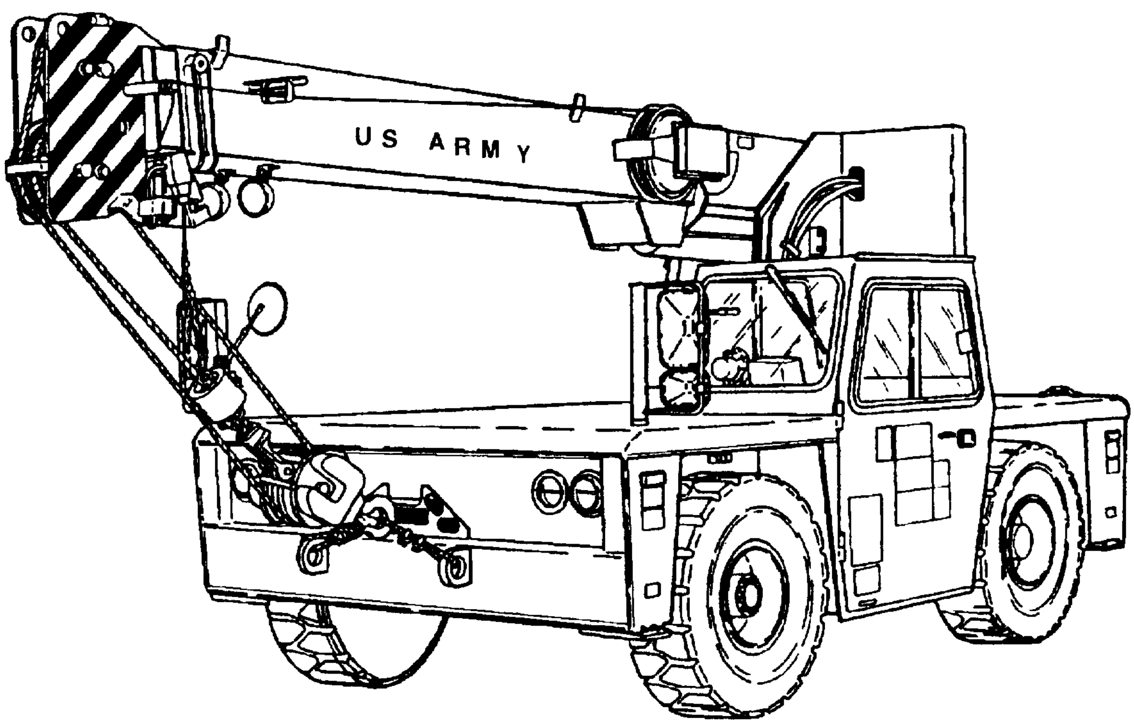
TECHNICAL MANUAL

Unit, Direct Support and General Support Maintenance Manual for WAREHOUSE CRANE 10,000 LB. CAPACITY, M469 WHEELED, DIESEL POWERED NSN 3950-01-412-5345 (Grove Model AP 308T)



Approved for public release: Distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY

JUNE 1997

SAFETY SUMMARY

WARNING

Cleaning with compressed air can create airborne particles that may enter the eyes or penetrate the skin. Pressure shall not exceed 30 psig. Wear goggles. Do not direct compressed air against the skin.

WARNING

Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry contacts battery terminal, a direct short may result in instant heating tools, damage to equipment, and injury or DEATH to personnel.

WARNING

Extreme care should be taken when removing radiator filler cap if temperature gage reads above 180° F (82° C). Contact by steam or hot coolant may result in injury or DEATH to personnel.

WARNING

Engine must be cool to the touch prior to working on coolant system components. Failure to comply could result in scalding or serious burns.

WARNING

Exhaust components can be hot causing burns to exposed skin. Allow exhaust components to cool before proceeding.

WARNING

Corrosion inhibitors contain alkali. Do not get in eyes; wear goggles/safety glasses when using. Avoid contact with skin. In case of contact, wash area with soap and water. If eyes are contacted, flush eyes with large amounts of water for at least fifteen minutes and GET IMMEDIATE MEDICAL ATTENTION.

SAFETY SUMMARY - Continued

WARNING

Dry cleaning solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves and use only in well-ventilated areas. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Keep away from heat and flame. Never smoke when using solvent: the flashpoint of type I solvent is 100° F (38° C) and for type II 138° F (50° C). Failure to do so may result in injury or DEATH to personnel.

If a person becomes dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, flush eyes with cold water and get immediate medical attention.

WARNING

EXHAUST GASES CAN KILL. Ensure that the area is properly ventilated. Brain damage or DEATH can result from heavy exposure to exhaust gases. Precautions must be followed to ensure personnel safety when operating the diesel engine.

1. Do not operate the engine in an enclosed area.

2. Do not idle the engine with the cab windows closed.

3. Be alert for exhaust gases.

4. Be alert for headaches, dizziness, sleepiness, loss of muscular control.

5. If you see another person with exhaust poisoning, remove that person from the area and expose to open air. Then keep the person warm and do not allow physical exercise. Administer artificial respiration if necessary and SEEK MEDICAL ATTENTION IMMEDIATELY.

6. Be aware that nuclear-biological-chemical (NBC) protection will not protect you for carbon monoxide poisoning.

SAFETY SUMMARY - Continued

WARNING

Ensure hydraulic system is shut down and pressure is relieved. A high pressure oil stream can pierce body and cause severe personal injury.

WARNING

Never use standard plumbing fittings for the hydraulic system. Always use high pressure hydraulic fittings. Standard fittings could fail resulting in severe personal injury.

WARNING

Hydraulic fluid under pressure can penetrate skin or damage eyes. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks, but do not use bare hand. Wear safety goggles for protection. If fluid enters skin or eye, get immediate medical attention.

WARNING

When removing boom lift cylinder, ensure cylinder is properly supported before disconnecting it from the boom.

WARNING

When removing the boom assembly, ensure blocking and lifting devices are capable of supporting the boom assembly.

WARNING

When removing the outrigger beam, ensure any blocking material used is capable of supporting the weight of the outrigger beam. Do not allow it to tilt or slide. Failure to do so could result in death or injury to personnel.

WARNING

Do not be misled by the term "low voltage". Voltages as low as 50 volts may cause death. For artificial respiration, refer to FM 21-11.

SAFETY SUMMARY - Continued

WARNING

Ensure the battery is disconnected before performing any maintenance on an electrical circuit which is not fused.

WARNING

Lead-acid battery gases can explode. Do not smoke, have open flames, or make sparks around the battery. If a battery is gassing, it can explode and cause injury to personnel.

Always wear safety goggles and acid-proof gloves when handling the battery. Avoid contact with the electrolyte. If spills occur, take immediate action to stop the burning effects. Wash skin with cold running water. Flush eyes with cold water for at least fifteen minutes. If taken internally, drink large amounts of water or milk, followed with milk of magnesia, beaten egg, or vegetable oil. In each case, SEEK IMMEDIATE MEDICAL HELP. If electrolyte is spilled on clothing, wash at once with cold water and neutralize with baking soda or household ammonia solution.

WARNING

Always disconnect negative battery cable first to reduce chance of shorting and personal injury. Such disconnections prevent electrical shock to personnel or equipment.

WARNING

Always connect positive battery cable first to reduce chance of shorting and personal injury.

WARNING

Always use the same fastener part number (or equivalent) when replacing fasteners. Do not risk using a fastener of lesser quality: and do not mix metric and inch (customary) fasteners. Mismatched or incorrect fasteners can result in damage, malfunction, or injury to personnel.

SAFETY SUMMARY - Continued

WARNING

Never crawl under the crane when performing maintenance unless the crane is securely blocked and/or on jack 'stands. Do not work on equipment that is only supported by a jack or hoist. Equipment may fall and cause serious injury or DEATH to personnel.

Keep clear of the crane or its components as they are being raised or lowered. Do not allow components suspended in the air to swing. Equipment may fall or strike personnel and cause serious injury or DEATH to personnel.

Extreme care must be taken when working on cable or chain under tension. A snapped cable or swinging load may result in injury or DEATH to personnel.

WARNING

Starting fluid is toxic and highly flammable. NEVER heat the container and NEVER discharge starting fluid in a confined area or near an open flame. Severe injury to personnel may result.

WARNING

When using steam cleaners, avoid contact with the steam which can cause burns, blindness, and other serious injuries. Wear protective apron, gloves, and safety goggles when using live steam.

WARNING

The wire rope can become frayed or contain broken wires. Wear heavy leather-palmed work gloves when handling the wire rope. Frayed or broken wires can injure the hands. Never let moving wire rope slide through hands, even when wearing gloves as a broke wire strand could penetrate the gloves and cut the hand.

Technical Manual

No. 10-3950-672-24-1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington, DC, *15 June 1997*

Unit, Direct Support Maintenance Manual
for
WAREHOUSE CRANE
10,000 LB. CAPACITY, M469
WHEELED, DIESEL POWERED
NSN 3950-01-412-5345
(Grove Model AP 308T)

REPORTING OF ERRORS

You can improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Tank-automotive and Armaments Command, ATTN: AMSTA-IM-OPIT, Warren MI 48397-5000. A reply will be furnished to you. You may also provide DA Form 2028-2 information to TACOM via datafax or e.mail. TACOM's datafax number for.AMSTA-IM-OPIT is: (810) 574-6323 and e.mail address is: tacom-tech-pubs@cc.tacom.army.mil

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

TABLE OF CONTENTS - VOLUME 1 **Page**

Approved for public release: Distribution is unlimited

TABLE OF CONTENTS - Continued

HOW TO USE THIS MANUAL

This manual is designed to help you operate and maintain the equipment. All task descriptions will take you step-by-step through the procedure. Don't take shortcuts. Before you begin any task, you should read through the complete procedure, make sure you know what needs to be done, then go back and follow the steps as written.

Pay particular attention to WARNINGS and CAUTIONS, as they contain information that will prevent injury to personnel or damage to equipment.

Use the alphabetical index at the back of the manual to find a topic not listed in the table of contents.

WARRANTY

THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, MADE BY EITHER THE DISTRIBUTOR OR THE MANUFACTURER ON NEW GROVE EQUIPMENT, EXCEPT THE MANUFACTURER'S WARRANTY AGAINST DEFECTS, MATERIAL AND WORKMANSHIP SET OUT BELOW:

NEW EQUIPMENT WARRANTY

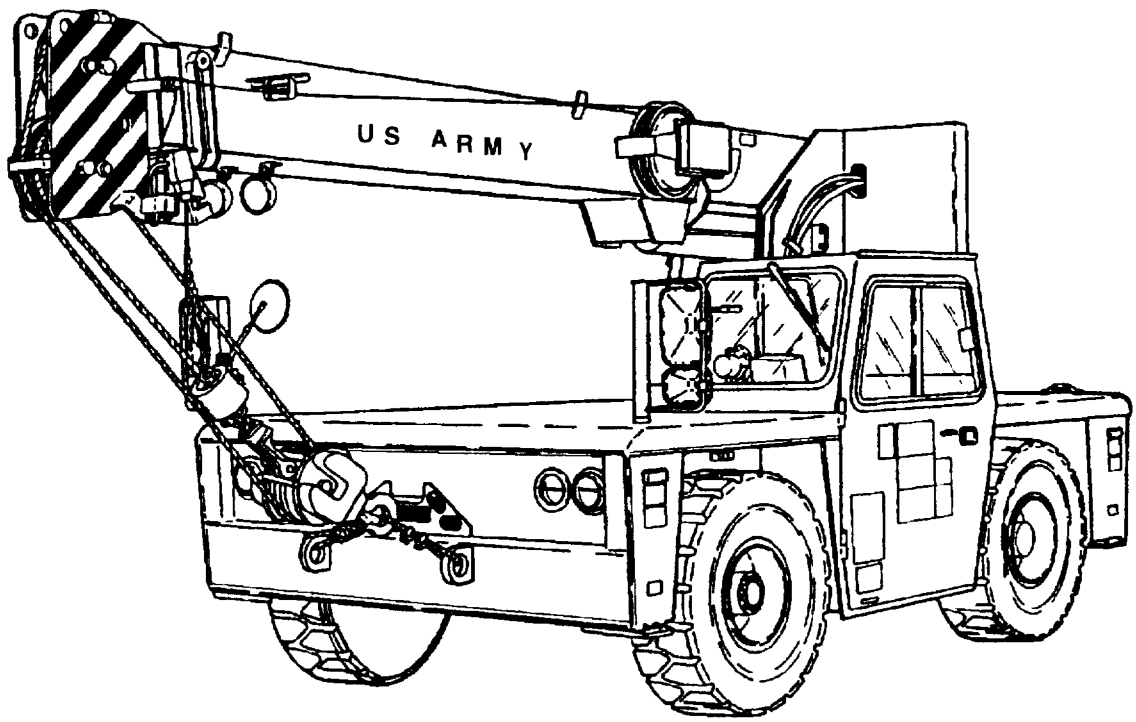
"The Manufacturer warrants each new product made by the Manufacturer to be free from defects in material and workmanship, its obligation and liability under this warranty being limited to replacing free of charge at its factory, any part proving defective under normal use and service for a period of fifteen (15) months CONUS or eighteen (18) months OCONUS beginning with Government acceptance of the crane. This warranty is in lieu of all other warranties, express or implied and the obligation and liability of the Manufacturer under this warranty shall not include any transportation or other charges or the cost of installation or any liability for direct, indirect, or consequential damages or delay resulting from the defect. Any operation beyond rated capacity or the improper use or application of the product or the substitution upon it of parts not approved by the Manufacturer shall void this warranty. This warranty covers only the products of Grove Manufacturing Company. The products of other Manufacturers are covered only by such warranties as are made by their Manufacturers."

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND OF ANY OTHER OBLIGATIONS OR LIABILITY ON THE PART OF THE MANUFACTURER, AND GROVE MANUFACTURING COMPANY NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH SUCH EQUIPMENT.

NOTE

The Cummins diesel engine is covered by a separate warranty as described in TM 10-3950-672-24-2.

There is a decal in the cab of the crane, near the main control panel, which has the warranty expiration date.



Warehouse Crane, M469

CHAPTER 1

INTRODUCTION

Section 1. General Information

1-1. SCOPE

This manual gives procedures for maintenance of the 10K Warehouse Crane M469. The manual contains maintenance procedures to be performed by organizational, direct support, and general support level personnel.

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

a. Reports of Maintenance and Unsatisfactory Equipment

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in Maintenance Management Update.

b. Reporting of Item and Packaging Discrepancies

Fill out and forward SF 364 [Report of Discrepancy (ROD)] as prescribed in AR 735-11-2/DLAR 4140.55/SECNAVINST4355.18/AFR 400-54/MCO 4430.3J.

c. Transportation Discrepancy Report (TDR) (SF 361)

Fill out and forward SF 361 Transportation Discrepancy Report (TDR) (SF361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/AFR 75-1 8/MCO P4610.19D/DLAR 4500.15.

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

Destruction of Army materiel to prevent enemy use shall be in accordance with TM 750-244-3.

1-4. ADMINISTRATIVE STORAGE

Equipment issued to and by the Army activities will have preventive maintenance in accordance with Preventive Maintenance Checks and Services (PMCS) performed before being placed into storage. When removing the equipment from administrative storage, the PMCS checks should be performed to ensure operational readiness.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs)

If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: Commander, U.S. Army Tank-automotive and Armaments Command, Attn. AMSTA-IM-JM, Warren, MI 48397-5000. We'll send you a reply.

Section 2. General Maintenance

GENERAL MAINTENANCE

MAINTENANCE

These general suggestions should be helpful in following the instructions in this manual. In analyzing a system malfunction, use a systematic procedure to locate and correct the problem.

1. Determine the problem.

2. List possible causes.

3. Devise checks.

4. Conduct checks in a logical order to determine the cause.

5. Consider the remaining service life of components against the cost of parts and labor necessary to replace them.

6. Make the necessary repair.

7. Recheck to ensure that nothing has been overlooked.

8. Functionally test the failed part in its system.

NOTE

Your safety and that of others is always the number one consideration when working around machines. Safety is a matter of thoroughly understanding the job to be done and the application of good common sense. It is not just a matter of do's and don'ts. Stay clear of all moving parts.

CLEANLINESS.

An important item in preserving the long life of the machine is keeping dirt out of working parts. Enclosed compartments, seals, and filters have been provided to keep the supply of air, fuel, and lubricants clean. It is important that these enclosures be maintained.

Whenever hydraulic, fuel, lubricating oil lines, or air lines are disconnected, clean the adjacent area as well as the point of disconnect. As soon as the disconnection is made, cap, plug or tape each line or opening to prevent entry of foreign material. The same recommendations for cleaning and covering apply when access covers or inspection plates are removed.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when they are installed. Leave new parts in their containers until ready for assembly.

Clean the rust preventive compound from all machined surfaces of new parts before installing them.

REMOVAL AND INSTALLATION.

When performing maintenance, do not attempt to manually lift heavy parts when hoisting equipment should be used. Never locate or leave heavy parts in an unstable position. When raising a portion of a crane or a complete crane, ensure the crane is blocked securely and the weight is supported by blocks rather than by lifting equipment.

When using hoisting equipment, follow the hoist manufacturers recommendations and use lifting devices that will allow you to achieve the proper balance of the assemblies being lifted and to ensure safe handling.

Unless otherwise specified, all removals requiring hoisting equipment should be accomplished using an adjustable lifting attachment. All supporting members (chains and cables) should be parallel to each other and as near perpendicular as possible to the top of the object being lifted.

CAUTION

THE CAPACITY OF AN EYEBOLT DIMINISHES AS THE ANGLE BETWEEN THE SUPPORTING MEMBERS AND THE OBJECT BECOMES LESS THAN 90 DEGREES. EYEBOLTS AND BRACKETS SHOULD NEVER BE BENT AND SHOULD ONLY HAVE STRESS IN TENSION.

Some removals require the use of lifting fixtures to obtain proper balance. The weights of some components are given in their respective sections of the manual.

If a part resists removal, check to be certain all nuts and bolts have been removed and that an adjacent part is not interfering.

DISASSEMBLY AND ASSEMBLY.

When assembling or disassembling a component or system, complete each step in turn. Do not partially assemble one part and start assembling some other part. Make all adjustments as recommended. Always check the job after it is completed to see that nothing has been overlooked. Recheck the various adjustments by operating the machine before returning it to the job.

PRESSING PARTS.

When pressing one part into another, use an antiseize compound or a molybdenum disulfide base compound to lubricate the mating surfaces.

Assemble tapered parts dry. Before assembling parts with tapered splines, be sure the splines are clean, dry, and free from burrs. Position the parts together by hand to mesh the splines before applying pressure.

Parts which are fitted together with tapered splines are always very tight. If they are not tight, inspect the tapered splines and discard the part if the splines are worn.

LOCKS.

Lockwashers, flat metal locks, or cotter pins are used to lock nuts and bolts.

Flat metal locks must be installed properly to be effective. Bend one end of the lock around the edge of the part. Bend the other end against one flat surface of the nut or bolt head.

Always use new locking devices on components which have moving parts.

When installing lockwashers on housings made of aluminum, use a flat washer between the lockwasher and the housing.

WIRES AND CABLES.

Batteries should always be disconnected prior to working on the electrical system.

When removing or disconnecting a group of wires or cables, tag each one to ensure proper identification during assembly.

SHIMS.

When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

BEARINGS.

Antifriction Bearings.

When an antifriction bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in nonflammable cleaning solution and allow them to drain dry. The bearing may be dried with compressed air BUT do not spin the bearing.

Discard the bearings if the races and balls or rollers are pitted, scored, or burned. If the bearing is serviceable, coat it with oil and wrap it in clean waxed paper. Do not unwrap new bearings until time of installation.

The life of an antifriction bearing will be shortened if not properly lubricated. Dirt in an antifriction bearing can cause the bearing to lock resulting in the shaft turning in the inner race or the outer race turning within the cage.

Double Row, Tapered Roller.

Double row, tapered roller bearings are precision fit during manufacture and components are not interchangeable. The cups, cones, and spacers are usually etched with the same serial number and letter designator. If no letter designators are found, wire the components together to assure correct installation. Reusable bearing components should be installed in their original positions.

Heating Bearings.

Bearings which require expansion for installation should be heated in oil not to exceed 250 degrees F (121 degrees C). When more than one part is heated to aid in assembly, they must be allowed to cool and then pressed together again. Parts often separate as they cool and contract.

Installation.

Lubricate new or used bearings before installation. Bearings that are to be preloaded must have a film of oil over the entire assembly to obtain accurate preloading. When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder.

When pressing bearings into a retainer or bore, uniformly apply pressure to the outer race. If the bearing is pressed on the shaft, uniformly apply pressure on the inner race.

Preload.

Preload is an initial load placed on the bearing at the time of assembly. Whether a tapered roller bearing should have preload could depend on any of several conditions: rigidity of the housings and shaft, bearing spread, speed of operation, etc.

To determine whether a bearing requires preload or end clearance, consult the disassembly and assembly instructions pertaining to that bearing.

Care should be exercised in applying preload. Misapplication of preload to bearings requiring end clearance can result in bearing failure.

Sleeve Bearings.

Do not install sleeve bearings with a hammer. Use a press and be sure to apply the pressure directly in line with the bore. If it is necessary to drive on a bearing, use a bearing driver or a bar with a smooth flat end. If a sleeve bearing has an oil hole, align it with the oil hole in the mating part.

GASKETS.

Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select material of the proper type and thickness. Be sure to cut holes in the right places. Blank gaskets can cause serious damage.

When removed, always install new cylinder head and manifold gaskets using recommended gasket compound on head gaskets to allow uniform sealing.

BATTERIES.

Clean batteries by scrubbing them with a solution of baking soda and water. Rinse with clear water. After cleaning, dry thoroughly and coat terminals and connections with an anticorrosion compound or grease.

If the machine is to be stored or not used for an extended period of time, the batteries should be removed. Store the batteries in a warm, dry place, preferably on wooden shelves. Never store on concrete. A small charge should be introduced periodically to keep the specific gravity rating at recommended level.

HYDRAULIC SYSTEMS.

WARNING

EXERCISE EXTREME CARE AROUND PRESSURIZED HYDRAULIC SYSTEMS. DO NOT WORK ON A HYDRAULIC SYSTEM WHILE IT IS IN OPERATION OR UNTIL ALL PRESSURE IS RELEASED.

Cleanliness.

Contaminants in a hydraulic system affect operation and will result in serious damage to the system components. Dirty hydraulic systems are a major cause of component failures.

Keep the System Clean.

When removing components of a hydraulic system, cover all openings on both the component and the crane.

If evidence of foreign particles is found in the hydraulic system, flush the system.

Disassemble and assemble hydraulic components on a clean surface.

Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Sealing Elements.

Inspect all sealing elements (0-ring, gaskets, etc.) when disassembling and assembling the hydraulic system components. Installation of new elements is always recommended.

Hydraulic Lines.

When installing metal tubes, tighten all bolts finger-tight. Then, in order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger-tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting.
Tighten bolts in both couplings.

Due to manufacturing methods there is a natural curvature to a hydraulic hose. The hose should be installed so any bend is with this curvature.

FATIGUE OF WELDED STRUCTURES.

Experience has shown that highly stressed welded structures when repeatedly subjected to varying stresses caused by twisting, shock, bending, and intentional and/or unintentional overloads, often become subject to weld cracking which may be attributed to fatigue of the welded joint. This condition is not uncommon in construction equipment.

Equipment should be periodically inspected for evidence of weld fatigue. The frequency of these inspections should be commensurate with the age of the equipment, the severity of the application, and the experience of the operators and maintenance personnel.

The following are known high stress areas applicable to Grove machines, and a visual inspection of these areas should be made part of an owner's planned preventive maintenance program:

a. Power Telescope - Boom wear pad retaining structures, hydraulic cylinder attaching points, boom pivot shaft retaining structures.

b. Outrigger pads, beams, boxes and attachment structures.

c. Main frames - generally in the area of doubler plates and crossmembers; at the junction of front and rear frame members on truck cranes.

d. Turntable bearing connection (where bearing is welded to the crane superstructure or chassis).

e. Counterweight support structures.

f. Chassis axle and suspension mounting structures.

g. Hydraulic cylinder end connections.

The above is provided only as a guide, and your inspection plan should not be limited to the areas listed. A thorough visual inspection of all weldments is good practice.

Anyone requiring more detailed inspection instructions and/or repair procedures may request same by contacting: Grove Manufacturing Company; Customer Services Department; P.O. Box 695, 1086 Wayne Avenue; Chambersburg, Pennsylvania 17201.

LOCTITE.

WARNING

LOCTITE TYPE ADHESIVES CONTAIN CHEMICALS THAT MAY BE HARMFUL IF MISUSED. READ AND FOLLOWTHE INSTRUCTIONS ON THE CONTAINER.

Always follow the directions on the Loctite container as not all Loctite types are suitable for all applications.

Various types of Loctite are specified throughout the Service Manual.

The following types of Loctite brand adhesives are available from the Parts Department of Grove Manufacturing Company.

Loctite Number	Grove Part Number
277	9999100806
242	9999100805
592	9999100804

FASTENERS AND TORQUE VALVES.

NOTE

Refer to Appendix D for Torque Value tables.

Use bolts of the correct length. A bolt which is too long may bottom before the head is tight against the part it is to hold. If a bolt is too short, there may not be enough threads engaged to hold the part securely. Threads can be damaged. Inspect them and replace fasteners, as necessary.

Torque values should correspond to the type bolts, studs, and nuts being used.

The torque tables are provided by Grove Manufacturing Company for reference when performing maintenance.

Use of proper torque values is extremely important. Improper torquing can seriously affect performance and reliability.

Identification of fastener grade is always necessary. When marked as a high strength bolt (grade 3, 5, etc.), the mechanic must be aware that he is working with a highly stressed component and the fastener should be torqued accordingly.

NOTE

Some special applications require variation from standard torque values. Reference should always be made to component overhaul procedures for recommendations.

Special attention should be given to the existence of lubricant, plating, or other factors that might require variation from standard torque values.

When maximum recommended torque values have been exceeded, the fastener should be replaced.

When referring to the applicable torque charts, use values as close as possible to the torque values shown to allow for wrench calibration tolerance. An erratic or jerking motion of the wrench can easily result in excessive torque. ALWAYS use a slow wrench movement and STOP when the predetermined value has been reached.

Torque wrenches are precision instruments and are to be handled with care to ensure calibrated accuracy. Calibration checks should be made on a scheduled basis. Whenever the wrench might be either overstressed or damaged, it should immediately be removed from service until recalibrated.

KNOW YOUR TORQUE WRENCH! Flexible beam type wrenches, even though they might have a preset feature, must be pulled at right angles and the force must be applied at the exact center of the handle. Force value readings must be made while the tool is in motion.

Rigid handle type torque wrenches are available with torque limiting devices that can be preset to required values and which eliminate dial readings.

NOTE

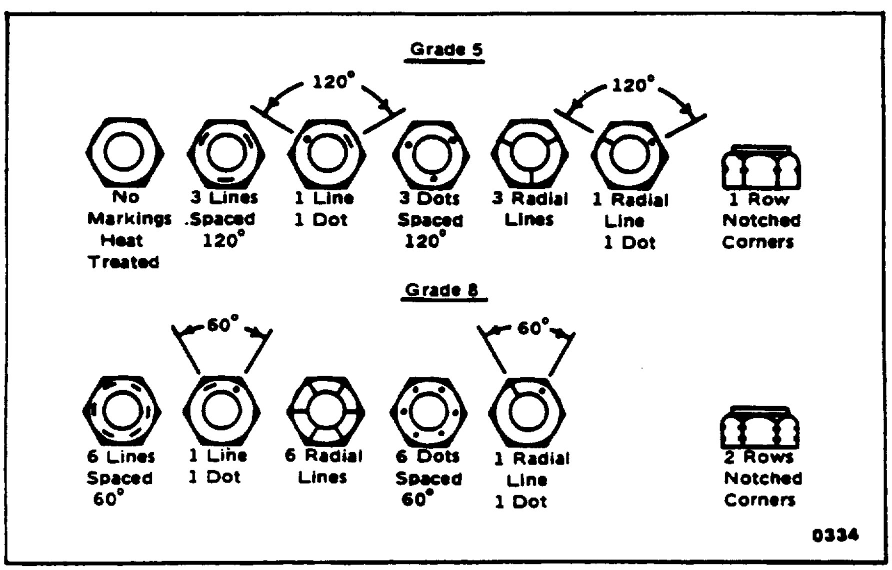
To convert pounds-feet of torque to Newton meters (N•m), multiply quantity by 1.356.

NOTE

To convert pounds-inch of torque to Newton meters (N.m), multiply quantity by 0.113.

NOTE

When multipliers and/or special tools are used to reach hard to get at spots, ensure torque readings are precisely calculated.



Nut Identification

CHAPTER 2

CRANE MAINTENANCE INSTRUCTIONS

Section 1. Repair Parts, Special Tools, TMDE, and Support Equipment

2-1 COMMON TOOLS AND EQUIPMENT

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

2-2 SPECIAL TOOLS, REPAIR PARTS, TMDE, AND SUPPORT EQUIPMENT

Reference Section III of Appendix B, Maintenance Allocation Chart, for a list of all special tools and test equipment needed to maintain the crane. Repair parts and special tools list, TM 10-3950672-24P contains a listing of the repair parts for this equipment.

Section 2. Service Upon Receipt

2-3 SUMMARY

The crane is shipped ready-for-operation and requires no maintenance or operator actions. However, it is recommended that a visual inspection of the hydraulic, fuel, air intake, and coolant system lines be made to ensure that lines and fittings are not loose or damaged as a result of shipment.

2-4 UNPACKING

To unpack the crane, remove the restraining strap securing the door. Then remove the fire extinguisher and place it in the mounting bracket inside the cab.

2-5 CHECKING AND UNPACKING EQUIPMENT

a. Inspect the crane for damage. If damaged, report damage on DD Form 6, Packaging Improvement Report.

b. Check the crane against the packing slip and ensure that shipment is complete. Report any discrepancies on DA Form 738-700.

c. Check the crane for any unauthorized modifications.

2-6 DEPROCESSING UNPACKED EQUIPMENT

The crane should be clean and free of excess grease. However, if during inspection, any excess grease or lubricant is found on the carrier frame or superstructure, is should be cleaned immediately.

2-7 PRELIMINARY SERVICING AND ADJUSTMENT

The crane is shipped completely serviced except for diesel fuel.

A complete walk around visual inspection of the crane should always precede operation. Special attention should be given to structural damage, loose equipment, leaks, or other conditions that could be affect safe operation. The following checklist should be considered the minimum requirement for such a visual inspection.

NOTE

See Section 3, PMCS for checking and servicing procedures.

a. Fuel system. Ensure fuel tank is full and cap is on tight. Open valve on fuel water separator (1/4 turn) and drain water from bowl. Do not tighten plastic valve.

b. Check engine oil and service as required. Do not overfill.

c. Check and service engine coolant at overflow bottle. Do not overfill.

d. Ensure battery cables are tight and not corroded.

e. Check all signal and running lights for proper operation. Replace burned out bulbs as needed. Ensure backup alarm and horn operate.

f. Check foot brake pedal and parking brake lever for proper operation.

g. Check fan belt for damage and for proper tension.

h. Check and service transmission oil level.

i. Ensure all daily lubrication has been performed.

j. Check and service hydraulic tank. Check hydraulic filter indicator.

k. Check tires (four places) for severe cuts and for correct inflation. Check lug nuts for proper torque.

l. Inspect wire rope in accordance with PMCS table. Check boom nose sheaves, guides. hoist drum, rollers, and other wire rope contact surfaces for sharp edges or other conditions that could damage wire rope.

m. Inspect the hook block for nicks, gouges, cracks, and other damage. Replace hook that is cracked, spread, or twisted. Be sure safety latch operates and is aligned.

n. Inspect air restriction indicator. Check air intake tubing for damage and loose clamps.

o. Inspect muffler and exhaust tubing for corrosion, damage, and loose clamps.

p. Check charge indicator on fire extinguisher for green indication.

q. Check and service the fluid level in the windshield washer fluid bottle.

Section 3. Organizational Preventive Maintenance Checks and Services

2-8 GENERAL

To make sure that your vehicle is ready for operation at all times, inspect it systematically so you can discover any defects and have them corrected before they result in serious damage or failure. The charts on the next few pages contain your organizational PMCS. The item numbers indicate the sequence of minimum inspection requirements. If you're operating the vehicle and notice something wrong which could damage the equipment if your continue operation, stop operation immediately.

Record all deficiencies and shortcomings, along with eh corrective action taken on a DA Form 2404. The Item Number column is the source for the numbers used on the TM Number column on DA Form 2404.

2-9 ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

The item numbers of the table indicated the sequence of the PMCS. Perform at the intervals shown below:

a. Do your (Q) PREVENTIVE MAINTENANCE quarterly (every three months).

b. Do your (S) PREVENTIVE MAINTENANCE semi-annually (every six months).

c. Do your (A) PREVENTIVE MAINTENANCE annually (once every year).

d. Do your (B) PREVENTIVE MAINTENANCE bi-annually (once every two years).

e. Do your (H) PREVENTIVE MAINTENANCE at the hour interval listed.

f. Do your (M) PREVENTIVE MAINTENANCE monthly (once a month).

If something doesn't work, troubleshoot it according to the instructions in this manual.

Always do your preventive maintenance in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

If anything looks wrong and you can't fix it, write it down on your DA Form 2404. If you find something seriously wrong, report it to direct support as soon as possible.

WARNING

Dry cleaning solvent PD-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes, and clothes and don't breather vapors. Do not use near open flame or excessive heat. The flash point is 100° to 138°F (38° to 59°C). If you become dizzy while using solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

WARNING

Compressed air, used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).

a. Keep it clean: dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as your work and as needed. Use dry cleaning solvent (PD-680) to clean metal surfaces. Use soap and water when you clean rubber or plastic material.

b. Bolts, nuts, and screws: Check that they are not loose, missing, bent, or broken. You can't try them all with a tool, of course, but look for chipped paint, bare metal or rust around bolt heads. Tighten any bolt, nut, or screw that you find loose.

c. Welds: Look for loose or chipped paint, rust or gaps where parts are welded together. If you find a bad weld, report it to intermediate direct support.

d. Electric wires and connectors: Look for cracked or broken insulation, bare wires and loose or broken connectors. Tighten loose connections and make sure the wires are in good condition.

e. Hoses and fluid lines: Look for wear, damage, and leaks. Make sure clamps and fittings are tight. Wet spots show leaks, but a stain around a fitting or connector can also mean a leak. If leakage comes from a loose fitting or connector, tighten the fitting or connector. If something is broken or worn out, either correct it or report it to intermediate direct support (refer to the Maintenance Allocation Chart).

WARNING

The cooling system is pressurized. Personal injury may result when removing the radiator cap after operating temperature is reached. Do not remove radiator cap when radiator is hot to touch.

WARNING

Do not smoke or allow flame or spark in the vicinity while checking or filling the batteries. The batteries generate - hydrogen a highly explosive gas. Wear safety goggles when adding distilled water.

CAUTION

Turntable bearing bolts cannot be retorqued more than one time. Stretching takes place each time they are torqued. If torque is lost, replace bolts.

CAUTION

In cold operation, charge batteries immediately after water has been added to prevent freezing and damage to batteries; run crane engine for one hour at 1500 RPMs.

It is necessary for your to know how fluid leaks affect the status of your equipment. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your equipment. Learn and be familiar with them and **REMEMBER** - when in doubt, notify your supervisor.

2-10 LEAKAGE DEFINITIONS FOR ORGANIZATIONAL PMCS

CLASS I Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

CLASS II Leakage of fluid great enough to form drops, but not enough to cause drops to drip from the item being checked/inspected.

CLASS III Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

Equipment operation is allowable with minor leakage (Class I or II). Of course consideration must be given to the fluid capacity in the item/system being checked/inspected. When operating with Class I or II leaks, continue to check fluid levels as required on your PMCS. Class II leaks should be reported to your supervisor.

2-11 ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART

M - MONTHLY (200 Hours) **S - SEMI-ANNUALLY (1000 Hours)** **B - BI-ANNUALLY**

Q - QUARTERLY (500 Hours) **A - ANNUALLY** **W - WEEKLY (50 Hours)** **H - HOURS**

ITEM NO	INTERVAL M	Q	S	A	B	W	H	ITEM TO BE INSPECTED PROCEDURE: CHECK, REPAIR, FILL, ADJUST PERFORM ALL OPERATOR PMCS FIRST
1	•							AXLE DIFFERENTIAL Check for proper level.
2	•							TRANSMISSION Change oil filters.
3		•						TRANSMISSION MOUNTING BOLTS Check torque. [lb ft (N•m)] -Trans to Engine [50-65 lb ft (60-88 N•m)] -Rear Engine Support to Trans [60-80 lb ft (81-108 N•m)]
4		•						TURNTABLE BOLTS **CAUTION** **Turntable bearing bolts cannot be retorqued more than one time. Stretching takes place each time they are torqued. If torque is lost, replace bolts.** Check torque. [lb ft (N•m)] -Outer race [370 lb ft (502 N•m)] -Inner race [370 lb ft (502 N•m)]
5		•						ENGINE MOUNTING BOLTS Check torque. [lb ft (N-m)] 75 lb ft (102 N•m)
6		•						ENGINE RPM -Governed RPM 2400.
7						•		WHEEL LUGS Check torque. [lb ft (N•m)] 300 lb ft (407 N•m)
8		•						MUFFLER CONNECTIONS Check for cracks or leaks
9		•						BOOM ALIGNMENT Check for proper adjustment.

2-11 ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART(continued)

M - MONTHLY (200 Hours) **S - SEMI-ANNUALLY (1000 Hours)** **B - BI-ANNUALLY**

Q - QUARTERLY (500 Hours) **A - ANNUALLY** **W - WEEKLY (50 Hours)** **H - HOURS**

ITEM NO	INTERVAL							ITEM TO BE INSPECTED PROCEDURE: CHECK, REPAIR, FILL, ADJUST PERFORM ALL OPERATOR PMCS FIRST
	M	Q	S	A	B	W	H	
10		•						HOIST MOUNTING BOLTS Check torque. [lb ft (N-m)] 370 lb ft (502 N•m)
11		•						GEARBOX MOUNTING BOLTS (Planetary Gear Reducer) Check torque. [lb ft (N•m)] 99 lb ft (134 N•m)
12		•						AXLE MOUNTING BOLTS Check torque. [lb ft (N•m)] -Front Drive Axle 250 lb ft (339 N•m)
13		•						DIFFERENTIAL BREATHERS Clean or replace.
14		•						FUEL TANK FILLER SCREEN Clean and check for broken screen.
15		•						WIRING HARNESS Check connectors and wiring for proper insulation.
16			•					SWING GEARBOX CASE (Planetary Gear Reducer) Check for cracks or leaks.
17			•					TRANSMISSION CASE Check for cracks or leaks.
18			•					BOOM WEAR PADS Notify Direct Support Maintenance to check boom wear pads for excessive wear. Clean or replace as necessary.
19			•					ENGINE INTAKE MANIFOLD Check for cracks or leaks. Check torque. [lb ft (N•m)] 18 lb ft (24 N•m)
20			•					AXLE DIFFERENTIAL Check for cracks or leaks.

2-11 ORGANIZATIONALPREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART (continued)

M - MONTHLY (200 Hours) | **S - SEMI-ANNUALLY (1000 Hours)** | **B - BI-ANNUALLY**

Q - QUARTERLY (500 Hours) | **A - ANNUALLY** | **W - WEEKLY (50 Hours)** | **H - HOURS**

ITEM NO	INTERVAL M	Q	S	A	B	W	H	ITEM TO BE INSPECTED PROCEDURE: CHECK, REPAIR, FILL, ADJUST PERFORM ALL OPERATOR PMCS FIRST
21			•					FRONT & REAR AXLE PLANETARY HUB Check for proper working order.
22			•					STEERING LINKAGE Check for excessive wear.
23			•					ENGINE COOLANT SYSTEM Clean and flush coolant system.

CHAPTER 3

MAINTENANCE

Section 1. CAB

3-1 SEAT ASSEMBLY

3-1.1 Removal

a. Pull release handle (1, Figure 3-1) and slide seat (2) forward off rails (3).

b. Remove seat assembly (2) from cab.

3-1.2 Installation

a. Position seat assembly (2, Figure 3-1) in cab with rear of seat slide on rail (3).

b. Slide seat assembly (2) rearward until release handle (1) locks in desired slot.

3-1.3 Seat Belt Removal

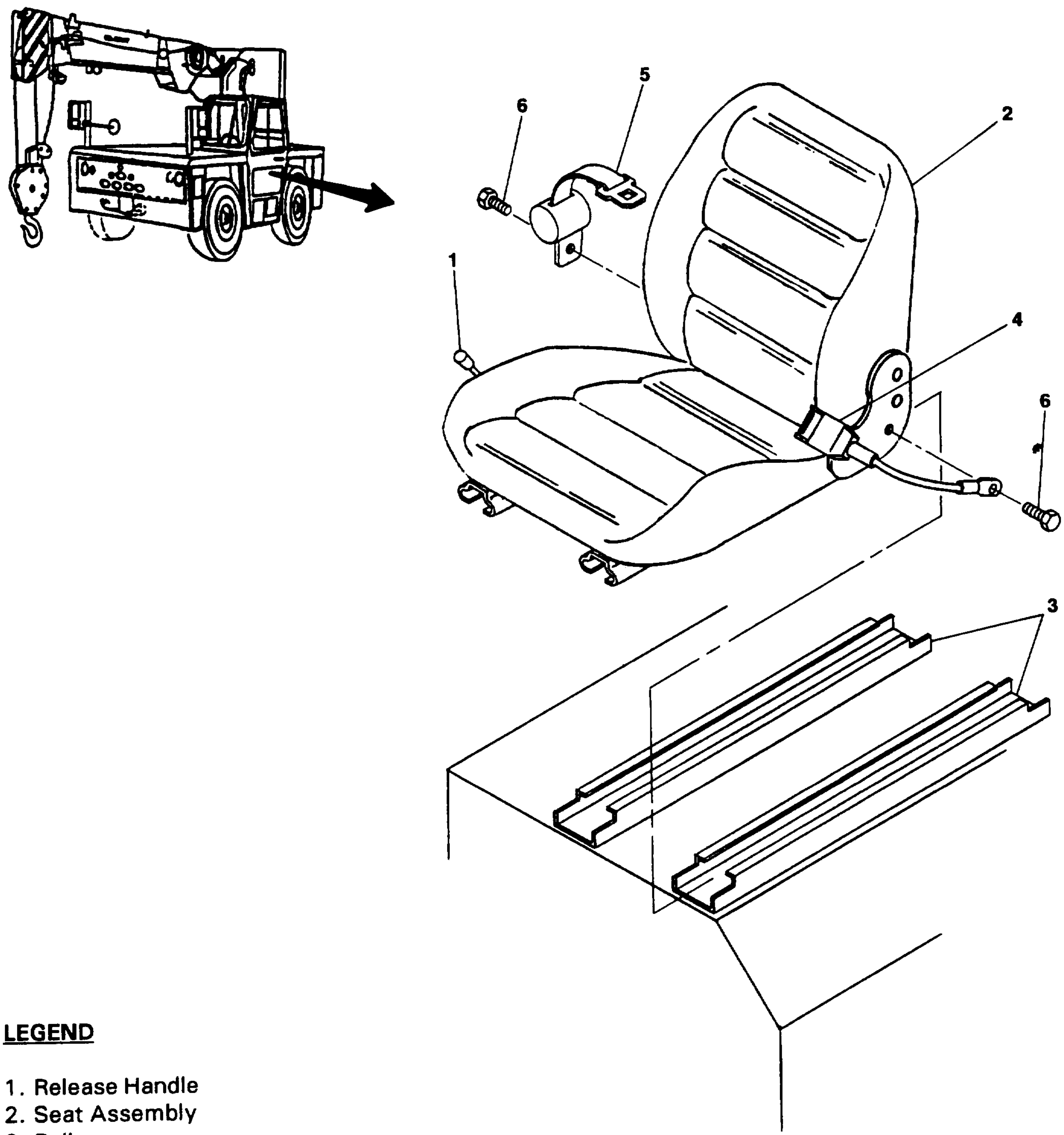
a. Remove bolt (6, Figure 3-1) securing seat belt buckle (4) to seat back.

b. Remove bolt (6) securing seat belt and retainer (5) to seat back.

3-1.4 Seat Belt Installation

a. Secure seat belt and retainer (5, Figure 3-1) to seat back with bolt (6).

b. Secure seat belt buckle (4) to seat back with bolt (6).



LEGEND

1. Release Handle
2. Seat Assembly
3. Rail
4. Seat Belt Buckle
5. Seat Belt and Retainer
6. Bolt

Figure 3-1. Seat Assembly.

3-2 CAB FAN ASSEMBLY

3-2.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.

b. Disconnect fan assembly (3, Figure 3-2) electrical connector from cab electrical harness.

c. Remove three mounting screws (1), three lockwashers (2), and fan assembly (3) from dash panel.

3-2.2 Installation

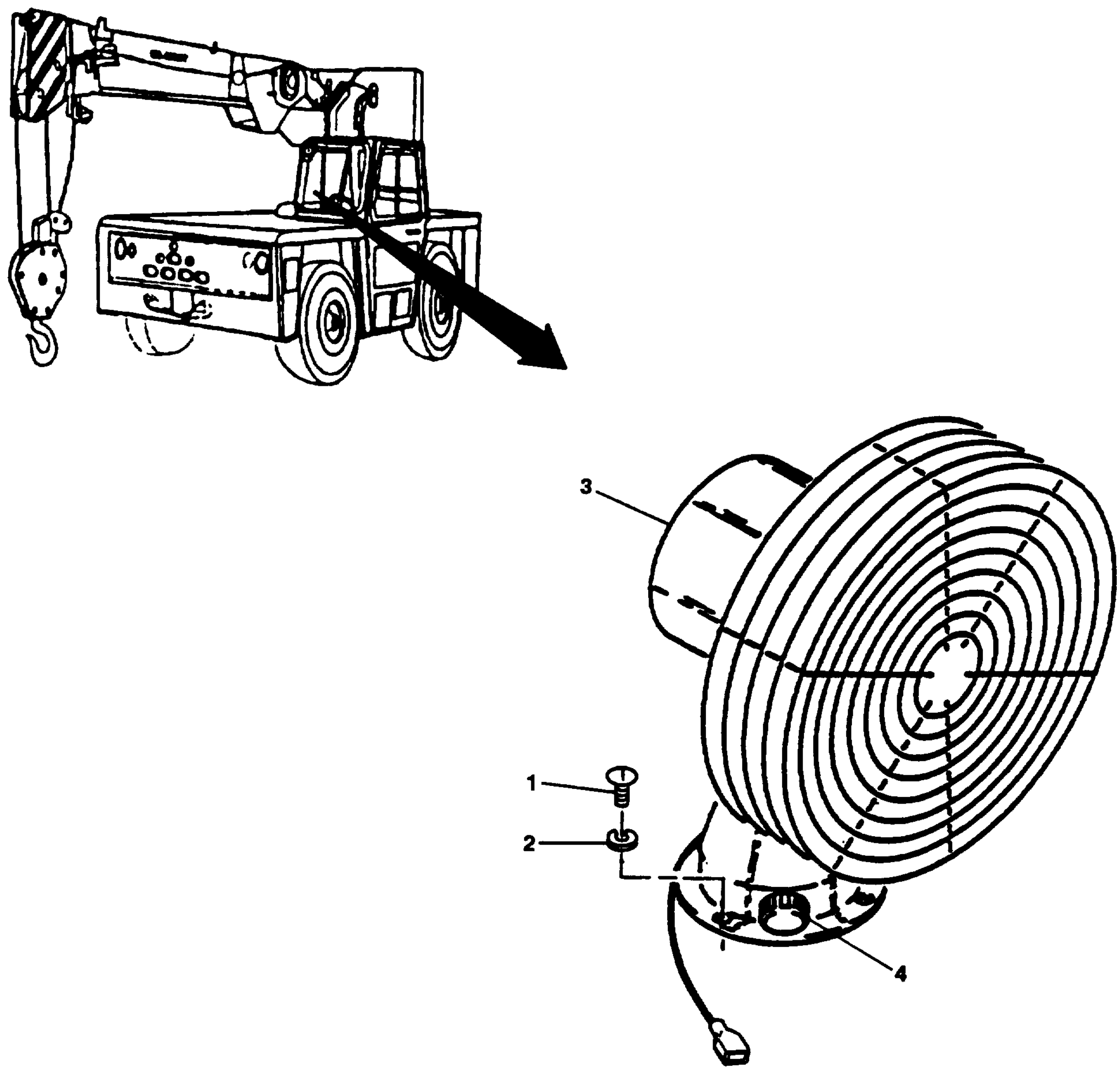
NOTE

Ensure fan control knob (4, Figure 3-2) faces rearward.

a. Install fan assembly (3) on dash panel with three mounting screws (1) and three lockwashers (2).

b. Connect fan assembly (3) electrical connector to crane electrical harness.

c. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Screw
2. Lockwasher
3. Fan Assembly
4. Knob

Figure 3-2. Cab Fan Assembly

3-3 WINDSHIELD WIPER AND WASHER ASSEMBLY

3-3.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.

b. Pry wiper arm (1, Figure 3-3) with wiper blade (2) from shaft of wiper motor (3).

c. Remove nut (4), collar (5) and felt washer (6) from shaft of wiper motor (3).

d. Remove nut (7), lockwasher (8), flat washer (9), wiper motor (3), and bushing (10) from cab frame.

e. Tag and disconnect three electrical leads from wiper motor (3).

NOTE

Nut (11) is factory positioned so that motor is parallel to windshield. Do not disturb setting.

f. Tag and disconnect electrical lead (23) from pump of pump/canister (14).

g. Position suitable container under pump/canister (14), disconnect hose (1 5) from pump, and drain fluid.

h. Remove four nuts (16), four lockwashers (17), four washers, ground wire (24) from lower left mounting stud (25), and pump/canister (14) from left front wheel well.

i. Disconnect hose (15) from nozzle (21).

j. Remove nut (19), lockwasher (20), nozzle (21), and rubber seal (22) from cab frame.

3-3.2 Installation

a. Install rubber seal (22, Figure 3-3) and nozzle (21) in cab frame with lockwasher (20), and nut (19).

b. Connect hose (15) to nozzle (21).

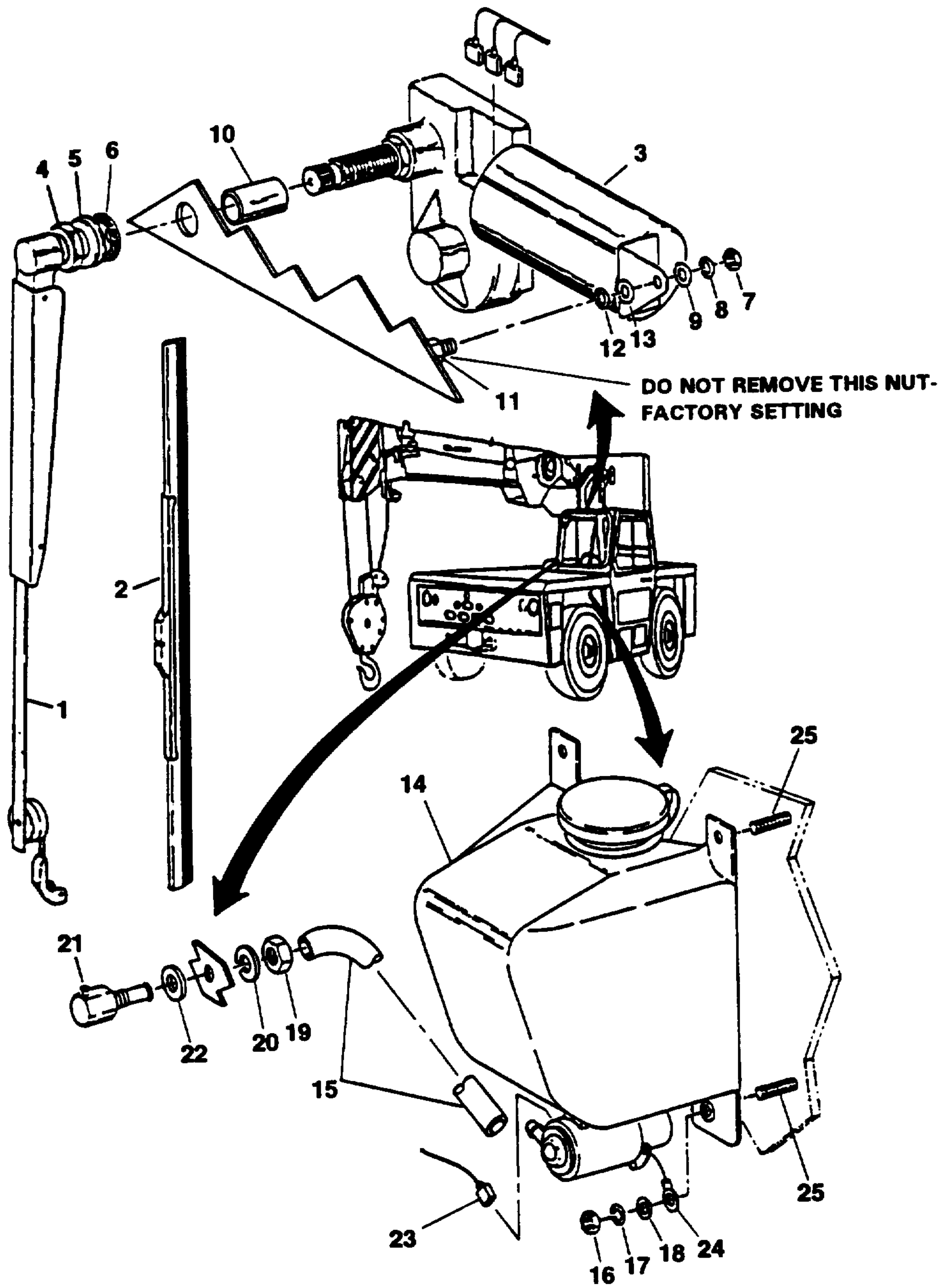
NOTE

Ensure ground wire is positioned on lower left mounting stud.

c. Position pump/canister (14) and ground wire on mounting studs in left front wheel well. Secure pump/canister (14) with four washers (18), four lockwashers (17) and four nuts (16).

d. Connect hose (15) to pump of pump/canister (14).

e. Connect electrical lead to pump of pump/canister (14) and remove tag.



LEGEND

1. Wiper Arm
2. Wiper Blade
3. Wiper Motor
4. Nut
5. Collar
6. Felt Washer
7. Nut
8. Lockwasher
9. Washer
10. Bushing
11. Nut
12. Lockwasher
13. Washer
14. Pump/canister
15. Hose
16. Nut
17. Lockwasher
18. Washer
19. Nut
20. Lockwasher
21. Nozzle
22. Rubber Seal
23. Electrical Lead
24. Ground Lead
25. Stud

Figure 3-3. Windshield Wiper and Washer Assembly

f. Connect three electrical leads to wiper motor (3) and remove tags.

g. Install bushing (10) on shaft of wiper motor (3), and position wiper motor (3) through hole in cab frame and onto frame stud.

h. Secure wiper motor (3) to frame stud with flat washer (9), lockwasher (8), and nut (7).

i. Install felt washer (6), collar (5), and nut (4) on shaft of wiper motor (3).

j. Press wiper arm (1) with wiper blade (2) onto shaft of wiper motor (3).

k. Connect negative battery cable and two electrical leads to battery.

3-4 DOOR AND LATCH ASSEMBLY

3-4.1 Removal

a. Open door assembly (1, Figure 3-4) and lift door off cab hinges.

b. Remove bolt (2), with hardware and latch extension (6), from latch (7).

c. Remove lockwasher (3), four flat washers (4), bushing (5) and latch extension (6) from bolt (2).

d. Remove two nuts (8), two lockwashers (9), and two screws (10) to loosen handle (13).

e. Remove two pins (11), two washers (12), latch extension (6), and handle (13) from door assembly (1).

f. Drill out four rivets (19) and remove latch (7) from door assembly (1).

g. Remove nut (14), lockwasher (15), bolt (16), washer (17), and strap (18) from door assembly (1).

3-4.2 Installation

a. Install strap (18, Figure 3-4) on door assembly (1) with washer (17), bolt (16), lockwasher (15), and nut (14).

b. Install latch (7) on door assembly (1) with four rivets (19).

c. Install latch extension (6) and handle (13) on door assembly (1) with two washers (12), two pins (11), two screws (10), two lockwashers (9), and two nuts (8).

d. Install latch extension (6) on latch (7) with bushing (5), four washers (4), lockwasher (3), and bolt (2).

e. Set door assembly (1) onto cab hinges and close door assembly.

3-4.3 Door Glass Replacement

WARNING

Use care when removing cracked or broken glass. Wear eye protection and gloves.

Follow silicone sealant manufacturer's instructions for applying sealant.

a. Pry locking strip open on molding around glass.

b. Remove glass and discard.

c. Remove and discard door glass molding.

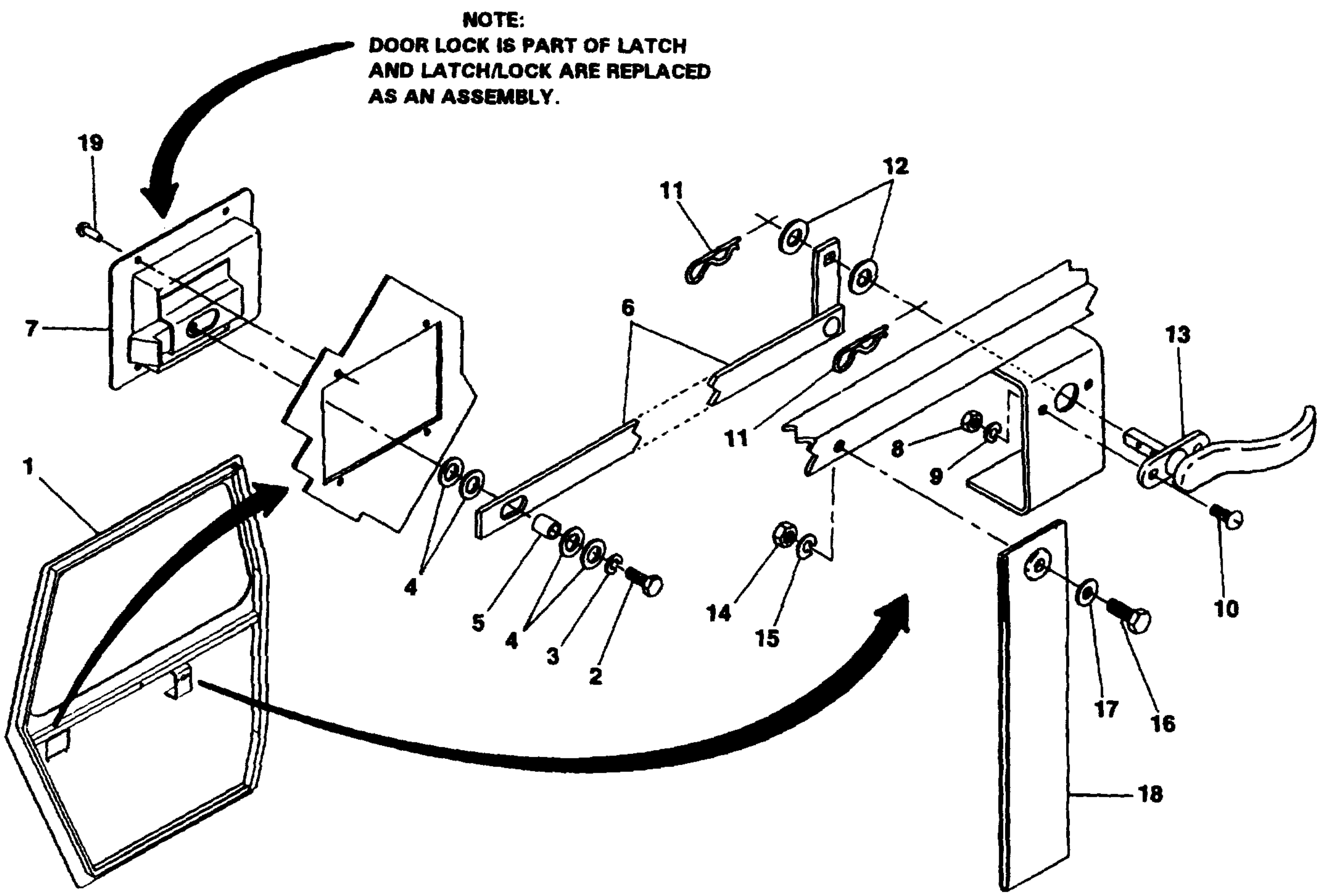
d. Cut new door glass molding to window opening size.

e. Install molding in window opening.

f. Fit glass into channel of molding. Work molding around glass until it is fully seated.

g. Seat locking strip onto molding to secure glass from outside of glass.

h. Apply silicone sealant at joint where molding end meets. Allow joint to dry and check for leaks.



LEGEND

1. Door Assembly
2. Bolt
3. Lockwasher
4. Washer
5. Bushing
6. Extension
7. Latch
8. Nut
9. Lockwasher
10. Screw
11. Pin
12. Washer
13. Handle
14. Nut
15. Lockwasher
16. Bolt
17. Washer
18. Strap
19. Rivet

Figure 3-4. Door and Latch Assembly

3-5 ACCELERATOR PEDAL ASSEMBLY

3-5.1 Removal

a. Set outriggers, refer to Operator's Manual, TM 10-3950-672-10.

b. From under the vehicle, remove two nuts (1, Figure 3-5), two washers (2), U-bolt (3), and cable mount (4) securing throttle cable to bracket (19).

c. Remove spring clip (5), pin (6), and throttle cable from lever (23).

d. Remove three bolts (7), three lockwashers (8), and pedal (9) with attached components from vehicle.

3-5.2 Disassembly

a. Remove spring clip (10, Figure 3-5) and pin (11) securing clevis (27) to lever (23).

b. Remove two nuts (12), two washers (13), and U-bolt (14) securing pedal (9) to bracket (15).

c. Remove bracket (15), lever (23), and bracket (19) as an assembly.

d. Remove two nuts (16), two washers (17), two bolts (18), and bracket (19) from bracket (1 5).

e. Remove circlip (20), two bearing liners (21), spring (22), and lever (23) from bracket (15).

f. Remove spring clip (24), pin (25), and rod end bearing (26) with clevis (27) from pedal (9).

NOTE

Count and note number of turns when removing clevis (27) to aid in assembly.

g. Unscrew clevis (27) from rod end bearing (26).

NOTE
Count and note number of turns when removing bolt (29) to aid in assembly.

h. Loosen nut (28) and remove bolt (29) from base of pedal (9).

i. Remove bellows (30) from base of pedal (9).

3-5.3 Assembly

a. Install bellows (30, Figure 3-5) on base of pedal (9).

b. Screw bolt (29) with nut (28) into base of pedal (9) the same number of turns noted during disassembly. Tighten nut (28).

c. Screw clevis (27) into rod end bearing (26) the same number of turns noted during disassembly.

d. Install rod end bearing (26) with clevis (27) on pedal (8) with pin (25) and spring clip (24).

e. Install two bearing liners (21), spring (22), and lever (23) on bracket (15). Secure lever (23) with circlip (20).

f. Install bracket (19) on bracket (15) with two bolts (18), two washers (17), and two nuts (16).

g. Position bracket (15), lever (23), and bracket (19) as an assembly under pedal (9), and attach clevis (27) to lever (23) with pin (11) and spring clip (10).

h. Secure bracket (15) to pedal (9) with U-bolt (14), two washers (13), and two nuts (12).

3-5.4 Installation

a. Install pedal (9, Figure 3-5) with attached components on cab floor with three bolts (7) and three lockwashers (8).

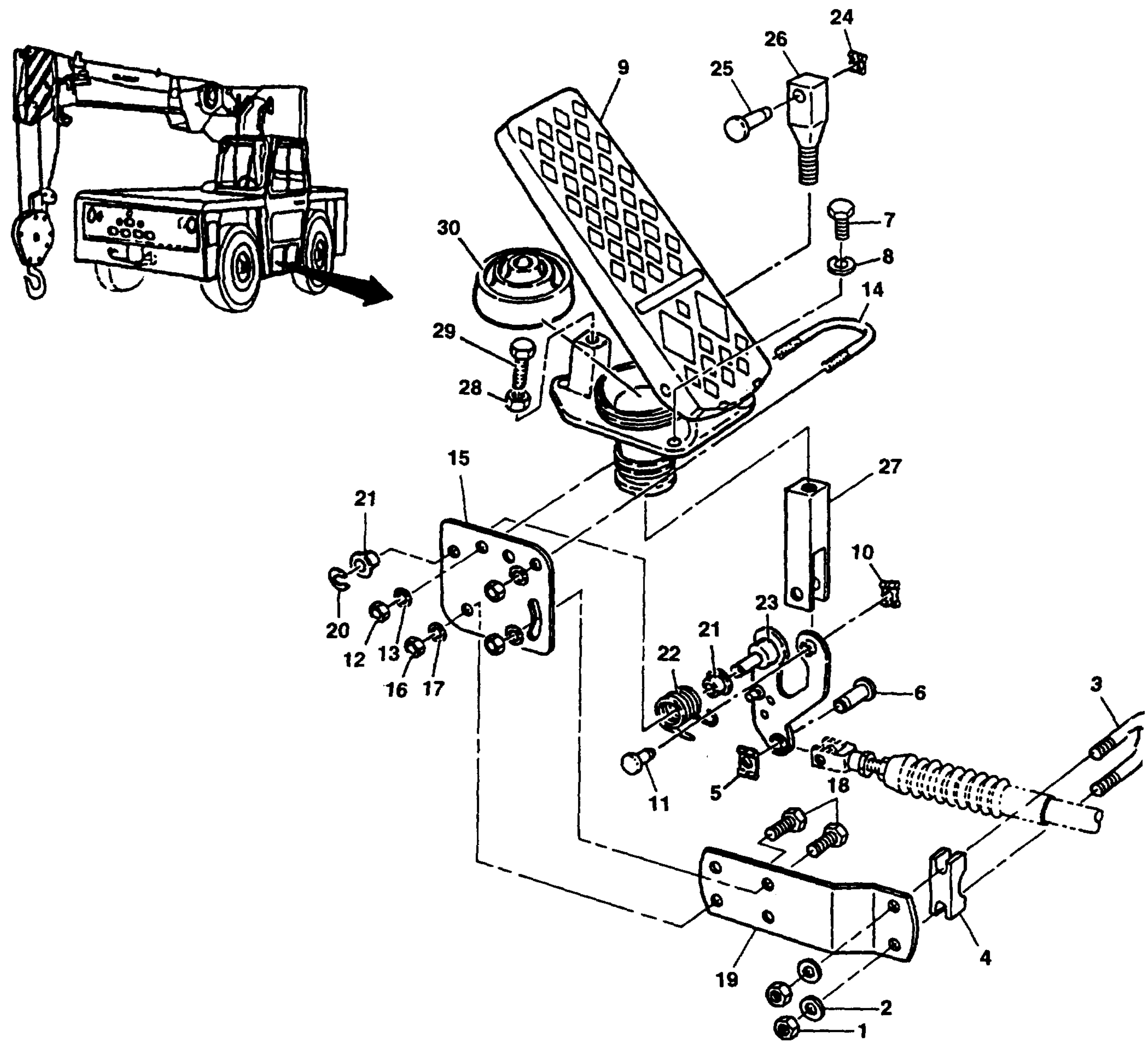
b. Attach throttle cable to lever (23) with pin (6) and spring clip (5).

c. Secure throttle cable to bracket (19) with cable mount (4), U-bolt (3), two washers (2), and two nuts (1).

NOTE

Ensure there is no slack in throttle cable between lever (23) and bracket (19). If necessary, loosen nuts (1) and reposition throttle cable to take up slack.

d. Stow outriggers, refer to Operator's Manual, TM10-3950-672-10.



LEGEND

1. Nut
2. Washer
3. U-bolt
4. Cable Mount
5. Spring Clip
6. Pin
7. Bolt
8. Lockwasher
9. Pedal
10. Spring Clip
11. Pin
12. Nut
13. Washer
14. U-bolt
15. Bracket
16. Nut
17. Washer
18. Bolt
19. Bracket
20. Circlip
21. Bearing Liner
22. Spring
23. Lever
24. Spring Clip
25. Pin
26. Rod End Bearing
27. Clevis
28. Nut
29. Bolt
30. Bellows

Figure 3-5. Accelerator Pedal Assembly

3-6 CAB HEATER/DEFROSTER ASSEMBLY

3-6.1 Description

The cab heater/defroster is a hot water type with a variable speed fan. It is mounted under the operator's seat. The heater system consists of a heater core, heater hoses, a fan, and an electric motor. The heater box assembly prevents personnel from accidentally coming in contact with the fan or heater core.

3-6.2 Theory of Operation

Hot water is carried by the heater hoses from the crane's engine to the heater core. A fan is used to circulate the heated air around the heater core out into the cab. The speed of the fan is controlled by a rotary switch located on the left side of the cab beside the seat. The air flow is vented through the box assembly for either heat or defrost. The vent is controlled by the push-pull knob located on the left side of the cab beside the seat.

NOTE

For more detailed information, refer to Appendix E.

WARNING

Before performing maintenance or inspection, disconnect battery negative leads from battery negative post.

WARNING

Engine must be cool to the touch prior to working on coolant system components. Failure to comply could result in scalding or serious burns.

3-6.3 Removal

a. Disconnect battery at negative battery post. Tag and disconnect the electrical leads to the motor.

NOTE

A suitable container should be used to catch draining coolant.

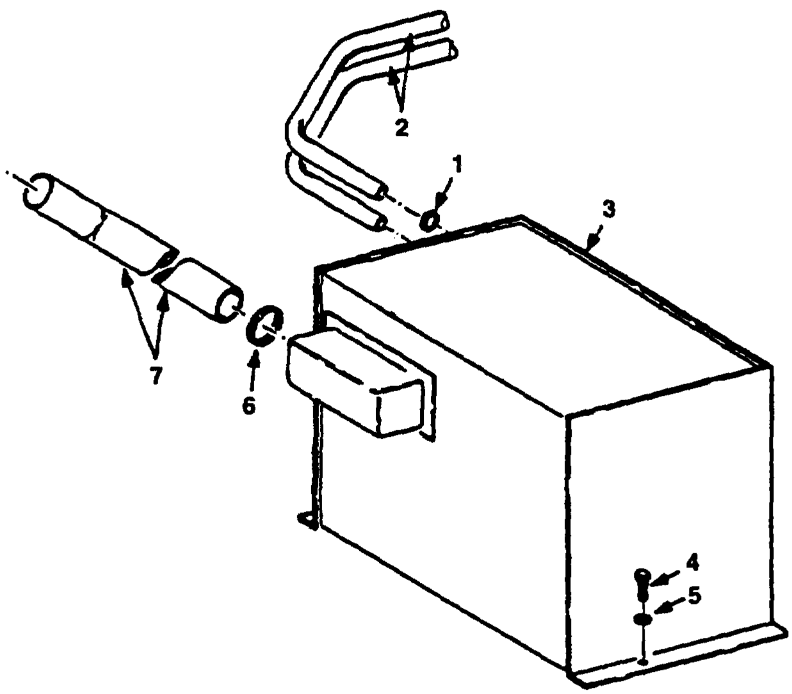
b. Ensure heater control knob is off. Then disconnect the heater hoses from the heater by loosening the hose clamps.
c. Cap or plug all openings.
d. Loosen clamp and disconnect the defroster hose from the heater
e. Mark control cable to aid in installation. Remove the clamps securing the control cable to the heater assembly and disconnect the cable from the heater.
f. Remove the three capscrews and lockwashers securing the heater to the cab. Remove the heater from the crane.

3-6.4 Inspection

a. Inspect the fan for any damage.
b. Inspect the heater core for any signs of leakage or other damage.
c. Inspect the heater hoses for frays, soft spots, wear, or any other damage.
d. Repair or replace any damaged component as necessary.

3-6.5 Installation

a. Install the heater under the seat and secure with the three capscrews and lockwashers.
b. Install the control cable to the heater with the clamps.
c. Install the defroster hose to the heater. Tighten clamp.
d. Install the heater hoses to the heater.
e. Secure the electrical leads to the motor as tagged during removal.
f. Check the heater for proper operation and ensure there are no leaks.



LEGEND

1 CLAMP
2 HOSE, HEATER
3 HEATER
4 SCREW, CAP
5 WASHER, LOCK
6 CLAMP
7 HOSE, DEFROSTER

Heater Defroster Installation

Section 2. Engine

3-7 ENGINE

3-7.1 Description

This Service Manual does not include detailed information on the engine itself. A separate manual, as prepared in detail by the engine manufacturer, is supplied with this Service Manual. However, a short description and maintenance of certain components of the fuel system is provided in this section. Refer to Appendix E for detailed information on the air intake system and water cooling system.

Engine speed is controlled by a foot throttle pedal in the cab. The throttle is connected to a cable to the governor speed control shaft through linkage on the diesel engine.

To aid in starting the diesel engine in cold weather, a starting aid injection system is provided. The system consists of a quick start switch located on the lower right side of the front console, an atomizer, valve assembly, and associated tubing.

3-7.2 Removal

a. Ensure the crane is on flat, level ground and set the outriggers.
b. Disconnect battery negative leads from battery negative post.
c. Disconnect the air filter tubing at the engine, refer to paragraph 3-17.
d. Disconnect the muffler exhaust piping at the engine, refer to paragraph 3-18.
e. Drain the engine coolant system, refer to paragraph 3-20.
f. Drain the engine lubrication system, refer to TM 10-3950-672-24-2.
g. Drain the transmission/torque converter oil system, refer to paragraph 3.

CAUTION

Mark the universal so it can be assembled as taken apart, otherwise severe drive line vibration may occur.

h. Remove the capscrews, washers, nuts, bolts, and clamp drive securing the shaft to the transmission and the capscrew, nut, washer, and clamp securing the shaft to the axle differential. Remove the drive shaft. Refer to paragraph 3-22.
i. Tag and disconnect radiator hoses, heater hoses, lines, and tubing from the engine, transmission, and all other components. Remove the radiator and oil cooler. Refer to paragraph 3-20.
j. Tag and disconnect all electrical leads from the engine and engine components.
k. Tag and disconnect the lines from the hydraulic pump and cap or plug all openings.
Remove the pump, refer to paragraph 3-41.

l. If necessary, remove the steering pump, refer to paragraph 3-33.
m. Disconnect the throttle cable from the throttle linkage.
n. Disconnect any transmission shifting linkage from the transmission, refer to paragraph 3-23.
o. Attach an adequate lifting device to the engine and transmission assembly and take up any slack.
p. With the lifting device supporting the weight of the engine, remove the bolts, nuts, and washers securing the engine to the mounting bracket. Remove the bolts, nuts, and washers securing the transmission to the frame.
q. Using the lifting device, lift the engine from the crane.
r. If a new engine is to be installed, remove all components, fittings, etc., from the old engine and install them on the new engine in the same locations. Ensure the same grade hardware, torque valves, and loctite as were installed by the factory are used.
s. Refer to Section 3, DRIVE TRAIN and remove the transmission from the engine, if necessary.

3-7.3 Installation

a. If the transmission was removed from the engine, refer to Section 3, DRIVE TRAIN and install the engine to the transmission.
b. With all the components and fittings installed on the new engine, lift the engine into the crane.
c. With the engine in position, secure the transmission to the frame with the bolts, nuts, and washers. Torque the bolts to 75 lb ft (101.7 N•m). Secure the engine to the mounting bracket with the bolts, nuts, and washers. Torque the bolts to 75 lb ft (101.7 N•m).
d. Remove the lifting device.
e. Connect the transmission shifting linkage to the transmission, refer to paragraph 3-23.
f. Connect the throttle cable to the throttle linkage.
g. If removed, install the steering pump and secure with the bolts and washers. Torque the bolts to 165 lb ft (223.7 N•m), refer to paragraph 3-33.
h. Connect all lines and tubing to the engine, transmission and other components as tagged during removal.
i. Install the hydraulic pump and secure with the bolts and washers. Torque the bolts to 165 lb ft (223.7 N•m). Connect the lines as tagged during removal, refer to paragraph 3-41.

j. Connect all electrical leads to the engine and engine components as tagged during removal.

k. Install the radiator and oil cooler and connect the heater hoses, lines, and tubing as tagged during removal.

l. Grind a flat on the washers to allow clearance for bend radius on the clamp and clamp drive and to provide proper torque of the capscrews and bolt. Secure the shaft to the axle differential with the clamp, capscrews, nuts, and washers. Torque the nuts 27 to 29 lb ft (36.6 to 39.3 N•m). Secure the shaft to the transmission with the clamp drive, capscrew, washers, nuts, and bolts.

m. Service the transmission, engine lubrication system, and engine cooling system.

n. Connect the muffler exhaust piping and air filter tubing to the engine, refer to paragraphs 3-17 and 3-18.

o. Bleed air from the fuel system. Refer to TM 10-3950-672-24-2 Engine Manual Index under Bleeding the Fuel System.

p. Start the engine. Check all hoses and fittings for leaks. Shut down the engine and check all fluid levels.

3-8 ENGINE OIL PRESSURE SWITCH

NOTE

This switch closes when oil pressure is below 5 psi illuminating the low oil pressure/high engine temperature indicator.

3-8.1 Testing

a. Using multimeter, check continuity across switch connectors.
b. If continuity is not indicated, replace switch.

3-8.2 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Tag and disconnect two electrical connectors for engine oil pressure switch (1, Figure 3-6).
c. Remove oil pressure switch (1) from engine.

3-8.3 Installation

a. Install oil pressure switch (1, Figure 3-6) in engine.
b. Connect two electrical connectors for oil pressure switch (1) and remove tags.
c. Connect negative battery cable and two electrical leads to battery.

3-9 ENGINE OIL PRESSURE SENDER

3-9.1 Testing

a. Remove engine oil pressure sender.
b. Set multimeter to ohms, attach positive lead of multimeter to sender terminal, and negative lead to sender body. Multimeter should indicate 240 ohms.
c. Using a hand operated vacuum/pressure tester, apply 50 psi and then 100 psi of pressure to sender while observing multimeter. Multimeter should indicate 103 ohms at 49-51 psi and 33 ohms at 99-101 psi.
d. If multimeter indications are not as above, replace sender.

3-9.2 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Tag and disconnect electrical lead to engine oil pressure sender (2, Figure 3-6).
c. Remove oil pressure sender (2) from engine.

3-9.3 Installation

a. Install oil pressure sender (2, Figure 3-6) in engine.
b. Connect electrical lead to oil pressure sender (2) and remove tag.
c. Connect negative battery cable and two electrical leads to battery.

3-10 ENGINE COOLANT TEMPERATURE SWITCH

WARNING

Engine must be cool to the touch prior to working on coolant system components. Failure to comply could result in scalding or serious burns.

NOTE

This switch closes when engine coolant temperature is above 210°F illuminating the low oil pressure/high engine temperature indicator.

3-10.1 Testing

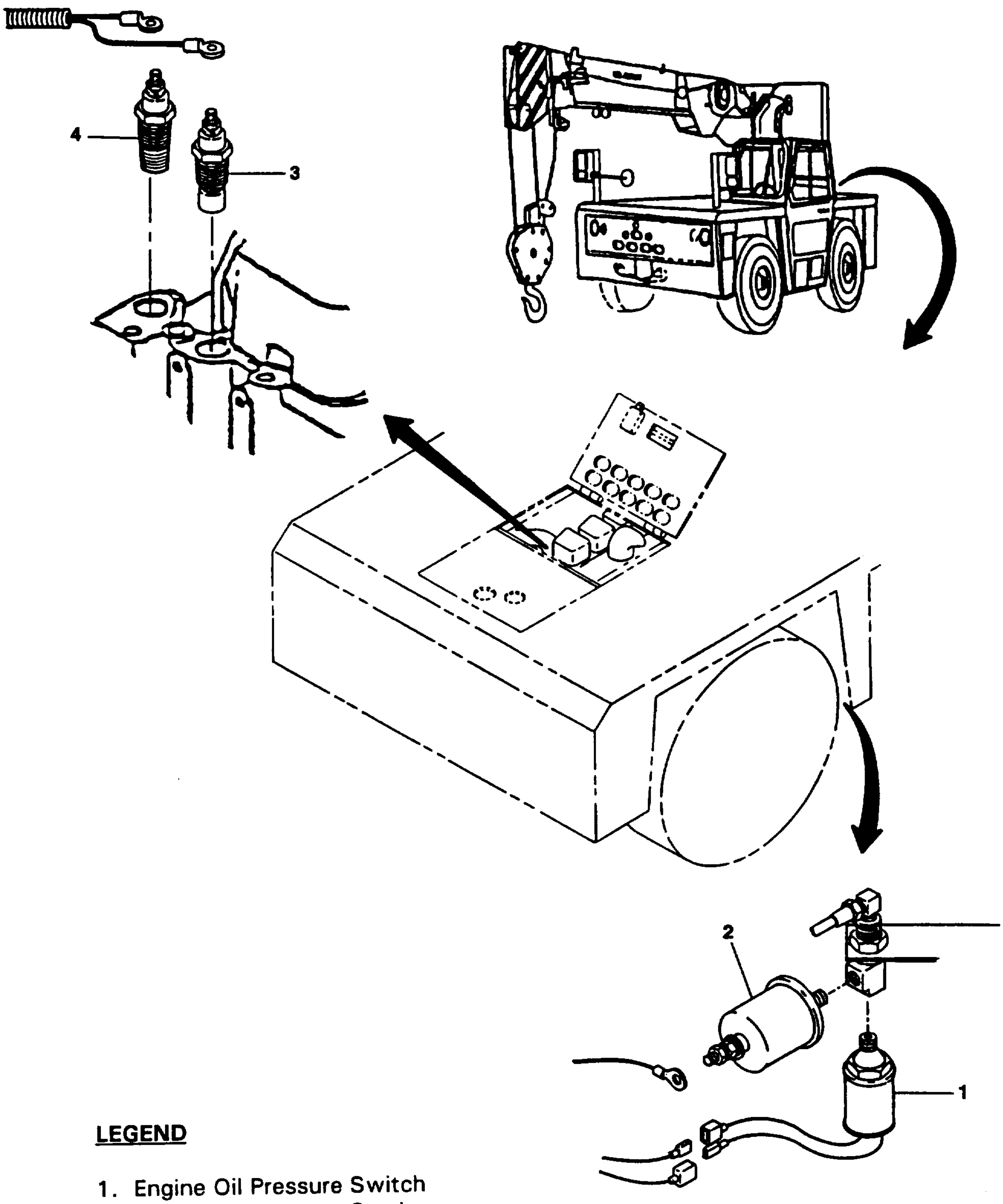
a. Open engine access door.
b. Set multimeter to ohms, attach positive lead of multimeter to switch terminal and negative lead to switch body.
c. If continuity is indicated, replace switch.
d. Close and secure engine access door.

3-10.2 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Open engine access door.
c. Drain engine coolant to a level below coolant temperature switch (3, Figure 3-6).
d. Tag and disconnect electrical lead to coolant temperature switch (3).
e. Remove coolant temperature switch (3) from engine.

3-10.3 Installation

a. Install coolant temperature switch (3, Figure 3-6) in engine.
b. Connect electrical lead to coolant temperature switch (3) and remove tag.
c. Service engine coolant system.
d. Close and secure engine access door.
e. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Engine Oil Pressure Switch
2. Engine Oil Pressure Sender
3. Engine Coolant Temperature Switch
4. Engine Coolant Temperature Sender

Figure 3-6. Engine Senders and Switches

3-11 ENGINE COOLANT TEMPERATURE SENDER

WARNING

Engine must be cool to the touch prior to working on coolant system components. Failure to comply could result in scalding or serious burns.

3-11.1 Testing

a. Open engine access door.
b. With an assistant in cab observing engine coolant temperature gauge, disconnect electrical lead from sender, and ground lead.
c. If engine coolant temperature gauge does not move, sender is OK. If gauge peaks to the right, replace sender.
d. Close and secure engine access door.

3-11.2 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Open engine access door.
c. Drain engine coolant to a level below coolant temperature sender (4, Figure 3-6).
d. Tag and disconnect electrical lead to coolant temperature sender (4).
e. Remove coolant temperature sender (4) from engine.

3-11.3 Installation

a. Install coolant temperature sender (4, Figure 3-6) in engine.
b. Connect electrical lead to coolant temperature sender (4) and remove tag.
c. Service engine coolant system.
d. Close and secure engine access door.
e. Connect negative battery cable and two electrical leads to battery.

3-12 FUEL SYSTEM

3-12.1 Description

The fuel system consists of the fuel tank, filters and/or strainer, fuel pump, and the fuel injectors.

a. Fuel Tank. The fuel tank is located on the right side of the crane. The tank has a total capacity of approximately 35 gal. (132.4 L) and a gauge level of 30 gal. (113.5 L). The tank is equipped with a lock-type filler cap and a fuel quantity sender unit which provides a signal to a quantity indicator on the instrument panel in the cab.

b. Fuel Pump. The diesel engine has a positive displacement gear-type metering fuel pump driven by an engine power take-off through a coupling to one of the accessories. The pump supplies fuel at low pressure to the injectors, where the high pressure necessary for atomization of the fuel is created.

   The fuel is finely atomized as it is injected into the cylinder and ignited by the heat of the compression. it is metered also, before injection, to meet the load requirements imposed upon the engine. Surplus fuel, returning from the injectors, is bypassed back to the fuel tank or to the inlet side of the pump. The continuous flow of fuel through the injectors helps to cool the injectors and to bypass air from the system.

c. Fuel Filter. The gasoline engine uses a replaceable cartridge type filter in the fuel system to remove impurities from the fuel. The filter is installed between the pump and the transfer pump outlet.

3-13 FUEL TANK

3-13.1 Removal

a. Position a suitable container under the fuel tank and drain all fuel from the tank.
b. Tag and disconnect the fuel line(s) from the tank.
c. Disconnect the electrical lead from the fuel quantity sender unit.
d. Support the weight of the tank and remove the bolts, nuts, and washers securing the tank to the mounting brackets. Remove the tank.
e. If a new tank is to be installed, remove the fittings and the fuel quantity sender from the tank and install them in the new tank.

3-13.2 Installation

a. Position the tank on the mounting brackets and secure with the washers, nuts, and bolts. Torque the bolts to 75 lb ft (101.7 N•m).
b. Connect the electrical lead to the fuel quantity sender unit.
c. Connect the line(s) to the tank.
d. Service the tank.

3-14 FUEL FILTER

Refer to TM 10-3950-672-24-2 Engine Manual Index under Fuel Filter Replacement.

3-15 FUEL FILTER WATER SEPARATOR

3-15.1 Draining

The sump of the fuel filter water separator should be drained daily, 30 minutes after the engine is shut down, to remove any water and sediment. Adhere to the following procedure.

a. Remove the cap from the vent valve.
b. Open the petcock.
c. Press down the vent valve.
d. Drain until fuel appears.
e. Close the petcock.
f. Close the vent valve.
g. Replace the cap on the vent valve.

3-15.2 Removal

a. Clean all dirt from the filter, especially the areas around the fuel line connections.
b. Tag, disconnect, and cap the fuel lines to the filter.
c. Remove the mounting nuts and washers.
d. Remove the filter.

3-15.3 Installation

a. Position the filter assembly on the mounting bracket.
b. Install the washers and nuts.
c. Connect the fuel lines as tagged prior to removal.
d. Bleed air from the fuel system. Refer to TM 10-3950-672-24-2 Index under Bleeding the Fuel System.

3-16 COLD START ASSEMBLY

3-16.1 Removal

a. Disconnect negative battery cable and two electrical leads from negative battery post.
b. Open engine access door.
c. Tag and disconnect two electrical connectors for starting fluid valve (3, Figure 3-7) from electrical harness.

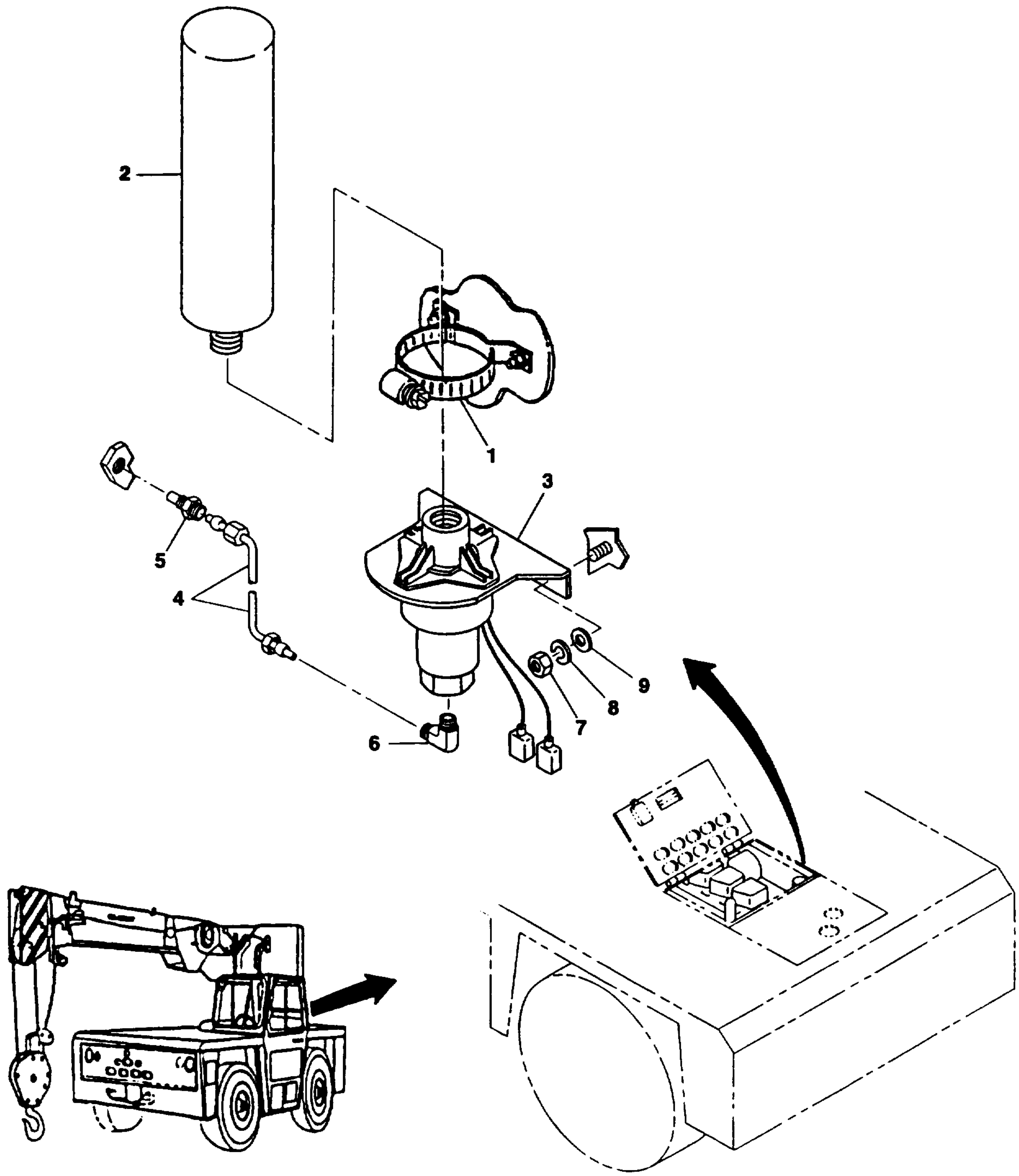
CAUTION

Cover opening to prevent dirt from falling into valve (3). Dirt could prevent starting fluid cylinder (2) from sealing properly.

d. Open clamp (1), unscrew starting fluid cylinder (2) from starting fluid valve (3), and remove starting fluid cylinder (2) from clamp (1).
e. Remove plastic tubing (4) between atomizer (5) and elbow (6). Cut wire ties as needed.
f. Remove atomizer (5) from engine intake manifold.
g. Remove two nuts (7), two lockwashers (8), and starting fluid valve (3) from studs on crane frame.
h. Remove elbow (6) from starting fluid valve (3).

3-16.2 Installation

a. Install elbow (6, Figure 3-7) on starting fluid valve (3).
b. Install starting fluid valve (3) on studs on crane frame with two lockwashers (8) and two nuts (7).
c. Install atomizer (5) in engine intake manifold.
d. Install plastic tubing (4) between atomizer (5) and elbow (6). Install new wire ties as needed.
e. Connect two electrical connectors for starting fluid valve (3) to electrical harness and remove tags.
f. Insert starting fluid cylinder (2) through clamp (1) and screw cylinder tightly into starting fluid valve (3).
g. Connect negative battery cable and two electrical leads to negative battery post.



LEGEND

1. Clamp
2. Cylinder
3. Valve
4. Tubing
5. Atomizer
6. Elbow
7. Nut
8. Lockwasher
9. Washer

Figure 3-7. Cold Start Assembly

3-17 AIR INTAKE AND EXHAUST SYSTEM

3-17.1 Description

The engine air intake system consists of an air cleaner and associated piping for channeling the air from the atmosphere to the engine intake manifold. The intake pipe also provides the necessary connections for starting aid to be injected into the air intake for quick start and a restriction indicator to indicate a dirty air cleaner, see Figure 3-8.

The air cleaner is the dry-type with a replaceable element. It is located on the deck behind the cab.

The optional cold weather starting system consists of an atomizer, valve assembly, and starting aid bottle (customer supplies). The quick start system is normally used during cold weather operations to facilitate engine starting. To operate the system, starter switch must be in the start position before the control is depressed. Depressing the control actuates the valve assembly, passing starting aid from the bottle through the atomizer into the air intake manifold where it mixes with the intake air to facilitate engine combustion.

3-17.2 Maintenance

NOTE

For more detailed information, refer to Appendix E.

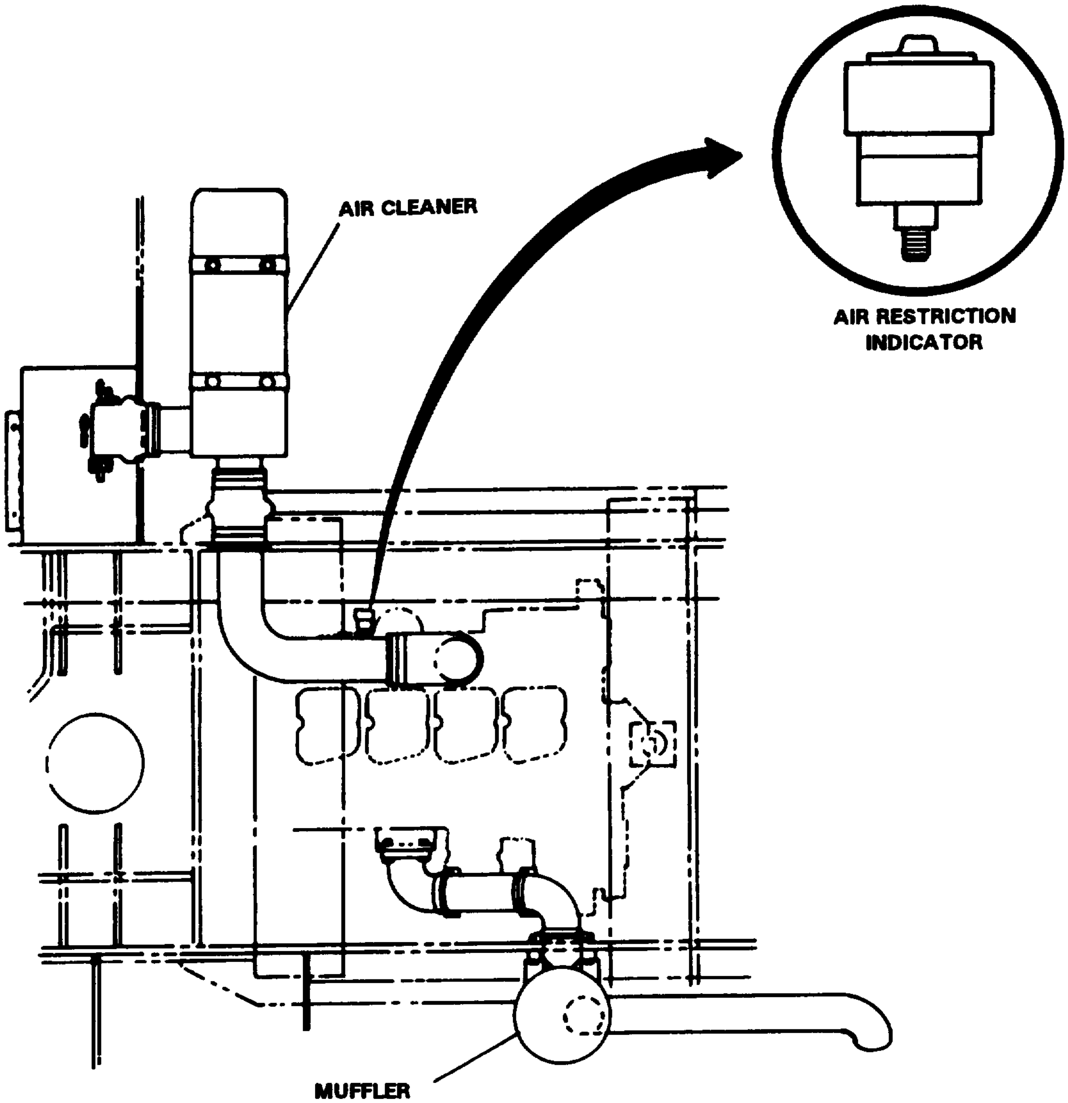


Figure 3-8. Exhaust and Air Cleaner Installation

3-18 MUFFLER AND EXHAUST PIPES

3-18.1 Removal

a. Set rear outriggers, refer to Operator's Manual, TM 10-3950-672-10.
b. Turn steering wheel all the way left to position left rear wheel to gain access to muffler.

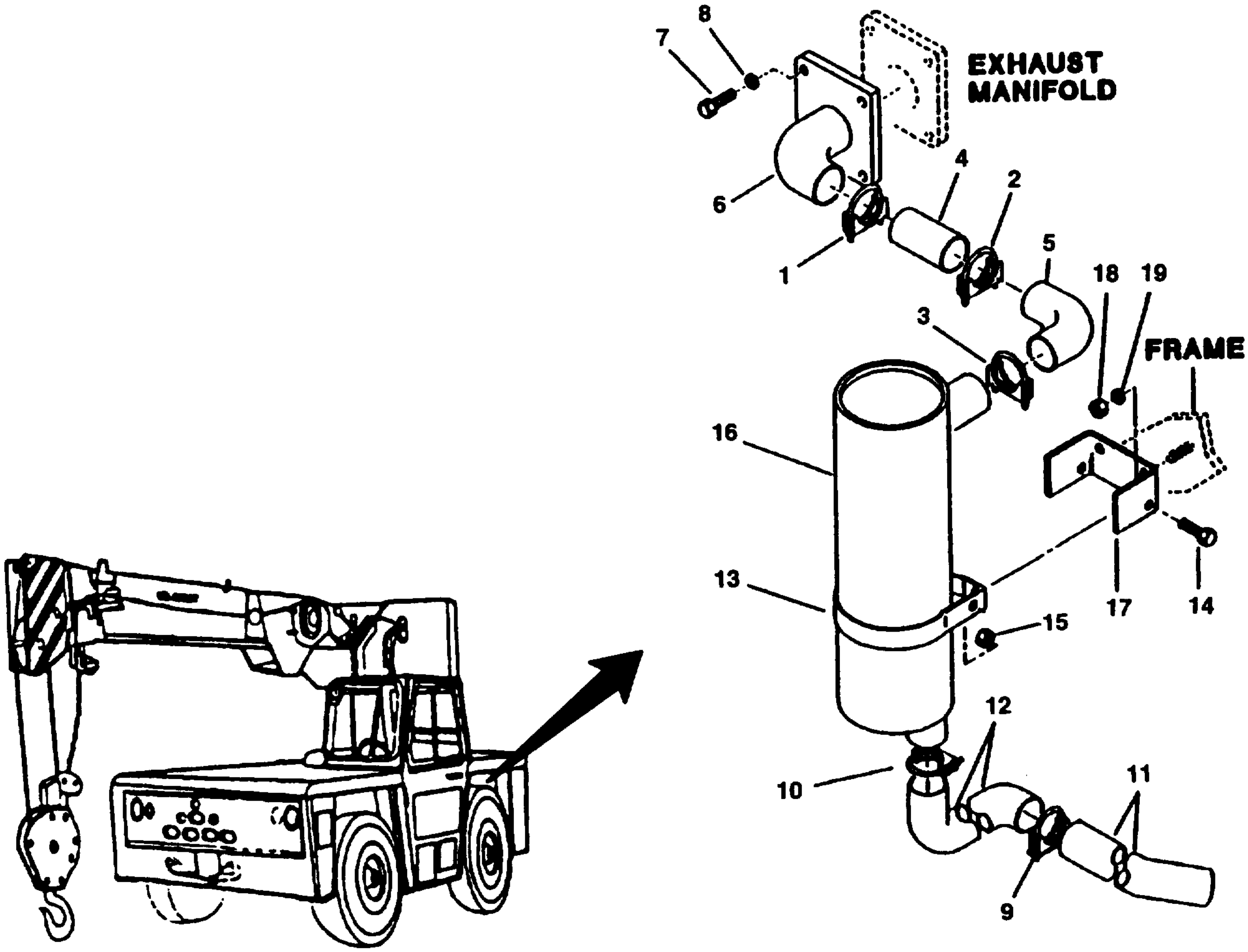
WARNING

Exhaust components can be hot causing burns to exposed skin. Allow exhaust components to cool before proceeding.

c. Loosen three pipe clamps (1, 2, and 3, Figure 3-9).
d. Disconnect and remove tube (4) and elbow (5). Slide three pipe clamps (1, 2, and 3) off of tube and elbow.
e. Remove four bolts (7) and four lockwashers (8) securing flange (6) to engine exhaust manifold. Remove flange (6) and cover opening in exhaust manifold.
f. Loosen two pipe clamps (9 and 10) and remove tailpipe (11) and exhaust tube (12).
g. Remove two bolts (14) and two nuts (15) securing muffler clamp (13). Remove muffler (16) with clamp (13). Then separate muffler (16) and clamp (13).
h. If damaged, remove muffler bracket (17). Remove two nuts (18) and two lockwashers (19) securing muffler bracket (1 7) to vehicle frame.

3-18.2 Installation

a. If removed, install new muffler bracket (17, Figure 3-9) and secure with two nuts (18) and two lockwashers (19).
b. Slide muffler clamp (13) over muffler (16). Then install muffler (16) and secure with two bolts (14) and two nuts (15).
c. Slide two pipe clamps (9 and 10) over tailpipe (11) and exhaust tube (12). Then install exhaust tube (12) on muffler (16) and tailpipe (11) on exhaust tube (12).
   Adjust position of both exhaust tube (12) and tailpipe (11). Then tighten both pipe clamps (9 and 10).
d. Slide pipe clamp (3) over muffler (16) inlet and position two pipe clamps (1 and 2) on tube (4).
e. Install elbow (5) in muffler inlet. Then install tube (4) in elbow (5). Do not tighten three pipe clamps (1, 2, and 3) at this time.



LEGEND

1. Pipe Clamp
2. Pipe Clamp
3. Pipe Clamp
4. Tube
5. Elbow
6. Flange
7. Bolt
8. Lockwasher
9. Pipe Clamp
10. Pipe Clamp
11. Tailpipe
1 2. Exhaust Tube
13. Muffler Clamp
14. Bolt
15. Nut
16. Muffler
17. Muffler Bracket
18. Nut
19. Lockwasher

Figure 3-9. Muffler and Exhaust Pipes

f. Remove cover over exhaust manifold opening and connect flange (6) and tube (4). Secure flange (6) to exhaust manifold with four bolts (7) and four lockwashers (8).
g. Reposition tube (4) and elbow (5) as required. Then tighten three pipe clamps (1, 2 and 3).

WARNING

Exhaust components can be hot causing burns to exposed skin.

h. Start diesel engine and check exhaust system for leaks. Shut down diesel engine. If necessary, allow exhaust system components to cool and tighten pipe clamps to stop leaks.
i. Stow rear outriggers, refer to Operator's Manual, TM 10-3950-672-10.

3-19 WATER COOLING SYSTEM

DESCRIPTION

The cooling system consists of the radiator, engine cooling circuit, and the connecting hoses. Its capacity varies according to the engine being used. The temperature is controlled by a 180 degree F (82 degrees C) thermostat located between the top of the engine and the top of the radiator. The radiator, in addition to cooling the engine, also contains a cooler which cools the automatic transmission oil.

At all times, the coolant should be properly inhibited against corrosion. If antifreeze is used, follow the antifreeze manufacturers requirements for proper protection in regards to cooling system capacity, and only ethylene gylcol base permanent antifreeze should be used.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

3-20 RADIATOR

3-20.1 Removal

a. Disconnect negative battery cable and two electrical leads from negative battery post.
b. Remove rear access cover, refer to paragraph 3-80.

WARNING

Allow engine and radiator to cool down before opening cap. Open radiator cap slowly to allow pressure to escape. Failure to comply could result in scalding or serious burns.

c. Remove radiator cap (1, Figure 3-10) and open radiator drain valve (2). Drain coolant (24.5 quart capacity) into clean, adequate container.
d. Remove recovery bottle (6) cap with two hoses (4 and 5) attached and set aside. Then loosen hose clamp (3) at radiator neck and disconnect hose (4).
e. Loosen circle clamp (7) and remove coolant recovery bottle (6).
f. Remove two hose clamps (8 and 9) securing radiator hoses (10 and 11) to radiator (12, Figure 1). Then disconnect both radiator hoses.
g. Remove fan guard (16) as follows:

    (1) Remove ten screws (13), ten lockwashers (14), ten washers (15), and fan guard (16) with supports (17 and 18).
    (2) Remove eight nuts (19), eight lockwashers (20), eight washers (21), eight screws (22), and eight washers (23). Separate fan guard (16) and supports (17 and 18).

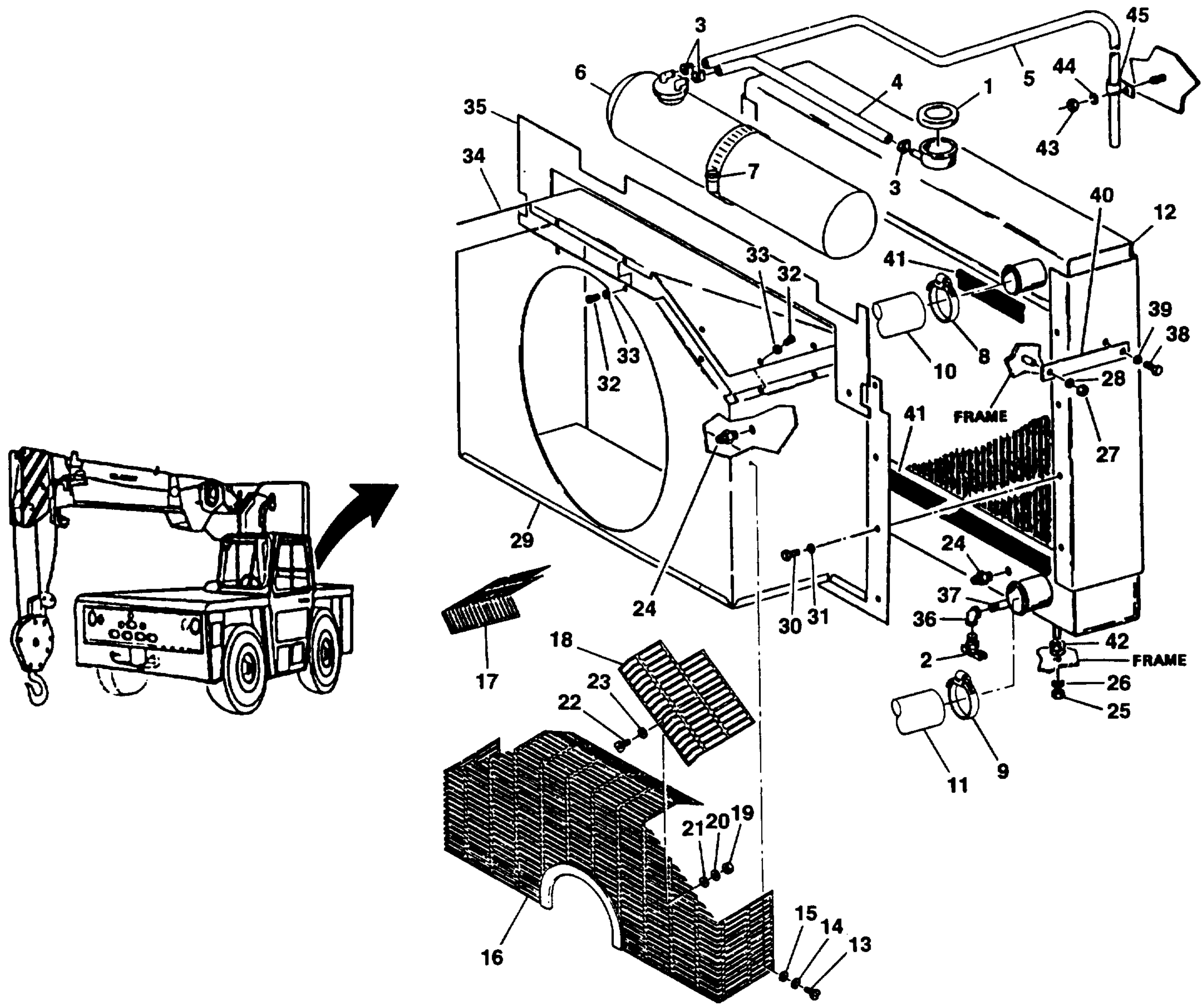
h. Disconnect two transmission oil cooler lines at bottom of radiator at fittings (24). Plug both transmission cooler lines.
i. Remove two nuts (25) and two flatwashers (26) securing bottom of radiator (12) to vehicle.

WARNING

The radiator assembly weighs 72 lbs. To prevent personal injury, use a suitable lifting device to remove radiator assembly.

NOTE

Radiator and lower shroud (29) are hoisted out of vehicle as a unit.



LEGEND

1. Radiator Cap
2. Drain Valve
3. Hose Clamp
4. Hose
5. Hose
6. Recovery Bottle
7. Circle Clamp
8. Hose Clamp
9. Hose Clamp
10. Hose
11. Hose
12. Radiator
13. Screw
14. Lockwasher
15. Washer
16. Fan Guard
17. Support, RH
18. Support, LH
19. Nut
20. Lockwasher
21. Washer
22. Screw
23. Washer
24. Fitting
25. Nut
26. Lockwasher
27. Nut
28. Lockwasher
29. Lower Shroud
30. Screw
31. Lockwasher
32. Screw
33. Lockwasher
34. Upper Shroud
35. Baffle
36. Elbow
37. Nipple
38. Bolt
39. Lockwasher
40. Strap
41. Rubber Strip
42. Shock Mount
43. Nut
44. Lockwasher
45. Clamp

Figure 3-10. Radiator and Fan Guard

j. Support radiator (12) and remove two nuts (27) and two lockwashers (28) securing sides of radiator to vehicle. Then lift radiator (12) with shroud (29) out of vehicle.
k. If necessary, remove ten bolts (30), ten lockwashers (31), and shroud (29) from radiator. Then remove eight screws (32), eight lockwashers (33), upper shroud (34), and baffle (35) from shroud (29).
l. If replacing radiator (12), remove drain valve (2), elbow (36), nipple (37), and two fittings (24) from radiator.
m. If replacing radiator (12) remove two bolts (38), two lockwashers (39), and two straps (40) from radiator.
n. If damaged, remove rubber molding (41) and two shock mounts (42).

3-20.2 Installation

a. If removed, install nipple (37, Figure 3-10), elbow (36), drain valve (2), and two fittings (24) in radiator (12).
b. If removed, cut and install two new strips of rubber molding (41) on radiator (12) where shroud mounts.
c. Install upper shroud (34) and baffle (35) on shroud (29) with eight screws (32) and eight lockwashers (33).
d. Install shroud (29) on radiator (12) with ten screws (30) and ten lockwashers (31).
e. If removed, secure two straps (40) to radiator (12) with two bolts (38) and two lockwashers (39).

WARNING

The radiator assembly weighs 72 lbs. To prevent personal injury, use a suitable lifting device to install radiator assembly.

f. If removed, install two new shock mounts (42) on radiator mounting studs. Then place radiator (12) with shroud (29) in engine compartment, lining up mounting holes in vehicle frame with studs on bottom of radiator.
g. If removed, secure two straps (40) to studs on vehicle frame with two nuts (29) and two lockwashers (28).
h. Install two nuts (25) and two washers (26) to secure bottom of radiator to vehicle frame.
i. Remove caps and connect two transmission oil cooler lines at fittings (24).

j. Install fan guard (16) as follows:

(1) Install supports (17 and 18) on fan guard (16) with eight screws (22), eight washers (23 and 21), eight lockwashers (20), and eight nuts (19).

(2) Install fan guard (16) on radiator with ten screws (13), ten lockwashers (14), and ten washers (15).

k. Connect radiator hoses (10 and 11) and secure with hose clamps (8 and 9).

l. Install coolant recovery bottle (6) and secure with circle clamp (7).

m. Install recovery bottle cap with hoses (4 and 5) attached. then connect hose (4) to radiator neck and tighten clamp (3).

n. Fill radiator with previously drained coolant.

o. Connect negative battery cable and two electrical leads to negative battery post.

p. Start engine and inspect radiator hoses and transmission oil cooler lines for leaks.
Check transmission fluid level. Shutdown engine and tighten clamps/fittings as needed.
Service transmission and coolant system if required, refer to Operator's Manual TM 10-3950-672-10.

q. Install rear access cover, refer to paragraph 3-80.

3-21 ENGINE COOLING FAN

3-21.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Remove fan guard, refer to paragraph 3-20.1 step g.
c. Remove four bolts (2, Figure 3-11) and four washers (3) securing engine cooling fan (1) and spacer (4) to water pump.

CAUTION

Fan blades are plastic and can crack in cold weather if mishandled. Handle with care.

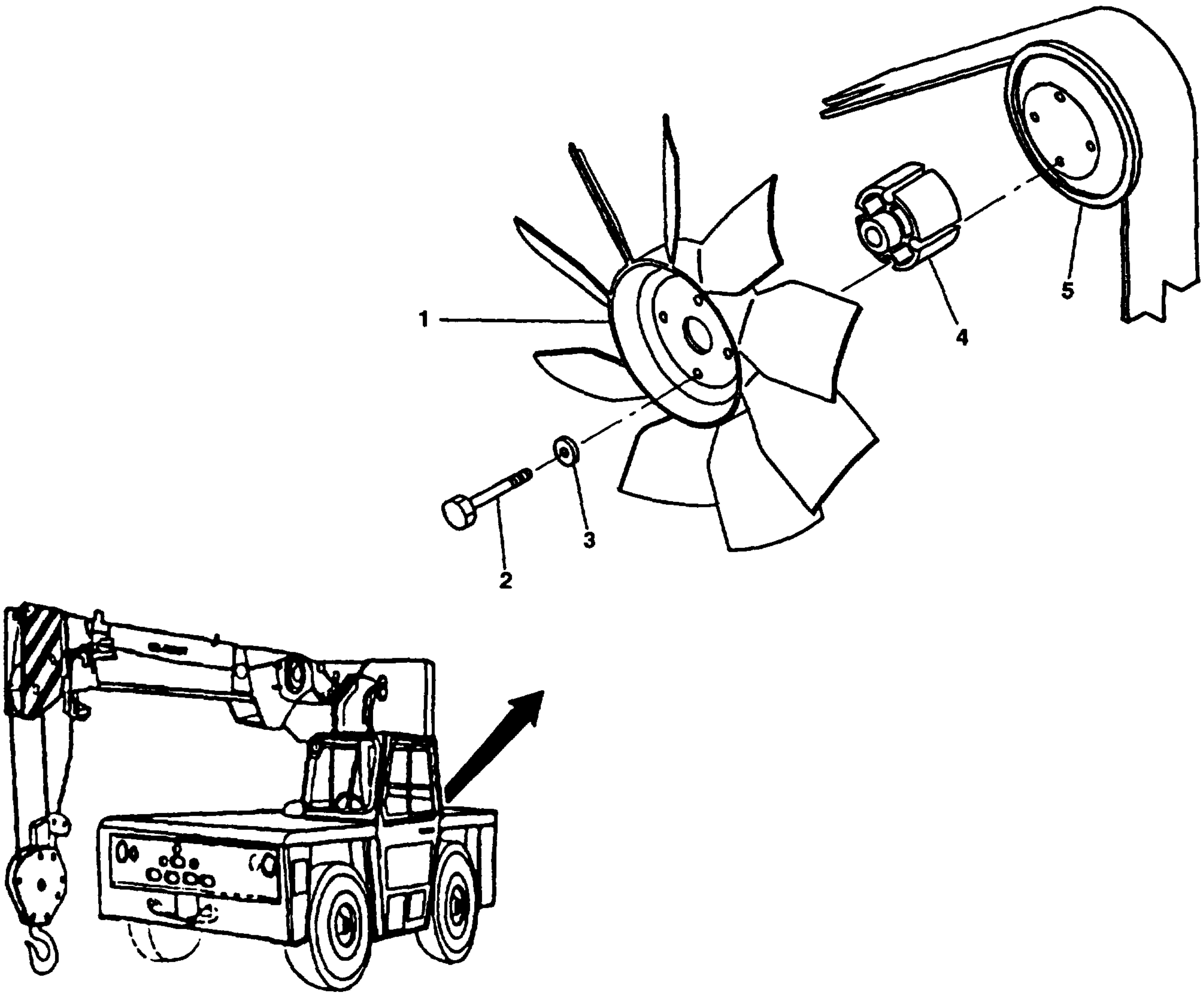
d. Remove engine cooling fan (1) and spacer (4) leaving pulley (5) and drive belt in place.

3-21.2 Installation

CAUTION

Ensure the word "FRONT" on the fan hub faces the radiator.

a. Position engine cooling fan (1, Figure 3-11) and spacer (4) on fan pulley (5). Align mounting holes in engine cooling fan, spacer, and fan pulley to water pump holes.
b. Apply loctite to threads of four bolts (2). Install four bolts (2), and four washers (3).
   Torque bolts to 18 lb ft (24 N•m).
c. Install fan guard, refer to paragraph 3-20.2 step j.
d. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Engine Cooling Fan
2. Bolt
3. Washer
4. Spacer
5. Fan Pulley

Figure 3-11. Engine Cooling Fan

Section 3. Drive Train

3-22 DRIVE LINE

3-22.1 Removal

a. Scribe an alignment mark across the flanges of the drive shaft.

b. Support the shaft so it does not fall when disconnected.

c. Remove the capscrews, washers, nuts, bolts, and clamp drive securing the shaft to the transmission and the capscrew, nut, washer, and clamp securing the shaft to the axle differential.

d. Remove the drive shaft.

3-22.2 Installation

a. Position the drive shaft aligning the alignment marks made during removal.

b. Grind a flat on the washers to allow clearance for bend radius on the clamp and clamp drive and to provide proper torque of the capscrews and bolt. Secure the shaft to the axle differential or with the clamp, capscrews, nuts, and washers. Torque the nuts 27 to 29 lb ft (36.6 to 39.3 N•m). Secure the shaft to the transmission with the clamp drive, capscrew, washers, nuts, and bolts.

3-22.3 Lubrication

The universal joints should be lubricated with EP-MPG (refer to Operator's Manual TM 10-3950-672-10). The interval between lubrications is generally satisfactory for normal service.

When subjected to extremely severe conditions, more frequent lubrication may be required.

Lubrication must be done with a low pressure adapter only. High pressure will rupture the cork seals.

3-23 C-6 AUTOMATIC TRANSMISSION

DESCRIPTION

The transmission is a three speed automatic capable of providing automatic upshifts and downshifts through the three forward gear ratios. The stall ratio is 1.89: 1. Gear ratios are as follows:

GEAR RATIOS	
Low (1st)	2.46:1
Int. (2nd)	1.46:1
Direct (3rd)	1.00:1
Reverse	2.175:1

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

TROUBLESHOOTING.

Before removal or operation of the transmission, perform a visual inspection. Visually inspect all lines, plugs, and tube connections at the transmission for oil leakage.

To make a thorough test of the transmission, ensure the engine is properly tuned and the oil level in the transmission is correct. During troubleshooting, the engine and transmission must be regarded as a single package.

If inspection does not reveal the cause of the trouble and the crane is operational, further troubleshooting is necessary. Do not remove the transmission from the crane until the mechanical, hydraulic, and air pressure tests are performed and the causes of trouble are checked against the troubleshooting chart.

Mechanical Checks.

LINKAGE CHECK.

1. A check should be made to ensure the linkage is free and returns to idle when released.
2. Ensure the D detent in the transmission corresponds exactly with the stop in the console. Leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted.

3-44 ENGINE IDLE SPEED CHECK.

Check the engine idle speed. If the idle speed is too low, the engine will run roughly. An idle speed that is too high will cause the crane to creep, have harsh transmission engagements, and harsh closed throttle downshift.

CONTROL PRESSURE TEST.

There are two methods of performing the control pressure test. One is to perform the test using the engine vacuum. The second method is to use a hand operated vacuum pump.

1. To perform the control pressure test using the engine vacuum, perform the following.

a. Attach a tachometer to the engine and a vacuum gauge to the transmission vacuum line at the manifold vacuum port.

CAUTION

PRESSURE GAUGES AFFECT THE SHIFT QUALITY OF THE TRANSMISSION. CARE SHOULD BE TAKEN NOT TO ACCELERATE OR DECELERATE RAPIDLY. POSSIBLE TRANSMISSION FAILURE COULD RESULT.

b. Firmly apply the parking brake and start the engine.

c. Adjust the engine idle speed to the specified rpm. If the engine idle speed cannot be brought within limits, check the throttle and downshift linkage for a binding condition. If linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit and its connecting tubes and hoses.

2. To perform the control pressure test using the vacuum pump method, perform the following.

a. Disconnect and temporarily plug the vacuum line at the vacuum diaphragm unit.

b. Attach a vacuum pump to the vacuum diaphragm. Apply both the parking and service brakes. Start the engine and vacuum pump.

c. Set the vacuum at 15 inches and read and record the control pressure in all the selector positions. Run the engine up to 1000 rpm, and reduce the vacuum to 10 inches. Read and record the control pressure in D, 2, and 1. Keep the engine rpm at 1000 and reduce the vacuum to 1 inch. Read and record the control pressure in D, 1, 2, and R.

VACUUM SUPPLY TEST.

Check the vacuum supply to the vacuum diaphragm unit and the diaphragm itself. To check the supply, disconnect the vacuum line at the diaphragm unit and connect it to vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak or poor engine vacuum. If the vacuum reading is OK, rapidly accelerate the engine momentarily. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted, or connected to a reservoir supply.

Air Pressure Checks.

GENERAL.

A no drive condition can exist even with correct transmission fluid pressure, because of inoperative clutches or bands. On automatic transmissions, an erratic shift can be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is at 2 (second) a no drive condition may be caused by an inoperative forward clutch. A no drive condition at D (drive) may be caused by an inoperative forward clutch or one-way clutch. When there is no drive in 1 (low) the difficulty could be caused by improper functioning of the forward clutch or simultaneous malfunction of the low-reverse band and the one-way clutch. Failure to drive in R (reverse) could be caused by a malfunction of the reverse-high clutch or low-reverse band or clutch.

To make air pressure checks, loosen the oil pan bolts and lower one edge to drain the transmission fluid. Remove the oil pan and the control valve body assembly. The inoperative clutches or bands can be located by introducing air pressure into the various transmission case passages.

FORWARD CLUTCH.

Apply air pressure to the transmission case forward clutch passages. A dull thud can be heard when the clutch piston is applied. If no noise is heard, place the finger tips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

GOVERNOR.

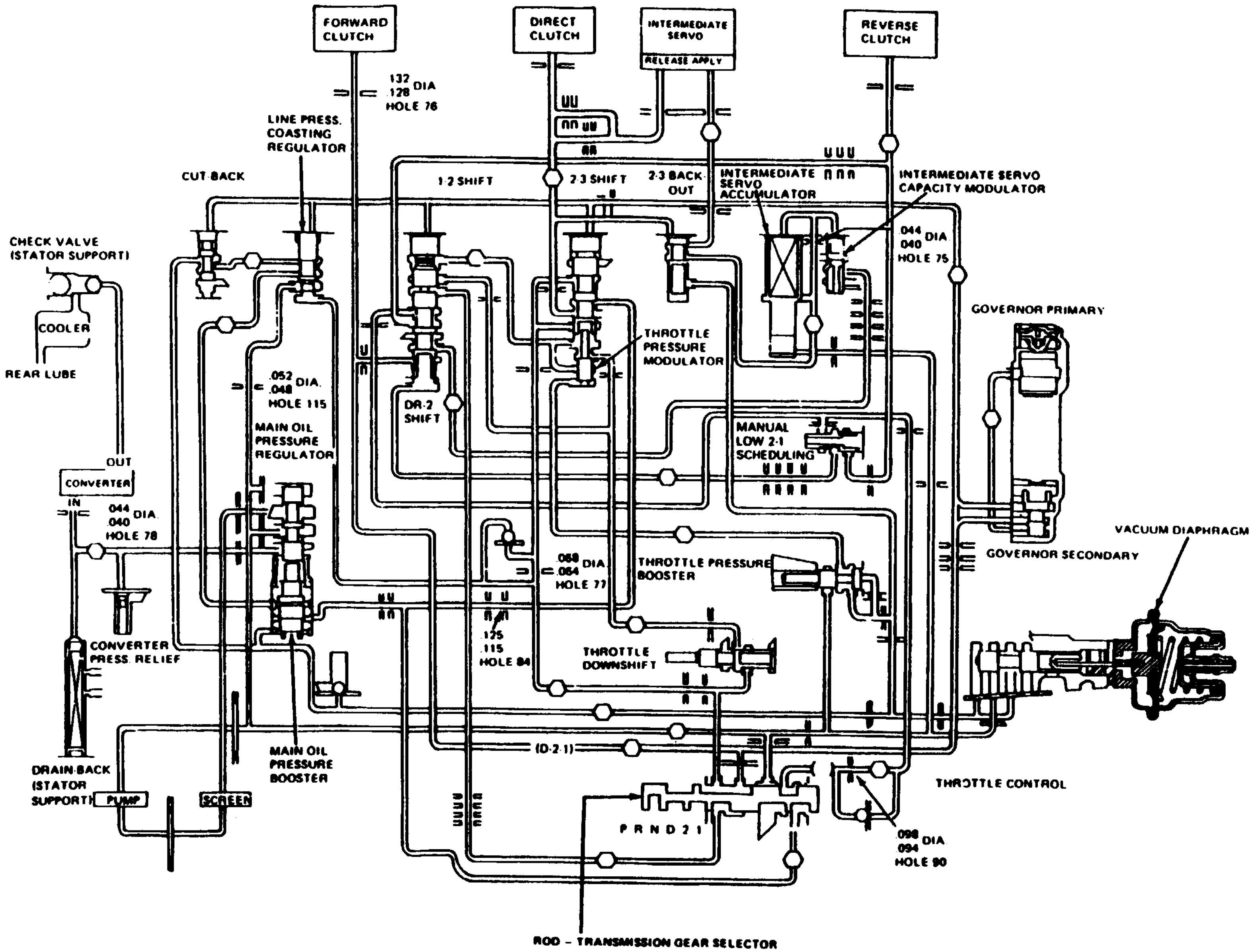
Apply air pressure to the control pressure to governor passage and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

REVERSE-HIGH CLUTCH.

Apply air pressure to the reverse-high clutch. A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the finger tips on the clutch drum and again apply air pressure to detect movement of the piston.

INTERMEDIATE SERVO.

Hold the air nozzle in the front servo apply tube or the intermediate servo apply passages. Operation of the servo is indicated by a tightening of the front or intermediate band around the drum. Continue to apply air pressure to the servo apply tube or passage. and introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate servo should release the band against, the apply pressure.


FORWARD CLUTCH
DIRECT CLUTCH
INTERMEDIATE SERVO
RELEASE APPLY
REVERSE CLUTCH
.132 .128 DIA HOLE 76
LINE PRESS. COASTING REGULATOR
CUT-BACK
1-2 SHIFT
2-3 SHIFT
2-3 BACK-OUT
INTERMEDIATE SERVO ACCUMULATOR
INTERMEDIATE SERVO CAPACITY MODULATOR
CHECK VALVE (STATOR SUPPORT)
COOLER
REAR LUBE
.044 .040 DIA HOLE 75
GOVERNOR PRIMARY
THROTTLE PRESSURE MODULATOR
.052 .048 DIA. HOLE 115
DR-2 SHIFT
MAIN OIL PRESSURE REGULATOR
MANUAL LOW 2-1 SCHEDULING
OUT
CONVERTER
IN
.044 .040 DIA. HOLE 78
.068 .064 DIA. HOLE 77
THROTTLE PRESSURE BOOSTER
GOVERNOR SECONDARY
VACUUM DIAPHRAGM
.125 .115 HOLE 84
CONVERTER PRESS. RELIEF
THROTTLE DOWNSHIFT
(D-2-1)
DRAIN-BACK (STATOR SUPPORT)
PUMP
SCREEN
MAIN OIL PRESSURE BOOSTER
THROTTLE CONTROL
P R N D 2 1
.098 .094 DIA. HOLE 90
ROD – TRANSMISSION GEAR SELECTOR

LOW-REVERSE CLUTCH.

Apply air pressure to the low-reverse clutch apply passage. A dull thud should be heard if the clutch is operating properly. If the passages are clear, remove the clutch assemblies, and clean and inspect the malfunctioning clutch to locate the trouble.

Hydraulic Checks.

FLUID LEVEL CHECK.

