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GRADALL®

COMBINED SERVICE MANUAL

G 3 R

7702-4002

July 2002
Starting Lot 1 thru Lot 10

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GRADALL®

OPERATOR'S MANUAL

G3R

7702-4003

July 2002

Starting PIN
NP-315777

Form #8018

Original Issue 4/81

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G3R

GRADALL®

Hydraulic Excavators

OPERATOR'S MANUAL

Covers G3R units starting PIN NP-315777



IMPORTANT

Read and understand this manual, the CIMA Off Highway Truck Safety Manual, and the CIMA Hydraulic Excavator User's Safety Manual before starting, operating or performing maintenance procedures on this machine.

KEEP THESE MANUALS IN CAB.

AVERTISSEMENT! Si vous ne lisez pas l'anglais, demandez a votre surveillant de vous donner les instructions de securite!

ATENCION! Si no lee ingles, preguntele a su supervisor para las instrucciones de seguridad!

VORSICHT! Wenn Sie kein Englisch lesen, Ihren Vorgestellten um die sieherheitsanweisungen bitten!

Part No. 7702-4003
Form No.8018

Bendix

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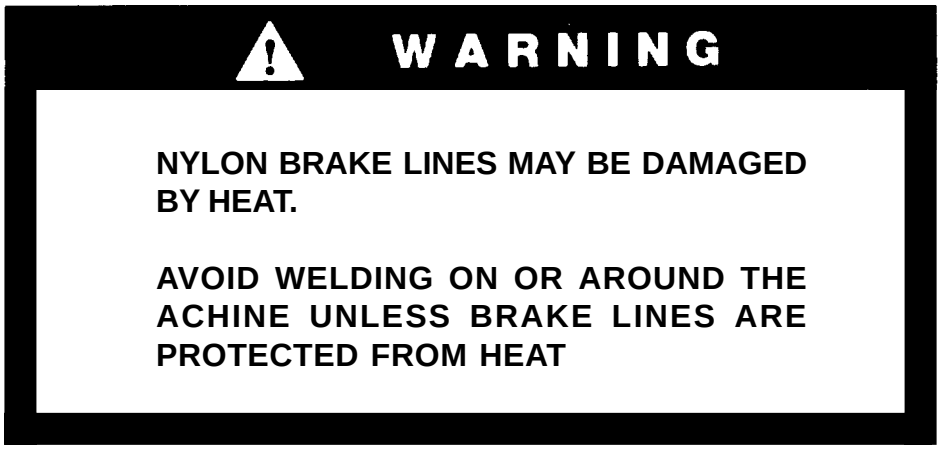
IMPORTANT SAFETY NOTICE

Safe operation depends on reliable equipment and proper operating procedures. Performing the checks and services described in this manual will help to keep your Gradall® Excavator in reliable condition and use of the recommended operating procedures can help you avoid accidents. Because some procedures may be new to even the experlenced operator we recommend that this manual be read, understood and followed by all who operate the unit.

Danger, Warning and Caution notes lin this manual will help you avoid injury and damage to the equipment. These notes are not intended to cover all eventualities; it would be impossible to anticipate and evaluate all possible applications and methods of operation for thlis equipment.

Any procedure not specifically recommended by The Gradall Division must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you aren't sure, contact your Gradall Distributor before operating.

Do not modify this machine without written permission from the Gradall Division.



NOTICE

The Gradall Division retains all proprietary rights to the information contained in this manual.

The Company also reserves the right to change specifications without notice.

The Gradall Division
406 Mill Avenue, S.W, New Philadelphia, Ohio 44663

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TABLE OF CONTENTS

IMPORTANT SAFETY NOTICE ..... inside front cover
TABLE OF CONTENTS 1
INTRODUCTION 2
- General 2
- Related Manuals 2
- Operator Qualifications 2
- Rough Terrain Capabilities 2
- Orientation 2
- PIN (Product Identification Number) Location 2

SAFETY HIGHLIGHTS 3-9

OPERATOR'S CAB 10
- Seat Adjustment 10
- Defroster 10
- Heater 10
- Steering Wheel 10
- Ventilation 10
- Windshield Wiper & Washer 11
- Fire Extinguisher 11

INSTRUMENT AND INDICATOR IDENTIFICATION 12
CONTROL IDENTIFICATION 13
CHECKS AND SERVICES BEFORE STARTING ENGINE 14-15

ENGINE OPERATION 16
- Starting the Engine 16
- Normal Engine Operation 16
- Cold Weather Starting Aids 17
- Stopping the Engine 17

WARM-UP AND OPERATIONAL CHECKS 18
PLAN YOUR TRIP 18
BRAKE SYSTEM 19
- General 19
- Service Brake 19
- Digging Brake 19
- Brake Adjust Indicator Light 20
- Parking/Emergency Brake 20
- Automatic Reservoir Drain 20

STEERING SYSTEM 21
TOWING 21
IF YOU GET STUCK 21

STABILIZER OPERATION 22
- Precautions 22
- Extending & Retracting Stabilizers 22

FRONT AXLE OSCILLATION 22
- General 22
- Normal Oscillation 22
- Oscillation Lock 22

DRIVE TRAIN 23
- Torque Converter 23
- Transmission 23
- Two & Four Wheel Drive 23

PARKING 24
- Precautions 24
- Parking Procedure 24

HOIST CYLINDER RE-POSITIONING 24
BUCKET INSTALLATION 25
A TYPICAL GRADALL DIGGING CYCLE 27-29

LIFTING AND POSITIONING A LOAD 30
- Precautions 30
- General 30
- Positioning Machine for Lift 30
- Planning a Lift 30-31

OPERATING TIPS 32-33
ABOUT YOUR GRADALL 33
LUBRICATION AND MAINTENANCE DIAGRAM 34-35
- Filter Elements 36
- Capacities 36
- Lubricants 36

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INTRODUCTION

General

This manual provides important information to familiarize you with operator maintenance requirements and with safe operating procedures for the Gradall Rough Terrain Hydraulic Excavator.

If you have any questions regarding the excavator, contact your Gradall Distributor. He is familiar with the unit and will be happy to help you.

Related Manuals & Decals

Separate publications are furnished with the excavator to provide information concerning safety, replacement parts, maintenance procedures, theory of operation and vendor components. A kit containing all decals for the G3R is available from your Gradall Distributor (part no. 7702-5002). He can also furnish additional manuals for your machine.

Operator Qualifications

This excavator has been designed for operators weighing from 104 to 220 pounds (47 to 100 kg) and from 59" to 73" (150 to 185 cm) tall. Potential operators beyond these limits should be observed while operating and driving the unit in a safe area to determine their ability for safe, efficient operation.

The operator must hold a valid applicable driver's license which requires acceptable age, vision, hearing, manual dexterity and response. He must also be in acceptable physical and mental condition (not undergoing medical treatment, using drugs or alcohol which would violate traffic laws).

Before driving the unit on the highway or operating the excavator at a worksite, the operator must familiarize himself with the machine by practicing in a safe, open area not hazardous to people or property.

The operator must read, understand and comply with instructions contained in the following material furnished with the excavator:

- This Operator's Manual
- CIMA Excavator User's Safety Manual
- CIMA Off-Highway Truck Safety Manual
- All instructional decals and plates
- Any optional equipment instructions furnished

Rough Terrain Capabilities

The excavator is designed for self-propelled travel between jobsites.

Refer to Safety Highlights section of this manual (pages 3 through 9) for recommendations on excavator operation and travel.

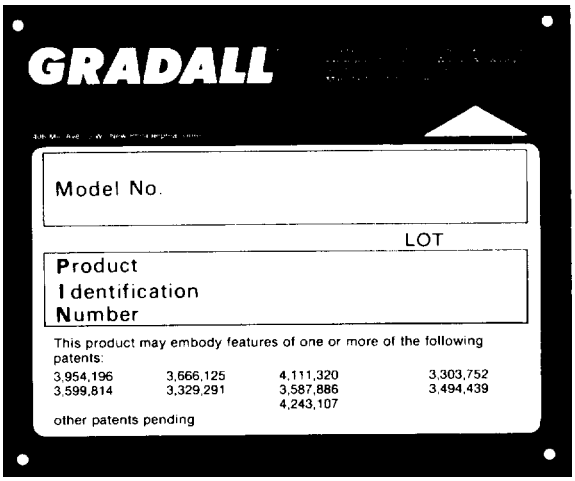
Orientation

When used to describe locations of components the upperstructure, the directions front, rear, right and left relate to the orientation of a man sitting in the operator's seat.

In relation to the carrier, front, rear, right and left are determined by the engine; the engine is at the front of the carrier and right and left relate to the orientation of a man standing behind the carrier and looking forward.

PIN Location (Product Identification No.)

Specify PIN and lot number when ordering parts and when discussing specific applications and procedures with your dealer. The PIN plate is located on front center portion of upperstructure frame.



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SAFETY HIGHLIGHTS

Read and understand this manual, CIMA Excavator User's Safety Manual, CIMA Off-Highway Truck Safety Manual and all instructional decals and plates before starting, operating or performing maintenance procedures on this equipment. Keep this manual in cab.

Watch for these symbols; they are used to call your attention to safety notices!

DANGER

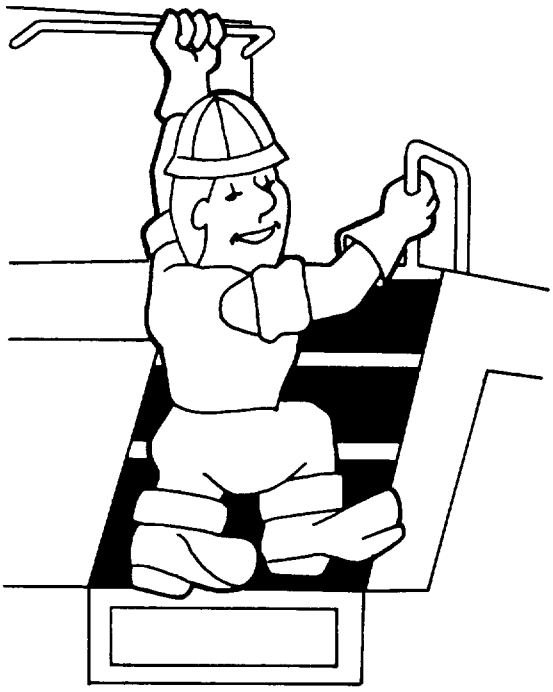
This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.

WARNING

This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.

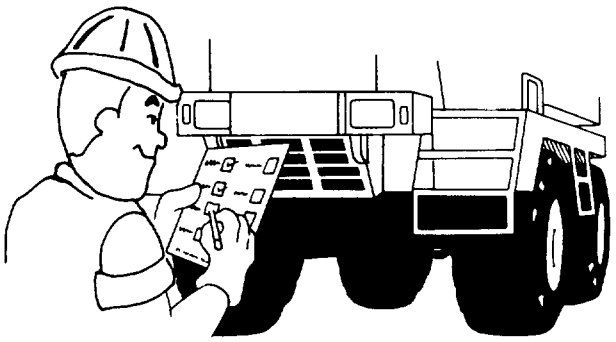
CAUTION

This symbol indicates a hazard which could result in injury or damage to equipment or property if proper precautions are not taken.



Repair or replace damaged steps and grab handles.

Maintain three point contact with grab handles and steps when climbing on and off machine. **Never jump from the machine.** Repair or replace damaged steps and grab bars.



