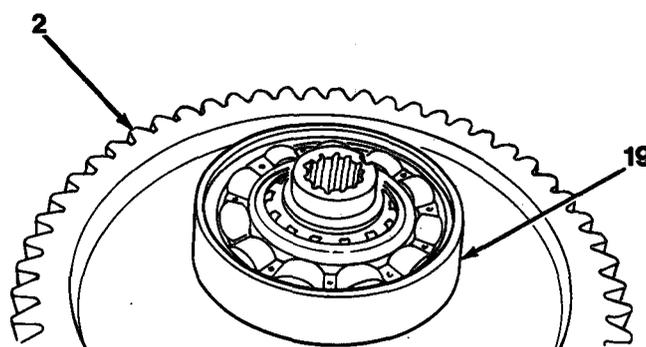


Figure 11-6

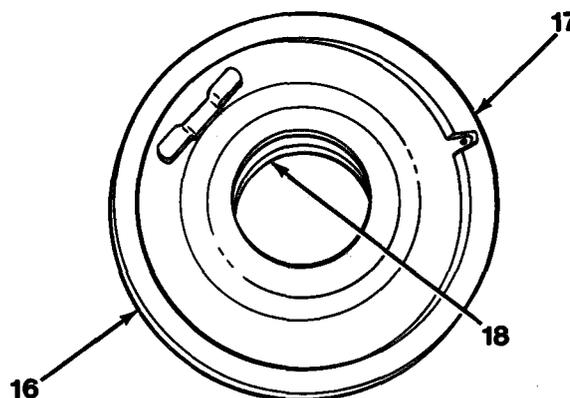


Figure 11-5

THIRD STAGE CLUTCH GROUP ASSEMBLY

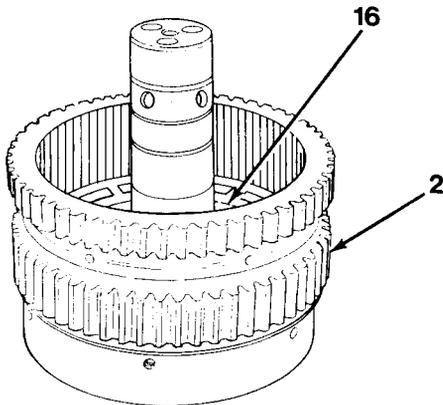


Figure 11-4

CAUTION

Use care when installing clutch piston or seal damage may result.

19. Install clutch piston (16) in clutch shaft assembly (2, Figure 11-4).

NOTE

Install springs as recorded during disassembly.

20. Install thrust washer (15), four springs (12) and snap ring retainer (14) in clutch shaft assembly (2, Figure 11-11).

21. Compress four springs (12) and hold down to install snap ring (13).

22. Install snap ring (13) on clutch shaft assembly (2).

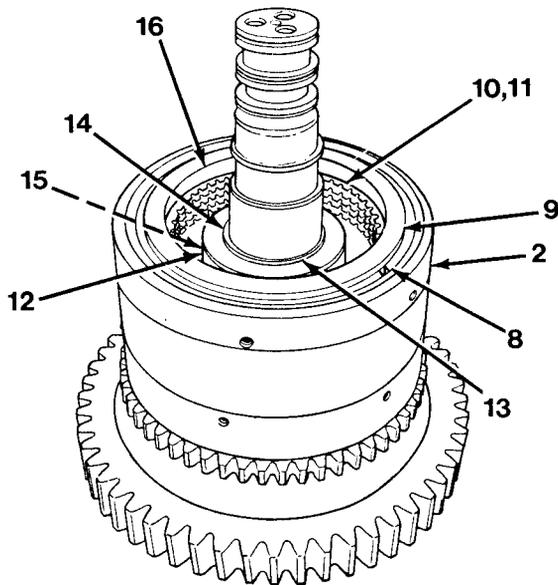


Figure 11-11

CAUTION

Use care when handling clutch plates so graphite coating doesn't flake off. Failure to follow this procedure could cause damage to equipment.

NOTE

- If clutch plates or clutch separator plates are new, install as a complete set.

- Clutch plates and clutch separator plates are to be installed alternately, starting with clutch separator plate and ending with clutch plate.

23. Install four clutch separator plates (11), clutch plates (10) and clutch plate retainer (9).
24. Install snap ring (8),
25. Install snap ring (7) into high gear welded assembly (5, Figure 11-15).
26. Install high gear welded assembly (5) on clutch shaft assembly (2, Figure 11-16).
27. Open snap ring (7) to install bearing (6) into high gear welded assembly (5, Figure 11-17).

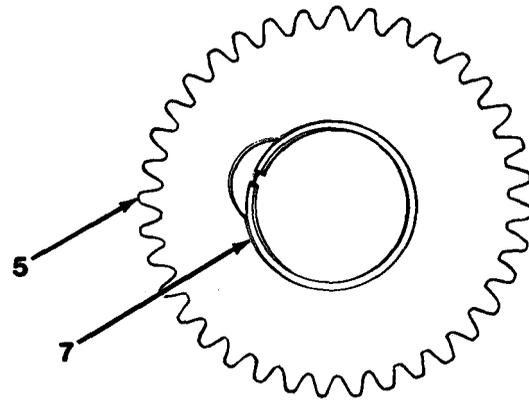


Figure 11-15

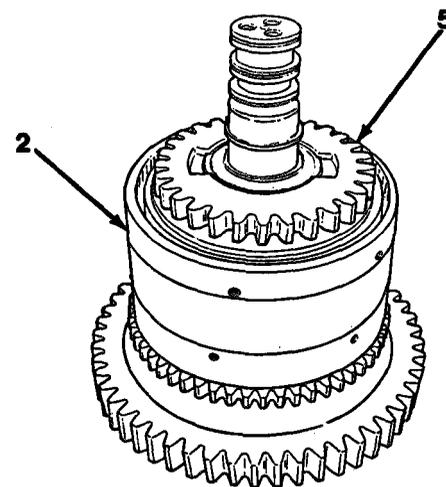


Figure 11-16

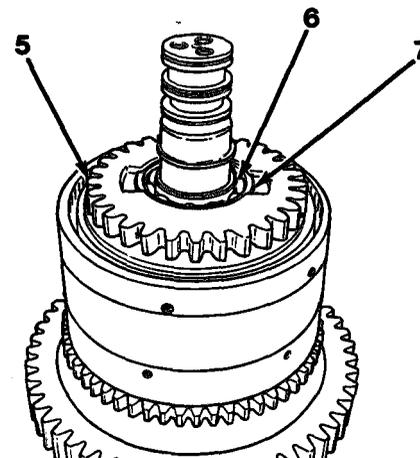


Figure 11-17

THIRD STAGE CLUTCH GROUP ASSEMBLY

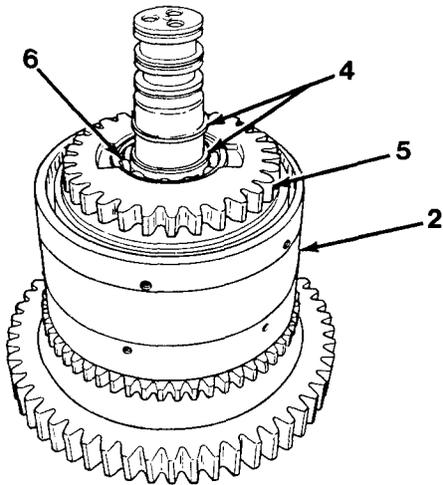


Figure 11-2

28. Install bearing (6) into high gear welded assembly (5, Figure 11-2).
29. Install two snap rings (4) on clutch shaft assembly (2).
30. Install bearing (3) on clutch shaft assembly (2, Figure 11-1).

NOTE

Use grease to lubricate the manifold seal rings.

31. Install three seal rings (1) on clutch shaft assembly (2).

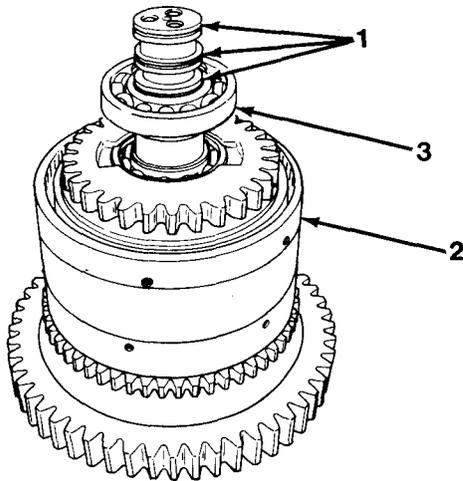


Figure 11-1

INPUT SHAFT GROUP

INPUT SHAFT GROUP DISASSEMBLY

1. Remove snap ring (1) from input shaft (2), Figure 11-1).
2. Remove snap ring (3) from input shaft (2).
3. Remove bearing (4) from input shaft (2) by using a press.
4. Remove bearing retainer (5) from input shaft (2).

INPUT SHAFT GROUP CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Soak all parts in lubricating oil MIL-L-2104, grade 10W, prior to installing.
3. Inspect all other parts (refer to Chapter 4).

INPUT SHAFT GROUP ASSEMBLY

1. Install bearing retainer (5) on input shaft (2), Figure 11-1).
2. Install bearing (4) on input shaft (2) by using a press.
3. Install snap ring (3) on bearing (4).
4. Install snap ring (1) on input shaft (2).

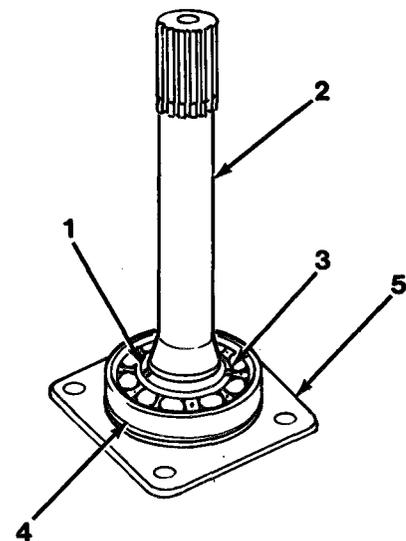


Figure 11-1

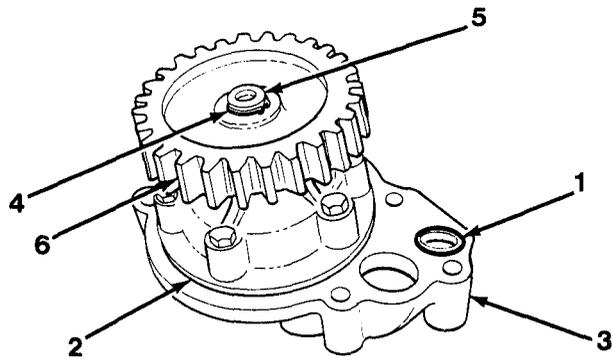


Figure 11-1

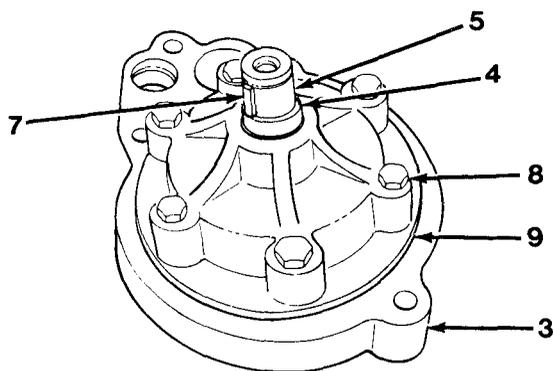


Figure 11-2

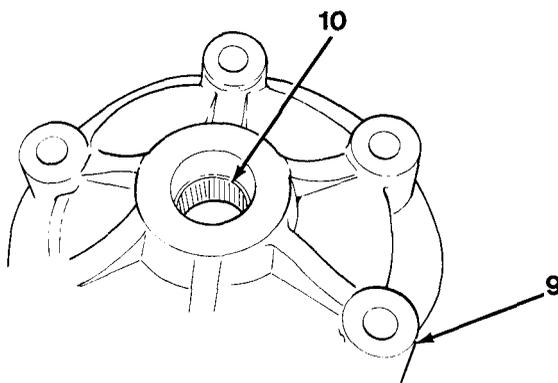


Figure 11-3

CHARGE PUMP

CHARGE PUMP DISASSEMBLY

1. Remove O-ring (1) and gasket (2) from pump manifold (3, Figure 11-1).
2. Remove snap ring (4) from shaft (5).
3. Using a puller, remove pump drive gear (6) from shaft (5).
4. Remove woodruff key (7) from shaft (5, Figure 11-2).
5. Remove second snap ring (4) from shaft (5).
6. Remove six capscrews (8).

NOTE

Matchmark charge pump retainer and pump manifold.

7. Remove charge pump retainer (9) from pump manifold (3).
8. Remove bearing (10) from charge pump retainer (9, Figure 11-3).
9. Remove thrust race (11) from shaft (5, Figure 11-4).

10. Remove greater assembly (12) from shaft (5).
11. Remove shaft (5) from pump manifold (3, Figure 11-5).
12. Remove woodruffkey (7) from shaft (5).
13. Remove thrust race (11) from shaft (5).
14. Remove bearing (10) from pump manifold (3, Figure 11-6).

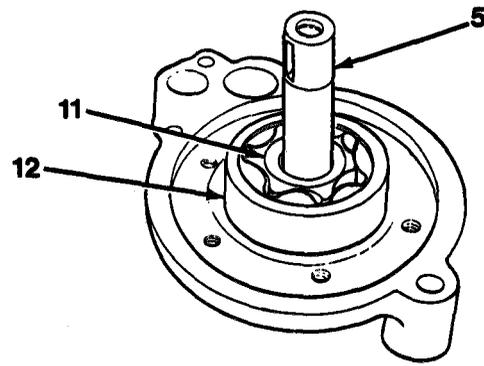


Figure 11-4

CHARGE PUMP CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect pump manifold and shaft for scratches.
3. Inspect greater assembly for scratches or discoloration.
4. Inspect thrust races for warpage or wear.
5. Inspect charge pump retainer for cracks.
6. Inspect all other parts (refer to Chapter 4).

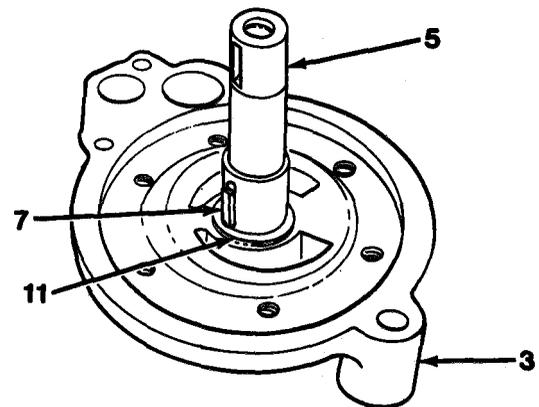


Figure 11-5

CHARGE PUMP ASSEMBLY

1. Press bearing (10) into pump manifold (3, Figure 11-6).
2. Install thrust race (11) into pump manifold (3, Figure 11-5).
3. Install woodruff key (7) into shaft (5).
4. Install shaft (5) into pump manifold (3).

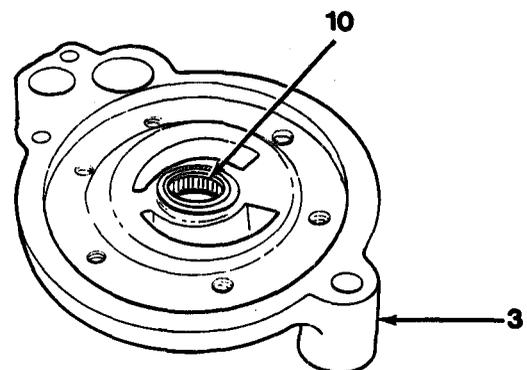


Figure 11-6

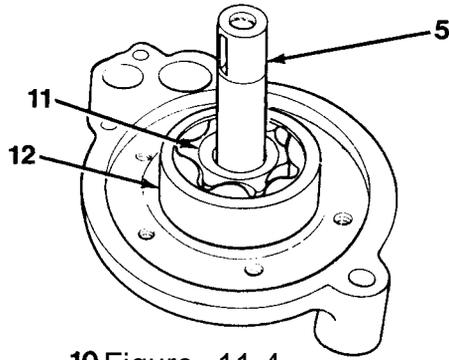


Figure 11-4

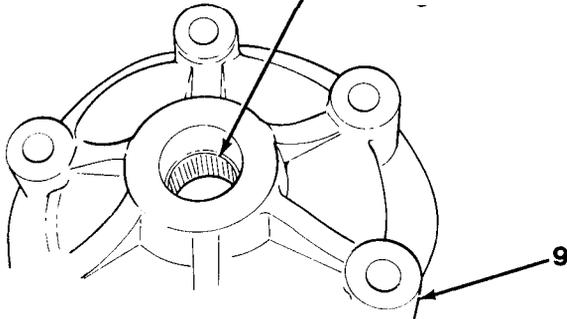


Figure 11-3

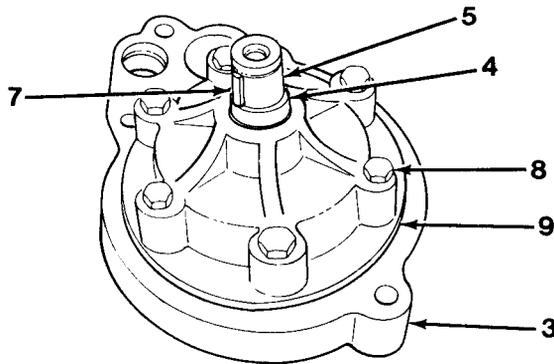


Figure 11-2

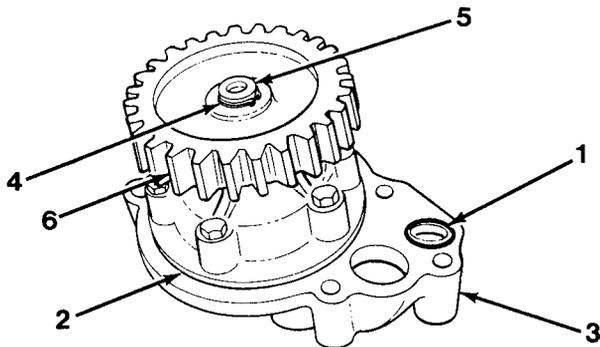


Figure 11-1

CHARGE PUMP ASSEMBLY

5. Install greater assembly (12) onto shaft (5, Figure 11-4).
6. Install thrust race (11) onto shaft (5).
7. Install bearing (10) in charge pump retainer (9, Figure 11-3).
8. Install charge pump retainer (9) on pump manifold (3, Figure 11-2). Line up match-marks made during disassembly.
9. Install six bolts (8) to secure charge pump retainer (9) to pump manifold (3).
10. Install snap ring (4) on shaft (5) up against pump retainer (9).
11. Install woodruff key (7) into shaft (5).
12. Heat pump drive gear (6, Figure 11- 1) to 350 degrees F (177 degrees C).
13. Install pump drive gear (6) on shaft (5).
14. Install snap ring (4) on shaft (5).

NOTE

Use sealant when installing gasket on pump manifold.

15. Install gasket (2) and O-ring (1) on pump manifold (3).

PUMP ADAPTER

PUMP ADAPTER DISASSEMBLY

1. Remove snap ring (1, Figure 11-1).
2. Remove ground driven pump gear (2) from pump adapter (3) by pressing out of bearing (4).
3. Remove cone of bearing (5) from ground driven pump gear (2, Figure 11-2) by using a split ring press.
4. Remove cup of bearing (5) from pump adapter (3, Figure 11-3).
5. Remove bearing (4) from pump adapter (3).
6. Remove O-rings (6) and (7).

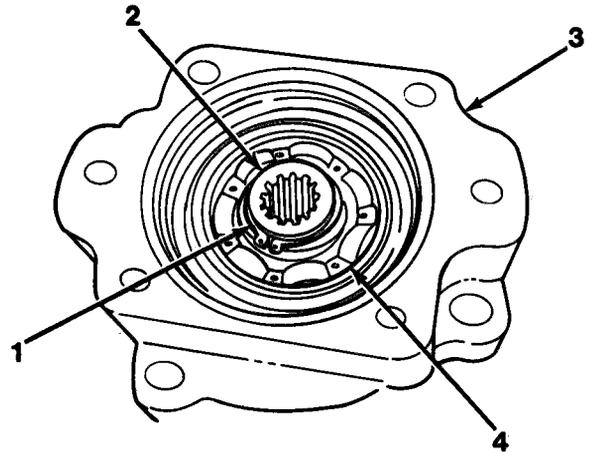


Figure 11-1

**PUMP ADAPTER CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Soak all parts in lubricating oil MIL-L-2104, grade 10W, prior to installing.
3. Inspect all other parts (refer to Chapter 4).

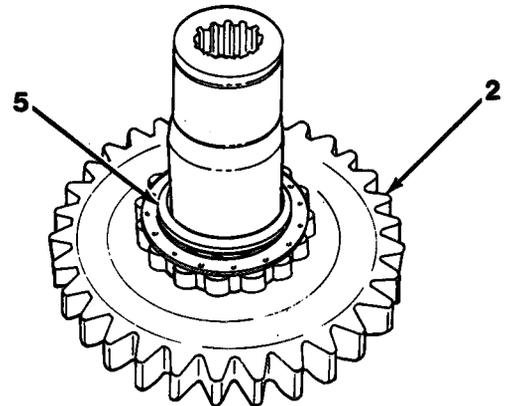


Figure 11-2

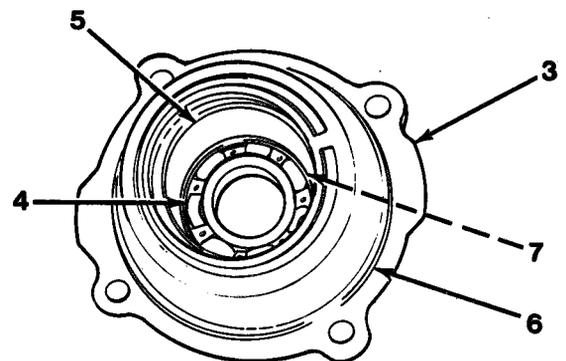


Figure 11-3

PUMP ADAPTER ASSEMBLY



Wear protective gloves when handling hot bearing. **SERIOUS INJURY** may result if hot bearing contacts skin.

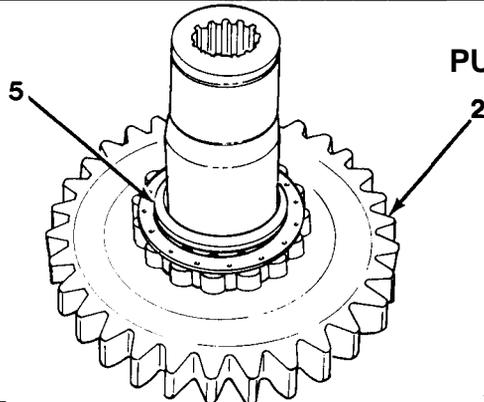


Figure 11-2

Heat cone of bearing (5, Figure 11-2) in oil to 350 degrees F (177 degrees C).

Install cone of bearing (5) on ground driven pump gear (2).

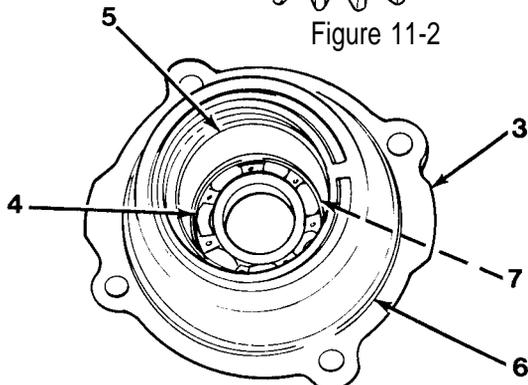


Figure 11-3

Install cup of bearing (5) into pump adapter (3, Figure 11-3) by using a press. Lip should be facing in when installing cup of bearing (5). Seat snap ring against pump adapter (3).

4. Install bearing (4) into pump adapter (3) by using a press. Seat snap ring against pump adapter (3).

5. Install ground driven pump gear (2) on pump adapter (3, Figure 11-1) by using a press.

6. Install snap ring (1) on ground driven pump gear (2).

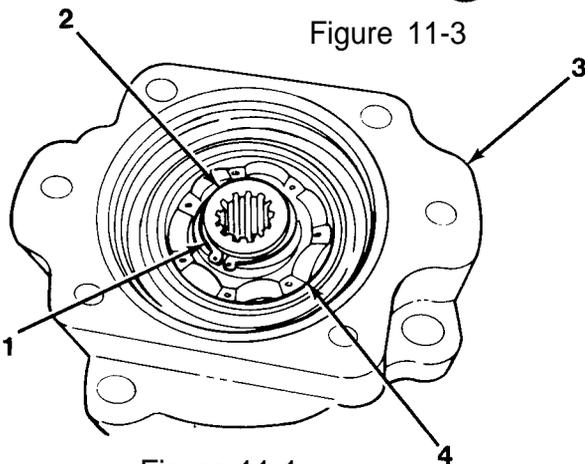


Figure 11-1

NOTE

Adjust bearing preload by tapping on end of ground driven pump gear with a rubber mallet to put pressure against snap ring and remove preload from bearing.

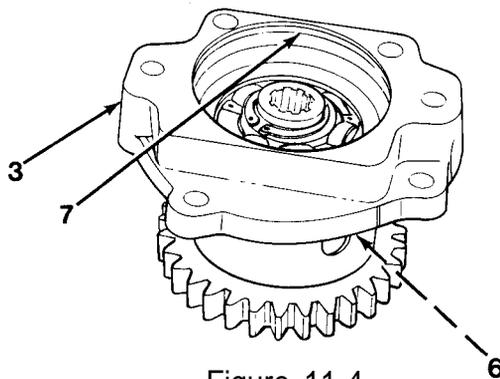


Figure 11-4

7. Install O-rings (7) and (6) to pump adapter (3, Figure 11-4).

CONTROL VALVE**CONTROL VALVE DISASSEMBLY****CAUTION**

Care must be taken not to lose two detent springs and balls when handling control valve. Failure to follow this procedure could cause damage to equipment.

NOTE

Record bore location of balls and springs to aid installation.

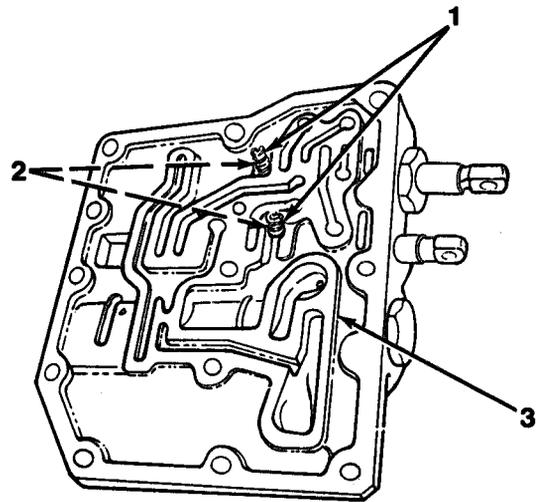


Figure 11-1

1. Remove two detent springs (1) and balls (2) from back side of valve body (3, Figure 11-1).
2. Remove neutral safety switch (4), reverse warning switch (5) and elbow (6, Figure 11-2).
3. Remove pipe plugs (7).

NOTE

Flat surface shown as TOP of control valve will be referred to as "top" for this maintenance procedure. Disassembly is started from bottom bore.

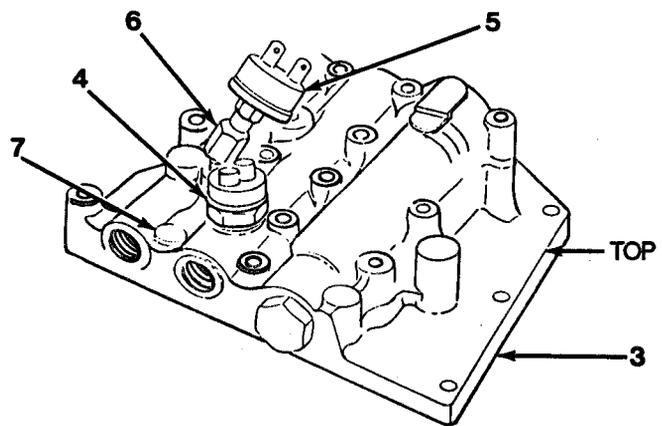


Figure 11-2

4. Place valve body (3) into a clean, soft-jawed vise.

CONTROL VALVE DISASSEMBLY

5. Remove plug (8) from bottom bore of valve body (3, Figure 11-3).
6. Remove O-ring (9) from plug (8).
7. Remove plug (10) from bottom bore of valve body (3).
8. Remove O-ring (9) from plug (10).
9. Remove oil seal (11) from plug (10).

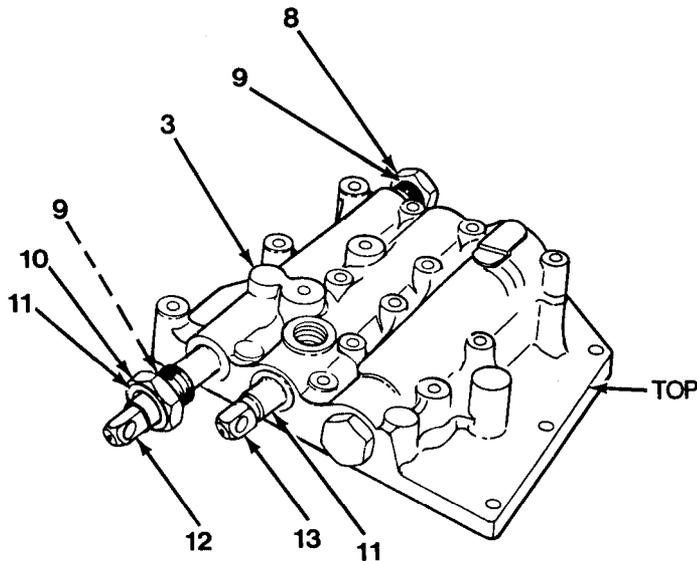


Figure 11-3

CAUTION

Use care when handling parts. Do not scratch the machine surface of stems. Failure to follow this procedure could cause damage to equipment.

10. Remove stem assembly (12) from bottom bore of valve body (3).
11. Push forward/reverse stem (13) into valve body (3).
12. Remove oil seal (11) from center bore of valve body (3).
13. Remove forward/reverse stem (13) from center bore of valve body (3)

14. Remove dump valve plug (14) from top bore of valve body (3, Figure 11-4).

15. Remove O-ring (15) from dump valve plug (14).

16. Remove dump valve spring (16).

17. Remove dump valve (17) from top bore of valve body (3).

18. Remove plug (8), from top bore of valve body (3, Figure 11-5).

19. Remove O-ring (9) from plug (8).

20. Remove regulator spool (18) from top bore of valve body (3).

21. Remove shim (19), snap ring (20) and orifice plate (21) from regulator spool (18).

22. Remove rolled needle (22) and roller (23) from back side of valve body (3, Figure 11-6).

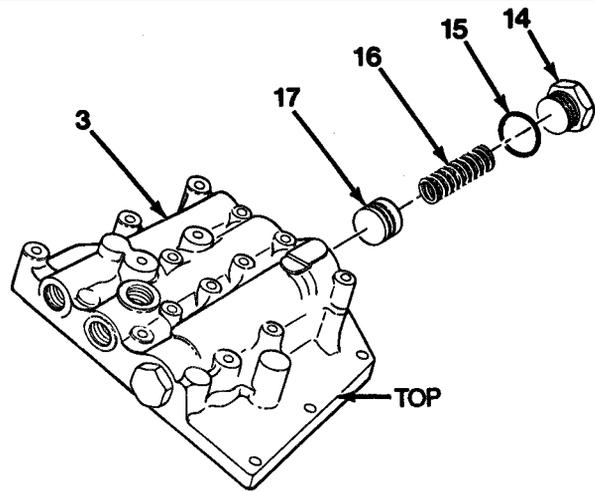


Figure 11-4

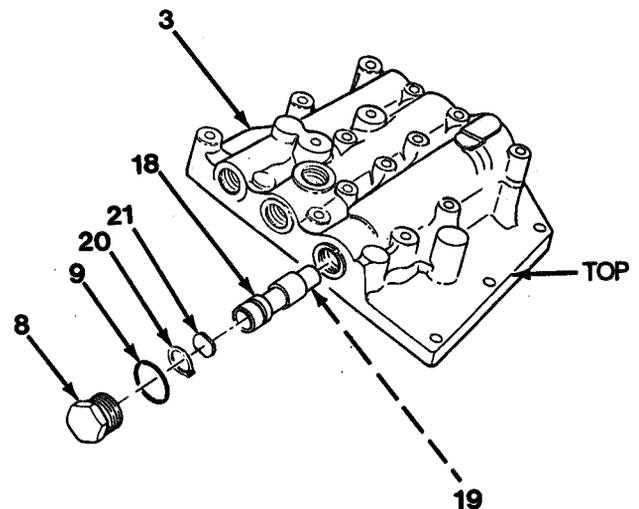


Figure 11-5

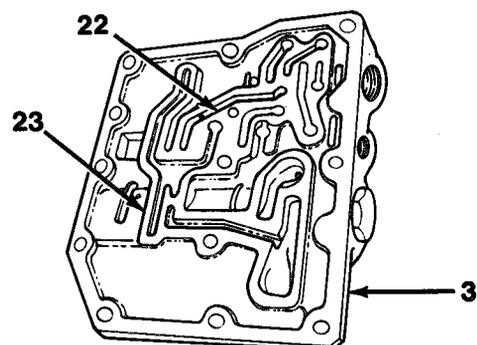


Figure 11-6

CONTROL VALVE DISASSEMBLY

23. Remove accumulator piston (24), accumulator spring (25) and washer (26) from top bore of valve body (3, Figure 11-7).

CONTROL VALVE CLEANING/INSPECTION

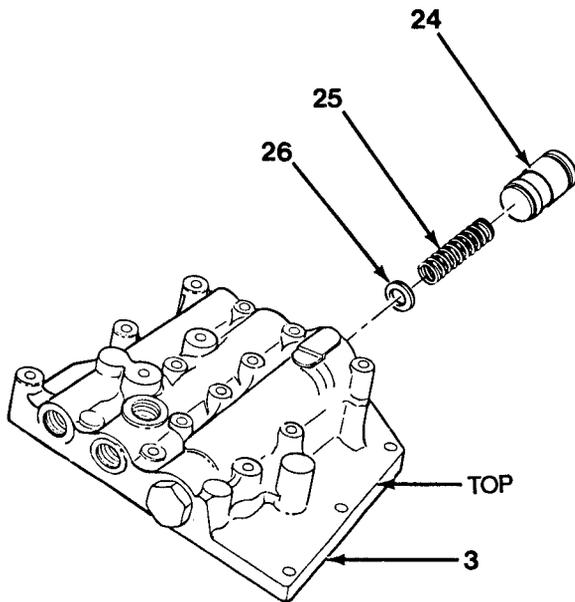


Figure 11-7

1. Clean all parts (refer to Chapter 2).
2. Inspect opening in orifice plate. Inside diameter should be 0.02 in. (0.5 mm) and outside diameter should be 0.550 to 0.555 in. (13.97 to 14.10 mm).
3. Inspect flatness of valve body.
4. Inspect dump valve and valve spool for scratches, gouges and wear.
5. Inspect dump valve and valve spool for freedom of movement in valve body.
6. Inspect all parts for cracks and flaking.
7. Inspect all parts for warpage, wear, scratches and gouges.
8. Inspect sealing surfaces for any scratches and score marks.

WARNING

Safety glasses or face protection must be used when working with compressed air. Failure to follow this procedure could cause **SERIOUS INJURY**.

9. Use compressed air to clean and inspect oil passages for leakage.

10. Soak all parts in lubricating oil ML-L 2104, grade 10W, prior to installing.

11. Measure detent springs. Spring specifications should be as follows:

LOAD	SPRING HEIGHT
0 lb (0 kg)	0.97 in. (24.6 mm)
7.00 lb (3.18 kg)	0.75 in. (19.1 mm)
11.00 lb (4.99 kg)	0.625 in. (15.88 mm)

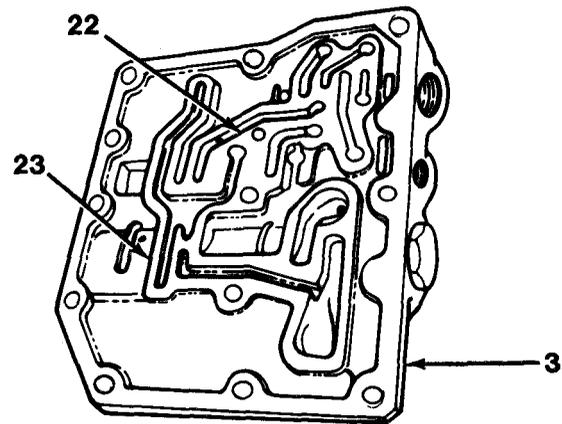


Figure 11-4

1. Install washer (26), accumulator spring (25) and accumulator piston (24) in top bore of valve body (3). Accumulator piston (24) should move freely in bore of valve body (3, Figure 11-7).

NOTE

Depress accumulator piston and accumulator spring in order to install roller in back side of valve body.

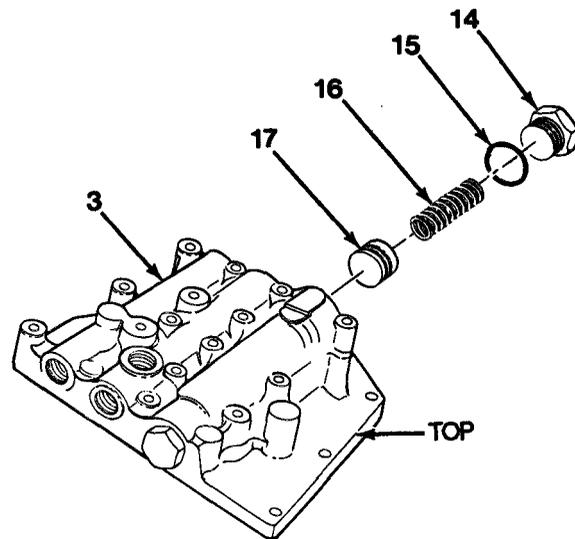


Figure 11-6

2. Install rolled needle (22) and roller (23) in back side of valve body (3, Figure 11-6).
3. Install dump valve (17) in top bore of valve body (3). Dump valve (17) should move freely in bore of valve body (3, Figure 11-5).
4. Install dump valve spring (16).
5. Install O-ring (15) on dump valve plug (14).
6. Install dump valve plug (14) in top bore of valve body (3).

CONTROL VALVE ASSEMBLY

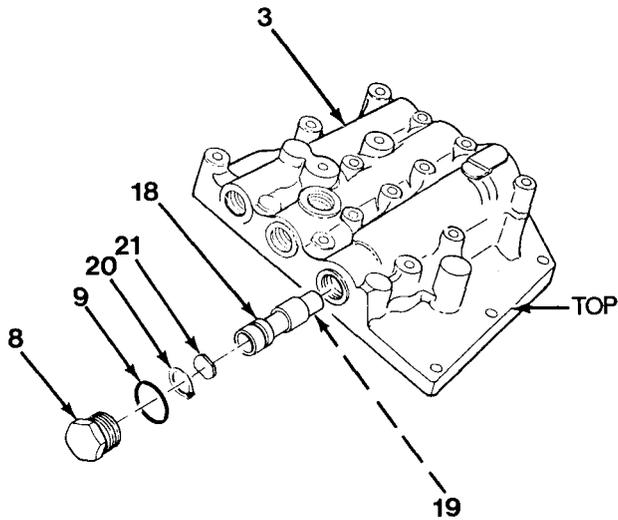


Figure 11-5

7. Install orifice plate (21), snap ring (20) and shim (19) to regulator spool (18, Figure 11-5).
8. Install regulator spool (18) in top bore of valve body (3). Regulator spool (18) should slide freely in bore of valve body (3).
9. Install O-ring (9) on plug (8).
10. Install plug (8) in top bore of valve body (3).
11. Install forward/reverse stem (13) in center bore of valve body (3), with linkage eye up. Push forward reverse stem (13, Figure 11-3) beyond seal seating surface.

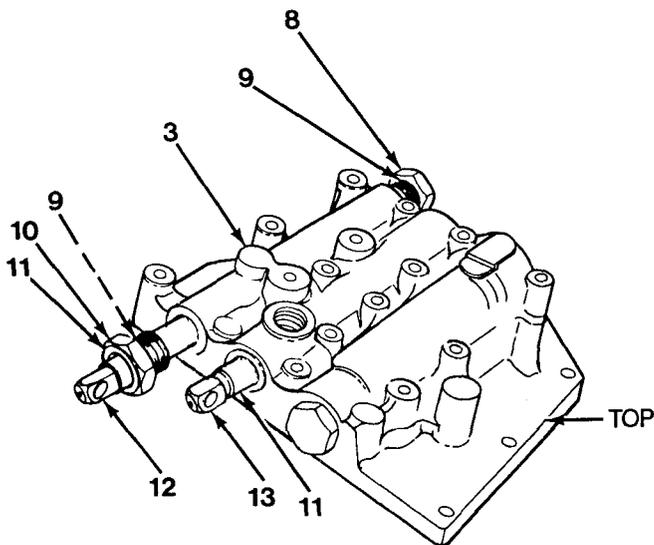


Figure 11-3

12. Using a seal driver, install oil seal (11) at top of bore on valve body (3), with lip of seal down.
13. Pull forward reverse stem (13) out of valve body (3) through oil seal (11), until linkage eye is protruding from oil seal (11).
14. Install stem assembly (12) in bottom bore of valve body (3), with linkage eye up.
15. Install oil seal (11) into plug (10).
16. Install O-ring (9) on plug (10).

17. Install plug (10) in bottom bore of valve body (3).
18. Install O-ring (9) onto plug (8).
19. Install plug (8) in bottom bore of valve body (3).
20. Remove valve body (3) from vise and lay on flat, clean surface.
21. Install pipe plugs (7, Figure 11-2).
22. Install elbow (6), reverse warning switch (5) and neutral safety switch (4) in valve body (3).
23. Install two balls (2) and detent springs (1) in back side of valve body (3, Figure 11-1).

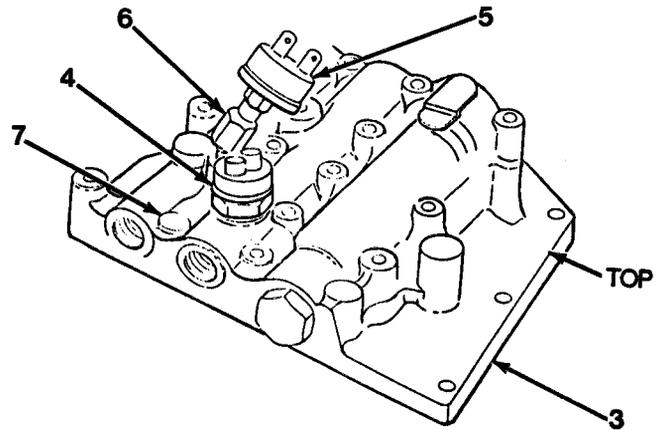


Figure 11-2

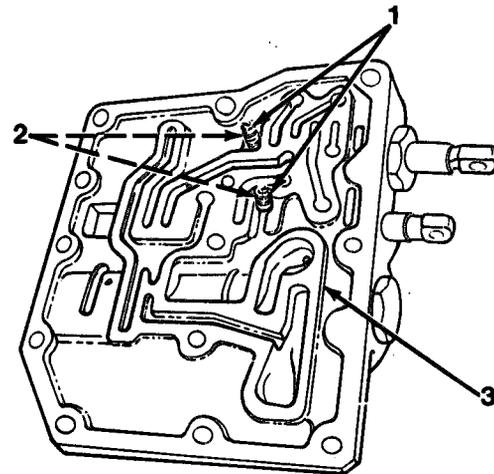


Figure 11-1

CONTROL VALVE PRESSURE CHECKS

NOTE

Pressure checks must be made with transmission oil temperature at 160 to 190 degrees F (71 to 88 degrees C).

PRESSURE REGULATOR TEST

1. Install 200 psi (1,379) gauge in port (1, Figure 11-1).
 2. Position forward-neutral-reverse shift lever in neutral and 1-2-3-4 shift lever in 1.
 3. Start engine and operate at approximately 2,000 rpm while reading pressure indicated on gauge. Pressure must be 155 to 180 psi (1,069 to 1,241 kPa). If pressure is within this range, proceed to Clutch Pack Pressure Test. If pressure is not within this range, proceed to step 4.
 4. Shut engine off.
 5. Remove plug (2), O-ring (3), regulator spool (4) and shims (5).
 6. Check O-ring (3) for nicks or damage and regulator spool (4) to insure that it works freely in valve body.
 7. Add shims (5) to increase pressure or remove shims (5) to decrease pressure.
 8. Install shims (5), regulator spool (4), O-ring (3) and plug (2).
 9. Repeat step 3.
 10. If required pressure range cannot be reached through shimming, replacement of charge pump may be required.
-

CLUTCH PACK PRESSURE TEST

1. Record pressure indicated on gauge with engine idling.
2. Repeat step 1 for 2nd, 3rd and 4th gears.
3. Apply brakes, shift forward-neutral-reverse lever to forward position and record pressure.
4. Shift to reverse and record pressure.
5. Return shift lever to neutral and shut engine off.
6. Pressures recorded in steps 1 thru 4 must not vary more than 10 psi (69 kPa). If pressures vary more than this, clutch packs must be rebuilt.
7. Remove gauge from port (1, Figure 11-1).

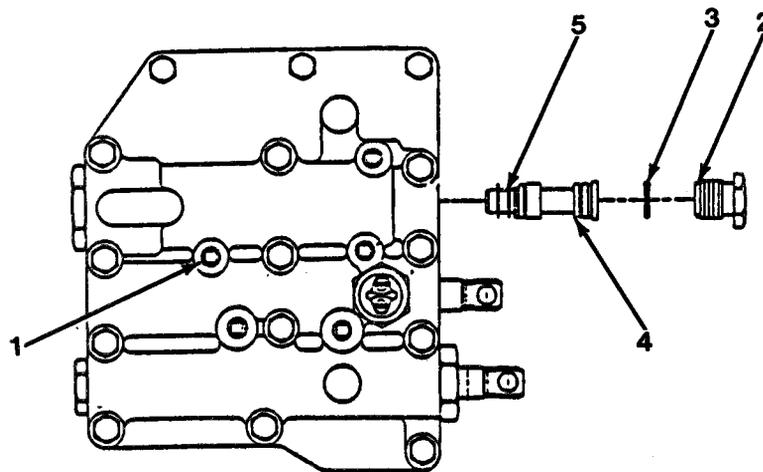


Figure 11-1

TRANSMISSION 2WD/AWD LINKAGE

**TRANSMISSION 2WD/4WD LINKAGE
REMOVAL**

1. Remove cotter pin (1) and pin (2) from clevis assembly (3) through the cut-out in bracket (12, Figure 11-1).
2. Remove two screws (4), lock nuts (5) and clamp (6) from bracket (4).
3. Remove cotter pin (7), pin (8) and two straps (9) from transmission.
4. Remove four cap screws (10), washers (11) and bracket (12).

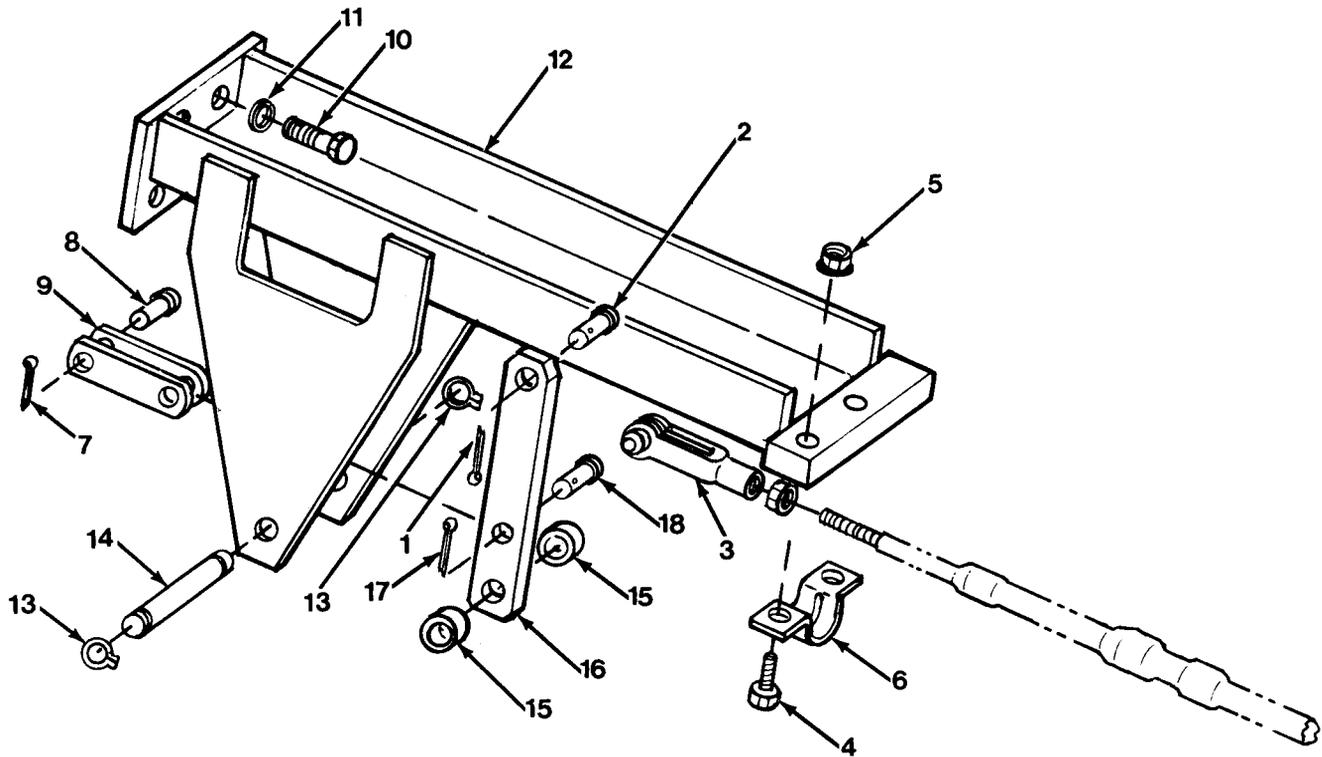


Figure 11-1

**TRANSMISSION 2WD/4WD LINKAGE
INSTALLATION**

1. Position bracket (12) over mounting holes in frame and install four washers (11) and cap-screws (10, Figure 11-1).
2. Position clamp (6) over cable on bracket (12) and install two screws (4) and lock nuts (5).
3. Position clevis (3) on lever (16) and install pin (2) and cotter pin (1).
4. Install pin (8) through two straps (9) and install cotter pin (7).
5. Check control for freedom of movement.

**TRANSMISSION 2WD/4WD LINKAGE
DISASSEMBLY**

1. Remove two snap rings (13), pin (14), two spacers (15) and lever (16, Figure 11-1).
2. Remove cotter pin (17), pin (18) and two straps (10).

**TRANSMISSION 2WD/4WD LINKAGE
CLEANING/inspection**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**TRANSMISSION 2WD/4WD LINKAGE
ASSEMBLY**

1. Position one strap (10) on each side of lever (16) and install pin (18) and cotter pin (17, Figure 11-1).
2. Install two spacers (15) on each side of lever (16) and install pin (14) in bracket (4).
3. Install two snap rings (13) on each end of pin (14).
4. Adjust linkage (refer to page 17-49).

CHAPTER 12
DRIVE SYSTEM

Title	Page
Tires and wheels	12-1
Front Axle	12-5
Rear Axle	12-9
Brake Assembly	12-12
Front Differential Assembly	12-17
Rear Differential Assembly	12-28
Tie Rod	12-33
Constant Velocity Joint and Axle Shaft	12-35
Planetary Wheel End	12-38
Pivot and Spindle Assembly	12-45
Front Drive Shaft	12-51
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TIRES AND WHEELS

TIRES AND WHEELS REMOVAL

1. Use outriggers or jack to raise affected tire off ground.
2. Support frame with jackstands.
3. Remove 10 lug nuts (1, Figure 12-1).
4. Remove tire and wheel assembly (2) from axle hub.

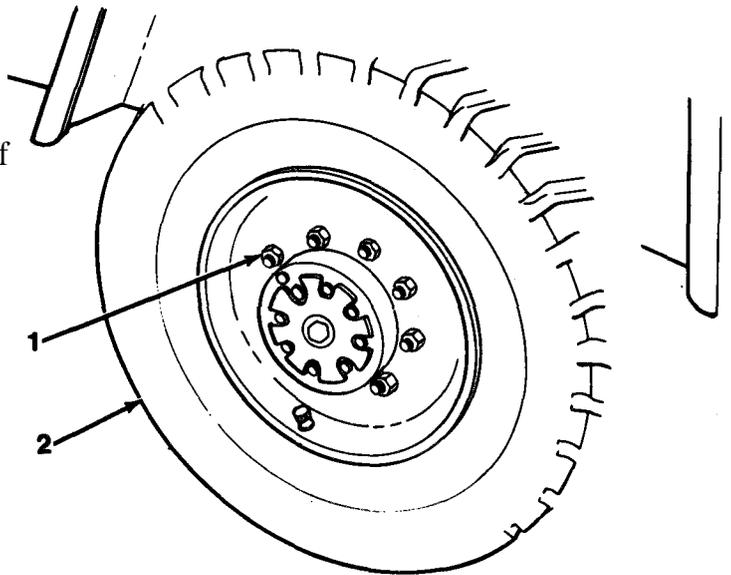


Figure 12-1

TIRES AND WHEELS INSTALLATION

NOTE

- Do not lubricate lug nuts.
- Tire tread is directional. Refer to travel direction arrow on sidewall of tire.

1. Install inflated tire and wheel assembly (2) on axle. Install 10 lug nuts (1, Figure 12-1) on hub studs.
2. Torque 10 lug nuts (1) to 450 to 500 lb-ft (610 to 678 N•m). Use sequence shown in Figure 12-2. Recheck after 8 hours of operation.
3. Remove jackstands.
4. Raise outriggers or remove jack.

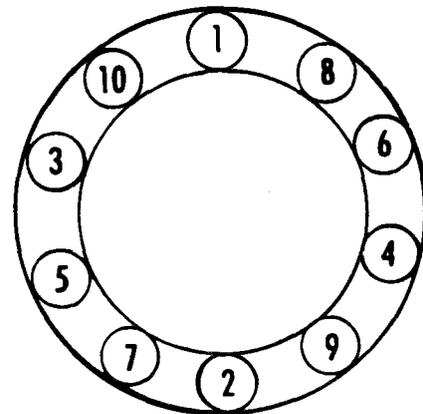


Figure 12-2

TIRES AND WHEELS DISASSEMBLY

⚠ WARNING

When deflating tires, always make certain tire is completely deflated before removing from rim. Failure to follow this procedure could cause DEATH or serious injury.

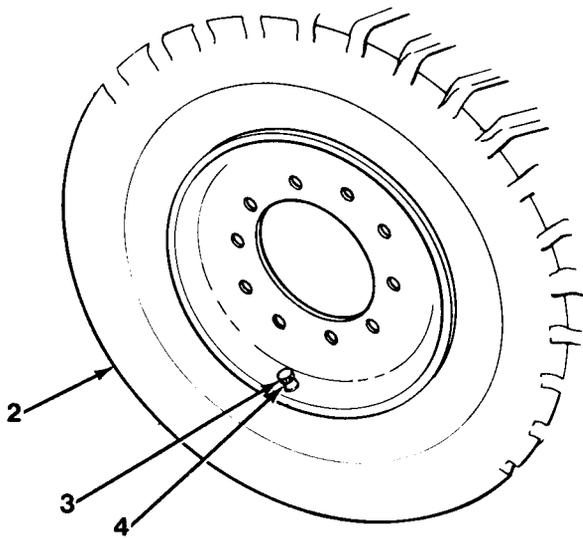


Figure 12-3

1. Remove valve stem cap (3) and completely deflate tire (2, Figure 12-3).
2. Demount deflated tire (2) from wheel using tire irons or remounting machine.
3. Remove and discard valve stem (4).

TIRES AND WHEELS CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

TIRES AND WHEELS ASSEMBLY

WARNING

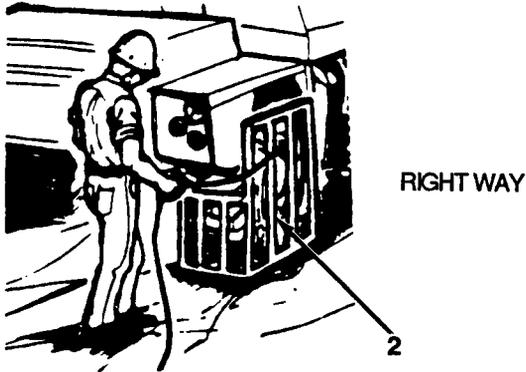
- When inflating tires, always make certain tires are properly seated. Improperly seated tires can burst with explosive force. Failure to follow this procedure could cause DEATH or serious injury.
- Do not mix one type of wheel with a different type of tire. Improper seating of these components can cause tire and wheel to fly apart with explosive force. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tire tread is directional. It will make a difference which direction a new tire should be mounted on the wheel. Refer to travel directional arrow on sidewall of tire.

1. Install new valve stem (4, Figure 12-3).
2. Apply lubricant to both beads of tire and wheel rim.
3. Position wheel flat on floor with valve stem (4) up. Using tire irons work tire (2) onto wheel or machine mount.

TIRES AND WHEELS ASSEMBLY



! WARNING

Always use a safety cage to inflate tire and wheel assembly to avoid DEATH or serious injury from exploding parts.

NOTE

Tire must be inflated before mounting on vehicle.



4. Place tire and wheel assembly (2, Figure 12-4) into safety cage.
5. Inflate tire. Recommended tire pressure for the 12.00 x 22.5, 14 PR Tire is 90 psi (621 kPa).
6. Install valve stem cap (3, Figure 12-3).

Figure 12-4

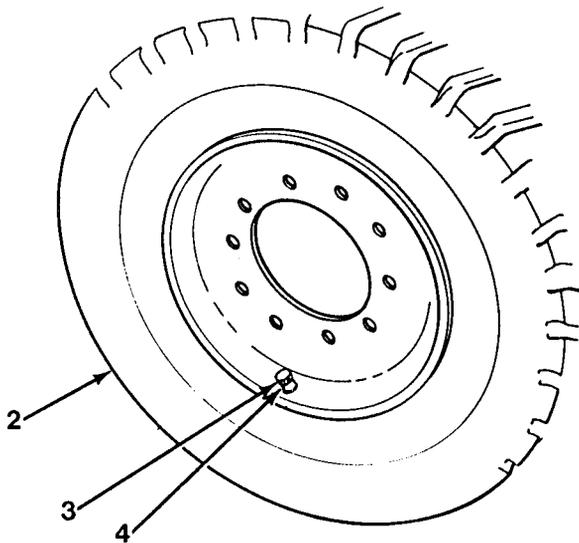


Figure 12-3

FRONT AXLE

FRONT AXLE REMOVAL

1. Use outriggers or jack to raise tires off ground.
2. Support frame with jackstands.
3. Remove tire and wheel assemblies (refer to page 12-1).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

4. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

5. Disconnect and cap all hydraulic lines to steering cylinders, brake lines and breather hose.
6. Remove two cotter pins (1), washers (2), pins (3) and parking brake assembly (4) from axle (8). Discard two cotter pins (1). Let parking brake assembly (4) hang by cable (6, Figure 12-1).

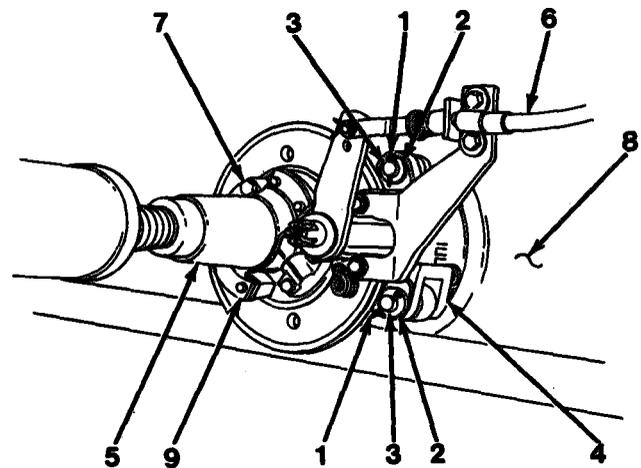


Figure 12-1

FRONT AXLE REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

7. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance,

8. Disconnect two wires to speedometer sensor unit.

9. Using floor jack, support front drive shaft (5, Figure 12- 1).

10, Remove four capscrews (7) to disconnect front axle (8) from front drive shaft spider bearing (9).

11. Using hydraulic floor jacks, support front axle (8).

12. Remove eight nuts (10), washers (11) and capscrews (12, Figure 12-2).

⚠ WARNING

Weight of axle assembly is approximately 1,323 (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

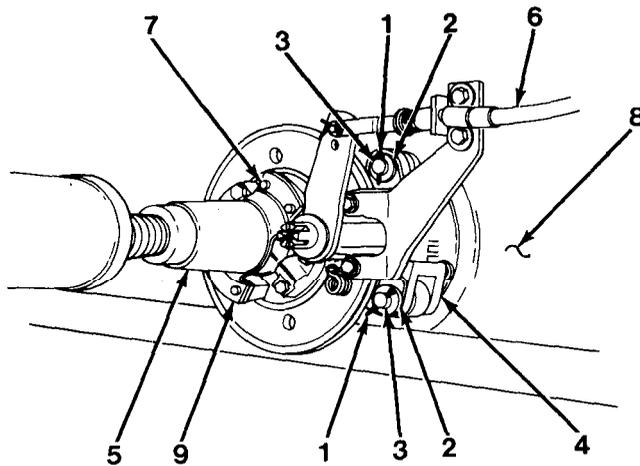


Figure 12-1

13. Remove front axle (8, Figure 12- 1) from under vehicle.

FRONT AXLE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FRONT AXLE INSTALLATION

CAUTION

Copper sealing washers are not reusable. If a previously tightened connection containing copper sealing washer(s) is loosened, the washer(s) must be replaced before retightening. Failure to follow this procedure could cause damage to equipment.

1. Transfer steering cylinders, brake connections, vent hose adapter and other attaching components to new axle before installing on vehicle.

WARNING

Weight of axle assembly is approximately 1,323 (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let ~personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Raise front axle (8, Figure 12-1) in position under vehicle.

3. Install eight capscrews (12), washers (11) and nuts (10, Figure 12-2). Torque eight capscrews (12) to 500 lb-ft (678 N•m).
4. Install four capscrews (7) to connect front axle (8) to front drive shaft spider bearing (9, Figure 12-1). Torque capscrews (7) to 50 lb-ft (68 N•m).

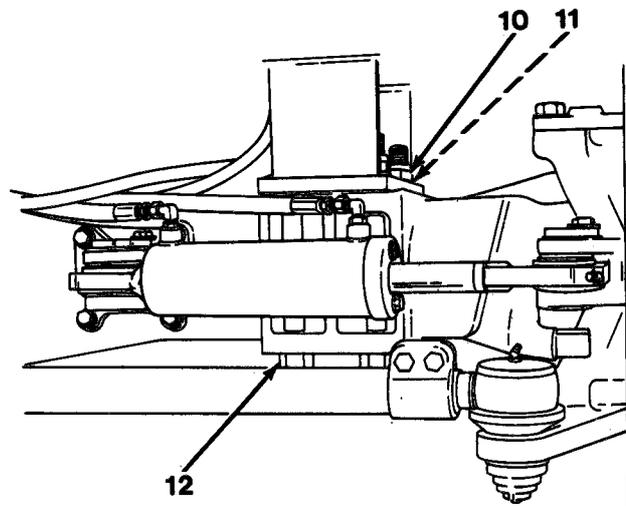


Figure 12-2

FRONT AXLE INSTALLATION

5. Position parking brake assembly (4) on axle (8) and install two pins (3), washers (2) and new cotter pins (1, Figure 12-1).

CAUTION

Speedometer sender wires must be connected as tagged for speedometer to work properly. Failure to follow this procedure could cause damage to equipment.

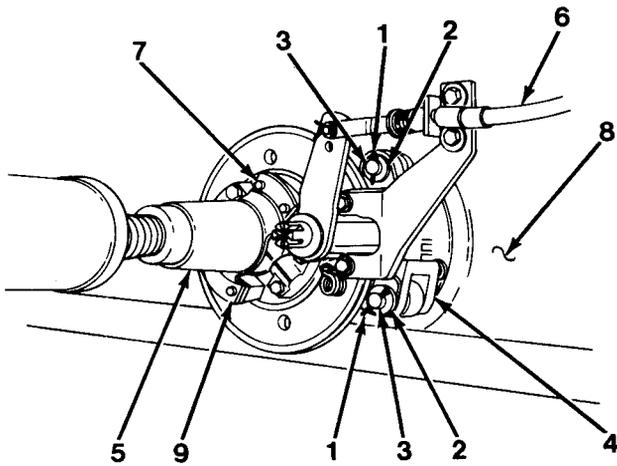


Figure 12-1

6. Connect two wires to speedometer sending unit.
7. Connect all brake lines, breather hose and hydraulic lines.
8. Bleed front brake system (refer to page 13-103).
9. Be sure outer hub drives and center axle differential have been serviced with lubricant.
10. Install tire and wheel assemblies (refer to page 12-1).
11. Remove jackstands.
12. Raise outriggers or remove jack.
13. Connect battery negative ground cable.
14. Close dipstick cap.

REAR AXLE

REAR AXLE REMOVAL

1. Use outriggers or jack to raise tires off ground.
2. Support frame with jackstands.
3. Remove tire and wheel assemblies (refer to page 12-1).

 **WARNING**

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

4. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

5. Disconnect axle centering indicator electrical wire (refer to page 10-63).

REAR AXLE REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

- Turn dipstick cap 1/4 turn to safety notch relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

- Disconnect and cap all hydraulic lines to steering cylinders, brake lines and breather hose.
- Disconnect and remove rear axle lockout cylinders retaining pins (refer to page 13-19).
- Remove four capscrews (1) to disconnect rear axle (2) from rear drive shaft spider bearing assembly (3, Figure 12-1).
- Using hydraulic floor jacks, support rear axle (2).
- Matchmark two caps (6) and bushings (8).
- Remove eight capscrews (4), washers (5) two caps (6) and grease zerks (7).

⚠ WARNING

Weight of axle assembly is approximately 1,323 lb (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause **DEATH** or serious injury.

- Remove rear axle (2) from under vehicle.
- Remove two bushings (8) from rear axle (2).

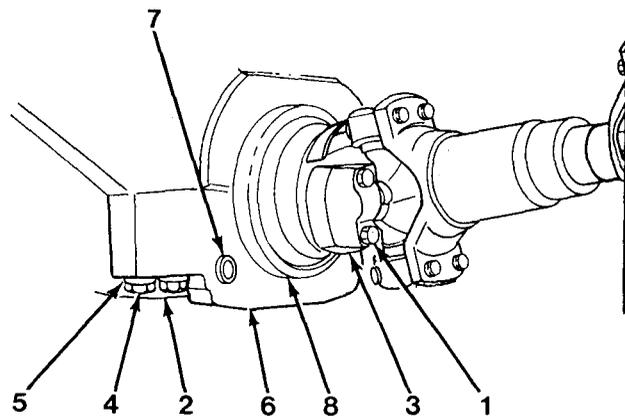


Figure 12-1

REAR AXLE CLEABUNG/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

REAR AXLE INSTALLATION

CAUTION

Copper sealing washers are not reusable. If a previously tightened connection containing copper sealing washer(s) is loosened, washer(s) must be replaced before retightening. Failure to follow this procedure could cause damage to equipment.

1. Transfer steering cylinders, brake connections, vent hose adapter and other attaching components to new axle before installing on vehicle.

WARNING

Weight of axle assembly is approximately 1,323 lb (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Apply Loctite RC680 to outside diameter of bushing (8) and install. Raise rear axle (2, Figure 12-1) in position under vehicle.
3. Install two grease zerks (7), caps (6), eight washers (5) and capscrews (4).

4. Torque eight capscrews (4) to 100 lb-ft (136 N•m).
5. Install four capscrews (1) to connect rear axle (2) to drive shaft spider bearing assembly (3).
6. Install lockout cylinder retaining pins (refer to page 13-20).
7. Connect all brake lines, breather hose and hydraulic lines.
8. Connect axle centering indicator electrical wire (refer to page 10-64).
9. Bleed rear brake system (refer to page 13-103).
10. Be sure outer hub drives and center axle differential have been serviced with lubricant, and bushings (8) greased.
11. Install tire and wheel assemblies (refer to page 12-1).
12. Remove jackstands.
13. Raise outriggers or remove jack.
14. Connect battery negative ground cable.
15. Close dipstick cap.

BRAKE ASSEMBLY

BRAKE ASSEMBLY REMOVAL



The brake linings contain asbestos. We ara protective breather respirator when performing maintenance on the brake assembly and brake drum.

Care must be taken when cleaning the brake assembly. Clean the assembly as a whole by using a solution of hot soapy water. Go over the assembly 3 times or enough to be sure it is completely clean to prevent the asbestos fibers from being released into the air and circulated in the maintenance area.

Do not use compressed air to dry the brake assembly; let it air dry.

Failure to follow this procedure could cause **SERIOUS INJURY**

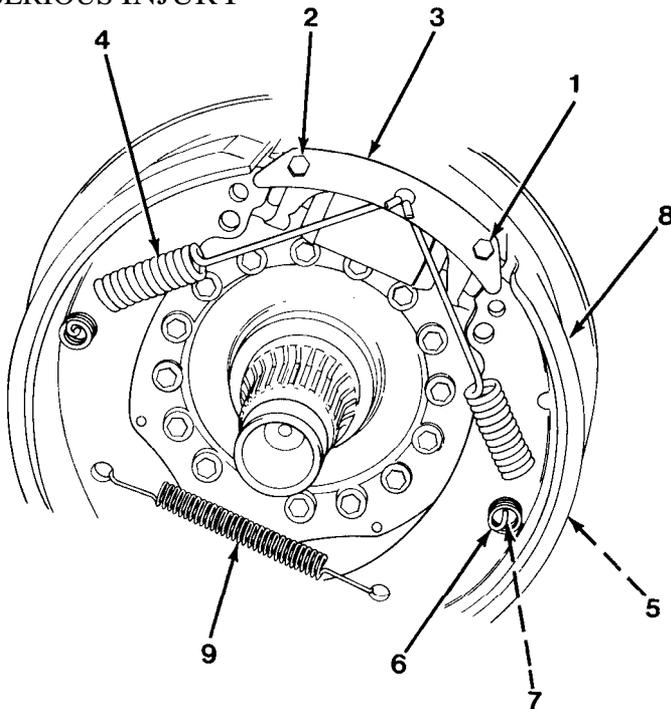


Figure 12-1

CAUTION

When brake linings have worn down to a thickness of 0.177 in. (4.50 mm) they must be replaced. Failure to do so may result in damage to brake drum.

NOTE

Replacement of parts other than brake drum, brake shoes, springs, banjo fitting, bleeder screw, or automatic adjuster will require disassembly of planetary wheel end.

1. Remove planetary wheel end (refer to page 12-39).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Disconnect and cap brake lines, if necessary.

NOTE

If no disassembly of brake assembly, do only step 6.

3. Remove bolt (1) from spring retainer plate (3) and relieve tension on springs (4, Figure 12-1).
4. Remove bolt (2), spring retainer plate (3), springs (4), spring retainer (5), spring (6), lockplate (7), brake shoes (8) and spring (9).
5. Unscrew bolt (10) from rear of automatic adjuster (11), and remove automatic adjuster (11, Figure 12-2).
6. Using a 9/16 in. hexdriver, remove 15 bolts (13), brake spider assembly (14), bolt (10) and two washers (12).
7. Remove banjo fitting assembly (15), six bolts and washers (16) and dust shield (17) from brake spider assembly (14, Figure 12-3).
8. Remove two bolts (18) and wheel cylinder (19) from brake spider assembly (14).

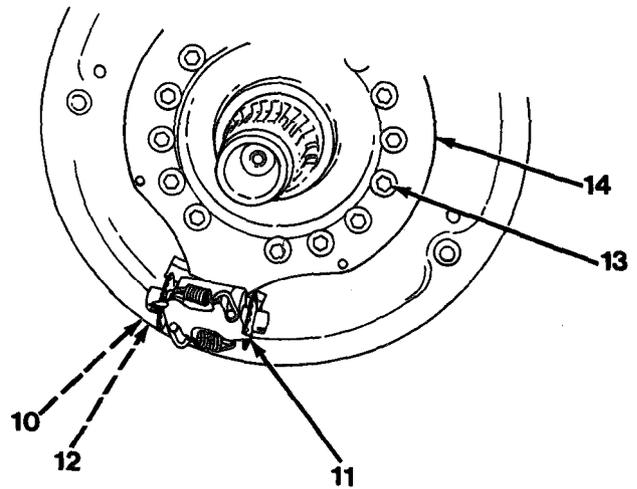


Figure 12-2

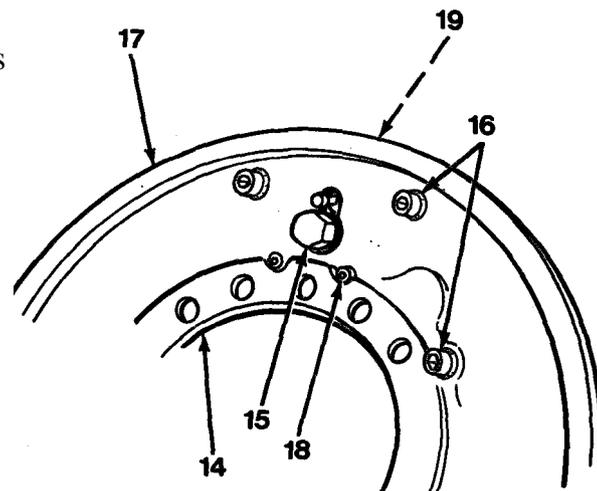


Figure 12-3

BRAKE ASSEMBLY CLEANING/ INSPECTION

1. Care must be taken when cleaning the brake assembly. Clean the assembly as a whole by using a solution of hot soapy water. Go over the assembly 3 times or enough to be sure it is completely clean to prevent the asbestos fibers from being released into the air and circulated in the maintenance area. Do not use compressed air to dry the brake assembly; let it air dry.
2. Inspect all parts (refer to Chapter 4).

BRAKE ASSEMBLY INSTALLATION

NOTE

If brake assembly was removed as an assembly, install it as an assembly. If it was removed by components, use the following procedures.

1. Install wheel cylinder (19), and two bolts (18) on brake spider assembly (14, Figure 12-3).

CAUTION

Copper sealing washers are not reusable. If previously tightened connection containing copper sealing washer(s) is loosened, washer(s) must be replaced before retightening. Failure to follow this procedure could cause damage to equipment.

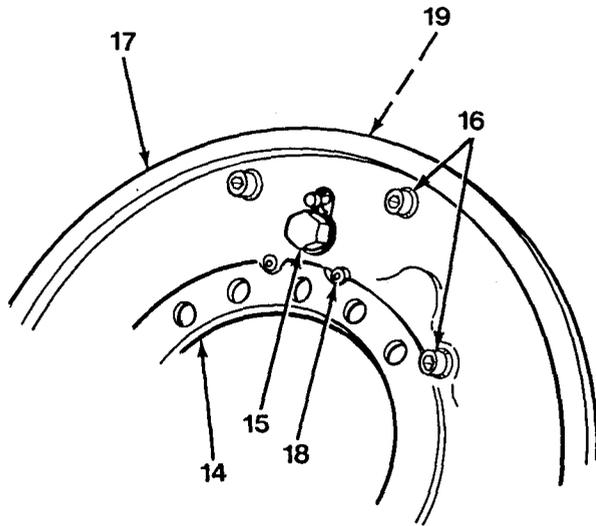


Figure 12-3

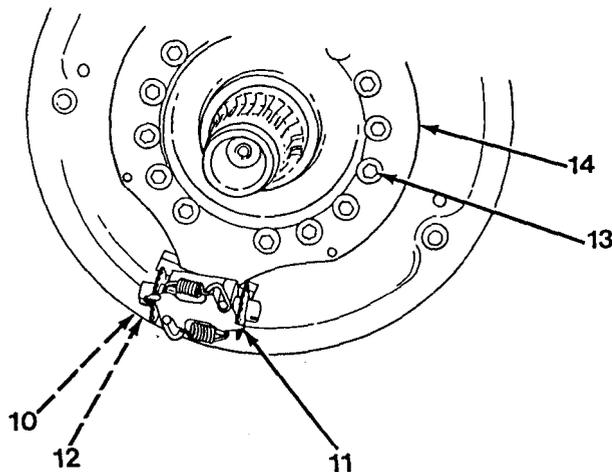


Figure 12-2

2. Install dust shield (17), six bolts and washers (16), and banjo fitting assembly (15) on brake spider assembly (14). Do not tighten until brake lines have been connected.
3. Install automatic adjuster (11), two washers (12) and bolt (10) on brake spider assembly (14, Figure 12-2) roughly centered. Hand tighten only.
4. Apply thread lock sealant MIL-S-461 63 or equivalent to bolt (13) threads. Install brake spider assembly (14) and 15 bolts (13). Torque bolts to 252 lb-ft (342 N•m).

NOTE

Clearance between adjusting plate and star wheel is set at 0.070 in. (1.78 mm) per side. Brake adjuster is designed to work with a total of 0.140 in. (3.56 mm). The maximum clearance on one side is 0.080 in. (2.03 mm). Replace adjuster if clearance is outside specified range.

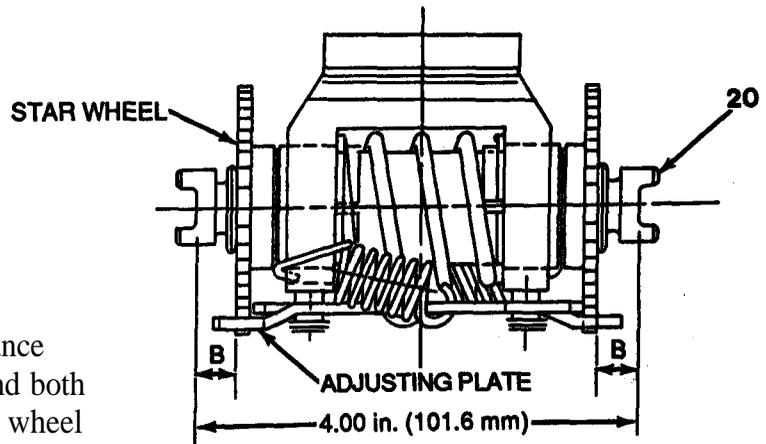


Figure 12-4

5. Turn adjustment screws (20) until distance between slots is 4.00 in. (101.6 mm) and both slots have the same distance (B) to star wheel on each side. By following this procedure, brake shoes will be properly centered.

6. Install brake shoes (8), lockplate (7), springs (6), spring retainers (5), spring (9), springs (4), spring retainer plate (3) and bolt (2, Figure 12-1). Using spring retainer plate (3), tension springs (4) and install bolt (1). Torque bolts (1) and (2) to 18 lb-ft (24 N•m).

7. After brake shoes (8) have been installed, check diameter of brake. Diameter must be 0.010 to 0.020 in. (0.25 to 0.51 mm) less than inside diameter of brake drum.

8. Install planetary wheel end (refer to page 12-41).

9. Loosen screw (10) to allow automatic adjuster (11, Figure 12-2) to move back and forth.

10. Using a feeler gauge through the inspection holes, center the brake assembly so there is an equal amount of clearance at each side.

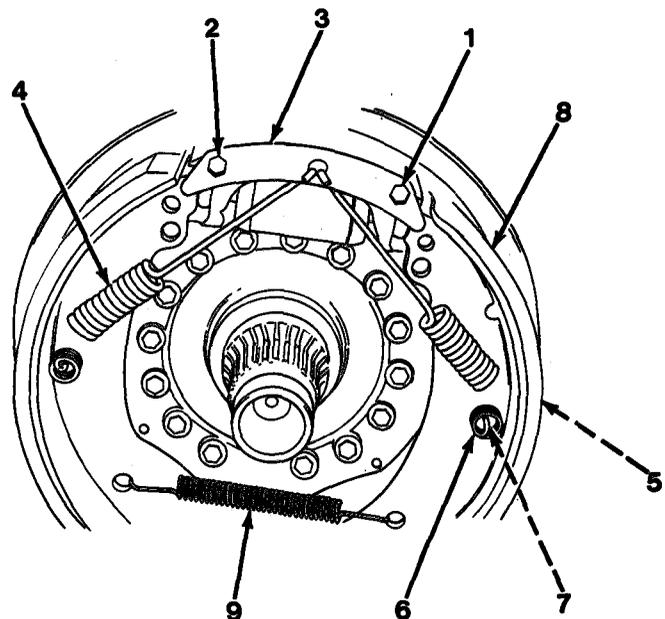


Figure 12-1

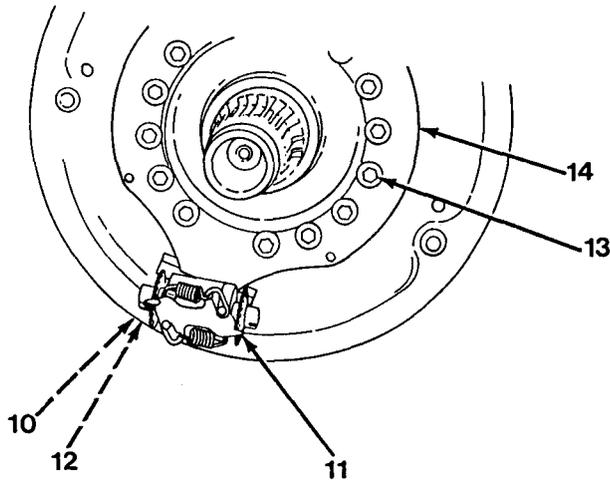


Figure 12-2

BRAKE ASSEMBLY INSTALLATION

11. With brake centered, torque bolt (10, Figure 12-2) to 60 lb-ft (82 N•m).
12. Check clearance between brake and drum. Clearance should be between 0.010 and 0.020 in. (0.25 and 0.51 mm).
13. If necessary, adjust clearance by turning star wheels with a brake adjusting tool through openings provided in dust shield.

FRONT DIFFERENTIAL ASSEMBLY

FRONT DIFFERENTIAL ASSEMBLY REMOVAL

CAUTION

Differential assembly may be removed with axle attached to vehicle, but this is not recommended. If differential assembly is removed with axle installed, use extreme care in positioning and hoisting differential assembly. Failure to follow this procedure could cause damage to equipment.

NOTE

Removal of differential assembly from axle or axle from vehicle is not required for pinion seal replacement.

1. Remove front axle (refer to page 12-5).
2. Remove oil from differential assembly (1, Figure 12-1) (refer to page 3-55).
3. Remove constant velocity joint (refer to page 12-35).

WARNING

Weight of axle assembly is approximately 1,323 lb (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

4. If axle is removed from vehicle, position axle with pinion flange on differential assembly (1) in an upward direction.

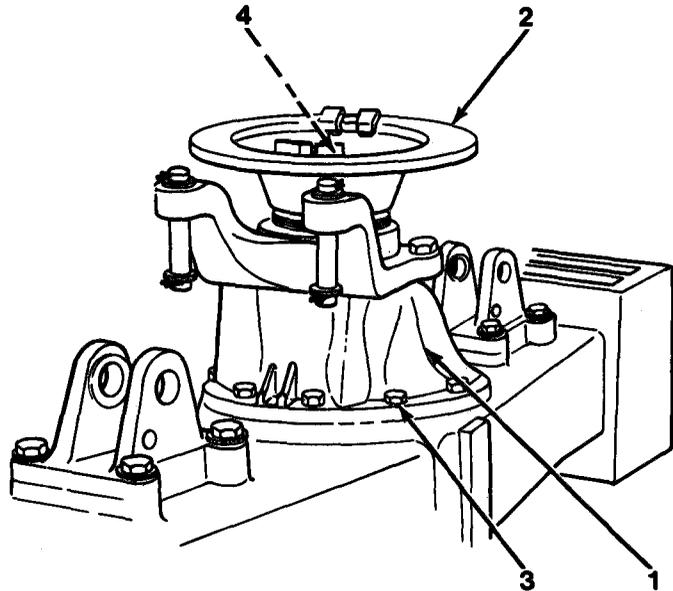


Figure 12-1

FRONT DIFFERENTIAL ASSEMBLY REMOVAL

⚠ WARNING

Weight of differential assembly is approximately 120 lb(54 kg). Use adequate lifting equipment to lift and support differential assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

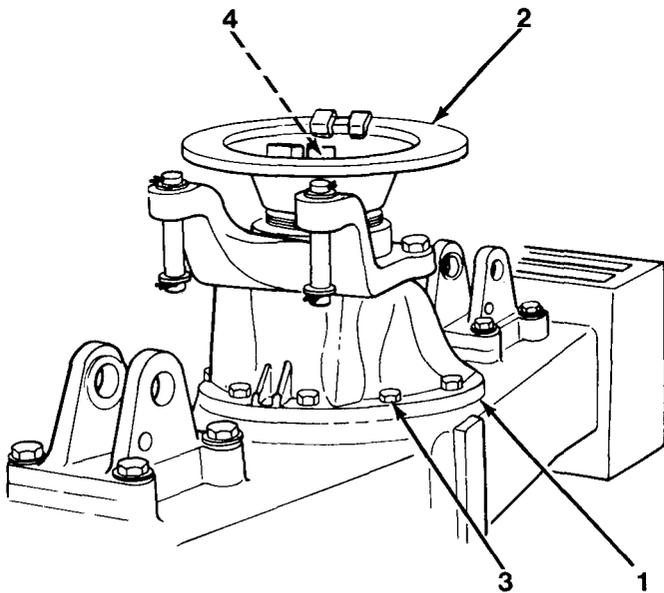


Figure 12-1

5. Using an overhead hoist, attach a suitable lifting fixture to input yoke and disc (2, Figure 12-1).
6. To ease alignment at installation, matchmark differential assembly (1) and axle housing.

⚠ WARNING

Heating differential mounting bolts to a temperature of 300 degrees F(149 degrees C) may be required to break down Loctite. Wear protective equipment while heating and handling differential mounting bolts. Failure to follow this procedure could cause SERIOUS INJURY.

7. Using a 19 mm socket wrench, remove 10 differential mounting bolts (3) securing differential assembly (1) to axle housing.
8. Unstake and loosen pinion nut (4) to aid in disassembly.

NOTE

A tap with a soft-faced mallet may be required to break seal between differential assembly and axle housing.

9. Apply pressure to hoist and lift differential assembly (1) from housing approximately 1 in. (25 mm). Rotate differential 90 degrees to align ring gear with clearance. cutouts in axle housing and remove from housing.

FRONT DIFFERENTIAL ASSEMBLY INSTALLATION **WARNING**

Weight of differential assembly is approximately 120 lb (54 kg). Use adequate lifting equipment to lift and support differential assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Install a suitable fixture to input yoke and disc (2) and suspend differential assembly (1, Figure 12-1) over axle housing opening.
2. Spread a bead of silicone sealant around differential assembly opening.
3. Lower differential assembly (1) into axle housing to approximately 1 in. (25 mm) from seating.

NOTE

Differential assembly must be rotated to align with axle shafts and matchmarks made during removal.

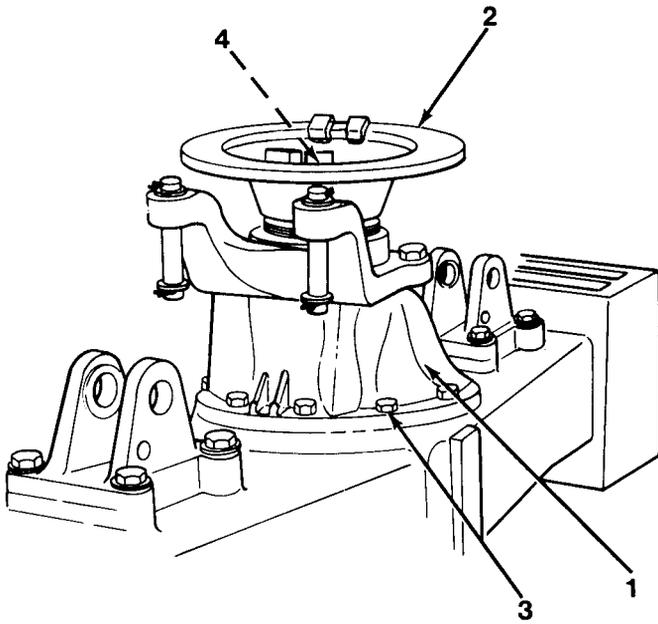


Figure 12-1

FRONT DIFFERENTIAL ASSEMBLY INSTALLATION

4. Lower and tap differential assembly (1, Figure 12-1) with a mallet to seat in axle housing.
5. Remove lifting fixture.
6. Apply Loctite 272 to 10 differential mounting bolts (3) and install.
7. Torque bolts (3) to 58 lb-ft (79 N•m).
8. Install constant velocity joints (refer to page 12-36).
9. Fill differential assembly (1) with oil (refer to page 3-57 and Lubrication Chart).
10. If removed, install front axle assembly (refer to page 12-7).

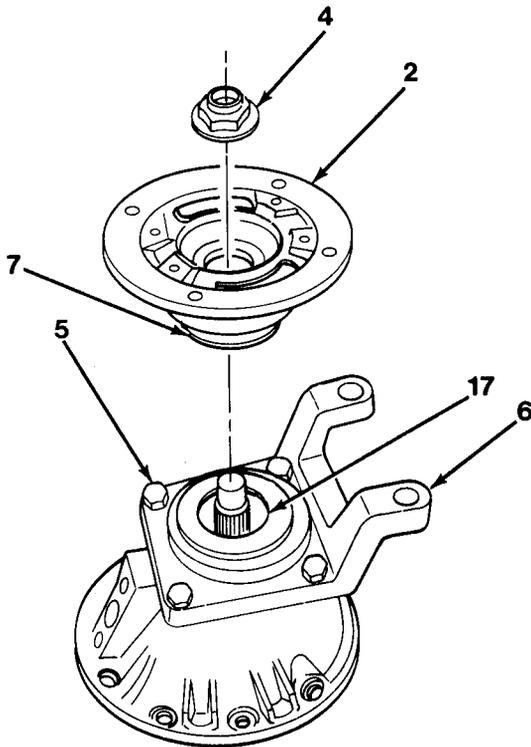


Figure 12-2

FRONT DIFFERENTIAL ASSEMBLY DISASSEMBLY

CAUTION

Do not interchange bearings, pinions or input yoke from other differentials. Preload is factory set. If differential assembly is disassembled, new bearings must be installed. Failure to follow this procedure could cause damage to equipment.

1. Remove pinion nut (4). Remove input yoke and disc (2) and dust shield (7, Figure 12-2).

NOTE

- Removal of bracket is not required unless bracket is to be replaced.
- Matchmark bracket and carrier housing for ease of assembly.

2. Remove four bolts (5) and using puller, remove bracket (6).

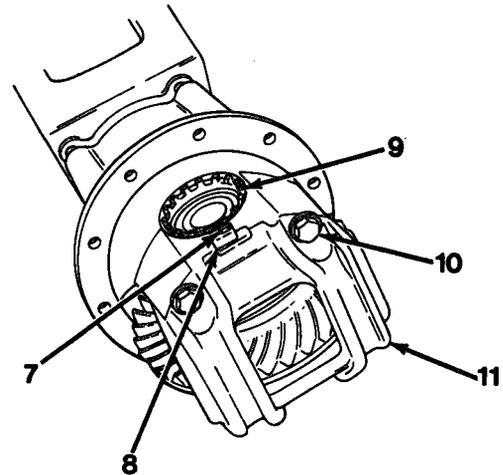


Figure 12-3

NOTE

If no other work than replacement of input yoke seal is required on differential assembly, remove input yoke seal and go to step i on page 12-26. For work on differential assembly other than replacement of seals, proceed as follows:

3. Using a 10 mm socket wrench, remove bolt (7) and adjusting nut lock (8, Figure 12-3).
4. Remove adjusting nut (9). Using a 19 mm socket wrench, remove bolts (10) and bearing cap (11).
5. Remove differential ring gear assembly (12), bearing cups (13) and (14) and shims (15, Figure 12-4).
6. Remove pinion (16, Figure 12-5). Remove input yoke seal (17), bearing cone (18) and shim (19).

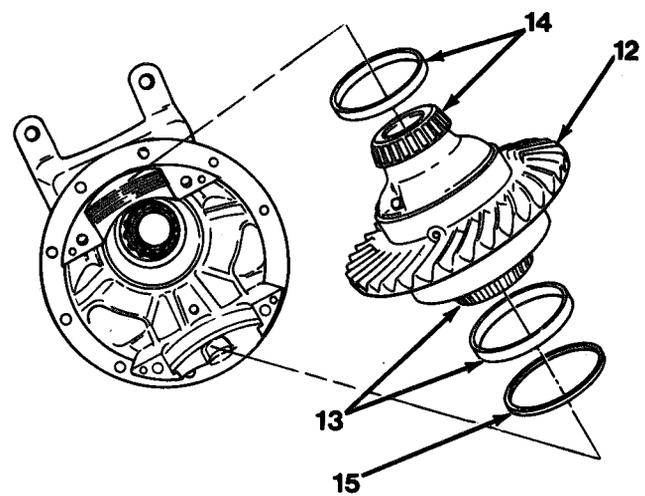


Figure 12-4

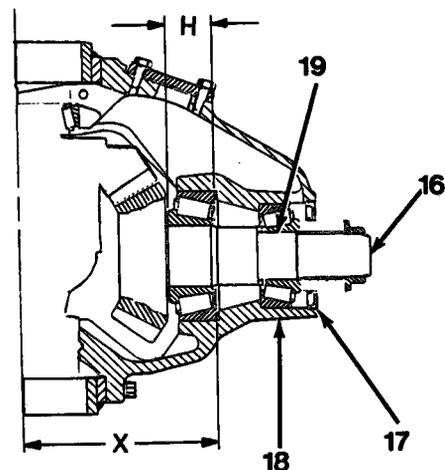


Figure 12-23

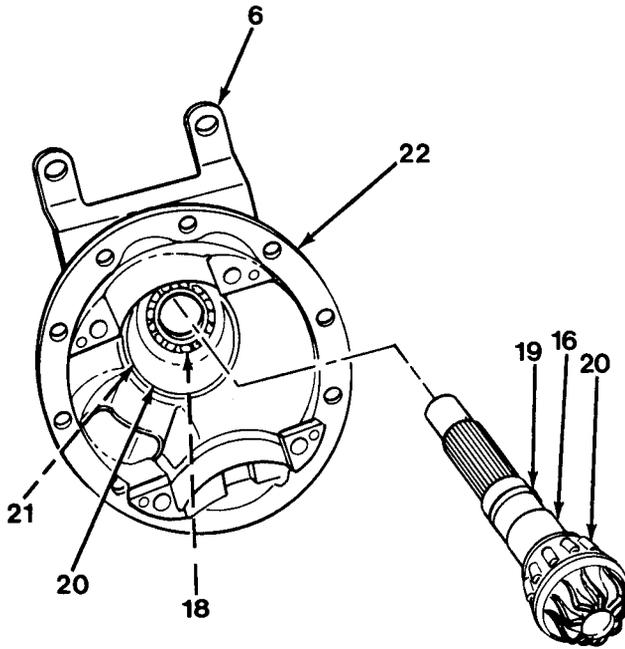


Figure 12-6

FRONT DIFFERENTIAL ASSEMBLY DISASSEMBLY

7. Using a bearing puller, remove bearing cone (20) from pinion (16, Figure 12-6).
8. Remove pinion bearing cups (18) and (20) and shim (21).
9. Remove bearing cones (13) and (14) from differential ring gear assembly (12, Figure 12-4).

FRONT DIFFERENTIAL ASSEMBLY CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FRONT DIFFERENTIAL ASSEMBLY ASSEMBLY

NOTE

Prior to assembly of differential assembly, pinion must be adjusted to determine the correct shims to use.

1. Install bracket (6) on carrier housing (22, Figure 12-6), if removed.
2. Determine the thickness of bearing shim (21) in carrier housing (22):
 - a. Place flat plate across bearing cap mounting surfaces of each bearing bore of the carrier housing (22). Measure and record the distance from plate to bottom of bearing bore. Add together. The result is Q.
 - b. Install bearing cap (11) and capscrews (10, Figure 12-3). Torque capscrews (10) to 79 to 87 lb-ft (108 to 118 N•m).

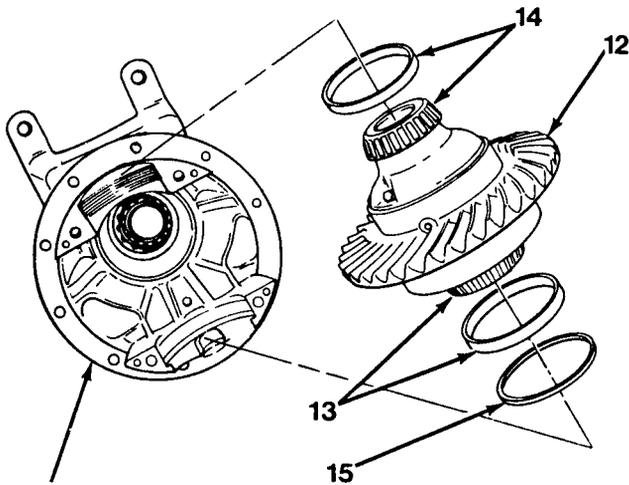


Figure 12-4

- c. Measure each of the bearing bore diameters. Add them together and divide by 2. The result is R.
- d. $S = R - Q$.
- e. Divide S by 2 and add to the value obtained by measuring from bearing carrier shoulder to bearing cap mounting surface of carrier housing (22, Figure 12-6) and the result is distance (X, Figure 12-5).
- f. Measure total thickness (H) of bearing behind head of pinion.
- g. Note value of “corrected tapered distance” marked on pinion (16).
- h. Calculate $Y = \text{thickness (H) of bearing (19) + “corrected tapered distance.”}$
- i. Shim thickness = $X - Y$.

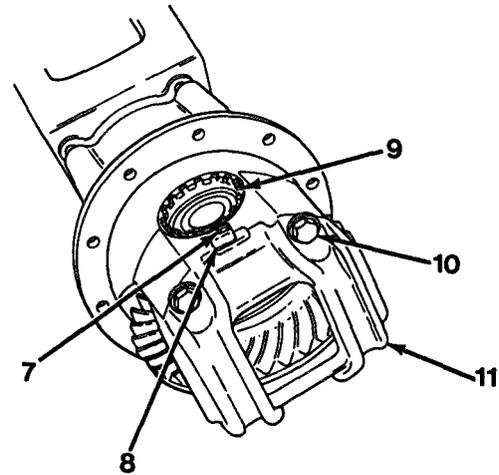


Figure 12-3

⚠ WARNING

Wear protective equipment while heating and handling bearing cone. Failure to follow this procedure could cause **SERIOUS INJURY**.

- 3. Heat bearing cone (20, Figure 12-6) to 176 degrees F (80 degrees C) and place into position on pinion (16). If difficulty is experienced, use a pusher.
- 4. Place selected shim (21) in carrier housing (22) and install bearing cup (20) using a hammer and bearing driver.
- 5. Install pinion (16) and secure in position temporarily for next series of measurements.

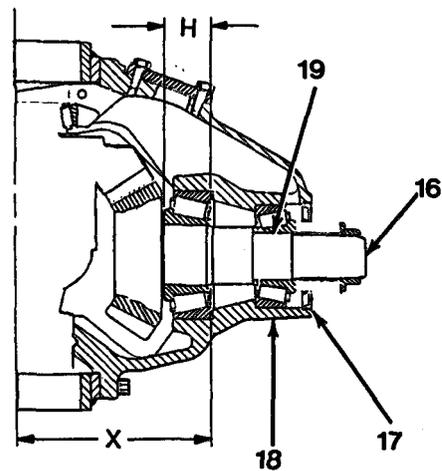


Figure 12-5

FRONT DIFFERENTIAL ASSEMBLY ASSEMBLY

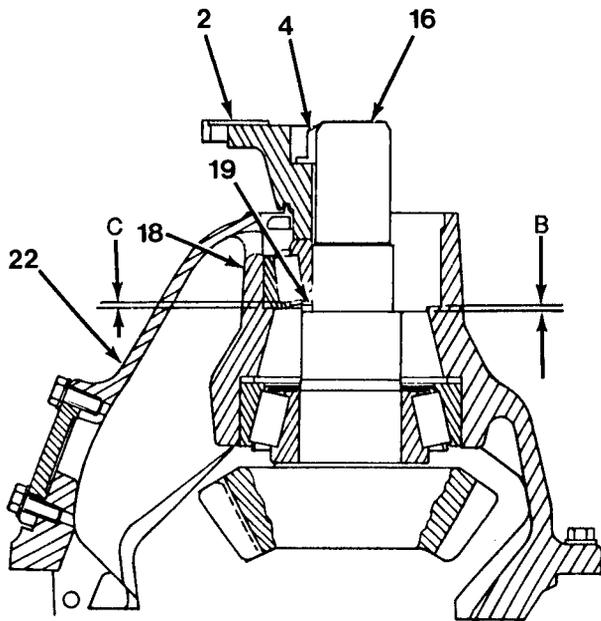


Figure 12-7

6. Determine thickness of bearing shim (19) on pinion (16, Figure 12-7).
 - a. Place carrier housing (22) with small end upward.
 - b. Using a depth gauge, measure distance from bearing cup seat to recess on pinion shaft and let it equal B.
 - c. Using a dial gauge, measure difference in height between cone and cup of bearing which is equal to C. Thickness of required shim (19) = $B + C - 0.001$ in. (0.03 mm).
 - d. Remove pinion (16) and install bearing cup (18) into small end of carrier housing (22).
 - e. Install pinion (16). Install selected shim (19) and bearing cone (18), input yoke (2) and nut (4).

- (1) Torque nut (4) to 405 to 433 lb-ft (549 to 587 N•m).

- (2) Using an lb-in. torque wrench on nut (4), check the rotational resistance of bevel pinion. It must be 26 to 34.7 lb-in. (2.94 to 3.92 N•m). If resistance is less than 26 lb-in. (2.94 N•m), reduce thickness of shims.

7. Adjustment of differential bearing assemblies is as follows:

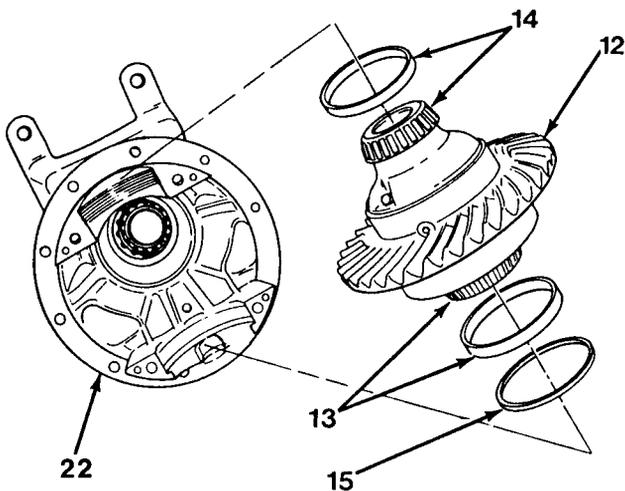


Figure 12-4

⚠ WARNING

Wear protective equipment while heating and handling bearing cones. Failure to follow this procedure could cause **SERIOUS INJURY**.

- a. Heat bearing cones (13) and (14, Figure 12-4) to approximately 176 degrees F (80 degrees C) and install Use a bearing driver, if necessary.
- b. Position carrier housing (22) with large opening upward. Fit bearing cups (13) and (14) and shim (15) on ring gear (12) and place assembly in carrier housing (22).

NOTE

The value of a correct backlash is 0.007 to 0.009 in (0.18 to 0.23 mm).

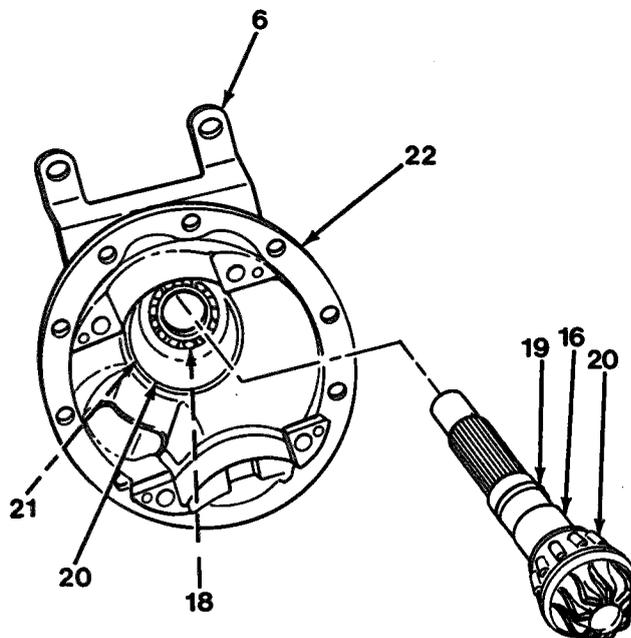


Figure 12-6

- c. Install centering pins, if removed.
- d. Install bearing cap (11). Apply Loctite 242 to bolts (10) and torque to 79 to 87 lb-ft (107 to 118 N•m). Install adjusting nut (9, Figure 12-3).
- e. Measure and record distance across machined surfaces on bearing cap (11) located above bearing bores.
 - (1) Tighten adjusting nut (9) until distance is 0.001 in. (0.03 mm) greater than the distance recorded in step e.
- f. Using a dial indicator, check backlash between pinion (16) and ring gear (12, Figure 12-6). Backlash must be 0.007 to 0.009 in. (0.18 to 0.23 mm).
- g. If required, adjust gear backlash (refer to page 12-26). If adjustment is necessary, repeat steps c thru g.
- h. Coat with Primer T and Loctite 222. Install adjusting nut lock (8) and bolt (7, Figure 12-3). Torque bolt (7) to 66 lb-in. (7.5 N•m).

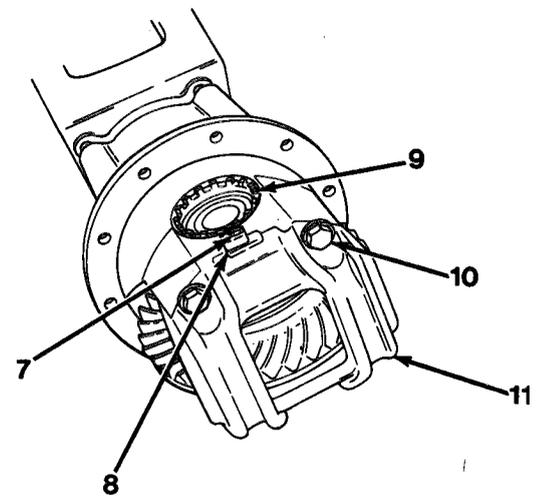


Figure 12-3

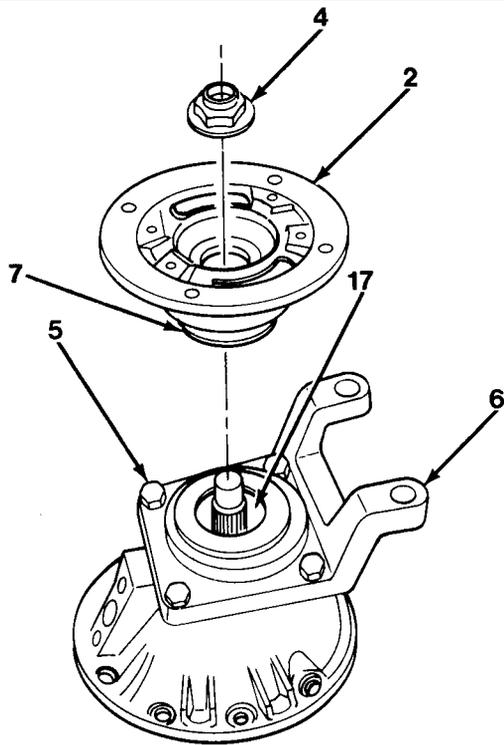


Figure 12-2

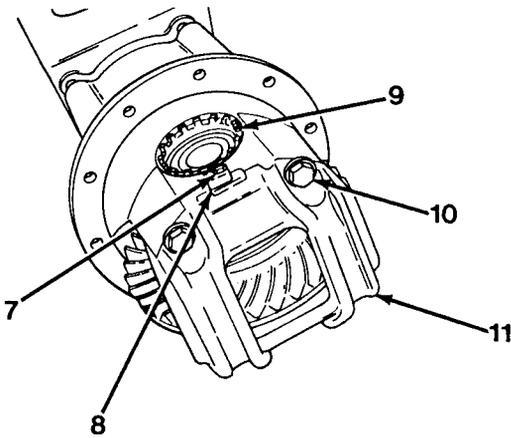


Figure 12-3

FRONT DIFFERENTIAL ASSEMBLY

- (1) Remove pinion nut (4) and input yoke and disc (2, Figure 12-2).
 - i. Lubricate and install new input yoke seal (17) flush.
 - j. Install input yoke and disc (2) and new pinion nut (4). Torque pinion nut (4) to 405 to 433 lb-ft (549 to 587 N•m).
 - k. Stake pinion nut (4) in two locations, 180 degrees apart.
 - l. File off washer face of bolts (10) flush with machined surface of bearing cap (11, Figure 12-3).

GEAR BACKLASH ADJUSTMENTS

When servicing differential assembly, it is important that the gear set be mounted correctly and the tooth contact be as specified in this manual. Incorrect differential mounting and/or tooth contact will severely reduce the life of the gear set.

Proper tooth contact is illustrated in Figure 12-8.

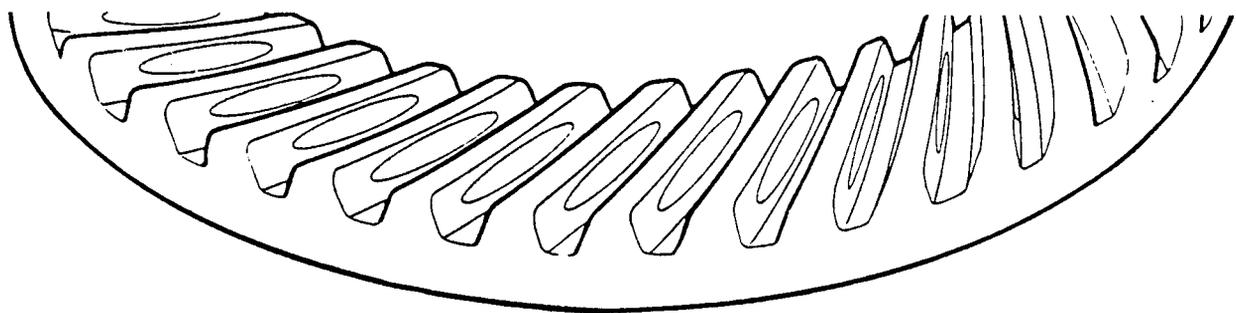


Figure 12-8

Apply white grease to ring gear and rotate pinion to check backlash pattern. Two adjustments affect the tooth contact. One affects the tooth contact along the length of the tooth (longitudinal). The other affects the tooth height (profile). These two adjustments must be considered separately to obtain correct tooth contact (Figure 12-9).

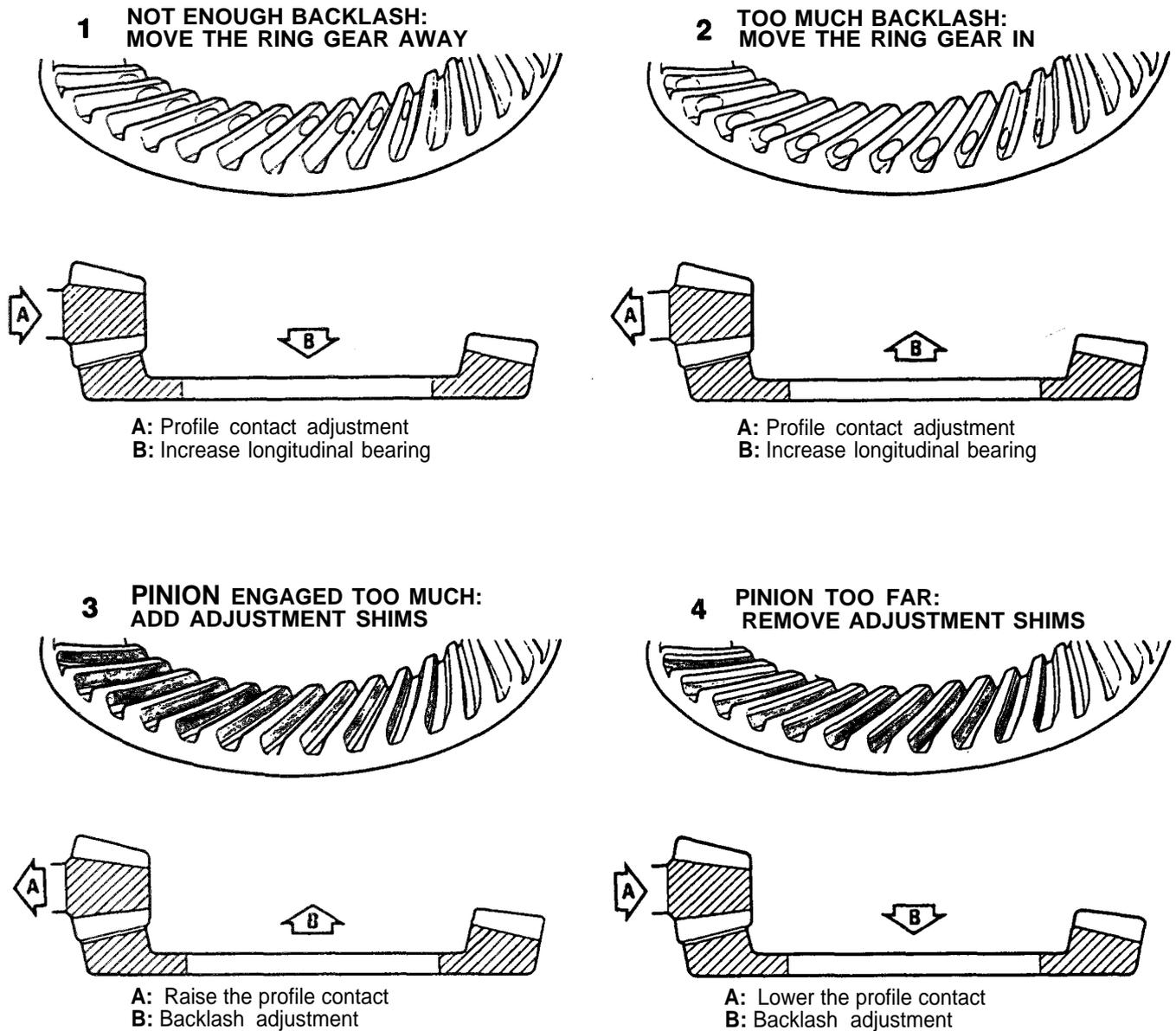


Figure 12-9

REAR DIFFERENTIAL ASSEMBLY**REAR DIFFERENTIAL ASSEMBLY
REMOVAL****⚠ WARNING**

Weight of axle assembly is approximately 1,323 lb (600 kg). Use adequate lifting equipment to lift and support axle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

CAUTION

Differential assembly may be removed with axle attached to vehicle, but this is not recommended. If differential assembly is removed with axle installed, use extreme care in positioning and hoisting differential assembly to prevent damage.

NOTE

Removal of differential assembly from axle or axle from vehicle is not required for pinion seal replacement.

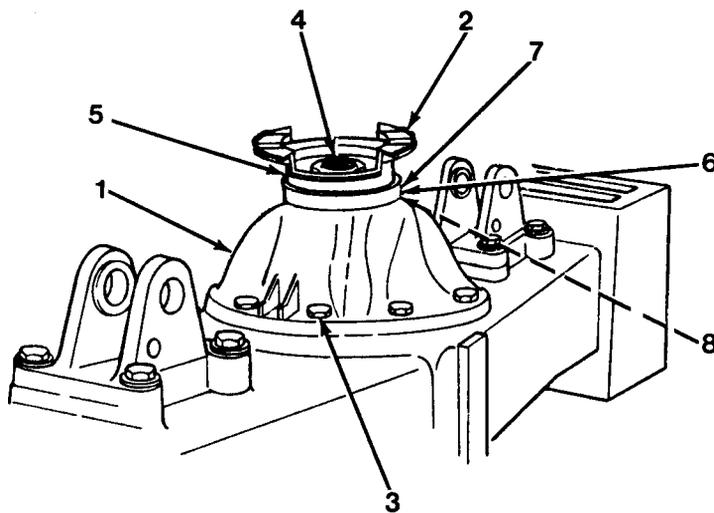


Figure 12-1

1. Remove rear axle (refer to page 12-9).
2. Remove oil from differential assembly (1, Figure 12- 1) (refer to page 3-57).
3. Remove constant velocity joint (refer to page 12-35).

-
- If axle is removed from vehicle, position axle with pinion flange on differential assembly (1) in an upward direction.

 **WARNING**

Weight of differential assembly is approximately 120 lb (54 kg). Use adequate lifting equipment to lift and support differential assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

- Using an overhead hoist attach a suitable lifting fixture to input yoke (2) on differential assembly (1).
- To ease alignment at installation, matchmark differential assembly (1) and axle housing.

 **WARNING**

Heating bolts to 300 degrees F (149 degrees C) may be required to breakdown Loctite. Wear protective equipment while heating and handling differential mounting bolts. Failure to follow this procedure could cause SERIOUS INJURY.

- Using a 19 mm socket wrench, remove 10 mounting bolts (3) securing differential assembly (1) to axle housing.
- Unstake and loosen pinion nut (4) to aid in disassembly of differential assembly (1).

NOTE

A tap with a soft-faced mallet may be required to break seal between differential assembly and axle housing.

- Apply pressure to hoist and lift differential assembly (1) from housing. Approximately 1 in. (25 mm). Rotate differential assembly (1) 90 degrees to align ring gear with clearance cutouts in axle housing and remove from housing.

REAR DIFFERENTIAL ASSEMBLY REMOVAL

CAUTION

Do not interchange bearings, pinions or input yoke from other axles. Preload is factory set. Failure to follow this procedure could cause damage to equipment.

10. Remove pinion nut (4). Remove input yoke (2) and dust shield (5, Figure 12-1).

NOTE

For work on differential assembly other than replacement of seals, refer to page 12-21, front differential disassembly and assembly. The disassembly for rear differential assembly is identical to the front (see step 3 of disassembly thru 7h of assembly).

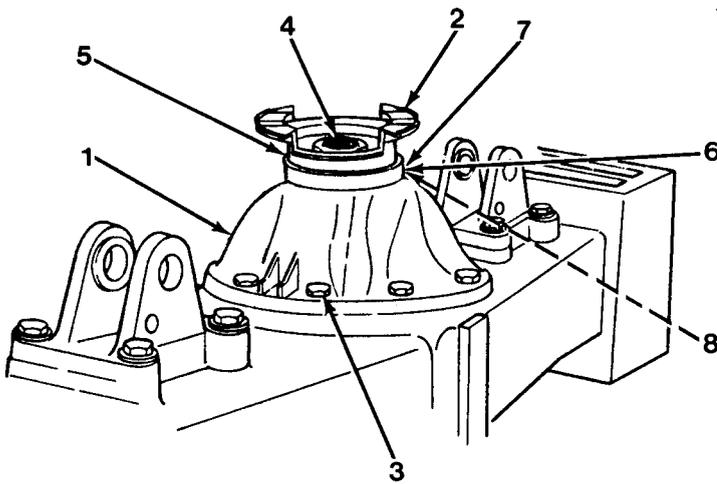


Figure 12-1

11. Remove trunnion (6) and spacer (7), if necessary.
12. Remove input yoke seal (8).

REAR DIFFERENTIAL ASSEMBLY INSTALLATION

WARNING

Wear protective equipment while heating and handling spacer. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Heat spacer (7) to approximately 350 degrees F (176degrees C). Install spacer (7)and trunnion (6, Figure 12-1).
2. Lubricate and install new input yoke seal (8) flush.
3. Install input yoke (2), dust shield (5) and new pinion nut (4). Torque pinion nut (2) to 405 to 433 lb-ft (549 to 587 N•m. Stake pinion nut (4) in two locations 180 degrees apart.
4. If differential was disassembled, file off washer face of bolts (9) flush with machined surface of bearing cap (10, Figure 12-2).

⚠ WARNING

Weight of differential assembly is approximately 120 lb (54 kg). Use adequate lifting equipment to lift and support differential assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Install a suitable lifting fixture to input yoke (2) and suspend differential assembly (1, Figure 12-1) over axle housing opening.
6. Spread a bead of silicone sealant around differential assembly opening.
7. Lower differential assembly (1) into axle housing to approximately 1 in. (25 mm) from seating.

NOTE

Differential assembly must be rotated to align with axle shafts and marks made during removal.

8. Lower and tap differential assembly (1) with a mallet to seat in axle housing.
9. Remove lifting fixture.
10. Apply Loctite 272 to 10 mounting bolts (3) and install.

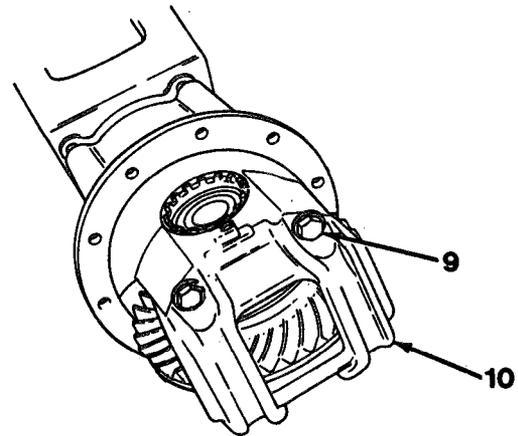


Figure 12-2

REAR DIFFERENTIAL ASSEMBLY INSTALLATION

11. Torque 10 mounting bolts (3, Figure 12-1) to 58 lb-ft (79 N•m).
12. Install constant velocity joints (refer to page 12-36).
13. Fill differential assembly (1) with oil (refer to page 3-57 and Lubrication Chart).
14. If removed, install rear axle (refer to page 12-11).

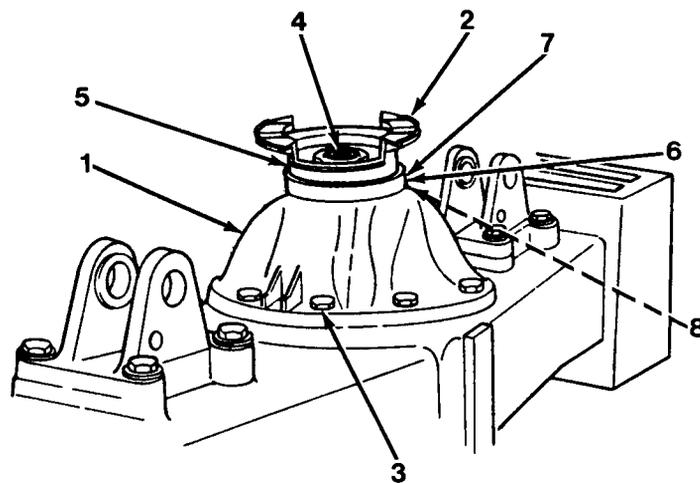


Figure 12-1

TIE ROD

TIE ROD REMOVAL

NOTE

The following is a maintenance procedure for rear tie rod. The maintenance procedure for front tie rod is identical.

1. Measure and record distance between tie rod ends (6, Figure 12-1) to aid in installation.
2. Loosen clamp assemblies (7) and unscrew tie rod (3).
3. Remove clamp assemblies (7).

NOTE

Remove tie rod ends only if necessary.

4. Remove cotter pins (1, Figure 12-1).
5. Remove tie rod nuts (2).
6. Separate tie rod ends (6) from tie rod levers (4).
7. Remove dust shield (5).
8. Remove grease fitting (8).

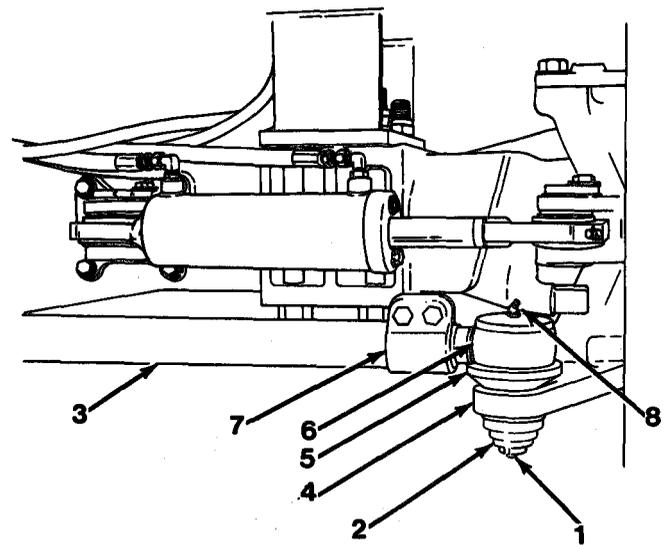


Figure 12-1

TIE ROD CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect dust shields for wear, tears and deformation.
3. Insert all other parts (refer to Chapter 4).

TIE ROD INSTALLATION

1. Install dust shield (5, Figure 12- 1).
2. Install tie rod ends (6) into tie rod levers (4).
3. Install tie rod nuts (2). Torque tie rod nuts (2) to 180 lb-ft (244 N•m) and advance to next castellation.
4. Install cotter pins (1),
5. Slide clamp assemblies (7) onto tie rod (3).
6. Screw tie rod (3) onto tie rod ends (6), using measurement recorded in removal.
7. Secure clamp assemblies (7).
8. Install grease fittings (8).

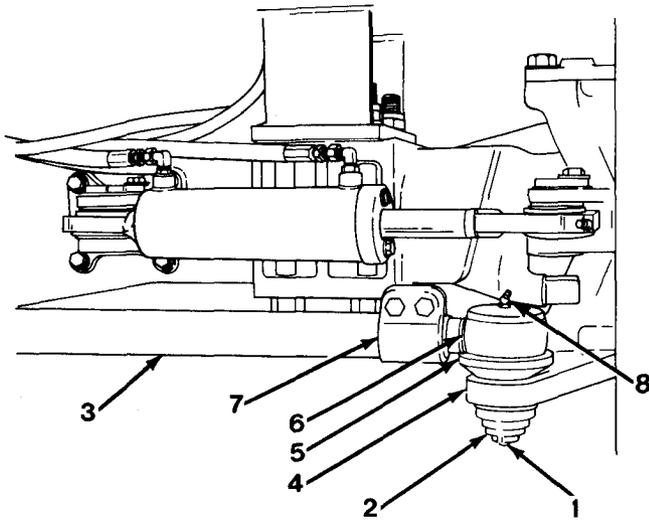


Figure 12-1

TIE ROD ADJUSTMENT

1. Position wheels straight ahead.
2. Loosen clamp assemblies.
3. Measure distance between outside edges of tread shoulders at axle height on front side of tires. Repeat measurement on back side of tires. When adjustment is correct, back side measurement will be 0.125 to 0.250 in. (3.18 to 6.35 mm) greater than front side measurement.
4. Turn tie rod assembly until measurements fall within tolerance found in step 3.
5. Torque clamp assembly to 33 lb-ft (45 N•m).
6. Perform steps 1 thru 5 for other axle, if necessary.

CONSTANT VELOCITY JOINT AND AXLE SHAFT

CONSTANT VELOCITY JOINT AND AXLE SHAFT REMOVAL

NOTE

- There is no difference in the maintenance procedures for front and rear constant velocity joint and axle shaft. Refer to the Koehring Commercial Parts Manual for differences in parts.
- Pivot and spindle assembly must be removed to remove constant velocity joint and shaft assembly.

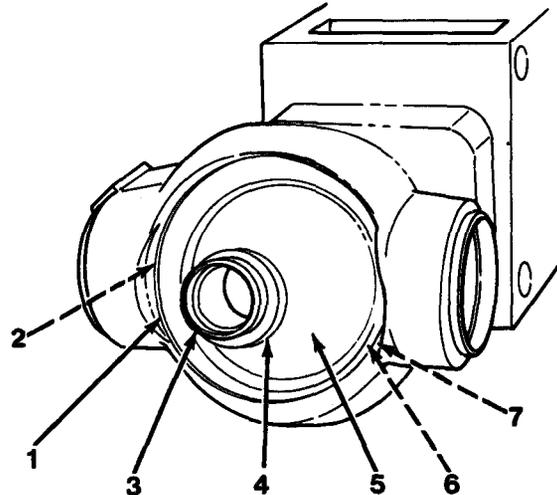


Figure 12-1

1. Remove pivot and spindle assembly (refer to page 12-45).
2. Remove nut (1) and seal assembly (2, Figure 12-1).
3. Remove face seal (3) and O-ring (4).

CAUTION

If a slide hammer or pry bar is used, extreme care must be exercised to prevent damage to bowl.

NOTE

It maybe necessary to use a pry bar or slide hammer and ring to remove bowl.

4. Remove bowl (5), guide bushing (6) and O-ring (7).

CONSTANT VELOCITY JOINT AND AXLE SHAFT REMOVAL

5. Remove constant velocity joint (8) and axle shaft (9) from axle housing (11, Figure 12-2).
6. Remove oil baffle (10) only if there is visible damage.

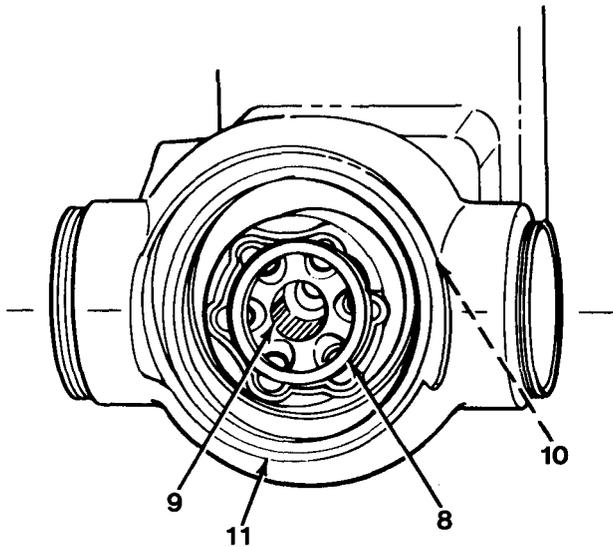


Figure 12-2

NOTE

Left and right axle shafts are different lengths. It may be necessary to place axle shaft into a soft-faced vise to separate it from constant velocity joint. Once it is secure in the vise, use a brass drift to remove joint from shaft. A “C” ring mounted on the shaft will compress into a groove to slip through joint. It will expand when shaft is out of joint.