Check the oil level in the transmission. The fluid level indication on the dipstick will be different at operating temperature (transmission hot) and room temperature (transmission cold).

The transmission should be checked at an operating temperature (transmission hot) of 150 degrees to 170 degrees F (66 degrees to 77 degrees C), dipstick is hot to touch. The dipstick reading at operating temperature should have the fluid level on the dipstick between ADD and DON'T ADD marks and/or between the arrows. If the transmission is not at an operating temperature of 150 degrees to 170 degrees F (66 degrees to 77 degrees C) and it becomes necessary to check the fluid level (such as pre-delivery) the fluid may be checked at room temperature 70 degrees to 95 degrees F (21 degrees to 35 degrees C) giving the dipstick a cool feeling. The dipstick reading at room temperature should have the fluid level on the dipstick between the middle and top holes.

FLUID CHECKING PROCEDURE.

Check the transmission fluid using the following procedure.

1. With the transmission in Park, engine at curb idle rpm, foot brakes applied, and crane on level surface, move the transmission selector lever through each range. Allow time in each range to engage the transmission, return to Park, and apply parking brake fully. Do not turn off the engine during the fluid level check.
2. Clean all dirt from the transmission fluid dipstick cap, before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. Be sure it is fully seated.
4. Pull the dipstick out of the tube again and check the fluid level.
5. For correct fluid level reading on the dip-stick, follow the appropriate instructions stated previously for transmission hot and transmission cold check.

Do not overfill the transmission. Overfill can cause the fluid to foam and spill out through the transmission vent with resultant transmission malfunction.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the crane is parked or being driven on a hill.

6. Install the dipstick making sure it is fully seated in the tube.

FLUID CONDITION CHECK.

After making a normal fluid check according to the procedures under Fluid Checking Procedures, check the condition of the transmission fluid as follows.

1. Observe the color and odor of the fluid. It should be dark reddish not brown or black. A burnt odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
2. Use an absorbent white facial tissue paper to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and repaired. This includes cleaning the torque converter and transmission cooling system.

FLUID LEVEL HIGH BEFORE STARTING ENGINE NORMAL DURING NORMAL CHECK.

If the fluid level is high before starting the engine and normal during normal check, check the following.

1. Check for correct operation of the drainback valve in the stator support.
2. Check the pump bushing.
3. Repair or replace pump, if required.

TRANSMISSION FLUID LEAKAGE CHECKS.

1. Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.

2. Check. the fluid filler tube connection at the transmission case. If leakage is found, install a new O-ring. The filler tube bracket should align properly.

3. If leakage is found at either the downshift control lever shaft or the manual lever shaft, replace either or both seals.

FLUID LEAKAGE IN CONVERTER AND FRONT PUMP AREA.

Leakage at the front of the transmission, is evidenced by fluid around the converter housing, and may have several sources. By careful observation, it Is possible in many instances, to pinpoint the source of the leak before removing the transmission.

1. Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only near the outside diameter of the housing

2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.

3. Fluid that leaks by a front pump-to-case bolt will be deposited on the Inside of the converter housing only. Fluid will not be deposited on the back of the converter.

4. Leakage by the front pump-to-case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.

5. Fluid leakage from the converter drain plugs will appear at the outside diameter of the converter.

Troubleshooting Chart.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Slow initial engagement.	a. Improper fluid level.	a. Perform fluid level check
	b. Damaged or improperly adjusted linkage.	b Service or adjust linkage
	c. Contaminated fluid	c: Perform fluid condition check.
	d. Improper clutch and band application, or low main control pressure	d. Perform control pressure test

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Rough initial engagement in either forward or reverse.	a. Improper fluid level.	a. Perform fluid level check.
	b. High engine idle.	b. Adjust idle
	c. Looseness in the driveshaft. U-joints or engine mounts.	c. Service as required
	d. Improper clutch or band application. or oil control pressure	d. Perform control pressure test
	e. Sticking or dirty valve body. body.	e. Clean. service or replace valve
3. Harsh engagements - (warm engine).	a. Improper fluid level.	a. Perform fluid level check.
	b. Throttle valve linkage misadjusted/long/disconnected/sticking damaged, return spring disconnected.	b. Adjust throttle valve linkage.
	c. Valve body bolts loose or too tight.	c. Tighten bolts.
	d. Valve body dirty or sticking valves.	d. Determine source of contamination. Service as required.
4. No/delayed forward engagement (reverse OK).	a. Improper fluid level.	a. Perform fluid level check.
	b. Manual linkage- misadjusted damaged.	b. Check and adjust or service as required.
	c. Low main control pressure. (Leakage.) Forward Clutch stator support seal rings leaking (#3. #4).	c. Control pressure test. note results.
	d. Forward clutch assembly burnt. Damaged/leaking check ball in cylinder. Leaking piston seal rings.	d. Perform air pressure test
	e. Valve body bolts loose or too tight.	e. Tighten bolts
	f. Valve body dirty or sticking valves.	f. Determine source of contamination Service as required.
	g. Transmission filter plugged.	g. Replace filter
	h. Pump damaged or leaking	h Visually Inspect pump gears. Replace pump if necessary

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. No/delayed reverse engagement (forward OK).	a. Improper fluid level.	a Perform fluid level check.
	b Manual linkage misadjusted/ damaged.	b. Check and adjust or service as required.
	c. Low main control pressure in reverse. Reverse clutch stator support seal rings leaking (#1, #2).	c. Control pressure test.
6. No/delayed reverse engagement and/or no engine breaking in manual low (1).	a. Improper fluid level.	a. Perform fluid level check.
	b. Low reverse servo piston seal leaking.	b. Check and replace piston seal.
	c. Planetary low one way clutch damaged.	c. Determine cause of condition. Service as required.
7. No engine braking in manual second gear.	a. Intermediate band out of adjustment.	a. Adjust intermediate band.
	b. Improper band or clutch application, or oil pressure control system.	b. Perform control pressure test.
	c. Intermediate servo leaking.	c. Perform air pressure test of intermediate servo for leakage. Service as required.
	d. Intermediate one way clutch damaged.	d. Replace.
	e. Polished or glazed band or drum.	e. Service or replace as required.
8. Forward engagement slips/ shudders/chatters.	a. Improper fluid level.	a. Perform fluid level check.
	b. Manual linkage misadjusted/ damaged.	b. Check and adjust or service as required.
	c. Low main control pressure.	c. Control pressure test.
	d. Valve body bolts loose or too tight.	d. Tighten bolts.
	e. Valve body dirty or sticking valves.	e. Determine source of contamination. Service as required.
	f. Forward clutch piston ball check not seating, or leaking.	f. Replace forward clutch cylinder. Service transmission as required.
	g. Forward clutch piston seals cut or worn.	g. Replace seals and service clutch as required.
	h. Low one way clutch (planetary) damaged.	h. Determine cause of condition. Service as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
9. Reverse shudder/chatters/ slips	a. Improper fluid level.	a. Perform fluid level check.
	b. Low main control pressure in reverse.	b. Control pressure test.
	c. Low reverse servo/leaking.	c. Air pressure test; visually inspect seal rings and piston bore.
	d. Low (planetary) one-way clutch damaged.	d. Determine cause of condition. Service as required.
	e. Reverse clutch drum bushing damaged.	e. Determine cause of condition. Service as required.
	f. Reverse clutch stator support seal ring grooves worn or damaged.	f. Determine cause of condition Service as required.
	g. Reverse clutch piston seals cut or worn.	g. Determine cause of condition. Service as required.
	h. Looseness in the driveshaft. U-joints or engine mounts.	h. Service as required.
10. No drive, slips or chatters in first gear in D. All other gears normal	a. Damaged or worn planetary one-way clutch.	a Service or replace one-way clutch.
11. No drive, slips or chatters in second gear.	a. Intermediate band out of adjustment.	a. Adjust intermediate band.
	b. Improper band or clutch application. or control pressure.	b. Perform control pressure test.
	c. Damaged or worn intermediate servo piston seals and/or internal leaks.	c. Perform air pressure test.
	d. Dirty or sticking valve body. body.	d. Clean, service or replace valve
	e. Polished. glazed intermediate band or drum.	e. Replace or service as required.
12. Starts up in 2nd or 3rd.	a. Improper band and/or clutch application, or oil pressure control system.	a. Perform control pressure test.
	b. Damaged or worn governor. Sticking governor.	b. Perform governor check. Replace or service governor. clean screen.
	c. Valve body loose.	c. Tighten valve.
	d. Dirty or sticking valve body.	d. Clean, service or replace valve body.
	e. Cross leaks between valve body and case mating surface.	e. Service or replace valve body and/or case as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
13. All upshifts harsh/delayed or no upshifts.	a. Improper fluid level.	a. Perform fluid level check.
	b. Manual linkage - misadjusted or damaged.	b. Check and adjust or service as required.
	c. Governor sticking. as required.	c. Perform governor test. Service
	d. Main control pressure too high.	d. Control pressure test. Service as required.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty or sticking valves.	f. Determine source of contamination. Service as required.
	g. Vacuum leak to diaphragm unit.	g. Check vacuum lines to diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests.
14. Mushy/early all upshifts/	a. Low main control pressure. pile up upshifts.	a. Control pressure test. Note results.
	b. Valve body bolts loose or too tight.	b. Tighten bolts.
	c. Valve body valve or throttle control valve sticking.	c. Determine source of contamination. Service as required.
	d. Governor valve sticking.	d. Perform governor test. Repair as required.
15. No 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check.
	b. Manual linkage - misadjusted/ damaged.	b. Check and adjust or service as required.
	c. Governor valve sticking. Intermediate band out of adjustment. band.	c. Perform governor test Service as required. Adjust intermediate
	d. Vacuum diaphragm bent. sticking or leaking.	d. Check diaphragm unit. Service as necessary.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty/sticking valves.	f. Determine source of contamination. Service as required.
	g. Intermediate clutch. band, and/ or servo assembly burnt.	g. Perform air pressure test.

SYMPTOM	PROBABLE CAUSE	SOLUTION
16. Rough/harsh/delayed 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check.
	b. Poor engine performance.	b. Tune engine.
	c. Intermediate band out of adjustment.	c. Adjust intermediate band.
	d. Main control pressure too high.	d. Control pressure test. Note results.
	e. Governor valve sticking.	e. Perform governor test. Service as required.
	f. Engine vacuum leak.	f. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests.
	g. Valve body bolts loose or too tight.	g. Tighten bolts.
	h. Valve body dirty/sticking valves.	h. Determine source of contamination. Service as required.
17. Mushy/early/soft/slipping 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check.
	b. Incorrect engine performance.	b. Tune adjust engine idle as required.
	c. Intermediate band out of adjustment.	c. Adjust intermediate band.
	d. Low main control pressure.	d. Control pressure test. Note results.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty/sticking valves.	f. Determine source of contamination. Service as required.
	g. Governor valve sticking.	g. Perform governor test. Service as required.
	h. Damaged intermediate servo or band.	h. Perform air pressure test. Service as required.
	i. Polished, glazed band or drum.	i. Service or replace as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
18. No 2-3 upshift.	a. Low fluid level. b. Throttle valve linkage misadjusted (long)}, sticking, or damaged. c. Low main control pressure to direct clutch. d. Valve body bolts loose or too tight. e. Valve body dirty/sticking valves.	a. Perform fluid level check. b. Adjust linkage. Service as re quired. c. Control pressure test. Note re suits. d. Tighten bolts. e. Determine source of contami nation, then service as required.
19. Harsh/delayed 2-3 upshift.	a. Incorrect engine performance. b. Engine vacuum leak. Damaged or worn intermediate servo release and high clutch piston check ball. d. Valve body bolts loose or too tight. e. Vacuum diaphragm or throttle valve control rod bent, sticking, or leaking.	a. Check engine tune-up. b. Check engine vacuum lines. Service as necessary. Check vacc. uum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. c. Air pressure test the interme diate servo apply and release the high clutch piston check ball. Ser vice as required. d. Tighten bolts. e. Check diaphragm and rod. Replace as necessary.
20. Soft/early/mushy 2-3 upshift.	a. Valve body bolts loose or too tight. b. Valve body dirty/sticking valves. c. Vacuum diaphragm or throttle valve control rod bent, sticking, or leaking.	a. Tighten bolts: b. Determine source of contami nation. Service as required. c. Check diaphragm and rod. Re place as necessary.
21. Erratic shifts.	a. Poor engine performance. b. Valve body bolts loose or too tight. c. Valve body dirty/sticking valves. d. Governor valve stuck. e. Output shaft collector body seal rings damaged.	a. Check engine tune-up. b. Tighten bolts. c. Line pressure test. note re-suits. Determine source of contamination. Service as required. d. Perform governor test. Service as required. e. Service as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
22. Shifts 1-3 in D.	a. Intermediate band out of adjustment.	a. Adjust band.
	b. Damaged intermediate servo and/or internal leaks.	b. Perform air pressure test. Service front servo and/or internal leaks.
	c. Improper band or clutch application, or oil pressure control system.	c. Perform control pressure test.
	d. Polished, glazed band or drum.	d. Service or replace band or drum.
	e. Dirty or sticking valve body,	e. Clean, service or replace valve body.
	f. Governor valve stuck.	f. Perform governor test. Service as required.
23. Engine over-speeds on 2-3 shift.	a. Linkage out of adjustment.	a. Service or adjust linkage.
	b. Improper band or clutch application, or oil pressure control system.	b. Perform control pressure test.
	c. Intermediate servo piston seals cut/leaking.	c. Replace seals. Check for leaks.
	d. Dirty or sticking valve body. body.	d. Clean, service or replace valve
24. No forced downshifts.	a. Kickdown linkage out of adjustment.	a. Service or adjust linkage.
	b. Damaged internal kickdown linkage.	b. Service internal kickdown linkage.
	c. Improper clutch or band application, or oil pressure control system.	c. Perform control pressure test.
	d. Dirty or sticking governor.	d. Perform governor test. Service or replace governor, clean screen.
	e. Dirty or sticking valve body. body.	e. Clean, service, or replace valve
25. Crane will not start.	a. Misadjusted neutral start switch.	a. Adjust neutral start switch
	b. Misadjusted linkage.	b. Adjust linkage.
	c. Defective neutral start switch.	c. Replace neutral switch.

REMOVAL

1. Refer to Section 2 - ENGINES and remove the engine and transmission as an assembly from the crane.

2. Block up the engine and attach an adequate lifting device to the transmission.

3. Disconnect the neutral switch wire at the plug connector.

4. If the transmission fluid has not yet been drained, place the drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With the fluid drained, install two bolts on the rear side of the pan to temporarily hold it in place.

5. Remove the converter drain plug access cover from the lower end of the converter housing.

6. Remove the converter to flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.

7. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid and remove the plug. After the fluid has been drained, reinstall the plug.

8. Disconnect the shift cable from the lever at the transmission.

9. Disconnect the oil cooler lines from the transmission.

10. Remove the vacuum hose from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip.

11. Remove the remaining converter housing to engine attaching bolts.

12. Move the transmission away from the engine.

INSTALLATION.

1. Torque the converter drain plug 18 to 28 lb ft (24 to 30 N•m).

2. Install the converter on the transmission ensuring the converter drive flats are fully engaged in the pump gear.

3. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.

NOTE

When moving the converter and transmission assembly into position with the engine, the converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow the converter drive flats to disengage from the pump gear.

4. Move the converter and transmission assembly into position with the engine, using care not to damage the flywheel and the converter pilot.

5. Install the converter housing to engine attaching bolts. Torque the bolts 50to 65 pounds-foot (67 to 88 Nm).

6. Connect the vacuum line to the vacuum diaphragm ensuring the line is in the retaining clip.

7. Connect the oil cooler lines to the transmission.

8. Connect the shift cable to the respective lever on the transmission.

9. Install the converter to flywheel attaching nuts. Torque the nuts 20 to 30 lb ft (27 to 40 N•m).

10. Install the converter housing access cover and secure with the attaching bolts.

11. Connect the neutral switch wire to the plug connector.

12. Refer to Section 2 - ENGINES and install the engine and transmission as an assembly into the crane.

13. Ensure the drain pan is securely attached, and fill the transmission to the correct level with the specified fluid.

TRANSMISSION SHIFT MODULATOR ADJUSTMENT PROCEDURE.

CAUTION

THE MODULATOR UNIT IS FACTORY ADJUSTED AND DISASSEMBLY OF THE MODULATOR LID SHOULD NOT BE REQUIRED. DISASSEMBLY COULD RESULT IN UNEQUAL TORQUING OF SCREWS CAUSING GASKET LEAKAGE AND/OR LOSS OF INTERNAL PARTS.

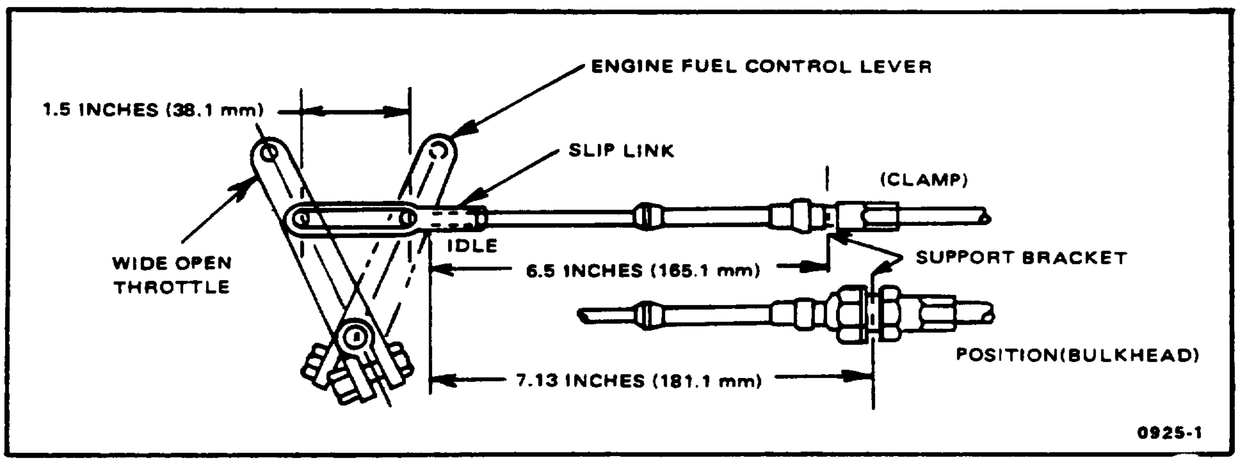
NOTE

The modulator is designed with positive stop at both ends of its 1.50 inch (3.81 mm) travel. The cable slip link must allow the lever to return to idle regardless of cable position.

1. Position the fuel control lever to wide open throttle. Pull the threaded cable rod end until resistance is felt against its internal stop. Adjust the cable slip link to provide free pin to pin condition for full lever. Refer to figure titled, Wide Open Throttle.

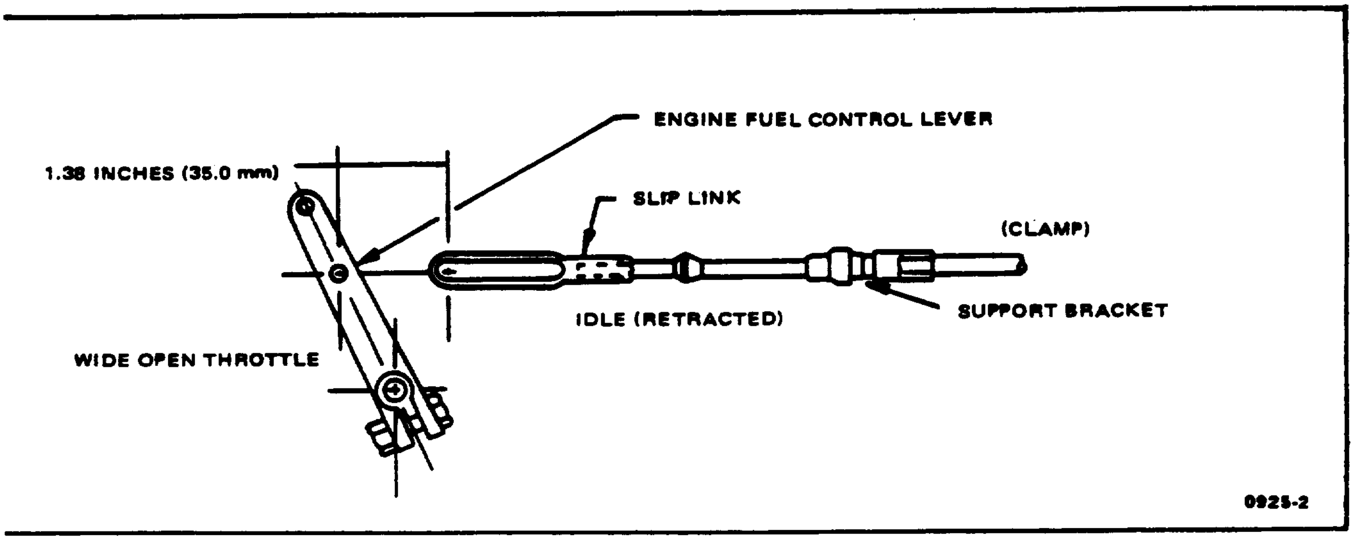
2. Inspect linkage for ease of movement and return to idle position.

3. If preliminary adjustment performed in step 1 fails to provide smooth up shifts at full throttle, perform the following adjustment procedure. With engine fuel control lever at wide open throttle and the modulator control cable threaded rod end in idle (retracted) position, set the slip link to 1.38 inches (35.0 mm). Refer to figure titled Wide Open Throttle (Modulator Control Lever In Idle). Install the slip link on the fuel control lever and operate the crane to check for smooth up-shifts in the transmission drive (D) mode. If improper shifting is still apparent, turn the slip link in or out on the threaded end of the modulator cable until smooth up-shift occurs.



Wide Open Throttle

Wide Open Throttle



Wide Open Throttle (Modulator Control Lever in Idle)

3-24 PARK BRAKE

The park brake consists of a brake and shoe assembly bolted to the transmission. The park brake is cable-actuated and controlled from the cab. The brake shoes are applied by pulling the cab-mounted lever. The lever pulls a cable attached to the brake cam. The cam is rocked as the cable is pulled thus applying the brake shoes. (Refer to Figure 3-12.)

The intended usage is for holding the vehicle when standing in a parked condition. The brake, when applied, holds the drive shaft from turning.

3-24.1 Removal

a. Refer to DRIVE LINE, in this section and remove the drive shaft.

b. Disconnect the parking brake actuating lever from the linkage.

c. Remove the transmission spline flange and drum.

d. Remove the bolts holding the carrier plate to the transmission housing. Slide the plate with the brake shoes and retaining springs off the transmission.

e. Remove the actuating lever, shoe retaining springs, and remove the shoes.

3-24.2 Inspection

a. Inspect the drum braking surface for roughness and scoring.

b. Replace the drum if worn or physically damaged.

c. Inspect the brake lining and replace if the distance between the braking surface of the lining and the top of the rivet head is less than 0.031 in. (0.794 mm).

3-24.3 Installation

a. Install the brake shoe lower retaining spring on the shoes. Position the shoes and lower retaining spring on the back of the carrier plate and install the shoe upper retaining springs and the actuating lever.

b. Install the assembly on the transmission with the lever properly positioned at ball socket and shoe ends. Install the brake mounting bolts and lockwashers.

c. Install the transmission drum and spline flange, nut, and cotter pin.

NOTE

If the drum mounting bolts are pressed into the companion flange, the drum can be mounted later as in step d, otherwise, the drum and flange should be assembled together and installed as a unit.

d. Install the brake drum. Refer to DRIVE LINE, in this section and install the drive shaft.

e. Connect the actuating lever to the parking brake linkage. Check the brake operation and adjust, if necessary.

3-24.4 Adjustment

a. Chock the wheels. Release the parking brake lever in the cab.

b. From under the crane, remove the cotter pin from the parking brake linkage adjusting clevis pin in the parking brake lever. Remove the clevis pin.

c. Lengthen the parking brake adjusting link by turning the clevis. Continue to lengthen the adjusting link until the shoes seat against the drum when the clevis pin is installed.

d. Remove the clevis pin and shorten the linkage adjustment until there is a slight clearance between the shoes and the drum (approximately 0.01 0 in. [0.254 mm] per shoe).

e. Install a new cotter pin in the clevis retaining pin and check brake operation.

LEGEND (Figure 3-1 2)

1. Nut
2. Lockwasher
3. Drum
4. Brake Shoe Assembly
5. Bolt
6. Spring
7. Bolt
8. Mount
9. Nut
10. Lockwasher
11. Spring
12. Lever
13. Drum
14. Brake Assembly
15. Shield
16. Bellcrank
17. Bolt
18. Lockwasher
19. Nut
20. Drum
21. Cam and Lever Assembly
22. Clevis Pin
23. Cotter Pin
24. Bolt
25. Washer
26. Brake Assembly
27. Washer
28. Bolt
29. Bar
30. Nut
31. Bolt
32. Washer
33. Washer
34. Bolt
35. Cable Support Bracket
36. Nut
37. Lockclip
38. Bolt
39. Nut
40. Nut
41. Clevis
42. Nut
43. Cotter Pin
44. Stud
45. Spacer
46. Clevis Pin
47. Clevis
48. Cotter Pin
49. Clevis
50. Clevis Pin

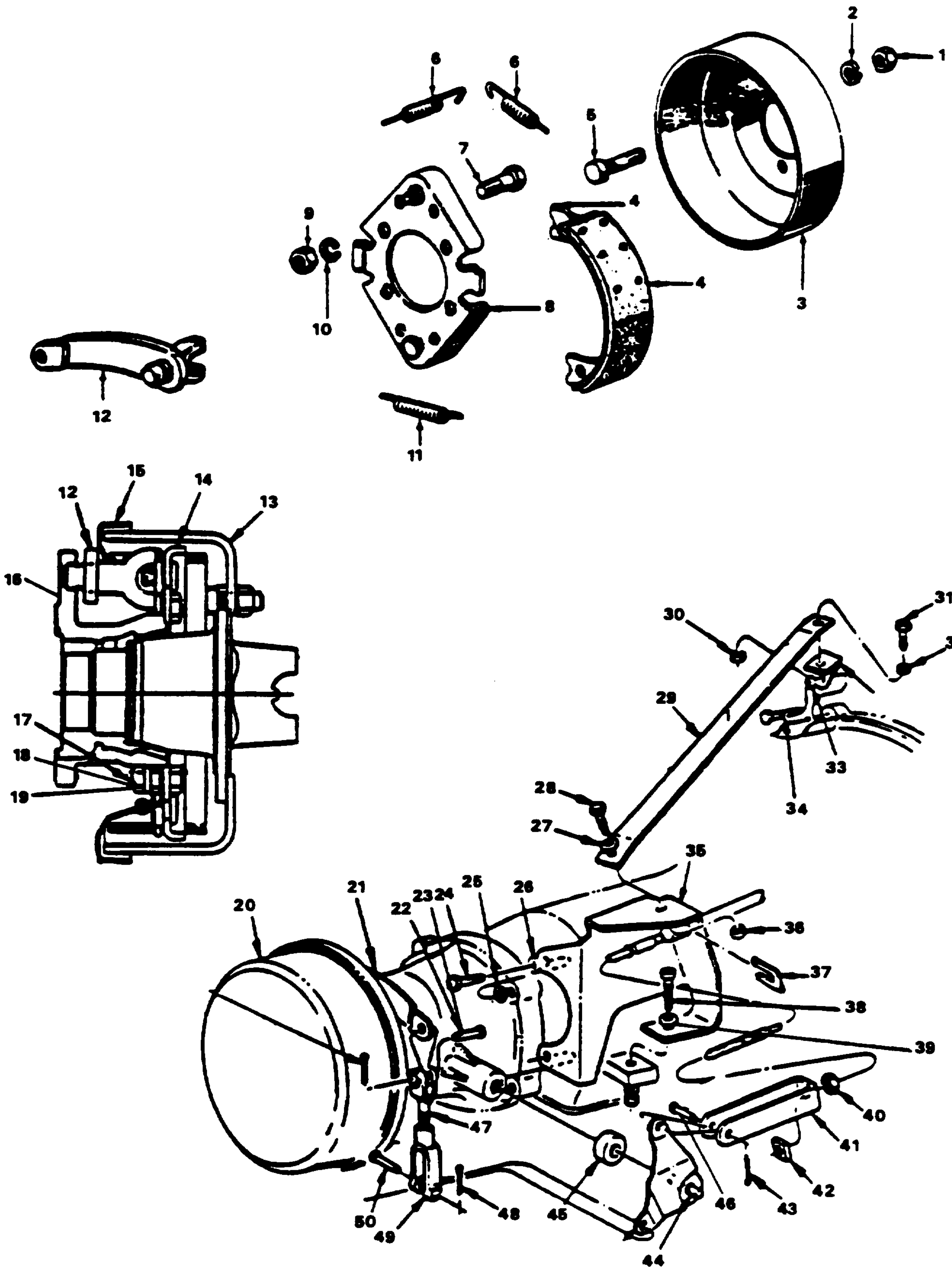


Figure 3-12. Park Brake (Automatic Transmission) (Sheet 1 of 2)

3-25 TRANSMISSION SHIFTING LEVER ASSEMBLY

3-25.1 Adjustment

a. Set outriggers, refer to Operator's Manual, TM 10-3950-672-10.

b. Remove hitch pin (1, Figure 3-13), clevis pin (2), and disconnect rod assembly (3) from shaft (4).

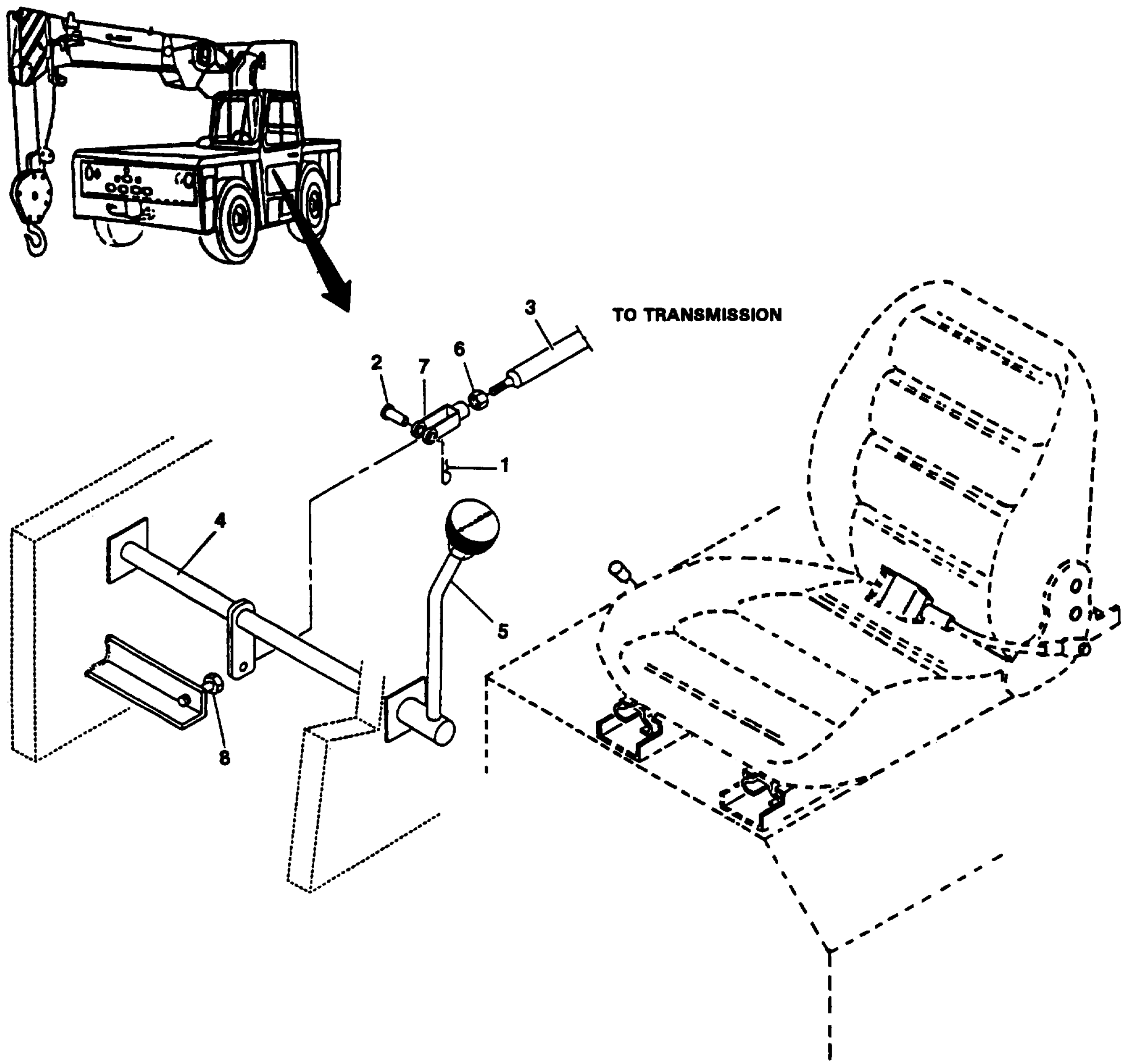
c. Pull rod assembly (3) forward (toward front of vehicle) through detents until movement stops. Then move rod assembly (3) rearward one detent (reverse position).

d. Move shift lever (5) rearward until shaft (4) contacts stop bolt (8).

e. Loosen jam nut (6) and turn yoke (7) until holes in yoke (7) align with holes in shaft (4).

f. Attach yoke (7) to shaft (4) with clevis pin (2), secure with hitch pin (1), and tighten jam nut (6) against yoke (7).

g. Stow outriggers, refer to Operator's Manual, TM10-3950-672-10.



LEGEND

1.	Hitch Pin	5.	Shift Lever
2.	Clevis Pin	6.	Nut
3.	Rod Assy	7.	Yoke
4.	Shaft	8.	Stop Bolt

Figure 3-13. Transmission Shifting Lever Assembly

Section 4. Axles and Brakes

3-26 FRONT DRIVE AXLE

The front drive axle is a single reduction, solid-mounted axle with floating axle shafts and a high traction differential, and is manufactured by Rockwell.

NOTE

For more detailed information, refer to Appendix E.

NOTE

The axle does not have to be removed from the crane to disassemble and perform maintenance on the drive unit.

3-26.1 Removal

CAUTION

Use care in handling the U-joint cross bearing assembly. When removed from the yoke, the inside needle bearings tend to fall out if any bearing caps slide off. Refer to U-Joint Bearing Assembly in this Section.

a. Loosen the wheel lug nuts one quarter turn while the wheels are still on the ground.

b. Using the outriggers, lift the frame until the wheels are at least two inches off the ground. Install cribbing or blocking which is capable of handling the weight of the crane under the crane for support.

CAUTION

Mark the universal so it can be assembled as taken apart, otherwise severe drive line vibration may occur.

c. Scribe a timing mark across the mating flanges of the drive shaft yoke to front axle and on the drive shaft U-joint to ensure original reassembly position.

d. If installed, remove the nuts, washers, capscrews, and clamps securing the drive shaft to the axle differential or gearbox and disconnect the drive shaft.

e. Tag, disconnect, and cap the hydraulic brake line at each wheel.

NOTE

The tire and wheel assembly weighs approximately 114 lbs (51.7 kg), depending on tire size.

f. Remove the wheel lug nuts and slide the tire and wheel assembly from both sides of the axle.

NOTE

The axle weighs approximately 526 lbs (238.5 kg). If the two-gear gearbox is installed, the axle weighs approximately 609.25 lbs (276.3 kg).

g. Position jacks which are capable of handling the weight of the axle, under the axle for support.

3-26.2 Cleaning

Completely assembled axles may be steam cleaned on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units, and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

3-26.3 Installation

a. Position the axle under the crane on jacks which are capable of handling the weight of the axle.

b. Raise the axle into place and secure to the frame with the eight bolts, nuts, and washers. Torque the bolts to 250 lb ft (339 N•m).

c. Install the wheels onto the axle. Refer to WHEELS AND TIRES in this section.

d. Connect the hydraulic brake line at each wheel as tagged during removal.

NOTE

To provide proper torque of the capscrews at installation, grind a flat on the washers as required to allow clearance for bend radius on the clamps and clamp drives.

e. Connect the drive line to the axle differential or gearbox, if installed, and secure with the clamps, capscrews, washers, and nuts. torque the capscrews 27 to 29 lb ft (37 to 39 N•m).

f. Bleed the hydraulic brake system. Refer to HYDRAULIC BRAKES in this section.

g. Remove the blocking and retract the outriggers to lower the wheels to the ground.

3-27 REAR STEER AXLE

DESCRIPTION

The rear steer axle incorporates a steer cylinder assembly and a left and right hand hub and spindle assembly or a left and right hand hub, brake, and spindle assembly.

A single 3-inch (7.62 cm) hydraulic cylinder is attached by a rod eye assembly to the link plates that are attached to the spindle assemblies. The cylinder provides the hydraulic power to turn the rear wheels when steering is required. The spindle welds are attached to the frame by means of a pin arrangement. The wheel hub contains the bearings, seals, washers, and nuts necessary to mount and adjust the hub.

MAINTENANCE

STEERING LINKAGE.

Removal.

1. Fully lower and retract the boom.

2. Chock the front and rear wheels.

3. Using an adequate lifting device or the outriggers, lift the frame until the wheels are at least two inches off the ground. Install cribbing or blocking which is capable of handling the weight of the crane under the frame for support.

4. Tag, disconnect, and cap the hydraulic lines to the steer cylinder.

5. Remove the bolts, locknuts, and washers securing the rod eye assemblies of the steer cylinder to the spindle link plates.

6. If necessary, remove the capscrew, flatwasher, washer, and locknut securing the link plates to the spindle assembly.

7. Remove the bolts and washers securing the steer cylinder to the frame and remove the steer cylinder.

Installation.

1. Install the steer cylinder to the frame and secure with the bolts and washers. Torque the bolts to 75 lb ft (102 N•m).

2. If removed, install the link plates to the spindle assembly and secure with the capscrew, flatwasher, washer, and nut. Torque the capscrew to 250 lb ft (339 N•m).

NOTE

If installing a new steer cylinder ensure the threads between the jam nut and rod eye assembly are free of dirt and oil and apply Locquic Primer T to the threads. Allow to dry and apply Loctite 242 adhesive/sealant, or equivalent, to the threads before tightening the jam nut. The rod eye assemblies must be adjusted equally on both sides of the cylinder rod.

3. Install the rod eye assemblies of the steer cylinder to the spindle link plates and secure with the capscrews, locknuts, and washers. Torque the capscrews to 583 lb ft (790 N•m).

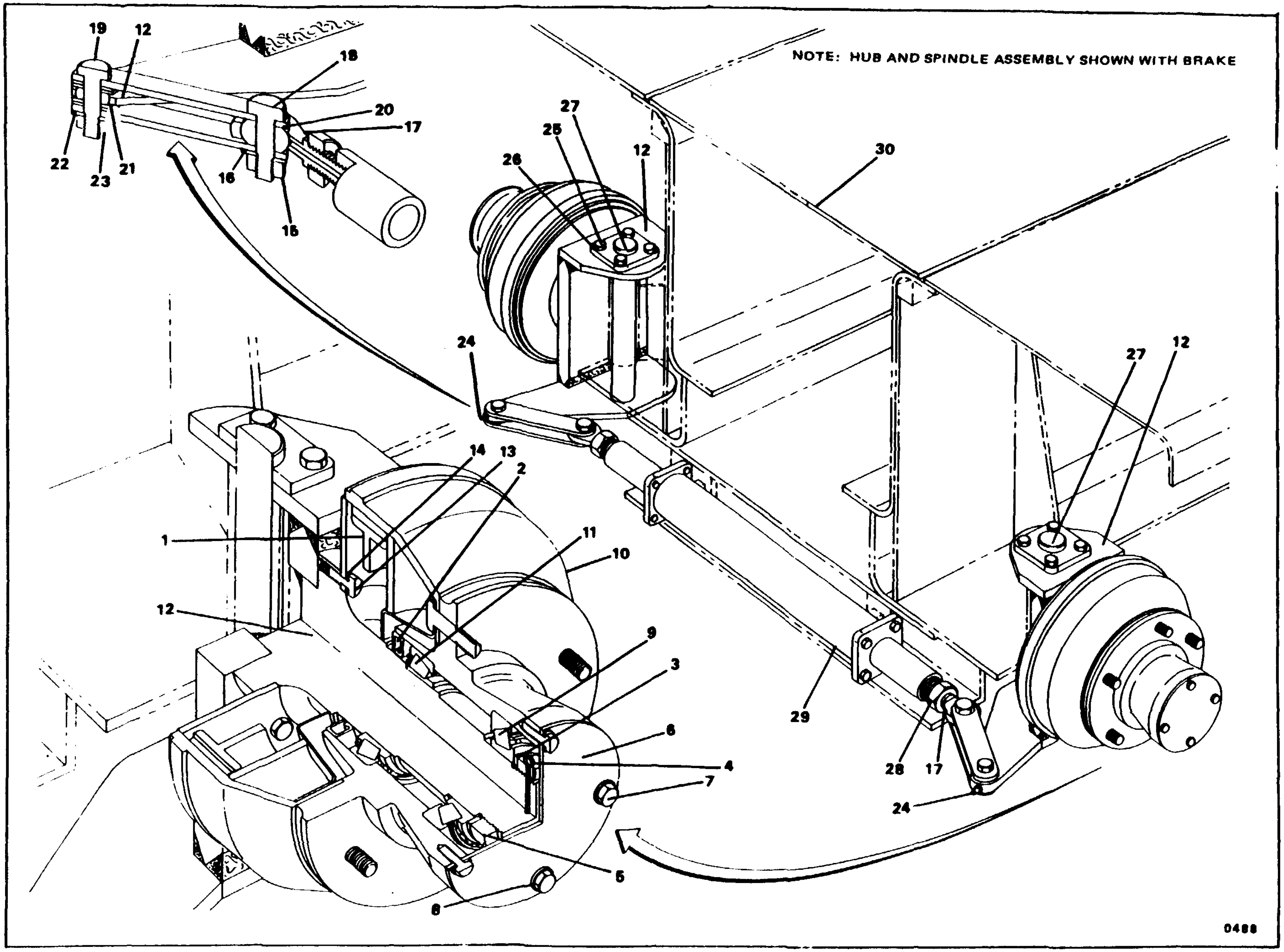
4. Connect the hydraulic lines to the steer cylinder as tagged during removal.

HUB AND SPINDLE ASSEMBLY.

Removal.

1. Fully lower and retract the boom.

2. Chock the front wheels.



Rear Axle Assembly

1.	Brake	11.	Roller Bearing Cone	21.	Flatwasher
2.	Seal	12.	Spindle Weld	22.	Washer
3.	Washer	13.	Capscrew	23.	Locknut
4.	Pin	14.	Lockwasher	24.	Grease Fitting
5.	Nut	15.	Locknut	25.	Bolt
6.	Cover	16.	Washer	26.	Washer
7.	Capscrew	17.	Rod Eye Assembly	27.	Pin Weldment
8.	Lockwasher	18.	Capscrew	28.	Jam Nut
9.	Roller Bearing Cone	19.	Capscrew	29.	Steer Cylinder
10.	Hub and Drum Assy	20.	Link Plate	30.	Frame Weldment

Legend for Rear Axle Assembly

3. Loosen the wheel lug nuts one quarter turn while the wheels are still on the ground.

4. Using an adequate lifting device, or the outriggers, lift the frame until the wheels are at least two inches off the ground. Install cribbing or blocking which is capable of handling the weight of the crane under the frame for support.

NOTE

The tire and wheel assembly weighs approximately 114 pounds (51.7 kg).

5. Remove the wheel lug nuts and remove the tire and wheel assembly.

6. Support the hub and spindle assembly with a suitable lifting device.

7. Remove the bolts, washers, and pin weld securing the hub and spindle assembly to the frame.

8. Remove the pin weld and bronze bushing from the hub and spindle assembly.

9. Remove the hub and spindle assembly from the frame.

Disassembly.

1. Remove the bolts and washers securing the cover to the hub. Remove the cover.

CAUTION

ENSURE THE ROLLER BEARINGS AND OTHER COMPONENTS ARE KEPT FREE OF DIRT.

2. Remove the washer, pin, and nuts from the end of the spindle.

3. Support the spindle and pull the hub from the spindle.

NOTE

The bearings may not release themselves when pulling the hub. It is not necessary to remove them if inspection reveals no damage.

4. If necessary, remove the bearings.

5. Remove the seal from the hub.

Assembly.

1. Install the seal in the hub.

2. If removed, clean, repack, and install the bearings.

3. Install the hub onto the spindle.

4. Install the adjust nut on the spindle. Tighten the adjusting nut to 50 lb ft (69 N•m) while rotating the wheel in both directions to ensure all bearing surfaces are In contact. Backoff the adjusting nut 1/16 to 1/4 turn.

NOTE

Ensure the pin is installed between the washer and jam nut.

5. Install the washer, pin, and jam nut onto the end of the spindle. Torque the jam nut to 250 lb ft (339 N•m). End play must be within 0.001 to 0.010 inches (0.025 to 0.254 mm).

6. Install the cover on the hub and secure with the bolts and washers.

Installation.

1. Using an adequate lifting device. position the hub and spindle assembly to the frame.

2. Install the bronze bushing and pin weld.

3. Secure the pin weld to the hub and spindle assembly with the bolts and washers. Torque the bolts to 75 lb ft (102 N•m).

4. Install the tire and wheel assembly on the hub and secure with the nuts. Torque the nuts to 300 lb ft (407 N•m).

5. Remove the cribbing and blocking and lower the wheels to the ground.

HUB, BRAKE. AND SPINDLE ASSEMBLY.

Removal.

1. Fully lower and retract the boom.

2. Chock the front wheels.

3. Loosen the wheel lug nuts one quarter turn while the wheels are still on the ground.

4. Using an adequate lifting device, or the outriggers, lift the frame until the wheels are at least two inches off the ground. Install cribbing or blocking which is capable of handling the weight of the crane under the frame for support.

NOTE

The tire and wheel assembly weighs approximately 114 pounds (51.7 kg).

5. Remove the wheel lug nuts and remove the tire and wheel assembly.

6. Support the hub and spindle assembly with a suitable lifting device.

7. Remove the bolts, washers. and pin weld securing the hub, brake, and spindle assembly to the frame.

8. Remove the pin weld and bronze bushing from the hub and spindle assembly.

9. Remove the hub, brake, and spindle assembly from the frame.

Disassembly.

Remove the bolts and washers securing the cover to the hub. Remove the cover.

CAUTION

ENSURE THE ROLLER BEARINGS AND OTHER COMPONENTS ARE KEPT FREE OF DIRT.

2. Remove the washer, pin, and nuts from the end of the spindle.

3. Support the spindle and pull the hub and drum straight off the spindle, being careful that the outer bearing cone does not drop off the spindle.

NOTE

The inner and outer bearing cups will remain seated inside the hub cavity. If the inner bearing cone slides off the spindle, the hub oil seal will remain inside the hub.

NOTE

It is not necessary to remove the bearing if inspection reveals no damage.

4. If necessary, remove the bearings from the hub using a press and sleeve or a suitable puller.

5. Using a long screwdriver or other pointed tool, pry the seal loose and discard.

NOTE

For removal of the brake drum and brake assembly, refer to the Front Axle in Appendix E.

Assembly.

NOTE

For installation of the brake assembly and brake drum, refer to the Front Axle In Appendix E.

1. Install the seal in the hub.

2. If removed, clean, repack, and install the bearings.

3. Install the hub and drum onto the spindle.

4. Install the adjusting nut on the spindle. Tighten the adjusting nut to 50 lb ft (69 N-m) while rotating the wheel In both directions to ensure all bearing surfaces are In contact. Backoff the adjusting nut 1/16 to 1/4 turn.

NOTE

Ensure the pin is installed between the washer and jam nut.

5. Install the washer, pin, and jam nut onto the end of the spindle. Torque the jam nut to 250 lb ft (339 N•m). End play must be within 0.001 to 0.010 inches (0.025 to 0.254 mm).

6. Install the cover on the hub and secure with the bolts and washers.

Installation.

1. Using an adequate lifting device, position the hub, brake and spindle assembly to the frame.

2. Install the bronze busing and pin weld.

3. Secure the pin weld to the hub, brake, and spindle assembly with the bolts and washers. Torque the bolts to 75 lb ft (102 N•m).

4. Install the tire and wheel assembly on the hub and secure with the nuts. Torque the nuts to 300 lb ft (407 N•m).

5. Remove the cribbing and blocking and lower the wheels to the ground.

3-28 U-JOINT BEARING ASSEMBLY

3-28.1 Removal

a. Remove drive line (shaft) (3, Figure 3-14), refer to paragraph 3-22.1.

b. Remove snap ring (1) securing cross bearing (2) in drive line (shaft) (3) yoke.

c. Secure exposed bearings to cross bearing assembly (2) with tape.

d. Press cross bearing (2) out of drive line (shaft) (3) yoke.

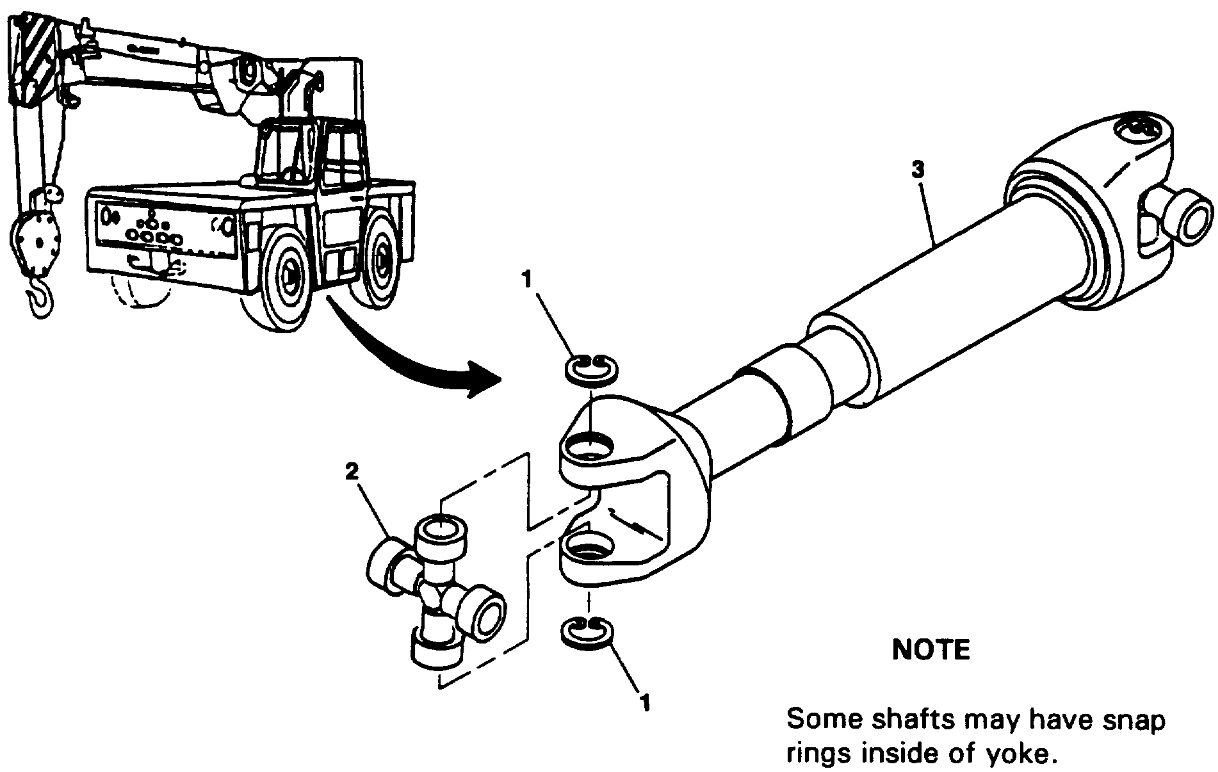
3-28.2 Installation

a. Press cross bearing (2, Figure 3-14) into drive line (shaft) (3) yoke.

b. Secure cross bearing (2) in drive line (shaft) (3) with snap ring (1).

c. Remove tape securing exposed bearings.

d. Install drive line (shaft) (3), refer to paragraph 3-22.2.



LEGEND

1. Snap Ring
2. Cross Bearing Assembly
3. Drive Line (Shaft)

Figure 3-14. U-Joint Bearing Assembly

3-29 HYDRAULIC BRAKES

DESCRIPTION

The brake is hydraulic actuated, installed on the front wheels, has a floating shoe design, requires manual shoe clearance adjustments, and is not power assisted. The brake assembly consists of a backing plate, two wheel cylinders, two brake shoe assemblies, two brake adjusters, and return springs. Actuation permits the shoes to center themselves in the drum with equal effectiveness in either direction.

MAINTENANCE

NOTE

For more detailed information refer to the applicable SM package.

NOTE

All brake maintenance, with the exception of replacement of the complete brake assembly, can be performed without removing the brake assembly.

REMOVAL.

1. Remove the wheels. Refer to FRONT DRIVE AXLE in this section.

2. Remove the wheel hub and drum assembly. Refer to the axle SM package.

3. Disconnect the brake lines from the brake assembly.

4. Remove the brake assembly. Refer to the axle SM package.

GENERAL.

A schedule for the periodic adjustment, cleaning, inspection, and lubrication of brake equipment should be established by the operator on the basis of past experience and severity of operation.

Linings and drums are parts particularly subject to wear depreciation. To compensate for this wear, brakes should be adjusted as frequently as required to maintain satisfactory operation and maximum safety. Adjustments should provide uniform lining clearance, correct travel of levers and proper equalization.

Brakes should be cleaned, inspected, lubricated, and adjusted each time the hubs are removed.

During a major overhaul, the following parts should be carefully checked and replaced with genuine replacement parts as required.

1. Check the backing plate for distortion, looseness, and sheared rivets.

2. Check the brake shoes for wear at the anchor pin holes.

3. Shoe return springs should be replaced at the time of overhaul.

4. Check the brake linings for grease saturation, wear, and loose rivets or bolts.

5. Check the drums for cracks, scoring, or other damage.

INSTALLATION.

1. Install the brake assembly. Refer to the axle SM package.

2. Connect the brake lines to the brake assembly.

3. Install the wheel hub and drum assembly. Refer to the axle SM package.

4. Install the wheels. Refer to FRONT DRIVE AXLE in this section.

5. Adjust the brakes. Refer to BRAKE SHOE ADJUSTMENT in this section.

6. Bleed the brake system. Refer to BLEEDING THE BRAKE SYSTEM in this section.

BLEEDING THE BRAKE SYSTEM.

The brake system should be bled whenever air becomes entrapped within the brake system (usually characterized by a spongy feeling during brake pedal application), whenever any brake system line has been opened, or whenever any brake component has been replaced.

Pressure Bleeding the Brake System.

NOTE

Before bleeding the brake system, ensure the master cylinder is filled to the proper level. Refer to Section 13 LUBRICATION for the proper brake fluid.

1. Fill the master cylinder reservoir with brake fluid.

2. Install the bleeding adapter on the master cylinder.

3. Fill the bleed tank at least one half full with brake fluid.

CAUTION

DO NOT LIFT, MOVE, OR SHAKE THE BLEED TANK AFTER THE AIR PRESSURE IS APPLIED. THIS MAY CAUSE ANY SEDIMENT IN THE TANK TO GO INTO SUSPENSION IN THE BRAKE FLUID.

4. Position the tank so it will not have to be moved again until the bleeding is finished.

5. Connect a 35 psi (241 kPa/2.41 bar) air source to the bleeder tank.

6. Open the bleeder tank valve and bleed all air out of the hose to be connected to the master cylinder adapter.

7. Connect the bleeder hose to the master cylinder adapter.

NOTE

Always bleed the wheel units beginning with the wheel having the longest brake line.

8. Connect one end of a bleeder hose to the bleeder valve on the wheel cylinder. Submerge the other end in a glass jar partially filled with clean brake fluid.

9. Open the bleeder valve and allow fluid to flow into the jar until it is a solid stream, free of air bubbles. Close the bleeder valve.

NOTE

Repeat steps 8 and 9 for the remaining wheel cylinders.

10. Bleed the valve at each of the wheel cylinders.

11. Remove the air supply from the bleeder tank.

12. Close the bleeder tank valve and disconnect the hose from the bleeder adapter on the master cylinder.

13. Remove the bleeder tank and hose.

14. Remove the bleeder adapter from the master cylinder.

15. Install and secure the master cylinder reservoir cover.

16. Start the engine and pump the brake pedal several times until approximately full pedal is obtained.

17. Release the brake pedal.

18. Remove the master cylinder reservoir plugs and check the fluid level. Add brake fluid as necessary.

19. Install and secure the master cylinder reservoir cover.

Manually Bleeding the Brake System.

NOTE

Before bleeding the brake system, ensure the master cylinder is filled to the proper level. Refer to Section 13 LUBRICATION for the proper brake fluid.

NOTE

Always bleed the wheel units beginning with the wheel having the longest brake line.

1. Connect the end of the bleeder hose to the bleed valve on the wheel cylinder. Submerge the other end in a jar partially filled with clean brake fluid.

2. Open the bleed valve on the wheel cylinder and allow fluid to flow into the jar while pumping the brake pedal until a solid stream free of air bubbles is acquired. Depress the brake pedal and close the bleeder valve, then release the brake pedal.

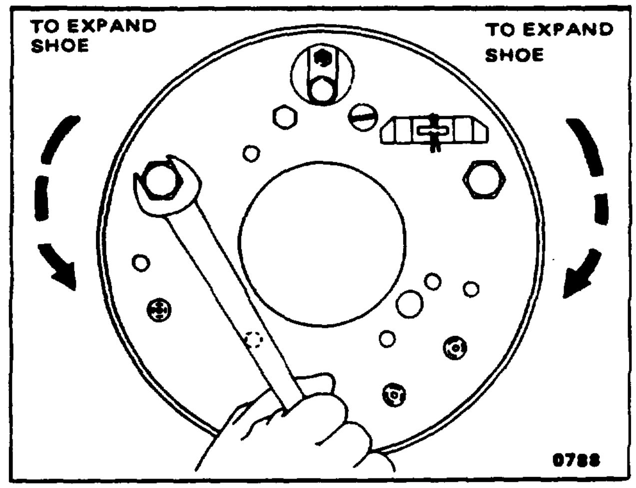
3. Repeat steps 1 and 2 for the remaining wheel cylinders.

4. Remove the master cylinder reservoir plugs and check the fluid level. Add brake fluid as required.

BRAKE SHOE ADJUSTMENT.

1. Two eccentric cams ride against the inside surface of each brake shoe. The cams can be adjusted by adjusting the bolts on the back of the backing plate with a 15/16-inch open end wrench.

2. Upon assembly, first actuate the brake to center the shoes in the drum.



Brake Shoe Adjustment

3. Adjust the liners out until a slight drag can be felt while the drum is in rotation, then back off the adjusting bolt until the drum can rotate freely. Subsequent adjustments to compensate for lining wear may be made by moving the shoe in or out by turning the eccentric cam in the desired direction.

3-30 BRAKE MASTER CYLINDER

DESCRIPTION

The brake master cylinder is located under the deck to the front of the cab. The master cylinder which has its own oil reservoir, is actuated directly by linkage to the brake pedal. The master cylinder incorporates two integrally designed pistons; the large piston for large volume and the small piston for high pressure.

Transfer from low pressure (large piston) to high pressure (small piston) is accomplished by means of a metered pressure relief valve.

The low pressure bore has a diameter of 1.75 inch (4.4 cm) and the high pressure bore has a diameter of 1-inch (2.5 cm). The stroke of the cylinder is 1.50 inches (3.8 cm).

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Slow pedal return sticking piston.	a. Fluid return ports of the relief valve may have become plugged through entrance of foreign matter.	a. Remove relief valve and wash in alcohol. Clean the return ports by hand using a 0.0625 inch (1.58 mm) drill.
	b. Poor quality or incorrect brake fluid.	b. Disassemble cylinder and wash all parts in alcohol then lubricate/service cylinder.
	c. Runout in O.D. and I.D. of low pressure pistons.	c. Replace defective component.
	d. Binding pedal linkage or heavy pedal.	d. Free up linkage pivots.
2. Brake drag or pressure build up.	a. No push rod end clearance.	a. Adjust the push rod to maintain the 0.0312 inch i0.792 mm) maxi-mum clearance to the secondary piston contact when pedal is fully retracted.
	b. Incorrect fluid or oil in the fluid causing cups to swell and stick.	b. Disassembly cylinder and re-build replacing all gaskets.

SYMPTOM	PROBABLE CAUSE	SOLUTION
3. Pedal loss. (pedal too low before braking action starts.)	a. Too much clearance between push rod and piston. (pedal loss at the start of the stroke means loss at the end of the stroke where it is most important.	a. Adjust push rod to maintain a 0.0312 inch (0.792 mm) maximum clearance to secondary piston contact when pedal is fully retracted.
	b. Brake lining badly worn requiring shoe adjustment.	b. Refer to HYDRAULIC BRAKES in this section and adjust the shoes.
	c. Faulty check valve.	c. If fluid drains from the end of the cylinder when the end plug is removed, the check valve is faulty and should be replaced. Refer to Appendix E for assembly procedures.
4. Spongy pedal	a. High pressure leaks.	a. Check all fittings and joints for leakage while the system is under pressure. If the cylinder end plug leaks remove the line connections and tighten by turning clockwise.

REMOVAL.

1. Disconnect the brake lines from the master cylinder. Cap or plug all openings.

2. Disconnect the brake linkage from the master cylinder.

3. Remove the capscrews and washers securing the master cylinder to the mounting bracket and remove the master cylinder.

INSTALLATION.

1. Position the master cylinder to the mounting bracket and secure with the capscrews and washers.

2. Connect the brake linkage to the master cylinder.

3. Connect the brake lines to the master cylinder.

4. If necessary, bleed the brake system. Refer to BLEEDING THE BRAKE SYSTEM in this section.

RELIEF VALVE ADJUSTMENT.

If Set Too High.

If the adjustment screw is set unnecessarily high, the brake pedal will be very heavy during the first of the pedal stroke and then a very noticeable pop will be felt with a resulting pedal drive. To correct this condition, perform the following steps.

1. Remove the filler plug to gain access to the adjustment screw in the top of the relief valve assembly.

2. Using a screw driver. release the adjustment by turning counter-clockwise on full turn at a time.

After each adjustment try the brake pedal for proper feel. Depress the brake pedal both rapidly and slowly. No pedal travel should be lost.

If adjustment by release of the relief valve adjustment screw will not correct pedal action, remove the entire relief valve assembly. Disassemble the relief valve and wash all parts in alcohol to eliminate piston sticking within the body of the valve.

If the corrections above do not correct pedal action, the relief valve may be mechanically defective. If so replace with a new valve.

If Set Too Low.

If the setting of the relief valve is too low, loss of pedal, low pedal, or inconsistent pedal action may occur. This is caused by the relief valve releasing the low pressure piston before full shoe extension has been attained. To correct this condition, perform the following steps.

1. Remove the filler plug to gain access to the adjustment screw in the top of the relief valve assembly.

2. Using a screw driver, turn the relief valve adjusting screw clockwise. Continue to adjust in this direction until pedal travel becomes constant.

3-31 WHEELS AND TIRES

DESCRIPTION

The tires are size 10.00 x 1 5H (16 PR). The tires and rims are available from different manufacturers.

CAUTION

DO NOT MIX TIRES AND RIMS OF DIFFERENT MANUFACUTRERS.

Each wheel assembly (tire and rim) weighs approximately 114 pounds (51.7 kg), and is mounted on the hub with (6) 3/4-16 UNF bolts.

NOTE

The tire diameters, widths, and weights may vary slightly depending on the tire manufacturer.

Off-highway tires are designed to operate with a certain sidewall deflection or bulge. Correct air pressure ensures prior deflection which, in turn, ensures proper traction, flotation, support of load, and prevents excessive flexing of the tire. Over inflation increases rim stresses, which results in lowered rim life.

Refer to and adhere to the inflation pressures on the Tire Inflation decal on the crane.

MAINTENANCE

WARNING

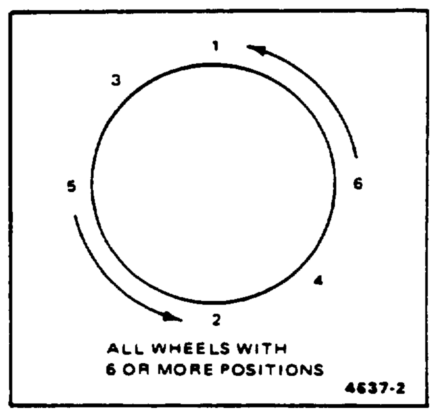
DO NOT ATTEMPT TO DEMOUNT OR MOUNT TIRES WITHOUT PROPER TRAINING. THE HIGH PRESSURES INVOLVED CAN CAUSE TIRE AND RIM PARTS AND TOOLS TO FLY WITH EXPLOSIVE FORCE, IF PROPER PROCEDURES ARE NOT USED, CAUSING SEVERE INJURY OR DEATH TO PERSONNEL AND DAMAGE TO THE CRANE AND SURROUNDING AREA.

MOUNTING WHEEL ASSEMBUES.

NOTE

Do not lubricate the wheel studs or lug nuts.

1. Position the wheel assembly on the mounting studs. Install the lug nuts and washer and tighten them until they are just snug, rotating the wheel so the nut being tightened is in the top position.
2. Ensure the wheel assembly is positioned properly on the hub.
3. Torque the lug nuts to 300 lb ft (407 N•m) in the sequence shown in the Lug Nut Torquing Sequence figure.



Lug Nut Tightening Sequence

Section 5. Steering System

3-32 STEERING SYSTEM

DESCRIPTION

The steering system consists of a power steering pump, a steering control valve, and a steer cylinder. The steering pump is driven by the engine and supplies hydraulic oil from the reservoir to the steering control valve. Depending upon the direction the steering wheel is turned, the steering control valve will route the hydraulic flow t: the applicable end of the steer cylinder. The rod of the steer cylinder will act against the applicable spindle to move the rear wheels in the desired direction.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Hard to steer left and right.	a. Hydraulic oil low.	a. Refill hydraulic reservoir.
	b. Clogged or loose hydraulic lines or fittings.	b. Clean or tighten lines or fittings.
	c. Insufficient lubricant on steer cylinder.	c. Lubricate steer cylinder.
	d. Defective pressure relief valve.	d. Repair or replace valve.
	e. Defective steering control valve.	e. Repair or replace valve.
	f. Defective steering pump.	f. Repair or replace pump.
2. Hard to steer either left or right.	a. Clogged or loose hydraulic lines or fittings.	a. Clean or tighten lines or fittings.
	b. Insufficient lubricant on steer cylinder.	b. Lubricate cylinder.
	c. Defective steer cylinder.	c. Repair or replace cylinder.
3. Steering is erratic left and right.	a. Hydraulic oil low.	a. Refill hydraulic reservoir.
	b. Clogged or loose hydraulic lines or fittings.	b. Clean or tighten lines or fittings.
	c. Defective pressure relief valve.	c. Repair or replace valve.
	d. Defective steering control valve.	d. Repair or replace valve.
	e. Defective steering pump.	e. Repair or replace pump.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Noisy steering pump caused by cavitation. small.	a. Hydraulic oil low. b. Suction line plugged or too	a. Refill hydraulic reservoir. b. Clean line and check for size.
5. Steering pump shaft seal leakage.	a. Worn shaft seal. **NOTE** **If replacing the shaft seal does not stop leakage, the pump should be disassembled and checked for the following.** b. Broken diaphragm seal or back-up gasket. c. Bearing out of position. d. Excessive internal wear.	a. Replace shaft seal. b. Replace seal or gasket. c. Replace bearing. d. Replace pump.

Functional Check.

A normal periodic functional check of the entire power steering system will generally be adequate to ensure satisfactory service.

1. Check all fittings for leakage. An accumulation of moist, black dirt is a good indication of leakage.

2. With the engine running at idle and at full throttle, and with the machine standing still and moving, turn the steering wheel through the full range of travel. Note any speed irregularities and sticky sensation. This may indicate dirt in the fluid. If the steering wheel continues to rotate when started and released a condition known as Motoring exists. This may also indicate dirty fluid in the system.

3. Ensure the system has adequate power. If there is an indication of hard steering, this can be caused by either a reduced oil flow to the control valve or a reduced system relief pressure. Adequate oil flow under all conditions can best be checked by timing the full travel of the cylinder with the steered axle unloaded and loaded. If there is a great difference at low engine speed and slight difference at high engine speeds this may indicate a defective pump drive. Adequate oil pressure can only be determined by connecting a pressure gauge (2500 psi [17,237.5 kPa/172.4 bar]full scale recommended) at the pump outlet port or at the IN port of the steering control valve. With the engine running at a medium speed, turn the steering wheel to one end of the travel and hold the cylinders at the travel limit briefly, just long enough to read the pressure gauge. Never hold the system at relief pressure for more than a few seconds at a time. The pressure gauge should indicate 1500 psi (10,342.5 kPa/1 03.4 bar). If not, adjust the pressure relief valve to 1500 psi (10,342.5 kPa/103.4 bar).

3-33 POWER STEERING PUMP

DESCRIPTION

The power steering pump is mounted on and driven by the engine. The pump is a gear type pump that supplies hydraulic oil from the hydraulic system reservoir to the steering system. The pump has an output of 6 gpm (22.7 lpm) and contains a relief valve with a relief setting of 1500 psi (10,342.5 kPa/103.4 bar).

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Noisy pump.	a. Low oil supply.	a. Fill reservoir.
	b. Oil too heavy.	b. Change to proper viscosity.
	c. Air leak in inlet line.	c. Check plumbing.
	d. Partly blocked inlet line.	d. Check for foreign object and/or clean lines.
2. Foaming oil.	a. Pump cavitation.	a. Refer to Symptom 1.
	b. Water in the oil.	b. Check reservoir.
3. Pump or oil overheating.	a. Oil supply too thin.	a. Drain and fill with proper viscosity oil.
	b. Oil supply contaminated.	b. Drain, clean filter, and fill with clean oil.
	c. Pump cavitating.	c. Refer to Symptom 1.
	d. System relief valve bypassing.	d. Check relief valve setting. Refer to Solution 4c.
4 Low flow.	a. Pump cavitating.	a. Refer to Symptom 1.
	b. Foaming oil.	b. Refer to Symptom 2.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4 Low flow.	c. Relief valve leaks, or set too low	c. Check relief valve for foreign particles.
	d. Speed too low.	d. Increase engine speed.
	e. Oil too hot.	e. Check temperature. Refer to Symptom 3. Solutions a through d.
5. Failure to build pressure.	a. Defective relief valve.	a. Check and reset or replace.
	b. Low oil supply.	b. Fill reservoir.

3-33.1 Removal

a. Tag and disconnect the hydraulic lines at the power steering pump. Cap the lines and openings.

b. Remove the bolts and washers securing the pump to the engine. Remove the pump.

3-33.2 Installation

a. Install the pump and secure with the bolts and washers. Torque the bolts to 165 lb ft (224 N•m).

b. Connect the hydraulic lines as tagged during removal.

3-33.3 Test

After the pump has been installed, run it for two to three minutes before pressurizing, ensuring the gears are constantly running in oil. Apply pressure gradually for an additional five minutes and monitor the pressure with a pressure gauge installed in a plugged outlet line. Ensure a sufficient quantity of oil is available on the suction side of the pump.

3-34 STEERING CONTROL VALVE

DESCRIPTION

The orbitrol steering control valve is located under the front console and is actuated by an orbitrol steering column and a steering wheel which are integral parts of the steering control valve. The steering valve provides precise full hydraulic steering which is accomplished by a metering system within the valve that is directly connected to the steering column and wheel.

THEORY OF OPERATION

Turning the steering wheel to the left or right causes a spool, enclosed in a precision sleeve, to rotate. As the spool is rotated, a set of lateral springs tend to move the sleeve in the same direction. Due to the springs, there is a time lag between the movement of the spool and sleeve. During this time lag, hydraulic oil from the IN port of the valve is permitted to flow to the gerotor set which meters hydraulic oil to the steer cylinder through the appropriate L or R port of the valve. When the sleeve rotates to the same position as the spool, the metered flow of hydraulic oil stops and oil flows from the IN port to the OUT port and back to the return manifold. It is the action between the spool and sleeve that permits incremental steering left or right. If hydraulic oil flow to the IN port is lost due to failure of the engine, torque converter or steering pump, rear wheel steering can still be accomplished with the steer control valve. When pressure is lost, a poppet valve closes and the gerotor set becomes a hydraulic pump. Turning the steering wheel mechanically actuates the gerotor set, pumping hydraulic oil from one side of the steer cylinder to the other. This means of steering is very difficult and requires a great amount of force to be applied to the steering wheel.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

Control Valve.

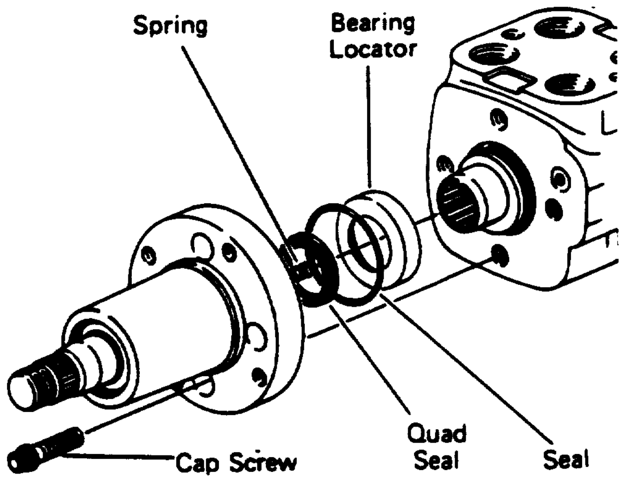
1. To gain access to the steering control valve, remove the screws securing the cover to the front of the cab. Pull the cover off far enough to disconnect any wiring necessary to remove the cover. Remove the cover.

2. Thoroughly clean the steering control valve and surrounding area of all dirt and contamination before disconnecting the hydraulic hoses from the valve.

3. Tag and disconnect the hydraulic hoses from the steering control valve. Cap or plug each hose and the ports of the valve.

4. Remove the bolts and washers securing the valve to the steering column. Remove the control valve.

Integral Column.



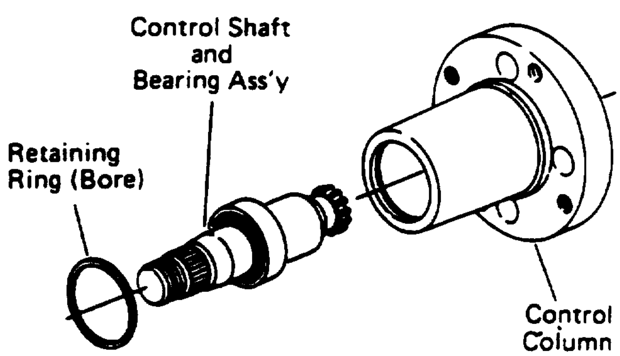
0868-27

1. Remove the four capscrews from the column.

2. Remove the column and spring.

3. Remove the bearing locator.

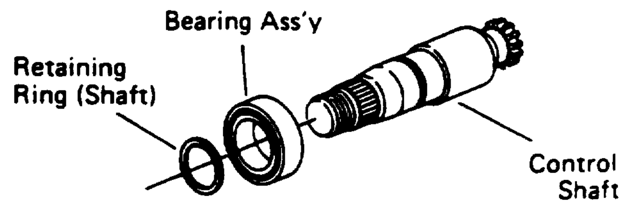
4. Remove the quad ring seal and 1-15/16 inch diameter seal from the column.



0868-28

5. Using a thin bladed screwdriver, pry the retaining ring from the bore of the control column.

6 Remove the control shaft and bearing assembly from the column. If the control shaft and bearing assembly is hard to remove, tap lightly with a plastic or rubber hammer on the splined end of the control shaft until the shaft breaks loose from the column.



0868-29

NOTE

The retaining ring fit is very tight. Be careful not to distort it when removing it from the shaft.

NOTE

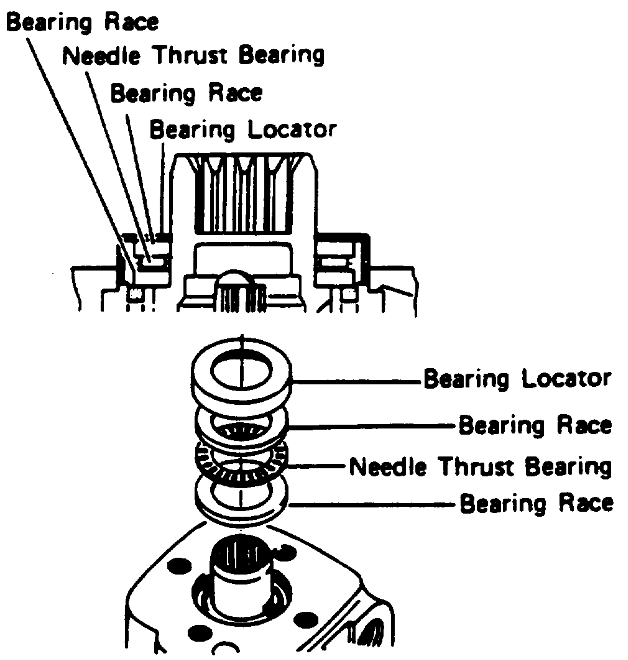
Remove the retaining ring only if it is necessary to remove the bearing assembly from the shaft.

7. If removing the bearing assembly from the shaft, remove the retaining ring from the shaft using a thin bladed screwdriver.

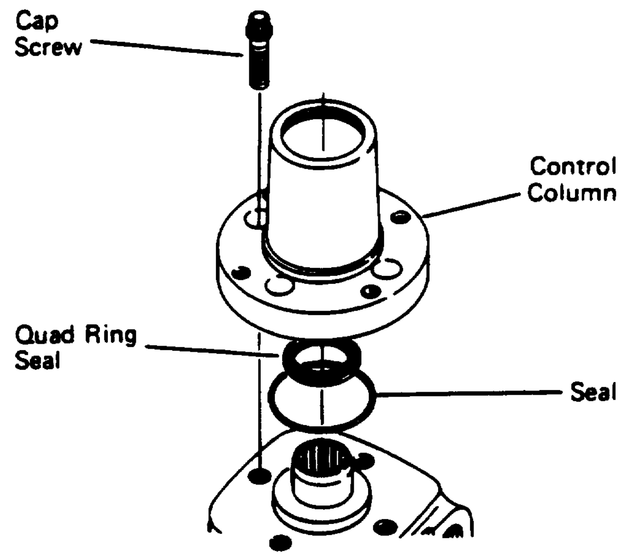
8. If necessary, remove the bearing assembly from the threaded end of the shaft.

INSTALLATION.

Integral Column.



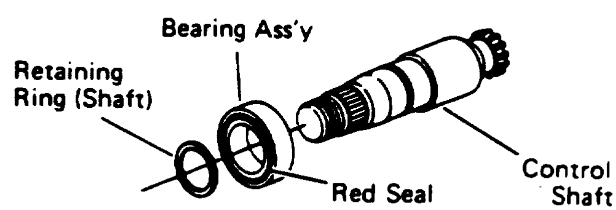
1. Install the bearing locator over the two bearing races and the needle thrust bearing. Using a soft plastic or rubber hammer, lightly tap the bearing locator in the housing.



2. Install the quad ring seal (dry). Lubricate the 1 15/1 6 inch diameter seal and install the seal in the column.

3. Install the column on the housing.

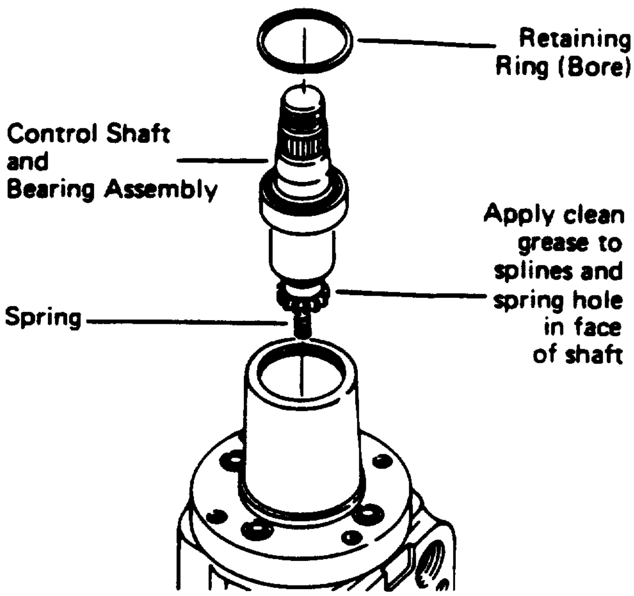
4. Align the bolt holes and install the four capscrews (dry). Using a criss-cross pattern. torque the capscrews to 200 lb in. (23 N•m).



5. Press the bearing assembly on the control shaft with the seal (red) side of the bearing assembly facing

toward the threaded end of the shaft. Ensure the bearing assembly seats against the shoulder of the shafts.

6. Install the retaining ring on the control shaft. Ensure the ring seats properly in the ring slot above the bearing assembly.



7. Apply clean grease to the splines and spring hole located in the face of the control shaft. Install the spring in the hole. The grease should hold the spring in place until the control shaft is installed in the column.

8. Insert the splined end of the control shaft in the column first, and install the control shaft and bearing assembly in the column. Turn the shaft to engage it with the spool. Push the bearing assembly in far enough to allow for installation of the retaining ring in the bore of the column.

9. Install the retaining ring in the bore of the column. Ensure that the retaining ring is fully seated in the ring groove.

Control Valve.

1. Position the control valve to the steering column and secure with the bolts and washers.

2. Connect the hydraulic hoses to the control valve as tagged during removal.

3. Prior to securing the cover to the front of the crane cab, start the engine and check for proper operation and any leaks.

4. Connect any wiring disconnected during removal. Install and secure the cover to the front of the cab.

3-35 STEER CYLINDER

DESCRIPTION

A single 3-inch (7.62 cm) hydraulic steer cylinder is installed on the rear axle.

The cylinder is attached by a rod end assembly to link plates that are attached to the spindle assemblies. Depending on the direction the steering wheel is turned, hydraulic oil from either the R port or L port of the steering control valve is directed to the appropriate side of the steer cylinder. Flow to the cylinder causes the cylinder to extend or retract thus turning the wheels.

MAINTENANCE

NOTE

Refer to CYLINDERS in Section 6 for Disassembly and Assembly procedures.

REMOVAL.

1. Tag and disconnect the hydraulic hoses from the steer cylinder ports. Cap or plug all openings.

2. Remove the bolts, locknuts, and washers securing the rod end assembly on both sides of the cylinder to the spindle link plates.

3. Remove the bolts and washers securing the steer cylinder to the frame and remove the steer cylinder from the crane.

INSTALLATION.

1. Position the steer cylinder to the frame and secure with the bolts and washers. Torque the bolts to 75 lb ft (102 N•m).

2. Align the rod end assemblies to the spindle link plates ensuring the rod end is equally adjusted on both sides of the cylinder rod. Install the bolts, locknuts, and washers and secure the cylinder. Torque the bolts to 583 lb ft (791 N•m).

3. Connect the hydraulic lines to the cylinder as tagged during REMOVAL

4. Operate the steering system and check for proper operation and any leakage.

Section 6. Hydraulic System

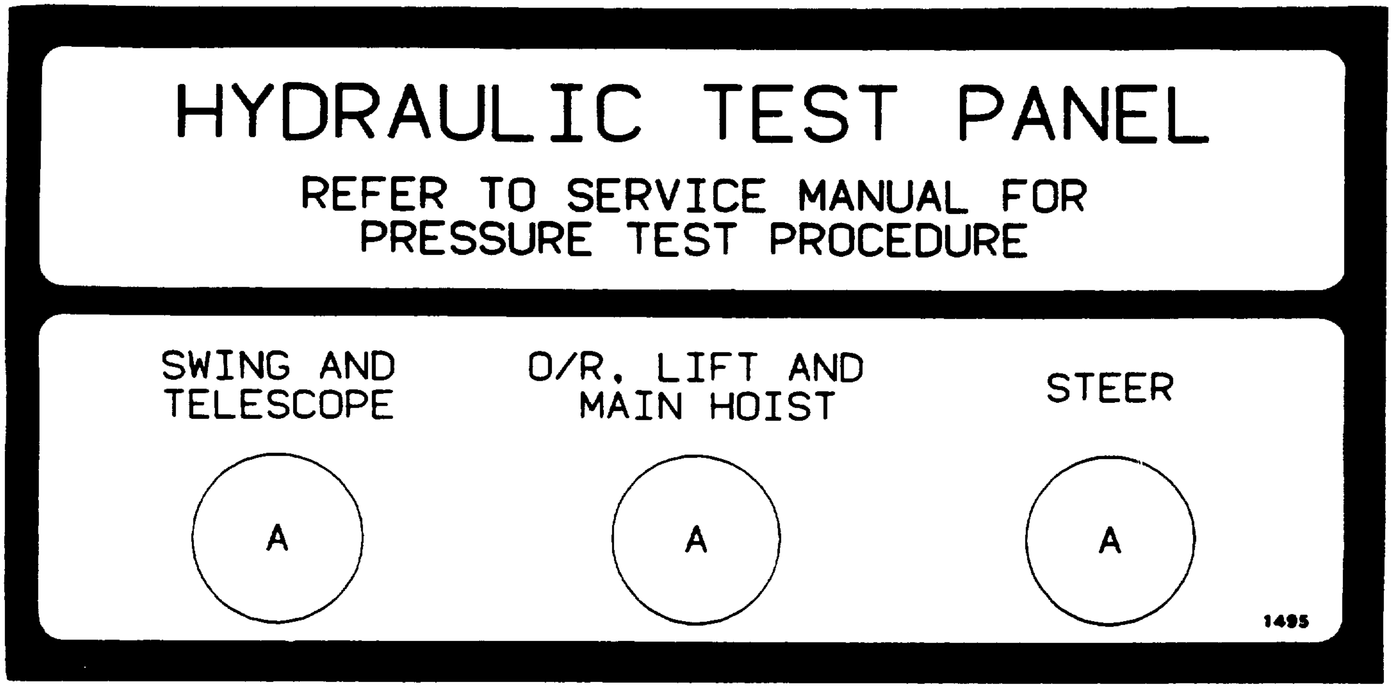
3-36 HYDRAULIC SYSTEM

DESCRIPTION

This Section describes the supply, pressure, and return hydraulic circuit, hydraulic pumps, all hydraulic cylinders, and all hydraulic valves. Description and operation of individual hydraulic circuits are discussed in their individual Sections.

A complete hydraulic system schematic showing all options is at the back of this Manual and an A.N.S.I. Graphical Symbols chart is provided in this Section.

A hydraulic test panel for checking relief valve settings is located at the front right side of the engine compartment. The test panel contains three fittings sealed with pipe plugs. By removing the pipe plugs and connecting a pressure gauge to the fittings, the pressure setting of the relief valves can be checked.



Hydraulic Test Panel Decal

MAINTENANCE

HYDRAULIC OIL RECOMMENDATIONS.

For the hydraulic oil specifications, refer to Section 13 LUBRICATION.

DRAINING AND FLUSHING.

If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained, and flushed.

1. Remove the reservoir drain plug. Allow approximately three minutes, after oil stops flowing from the drain port, for the side walls to drain.

2. Clean and install the reservoir plug and fill the reservoir with a 50-50 mixture of fuel oil and clean hydraulic oil.

3. Cycle the crane through all functions several times; then return the crane to its stowed position and turn the front and rear wheels to the extreme left. Shut down the engine.

4. Remove the reservoir drain plug and drain the reservoir. Clean and install the drain plug and fill the reservoir with clean oil.

CAUTION

OIL SUPPLY LINES MUST BE CONNECTED TO THE CYLINDERS WHEN FLUSHING THE SYSTEM.

NOTE

Draining the various components will be facilitated by connecting a drain line in place of the disconnect return line.

5. Disconnect the return line from the lift cylinder and raise the boom to maximum elevation.

6. Connect the cylinder return line and lower the boom to its stowed position. Replenish the reservoir oil level as required.

CAUTION

WHEN DRAINING THE STABILIZER CYLINDERS. ALWAYS OPERATE EITHER BOTH FRONT OR BOTH REAR CYLINDERS TOGETHER TO PREVENT TWISTING THE CRANE.

7. Disconnect the return lines from a pair of outrigger stabilizer cylinders and activate the cylinders to their maximum down position.

8. Connect the return lines and raise the stabilizer cylinders to the stowed position. Replenish the oil level as necessary.

9. Repeat steps 7 and 8 for the remaining two outrigger stabilizer cylinders.

10. Disconnect the return line from the telescope cylinder and fully extend the boom.

11. Connect the return line and retract the boom.

Replenish the reservoir oil level as necessary.

12. Disconnect the return lines from the steer cylinder and turn the wheels to the extreme right.
13. Connect the return lines and turn the wheels to the extreme left and then back to center. Replenish the reservoir oil level as necessary.

CAUTION

WHEN OILS ARE CHANGED OR ADDED, ENSURE THAT OILS OF DIFFERENT MANUFACTURERS ARE OF THE SAME SPECIFICATIONS. HOWEVER, DISCOLORATION (MILKINESS) MAY OCCUR.

When hydraulic oils are changed, recheck the reservoir oil level after brief system operation and add oil as required.

Reservoir gauge level capacity is 30.0 gallons (113.5 liters) and total capacity is 35.0 gallons (132.4 liters).

Ensure the crane is in the travel mode of operation when the oil system is being filled. The system must be filled with all cylinders retracted and the boom at rest. Fill the reservoir to the full mark on the reservoir sight gauge. After the reservoir is filled, operate all circuits and recheck the reservoir sight gauge. Add oil as required.

REMOVING AIR FROM THE HYDRAULIC SYSTEM.

Due to the manner in which the hydraulic system is designed, air entering the hydraulic oil will normally be removed automatically by passage of the oil over the baffles in the hydraulic reservoir. However, if a component has been replaced, the reservoir level is too low, or a leak develops in the suction lines to the pumps, air can enter the system. If air becomes entrapped in the hydraulic oil, it may be detectable in pumps and motor operated components such as the swing mechanism and hoist(s), because it can cause these units to become noisy during operation. Should noisy operation occur, first check the level of the hydraulic reservoir and replenish as necessary. Then inspect for leaks in the suction lines leading to the pumps.

Minute leaks may be difficult to locate. Should you encounter a leak that is not readily detectable, the following method may be used when checking for

LINES AND LINE FUNCTIONS	
LINE, WORKING	
LINE, PILOT	
LINE DRAIN	
CONNECTOR	
LINE, FLEXIBLE	
LINES JOINING	
LINES PASSING	
DIRECTION OF FLOW	
LINE TO RESERVOIR ABOVE FLUID LEVEL	
BELOW FLUID LEVEL	
LINE TO VENTED MANIFOLD	
PLUG OR PLUGGED CONNECTION	
RESTRICTION FIXED	
RESTRICTION, VARIABLE	
PUMPS	
SINGLE, FIXED DISPLACEMENT	
SINGLE, VARIABLE DISPLACEMENT	
ACTUATORS	
MOTOR, FIXED DISPLACEMENT REVERSIBLE	
MOTOR, FIXED DISPLACEMENT NON-REVERSIBLE	
MOTOR, VARIABLE DISPLACEMENT, REVERSIBLE	
CYLINDER - SINGLE ACTING	
CYLINDER - DOUBLE ACTING DIFFERENTIAL	
NON-DIFFERENTIAL	

VALVES	
CHECK	
ON-OFF (MANUAL SHUT-OFF)	
PRESSURE RELIEF	
PRESSURE REDUCING	
FLOW CONTROL, ADJUSTABLE - NON-COMPENSATED	
FLOW CONTROL, ADJUSTABLE (TEMPERATURE AND PRESSURE COMPENSATED)	
TWO POSITION TWO CONNECTION	
TWO POSITION THREE CONNECTION	
TWO POSITION FOUR CONNECTION	
THREE POSITION FOUR CONNECTION	
TWO POSITION IN TRANSITION	
VALVES CAPABLE OF INFINITE POSITIONING (HORIZONTAL BARS INDICATE INFINITE POSITIONING ABILITY)	

METHODS OF OPERATION	
SPRING	
MANUAL	
PUSH BUTTON	
PUSH-PULL LEVER	
PEDAL OR TREADLE	
MECHANICAL	
DETENT	
PRESSURE COMPENSATED	
SOLENOID, SINGLE WINDING	
REVERSING MOTOR	M
PILOT PRESSURE REMOTE SUPPLY	
INTERNAL SUPPLY	

MISCELLANEOUS	
ROTATING SHAFT	
ENCLOSURE	
RESERVOIR VENTED	
PRESSURIZED	
PRESSURE GAUGE	
ELECTRIC MOTOR	M
ACCUMULATOR, SPRING LOADED	
ACCUMULATOR, GAS CHARGED	
HEATER	
COOLER	
TEMPERATURE CONTROLLER	
FILTER, STRAINER	

such leaks. Seal all normal openings in the hydraulic system and the reservoir. Using a positive means to control the pressure (i.e. a regulator), pressurize the hydraulic system to 2 to 4 psi (13.79 to 27.6 kPa/0. 1379 to 0.276 bar) and inspect all joints and fittings for evidence of leaks. A soap solution applied to the fittings and joints may also prove helpful in detecting minute leaks while the system is pressurized. Remove the pressure, repair any leaks found, and reopen any openings (vents, etc.) closed for inspection. Refill the reservoir after completing any repairs or service. Operate all hydraulic circuits several times in both directions. This action should return any entrapped air to the reservoir where it can be removed from the oil by the baffle system provided.

NOTE

On cranes with booms that can not be lowered to below horizontal, the outriggers may be used to raise the machine in order to lower the boom nose below horizontal.

CAUTION

LOCATE THE CRANE ON A FIRM SUPPORTING SURFACE AND POSITION THE BOOM IN THE MOST STABLE POSITION WHEN EXTENDING THE BOOM AT LOW ANGLES.

On cranes with boom telescope cylinders attached so the rod (ram) moves while the cylinder barrel remains stationary, cycling may not remove the air. Lowering the boom to below horizontal and fully telescoping the boom in and out several times should remove entrapped air from the cylinders.

However, if the air is not readily removed, lower the boom to below horizontal, extend the telescope cylinder as far as practicable, and allow the boom to remain in this position overnight. This should allow entrapped air to find its way to the holding valve where telescoping the boom IN the next morning should force the air back to the reservoir.

While allowing the boom to remain in an extended and lowered position overnight is helpful in removing entrapped air from the hydraulic cylinder, ensure the boom is first telescoped IN (not OUT) in the morning. Telescoping OUT may cause air to be forced back into a cylinder.

WARNING

EXTREME CARE MUST BE USED WHEN REMOVING ANY PLUGS OR RESTRICTIONS FROM A HYDRAULIC SYSTEM SUSPECTED TO HAVE ENTRAPPED AIR THAT MAY BE PRESSURIZED.

Entrapped air may be removed from cylinders having wet rods by cycling. On certain cylinders, a plugged port is provided on the rod end to bleed-off entrapped air.

WARNING

DO NOT ATTEMPT TO LOOSEN FITTINGS IN PRESSURIZED LINES OR WHILE THE HYDRAULIC PUMP IS IN OPERATION.

In the event that air entrapment should persist, bleeding of air by loosening various clamp and screw type fittings may become necessary.

CONTROL VALVES.

The control valves that control the crane functions are installed under the dash in the cab. Access to the control valves is gained by removing the cover in front of the cab. Mechanical linkage extends from the base of the control levers, under the cab, to the respective control valves.

Inspection.

Inspect the control valves for visible damage, binding spools, and evidence of leakage. If excessive internal leakage is suspected during operation with a spool in its center position, it is possible that the area between the spool and working section bore of the valve body is worn beyond serviceable limits. If this condition exists, the spool and body must be replaced as an assembly.

Valve Leakage.

Dripping oil indicates some type of external leakage. The machine should be removed from service for immediate repairs. External leaks sometimes develop at fittings and seals. Spool seals are susceptible since they are subject to wear. Seals may be damaged by temperatures that are too high, or by dirt or paint accumulation on the spool. Damaged seals must be replaced.

A component functioning at reduced efficiency may indicate that the control valve for that component is leaking internally. Assuming preliminary check-out reveals that adequate volume is being supplied to the affected valve bank, relief valves are properly adjusted, and the component is not at fault, check the valve for scored or worn parts. Scoring is a sign of the number one problem in hydraulics contamination: external contamination by dust or internal contamination by debris from deteriorating components or oxidized oil. Scored or severely worn valve components must be replaced.

Warped mounting surfaces can distort the assembly and cause leakage and binding. To check for valve distortion, loosen the mounting bolts slightly. If the leakage stops when the bolts have been backed off slightly, distortion was the problem. To correct this condition, shim the valve assembly to level and retighten the mounting bolts.

Check valves in the control valves are designed to permit a flow of oil in one direction only. If a piece of dirt or rust has worked its way into the check valve and lodges between the poppet and seat, it will keep the valve open and allow a return flow of oil. The remedy is to clean the valve, but it is also a good idea to follow through and ensure the hydraulic system filters are still serviceable.

Binding Spools.

Some of the most common causes for stiff spool movement or jammed spool action are; system overheating, excessive pressure, contaminated or deteriorated oil, or warped mountings. When scorched or deteriorated oil or contamination is the cause, flushing the system and replenishing with clean oil may solve the problem. If the spool bores are badly scored or galled, the valve must be removed for servicing.

Warping occurs when mounting plates are not level or they become distorted from machine damage. As mentioned previously, the valve can be shimmed level.

Also, check the valve for rust. Rust or dirt collecting on the linkages can prevent free movement of the spool, and keep it from the true center position. Excessive system pressure can create both internal and external leaks in valves that are otherwise sound. Therefore, it is extremely important that relief valves be adjusted only by qualified personnel using the proper equipment.

3-37 HYDRAULIC HOSES, LINES, AND FITTINGS (TYPICAL)

3-37.1 Removal

WARNING

Fluid leaks under pressure may not be visible. A high pressure oil stream can pierce body and cause severe personal injury. Always wear safety goggles to protect eyes and heavy gloves to protect hands. Prior to servicing any component, reduce hydraulic pressure in system to zero and then disconnect power source.

a. Relieve hydraulic pressure by moving control levers through full range with engine shut down.
b. Remove hose or line (1, Figure 3-15), as applicable, from fitting (2).
c. Remove fitting (2) from component.

3-37.2 Installation

WARNING

Never use standard plumbing fittings for the hydraulic system. Always use high pressure hydraulic fittings. Standard fittings could fail resulting in severe personal injury.

a. Install fitting (2, Figure 3-15) in component.
b. Install hose or line (1), as applicable, on fitting (2).

WARNING

Hydraulic fluid under pressure can penetrate skin or damage eyes. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks, but do not use bare hand. Wear safety goggles for protection. If fluid enters skin or eye, get immediate medical attention.

c. Start up hydraulic system and check for leaks.

LEGEND

1. Hose/Line
2. Fitting

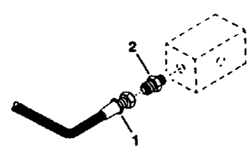


Figure 3-15. Hydraulic Hoses, Lines, and Fittings (Typical)

3-38 HYDRAULIC TANK

3-38.1 Removal

a. Disconnect negative battery cable and two electrical leads from negative battery post.

b. Remove drain plug (2, Figure 3-16) from hydraulic tank (1) and drain hydraulic oil into suitable container (tank capacity 35 gal.). Dispose of oil according to local regulations.

c. Remove two bolts (3) and two lockwashers (4) securing hydraulic line (5) to return filter assembly (19).

d. Remove two locknuts (6), two washers (7), and two bolts (8) securing bottom of hydraulic tank to crane frame.

e. Tag and disconnect two electrical leads from temperature switch (26).

f. Remove two bolts (9), two lockwashers (10), and disconnect suction hose (11), steering pump hose (12), and return tube (13) from back of reservoir.

g. Remove locknut (14), washer (15), hold-down (15), and hydraulic tank (1) from crane frame.

h. Remove six bolts (17), six lockwashers (18), return filter assembly (19), and gasket (20) from hydraulic tank (1). Discard gasket (20).

i. Remove clamp (21), cover (22), and o-ring (23) from hydraulic tank (1). Discard o-ring (23).

j. Remove breather cap (24), oil level gauge (25), and temperature switch (26) from hydraulic tank (1).

3-38.2 Installation

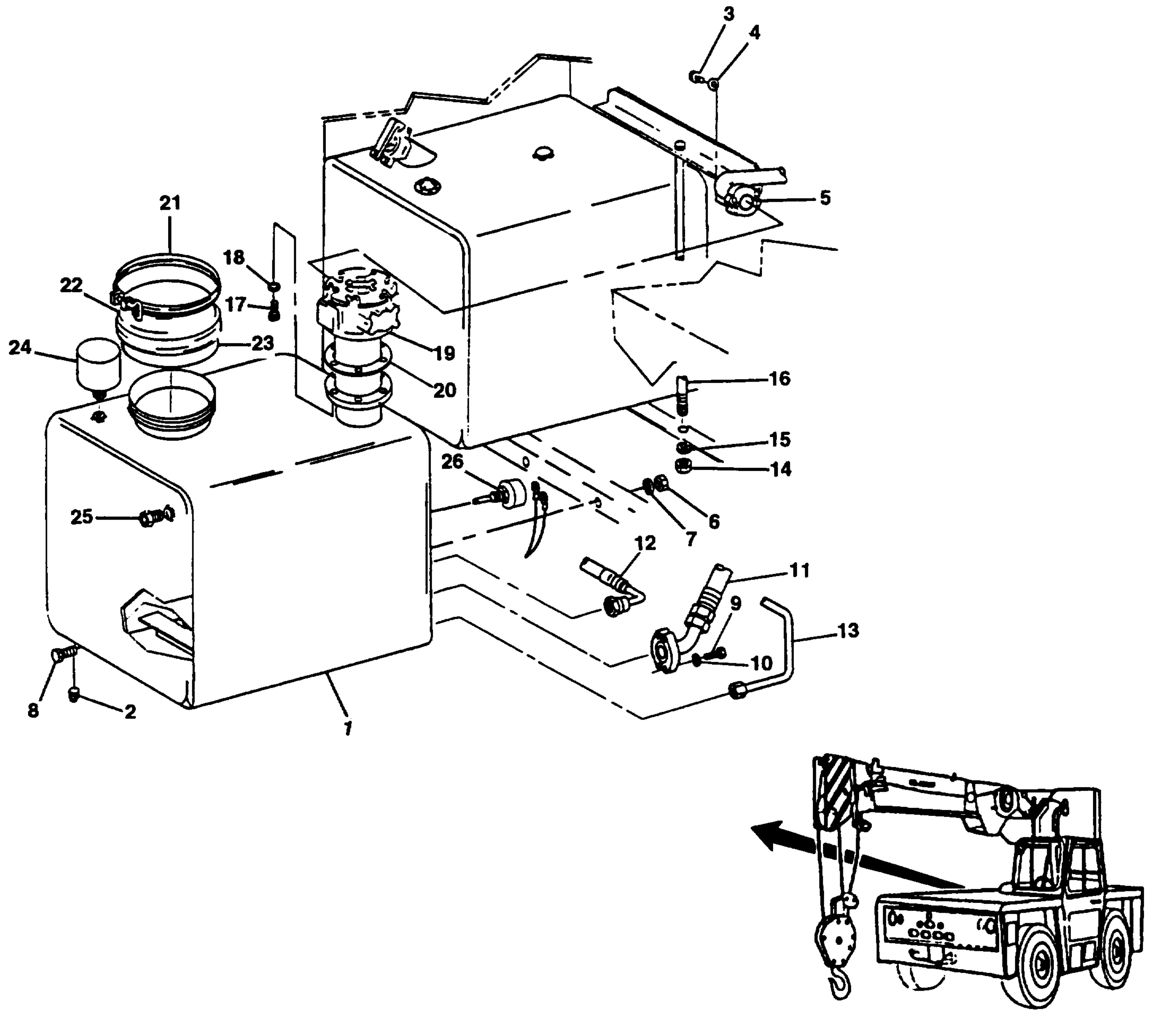
a. Install temperature switch (26, Figure 3-1 6), oil level gauge (25), and breather cap (24) in hydraulic tank (1).

b. Install new gasket (20) and return filter assembly (19) in hydraulic tank (1) with six lockwashers (18) and six bolts (17).

c. Install hydraulic tank (1) on crane frame with hold-down (16), washer (15), nut (14), two bolts (8), two washers (7), and two nuts (6). Torque nuts (6 and 14) to 75 lb ft (102 N•m).

d. Connect return tube (13), steering pump hose (12), and suction hose (11) with two washers (10) and two bolts (9) to back of reservoir.

e. Connect two electrical leads to temperature switch (26) and remove tags.



LEGEND

1. Hydraulic Tank
2. Drain Plug
3. Bolt
4. Lockwasher
5. Return Line
6. Nut
7. Washer
8. Bolt
9. Bolt
10. Washer
11. Suction Hose
12. Steering Pump Hose
13. Return Tube
14. Nut
15. Washer
16. Hold-Down
17. Bolt
18. Lockwasher
19. Return Filter
20. Gasket
21. Clamp
22. Cover
23. O-ring
24. Breather Cap
25. Sight Glass
26. Temp. Switch

Figure 3-16. Hydraulic Tank

f. Connect hydraulic line (5) to return filter assembly (19) with two lockwashers (4) and two bolts (3).

g. Install drain plug (2) in hydraulic tank (1) and service reservoir with new hydraulic oil. Refer to Operator's Manual, TM10-3950-672-10, for proper hydraulic oil.

h. Install new o-ring (23), cover (22), and clamp (21) on hydraulic tank (1).

WARNING

Hydraulic fluid under pressure can penetrate skin or damage eyes. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks, but do not use bare hand. Wear safety goggles for protection. If fluid enters skin or eye, get immediate medical attention.

i. Start up hydraulic system and check for leaks.

j. Connect negative battery cable and two electrical leads to negative battery post.

3-39 SUPPLY PRESSURE AND RETURN CIRCUIT

DESCRIPTION

The supply pressure end return circuit routes hydraulic oil from the pump to the directional control valves for the individual operating circuits. The supply pressure and return circuit consists of the reservoir, pump, oil filter, hydraulic swivel, and oil cooler. The operating circuit's description and components begin with the circuit's directional control valves. Refer to HYDRAULIC PUMP in this section for Description and Maintenance of the hydraulic pump. Refer to Section 9, SWIVELS for Description and Maintenance of the hydraulic swivel.

HYDRAULIC RESERVOIR AND FILTER.

The reservoir, attached to the right side of the crane chassis, has a total capacity of approximately 35.0 gallons (132.4 liters) and a gauge level capacity of approximately 30.0 gallons (113.5 liters). The all-steel reservoir has an internally mounted full-flow filter and integral baffles that help cool the oil and prevent oil foaming.

Oil flows through individual tubing from the back of the reservoir to the hydraulic pump. The return flow is also to the back of the reservoir, but on the opposite side of a baffle plate which acts to separate return and supply oil. Two return lines are connected to the back of the reservoir. One goes directly into the reservoir. The other return line goes directly into the filter case inside the reservoir.

A sight gauge is located on the front of the reservoir to indicate oil level. A breather used as a filter is located on the top of the reservoir to allow air to enter or exhaust from the reservoir. It is most important that the breather be kept clean to prevent damage to the reservoir. Change interval would be dependent upon environmental conditions. Under severely dusty conditions, the change interval should be once every 3 to 4 months, moderate condition change interval should be 6 to 8 months, and mild condition interval should be once yearly. A large round access cover on the top center of the reservoir provides access for cleaning. This opening may also be used to fill the reservoir after it has been completely drained.

The oil filter is located in the reservoir. The filter housing contains a replaceable 3 micron filter element. An indicator on the filter tells what condition the filter is in, i.e. dirty or clean, whether the filter is functioning or by-passing, or if an element was not installed. The filter bypass valve is either positively closed when normal filtration is in progress, or is positively open when the filter has reached its bypass setting.

OIL COOLER.

The air cooled hydraulic oil cooler is mounted to the front of the crane under a bolt-on cover. The oil cooler consists of a fan, an electric motor, and a temperature switch. The fan draws cool air through the cooling fins on the cooler. The oil cooler cools the oil utilized in the swing and telescope circuits. Return oil flows from the oil cooler directly to the return filter in the reservoir.

A temperature switch installed in the back of the reservoir controls the operation of the fan motor.

When the temperature switch senses a temperature of 160 degrees F (71 degrees C), the motor is energized and continues running until the oil temperature is reduced to 148 degrees F (65 degrees C).

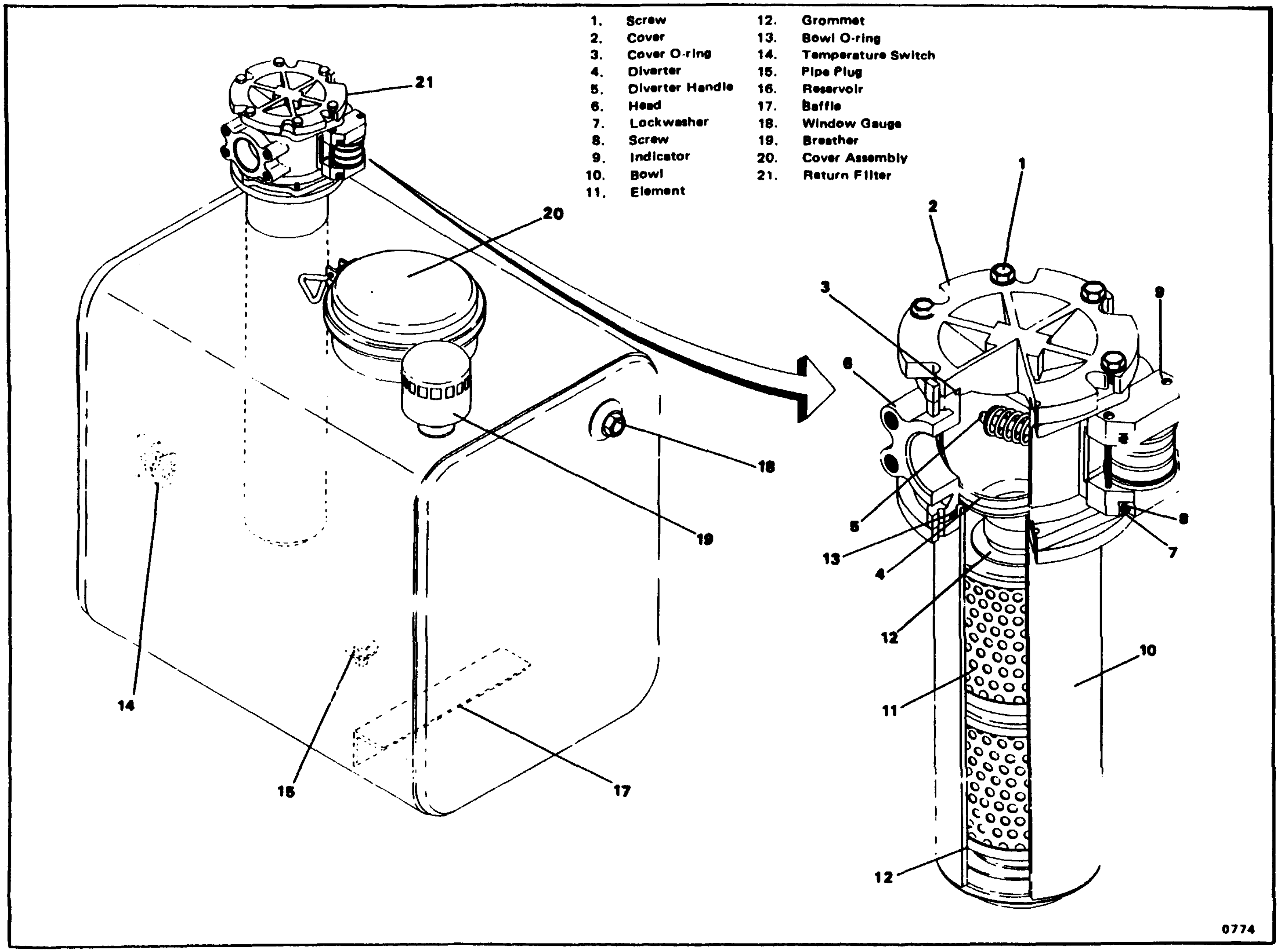
PUMP DISTRIBUTION.

Section One.

Section one of the hydraulic pump supplies the 3-valve bank housing the outrigger/tow winch, lift, and main hoist directional control valve.

Section Two.

Section two of the hydraulic pump supplies the 2-valve bank housing the swing and telescope directional control valve.



Hydraulic Reservoir and Filter

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. No oil flows in systems.	a. Low oil level.	a. Fill reservoir.
b.	Pump coupling or shaft sheared or disengaged.	b. Properly engage the pump drive. If drive or coupling is damaged or sheared. remove and repair or replace as necessary.
	c. Reservoir-to-pump supply line broken or restricted. Air entering at suction lines. Pump not priming.	c. Clean, repair, or replace line as necessary. Check all lines for security, suction lines for cracks, and proper attachment. Tighten, repair. or replace components as necessary.
	d. Internal contamination.	d. Repair or replace pump. Drain, flush, and refill system with recommended oil.
2. Excessive pressure buildup.	a. System relief valve set too high.	a. Use adequate pressure gauge and adjust system relief valve as necessary.
	b. Restricted pump-to-control valve supply line.	b. Clean, repair, or replace line as necessary.
3. Pump noise. Accompanied by oil foaming in reservoir.	a. Air entering at suction lines. Low oil level.	a. Check all lines for security and proper attachment. Tighten, repair, or replace components as necessary. Ensure that oil level in reservoir is adequate. Fill to HIGH mark on sight gauge.
	b. Excessive engine rpm.	b. Regulate engine speed.

3-40 HYDRAULIC FILTER

Removal and Disassembly.

WARNING

ENSURE ALL HYDRAULIC SYSTEMS ARE SHUT DOWN AND THE PRESSURE IS RELIEVED.

1. Shut down all hydraulic systems.

2. Wipe any dirt from the filter housing and filter head.

3. Remove the screws from the filter cover and remove the cover. Inspect the cover O-ring and replace it if there is any evidence of damage.

4. Remove the screws securing the head to filter bowl. Remove the head. Inspect the bowl O-ring and replace It If there is any evidence of damage.

5. Remove the hitch clip pin from the diverter handle and remove the diverter and poppet valve assembly. Inspect the diverter O-ring and replace it if there is any evidence of damage.

6. Remove the elements.

7. If necessary, remove the screws and lockwashers securing the indicator to the head. Inspect the indicator, O-ring seals, and gasket sponges for damage. Replace, if necessary.

8. Ensure the new filter element(s) is correct by comparing the part number with that of the used filter element(s).

9. Discard the used filter element(s).

Assembly and Installation.

1. If removed, install the indicator to the head and secure with the lockwashers and screws.

2. Install the filter elements(s) into the filter bowl.

3. Install the diverter and poppet valve assembly into the head and secure with the diverter handle and hitch clip pin.

4. Install the head to the filter bowl and secure with the screws.

5. Install the filter cover and secure with the screws.

6. Start up the hydraulic system and check for leaks.

3-41 HYDRAULIC PUMP

DESCRIPTION

The hydraulic pump is mounted on and is driven by the diesel engine through an adapter and coupling on the crankshaft. The pump is a gear-type unit and consists of two section. The first section has an output of 27.4 gpm (103.7 lpm) and the second section has an output of 18.9 gpm (71.5 lpm) @ 2400 rpm.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Noisy pump caused by cavitation.	a. Oil supply low.	a. Fill the hydraulic reservoir.
	b. Air leaking into the suction line.	b. Tighten all fittings.
	c. Incorrect oil in reservoir.	c. Drain and fill reservoir with non-foaming oil.
2. Oil heating.	a. Oil supply is low.	a. Fill the reservoir.
	b. Contaminated oil.	b. Drain the reservoir and refill with clean oil.
	c. Oil in system too light.	c. Drain the reservoir and refill with proper viscosity oil.
3.Shaft seal leakage.	a. Worn shaft seal.	a. Replace the seal.
4.Foaming Oil.	a. Low oil level.	a. Fill the reservoir.
	b. Air leaking into the suction line.	b. Tighten the fittings.
	c. Wrong kind of oil.	c. Drain and fill reservoir with non-foaming oil.

REMOVAL.

1. Tag and disconnect the hydraulic lines from the pump. Cap or plug all openings.

2. Remove the bolts and washers securing the pump and slide the pump shaft from the drive adapter.

INSTALLATION.

1. Slide the pump shaft into the drive adapter. Install the bolts and washers and secure the pump. If a Cummins engine is installed, torque the bolts to 58 lb ft (79 N•m).

2. Connect the hydraulic lines to the pump as tagged during removal.

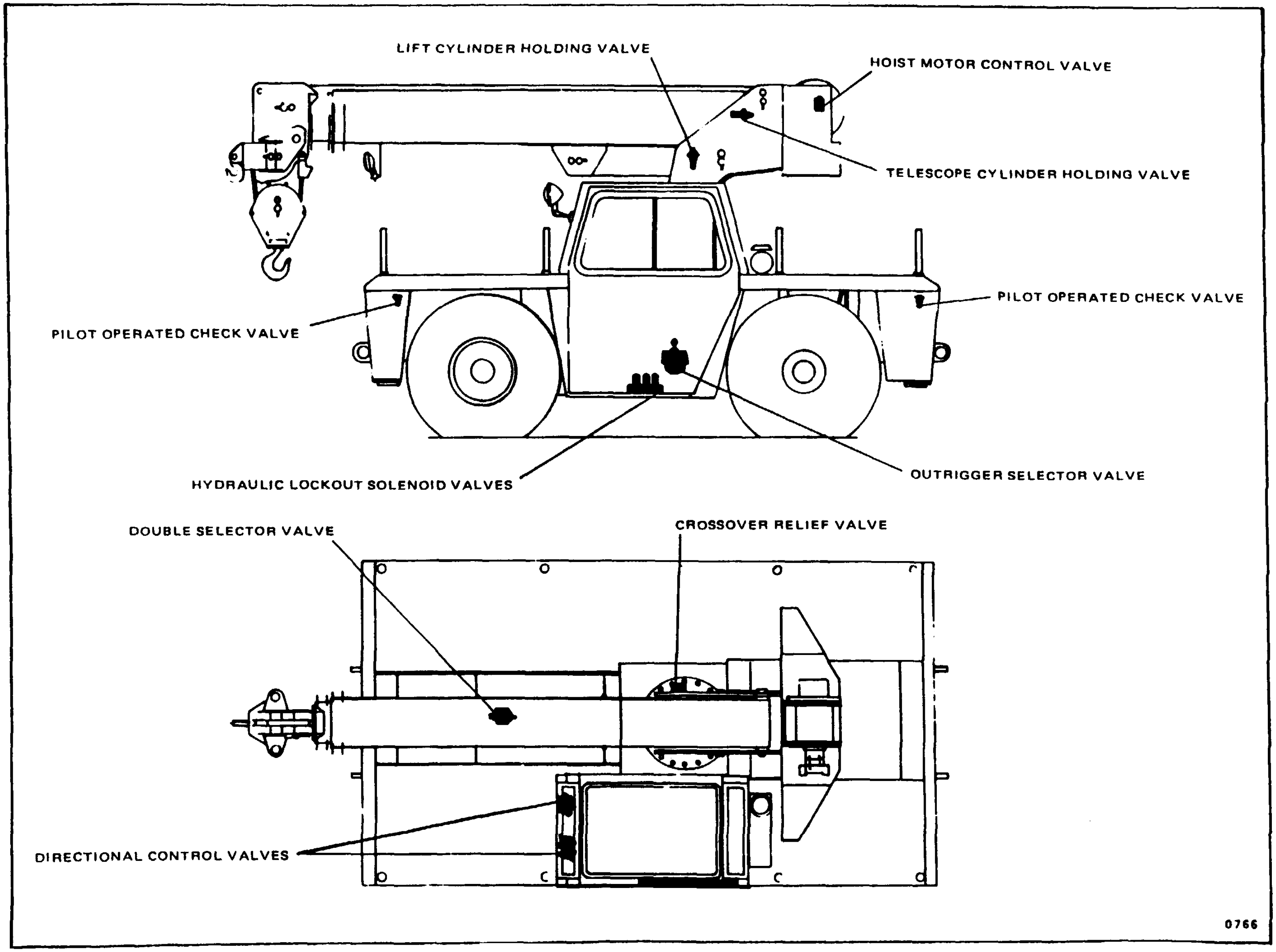
3-42 VALVES

GENERAL

This subsection provides descriptive information for all the hydraulic valves used on this crane. For a listing of all valves, the circuit they are used in, and their physical location, refer to the Valve Usage Table. The description of the valves given here is for the valve itself. For information on how the valve functions in the individual circuits, refer to the Description and Operation of that circuit.

VALVE USAGE TABLE

Valve Name	Circuit Used In	Physical Location
Directional Control Valves: Open Spool Hoist	 Swing Under the front console	 Under the front console
Closed Spool Boom Lift Outrigger	Telescope Under the front console Under the front console	Under the front console
Double Selector Valve	Outrigger	In the battery box
Holding Valves Telescope	Boom Lift Port block of each cylinder	Port block of each cylinder
Pilot Operated Check Valve	Outrigger	Port block of each cylinder
Outrigger Selector Valve	Outrigger	In the cab
Hydraulic Lockout Solenoid Valves Boom Lift Hoist	Telescope the cab floor	Between the frame rails under
Hoist Motor Control Valve	HO-12 Hoist	On the hoist motor
Crossover Relief Valve assembly	Swing	On the swing drive
Thermal Relief Valve	Lift	In Line



Valve Locations

3-43 RELIEF VALVES

DESCRIPTION

Relief valves are used to protect a component, a circuit, or a system from overpressurization. Most of the relief valves are located in the directional control valves, but some are located in the line between components (e.g., double crossover relief valve), while others are part of a component.

MAINTENANCE

GENERAL.

Relief valves are checked and adjusted by causing a given circuit to reach its prescribed pressure limit (stall). At this point the relief valve opens, returning oil to the reservoir. Hydraulic motor circuits may be stalled by preventing rotation of the motor shaft prior to actuating the control valve. Cylinder circuits may be stalled by extending or retracting a cylinder to its limit of travel.

By placing a pressure gauge in the proper line or port, a pressure reading will indicate the point at which the relief valve opens. The needle on the meter face will climb until it reaches the relief valve setting. At that point the needle will stop climbing and fluctuate, indicating the relief valve is open and returning oil to the reservoir.

Correct relief valve adjustment is mandatory if any hydraulic circuit is to function properly. Settings must be within tolerances. Therefore, adjustment should be performed only by qualified technicians using the correct equipment, after the need for adjustment has been established.

Each valve bank has one main relief valve limiting maximum operating pressure of the component(s) in that circuit. In addition, circuit relief valves further limit operating pressures as required by circuit design.

The following test and Tables list Main and Circuit Relief Valve Settings. If the pressure setting of any relief valve is not ± 100 psi (±689.5 kPa/6.8 bar) of that listed in the tables, adjustment is necessary.

CAUTION

DO NOT OVERTIGHTEN THE SCREW OR LOCKNUT.

CAUTION

DO NOT HOLD THE RELIEF VALVE OPEN FOR MORE THAN ONE MINUTE AT A TIME.

NOTE

To adjust a relief valve, turn the adjustment screw (in to increase or out to decrease) until the proper setting is reached.

MAIN RELIEF SETTINGS

Valve Bank	Setting psi (kPa/bar)
Two Section	2500 (17,237/172.3)
Three Section	3000 (20,685/206.8)

CIRCUIT RELIEF SETTINGS

Valve Bank	Circuit Relief - psi (kPa/bar)	Main Relief - psi (kPa/bar)
Hoist		3000 (20,685/206.8)
Lift (down)	350 (2413/24.1)	3000 (20.685/206.8)
Telescope (2 Section Boom) (Retract)	1000 (6,895/68.9)	2500 (17,237/172.3)
Swing	1780 (12,273/122.7)	3000 (20,685/206.8)
Outrigger		3000 (20,685/206.8)

Swing.

1. Install the pressure gauge in the test port on the control valve.

2. Set the throttle to 1000 rpm.

3. Disconnect the hydraulic line to the swing brake release port and cap the line. Plug the open port on the brake.

4. Swing first one direction then the other, holding momentarily in each position. Note the maximum pressure reading at each position. If the readings are not ± 100 psi (689.5 kPa/6.89 bar) of that listed in the CIRCUIT REUEF SETTING table, adjust the pressure setting as necessary.

5. If the valve cannot be adjusted to within the 100 psi (689.5 kPa/6.89. bar) tolerance, shut down the crane and replace the relief valve.

6. After the required pressure setting has been obtained, shut down the engine. Connect the swing brake release line to the swing brake, remove the pressure gauge and install the pipe plug.

NOTE

Release the control lever after taking each reading and while making adjustments.

When the proper pressure setting has been attained, tighten the adjustment screw locknut and recheck the pressure. It is possible that the setting may change while tightening the locknut.

NOTE

An accurate 0 to 6000 psi (0 to 34,475 kPa/344.75 bar) pressure gauge should be used when adjusting relief valves. Pressure test ports are located on the hydraulic test panel. These test ports are connected to the inlet line of each valve bank.

PREPARATION.

1. Start and warm up the engine until the hydraulic oil temperature reaches a minimum of 70 degrees F (21.1 degrees C).

WARNING

DO NOT ATTEMPT TO LOOSEN THE FITTINGS IN PRESSURIZED LINES OR WHILE THE HYDRAULIC PUMP IS IN OPERATION.

2. Shut down the engine.

MAIN RELIEF VALVE ADJUSTMENT.

WARNING

NEVER USE STANDARD PLUMBING FITTINGS FOR THE HYDRAULIC SYSTEM, ALWAYS USE HIGH PRESSURE HYDRAULIC FITTINGS.

1. Plumb the pressure gauge into the pressure test port on the control valve bank.

2. Set the throttle to 2400 rpm.

3. Position the LIFT control lever to LOWER and hold momentarily.

4. If the pressure readings are not ± 100 psi (689.5 kPa/6.89 bar) of 3000 psi (20,685 kPa/206.8 bar) set the relief valve.

5. After the required pressure setting has been obtained, shut down the crane and remove the pressure gauge.

CIRCUIT RELIEF VALVE ADJUSTMENT.

Lift Retract.

NOTE

Lift extend uses the valve bank main relief valve.

1. Remove the pipe plug from the pressure test port and install the pressure gauge.

2. Set the throttle to 1000 rpm.

3. Move the BOOM control lever to DOWN and hold momentarily. Note the maximum reading on the pressure gauge. If the reading is not ± 100 psi (689.5 kPa/6.89 bar) of that listed in the CIRCUIT RELIEF SETTING table, adjust the pressure setting as necessary.

4. Shut down the engine. Remove the pressure gauge and install the pipe plug.

Telescope Retract.

NOTE

Telescope extend uses the valve bank main relief valve.

1. Install the pressure gauge in the test port on the applicable control valve.

2. Set the throttle to 1000 rpm.

3. Move the TELESCOPE control lever to IN and hold momentarily. Note the maximum reading on the pressure gauge. If the reading is not ± 100 psi (689.5 kPa/6.89 bar) of that listed in the CIRCUIT RELIEF SETTING table, adjust the pressure setting as necessary.

4. Shut down the engine. Remove the pressure gauge and install the pipe plug.

3-44 DIRECTIONAL CONTROL VALVE

DESCRIPTION

The directional control valves are four-way, three-position valves with either an open or closed spool. Whether a valve has an open or closed spool is determined by whether, with the spool in the neutral position, the work ports are open to the reservoir return passage. If the work ports are open to the reservoir return passage the valve is classified as an open spool type: if they are not, the valve is a closed spool type. (Refer to the Valve Usage Table for circuit applicability by valve type). Additionally, the valve spool is spring loaded to the neutral position.

The open spool directional control valve is constructed with a through passage to allow flow to pass to the next valve(s) in the bank and on to the reservoir, when the valve spool is in the neutral position. By positioning the valve spool to a work position, the through passage is blocked and flow is diverted to the dead end parallel passage. This causes flow to be directed to the component's open supply work port. Return flow is routed from the return work port to the reservoir return passage by the opposite end of the valve spool.

This flow pattern is applicable in either direction the valve may be positioned. If it is necessary to open more than one directional control valve in the same valve bank, it may be required to partially close or feather the valves that are located in the bank first, in regards to flow from the pump, in order to provide sufficient flow to the valves located last in the bank.

The closed spool directional control valve functions basically the same way as the open spool directional control valve in that the through passage of the valve must be blocked off by the valves' spool to divert flow to the dead end parallel passage. With flow diverted to the parallel passage, pressure then must unseat the load check valve to allow the flow to reach the open work port. The load check valve is provided to prevent back sliding of components which support heavy loads as is evidenced by the circuits this valve is used in. Return flow from the component is through the return work port to the reservoir return passage.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Gain access to the control valves by removing the capscrews, nuts, washers, and clamps securing the console assembly to the frame. Lift the console assembly off the control valves.

2. Tag and disconnect the hydraulic lines from the valve bank. Cap and plug all openings.

3. Tag and disconnect any electrical leads from the valve bank.

4. Remove the cotter pins and clevis pins attaching the control levers to the valve(s). Replace the hardware in the linkage to prevent loss.

5. Remove the capscrews and washers securing the valve bank to the mounting plate and remove the valve bank.

INSTALLATION.

1 Position the valve bank on the mounting plate and secure with the capscrews and washers.

2. Connect the control levers to the valve(s) and secure with the cotter pins and clevis pins.

3. Connect any electrical leads to the valve bank as tagged during removal.

4. Connect the hydraulic lines to the valve bank as tagged during removal.

5. Install the console assembly to the frame. Secure the top of the console assembly with the clamps, washers, and nuts. Secure the sides of the console with the capscrews and washers. Torque the capscrews to 31 lb ft (42 N•m).