Perform all "CHECKS & SERVICES BEFORE STARTING ENGINE" (pages 14 & 15) and all "WARM-UP & OPERATIONAL CHECKS" (page 18) at beginning of your shift. **Complete all required maintenance before operating or driving the unit.**

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SAFETY HIGHLIGHTS

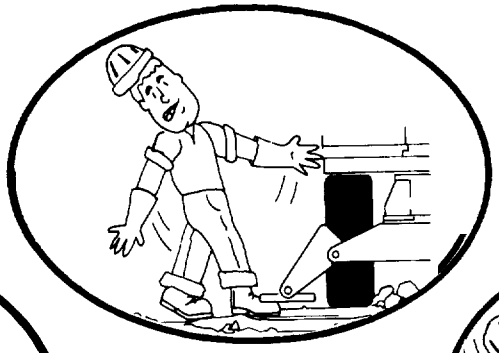


Be particularly careful if this is not the machine you usually operate. **Read the manuals** listed on page 2 and then **operate the unit** in **a safe, open area** to become familiar with the controls.

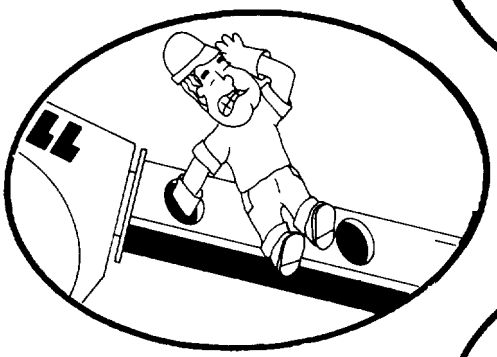


Learn and **follow your employer's safety rules.**

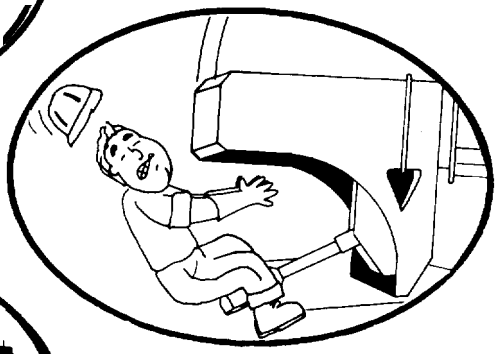
Learn to recognize 'PINCH POINTS'



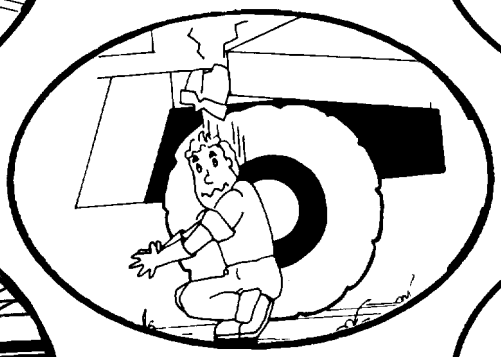
Stabilizers



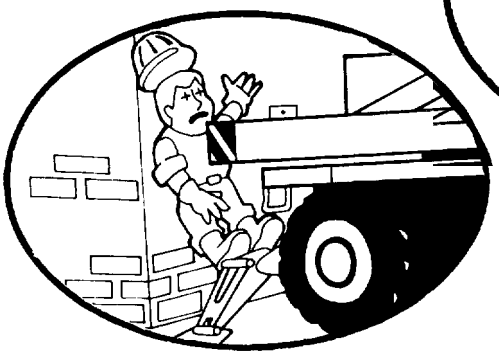
Boom Holes



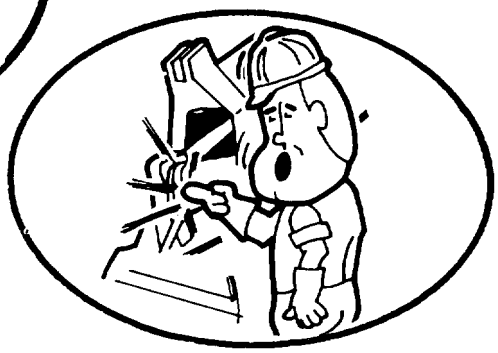
Boom Cradle



Upperstructure & Carrier



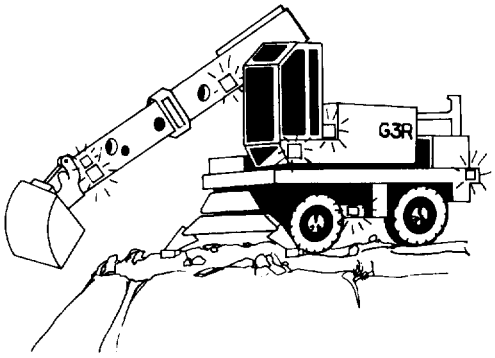
Counterweight & Another Object



Learn to recognize "PINCH POINTS" and stay clear of them. Getting caught in a pinch point can cause serious injury or death.

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SAFETY HIGHLIGHTS



Check to be sure all **DANGER, WARNING, CAUTION** and **INSTRUCTION DECALS** are in place and can be read. Clean or replace decals as required.



Some owners alter their machines. Check to be sure your machine fits the pictures and description in this manual. If it differs, or if you aren't sure, contact your Gradall distributor before you run your unit.



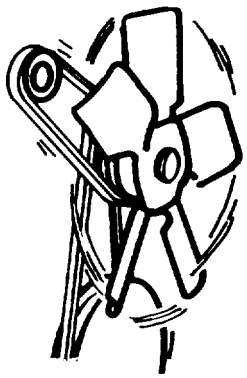
Do not carry passengers or move the unit until all other persons are off and are clear of the machine.



Keep steps and deck areas free of mud, oil, grease and other foreign material. Replace non-skid surface material as required.



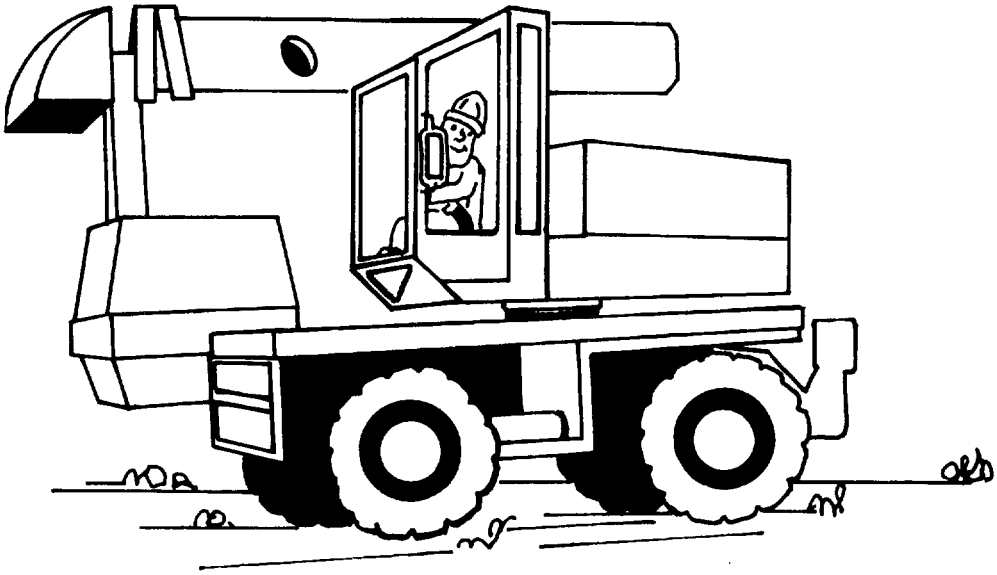
Never carry a water can, equipment, or other worker's tools or personal items on the machine. Such items can cause other workers to approach the machine without your knowledge and result in serious injury or death.



Stay clear of moving fan, belts, pulleys, meshing gears, drive shafts and other moving parts. Do not operate without covers and guards in place.

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SAFETY HIGHLIGHTS



TRAVEL TO AND FRBSITE ONLY UNDER FOLLOWING CONDITIONS:

Boom secured in rest

Bucket posistion for maximum visibility

Stabilizers raised fully

No load attached to any part of machine

Joystick switch in off position

Travel in accordance with local requirements

Tires inflated to proper pressure

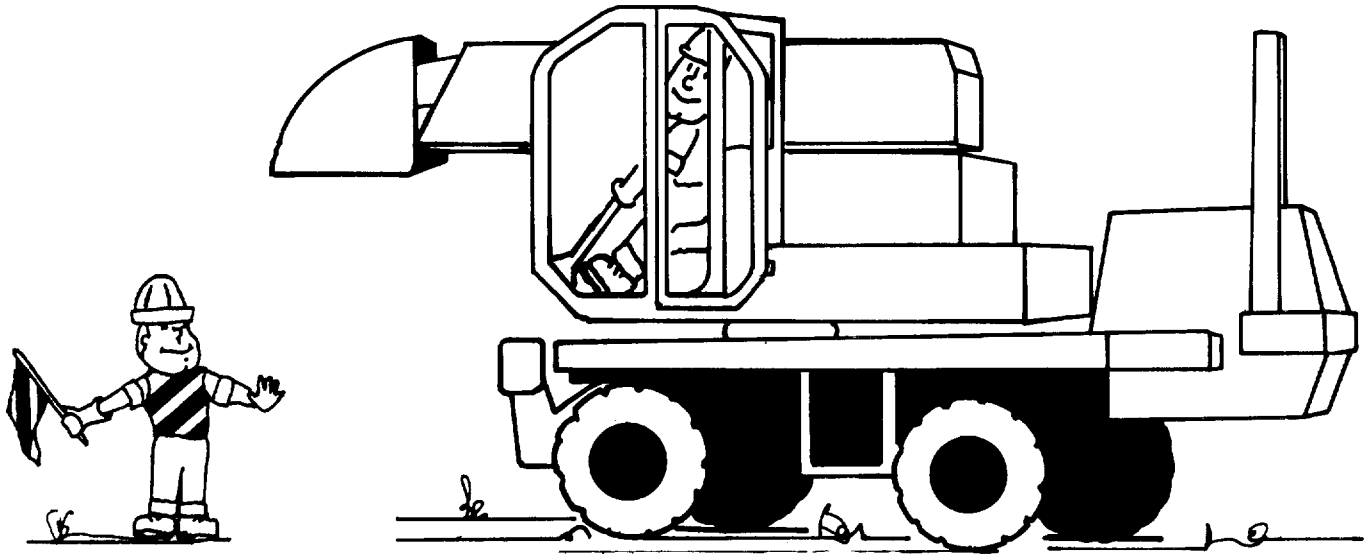
Mirrors clean and properly adjusted

Seat belt buckled snugly across lap

Door secured in closed position

Front windows secured in closed position

Plan your route



REPOSITION UNIT FOR EXCAVATOR OPERATION ONLY UNDER FOLLOWING CONDITIONS:

Signal persons positioned clear to observe and signal operator for safe travel and guide traffic.