7. Separate axle shaft (9) from constant velocity joint (8, Figure 12-3).

CONSTANT VELOCITY JOINT AND AXLE SHAFT CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

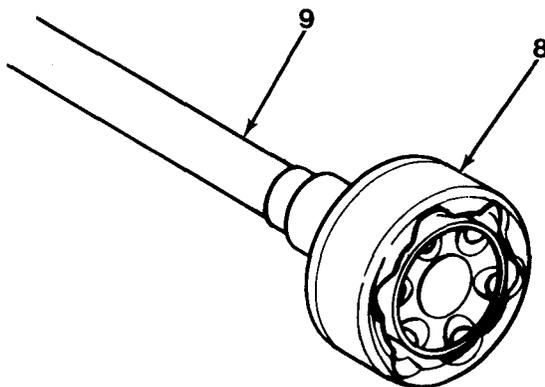


Figure 12-3

CONSTANT VELOCITY JOINT AND AXLE SHAFT INSTALLATION

CAUTION

All parts must be clean before installation to prevent damage to constant velocity joint.

NOTE

Make sure axle shaft has a “C” ring installed in the groove before assembling constant velocity joint and shaft. “C” ring will be compressed as it goes through joint and will expand to hold assembly when compression is released.

1. Insert end of axle shaft (9) into constant velocity joint (8, Figure 12-3).
2. Lubricate constant velocity joint (8) and inner surface of axle housing (11, Figure 12-2).
3. Install oil baffle (10), if removed.
4. Insert axle shaft (9) and constant velocity joint (8) into axle housing (11).
5. Place guide bushing (6) over small end of bowl (5) and push to large portion of bowl (5, Figure 12-1).
6. Lubricate O-ring (4) and face seal (3) with lithium-based grease and install on bowl (5).

NOTE

Make sure O-ring is on rear of guide bushing.

7. Lubricate with lithium-based grease and install O-ring (7), guide bushing (6), bowl (5), O-ring (4) and face seal (3, Figure 12-1) as an assembly into axle housing (11, Figure 12-2).
8. Using lithium-based grease, lubricate seal assembly (2, Figure 12-1) and install. Fill free intervals between parts with grease.

CONSTANT VELOCITY JOINT AND AXLE SHAFT REMOVAL

9. Apply a bead of silicone around threaded portion of nut (1, Figure 12-1).
10. Install nut (1). Turn nut (1) in counterclockwise direction to engage the leading thread. Torque nut (1) in clockwise direction to 100 lb-ft (136 N•m).
11. Install pivot and spindle assembly (refer to page 12-47).

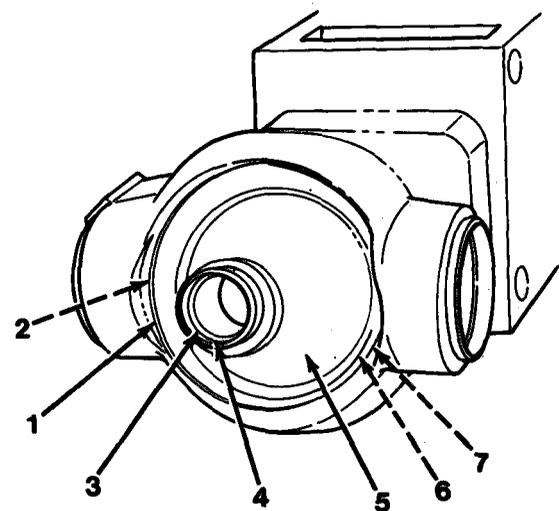


Figure 12-1

PLANETARY WHEEL END

PLANETARY WHEEL END REMOVAL

1. Remove tire and wheel assemblies (refer to page 12-1).

⚠ WARNING

- Weight of brake drum is approximately 81 lb (37 kg). Use adequate lifting equipment to lift and support brake drum. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.
- The brake linings contain asbestos, Wear a protective breather respirator when performing maintenance on the brake assembly and brake drum.

Care must be taken when cleaning the brake assembly. Clean the assembly as a whole by using a solution of hot soapy water. Go over the assembly 3 times or enough to be sure it is completely clean to prevent the asbestos fibers from being released into the air and circulated in the maintenance area.

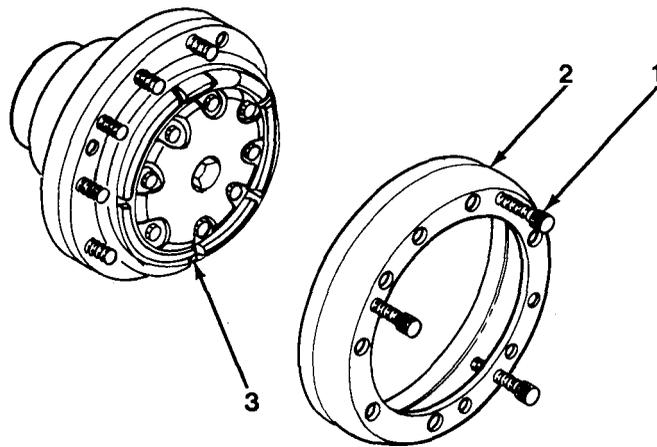


Figure 12-1

Do not use compressed air to dry the brake assembly; let it air dry.

Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Jacking bolts maybe required to remove brake drum. There is no difference in the maintenance procedures for front and rear planetary wheel ends. Refer to the Koehring Commercial Parts Manual for differences in parts.

2. Remove three assembly screws (1) and brake drum (2, Figure 12-1).
3. Position a suitable container to accept oil from wheel end.
4. Rotate wheel hub so that drain plug (3) is at 6 o'clock position. Remove drain plug (3).
5. Remove fill plug and washer (4) and eight bolts (5) from wheel end cover (6). Remove wheel end cover (6), thrust plug (7) and O-ring (8, Figure 12-2) from wheel hub. A punch and hammer may be required for this
6. Remove four sector plates (9).

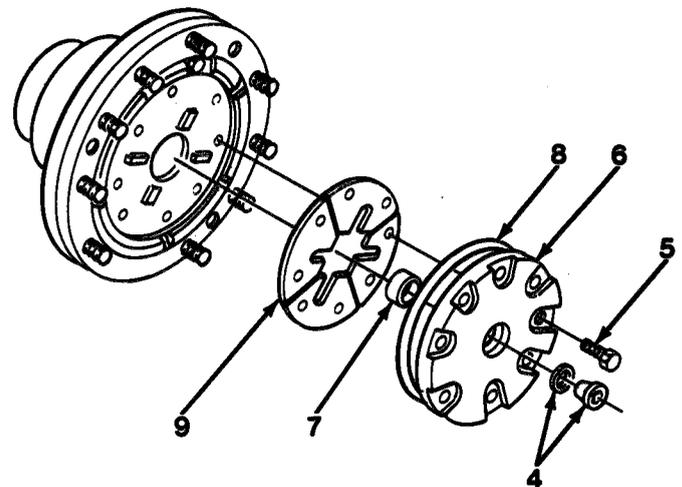


Figure 12-2

PLANETARY WHEEL END REMOVAL

NOTE

Do not remove thrust plug from wheel end cover unless replacement is required.

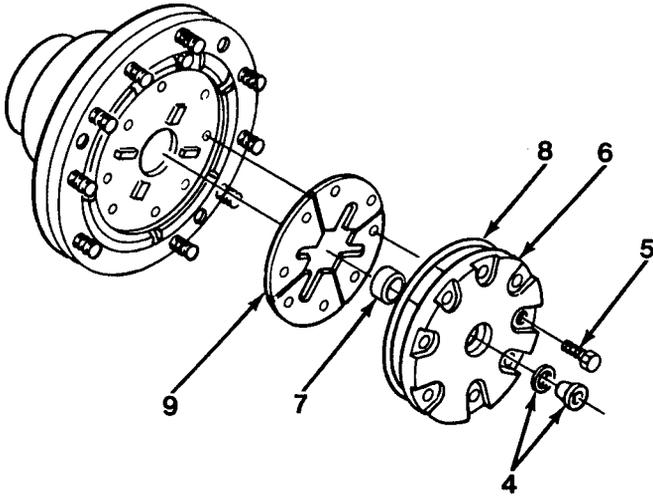


Figure 12-2

7. Remove O-ring (8) and, if necessary, thrust plug (7) from wheel end cover (6, Figure 12-2).
8. Remove planetary gear carrier assembly (10, Figure 12-3) by pulling outward.
9. Remove sun gear (11) and coupler (12).

NOTE

It may be necessary to strike ring gear carrier assembly with a soft-faced mallet to jar centering cone loose before removing. Outer hub bearing assembly comes off when ring gear carrier assembly is removed.

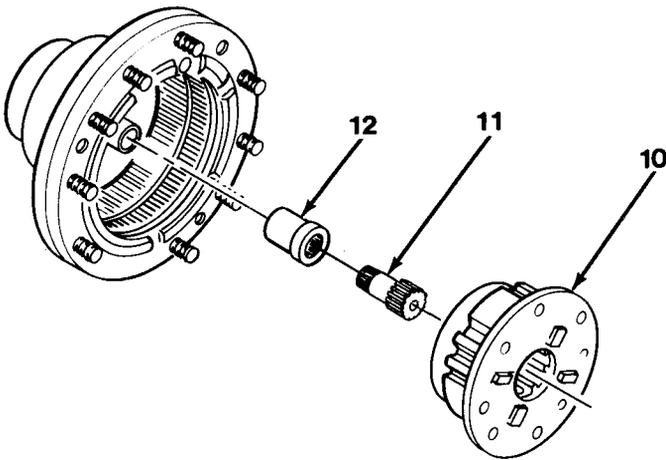


Figure 12-3

10. Straighten tab on lockwasher (14). Remove spindle nut (13), lockwasher (14) and centering cone (15, Figure 12-4).

⚠ WARNING

Weight of hub and studs is approximately 79 lb (36 kg). Use adequate lifting equipment to lift and support hub and studs. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

11. Remove ring gear carrier assembly (16) and hub (17, Figure 12-5).

PLANETARY WHEEL END INSTALLATION

CAUTION

All parts must be cleaned before installation to prevent damage to gears.

1. Apply grease to hub seal lips and to hub seal runner.

WARNING

Weight of hub and studs is approximately 79 lb (36 kg). Use adequate lifting equipment to lift and support hub and studs. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Position hub (17, Figure 12-5) onto pivot and spindle.
3. Install ring gear carrier assembly (16).
4. Install centering cone (15), lockwasher (14) and spindle nut (13, Figure 12-4). Tighten spindle nut (13) according to procedures in steps a, b and c below:
 - a. Tighten spindle nut (13) while rotating hub to correctly position all components (bearings and spindle cone). Torque spindle nut (13) to 258 to 295 lb-ft (350 to 400 N•m).
 - b. Apply 15.8 lb (70 N) tangential force to wheel stud. Adjust spindle nut (13) by loosening until rotation of hub is obtained.
 - c. Secure spindle nut (13) by bending tab on lockwasher (14).

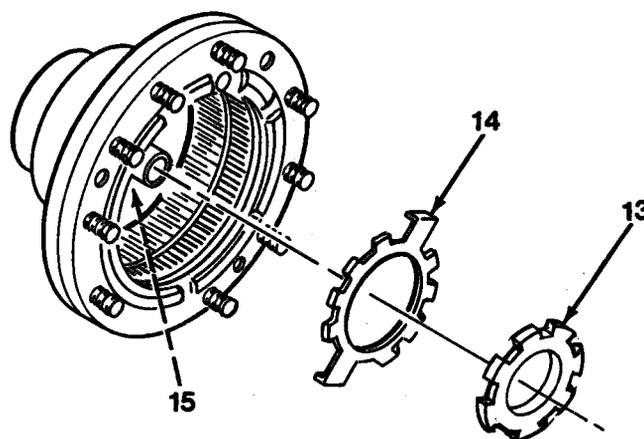


Figure 12-4

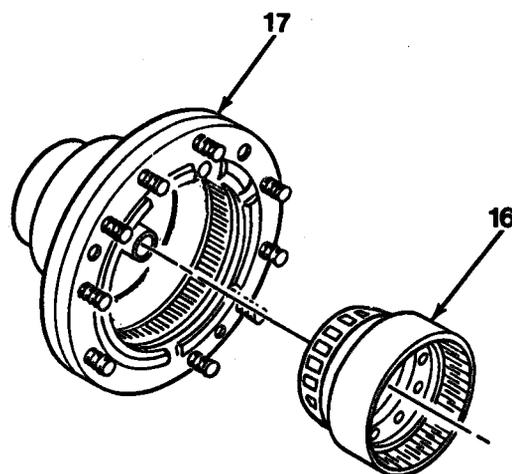


Figure 12-5

**PLANETARY WHEEL END
INSTALLATION**

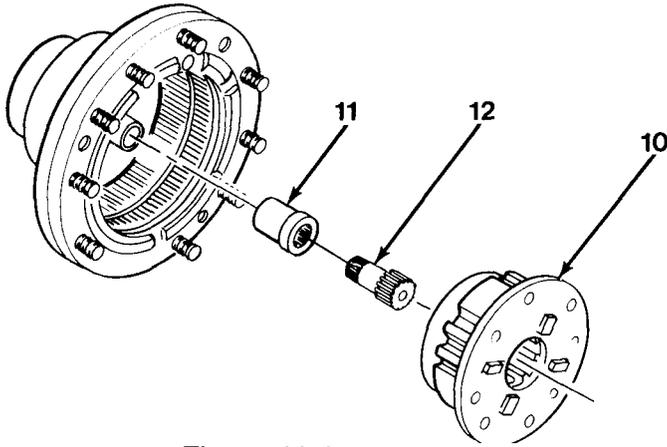


Figure 12-3

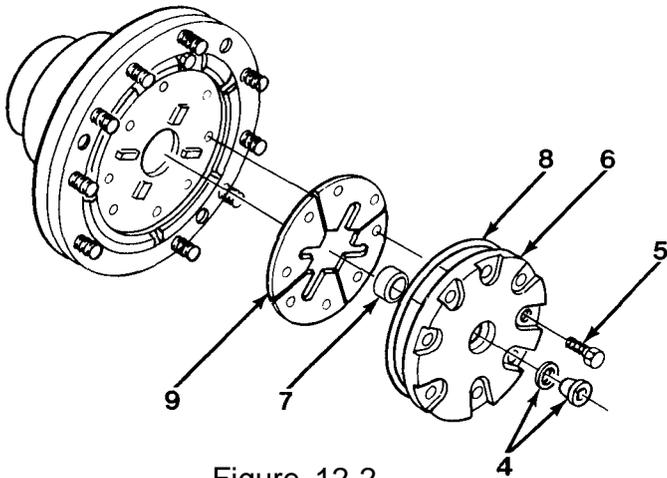


Figure 12-2

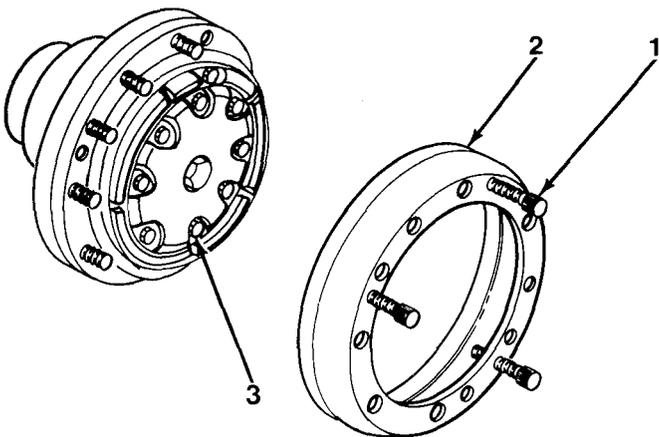


Figure 12-1

6. Install planetary carrier assembly (10, Figure 12-3).
7. Install four sector plates (9, Figure 12-2).
8. If removed, install thrust plug (7) into wheel end cover.
9. Lubricate O-ring (8) and install onto wheel end cover (6).
10. Install wheel end cover (6) with eight bolts (5) and torque to 58 lb-ft (79 N•m).
11. Install drain plug (3, Figure 12-1).

⚠ WARNING

Weight of brake drum is approximately 81 lb (37 kg). Use adequate lifting equipment to lift and support brake drum. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

12. Install brake drum (2) and screws (1). Tighten screws (1) to 14 to 18 lb-ft (19 to 24 N•m).
13. Install tire and wheel assemblies (refer to page 12-1).
14. Fill with oil (refer to page 3-57, step 6, and Lubrication Chart).

PLANETARY WHEEL END DISASSEMBLY

NOTE

If there are no visible signs of damage, bearing assemblies or oil seal and runner should not be removed.

1. Remove bearing cone (18), if necessary, from ring gear carrier assembly (16, Figure 12-6).

NOTE

Hub seal runner remains on pivot and spindle when hub assembly is removed.

2. Remove hub seal (19) and bearing cone (20) from hub (17, Figure 12-7).

NOTE

Remove hub seal runner only if inspection proves necessary.

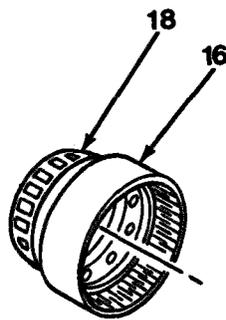


Figure 12-6

3. If hub seal runner (21) is damaged, remove 15 bolts which attach brake assembly to pivot and spindle assembly and remove brake assembly (refer to page 12-12).

WARNING

Wear protective equipment while heating and handling seal runner. Failure to follow this procedure could cause **SERIOUS INJURY**.

4. Remove hub seal runner (21), if necessary. Apply moderate heat and use pry bar to remove.
5. Remove 10 studs (22), if necessary, from hub (17).
6. Remove two bearing cups (18) and (20) from hub (17) if inspection proves necessary.

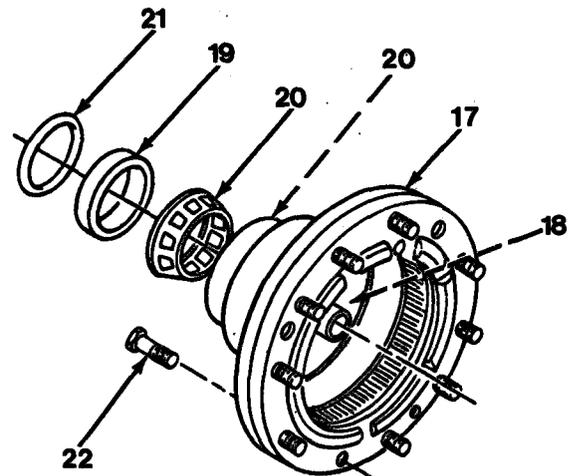


Figure 12-7

**PLANETARY WHEEL END CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect ring gear carrier assembly for deformed or scored teeth.
3. Inspect wheel hub and studs for damage. Check inner portion of hub for damaged teeth, rough spots on bearing surface or cracks.
4. Inspect studs for deformed shanks or damaged threads
5. Inspect all other parts (refer to Chapter 4).

**PLANETARY WHEEL END ASSEMBLY
ASSEMBLY**



WARNING

Wear protective equipment while heating and handling seal runner. Failure to follow this procedure could cause **SERIOUS INJURY**.

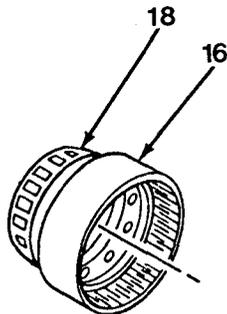


Figure 12-6

NOTE

Hub seal must be installed in the hub concentric and perpendicular to the axis.

1. Heat hub seal runner(21, Figure 12-7), if removed, to approximately 176 degrees F (80 degrees C), install and secure with Loctite 549.
2. If removed, install brake assembly and 15 bolts which attach the brakes to pivot and spindle assembly (refer to page 12-14).
3. If removed, install two bearing cups (18) and (20).
4. Install hub seal (19) into hub (17) against shoulder.
5. If removed, heat bearing cone (18) to approximately 176 degrees F (80 degrees C) and install on ring gear carrier (16, Figure 12-6).
6. If removed, install 10 studs (22) to hub (17, Figure 17-7).

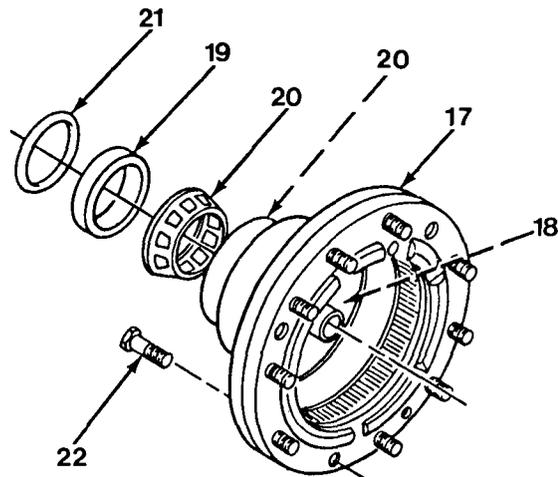


Figure 12-7

PIVOT AND SPINDLE ASSEMBLY

PIVOT AND SPINDLE ASSEMBLY REMOVAL

NOTE

There is no difference in the maintenance procedures for front and rear pivot and spindle assemblies.

1. Remove tie rod assembly, if necessary (refer to page 12-33).

NOTE

It is not necessary to remove planetary wheel end or brake assembly from pivot and spindle assembly to remove constant velocity joint or differential assembly.

2. Remove planetary wheel end (refer to page 12-39).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all parts. Remove caps, plugs and tags following maintenance.

3. Disconnect and cap brake lines, if necessary.
4. Remove brake assembly (refer to page 12-12).

⚠ WARNING

Weight of pivot and spindle assembly is approximately 69 lb (30 kg). Use adequate lifting equipment to lift and support pivot and spindle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Position hoist above pivot and spindle assembly (7, Figure 12-1). Support pivot and spindle assembly (7) with sling.
6. Remove eight bolts (1), pivot cap (2) and tie rod lever (3).
7. Remove and measure shim packs (4). Record measurements and locations of shims.

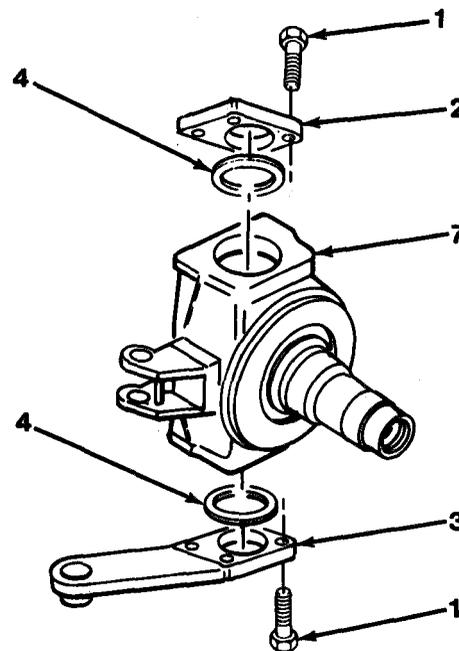


Figure 12-1

PIVOT AND SPINDLE ASSEMBLY REMOVAL

8. Remove and tag trunnions (5, Figure 12-2).
9. Remove upper and lower bearings (6) from trunnions (5), if necessary.
- 10 Pull pivot and spindle assembly (7) horizontally outward.
- 11 If inspection proves necessary, pull out bearing cups (6).

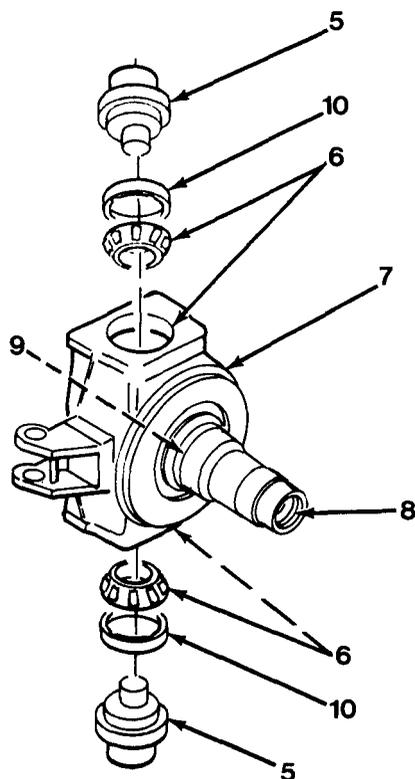


Figure 12-2

NOTE

Pivot and spindle assembly consists of a thrust ring on splined end, a shaft bushing on other end and pivot and spindle.

- 12 If inspection proves necessary, remove thrust ring (8) and shaft bushing (9).
- 13 Remove and discard trunnion seals (10).
- 14 Remove mid-shaft (11, Figure 12-3).

**PIVOT AND SPINDLE ASSEMBLY
CLEANING/INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**PIVOT AND SPINDLE ASSEMBLY
INSTALLATION**

NOTE

If bearings, trunnions, main housing or pivot spindle have not been replaced, use shim pack thickness recorded during removal and go to step 2.

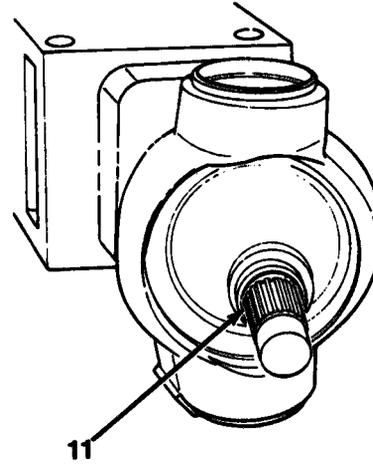


Figure 12-3

- 1 Perform the following procedures to determine required lower shimming:

NOTE

Lower shims insure alignment of pivot, axle housing sphere and axle Shaft.

- a. Read pivot dimension - X (distance from lower machined surface to center of pivot) on lower face of pivot and spindle assembly Figure 12-4).
- b. Measure height of trunnion hearing assembly and call it Y.
- c. Read axle housing measurement-Z (distance from bearing cup seat to center line of axle housing) as stamped in bottom of lower trunnion cavity.
- d. To calculate thickness of required lower shim, substitute dimensions in the following equation:

e. Lower shim = $X - (Y + Z)$

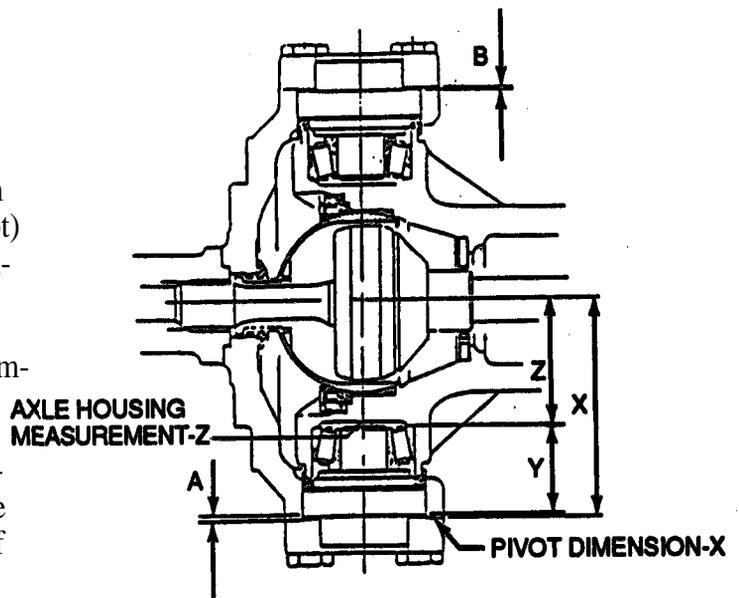


Figure 12-4

PIVOT AND SPINDLE ASSEMBLY INSTALLATION

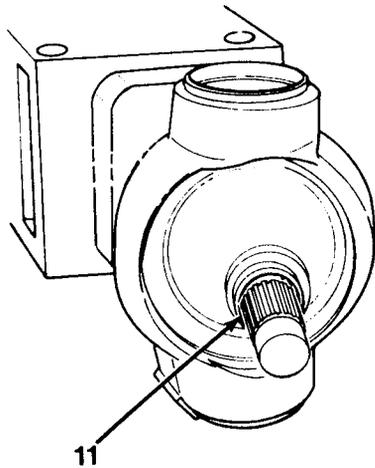


Figure 12-3

! WARNING

Weight of housing assembly is approximately 631 lb (286 kg). Use adequate lifting equipment to lift and support housing assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Place axle housing with input yoke in an upward direction. This will ease installation of trunnion/bearing assemblies.

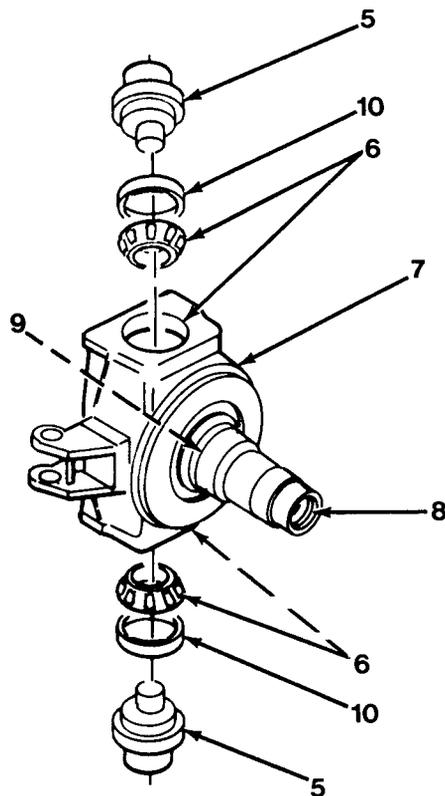


Figure 12-2

2. Install mid-shaft (11, Figure 12-3).
3. If removed, install thrust ring (8) in splined end and shaft bushing (9, Figure 12-2).
4. Grease center bore of pivot and spindle assembly (7).

NOTE

If bearing cups were removed, install them at this time using a bearing installing tool. Apply grease to trunnion bore in axle housing.

5. Pack trunnion bearings (6) with grease.
6. Install new trunnion seals (10) and bearings (6) onto trunnions (5),

WARNING

Weight of pivot and spindle assembly is approximately 67 lb (30 kg). Use adequate lifting equipment to lift and support pivot and spindle assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

7. Install pivot and spindle assembly (7) onto axle housing.
8. Lubricate trunnion bores in pivot and spindle assembly (7).
9. Insert trunnions (5) into axle housing through pivot and spindle assembly (7).

NOTE

Make sure correct shim packs are with comet trunnion/bearing assemblies.

10. Install lower shim packs (4).

CAUTION

Do not torque bolts at this time. Damage to axle could result.

11. Install tie rod lever (3) and four bolts (1) to pivot and spindle assembly (7, Figure 12-1).

NOTE

If axle housing, pivot and spindle assembly or trunnion assemblies have been replaced, shimming must be checked and a preload check must be made. If not, go to step 13.

12. Perform the following procedures to determine the required upper shimming:
 - a. Install all shims (4) supplied in shim kit.
 - b. Install pivot cap (2) and bolts (1). Torque bolts (1) in diagonal pattern to 30 lb-ft (41 N•m), then retorque them in the same pattern, increasing the torque in 2 lb-ft (2.7 N•m) increments until all have been torqued to 35 lb-ft (47 N•m).

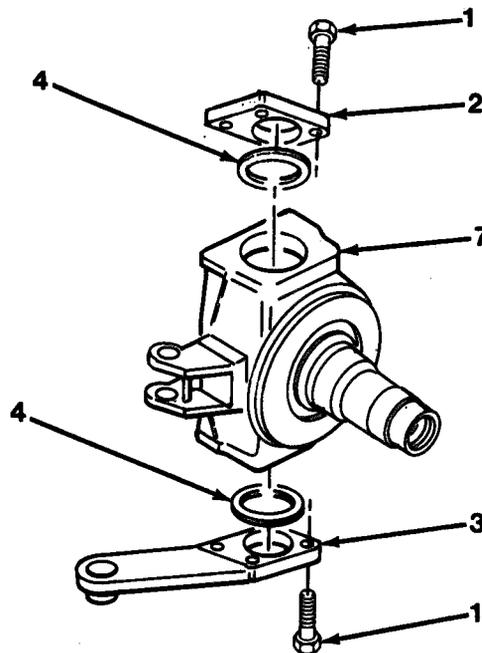


Figure 12-1

PIVOT AND SPINDLE ASSEMBLY INSTALLATION

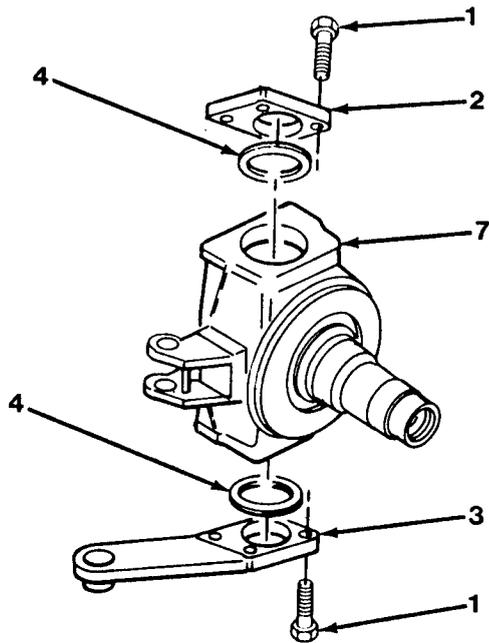


Figure 12-1

c. Move pivot through 5 to 10 complete turns to seat bearing.

d. Using the procedure from step 6, retorque bolts (1, Figure 12-1) to 35 lb-ft (47 N•m).

e. Using a feeler gauge, measure the gap between pivot and spindle assembly (7) and pivot cap (2) on all four sides.

f. The average of the gaps is the amount to be subtracted from shim kit to obtain upper shim pack (4).

g. Remove bolts (1), pivot cap (2) and shim kit (4).

13. Install shim pack (4) onto upper trunnion/bearing assembly.

14. Apply grease to bore of pivot cap (2) and snug pivot cap (2) to pivot and spindle assembly (7) with bolts (1).

15. Torque all bolts (1) to 542 lb-ft (735 N•m).

FRONT DRIVE SHAFT

FRONT DRIVE SHAFT REMOVAL

1. Support front end of drive shaft assembly (4, Figure 12-1).
2. Remove four capscrews (1) from front spider bearing assembly (2).
3. Support rear end of drive shaft assembly (4).
4. Remove four capscrews (1) from rear spider bearing assembly (3, Figure 12-2).
5. Lower drive shaft assembly (4) and remove from under vehicle.

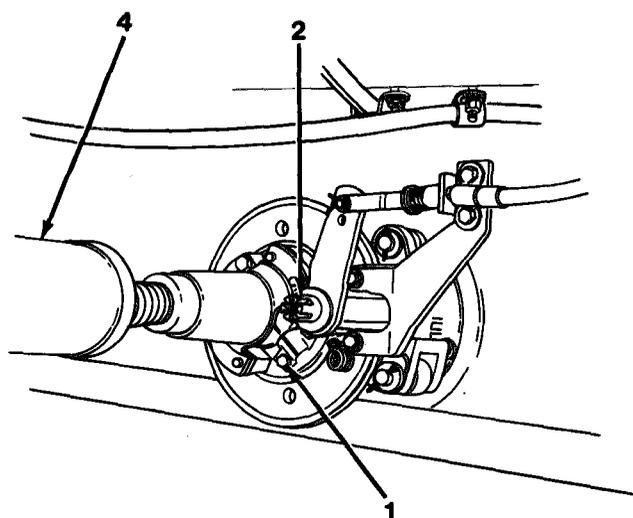


Figure 12-1

FRONT DRIVE SHAFT INSTALLATION

1. Position drive shaft assembly (4, Figure 12-2).
2. Install four capscrews (1) in rear spider bearing assembly (3).
3. Position front end of drive shaft assembly (4).
4. Install four capscrews (1) in front spider bearing assembly (2, Figure 12-1).
5. Torque eight capscrews (1) to 50 lb-ft (68 N•m).

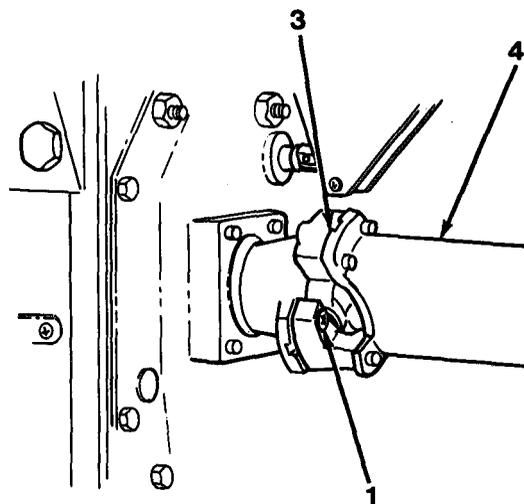


Figure 12-2

FRONT DRIVE SHAFT DISASSEMBLY

1. Remove four capscrews (5) and rear spider bearing assembly (3) from tube assembly (8, Figure 12-3).
2. Remove grease fitting (6).
3. Remove four capscrews (5) and front spider bearing assembly (2, Figure 12-4).
4. Remove two grease fittings (6).
5. Unscrew dust cap (11).
6. Separate slip yoke assembly (7) from tube assembly (8).
7. Remove split washer (9), felt washer (10) and split washer (9).
8. Remove dust cap (11).

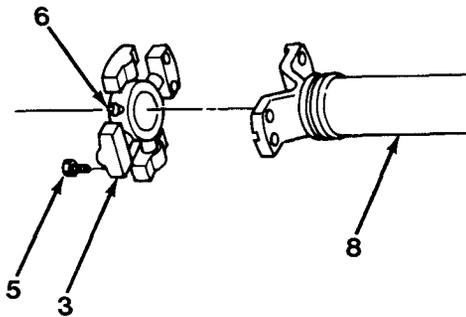


Figure 12-3

FRONT DRIVE SHAFT CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FRONT DRIVE SHAFT ASSEMBLY

1. Install two grease fittings (6, Figure 12-4).
2. Install dust cap (11) on tube assembly (8).
3. Install split washer (9), felt washer (10) and split washer (9) on tube assembly (8).
4. Install tube assembly (8) into slip yoke assembly (7).

5. Tighten dust cap (11).
6. Install front spider bearing assembly (2) and four capscrews (5).
7. Install rear spider bearing assembly (3) and four capscrews (5) to tube assembly (8, Figure 12-3).
8. Install grease fitting (6).
9. Torque eight capscrews (5) to 50 lb-ft (68 N•m).

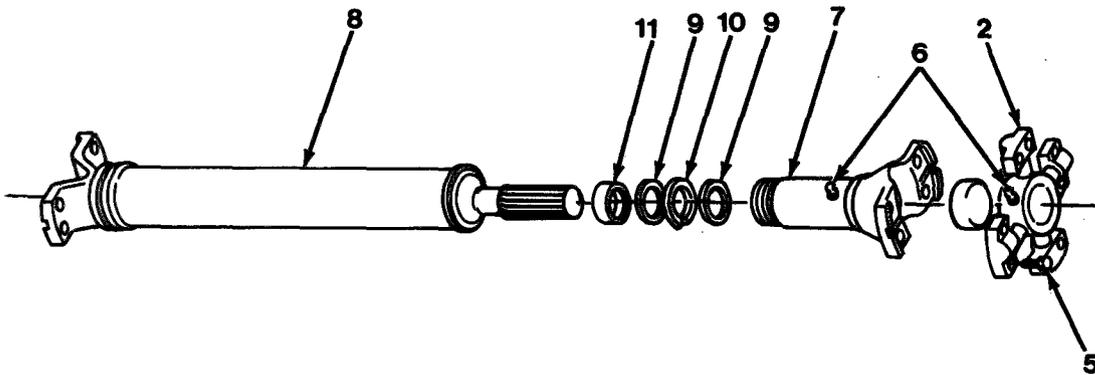


Figure 12-4

REAR DRIVE SHAFT

REAR DRIVE SHAFT REMOVAL

1. Remove four capscrews (1) from front spider bearing assembly (2, Figure 12-1).
2. Remove four capscrews (1) from rear spider bearing assembly (3).
3. Lower drive shaft assembly (4) and remove from under vehicle.

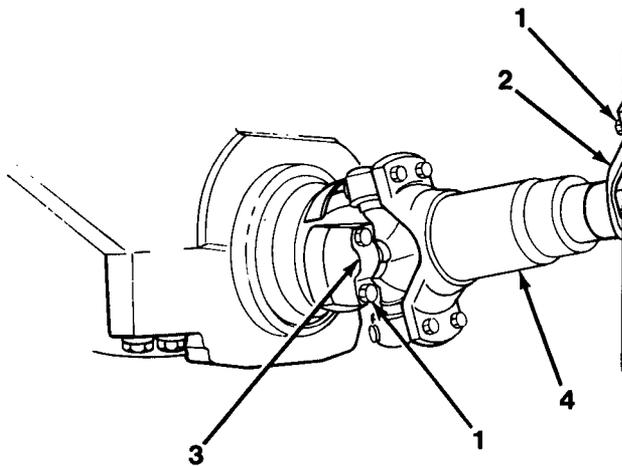


Figure 12-1

REAR DRIVE SHAFT INSTALLATION

1. Position drive shaft assembly (4, Figure 12- 1) under vehicle.
2. Install four capscrews (1) in rear spider bearing assembly (3).
3. Install four capscrews (1) in front spider bearing assembly (2).
4. Torque eight capscrews (1) to 50 lb-ft (68 N•m).

REAR DRIVE SHAFT DISASSEMBLY

1. Remove four capscrews (5) and front spider bearing assembly (2, Figure 12-2).
2. Remove four capscrews (5) and rear spider bearing assembly (3).
3. Unscrew dust cap (10).
4. Separate slip yoke assembly (6) from stub yoke (7).

5. Remove split washer (8), felt washer (9) and split washer (8).
6. Remove dust cap (10).
7. Remove three grease fittings(11).

REAR DRIVE SHAFT CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

REAR DRIVE SHAFT ASSEMBLY

1. Install three grease fittings (11, Figure 12-2).
2. Install dust cap (10) on stub yoke (7).
3. Install split washer (8), felt washer (9) and split washer (8) on stub yoke (7).
4. Install stub yoke (7) into slip yoke assembly (6).
5. Tighten dust cap (10).
6. Install rear spider bearing assembly (3) and four capscrews (5).
7. Install all front spider bearing assembly (2) and four capscrews (5).
8. Torque eight capscrews (5) to 50 lb-ft (68 N•m).

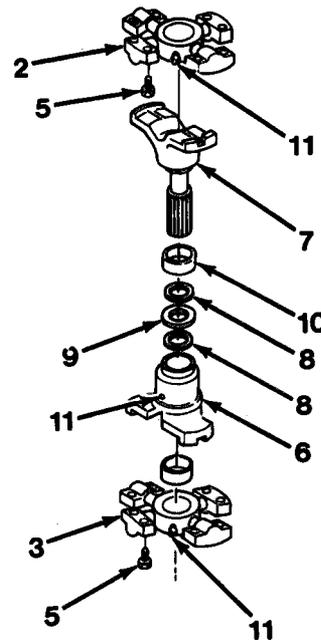


Figure 12-2

CHAPTER 13
HYDRAULIC SYSTEM

Title	Page
Boom Hoist Cylinder	13-1
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BOOM HOIST CYLINDER

BOOM HOIST CYLINDER REMOVAL

1. Start engine. Elevate boom to 30 degrees to allow for removal of hoist cylinder rod end at boom attachment point.

⚠ WARNING

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Block boom to support weight.

⚠ WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Secure boom hoist cylinder (8) in lifting device. Remove capscrew and lockwasher (1), rod (2) and pin (3) from rod end of boom hoist cylinder (8, Figure 13-1).
4. Retract boom hoist cylinder (8) rod by pushing boom hoist lever and retracting boom hoist cylinder (8) approximately 6 in. (152 mm). Shut engine off.

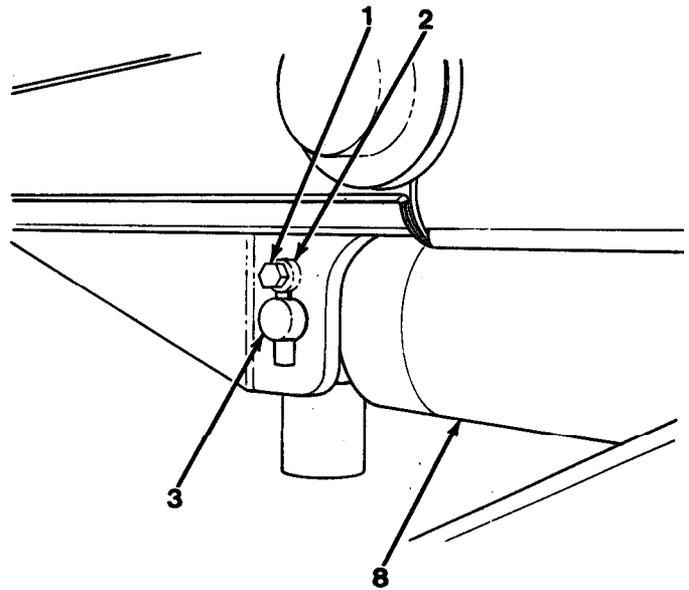


Figure 13-1

BOOM HOIST CYLINDER REMOVAL

WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

5. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

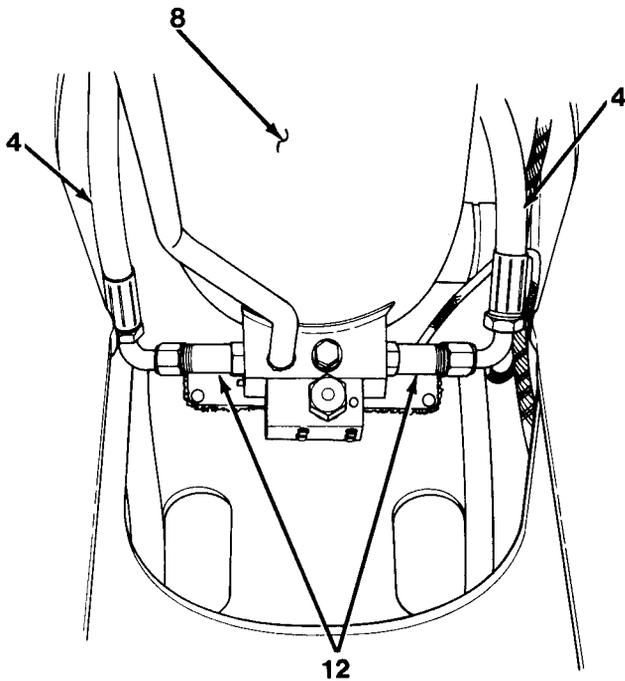


Figure 13-2

6. Disconnect two boom hoist cylinder hoses (4) from adapters (12) on boom hoist cylinder (8, Figure 13-2).
7. Remove capscrew and lockwasher (5), rod (6) and pin (7). Boom hoist cylinder (8, Figure 13-3) is now free. Carefully lift out of upper-structure and move to work area.
8. Lower boom to horizontal position and block.
9. Remove four capscrews (9), lockwashers (10), hold valve and O-rings (11), two adapters (12) and O-rings (13).

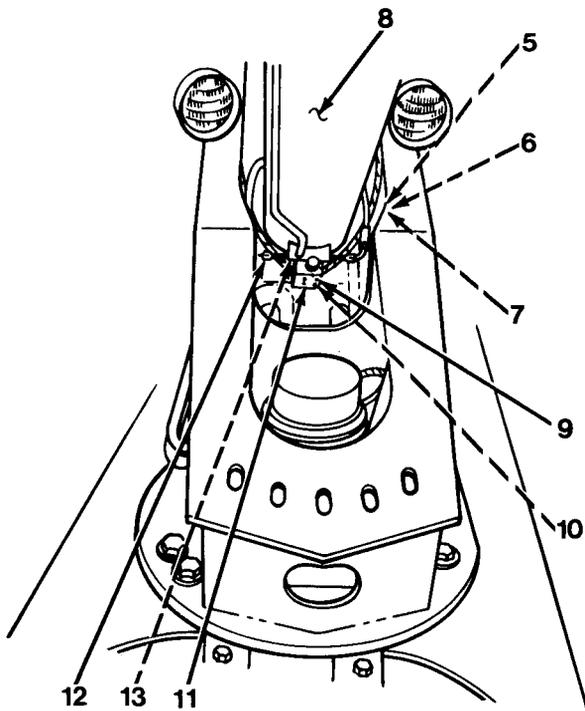


Figure 13-3

BOOM HOIST CYLINDER INSTALLATION

1. Install two O-rings (13) on adapters (12). Position hold valve and O-rings (11) on boom hoist cylinder (8) and install four lockwashers (10), capscrews (9, Figure 13-3) and two adapters (12).

⚠ WARNING

Weight of boom is approximately 3,MI0 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Raise boom to 30 degrees using suitable lifting equipment.

⚠ WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Secure boom hoist cylinder (8) in suitable Ming device. Lift and position boom hoist cylinder (8) in upperstructure. Install pin (7), rod (6) and capscrew and lockwasher (5) in cylinder end of boom hoist cylinder (8).
4. Clean threads of boom hoist cylinder hoses (4) and adapters (12) in boom hoist cylinder (8, Figure 13-2) with primer T.

5. Apply Lode 242 to hoses (4) and adapters (12).
- 60 Install hoses (4) to adapters (12) at a 50-degree angle up from the long axis of the boom hoist cylinder (8).

⚠ WARNING

Stay clear of boom hoist cylinder rod while extending and retracting to remove air. **SERIOUS INJURY** may result if rod jumps unexpectedly.

7. Close dipstick cap. Start engine and slowly extend boom hoist cylinder (8) rod 2 times to remove air trapped in cylinder. Then extend boom hoist cylinder (8) rod to attachment point and shut engine off.
8. Install pin (3), rod eye (2) and capscrew and lockwasher (1) to secure rod end of boom hoist cylinder (8, Figure 13-1).
9. Remove supports from boom hoist cylinder (8).
10. Start engine and check for hydraulic fluid leaks. Shut engine off.
11. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

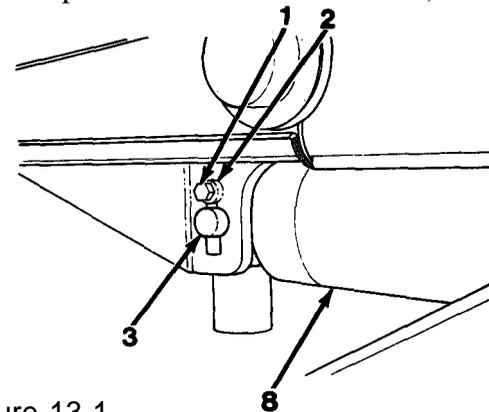


Figure 13-1

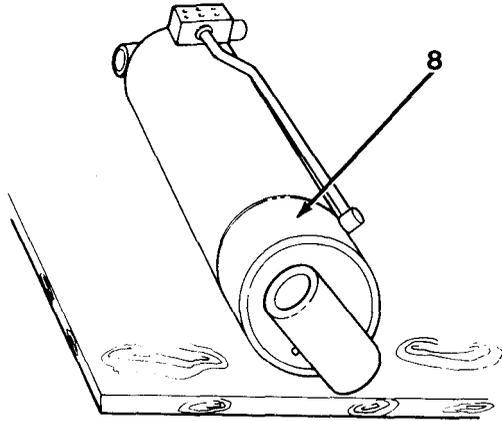


Figure 13-4

BOOM HOIST CYLINDER DISASSEMBLY

1. Place boom hoist cylinder (8, Figure 13-4) in appropriate holding device or fixture.
2. Using spanner wrench, unscrew gland (14) from cylinder tube (15, Figure 13-5).
3. Position suitable container under cylinder hold valve and gland areas and pull rod assembly (16) out of cylinder tube (15).

⚠ WARNING

Heating nut to a temperature of approximately 300 degrees F (149 degrees C) maybe required to break down Loctite. Wear protective equipment while heating and handling parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

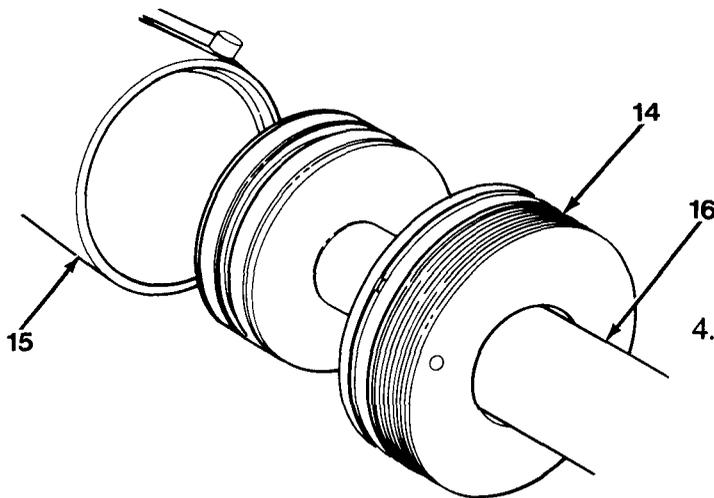


Figure 13-5

4. Remove nut (17), piston (18) and gland (14) from rod assembly (16, Figure 13-6).

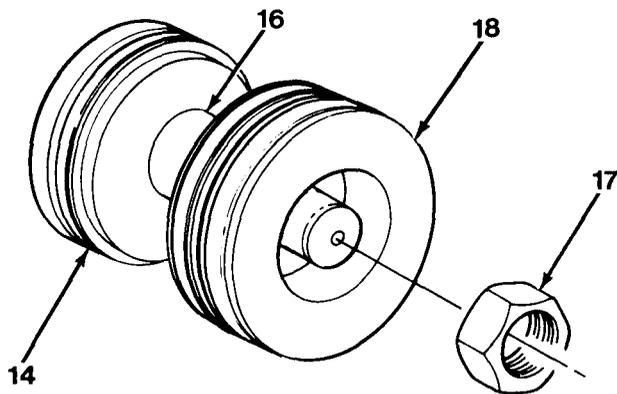


Figure 13-6

NOTE

Piston seal and expander ring should be cut to ease in disassembly,

5. Remove and discard piston seal (19) and square expander ring (20, Figure 13-7).
6. Remove two wear rings (21) from outside diameter of piston (18).
7. Remove O-ring (22) from inside diameter of piston (18).
8. Remove O-ring (23) and back-up ring (24) from outside diameter of gland (14, Figure 13-8).
9. Remove rod wiper (25) and rod seal (26) from inside of gland (14).

CAUTION

Removal of bushings may cause destruction of bushings. Remove bushings only if inspection indicates replacement is necessary.

10. Remove four bushings (27, Figure 13-9), if necessary.

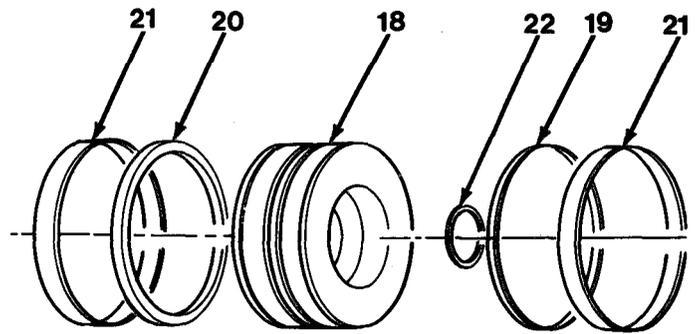


Figure 13-7

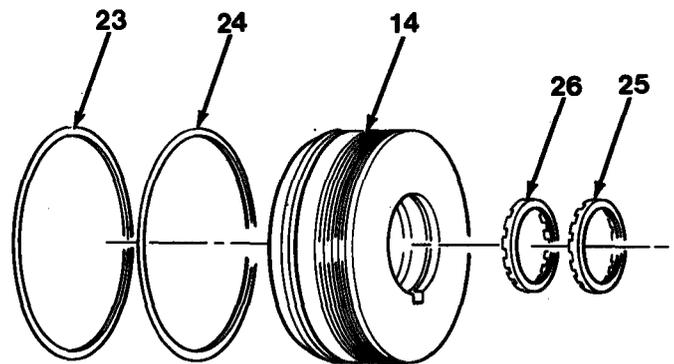


Figure 13-8

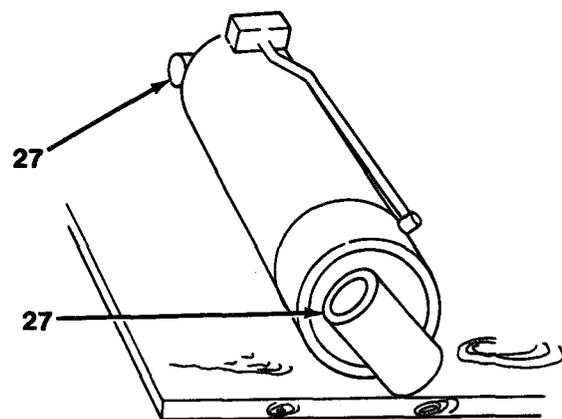


Figure 13-9

BOOM HOIST CYLINDER CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).
3. Inspect boom hoist cylinder bushing. Maximum I.D. is 2.543 in. (64.59 mm). If I.D. is more than limit, replace boom hoist cylinder bushing.
4. Inspect boom hoist cylinder base pin. Minimum O.D. is 2.474 in. (62,84 mm). If O.D. is less than limit, replace boom hoist cylinder base pin.

BOOM HOIST CYLINDER ASSEMBLY**⚠ WARNING**

Liquid nitrogen is extremely cold, having a temperature of -320 degrees F (-195 degrees C). Skin contact with liquid nitrogen or with an object cooled by liquid nitrogen will result in **SEVERE INJURY**. Wear protective gloves that will not absorb liquid nitrogen. Excess liquid nitrogen must be disposed of promptly since liquid nitrogen will condense oxygen from the atmosphere. The mixture of liquid nitrogen and liquid oxygen is a powerful oxidizer and may react violently with easily oxidizable substances.

NOTE

Cool bushings (27, Figure 13-9), if removed, in liquid nitrogen to cool them. Apply Loctite RC680 and install four bushings (27).

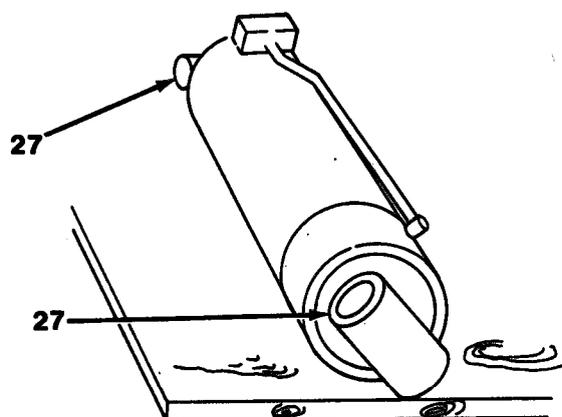


Figure 13-9

1. Submerge four bushings (27, Figure 13-9), if removed, in liquid nitrogen to cool them. Apply Loctite RC680 and install four bushings (27).

BOOM HOIST CYLINDER ASSEMBLY

CAUTION

Rod seal is installed with open end and lips toward the interior of cylinder. Rod wiper is installed with lip toward the outside of cylinder. Use care to avoid nicking or scratching seal lips. Failure to follow this procedure could cause damage to equipment.

NOTE

Coat all internal parts with clean hydraulic oil before assembling.

2. Install rod seal (26) and rod wiper (25) inside gland (14, Figure 13-8).
3. Install back-up ring (24) and O-ring (23) on outside diameter of gland (14).
4. Install O-ring (22) on inside diameter of piston (18, Figure 13-7).

CAUTION

Do not allow piston seal to twist in seal groove. Piston seal can be made pliable by soaking in 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

5. Install two wear rings (21), square expander ring (20) and new piston seal (19) on outside diameter of piston (18).

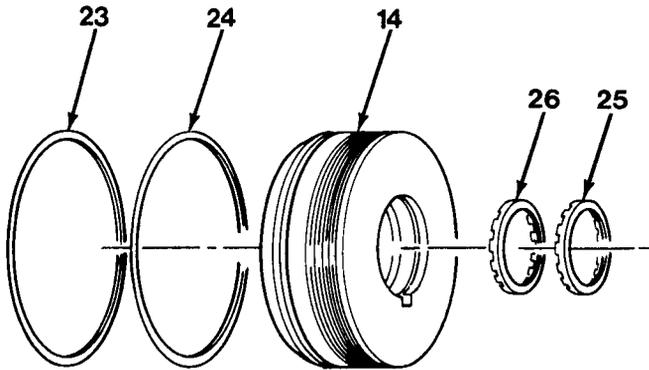


Figure 13-8

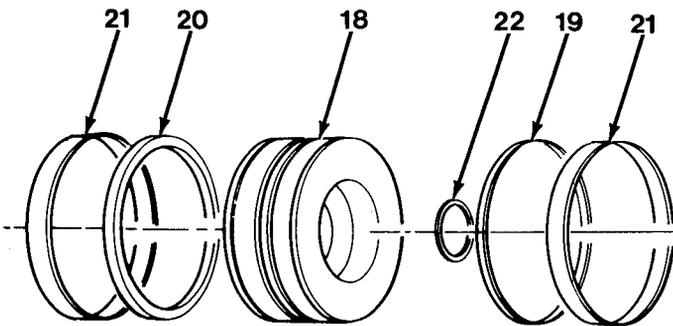


Figure 13-7

6. Install piston (18) and gland (14) on rod assembly (16, Figure 13-6).
7. Apply Loctite 277 to threads on rod assembly (16). Install nut (17) and torque to 250 lb-ft (339 N•m).
8. Install assembled rod assembly (16) in cylinder tube (15). Screw gland (14, Figure 13-5) in cylinder tube (15). Tighten with spanner wrench.
9. Push rod assembly (16) all the way into cylinder tube (15).

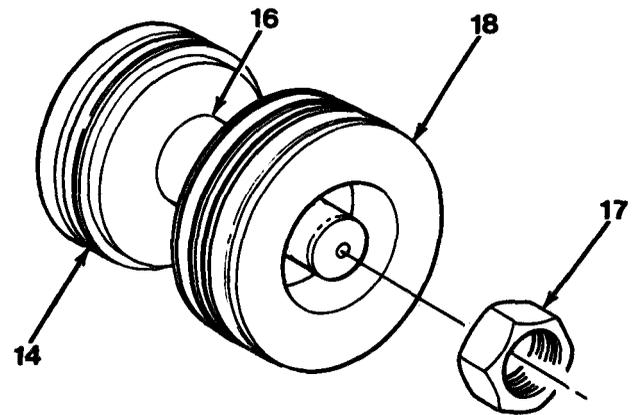


Figure 13-6

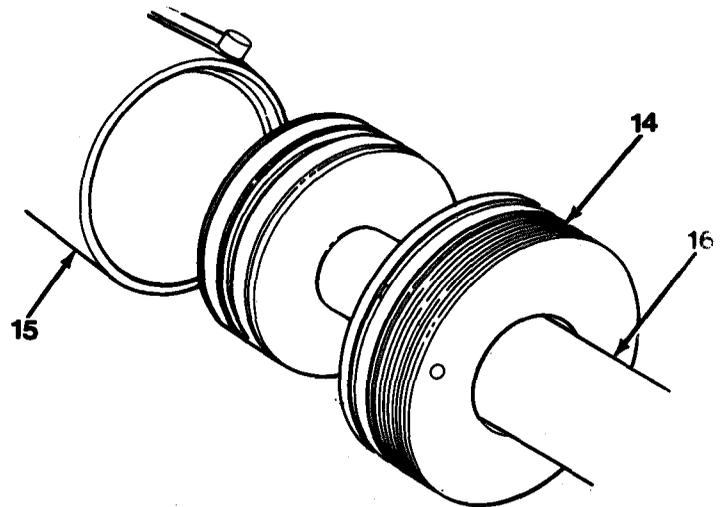


Figure 13-5

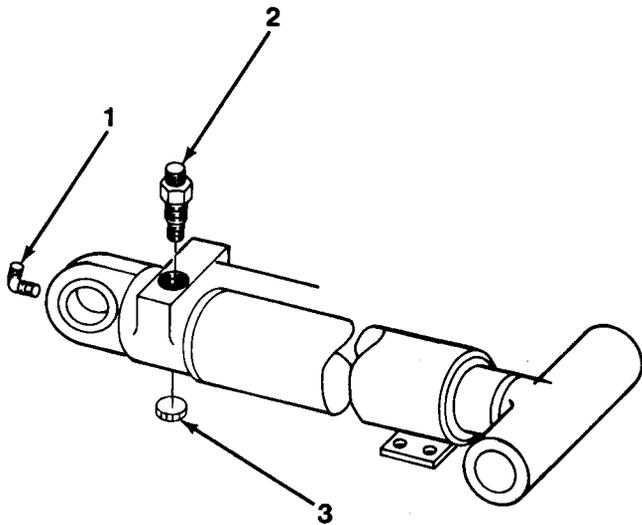


Figure 13-1

BOOM EXTEND CYLINDER

BOOM EXTEND CYLINDER REMOVAL

1. Remove boom (refer to page 15-1).
2. Disassemble boom (refer to page 15-6).

BOOM EXTEND CYLINDER INSTALLATION

1. Assemble boom (refer to page 15-9).
2. Install boom (refer to page 15-4).

BOOM EXTEND CYLINDER DISASSEMBLY

1. Remove grease zerker (1, Figure 13-1).
2. Position suitable container under counterbalance valve (2) area and remove counterbalance valve (2) and plug (3).
3. Pull rod assembly (21) half way out of cylinder case (4, Figure 13-2).
4. Place support under outer end of rod assembly (21).

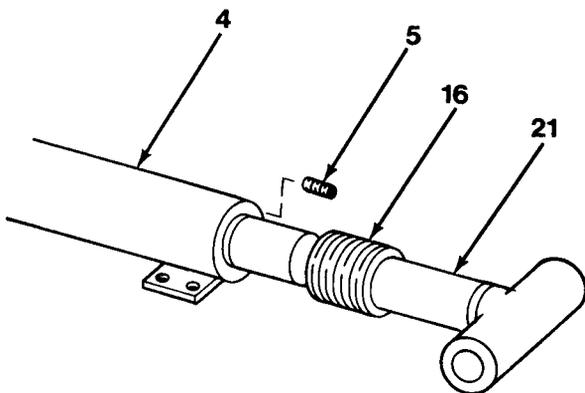


Figure 13-2

CAUTION

Head gland should unscrew freely. If, after several turns, a bind is noticed, STOP: DO NOT FORCE THREADS. Place a "C" clamp over threaded end of cylinder case in line with port tube. Gradually draw down "C" clamp until head gland can be unscrewed easily. Failure to follow this procedure could cause damage to equipment. The reason for an occasional bind is due to the fact that heat generated from welding of port tube to cylinder case may cause a slight cylinder case eccentricity. This most generally occurs when boom extend cylinder has been in service for only a short period of time. Extended service stress relieves the weld and improves concentricity. This same procedure can be used in reassembly if a bind occurs when installing head gland.

5. Remove setscrew (5) from cylinder case (4).
6. Using spanner wrench, unscrew head gland (16).

NOTE

Be sure head gland threads are fully disengaged from cylinder case threads.

7. Pull assembled rod assembly (21) out, gently bumping head gland (16), forcing head gland (16) out of cylinder case (4).

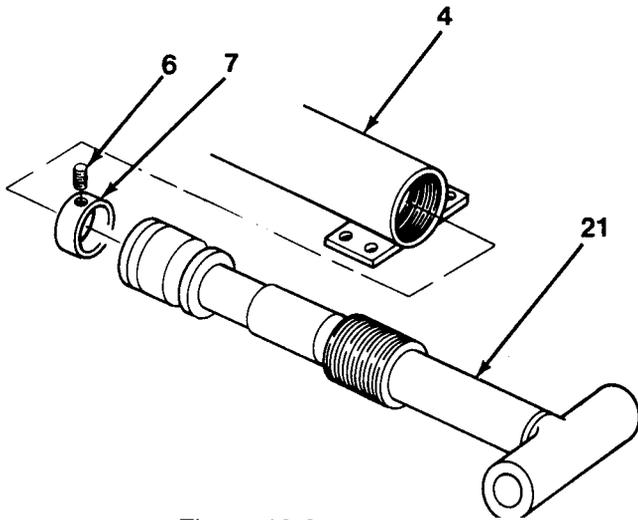


Figure 13-3

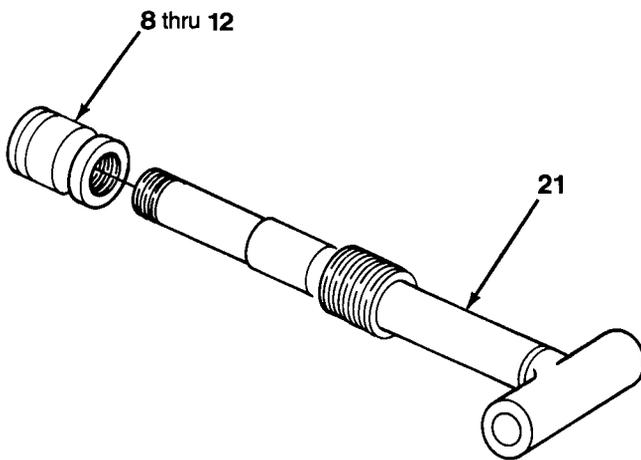


Figure 13-4

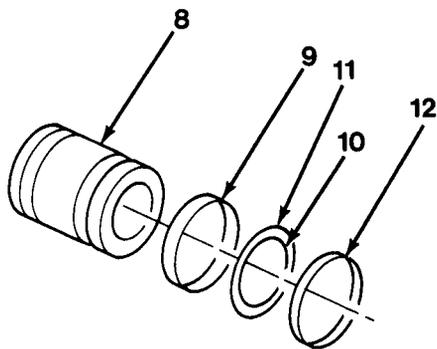


Figure 13-5

BOOM EXTEND CYLINDER DISASSEMBLY

CAUTION

Once head gland has cleared cylinder case mouth, rod assembly must be supported close to cylinder case prior to piston being pulled past cylinder case threads to avoid damage to cylinder case threads and/or piston seals,

8. Pull cylinder rod (21) completely out of cylinder case (4, Figure 13-3).
9. Remove two Nylok setscrews (6) from butress ring nut (7).
10. Using chain or strap wrench, remove butress ring nut (7).
11. Remove items 8 thru 12 as an assembly from cylinder rod (21, Figure 13-4).

NOTE

Piston seal and O-ring should be cut to ease disassembly.

12. Remove wear ring (9), O-ring (10), piston seal (11) and piston ring (12) from piston (8, Figure 13-5).

13. Remove two back-up rings (13) and O-ring (14) from piston (8, Figure 13-6).
14. Remove spacer (15) from rod assembly (21, Figure 13-7).
15. Remove items 16 thru 20 as an assembly from rod assembly (21, Figure 13-8).
16. Remove back-up ring (17) and O-ring (18) from head gland (16, Figure 13-9).

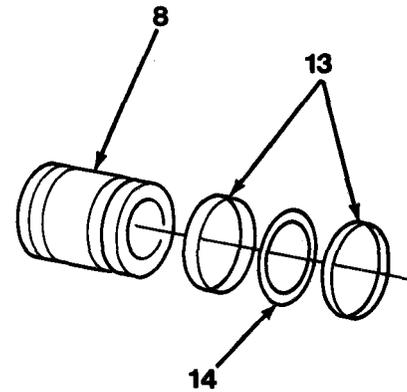


Figure 13-6

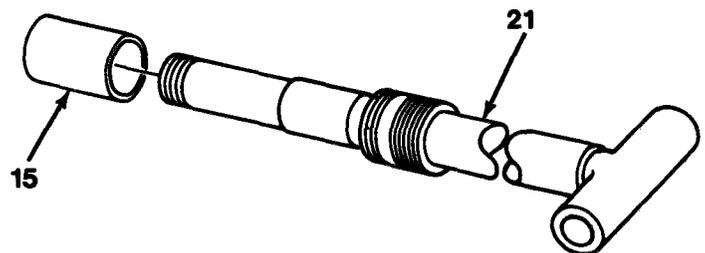


Figure 13-7

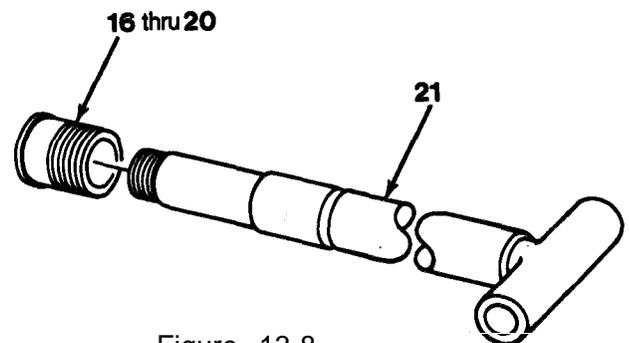


Figure 13-8

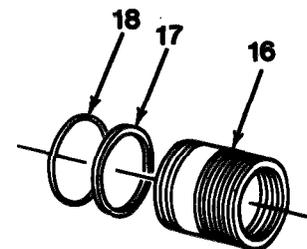


Figure 13-9

**BOOM EXTEND CYLINDER
DISASSEMBLY**

17. Remove wiper (19) and U-cup seal (20) from head gland (16, Figure 13- 10).

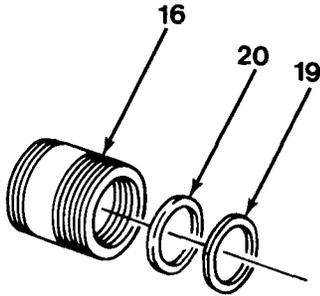


Figure 13-10

**BOOM EXTEND CYLINDER CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts for wear, burrs, nicks and corrosion. Replace worn or damaged parts.
3. Polish metal surfaces having minor blemishes with fine crocus cloth.
4. Coat all parts with clean hydraulic oil.

BOOM EXTEND CYLINDER ASSEMBLY

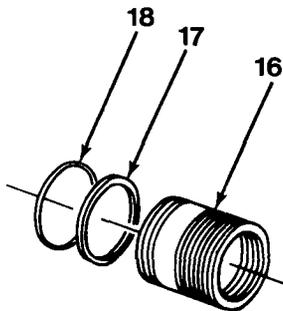


Figure 13-9

Two seal lips of U-cup seal must point toward inside of cylinder case, and wiper seal lips must point toward outside of cylinder case. Use care to avoid nicking or scratching seal lips. Failure to follow this procedure could cause damage to equipment.

NOTE

Lubricate all parts with clean hydraulic oil.

1. Install U-cup seal (20) and wiper (19) in head gland (16, Figure 13-10).
2. Install back-up ring (17) and O-ring (18) on head gland (16, Figure 13-9) with O-ring (18) towards inside of cylinder case.

3. Install items 16 thru 20 as an assembly on rod assembly (21, Figure 13-8).
4. Install spacer (15) on rod assembly (21, Figure 13-7).
5. Install O-ring (14) and two back-up rings (13) in piston (8, Figure 13-6).

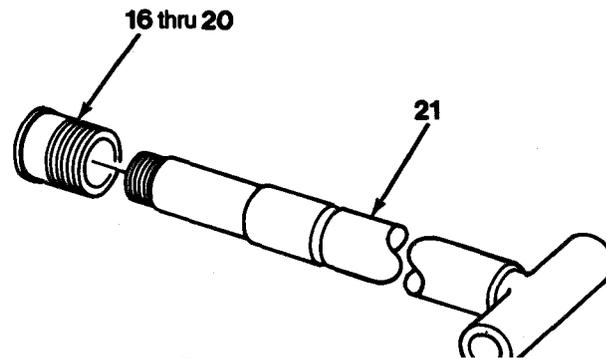


Figure 13-8

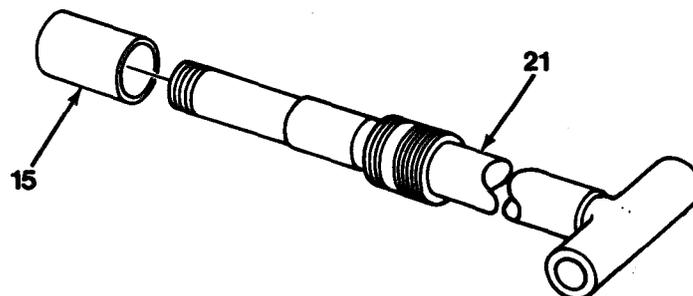


Figure 13-7

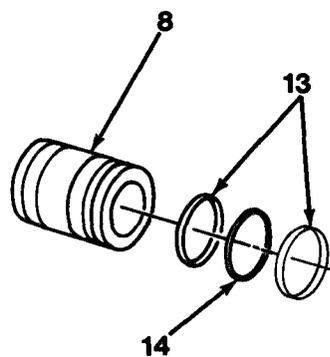


Figure 13-6

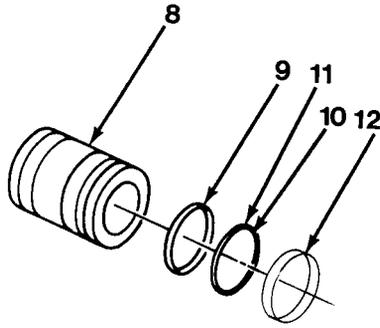


Figure 13-5

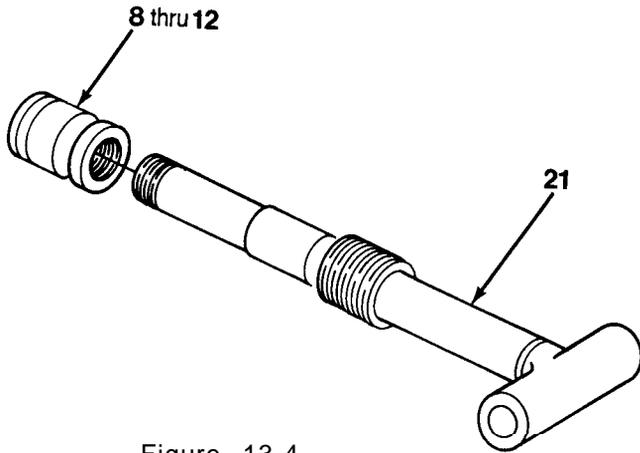


Figure 13-4

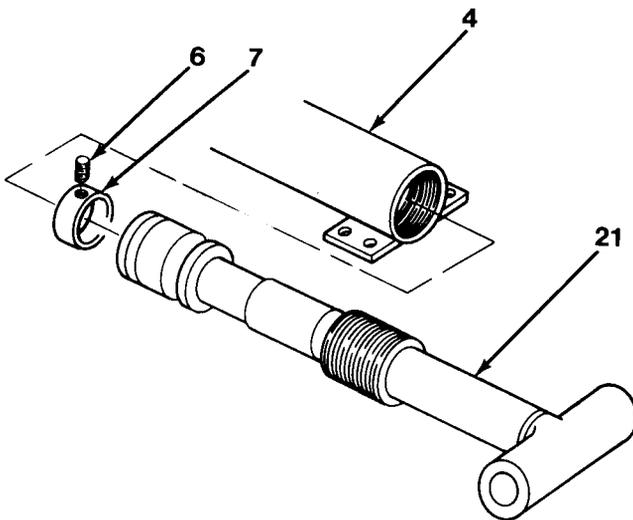


Figure 13-3

BOOM EXTEND CYLINDER ASSEMBLY

CAUTION

Do not allow piston seal to “twist” in seal groove. Piston seal can be made pliable to aid in installation by soaking in 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

6. Install O-ring (10) and piston seal (11) on piston (8, Figure 13-5).
7. Install piston ring (12) and wear ring (9) on piston (8).
8. Install items 8 thru 12 as an assembly on rod assembly (21, Figure 13-4).
9. Install and tighten buttress ring nut (7) on rod assembly (21, Figure 13-3).
10. Install two Nylok setscrews (6).

CAUTION

- Use extreme caution in slipping piston and piston rings past cylinder mouth threads to avoid damage to piston seals or case threads.
- Make sure the outer end of cylinder threads are properly lubricated before attempting to screw head gland into cylinder case. Use caution to avoid cutting O-ring on head gland as it is slipped past threads in cylinder case. After boom extend cylinder has been assembled, rod assembly should be pushed all the way in (fully retracted) prior to the installation of counterbalance valve. Failure to follow this procedure could cause damage to equipment.

NOTE

- Before attempting to start piston into cylinder case, carefully oil cylinder threaded area and piston. The mouth of cylinder case is chamfered immediately behind the threaded area to compress piston rings during assembly. It may be necessary to oscillate the outer end of cylinder rod to cause rings to compress as they enter the chamfered portion of cylinder case.
- If piston seal has been overly

stretched during installation onto piston, it may be necessary to shrink this seal into its groove in order to get piston to enter cylinder case. This can be accomplished in either of the following ways:

- a. Place a piston ring compressor over seal and leave compressed for several hours prior to assembly of cylinder.
- b. Freeze or chill seal by using either a CO₂ type fire extinguisher or dry ice prior to installing piston into cylinder case.

11. Install assembled rod assembly (21) in cylinder case (4, Figure 13-2).
12. Using spanner wrench, install head gland (16) in cylinder case (4).
13. Tighten setscrew (5).

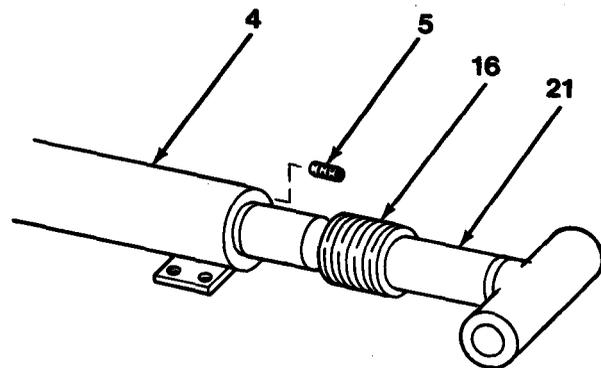


Figure 13-2

BOOM EXTEND CYLINDER ASSEMBLY

14. Install plug (3) and counterbalance valve (2, Figure 13-1).

15. Install grease zerk (1).

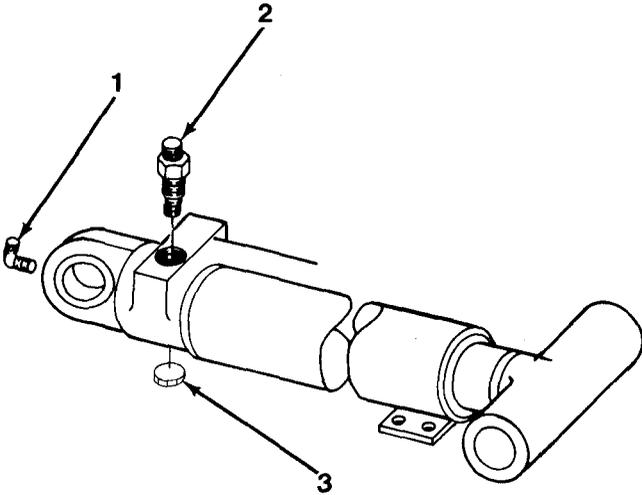


Figure 13-1

AXLE LOCKOUT CYLINDER**AXLE LOCKOUT CYLINDER REMOVAL****NOTE**

The following is a maintenance procedure for one axle lockout cylinder assembly. The maintenance procedure for the remaining axle lockout cylinders assemblies is identical.

1. Start engine. Center boom over cab.
2. Using outrigger, raise rear of carrier up until tire is off ground. Place jackstands under axle. Shut engine off.
3. Open engine housing for access to cylinder hose fittings.

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
5. Disconnect and cap hose (1, Figure 13-1).

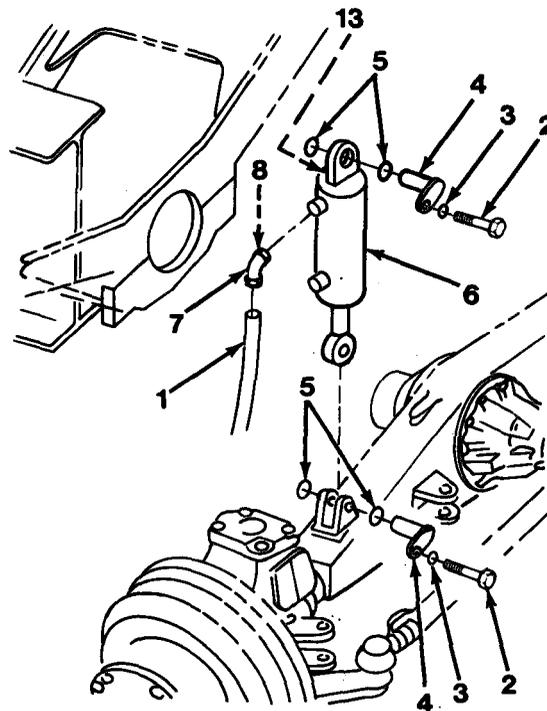


Figure 13-1

AXLE LOCKOUT CYLINDER REMOVAL

6. Support cylinder (6), and remove capscrew (2) and washer (3, Figure 13- 1) from each pin (4).
7. Using brass or soft metal punch, drive out bottom pin (4). Drive out top pin (4). Remove two washers (5) from each pin (4).
8. Remove cylinder (6) from carrier.
9. Remove elbow (7) and O-ring (8) from cylinder (6).

AXLE LOCKOUT CYLINDER INSTALLATION

1. Install O-ring (8) and elbow (7) on cylinder (6, Figure 13-1).
2. Set cylinder (6) into position.
3. Align cylinder (6) bottom mounting holes with axle. Install one of two washers (5), pin (4) and remaining washer (5). Secure pin (4) with washer (3) and capscrew (2).
4. Align remaining cylinder (6) mounting hole with frame. Install one washer (5), pin (4) and remaining washer (5). Secure with washer (3) and capscrew (2).
5. Connect hydraulic hose (1).
6. Close dipstick cap and start engine. Slightly open bleeder screw (13) to bleed air from axle lockout cylinders. Check for leaks.
7. Remove jackstands supporting axle and lower carrier to ground using outrigger. Shut engine off.
8. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

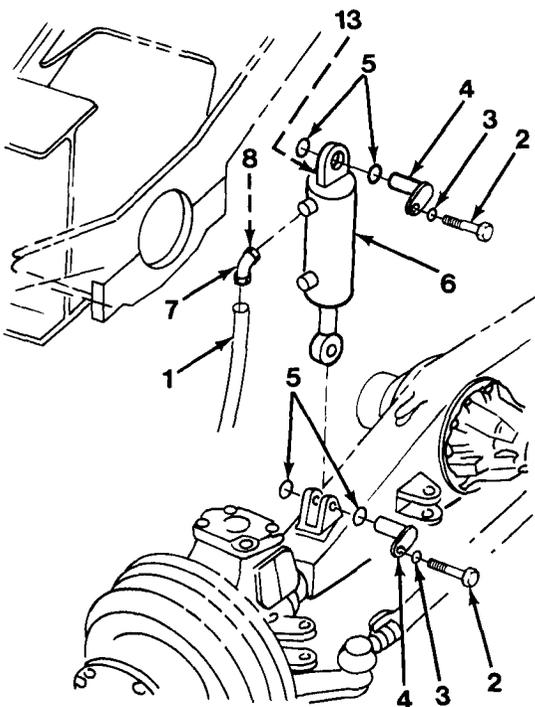


Figure 13-1

AXLE LOCKOUT CYLINDER DISASSEMBLY

1. Remove two grease fittings (9, Figure 13-2).
2. Remove breather port (10) and O-ring (11) from barrel assembly (31).
3. Remove bleeder screw (12) and O-ring (13) from barrel assembly (31).
4. Remove two setscrews (14) from cap (15).
5. Remove cap (15) from barrel assembly (31), using chain or strap wrench.

6. Position pan under barrel assembly (31) and carefully pull rod assembly (16) from barrel assembly (31).

WARNING

Heating nut to a temperature of 300 degrees F (149 degrees C) may be required to break down Loctite. Wear protective equipment while heating and handling parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

7. Remove nut (17) from rod assembly (16).
8. Remove piston (18) from rod assembly (16).

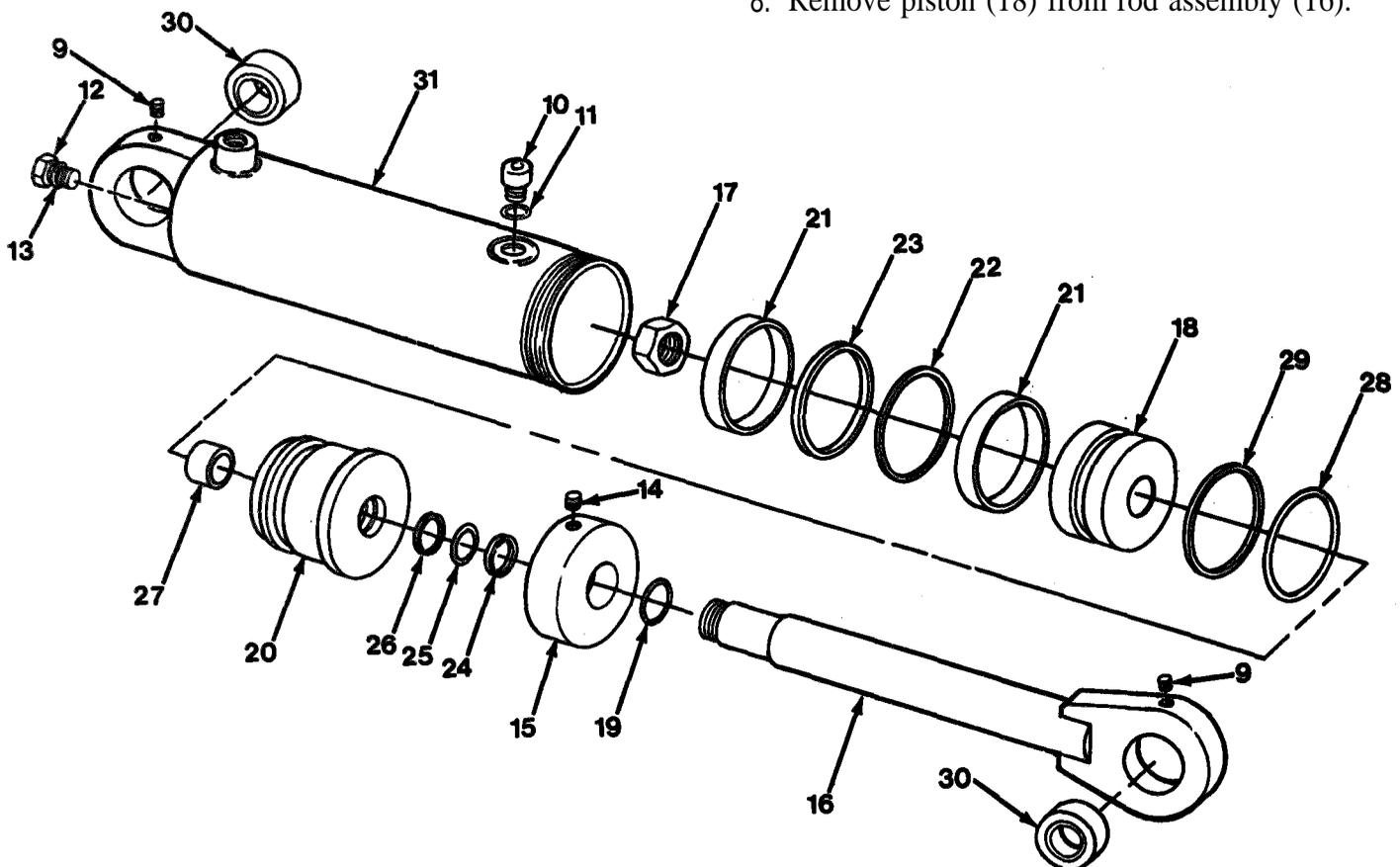


Figure 13-2

**AXLE LOCKOUT CYLINDER
DISASSEMBLY**

9. Remove O-ring (19) from rod assembly (16, Figure 13-2).
10. Remove sleeve (20) from rod assembly (16).
11. Remove cap (15) from rod assembly (16).
12. Remove two wear rings (21), piston seal (22) and load ring (23).
13. Remove rod wiper (24), back-up ring (25), O-ring (26), sleeve wear ring (27), O-ring (28) and back-up ring (29) from sleeve (20).

CAUTION

Removal of bearings may cause destruction of bearings. Remove bearings only if inspection indicates replacement is necessary.

14. Remove two bearings (30), if necessary.

**AXLE LOCKOUT CYLINDER CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

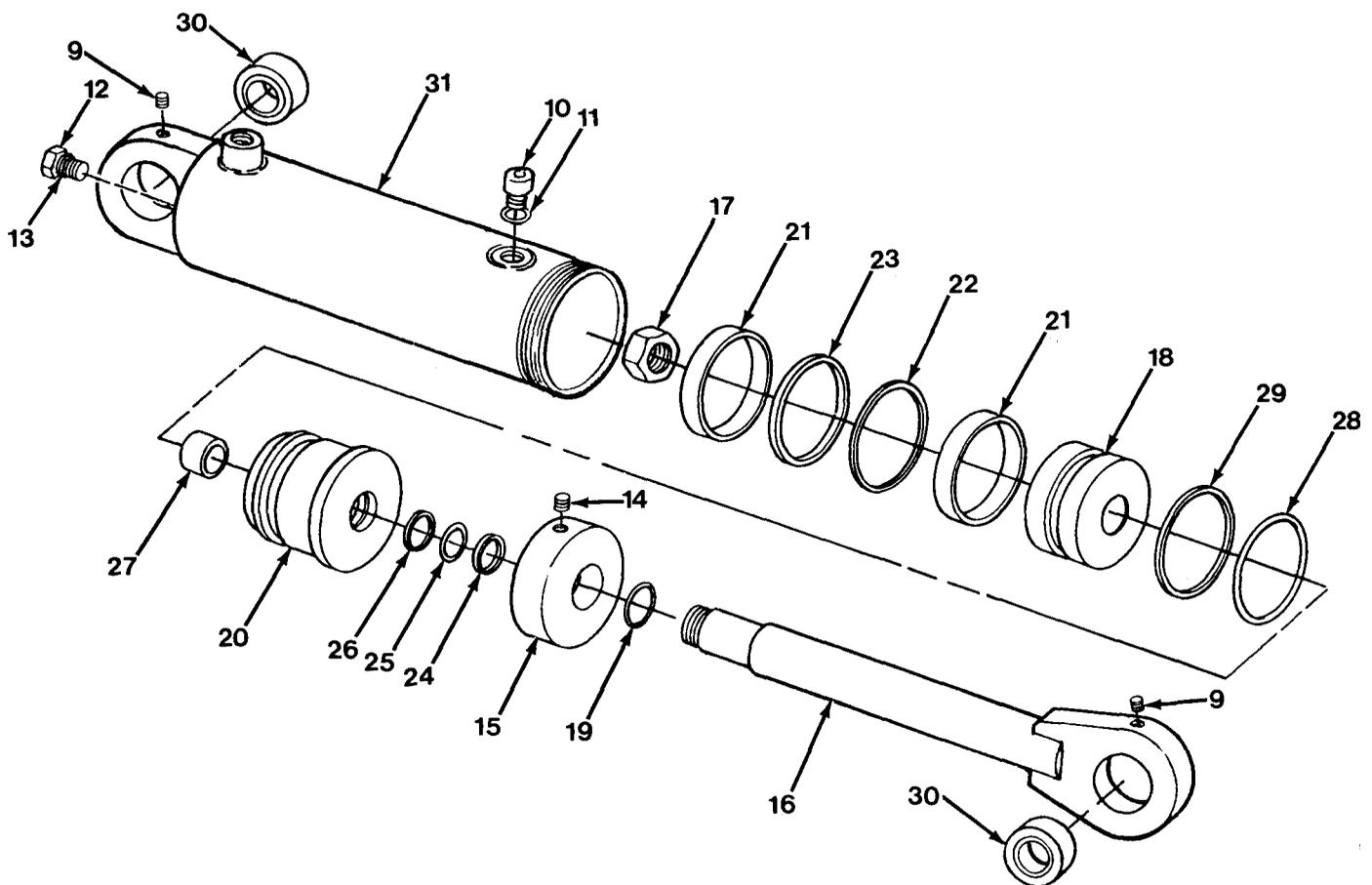


Figure 13-2

AXLE LOCKOUT CYLINDER ASSEMBLY

NOTE

Before assembly of axle lockout cylinder, coat all internal parts with clean hydraulic oil.

1. Install O-ring (26), back-up ring (25) in sleeve (20, Figure 13-2).
2. Install rod wiper (24) in top of sleeve (20) with lip toward outside.
3. Install sleeve wear ring (27) through groove end of sleeve (20).
4. Install back-up ring (29) and O-ring (28) on sleeve (20).

Do not allow piston seal to “twist” in seal groove. Piston seal can be made pliable to aid in installation by soaking in 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

5. Install load ring (23) and piston seal (22) on piston (18).

6. Install two piston wear rings (21) on piston (18).
7. Install bearings (30) in rod assembly (16) and band assembly (31), if removed.
8. Install cap (15) on rod assembly (16).

NOTE

Lubricate sleeve internal diameter with clean hydraulic oil before installation of remaining parts.

9. Install assembled sleeve (20) on rod assembly (16).
10. Install O-ring (19) on rod assembly (16).

NOTE

Lubricate piston internal diameter before installing.

11. Install assembled piston (18) on rod assembly (16). Seat piston recess on O-ring (19).
12. Apply Loctite 272 to threads on shaft of rod assembly (16) and install nut (17). Torque nut (17) to 250 lb-ft (339 N•m).

AXLE LOCKOUT CYLINDER ASSEMBLY

NOTE

Lubricate barrel assembly internal diameter, piston and sleeve outside diameter before further assembly.

13. Slide rod assembly (16) into barrel assembly (31, Figure 13-2).

14. Tighten cap (15) on barrel assembly (12).

15. Install and tighten two setscrews (14).

16. Install O-ring (13) on bleeder screw (12) and install in barrel assembly (31).

17. Install O-ring (11) on breather port (10) and install in barrel assembly (31).

18. Install grease fittings (9) in barrel assembly (31).

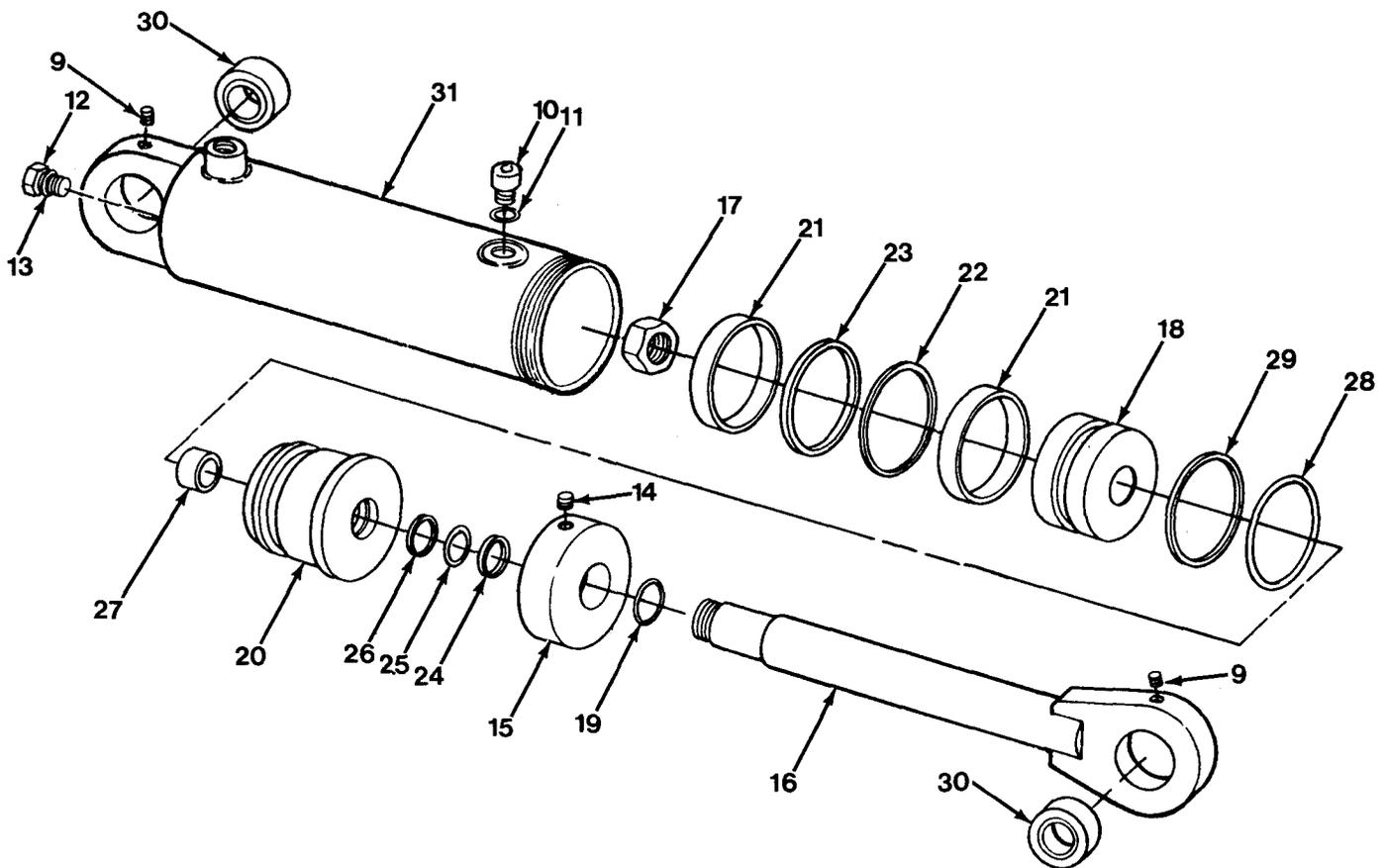


Figure 13-2

OUTRIGGER CYLINDER ASSEMBLY

OUTRIGGER CYLINDER ASSEMBLY REMOVAL

NOTE

The following is a maintenance procedure for one outrigger cylinder assembly. The maintenance procedure for the remaining outrigger cylinder assemblies is identical.

1. Fully extend and lower outriggers (refer to Koehring Commercial Operation Instructions manual). Position jackstands under axles and lower carrier onto jackstands.
2. Support outrigger beam and outrigger cylinder assembly (11, Figure 13-1) with wood blocks.
3. Using a punch, remove pin (1) by driving through pin (2).
4. Using a brass drift pin, remove pin (2) by driving pin through beam.
5. Start engine. Retract outrigger cylinder rod into outrigger cylinder assembly (11). Shut engine off.

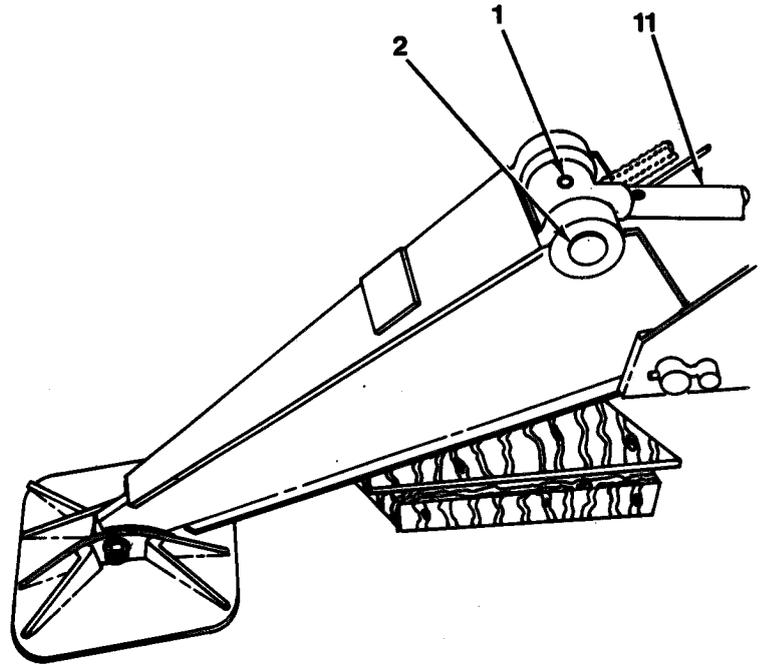


Figure 13-1

OUTRIGGER CYLINDER ASSEMBLY REMOVAL

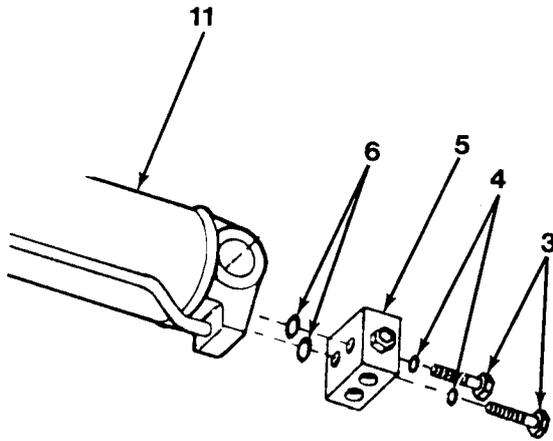


Figure 13-2

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

6. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

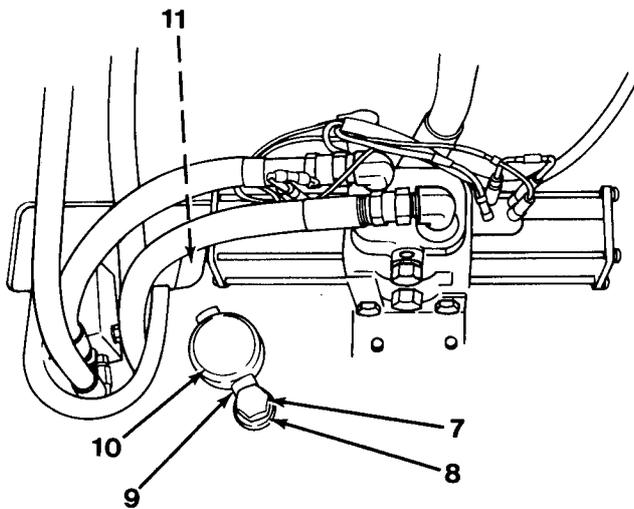


Figure 13-3

7. Remove two cap screws (3), lockwashers (4), hold valve (5) and two O-rings (6, Figure 13-2).
8. Remove cap screw (7), lockwasher (8) and rod end (9, Figure 13-3).
9. Using a brass drift pin, remove pin (10) by driving pin through frame, inside cab.

⚠ WARNING

Weight of outrigger cylinder assembly is approximately 125 lb (57 kg). Use adequate lifting equipment to lift and support outrigger cylinder assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause **DEATH** or serious injury.

- Using hoist and sling, remove outrigger cylinder assembly (11).

OUTRIGGER CYLINDER ASSEMBLY INSTALLATION

⚠ WARNING

Weight of outrigger cylinder assembly is approximately 125 lb (57 kg). Use adequate lifting equipment to lift and support outrigger cylinder assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

- Using hoist and sling, install outrigger cylinder assembly (11, Figure 13-3).
- Install pin (10) through frame and outrigger cylinder assembly (11).
- Install rod end (9), lockwasher (8) and cap-screw (7).
- Position two O-rings (6) on hold valve (5) and install with two lockwashers (4) and cap-screws (3, Figure 13-2).
- Start engine. Extend outrigger cylinder rod to align outrigger cylinder rod end with beam. Check for leaks. Shut engine off.
- Install pin (2, Figure 13-1) and drive pin into beam.
- Install pin (1) into pin (2).
- Remove wood blocks supporting outrigger beam and cylinder assembly (11).

- Raise carrier using outriggers (refer to Koehring Commercial Operation Instructions manual). Remove jackstands and lower carrier to the ground using outriggers.
- Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

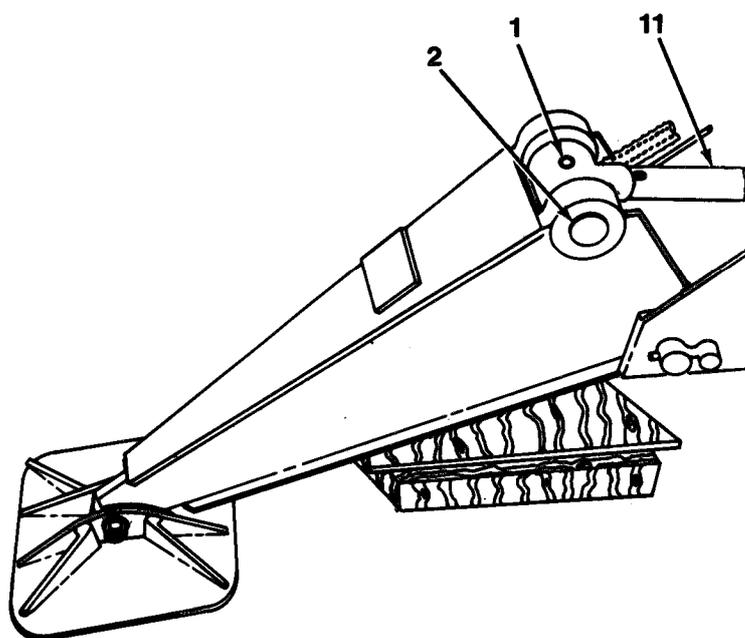


Figure 13-1

OUTRIGGER CYLINDER ASSEMBLY DISASSEMBLY

1. Using spanner wrench, unscrew gland (12) from cylinder barrel (26, Figure 13-4).
2. Position containers under hold valve mounting block and cylinder mouth to catch oil and slowly remove assembled rod (13).

⚠ WARNING

Heating nut to approximately 300 degrees F (149 degrees C) may be required to break down Loctite. Wear protective equipment while heating and handling parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

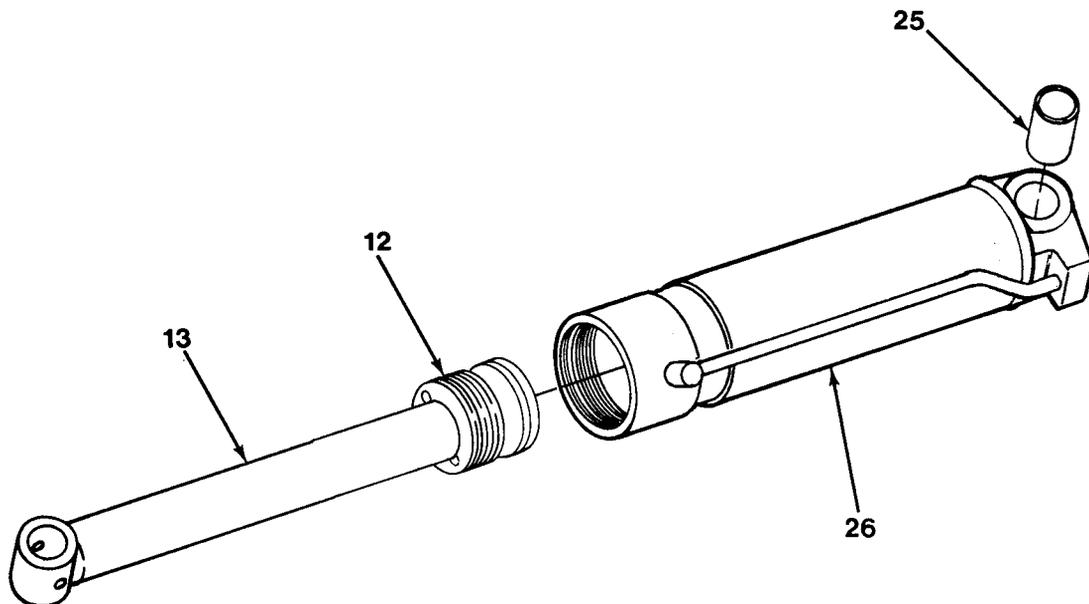


Figure 13-4

3. Remove retaining nut (14, Figure 13-5).
4. Remove piston (15) and gland (16) from rod (13).

NOTE

Piston seal and expander ring should be cut to ease disassembly.

5. Remove seal (17), expander ring (18) and two wear rings (19) from outside of piston (15, Figure 13-6).
6. Remove O-ring (20) from inside of piston (15).
7. Remove Cl-ring (21) and back-up ring (22) from outside of gland (16, Figure 13-7).
8. Remove rod wiper (23) and poly-pak seal (24) from inside of gland (16).

CAUTION

Removal of bushings may cause destruction of bushings. Remove bushings only if inspection indicates replacement is necessary.

9. Remove two bushings (25) from base end of cylinder barrel (26, Figure 13-4), if necessary.

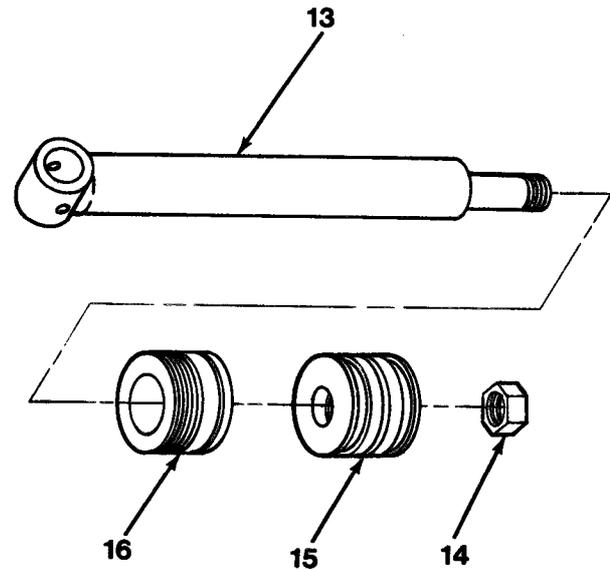


Figure 13-5

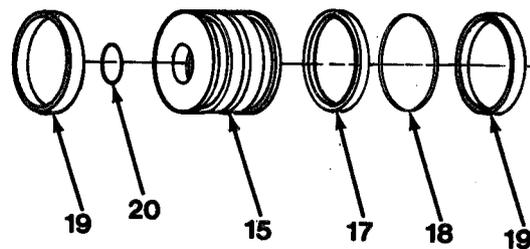


Figure 13-6

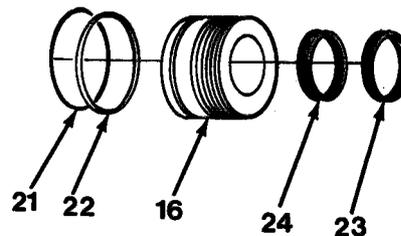


Figure 13-7

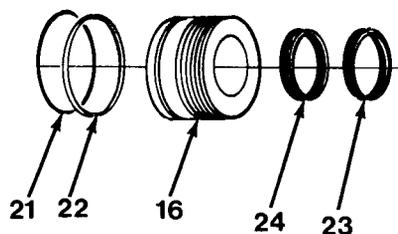


Figure 13-7

OUTRIGGER CYLINDER ASSEMBLY ASSEMBLY

NOTE

Coat all internal parts with clean hydraulic oil before assembly.

1. Install poly-pak seal (24), with lips toward inside of cylinder and rod wiper (23), with lip toward outside of cylinder, in gland (16, Figure 13-7).
2. Install back-up ring (22) and O-ring (21) to outside of gland (16).

CAUTION

Do not allow seal to “twist” in seal groove. Seal can be made pliable to aid in installation by soaking in 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

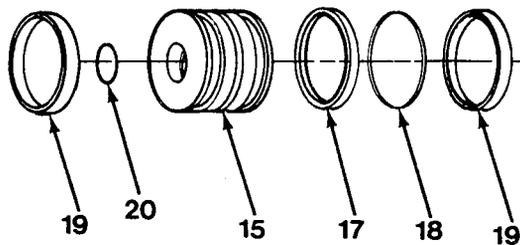


Figure 13-6

3. Install two wear rings (19), expander ring (18) and seal (17) to outside of piston (15, Figure 13-6).

4. Install O-ring (20) on inside of piston (15).
5. Install gland (16), piston (15) and retaining nut (14) on rod (13, Figure 13-5). Torque nut (14) to 400 Ib-ft (542 N•m).
6. Install assembled rod (13) in cylinder barrel (26) and secure gland (12, Figure 13-4).

⚠ WARNING

Liquid nitrogen is extremely cold, having a temperature of -320 degrees F (-195 degrees C). Skin contact with liquid nitrogen or with an object cooled by liquid nitrogen will result in SEVERE INJURY. Wear protective gloves that will not absorb liquid nitrogen. Excess liquid nitrogen must be disposed of promptly since liquid nitrogen will condense oxygen from the atmosphere. The mixture of liquid nitrogen and liquid oxygen is a powerful oxidizer and may react violently with easily oxidizable substances.

NOTE

Cool bushings to -320 degrees F (-195 degrees C) by submerging bushings in liquid nitrogen before installing.

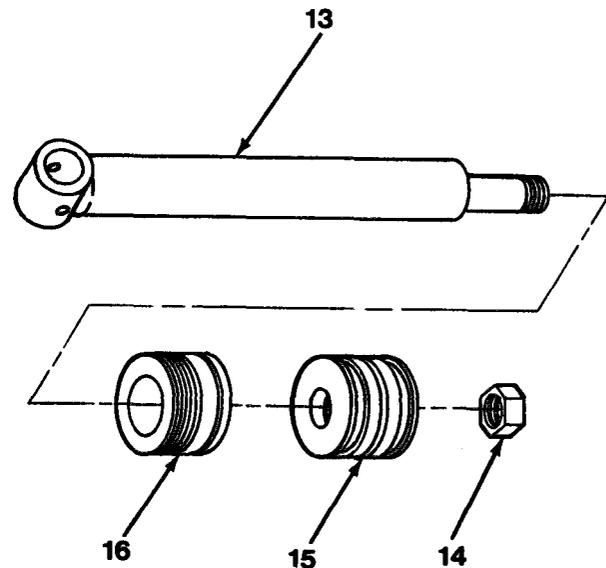


Figure 13-5

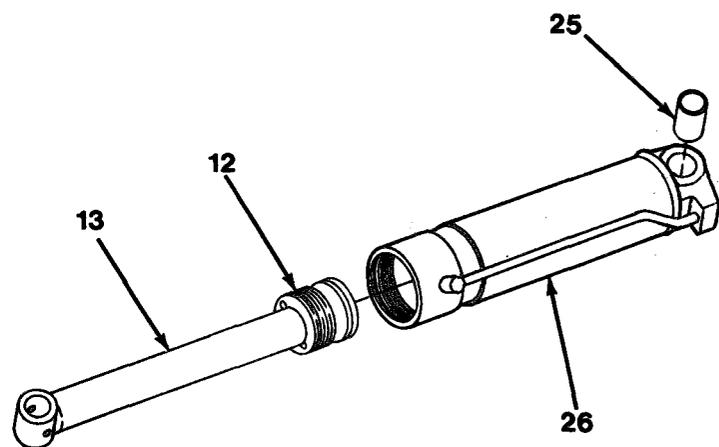


Figure 13-4

7. Submerge two bushings (25), if removed, in liquid nitrogen to cool them. Apply Loctite 680 to bushing bore in base end of cylinder barrel (25), and install two bushings into base end of cylinder barrel (25) by using a press.

STEERING CYLINDERS

STEERING CYLINDERS REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

The following is a maintenance procedure for one steering cylinder assembly. The maintenance procedure for the remaining three steering cylinders is identical.

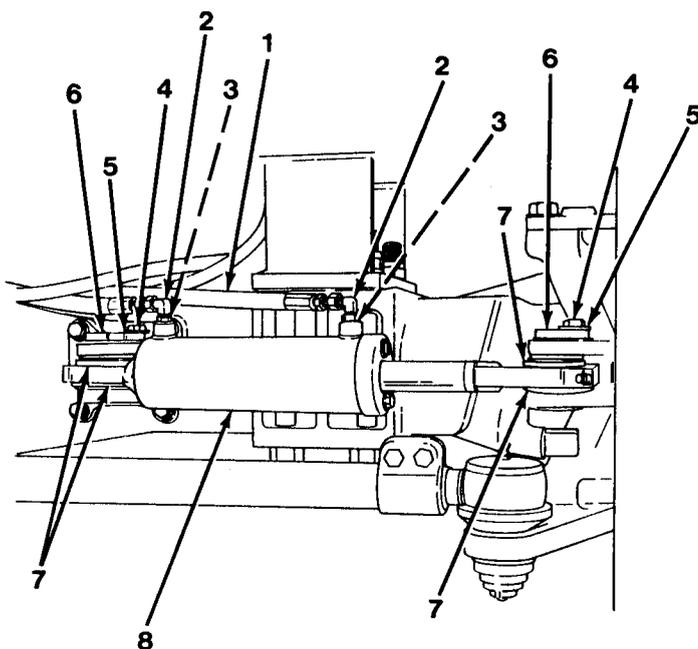


Figure 13-1

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Disconnect two hydraulic lines (1) from elbows (2, Figure 13- 1).
3. Remove two elbows (2) and O-rings (3).
4. Remove two cap screws (4) and washers (5).
5. Using driver and hammer, drive out two pins (6).

- Remove four washers (7) and steering cylinder (8).

STEERING CYLINDERS INSTALLATION

- Install steering cylinder (8) and four washers (7, Figure 13-1).
- Install two pins (6).
- Install two washers (5) and capscrews (4).
- Install two O-rings (3) and elbows (2).
- Connect two hydraulic lines (1) to elbows (2).
- Close dipstick cap. Start engine and check for hydraulic oil leakage. Shut engine off.
- Check hydraulic oil level Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

STEERING CYLINDERS DISASSEMBLY

- Remove two grease fittings (9, Figure 13-2).

CAUTION

Removal of bearings may cause destruction of bearings. Remove bearings only if inspection indicates replacement is necessary.

- Press out two bearings (10), if necessary.
- Remove two capscrews and lockwashers (11).
- Remove cap (12) from cylinder barrel assembly (23).

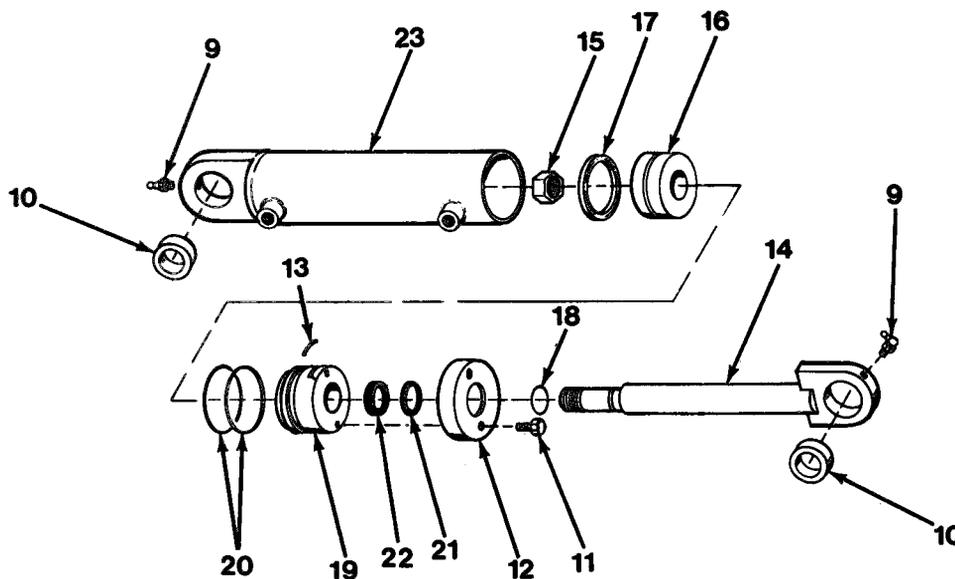


Figure 13-2

STEERING CYLINDERS DISASSEMBLY



5. Depress sleeve (19) into cylinder barrel assembly (23) past lockwire (13, Figure 13-2).
6. Carefully remove lockwire (13) from groove in cylinder barrel assembly (23).

Heating nut to a temperature of approximately 300 degrees F (149 degrees C) may be required to break down Loctite. Wear protective equipment while heating and handling parts. Failure to follow this procedure could cause **SERIOUS INJURY**.

Before removing cylinder barrel assembly, deburr edges from outside edge of lockwire groove. Failure to remove burrs could result in damage to cylinder barrel assembly.

7. Remove rod assembly (14) from cylinder barrel assembly (23).

8. Remove nut (15).
9. Remove piston (16) as an assembly.
10. Remove seal assembly (17) from piston (16).
11. Remove O-ring (18) from rod assembly (14).
12. Remove sleeve (19) as an assembly.
13. Remove O-ring with back-up ring (20), rod wiper (21) and seal (22) from sleeve (19).
14. Remove cap (12) from rod assembly (14).

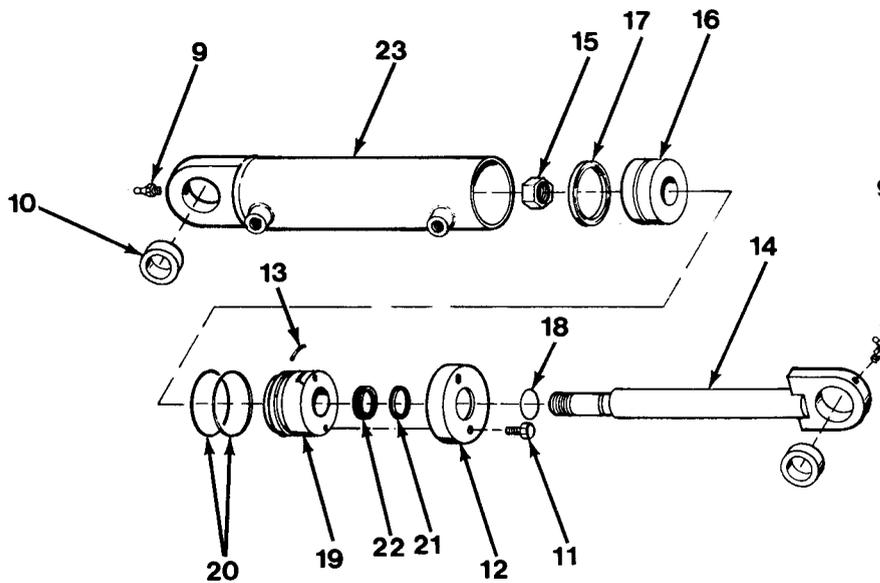


Figure 13-2

STEERING CYLINDERS CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Check all parts for wear, bum, nicks and corrosion. Replace worn or damaged parts.
3. Polish surfaces having minor blemishes with fine crocus cloth.
4. Inspect two pins.
5. Inspect two bearings. Maximum I.D. is 1.005 in. (25.53 mm). If I.D. is greater than limit replace bearings.
6. Inspect all other parts (refer to Chapter 4).

STEERING CYLINDERS ASSEMBLY

NOTE

Lubricate all internal parts with clean hydraulic oil.

1. Slide cap (12) on rod assembly (14, Figure 13-2).

CAUTION

Two seal lips of seal must point toward inside of cylinder barrel assembly. Rod wiper must point toward outside of cylinder barrel assembly. Use care to avoid nicks and scratches of seal lips. Failure to follow this procedure could cause damage to equipment.

2. Assemble seal (22), rod wiper (21) and O-ring with back-up ring (20) to sleeve (19).

STEERING CYLINDERS ASSEMBLY

3. Slide sleeve (19) as an assembly on rod assembly(14, Figure 13-2).
4. Assemble O-ring (18) on rod assembly (14) and seal assembly (17) on piston (16).
5. Slide piston (16) as an assembly on rod assembly (14).
6. Coat threads of rod assembly (14) with Loctite 277and install nut (15). Torque nut (15) to 250 lb-ft (339 N•m).
7. Slide assembled rod assembly (14) into cylinder barrel assembly (23).
8. Depress sleeve (19) past groove of lockwire (13) in cylinder barrel assembly (23).
9. Insert lockwire (13) in groove of cylinder barrel assembly (23).
10. Pull out on rod assembly (14) until sleeve (19) locks in place with lockwire (13).
11. Slide cap (12) onto cylinder barrel assembly (23) and install two capscrews and lockwashers (11) through cap (12) and into sleeve (19).
12. Press in two new bearings (10), if removed.
14. Install two grease fittings (9).

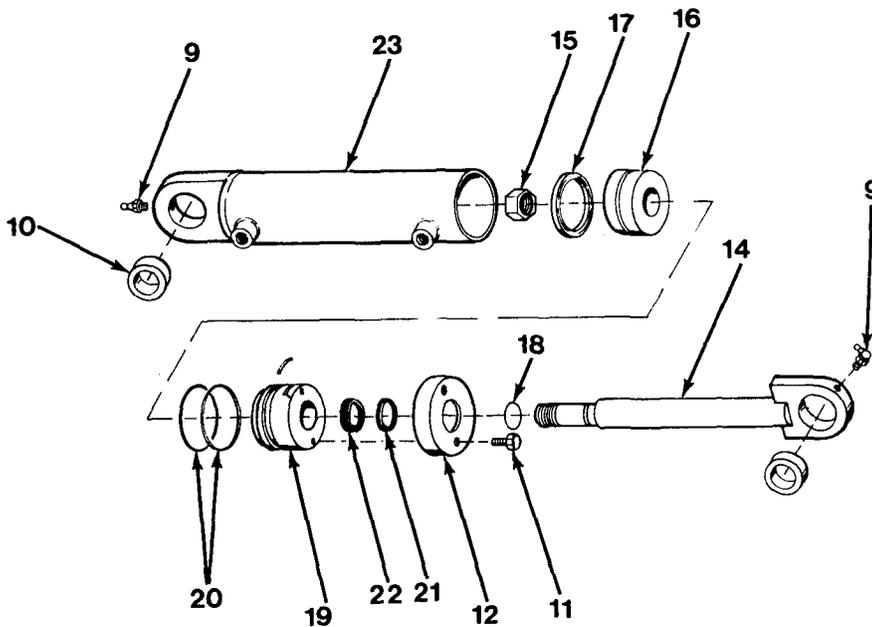


Figure 13-2

MAIN HYDRAULIC PUMP

MAIN HYDRAULIC PUMP REMOVAL

1. Open engine hood and remove hood support (refer to page 14-25).

WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

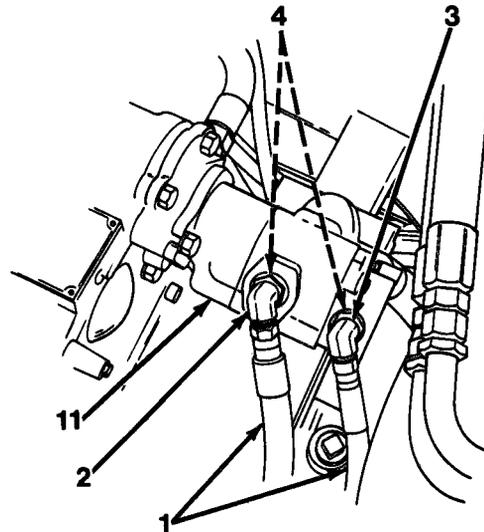


Figure 13-1

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
3. Disconnect two hoses (1) from elbows (2) and (3, Figure 13-1).
4. Remove elbows (2) and (3) and two O-rings (4) from pump (11).
5. Remove four socket head capscrews (5) and lockwashers (6). Supply hose (7) is now free from pump (11). Remove O-ring (8) from supply hose (7, Figure 13-2).
6. Remove two capscrews (9) and washers (10). Remove pump (11).