FUNCTIONAL CHECK.

1. Start the engine and check the operation at high and low idle speed with no load applied.

2. Set the engine speed to the recommended operating rpm.

3. Operate the control lever(s) of the affected circuit(s). Check for smooth operation of cylinders and motors. Check the valve bank(s) and lines for leakage.

3-45 HOLDING VALVES

DESCRIPTION

Two different holding valves are utilized on the crane, one in the lift cylinder and one in the telescope cylinder. Both valves are installed in the port block of their respective cylinder.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. To remove the holding valve, unscrew it from the port block.

INSTALLATION.

1. Check the inside of the port block for any sharp edges or burrs and remove as necessary with emery cloth.

2. Install new O-rings onto the holding valve.

3. Lubricate the holding valve and O-rings with clean hydraulic oil.

CAUTION

DO NOT DAMAGE THE O-RINGS DURING INSTALLATION OF THE HOLDING VALVE. IF THE HOLDING VALVE TURNS FREELY THEN GETS HARD TO TURN, THEN EASY TO TURN; REMOVE THE HOLDING VALVE AND CHECK THE O-RINGS. THEY HAVE PROBABLY BEEN DAMAGED BY A SHARP EDGE OF A PORT.

NOTE

The holding valve should turn by hand until compression of the O-rings begins.

4. Carefully install the holding valve into the port block until fully seated.

3-46 PILOT OPERATED CHECK VALVE

DESCRIPTION

The pilot operated check valve is located in the outrigger stabilizer, port block. The check valve provides two functions; the first function is a holding valve, the second function provides a thermal relief of the stabilizer.

NOTE

For more detailed information refer to Appendix E.

THEORY OF OPERATION

Pressure is applied through port A of the valve. The pressure lifts the poppet off its seats and fluid flows through port C to the component. The return flow from the component is held in check by the check valve until sufficient pressure builds against the base of the piston to cause the stem to unseat the check valve. When the check valve is unseated, oil flows through port C and through port B in the poppet. Fluid then flows around the check valve seat and out the piston stem hole to port A. If the piston is moved far enough the piston will unseat the poppet and increase flow. When this happens there is little or no flow through port B around the check valve seat.

MAINTENANCE

REMOVAL.

1. To remove the check valve, unscrew the check valve from the stabilizer port block.

INSTALLATION.

1. Check the inside of the port block for any sharp edges or burrs and remove as necessary with emery cloth.

2. Install new O-rings onto the check valve.

3. Lubricate the check valve and O-rings with clean hydraulic oil.

CAUTION

DO NOT DAMAGE THE O-RINGS DURING INSTALLATION OF THE CHECK VALVE. IF THE CHECK VALVE TURNS FREELY THEN GETS HARD TO TURN, THEN EASY TO TURN, REMOVE THE CHECK VALVE AND CHECK THE O-RINGS. THEY HAVE PROBABLY BEEN DAMAGED BY A SHARP EDGE OF A PORT.

NOTE

The check valve should turn by hand until compression of the O-rings begins.

4. Carefully install the check valve into the port block until fully seated.

3-47 OUTRIGGER SELECTOR VALVE

DESCRIPTION

The OUTRIGGER SELECTOR valve is located in the cab to the left of the seat. It is an eight position hydraulic selector valve marked FRONT, RIGHT, LEFT, and REAR, RIGHT, LEFT. The selector valve directs the flow of hydraulic oil from the outrigger directional control valve to the appropriate outrigger(s). To operate one outrigger only, position the selector valve lever to one of four positions; FRONT RIGHT. FRONT LEFT, REAR RIGHT, or REAR LEFT. To operate two outriggers at one time, position the selector valve lever to either FRONT, RIGHT, LEFT, or REAR.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Remove the hoses and fittings from the selector valve. Cap or plug all openings.

2. Remove the eleven bolts and washers securing the selector valve to the mounting bracket.

INSTALLATION.

1. Position the outrigger selector valve on the mounting bracket and secure with the eleven bolts and washers.

2. Connect the hoses and fittings to the selector valve as tagged prior to removal.

FUNCTIONAL CHECK.

1. Activate the hydraulic system.

2. Using the outrigger control lever and outrigger selector, extend and retract the outriggers.

3. Observe the outrigger for adequate speed of extension and retraction and smooth operation.

4. Check the hydraulic connections for evidence of leakage.

3-48 SOLENOID VALVE

DESCRIPTION

Three two-way solenoid valves are used in the hydraulic override installation and are installed between the frame rails under the cab floor. The valve is a normally closed valve with an electrical coil which when energized shifts the cartridge in the valve body to align the ports in the valve. This alignment of ports routes the hydraulic flow in the desired direction.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Remove the bolts, washers, and nuts securing the solenoid valve(s) to the mounting plate. Remove the valve.

INSTALLATION.

1. Install the valve to the mounting plate and secure with the bolts, washers, and nuts.

3-49 HOIST MOTOR CONTROL VALVE

DESCRIPTION

The hoist motor control valve is designed to provide an even flow of oil to the hoist motor in both directions.

To drive the hoist motor in the raise direction, hydraulic oil flows through the in port and pushes the free flow poppet off its seat. The oil then flows to the out port and on to the hoist drive motor.

When driving the hoist motor in the lower direction, oil from the directional control valve enters the out port. The pilot operated poppet is held shut by the adjustment spring until pilot pressure of sufficient force is sensed at the pilot pressure port to move the pilot operated poppet off its seat. This allows flow to the return reservoir through the directional control valve.

An orifice plug is installed in the pilot pressure port to restrict back flow when the directional control valve is closed. The restriction prevents the pilot operated poppet from chattering on its seat.

A vent is provided that vents the area between the pilot piston seal and the free flow poppet and pilot operated poppet seals to prevent a hydraulic lock should weepage around the seals occur.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Tag and disconnect the hydraulic lines to the motor control valve. Cap or plug all lines and openings.

2. Remove the capscrews and lockwashers securing the valve to the hoist motor. Remove the valve.

INSTALLATION.

1. Install the valve on the hoist motor and secure with the capscrews and lockwashers.

2. Connect the hydraulic lines to the motor control valve as tagged during removal.

3-50 CROSSOVER RELIEF VALVE

DESCRIPTION

The crossover relief valve with shuttle valve is designed to protect the system from excessive pressure buildup and to maintain a given pressure in the system. The crossover relief valve relieves surge pressure in the swing circuit that could occur if the motor is suddenly stopped. It also provides for smoothly starting and stopping of the swing motor. The valve consists of a drilled and ported block with two relief valves and two check valves with orifice plugs installed in the block. The relief valves relieve pressure from one line to the other and therefore there is no connection to the reservoir.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Tag and disconnect the hydraulic lines to the valve. Cap or plug all openings.

2. Remove the capscrews and washers securing the valve. Remove the valve.

INSTALLATION.

1. Install the valve and secure with the capscrews and washers.

2. Connect the hydraulic lines to the valve as tagged during removal.

3-51 CYLINDERS

GENERAL

This sub-section provides descriptive information for all the hydraulic cylinders used on this crane. The description of the cylinder given here is for the cylinder itself.

For information on how the cylinder functions in the individual circuits, refer to the Description and Operation of that circuit.

MAINTENANCE

GENERAL.

There must be a gap between the ends of each wear ring when it is installed onto the piston or head. In addition, each wear ring gap is to be located as follows. Divide 360 degrees by the number of wear rings on the component. The resulting value is the number of degrees each wear ring gap is to be located with respect to each other.

The approximate wear ring gaps are as follows.

PISTON WEAR RING GAP			
Piston Size		**Wear Ring Gap**	
Inch	**mm**	**Inch**	**mm**
1 to 4.75	25.4 to 120.66	0.125	3.175
5.50 to 10.0	139.70 to 254.00	0.187	4.750
greater than 10.0	greater than 254.0	0.250	6.350

HEAD WEAR RING GAP			
Head Size		**Wear Ring Gap**	
Inch	**mm**	**Inch**	**mm**
1 to 4.75	25.40 to 120.65	0.125	3.175
5 to 10.0	127.00 to 254.00	0.187	4.750
greater than 10.0	greater than 254.00	0.250	6.350

3-52 LIFT CYLINDER

DESCRIPTION

The lift cylinder is the double acting type with a cylinder bore of 7.0 inches (17.7 cm). The retracted length of the cylinder from the center of the rod bushing to the center of the barrel bushing is 37 inches (93.9 cm) and the extended length of the cylinder is 59.06 inches (150.0 cm). Foreign matter is prevented from entering the cylinder by a wiper seal. O-rings are used within the cylinders to prevent internal and external damage.

MAINTENANCE

DISASSEMBLY.

NOTE

Any maintenance requiring disassembly of the cylinders should include replacement of all seals and rings.

1. Drain all hydraulic oil from the cylinder.

2. Remove the socket setscrew from the barrel on the rod end of the cylinder.

WARNING

DO NOT USE AIR PRESSURE TO REMOVE THE CYLINDER ROD ASSEMBLY. USE ONLY A SOURCE OF CONTROLLED HYDRAULIC OIL PRESSURE IF THE ROD ASSEMBLY IS HARD TO MOVE.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

3. Withdraw the cylinder rod assembly from the barrel, and move it to a clean work area.

NOTE

It is advisable to cover the cylinder barrel opening to avoid contamination.

4. Secure the cylinder rod to prevent it from moving. Remove the setscrew from the piston and rod.

5. Unscrew the piston from the rod.

6. Remove the head from the rod.

CAUTION

WHEN REMOVING THE SEALS AND RINGS, AVOID SCRATCHING THE GROOVED AND GLAND SURFACES.

NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate installation of new seals and rings.

7. Remove the seal assemblies from the outside of the piston and the backup rings and O-ring from the inside of the piston.

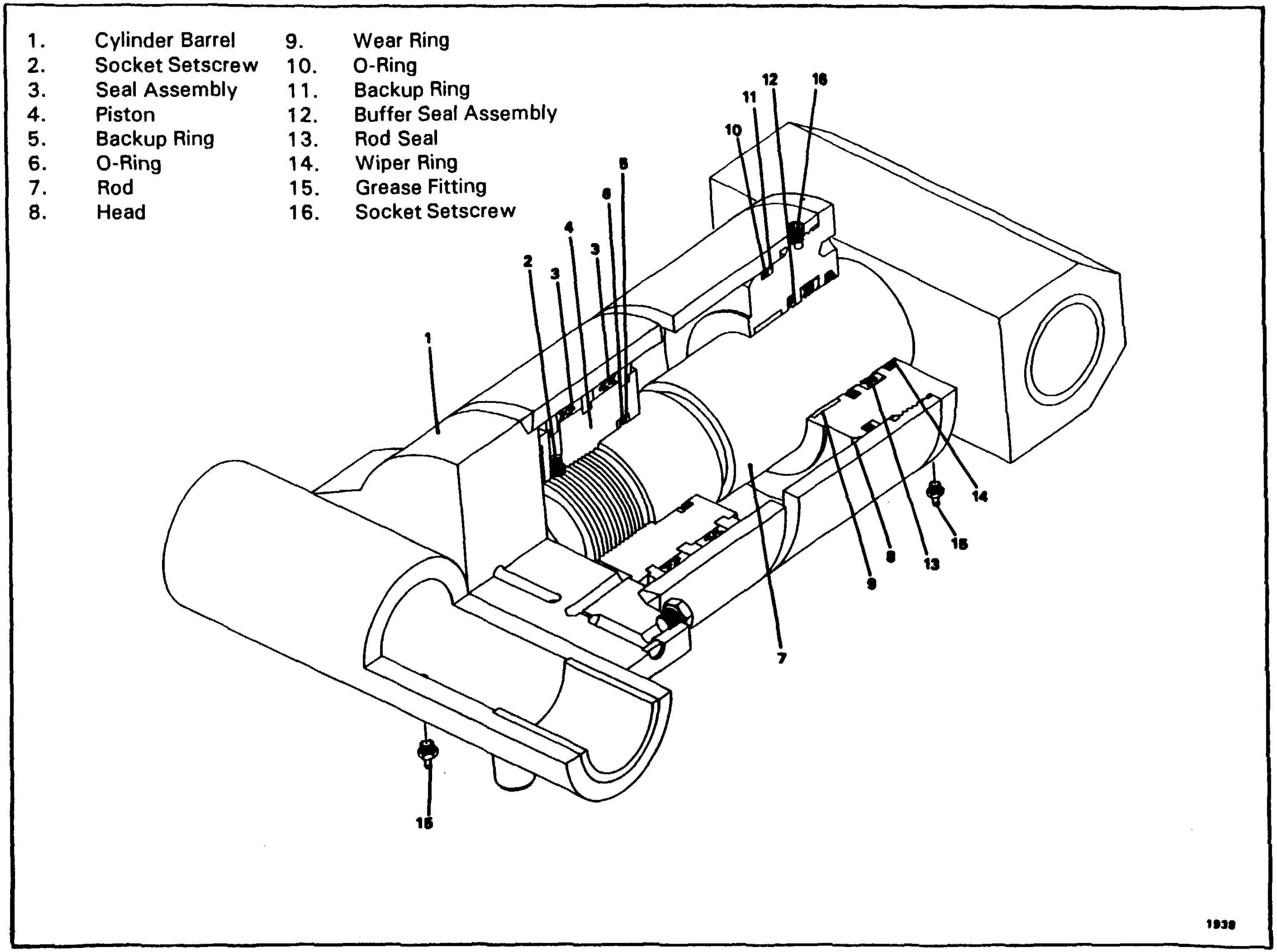
NOTE

Note the sequence of each seal making up the rod seal and its location on the rod to ensure proper assembly.

8. Remove the O-ring and backup ring from the outside of the head and the wear ring, buffer seal assembly, rod seal, and wiper ring from the inside of the head.

9. If necessary, remove the holding valve from the port block.

10. If necessary, remove the grease fittings.



Lift Cylinder

CLEANING AND INSPECTION.

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.

CAUTION

BEFORE INSTALLING NEW SEALS AND RINGS, CLEAN ALL SURFACES AND CAREFULLY REMOVE BURRS AND NICKS. PARTS DISPLAYING EXCESSIVE WEAR OR DAMAGE SHOULD BE REPLACED.

2. Stone out minor blemishes and polish with a fine crocus cloth.

3. Clean with solvent and dry with compressed air any parts that have been stoned and polished.

4. Inspect the barrel carefully for scoring.

ASSEMBLY.

1. If removed, install the grease fittings.

NOTE

Steps 1, 2, 3, and 4 are used only if the holding valve has been removed.

2. Check the inside of the port block for any sharp edges or burrs and remove as necessary with emery cloth.

3. Install new O-rings onto the holding valve.

4. Lubricate the holding valve and O-rings with clean hydraulic oil.

CAUTION

DO NOT DAMAGE THE O-RINGS DURING INSTALLATION OF THE HOLDING VALVE. IFTHE HOLDING VALVE TURNS FREELY THEN GETS HARD TO TURN, THEN EASY TO TURN; REMOVE THE HOLDING VALVE AND CHECK THE 0RINGS. THEY HAVE PROBABLY BEEN DAMAGED BY A SHARP EDGE OF A PORT.

NOTE

The holding valve should turn by hand until compression of the O-rings begins.

5. Carefully install the holding valve into the port block until fully seated.

NOTE

Coat all seals and rings with clean hydraulic oil.

CAUTION

AVOID STRETCHING THE SEALS AND RINGS. ENSURE THE SEALS AND RINGS ARE INSTALLED IN THE PROPER ORDER.

6. Install the O-ring and backup ring onto the outside of the head.

NOTE

Ensure the rod seal is installed in the sequence as noted during disassembly.

7. Install the wiper ring, rod seal, buffer seal, and the wear ring into the inside of the head.

8. Install the seal assemblies onto the outside of the piston.

9. Install the O-ring and backup rings into the inside of the piston. Ensure the O-ring is between the backup rings.

10. Lubricate the rod with clean hydraulic oil.

11. Install the head onto the rod. Remove the cover from the cylinder barrel.

12. Clean all oil from the threads of the cylinder rod and barrel and apply NEVER-SEEZ (paste type) compound.

13. Install the piston on the rod and tighten with a spanner wrench. Apply Locquic Primer T to the threads of the setscrew. Allow to dry and apply Loctite 271 adhesive/sealant to the threads of the setscrew. Install the setscrew and secure the piston on the rod.

CAUTION

AVOID SCRATCHING OR DAMAGING THE GROOVED AND GLAND SURFACES, OR THE RINGS AND SEALS.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

14. Lubricate the piston and head with clean hydraulic oil and install the rod assembly into the barrel with a twisting motion.

15. Apply Locquic Primer T to the threads of the setscrew. Allow to dry and apply Loctite 271 adhesive/sealant to the threads of the setscrew. Install the setscrew into the barrel on the rod end of the cylinder.

WARNING

DO NOT USE AIR PRESSURE TO CYCLE OR PRESSURIZE THE CYLINDER.

16. Pressurize and cycle the cylinder. Check for proper operation and any leakage.

3-53 TELESCOPE CYLINDER

The boom telescope cylinder is of the double acting type. The cylinder has a bore of 4.5 in. (11.4 cm). The retracted length from the end of the barrel to the centerline of the holding block is 142.0 in. (360.6 cm). The extended length from the end of the barrel to the centerline of the port block is 263.75 in. (669.9 cm). Foreign matter is prevented from entering the cylinder by a wiper seal during rod retraction. The cylinder rod is secured to the boom base and the cylinder barrel is attached to the fly section.

Disassembly.

NOTE

Any maintenance requiring disassembly of the cylinder should include replacement of all cylinder seals.

1. Drain all hydraulic oil from the cylinder.

2. Remove the four bolts from the head retaining plate on the rod end of the cylinder.

WARNING

DO NOT USE AIR PRESSURE TO REMOVE THE CYLINDER ROD ASSEMBLY. USE ONLY A SOURCE OF CONTROLLED HYDRAULIC OIL PRESSURE IF THE ROD ASSEMBLY IS HARD TO MOVE.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD.

3. Withdraw the cylinder rod assembly from the barrel and move it to a clean work area.

NOTE

It is advisable to cover the cylinder barrel opening to prevent contamination.

4. Secure the cylinder rod to prevent it from moving. Remove the setscrew from the piston and rod.

5. Unscrew the piston from the rod.

6. Remove the spacer and head from the rod.

7. Remove the head retaining plate from the rod.

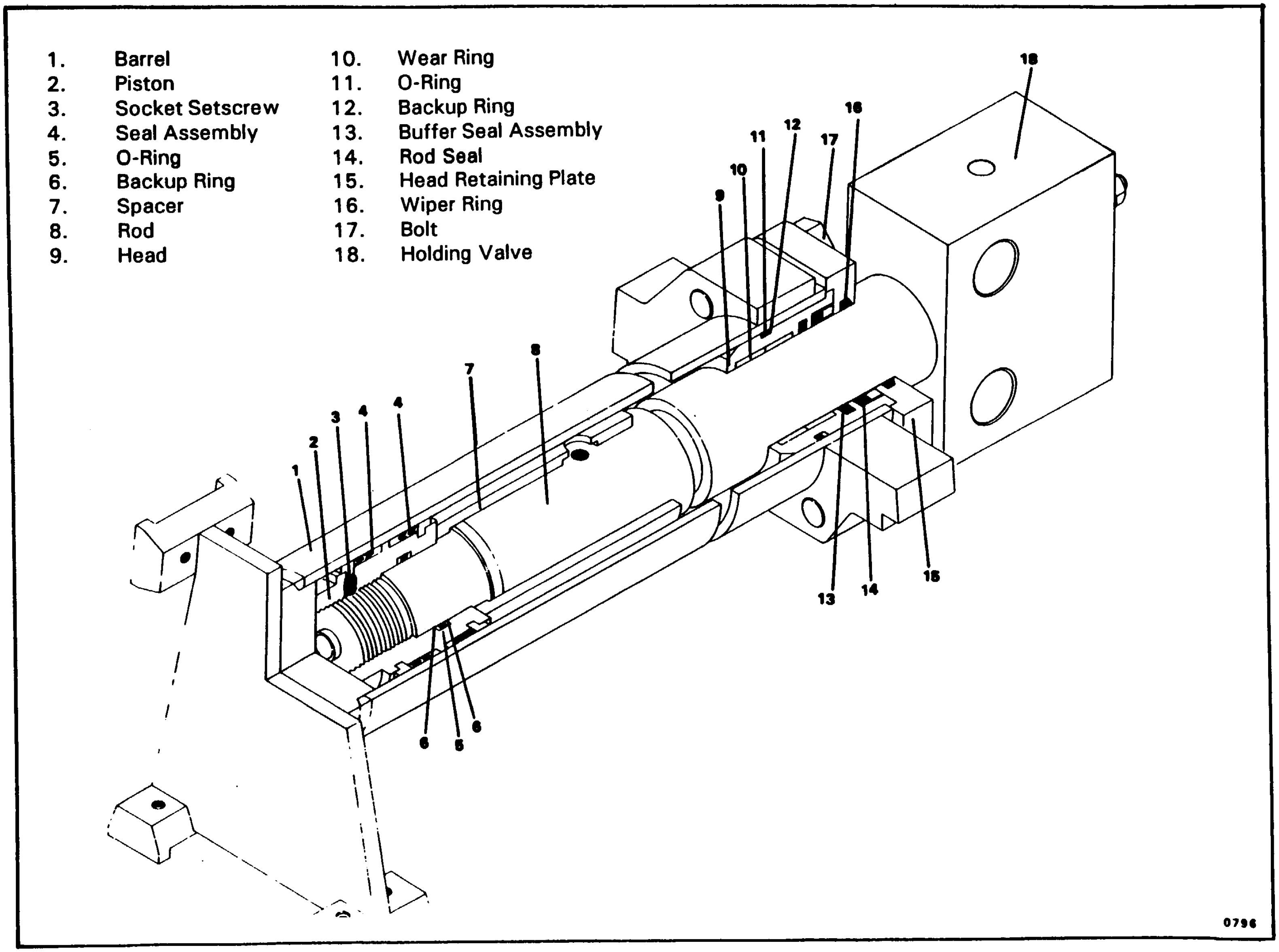
CAUTION

WHEN REMOVING SEALS AND RINGS, AVOID SCRATCHING GROOVED AND GLAND SURFACES.

NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate installation of new items.

8. Remove the seal assemblies from the outside of the piston and the O-ring and backup rings from the inside of the piston.



4.50 Inch (11.4 cm) Telescope Cylinder

NOTE

Note the sequence of each seal making up the buffer seal and its location on the rod to ensure proper assembly.

9. Remove the O-ring and backup ring from the outside of the head and the wear rings, buffer seal assembly, and rod seal from the inside of the head.

10. Remove the wiper ring from the head retaining plate.

11. If necessary, remove the holding valve from the port block.

Cleaning and Inspection.

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.

CAUTION

BEFORE INSTALLING NEW SEALS AND RINGS, CLEAN ALL SURFACES AND CAREFULLY REMOVE BURRS AND NICKS. PARTS DISPLAYING EXCESSIVE WEAR OR DAMAGE SHOULD BE REPLACED.

2. Stone out minor blemishes and polish with a fine crocus cloth.

3. Clean with solvent and dry with compressed air any parts that have been stoned and polished.

4. Inspect the barrel carefully for scoring.

Assembly.

NOTE

Coat all seals and rings with clean hydraulic oil.

CAUTION

AVOID STRETCHING THE SEALS AND RINGS. ENSURE THE SEALS AND RINGS ARE INSTALLED IN THE PROPER ORDER.

NOTE

Steps 1, 2, 3, and 4 are used only if the holding valve has been removed.

1. Check the inside of the port block for any sharp edges or burrs and remove as necessary with emery cloth.

2. Install new O-rings onto the holding valve.

3. Lubricate the holding valve and O-rings with clean hydraulic oil.

CAUTION

DO NOT DAMAGE THE O-RINGS DURING INSTALLATION OF THE HOLDING VALVE. IFTHE HOLDING VALVETURNS FREELY THEN GETS HARD TO TURN, THEN EASY TO TURN: REMOVE THE HOLDING VALVE AND CHECK THE O-RINGS. THEY HAVE PROBABLY BEEN DAMAGED BY A SHARP EDGE OF A PORT.

NOTE

The holding valve should turn by hand until compression of the O-rings begins.

4. Install the wiper ring into the head retaining plate.

5. Install the O-ring and backup ring onto the outside of the head.

NOTE

Ensure the buffer seal is installed in the sequence as noted during disassembly.

6. Install the rod seal, buffer seal assembly, and wear rings into the inside of the head.

7. Install the seal assemblies onto the outside of the piston.

8. Install the O-ring and both backup rings into the inside of the piston. Ensure the O-ring is between the backup rings.

9. Lubricate the rod with clean hydraulic oil.

10. Install the head retaining plate on the rod.

11. Install the head onto the rod. Remove the cover from the cylinder barrel.

12. Clean all oil from the threads of the cylinder rod and barrel and apply NEVER-SEEZ (paste type) compound.

13. Install the spacer and piston on the rod. Tighten the piston with a spanner wrench. Apply Locquic Primer T to the threads of the setscrew. Allow to dry and apply Loctite 271 adhesive/sealant to the threads of the setscrew. Install the setscrew and secure the piston on the rod.

CAUTION

AVOID SCRATCHING OR DAMAGING THE GROOVE AND GLAND SURFACES. OR THE RINGS AND SEALS.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

14. Lubricate the piston and head with clean hydraulic oil and install the rod assembly into the barrel with a twisting motion.

15. Bolt the head retaining plate to the cylinder barrel. Torque to 250 lb ft (339 N•m).

WARNING

DO NOT USE AIR PRESSURE TO CYCLE OR PRESSURIZE THE CYLINDER.

16. Pressurize and cycle the cylinder. Check for proper operation and any leakage.

3-54 STEER CYLINDER

DESCRIPTION

The steer cylinder has a 3-inch (7.62 cm) diameter bore and is the double acting type. The cylinder is mounted on the rear axle. O-rings are used within the cylinder to prevent internal and external leakage. A wiper ring is mounted on each end of the cylinder barrel to wipe dirt from the rod as it is retracted.

MAINTENANCE

DISASSEMBLY.

NOTE

Any maintenance requiring disassembly of the cylinder-should include replacement of all cylinder seals.

1. Drain all hydraulic oil from the cylinder.

2. Remove the bolts from the head plates on each end of the cylinder.

WARNING

DO NOT USE AIR PRESSURE TO REMOVE THE CYLINDER ROD ASSEMBLY. USE ONLY A SOURCE OF CONTROLLED HYDRAULIC OIL PRESSURE IF THE ROD ASSEMBLY IS HARD TO MOVE.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD.

3. Withdraw the cylinder rod assembly from the barrel, and move it to a clean work area. Cap or plug the ends of the rod to protect the threads.

NOTE

It is advisable to cover the cylinder barrel opening to avoid contamination.

4. Secure the cylinder rod to prevent it from moving.

5. Remove the piston from the rod.

6. Remove the spacers and heads from each end of the head.

CAUTION

WHEN REMOVING THE SEALS AND RINGS, AVOID SCRATCHING THE GROOVED AND GLAND SURFACES.

NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate installation of new seals and rings.

7. Remove the crown seal and wear rings from the outside of the piston.

NOTE

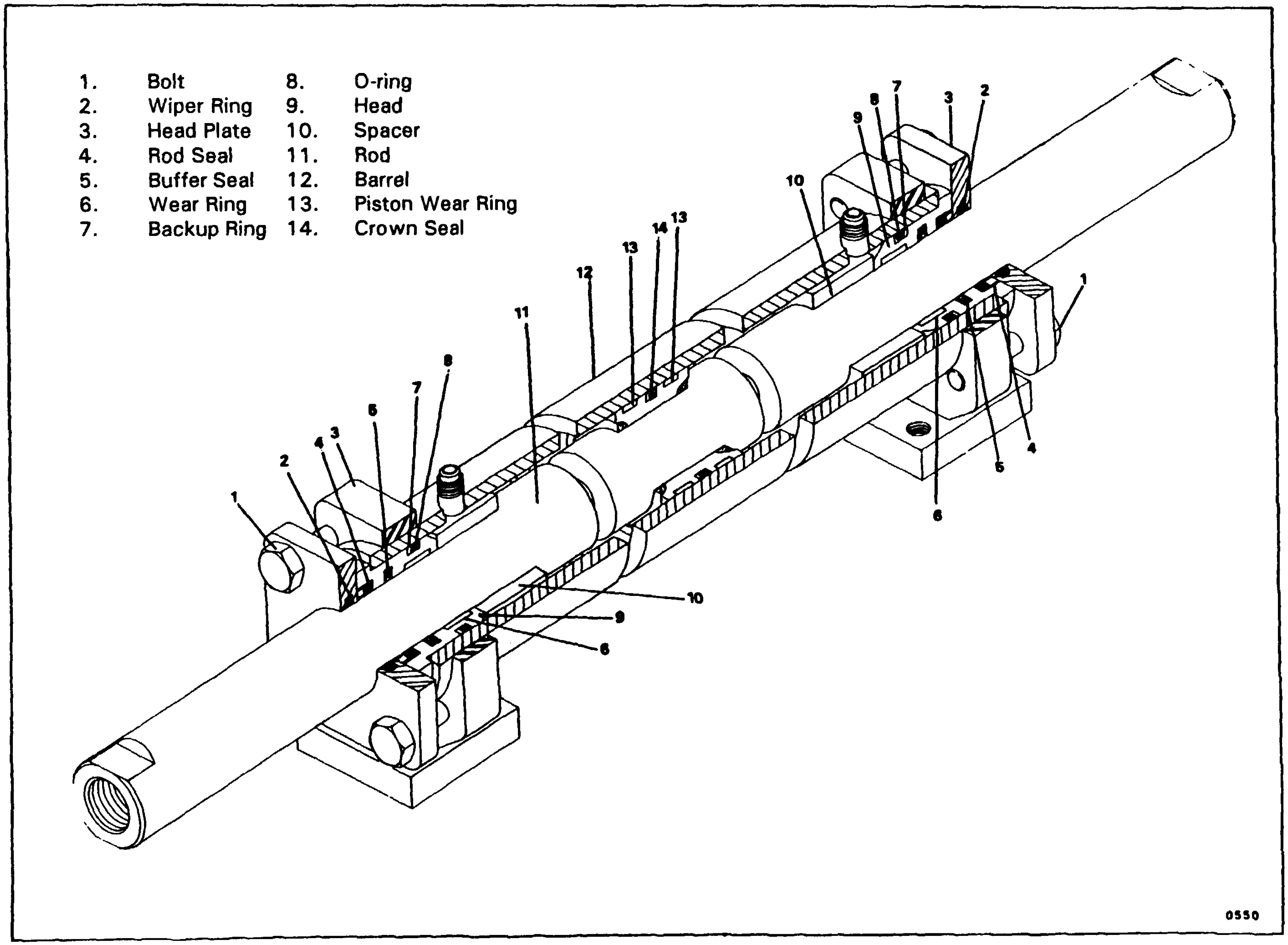
Note the sequence of each seal making up the rod seal and its location on the rod to ensure proper assembly.

8. Remove the O-ring and backup ring from the outside of the heads and the rod seal, buffer seal assembly, and wear ring from the inside of the heads.

9. Remove the wiper ring from each head plate.

CLEANING AND INSPECTION.

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.



Steer Cylinder

CAUTION

BEFORE INSTALLING NEW SEALS AND RINGS, CLEAN ALL SURFACES AND CAREFULLY REMOVE BURRS AND NICKS. PARTS DISPLAYING EXCESSIVE WEAR OR DAMAGE SHOULD BE REPLACED.

2. Stone out minor blemishes and polish with a fine crocus cloth.

3. Clean with solvent and dry with compressed air any parts that have been stoned and polished.

4. Inspect the barrel carefully for scoring.

ASSEMBLY.

NOTE

Coat all seals and rings with clean hydraulic oil.

CAUTION

AVOID STRETCHING THE SEALS AND RINGS. ENSURE THE SEALS AND RINGS ARE INSTALLED IN THE PROPER ORDER.

1. Install the wiper ring in each head plate.

2. Install the O-ring and backup ring onto the outside of the heads.

NOTE

Ensure the rod seal is installed in the sequence as noted during disassembly.

3. Install the rod seal, buffer seal assembly. and wear ring into the inside of the heads.

4. Install the crown seal and wear rings onto the outside of the piston.

5. Lubricate the rod with clean hydraulic oil.

6. Install the heads and spacers onto the rod. Remove the cover from the cylinder barrel.

7. Install the piston onto the rod.

CAUTION

AVOID SCRATCHING OR DAMAGING THE GROOVED OR GLAND SURFACES OR THE RINGS AND SEALS.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

8. Remove the caps or plugs from the rod ends. Lubricate the piston and heads with clean hydraulic oil and install the rod assembly into the barrel with a slight twisting motion.

9. Install the head plates on each end of the cylinder and secure with the bolts. torque the bolts to 75 lb ft (101 N•m).

WARNING

DO NOT USE AIR PRESSURE TO CYCLE OR PRESSURIZE THE CYLINDER.

10. Pressurize and cycle the cylinder. Check for proper operation and any leakage.

3-55 STABILIZER (OUTRIGGER) CYLINDER

DESCRIPTION

The four stabilizer cylinders have 3-inch (7.6 cm) diameter bores and are the double acting type. The barrel end of the cylinders are attached to the frame and the rod end of the cylinders are attached to the outrigger beam. The retracted length of the cylinder from the center of the barrel to the center of the rod attach point is 40.19 inches (102.0 cm) and the extended length of the cylinder is 69.19 inches (175.7 cm). A port block is welded to the cylinder barrel and a pilot operated check valve is threaded into the port block. O-rings are used within the cylinder to prevent internal and external damage. A wiper ring is mounted in the cylinder head to wipe the rod as it is retracted into the barrel.

MAINTENANCE

DISASSEMBLY.

NOTE

Any maintenance requiring disassembly of the cylinder should include replacement of all cylinder seals.

1. Drain all hydraulic oil from the cylinder.

2. Remove the setscrews securing the barrel to the head.

WARNING

DO NOT USE AIR PRESSURE TO REMOVE THE CYLINDER ROD ASSEMBLY. USE ONLY A SOURCE OF CONTROLLED HYDRAULIC OIL PRESSURE IF THE ROD ASSEMBLY IS HARD TO MOVE.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

3. Remove the cylinder rod assembly from the cylinder barrel and move it to a clean work area.

NOTE

It is advisable to cover the cylinder barrel opening to avoid contamination.

4. Secure the cylinder rod to prevent it from moving.

CAUTION

WHEN REMOVING THE SEALS AND RINGS, AVOID SCRATCHING THE GROOVED AND GLAND SURFACES.

NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate installation of new items.

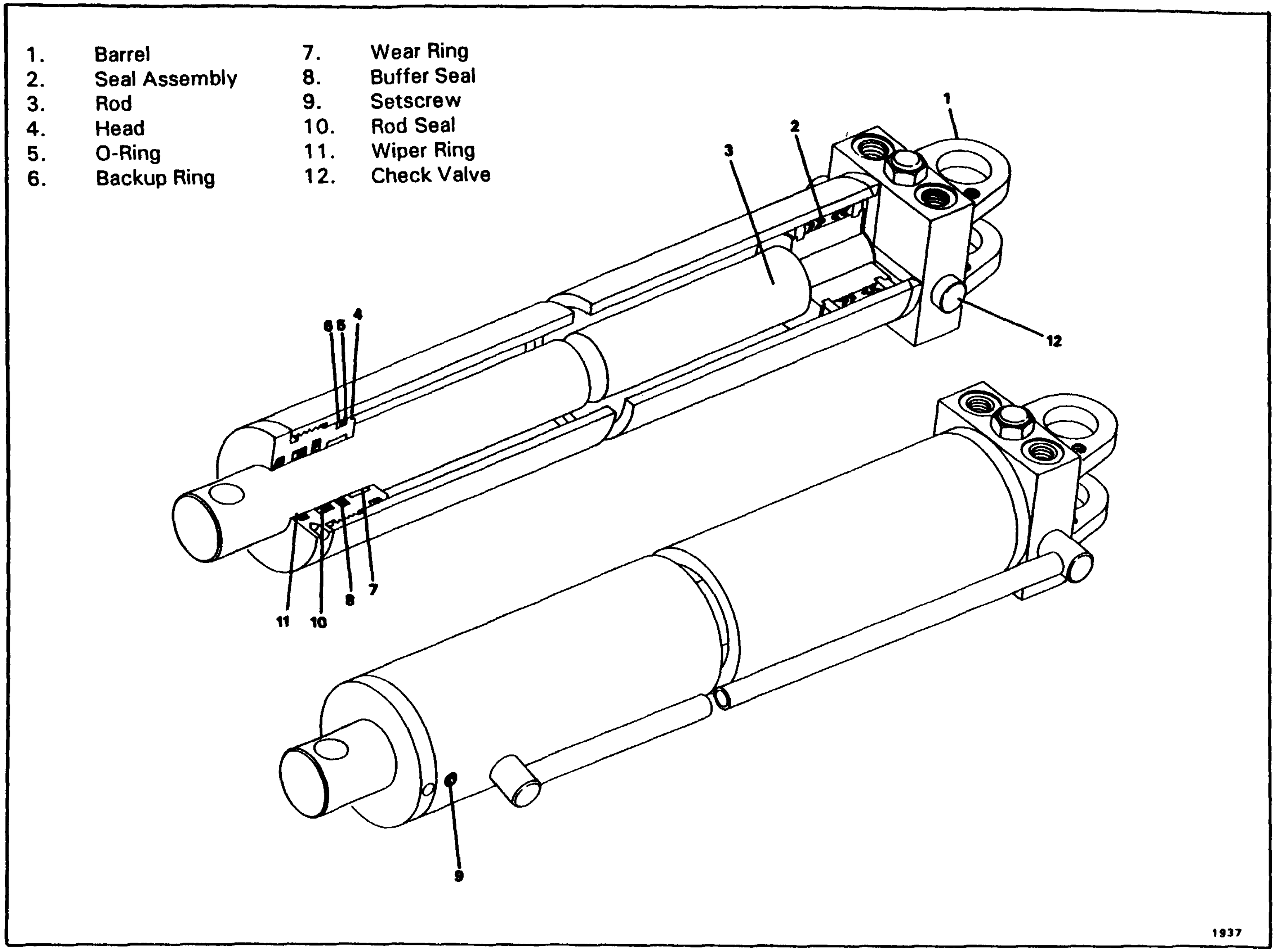
5. Remove the seal assembly from the outside of the piston.

6. Remove the head from the rod.

NOTE

Note the sequence of each seal making up the rod seal and its location on the rod to ensure proper assembly.

7. Remove the wear ring, buffer seal assembly, rod seal, and wiper ring from the inside of the head. Remove the O-ring and backup ring from the outside of the head.



Stabilizer (Outrigger) Cylinder

8. If necessary, remove the pilot operated check valve from the port block.

CLEANING AND INSPECTION.

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.

CAUTION

BEFORE INSTALLING NEW SEALS AND RINGS, CLEAN ALL SURFACES AND CAREFULLY REMOVE BURRS AND NICKS. PARTS DISPLAYING EXCESSIVE WEAR OR DAMAGE SHOULD BE REPLACED.

2. Stone out minor blemishes and polish with a fine crocus cloth.

3. Clean with solvent and dry with compressed air any parts that have been stoned and polished.

4. Inspect the barrel carefully for scoring.

ASSEMBLY.

NOTE

Steps 1, 2, 3, and 4 are used only if the check valve has been removed.

1. Check the inside of the port block for any sharp edges or burrs and remove as necessary with emery cloth.

2. Install new O-rings onto the check valve.

3. Lubricate the check valve and O-rings with clean hydraulic oil.

CAUTION

DO NOT DAMAGE THE O-RINGS DURING INSTALLATION OF THE CHECK VALVE. IF THE CHECK VALVE TURNS FREELY THEN GETS HARD TO TURN, THEN EASY TO TURN; REMOVE THE CHECK VALVE AND CHECK THE O-RINGS. THEY HAVE PROBABLY BEEN DAMAGED BY A SHARP EDGE OF A PORT.

NOTE

The holding valve should turn by hand until compression of the O-rings begins.

4. Carefully install the check valve into the port block until fully seated.

CAUTION

WHEN INSTALLING NEW SEALS AND RINGS, AVOID STRETCHING THE SEALS OR SCRATCHING THE GROOVED AND GLAND SURFACES.

NOTE

Lubricate new seals and rings with clean hydraulic oil.

5. Install the O-ring and backup ring onto the outside of the head.

NOTE

Ensure the rod seal is installed in the sequence as noted during disassembly.

6. Install wiper ring, rod seal, buffer seal assembly, and wear ring into the inside of the head.

7. Lubricate the rod with clean hydraulic oil.

8. Install the head onto the rod. Remove the cover from the cylinder barrel.

9. Install the seal assembly onto the outside of the piston.

CAUTION

AVOID SCRATCHING OR DAMAGING THE GROOVED AND GLAND SURFACES, OR THE RINGS AND SEALS.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN THE CYLINDER ROD. DAMAGE TO THE ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

10. Lubricate the piston and head with clean hydraulic oil and install the rod assembly into the barrel with a twisting motion.

11. Apply Locquic Primer T to the threads of the setscrew. Allow to dry and apply Loctite 271 adhesive/sealant to the threads of the setscrew. Install the setscrew into the barrel securing it to the head.

WARNING

DO NOT USE AIR PRESSURE TO CYCLE OR PRESSURIZE THE CYLINDER.

12. Pressurize and cycle the cylinder. Check for proper operation and any leakage.

Section 7. Swing System

3-56 SWING SYSTEM

DESCRIPTION

The superstructure swing system provides 360 degrees continuous rotation. Swinging in either direction is controlled by the swing control lever in the cab.

The swing circuit consists of the directional control valve, drive motor, gear reducer with integral brake, and a crossover relief valve containing a shuttle valve, relief valves, and check valves.

A multi-disc type brake is an integral part of the gear reducer and is mounted between the motor and the gear reducer. The crossover relief valve is mounted to the swing motor.

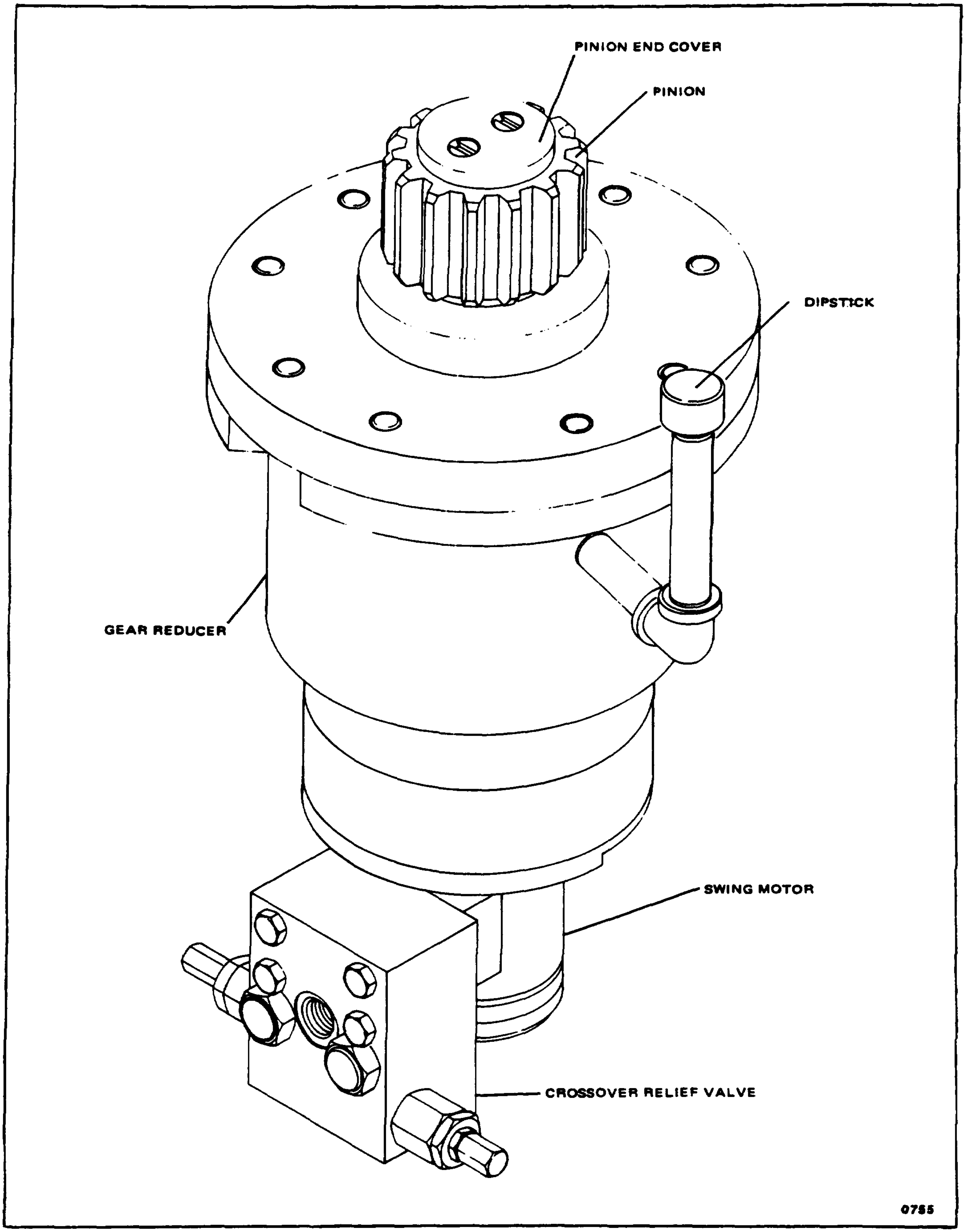
THEORY OF OPERATION

The system is supplied by the 22.0 gpm (83.2 Ipm) pump. The oil flows to the swing directional control valve bank. A 3000 psi (20,685 kPa/206.8 bar) main relief valve is located in the valve bank. When the directional control lever is pushed forward (RIGHT), the flow is directed through the crossover relief valve (set at 1780 psi [12,273.1 kPa/122.7 bar]) to the swing motor causing the gear reducer to rotate the superstructure to the right. Pulling the directional control lever back (LEFT) causes the gear reducer to rotate the superstructure to the left. A shuttle valve in the crossover relief valve, installed between the swing left and swing right lines, provides pressurized oil to the swing brake assembly to release the swing brake.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Boom swing operation erratic In either direction.	a. Damaged relief valve. b. Swing brake dragging (not releasing properly).	a. Replace relief valve. b. Readjust and/or replace necessary parts.



Swing System Components

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Boom swing operation erratic in either direction. (continued)	c. Low engine rpm.	c. Increase engine rpm to obtain smooth swing operation.
	d. Low hydraulic oil.	d. Replenish hydraulic oil to proper level.
	e. Improper movement of control lever to neutral.	e. Feather controls to neutral to maintain smooth stopping action.
	f. Insufficient lubricant on swing bearing.	f. Lubricate bearing properly
	g. Crane not level.	g. Level crane using outriggers. (If equipped)
	h. Damaged swing motor.	h. Repair or replace swing motor.
	i. Excessive overload.	i. Reduce load.
	j. Restricted or partly clogged hydraulic hose or fitting.	j. Replace hose or fittings.
	k. Pump cavitation in swing section.	k. Retighten suction hose or replace any damaged fitting.
	I. Improperly torqued turntable bolts.	I. torque turntable bolts evenly.
	m. Excessive preload on upper and lower pinion shaft bearing.	m. Adjust as necessary.
	n. Improperly torqued swing motor attachment bolts.	n. Torque swing motor attachment bolts.
	o. Malfunction of the swing box.	o. Remove swing box and make necessary repairs.
	p. Worn or damaged pump section.	p. Repair or replace damaged section.
2. Boom swing operation erratic in one direction only.	a. Relief valve inoperative.	a. Clean. readjust. and/or replace relief valve.
	b. Crane not level.	b. Level crane using outriggers. (If equipped)
	c. Turntable bearing binding due to continuous limited swing. (Example: concrete pourer.)	c. Rotate machine 360 degrees in both directions several times and lubricate turntable bearing.
	d. Restricted hose or fitting.	d. Replace hose or fitting.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Boom swing operation erratic in one direction only. (continued)	e. Crossover relief valve malfunctioning.	e. Replace crossover relief valve.
	f. Damaged swing pinion.	f. Replace pinion.
3. Boom will not swing in either direction.	a. Damaged relief valve.	a. Remove. clean. and repair or replace relief valve.
	b. Damaged swing motor.	b. Repair or replace swing motor.
	c. Swing brake not releasing properly.	c. Repair as necessary.
	d. Completely inoperative crossover relief valve.	d. Replace crossover relief valve.
	e. Internal damage to swing box.	e. Remove swing box and repair.
	f. Worn or damaged hydraulic pump section.	f. Replace pump section.
4. Swing operation slow in either direction.	a. Damaged relief valve.	a. Adjust, repair or replace valve.
	b. Improperly adjusted swing brake.	b. Readjust.
	c. Improperly adjusted crossover relief valve.	c. Adjust valve. (Refer to VALVES in Section 6.)
	d. Improperly lubricated swingbearing.	d. Lubricate bearing per recommendations.
	e. Improper size hose and/or fittings installed.	e. Replace with correct hose/fitting.
	f. Clogged or restricted hydraulic hoses or fittings.	f. Clean or replace damaged parts.
	g. Worn or damaged output shaft bearings.	g. Replace bearings.
	h. Worn or damaged swing motor.	h. Repair or replace motor.
	i. Worn or damaged hydraulic pump section.	i. Repair or replace pump section.

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Swing operation slow in one direction only.	a. Crane not level. (If equipped) b. Damaged relief valve. c. Improperly adjusted crossover relief valve. d. Clogged or restricted hose. e. Improperly torqued turntable bearing.	a. Level crane using outriggers. b. Repair or replace relief valve. c. Adjust valve. (Refer to VALVES in Section 6.) d. Replace hose or fitting. e. Torque turntable bearing.
6. Boom swings slowly.	a. Insufficient hydraulic volume. b. Damaged relief valve. c. Damaged swing motor.	a. Check delivery of hydraulic pump. Ensure sufficient fluid is available to pump. Check pump drive speed. b. Adjust, repair or replace valve. c. Repair or replace motor.
7. Swing motor continues to operate when swing control is in neutral position.	a. Control valve spool sticking or valve otherwise damaged.	a. Repair or replace valve.
8. Swing motor turning in wrong direction.	a. Improper port connections.	a. Reverse port connections.
9. Swing motor noisy.	a. Air in system. b. Motor binding.	a. Refer to Section 6 - HYDRAULICS for removal of air from the system. b. Repair or replace motor.

3-57 SWING MOTOR

Description

The swing motor is mounted on the brake housing and drives the gear reducer through the brake assembly. The swing motor is a hydraulic gerotor-type with low speed and high torque characteristics. It has only three moving parts; the commutator valve, the drive, and the gerotor star. The motor has two ports for connection to the hydraulic system.

MAINTENANCE

NOTE

For more detailed information, refer to Appendix E.

REMOVAL

NOTE

Indents in the swing motor housing are for clearance and for accessibility to the turntable bolts with the swing motor installed. Before removing the swing motor, note the orientation of the housing indents and ensure that the motor is installed in the same manner.

1. Clean the port area around the motor. Tag and disconnect the hydraulic lines from the motor assembly. Cap or plug all openings.
2. Remove the capscrews and washers securing the cross over relief valve to the motor and remove the relief valve.

CAUTION

Pull straight up on the motor assembly to avoid damaging the splined shaft.

3. Remove the capscrews and washers securing the motor to the gear reducer and lift the swing motor free.

INSTALLATION

CAUTION

Use care when engaging the swing motor drive gear, do not force the shaft to engage.

NOTE

Apply Never Seez compound to splines and pilot areas prior to assembly.

1. Apply RTV silicone to the surface of the brake. Position the swing motor on the brake, engaging the shaft with the brake input shaft.
2. Install the cross over relief valve to the motor and secure with the capscrews and washers.
3. Apply thread sealant to the capscrews. Install the capscrews and secure the motor to the brake housing. Torque the capscrews to 109 lb ft (148 Nom).
4. After motor has been installed, remove four of the 3/8-inch bolts from the motor end of the brake assembly. Clamp the stops firmly against the motor flanges and torque the bolts to 35 lb ft (47 Nom).
5. Connect the hydraulic lines to the swing motor as tagged during removal.

TEST

1. Test the swing of the superstructure in each direction. Stop and start swing several times.
2. Inspect for hydraulic leaks and repair as necessary.

DESCRIPTION

The planetary gear reducer is bolted to the turntable frame. The gear reducer pinion meshes with the turntable bearing to rotate the turntable. The gear reducer has an integral brake mounted to it, and the swing motor is mounted on the brake. The crossover relief valve is mounted on the swing motor. The swing motor drives the gear reducer through the brake assembly. The gear reducer has a ratio of 27.98:1 and has an air vent to allow air to escape when the reducer is being filled with oil.

MAINTENANCE

REMOVAL.

1. Extend and set the outriggers.
2. Tag, disconnect, and cap all hydraulic lines from the swing motor and reducer.
3. Remove the nuts, spring washers, and flatwashers securing the pinion guard and remove the guard.
4. Remove the slotted flat screws securing the pinion end cap and remove the end cap and pinion.
5. The gear reducer must be supported before the mounting bolts are removed. It can be supported from the top by installing an eye bolt in the hole where the pinion cap is normally installed. Use an adequate lifting device to lower the gear reducer to the ground after the mounting bolts and washers have been removed. The gear reducer can be supported from the underside using an automatic transmission jack (or equivalent). Lower the gear reducer after removing the bolts and washers, and move to a clean work area.

INSTALLATION.

1. Install an eye bolt in the hole where the pinion cap is normally installed, and attach an adequate lifting device.
2. Carefully raise the gear reduction assembly into place. While holding in place with the lifting device, apply Loctite 271 to the threads of the mounting bolts, and install the bolts and washers securing the gear reduction assembly to the frame weld. Torque the bolts to 99 lb ft (134 Nom).
3. Remove the lifting device and eye bolt. Apply never-seeze compound to the splines of the pinion shaft. Install the pinion and pinion end cap. Apply Loctite 271 to the screws. Install the slotted flat screws and secure the end cap.
4. Install the pinion guard and secure with the nuts, spring washers, and flat washers.
5. Connect the hydraulic lines to the swing motor and gear reducer as tagged during removal.
6. Service the assembly as indicated in Section 13 - LUBRICATION.

TEST.

1. Test the swing of the superstructure in each direction. Start and stop swing several times.
2. Inspect for hydraulic leaks and repair as necessary.

3-59 SWING BEARING

DESCRIPTION

The swing bearing mates the superstructure to the carrier. The bearing outer race is bolted to the superstructure and the inner race is bolted to the carrier.

The inner race contains one grease fitting for lubrication of the bearing. The outer race incorporates 94 gear teeth that mesh with the pinion gear of the gear reducer to provide rotation.

MAINTENANCE

GENERAL

The swing bearing is the most critical maintenance point of the crane. It is here, at the centerline of rotation, that stresses of loads are concentrated. In addition, the bearing provides the only attachment between the superstructure and carrier. Therefore, proper care of the bearing and periodic maintenance of the turntable-to-bearing attach bolts IS A MUST -to ensure safe and efficient operation.

TORQUING TURNTABLE BOLTS.

General.

WARNING

FAILURE TO MAINTAIN PROPER TORQUE OF THE TURNTABLE BEARING ATTACHING BOLTS WILL RESULT IN DAMAGE TO THE CRANE AND POSSIBLE INJURY TO PERSONNEL.

Maintaining proper torque values for bolts is extremely important for structural strength, performance, and reliability of the crane. Variations in torque can cause distortion, binding, or complete separation of the superstructure from the carrier.

CAUTION

REPEATED RETORQUING MAY CAUSE BOLTS TO STRETCH. IF BOLTS KEEP WORKING LOOSE, THEY MUST BE REPLACED WITH NEW BOLTS AND NUTS OF THE PROPER GRADE AND SIZE.

Proper identification of bolt grade is important. When marked as a high strength bolt (grade 8), the serviceman must be aware of bolt classifications and that he is installing a high strength heat-treated tempered component and the bolt must be installed according to specifications. Special attention should be given to the existence of lubricant and plating that will cause variation from dry torque values. When a high strength bolt is removed, or untorqued, the bolt must be replaced with a new bolt of the same classification, along with a new grade 8 nut.

WARNING

IT IS MANDATORY THAT BEARING ATTACHING BOLTS BE INSPECTED FOR LACK OFTORQUE AND RETORQUED AS REQUIRED, AFTER THE FIRST 300 HOURS OF CRANE OPERATION. THE BOLTS MAY LOOSEN IN SERVICE DUE TO VIBRATION, SHOCK-LOADS, AND TEMPERATURE CHANGES. THEREFORE, PERIODIC INSPECTION SHOULD BE ACCOMPLISHED EVERY 500 HOURS THEREAFTER, ENSURING THE BOLTS ARE PROPERLY TORQUED.

KNOW YOUR TORQUE WRENCH! Flexible beam type wrenches, even though they might have a preset feature, must be pulled at right angles and the force must be applied at the center of the handle. Force value readings must be made while the tool is in motion. Rigid handle type, with torque limiting devices that can be preset to required values, eliminate dial readings and provide more reliable, less variable readings.

NOTE

If multipliers and/or special tools are used to reach hard to get at areas, ensure torque readings are accurate.

Torque wrenches are precision instruments and must be handled with care. To ensure accuracy, calibrations must be made on a scheduled basis. Whenever there is a possibility that a torque wrench may have been overstressed or damaged, it should immediately be removed from service until recalibrated. When using a torque wrench, any erratic or jerking motion can result in the application of excessive or improper torque. ALWAYS use a slow, even movement and STOP when the predetermined value has been reached.

If it is reported by the crane operator or suspected that the crane has been overloaded beyond the capacities specified above the bold line on the crane's capacity chart, then all turntable bolts must be inspected for looseness and retorqued to specifications.

Turntable bolts should be torqued diametrically opposed, working in sequence from one side of the circle to the opposite side rather than tightening adjacent bolts successively. Torque first to 50% then to the final torque value.

When using step wrenches, calculated wrench settings are valid only when the following conditions are met.

1. Torque wrenches must be those specified and forces must be applied at the handle grip. The use of handle extensions will change applied torque to the bolt.
2. All handles must be parallel to the step wrench during final tightening. Multiplier reaction bars may be misaligned no more than 30 degrees without causing serious error in torque.
3. Multiplier reaction bar handles must be propped or supported within the outer 1/4 of the handle length, or serious under or over tightening will occur.

The inner race of the bearing is secured to the carrier frame by 23 0.75 inch grade 8 bolts. The outer race of the bearing is secured to the superstructure by 20 0.75 inch hex socket head capscrews.

Torque Values.

Torque the outer race hex socket head capscrews to 395 lb ft (536 N•m).

Torque the inner race bolts to 370 lb ft (502 N•m).

Using the 4 to 1 multiplier and no step wrench, set the torque wrench for 106 lb ft (144 N•m).

Using the 4 to I multiplier and six Inch step wrench, set the torque wrench for 78 lb ft (106 N•m).

Tools Required.

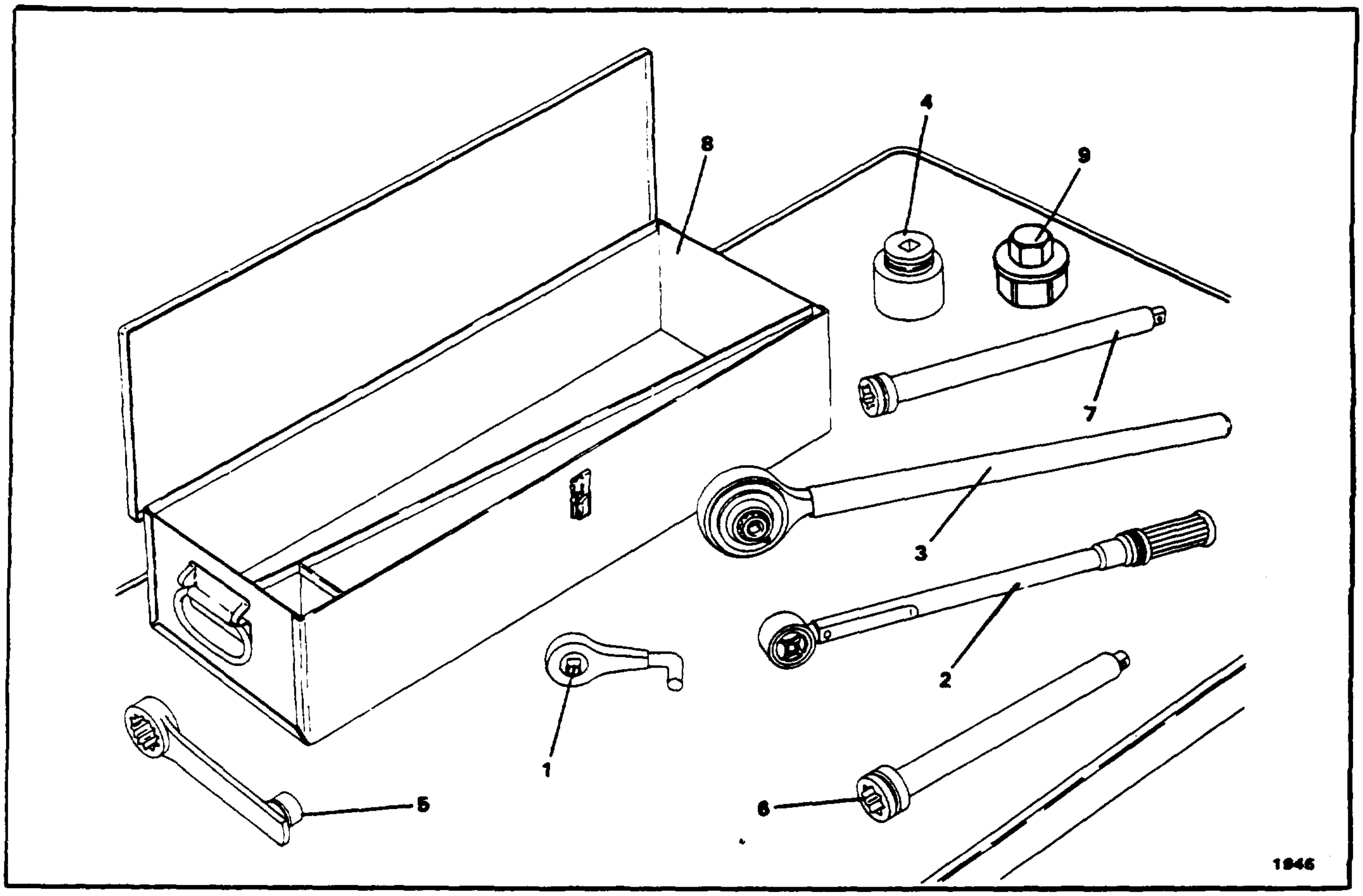
The figure titled Special Turntable Bolt Torquing Tools illustrates and lists the complete set of special tools required to torque the turntable bolts.

Outer Race Torquing.

1. Extend and set the outriggers, if equipped. Fully elevate the boom.
2. Torque the corner bolts 3, 8, 13, and 18 using the hex nut adapter and step wrench.
3. Torque all other bolts in a diametrically opposed sequence using the hex nut adapter, 4 to 1 multiplier, and step wrench.
4. First torque all bolts to 185 lb ft (251 N•m) and then to a final torque of 370 lb ft (502 N•m).

Inner Race Torquing.

1. Extend and set the outriggers.
2. An access hole is available on the turntable top plate for inner race bolt torquing. First torque all bolts to 185 lb ft (251 N•m) and then to a final torque of 370 lb ft (502 N•m).
3. Torque the bolts in a clockwise motion using a socket, extension, 4 to 1 multiplier, and torque wrench.
4. Swing the turntable until the next series of bolts are exposed within the access area.



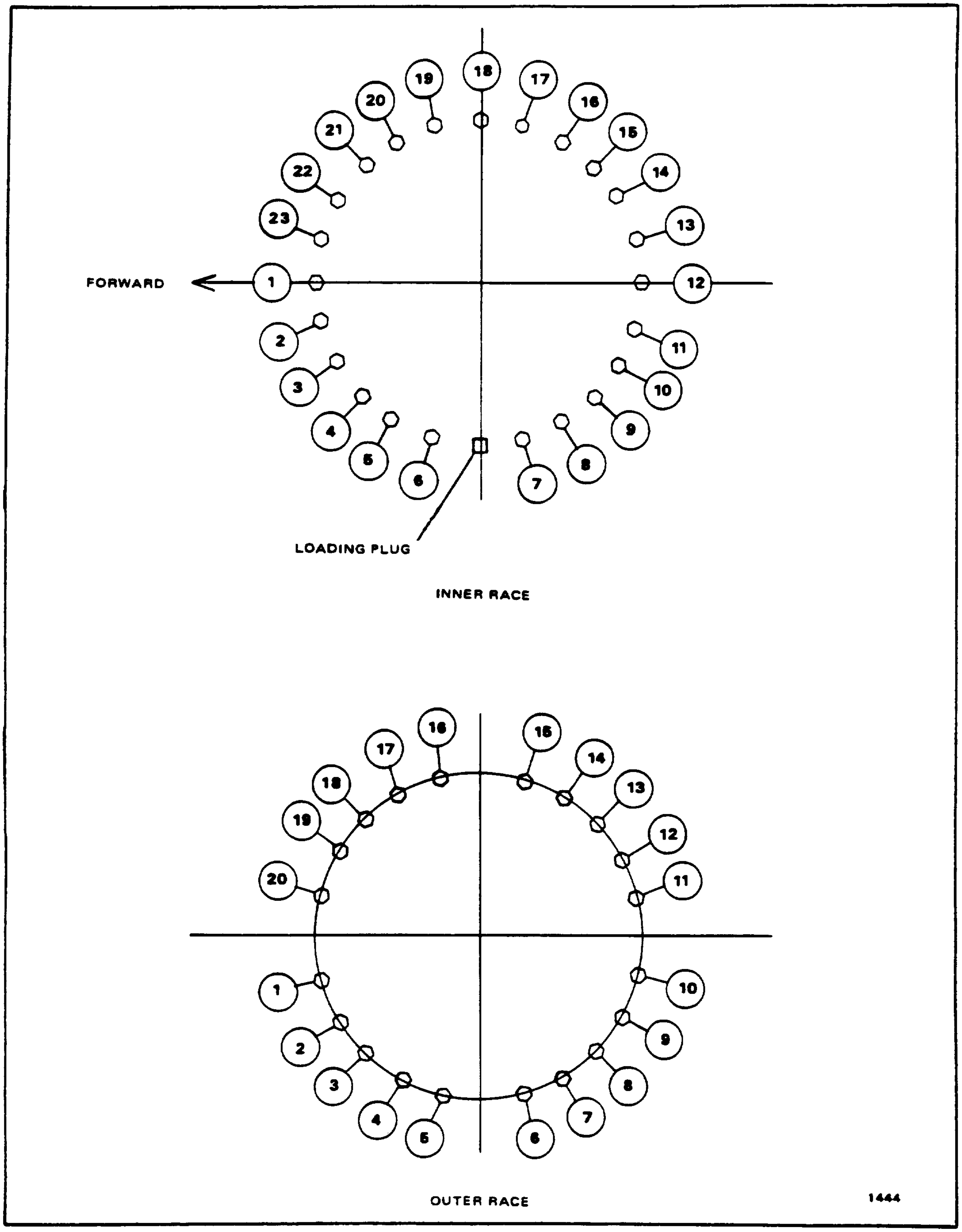
DESCRIPTION	WILLIAMS TOOL NO.	GROVE PART NO.	QUANTITY REQUIRED
1. Backlash Adapter	ST-50ABR	9-999-100141	1
2. 3/4" Drive Torque Wrench	HTW-4RCF	9-999-100159	1
3. 4 to 1 Multiplier (1/2" Input 3/4" Output)	TM75OLW	9-999-100134	1
4. 1 1/8" Socket 3/4" Drive	6-636	9-999-100142	1
5. 6" x 1 1/8" 12 Pt. Box 3/4" Drive Step Wrench	M-10811	9-999-100122	1
6. 10" Extension 3/4" Drive	6-110	9-999-100138	1
7. 13" Extension 3/4" Drive	6-113	9-999-100137	2
*8. Tool Box	TB-11	9-999-100146	1
9. 1 1/8” x 5/8" Hex Nut Adapter		9-999-100844	1

* Optional

Special Turntable Bolt Torquing Tools

Orders for special tools shall be referred to:

Grove Manufacturing Company
Customer Services
1086 Wayne Ave.
Chambersburg, Pa. 17201



Inner and Outer Race Bolt Pattern

REMOVAL.

1. Fully extend and set the outriggers.
2. Ensure the boom is in the travel position.
3. Elevate the boom slightly and shut down the engine.
4. Remove the boom and lift cylinder following the procedures outlined in Section 8, BOOM.
5. Tag and disconnect the battery cables from the battery.
6. Remove the swivel following the procedure outlined in Section 9, SWIVELS.
7. If necessary, disconnect the electrical connectors from the terminal block.
8. Remove the nuts, spring washers, and flatwashers securing the pinion guard and remove the guard. Remove the slotted flat screws securing the pinion end cap and remove the end cap and pinion.

WARNING

ENSURE THE LIFTING DEVICE IS CAPABLE OF FULLY SUPPORTING THE WEIGHT OF THE SUPERSTRUCTURE.ENSURETHE SUPERSTRUCTURE WILL NOT TILT OR SLIDE DURING LIFTING AND MOVING.

CAUTION

USE SPARE PIVOT SHAFTS OR OTHER MATERIAL CAPABLE OF SUPPORTING THE WEIGHT OF THE SUPERSTRUCTURE. DO NOT DAMAGE THE PIVOT SHAFT BUSHINGS.

NOTE

If a lifting device capable of lifting the entire superstructure is not available, superstructure weight may be reduced by removing the hoist.

9. Install spare pivot shafts or other suitable material through the lower lift cylinder pivot bushings and through the boom pivot bushings.
10. Attach a suitable lifting device to the spare pivot shafts and take in cable or chain to remove slack. Do not pull up on the superstructure.

WARNING

ENSURE THE SUPERSTRUCTURE IS FULLY SUPPORTED BEFORE PROCEEDING.

NOTE

If the same bearing is to be used again, mark the pinion and bearing where the teeth mesh (point of maximum eccentricity). This will facilitate installation and checking the gear backlash.

11. Remove the bolts and washers attaching the turntable bearing to the superstructure.

WARNING

ENSURETHATANY BLOCKING MATERIAL USED IS CAPABLE OF FULLY SUPPORTING THE WEIGHT OFTHE SUPERSTRUCTURE AND WILL NOT ALLOW IT TO TILT OR SHIFT.

12. Carefully lift the superstructure, guiding it over the swivel, and set it on blocking that will not allow the superstructure to tilt or shift. Leave the lifting device attached.

NOTE

If the same bearing is to be used again, mark the position of the bearing on the carrier so it can be installed in the exact position it was before removal.

13. Remove the bolts and washers attaching the turntable bearing to the carrier.

NOTE

Depending upon the manufacturer, the bearing weighs between 134 and 139 pounds (60.7 and 63.0 kg). Ensure the bearing lifting device is capable of supporting the weight.

14. Using the lifting device, remove the turntable bearing from the carrier.

INSPECTION.

Check the bearing teeth for chipping or cracking. If any evidence of these is found, replace the bearing. Ensure the bolt holes are free of dirt, oil, or foreign material.

INSTALLATION.

CAUTION

ANYTIME A GRADE 8 TURNTABLE BOLT HAS BEEN REMOVED, IT MUST BE REPLACED WITH A NEW GRADE 8 BOLT.

NOTE

Installation is in the travel position.

1. Using an appropriate lifting device, set the turntable bearing in position on the carrier. If the same bearing is being used, position it as marked prior to removal.
2. Install new bolts, nuts, and washers securing the bearing to the carrier. Refer to Inner Race Torquing in this subsection.

NOTE

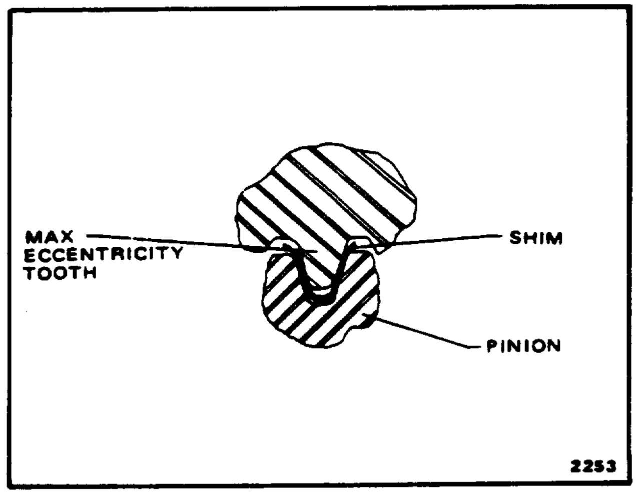
Installation is in the travel position.

3. Using an appropriate lifting device, align the superstructure over the bearing on the carrier. Lower the superstructure into position on the bearing.
4. Install the bolts and washers. Refer to Outer Race Torquing in this subsection.

NOTE

If a new bearing is being installed, a new pinion gear must also be used.

5. Install the gearbox pinion aligning the high point (maximum eccentricity) on the turntable bearing. Using a 0.005 inch (0.127 mm) thick shim, check the backlash (see figure). If the pinion must be moved to achieve proper backlash, contact your local service representative or Grove Customer Services, Chambersburg, Pennsylvania.



Backlash Adjusting Shim

6. Install the swivel following the procedure outlined in Section 9, SWIVELS.
7. If disconnected, connect the electrical connectors to the terminal block.
8. Install the pinion and cap and secure with the slotted flat screws. Install the pinion cover and secure with the nuts, spring washers, and flatwashers.
9. Install the boom and lift cylinders following the procedures outlined in Section 8, BOOM.
10. Connect battery cables to the battery.

TESTING.

Activate the crane and check for proper function.

NOTE

If the superstructure does not turn freely after bearing and pinion replacement, contact your local service representative or Grove Customer Services, Chambersburg, Pennsylvania.

Section 8. Boom

3-60 BOOM

The boom is a 14 to 24 ft (4.2 to 7.3 m) two-section full power boom and is trapezoidal in design. It consists of a telescope cylinder, a base section, and a telescope. The telescope cylinder is used to extend and retract the telescope section.

Boom assembly lift is provided by a 7 in. (1 7.8 cm) diameter bore lift cylinder. Boom elevation is from 0° to 70° from horizontal.

3-60.1 Removal

a. Extend and set the outriggers and fully retract the boom.
b. Remove the hook block and wind all the wire rope onto the hoist drum.
c. Elevate the boom slightly to allow for withdraw of the lift cylinder rod end from the lift cylinder attach fitting.

WARNING

Ensure the blocking and lifting devices are capable of supporting the boom assembly.

d. Attach a suitable lifting device to the boom to provide equal weight distribution. Place a safety block in position under the boom and rest the boom on the safety block.
e. Disconnect electrical wiring from the boom.
f. Tag and disconnect the hydraulic lines to the telescope cylinder. Cap the lines and openings.

WARNING

Ensure the boom lift cylinder is properly supported before disconnecting it from the boom.

g. Block the lift cylinder.
h. Remove the bolts, washers, nuts, and plates securing the rod end pivot shaft to the lift cylinder attach fitting.
i. Remove the rod end pivot shaft.
j. Activate the hydraulic system and withdraw the lift cylinder rod enough to clear the attach fitting.

WARNING

Shut down the crane before proceeding.

k. Take up the clack on the boom lifting device.
l. Remove the retainer plates, bolts, and washers securing the boom pivot shaft to the boom and turntable assemblies. Remove the boom pivot shaft.
m. Raise the boom clear of the crane and lower it to ground level for service.

3-60.2 Installation

WARNING

Ensure blocking and lifting devices are capable of supporting the boom assembly.

a. Attach the boom lifting device to provide equal weight distribution.
b. Suspend the boom over the crane.
c. Lower the boom into position and align the boom pivot shaft mounting holes for installation of the pivot shaft.
d. Lubricate and install the boom pivot shaft. Shim as necessary and secure it with the washers, bolts, and retainer plates. Torque the capscrews to 75 lb ft (102 N•m).

CAUTION

Extend the cylinder rod ends only enough to align them with the holes in the lift cylinder attach fitting.

CAUTION

Before installing the lift cylinder rod end pivot shaft, ensure the lift cylinder rod ends are aligned with the lift cylinder attach fitting.

e. Lubricate and install the rod end pivot shaft.
f. Install the plates, washers, nuts, and bolts securing the rod end pivot shaft to the lift cylinder attach fittings. Torque the bolts to 75 lb ft (102 N•m).
g. Connect the hydraulic lines to the telescope cylinder as tagged prior to removal.
h. Connect the electrical wires to the boom as tagged prior to removal.
i. Remove the lifting device from the boom.
j. Activate the hydraulic system and raise the boom slightly to remove the boom and lift cylinder support blocking.
k. Check for proper operation of the boom.

3-60.3 Disassembly

NOTE

The boom may be disassembled with the base section remaining on the crane if repair of the base section is not required. If the base section is not being removed from the crane for disassembly, start with step b.

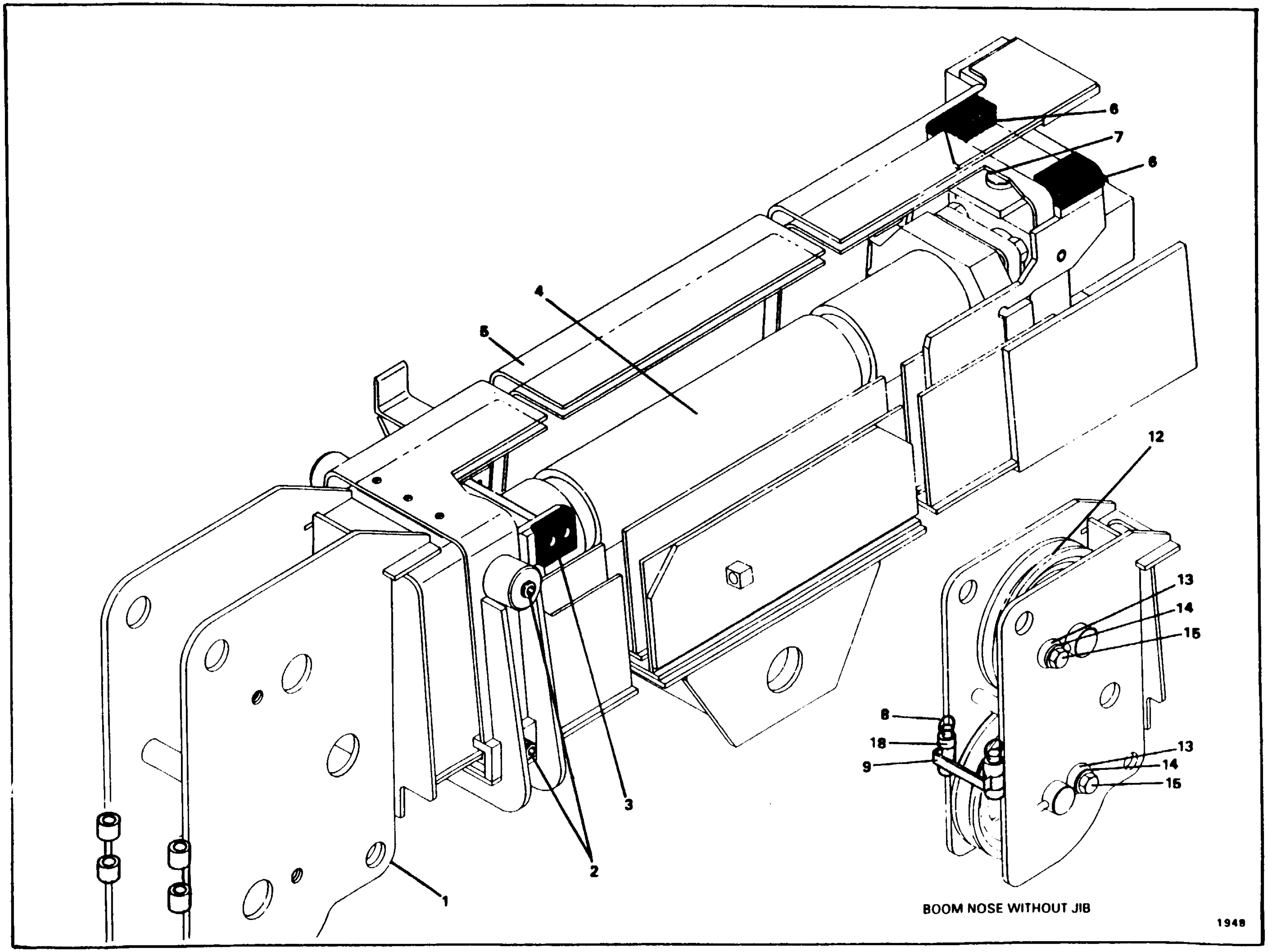
a. Remove the boom in accordance with removal procedures (paragraph 3-60.1).
b. Place the boom in a horizontal position.
c. Remove the bolts, washers, and plates securing the pins which connect the telescope cylinder to the base section. Remove the pins.
d. Back off the setscrews of the base section adjustable wear pads to provide additional clearance.
e. Remove the upper front base section plate.
f. Remove the capscrews, washers, and plates securing the lower base section wear pads. Remove the wear pads.
g. Remove the upper rear wear pads.
h. Remove the telescope section from the base section and place in a horizontal position.
i. Remove the capscrews, washers, and stop blocks securing the telescope cylinder assembly to the fly section. Remove the cylinder assembly.
j. If necessary, remove the wear pads from the cylinder.

3-60.4 Assembly

NOTE

The following thread locking adhesive/sealant procedure should be used for all bolts and fasteners. Apply a light coat of Locquic Primer T to the threads and allow to dry. Apply several stringer beads of Loctite 242 perpendicular to the threads and several beads parallel to the threads. Allow to cure before installation.

a. If removed, install the wear pads to the cylinder.
b. Install the telescope cylinder into the telescope section and secure with the stop blocks, washers, and capscrews. Torque the capscrews to 203 lb ft (275 N•m).



Two-Section Boom

c. Install the telescope section into the base section.
d. Install the lower base section wear pads and secure with the plates, washers, and capscrews. Torque the capscrews to 1 5 lb ft (20 N•m).
e. Install the upper front base section plate and secure with the screws.
f. Install the screws in the base section adjustable wear pads.
g. Secure the telescope cylinder to the base section with the pins, plates, washers, and bolts. Torque the bolts 10 to 1 2 lb ft (14 to 16 N•m).
h. Refer to paragraph 3-60.2 for installation procedures.

3-60.5 Functional Check

a. Activate the hydraulic system.
b. Elevate the boom and hold it in the extended position. The boom should stay in position until retracted by the operator.
c. Extend and retract the boom several times at various elevations. Check for smooth operation of the telescope cylinder.
d. Check operation of all electrical/electronic components affected by boom removal.

3-60.6 Alignment and Inspection

Visually inspect the telescoping sections for adequate lubrication of bottom plates. Observe extended sections for evidence of cracks, warping, or other damage. Periodically check security of boom wear pads. Check boom nose sheaves for security and freedom of movement.

3-61 TELESCOPE CIRCUIT

The boom telescope circuit consists of the telescope cylinder, telescope control valve, telescope relief valve, holding valve, boom assembly, swivel, and lockout solenoid valve. The holding valve is located on and threaded into the cylinder. The telescope control valve is located in the valve compartment behind the front console in the cab.

Movement of the telescope control valve lever forward (OUT) or rearward (IN) from center (neutral) shifts a spool within the telescope control valve which aligns appropriate passages in the control valve to route oil to the holding valve. The holding valve, with its internal makeup of valves and springs, passes oil to and from the telescope cylinder.

The telescope control valve is the closed spool-type and is described under VALVES in Section 6.

The boom telescope cylinder has a 4.5 in. (1 1.4 cm) bore. The cylinder is internally ported (rod ported). Oil from the telescope control valve is routed to the cylinder by external lines. Foreign material is prevented from entering the cylinder by a wiper seal during rod retraction. O-ring seals prevent internal and external leakage. The cylinder rod is secured to the boom base and the cylinder barrel is attached to the fly section.

The holding valve is threaded into the rod end of the telescope cylinder. The holding valve functions during the retraction, extension, or holding operation. During extension, oil unseats the poppet (check) valve in the holding valve when pressure is 6 ± 4 psi (41.37 ± 27.58 kPa/0.414 ± 0.276 bar). This oil is routed to the piston side of the cylinder which forces the rod out of the cylinder, causing the boom section to extend.

During retraction, oil enters the retract port and flows to the rod side of the cylinder. when pilot pressure reaches a pre-determined value, the main poppet unseats, and oil flows from the piston side of the cylinder to the reservoir, causing the boom section to retract.

When holding the boom section at a given length, oil is trapped in the cylinder by the holding valve. Refer to Appendix E for a complete description of the holding valve operation.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Erratic operation of extending telescoping cylinder.	a Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Damaged relief valve	b. Repair or replace relief valve.
	c. Air in telescope cylinder.	c. Bleed by lowering telescope cylinder below horizontal.
	d. Low engine rpm.	d. Increase engine rpm to recommended setting.
	e. Lack of lubrication on boom sections.	e. Properly lubricate all boom sections.
	f. Extremely tight boom nose sheaves.	f. Inspect and properly lubricate boom nose sheaves.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Erratic operation of extending telescoping cylinder. (continued)	g. Improper boom alignment caused from side loading.	g. Reduce and properly hoist load.
	h. Worn boom wear pads.	h. Replace wear pads and properly lubricate.
	i. Distorted boom section.	i. Replace distorted section.
	j. Damaged telescope cylinder.	j. Repair or replace cylinder.
	k. Clogged, broken, or loose hydraulic lines or fittings.	k. Clean, tighten, or replace lines or fittings.
	I. Damaged control valve.	I. Repair or replace control valve.
2. Erratic operation of retracting telescoping cylinder.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Damaged relief valve.	b. Repair or replace relief valve.
	c. Air in cylinder.	c. Bleed by lowering telescoping cylinders below horizontal and cycle telescope cylinder,
	d. Low engine rpm.	d. Increase engine rpm to recommended setting.
	e. Lack of lubrication.	e. Properly lubricate all boom sections.
	f. Check valve malfunctioning.,	f. Repair or replace check valve.
	g. Improper boom alignment caused from side loading.	g. Reduce and properly hoist load.
	h. Extremely tight boom nose sheaves.	h. Inspect and properly lubricate.
	i. Distorted boom section.	i. Replace distorted section.
	j. Worn boom wear pads.	j. Replace wear pads and properly lubricate.
	k. Bent cylinder rod.	k. Replace cylinder rod and all cylinder seals.
	I. Scored cylinder barrel.	I. Repair or replace cylinder barrel.
	m. Damaged piston seals.	m. Replace all cylinder seals.
	n. Loose or damaged piston.	n. Replace all seals and retorque or replace piston.

SYMPTOM	PROBABLE CAUSE	SOLUTION
3. Telescope cylinder will not extend.	a. Low hydraulic oil level.	a. Replenish oil to proper level.
	b. Relief valve malfunctioning.	b. Repair or replace relief valve.
	c. Excessive load.	c. Reduce load.
	d. Clogged hose and fittings.	d. Replace hose or fittings. (Refer to manufacturer's specifications).
	e. Broken valve linkage.	e. Repair or replace linkage.
	f. Broken valve spool.	f. Replace valve.
	g. Damaged piston seals.	g. Replace all cylinder seals.
	h. Damaged piston.	h. Replace piston and all cylinder seals.
	i. Bent boom section.	i. Replace damaged boom section.
	j. Broken hydraulic pump coupling.	j. Replace broken hydraulic pump coupling.
	k. Worn or damaged hydraulic pump section.	k. Repair or replace pump section.
4. Telescope cylinder will not retract.	a. Low hydraulic oil level.	a. Replenish oil to proper level.
	b. Relief valve damaged.	b. Repair or replace relief valve.
	c. Excessive load.	c. Reduce load. (Refer to load chart).
	d. Inoperative check valve.	d. Replace check valve.
	e. Clogged hose and fittings.	e. Replace hose or fittings. (Refer to manufacturer's specifications).
	f. Broken valve linkage.	f. Replace or repair linkage.
	g. Broken valve spool.	g. Replace valve section.
	h. Broken piston.	h. Replace piston and all cylinder seals.
	i. Damaged piston seals.	i. Replace all cylinder seals.
	j. Bent boom section.	j. Replace damaged boom section.
	k. Broken hydraulic pump coupling.	k. Replace broken hydraulic pump coupling.
	I. Worn or damaged hydraulic pump.	I. Repair or replace pump.
	m. Broken hydraulic pump shaft.	m. Replace pump shaft.

REMOVAL AND INSTALLATION.

Removal and installation of the telescope cylinder from the boom is described under disassembly and assembly of the boom. Refer to BOOM MAINTENANCE in this Section.

DISASSEMBLY AND ASSEMBLY.

Disassembly and assembly procedures of the telescope cylinder and control valve are provided in Section 6 under CYLINDERS and VALVES respectively.

3-62 LIFT CIRCUIT

DESCRIPTION

The boom lift circuit consists of the lift cylinder, holding valve, lift control valve, thermal relief valve, swivel, and lockout solenoid valve if the hydraulic lockout option is provided. The holding valve is located in the port block which is welded to the outside of the cylinder barrel. The lift control valve is located in the valve compartment behind the front console in the cab.

Movement of the control lever forward (DOWN) or rearward (UP) from center (neutral) shifts a spool within the lift control valve. Appropriate passages in the control valve route oil to the holding valve. The holding valve passes oil to and from the cylinder as required.

Boom elevation is 0 degrees to 70 degrees from horizontal. The lift control valve is the closed spool type, and is described under VALVES in Section 6.

The holding valve is threaded into the cylinder port block. The holding valve functions when booming up (cylinder rod extended), booming down (cylinder rod retracted), or holding (cylinder rod stationary).

When booming up, oil unseats the poppet (check) valve in the holding valve, letting oil flow to the piston side of the cylinder. Pressure is applied to the piston, forcing the rod to extend, raising the boom.

When booming down, oil enters the retract port of the port block and flows to the cylinder rod side. When pilot pressure reaches a pre-determined value, the main poppet unseats and oil flows from the piston side of the cylinder to the reservoir.

When holding the boom, oil is trapped in the cylinders by the holding valve. Refer to the applicable SM package for a complete description of holding valve operation.

The lift cylinder is the double acting type with a cylinder bore of 7 inches (17.8 cm). For a detailed description of the lift cylinder, refer to Lift Cylinder in Section 6 HYDRAULIC SYSTEM.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1 Boom raises erratically.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase engine rpm to recommended setting.
	c. Main relief valve damaged.	c. Replace relief valve.
	d. Air in cylinder rods.	d Bleed cylinder rods.
	e. Bent boom pivot shaft.	e. Replace pivot shaft.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Boom lowers erratically.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper oil level.
	b. Low engine rpm.	b. Increase engine rpm to recommended level.
	c. Circuit and/or relief valve inoperative.	c. Repair or replace relief valve.
	d. Air in hydraulic cylinders.	d. Bleed air from cylinders.
	e. Control valve linkage out of adjustment.	e. Adjust linkage to obtain full spool travel.
	f. Damaged hydraulic pump section.	f. Repair or replace pump section.
3. Boom raise: slowly.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase and maintain engine rpm.
	c. Damaged relief valve.	c. Repair or replace relief valve.
	d. Extremely cold hydraulic oil.	d. Operate unit to bring oil to operating temperature.
	e. Improper hose or fitings, installed.	e. Replace hose or fittings. (Refer to Parts Manual).
	f. Control valve linkage out of adjustment.	f. Adjust linkage to obtain full spool travel.
	g. Operating two functions within the same control valve bank assembly.	g. Feather controls to obtain desired speed of both functions.
	h. Restriction in return hose.	h. Replace return hose.
	i. Cylinder piston seals leaking.	i. Replace all cylinder seals.
	j. Scored cylinder barrels.	j. Hone or replace barrel.
	k. Worn hydraulic pump section.	k. Repair or replace pump section.
4. Boom lowers slowly.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase rpm to recommended level.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Boom lowers slowly. (continued)	c. Damaged relief valve.	c. Repair or replace relief valve.
	d. Operating two functions within the same control valve bank assembly.	d. Feather controls to obtain desired speed of both functions.
	e. Extremely cold hydraulic oil.	e. Operate unit to bring oil to operating temperature.
	f. Improper hose or fittings installed.	f. Replace hose or fittings. (Refer to Parts Manual).
	g. Control valve linkage out of adjustment.	g. Adjust linkage to obtain full spool travel.
	h. Restriction in return hose.	h. Replace return hose.
	i. Cylinder piston seals worn.	i. Replace all cylinder seals.
	j. Scored cylinder barrels.	j. Hone or replace barrel.
	k. Worn hydraulic pump section.	k. Repair or replace pump section.
	I. Piston rod broken (loose from piston).	I. Replace piston rod and all cylinder seals.
5. Boom will not raise. per level.	a. Low hydraulic oil.	a. Replenish hydraulic oil to pro-
	b. Main relief valve or circuit relief valve damaged.	b. Repair or replace relief valve.
	c. Excessive load.	c. Reduce load as required.
	d. Improperly adjusted control valve linkage.	d. Adjust linkage to obtain full spool travel.
	e. Worn or damaged hydraulic pump section.	e. Repair or replace pump section.
	f. Broken pump shaft.	f. Replace pump shaft and seals.
	g. Broken pump drive coupling.	g. Replace drive coupling.
	h. Broken control valve spool.	h. Replace control.
6. Boom will not lower.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper level.
	b. Main relief valve or circuit relief valve damaged.	b. Repair or replace relief valve.

SYMPTOM	PROBABLE CAUSE	SOLUTION
6. Boom will not lower. (continued)	c. Improperly adjusted control valve linkage.	c. Adjust linkage to obtain full spool travel.
	d. Worn or damaged hydraulic pump section.	d. Repair or replace pump section.
	e. Broken pump shaft.	e. Replace pump shaft and seals.
	f. Broken pump drive coupling.	f. Replace drive coupling.
	g. Broken control valve spool	g. Replace control valve.

NOTE

Refer to Section 6 for lift cylinder Disassembly and Assembly procedures. Maintenance not requiring removal of the cylinder barrels, such as packing, may be performed without removing the cylinders from the turntable. However, all disassembly and assembly should be conducted in a clean dust-free area.

REMOVAL.

1. Extend and set the outriggers.
2. Elevate the boom so that the lift cylinder is extended approximately one foot (0.3 m).

WARNING

ENSURE ANY BLOCKING OR CRIBBING USED IS CAPABLE OF SUPPORTING THE BOOM.

3. Ensure the boom is fully supported by placing blocking or cribbing under the boom. Rest the boom on the blocking or cribbing.

WARNING

ENSURE THE LIFTING/SUPPORTING DEVICE IS CAPABLE OF SUPPORTING THE LIFT CYLINDER.

4. Attach an adequate lifting/supporting device to the lift cylinder.
5. Remove the nuts, washers, bolts and plates securing the lift cylinder shaft.
6. Block the cylinder in place and pry out the pivot shaft.
7. Retract the cylinder rod.
8. Tag and disconnect the hydraulic hoses from the lift cylinder. Cap or plug all openings.
9. Remove the bolts, washers, and plates securing the boom pivot shaft to the turntable.
10. Take up any slack in the lifting device. Tap out the boom pivot shaft and remove the lift cylinder.

DISASSEMBLY AND ASSEMBLY.

Disassembly and assembly procedures of the lift cylinder holding valve, and control valve are provided in Section 6 under CYLINDERS and VALVES respectively.

INSTALLATION.

1. Attach an adequate lifting device to the lift cylinder and lower the cylinder into place on the turntable.
2. Install the boom pivot shaft and secure with the plates, washer, and bolts. Torque the bolts to 75 lb ft (102 N•m).
3. Align the lift cylinder rod end with the attach point on the boom. Install the lift cylinder shaft through the cylinder and boom attach points. Shut down the engine.
4. Secure the lift cylinder shaft with the plate, washers, and bolts. Torque the bolts to 75 lb ft (102 N•m).
5. Connect the hydraulic lines to the lift cylinder as tagged during removal.
6. Remove the lifting and supporting devices from the boom and lift cylinder. Activate the hydraulic system and check the lift cylinder for proper operation and any leaks.

3-63 HOOK BLOCK

Hook block for this crane is a 8.5 ton, one sheave assembly weighing 152 lb (68.9 kg). The hook block uses a one piece pivot block and the hook is provided with a heavy duty safety latch. A grease fitting is provided to ensure lubrication of all moving parts.

MAINTENANCE

DISASSEMBLY.

1. Remove the cotter pin, slotted nut, washer, and bearing from the block weldment.
2. Remove the hook from the block weldment.
3. Remove the bolt, washer, and bushing from the rivet eye bolt in the sheave shaft.
4. Remove the eye bolt, sheave shaft, bushings, and sheave(s) assembly from the hook block weld.

INSPECTION.

1. Examine all components for cracks and damage.
2. Ensure the safety latch functions properly.
3. Check for spreading of the hook.

ASSEMBLY.

1. Install the sheave(s) assembly bushings, and sheave shaft in the order and position removed.
2. Install the rivet eye bolt through the sheave shaft.

Secure with the bushing, washer, and bolt. Torque the bolt to 250 lb ft (339 N•m).

3. Grease the bearing and install the bearing into the block weldment.
4. Install the hook in position in the hook block weldment.
5. Install the washer and slotted nut on the hook.

NOTE

Position the nut and cotter pin to provide free rotation of hook with minimum clearance.

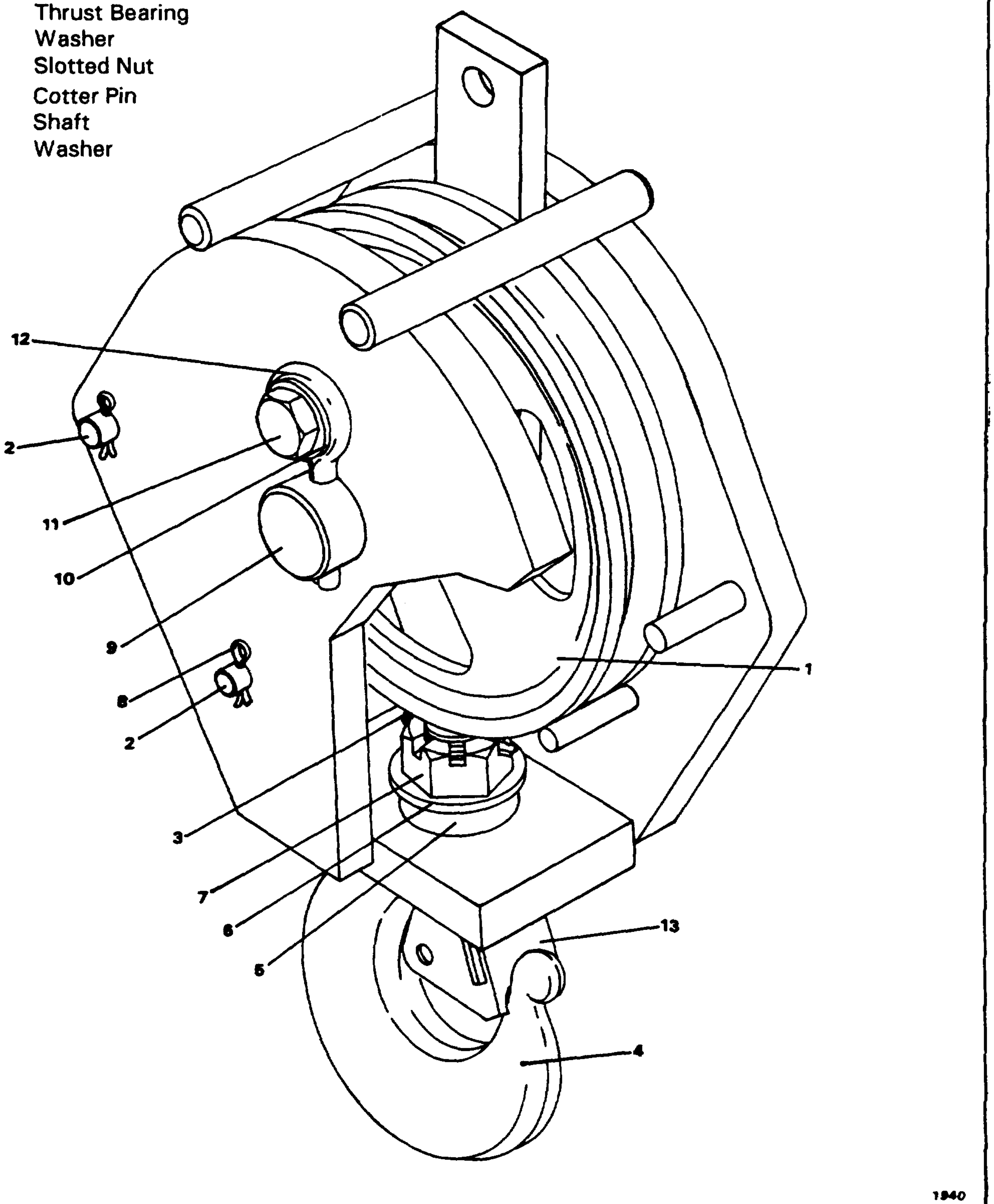
6. Install the cotter pin in the nut.

PERIODIC MAINTENANCE.

It is recommended that the hook block be inspected every 50 hours. A complete disassembly inspection should be conducted every quarter or 500 hours in the area of the hook, hex nut, and threaded areas for corrosion and proper fit. After assembly of the hook a liberal coating of multipurpose grease should be applied to the nut and threaded areas by brush or hand to prevent corrosion. Grease containing molybdenum disulfide should not be used.

For hook blocks and other load handling devices not manufactured by Grove Manufacturing Company; follow the Manufacturer's inspection and testing recommendations to assure an adequate preventative maintenance program is established.

1. Sheave Assembly
2. Shaft
3. Cotter Pin
4. Hook
5. Thrust Bearing
6. Washer
7. Slotted Nut
8. Cotter Pin
9. Shaft
10. Washer
11. Bolt
12. Rivet Eye Bolt
13. Heavy Duty Flapper Latch
14. Link



8.5 Ton, Single Sheave Hook Block Assembly

3-64 WIRE ROPE

GENERAL.

The following information is a compendium of information from various wire rope manufacturers and includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and Grove. The inspection interval shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. Periodic Inspections need not be at equal calendar intervals and should be performed at shorter time intervals as the wire rope approaches the end of its useful life. A periodic inspection shall be performed at least once a year. The following provides inspection and maintenance procedures for wire ropes used on Grove products, (e.g. wire rope used as load lines [hoisting cables], boom extension and retraction cables, pendant cables, tow winch cables, and hook block 'tie down' cables).

ENVIRONMENTAL CONDITIONS.

The life expectancy of wire rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the wire rope to abrasive material may shorten normal wire rope life. Frequent/periodic inspections and maintenance of your wire rope is recommended for preventing premature wear and to insure long--term satisfactory performance.

DYNAMIC SHOCK LOADS.

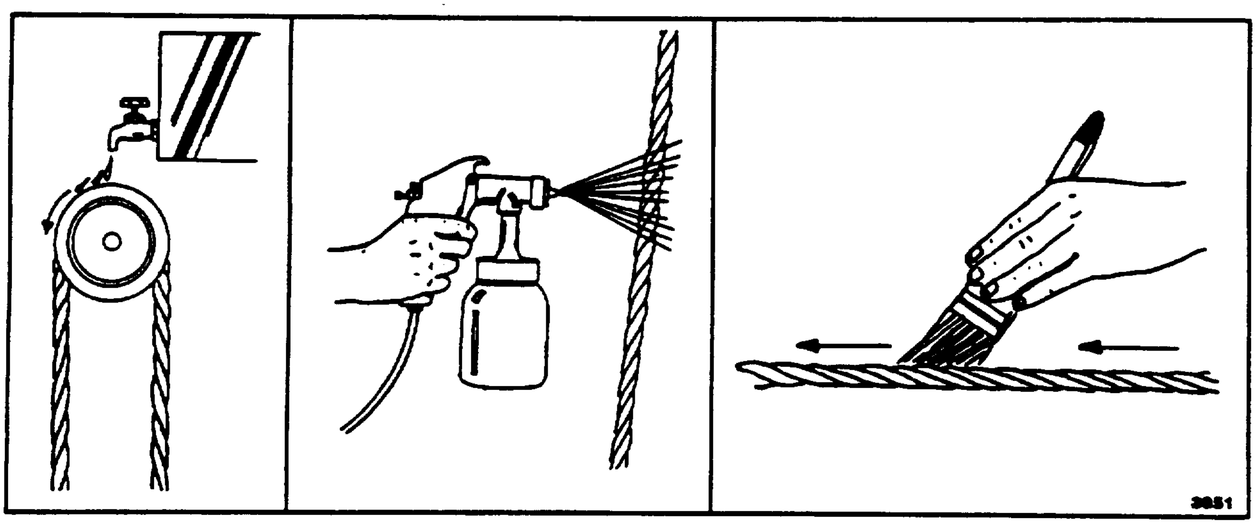
Subjecting wire rope to abnormal loads beyond the endurance limit will shorten the wire ropes, life expectancy.

Examples of this type of loading are listed below.

1. High velocity movement e.g.; hoisting or swinging of a load followed by abrupt stops.
2. Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
3. Moving a load that is beyond the rated capacity of the lifting mechanism, i.e.; overloading.

LUBRICATION.

A wire rope cannot be lubricated sufficiently during manufacture to last it's entire life. Therefore, new lubricant must be added throughout the life of a rope to replace factory lubricant which is used or lost. It is important that lubricant applied as part of a maintenance program shall be compatible with the original lubricant, and to this end, the rope manufacturer should be consulted. Lubricant applied shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when lubricating rope. The object of rope lubrication is to reduce internal friction and to prevent corrosion.



Wire Rope Lubrication

During fabrication, ropes receive lubrication; the kind and amount depends on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

The following are important characteristics of a good wire rope lubricant:

1. It should be tree from acids and alkalis.
2. It should have sufficient adhesive strength to remain on the ropes.
3. It should be of a viscosity capable of penetrating the interstices between wires and strands.
4. It should not be soluble in the medium surrounding it under the actual operating conditions (i.e. water).
5. It should have a high film strength.
6. It should resist oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Cleaning can be accomplished by using a stiff wire brush and solvent, compressed air, or live steam. Immediately after the wire rope is cleaned, it should be lubricated. Many techniques may be used; these include bath, dripping, pouring, swabbing, painting or pressure spray methods. Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. It should be noted, the service life of wire rope will be directly proportional to the effectiveness of the method used and amount of lubricant reaching the working parts of the rope.

PRECAUTIONS AND RECOMMENDATIONS DURING INSPECTION OR REPLACEMENT.

1. Always lock out equipment power when removing or installing wire rope assemblies.
2. Always use safety glasses for eye protection.
3. Wear protective clothing, gloves, and safety shoes as appropriate.
4. Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.
5. When replacing fixed length cable assemblies (e.g. pendants) having permanently attached end fittings use only pre-assembled lengths of wire rope as supplied from Grove Product Support. Do not build lengths from individual components.
6. Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
7. Never electroplate wire rope assemblies.
8. Do not weld any wire rope assembly or component unless welding is recommended by the wire rope manufacturer. Welding spatter shall never be allowed to come in contact with the wire rope or wire rope ends. In addition, be sure that the wire rope is not an electrical path during other welding operations.
9. Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly shall be discarded.
10. On systems equipped with two or more wire rope assemblies operating as a matched set, they shall be replaced as an entire set.
11. Do not paint or coat wire ropes with any substance except approved lubricants.

WIRE ROPE INSPECTION (RUNNING ROPES AND PENDANT CABLES).

Wire rope should be inspected frequently/dally and periodically/yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from machine to machine and may vary based on environmental conditions, frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

Any deterioration observed in the wire rope should be noted in the equipment inspection log and an assessment concerning wire rope replacement should be made by a qualified person.

Frequent Inspection.

A frequent daily visual inspection is recommended for all running ropes in service. This inspection should be made on all wire rope which can be expected to be in use during the day's operation. This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement such as:

a. Distortion, Kinking, Crushing, Un-stranding, Bird caging, Reduction of diameter, etc.
b. General corrosion
c. Broken or cut strands
d. Number, distribution and type of broken wires
e. Evidence of core failure
f. End fitting wear/abrasion

Periodic Inspection.

Wire rope should be inspected periodically/annually or at a shorter time interval if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Only the outer surface of the wire rope need be inspected, and no attempt should be made to open the rope. Periodic inspection should include all items listed under frequent inspection plus the following:

a. Inspect for reduction of rope diameter below nominal diameter.

b. Inspect for severely corroded or broken wires at end connections.

c. Inspect for severely corroded, cracked, bent, worn, or improperly applied end connections.

d. Inspect wire rope in areas subjected to rapid deterioration such as:

1. Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited
2. Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.

e. Inspect boom nose sheaves, hook block sheaves, boom extension/jib sheaves, auxiliary boom nose sheaves, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

WIRE ROPE REPLACEMENT (ALL WIRE ROPE).

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgment of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by Grove. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

a. In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.

b. Wear of one-third the original diameter of outside individual wires. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.

c. Evidence of any heat damage from any cause.

d. Reductions from nominal diameter of more than

- 1/64 inch for diameters up to and including 5/16 inch
- 1/32 inch for diameters 318 and 1/2 inch inclusive
- 3/64 inch for diameters 9/16 to 3/4 inch inclusive
- 1/16 inch for diameters 7/8 to 1 1/8 inches inclusive
- 3/32 inch for diameters 1/14 to 1 1/2 inches inclusive

e. In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

f. Grove recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.

g. Grove recommends for cable extended booms, that boom extension cables be replaced every seven (7) years.

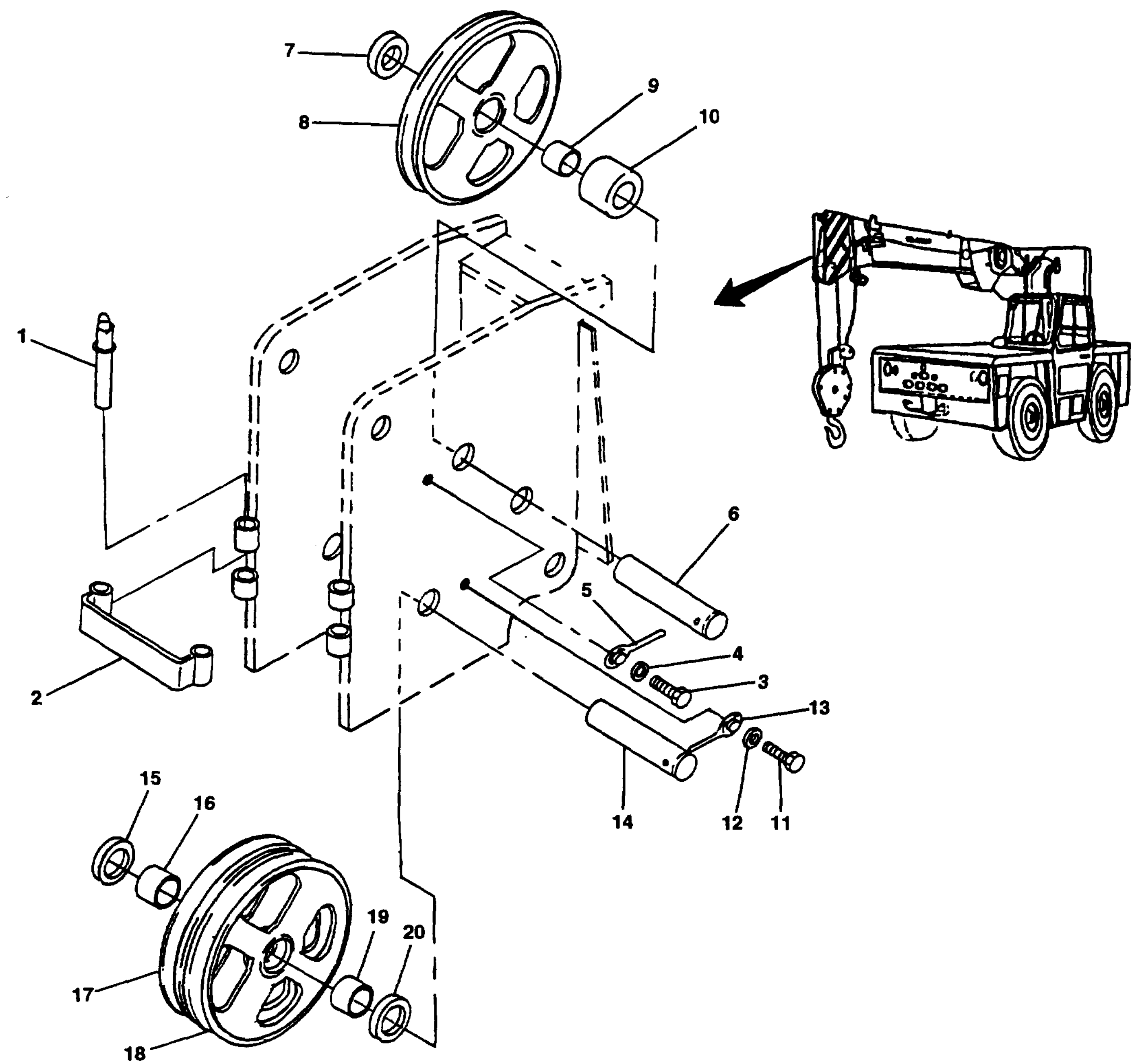
3-65 BOOM NOSE SHEAVE ASSEMBLY

3-65.1 Removal

a. Remove hook block and wind all wire rope onto hoist drum.
b. Remove two detent pins (1, Figure 3-17) and retainer (2) from boom nose.
c. Remove bolt (3), lockwasher (4), pin bolt (5), shaft (6), three bushings (7, 9, and 10), and sheave (8) from boom nose.
d. Remove bolt (1 1), lockwasher (12), pin bolt (13), shaft (14), four bushings (15, 16, 19, and 20), and two sheaves (17 and 18) from boom nose.

3-65.2 Installation

a. Install two sheaves (17 and 18, Figure 3-17) in boom nose with four bushings (15, 16, 19, and 20), shaft (14), pin bolt (13), lockwasher (12), and bolt (11).
b. Install sheave (8) in boom nose with three bushings (7, 9, and 10), shaft (6), pin bolt (5), lockwasher (4), and bolt (3).
c. Reeve wire rope through three sheaves (8, 1 7, and 1 8), antitwo-block weight, and hook block. Refer to Operator's Manual, TM10-3950-672-10, for cable reeving.
d. Install retainer (2) on boom nose with two detent pins (1).



LEGEND

1. Detent Pin	8. Sheave	15. Bushing
2. Retainer	9. Bushing	16. Bushing
3. Bolt	10. Bushing	17. Sheave
4. Washer	11. Bolt	18. Sheave
5. Pin Bolt	12. Washer	19. Bushing
6. Shaft	13. Pin Bolt	20. Bushing
7. Bushing	14. Shaft	

Figure 3-17. Boom Nose Sheave Assembly

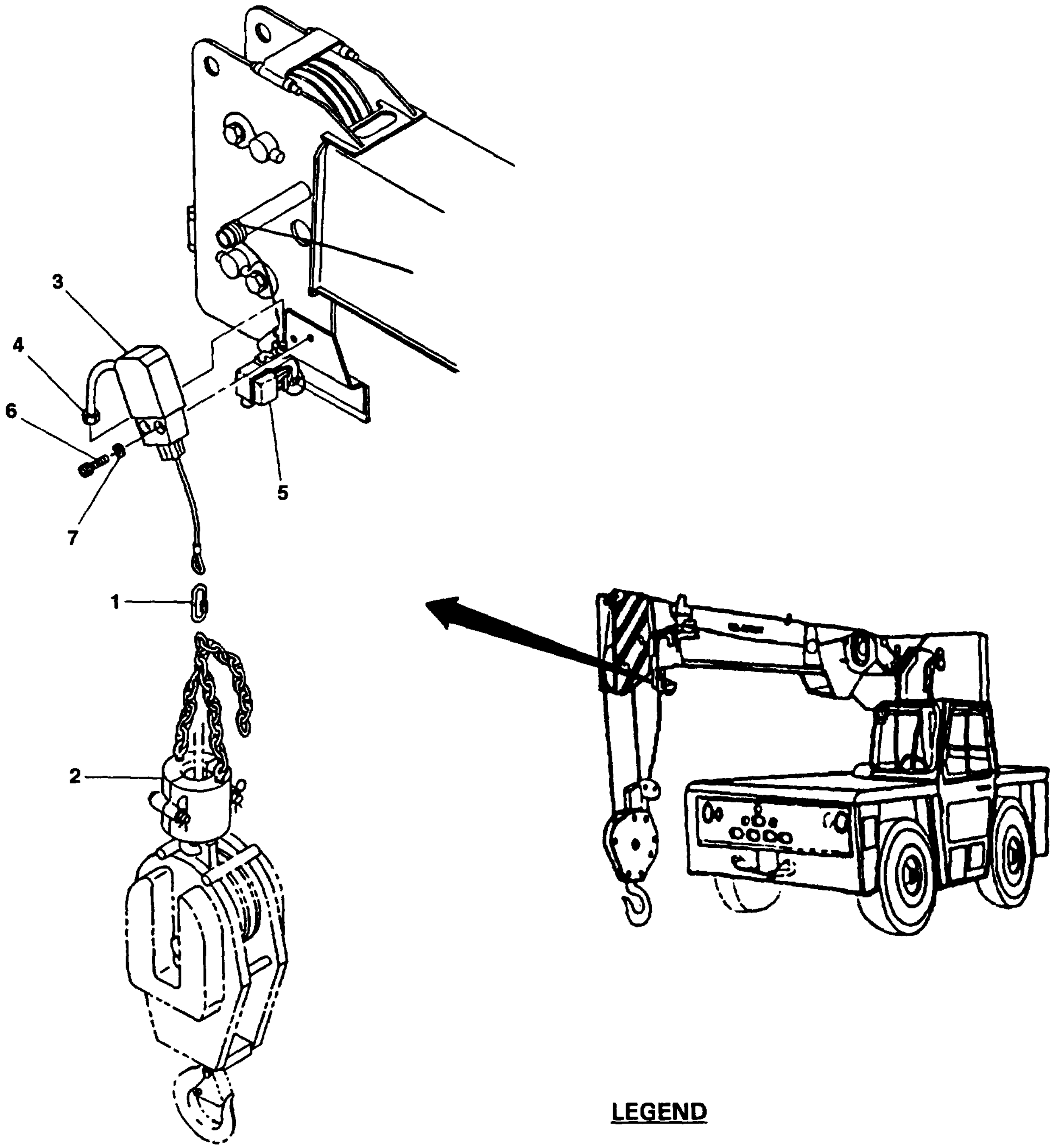
3-66 ANTITWO-BLOCK SYSTEM SWITCH

3-66.1 Removal

a. Disconnect negative battery cable and two electrical leads from negative battery post.
b. Unscrew link (1, Figure 3-18) and disconnect weight assembly (2) and link (1) from antitwo-block switch (3).
c. Disconnect cable connector (4) from junction box (5).
d. Remove two screws (6), two lockwashers (7), and antitwo-block switch (3) from boom nose.

3-66.2 Installation

a. Install antitwo-block switch (3, Figure 3-1 8) on boom nose with two lockwashers (7) and two screws (6).
b. Connect cable connector (4) to junction box (5).
c. Connect negative battery cable and two electrical leads to negative battery post.
d. Start crane and position hook block to a minimum dimension of 4 ft 10 in. from bottom of boom nose. Shut down crane.
e. Lay weight assembly (2) on hook block and attach weight assembly (2) chain to antitwo-block switch (3) cable with link (1) so that no slack exists in chain.



LEGEND

1. Link
2. Weight Assembly
3. Antitwo-Block Switch
4. Cable Connector
5. Junction Box
6. Screw
7. Lockwasher

Figure 3-18. Antitwo-Block System Switch

3-67 ANTITWO-BLOCK SYSTEM CABLE REEL

3-67.1 Removal

a. Disconnect negative battery cable and two electrical leads from negative battery post.
b. Disconnect cable connector (1, Figure 3-19) from junction box (2).

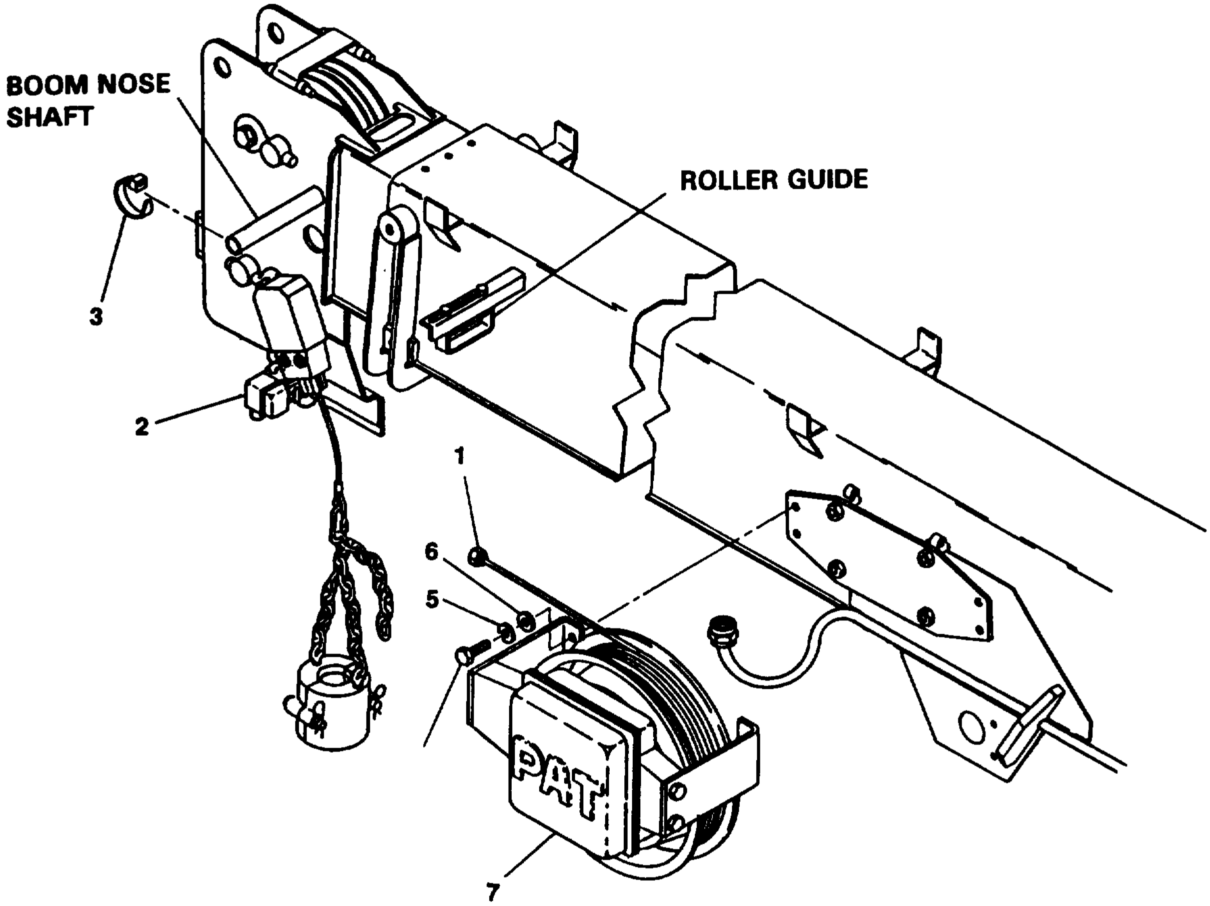
NOTE

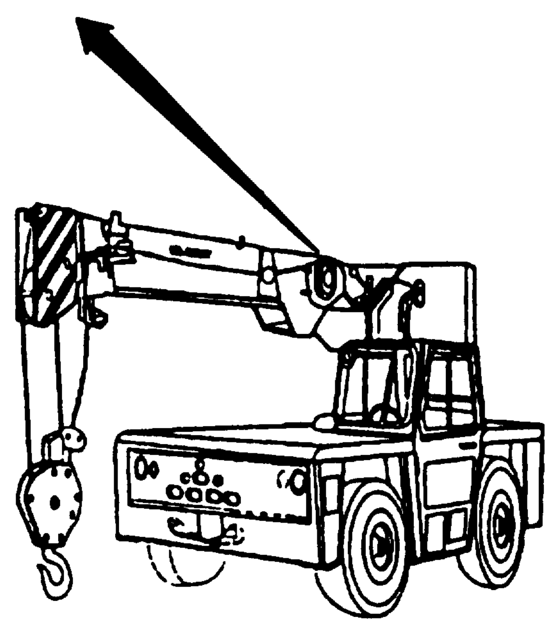
Count and record number of turns cable is wrapped on boom nose shaft.

c. Remove strap (3), unwrap cable from shaft on boom nose, and allow cable to rewind onto cable reel assembly (7).
d. Disconnect electrical connector from box on outside of cable reel assembly (7).
e. Remove four screws (4), four lockwashers (5), four washers (6), and cable reel assembly (7) from boom mounting plate.

3-67.2 Installation

a. Install cable reel assembly (7, Figure 3-19) on boom mounting plate with four washers (6), four lockwashers (5), and four screws (4).
b. Connect electrical connector to box on cable reel assembly (7).
c. Route cable through roller guide assembly (under roller), wrap cable around end of boom nose shaft (same number of turns as recorded during removal), and connect cable connector (1) to junction box (2).
d. Secure cable wraps around boom nose shaft together with strap (3).
e. Connect negative battery cable and two electrical leads to negative battery post.





LEGEND

1. Cable Connector
2. Junction Box
3. Strap
4. Screw
5. Lockwasher
6. Washer
7. Cable Reel Assembly

Figure 3-19. Antitwo-Block System Cable Reel

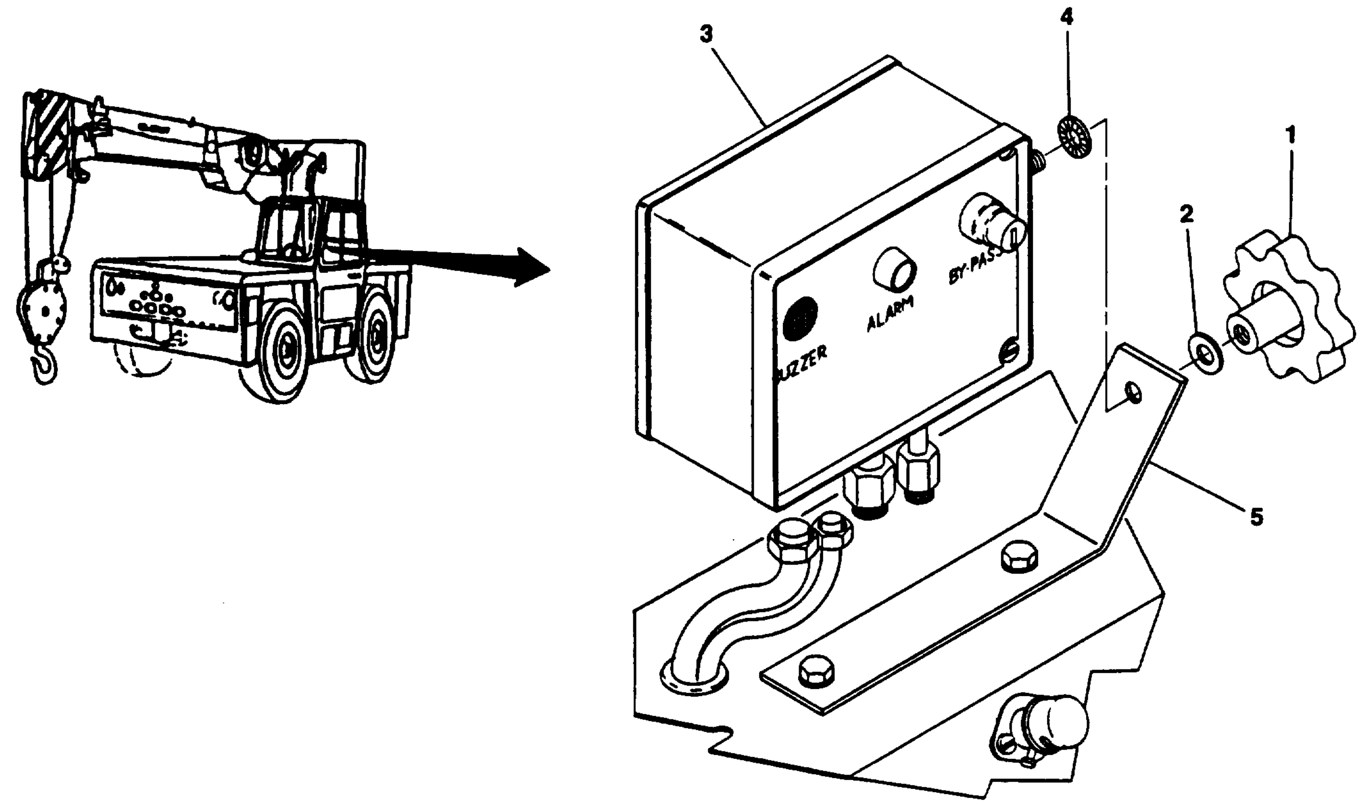
3-68 ANTITWO-BLOCK SYSTEM CONSOLE

3-68.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Tag and disconnect two electrical connectors from console (3, Figure 3-20).
c. Unscrew knob (1), remove washer (2), move console (3) away from mounting bracket (5), and remove serrated washer (4).
d. Remove console (3) from vehicle.