Boom fully retracted, horizontal and centered over front or rear in direction of travel

Bucket positioned for maximum visibility

No load attached to any part of machine

Transmission in proper range

Tires properly inflated

Door secured in open or closed position

Be sure area is clear of bystanders

Stabilizers raised to clear all obstructions

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⚠ WARNING

Travel on off-highway grades is recommended only under the following conditions:

Boom secured in rest

Tires properly inflated

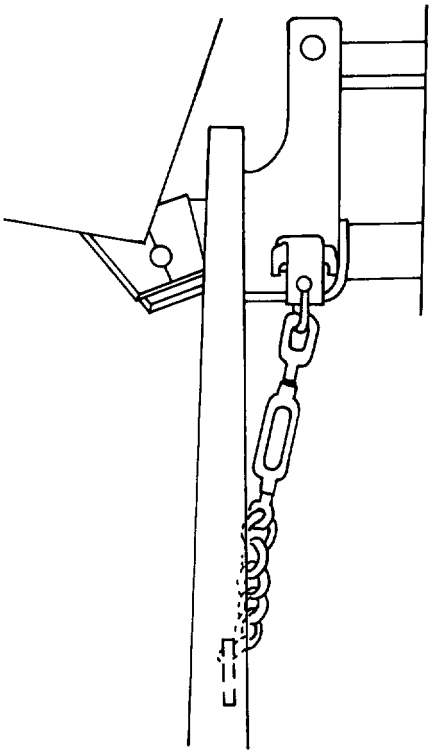
Surface is firm enough to support unit

Surface provides adequate traction to prevent slipping

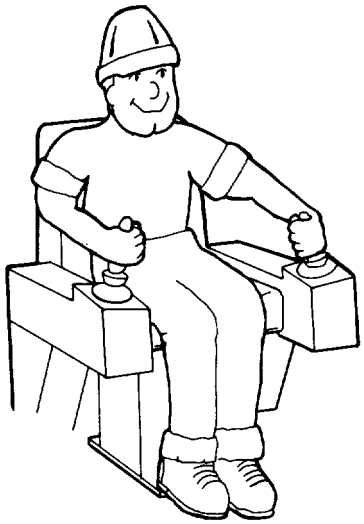
Surface is not rough enough or steep enough to cause tipping

Transmission is in 1st gear and low range

All doors and windows secured



Use boom tie-down device to secure boom in rack when traveling between jobsites.



Remain seated while operating upperstructure. A joystick switch is located in the operator's seat to de-energize joysticks when operator rises from seat.

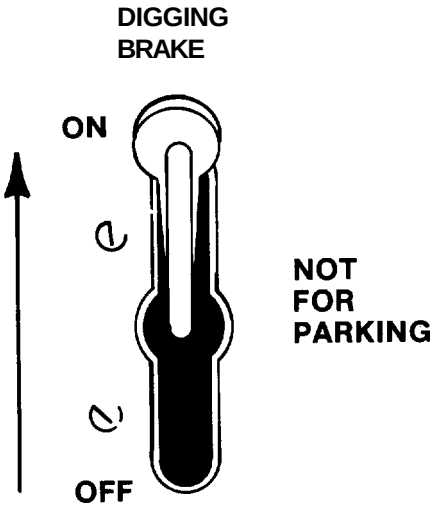
Always **sound horn** to warn others of unexpected machine movements (horn button is located at top of left joystick).

The unit is also equipped with an automatic **back-up alarm** to warn others of reverse travel.

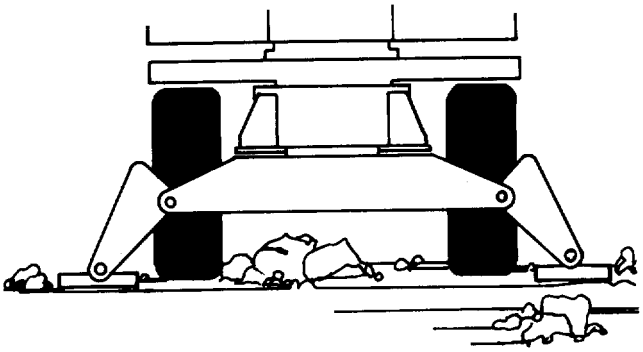


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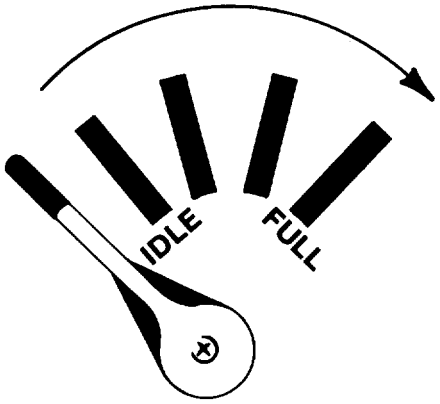
SAFETY HIGHLIGHTS



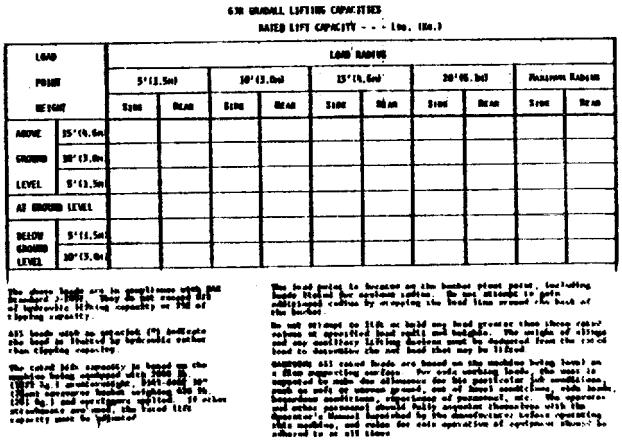
Always **apply digging brake** to prevent carrier movement **while operating upperstructure**.



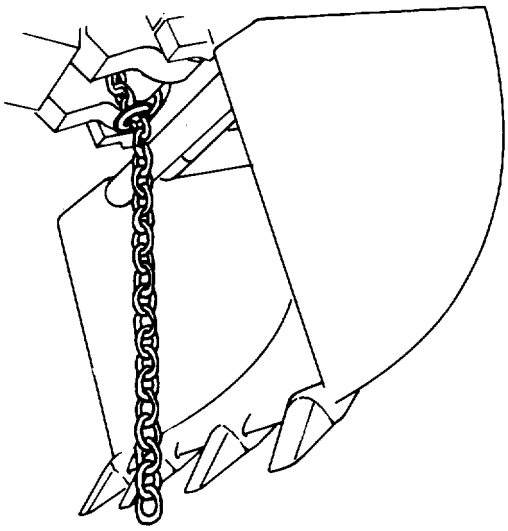
Always **lower stabilizers** for maximum machine leveling and stability before operating upperstructure. Use a mat or timber under stabilizer pad if necessary for leveling or to compensate for soft ground.



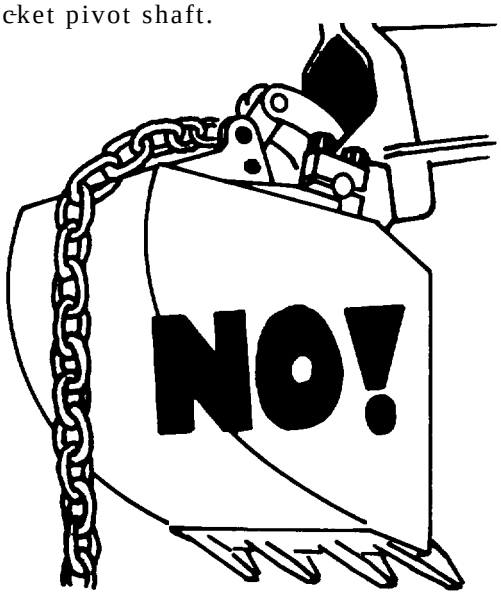
Run engine at full throttle for all excavator operation except warm-up. Always **run at full throttle when lifting and positioning a load.**



Always **check Lift Capacity Chart** to be sure planned lift can be performed safely.

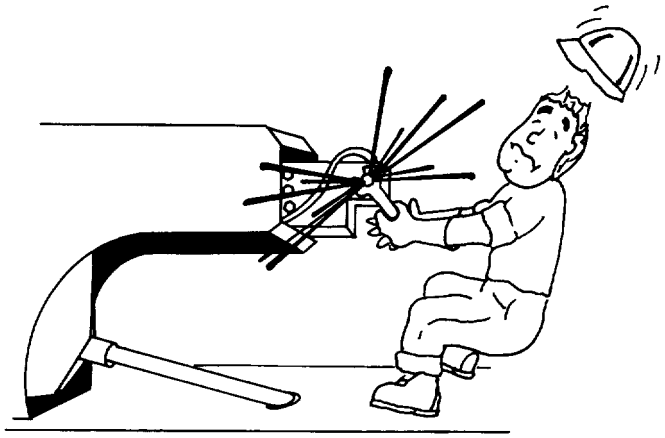


Attach load only as shown. Lift Capacity Chart values are based on load hanging vertically from bucket pivot shaft.

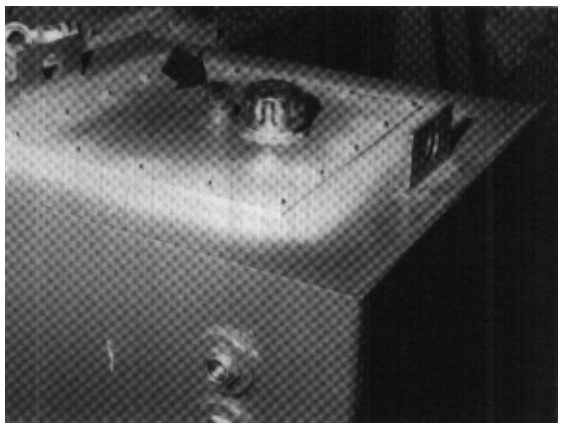


Never pass load line over bucket. Relief valves in bucket circuit could cause unexpected, dangerous movement of the load.

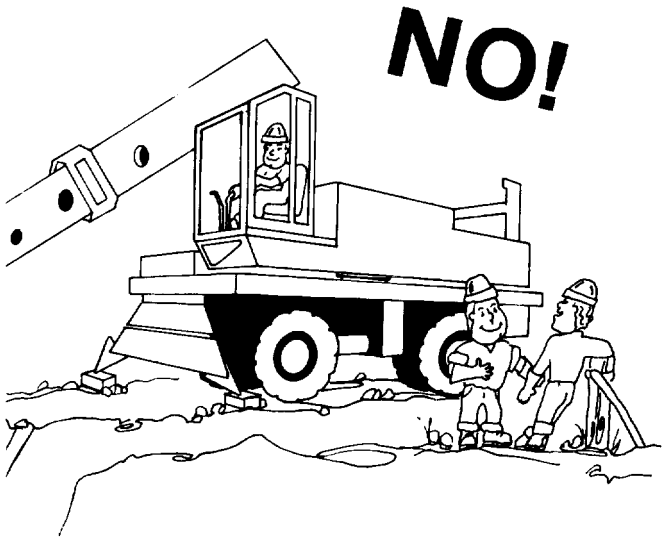
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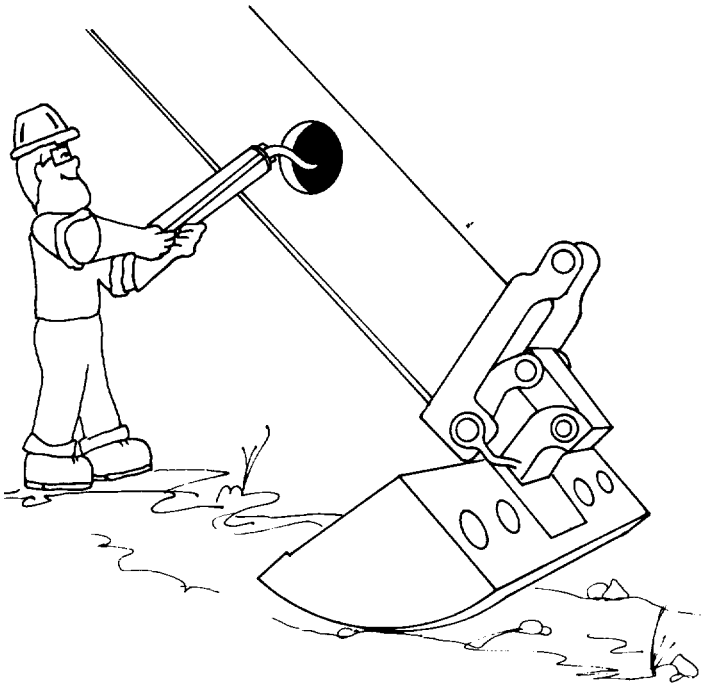
Pressure can be maintained in hydraulic circuits long after the engine has been shut down. This pressure can cause oil (or items such as pipe plugs) to **"shoot out"** at high speed **it pressure is not released** correctly. Contact maintenance personnel to have pressure relieved.