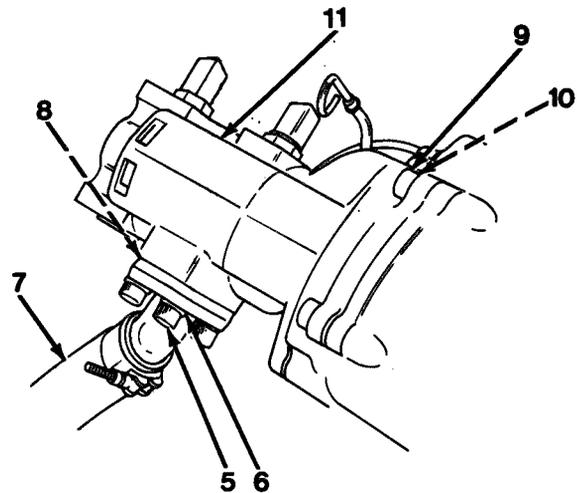


Figure 13-2

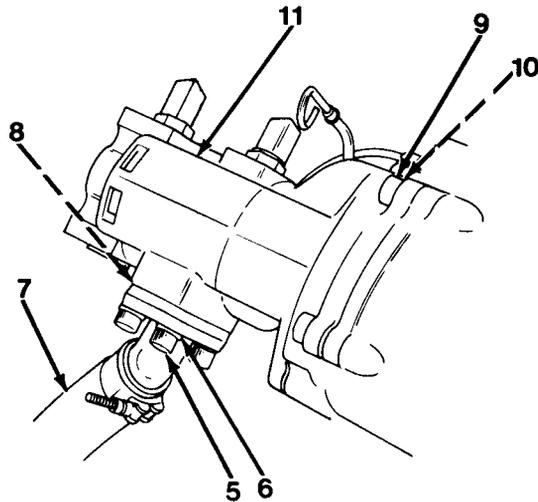


Figure 13-2

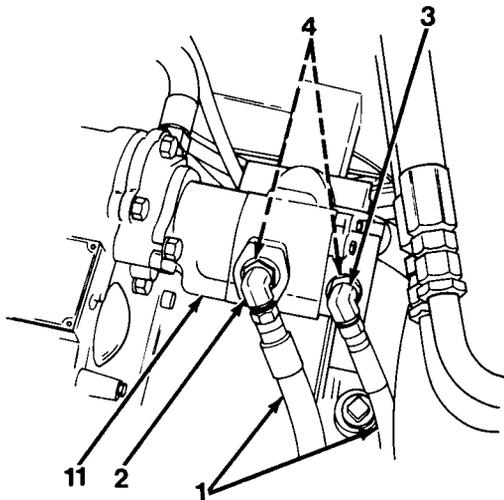


Figure 13-1

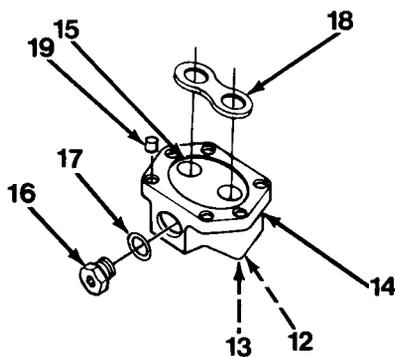


Figure 13-3

MAIN HYDRAULIC PUMP INSTALLATION

1. Coat pump (11, Figure 13-2) splines with antiseize thread compound MIL-A-907. Apply Loctite 515 to pump (11) mounting flange.
2. Position pump (11) and align mounting holes.
3. Apply Loctite 271 to threads of two cap-screws (9) and install two washers (10) and capscrews (9).
4. Install two O-rings (4) and elbows (3) and (2) in pump (11). Connect two hoses (1) to elbows (3) and (2, Figure 13- 1).
5. Install O-ring (8) in supply hose (7) and secure supply hose (7) with four lockwashers (6) and sockethead capscrews (5) to pump (11, Figure 13-2).
6. Close dipstick cap. Start engine to run pump and check for leaks. Shut engine off.
7. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

MAIN HYDRAULIC PUMP DISASSEMBLY

NOTE

Matchmark front body, rear body and rear cover before disassembly.

1. Remove four capscrews (12) and special washers (13) from rear cover (14, Figure 13-3).
2. Remove rear cover (14).
3. Remove square ring (15).

4. Remove socket head plug (16) from rear cover (14).
5. Remove C1-ring (17) from socket head plug (16).
6. Remove thrust plate (18) from rear cover (14). Note position of thrust plate (18) before removal.
7. Remove two dowel pins (19).
8. Separate rear body (20) from front body (21, Figure 13-4).

NOTE

Matchmark ends of gear shafts before removing gears.

9. Remove rear drive gear (22) and driven gear (23).
10. Remove wear plate (24).
11. Remove and discard loading seal (25) from wear plate (24).

NOTE

Note position of thrust plate before removal.

12. Remove square ring (26), two dowel pins (27) and thrust plate (28) from rear body (20).

NOTE

Matchmark ends of gear shaft before removing gear.

13. Remove drive gear (29) and driven gear (30, Figure 13-5).

14. Remove wear plate (31) from front body (21).

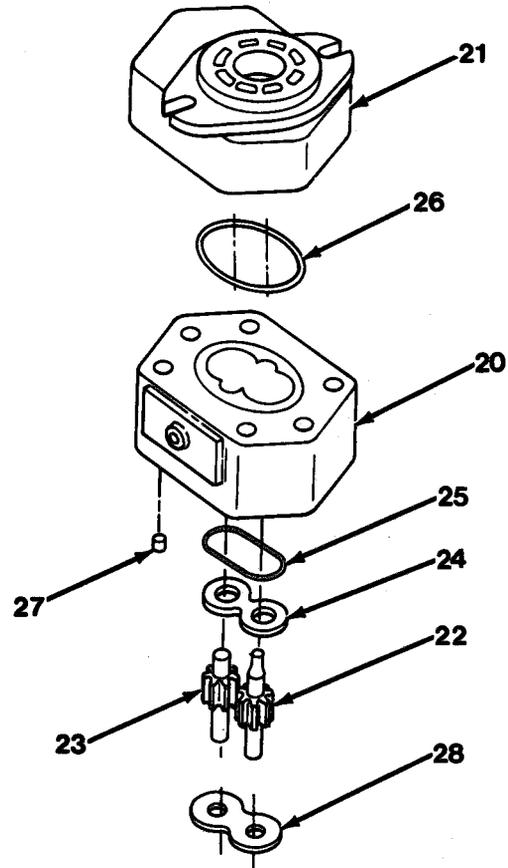


Figure 13-4

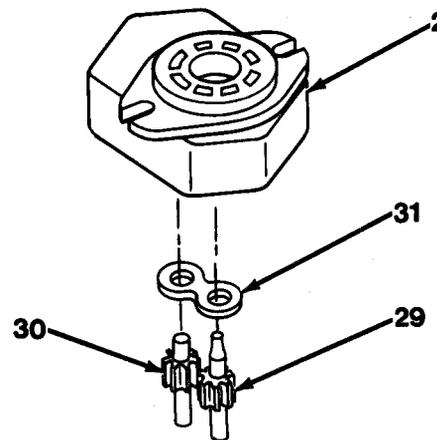


Figure 13-5

MAIN HYDRAULIC PUMP DISASSEMBLY

15. Remove loading seal (32) from wear plate (31, Figure 13-6).
16. Remove shaft seal (33) from front body (21).

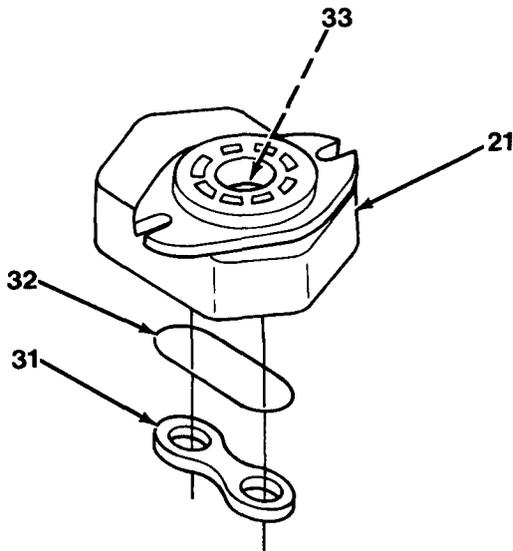


Figure 13-6

MAIN HYDRAULIC PUMP CLEANING/
INSPECTION

NOTE

Service pump only in a clean, dust-free location and use only clean tools and equipment. Dust will damage the internal pump components.

1. Clean all parts (refer to Chapter 2).
2. Inspect wear plates. A smooth wear pattern on the plate face which is slightly heavier on the inlet side is normal. If surface is severely scored or discolored, plate must be replaced.
3. Inspect thrust plates. A wear pattern similar to wear plate on the bronze side is normal.
4. Inspect gears. Check journals and faces of each gear. They must be smooth and free from nicks or burrs. If any surfaces are discolored, gear must be replaced.

5. Inspect bearing. Inside of bearing should be smooth. A light contact pattern is normal. If severe wear or roughness is apparent, the part that bearing is housed in must be replaced.
Bearing cannot be replaced.
6. Inspect pump bodies. A wear pattern around the inside diameter of gear pockets is normal. Large grooves indicate pump body must be replaced.
7. Inspect shaft seal. Check bore of front body where seal was removed for deep scores, nicks or burrs.
8. Inspect all other parts (refer to Chapter 4).

MAIN HYDRAULIC PUMP ASSEMBLY

NOTE

All gears and bearing should be lubricated with hydraulic oil during assembly. Shaft seal lips should be lubricated with Lubriplate before shaft installation.

1. Secure front body (21, Figure 13-6) in a holding fixture.

MAIN HYDRAULIC PUMP ASSEMBLY

CAUTION

Do not bottom shaft seal in front body bore. Failure to follow this procedure could cause damage to equipment.

NOTE

Install shaft seal with open side toward pump.

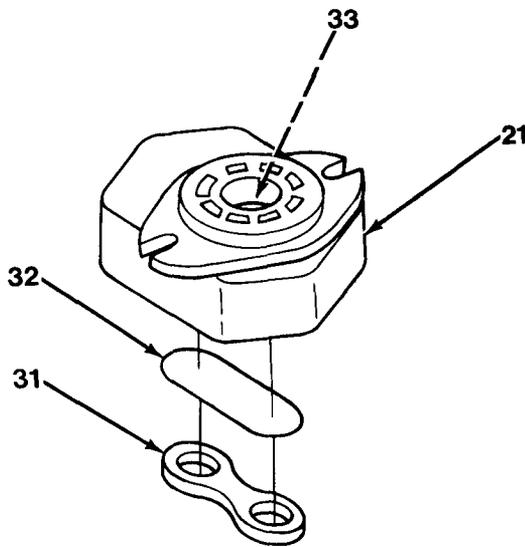


Figure 13-6

2. Press new shaft seal (33) in front body (21) to 0.156 in. (3.96 mm) below face of front body (21, Figure 13-6).
3. Install loading seal (32) into wear plate (31). Use a small amount of grease MIL-G-10924 to retain loading seal (32) in groove of wear plate (31) during installation. The flat surface of loading seal (32) should face out and will stick up slightly out of wear plate (31).
4. Install wear plate (31) and loading seal (32) into gear pocket of front body (21). Install wear plate (31) with flat side up and seal ends pointing toward the inlet side.

NOTE

Use a sleeve inserted in shaft seal to prevent seal damage during gear installation.

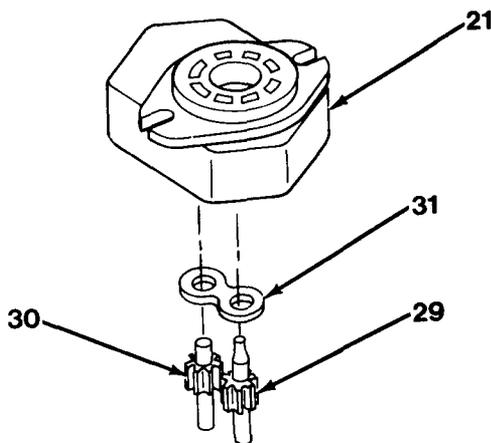


Figure 13-5

5. Align matchmarks and install driven gear (30) and driving gear (29) into front body (21, Figure 13-5).
6. Install thrust plate (28) into rear body (20, Figure 13-4). Note position from disassembly (brass side toward gears).

7. Install two dowel pins (27) and square ring (26) into rear body (20). Use a small amount of grease MIL-G-10924 to retain square ring (26) during assembly.
8. Align matchmarks and install rear body (20) to front body (21).
9. Install loading seal (25) on wear plate (24). Use a small amount of grease MIL-G-10924 to retain loading seal ends during installation.
10. Install wear plate (24) and loading seal (25) with flat side up and loading seal ends toward the inlet side.
11. Install driven gear (23) and rear drive gear (22) into rear body (20).
12. Install thrust plate (18, Figure 13-3) into rear cover (14) with brass side toward gears.
13. Install two dowel pins (19) and square ring (15) into rear cover (14). Use a small amount of grease MIL-G-10924 to retain square ring (15) during installation.
14. Install O-ring (17) on socket head plug (16).
15. Install socket head plug (16) into rear cover (14).
16. Align matchmarks and install rear cover (14).
17. Install four special washers (13) and cap-screws (12). Torque four cap screws (12) to 34 to 38 lb-ft (46 to 52 N•m).
18. Rotate shaft; some resistance will be felt.

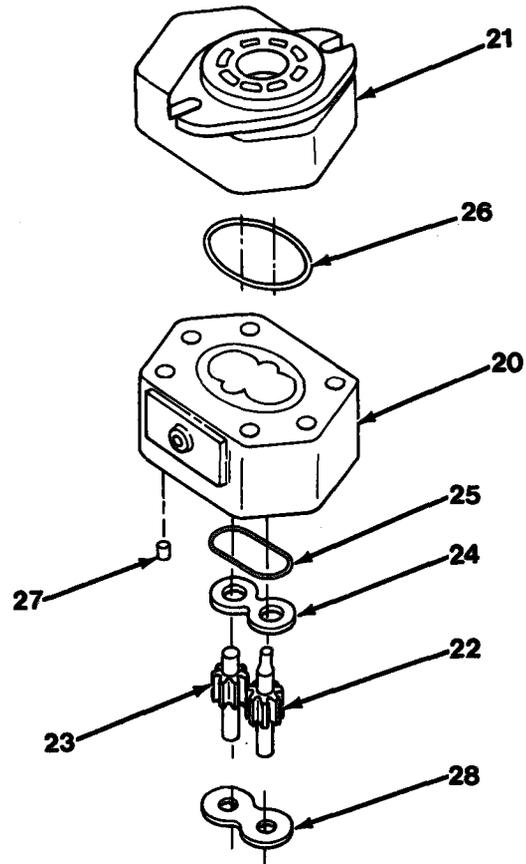


Figure 13-4

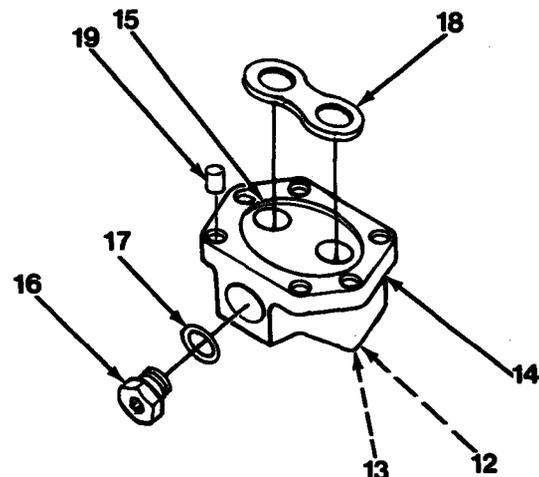


Figure 13-3

GROUND DRIVEN STEERING PUMP

GROUND DRIVEN STEERING PUMP
REMOVAL**⚠ WARNING**

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.
- Use a suitable container to catch hydraulic oil when hoses are removed from pump,

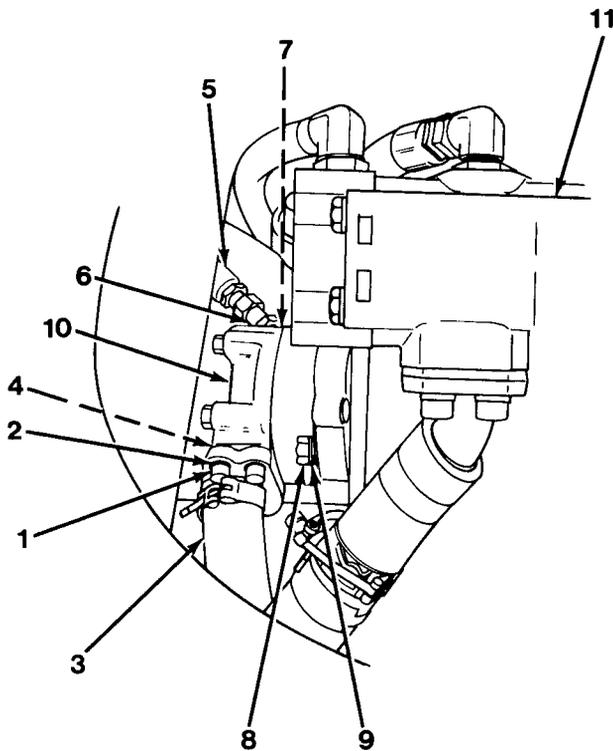


Figure 13-1

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Drain hydraulic reservoir (refer to page 3-52).
3. Remove four capscrews (1) and lockwashers (2, Figure 13-1).
4. Remove hose (3) from pump (10).
5. Remove O-ring (4) from hose (3).
6. Remove hose (5) from elbow (6).

7. Remove elbow (6) from pump (10).
8. Remove O-ring (7) from elbow (6).
9. Remove two capscrews (8) and lockwashers (9) attaching pump (10) to transmission (11).
10. Remove pump (10).

GROUND DRIVEN STEERING PUMP INSTALLATION

1. Coat splines of pump (10, Figure 13-1) with antiseize thread compound MIL-A-907. Apply Loctite 515 to pump (10) mounting flange.
2. Apply Loctite 271 to two capscrews (8).
3. Position pump (10) on transmission (11) and install two lockwashers (9) and capscrews (8).
4. Install O-ring (7) on elbow (6).
5. Install elbow (6) on pump (10).
6. Install hose (5) on elbow (6).
7. Install O-ring (4) on hose (3).
8. Position hose (3) on pump (10) and install four lockwashers (2) and capscrews (1).
9. Fill hydraulic reservoir (refer to Koehring Commercial Operation Instructions manual).
10. Start engine and check for leaks.

GROUND DRIVEN STEERING PUMP DISASSEMBLY

NOTE

Matchmark pump sections before disassembly.

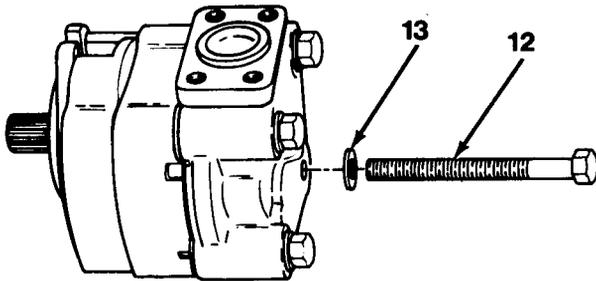


Figure 13-2

NOTE

Record position of thrust plate before removal.

1. Remove four cap screws (12) and washers (13, Figure 13-2).

2. Lift off flange (14) from gear plate (22) and remove thrust plate (15, Figure 13-3).
3. Remove two O-rings (16) from thrust plate (15, Figure 13-4).
4. Remove O-ring (17), back-up ring (18) and O-ring (19) from flange (14).

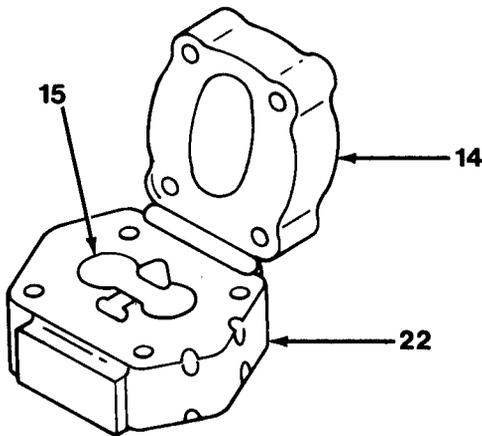


Figure 13-3

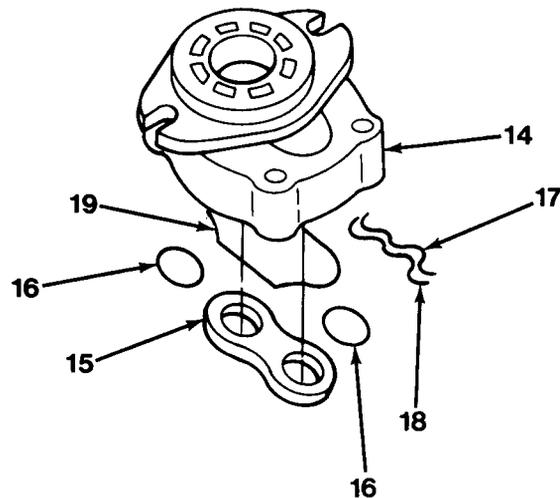


Figure 13-4

NOTE

Matchmark ends of gear shafts before removing.

5. Remove idler gear (20) and drive gear (21) from gear plate (22, Figure 13-5).
6. Separate gear plate (22) from cover plate (23, Figure 13-6).
7. Remove eight dowel pins (24) from gear plate (22).
8. Remove thrust plate (25, Figure 13-7).

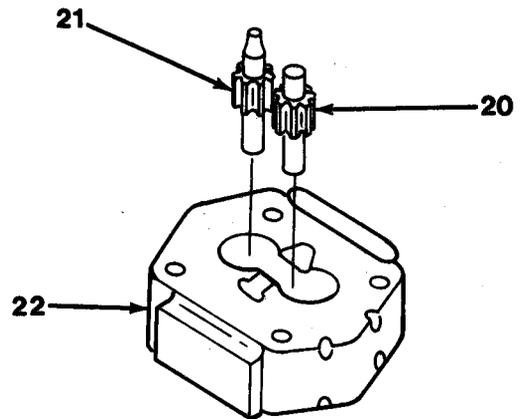


Figure 13-5

NOTE

Record position of thrust plate.

9. Remove two O-rings (26) from thrust plate (25).
10. Remove O-ring (27), back-up ring (28) and O-ring (29) from cover plate (23).

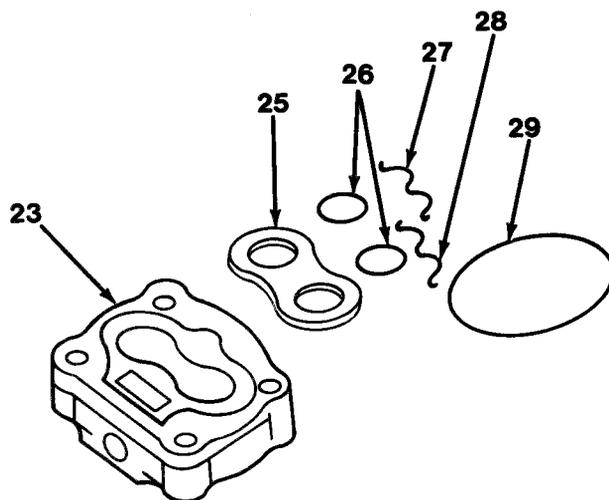


Figure 13-7

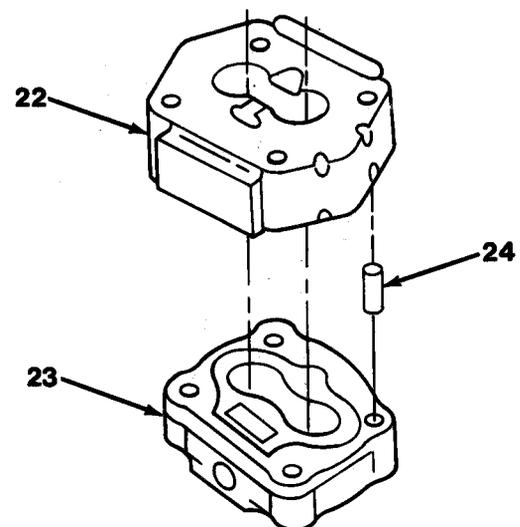


Figure 13-6

GROUND DRIVEN STEERING PUMP DISASSEMBLY

11. Remove plug (30), seal (31), snap ring (32) and seal (33) from flange (14, Figure 13-8).

GROUND DRIVEN STEERING PUMP CLEANING/inspection

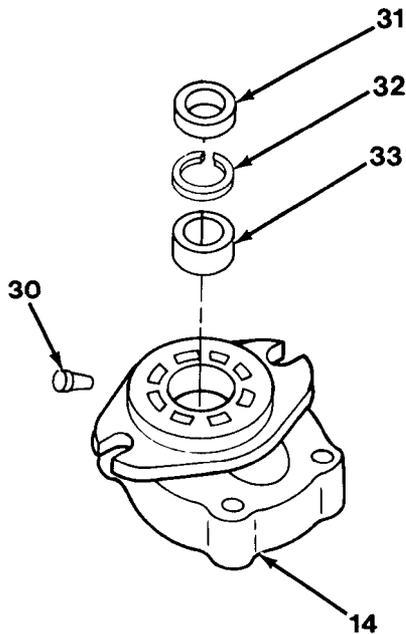


Figure 13-8

1. Clean all parts (refer to Chapter 2).
2. A smooth wear pattern on thrust plate face which is slightly heavier on inlet side is normal. If surface is severely scored or discolored, thrust plate must be replaced.
3. Inspect gears. Check journals and faces of each gear. They must be smooth and free from nicks and burrs. If any surfaces are discolored, gear must be replaced.
4. Inside of bearings should be smooth. A light contact pattern is normal. If severe wear or roughness is apparent, the part in which bearings are housed must be replaced. Bearings themselves cannot be replaced.
5. Gear plate pockets should be free from any large grooves around the inside diameter. A gear wipe pattern on this diameter on inlet side is normal, and necessary for proper pump operation.
6. Inspect all other parts (refer to Chapter 4).

GROUND DRIVEN STEERING PUMP ASSEMBLY

1. Install seal (33), snap ring (32), seal (31) and plug (30) on flange (14, Figure 13-8).
2. Install O-ring (29), back-up ring (28) and O-ring (27) in cover plate (23, Figure 13-7).
3. Install two O-rings (26) in thrust plate (25). Install thrust plate (25) on cover plate (23) as recorded during disassembly.
4. Install eight dowel pins (24) in gear plate (22, Figure 13-6).
5. Align matchmarks and install gear plate (22) on cover plate (23).
6. Align matchmarks and install drive gear (21) and idler gear (20) in gear plate (22, Figure 13-5).

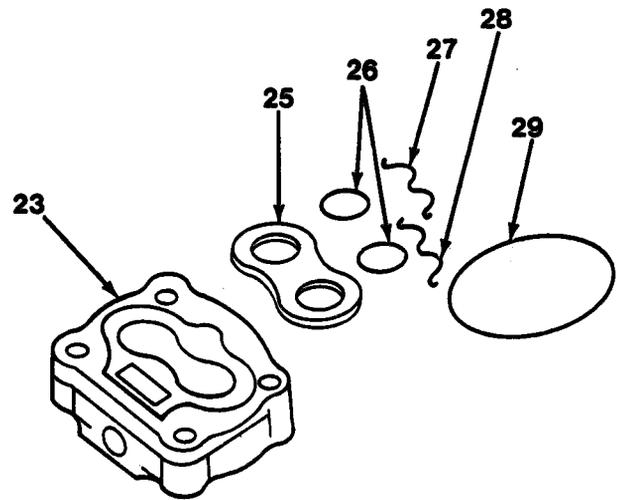


Figure 13-7

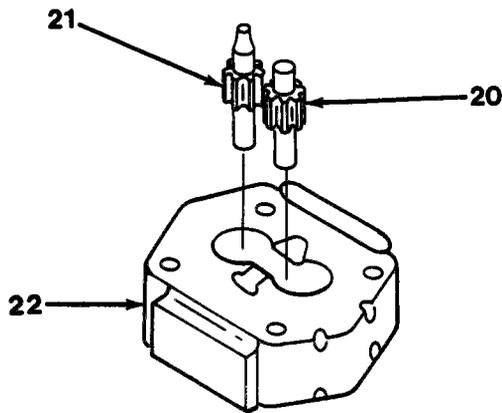


Figure 13-5

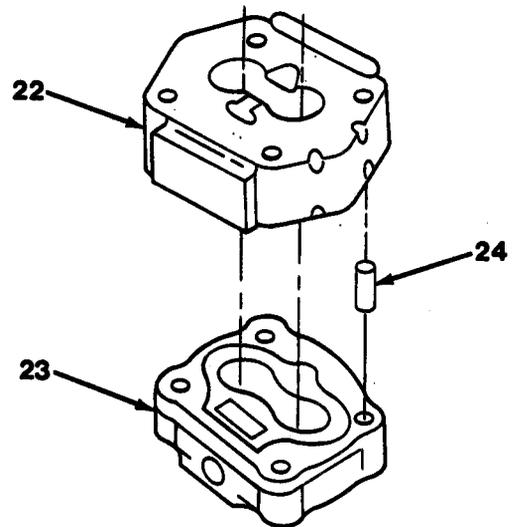


Figure 13-6

GROUND DRIVEN STEERING PUMP ASSEMBLY

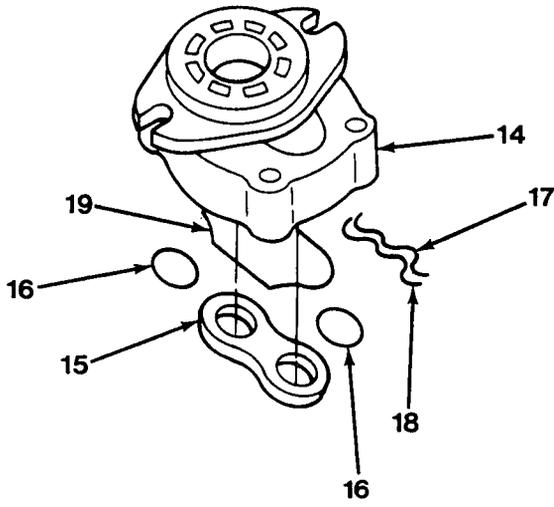


Figure 13-4

7. Install two O-rings (16) in thrust plate (15, Figure 13-4).
8. Install thrust plate (15) in flange (14) as recorded during disassembly.
9. Install new O-ring (19), back-up ring (18) and O-ring (17) in flange (14).
10. Align matchmarks and install flange (14) on gear plate (22, Figure 13-3).
11. Install four washers (13) and capscrews (12, Figure 13-2). Torque capscrews (13) to 35 lb-ft (47 N•m).

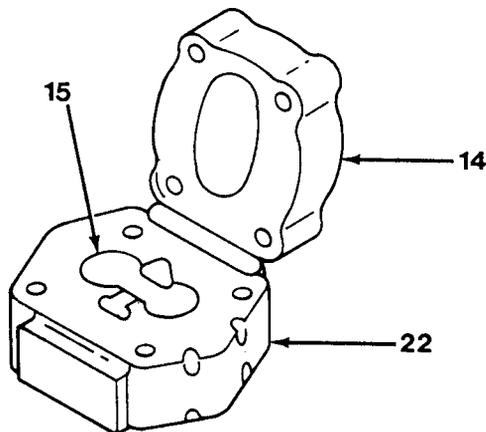


Figure 13-3

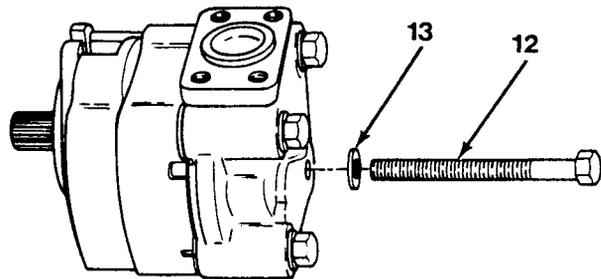


Figure 13-2

SWING MOTOR

SWING MOTOR REMOVAL



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in instigation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Disconnect hydraulic hoses (1) and (2) and remove two adapters (3) and two O-rings (4, Figure 13-1).
3. Remove two capscrews (5).
4. Remove swing motor (6) from case.

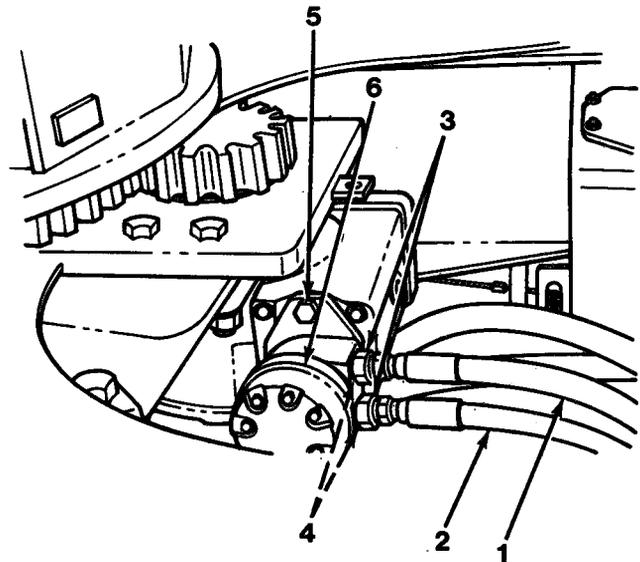


Figure 13-1

SWING MOTOR INSTALLATION

1. Coat motor spline with antiseize thread compound MIL-A-907. Apply Loctite 515 to motor mounting flange.
2. Install swing motor (6, Figure 13-1) to case.
3. Apply Loctite 271 to threads of two capscrew (5) and install two capscrews (5).
4. Install two O-rings (4) and adapters (3) and connect hydraulic hoses (1) and (2) to adapters (3).

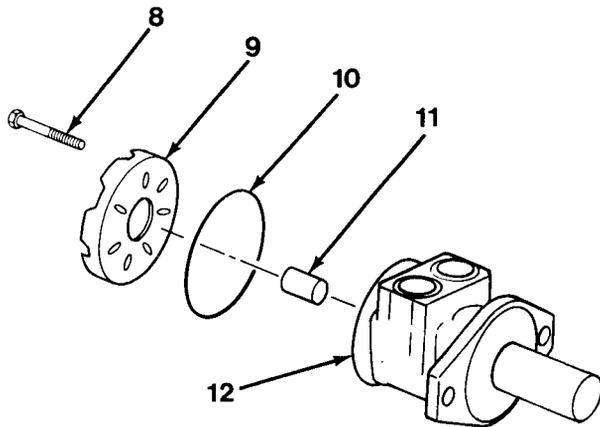


Figure 13-2

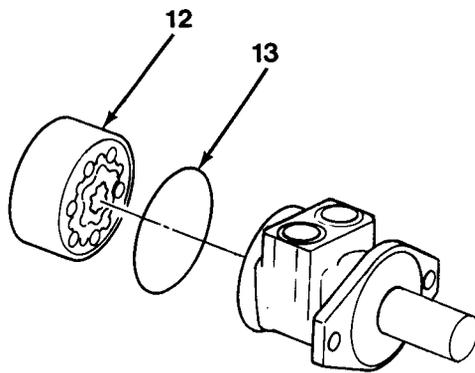


Figure 13-3

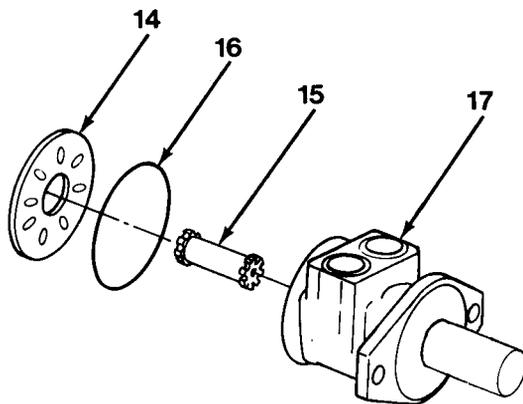


Figure 13-4

SWING MOTOR DISASSEMBLY

CAUTION

Do not clamp housing port area between vise jaws as it might distort housing around commutator or preventing disassembly of commutator.

1. Clamp swing motor in a soft-jawed vice with end cover (9, Figure 13-2) up.
2. Remove seven bolts (8).
3. Remove end cover (9) and seal ring (10) from rotor assembly set (12).
4. Remove drive link spacer/washer (11).
5. Remove rotor assembly set (12) and seal ring (13, Figure 13-3).
6. Remove wear plate (14), drive link (15) and seal ring (16) from housing (17, Figure 13-4).

7. Remove commutator (18) by inserting two fingers into center cavity and lifting. Remove drive pin (19, Figure 13-5) from commutator (18) only if it must be replaced.

NOTE

A damaged thrust bearing would be indicated by a roughness felt or heard when removing coupling shaft and drive link. Replacement of thrust washer and bearing will be required if roughness is detected.

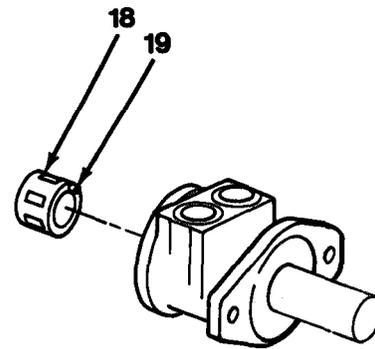


Figure 13-5

8. Remove coupling shaft (20, Figure 13-6).
9. Remove swing motor from vise and place on a clean flat work surface with mounting flange up. Remove dirt and water seal (21) from housing (17, Figure 13-7).

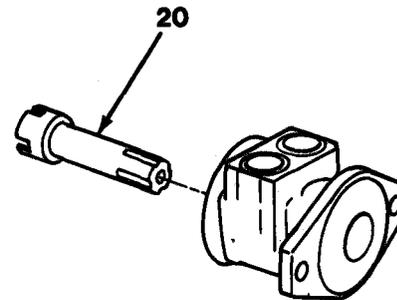


Figure 13-6

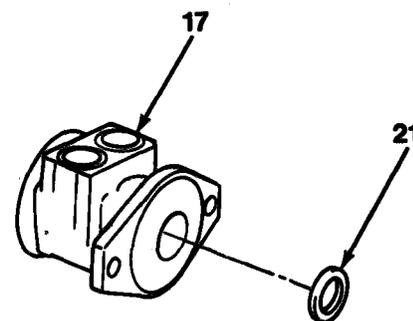


Figure 13-7

SWING MOTOR DISASSEMBLY

CAUTION

Use care when removing bearing; do not damage bore of commutator. Failure to follow this procedure could cause damage to equipment.

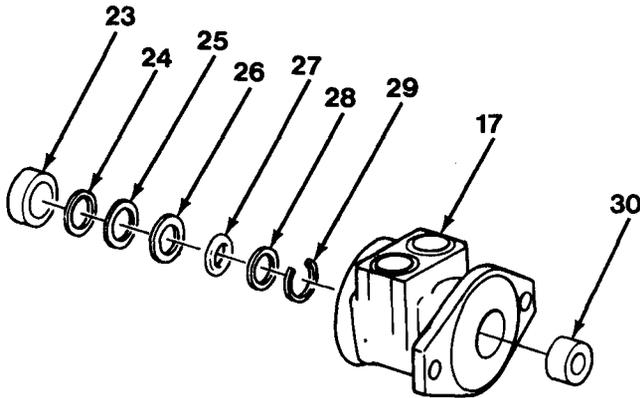


Figure 13-8

10. Position swing motor in a soft-jawed vice as in step 1. Using a bearing puller, remove inner bearing (23), thrust washer (24), thrust bearing (25), thrust washer (26), inner seal (27) and back-up washer (28) from housing (17, Figure 13-8). Discard inner bearing (23).
11. Using snap ring pliers, remove retaining ring (29).
12. Using a bearing puller, remove and discard bearing (30).

SWING MOTOR CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts for wear, nicks, burrs and spalling on the ground surfaces.

NOTE

A polished pattern on cover surface from rotation of rotor is normal. Any discoloration of end cover would indicate excessive fluid temperature or excessive speed and require system investigation for cause and a close inspection of end cover, rotor assembly set and wear plate.

3. Inspect bolt head recesses for damage that would prevent bolt heads from sealing properly.
4. If inspection reveals damage to rotor assembly set commutator or housing, swing motor should be replaced as an assembly. Time parts are all matched to each other and are not serviced separately.
5. Inspect all other parts (refer to Chapter 4).

SWING MOTOR ASSEMBLY

NOTE

Coat all internal parts with hydraulic oil before assembling.

1. Install retaining ring (29, Figure 13-8) with rounded surface of ring facing in toward larger housing cavity.
2. Install back-up washer (28) and inner seal (27). Inner seal (27) must be installed flush against back-up ring with seal lip facing out toward thrust washer.

NOTE

Use a bearing mandrell and press when installing bearings.

3. Install thrust washer (24), thrust bearing (25), thrust washer (26) and new inner bearing (23). Press inner bearing (23) into a depth of 0.125 to 0.135 in. (3.18 to 3.43 mm).

SWING MOTOR ASSEMBLY

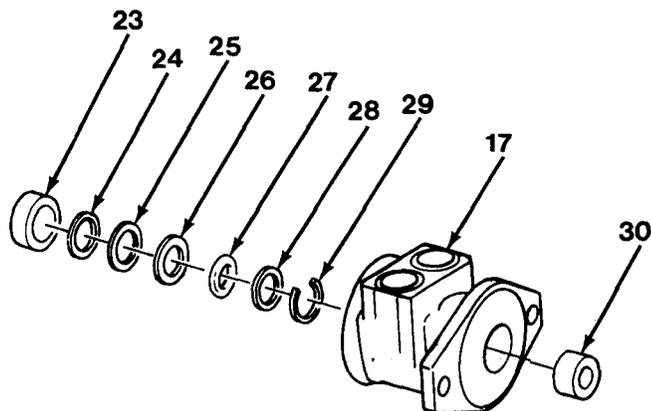


Figure 13-8

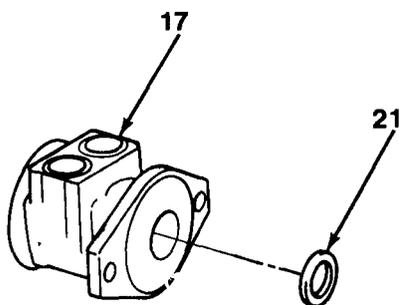


Figure 13-7

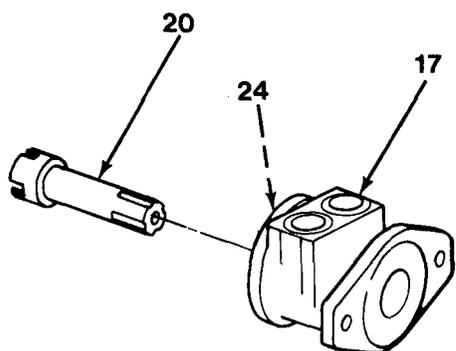


Figure 13-9

Apply molybdenum disulfide MIL-M-7866 to new bearing (30) rollers. Turn housing (17, Figure 13-8) over and install new bearing (30) to a depth of 1.598 to 1.618 in. (40.59 to 41.10 mm). Make sure new bearing (30) is not cocked and is square to housing (17).

5. Apply molybdenum disulfide MIL-M-7866 to seal lip and install dirt and water seal (21) in housing (17, Figure 13-7). Seat dirt and water seal (21) against bearing, with seal lip facing bearing.
6. Place swing motor in a soft-jawed vice with mounting flange down, and clamp vice jaws against edges of mounting flange.
7. Install coupling shaft (20) into housing (17) seating it against thrust washer (24, Figure 13-9). Coupling shaft must rotate smoothly on thrust bearing package.

8. Install new drive pin (19), if removed, into commutator (18, Figure 13-5) drive pin hole until it bottoms out.

CAUTION

Do not force commutator into bore. It is a close slip fit and must rotate. Failure to follow this procedure could cause damage to equipment.

9. Install commutator (18) assembly into housing (17) commutator bore. Commutator (18) must not be cocked as it enters the bore. Drive pin (19) must be in line with coupling shaft (20, Figure 13-10) drive pin slot indicated by timing mark. Engage drive pin (19) end that protrudes from commutator into coupling shaft (20) drive pin slot rotating coupling shaft (20) if necessary. Commutator (18) will be below housing wear plate surface when correctly seated.

NOTE

Commutator drive pin and coupling shaft drive pin slot, at this point in the assembly are visible through commutator center cavity for coupling pin engagement purposes.

10. Install either end of drive link (15) through commutator (18) cavity and engage lower drive link spines into mesh with internal spines in coupling shaft (20). A spline valley on both ends of the drive link will now be in line with commutator drive pin (19) and the timing mark.

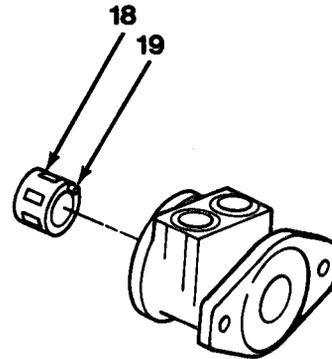


Figure 13-5

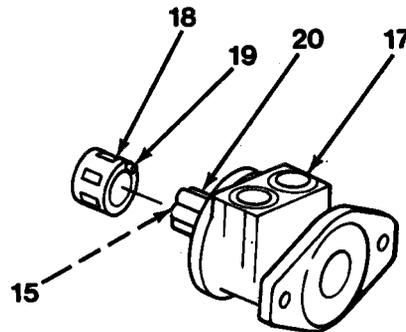


Figure 13-10

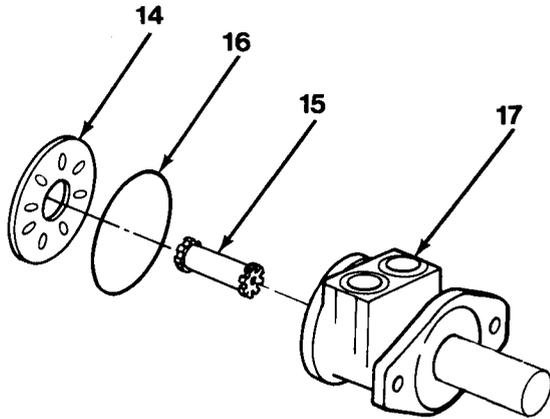


Figure 13-4

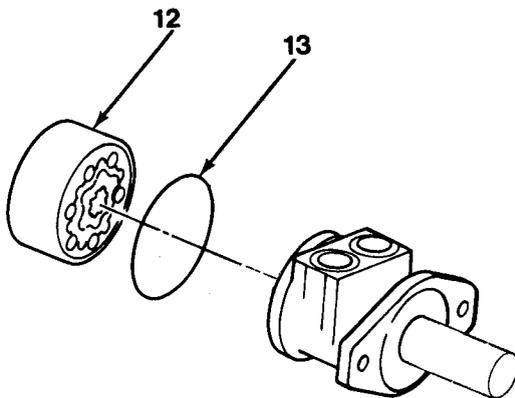


Figure 13-3

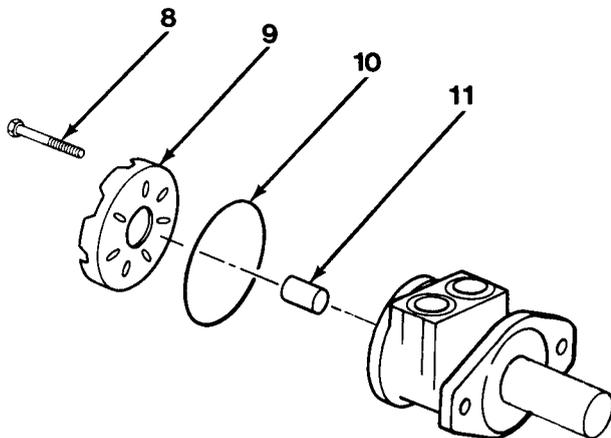


Figure 13-2

SWING MOTOR ASSEMBLY

11. Install new seal (16) in seal groove of housing (17, Figure 13-4).
12. Place wear plate (14) with either side up onto rotor assembly (12, Figure 13-3) and align wear plate bolt holes with rotor assembly set (12) bolt slots.
13. Install new seal ring (13) into seal ring groove in rotor assembly set (12).

CAUTION

Be careful not to disengage rotor, drive link or coupling shaft while aligning bolt holes as this could affect the timing that was just achieved. The meshing of the precise rotor teeth with the precise drive link splines and valleys as described is absolutely crucial to a correctly timed and functional motor. Misalignment by one spline tooth will be indicated by the timing mark on coupling shaft being 45 degrees from the specified rotor lobe. Failure to follow this procedure could cause damage to equipment.

14. Locate on rotor assembly set (12) the only two spline teeth that are on same center line with two rotor lobes.

15. Take rotor assembly set (12), seal ring (13) and wear plate (14, Figure 13-4) as a unit and align rotor spline teeth from step 14 with drive link (15) spline valley identified in step 10.
16. Install drive link spacer/washer (11, Figure 13-2) into rotor spline cavity onto end of drive link (15, Figure 13-4).
17. Apply a small amount of grease MIL-G-10924 to seal ring (10) and insert seal ring (10) into end cover (9, Figure 13-2) seal ring groove.
18. Install end cover (9) assembly onto rotor assembly set (12) with seal ring (10) against rotor assembly set (12) and align end cover (9) bolt holes with rotor assembly set (12) bolt holes.
19. Install seven bolts (8) finger tight. Torque seven bolts (8) to 22 to 26 lb-ft (30 to 35 N•m).

ROTARY MANIFOLD

NOTE

ROTARY MANIFOLD REMOVAL

1. Start engine and raise boom to a height suitable to provide access to inside of upper-structure frame.

 **WARNING**

Weight of boom is approximately 3100 lb (1406kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Use a lifting device to support boom.
3. Shut engine off. Relieve all line pressure by operating control levers for boom, hoist, extend and winch in operator's compartment.

 **WARNING**

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause SERIOUS INJURY.

4. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

- Remove lower hoses first and, using suitable container, catch hydraulic oil that drains from manifold and hoses.
- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.
- Record port number stamped on manifold and type of adapter in each port before disconnecting hoses.

5. Disconnect six hoses (1, Figure 13-1) from bottom of manifold.
6. Remove six adapters (2) and O-rings (3) from manifold.
7. Disconnect six hoses (4, Figure 13-2) from side of manifold.

NOTE

Record port number stamped on manifold and type of elbow in each port before removal.

8. Remove six elbows (5) and O-rings (6) from side of manifold.
9. Remove stop pin (7) and lockwasher (8) from stop pin ear (9) attached to side of upperstructure.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

10. Remove electrical collector ring (refer to page 10-57).
11. Remove three capscrews (10) and washers (11, Figure 13-1) from bottom of manifold.

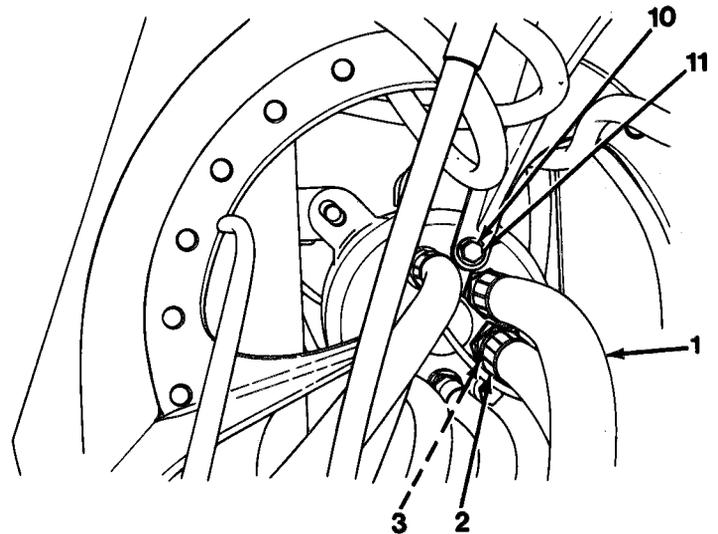


Figure 13-1

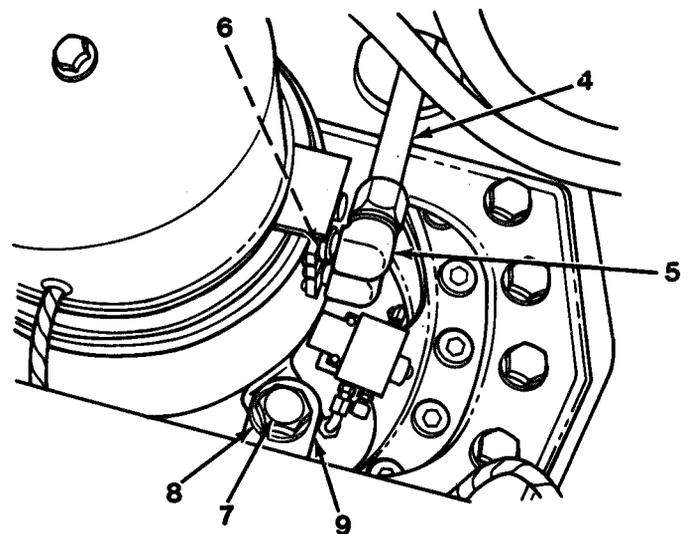


Figure 13-2

ROTARY MANIFOLD REMOVAL

⚠ WARNING

Weight of manifold is approximately 200 lb (91 kg). Use adequate lifting equipment to lift and support manifold. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

12. Loosen axle lockout valve mounting nuts (12, Figure 13-3).
13. Using a hoist and sling, remove manifold (13) by lifting and turning to clear stop pin ear (9) on upperstructure as manifold is removed.

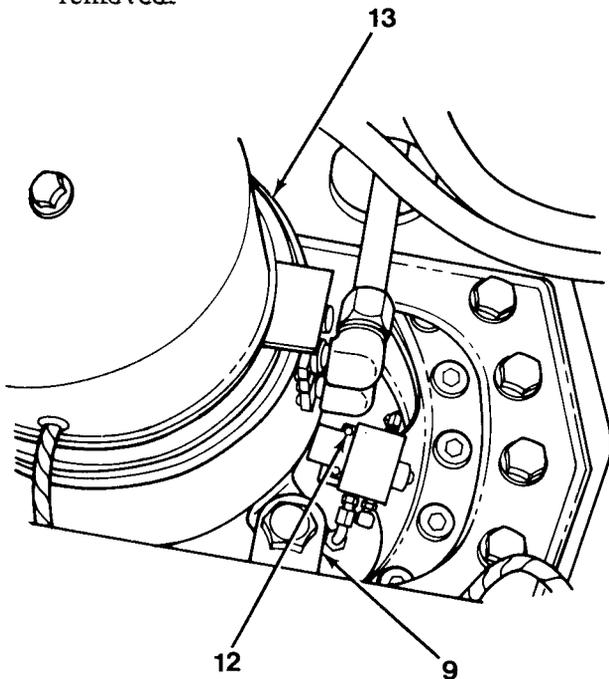


Figure 13-3

ROTARY MANIFOLD INSTALLATION

⚠ WARNING

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Use lifting device to support beam,

⚠ WARNING

Weight of manifold is approximately 200 lb (91 kg). Use adequate lifting equipment to lift and support manifold. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

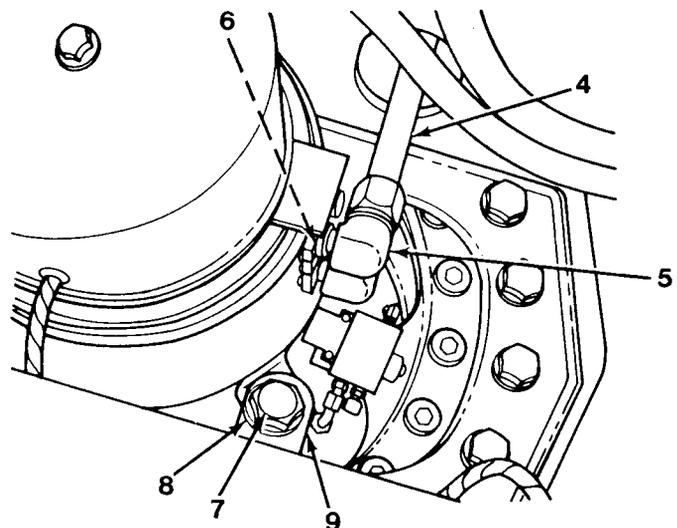


Figure 13-2

2. Using hoist and sling, install rotary manifold (13) by lifting manifold (13) over opening in carrier and lowering straight down and turning manifold to avoid stop pin ear (9, Figure 13-3) located on upperstructure.
3. Align ear on side of manifold to hole in stop pin ear (9).
4. Install lockwasher (8) and stop pin (7, Figure 13-2) into manifold.
5. Install three washers (11) and capscrews (10, Figure 13-1) through frame and into bottom of manifold.
6. Install six O-rings (6) and elbows (5, Figure 13-2) to side of manifold, as recorded.
7. Connect six hoses (4) to side of manifold.
8. Install six O-rings (3) and adapters (2, Figure 13-1) to bottom of manifold, as recorded.
9. Connect six hoses (1) to bottom of manifold.
10. Install electrical collector ring (refer to page 10-59).
11. Remove Ming device from boom.
12. Adjust axle lockout valve (refer to page 13-90).
13. Close dipstick cap. Start engine and operate control levers for boom hoist, telescope and winch several times to remove any air trapped in system.
14. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
15. Return boom to travel position. Shut engine off.

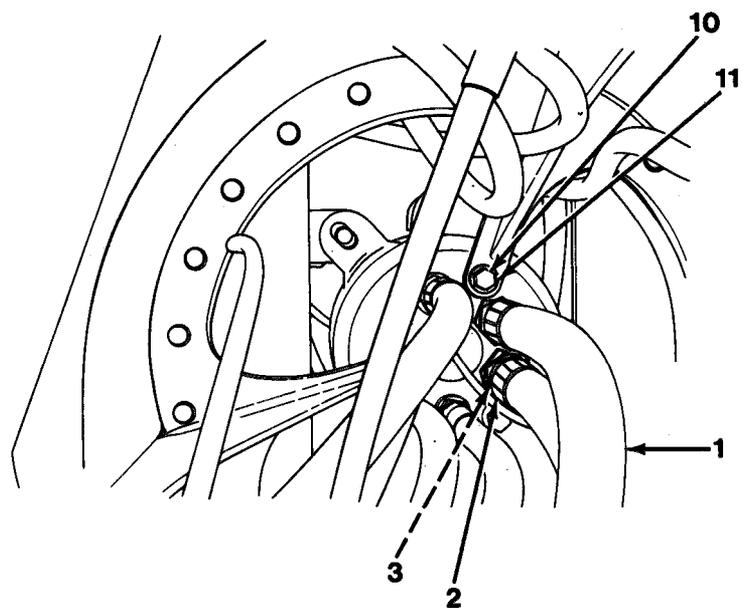


Figure 13-1

ROTARY MANIFOLD DISASSEMBLY

NOTE

Matchmark spool to case and aid in assembly.

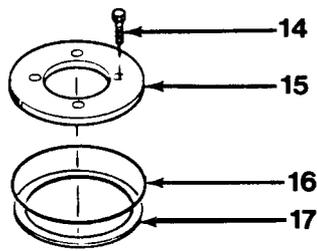


Figure 13-4

1. Remove four capscrews (14), plate (15), O-ring (16), and thrust washer (17, Figure 13-4).
2. Remove spool (18) from case (19, Figure 13-5) by pushing spool (18) out while holding case (19).
3. Remove back-up ring (20) and O-ring (21) from spool (18).
4. Remove two wear rings (22), seven teflon seals (23) and rectangular rings (24) from spool (18).
5. Remove O-ring (21) and back-up ring (20) from spool (18).
6. Remove and discard thrust washer (25) from spool (18).

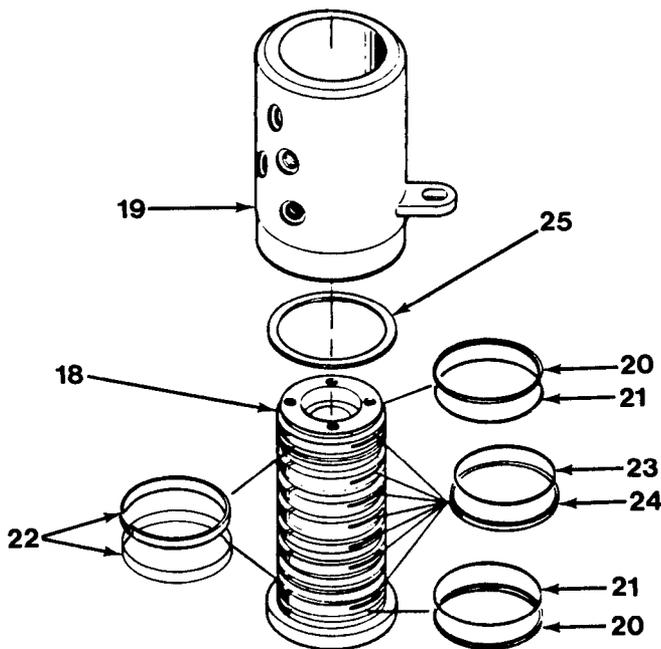


Figure 13-5

ROTARY MANIFOLD CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect bore of case for scoring or deep scratches that would indicate a contaminated hydraulic system.
3. Inspect spool for wear or damage.
4. Inspect hydraulic hose ports for contamination and crossed or stripped threads.
5. Inspect all other parts (refer to Chapter 4).

ROTARY MANIFOLD ASSEMBLY

NOTE

When replacing seals, caution must be used to prevent stretching, cutting or nicking seals. Seals must be walked on one side at a time. Before starting assembly, coat entire spool and bore of case with hydraulic oil.

1. Install thrust washer (25) on spool (18, Figure 13-5).
2. Install back-up ring (20) and O-ring (21) on spool (18).

CAUTION

Do not allow rectangular rings to "twist" in seal groove. Seals can be made pliable to aid in installation by soaking in 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

NOTE

Compress teflon seals while they cool so that seals return to their original shape.

3. Install seven rectangular rings (24), teflon seals (23) and two wear rings (22) on spool (18).
4. Carefully install spool (18) by pushing spool (18) into case (19) from bottom. Align matchmarks and seat spool (18) firmly.
5. Install O-ring (21) and back-up ring (20) on spool (18).
6. Install thrust washer (17), O-ring (16) and cover (15) with four capscrews (14, Figure 13-4).

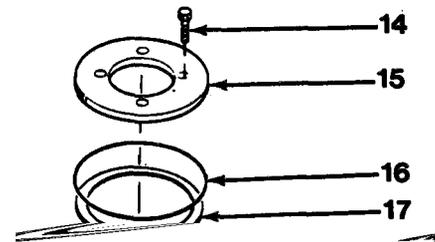


Figure 13-4

HYDRAULIC RESERVOIR

HYDRAULIC RESERVOIR REMOVAL

1. Start engine. Rotate boom to right side of carrier. Shut engine off.
2. Remove deck plate (refer to page 14-9).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

3. Turn dipstick cap 1/4 turn to safety to relieve pressure.

NOTE

Hydraulic reservoir capacity is 23.8 gallons (90.1 L).

4. Remove drain plug and O-ring (1) and drain hydraulic reservoir (9, Figure 13-1) into suitable container.
5. Remove return filter assembly (2, Figure 13-2) (refer to page 13-69).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

6. Disconnect hose (3) from elbow (4).
7. Remove elbow (4) and O-ring (5).

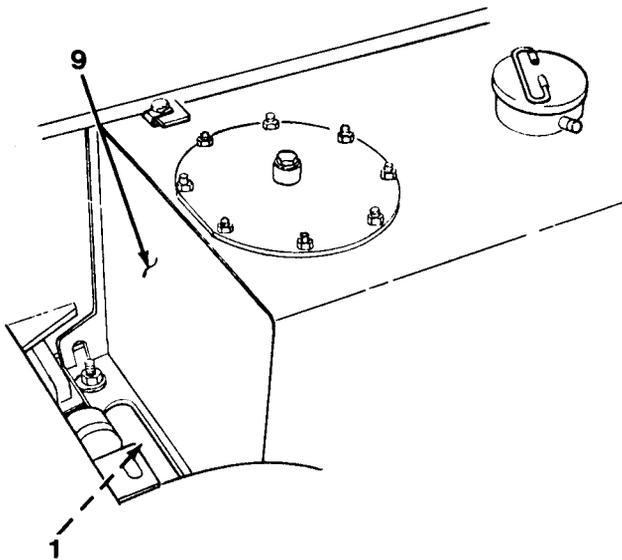


Figure 13-1

HYDRAULIC RESERVOIR REMOVAL

8. Remove suction manifold assembly (refer to page 13- 98).
9. Remove four nuts (6), washers (7), two cap-screws (8) and washers (7).

⚠ WARNING

Weight of hydraulic reservoir is approximately 190 lb (86 kg). Use adequate lifting equipment to lift and support hydraulic reservoir. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

10. Remove hydraulic system valve bank (refer to page 13-71).
11. Using suitable hoist and sling, lift hydraulic reservoir (19, Figure 13-1) out of carrier.
12. Remove four washers (7).

HYDRAULIC RESERVOIR INSTALLATION

1. Install four washers (7, Figure 13-2).

⚠ WARNING

Weight of hydraulic reservoir is approximately 190 lb (86 kg). Use adequate lifting equipment to lift and support hydraulic reservoir. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Using suitable hoist and sling, lift and position hydraulic reservoir (9, Figure 13-1) in carrier.
3. Install hydraulic system valve bank (refer to page 13-72).
4. Install four washers (7), two capscrews (8), washers (7) and four nuts (6, Figure 13-2).
5. Install suction manifold (refer to page 13-97).
6. Install O-ring (5) and elbow (4).

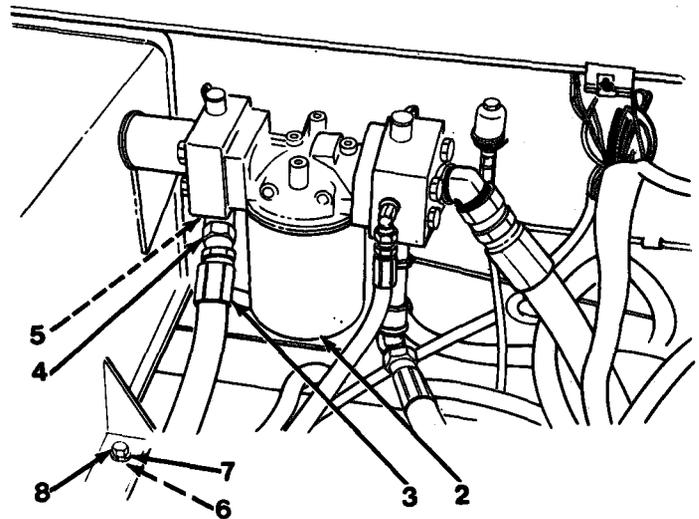
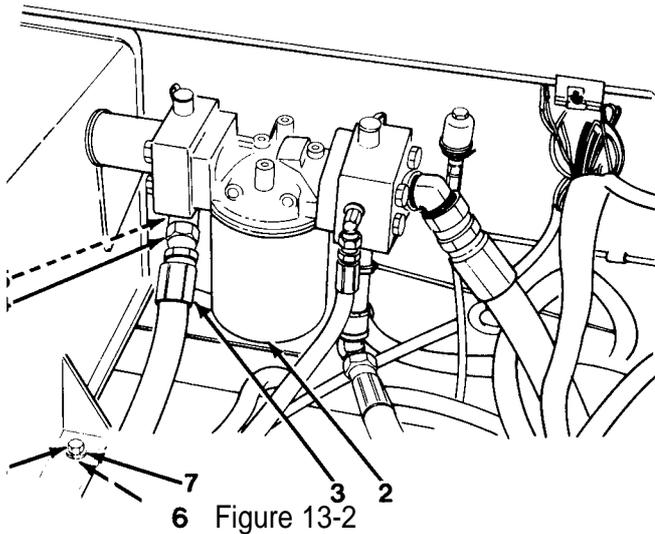


Figure 13-2



6 Figure 13-2

HYDRAULIC RESERVOIR INSTALLATION

7. Connect hose (3) to elbow (4, Figure 13-2).
8. Install drain plug and O-ring (1, Figure 13-1).
9. Install return filter assembly (2) (refer to page 13-70).
10. Fill reservoir to proper level. Pressurize system and check for leaks.
11. Bleed air from suction filter housing (refer to page 3-53).
12. Install deck plate (refer to page 14-9).

HYDRAULIC RESERVOIR DISASSEMBLY

1. Remove two disconnect nipples (10), O-rings (11) and dust caps (12, Figure 13-3).
2. Remove dipstick cap (13).
3. Remove eight nuts (14), washers (15), plug (16), O-ring (17), cover (18), O-ring (19), filter (20) and O-ring (21) from reservoir.

HYDRAULIC RESERVOIR CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

HYDRAULIC RESERVOIR ASSEMBLY

1. Install O-ring (21) and filter (20) in reservoir (Figure 13-3).
2. Install O-ring (19), cover (18), O-ring (17), plug (16), eight washers (15) and nuts (14) on reservoir.
3. Install dipstick cap (13), two dust caps (12), O-rings (11) and disconnect nipples (10).

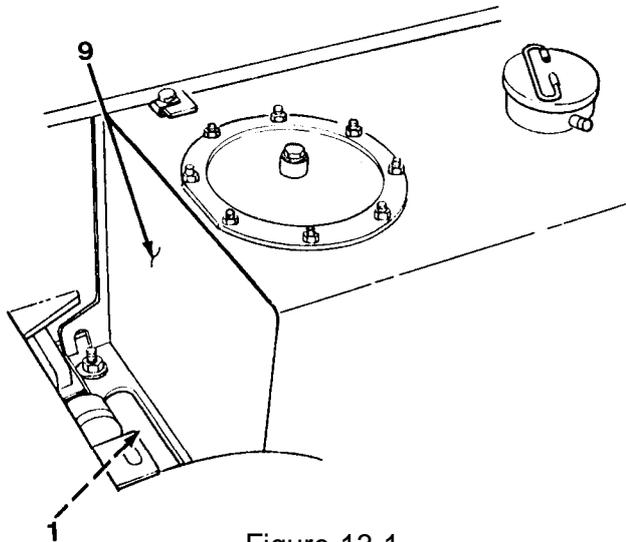


Figure 13-1

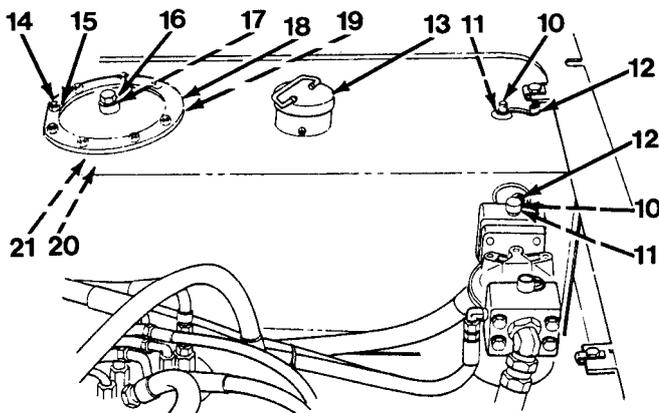


Figure 13-3

RETURN FILTER

NOTE

RETURN FILTER REMOVAL

1. Remove deck plate (refer to page 14-9).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
3. Position suitable container under filter to catch hydraulic oil.
4. Remove spin-on filter element (1, Figure 13-1) letting oil drain into container.

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

5. Disconnect hoses (2), (3) and (4) and remove elbows (5), (6) and (7) and O-rings (8), (9) and (10).
6. Remove check valve (11), adapter (12) and O-ring (13).
7. Remove nipple (14), dust cap (15) and O-ring (16) from manifold (19).
8. Remove four capscrews (17), washers (18), manifold (19) and O-ring (20).
9. Remove four capscrews (21), filter head (22) and O-ring (20).

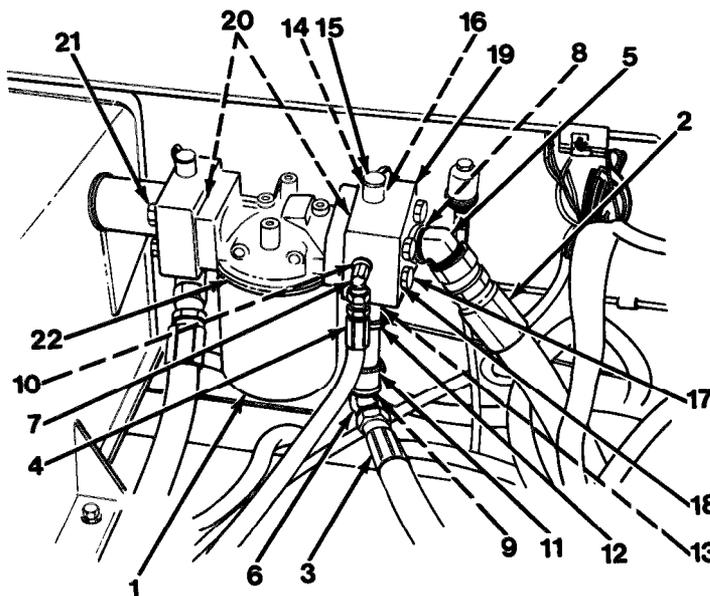


Figure 13-1

RETURN FILTER CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

RETURN FILTER INSTALLATION

1. Install two O-rings (20), filter head (22), and four capscrews (21, Figure 13-1).
2. Install manifold (19), four washers (18) and capscrews (17).
3. Install dust cap (15), nipple (14) and O-ring (16) on manifold (19).
4. Install O-ring (13), adapter (12) and check valve (11).
5. Install O-rings (10), (9) and (8) and elbows (7), (6) and (5).
6. Connect hoses (4), (3) and (2) cm elbows (7), (6) and (5).
7. Apply film of oil on filter seal and install spin-on filter element (1).
8. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
9. Pressurize system and check for leaks.
10. Install deck plate (refer to page 14-9).

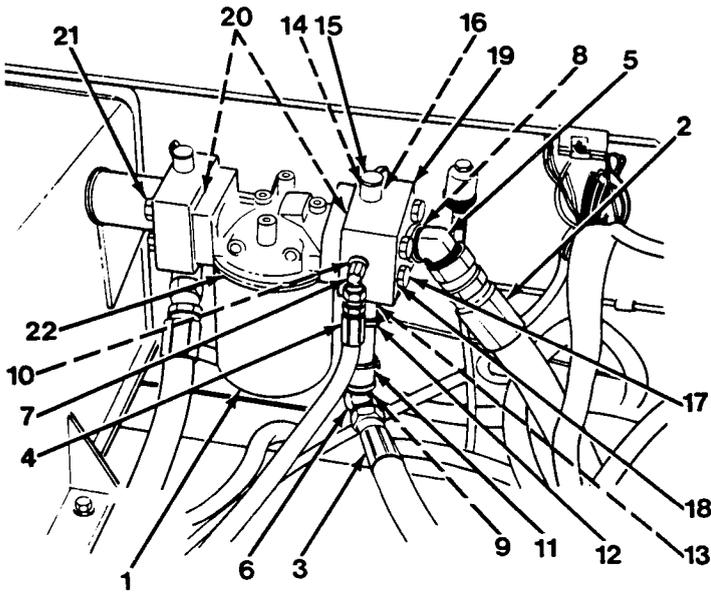


Figure 13-1

HYDRAULIC SYSTEM VALVE BANK

HYDRAULIC SYSTEM VALVE BANK REMOVAL

1. Remove deck plate and pinion cover plate from behind driver's cab (refer to page 14-9).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
3. Disconnect control cables and disconnect assemblies from control valve (refer to page 17-55).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in instigation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Disconnect all attaching hoses and fittings.
5. Remove three nuts (1), lockwashers (2) and capscrews (3, Figure 13-1).
6. Remove control valve (4) from frame location.
7. Remove three washers (5) from top frame.

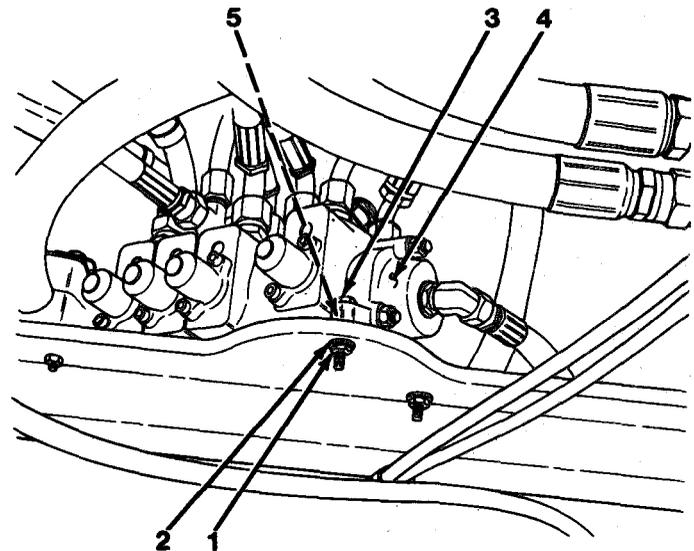


Figure 13-1

HYDRAULIC SYSTEM VALVE BANK CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

HYDRAULIC SYSTEM VALVE BANK INSTALLATION

1. Install three washers (5, Figure 13- 1) to top frame.
2. Position control valve (4) on frame location.
3. Install three capscrews (3), lockwashers (2) and nuts (1).
4. Connect all hoses and fittings. Note tags to insure correct location.
5. Connect control cables (refer to page 17-58).
6. Close dipstick cap. Start engine. Operate control levers. Make sure each component operates correctly. Check for leaks. Shut engine off.
7. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
8. Install deck plate and pinion cover plate (refer to page 14-9).

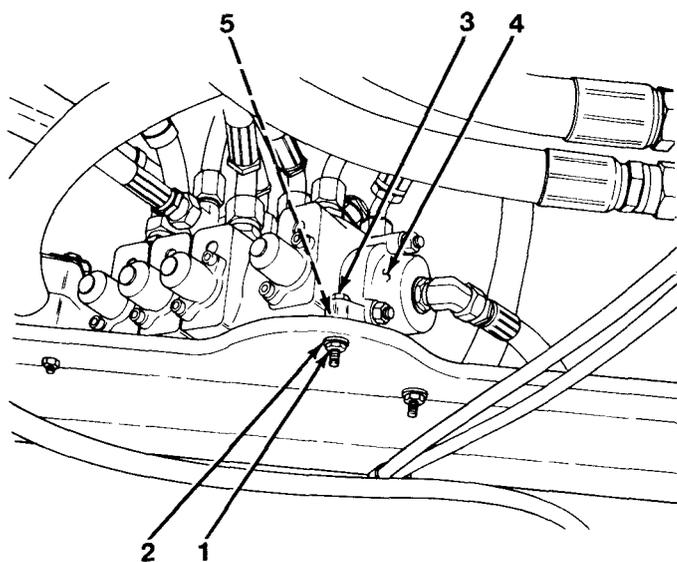


Figure 13-1

HYDRAULIC SYSTEM VALVE BANK TEST AND ADJUSTMENT

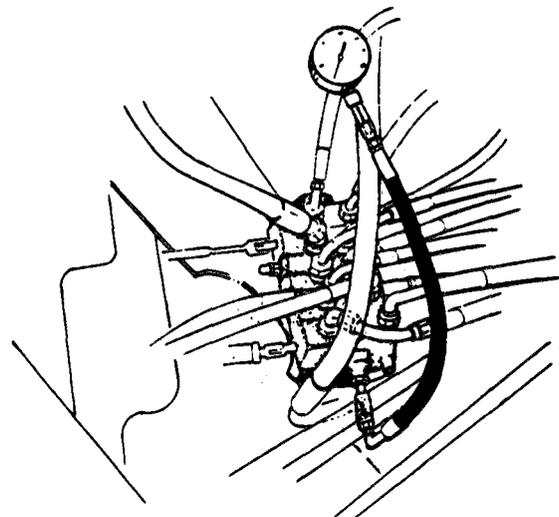
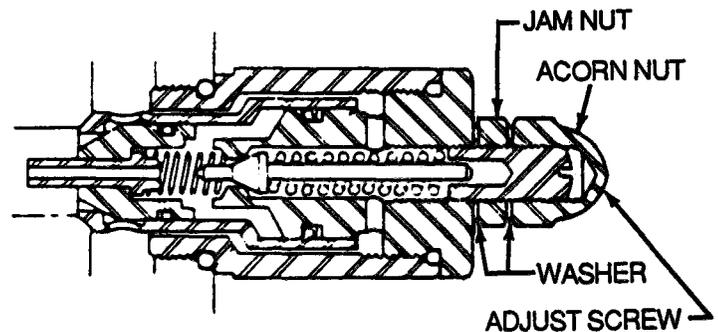
1. Remove deck plate (refer to page 14-9).
2. Remove pinion cover plate (refer to page 14-9).
3. Remove acorn nut from relief valve located on middle inlet of main control valve (Figure 13-2).
4. Remove dust cap and install a 0-4,000 psi (0-27,580 kPa) gauge equipped with short pressure hose and 1/4 in. female quick disconnect onto disconnect nipple located at end of main control valve.
5. Run engine at full rpm so pump will develop required flow.
6. Operate boom retract spool control valve to its extreme position long enough to get a pressure reading on gauge.
7. Hold adjusting screw and loosen jam nut. On relief valve, turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure, until desired pressure setting is obtained.

NOTE

Main control valve should be set at $2,750 \pm 50$ psi ($18,961 \pm 345$ lcpa) at full flow.

8. Hold adjusting screw and tighten jam nut. Install and tighten acorn nut.
9. Remove pressure gauge from test port and install dust cap.

RELIEF VALVE FOR THE MAIN CONTROL AND WINCH CONTROL VALVES



MAIN CONTROL VALVE

Figure 13-2

OUTRIGGER SOLENOID VALVE

OUTRIGGER SOLENOID VALVE REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

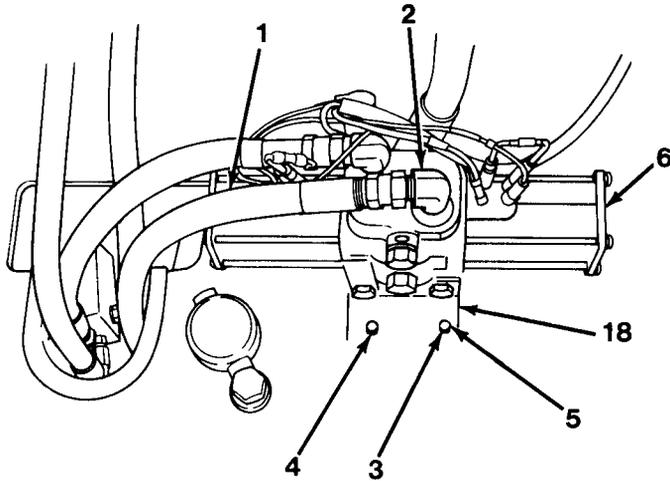


Figure 13-1

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

2. Disconnect four electric wires connected to outrigger solenoid valve (6, Figure 13-1).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

3. Disconnect three hoses (1) and remove elbows and O-rings (2) on outrigger solenoid valve (6). Cap hoses and plug holes in outrigger solenoid valve (6).
4. Remove four nuts (3), washers (4) and cap-screws (5) from mounting brackets (18). Remove outrigger solenoid valve (6) from carrier to a clean work bench.

OUTRIGGER SOLENOID VALVE INSTALLATION

1. Position outrigger solenoid valve (6) over mounting holes in outrigger box and install four capscrews (5), washers (4) and nuts (3, Figure 13-1).
2. Install three elbows and O-rings (2).
3. Connect three hoses (1) on elbows (2).
4. Connect four electric wires to outrigger solenoid valve.
5. Close dipstick cap. Start engine. Operate outrigger controls to bleed air from system. Check for leaks. Shut engine off.
6. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

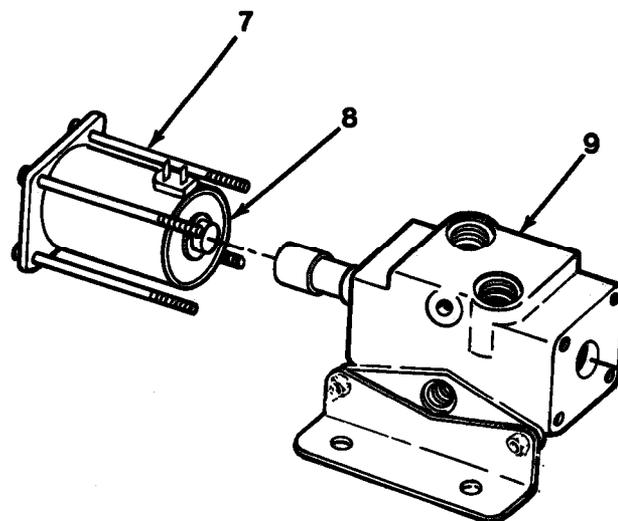


Figure 13-2

OUTRIGGER SOLENOID VALVE DISASSEMBLY

1. Remove eight capscrews (7) from case and tube assemblies (9, Figure 13-2).
2. Remove two solenoid coils (8) from case and tube assemblies (9).
3. Remove two spring retainers (10), springs (11) and spring retainers (12) from tubes (13, Figure 13-3).

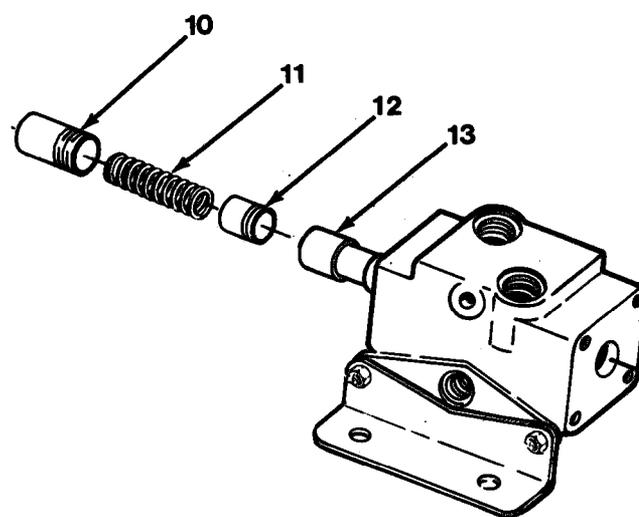


Figure 13-3

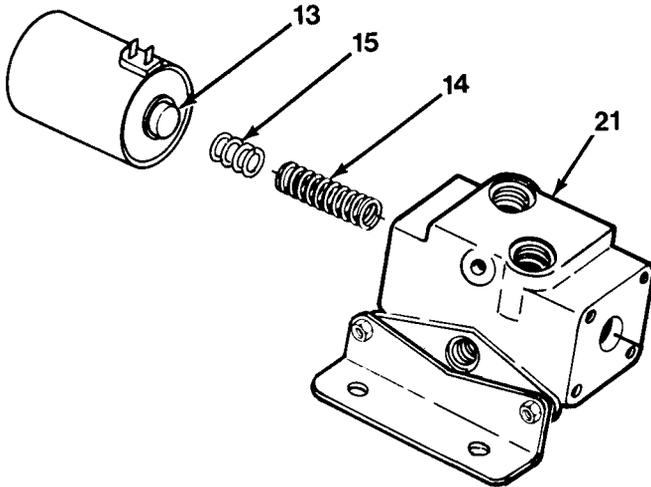


Figure 13-4

OUTRIGGER SOLENOID VALVE DISASSEMBLY

4. Remove two tubes (13) and springs (14, Figure 13-4).
5. Remove and discard four seals (15) from tubes (13).
6. Remove two retaining washers (16) and spool (17) from body (21, Figure 13-5).
7. Remove two brackets (18), only if damaged, by removing two capscrews (19) and nuts (20, Figure 13-6).

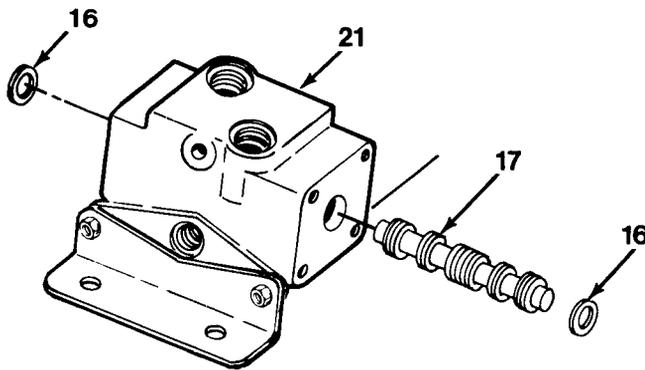


Figure 13-5

OUTRIGGER SOLENOID VALVE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

OUTRIGGER SOLENOID VALVE ASSEMBLY

1. If removed, install two brackets (18), two capscrews (19) and nuts (20) to body (21, Figure 13-6).
2. Coat spool (17) with clean hydraulic oil and install spool (17) and two retaining washers (16) to body (21, Figure 13-5).
3. Install four new seals (15) on two tubes (13, Figure 13-4).
4. Install two springs (14) and tubes (13) to body (21).

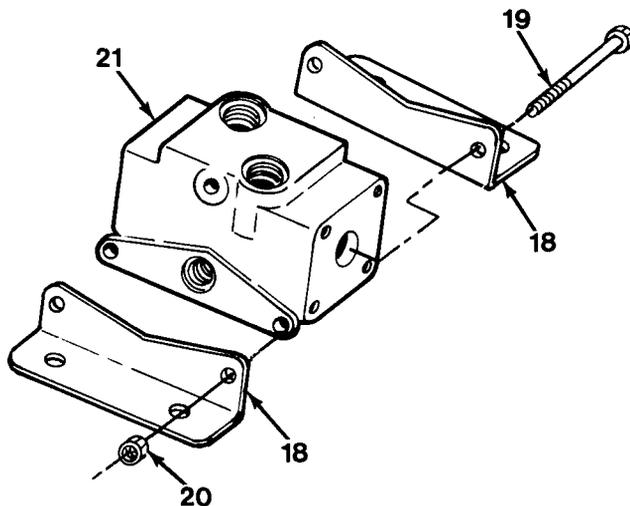


Figure 13-6

5. Install two spring retainers (12), springs (11) and spring retainers (10) to tubes (13, Figure 13-3).
6. Install two solenoid coils (8) to case and tube assemblies (9, Figure 13-2).
7. Install eight screws (7) to case and tube assemblies (9).

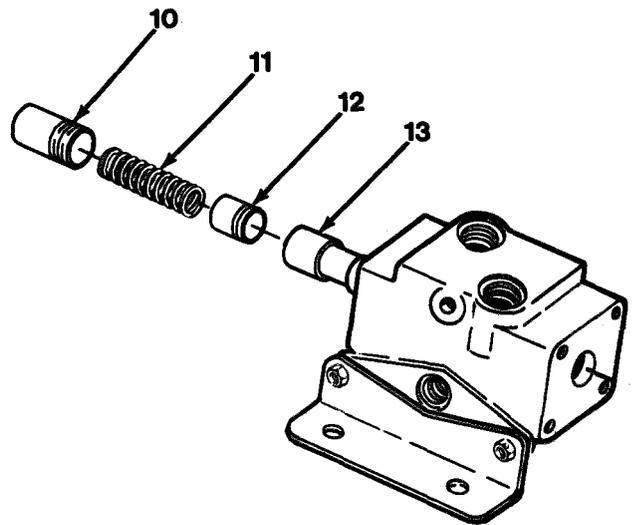


Figure 13-3

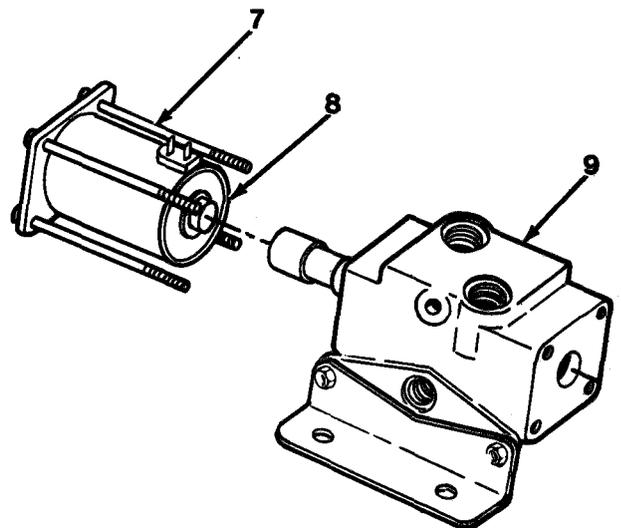


Figure 13-2

STEERING SELECTOR VALVE

STEERING SELECTOR VALVE REMOVAL

1. Start engine. Place boom in travel position.
2. Lower outriggers to ground. Level vehicle. Shut engine off.

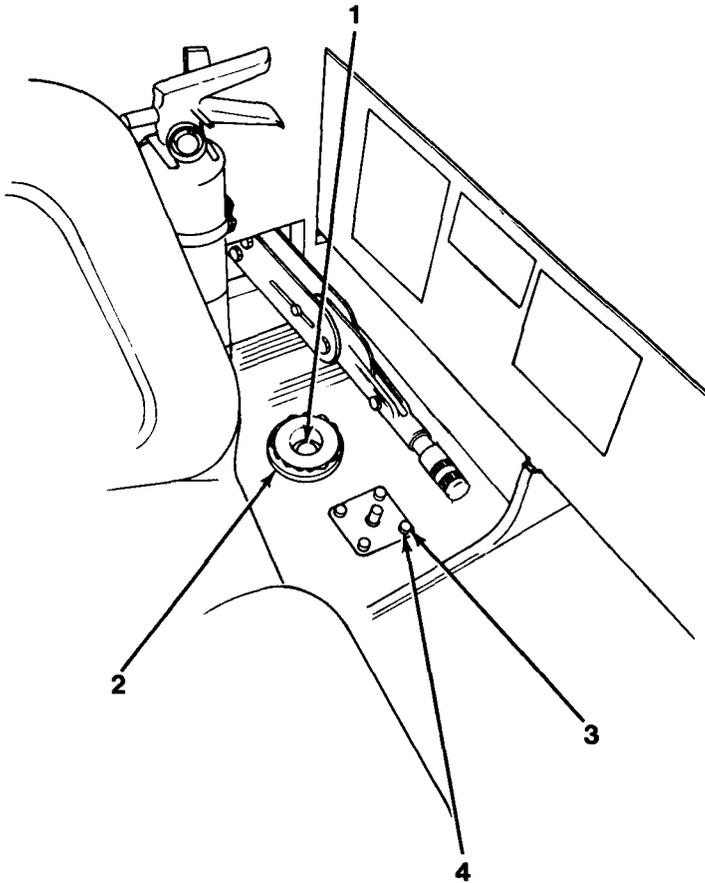


Figure 13-1

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

3. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Matchmark knob and vehicle body, noting position of arrow.

4. Remove set screw (1) and knob (2, Figure 13-1).

NOTE

Matchmark cap and underside of vehicle.

5. From inside of cab, remove four capscrews (3) and lockwashers (4).

NOTE

- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.
- A container will be necessary to catch hydraulic oil remaining in hose and tube assemblies after disconnecting.

6. From underside of vehicle, disconnect hoses (5), (6), (7) and (8) and remove steering selector valve (9, Figure 13-2).
7. Remove two elbows (10), adapters (11) and four O-rings (12).

STEERING SELECTOR VALVE
INSTALLATION

1. Install four O-rings (12), two adapters (11) and elbows (10, Figure 13-2).
2. Connect hoses (5), (6), (7) and (8) to elbows (10) and adapters (11).
3. Install valve (9) aligning matchmark on cap with matchmark on underside of vehicle.
4. From inside cab, install four lockwashers (4) and capscrews (3, Figure 13-1).

NOTE

Align matchmark on knob with matchmark on vehicle body.

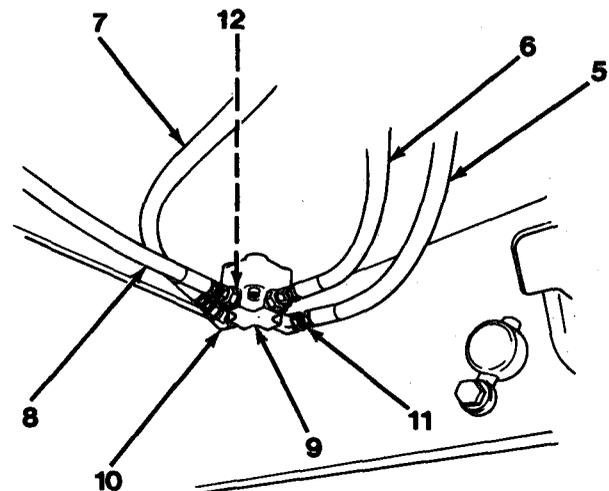


Figure 13-2

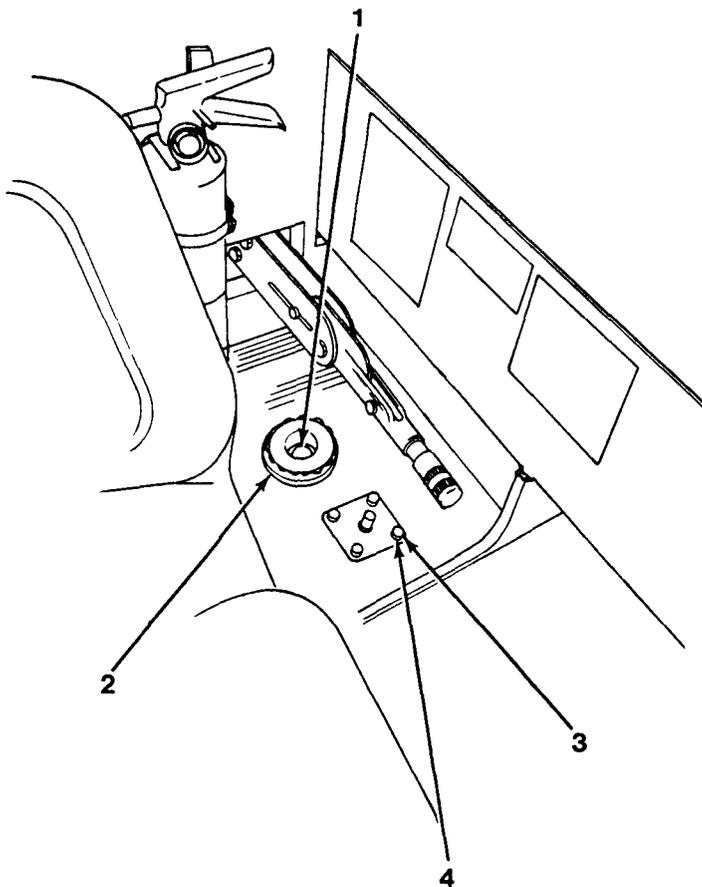


Figure 13-1

STEERING SELECTOR VALVE INSTALLATION

5. Install knob (2) and set screw (1, Figure 13-1).
6. Close dipstick cap, Start engine. Check selector valve operation and check for hydraulic oil leakage.
7. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

STEERING SELECTOR VALVE DISASSEMBLY

NOTE

Prior to disassembly, matchmark body and cap.

1. Remove four socket head capscrews (13, Figure 13-3).
2. Lift body (14) from cap (15).
3. Remove shaft washer (16) and body-cap O-ring (17).
4. Remove four seals (18) and spring seals (19).
5. Remove four back-up seal rings (20) and O-rings (21).

NOTE

Prior to disassembly, matchmark disc to cap and disc to shaft.

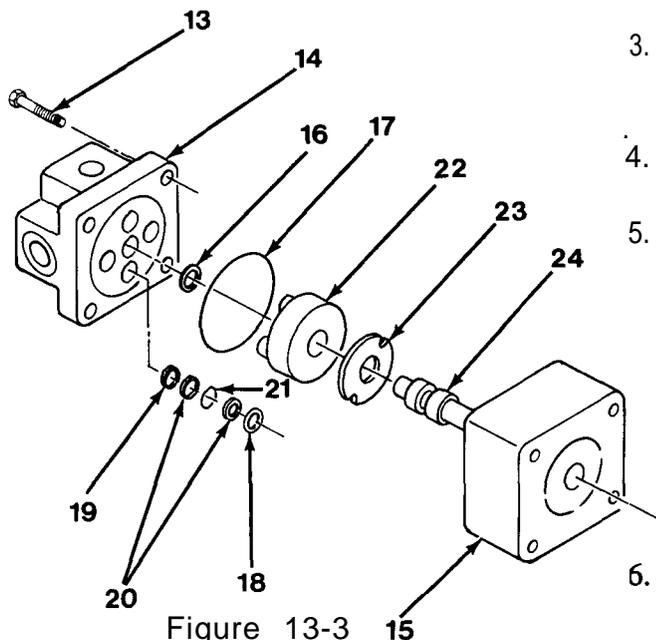


Figure 13-3

6. Remove disc (22), stop plate (23) and shaft (24).

7. Remove bearing (25) and race (26) from cap (15, Figure 13-4).
8. Remove two detent balls (27), detent springs (28) and detent bushings (29).
9. Remove shaft O-ring (30) and shaft back-up ring (31, Figure 13-5).
10. Remove stop pin (32) from cap (15).

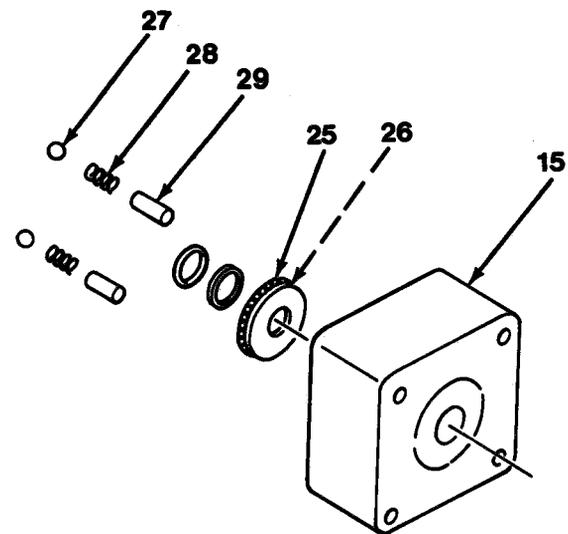


Figure 13-4

**STEERING SELECTOR VALVE
CLEANING/INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**STEERING SELECTOR VALVE
ASSEMBLY**

1. Install stop pin (32, Figure 13-5) and two detent bushings (29, Figure 13-4).
2. Install two detent balls (27) and detent springs (28).
3. Install new back-up ring (31) and shaft O-ring (30, Figure 13-5).
4. Install race (26) and bearing (25, Figure 13-4).
5. Install stop plate (23, Figure 13-3).
6. Align matchmarks from shaft (24), disc (22) and cap (15) and install shaft (24) and disc (22) in cap (15).

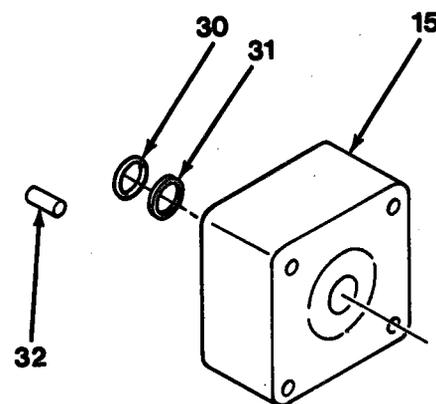
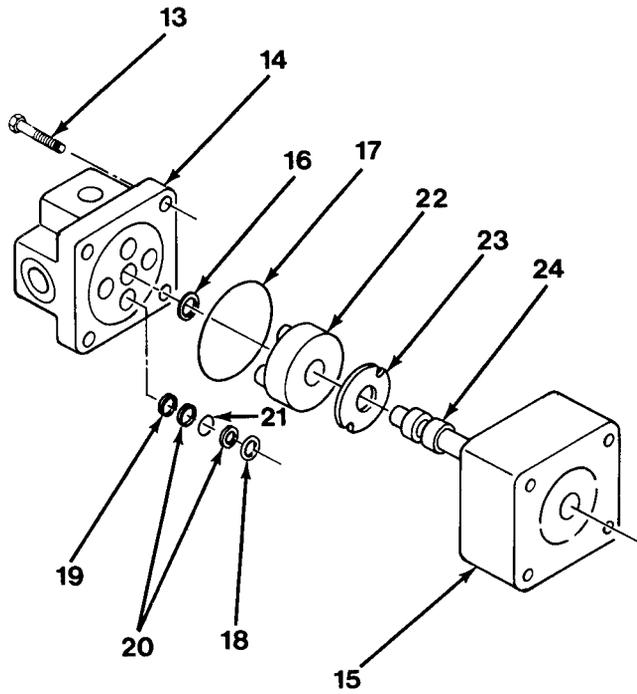


Figure 13-5

STEERING SELECTOR VALVE ASSEMBLY



7. Install four back-up seal rings (20) and O-rings (21) on four spring seals (19, Figure 13-3). Install four assembled spring seals (19).
8. Install four seals (18).
9. Install body-cap O-ring (17) and shaft washer (16) in body (14).
10. Align matchmarks on body (14) and cap (15) and using four capscrews (13), install cap (15) on body (14).

Figure 13-3

FLOW DIVIDER AND STEERING VALVE

FLOW DIVIDER AND STEERING VALVE REMOVAL

1. Remove deck plate (refer to page 14-9).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

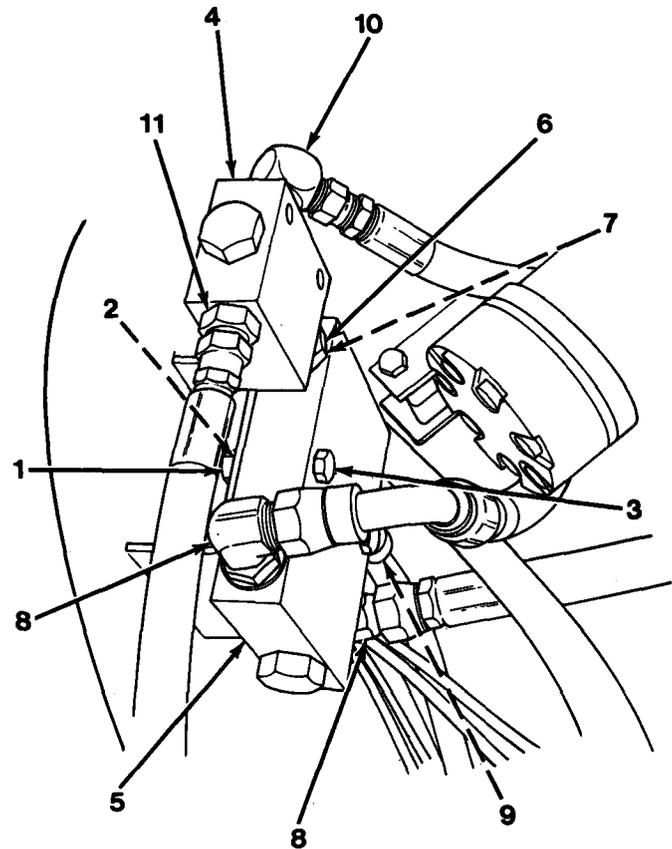


Figure 13-1

3. Disconnect hoses from flow divider (4) and steering valve (5, Figure 13-1).
4. Remove two nuts (1), lockwashers (2) and capscrews (3).
5. Remove flow divider (4) and steering valve (5) as a unit from its frame location.
6. Remove flow divider (4) horn steering valve (5). Remove adapter (6) and two O-rings (7).

FLOW DIVIDER AND STEERING VALVE REMOVAL

7. Remove two elbows and O-rings (8, Figure 13-1).
8. Remove adapter and O-ring (9).
9. Remove elbow and O-ring (10) and adapter and O-ring (11).

FLOW DIVIDER AND STEERING VALVE INSTALLATION

1. Install adapter and O-ring (11).
2. Install elbow and O-ring (10).
3. Install adapter and O-ring (9).
4. Install two elbows and O-rings (8).
5. Install two O-rings (7) and adapter (6). Install flow divider (4) onto steering valve (5).
6. Install flow divider (4) and steering valve (5, Figure 13- 1) as a unit.
7. Install two capscrews (3), lockwashers (2) and nuts (1).
8. Connect all hoses and fittings. Note tags to insure correct location.
9. Close dipstick cap. Start engine. Check for leaks. Shut engine off.
10. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
11. Check for proper operation of steering including ground driven steering (engine off) and vehicle in motion.
12. Install deck plate (refer to page 14-9).

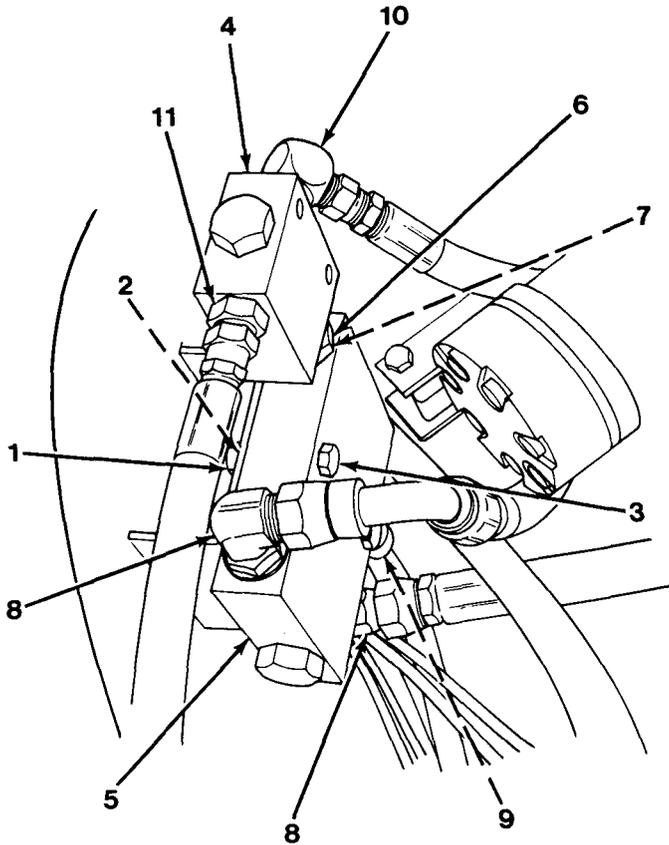


Figure 13-1

FLOW DIVIDER AND STEERING VALVE DISASSEMBLY

1. Remove three check valves (12) from steering valve (5, Figure 13-2).
2. Remove O-ring (13), back-up ring (14) and O-ring (15) from each check valve (12).
3. Remove piston (16) from steering valve (5.)

FLOW DIVIDER AND STEERING VALVE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

FLOW DIVIDER AND STEERING VALVE ASSEMBLY

1. Install piston (16) into steering valve (5, Figure 13-2).
2. Install O-ring (15), back-up ring (14) and O-ring (13) on each check valve (12).
3. Install three check valves (12) into steering valve (5).

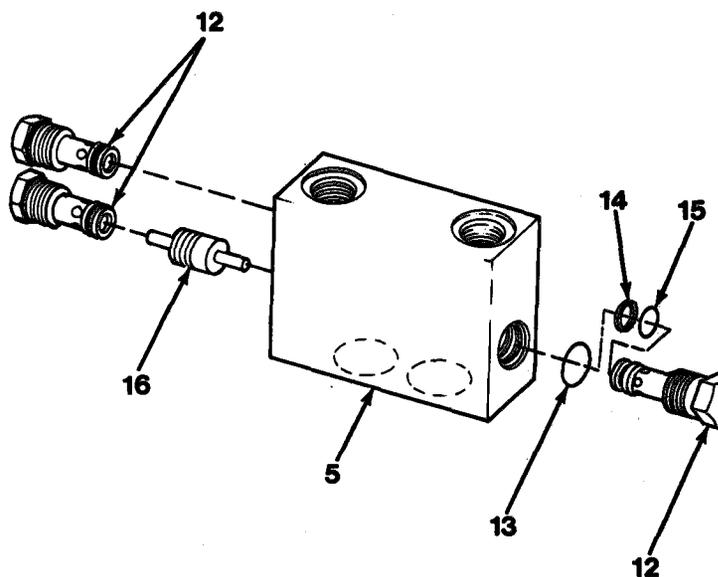


Figure 13-2

RELIEF VALVE

RELIEF VALVE REMOVAL

! WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Remove lower dash panel (refer to page 13-114, step 2).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

3. Disconnect hoses from relief valve (5, Figure 13-1).
4. Loosen jam nut (1) on adapter (6).
5. Remove tee (2) from adapter (9).
6. Disconnect hose (3) and remove elbow and O-ring (4) from inlet port on brake booster (12).
7. Remove relief valve (5) and adapter (6) from brake booster (12).
8. Remove adapter (6) from relief valve (5).
9. Remove O-rings (7).
10. Remove elbow and O-ring (8).
11. Remove adapter and O-ring (9).
12. Remove nipple and O-ring (10) and dust cap (11).

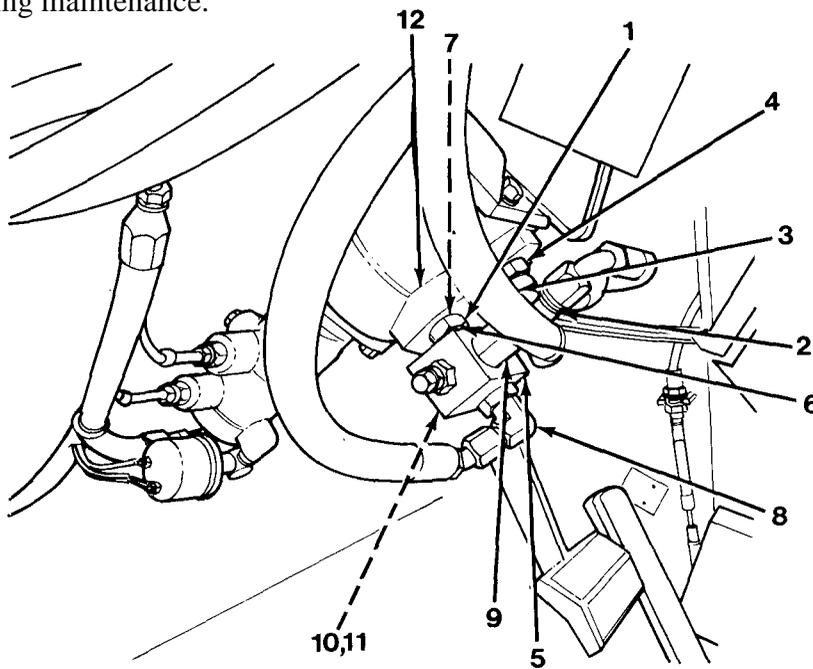


Figure 13-1

RELIEF VALVE CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

RELIEF VALVE INSTALLATION

1. Install dust cap (11) and nipple and O-ring (10, Figure 13-1).
2. Install adapter and O-ring (9).
3. Install elbow and O-ring (8).
4. Install O-rings (7) on adapter (6).
5. Install adapter (6) to relief valve (5).
6. Install relief valve (5) on brake booster (12).
7. Install elbow and O-ring (4) on brake booster (12).
8. Install tee (2) on adapter (9).
9. Tighten jam nut (1) on adapter (6).
10. Connect all hoses to relief valve (5) and brake booster (12).
11. Install lower dash panel (refer to page 13-115, step 5).
12. Close dipstick cap. Start engine. Check for leaks. Shut engine off.
13. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

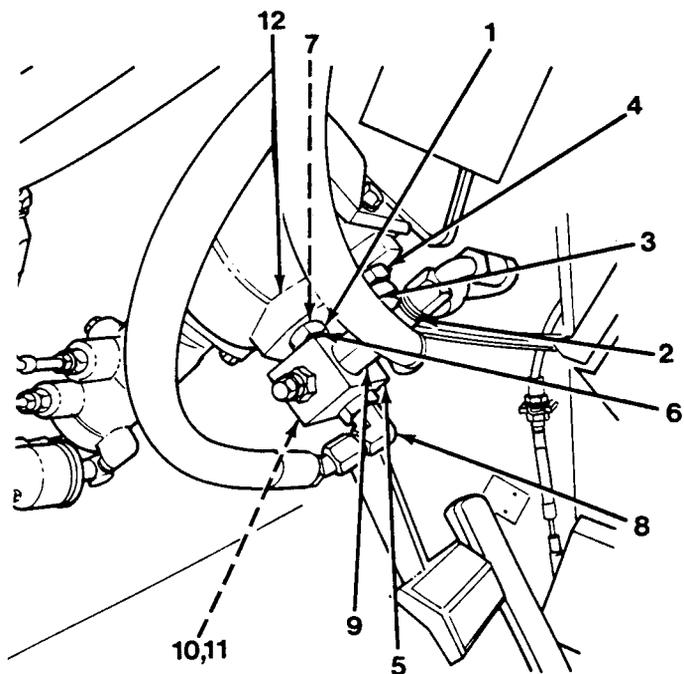


Figure 13-1

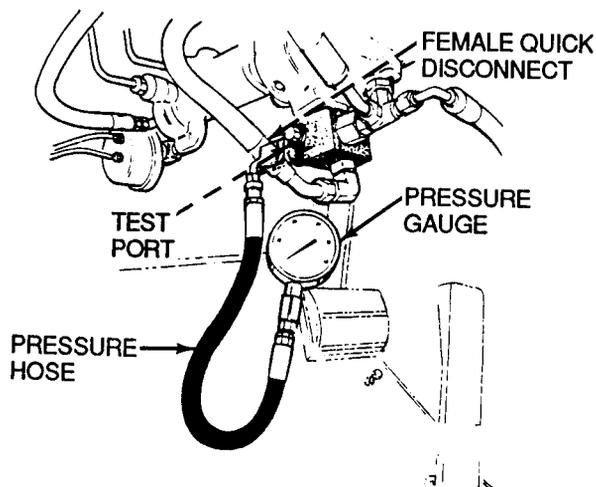


Figure 13-2

RELIEF VALVE TESTING AND ADJUSTMENT

1. Remove lower dash panel (refer to page 13-114, step 2).
2. Remove dust cap (11, Figure 13-1).
3. Install a 0-4,000 psi (0-27,580 kPa) gauge equipped with a short pressure hose and 1/4 in. female quick disconnect on test port (Figure 13-2).
4. Start engine. Run engine at full rpm.
5. Hold steering wheel in full turn position long enough to get pressure reading.

NOTE

Valve setting is $2,500 \pm 50$ psi ($17,238 \pm 345$ kPa) at full rpm. Relief valve controls steering and swing pressure.

6. Hold adjusting screw and loosen jam nut. Hold steering wheel in full position and turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure until desired pressure setting is obtained (Figure 13-3).
7. Hold adjusting screw and tighten jam nut.
8. Repeat step 5.
9. Shut engine off.
10. Remove pressure gauge from test port.
11. Install dust cap (11, Figure 13-1).
12. Install lower dash panel (refer to page 13-115, step 5).

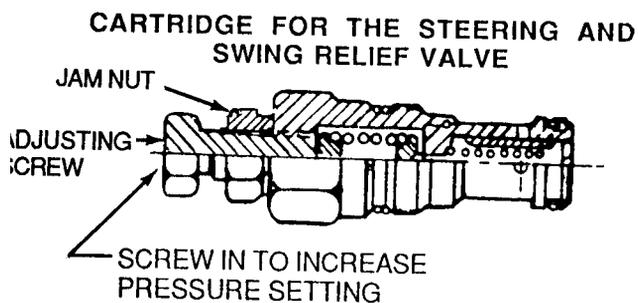


Figure 13-3

AXLE LOCKOUT VALVE

AXLE LOCKOUT VALVE REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Disconnect hoses (1), (2) and (3) from axle lockout valve (7, Figure 13- 1).
3. Remove two mounting nuts (4), washers (5) and capscrews (6).
4. Remove axle lockout valve (7) from vehicle.
5. Remove adapter (9), two elbows (8), and three O-rings (10) from axle lockout valve (7).

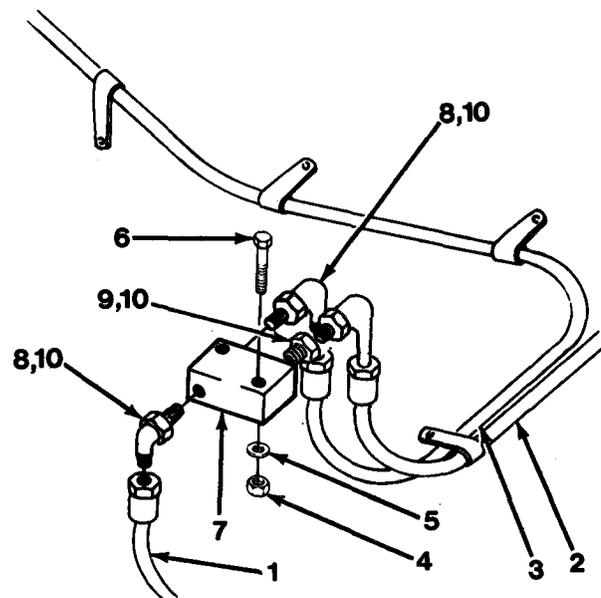


Figure 13-1

AXLE LOCKOUT VALVE CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

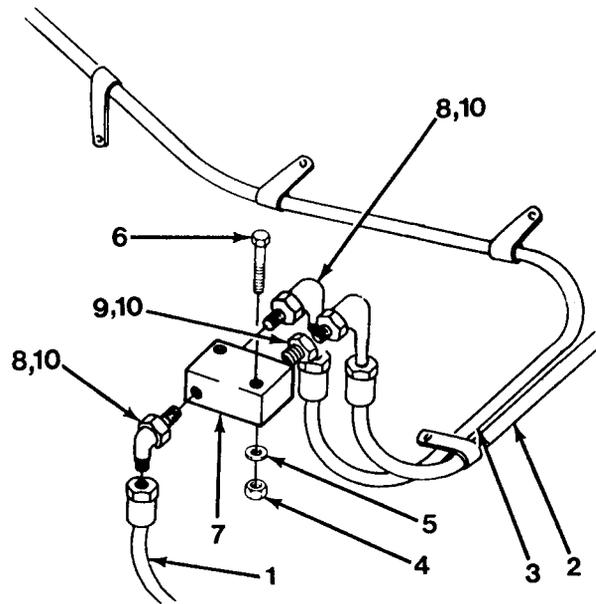


Figure 13-1

AXLE LOCKOUT VALVE INSTALLATION

1. Install three O-rings (10), two elbows (8), and adapter (9) in axle lockout valve (7, Figure 13- 1), Install elbows (8) pointing down.
2. Install axle lockout valve (7).
3. Install two capscrews (6), washers (5) and mounting nuts (4). Do not tighten capscrews (6) at this time.
4. Install hoses (1), (2) and (3).
5. Close dipstick cap. Start engine. Rotate upperstructure to the travel position and check for leaks.
6. Open bleed screws on axle lockout cylinders until all air escapes. Tighten bleed screws. Shut engine off.
7. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual),
8. Adjust axle lockout valve.

AXLE LOCKOUT VALVE ADJUSTMENT

1. Start engine and rotate upperstructure approximately 45 degrees. Shut engine off.
2. Insert 0.010 in. (0.25 mm) gauge between axle lockout valve rollers and high area of cam surface on rotary manifold (Figure 13-2). Slide axle lockout valve toward rotary manifold until axle lockout valve spring is fully compressed and hold in that position while tightening mounting nuts.
3. Remove 0.010 in. (0.25 mm) gauge.

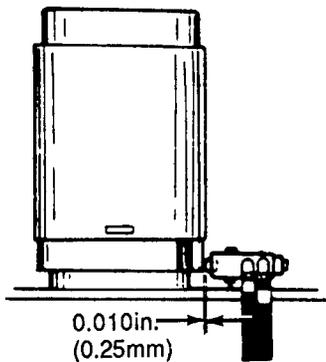


Figure 13-2

GENERAL HOSE REPAIR

All hoses and tubes are to be kept clear of any foreign elements and must be checked for damage, leaks, loose fittings and loose clamps. If a stain appears around a connection, it is usually the sign of a leak and must be checked.

WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

The following are some suggested procedures to maintain good hose and tube connections:

1. Check all seals for leaks, cracks, fraying and deterioration. Be sure seals are properly installed.
2. Check all gaskets for leaks caused by deterioration. When installing new gaskets, be sure all mounting surfaces are clear of old gasket material.
3. Check all joints and plugs for signs of leakage. Tighten all plugs and screws as required.

CAUTION

When installing any hydraulic fitting, torque the fitting to align with the connecting lines. Do not over-torque the fitting and try to reposition it later. Repositioning can loosen fittings and cause leaks. It can also damage pre-formed packings.

4. Check all fittings and connectors. If stained or loose, torque per charts in Appendix A.

All hoses and tubes are to be tagged before disconnecting to aid in assembly and all open ports are to be plugged or capped to avoid contamination. Be sure to remove tags, plugs and caps before installing hoses or tubes.

When installing fittings, be sure to refer to the maintenance instructions of that component for recommended sealant or lubricant to be used, if required.

CAUTION

Do not clean seals or flexible hoses with dry cleaning solvent. Dry cleaning solvent causes leather, rubber and synthetic materials to dry rot and lose pliability, making them unserviceable.

Be sure all hoses and tubes are properly cleaned before installing (refer to Chapter 2).

Hoses and tube clamps that are mounted with capscrews must have Loctite 242 applied to capscrew threads.

OUTRIGGER HYDRAULICS

OUTRIGGER HYDRAULICS REMOVAL



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Remove right front outrigger hold valve (refer to page 13-26, step 7).
3. Remove hoses (1) and (2), from outrigger hold valve, solenoid and elbow (6, Figure 13-1).
4. Remove left front outrigger hold valve (refer to page 13-26, step 7).
5. Remove nut (11), washer (12), clamps (3) and washer (16).
6. Remove hoses (4) and (5), elbow (6) and tee (7) from outrigger hold valve.
7. Disconnect hose (8) from elbow (9).
8. Remove one of two plastic ties (10), four of seven nuts (11), washers (12), two of four clamps (13), two of six clamps (14), clamp (15) and four of seven washers (16).
9. Remove hose (8) from elbow (17).

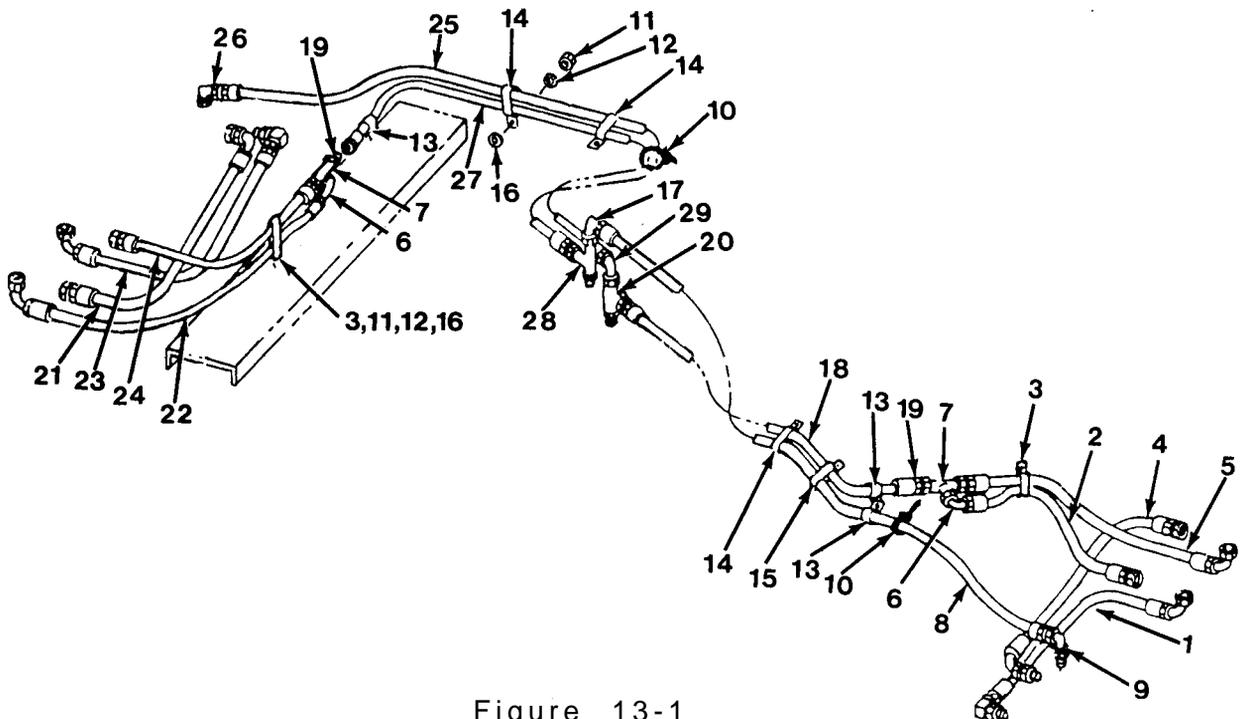


Figure 13-1

10. Remove elbow (6) from tee (7).
 11. Remove tee (7) from adapter (19) and remove adapter (19) from hose (18).
 12. Remove hose (18) from tee (20).
 13. Remove right rear outrigger hold valve (refer to page 13-26, step 7).
 14. Remove hoses (21) and (22) from outrigger hold valve, solenoid and elbow (6).
 15. Remove left rear outrigger hold valve (refer to page 13-26, step 7).
 16. Remove nut (11), washer (12), clamp (3) and washer (16).
 17. Remove hoses (23) and (24), elbow (6) and tee (7) from outrigger hold valve.
 18. Disconnect hose (25) from elbow (26).
 19. Remove remaining three of seven nuts (1 1), washers (12), two of six clamps (14), one of four clamps (13) and three of seven washers (16).
 20. Remove remaining two of six clamps (14), remaining one clamp (13) and remaining plastic tie (10) from hoses (25) and (27).
 21. Remove hose (25) from tee (28).
 22. Disconnect hose (27) from elbow (29).
 23. Remove hose (27) from adapter (19).
 24. Remove adapter (19) and elbow (6) from tee (7).
 25. Remove elbow (29) from tee (20).
 26. Remove elbow (17) from tee (28).
-

OUTRIGGER HYDRAULICS CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

OUTRIGGER HYDRAULICS INSTALLATION

1. Apply Loctite 242 to outrigger hold valve adapter threads. Install hoses (22) and (21) on right rear outrigger hold valve, solenoid and elbow (6, Figure 13- 1).
2. Install outrigger hold valve (refer to page 13-27, step 4).
3. Apply Loetite 242 to outrigger hold valve adapter threads. Install hoses (24) and (23) on left rear outrigger hold valve and tee (7).
4. Install outrigger hold valve (refer to page 13-27, step 4).