3-68.2 Installation

a. Position console (3, Figure 3-20) in vehicle.
b. Install serrated washer (4) on stud of console (3) and install console (3) on mounting bracket (5) with washer (2) and knob (1).
c. Connect two electrical connectors to console (3) and remove tags.
d. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Knob
2. Washer
3. Console
4. Serrated washer
5. Mounting Bracket

Figure 3-20. Antitwo-Block System Console

Section 9. Swivels

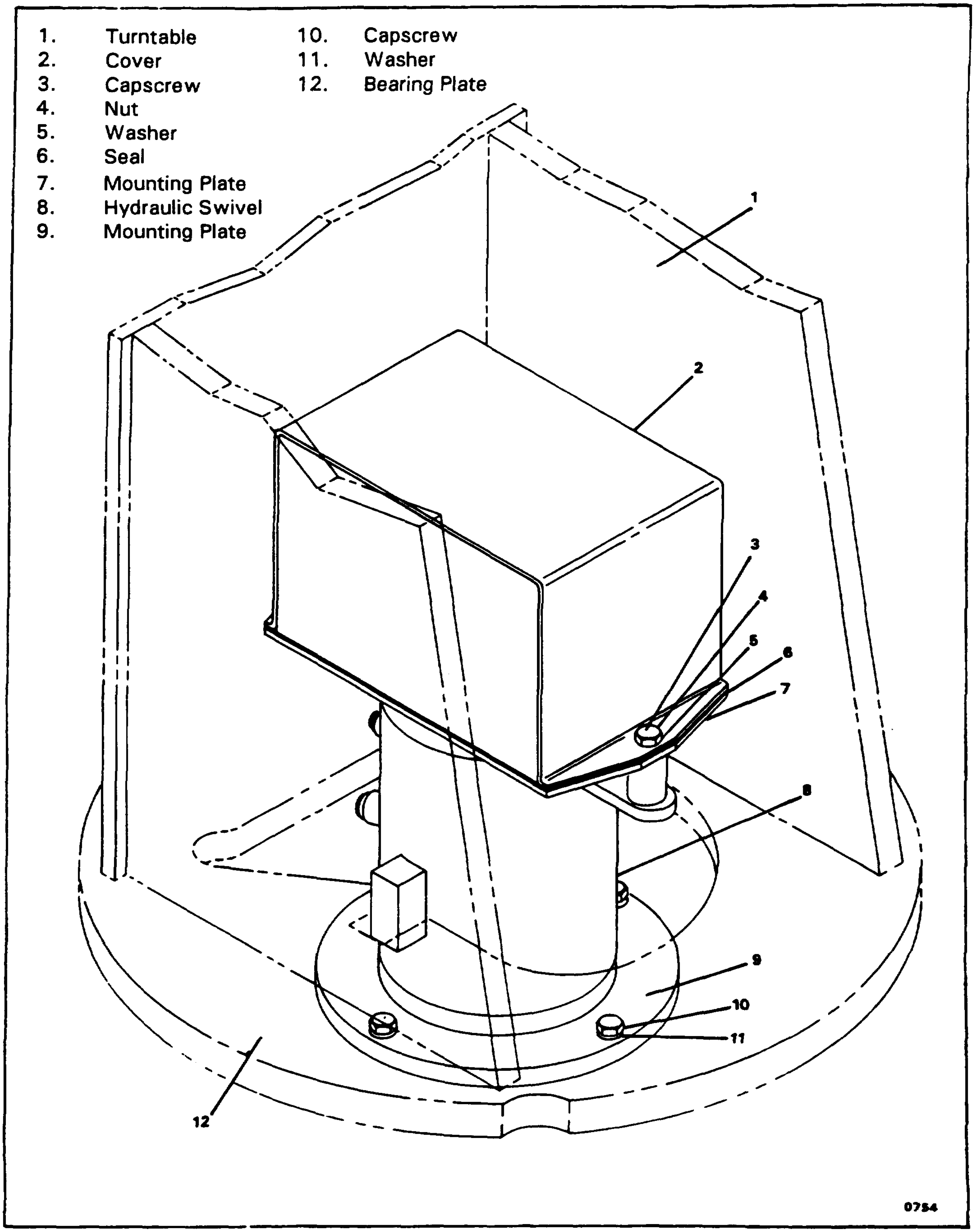
3-68 SWIVELS

DESCRIPTION

The swivel installation consists of a hydraulic swivel and an optional electrical swivel. Solid connections cannot be used to transfer oil or electricity between the carrier and superstructure due to the continuous 360 degree swing. The use of swivels efficiently accomplishes this function.

The spool portion of the hydraulic swivel is mounted on a spool mounting plate bolted to the carrier bearing plate. The barrel portion of the hydraulic swivel has a lug welded to the barrel case that fits in a slot on the turntable bearing plate. This permits the barrel portion of the swivel to rotate around the stationary spool as the superstructure rotates.

The electrical swivel center or collector ring assembly is secured by setscrews to a center post, which is bolted to the spool of the hydraulic swivel. This allows the collector ring assembly to remain stationary with the carrier. The outer portion or brush assembly is spring mounted on two pins which are located on a mounting plate attached to the swivel barrel. This allows the brush assemblies to rotate with the superstructure. The springs on the mounting plate pins allow the swivel to float and not bind when the superstructure rotates.



Hydraulic and Electrical Swivel Installation

3-69. 6 PORT HYDRAULIC SWIVEL

DESCRIPTION

Each of the ports on the spool and barrel of the swivel is stamped with the port number. The function of each port is described below.

Port Number	Function	Test Pressure
1	Lift Down	3000 PSI (20685 kPa/206.8 bar)
2	Lift Up	3000 PSI (20685 kPa/206.8 bar)
3	Hoist Down	3000 PSI (20685 kPa/206.8 bar)
4	Hoist Up	3000 PSI (20685 kPa/206.8 bar)
5	Telescope - Extend	3000 PSI (20685 kPa/206.8 bar)
6	Telescope - Retract	3000 PSI (20685 kPa/206.8 bar)
W	Hoist Motor Weep Line	500 PSI (3447.5 kPa/34.4 bar)

THEORY OF OPERATION

The hydraulic swivel allows oil to flow from the control valve to various crane functions on the superstructure. All oil is routed into the spool portions of the swivel where, through a series of internally drilled passages, oil is transferred to a channel on the spool exterior. This channel corresponds with a mating port on the barrel of the swivel. Each channel is separated by a series of teflon and O-ring seals that prevent transfer of oil between the channels.

MAINTENANCE

NOTE
For more detailed information refer to Appendix E.

REMOVAL.

1. Ensure the boom is over the front.
2. Extend the outriggers and set them just enough to make contact with the ground. Do not lift the crane on the outriggers.
3. Elevate the boom enough from horizontal to install blocking between the boom base and the lift cylinder. Shut down the engine.
4. Remove the electrical swivel. (Refer to ELECTRICAL SWIVEL Removal in this Section.)
5. Remove the capscrews and lockwashers securing the swivel mounting plate to the carrier bearing plate.
6. Lift the swivel up enough to tag and disconnect the hydraulic lines from the spool of the swivel. Cap or plug all openings.
7. Tag and disconnect the hydraulic lines from the barrel of the swivel. Cap or plug all openings.
8. Using a suitable lifting device, insert two eyebolts on the swivel top plate and lift straight up on the swivel.

9. Remove the swivel from the crane and move it to a clean work area.

INSTALLATION.

1. Install the eyebolts to be used for lifting the swivel.

2. Carefully position the swivel into place on the crane.

3. Before lowering the swivel completely into the carrier bearing plate, connect the hydraulic lines to the spool of the swivel as tagged during removal.

4. Connect the hydraulic lines to the barrel as tagged during removal.

5. Secure the swivel mounting plate to the carrier bearing plate with the capscrews and lockwasher.

Torque the capscrews to 31 lb ft (42 N-m).

6. Unhook the lifting device from the eyebolts and remove the eyebolts and lifting device.

7. Install the electrical swivel. (Refer to ELECTRICAL SWIVEL Installation in this Section).

8. Remove the blocking material from the lift cylinder.

9. Activate all systems. cycle all functions and observe for proper operation and any leakage.

3-70 ELECTRICAL SWIVEL

DESCRIPTION

The swivel consists of ten sets of brushes and collector rings, and a cover.

Each brush set incorporates two brushes, leads, and clips which are attached to a brush holder assembly. The collector ring leads are formed into one harness routed downward through the center of the hydraulic swivel.

The swivel cover is secured with capscrews and washers that attach it to the mounting plate of the electric swivel. The mounting plate is attached to the barrel of the hydraulic swivel.

MAINTENANCE

NOTE

For more detailed information refer to Appendix E.

REMOVAL.

1. Perform steps 1 through 3 of HYDRAULIC SWIVEL Removal in this section.
2. Remove the bolts, lockwashers, and nuts securing the swivel cover. Remove the cover.

NOTE

On swivels equipped with crimp - type connectors on the collector core wires, do not disconnect the collector core wires at the top of the swivel assembly.

3. Tag and disconnect the wires on the top of the swivel collector.
4. Secure the wires in the center harness and if the hydraulic swivel is to be removed, route the harness down through the center of the hydraulic swivel.
5. Loosen the setscrews securing the electrical swivel collector to the center post. Remove the swivel.
6. If necessary, remove the springs from the mounting plates.

INSTALLATION.

1. If removed, route the collector ring harness through the center of the hydraulic swivel.
2. If removed, install the springs onto the mounting posts.
3. Guide the collector ring assembly over the center post and onto the two springs and pins on the mounting plate.
4. Exert a downward pressure on the collector core and brush assembly. Compress the springs to a height of 1.625 inches (4.1 cm). Secure the collector and brush assembly to the center post by tightening the setscrews in the collector core.
5. Connect the wires on the top of the swivel collector. Ensure the numbers on the collector ring harness wires match the numbers on the collector ring wires.
6. Install the swivel cover and seal. Secure with the capscrews, lockwashers, and nuts.
7. Remove the blocking material from the lift cylinder.
8. Activate all systems, cycle all functions and observe for proper operation and any leakage.

PREVENTIVE MAINTENANCE.

It is recommended that a normal inspection of the electrical swivel collector ring and brush assembly be established. An example of this could be at approximately 100 to 150 engine operating hours. When this time limit is reached, perform the following.

1. Check the collector ring and brush assembly for any corrosion, pitting, arcing, and wear.

2. If the swivel has a grease fitting instead of a nylon bushing, grease it. Use no more than about 1 ounce (0.028 kg) of a good quality bearing grease.

3. Check the collector ring setscrews and ensure they are tight.

4. Check the brush and arm assembly springs. Ensure they are holding the brushes firmly against the collector rings.

Section 10. Hoist

3-71 HOIST

DESCRIPTION

One hoist is available, the Grove HO-12. The hoist is a single speed assembly consisting of a hoist control valve, a vane type motor, the brake, cable drum, clutch assembly, and the motor and brake end housings.

The hoist is installed at the rear of the turntable. Hoist usage is controlled by a hoist control lever. If the optional cable follower assembly is provided, it is installed on the rear side of the hoist.

The following is a list of specifications for the model HO-12 hoist.

Drum Dimensions	Drum dimensions are 9.625 inches (24.4 cm) diameter with 9.0 inches (22.8 cm) length.
Cable Capacity	Cable capacity for the 9.0 inch (22.8 cm) drum with 9/16 inch cable is 135 feet (41.1 m).
Permissible Line Pull	Refer to the Line Pulls and Reeving Info Chart in the cab.

NOTE

For more detailed information refer to Appendix E.

THEORY OF OPERATION

The first section of the hydraulic pump supplies oil to the hoist directional control valve. The control valve supplies oil through swivel port 4 to the hoist motor control valve. The control valve is actuated by the main hoist control lever. Hydraulic oil from the hoist returns to the reservoir through hydraulic swivel port 3.

MAINTENANCE

REMOVAL

1. Remove the cable and cable follower. (Refer to CABLE FOLLOWER - REMOVAL in this Section.)
2. Attach a suitable lifting sling to the hoist.
3. Tag and disconnect the hydraulic supply lines to the hoist; cap or plug all lines and openings.
4. Remove the capscrews, nuts, washers, and plates securing the hoist and remove the hoist from the back of the turntable.

HOIST INSTALLATION AND ALIGNMENT.

1. Ensure the hoist mount is clean and free from debris and the hoist has not been damaged during handling.
2. With the hoist supported in a suitable lifting sling, position the hoist on the mount.
3. Check the hoist to boom alignment according to the HOIST TO BOOM ALIGNMENT procedure in this section.
4. Place a level between the boom pivot shaft bushings.

5. Place a level across the top of the hoist drum and determine if the hoist is sitting in the same plane in relation to the level positioned between the boom pivot shaft bushings.

6. Install the plates, washers, nuts, and capscrews and secure the hoist. Torque the capscrews to 370 lb ft (501 N•m).

7. Connect the hydraulic lines and hoses as tagged prior to removal.

8. Remove the lifting sling from the hoist.

9. Install the cable follower. Refer to CABLE FOLLOWER INSTALLATION in this section.

10. Service the hoist. Refer to SERVICING in this section.

11. Install the cable, following procedures outlined under INSTALLING CABLE ON THE HOIST, in the Operator's Manual TM 10-3950-672-10.

FUNCTIONAL CHECK.

1. Attach a test weight to the hook and raise and lower the load several times.

2. Check the hoist for smooth operation of the hoist motor and brake system.

3. Ensure the hydraulic connections are secure and free from leaks.

SERVICING.

1. Remove the cable from the hoist (if applicable).

2. Rotate the hoist drum until one drain plug is at the highest point.

3. Remove the drain plugs.

NOTE

Drum lubricant capacity is approximately 2 quarts (1.8 liters).

4. Fill the drum with EPGL-80W/140 lubricant.

5. Install the pipe plugs.

ADJUSTMENT OF THE MOTOR CONTROL VALVE.

The following adjustment procedures are to be used when unacceptable hoist operating characteristics have been traced to the motor control valve. Optimum hoist performance is obtained when hydraulic oil temperature is at 170 to 180 degrees F (77 to 82 degrees C) or at 165 degrees (74 degrees C) on units with a thermostat controlled oil cooler if environmentally possible.

NOTE

For the following procedures, refer to the figure titled Hoist Motor Control Valve Adjustment.

1. Hoist will not raise the maximum load.

If the hoist will not raise the maximum load, check the system pressure. If the system pressure is low, adjust to the proper system pressure.

2. Hoist is lowering rough.

NOTE

Some very rough conditions may require as much as 0.060 inch (0.152 mm) additional shim to correct the rough lowering condition.

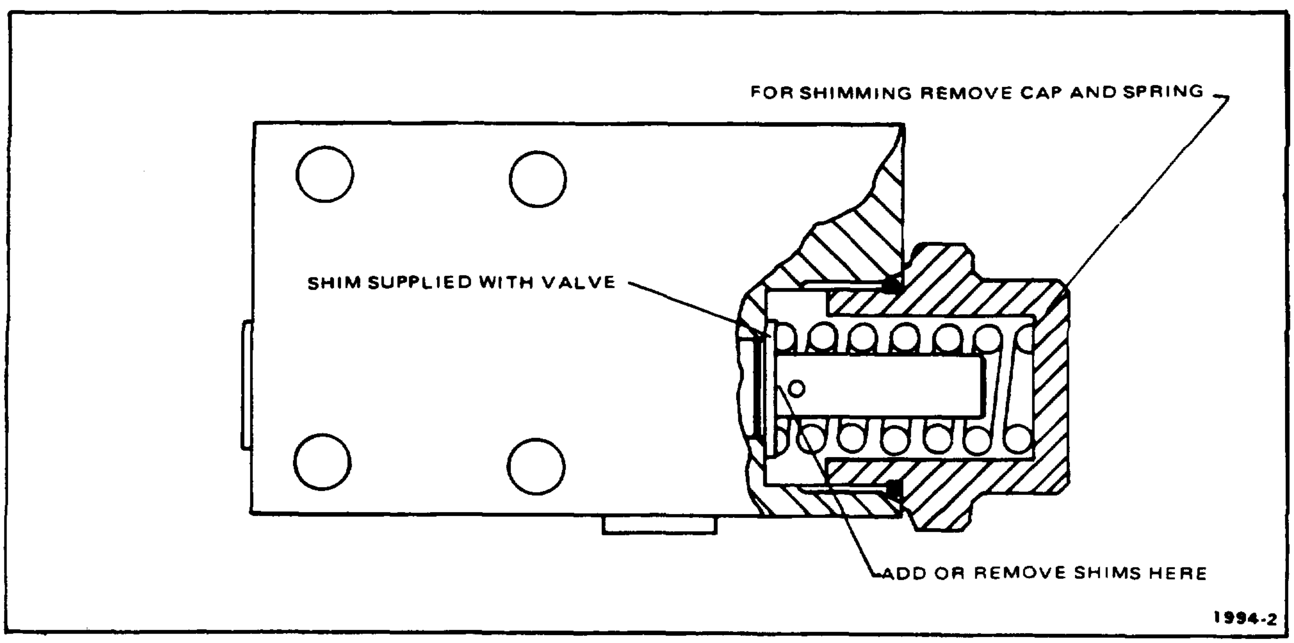
Remove the cap and spring and add shims (in 0.005 inch [0.0127 mm] increments) as needed to correct the rough lowering condition. Install the spring and end cap. Too many shims may create a loss of or poor control. If this happens, remove shims until control is obtained.

3. Hoist has loss of or poor control when lowering a load.

Remove the cap and spring and remove the shim(s) in the valve. Install an amount of shims smaller in thickness than the original shim(s) to correct the problem. Install the spring and cap.

4. Hoist brake is chattering during the lowering of a load.

Remove the cap and spring and add the needed thickness of shims (in 0.005 inch [0.0127 mm] increments) to correct the chattering condition. Install the cap and spring.



Hoist Motor Control Valve Adjustment

3-72 CABLE FOLLOWER

DESCRIPTION

The cable follower is installed on the rear side of the hoist. It applies a downward spring pressure against the cable onto the hoist drum. The pressure ensures the cable will be uniformly wound onto the hoist drum, and also prevents cable jumping under abnormal line conditions.

MAINTENANCE

REMOVAL.

1. Loosen the adjusting nuts and remove the extension springs.

2. Remove the bolts, washers, and nuts securing the lever welds to the side plate weld.

3. Remove the capscrews securing one of the side plates, ensuring the roller assembly is not dropped when the side plate is removed.

4. Remove the capscrews securing the side plates to the hoist, and lift the follower assembly from the crane.

DISASSEMBLY

NOTE

The cable follower should be disassembled in a clean work area.

1. Remove the capscrews and washers securing the angle to the cable follower shaft.
2. Remove the angle and shim washer from the end of the cable follower shaft and slide the roller assembly off the shaft.
3. Remove the shaft bearings and the other shim washer from the roller assembly.

CLEANING AND INSPECTION.

1. Clean all grease from the shaft and bearings.
2. Check the inner shaft, the roller, and the shaft bearings, for cracks, scoring, or grooving. Replace if necessary.
3. Check the spring tension. If the springs will not provide sufficient tension when adjusted, replace them.

ASSEMBLY.

1. Install the inner shaft bearings into the roller assembly.
2. Install on e shim washer on the inner shaft.

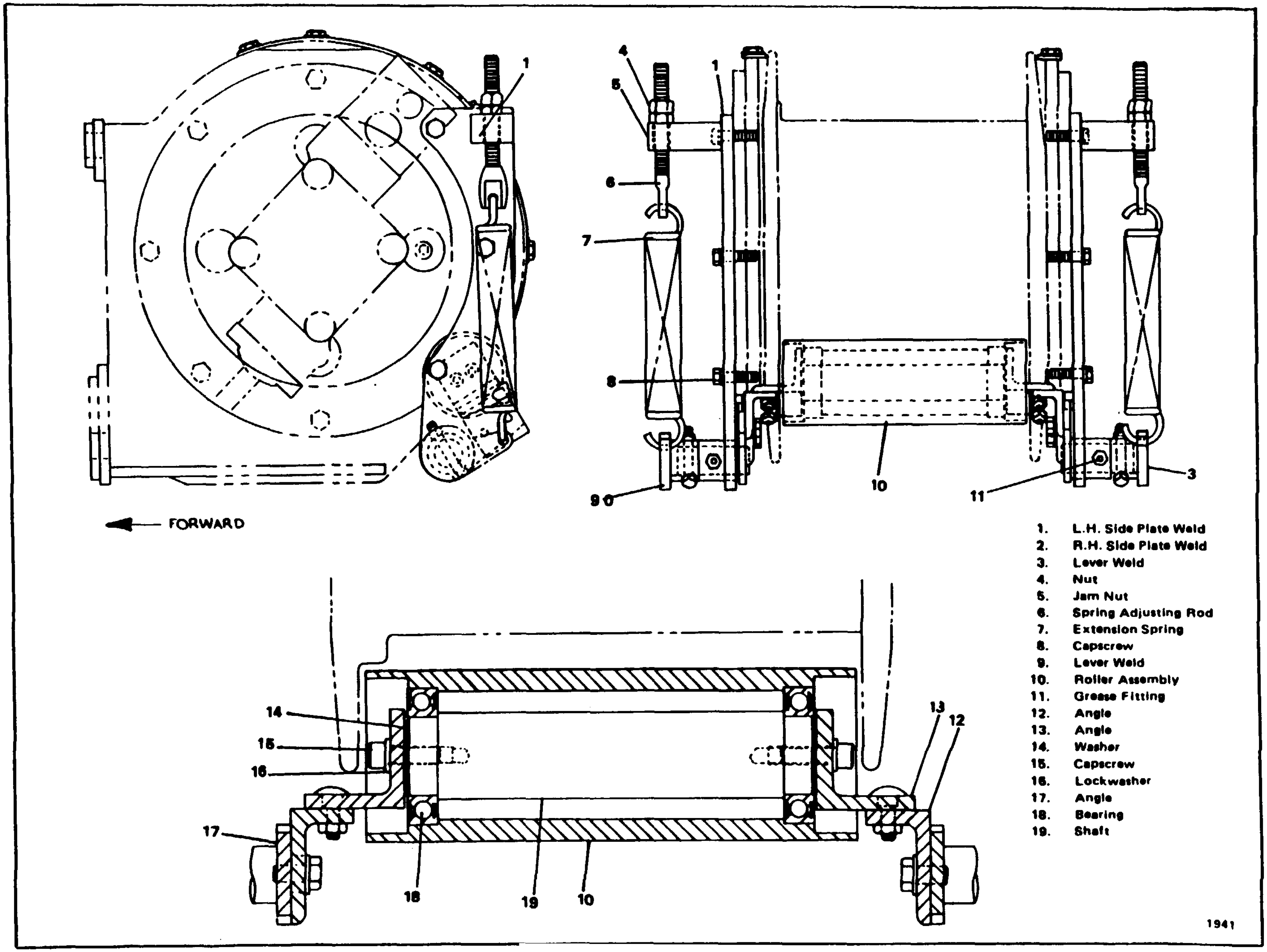
NOTE

Locate the roller assembly as parallel as possible, 0.625 inches (15.8 mm) from the hoist drum and 0.125 inches (3.1 mm) from the left flange.

3. Install the roller assembly on the inner shaft and install a shim washer on the end.
4. Ensure the roller assembly and bearings are fully seated and install the angle on the cable follower shaft.
5. Apply medium strength threadlocking adhesive/sealant and primer to the capscrews. Install the capscrews and washers and secure the angle to the roller assembly.

INSTALLATION.

1. Using a suitable lifting device, install the follower assembly on the hoist.
2. Install the side plates to the hoist and secure with the capscrews. Torque the capscrews to 31 lb ft (42 N•m). Fill the side plate assemblies with grease through the grease fittings on each side plate weld.



Cable Follower Assembly

3. Install the lever welds to the side plate welds and secure with bolts. washers, and nuts. Torque the bolts 10 to 12 lb ft (14 to 16 N•m).

4. Install the extension springs. Adjust the spring adjusting rod to extend the extension spring approximately 1 -inch (25.4 mm). Tighten the adjusting nuts.

5. Refer to operators manual, TM 10-3950-672-10 and lubricate the cable follower as specified.

3-73 VANE TYPE MOTOR

DESCRIPTION

The vane type motor is a fixed displacement, rotary balanced motor that converts hydraulic oil flow into rotary mechanical motion. The motor consists of four basic sub-assemblies; a body or housing and shaft with a permanently lubricated bearing, a front port plate assembly consisting of the port plate with a built-in check valve, a cam ring assembly containing the rotor, vanes. vane springs and cam ring, and the end cap assembly consisting of the end cap and needle bearing.

MAINTENANCE

NOTE
For more detailed information refer to Appendix E.

REMOVAL.

1. Tag and disconnect the hydraulic lines from the motor and hoist motor control valve. Cap or plug all lines and openings.

2. Remove the bolts and washers securing the motor to the end housing. Remove the motor.

INSTALLATION.

1. Apply high strength thread locking adhesive/sealant and primer to the bolts. Position the motor In place on the end housing and secure with the bolts and washers. Torque the bolts to 68 lb ft (92 N-m).

2. Connect the hydraulic lines to the motor and hoist motor control valve as tagged during removal.

3-74 HOIST TO BOOM ALIGNMENT

PROCEDURE.

1. Lower the boom to the level position.

2. Find a line on top of the hoist drum which is parallel to the drum axis as follows.

a. Use a Miracle Point Gauge and find a zero degree dial point next to each flange on top of the drum.

NOTE

If this special equipment is not available, sufficient accuracy in locating a centerline may be obtained by using a steel square against the machined inner surfaces of both flanges. It is advisable to avoid using any cast surfaces in this procedure unless a check from both flanges indicates that the resultant line is straight.

b. Draw a line between the hoist drum flanges, passing through both points as located above and determine the midpoint.

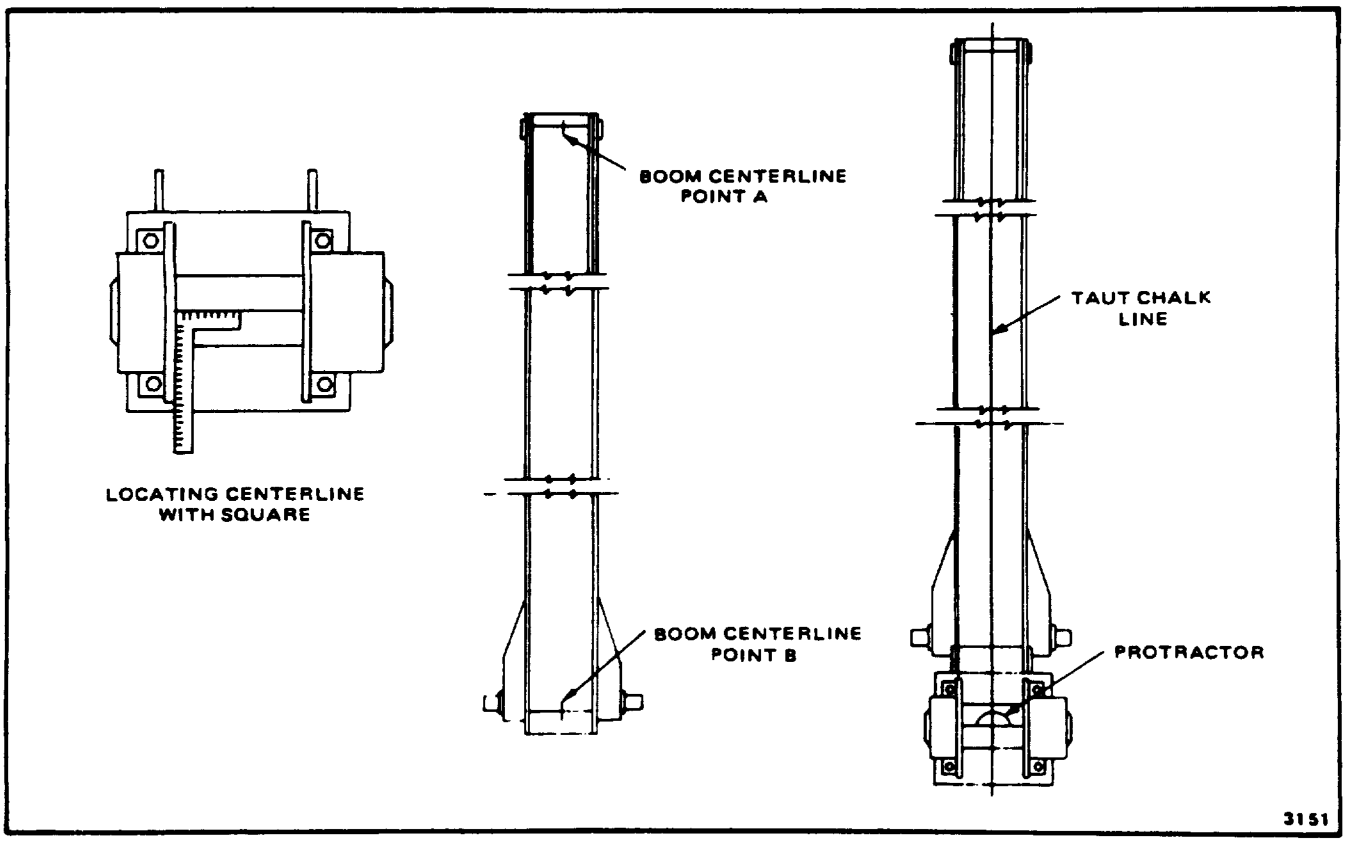
3. Find the midpoint of the lines drawn across the top of the base boom section, perpendicular to its length, at both ends of the boom section. (Figure points A and B.)

4. Check as follows to see if the hoist is aligned perpendicularly to the boom.

a. String a chalk line from point A, (outer boom centerline) across the base section centerline and the hoist drum midpoint.

b. Pull the line taut. aligning it directly over the top of point B.

c. With a protractor, measure the angle between the chalk line and the cross line drawn on the hoist. If the measurement of the angle exceeds 90 degrees ± 1 /2 degree, realignment will be necessary.



Hoist to Boom Alignment

CAUTION

DO NOT ALTER HOLES OR STOP BLOCKS ON THE CRANE MOUNTING PLATE. AS VERY SMALL ADJUSTMENTS RESULT IN LARGE ANGULAR CHANGES. EXTREME CARE SHOULD BE TAKEN TO AVOID OVERCORRECTION.

5. If realignment is necessary, remove the hoist mounting bolts and shift the hoist as necessary to achieve the minimum angular tolerance. Trial and error location may be necessary for proper line-up of the bolt holes and stop blocks. If all bolts cannot be inserted or the stop blocks interfere with line-up, a slight elongation of the hoist bolt holes and/or shimming of the mounting lugs might be necessary.

Section 11. Frame and Outriggers

3-75 OUTRIGGERS

3-75.1 Description

The outriggers are the oblique telescoping type and consist of a removable outrigger beam and a cylinder assembly. The outriggers are controlled by a toggle switch, an outrigger selector valve, and a double selector valve. The outrigger selector valve is located in the cab to the left of the seat. The double selector valve, if installed, is located in the battery box. Each stabilizer cylinder has a port block mounted on its side. A pilot operated check valve is threaded into the port block.

A level is mounted on the right side of the cab. The level provides the operator with a visual indication of crane levelness.

3-75.2 Theory of Operation

Flow from the 32 gpm (121.1 lpm) pump section supplies the outrigger circuit. Positioning the OUTRIGGER control switch to DOWN/OUT positions the spool in the control valve to permit oil to flow to the OUTRIGGER SELECTOR valve. Positioning the selector valve switches to one of the eight positions (FRONT, REAR, LEFT, RIGHT, FRONT RIGHT, REAR RIGHT, FRONT LEFT, or REAR LEFT) allows the hydraulic oil to flow to the appropriate cylinder(s). The oil first unseats the check valve and the pressure on the piston, then extends the outrigger. Oil from the rod side of the cylinder flows back through the control valve, then to the tank. Positioning the OUTRIGGER control switch to UP/IN positions the spool in the control valve to permit oil to flow to the rod side of the cylinder(s). The pilot pressure from the pressurized retract line unseats the check valve allowing oil to flow from the piston side of the cylinder(s) to the SELECTOR valve. The oil flows from the SELECTOR valve, through the control valve, and back to the tank.

3-75.3 Removal

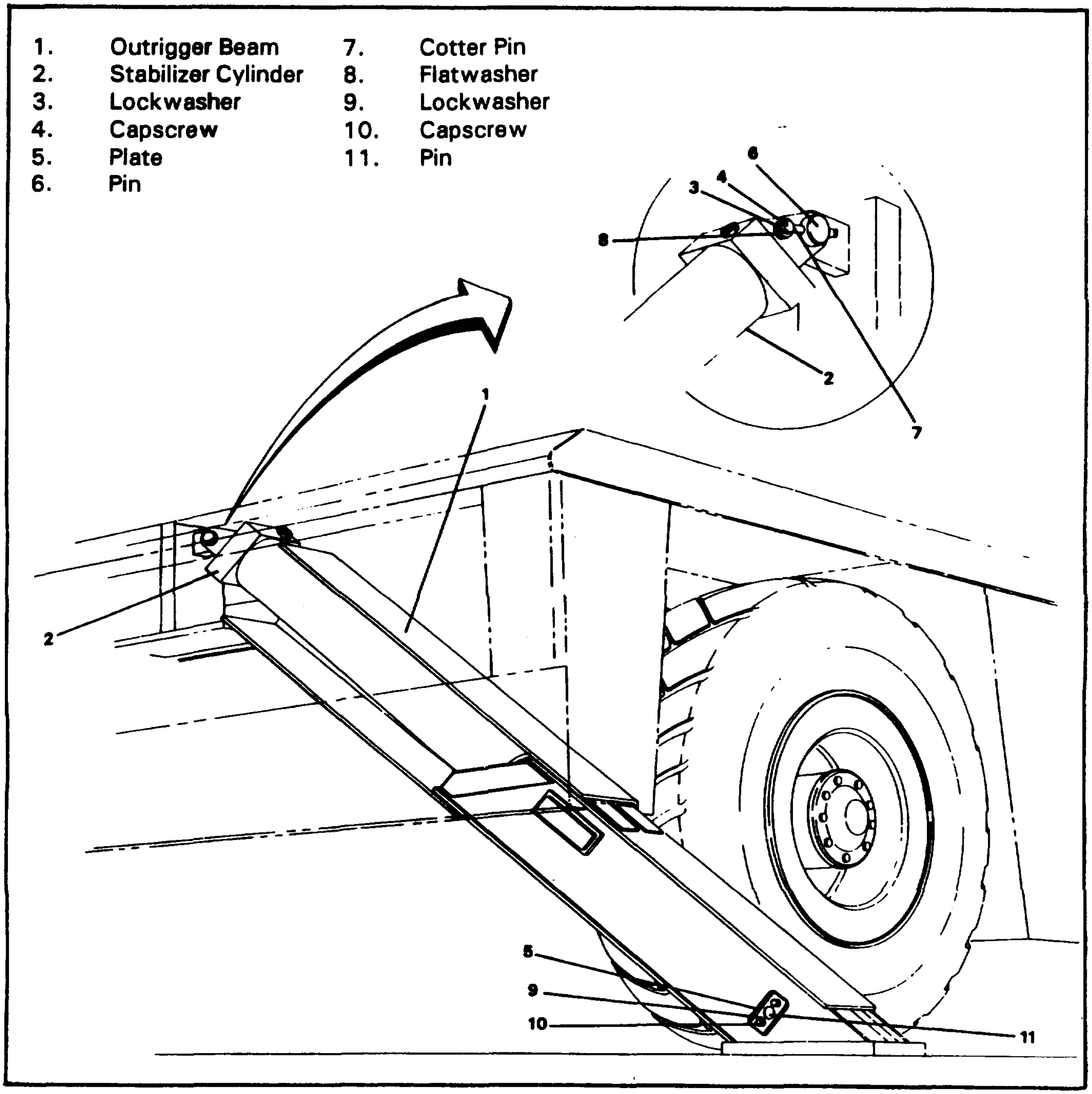
a. Extend the outrigger slightly to facilitate attaching a lifting device to the outrigger beam.
b. Using an adequate lifting device, lift the frame enough to enable removal of the outrigger beam. Install cribbing or blocking which is capable of handling the weight of the crane under the frame for support.
c. Shut down the engine.
d. Tag and disconnect the hydraulic lines to the cylinder. Cap or plug all openings.

CAUTION
Use an adequate support to fully support the cylinder.

e. Place a soft wood support between the outrigger beam and the cylinder.

CAUTION
When blocking up the cylinder, place the support under the port block.

f. Remove the capscrew, washer, flatwasher, cotter pin, and pin securing the cylinder barrel to the frame.
g. Attach a suitable lifting device to the outrigger beam.
h. Pull the outrigger beam out of the outrigger box readjusting the lifting attachment to prevent the cylinder from sliding or tilting when the outrigger beam clears the outrigger box.



Outrigger Installation

WARNING

Ensure any blocking material used is capable of supporting the weight of the outrigger beam. Do not allow it to tilt or slide. Failure to do so could result in death or injury to personnel.

i. Position the outrigger beam on blocking material.
j. Remove the cylinder support.

NOTE

For Removal and Installation of the cylinder, refer to OUTRIGGER STABILIZER CYLINDER in this Section.

NOTE

For Removal and Installation of the double selector valve used when the optional tow winch is installed, refer to Section 6 VALVES.

3-75.4 Inspection

Inspect the outrigger beams for bends, evidence of cracks, or other damage. Check the outrigger beam internally for hydraulic fluid, which may indicate a leaking cylinder, loose connection, or damaged hydraulic line.

3-75.5 Installation

a. Place a soft wood support between the outrigger beam and the port block of the cylinder.
b. Attach a suitable lifting device to the outrigger beam.
c. Slide the beam into the outrigger housing being careful not to let the cylinder slide or tilt. Align the cylinder barrel with the frame mount.
d. Install the cylinder barrel to the frame mount. Apply anti-seize to the pin and secure the cylinder barrel to the frame mount with the pin, cotter pin, flatwasher, washers, and capscrew.
e. Connect the hydraulic lines to the cylinder as tagged prior to removal.
f. Remove any blocking material in the outrigger assembly.
g. Activate the system and check for proper operation and any leaks.

3-76 OUTRIGGER STABILIZER CYLINDER

DESCRIPTION

The 3-inch (7.62 cm) stabilizer cylinder is 40.19 inches (102.0 cm) long from the center of the barrel to the center of the rod bushing and has a stroke of 29.0 inches (73.6 cm). The barrel end of the cylinder is attached to the frame by means of a pin, capscrew, lockwasher, flatwasher, and cotter pin. The rod end of the cylinder is attached by means of a plate, pin, bolt, and washer, to the outrigger beam. There are four stabilizer cylinders on the crane and each cylinder weighs 80 pounds (36.2 kg) dry and 82.5 pounds (37.4 kg) wet.

MAINTENANCE

NOTE

Refer to CYLINDERS in Section 6 for Disassembly and Assembly of the cylinder.

REMOVAL.

1. Remove the outrigger beam. (Refer to OUTRIGGERS, Removal in this Section).
2. Remove the plate, pin, bolt, and washer securing the rod end of the cylinder to the outrigger beam.
3. Remove the cylinder.

INSTALLATION.

1. Install the cylinder into the outrigger beam.
2. Apply anti-seize compound to the pin, and install the plate, pin, washer, and bolt securing the rod end of the cylinder to the outrigger beam.
3. Install the outrigger beam. (Refer to OUTRIGGERS, Installation in this Section).

FUNCTIONAL CHECK.

1. Activate the hydraulic system; using the outrigger control lever and outrigger selector. Extend and retract the outrigger.
2. Observe the operation of the outrigger beam.
3. Check the hydraulic connections for any evidence of leakage.

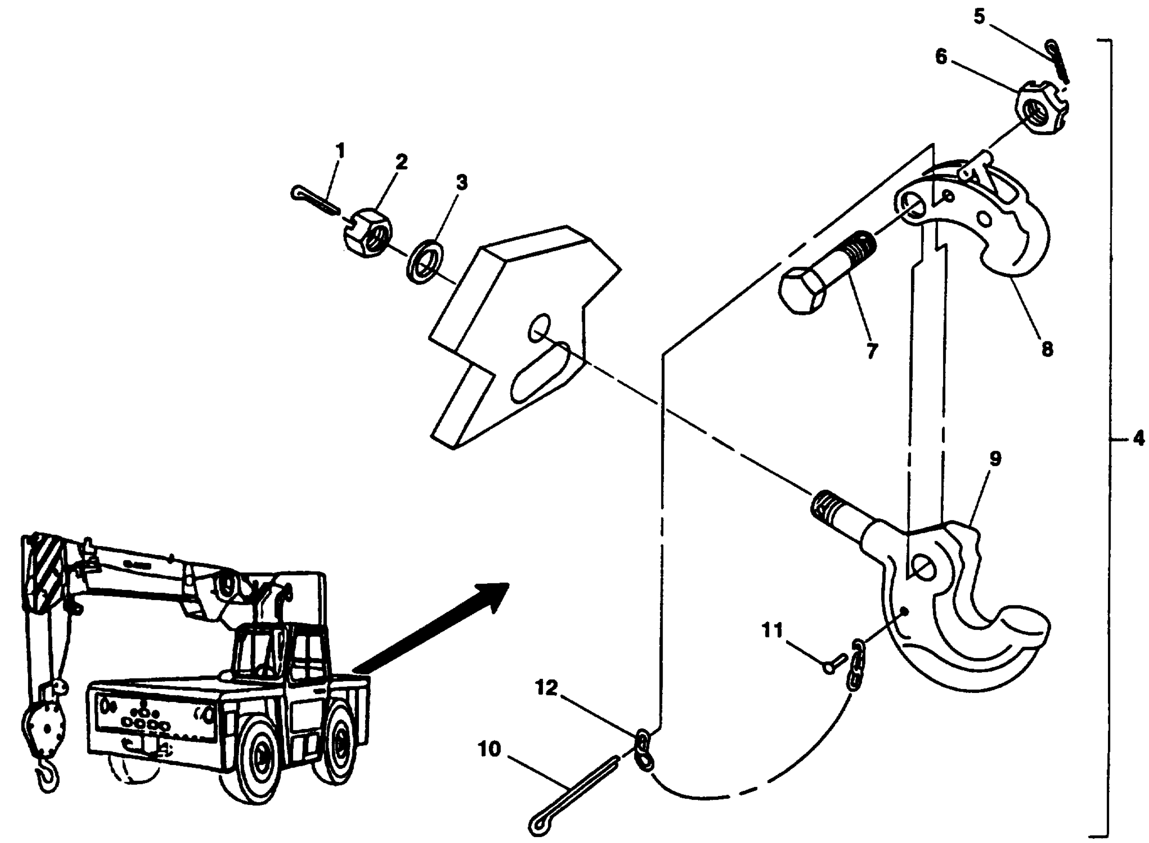
3-77 OUTRIGGER SELECTOR VALVE

DESCRIPTION

The OUTRIGGER SELECTOR valve is located in the cab to the left of the seat. It is an eight position hydraulic valve that directs the flow of hydraulic oil from the outrigger directional control valve to the appropriate outrigger(s).

NOTE

For a more detailed DESCRIPTION and MAINTENANCE of the outrigger selector valve, refer to VALVES in Section 6 -HYDRAULIC SYSTEM.



LEGEND

1. Cotter Pin
2. Slotted Nut
3. Washer
4. Pintle Hook Assy
5. Cotter Pin
6. Slotted Nut
7. Bolt
8. Hook Jaw
9. Hook Body
10. Cotter Pin
11. Rivet
12. Chain

Figure 3-21. Pintle Hook Assembly

3-78 PINTLE HOOK

3-78.1 Removal

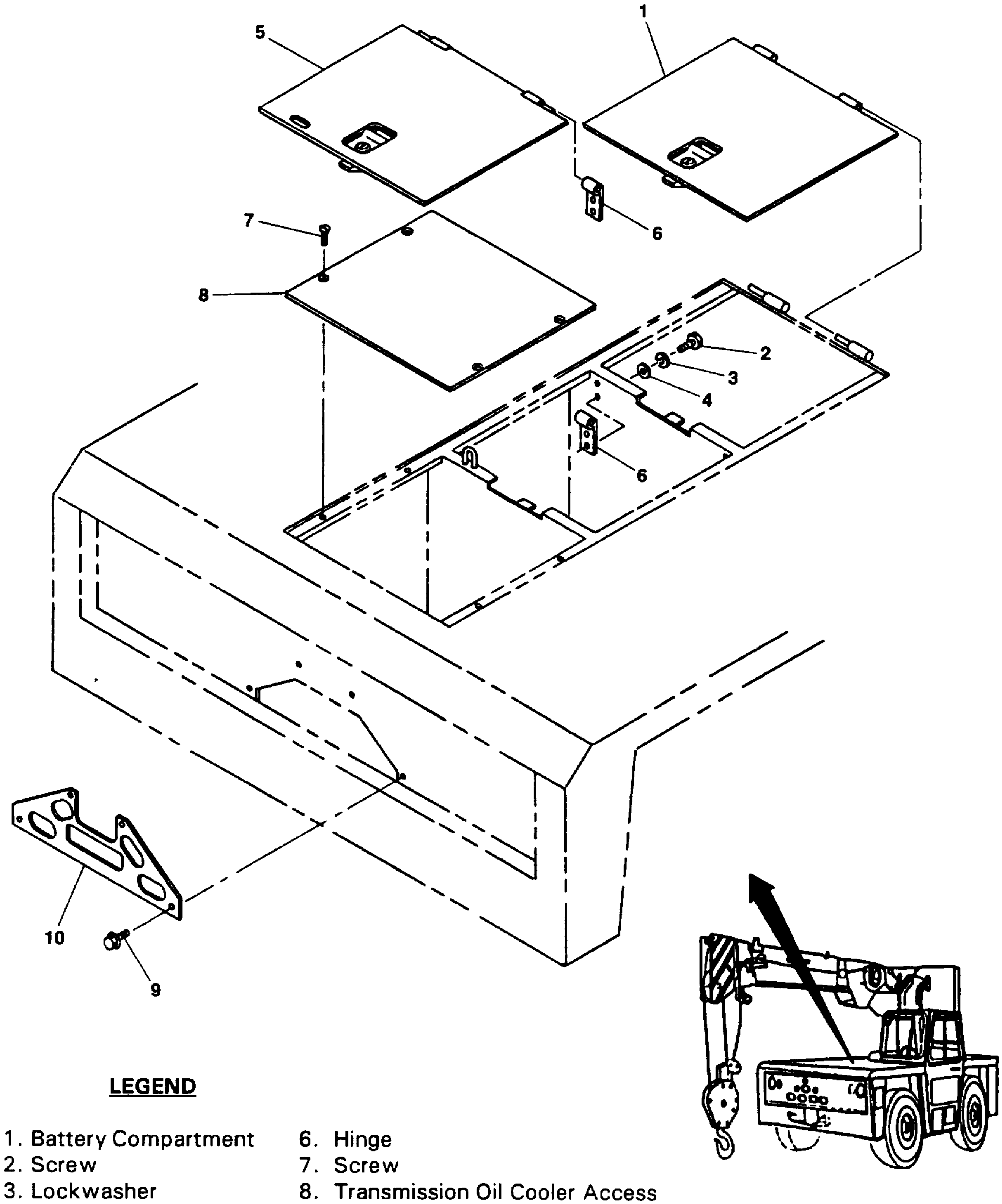
a. Remove radiator, refer to paragraph 3-20.1.
b. Remove cotter pin (1, Figure 3-21), slotted nut (2), washer (3), and pintle hook assembly (4) from crane frame.

3-78.2 Repair

a. Remove cotter pin (5, Figure 3-21), slotted nut (6), bolt (7), and hook jaw (8) from hook body (9).
b. Remove cotter pin (10), rivet (11), and chain (12) from hook body (9).
c. Inspect parts for damage and replace as necessary.
d. Install chain (12) on hook body (9) with rivet (11) and insert cotter pin (10) in chain.
e. Apply anti-seize compound to threads of bolt (7) and install hook jaw (8) on hook body (9) with bolt (7), slotted nut (6). Tighten slotted nut (6) and back off nut until hook jaw (8) will pivot and hole in shaft of bolt (7) aligns with slots in nut (2). Secure slotted nut (2) with new cotter pin (5).

3-78.3 Installation

a. Insert pintle hook assembly (4, Figure 3-21) through crane frame and secure with washer (3) and slotted nut (2). Tighten slotted nut (2), back off nut until pintle hook assembly (4) will rotate, and hole in shaft of hook body (9) aligns with slotted nut (2).
b. Secure slotted nut (2) with new cotter pin (1).
c. Install radiator, refer to paragraph 3-20.2.



<u>LEGEND</u>

1. Battery Compartment
2. Screw
3. Lockwasher
4. Washer
5. Tool Box Compartment
6. Hinge
7. Screw
8. Transmission Oil Cooler Access
9. Screw, Self-tapping
10. Cover Plate

Figure 3-22. Access Covers, Front

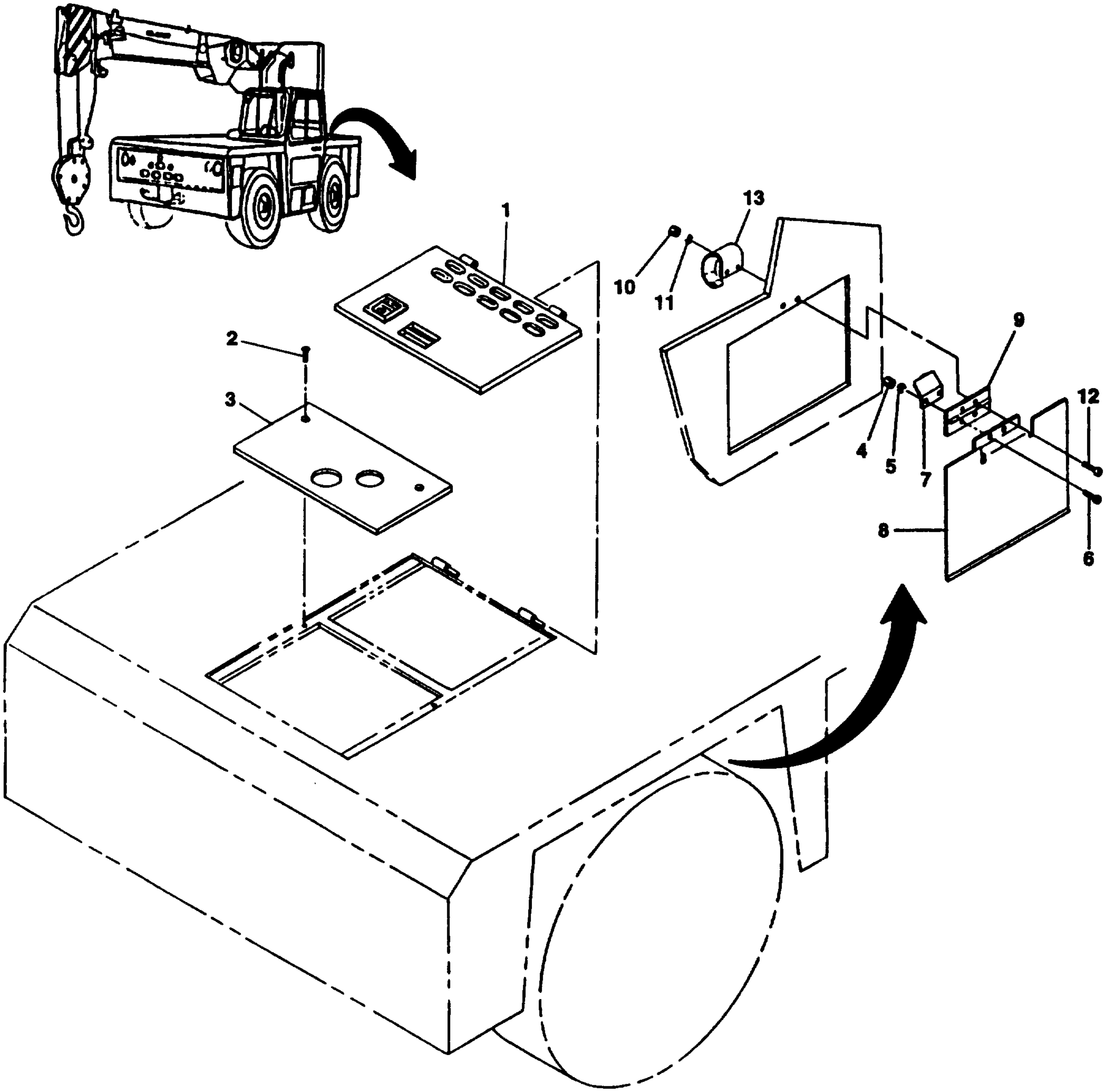
3-79 FRONT ACCESS COVERS

3-79.1 Removal

a. Open cover (1, Figure 3-22) and slide cover off crane deck hinges.
b. Remove four screws (2), four lockwashers (3), four washers (4), and cover (5) from crane deck.
c. Remove two hinges (6) from cover (5).
d. Remove four screws (7) and cover (8) from crane deck.
e. Remove four self-tapping screws (9) and cover plate (10) from crane frame.

3-79.2 Installation

a. Install cover plate (10, Figure 3-22) on crane frame with four self-tapping screws (9).
b. Install cover (8) on crane deck with four screws (7).
c. Slide two hinges (6) onto pins of cover (5).
d. Install cover (5) on crane deck with four screws (2), four lockwashers (3), and four washers (4).
e. Slide cover (1) into crane deck hinges and close cover.



LEGEND

1. Cover	6. Screw	10. Nut
2. Screw, Self-tapping	7. Lower Spring	11. Lockwasher
3. Cover Plate	8. Cover	12. Screw
4. Nut	9. Hinge	13. Upper Spring
5. Lockwasher		

Figure 3-23. Access Covers, Rear

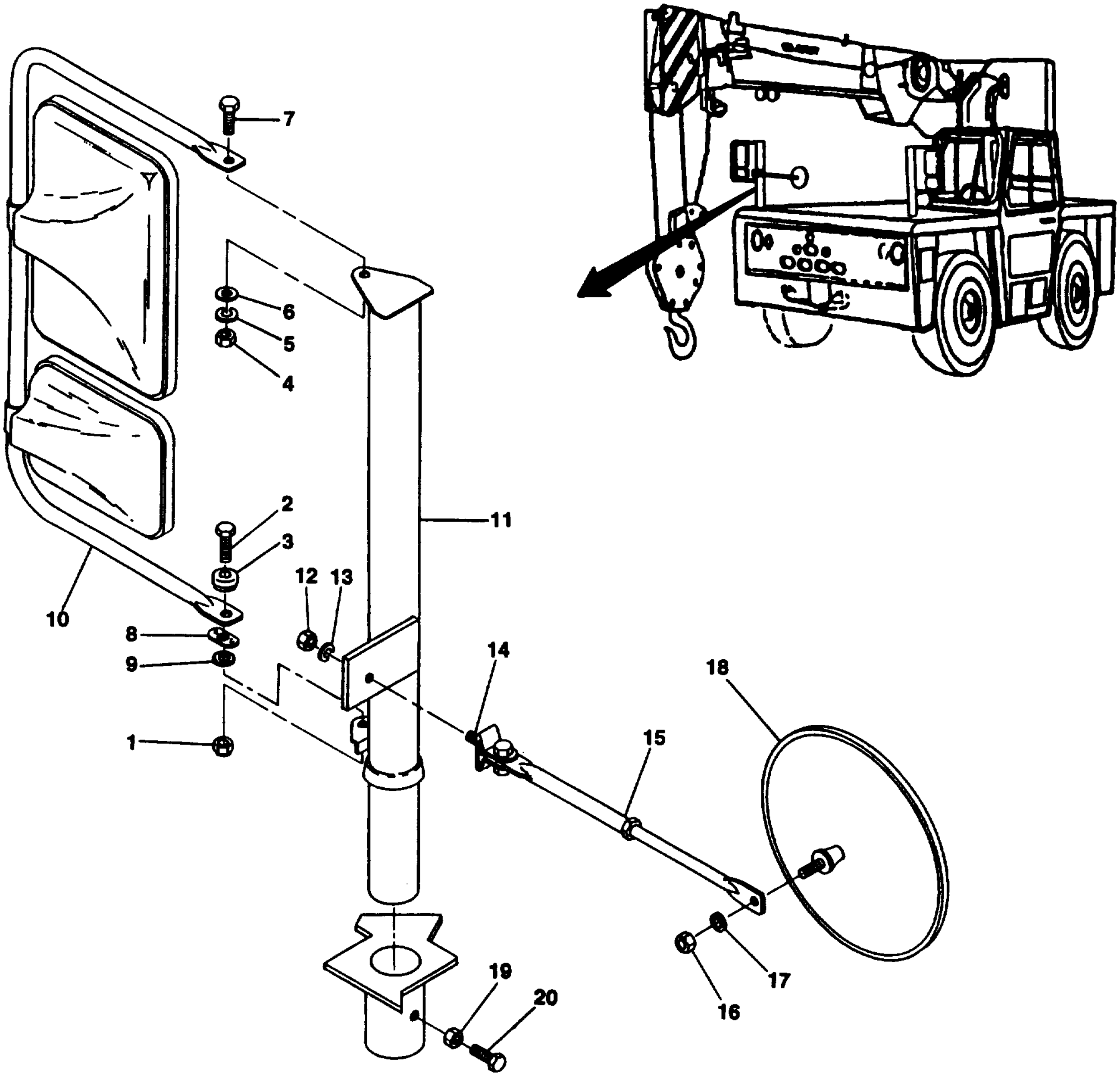
3-80 REAR ACCESS COVERS

3-80.1 Removal

a. Open cover (1, Figure 3-23) and slide cover off crane deck hinges.
b. Remove two self-tapping screws (2) and cover plate (3) from crane deck.
c. Remove two nuts (4), two lockwashers (5), two screws (6), lower spring (7), and cover (8) from hinge (9).
d. Remove two nuts (10), two lockwashers (11), two screws (12), upper spring (13), and hinge (9) from crane frame.

3-80.2 Installation

a. Install hinge (9, Figure 3-23) and upper spring (13) on crane frame with two screws (12), two lockwashers (11), and two nuts (10).
b. Install cover (8) and lower spring (7) on hinge (9) with two screws (6), two lockwashers (5), and two nuts (4).
c. Install cover plate (3) on crane deck with two self-tapping screws (2).
d. Slide cover (1) into crane deck hinges and close cover.



LEGEND

1. Locknut	6. Washer	11. Bracket	16. Nut
2. Screw	7. Screw	12. Nut	17. Lockwasher
3. Cushion Washer	8. Locking Plate	13. Lockwasher	18. Mirror
4. Nut	9. Star Washer	14. Carriage Bolt	19. Jam Nut
5. Lockwasher	10. Mirror Assy	15. Bracket	20. Screw

Figure 3-24. Mirror Assembly, Right Side

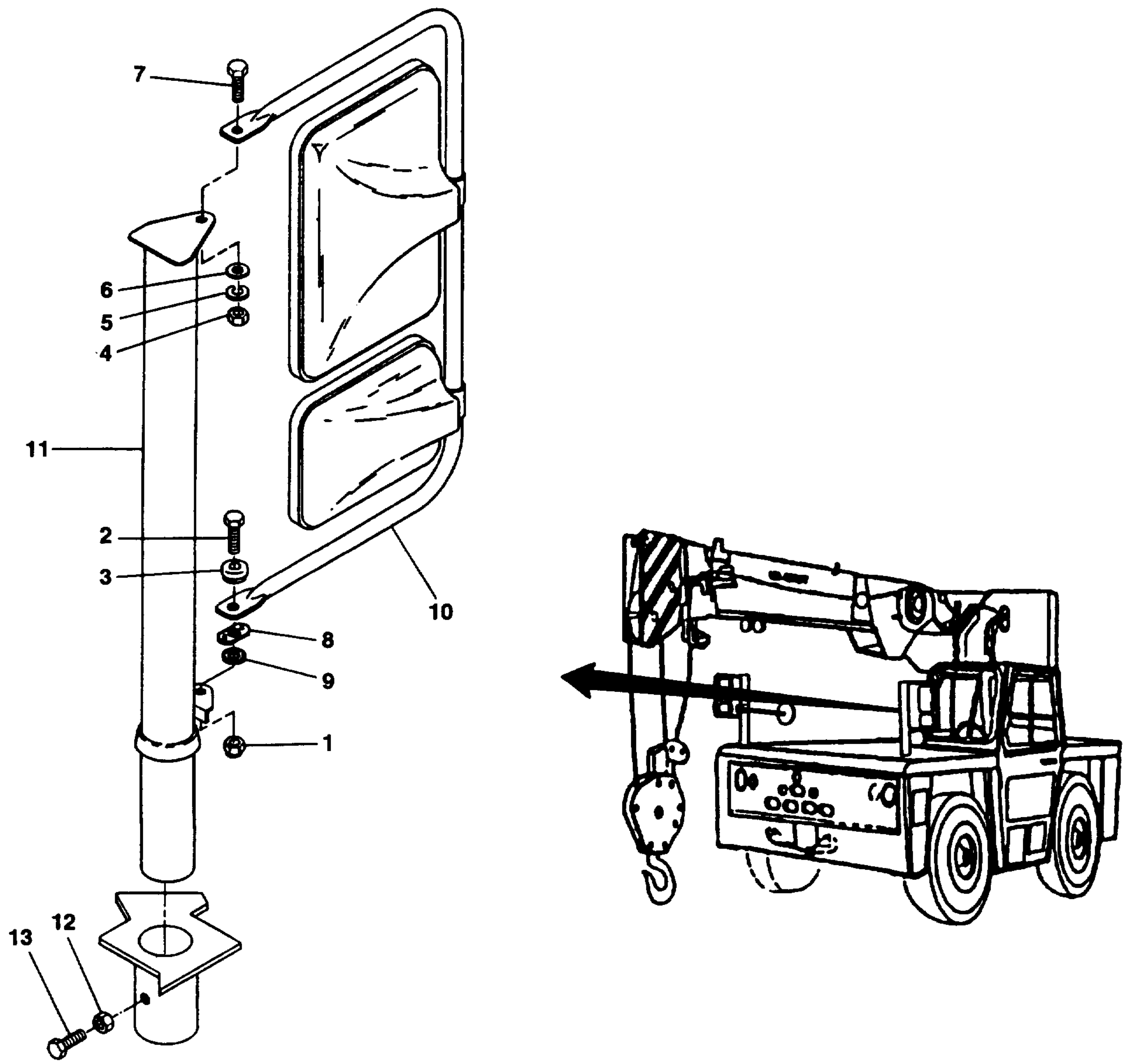
3-81 MIRROR ASSEMBLY (RIGHT SIDE)

3-81.1 Removal

a. Remove locknut (1, Figure 3-24), bolt (2), cushion washer (3), nut (4), lockwasher (5), washer (6), screw (7), locking plate (8), star washer (9), and mirror assembly (10) from bracket (11).
b. Remove hex nut (12), lockwasher (13), carriage bolt (14), and bracket (15) with mirror (18) from bracket (11).
c. Remove nut (16), lockwasher (17), and mirror (18) from bracket (15).
d. Loosen jam nut (19) and screw (20), and remove bracket (11) from socket in crane frame.

3-81.2 Installation

a. Install bracket (11, Figure 3-24) in socket in crane frame and tighten screw (20) and jam nut (19).
b. Install mirror (18) on bracket (15) with lockwasher (17) and nut (16).
c. Install bracket (15) with mirror (18) on bracket (11) with carriage bolt (14), lockwasher (13), and nut (12).
d. Install mirror assembly (10) on bracket (11) with locking plate (8), star washer (9), screw (7), washer (6), lockwasher (5), nut (4), cushion washer (3), bolt (2), and locknut (1).



LEGEND

1. Locknut
2. Screw
3. Cushion washer
4. Nut
5. Lockwasher
6. Washer
7. Screw
8. Locking Plate
9. Star Washer
10. Mirror Assy
11. Bracket
12. Jam Nut
13. Screw

Figure 3-25. Mirror Assembly, Left Side

3-82 MIRROR ASSEMBLY (LEFT SIDE)

3-82.1 Removal

a. Remove locknut (1, Figure 3-25), screw (2), cushion washer (3), nut (4), lockwasher (5), washer (6), screw (7), locking plate (8), star washer (9), and mirror assembly (10) from bracket (11).
b. Loosen jam nut (12) and screw (13), and remove bracket (11) from socket in crane frame.

3-82.2 Installation

a. Install bracket (11, Figure 3-25) in socket in crane frame and tighten screw (13) and jam nut (12).
b. Install mirror assembly (10) on bracket (11) with locking plate (8), star washer (9), screw (7), washer (6), lockwasher (5), nut (4), cushion washer (3), screw (2), and locknut (1).

Section 12. Electrical System

3-83 ELECTRICAL SYSTEM

3-83.1 Description

The electrical system is 12-volt operation with 12-volt starting and consists of an alternator and one lead-acid battery. The system is the single-wire ground return-type, utilizing the machine's structure as ground.

Electrical power is transferred to and from the carrier and superstructure through the electrical swivel. The swivel has ten slip rings. For more detailed information on the electrical swivel, refer to Section 9 - SWIVELS.

The fuse and relay panel is located on the cab wall under the front console.

Electrical schematics and wiring diagrams are located in Appendix F.

The 65-ampere alternator is mounted on the engine and is belt driven. When the engine is running, the alternator supplies the crane electrical leads and the voltage to recharge the batteries and maintain them at a full state of charge.

The 12-volt battery is located in a box to the right front of the cab under the deck cover. The battery is the maintenance-free-type and is completely sealed, except for a small vent hole in the side of the battery. The vent hole allows what small amount of gasses that are produced in the battery to escape.

3-83.2 General Maintenance

Electrical system maintenance includes replacement of damaged components. Standard wiring practices should be observed when replacement is necessary.

WARNING

If it should become necessary to perform electrical maintenance on live or hot circuits, remove all rings, watches, and other jewelry before performing maintenance as serious burns may result from accidental grounding or shorting circuits.

WARNING

Ensure the battery is disconnected before performing any maintenance on an electrical circuit which is not fused. Multimeter resistance and continuity checks should be made with either the wire or component to be checked out of the circuit or the battery cables disconnected from the negative post.

CAUTION

Never replace original wiring with wiring of a smaller diameter.

3-83.3 Troubleshooting

Most troubles associates with the electrical system can be traced to the electrical swivel. Troubles common to the swivel are:

a. Improper mounting.
b. Foreign material between the brushes and slip rings.
c. Incorrect wiring from the swivel to the components.
d. Incorrect wire size.
e. Worn brushes.
f. Improper spring tension on the brush assembly.
g. Loose setscrews on the collector ring assembly.

To isolate electrical troubles, a multimeter should be used. The multimeter, when used properly, can provide readings necessary for service personnel to determine the following:

a. Opens in the electrical system.
b. Resistance in the electrical system.

The following is a list of tools necessary for connector maintenance.

Extraction (Amp)

FOR BLACK CIRCUIT CONNECTORS (AMP)

14 gauge wire - P/N 305183
12 to 8 gauge wire - P/N 91019-3

FOR IN-LINE CONNECTORS (AMP)

4 to 9 circuit - P/N 453300-1
15 circuit- PIN 458944-1

Extraction (Deutsche)

12 gauge wire - P/N 114010
16 gauge wire - P/N 0411-204-1605
8 to 10 gauge wire - P/N 114008
4 to 6 gauge wire - P/N 114009

Crimping (Amp)

	Tool	Die
14 to 12 gauge wire	P/N 69710-1	P/N 90145-1
10 to 8 gauge wire	P/N 69710-1	P/N 90140-1
4 to 9 circuit in-line connectors	P/N 69710-1	P/N 90306-1
15 circuit in-line connectors	P/N 90299-1	

Crimping (Deutsche)

12 gauge wire P/N HDT 12-00
16 gauge wire P/N HDT 16-00
8 to 10 gauge wire P/N HDT 08-00
4 to 6 gauge wire P/N HDT 04-00

Because the pins are crimped to the wires, it is not possible to remove the pin. Using the proper extraction tool, remove the pin(s) from the plug or receptacle. Cut the wire as close to the pin as possible. After cutting the pin off, the wire will most likely be too short. Using a wire that is too short will allow pressure to be applied to the pin and wire where they are crimped when the pin is inserted in the plug or receptacle. Add a short length of the same size wire to the short wire by crimp splice or solder. Use heat shrinkable tubing or other suitable material to insulate the splice.

3-84 ALTERNATOR

3-84.1 Removal

a. Open the engine compartment.
b. Disconnect battery negative leads from battery negative post.
c. Remove the drive belt. See "Drive Belt Removal", in Index of this TM.
d. Disconnect 3-wire plug from 3-wire socket at rear of alternator (Blue-Yellow-Black leads).
e. Remove terminal nut (1, Figure 3-26) and washer (2) from terminal B +. Tag and remove Blue (No. 196) and (No. 5) wire, and blue condenser wire (196) from terminal B +.
f. Tag and disconnect Black (No. 174) and Blue (196) from B- terminal. Leave condenser in place on B- terminal.
g. Remove two capscrews (26) from alternator brace. Remove alternator brace (27) from alternator.
h. Remove one pivot hex flange screw (23) from alternator support bracket (24). Leave bracket (24) attached to engine block.
i. Remove alternator from engine.

3-84.2 Disassembly

a. Remove two terminal nuts (1 and 21, Figure 3-26), two washers (2 and 22), and two screws (3). Move voltage regulator (4) away from rear housing (8), disconnect electrical connector from brush assembly (6), and remove voltage regulator (4).
b. Remove two screws (5) and brush assembly (6) from rear housing (8).

CAUTION

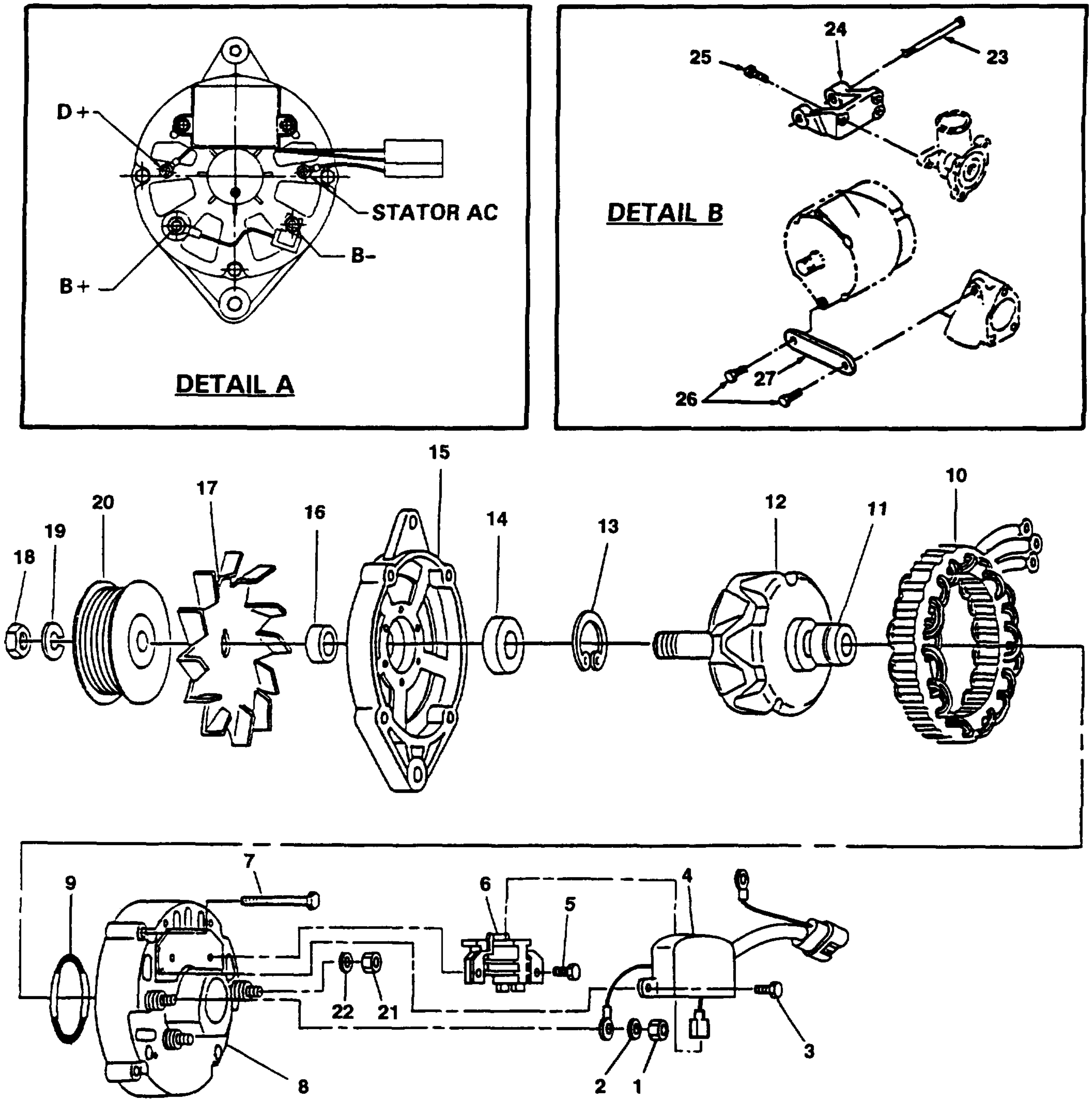
Do not insert screwdriver blades deeper than 1/16 inch (1.587 mm) to avoid damaging stator winding.

c. Match mark front and rear housings, and remove four screws (7). Insert two flat tip screwdrivers in opposite openings between stator (10) and rear housing (8), refer to Figure 3-27.

NOTE

Mark stator (10) location prior to prying apart and removing from front housing (15).

d. Pry units apart and remove rear housing (8, Figure 3-26) and stator (10) from front housing (15).



LEGEND

1. Nut	8. Rear Housing	15. Frt. Housing	22. Washer
2. Washer	9. Retainer	16. Spacer	23. Pivot Hex Flange Screw
3. Screw	10. Stator	17. Fan	24. Support Bracket
4. Voltage Reg.	11. Bearing	18. Nut	25. Screw
5. Screw	12. Rotor Assy	19. Lockwasher	26. Screw, Cap
6. Brush Assy	13. Retainer	20. Pulley	27. Alternator Brace
7. Screw	14. Bearing	21. Nut	

Figure 3-26. Alternator Assembly

NOTE

To remove nut (18), place rotor assembly (12) in a soft-jawed vise.

e. Remove nut (18), lockwasher (19), pulley (20), fan (17), and spacer (16) from rotor assembly (12) shaft.
f. Using arbor press, remove rotor assembly (12) from front housing (15).
g. Remove bearing retainer (1 3) and press bearing (14) from front housing (15).

3-84.3 Inspection

a. Inspect brushes for cracks, grooves on sides, being oil soaked, and that they are at least 0.1875 inch (4.7625 mm) long.
b. Inspect rear housing for cracked or broken casting, stripped threads, and severe wear of rear bearing bore.
c. Inspect fan for cracked or broken fins and for worn mounting hole.
d. Inspect front housing for cracked or broken casting, stripped threads, and bore of mounting foot for elongation.
e. Inspect other components for damage such as broken terminals or insulation, discoloration, stripped threads, and other obvious damage.
f. Replace damaged components as necessary.

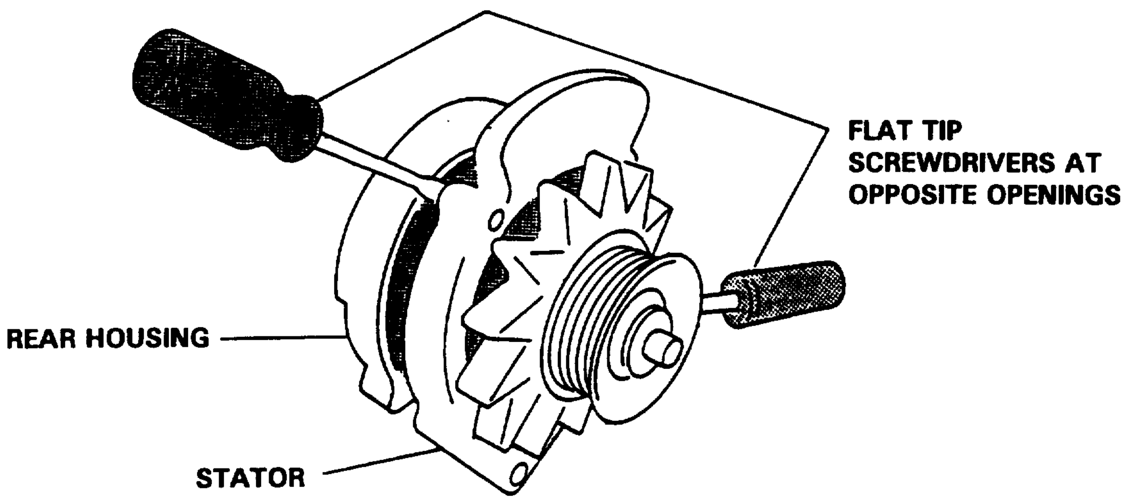


Figure 3-27. Stator and Rear Housing Separation

3-84.4 Testing

a. Set multimeter for ohms and check brush assembly (refer to Figure 3-28) for continuity between mount A and brush B, and terminal C and brush D. Check for open circuits between mount A and terminal C, mount A and brush D, terminal C and brush B, and brush B and brush D, refer to Figure 3-28. Replace brush assembly if indications are other than stated.

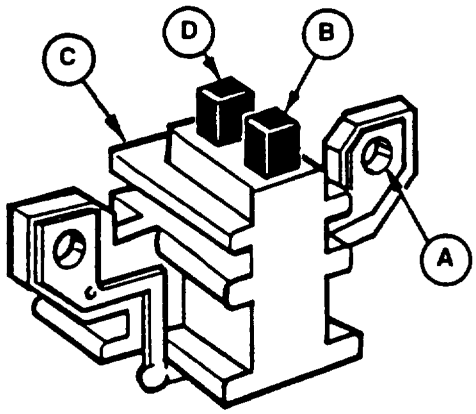


Figure 3-28. Testing Brush Assembly

b. Set multimeter for ohms and check stator for open circuits between point D (lamination) and each terminal A, B, and C, refer to Figure 3-29. If continuity is noted between lamination and any terminal, stator is defective and must be replaced.

c. Set multimeter for ohms and check stator windings for continuity between terminals A-B, A-C, and B-C, refer to Figure 3-29. If open, replace stator.

d. Set multimeter for ohms and check resistance of rotor assembly for 3.0 to 3.6 ohms between slip rings, as shown on Figure 3-30. Also check that open circuits are indicated between pole fingers and each slip ring. Replace entire rotor assembly if indications are other than stated.

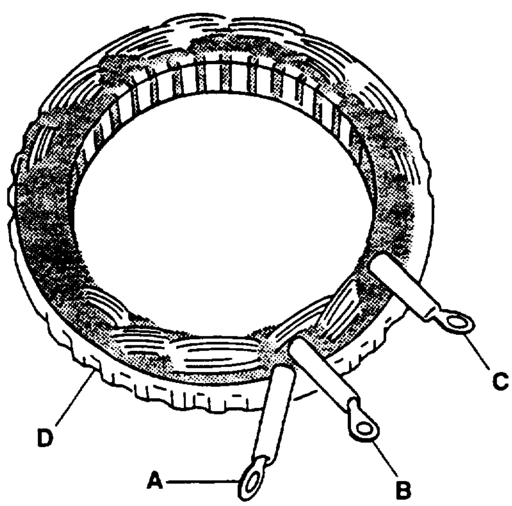


Figure 3-29. Testing Stator Windings

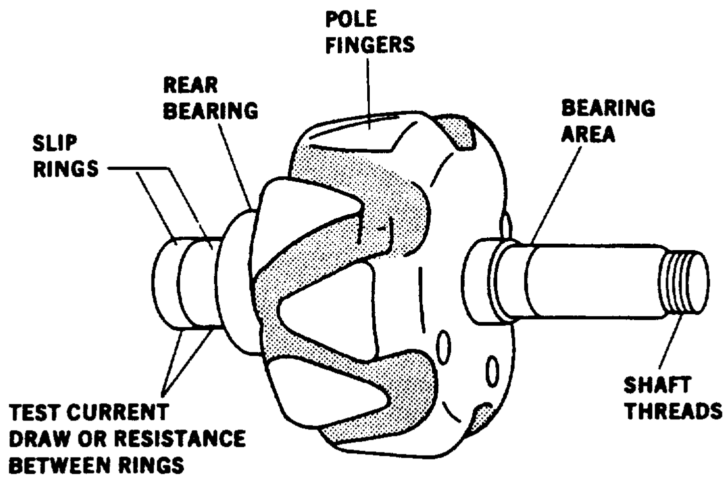


Figure 3-30. Testing Rotor

3-84.5 Assembly

a. Using press, install front bearing (16, Figure 3-26) in front housing (15).
b. Install front bearing retainer (13).
c. Using arbor press, press front housing (15) over rotor assembly (12) until inner bearing race contacts shoulder on shaft.
d. Position pulley spacer (16), fan (17), and pulley (20) on rotor assembly (12) shaft.
e. Install lockwasher (19) and nut (18) on rotor assembly (12) shaft. Place rotor assembly in soft jawed vise and torque nut 40 to 50 lb ft (54 to 68 N-m).
f. Position stator (10) in front housing (15) with stator leads at top and notches in lamination aligned with bolt holes.
g. If damaged, replace retainer (9) in rear housing (8).
h. Position rear housing (8) over slip rings of rotor assembly (12) with front and rear housing bolt holes aligned and stator leads extending through openings at top of rear housing (8).
i. Install four screws (7). Torque screws to 50 to 60 lb ft (67 to 81 Nom).
j. If necessary, remove four screws (7) and rotate rear housing (8) and stator (10) to align housings as match marked on disassembly. Reinstall screws and torque screws to 50 to 60 lb ft (5.65 to 6.78 Nom).
k. Install brush assembly (6) in rear housing (8) with two screws (5).

l. Connect voltage regulator (4) electrical connector to brush assembly (6) and install voltage regulator (4) on rear housing (8) with two screws (3).
m. Connect voltage regulator lead to terminal (D +) with terminal washer (2) and terminal nut (1), refer to Figure 3-26, Detail A for terminal location.
n. Connect jumper wire from voltage regulator harness connector to rear housing terminal (Stator AC) with terminal washer (22) and terminal nut (21), refer to Figure 3-26, Detail A for terminal location.

3-84.6 Installation

a. Position the alternator on the alternator support bracket (24, Figure 3-26) and install the pivot hex flange screw (23). Do not torque the capscrew at this time.
b. Install the alternator link capscrews (26). Torque the screws to 18 lb ft (24 N•m).
c. Torque the pivot hex flange screw (23) to 32 lb ft (44 N•m).
d. Position the belt around the alternator pulley. If necessary, refer to TM 10-3950672-24-2. Maximum deflection should be 0.375 to 0.50 in. (9.5 to 12.7 mm). Gauge pressure should be 80 to 110 lb ft (108 to 149 N•m). If gauge reading is not acceptable, replace automatic belt tensioner, refer to TM 10-3950-672-24-2.
e. Connect the electrical leads to the terminals as tagged during removal.

3-85 BATTERY

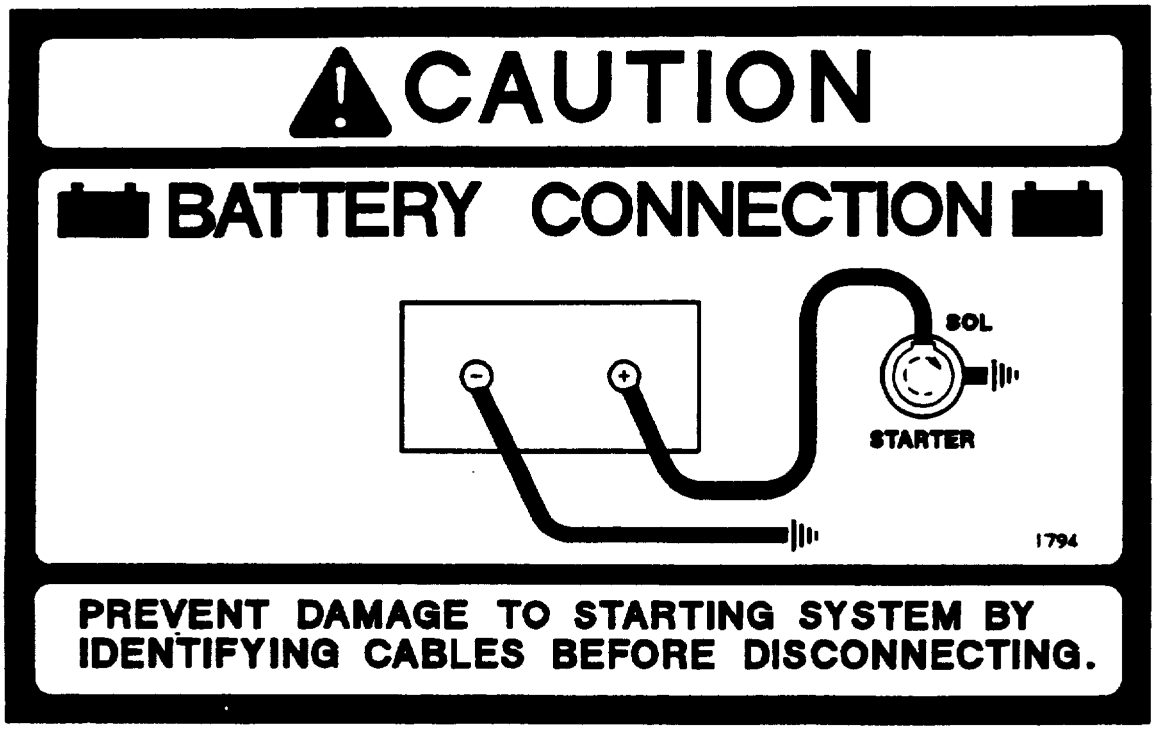
3-85.1 Removal

a. Lift the hinged deck cover.
b. Tag and disconnect wire lugs (4, 15, and 16, Figure 3-31) from the negative terminal (1). Then tag and disconnect wire lugs (5 and 14) at positive terminal (3).
c. Remove the bolt, nut, and lockwasher from the angle bracket holddown rod and remove the angle holddown bracket.
d. Remove the battery.

3-85.2 Installation

a. Install the battery.
b. Install the angle holddown bracket and rod, and secure the rod to the angle with the bolt, nut, and lockwasher.
c. Connect all leads to the battery's terminals starting with the positive wire lugs (5 and 14, Figure 3-31).
d. Close the deck cover.

3-86 BATTERY CABLES



3-86.1 Removal

WARNING

Always disconnect negative battery cable first to reduce chance of shorting and personal injury.

a. Disconnect negative battery cable clamp (1, Figure 3-31) from battery (2).
b. Disconnect positive battery cable clamp (3) from battery (2).
c. Disconnect negative battery cable (4) from crane chassis ground. Remove negative battery cable from crane.
d. Remove nut (6), lockwasher (7), and positive battery cable (5) from starter. Remove positive battery cable (5) from crane.
e. Remove nut (8), lockwasher (9), bolt (10), two wire lugs (15 and 16), and cable clamp (1) from negative battery cable (4).
f. Remove nut (11), lockwasher (12), bolt (13), one wire lug (14), and cable clamp (3) from positive battery cable (5).

3-86.2 Installation

a. Install cable clamp (3, Figure 3-31) and one wire lug (14) on positive battery cable (5) with bolt (13), lockwasher (12), and nut (11).

b. Install cable clamp (1) and two wire lugs (15 and 16) on negative battery cable (4) with bolt (10), lockwasher (9), and nut (8).

c. Position positive battery cable (5) in crane and connect to starter with lockwasher (7) and nut (6).

d. Position negative battery cable in crane and connect to crane chassis ground.

WARNING

Always connect positive battery cable first to reduce chance of shorting and personal injury.

e. Clean positive battery post and connect positive battery cable clamp (3) at battery (2).

f. Clean negative battery post and connect negative battery cable clamp (1) at battery (2).

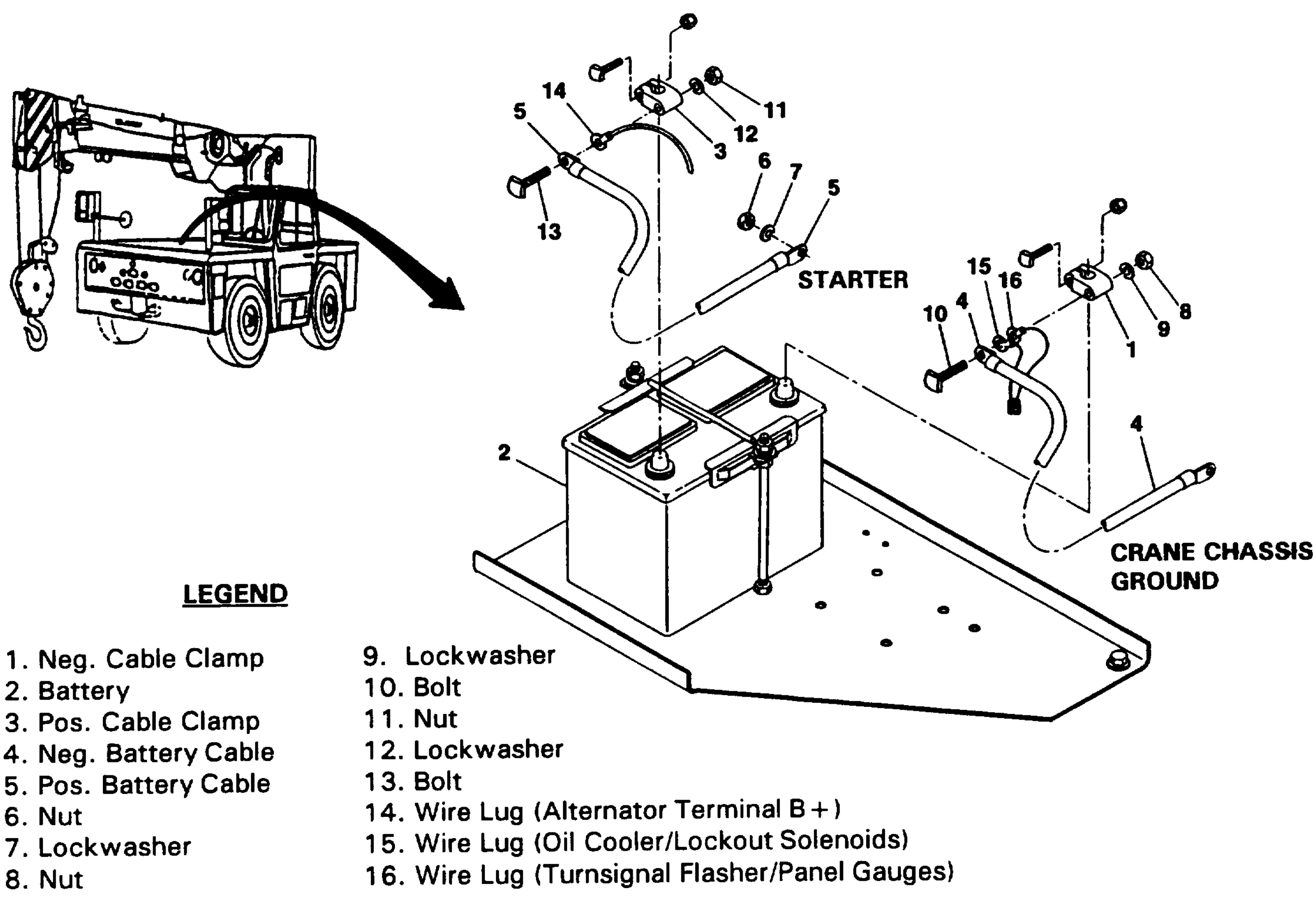


Figure 3-31. Battery Cables

3-87 FUSE AND RELAY PANEL

3-87.1 Removal

a. Disconnect negative leads from negative battery post.
b. Tag and disconnect all leads to both fuse blocks.
c. Tag and disconnect all leads to the terminal blocks.
d. Remove the nuts and lockwashers securing the panel to the cab wall and remove the panel.
e. If necessary, remove the screws, lockwashers, and nuts securing the terminal blocks and fuse blocks.

3-87.2 Installation

a. If removed, install the two fuse blocks and secure with the screws, lockwashers, and nuts.

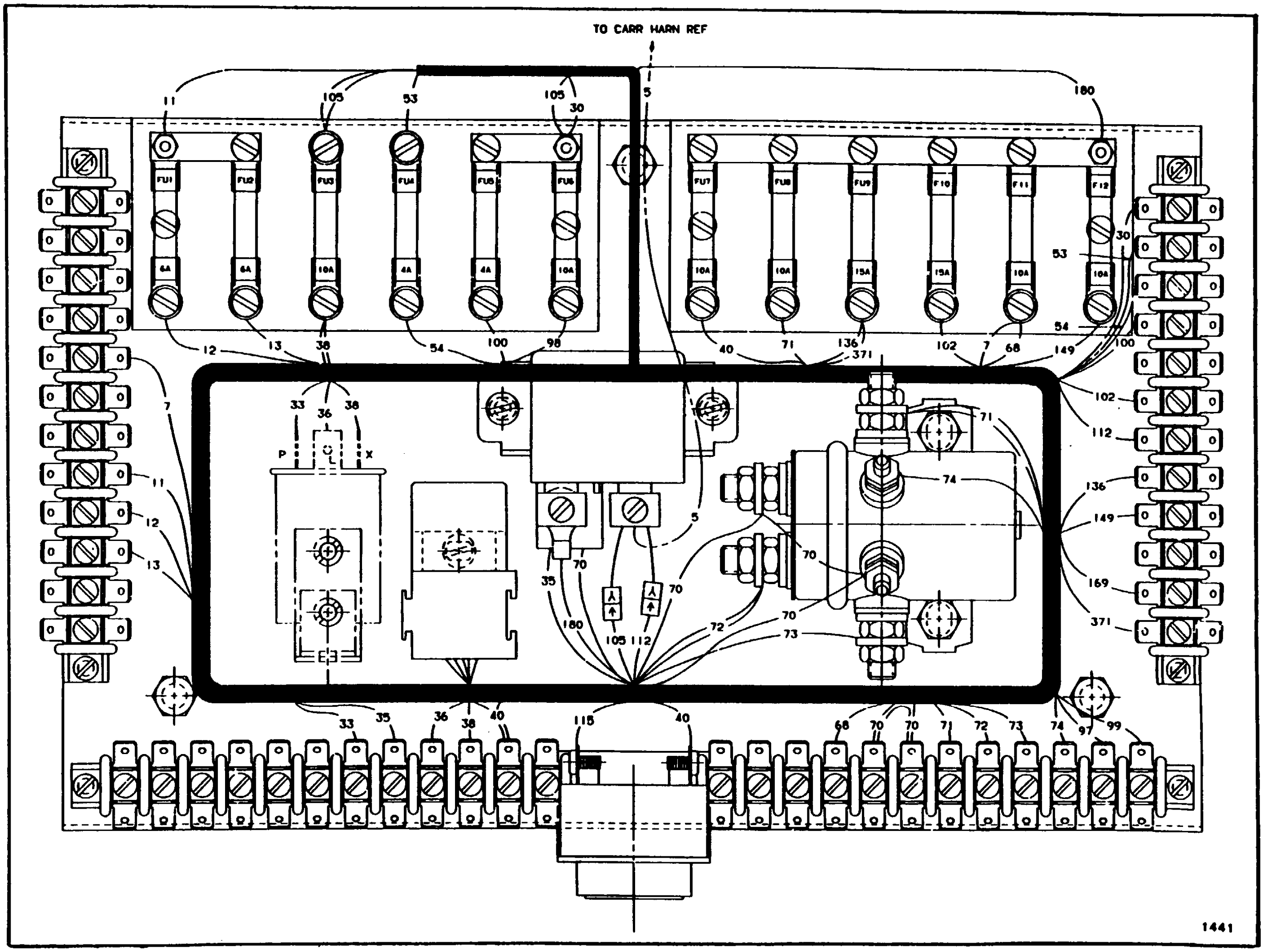
NOTE

Ensure the fuses are of the proper amperage before placing in the fuse blocks.

b. If removed, install the fuses in the fuse blocks.
c. If removed, install the terminal blocks and secure with the screws, lockwashers, and nuts.
d. Install the panel to the cab wall and secure with the nuts and lockwashers.
e. Connect the leads to the terminal blocks as tagged during removal.
f. Connect the leads to the fuse blocks as tagged during removal.
g. Connect negative leads to battery negative post.

FUSE DATA

Fuse No.	Amps	Circuits
FU1	6	Left Headlights; Work Lights
FU2	6	Right Headlights; Work Lights
FU3	10	Stop Lights, Turnsignals; Taillights
FU4	4	Gauge Lights
FU5	4	Boom Floor Lights
FU6	10	Horn; Backup Lights
FU7	10	Dome Light; Gauge Lights; A2B; Engine Distress
FU8	10	A2B
FU9	15	Oil Fan; Gearshift
FU10	15	Cab Fan; Heater Fan; Spotlight
FU11	10	Windshield Wiper

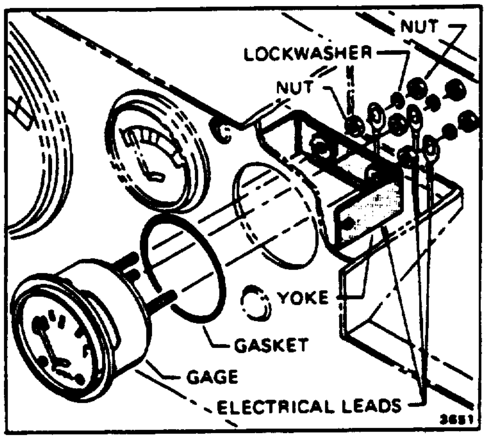


Fuse and Relay Panel (Sheet 1 of 2)

3-88 INSTRUMENTS

3-88.1 Removal

a. Disconnect negative leads from negative battery post.
b. Remove the nuts, washers, and screws securing the cover to the front of the console. Remove the cover and disconnect the worklight connector and lay the cover aside.
c. Remove the hardware securing the gauge to the instrument panel; then remove the gauge.
d. Tag and disconnect the electrical leads to the gauge, then tape the lead ends.



Instrument Removal and Installation

3-88.2 Inspection

a. Examine gauges for cracked and broken lenses. Check gauge terminals and mounting studs for damage.
b. Check wiring for damaged insulation or damaged terminals.

3-88.3 Installation

a. Connect the electrical leads as marked prior to removal.
b. Place the gauge into position on the panel and secure it with the attaching hardware.
c. Position the cab front cover plate and secure with the screws, washers, and nuts.
d. Connect negative leads to battery negative post.

3-88.4 Functional Check

Start the engine and observe for proper functioning of the repaired indicator. Refer to operators manual, TM 10-3950-672-10. Troubleshoot further as necessary, any system malfunction not corrected by repair or replacement of the indicator or associated wiring.

3-89 ELECTRICAL SWITCHES

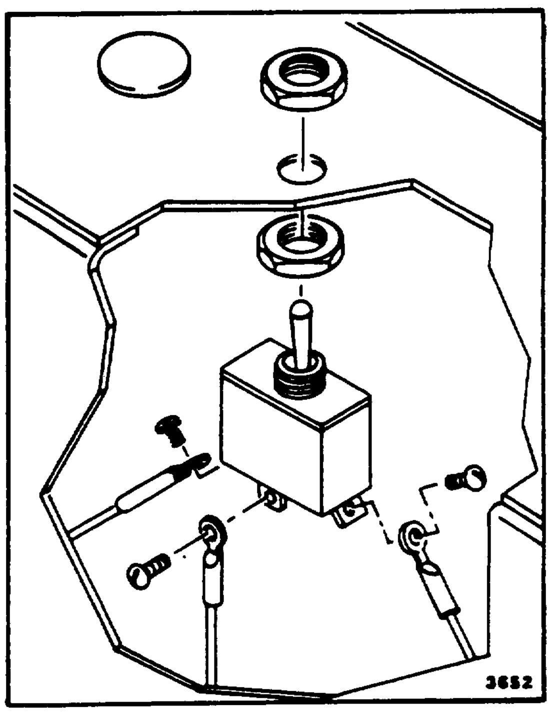
3-89.1 Removal

a. Disconnect negative leads to negative battery post.
b. Gain access to the front console as described under Instrument Removal.
c. Remove the hardware securing the switch to the console; then remove the switch.
d. Tag and disconnect the leads from the switch; then tape the lead ends.

3-89.2 Inspection

a. Visually check the switch for evidence of cracks, damaged connections, or other damage.
b. Check wiring for damaged insulation or damaged terminals.
c. Perform the following check to determine switch serviceability.

(1) Using an ohmmeter, check for continuity between the switch terminals with switch in ON or activated position.
(2) Position switch to OFF. Ohmmeter should register zero (no continuity).



Electrical Switch Removal and Installation

3-89.3 Installation

a. Connect the electrical leads as marked prior to removal.
b. Position the switch on the panel and secure it with the attaching hardware.
c. Install the cab front console cover.
d. Connect negative leads to battery negative post.

3-89.4 Functional Check

Operate the switch as described in the operators manual, TM 10-3950-672-10. Observe it for proper functioning in the applicable circuit. Continue troubleshooting as necessary any system or circuit malfunction not corrected by repair or replacement of the switch or associated wiring.

3-90 CLEARANCE LIGHT

3-90.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Disconnect light assembly (1, Figure 3-32) electrical connector from crane electrical harness.
c. Unsnap lens (2) and remove two nuts (3), two lockwashers (4), two screws (5), and light assembly (1) from crane frame.
d. Remove two bulbs (6) from light assembly (1).

3-90.2 Installation

a. Install two bulbs (6, Figure 3-32) in light assembly (1).
b. Install light assembly (1) in crane frame with two screws (5), two lockwashers (4), and two nuts (3).
c. Snap lens (2) on light assembly (1) and connect electrical connector to crane electrical harness.
d. Connect negative battery cable and two electrical leads to battery.

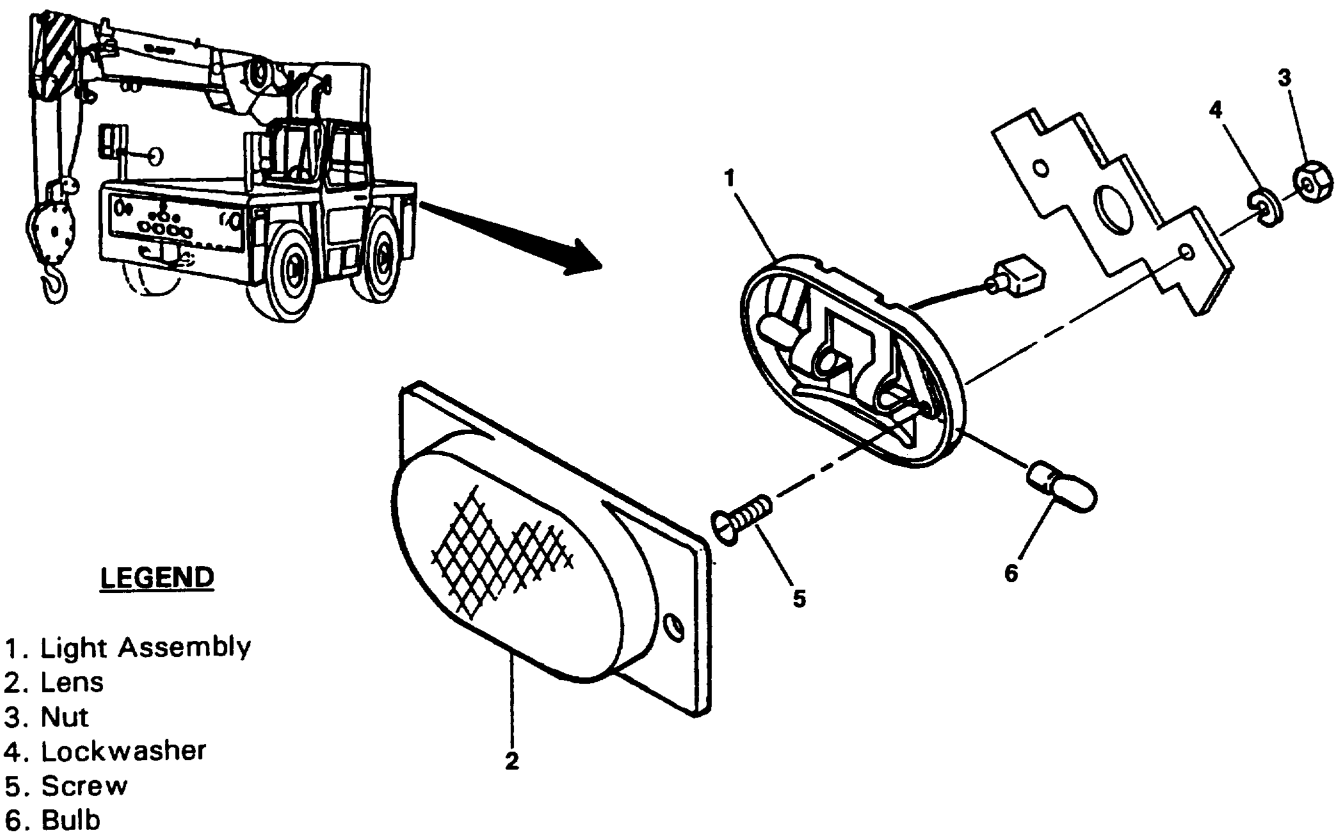
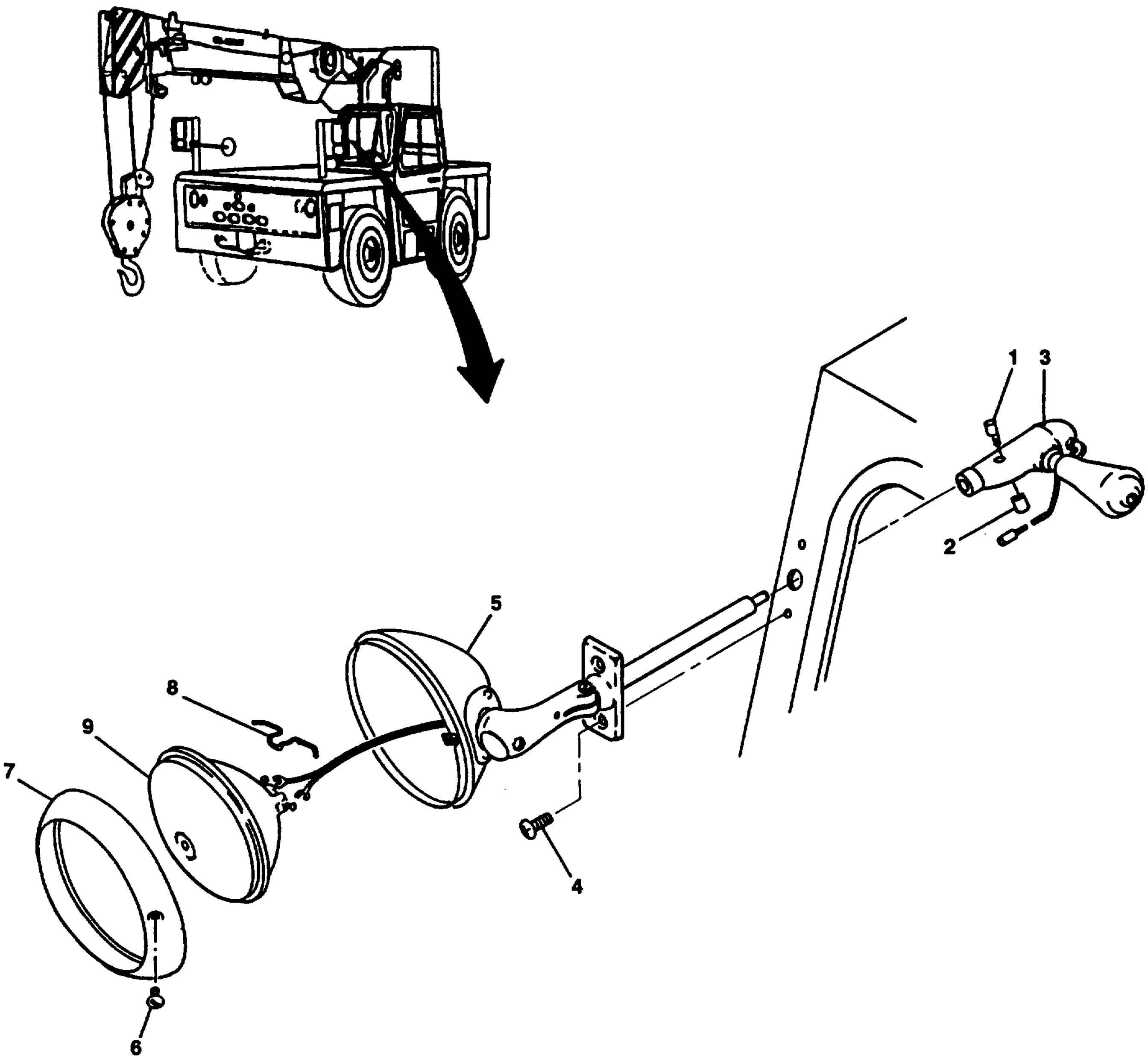


Figure 3-32. Clearance Light



LEGEND

1. Bolt
2. Cylindrical nut
3. Handle
4. Screw
5. Shaft and Light Assy
6. Screw
7. Retaining Ring
8. Retainer
9. Sealed Beam

Figure 3-33. Spotlight

3-91 SPOTLIGHT

3-91.1 Removal

a. Disconnect negative leads from negative battery post.
b. Disconnect spotlight assembly electrical connector from crane electrical harness.
c. Remove bolt (1, Figure 3-33) and cylindrical nut (2), and separate handle (3) from shaft and light assembly (5).
d. Remove two screws (4) and pull shaft and light assembly (5) from cab frame.
e. Remove screw (5), retaining ring (6), four retainers (clips) (8), two electrical leads, and sealed beam (7) from shaft and light assembly.
f. Remove four retainers (8) and separate retaining ring (7) and sealed beam (9).

3-91.2 Installation

a. Install sealed beam (9, Figure 3-33) in retaining ring (7) and secure with four retainers (8).
b. Position sealed beam (9) with retaining ring (7) to shaft and light assembly (5), connect two electrical leads, and secure assembly with screw (6).
c. Push shaft and light assembly (5) through cab frame and secure with two screws (4).
d. Install handle (3) on shaft and light assembly (5) with bolt (1) and cylindrical nut (2).
e. Connect spotlight assembly electrical connector to crane electrical harness.
f. Connect negative leads to battery negative post.

3-92 DOME LIGHT

NOTE

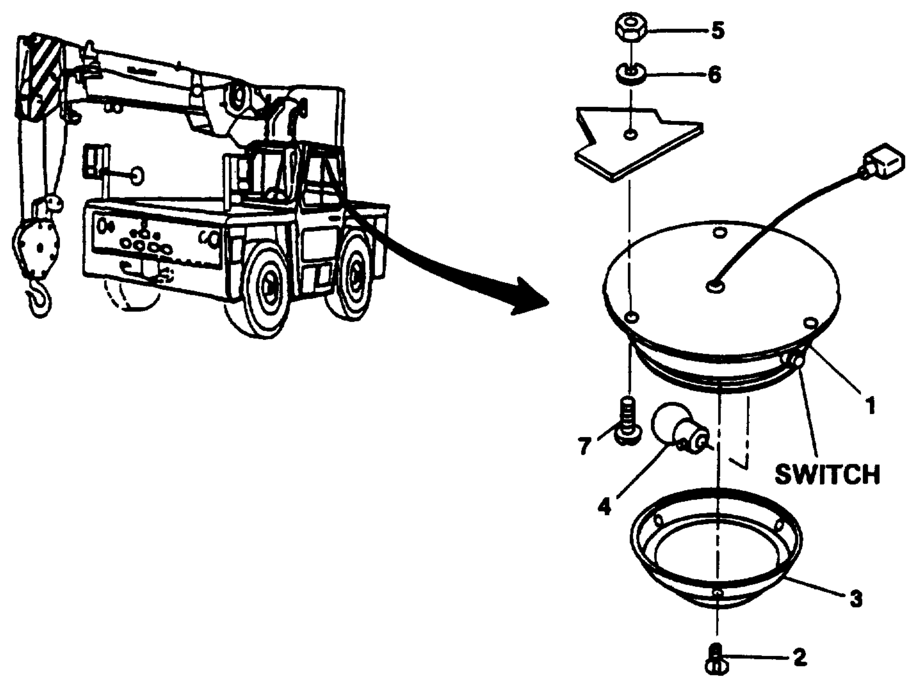
The dome light switch which is integral to the base (1, Figure 3-34) is not replaceable. If damaged, replace the entire dome light assembly.

3-92.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Disconnect electrical connector from crane electrical harness.
c. Remove three screws (2, Figure 3-34), lens (3), and bulb (4) from dome light base (1).
d. Remove three nuts (5), three lockwashers (6), three screws (7), and dome light base (1) from cab frame.

3-92.2 Installation

a. Install dome light base (1, Figure 3-34) on cab frame with three screws (7), three lockwashers (6), and three nuts (5).
b. Install bulb (4) and lens (3) in dome light base (1) with three screws (2).
c. Connect electrical connector to crane electrical harness.
d. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Light Assy
2. Screw
3. Lens
4. Bulb
5. Nut
6. Lockwasher
7. Screw

Figure 3-34. Dome Light

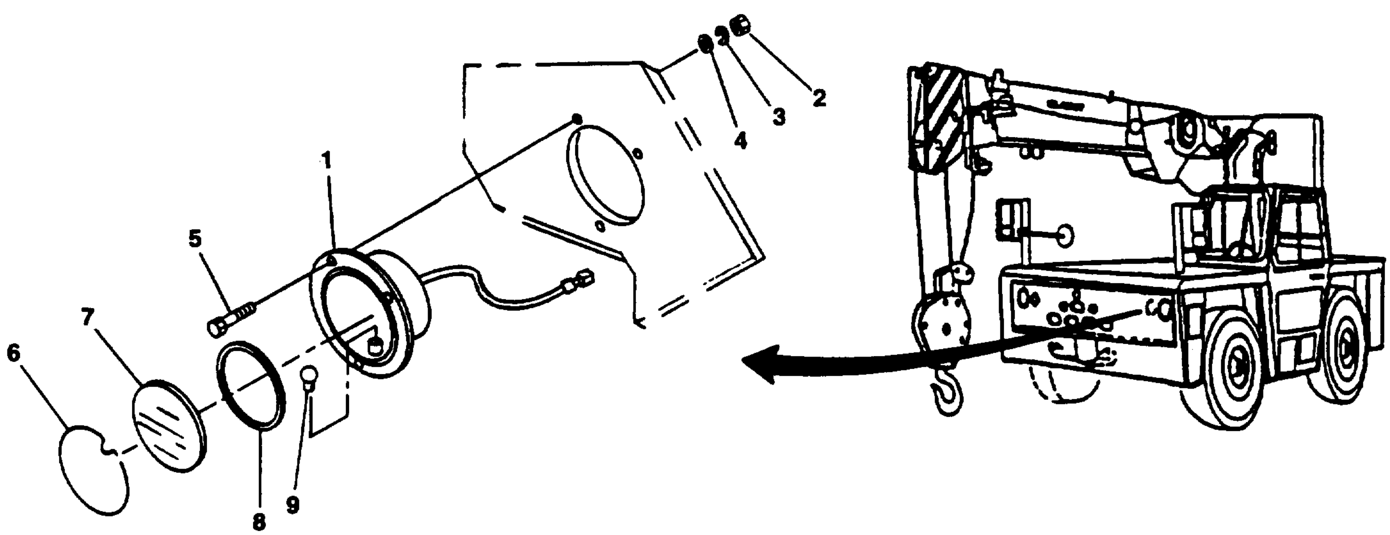
3-93 TURN SIGNAL LIGHT (FRONT)

3-93.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Disconnect light assembly (1, Figure 3-35) electrical connector from crane electrical harness.
c. Remove three nuts (2), three lockwashers (3), three washers (4), three bolts (5), and light assembly (1) from crane frame.
d. Remove retaining ring (6), lens (7), gasket (8), and bulb (9) from light assembly (1).

3-93.2 Installation

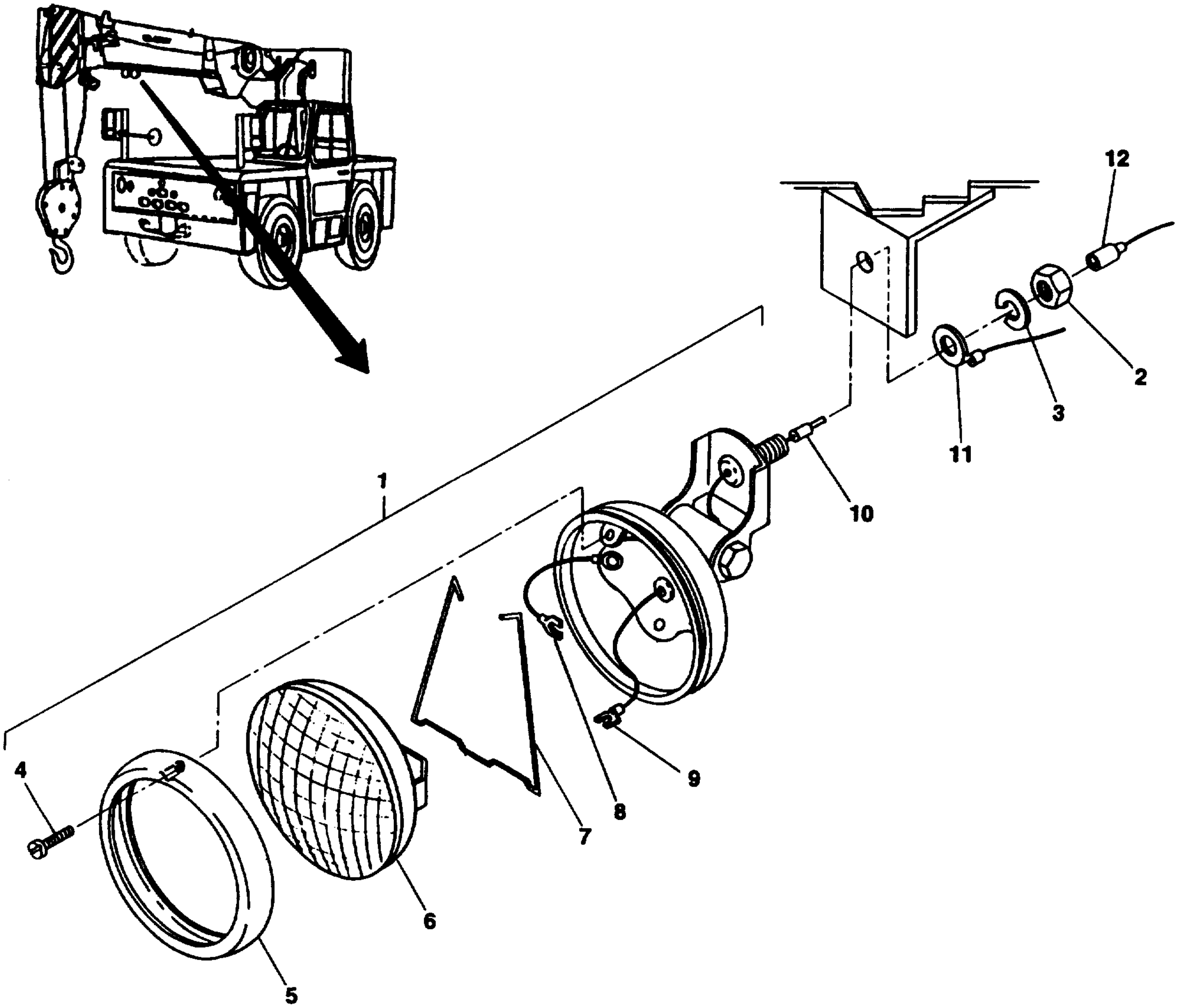
a. Install bulb (9, Figure 3-35), gasket (8), lens (7), and retaining ring (6) in light assembly (1).
b. Install light assembly (1) in crane frame with three bolts (5), three washers (4), three lockwashers (3), and three nuts (2).
c. Connect light assembly (1) electrical connector to crane electrical harness.
d. Connect negative battery cable and two electrical leads to battery.



LEGEND

1. Light Assy
2. Nut
3. Lockwasher
4. Washer
5. Bolt
6. Retaining Ring
7. Lens
8. Gasket
9. Bulb

Figure 3-35. Turn Signal Light



LEGEND

1. Boom Light Assy
2. Nut
3. Lockwasher
4. Screw
5. Retaining Ring
6. Sealed Beam
7. Retainer
8. Ground Lead
9. Power Lead
10. Power Connector
11. Harness Ground Wire
12. Harness Receptacle

Figure 3-36. Boom Light

3-94 BOOM LIGHT

3-94.1 Removal

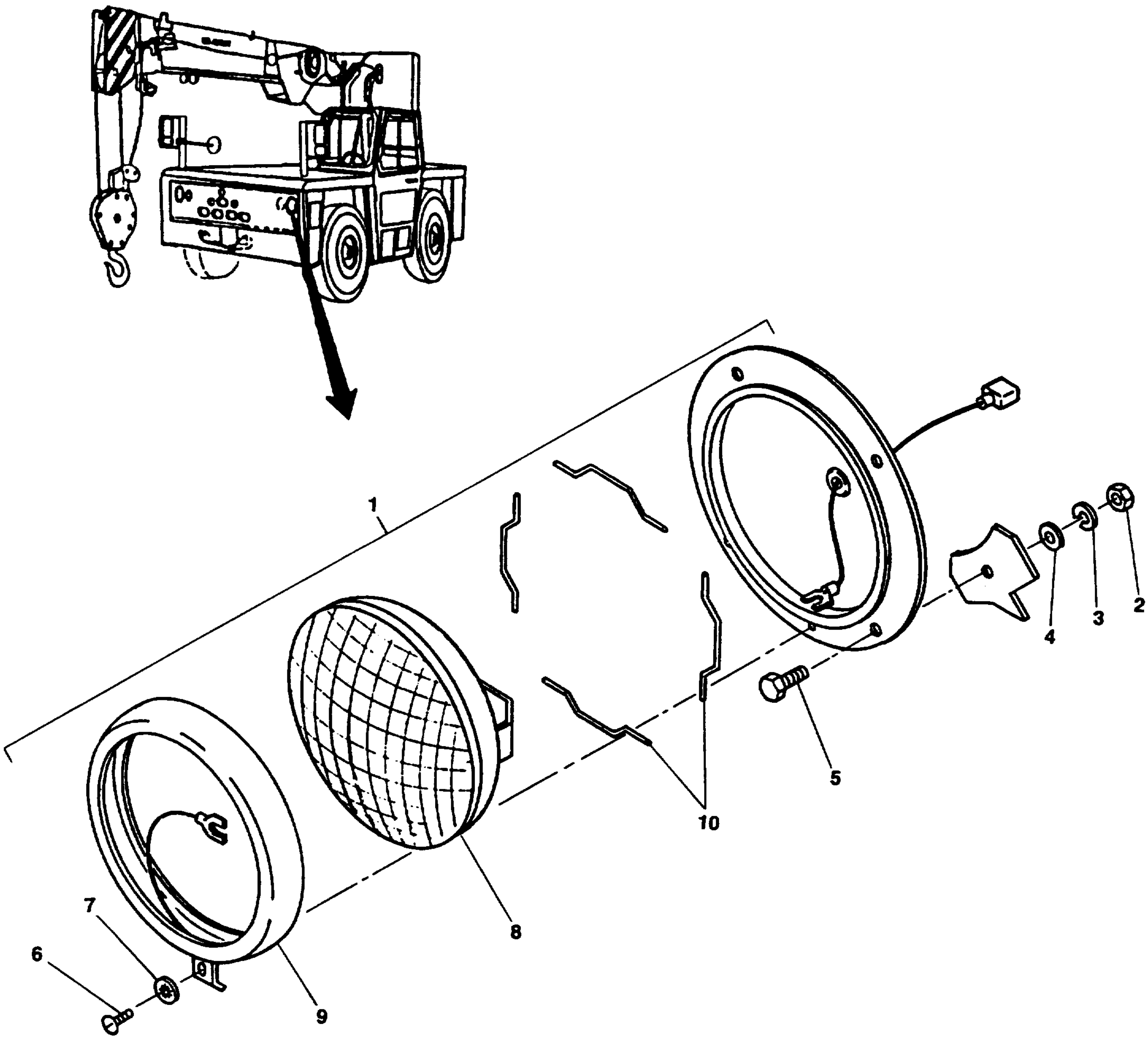
a. Disconnect negative leads from negative battery post.
b. Disconnect boom light assembly (1, Figure 3-36) electrical connector (10) from crane electrical harness receptacle (12).
c. Remove nut (2), lockwasher (3), harness ground wire (11), and boom light assembly (1) from mounting bracket.
d. Remove screw (4), disconnect two electrical leads (8 and 9), and remove sealed beam (6) with retaining ring (5) from boom light assembly (1).
e. Remove retainer (7) and separate retaining ring (5) from sealed beam (6).

3-94.2 Installation

NOTE

Align tabs on retaining ring (5, Figure 3-36) with boss on sealed beam (6).

a. Install retaining ring (5) on sealed beam (6) and secure with retainer (7).
b. Position sealed beam (6) with retaining ring (5) to boom light assembly (1), connect two electrical leads (8 and 9), and secure with screw (4).
c. Install boom light assembly (1) on mounting bracket, position harness ground wire (11) on mounting stud, and secure assembly with lockwasher (3) and nut (2).
d. Connect boom light assembly (1) electrical connector (10) to crane electrical harness receptacle (12).
e. Connect negative leads to battery negative post.



LEGEND

1. Light Assy	6. Screw
2. Nut	7. Star Washer
3. Lockwasher	8. Sealed Beam
4. Washer	9. Retaining Ring
5. Bolt	10. Retainer

Figure 3-37. Headlight/Back-up Light

3-95 HEADLIGHT/BACK-UP LIGHT

3-95.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Disconnect light assembly (1, Figure 3-37) electrical connector from crane electrical harness.
c. Remove four nuts (2), four lockwashers (3), four washers (4), four bolts (5), and light assembly (1) from crane frame.
d. Remove screw (6) and star washer (7), disconnect two electrical leads, and remove sealed beam (8) with retaining ring (9) from light assembly (1).
e. Remove four retainers (10) and separate retaining ring (9) from sealed beam (8).

3-95.2 Installation

NOTE

Align tabs on retaining ring (9, Figure 3-37) with boss on sealed beam (8).

a. Install retaining ring (9) on sealed beam (8) and secure with four retainers (10).
b. Position sealed beam (8) with retaining ring (9) to light assembly (1), connect two electrical leads, and secure with screw (6) and star washer (7).
c. Install light assembly (1) in crane frame with four bolts (5), four washers (4), four lockwashers (3), and four nuts (2).
d. Connect light assembly (1) electrical connector to crane electrical harness.
e. Connect negative battery cable and two electrical leads to battery.

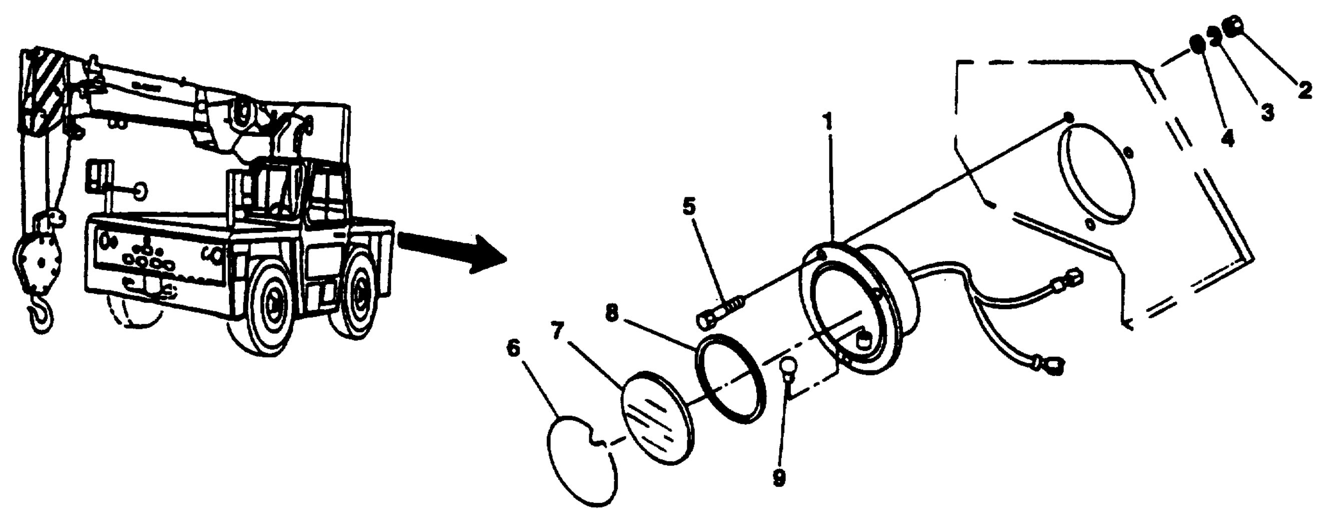
3-96 TAIL, BRAKE, AND TURN SIGNAL LIGHT

3-96.1 Removal

a. Disconnect negative leads from negative battery post.
b. Disconnect two electrical connectors for light assembly (1, Figure 3-38) from crane electrical harness.
c. Remove three nuts (2), three lockwashers (3), three washers (4), three bolts (5), and light assembly (1) from crane frame.
d. Remove retaining ring (6), lens (7), gasket (8), and bulb (9) from light assembly (1).

3-96.2 Installation

a. Install bulb (9, Figure 3-38), gasket (8), lens (7), and retaining ring (6) in light assembly (1).
b. Install light assembly (1) in crane frame with three bolts (5), three washers (4), three lockwashers (3), and three nuts (2).
c. Connect two electrical connectors for light assembly (1) to crane electrical harness.
d. Connect negative leads to battery negative post.