Always **release pressure from hydraulic fluid reservoir** before removing filler cap.



Do not operate with bystanders or other workers near machine.



Always be sure **bucket is resting firmly on ground** and that **engine is stopped** before performing lubrication or maintenance procedures inside boom.

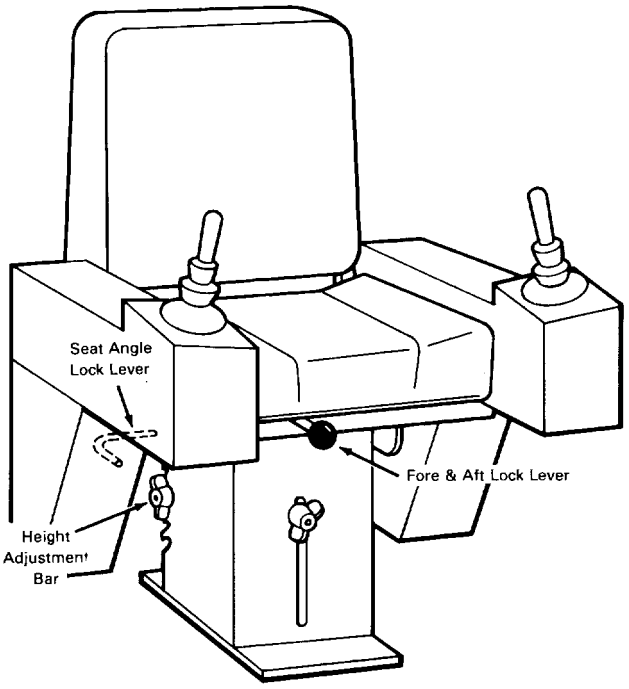
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OPERATOR'S CAB

Seat Adjustment

The operator's seat and pedestal combination include adjustments for height, seat angle and fore and aft positioning.

Always fasten seat belt before operating.



Stop engine before adjusting seat.

Adjust seat height by loosening wing nut on front of pedestal and wing nuts on ends of height adjustment bar at rear of pedestal. Raise or lower seat as required and position adjustment bar in appropriate slots. Tighten wing nuts to secure adjustment.

Adjust fore and aft positioning by moving fore and aft lock lever to left. Slide seat to desired position and release lever. It may be necessary to jog seat slightly to lock adjustment.

Adjust seat angle by depressing seat angle lock lever and moving seat to desired angle. Secure adjustment by releasing lever. Check to be sure adjustment lock tab is seated in one of the adjustment slots on rear of pedestal.

Defroster

A defroster fan is mounted near the steering column and is controlled by a switch on the overhead instrument/control panel. The fan includes a swivel mounting to direct air flow as required.

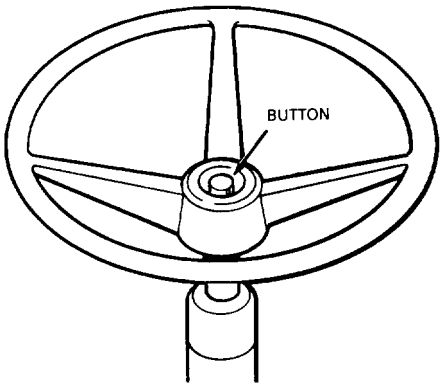
Heater

WARNING

Be sure heater exhaust gasses are piped to the outside if heater is to be operated in an enclosed area. Exhaust may contain carbon monoxide, an odorless, colorless and poisonous gas.

Heaters are provided as optional equipment. If your unit is equipped with a heater, be sure to follow manufacturer's instructions provided.

Steering Wheel



The steering wheel can be raised or lowered to any of five different positions for operator comfort. Press button at center of wheel, move wheel to desired height and release button. It may be necessary to raise or lower wheel slightly to lock in place.

Ventilation

Varying degrees of cab ventilation can be attained by opening the door, the rear window, the upper front window and by removing the lower front window.

WARNING

To avoid accidental actuation of controls always stop engine before opening or closing door or windows.

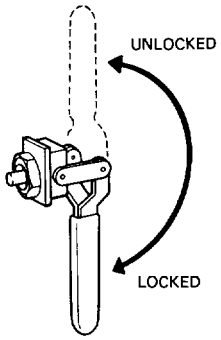
Door

Keep door latched in fully closed or fully opened position when operating the upperstructure. Be sure latch is fully engaged.

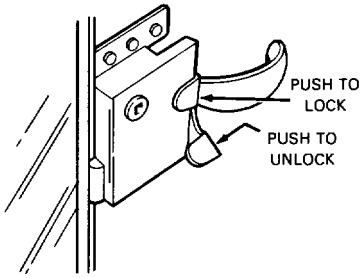
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Upper Front Window

NOTE: Steering wheel must be in its lowest position to open or close upper front window. Cab door must be open.



To open upper front window, unlock toggle latches and swing window upward until latch on ceiling is fully engaged. Engage ceiling latch lock to prevent accidental unlatching. Attach safety hook to secure window.



To close upper front window, disengage safety hook and ceiling latch lock. While supporting window, disengage ceiling latch and lower window to fully closed position. Move toggle latches to locked position.

Lower Front Window

NOTE: Upper front window must be open to remove lower front window.

To remove lower front window, unlock toggle latches and lift window from frame. Position window on rack behind seat and secure by locking toggle latches in tabs provided.

Reverse procedure to install window.

Rear Window

To open rear window squeeze latch and slide to position desired.

Windshield Wiper & Washer

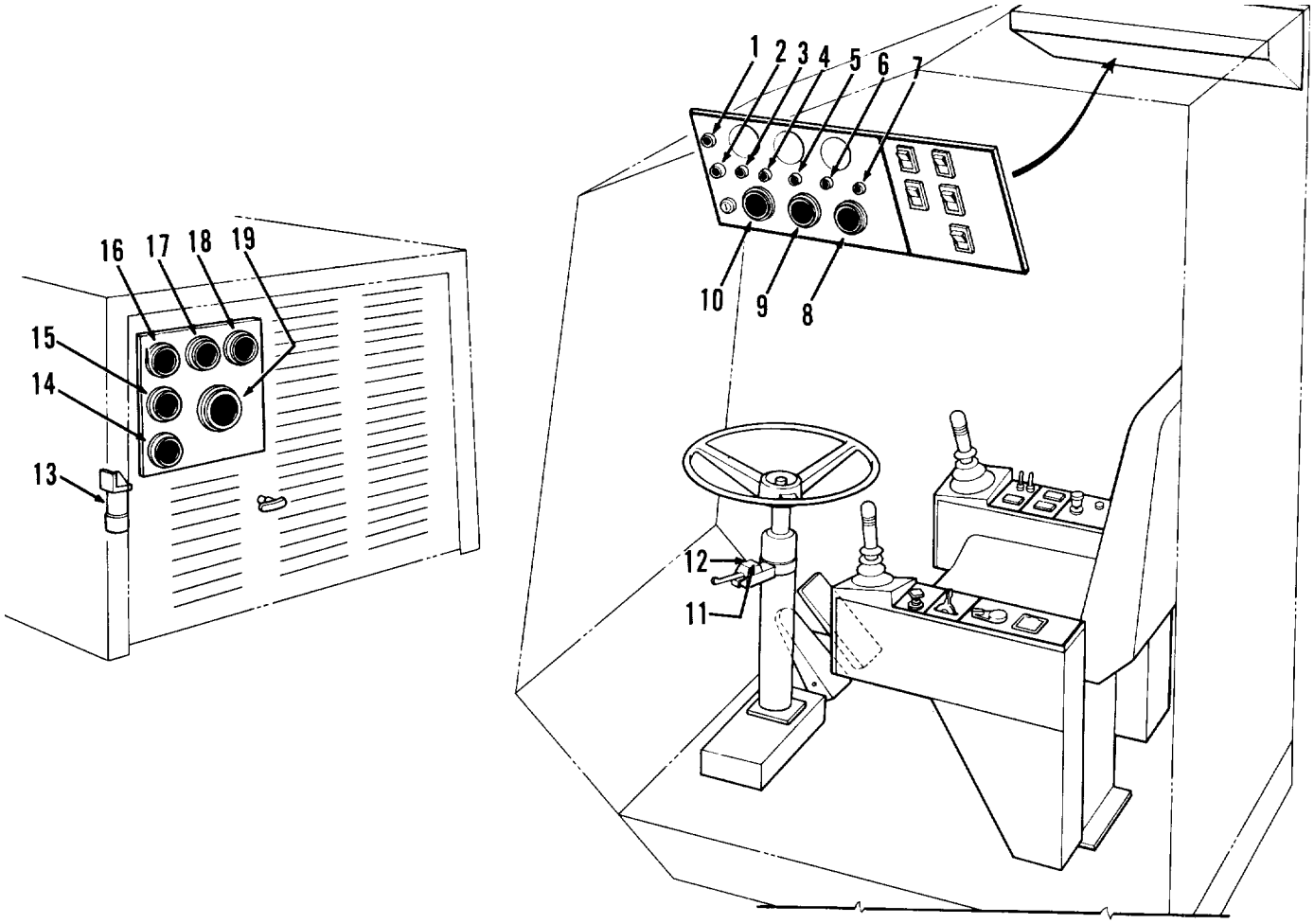
The windshield wiper and washer are controlled by switches located on the overhead instrument/control panel. The wiper and washer are mounted on the upper front window and are stored with the window.

Fire Extinguisher

A fire extinguisher is located at the rear of the left cab wall. Read and understand the instructions printed on the extinguisher regarding its care and operation. Check often to be sure the extinguisher is fully charged.