5. Install hose (25) on elbow (26) and tee (28).
6. Install elbow (6) in tee (7).
7. Install adapter (19) on tee (7).
8. Install hose (27) on adapter (19).
9. Install hose (27) on elbow (29).
10. Install washer (16), clamp (3), washer (12) and nut (11).
11. Install two of six clamps (14) and clamp (13) on hoses (27) and (25).
12. Install three of seven washers (16), two of four clamps (14), clamp (13) and three of seven washers (12) and nuts (11).
13. Install one of two plastic ties (10) on hoses (27) and (25).

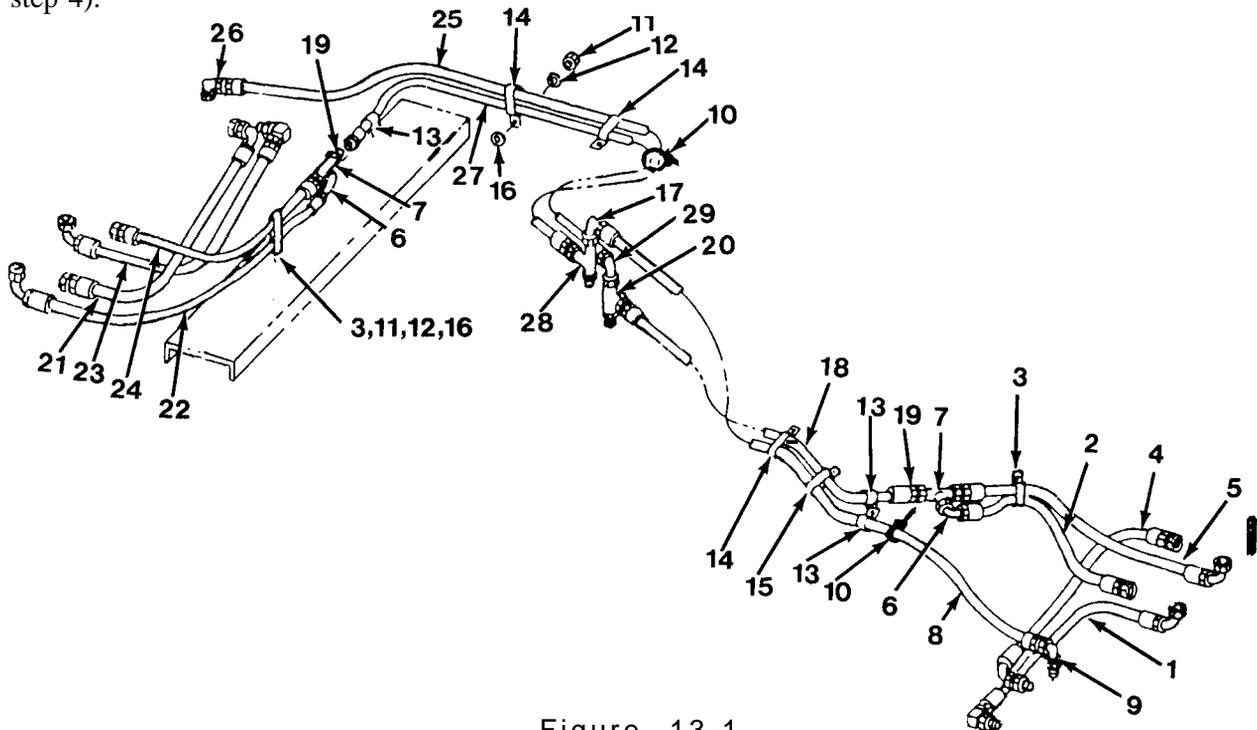


Figure 13-1

-
14. Apply Loctite 242 to left front outrigger hold valve adapter threads. Install hoses (5) and (4) on solenoid, tee (7) and outrigger hold valve.
 15. Install outrigger hold valve (refer to page 13-27, step 4).
 16. Apply Loctite 242 to right front outrigger hold valve threads. Install hoses (2) and (1) on outrigger hold valve, solenoid and elbow (6).
 17. Install outrigger hold valve (refer to page 13-27, step 4).
 18. Install elbow (17) on tee (28).
 19. Install one end of hose (8) on elbow (17) and the other end on elbow (9).
 20. Install adapter (19) on tee (7).
 21. Install elbow (6) on tee (7).
 22. Install hose (18) on adapter (19).
 23. Install tee (20) on elbow (29).
 24. Install hose (18) on tee (20).
 25. Install washer (16), clamp (3), washer (12) and nut (11).
 26. Install two of four clamps (13) and two of four clamps (14) on hoses (18) and (8).
 27. Install clamp (15), remaining four of seven washers (16), remaining two of four clamps (13), remaining two of six clamps (14) and remaining four of seven washers (12) and nuts (11).
 28. Install remaining one of two plastic ties (10) on hose (8).
 29. Close dipstick cap. Start engine. Check for leaks. Shut engine off.
 30. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
-

SUCTION HYDRAULICS

NOTE

SUCTION HYDRAULICS REMOVAL



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Drain hydraulic reservoir (refer to page 3-52).

3. Loosen four clamps (1) and remove hose (2, Figure 13-1).
4. Remove four clamps (1) from hose (2).
5. Remove four capscrews (3), two cover plates (4) and half clamps (5).
6. Loosen two T-bolt clamps (6) and remove pump suction tube (7).
7. Loosen two T-bolt clamps (8) and remove hoses (9) and (10). Remove four T-bolt clamps (8) from hoses (9) and (10).
8. Remove four capscrews (11), lockwashers (12) and beaded insert (13).
9. Remove O-ring (14) from inside beaded insert (13).

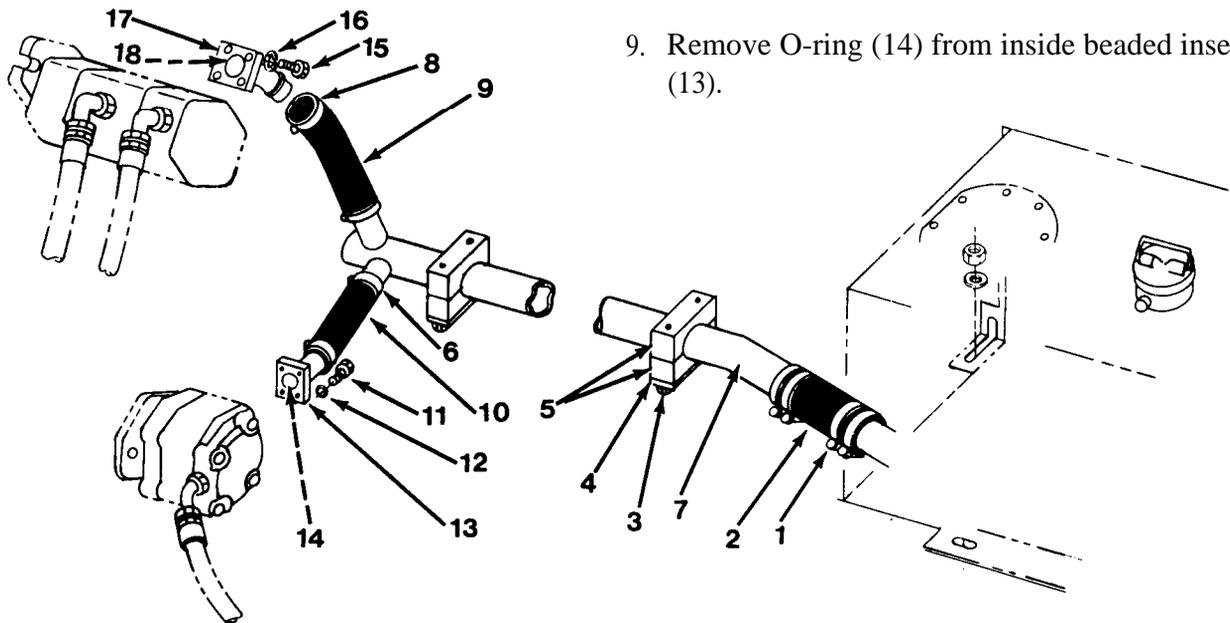


Figure 13-1

10. Remove four capscrews (15), lockwashers (16) and beaded insert (17).

11. Remove O-ring (18) from inside beaded insert (17).

SUNTION HYDRAULICS CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).

2. Inspect all parts (refer to Chapter 4).

SUCTION HYDRAULICS INSTALLATION

1. Install O-ring (18) in beaded insert (17, Figure 13-1).

2. Position beaded insert (17) and install four lockwashers (16) and capscrews (15).

3. Install O-ring (14) in beaded insert (13).

4. Position beaded insert (13) and install four lockwashers (12) and capscrews (11).

5. Position T-bolt clamp (8) on hose (9).

6. Install hose (9) on beaded insert (17) and tighten T-bolt clamp (8).

7. Install T-bolt clamp (8) on hose (10).

8. Install hose (10) on beaded insert (13) and tighten T-bolt clamp (8).

9. Install two T-bolt clamps (6) on hoses (9) and (10).

10. Install pump suction tube (7) in hoses (10) and (9) and tighten two T-bolt clamps (6).

11. Position pump suction tube (7) and install two half clamps (5), cover plates (4) and four capscrews (3).

12. Install four clamps (1) on hose (2).

13. Install hose (2) and tighten four clamps (1).

14. Fill hydraulic reservoir (refer to page 3-53, step 9).

15. Close dipstick cap. Start engine. Check for leaks. Shut engine off.

16. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

10. Remove cage (13), ball (14), spring (15) and O-ring (16).
11. Remove spring (17) from housing (38, Figure 13-4).

CAUTION

Care should be taken when removing retaining ring so it will not scratch or mar housing bore. Failure to follow this procedure could cause damage to equipment.

12. Remove retaining ring (18) and piston (19) from housing (38).
13. Remove and discard cup (20) from piston (19).

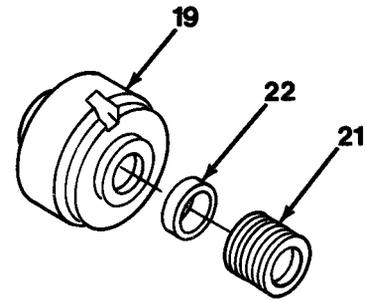


Figure 13-5

14. Remove retainer (21) and seat (22) from piston (19, Figure 13-5).
15. Remove retaining ring (23) from flange end of housing (38, Figure 13-6).
16. Remove piston (24) and spring (25) from housing (38, Figure 13-7).

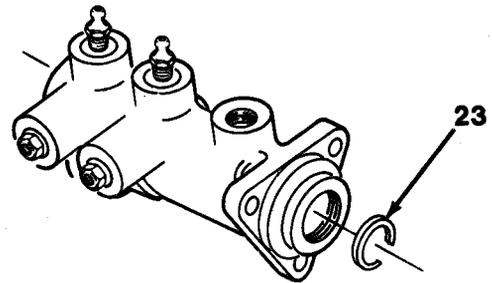


Figure 13-6

17. Remove and discard cup (26) from piston (24).
18. Remove retaining ring (27) from piston (24, Figure 13-8).

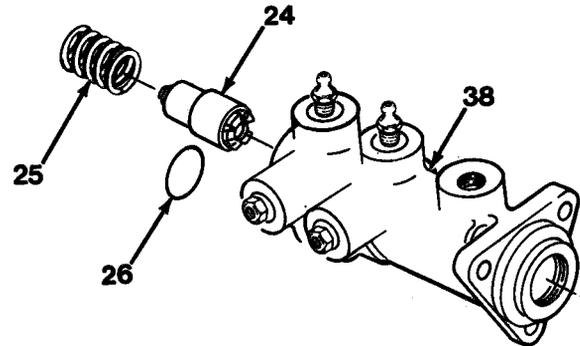


Figure 13-7

19. Remove washer (28) and piston (29).
20. Remove and discard two cups (30), O-ring (31) and back-up ring (32) from piston (29).

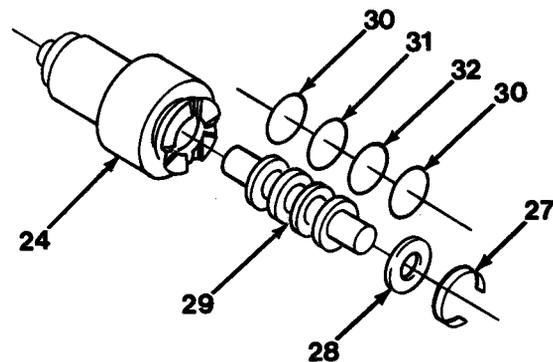


Figure 13-8

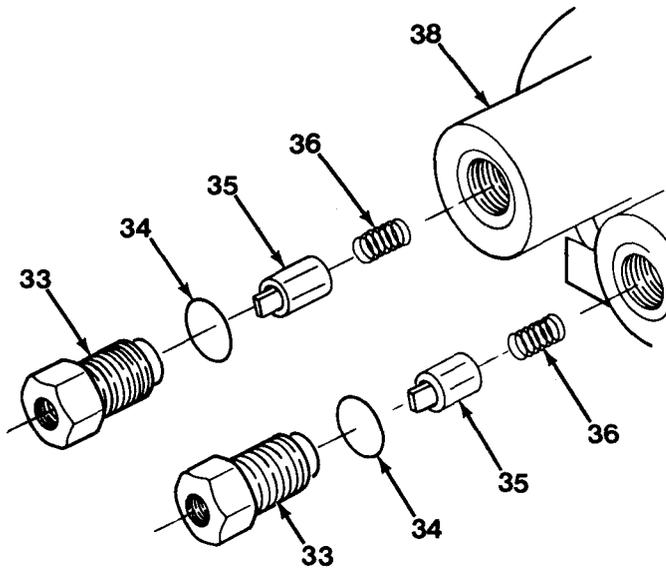


Figure 13-9

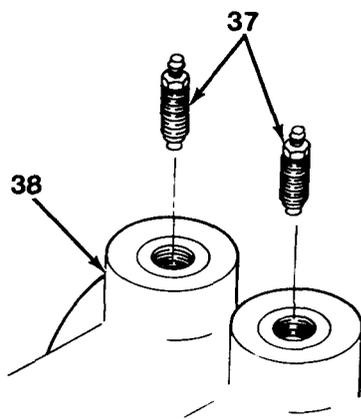


Figure 13-10

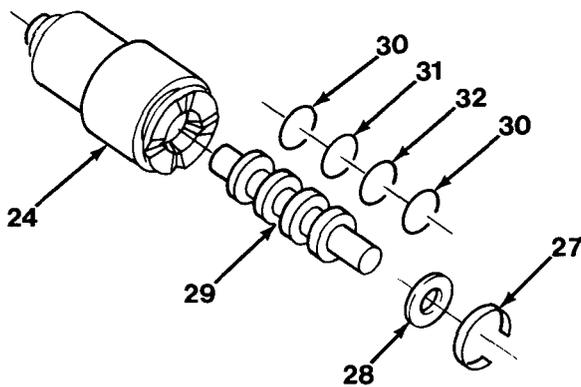


Figure 13-8

MASTER CYLINDER DISASSEMBLY

21. Remove two adapters (33), two O-rings (34), two valves (35) and two springs (36) from housing (38, Figure 13-9). Discard two O-rings (34).
22. Remove two bleeder screws (37) from housing (38, Figure 13-10).

MASTER CYLINDER CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

MASTER CYLINDER ASSEMBLY

NOTE

Lubricate all rubber components from repair kit with clean brake fluid before assembly.

1. Install two bleeder screws (37) in housing (38, Figure 13-10).
2. Install two springs (36), valves (35), new O-rings (34) and adapters (33, Figure 13-9).
3. Install new back-up ring (32), new O-ring (31) and two new cups (30) on piston (29, Figure 13-8).
4. Install piston (29) and washer (28) into piston (24). Secure with retaining ring (27).

5. Install new cup (26) on piston (24, Figure 13-7).
6. Install retaining ring (23) in flange end of housing (38, Figure 13-6).
7. Install spring (25) and piston (24, Figure 13-7).
8. Install seat (22) and retainer (21) on piston (19, Figure 13-5).
9. Install new cup (20, Figure 13-4).

CAUTION

Care should be taken when installing retaining ring so it will not scratch or mar housing bore. Failure to follow this procedure could cause damage to equipment.

10. Install piston (19) in housing (38). Secure with retaining ring (18).
11. Install spring (17).

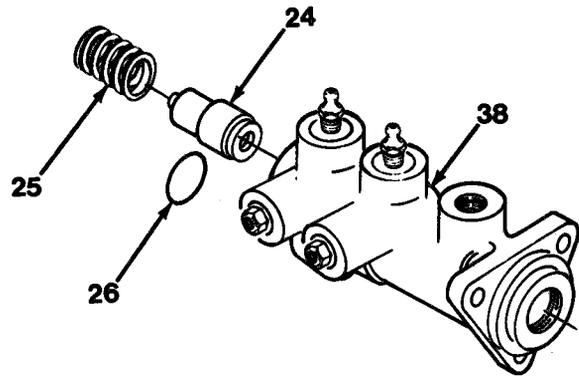


Figure 13-7

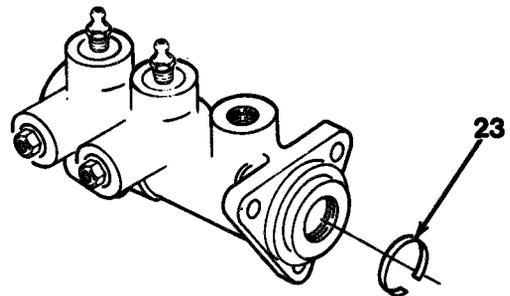


Figure 13-6

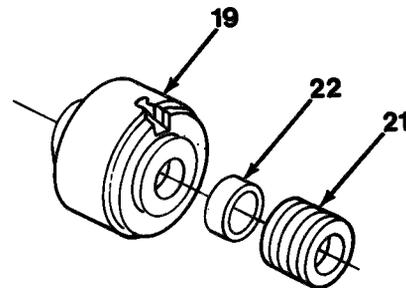


Figure 13-5

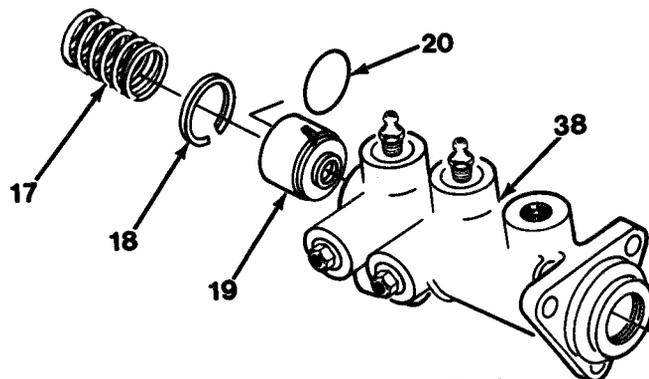


Figure 13-4

MASTER CYLINDER ASSEMBLY

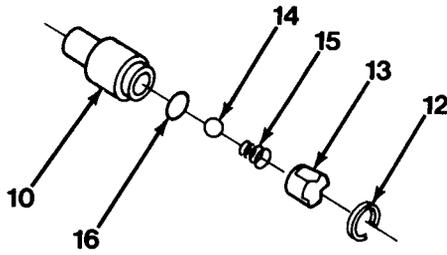


Figure 13-3

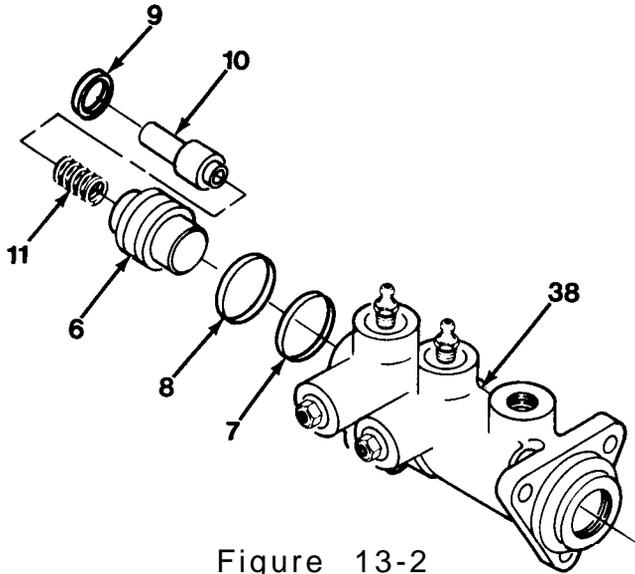


Figure 13-2

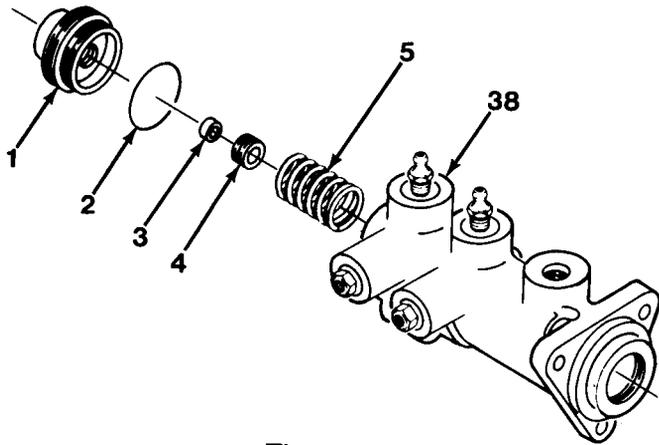


Figure 13-1

12. Install new O-ring (16), spring (15), ball (14) and cage (13) into stem (10). Secure with retaining ring (12, Figure 13-3).

13. Install spring (11) and stem (10) into piston (6). Secure with retaining ring (9, Figure 13-2).

14. Install new cups (8) and (7) on piston (6).

15. Install piston (6) in housing (38). Note direction of piston (6).

16. Install spring (5) in housing (38, Figure 13-1).

17. Install retainer (4), seat (3) and O-ring (2) on end cap (1).

18. Depress spring (5) and install end cap (1) on housing (38). Torque end cap (1) to 25 to 35 lb-ft (34 to 48 N•m).

BLEEDING PROCEDURES**CAUTION**

Never reuse fluid that has been drained from the system. Failure to follow this procedure could cause damage to equipment.

NOTE

Be sure that you maintain a high level of fluid in reservoir during and after the entire bleeding process. Use only hydraulic brake fluid MIL-B-46176.

1. Make sure master cylinder is securely mounted to power assist section, all fittings are tight and reservoir is full with proper fluid.
 2. Do not depress pedal and connect pressure bleeder into reservoir adapter. Recommended bleeding pressure is 30 psi (207 kPa) maximum.
 3. Open wheel cylinder bleeder screw closest to master cylinder outlet. Most of air contained in system will escape by this route. Close bleeder screw.
 4. Continue to next bleeder screw. At each point when air bubbles disappear, close bleeder screw.
 5. Open bleeder screw at master cylinder. Actuate cylinder to remove any residual air. Tighten bleeder screw before permitting pedal to return.
 6. Remove pressure bleeder.
 7. Actuate pedal several times. If pedal is spongy, check for system leaks and repeat bleeding process.
-

STEERING SYSTEM HYDRAULICS

**STEERING SYSTEM HYDRAULICS
REMOVAL**



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove all caps, plugs and tags following maintenance.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Remove hose (1) from steering valve (2) and tee (3, Figure 13-1).
3. Remove hose (4) from steering valve (2) and elbow (5).
4. Remove five clamps (6) and clamp (7).
5. Remove hose (8) from elbow (9) and tee (31).
6. Remove plastic ties (15) as required, six clamps (6) and four clamps (7).
7. Remove hose (12) from adapter (13) and tee (36).
8. Remove plastic tie (15), four clamps (7) and three clamps (6).

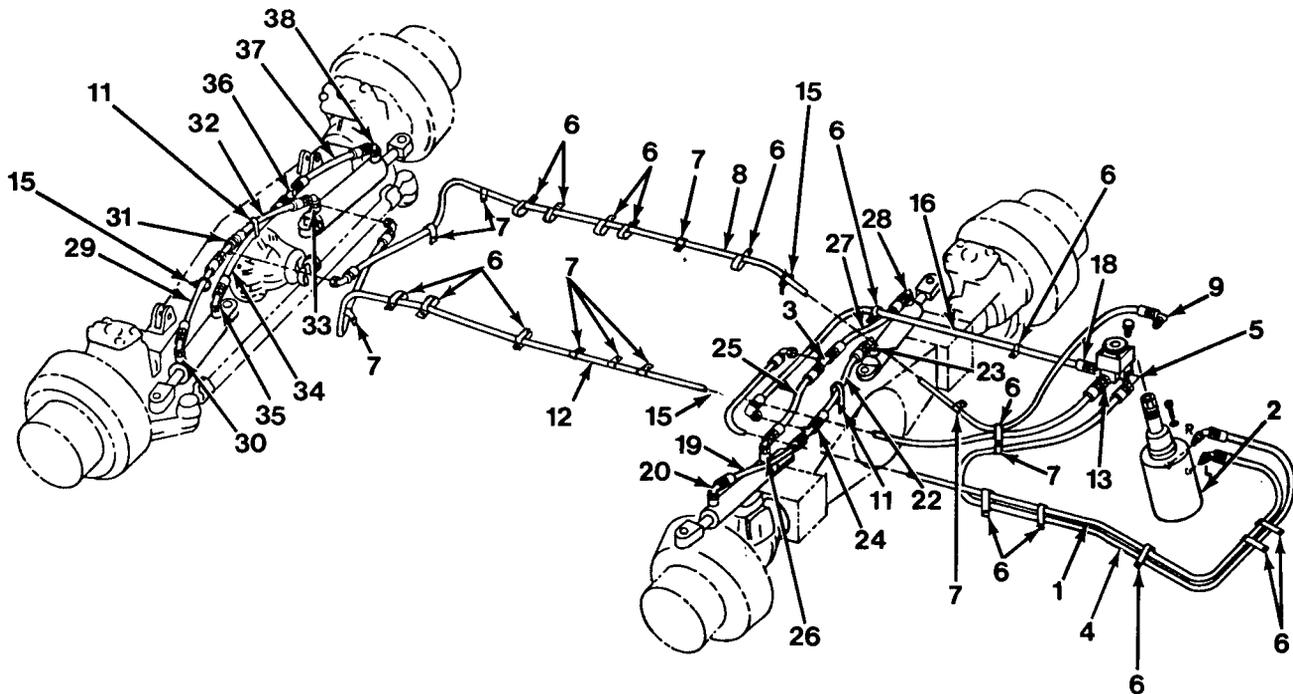


Figure 13-1

-
9. Remove hose (16) from tee (24) and adapter (18).
 10. Remove two clamps (6).
 11. Remove hose (19) from elbow (20) and tee (24).
 12. Remove hose (22) from elbow (23) and tee (24).
 13. Remove two clamps (11).
 14. Remove hose (25) from elbow (26) and tee (3).
 15. Remove hose (27) from elbow (28) and tee (3).
 16. Remove hose (29) from elbow (30) and tee (31).
 17. Remove hose (32) from elbow (33) and tee (31).
 18. Remove hose (34) from elbow (35) and tee (36).

19. Remove hose (37) from elbow (38) and tee (36).

STEERING SYSTEM HYDRAULICS CLEANING /INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

STEERING SYSTEM HYDRAULICS INSTALLATION

1. Install hose (37) on elbow (38) and tee (36).
2. Install hose (34) on elbow (35) and tee (36).
3. Install hose (32) on elbow (33) and tee (31).

**STEERING SYSTEM HYDRAULICS
INSTALLATION**

4. Install hose (29) on elbow (30) and tee (31, Figure 13-1).
5. Install hose (27) on elbow (28) and tee (3).
6. Install hose (25) on elbow (26) and tee (3).
7. Install hose (22) on elbow (23) and tee (24).
8. Install two clamps (11).
9. Install hose (19) on elbow (20) and tee (24).
10. Install hose (16) on tee (24) and adapter (18).
11. Install two clamps (6).
12. Install hose (12) on tee (36) and adapter (13).
13. Install three clamps (6), four clamps (7) and plastic tie (15).
14. Install hose (8) on elbow (9) and tee (31).
15. Install six clamps (6), two clamps (7) and plastic ties (15) as required.
16. Install hose (4) on elbow (5) and steering valve (2).
17. Install hose (1) on tee (3) and steering valve (2).
18. Install clamp (7) and five clamps (6).
19. Pressure hydraulic system and check for leaks.
20. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

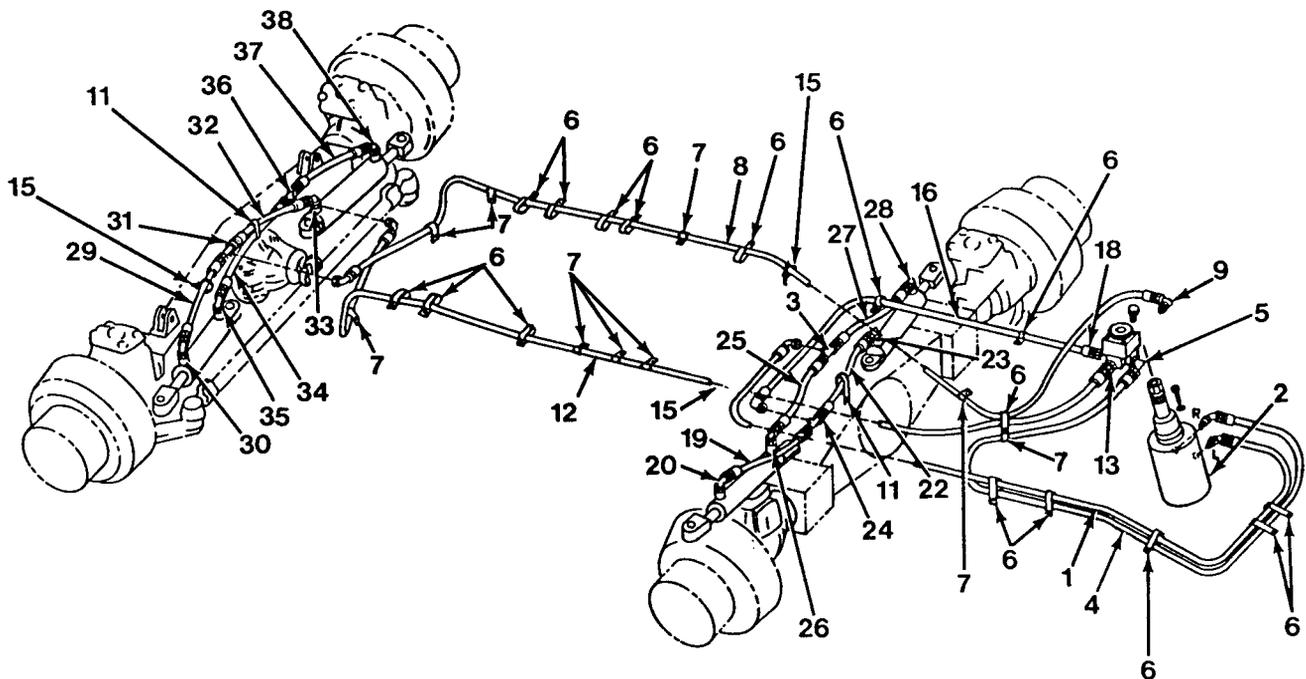


Figure 13-1

LOWER BOOM, SWING, WINCH HYDRAULICS

LOWER BOOM, SWING, WINCH HYDRAULICS REMOVAL



Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Turn dipstick 1/4 turn to safety notch to relieve pressure.

NOTE

- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.
- Position suitable container under vehicle to catch hydraulic oil that will run from hoses when disconnected.

2. Disconnect hoses (1) and (2, Figure 13-1) from swing motor.
3. Remove hoses (1) and (2) from main control valve.
4. Remove five lock nuts (3), washers (4) and capscrews (5) horn cushion (13).
5. Remove two lock nuts (6), washers (7) and capscrews (8) from cushion (13).

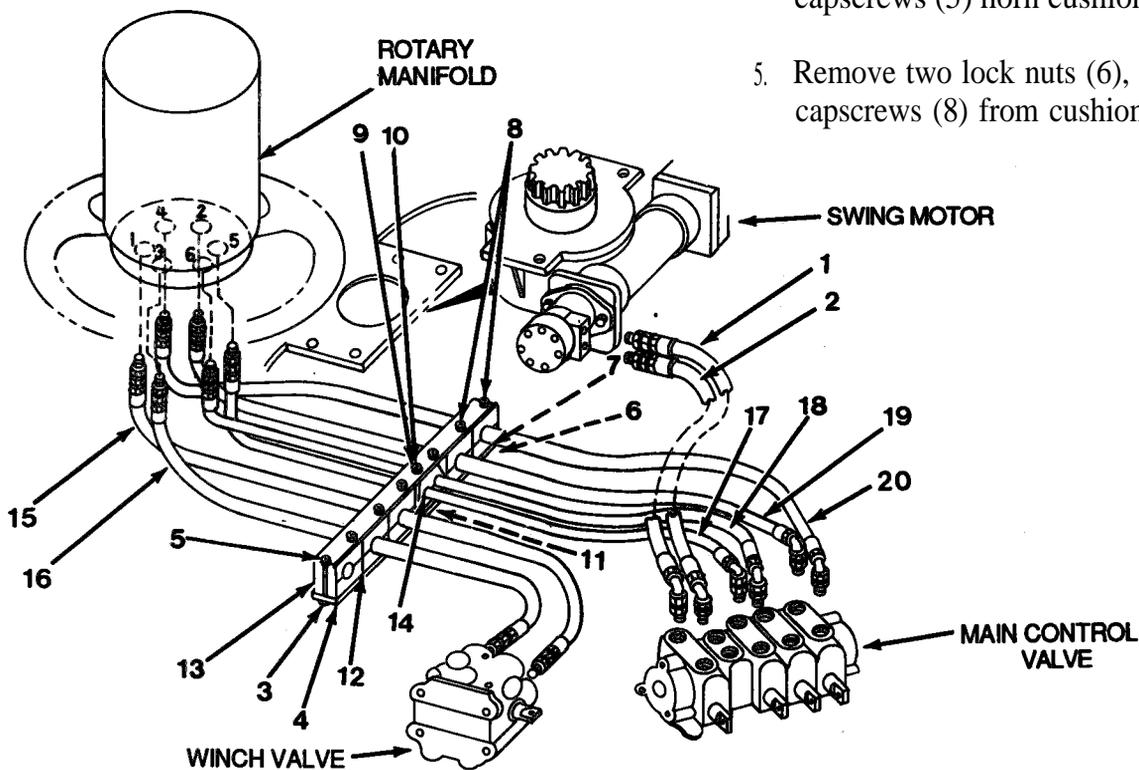


Figure 13-1

**LOWER BOOM, SWING, WINCH
HYDRAULICS REMOVAL**

5. Remove plate (12) and bottom half of cushion (13).
6. Remove lock nut (9), washer (10), capscrew (11), plate (14) and top half of cushion (13, Figure 13-1).
7. Disconnect hoses (15) and (16) from rotary manifold.
8. Remove hoses (15) and (16) from winch valve.
9. Disconnect hoses (17), (18), (19) and (20) from rotary manifold.
10. Remove hoses (17), (18), (19) and (20) from main control valve.

**LOWER BOOM, SWING, WINCH
HYDRAULICS CLEANING/INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**LOWER BOOM, SWING, WINCH
HYDRAULICS INSTALLATION**

1. Install hoses (20), (19), (18) and (17, Figure 13-1) on rotary manifold.
2. Connect hoses (20), (19), (18) and (17) on main control.
3. Install hoses (16) and (15) on winch valve.
4. Connect hoses (16) and (15) on rotary manifold.
5. Install top half of cushion (13), plate (14), capscrew (11), lockwasher (10) and locknut (9) in cushion (13).

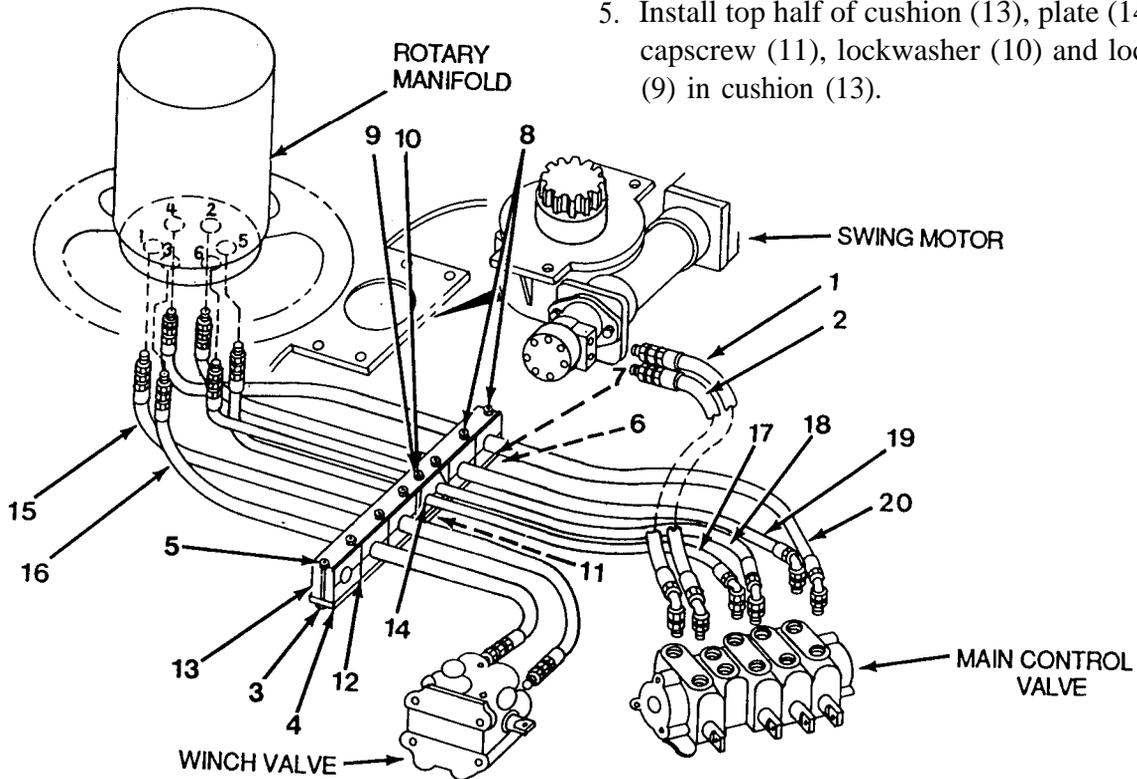


Figure 13-1

6. Position hoses (20), (19), (18), (17), (16) and (15) in cushion (13).
7. Install bottom half of cushion (13) and plate (12).
8. Install two capscrews (8), washers (7) and lock nuts (6).
9. Install five capscrews (5), washers (4) and lock nuts (3) in cushion (13).
10. Install hoses (2) and (1) on main control valve.
11. Connect hoses (2) and (1) on swing motor.
12. Close dipstick cap. Start engine. Check for leaks. NW engine off.
13. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

RETURN AND PRESSURE HYDRAULICS

**RETURN AND PRESSURE HYDRAULICS
REMOVAL**



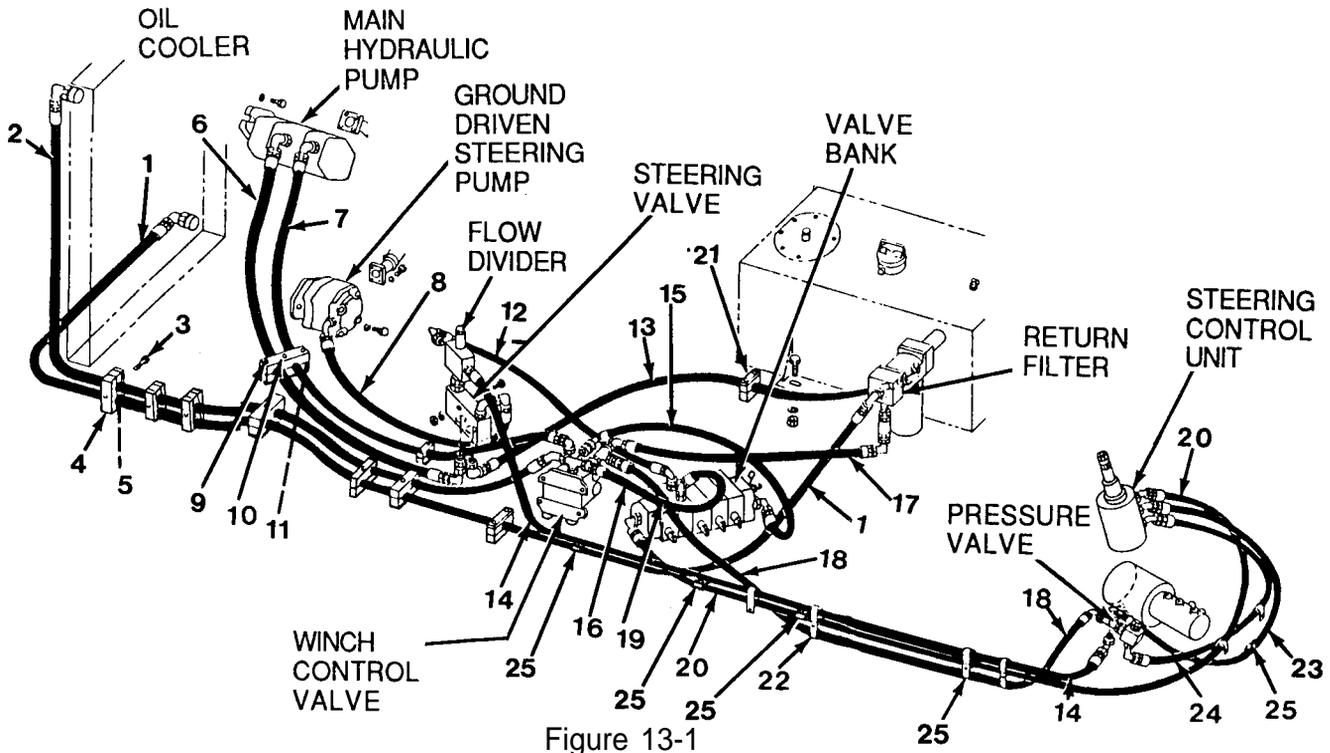
Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

2. Disconnect hoses (1) and (2, Figure 13-1) from oil cooler.
3. Remove eight capscrews (3), half clamps (4) and seven cover plates (5) from hoses (1) and (2).
4. Disconnect hoses (6), (7) and (8) from main hydraulic pump and ground driven steering pump.
5. Remove five capscrews (9), cushions (10) and two plate covers (11) from hoses (6) and (7).
6. Remove hoses (6) and (8) from steering valve.
7. Disconnect hoses (12), (13) and (14) from steering valve and flow divider.
8. Remove hoses (7) and (2) from winch control valve.



9. Disconnect hoses (15), (16), (17) and (18) from winch control valve.
10. Remove plastic tie (19) and hoses (12), (15) and (16) from valve bank.
11. Disconnect hose (20) from valve bank.
12. Remove clamp (21) and hoses (1), (17) and (13) from return filter.
13. Remove three chunps (22), three clamps (25) and hoses (14) and (18) from pressure valve on booster valve.
14. Disconnect hoses (23) and (24) from pressure valve.
15. Remove six clamps (25) and hoses (20), (23) and (24) from steering control unit.

RETURN AND PRESSURE HYDRAULICS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

RETURN AND PRESSURE HYDRAULICS INSTALLATION

1. Install hoses (24), (23) and (20) and six clamps (25, Figure 13- 1) to steering control unit.
2. Connect hoses (24) and (23) to pressure valve on booster valve.
3. Install hoses (18) and (14), three clamps (22) and three clamps (25) to pressure valve.

4. Install hoses (13), (17) and (1) and clamp (21) to return filter.
5. Connect hose (20) to valve bank
6. Install hoses (16), (15) and (12) and plastic tie (19) to valve bank.

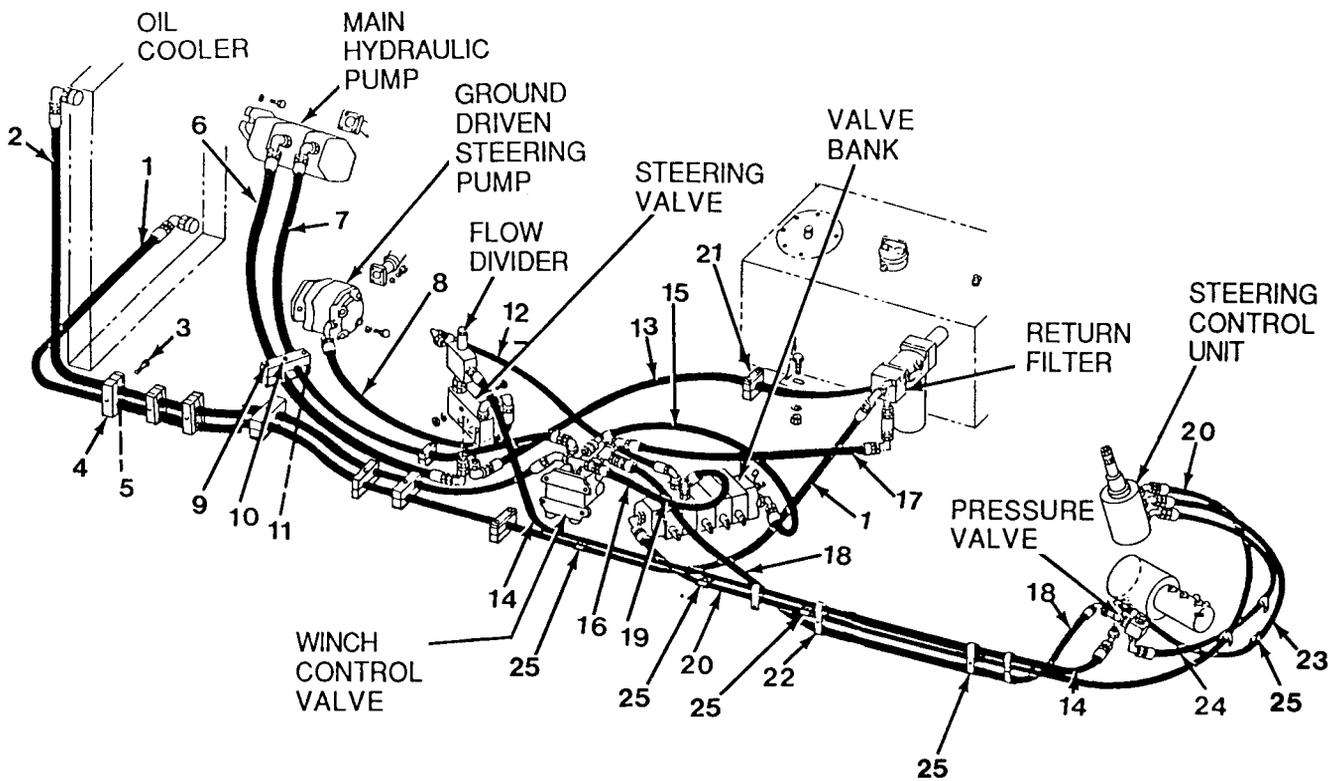


Figure 13-1

7. Connect hoses (18), (17), (16) and (15) to winch control valve.
8. Install hoses (2) and (7) to winch control valve.
9. Connect hoses (14), (13) and (12) to flow divider and steering valve.
10. Install hoses (9) and (6) to steering valve.
11. Install two plate covers (11), four cushions (10) and capscrews (9) to hoses (7) and (6).
12. Connect hoses (8), (7) and (6) to main hydraulic pump and ground driven steering pump.
13. Install 7 cover plates (5), 14 half clamps (4) and capscrews (3) to hoses (2) and (1).
14. Connect hoses (2) and (1) to oil cooler.
15. Close dipstick cap. Start engine. Check for leaks. Shut engine off.
16. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

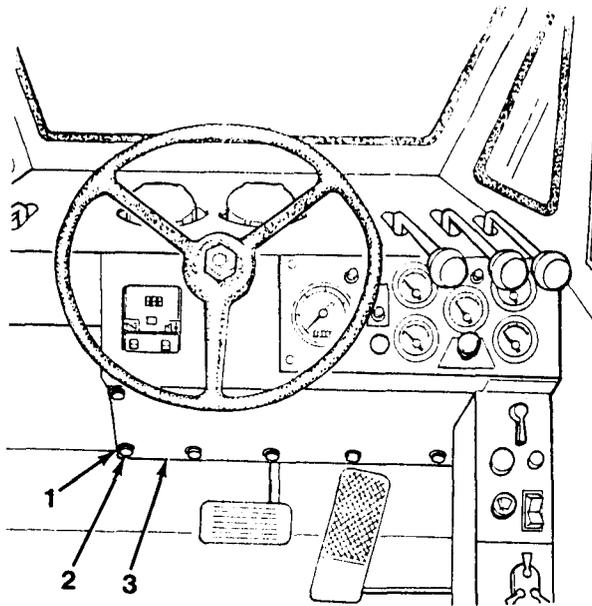


Figure 13-1

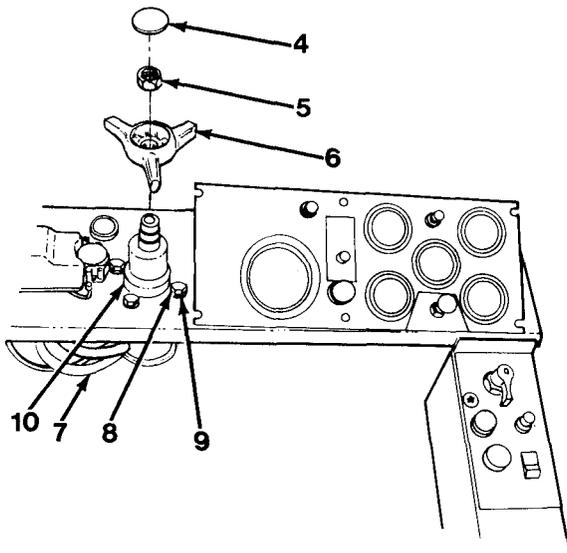


Figure 13-2

STEERING CONTROL UNIT

STEERING CONTROL UNIT REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick 1/4 turn to safety notch to release pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Remove six cap screws (1), lockwashers (2) and lower dash panel (3, Figure 13-1).
3. Remove steering wheel cap (4), nut (5) and steering wheel (6, Figure 13-2).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Disconnect five hoses (7) from control unit (10).
5. Remove four cap screws (8), lockwashers (9) and control unit (10) from under dash.

STEERING CONTROL UNIT INSTALLATION

1. Position control unit (10, Figure 13-2) under dash and align mounting holes.
2. Install four lockwashers (9) and capscrews (8).
3. Connect five hoses (7) on control unit (10).
4. Install steering wheel (6), nut (5) and cap (4).
5. Install lower dash panel (3), six lockwashers (2) and capscrews (1, Figure 13-1).
6. Close dipstick cap. Start engine. Check for leaks. Shut engine off.
7. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

STEERING CONTROL UNIT DISASSEMBLY

1. Remove and discard dirt seal (11, Figure 13-3).
2. Remove retaining ring (12).

NOTE

Remove seal package using one of the two following methods.

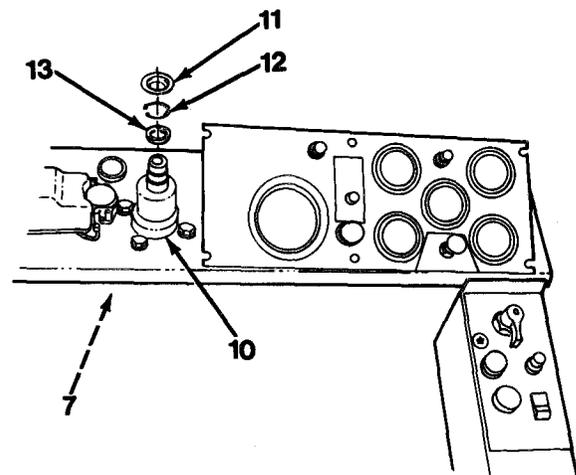


Figure 13-3

STEERING CONTROL UNIT DISASSEMBLY

3. If control unit (10) has not been removed from vehicle and five hoses (7) have not been disconnected, with engine running, rotate shaft of control unit (10) in counterclockwise direction to pressurize control unit (10) and force seal package (13, Figure 13-3) out. Discard old seal package (13).

4. If control unit (10) has been removed from vehicle, plug three of four ports in control unit (10) and attach air hose to remaining port. With air pressure, force seal package (13) out. Discard old seal package (13).

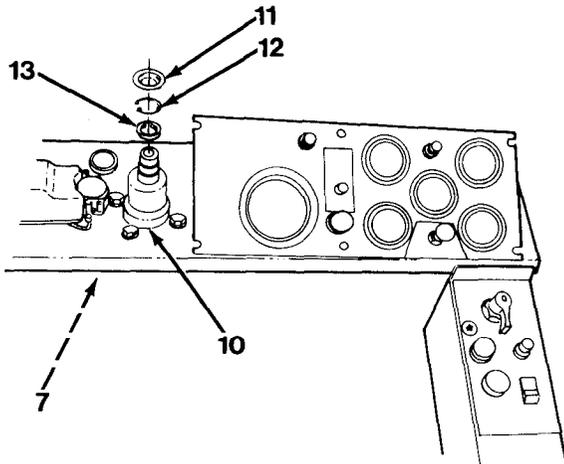


Figure 13-3

STEERING CONTROL UNIT CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

STEERING CONTROL UNIT ASSEMBLY

CAUTION

Keep new seal package free of particles of lint, felt and dirt. Failure to follow this procedure can cause new seal package to leak, damaging equipment.

NOTE

Clean input shaft of control unit and upper cover seal bore to remove particles of dirt, felt and lint with a clean, lint-free rag.

1. Cover control unit (10) shaft with cellophane tape to protect new seal package (13, Figure 13-3) new it is assembled.
2. Lubricate new seal package (13) with hydraulic oil and install and control unit (10) shaft lip side first
3. Remove cellophane tape.
4. Install new seal package (13) washer with small end first on control unit (10) shaft.
5. Using deep-well socket push new seal package (13) washer down into upper cover of control unit (10).
6. Install retaining ring (12) on control unit (10) shaft and push down into upper groove in control unit (10) cover.
7. Install new dirt seal (11) on control unit (10) shaft and press down into control unit (10) upper cover.

HYDRAULIC BRAKES

HYDRAULIC BRAKES REMOVAL

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Disconnect hoses (6) and (7) from master cylinder reservoirs (5, Figure 13- 1).
2. Remove two capscrews (1), lockwashers (2), washers (3), nuts (4) and master cylinder reservoirs (5).
3. Remove hoses (6) and (7) from two elbows (8).
4. Remove two elbows (8) from booster valve (43).

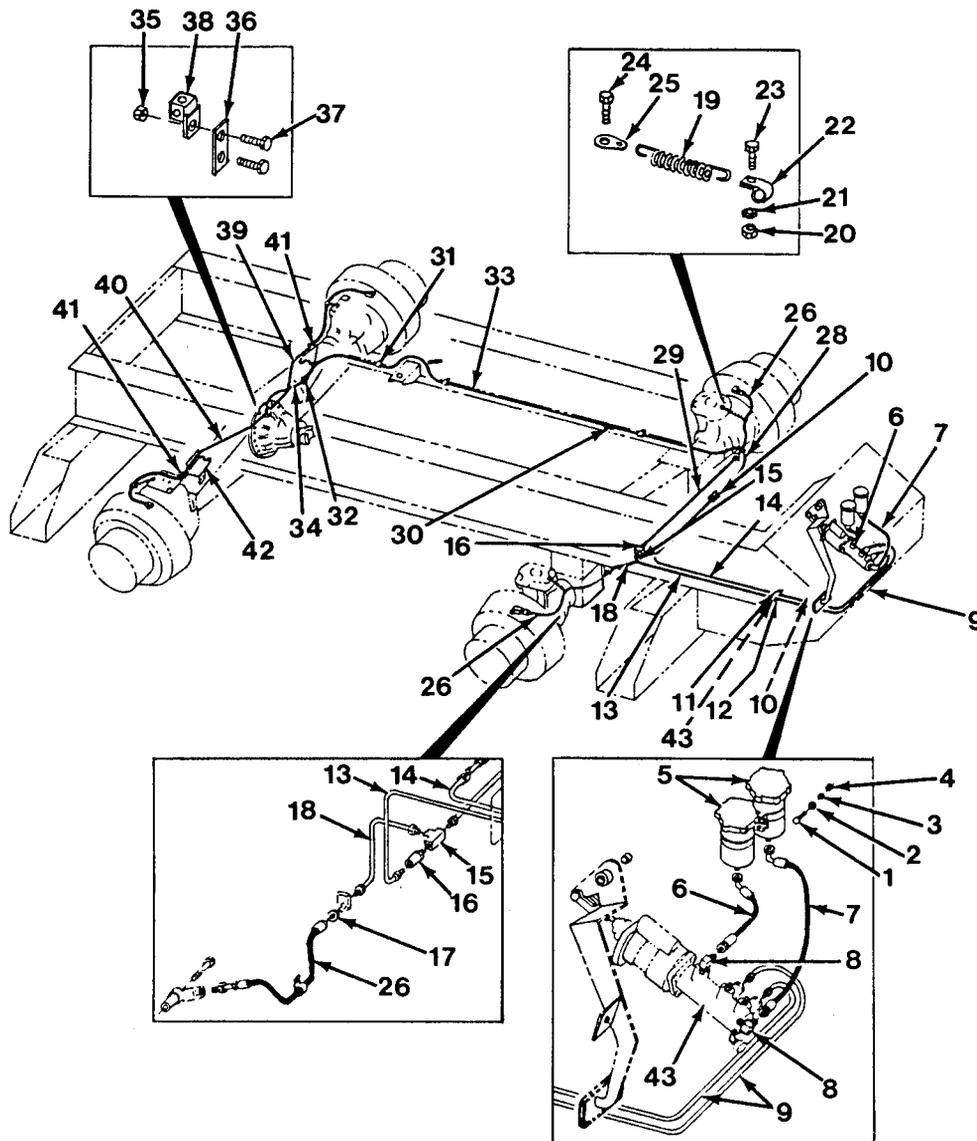


Figure 13-1

-
5. Remove two tubes (9) and couplings (10) from tubes (13) and (14).
 6. Remove nut (11), capscrew (43), clamp (12) and tube (13) from tee fitting (15) and reducer fitting (16) near front axle.
 7. Remove tube (14) and coupling (10) from tube (28).
 8. Remove tee fitting (15), reducer fitting (16) and tube (18) from hose (26).
- NOTE
- Steps 9 and 10 is the removal procedure for one outer axle area. The removal procedure for the other three outer axle areas is identical.
9. Unhook and remove spring (19), nut (20), washer (21), clamp (22), capscrew (23), capscrew (24) and spring hock (25) from outer axle.
 10. Remove hose (26) from outer axle.
 11. Remove two nuts (17) and hose (26) from frame.
 12. Remove tube (29) from frame between front outer axles.
 13. Remove tube (28) from tube (33).
 14. Remove coupling (30), three clamps (31), and tube (33) from frame between front and rear axles.
 15. Remove nut (32) on hose (34) from frame.
 16. Remove hose (34) from tee fitting (38) on rear axle.
 17. Disconnect tubes (39) and (40) from tee fitting (38).
 18. Remove nut (35), plate (36), capscrew (37) and tee fitting (38) on rear axle near differential.
-

HYDRAULIC BRAKES REMOVAL

19. Remove tubes (39) and (40) and two nuts (41) from brackets (42, Figure 13-1) on each side of rear axle.
20. Repeat steps 9 and 10 for removal of hoses on rear outer axles.

HYDRAULIC BRAKES CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).

2. Inspect all parts (refer to Chapter 4).

HYDRAULIC BRAKES INSTALLATION

1. Install two nuts (41) and tubes (40) and (39) to brackets (42, Figure 13-1) on each side of rear axle.
2. Install tee fitting (38), capscrew (37), plate (36) and nut (35) on rear axle near differential.

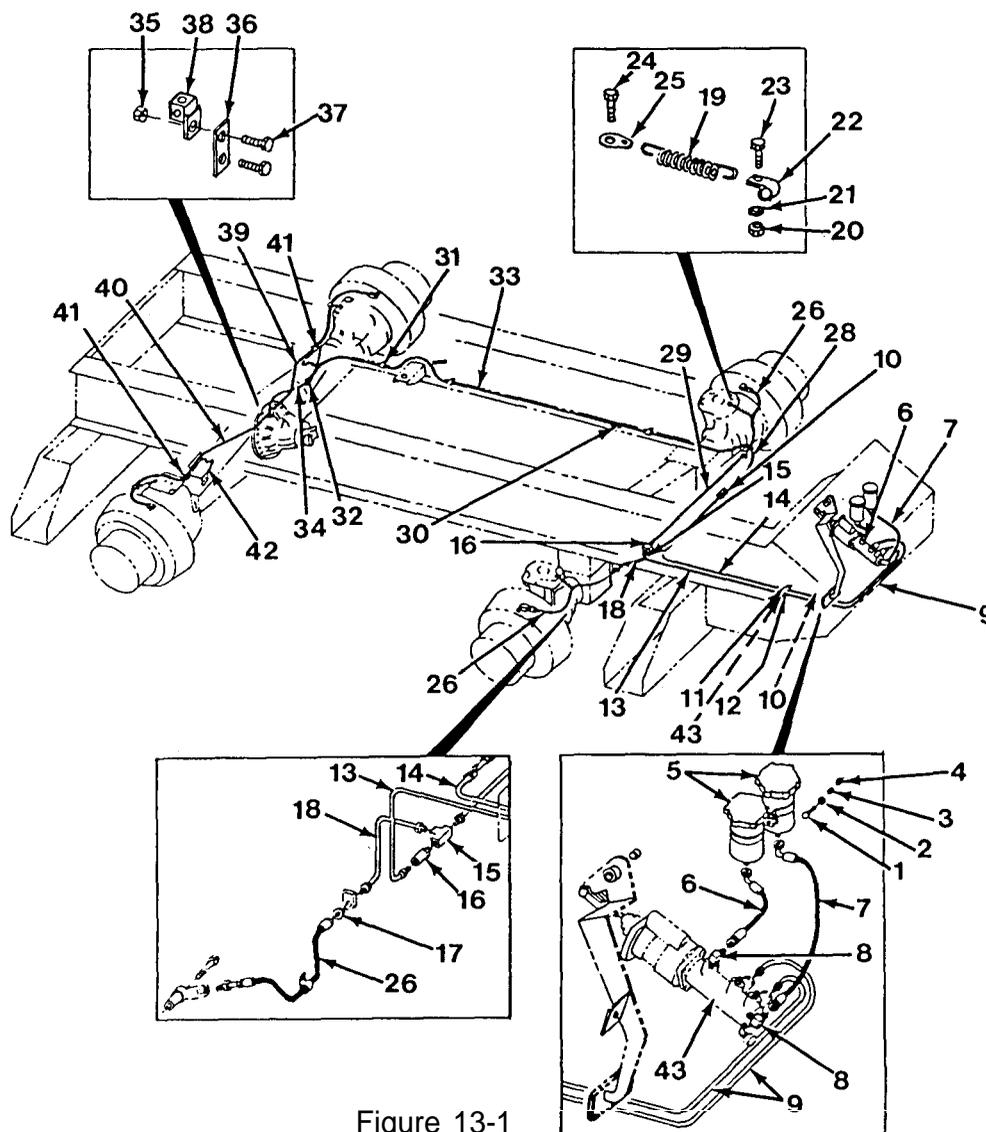


Figure 13-1

3. Connect tubes (40) and (39) to tee fitting (38).
4. Install hose (34) to tee fitting (38).
5. Install nut (32) on hose (34) to frame.
6. Install tube (33), three clamps (31) and coupling (30) to frame between rear and front axles.
7. Install tube (28) to tube (33).
8. Install tube (29) to frame between front outer axles.

NOTE

Steps 9 and 10 is the installation procedure for one outer axle area. The installation procedure for the other three outer axle areas is identical.

9. Install hose (26) to outer axle.
 10. Install spring hook (25), capscrew (24), capscrew (23), clamp (22), washer (21), nut (20) and spring (19).
 11. Follow steps 9 and 10 for installation of hoses on rear outer wheels.
 12. Install nuts (17) and hose (26) to frame.
 13. Install tube (18), nut (17), reducer fitting (16) and tee fitting (15) to hose (26).
 14. Install tube (14) to tube (28) and coupling (10).
 15. Install tube (13), clamp (12), nut (11) and capscrew (43) to reducer fitting (16) and tee fitting (15) near front axle.
-

HYDRAULIC BRAKES INSTALLATION

16. Install two couplings (10) and tubes (9) to tubes (14) and (13, Figure 13-1).
17. Install two elbows (8) to booster valve (43).
18. Install hoses (7) and (6) to two elbows (9).
19. Install two master cylinder reservoirs (5), nuts (4), washers (3), lockwashers (2) and capscrews (1).
20. Connect hoses (7) and (6) to two master cylinder reservoirs (5).
21. Bleed brakes (refer to page 13-105).

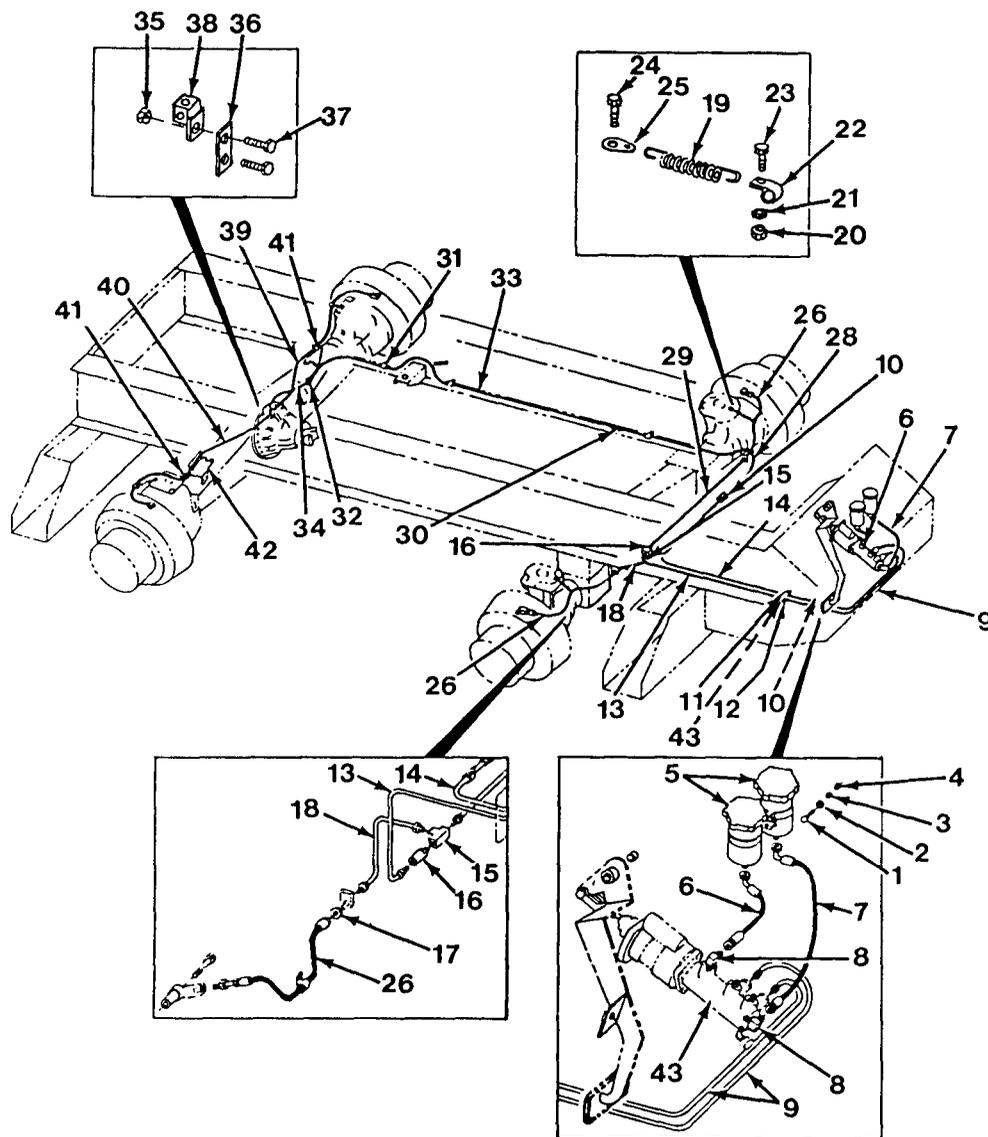


Figure 13-1

UPPER HYDRAULIC LINES

UPPER HYDRAULIC LINES REMOVAL

1. Start engine. Raise boom to a height suitable to provide access to inside of upperstructure frame. Shut engine off.

 **WARNING**

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Use a lifting device to support boom.

 **WARNING**

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause SERIOUS INJURY.

3. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
4. Relieve all line pressure by operating control levers for boom hoist extend and winch in operator's compartment.

UPPER HYDRAULIC LINES REMOVAL

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

5. Disconnect hoses (1) and (2, Figure 13-1) from winch.

6. Disconnect and remove hoses (1) and (2) from two tubes (6).
7. Remove six capscrews (4), two plates (5) and eight clamps (8).
8. Remove two tubes (3) from rotary manifold.
9. Disconnect two hoses (11) from rotary manifold.
10. Remove four lock nuts (7), washers (8) and (9) and clamps (10).

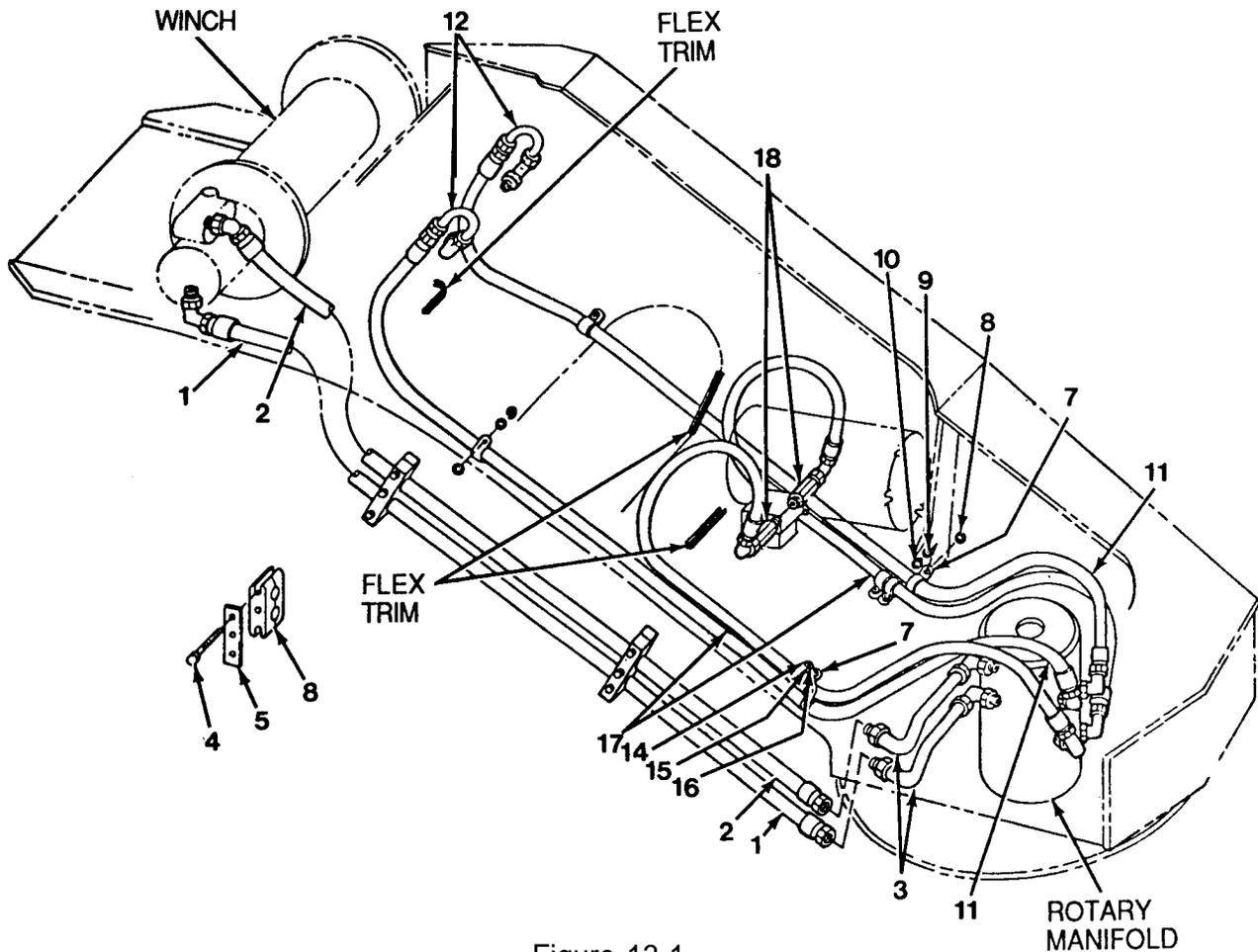


Figure 13-1

11. Remove two hoses (11) with flex trim from tubes (12).
12. Remove two tubes (12) from elbows.
13. Disconnect two hoses (17) from rotary manifold.
14. Remove four lock nuts (7), washers (14) and (15) and clamps (16).
15. Remove two hoses (17) with flex trim and adapters (18).

UPPER HYDRAULIC LINES CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

UPPER HYDRAULIC LINES INSTALLATION

1. Install two adapters (18) and hoses (17) with flex trim.
2. Connect two hoses (17) to rotary manifold.
3. Install four clamps (16), washers (15) and (14) and lock nuts (7).
4. Install two tubes (12) to elbows.
5. Install two hoses (11) with flex trim to tubes (12).
6. Connect two hoses (11) to rotary manifold.
7. Install four clamps (10), washers (9) and (8) and lock nuts (7).

8. Install two tubes (3) to rotary manifold.
9. Connect hoses (2) and (1) to tubes (3).
10. Install hoses (2) and (1) to winch.
11. Install eight clamps (8), two plates (5) and six capscrews (4).
12. Close dipstick cap. Start engine. Operate control levers for boom hoist, extend and winch several times to relieve any air trapped in hydraulic system.
13. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).



Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

14. Return boom to travel position. Shut engine off.

CHAPTER 14
FRAME AND CAB

Title	Page
Marking Decals	14-1
Pintle Hook	14-3
Outrigger Assembly	14-5
Fenders, Deck Plates, Battery Box and Tool Box With Covers	14-8
Seat	14-11
Seat Belt	14-12
Mirror	14-13
Cab	14-15
Cab Door	14-19
Engine Hood and Grill Guard	14-22
Hood Support	14-25
Hook Block Tieback	14-26

MARKING DECALS

Decals are notes that are strategically placed on the vehicle for your convenience and protection. Pay attention to what they say.

WARNING

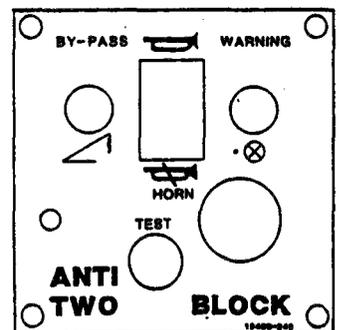
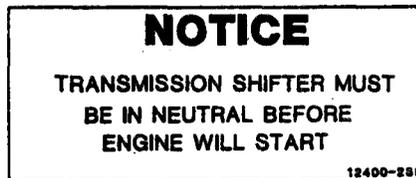
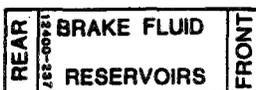
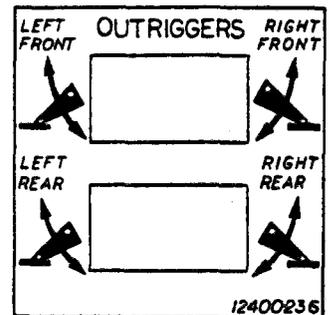
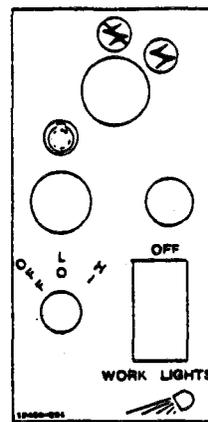
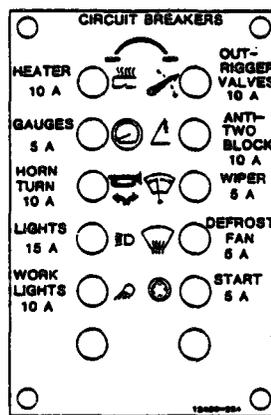
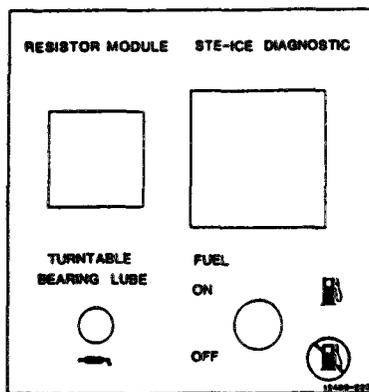
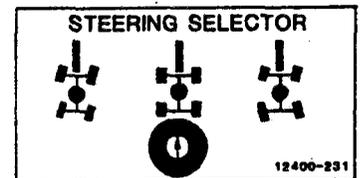
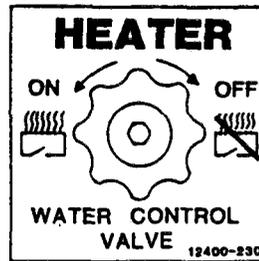
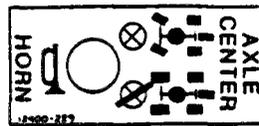
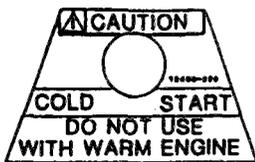
Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Use only in well ventilated areas and avoid contact with eyes, skin or clothing. Wear the proper protective clothing and equipment goggles or safety glasses, face shield and gloves. Do not breath vapors. Do not use near sparks or open flames and do not smoke while using it Failure to follow these procedures could cause DEATH or serious injury.

REMOVING AND INSTALLING STICKY BACKED MARKING DECALS

When replacing sticky backed marking decals, scrape off all remnants of old decal. Clean all dust and dirt from the mounting surface. Remove any preservative compounds with dry cleaning solvent P-D-680. When the mounting surface is clean and dry, apply decal by pressing firmly in place.

REMOVING AND INSTALLING RIVETED MARKING DECALS

When replacing riveted marking decals, drill out and discard rivets. Clean all dust and dirt from the mounting surface. When the mounting surface is clean and dry, hold marking decals while installing rivets.



PARKING BRAKE

DISENGAGED

CAUTION

DISENGAGE BEFORE TRAVELING

12400-238

SLAVE RECEPTACLE

24 VOLTS

12400-270

CAUTION

TO PREVENT SERIOUS BODILY INJURY, KEEP CLEAR OF STABILIZERS WHILE OPERATING.

12400-267

TRANSMISSION OIL

12400-251

ENGINE OIL

12400-252

CAUTION

HEARING PROTECTION REQUIRED WHEN WORKING WITHIN 40 FEET FROM THE CRANE.

12400-250

BEFORE OPERATING OR REPAIRING MAINTAINANCE FROM REMOVAL, ALWAYS LOCKOUT / TAGOUT / STOP IT AND DISCONNECT ALL ELECTRICAL POWER TO PREVENT UNEXPECTED STARTING OF ANY PARTS OF THE CRANE. IF NECESSARY, REMOVE AND REINSTALL GUARDS FROM OPERATIONS.

DANGER

TO AVOID SERIOUS BODILY INJURY DO NOT GET ON OR BETWEEN THIS CRANE AND THE LOAD BEING LIFTED. YOU HAVE BEEN INSTRUCTED IN THE OPERATING AND MAINTENANCE MANUALS OF THE OPERATOR AND SERVICE PERSONNEL.

IT IS THE USER'S RESPONSIBILITY TO FOLLOW MAINTENANCE INSTRUCTIONS ON MACHINE OPERATION, SERVICE AND APPLICATION AND OBSERVE PERMITTED LIMITS AND RESTRICTIONS.

CAUTION

THE SLAVE CRANE SYSTEM MUST BE DISCONNECTED AFTER INSTALLATION OF EACH LOAD LINE AND AT THE START OF EVERY WORK SHIFT. CONSULT OPERATOR'S MANUAL FOR PROPER OPERATION AND SAFETY PROCEDURES.

CAUTION

HEARING PROTECTION REQUIRED WHILE OPERATING THIS VEHICLE.

12400-247

SHIPPING DATA FOR LRT-110 TYPE I

C-541 AIRCRAFT

WEIGHT	LOCATION	WEIGHT	LOCATION
11,000 LBS (5,000 KG)	Front	11,000 LBS (5,000 KG)	Rear

OVERALL LENGTH: 26' 0" (7.92 M)
OVERALL WIDTH: 10' 0" (3.05 M)
OVERALL HEIGHT: 10' 0" (3.05 M)

12400-248

OPERATING INSTRUCTIONS

SAFETY

OPERATION

MAINTENANCE

STORAGE

REPAIRS

ADDITIONAL INFORMATION

12400-249

LUBRICATION

LRT 110

POINT	TYPE	AMOUNT
1	SAE 10W-30	1.0
2	SAE 10W-30	1.0
3	SAE 10W-30	1.0
4	SAE 10W-30	1.0
5	SAE 10W-30	1.0
6	SAE 10W-30	1.0
7	SAE 10W-30	1.0
8	SAE 10W-30	1.0
9	SAE 10W-30	1.0
10	SAE 10W-30	1.0
11	SAE 10W-30	1.0
12	SAE 10W-30	1.0
13	SAE 10W-30	1.0
14	SAE 10W-30	1.0
15	SAE 10W-30	1.0
16	SAE 10W-30	1.0
17	SAE 10W-30	1.0
18	SAE 10W-30	1.0
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35	SAE 10W-30	1.0
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92	SAE 10W-30	1.0
93	SAE 10W-30	1.0
94	SAE 10W-30	1.0
95	SAE 10W-30	1.0
96	SAE 10W-30	1.0
97	SAE 10W-30	1.0
98	SAE 10W-30	1.0
99	SAE 10W-30	1.0
100	SAE 10W-30	1.0

12400-253

WARRANTY

LRT 110 TYPE I

MSN: _____

POUCH 84885

START DATE: _____

EXPIRATION DATE: _____

CRANE, WHEEL MOUNTED

MOD. NO. LRT110-TYP. I SERIAL NO. _____

7.5 TON CAP. CONTRACT NO. 8A8807-88-C-1100 MFG. 81488

MSN: _____ USA REG. NO. _____

MPR WORKING CRANES & EXCAVATORS WAVERLY IOWA 50677 USA

CARC WEIGHT SHIPPING DATE

U.S.

SWING

TELESCOPE

BOOM HOIST

WINCH

12400-254

WARNING

SHOULDER CABLE INSTRUCTIONS

SHOULDER CABLES ARE MADE FROM STEEL WIRE OF ALL TYPES. IN SOME CASES THEY HAVE A PLAIN END AND IN OTHER CASES THEY HAVE A PLAIN END AND A PLAIN END.

1. Always check the cable for fraying, kinks, or other damage before use.
2. Do not use a cable that has been damaged or is otherwise unsafe.
3. Do not use a cable that has been damaged or is otherwise unsafe.
4. Do not use a cable that has been damaged or is otherwise unsafe.
5. Do not use a cable that has been damaged or is otherwise unsafe.
6. Do not use a cable that has been damaged or is otherwise unsafe.
7. Do not use a cable that has been damaged or is otherwise unsafe.
8. Do not use a cable that has been damaged or is otherwise unsafe.
9. Do not use a cable that has been damaged or is otherwise unsafe.
10. Do not use a cable that has been damaged or is otherwise unsafe.

12400-255

PSA

POWER SPRING ASSOCIATION

SAFETY

12400-256

CAUTION

BEFORE OPERATING OR REPAIRING MAINTAINANCE FROM REMOVAL, ALWAYS LOCKOUT / TAGOUT / STOP IT AND DISCONNECT ALL ELECTRICAL POWER TO PREVENT UNEXPECTED STARTING OF ANY PARTS OF THE CRANE. IF NECESSARY, REMOVE AND REINSTALL GUARDS FROM OPERATIONS.

1. Do not use a cable that has been damaged or is otherwise unsafe.
2. Do not use a cable that has been damaged or is otherwise unsafe.
3. Do not use a cable that has been damaged or is otherwise unsafe.
4. Do not use a cable that has been damaged or is otherwise unsafe.
5. Do not use a cable that has been damaged or is otherwise unsafe.
6. Do not use a cable that has been damaged or is otherwise unsafe.
7. Do not use a cable that has been damaged or is otherwise unsafe.
8. Do not use a cable that has been damaged or is otherwise unsafe.
9. Do not use a cable that has been damaged or is otherwise unsafe.
10. Do not use a cable that has been damaged or is otherwise unsafe.

12400-257

DANGER

DEATH OR INJURY CAN RESULT FROM CONTACTING ELECTRICAL POWER LINES.

ALWAYS CONTACT THE ELECTRIC POWER LINE OWNER. THE ELECTRIC POWER SHALL BE DISCONNECTED OR THE POWER LINES MOVED OR INSULATED BEFORE MACHINE OPERATIONS BEGIN.

POWER LINE VOLTAGE	REQUIRED CLEARANCE
0-100 V	10 FT
100-200 V	15 FT
200-300 V	20 FT
300-500 V	25 FT
500-750 V	30 FT
750-1000 V	35 FT

12400-258

PHONE SIGNALS

1	2	3	4
5	6	7	8
9	0		

WARNING

BEFORE OPERATING OR REPAIRING MAINTAINANCE FROM REMOVAL, ALWAYS LOCKOUT / TAGOUT / STOP IT AND DISCONNECT ALL ELECTRICAL POWER TO PREVENT UNEXPECTED STARTING OF ANY PARTS OF THE CRANE. IF NECESSARY, REMOVE AND REINSTALL GUARDS FROM OPERATIONS.

12400-259

D

DIESEL FUEL

12400-260

WARNING

BEFORE OPERATING OR REPAIRING MAINTAINANCE FROM REMOVAL, ALWAYS LOCKOUT / TAGOUT / STOP IT AND DISCONNECT ALL ELECTRICAL POWER TO PREVENT UNEXPECTED STARTING OF ANY PARTS OF THE CRANE. IF NECESSARY, REMOVE AND REINSTALL GUARDS FROM OPERATIONS.

12400-261

CAUTION

IN THIS ENCLOSURE ARE POWER SPRINGS UNDER TENSION. DO NOT DISASSEMBLE SPRING MOTOR BEFORE CONSULTING MAINTENANCE MANUAL.

12400-262

PINTLE HOOK

PINTLE HOOK REMOVAL

- 1 Remove grill guard (refer to page 14-22).
2. Remove grease zerk (1, Figure 14-1).
3. Remove cotter pin (2).
4. Remove nut (3).
5. Remove pintle hook (4).
6. Remove machinery bushing (5).

PINTLE HOOK INSTALLATION

1. Install machinery bushing (5, Figure 14-1).
2. Install pintle hook (4).
3. Install nut (3) flush with machinery bushing (5).

NOTE

It maybe necessary to back off nut slightly to install cotter pin.

4. Install cotter pin (2). Bend cotter pin around nut (3).
5. Install grease zerk (1).
6. Install grill guard (refer to page 14-23).

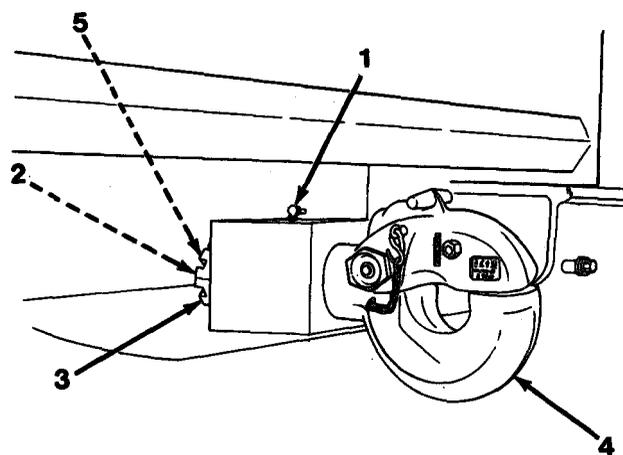


Figure 14-1

PINTLE HOOK DISASSEMBLY

Remove two grease zerks (6, Figure 14-2).

PINTLE HOOK CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

PINTLE HOOK ASSEMBLY

Install two grease zerks (6, Figure 14-2).

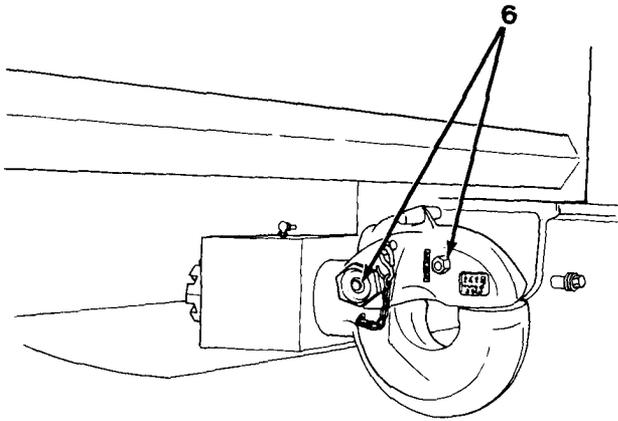


Figure 14-2

OUTRIGGER ASSEMBLY

OUTRIGGER ASSEMBLY REMOVAL AND DISASSEMBLY

1. Fully extend and lower all outriggers without putting any pressure on outrigger pads (refer to Koehring Commercial Operation Instructions manual).

NOTE

The following is a maintenance procedure for one outrigger assembly. The maintenance procedure for the remaining outrigger assemblies is identical.

2. Support cylinder and beam (7, Figure 14-1) with wood blocks.
3. Using a punch, remove pin (1) by driving through pin (2).
4. Using a brass drift remove pin (2) by driving through beam (7).
5. Remove capscrew (3), lockwasher (4) and rod end (5).
6. Using a brass drift remove pin (6) by driving through beam (7).

WARNING

Weight of beam is approximately 129 lb (59 kg). Use adequate lifting equipment to lift and support beam. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

7. Remove beam (7) from frame.
8. Remove nut (8), washer (9), bolt (10) and pad (11) from beam (7).
9. Remove two grease zerks (12) and two grease zerks (13) from beam (7).
10. Using a press, remove four bushings (14) from beam (7), if necessary.

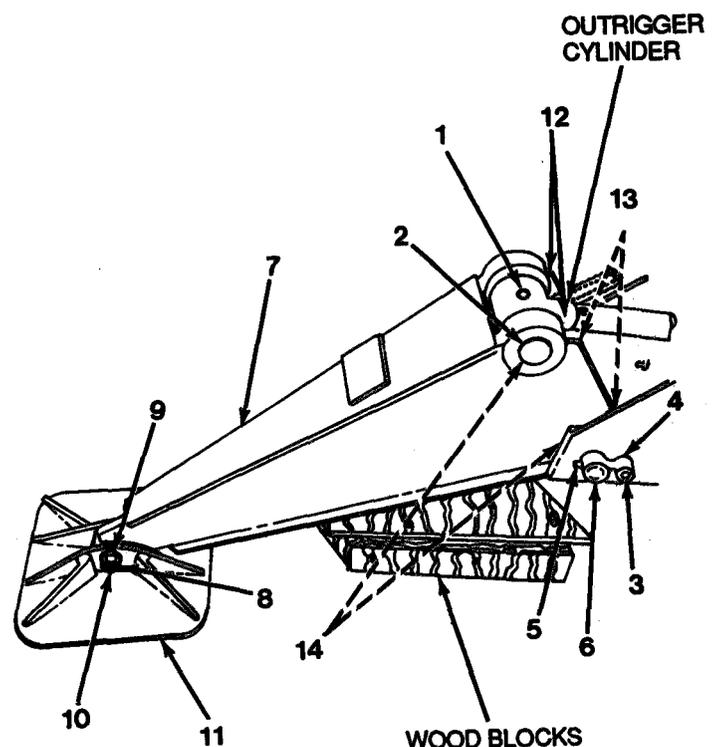


Figure 14-1

OUTRIGGER ASSEMBLY CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect beam bushings. Maximum I.D. is 2.033 in. (51.64 mm). If I.D. is greater than limit, replace bushings.
3. Inspect outrigger beam pins. Minimum O.D. is 1.964 in. (49.89 mm). If O.D. is less than limit, replace pins.
4. Inspect pad pivot bolt. Minimum O.D. is 1.230 in. (31.24 mm). If O.D. is less than limit, replace bolt.
5. Inspect pivot bolt bushing. Maximum I.D. is 1.275 in. (32.39 mm). If I.D. is greater than limit, replace outrigger beam.
6. Inspect all other parts (refer to Chapter 4).

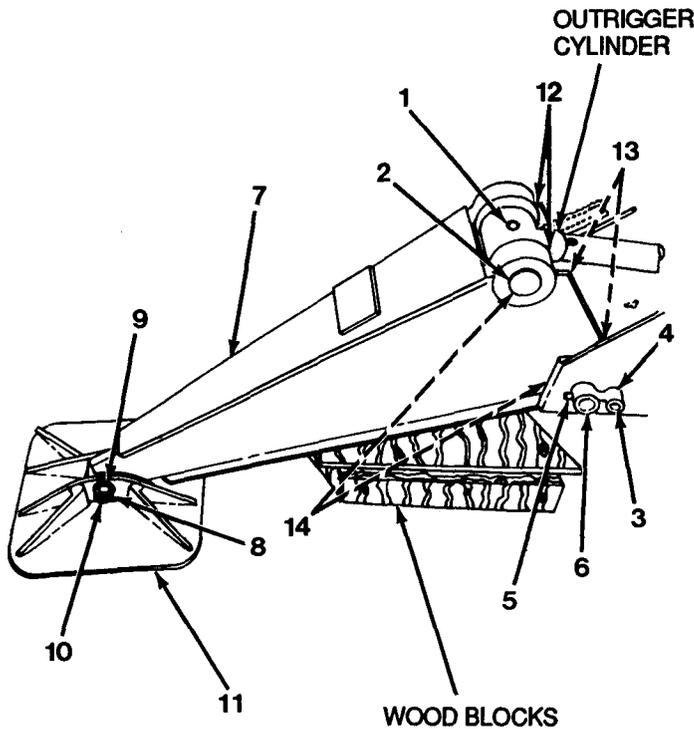


Figure 14-1

OUTRIGGER ASSEMBLY ASSEMBLY AND INSTALLATION

⚠ WARNING

Liquid nitrogen is extremely cold, having a temperature of -320 degrees F (-195 degrees C). Skin contact with liquid nitrogen or with an object cooled by liquid nitrogen will result in SEVERE INJURY. Wear protective gloves that will not absorb liquid nitrogen. Excess liquid nitrogen must be disposed of promptly since liquid nitrogen will condense oxygen from the atmosphere. The mixture of liquid nitrogen and liquid oxygen is a powerful oxidizer and may react violently with easily oxidizable substances.

NOTE

Cool bushings to -320 degrees F (-195 degrees C) submerging bushings in liquid nitrogen.

1. Submerge four bushings (14, Figure 14-1), if removed, in liquid nitrogen to cool them. Apply Loctite RC680 to outrigger bushing beam bore.
2. Using a press, install four chilled bushings (14) in beam (7).
3. Stake beam as indicated in Figure 14-2.
4. Install two grease zerks (13) and two grease zerks (12) in beam (7, Figure 14-1).
5. Install pad (11), bolt (10), washer (9) and nut (8) in beam (7).
6. Install beam (7) in frame, aligning holes in beam (7) with holes in frame. Support on wood blocks.
7. Using a brass drift install pin (6) by driving through beam (7).
8. Install rod end (5), lockwasher (4) and cap-screw (3).
9. Using a brass drift install pin (2) by driving through beam (7) and cylinder rod eye.
10. Install new pin (1) flush with rod end on cylinder.
11. Remove wood blocks supporting beam (7) and cylinder
12. Raise all outriggers and check operation (refer to Koehring Commercial Operation Instructions manual).

⚠ WARNING

Weight of beam is approximately 129 lb (59 kg). Use adequate lifting equipment to lift and support beam. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

6. Install beam (7) in frame, aligning holes in beam (7) with holes in frame. Support on wood blocks.
7. Using a brass drift install pin (6) by driving through beam (7).

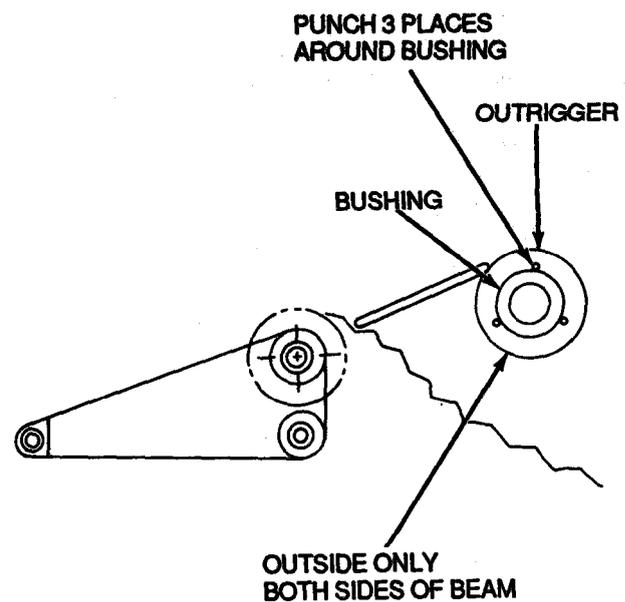


Figure 14-2

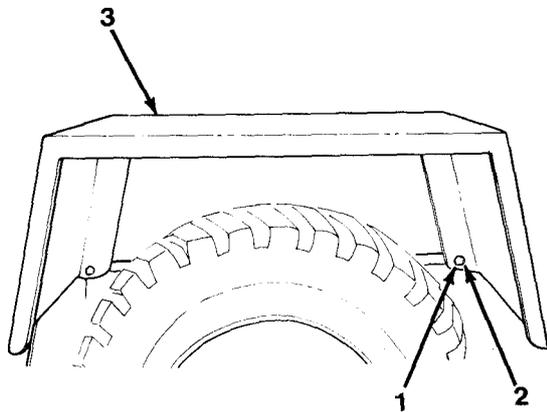


Figure 14-1

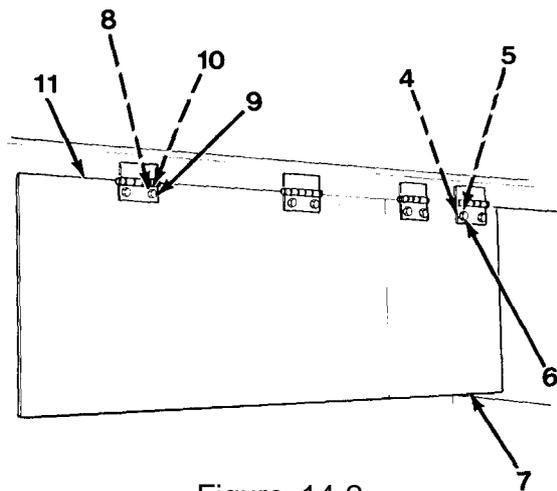


Figure 14-2

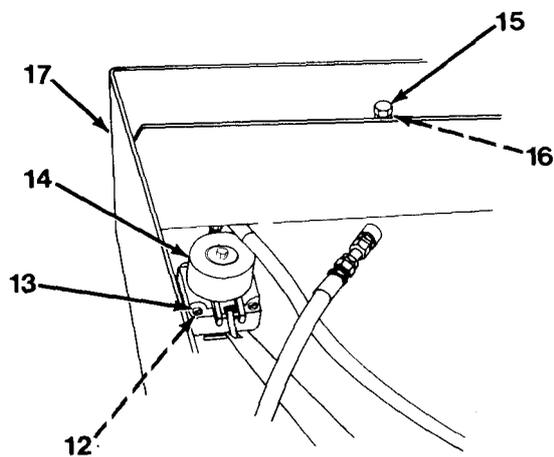


Figure 14-3

FENDERS, DECK PLATES, BATTERY BOX AND TOOL BOX WITH COVERS

FENDER REMOVAL

NOTE

The following is a maintenance procedure for one fender. The maintenance procedure for the remaining fenders is identical.

1. Support fender (3, Figure 14-1).
2. Remove six nuts (1) and washers (2) from studs on frame.



Weight of fender is approximately 99 lb (45 kg). Use adequate lifting equipment to support fender. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Remove fender (3).

BATTERY BOX AND TOOL BOX WITH COVERS REMOVAL

1. Remove batteries (refer to page 10-16).
2. Remove four nuts (4), washers (5) and cap screws (6, Figure 14-2).
3. Remove battery cover (7).
4. Remove four nuts (8), washers (9) and cap screws (10).
5. Remove tool box cover (11).

6. Remove three nuts (12), capscrews (13) and hand pump (14) from inside of tool box (17, Figure 14-3).
7. Remove all tools and spare parts from tool box (17).
8. Support tool box (17) with suitable blocking or a floor jack.

⚠ WARNING

Weight of tool box is approximately 180 lb (82 kg). Use adequate lifting equipment to support tool box. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

9. Remove six capscrews (15), washers (16) and tool box (17).

DECK PLATES REMOVAL

1. Remove five capscrews (18), washers (19), deck plate (20) and five clips (21, Figure 14-4).
2. Remove three nuts (22), four washers (23) and capscrew (24).
3. Remove pinion cover (25).

FENDERS, DECK PLATES, BATTERY BOX AND TOOL BOX WITH COVERS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

DECK PLATES INSTALLATION

1. Install pinion cover (25, Figure 14-4).
2. Install washer (23), capscrew (24), three washers (23) and three nuts (22).
3. Install five clips (21), deck plate (20), five washers (19) and capscrews (18).

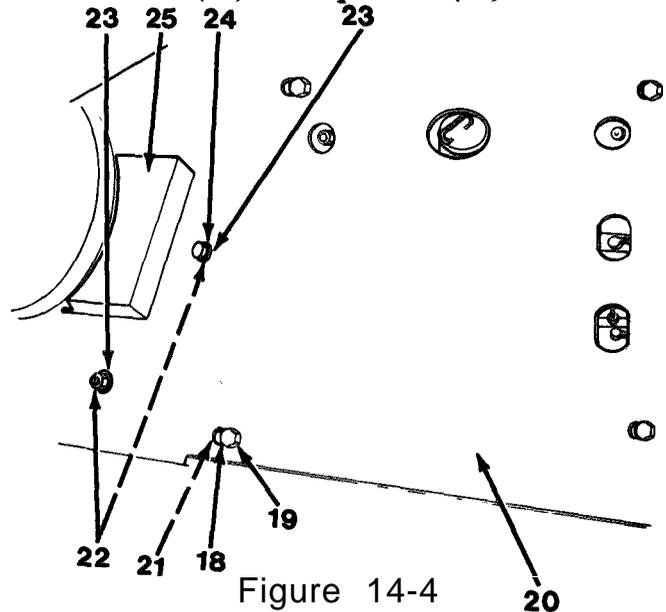


Figure 14-4

BATTERY BOX AND TOOL BOX WITH COVERS INSTALLATION

⚠ WARNING

Weight of tool box is approximately 180 lb (82 kg). Use adequate lifting equipment to support tool box. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Support tool box (17, Figure 14-3) on suitable blocking or floor jack.
2. Install tool box (17), six washers (16) and capscrews (15).

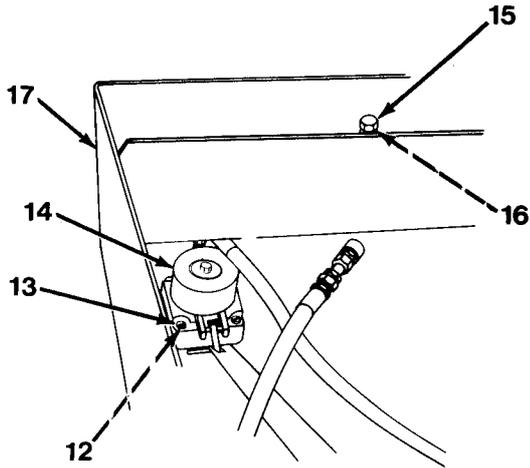


Figure 14-3

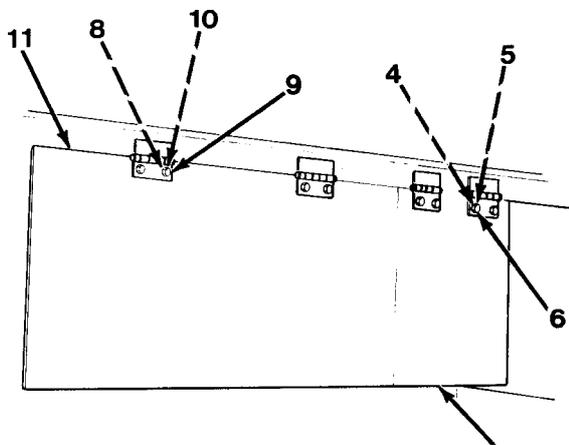


Figure 14-2

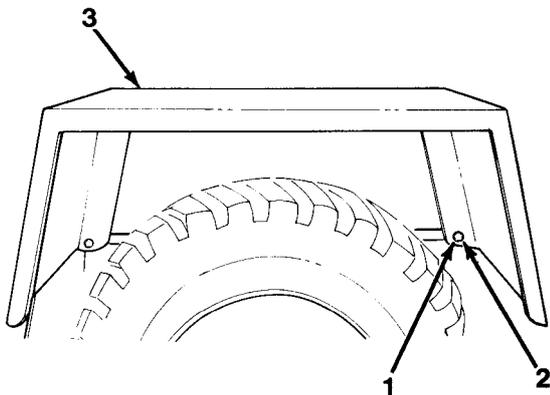


Figure 14-1

BATTERY BOX AND TOOL BOX WITH COVERS INSTALLATION

3. Install all tools and spare parts removed earlier.
4. Install hand pump (14), three cap screws (13) and nuts (12) to secure hand pump (14) to inside of tool box (17).
5. Install tool box cover (11, Figure 14-2).
6. Install four cap screws (10), washers (9) and nuts (8).
7. Install battery cover (7).
8. Install four cap screws (6), washers (5) and nuts (4).
9. Install batteries (refer to page 10-20).

FENDER INSTALLATION

WARNING

Weight of fender is approximately 99 lb (45 kg). Use adequate lifting equipment to support fender. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Install fender (3, Figure 14-1).
2. Install six washers (2) and nuts (1) to studs on frame.

SEAT

SEAT REMOVAL

1. Remove four mounting lock nuts (1, Figure 14-1).
2. Remove seat (2) from inside cab and four capscrews (3) from slide rails (6).
3. Adjust slide rails (6) forward or back to remove four capscrews (4), washers (5) and slide rails (6) from seat (2, Figure 14-2).

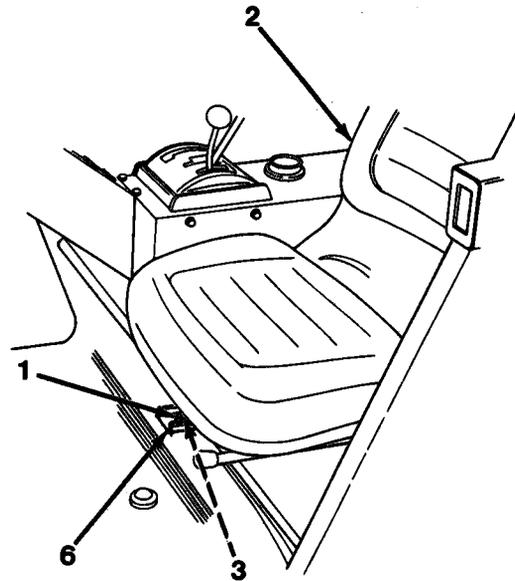


Figure 14-1

SEAT CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

SEAT INSTALLATION

1. Install four washers (5) and capscrews (4) to mount slide rails (6) to seat (2, Figure 14-2).
2. Adjust slide rails (6) forward or back to align mounting holes. Install four capscrews (3) in slide rails (6) and install seat (2, Figure 14-1) on cab floor.
3. Install four locknuts (1).

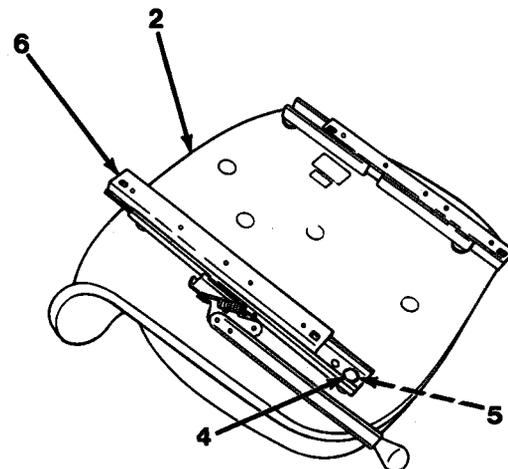


figure 14-2

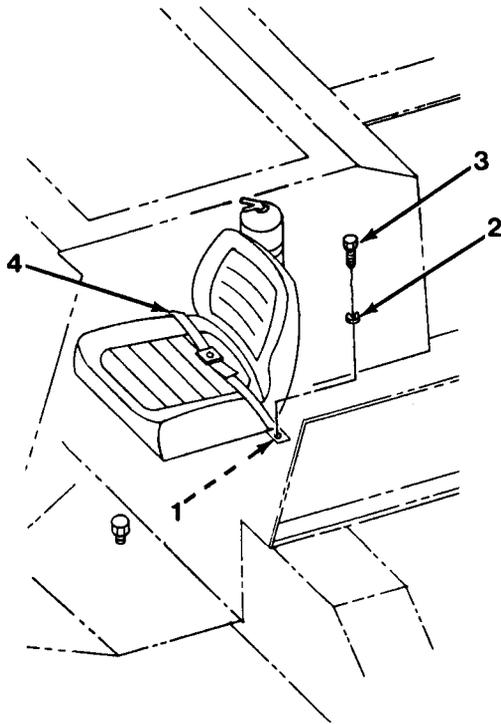


Figure 14-1

SEAT BELTS

SEAT BELT REMOVAL

1. Remove two lock nuts (1) and washers (2, Figure 14-1).
2. Remove two capscrews (3) and seat belts (4) from inside cab floor.

SEAT BELT CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

SEAT BELT INSTALLATION

1. Install two seat belt halves (4) and capscrews (3, Figure 14-1) to inside cab floor.
2. Install two washers (2) and lock nuts (1),

MIRROR

MIRROR REMOVAL

NOTE

The following is a maintenance procedure for left mirror. The maintenance procedure for right mirror is identical.

Remove two nuts (1), washers (2), capscrews (3) and mirror (4, Figure 14-1) assembly.

MIRROR INSTALLATION

Position mirror (4) assembly and install two capscrews (3), washers (2) and nuts (1, Figure 14-1).

MIRROR DISASSEMBLY

1. Remove nut (5) and bracket (6, Figure 14-1).
2. Remove nut (7), washer (8) and capscrew (9).
3. Remove nut (10), washer (11) and mirror (4).
4. Remove nut (12), washer (13), capscrew (14, washer (13) and bracket (15).

MIRROR CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

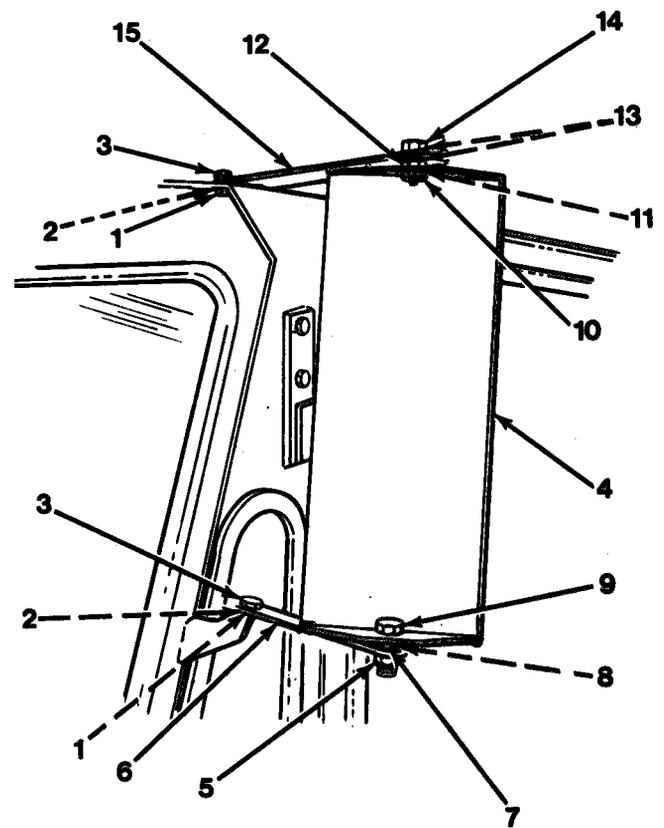
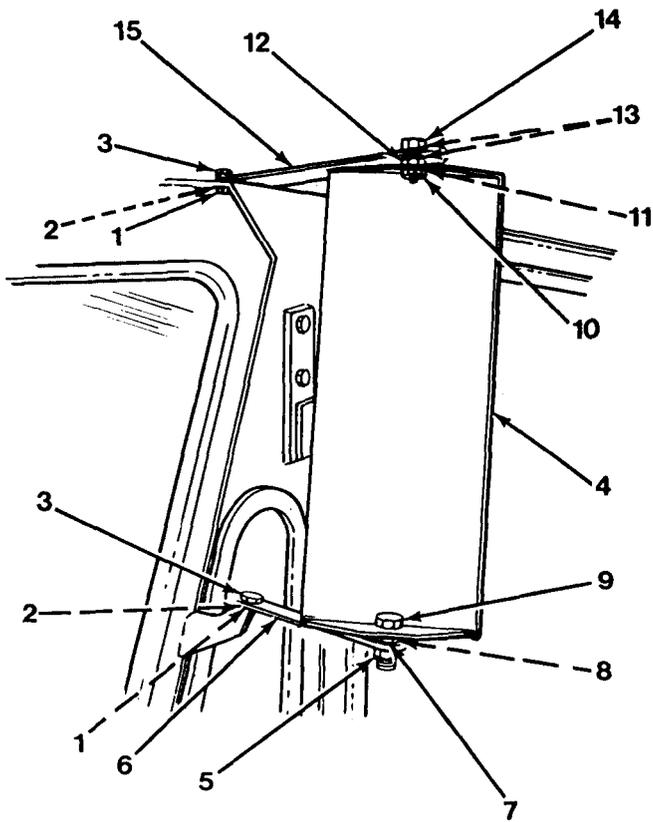


Figure 14-1



MIRROR ASSEMBLY

1. Install capscrew (14), washer (13), bracket (15), washer (13) and nut (12, Figure 14-1).
2. Install mirror (4), washer (11) and nut (10).
3. Install capscrew (9) in mirror (4).
4. Install washer (8) and nut (7).
5. Install bracket (6) and nut (5).

Figure 14-1

CAB**CAB REMOVAL**

1. Start engine. Rotate boom to right side of carrier. Shut engine off.
2. Remove cab door (refer to page 14-19).
3. Remove windshield wiper (refer to page 17-26).
4. Remove mirrors (refer to page 14-13).
5. Remove defroster fan (refer to page 17-24).
6. Remove two nuts (1), capscrews (2) and clamps (3) securing defroster fan harness to cab (4, Figure 14-1).
7. Remove 18 lock nuts (5) and washers (6) securing cab (4).

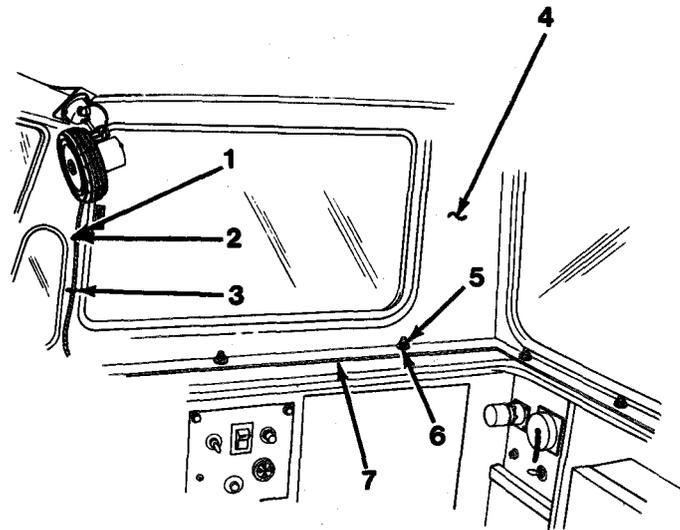


Figure 14-1

⚠ WARNING

Weight of cab is approximately 250 lb (113 kg). Use adequate lifting equipment to lift and support cab. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

8. Attach hoist with sling through door and window openings in cab (4).
9. Using hoist and sling, lift cab (4) off.
10. Remove seals (7), if necessary.
11. Remove fire extinguisher (8), four capscrews (9), lockwashers (10) and bracket (11, Figure 14-2).

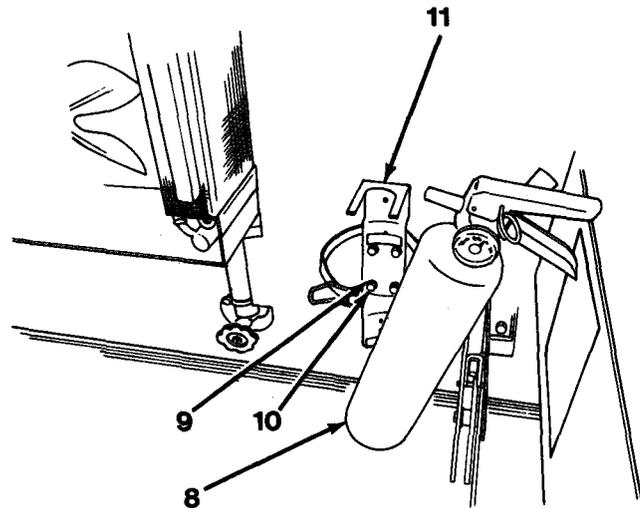


Figure 14-2

CAB REMOVAL

NOTE

Floormats are held in place with adhesive and should not be removed unless inspection indicates replacement is necessary.

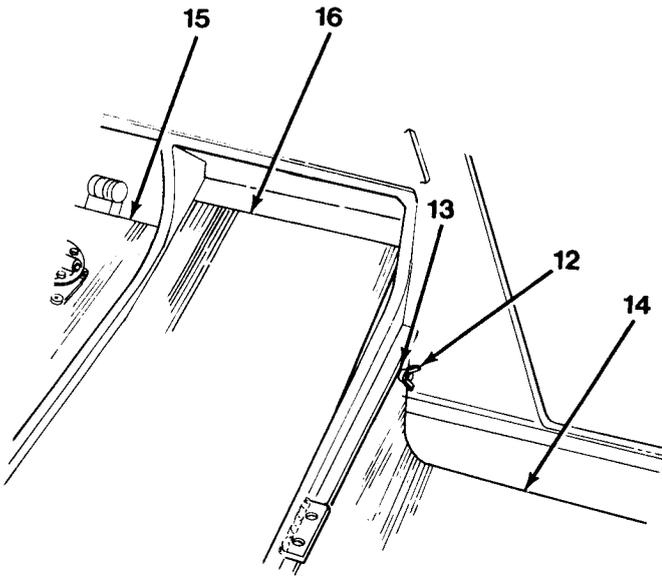


Figure 14-3

14. If necessary, remove two wing nuts (12), washers (13) and floormat (14, Figure 14-3). Remove all adhesive from cab floor.
15. Remove floormats (15) and (16), if replacement is necessary.

NOTE

Insulation pads are held in place with adhesive and should not be removed unless inspection indicates replacement is necessary.

16. If left front or right side insulation pad replacement is necessary, remove cab main harness (refer to page 10-36, steps 3 and 6).
17. If lower right insulation pad replacement is necessary, remove right-hand dash panel (refer to page 17-64).
18. If necessary, remove eight insulation pads. Remove all adhesive from cab wall.

CAB INSTALLATION

1. If removed, apply 3M #1300 adhesive to cab walls and install eight insulation pads.
2. If removed, install right-hand dash panel (refer to page 17-69).
3. If removed, install cab main harness (refer to page 10-37).
4. If removed, install floormats (16) and (15). Apply 3M #1300 adhesive to mating surfaces and install floormat (14), two washers (13) and wing nuts (12, Figure 14-3).
5. Install seat belts (refer to page 14-12).
6. Install seat (refer to page 14-11).
7. Install bracket (11), four lockwashers (10), capscrews (9) and fire extinguisher (8, Figure 14-2).
8. If removed, install seals (7, Figure 14-1). Seal ends of seals (7) together with silicone.

11. Secure defroster fan harness to cab with two clamps (3), capscrews (2) and nuts (1).
12. Install defroster fan (refer to page 17-25).
13. Install mimers (refer to page 14-13).
14. Install windshield wiper (refer to page 17-27).
15. Install cab door (refer to page 14-20).

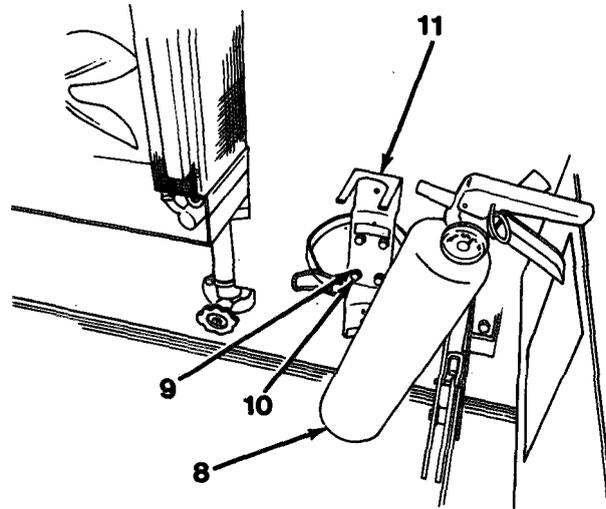


Figure 14-2

⚠ WARNING

Weight of cab is approximately 250 lb (113 kg). Use adequate lifting equipment to lift and support cab. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

9. Using a hoist with sling through door and window openings, position cab (4) mounting holes over studs in frame and install cab (4).
10. Install 18 washers (6) and lock nuts (5) to secure cab (4).

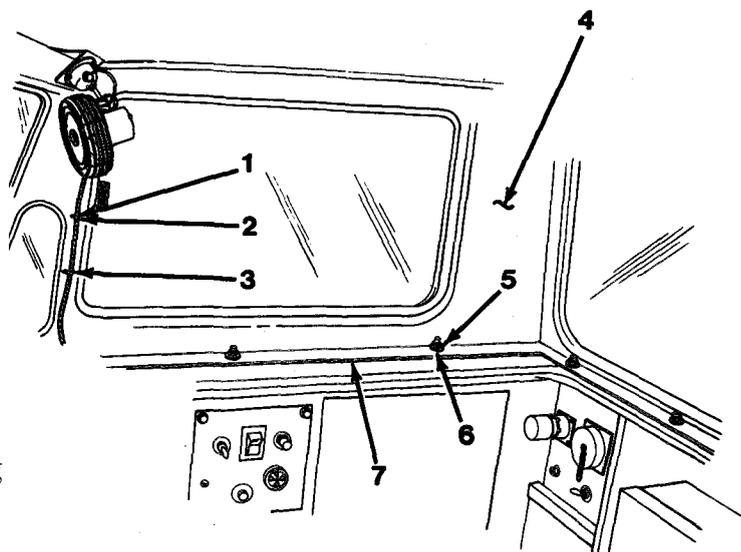


Figure 14-1

CAB DISASSEMBLY

NOTE

Do not remove glass panels or weather strips unless inspection indicates replacement is necessary.

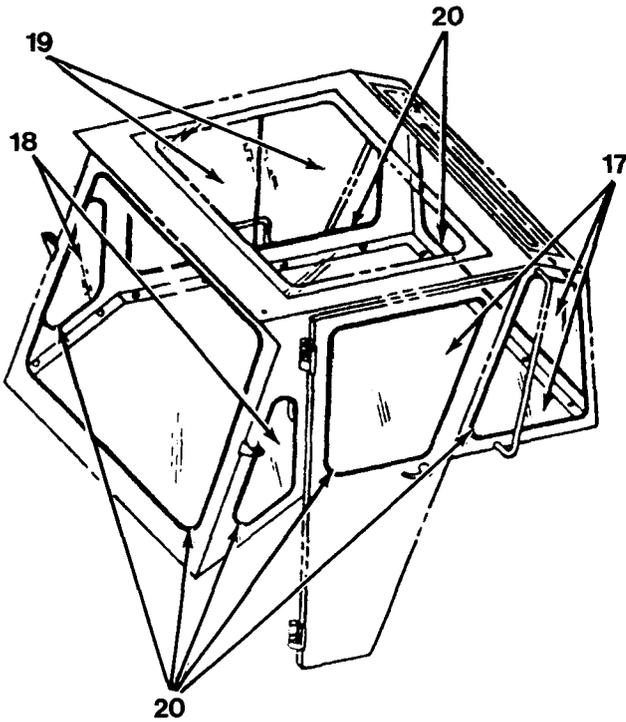


Figure 14-4

1. If necessary, remove glass panels (17), (18) and (19), using a pointed object to remove from weather strips (20, Figure 14-4).
2. If necessary, remove weather strips (20).

CAB CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

CAB ASSEMBLY

1. If removed, apply a bead of silicone in both cab and glass channels of weather strips (20) for glass panels (18).
2. If removed, install glass panels (18).
3. If removed, apply a bead of silicone in window frame channel of weather strips (20) for glass panels (19).
4. If removed, install glass panels (19).
5. If removed, install remaining weather strips (20, Figure 14-4).
6. If removed, install remaining glass panels (17) in weather strips (20). Seal joints with silicone sealant, as required.

CAB DOOR

CAB DOOR REMOVAL

1. Unlatch door (1) and lift door (1) off of pins on hinges (6, Figure 14-1).

NOTE

Record number of shims to aid in installation.

2. Remove two nuts (2), washers (3), lockwashers (4), capscrews (5), hinges (6) and shims (7) from top of doorway.
3. Remove two nuts (2), washers (3), lockwashers (4), capscrews (5), hinges (6) and shims (7) from bottom of doorway.
4. Drive out roll pin (8) from inside handle (9, Figure 14-2).
5. Remove inside handle (9), four screws (10), inside latch (11) and spacer plate (12).
6. Remove two screws (13) and outside handle (14, Figure 14-3).

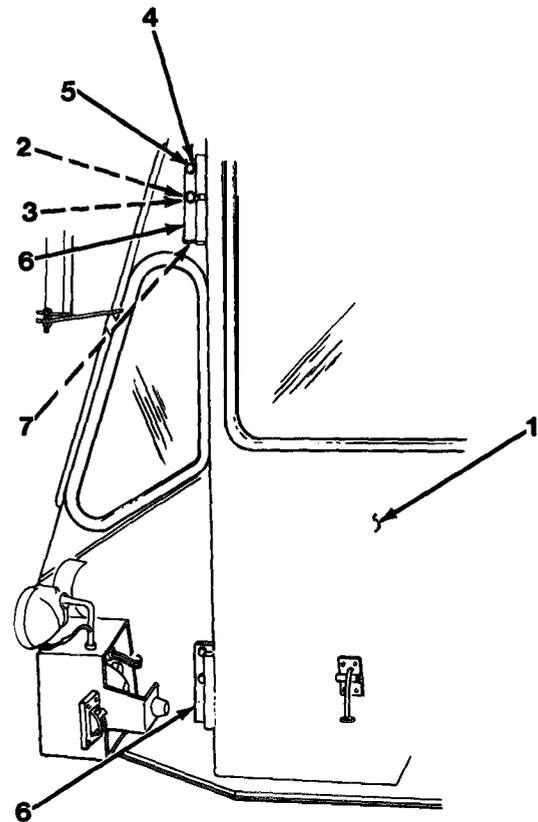


Figure 14-1

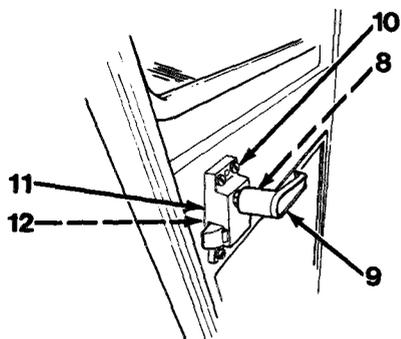


Figure 14-2

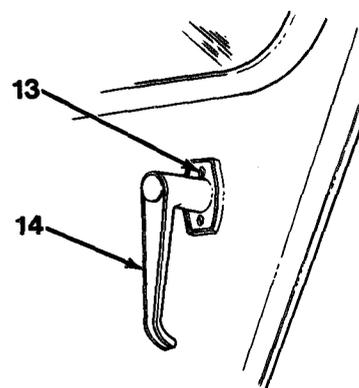


Figure 14-3

CAB DOOR REMOVAL

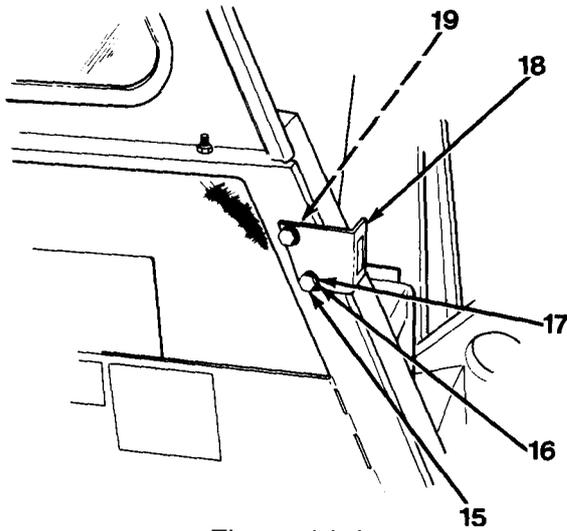


Figure 14-4

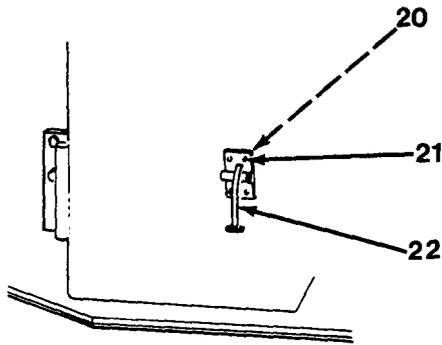


Figure 14-5

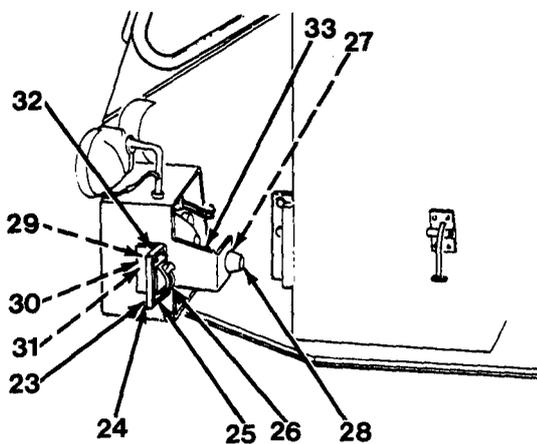


Figure 14-6

NOTE

Record number of shims to aid in assembly.