LEGEND

1. Light Assy	6. Retaining Ring
2. Nut	7. Lens
3. Lockwasher	8. Gasket
4. Washer	9. Bulb
5. Bolt	

Figure 3-38. Tail, Brake, and Turn Signal Light

3-97 BACK-UP ALARM

3-97.1 Removal

a. Disconnect negative battery cable and two electrical leads from battery.
b. Tag and disconnect two electrical leads from back-up alarm (1, Figure 3-39).
c. Remove two nuts (2), two lockwashers (3), two washers (4), and back-up alarm (1) from crane frame.

3-97.2 Installation

a. Install back-up alarm (1, Figure 3-39) on crane frame with two washers (4), two lockwashers (3), and two nuts (2).
b. Connect two electrical leads to back-up alarm (1) and remove tags.
c. Connect negative battery cable and two electrical leads to battery.

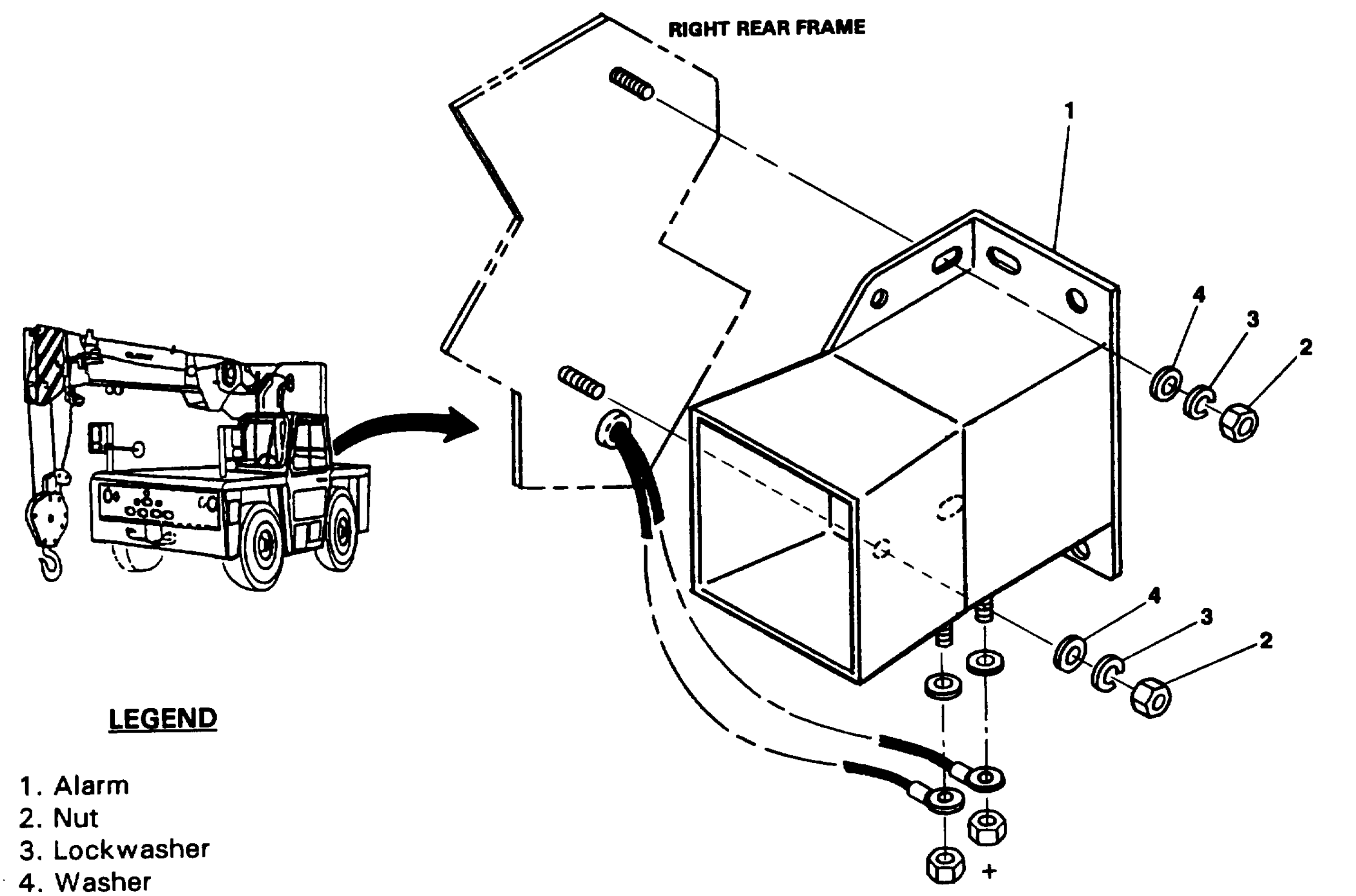


Figure 3-39. Back-up Alarm

3-98 CHASSIS WIRING HARNESS

3-98.1 Removal

NOTE

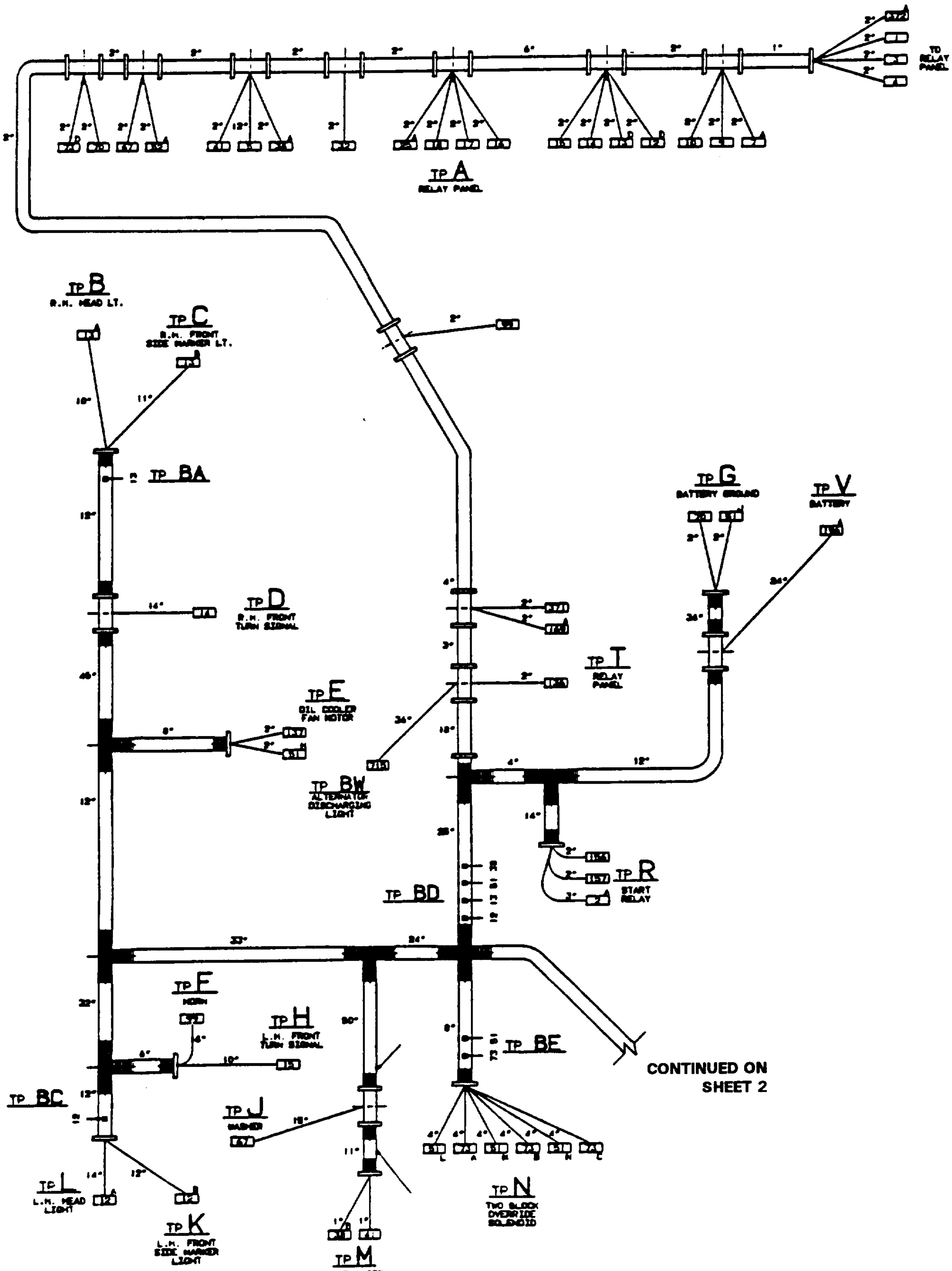
To aid removal, refer to electrical schematic in Appendix F.

a. Disconnect negative battery cable 150 and wires 70 and 51 J from negative battery post.
b. Tag and disconnect wire 13A from right headlight.
c. Tag and disconnect wire 13B from right front side marker light.
d. Tag and disconnect wire 14 from right front turn signal light.
e. Tag and disconnect wire 12A from left headlight.
f. Tag and disconnect wire 12B from left front side marker light.
g. Tag and disconnect wire 15 from left front turn signal light.
h. Tag and disconnect wire 99 from horn.

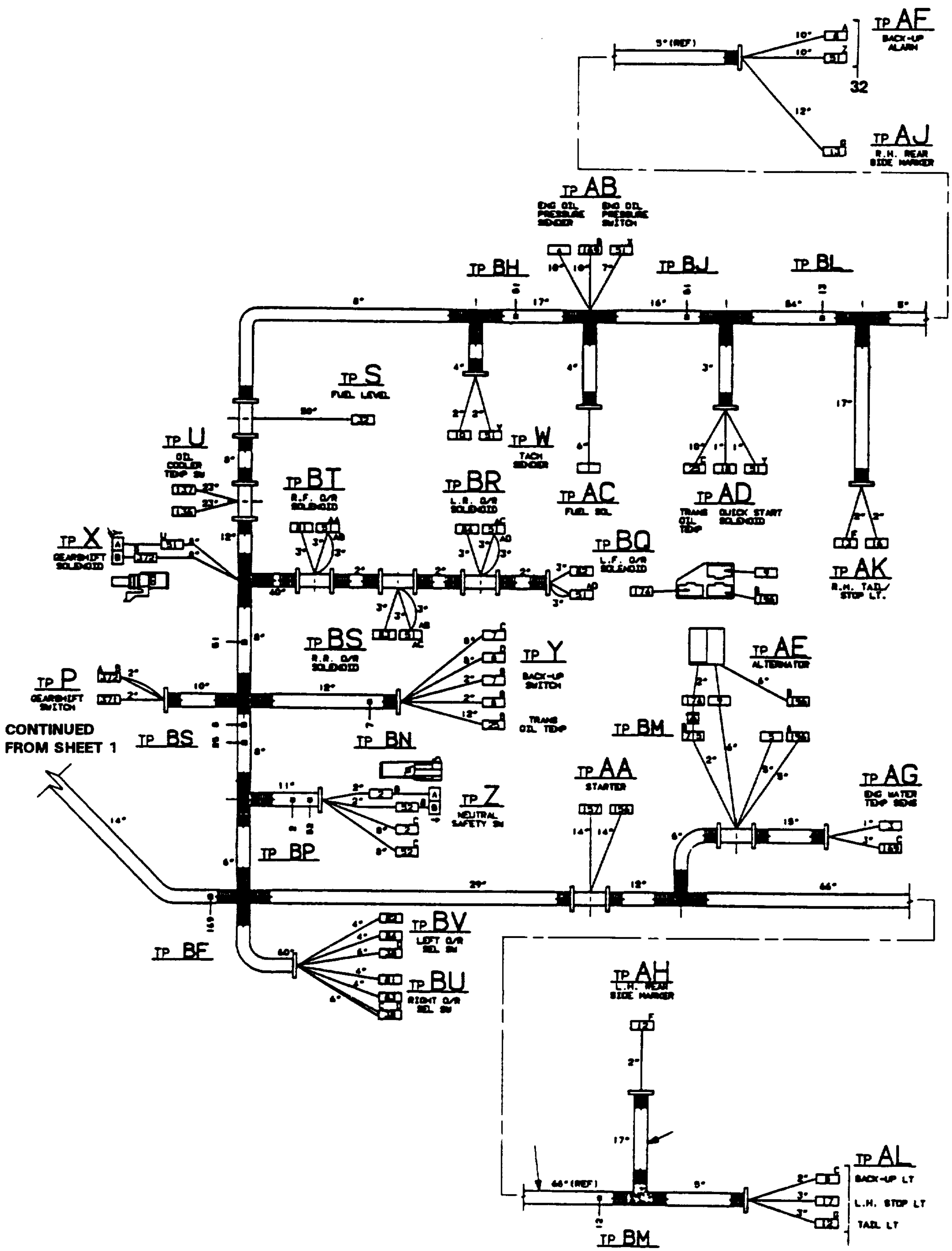
NOTE

All wires numbered 51 (various suffixes) are common ground.

i. Tag and disconnect wires 137 and 51 H from oil cooler fan motor.
j. Tag and disconnect wire 715 from alternator discharging light.
k. Tag and disconnect wires 38 and 41 from brake switch.
l. Tag and disconnect wires 73, 70, 67, 52A, 41, 5, 38A, 32, 25A, 18, 17, 16, 15, 14, 13D, 12D, 10, 9, 7A, 372A, 1, 3, 4, 99, 371, 169A, and 136 from crane relay panel.
m. Tag and disconnect wires 51 L, 73A, 51 M, 73B, 51N, and 73C from two-block override solenoid.
n. Tag and disconnect wires 156, 157, and 2A from starter relay.
o. Tag and disconnect wire 1 96A from battery connector.
p. Tag and disconnect wires 137 and 136 from oil cooler temperature switch.
q. Tag and disconnect connector from gearshift solenoid.



Chassis Wiring Harness (Sheet 1 of 2)



Chassis Wiring Harness (Sheet 2 of 2)

r. Tag and disconnect wires 372A, 372B, and 371 from gearshift switch.
s. Tag and disconnect wires 82, 84, and 38D from left outrigger selector switch.
t. Tag and disconnect wires 81, 83, 38C, and 38D from right outrigger selector switch.
u. Tag and disconnect wires 81, 51AA, and 51AB from right front outrigger solenoid.
v. Tag and disconnect wires 84, 51 AC, and 51AD from left rear outrigger solenoid.
w. Tag and disconnect wires 82 and 51 AD from left front outrigger solenoid.
x. Tag and disconnect wires 83, 51AB, and 51AC from right rear outrigger solenoid.
y. Tag and disconnect wires 7C, 8D, 7B, and 8B from backup switch.
z. Tag and disconnect wire 25B from transmission oil temperature switch.
aa. Tag and disconnect connector and wires 2C and 52C from neutral safety switch.
bb. Tag and disconnect wires 1 0 and 51V from tachometer sender.
cc. Tag and disconnect wires 4 and 1 69B from engine oil pressure sender.
dd. Tag and disconnect wire 51X from engine oil pressure switch.
ee. Tag and disconnect wire 1 from fuel solenoid.
ff. Tag and disconnect wires 157 and 156 from starter.
gg. Tag and disconnect connector and wires 1 96B, 5, and 1 96A from alternator.
hh. Tag and disconnect wires 3 and 1 69C from engine water temperature sensor.
ii. Tag and disconnect wire 32 from fuel level switch.
jj. Tag and disconnect wires 18 and 51Y from quick start solenoid.
kk. Tag and disconnect wire 25C from transmission oil temperature switch.
II. Tag and disconnect wires 1 3F and 16 from right tail/stoplight.
mm. Tag and disconnect wire 1 3G from right rear side marker light.
nn. Tag and disconnect wires 8A and 51Z from backup alarm.
oo. Tag and disconnect wires 17 and 1 2G from left tail/stoplight.
pp. Tag and disconnect wire 8C from backup light.

qq. Tag and disconnect wire 1 2F from left rear side marker light.
rr. Remove wire ties and/or clamps securing harness to crane and remove chassis harness.

3-98.2 Installation

NOTE
To aid installation, refer to electrical schematic in Appendix F.

a. Position chassis harness in crane.
b. Connect wire 1 2F to left rear side marker light and remove tag.
c. Connect wire 8C to backup light and remove tag.
d. Connect wires 17 and 12G to left tail/stoplight and remove tag.
e. Connect wires 8A and 51Z to backup alarm and remove tag.
f. Connect wire 1 3G to right rear side marker light and remove tag.
g. Connect wires 1 3F and 16 to right tail/stoplight and remove tag.
h. Connect wire 25C to transmission oil temperature switch and remove tag.
i. Connect wires 18 and 51Y to quick start solenoid and remove tag.
j. Connect wire 32 to fuel level switch and remove tag.
k. Connect wires 3 and 1 69C to engine water temperature sensor and remove tag.
l. Connect wires 1 96B, 5, and 1 96A to alternator terminal B + and connect multi-pin connector to alternator and remove tag.
m. Connect wires 157 and 156 to starter and remove tag.
n. Connect wire 1 to fuel solenoid and remove tag.
o. Connect wire 51X to engine oil pressure switch and remove tag.
p. Connect wires 4 and 169B to engine oil pressure sender and remove tag.
q. Connect wires 10 and 51V to tachometer sender and remove tag.
r. Connect wires 2C and 52C and connector to neutral safety switch and remove tag.
s. Connect wire 25B to transmission oil temperature switch and remove tag.

t. Connect wires 7C, 8D, 7B, and 8B to backup switch and remove tag.
u. Connect wires 83, 51 AB, and 51 AC to right rear outrigger solenoid and remove tag.
v. Connect wires 82 and 51AD to left front outrigger solenoid and remove tag.
w. Connect wires 84, 51 AC, and 51AD to left rear outrigger solenoid and remove tag.
x. Connect wires 81, 51 AA, and 51 AB to right front outrigger solenoid and remove tag.
y. Connect wires 81, 83, 38C, and 38D to right outrigger selector switch and remove tag.
z. Connect wires 82, 84, and 38D to left outrigger selector switch and remove tag.
aa. Connect wires 372A, 372B, and 371 to gearshift switch and remove tag.
bb. Connect connector to gearshift solenoid and remove tag.
cc. Connect wires 1 37 and 1 36 to oil cooler temperature switch and remove tag.
dd. Connect wire 1 96A to battery connector and remove tag.
ee. Connect wires 156, 157, and 2A to starter relay and remove tag.
ff. Connect wires 51L, 73A, 51 M, 73B, 51N, and 73C to two-block override solenoid and remove tag.
gg. Connect wires 73, 70, 67, 52A, 41, 5, 38A, 32, 25A, 18, 17, 16, 15, 14, 13D, 12D, 10, 9, 7A, 372A, 1, 3, 4, 99, 371, 1 69A, and 1 36 to crane relay panel and remove tag.
hh. Connect wires 38 and 41 to brake switch and remove tag.
ii. Connect wire 715 to alternator discharging light and remove tag.
jj. Connect wires 137 and 51 H to oil cooler fan motor and remove tag.
kk. Connect wire 99 to horn and remove tag.
ll. Connect wire 15 to left front turn signal light and remove tag.
mm. Connect wire 12B to left front side marker light and remove tag.
nn. Connect wire 12A to left headlight and remove tag.
oo. Connect wire 14 to right front turn signal light and remove tag.
pp. Connect wire 1 3B to right front side marker light and remove tag.

qq. Connect wire 1 3A to right headlight and remove tag.

rr. Secure harness to chassis with wire ties as necessary to prevent chafing and interference with other components. Install any clamps that were removed.

ss. Connect negative battery cable 150 and wires 70 and 51J to negative battery post.

3-99 STARTER

3-99.1 Test

Testing Starter Motor (Installed)

a. Make sure battery is fully charged and that all battery and starter cables are serviceable and properly installed.

b. Connect a multimeter as shown in Figure 3-40. Momentarily connect a jumper as shown in Figure 3-40. Multimeter should indicate battery voltage and starter should crank engine. If multimeter does not read battery voltage, the starter relay is defective. If multimeter indicates battery voltage, but starter does not operate, starter is defective.

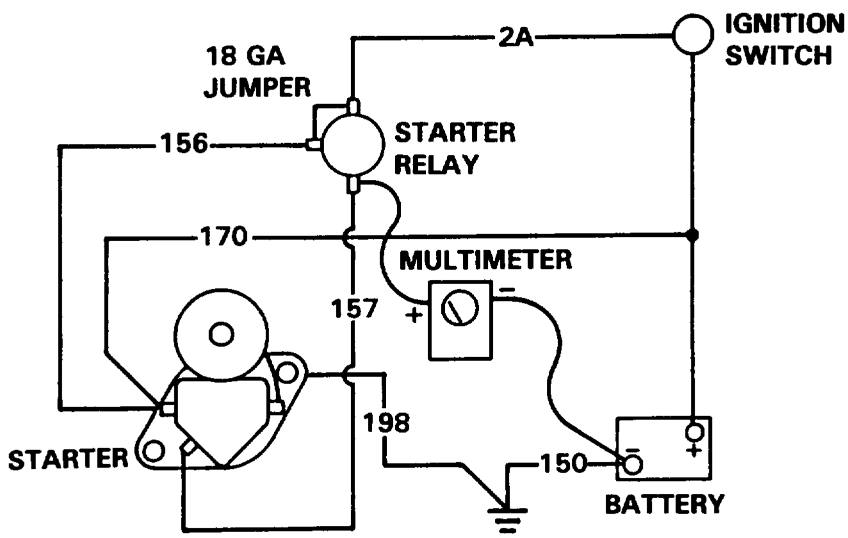


Figure 3-40. Starter Relay Test Circuit

Testing Starter Components

a. Using a growler tester, place armature on it and hold a-hack saw blade against armature core while slowly rotating armature. A short circuited armature causes blade to vibrate and be attracted to core. An armature which is short circuited must be replaced.

b. Set multimeter for ohms and touch one probe to a commutator segment and other probe to armature core, refer to Figure 3-41. There should be no continuity. If there is continuity, armature is grounded. Replace armature if grounded.

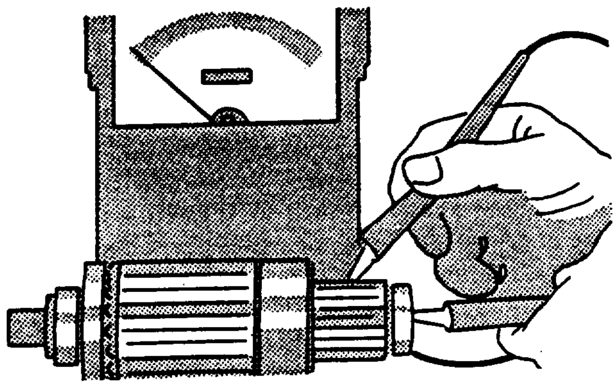


Figure 3-41. Testing for Grounded Windings

c. Set multimeter for ohms and touch probes to two segments, refer to Figure 3-42. There should be continuity at any point. If there is no continuity, winding is open circuited. Replace armature if open circuited.

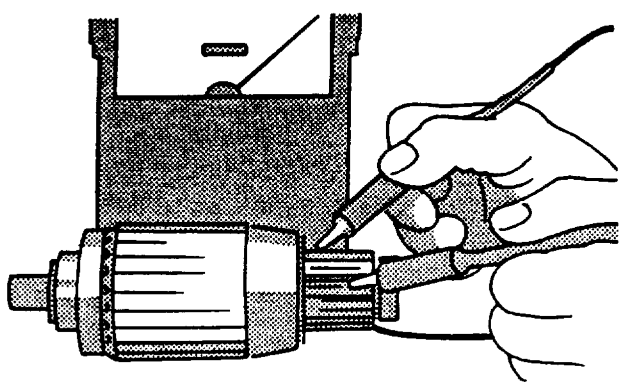


Figure 3-42. Checking for Open Circuit Windings

d. Set multimeter for ohms and touch one probe to positive brush holder plate and other probe to the holder plate, refer to Figure 3-43. There should be no continuity. If there is continuity, replace brush holder.

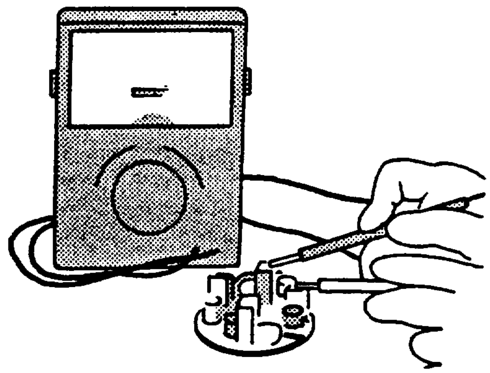


Figure 3-43. Checking Brush Holder

e. Using a multimeter, touch one probe to field winding end of brush and other probe to bare surface of yoke body, refer to Figure 3-44. There should be no continuity. If there is continuity, field windings are grounded. Replace yoke assembly.

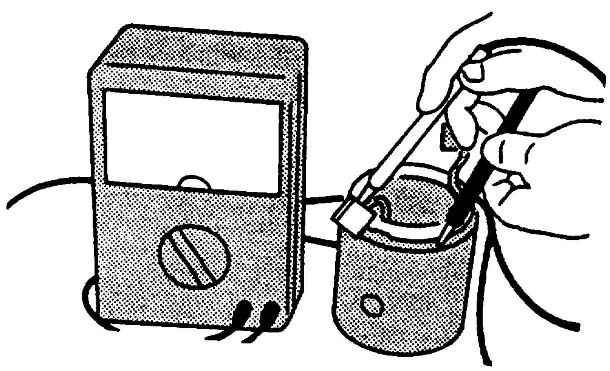


Figure 3-44. Checking Field Coils

f. Using a multimeter, touch one probe to lead wire and other probe to brush, refer to Figure 3-45. There should be continuity. If there is no continuity, field windings are open circuited. Replace yoke assembly

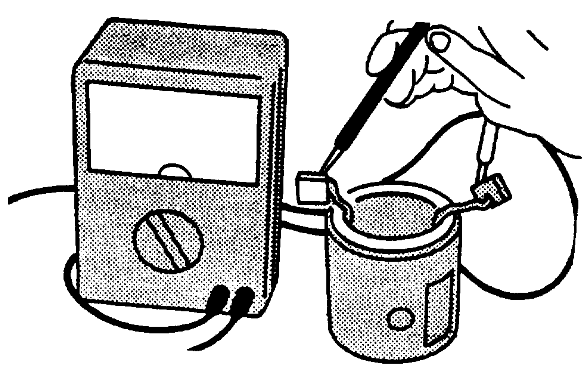


Figure 3-45. Checking for Open Field Coil

3-99.2 Bench Test

NOTE

Refer to TM 10-3950-672-24-2 Electrical Section for starter removal and installation data.

a. Turn overrunning clutch (19, Figure 3-47) clockwise by hand. Pinion (19) should turn freely.
b. Turn overrunning clutch counterclockwise. A definite resistance should be felt. If a definite resistance is not felt, clutch assembly is defective, disassemble the starter clutch.
c. If armature turns freely and the clutch is not defective, test starter under no-load conditions.

CAUTION

Do not conduct the no-load test unless the armature turns freely.

d. Connect a 12 VDC source (A) to starter battery terminal (B) and starter frame (C). Use heavy duty cables, refer to Figure 3-46.

A - 12-VOLT BATTERY
B - BATTERY TERMINAL
C - STARTER FRAME
D - REMOTE START SWITCH (STARTING RELAY)
E - SWITCH TERMINAL

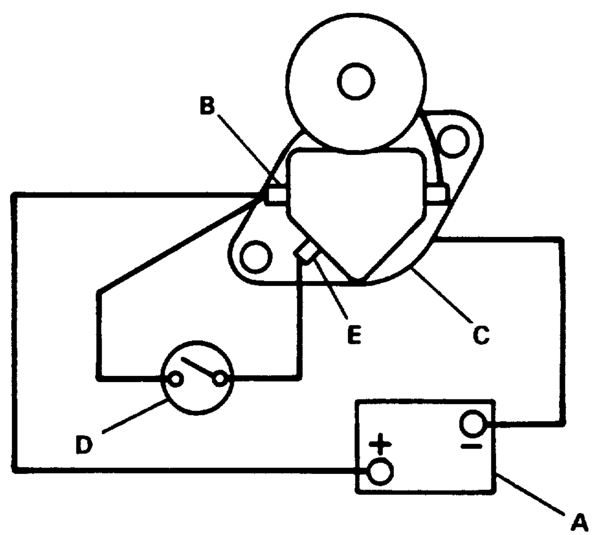
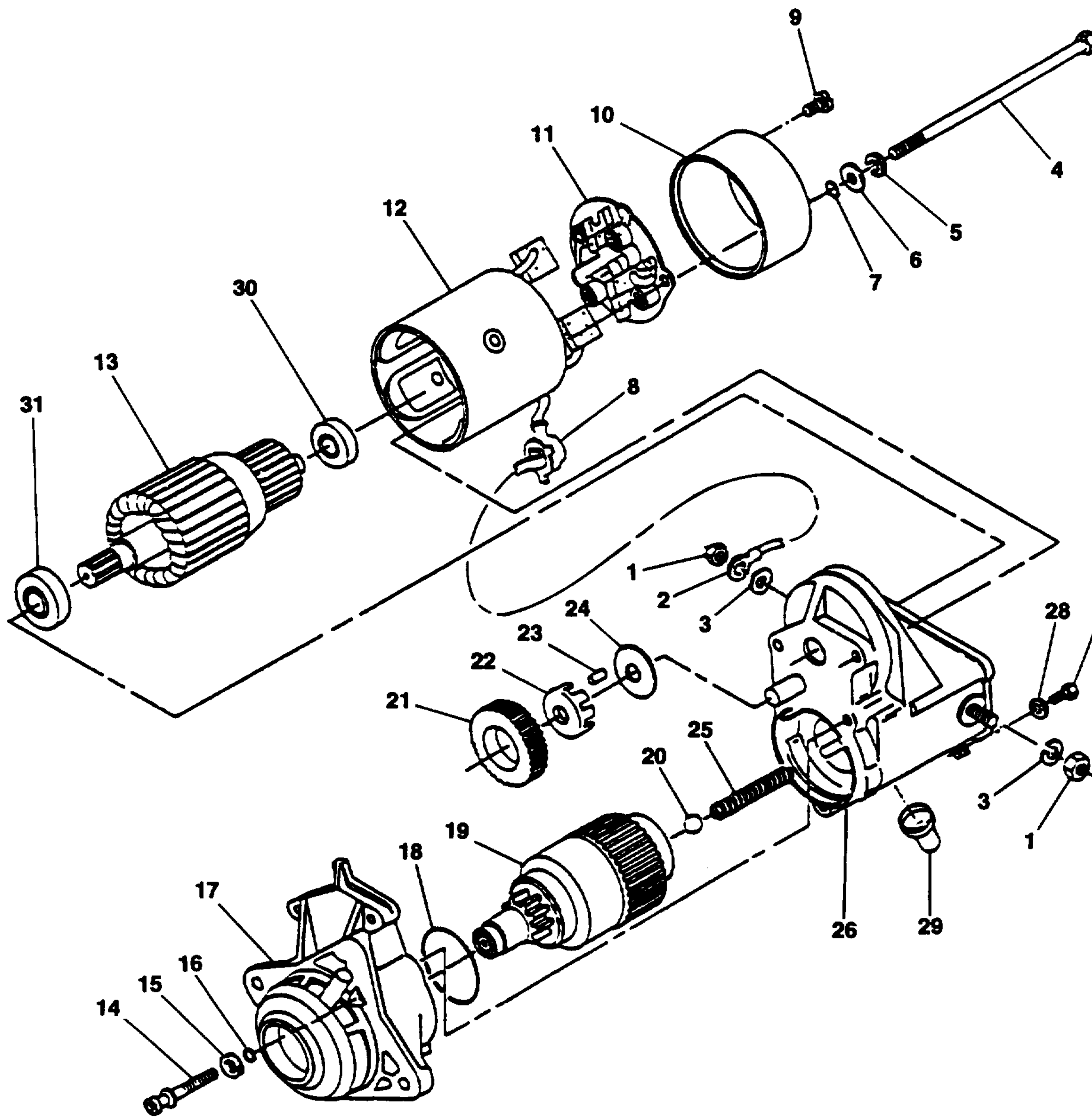


Figure 3-46. Starter Bench Test Setup



LEGEND

1. Nut
2. Lead Wire
3. Washer
4. Bolt
5. Lockwasher
6. Washer
7. Packing
8. Rubber Cover

9. Screw
10. End Frame
11. Brush Holder
1 2. Yoke
13. Armature
14. Screw
1 5. Washer
16. Packing

17. Housing
18. Seal
19. Clutch
20. Ball
21. Pinion
22. Retainer
23. Roller
24. Washer

25. Spring
26. Mag. Switch
27. Screw
28. Lockwasher
29. Boot
30. Bearing
31. Bearing

Figure 3-47. Starter Assembly

e. Connect a remote start switch (D) between switch terminal (E) and battery terminal (B).
f. When switch is activated, starter should engage and run.
g. If magnetic switch plunger only chatters, hold-in winding is open-circuited. If nothing happens, either the pull-in winding is open-circuited or mechanical parts are sticking. To check for sticking, remove magnetic switch end cover and push plunger by hand.

NOTE

The magnetic switch cannot be repaired.

h. If plunger engages properly, but starter does not run, check for defective bearings, brushes, reduction gears, armature, and field windings.

3-99.3 Disassembly

a. Remove nut (1, Figure 3-47), yoke assembly lead wire (2), and washer (3) from magnetic switch assembly (26).
b. Remove two bolts (4), two lockwashers (5), two washers (6), two packings (7), and yoke (12) from magnetic switch assembly (26). Discard lockwashers (5) and packings (7).
c. Remove two screws (9) and yoke assembly end frame (10).
d. Lift brush springs and remove brushes from brush holder (11), refer to Figure 3-48.
e. Remove brush holder (11, Figure 3-47) from yoke (12).
f. Remove armature (13) from magnetic switch assembly (26).
g. Remove three screws (14), washers (15), and packings (16) from housing (17).
Remove housing (17) from magnetic switch assembly (26). Remove and discard seal (18).
h. Remove overrunning clutch (19) from magnetic switch assembly (26).
i. Remove steel ball (20) from overrunning clutch (19).
j. Remove starter pinion (21), retainer (22), and five rollers (23) from housing (17).
k. Remove washer (224 and spring (25) from magnetic switch assembly (26).
l. If necessary, remove screw (27) and lockwasher (28) from magnetic switch assembly (26).

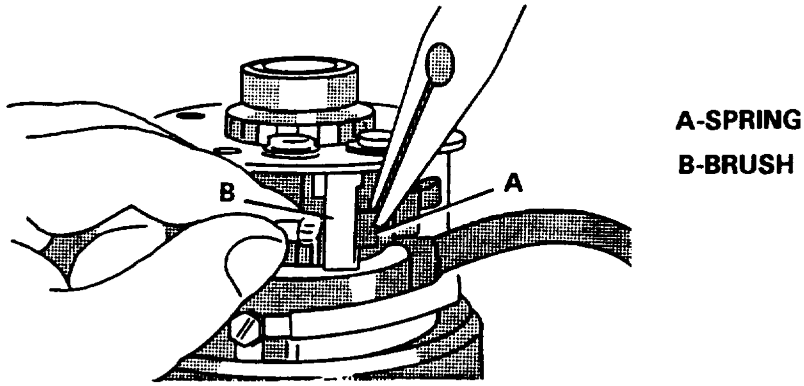


Figure 3-48. Removing Brushes

3-99.4 Inspect, Measure, and Repair

a. Check armature commutator run-out as follows:
   (1) Place armature bearings on V-blocks.
   (2) Zero dial indicator on commutator.
   (3) Rotate armature and record run-out. Standard is 0.0008 in. (0.02 mm), with a limit of 0.00197 in. (0.5 mm).
   (4) If run-out exceeds limit, replace armature.

b. Using a micrometer, measure OD of commutator. If measurement is less than 1.38 in. (35 mm), replace armature.

c. Measure commutator segment mica depth as shown in Figure 3-49. 'If depth is less than 0.0079 (0.2 mm), undercut the mica.

d. Check commutator surface for burn spots. This usually indicates an open circuit.
   Remove these spots using #400 abrasive paper.

e. Inspect bearings (30 and 31, Figure 3-47) for wear and damage. If damaged or worn, replace bearings using a press.

f. Check field windings of yoke (12) for wear or damage. Check all connections for clean and tight solder joints.

g. Measure brush length. If less than 0.51 in. (13 mm), replace brush holder and/or yoke assembly.

h. Check brush springs for damage or corrosion. If damaged or corroded, replace brush holder.

i. Check that overrunning clutch rotates freely in direction of starter rotation and that it will be locked when trying to rotate in opposite direction.

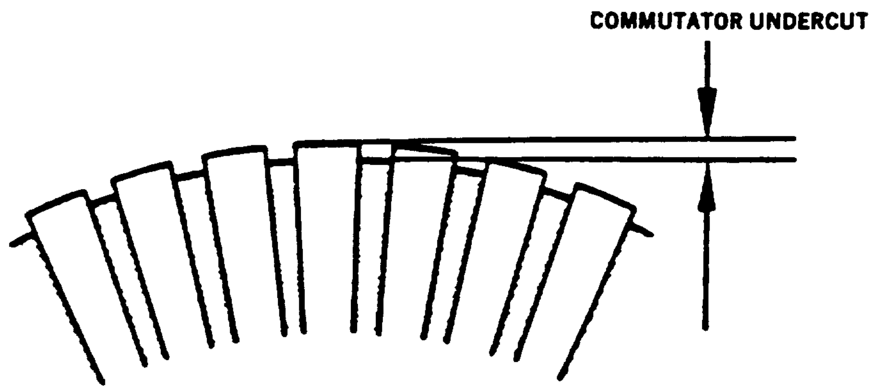


Figure 3-49. Measuring Segment Mica Depth

3-99.5 Assembly

a. If removed, install screw (27, Figure 3-47) with lockwasher (28).

b. Apply general purpose grease to retainer (22), rollers (23), overrunning clutch (19), steel ball (20), spring (25), and bearings (30 and 31).

c. Install washer (24) and spring (25) in magnetic switch assembly (26).

d. Install five rollers (23), retainer (22), and starter pinion (21) in housing (17).

e. Place steel ball (20) in overrunning clutch (19) and install both in housing (17).

f. Position assembled housing (17) with new seal (18) on magnetic switch assembly (26) and secure with three screws (14), washers (15), and new packings (16).

   Torque screws 5.1 to 8.7 ft lbs (6.9 to 11.8 Nom).

g. Install armature (1 3) in magnetic switch assembly (26).

h. Position brush holder (11) to yoke (1 2). Lift springs and install brushes, refer to Figure 3-48. Ensure negative brushes (connected to brush holder) are installed in negative holes (not insulated) and positive brushes (connected to yoke) are installed in positive holes (separated from plate with insulator). Ensure positive brush leads are not grounded.

i. Position yoke assembly end frame (10, Figure 3-47) on yoke (12) engaging tab on end frame with lead wire grommet. Secure with two screws (9). Torque screws 1.95 to 3.40 ft lbs (2.6 to 4.6 N•m).

j. Position yoke (12) on magnetic switch assembly (26) engaging tab on yoke assembly with notch in magnetic switch assembly. Secure with two bolts (4), two new lockwashers (5), two washers (6), and two new preformed packings (7). Torque bolts 5.1 to 8.7 ft lbs (6.9 to 11.8 N•m).

k. Connect yoke assembly lead wire (2) to terminal on magnetic switch assembly (26) with washer (3) and nut (1). Torque nut 18.1 to 26 ft lbs (24.5 to 35.3 N•m). Ensure rubber cover (8) for lead wire is installed securely.

APPENDIX A

REFERENCES

A-1 SCOPE

This appendix lists all forms and publications that are referenced in this manual.

A-2 PAMPHLETS

DA Pam 25-30	Consolidated Index of Army Publications and Blank Forms
DA Pam 738-750	The Army Maintenance Management System (TAMMS)

A-3 FORMS

DA Form 2404	Equipment Inspection and Maintenance Worksheet
DA Form 2028	Recommended Changes to Publications and Blank Forms
DA Form 2028-2	Recommended Changes to Equipment Technical Publications
SF 361	Transportation Discrepancy Report
SF 364	Report of Discrepancy (ROD)
SF 368	Product Quality Deficiency Report

A-4 SUPPLY BULLETINS

SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment

A-5 TECHNICAL BULLETINS

None

A-6 TECHNICAL MANUALS

TM 43-0139	Painting Instructions for Field Use
TM 10-3950-672-10	Operators Manual, Warehouse Crane, M469
TM 1 0-3950-672-24P	Repair Parts and Special Tools List, Warehouse Crane, M469

A-7 FIELD MANUALS

FM 21-11	First Aid for Soldiers

A-8 MISCELLANEOUS PUBLICATIONS

CTA 50-970	Expendable Items (Except: Medical, Class V, Repair Parts and Heraldic Items)

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1 THE ARMY MAINTENANCE SYSTEM

a. This introduction (section I) provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under the standard Army Maintenance System concept.

b. The Maintenance Allocation Chart (MAC) in section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels, which are shown on the MAC in column (4) as:

Unit includes two subcolumns, C (operator/crew) and 0 (organizational) maintenance.

Direct Support includes an F subcolumn.

General Support includes an H subcolumn.

Depot includes a D subcolumn.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2 MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. **Inspect**. To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. **Test**. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. **Service**. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical, or gases.

B-2 MAINTENANCE FUNCTIONS - Continued

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly) end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with the 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.

B-3 EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a. Column (1) - Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules within the next higher assembly.

b. Column (2) - Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column (3) - Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2.

B-3 EXPLANATION OF COLUMNS IN THE MAC, SECTION II Continued

d. Column (4) Maintenance Level. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the lowest 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 tasks within the listed maintenance function vary at different maintenance levels, appropriate work time figures will be shown for each level. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition and typical field operating conditions. This time includes preparation time, (including 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 function authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

C - Operator/Crew (Unit Level Maintenance)
O - Organizational (Unit Level Maintenance
F - Direct Support
H - General Support
D - Depot

e. Column (5) - Tools and Equipment. Column 5 specifies by code, those common tool sets, (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. Column (6) Remarks. Column 6 identifies remarks defined in Section IV of the MAC.

B-4 EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III

a. Column (1) - Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, column 5.

b. Column (2) - Nomenclature. This column lists the name and nomenclature of the tools and test equipment required to perform the maintenance function.

c. Column (3) - Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

d. Column (4) - National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Column (5) - Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code For Manufacturers code (five digit) in parenthesis.

B-5 EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

a. Column (1) - Reference Code. This code refers to the appropriate item in Section II, Column 6 of the MAC.

b. Column (2) - Remarks. This column provides the required explanatory information necessary to clarify items appearing in Section II of the MAC.

Section II. MAINTENANCE ALLOCATION CHART
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
01	ENGINE								
	Engine Assembly:	Inspect Test Service Replace Repair	0.1	 0.5 1.5	 16.0	 32.0		1, 2, 6, 12, 13, 14, 16, 18, 19, 20, 22, 24, 37, 38, 39, 40	
0101	Crankcase, Block Cylinder Head:								
	Cylinder Head	Inspect Replace Repair			0.5 10.0	 8.0		6, 8, 9, 10, 11, 12, 13, 24, 37, 38, 39, 40	
	Block	Inspect Replace Repair				1.0 20.0 8.0			
0102	Crankshaft:								
	Crankshaft	Inspect Replace				0.3 4.0		6, 8, 9, 12, 13, 24	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0103	Flywheel Assembly:								
	Flywheel	Inspect			0.3			10, 11,15, 16, 24	
		Replace			2.0				
		Repair				1.0			
	Flywheel Housing	Inspect			0.1				
		Replace			18.0				
0104	Pistons, Connect Rods:								
	Pistons	Inspect				0.8		6, 8, 9, 12, 13, 24	
		Replace				8.0			
		Repair				6.0			
	Connect Rods	Inspect				0.8			
		Replace				2.5			
0105	Valves, Camshaft, & Timing System:								
	Rocker Arm Assembly	Inspect		0.8				9, 12, 22, 24	
		Adjust		1.5					
		Replace			4.0				
	Valves, Camshaft	Inspect			1.2				
		Replace			2.3				
		Repair			2.0				

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0106	Engine Lubricate System:								
	Oil Cooler	Inspect Replace		0.2 4.0				10,11,15, 16, 24	
	Oil Pan	Inspect Replace			4.0 4.0				
	Oil Pump	Inspect Replace Test		 0.3	0.5 4.0				
03	FUEL SYSTEM								
0301	Fuel Injector:	Replace			1.0			21, 23, 24, 20	
0302	Fuel Pumps:								
	Fuel Injection	Inspect Replace Repair			0.5 2.0	 15.0			
	Lift Pump Replace	Inspect			0.5 5.0				

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0304	Air Cleaner:								
	Air Cleaner Assembly	Inspect Service Replace Repair	0.1	 0.5 0.2 1.0				24	
0306	Tanks, Lines, Fittings, Headers:								
	Tank, Fuel Assembly	Inspect Service Replace		0.5 1.0 2.0				24, 12, 16	
	Lines, Fittings	Inspect Replace		0.5 2.0					
0309	Fuel Filters:								
	Fuel Water Separator/Filter	Inspect Service Replace	0.2 0.4	 1.0				21, 23, 24, 20	
0311	Engine Starting Aid:								
	Cold Start Assembly	Inspect Service Replace		0.2 0.5 1.0				21, 23, 24	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0312	Accelerator, Throttle/Choke Control:								
	Accelerator Control	Inspect Replace Repair		0.2 2.5 1.5				24	
04	EXHAUST SYSTEM								
	Muffler & Pipes:	Inspect Replace	0.1	 2.0				24	
05	COOLING SYSTEM								
0501	Radiator:	Inspect Test Service Replace		0.5 2.0 1.5 3.5				11, 30, 32	
0503	Thermostat & Housing Gasket, Hoses & Clamps:								
	Thermostat & Housing Gasket	Test Replace		1.5 1.0				24	
	Hoses & Clamps	Inspect Replace		0.5 2.0					

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0504	Water Pump:	Inspect Replace		0.5	 3.0				
0505	Fan Assembly:								
	Fan	Inspect Replace	0.1	 0.5				24	
	Belt, Drive	Inspect Replace	0.1	 0.5					
06	ELECTRICAL SYSTEM								
0601	Alternator:	Test Replace Repair		0.2 0.5	 3.0			1, 4, 5, 16, 19, 20,	
0603	Starting Motor:								
	Starter/Solenoid Assembly Repair	Test Replace		1.0 0.5	 3.0			1, 4, 5, 16, 19, 20	
0607	Instrument or Engine Control Panel:								
	Switches/Circuit Breakers & Instruments	Inspect Replace		0.5 3.0				4, 16	

Section 11. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0608	Miscellaneous Items:								
	Light Switches	Inspect Replace		0.5 1.0				21, 23, 24,	
	Fuse and Relay Panel	Inspect Replace		0.5 0.5					
0609	Lights:								
	Vehicle Head, Tail, Stop, Back-up, Spot, Flood & Clearance Lights	Inspect Replace		 0.3 0.5				21, 23, 24	
0610	Gages, Sending Units & Warning Switches:								
	Oil Temperature, Oil Pressure, Coolant Temperature, & Transmission Temperature Gage; Fuel Quantity Sending Unit; Low Oil Pressure, High Engine Temperature Switches	Inspect Replace Test	0.1	 0.5 0.2				21. 23	
0611	Horn & Back-up Alarm:	Inspect Replace	0 1	 1.0				21, 23	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0612	Batteries, Storage:	Inspect Replace		0.5 1.5				3, 4, 5	
	Battery Tie Down Replace	Inspect		0.5 2.0					
	Battery Cables	Inspect Replace Repair		0.5 0.5	 1.0				
0613	Hull or Chassis Wiring Harness:								
	Wiring Harnesses	Test Replace Repair		1.0	 13.0 2.0			21, 23, 5	
07	TRANSMISSION								
0705	Gear Shift, Shift Modulator:	Adjust Replace		0.5 1.0					
0708	Torque Converter:	Replace			20.0			14, 15, 24	
0710	Transmission Assembly:	Service Inspect Test Replace Repair	2.0	 0.2 0.5	 12.0	 24.0		2, 4, 6, 8, 9, 10, 12, 13, 14, 15, 24	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	 O	 Direct Support F	 General Support H	 Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
0721	Coolers, Pumps, Motors Trans:								
	Front Pump	Inspect Replace Repair		1.0 2.0	 3.0			21, 23, 24, 2	
09	PROPELLER & PROPELLER SHAFTS								
	Drive Line Assembly:	Inspect Service Replace Repair		0.5 0.5 1.5 2.5				24, 21	
10	FRONT AXLE								
1000	Front Axle Assembly:	Service Inspect Replace Repair		1.0 0.5	 16.0	 8.0		2, 4, 12, 13, 17, 24, 6	
1002	Differential, Front Spin or No-Spin:	Inspect Service Replace Repair		0.5 0.5	 12.0 8.0			13, 14, 2	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
1003	Planetary Drive:	Inspect Service Replace Repair		0.5 1.0	 8.0 8.0			2, 13, 14, 24	
11	REAR AXLE								
1100	Rear Axle Assembly:	Service Replace Repair		1.0	 16.0	 8.0		2, 4, 6, 12, 13, 17, 24	
1104	Steering Mechanism:								
	Steering Cylinder & Linkage	Inspect Service Replace Repair		0.2 0.5	 5.0	 4.0		4, 6, 10, 21, 23, 24	
12	BRAKES								
1202	Service Brakes:								
	Brakeshoes and Related Parts	Inspect Adjust Replace		1.0 1.5 8.0				24, 29	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
1204	Hydraulic Brake System:								
	Master Cylinder	Service		0.2				4, 6, 10, 21, 23, 24	
		Inspect		0.2					
		Replace			1.5				
		Adjust		0.5					
13	WHEELS & TRACKS								
1313	Tires:	Inspect	0.1					21, 23, 24	
		Service	0.2						
		Replace		3.0					
14	STEERING:								
1401	Steering Control Valve Assembly with Steering Wheel:	Replace			8.0			2, 12, 13, 22, 23, 24	
		Inspect			0.5				
		Repair			4.0				
1411	Hoses, Lines & Fittings:	Inspect	0.1					2, 15, 24, 27	
		Replace		1.0					
1412	Hydraulic Pump (Steering):	Inspect		0.2				2, 15, 24, 27	
		Replace		1.5					
		Repair			4.0				

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
15	FRAME, TOWING ATTACHMENTS & DRAWBARS								
1503	Pintle Hook:	Service Replace Repair		0.1 0.5 0.2				24	
1507	Landing Gear, Leveling Jack:								
	Outrigger Assembly	Inspect Replace	0.1		 2.0			21, 23, 24	
	Cylinder, Stabilizer	Inspect Replace Repair			0.2 1.0 3.8			15, 21, 23, 24	
	Selector Valve	Inspect Replace Test			0.2 1.0 0.5				
18	BODY, CAB, HOOD & HULL								
1801	Door Assembly with Latch/Handle:	Inspect Replace	0 1	 1.5				21, 23, 24	
	Access Covers, Engine Battery & Tool Box	Inspect Replace	0.1	 2.0					

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
1806	Upholstery Seat:								
	Seat Assembly	Inspect Replace	0.1	 2.0				21, 23, 24	
22	BODY, CHASSIS, OR HULL & ACCESSORY ITEMS								
	Mirrors, Windshield Wiper & Cab Fan:	Inspect Replace	0.1	 1.0				24	
2207	Cab Heater & Defroster Assembly	Inspect Replace	0.1	 4.0				12, 13, 24, 20	
24	HYDRAULIC & FLUID SYSTEM								
2401	Hydraulic Pump:	Inspect Replace Repair			0.5 2.0 6.0			12, 13, 15	
2402	Hydraulic Control Valve:	Inspect Replace Repair	0.2	 2.0	 6.0			2, 12, 13, 15, 24	
2406	Strainers, Filters, Lines and Fittings:	Inspect Replace	0.1	 1.5				2, 21, 23, 24	

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
2407	Hydraulic Cylinders:								
	Lift Cylinder	Inspect			0.5			12, 13, 15, 24	
	Replace				2.0				
	Repair				5.0				
	Tele Cylinder	Inspect			0.5			12, 13, 15, 24	
		Replace			2.0				
		Repair			12.0				
2408	Hydraulic Reservoir:	Inspect	0.1					2, 12, 13, 24, 21, 23	
		Service		0.2					
		Replace		2.0					
68	WARNING, SCANNING AND SIGNALING DEVICES AND NAVIGATIONAL INSTRUMENTS								
6801	Anti Two-Block Warning System:	Inspect	0.1					5, 12, 13, 24	
		Replace				12.0			

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
74	CRANES, SHOVELS AND EARTH MOVING EQUIPMENT AND COMPONENTS								
7411	Crane Attachments:								
	Boom Assembly	Inspect	0.1					4, 6, 8, 9,	
		Service		0.2				10, 11,12,	
		Replace			10.0			13, 24, 25,	
		Repair			10.0			26, 32, 33,	
								20, 31	(A)
	Sheave Assembly, Boom Nose	Inspect	0.1					29, 31	
		Service		0.1					
		Replace		1.5					
		Repair			2.0				
	Cable, Wire Rope	Inspect	0.2					29, 31	
		Service		2.0					
		Replace		2.0					
	Hook Block	Inspect	0.1					29, 31	
		Service		0.2					
		Replace		1.0					
		Repair			4.0				

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
7417	Hoists:								
	Hoist Assembly	Inspect		0.2				2, 4, 5, 10, 12, 13, 15, 22, 24	
		Service		0.3					
		Replace			8.0				
		Repair			8.0				
	Hydraulic Motor, Hoist	Inspect		0.5					
		Replace			3.0				
		Repair			2.0				
	Cable Follower	Inspect		0.2					
		Replace		1.0					
		Repair			2.5				
7419	Turntable:								
	Swing Bearing	Inspect		0.5				24, 12, 13, 15	
		Replace			7.0				
		Test			3.0				
	Planetary Gear Reducer	Inspect		0.3					
		Replace			4.0				
		Repair			4.0				
		Test			1.0				
	Swing Motor	Inspect		0.5					
		Replace		3.0					
		Repair		2.0					
		Test		0.5					

Section II. MAINTENANCE ALLOCATION CHART - Continued
FOR CRANE, WAREHOUSE M469

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Hydraulic Swivel	Inspect		0.5					
		Replace			6.0				
		Repair			2.0				
		Test			0.5				
	Electrical Swivel	Inspect		0.5					
		Replace			3.0				
		Repair			2.0				

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR CRANE, WAREHOUSE M469

Tool or Test Equipment Ref Code	Maintenance Level	Nomenclature	National/NATO Stock Number	Tool Number
1	O,F,H	Analyzer, Set Engine; STE/ICE	4910-00-124-25	2389409
2	F	Lubrication Service Unit, Trailer Mtd	4930-00-017-9167	901765-1
3	F,H	Shop Equipment Battery Servicing Shelter Mtd	4940-00-209-6234	SC4940-95-CL-A58
4	F	Shop Equipment Contact Maintenance Truck Mtd SC4940-95-CL-B05	4930-00-294-9518	SECM-1975
5	F,H	Shop Equip Electrical Rep Semitrailer Mtd SC4940-95-CL-B05	4940-01-150-3113	85236
6	H	Shop Equip Gen Purpose Rep, Semitrailer Mtd SC4940-95-CL-B02	4930-01-006-3229	13221E9020
7	F	Shop Equipment Organizational Repair Light Truck Mtd SC4940-95-CL-B03	4940-01-028-2672	SEORLT-S-12-050-118
8	H	Shop Equipment Machine Shop; FM Heavy Less Power	3470-00-754-0738	SC3470-95 CLA15
9	H	Shop Equipment Machine Shop; FM Heavy Suppl No.1	3470-00-754-0739	SC3470-95-CL-A16
10	F	Shop Equipment Machine Shop; FM Basic	3470-00-754-0708	SC3470-95-CL-A02
11	F	Shop Equipment Welding, Field Maintenance	4940-00-37-7268	SC3470-95-CL-A08

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued FOR CRANE, WAREHOUSE M469

Tool or Test Equipment Ref Code	Maintenance Level	Nomenclature	National/NATO Stock Number	Tool Number
12	F,H	Shop Equipment Auto-Maintenance and Repair, FM Basic	4910-00-754-0705	SC4910-95-CL-A31
13	F,H	Shop Equipment Auto-Maintenance and Repair, FM Suppl No.1	4910-00-754-0706	SC4910-95-CL-A62
14	H	Shop Equipment Auto-Maintenance and Repair, FM Suppl No.2	4910-00-754-0707	SC4910-95-CL-A63
15	F,H	Tool Outfit Hydraulic Sys; Test and Repair, 3/4 Ton Trailer Mtd SC4940-95-CL-B07	4940-01-036-5784	13221E6850
16	F,H	Shop Equipment Fuel and Electric System Engine FM Basic	4940-00-754-0714	SC4910-95-CL-A01
17	H	Stand Maintenance Auto-Axle Wheel Mtd. Front and Rear Axle Unit	4910-00-241-3329	150-AX
18	H	Test Set Diesel Injector	4910-00-317-8265	5910359
19	F	Test Stand Auto-Generator and Starter, Floor Mtd. 500 AMP	4910-00-767-0218	MIL-T4544
20	F,H	Tool Kit Auto-Fuel and Electric System Repair	5180-00-754-0655	SC5180-95-CL-B08
21	O,F,H	Shop Equipment Auto-Maintenance and Repair Common No.1	4910-00-754-0654	SC4910-95-CL-A74

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued
FOR CRANE, WAREHOUSE M469

Tool or Test Equipment Ref Code	Maintenance Level	Nomenclature	National/NATO Stock Number	Tool Number
22	F	Shop Equipment Auto-Maintenance and Repair; Common No.2	4910-00-754-0650	SC4910-95-CL-A72
23	O,F,H	Shop Equipment Auto-Maintenance and Repair; Org Suppl No.1	4910-00-754-0653	SC4910-95-CL-A73
24	O,F,H	Tool Kit, General Mechanic-Auto	5180-00-177-7033	SC5180-90-CL-N26
25	H	Tool Kit Body and Fender Repair	5180-00-357-7731	SC5180-90-CL-N62
26	F,H	Tool Kit; Metal Workers	5180-00-754-0643	SC5180-90-CL-N34
27	F	Tool Kit, Hyd Repair; Army Aircraft	5180-00-323-4891	SC5180-99-CL-A03
28	F,H	Tool Kit; Machinist, Post-Camp-Station	5280-00-511-1950	SC5280-95-CL-A02
29	O	Tool Kit, General Mechanic; Equip Maintenance and Repair	5180-00-699-5273	SC5180-90-CL-N05
30	O,F	Welding Shop Trailer Mtd, Oxy-Acet/Elec Arc	3431-01-090-1231	11022000
31	F	Tool Kit Rigging Wire Rope	5180-00-596-1513	SC5180-90-CL-N17
32	F,H	Tool Kit Welders	5180-00-754-0661	SC5180-90-CL-N39

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued
FOR CRANE, WAREHOUSE M469

Tool or Test Equipment Ref Code	Maintenance Level	Nomenclature	National/NATO Stock Number	Tool Number
33	F,H	Torch Arc Weld Gas Shield, 400 AMP	3431-00-165-4112	MIL W80105
34	F,H	Welding Machine Arc; Transformer 300 AMP AC/DC	3431-00-620-5999	425ACDCG
35	H	Welding Set Arc Inert Gas Shield Water Cool General Purpose Aluminum SC3431-95-CL-A02	3431-00-731-4163	EDTS004-61
36	H	Shop Equipment Canvas and Glass Shop, Shelter Mtd	4940-00-209-6239	SC4940-95-CL-A63
37	H	Liner Puller	5120-01-143-2032	3376015
38	H	Liner Driver		ST-1229
39	F	Intake Valve Seat Extractor		337796
40	F	Exhaust Valve Seat Extractor		ST-1276-1

Section IV. REMARKS

Reference Code	Remarks
(A)	No heating, welding, cutting or drilling unless authorized by the manufacturer.
(B)	Reference TC9-510, Metal body repair and related operations.

APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1 SCOPE

This appendix lists the expendable supplies and materials you will need to operate and maintain the Crane, Warehouse M469. These items are authorized to you by CTA 50-970, Expendable Items (except Medical, Class V, Repair Parts and Heraldic Items).

C-2 FORMS

a. Column (1) Item Number

This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "use cleaning compound, item 1, app E).

b. Column (2) Level

This column identifies the lowest level of maintenance that requires the listed item. One of the following codes appears in column (2).

C - Operator/Crew (Unit)
O - Organizational (Unit)

c. Column (3) National Stock Number

This is the national stock number assigned to the item. Use it to request or requisition the item.

d. Column (4) Description

Indicates Federal item name and, if required, a description to identify the item. The last line for each item indicates the Contractor and Government Entity (CAGE) code in parentheses followed by the part number.

e. Column (5) Unit of Measure (U/M)

Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., EA, IN, PR). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	O			EA
			(LATER)	
2	O			TU
3	O			GL
4	O			EA
5	O			CN

APPENDIX D

TORQUE VALUE CHARTS

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2
				TORQUE POUNDS/FOOT										
CAPSCREW	S.A.E. 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	19	30	45	66	93	150	202	300	659		1057
CAPSCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	30	47	69	103	145	234	372	551	1211		1943
CAPSCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium - Carbon Steel or Low Alloy Heat Treated	31	50	75	110	150	250	378	583	1097		1748
CAPSCREW	A.S.T.M. 354BB STEEL													
CAPSCREW	A.S.T.M.A. A 325					100		200	355	525	790	1495		2600
CAPSCREW	A.S.T.M. A-354 BC STEEL	125,000 P.S.I	Low Alloy or Med. Carb. Quenched Tempered	34	54	81	119	167	269	427	644	1392		2234
CAPSCREW	S A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	43	69	106	150	209	350	550	825	1815		2913
CAPSCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, Quenched Tempered Roll Threaded											
CAPSCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	46	75	115	165	225	370	591	893	1964	2633	3150
SOCKET CAPSCREW	SOCKET HEAD CAPSCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I.	High Carbon Alloy Quenched Tempered	50	81	121	176	240	395	629	964	2120		3402
CAPSCREW	N.A.S. 144 AIRCRAFT STD. MS20000 MIL. STD.													
CAPSCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy Quenched Tempered	56	91	136	198	270	444	708	1085	2385		3827

Torque values as shown are for nut-bolt combinations that have not been plated and have not had special lubrications applied to them and/or for those using flat or split ring types of washers. (Discount the residual lubricant present that was applied at the time of manufacture.)

Figure D-1. Torque Values (Sheet 1 of 3)

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2
				TORQUE POUNDS/FOOT										
CAPSCREW	S.A.E. 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	17	27	40	59	84	135	182	270	593		951
CAPSCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	27	42	62	93	131	211	335	496	1090		1748
CAPSCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium Carbon Steel or Low Alloy Heat Treated	28	45	68	99	135	225	340	524	987		1573
CAPSCREW	A.S.T.M. 354BB STEEL													
CAPSCREW	A.S.T.M.A. A-325					90		180	320	473	711	1346		2340
CAPSCREW	A.S.T.M. A-354-BC STEEL	125,000 P.S.I	Low Alloy or Med. Carb. Quenched Tempered	31	49	73	107	150	242	384	580	1253		2010
CAPSCREW	S.A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	39	62	95	135	188	315	495	743	1634		2620
CAPSCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, Quenched Tempered Roll Threaded											
CAPSCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	41	68	104	149	203	333	532	804	1768	2367	2835
SOCKET CAPSCREW	SOCKET HEAD CAPSCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I.	High Carbon Alloy Quenched Tempered	45	73	109	158	216	356	566	868	1908		3062
CAPSCREW	N.A.S. 144 AIRCRAFT STD. MS20000 MIL. STD.													
CAPSCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy Quenched Tempered	50	82	122	178	243	400	637	977	2147		3444

Torque values as shown are for nut-bolt combinations that have been plated or have had lubrication applied.

Figure D-1. Torque Values (Sheet 2 of 3)

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	M4	M5	M6	M7	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
		TORQUE POUNDS/FOOT														
	8.8	2	4	7	11	18	32	58	94	144	190	260	368	470	707	967
	10.9	2.9	6	10	16	25	47	83	133	196	269	366	520	664	996	1357
	12.9	3.6	7	11	20	29	58	100	159	235	323	440	628	794	1205	1630

0053

Torque values as shown are for nut-bolt combinations that have not been plated and have not had special lubrications applied to them and/or for those using flat or split ring types of washers. (discount the residual lubricant present that was applied at the time of manufacture.)

Metric Torque Values

Figure D-1. Torque Values (Sheet 3 of 3)

APPENDIX E

SERVICE MAINTENANCE PACKAGES

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

AIR INTAKE SYSTEM

DESCRIPTION

The engine air intake system consists of an air cleaner and associated piping for channeling the air from the atmosphere to the engine intake manifold. The intake pipe also provides the necessary connections for a restriction indicator to indicate a dirty air cleaner. The air cleaner is the dry-type with a replaceable element.

MAINTENANCE

TROUBLESHOOTING.

Dust passing the air cleaner, even through small holes, can cause rapid engine wear. Ensure all connections between the air cleaner and the engine are tight and sealed. If these connections are all well sealed, and there is still evidence of dust leakage, check the following places for possible trouble.

NOTE

> **Dust that gets by the air cleaner system can often be detected by looking for dust streaks on the air transfer tubing or just inside the intake manifold inlet.**

1. Inspect the air cleaner outlet tube for damage.

2. Ensure the element gasket washer is not damaged and the washer's rubber face seals against the element.

3. Inspect the element gasket for damage.

4. Check for structural failures. Any damaged parts must be replaced.

5. Inspect the restriction indicator tap for leaks.

Check For Filter Restriction.

As a dry cleaner element becomes loaded with dust, the vacuum on the engine side of the air cleaner (at the air cleaner outlet) increases. The vacuum is generally measured as restriction in inches of water.

The engine manufacturer places a recommended limit on the amount of restriction the engine will withstand without loss of performance before the air filter element is cleaned or replaced. For the Cummins diesel engine, the maximum allowable air restriction is 20 inches (50.8 cm) of water maximum with a dirty air filter at maximum governed speed.

Mechanical gauges, warning devices, indicators, and water manometers can be used to determine when the air intake restriction reaches the maximum recommended limit.

The AP308T features an air restriction indicator mounted in the air intake piping just after the air cleaner assembly. The indicator consists of a spring in a clear tube with graduated scale lines scribed on the outside of the tube to indicate vacuum pressure. A red line on the graduated scale indicates when the air filter should be cleaned or replaced.

With a new air filter installed, the engine draws air through the filter virtually unrestricted. As dirt and other foreign matter become trapped by the air filter, vacuum pressure in the air intake piping gradually increases as the engine pulls air through the restricted filter. The gradual increase in vacuum pressure results in a gradual compression of the spring in the air restriction Indicator. As the spring compresses, it indicates the current level of air restriction.

FILTER ELEMENT REPLACEMENT.

CAUTION

NEVER SERVICE THE AIR CLEANER WHILE THE ENGINE IS RUNNING.

1. Loosen the hex head bolt on the clamp band and remove the clamp band and baffle.

2. Remove the thumbscrew and washer; then withdraw the element.

3. Clean the element as outlined in ELEMENT CLEANING. Replace the element after six cleanings or annually, whichever comes first.

4. Inspect all parts of the intake system and air cleaner.

5. Install the cleaned or new element into the air cleaner body, securing it with the washer and thumbscrew.

6. Ensure the O-ring around the air cleaner body is in place and not damaged.

7. Install the baffle on the air cleaner body with the two arrows pointing up. Secure with the clamp band and tighten the hex head bolt.

ELEMENT CLEANING.

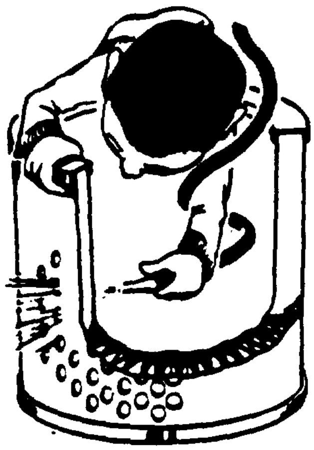
Washing in a water-detergent solution or blowing out with compressed air are two accepted methods for cleaning the element of the air cleaners. If the elements contain substantial amounts of soot or oil fumes, washing in water works better than compressed air. If the contaminant is found to be mostly loose dust, either method works equally well.

If cleaned with compressed air, elements can be put back into service immediately; however, if cleaned by washing, elements must be dried before returning them to service.

NOTE

Some elements are partially covered by a plastic sleeve with fins. The covered portion can be cleaned with water or air without removing the sleeve. Use a stiff fiber (not wire) brush to remove oil and grease deposits from the sleeve and fins. Never remove the sleeve and fins from the element.

Cleaning With Compressed Air.



0262-1

CAUTION

PRESSURE ATTHE AIR NOZZLE MUST NOT EXCEED 100 PSI (689 KPA/6.89 BAR).

1. Direct a jet of clean, dry air from the inside of the filter element, perpendicular to the pleats.

2. Move the air jet up and down along the pleats, slowly rotating the element, until no more dust is being removed. Do not rupture the element with the nozzle or the air jet.

Cleaning With Water.

1. The elements can be cleaned by washing with water and a good non-sudsing detergent. Direct a jet of clean, dry air from the inside of the filter element. When the loose dust and soot have been removed, the element is ready to be washed.

CAUTION

NEVER USE GASOLINE OR SOLVENTS TO CLEAN THE ELEMENTS.

2. Dissolve the detergent in a small amount of cool water.

3. Add warm water (approximately 100 degrees F [38 degrees C]) to get the proper proportions of detergent and water (about one cup of detergent to five gallons of water).

4. Soak the element in the solution for at least 15 minutes.

0262-2

5. Agitate the element for about two minutes to loosen the dirt.

0252-3

CAUTION

WATER PRESSURE FROM A HOSE OR TAP SHOULD NOT EXCEED 40 PSI (276 KPA/2.76 BAR).

6. Rinse the element with clean water until the water coming through the element is clean. Air-dry the element thoroughly before using.

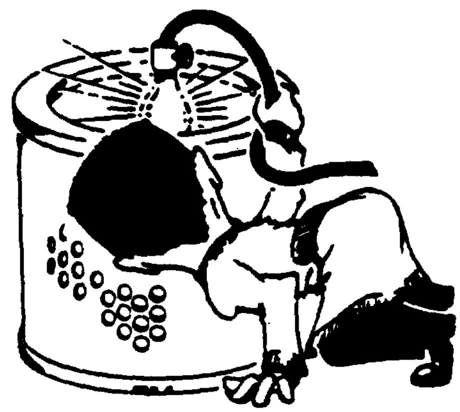
CAUTION

HEATED AIR (MAXIMUM TEMPERATURE 160 DEGREES F [71 DEGREES C]) MUST HAVE CIRCULATION. DO NOT USE LIGHT BULBS FOR DRYING ELEMENTS.

7. Mechanized drying methods can be used.

INSPECTION.

Element.



0252-4

CAUTION

DO NOT TOUCH THE INSIDE OF THE FILTER WITH A BARE LIGHT BULB.

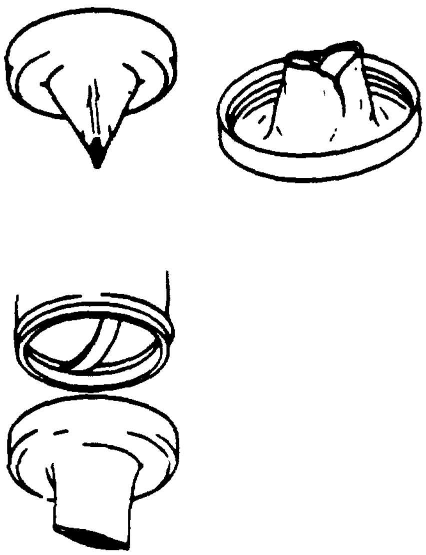
After cleaning the filter element, inspect the element for damage. Look for dust on the clean air side. the slightest rupture, or damaged gaskets. A good method to use to detect ruptures in the element is to place a light inside the element and look toward the light from the outside. Any hole in the element, even the smallest. will pass dust to the engine and cause unnecessary engine wear. Element replacement is recommended if such holes are evident.

Air Cleaner Body.

Before installing the filter element, remove any foreign material (leaves, lint or other foreign matter)that may have collected inside the air cleaner body. Inspect the inside of the body for dents or other damage that would interfere with air flow or with the fins on the element or inside the body. Repair any body dents, being careful not to damage the sealing surfaces.

Vacuator Valve.

Vacuator valves are designed to expel loose dust and dirt accumulations from the air cleaner body automatically, thus lengthening the element service-life. The valve lips must point straight down to operate effectively, and must be kept free from debris. Mud and chaff can lodge in these lips periodically and hold them open during engine operation.



Check the condition of the valve and lips frequently and keep them clean. The valve lips should be open only when the engine is shut down, or running at low idle speed. If the valve is turned inside out, check for a clogged air cleaner inlet. Malfunction of this valve does not reduce the air cleaner effectiveness, but does allow the element to get dirty faster and reduces serviceable life. If a valve is lost or damaged. replace it with a new valve of the same part number.

Duct Work.

1. Check the intake pipe cap and screen for accumulation of leaves, trash, and other debris that could restrict air flow. Repair the screen or replace the cap if any large holes are found in the screen.

2. Check all mounting hardware for security to eliminate possible vibration of intake piping. Such vibration leads to early failure of hoses, clamps, and mounting parts, and can cause hoses to slip off the connecting pipes, allowing unfiltered air into the engine air intake.

3. Check hoses for cracks, chafing, or deterioration, and replace at the first sign of probable failure.

WATER COOLING SYSTEM

DESCRIPTION

The cooling system consists of the radiator, engine cooling circuit, and the connecting hoses. Its capacity varies according to the engine being used. The temperature is controlled by a 180 degree F (82 degrees C) thermostat located between the top of the engine and the top of the radiator. The radiator, in addition to cooling the engine, also contains a cooler which cools the automatic transmission oil. At all times, the coolant should be properly inhibited against corrosion. If antifreeze is used, follow the antifreeze manufacturers requirements for proper protection in regards to cooling system capacity, and only ethylene glycol base permanent antifreeze should be used. Engines equipped with cooling system filters should not use antifreeze with antileak additives because the additives will clog the filter.

MAINTENANCE

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Engine overheating.	**Coolant Loss.**	
	a. Leaks at any of the following: gaskets, hose connections, water pump, radiator, heater, core plugs, drain cock or plugs, cracked head or block.	a. Chock, locate, and repair leaks. Replace hoses, clamps, and other parts as required.
	NOTE Internal leakage is Indicated by the presence of coolant in the engine crankcase, or oil in the radiator. Check for cracked cylinder head or block, or a blown head gasket.	
	Boiling.	
	a. Radiator or other parts of cooling system clogged with rust or scale.	a. Drain and flush cooling system.
	b. Grille or bug screen clogged.	b. Clear obstructions.
	c. Radiator core fins damaged.	c. Straighten fins.
	d. Thermostat damaged - stuck closed.	d. Replace thermostat.
	e. Water pump leaking air into system.	e. Repair or replace water pump.
	f. Radiator hose collapsed or rotting inwardly.	f. Replace radiator hoses.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Engine overheating (continued).	g. Radiator pressure cap damaged.	g. Replace cap.
	h. Cylinder head loose, causing exhaust gas leakage into cooling system.	h. Check and tighten.
	i. Water pump impeller corroded or loose on shaft.	i. Repair or replace water pump.
	j. Antifreeze protection inadequate, causing partial freeze-up.	j. Check and add antifreeze as required.
	After Boil.	
	a. Improper installation of thermostat.	a. Check and correct.
	b. Damaged thermostat.	b. Replace thermostat.
	c. High temperature thermostat used with alcohol-type antifreeze. antifreeze.	c. Use thermostat of proper operating range; use ethylene-glycol type
	d. Excessive sediment in cooling system.	d. Drain and flush cooling system.
Foaming.	a. Excessive sediment in cooling system.	a. Drain and flush cooling system.
	b. Air or exhaust leak into cooling system.	Check, locate, and repair.
	Radiator Air Flow Obstructed.	
	a. Leaves, dirt and foreign material.	a. Clean away obstruction.
	b. Bent fan blades.	b. Straighten blades or replace fan.
	c. Improper valve timing or sticking valves.	c. Check and repair or re-time engine.
	d. Clogged muffler or pipe.	d. Check and correct.
	e. Dragging brakes.	e. Check brakes and repair as required.
	f. Low engine oil level.	f. Check and add oil as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Engine overheating (continued).	g. Engine overloaded.	g. Operate engine in proper load range.
	h. Stiff rebuilt engine.	h. Break-in engine properly.
2. Overcooling.	a Thermostat not installed.	a. Install thermostat.
	b. Damaged thermostat stuck open.	b. Replace thermostat.
	c. Short runs and intermittent driving.	c. Warm up engine properly.

GENERAL.

The cooling system includes the radiator, thermostat, the fan, and fan and water pump drive belts. Radiator hoses are also included in this group.

Because the effects or damage that result from an improperly maintained cooling system usually occur gradually, this system is often times neglected. However, the cooling system must be treated with the same attention to maintenance as is given such other systems as fuel, air, and brakes. A review of the cooling system's function will show this more clearly.

In general, the circulation of water through the cooling system relies entirely upon the water pump. The water pump draws water from the radiator and forces it through the water jackets and cylinder head. There it accumulates heat. Then the water flows to the upper radiator tank and down through the radiator core, being cooled by air from the fan. This process of removing heat from water as it circulates holds the engine to its efficient operating temperature.

The following paragraphs point out several facts about cooling system components, the effects of cooling system neglect, and procedures to be followed for cooling system maintenance.

EFFECTS OF COOLING SYSTEM NEGLECT.

Whenever an engine does not perform at top efficiency, neglected cooling system may be at fault even though the engine part directly responsible is not even a part of the cooling system. Most of these problems will be traced to overheating; however, an engine that is running too cold can be just as troublesome.

Overheating.

An engine that is overheating may lead to troubles such as the following.

1. Burned valves.
2. Pinging or knocking.
3. Excessive fuel consumption.
4. Poor lubrication - increased engine wear.
5. Sticking valves.
6. Short injector life.
7. Engine hot spots.
8. Need for higher grade fuel.

Overcooling.

The following engine troubles result when an engine is overcooled.

1. Excessive fuel consumption.
2. Sludge formation in crankcase.
3. Corrosive acids formed in crankcase.
4. Excessive fuel deposits in the exhaust system

RUST PREVENTION.

To keep engines operating at newness efficiency, all forms of rust formation must be prevented. The formation of rust in the cooling system is a result of the interaction of water, iron, and oxygen, and can only be prevented by maintaining full strength corrosion protection at all times.

For rust protection during the winter months an antifreeze having a corrosion preventive should be installed in the fall. When spring arrives, drain the old antifreeze solution from the cooling system as all corrosion inhibitors are weakened and may be entirely exhausted by this time depending on how the engine has been taken care of and how many operating hours have been put on it. To rustproof the cooling system for summer driving, add a good rust inhibitor with the first fill of clean water, if water is to be used, in the spring. This solution should then be drained in the fall and a fresh filling of chemically treated anti-freeze installed. A good quick test to determine if the cooling system needs cleaning or flushing due to rust, scale, or grease is to wipe the inside of the filler neck and header tank with the finger. If any sludge or excessive rust and scale are present and evidence by this test, the system needs a thorough cleaning.

SEASONAL CARE.

The cooling system of any vehicle should be drained and flushed out at least once a year. Unless the coolant has a corrosion preventive in it, rust and scale will eventually clog up the cooling system. Any effective commercially available flushing agent should be used at least once a year, and preferably twice a year, to ensure against a buildup of rust and scale.

NOTE

Remove the radiator cap when draining the system to ensure proper draining.

CLEANING

<u>WARNING</u>

THE COOLING SYSTEM IS PRESSURIZED. PERSONNEL INJURY FROM SCALDING MAY RESULT WHEN REMOVING THE RADIATOR CAP AFTER THE COOLANT HAS REACHED OPERATING TEMPERATURE. ALLOW THE ENGINE TO COOL BEFORE BEGINNING THE CLEANING OPERATION.

1. Turn on coolant flow to the heater to allow complete circulation during the draining, cleaning, and flushing operation.

2. Slowly open radiator cap to allow any pressure in the system to escape. Then open the radiator drain cock and drain the engine coolant into a suitable container. Open the drain cock on the engine block and drain the coolant from the engine. Close both drain cocks.

3. Following the cleaning compound manufacturer's instructions, pour cleaning compound into radiator. Then fill coolant system with clean, fresh water. Install the radiator cap.

4. Place a clean, suitable drain pan under the radiator to catch any overflow from the overflow bottle. Do not allow cleaning solution to spill onto painted surfaces of the vehicle.

5. Start the diesel engine and allow the engine coolant temperature to reach its operating temperature of 1800 F (82^{o} C) or above. If necessary, cover the radiator to achieve the necessary operating temperature, but do not allow the coolant to boil over. Allow the engine to idle for at least two hours (or as specified by the cleaning compound manufacturer) with the coolant temperature at 180^{o} F (82^{o} C). Do not drive the crane and If necessary, add water to the overflow bottle to maintain the cleaning solution at the "HOT" level. Stop the diesel engine as needed if the cleaning solution begins to boil.

6. Stop the diesel engine and observe the coolant temperature gauge. When there is no change in the temperature gauge reading (indicating the coolant temperature has dropped), slowly remove the radiator cap and open the radiator drain cock and drain the cleaning compound into a suitable container. Then open the engine block drain cock and drain the engine block into a suitable container. Close both drain cocks.

7. If the radiator core clogging is relieved but not fully corrected, after allowing the engine to cool, pressure flush the cooling system and repeat the cleaning operation.

8. If pressure flushing the system does not correct coolant system problems then the radiator must be replaced.

PRESSURE FLUSHING.

1. Disconnect the upper radiator hose which connects the radiator core to the engine water outlet, and remove the thermostat from the engine water outlet.

2. Clamp a convenient length of hose to the radiator core outlet opening, and attach another suitable length of hose to the radiator inlet opening to carry away the flushing stream.

3. Connect the flushing gun to compressed air and water pressure, and clamp the gun nozzle to the hose attached to the radiator outlet opening.

4. With the radiator cap on tight, fill the core with water. Turn on air pressure in short blasts to prevent core damage.

5. Continue filling the radiator with water and applying air pressure as above until the water comes out clear.

6. Clamp the flushing gun nozzle firmly to a hose attached securely to the engine water outlet opening. Fill the engine block with water, partly covering the water inlet opening to permit complete filing.

7. Turn on compressed air to blow out water and loose sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.

8. For badly clogged water jackets that do not respond to regular pressure flushing, remove the engine cylinder head and core hole plugs, and with a suitable length of small copper tubing attached to the flushing gun nozzle, flush the water jackets through the openings.

9. When the vehicle is equipped with a water heater connected to the cooling system, flush the heater, following the same procedure as for the radiator core.

10. After completing the flushing operation, clean out the radiator overflow pipe; inspect the water pump; clean the thermostat and the radiator cap control valves. Check the thermostat for proper operation before installation.

11. Blow insects and dirt from the radiator core air passages, using water, if necessary, to soften obstructions.

COMPONENT INSPECTION.

Radiator.

1. Top and Bottom Tank. Look for leaks, particularly where the tank is soldered to the core. Vibration and pulsation from pressure can fatigue soldered seams.

2. Filler Neck. The sealing seat must be smooth and clean. Cams on filler neck must not be bent or worn so as to allow a loose fitting cap. Ensure the overflow tube is not plugged.

3. Radiator Cap. This is the pressure-setting type. Its purpose is to hold the cooling system under a slight pressure, increasing the boiling point of the cooling solution and preventing loss of solution due to evaporation and overflow.

The cap has a spring-loaded valve, the seat of which is below the overflow pipe in the filler neck. This prevents the escape of air or liquid while the cap is in position. When the cooling system pressure reaches a predetermined point, the cap valve opens and will again close when the pressure falls below the predetermined point.

When removing the pressure type cap from the radiator, perform the operation in two steps. Loosening the cap to its first notch raises the valve from the gasket and releases the pressure through the overflow pipe. In the first stage position of the cap, it should be possible to depress the cap approximately 0.125-inch (3.175 mm). The prongs on the cap can be bent to adjust this condition. Care must be taken that the cap is not too loose as this would prevent proper sealing.

WARNING

WHEN REMOVING THE CAP, LOOSEN IT SLOWLY AND THEN PAUSE A MOMENT. THIS WILL AVOID POSSIBLE BURNING BY HOT WATER OR STEAM.CONTINUE TO TURN THE CAP TO THE LEFT UNTIL IT CAN BE REMOVED.

4. Tubes. Because these are very small they can be come easily clogged, or partially so, by rust and scale The general condition of the cooling system and operating temperature are indications as to whether or no1 tubes are clean. Another good test is to feel the core for cold spots.

5. Fins. These thin metal sheets dissipate heat picked up by the tubes. They should be kept free of bugs, leaves, straw etc., so as to allow the free passage of air. Bent fins should be straightened.

Engine Water Jacket.

The water jacket permits coolant to be circulated around the cylinder walls, combustion chamber, and valve assemblies. Some of these coolant passages are small and can easily become clogged, if the cooling system does not receive the proper maintenance.

1. Core Plugs. These are sometimes mistakenly called freeze plugs. They do not provide protection against freezing expansion, but are only present because of engine block casting methods. Remove and replace core plugs that show signs of leaking or rusting through. Use an installation tool for core plug replacement.

2. Drain Plugs. The water jacket of each engine has one or more drain plugs. These should receive seasonal care and kept free of rust and scale.

3. Gaskets. Gaskets must be in good condition to prevent both internal and external leaks. If there are external leaks around gaskets, there may also be internal leaks into the engine. Proper tightening of the head bolts with a torque wrench is essential for preventing leaks around the head gasket.

Water Pump.

The pump should be checked carefully for leaks and proper lubrication, and if leaking, cracked, or worn, it should be rebuilt or replaced promptly.

Fans and Belts.

The fan should be checked for loose or bent blades. A loose blade might work free during operation and cause damage.

A bent blade could cause an imbalance and cause the water pump to fail prematurely, and it will reduce the fan's efficiency.

Refer to the engine manual for your particular engine for fan and other belt adjustment specifications.

When one belt of dual drives is damaged or worn, they must both be changed as a matched pair.

Thermostat.

Thermostats used in these carriers are of the non-adjustable type and are incorporated in the cooling system for the purpose of retarding or restricting the circulation of coolant during engine warm up. Engine overheating and loss of coolant is sometimes due to an inoperative thermostat. To check for this condition, remove the thermostat and test by submerging it in hot water and noting the temperature at which the thermostat opens and closes. Use an accurate high temperature thermometer for making this test.

Hose and Clamps.

Hoses and their connections must be checked regularly because they are often the source of hidden trouble. Hoses may often times appear in good condition on the outside while the inside will be partially deteriorated. If there are any doubts about a hose doing its job, replacement should be made. The clamps should be inspected to make sure they are strong enough to hold a tight connection.

TEST EQUIPMENT.

The hydrometer is a primary aid in maintaining the cooling system at top efficiency. Hydrometers, which are used to test the freezing protection of an anti-freeze solution, work on the principle of specific gravity or weight of the antifreeze solution. They are simple to use provided they are used in the proper manner. When using the temperature sensitive hydrometer, the solution must be warm (at least 110 degrees F [43 degrees C]), the temperature and level must be noted correctly, and the float must be able to move freely. Read only the hydrometer scale corresponding to the type antifreeze solution in the radiator.

Keep the hydrometer clean inside and out, and treat it with the same care as given any other precision instrument.

NOTE

Hydrometers do not correctly register the freezing protection of a mixture of methanol and glycol base antifreeze. Therefore, always flush the cooling system with the thermostat removed before adding antifreeze for the winter.

ANTIFREEZE.

When freeze protection is required, an ethylene glycol base permanent antifreeze should be used. An inhibitor is included in this type of antifreeze and no additional inhibitors are required on initial fill if a minimum antifreeze concentration of 30 percent by volume is used. Solutions of less than 30 percent concentration do not provide sufficient corrosion protection. Concentration over 67 percent adversely affect freeze protection and heat transfer rates.

Inhibitor depletion will occur in ethylene glycol base antifreeze through normal service. The inhibitors should be replenished at approximately 500 hour intervals with a non-chromate inhibitor. Commercially available inhibitors may be used to re-inhibit antifreeze solutions.

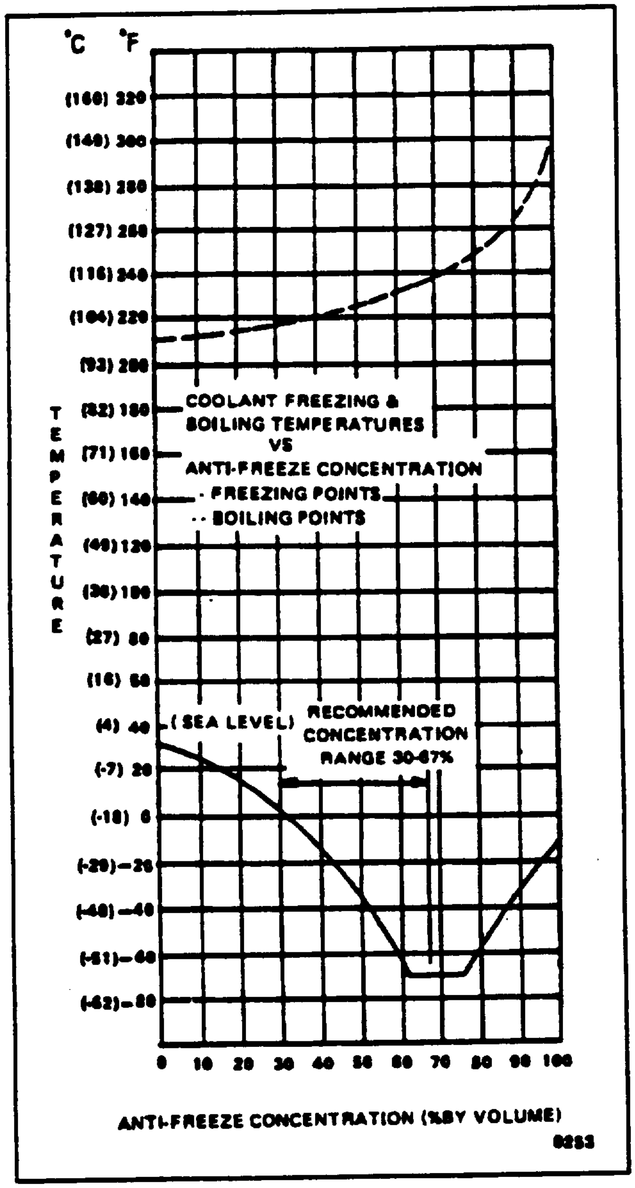
COOLANT RECOMMENDATIONS.

1. Always use a proper inhibited coolant.
2. If freeze protection is required, always use ethylene glycol antifreeze.
3. Re-inhibit antifreeze with a non-chromate inhibitor.
4. Always follow the manufacturer's recommendations on inhibitor usage and handling.
5. Do not use soluble oil.
6. Chromate inhibitors should NEVER be used with permanent antifreeze.
7. Sealer type antifreeze should NOT be used.
8. Maintain the prescribed inhibitor strength.

COOLANT FILTER.

The Cummins engines have a coolant filter of the canister or spin-on type that requires periodic servicing. It is suggested that this be done when the coolant is changed.

Close the shut-off valves in the inlet and drain lines before disassembling the filter. Some engines may have a push button valve on the rear of the water pump housing that must be closed (pushed in) when changing the water filter.



Anti-Freeze Concentration Chart

TRANSMISSION

DESCRIPTION

The transmission is a three speed automatic transmission manufactured by Ford Motor Company. The transmission is capable of providing automatic up-shifts and downshifts through the three forward gear ratios. The stall ratio is 1.89:1. Gear ratios are as follows:

GEAR RATIOS

LOW (1st)	2.46: 1
INT. (2nd)	1.46: 1
DIRECT (3rd)	1.00: 1
REVERSE	2.175: 1

MAINTENANCE

TROUBLESHOOTING.

Before removal or operation of the transmission, perform a visual inspection. Visually inspect all lines. plugs, and tube connections at the transmission for oil leakage.

To make a thorough test of the transmission. ensure the engine is properly tuned and the oil level in the transmission is correct. During troubleshooting, the engine and transmission must be regarded as a single package.

If inspection does not reveal the cause of the trouble and the crane is operational, further troubleshooting is necessary. Do not remove the transmission from the crane until the mechanical, hydraulic, and air pressure tests are performed and the causes of trouble are checked against the troubleshooting chart.

Mechanical Checks.

LINKAGE CHECK.

1. A check should be made to ensure the linkage is free and returns to idle when released.
2. Ensure the D detent in the transmission corresponds exactly with the stop in the console. Leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted.

ENGINE IDLE SPEED CHECK.

Check the engine idle speed. If the idle speed is too low, the engine will run roughly. An idle speed that is too high will cause the crane to creep, have harsh transmission engagements, and harsh closed throttle downshift.

CONTROL PRESSURE TEST.

There are two methods of performing the control pressure test. One is to perform the test using the engine vacuum. The second method is to use a hand operated vacuum pump.

1. To perform the control pressure test using the engine vacuum, perform the following.

a. Attach a tachometer to the engine and a vacuum gauge to the transmission vacuum line at the manifold vacuum port.

CAUTION

PRESSURE GAUGES AFFECT THE SHIFT QUALITY OF THE TRANSMISSION. CARE SHOULD BE TAKEN NOT TO ACCELERATE OR DECELERATE RAPIDLY. POSSIBLE TRANSMISSION FAILURE COULD RESULT.

b. Firmly apply the parking brake and start the engine.

c. Adjust the engine idle speed to the specified rpm. If the engine idle speed cannot be brought within limits, check the throttle and downshift linkage for a binding condition. If linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit and its connecting tubes and hoses.

2. To perform the control pressure test using the vacuum pump method, perform the following.

a. Disconnect and temporarily plug the vacuum line at the vacuum diaphragm unit.

b. Attach a vacuum pump to the vacuum diaphragm. Apply both the parking and service brakes. Start the engine and vacuum pump.

c. Set the vacuum at 15 inches and read and record the control pressure in all the selector positions. Run the engine up to 1000 rpm, and reduce the vacuum to 10 inches. Read and record the control pressure in D, 2. and 1. Keep the engine rpm at 1 000 and reduce the vacuum to 1 inch. Read and record the control pressure in D. 1, 2. and R.

VACUUM SUPPLY TEST.

Check the vacuum supply to the vacuum diaphragm unit and the diaphragm itself. To check the supply, disconnect the vacuum line at the diaphragm unit and connect it to vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak or poor engine vacuum. If the vacuum reading is OK. rapidly accelerate the engine momentarily. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted. or connected to a reservoir supply.

Air Pressure Checks.

GENERAL.

A no drive condition can exist even with correct transmission fluid pressure, because of inoperative clutches or bands. On automatic transmissions, an erratic shift can be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is at 2 (second) a no drive condition may be caused by an inoperative forward clutch. A no drive condition at D (drive) may be caused by an inoperative forward clutch or one-way clutch. When there is no drive in 1 (low) the difficulty could be caused by improper functioning of the forward clutch or simultaneous malfunction of the low-reverse band and the one-way clutch. Failure to drive in R (reverse) could be caused by a malfunction of the reverse-high clutch or low-reverse band or clutch.

To make air pressure checks. loosen the oil pan bolts and lower one edge to drain the transmission fluid. Remove the oil pan and the control valve body assembly. The inoperative clutches or bands can be located by introducing air pressure into the various transmission case passages.

FORWARD CLUTCH.

Apply air pressure to the transmission case forward clutch passages. A dull thud can be heard when the clutch piston is applied. If no noise is heard. place the finger tips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

GOVERNOR.

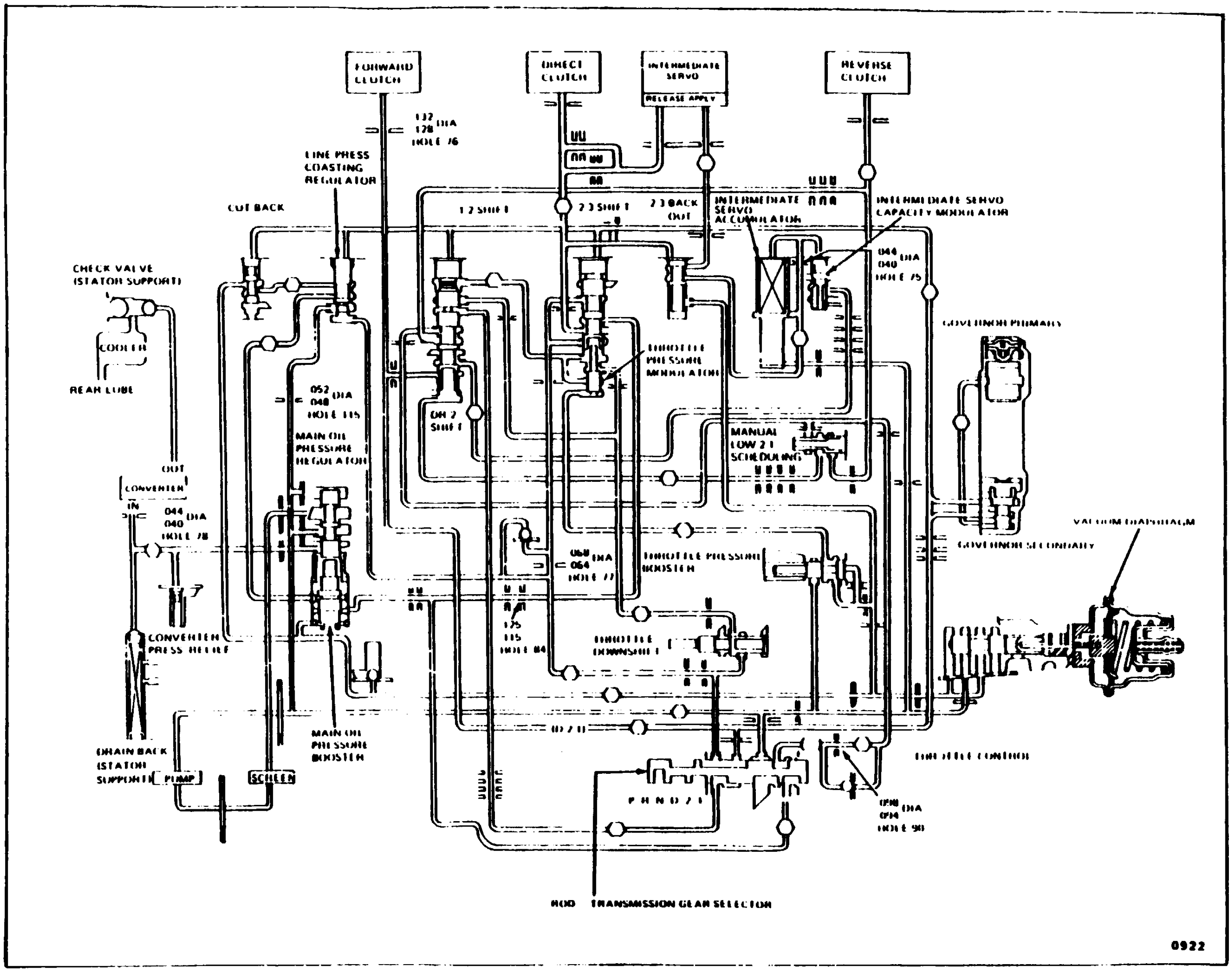
Apply air pressure to the control pressure to governor passage and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

REVERSE-HIGH CLUTCH.

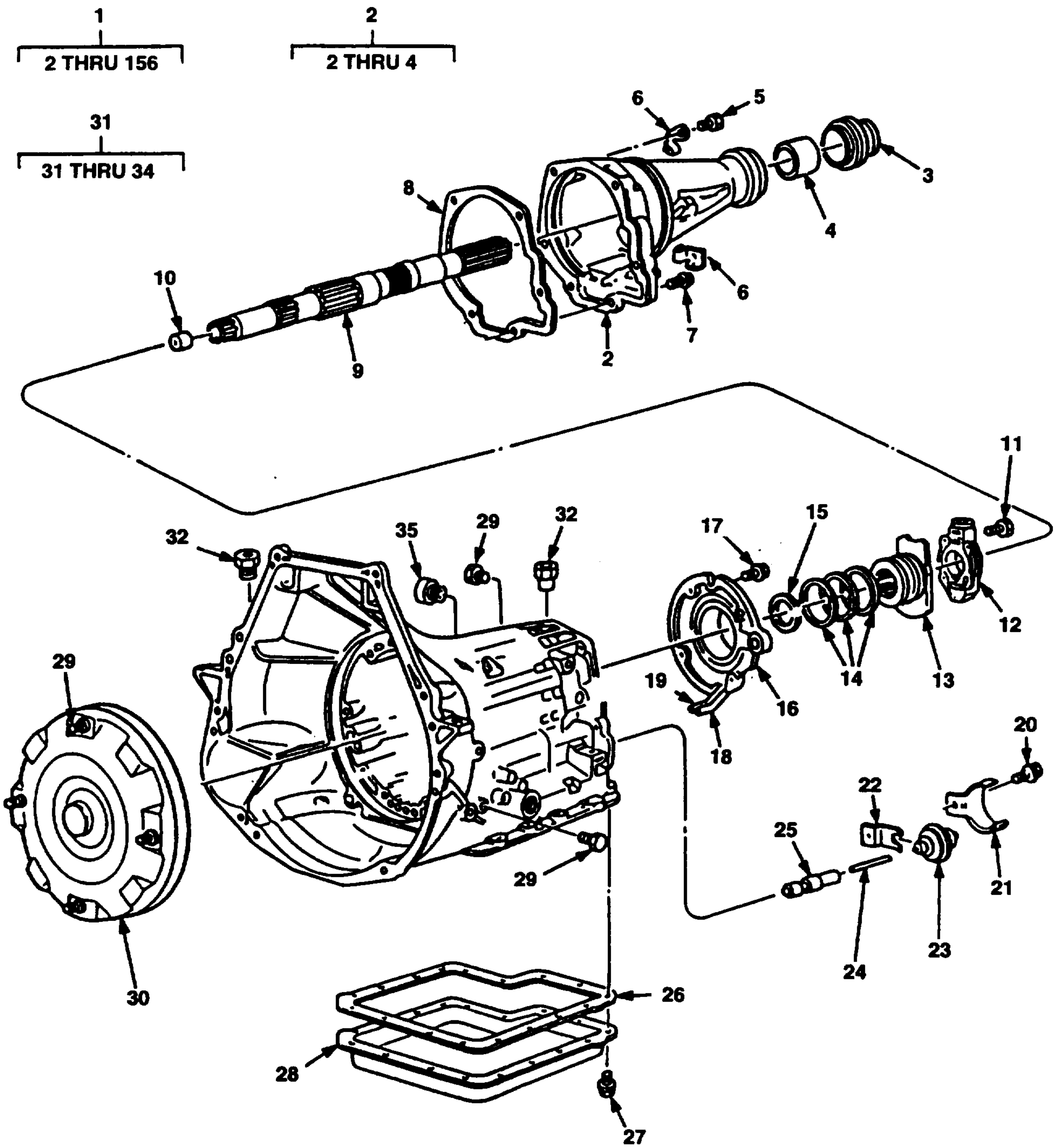
Apply air pressure to the reverse-high clutch. A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the finger tips on the clutch drum and again apply air pressure to detect movement of the piston.

INTERMEDIATE SERVO.

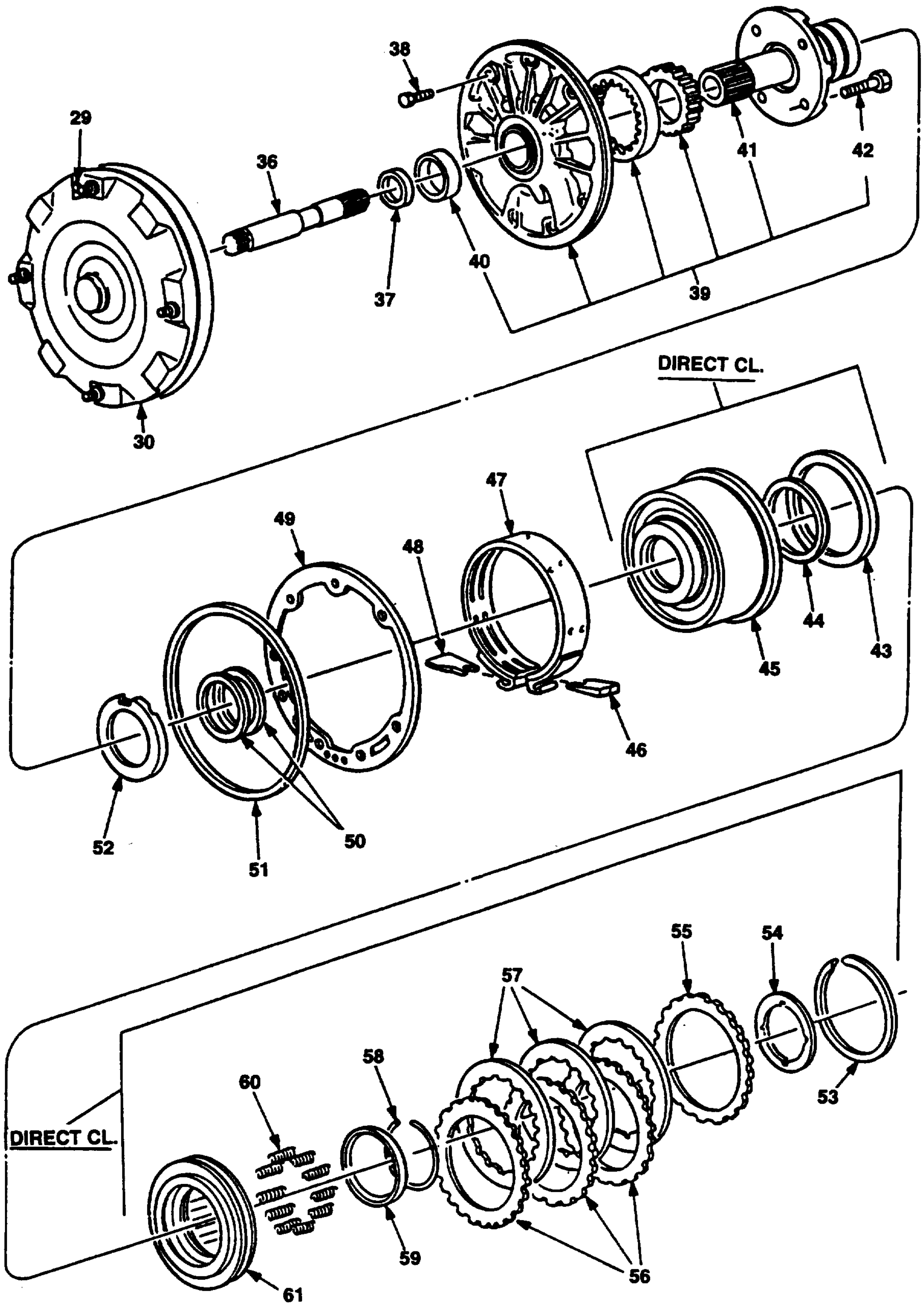
Hold the air nozzle in the front servo apply tube or the intermediate servo apply passages. Operation of the servo is indicated by a tightening of the front or intermediate band around the drum. Continue to apply air pressure to the servo apply tube or passage. and introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate servo should release the band against the apply pressure.



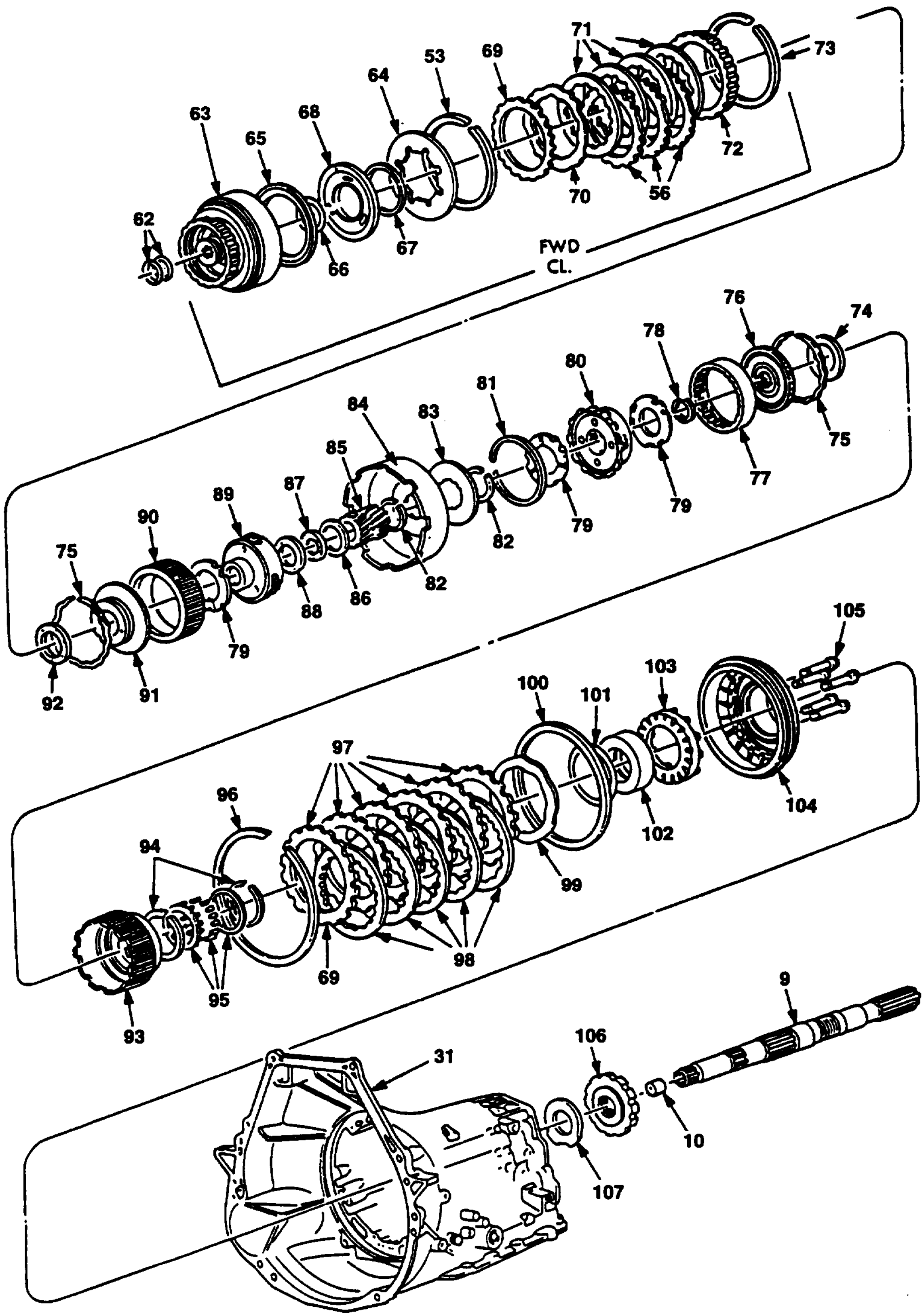
Hydraulic Control System



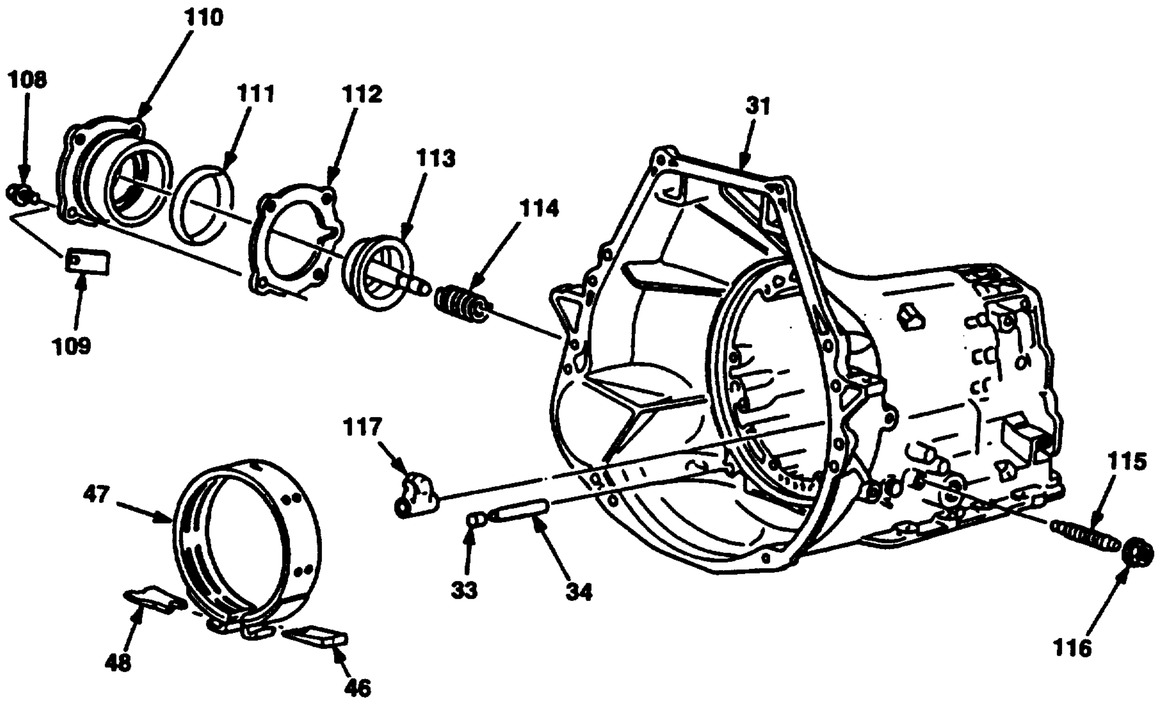
Transmission Assembly Exploded View (Sheet 1 of 6)



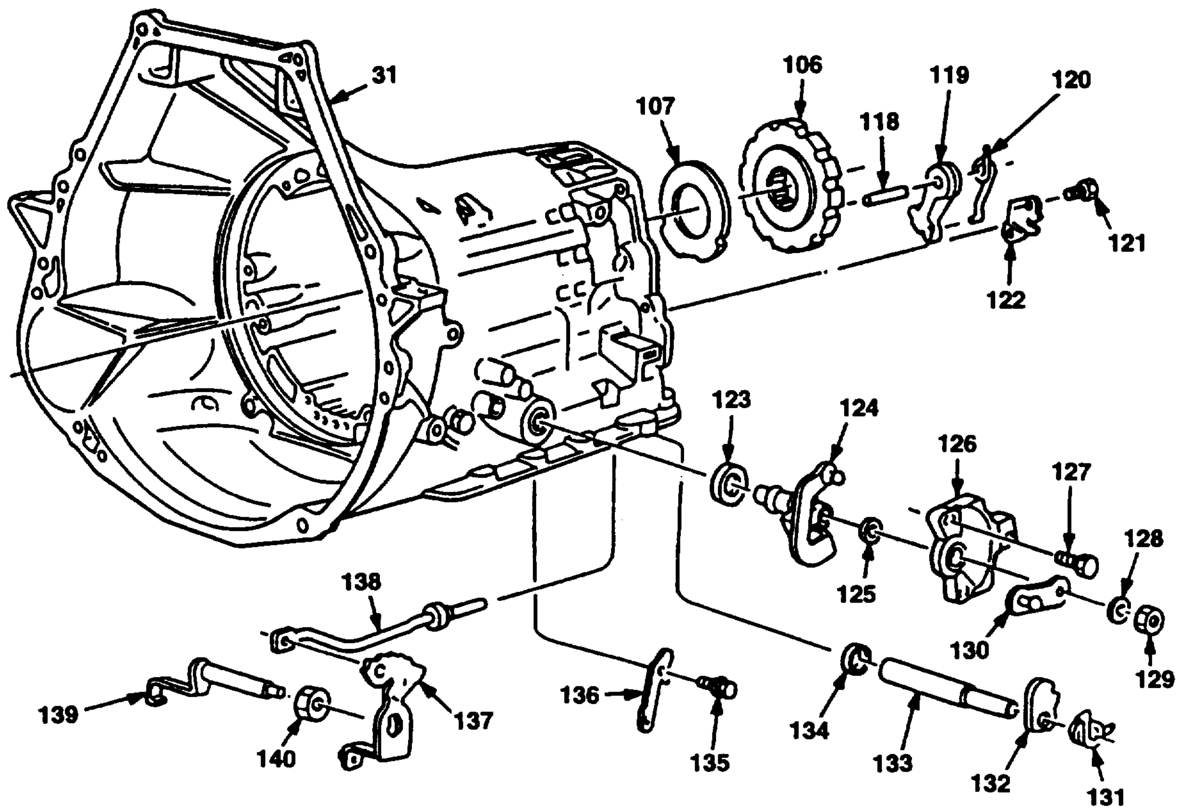
Transmission Assembly Exploded View (Sheet 2 of 6)



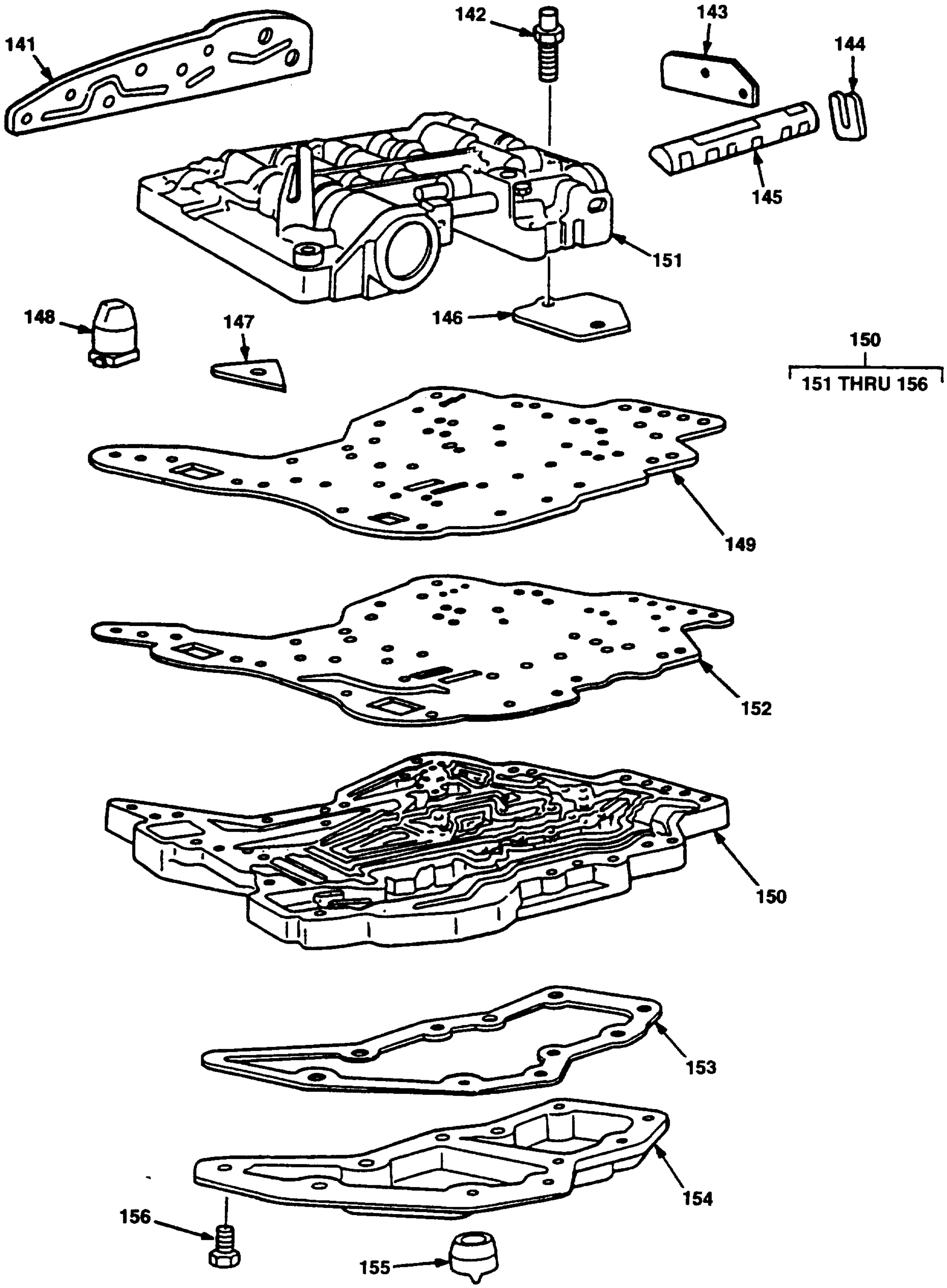
Transmission Assembly Exploded View (Sheet 3 of 6)



Transmission Assembly Exploded View (Sheet 4 of 6)



Transmission Assembly Exploded View (Sheet 5 of 6)



Transmission Assembly Exploded View (Sheet 6 of 6)

1	TRANSMISSION, AUTO
2.	HOUSING
3.	SEAL, OUTPUT SHAFT
4.	BUSHING
5.	BOLT
6.	CLIP
7.	BOLT
8.	GASKET
9.	SHAFT, OUTPUT
10.	PILOT
11.	SCREW
12.	BODY ASSEMBLY
13.	COLLECTOR, OIL
14.	SEAL, GOVERNOR HOUSING
15.	RING, RETAINING
16.	SLEEVE, OIL DISTRIBUTION
17.	BOLT
18.	TUBE, OUTLET
19.	TUBE, INLET
20.	SCREW
21.	CLIP
22.	CLIP
23.	DIAPHRAGM
24.	ROD
25.	VALVE
26.	GASKET
27.	BOLT
28.	PAN, OIL
29.	PLUG
30.	CONVERTER ASSEMBLY
31.	CASE ASSEMBLY
32.	PLUG
33.	RETAINER
34.	SHAFT
35.	VENT
36.	SHAFT, INPUT
37.	SEAL, SMALL
38.	BOLT
39.	PUMP ASSEMBLY
40.	BUSHING
41.	STATOR
42.	BOLT
43.	SEAL, PISTON, OUTER
44.	SEAL, PISTON, INNER
45.	DRUM, BRAKE
46.	ANCHOR
47.	BAND
48.	STRUT
49.	GASKET
50.	SEAL, INTERMEDIATE
51.	SEAL, LARGE
52.	WASHER, .114
52.	WASHER, .119
52.	WASHER,.057
52.	WASHER,.078
52.	WASHER,.094
53.	RING, RETAINING
53.	RING, RETAINING
53.	RING, RETAINING
53.	RING, RETAINING
53.	RING, RETAINING
54.	WASHER
55.	PLATE, PRESSURE
56.	PLATE, CLUTCH, EXTERNAL
57.	PLATE, CLUTCH, INTERNAL
58.	RING, RETAINING
59.	RETAINER
60.	SPRING
61.	PISTON
62.	SEAL
63.	CYLINDER ASSEMBLY
64.	DISC, SPRING
65.	SEAL, PISTON, OUTER
66.	SEAL
67.	RING, RETAINING
68.	PISTON
69.	PLATE, PRESSURE
70.	SPRING, PRESSURE
71.	PLATE, CLUTCH, INTERNAL
72.	PLATE, PRESSURE
73.	RING, RETAINING
73.	RING, RETAINING
74.	WASHER, HUB THRUST
75.	RING, RETAINING
76.	HUB, OUTPUT SHAFT
77.	GEAR, RING, OUTPUT
78.	RING, RETAINING
79.	WASHER, PLANET CARRIER
80.	GEAR
81.	RING, RETAINING
82.	RING, RETAINING
83.	WASHER
84.	SHELL, INPUT
85.	GEAR
86.	RACE, BEARING, REAR
87.	BEARING, SUN GEAR
88.	RACE, BEARING, FRONT
89.	PLANET, GEAR, FORWARD
90.	GEAR, RING, FORWARD
91.	HUB, FORWARD CLUTCH
92.	WASHER, FORWARD CLUTCH
93.	CLUTCH, REVERSE

94. RING, RETAINING
95. CLUTCH, OVERRUNNING
96. RING, RETAINING
97. PLATE, CLUTCH, EXTERNAL
98. PLATE, CLUTCH, INTERNAL
99. SPRING, CLUTCH
100. SEAL, PISTON, OUTER
101. SEAL, PISTON, INNER
102. RACE, OVERRUNNING CLUTCH
103. RETAINER, SPRING
104. PISTON ASSEMBLY
105. BOLT
106. GEAR ASSEMBLY
107. WASHER, OUTPUT SHAFT
108. BOLT
109. TAG
110. COVER
111. SEAL
112. GASKET
113. PISTON
114. SPRING
115. SCREW
116. NUT AND WASHER
117. LEVER
118. SHAFT, PARKING PAWL
119. PAWL, PARKING
120. SPRING, PARKING PAWL
121. SCREW
122. BRACKET
123. SEAL, OIL
124. LEVER
125. SEAL, CONTROL LEVER
126. SWITCH, NEUTRAL/REVERSE
127. SCREW
128. WASHER, LOCK
129. NUT
130. LEVER ASSEMBLY, DOWN
131. SPRING
132. PLATE ASSEMBLY
133. SHAFT, PARKING PLATE
134. PLUG, PARKING PLATE
135. SCREW
136. LEVER ASSEMBLY
137. LEVER
138. ROD ASSEMBLY, PARKING
139. LEVER, DOWNSHIFT
140. NUT
141. PLATE, SHIFT VALVE
142. BOLT
143. PLATE, THROTTLE
144. RETAINER
145. VALVE, MANUAL
146. PLATE
147. PLATE
148. TUBE
149. PLATE
150. CONTROL UNIT ASSY
151. BODY, VALVE
152. GASKET
153. GASKET
154. FILTERING DISK, FLUID
155. TUBE
156. BOLT

LOW-REVERSE CLUTCH.

Apply air pressure to the low-reverse clutch apply passage. A dull thud should be heard if the clutch is operating properly. If the passages are clear, remove the clutch assemblies, and clean and inspect the malfunctioning clutch to locate the trouble.

Hydraulic Checks.

FLUID LEVEL CHECK.

Check the oil level in the transmission. The fluid level indication on the dipstick will be different at operating temperature (transmission hot) and room temperature (transmission cold).

The transmission should be checked at an operating temperature (transmission hot) of 150 degrees to 170 degrees F (66 degrees to 77 degrees C), dipstick is hot to touch. The dipstick reading at operating temperature should have the fluid level on the dipstick between ADD and DON'T ADD marks and/or between the arrows. If the transmission is not at an operating temperature of 150 degrees to 170 degrees F (66 degrees to 77 degrees C) and it becomes necessary to check the fluid level (such as pre-delivery)the fluid may be checked at room temperature 70 degrees to 95 degrees F (21 degrees to 35 degrees C) giving the dipstick a cool feeling. The dipstick reading at room temperature should have the fluid level on the dipstick between the middle and top holes.

FLUID CHECKING PROCEDURE.

Check the transmission fluid using the following procedure.

1. With the transmission in Park, engine at curb idle rpm, foot brakes applied, and crane on level surface, move the transmission selector lever through each range. Allow time in each range to engage the transmission, return to Park, and apply parking brake fully. Do not turn off the engine during the fluid level check.
2. Clean all dirt from the transmission fluid dipstick cap, before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. Be sure it is fully seated.
4. Pull the dipstick out of the tube again and check the fluid level.
5. For correct fluid level reading on the dipstick, follow the appropriate instructions started previously for transmission hot and transmission cold check.

Do not overfill the transmission. Overfill can cause the fluid to foam and spill out through the transmission vent with resultant transmission malfunction.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the crane is parked or being driven on a hill.

6. Install the dipstick making sure it is fully seated in the tube.

FLUID CONDITION CHECK.

After making a normal fluid check according to the procedures under Fluid Checking Procedures, check the condition of the transmission fluid as follows.

1. Observe the color and odor of the fluid. It should be dark reddish not brown or black. A burnt odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
2. Use an absorbent white facial tissue paper to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and repaired. This includes cleaning the torque converter and transmission cooling system.

FLUID LEVEL HIGH BEFORE STARTING ENGINE NORMAL DURING NORMAL CHECK.

If the fluid level is high before starting the engine and normal during normal check, check the following.

1. Check for correct operation of the drainback valve in the stator support.
2. Check the pump bushing.
3. Repair or replace pump. if required.

TRANSMISSION FLUID LEAKAGE CHECKS.

1. Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.
2. Check the fluid filler tube connection at the transmission case. If leakage is found. install a new O-ring. The filler tube bracket should align properly.
3. If leakage is found at either the downshift control lever shaft or the manual lever shaft. replace either or both seals.

FLUID LEAKAGE IN CONVERTER AND FRONT PUMP AREA.

Leakage at the front of the transmission. is evidenced by fluid around the converter housing, and may have several sources. By careful observation. it is possible in many instances, to pinpoint the source of the leak before removing the transmission

1. Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.
3. Fluid that leaks by a front pump-to-case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.
4. Leakage by the front pump-to-case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.
5. Fluid leakage from the converter drain plugs will appear at the outside diameter of the converter

Troubleshooting Chart.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Slow initial engagement.	a. Improper fluid level.	a Perform fluid level check.
	b. Damaged or improperly adjusted linkage.	b. Service or adjust linkage.
	c. Contaminated fluid.	c. Perform fluid condition check.
	d. Improper clutch and band application, or low main control pressure.	d. Perform control pressure test.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Rough initial engagement in either forward or reverse.	a. Improper fluid level.	a. Perform fluid level check.
	b. High engine idle.	b. Adjust idle.
	c. Looseness in the driveshaft, U-joints or engine mounts.	c. Service as required.
	d. Improper clutch or band application. or oil control pressure.	d. Perform control pressure test.
	e. Sticking or dirty valve boy. body.	e. Clean. service or replace valve
3. Harsh engagements - (warm engine).	a. Improper fluid level.	a. Perform fluid level check.
	b. Throttle valve linkage misadjusted/long/disconnected/sticking/damaged/return spring disconnected.	b. Adjust throttle valve linkage.
	c. Valve body bolts loose or too tight.	c. Tighten bolts.
	d. Valve body dirty or sticking valves.	d. Determine source of contamination. Service as required.
4. No/ delayed forward engagement {reverse OK).	a. Improper fluid level.	a. Perform fluid level check.
	b. Manual linkage - misadjusted/ damaged.	b. Check and adjust or service as required.
	c. Low main control pressure. (Leakage.) Forward clutch stator support seal rings leaking (#3, #4).	c. Control pressure test, note results.
	d. Forward clutch assembly burnt. Damaged/leaking check ball in cylinder. Leaking piston seal rings.	d. Perform air pressure test.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f Valve body dirty or sticking valves.	f. Determine source of contamination. Service as required.
	g. Transmission filter plugged.	g. Replace filter.
	h. Pump damaged or leaking.	h. Visually inspect pump gears. Replace pump if necessary.