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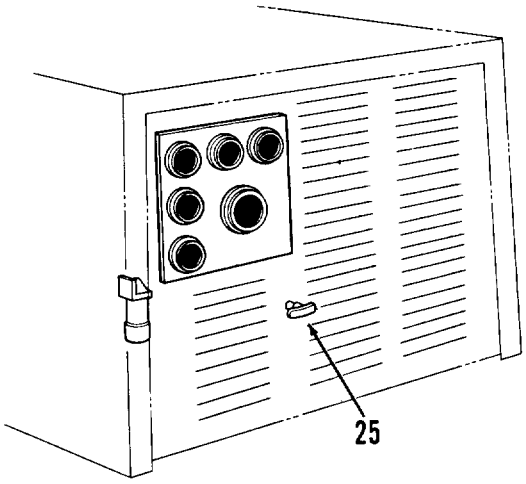
INSTRUMENT AND INDICATOR IDENTIFICATION

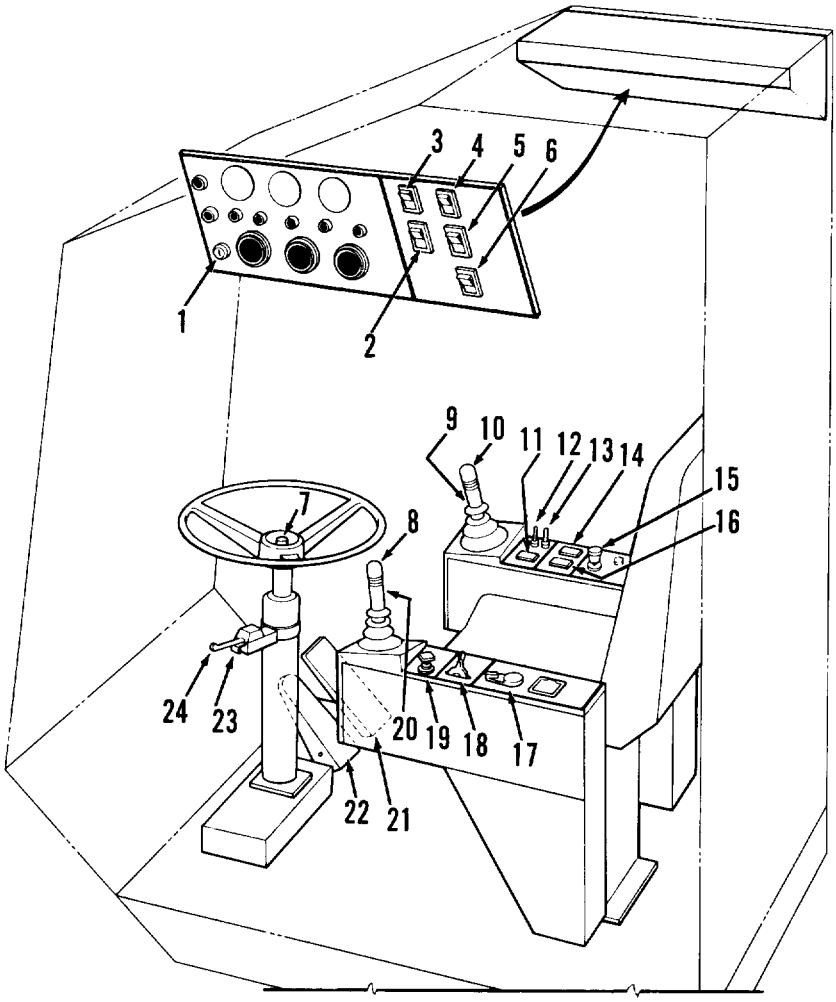


1. Engine Alert Indicator (glows and buzzes to indicate high engine coolant temperature or low engine oil pressure)
2. Low Air Indicator (glows and buzzes to indicate low brake system air pressure)
3. Key On Indicator
4. Brake Adjust Indicator (glows to indicate low brake fluid level or brakes in need of adjustment)
5. Digging Brake Indicator
6. Main Hydraulic Filter Condition Indicator (glows to indicate hydraulic oil is bypassing main system filter)
7. Auxiliary Hydraulic Filter Condition Indicator (glows to indicate hydraulic oil is by-passing auxiliary system filter)
8. Engine Hourmeter
9. Voltmeter
10. Air Pressure Gage
11. Turn Signal Indicators
12. Hazard Flasher Indicator
13. Air Cleaner Condition Indicator
14. Torque Converter Temperature Gage
15. Transmission Clutch Pressure Gage
16. Engine Oil Pressure Gage
17. Engine Coolant Temperature Gage
18. Fuel Gage
19. Tachometer (optional)

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CONTROL IDENTIFICATION





1. Ignition/Start Switch
2. Windshield Wiper Switch
3. Joystick Switch
4. Defroster Fan Switch
5. Windshield Washer Switch
6. Headlight/Clearance Light Switch
7. Steering Wheel Adjustment Button
8. Horn Switch
9. Boom In/Out & Swing Joystick
10. Tilt Switch
11. Transmission Range Selector Switch
12. Transmission Gear Selector Switch
13. Transmission Direction Selector Switch
14. Right Stabilizer Switch
15. Lighter
16. Left Stabilizer Switch
17. Throttle Control Valve
18. Digging Brake Control Valve
19. Parking Brake Control Valve
20. Boom Hoist & Bucket Joystick
21. Accelerator Pedal
22. Brake Pedal
23. Hazard Flasher Switch
24. Turn Signal Switch
25. Manual Throttle Control

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CHECKS AND SERVICES BEFORE STARTING ENGINE

(To be performed at beginning of each work shift)

Complete all required maintenance before operating unit.

WARNING

Use extreme caution when checking items beyond your normal reach. Use an approved safety ladder.

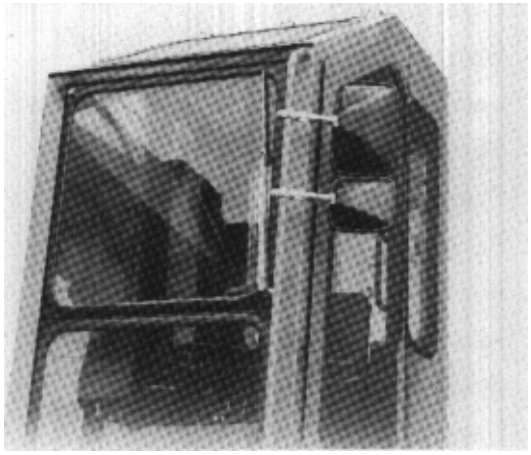
Before removing filler caps or fill plugs, wipe all dirt and grease away from the ports. f dirt is allowed to enter these ports, it can shorten the life of o-rings, seals, packings and bearings.

When adding fluids or changing filters elements, refer to the lubrication section of this manual to determine the proper type to be used.

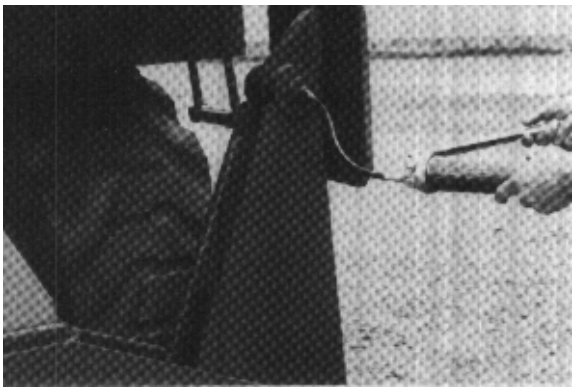
If spark arrestors are required, be sure they are in place and in good working order.



Inspect unit for obvious damage, vandalism and needed maintenance. Check for signs of fuel, lubricant, coolant and hydraulic leaks. Open all access doors and look for loose fittings, clamps, components and attaching hardware. Replace hydraulic fines that are cracked, brittle, cut or show signs of abrasion.



Check to **be sure windows and mirrors are clean** and that mirrors are properly adjusted.

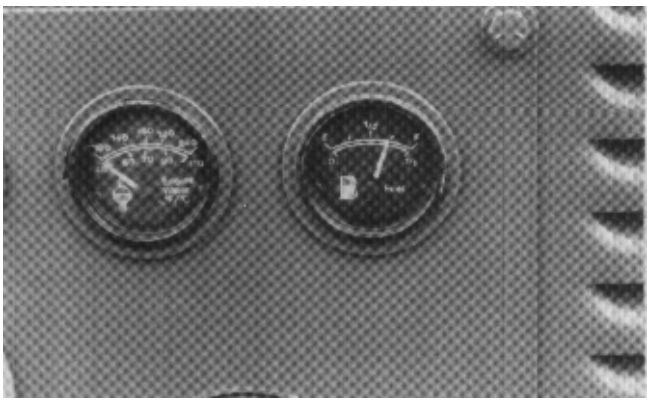


Service the unit in accordance with the lubrication and maintenance schedule.



Check hydraulic fluid level in sight gages with machine level, boom in rack and all other cylinders fully retracted. With cold oil, fluid should be visible in lower sight gage. Replenish as necessary.

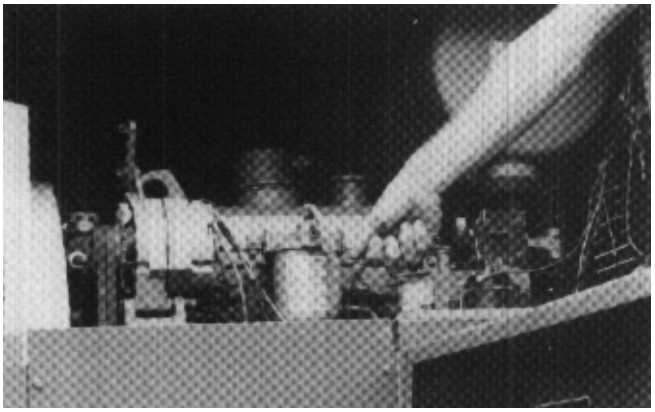
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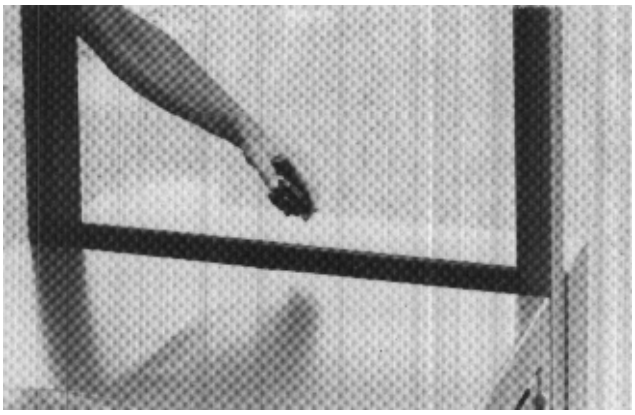
Check fuel level and replenish as necessary. It is recommended that the unit be refueled at the end of the work shift to minimize condensation.

WARNING

Engine should be turned off while refueling. Be sure the area is free of open flame, sparks or any condition which could cause fuel to ignite.



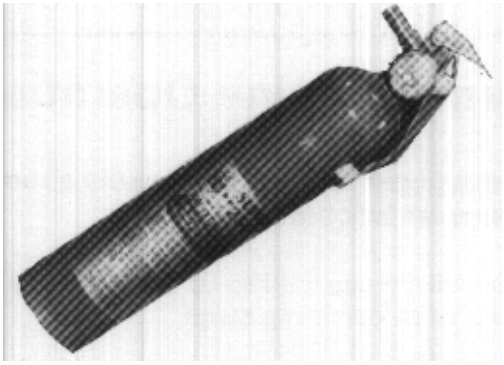
Check oil level in engine crankcase and replenish as necessary. DO NOT OVERFILL.