7. Remove two capscrews (15), lockwashers (16), washers (17), striker (18) and shims (19, Figure 14-4).

NOTE

It may be necessary to cut or peel back insulation on door to gain access to nut securing door latch.

8. Remove four nuts (20), screws (21) and door latch (22, Figure 14-5).
9. Remove four nuts (23), washers (24), screws (25) and door latch plate (26, Figure 14-6).
10. Remove nut (27) and bumper (28).
11. Remove two lock nuts (29), washers (30), bolts (31), plate (32) and bracket (33).

CAB DOOR CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

CAB DOOR INSTALLATION

1. Install bracket (33), plate (32), two bolts (31), washers (30) and lock nuts (29, Figure 14-6).
2. Install bumper (28) and nut (27).
3. Install door latch plate (26), four screws (25), washers (24) and nuts (23).

4. Install door latch (22), four screws (21) and nuts (20, Figure 14-5).

NOTE

Use number of shims recorded in removal.

5. Install shims (19), striker (18), two washers (17), lockwashers (16) and capscrews (15, Figure 14-4).
6. Install outside handle (14) and two screws (13, Figure 14-3).
7. Install spacer plate (12), inside latch (11), four screws (10) and inside handle (9, Figure 14-2).
8. Install roll pin (8) to secure inside handle (9).

NOTE

Use number of shims recorded in removal.

9. Install shims (7), hinges (6), two capscrews (5), washers (4), lockwashers (3) and nuts (2, Figure 14-1) at bottom of doorway.
10. Install shims (7), hinges (6), two capscrews (5), washers (4), lockwashers (3) and nuts (2) at top of doorway.
11. Lift door (1) over pins on hinges (6) and align hinges. Lower door (1) onto hinge pins.

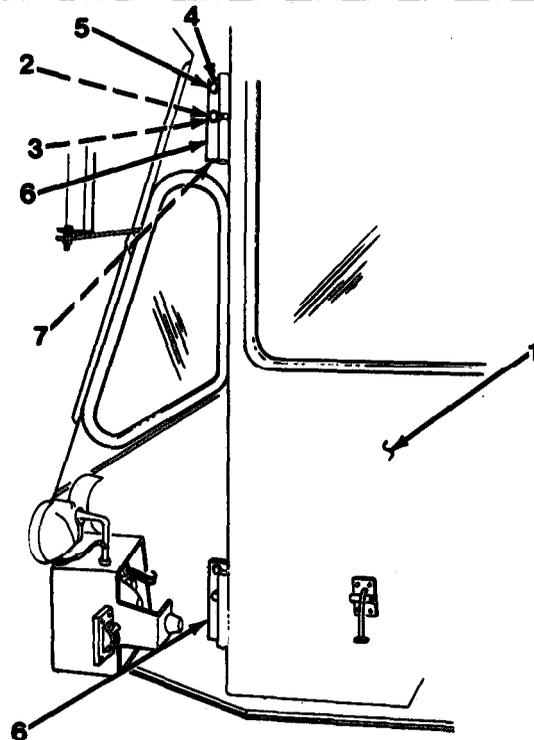


Figure 14-1

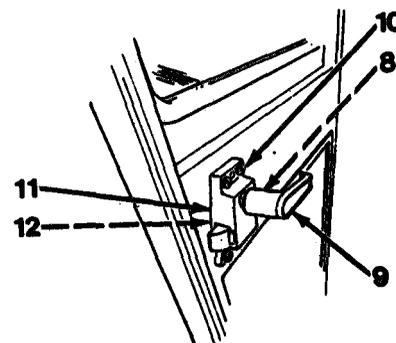


Figure 14-2

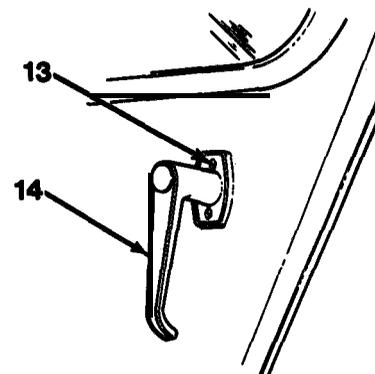


Figure 14-3

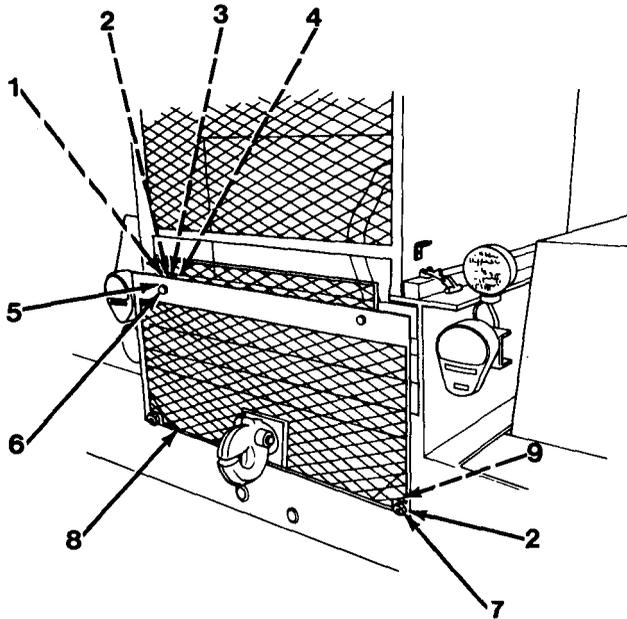


Figure 14-1

ENGINE HOOD AND GRILL GUARD

GRILL GUARD REMOVAL

1. Remove two nuts (1), washers (2), washers (3), bosses (4), washers (5) and socket head capscrews (6, Figure 14-1).
2. Remove two nuts (7), washers (2), grill guard (8) and two bosses (9).

ENGINE HOOD REMOVAL

1. Disconnect engine hood (10) by unlatching lower latches (11, Figure 14-2).
2. Pull engine hood (10) approximately half way out.
3. Push inward on side of engine hood (10) just above cam follower (12) and lift engine hood (10) to position cam follower (12) on top of guide rail (13).
4. Repeat for other cam follower (12) and lift engine hood (10) up and off frame.
5. Remove four capscrews (14) and two lower latches (11).
6. Remove four screws (15) and two blocks (16).

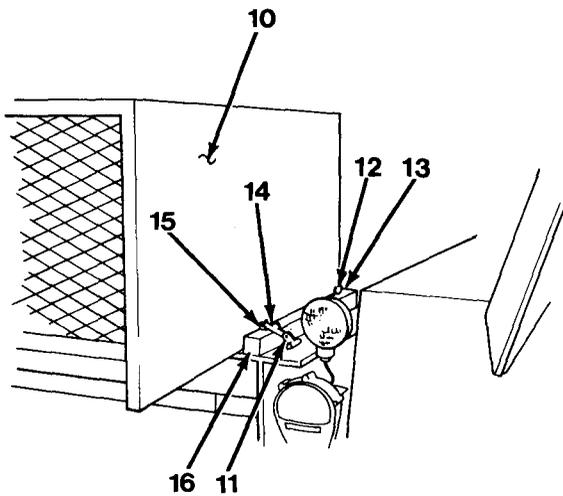


Figure 14-2

ENGINE HOOD AND GRILL GUARD CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

ENGINE HOOD INSTALLATION

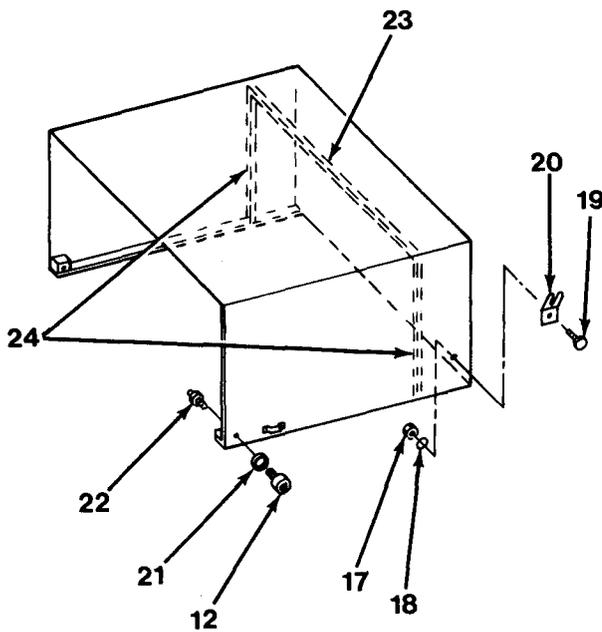
1. Install two blocks (16) and four screws (15, Figure 14-2).
2. Install two lower latches (11) and four cap-screws (14).
3. Position engine hood (10) onto top of guide rails (13) past hood on radiator.
4. Push inward on side of engine hood (10) just above earn follower (12) and position cam follower (12) under guide rails (13).
5. Push engine hood (10) back and latch in place with lower latches (11).

GRILL GUARD INSTALLATION

1. Install two bosses (9) and grill guards (8, Figure 14-1).
2. Install two washers (2) and nuts (7).
3. Install two socket head capscrews (6), washers (5), grill guard (8) and two bosses (9).
4. Install two washers (3), washers (2) and nuts (1).

ENGINE HOOD DISASSEMBLY

1. Remove four nuts (17), washers (18), cap-screws (19) and two upper latches (20, Figure 14-3).
2. Remove two cam followers (12) and lock-washers (21).
3. Remove two grease zerks (22).
4. Remove stripping (23) and two strippings (24).



ENGINE HOOD ASSEMBLY

1. Install two strippings (24) and stripping (23, Figure 14-3).
2. Install two grease zerks (22).
3. Install two lockwashers (21) and cam followers (12).
4. Install two upper latches (20), four cap screws (19), washers (18) and nuts (17).

Figure 14-3

HOOD SUPPORT

HOOD SUPPORT REMOVAL

1. Start engine. Rotate boom to right side of carrier. Shut engine off.
2. Remove nut (1), capscrew (2), plate (3), spacer (4) and two clamps (5) from hoses (6) and (7, Figure 14-1).
3. Remove two nuts (8) and U-bolt (9).
4. Loosen nut (10) on T-bolt clamp (11) and remove T-bolt clamp (11), 90-degree elbow (12) and stack cap (13) as an assembly.
5. Disconnect restriction indicator hose (14) from restriction indicator (15).
6. Remove six nuts (16), washers (17) and hood support (18).

HOOD SUPPORT CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

HOOD SUPPORT INSTALLATION

1. Install hood support (18), six washers (17) and nuts (16, Figure 14-1) on frame.
2. Connect restriction indicator hose (14) to restriction indicator (15).
3. Install stack cap (13), 90-degree elbow (12) and T-bolt clamp (11) as an assembly and tighten nut (10) on T-bolt clamp (11).

4. Install U-bolt (9) and two nuts (8).
5. Install two clamps (5), spacer (4), plate (3), capscrew (2) and nut (1) on hoses (6) and (7).
6. Start engine. Return boom to travel position. Shut engine off.

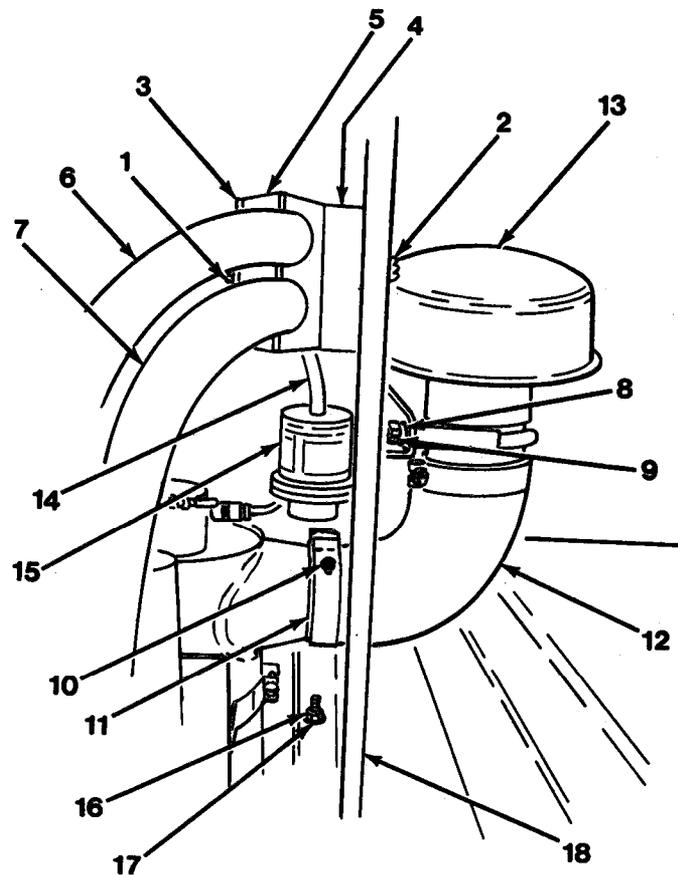


Figure 14-1

HOOK BLOCK TIEBACK

HOOK BLOCK TIEBACK REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Welder is to be qualified per AWS D14.3 or equivalent.

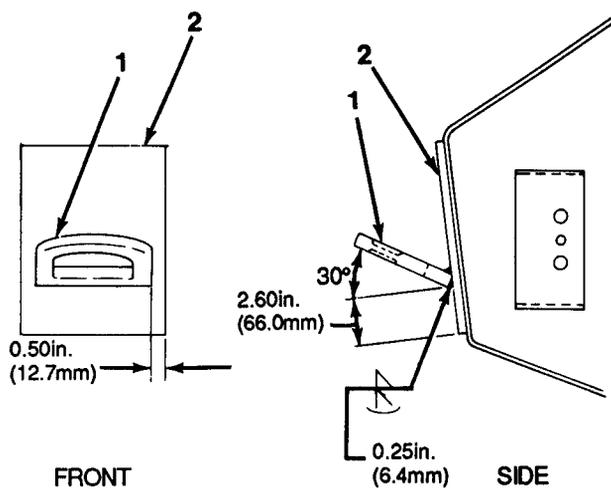


Figure 14-1

1. Disconnect battery negative ground cable.
2. Burn off hook block tieback (1) approximately 0.25 in. (6.4 mm) from surface of mounting plate (2, Figure 14- 1).
3. Grind mounting plate (2) smooth.
4. Insure all carbon residue from air arc has been removed by grinding.

HOOK BLOCK TIEBACK INSTALLATION

1. Position hook block tieback (1) on mounting plate (2, Figure 14- 1) as shown.
2. Tack in place.

3. Weld in place with 0.25 in. (6.4 mm) fillet weld and groove weld as shown. Use the following American Welding Society procedures:

SMAW (Shielded Metal Arc Welding)

Use AWS E7018 or E11018 electrode.

GMAW (Gas Metal Arc Welding)

Use AWS E70T-1 Flux Core electrode or E70S-3, E70S-6 Type Solid electrode.

GCAW (Flux Core Arc Welding)

Use AWS E70T-1 Flux Core electrode or E70S-3, E70S-6 Type Solid electrode.

4. Connect battery negative ground cable.

TM5-3810-305-24

CHAPTER 15

CRANE

Title	Page
Boom	15-1
Swing Bearing	15-15
Upperstructure	15-18
Swing Gear Box	15-25
Boom Angle Indicator	15-34

BOOM

BOOM REMOVAL

1. Remove hook block assembly (refer to Koehring Commercial Operation Instructions manual).
2. Start engine. Take up cable on winch, maintaining tension on cable at all times.
3. Place carrier upon outriggers.
4. Place boom in a horizontal position and fully retract. Shut engine off.

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

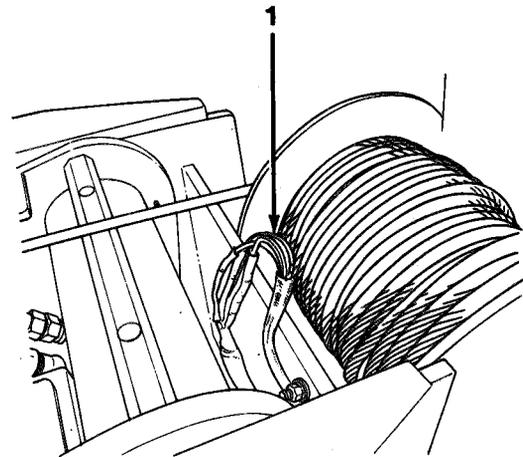


Figure 15-1

5. Disconnect battery negative ground cable.
6. Tag and disconnect electrical wiring (1, Figure 15-1) from boom base, and insulate electrical connectors.
7. Connect battery negative ground cable.

BOOM REMOVAL

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

8. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
9. Turn ignition switch ON. Bleed pressure from boom extend cylinder by operating boom telescope lever.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

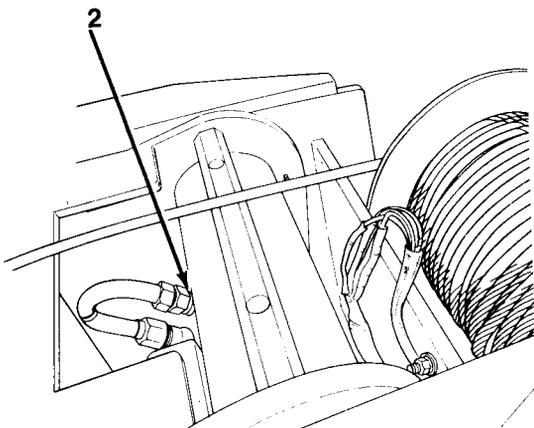


Figure 15-2

10. Disconnect two hydraulic hoses (2, Figure 15-2) from boom extend cylinder.
11. Close dipstick cap. Start engine. Elevate boom to 10 degrees to allow for placement of wood block under boom hoist cylinder. Shut engine off.

⚠ WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause **DEATH** or serious injury.

12. Place wood block to support boom hoist cylinder (Figure 15-3). Hold anti-two block BY-PASS switch down and lower boom hoist cylinder onto wood block. Shut engine off.

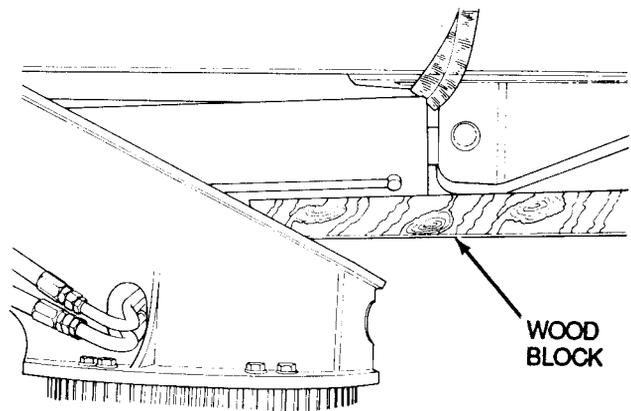


Figure 15-3

WARNING

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

CAUTION

Use webbing or wire mesh slings to prevent damage of boom. If chain or cables are wed, boom comers must be protected. Failure to follow this procedure could cause damage to equipment.

13. Attach lifting device to boom, making sure slings are placed for equal weight distribution (Figure 15-4). Take up slack
14. Remove capscrew (3), lockwasher (4), rod (5) and pin (6) from boom hoist cylinder (7, Figure 15-5) at boom.
15. Start engine. Retract boom hoist cylinder rod by pushing boom hoist lever and holding anti-two block BY-PASS switch. Cylinder rod must clear attachment point on boom. shut engine off.

NOTE

Record number of shims during removal to aid in installation.

16. Remove capscrew (8), lockwasher (9), rod (10), boom base pin (11) and shims (12, Figure 15-6).

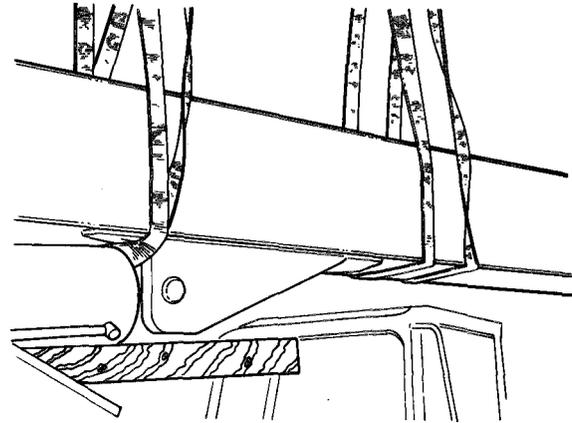


Figure 15-4

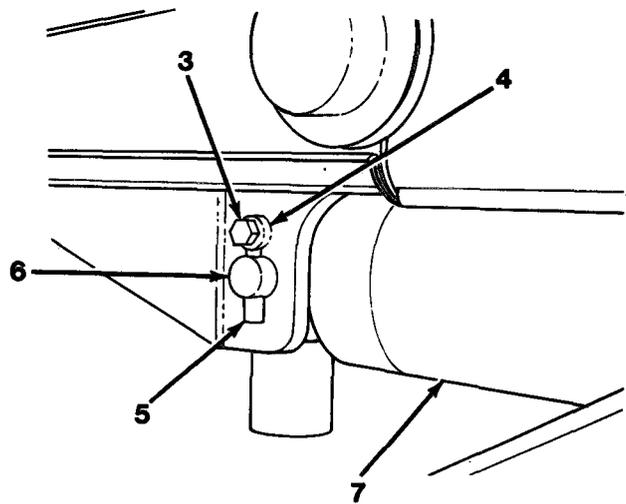


Figure 15-5

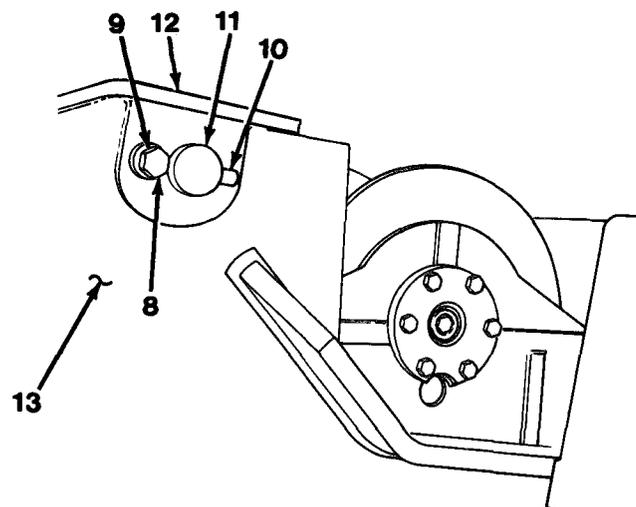


Figure 15-6

BOOM REMOVAL

17. Lift boom (13, Figure 15-6) off carrier with lifting device and lower onto support.

BOOM INSTALLATION

⚠ WARNING

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Attach lifting device to boom making certain slings are placed for equal weight distribution (Figure 15-4). Take up slack and raise boom to upperstructure.

NOTE

Use same number of shims recorded in removal.

2. Align boom (13) so that pivot holes match pivot holes in upperstructure. Install shims (12), boom base pin (11), rod (10), lock-washer (9) and capscrew (8, Figure 15-6).

⚠ WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Start engine. Extend boom hoist cylinder rod by pulling boom hoist lever. Align rod end with attachment point on boom. Shut engine off.

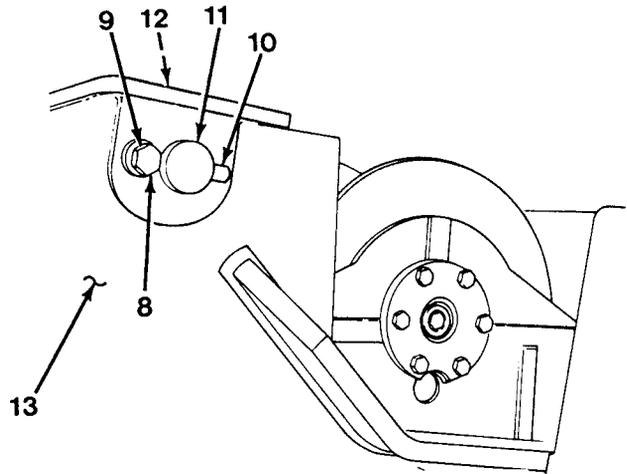


Figure 15-6

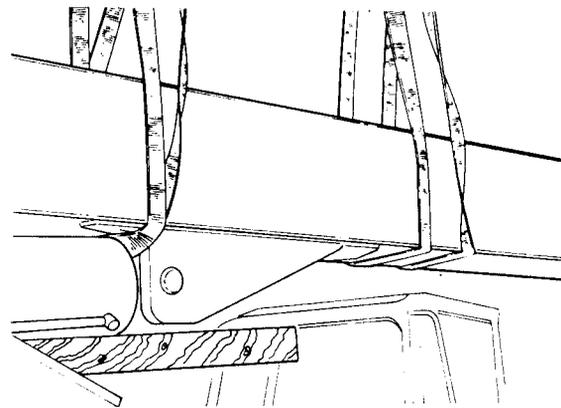


Figure 15-4

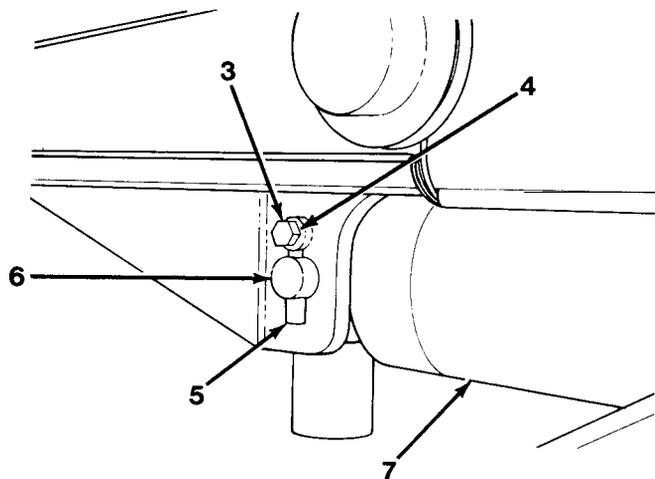


Figure 15-5

4. Install pin (6), rod (5), lockwasher (4) and capscrew (3) on boom hoist cylinder (7, Figure 15-5).
5. Start engine. Raise boom 10 degrees and remove wood block (Figure 15-3). Hold anti-two block BY-PASS switch and lower boom. Shut engine off.

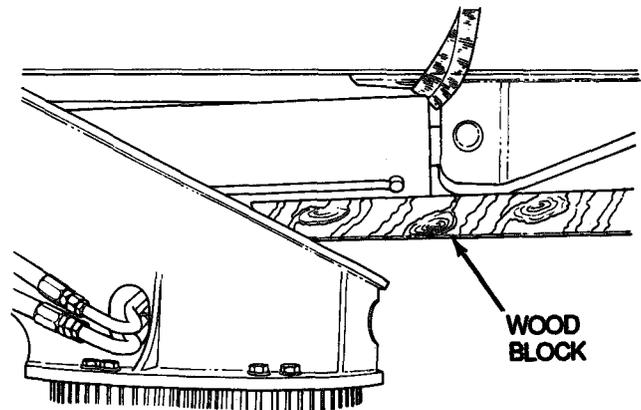


Figure 15-3

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

6. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
7. Remove caps from hydraulic hoses and cylinder tubes. Install two hydraulic hoses (2, Figure 15-2) to boom extend cylinder.
8. Close dipstick cap.

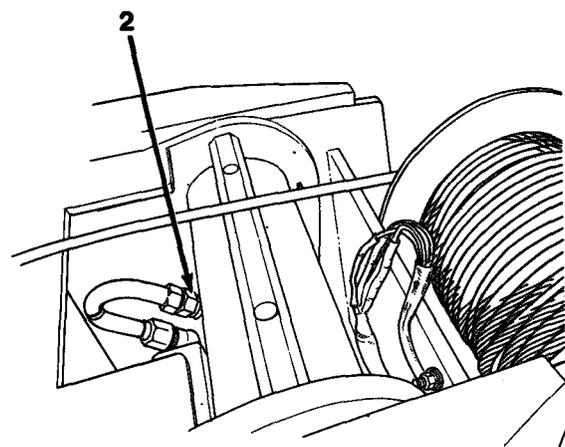


Figure 15-2

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause **DEATH** or serious injury.

9. Disconnect battery negative ground cable.
10. Connect electrical wiring (1, Figure 15-1) to boom.
11. Connect battery negative ground cable.

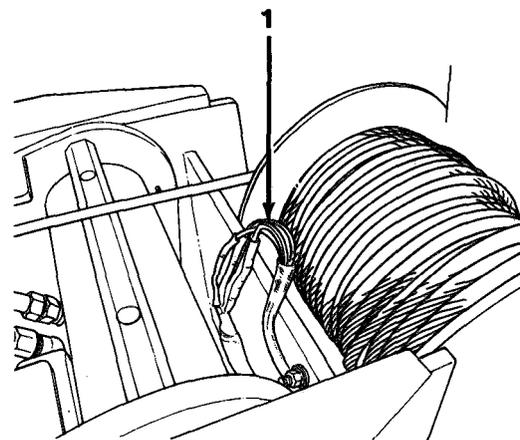


Figure 15-1

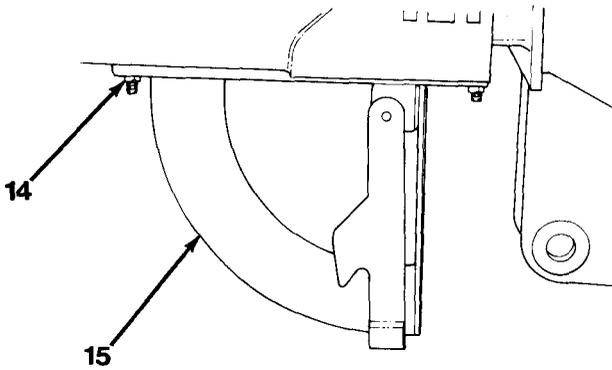


Figure 15-7

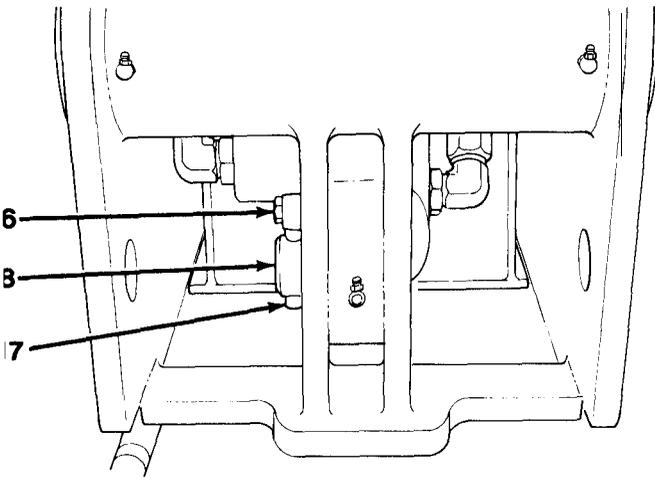


Figure 15-8

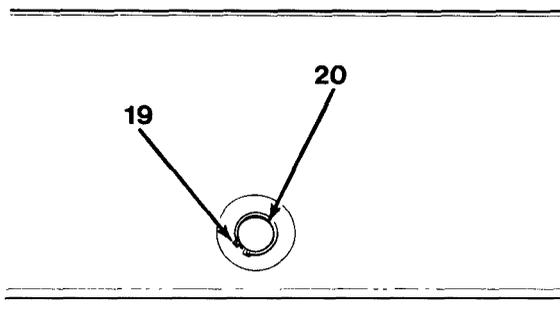


Figure 15-9

BOOM INSTALLATION

12. Start engine. Take carrier off of outriggers.
13. Push winch control lever and pay out cable over boom sheaves, maintaining tension on cable at all times. Shut engine off.
14. Connect hook block assembly (refer to Koehring Commercial Operation Instructions manual).
13. Start engine. Check for hydraulic oil leaks. Shut engine off.
14. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).

BOOM DISASSEMBLY

1. Remove boom electrical (refer to page 10-48).
2. Remove four lock nuts (14) and boom angle indicator and strip (15, Figure 15-7).
3. Remove capscrew (16), rod end (17), and pin (18, Figure 15-8) from upperstructure (base) end of boom extend cylinder.

⚠ WARNING

Weight of boom tip section is approximately 1,500 lb (680 kg). Use adequate lifting equipment to lift and support boom tip section. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

4. Slide boom tip section with boom extend cylinder out of boom base section.

5. Remove snap ring (19) and pin (20, Figure 15-9).
6. Remove two capscrews (21) and wear bar (22, Figure 15-10).

⚠ WARNING

Weight of boom extend cylinder is approximately 415 lb (188 kg). Use adequate lifting equipment to lift and support boom extend cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

7. Remove boom extend cylinder (23, Figure 15-11) from rear of boom tip section.
8. Remove two grease zerks (24) and two bushings (25) from boom base section, if inspection proves necessary.

NOTE

Record the number of shims removed to aid in assembly.

9. Remove 10 capscrews (26), 6 capscrews (27), 16 washers (28), shims (29), 5 small pads (30) and 2 large wear pads (31, Figure 15-12) from end of boom tip. Inspect pads (30) and (31) and replace if worn.

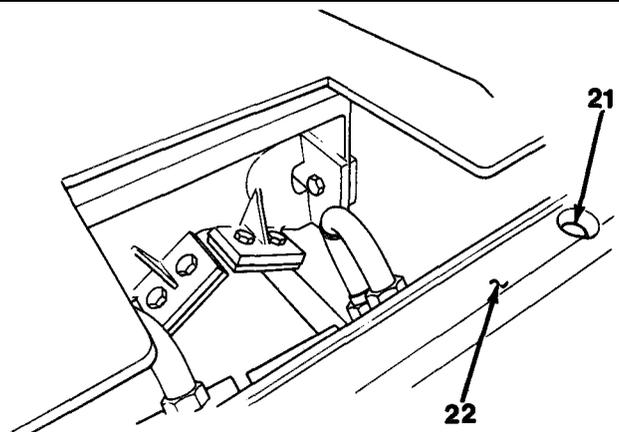


Figure 15-10

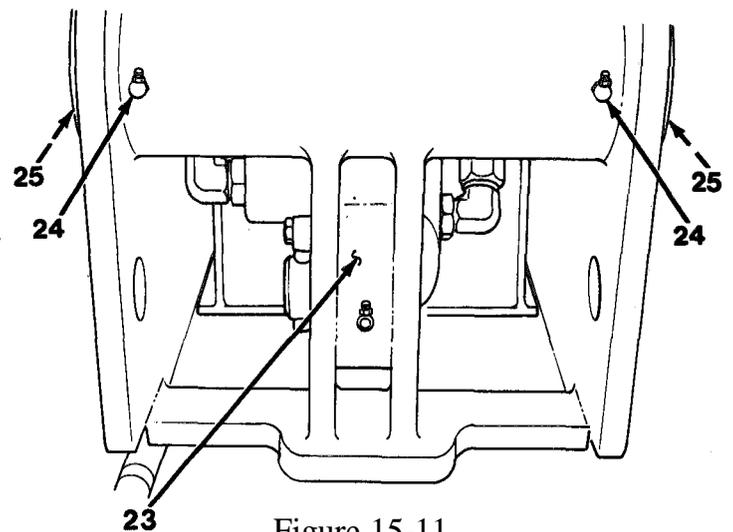


Figure 15-11

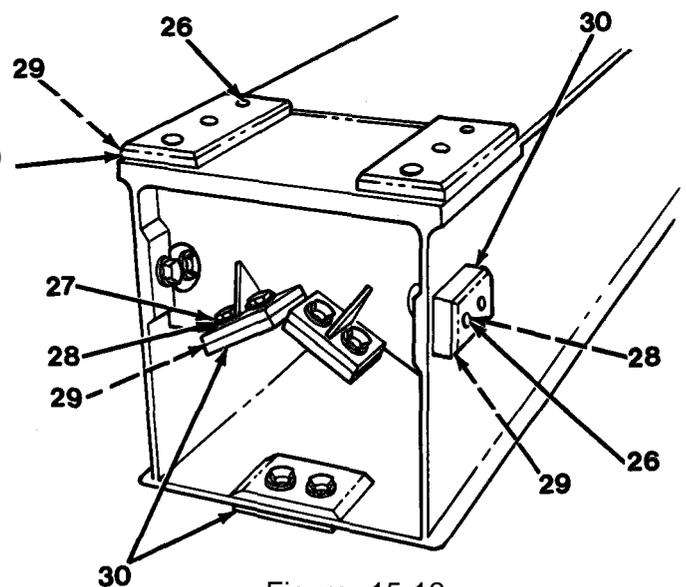


Figure 15-12

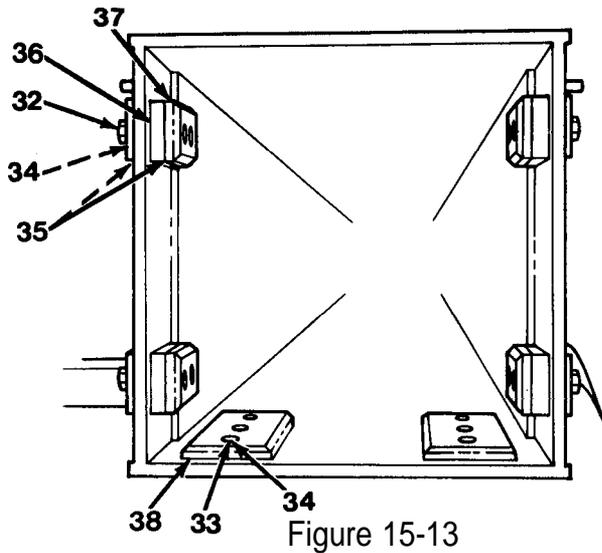


Figure 15-13

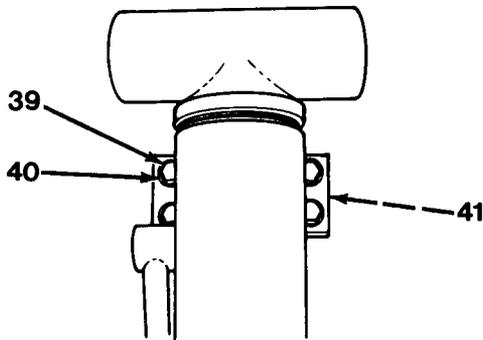


Figure 15-14

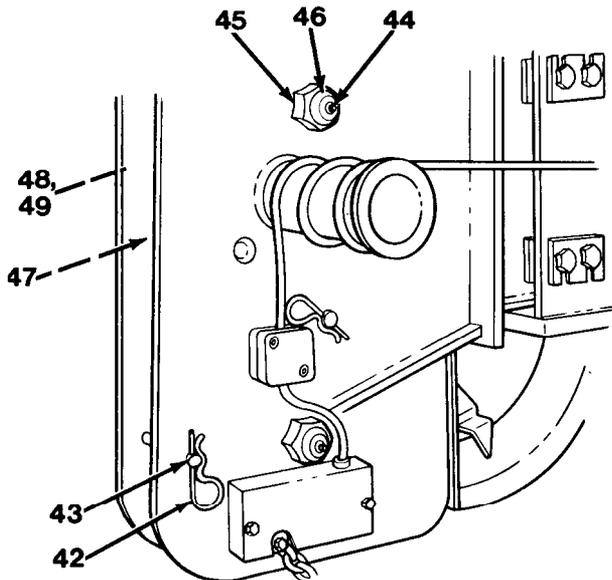


Figure 15-15

BOOM DISASSEMBLY

10. Remove 8 capscrews (32), 6 capscrews (33), 14 washers (34), shims (35), 4 spacers (36), small pads (37) and 2 large wear pads (38, Figure 15- 13) from front end of boom base. Inspect pads (37) and (38) and replace if worn.
11. Remove four capscrews (39), washers (40) and two small pads (41, Figure 15-14) from boom extend cylinder.
12. Remove six hair pin totters (42) and three cable retaining pins (43, Figure 15-15) from boom tip.
13. Remove four grease zerks (44), two lock nuts (45), boom pins (46), three sheaves (47), two spacer washers (48) and tube (49) from boom tip.
14. Remove two cotter pins (50), two plain washers (51) and bracket (52, Figure 15-16) from top of boom base section.
15. Remove two tubes (53) and elbows and O-rings (54, Figure 15- 17) from boom extend cylinder.

BOOM CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect boom pads. Minimum thickness is 0.31 in. (7.9 mm).
3. Inspect wear bar. If wear bar is worn more than 0.25 inch (6.4 mm), replace wear bar.
4. Inspect boom hoist cylinder pin. Minimum O.D. is 2.474 in. (62.84 mm). If O.D. is less than limit replace pin.
5. Inspect boom hoist cylinder pin bushing. Maximum I.D. is 2.543 in. (64.59 mm). If I.D. is greater than limit replace bushing.
6. Inspect relax boom extend cylinder pin. Minimum O.D. is 1.700 in. (43.18 mm). If O.D. is less than limit, replace pin.
7. Inspect front boom extend cylinder pin. Minimum O.D. is 1.450 in. (36.83 mm). If O.D. is less than limit, replace pin.
8. Inspect boom base pin. Minimum O.D. is 2.738 in. (69.55 mm). If O.D. is less than limit replace pin.
9. Inspect boom sheave pins. Minimum O.D. is 1.174 in. (37.44 mm); If O.D. is less than limit replace pins.
10. Inspect boom tip sheave bushing. Maximum I.D. is 1.519 in. (38.58 mm). If I.D. is greater than limit, replace bushing.
11. Inspect boom base pin bushing. Maximum I.D. is 2.784 in. (70.71 mm). If I.D. is greater than limit, replace bushing.
12. Inspect all other parts (refer to Chapter 4).

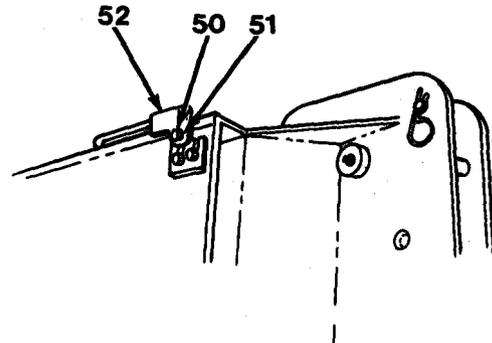


Figure 15-16

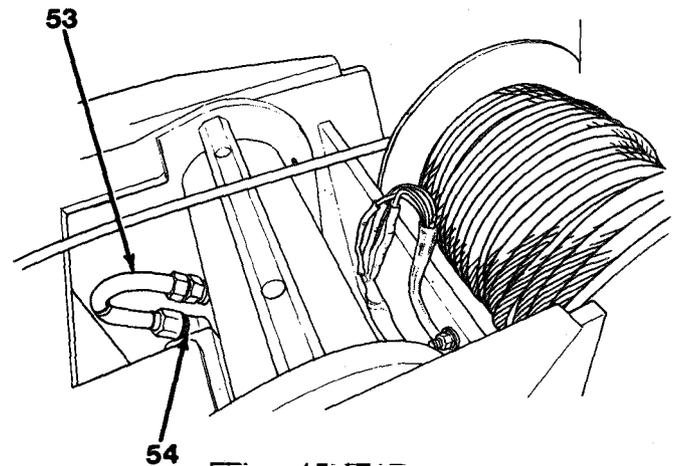


Figure 15-17

BOOM ASSEMBLY

1. Install bracket (52), two washers (51) and cotter pins (50, Figure 15-16) on top of boom tip section.

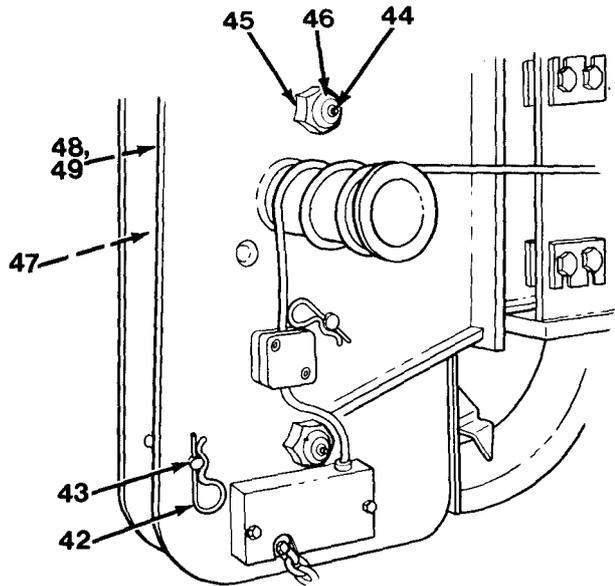


Figure 15-15

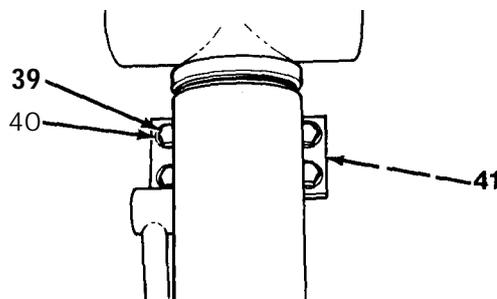


Figure 15-14

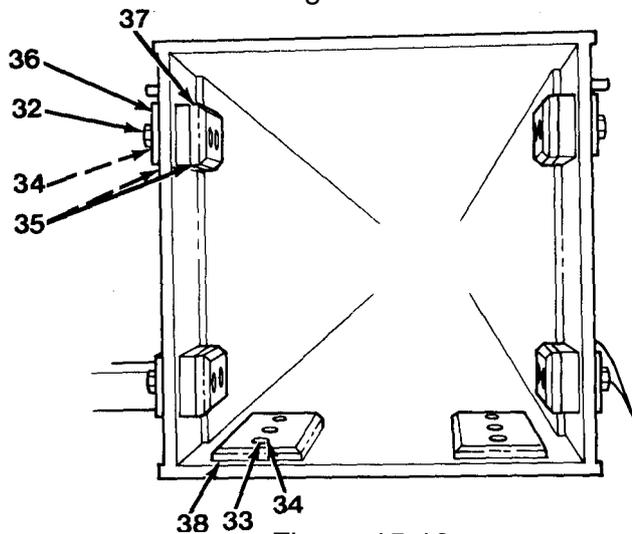


Figure 15-13

BOOM ASSEMBLY

2. Install tube (49), two spacer washers (48), three sheaves (47), two boom pins (46), lock nuts (45) and four grease zerks (44, Figure 15-15) on boom tip.
3. Install three cable retaining pins (43) and six hair pin totters (42) in boom tip.
4. Install two small pads (41), four washers (40) and capscrews (39, Figure 15-14) to boom extend cylinder.

NOTE

Install same number of shims recorded in disassembly.

5. Install 2 large wear pads (38), 4 small pads (37), spacers (36), shims (35), 14 washers (34), 6 capscrews (33) and 8 capscrews (32, Figure 15-13) to front end of boom base.
6. Install 2 large wear pads (31), 5 small pads (30), shims (29), 16 washers (28), 6 capscrews (27) and 10 capscrews (26, Figure 15-12).

⚠ WARNING

Liquid nitrogen is extremely cold, having a temperature of -320 degrees F (-195 degrees C). Skin contact with liquid nitrogen or with an object cooled by liquid nitrogen will result in SEVERE INJURY. Wear protective gloves that will not absorb liquid nitrogen. Excess liquid nitrogen must be disposed of promptly since liquid nitrogen will condense oxygen from the atmos-

where. The mixture of liquid nitrogen and liquid oxygen is a powerful oxidizer and may react violently with easily oxidizable substances.

NOTE

Cool bushings to -320 degrees F (-195 degrees C) by submerging bushings in liquid nitrogen.

7. Submerge two bushings (25, Figure 15-11) in liquid nitrogen to cool them.
8. If removed, using a press, install two bushings (25) in base boom section.
9. Install two grease zerks (24).
10. Install two O-rings and elbows (54) and tubes (53, Figure 15-18) on boom extend cylinder 25

⚠ WARNING

Weight of boom extend cylinder is approximately 415 lb (188 kg). Use adequate equipment to lift and support boom extend cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

11. Install boom extend cylinder (23, Figure 15-11) in boom tip section.
12. Install wear bar (22) and two capscrews (21, Figure 15-18).

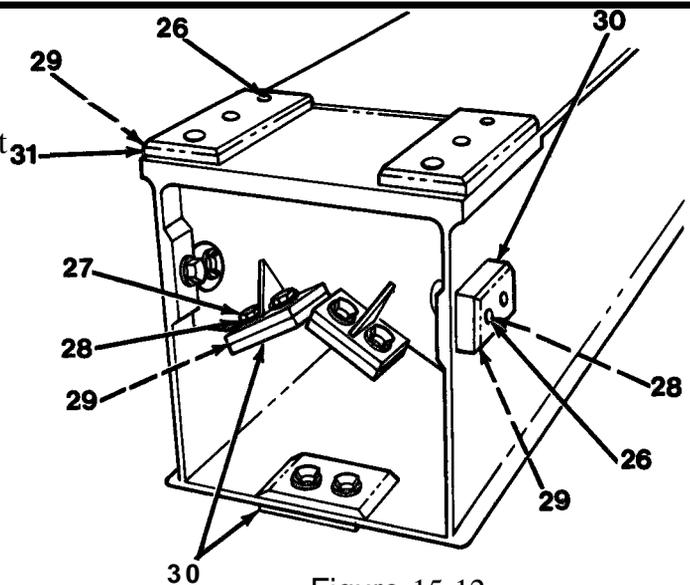


Figure 15-12

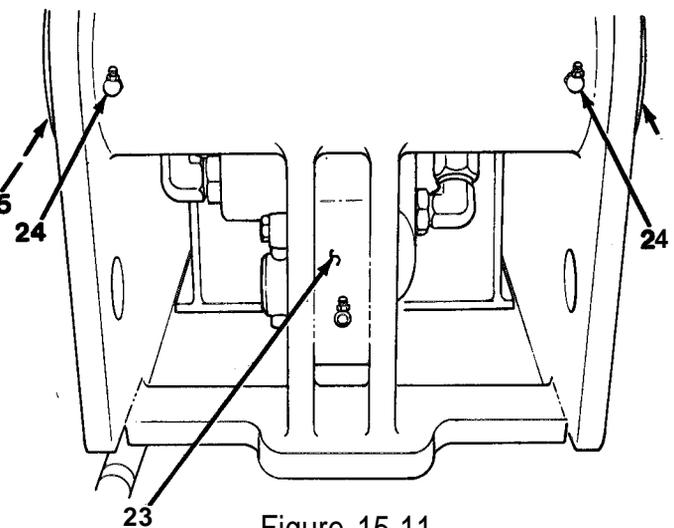


Figure 15-11

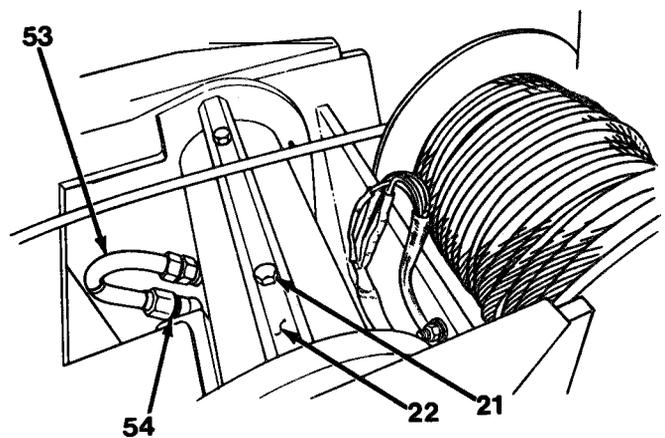


Figure 15-18

BOOM ASSEMBLY

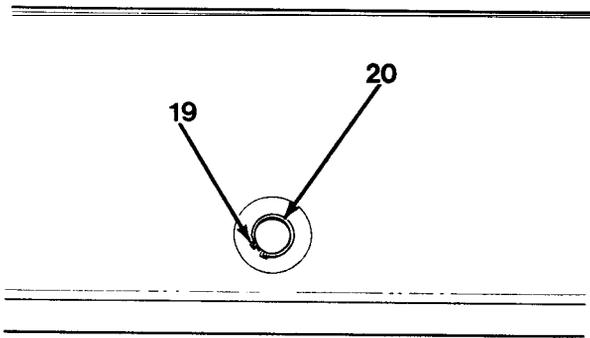


Figure 15-9

13. Install pin (20) and snap ring (19, Figure 15-9).

⚠ WARNING

Weight of boom tip section is approximately 1,500 lb (680 kg). Use adequate lifting equipment to lift and support boom tip. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

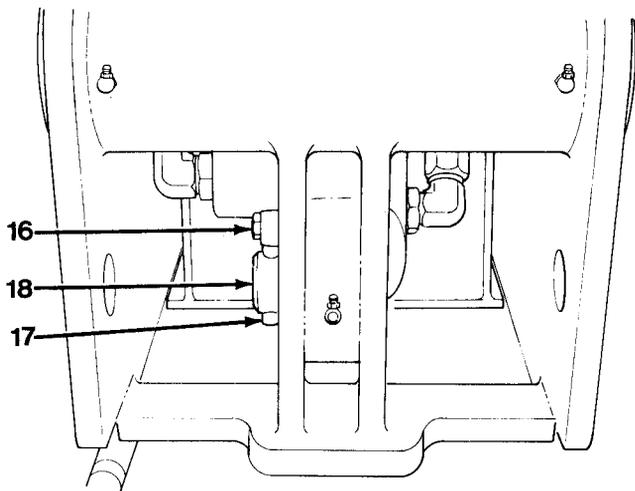


Figure 15-8

14. Slide boom tip section with boom extend cylinder into boom base section.

15. Install pin (18), rod end (17) and capscrew (16, Figure 15-8).

16. Install boom angle indicator (15) and four lock nuts (14, Figure 15-7).

17. Install boom electrical (refer to page 10-52).

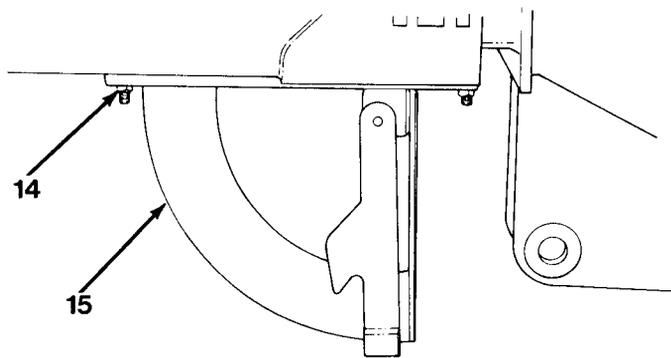


Figure 15-7

BOOM ADJUSTMENT

1. Level carrier using outriggers.
2. Reeve cable on single part line over boom tip sheaves. Start engine. Fully extend boom and raise boom to the fully raised position. Lower hook block so that it is 5 ft (1.5 m) off the ground.

NOTE

This procedure may require a load. Use approximately 500 lb (227 kg).

3. Check hook block alignment. Adjust boom pads on sides of sections at front of lower section and rear of tip section so that cable is hanging within the width of lower boom section by adding or subtracting shims under pads.
4. Lower boom fully. Stand at rear of boom and swing boom from side to side. Watch for side play between boom base section and boom tip section. If there is an appreciable amount of play between sections, boom tip will have to be reshimmed.

NOTE

See steps 9 thru 11 in disassembly for locations of pads.

BOOM ADJUSTMENT

5. If reshimming is required, check pad sets by measuring the gap between side wear pads and surface where pad slides on. Add the gaps on both sides of boom together for each set of pads which are directly opposite each other; the total gap should be 0.06 to 0.09 in. (1.5 to 2.3 mm) per set.
6. Pad sets on front of boom base can be replaced without disassembling boom.
7. To replace pad sets on boom extend cylinder and boom tip section, disassemble boom (refer to page 15-6).

SWING BEARING

SWING BEARING REMOVAL

1. Remove upperstructure (refer to page 15-18).
2. Disconnect lubrication hose(1) and remove fitting (2) from inside swing bearing (4, Figure 15-1).

NOTE

Mark position of swing bearing inspection plug retaining pin relative to carrier frame.

3. Remove 22 capscrews (3) from swing bearing (4).

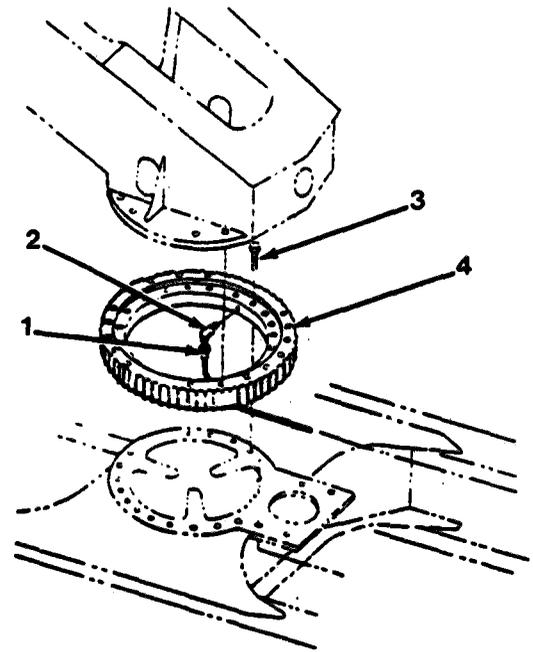


Figure 15-1

SWING BEARING REMOVAL

⚠ WARNING

Weight of swing bearing is approximately 187 lb (85 kg). Use adequate lifting equipment to lift and support swing bearing. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

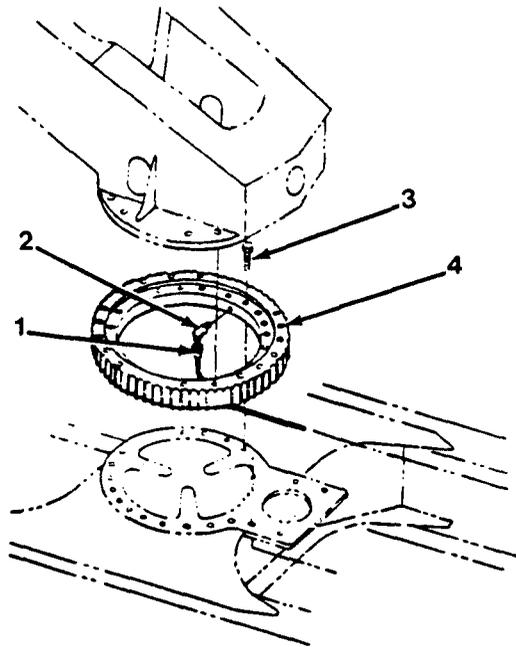


Figure 15-1

4. Install two lifting eye bolts in swing bearing 180 degrees apart. Attach lifting device and lift swing bearing (4, Figure 15-1) over rotary manifold and electrical collector ring.

SWING BEARING CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

SWING BEARING INSTALLATION

⚠ WARNING

Weight of swing bearing is approximately 187 lb (85 kg). Use a adequate lifting equipment to lift and support swing bearing. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Install two lifting eye bolts in swing bearing 180 degrees apart. Attach lifting device and lift swing bearing (4, Figure 15-1) over rotary manifold and electrical collector ring. Locate mark made during removal and lineup swing bearing inspection plug retaining pin with mark.
2. Install 22 capscrews (3, Figure 15-1) and torque to 722 lb-ft (979 N•m) in sequence shown in Figure 15-2.
3. Install fitting (2) and connect lubrication hose (1, Figure 15-1).
4. Install upperstructure (refer to page 15-20).

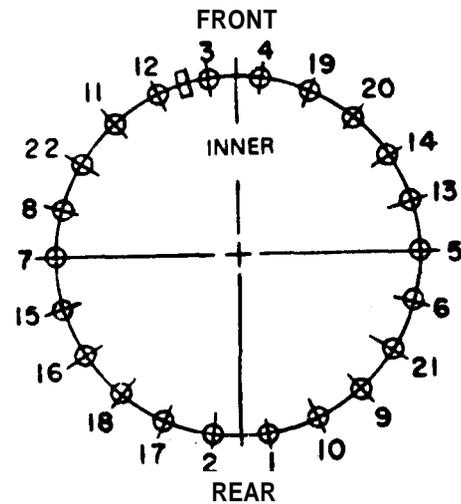


Figure 15-2

UPPERSTRUCTURE

UPPERSTRUCTURE REMOVAL

1. Remove boom (refer to page 15-1).

⚠ WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Use a lifting device to raise boom hoist cylinder and hold it in vertical position.

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause SERIOUS INJURY.

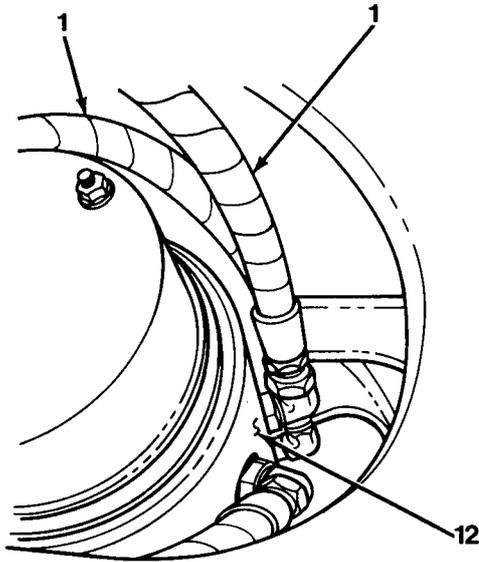


Figure 15-1

3. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
4. Tag and disconnect two boom extend cylinders hoses and boom hoist cylinder hoses (1) from rotary manifold (12, Figure 15- 1). Plug hoses and cap manifold port elbows.
5. Tag and disconnect two winch hydraulic tubes (2) from rotary manifold (12, Figure 15-2). Plug tubes and cap manifold port elbows.

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment.. Failure to follow this procedure could cause DEATH or serious injury.

6. Disconnect battery negative ground cable.
7. Tag and disconnect collector ring wiring harness (3) from top of rotary manifold (12).
8. Remove stop pin (4) and lockwasher (5) from torque arm bracket (6) on upperstructure(11).
9. Remove 10 capscrews (7) and 20 washers (8) from inside of upperstructure (11).

CAUTION

Block boom hoist cylinder with wood block to prevent hoist cylinder from contacting rotary manifold. Failure to follow this procedure could cause damage to equipment.

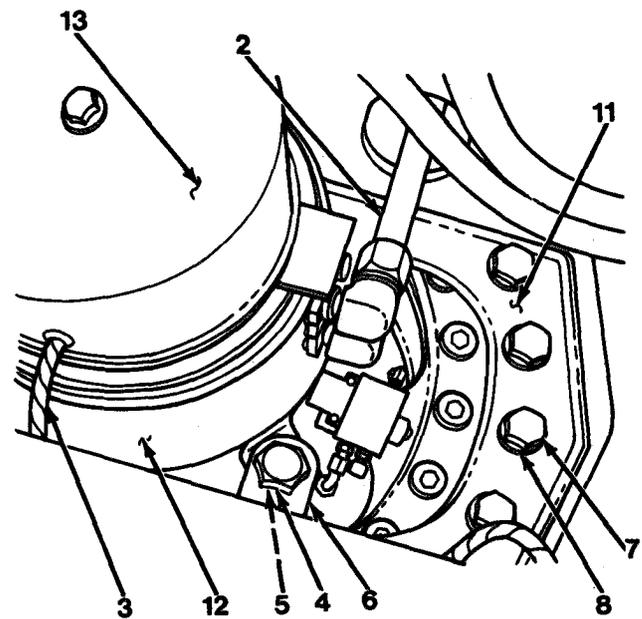


Figure 15-2

10. Lower boom hoist cylinder onto wood block.

UPPERSTRUCTURE REMOVAL

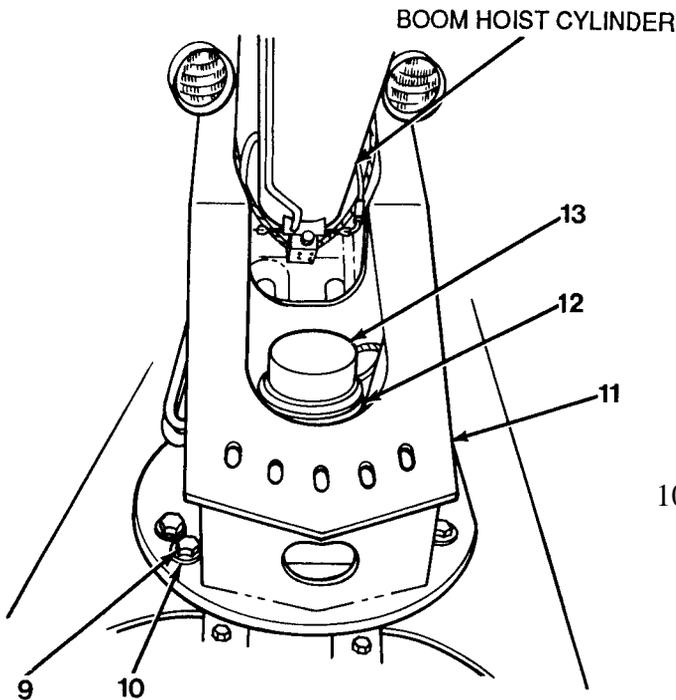


Figure 15-3

⚠ WARNING

Weight of upperstructure is approximately 6,000 lb (2,722 kg). Use adequate lifting equipment to lift and support upperstructure. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

10. Use a lifting device on upperstructure (11) to support the weight. Remove 8 capscrews (9) and 16 washers (10, Figure 15-3) on outside of upperstructure (11).

⚠ WARNING

Upperstructure must be properly supported when lowering to ground. Failure to properly support upperstructure could cause DEATH or serious injury.

11. Raise upperstructure (11) to a height sufficient to clear rotary manifold (12) and electrical collector ring (13). Lower to a suitable location.

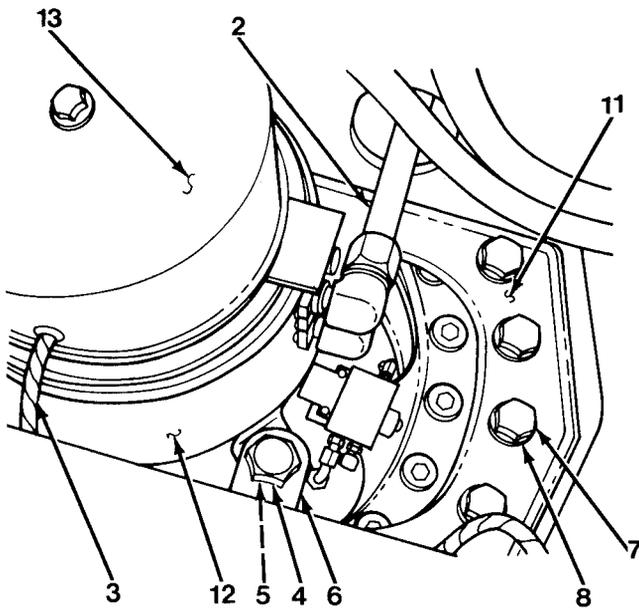


Figure 15-2

UPPERSTRUCTURE INSTALLATION

⚠ WARNING

Weight of upperstructure is approximately 6,000 lb (2,722 kg). Use adequate lifting equipment to lift and support upperstructure. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

CAUTION

Block boom hoist cylinder with wood block to prevent boom hoist cylinder from contacting rotary manifold. Failure to follow this procedure could cause damage to equipment

1. Use a lifting device to lift upperstructure (11) to a height sufficient to clear rotary manifold (12) and electrical collector ring (13) and lower onto frame. Use wood block under boom hoist cylinder to protect electrical collector ring (13) and rotary manifold (12, Figure 15-3).
2. Install 8 capscrews (9) and 16 washers (10) on outside of upperstructure (11).

WARNING

Weight of boom hoist cylinder is approximately 507 lb (230 kg). Use adequate lifting equipment to lift and support boom hoist cylinder. Do not lift over Personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

3. Use lifting device to raise boom hoist cylinder and hold it in a vertical position.
4. Install 10 capscrews (7) and 20 washers (8) on inside of upperstructure(11, Figure 15-2). Torque both inside and outside capscrews to 722 lb-ft (979 N•m) in sequence shown in Figure 15-4.

CAUTION

Torque arm on rotary manifold must be aligned with torque arm bracket on upperstructure before stop pin is installed. Failure to follow this procedure could cause damage to equipment.

NOTE

If necessary, rotate upperstructure manually to align torque arm brackets.

5. Install lockwasher (5) and stop pin (4) in torque arm bracket (6) on upperstructure (11, Figure 15-2).

NOTE

Individual connectors must be insulated.

6. Connect collector ring wiring harness (3) to electrical collector ring (13). Install plastic tubes and secure with tie wraps.
7. Connect two winch tubes (2) to rotary manifold (12) elbows.

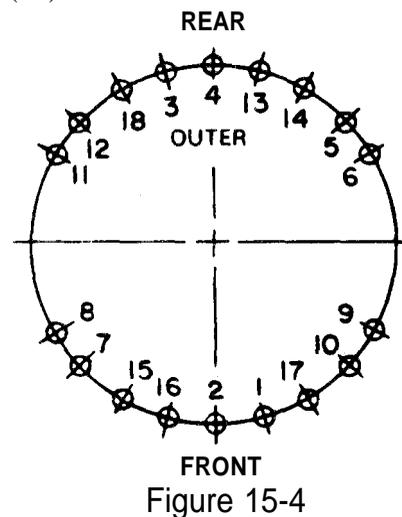


Figure 15-4

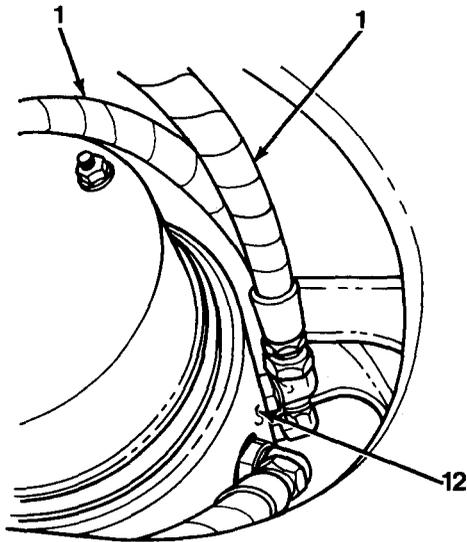


Figure 15-1

UPPERSTRUCTURE INSTALLATION

8. Connect two boom extend cylinder hoses and boom hoist cylinder hoses (1, Figure 15-1) to rotary manifold (12) elbows.
9. Lower boom hoist cylinder onto wood block.
10. Connect battery negative ground cable.
11. Install boom (refer to page 15-4).

UPPERSTRUCTURE DISASSEMBLY

1. Remove boom hoist cylinder and hold valve (refer to page 13-1).
2. Remove winch (refer to page 16-1).

Weight of counterweight is approximately 2,200 lb (998 kg). Use adequate lifting equipment to lift and support counterweight. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this tire could cause DEATH or serious injury.

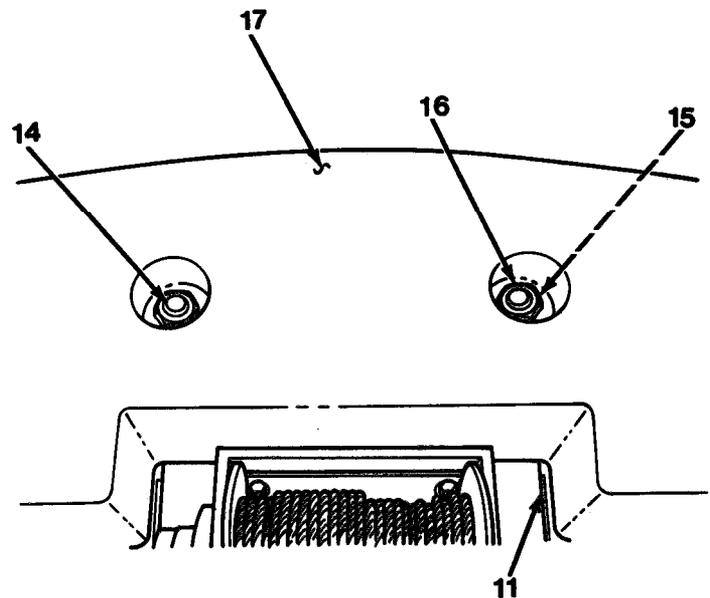


Figure 15-5

3. Support counterweight (17) with a lifting device. Remove two locknuts (16), washers (15) and capscrews (14). Lift off counterweight (17) from upperstructure (11, Figure 15-5).

UPPERSTRUCTURE ASSEMBLY



Weight of counterweight is approximately 2,200 lb (998 kg). Use adequate lifting equipment to lift and support counterweight. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

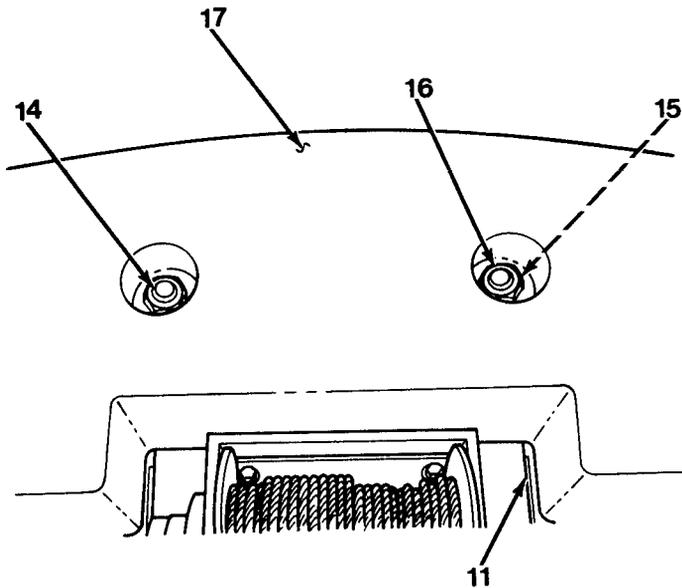


Figure 15-5

1. Support counterweight (11) with a lifting device. Lower counterweight (17) onto upperstructure (11) and secure with two capscrews (14), washers (15) and lock nuts (16, Figure 15-5). Torque capscrews (14) to 845 lb-ft (1,146 N•m).
2. Install winch (refer to page 16-2).
3. Install boom hoist cylinder (refer to page 13-3).

SWING GEAR BOX

SWING GEAR BOX REMOVAL

1. Remove deck plate and pinion cover (refer to page 14-9).
2. Rotate upperstructure to the right.
3. Remove swing motor (refer to page 13-51, steps 3 and 4).

⚠ WARNING

Weight of swing gearbox is approximately 125 lb (57 kg). Use adequate lifting equipment to lift and support swing gear box. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

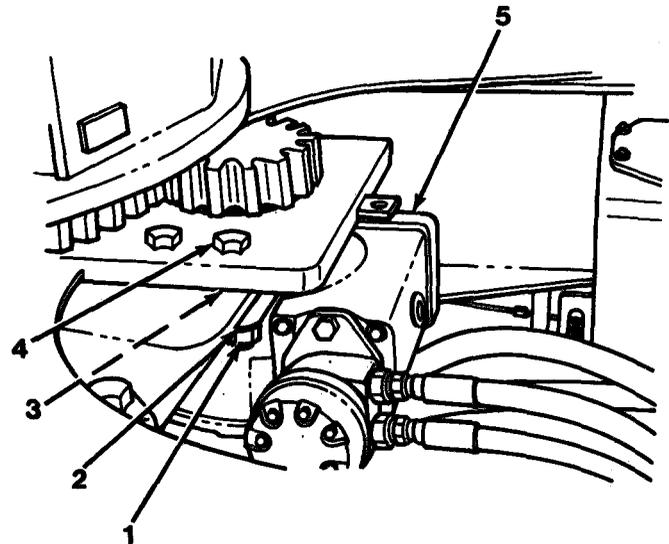


Figure 15-1

4. Wing adequate hoist and sling, support swing gear box (5, Figure 15-1).

NOTE

It will be necessary to rotate upperstructure by hand to access rear hardware.

5. Attach a 7/8 wrench to protruding shaft of swing box drive. Turn swing box drive clockwise to swing upperstructure to the right and counterclockwise to swing upperstructure to the left.
6. Remove four nuts (1), washers (2), spacers (3) and capscrews (4).
7. Lower swing gear box (5) down and out of pilot hole. Remove from vehicle.

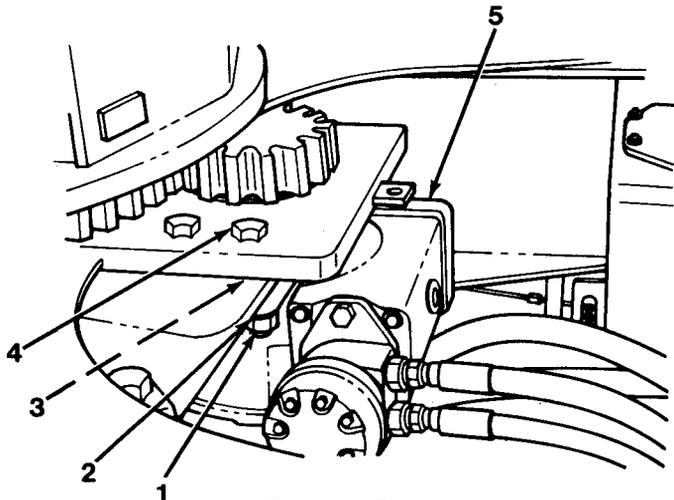


Figure 15-1

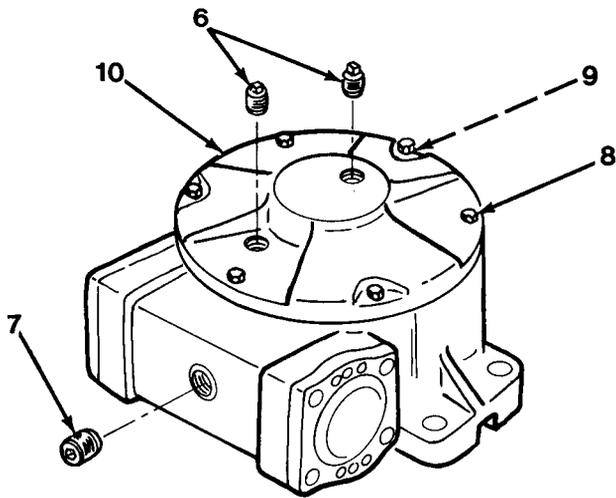


Figure 15-2

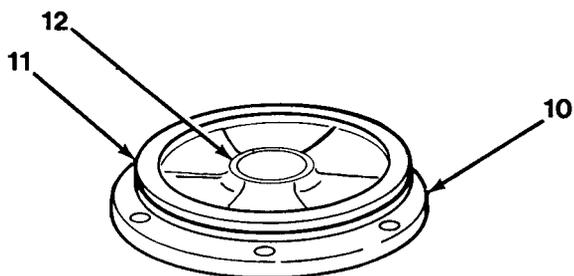


Figure 15-3

SWING GEAR BOX INSTALLATION

⚠ WARNING

Weight of swing gear box is approximately 125 lb (57 kg). Use adequate lifting equipment to lift and support swing gear box. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Using adequate hoist and sling, support swing gear box (5, Figure 15-1).
2. Position swing gear box (5) in place.

NOTE

It will be necessary to rotate upperstructure by hand to access rear hardware.

3. Attach a 7/8 wrench to protruding shaft of swing box drive. Turn swing box drive clockwise to swing upperstructure to the right and counterclockwise to swing to the left.
4. Install four capscrews (4), spacers (3), washers (2) and nuts (1). Torque capscrews (4) to 344 lb-ft (466 N•m).
5. Install swing motor (refer to page 13-51).
6. Mart vehicle and operate swing lever control. Check for leaks.
7. Install pinion cover and deck plate (refer to page 14-9).

SWING GEAR BOX DISASSEMBLY

1. Remove two drain plugs (6) from cover (10). Remove pipe plug (7, Figure 15-2) to drain oil into suitable container.
2. Remove six capscrews (8) and lockwashers (9) horn cover (10).
3. Remove cover (10).
4. Remove O-ring (11, Figure 15-3) from cover (10).
5. Remove bushing (12) from cover (10), if necessary.
6. Remove four capscrews (13) and lockwashers (14) securing bearing retainer (15, Figure 15-4).
7. Remove bearing retainer (15).
8. Remove O-ring (16) and seal (17).
9. Remove four capscrews (19) securing bearing container (20, Figure 15-5).
10. Remove bearing container (20) and O-ring (21).

NOTE

Record number of shim(s) removed to aid in assembly.

11. Remove shim(s) (18).
12. Remove two bearing cups (22). This will allow worm (24, Figure 15-6) to drop for aid in removal.

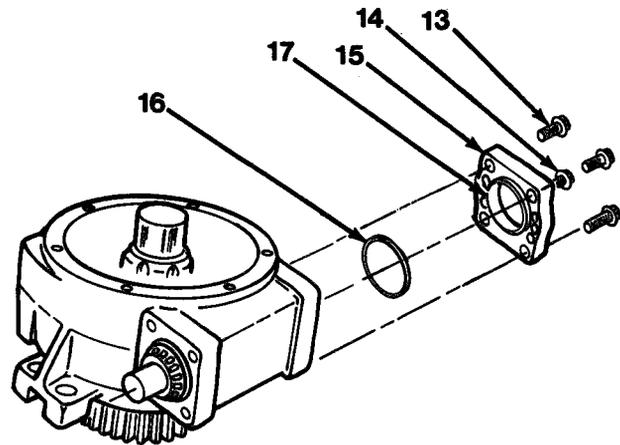


Figure 15-4

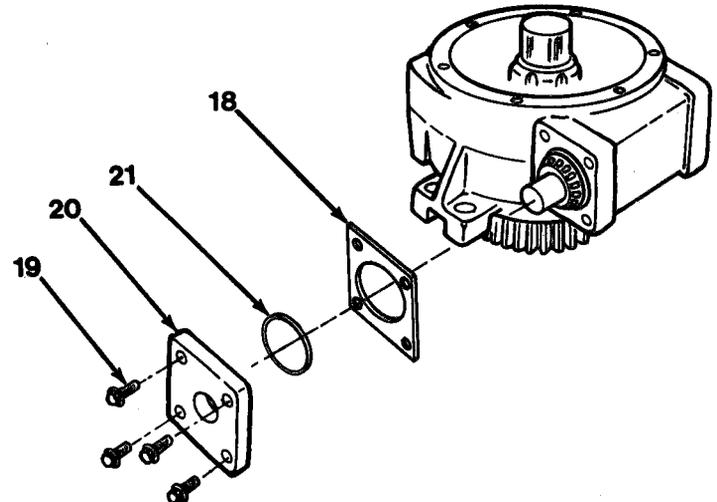


Figure 15-5

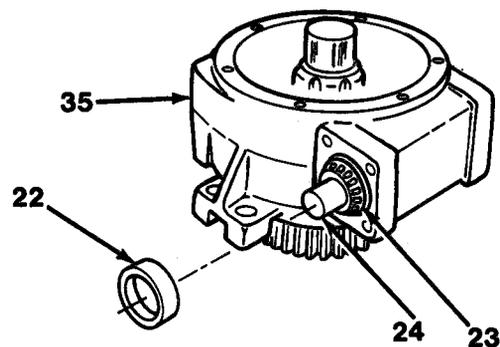


Figure 15-6

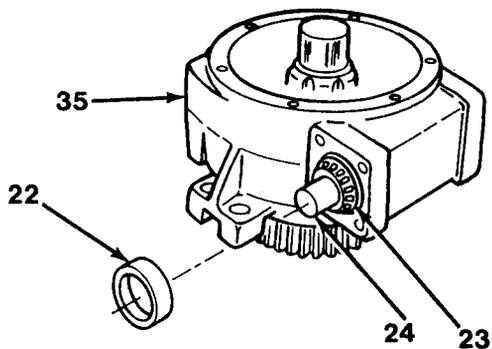


Figure 15-6

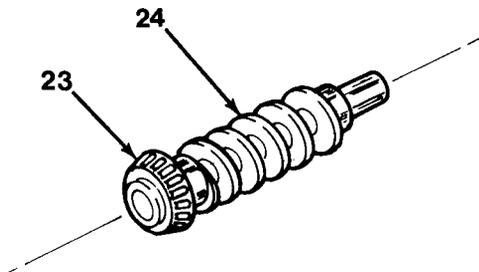


Figure 15-7

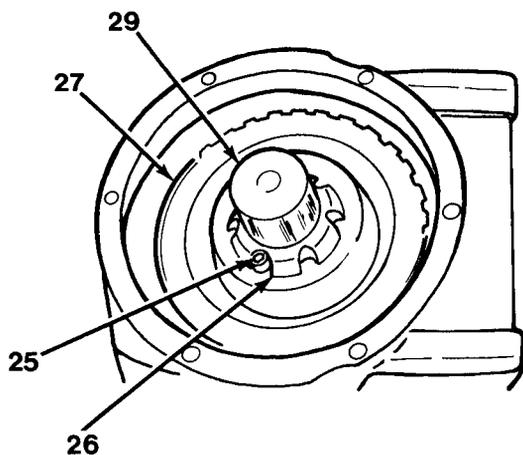


Figure 15-8

SWING GEAR BOX DISASSEMBLY

13. Rotate worm (24) out to one end of housing (35) and remove one of two bearing cones (23, Figure 15-6).
14. Remove worm (24) from opposite end of housing (35).
15. Remove remaining bearing cone (23) from worm (24, Figure 15-7).
16. Remove capscrew (25) and nut (26, Figure 15-8).

NOTE

Gear puller is required to remove worm gear from output shaft, utilizing two 1/2- 13 NC tapped holes in worm gear.

17. Remove worm gear (27) from output shaft (29).
18. Remove two keys (28) from output shaft (29, Figure 15-9).
19. Press shaft (29) out of housing (35). Remove seal (30) and one bearing cone (31, Figure 15-10) from shaft.

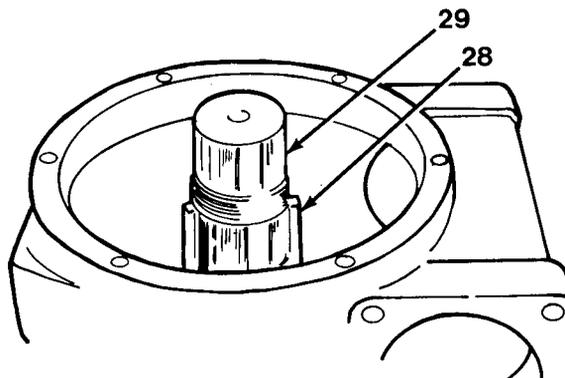


Figure 15-9

NOTE

It is not recommended to remove spacer from output shaft. If worn, replace output shaft, spacer and O-ring.

20. Remove cone (31) from housing (35, Figure 15-11).
21. Using hammer and punch, remove two bearing cups (32) from housing (35, Figure 15-12).
22. Remove vent plug (33) and grease zerk (34) from housing (35, Figure 15-11).

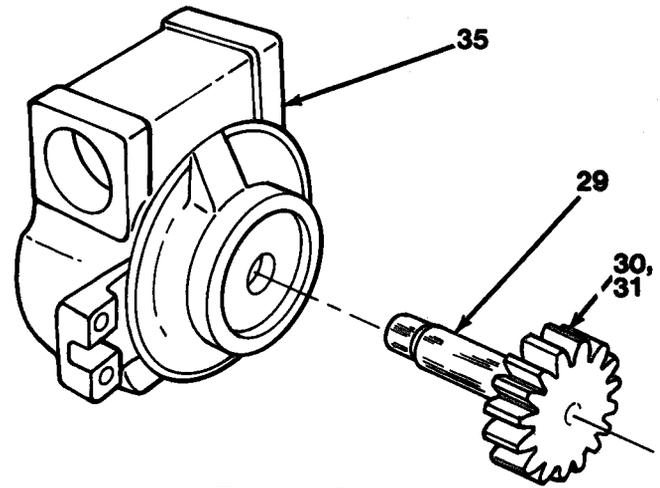


Figure 15-10

SWING GEAR BOX CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

SWING GEAR BOX ASSEMBLY

1. Install grease zerk (34) and vent plug (33) to housing (35, Figure 15-11).
2. Install two bearing cups (32) in housing (35, Figure 15-12).

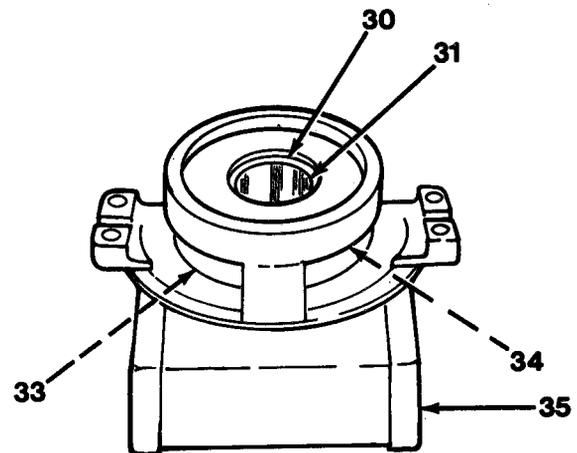


Figure 15-11

NOTE

Install seal with Loctite #54931 sealant on outer diameter of seal. Lubricate seal lip with antiseize thread compound MIL-A-907.

3. Install one of two bearing cones (31) and seal (30, Figure 15-11).

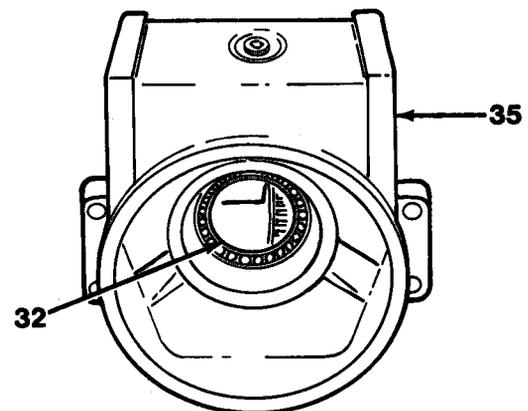


Figure 15-12

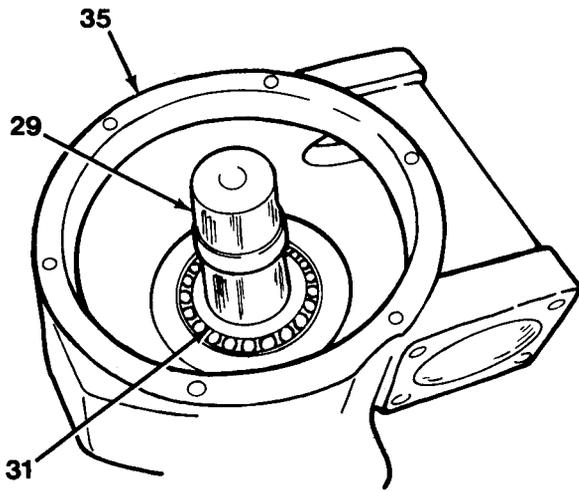


Figure 15-13

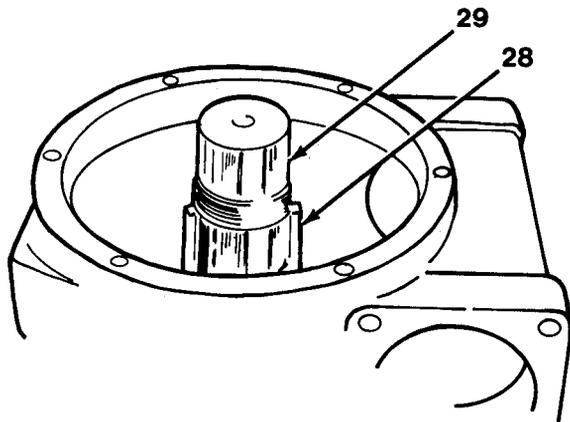


Figure 15-9

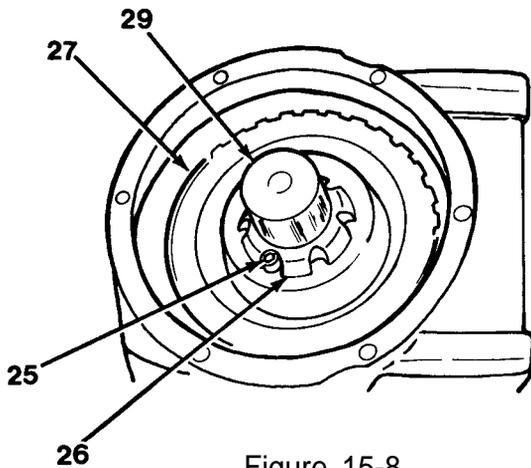


Figure 15-8

SWING GEAR BOX ASSEMBLY

4. Install output shaft (29, Figure 15-13).
5. Turn housing (35) over and install remaining bearing cone (31). Press completely onto shaft (29).
6. Install keys (28) on output shaft (29, Figure 15-9).

CAUTION

When pressing worm gear onto shaft, position worm so not to damage bronze worm gear.

7. Press worm gear (27) onto output shaft (29, Figure 15-8) with gear hub facing up.
8. Install nut (26). Torque nut (26) to approximately 5 lb-ft (6.8 N•m).
9. Install capscrew (25). Torque capscrew (25) to 15 lb-ft (20 N•m).

10. Press one of two bearing cones (23) on worm (24, Figure 15-7).
11. Install worm (24) and bearing (23) in housing (35, Figure 15-6).
12. Press remaining bearing cone (23) on worm (24).
13. Press two bearing cups (22) in housing (35).

NOTE

If any part(s) on worm axis have been replaced, shim thickness must be recalculated to give 0 to 0.005 in. (0 to 0.13 mm) end play on worm.

14. Install O-ring (21) and shim(s) (18) on bearing container (20, Figure 15-5).
15. Install four capscrews (19) and bearing container (20). Torque four capscrews (19) to 58 lb-ft (79 N•m).

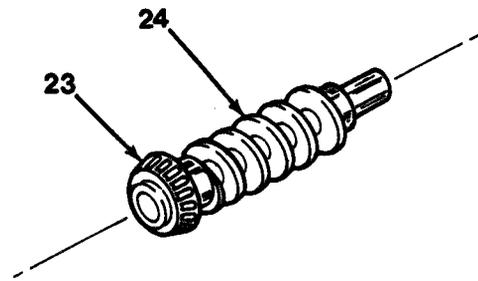


Figure 15-7

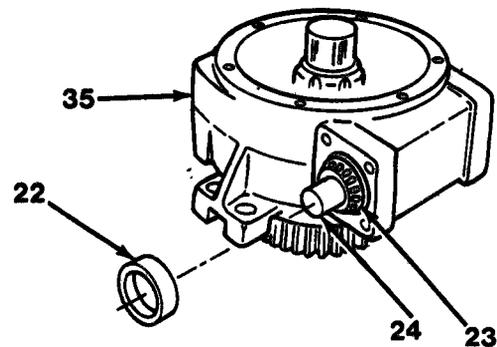


Figure 15-6

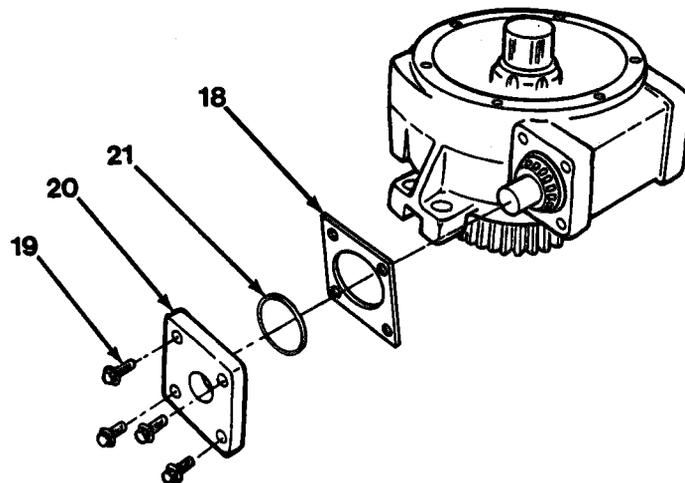


Figure 15-5

SWING GEAR BOX ASSEMBLY

NOTE

Install seal with Loctite #54931 sealant on outer diameter of seal. Lubricate seal lip with antiseize thread compound MIL-A-907.

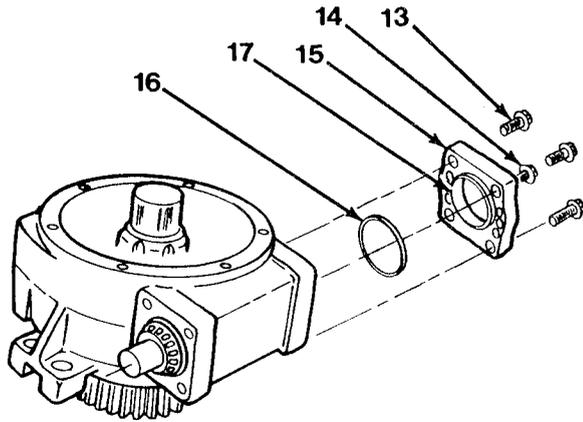


Figure 15-4

16. Install seal (17) and O-ring (16) on bearing retainer (15, Figure 15-4).
17. Install bearing retainer (15) with four lock-washers (14) and capscrews (13). Torque capscrews (13) to 58 lb-ft (79 N•m). Worm should rotate freely by hand.
18. Install bushing (12) and O-ring (11) on cover (10, Figure 15-3).

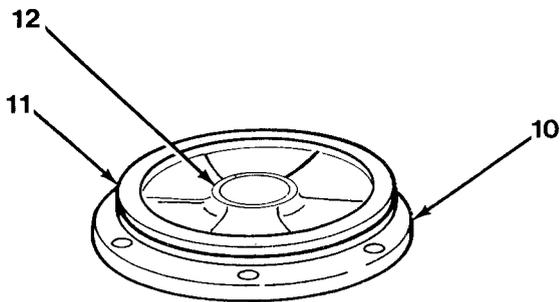


Figure 15-3

19. Install cover (10), six lockwashers (9) and capscrews (8, Figure 15-2). Torque capscrews 8) to 58 lb-ft (79 N•m).

20. Install two drain plugs (6) in cover (10).

21. With pinion up and swing gear box level, fill with gear oil per lubrication chart, or until oil runs out of fill level hole. Install fill pipe plug (7).

22. Grease bearings through zerk (34) located under pinion gear in housing (35, Figure 15-14).

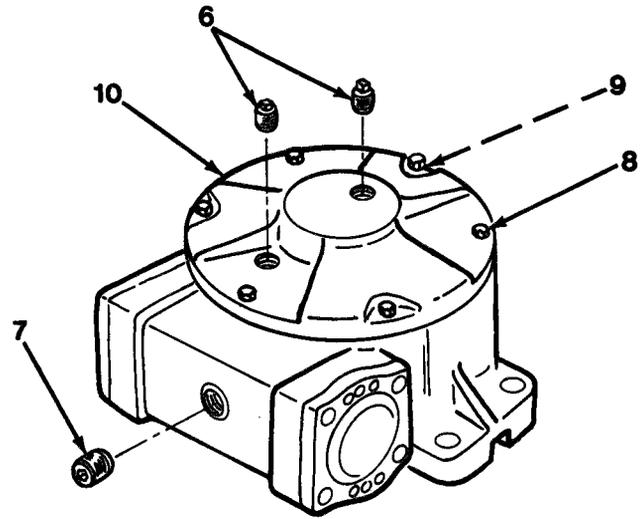


Figure 15-2

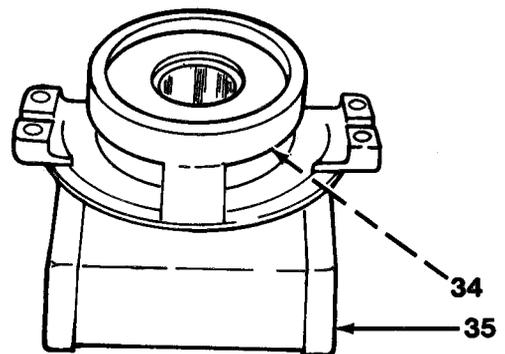


Figure 15-14

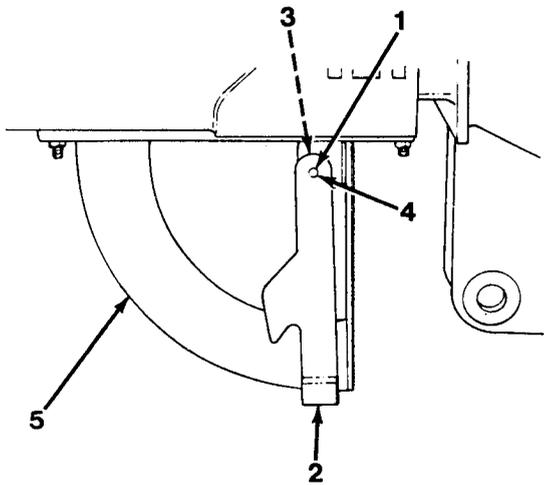


Figure 15-1

BOOM ANGLE INDICATOR

BOOM ANGLE INDICATOR DISASSEMBLY

1. Remove lock nut (1), pendulum (2) and spacer (3, Figure 15-1).
2. If necessary, remove cam follower (4) by pressing it out of bracket (5).

BOOM ANGLE INDICATOR ASSEMBLY

1. If removed, apply Loctite RC680 to cam follower (4) and press into bracket (5) until the stud end of cam follower (4) is 0.03 in. (0.8 mm) below the surface of bracket (5).
2. Install spacer (3), pendulum (2) and locknut (1). Torque locknut (1) to 21 lb-ft (28 N•m).

CHAPTER 16

WINCH

Title	Page
Winch	16-1
Primary Planet Carrier	16-14
Output Planet Carrier	16-16
Brake Clutch	16-18
Winch Brake Valve	16-21
Motor Support Brake Cylinder	16-24
Winch Motor	16-31
Hook Block	16-39
Winch Control Valve	16-41

WINCH

WINCH REMOVAL

1. Remove cable from drum (refer to Koehring Commercial Operation Instructions manual).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

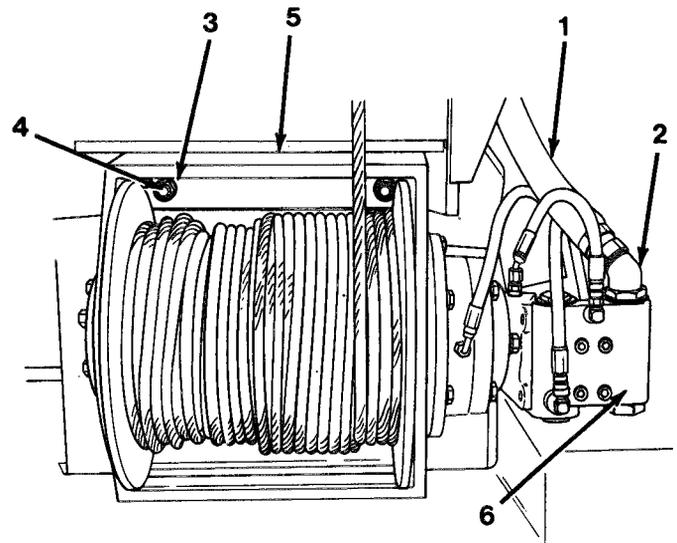


Figure 16-1

3. Disconnect two hydraulic hoses (1) and remove two elbows (2) from brake valve assembly (6, Figure 16-1).
4. Remove four lock nuts (3) and capscrews and washers (4) from winch base (5).

WINCH REMOVAL

⚠ WARNING

Weight of winch is approximately 300 lb (136 kg). Use adequate lifting equipment to lift and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Attach hoist and sling to winch base (5, Figure 16-1) and remove.

WINCH INSTALLATION

⚠ WARNING

Weight of winch is approximately 300 lb (136 kg). Use adequate lifting equipment to lift and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Attach hoist and sling to winch base (5, Figure 16-1) and install.
2. Install four capscrews and washers (4) and lock nuts (3) to secure winch base (5).
3. Install two elbows (2) and connect two hydraulic hoses (1) to brake valve assembly (6).
4. Close dipstick cap.
5. Install cable on drum (refer to Koehring Commercial Operation Instructions manual).

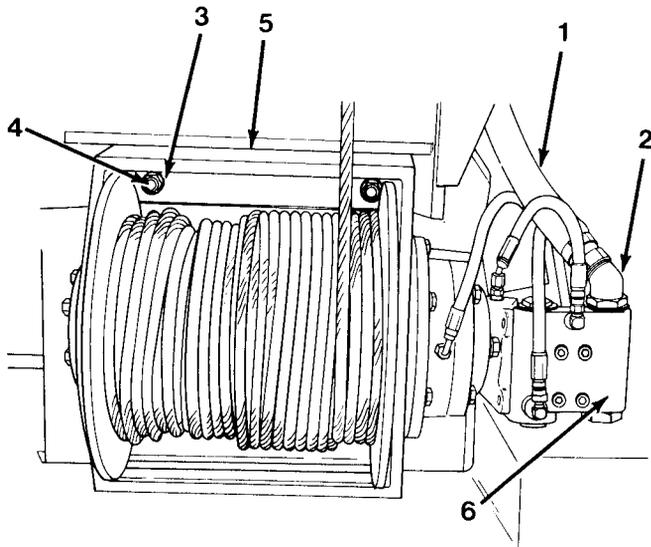


Figure 16-1

WINCH DISASSEMBLY**CAUTION**

Work should be done in a clean, dust-free area as cleanliness is of the utmost importance when servicing hydraulic equipment. Failure to follow this procedure could cause damage to equipment.

NOTE

It may be necessary to insert a bar into anchor pocket and manually rotate drum in the direction to hoist a load until drain holes are aligned.

1. Install a short piece of 1 in. (25 mm) I.D. pipe in larger threads of drain hole to drain lubricating oil.
2. Remove drain plug (1) and O-ring (2, Figure 16-1) through pipe. Remove pipe from drain hole.

NOTE

Do not remove relief valve unless inspection indicates replacement is necessary.

3. Remove relief valve (3), if inspection proves necessary.

WARNING

Weight of winch is approximately 300 lb (136 kg). Use adequate lifting equipment to lift

and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

4. Remove oil level plug (4) and O-ring (5), and stand winch on bearing support end.
5. Disconnect hydraulic hose (6, Figure 16-2).

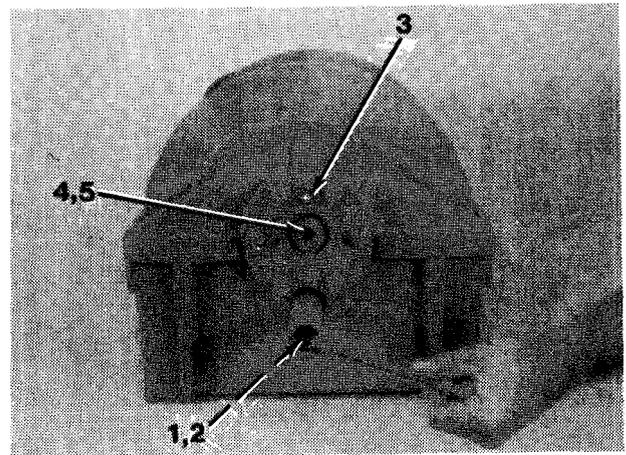


Figure 16-1

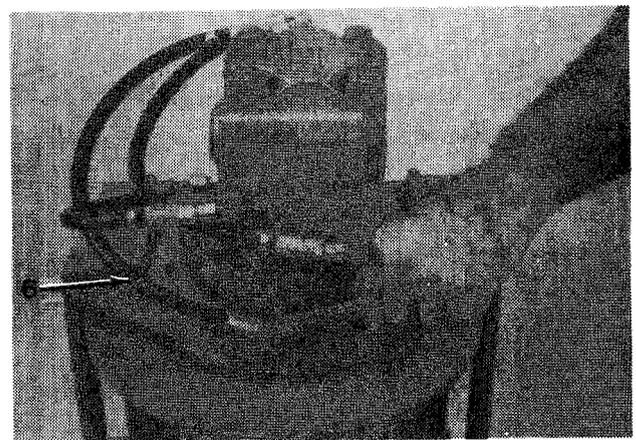


Figure 16-2

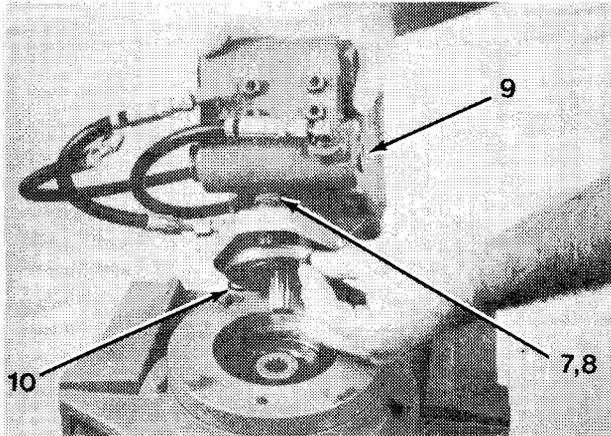


Figure 16-3

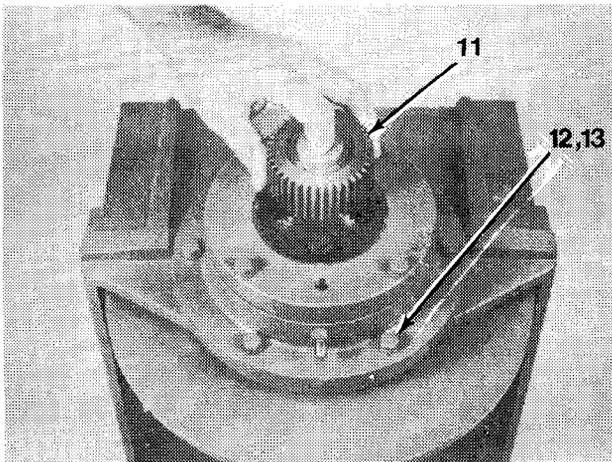


Figure 16-4

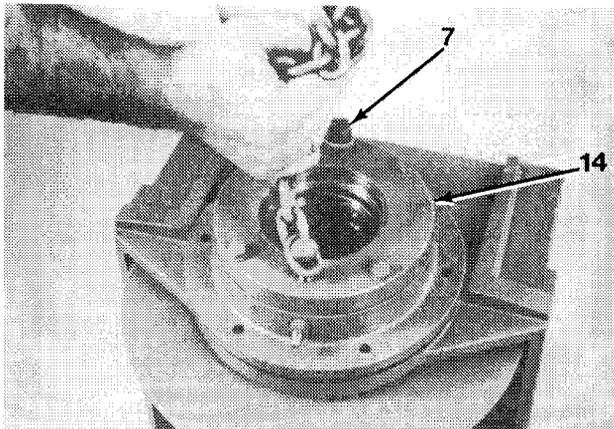


Figure 16-5

WINCH DISASSEMBLY

6. Remove two cap screws (7), lockwashers (8), motor (9) and O-ring (10, Figure 16-3).
7. Remove brake clutch assembly (11, Figure 16-4) from motor support.
8. Remove six cap screws (12) and lockwashers (13).
9. Install two cap screws (7, Figure 16-5) and a short piece of chain into motor mounting bolt holes.

CAUTION

Use care to avoid damaging sealing or bearing surfaces while removing brake cylinder assembly. Failure to follow this procedure could cause damage to equipment.

10. Remove brake cylinder assembly (14) from winch assembly by using chain as a handle.

11. Remove snap ring (15) and sun primary gear (16, Figure 16-6).
12. Remove drum closure (17) and O-ring (18) from inside of drum (30).
13. Remove seal (19) and ball bearing (20) from inside of drum closure (17, Figure 16-7),
14. Remove thrust ring (21) from primary planet carrier (22, Figure 16-8).
15. Remove primary planet carrier (22) from drum (30, Figure-16-9).

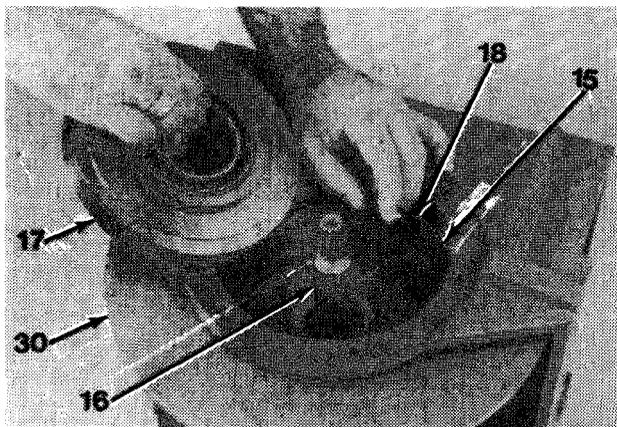


Figure 16-6

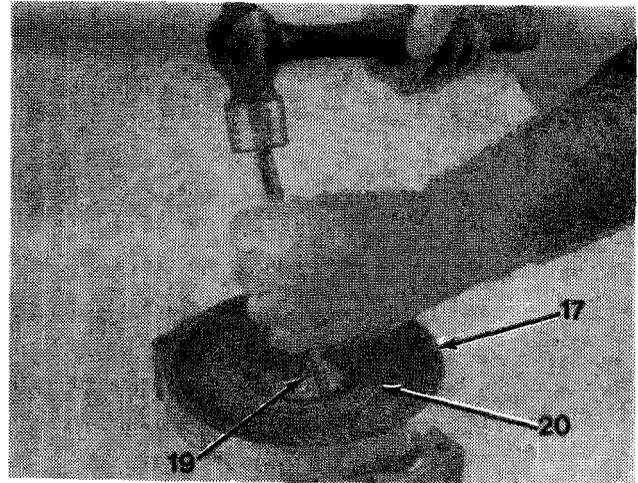


Figure 16-7

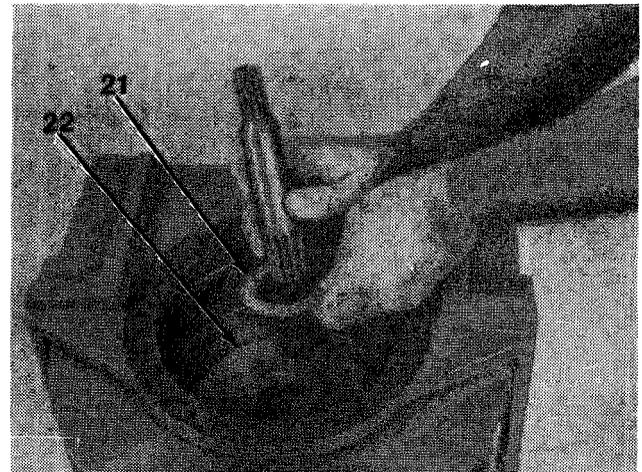


Figure 16-8

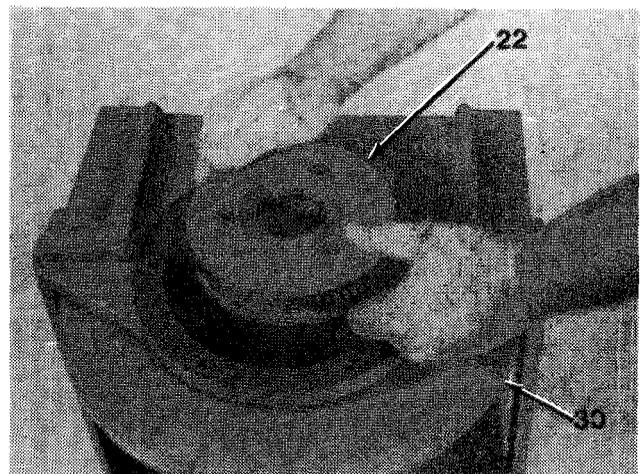


Figure 16-9

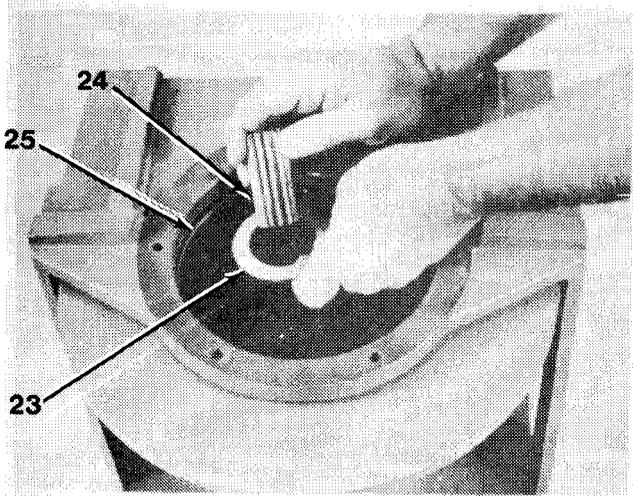


Figure 16-10

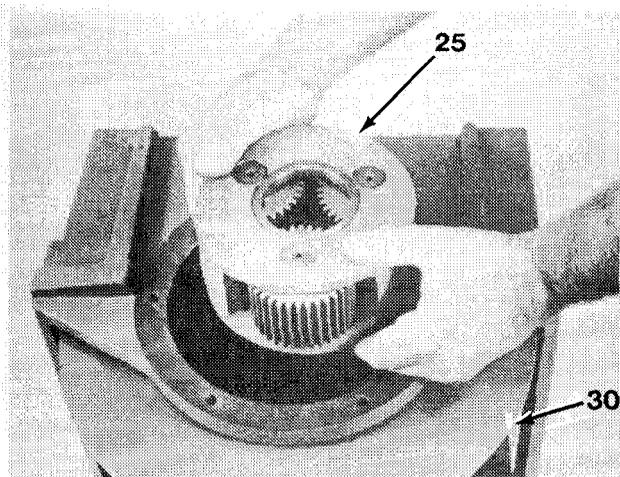


Figure 16-11

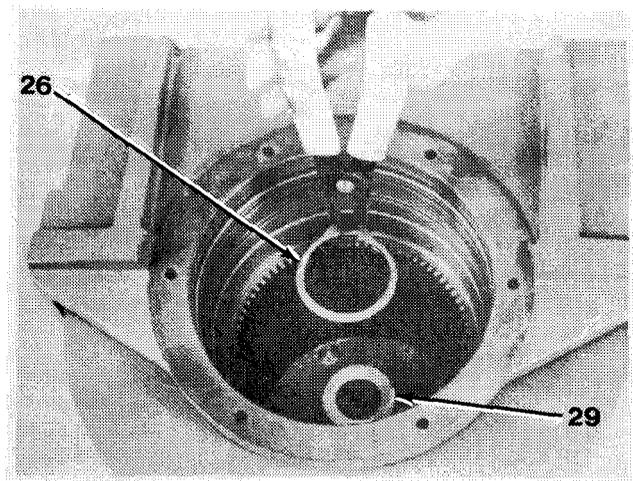


Figure 16-12

WINCH DISASSEMBLY

16. Remove thrust washer (23) and sun output gear (24) from output planet carrier (25, Figure 16-10).
17. Remove output planet carrier (25) from drum (30, Figure 16-11).

⚠ WARNING

Weight of winch is approximately 150 lb (68 kg). Use adequate lifting equipment to lift and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

18. Remove snap ring (26) from bearing support (29) and stand winch on motor end with bearing support (29, Figure 16-12) up.

CAUTION

Use care when removing drum. Failure to follow this procedure could cause damage to sealing or bearing surfaces.

19. Remove six cap screws (27), lockwashers (28) and bearing support (29, Figure 16-13).

20. Remove drum (30) from base (33).
21. Remove seal (31) and bearing (32) from support end of drum (30, Figure 16-14).

WINCH CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect ring gear (machined into inside surface of drum) teeth for nicks, spalling and wear.
3. Inspect all other parts (refer to Chapter 4).

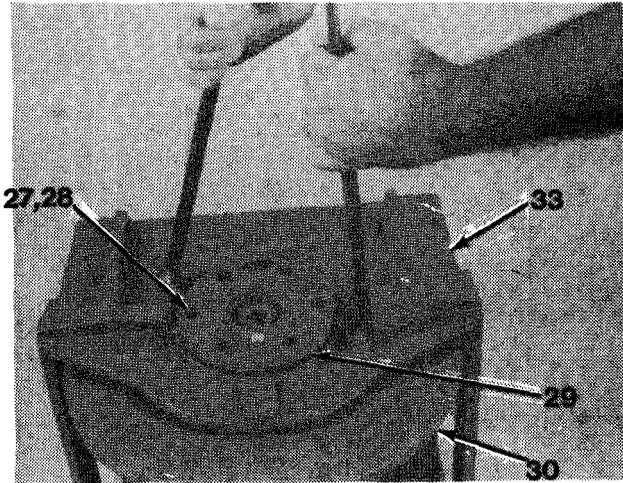


Figure 16-13

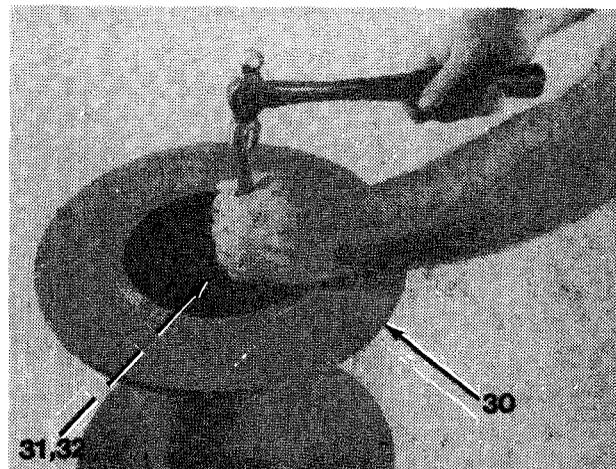


Figure 16-14

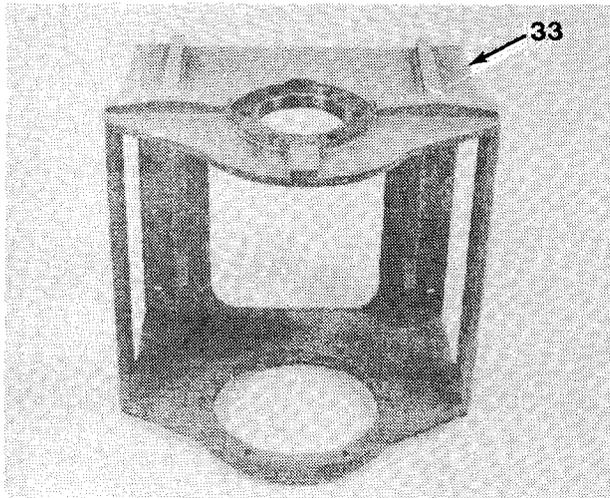


Figure 16-15

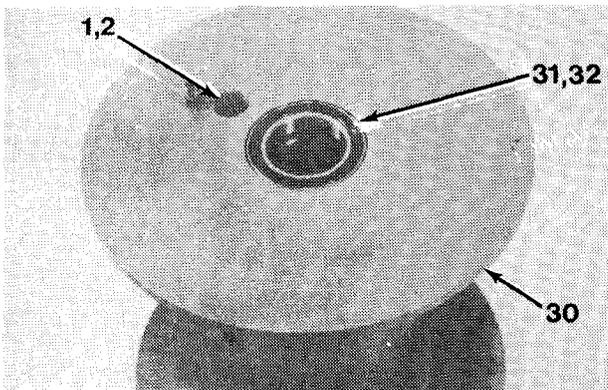


Figure 16-16

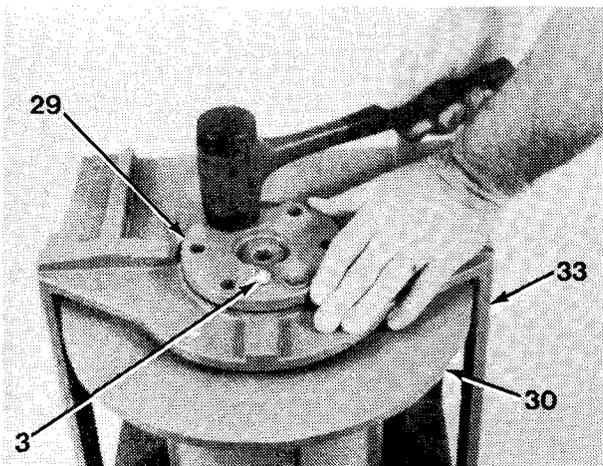


Figure 16-17

WINCH ASSEMBLY

1. Place base (33, Figure 16-15) on side with bearing support end up.

NOTE

- Lubricate all O-rings and oil seals with lubricating oil MIL-L-2105, grade 80W90, prior to installation.
- Use a sealing compound on outside surface of oil seals and a light coat of thread sealing compound on pipe threads. Avoid getting thread compound inside parts or passages which conduct lubricating oil.

2. Install bearing (32) and seal (31) in drum (30, Figure 16-16). Install seal (31) with spring side of seal away from bearing, and press into drum, using a flat plate to avoid distortion.
3. Install O-ring (2) and drain plug (1) securely.

WARNING

Weight of winch is approximately 95 lb (43 kg). Use adequate lifting equipment to lift and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

4. Install drum (30) and center in opening of base (33, Figure 16-17).
5. Install relief valve (3), if removed.
6. Lubricate bearing support (29) with lubricating oil MIL-L-2105, grade 80W90.

7. Install bearing support (29), in base (33) and drum (30).

CAUTION

Be sure relief valve is located above the horizontal centerline for the intended application. Oil leakage may occur if vent is positioned incorrectly.

8. Install six lockwashers (28) and capscrews (27, Figure 16-18).

WARNING

Weight of winch is approximately 150 lb (68 kg). Use adequate lifting equipment to lift and support winch. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

CAUTION

Snap ring will keep output planet carrier correctly positioned in winch. Gear train damage may occur if snap ring is omitted.

9. Stand winch on bearing support end and install snap ring (26) in bearing support (29), Figure 16-12).
10. Install sun output gear (24) and thrust washer (23) into output planet carrier (25, Figure 16-19).

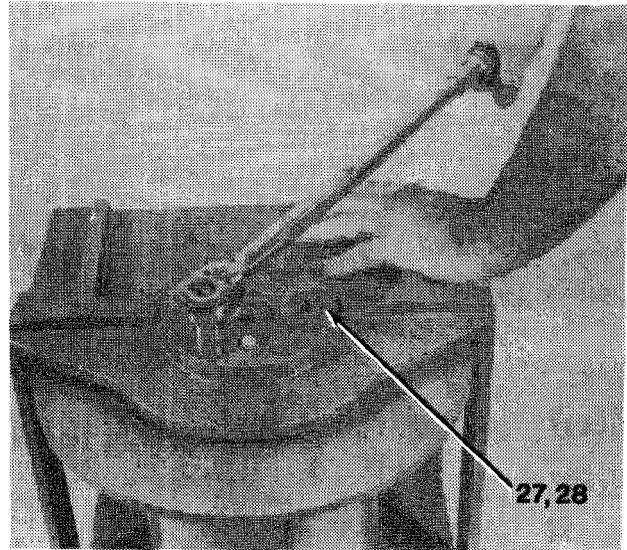


Figure 16-18

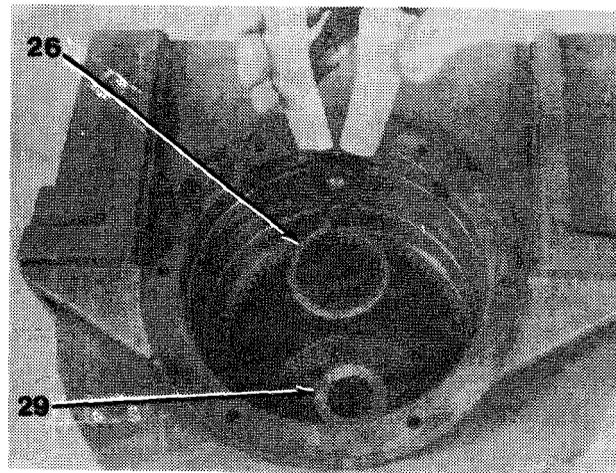


Figure 16-12

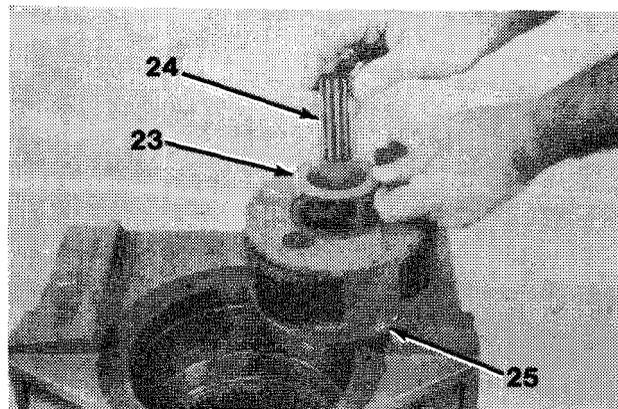


Figure 16-19

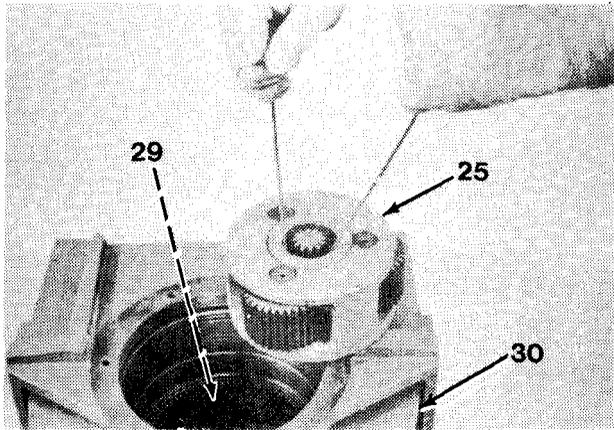


Figure 16-20

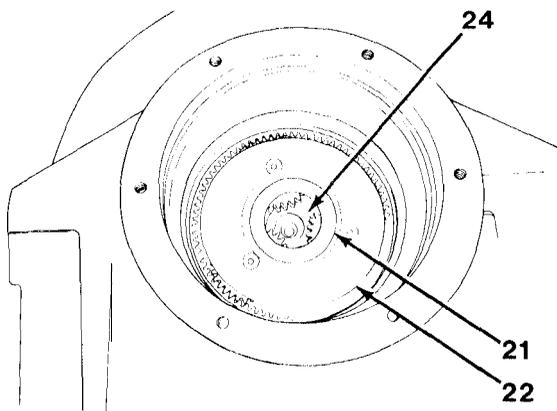


Figure 16-21

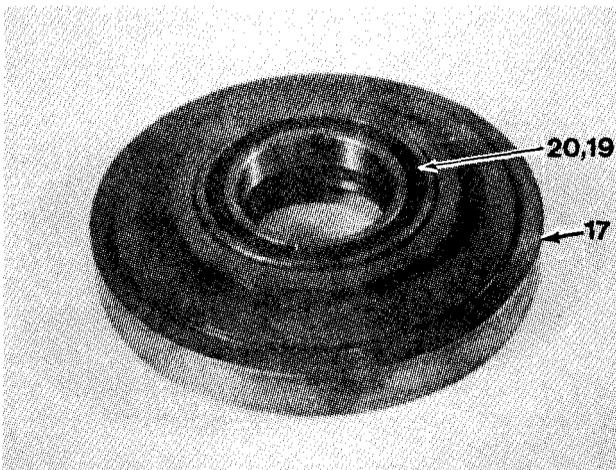


Figure 16-22

WINCH ASSEMBLY

11. Install output planet carrier (25) into drum closure (30) while meshing planet gears with ring gear and planet carrier with bearing support (29, Figure 16-20).
12. Install primary planet carrier (22), meshing planet gears with ring gear and planet carrier with output gear (34, Figure 16-21).
13. Install thrust ring (21) into primary planet carrier (22).
14. Install bearing (20) and seal (19) in drum closure (17, Figure 16-22). Install seal (19) with spring side of seal (19) away from bearing (20) by using a flat plate to avoid distortion.