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. No/delayed reverse engagement forward OK)	a. Improper fluid level'	a Perform fluid level check(
	b. Manual linkage misadjusted damaged	b Check and adjust or service 5s required
	c. Low main control pressure In reverse. Reverse clutch stator support seal rings leaking (#1, #2)	c. Control pressure res:
6. No/delayed reverse engagement and/or no engine breaking In manual low {1).	a. Improper fluid level.	a. Perform fluid level check
	b. Low reverse servo piston seal leaking.	b. Check and replace piston seal
	c. Planetary low one way clutch damaged.	c. Determine cause of condition Service as required
7. No engine braking in manual second gear	a. Intermediate band out of adjustment	a. Adjust Intermediate band
	b. Improper band or clutch application. or oil pressure control system.	b. Perform control pressure :es.
	c. Intermediate servo leaking	c. Perform air pressure test of Intermediate servo for leakage Service as required
	d. Intermediate one way clutch damaged.	d Replace
	e. Polished or glazed band or drum.	e. Service or replace as required
8. Forward engagement slips,' shudders/chatters.	a. Improper fluid level.	a. Perform fluid level check
	b. Manual linkage misadjusted., damaged.	b. Check and adjust or service as required
	c. Low main control pressure.	c Control pressure test.
	d. Valve body bolts loose or too tight.	d Tighten bolts
	e. Valve body dirty or sticking valves.	e. Determine source of contamination Service as required
	f. Forward clutch piston ball check not seating or !leaking	f. Replace forward clutch cvlinder Service transmission as re quired
	g. Forward clutch piston seals cut or worn	g Replace seals and service.: clutch as required
	h. Low one way clutch (planetary) damaged	Determine cause of condition Service as required

SYMPTOM	PROBABLE CAUSE	SOLUTION
9. Reverse shudder/chatters/ slips.	a. Improper fluid level.	a. Perform fluid level check.
	b. Low main control pressure in reverse.	b Control pressure test
	c. Low reverse servo/leaking.	c Air pressure test: visually In-spect seal rings and piston bore
	d. Low (planetary) one-way clutch damaged.	d. Determine cause of condition Service as required.
	e. Reverse clutch drum bushing damaged.	e. Determine cause of condition Service as required.
	f. Reverse clutch stator support seal ring grooves worn or damaged.	f. Determine cause of condition. Service as required.
	g. Reverse clutch piston seals cut or worn.	g. Determine cause of condition Service as required.
	h. Looseness in the driveshaft, U-joints or engine mounts.	h. Service as required.
10. No drive, slips or chatters in first gear in D. All other gears normal.	a. Damaged or worn planetary one-way clutch.	a. Service or replace one-way clutch.
11. No drive, slips or chatters in second gear.	a. Intermediate band out of ad-justment.	a. Adjust intermediate band.
	b. Improper band or clutch appli-cation. or control pressure.	b. Perform control pressure test
	c. Damaged or worn intermediate servo piston seals and/or internal leaks.	c. Perform air pressure test.
	d. Dirty or sticking valve body. body.	d. Clean. service or replace valve
	e. Polished. glazed intermediate band or drum.	e. Replace or service as required.
12. Starts up in 2nd or 3rd.	a. Improper band and/or clutch application, or oil pressure control system.	a. Perform control pressure test.
	b. Damaged or worn governor. Sticking governor	b. Perform governor check Re-place or service governor. clean screen.
	c. Valve body loose.	c. Tighten valve.
	d. Dirty or sticking valve body. body	d. Clean. service or replace valve
	e. Cross leaks between valve body and case mating surface.	e. Service or replace valve body and/or case as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
13. All upshifts harsh/delayed or no upshifts.	a. Improper fluid level.	a. Perform fluid level check
	b. Manual linkage - misadjusted or damaged	b. Check and adjust: or service as required
	c. Governor sticking. as required.	c. Perform governor test Service
	d. Main control pressure too high. as required.	d. Control pressure test. Service
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty or sticking valves.	f. Determine source of contamination. Service as -required
	g. Vacuum leak to diaphragm unit.	g. Check vacuum lines to diaphragm unit. Service as necessary Perform vacuum supply and diahragm tests.
14 Mushy/early all upshifts/ pile up upshifts.	a. Low main control pressure. suits.	a. Control pressure test. Note re-
	b. Valve body bolts loose or too tight.	b. Tighten bolts.
	c. Valve body valve or throttle control valve sticking.	c. Determine source of contami,-nation. Service as required.
	d. Governor valve sticking. as required.	d. Perform governor test. Repair
15. No 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check
	b. Manual linkage- misadjusted/ damaged.	b. Check and adjust or service as required.
	c. Governor valve sticking. Intermediate band out of adjustment. band.	c. Perform governor test. Service as required. Adjust intermediate
	d. Vacuum diaphragm bent. sticking or leaking.	d. Check diaphragm unit. Service as necessary.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty/sticking valves.	f. Determine source of contamination. Service as required.
	g. Intermediate clutch, band, and/ or servo assembly burnt.	g. Perform air pressure test.

SYMPTOM	PROBABLE CAUSE	SOLUTION
16 Rough/harsh/delayed 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check.
	b. Poor engine performance.	b Tune engine
	c. Intermediate band out of adjust-ment.	c. Adjust intermediate band.
	d. Main control pressure too high. results.	d. Control pressure test. Note
	e. Governor valve sticking. as required.	e. Perform governor test. Service
	f. Engine vacuum leak.	f. Check engine vacuum lines. Service as necessary. Check vac-uum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests.
	g. Valve body bolts loose or too tight.	g. Tighten bolts.
	h Valve body dirty/sticking valves.	h. Determine source of contami-nation. Service as required.
17. Mushy/early/soft, slipping 1-2 upshift.	a. Improper fluid level.	a. Perform fluid level check.
	b. Incorrect engine performance. quired.	b. Tune adjust engine idle as re-
	c. Intermediate band out of adjust-ment.	c. Adjust intermediate band.
	d. Low main control pressure.	d. Control pressure test. Note re-sults.
	e. Valve body bolts loose or too tight.	e. Tighten bolts.
	f. Valve body dirty/sticking valves.	f. Determine source of contami-nation. Service as required.
	g. Governor valve sticking. as required.	g. Perform governor test. Service
	h. Damaged intermediate servo or band.	h. Perform air pressure test Ser-vice as required.
	i. Polished. glazed band or drum.	i. Service or replace as required

SYMPTOM	PROBABLE CAUSE	SOLUTION
18. No 2-3 upshift.	a. Low fluid level.	a. Perform fluid level check
	b. Throttle valve linkage misadjusted (long), sticking, or damaged.	b Adjust linkage Service as required
	c. Low main control pressure to direct clutch.	c. Control pressure test Note results.
	d. Valve body bolts loose or too tight.	d. Tighten bolts
	e. Valve body dirty/sticking valves.	e Determine source of contami. nation, then service as required
19. Harsh/delayed 2-3 upshift.	a. Incorrect engine performance.	a. Check engine tune-up
	b. Engine vacuum leak.	b. Check engine vacuum lines Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum Supply and diaphragm tests.
	c. Damaged or worn intermediate servo release and high clutch piston check ball.	c. Air pressure test the intermediate servo apply and release the high clutch piston check ball Service as required.
	d. Valve body bolts loose or too tight.	d. Tighten bolts
	e. Vacuum diaphragm or throttle valve control rod bent. sticking. or leaking.	
	e. Check diaphragm and rod Replace as necessary.	
20. Soft/early/mushy 2-3 upshift. tight.	a. Valve body bolts loose or too	a. Tighten bolts.
	b. Valve body dirty/sticking valves.	b. Determine source of contamination. Service as required
	c. Vacuum diaphragm or throttle valve control rod bent, sticking. or leaking.	c. Check diaphragm and rod Replace as necessary
21. Erratic shifts.	a. Poor engine performance.	a. Check engine tune-up
	b. Valve body bolts loose or too tight.	b. Tighten bolts
	c. Valve body dirty/sticking valves.	c. Line pressure test. note results. Determine source of contamination. Service as required
	d. Governor valve stuck.	d. Perform governor test Service as required.
	e. Output shaft collector body seal rings damaged	e Service as required.

SYMPTOM	PROBABLE CAUSE	SOLUTION
22. Shifts 1-3 in D.	a. Intermediate band out of adjustment.	a. Adjust band.
	b. Damaged Intermediate servo and/or internal leaks,	b. Perform air pressure test: Service front servo and or Internal leaks.
	c. Improper band or clutch application, or oil pressure control system.	c. Perform control pressure test.
	d. Polished, glazed band or drum.	d. Service or replace band or drum.
	e. Dirty or sticking valve body.	e. Clean. service or replace valve body.
	f. Governor valve stuck.	f. Perform governor test. Service as required.
23. Engine over-speeds on 2-3 Shift.	a. Linkage out of adjustment.	a. Service or adjust linkage
	b. Improper band or clutch application. or oil pressure control system.	b. Perform control pressure test.
	c. Intermediate servo piston seals cut/leaking.	c. Replace seals. Check for leaks.
	d. Dirty or sticking valve body.	d. Clean. service or replace valve body.
24. No forced downshifts.	a. Kickdown linkage out of adjustment.	a. Service or adjust linkage.
	b. Damaged internal kickdown linkage.	b. Service Internal kickdown linkage.
	c. Improper clutch or band application, or oil pressure control system.	c. Perform control pressure test.
	d. Dirty or sticking governor.	d. Perform governor test. Service or replace governor, clean screen.
	e. Dirty or sticking valve body.	e. Clean, service. or replace valve body.
25. Vehicle will not start.	a. Misadjusted neutral start switch.	a. Adjust neutral start switch
	b. Misadjusted linkage.	b. Adjust linkage
	c. Defective neutral start switch.	c. Replace neutral switch.

GENERAL OVERHAUL INFORMATION.

Special Tools and Equipment.

In addition to common tools ordinarily used. the following special tools and equipment will be beneficial in servicing the transmission, and are available from Ford Motor Company, Dearborn, Michigan,

SPECIAL SERVICE TOOLS	
Number	**Description**
T50T-100-A	Impact Slide Hammer
T59L-100-B	Impact Slide Hammer
T58L-101-A	Puller Attachment
T57L-500-B	Bench Mounted Holding Fixture
Tool-1175-AC	Seal Remover
Tool-4201-C	Dial Indicator with Bracketry
Tool-7000-DD	Rubber Tip for Air Nozzle
Tool-7000-DE	Air Nozzle Assembly
T66L-7003-CZ	Front Pump Bushing Replacer
T67P-7341-A	Shift Linkage Insulator Tool
T84P-7341-A	Shift Linkage Grommet Remover
T84P-7341-B	Shift Linkage Grommet Remover
T61L-7657-B	Extension Housing Seal Replacer
T77L-7697-C	Extension Housing Bushing Replacer
T77L-7697-D	Extension Housing Bushing Remover
T76L-7902-C	Converter Clutch Torquing Tool
T80L-7902-A	End Play Checking Tool
T77L-7902-A	Converter Clutch Holding Tool
T73P-77060-A	Output Shaft Retainer Pliers
Tool-77288	Shift Lever Seal Replacer
T71P-77370-A	Band Adjustment Torque Wrench Set
T65L-77515-A	Clutch Spring Compressor
T77L-77548-A	Lip Seal Protector
T63L-77837-A	Front Pump Seal Replacer
T83T-7B200-AH	VRV Gage Block
T69L-7D044-A	Clutch Housing Bushing Tool
T74P-77247-A	Neutral Start Switch Socket Tool
T82L-7006-A	Air Pressure Check Plate
T82P-7006-C	Capscrews for Air Pressure Check Plate
T83L-7902-A1	Torque Adapter Turning Tool
T83L-7902-A2	Pilot Guide
T80L-77030-B	Servo Piston Remover
T83L-7902-A3	Holding Fixture
ROTUNDA EQUIPMENT	
014-00028	Torque Converter Cleaner
072-00004	Torque Converter Leak Tester
019-00027	Automatic Transmission Tester

CLEANING AND INSPECTION.

Transmission.

It is important to completely clean all transmission components, including converter, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the direct Clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission.

Clean all parts with suitable solvent and use moisture free air to dry off all parts and clean out fluid passages.

The composition clutch plates, bands. and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for fifteen minutes before being assembled.

Do not reuse the control valve body to filter gasket or try to clean in solvent. Replace the valve body to filter gasket upon assembly of the transmission.

Control Valve Body.

1. Clean all parts thoroughly in clean solvent, and blow dry with moisture free compressed air. If the valve body-to-screen gasket is removed, the gasket should not be cleaned in a degreaser, solvent, or any type of detergent solution. To clean the gasket, wipe it off with a lint-free cloth.
2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or scores. Use crocus cloth to polish valves and plugs. Avoid rounding the sharp edges of the valves and plugs with the cloth.
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.
4. Inspect the separator plate screen for obstructions. The screen must be clean and free of foreign material. If contaminated, remove it from the separator plate, clean in a suitable solvent. and thoroughly blow clean with compressed air.
5. Roll the manual valve on a flat surface to check for bent condition.

Intermediate Servo.

1. Inspect the servo bore for cracks and the servo piston for damage, and the piston bore and the servo piston stem for scores. Check fluid passages for obstructions. Replace damaged seals.
2. Check the servo spring and servo band strut(s) for distortion.
3. Inspect the cover seal and gasket cover sealing surface for damage.

Extension Housing.

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Replace. if required.
3. Inspect the rear seal for hardness, cracks, or wear. If the seal shows wear or deterioration. replace the seal.
4. Inspect the seal counterbore and remove all burrs and scores with crocus cloth.

Governor.

1. Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the valves or body is deeply scored.
2. Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions. All fluid passages must be clean.
3. Inspect the mating surfaces of the governor body and governor distributor for burrs and distortion. Mating surfaces must be smooth and flat.

Front Pump.

1. Inspect the mating surfaces of the pump body and case for burrs.

2. Inspect the drive and driven gear bearing surface for scores and check gear teeth for burrs.

3. Inspect the front pump seal for cuts or nicks., and the pump bushing for scoring.

4. Check the fluid passages for obstructions.

5. If any parts are found damaged or worn, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.

6. Check the large seal ring groove of the pump body for damage. Check the gasket mating surface of the pump body for damage.

Reverse-High Clutch.

1. Inspect the drum band surface, the bushing, and thrust surfaces for scores. Minor scores may be removed with crocus cloth. Badly scored parts must be replaced.

2. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve in the clutch piston for free movement. Check the orifice to ensure it is not plugged.

3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

4. Inspect the clutch plates for wear, scoring, and fit on the clutch hub serrations. Replace all plates that are badly scored, worn, or do not fit freely in the hub serrations.

5. Inspect the Clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.

6. Inspect the clutch piston check ball for freedom of movement and proper seating.

Forward Clutch.

1. Inspect the clutch cylinder thrust surfaces. pis ton bore. and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.

2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace. if necessary Inspect the piston check ball for freedom of movement and proper seating.

3. Check the clutch release spring for distortion and cracks. Replace the spring if distorted or cracked.

4. Inspect the composition clutch plates, steel clutch plates. and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.

5. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear 6. Check the splines on the stator support for wear. Inspect the bushing in the stator support for scores. Check the input shaft for damaged or worn splines. Replace the shaft if the splines are excessively worn.

Direct Clutch Piston.

Inspect the piston check ball for freedom of movement. Improper seating of check ball will cause leakage. Leakage can be detected by turning the piston upside down (flat side of piston facing you) allowing the check ball to seat in the piston. Pour a small quantity of solvent over the check ball. If solvent drips past the check ball, replace the piston.

Low-Reverse Clutch.

1. Inspect the clutch cylinder piston born, and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the case if it is badly scored or damaged

2. Check the fluid passage in the case for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace, if necessary.

3. Check the piston return springs for distortion. Check the piston return spring retainer for flatness.

4. Inspect the composition clutch piates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.

5. Check the clutch hub splines.

Planetary One-Way Clutch.

1. Inspect the intermediate outer and inner races for scores or damaged surface areas where rollers contact the races.

2. Inspect the rollers and springs for excessive wear or damage.

3. Inspect the spring and roller cage for bent or damaged spring retainers.

Converter and Fluid Cooler.

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and must be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler must be cleaned by using the Rotunda Torque Converter Cleaner (model 014-00028), or equivalent. Under no circumstances should an attempt be made to clean converters by hand agitation with solvent.

ASSEMBLY PROCEDURES.

Selective Parts.

1. Certain parts are provided in graduated thicknesses to provide correct clutch clearances. Because the initial selection has already been made for the particular transmission, it should not be necessary to re-select components if components affecting the original selection are not replaced.

NOTE
To maintain relationship of involved components, it may be desirable to identify the related parts during disassembly.

2. If any parts require replacement. the correct clutch clearances will be given in the affected assembly procedure.

Torque Specifications.

Toque specifications for various items are provided in chart form. These same torque values are included In the assembly procedures.

TRANSMISSION DISASSEMBLY (MAJOR COMPONENT REMOVAL).

Control Valve Body.

1. If not already done, remove the transmission pan attaching bolts and remove the pan and gasket.

Remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipment and should be discarded when the oil pan is removed.

2. Remove the valve body attaching bolts and remove the valve body from the case.

Intermediate Servo.

1. Remove the bolts that attach the servo to the transmission case.

2. Remove the cover, piston, spring, and gasket from the case, screwing the band adjusting screw inward as the piston is removed. This places enough tension on the band to keep the struts properly engaged in the band end notches while the piston is removed.

3. Apply air pressure to the port in the servo cover to remove the piston and rod. If the piston or piston sealing lips are damaged, the complete piston and rod assembly should be replaced at assembly.

4. Remove the seal from the cover.

Extension Housing Bushing and Rear Seal.

1. If only the rear seal needs replaced, carefully remove it with a tapered chisel or special tools. T50T100-A and 1175-AC.

NOTE
If using special tool T77L-7697D, bushing remover, to remove the bushing, ensure the spline seal is not damaged.

2. Remove the bushing using special tool T77L7697-D, or equivalent.

TORQUE SPECIFICATIONS		
Item	**(lb ft)**	**N•m**
Converter to Flywheel	20-34	27-46
Front Pump to Transmission Case	16-30	22-41
Overrunning Clutch Race to Case	18-25	24-34
Oil Pan to Case	8-12	11-16
Stator Support to Pump	12-16	16-22
Converter Cover to Converter Housing	12-16	16-22
Guide Plate to Case	12-16	16-22
Intermediate Servo Cover to Case	14-20	19-27
Diaphragm Assembly to Case	12-16	16-22
Distributor Sleeve to Case	12-16	16-22
Extension Assembly to Transmission Case	25-35	34-48
Plug Case Front Pump or Line Pressure	6-12	8-16
Pressure Gauge Tap	6-12	8-16
Band Adjusting Screw Locknut to Case	35-40	48-54
Converter Drain Plug	8-28	11-38
Manual Valve Inner Lever to Shaft	30-40	41-54
Downshift Lever to Shaft	12-16	16-22
Transmission to Engine	50-65	68-88
Rear Engine Support to Transmission	60-80	81-109
Plug Case - Throttle Pressure	6-12	8-16
5/16" Fitting - Cooler Line Connector to Case - Front and Rear (Case Fitting)	18-23	24-31
5/16" Tube Nut - Cooler Line to Transmission Case Fitting	12-18	16-24
	(lb in.)	**N•m**
End Plates to Body	20-45	2-5
End Plates to Body	20-45	2-5
Inner Downshift Lever Stop	20-45	2-5
Reinforcement Plate to Body	20-45	2-5
Screen and Lower to Upper Valve Body	40-55	5-6
Shift Valve Plate to Upper Body	20-45	2-5
Upper to Lower Body	40-55	5-6
Reinforcing Right Side Plate to Lower Body	20-45	2-5
Control Assembly to Case	95-125	11-14
Governor Body to Collector Body	90-120	10-14
Detent Spring to Case	80-120	9-14
Rear Engine Support to Frame	40-60	5-7
Neutral Switch to Case	55-75	6-9

Extension Housing.

1 Remove the extension housing attaching bolts. Slide the extension housing off the output shaft. Remove the gasket.

Governor.

1. Remove the four governor body to oil collector attaching bolts.
2. Remove the governor from the collector body flange.

TRANSMISSION DISASSEMBLY AND ASSEMBLY (SUBASSEMBLIES).

General.

Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces. Lubricate all internal parts of the transmission with clean automatic transmission fluid before assembly.

Do not use any other lubricants except on gaskets and thrust washers. These may be coated with petroleum jelly to facilitate assembly. Always use new gaskets and seals when assembling the transmission.

Tighten all bolts and screws to the recommended torque as outlined in the Torque Specifications chart.

Transmission Disassembly.

1. Remove the converter. Mount the transmission in holding fixture Rotunda model 014-00106, or equivalent.
2. If not already done, remove the fluid pan attaching bolts. Remove the pan and gasket.
3. If not already done, remove the valve body attaching bolts. Lift the valve body from the transmission case.
4. Attach a-dial indicator, special tool 4201-C. or equivalent, to the front pump. Center the output shaft using seal replacer tool T61L-7657-B. or equivalent.
5. Pry the gear train to the rear of the case and at the same time, press the input shaft inward until it bottoms. Set the dial indicator to read zero.
6. Pry the gear train forward, and note the amount of gear train end play on the dial indicator. Record the end play to facilitate assembly of the transmission.

   Remove the dial indicator from the pump and the tool from the output shaft.
7. Remove the vacuum diaphragm. valve rod, and the throttle valve from the bore in the rear of the case. Remove the input shaft out of the front pump.
8. Remove the front pump attaching bolts. Pry the gear train forward to remove the pump.
9. Loosen the band adjustment screw and remove the two struts.
10. Rotate the band 90 degrees counterclockwise to align the ends with the slot in the case. Slide the band off the reverse-high clutch drum.
11. Remove the forward part of the gear train as an assembly.
12. If not already done, remove the bolts that attach the servo cover to the transmission case.
13. If not already done, remove the cover, piston, spring and gasket from the case.
14. Remove the large snap ring that secures the reverse planet carrier in the low-reverse clutch hub.

    Lift the thrust washers and planet carrier from the drum.
15. Remove the snap ring that secures the reverse ring gear and hub on the output shaft. Slide the ring gear and hub off the shaft. Remove the thrust washer.
16. Rotate the low-reverse clutch hub in a clockwise direction and at the same time. withdraw it from the case.

17. Remove the reverse clutch snap ring from the case, then remove the clutch discs, plates, and pressure plate from the case.

18. If not already done, remove the extension housing attaching bolts from the case. Remove the extension housing and gasket.

19. Slide the output shaft assembly from the transmission case.

20. Remove the distributor sleeve attaching bolts and remove the sleeve, parking pawl gear, and the thrust washer. If the thrust washer is staked in place, use a sharp chisel and cut off the metal from behind the thrust washer. Be sure to clean the rear of the case with air pressure or a suitable solvent to remove any metal particles.

21. Compress the reverse clutch piston release spring with clutch spring compressor tool T65L77515-A. or equivalent. Remove the snap ring. Remove the tool and the springs and retainer assembly.

22. Remove the one-way clutch inner race attaching bolts from the rear of the case. Remove the inner race from inside of the case.

23. Remove the low-reverse clutch piston from the case using air nozzle tool 7000-DE, or equivalent.

Disassembly of the Control Valve Body.

NOTE

The valve body-to-screen gasket should not be cleaned in a degreaser solvent or any type of detergent solution when disassembling the main control. To clean the gasket. wipe it off with a lint free cloth.

1. Remove the nine screws that attach the screen to the lower valve body and remove the screen and gasket.

2. Remove the five upper to lower valve body and hold down plate attaching screws. Remove the seven attaching screws from the underside of the lower valve body.

NOTE

When removing the separator plate and gasket, be careful not to lose the check valves and springs.

3. Separate the bodies and remove the separator plate and gasket. Remove and clean the separator plate screen, if necessary.

4. Remove the manual valve retaining pin from the upper valve body.

5. Slide the manual valve out of the valve body

6. Cover the downshift bore with a finger, then working from the underside of the body remove the downshift valve retainer. Remove the spring and downshift valve.

7. Apply hand pressure on the pressure boost valve sleeve end and remove the sleeve retaining clip from the under side of the body. Slowly release hand pressure and remove the sleeve and the pressure boost valve. Remove the two springs, the spring retainer and the main regulator valve from the bore

8. Apply pressure on the throttle boost valve retaining plate and remove the two attaching screws. Slowly release the pressure and remove the plate, throttle pressure boost valve and spring, and the manual low 2-1 scheduling valve and spring from the body.

9. Apply pressure on the remaining valve retaining plate and remove the eight attaching screws.

10. Hold the valve body so that the plate is facing upward. Slowly release the pressure and remove the plate.

11. Remove the spring and the intermediate servo modulator valve from the valve body.

12. Remove the intermediate servo accumulator valve and springs.

13. Remove the 2-3 back-out valve and spring.

14. Remove the 2-3 shift valve. spring. and the throttle modulator valve

15. Remove the 1-2 shift valve, DR-2 shift valve, and the spring from the valve body.

16. Remove the line pressure coasting regulator valve from the body.

17. Remove the cutback control valve to complete the disassembly of the control valve.

Assembly of the Control Valve Body.

1. Install the downshift valve and spring in the valve body. Compress the spring and install the retainer from the underside of the body.

2. Install the valve body on a clean surface with the passage side facing up. Install the converter relief valve spring in its bore. Coat the converter pressure relief valve with petroleum jelly and place it on top of the spring. Install the 2-3 shift valve check ball in its cavity. Install the throttle pressure relief valve spring in its bore. Coat the throttle pressure relief valve check ball with petroleum jelly and place it on top of the spring.

3. If previously removed, install the separator screen in the separator plate ensuring that the screen tabs are flush with the separator plate surface. Carefully position the separator plate and new gasket on the lower valve body. Install the two hold down plates on the separator plate and install the attaching screws finger tight.

4. Install the lower body and plate assembly on the upper valve body and install the attaching screws finger tight.

5. Install the oil screen screws loosely, without the screen, to properly align the upper and lower valve bodies, gasket, and separator plate.

6. Torque the two bolts that are covered by the screen 40 to 55 lb in. (5 to 6 N•m).

7. Remove the oil screen attaching screws and install the gasket and oil screen in position on the lower valve body. install the screen attaching screws.

8. Torque all the valve body and screen attaching screws 40 to 55 lb in. (5 to 6 N•m).

9. Install the cutback control valve and the line pressure coasting regulator valve in the valve body.

10. Install the one spring, DR-2 shift valve. and the 1-2 shift valve in the body.

11. Install the throttle modulator valve and spring and the 2-3 shift valve in the valve body.

12. Install the spring and the 2-3 backout valve in the valve body.

13. Install the two springs and the intermediate servo accumulator valve in the valve body.

14. Install the intermediate servo modulator valve and spring in the body.

15. Carefully install the valve retaining plate on the body and secure with the eight attaching screws. Torque the two hex washer head screws 20 to 45 lb in. (2 to 5 Nom). Torque the remaining six screws 20 to 40 lb in. (2 to 5 N•m).

16. Install the throttle pressure boost valve and spring in the valve body. Install the manual low 2-1 scheduling valve and spring In the valve body and install the retaining plate. Torque the attaching screws 20 to 45 lb in. (2 to 5 N•m).

17. Install the spring retainer on the stem of the main regulator valve so that the retainer flange is next to the valve shoulder. Install the main regulator valve, spring retainer, two springs, pressure boost valve, and sleeve in the bore. Apply hand pressure on the end of the pressure boost valve sleeve and install the spring clip retainer in the groove on the under side of the body so that the clip is inserted into the end groove in the sleeve. Ensure the pressure boost valve sleeve is free in its bore.

18. Install the manual valve in the valve body and install the retaining pin in the body.

Disassembly of the Intermediate Servo.

1. If not previously removed, apply air pressure to the port in the servo cover to remove the piston and rod. If the piston or piston sealing lips are damaged replace the complete piston and rod assembly.

2. Remove the seal and gasket from the cover.

Assembly of the Intermediate Servo.

1. Dip the new seals in transmission fluid. Install a new seal and gasket on the cover.

2. Dip the piston in transmission fluid and install it in the cover.

Disassembly of the Governor.

1. If not previously removed. remove the governor body attaching bolt and remove the governor.

2. Remove the snap ring that secures the governor oil collector body on the output shaft and slide it off the front of the shaft.

3. Remove the seal rings from the oil collector body.

Assembly of the Governor.

1. Carefully install new seal rings on the oil collector body.

2. Working from the front end of the output shaft. slide the governor oil collector body into place on the shaft and secure with the snap ring. Ensure the snap ring is seated in the groove.

3. Install the governor assembly on the oil collector body and secure with the attaching screws. Torque the screws 90 to 120 lb in. (10 to 14 N•m).

Disassembly of the Downshift and Manual Linkage.

1. Remove the nut and lockwasher that secures the outer downshift lever to the transmission and remove the lever.

2. Slide the inner downshift lever assembly out from the inside of the case.

3. Remove the two bolts securing the neutral start switch.

4. Remove the C-ring securing the parking pawl actuating rod to the manual lever. Remove the rod from the case.

5. Remove the nut securing the inner manual lever to the shaft. Remove the inner lever from the shaft. Slide the outer lever and shaft from the case.

6. Remove the seal from the case with tools T59L1 00-B and T58L101 -A hammer and puller, or equiva lent.

Assembly of the Downshift and Manual Linkage.

1. Dip the new seal in transmission fluid and install it in the case using seal replacer tool 77288, or equivalent.

2. Slide the outer manual lever and shaft In the transmission case. Install the Inner lever on the shaft, ensuring the leaf spring roller is positioned In the Inner manual lever detent. Install the attaching nut and torque 30 to 40 lb ft (41 to 54 Nom).

3. ' Install the parking pawl actuating rod and secure it to the inner manual lever with the C-ring.

4. Slide the neutral start switch on the outer lever shaft and install the bolts in the case.

5. With the transmission manual lever in neutral, rotate the switch and install the gauge pin (No. 43 drill shank end) into the gauge pin holes of the switch.

The gauge pin must be installed a full 0.4844 inches (12.303 mm) into the three holes of the switch.

6. Torque the attaching bolts 55 to 75 pounds-inch (63.3 to 86.4 kgcm). Remove the gauge pin from the switch.

7. Install a new downshift lever seal in the recess of the outer lever shaft. Slide the downshift lever and shaft into Position.

8. Install the outer downshift lever on the shaft and secure with the lockwasher and nut. Torque the nut 12 to 16 lb ft (16 to 22 Nom).

Disassembly of the Parking Pawl Linkage.

1. Remove the bolts securing the parking pawl guide plate to the case. Remove the plate.

2. Remove the spring, parking pawl, and shaft from the case.

3. Working from the pan mounting surface, drill a 0. 1 25 inch (3.1 mm) diameter hole through the center of the cupped plug. Pull the plug from the case with a wire hook.

4. Unhook the end of the spring from the park plate Slot to relieve the tension.

5. Thread a 1/4-20 inch or 8-32 x 1-1/4 inch screw into the park plate shaft. Pt ' the shaft from the case with the screw. Remove tl.3 spring and park plate.

Assembly of the Parking Pawl Linkage.

1. Install the spring and park plate in the case and install the shaft. Install the end of the spring into the Slot of the park plate.

2. Install a new cupped plug to retain the shaft.

3. Install the parking pawl shaft in the case. Install the parking pawl and spring into place on the shaft.

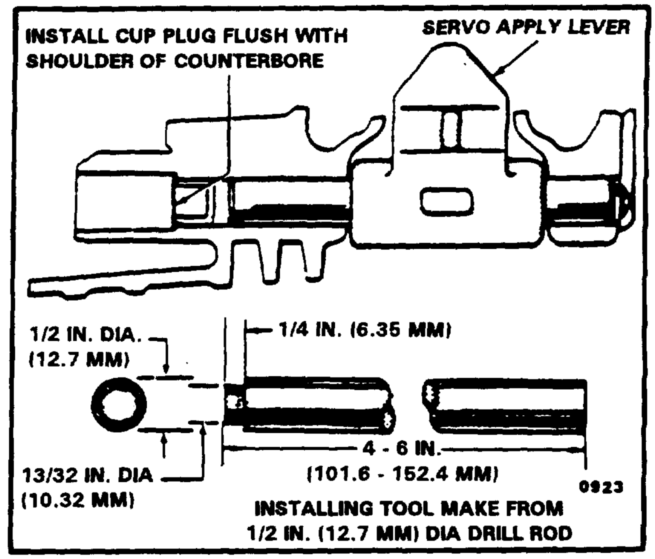
4. Install the guide plate on the case, ensuring the actuating rod is seated in the slot of the plate. Secure the plate with the two bolts and lockwashers. Torque the bolts 12 to 16 lb ft (16 to 22 N•m).

Disassembly of the Servo Apply Lever.

1. Working from the inside of the transmission case, carefully drive on the servo apply lever shaft to remove the cup plug. The shaft can be withdrawn from the case by hand.

Assembly of the Servo Apply Lever.

1. Hold the servo apply lever in position and install the new shaft.



Servo Apply Lever installation

2. Coat the cup plug with threadlock and sealer. Using the fabricated tool shown in the illustration titled, Servo Apply Lever Installation, drive the cup plug into position in the case. Ensure the plug is flush with the shoulder of the counterbore.

Disassembly of the Front Pump.

1. Remove the two seal rings and the selective thrust washer.

2. Remove the large square seal from the outside diameter of the pump housing.

3. Remove the five bolts that secure the stator support to the pump housing. Lift the support from the housing.

4. Remove the drive and the driven gear from the housing.

5. If the pump housing bushing is worn or damaged, it must be replaced. Install the new bushing in position ensuring the half moon slot in the bushing is on top and in line with the oil lube hole near the seal bore. Press the bushing in 0.060 to 0.080 inches (1.52-2.03 mm) below the front face of the bushing bore. Use bushing replacer tool T66L-7003-C2. or equivalent, and a handle to seat the bushing properly. Ensure the half moon slot is in past the lube hole to provide proper lubrication.

FRONT PUMP SUPPORT THRUST WASHER SELECTION		
IDENTIFICATION COLOR	THICKNESS	
	INCH	MM
Blue	0.056-0.060	1.42-1.52
Natural (White)	0.073-0.077	1.85-1.95
Red	0.088-0.092	2.23-2.33

Assembly of the Front Pump.

NOTE

Each drive and driven gear has either an identification mark or chamfered teeth or one face. The identification mark on the chamfered surface on each gear must be installed toward the front of the pump housing.

1. Install the drive and driven gears in the pump housing.

2. Install the stator support in the pump housing and secure with the five attaching bolts. Torque the bolts 12 to 16 lb ft (16 to 22 N•m).

3. Install two new seal rings on the stator support. Ensure the ends of the rings are engaged to lock them in place.

4. Install a new square seal on the outside diameter of the pump housing.

5. Install the selective thrust washer. Refer to the Front Pump Support Thrust Washer Selection chart to ensure the thickness of the washer is correct.

NOTE

Before installing the pump on the converter, perform the Stator to Impeller Interference Check. the Stator to Turbine Interference Check. the Converter End Play Check, and the One Way Clutch Check.

6. Install the pump on the converter, ensuring the drive gear engages the converter hub. Rotate the pump to ensure the gears rotate freely.

Stator to Impeller Interference Check.

1. Install the front pump assembly on a bench with the spline end of the stator shaft pointing up.

2. Mount a converter on the pump with the splines on the one-way clutch inner race engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.

3. Hold the pump stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.

4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades and the converter should be replaced.

Stator to Turbine Interference Check.

1. Install the converter on the bench front side down.

2. Install the front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.

3. Install the input shaft, engaging the splines with the turbine hub.

4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.

5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. If this condition exists. the converter should be replaced.

TORQUE - CONVERTER END - PLAY				
Converter End- Play				
Transmission Model	New or Rebuilt Converter		Used Converter	
	Inch	mm	inch	mm
C6	0.021 Max.	0.533 Max.	0.040 Max.	1.01 Max

Converter End Play Check.

1. Install the end play checking tool T80L-7902-A, or equivalent, into the converter pump drive hub until it bottoms.

2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked into the spline.

3. Attach a dial indicator, tool 4201-C, or equivalent, to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at zero.

4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits.

5. Loosen the threaded inner post to free the tool, and then remove the tool from the converter.

Converter One-Way Clutch Check.

1. Insert the one-way clutch holding tool T77L7902-A. or equivalent, in one of the grooves in the stator thrust washer.

2. Insert the one-way clutch torquing tool T77L7902-D, or equivalent. In the converter pump drive hub so as to engage the one-way clutch inner race.

3. Attach a torque wrench to the one-way clutch torquing tool. With the one-way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one-way clutch should lockup and hold a 10 lb ft (14 N•m) force. The converter one-way clutch should rotate freely in a clockwise direction. Try the clutch for lockup and hold in at least five different locations around the converter.

4. If the clutch fails to lock up and hold at 10 pounds-foot (1.38 kgm) torque. replace the converter unit.

Disassembly of the Reverse High Clutch.

1. Separate the drive train. Remove the pressure plate snap ring.

2. Remove the pressure plate and the drive and driven (internal and external spline) clutch plates.

3. Install the clutch spring compressor tool T65L77515-A, or equivalent, on the reverse-high clutch drum. Ensure the legs clear the snap ring enough to remove it. Remove both snap rings and remove the tool.

4. Remove the spring retainer and the piston return springs.

5. Apply air pressure to the piston apply hole in the clutch hub using air nozzle tool 7000-DE. or equivalent, and remove the piston.

6. Remove the piston outer seal from the piston and the inner seal from the clutch drum.

7. Remove the front and rear bushings from the clutch drum If they are worn or damaged. To remove the front bushing. use a cape chisel and cut along the bushing seam until the chisel breaks through the bushing wall Pry the loose ends of the bushing up with an awl and remove the bushing. To remove the rear bushing, use tool T69L-7D044-A or equivalent.

and press the bushing from the drum.

Assembly of the Reverse-High Clutch.

1. If the clutch drum bushings were removed. Install the drum in a press and press new bushings into the drum with bushing tool T69L-7DO44-A, or equivalent.

TRANSMISSION CLUTCH PLATE USAGE				
Transmission Model	Steel	Friction	Clearance	
			Inch	mm
Forward Clutch				
PGD, PJD	4 1	4	0.021-0.046	0.533-1 168
High Clutch				
PGD. PJD	3	3	0.022-0.036	0.558-0 914
Reverse Clutch				
PJD	5 2	5		
PGD	4 2	4		

2. Dip the new seals in transmission fluid and install one on the drum and one on the piston.

3. Install the piston in the clutch drum.

4. Install the piston return springs in the piston sockets. Install the spring retainer on the springs.

NOTE

Before releasing the pressure on the clutch spring compressor tool, ensure the snap ring is positioned inside of the four snap ring guides on the spring retainer.

5. Install the clutch spring compressor tool T65L7751 5-A, or equivalent, and compress the springs. Ensure the spring retainer is centered while compressing the springs. Install the snap ring.

6. Refer to the Transmission Clutch Plate Usage chart for the number of plates to be used. Dip the clutch plates in clean transmission fluid. Install the clutch plates alternately starting with a steel drive (internal) plate. If using new clutch plates, soak the plates in automatic transmission fluid for 15 minutes before they are assembled.

CLUTCH PLATE SELECTIVE SNAP RINGS Snap Ring Thickness	
Inch	mm
0.056-0.060	1 42-1.52
0.064-0.069	1.62-1 75
0.074-0.078	1 87-1 98
0.083-0.087	2.10-2.20
0.092-0.096	2.33-2.43
0.110-0.114	2.79-2.89
0.218-0.132	3.25-3.35

7. After all clutch plates have been installed., install the pressure plate in the clutch drum. Install the pressure plate selective snap ring.

8. With a feeler gauge. check the clearance between the pressure plate and snap ring while the pressure plate is held downward. The clearance should be 0.022 to 0.036 inches (0.558 to 0.914 mm). If the clearance is not within specifications, refer to the Clutch Plate Selective Snap Rings chart for the correct size snap ring. Install the correct size snap ring and re-check the clearance.

Disassembly of the Forward Clutch.

1. Remove the clutch pressure plate snap ring.

2. Remove the rear pressure plate, the drive and driven plates, wave plate, and the forward pressure plate from the clutch hub.

3. Remove the snap ring that secures the disc spring in the clutch cylinder. Using tool T65L-77515A, or equivalent, remove the disc spring.

4. Using an air nozzle tool 7000-DE, or equivalent, apply air pressure to the clutch cylinder to remove the piston.

5. Remove the seal from the piston and the seal from the clutch hub.

Assembly of the Forward Clutch.

1. Dip the two new seals in transmission fluid. Install the smaller seal on the clutch hub and the lip seal on the clutch piston.

2. Using the lip seal protector tool T77L-77548-A, or equivalent, install the clutch piston and lip seal.

3. Install the installation tool into the forward clutch cylinder so that the bore of the tool is aligned with the piston bore in the cylinder. Press the piston into the cylinder until it bottoms in the bore. Remove the installation tool.

NOTE

Position the disc spring in the cylinder with the dished face downward.

4. Ensure the steel pressure ring is in the groove on the piston. Install the spring so that the pressure ring and spring are in contact. Secure the disc with the retaining snap ring.

5. Install the forward pressure plate with the flat side up and the beveled side down. Dip the clutch plates in clean transmission fluid. Install the wave plate, a steel plate. and a composition driven plate. Install the remaining plates in the previous sequence. Refer to the Transmission Clutch Plate Usage chart for the number of plates required. The last plate installed will be the rear pressure plate. Install the snap ring and ensure it seats fully in the groove.

6. With a feeler gauge, check the clearance between the snap ring and the pressure plate while exerting downward pressure on the plate. The clearance should be 0.021 to 0.046 inches (0.533-1.168 mm). If the clearance is not within specifications, refer to the Clutch Plate Selective Snap Rings chart for the correct size snap ring. Install the correct size snap ring and re-check the clearance.

Disassembly of the Input Shell and Sun Gear.

1. Remove the rear snap ring from the sun gear.

2. Remove the thrust washer wear plate from the input shell and sun gear.

3. Working from inside the input shell remove the sun gear. Remove the snap ring from the gear.

Assembly of the Input Shell and Sun Gear.

1. Install the forward snap ring on the forward end (short end) of the sun gear. Working from inside the input shell, slide the sun gear and snap ring into place ensuring the longer end is at the rear.

2. Install the thrust washer wear plate on the sun gear and install the rear snap ring.

Disassembly of the Output Shaft Hub and Ring Gear.

1. Remove the hub snap ring from the ring gear.

2. Lift the hub from the ring gear.

Assembly of the Output Shaft Hub and Ring Gear.

1. Position the hub in the ring gear.

2. Secure the hub with the snap ring. Ensure the snap ring is fully engaged with the groove.

Disassembly of the One-Way Clutch.

1. Remove the snap ring and bushing from the rear of the low-reverse clutch hub.

2. Remove the rollers from the spring assembly and lift the spring assembly from the hub.

3. Remove the remaining snap ring from the hub.

Assembly of the One-Way Clutch.

1. Install a snap ring in the forward snap ring groove of the low-reverse clutch hub.

2. Install the low-reverse clutch hub on the bench with the forward end down.

3. Install the one-way clutch spring assembly on top of the snap ring.

4. Install a roller into teach of the spring assembly compartments.

5. Install the bushing on top of the spring assembly.

6. Install the remaining snap ring at the rear of the low-reverse clutch hub to secure the assembly.

Disassembly of the Low-Reverse Clutch Piston.

1. Remove the inner and the outer seal from the low-reverse clutch piston.

Assembly of the Low-Reverse Clutch Piston.

1. Dip the two new seals in clean transmission fluid.

2. Install the seals on the piston.

TRANSMISSION ASSEMBLY.

1. Mount the transmission in a holding fixture.

2. Tap the low-reverse piston into place in the case with a clean rubber hammer.

3. Hold the one-way clutch inner race in position and secure with the attaching bolts. Torque the bolts 18 to 25 lb ft (24 to 34 N•m).

4. Install the low-reverse clutch return spring and retainer assembly in the clutch piston.

5. Install the retainer snap ring in place on the one-way clutch inner race.

6. Install the compressing tool T65L-7751 5-A, or equivalent, and compress the springs just enough to install the low-reverse clutch piston snap ring.

7. Install the snap ring, then remove the compressing tool.

8. Place the transmission case on the bench with the front end facing down.

NOTE
Do not re-stake the thrust washer.

9. Install the parking gear thrust washer and the gear on the case.

10. Install the collector and tubes in place on the rear of the case and secure with the attaching bolts. Torque the bolts 12 to 16 lb ft (16 to 22 N•m).

11. Install the output shaft and governor as an assembly.

12. Clean the mounting surface on the transmission case and extension housing. Install a new gasket on the transmission case. Install the extension housing on the case and secure with the attaching bolts. Torque the bolts 25 to 35 lb ft (34 to 48 N•m).

13. Mount the transmission case in the holding fixture.

14. Coat a new gasket with petroleum jelly and install on the servo cover.

15. Install the servo spring on the piston rod.

16. Install the servo piston rod in the case. Install the servo cover and secure with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened. Torque the bolts 14 to 20 lb ft (19 to 27 N•m).

17. Align the low-reverse clutch hub and one-way clutch with the inner race at the rear of the case. Rotate the low-reverse clutch hub clockwise while applying pressure to seat it on the inner race.

18. Install the low-reverse clutch plates, starting with the wave plate next to the piston and following alternately with steel and friction plates. Retain them with petroleum jelly. If new composition plates are being used, soak them in clean transmission fluid for fifteen minutes before installation. Install the pressure plate and the snap ring. Test the operation of the low-reverse clutch by applying air pressure at the clutch pressure apply hole in the case.

SELECTIVE THRUST WASHER THICKNESS		
IDENTIFICATION COLOR	THICKNESS	
	INCH	MM
Blue	0.056-0.060	1.42-1.52
Natural (White)	0.073-0.077	1.85-1.95
Red	0.088-0.092	2.23-2.33

19. Install the reverse planet ring gear thrust washer and the ring gear and hub assembly. Install the snap ring in the groove on the output shaft.

20. Install the front and rear thrust washers onto the reverse planet assembly and retain them with petroleum jelly. Install the assembly into the ring gear and install the snap ring.

21. Set the reverse-high clutch assembly on a bench with the front end facing down. Install the thrust washer on the rear end of the reverse-high clutch assembly. Retain the thrust washer with petroleum jelly and install the splined end of the forward clutch into the open end of the reverse-high clutch with splines engaging the direct clutch friction plates.

22. Install the thrust washers and retain them with petroleum jelly on the front end of the forward planet ring gear and hub. Install the ring gear into the forward clutch.

23. Install the thrust washer on the front end of the forward planet assembly. Retain the washer with petroleum jelly and install the assembly into the ring gear. Install the input shell and sun gear assembly.

24. Install the reverse-high clutch assembly, forward clutch assembly, forward planet assembly and drive input shell, and sun gear as an assembly into the transmission case.

25. Install the intermediate band into the case around the reverse-high clutch drum. Install the struts and tighten the band adjusting screw sufficiently to retain the band.

26. Install a selective thickness bronze thrust washer on the rear shoulder of the stator support and retain it with petroleum jelly. If the end play was not within specification when checked prior to disassembly, replace the washer with one of proper thickness. Refer to the Selective Thrust Washer Thickness chart.

27. Using two 5/16-inch bolts three Inches long, make two alignment studs. Cut the heads from the bolts and grind a taper on the cut end. Temporarily install the two studs opposite each other in the mounting holes of the case. Slide a new gasket onto the studs. Install the pump on the case, ensuring no damage is done to the large seal on the outside diameter of the pump housing. Remove the aligning studs. Install six of the seven mounting bolts. Torque the bolts 16 to 30 lb ft (22 to 41 N•m).

28. Clean all dirt from the band adjusting screw, and remove and discard the locknut. Adjust the intermediate band by Installing a new locknut and tightening the adjusting screw to 10 lb ft (14 N•m). Back off the adjusting screw exactly 1 1/2 turns. Hold the adjusting screw from turning and torque the locknut 35 to 40 lb ft (48 to 54 N•m). After adjustment is made, Install the input shaft with the long splined end installed into the forward clutch assembly.

29. Install tool 4201-C dial indicator. or equivalent, at the seventh pump mounting bolt and check the transmission end play following steps 2, 3, and 4 of Disassembly. End play should be 0.008 to 0.044 inch (0.203 to 1.117 mm). If end play is not within specification. install a selective thrust washer. Refer to the Selective Thrust Washer Thickness chart. Remove the dial indicator.

30. Install the seventh pump mounting bolt. Torque the bolt 16 to 30 lb ft (22 to 41 N•m).

31. Install the main control valve body on the case ensuring the selector and downshift levers engage the valves properly, and secure with the attaching bolts. Torque the bolts 95 to 125 lb In. (11 to 14 N•m).

32. Install the primary throttle valve, rod, and the vacuum diaphragm in the case. Torque the diaphragm attaching bolt 12 to 16 lb ft (16 to 22 N•m).

33. Clean the transmission pan and gasket surfaces thoroughly. Install a new pan gasket and the pan. Secure the pan to the transmission case with the attaching bolts. Torque the bolts 8 to 12 lb ft (11 to 16 N•m).

34. Install the converter assembly.

Installation of the Governor.

1. Install the governor to the oil collector flange and secure with the attaching bolts. Torque the bolts 90 to 120 lb In. (10 to 14 N•m).

Installation of the Extension Housing.

NOTE

Perform steps 1 and 2 if not done during Transmission Assembly.

1. Clean the mounting surface on the transmission case and extension housing. Install a new gasket on the transmission case.

2. Hold the extension housing in place and secure with the attaching bolts. Torque the bolts 25 to 35 lb ft (34 to 48 N•m).

Installation of the Extension Housing Bushing and Rear Seal.

1. Install a new bushing using bushing replacer tool T77L-7697-C. or equivalent.

2. Before installing the seal, inspect the counterbore of the housing for burrs. Remove any burrs with crocus cloth. Install the seal into the housing with seal replacer tool T61L-7657-B, or equivalent. The seal should be firmly seated in the bore. Coat the inside diameter of the end of the seal with Multi-Purpose Long-Life Lubricant.

Installation of the Intermediate Servo.

NOTE

Perform steps 1 through 6 if not done during Transmission Assembly.

1. Dip the new seal in transmission fluid.

2. Install a new seal on the cover.

3. Coat a new gasket with petroleum jelly, and install on the servo cover 4. Dip the piston in transmission fluid and install it in the cover.

5. Install the servo spring on the piston rod.

6. Install the servo piston and cover in the case and secure the cover to the case with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened. Torque the bolts 14 to 20 lb ft (19 to 27 N•m).

Installation of the Control Valve Body.

NOTE

Perform steps 1 and 2 if not done during Transmission Assembly.

1. Install the valve body on the case ensuring the selector and downshift levers engage the valves properly, and secure with the attaching bolts. Torque the bolts 95 to 125 lb in. (11 to 14 N•m).

2. Clean the transmission pan and gasket surfaces thoroughly. Install a new pan gasket and the pan. Secure the pan to the transmission case with the attaching bolts. Torque the bolts 8 to 12 lb ft (11 to 16 N•m).

LUBRICATION.

The fluid level indicator should be used to determine actual fluid requirements. Check the oil level at normal operating temperature. Refer to TROUBLESHOOTING Hydraulic Checks.

If it is necessary to add or replace fluid. use DEXRON II, or equivalent. If a partial drain was done, add 5 quarts (4.7 liters) shallow pan or 6 quarts (5.6 liters) deep pan of fluid to the transmission through the filler tube. Check the fluid level. If a complete drain was done the approximate refill capacity is 11.75 quarts (11.2 liters). The approximate dry capacity includes cooler and lines.

FRONT DRIVE AXLE

DESCRIPTION

The front drive axle is a F-146-FSHX axle manufactured by Rockwell. The axle incorporates a single reduction carrier with a heavy duty hypoid drive pinion and ring gear. The differential and gear assembly is mounted on tapered roller bearings.

The straddle mounted pinion has two tapered roller bearings in front of the pinion teeth which take the forward and reverse thrust and a third bearing behind the pinion teeth to carry the radial load.

MAINTENANCE

DISASSEMBLY OF THE WHEEL ENDS.

Removal of the Wheel Hub and Drum Assembly.

1. Remove the axle shaft to hub nuts, washers, dowels, and studs. Remove the axle drive shaft and drive shaft gasket.

2. Remove the outer wheel bearing lock nut and washer and inner wheel bearing adjusting nut from the spindle.

3. Pull the hub and drum straight off the spindle, being careful that the outer bearing cone does not drop off the spindle.

NOTE

The inner and outer bearing cups will remain seated inside the hub cavity. If the inner bearing cone slides off the spindle, the hub oil seal will remain inside the hub.

Removal of the Brake Drum.

CAUTION

DO NOT STRIKE WHEEL STUDS WITH A STEEL HAMMER OR TWIST TO REMOVE THEM.

NOTE

If a press is not available, a brass hammer or a drift may be used to drive out the studs.

1. Remove the wheel studs from the brake drum and hub by placing the hub and drum assembly in a press. Position the open end of the drum downward and press out the studs.

Disassembly of the Bearing Cups and Seal from the hub.

1. If the seal is still seated in the hub, remove it by using a long screwdriver or other pointed tool to pry loose. Discard the seal.

2. Remove the inner and outer bearing cups from the hub using a press and sleeve or a suitable puller.

Removal of the Oil Slinger and Brake.

1. Remove the oil slinger from the hub.

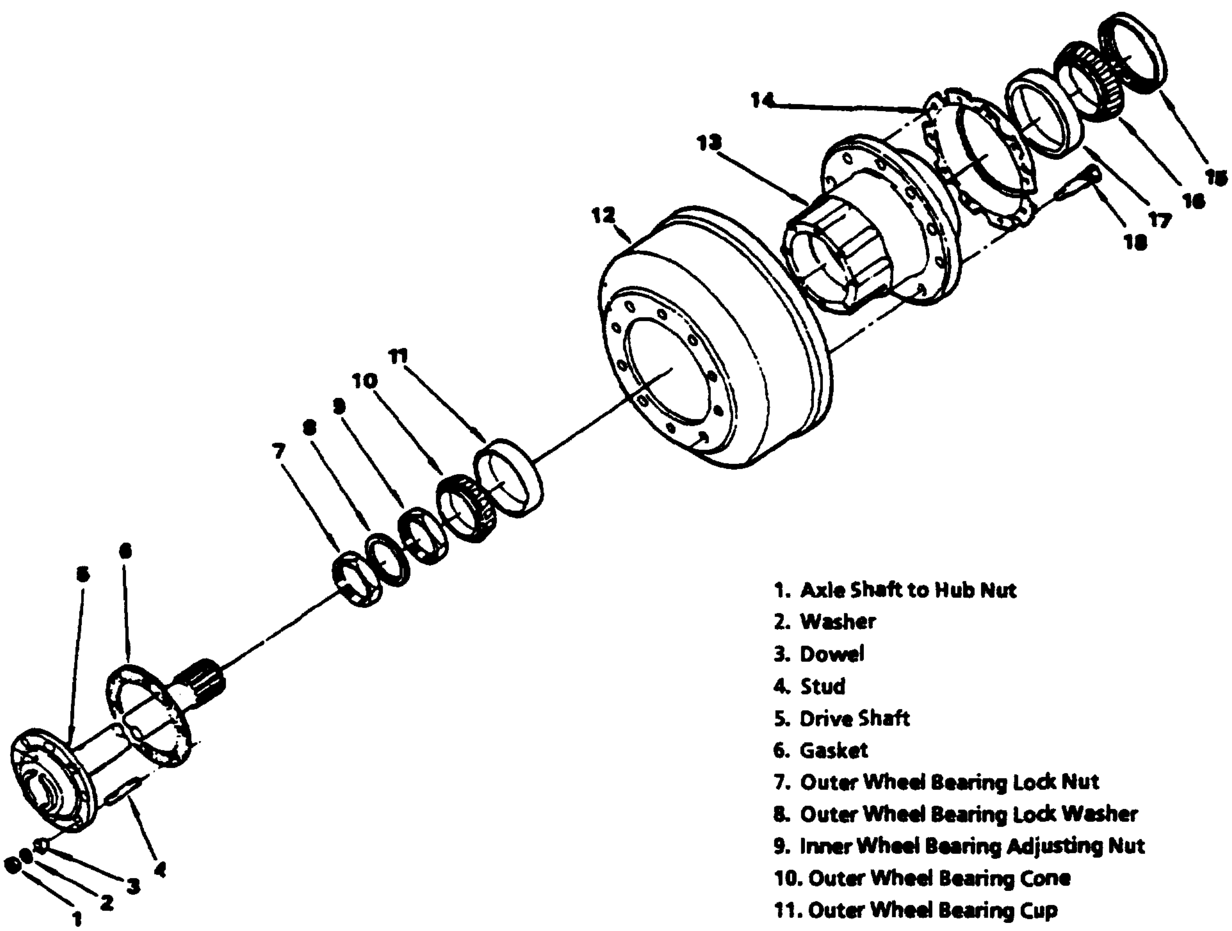
2. Remove the bolts, lockwashers, and nuts and remove the brake from the backing plate. Remove the brake assembly to a clean work area. If maintenance is required on the brake assembly, refer to the BRAKES SM package.

ASSEMBLY OF THE WHEEL ENDS.

Silicone RTV Gasket Application.

NOTE

Where silicone RTV gasket material is used, Dow Siliastic No. RTV-732 Black and General Electric No. RTV1473 Black meet the requirements. However., silicone RTV is also available in bulk under Rockwell part number 1199-Q-2981; in 10 oz. tubes, part number 1250-X-388, or in 3 oz. tubes, part number 1199-T3842.



1. Axle Shaft to Hub Nut
2. Washer
3. Dowel
4. Stud
5. Drive Shaft
6. Gasket
7. Outer Wheel Bearing Lock Nut
8. Outer Wheel Bearing Lock Washer
9. Inner Wheel Bearing Adjusting Nut
10. Outer Wheel Bearing Cone
11. Outer Wheel Bearing Cup
12. Brake Drum
13. Wheel Bearing Hub
14. Hub Oil Slinger
15. Seal
16. Inner Bearing Cone
17. Inner Bearing Cup
18. Wheel Stud

1438

Wheel End Assembly- Exploded View

Removal of all gaskets including silicone RTV is accomplished by peeling or scraping the used gasket off the hub mating surface of the drive flange.

WARNING

MINOR CONCENTRATIONS OF ACETIC ACID VAPOR MAY BE PRODUCED DURING APPLICATION. ADEQUATE VENTILATION SHOULD BE PROVIDED WHEN SILICONE RTV IS APPLIED IN CONFINED AREAS.

WARNING

EYE CONTACT WITH THESE SILICONE RTV MATERIALS MAY CAUSE IRRITATION. IF EYE CONTACT TAKES PLACE, FLUSH THE EYES WITH WATER FOR 15 MINUTES AND HAVE THE EYES EXAMINED BY A DOCTOR.

Application of silicone RTV gasket material is as follows:

1. Remove dirt, grease, or moisture from the hub mating surface of the drive shaft.

2. Dry the surface.

3. Apply a thin bead, maximum 0.125 inch (3.175 mm) diameter, completely around one mating surface to ensure complete sealing and prevent leakage.

4. Assemble the components immediately to permit silicone RTV gasket material to spread evenly.

Installation of the Oil Slinger and Brake.

1. Install the brake assembly to the backing plate and secure with the bolts, lockwashers, and nuts.

2. Install the oil slinger on the hub.

Assembly of the Bearing Cups and Seal to the Hub.

1. If the wheel bearings were removed from the hub, install the inner and outer bearing cups into the hub using a press and suitable sleeve.

CAUTION

DO NOT USE EXCESSIVE PRESSURE TO INSTALL THE SEAL OR TAP THE SEAL AFTER IT HAS BUTTOMED, AS IT WILLCRUSHTHE SEAL RETAINER AND CAUSE SEAL DAMAGE.

2. Place the inner bearing cone into position inside the hub against its cup, and install a new hub oil seal. Tap the seal into position until it bottoms in the bore.

Installation of the Brake Drum.

1. Place the hub in a press with the inner end pointing upward.

CAUTION

DO NOT STRIKE THE STUDS WITH A STEEL HAMMER.

NOTE

Before pressing the wheel studs into position, ensure that the stud serrations in the corresponding holes of the hub and drum and serrations of the wheel studs align correctly, otherwise as studs are being pressed through, a larger hole will develop causing loose wheel studs.

NOTE

If a press is not available, a brass hammer or drift may be used to seat the wheel studs.

Installation of the Wheel Hub and Drum Assembly.

1. Install the hub and drum assembly onto the spindle being careful not to damage the oil seal in the hub. Press the hub until the inner bearing is seated flush on the spindle.

2. Place the outer bearing cone into position on the spindle and against its cup in the hub.

NOTE

After completing steps 3 and 4, adjust the bearing following the procedure under Wheel Bearing Adjustment in this package.

3. Install the inner wheel bearing adjusting nut onto the spindle against the outer bearing.

4. Install the outer wheel bearing lock washer and lock nut onto the spindle and against the adjusting nut.

5. Coat the inside hub mating surface of the drive shaft with silicone RTV gasket material, following the procedure under Silicone RTV Gasket Application in this package.

6. Apply a small amount of wheel bearing grease to the internal splines of the drive shaft.

7. Install the axle drive shaft and secure with the axle shaft to hub nuts, washers, dowels, and studs.

Wheel Bearing Adjustment.

1. Tighten the bearing adjusting nut to 50 lb ft (68 N•m) while rotating the hub in both directions to seat the bearings.

2. Back off the adjusting nut 1/16 to 1/4 turn.

3. Torque the jam nut to 250 lb ft (339 N•m).

4. The end play must be within the limits of 0.001 to 0.010 inch (0.025 to 0.254 mm) loose.

DISASSEMBLY OF THE DRIVE UNIT.

Removal of the Drive Unit from the Housing.

1. Remove the plug from the bottom of the axle housing and drain the lubricant.

2. Disconnect the propeller shaft.

NOTE

Step 3 is for axles with a two gear gear box only.

3. Remove the gearbox. Refer to Two Gear Gearbox in the Service Manual.

WARNING

DO NOT HIT THE CIRCULAR DRIVING LUGS ON THE SHAFT HEAD AS THIS MAY CAUSE THE LUGS TO SHATTER OR SPLINTER. DO NOT USE CHISELS OR WEDGES TO LOOSEN THE SHAFT OR DOWELS AS THIS WILL DAMAGE THE HUB, SHAFT, AND OIL SEAL.

NOTE

To loosen the dowels, hold a 1.5-inch (3.81 cm) diameter brass drift against the center of the axle shaft head, inside the circular driving lugs. Strike the drift a sharp blow with a 5 to 6 pound (2.3 to 2.8 kg) hammer or sledge. A 1.5-inch (3.81 cm) diameter brass hammer is an excellent and safe drift.

4. Remove the axle shaft stud nuts, lockwashers, and tapered dowels.

5. Remove the axle shaft from the drive unit and housing.

6. Remove the carrier to housing stud nuts and lockwashers. Loosen the two top nuts but leave them on the studs to prevent the carrier from falling.

7. Break the carrier loose from the housing with a rawhide mallet.

8. To remove the carrier from the housing, place a roller jack under the carrier. Remove the top nuts and lockwashers and work the carrier free. A small pinch bar may be used to straighten the carrier in the housing bore. However, the end must be rounded to prevent indenting the carrier flange.

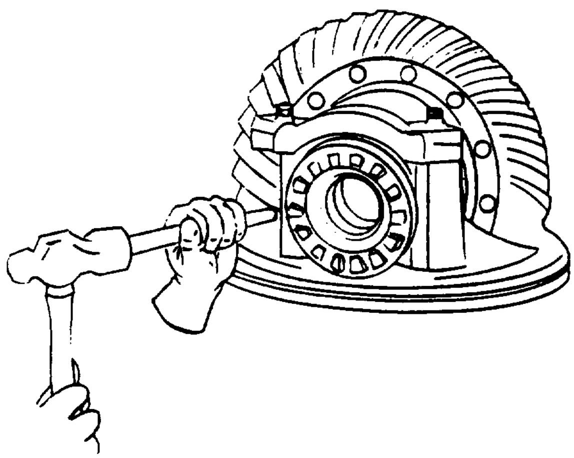
9. Place the carrier in a suitable holding fixture.

Removal of the Differential Case and Gear Assembly.

NOTE

If the initial inspection indicates the drive gear is not going to be replaced, the established backlash should be measured and noted for reference and used at assembly.

1. Loosen the jam nut and back off the thrust block adjusting screw.

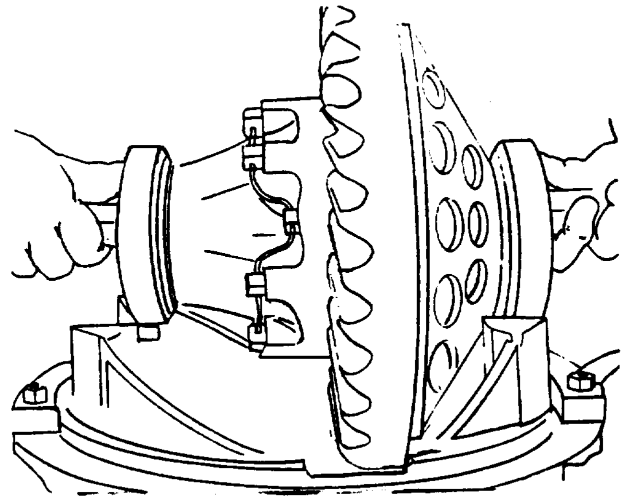


2. Center punch one differential carrier leg and bearing cap to identify in assembly.

3. Cut the lockwire, if used, and remove the leg capscrews and cotter key.

4. Remove the bearing adjusting ring and the carrier cap.

5. Repeat Steps 3 and 4 for removal of the carrier cap on the opposite side.

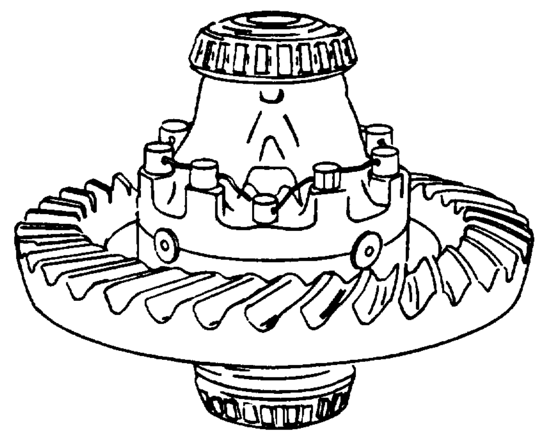


6. Lift out the differential and gear assembly.

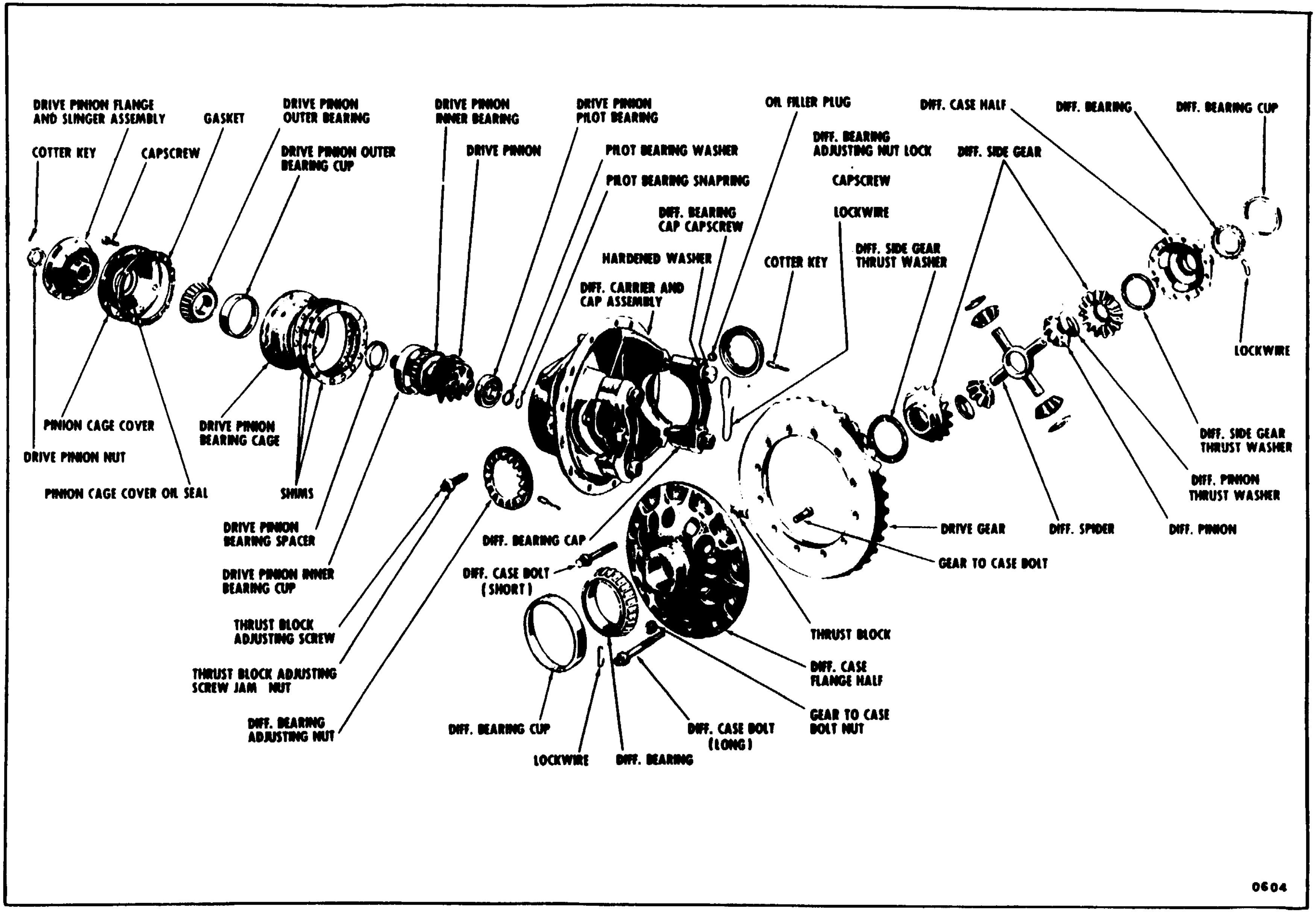
Disassembly of the Differential Case and Gear Assembly.

NOTE

Refer to NoSPIN DIFFERENTIAL in this Section for disassembly of the NoSPIN differential.



0603-3



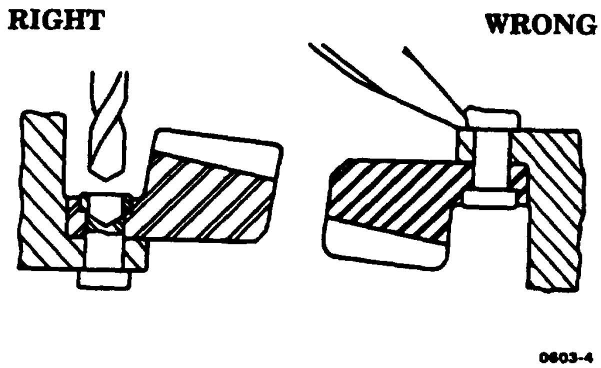
Drive Unit - Exploded View

1. If the original identification marks are not clear, mark the differential case halves with a punch or chisel for correct alignment on assembly.

2. Remove the-lockwire, if used, and capscrews and separate the case halves.

3. Remove the spider, spider pinions, side gears and thrust washers.

4. If the gear is to be replaced for any reason, remove the rivets and separate the gear from the case.

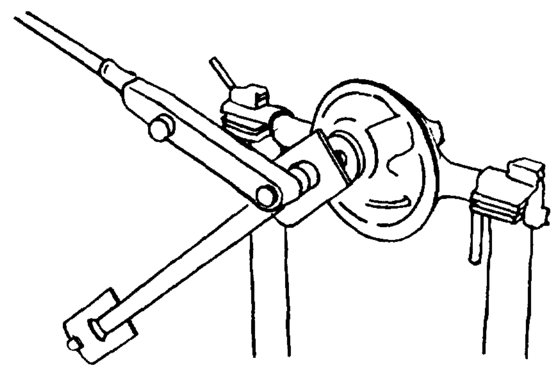


CAUTION
DO NOT CHISEL OUT THE RIVETS.

a. Carefully center-punch the rivets in the center of the head.
b. Use a drill 0.03125-inch (0.79375 mm) smaller than the body of the rivet to drill through the head from the gear side.
c. Press out the rivets.

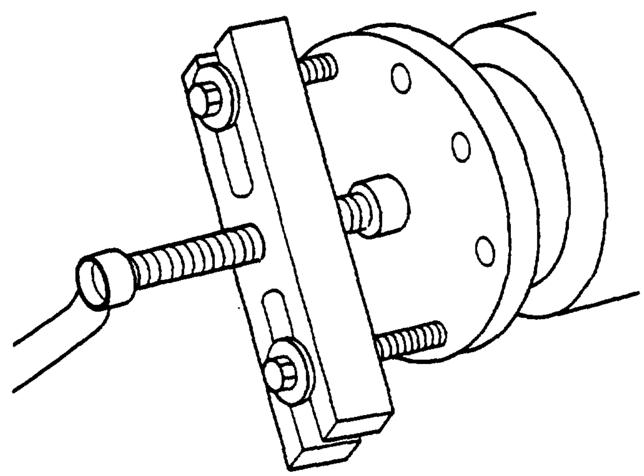
5. If it is necessary to replace the differential bearings, remove them with a suitable puller.

Removal of the Pinion and Cage Assembly.



1. Hold the flange or yoke with a suitable tool and remove the pinion shaft nut and washer.

CAUTION
DRIVING THE FLANGE OFF WILL CAUSE EXCESSIVE RUNOUT.



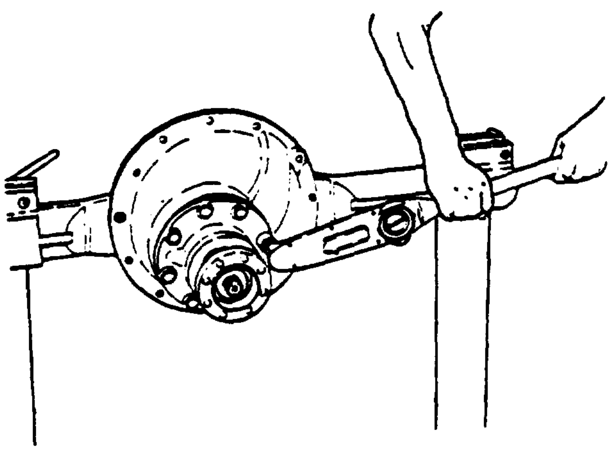
2. Remove the flange or yoke with a suitable puller.

3. Remove the pinion cage stud nuts or capscrews.

4. Remove the bearing cover and oil seal assembly.

CAUTION

THE USE OF A PINCH BAR WILL DAMAGE THE SHIMS. DRIVING THE PINION FROM THE INNER END WITH A DRIFT WILL DAMAGE THE BEARING LOCK RING GROOVE.



5. Remove the bearing cage. The original may have pulled holes.

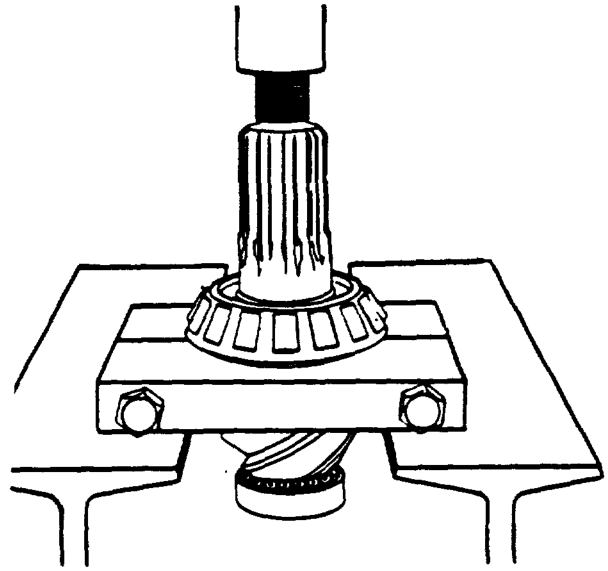
6. Wire the shim pack together to facilitate adjustment on assembling.

Disassembly of the Pinion and Cage Assembly.

1. Tap the shaft out of the cage with a soft mallet or press the shaft from the cage.

2. Remove the outer bearing from the cage.

3. Remove the spacer or spacer combination from the pinion shaft.



4. If it is necessary to replace the rear thrust bearing or radial bearing, remove them with a suitable puller.

5. Remove the oil seal assembly from the bearing cover.

ASSEMBLY OF THE DRIVE UNIT.

Silicone RTV Gasket Application.

CAUTION

FAILURE TO USE THE APPROPRIATE GASKET MATERIAL WILL CAUSE THE AXLE TO LEAK.

NOTE

Where silicone RTV gasket material is used, Dow Siliastic No. RTV-732 Black and General Electric No. RTV-1473 Black meet the requirements. However, silicone RTV is also available in bulk under Rockwell part number 1199-Q-2981; in 10 oz. tubes, part number 1250-X-388, or in 3 oz. tubes, part number 1199-T3842.

Removal of all gaskets including silicone RTV is accomplished by peeling or scraping the used gasket off the carrier to housing surfaces.

WARNING

MINOR CONCENTRATIONS OF ACETIC ACID VAPOR MAY BE PRODUCED DURING APPLICATION. ADEQUATE VENTILATION SHOULD BE PROVIDED WHEN SILICONE RTV IS APPLIED IN CONFINED AREAS.

WARNING

EYE CONTACT WITH THESE SILICONE RTV MATERIALS MAY CAUSE IRRITATION. IF EYE CONTACT TAKES PLACE, FLUSH THE EYES WITH WATER FOR 15 MINUTES AND HAVE THE EYES EXAMINED BY A DOCTOR.

Application of silicone RTV gasket material is as follows.

1. Remove dirt, grease, or moisture from the surface of the carrier and housing.

2. Dry the surface.

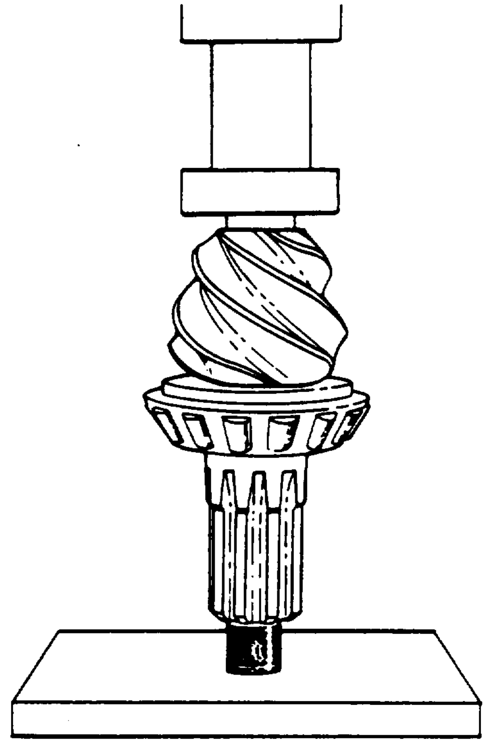
3. Apply a thin bead, maximum 0.125 inch (3.175 mm) diameter, completely around one mating surface and all fastener holes to ensure complete sealing and prevent leakage.

4. Assemble the components immediately to permit silicone RTV gasket material to spread evenly.

Assembly of the Pinion and Cage Assembly.

1. If new cups are to be installed, press firmly against the pinion bearing cage shoulders.

2. Lubricate the bearings and cups with light machine oil.



3. Press the rear thrust and radial bearing firmly against the pinion shoulders with a suitable sleeve that will bear only on the bearing inner race.

4. Install the radial bearing lock ring and squeeze the ring into the pinion shaft groove with pliers.

5. Insert the pinion and bearing assembly in the pinion cage and position the spacer or spacer combination over the pinion shaft.

6. Press the front bearing firmly against the spacer.

7. Rotate the cage several revolutions to assure normal bearing contact.

8. While in the press under pressure, check the bearing preload torque. Wrap soft wire around the cage and pull on a horizontal line with a pound (kilogram) scale. If a press is not available, the pinion nut may be tightened to the correct torque and the preload checked.

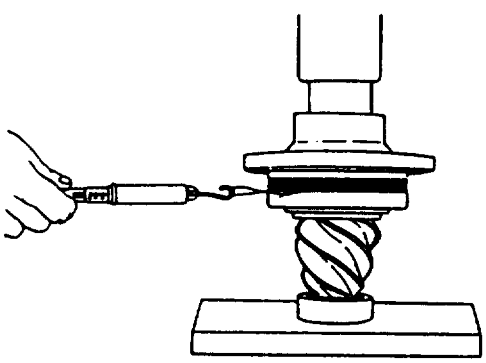
PINION SHAFT THREAD SIZE	PINION NUT TORQUE (required to obtain correct pinion bearing preload)		PRESS LOAD (required to obtain correct pinion bearing preload)	
	lb ft	N•m	lb ft	N•m
7/8"-20	200-275	271 - 373	22,000	13,560
1"-20	300- 400	407 - 542	30,000	40,680
1 1/4 "-12	700- 900	949 - 1,220	54,000	73,224
1 1/4 "-18	700- 900	949- 1,220	54,000	73,224
1 1/2"-12	800- 1,100	1,085- 1,492	54,000	73,224
1 1/2"-18	800-1,100	1,085- 1,492	54,000	73,224
1 3/4"-12	900- 1,200	1,220- 1,627	50,000	67,800

Pinion Bearing Preload

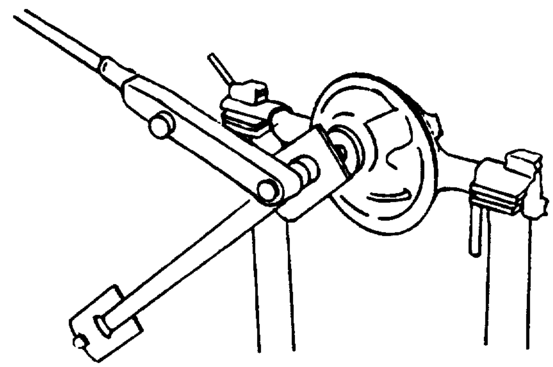
NOTE

Use rotating torque, not starting torque. If the rotating torque is not within 5 to 25 lb in. (1 to 3 N•m) for new bearings or 5 to 15 lb in. (1 to 2 N•m) for reused bearings, use a thinner spacer to increase or a thicker spacer to decrease preload.

EXAMPLE: Assuming the pinion cage diameter to be 6 in. (15.24 cm), the radius would be 3 in. (7.62 cm) and with 5 lb (2.268 kg) pull would equal 15 lb in. (2 N•m) preload torque.



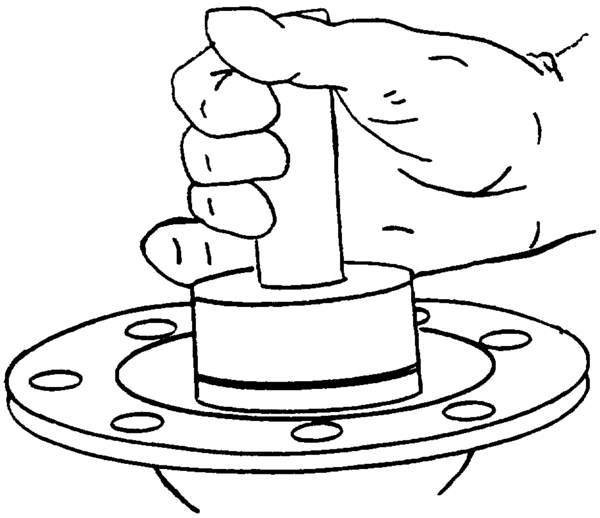
9. Press the flange or yoke against the forward bearing and install the washer and the pinion shaft nut.



10. Place the pinion and cage assembly over the carrier studs. Hold the flange and tighten the pinion shaft nut to the correct torque. The flange must be held with a suitable tool or fixture to tighten the nut.

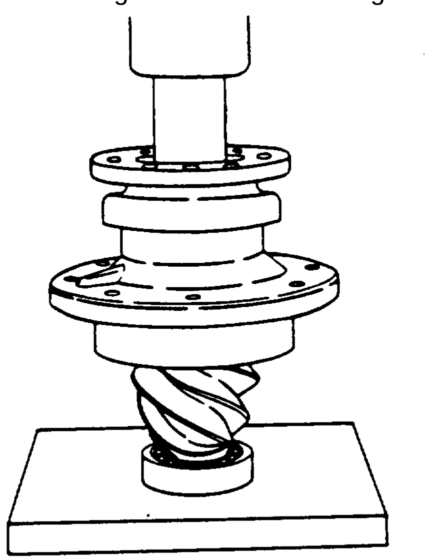
11. Recheck the pinion bearing preload torque. If the rotating torque is not within 5 to 25 lb in. (1 to 3 N•m) for new bearings or 5 to 15 lb in. (1 to 2 N•m) for reused bearings, repeat the foregoing procedure.

12. Hold the flange and remove the pinion shaft nut and flange.



13. Lubricate the pinion shaft oil seal and cover the outer edge of the seal body with a non-hardening sealing compound. Press the seal against the cover shoulder with a seal driver.

14. Install a new gasket and the bearing cover.



15. Press the flange against the forward gearing and install the washer and the pinion shaft nut.

CAUTION

DO NOT BACK OFF TO ALIGN COTTER KEY HOLES.

16. Tighten to the correct torque. If a drilled or castellated fastener is employed, install a cotter key. Refer to Torque Values in this Sub-Section.

Installation of the Pinion and Cage Assembly.

1. Install the correct shim pack. Locate thin shims on both sides for maximum sealing ability.

2. Position the pinion and cage assembly over the studs and tap it into position with a soft mallet.

3. Install the lockwashers and the stud nuts or capscrews. Tighten to the correct torque.

Assembly of the Differential and Ring Gear Assembly.

NOTE

Refer to NoSPIN DIFFERENTIAL in this Section for assembly of the NoSPIN differential.

Proper service replacement of the differential ring gear onto the differential case half is necessary for correct gear adjustment and longer drive unit service life. For correct installation, it is recommended the ring gear be heated in water to approximately 160 to 180 degrees F (71 to 82 degrees C) for about ten minutes before assembly. This will allow an easier fit of the gear over the differential case pilot, without the use of a press, and without damaging the case and the ring gear mating surfaces.

The gear should not be pressed or driven on the case, as this would cause excessive metal particles to lodge between the gear and case, thus resulting in gear runout. Proper installation should, therefore, incorporate preheating the gear as described above to ensure correct interference fit and to eliminate metal pickup.

1. Rivet the hypoid gear to the case half with new rivets. Rivets should not be heated, but always upset cold. When the correct rivet is used, the head being formed will be at least 0.1 25-inch (3.18 mm) larger in diameter then the rivet hole. The heat will then be approximately the same height as the preformed head. Excessive pressure will cause distortion of the case holes and result in gear eccentricity.

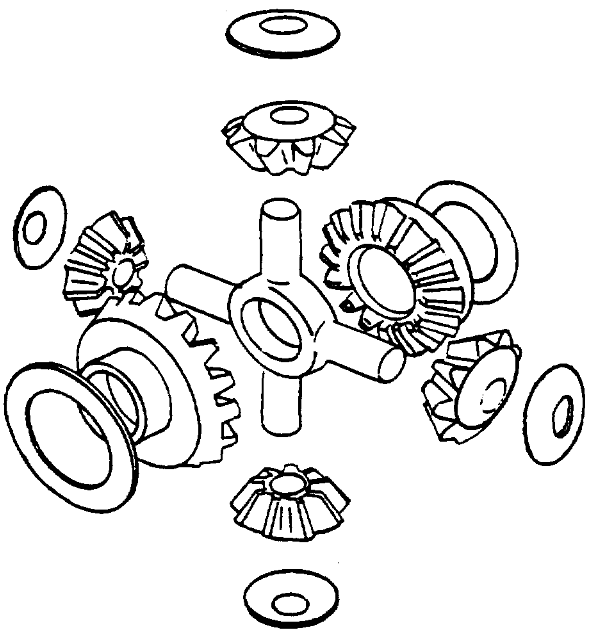
Tonnage required for squeezing cold rivets: These pressures are approximately for annealed steel rivets and pressure may be adjusted to suit individual working conditions.

DIAMETER OF RIVET	TONNAGE REQUIRED
7/16 inch	22
1/2 inch	30
9/16 inch	36
5/8 inch	45

Final pressure should be held for approximately one minute to ensure the rivet has filled the hole.

Differential case and gear bolts are also available for service replacement of rivets. The use of bolts greatly facilitates servicing these units in the field and eliminates the need for special equipment necessary to cold upset rivets correctly.

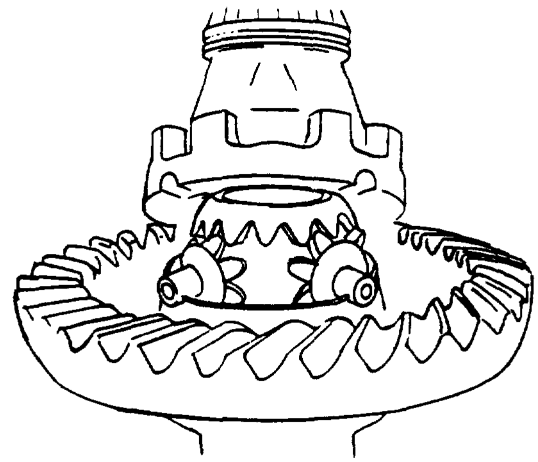
2. Lubricate the differential case inner walls and all component parts with axle lubricant.



3. Position the thrust washer and the side gear in the gear case half.

4. Place the spider with pinions and thrust washers in position.

5. Install the second side gear and the thrust washer.



NOTE

The case bolts must be treated with adhesive before installing using either new Dri-Loc bolts or applying Loctite No. 277. New Dri-Loc bolts have adhesive on the threads, but it is usable only once. When the same bolt is reused, Loctite No. 277 must be used as in step 7.

6. Wipe excess oil residue from the threaded holes in the case.

NOTE

Do not apply liquid Loctite No. 277 or any other type of fastener retainer material, sealant or adhesive, on new Dri-Loc bolts or in the threaded holes.

7. If new Dri-Loc bolts are to be used, proceed to step 8. Otherwise adhere to the following.

a. Wipe excess oil residue from the bolts.

NOTE

Do not apply Loctite to the bolt, since trapped air in the hole will create back pressure and "blow out" the Loctite as the bolt advances.

b. Apply liquid Loctite No. 277 to the threaded holes only, by letting four or five drops run down the side of each hole. Visually check to ensure the Loctite has contacted the threads.

8. Align mating marks, position the mating case half, and draw the assembly together with three equally spaced bolts.

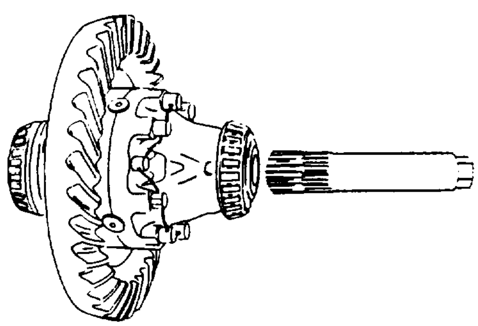
9. Install the remaining bolts and tighten to the correct torque. Refer to Torque Values in this Sub-Section.

10. If the bearings are to be replaced, press squarely and firmly on the differential case halves with a suitable sleeve.

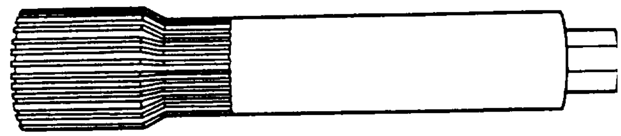
11. Check the rolling resistance of the differential nest as follows.

NOTE
Use soft metal covers over the vice jaws to protect the ring gear.

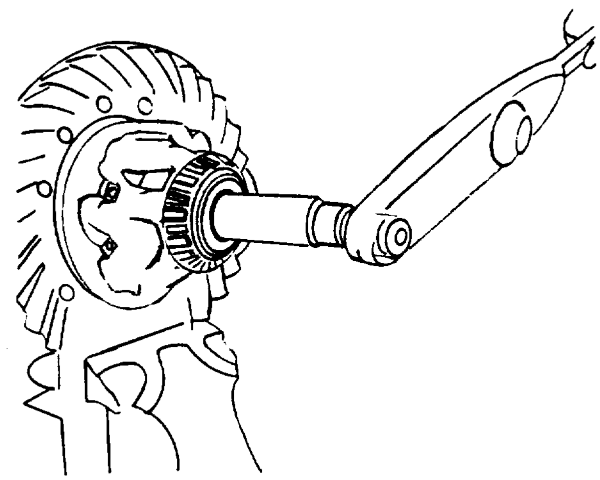
a. Place the differential and ring gear assembly in a vise.



b. Insert a checking tool into the differential nest. Allow the splines of the tool to engage with the spline of one sidegear only.



NOTE
The checking tool can be made by cutting an axle shaft to an appropriate length and welding a nut on the end to accept a wrench socket.



c. Using a suitable socket and torque wrench, rotate the differential nest while observing the scale on the torque wrench. The correct rolling resistance of the differential assembly is 50 pounds-foot (6.91 kgm) torque maximum applied to one sidegear.

Installation of the Differential and Gear Assembly.

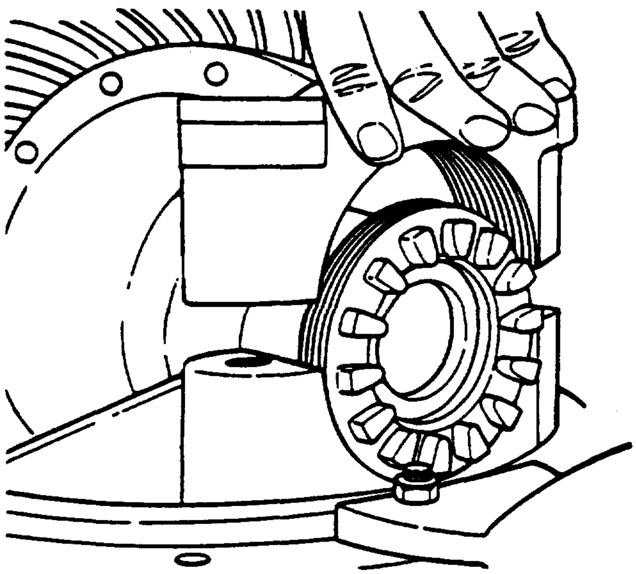
1. Temporarily install the bearing cups, threaded adjusting ring (where employed), and bearing caps. Tighten the capscrews to the proper torque.

2. The bearing cups must be a hand push fit in the bores. If they are not, the bores must be reworked with a scraper or some emery cloth until a hand push fit is obtained. Use a blued bearing cup as a gauge and check the fits as work progresses. Once the cup fits properly, remove the bearing caps.

3. Lubricate the differential bearing cones and cups with the recommended axle lubricant.

4. Place the cups over the bearings and position the assembly in the carrier housing.

5. Insert the bearing adjusting nuts and turn handtight against the bearing cups.



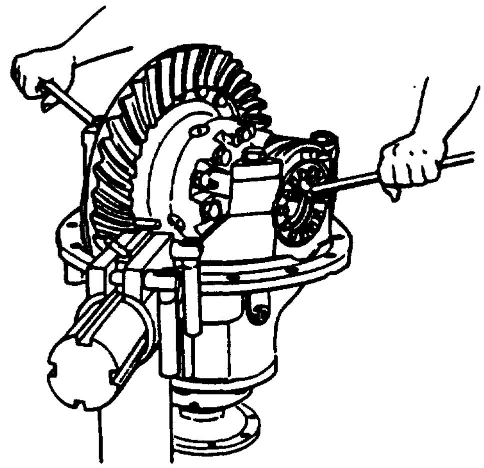
CAUTION

IF THE BEARING CAPS DO NOT POSITION PROPERLY, THE ADJUSTING NUTS MIGHT BE CROSS THREADED. REMOVETHE CAPS AND REPOSITION THE ADJUSTING NUTS. FORCING THE CAPS INTO POSITION WILL RESULT IN IRREPARABLE DAMAGE TO THE CARRIER HOUSING OR BEARING CAPS.

6. Install the bearing caps in the correct location as marked and tap lightly into position.

7. Install the carrier leg capscrews and tighten to the required torque. Install the adjusting nut lock (cotter keys or lock plate). If the carrier leg capscrews are drilled or castellated, lock wire after final adjustments are made. Refer to Torque Values in this Sub-Section.

Adjustment of Differential Bearing Preload.



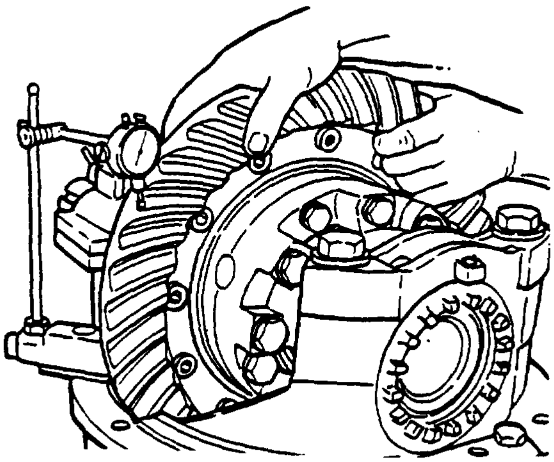
1. Using a dial indicator at the backface of the gear, loosen the bearing adjusting nut on the side opposite the gear only sufficient to notice end play on the indicator.

2. Tighten the same adjusting nut only enough to obtain 0.000 end play.

3. Check the gear for runout. If runout exceeds 0.008-inch (0.203 mm), remove the differential and check for cause.

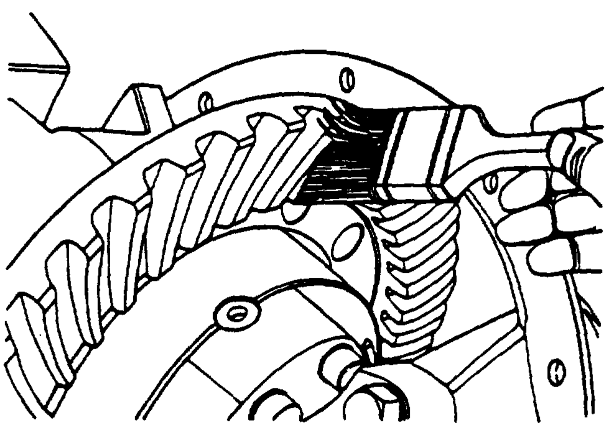
4. Tighten the adjusting nuts one notch each from 0.000 end play to preload the differential bearings.

Checking Hypoid Gear Backlash.



It the driver gear is not going to be replaced, we suggest the established backlash recorded before disassembly be used. For new gears the new backlash should be initially set at 0.010-inch (0.254 mm). Adjust backlash by moving the gear only. This is done by backing off one adjusting ring and advancing the opposite ring the same amount. After satisfactory contacts have been established, the backlash can be altered within the limits of 0.005 to 0.015 inch (0.127 to 0.381 mm) to obtain a better contact position.

Check Tooth Contact.



1. Apply oiled red lead lightly to the hypoid gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape, and location of the contacts.

2. Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be automatically correct when drive side is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

CORRECT TOOTH CONTACT.

Gears Unloaded

1. With adjustments properly made (pinion at correct depth and backlash set at 0.010-inch (0.254 mm]) the contacts shown above will be procured. The area of contact favors the toe and is centered between the top and bottom of the tooth.

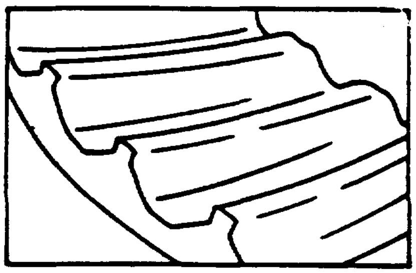
2. The hand rolled pattern shown (gears unloaded) will result in a pattern centered in the length of the tooth when the gears are under load. The loaded pattern will be almost full length and the top of the pattern will approach the top of the gear.

Gears Loaded

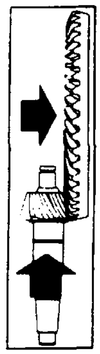
3. The pattern on the coast side of the teeth will appear the same width as the drive side shown. However, the overall length will be centered between the toe and heel of the gear tooth.

4. Set a used hypoid gear to have the tooth contacts match the existing wear patterns. Hand rolled patterns of used gears will be smaller in area and should be at the toe end of the wear patterns.

Incorrect Tooth Contact.

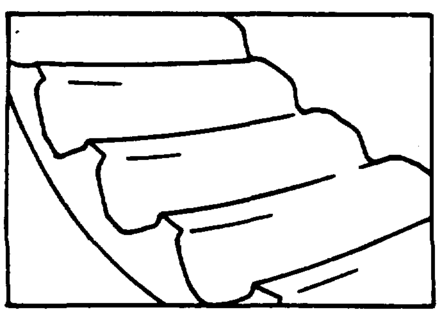


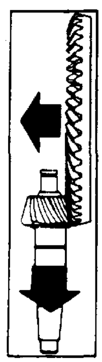
0603-22



0603-25

1. A high contact indicates the pinion is too far out. Set the pinion to the correct depth by removing shims under the pinion cage. Slight outward movement of hypoid gear may be necessary to maintain correct backlash.





0603-23

2. A low contact indicates the pinion is too deep. Set the pinion to the correct depth by adding shims under the pinion cage. Slight inward movement of the hypoid gear may be necessary to maintain correct backlash.

New Gear Set.

<u>CAUTION</u>

IF THE PINION OR DRIVE GEAR REQUIRE REPLACEMENT, BOTH MUST BE REPLACED IN MATCHED SETS.

Before installing a new pinion and gear set, check and compare the Matching number of both the pinion and drive gear, they must be the same. An example of this number would be M29 or any combination of a letter and number marked on the nose of the pinion and on the front face of the drive gears.

Installation of the Thrust Screw.

1. Remove the carrier from the stand and position it with the backface of the hypoid gear upward.

2. Remove the thrust screw and the locknut.

3. Install the thrust screw and the locknut and tighten the thrust screw firmly against the backface of the hypoid gear.

4. To secure the correct adjustment of 0.010 to 0.020-inch (0.254 to 0.508 mm) clearance, loosen the adjusting screw (or thrust screw) 1/4 turn and lock it securely with the nut.

5. Recheck to ensure the minimum clearance of 0.010-inch (0.254 mm) during full rotation of the bevel gear.

Assembly of the Drive Unit.

1. Remove any accumulation of dirt, grit, or gum from the housing bowl and sleeves. Clean the housing thoroughly with solvent and blow it dry with compressed air.

2. Inspect the housing for cracks, loose studs, nicks, and burrs at machined surfaces. Remove nicks and burrs with stone or file. Make all necessary repairs or parts replacement before installing the drive unit in the housing.

3. Apply silicone RTV gasket material to the drive unit or the housing in accordance with the procedure under Silicone RTV Gasket Application.

CAUTION

DRIVING THE CARRIER INTO THE HOUSING WITH A STEEL HAMMER WILL DAMAGE THE CARRIER FLANGE.

4. Roll the carrier into position on a roller jack. Start the carrier into the housing with four flatwashers and nuts equally spaced and tighten alternately to draw the carrier squarely into the axle housing.

5. Remove the nuts and flatwashers and install the lockwashers and stud nuts or capscrews. Tighten to the correct torque. Refer to Torque Values in this package.

6. Install the axle shafts in the housing.

7. Install the tapered dowels, the lockwashers, and the stud nuts. Tighten the nuts 60 to 75 pounds-foot (8.2 to 10.3 kgm).

NOTE

Step 8 is for axles with a two gear gearbox only.

8. Install the gearbox. Refer to Two Gear Gearbox in the Service Manual.

9. Connect the propeller shaft.

10. Fill the axle housing until the oil starts to run out the check hole, CLEANING, INSPECTION, AND REPAIR.

Cleaning.

Parts having ground and polished surfaces such as gears, shafts, and bearings, should be cleaned in a suitable solvent such as kerosene or diesel fuel oil.

CAUTION

AVOID THE USE OF GASOLINE. DO NOT CLEAN THESE PARTS IN A HOT SOLUTION TANK OR WITH WATER AND ALKALINE SOLUTIONS SUCH AS SODIUM HYDROXIDE, ORTHOSILICATES, OR PHOSPHATES.

Steam cleaning is not recommended for assembled drive units after they have been removed from the housing. When this method of cleaning is used, water is trapped in the cored passage of the castings and in the close clearances between parts as well as on the parts. This can lead to corrosion (rust) of critical parts of the assembly and the possibility of circulating rust particles in the lubricant. Premature failure of bearings, gears, and other parts can be caused by this practice. Assembled drive units cannot be properly cleaned by steam cleaning, dipping, or slushing. Complete drive unit disassembly is necessary for a thorough cleaning.

ROUGH PARTS.

WARNING

EXERCISE CARE TO AVOID SKIN RASHES AND INHALATION OF VAPORS WHEN USING ALKALI CLEANERS.

Rough parts such as differential carrier castings, cast brackets, and some brake parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts are not ground or polished. The parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the rinse water. The parts should be thoroughly rinsed after cleaning to remove all traces of alkali.

COMPLETE ASSEMBLIES.

Completely assembled axles may be steam cleaned on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units, and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

DRYING.

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless, absorbent, paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings, or contaminated oil. Bearings should never be dried by spinning with compressed air.

CORROSION PREVENTION.

Parts that have been cleaned, dried, inspected, and are to be immediately assembled, should be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good RUST PREVENTIVE and wrapped in special paper or other material designed to prevent corrosion.

Inspection.

It is impossible to overstress the importance of careful and thorough inspection of drive unit components prior to assembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary, will eliminate costly and avoidable difficulties.

INSPECTION OF THE DRIVE UNITS.

1. Inspect all bearings, cups, and cones, including those not removed from parts of the drive unit, and replace if rollers or cups are worn, pitted, or damaged in any way.

Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid the use of drifts and hammers. They may easily mutilate or distort component parts.

2. Inspect the hypoid gears for wear or damage. Gears which are worn, ridged, pitted, or scored, should be replaced. When necessary to replace either the pinion or gear of hypoid set, the entire gear set should be replaced.

3. Inspect the differential assembly for the following.

a. Pitted, scored, or worn thrust surfaces of the differential case, halves, thrust washers, spider trunnions, and differential gears. Thrust washers must be replaced in sets. The use of a combination of old and new washers will result in premature failure.

b. Wear or damage to the differential pinion and side gear teeth. Always replace differential pinions and side gears in sets.

4. Inspect the axle shafts for signs of torsional fractures or other indication of impending failure.

5. When servicing drive units assembled with Dri-Loc or Loctite No. 277 in threaded case holes where the bolts do not require removal, check each bolt for tightness by applying the minimum amount of torque specified for that fastener. If the bolt does not rotate, it is satisfactory. If the bolt rotates to any degree, it must be removed from the case halves and Loctite No. 277 must be applied to the threaded hole.

INSPECTION OF DRIVE UNIT HOUSING.

1. Remove any accumulation of dirt, grit, or gum from housing bowl and sleeves. Clean housing thoroughly with solvent and blow dry with compressed air.

2. Inspect housing for cracks, loose studs, nicks, and burrs at machined surfaces. Remove nicks and burrs with stone or file. Make all necessary repairs or parts replacement before installing drive unit in housing.

Repair.

1. Replace all worn or damaged parts. Replace 'trunnion sockets if scratched. Replace all hex nuts with rounded corners, washers, distorted snap rings, oil seals, gaskets, and socket felts at a time of overhaul.

2. Use only genuine Rockwell-Standard parts for satisfactory service. For example, using gaskets of improper material generally leads to mechanical trouble due to variations in thickness and the inability of certain materials to withstand compression, oil, etc.

3. Remove nicks, mars, and burrs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose. Studs must be tight prior to assembling the parts.

4. The burrs caused by lockwashers at the spot face of stud holes of knuckle flanges, spider flange, or hub cover should be removed to assure easy assembly of these parts.

5. When assembling component parts use a press where possible.

LUBRICATION.

General.

The efficiency and life of mechanical equipment is as dependent on proper lubrication as on proper engineering design. The importance of proper lubrication is increased because of greater gear tooth and bearing pressures and higher speeds in present day vehicles. For this reason, the best possible lubricants should be used.

The grease recommendations are based on commercial products that have given satisfactory results in normal operation. However, there are many proprietary grease products on the market which will perform satisfactorily, and may be preferable because of supply problems, common usage for other truck components, etc. Where such products are recommended by reputable grease suppliers for the specific lubrication of Rockwell components, Rockwell has no objections, provided that these substitute products are equal to or better than the Rockwell recommendations in lubrication properties, water resistance, corrosion protection, high and low temperature characteristics, oxidation stability, shear stability, etc.

It is advisable to consider the reputation of the refiner or vendor when selecting a lubricant. He is responsible for the quality and correct application of his product. A high quality lubricant incorrectly applied may greatly reduce the maximum service built into our product. Past experience has proven that a large portion of service problems can be traced to an improper lubricant application.

The purpose in compiling these specifications is to provide a guide to aid in the selection of a lubricant which will render the most satisfactory service.

New and Reconditioned Axle Service.

All new axles should be checked for correct oil level before being placed into service.

With new axles.-the original drive axle lubricant should be drained at 1000 miles (1600 km) but no later than 300 miles (4800 km). Drain the lubricant initially used in the assembly while the assembly is still warm. Axles should not be flushed with any solvent such as kerosene.

For reconditioned axles, follow the same procedures as above after overhaul.

Fill the axle housings to the bottom of the level hole (in the carrier or housing) with specified lubricant with the vehicle on level ground.

Magnetic Drain Plugs.

Any drive axle, while it is working, generates wear particles at a fairly steady rate. These wear particles are very fine, but hard. If these hard wear particles are allowed to circulate in the lubricant, the anti-friction bearings will wear at a faster rate than they would if the hard wear particles were removed as they are generated.

Magnetic drain plugs perform the vital function of trapping these small metallic particles that circulate in the lubricant, through the gears and bearings, causing rapid wear and premature failure. The magnet must be strong enough to firmly hold the particles under service conditions. Plugs with elements having a minimum pickup capacity of 2 pounds (0/.907 kg) of low carbon steel in plate or bar forms are recommended.

Magnets will rapidly lose effectiveness as collected material bridges the gap between the two poles. Change plugs before this occurs. It may be necessary to change plugs one or more times between complete lubrication changes. The removed plugs can be cleaned and reused.

NOTE

For maximum protection against wear particles, it is desirable that magnetic plugs be employed at any drain, fill, or level hole location of the drive unit.

Lubricant Change Schedule.

There are very practical reasons for recommending lubricant changes. Fluid lubricants serve more than one purpose.

They not only lubricate but they transport chemically reactive additives, they wash away minute wear particles, serve as a corrosion inhibitor, and also act as a heat transfer medium. Draining and refilling with a fresh supply assists in eliminating both magnetic and nonmagnetic wear particles which may not have been trapped by a magnetic plug. Exposure to heat and use may also alter the desirable performance properties which are reassured through a lubricant change.

A regular schedule for changing the lubricant in a particular vehicle and operation can be accurately determined by analysis of samples taken from the assembly at specified intervals or mileages. The lubricant supplier frequently makes available his laboratory facilities for determining the useful life of his product under actual service conditions. The finally recommended schedule may be correlated, for economic reasons, with lubricant changes governed by climatic conditions and magnetic drain plug maintenance. Lubricant changes should be made as climatic temperatures demand, regardless of vehicle mileage, accumulated hours of operation, or established change schedule.

DRIVE UNITS.

If it is desirable to select an arbitrary lubricant change schedule, we recommend changing the lubricant at 25,000 to 30,000 mile (40,234 to 48.280 kilometers) intervals or at 2000 hours of operation when the yearly usage is in excess of 60,000 miles (96,561 kilometers) or 4000 hours.
When yearly usage is less than 60,000 miles (96,561 kilometers) or 4000 hours, the lubricant should be changed twice yearly (spring and fall) irrespective of mileage or hours of operation.

HIGH TEMPERATURE OPERATION.

The normal operating temperature of compounded lubricants during the summer season is approximately 160 degrees to 220 degrees F (71 degrees to 104 degrees C). The chemicals and additives that give _ these lubricants increased load carrying capacity oxidize faster at temperatures above 220 degrees F (104 degrees C), contributing to more rapid lubricant deterioration. For this reason, lubricants of this type that operate continuously at high temperatures must ' be changed more frequently to realize the inherent advantages they offer.

Oil Viscosities.

For service purposes and the convenience of description, the term Standard indicates a lubricant of proper viscosity for average temperature conditions during the spring, summer, and fall in the continental United States (except for Alaska), and a part of the continental United States during the winter.

Optional viscosity lubricants should be used whenever vehicles are parked at outside temperatures lower than the minimum given for the Standard lubricant.

The proper viscosity of oil for the specific component shall be selected from the table of ambient temperatures. Where more than one lubricant can be selected from this table, the high viscosity oil should be used.

However, experience has shown that the use of an S.A.E. 140 viscosity grade lubricant (Rockwell specifications 0-76, 0-76-A, and 0-76-B) will result in longer gear life.

Unusual temperature or operating conditions may require other or more specific lubricant recommendations. Rockwell will review these circumstances, upon request, and make optional gear oil or grease recommendations. It is essential that all details of vehicle operation, loads, area temperatures, etc., are clearly and completely stated when applying to Rockwell Engineering department for an optional lubricant recommendation.

Multigrade and synthetic lubricants may be used provided the complete specifications (including viscosity stability in service) of each viscosity grade listed are met.

CAUTION

THE SYNTHETIC LUBRICANT MUST BE COMPATIBLE WITH THE STANDARD COMMERCIAL SEALS USED IN THE AXLE (PINION AND WHEEL END), OTHERWISE SPECIAL SEALS MUST BE INSTALLED. FURTHER, THE SEALS USED MUST PASS ROCKWELL SPECIFICATION J-11 WHEN TESTED IN THE SYNTHETIC LUBRICANT.

Synthetic lubricants may be used in drive axles provided they meet all of the requirements of Rockwell-Standard specifications 0-76, 0-76-A, 0-76-B, 0-76-C, 0-76-D, 0-76-F, or 0-76-J.

Preparation for Storage.

In the event the carrier is a spare and may not be immediately installed, all gears and bearings should be thoroughly oiled and the carrier placed in a dust-proof container.

Specifications of Recommended Lubricants (Oil and Grease).

DRIVE UNITS.

The design of hypoid gear teeth, which mesh with a sliding action, enables them to withstand higher unit pressures.

Therefore, the lubricant should have extreme pressure properties. Only lubricants with the S.A.E. designation API-GL-5 meet these requirements and are recommended for hypoid gears.

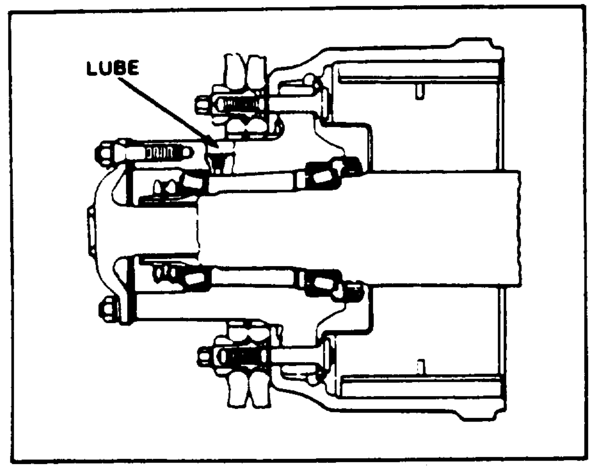
LUBRICANT: Standard: 0-76, 0-76-A or 0-76-B (Refer to OIL VISCOSITIES)
Optional: 0-76-C, 0-76-D, 0-76-F, or 0-76-J (Refer to OIL VISCOSITIES)

CHANGE INTERVAL: Check every 1000 miles (1600 km). Drain and refill to the top of the filler neck or the bottom of the tapped hole every 25.000 to 30,000 miles (40,000 to 48,000 km) when yearly mileage is in excess of 60,000 miles (96,000 km). If yearly mileage is less than 60,000 (96,000 km) change twice a year (spring and fall).

WHEEL BEARINGS.

LUBRICANT.

Oil filled hubs standard 0-76-C or 0-76-D optional 0-76-F or 0-76-J



CHANGE INTERVAL.

Check every 1000 miles (1609 km) and change whenever the seals are replaced or when the brakes are relined, or at least once a year.

Lubricant Capacities.

Lubricant capacities are given as a guide only. All measurements are taken still filled, with the pinion shaft on the horizontal centerline, to the bottom of the tapped level hole. Refer to Section 13, LUBRICATION for the capacity.

The lubricant capacities of two similar axles in the same series may vary considerably due to design changes and the vehicle manufacturer's installation. The actual service capacity may be accurately determined by carefully measuring the amount of specified lubricant necessary to fill the assembly to the correct level and measuring the lubricant again as it is drained from the unit. The vehicles should be on a level surface when this inspection is made.

PINION SHAFT (INPUT) NUTS

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
7/8 inch 20	200 275	(27.7 38.0)
1 inch 20	300 400	(41.5 55.3)
1 1/4 inch 20	700 900	(96.8 124.4)
1 1/4 inch 18	700 900	(96.8 124.4)
1 1/2 inch 12	800 1100	(110.6 152.1)
1 1/2 inch 18	800 1100	(110.6 152.1)
1 3/4 inch 12	900 1200	(96.8 165.9)

OIL FILLER PLUG. Thread into carrier housing to allow one thread standout.

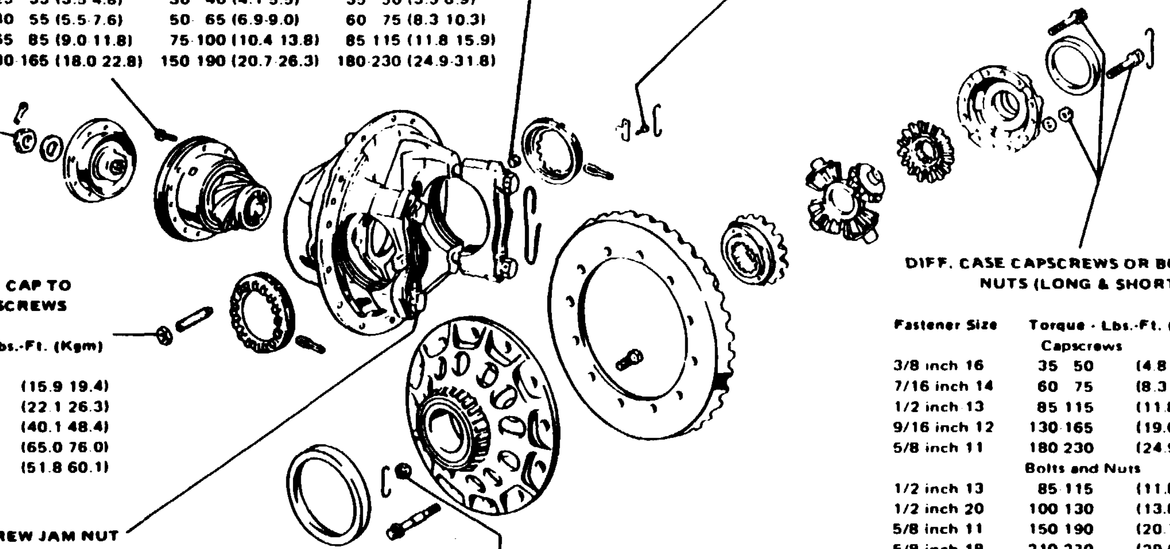
Fastener Size	Torque - Lbs.-Ft. (Kgm)	
3/4 inch 14	35	(4.8)

ADJUSTING RING LOCK TO DIFF. BEARING CAP CAPSCREWS

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
	Capscrews Using Lockwire	
5/16 inch 18	15 20	(2.1 2.8)
	Capscrews Not Using Lockwire	
5/16 inch 18	20 30	(2.8 4.1)

PINION BEARING CAGE TO CARRIER CAPSCREW

Fastener Size	Torque - Pounds-Foot (Kgm) Grade 5	Grade 7	Grade 8
3/8 inch 16	25 35 (3.5 4.8)	30 40 (4.1 5.5)	35 50 (3.5 6.9)
7/16 inch 14	40 55 (5.5 7.6)	50 65 (6.9 9.0)	60 75 (8.3 10.3)
1/2 inch 13	65 85 (9.0 11.8)	75 100 (10.4 13.8)	85 115 (11.8 15.9)
5/8 inch 11	130 165 (18.0 22.8)	150 190 (20.7 26.3)	180 230 (24.9 31.8)



DIFF. BEARING CAP TO CARRIER CAPSCREWS

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
9/16 inch 12	115 140	(15.9 19.4)
5/8 inch 11	160 190	(22.1 26.3)
3/4 inch 10	290 350	(40.1 48.4)
7/8 inch 9	470 550	(65.0 76.0)
7/8 inch 14	375 435	(51.8 60.1)

THRUST SCREW JAM NUT

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
3/4 inch 16	150 190	(20.7 26.3)
7/8 inch 14	150 190	(20.7 26.3)
1 1/8 inch 16	150 190	(20.7 26.3)

GEAR TO DIFF. CASE BOLT NUTS

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
1/2 inch 20	85 115	(11.8 15.9)
5/8 inch 18	180 230	(24.9 31.8)

DIFF. CASE CAPSCREWS OR BOLTS AND NUTS (LONG & SHORT)

Fastener Size	Torque - Lbs.-Ft. (Kgm)	
	Capscrews	
3/8 inch 16	35 50	(4.8 6.9)
7/16 inch 14	60 75	(8.3 10.4)
1/2 inch 13	85 115	(11.8 15.9)
9/16 inch 12	130 165	(19.0 22.8)
5/8 inch 11	180 230	(24.9 31.8)
	Bolts and Nuts	
1/2 inch 13	85 115	(11.8 15.9)
1/2 inch 20	100 130	(13.8 18.0)
5/8 inch 11	150 190	(20.7 26.3)
5/8 inch 18	210 270	(29.0 37.3)

All torques given apply to parts lightly coated with rust preventative type oil. For dry parts - increase torques 10%. For parts heavily coated with oil - decrease torques 10%.

8637

Drive Unit Torque Values

FRONT STEERING CONTROL VALVE

DESCRIPTION

The steering control valve is located under the dash and is actuated by a conventional steering column and wheel providing precise full hydraulic steering. This is accomplished by a metering system within the valve that is directly connected to the steering column and wheel.

THEORY OF OPERATION

Turning the steering wheel to the left or right causes a spool, enclosed in a precision sleeve, to rotate. As the spool is rotated, a set of lateral springs tend to move the sleeve in the same direction. Due to the springs, there is a time lag between the movement of the spool and sleeve. During this time lag, hydraulic oil from the IN port of the valve is permitted to flow to the gerotor set which meters hydraulic oil to the steering cylinders through the appropriate L or R port of the valve. When the sleeve rotates to the same position as the spool, the metered flow of hydraulic oil stops and oil flows from the IN port to the OUT port and back to the return manifold. It is the action between the spool and sleeve that permits incremental steering left or right. If hydraulic oil flow to the IN port is lost due to failure of the engine, torque converter or steering pump, front wheel steering can still be accomplished with the steer control valve. When pressure is lost; a poppet valve closes and the gerotor set becomes a hydraulic pump. Turning the steering wheel mechanically actuates the gerotor set. pumping hydraulic oil from one side of the steer cylinders to the other. This means of steering is very difficult and requires a great amount of force to be applied to the steering wheel.

MAINTENANCE

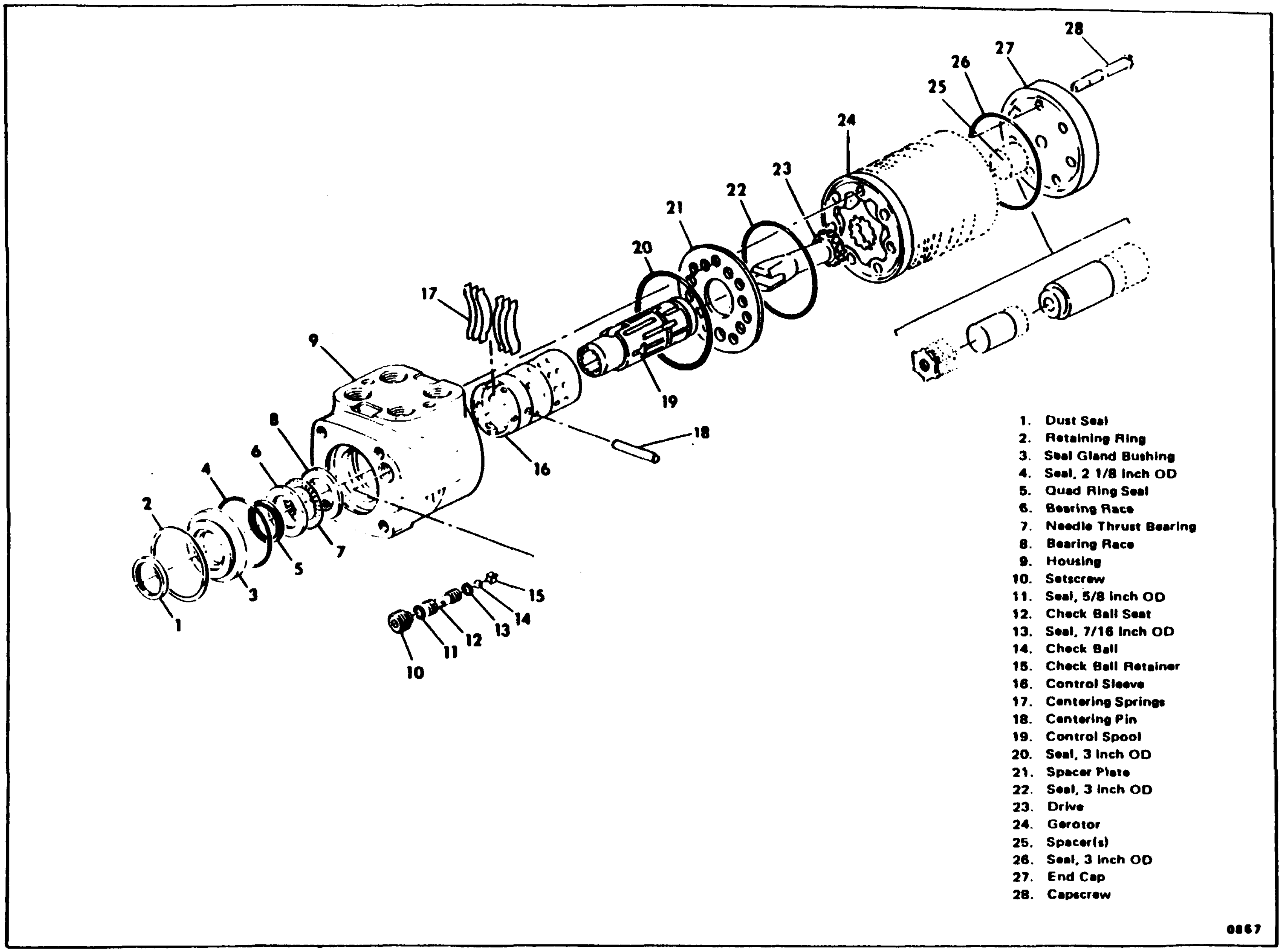
PRIOR TO DISASSEMBLY.

1. Observe the shaft area of the unit immediately upon removal. If it shows an appreciably oil wetted appearance, this indicates the shaft seal may have been leaking.

2. If there is a functional problem or leakage at the control end of the unit, the disassembly of the control end of the unit only will be required and it is generally advisable to leave the gerotor end assembled.

3. If a complete teardown and assembly of the unit is planned, clean all paint and surface contamination from the unit at points of separation. This is extremely important at the meter end of the unit so no paint flakes or particles will enter these closely fitted parts as they are being assembled. To clean the unit adequately, first plug all four ports, then wire brush around the meter area, ringing and blowing away all surface contamination before any disassembly is begun.

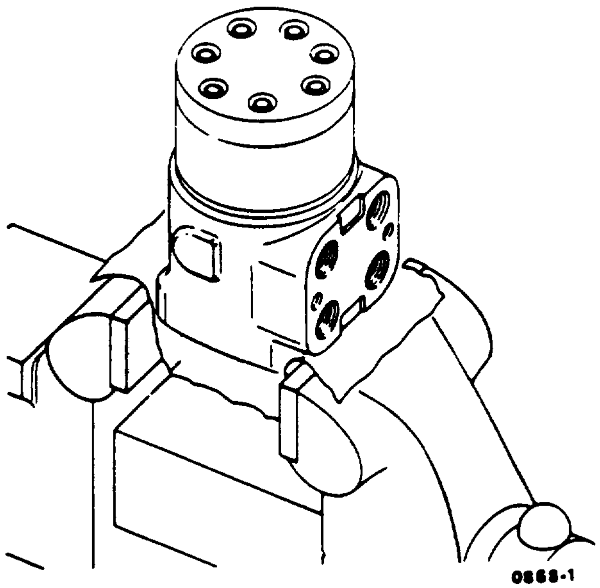
4. For any disassembly, an extremely clean bench area is necessary. Do not use shop cloths or cotton waste to wipe or clean the parts. The lint deposited by these cloths can disrupt the function or cause leaks. The clean inside surface of a corrugated container is frequently a very adequate assembly surface. Assembly is generally easier and more satisfactory with clean dry parts. After parts are rinsed clean in solvent, they may be blown dry with an air hose or placed on clean paper towels to drain and dry.