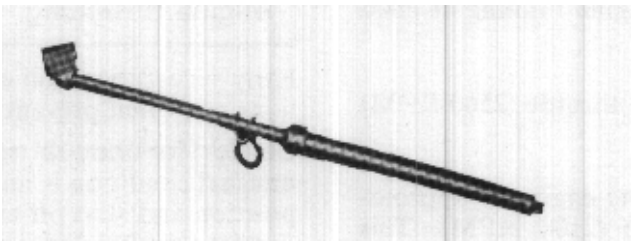
Check engine coolant level and replenish as necessary. Be sure anti-freeze solution is adequate for expected temperatures. Be sure radiator fins are clean.

WARNING

If it is necessary to check the coolant level in a hot radiator, shut off the engine and relieve pressure before removing the radiator cap. Relieve pressure by holding the cap with rags and turning to the left till pressure begins to escape. Wait a few minutes till sound of escaping pressure stops and remove cap cautiously.



Check for presence of fully charge fire extinguisher.



Check tire pressures only when tires are cold. Notify maintenance personnel if pressures are low.

14.00 x 24 (12 ply) ..... 50 psi
17.50 x 25 (14 ply) ..... 45 psi

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ENGINE OPERATION

NOTE: If engine is being started at beginning of work shift be sure to perform all "CHECKS AND SERVICESBEFORE STARTING ENGINE" (pages 14 AND 15).

Starting the Engine

1. With FORWARD/ REVERSE selector switch in N (neutral) insert ignition key and turn clockwise to ON position. Key ON indicator light should glow and continue to glow while engine is running.

If brake system air pressure is below 60 psi the Low Air indicator light will glow and buzzer will sound.

Turning ignition switch to ON will also cause Engine Alert indicator light to glow and buzzer to sound.

⚠ CAUTION

Turning ignition switch to START position while engine flywheel is rotating can cause serious damage to engine and/or starting motor.

2. Set throttle control at 1/3 to 1/2 throttle. Throttle controls in cab are air pressure operated. If there is insufficient air pressure, use manual throttle at rear of engine compartment. Twist handle counterclockwise to unlock and clockwise to lock. Use this control only for starting engine without system air pressure.
3. Sound horn as a warning to others before starting engine.
4. Turn ignition switch key clockwise to START position to engage starter motor. Release key immediately when engine starts. If engine fails to start within 30 seconds, release key and allow starter motor to cool for a few minutes before trying again.
5. After engine starts, observe ENGINE ALERT indicator light. If light continues to glow for more than ten seconds after engine starts, stop engine immediately and determine cause. When light glows while engine is running it indicates low engine oil pressure or high engine coolant temperature. Correct cause of malfunction before starting engine.
6. When Engine Alert indicator light goes out, observe gages on instrument panel and engine compartment to be sure all systems are functioning properly.
7. Warm up engine until coolant temperature reaches operating range (170°F.-77°C.)

Normal Engine Operation

Observe gages frequently to be sure all engine system are functioning properly.

Engine Oil Pressure: 40 to 60 psi (276 to 414 kPa) with RPM in operating range

Engine Coolant Temperature: 170 to 195°F. (77 to 90°C).

Voltmeter Indication of Alternator Output: Approximately 14 volts with engine running at 2000 RPM

Always operate engine at full throttle (2500 RPM) for excavator operation.

For continuous travel, operate engine at approxmately 85% of full throttle (2100 RPM) This practice provides reserve power for varying road conditions.

When using engine braking power to slow travel (releasing accelerator and permitting carrier to "push" engine) take care to avoid overspeeding the engine. The engine governor has no control over engine speed when engine is being "pushed" by carrier load.

Select an appropriate gear ratio and use service brake to slow travel down steep slopes.

⚠ CAUTION

Always keep engine covers closed whiled engine is running.

Early recognition and correction of unusual conditions can often prevent a major breakdown.

Be alert for unusual noises or vibration. When an unusual condition is noticed, stop machine in a safe position and shut off engine. Determine cause and correct problem before continuing.

Avoid prolonged idling. Idling causes engine temperature to drop and this permits formation of heavy carbon deposit and dilution of lubricating oil by incompletely burned fuel. If the engine is not being used, turn it off.

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Cold weather starting aids

Diesel engine ignition is accomplished by heat generated when fuel/air mixture is compressed within the cylinders. Because this heat may be insufficient to start a cold engine in cold weather, the use of starting aids has become common practice.

Because of the wide variety of starting aids available it would be impractical to attempt to provide specific instructions for their use in this manual. Carefully follow instructions furnished with your starting aid.

If you use a starting aid employing ether or a similar substance pay particular attention to manufacturer's warnings.

Stopping the engine

Operate engine at idle speed for a few minutes before turning it off. This allows engine coolant and lubricating oil to carry excessive heat away from critical engine areas.

Do not "gun" engine before shut down; this practice causes raw fuel to remove oil film from cylinder walls and dilute lubricant in crank case.

To stop engine, turn ignition switch key counter-clockwise to OFF position.

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WARM-UP & OPERATIONAL CHECKS

(To be performed at beginning of each work shift)

Complete all required maintenance before operating

The safety, efficiency and service life of your excavator will be increased by performing the operational checks indicated.

While engine is warming to operating temperature, check operation of the following:

1. Heater (depending on season)
2. Defroster Fan
3. Windshield Washer and Wiper
4. All Lights
5. Horn
6. Low Air Indicator Light (should go out when system pressure reaches approximately 60 psi (414 kPA))
7. Air Pressure Gage (system should build and maintain approximately 125 psi (862 kPA))
8. Engine Oil Pressure Gage (should indicate 40 to 60 psi (276 to 414 kPa) with engine running at 2500 RPM)
9. Voltmeter (should indicate 14 volts with engine running at 2000 RPM)
10. Torque Converter/Transmission Oil Pressure Gage (should indicate 180 to 220 psi (1241 to 1517 kPa))

After engine has reached operating temperature (170 to 195°F. (77 to 90°C.)) check the operation of the following:

1. Torque Converter/ Transmission Oil Temperature Gage (should indicate 180 to 200°F. (82 to 93°C.))
2. Torque Converter/Transmission Oil Level (check transmission dipstick with engine running and oil at operating temperature)
3. Parking Brake
4. Service Brake
5. Carrier Drive Train
6. Steering
7. Travel Alarm
8. Hydraulic Filter Indicator Lights (these lights glow to indicate that hydraulic oil is by-passing the filters). Cold oil may cause the lights to glow even if filters are clean. If lights continue to glow after torque converter oil reaches operating temperature, the filters probably require service. Do not operate excavator with clogged filters.

⚠ CAUTION

Continued operation with hydraulic fluid by-passing the filters (red light glowing) can cause severe damage to hydraulic system components.

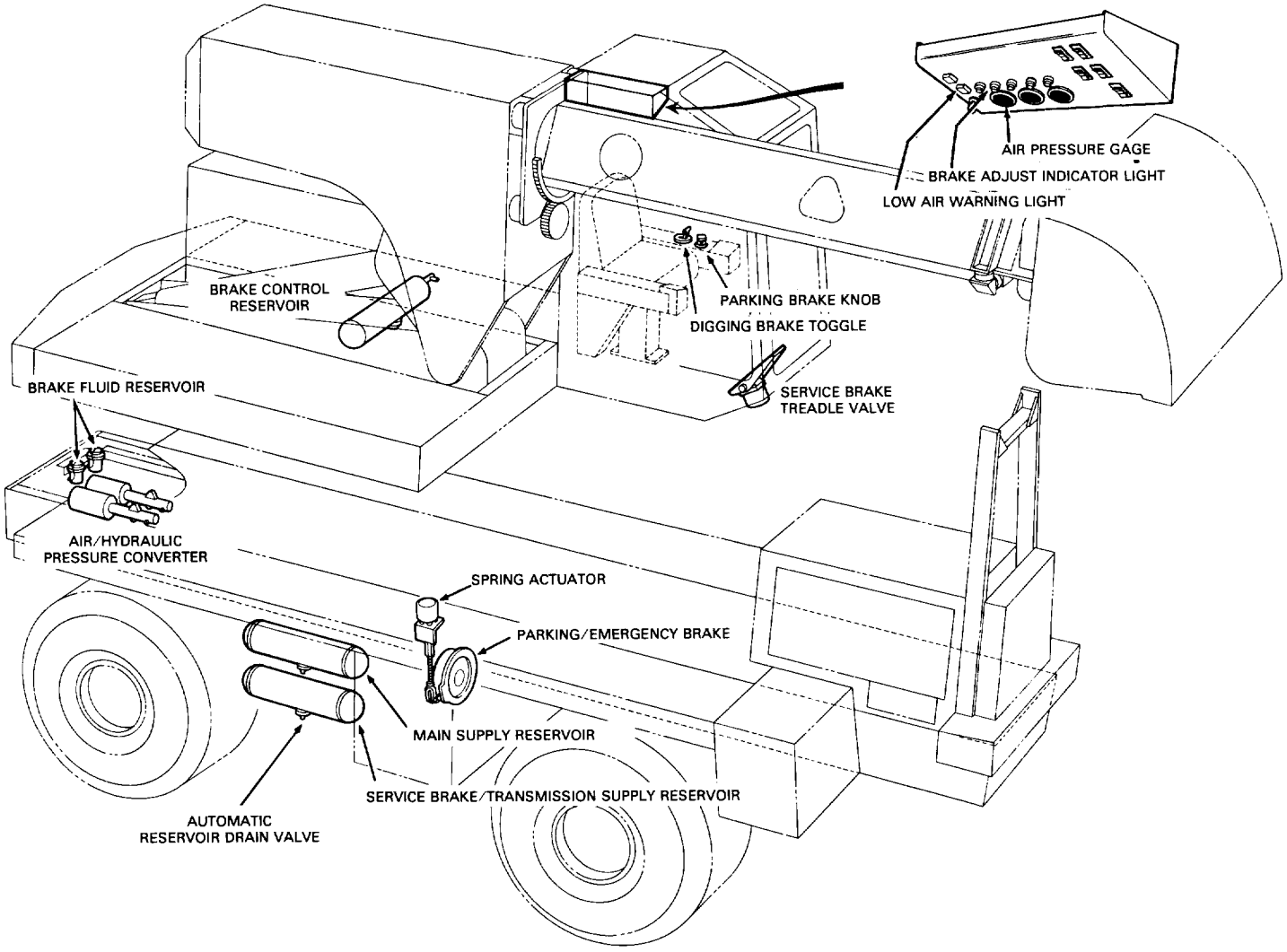
When hydraulic filter indicator lights indicate that the excavator may be operated, perform the following operational checks.

1. Boom hoisting and lowering
2. Boom extension and retraction
3. Bucket opening and closing
4. Boom tilt right and left
5. Swing right and left
6. Stabilizer lowering and raising

PLAN YOUR TRIP

1. Plan a safe route to your destination.
2. Aask your supervisor about permit requirements.
3. Check on load and clearance limits along your route.
   Dimensions for your unit are shown below:
   Height - varies depending on attachment - measure unit to be sure.
   Width . . . . . 8’(2.44 m)
   Ground . . . . . 15” (381 mm)
   Weight - varies depending on options - weight unit to be sure.

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General

The brake system furnished on the excavator carrier includes a service brake, digging brake, parking brake and a spring type emergency brake.

Service brake

Foot pressure on the brake treadle activates the service brake. Treadle actuation applies air pressure to an air/hydraulic pressure converter. Air pressure at the converter causes a flow of brake fluid to apply service brake at all wheels. Just as in an auto, the greater the foot pressure, the harder the brakes are applied.