15. Install O-ring (18, Figure 16-23) in drum.
16. Lubricate O-ring (18) and drum opening with lubricating oil MIL-L-2105, grade 80W90.
17. Install drum closure (17) and snap ring (15) into drum (30).
18. Install sun primary gear (16) into primary planet carrier (22, Figure 16-24) while meshing sun primary gear (16) with planet gears.
19. Lubricate pilot, oil seal and bearing surfaces of brake cylinder assembly (14, Figure 16-5) with lubricating oil MIL-L-2105, grade 80W90.
20. Install brake cylinder assembly (14) into base (33) and drum (30).

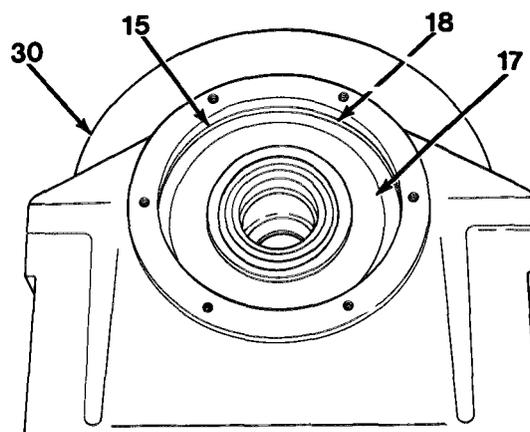


Figure 16-23

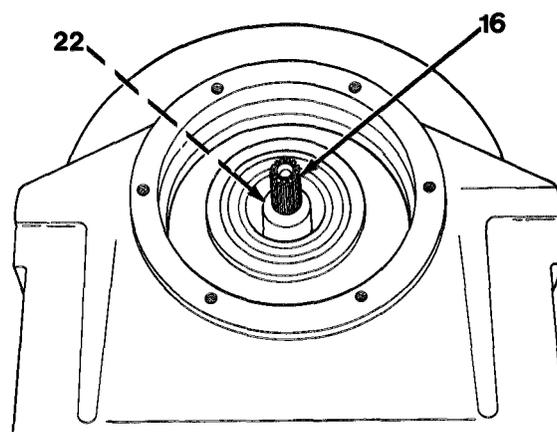


Figure 16-24

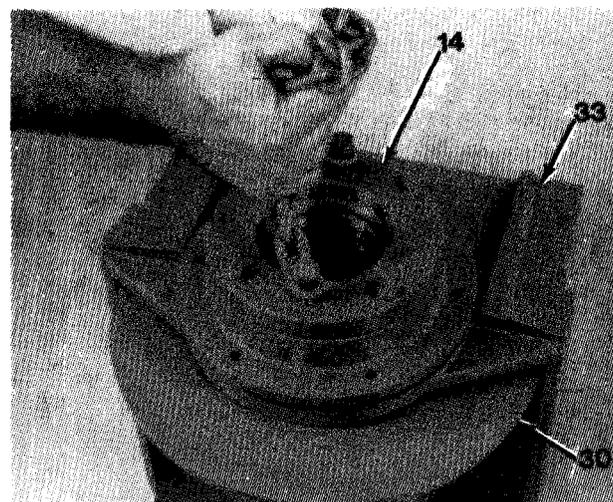


Figure 16-5

WINCH ASSEMBLY

21. Install six lockwashers (13) and capscrews (12, Figure 16-25).

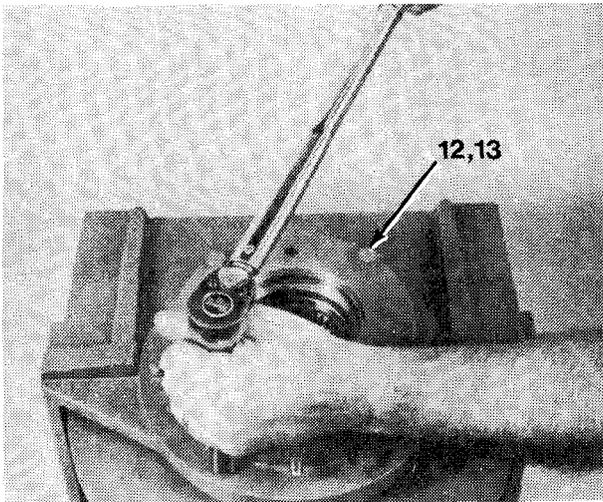


Figure 16-25

CAUTION

Be certain snap ring is seated in groove in splined bore of cam. Snap ring will keep brake clutch assembly correctly positioned in center of friction brake pack. Binding of brake or brake failure may occur if snap ring is omitted.

NOTE

- When installed correctly, cam should turn freely in opposite direction drum turns to pull wire rope in. An easy way to check rotation is to hold outer race in one hand, and rotate cam.
- If brake discs are misaligned, preventing installation of clutch, with a hand pump, apply 750 to 1,000 psi (5,171 to 6,895 kPa) to brake release port adapter. Brake discs will move freely with brake released, permitting alignment of discs, brake clutch and sun primary gear.

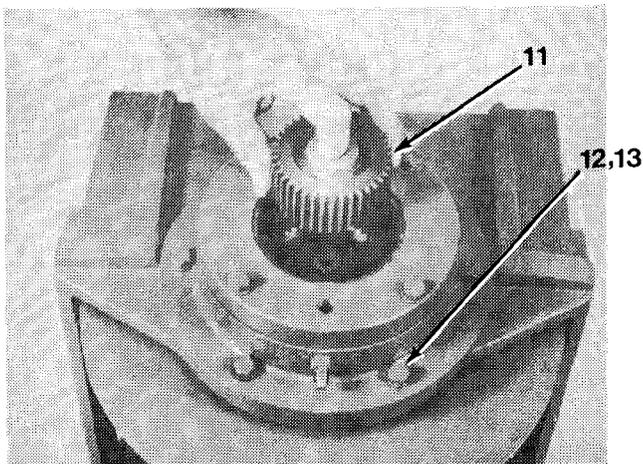


Figure 16-4

22. Install brake clutch assembly (11, Figure 16-4).

23. Install O-ring (10) on pilot of motor (9, Figure 16-3).
24. Lubricate O-ring (10) with lubricating oil NIIL-L-2105, grade 80W90.
25. Install motor (9) engaging motor shaft with brake clutch cam and lower motor into place.
26. Install two lockwashers (8) and capscrews (7).
27. Connect hose (6, Figure 16-2).
28. Check all capscrews and fittings to make certain they have been tightened correctly.
29. Refill winch assembly with lubricating oil MIL-L-2105, grade 80W90 (refer to Koehring Commercial Operation Instructions manual).
30. Install O-ring (5) and oil level plug (4, Figure 16-26).

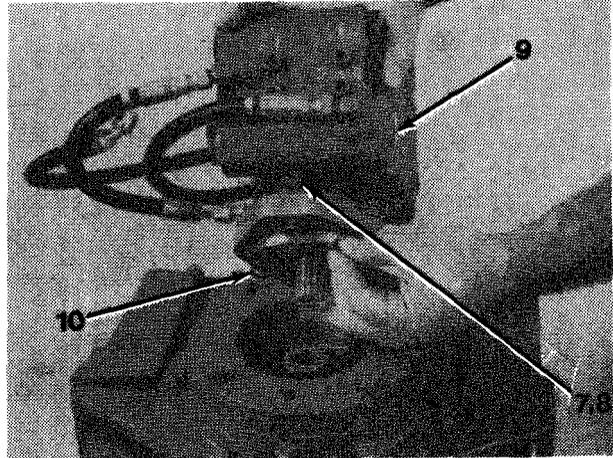


Figure 16-3

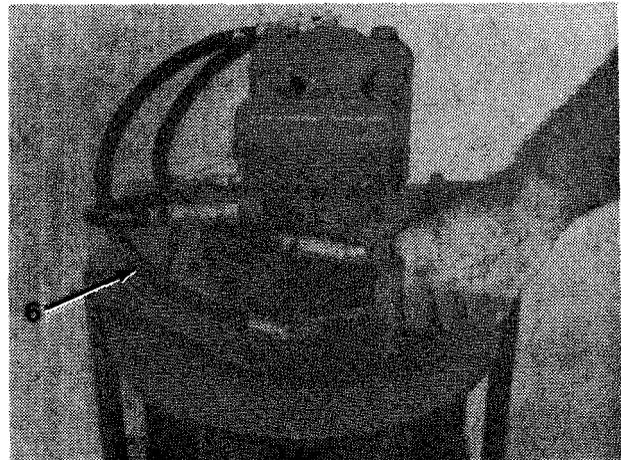


Figure 16-2

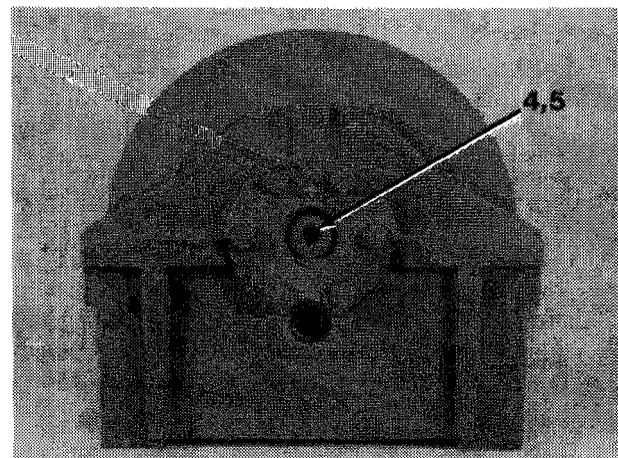


Figure 16-26

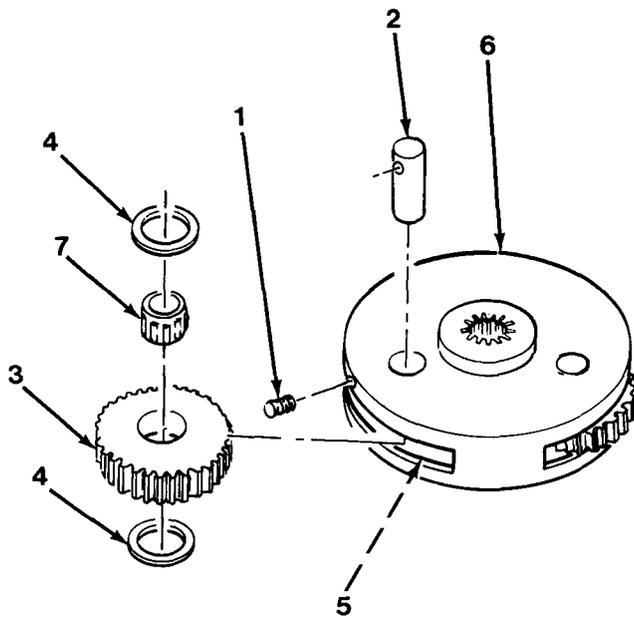


Figure 16-1

PRIMARY PLANET CARRIER

PRIMARY PLANET CARRIER DISASSEMBLY

1. Drive three rollpins (1) into center of gear shafts (2, Figure 16-1).
2. Drive three gear shafts (2) out enough to remove three rollpins (1).
3. Remove and discard three rollpins (1).
4. Remove three gear shafts (2), three planet gears (3), six thrust bearing races (4) and thrust washer (5) from primary planet carrier (6).
5. Remove roller bearing (7) from each of three planet gears (3).

PRIMARY PLANET CARRIER CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect roller bearings for spalling, corrosion, discoloration, material displacement and wear.
3. Inspect bearing cage and cage bars for unusual wear or deformation and cage's ability to separate, retain and guide rollers properly.
4. Inspect thrust washer contact areas for wear.
5. Inspect gears and shafts for wear and pitting.
6. Inspect all other parts (refer to Chapter 4).

PRIMARY PLANET CARRIER ASSEMBLY

1. Install roller bearing (7) in each of three planet gears (3, Figure 16-1).
2. Install thrust washer (5), three planet gears (3), six thrust bearing races (4) and three gear shafts (2) in primary planet carrier (6).

NOTE

Gear shaft holes must be aligned with holes in primary planet carrier.

3. Install three new rollpins (1) through holes in primary planet carrier (6) and in three gear shafts (2).
4. Recess three rollpins (1) slightly and stake primary planet carrier (6) to secure three rollpins (1).

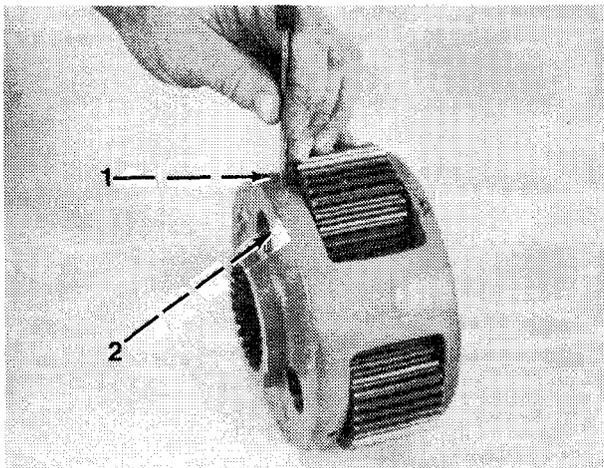


Figure 16-1

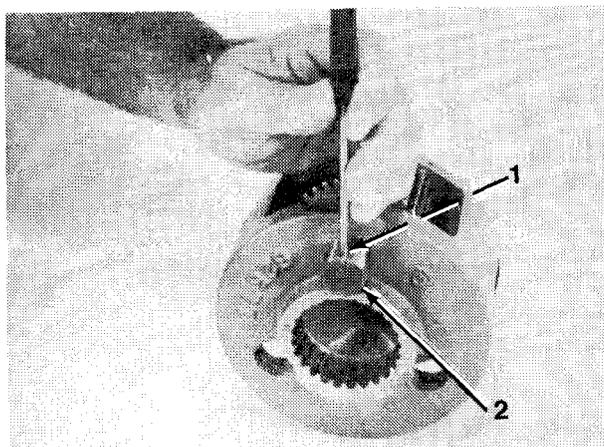


Figure 16-2

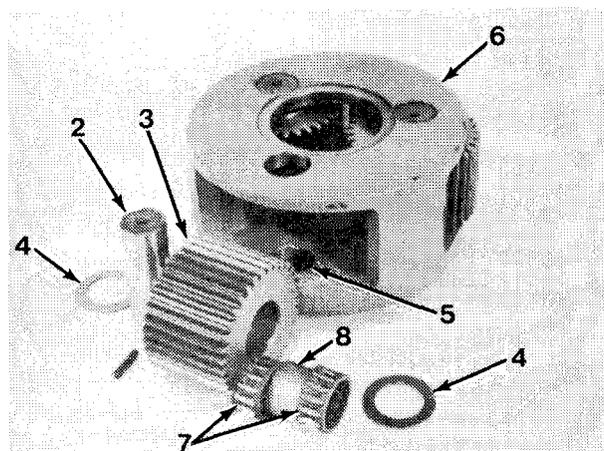


Figure 16-3

OUTPUT PLANET CARRIER

OUTPUT PLANET CARRIER DISASSEMBLY

1. Drive three rollpins (1) into center of gear shafts (2, Figure 16-1).
2. Drive three gear shafts (2) out enough to remove three rollpins (1, Figure 16-2).
3. Remove and discard three rollpins (1).
4. Remove three gear shafts (2), planet gears (3), six bearing races (4) and output thrust plate (5) from output planet carrier (6, Figure 16-3).
5. Remove two roller bearings (7) and bearing spacer (8) from each of three planet gears (3).

OUTPUT PLANET CARRIER CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect roller bearings for spalling, corrosion, discoloration, material displacement and wear.
3. Inspect bearing cage and cage bars for unusual wear or deformation and cage's ability to separate, retain and guide rollers properly.
4. Inspect thrust washer contact areas for wear.
5. Inspect gears and shafts for wear and pitting.
6. Inspect all other parts (refer to Chapter 4).

OUTPUT PLANET CARRIER ASSEMBLY

1. Install bearing spacer (8) and two roller bearings (7) in each of three planet gears (3, Figure 16-3).
2. Install output thrust plate (5), six bearing races (4), three planet gears (3) and gear shafts (2) in output planet carrier (6).

NOTE

Gear shaft holes must be aligned with holes in output planet carrier.

3. Install three new rollpins (1) through holes in output planet carrier (6) and in three gear shafts (2, Figure 16-4).
4. Recess three rollpins (1) slightly and stake output planet carrier (6) to secure three rollpins (1).

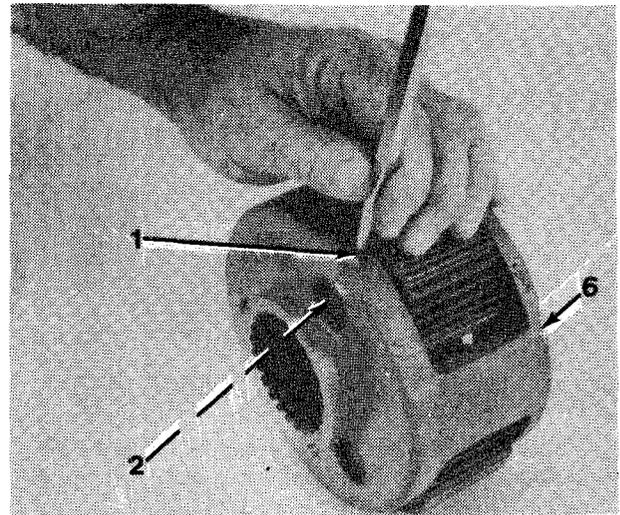


Figure 16-4

BRAKE CLUTCH

BRAKE CLUTCH DISASSEMBLY

1. Remove one of two retaining rings (1) and brake roller retainers (2, Figure 16-1).

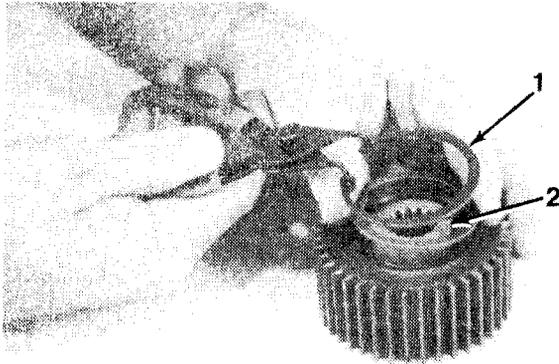


Figure 16-1

NOTE

Use a shop cloth to retain rotor springs and rotor plungers when brake cam is pushed out of brake race.

2. Remove brake cam (3), four rotor rollers (4), rotor springs (5), second roller retainer (6) and remaining retaining ring (7) from brake race (10, Figure 16-2).
3. Separate four rotor plungers (8) from four rotor springs (5).
4. Remove snap ring (9) from brake cam (3).

BRAKE CLUTCH CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).

! WARNING

The polished surfaces of brake race and rotor rollers must be perfectly smooth to insure positive engagement of clutch. The slightest defect may reduce brake clutch effectiveness. Failure to follow this procedure could cause DEATH or serious injury.

2. Inspect brake race and rotor rollers for nicks, burrs and other deformities. They must be perfectly smooth.
3. Inspect all other parts (refer to Chapter 4),

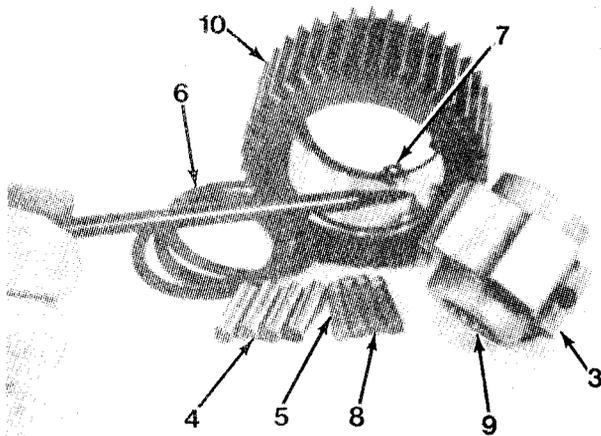


Figure 16-2

BRAKE CLUTCH ASSEMBLY

1. Install one retaining ring (7) and roller retainer (6) into brake race (10, Figure 16-2).
2. Install brake cam (3) inside brake race (10, Figure 16-3) with centerline of rotor spring holes level with top surface of brake race (10). Use a spacer to hold brake cam (3) in position.
3. Install four rotor plungers (8) inside four rotor springs (5).

NOTE

The two rotor rollers opposite each other should be installed first.

4. Install four rotor springs (5) and plungers (8) inside brake cam (3).

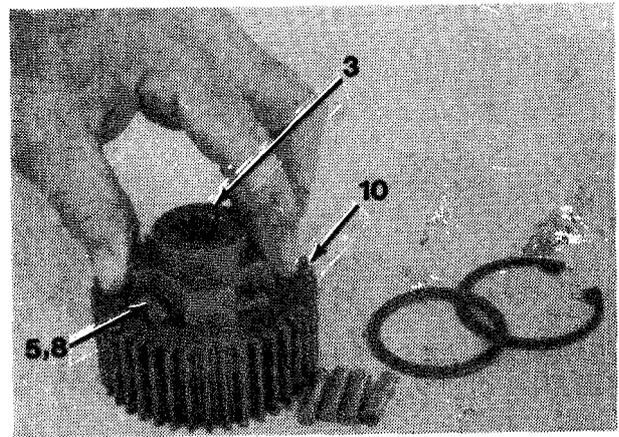


Figure 16-3

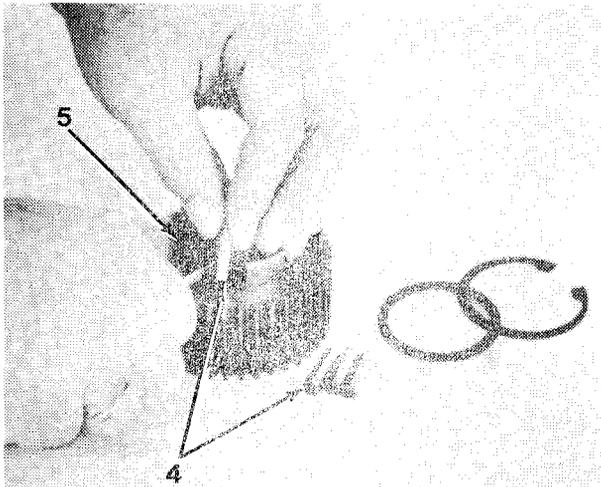


Figure 16-4

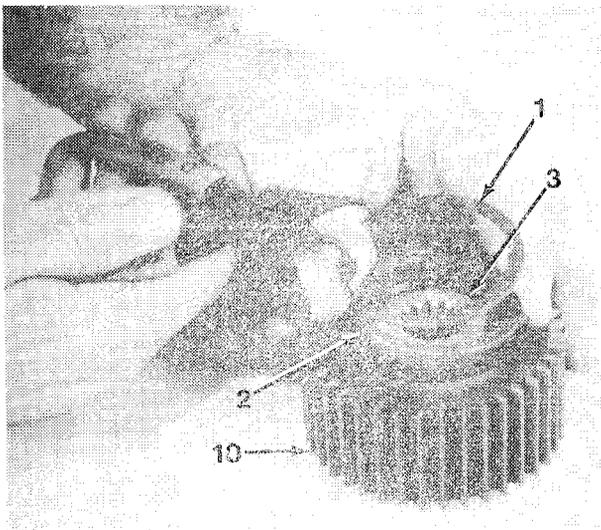


Figure 16-5

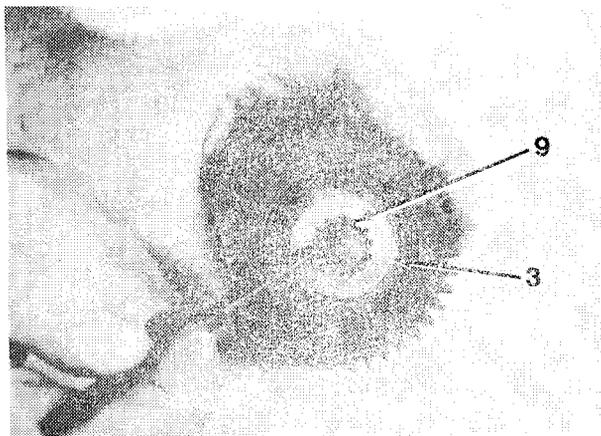


Figure 16-6

BRAKE CLUTCH ASSEMBLY

4. Using a small, flat-blade screwdriver, compress each rotor spring (5) while installing each rotor roller (4, Figure 16-4),
5. Press brake cam (3) into brake race (10, Figure 16-5).
6. Install remaining brake roller retainer (2) and retaining ring (1).

⚠ WARNING

Make sure snap ring is seated in groove in splined bore of cam. Snap ring will keep brake clutch assembly correctly positioned in center of friction brake pack. Brake may bind or fail if snap ring is not correctly installed. Failure to follow this procedure could cause DEATH or serious injury.

7. Install snap ring (9). Make sure snap ring (9) is seated in groove in splined bore of brake cam (3, Figure 16-6).

WINCH BRAKE VALVE

WINCH BRAKE VALVE DISASSEMBLY

1. Remove elbow (1), O-ring (2), ball (3) and spring (4) from housing (24, Figure 16-1).
2. Remove elbow (5), O-ring (6) and pilot orifice (7) from housing (24).
3. Remove spring retainer (8), O-ring (9) and spring (10).
4. Remove cap plug (11), damper piston (12) and spool (13) as a unit from housing (24). Remove O-ring (14) from cap plug (11).

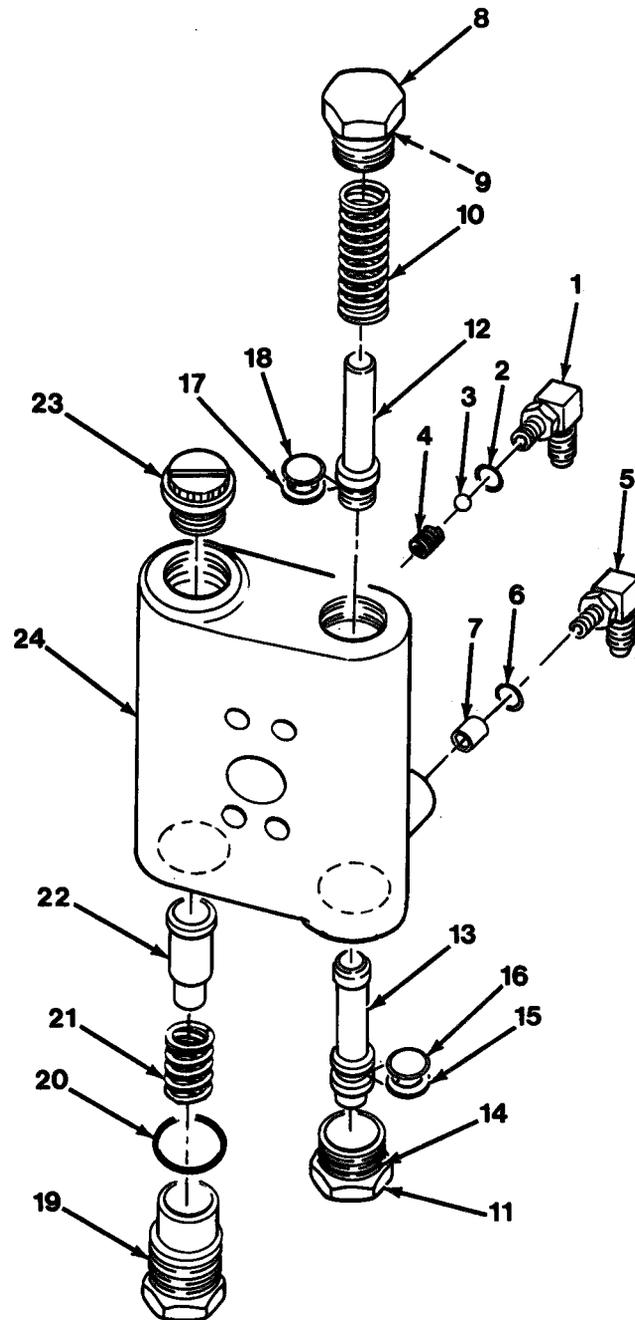


Figure 16-1

WINCH BRAKE VALVE DISASSEMBLY

5. Remove back-up ring (15) and O-ring (16) from spool (13, Figure 16-1).
6. Separate damper piston (12) from spool (13),
7. Remove back-up ring (17) and O-ring (18) from damper piston (12).
8. Remove spring retainer (19), O-ring (20), spring (21), check valve poppet (22) and plug (23) from housing (24).

WINCH BRAKE VALVE CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

WINCH BRAKE VALVE ASSEMBLY

NOTE

Coat all parts with clean oil prior to assembly.

1. Install plug (23), check valve poppet (22), spring (21), O-ring (20) and spring retainer (19) in housing (24, Figure 16-1).
2. Install O-ring (18) and back-up ring (17) on damper piston (12).
3. Install damper piston (12) into spool (13).
4. Install O-ring (16) and back-up ring (15) on spool (13).

5. Install spool (13) and damper piston (12) as a unit in housing (24). Center unit in housing while installing.
6. Install O-ring (14) and cap plug (11) in housing (24).
7. Install spring (10), O-ring (9) and spring retainer (8).
8. Install pilot orifice (7), O-ring (6) and elbow (5) in housing (24).
9. Install spring (4), ball (3), O-ring (2) and elbow (1) in housing (24). Ball (3) should rest on spring (4).

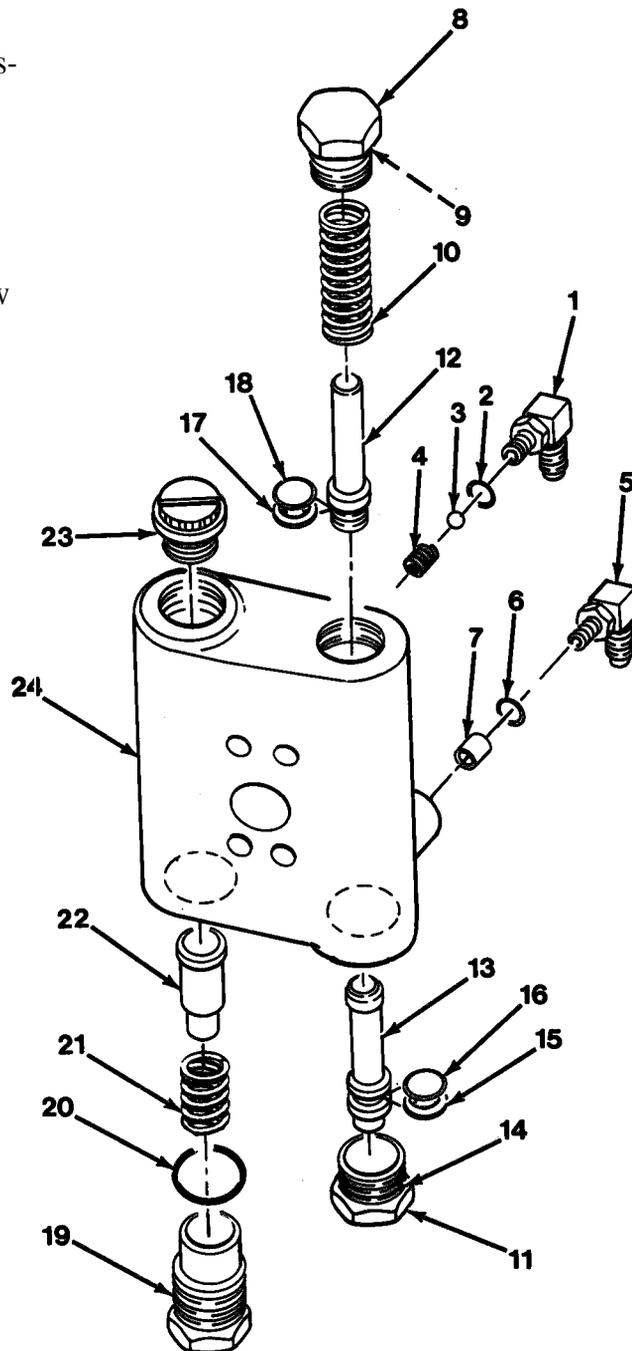


Figure 16-1

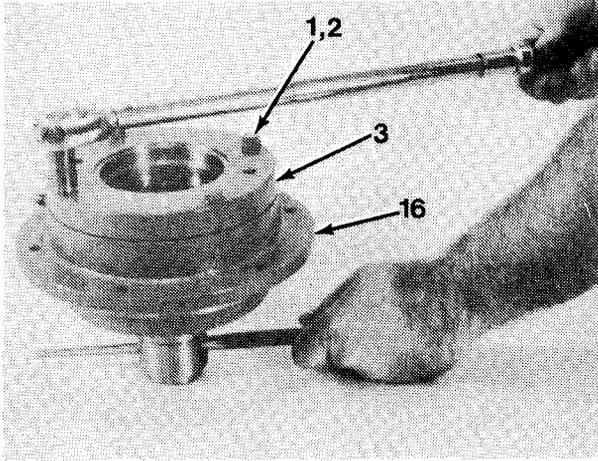


Figure 16-1

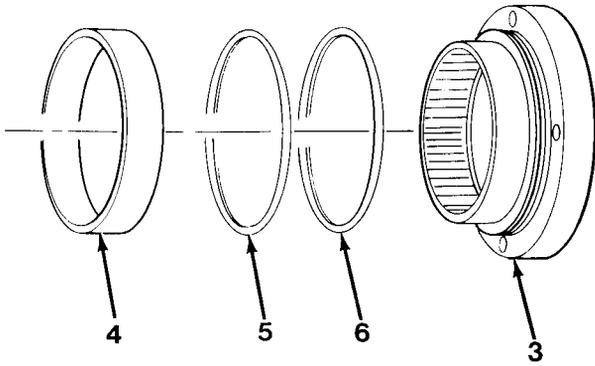


Figure 16-2

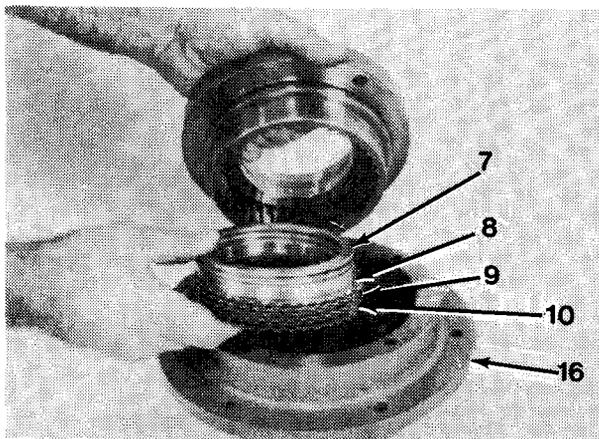


Figure 16-3

MOTOR SUPPORT BRAKE CYLINDER

MOTOR SUPPORT BRAKE CYLINDER DISASSEMBLY

1. Remove four cap screws (1), lockwashers (2) and motor support (3) from brake cylinder (16, Figure 16-1).
2. Remove seal (4), O-ring (5) and back-up seal ring (6) from motor support (3, Figure 16-2).
3. Remove one spacer (7), two brake spacers (8), five friction discs (9), six brake discs (10) and remaining spacer (7) from brake cylinder (16, Figure 16-3).
4. Remove piston back-up ring (11) and pressure plate (12) from brake cylinder (16, Figure 16-4).
5. Remove 12 die springs (13) from brake cylinder (16, Figure 16-5).
6. Remove adapter (14) and O-ring (15) from brake cylinder (16, Figure 16-6).

MOTOR SUPPORT BRAKE CYLINDER CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Check broke release port. It must be free of contamination.
3. Check friction discs for distortion by placing on a flat surface and using a straight-edge. Friction material must be even across entire surface with groove pattern visable. Replace friction disc if splines are worn to a point, disc is distorted or friction material is worn unevenly.
4. Check steel brake discs for distortion by placing on a flat surface and using a straight-edge. Check surface for signs of material transfer or heat discoloration. Replace brake disc if splines are worn to a point, or disc is distorted or heat discolored.

CAUTION

Brake springs must be replaced as a set. Failure to replace springs as a set may result in uneven brake application pressure and repeated brake spring failure.

5. Check brake spring free length. Minimum free length is 1.188 in. (30.18 mm). Check springs for cracking. If brake spring is to be replaced, all 12 must be replaced.
6. Inspect all other parts (refer to Chapter 4).

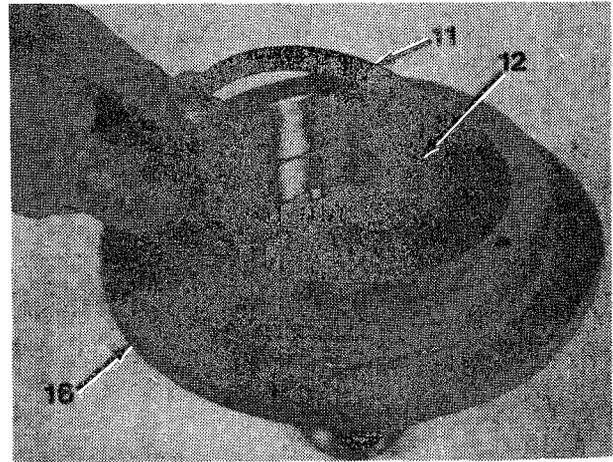


Figure 16-4

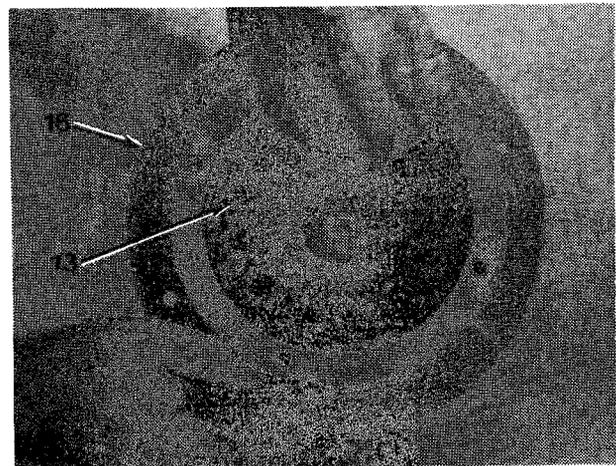


Figure 16-5

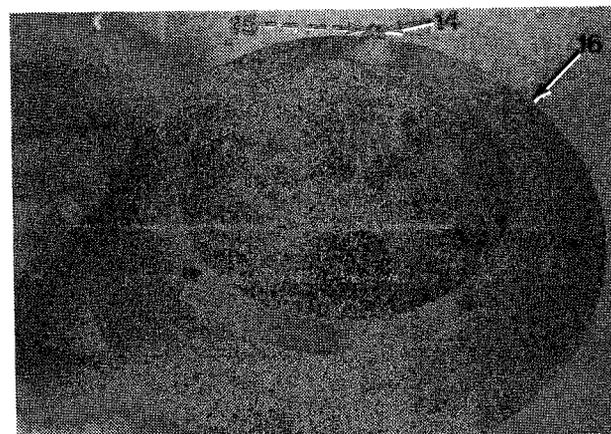


Figure 16-6

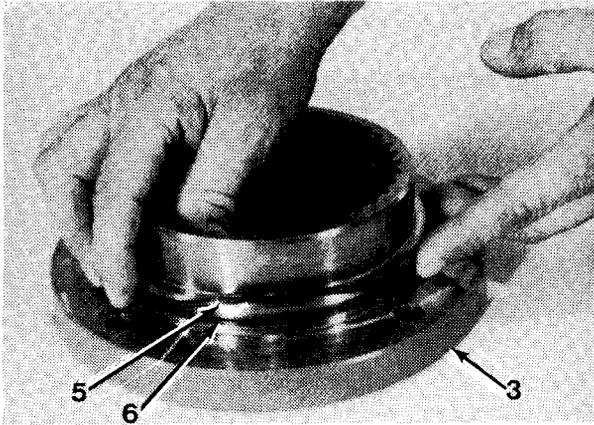


Figure 16-7

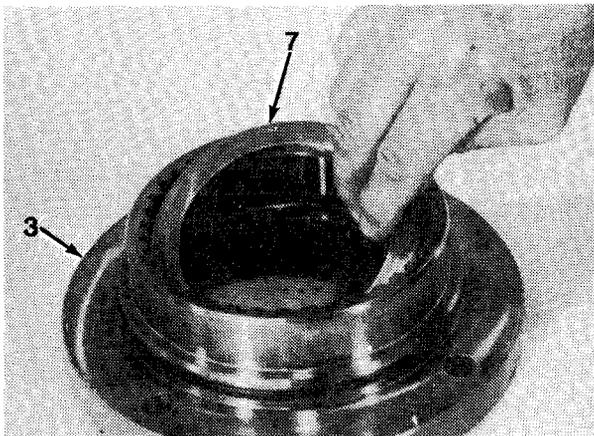


Figure 16-8

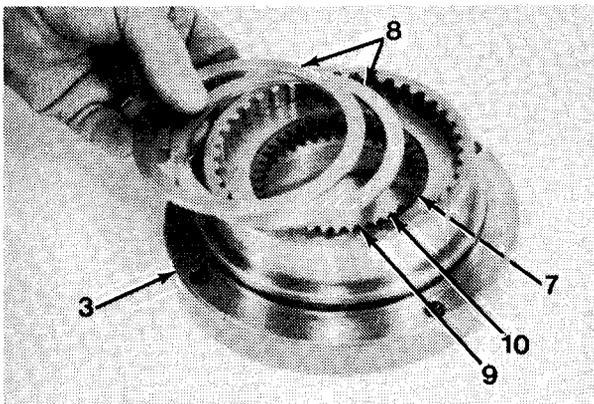


Figure 16-10

MOTOR SUPPORT BRAKE CYLINDER ASSEMBLY

1. Install back-up seal ring (6) and O-ring (5) on motor support (3, Figure 16-7). Install with motor mounting surface down.
2. Install one spacer (7) in motor support (3, Figure 16-8).

NOTE

Lubricate all discs with clean lubricating oil MIL-L-2105, grade 80W90, before assembling.

3. Install one of six brake discs (10) against spacer (7) followed by one of five friction discs (9). Install remaining five of six brake discs (10) and friction discs (9), alternately, ending with brake disc (10, Figure 16-10) on top.
4. Install two brake spacers (8) in motor support (3) on brake disc (10).

5. Install remaining spacer (7) in motor support (3, Figure 16-11).
6. Check brake stack height by placing pressure plate (12) on top of spacer (7, Figure 16-12), holding pressure plate (12) down firmly by hand.
7. Measure clearance in three places between motor support (3) and pressure plate (12). Average gap must be between 0.153 in. (3.88 mm) maximum and 0.080 in. (2.03 mm) minimum. If gap exceeds maximum limit, there are too many brake discs (10, Figure 16-10) in stack or brake discs (10) are distorted. If gap is less than minimum, there are too few brake discs (10) in stack or friction discs (9, Figure 16-12) are worn. Corrective action must be taken to obtain required gap.
8. Remove pressure plate (12, Figure 16-12) when stack height is correct.
9. Lubricate seal (4) and motor support (3, Figure 16-13) sealing surfaces with clean lubricating oil MIL-L-2105, grade 80W90.
10. Install seal (4) on motor support (3) with lip of seal (4) down.

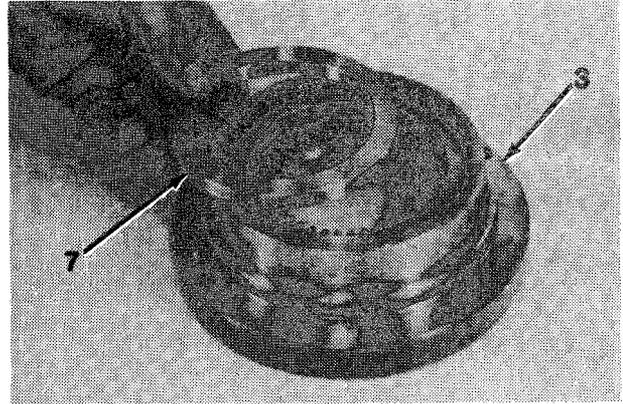


Figure 16-11

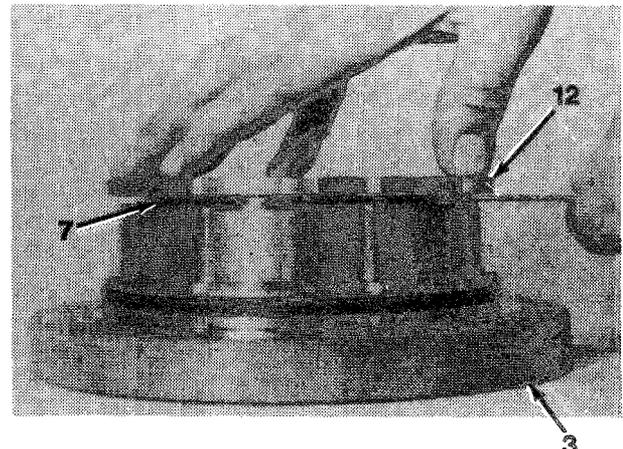


Figure 16-12

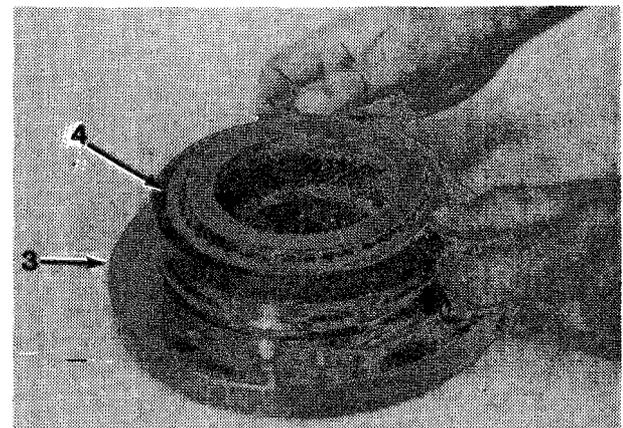


Figure 16-13

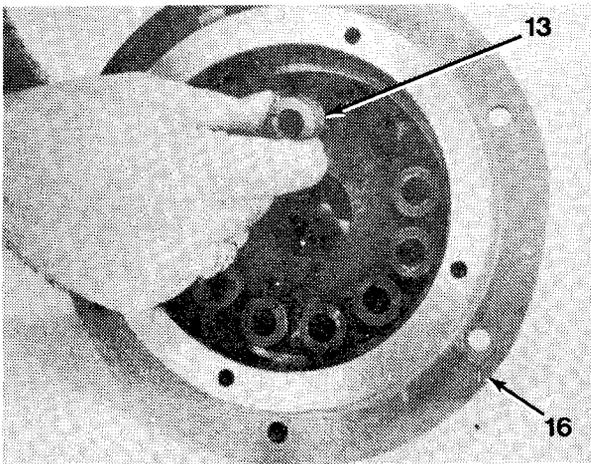


Figure 16-14

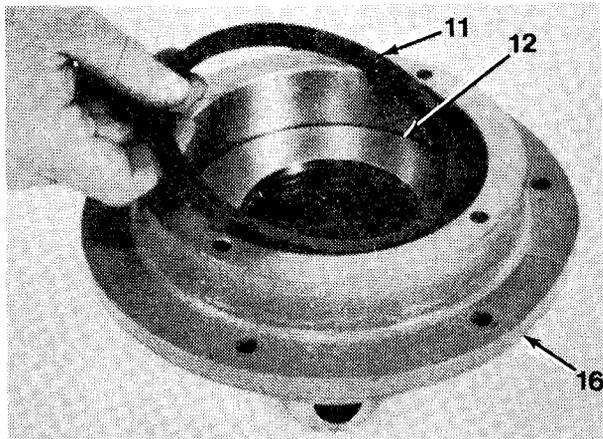


Figure 16-15

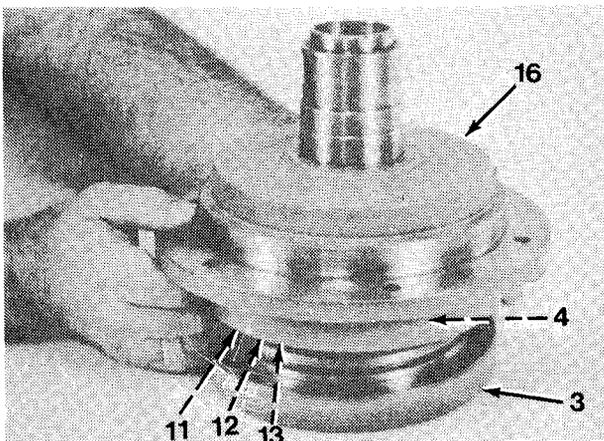


Figure 16-16

MOTOR SUPPORT BRAKE CYLINDER ASSEMBLY

11. Install 12 die springs (13) in brake cylinder (16, Figure 16-14).
12. Install pressure plate (12) and piston back-up ring (11) in brake cylinder (16, Figure 16-15).
13. Depress piston back-up ring (11) to one side to hold pressure plate (12) and die springs (13) in place while brake cylinder (16) is lowered over motor support (3, Figure 16-16).
14. Apply petroleum jelly to entire sealing surface of brake cylinder (16) and seal (4).

CAUTION

Use care when installing brake cylinder to avoid damaging piston seal or motor support O-ring. A press may be necessary to avoid tilting brake cylinder during installation.

15. Install brake cylinder (16) over motor support (3).
16. Install four lockwashers (2) and capscrews (1, Figure 16-1).
17. Install new O-ring (15) and adapter (14) in brake cylinder (16, Figure 16-6).

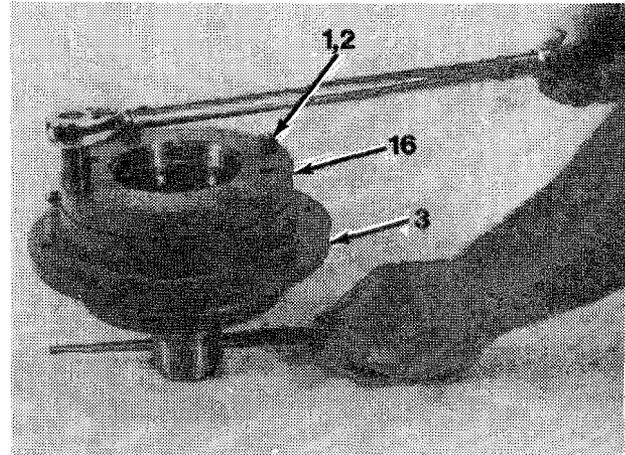


Figure 16-1

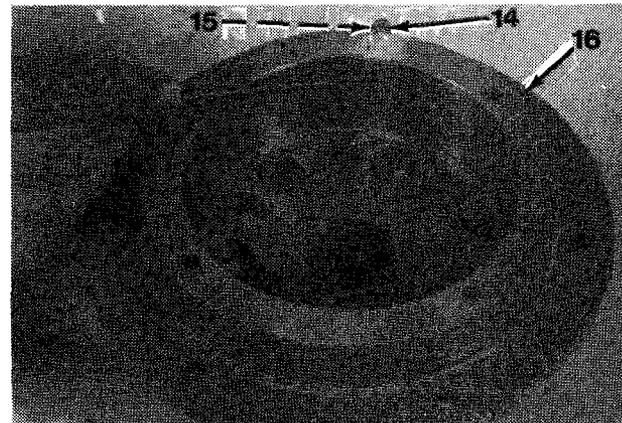


Figure 16-6

MOTOR SUPPORT BRAKE CYLINDER TEST

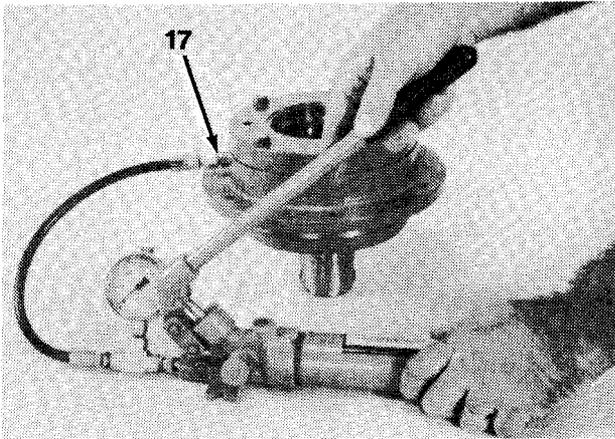


Figure 16-17

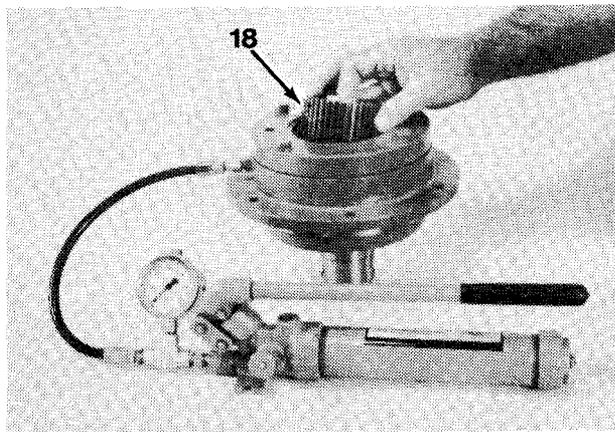


Figure 16-18

1. Install a -4 J.I.C. fitting (17, Figure 16-17) in brake release port.
2. Connect a hand pump with a 0-4,000 psi (0-27,580 kPa) gauge and a shut-off valve to the 4-J.I.C. fitting.
3. Apply 1,000 psi (6,895 kPa) pressure and close shut-off valve.
4. Check pressure gauge after 5 minutes for loss of pressure. If loss of pressure is detected, brake cylinder assembly should be disassembled for inspection of sealing surfaces and/or replacement of defective parts.
5. While pressure is applied and brake is released, install brake clutch assembly (18, Figure 16-18) in brake stack. Turn brake clutch assembly (18) in both directions, alternately, while installing in order to align brake disc splines.
6. Release pressure and remove hand pump and -4 J.I.C. fitting (17, Figure 16-17).
7. Remove brake clutch assembly (18, Figure 16-18).

WINCH MOTOR

WINCH MOTOR DISASSEMBLY

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

1. Disconnect hose (1) from winch brake valve assembly (5, Figure 16-1).
2. Remove two hoses (1) and tee (2) from motor (34, Figure 16-2).
3. Disconnect hose (3) from winch brake valve assembly (5, Figure 16-3).
4. Remove hose (3) from motor (34).

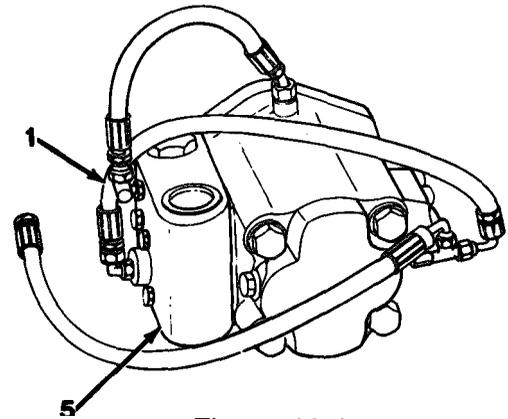


Figure 16-1

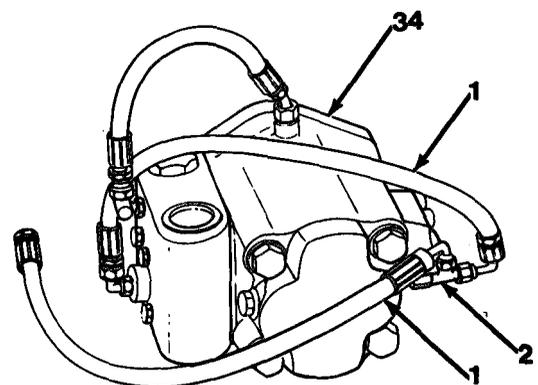


Figure 16-2

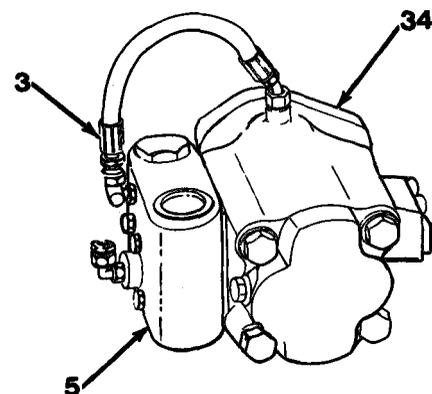


Figure 16-3

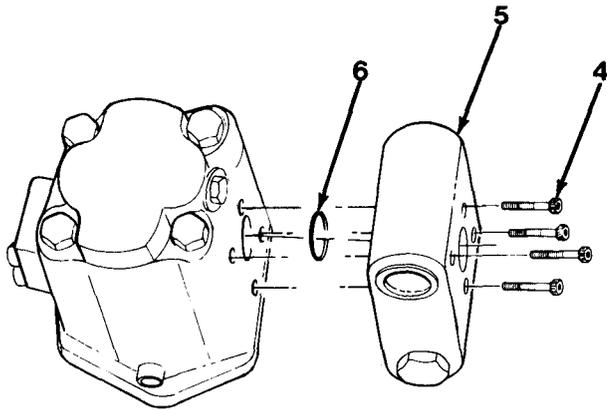


Figure 16-4

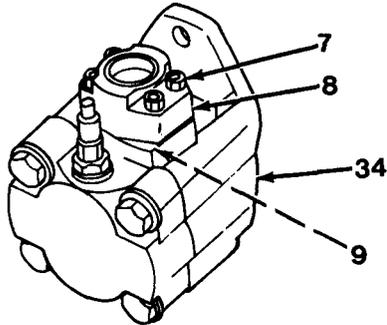


Figure 16-5

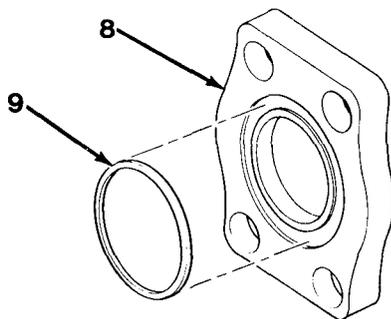


Figure 16-6

WINCH MOTOR DISASSEMBLY

NOTE

Matchmark brake valve assembly and winch motor gear housing prior to disassembly.

5. Remove four allen screws (4), winch brake valve assembly (5) and O-ring (6, Figure 16-4).
6. Remove four allen screws (7) and split flange adapter (8) from motor (34, Figure 16-5).
7. Remove O-ring (9) from split flange adapter (8, Figure 16-6).

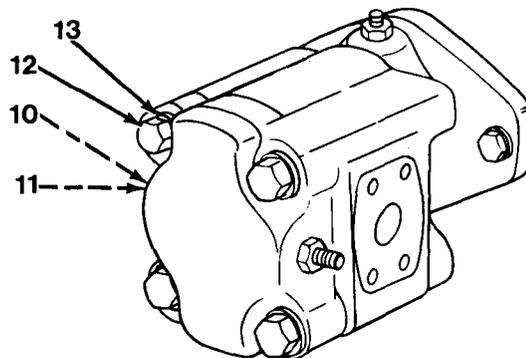


Figure 16-7

8. Remove drain plug (10) and O-ring (11, Figure 16-7) to drain hydraulic oil.

NOTE

Matchmark gear housing to shaft end cover and port end cover.

9. Remove four capscrews (12) and washers (13).

10. Remove shaft end cover (14, Figure 16-8).

11. Remove six pocket seals (15) and gasket seal (16) from gear housing (20, Figure 16-9).

12. Remove port end cover (17).

13. Remove remaining six pocket seals (15) and gasket seal (16).

NOTE

Matchmark thrust plates to gear housing.

14. Remove two thrust plates (18) by tapping on shafts (19) to unseat thrust plates (18, Figure 16-10).

15. Remove two shafts (19) from gear housing (20).

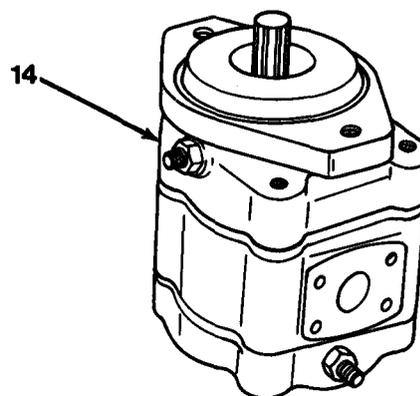


Figure 16-8

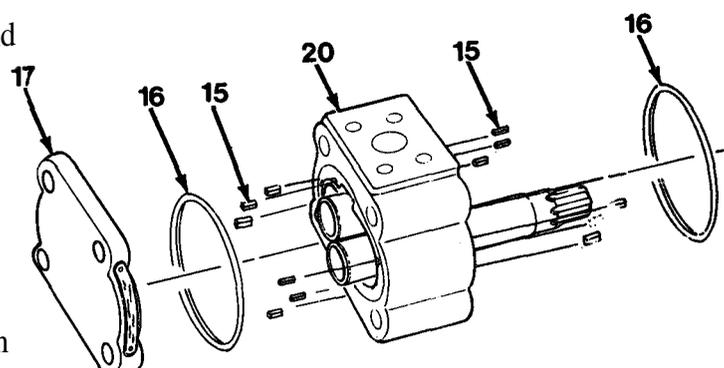


Figure 16-9

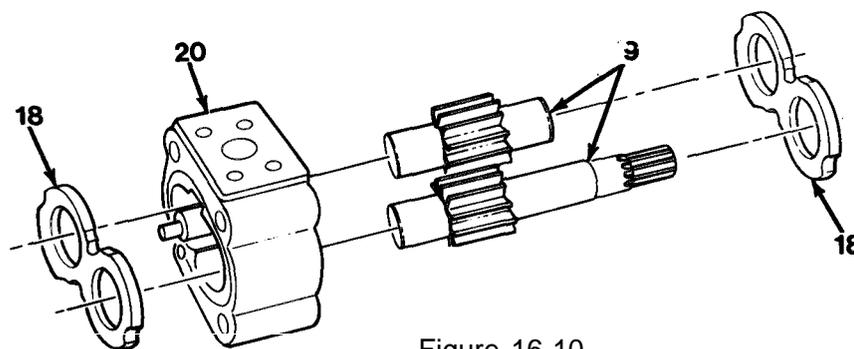


Figure 16-10

WINCH MOTOR DISASSEMBLY

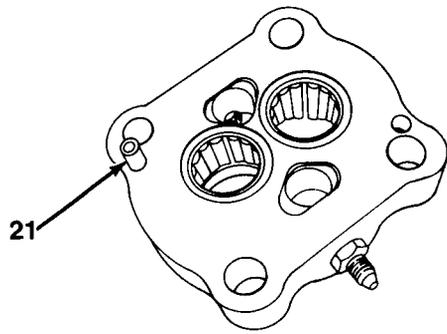


Figure 16-11

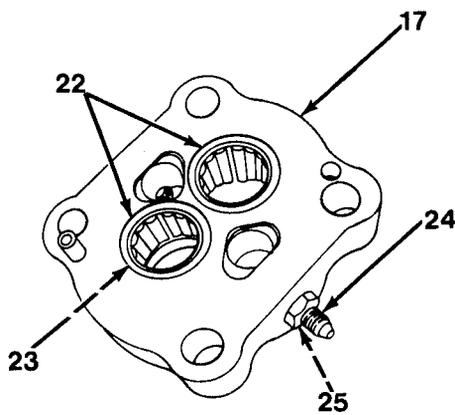


Figure 16-12

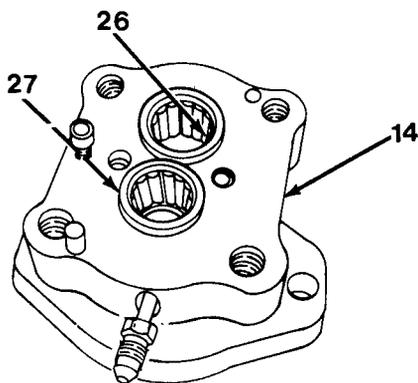


Figure 16-13

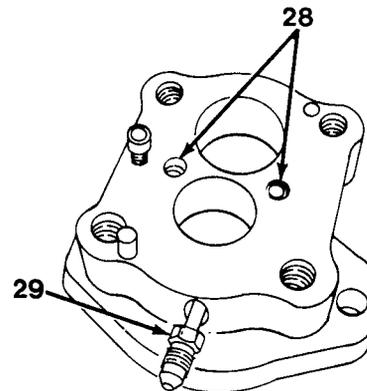


Figure 16-14

16. Remove four dowel pins (21, Figure 16-11), if inspection proves necessary.
17. Remove two bearings (22) and ring seal (23) from port end cover (17, Figure 16-12).
18. Remove adapter (24) and O-ring (25) from port end cover (17).
19. Remove two bearings (26) and ring seal (27) from shaft end cover (14, Figure 16-13).
20. Remove two check assemblies (28) and adapter (29, Figure 16-14).

21. Remove snap ring (30), spacer (31), seal retainer (32) and lip seal (33) from shaft end cover (14, Figure 16-15).

WINCH MOTOR CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

WINCH MOTOR ASSEMBLY

1. Install lip seal (33), seal retainer (32), spacer (31) and snap ring (30) into shaft end cover (14, Figure 16-15).
2. Install two check assemblies (28) and adapter (29, Figure 16-14).
3. Install ring seal (27) and two bearings (26) in shaft end cover (14, Figure 16-13).
4. Install ring seals (23) and two bearings (22) in port end cover (17, Figure 16-12).
5. Install O-ring (25) and adapter (24) in port end cover (17).

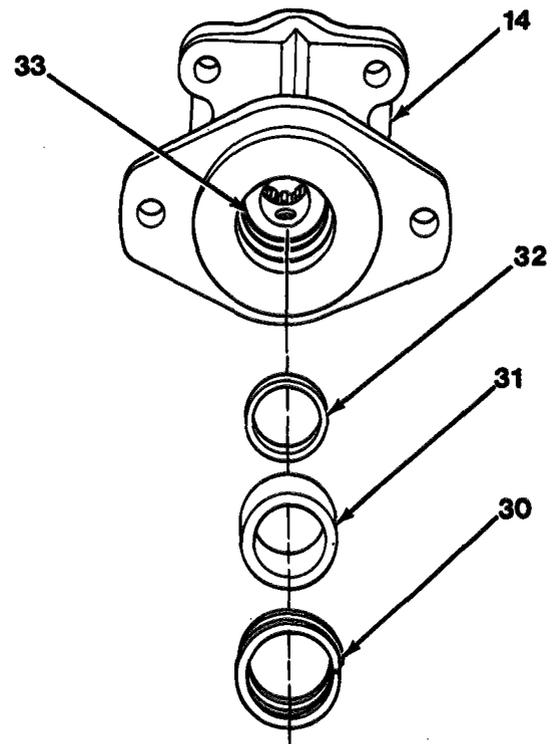


Figure 16-15

WINCH MOTOR ASSEMBLY

6. Install four dowel pins (21, Figure 16-11), if removed.

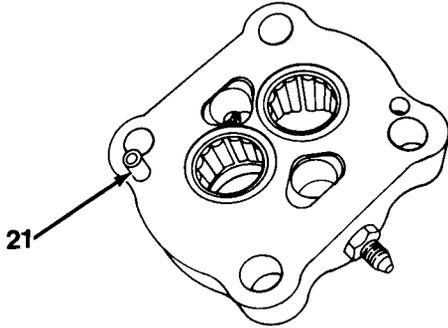


Figure 16-11

7. Install thrust plate (18) as matchmarked in gear housing (20, Figure 16-10). Thrust plate (18) is installed flush with gear housing (20).

8. Install six pocket seals (15) and gasket seal (16) in gear housing (20, Figure 16-9).

9. Install port end cover (17) on gear housing (20, Figure 16-16) as matchmarked during disassembly.

10. Install two shafts (19) in gear housing (20, Figure 16-10).

11. Install remaining thrust plate (18) as matchmarked in gear housing (20). Thrust plate (18) is installed flush with gear housing (20).

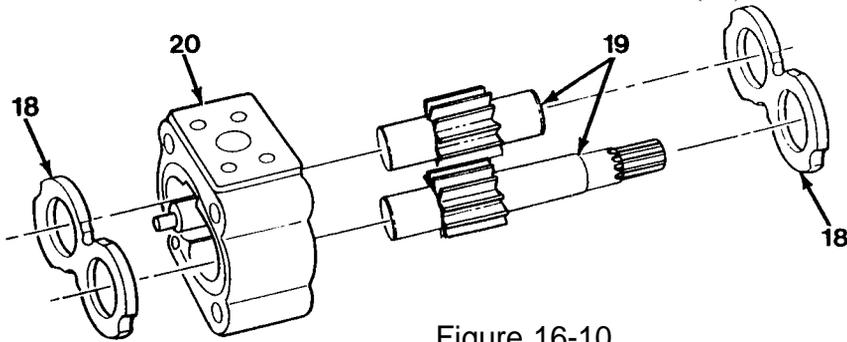


Figure 16-10

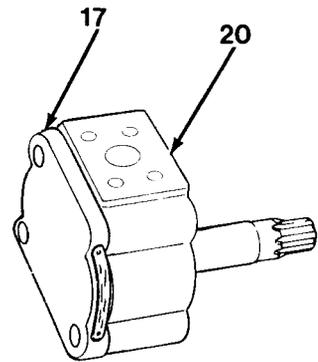


Figure 16-16

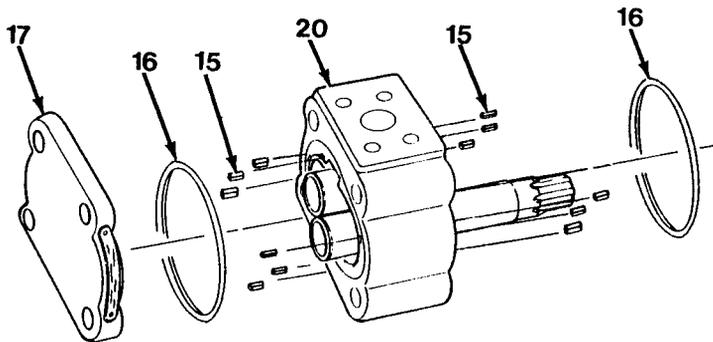


Figure 16-9

12. Install remaining six pocket seals (15) and gasket seal (16) in gear housing (20, Figure 16-9).
13. Install shaft end cover (14, Figure 16-8) as matchmarked.
14. Install four washers (13), capscrews (12), O-ring (11) and drain plug (10, Figure 16-7).
15. Install O-ring (9) and split flange adapter (8) on motor (34) with four allen screws (7, Figure 16-5).
16. Install O-ring (6), winch brake valve assembly (5) and four allen screws (4, Figure 16-4).

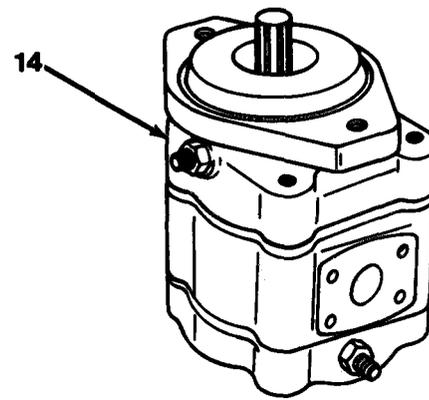


Figure 16-7

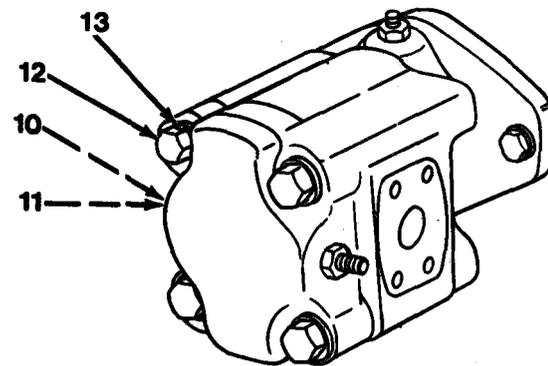


Figure 16-8

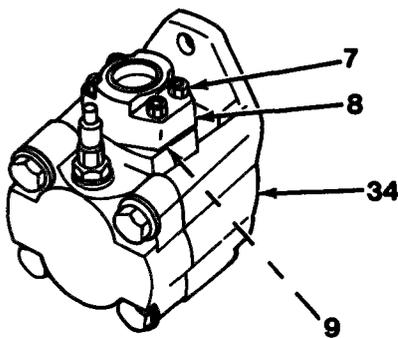


Figure 16-5

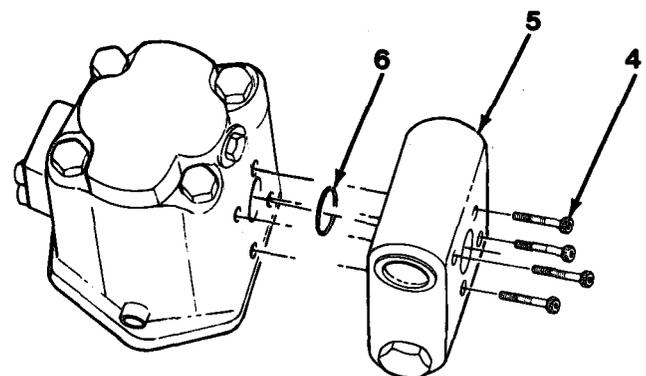


Figure 16-4

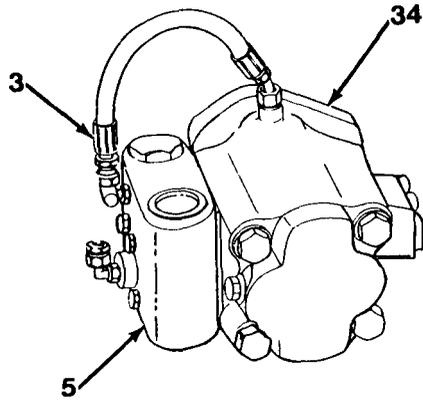


Figure 16-3

WINCH MOTOR ASSEMBLY

17. Install hose (3, Figure 16-3).
18. Install tee (2) and two hoses (1, Figure 16-2).
19. Connect hose (1) to winch brake valve assembly (5, Figure 16-1).

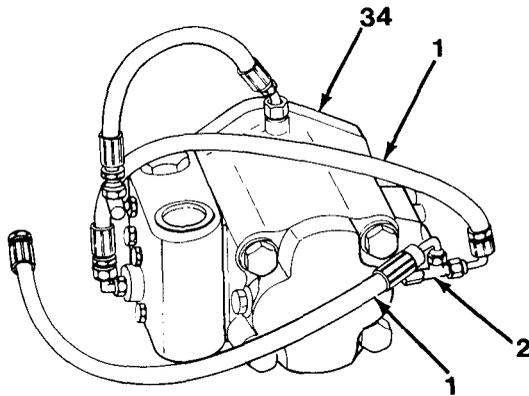


Figure 16-2

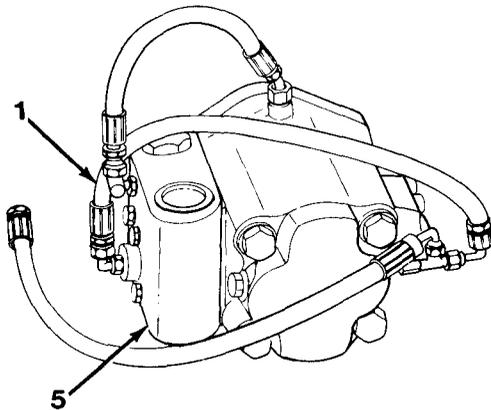


Figure 16-1

HOOK BLOCK

HOOK BLOCK REMOVAL AND INSTALLATION

Refer to Koehring Commercial Operation Instructions manual for removal and installation of hook block assembly.

HOOK BLOCK DISASSEMBLY



Weight of hook block is approximately 235 lb (107 kg). Use adequate lifting equipment to lift and support hook block. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Remove three nuts (1), cotter pin (2) and cable side plate (3, Figure 16-1).
2. Remove three tubes (4).
3. Remove spacer (5), washer (6), sheave (7), washer (6), spacer (5) and shaft (8, Figure 16-2).
4. Remove grease zerk (9) from sheave (7).
5. Press bushing (10) out of sheave (7), if necessary.
6. Remove trunnion (11) and hook (12) as an assembly. Remove lock nut (13), thrust bearing (14), trunnion (11), grease zerk (15), and latch kit (16) from hook (12).
7. Press bushing (17) out of trunnion (11), if necessary.
8. Remove three capscrews (18) from cable side plate (19).

HOOK BLOCK CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

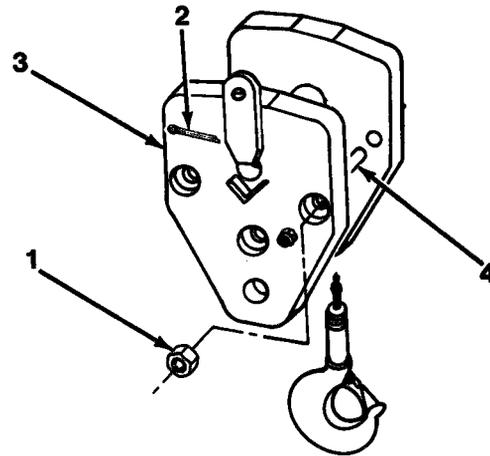


Figure 16-1

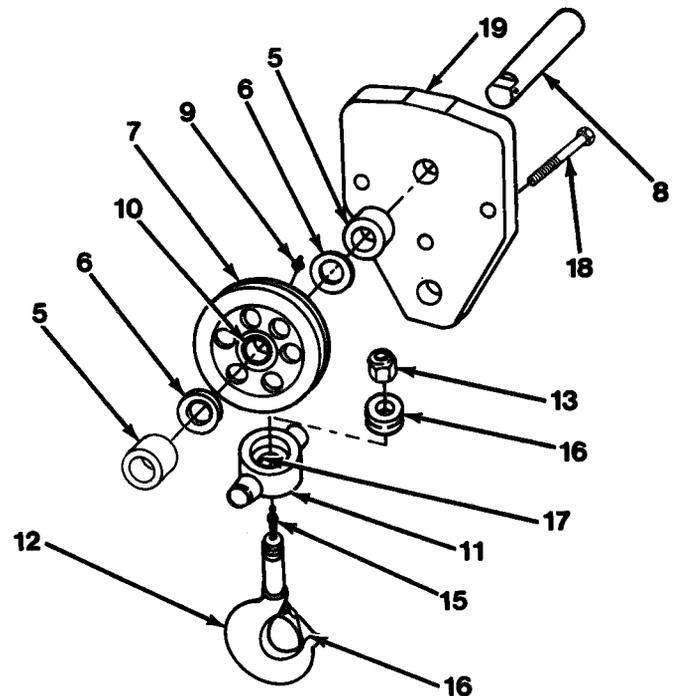


Figure 16-2

HOOK BLOCK ASSEMBLY

⚠ WARNING

Weight of hook block is approximately 235 lb (107 kg). Use adequate lifting equipment to lift and support hook block. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Clean bushing (17) and trunnion (11) with Loctite Primer T and allow to dry. Apply Loctite RC 640 and press bushing (17) into trunnion (11, Figure 16-2).

CAUTION

Thrust bearing must be installed with sheet metal cover down against trunnion. Failure to follow this procedure could cause damage to equipment.

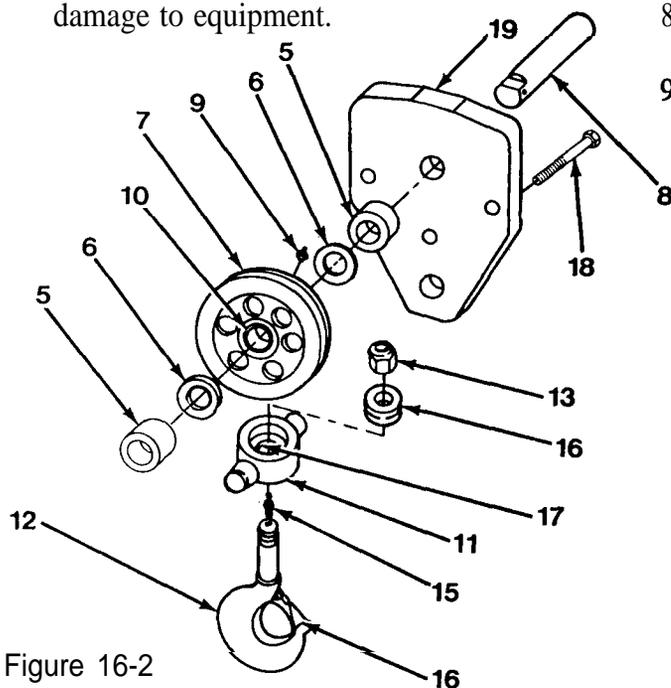


Figure 16-2

2. Install latch kit (16), grease zerk (15), trunnion (11) and thrust bearing (14) on hook (12).
3. Apply Loctite Primer T to hook (12) and lock nut (13) threads and allow to dry. Apply Loctite 271 to hook (12) threads and install lock nut (13) on hook (12). Tighten locknut (13) until the machined shoulder on hook (12) is approximately 0.12 in. (3.0 mm) away from bottom of trunnion (13). Do not pull hook (12) tight against trunnion (11).
4. Install three capscrews (18) in cable side plate (19).
5. Install trunnion (11) and hook (12) as a assembly.
6. Install bushing (10) and grease zerk (9) in sheave (8).
7. Install shaft (8), spacer (5), washer (6), sheave (7), washer (6) and spacer (5).
8. Install three tubes (4, Figure 16-1).
9. Install cable side plate (3), cotter pin (2) and three nuts (1). Torque nuts (1) to 50 lb-ft (68 N•m).

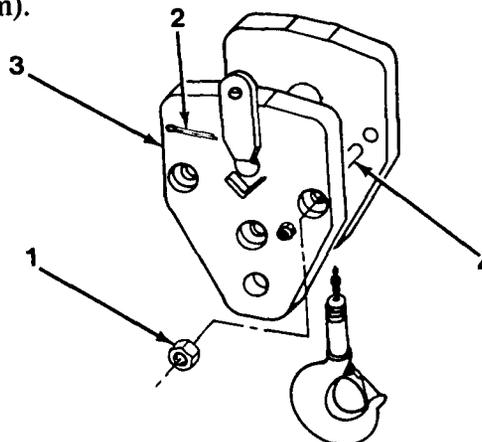


Figure 16-1

WINCH CONTROL VALVE

WINCH CONTROL VALVE REMOVAL

1. Remove deck plate (refer to page 14-9).

⚠ WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

2. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
3. Disconnect winch control cable (refer to page 17-56, Step 1).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Disconnect all attaching hoses and fittings (refer to page 13-107).
5. Remove three nuts (1) and lockwashers (2) securing winch control valve (3, Figure 16-1) to frame location.
6. Remove winch control valve (3) and three washers (4) from frame location.

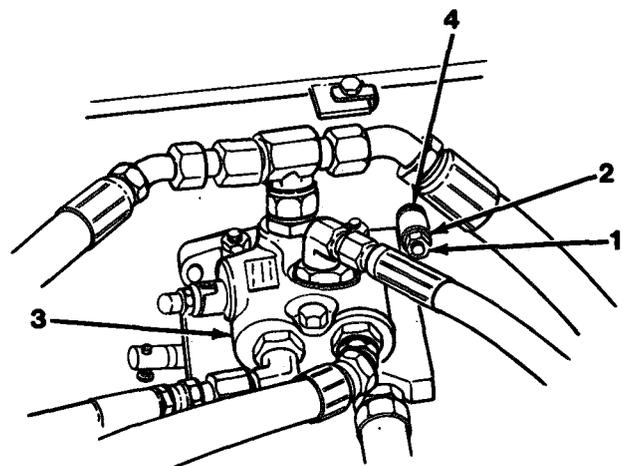


Figure 16-1

WINCH CONTROL VALVE INSTALLATION

1. Install three washers (4), and winch control valve (3, Figure 16-1) on frame.
2. Install three lockwashers (2) and nuts (1).
3. Connect all hoses and fittings (refer page 13-108).
4. Connect winch control cable (refer to page 17-59, step 5).

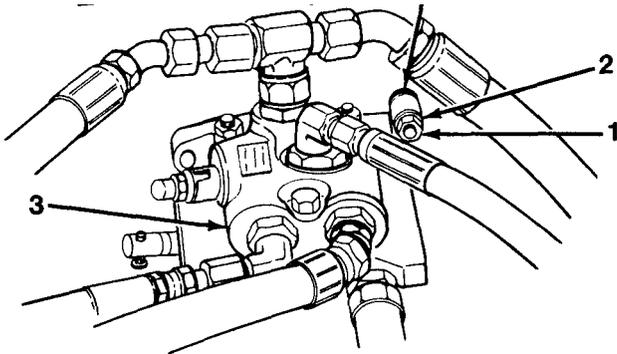


Figure 16-1

⚠ WARNING

Keep all personnel away from winch and hook block area. Failure to follow this procedure could cause DEATH or serious injury.

5. Close dipstick cap. Start engine and operate winch control lever. Make sure components operate correctly. Check for leaks.
6. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
7. Install deck cover plate (refer to page 14-9).

WINCH CONTROL VALVE TEST AND ADJUSTMENT

1. Remove deck cover (refer to page 14-9).
2. Disconnect brake release hose (5, Figure 16-2) attached to winch motor, lower port and cap tee before checking pressure. Vent hose to atmosphere.

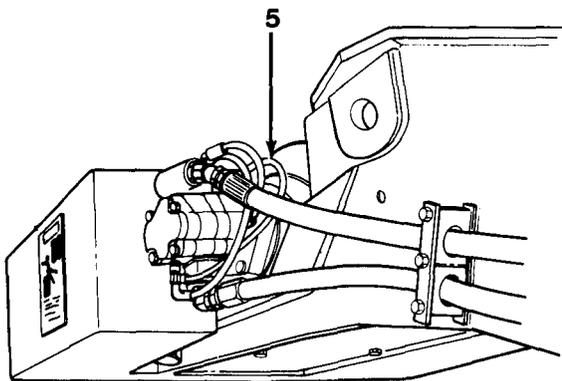


Figure 16-2

3. Remove dust cap (6, Figure 16-3) from test port located on inlet end of main control valve.
4. Install a 0-4,000 psi (0-27,580 kPa) gauge equipped with short pressure hose and 1/4 in. female quick disconnect.
5. Remove acorn nut (7, Figure 16-4) from relief on winch valve.

⚠ WARNING

Keep all personnel away from winch and hook block area. Failure to follow this procedure could cause DEATH or serious injury.

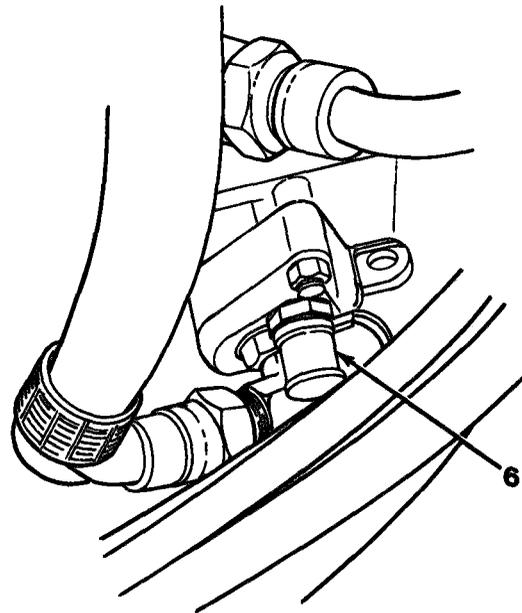


Figure 16-3

6. Run engine at full rpm, operate winch lever in lowering mode and hold long enough to get a pressure reading.
7. Hold adjusting screw (8) and loosen jam nut (9). Turn adjusting screw (8) clockwise to increase pressure or counterclockwise to decrease pressure, until desired pressure setting is obtained.

NOTE

Winch control valve is set at 2,650 (+50, -0) psi (18,272 [+345, -0] kPa).

8. Hold adjusting screw (8) and tighten jam nut (9). Install and tighten acorn nut (7).

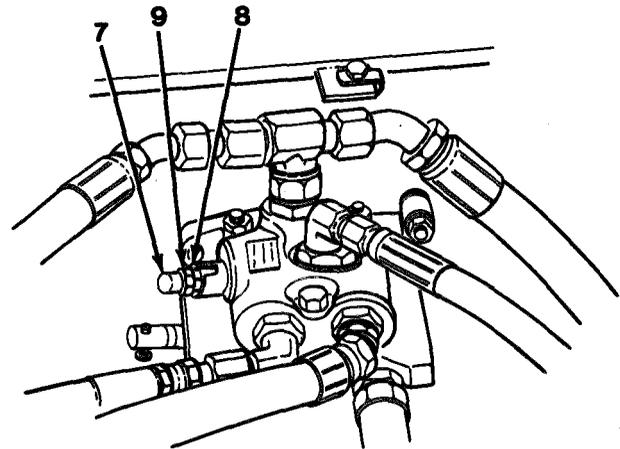


Figure 16-4

WINCH CONTROL VALVE TEST AND ADJUSTMENT

9. Remove pressure gauge from test port and install dust cap (6, Figure 16-3).
10. Remove cap from tee and connect brake release hose (5, Figure 16-2).
11. Install deck cover (refer to page 14-9).

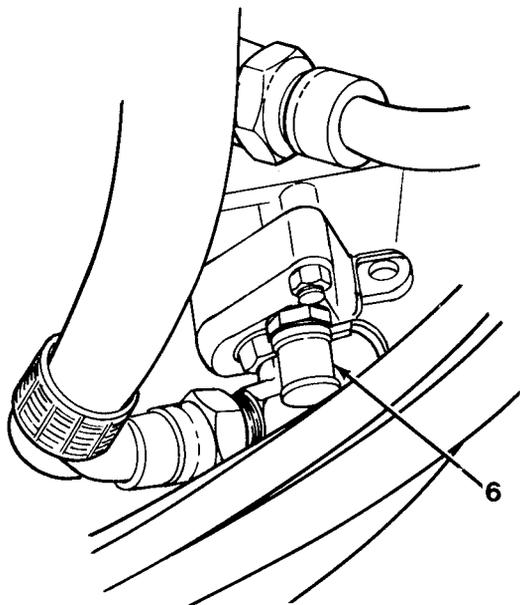


Figure 16-3

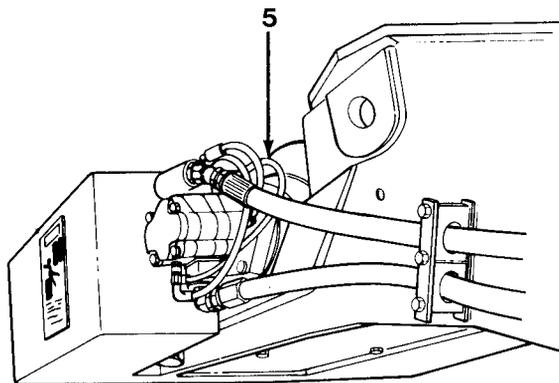


Figure 16-2

CHAPTER 17
OPERATOR'S CONTROLS

Title	Page
Boom Hoist Winch, and Outrigger Valve Controls	17-1
Swing/Telescoping Valve Controls	17-4
Transmission Shift Controls	17-6
Throttle Control	17-10
Heater	17-15
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Brake Pedal and Linkage	17-28
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Transmission Cable	17-46
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BOOM HOIST, WINCH, OUTRIGGER VALVE CONTROLS

BOOM HOIST, WINCH, OUTRIGGER VALVE CONTROLS REMOVAL

1. Remove dash panels (refer to page 17-61).
2. Remove three cotter pins (1) and pins (2) to disengage yokes (3) from handles (4, Figure 17-1).
3. Loosen three jam nuts (5) and remove knobs (6, Figure 17-2) and jam nuts (5).
4. Remove two capscrews (7), lockwashers (8) and bracket (9).

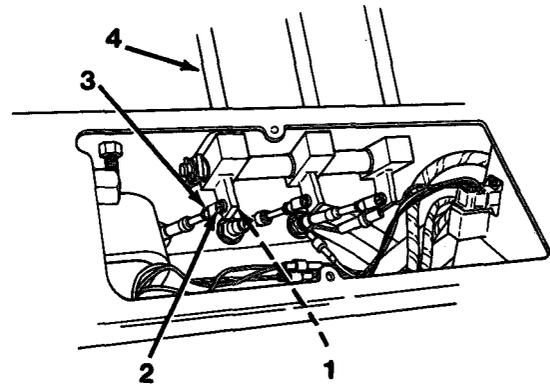


Figure 17-1

BOOM HOIST, WINCH, OUTRIGGER VALVE CONTROLS INSTALLATION

1. Position bracket assembly (9, Figure 17-2) under dash panel.
2. Install two lockwashers (8) and two cap-screws (7).
3. Install three jam nuts (5) and knobs (6) and lock in place with jam nuts (5).
4. Position three yokes (3) on end of handles (4, Figure 17-1).
5. Install three pins (2) and cotter pins (1).
6. Install dash panels (refer to page 17-66).

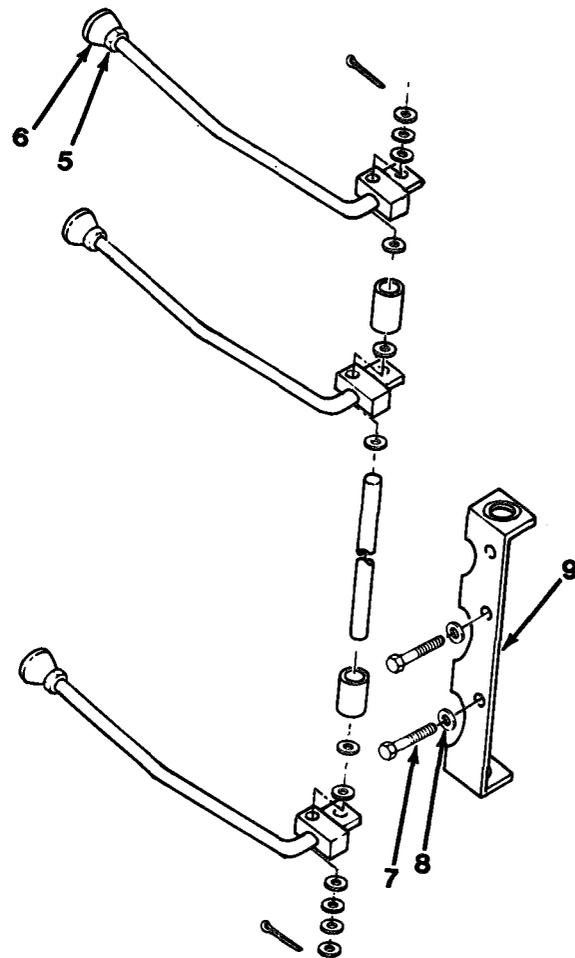


Figure 17-2

**BOOM HOIST, WINCH, OUTRIGGER
VALVE CONTROLS DISASSEMBLY**

1. Remove two cotter pins (10, Figure 17-3).

NOTE

Record number of washers removed to aid in assembly.

2. Carefully pull pin (11) out of bracket assembly (9). Washers (12), three handles (4) and two tubes (13) will slide off pin (11) when removed.
3. Remove two bushings (14) from bracket assembly (9).
4. Remove bushings (15) from handles (4).

**BOOM HOIST, WINCH, OUTRIGGER
VALVE CONTROLS CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**BOOM HOIST, WINCH, OUTRIGGER
VALVE CONTROLS ASSEMBLY**

1. Install bushings (15) in handles (4, Figure 17-3).
2. Install two bushings (14) in bracket assembly (9).
3. Install pin (11) by pushing through bushing (14) and bracket assembly (9). Install two washers (12) on pin (11).
4. Install handle (4) and washer (12).

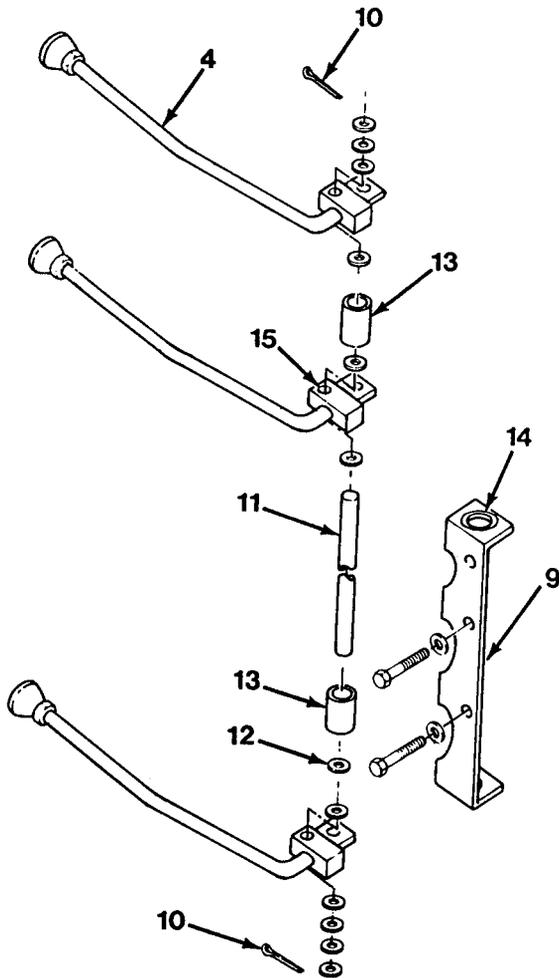


Figure 17-3

5. Continue pushing pin (11) and install tube (13), washer (12), handle (4), washer (12), tube (13), two washers (12) and handle (4).

NOTE

Add washers as required to minimize end play in handles without causing binding.

6. Secure pin (11) in place with two washers (12) and cotter pins (10).

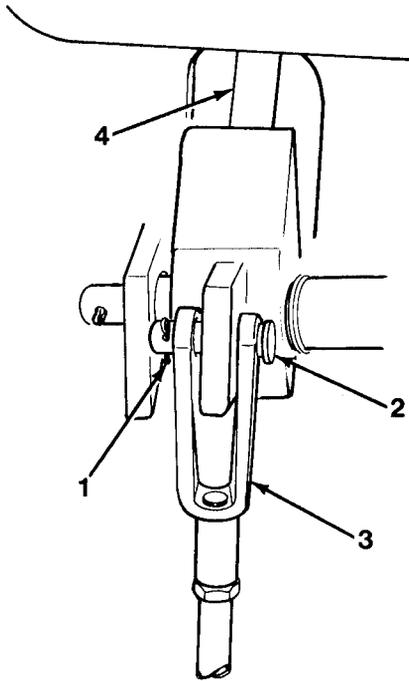


Figure 17-1

SWING/TELESCOPING VALVE CONTROLS

SWING/TELESCOPING VALVE CONTROLS REMOVAL

1. Remove lower dash panel (refer to page 13-114, step 2).
2. Remove two cotter pins (1) and pins (2) to disengage yokes (3) from handles (4, Figure 17-1).
3. Loosen two jam nuts (5) and remove knobs (6, Figure 17-2) and jam nuts (5).
4. Remove two capscrews (7), lockwashers (8) and bracket assembly (9).

SWING/TELESCOPING VALVE CONTROLS INSTALLATION

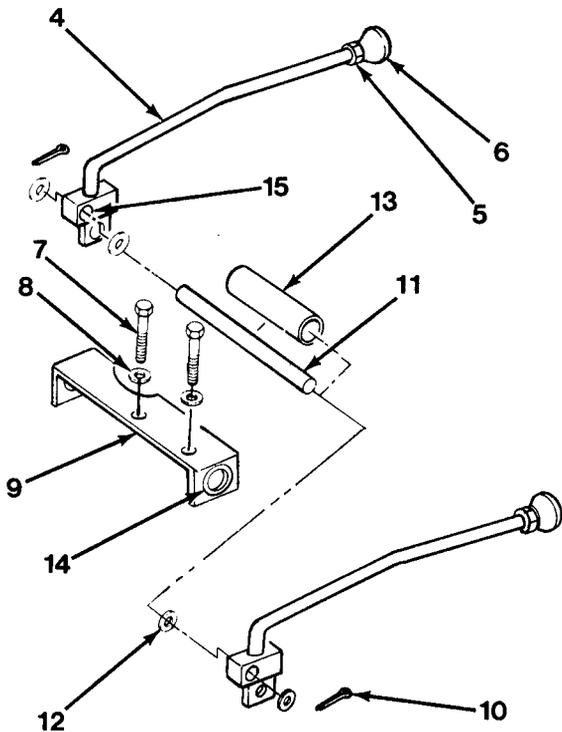


Figure 17-2

1. Position bracket assembly (9) under dash and install two lockwashers (8) and capscrews (7, Figure 17-2).
2. Install two jam nuts (5) and knobs (6) and lock in place with jam nuts (5).
3. Position yokes (3) on end of two handles (4, Figure 17-1).
4. Install pins (2) and cotter pins (1).
5. Install lower dash panel (refer to page 13-115, step 5).

**SWING/TELESCOPING VALVE
CONTROLS DISASSEMBLY**

1. Remove two cotter pins (10, Figure 17-2).

NOTE

Record number of washers removal to aid in assembly.

2. Carefully pull pin (11) out of bracket assembly (9). As pin (11) is removed, washers (12), two handles (4) and tube (13) will slide off pin (11).
3. Remove two bushings (14) from bracket assembly (9).
4. Remove bushings (15) from handles (4).

**SWING/TELESCOPING VALVE
CONTROLS CLEANING/INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**SWING/TELESCOPING VALVE
CONTROLS ASSEMBLY**

1. Install bushings (15) in handles (4, Figure 17-2).
2. Install two bushings (14) in bracket assembly (9).
3. While pushing pin (11) through bushing (14), install washer (12), handle (4), washer (12), tube (13), washer (12) handle, (4) and washer (12).

NOTE

Add washers as required to minimize end play in handles without causing binding.

4. Secure pin (11) in place with washers (12), as required, and two cotter pins (10).

TRANSMISSION SHIFT CONTROLS

**TRANSMISSION SHIFT CONTROLS
REMOVAL**

1. Remove right-hand dash panel (refer to page 17-64).

**TRANSMISSION SHIFT CONTROLS
INSTALLATION**

1. Install right-hand dash panel (refer to page 17-69).

**TRANSMISSION SHIFT CONTROLS DIS-
ASSEMBLY**

1. Remove four capscrews (1) and lockwashers (2, Figure 17-1).
2. Remove two capscrews (3) and lockwashers (4).
3. Remove two side housings (5) and extruded spacers (6) from control assembly.

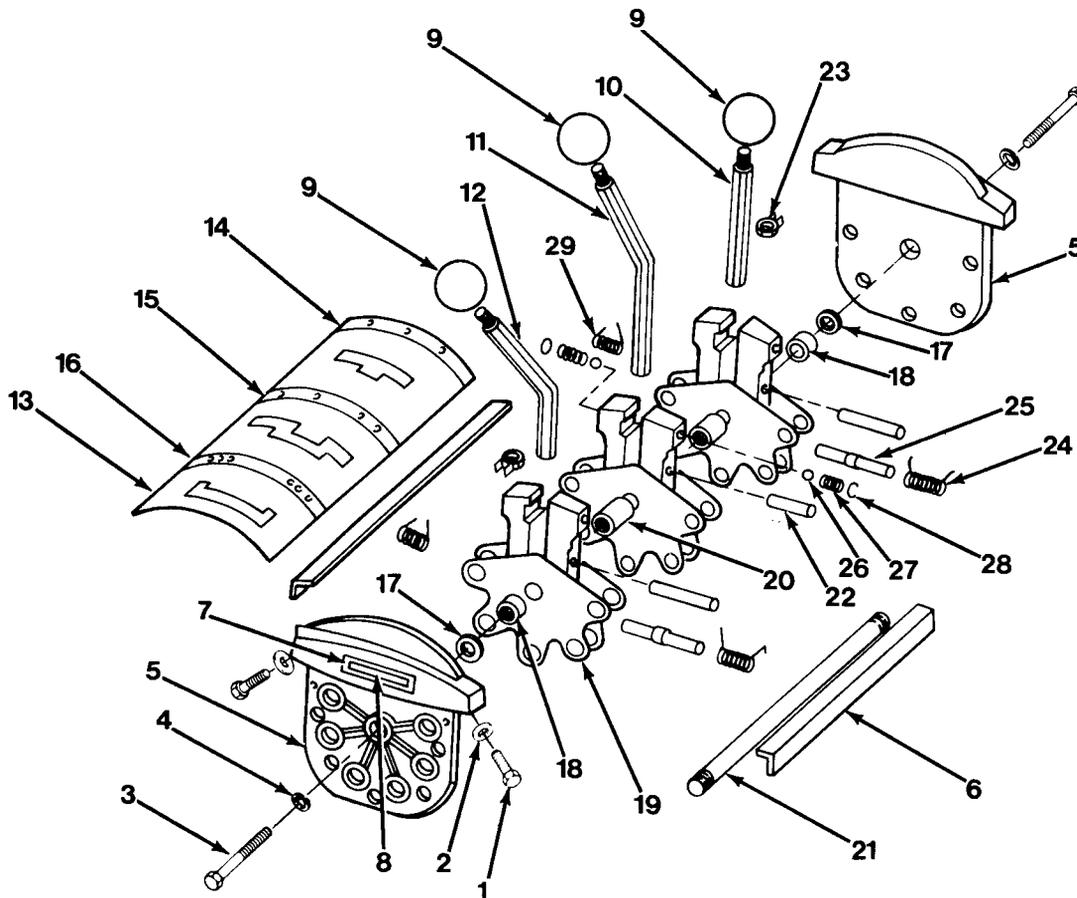


Figure 17-1

4. Remove two access caps (7) and decals (8).
5. Remove three ball knobs (9) from shift levers (10), (11) and (12).
6. Remove gate plate (13) from control assembly.
7. Remove position strips (14), (15) and (16).
8. Remove two retaining rings (17) and spacers (18).
9. Remove time actuator assemblies (19) and two spacers (20) from shaft (21).
10. Drive pin spring (22) from actuator assembly (19) and remove lever (10). Remove lever detent (23).
11. Repeat step 10 for remaining two actuator assemblies (19).
12. Straighten ends of torsion springs (24) and (29) extending through actuator assembly (19).
13. Remove torsion springs (24) and (29) and torsion spring shaft (25) from actuator assembly (19) and torsion springs (24) and (29) from torsion spring shaft (25).
14. Repeat steps 12 and 13 for remaining actuator assembly.
15. Remove balls (26), springs (27) and slugs (28) from center actuator assembly (19).

TRANSMISSION SHIFT CONTROLS CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

TRANSMISSION SHIFT CONTROLS AS- SEMBLY

1. Install lever detent (23) on lever (10, Figure 17-1).
2. Position lever in actuator assembly (19).
3. Install pin spring (22).
4. Repeat steps 1, 2 and 3 for remaining lever(s).
5. Install ball (26), spring (27) and slug (28).
6. Repeat step 5 for opposite side of center actuator assembly (19).
7. Install torsion springs (24) and (25) on torsion spring shaft (25). Insert spring ends through mounting holes on actuator assembly and bend over to secure.
8. Repeat step 7 for remaining actuator assembly (19).
9. Install shaft (21), two spacers (20) and three actuator assemblies (19).
10. Install two spacers (18) on each end of shaft (21) and secure each end of shaft (21) with retaining ring (17).
11. Install gate plate (16) on control assembly.
12. Install position strips (15), (14) and (13).

13. Install three ball knobs (9) on levers (12), (11) and (10).
14. Install two side housings (5) and extruded spacers (6).
15. Secure two side housings (5) with two cap-screws (3) and lockwashers (4).
16. Secure two extruded spacers (6) with four capscrews (1) and lockwashers (2).
17. Install two access caps (7) and decals (8).

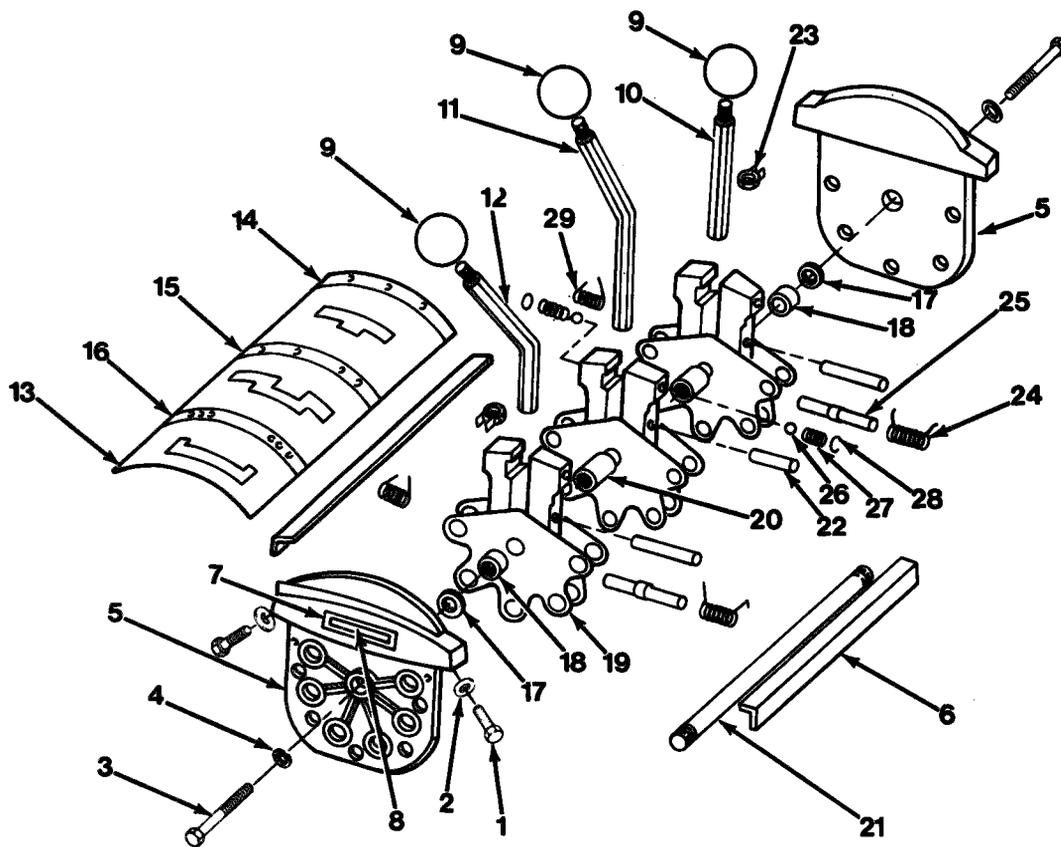


Figure 17-1

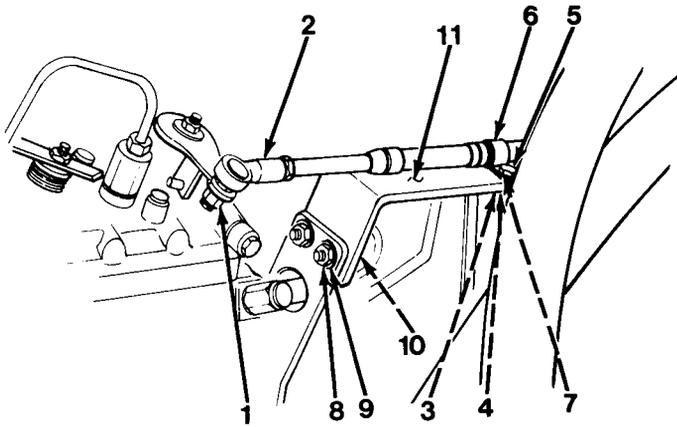


Figure 17-1

THROTTLE CONTROL

THROTTLE CONTROL REMOVAL

1. Slide open engine cover.
2. Remove nut (1) and disconnect throttle cable (2, Figure 17-1) from fuel injection pump. Install nut (1) on throttle cable (2) to prevent loss.
3. Remove two nuts (3), washers (4), capscrews (5), clamp (6) and shim (7).
4. Remove two nuts (8), lockwashers (9), capscrews (10) and bracket (11).
5. Cut and discard plastic ties (12, Figure 17-2).
6. Remove nut (13), washer (14), clamp (15) and detach throttle cable (2, Figure 17-3). Install clamp (15), washer (14) and nut (13) on frame to prevent loss.

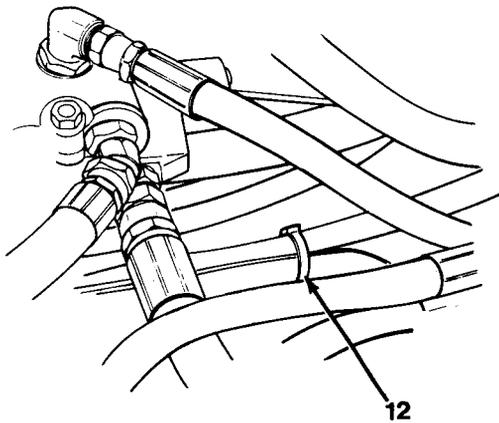


Figure 17-2

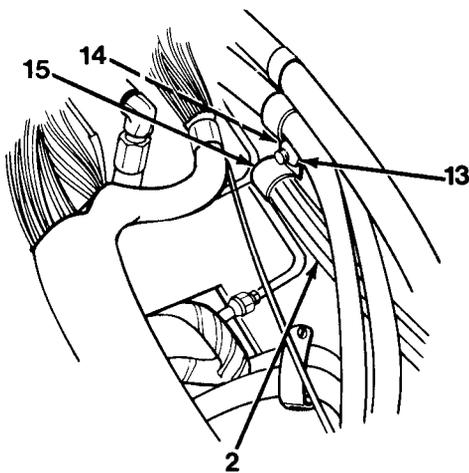


Figure 17-3

7. Remove two nuts (16), washers (17), lock-washers (18), washers (19) and cover (20, Figure 17-4).
8. Remove cotter pin (21) and pin (22) from end yoke (25) and bell crank (23, Figure 17-5).

NOTE

Do not remove end yoke from throttle cable unless necessary. If removal is necessary, mark distance from end of cable prior to removal.

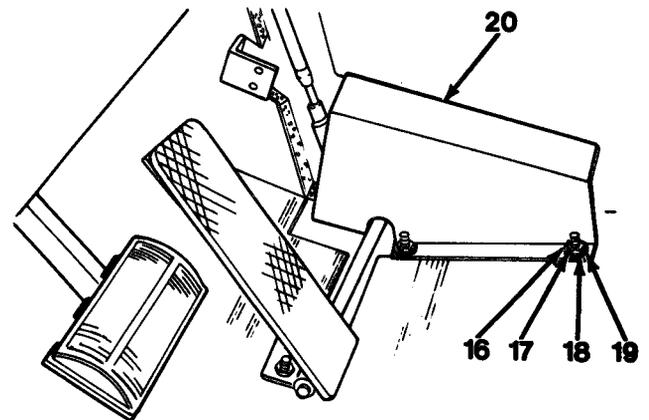


Figure 17-4

9. Loosen nut (24), if necessary, to remove end yoke (25).
10. Loosen nut (26) and disconnect throttle cable (2) from weldment and pull throttle cable (2) through opening in cab.
11. Remove spring (27).
12. Remove nut (28), washer (29) and hook (30).
13. Remove two nuts (31), washers (32) and capscrews (33).
14. Remove two nuts (34), washers (35), capscrews (36), bell crank (23) and pedal (37) as an assembly.
15. Remove bushing (38).
16. Remove two roll pins (39), pedal (37), bracket (40) and bushing (41) from bell crank (23).
17. Loosen nut (42) and remove capscrew (43) and nut (42, Figure 17-6), only if necessary.

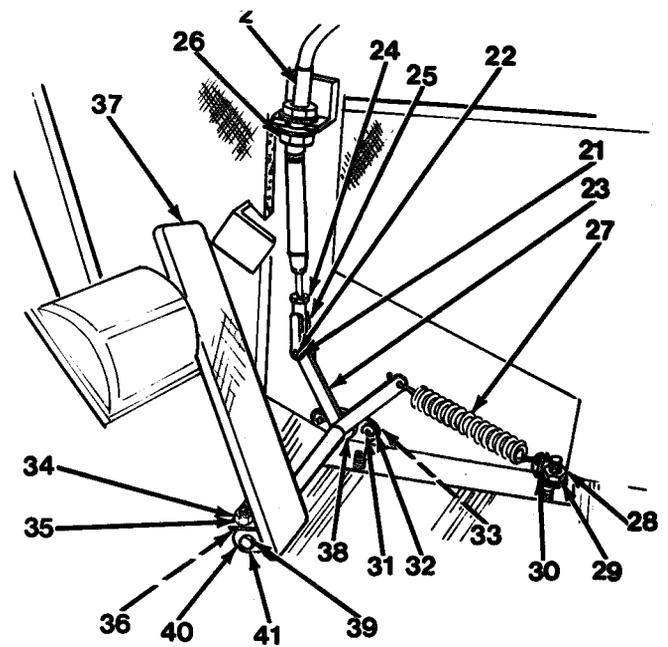


Figure 17-5

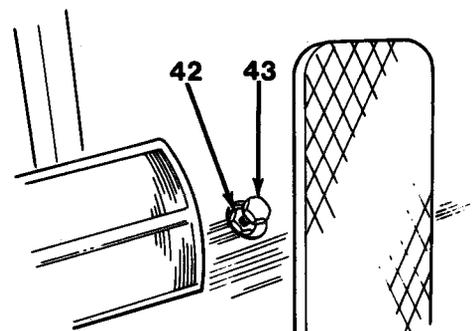


Figure 17-6

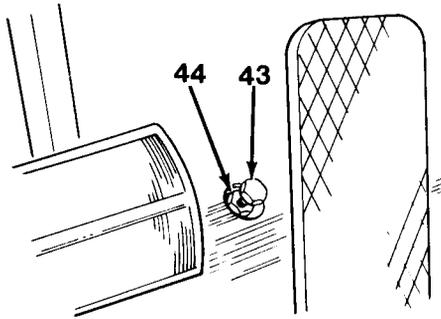


Figure 17-6

THROTTLE CONTROL CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

THROTTLE CONTROL INSTALLATION

1. Install nut (42) and cap screw (43) and tighten nut (42, Figure 17-6) to secure, if removed.

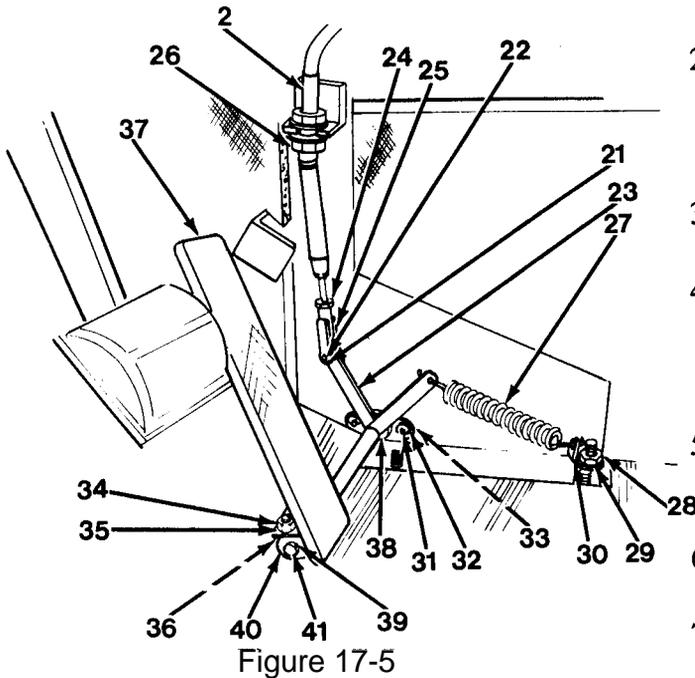


Figure 17-5

2. Install pedal (37), bushing (41), bracket (40) and two roll pins (39) on bell crank (23, Figure 17-5).
3. Install bushing (38).
4. Install bell crank (23) and pedal (37) as an assembly and secure with two cap screws (36), washers (35) and nuts (34).

5. Install two cap screws (33), washers (32) and nuts (31).

6. Install hook (30), washer (29) and nut (28).

7. Install spring (27).

8. Install throttle cable (2) and push through opening in cab. Position throttle cable (2) in weldment and tighten nut (26) to secure.

9. Install end yoke (25), if removed, and secure with nut (24). Install to distance as marked.

10. Install pin (22) and cotter pin (21) to attach end yoke (25) and bell crank (23).

11. Install cover (20), two washers (19), lock-washers (18), washers (17) and nuts (16, Figure 17-4).

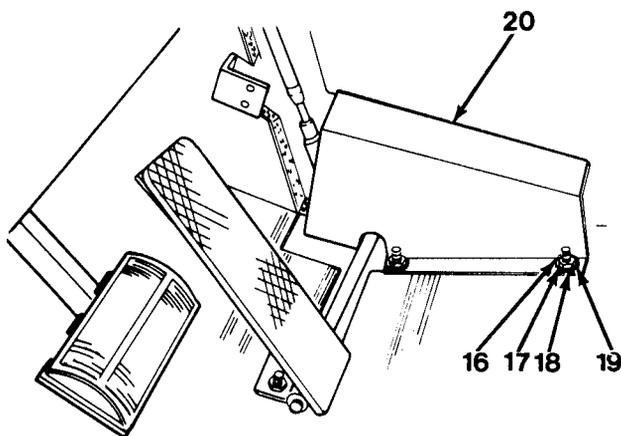


Figure 17-4

12. Remove nut (13), washer (14) and clamp (15) from frame and position throttle cable (2, Figure 17-3). Install clamp (15), washer (14) and nut (13).
13. Install new plastic ties (12, Figure 17-2).
14. Install bracket (11), two capscrews (10), lockwashers (9) and nuts (8, Figure 17-1).
15. Install shim (7), clamp (6), two capscrews (5), washers (4) and nuts (3) to secure throttle cable (2) to bracket (1).
16. Remove nut (1) from throttle cable (2) and connect throttle cable (2) to fuel injection pump. Install nut (1).
17. Check throttle cable adjustment (refer to page 17-14).
18. Wide engine cover closed.

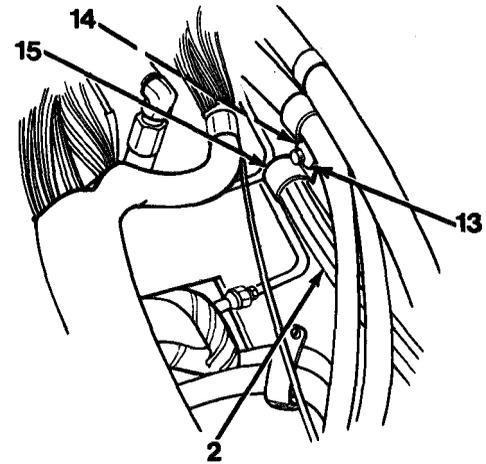


Figure 17-3

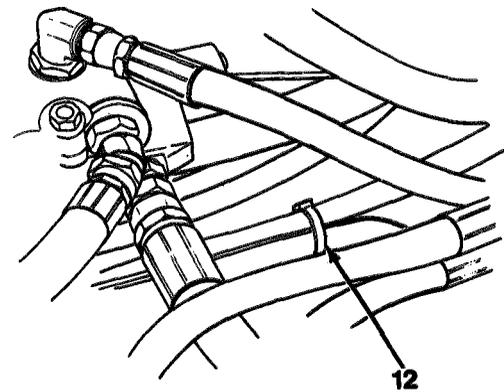


Figure 17-2

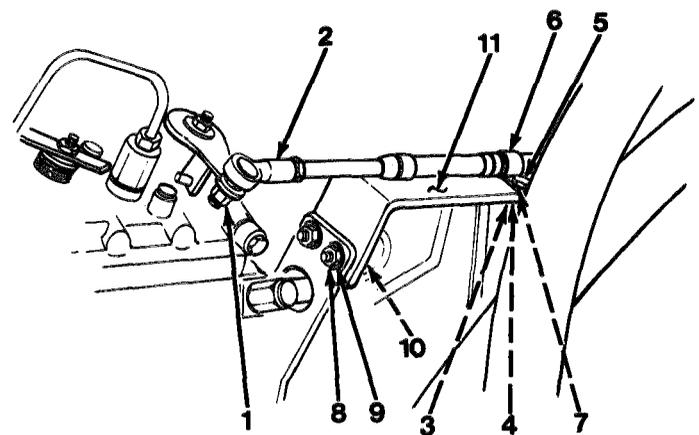


Figure 17-1

THROTTLE CONTROL ADJUSTMENT

NOTE

Throttle control adjustment will require two people to make the adjustment.

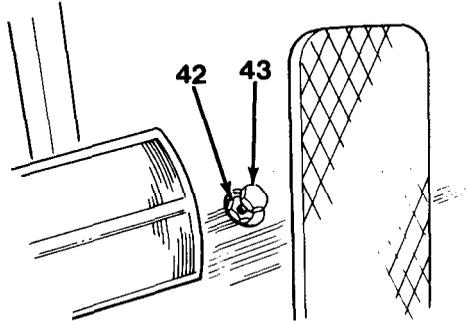


Figure 17-6

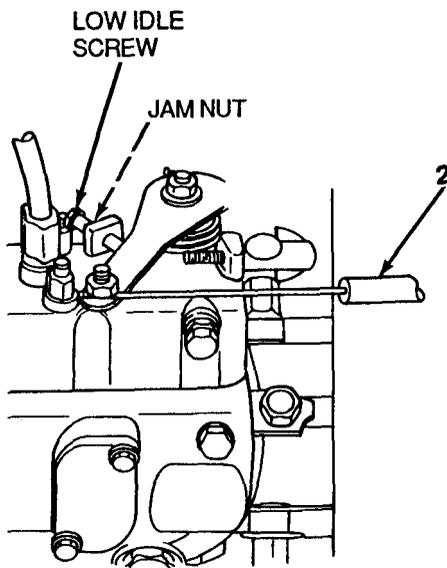


Figure 17-7

1. Release jam nut (42) on pedal stop capscrew (43, Figure 17-6) and screw all the way in.
2. Adjust cable (2, Figure 17-7) and linkage so that engine injection pump lever has full stop to stop travel. If full travel is not obtained, jam nuts on pedal end of cable conduit on cable end fittings must be adjusted to increase travel.
3. Check cable (2) to insure that threads on cable ends are not entering wiper seals on ends of cable conduit. If one does, ball joint and yoke on cable ends must be readjusted to move threads on cable core further away from that wiper seal.
4. Adjust pedal stop capscrew (43) on floor of cab by loosening the nut (42, Figure 17-6) and screwing capscrew (43) in or out.
5. Pedal should rest against stop capscrew (43) just as arm on fuel injection pump touches high idle stop.
6. Hold capscrew (43) in position and tighten jam nut (42).
7. Check cable (2, Figure 17-7) for free travel.
8. If adjustment of low idle is required, loosen jam nut and turn capscrew to obtain required rpm. Tighten jam nut.

HEATER

HEATER REMOVAL

 **WARNING**

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.

 **WARNING**

Hot coolant and alkali contained in cooling system can burn severely. Even with cooling system drained, residual coolant remains in system lines and fittings. Wear protective goggles, face shield and clothing when handling cooling system components. If coolant contacts eyes, skin or clothing, flush with large amounts of cold water and seek medical attention, if required. Failure to follow these procedures could cause SERIOUS INJURY.

NOTE

Use suitable container to catch draining coolant.

2. Drain coolant from radiator to a level below heater (refer to page 3-56).

HEATER REMOVAL

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

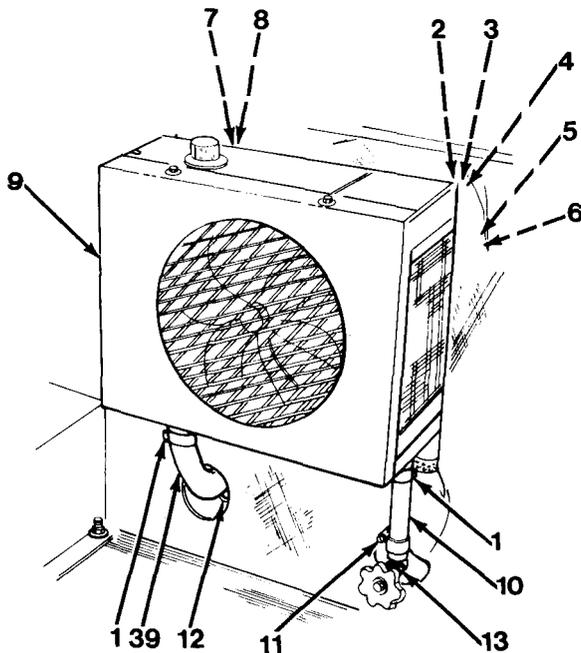


Figure 17-1

3. Loosen two clamps (1) and disconnect hoses (10) and (39) from heater assembly (9, Figure 17-1).

4. Remove two clamps (1).

NOTE

- Remove all plastic ties from heater hoses to aid in removal.
- Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

5. Remove nut (2), lockwasher (3) and wire assembly (4).

6. Disconnect wire assembly (5) from wire assembly (6).

7. Remove three nuts (7) and lockwashers (8).

8. Remove heater assembly (9) from vehicle.

9. Loosen clamp (11) and remove hose (10).

10. Remove clamp (11).

11. Remove grommet (12).

12. Remove valve (13).

13. From outside rear of cab, loosen clamp (15) and disconnect hose (43) from 90-degree elbow (14, Figure 17-2).
14. Remove 90-degree elbow (14).
15. Remove clamp (15) from hose (43).
16. From outside rear of cab, remove nut (16), washer (17), clamp (18) and washer (19, Figure 17-3).
17. From under right frame, remove two bolts (20), washers (21), clamps (22) and (23), bars (24) and four clamps (25, Figure 17-4).