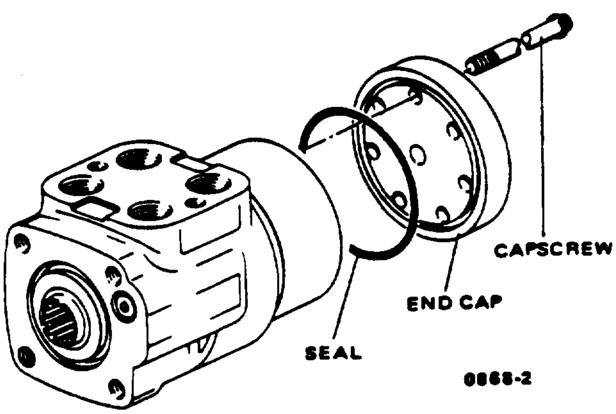
Power Steering Control Valve-Exploded View

DISASSEMBLY.

Meter (Gerotor) End.



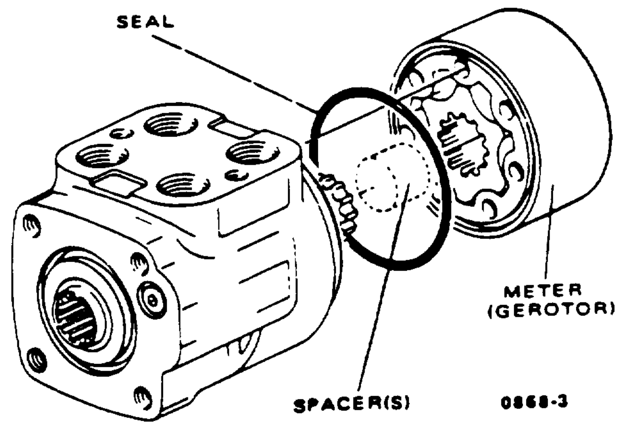
1. Clamp the unit in a vise, meter end up. Clamp lightly on the edges of the mounting area. Use protective material on the vise jaws. Do not overtighten the jaws.



2. Remove the 5/16-inch capscrews.

3. Remove the end cap.

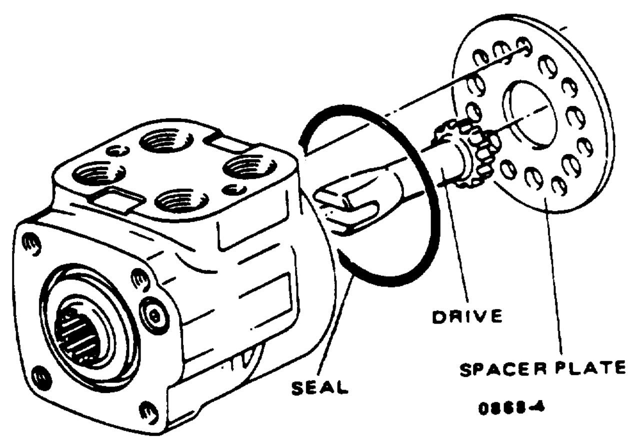
4. Remove the seal from the end cap.



5. Remove the meter. Be careful not to drop the star.

6. Remove the seal from the meter.

7. Remove the drive spacer(s).

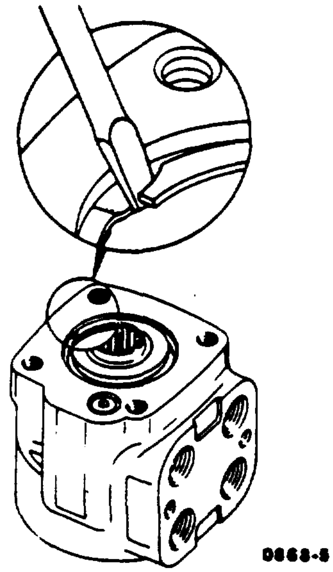


8. Remove the drive.

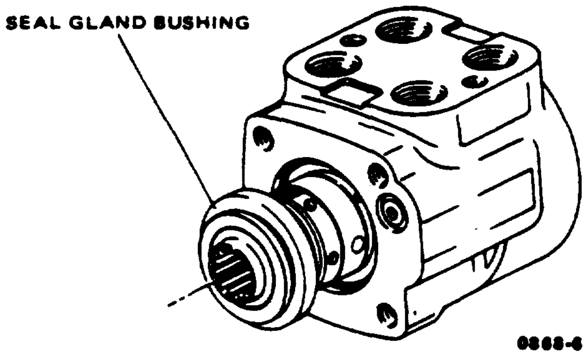
9. Remove the spacer plate:

10. Remove the seal from the housing.

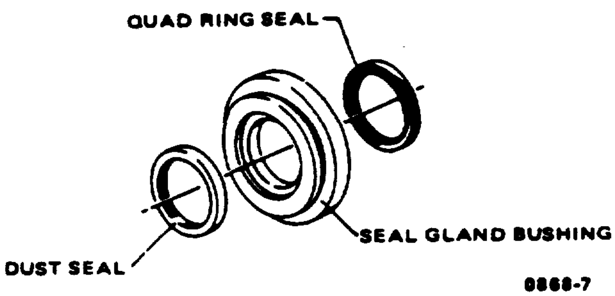
Control End.



11. Remove the housing from the vise. Place the housing on a clean soft cloth to protect the surface finish. Use a thin bladed screwdriver to pry the retaining ring from the housing.

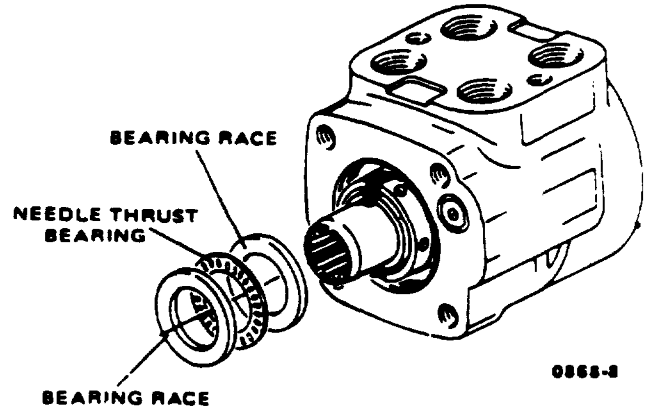


12. Rotate the spool and sleeve until the pin is horizontal. Push the spool and sleeve assembly forward with the thumbs just far enough to free the seal gland bushing from the housing. Remove the bushing.

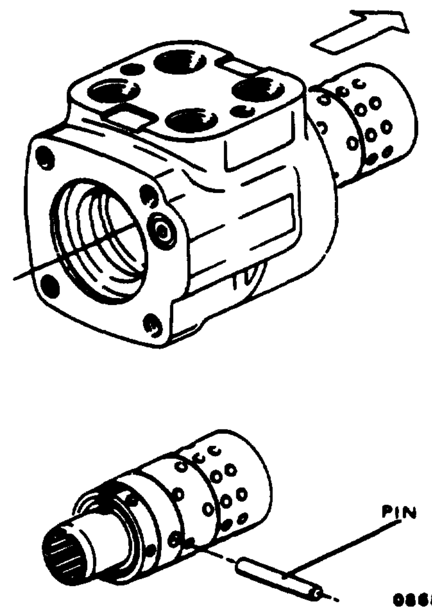


13. Remove the quad ring seal from the seal gland bushing.

14. Use a thin bladed screwdriver to pry the dust seal from the seal gland bushing. Do not damage the bushing.



15. Remove the two bearing races and the needle thrust bearing from the spool and sleeve assembly.

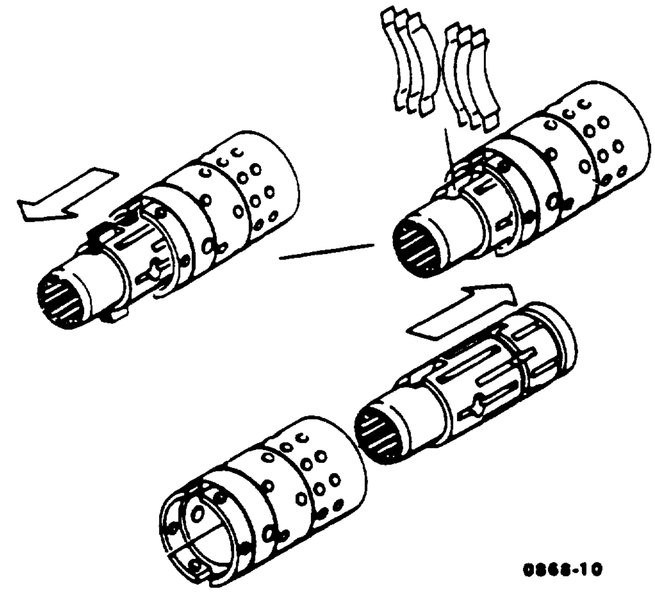


16. Remove the spool and sleeve assembly from the fourteen hole end of the housing.

CAUTION

DO NOT BIND THE SPOOL AND SLEEVE IN THE HOUSING. ROTATE THE SPOOL AND SLEEVE ASSEMBLY SLOWLY WHEN REMOVING IT FROM THE HOUSING.

17. Push the centering pin from the spool and sleeve assembly.

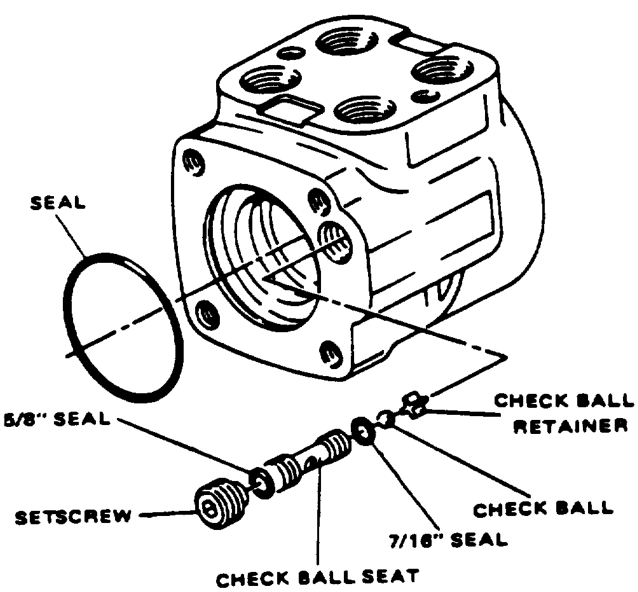


0868-10

18. Push the spool partially from the control end of the sleeve, then carefully remove the six centering springs from the spool by hand.

19. Push the spool back through and out of the sleeve. Rotate the spool slowly when removing it from the sleeve.

20. Remove the seal from the housing.



0868-11

21. Remove the setscrew from the housing.

22. Screw a 1/8" 24 machine screw into the end of the check ball seat. Then by pulling on the screw, with pliers, lift the seat out of the housing.

23. Remove the two seals from the check valve seat.

24. Tip the housing to remove the check ball and the check ball retainer.

ASSEMBLY.

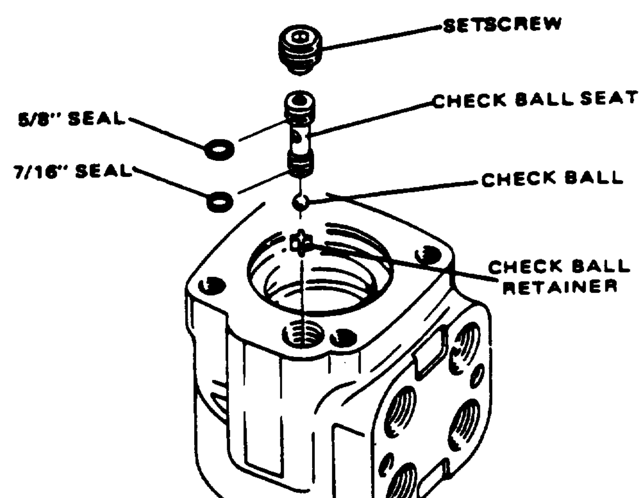
Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with a cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

NOTE

Lubricate all seals (with the exception of the quad ring seal) with a petroleum jelly, such as Vaseline. Do not use excessive lubricant on the seals for the gerotor section'.

Refer to the parts listings covering your steering control unit when ordering replacement parts. Replace all old seals with new seals during assembly.

Control End.



0868-12

1. Use needle nose pliers to lower the check ball retainer into the check valve hole of the housing. Ensure the retainer lays flat in the housing and Is not tilted on edge.

2. Install the check ball into the housing.

3. Lubricate both seals and install the 5/8 inch diameter seal on the large diameter end of the check

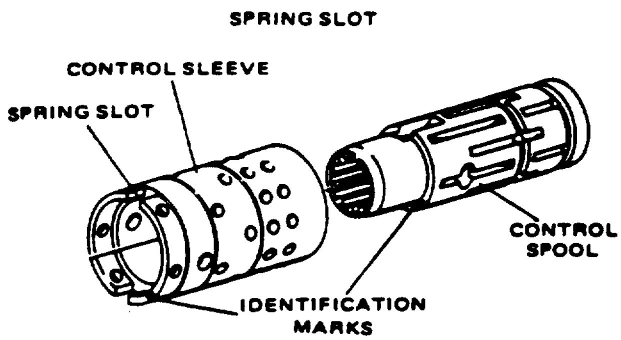
ball seat. Install the 7/16 inch diameter seal on the small diameter end of the check ball seat.

CAUTION

WHEN INSTALLING THE SEAL. DO NOT TWIST OR DAMAGE THE SEALS.

4. Lubricate and install the check ball seat in housing; insert open end of seat first. Do not damage seals when installing check ball seat. Push the check ball seat to the bottom of the hole.

5. Install the setscrew. Use a 0.3124-in. Allen wrench to torque the setscrew to 100 lb in. (11 N•m). To prevent interference, the top of the setscrew must be slightly below the housing mounting surface.

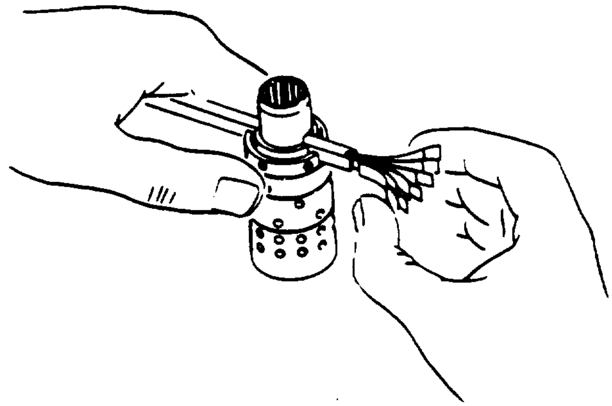


0868-13

6. Assemble the spool and sleeve carefully so the spring slots line up at the same end. Rotate the spool while sliding the parts together. Test for free rotation. The spool should rotate smoothly in the sleeve with fingertip force applied at the splined end.

NOTE

Some spool and sleeve sets have identification marks, align these marks as shown.

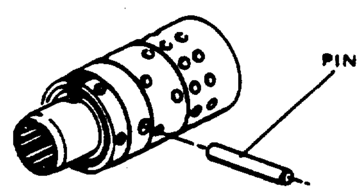


0868-14

7. Bring the spring slots of both parts in line and stand the parts on the end of the bench. insert the spring installation tool through the spring slots of both parts. A tool is available as Char-Lynn Part No. 600057. Position three pairs of centering springs (two sets of three each) on the bench so the extended edge is down and the arched center section is together. In this position, enter one end of the entire spring set into the spring installation tool.

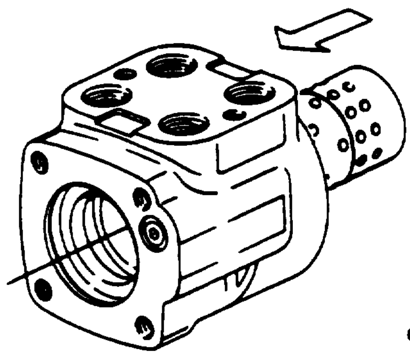
8. Compress the extended end of the centering spring set and push it into the spool sleeve assembly, withdrawing the installation tool at the same time.

9. Center the spring set in the parts so they push down evenly and are flush with the upper surface of the spool and sleeve.



0868-15

10. Install the pin through the spool and the sleeve assembly until the pin becomes flush at both sides of the sleeve.



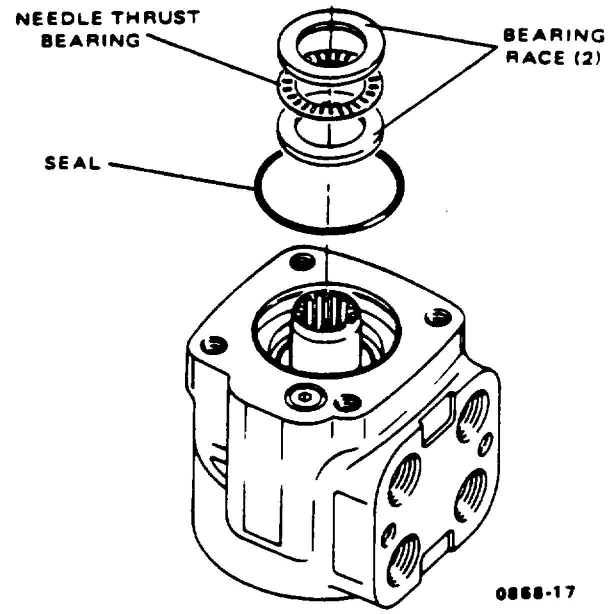
0868-16

11. Position the spool and sleeve assembly so the splined end of the spool enters the fourteen hole end of the housing first.

CAUTION

BE EXTREMELY CAREFUL THAT THE PARTS DO NOT TILT OUT OF POSITION WHILE ENTERING. PUSH THE PARTS GENTLY INTO PLACE WITH A SLIGHT ROTATING ACTION. KEEP THE PIN NEARLY HORIZONTAL. BRING THE SPOOL ASSEMBLY ENTIRELY WITHIN THE HOUSING BORE UNTILTHE PARTS ARE FLUSH ATTHE METER END OR FOURTEEN HOLE END OF THE HOUSING. DO NOT PULL THE SPOOL ASSEMBLY BEYOND THIS POINT TO PREVENT THE CROSS PIN FROM DROPPING INTO THE DISCHARGE GROOVE OF THE HOUSING. WITH THE SPOOL ASSEM BLY IN THIS FLUSH POSITION. CHECK FOR FREE ROTATION WITHIN THE HOUSING BY TURNING WITH LIGHT FINGERTIP FORCE AT THE SPLINED END.

12. Place the housing on a clean cloth and install the 2 1/8-inch diameter seal in the housing.

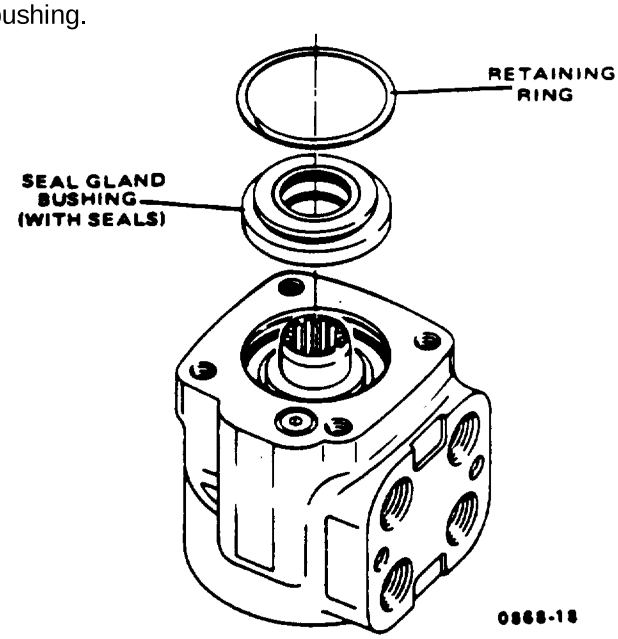


0868-17

13. Install the two bearing races and the needle thrust bearing as shown in the figure.

14. Install the 1 1/4-inch diameter dust seal in the seal gland bushing. The flat or smooth side of the dust seal must face down towards the bushing.

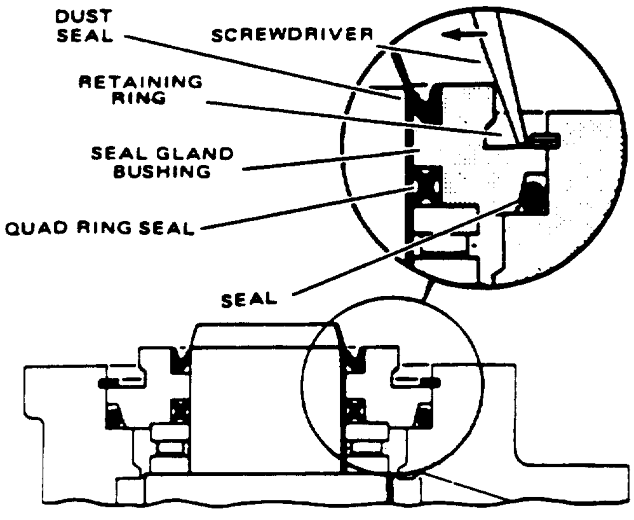
15. Install the dry quad ring seal in the seal gland bushing. Smooth the seal in place with a finger. Do not use any seal that falls freely into the pocket of the bushing.



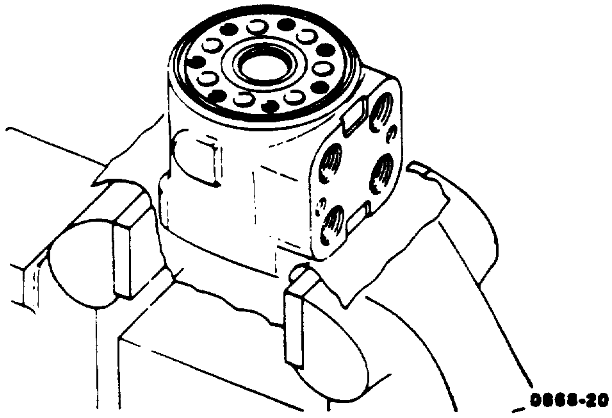
0868-18

16. Install the seal gland bushing over the spool end with a twisting motion. Tap the bushing in place

with a rubber hammer. Ensure the bushing is flush against the bearing race.



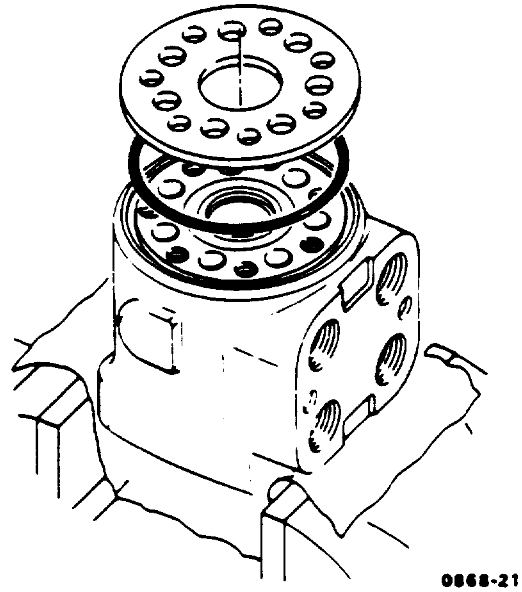
17. Install the retaining ring in the housing. After installing the ring, tap on the ring end or pry with a screwdriver around the entire circumference of the ring to properly seat the ring in the groove.



18. Clamp the housing in the vise. Clamp lightly on the edges of the mounting area. Do not over-tighten the jaws.

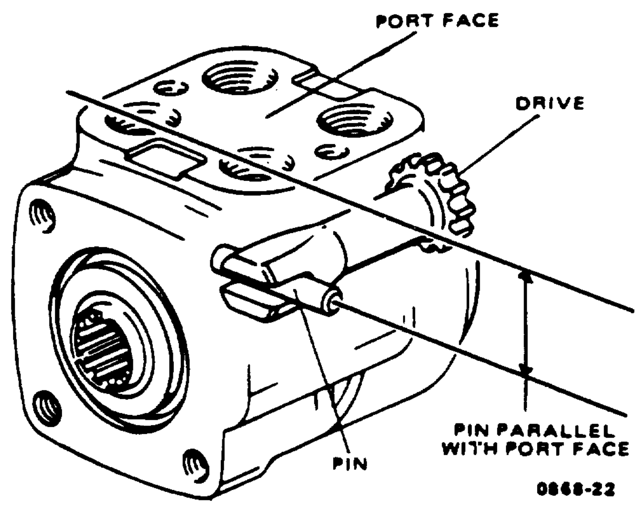
NOTE

Check to ensure the spool and sleeve are flush or Slightly below the fourteen hole surface of the housing. Clean the upper surface of the housing by wiping with the palm of the clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for assembly. Do not use cloth or paper to clean the surfaces.

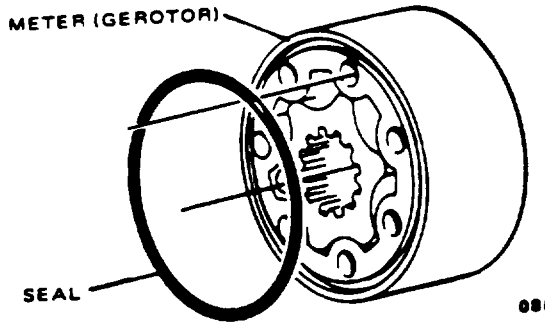


19. Install the 3 inch diameter seal in the housing.

20. Install the spacer plate. Align the bolt holes in the spacer plate with the tapped holes in the housing.

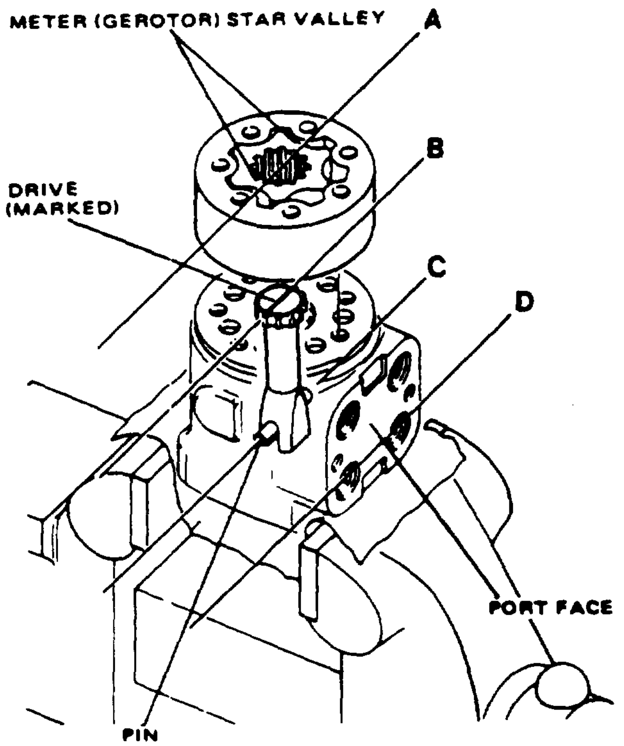


21. Rotate the spool and sleeve assembly until the pin is parallel with the port face. Install the drive and ensure the drive is engaged with the pin. To ensure proper alignment, mark the drive as shown in the figure, (ref. 8). Note the relationship between the slotted end of the drive to the splined end of the drive when marking.



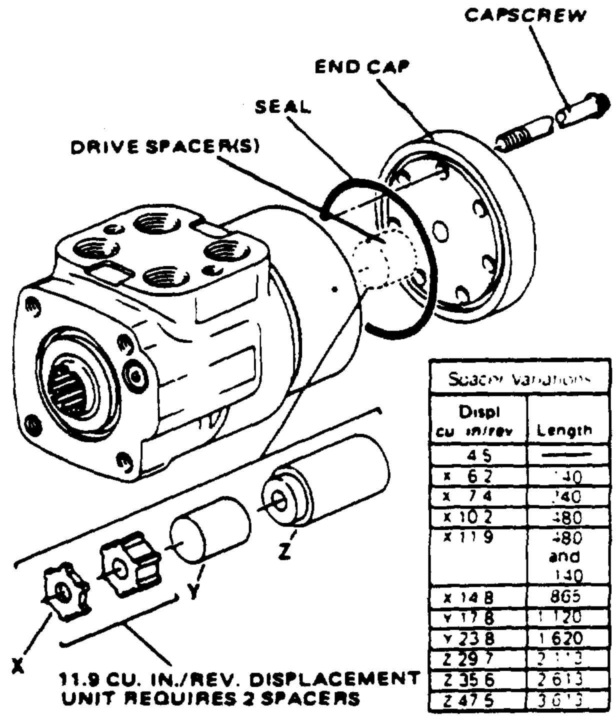
0868-23

22. Install 3 inch diameter seal in the gerotor.



0868-24

23. With the seal side of the meter toward the spacer plate, align the star valleys (ref. A) on the drive (ref. B). Note the parallel relationship of reference lines A, B, C, and D. Align the bolt holes without disengaging the meter from the drive.



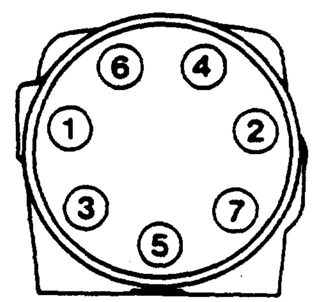
Spacer Variations	
Displ cu in/rev	Length
4 5	——
x 6 2	140
x 7 4	140
x 10 2	480
x 11 9	480 and 140
x 14 8	865
Y 17 8	1 120
Y 23 8	1 620
Z 29 7	[illegible]
Z 35 6	2 613
Z 47 5	[illegible]

0868-25

24. Install the drive spacer(s) when used, in the meter.

25. Install the 3 inch diameter seal in the end cap.

26. Install the end cap on the gerotor and align the holes.



0868-26

27. Install seven dry capscrews in the end cap. Pretighten the screws to 150 lb in. (17 N•m), then torque the screws to 275 lb in. (31 N•m) in the sequence shown in the figure.

STEER PUMP

DESCRIPTION

The power steering pump is a gear type pump. Mounted in the end cover of the pump are a pressure relief valve and a flow control valve. The pump is spline driven.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Noisy pump.	a. Low oil supply.	a. Fill reservoir.
	b. Oil too heavy.	b. Change to proper viscosity.
	c. Air leak in inlet line.	c. Check plumbing.
	d. Partly blocked inlet line.	d. Check for foreign object and/or clean lines.
2. Foaming oil.	a. Pump cavitation.	a. Refer to Symptom 1.
	b. Water in the oil.	b. Check reservoir.
3. Pump or oil overheating.	a. Oil supply too thin.	a. Drain and fill with proper viscosity oil.
	b. Oil supply contaminated.	b. Drain, clean filter. and fill with clean oil.
	c. Pump cavitating.	c. Refer to Symptom 1.
	d. Pump drive shaft excessively misaligned with pump driven shaft.	d. Check alignment.
	e. Pump drive shaft axially loaded by driving shaft.	e. Check for clearance at ends of shafts, for shaft misalignment or worn driving splines.
	f. System relief valve bypassing.	f. Check relief valve setting. Refer to Solution 4c.
4. Low flow.	a. Pump cavitating.	a. Refer to Symptom 1.
	b. Foaming oil.	b. Refer to Symptom 2.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Low flow. (continued)	c. Relief valve leaks or set too low.	c. Check relief valve for foreign particles.
	d. Speed too low.	d. Increase engine speed.
	e. Oil too hot	e. Check temperature. Refer to Symptom 3. Solution a through e.
5. Failure to build pressure.	a. Defective relief valve.	a. Check and reset or replace.
	b. Low oil supply.	b. Fill reservoir.

DISASSEMBLY.

1. Clean the unit thoroughly with solvent, kerosene, or other non-corrosive cleaning fluid. which will not affect rubber components.

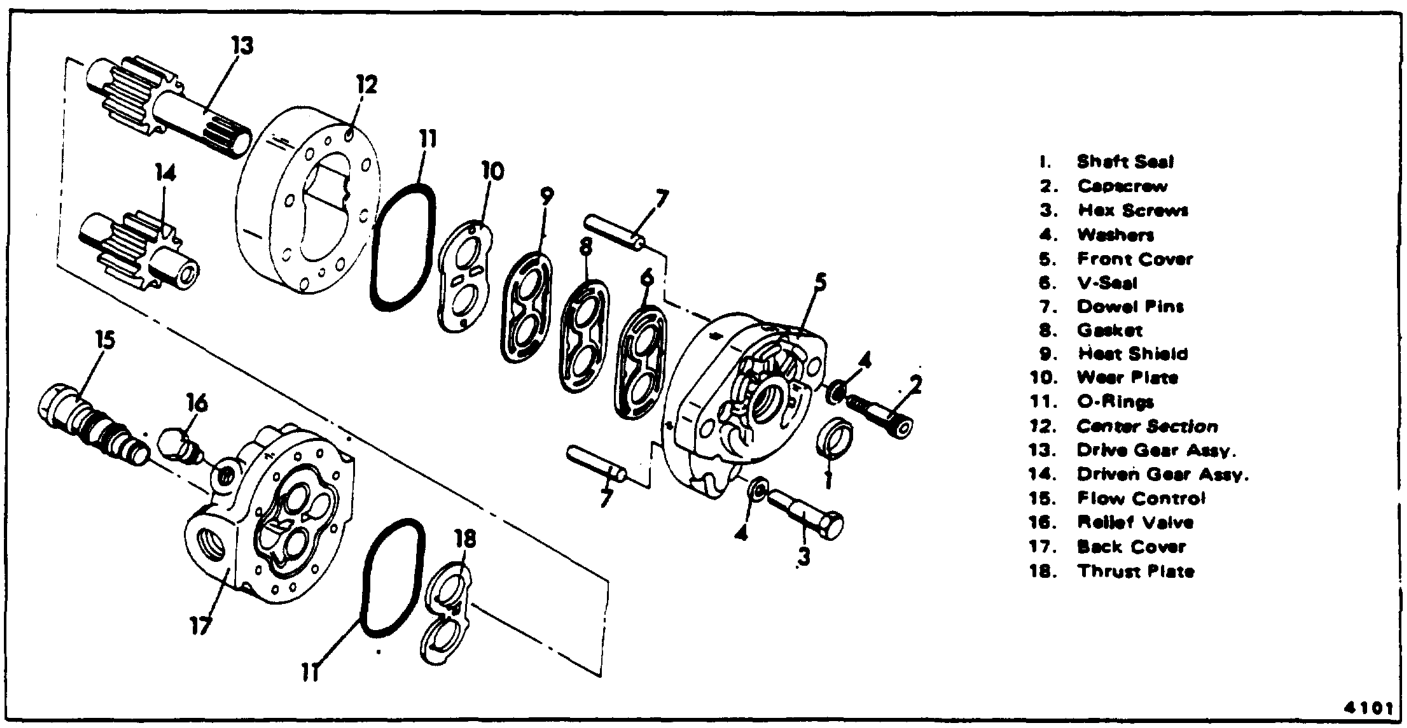
2. Scribe a line across the three sections of the pump to act as a guide in assembly.

3. Remove the six hex screws (3) and two capscrews (2).

4. Remove the front cover (5) by lightly tapping the flange with a soft metal hammer.

5. The center section (12) will remain attached to either the front cover (5) or back cover (17). Place the drive gear (13) into the unseparated section, and while holding the center section (12), tap lightly to separate. Be careful to avoid cocking on the dowel pins (7).

6. Remove the wear plate (10) and thrust plate (18).



Steer Pump - Exploded View

7. Mark the front cover island next to the pressure vent hole in the heat shield (9), gasket (8), and V-seal (6) to act as a guide in assembly. The location of this vent hole determines pump rotation.

8. Use a small diameter wire (a paper clip will do) to remove the phenolic heat shield (9), the paper compound gasket (8) and the rubber V-seal (6). Discard these parts and replace when the pump is assembled.

9. Remove both O-rings (11) and discard.

10. Do not remove the shaft seal (1) in the front cover (5) unless it is damaged or leaking. If the seal is to be-replaced, use great care not to damage the seal recess or bearing. Heating the cover in an oven to 250 degrees F (121 degrees C) will reduce the press fit.

11. If the flow control is defective, replace it as a cartridge.

12. If the relief valve is defective, replace it as a complete relief valve unit.

INSPECTION.

Drive and Driven Gear Assemblies.

1. Inspect the shafts for roughness in the bearing and sealing areas. Measure for wear. The minimum acceptable diameter is 0.7492 inch (19.03 mm).

2. Inspect the splines for damage or excessive wear.

3. Inspect the gear end faces, outside diameter, and teeth for roughness and score marks. Minimum gear width is 1.3840 inches (35.154 mm).

4. Ensure the snap rings are secure; break any sharp edges on the sides of the gears.

5. Gears and shafts are available only as assemblies. One gear assembly may be replaced separately if the other is in good condition.

Front Cover and Back Cover Assemblies.

1. If any bearing bore diameter exceeds 0.7518 inches (19.096 mm), the cover should be discarded. The bearings are not supplied separately.

2. Replace the shaft seal (1) only if it shows excessive wear or cracking.

3. Check all internal threads for damage.

4. The bearings must be below the cover faces and show no signs of contact with the snap rings on the gear shafts.

5. If the bearings are scored, rough, or show signs of heat discoloration, the cover assembles should be re-placed.

Center Section.

1. Inspect the wall of the gear bore diameters for excessive wear or score marks. The center section gear bores will show signs of wear on the inlet side of the pump. A wear ridge will develop at the end of the gear bore where the thrust plate is located. This wear ridge should not exceed 0.03125 inch (0.79375 mm).

2. Lightly lap the faces to remove any nicks or burrs. Do not break the inside edges.

GENERAL.

The following parts should be replaced at every major overhaul: wear plate(10), thrust plate(18), fiber heat shield (9), paper gasket (8), V-seal (6), and O-rings (11). The shaft seal (1) should be replaced only when necessary.

ASSEMBLY.

1. All parts must be thoroughly cleaned prior to assembly by dipping in solvent and brushing to remove all traces of contamination. The pump should be assembled in a dirt free area.

2. Install the shaft seal (1), if it was removed, in the front cover with the spring loaded lip facing inward.

Force the seal into place, using a flat steel rod slightly smaller in diameter than the OD of the seal. This will permit the tool to enter the seal recess and bottom the rotary seal on the stop. (The front cover [5] must be backed up on a smooth, clean surface to prevent damaging its face).

NOTE

The load to force the seal into place should be applied exactly in line with the housing seal bore to prevent bending the steel seal retainer. and/or scoring the seal housing bore.

3. Install the V-seal (6), the gasket (8), and heat shield (9) into the front cover cavity as follows. Ensure the small vent hole through the parts is in line and positioned next to the scribe mark on the island. This position locates the vent holes on the outlet side of the pump.

4. Face the lips on the U-seal toward the cavity and insert it into the groove with the aid of a dull tool to prevent damage to the rubber surface. A small screwdriver can be used.

5. Firmly press the gasket toward the bottom of the cavity with the thumbs to ensure all of its perimeters are completely within the groove to avoid interference with subsequent assembly.

6. Firmly press the heat shield toward the bottom of the cavity with the thumbs to provide sufficient space for the wear plate.

7. Install the O-ring (11) into the groove provided in the front cover face. Oil the O-ring and stretch it slightly, if necessary, so it will remain in its groove.

8. Install the wear plate (10) with the bronze surface against the gears and the small vent hole in line with the hole in the heat shield. Press the wear plate. The wear plate shall be sufficiently within the oval cavity so it is axially retained.

9. Install the drive gear (13) and driven gear (14) assemblies into the front cover. Apply oil to the shaft at the drive end to prevent damage to the shaft seal caused by sharp edges on the drive shaft passing through the shaft seal. An oil coated shaft, rotated slowly, will usually cause no damage to the seal. Check to see the shaft seal lip and spring is not pushed out by the shaft.

10. Check the wear plate to ensure it is still seated into its oval cavity and install the center section (12) over the gears until it engages the wear plate. The center section must be positioned so the previously scribed lines on the housing exteriors are in line with those scribed on the front cover. The small slot located mid-way between the bores should align with the small vent hole in the wear plate. The face containing the slot must be in contact with the wear plate.

11. Install the dowel pins (7) and add a generous amount of clean hydraulic oil into the gear cavities.

12. Rotate the gears to distribute the oil.

13. Position the thrust plate (18) on top of the gears in the center section, with the bronze face toward the gears. The open side should be toward the inlet.

14. Install the O-ring (11) into its back cover face groove. Oil the O-ring, the cover face, and the bearings. Install the back cover so the scribe marks are in line with the marks on the center section and front cover.

15. Install the housing retaining screws and tighten alternately to 190 to 210 lb in. 122 to 24 N•m).

16. Add a generous amount of clean hydraulic oil into both ports to ensure the pump is adequately lubricated. Rotate the drive shaft to distribute the oil and check for freedom of shaft rotation. The shaft should be free to rotate with the help of a short wrench [100 lb in. (11 N•m) maximum).

BRAKE MASTER CYLINDER

DESCRIPTION

The brake master cylinder is located under the deck to the front of the cab. The master cylinder which has its own oil reservoir, is actuated directly by linkage to the brake pedal. The master cylinder incorporates two integrally designed pistons; the large piston for large volume and the small piston for high pressure.

Transfer from low pressure (large piston) to high pressure (small piston) is accomplished by means of a metered pressure relief valve. The low pressure bore has a diameter of 1.75 inch (4.4 cm) and the high pressure bore has a diameter of 1 -inch (2.5 cm). The stroke of the cylinder is 1.50 inches (3.8 cm)

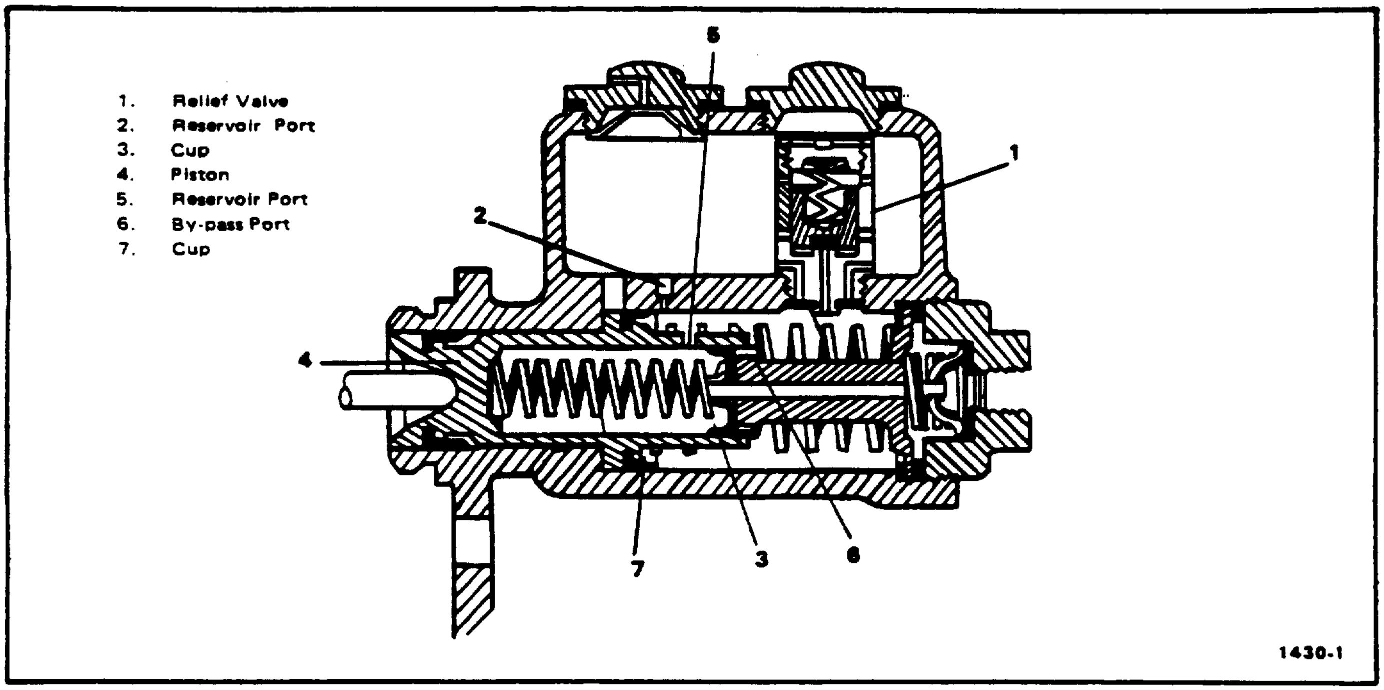
THEORY OF OPERATION

BRAKES COMPLETELY RELEASED.

With the brakes completely released, fluid is at reservoir pressure. Relief valve (1) is closed and reservoir ports (2) and (5) are open allowing fluid to pass freely.

Initial brake pedal movement carries the low pressure piston (4) forward closing reservoir ports (2) and (5). Cylinder displacement to the brake line is made up of the displacement of cup (7) in the low pressure chamber, and cup (3) in the high pressure chamber.

Fluid displaced by cup (7)travels through by-pass port (6) over cup (3) and into the brake lines. Relief valve (1) remains closed during this portion of the cylinder cycle.

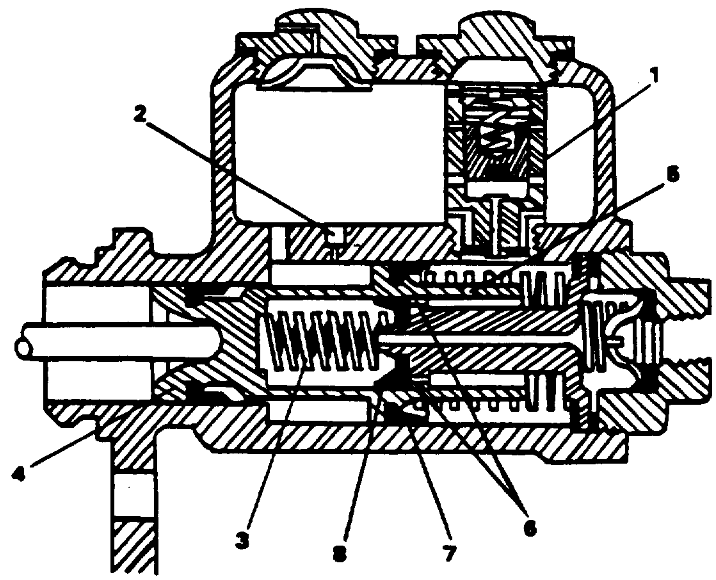


Brakes Completely Released

BRAKES FULLY APPLIED.

Displacement continues until the braking surfaces are in contact and a line pressure buildup occurs. When the line pressure reaches the pre-determined pressure setting of the relief valve (factory set). the relief valve opens allowing further displacement from cup (7) to flow directly into the reservoir. Cup (8) flares due to the pressure drop across it. and the cylinder displacement to the brake line is made up only of the displacement of cup (8). Line pressure is developed in relation to the diameter of cup (8), input force, and the pedal ratio used.

1. Relief Valve
2. Reservoir Port
3. Return Spring
4. Piston
5. Reservoir Port
6. By-pass Port
7. Cup
8. Cup



Brakes Fully Applied

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Slow pedal return-sticking piston.	a. Fluid return ports of the relief valve may have become plugged through entrance of foreign matter.	a. Remove relief valve and wash in alcohol. Clean the return ports by hand using a 0.0625 inch (1,58 mm) drill.
	b. Runout in O.D. and I.D. of low pressure pistons.	b. Replace defective component.
2. Brake drag or pressure build up.	a. No push rod end clearance.	a. Adjust the push rod to maintain a 0.0312 inch (0.792 mm) maximum clearance to the secondary piston contact when pedal is fully retracted.
	b. Incorrect fluid or oil in the fluid causing cups to swell and stick.	b. Disassemble cylinder and rebuild replacing all gaskets.
3. Pedal loss. (pedal too low before braking action starts.)	a. Too much clearance between push rod and piston. (pedal loss at the start of the stroke means loss at the end of the stroke where it is most important.)	a. Adjust push rod to maintain a 0.0312 inch (0.792 mm) maximum clearance to secondary piston contact when pedal is fully retracted.
	b. Faulty check valve.	b. If fluid drains from the end of the cylinder when the end plug is removed, the check valve is faulty and the cylinder should be replaced.
	c. Relief valve setting too low.	c. Refer to Appendix E, Relief Valve Adjustment, and adjust the relief valve.
	d. Relief valve setting too low.	d. Refer to Appendix E, Relief Valve Adjustment, and adjust the relief valve.

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Spongy pedal.	a. Air trapped in system.	a. Refer to HYDRAULIC BRAKES in Section 3 and bleed the brake system.
	b. High pressure leaks.	b. Check all fittings and joints for leakage while the system is under pressure. If the cylinder end plug leaks remove the line connections and tighten by turning clockwise.
	c. Loose wheel bearings. **NOTE** **If wheel bearings are loose. the relief valve will release the low pressure piston with its large volume displacement capacity before the wheel cylinders have centralized the drums. When this occurs, the high pressure piston falls short of the volume displacement capacity required.**	c. Refer to Appendix E, FRONT DRIVE AXLE, and adjust the wheel bearings.
	d. Incorrect anchor adjustment. If this condition exists, the relief valve will release and cause the same results as loose wheel bearings.	d. Refer to Appendix E, FRONT DRIVE AXLE, and adjust the anchor settings.
	e. Worn or cracked brake drums.	a. Replace drums. (lathe turning the drums will not correct drum stretching.)

ROCKWELL FSH HYDRAULIC BRAKES

DESCRIPTION

The brake is a floating shoe, hydraulic actuated brake, consisting of a backing plate assembly, wheel cylinder assembly, two brake shoe assemblies, two brake adjustment bolts, and shoe hold down spring assemblies.

Actuation permits the shoes to center themselves in the drum with equal effectiveness in either direction.

MAINTENANCE

DISASSEMBLY.

1. Refer to Chapter 3, Section 4 - FRONT DRIVE AXLE and remove the wheels.

CAUTION

DO NOT APPLY MORE THAN 20 LB FT (27 N•m) TORQUE TO THE HEADS OF THE ADJUSTMENT BOLTS. DO NOT USE A POWER WRENCH ON THE ADJUSTMENT BOLTS.

2. Remove the brake drums. If necessary, manually retract the brake shoes by rotating the adjustment bolts so that the brake drums will clear the linings. To retract each brake shoe, rotate the adjustment bolt heads 1/8 turn.

3. Release and remove the shoe return spring.

4. Push down on the shoe retainers so that the retainer nails can be reached with pliers. Hold the retainers so that they do not twist while rotating the nails 1/4 turn. Remove the retainers, springs, and retainer nails.

5. Remove the brake shoes.

6. If complete disassembly is necessary, disconnect the hydraulic line, remove the wheel cylinder attaching capscrews and wheel cylinder.

CLEANING AND INSPECTION.

Cleaning.

CAUTION

DO NOT USE CLEANING SOLVENTS ON THE HYDRAULIC SEALS, BOOTS, OR PISTONS. CLEANING SOLVENTS CAN DAMAGE THESE COMPONENTS. PROTECT THE BRAKE LINING FROM SOLVENTS, LUBRICANTS, RUST INHIBITORS, OR OTHER CONTAMINANTS THAT CHANGE THE FRICTION PROPERTIES OF THE LINING. CONTAMINATED LININGS MUST BE REPLACED.

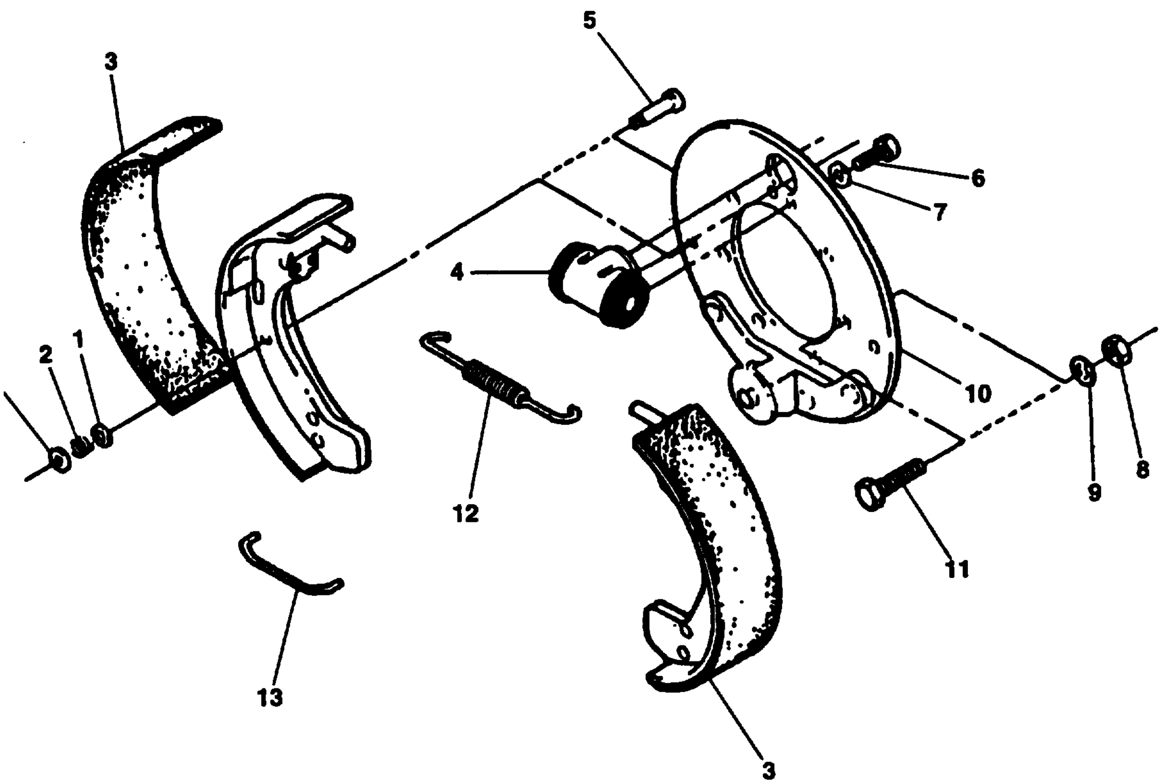
1. Using a cleaning solvent, clean ground or polished parts and surfaces. Kerosene or diesel fuel can be used for this purpose. do not use gasoline. Do not clean ground or polished parts in a hot solution tank or with water, steam, or alkaline solutions. These solutions will cause corrosion of the parts.

WARNING

USE CARE WHEN USING CLEANING SOLVENTS. FOLLOW THE INSTRUCTIONS SUPPLIED BY THE SOLVENTMANUFACTURERTO PREVENT INJURY.

WARNING

USE CARE WHEN USING HOT SOLUTION TANKS AND ALKALINE SOLUTIONS. FOLLOW THE INSTRUCTIONS SUPPLIED BY THE ALKALINE MANUFACTURER TO PREVENT INJURY.



1. RETAINER
2. SPRING
3. BRAKE SHOE SET
4. CYLINDER ASSY, WHEEL
5. PIN, STRAIGHT, HEAD
6. BOLT
7. WASHER, LOCK
8. NUT
9. WASHER, LOCK
10. PLATE
11. SCREW, CAP HEX HEAD
12. SPRING
13. CLIP, RETAINING

BRAKE ASSEMBLY

2. Rough parts can be cleaned with the ground or polished parts, or in hot solution tanks with a weak alkaline solution. Parts must remain in the hot solution tanks until they are completely cleaned and heated.

3. Parts must be dried immediately after they are cleaned with clean paper or rags, or compressed air.

NOTE

Wheel cylinders and cup seals must only be lubricated with the fluid used in the brake system. Cylinder boots must be kept dry.

4. To prevent corrosion and rust on cleaned parts, apply axle lubricant to the cleaned and dried metal parts that are not damaged and are to be immediately assembled. If parts are to be stored, apply a special material that prevents rust and corrosion to all surfaces.

Also, put a cover over the parts of a special paper or other material that prevents corrosion and rust.

Inspection.

It is important that all parts be carefully inspected before assembly. Check all parts for wear or damage and repair or replace them as required. Replacement of these parts now can prevent failure of the assembly later.

1. Check all castings and backing plates for cracks, loose rivets, and correct alignment. Replace all damaged parts.

2. Check all adjusting bolts, guide pins, and pawl pins for corrosion and wear. Replace or repair damaged parts.

3. Check brake shoes for rust, expanded rivet holes, broken welds and correct alignment. Replace damaged shoes.

4. Check anchors, anchor pins, and shoe bushings for wear or damage. Replace as necessary.

5. Replace all shoe return springs at time of brake overhaul.

6. Check the brake drums for cracks, severe heat checking, heat spotting, scoring, pitting, and distortion. Replace damaged brake drums.

7. Inspect the wheel cylinders for leaks and smooth action. Refer to WHEEL CYLINDER MAINTENANCE.

WHEEL CYLINDER MAINTENANCE.

When the brake shoes are replaced or a cylinder is leaking, check to see if the wheel cylinders need overhauling or replacing.

There are two types of wheel cylinder failures; leaks and poor cylinder action.

CAUTION

LEAKS WHICH COAT THE OUTSIDE OF THE BOOT AND CYLINDER WITH FLUID, CAUSE A DECREASE FLUID LEVEL IN THE RESERVOIR OR DAMPEN AND STAIN THE BRAKE LININGS ARE DANGEROUS. THESE LEAKS CAN CAUSE THE BRAKES TO GRAB OR FAIL AND MUST BE IMMEDIATELY CORRECTED. CONTAMINATED LININGS MUST BE REPLACED.

Cylinder leaks can be caused by:

a. Wrong type of brake fluid causing the seals to leak.

CAUTION

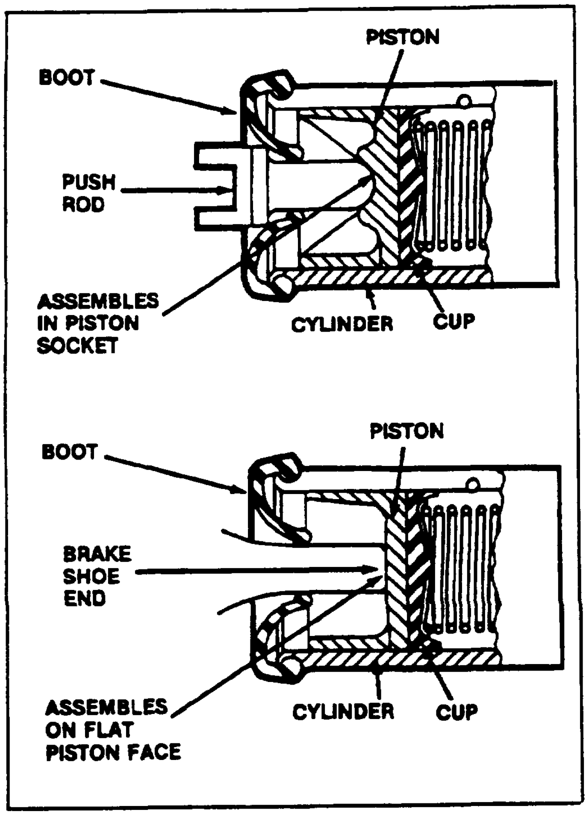
ENSURE THE CORRECT BRAKE FLUID AND SEALS ARE USED. THE USE OF THE WRONG BRAKE FLUID CAN DAMAGE THE CUP SEALS OF THE WHEEL CYLINDER. DIFFERENT TYPES OF BRAKE FLUID MUST NOT BE MIXED. REFER TO THE OPERATORS MANUAL, TM 10-3950-672-10 FOR CORRECT LUBRICATION.

b. Corrosion or damage on the surface of the cylinder bore.

c. Worn or oversize cylinder bore.

d. Damaged seal cups.

To find leaks that are not immediately visible, pull back the cylinder boot. A small amount of fluid on the inside of the boot is normal. Unless other conditions causing poor brake performance are known, the wheel cylinder must be checked.



Poor cylinder action can be caused by:

a. Corrosion or deposits in the cylinder bore.

b. Swollen cups caused by contaminated or wrong type of brake fluid.

c. Cups wedged into excessive clearance between the piston and the cylinder bore.

d. Wrong type of pistons for push rods or brake shoe ends.

Light corrosion or rough areas can be removed with crocus cloth or a cylinder hone. Use brake fluid as a lubricant when cleaning the cylinder. If the bore cannot be easily cleaned, the cylinder must be replaced.

NOTE

The wheel cylinder is a consumable part. No seal kit or other repair parts are available.

ASSEMBLY.

NOTE

Do not permit grease to come in contact with the brake drum or linings. Grease on the linings can cause poor brake performance. Contaminated linings must be replaced.

1. Before assembly, apply a thin layer of brake lubricant, NLGI Grade No.2, Rockwell specification 0-616 to the following parts:

a. The push rod ends of the shoes and cylinder.

b. Surfaces of the adjusting cams and the matching surfaces of the brake shoes.

c. Surfaces of the shoe support pads on the backing plate assembly and the ends of the shoe webs that slide against the anchor bracket.

2. Install the wheel cylinder to the backing plate.

Tighten the wheel cylinder attaching screw and capscrew 25 to 35 lb ft (34 to 48 N•m).

3. Connect the hydraulic line.

4. Install the brake shoes in position so that the push rod ends of the shoes are engaged with the wheel cylinder or push rods.

5. Assemble the retainer nails, springs, and retainers. Lock the nails in position by pushing down on the retainers while twisting the nails 1/4 turn with pliers.

6. To assemble the shoe return spring, put one hook in position in a brake shoe. Pull the spring open to install the opposite hook in the other shoe.

7. Assemble the retainer spring clip into the brake shoes.

8. Bleed the hydraulic system after all the brakes are assembled and perform a brake adjustment. Refer to Section 3.

HOIST MOTOR CONTROL VALVE (GROVE 15B HOIST)

DESCRIPTION

The hoist motor control valve is designed to provide an even flow of oil to the hoist motor in both directions.

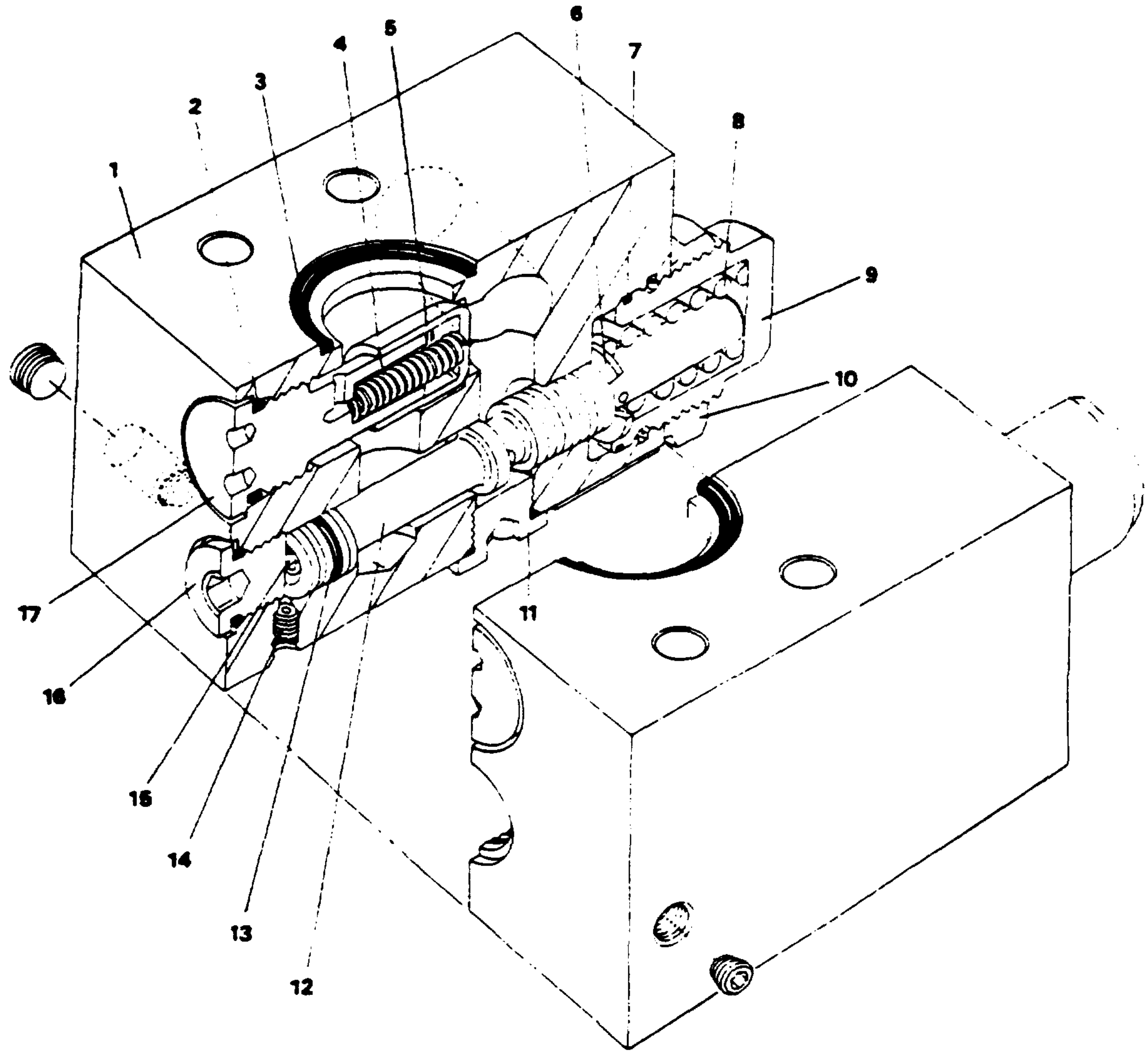
To drive the hoist motor in the raise direction, hydraulic oil flows through the in port and pushes the free flow poppet off its seat. The oil then flows to the out port and on to the hoist drive motor.

When driving the hoist motor in the lower direction. oil from the directional control valve enters the out port. The pilot operated poppet is held shut by the adjustment spring until pilot pressure of sufficient force is sensed at the pilot pressure port to move the pilot operated poppet off its seat.

This allows flow to the return reservoir through the directional control valve.

An orifice plug is installed in the pilot pressure port to restrict back flow when the directional control valve is closed. The restriction prevents the pilot operated poppet from chattering on its seat.

A vent is provided that vents the area between the pilot piston seal and the free flow poppet and pilot operated poppet seals to prevent a hydraulic lock should weepage around the seals occur.



1.	Body	7.	O-Ring	13.	O-Ring
2.	O-Ring	8.	Spring	14.	Orifice
3.	O-Ring	9.	Adjusting Spring	15.	Plug
4.	Spring	10.	Nut	16.	Plug
5.	Poppet	11.	Plug	17.	Plug
6.	Washer	12.	Spool		

MAINTENANCE

DISASSEMBLY.

1. Remove O-ring (3) from the valve body (1).

2. Remove the plug (17) and O-ring (2), spring (4), and poppet (5) from the valve body.

3. Remove nut (10),. spring (8), O-ring (7), and washer (5) from the valve body.

4. Remove the spool (12) from the valve body. Remove the O-ring (13) from the spool. Remove plug (15) from the spool.

5. Remove plug (11) and orifice (14).

6. Remove plug (16) and O-ring. Remove all of the remaining plugs from the valve body.

CLEANING AND INSPECTION.

1. Clean all parts in a suitable solvent and dry with air.

2. Inspect the spool and poppet for nicks and scratches. Minor nicks and scratches may be removed with crocus cloth.

ASSEMBLY.

NOTE

It is recommended O-rings be replaced with new O-rings at assembly.

1. Prior to assembly coat all parts with clean hydraulic oil.

2. Install O-ring and plug (16) into the valve body.

3. Install plug (11) and orifice (14).

4. Install plug (15) and O-ring (13) into the spool (12). Install spool (12) into the valve body.

5. Install washer (6) onto the spool. Install the O-ring onto plug (9).

6. Install spring (8) and secure to the spool with plug (9).

7. Install poppet (5), spring (4), O-ring (2), and plug (17) into the valve body.

8. Install the remaining plugs into the valve body.

PILOT OPERATED CHECK VALVE

DESCRIPTION

The pilot operated check valve is usually located in the port block on the outrigger stabilizer cylinder. The valve is normally closed and is opened by pilot pressure.

MAINTENANCE

DISASSEMBLY.

1. Remove the backup rings (13 and 15) and 0rings (2, 4, and 11) from the body (1).

2. Remove the bottom plug from the body (1), remove the O-ring (16), orifice (18), O-ring (17),-piston (14), spring (3), piston (19), and stem (20).

NOTE

Some valves will not have a seal ring (24) or a retaining ring (25).

3. Remove the plug (8), O-ring (7), springs (6 and 10), spring end (9), ball (5), poppet (12), seal ring (24), and retaining ring (25).

CLEANING AND INSPECTION.

1. Clean all parts with solvent and dry with compressed air. Check all parts for serviceability.

ASSEMBLY.

NOTE

Coat all parts with clean hydraulic oil prior to assembly. It is recommended O-rings and backup rings be replaced at assembly.

1. Install the stem (20), piston (14), spring (3), piston (19), O-ring (17), orifice (18) into the bottom of the valve.

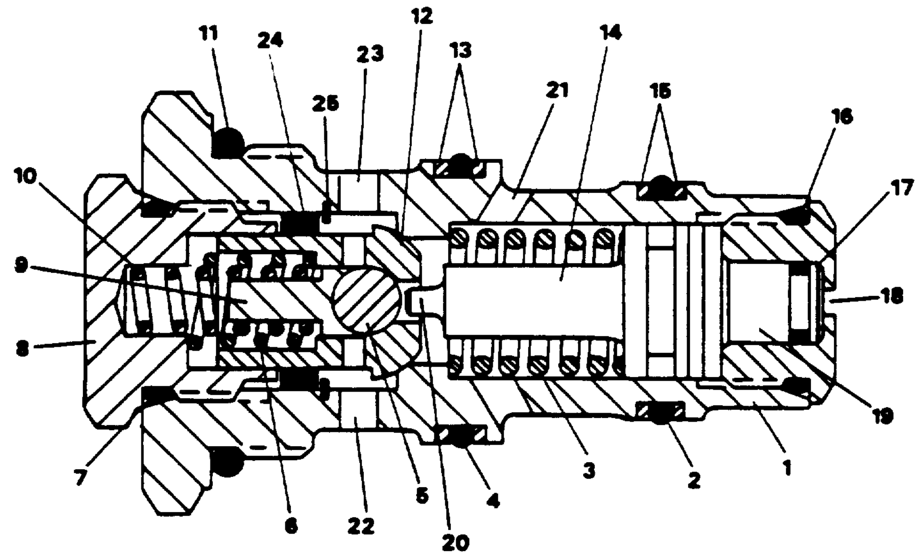
2. Install O-ring (16) onto the bottom plug. Install the plug into the valve.

3. Install the poppet (12), ball (5), spring end (9), and springs (6 and 10) into the top of the valve.

4. Install the O-ring (7) and plug (8) into the body (1).

5. Install the O-ring (11) onto the body (1).

6. Install the O-rings (2 and 4) and backup rings (13 and 15) onto the body (1).



1.	Body	9.	Spring End	17.	O-Ring
2.	O-Ring	10.	Spring	18.	Orifice
3.	Spring	11.	O-Ring	19.	Piston
4.	O-Ring	12.	Poppet	20.	Stem
5.	Ball	13.	Backup Ring	21.	Port A
6.	Spring	14.	Piston	22.	Port B
7.	O-Ring	15.	Backup Ring	23.	Port C
8.	Plug	16.	O-Ring	24.	Seal Ring
				25.	Retaining Ring

1143

Pilot Operated Check Valve

HOLDING VALVE

DESCRIPTION

The holding valve is ported to allow hydraulic flow in two directions. To raise a load, the oil must unseat the free flow poppet valve. In this case, oil pressure must overcome the main poppet spring. To do this, the oil flows through the oil ports of the pilot release poppet valve which applies pressure to the inside face of the free flow poppet. When the main poppet unseats, the oil flows past the main poppet seat to the component to be worked.

When a load is to be lowered, as in retracting the boom, better control is necessary because of the weight of the load. For this reason a pilot pressure is used for positioning the main poppet valve which is being held against its seat by heavy springs. The pilot pressure is sensed from the lowering side of the hydraulic circuit. As the directional control valve is opened to the lower position, pressure is applied to the pilot piston. The pilot piston moves against the pilot release poppet until it unseats the pilot release poppet valve which port oil to the return side of the directional control valve.

The free flow check valve is provided for venting the pressure side of the pilot piston.

A vent is provided for venting the area between the pilot piston O-rings should weepage occur. A second vent is provided at the adjustment end of the pilot release poppet valve should weepage occur past the O-ring seal into the spring area.

MAINTENANCE

DISASSEMBLY.

NOTE

Do not remove the allen head plug on the top end of the holding valve.

1. Remove the adjusting stem assembly from the valve by turning the nut counterclockwise.

2. Remove the stem, spring, and spool from the valve.

3. Remove the plug from the base of the valve.

4. Remove all O-rings and backup rings from the valve assembly.

CLEANING AND INSPECTION.

1. Clean all parts in solvent and dry with air.

ASSEMBLY.

NOTE

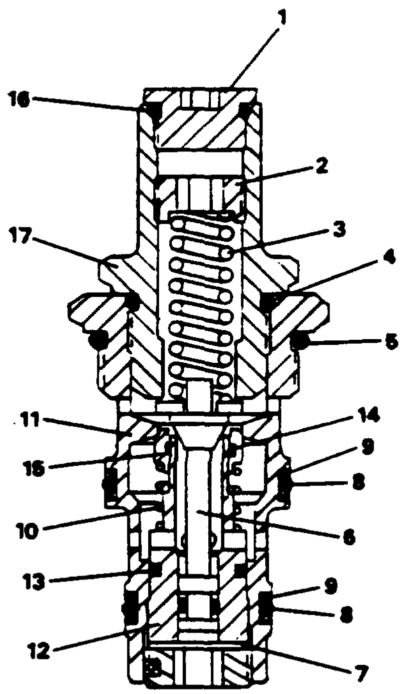
It is recommended that all O-rings and backup rings be replaced at assembly with new parts.

1. Install all O-rings and backup rings onto the valve and lubricate with clean hydraulic oil prior to assembly.

2. Install the plug in the base of the valve.

3. Install the spool, spring, and stem into the valve body.

4. Install the O-ring onto the adjusting stem assembly. Coat the O-ring with clean hydraulic oil and install the adjusting stem assembly into the valve body.



1. Plug
2. Adjusting Screw
3. Spring
4. O-Ring
5. O-Ring
6. Spool
7. Orifice
8. O-Ring
9. Backup Ring
10. Spring
11. Body
12. Poppet
13. O-Ring
14. O-Ring
15. Backup Ring
16. O-Ring

1144

Holding Valve

HOLDING VALVE

DESCRIPTION

The holding valve is ported to allow hydraulic flow in two directions. To raise a load, the oil must unseat the free flow poppet valve. In this case, oil pressure must overcome the main poppet spring. To do this, the oil flows through the oil ports of the pilot release poppet valve which applies pressure to the inside face of the free flow poppet. When the main poppet unseats, the oil flows past the main poppet seat to the component to be worked.

When a load is to be lowered, as in retracting the boom, better control is necessary because of the weight of the load. For this reason a pilot pressure is used for positioning the main poppet valve which is being held against its seat by heavy springs. The pilot pressure is sensed from the lowering side of the hydraulic circuit. As the directional control valve is opened to the lower position, pressure is applied to the pilot piston. The pilot piston moves against the pilot release poppet until it unseats the pilot release poppet valve which port oil to the return side of the directional control valve.

The free flow check valve is provided for venting the pressure side of the pilot piston.

A vent is provided for venting the area between the pilot piston O-rings should weepage occur. A second vent is provided at the adjustment end of the pilot release poppet valve should weepage occur past the O-ring seal into the spring area.

MAINTENANCE

DISASSEMBLY.

NOTE

Do not remove the adjustment stem or locknut during disassembly.

1. Remove the adjustment end of the valve by turning the large nut counterclockwise. Do not remove the adjusting stem.

2. Remove the O-ring from the nut

3. Remove the valve spring and seats.

4. Remove the inner sleeve from the valve.

5. Remove the plug from the inner sleeve. Remove the spring and ball.

6. Remove the O-rings and backup rings from the valve.

ASSEMBLY.

NOTE

It is recommended that all O-rings and backup rings be replaced with new parts at assembly.

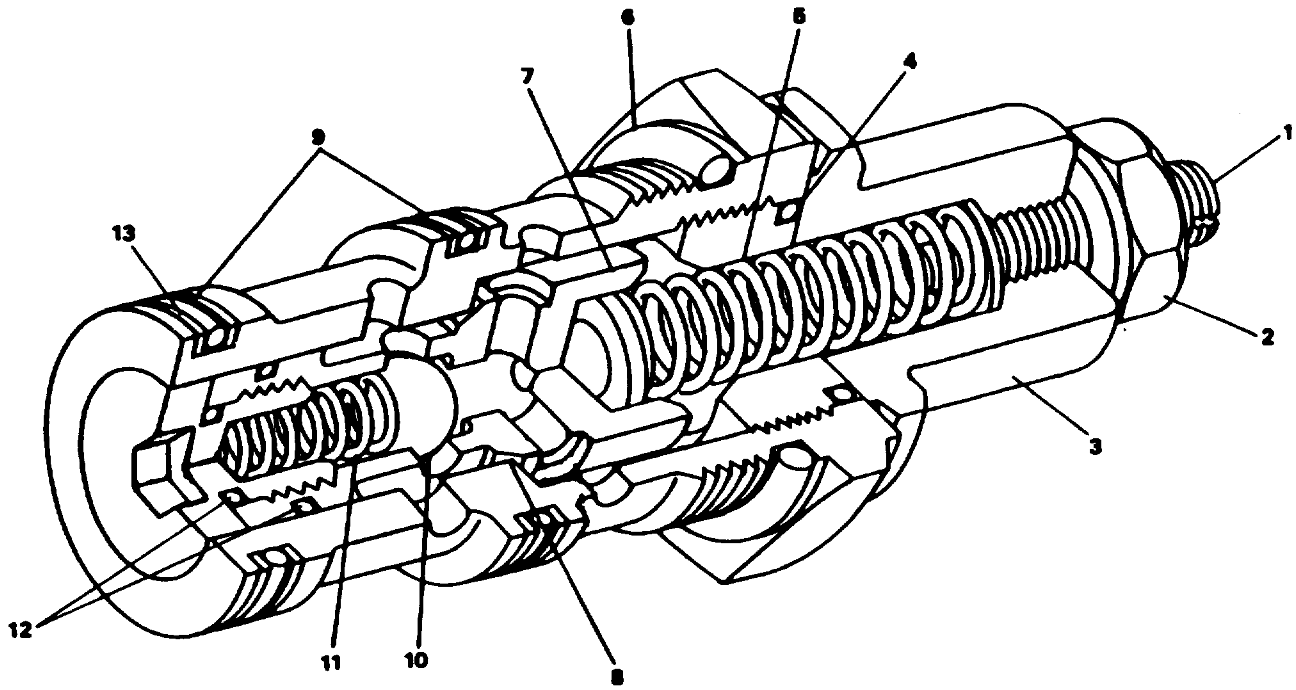
1. Install all backup rings and O-rings onto the valve.

2. Install the ball and spring into the sleeve and secure with the plug.

3. Coat the sleeve with clean hydraulic oil and install the sleeve into the valve.

4. Install the valve seats and spring into the valve body.

5. Install the O-ring onto the adjustment end nut and install the adjusting stem into the valve.



1.	Adjustment Nut	7.	Spring Guide
2.	Jam Nut	8.	Poppet
3.	Plug	9.	O-Ring
4.	O-Ring	10.	Check Ball
5.	Spring	11.	Spring
6.	O-Ring	12.	O-Ring
		13.	Backup Ring

HYDRAULIC PUMP

DESCRIPTION

The hydraulic pump is a two section gear type pump mounted on and driven by the engine through an adapter and/or coupler on the crankshaft.

MAINTENANCE

DISASSEMBLY.

NOTE

Any maintenance requiring disassembly of the pump should include replacement of seals and plates.

1. Clean the outside of the pump thoroughly and disassemble in a clean work area.

2. Scribe a line the entire length of the outside of the pump to aid in assembly.

3. Clamp the pump in a vise with the shaft down.

4. Remove the bolts (18) and washers (17) from the cover (16). Remove the cover (16).

5. Remove the gasket (11) and dowel pins (12) from the cover (16).

6. Remove the thrust plate (10).

7. Remove the drive gear (14) and driven gear (1 5) and keep them together as a set.

8. Remove the wear plate (7), spacer (6), and seal (5).

9. Remove the bolts (1) and washers (2) from the front housing (4).

10. Remove the rear housing (13).

11. Remove the dowel pins (12) and gasket (11) from the housing (13).

12. Remove the thrust plate (10).

13. Remove the drive gear (8) and driven gear (9) and keep them together as a set.

14. Remove the shaft seal (3).

15. Remove the wear plate (7), spacer (6), and seal (5).

INSPECTION.

1. Inspect the components for sharp edges, roughness, nicks, and burrs. If any areas are not smooth, polish with a fine crocus cloth. If components show unusual wear, replace the entire pump.

2. Replace all seals and plates.

ASSEMBLY.

NOTE

Lubricate all internal components and the lips of the shaft seal before assembly.

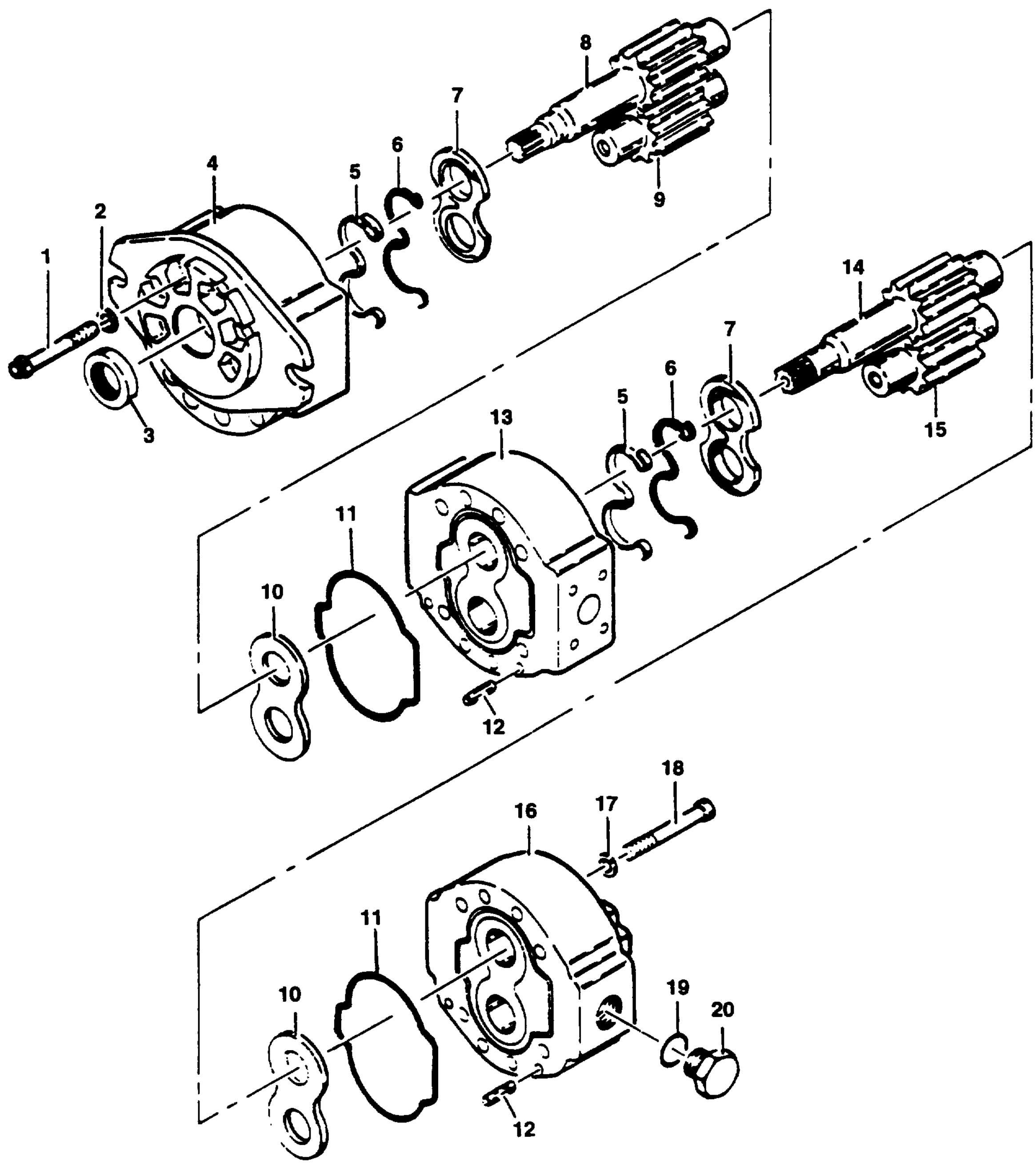
1. Install the shaft seal (3) into the front housing (4) to a depth of 1/4-inch from the pilot face.

NOTE

Do not push the pressure seal (5) to the bottom of the groove. The seal must be in the wear plate groove and stick above the plate surface 0.005 inch (0.127 mm) minimum.

2. Invert the housing (4) with the bores facing up and install the wear plate (7), spacer (6), and pressure seal (5), into the bottom of the gear pocket in the

1. Bolt
2. Washer
3. Shaft Seal
4. Front Housing
5. Pressure Seal
6. Spacer
7. Wear Plate
8. Drive Gear
9. Driven Gear
10. Thrust Plate
11. Gasket
12. Dowel Pin
13. Rear Housing
14. Drive Gear
15. Driven Gear
16. Cover
17. Washer
18. Bolt
19. O-Ring
20. Plug



housing. Ensure the pressure seal (5) is installed with the flat face down and the legs of the seal toward the inlet of the pump.

3. Install the drive gear (8) through the shaft seal (3) being careful not to cut the shaft seal.

4. Install the driven gear (9), with the short journal up.

5. Install the thrust plate (10) toward the gears.

6. Install two dowel pins (12) and the gasket (11) in the housing (4) groove.

7. Install the rear housing (13) over the dowel pins (12) in the front housing (4).

8. Follow the procedure in the note preceding step 2 and the procedure in step 2 and install the second wear plate (7), spacer (6), and pressure seal (5).

9. Install the drive gear (14) and driven gear (15) with the short journal up on the driven gear.

10. Install the second thrust plate (10).

11. Install two dowel pins (12) and the second gasket (11) into the cover (16).

12. Install the cover (16) and secure with the bolts (18) and washers (17).

13. Invert the assembly and install the bolts (1) and washers (2) in the front housing (4). Torque the bolts 28 to 35 lb ft (38 to 47 Nom).

14. Rotate the pump shaft by hand or with pliers. The pump will have a small amount of drag, but should turn freely after a short period of use.

CROSSOVER RELIEF VALVE

DESCRIPTION

The crossover relief valve with shuttle valve is designed to protect the system from excessive pressure buildup and to maintain a given pressure in the system. The crossover relief valve relieves surge pressure in the swing circuit that could occur if the motor is suddenly stopped. It also provides for smooth starting and stopping of the swing motor. The valve consists of a drilled and ported block with two relief valves and two check valves with orifice plugs installed in the block. The relief valves relieve pressure from one line to the other and therefore there is no connection to the reservoir.

MAINTENANCE

NOTE

Repair is limited to the replacement of the defective components.

DISASSEMBLY.

1. Remove the relief valve cartridges from the valve body.

2. Remove and discard the O-rings and backup rings from the relief valves.

3. Remove the check valves from the valve body.

4. Remove and discard the O-rings from the check valves.

CLEANING AND INSPECTION.

1. Clean all parts with solvent and dry with compressed air. Check all parts for serviceability.

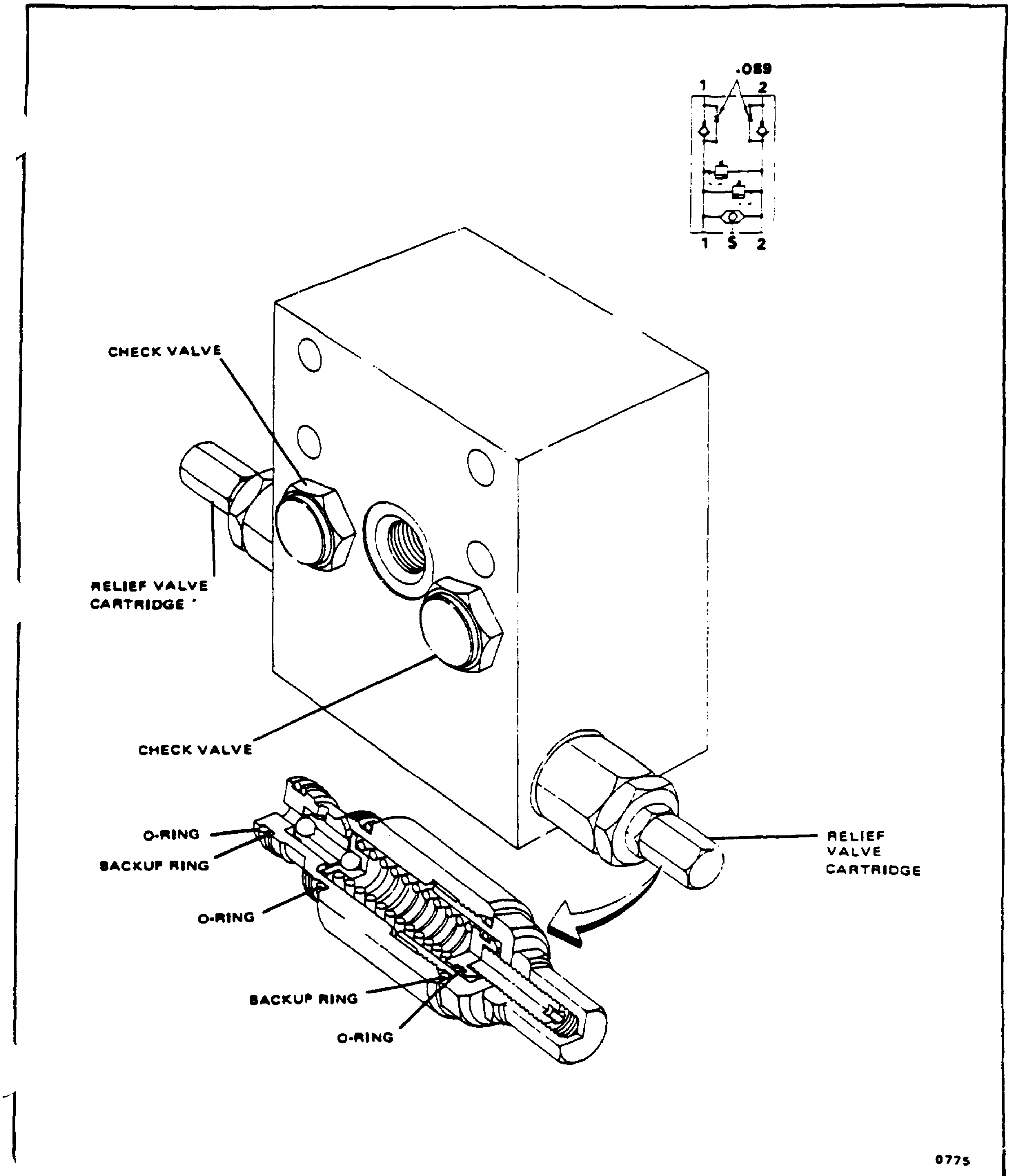
ASSEMBLY.

1. Install new O-rings onto the check valves.

2. Install the check valves into the valve body.

3. Install new O-rings and backup rings onto the relief valve cartridges.

4. Install the relief valve cartridges into the valve body.



Crossover Relief Valve

SOLENOID VALVE

DESCRIPTION

The two-way solenoid valve is a normally closed valve with an electrical coil which when energized, shifts the cartridge in the valve body to align the ports in the valve. This alignment of ports routes the hydraulic flow in the desired direction.

MAINTENANCE

NOTE

Repair is limited to the replacement of the defective components.

DISASSEMBLY.

1. Remove the cartridge solenoid valve(s) from the valve body.

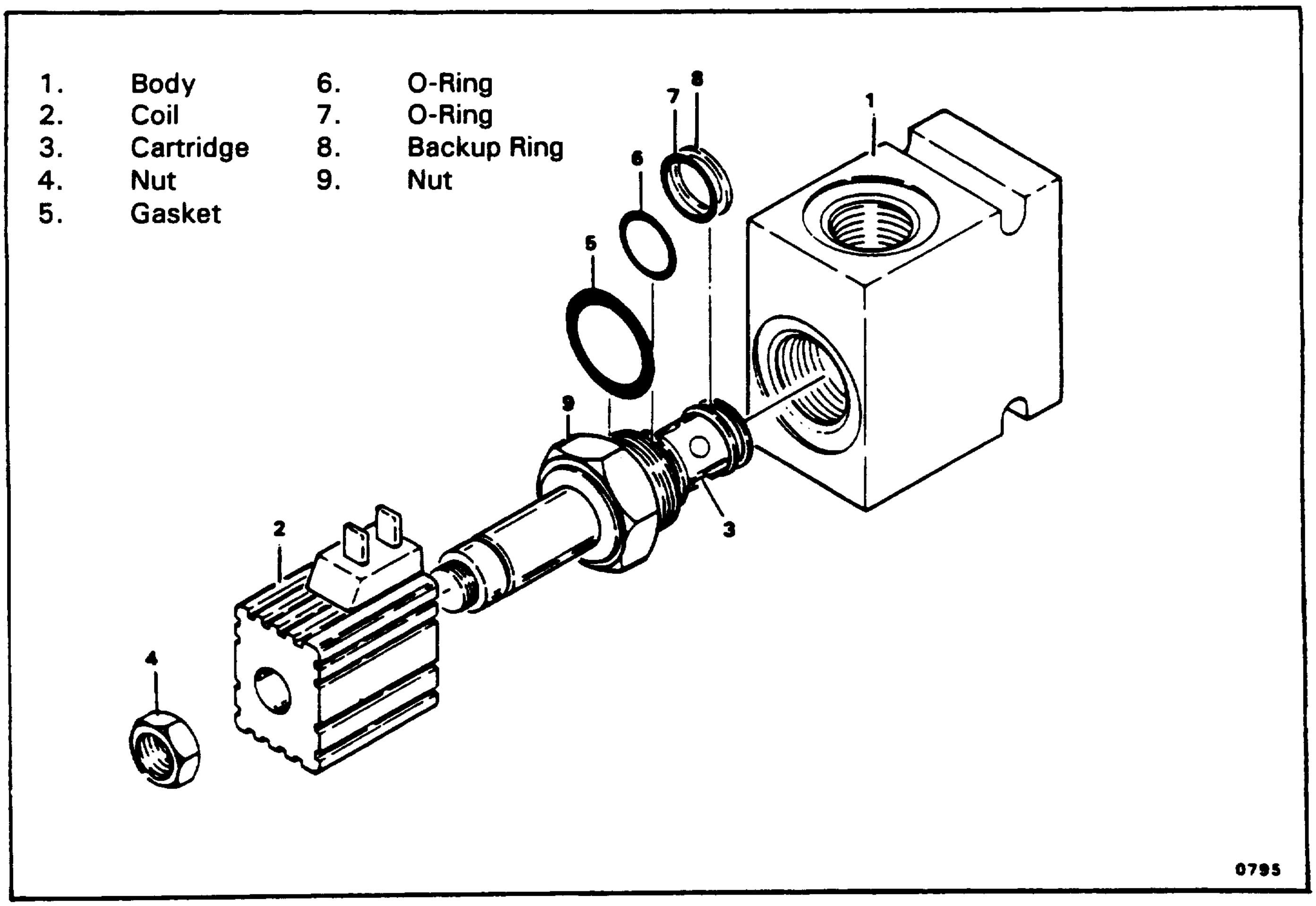
2. Remove and discard the O-rings from the valve.

ASSEMBLY.

1. Install new O-rings onto the valve.

2. Install the cartridge solenoid valve(s) into the valve body. Torque the valve 450 to 500 lb in. (51 to 57 N•m).

3. If the jam nut on the solenoid was loosened, torque the jam nut 120 to 140 lb in. (14 to 16 N•m).



2-Way Solenoid Valve - Exploded View

DIRECTIONAL CONTROL VALVE

DESCRIPTION

The directional control valves are four-way, three position valves with either an open or closed spool. Whether a valve has an open or closed spool is determined by whether, with the spool in the neutral position, the work ports are open to the reservoir return passage. If the work ports are open to the reservoir return passage the valve is classified as an open spool type: if they are not, the valve is a closed spool type. Additionally, the valve spool is spring loaded to the neutral position.

The open spool directional control valve is constructed with a through passage to allow flow to pass to the next valve(s) in the bank and on to the reservoir, when the valve spool is in the neutral position. By positioning the valve spool to a work position, the through passage is blocked and flow is diverted to the dead end parallel passage. This causes flow to be directed to the component's open supply work port. Return flow is routed from the return work port to the reservoir return passage by the opposite end of the valve spool This flow pattern is applicable in either direction the valve may be positioned. If it is necessary to open more than one directional control valve in the same valve bank, it may be required to partially close or feather the valves that are located in the bank first, in regards to flow from the pump, in order to provide sufficient flow to the valves located last in the bank.

The closed spool directional control valve functions basically the same way as the open spool directional control valve in that the through passage of the valve must be blocked off by the valves' spool to divert flow to the dead end parallel passage. With flow diverted to the parallel passage, pressure then must unseat the load check valve to allow the flow to reach the open work port. The load check valve is provided to prevent back sliding of components which support heavy loads as is evidenced by the circuits this valve is used in. Return flow from the component is through the return work port to the reservoir return passage.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Sticking spool.	a. Excessively high oil temperature.	a. Eliminate any restriction in pipe line or filtering system.
	b. Dirt in oil.	b. Change oil and flush system.
	c. Pipe fittings too tight.	c. Check torque. Retorque as necessary.
	d. Valve warped from mounting.	d. Loosen valve and check.
	e. Excessively high pressure in valve. (Relief valve notworking properly).	e. Check pressure at inlet and at working ports.
	f. Handle or linkage binding.	f. Free linkage.
	g. Return spring damaged or broken.	9. Replace faulty parts.
	h. Spring or valve cap binding.	h. Loosen cap and retighten.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Leaking seals.	a. Paint or dirt on or under seal.	a. Remove and clean, as necessary.
	b. Excessive back pressure.	b. Open or enlarge line to reservoir.
	c. Scored spool.	c. Replace valve.
	d. Cut or scored seal.	d. Replace faulty parts.
3. Unable to move spool in or out.	a. Dirt in valve.	a. Clean and flush out valve assembly.
	b. Spool cap full of oil.	b. Replace seals.
	c. Bind in linkage.	c. Free linkage.
4. Poor hydraulic system performance or failure.	a. Damaged pump.	a. Repair or replace pump.
	b. Dirt in relief valve.	b. Disassemble and clean relief valve.
	c. Relief valve damaged.	c. Replace relief valve.
	d. Worn cylinder(s) or motor(s).	d. Repair or replace damaged components.
	e. Load too heavy.	e. Reduce load. (Refer to load chart for rated capacities).
	f. Internal valve crack.	f. Replace valve.
	g. Spool not at full stroke.	g. Check movement and linkage.
	h. Oil low in reservoir.	h. Add oil. Fill to FULL mark on sight gauge.
	i. System filter clogged.	i. Clean or replace filter element.
	j. Line restricted.	j. Check lines. Clean or repair as necessary.

DISASSEMBLY.

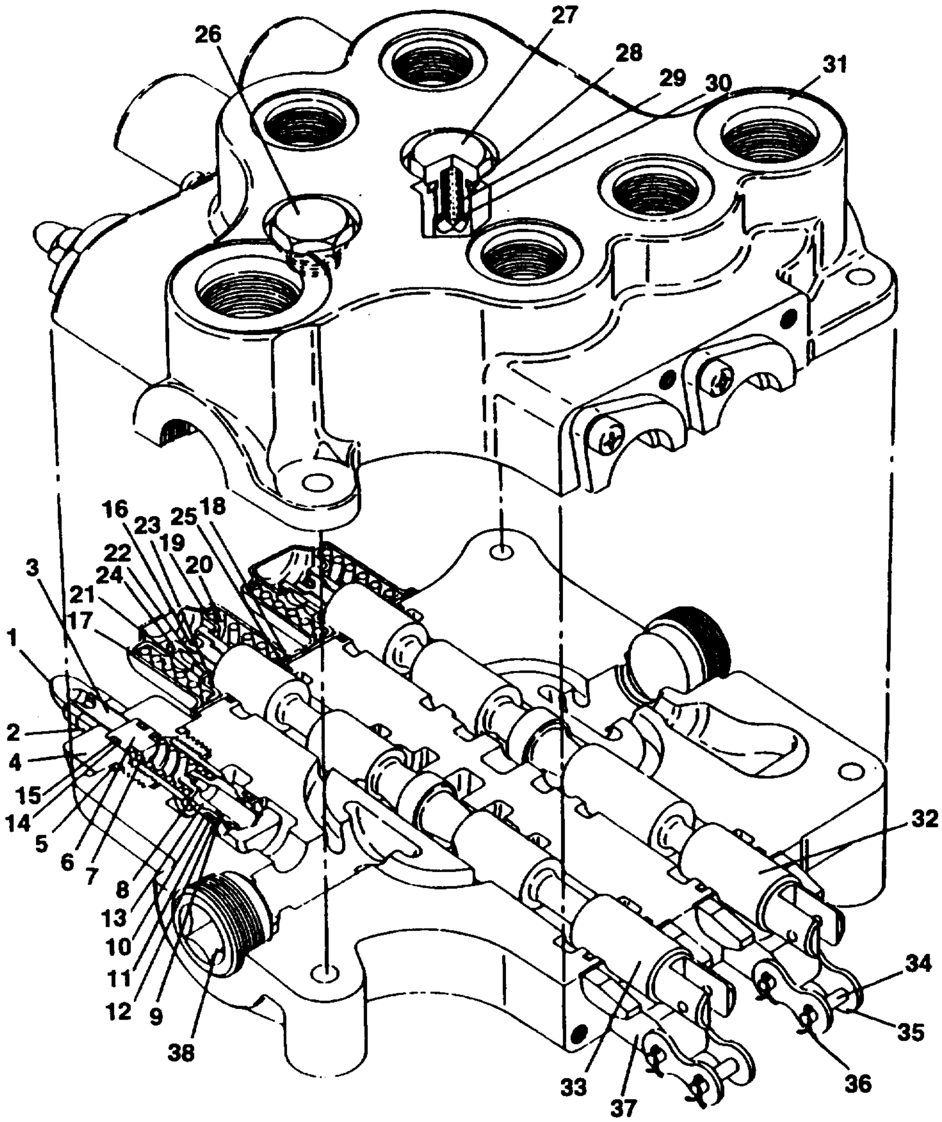
CAUTION

USE CARE WHEN HANDLING THE VALVE HOUSING TO AVOID DAMAGING THE FACES OR O-RING GROOVES.

1. Remove the nuts and relief cap and remove the relief valve from the valve bank. Discard the O-rings.

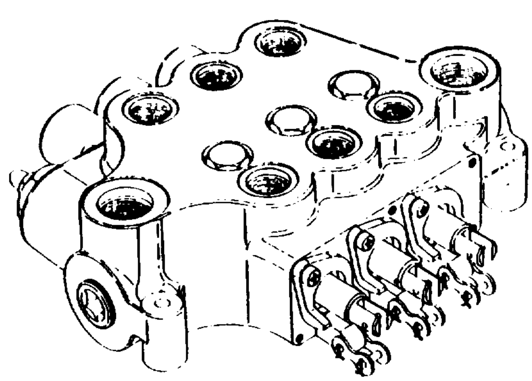
2. Remove the screws securing the end caps. Remove the end caps and centering springs.

3. Remove the holding check valve from the housing. Discard the O-ring.



2 BANK ASSEMBLY

1. Acorn Nut
2. Jam Nut
3. Screw
4. Relief Valve w/Cap
5. O-Ring
6. Follower
7. Spring
8. Poppet
9. Slipper Seal
10. Backup Ring
11. Seal
12. Backup Ring
13. Relief Barrel
14. Backup Ring
15. Seal
16. Screw
17. End Cap
18. Retaining Plate
19. Collar
20. Spring
21. Collar
22. Collar Stop
23. Spacer
24. Spring Retainer
25. Spool Seal
26. Check Plug
27. Holding Check
28. O-Ring
29. Check Spring
30. Poppet
31. Housing
32. Spool
33. Spool
34. Pin
35. Connecting Plate
36. Cotter Pin
37. Bracket
38. Plug



3 BANK ASSEMBLY

Directional Control valve

4. Remove the plugs from the unused ports.

ASSEMBLY.

CAUTION

INSTALL NEW O-RINGS AND SEALS ON OR IN ALL COMPONENT PARTS. COAT O-RINGS AND SEALS WITH CLEAN HYDRAULIC FLUID PRIOR TO ASSEMBLY.

1. Remove any burrs from the face of the housing and ensure all mating surfaces are clean.

2. Install the plugs in the unused ports.

3. Install a new O-ring and the holding check valve into the valve housing.

4. Install the centering springs and end caps and secure with the screws.

5. Install new O-rings and the relief valve into the valve body. Install the relief cap and nuts.

SWING MOTOR

DESCRIPTION

The swing motor is a hydraulic gerotor type with low speed and high torque characteristics. It has only three moving parts, the commutator valve, the drive, and the gerotor star. The motor has two ports for connection to the hydraulic system.

MAINTENANCE

NOTE

The swing motor shown is typical of all swing motors, however a splined output shaft is used instead of a keyed output shaft.

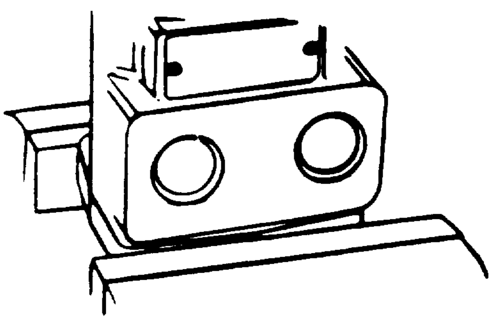
NOTE

The swing motor shown is typical of all swing motors. however, a drive spacer may or may not be installed.

DISASSEMBLY.

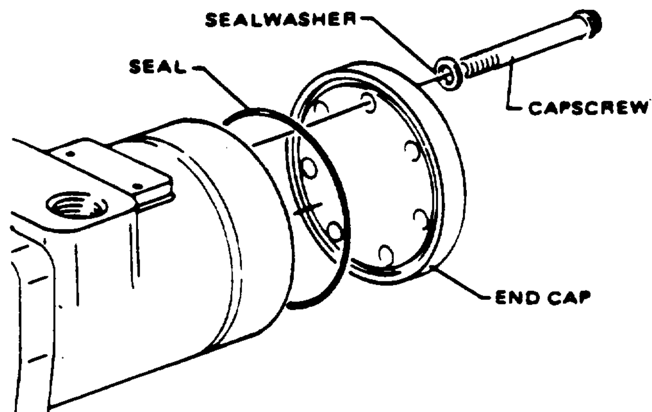
NOTE

It is recommended that the motor be kept in a vise during disassembly.



2187-1

1. Place the motor in a vise and clamp across the edge of the flange with the output shaft down. When clamping use a protective device on the vise, such as special soft jaws or pieces of hard rubber or board.

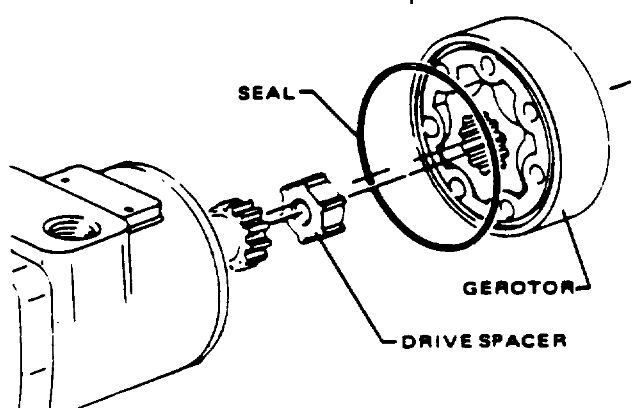


2187-2

2. Remove the capscrews and sealwashers.

3. Remove the end cap.

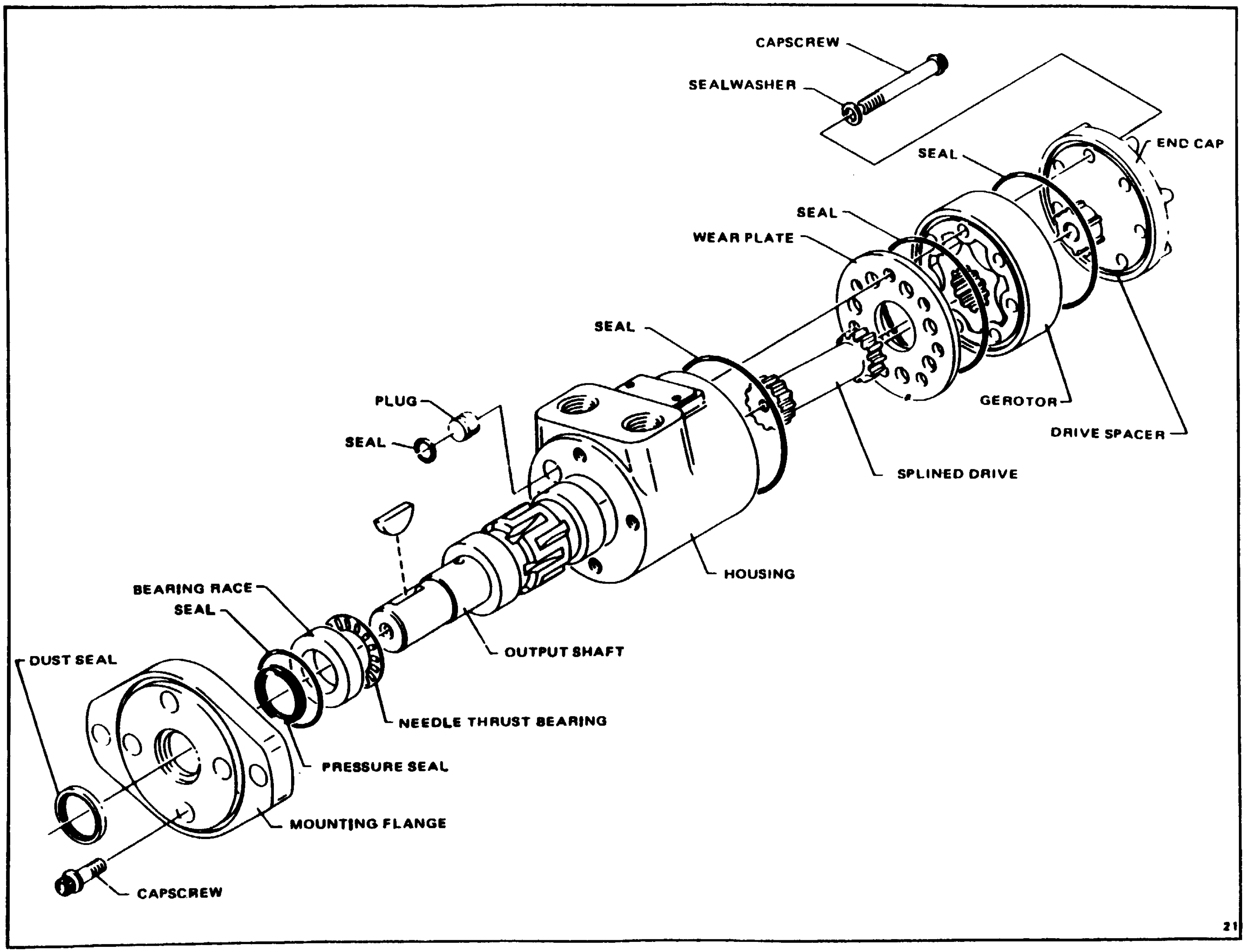
4. Remove the seal from the end cap.



2187-3

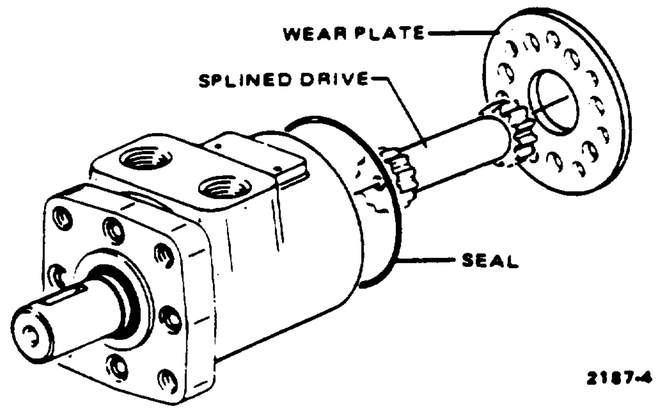
5. Remove the gerotor.

6. Remove the seal from the gerotor.



Swing Motor - Exploded View

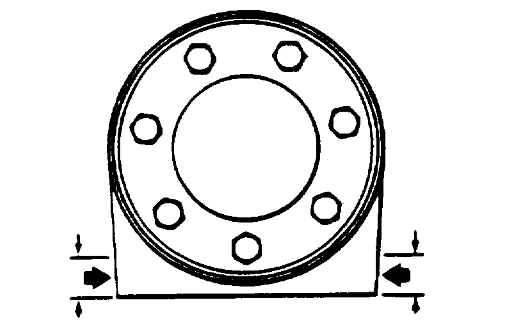
7. Remove the drive spacer.

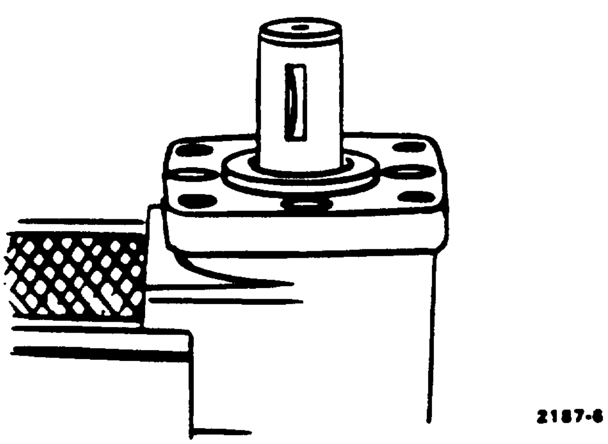


8. Remove the splined drive.

9. Remove the wear plate.

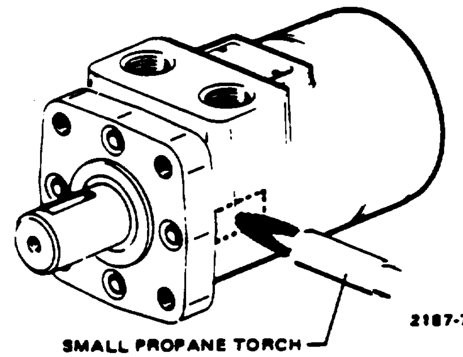
10. Remove the seal from the housing.

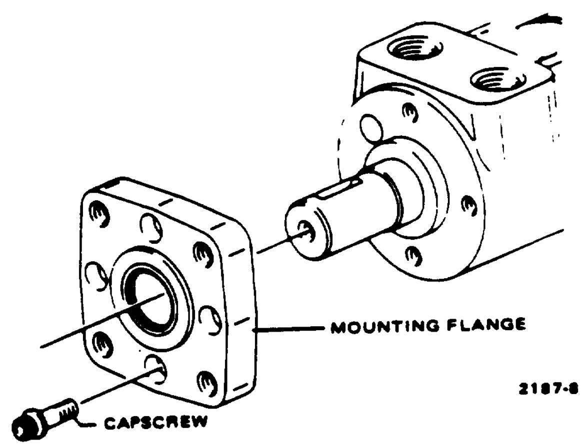




11. Reposition the motor in the vise, clamping across the ports as shown above, not on the housing. Excessive clamping pressure on the housing causes distortion.

12. Remove the 4 capscrews from the mounting flange. These motors are assembled using Loctite on the screws to hold them in place. The screws will require approximately 300 to 400 lb in. (34 to 45 Nom) of torque to break loose and approximately 100 lb In. (11 N•m) torque to remove after they are broken loose. Do not use an impact wrench on screws held with Loctite, this may result In rounded heads or broken sockets. If It requires more than 400 lb In. (45 N•m) to remove the capscrews, proceed to step 13, otherwise, proceed to step 14.



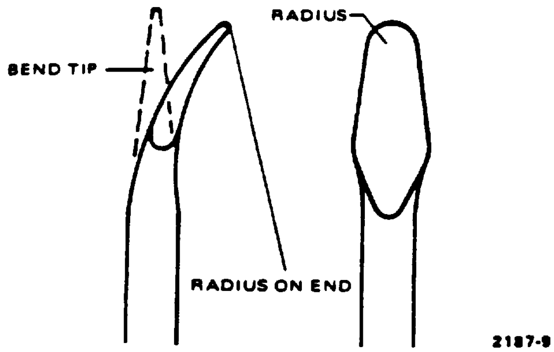


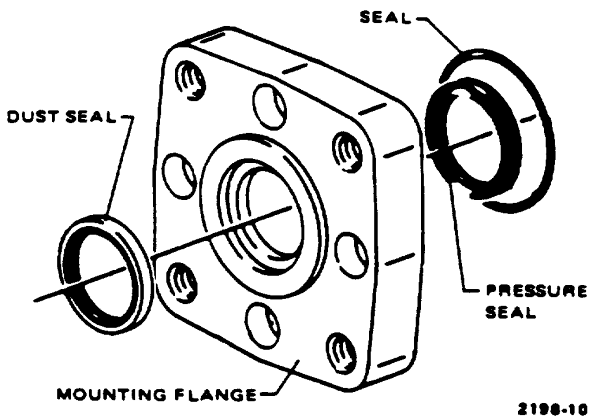
CAUTION

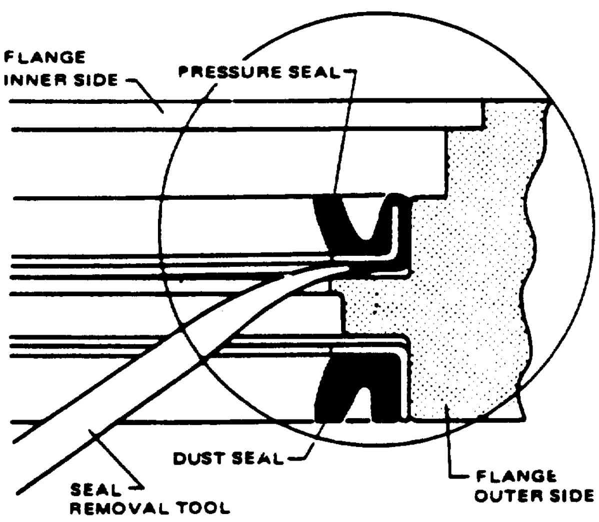
BE CAR EFUL NOTTO OVERHEAT AND DAMAGE THE MOTOR.

13. Use a small flame propane torch to heat a small area of the housing where the screw enters (see the figure above). Apply torque to the capscrew with a socket wrench gradually as heat is applied for 8 to 10 seconds. As soon as the screw breaks loose, remove the heat from the housing, and continue turning the screw until it is completely removed.

14. Remove the motor from the vise and place it on a clean flat surface. Carefully remove the flange from the housing.



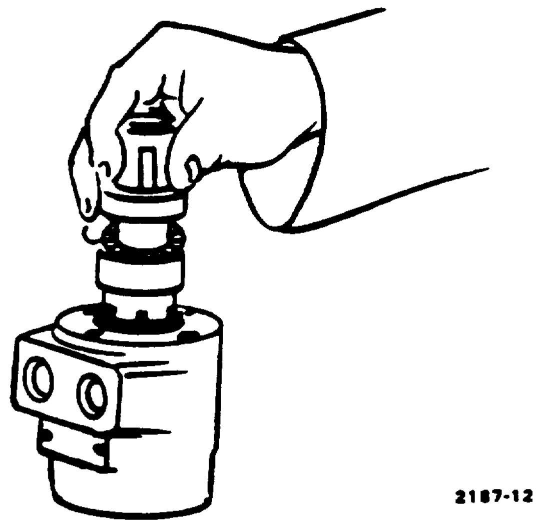




NOTE

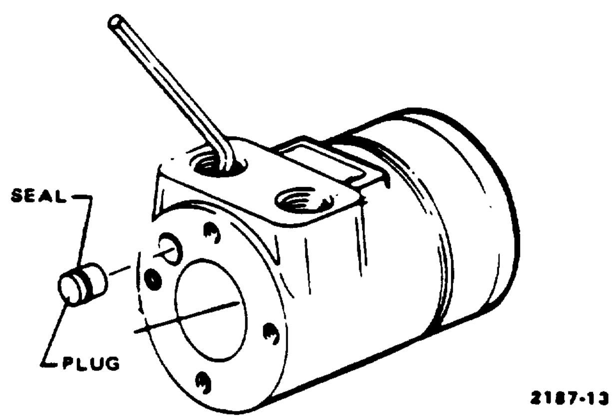
The dust seal, pressure seals, and seal will come off with the flange.

15. Use a seal remover tool, like the one shown above to remove the dust seal and pressure seal. Work from the outer side to remove each seal. Work the nose of the tool between the pressure seal and the flange. Pry the seal partway. Remove the tool and repeat at a point 180 degrees away. Push the seal completely out of the cavity.



16. Remove the output shaft from the housing.

17. Remove the bearing race and needle thrust bearing from the shaft.



18. A metal plug and seal is used to plug a machining hole in the housing. It is not necessary to remove the plug and replace the seal unless leakage is occurring around the plug. To remove the plug, insert an so Allen wrench through the port opening and push it out.

CLEANING AND INSPECTION.

1. Check all mating surfaces, and replace any parts having scratches or burrs that could cause leakage or damage.

2. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe them with a cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage.

3. Check around the chamfered area of the shaft for burrs, nicks, or sharp edges that can damage the seals when assembling the flange. Nicks or burrs may be removed with a hard, smooth stone (such as an Arkansas stone). Do not try to file or grind this part.

4. Wash the housing with non-petroleum base solvent to remove oil, grease, and debris. Petroleum base solvents may leave residue detrimental to the successful use of Loctite. Pay particular attention to the four tapped holes on the flange end.

NOTE

Fully cured Loctite resists most solvents, oils, gasoline, kerosene. and is not effected by cleaning operations.

5. Blow dry the motor with compressed air. Clean and dry the tapped holes.

NOTE

It is not necessary to remove the cured Loctite that is securely bonded in the tapped holes; however, any loose particles of cured Loctite should be removed.

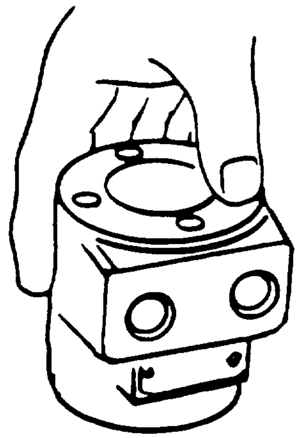
6. Wire brush the screw threads to remove any cured Loctite and other debris. Discard any screws that have damaged threads or a corroded, damaged, or rounded head.

7. Wash the screws with non-petroleum base solvent. Blow dry with compressed air.

ASSEMBLY.

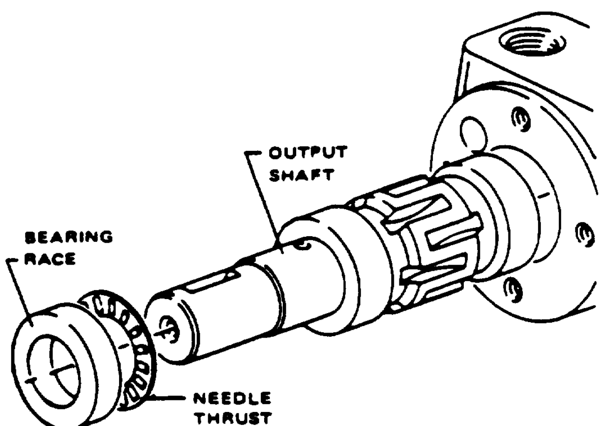
NOTE

Use all new seals when assembling the motor. Lubricate the seals with petroleum jelly before assembly. Do not stretch the seals before installing.



2187-14

1. If the plug and seal were removed, lubricate the seal and install it on the plug. Push the plug into the housing so the plug and housing are flush. Be careful not to damage the seal.

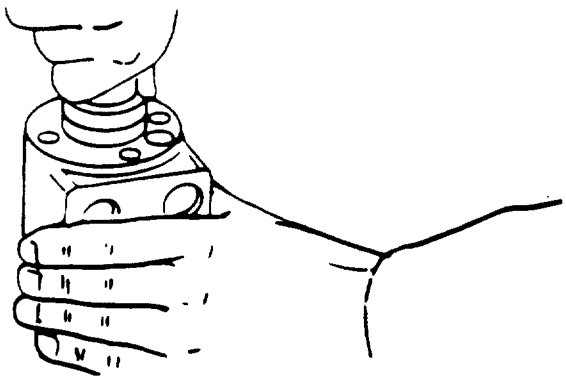


2187-15

NOTE

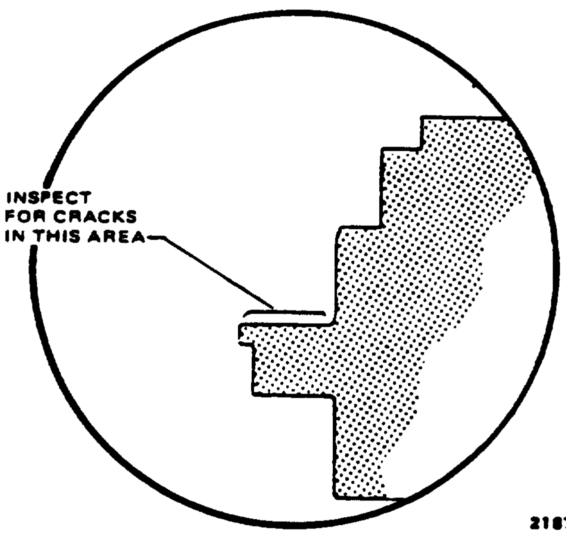
Do not allow oil to get into the tapped holes.

2. Lubricate the output shaft with hydraulic oil. Install the shaft in the housing.



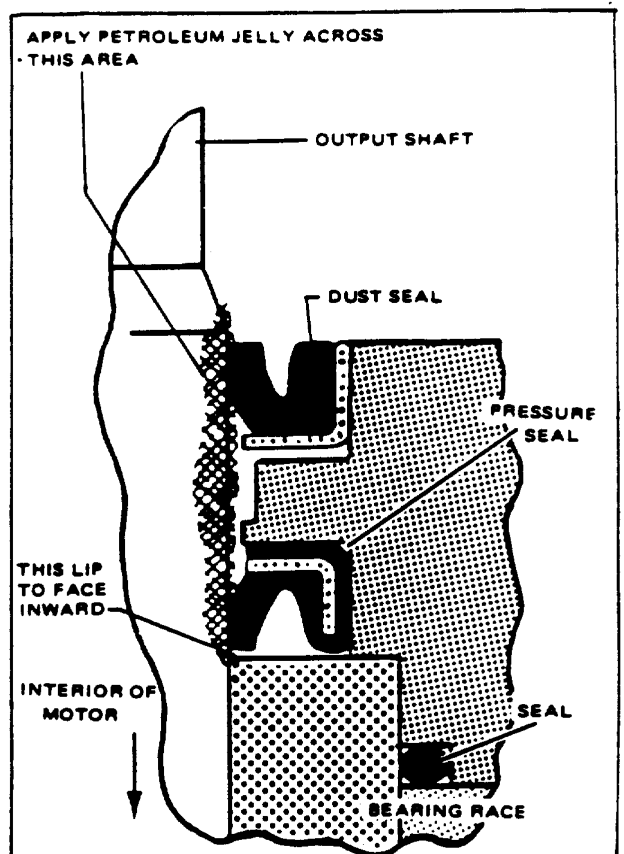
2187-16

3. Install the needle thrust bearing then the bearing race on the shaft. Pull the shaft partially out of the housing, them push all three parts in the housing together. The bearing race must rotate freely when in position.



2187-17

4. Clean the mounting flange and output shaft to remove all loose metallic chips, particles, dirt or other contamination, including oil. During cleaning, visually inspect the seal seat in the mounting flange for scratches or other marks that might damage the seal. Check for cracks in the flange, that might cause leakage.



Seal Installation

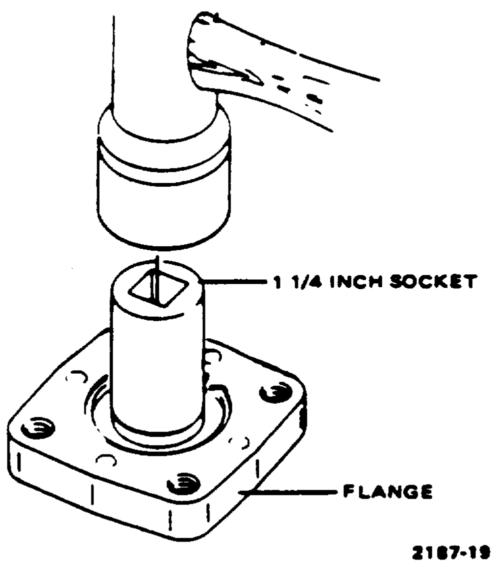
NOTE

The pressure seals are marked "Pressure Seal 9057-1". Check the seals before installing to ensure they are installed in the correct places. The dust seal is smaller in diameter than the pressure seal. If installed in the wrong place, leakage around the shaft will occur.