WARNING

Do not "fan" the brake valve treadle. Along series of rapid brake applications can reduce system pressure to a point where effective service braking will be lost until air compressor can restore pressure.

If brake system air pressure drops below 60 psi (414 kPa), the LOW AIR warning light will glow and buzzer will sound. If proper system pressure cannot be maintained, stop the carrier as soon as possible and notify maintenance personnel. Do not resume operation until proper system pressure can be maintained (60 to 125 psi (414 to 862 kPa)).

Digging brake

An application of the digging brake is actually an application of the service brake with one difference; it is controlled by a toggle valve rather than the treadle valve.

WARNING

Move digging brake control toggle to ON position only when carrier is stopped. Maximum braking is applied to wheels when toggle is moved to ON.

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Always move DIGGING BRAKE toggle to ON position to hold excavator in position when digging. Move toggle to OFF position to release digging brake before repositioning excavator.

Brake Adjust Indicator Light

When glowing, the brake adjust indicator light signals a dangerous condition in the brake system. Stop unit in a safe location as soon as possible.

Check fluid level in brake system reservoirs and replenish as required.

If fluid level in reservoirs was adequate, notify maintenance personnel that brake shoes require adjustment.

⚠ WARNING

Service brake may be inadequate to stop unit with low fluid level or excessively worn brake shoes. Do not drive the unit if proper fluid level cannot be maintained. If light was caused by worn brake shoes, unit may be driven slowly, for a short distance, to a maintenance facility.

Parking/Emergency Brake

The parking/emergency brake is applied to a drum on the transmission rear output shaft. It is not applied to the wheels and will not stop the unit in as short a distance as the service brake.

This brake is set by a spring actuator and is released by brake system air pressure. Approximately 70 psi (483 kPa) is required for full release.

Apply the parking brake by raising the PARKING BRAKE knob (mounted on left arm rest). Depress knob fully to release brake.

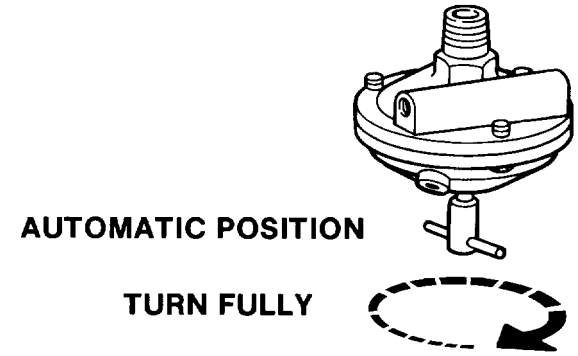
Emergency brake application is actually an automatic application of the parking brake. When air system pressure drops to 40 psi (276 kPa) the parking brake knob will raise automatically to apply brake.

Because air pressure is required to release parking/ emergency brake, an automatic application will remain ON until air pressure can be restored.

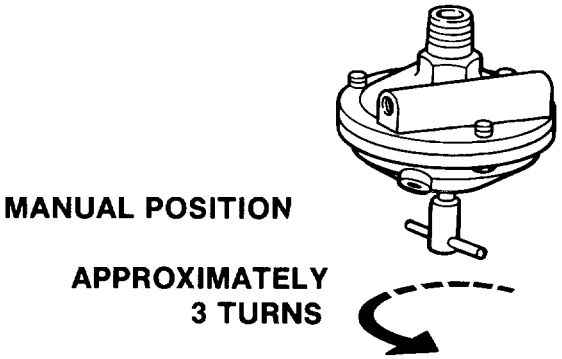
If unit cannot be moved, display appropriate warning flags, flares or lights. Notify maintenance personnel as soon as possible.

Automatic reservoir drain

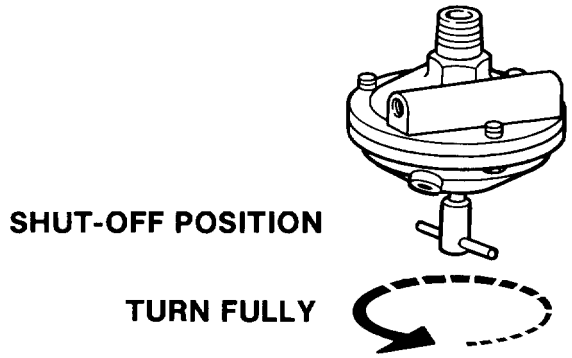
Automatic drain valves are provided on each air reservoir (3) to eliminate moisture from the brake system. These valves contain an automatic heating element to thaw ice which may form in cold weather. A control screw located on the bottom of the valve can be set in three positions, AUTOMATIC, MANUAL DRAIN and SHUT OFF.



In AUTOMATIC position (control rotated fully to left) valve functions automatically to drain moisture. Each time air compressor begins a loading or unloading cycle, accumulated moisture will be expelled from the valve. Keep control in AUTOMATIC position for normal operation.



In MANUAL DRAIN position, moisture and air pressure are drained from the reservoir. Fan brake pedal to reduce air pressure until the compressor cuts in to restore pressure. Stop engine and turn control as shown and check for accumulation of moisture. If there is an accumulation, valve must be repaired or replaced.



In SHUT OFF position (control rotated fully to right) valve functions as a closed drain cock. Keep control in this position only if valve is detective. Notify maintenance personnel immediately if valve is defective. Be sure to drain moisture from reservoir daily if unit is being operated with a defective valve.

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The power steering system provides easier steering and greater control in the event of a blowout or soft ground. “Road feel” is similar to that of a conventional manual steering system.

CAUTION

Use of power steering while carrier is stopped causes unnecessary stress on system component and can cause serious damage to system.

Holding steering wheel in full left turn or full right turn position will cause system to overheat. This can cause steering pump to fail.

WARNING

Be alert for any increase in effort needed to steer. If any difference is noted, notify maintenance personnel immediately for correction. If power assist feature should fail for any reason IT WOULD BECOME VERY DIFFICULT TO STEER. For this reason it is extremely Important that you NEVER TURN ENGINE OFF WHILE TRAVELING.

In the event power steering fails, stop as soon as possible. Do not drive unit until problem has been corrected.

TOWING

To tow unit for a short distance (not to exceed 1/4 mile travel in one hour):

1. Secure boom in rack using tie-down device.
2. Turn ignition switch to ON position
3. Position transmission direction selector in forward or reverse to unlock front axle oscillation.
4. If brake system pressure cannot be maintained, disconnect parking brake linkage at brake arm and tow using a tow bar.

For greater distances, do not attempt to tow unit unless a wrecker of sufficient capacity is available to lift the front wheels from the ground. Lifting the front requires 17,000 pounds (7711 kg) lift capacity. Gross vehicle weight is 35,000 pounds (15,876 kg).

CAUTION

Before towing, be sure to disconnect propeller shaft at rear axle or serious transmission damage could occur.

If a wrecker of sufficient capacity is not available, load unit on a suitable carrying vehicle for transport to a repair facility.

IF YOU GET STUCK

If unit becomes stuck in soft ground you can use the boom to help free it.

Shift unit to Low Range, First Gear and to Forward or reverse as appropriate.

Position boom over rear of carrier and imbed bucket in ground or against a solid object.

While accelerating, extend or retract boom as required to help push or pull unit to solid ground. Raise or lower boom as necessary to keep rear wheels in proper contact with ground.

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STABILIZER OPERATION

Precautions

Always lower stabilizers before operating upperstructure.

Be sure ground is firm enough to support stabilizers. It it isn't use mats under stabilizer floats.

Use mats if there is a possibility of stabilizers being frozen in ground.

If a stabilizer cylinder shows signs of leakage, have it repaired before using it.

Be sure to raise stabilizers before traveling.

Extending & Retracting Stabilizers

1. Position machine for safe, efficient operation.
2. Apply digging brake.

⚠ WARNING

Extend and retract stabilizers only when you have a clear view of them. If circumstances prevent a clear view, use a signal man.

3. While observing stabilizer or signal man, move appropriate switch in proper direction as indicated on decal.

⚠ WARNING

Observe extent of stabilizer float penetration. If ground is too soft to provide solid support, use mats as required under stabilizers.

4. Extend second stabilizer in same manner as the first.
5. With both stabilizers in firm contact with the ground, extend and/or retract stabilizers as necessary to obtain maximum leveling of machine.

FRONT AXLE OSCILLATION

General

The front axle has an oscillation type suspension which provides a rigid base for excavator operation but still permits the front wheels to follow ground contour when traveling over rough terrain.

Normal Oscillation

With the direction selector which positioned in either F (forward) or R (reverse) oscillation lock valves opened automatically. Under this condition the oscillation cylinders will drift freely permitting the front axle to oscillate as the front wheels follow ground contour.

Oscillation Lock

With the direction selector switch positioned in N (neutral) oscillation lock valves are closed automatically. In this condition the oscillation cylinders are hydraulically locked to make a rigid connection between the front axle and carrier frame for upperstructure operation.

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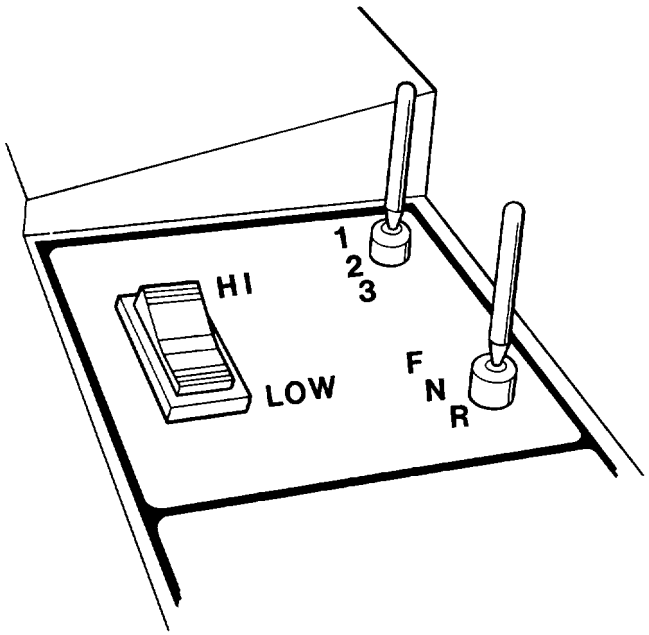
Torque Converter

There are no operator controls for the torque converter. It functions automatically to permit starting from a standstill in any transmission speed range.

Torque converter oil temperature and oil pressure gages are provided to monitor torque converter operation. Normal operating temperature is 180° to 200° F. (82° to 93° C.) and operating pressure is 180 to 220 psi (1241 to 1516 kPa) with oil at operating temperature and engine running at 600 RPM.

Transmission

The transmission provides six speeds forward six speeds reverse: 1st, 2nd and 3rd in both high and low ranges.



There are three operator control switches for the transmission: the gear selector (1,2 and 3); the range selector (LOW and HI); and the direction selector F (forward); N (neutral), and R (reverse).

⚠ CAUTION

Wait until the brake system has reached full operating pressure before moving the carrier.

To operate the transmission, perform the following procedure:

1. With unit stopped and directional selector in N (neutral) move HI/LOW selector to desired speed range.

⚠ CAUTION

Shift the HI/LOW selector and the direction selector ONLY when the carrier is stopped. Shifting these controls while traveling could cause serious transmission damage.