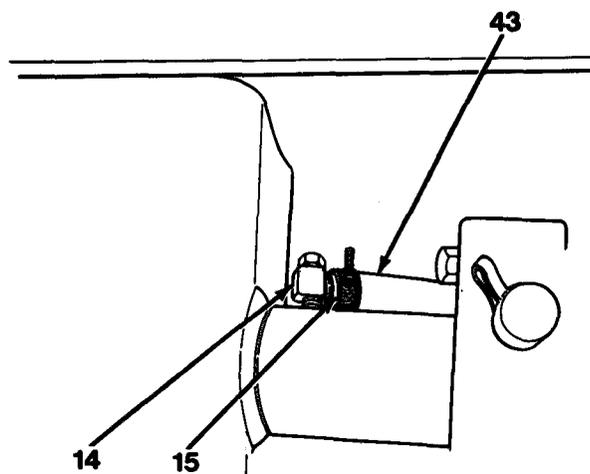


Figure 17-2

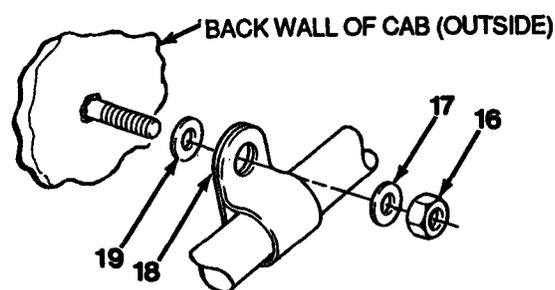


Figure 17-3

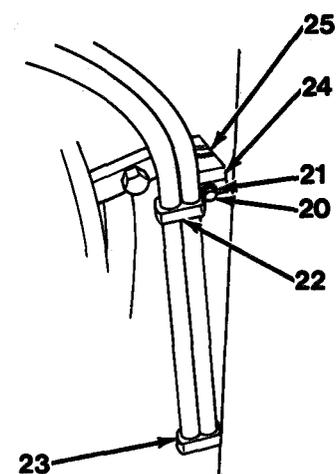


Figure 17-4

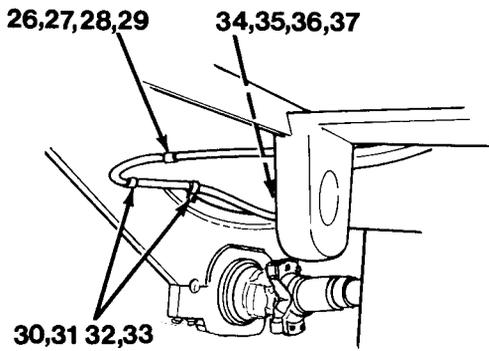


Figure 17-5

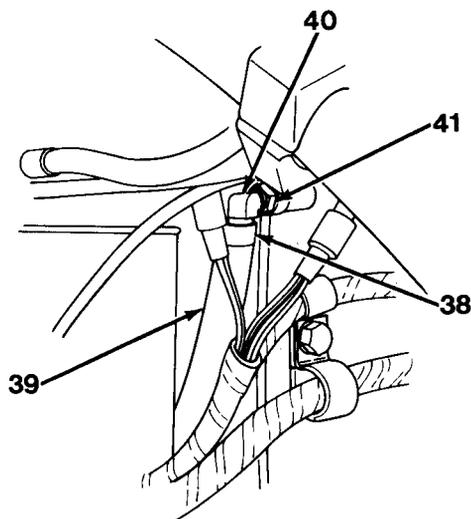


Figure 17-6

HEATER REMOVAL

18. Remove nut (26), washer (27), clamp (28) and washer (29, Figure 17-5).
19. From rear axle and right frame, remove nut (30), washer (31), two clamps (32) and washer (33).
20. From rear axle and left frame, remove three nuts (34), washers (35), clamps (36) and washers (37).
21. Loosen clamp (38) and disconnect hose (39, Figure 17-6).
22. Remove clamp (38) and hose (39).
23. Remove 90-degree elbow (40) and bushing (41).
24. Loosen clamp (42) and disconnect hose (43, Figure 17-7).
25. Remove clamp (42) and hose (43).
26. Remove 90-degree elbow (44) and bushing (45).

HEATER CLEANING/INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

HEATER INSTALLATION

1. Install bushing (45) and 90-degree elbow (44, Figure 17-7).
2. Install hose (43) and clamp (42).
3. Install bushing (41) and 90-degree elbow (40, Figure 17-6).
4. Install hose (39) and clamp (38).

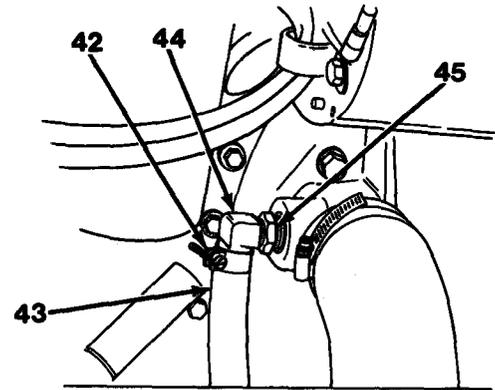


Figure 17-7

NOTE

Position heater hoses on rear axle, right frame, left frame, and to cab to aid in installing clamps.

5. Install three washers (37), clamps (36), washers (35) and nuts (34, Figure 17-5) on rear axle and left frame.
6. Install washer (33), two clamps (32), washer (31) and nut (30) on rear axle and right frame.
7. Install washer (29), clamp (28), washer (27) and nut (26).

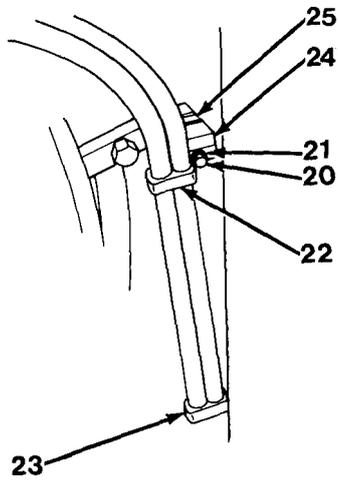


Figure 17-4

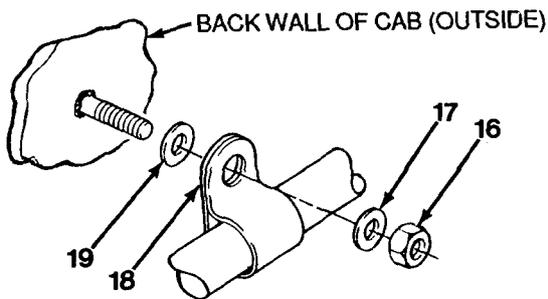


Figure 17-3

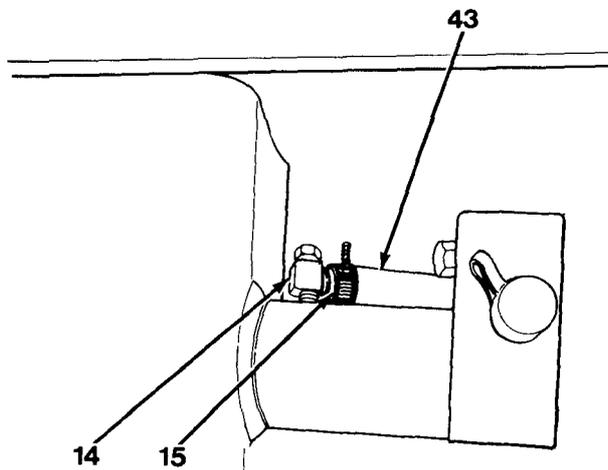


Figure 17-2

HEATER INSTALLATION

8. Install four clamps (25), two clamps(24), clamps (23) and (22), washers (21) and bolts (20, Figure 17-4) under right frame.
9. Install washer (19), clamp (18), washer (17) and nut (16, Figure 17-3) on outside rear of cab.
10. Install clamp (15) on hose (43, Figure 17-2).
11. Install 90-degree elbow (14).
12. Secure hose (43) to 90-degree elbow (14) with clamp (15).

13. Install valve (13, Figure 17-1).
14. Install grommet (12).
15. Install clamp (11) on hose (10).
16. Secure hose (10) to valve (13) with clamp (11).
17. Install heater assembly (9), three lockwashers (8) and nuts (7).
18. Connect wire assembly (6) to wire assembly (5).
19. Install wire assembly (4), lockwasher (3) and nut (2).
20. Install two clamps (1), one on hose (39) and one on hose (10).
21. Connect hoses (39) and (10) to heater assembly (9) and secure with clamps (1).
22. Install plastic ties where necessary to keep hoses from sagging.
23. Fill radiator to proper coolant level (refer to Koehring Commercial Operation Instructions manual).

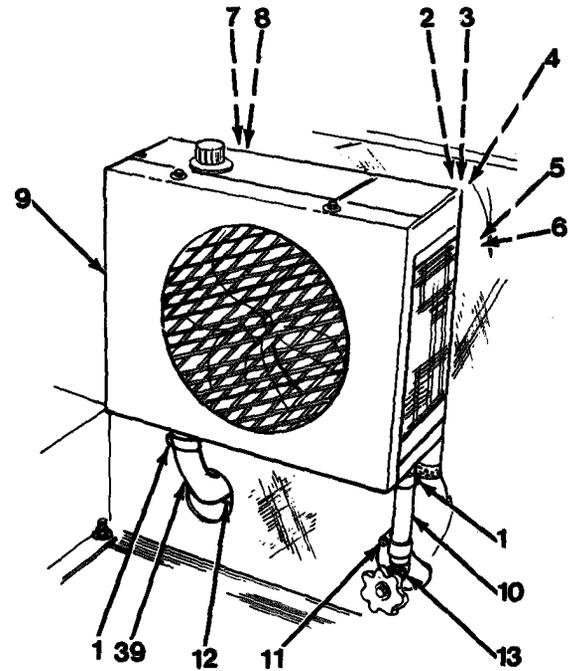


Figure 17-1

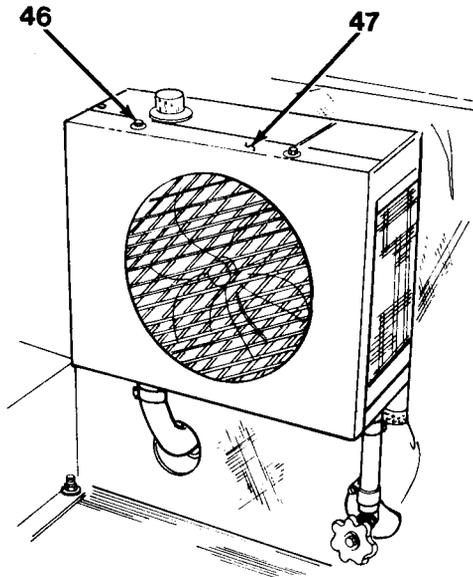


Figure 17-8

HEATER DISASSEMBLY

1. Remove four screws (46) and cover assembly (47, Figure 17-8).
2. Remove two heater cores (48), clamps (49), pads (50) and hose (51, Figure 17-9) as an assembly.
3. Remove two pads (50), clamps (49) and hose (51) from two heater cores (48).
4. Loosen setscrew (52) and remove fan (53).
5. Disconnect wire assembly (54).
6. Remove two screws (55, Figure 17-10).
7. Remove motor (56) and motor support (57) as an assembly.
8. Remove two nuts (58) and motor (56) from motor support (57).
9. Pull knob off of switch assembly (59) and remove nut. Remove switch assembly (59) from casing assembly (60).

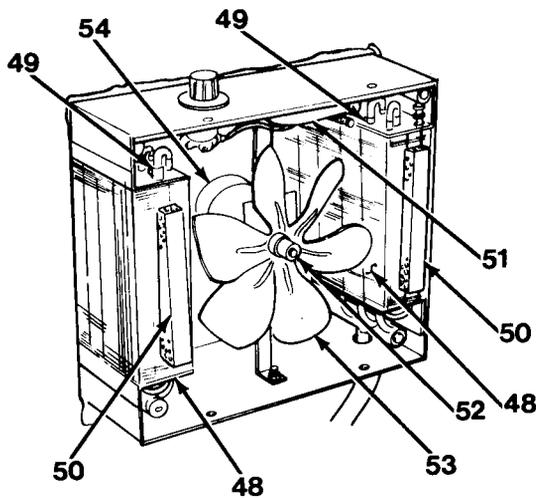


Figure 17-9

HEATER ASSEMBLY

1. Install switch assembly (59) in casing assembly (60, Figure 17-10) and secure with nut. Install nut on switch assembly (59).
2. Install motor (56) and two nuts (58) on motor support (57).
3. Install motor (56) and motor support (57) as an assembly.
4. Install two screws (55).
5. Connect wire assembly (54, Figure 17-9).
6. Install fan (53) and align setscrew (52) with flat side of motor (56) shaft. Tighten set-screw (52).
7. Install hose (51) and two clamps (49) to two heater cores (48).
8. Install two pads (50).
9. Install two heater cores (48), pads (50), clamps (49) and hose (51) as an assembly.
10. Install cover assembly (47) and four screws (46, Figure 17-8).

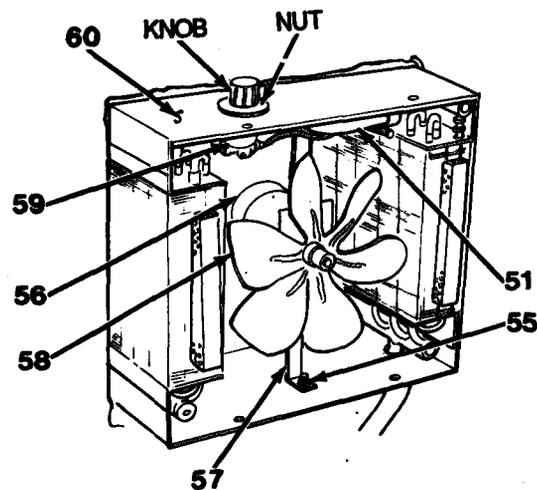


Figure 17-10

DEFROSTER FAN

DEFROSTER FAN REMOVAL

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

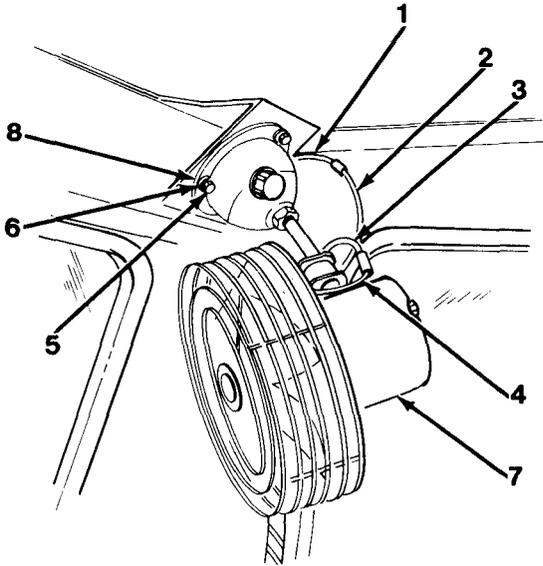


Figure 17-1

1. Disconnect battery negative ground cable.
2. Disconnect wire assembly (1) from wire assembly (2, Figure 17-1).
3. Disconnect wire assembly (3) from wire assembly (4).
4. Remove three bolts (5) and lockwashers (6).
5. Remove defroster fan assembly (7) and three washers (8).

**DEFROSTER FAN CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

DEFROSTER FAN INSTALLATION

1. Install three washers (8), defroster fan assembly (7), three lockwashers (6) and bolts (5, Figure 17-1).
2. Connect wire assembly (4) to wire assembly (3).
3. Connect wire assembly (2) to wire assembly (1).
4. Connect battery negative ground cable.

WINDSHIELD WIPER

WINDSHIELD WIPER REMOVAL

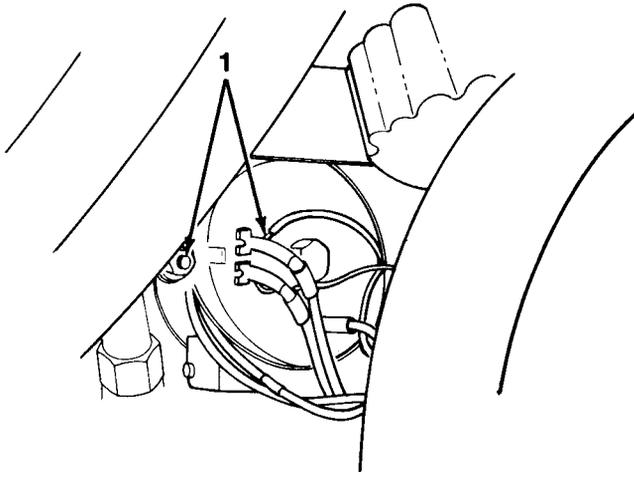


Figure 17-1

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

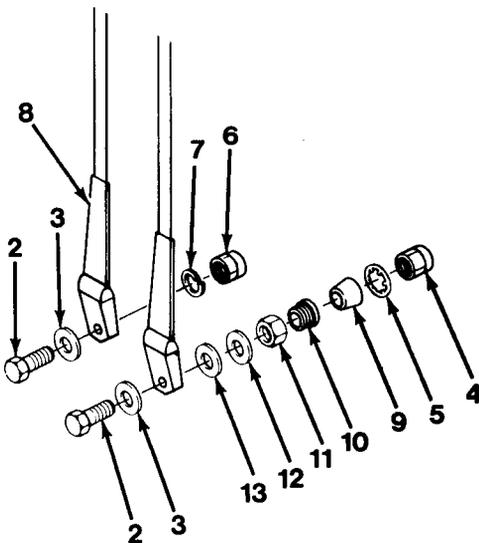


Figure 17-2

2. Disconnect electrical wires (1, Figure 17-1).
3. Remove two capscrews (2) and lockwashers (3, Figure 17-2).
4. Remove cap nut (4) and internal tooth star washer (5).
5. Remove cap nut (6) and washer (7).
6. Remove wiper arm (8), cone (9) and rubber boot (10).
7. Remove nut (11) and washers (12) and (13).
8. Remove nut (14) connecting linkage to wiper motor (16, Figure 17-3).

9. Using an offset screwdriver, remove three screws with external tooth washers (15) and wiper motor (16).
10. Remove two screws with external tooth washers (17), wiper linkage (18), motor bracket (19), external bracket (20) and gasket (21). Discard gasket (21).

WINDSHIELD WIPER CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

WINDSHIELD WIPER INSTALLATION

1. Install wiper linkage (18) in motor bracket (19) and secure with two screws with external tooth washers (17, Figure 17-3).
2. Install new gasket (21), external bracket (20, Figure 17-3), two capscrews (2) and lock-washers (3, Figure 17-2).
3. Install washers (13) and (12) and nut (11).
4. Install nut (14) connecting linkage to wiper motor (16, Figure 17-3)
5. Install three screws with external tooth washers (15).
6. Install rubber boot (10), cone (9), wiper arm (8), internal tooth star washer (5), cap nut (6), washer (7) and cap nut (4, Figure 17-2).
7. Connect electrical wires (1, Figure 17-1).
8. Connect battery negative ground cable.

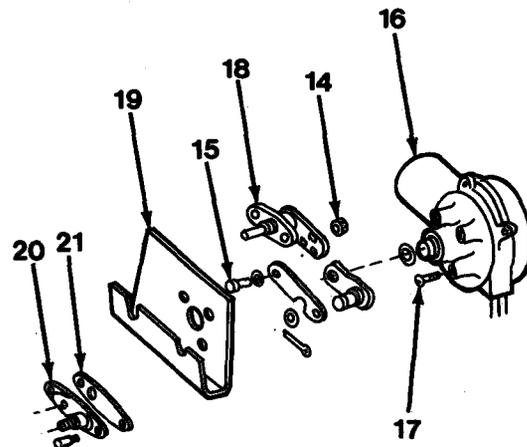


Figure 17-3

BRAKE PEDAL AND LINKAGE

BRAKE PEDAL AND LINKAGE REMOVAL

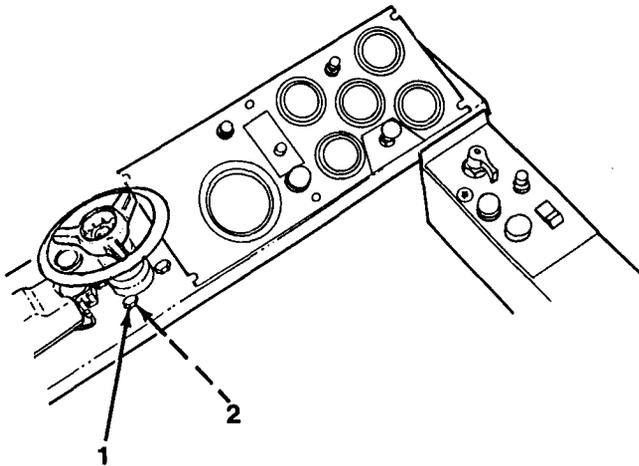


Figure 17-1

1. Remove lower dash panel (refer to page 13-114, step 2).
2. Remove four capscrews (1) and lockwashers (2, Figure 17-1) and lower steering assembly down so that steering wheel rests on instrument panel,
3. Remove cotter pin (3) and pin (4, Figure 17-2).
4. Remove self-locking nut (5), machinery bushing (6), phenolic washer (7) and shoulder bolt (8).
5. Remove pedal (9), bushing (10) and rubber pedal (11) as an assembly.
6. Remove bushing (10) only if inspection indicates.
7. Remove rubber pedal (11).
8. Remove four capscrews (12) and lockwashers (13) from booster valve.
9. Remove bracket (14), capscrew (15), nut (16), bumper (17) and machine screw (18) as an assembly.
10. Remove machine screw (18), bumper (17), nut (16) and capscrew (15) from bracket (14).
11. Remove four nuts (19), lockwashers (20), capscrews (21) and bracket (22).

**BRAKE PEDAL AND LINKAGE
CLEANING/INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

**BRAKE PEDAL AND LINKAGE
INSTALLATION**

1. Install bracket (22), four capscrews (21), lockwashers (20) and nuts (19, Figure 17-2).
2. Install capscrew (15) and nut (16) to bracket (14).
3. Install bumper (17) and machine screw (18) to capscrew (15).
4. Position bracket (14) on bracket (22).
5. Install four lockwashers (13) and capscrews (12) through bracket (22) into booster valve.
6. Heat rubber pedal (11) in hot water and install on pedal (9).
7. Install bushing (10), if removed.
8. Position pedal (9) against bracket (22).

NOTE

Coat bearing area of shoulder bolt with molybdenum disulfide MIL-M-7866.

9. Install shoulder bolt (8), phenolic washer (7), machinery bushing (6), apply Loctite 271 to nut (5) and install.
10. Position booster valve clevis to pedal (9).
11. Install pin (4) and cotter pin (3).

12. Install four lockwashers (2) and capscrews (1, Figure 17-1) in steering assembly.
13. Install lower dash panel (refer to page 13-117, Step 6).

**BRAKE PEDAL AND LINKAGE
ADJUSTMENT**

1. Adjust rod length to obtain 1.62 in. (41.1 mm) of master cylinder push rod travel when pedal is fully depressed.
2. Adjust stop bumper to allow 0.50 in. (12.7 mm) of free play at pedal.

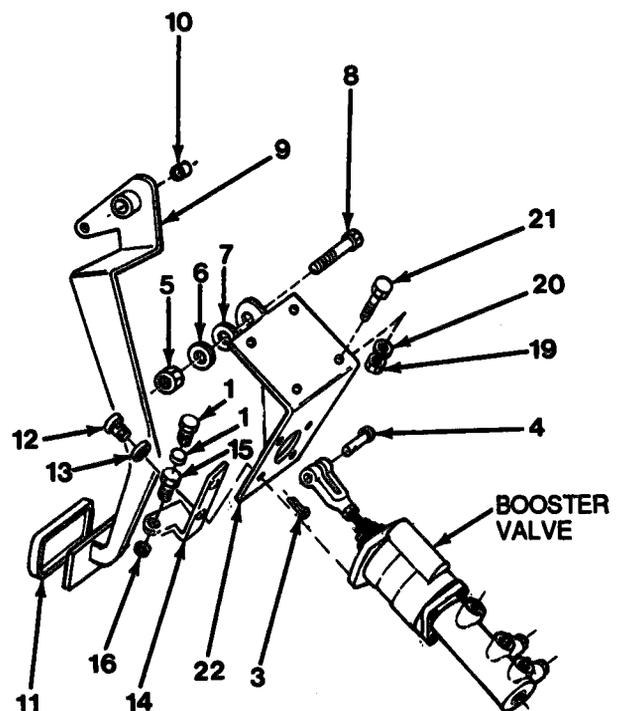


Figure 17-2

BRAKE BOOSTER VALVE

BRAKE BOOSTER VALVE REMOVAL

! WARNING

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause **SERIOUS INJURY**.

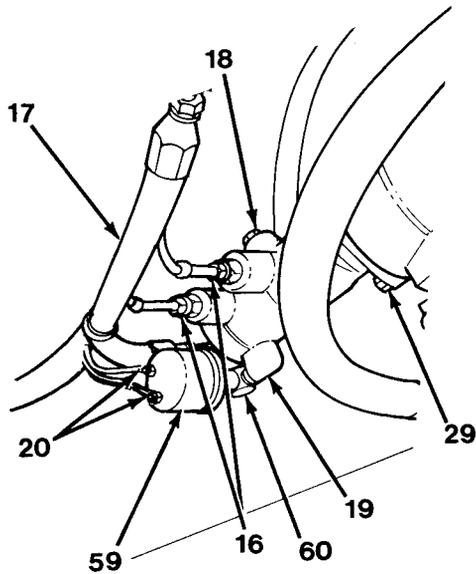


Figure 17-1

1. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
2. Remove lower dash panel (refer to page 13-116, step 1).
3. Position oil drain pan under master cylinder and brake booster valve (29, Figure 17-1).
4. Remove relief valve (refer to page 13-86).

NOTE

Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

4. Disconnect two brake lines (16) and hoses (17) and (18) from brake master cylinder (19). Drain fluid from system into container and discard.

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

5. Disconnect battery negative ground cable.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

6. Disconnect two stop light wires (20) from brake light switch (59) on master cylinder (19).
7. Remove brake light switch (59) and elbow (60) from master cylinder (19).
8. Remove four capscrews (21) and lockwashers (22, Figure 17-2) and lower steering assembly down so that steering wheel rests on instrument panel.
9. Remove and discard cotter pin (23, Figure 17-3).
10. Remove pin (24) from yoke (25) connecting brake bolter valve (29) to brake pedal (26).

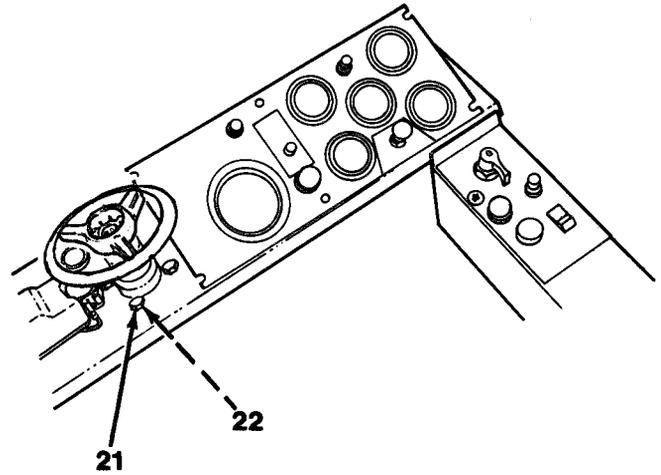


Figure 17-2

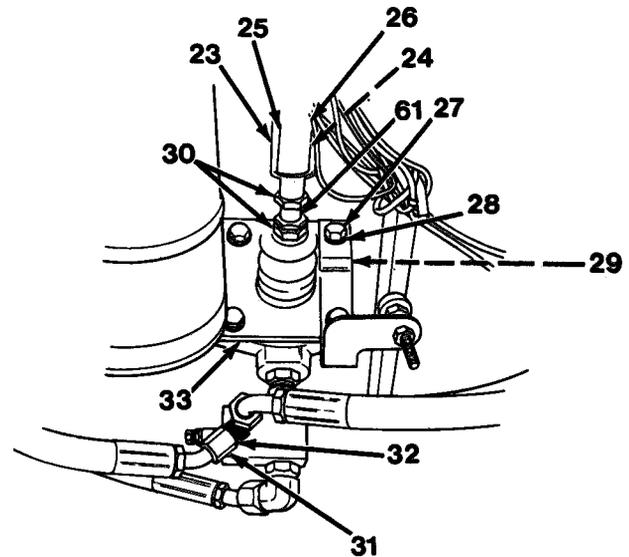


Figure 17-3

BRAKE BOOSTER VALVE REMOVAL

NOTE

Brake pedal stop bracket will be removed along with brake booster mounting brackets.

11. Remove four capscrews (27) and washers (28) holding brake booster valve (29) and pedal stop bracket to mounting bracket (33), Figure 17-3).

12. Lower and remove brake booster valve (29) from under dash.

NOTE

Before removing yoke, measure and retain distance between locking nuts to aid in assembly.

13. Remove yoke (25) and push rod (61) by loosening jam nuts (30) and unscrewing from brake booster valve (29), if required.

14. Remove two elbows (31) and O-rings (32) from master cylinder (19).

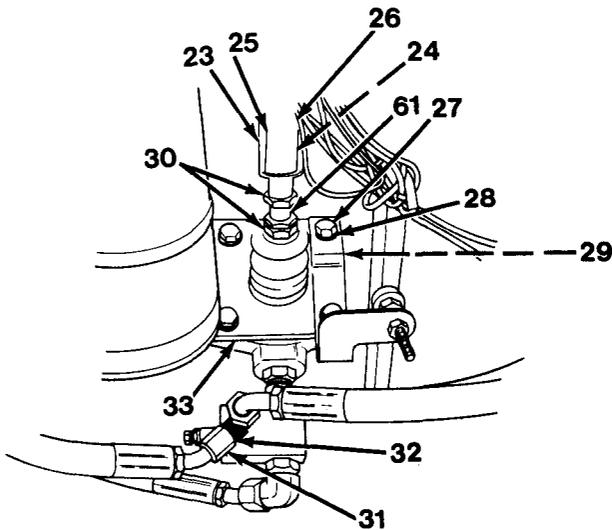


Figure 17-3

BRAKE BOOSTER VALVE INSTALLATION

NOTE

If yoke was disassembled, use measurement taken in disassembly to assemble yoke to rod.

1. Install yoke (25), push rod (61) and jam nuts (30, Figure 17-3).
2. Install O-ring (32) and two elbows (31) to master cylinder (19).

3. Position brake booster valve (29), master cylinder (19) and brake pedal stop bracket under dash on mounting bracket (33).
4. Install four washers (28) and capscrews (27).
5. Attach yoke (25) to brake pedal (26) using pin (24).
6. Install new cotter pin (23) in pin (24).
7. Install four lockwashers (22) and capscrews (21, Figure 17-2) in steering wheel pump.
8. Connect hoses (18) and (17) and two brake lines (16) to master cylinder (19).
9. Install elbow (60) and brake light switch (59) to master cylinder (19, Figure 17-1).
10. Install two brake light wires (20) to brake light switch on master cylinder (19).
11. Install relief valve (refer to page 13-87).
12. Connect battery negative ground cable.
13. Fill and bleed brake system (refer to page 13-103).
14. Road test brake system and check for leaks.

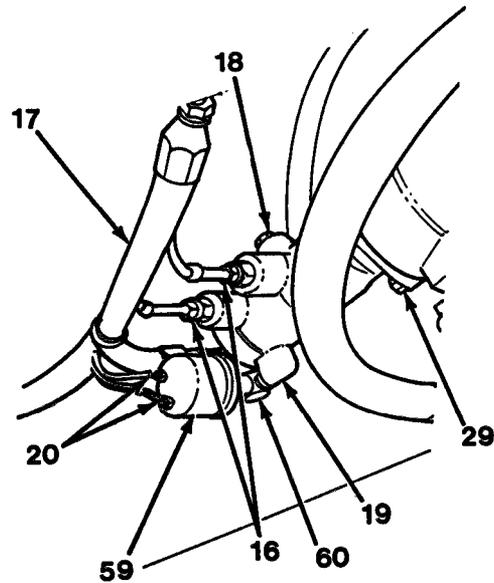


Figure 17-1

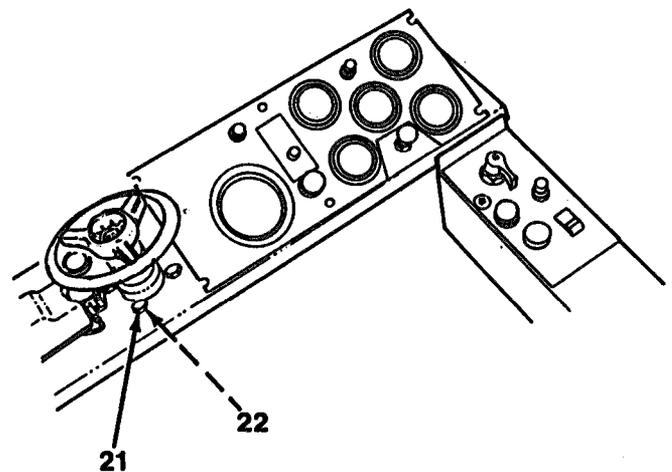


Figure 17-2

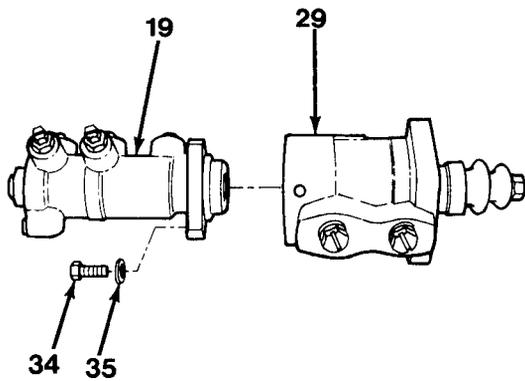


Figure 17-4

BRAKE BOOSTER VALVE DISASSEMBLY

1. Matchmark across ends of brake booster valve (29) and master cylinder (19, Figure 17-4) where they attach.
2. Remove three cap screws (34) and washers (35) from master cylinder (19). Separate booster valve (29) and master cylinder (19).

NOTE

Drain fluid from booster assembly before disassembling.

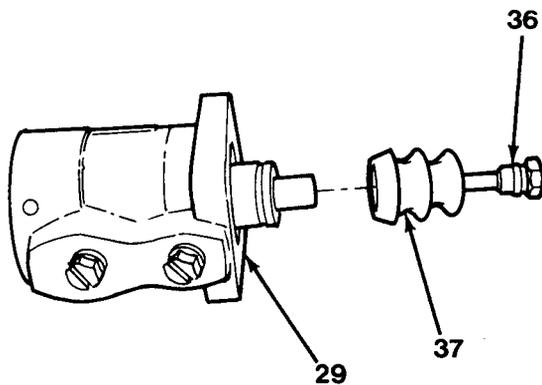


Figure 17-5

3. Remove push rod (36) and boot (37, Figure 17-5). Discard boot (37).
4. Loosen end plug (41) with spanner wrench and remove piston assembly (45) from brake booster valve (29, Figure 17-6) housing.
5. Remove spring (39) and retainer (40) from internal assembly.
6. Remove end plug (41) from piston assembly (45).

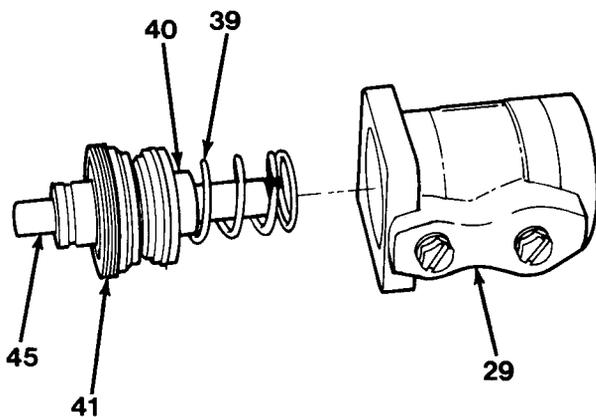


Figure 17-6

7. Remove O-ring (42) from end plug (41, Figure 17-7).
8. Remove cup (43) and back-up ring (44) from bore of end plug (41).

CAUTION

Care should be taken when removing piston ring. Failure to follow this procedure could cause damage to equipment.

NOTE

Record position of piston from piston assembly to aid in assembly.

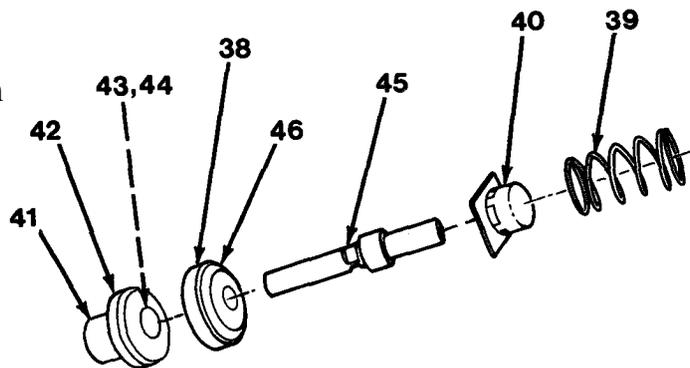


Figure 17-7

9. Remove piston assembly (45) from piston assembly (38) and remove piston ring (46) from piston (38).
10. Remove retainer ring (47) from piston assembly (45). Retainer ring (47) is under tension of spring (51, Figure 17-8).

CAUTION

Caution should be taken so as not to scratch bore of piston when removing cup and back-up ring. Failure to follow this procedure could cause damage to equipment.

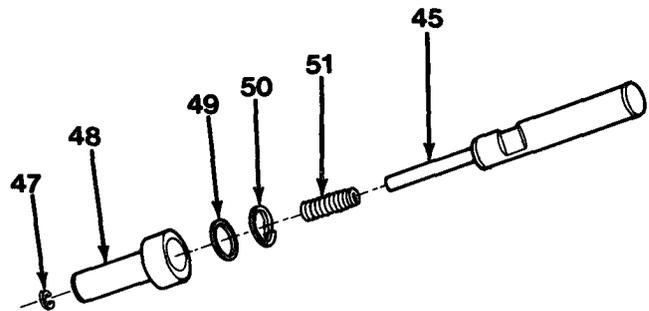


Figure 17-8

11. Remove piston (48) from piston (45).
12. Remove cup (49) and back-up ring (50) from bore of piston (48).
13. Remove spring (51) from piston (45).

BRAKE BOOSTER VALVE DISASSEMBLY

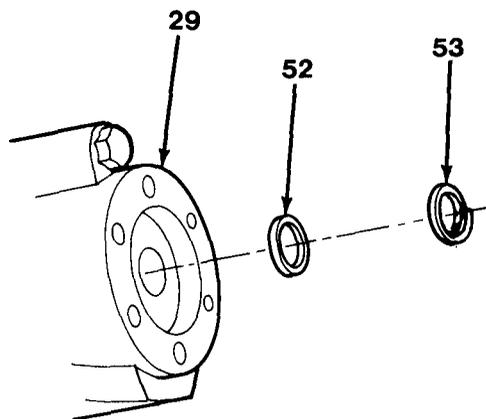


Figure 17-9

Care should be taken so as not to scratch housing bore when removing cup and back-up ring. Failure to follow this procedure could cause damage to equipment.

14. Remove cup (52) and back-up ring (53) from brake booster valve (29, Figure 17-9) housing.

15. Remove plug (54) and O-ring (55) from plug (54, Figure 17-10).

NOTE

Record number of shims when removed.

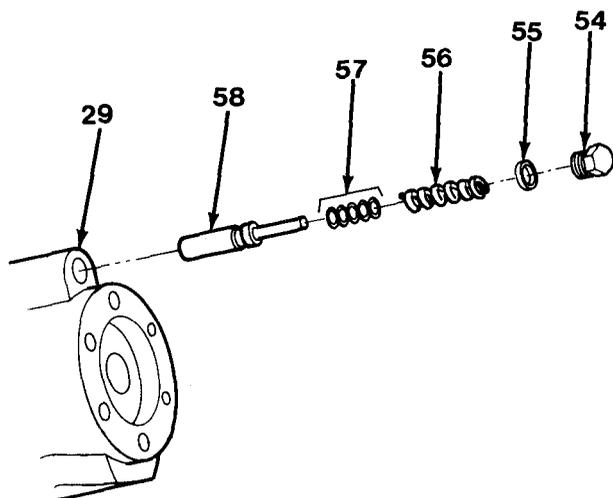


Figure 17-10

16. Remove spring (56), shims (57) and piston (58) from brake booster valve (29) housing.

**BRAKE BOOSTER VALVE CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

BRAKE BOOSTER VALVE ASSEMBLY**CAUTION**

Use only clean hydraulic oil to lubricates. Failure to follow this procedure could cause damage to equipment.

1. Lubricate all parts with hydraulic oil before assembling.
2. Install piston (58), shims (57) as recorded, and spring (56) in brake booster (29, Figure 17-10) housing. Piston (58) must be free to move in housing (29).
3. Install O-ring (55) and plug (54).

CAUTION

Two lips of U-cup must point toward inside of brake booster. Use care to avoid nicking or scratching seal lips.

4. Install cup (52) and back-up ring (53) in brake booster (29, Figure 17-9) housing.

BRAKE BOOSTER VALVE ASSEMBLY

5. Install spring (51) on piston (45, Figure 17-8).

CAUTION

Two lips of U-cup must be away from piston. Use care to avoid nicking or scratching seal lips.

6. Install back-up ring (50) and cup (49) in piston (48). Do not mar piston bore.
7. Install piston (48) over spring (51) and piston (45).
8. Install retaining ring (47) on piston (45).

CAUTION

Do not allow the piston seal to “twist” in the seal groove. The piston seal can be made pliable to aid in installation by soaking in approximately 300 degree F (149 degree C) oil. Failure to follow this procedure could cause damage to equipment.

9. Install new piston ring (46) on piston (38, Figure 17-7). Caution should be taken when installing piston ring (46).
10. Install piston assembly (45) on piston assembly (38). Note direction of piston (45) as recorded during disassembly.
11. Install back-up ring (44) and cup (43) in bore of end plug (41).
12. Install O-ring (42) on end plug (41).
13. Install end plug (41) on piston assembly (45).

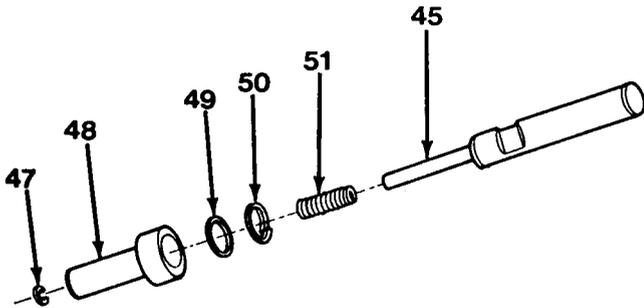


Figure 17-8

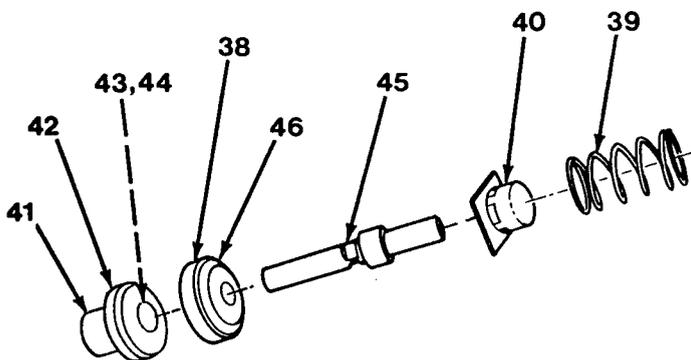


Figure 17-7

13. Install retainer (40) over piston assembly (45) and install spring (39) over retainer (40), Figure 17-6).
14. Install entire internal parts assembly into brake booster valve (29) housing bore. Use a spanner wrench to tighten end plug (41).
15. Install new boot (37) and push rod (36) into boot (37, Figure 17-5).
16. Align matchmarks on brake booster valve (29) and master cylinder (19). Install three washers (35) and capscrews (34, Figure 17-4).

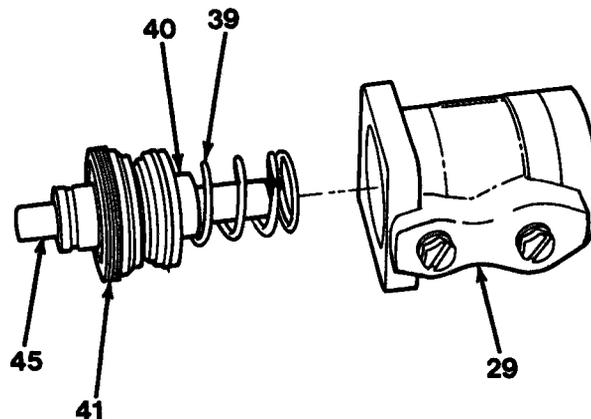


Figure 17-6

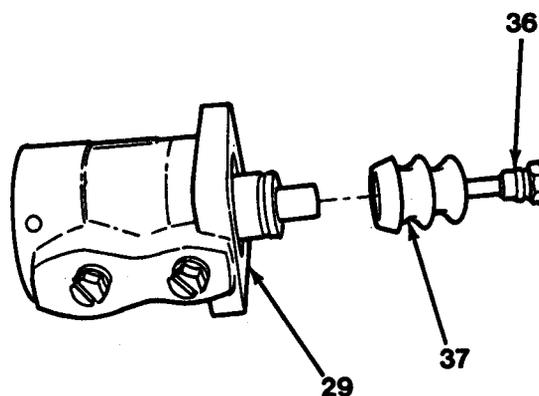


Figure 17-5

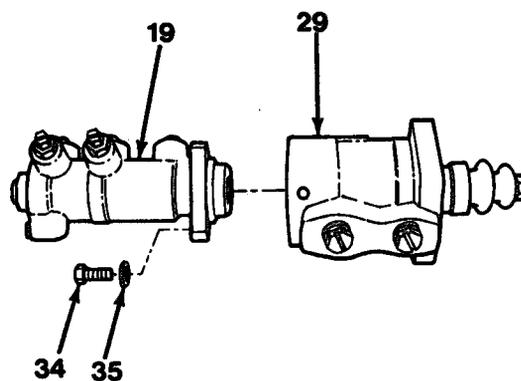


Figure 17-4

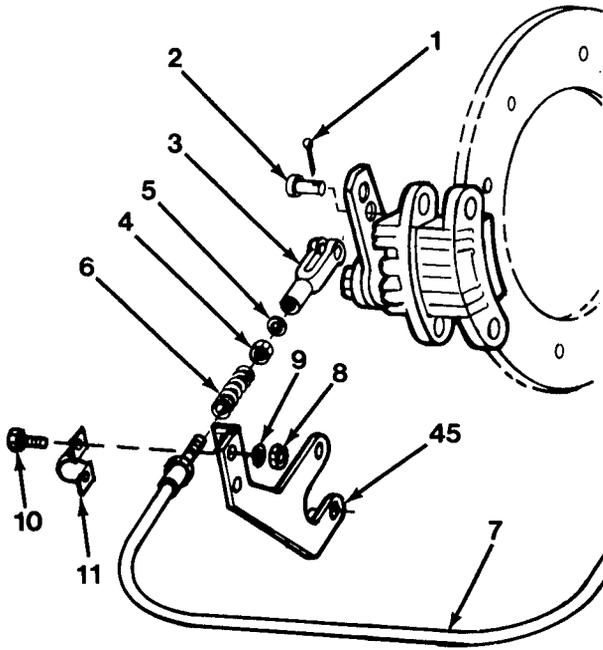


Figure 17-1

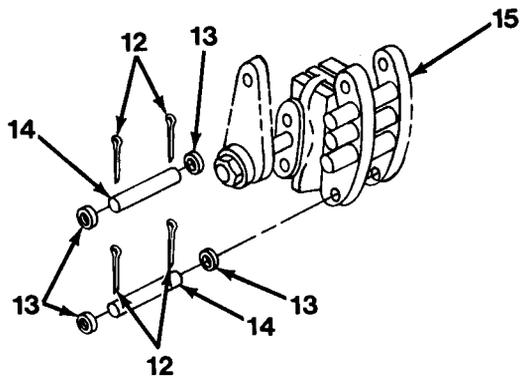


Figure 17-2

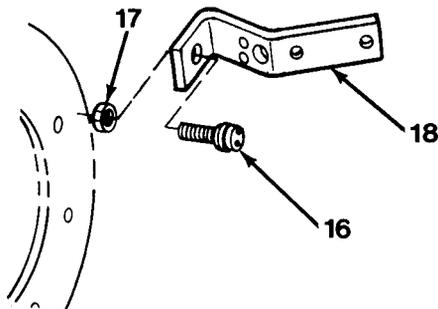


Figure 17-3

PARKING BRAKE

PARKING BRAKE REMOVAL

1. Remove cotter pin (1) and pin (2, Figure 17-1).
2. Remove yoke (3), nut (4), washer (5) and spring (6) from end of cable (7).
3. Remove two nuts (8), lockwashers (9), cap-screws (10) and clamp (11) from cable (7).
4. Remove cable (7) from bracket (45).
5. Remove four cotter pins (12), washers (13) and two mounting pins (14) from caliper assembly (15, Figure 17-2) on front axle.
6. Remove caliper assembly (15) from front axle for further disassembly.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

7. Disconnect wiring harness on sensor (16, Figure 17-3).
8. Remove jam nut (17) and sensor (16) from bracket (18).

9. Remove four nuts (19), lockwashers (20), washers (21) and four clamps (22) to release cable (7, Figure 17-4) from vehicle frame.
10. Remove two nuts (23), lockwashers (24), capscrews (25), spacer (26), clamp (27) and two spacers (28) from cable (7) mounted to lever (29, Figure 17-5).
11. Remove cotter pin (30) and pin (31) to release cable (7) from lever (29).
12. Remove cable (7) by pulling out of cab.
13. Remove four nuts (32) and lockwashers (33) from rear of cab.
14. Remove four capscrews (34) inside cab to remove lever (29).

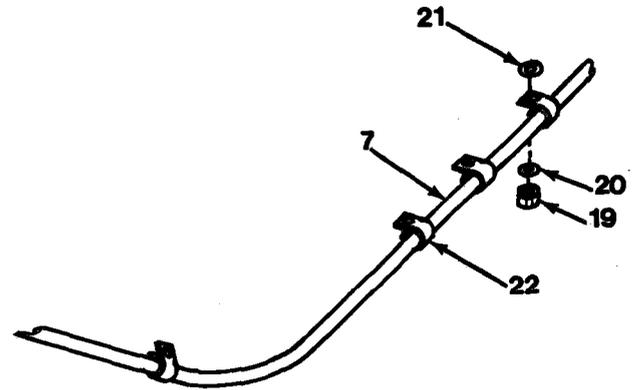


Figure 17-4

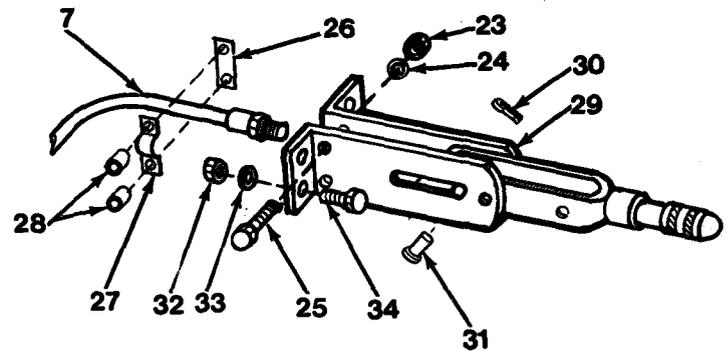


Figure 17-5

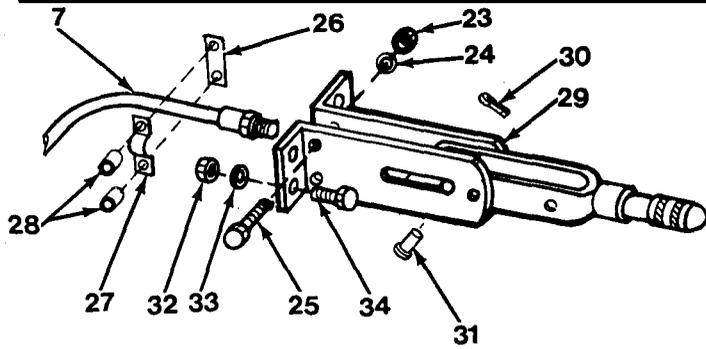


Figure 17-5

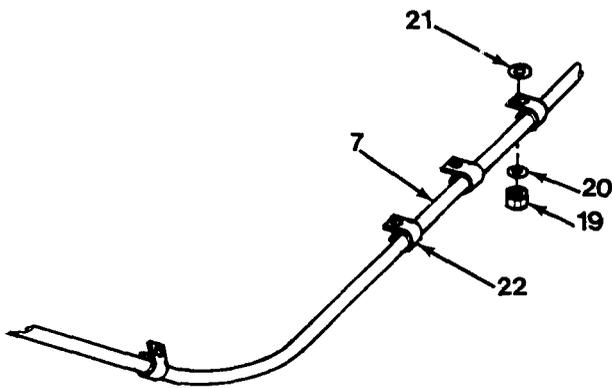


Figure 17-4

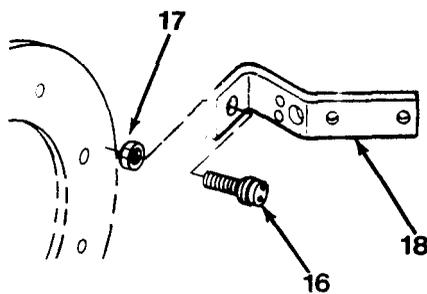


Figure 17-3

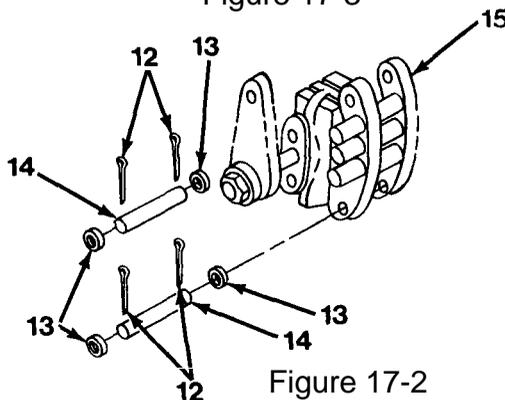


Figure 17-2

PARKING BRAKE INSTALLATION

1. Install four capscrews (34), lockwashers (33) and nuts (32) securing lever (29, Figure 17-5) to cab.
2. Push cable (7) through rear of cab.
3. Install pin (31) and cotter pin (30) attaching end of cable (7) to lever (29).
4. Install two spacers (28), clamp (27), spacer (26), two capscrews (25), lockwashers (24) and nuts (23) mounting cable (7) to lever (29).
5. Install four clamps (22), washers (21), lockwashers (20) and four nuts (19) to secure cable (7, Figure 17-4) to vehicle frame.
6. Install sensor (16) on bracket (18) with jam nut (17, Figure 17-3). Adjust sensor (refer to page 17-45, step 3).
7. Connect wiring harness to sensor (16). Note tag from removal.
8. Position caliper assembly (15, Figure 17-2) on front axle.
9. Apply grease MIL-G-10924 to two mounting pins (14) and install two mounting pins (14), four washers (13) and cotter pins (12) securing caliper assembly (15) to front axle.

10. Install clamp (11), two capscrews (10), lockwashers (9) and nuts (8) to secure cable (7) to bracket (45, Figure 17-1).
11. Install spring (6), washer (5), nut (4) and yoke (3) on end of cable (7).
12. Install pin (2) and cotter pin (1) in hole closest to lever pivot.
13. Check cable (7, Figure 17-1) for correct adjustment and ease of movement. With lever in cab in up position, pins (49) should rest in bottom of groove in cam (39, Figure 17-6).
14. Adjust two pad holder assemblies (42) clearance to 0.010 to 0.020 in. (0.25 to 0.51 mm) by turning castle nut (36) in or out until proper clearance has been obtained. Install cotter pin (35).
15. Inspect actuator linkage for adequate freedom of movement for positive brake operation.

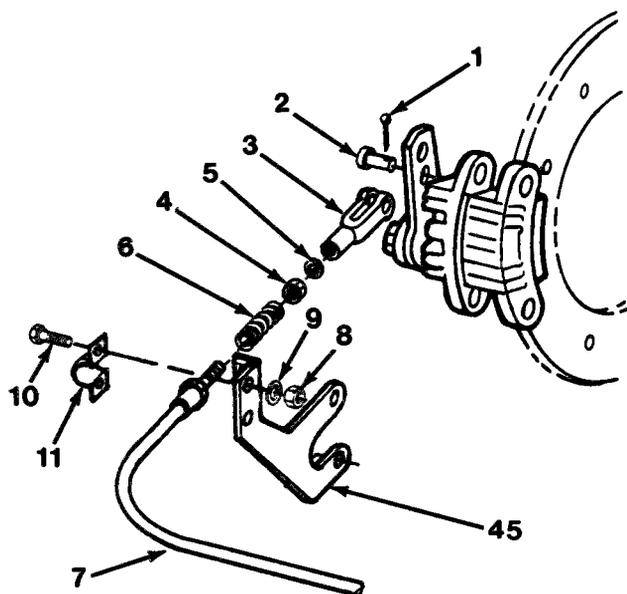


Figure 17-1

PARKING BRAKE DISASSEMBLY

1. Remove cotter pin (35), castle nut (36) and washer (37) from stud in cam side casting (38, Figure 17-6). Discard cotter pin (35).
2. Remove operating cam (39) from stud in cam side casting (38).
3. Remove two springs (40) and spring (41).
4. Remove two pad holder assemblies (42).
5. Remove two bolts (43), washers (44) and bracket (45).

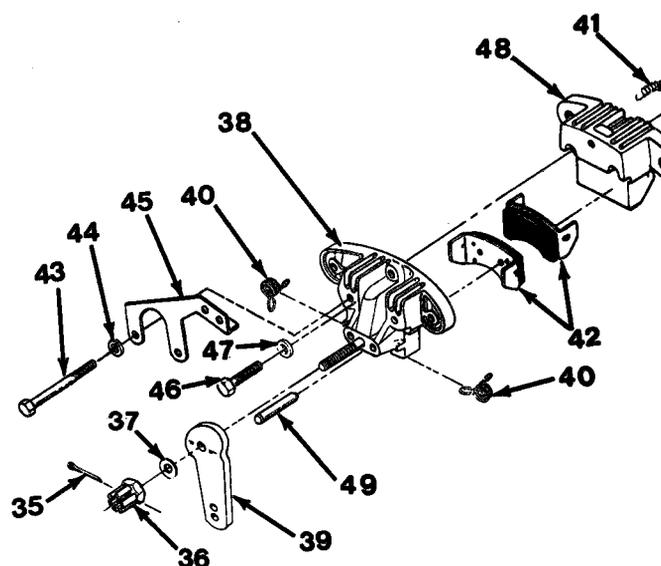


Figure 17-6

PARKING BRAKE DISASSEMBLY

6. Remove bolt (46) and washer (47) to separate cam side casting (38) and carrier casting (48, Figure 17-6).
7. Remove two push pins (49) from cam side casting (38).

PARKING BRAKE CLEANING/INSPECTION

1. Clean all parts with denatured alcohol and blow dry with compressed air.
2. Replace pad holder assemblies if lining material is less than 0.125 in. (3.18 mm) thick.
3. Inspect all other parts (refer to Chapter 4).

PARKING BRAKE ASSEMBLY

NOTE

- Lightly lubricate all moving parts except friction plates.

- Stamped on the back of each pad holder is a code number. The first or first and second numbers specify the friction material type. The new friction pad material must be the same as the pads being replaced.

1. Position two pad holder assemblies (42) on cam side casting (38) and carrier casting (48, Figure 17-6).
2. Install two springs (40) and spring (41) holding pad holder assemblies (42) in place.
3. Position cam side casting (38) and carrier casting (48) together. Install washer (47) and bolt (46). Torque bolt (46) to 32 lb-ft (43 N•m).
4. Install bracket (45) with two washers (44) and bolts (43). Torque bolts (43) to 32 lb-ft (43 N•m).
5. Install two push pins (49) in cam side casting (38).

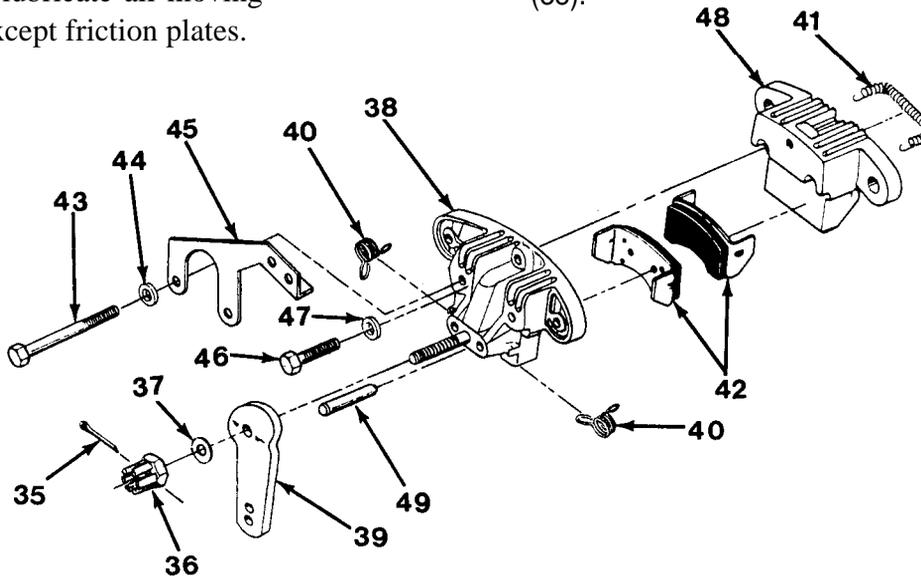


Figure 17-6

6. Install operating cam (39) on stud in cam side casting (38).
7. Install washer (37), castle nut (36) on stud in cam side casting (38). Do not install cotter pin (35) at this time. See step 14 of installation.
8. All sliding parts must move freely.

PARKING 13 BRAKE/SPEEDOMETER ADJUSTMENT

1. Adjust pad holder assemblies (42) clearance to 0.010 to 0.020 in. (0.25 to 0.51mm) by turning castle nut (36, Figure 17-6) in or out until proper clearance has been obtained.
2. Additional adjustment can be made on lever. Turn lever handle right to tighten cable, or left to loosen cable.
3. Loosen jam nut (17) on sensor (16, Figure 17-7). Using a feeler gauge, adjust sensor (16) so the gap between sensor (16) and parking brake disc measures 0.025 to 0.040 in. (0.64 to 1.02 mm). Tighten jam nut (17).

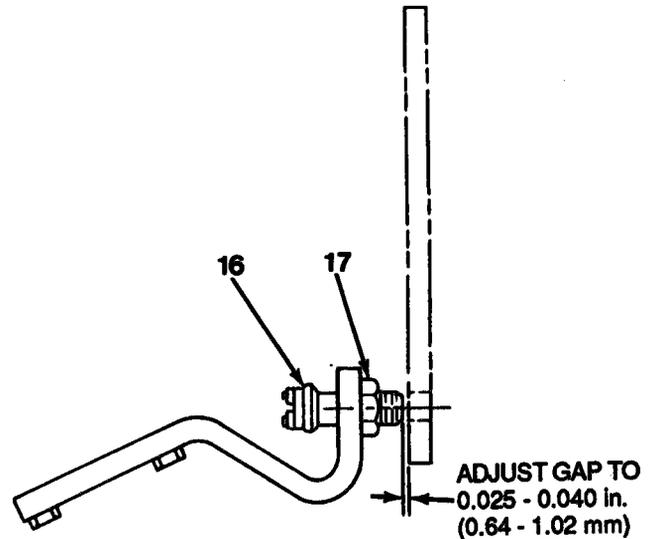


Figure 17-7

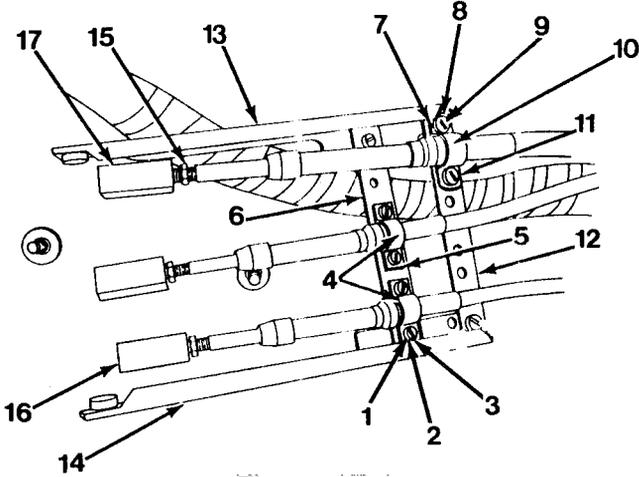


Figure 17-1

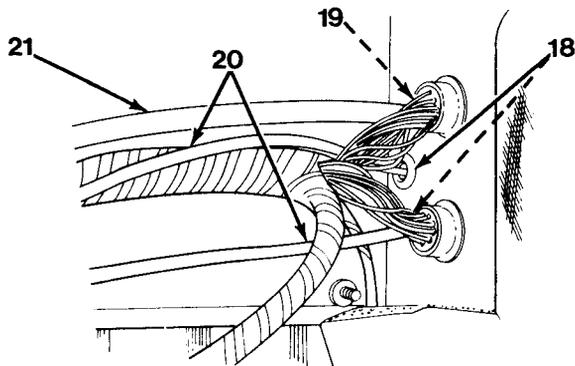


Figure 17-2

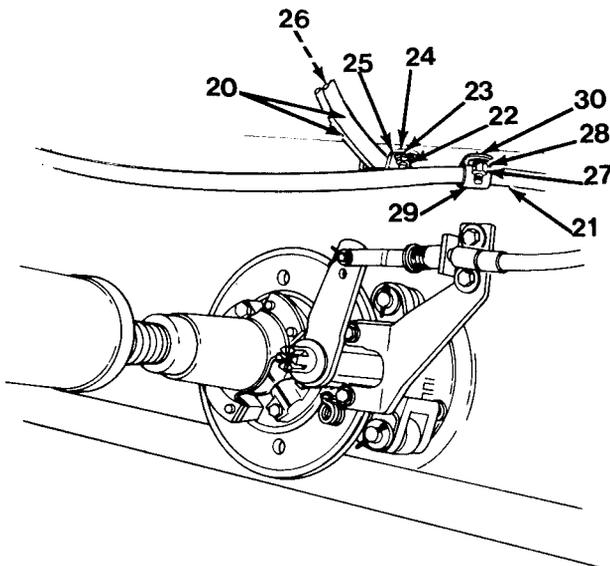


Figure 17-3

TRANSMISSION CABLE

TRANSMISSION CABLE REMOVAL

1. Remove right-hand dash panel (refer to page 17-64).
2. Remove five nuts (1), lockwashers (2), screws (3), two clamps (4) and shims (5) from lever shim (6, Figure 17-1).
3. Remove lever shim (6).
4. Remove three nuts (7), lockwashers (8), screws (9), clamp (10) and shim (11) from lever shim (12).
5. Remove left hanger (13) and right hanger (14).

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

6. Release three jam nuts (15) and remove two cable terminals (16) and cable terminal (17).
7. Remove two grommets (18) and grommet (19, Figure 17-2) from rear cab panel.
8. Push two cables (20) and cable (21) through rear cab panel.

9. Remove nut (22), washer (23), washer (24) and clamp (25) from two cables (20). Cut and remove three wire ties (26, Figure 17-3) from two cables (20).

10. Remove two lock nuts (27), washers (28), clamps (29), and washers (30) from cable (21).

11. Near center of vehicle, cut and remove wire tie (26) from cable (21).

12. Remove two cotter pins (33) and pivots (34) from side transmission shift controls. Remove two pivots (34) from end of cables (20, Figure 17-4).

13. Remove cotter pin (35) and pin (36) from clevis (42, Figure 17-5) through cut out in bracket.

14. Remove two screws (38), lock nuts (39) and clamp (40) from bracket (41).

15. Remove clevis (42) from end of cable by loosening jam nut (43) and unscrewing clevis (42). Remove cable (21) from vehicle.

16. Loosen two jam nuts (44) on each cable (20, Figure 17-6).

17. Disconnect two cables (20) from bulkhead bracket on side of transmission.

18. Remove two cables (20) from vehicle.

19. Remove four nuts (44) and washers (45) from two cables (20).

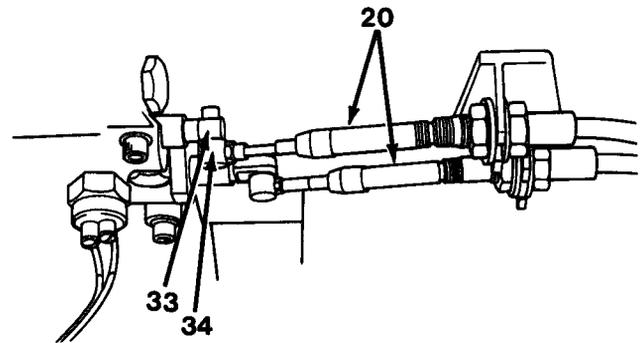


Figure 17-4

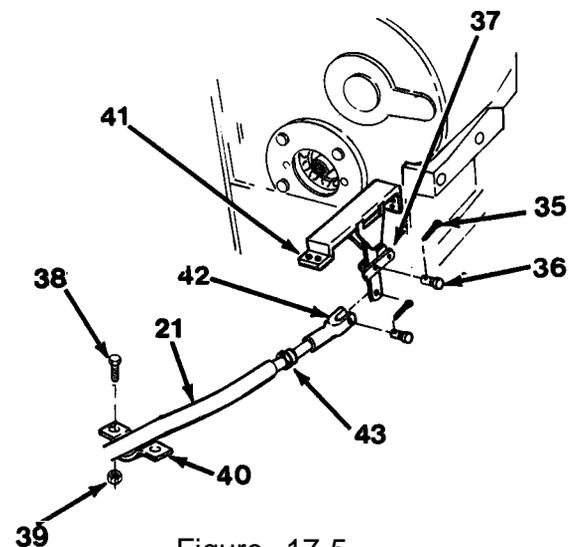


Figure 17-5

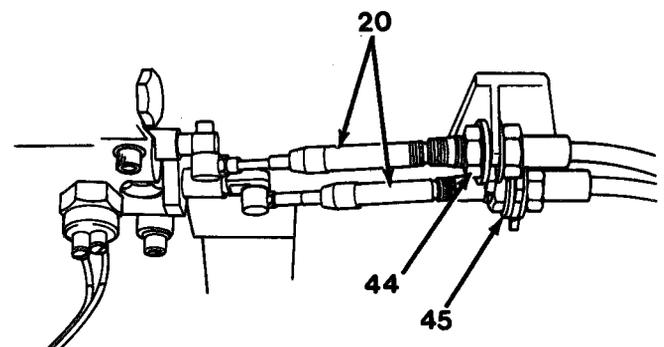


Figure 17-6

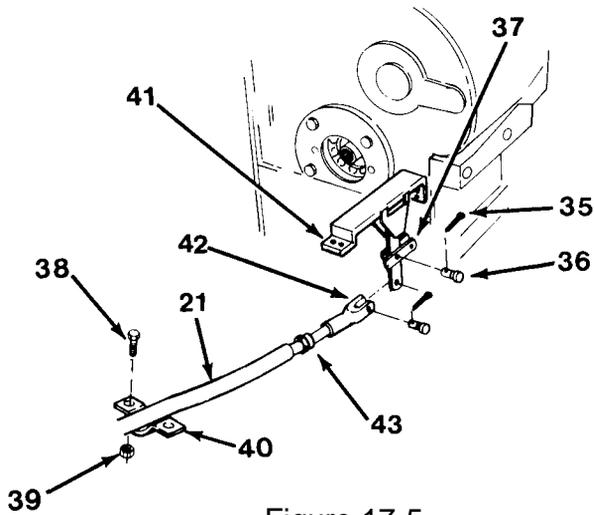


Figure 17-5

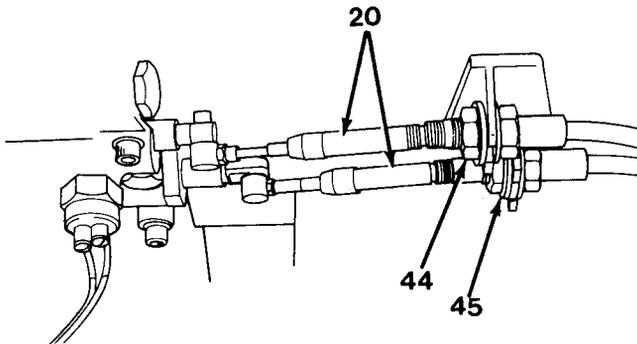


Figure 17-6

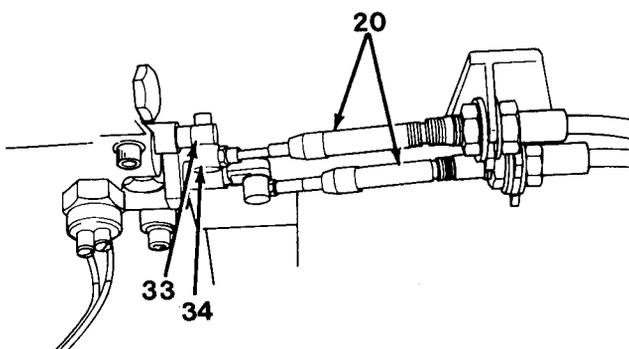


Figure 17-4

TRANSMISSION CABLE CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

TRANSMISSION CABLE INSTALLATION

1. Install jam nut (43) and clevis (42) on cable (21) and tighten jam nut (43) against clevis (42, Figure 17-5).
2. Position clamp (40) over cable on bracket (41).
3. Install two screws (38) and lock nuts (39).
4. Position clevis (42) on lever (37) and install pin (36) and cotter pin (35) through cut out in bracket.
5. Install nut (44), two washers (45) and nut (44) on each cable (20, Figure 17-6).
6. Position two cables (20) in bulkhead bracket on side of transmission. Tighten two jam nuts (44) to secure each cable.
7. Install two pivots (34) on cables (20). Install two pivots (34) in valve body on side of transmission and install two cotter pins (33, Figure 17-4) in pivots (34).
8. Install two grommets (18) and grommet (19, Figure 17-2) in rear cab panel.
9. Push two cables (20) and cable (21) through grommets (19) and (18) in rear of cab panel.
10. Install three jam nuts (15) on cables (21) and (20, Figure 17-1).

11. Install two cable terminals (16) on cables (20) and cable terminal (17) on cable (21).
12. Install three screws (9), lockwashers (8), nuts (7), clamp (10), shim (11) on lever shim (12) with left hanger (13) and right hanger (14).
13. Install five screws (3), lockwashers (2), nuts (1), two clamps (4) and two shims (5) on lever shim (6) with right hanger (14) and left hanger (13).

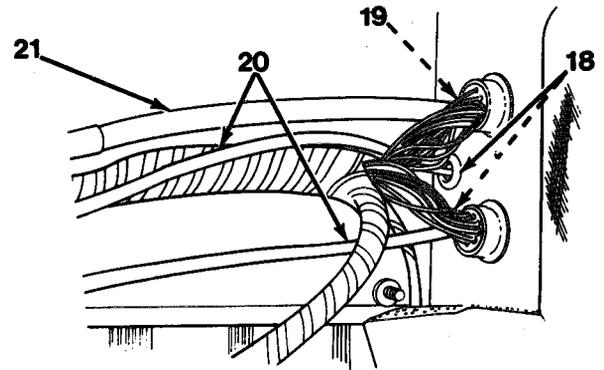


Figure 17-2

14. Near center of vehicle install tie wrap (26) on cable (21, Figure 17-3) to secure cable (21) to vehicle.
15. Install two clamps (29), flatwashers (30), washers (28) and lock nuts (27) on cable (21).
16. Install clamp (25), washer (24), washer (23), nut (22) to secure two cables (20) under vehicle. Install three tie wraps (26) on cables (20) to secure cables (20) to bottom of vehicle.

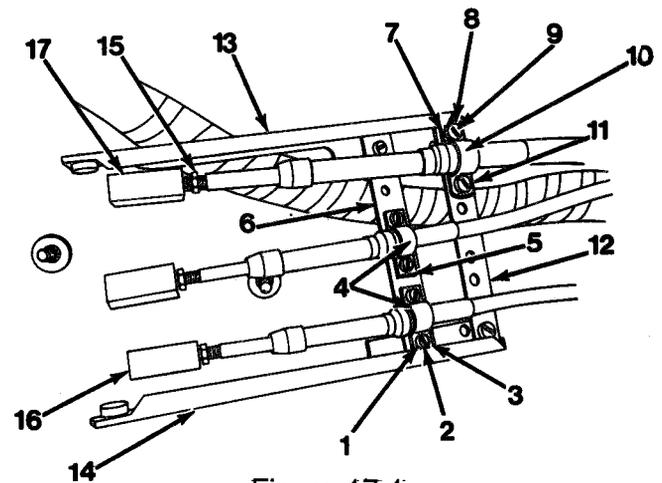


Figure 17-1

17. Install right-hand dash panel (refer to page 17-69).
18. Check cables (21) and (20) for freedom of movement.

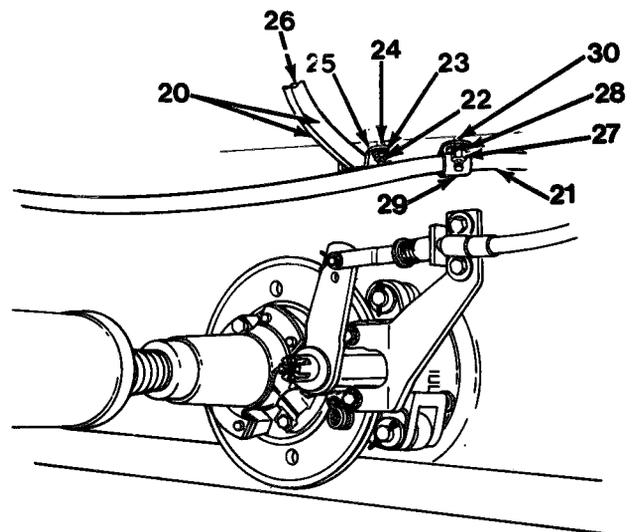


Figure 17-3

TRANSMISSION CABLE ADJUSTMENT

TWO-WHEEL-FOUR-WHEEL CABLE

1. Put lever in cab into two-wheel drive position.
2. Pull shaft spool on transmission to full out position.
3. Clamp cable to bracket aligning groove in cable with groove in clamp.

TWO-WHEEL-FOUR-WHEEL CABLE

4. Thread yoke jam nut all the way onto rod end. Thread yoke onto rod end and adjust to insert pin.
5. Check lever in cab for full movement from stop to stop. Adjust yoke if lever is not centered between stops.
6. Tighten jam nut on yoke.
7. Insert cotter pin into pin.

FORWARD-REVERSE CABLE

1. Move forward-neutral-reverse selector lever in cab to forward position:
2. Push top spool on transmission to full in position.
3. Center jam nuts on cable and slide cable into slot in bracket on transmission mount.
4. Thread jam nut for pivot all the way onto rod end and adjust pivot on cable end to insert into hole in spool. Tighten pivot jam nut.
5. Tighten jam nuts on cable bracket.
6. Shift lever in cab must be in forward position and centered in gate. Move lever to reverse position. Check that lever is centered in gate. If lever is not centered in gate, adjust jam nuts on cable forward or backward until levers are centered in gates. Retighten jam nuts.
7. Insert cotter pin into pivot.

GEAR SHIFT CABLE

1. Move gear selector shift lever in cab to fourth gear position.
2. Push bottom spool on transmission to full in position.
3. Center jam nuts on cable and slide cable into slot in bracket on transmission mount.
4. Thread jam nut for pivot all the way onto cable end and adjust pivot on cable end to insert into hole in spool.
5. Tighten jam nuts on cable to bracket.
6. Shift lever in cab must be in fourth gear and centered in gate. Move lever to first gear. Check that lever is centered in gate. If lever is not centered in gate, adjust jam nuts until levers are centered. Retighten jam nuts.
7. Insert cotter pin into pivot.

VEHICLE LEVEL

VEHICLE LEVEL REMOVAL

Remove three screws (1), lockwashers (2), six nuts (3) and bubble level (4, Figure 17-1).

VEHICLE LEVEL INSTALLATION

NOTE

Installation of bubble level is critical to the proper operation of vehicle and must be installed properly.

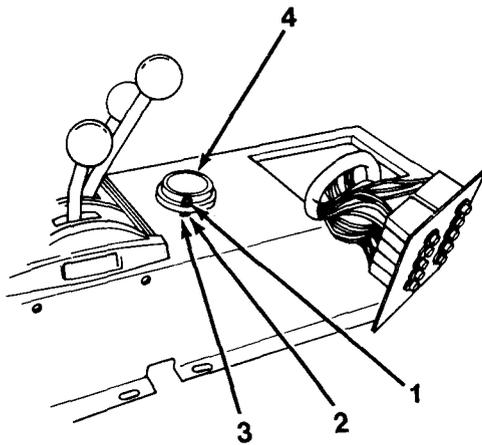


Figure 17-1

1. Park vehicle on level ground.
2. Center boom over cab in travel position.
3. Lower outrigger pads and raise tires off ground.
4. Remove deck plate and pinion cover (refer to page 14-9).
5. Clean machined surface of frame around swing pinion.
6. Place a bubble level on the machined surface of frame next to swing pinion.
7. By raising or lowering outrigger pads, level the frame in both side to side and front to rear directions.

8. Install three screws (1) in machine bubble level (4, Figure 17-1).
9. Install two nuts (3) then one lockwasher (2) on each screw (1). Tighten two nuts (3) on each screw (1) up to machine bubble level (4).
10. Position machined bubble level (4) and start screws (1) in mounting holes.
11. Adjust three screws (1) until bubble in machine bubble level (4) is centered in center circle.
12. Hold screws (1) in place and tighten bottom nut (3) and lockwasher (2) down against panel.
13. Recheck bubble level on frame and machine bubble level (4).
14. Return vehicle to tires.

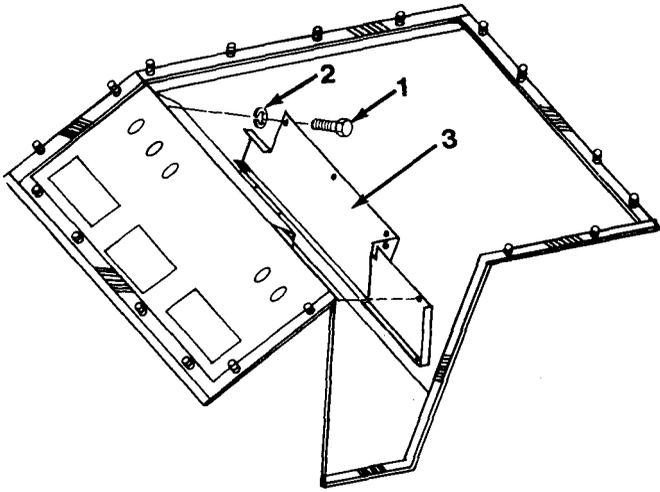


Figure 17-1

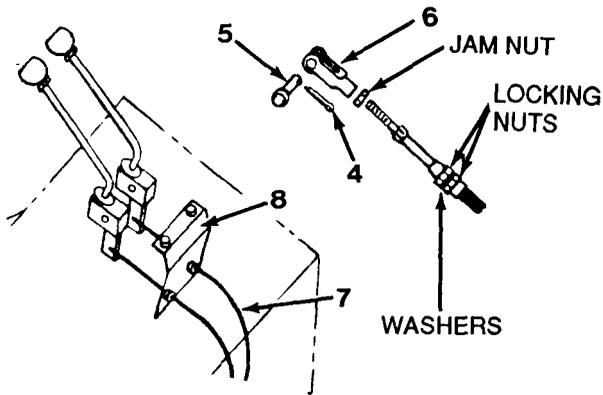


Figure 17-2

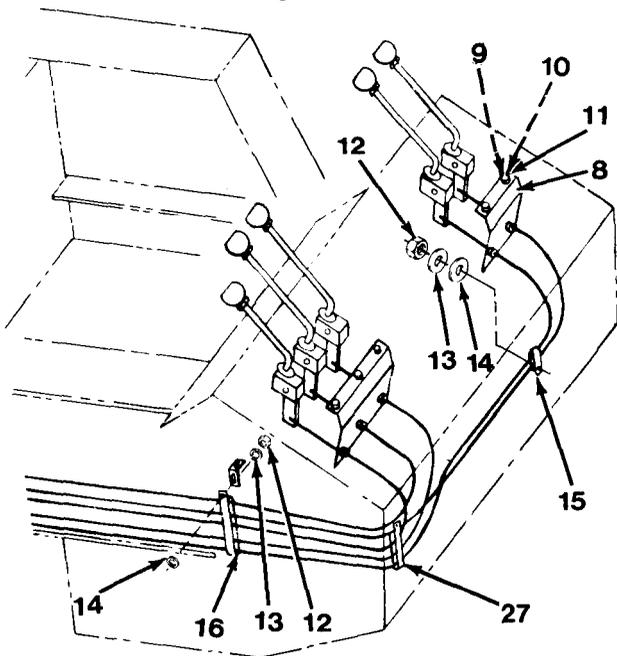


Figure 17-3

VALVE CONTROL CABLES

VALVE CONTROL CABLES REMOVAL

NOTE

The following is a maintenance procedure for removal of one operator's end of valve control cable. The maintenance procedure for removal of the operator's end of the remaining valve control cables is identical.

1. Remove six capscrews (1), lockwashers (2) and lower dash panel (3, Figure 17-1).
2. Remove cotter pin (4), pin (5) and yoke (6, Figure 17-2) from lever assembly.
3. Loosen and remove jam nut and remove yoke (6).
4. Loosen locking nuts and pull cable (7) from bracket (8).
5. Remove two locking nuts and washers from cable (7).
6. Remove two nuts (9), lockwashers (10) and capscrews (11) from bracket (8, Figure 17-3)
7. Remove two lock nuts (12), washers (13) and washers (14) from clamps (15) and (27).
8. Spread two clamps (15) and (27) apart and remove cable.

9. Remove two lock nuts (12), washers (13) and washers (14) from clamps (16).
10. Spread two clamps (16) apart and remove cable.
11. Pull cable through operator's cab access hole.

SWING AND OUTRIGGER CABLE REMOVAL

NOTE

The valve end of boom hoist, extend and winch cables are different from outrigger and swing cable. The end of each cable group must be removed using the correct procedure.

1. Remove cotter pin (17) and pin (18, Figure 17-4). Discard cotter pin (17).
2. Remove two jam nuts (19) and clevis (20).
3. Loosen two locking nuts and pull cable from bracket.
4. Remove two locking nuts and washers from cable.
5. Carefully pull cable out of vehicle.

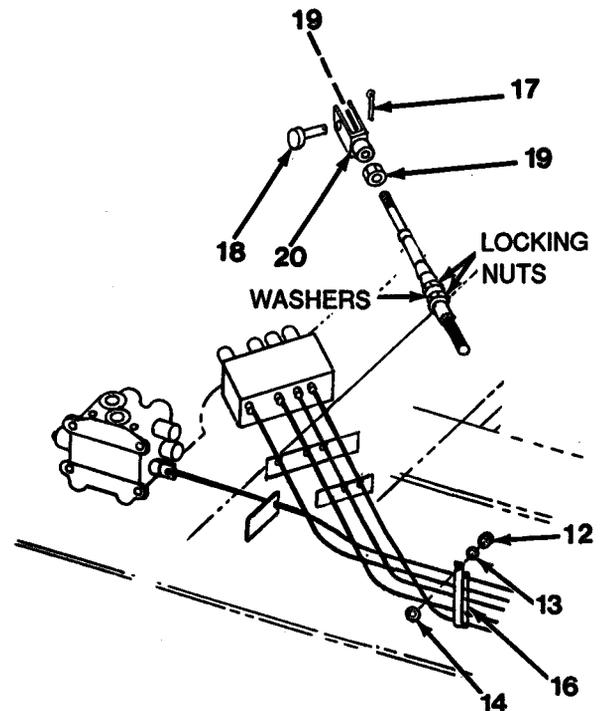


Figure 17-4

BOOM HOIST, EXTEND AND WINCH CABLE REMOVAL

1. Remove cotter pin (21) and pin (22, Figure 17-5).

NOTE

- Clevis is not removed from disconnect assembly on winch cable. Disconnect assembly and clevis are removed as an unit.
- Use steps 5,3,4 and 6 for winch cable removal.

2. Remove capscrew (23) and clevis (24).

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

3. Disconnect two wires from disconnect assembly (25).
4. Loosen jam nut (26) and remove disconnect assembly (25).
5. Remove jam nut (26) from cable.
6. Loosen two locking nuts and lift cable assembly from bracket. Remove locking nuts and washers from cable.
7. Remove cable from carrier and discard.

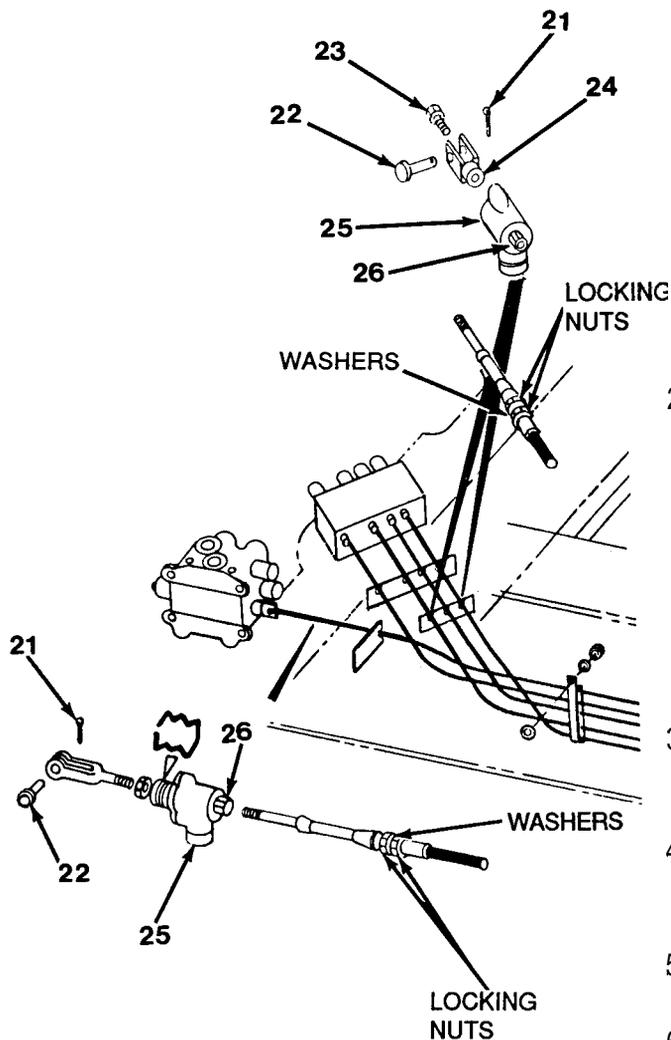


Figure 17-5

VALVE CONTROL CABLES CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

VALVE CONTROL CABLES INSTALLATION

NOTE

The following is a maintenance procedure for installation of the operator's end of one valve control cable. The maintenance procedure for installation of the operator's end of the remaining valve control cables is identical.

1. Pull cable through access hole in rear cab panel.
2. Install two locking nuts and washers on cable (7, Figure 17-2).
3. Install jam nut and yoke (6) on cable (7).
4. Install yoke (6), pin (5) and cotter pin (4) on lever assembly.

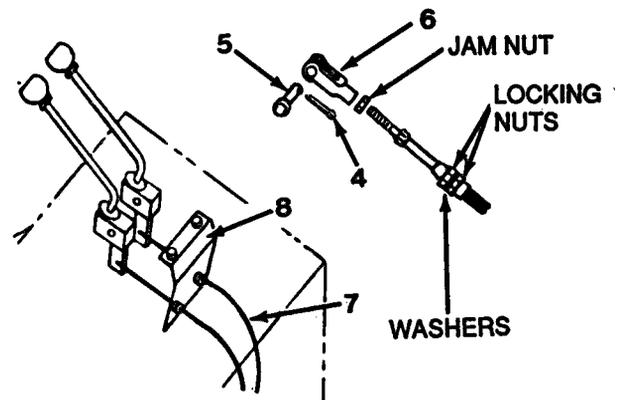


Figure 17-2

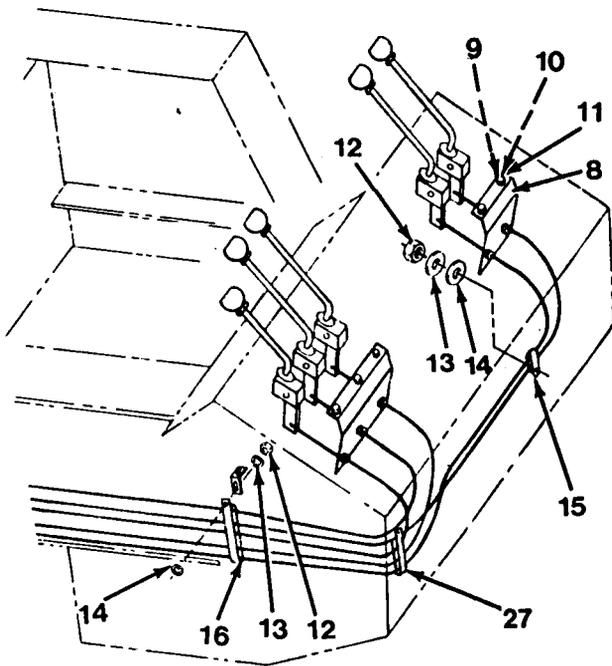


Figure 17-3

VALVE CONTROL CABLES INSTALLATION

- A5. Install bracket (8) with two capscrews (11), lockwashers (10) and nuts (9, Figure 17-3).
6. Tighten locking nuts and washers on bracket (8).
7. Position cable (7) through clamps (16) and install washer (14), washer (13) and nuts (12).
8. Position cable (7) through clamp (27) and clamp (15) and install two washers (14), washers (13) and lock nuts (12).
9. Install front panel (3) with six lockwashers (2) and capscrews (1, Figure 17-1).

SWING AND OUTRIGGER CABLE INSTALLATION

NOTE

The valve end of boom hoist, extend and winch cables are different from outrigger and swing cable. The end of each cable group must be installed using the correct procedure.

1. Carefully position cable in place on vehicle.
2. Install two washers and locking nuts on cable.
3. Tighten two locking nuts to hold cable in place.

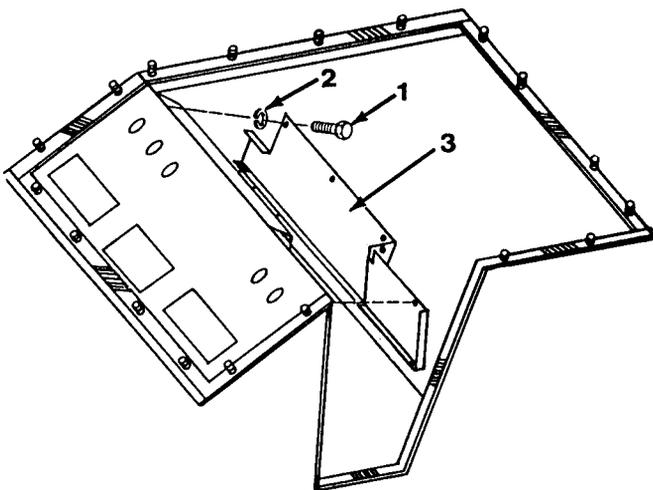


Figure 17-1

4. Install two jam nuts (19) and clevis (20, Figure 17-4) on end of cable. Thread two jam nuts (19) and clevis (20) to full threaded engagement. Tighten rear jam nut (19) to lock clevis (20) in place.
5. Position cable in place and install pin (18) and cotter pin (17).

BOOM HOIST, EXTEND AND WINCH CABLE INSTALLATION

NOTE

Before tightening jam nut, see adjustment procedure.

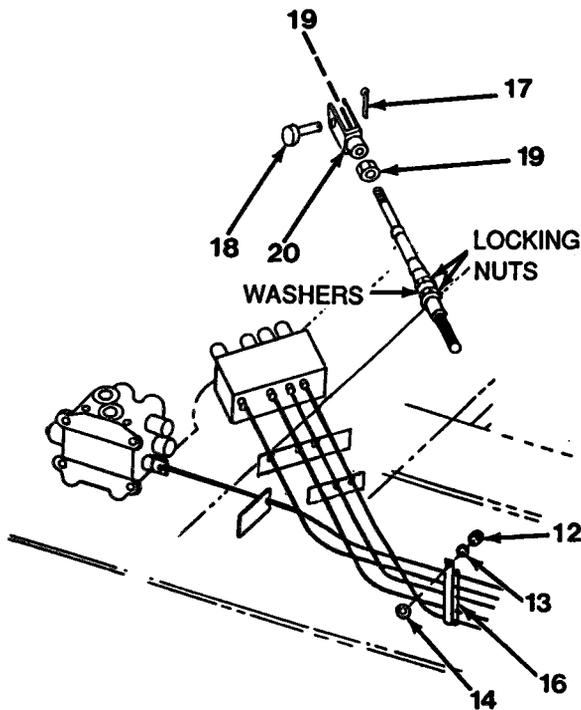


Figure 17-4

1. Install clevis (24) and capscrew (23) on end of disconnect assembly (25, Figure 17-5), telescope and boom hoist cable only.

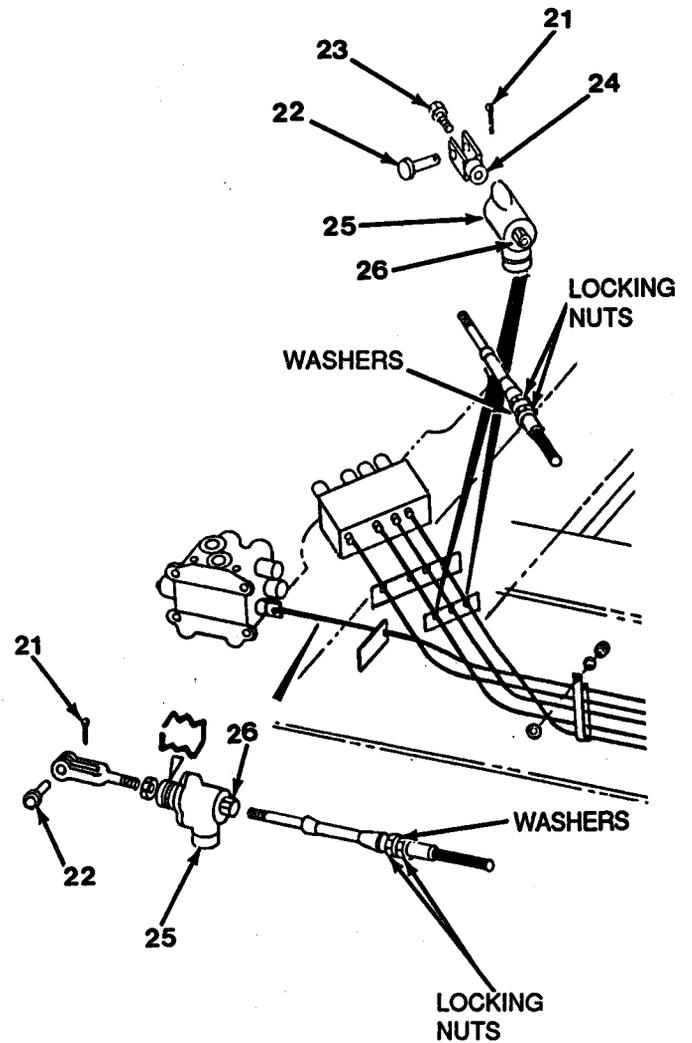


Figure 17-5

BOOM HOIST, EXTEND AND WINCH CABLE INSTALLATION

2. Install jam nut (26) and disconnect assembly (25, Figure 17-5) on cable end. Tighten jam nut (26) securing disconnect assembly (25) on cable end.
3. Connect two wires on disconnect assembly (25). Note tag from removal.
4. Position cable in place and install pin (22) and cotter pin (21).
5. Tighten two locking nuts securing cable in bracket.
6. Check cable operation for correct adjustment and movement.

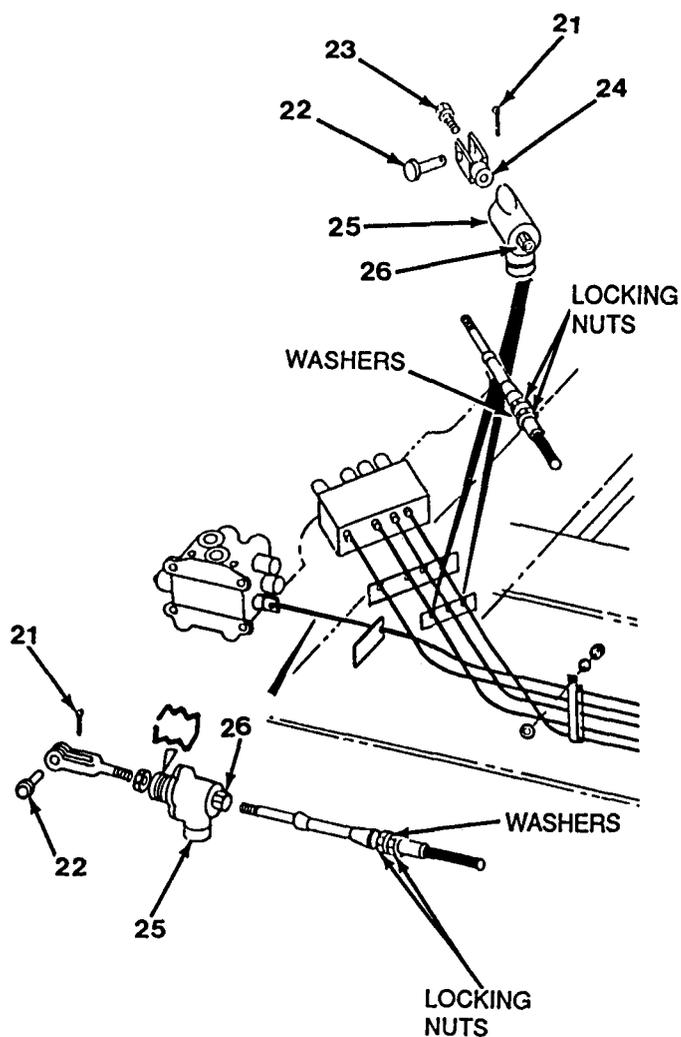


Figure 17-5

VALVE CONTROL CABLE ADJUSTMENT

1. Adjustment on hoist, winch and telescope cables are made by installing disconnect assemblies (25) until they bottom on cable ends. Turn out two turns and tighten jam nuts (26, Figure 17-5).
2. Adjustment for hoist winch and telescope levers are made with electrical power disconnected. Push levers to full forward position (full rearward for winch). Adjust yoke (6) so that no movement to valve bank piston is made. Reposition locking nuts on cable if further adjustment is necessary.
3. Return levers to neutral position. Adjust yoke (6) on remaining levers in alignment with hoist and telescope levers.
4. Tighten jam nuts on all five cables for operators safety.

DASH PANEL GAUGES AND SWITCHES

DASH PANEL GAUGES AND SWITCHES REMOVAL

WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

1. Disconnect battery negative ground cable.
2. Remove lower dash panel (refer to page 13-114, step 2).

CAUTION

When removing dash, care must be used to avoid damage to electrical wires attached to back of gauges.

DASH PANEL

3. Remove five bolts (1) and one bolt (2), six lockwashers (3) and washers (4, Figure 17-1),
4. Loosen jam nut (5) and remove cold start knob (6).
5. Remove jam nut (5) and cable lock nut (7). Pull cold start cable out of dash panel (10).
6. Disconnect two plastic cannon-style electrical connectors under right-hand corner of dash panel (10).
7. Remove screw (8) from turn signal switch mounting band to release ground wire and clamp (9) and remove dash panel (10) assembly to a work bench for further disassembly.

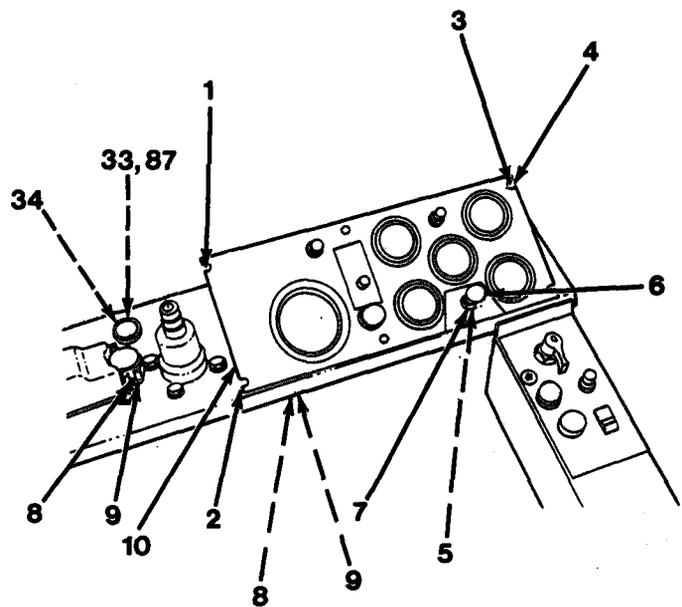


Figure 17-1

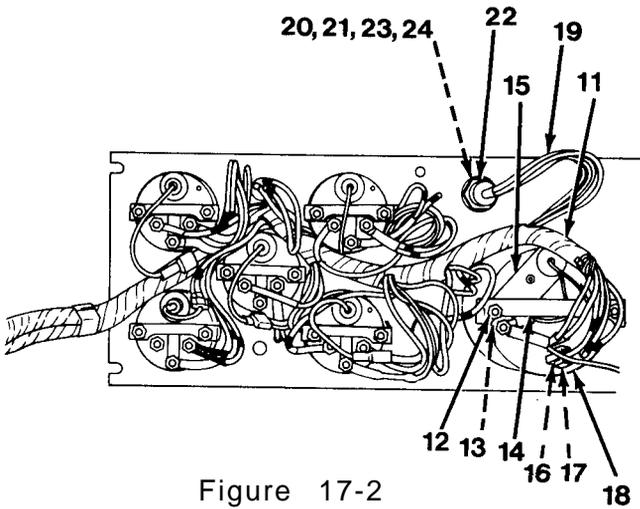


Figure 17-2

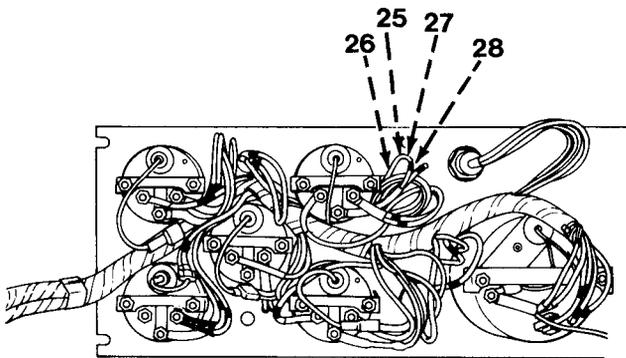


Figure 17-3

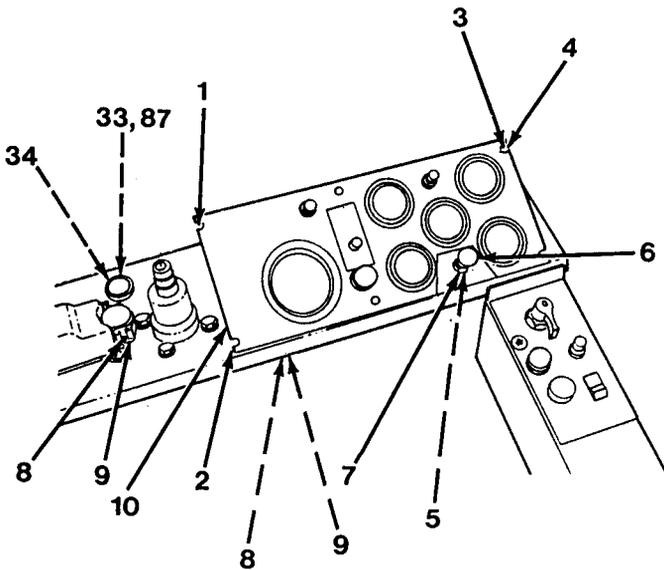


Figure 17-1

DASH PANEL GAUGES AND SWITCHES REMOVAL

DASH PANEL

8. Removal of gauges: Tag and disconnect wires (11) from back of gauge and light. Remove two nuts (12), washers (13) and bracket (14). Pull gauge (15) out of panel. Remove light bulb assembly (16) from gauge (15). Remove filter (17) from light bulb (16). Push down and twist light bulb (16) to remove from socket (18, Figure 17-2). If necessary, use same procedure to remove remaining five gauges.

9. Removal of three dash lights: Tag and disconnect two wires (19), and remove nut (20) and internal tooth washer (21). Pull light socket (22) through dash panel. Unscrew cover (24), remove filter, and push and turn light bulb (23) to remove from socket (22). Follow same procedure to remove remaining two dash lights, if necessary.

10. Removal of axle centering lights: Hold socket (25) and remove nut (26). Pull socket (25) through back of panel and remove washer (27). To replace bulb (28, Figure 17-3), unscrew red lens cap and pull bulb (28) from back of lens cap. Follow same procedure to remove remaining anti-two block warning lights, if necessary.

11. Removal of horn button: Tag and disconnect wires (29) from back of horn button (30). Loosen nut (31) on back of horn button (30) and unscrew rubber cover (32, Figure 17-4). Push out through rear of dash panel.
12. Removal of speedometer alarm Unscrew plastic retaining nut (87) and push speedometer alarm (33) through panel. Tag and disconnect wires (34, Figure 17-1).

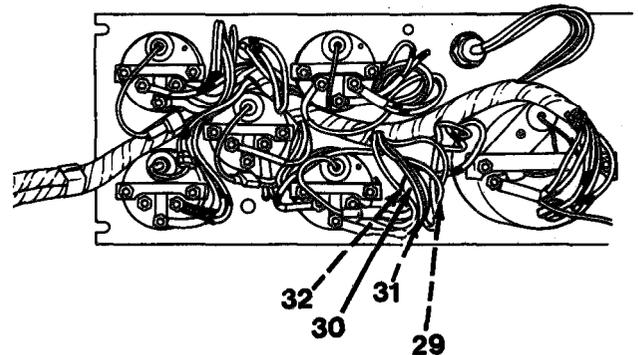


Figure 17-4

NOTE

It is not necessary to remove side sloping panel to remove switches.

SIDE SLOPING DASH PANEL

13. Removal of ignition switch (35, Figure 17-5): Remove screw from knob, pull knobs off switch (35) and remove nut. Pull switch through back of panel. Tag and disconnect wires.
14. Removal of wiper switch (36): Pull knob up, remove nut, washer and push switch (36) through panel. Tag and disconnect wires.
15. Removal of work light (37) and outrigger switches (38): Pull switch up through panel and tag and disconnect wires. Follow same procedure to remove remaining outrigger switches and work lights, if necessary.
16. Removal of master light switch (39): Remove three screws, three levers, four screws and push switch down through panel. Tag and disconnect wires.
17. Removal of start button (40): Refer to step 11.
18. Removal of side sloping dash panel: Refer to page 17-64, step 22.

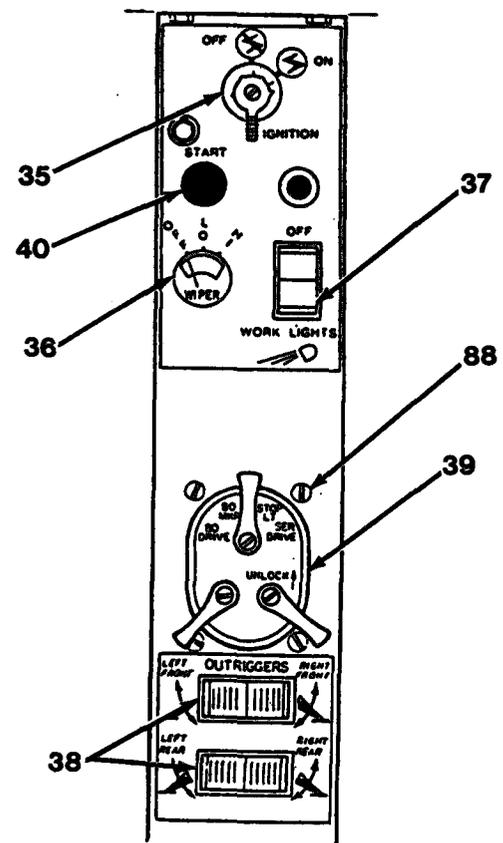


Figure 17-5

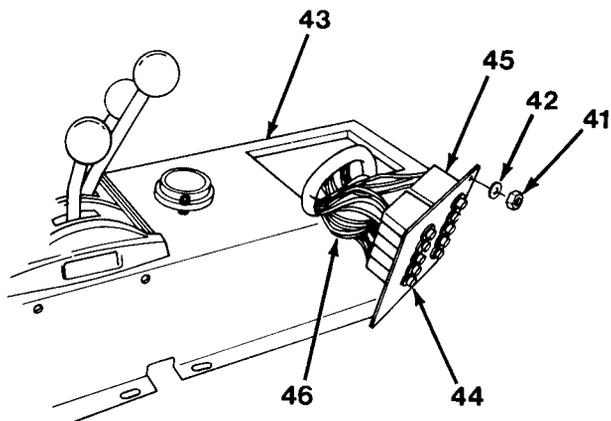


Figure 17-6

DASH PANEL GAUGES AND SWITCHES REMOVAL

CIRCUIT BREAKER PANEL

19. Removal of circuit breakers: Remove four capscrews (41) and washers (42). Lift circuit breaker panel (43) up and out of frame. Remove retaining nut (44) and push circuit breaker (45) through panel (43). Tag and disconnect wires (46, Figure 17-6). If necessary, remove nine remaining circuit breakers (45) using the same procedure.

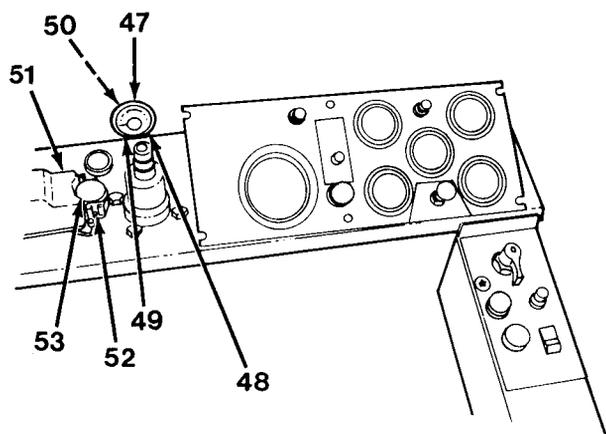


Figure 17-7

SPEEDOMETER AND TURN SIGNAL

20. Removal of speedometer (47): Remove two screws (48) and lockwashers (49). Slide case down wires (50, Figure 17-7). Tag and remove wires.
21. Removal of turn signal (51): Tag and disconnect wires (52) and remove two retaining screws (53) and turn signal (51).

RIGHT-HAND DASH

22. Remove two capscrews and nuts (54) and washers (55, Figure 17-8).

NOTE

If only removal of side sloping dash panel is required, proceed to step 35.

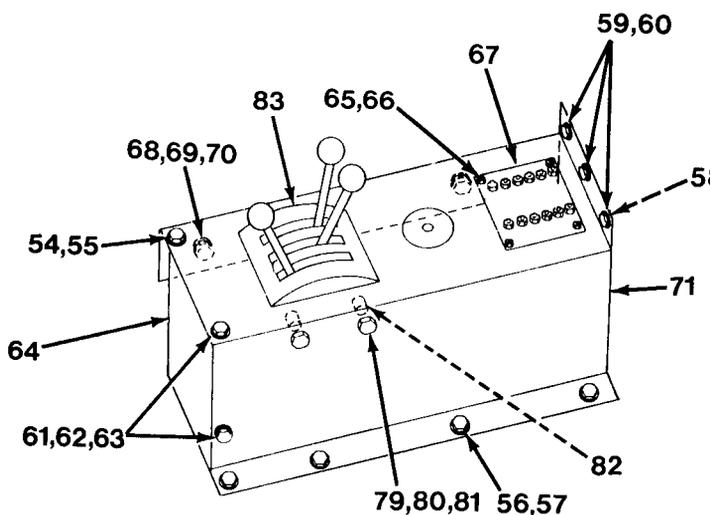


Figure 17-8

23. Remove seat (refer to page 14-11).
24. Remove four nuts (56) and washers (57).
25. Remove three nuts (58), capscrews (59) and washers (60).
26. Remove two capscrews (61), lockwasher (62), washer (63) and cover (64).

27. Remove four capscrews (65), lockwashers (66) and lay circuit breaker panel (67) against back cab wall.
28. Remove two capscrews (68), lockwasher (69) and washer (70).
29. Lift right-hand dash (71) and rotate 1/4 turn to allow access to shift control linkage.
30. Remove six nuts (72), lockwashers (73) and capscrews (74, Figure 17-9).
31. Remove three clamps (75) and shims (76).

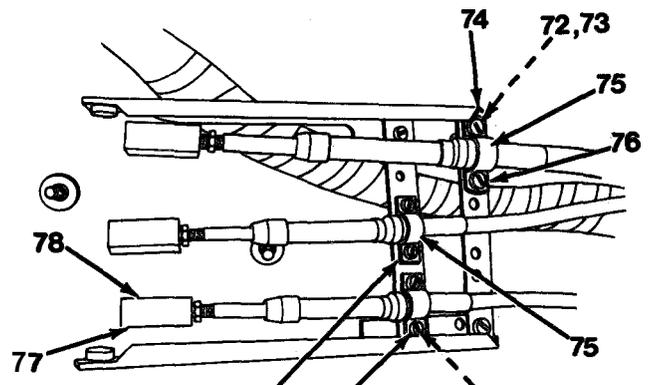


Figure 17-9

NOTE

Tag cable terminals and record holes in shifter to aid in assembly.

32. Remove three cotter pins (77) and pins (78) from cable terminal.
33. Remove four capscrews (79), lockwashers (80), washer (81) and spacer (82) and remove shifter (83, Figure 17-8).
34. Remove bubble level, if necessary (refer to page 17-52).
35. Remove two nuts (84), capscrew (85) and side sloping dash panel (86, Figure 17-10).
36. Remove switches, if necessary (refer to side sloping dash panel, page 17-63).

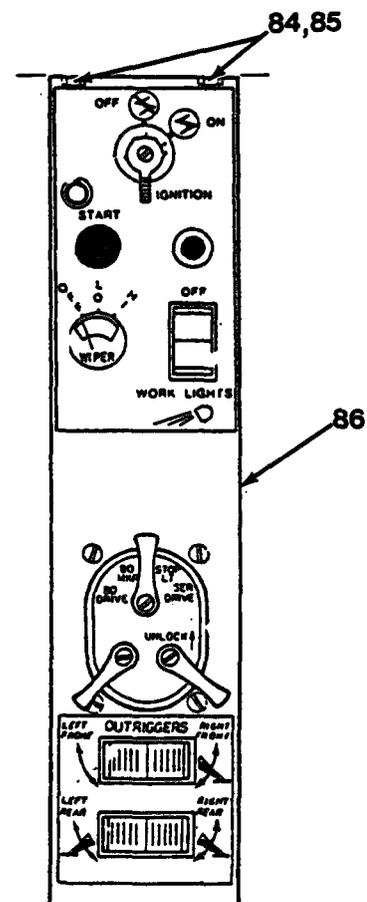


Figure 17-10

DASH PANEL GAUGES AND SWITCHES INSTALLATION

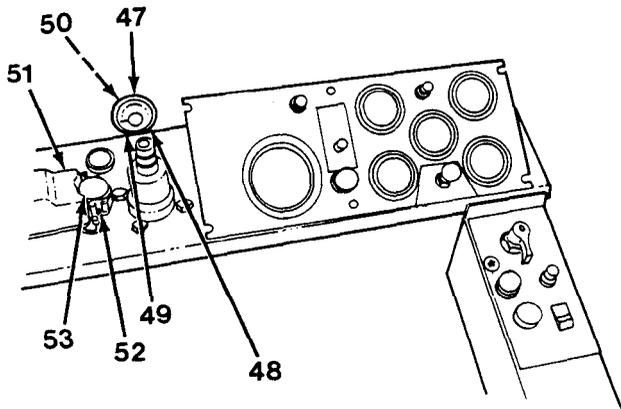


Figure 17-7

1. Installation of turn signal: Position turn signal (51) on stud and connect wires (52). Install retaining screws (53, Figure 17-7) in turn signal strap and turn signal (51). Position and tighten.
2. Installation of speedometer: Install case on wires (50) and connect wires (50) to speedometer (47). Slide case up wires and install speedometer (47) in case. Position speedometer on dash and install two lockwashers (49) and screws (48).

CIRCUIT BREAKER PANEL

3. Installation of circuit breakers: Connect wires (46) to circuit breaker (45) and remove tags. Push circuit breaker (45) up through panel (43) and install retaining nut (44). Use same procedure to install remaining nine circuit breakers. Position panel (43) and install four washers (42) and capscrews (41, Figure 17-6).

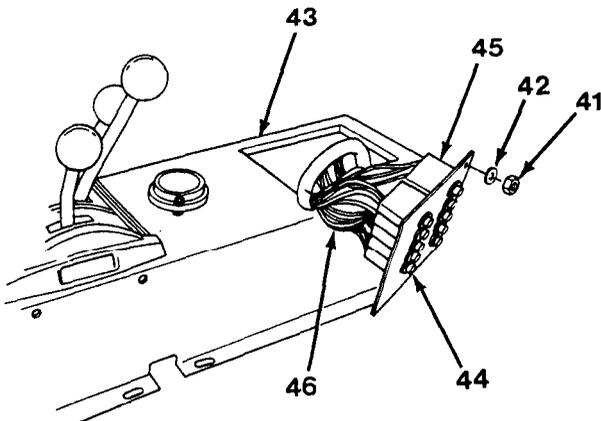


Figure 17-6

SIDE SLOPING DASH PANEL

4. Installation of side sloping dash panel: Refer to page 17-69, step 23.
5. Installation of start button: Refer to step 11.
6. Installation of master light switch (39): Connect wires to light switch (39) and remove tags. Push switch (39) up through panel and install four screws (88, Figure 17-5). Install three levers on light switch (39) and install three screws in levers.

7. Installation of work light and outrigger switches: Pull wires up through panel and install on switch (37). Remove tags and push switch (37) down through panel. Use same procedure to install remaining two outrigger switches (38).
8. Installation of wiper switch: Connect wires to wiper switch (36) and remove tags. Push switch (36) through panel. Install washer, nut and knob. Tighten nut.
9. Installation of ignition switch: Push switch (35) in through back of panel and install nut, knob and screw. Connect wires to switch.

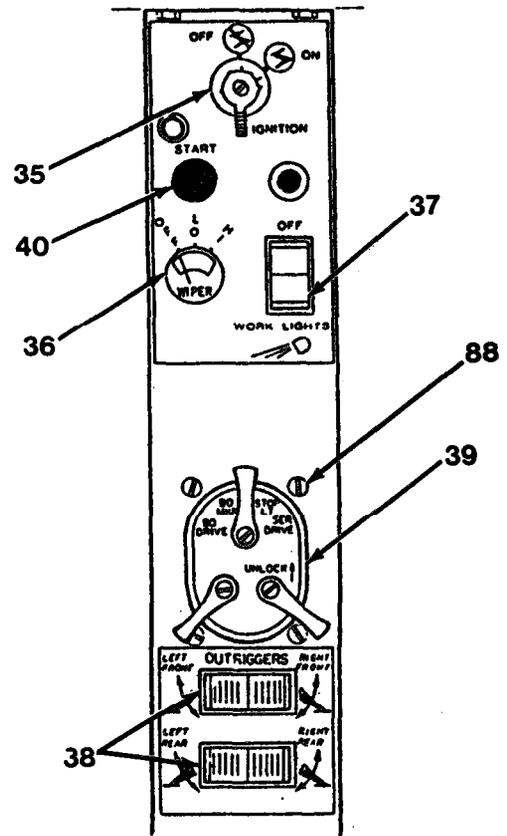


Figure 17-5

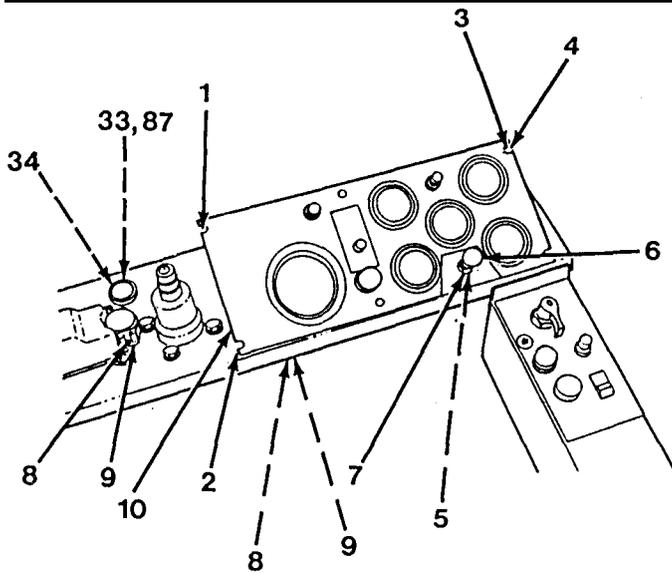


Figure 17-1

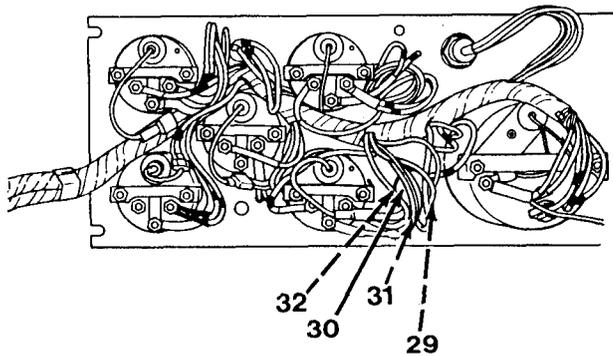


Figure 17-4

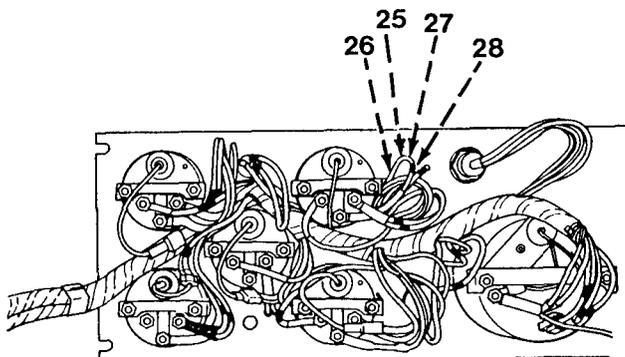


Figure 17-3

DASH PANEL GAUGES AND SWITCHES INSTALLATION

DASH PANEL

10. Installation of speedometer alarm: Push speedometer alarm (33) through dash and install plastic retaining nut (87) on front of speedometer alarm. Install wires (34, Figure 17-1).
11. Installation of horn button: Connect wires (29). Install nut (31) on horn button (29), push horn button through dash and install rubber cover (32, Figure 17-4). Tighten nut (31).
12. Installation of axle centering light: Install light bulb (28) in red lens cap and install in socket (25). Install washer (27) and push socket (25) through panel. Install nut (26, Figure 17-3).
13. Installation of three dash lights: Install light bulb (23) and filter in socket (22). Connect wires (19). Push socket (22) through dash and install internal tooth washer (21) and nut (20, Figure 17-2). Install cover (24).
14. Installation of gauges: Install light bulb (16) and filter (17) in socket (18). Push gauge (15) through panel. Install bracket (14), two washers (13) and nuts (12). Connect wires (11).
15. Installation of dash: Carefully lift and position dash (10) over mounting holes and install screw (8) to turn signal switch mounting band and secure clamp and ground wire (9, Figure 17-1).

16. Connect two plastic cannon-style electrical connectors under right-hand corner of dash panel (10)
17. Position cold start cable in dash panel (10), install cable lock nut (7), cold start knob (6) and jam nut (5).
18. Install six washers (4), lockwashers (3), one bolt (2) and five bolts (1).
19. Test speedometer alarm (refer to page 17-71).
20. If new tachometer is installed (refer to page 17-71).
21. Install lower dash panel (refer to page 13-115, step 5).

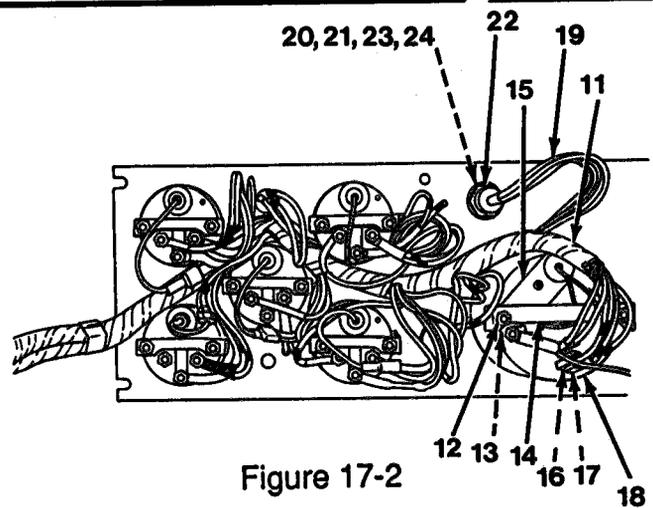


Figure 17-2

RIGHT-HAND DASH

22. Install switches, if removed (refer to side sloping dash panel, page 17-66, step 5).
23. Install side sloping dash panel (86), capscrew (85) and nut (84, Figure 17-10).

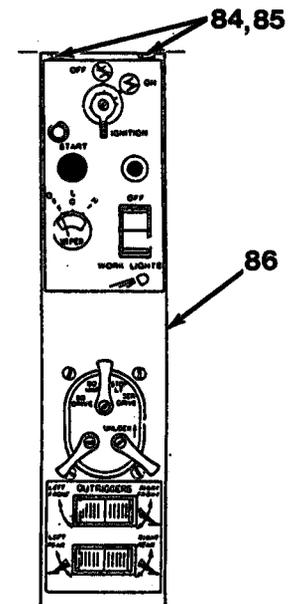


Figure 17-10

NOTE

If only installation of side sloping control panel is required, proceed to step 30.

24. Install shifter (83) in right hand dash (71) with four spacers (82), washers (81), lockwashers (80) and capscrews (79, Figure 17-8).
25. Position right-hand dash (71) in cab to allow access to shift control linkage.