5. Install the dust seal in the flange as shown in the Seal Installation figure. Press the seal into place carefully, using a tool which will provide proper guiding and positioning to eliminate damage to the rubber portion or distortion of the metal container.

6. Lubricate the outside diameter of the pressure seal with petroleum jelly. Place the seal in the flange and press into place as shown in the Seal Installation figure.

This seal has a metal case with rubber molded around it. Install it carefully to prevent damage to the seal, especially distortion to the metal case. The preferred method of installation is to use a press and a seal installation tool. If a press is not available, use the following method. After lubrication, insert the seal into the flange with the lip up as shown in the Seal Installation figure.



Use a 1.25 inch socket, or equivalent tool that has the same outside diameter as that of the seal. Carefully tap the socket until the seal is completely seated. It is extremely important that the seal is installed straight.

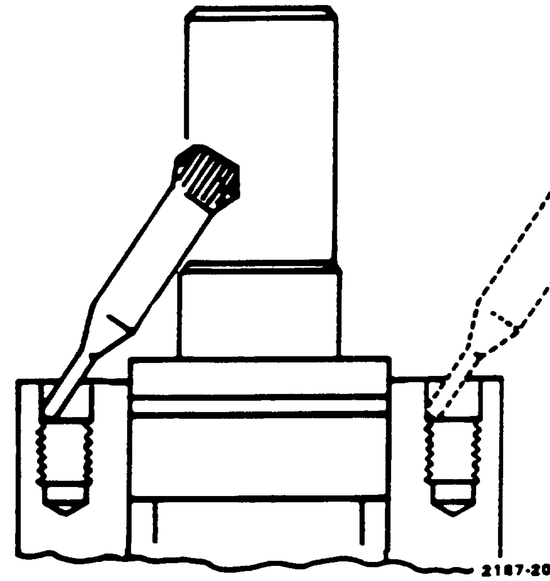
Liberally fill the space between the dust seal and pressure seal as well as the lips of both seals with petroleum jelly, as shown in the Seal Installation figure.

7. Install the 1.9375 inch (4.92 cm) diameter seal in the flange.

8. Apply a light coat of Loctite Primer NF on the bolts and in the tapped holes of the housing. Allow primer to air dry for at least one minute. Do not force dry with air jet, as the primer will blow away. Use of the primer is optional. With the primer, curing time with Loctite is approximately 15 minutes. Without the primer, curing time is approximately 6 hours.

PLACE TIP OF APPLICATOR OF TOP OF THREADED PORTION

APPLY 3 OR 4 DROPS IN EACH HOLE



9. Apply three or four drops of Loctite adhesive (Loctite number 601 sealant) at the top of the threads in each of the 4 holes in the housing, as shown above. Also apply one drop of Loctite to one side of the threads of each capscrew. Do not allow parts with Loctite applied to the surface to contact any metal parts other than their proper assembly. Wipe off any excess Loctite from the housing face, using a nonpetroleum base solvent. Do not apply Loctite to the threads more than fifteen minutes before installation of the capscrews. If the housing stands for more than 15 minutes, repeat the application. No additional cleaning or removal of previous Loctite is necessary.

10. Before installing the flange and seal assembly over the shaft, place a protective sleeve or bullet over the shaft. Install the flange. Rotate the flange slowly while pushing down over the shaft. Be careful not to invert or damage the seals.

11. Clamp the motor in a vise as shown in step 11 of DISASSEMBLY. Install the capscrews and torque immediately 225 to 250 lb in. (25 to 28 N•m). If you use primer, allow the Loctite to cure for 10 to 15 minutes, without primer allow 6 hours before subjecting the motor to high torque reversals. On all other applications, you can run the motor immediately. If you use new bolts, ensure they are the

correct length, (0.875 inch [22.23 mm] under head length). Longer screws will not permit proper seal between the flange and housing.

12. Clamp the housing in a vise, gerotor end up. Refer to step 1 of DISASSEMBLY or the correct clamping procedure.

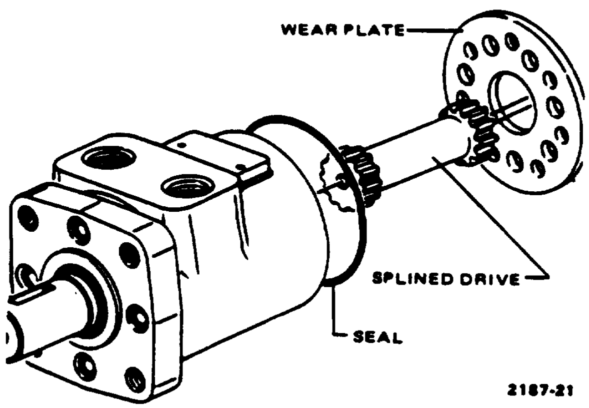
CAUTION

DO NOT STRETCH THE SEALS BEFORE INSTALLING THEM IN THE GROOVE.

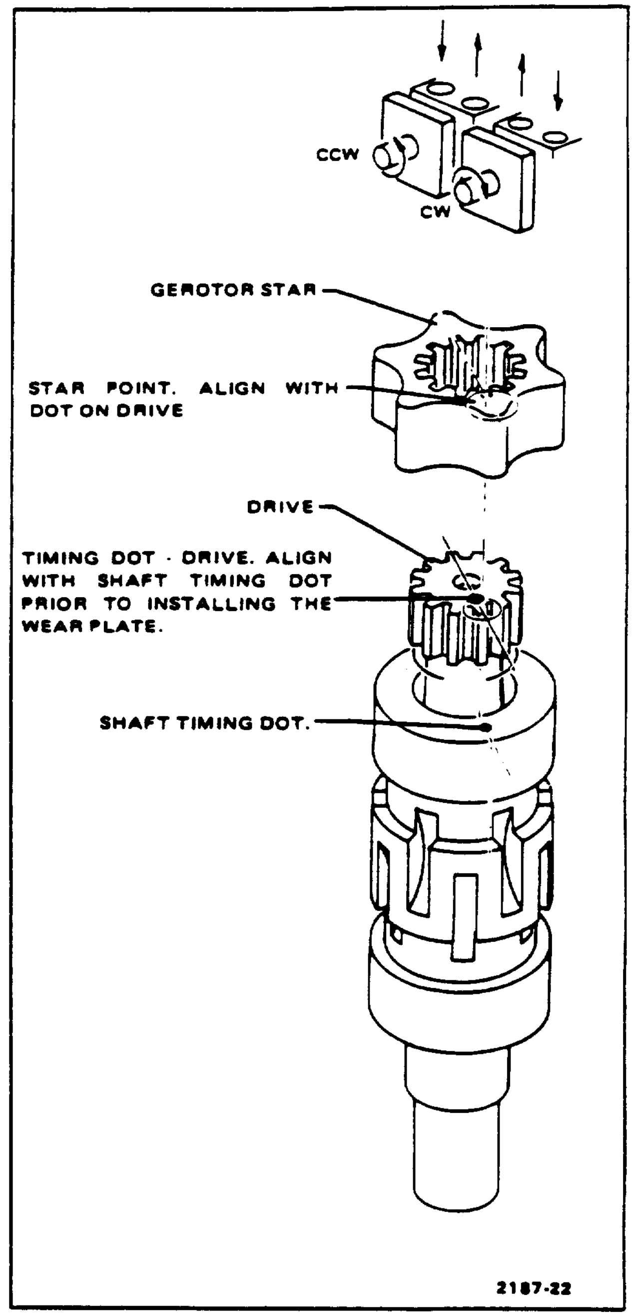
NOTE

To aid in the installation of the seals, apply a light coating of clean petroleum jelly to the seal before installing.

13. Pour approximately 35 cc of hydraulic oil in output shaft.



14. Install the 2.875 inch (7.3 cm) diameter seal in the housing seal groove and install the wear plate on the housing.

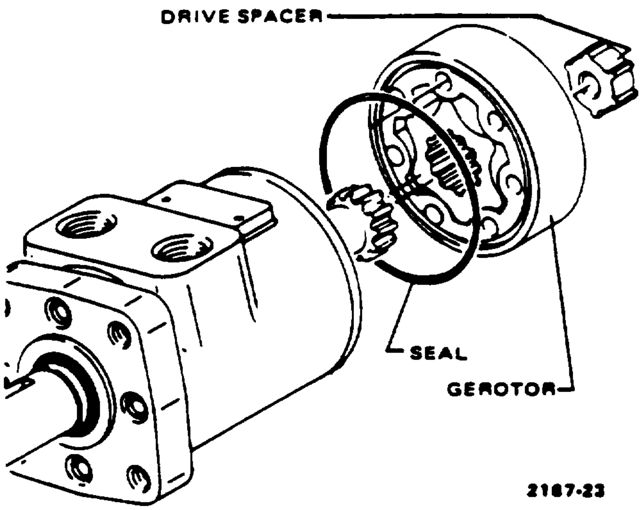


Motor Timing

NOTE

The timing marks are machined on the shaft and drive.

15. Install the drive with the timing mark on the drive tooth aligned with the timing mark on the shaft. Refer to the Motor Timing figure.

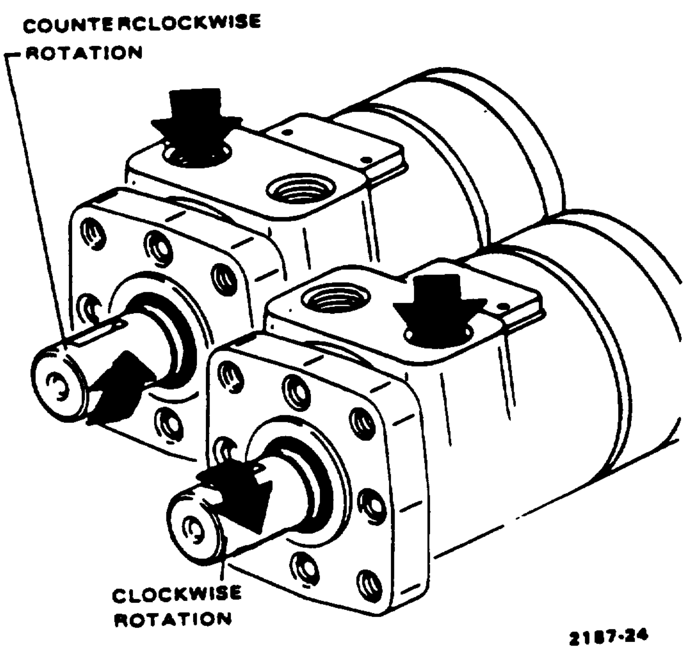


16. Install the 2.875 inch (7.3 cm) diameter seal in the gerotor seal groove.

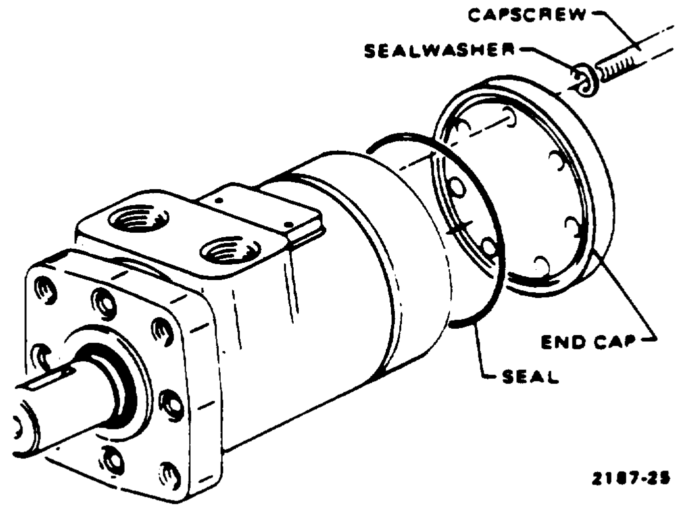
17. Carefully place the gerotor on the wear plate, seal side toward the wear plate. Install the gerotor with any tooth aligned with the timing mark on the drive.

18. Turn the gerotor to line up the holes for the capscrews, be careful not to disengage the star from the drive.

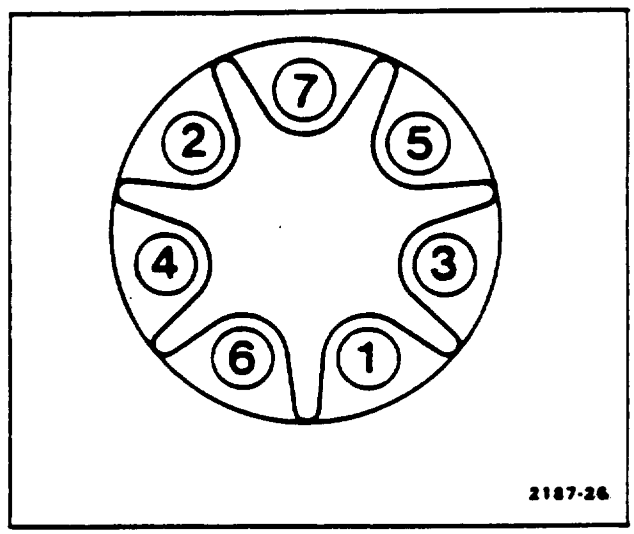
19. Install the drive spacer.



20. With the orientation shown in the Motor Timing figure, the output shaft will rotate as shown with the ports pressurized as shown.



21. Install the 2.875 inch (7.3 cm) diameter seal in the end cap, then carefully place the end cap on the gerotor.



Torquing Sequence

22. Install the capscrews and sealwashers In the end cap. Pretighten all screws 15 to 40 lb in. (2 to 5 N•m). Check to ensure the seals are seated properly in the grooves. Tighten the capscrews to a final torque of 175 to 200 lb in. (20 to 23 N•m) following the Torquing Sequence figure.

PLANETARY GEAR REDUCER

DESCRIPTION

The planetary gear reducer is bolted to the turntable frame weld. The gear reducer pinion meshes with the turntable bearing to rotate the turntable. The gear reducer has an integral brake mounted to it, and the swing motor is mounted on the brake. The crossover relief valve is mounted on the swing motor. The swing motor drives the gear reducer through the brake assembly. The gear reducer has a ratio of 27.98: 1.

MAINTENANCE

DISASSEMBLY.

1. Remove the drain plug and drain all oil from the gear reducer.

2. Remove the capscrews and washers securing the relief valve to the motor and remove the relief valve.

NOTE

The motor bolts were installed with thread sealant.

3. Remove the socket head capscrews and lockwashers securing the motor to the brake housing and remove the motor.

4. Remove the bolts (1) and washers (2) securing the brake housing (3) to the end cover (4). Remove the brake housing (3) and springs (16).

5. Remove the piston (5) and cylinder head (6).

6. Remove the O-rings (7) and backup rings (8) from the head (6) and piston (5).

7. Remove the brake discs (9) and stators (10).

8. Remove the bolts (1) securing the end cover (4) to the internal gear (12).

9. Remove the O-ring (13), bearing (14), and bearing races (15) from the end cover (4).

10. Press the primary sun gear (17) from the end cover (4). Remove the spacer (18), and oil seal (19).

11. Remove the primary planetary assembly (20) and set aside for later disassembly.

12. Remove the thrust races (21) and bearing (22).

13. Remove the secondary sun gear (37).

14. Remove the secondary planetary assembly (23) and set aside for later disassembly.

15. Remove the O-ring (24) from the internal gear (12).

16. Bend down the tabs of the lockwasher (25), and remove the locknut (26) and lockwasher (25).

17. Press the output shaft (27) from the hub (28).

18. Remove the bearing (29) and oil seal (30) from the shaft (27).

19. Remove the bearing (29) from the hub.

20. Press the roll pins (31) into the planet shafts (32) of the primary planetary assembly (20).

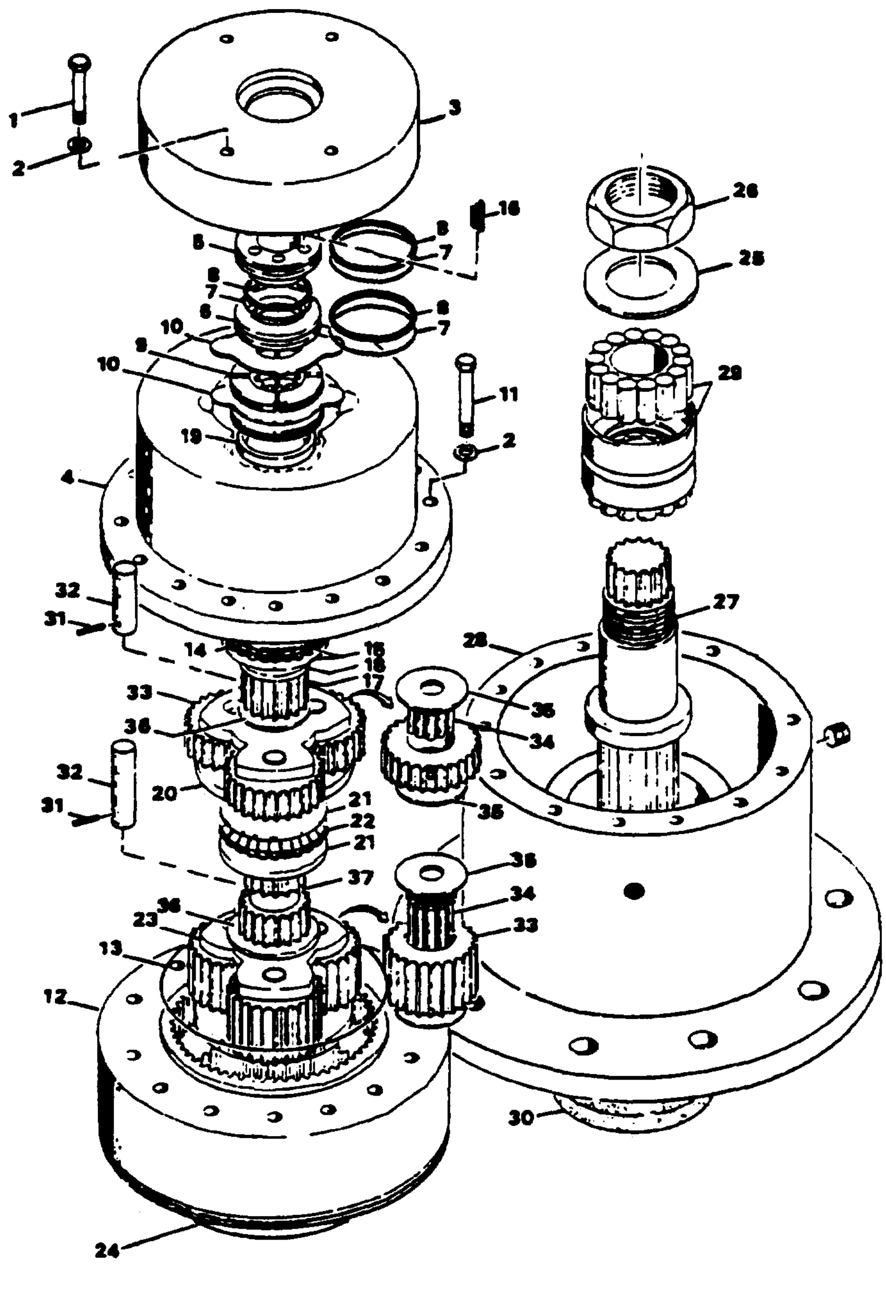
21. Press out the planet shafts (32) and remove the gears (33), bearings (34), and thrust races (35).

22. Remove the spacer (36) from the planet carrier housing.

23. Repeat steps 20 through 22 for the secondary planetary assembly (23).

CLEANING AND INSPECTION.

1. Clean all parts with a suitable cleaning solvent and dry with compressed air or a lint free, clean cloth.



1. Bolt
2. Washer
3. Brake Housing
4. End Cover
5. Piston
6. Cylinder Head
7. O-ring
8. Backup Ring
9. Brake Disc
10. Stator
11. Bolt
12. Internal Gear
13. O-ring
14. Bearing
15. Bearing Race
16. Spring
17. Primary Sun Gear
18. Spacer
19. Oil Seal
20. Primary Planetary Assembly
21. Bearing Race
22. Bearing
23. Secondary Planetary Assembly
24. O-ring
25. Lockwasher
26. Locknut
27. Output Shaft
28. Hub
29. Bearing
30. Oil Seal
31. Roll Pin
32. Planet Shaft
33. Gear
34. Bearing
35. Thrust Washer
36. Spacer
37. Secondary Sun Gear
38. End Cap (Not Shown)
39. Screw (Not Shown)
40. Pinion (Not Shown)

0798

Gear Reduction Assembly - Exploded View

2. Inspect all bearings for damage to the rolls, cages, or quills.

3. Inspect all gear teeth for cracks, pitting, or other damage.

4. Inspect all bearing surfaces for scoring, scratches, or other damage.

ASSEMBLY.

NOTE

Prior to assembly, all bearings must be packed with a high quality extreme pressure grease.

1. Install the bearings (34) into the inside of all three primary planet assembly gears (33).

2. Install two of the gears (33) with bearings (34) into the primary planet assembly (20) with the planet shafts (32). When pressing in the planet shafts (32) ensure the roll pin (31) hole is aligned with the hole in the primary planet assembly (20) housing.

3. Secure the two planet shafts (32) into position with the roll pins (31).

4. Install the spacer (36) into the splined end of the primary planet assembly (20) and under the two previously installed gears (33).

5. Install the other gear (33) with bearing (34) into the primary planet assembly (20) with the planet shaft (32). When pressing in the planet shaft (32), ensure the roll pin (31) hole is aligned with the hole in the primary planet assembly (20) housing.

6. Repeat steps 1 through 5 for the secondary planetary assembly (23).

7. Press the upper bearing (29) onto the output shaft (27) and press the output shaft into the hub (28).

CAUTION

USE EXTREME CARE WHEN INSTALLING THE OIL SEAL (30) INTO THE HUB (28). ENSURE IT IS FLUSH WITH THE HUB (28) AND NOT DAMAGED ON THE OUTPUT SHAFT (27) SPLINES.

8. Install the oil seal (30) into the hub (28) ensuring that it is flush with the hub (28) and not damaged on the splines of the output shaft.

9. Turn the assembly over with the output shaft (27) down.

10. Install the lockwasher (25) with the tabs up.

11. Install the locknut (26) with the bevel side down. Tighten the nut until the output shaft (27) turns with the locknut (26). Continue to tighten until the next tab on the lockwasher (25) lines up. Bend the tabs until the locknut (26) is secure.

12. Install the secondary planetary assembly (23) with the splined side down and engaged with the output shaft (27).

13. Install the secondary sun gear (37).

14. Install the thicker bearing race (21), then the bearing (22), then the thinner bearing race (21).

15. Install the O-ring (24) onto the internal gear (1 2) and install the internal gear (12) onto the hub (28).

16. Install the spacer (18) onto the primary planetary assembly (20).

17. Install two thin bearing races (15) and the bearing (14) onto the primary planet assembly (20).

18. Temporarily install the end cover (4) onto the internal gear (12) and check for a small amount of clearance between the end cover (4) and the primary planetary assembly (20).

19. Remove the end cover (4) and spacer (18).

20. Install the oil seal (19) into the end cover (4) and the O-ring (13) onto the internal gear (12).

21. Lubricate the primary sun gear (17) shaft with grease and install the shaft. Install the spacer (18) over the shaft and onto the primary planetary assembly (20).

CAUTION

DO NOT DAMAGE THE OIL SEAL WHEN INSTALLING THE END COVER (4) ONTO THE INTERNAL GEAR.

22. Carefully install the end cover (4) over the primary sun gear (17)with a slight rotating motion. Do not damage the oil seal (19) on the splines of the sun gear.

23. Apply thread sealant to the bolts (11) and install the bolts (11) securing the end cover (4) to the Internal gear (12). Torque the bolts to 35 lb ft (48 N•Om).

24. Install the brake discs (9) and the stators (10), another brake disc (9) and then a thin stator (10).

25. Install the O-rings (7) and backup rings (8) on both the inside and outside of the cylinder head (6) with the o-rings (8) up as the head would be installed in the brake housing (3).

26. Install the O-ring (7) and backup ring (8) into the piston (5) so the O-ring (7) faces the O-ring (7) in the head (6).

27. Install the springs (16) into the piston and install the head (6) and piston (5) into the brake housing (3).

28. Remove dirt grease, or moisture from the end cover surface. Dry the surface or allow to dry naturally. Apply never-seez compound and RTV silicon to the surface of the end cover.

29. Install the brake housing assembly (3) with the brake release port lined up with the alignment hole used earlier.

30. Apply thread sealant to the bolt (1) threads and Install the bolts (1) and washers (2) securing the brake housing (3) to the end cover (4). Torque the bolts to 35 lb ft (48 N•m).

31. Install the motor to the brake housing. Apply thread sealant to the socket head capscrews. Install the capscrews and secure the motor to the brake housing. Torque the capscrews to 109 lb ft (148 Nom).

32. Install the relief valve to the motor with the capscrews and washers.

GROVE MODEL HO-12 HOIST

DESCRIPTION

The Grove Model HO-12 hoist is a single speed hoist consisting of a hoist control valve, a vane type motor, the brake, cable drum, clutch assembly, and the motor and brake end housings.

The following is a list of specifications for the model HO-12 hoist.

Drum Dimensions	Drum dimensions are 9.625 inches (24.4 cm) diameter with 9.0 inches (22.8 cm) length.
Cable Capacity	Cable capacity for the 9.0 inch (22.8cm)drum with 9/16 inch cable is 135 feet (41.1 m).
Permissible Line Pull	Refer to the Line Pulls and Reeving Info Chart in the cab.

THEORY OF OPERATION

The first section of the hydraulic pump supplies oil to the hoist directional control valve. The control valve supplies oil through swivel port 4 to the hoist motor control valve. The control valve is actuated by the main hoist control lever. Hydraulic oil from the hoist returns to the reservoir through hydraulic swivel port 3.

The hoist drum rotates on anti-friction bearings located in the drum ends. A shaft splined to the drive motor transmits the drive motor rotation to the primary carrier assembly. A second shaft transmits this rotation from the secondary carrier assembly to the clutch assembly. Brake discs and plates mounted on the clutch restrict or stop drum rotation as determined by the action of the hydraulic operated brake.

Oil from the hoist directional control valve flows to the hoist control valve mounted on the hoist drive motor. When hoisting up, oil enters the IN Port of the hoist control valve and unseats the free flow poppet. Oil then flows from the OUT port of the valve to the up port of the motor, which drives the hoist to wind cable onto the drum.

When hoisting down, oil flows to the down port of the hoist motor, the hoist brake, and the pilot line of the hoist control valve. The pilot operated poppet of the hoist control valve and the hoist brake are controlled by the pressure in the down line. Because the poppet in the hoist control valve is closed and oil cannot flow from the raise port of the motor, pressure rises in the down line. As the pressure rises, the hoist brake will release and as pressure continues to rise, the pilot pressure in the hoist control valve will open the poppet allowing the hoist to run in a down direction and oil flow to the reservoir. If the load-drop speed increases, the pressure in the down line will decrease. This decrease in pressure will cause the poppet in the hoist control valve to close and causes the spring actuated brake to slow or stop the hoist. The hoist control valve prevents the load from driving the hoist motor during hoist down operation.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Hoist will not raise load	a. Too much cable on drum.	a. Each layer of cable on the drum reduces the line pull. By reducing the amount of cable on the drum, the pull will increase.
	b. Improper reeving.	b. Multiply the line pull times the number of lines used, adjusting for the amount of cable on the drum; compare with load. Add parts of line if load exceeds results.
	c. Load capacity exceeded.	c. Reduces load. (Refer to applica-ble Load Chart).
	d. Hydraulic oil low.	d. Replenish system.
	e. Broken hydraulic lines of fit-tings.	e. Replace lines or fittings.
	f. Damaged relief valve	f. Repair or replace valve.
	g. Damaged hoist control valve.	g. Repair or replace valve.
	h. Damaged primary drive assem-bly.	h. Repair or replace primary drive assembly.
	i. Sheared shaft on pump or dam-aged pump.	i. Install a 0 to 5000 psi (0 to 34.475 kPa/344.8 bar) guage in the inlet line of the hoist valve bank. Activate the system. No pressure or excessively low pressure indicates a damaged pump or drive shaft. Re-pair or replace.
	j. Motor control valve out of adjustment.	j. Refer to Adjustment of the Motor Control Valve in this Section and adjust the valve.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Hoist will not lower.	a. Broken lines or fittings.	a. Replace lines or fittings.
	b. Damaged relief valve.	b. Repair or replace valve
	c. Damaged hoist control valve.	c. Repair or replace valve.
	d. Damaged primary drive assembly.	d. Repair or replace primary drive assembly.
	e. Motor control valve out of adjustment.	e. Refer to Adjustment of the Motor Control Valve in this Section and adjust the valve.
3. Slow operation down.	a. Low engine rpm.	a. Increase speed.
	b. Damaged circuit relief valve.	b. Refer to Chapter 3, Section 6 - VALVES (HYDRAULIC SYSTEM).
	c. Damaged hydraulic pump.	c. Install flow meter in exhaust line of the pump. Under moderate load, check for proper output. Refer to Chapter 3, Section 6 - HYDRAULIC PUMPS (HYDRAULIC SYSTEM). Damaged pumps normally build heat. By hand, carefully check the temperature of the pump in relation to the other hydraulic pump.
4. Slow operation up.	a. Low engine rpm.	a. Increase engine rpm to recommended setting.
	b. Damaged main relief valve.	b. Refer to Chapter 3, Section 6 - HYDRAULIC SYSTEM.
	c. Damaged hydraulic pump.	c. Install flow meter in exhaust line of the pump. Under moderate load, check for proper output. Refer to Chapter 3, Section 6 - HYDRAULIC PUMPS (HYDRAULIC SYSTEM). Damaged. pumps normally build heat. By hand, carefully check the temperature of the pump in relation to the other hydraulic pump.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Slow operation up. continued)	d. Damaged O-rings in brake piston.	d. Install a pressure gauge (0 to 5000 psi [0 to 34.475 kPa/344.8 bar]) in the pipe plug hole in the line going into the center of the brake housing. The inability to build or hold pressure at 500 psi (3447.5 kPa/34.48 bar) in this line indicates defective O-rings - replace if damaged.
	e. Warped brake piston.	e. Replace piston.
	f. Motor control valve out of adjustment.	f. Refer to Adjustment of the Motor Control Valve in this Section and adjust the valve.
5. Erratic operation up.	a. Low engine rpm.	a. Increase speed.
b.Damaged motor. 5000 psi [0 to 34,475 kPa/344.8 bar]) in the inlet and exhaust line of the motor. Hoist upwards in low speed Observe meter readings. If the motor has excessively more or less pressure than normal, it is damaged - repair or replace damaged motor.	b. Install pressure gauge (0 to	
6. Erratic operation down	a. Air in brake release line.	a. Bleed pilot pressure line going into brake housing.
	b. Low engine rpm.	b. Increase speed.
	c. Damaged circuit relief valve.	c. Refer to Chapter 3, Section 6 - VALVES (HYDRAULIC SYSTEM).
	d. Motor control valve out of adjustment.	d. Refer to Adjustment of the Hoist Motor Control Valve.
7. Sticking spool in the control valve	a. Excessively high oil temperature.	a. Eliminate any restriction in pipe line or filtering system.
	b. Dirt in oil.	b. Change oil and flush system.
	c. Valve warped from mounting.	c Loosen valve and check.
	d Excessively high pressure In valve (Relief valves not working properly)	d Check pressure at inlet and at working ports.
	e. Handle or linkage binding	e. Free linkage

SYMPTOM	PROBABLE CAUSE	SOLUTION
7. Sticking spool in the control valve. (continued)	f. Spacer bent.	f. Replace valve.
	g. Return spring damaged.	g. Replace faulty parts.
	h. Spring or valve cap binding.	h. Loosen cap, recenter and retighten.
	i. Oil not thoroughly warmed up.	i. Allow time for system warm up.
8 Leaking seals.	a. Paint on or under seal.	a. Remove and clean. as necessary.
	b. Dirt under seal.	b. Remove and clean, as necessary.
	c. Scored spool.	c. Replace valve.
	d. Loose seal plates.	d. Clean and tighten plates.
	e. Cut or scored seal.	e. Replace faulty parts.
9. Unable to move spool in or out.	a. Dirt in valve.	a. Clean and flush out valve assembly.
	b. Spool cap full of oil.	b. Replace seals.
	c. Bind in linkage.	c. Free linkage.
10. Load drops when spool moved from neutral.	a. Dirt in check valve.	a. Disassemble and clean check valve.
	b. Scored check valve poppet or seat.	b. Replace poppet or lap poppet to seat.
	c. Motor control valve out of adjustment.	c. Refer to Adjustment of the Motor Control Valve in this Section and adjust the valve.
11. Poor hydraulic system performance or failure.	a. Damaged pump.	a. Check pressure and repair or replace pump.
	b. Dirt in relief valve.	b. Disassemble and clean relief valve.
	c. Relief valve damaged.	c. Replace relief valve.
	d. Worn hoist motor.	d. Repair or replace damaged components.

DISASSEMBLY.

NOTE

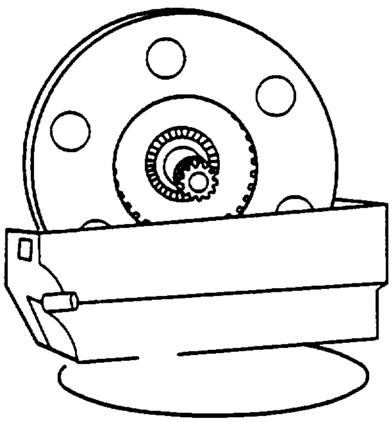
Any maintenance involving disassembly of the hoist should include replacement of all gaskets and O-rings.

Brake Assembly.

1. Disconnect the hydraulic lines to the brake housing (6); cap or plug all lines and openings.

2. Remove the capscrews (29) and washers (30) securing the brake assembly to the brake end housing. Remove the brake assembly.

3. Remove the springs (21) from the piston (7).

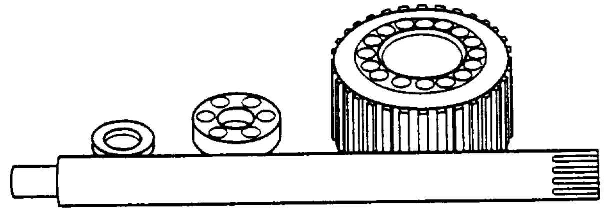


4. Using a suitable puller, remove the piston and clutch assembly.

5. Remove the stators (9), discs (10), and spacer (20).

6. Remove the snap ring (19) from the shaft (13).

7. Using a soft faced hammer, remove the piston (7) from the clutch assembly (8).

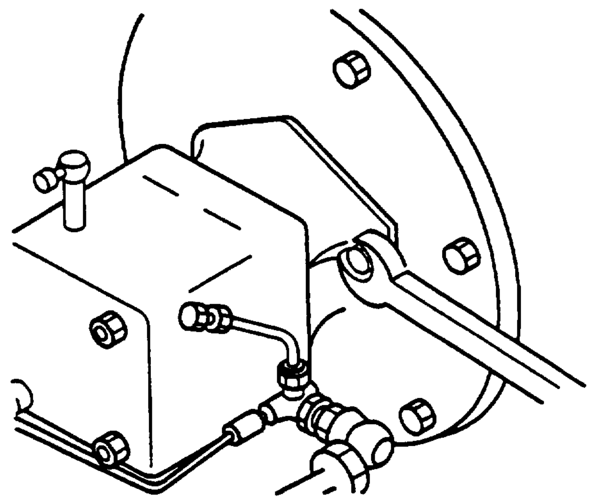


8. Tap the shaft (13), spacer (20), and bearings (1 7) from the clutch (8).

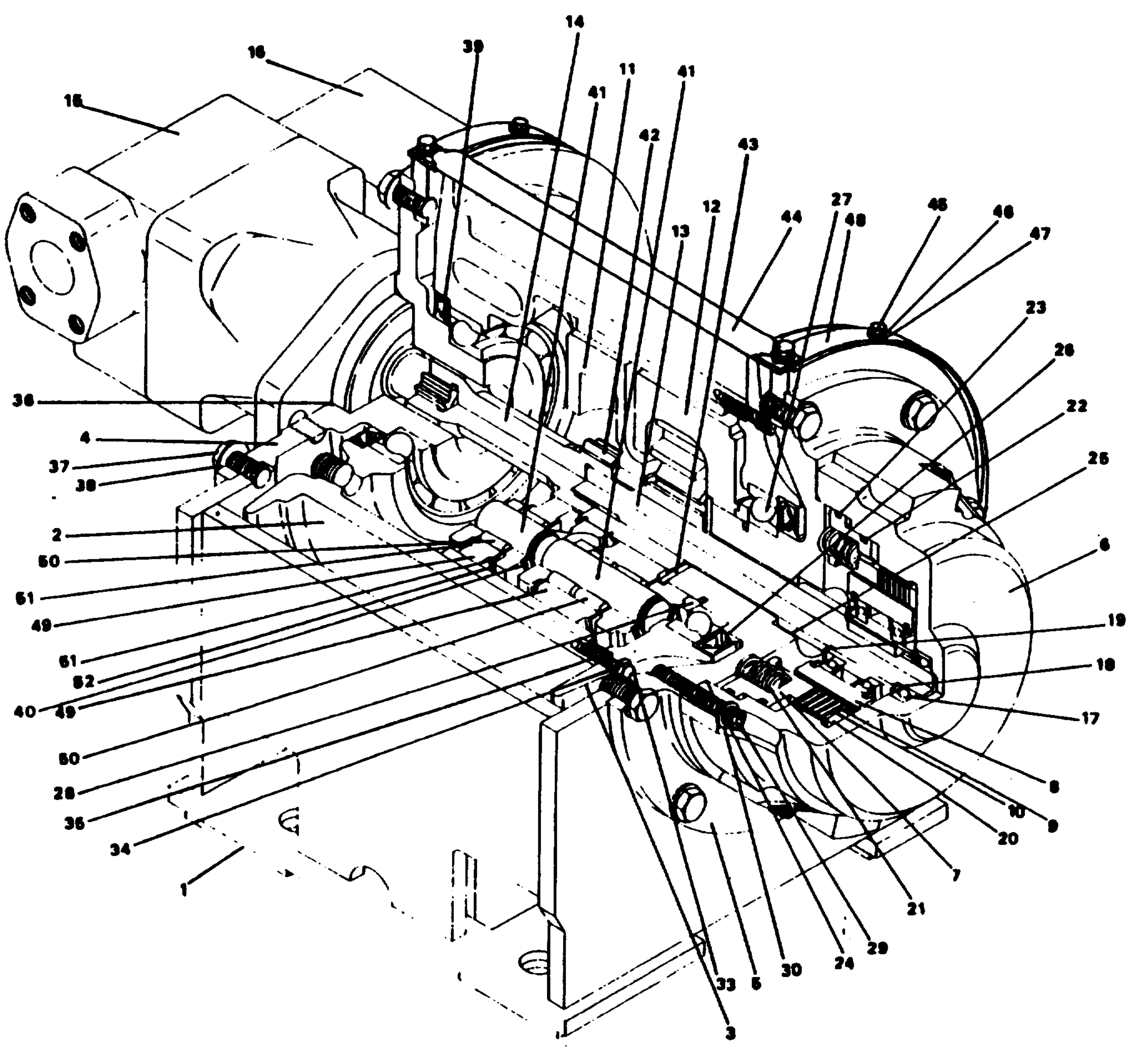
9. Remove the O-rings (22 and 23) from the piston (7).

Hydraulic Motor.

1. Tag and disconnect the hydraulic lines from the motor (1 5) and the hoist motor control valve (1 6). Cap or plug all lines and openings.



2. Remove the bolts and washers securing the motor to the motor end cover (4). Remove the motor. For maintenance of the vane type motor, refer to the applicable SM package.



1. Housing	14. Input Shaft	27. Ball Bearing	40. Circlip
2. Cable Drum	15. Motor	28. Spacer	41. Pin
3. R H Drum End	16. Brake Control Valve	29. Capscrew	42. Gear
4. Motor End Housing	17. Ball Bearing	30. Lockwasher	43. Spacer
5. Brake End Housing	18. Spacer	31. Capscrew	44. Cable Deflector
6. Brake Housing	19. Retaining Ring	32. Washer	45. Screw
7. Piston	20. Spacer	33. Capscrew	46. Flatwasher
8. Clutch Assembly	21. Spring	34. Lockwasher	47. Washer
9. Stator	22. O-Ring	35. O-Ring	48. Hoist Housing
10. Friction Disc	23. O-Ring	36. O-Ring	49. Planet Gear Collar
11. Primary Carrier Assy	24. O-Ring	37. Capscrew	50. Needle Bearings
12. Second Carrier Assy	25. Seal	38. Washer	51. Thrust Washer
13. Main Shaft	26. Oil Seal	39. Oil Seal	52. O-Ring

HO-12 Grove moist - cutaway

Hoist.

1. Remove the screws (45), flatwashers (46). and washers (47), securing the cable deflector (44) and the hoist housing collars (48). Remove the deflector (44) and collars (48).

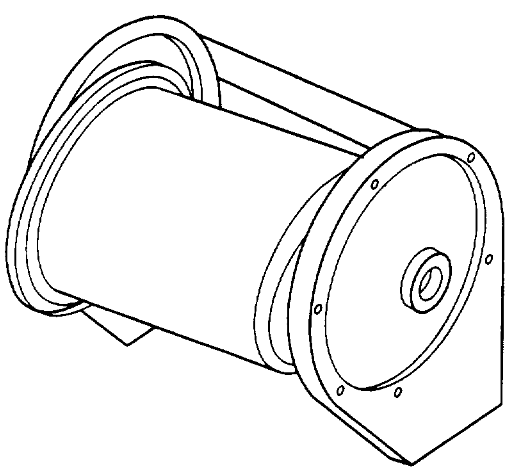
2. Remove the capscrews (37) and washers (38) from the motor end housing (4). Remove the housing.

3. Remove the capscrews (31) and washers (32) from the brake end housing (5) and remove the housing. Remove the seals (26) from the housing.

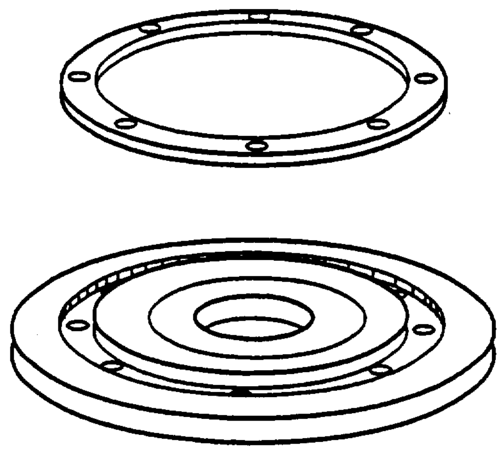
NOTE

Photos of the right hand drum end (3) show eight bolt holes. Quantity of bolts has been increased to sixteen.

4. Remove the capscrews (33) and washers (34) from the right hand drum end (3).

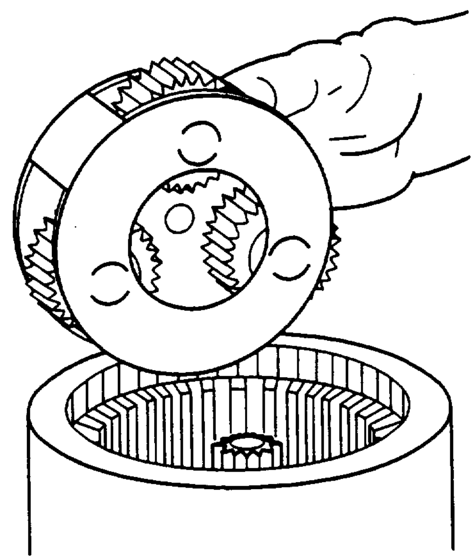


5. Pull the drum (2) from the housing (1).

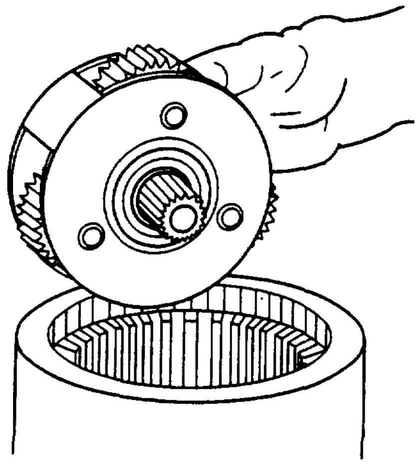


6. Remove the right hand drum end (3) from the housing.

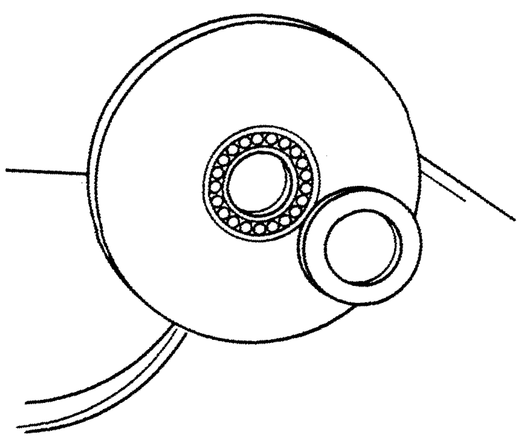
7. Remove the spacer (28) from the right hand drum end (3).



8. Remove the secondary carrier (12) from the drum (2).



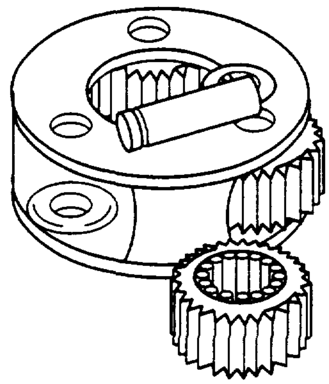
9. Remove the primary carrier (11) from the drum (2).



10. Remove the seal (39) from the cable drum (2).

Primary and Secondary Carrier.

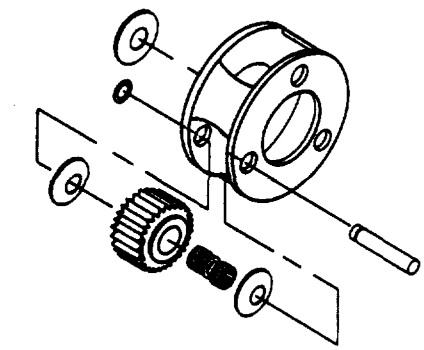
1. Remove the circlip (40) from the pin (41) securing the gears (49) in the carrier.

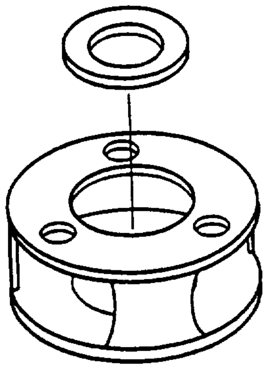


2. Use a brass drift to drive the pin (41) out of the carrier and planet gear.

NOTE
Be careful not to lose any of the needle bearings.

3. Remove the planet gear (49), thrust washers (51), O-ring (52), and needle bearings (50).





4. Remove the spacer (43) from the secondary carrier (12).

5. Repeat steps 1, 2, 3, and 4 for the other planet gears.

CLEANING AND INSPECTION.

1. Clean all parts with a suitable solvent and dry with compressed air.

CAUTION
DO NOT ALLOW COMPRESSED AIR TO SPIN THE BEARINGS.

2. Clean all tapped holes and threads using taps and dies.

3. Check all parts for cracks, nicks, or other damage. Polish out any minor blemishes on the brake piston or cylinder mating surfaces with a fine crocus cloth.

4. Examine the bearings for smoothness and freedom of movement.

5. Prelubricate all seals, O-rings, and bearings with 90weight EPGL gear lubricant unless otherwise specified.

ASSEMBLY.

NOTE
Any maintenance involving disassembly of the hoist should include replacement of all gaskets and O-rings.

Primary and Secondary Carrier.

1. Install the spacer (43) in the secondary carrier.

NOTE
The primary carrier has one row of needle bearings and the secondary carrier has two rows of needle bearings.

2. Place a small amount of EP-MPG grease around the inner diameter of the planet gear (49). Position one of the thrust washers (51) on a flat surface and place the planet gear (49) in position on top of it. Install the needle bearings (50) in place using grease to hold them upright. A socket just smaller than the diameter of the pin can be used to stabilize the rollers until they are all in place. If assembling the primary carrier, position the other thrust washer in place. If assembling the secondary carrier, install the second row of needle bearings before installing the thrust washer.

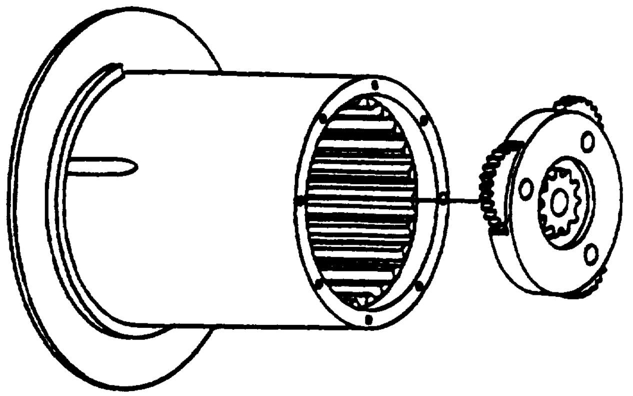
3. Carefully install the planet gear (49) in the carrier and carefully install the pin (41). Ensure all the rollers are in position.

4. Secure the pin (41) with the circlip (40).

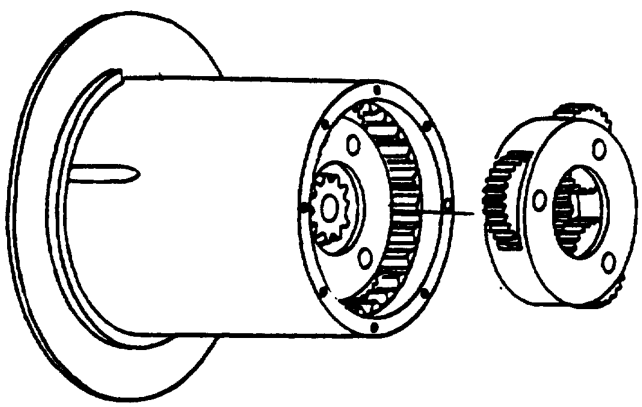
5. Repeat steps 2, 3, and 4 for the other planet gears.

Hoist.

1. Wipe the surface of the cable drum end clean. Apply a light coat of Locquic Primer T to the area between the seal and drum end. Allow 30 to 60 minutes to dry, and apply Loctite 290 adhesive. Install the seal (39) in the cable drum (2).



2. Install the primary carrier (11) into the drum (2).

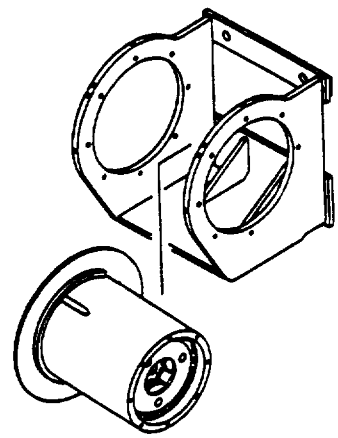


3. Install the secondary carrier (12) into the drum (2).

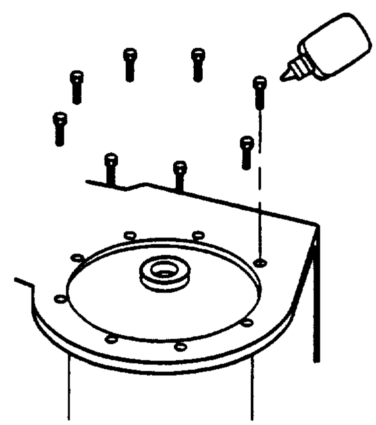
4. Clean the surface of the right hand drum end (3). Apply a thin even film of silicone adhesive sealant (RTV silicone rubber) to the surface and install the O-ring (35).

5. Wipe the surface of the cable drum (2) and right hand drum end (3) clean. Apply a light coat of Locquic Primer T to the area between the seal and drum end. Allow 30 to 60 minutes to dry and apply Loctite 290 adhesive. Install the spacer (28) in the right hand drum end (3).

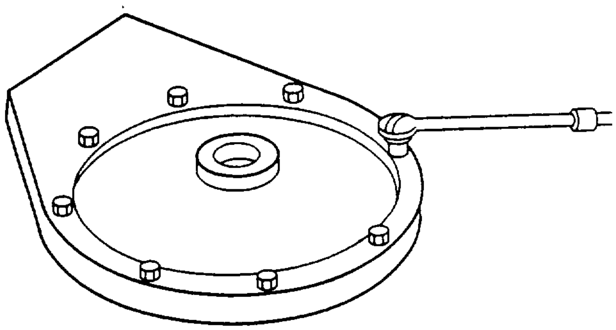
6. Apply a thin even film of silicone adhesive sealant (RTV silicon rubber) to the cable drum (2) and right hand drum end (3) surfaces. Install the right hand drum end into the housing (2).



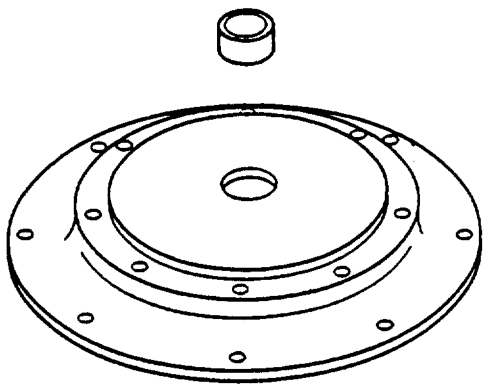
7. Install the cable drum (2) into the housing (1).



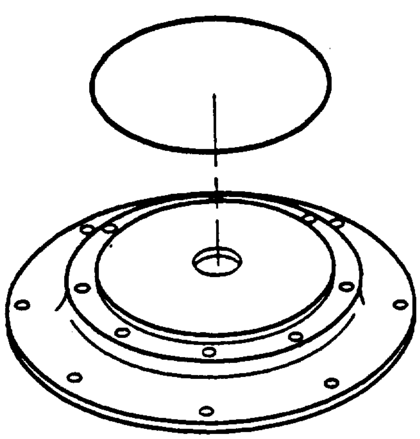
8. Ensure the thread surface of the capscrews (33) are free of dirt and oil. Apply high strength thread locking adhesive/sealant and primer to the threads of the capscrews (33). Install the capscrews (33) and washers (34) and secure the right hand drum end (3) to the cable drum (2).



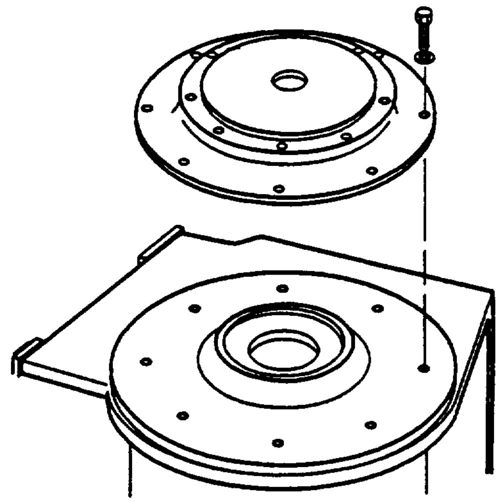
9. Torque the capscrews (33) to 41 lb ft (56 Nom).



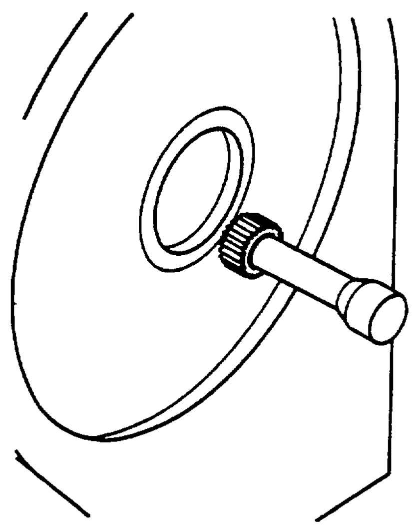
10. Install the seals (26) in the brake end housing (5).



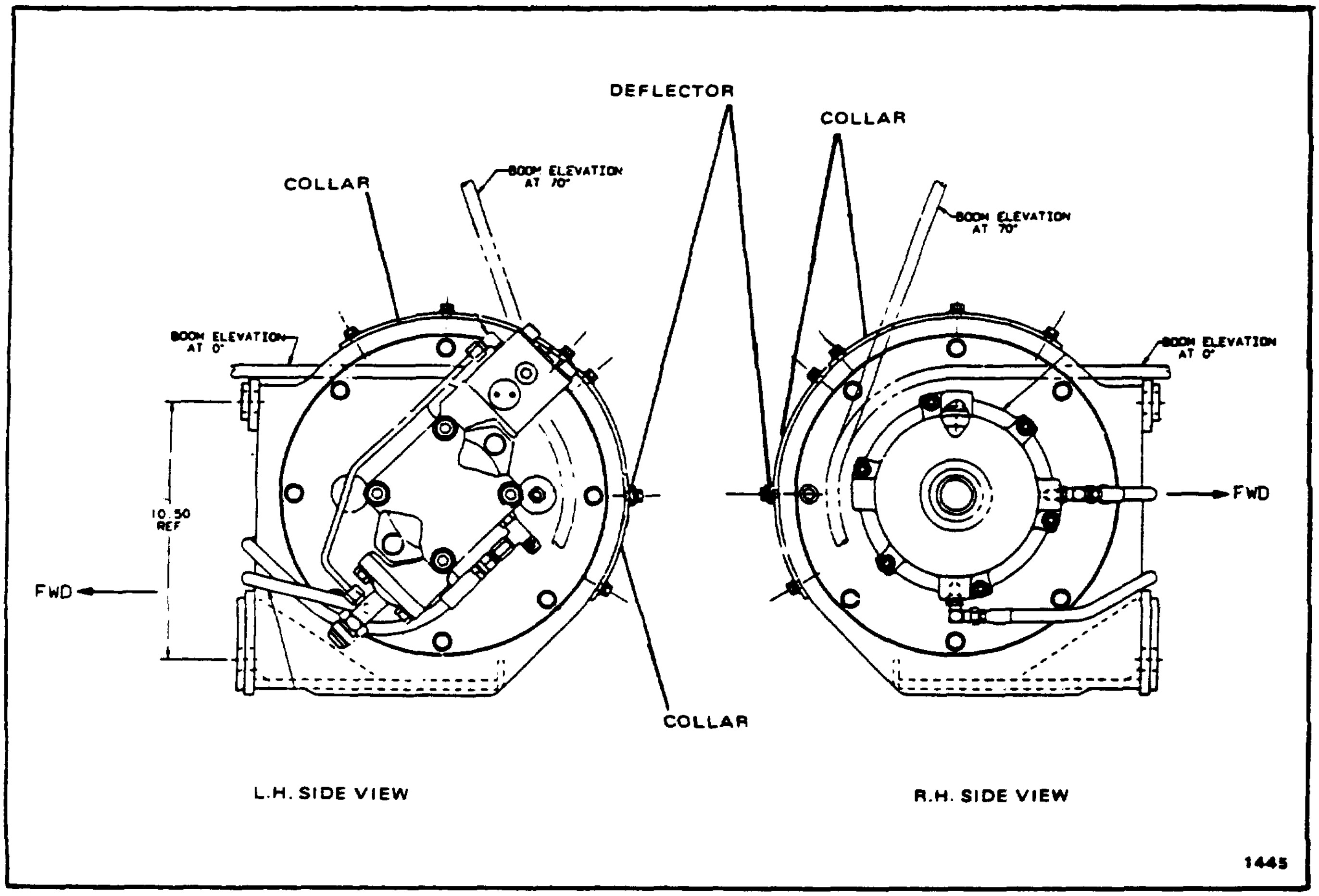
11. Install the O-ring (24) on the brake end housing cover (5).



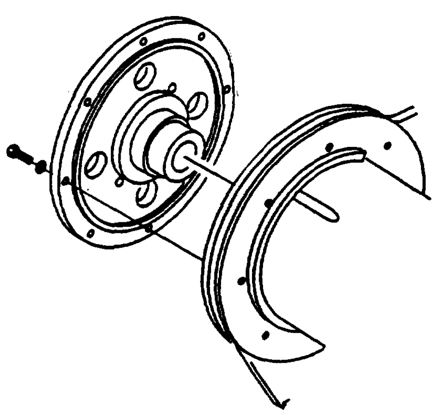
12. Install the brake end housing cover (5) to the right hand drum end (3) securing with the washers (32) and capscrews (31). Torque the capscrews to 31 lb ft (42 Nom).



13. Install the input shaft (14) into the motor end housing (4).



Deflector and Collar Location

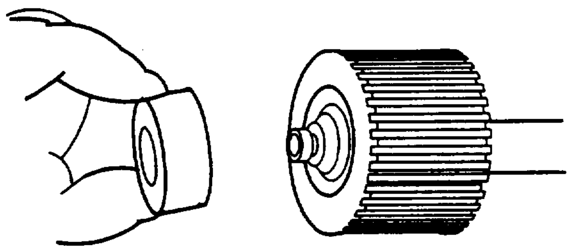


14. Install the motor end housing cover (4) to the drum with the washers (38) and capscrews (37). Torque the capscrews to 31 lb ft (42 N•m).

15. Install the hoist housing collars (48) and deflector (44). Refer to figure titled, Deflector and Collar Location, for proper location. Install the washers (47), flatwashers (46), and screws (45) and secure the collars and deflector. Torque the screws 12 to 14 lb ft (16 to 19 N•m).

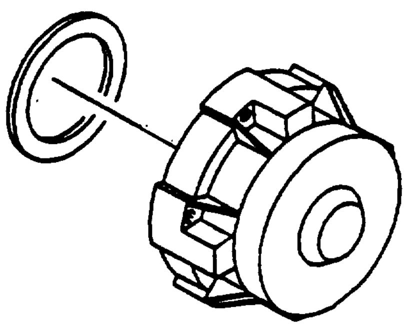
Brake Assembly.

1. Install the shaft (13) into the clutch (8) with the two bolt holes in the clutch up.

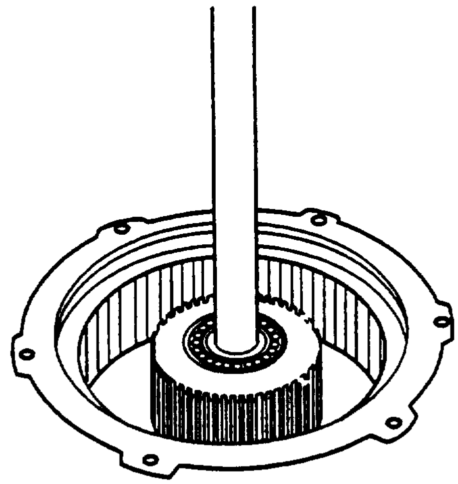


2. Install the bearing (17) and spacer (18) on the shaft (13).

3. Install the O-rings (22 and 23) on the piston (7).

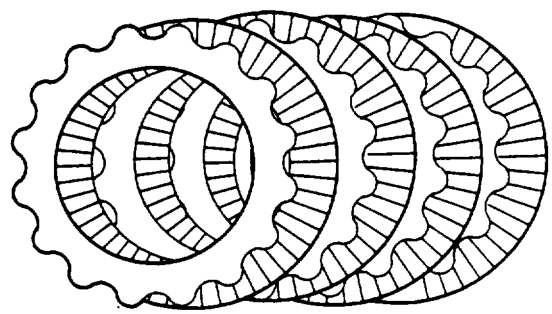


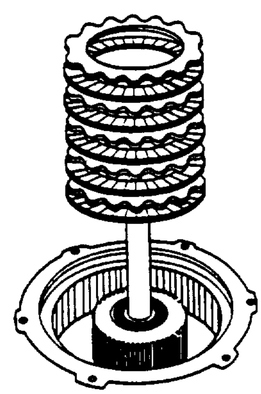
4. Install the spacer (20) into the brake housing (6).



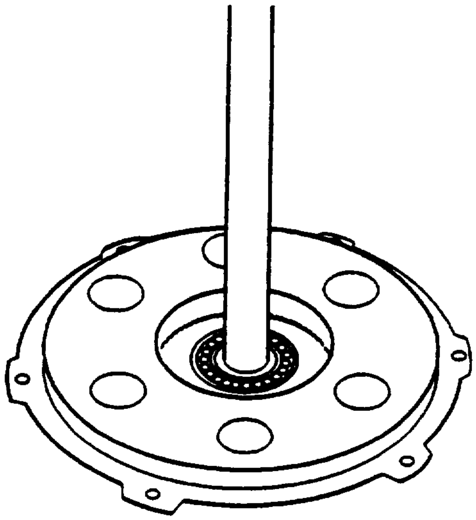
5. Install the clutch assembly (8) into the brake housing (6).

6. Install the snap ring (19) onto the shaft.



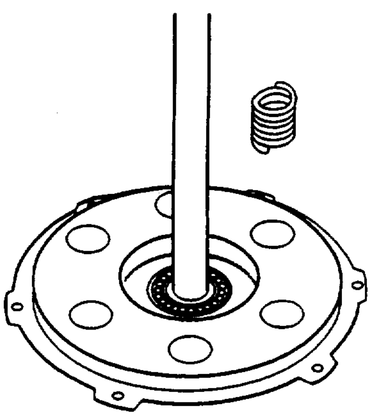


7. Install a brake stator (9) followed by a brake disc (10) alternating until all discs and stators are installed.

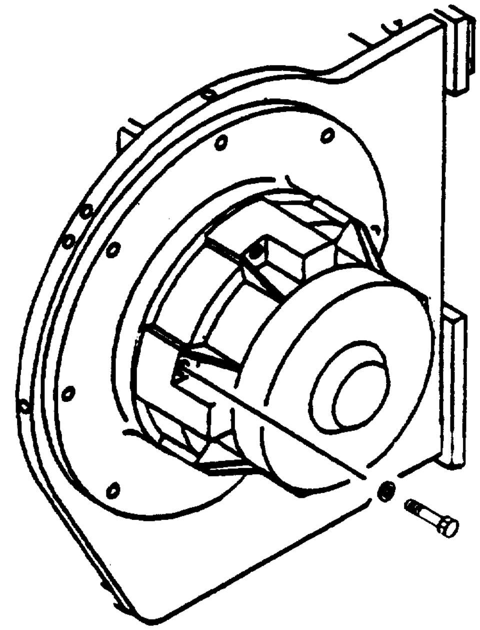


NOTE
The 0.030 diameter vent hole in the piston should be located toward the top of the brake housing.

8. Install the piston (7) into the brake housing (6).



9. Install the springs (21) into the piston (7).



10. Position the brake assembly in place on the brake end housing cover (5). Secure with the capscrews (29) and lockwashers (30). Torque the bolts to 31 lb ft (42 N•m).

Hydraulic Motor.

1. Position the motor in place on the motor end housing cover (4). Secure with the washers and bolts. Torque the capscrews to 75 lb ft (101 N•m).

VANE TYPE MOTOR

DESCRIPTION

The vane type motor is a fixed displacement, rotary balanced motor that converts hydraulic oil flow into rotary mechanical motion. The motor consists of four basic subassemblies; a body or housing and shaft with a permanently lubricated bearing, a front port plate assembly consisting of the port plate with a built-in check valve, a cam ring assembly containing the rotor, vanes, vane springs and cam ring, and the end cap assembly consisting of the end cap and needle bearing.

THEORY OF OPERATION

During operation, hydraulic oil flows through either one of the two ports in the end cap and is directed to both sides of the cam ring assembly through the cast ports in the end cap and port plate assembly. The pressure applied against the vanes forces the rotor to turn and at the same time rotates the motor shaft. As the rotor turns, the oil moves to the discharge ports in the port plate and end cap.

MAINTENANCE

TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1 External leakage.	a. Seal failure.	a. Replace seal.
	b. Defective casting.	b. Replace casting.
2. Leakage at fittings.	a. Cracked casting. b. Defective threads. c. Damaged O-ring d. Burr.	a. Replace. b. Replace. c. Replace. d. Stone or file flat.
3. Loss in speed under load.	a. Low inlet pressure. b. Excessive back-pressure at out-let. c. Scored port plate or end cap. d. High oil temperature.	a. Check pressure. b. Check pressure. Check the line for restrictions. c. Relap flat to clean up. d. Use heavier oil; adjust relief valve setting.
4. Poor speed control.	a. Worn rotating group.	a. Replace.

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Motor fails to start turning.	a. Insufficient torque.	a. Increase relief valve pressure setting.
	b. Excessive motor leakage.	b. Check flow from motor outlet if excessive, check shuttle valve in front port plate. Pressure not loading plate causing plate to move away from cam ring.
	c. Worn port plates.	c. Replace.
	d. Worn rotating group.	d. Replace.
	e. Defective O-ring on OD of front port plate.	e. Replace O-ring if damaged.
	f. Insufficient pump delivery.	f. Pump worn.
	g. Motor too small.	g. Use larger size cam ring.
6. Shaft play.	a. Worn bearings.	a. Replace.
	b. Hammering coupling on shaft.	b. Coupling bore should be slip fit on shaft.
7. Excessive noise.	a. Worn or damaged internal parts.	a. Disassemble to remove rotor, vane, cam ring assembly. Inspect for exessive wear. Check condition of faces of port plate and end cap. Rework (lap) or replace if scuffed.
	b. Air in system.	b. Bleed air off- check fittings for, tightness.

DISASSEMBLY.

Drain all fluid from the motor and thoroughly clean all exterior surfaces. Prepare a clean, lint-free surface on which to lay the internal parts of the motor.

1. Secure the motor in a vise or other suitable holding fixture with the shaft (21) extended down.

2. Remove the screws (1) and remove the end cap (2) from the body.

3. Remove the rubber seal ring (3) from the end cap (2).

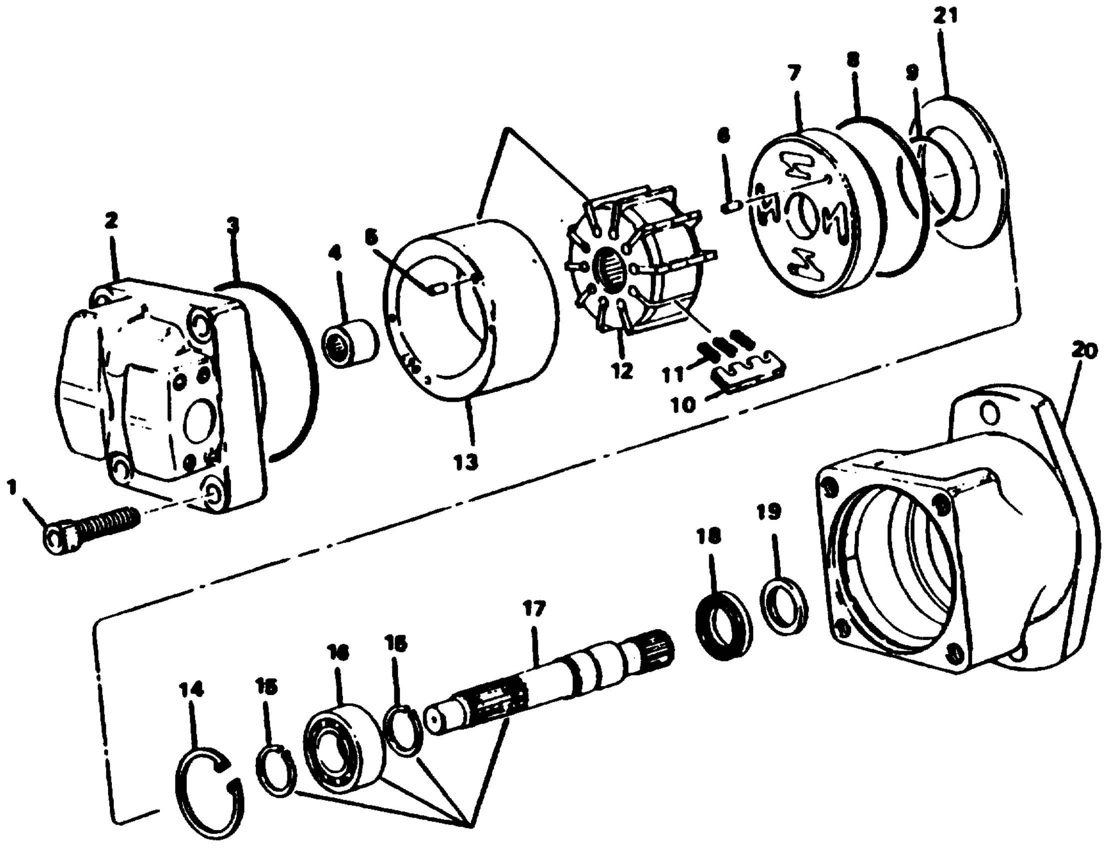
4. Check the needle bearing (4) in the end cap. If it is worn or damaged, remove it. It must be replaced.

5. Remove the dowel pin (5) from the cam ring assembly (6).

6. Thread two No. 10-24 screws in the two tapped holes provided as puller holes in the cam ring (7) and remove the cam ring assembly (6) as a unit (7, 8, 9, and 10).

NOTE

If resistance is encountered when lifting the cam ring assembly, lightly tap the outside of the body while lifting the assembly. This will help in removing the cam ring, rotor, vanes, and springs as a unit.



1. Capscrew
2. End Cap
3. O-Ring
4. Bearing
5. Pin
6. Pin
7. Plate
8. O-Ring
9. O-Ring
10. Vanes
11. Springs
12. Vanes
13. Cam Ring
14. Snap Ring
15. Ring
16. Bearing
17. Shaft
18. Shaft Seal
19. Felt Washer
20. Body
21. Belleville Washer

Vane Motor - Exploded View

WARNING

THE VANES ARE HELD AGAINST THE CAM RING BY TENSION FROM THE SPRINGS IN THE ROTOR. IF THE ROTOR IS PULLED FROM THE CAM RING WITH NO PROTECTION, TENSION FROM THE SPRINGS WILL THROW THE VANES OUT IN ALL DIRECTIONS. THE FOLLOWING PROCEDURE MUST BE FOLLOWED WHEN DISASSEMBLING THE ROTOR AND VANES FROM THE CAM RING.

7. Place the cam ring assembly on a clean, flat surface. Push the rotor and vanes from the cam ring far enough to secure a piston ring compressor over the vanes (8) and around the rotor (10).

8. After the compressor is in place, push the rotor and vanes the remainder of the way out of the cam ring.

9. Release the tension on the compressor and remove the vanes (8) and vane springs (9) from the rotor (10).

10. Remove the dowel pin (11) from the port plate assembly (1 2).

11. Thread two No. 10-24 screws into the puller holes in the port plate assembly (12) and remove it from the body (24).

12. Remove the setscrews (13) in the side. Remove the adapter valve (14) and balls (26) from the drilled passage. The drilled holes in the port plate must be clean and free from burrs.

13. Remove the rubber seals (15 and 16) and the belleville washer (25).

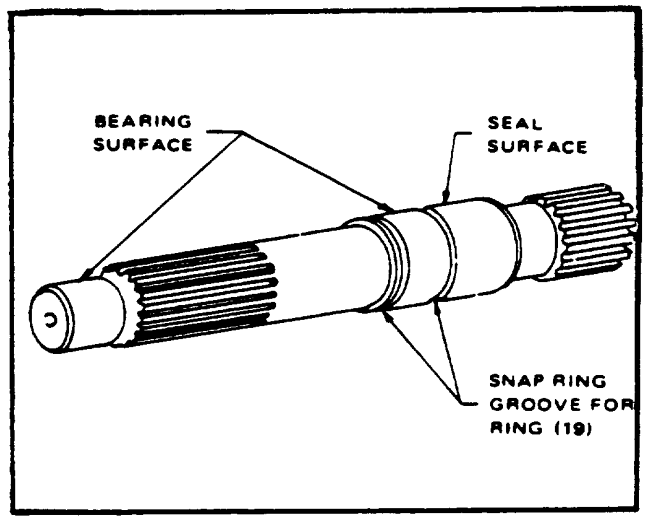
14. Remove the snap ring (17) from the housing (24).

15. Press on the external end of the shaft (21) and remove the shaft and bearing assembly (18) from the housing.

16. Examine the bearing (20) for wear before removing it from the shaft. Apply a little pressure to the outer race and rotate the bearing to check the steel balls and race for wear or cracks. Check for looseness. Remove the bearing from the shaft if a replacement is needed. Inspect the outside diameter of the shaft at the point of contact with the bearing and also the sealing surface area for the shaft seal.

CAUTION

THE TWO SNAP RINGS (19) MUST BE REMOVED BY PASSING OVER THE INTERNAL END OF THE SHAFT AND NOT THE SHAFT SEAL SURFACE. DAMAGED SEAL SURFACE WILL CAUSE THE SEAL TO LEAK.



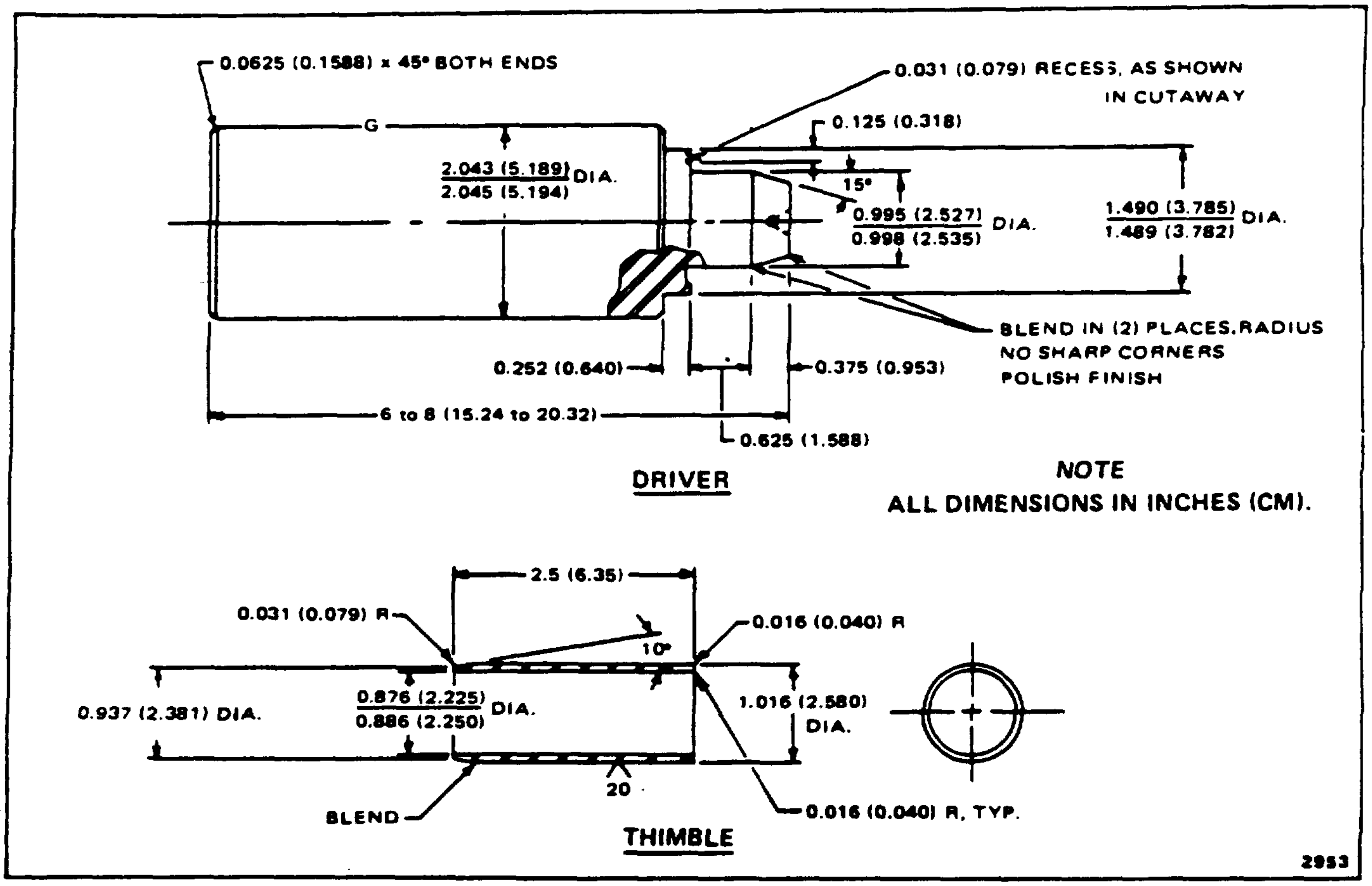
Motor Shaft

17. Remove one of the snap rings (19) and press the bearing (20) from the shaft. Remove the other snap ring (19).

18. Remove the felt wiper (23) and shaft seal (22) from the body.

CLEANING AND INSPECTION.

1. Wash all metal parts in cleaning solvent (Stoddard Solvent or equal) and dry thoroughly.



Vane Motor Special Tools

2. Inspect the seals for wear, breaks, cuts, and brittleness. Check closely the shaft seal for scratches and cracks. Discard and replace all defective seals.

3. Inspect all springs for wear on the OD, for cracks or permanent set. Replace all defective springs.

4. Inspect the bearings for wear or flat spots. If the bearings are rough or loose they must be replaced.

5. Inspect the cam ring for excessive wear (ripples or washboard marks on the contour). Replace a badly worn or defective cam ring.

6. Inspect the rotor for scored, marred, or scratched (faces and vane slots) surfaces. Replace a defective rotor.

7. Inspect the vanes for excessive wear marks (burrs, nicks, and scoring). Replace any defective vanes.

8. Inspect the wear surfaces of the port plate and end cap for deep scratches. Replace if defective.

9. Inspect the housing and end cap for cracks or other casting damage. Replace all damaged castings.

10. Inspect the shaft for excessive wear (internal, spline, bearing surface. and drive end). Replace if defective.

CAUTION

DIRT IS A MAJOR CAUSE OF WEAR AND MOTOR FAILURE. COVER ALL PARTS AFTER CLEANING TO PREVENT DUST AND DIRT FROM SETTLING ON THEM. ALL SURFACES SHOULD BE COATED WITH A FILM OF HYDRAULIC LUBRICATING OIL AFTER THEY HAVE BEEN CLEANED.

ASSEMBLY.

Immerse the seals and bearings in clean hydraulic fluid to make the assembly easier and to provide initial lubrication.

NOTE

Do not install the retaining ring over the external drive end of the shaft as damage may be done to the seal surface next to the groove.

1. Install one retaining ring (19) in the groove nearest the external drive end of the shaft (21).

NOTE

There is an intentional interference fit between the ball bearing inner race and the shaft OD.

2. Press on the ball bearing inner race only and press the ball bearing (20) on the shaft (21) and against the retaining ring (19). Install the other retaining ring (19) into the groove provided.

NOTE

Two special tools must be fabricated to accomplish the following steps. See the figure for specifications on making these special tools.

3. Saturate the felt wiper (23) in oil and remove all excess oil. Position the housing (24) on a clean flat surface with the center line vertical and the large bore up. Install the felt wiper (23) into the bore in the housing (24).

4. Position the shaft seal (22) on the shaft seal driver (special tool) with the open face of the seal against the driver.

5. Apply lubricating fluid to the OD of the seal and install the seal in the 1 1/2-inch bore of the housing (24).

NOTE

Ensure no sealing compounds get on the seal element or the shaft. Keep all foreign matter from the sealing lips of the seal to prevent cuts and abrasions.

6. Position the thimble (special tool) over the coupling end of the shaft assembly (18) and press the assembly into the housing (24).

7. Press on the outer race of the bearing until the bearing is seated against the bottom of the bearing bore. Remove the thimble from the shaft.

8. Install the snap ring (17) in the housing (24). Ensure the snap ring is fully seated in the groove.

NOTE

Inspect the check valve drilling in the port plate to ensure all the passages are clean.

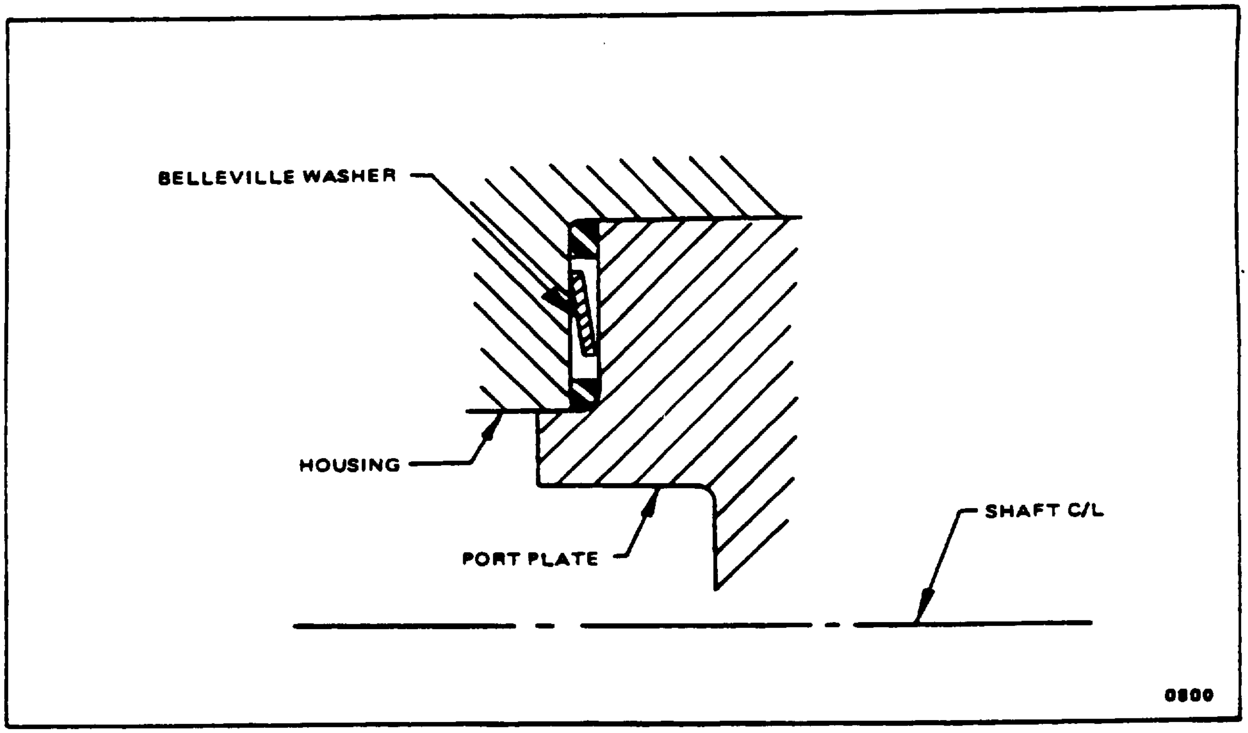
9. Position the port plate (12) so the check valve drilling is vertical. Install one 0.187 diameter ball (26).

10. Install the adaptor valve (14) with the chamfered end first.

11. Install the setscrew (13) until it bottoms against the adaptor valve (14). Firmly hand tighten the setscrew. This should jam the chamfered end of the adaptor valve (14) into the chamfered seat between the no. 4drill and "Q" drill in the port plate (12) to create a metal to metal seal.

12. Lubricate the seals (15 and 16). Install seal (15) in the bottom of the bore of the housing (24) and seal (16) around the small diameter of the port plate (12).

13. Position the housing (24) centerline vertical and the large bore up, and install the belleville washer (25) in the bottom of the housing bore. The outside diameter of the belleville washer should contact the housing (24) and should also be centered inside seal (15). Refer to Location of Belleville Washer illustration.



Location of Belleville Washer

14. Install the port plate (12) into the housing (24) until it bottoms on the belleville washer (25).

15. Line up the dowell pin hole with the threaded hole for the end cap, at the lower right corner of the housing (24). Install the dowel pin (11) in the dowel pin hole in the port plate (12).

16. Place the cam ring (7), rotor (10), vanes (8), and vane springs (9) on a clean flat surface. Arrange the vanes side by side with the three spring holes up. Insert the vane springs in the vanes. Install the vanes with the springs in slots in the rotor.

CAUTION
ENSURE THE SPRINGS ARE STARTED IN THE HOLES IN EACH ROTOR SLOT.

17. Place a ring compressor around the vanes and tighten the compressor gradually until the springs and vanes are in the position they will occupy while in the cam ring. Place a backup plate, slightly smaller than the outside diameter of the rotor in the ring compressor and push the rotor, springs and vanes into the cam ring. The backup plate will prevent the vanes from sliding end wise in the rotor slots and damaging the slots and springs.

WARNING
ENSURE THE ROTOR AND VANE ASSEMBLY IS INSERTED FAR ENOUGH IN THE CAM RING TO PREVENT THE VANES FROM FLYING OUT OF POSITION WHEN THE RING COMPRESSOR IS REMOVED.

18. Lubricate the running face of the port plate. Thread two No. 10-24 screws into the tapped holes on the side of the cam ring (7) that indicates the cam size. Insert the dowel pin (5) in the cam ring (7) and position the complete assembly in the body over the other dowel pin (11). See the exploded drawing for the correct position.

19. Press the needle bearing (4) into the end cap (2). The bearing should be flush with the counterbore approximately 1/32 deep from the wear face.

20. Lubricate the rubber seal (3) and install around the diameter of the cap (2).

21. Lubricate the pumping cartridge and running face of the end cap (2). Line up the dowel pin hole in the end cap (2) with the dowel pin (11) in the cam.

22. Install the cap (2) into the housing (24) and secure with the capscrews (1). Torque the capscrews 70 to 80 lb ft (95 to 108 N•m).

HYDRAULIC SWIVEL

DESCRIPTION

The hydraulic swivel is used to provide hydraulic oil from the carrier to the superstructure or from the superstructure to the carrier. The hydraulic swivel is located at the centerline of rotation of the superstructure. The hydraulic swivel consists of a case, a spool, a mounting plate, and seals.

THEORY OF OPERATION

All oil is routed into the spool portion of the swivel where, through a series of internally drilled passages, oil is transferred to a circumferential channel on the spool exterior. This channel corresponds with a mating port on the barrel of the swivel. Each channel is separated by a series of teflon and O-ring seals that prevents transfer of oil and pressure. Return oil flow from the crane functions is accomplished In the same manner through another set of ports.

MAINTENANCE

DISASSEMBLY.

NOTE

There are two major differences in hydraulic swivels. they may vary in the amount of ports and the method in which the spool is retained in the case. The spool may be held within the case by either a snap ring or by capscrews with retaining clips.

NOTE

Any maintenance requiring disassembly of the hydraulic swivel should include replacement of all seals and rings.

1. Remove the capscrews and retaining clips or the snap ring that secures the spool in the swivel case.

2. Withdraw the spool from the barrel.

NOTE

During routine maintenance it is not necessary to remove the mounting plate. Use the mounting plate for blocking.

3. Plate the spool on a clean work surface in a dust-free area and block the spool to prevent movement during disassembly.

CAUTION

WHEN REMOVING THE SEALS AND RINGS, AVOID SCRATCHING THE GROOVED AND GLAND SURFACES.

4. Remove the seals and rings from the spool NOTE Aligning the discarded seals and rings in the order of disassembly will assist with installation of new seals and rings.

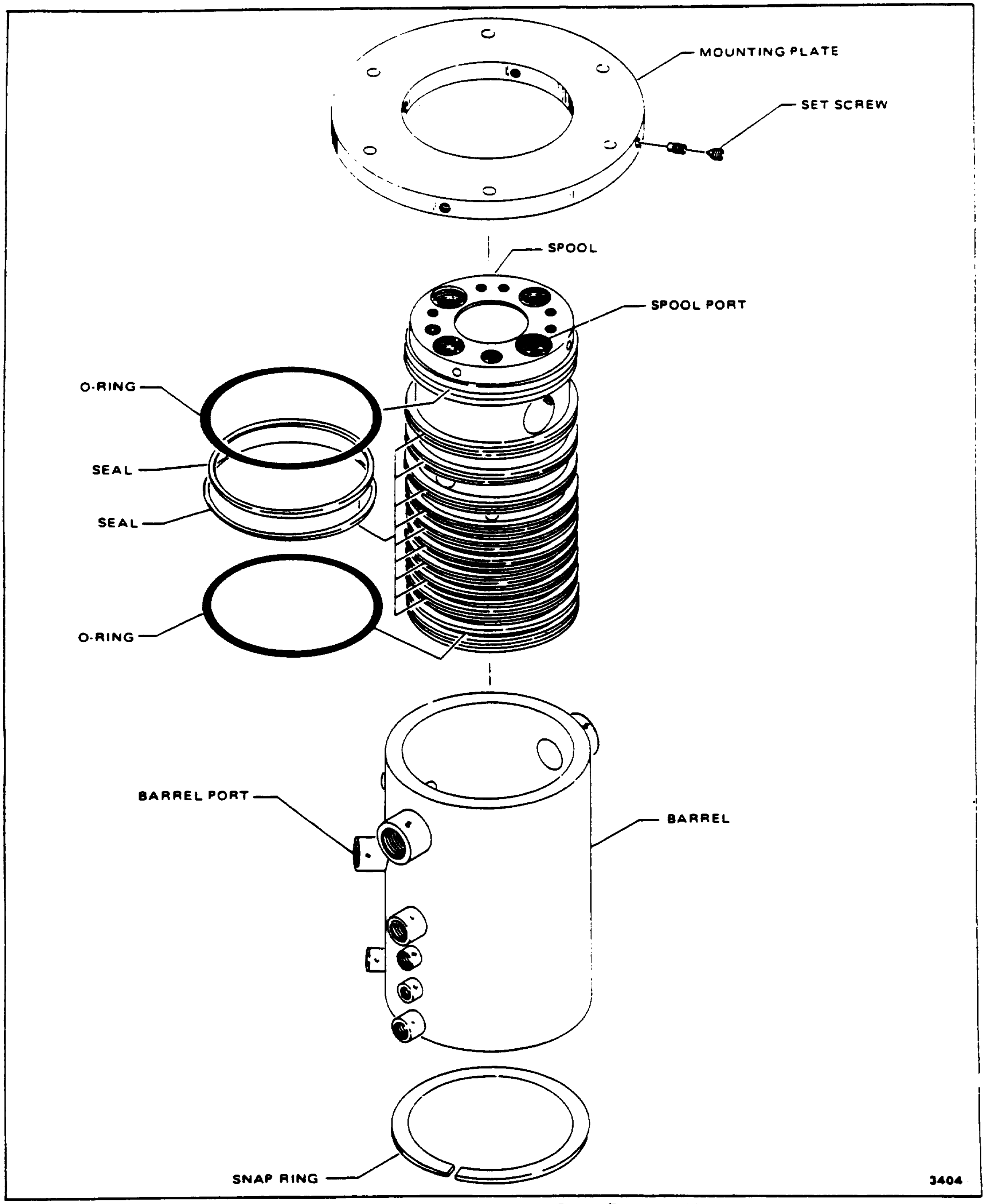
CLEANING AND INSPECTION.

1. Clean the spool and barrel with a suitable solvent and dry with compressed air.

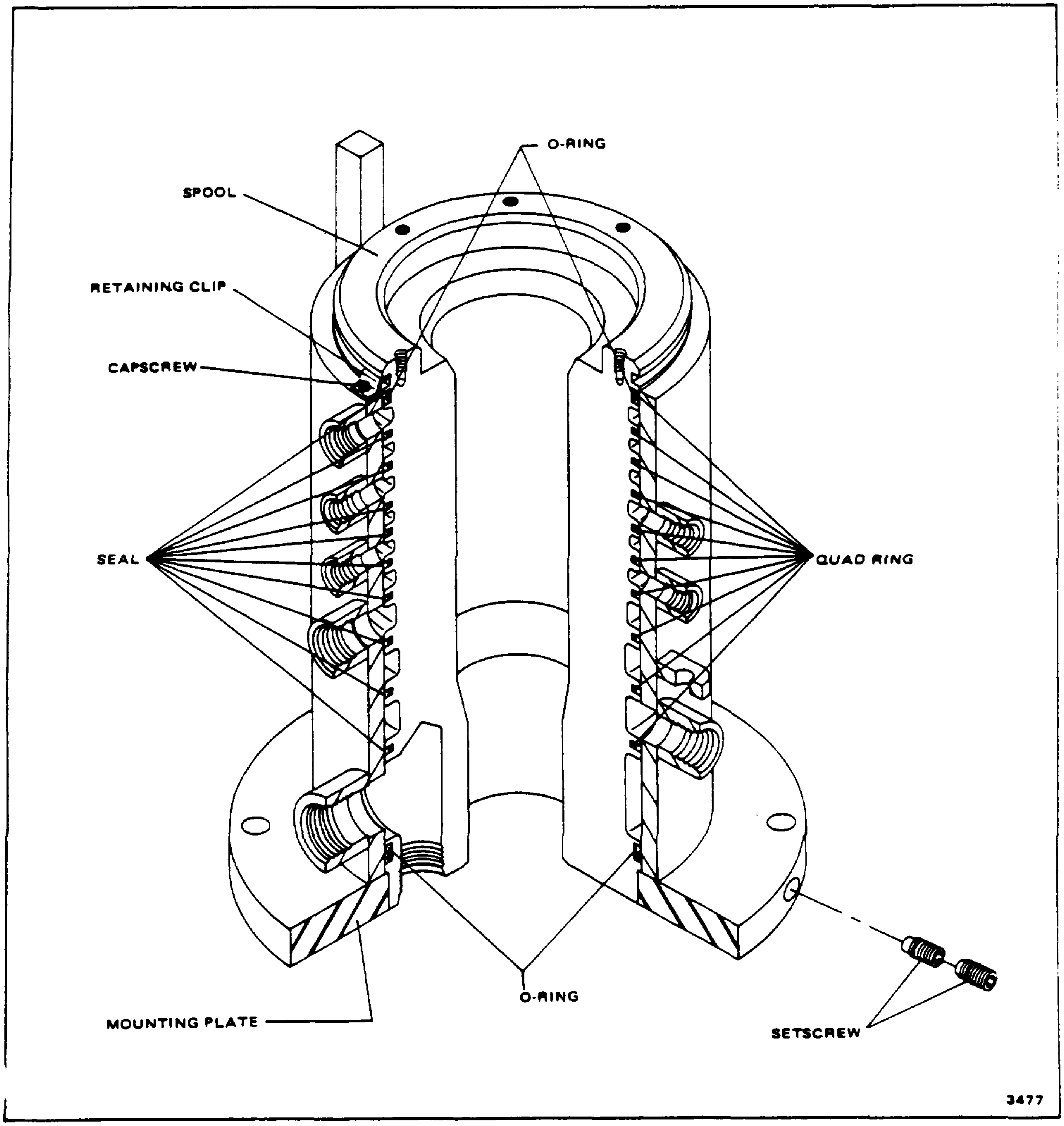
2. Check the spool and the inside of the barrel for scratches, grooves, scoring, etc. If any grooves have developed with a depth exceeding 0.005-inch (0.1270 mm), the unit should be replaced.

ASSEMBLY.

1. Lubricate the spool, seals, and rings with hydraulic oil or STP.



Typical Hydraulic Swivel with Snap Ring - Exploded View



Typical Hydraulic Swivel with Capscrews and Retaining clips - Exploded View

CAUTION

WHEN INSTALLING NEW SEALS AND RINGS, AVOID STRETCHING THE SEALS OR SCRATCHING THE GROOVED OR GLAND SURFACES.

2. Install new seals and rings on the spool using a walking method.

CAUTION

PROPER ALIGNMENT WHEN INSERTING THE SPOOL IS REQUIRED. DO NOT FORCE THE SPOOL INTO THE BARREL.

3. Insert the spool-into the berrrel. Secure the spool to the barrel with the capscrews and retaining clips or the snap ring.

TEST.

NOTE

For individual port test pressures refer to the HYDRAULIC SWIVEL in the Service Manual.

NOTE

Use only 10W hydraulic oil during pressure testing.

1. Install a pressure gauge into a port on the swivel case.

2. Install a pressure line in the corresponding port in the swivel spool.

3. Allow the ports, on each side of the port to be tested, to vent in order to detect leakage.

4. Pressurize the port to be tested while rotating either the spool or case 360 degrees.

5. If leakage is detected disassemble the swivel and determine the cause.

6. Pressure check each port individually until all ports have been tested.

ELECTRIC SWIVEL

DESCRIPTION

The electrical swivel consists of brushes, collector rings, and a cover assembly. It is mounted on top of the air/hydraulic swivel. The electrical swivel is used to conduct power between the carrier and the superstructure.

THEORY OF OPERATION

The electrical swivel is located on top of the air/transmission swivel and transfers electricity between the carrier and superstructure. Wiring harnesses transmit the electricity from the carrier components to the collector ring assembly on the swivel. The brush assembly then picks up the electricity and through wiring harnesses transmits the electricity to the superstructure components.

MAINTENANCE

NOTE

Although the amount of slip rings will vary, disassembly and assembly procedures are the same.

DISASSEMBLY.

NOTE

Do not disconnect the collector core wires at the top of the swivel assembly.

1. Move the swivel to a clean work area and block it from moving. (Block against the center post.)

2. Perform Prior to Disassembly located in the CLEANING AND INSPECTION part of this Package.

3. Tag and disconnect the knife disconnects on the brush and arm assemblies.

4. Remove the nuts and washers on the brush holding studs.

5. Remove the nylon outboard bearing.

6. If there are any spacers (on the brush holding studs) located under the nylon outboard bearing, remove and save them.

CAUTION

ENSURE THE BRUSH AND ARM ASSEMBLIES ARE PROPERLY TAGGED WITH THE CORRESPONDING CIRCUIT NUMBERS.

NOTE

When removing the brush and arm assemblies. it will help if they are kept in order.

7. Remove the brush and arm assemblies.

8. Loosen the setscrews securing the collector core to the mounting bracket and remove the collector core.

9. Remove the nylon bearing from the mounting bracket.

10. Perform After Disassembly located in the CLEANING AND INSPECTION part of this Package.

CLEANING AND INSPECTION.

Prior to Disassembly.

1. Check all brushes for proper contact with the collector ring conductors. Note any brush sets which

are oil-soaked or worn to one-half of their original length. These must be replaced.

2. Check the spring tension of each brush. Any that are damaged or weak must be replaced. Spring tension should be sufficient to firmly hold the brushes against the collector ring.

3. Inspect the collector ring conductors for arcing, pitting, and corrosion. Under some conditions, the ring will have a tendency to collect fine silt and in a salt atmosphere, corrosion will occur. If this happens, rotate the collector core several times. This should clean the ring. If it does not, it might be necessary to clean the core after disassembly.

4. Check the continuity between each of the collector core rings surfaces and the electrical leads. If any conductors are defective they must be replaced.

After Disassembly.

1. If the collector rings are corroded, it may be necessary to use a standard non-residue solvent to clean them. Then lightly sand the brushes with double-ought (2/0) nonabrasive material. Blow out any dust with compressed air.

2. Any brush sets that are oil soaked cannot be cleaned. They must be replaced.

3. If the nylon bearing is worn, replace it.

ASSEMBLY.

1. Install the nylon bearing in the mounting bracket.

2. Install the collector core in the mounting bracket and tighten one setscrew to secure the core to the center post. (This setscrew will be loosened later).

CAUTION

ENSURE THE BRUSH AND ARM ASSEMBLIES ARE INSTALLED IN THE PROPER ORDER.

CAUTION

ENSURE THAT ANY BRUSH AND ARM ASSEMBLIES THAT HAVE BEEN REPLACED ARE OF THE PROPER ELECTRICAL CAPACITY.

NOTE

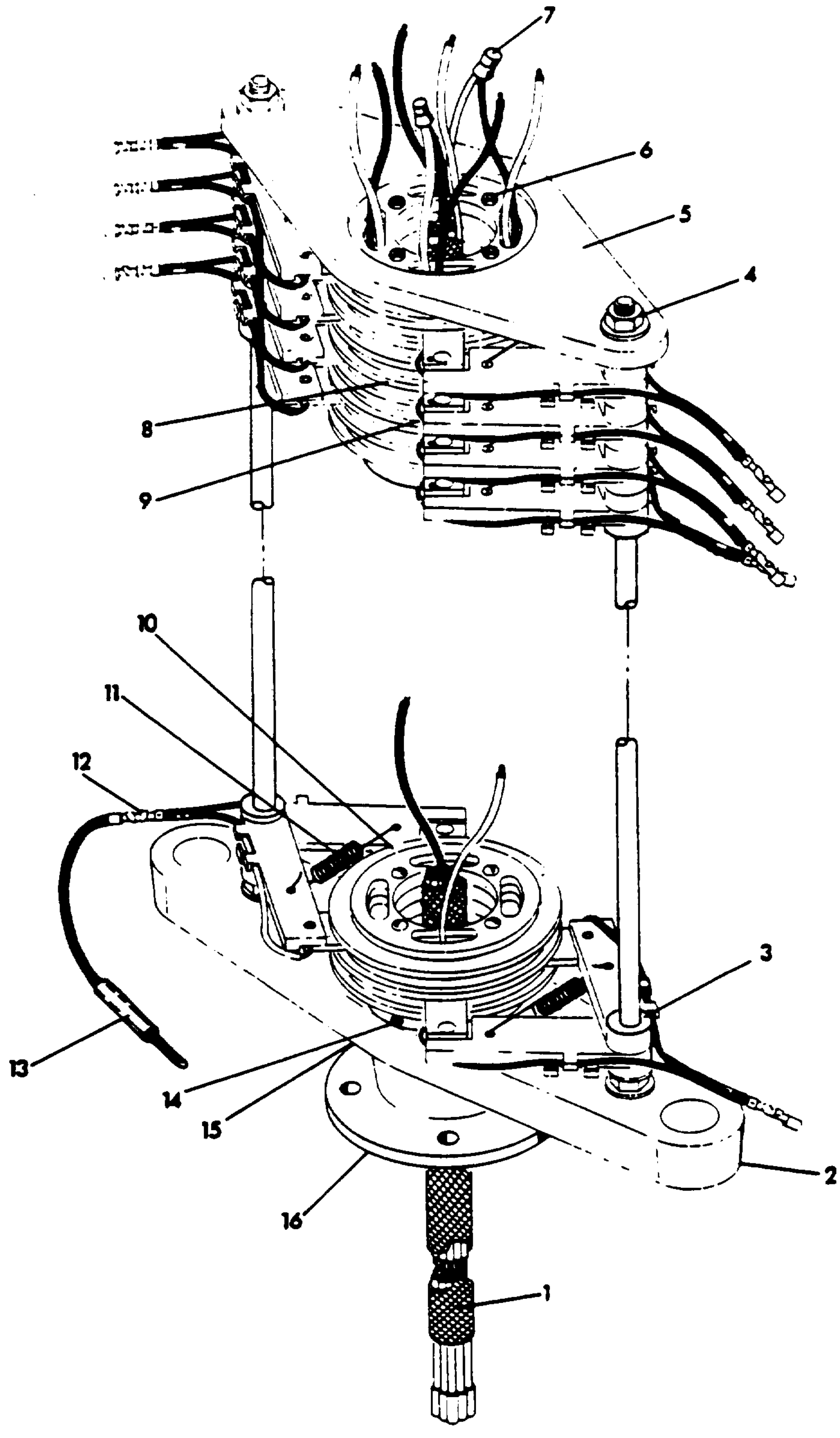
When installing the brush and arm assemblies, do not unhook the springs. Use your fingers to spread the brush arms while sliding the brush and arm assemblies onto the holding studs.

3. Install the brush and arm assemblies.

4. Install any spacers that were taken off.

5. Install the nylon outboard bearing and the nuts and washers.

6. Connect the knife disconnects on the brush and arm assemblies. Slide the plastic sleeves over the knife disconnects.



1. Collector Ring Harness
2. Mounting Bracket
3. Brush and Arm Assembly
4. Brush Holder Stud
5. Nylon Outboard Bearing
6. Brass Studs
7. Crimp Connectors
8. Nylon Ring
9. Brass Ring
10. Collector Core
11. Brush Spring
12. Knife Disconnect
13. Plastic Sleeve
14. Setscrew
15. Nylon Bearing (Not Visible)
16. Center Post

CAB HEATER/DEFROSTER (HOT WATER)

DESCRIPTION

The heater system consists of a heater core, heater hoses, a fan, and an electric motor. The heater box assembly prevents personnel from accidentally coming in contact with the fan or heater core.

THEORY OF OPERATION

Hot water is carried by the heater hoses from the engine to the heater core. A fan is used to circulate the heated air around the heater core out into the cab. The air flow is vented through the box assembly for either heat or defrost. The vent is controlled by the push-pull knob.

MAINTENANCE

DISASSEMBLY.

1. Remove the four screws securing the motor to the heater box. Remove the motor.

2. Remove the setscrew securing the fan to the motor shaft. Remove the fan.

3. Remove the chrome strip from the clips on the front upper cover.

4. Remove the front lower cover.

5. Remove the two screws securing the front upper cover to the heater box and remove the cover.

6. Slide the heater core from the box assembly.

INSPECTION.

1. Inspect the fan for any damage.

2. Inspect the heater core for any signs of leakage or other damage.

3. Inspect the heater hoses for frays, soft spots, wear, or any other damage.

4. Repair or replace any damaged component as necessary.

ASSEMBLY.

1. Install the heater core into the box assembly.

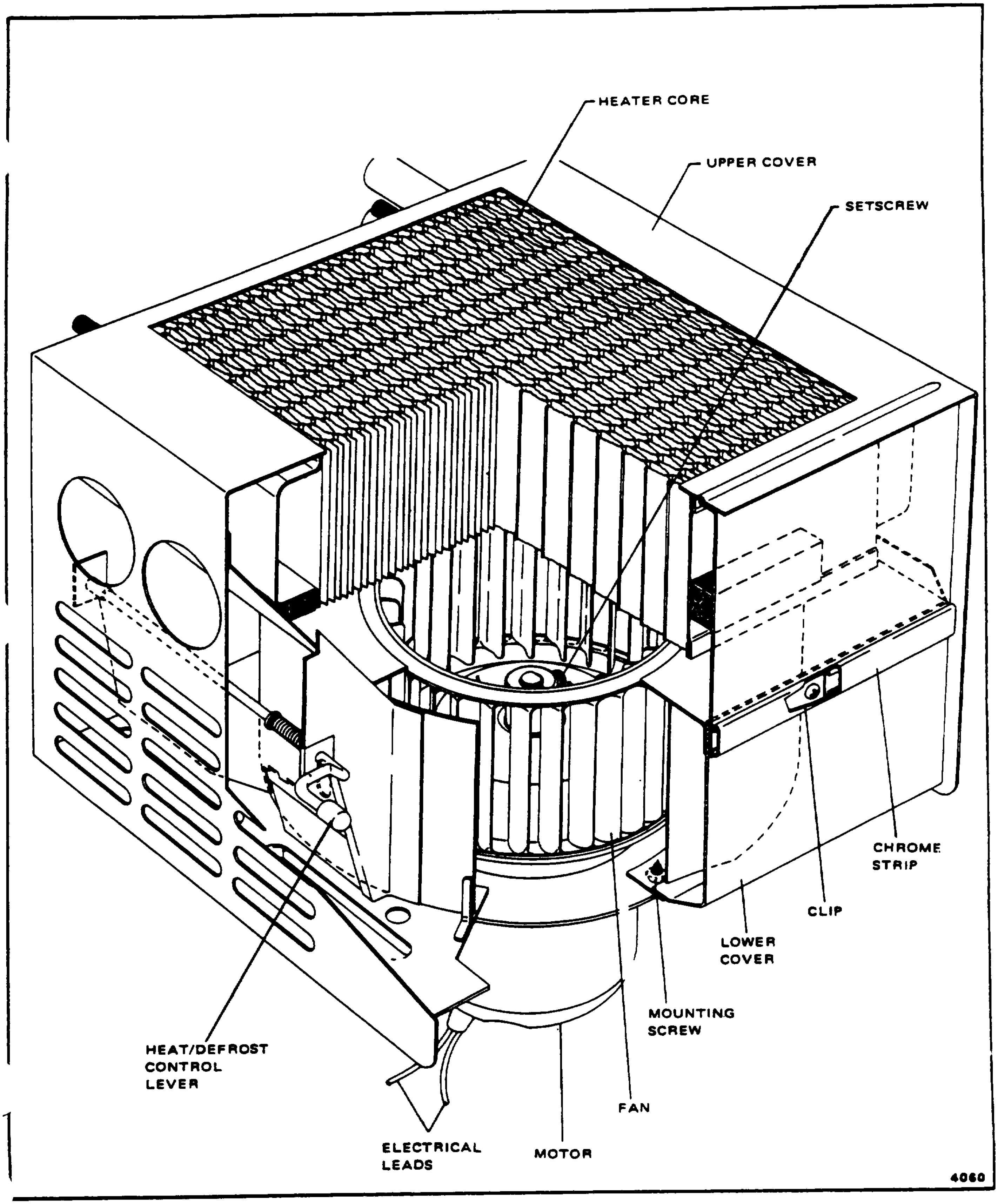
2. Install the front upper cover to the heater box with the two screws.

3. Install the front lower cover to the heater box.

4. Install the chrome strip to the clips on the front upper cover.

5. Install the fan to the motor shaft using the setscrew to secure it.

6. Install the motor to the heater box with the four screws.



Cab Heater/Defroster

ALPHABETICAL INDEX

ALPHABETICAL INDEX

ALPHABETICAL INDEX

ALPHABETICAL INDEX

ALPHABETICAL INDEX

Subject **Page**

E

ALPHABETICAL INDEX

Subject **Page**

E - continued

F

ALPHABETICAL INDEX

Subject **Page**

F - continued

G

ALPHABETICAL INDEX

Subject **Page**

G - continued

H

ALPHABETICAL INDEX

Subject **Page**

H - continued

I, J, K

ALPHABETICAL INDEX

Subject **Page**

I, J, K - continued

L

M, N

ALPHABETICAL INDEX

Subject **Page**

O

P, Q

ALPHABETICAL INDEX

Subject	Page

P, Q - continued

R

S

ALPHABETICAL INDEX

Subject **Page**

S - continued

ALPHABETICAL INDEX

Subject **Page**

S - continued

T

ALPHABETICAL INDEX

Subject **Page**

U

V

W, X, Y, Z

ALPHABETICAL INDEX

Subject **Page**

W, X, Y, Z - continued

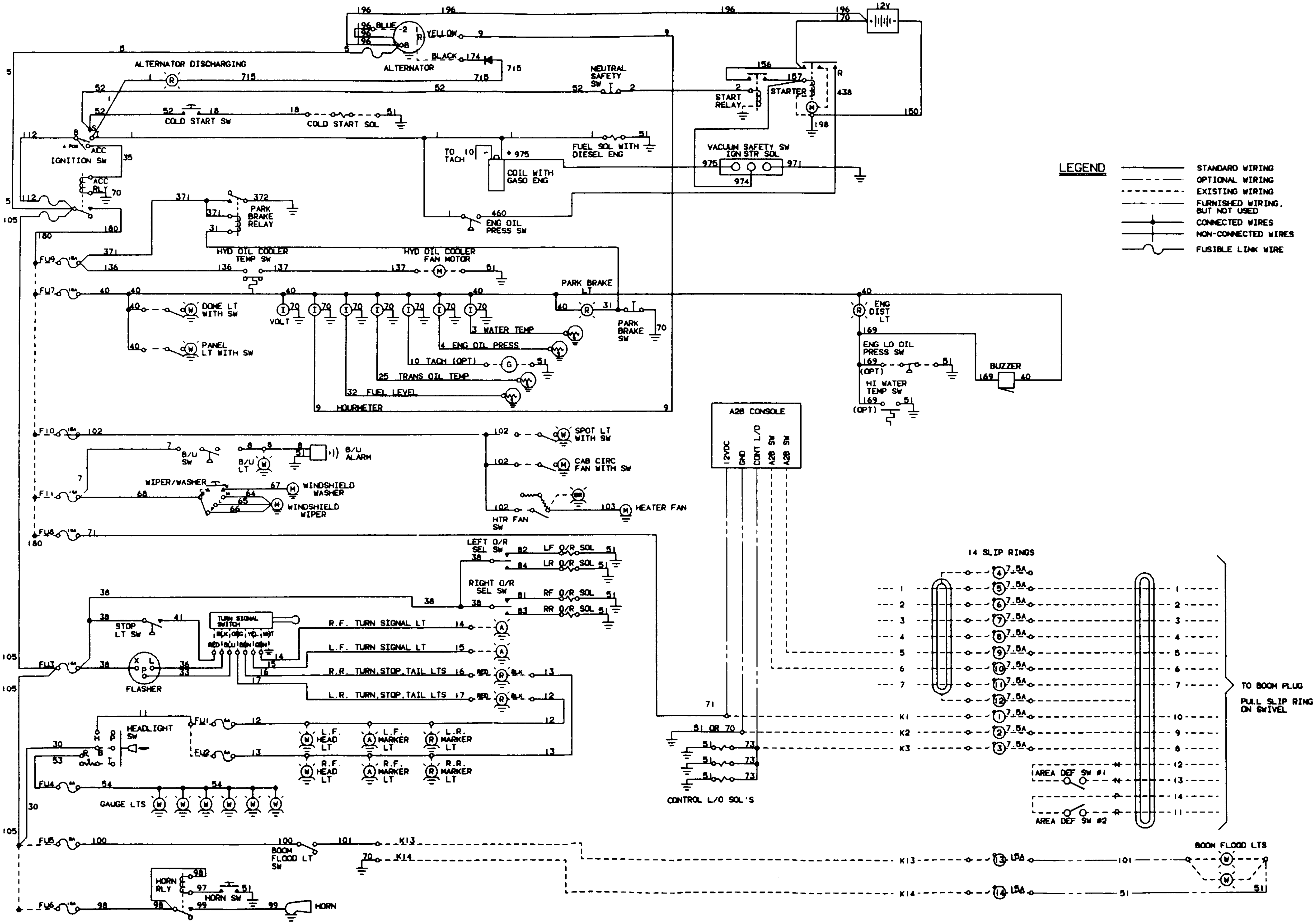


Figure FO-1. Electrical Schematic (Sheet 1 of 3).
FP-1/(FP-2 blank)

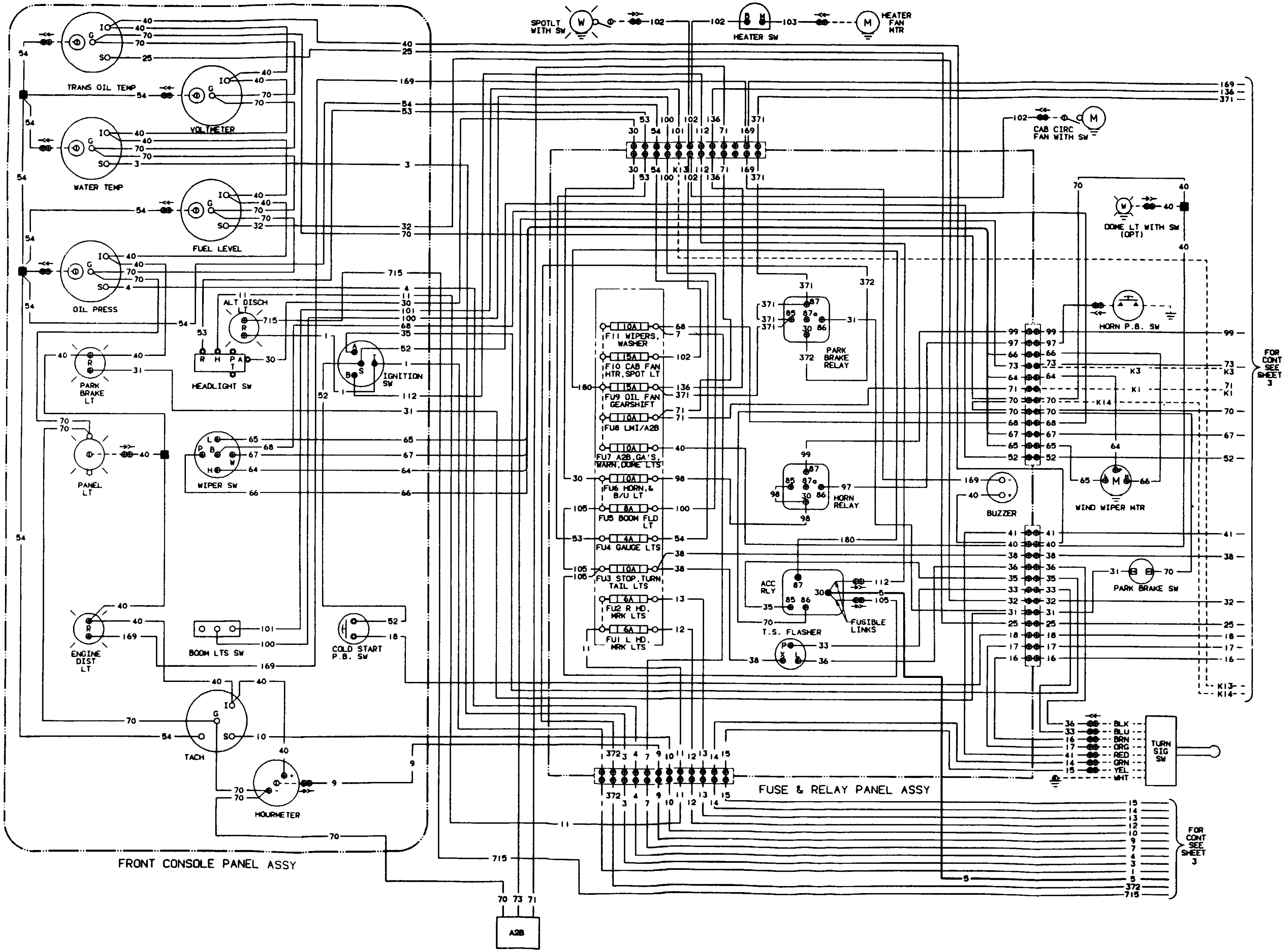


Figure FO-1. Electrical Schematic (Sheet 2 of 3).
FP-3/(FP-4 blank)

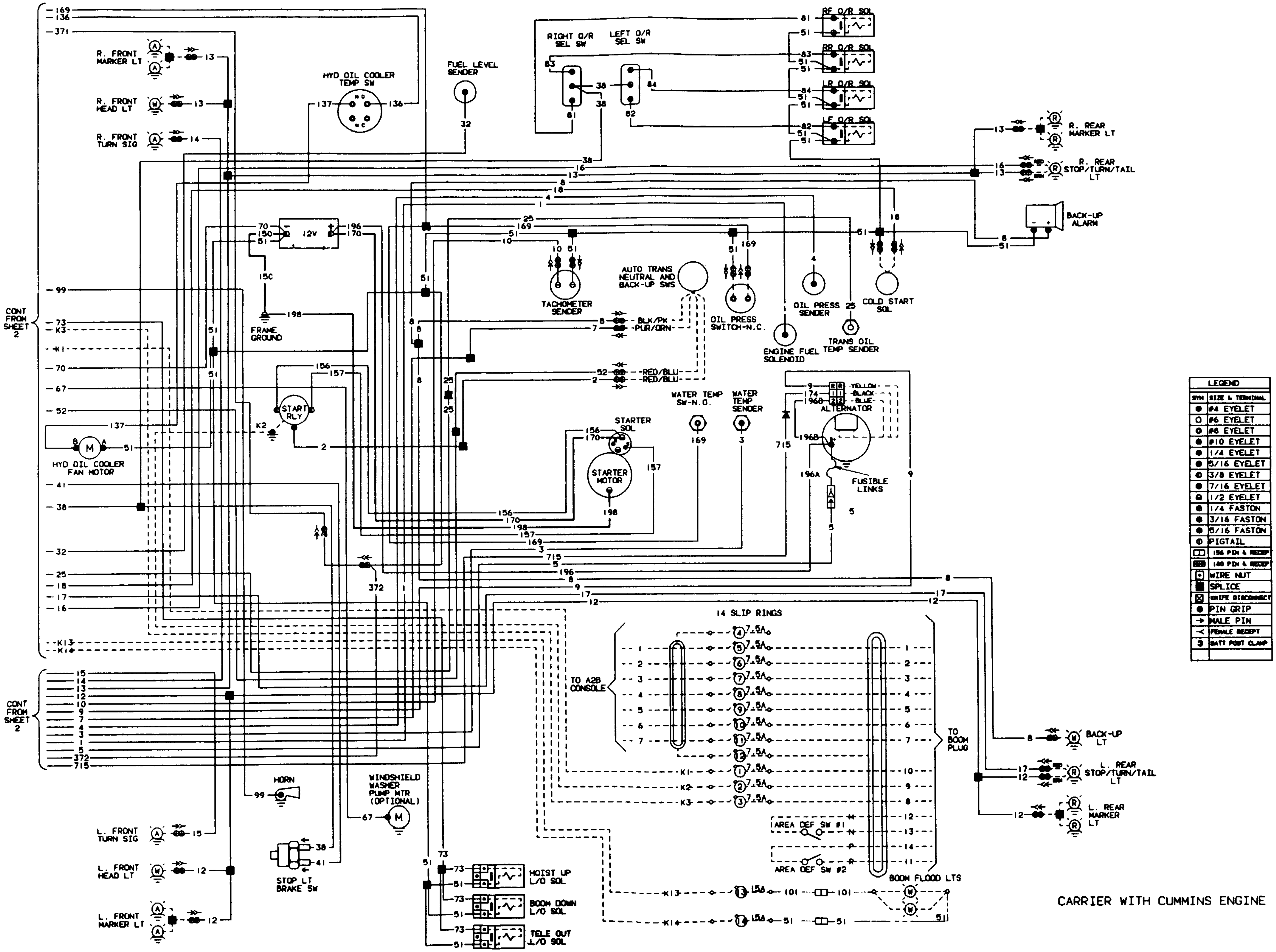


Figure FO-1. Electrical Schematic (Sheet 3 of 3).

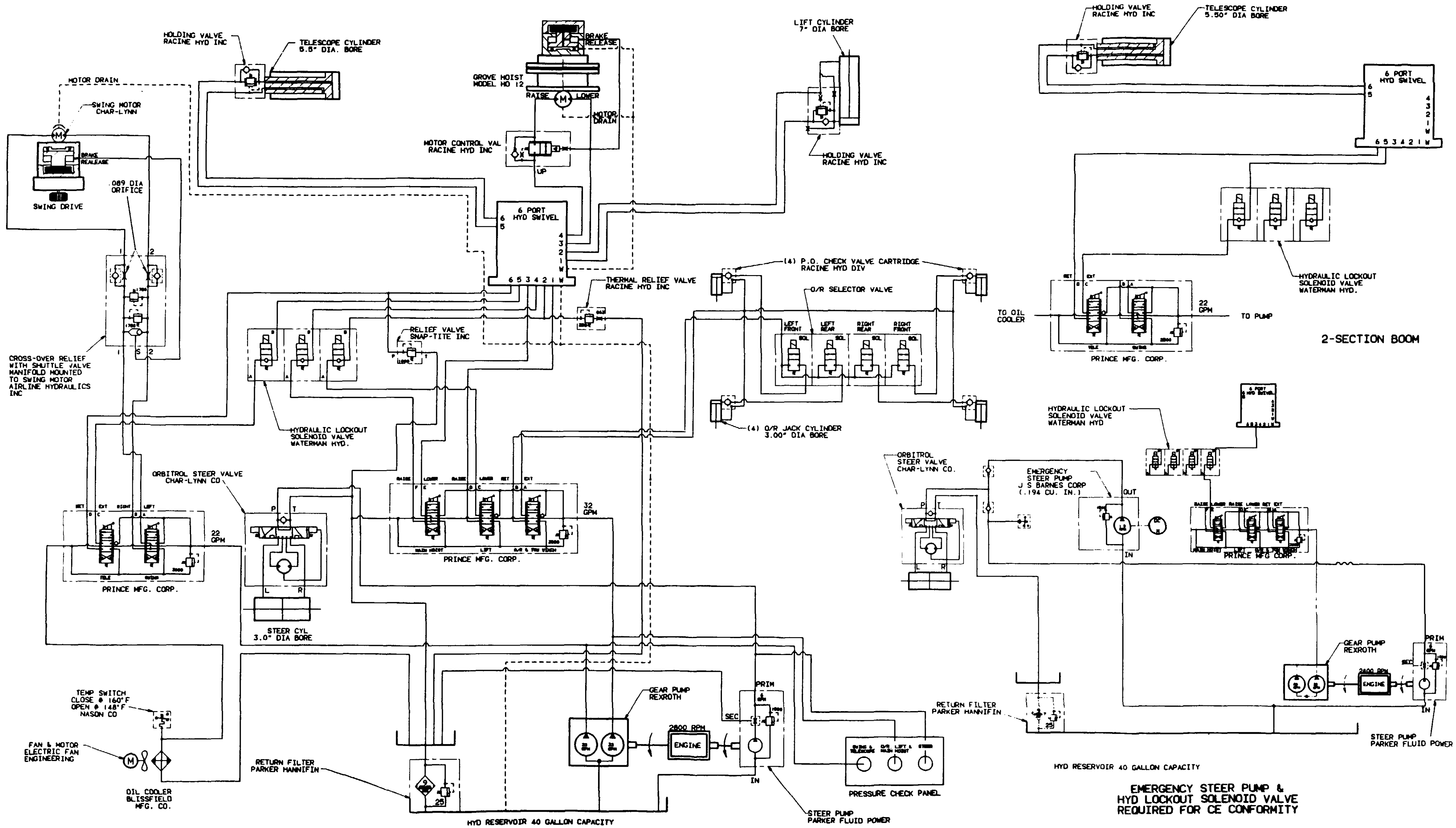


Figure FO-2. Hydraulic Schematic.

By Order of the Secretary of the Army:

DENNIS J. REIMER
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
03717

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 075558-000