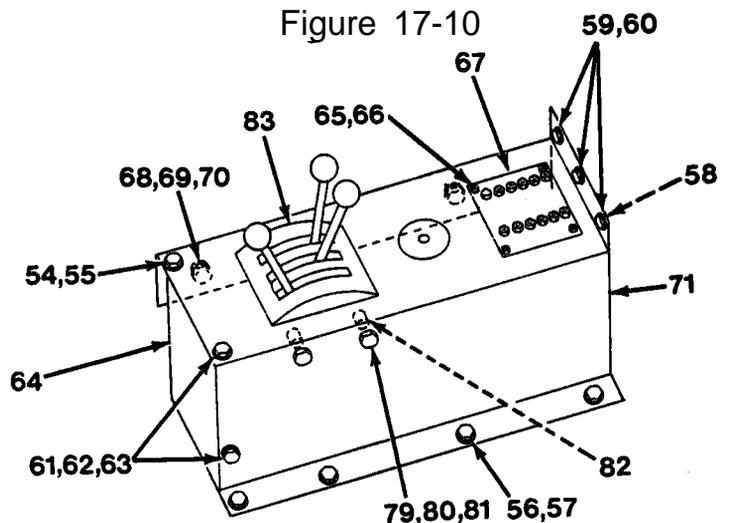


Figure 17-8

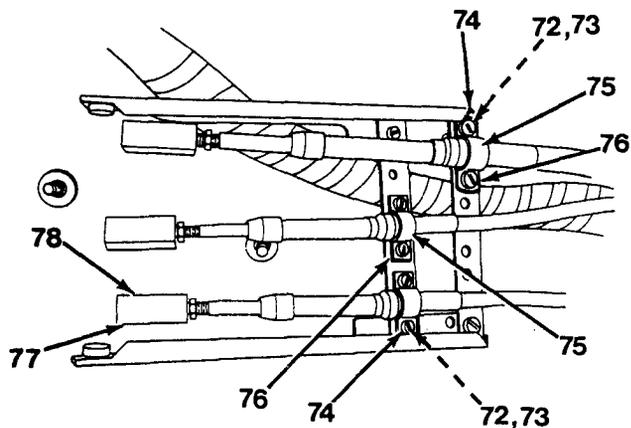


Figure 17-9

RIGHT HAND DASH

26. Position cable terminal as recorded during disassembly and install three pins (78) and cotter pins (77, Figure 17-9).
27. Install three shims (76), clamps (75), six cap screws (74), lockwashers (73) and nuts (72).
28. Rotate right-hand dash (71, Figure 17-8) 1/4 turn and position it in cab.
29. Install two washers (70), lockwasher (69) and cap screw (68).
30. Install but DO NOT TIGHTEN washers (55), cap screws and nuts (54), cover (64), washers (63), lockwashers (62), cap screws (61), washer (60), cap screw (59), nuts (58), washers (57) and nuts (56).
31. Tighten cap screws and nuts (54), cap screws (61), cap screws (59) and nuts (56).
32. Install circuit breaker panel (67), four lockwashers (66) and cap screws (65). If circuit breaker panel was completely remove (refer to page 17-66).
33. Install bubble level, if removed (refer to page 17-52).
34. Install seat (refer to page 14-12).
35. Connect battery negative ground cable.

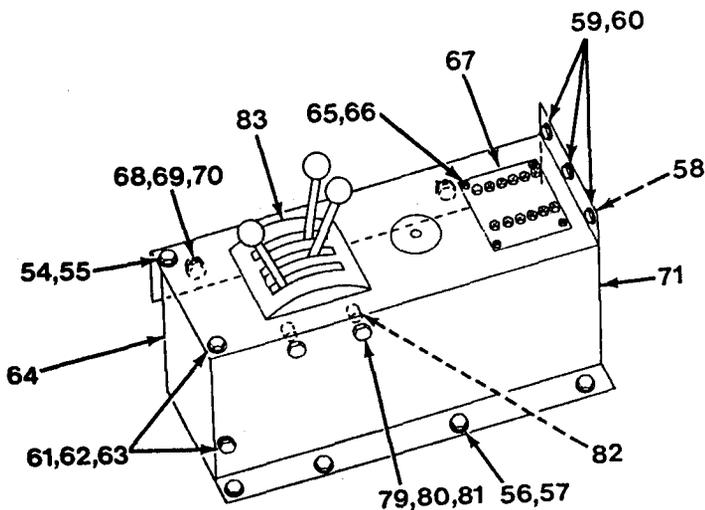


Figure 17-8

SPEEDOMETER ALARM TEST

1. Remove lower dash panel (refer to page 13-114, step 2).
2. Strip both ends of a 18in. (457 mm) piece of 14-gauge wire back approximately 0.50 in. (12.7 mm).
3. Turn ignition switch ON.
4. Touch one end of wire to negative terminal on back of speedometer alarm (wire no. 33 is attached to it) and the other to a good ground.
5. Speedometer alarm should sound when ground contact is made. If not, check for 24 volts at positive terminal of speedometer alarm. If 24 volts is present, replace speedometer alarm.
6. Install lower dash (refer to page 13-115, step 5).

ADJUSTMENT OF TACHOMETER

1. Remove lower dash panel (refer to page 13-114, step 2).
2. Connect STE-ICE VTM (refer to page 5-1).
3. Perform STE-ICE Test 10, and with small screwdriver adjust tachometer with set screw on rear of tachometer to match VTM reading at governed speed, no load.
4. Install lower dash panel (refer to page 13-115, step 5).

CHAPTER 18
TYPE II SUPPLEMENT

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TYPE II ENGINE AND TRANSMISSION ASSEMBLY

TYPE II ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

1. Rotate upperstructure and boom to an attitude of 90 degrees to carrier frame.
2. Remove sliding engine hood (refer to page 14-22).
3. Remove nut (1), capscrew (2), plate (3), spacer (4) and two clamps (5) from hoses (6) and (7). Remove two nuts (8) and lockwashers (9). Loosen nut (10) on T-clamp (11) and remove 90-degree elbow (12) and stack cap (13). Disconnect restriction indicator hose (14) from restriction indicator (15, Figure 18-1).
4. Remove six nuts (16) washers (17) and hood support (18).

⚠ WARNING

Remove jewelry and disconnect battery negative ground cable before performing maintenance on this equipment. Failure to follow this procedure could cause DEATH or serious injury.

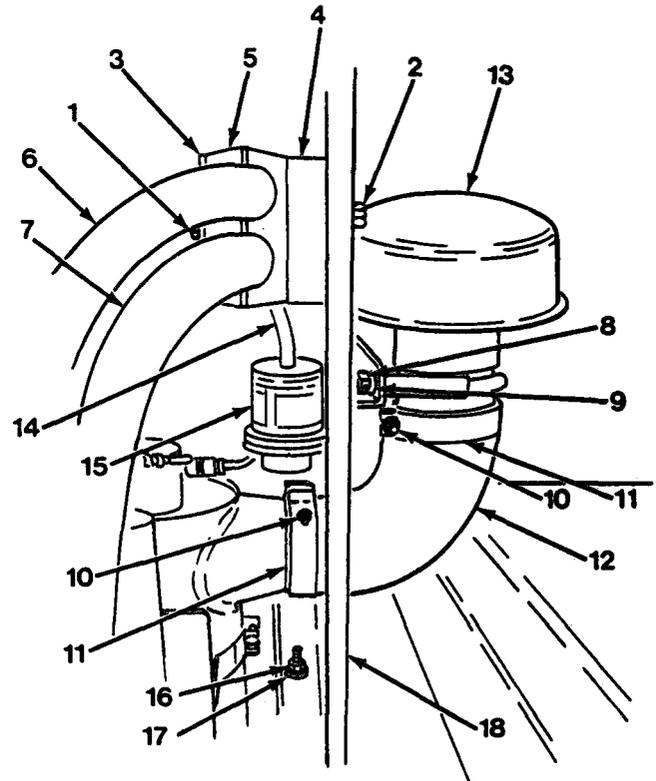


Figure 18-1

5. Disconnect battery negative ground cable.

TYPE II ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

6. Remove radiator and oil cooler (refer to page 9-5).

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

7. Disconnect all electrical connections (19, Figure 18-2) from alternator, starter and temperature and pressure sending units. Remove all mounting hardware from wiring harness.

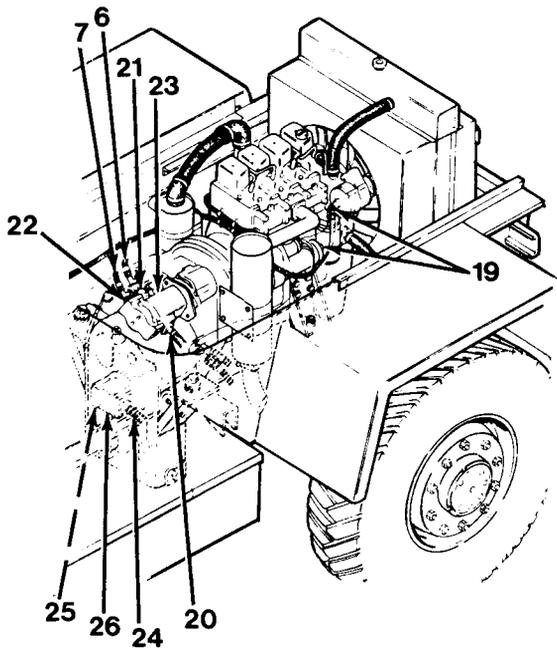


Figure 18-2

NOTE

- Drain fluids from engine (refer to page 3-47) and transmission (refer to page 3-50).

- Tag all hose and tube assemblies before disconnecting to aid in installation. Cap and plug all ports. Remove caps, plugs and tags following maintenance.

8. Disconnect hoses (6) and (7) from charge pump on the top right-hand side of transmission. Secure hoses out of the way for removal.
9. Disconnect hoses (20), (21) and (22) from main hydraulic pump (23). Remove hoses (24) and (25) from ground driven steering pump (26) on the transmission (refer to pages 13-44 and 13-37).
10. Remove two cotter pins (27) to disconnect two control cables (28) from transmission control valve (29). Loosen two jam nuts on each cable (28) and remove cables from mounting bracket. Remove two oil coder hoses (30) and (31, Figure 18-3) from the left side of transmission.
11. Disconnect fuel hoses (32) and (33) (refer to page 7-18). Disconnect injector pump throttle cable (34) and disconnect cold start cable (35, Figure 18-4).

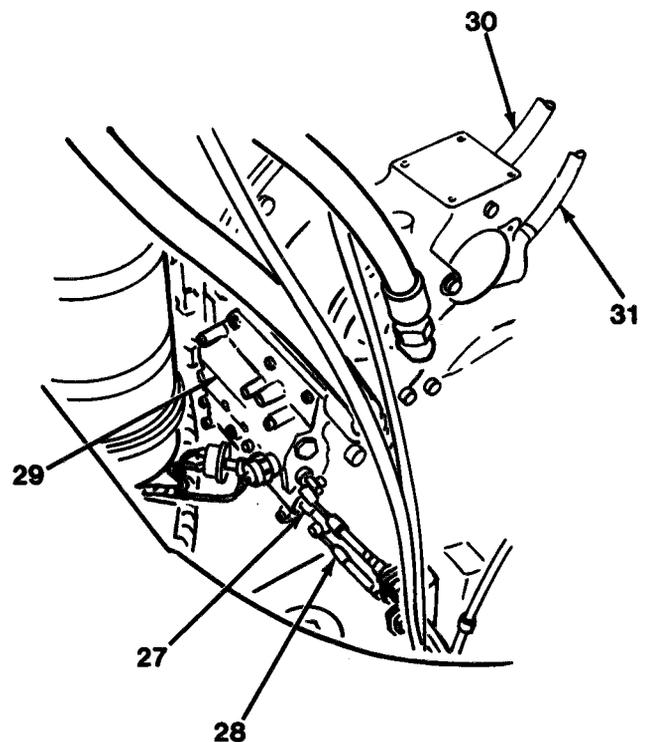


Figure 18-3

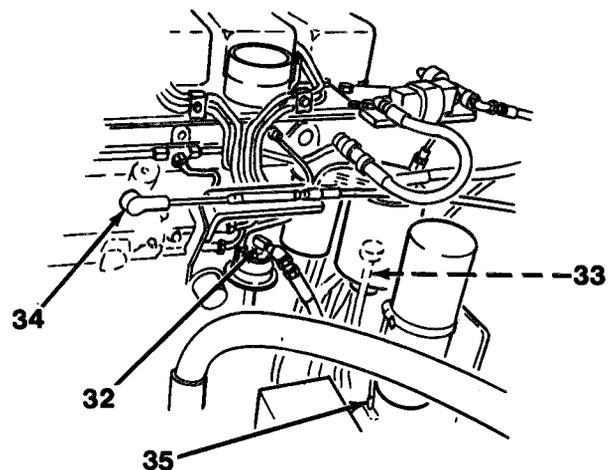


Figure 18-4

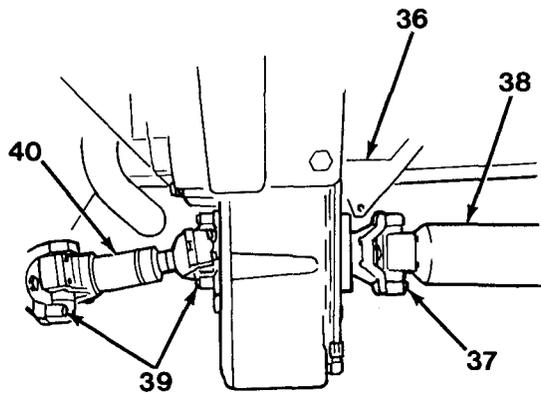


Figure 18-5

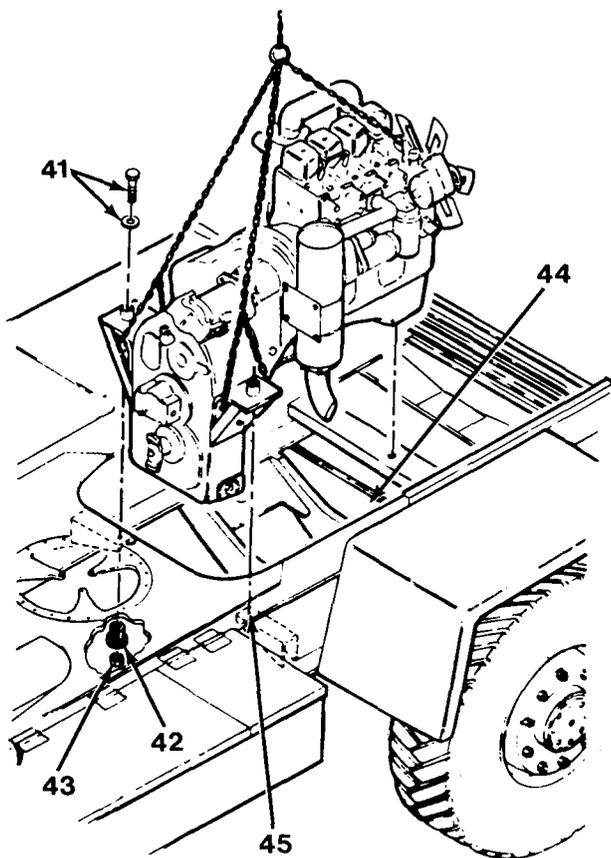


Figure 18-6

TYPE II ENGINE AND TRANSMISSION ASSEMBLY REMOVAL

12. Remove shift bracket (36, Figure 18-5) as an assembly from above front drive shaft (refer to page 11-80).
13. Remove four capscrews (37) and disconnect front drive shaft (38) from transmission. Support front drive shaft on suitable blocks.
14. Remove eight capscrews (39) and rear drive shaft (40) from transmission and rear axle.
15. Engine/transmission assembly is mounted at four points with rubber shock mounts, two on the left side and two on the right side of transmission and engine. Remove four capscrews and washers (41), spacers (42), and nuts (43) securing engine at the four locations (44) and (45, Figure 18-6). Check to make sure the path up and out of frame is clear of hoses, wires and brackets.

⚠ WARNING

Weight of engine/transmission assembly is approximately 1,800 lb (816 kg). Use adequate lifting equipment to lift and support engine/transmission assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

16. Attach hoist and chains to front engine lift eye and rear transmission mounts. Gradually hoist engine/transmission assembly up, guiding it slightly forward to clear hydraulic pump on the rear of transmission. Move engine transmission assembly away from carrier.

17. Lower engine transmission assembly on to a suitable support stand.

REMOVE TRANSMISSION FROM ENGINE

1. Engine flywheel is bolted to transmission converter drive plate with 12 capscrews (46). Access to these capscrews (46) is through engine side of flywheel housing. Remove capscrews (47), cover plate (48), and plug (49, Figure 18-7) on the right side of flywheel housing.
2. With a barring tool or large screwdriver, rotate ring gear through plug (49) access hole until each capscrew (46) is lined up with access hole (50). Use a 9/16 in. socket and remove 12 capscrews (46).

WARNING

Weight of transmission is approximately 1,100 lb (499 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

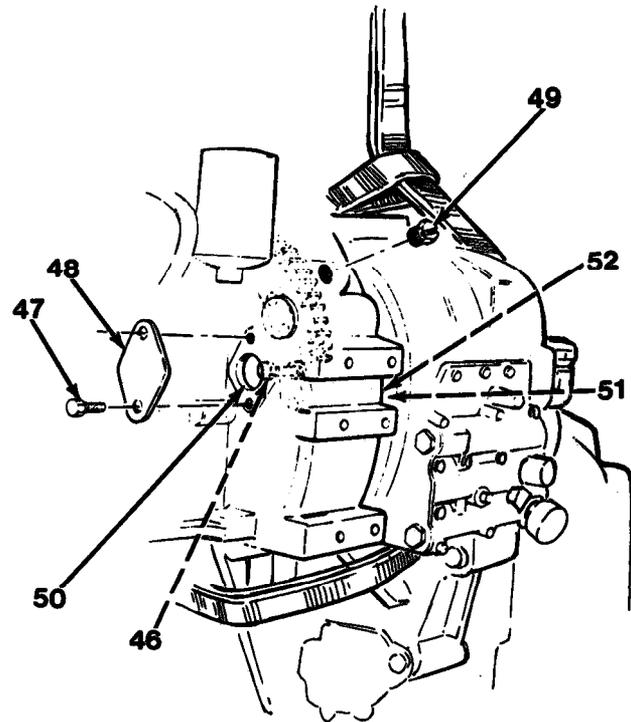


Figure 18-7

3. Attach hoist and sling around converter housing on transmission.
4. With transmission supported, remove 12 (M10-1.50 x 35 mm) capscrews (51) and lockwashers (52) from transmission and flywheel housing.

REMOVE TRANSMISSION FROM ENGINE

5. Pull transmission straight out of flywheel housing and support it on a suitable work stand.
6. Repairs to or replacement of transmission can now be made. If changing to a new transmission, remove and transfer all adapters and mounting brackets. Capscrews fastening mounting brackets to transmission require a torque of 260 lb-ft (352 N•m). Plug openings in replaced transmission before sending it off to the repair shop.
7. If necessary for repair of transmission, remove main hydraulic pump and ground driven steering pump (refer to pages 13-37 and 13-44).

INSTALL TRANSMISSION TO ENGINE

1. Examine capscrews for damaged threads. Check flywheel ring gear for condition before attaching transmission.
2. Using a dial indicator, check engine crankshaft end play. It should be from 0.005 to 0.010 in. (0.13 to 0.25 mm). The same end play should be present after attaching transmission.
3. Install a 3/8-24 x 2 1/4 threaded guide stud, with a screwdriver slot in the end, into one of the threaded inserts on converter drive plate from engine side.
4. Rotate flywheel until one of the holes in flywheel is aligned with flywheel access hole (50, Figure 18-7).

⚠ WARNING

Weight of transmission is approximately 1,100 lb (499 kg). Use adequate lifting equipment to lift and support transmission. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

5. Support and align transmission to flywheel. Align protruding stud from drive plate face with mounting holes in flywheel aligned in step 4.

DO NOT FORCE TRANSMISSION AT ANY TIME. Forcing transmission into pilot sleeve of flywheel can preload crankshaft and cause engine and transmission damage.

6. Push transmission into engine.
7. Install 12 lockwashers (52) and capscrews (51) to transmission and flywheel housing.
8. Check crankshaft end play and compare measurement with what was observed in step 2. No end play can mean crankshaft has been preloaded. Do not proceed until the reason for preload has been determined and corrected.
9. Remove guide stud then install capscrews (46) one by one through access hole (50) and through flywheel into drive plate. Hand tighten all the way around. With a torque wrench, torque capscrews (46) to 31 ± 2 lb-ft (42 ± 3 N•m).

10. Recheck crankshaft end play and compare it with what was observed in step 2. No end play can mean the crankshaft has been preloaded. Do not proceed until the reason for preload has been determined and corrected. When satisfactory, replace cover plate (48), capscrews (47) and plug (49).

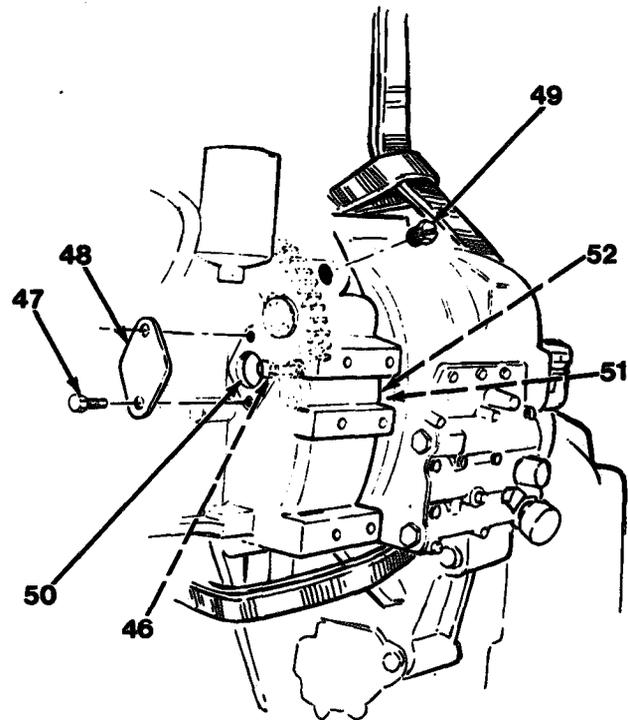


Figure 18-7

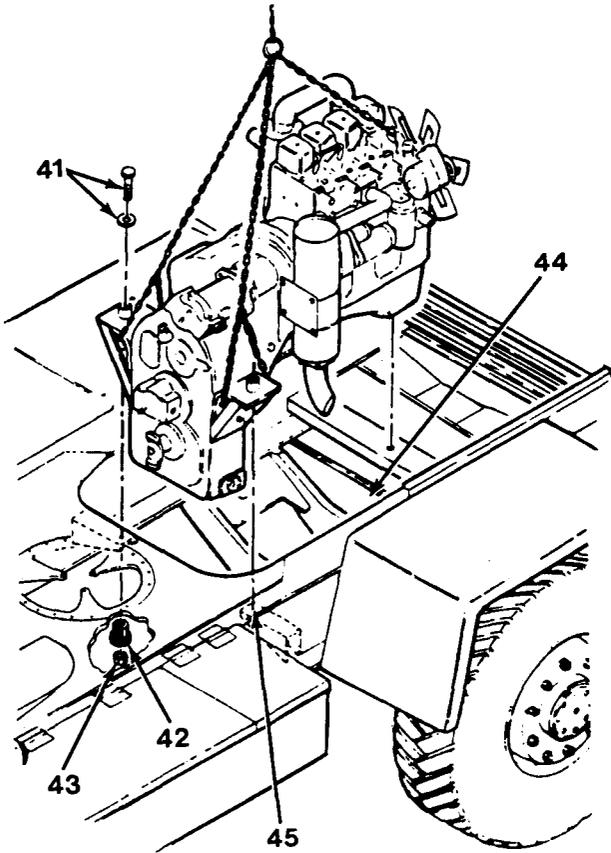


Figure 18-6

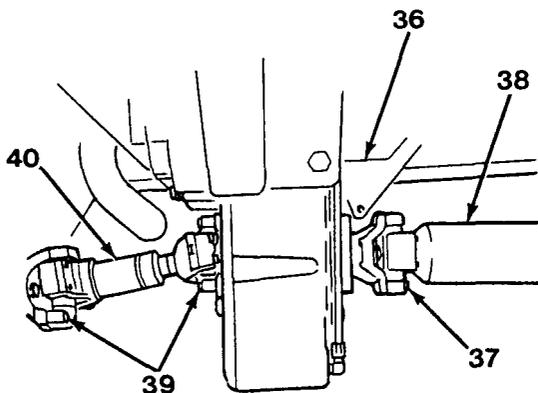


Figure 18-5

INSTALL TRANSMISSION TO ENGINE

11. If hydraulic pumps have been removed, install ground driven steering pump and main hydraulic pump (refer to pages 13-45 and 13-38).

Engine/transmission assembly is ready to return to carrier frame.

TYPE II ENGINE AND TRANSMISSION ASSEMBLY INSTALLATION

When the reassembled engine/transmission assembly is ready for installation, check rubber cushion mounts for deterioration or distortion. Replace if condition warrants. Examine all connecting components to make sure they are in position to install.

⚠ WARNING

Weight of engine/transmission assembly is approximately 1,800 lb (816 kg). Use adequate lifting equipment to lift and support engine transmission assembly. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

1. Using hoist and chains, lower engine/transmission assembly into position over frame. Slowly lower and guide assembly back into its location in frame. Install four spacers (42), washers and capscrews (41), and nuts (43) to four mounting locations (44) and (45, Figure 18-6) and tighten.
2. Install rear drive shaft (40) and eight capscrews (39, Figure 18-5) to transmission and

3. Connect front drive shaft (38) and install four capscrews (37) to transmission. Torque four capscrews (37) to 50 lb-ft (68 N•m).
4. Install shift bracket (36) as an assembly (refer to page 11-81) and adjust assembly (refer to page 17-49).
5. Connect cold start cable (35), injector pump throttle cable (34) and fuel hoses (32) and (33, Figure 18-4).

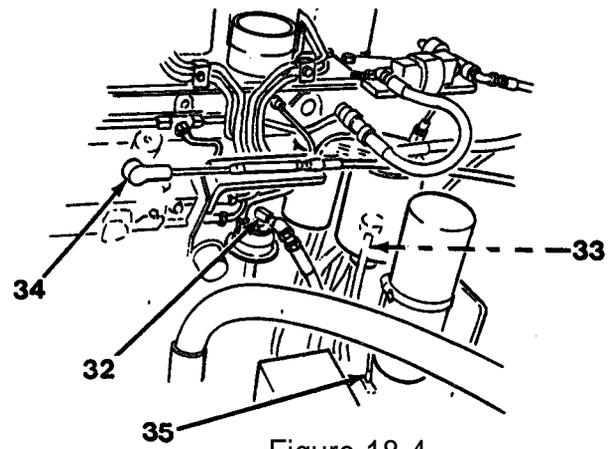


Figure 18-4

6. Connect transmission oil cooler hoses (30) and (31). Using two cotter pins (27), connect two control cables (28) to control valve (29, Figure 18-3) on right-hand side of transmission.
7. Connect control cables in their mounting bracket and tighten two jam nuts on each cable. Check and adjust cable (refer to page 17-49).
8. Connect hoses (24) and (25) to ground driven steering pump (26) and hoses (20), (21) and (22) to main hydraulic pump (23, Figure 18-2) (refer to pages 13-45 and 13-38).

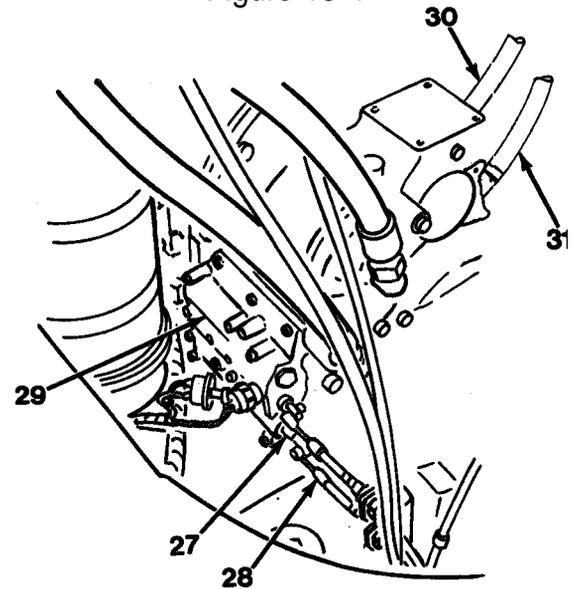


Figure 18-3

9. Connect filter hoses (6) and (7) to charge pump on top right-hand side of transmission.
10. Connect all electrical connections (19) to temperature and pressure sending units, alternator and starter.
11. Install radiator and oil cooler (refer to page 9-10).
12. Connect battery negative ground cable.

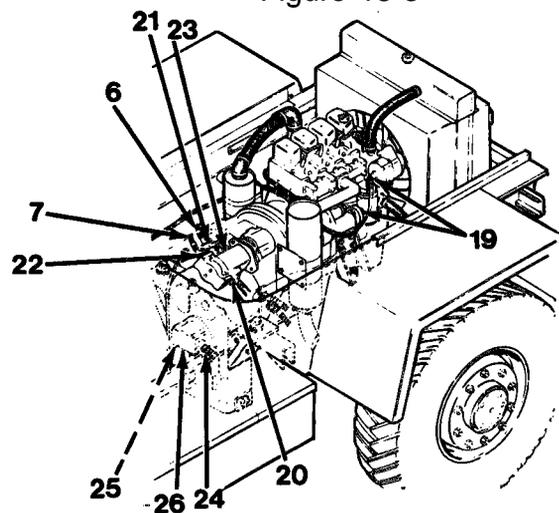


Figure 18-2

ENGINE AND TRANSMISSION INSTALLATION

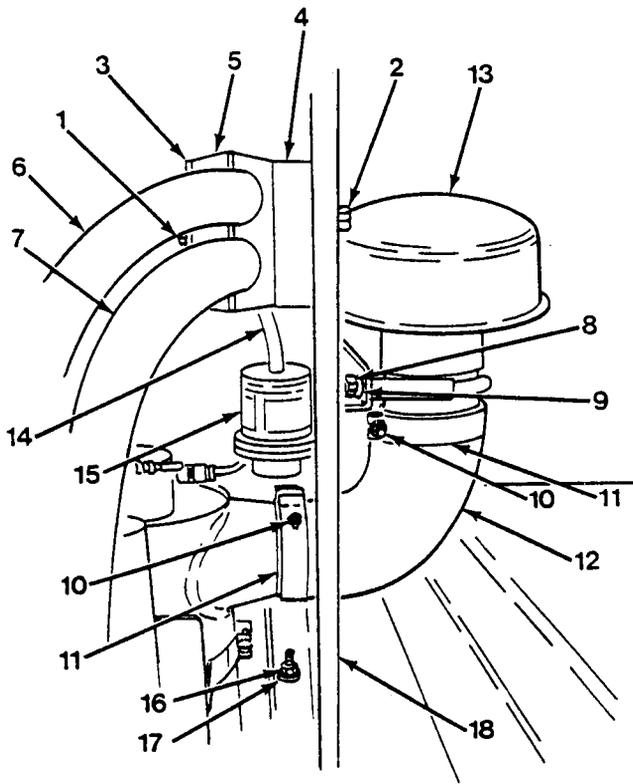


Figure 18-1

13. Install hood support (18), six washers (17) and nuts (16, Figure 18-1) on frame.
14. Connect restriction indicator hose (14) to restriction indicator (15). Install stack cap (13), 90-degree elbow (12) and T-clamps (11). Tighten nuts (10). Install two lock-washers (9) and nuts (8). Install two clamps (5), spacer (4), plate (3), capscrew (2) and nut (1) on hoses (6) and (7).
15. Fill engine and transmission with proper fluids to proper levels (refer to pages 3-47 and 3-50).
16. Check that everything has been connected and installed, all connections are tight and no leaks are evident.
17. Install sliding engine hood (refer to page 14-23).
18. Conduct a start-up to check out operation of unit.

MAST ASSEMBLY**MAST ASSEMBLY DISASSEMBLY****NOTE**

Do not disassemble unless mast assembly is not turning freely.

1. Remove four capscrews (1), washers (2), cap (3), spacer (4) and shims (5) from swivel (6), Figure 18-1).
2. Remove swivel (6) and spud (7) from mast (8).
3. Using a bearing puller, separate swivel (6) from spud (7).
4. Remove one cone (9) and two cups (10) from swivel (6).
5. Remove one cone (9) from spud (7).

**MAST ASSEMBLY CLEANING/
INSPECTION**

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

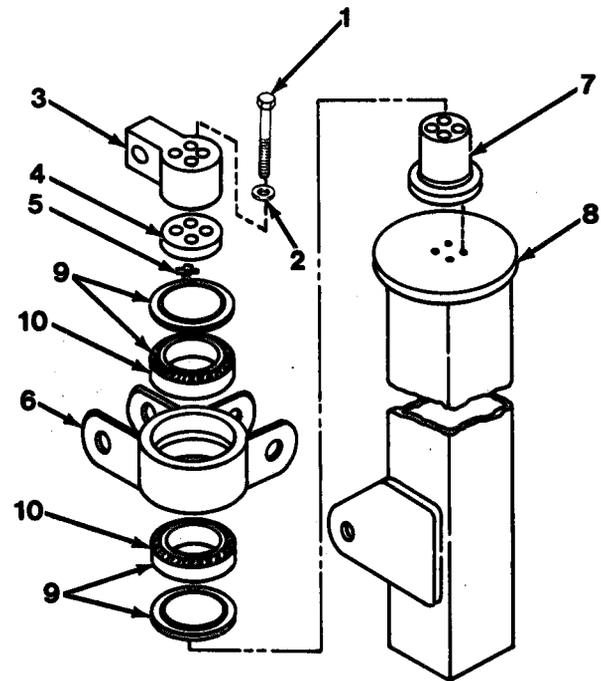


Figure 18-1

MAST ASSEMBLY ASSEMBLY

CAUTION

There is a limit to which gaging material will compress, thus resulting in a false measurement. If 0.12 in. (3.0 mm) material crushes to below 0.05 in. (1.3 mm), remeasure using 0.06 in. (1.5 mm) material.

NOTE

If using new parts, before installing cap and capscrews, place one piece of either 0.12 in. (3.0 mm) or 0.06 in. x 2.00 in. (1.5 x 50.8 mm) gauging material across end of spud. Install cap and capscrews and evenly torque until no end play is felt in bearing, and slight resistance is felt in bearing rotation. Remove capscrew, cap and gauging material. Measure, using a micrometer, to find proper shim pack requirement. Build up shim pack equal to or up to 0.002 in. (0.05 mm) thicker than measurement.

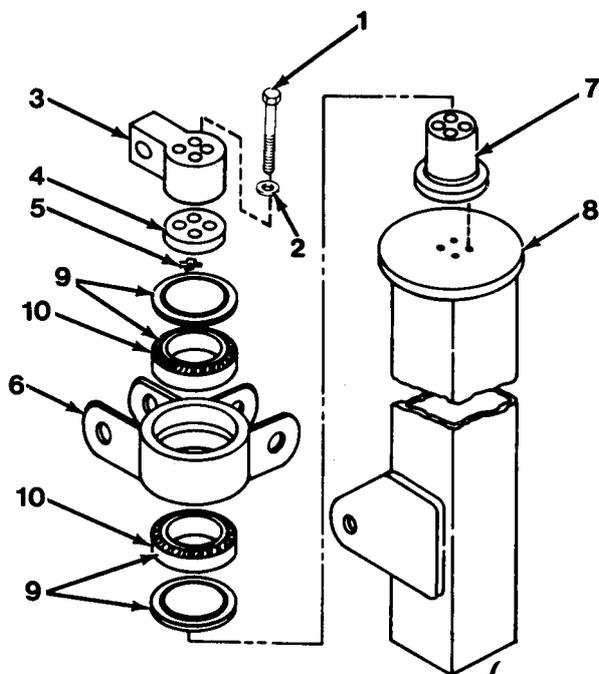


Figure 18-1

1. Install spud (7) to mast (8, Figure 18-1),
2. Pack cups (10) with grease ML-G- 10924.
3. Install two cups (10) and cones (9) into swivel (6).
4. Press and install swivel (6) onto spud (7).
5. Install shims (5), spacer (4), cap (3), four washers (2) and capscrews (1) to swivel (6). Torque capscrews (1) to 74 lb-ft (100 N•m),

PIVOT BEARINGS

PIVOT BEARINGS DISASSEMBLY

NOTE

Do not disassemble unless pivot is not turning freely.

1. Remove two capscrews (1), washers (2), cap (3) and shims (4) from housing assembly (5, Figure 18-1).
2. Using a bearing puller, remove housing assembly (5) from frame spud (8).
3. Remove cone (6) and two cups (7) from housing (5).
4. Remove cone (6) from spud (8).

PIVOT BEARINGS CLEANING/ INSPECTION

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

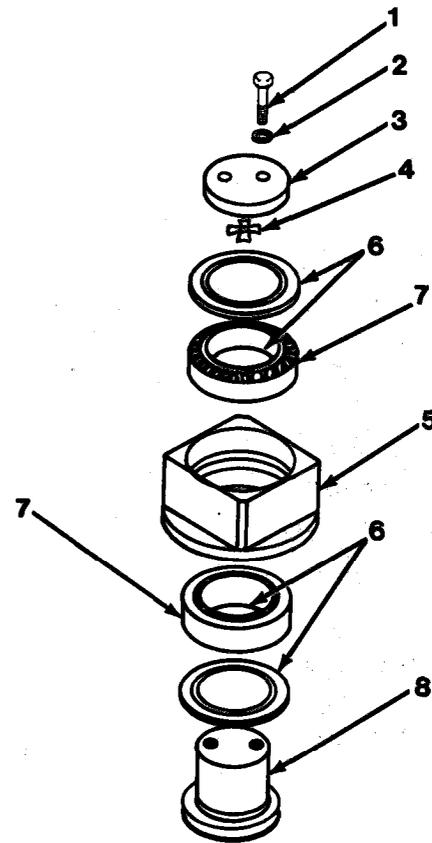


Figure 18-1

PIVOT BEARINGS ASSEMBLY

CAUTION

There is a limit to which gaging material will compress, thus resulting in a false measurement. If 0.12 in. (3.0 mm) material crushes to below 0.05 in. (1.3 mm), remeasure using 0.06 in. (1.5 mm) material.

NOTE

If using new parts, before installing cap and capscrews, place one piece of either 0.12 in. (3.0 mm) or 0.06 in. x 2.00 in. (1.5 x 50.8 mm) gauging material across end of spud. Install cap and capscrews and evenly torque until no end play is felt in bearing, and slight resistance is felt in bearing rotation. Remove capscrew, cap and gauging material. Measure, using a micrometer, to find proper shim pack requirement. Build up shim pack equal to or up to 0.002 in. (0.05 mm) thicker than measurement.

6. Install shims (4), cap (3), two washers (2) and capscrews (1) to housing assembly (5). Torque two capscrews (1) to 74 lb-ft (100 N•m).

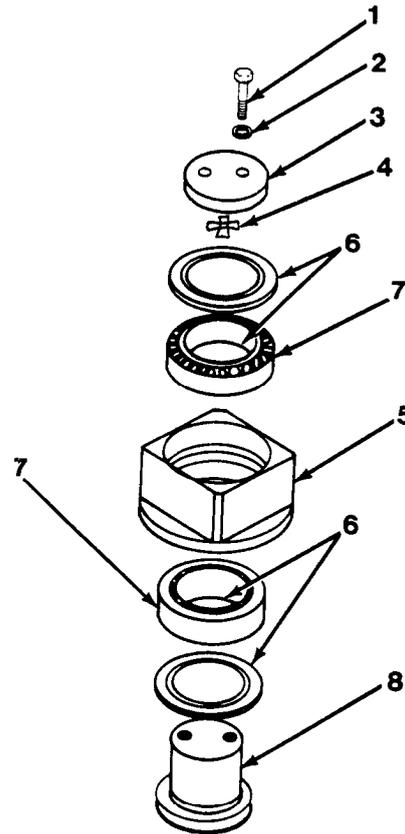


Figure 18-1

1. Pack bearings with grease MIL-G-10924,
2. Install two cups (6) and one cone (7) into housing (5, Figure 18-1).
3. Install housing assembly (5) onto frame spud.
4. Install one cone (7) onto spud (8).
5. Apply Loctite 242 on threads of two capscrews (1).

TRUSS ROD

TRUSS ROD DISASSEMBLY

NOTE

Do not disassemble truss rod unless replacement of rod end or truss is necessary. Adjustment of length has been set at factory and should not require readjusting unless the assembly is being replaced as a unit.

1. Loosen jam nut (1) and remove rod end (2) from truss rod (3, Figure 18-1).
2. Remove jam nut (1) from rod end (2).

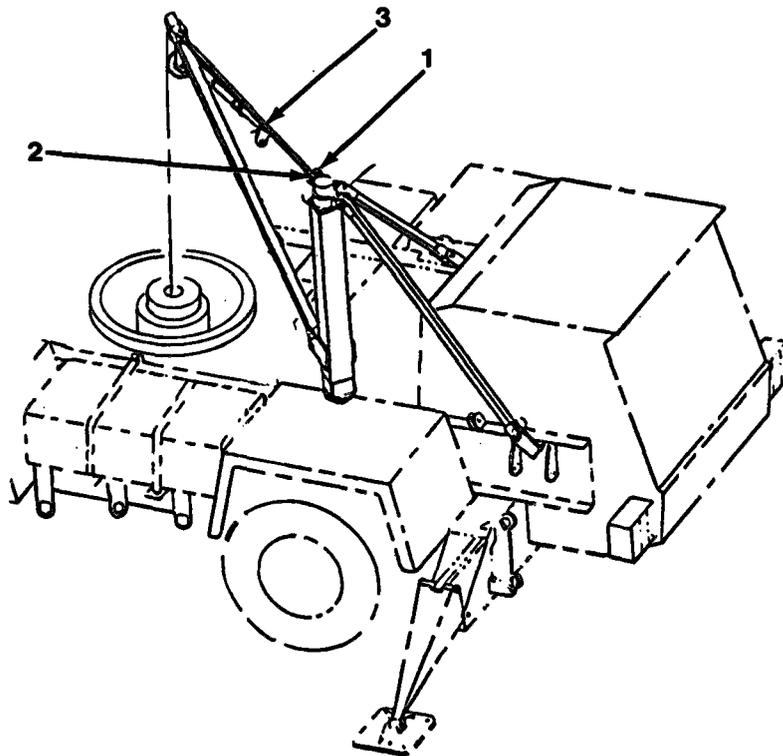


Figure 18-1

TRUSS ROD ASSEMBLY

1. Install jam nut (1) on rod end (2, Figure 18-1).
2. Install rod end (2) into truss rod (3). Do not tighten jam nut at this time.
3. Assemble mast assembly per Koehring Cranes and Excavators Operator's Manual.
4. Raise boom to full hoist position (refer to Koehring Cranes and Operators Manual).
5. With a plumb bob connected to the sheave bracket, adjust the rod end in or out until plumb bob hangs 1.00 in. (25.4 mm) from center of collector ring closer to mast assembly.
6. Tighten jam nut (1).
7. Disassemble mast assembly and stow components per Koehring Cranes and Excavators Operator's Manual.
8. Lower boom to travel position (refer to Loehring Cranes and Excavators Operator's Manual).

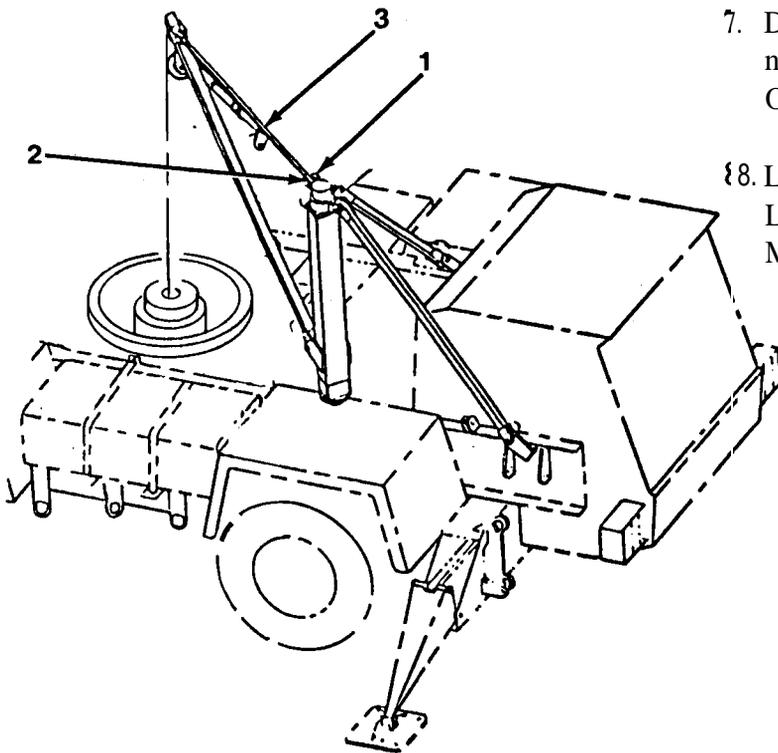


Figure 18-1

ROTARY MANIFOLD QUICK DISCONNECTS

ROTARY MANIFOLD QUICK DISCONNECTS REMOVAL

1. Start engine and raise boom to a height suitable to provide access to the inside of upperstructure frame.

 **WARNING**

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

2. Use lifting device to support boom.
3. Shut engine off.

 **WARNING**

Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause SERIOUS INIURY.

4. Turn dipstick cap 1/4 turn to safety notch to relieve pressure.
 5. Release all line pressure by turning ignition switch ON and operating control levers for boom, hoist extend and winch in the operator's compartment. Turn ignition switch OFF.
-

ROTARY MANIFOLD QUICK DISCONNECTS REMOVAL

NOTE

- Remove lower hoses frost and using a suitable container, catch oil that drains from manifold and lines.
- Tag all hose assemblies before disconnecting to aid in installation, Cap and plug all ports. Remove caps, plugs and tags following maintenance.
- Record port number stamped on manifold and type of adapter in each port before removing hose,

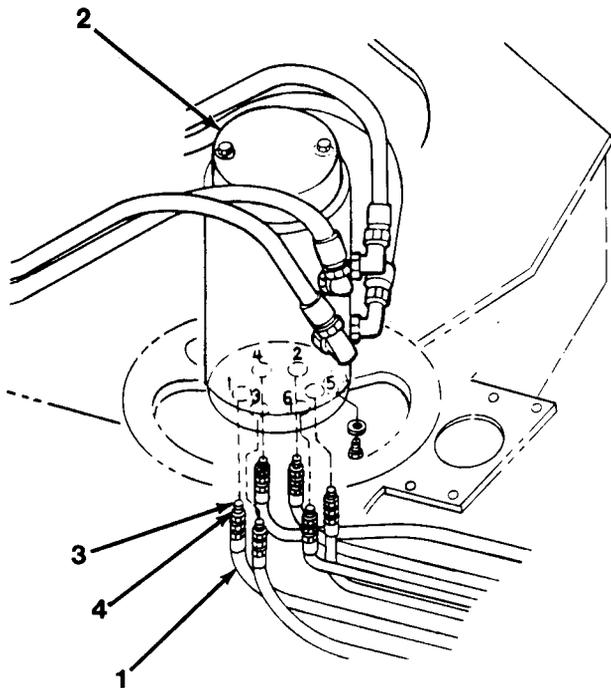


Figure 18-1

6. Disconnect six hoses (1) from bottom of manifold (2). Remove six adapters (3) and O-rings (4, Figure 18-1) from bottom of manifold (2),

NOTE

Record port number stamped on manifold and type of quick disconnect in each port before removal,

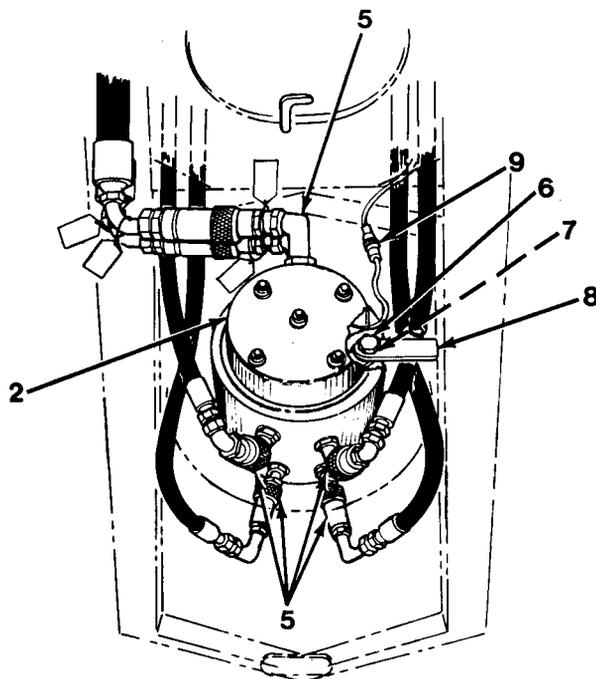


Figure 18-2

7. Disconnect six hoses and remove six quick disconnects and elbows (5) from side of manifold (2, Figure 18-2).
8. Remove stop pin (6) and lockwasher (7) from ear (8) attached to side of upperstructure.

NOTE

Tag all wire assemblies before disconnecting to aid in installation. Remove tags following maintenance.

9. Disconnect electrical connector (9) that is attached to electrical collector ring.
10. Disconnect electrical connectors (10) on bottom of manifold (2, Figure 18-3) (refer to page 10-57).
11. Remove three capscrews (11) and washers (12) from bottom of manifold (2).
12. Loosen axle lockout valve mounting nuts (refer to page 13-89).

⚠ WARNING

Weight of manifold is approximately 200 lb (91 kg). Use adequate lifting equipment to lift and support manifold. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

13. Using hoist and sling, remove manifold (2) by lifting and turning it at the same time to clear stop pin ear (8, Figure 18-2) on upper-structure as manifold (2) is removed.

ROTARY MANIFOLD QUICK DISCONNECTS CLEANING/inspection

1. Clean all parts (refer to Chapter 2).
2. Inspect all parts (refer to Chapter 4).

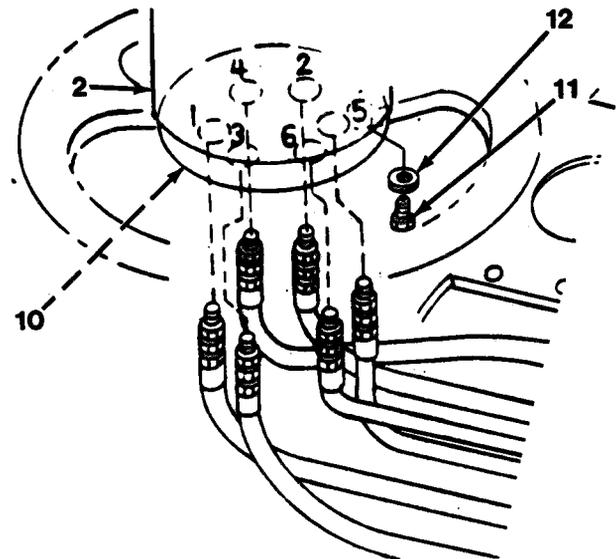


Figure 18-3

ROTARY MANIFOLD QUICK DISCONNECTS INSTALLATION

⚠ WARNING

Weight of manifold is approximately 200 lb (91 kg). Use adequate lifting equipment to lift and support manifold. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

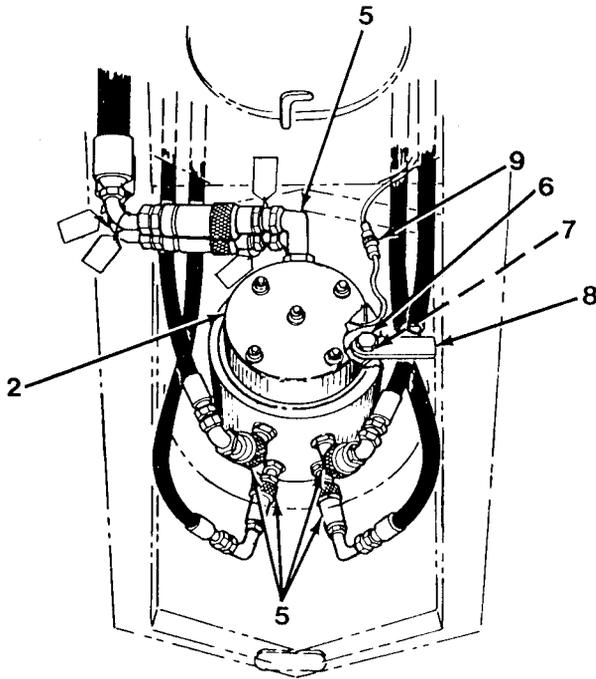


Figure 18-2

1. Using hoist and sling, install rotary manifold (2) by lifting manifold (2) over opening in carrier and lowering down and turning manifold (2) to avoid stop pin ear (8, Figure 18-2) located on upperstructure.
2. Align ear on side of manifold (2) to the hole in stop pin ear (8). Install stop pin (6) and lockwasher (7) through stop pin ear (8) into manifold (2).
3. Install three washers (12) and capscrews (11) through frame and into bottom of manifold (2, Figure 18-3).

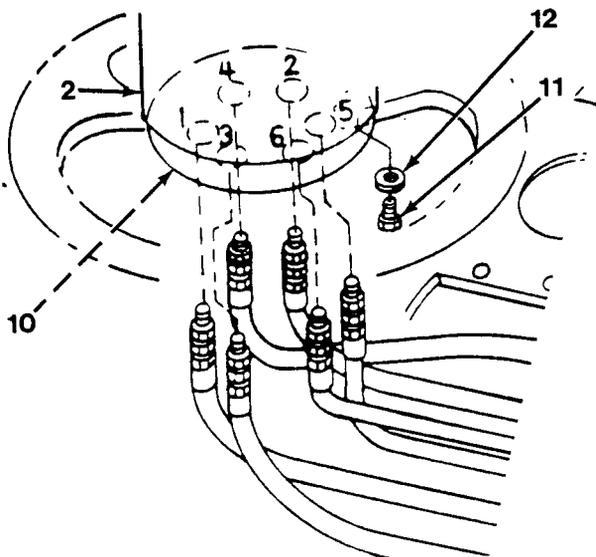


Figure 18-3

4. Install O-rings (4) and adapters (3) and connect six hoses (1) to bottom of manifold (2, Figure 18-1).
5. Install six quick disconnects and elbows (5, Figure 18-2) and six hoses to side of manifold (2).
6. Install electrical leads (10) to bottom of manifold (2, Figure 18-3) (refer to page 10-62, step 19).
7. Install electrical lead (9) to electrical collector ring at top of manifold (2, Figure 18-2).

⚠ WARNING

Weight of boom is approximately 3,100 lb (1,406 kg). Use adequate lifting equipment to lift and support boom. Do not lift over personnel or let personnel walk underneath suspended load. Failure to follow this procedure could cause DEATH or serious injury.

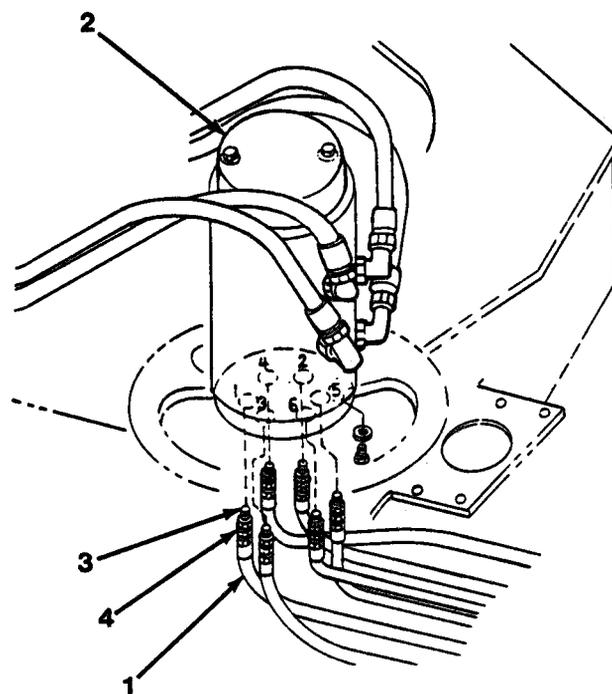


Figure 18-1

8. Remove Ming device from boom.
9. Adjust axle lockout valve (refer to page 13-90).
10. Close dipstick cap. Start engine and operate control levers for boom hoist, extend and winch several times to remove any air trapped in the system. Check hydraulic oil level. Fill to proper level, if necessary (refer to Koehring Commercial Operation Instructions manual).
11. Return boom to travel position.

TYPE II FENDERS AND DECK

Type II Maintenance Procedures differ from Type I only in that front fenders have only five washers and nuts holding each fender and tool box itself is not removable.

Refer to Chapter 14 for Frame, Fender and Deck Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II BOOM

Type II Work Light Bracket Removal consists of removing a capscrew (1), lockwasher (2) and bracket (3, Figure 18-1). Installation is reverse of removal.

All other Type I and Type II Maintenance Procedures are identical. Refer to Chapter 15 for Boom Maintenance and the Koehring Commercial Parts Manual for parts.

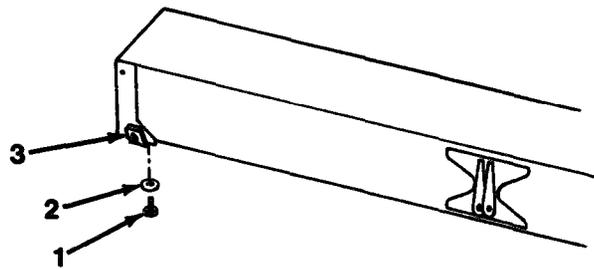


Figure 18-1

TYPE II MARKING DECALS

Type I and Type II Maintenance Procedures are identical.

Refer to Chapter 14 for Marking Decal Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II REAR ELECTRICAL

Type I and Type II Maintenance Procedures are identical.

Refer to Chapter 10 for Rear Electrical Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II HEATER

Type I and Type II Maintenance Procedures are identical,

Refer to Chapter 17 for Heater Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II FUEL TANK

Type 1 and Type II Maintenance Procedure are identical.

Refer to Chapter 7 for Fuel Tank Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II PINTLE HOOK

Type I and Type II Maintenance Procedures are identical.

Refer to Chapter 14 for Pintle Hook Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II OUTRIGGERS

Type 1 and Type II Maintenance Procedure are identical.

Refer to Chapter 14 for Outrigger Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II TRANSMISSION SHIFT ASSEMBLY

Type II Transmission Shift Assembly differs from the Type I only in clamps and clamp hardware.

All other Type I and Type II Maintenance Procedures are identical. Refer to Chapter 17 for Transmission Shift Assembly Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II UPPERSTRUCTURE

Type I and Type II Maintenance Procedures are identical.

Refer to Chapter 15 for Upperstructure Maintenance and the Koehring Commercial Parts Manual for parts.

TYPE II GENERAL HOSE REPLACEMENT AND HYDRAULIC QUICK DISCONNECTS

Type I and Type II Maintenance Procedures are identical.

Refer to Chapter 13 for General Hose Replacement and the Koehring Commercial Parts Manual for parts.

TM5-3810-305-24

CHAPTER 19
PREPARATION FOR SHIPMENT

Title	Page
Reparation for Shipment	19-1

PREPARATION FOR SHIPMENT

When vehicle is pulled out of storage to be shipped, it must be restored to active service according to the instructions in Chapter 20.

Shipping instructions are found in the Transportability Section of the Koehring Commercial Operation Instructions manual.

CHAPTER 20
STORAGE

Title	Page
Machine Storage	20-1
Short-Term Storage (30 Days or Less)	20-1
Long-Term Storage (More Than 30 Days)	20-2
Restoration to Service	20-4
Restoring Engine to Service	20-5
Restoring Transmission to Service	20-5

MACHINE STORAGE

Machines being placed in storage must be adequately protected from deterioration during the period of idleness. This will insure that they can be restored to active service with a minimum effort.

Determine the amount of time that the machine will be in storage. This will determine which procedure will be followed in preparing the crane. Storage procedures for 30 days or less will be found under Short-Term Storage. Storage procedures for more than 30 days will be found under Long-Term Storage.

SHORT-TERM STORAGE (30 DAYS OR LESS)

The crane should be thoroughly cleaned, lubricated and painted surfaces retouched anywhere paint has deteriorated. Exposed portions of all hydraulic cylinder rods should be coated with multipurpose grease. Coat unpainted metal surfaces with multipurpose grease after removing any rust accumulation.

When an engine is to be stored or removed from operation for a period of time, special precautions should be taken to protect the interior and exterior of the engine, transmission and other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

It will be necessary to remove all rust or corrosion completely from any exposed part before applying a rust-preventive compound. Therefore, it is recommended that the engine be processed for storage as soon as possible after removal from operation.

1. Drain the engine crankcase of oil.
2. Fill the crankcase to the proper level with the recommended viscosity and grade of oil.
3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for 2 minutes at 1,200 rpm and no load.

NOTE

Do not drain the fuel system or the crankcase after this run.

4. Check the air cleaner and service it, if necessary.
5. If freezing weather is expected during the storage period, check the antifreeze for the low freeze point capability.
6. Clean the entire exterior of the engine (except the electrical system) with fuel oil and dry it with compressed air.
7. Seal all of the engine openings. The material used for this purpose must be waterproof, vaporproof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

The following procedures will prepare a transmission for a storage period of 30 days or less:

1. Drain the transmission oil and remove the transmission oil filter element.
2. Install the drain plugs and new oil filter element.
3. Refill to operating level with lubricating oil MIL-L-2104, grade low.

SHORT-TERM STORAGE (30 DAYS OR LESS)

CAUTION

Do not allow temperature to exceed 250 degrees F (121 degrees C). Failure to follow this procedure could cause damage to equipment.

4. Operate the unit for at least 5 minutes at a minimum of 1,000 rpm. Shift the transmission slowly through all selector positions to thoroughly distribute the oil, then stall the converter to raise the oil temperature to 225 degrees F (107 degrees C).
5. As soon as the unit is cool enough to touch, seal all openings and breathers with moisture-proof tape.
6. Coat all exposed, unpainted surfaces with a good grade of preservative grease, such as Petrolatum MIL-C-11796, class 2.

LONG-TERM STORAGE (MORE THAN 30 DAYS)

Long-term storage requires greater preparation than short-term storage and must be undertaken with greater care.

The crane should be prepared as follows:

1. Perform the short-term machine storage preparation, making certain that all points with grease fittings are liberally lubricated.
2. Drain and refill the swing reducer, winch, axle differentials, planetary hubs and hydraulic reservoir.
3. Distribute the new hydraulic oil to all parts of the system by operating all functions.

4. Clean the batteries and battery cables with a baking soda solution and rinse them with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte, if necessary, and fully charge the batteries.
5. Coat the external ring gear of the swing bearing with open gear lubricant.
6. Fill the hydraulic reservoir to the top after the machine is parked in its storage spot.
7. Coat wire rope with lubricant.
8. Coat exposed cylinder rods with grease.

Prepare the engine for long-term storage as follows:

1. Drain and thoroughly flush the cooling system with clean, soft water.
2. Refill the cooling system with clean, soft water.
3. Add a rust inhibitor to the cooling system.
4. Remove, check and recondition the injectors, if necessary, to insure they will be ready to operate when the engine is restored to service.
5. Reinstall the injectors in the engine, time them and adjust the valve clearance.
6. Circulate the coolant through the entire system by operating the engine until normal operating temperature is reached (160 to 185 degrees F [71 to 85 degrees C]).
7. Stop the engine.

-
8. Remove the drain plug and completely drain the engine crankcase. Reinstall and tighten the drain plug. Install new lubricating oil filter elements and gaskets.
 9. Fill the crankcase to the proper level with a 30-weight preservative lubricating oil MIL-L-21260, grade 2 (P1O), or equivalent.
 10. Drain the engine fuel tank.
 11. Refill the fuel tank with enough rust preventive fuel oil, such as American Oil Diesel Run-In Fuel (LF 4089), Mobil 4Y17, or equivalent, to enable the engine to operate 10 minutes.
 12. Drain the fuel filter and strainer. Remove the retaining bolts, shells and elements. Discard the used elements and gaskets. Wash the shells in clean fuel oil and insert new elements. Fill the cavity between the element and shell about two-thirds full of the same rust-preventive compound as used in the fuel tank and reinstall the shell.
 13. Operate the engine for 5 minutes to circulate the rust-preventive compound throughout the engine.
 14. Service the air cleaner.
 15. Apply a non-friction, rust-preventive compound to all exposed parts. If it is convenient, apply the rust-preventive compound to the engine flywheel.
 16. Drain the engine cooling system (tag cap).
 17. The oil may be drained from the engine crankcase if so desired. If the oil is drained, reinstall and tighten the drain plug (tag cap).
 18. Clean the batteries and battery cables with a baking soda solution and rinse them with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte, if necessary, and fully charge the batteries.
 19. Insert heavy paper strips between the pulleys and belts to prevent sticking.
 20. Seal all of the openings in the engine, including the exhaust outlet, with moisture-resistant tape. Use cardboard, plywood or metal covers where practical.
 21. Clean and dry the exterior painted surfaces of the engine. Spray the surfaces with a suitable liquid automobile body wax, a synthetic resin varnish or a rust-preventive compound.
 22. Cover the engine with a good weather-resistant tarpaulin or other cover if it must be stored outdoors. A clear plastic cover is recommended for indoor storage.
- The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective-steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of 1 year and apply additional treatment as required.
- There are two methods of preparing the transmission for long-term storage: without oil and with oil.
- Long-term storage without oil:
1. Drain oil.
 2. Seal all openings and breathers, except oil drain hole, with moisture-proof tape.
 3. Coat all exposed, unpainted surfaces with a good grade of preservative grease.
-

LONG-TERM STORAGE (MORE THAN 30 DAYS)

4. Atomize or spray 2 ounces (59 ml) of Motorstor*, or equivalent, into the transmission through the oil drain hole. Install the drain plug.
5. If additional storage time is required, steps 3 and 4 above should be repeated at yearly intervals.

Long-term storage with oil:

1. Drain oil and remove the transmission oil filter element(s).
2. Install the drain plugs and new filter element(s).
3. Fill the transmission to operating level with a mixture of 30 parts hydraulic transmission oil, type C3, to 1 part Motorstor preservative, or equivalent.

CAUTION

Do not allow temperature to exceed 250 degrees F (121 degrees C). Failure to follow this procedure could cause damage to equipment.

*Motorstor is a preservative additive manufactured by the Daubert Chemical Company, Chicago, Illinois. Motorstor (under the designation of "Nucle Oil") is covered by US Military Specifications MIL-L-46002 (ORD) and MIL-I-23310 (WEP).

4. Operate the unit for approximately 5 minutes at a minimum of 1,000 rpm. Shift the transmission slowly through all selector positions to thoroughly distribute the oil, then stall the converter to raise the oil temperature to 225 degrees F (107 degrees C).
5. As soon as the unit is cool enough to touch, seal all openings and breathers with moisture-proof tape.
6. Coat all exposed, unpainted surfaces with a good grade of preservative grease.
7. If additional storage time is required, steps 3 through 6 above should be repeated at yearly intervals, except it is not necessary to drain the transmission each year - just add Motorstor, or equivalent.

RESTORATION TO SERVICE

Remove the crane from storage via the following procedure:

1. Remove preservative lubricants from all surfaces.
2. Check all fluid levels, adding or draining as required.
3. Lubricate the machine according to lubrication instructions, making certain that all points with grease fittings are lubricated.
4. Make a thorough visual inspection of the entire machine, placing special emphasis on the condition of all hydraulic hoses.

RESTORING ENGINE TO SERVICE

1. Remove the covers and tape from all the openings of the engine, fuel tank and electrical equipment. Do not overlook the exhaust outlet.
2. Wash the exterior of the engine with fuel oil to remove the rust-preventive compound.
3. Remove the paper strips from between the pulleys and belts.
4. Check the crankcase oil level. Fill the crankcase to the proper level with the recommended lubricating oil.
5. Fill the fuel tank with the fuel specified under Diesel Fuel Oil Specifications.
6. Close the drain cock and fill the engine cooling system with a clean antifreeze solution MIL-A-46153, 50% Base/50% Water.
7. Install and connect the battery.
8. Service the air cleaner as outlined under Air System.
9. The small amount of rust-preventive compound which remains in the fuel system will cause a smoky exhaust for a few minutes.

RESTORING TRANSMISSION TO SERVICE

If Motostor, or equivalent, was used in preparing the transmission for storage, use the following procedure to restore the unit to service:

1. Remove the tape from all openings and breathers.

2. Wash off all the external grease with solvent.
3. Add hydraulic transmission oil, type C3, to proper level.

NOTE

It is not necessary to drain C3 oil and Motorstor mixture from the transmission.

If Motorstor, or equivalent, was not used in preparing the transmission for storage, use the following procedure to restore the unit to service:

1. Remove the tape from all openings and breathers.
2. Wash off all the external grease with solvent.
3. Drain oil.
4. Install new oil filter element(s).
5. Refill transmission with hydraulic transmission oil, type C3, to proper level.

APPENDIX A

TORQUE SPECIFICATIONS

Title	Page
Fastener Identification	A-1
Engine Fastener Torque Values	A-3
Transmission Fastener Torque Values	A-3
All Other Fasteners Except Engine and Transmission English Measurement Torque Values	A-4
All Other Fasteners Except Engine and Transmission Metric Measurement Torque Values	A-5
Hydraulic Tube Assembly	A-6

CAUTION

- When installing capscrews, always make certain they are replaced in their proper locations.
- When replacing capscrews or nuts, always use a new capscrew or nut of the same size and strength.
- Do not use standard torque chart values if a specific torque is referenced in the procedure.
- All torque values listed in this manual are dry torques. Dry hardware is defined as hardware as received from supply without any additional lubricants being applied.

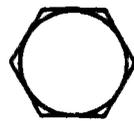
Failure to follow these procedures could cause damage to equipment.

NOTE

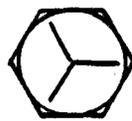
The LRT 110 Crane uses both English and Metric dimensions.

FASTENER IDENTIFICATION

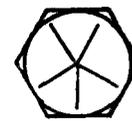
For English Measurement (in.) Capscrew Heads (Figure A-1)



GRADE 2

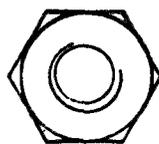


GRADE 5

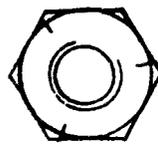


GRADE 8

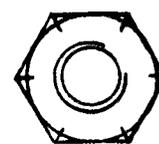
For English Measurement (in.) Nuts (Figure A-2)



GRADE 2
NO MARKING



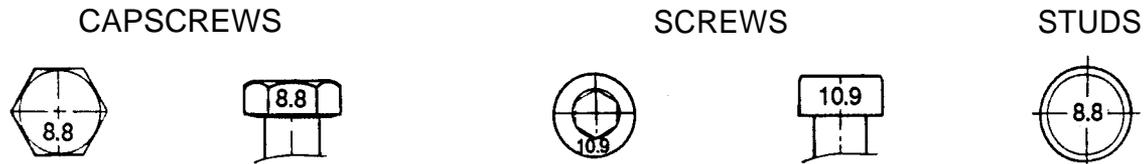
GRADE 5
3 MARKS
120 DEGREES
APART ON
CORNERS



GRADE 8
6 MARKS

For Metric Measurement Fasteners (Figure A-3)

Markings on capscrews, screws and studs should be obligatory for property classes equal to or higher than 8.8, preferably on top of the head by indenting or embossing on the side of the head, Marking is required for socket head capscrews with a nominal diameter greater than M5. Studs must be marked at nut end.



Markings on nuts should be obligatory for property classes equal to or higher than 8, preferably on one side or on one bearing surface of the nut by indenting. Marking should be mandatory for nuts with a nominal diameter over M5.

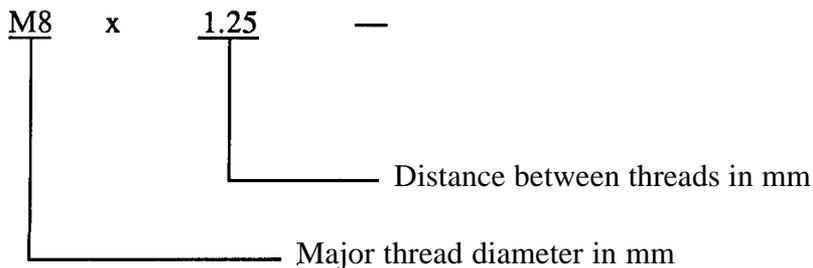
Symbols (Figure A-4)

PROPERTY CLASS	4	5	6	8	10	12	14
Design Symbol	4	5	6	8	10	12	14
ALTERNATIVE MARKING Code Symbol							

The alternative marking system for hexagon nuts may be on one of the external chamfers of the nut by embossing or indenting or, if possible, by indenting on one bearing surface (Figure A-5).



Metric Capscrew Nomenclature



ENGINE FASTENER TORQUE VALUES

Class	8.8	10.9	12.9
Thread Diameter mm	Torque lb-ft [N•m]	Torque lb-ft [N•m]	Torque lb-ft [N•m]
5	5 [7]	6 [8]	6 [8]
6	7 [9]	10 [14]	10 [14]
7	10 [14]	15 [20]	20 [27]
10	18 [24]	25 [34]	28 [38]
12	32 [43]	47 [64]	57 [77]
14	57 [77]	83 [113]	101 [137]
16	94 [127]	133 [180]	159 [216]
18	144 [195]	196 [266]	235 [319]
	190 [258]	265 [359]	325 [441]

CAUTION

Do not use standard torque chart values if a specific torque is referenced in the procedure. Failure to follow this procedure could cause damage to equipment.

TRANSMISSION FASTENER TORQUE VALUES

Thread Size	Torque lb-ft [N•m]
1/4 - 20	8 [11]
1/4 - 28	10 [14]
5/16 - 18	17 [23]
5/16 - 24	19 [26]
3/8 - 16	30 [41]
3/8 - 24	35 [47]
7/16 - 14	50 [68]
7/16 - 20	55 [75]
1/2 - 13	75 [102]
1/2 - 20	85 [115]
9/16 - 12	110 [149]
9/16 - 18	120 [163]
5/8 - 11	150 [203]
5/8 - 18	170 [230]
3/4 - 10	270 [366]
3/4 - 16	300 [407]

**ALL OTHER FASTENERS EXCEPT ENGINE AND TRANSMISSION
ENGLISH (IN.) MEASUREMENT TORQUE VALUES**

Nominal Diameter in.	Grade 2 lb-ft [N•m]	Grade 5 lb-ft [N•m]	Grade 8 lb-ft [N•m]
1/4	*4 [5] 6 [8]	8 [11]	12 [16]
5/16	*7 [9] 12 [16]	20 [27]	25 [34]
3/8	*12 [16] 20 [27]	30 [41]	45 [61]
7/16	*20 [27] 35 [47]	50 [68]	75 [102]
1/2	*30 [41] 50 [68]	80 [108]	110 [149]
9/16	*45 [61] 75 [102]	115 [156]	160 [217]
5/8	*60 [81] 100 [136]	160 [217]	225 [305]
3/4	*110 [149] 180 [244]	280 [380]	400 [542]
7/8	175 [237]	450 [610]	640 [868]
1	265 [359]	680 [922]	970 [1,315]
1-1/8	375 [508]	840 [1,139]	1,380 [1,871]
1-1/4	530 [719]	1,200 [1,627]	1,930 [2,617]
1-3/8	700 [949]	1,570 [2,129]	2,540 [3,444]
1-1/2	930 [1,261]	2,080 [2,820]	3,380 [4,583]
1-3/4	1,460 [1,979]	2,430 [3,295]	5,300 [7,186]
2	2,200 [2,983]	3,200 [4,339]	7,990 [10,833]
2-1/4	3,200 [4,339]	5,350 [7,254]	11,690 [15,849]
2-1/2	4,400 [5,966]	7,300 [9,897]	15,990 [21,679]

NOTE: Torque values are to be within ± 5 percent.

*Torque values for bolts and screws longer than 6 in. (152 mm).

**ALL OTHER FASTENERS EXCEPT ENGINE AND TRANSMISSION
METRIC MEASUREMENT TORQUE VALUES**

Nominal Diameter mm	Grade 8.8 lb-ft [N•m]	Grade 10.9 lb-ft [N•m]	Grade 12.9 lb-ft [N•m]
M4	2.5 [3.4]	3.5 [4.7]	4 [5.4]
M5	5 [7]	7 [9]	8 [11]
M6	8 [11]	12 [16]	14 [19]
M8	20 [27]	29 [39]	34 [46]
M10	41 [56]	57 [77]	68 [92]
M12	71 [96]	100 [136]	119 [161]
M14	113 [153]	160 [217]	189 [256]
M16	176 [239]	249 [338]	294 [399]
M18	243 [329]	343 [465]	405 [549]
M20	344 [466]	486 [659]	574 [778]
M22	468 [635]	661 [896]	781 [1,059]
M24	594 [805]	840 [1,139]	993 [1,346]
N127	940 [1,274]	1,328 [1,801]	1,569 [2,127]
M30	1,307 [1,772]	1,847 [2,504]	2,183 [2,960]

NOTE

The values result in 75 percent use of the screw yield point with a coefficient of friction total 0.20. The compliance with the tightening torques is controlled by torque wrenches.

HYDRAULIC TUBE ASSEMBLY

Tube To Fitting - 37-Degree Flare

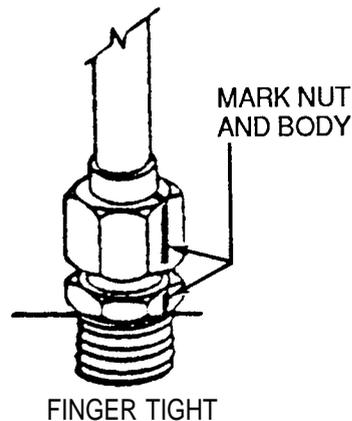
NOTE

Assembly torques are for steel 37-degree flared fittings without lubrication.

Size	Torque lb-in. [N•m]
4	100-140 [11-16]
6	225-275 [25-31]
8	450-550 [51-62]
10	600-700 [68-79]
12	1,000-1,100 [113-124]
14	1,200-1,300 [136-147]
16	1,400-1,550 [158-175]
20	2,100-2,400 [237-271]
24	3,000-3,400 [339-384]
32	3,500-4,000 [395-452]

Flats Method (Alternative Torque Procedure)

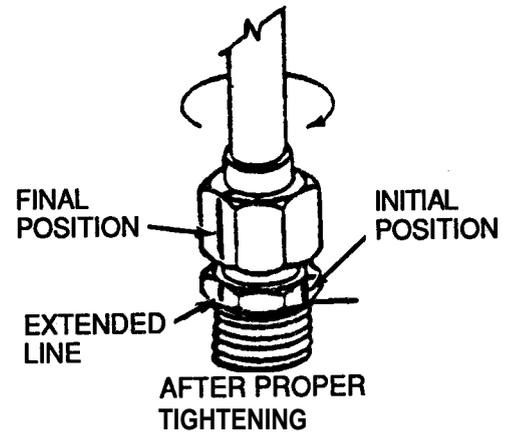
1. Align tube and fitting.
2. Tighten nut by hand, or very lightly with a wrench, to bring all surfaces in metal-to-metal contact.
3. Mark nut and body hex as shown (Figure A-6).



Flats From Finger Tight (F.F.F.T.) Method

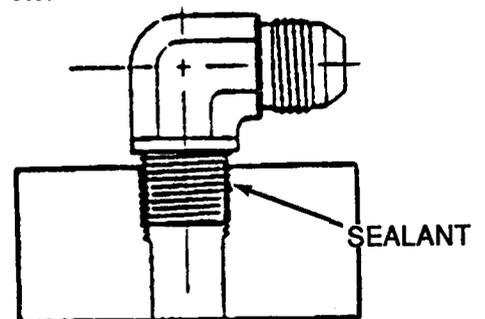
Size	New Parts F.F.F.T	Old Fitting Reassembly F.F.F.T.
4	2-2 1/2	3/4- 1
6	2-2 1/4	1
8	1 1/2-1 3/4	1
10	1 1/2-1 3/4	3/4
12	1 1/2	3/4
14	2	1 3/4
16	1 3/4-1 1/2	3/4-1
20	1-1 1/2	3/4- 1
24	1 1/4-1 1/2	1-1 1/4
32	1-1 1/4	3/4-1

4. Tighten nut further to number of flats indicated on table above.
5. After tightening, extend line from nut to body (optional for ease of reassembly) (Figure A-7).



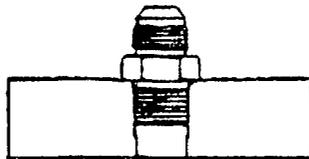
Fitting To Port-Pipe Thread Port (Figure A-8)

1. Make certain both sets of threads are free from nicks, burrs, dirt, etc.
2. Tighten fitting approximately three turns past finger tight.
3. Apply thread sealant.



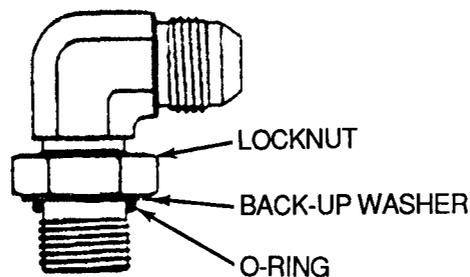
Fitting To Port-Nonadjustable SAE Straight Thread O-Ring Fitting (Figure A-9)

1. Make certain both sets of threads are free from nicks, burrs, dirt, etc.
2. Lightly coat O-ring with oil.
3. Tighten to torque level listed in Torque Chart.



Fitting To Port-Adjustable SAE Straight Thread O-Ring Fitting (Figure A-10)

1. Make certain both sets of threads are free from nicks, burrs, dirt, etc.
2. Lightly coat O-ring with oil.
3. Back nut off as far as possible.
4. Tighten fitting by hand, until back-up washer is tight against face and will not slide up any farther.
5. To position fitting, unscrew not more than one turn.
6. Hold fitting in correct position and tighten to torque listed in Torque Chart.

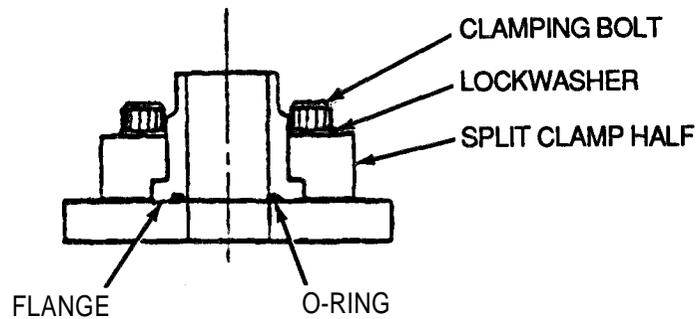


SAE Straight Thread O-Ring Fitting Installation Torques

Size	Thread	Torque lb-in. [N•m]
2	5/16 -24	85-95 [9.6-10.7]
3	3/8 -24	170-190 [19-21]
4	7/16 -20	190-210 [21-24]
5	1/2 -20	260-280 [29-32]
6	9/16 -18	290-310 [33-35]
8	3/4 -16	480-520 [54-59]
10	7/8 -14	820-840 [93-95]
12	1 1/16-12	1,180-1,220 [133-138]
16	1 5/16-12	1,750-1,850 [198-209]
20	1 7/8 -12	2,250-2,350 [254-266]
24	2 -12	2,700-2,900 [305-328]
32	2 1/2 -12	3,500-4,000 [395-452]

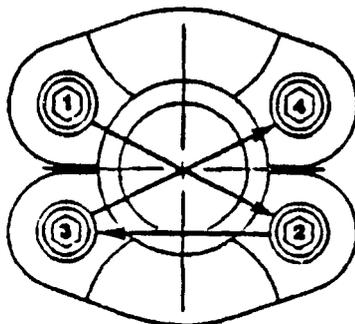
Fitting To Port-SAE Four Bolt Split Flange

1. Make certain both sets of threads are free from nicks, burrs, dirt, etc.
2. Position flange on port and hand tighten all four bolts (Figure A-11).



Fitting To Port-SAE Four Bolt Split Flange

3. Tighten bolts in a diagonal sequence (Figure A-12) and in small increments to torque level in Torque Chart.



TORQUING SEQUENCE

Assembly-Fitting To Port SAE Four Bolt Split Flange Torques

Flange Size	Bolt Thread	Torque lb-in. [N•m]
1/2	5/16-18	175-225 [20-25]
3/4	3/8 -16	250-350 [28-40]
1	3/8 -16	325-425 [37-48]
1 1/4	7/16-14	425-550 [48-62]
1 1/2	1/2 -13	550-700 [62-79]
2	1/2 -13	650-800 [73-90]

APPENDIX B REFERENCES

A-1. SCOPE

This appendix lists Army regulations, forms, field manuals, technical manuals, and other publications referenced in this manual and which apply to organizational maintenance.

A-2. ARMY REGULATIONS

Reporting of Transportation Discrepancies in Shipments AR 55-38
Department of the Army information Security Program Regulation. AR 380-5

A-3. DEPARTMENT OF THE ARMY PAMPHLETS

Consolidated Index of Army Publications and Forms DA Pam 25-30
The Army Maintenance Management System (TAMMS). DA Pam 738-750
U.S. Army Equipment Index of Modification Work Orders. DA Pam 750-10

A-4. FORMS

U. S. Army Accident investigation Report. DA Form 285
Equipment Operator's Qualifications Record (Except Aircraft). DA Form 348
Recommended Changes to Publications and Blank Forms. DA Form 2028
Recommended Changes to Equipment Technical Manuals. DA Form 2028-2
Organizational Control Record for Equipment. DA Form 2401
Equipment Inspection and Maintenance Worksheet. DA Form 2404
Maintenance Request DA Form 2407
Preventive Maintenance Schedule and Record. DD Form 314
Processing and Reprocessing Record for Shipment, Storage, and
Issue of Vehicles and Spare Engines. DD Form 1397
DOD Fire incident Report DD Form 2324
U.S. Government Motor Vehicle Operator's Identification Card OF Form 346
Operator's Report on Motor Vehicle Accident SF Form 91
Transportation Discrepancy Report... SF Form 361
Report of Discrepancy(ROD) SF Form 364
Product Quality Deficiency Report (7540-00-1 05-0078) SF Form 368

A-5. FIELD MANUALS

NBC Contamination Avoidance FM 3-3
NBC Protection FM 3-4
NBC Decontamination FM 3-5
Field Behavior of NBC Agents (Including Smoke and Incendiaries) FM 3-6
Camouflage FM 5-20
Vehicle Recovery Operations FM20-22
First Aid for Soldiers FM21-11
Visual Signals FM 21-60
Basic Cold Weather Manual FM31-70
Northern Operations FM31-71
Desert Operations FM90-3
Mountain Operations (Howto Fight) FM90-6

APPENDIX C
MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

C-1. GENERAL.

C-1.1 This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

C-1.2 The maintenance allocation chart (MAC) in section II designates overall authority and responsibility for the performance of maintenance functions on the LRT-110 Rough Terrain Crane, Types I and II. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels.

C-1.3 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.

C-1.4 Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

C-2. MAINTENANCE FUNCTIONS.

Maintenance functions will be limited to and defined as follows:

C-2.1 Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e. g., by sight, sound, or feel).

C 2.2 Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards. Test functions

C-2. MAINTENANCE FUNCTIONS (CONT)

are authorized when a specific requirement exists. Normal testing during fault isolation is not included in the MAC.

C-2.3 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.

C-2.4 Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

C-2.5 Aline. To adjust specified variable elements of an item to bring about optimum or desired performance.

C-2.6 Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of 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.

C-2.7 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.

C-2.8 Replace. To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and is shown as the third position code of the SMR code.

C-2. MAINTENANCE FUNCTIONS (CONT)

C-2.9 Repair. The application of maintenance services¹, including fault location/troubleshooting², removal/installation, and disassembly/assembly³ procedures, and maintenance actions⁴ 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.

C-2.10 Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

¹Services - Inspect, test, service, adjust, align, calibrate, and/or replace.

²Fault 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).

³Disassemble/assemble - Encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least competency identified as maintenance significant (i.e., assigned an SMR code) for the level of maintenance under consideration.

⁴Actions - Welding, grinding, riveting, straightening, facing, remachining, and/or resurfacing.

C-2. MAINTENANCE FUNCTIONS (CONT)

C-2.11 Rebuild. Consists of those services/actions necessary for the restoration of unservicable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

C-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

C-3.1 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-3.2 Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

C-3.3 Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2. (For detailed explanation of these functions, see paragraph B-2.)

C-3.4 Column 4, Maintenance Level. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn (s), the level 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 level of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance level, appropriate work time figures will be shown for each level. The work time figure represents the average time

C-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II (CONT)

required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating condition. 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 levels are as follows.

- C Operator or crew
- O Unit maintenance
- F Direct Support
- H General Support
- D Depot maintenance

C-3.5 Column 5, Tools and Equipment. Column 5 specifies, by code, those column tool sets (not individual tools and special tools, TMDE, and support equipment required to perform the designated function.

C-3.6 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.

C-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENT, SECTION III.

C-4.1 Column 1, Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, section II, column 5 .

C-4.2 Column 2, .Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

C-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS,
SECTION III (CONT)

C-4.3 Column 3, Nomenclature. Name or identification of the tool or test
equipment.

C-4.4 Column 4, National Stock Number. The National stock number of the
tool or test equipment.

C-4.5 Column 5, Tool Number. The manufacturer's part number.

C-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

C-5.1 Column 1, Reference. The code recorded in column 6.
section II.

C-5.2 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

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MA		IT L		EL		TOOLS & EQUIP. (5)	Remarks (6)
			U	T	IN	ED				
			C	O	F	H	D			
01	ENGINE									
0100	Engine Assembly:	Inspect	0.1	0.5					11	A
		Test		0.5					9	
		Service		1.5						
		Replace			8.0				12	
		Repair		1.5	4.0	12.0			12,5,7, 8,9,12, 15,16,17	B
		Overhaul						35.0	12,5,7, 8,9,12, 15,16,17	
0101	Crankcase, Block, Cylinder Head:									
	Block	Replace					12.0		1,5,8,12	
		Repair					8.0		1,5,6,12	
	Head, Cylinder	Replace			6.0				12	
		Repair					6.0		1, 12	
0102	Crankshaft:									
	Crankshaft	Replace							5,8,12	
		Repair							5,12	
0103	Flywheel Assembly:									
	Flywheel	Replace			10.0				8,12	
		Repair					12.0		5,12	
	Flywheel Housing	Replace			10.0				12	
		Repair			4.0				12	
0104	Pistons, Connecting Rods:									
	Pistons	Replace					6.0		12,12	C
		Repair					5.0		1,12	
0105	Valves, Camshafts & Timing System									
	Rocker Arm Assembly	Adjust		1.5					11	
		Replace			3.0				11,12	
		Repair			2.0				11,12	
	Camshaft	Replace					6.0		12	C

* MA INTENANCE LEVELS:
C-OPERATOR/CREW
O-ORGANIZATIONAL

= UNIT

F-INTERMEDIATE DIRECT SUPPORT
H-INTERMEDIATE GENERAL SUPPORT

D-DEPOT

SECTION II. MAINTENANCE - ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MA		IT L IN F	EL ED H	D	TOOLS / EQUIP. (5)	Remarks (6)
			C	O					
0106	Engine Lubrication System:								
	Oil Cooler	Test Replace Repair		1.0 4.0	2.0			14 11	
03	FUEL SYSTEM								
0301	Fuel Injector:	Test Replace Repair			0.3 1.0 1.5			3,7 7 7	
0302	Fuel Pumps:								
	Fuel Injection	Test Adjust Replace Repair Overhaul			3.0 1.0 4.0 1.5		10.0	7 7 12 7,12 7,18,19, 20	D
0304	Air Cleaner:								
	Air Cleaner Assembly	Inspect Service Replace Repair	0.1	0.5 0.2 1.0				11 11 11	
0306	Tanks, Lines, Fittings Headers:								
	Fuel Tank Assy	Replace Repair		2.0	1.5			11 10,11	
0312	Accelerator, Throttle, or Choke Controls	Repair		1.0				11	
04	EXHAUST SYSTEM								
0401	Muffler & Pipes:								
	Muffler & Pipes	Inspect Replace	0.2	1.0				11	
05	COOLING SYSTEM								
0501	Radiator:	Test Service Replace Repair	0.2	2.0 1.0 2.0 0.5	4.0			14 11 11,12	E F

MAINTENANCE LEVELS:
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H-INTERMEDIATE GENERAL SUPPORT

D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL			EL		TOOLS & EQUIP. (5)	Remarks (6)
			L	T	IN	ED	D		
			C	O	F	H			
0503	Water Manifold, Heaters Thermostats & Housing Gasket:								
	Thermostat	Test Replace		1.5 1.0			14 11		
0505	Fan Assembly								
	Belts, Drive Assembly	Inspect Adjust Replace	0.1	0.5 0.5			11 11		
06	ELECTRICAL SYSTEM								
0601	Generator, Alternator	Test Replace Repair		0.2 0.5	3.0		10 11 7		
0603	Starting Motor:								
	Starter & Solenoid Assembly	Test Replace Repair		0.3 0.5	3.0		10 11 7		
0606	Engine Safety Controls:								
	Switch, Neutral Safety	Test Replace		0.2 0.5			10 11		
0607	Instrument or Engine Control Panel:								
	Switches/Circuit Breakers, Lights, Panel Electrical Gauges	Test Replace		0.3 2.0			10 11		
	Anti-Two Block Panel	Inspect Replace Repair	0.1	0.5 0.2	1.0		11 7,11	G	
0608	Miscellaneous Items:								
	Light Switches and Fuses	Test Replace		0.3 1.0			10 11		

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SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M/		IT LI	EL		TOOLS EQUIP. (5)	Remarks (6)
			L	T		IN	ED		
			C	O	F	H	D		
0609	Lights: Vehicle Headlights, Tail, Stop, Clearance and Floodlights	Test Replace		0.3 0.5				10 11	
0610	Sending Units & Warning Switches	Inspect Replace	0.1	0.5				10 11	
	Axle Centering Light Assembly	Test Replace		0.2 0.5				10 11	
0611	Horn, Alarm, Siren:	Inspect Replace	0.1	0.5				10 11	
0612	Batteries, Storage Wet or Dry:	Test Service Replace Repair		0.5 1.0 1.5	2.0			10,14 14 11	
	Battery Box and Tie Down	Replace		2.0				11	
	Battery Cables	Service Replace		0.5 0.5				10,14 11	
0613	Hull or Chassis Wiring Harness:								
	Wiring Harness, Main	Test Replace		0.5	0.9			10 12	
07	TRANSMISSION								
0705	Gear Shift, Vacuum Booster and Controls:								
	Transmission Controls	Adjust Replace Repair		0.5 1.0	1.0			4,11 11 12	
0708	Torque Converter	Replace Repair			14.0		20.0	12 12	
0710	Transmission Assembly:	Replace Repair			12.0 2.5		16.0	12 4,5,11	B
	Drive Plate Assembly:	Overhaul Inspect Repair					24.0	4,5, 12,16	
					0.2 0.5				

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H-INTERMEDIATE GENERAL SUPPORT

D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M/IT L EL					TOOLS & EQUIP. (5)	Remarks (6)
			C	O	F	H	D		
0721	Coolers, Pumps, Motors Transmission:								
	Cooler	Inspect Replace	0.1	2.0				11	
09	PROPELLER & PROPELLER SHAFTS								
	Propeller Shaft Assembly	Service Replace Repair		0.2 2.0 2.0				14 11 14	
10	FRONT AXLE								
1000	Front Axle Assembly	Service Replace Repair Overhaul		1.0 1.0	12.0 2.0	6.0		14 12 1,5,11, 12,15 1,5,12, 15	B
1002	DIFFERENTIAL:								
	Front Differential Carrier Assembly	Replace Repair			6.0 8.0			12 1,5,12	
1003	Planetary Drive:	Service Replace Repair		0.1	8.0 8.0			14 12 1,5,12, 15	
11	REAR AXLE								
1100	Rear Axle Assy:	Service Replace Repair Overhaul		1.0 1.2	12.0 2.0	6.0		14 12 1,5,11, 12,15 1,5,12, 15	B
1102	Differential:								
	Rear Differential Carrier Assy	Replace Repair			6.0 8.0			12 1,5,12, 15	

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D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	L C	MA		JT L E		TOOLS & EQUIP. (5)	Remarks (6)		
				T	O	I	H			E	D
						F					
1103	Planetary Drive:	Service Replace Repair		0.1				14 12 1.5,12, 15			
12	BRAKES										
1201	Parking Brake Assembly:	Adjust Replace Repair	0.2	1.5 1.5				11 11 14			
	Brake Caliper	Replace Repair		1.5 1.0				11 14			
1202	Service Brakes:										
	Brakeshoe and Related Parts	Adjust Replace		1.0		3.0		14 15			
1204	Hydraulic Brake System:										
	Brake Reservoir	Service	0.1								
	Master Cylinder	Replace		1.0				11			
	Brake Booster	Replace Repair		1.5		2.0		11 12			
13	WHEELS AND TRACKS										
1301	Suspension Assembly:										
	Axle Lockout Valve	Replace:		1.0				11			
	Axle Lockout Cylinder	Service Replace, Repair		0.1 1.5		2.0		14 11 12			
1313	Tires, Tubes, Tire Chains:										
	Tires	Inspect Service Replace	0.2	0.1 0.5				11 11			

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 F-INTERMEDIATE DIRECT SUPPORT
 H-INTERMEDIATE GENERAL SUPPORT
 D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M AINT L EVEL					TOOLS & EQUIP (5)	Remarks (6)
			T		I		D		
			C	O	F	H			
	STEERING								
1401	Mechanical Steering Gear Assembly:								
	Tie Rod Assembly	Adjust		0.5			11		
		Replace		1.0			11		
		Repair		1.0			14		
1410	Ground Drive Steering Pump	Replace		2.0			11		
		Repair			3.0		12		
1411	Hoses, Lines, and Fittings	Inspect	0.1						
		Replace		1.0			11		
		Repair			1.0				
1412	Hydraulic Cylinders								
	Steering Cylinder	Service	0.1				14		
		Replace		1.0			11		
		Repair			4.0		12		
1414	Steering System Valve Steering Unit	Inspect	0.1						
		Replace		1.0			11		
		Repair			4.0		12		
	Steering Valve Selector	Inspect	0.1						
		Replace		2.0			11		
		Repair			3.0		12		
	Steering Valve	Inspect	0.1						
		Replace		1.0			11		
		Repair			1.0		12		
15	FRAME AND TOWING ATTACHMENTS AND DRAWBAR								
1503	Pintles and Towing Attachments:								
	Pintle Hook	Service	0.1				14		
		Replace		0.5			11		
		Repair		0.5			14		

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SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	UNIT			EL		TOOLS EQUIP (5)	Remarks (6)
			C	O	F	H	D		
18	BODY, CAB, HOOD AND HULL								
1801	Body, Cab, Hood and Hull Assembly:								
	Door, Latches and Handles	Inspect Replace Repair	0.1	1.5 1.0				11 11	
	Engine Hood	Inspect Replace Repair	0.1	1.5	1.0			11 12	
1802	Fenders, Switches and Attaching Parts, Windshield Glass Panels	Inspect Repair	0.1	1.0				13	H
	Fender and Decking	Inspect Replace Repair	0.1	2.0	1.5			11 12	
	Outrigger Assembly	Inspect Service Replace Repair	0.2	0.2	2.3	0.7		.4 .2 .2	
1806	Upholstery Seat:								
	Seat Assembly	Inspect Replace Repair	0.1	1.5 1.0				1 1	
1808	Stowage Rack, Boxes, Straps, Carrying Cases, Cable Reels, Hose Reels, etc.:								
	Tool Box	Inspect Replace Repair	0.1	2.0	1.0			1 2	I

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 D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M I T L L ED					TOOLS & EQUIP (5)	Remarks (6)
			C	O	F	H	D		
20	HOIST WINCH, CAPSTAN, WINDLASS POWER CONTROL UNIT AND POWER TAKEOFF								
2001	Winch Assembly:	Inspect Service Replace Repair	0.1	0.2 0.4	2.0	5.0	14 12 1,5,11, 12,17 12,17	F	
	Overhaul					10.0			
	Brake Valve Assembly	Inspect Replace Repair	0.1	0.5	0.0		11 12		
	Motor, Hyd	Inspect Replace Repair	0.4	0.5	1.0		11 12		
22	BODY CHASSIS ACCESSORY ITEMS								
	Accessory Items:	Inspect Replace Repair	0.1	0.5 0.2			11 10,11		
2202	Heater Assy	Inspect Replace Repair	0.1	0.8 1.0	2.5		10,11 7,11,12	J	
24	HYDRAULIC LIFT COMPONENTS								
2401	Hydraulic Pump:								
	Main Pump	Test Replace Repair			1.0 2.0 12.0		3,4,12 12 12		
2402	Hydraulic Control Valve:								
	Winch Control Valves	Inspect Replace	0.1	2.0			11		
	Main Control Valve	Inspect Replace	0.2	3.5			11		

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D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M. JT L			EL		TOOLS & EQUIP. (5)	Remarks (6)
			C	T	F	ED	H		
2403	Rotary Manifold	Replace Repair			6.0 2.0			12 12	
	Hold Valves	Inspect Replace	0.1			2.0		12	
	Solenoid Valve	Inspect Replace Repair	0.1	1.0	1.0			11 12	
	Hydraulic Control and/or Manual Controls:								
	Valve Controls	Inspect Replace Repair	0.1	2.0 1.5				11 14	
2406	Hoist Control Disconnect Assy	Inspect Replace	0.1	0.5				11	
	Hydraulic Lines and Fittings:								
2407	Hydraulic Lines and Fittings:	Inspect Replace	0.1	1.5				11	
	Hydraulic Cylinders:								
2408	Boom Hoist Cylinder	Inspect Replace Repair	0.1	2.0			6.0	11 12	
	Extend Cylinder	Inspect Replace Repair	0.1	0.3	2.0		6.0	12 11,12	FK
	Outrigger Cylinder	Inspect Service Replace Repair	0.1 0.2		2.3		6.0	14 12 12	
2408	Hydraulic Reservoir:	Inspect Service Replace Repair	0.1	0.2 2.0	1.5			14 14 12	

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H-INTERMEDIATE GENERAL SUPPORT

D-DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	M I T L				D	TOOLS & EQUIP (5)	Remarks (6)
			I T		L ED				
			C	O	F	H			
42	ELECTRICAL EQUIPMENT								
4209	Travel Alarm	Test Repair		0.2 0.5			10 11		
	Over Speed Alarm	Test Replace		0.2 0.5			10 11		
4215	TMDE	Test Replace Repair			0.2 8.0 1.4		10 11 11		
74	CRANE COMPONENTS								
7403	Swingers:								
	Swing and Bearing Assembly	Replace Repair				5.0 5.5	12,19 12		
	Swing Motor	Replace Repair		2.5	2.0		11 12		
	Swing Gear Box	Replace Repair		2.5	2.0		11 12		
7404	Electrical Controls:								
	Collector Ring Assembly	Replace Repair			1.0	1.5	7,12 7,12		
	Anti-Two Block Assembly	Inspect Replace Repair	0.5	4.0 1.0			11 10,11		
7411	Crane Attachments:								
	Boom Assembly	Inspect Test Adjust Service Replace Repair	0.1 0.2		2.0 1.8 3.0	5.0	12 12 12,19		
	Boom Angle Indicator	Inspect Replace Repair	0.1	0.3 0.5			11	L	

* MAINTENANCE LEVELS:
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Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

FOR

LRT-I 10 ROUGH TERRAIN CRANE, TYPES I AND II

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	H	Gage, Depth, 0/0.5-0.0005	5210-00-309-9192	S640G
2	H	Compressor, Piston Ring	5120-00-250-6055	RC40C
3	O	Gage, Pressure, 0-4000 psi	6685-00-972-1372	5821220000
4	O	Gage, Pressure, 0-200 psi	5685-01-043-9161	S75560
5	F	Indicator, Dial Test	5210-01-192-9432	CM6400
6	H	Puller, Wet Sleeve		CG80
7	F	Shop Equipment, Fuel and Electrical System Repair	1910-00-754-0714	sc4910- 95 CLA01
8	F	Stand, Engine	1910-00-529-8387	MI LS-45004
9	O	Test Equipment, Internal Combustion Engine	1910-00-124-2554	2389409

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS
 FOR
 LRT-110 ROUGH TERRAIN CRANE, TYPES I AND II (CONT)

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
10	0	Tool Kit, Auto Fuel and Electrical System Repair	4910-00-754-0655	SC4910- 95CLA50
11	0	Tool Kit, General Mechanics Auto- motive	5180-00-177-7033	SC5180-90- CL-N26
12	F	Tools, Shop Equipment, Auto- motive, Field Maintenance	4910-00-754-0705	SC491095 CLA31
13	0	Tools, Shop Equipment, Auto- motive and Repair Organizational Maintenance Common No. 2	4910-00-754-0650	SC4910-95 CLA72

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS
 FOR
 LRT-110 ROUGH TERRAIN CRANE, TYPES I AND II (CONT)

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
14	O	Tools, Shop Equipment Automotive and Repair, Organizational Maintenance Common No. 1	1910-00-754-0654	SC4910 95CLA74
15	F	Tool Kit, Direct Support		709A4461/ 81495
16	G	Tool Kit, General Support		709A4462/ 81495
17	F	Fitting	1730-00-973-8756	12019-459/ 81495
18	D	Injection Pump Tool Kit		7144-158Q/ 31147
19	D	Tester, Fuel Injector Pump	1910-01-214-3172	HF491/31147 05083
20	D	Tester, Fuel Injector Pump	1910-01-124-9123	67-7622/ 05083

Section IV. REMARKS
FOR
LRT-110 ROUGH TERRAIN CRANE, TYPES I AND II

REFERENCE CODE	REMARKS
A	Crew inspection limited to that authorized in PMCS table.
B	All repairs performed by unit or intermediate direct support maintenance are limited to authorized items listed in TM 5-3810-305-24P.
C	Replacement and repair times do not include cylinder head replacement time.
D	Intermediate direct support maintenance limited to replacement of external components as authorized in TM 5-3810-305-24P. Crew servicing is restricted to checking and filling with coolant only. Unit maintenance is limited to authorized items listed in TM 5-3810-305-24P.
G	Unit repair limited to replacement of bulb and lens cap.
H	Includes all general maintenance to cab such as replacement of seals, panels, etc.

Section IV. REMARKS
FOR
ROUGH TERRAIN CRANE, TYPES I AND II (CONT)

REFERENCE CODE	REMARKS
I	Replacement of the tool box pertains to type 1 only.
J	Unit repair limited to replacement of cover.
K	Axles removed from crane.
L	Replace components only.

APPENDIX D

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES														
M-MONTHLY		Q-QUARTERLY		S-SEMIANNUALLY		A-ANNUALLY		B-BIENNIALLY		H-HOURS		MI-MILES		
ITEM NO.	INTERVAL								ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED PERFORM ALL OPERATOR PMCS FIRST					
	M	Q	S	A	B	H	MI							
1						150		<p><u>WARNING</u></p> <p>Compressed air used for cleaning purposes must not exceed 30PSI (207 KPa). Safety glasses must be used when cleaning parts. Failure to follow these procedures could cause SERIOUS INJURY.</p> <p><u>NOTE</u></p> <p>When the air restriction indicator is in the red zone, the air cleaner will need to be serviced.</p> <p>Change oil filter every 150 hours of operation for the duration of the warranty period. After warranty period, refer to TB-43-0210, Oil Analysis Program. (Ref: page 3-45).</p> <p><u>WARNING</u></p> <p>Diesel fuel and other combustible materials are used in operation and maintenance of this equipment. DO NOT smoke or allow open flames in areas where combustible materials are stored or used. Failure to follow this procedure could cause DEATH or SERIOUS INJURY.</p>						
2						500		Change fuel filter elements (Ref: Pg 3-48).						
3						90		Check swing reducer on level (Ref: Pg 3-45).						
4		X				250		Service air filter.						
5						500		Clean hydraulic suction filter (Ref: Pg 3-49).						
6						500		Drain fuel tank of water and sediment (Ref to Pg 3-48).						
7						500		Change transmission oil and oil filter (Ref to 3-50).						

D-1

Appendix D

TMS-3810-305-24

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

M-MONTHLY Q-QUARTERLY S-SEMIANNUALLY A-ANNUALLY B-BIENNIALLY H-HOURS MI-MILES

ITEM NO.	INTERVAL							ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED PERFORM ALL OPERATOR PMCS FIRST
	M	Q	S	A	B	H	MI	
								<u>WARNING</u>
8				X				<p>Cooling system is pressurized. Use extreme caution and proper protection when removing radiator cap after operating temperature is reached. Steam and hot gases will be escaping through the radiator cap: avoid being burned by these escaping gases. When removing cap, loosen it slowly to the left, then pause a moment. Continue to turn cap until it can be removed. Failure to follow this procedure could cause SERIOUS INJURY.</p> <p>Check antifreeze protection & alkalinity concentration.</p>
9			X			1000		Adjust engine valve lash clearance (Ref to Pg 6-38).
10			X			1000		Change winch oil (Ref to Pg 3-53).
								<u>WARNING</u>
								<p>Never disconnect hydraulic lines or fittings before venting pressure. Turn dipstick cap 1/4 turn to safety notch to relieve pressure. Failure to follow this procedure could cause SERIOUS INJURY.</p>
11			X			1000		Check relief valve pressure settings (Ref to Pg 3-59).
12			X			1000		Tighten swing bearing bolts (Ref to Pg 15-17).
								<u>WARNING</u>
								<p>NEVER perform fan hub bearing end play check with engine running. Failure to follow this procedure could cause SERIOUS INJURY.</p>
								<u>NOTE</u>
								Vehicle must be level for axle hub and differential oil level checks.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

M-MONTHLY

Q-QUARTERLY

S-SEMIANNUALLY

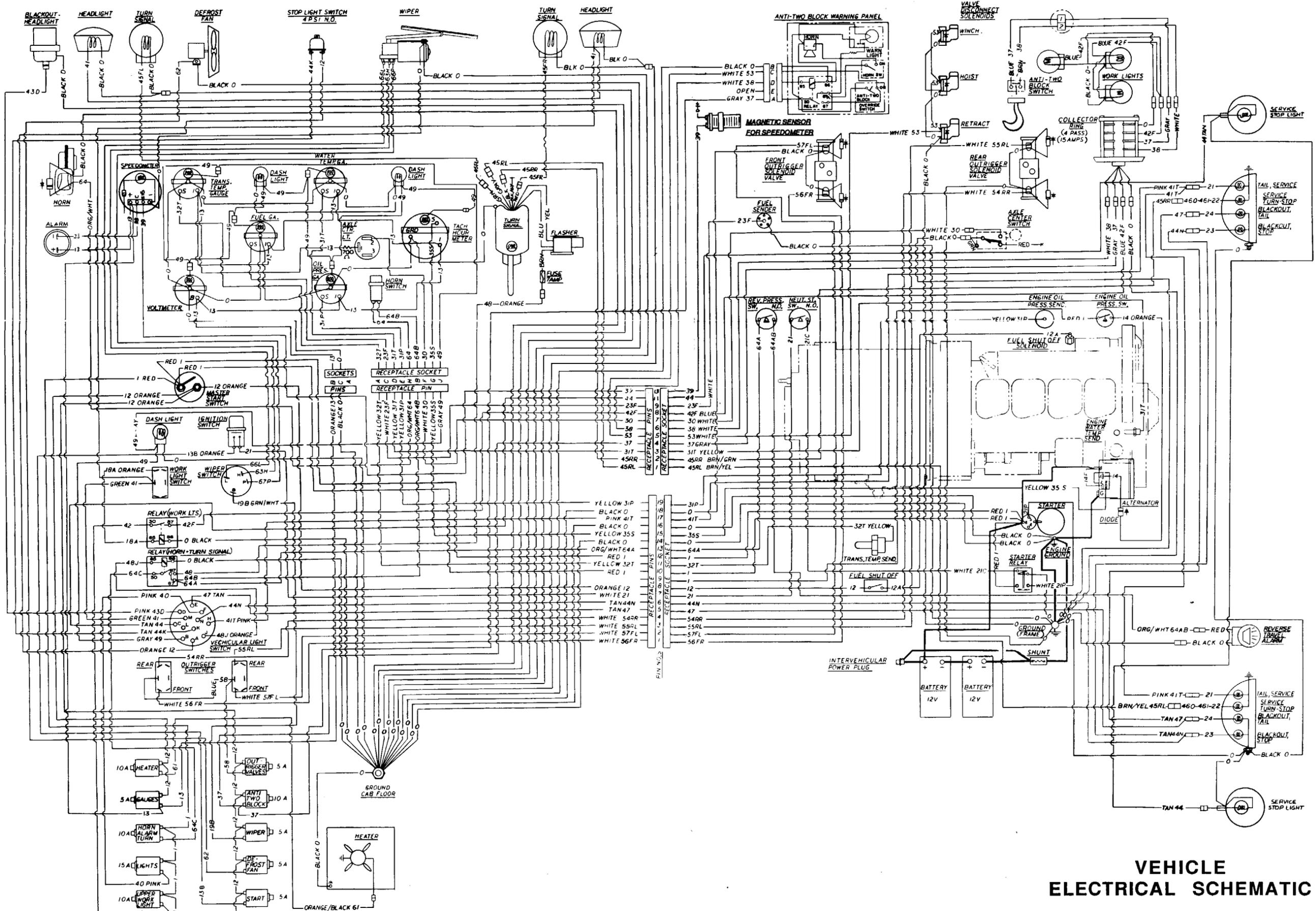
A-ANNUALLY

B-BIENNIALLY

H-HOURS

MI-MILES

ITEM NO.	INTERVAL							ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED PERFORM ALL OPERATOR PMCS FIRST
	M	Q	S	A	B	H	MI	
13			X			1000		Check axle differential and hub oil (Ref to Pg 3-51).
14			X			1000		Check brake shoes for wear (Ref to Pg 12-12).
15			X			1000		Check fan hub bearing for end play (Ref to Pg 3-52).
16				X				Drain and clean hydraulic reservoir (Ref to Pg 3-13).
17				X		18500		Drain and refill swing reduction unit (Ref to Pg 3-56).
18				X		18500		Change axle hub and differential oil (Ref to Pg 3-57).
19			X					Change crane emergency hand pump for proper operation. Pump 5 gallons of hydraulic fluid through the pump.



WIRE COLOR	WIRE NUMBER	LOCATION
BATTERY FEED GROUP		
Black	0	Ground - Negative Side of Battery
Red	1	Battery to Master Switch & Breaker, to Starter Solenoid
Orange	12	Master Switch to Accessories
Orange	12A	Fuel Shutoff Switch to Fuel Solenoid
Orange	13	Circuit Breaker to Start Button. Circuit Breaker to Gauges.
Orange	13B	Circuit Breaker to Ignition
Orange	14	Alternator to Oil Pressure Switch
Green	14F	Alternator Field
Orange	18A	Work Light Switch to Relay
Green/White TR	19B	Circuit Breaker to Wiper Switch

ENGINE AND TRANSMISSION GROUP		
White	21	Crank Motor, Ignition Switch to Neutral Start Switch
White	21C	Trans. Neutral Start Switch to Engine Start Relay
White	21P	Engine Gauge to Fuel Sender
White	23F	Fuel Gauge to Fuel Sender

MONITORING GROUP		
Yellow	39	Speedometer to Magnetic Sensor
Yellow	33	Speedometer "C" Term. to Alarm
White	30	Axle Center Light to Axle Center Micro Switch
Yellow	31P	Engine Oil Pressure Gauge to Oil Pressure Sender
Yellow	31T	Engine Water Temp. Gauge to Water Temp. Sender
Yellow	32T	Transmission Oil Temp. Gauge to Trans. Oil Temp. Sender
Yellow	35S	Tachometer "S" Signal to Alternator "R" Terminal
Gray	37	Anti-Two Block Breaker to Anti-Two Block Panel "A" Pin
White	38	Anti-Two Block Panel "D" Pin to Anti-Two Block-Boom Switch

LIGHTING GROUP		
Pink	40	Circuit Breaker to Blackout Light Switch "F" Pin
Green	41	Blackout Light Switch "M" Pin to Work Light Sw. to Headlights
Pink	41T	Blackout Light Switch "H" Pin to Tail Lights
Blue	42	Work Light Breaker to Light Relay "30" Term.
Blue	42F	Light Relay "87" Term. to Boom Work Lights
Pink	43D	Blackout Light Sw. "D" Pin to Blackout Headlight
Tan	44	Blackout Light Sw. "C" Pin to Turn Signal Switch - Stop Lt.
Tan	44K	Blackout Light Sw. "K" Pin to Stop Light Switch

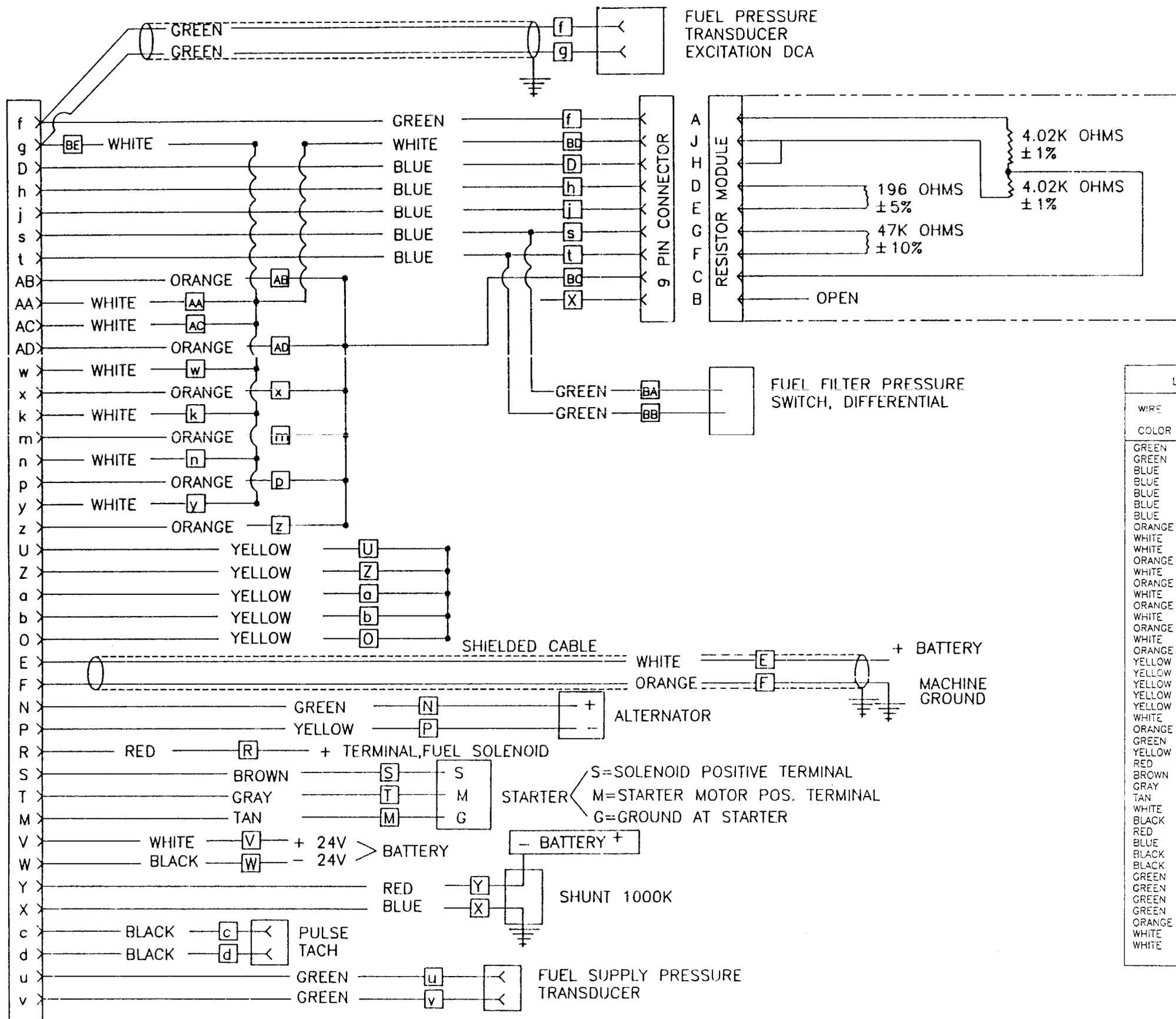
WIRE COLOR	WIRE NUMBER	LOCATION
LIGHTING GROUP - Continued		
Tan	44N	Blackout Light Sw. "N" Pin to Blackout Stop Light "23" Term.
Brown/Green TR	45FR	Turn Signal Switch to Turn Signal - Front Right
Brown/Yellow TR	45FL	Turn Signal Switch to Turn Signal - Front Left
Brown/Green TR	45RR	Turn Signal Switch to Turn Signal - Rear Right
Brown/Yellow TR	45RL	Turn Signal Switch to Turn Signal - Rear Left
Tan	47	Blackout Light Sw. "E" Pin to Blackout Tail Lights
Orange	48	Blackout Relay "87" Term. to Flasher Fuse
Orange	48J	Blackout Light Sw. "J" Pin to Blackout Relay "85" Term
Gray	49	Blackout Light Sw. "B" Pin to Instrument Panel Lights

CONTROL GROUP		
White	53	Anti-Two Block Panel "C" Pin to Valve Disconnect Solenoids
White	54RR	Outrigger Switch to Outrigger Solenoid Valve - Rt. Rear
White	55RL	Outrigger Switch to Outrigger Solenoid Valve - Left Rear
White	56FR	Outrigger Switch to Outrigger Solenoid Valve - Rt. Frt.
White	57FL	Outrigger Switch to Outrigger Solenoid Valve - Left Frt.
Blue	58	Outrigger Circuit Breaker to Outrigger Switches

ACCESSORIES GROUP		
Orange/Black TR	61	Heater Circuit Breaker to Heater
Orange/Red TR	62	Defrost Fan Circuit Breaker to Defrost Fan
Orange/White TR	63H	Wiper Switch "H" Term. to Wiper Motor "H" Term.
Orange/White TR	64	Horn Switch to Horn
Orange/White TR	64A	Relay to Reverse Pressure Switch
Orange/White TR	64B	Relay to Horn Switch
Orange/White TR	64AB	Reverse Pressure Switch to Backup Alarm
Orange/White TR	64C	Horn Circuit Breaker to Relay
Orange/White TR	66L	Wiper Switch "L" Term. to Wiper Motor "L" Term.
Orange/White TR	67P	Wiper Switch "P" Term. to Wiper Motor "P" Term.

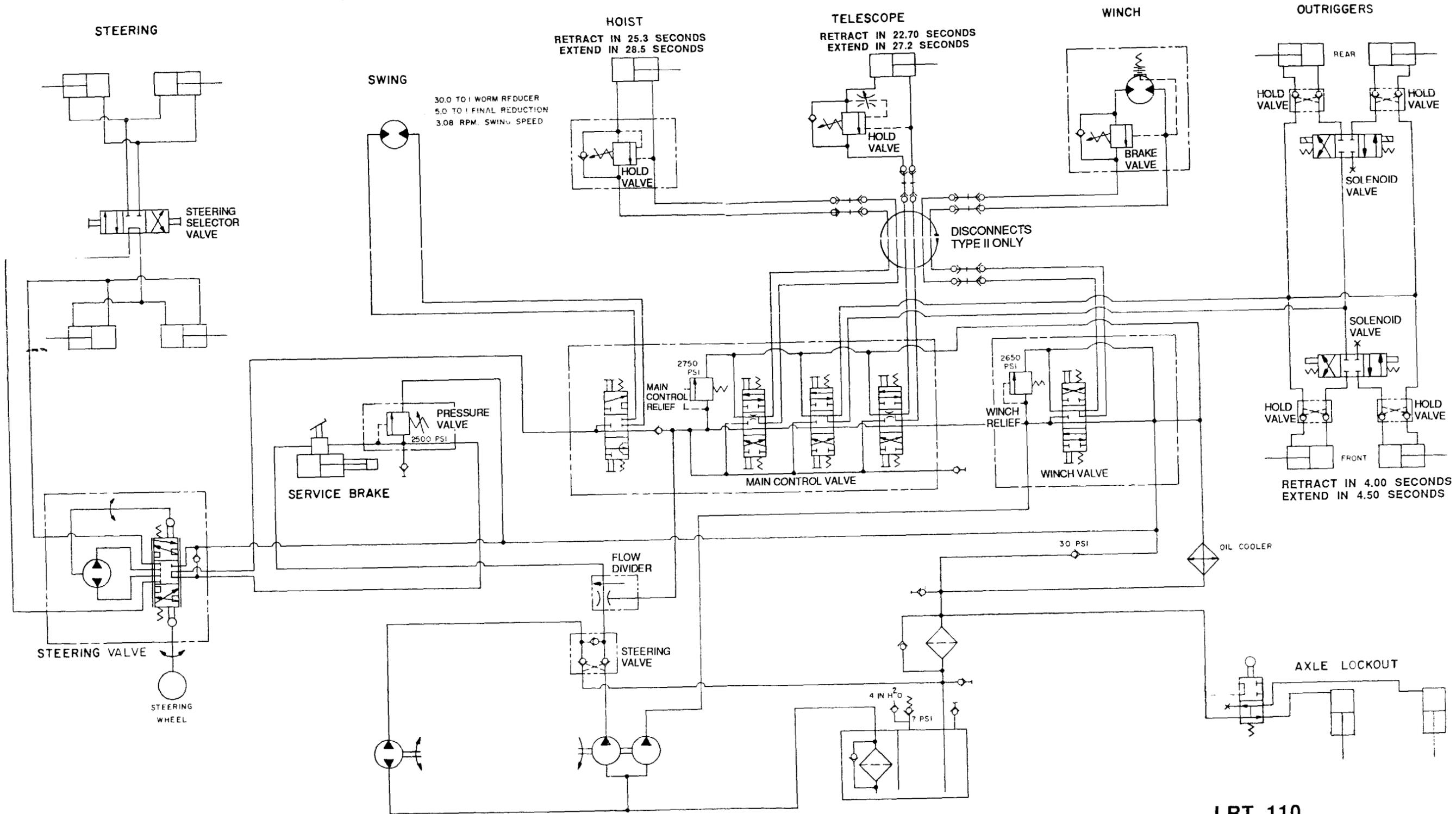
LRT 110 ELECTRICAL SYSTEM IDENTIFICATION

54 PIN DCA CONNECTOR



LRT 110 STE-ICE ELECTRICAL SYSTEM IDENTIFICATION		
WIRE COLOR	WIRE NUMBER	LOCATION
GREEN	f	FUEL PRESSURE DCA TRANSDUCER
GREEN	g	FUEL PRESSURE DCA TRANSDUCER
BLUE	D	DCA INDICATOR
BLUE	h	CODE RESISTOR
BLUE	j	CODE RESISTOR RETURN
BLUE	s	FUEL FILTER Δ P +
BLUE	t	FUEL FILTER Δ P -
ORANGE	AB	JUMPER WIRE
WHITE	AA	JUMPER WIRE
WHITE	AC	FUEL RETURN PRESSURE +
ORANGE	AD	FUEL RETURN PRESSURE -
WHITE	w	JUMPER WIRE
ORANGE	x	JUMPER WIRE
WHITE	k	JUMPER WIRE
ORANGE	m	JUMPER WIRE
WHITE	n	JUMPER WIRE
ORANGE	p	JUMPER WIRE
WHITE	y	JUMPER WIRE
ORANGE	z	JUMPER WIRE
YELLOW	U	DCA CHANNELS
YELLOW	Z	JUMPER WIRE
YELLOW	a	JUMPER WIRE
YELLOW	b	JUMPER WIRE
YELLOW	O	JUMPER WIRE
WHITE	E	BATTERY POSITIVE
ORANGE	F	MACHINE GROUND
GREEN	N	ALTERNATOR +
YELLOW	P	ALTERNATOR -
RED	R	FUEL SOLENOID + TERMINAL
BROWN	S	STARTER SOLENOID + TERMINAL
GRAY	T	STARTER MOTOR + TERMINAL
TAN	M	GROUND AT STARTER
WHITE	V	BATTERY POSITIVE
BLACK	W	BATTERY NEGATIVE
RED	Y	SHUNT NEGATIVE
BLUE	X	SHUNT GROUND
BLACK	c	PULSE TACHOMETER
BLACK	d	PULSE TACHOMETER
GREEN	u	FUEL SUPPLY PRESSURE TRANSDUCER
GREEN	v	FUEL SUPPLY PRESSURE TRANSDUCER
GREEN	BA	FUEL FILTER PRESSURE SWITCH DIFFERENTIAL
GREEN	BB	FUEL FILTER PRESSURE SWITCH DIFFERENTIAL
ORANGE	BC	CODE RESISTOR
WHITE	BD	CODE RESISTOR
WHITE	BE	JUMPER WIRE

STE-ICE ELECTRICAL SCHEMATIC



LRT 110
HYDRAULIC SCHEMATIC

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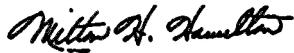
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TEAR ALONG PERFORATED LINE

THE METRIC SYSTEM AND EQUIVALENTS

WEIGHT MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
 1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
 1 Kilogram = 1000 Grams = 2.2 lb.
 1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
 1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
 1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
 1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

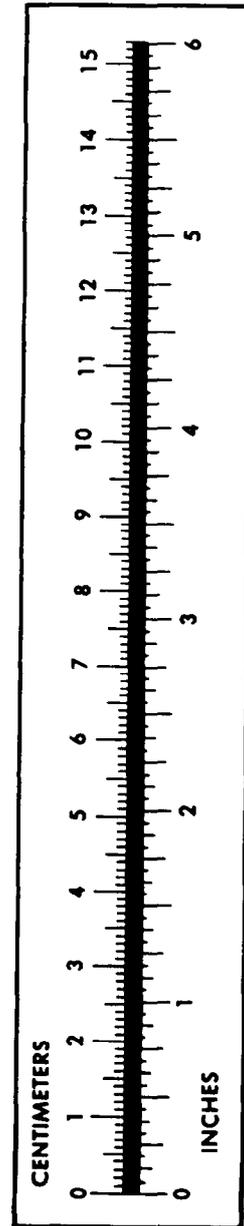
TEMPERATURE

$5/9(^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212° Fahrenheit is equivalent to 100° Celsius
 90° Fahrenheit is equivalent to 32.2° Celsius
 32° Fahrenheit is equivalent to 0° Celsius
 $9/5^{\circ}\text{C} + 32 = ^{\circ}\text{F}$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
its	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
ometers per Liter	Miles per Gallon	2.354
ometers per Hour	Miles per Hour	0.621



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