2. Move gear selector to desired gear (I, 2 or 3). This may be shifted while moving.
3. Move direction selector to F (forward) or R (reverse) as desired.
4. Release parking or digging brake if applied.
5. Release service brake treadle if depressed and depress accelerator to obtain desired speed.
6. Stop unit by releasing accelerator and depressing service brake treadle.
7. When unit has stopped, apply parking brake and release service brake treadle.
8. Move direction selector to N (neutral).

Two & Four Wheel Drive

There are no operator controls for two and tour wheel drive. When the transmission range selector is moved to LOW, four wheel drive is engaged automatically. Moving transmission range selector to HI causes front axle drive to be disengaged automatically.

⚠ CAUTION

Use LO range when driving on unimproved surfaces.

PARKING

Precautions:

Avoid parking on roads or highways. If it cannot be avoided be sure to display warning flags during day and flares or flashing lights at night.

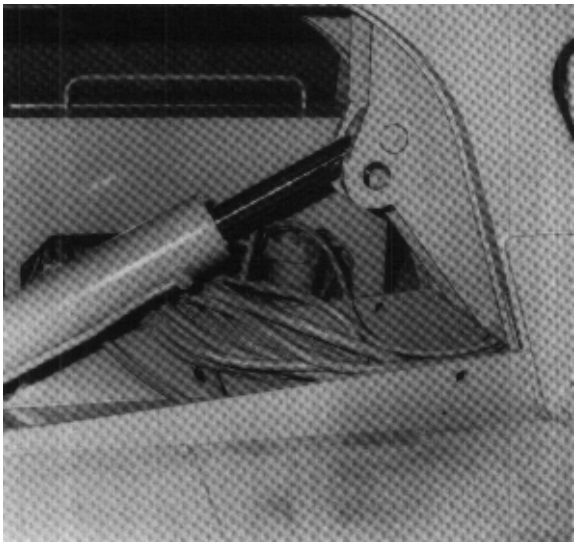
Avoid parking on banks, a slope or near an excavation. Park on level ground and block wheels.

Parking Procedure

1. Position unit in a safe, level parking area.
2. Apply parking brake.
3. Position transmission direction selector in neutral, the gear selector in 1st gear and the range selector in low range.
4. Retract boom and position it in boom rack.
5. Retract stabilizer jacks fully.
6. Turn off all accessories
7. Allow engine to cool at idle speed for a few minutes and then turn off. Remove ignition key.
8. Fill fuel tank to minimize condensation.
9. Install vandal covers if available.
10. Disconnect battery if unit is in an area where tampering seems possible.
11. Lock cab and storage compartments.

Two-Position Hoist Cylinder

The Hoist Cylinder can be pinned at the rod end to the cradle in two different positions. The top position (boom will lower 75°) permits greater power (lifting capacity), while the lower hole (boom will lower 90) gives greater boom up and down speed.



How to re-position Hoist Cylinder:

Have operator place boom firmly on the ground. Set parking brake.

Securely block Hoist Cylinder so that it will remain stationary when top pin is removed.

Remove Cap Screw and Lollipop Pin that secures Hoist Cylinder Pin.

Remove Hoist Cylinder Pin.

Clean and grease Pin and all open holes.

Carefully re-position blocking with crow bar and line-up cylinder rod with other hole position.

Move Boom Lower or Boom Raise Joystick Control to re-position cylinder rod for pin placement in second hole.

Replace Hoist Cylinder Pin and secure with Cap Screw and Lollipop Pin.

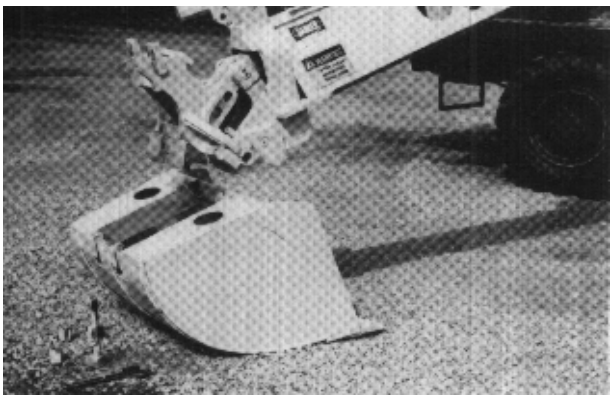
Remove blocking.

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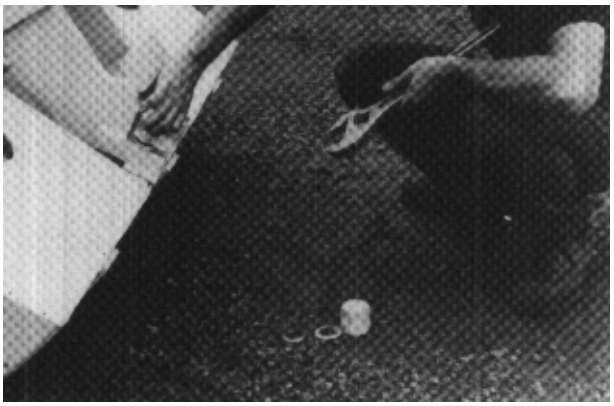
ATTACHMENT INSTALLATION

WARNING

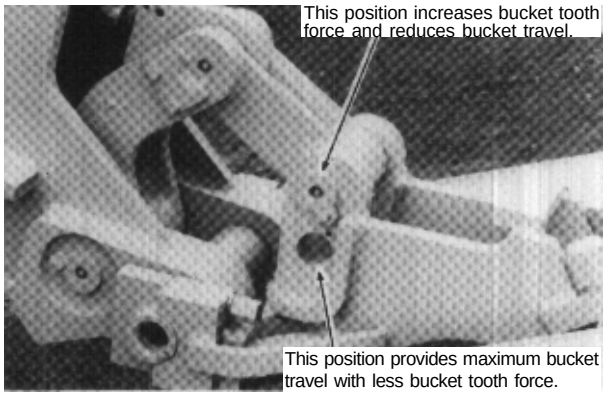
Keep boom in fully extended position while installing bucket. Stay clear until bucket adapter has been fitted to buckets as shown in step 2.



1. Position bucket adapter above bucket tube as Shown and lower boom until concave section of adapter contacts bucket tube.



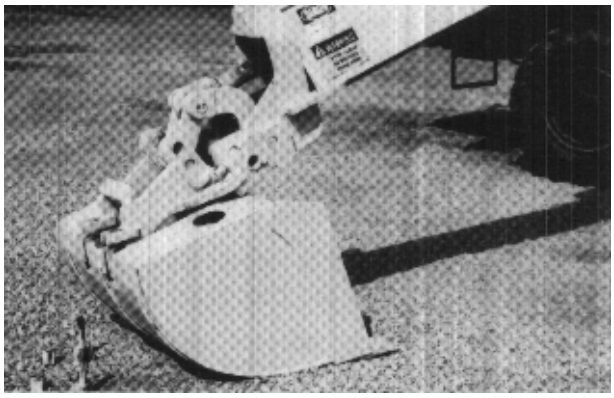
3. Install adapter wedge bolts, washers and nuts and tighten finger tight.



5. Position bucket linkage as desired.

CAUTION

Digging with a loose or an improperly fitted bucket can shear adapter bolts and cause excessive wear.



2. Move adapter toward “Bucket Close” position until outer end of adapter contacts bucket.



4. Raise boom slightly until bucket just clears ground and tighten nuts. Check often to be sure nuts remain tight.

6. Check to be sure bucket travel is limited by stops when opening and by bucket tube when closing —NOT by cylinder bottoming.

CAUTION

Never fully extend bucket cylinder without a bucket installed or cylinder rod will be damaged.

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A TYPICAL GRADALL DIGGING CYCLE

1. Position unit for efficient digging cycle, apply digging brake and **shift transmission direction selector to N (neutral).**

⚠ WARNING

Avoid accidental of the controls. Always stop engine before repositioning door and windows.

2. Stop engine and secure door and windows in desired position for ventilation (page 11). Remove boom hold-down device.

3. Warm up engine and hydraulic oil and then move throttle selector to full throttle position.

NOTE: With throttle selector positioned at full throttle, engine will return to idle each time digging brake is released and then return to full throttle when digging brake is applied.

⚠ WARNING

Run engine at full throttle for all excavator functions except warm-up

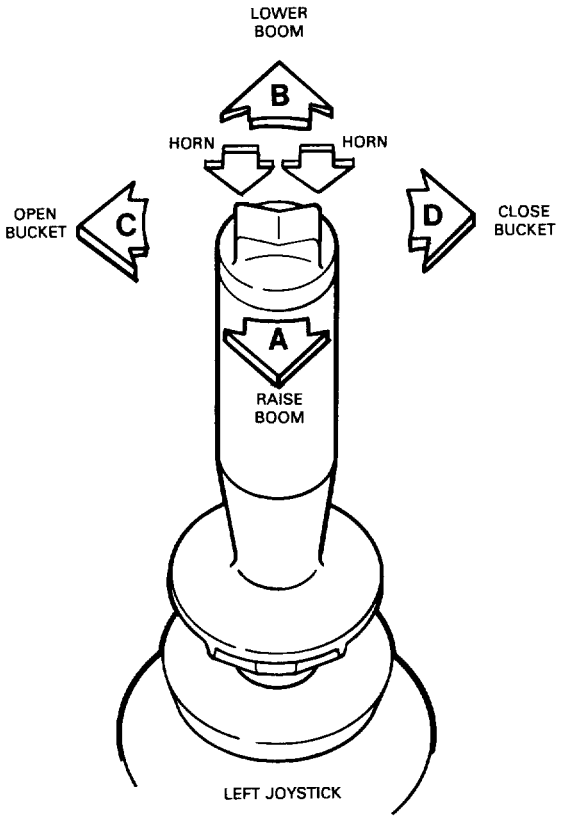
Always run at full throttle when lifting and positioning a load to keep cylinders charged.

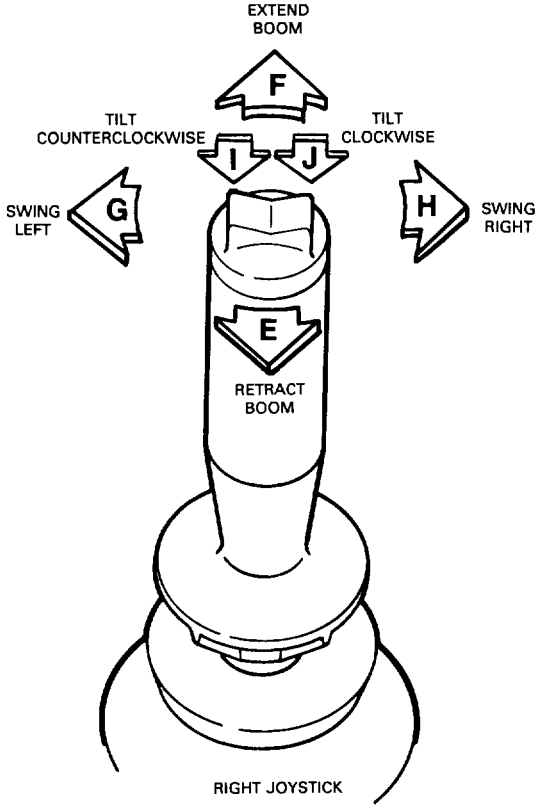
4. Position stabilizers for maximum stability and machine leveling (page 22).

5. Move JOYSTICK rocker switch to ON position.

NOTE: A second joystick switch is located in the operator's seat to de-energize the joystick when the operator rises from the seat.

Practice with joystick controls in a safe, open area.



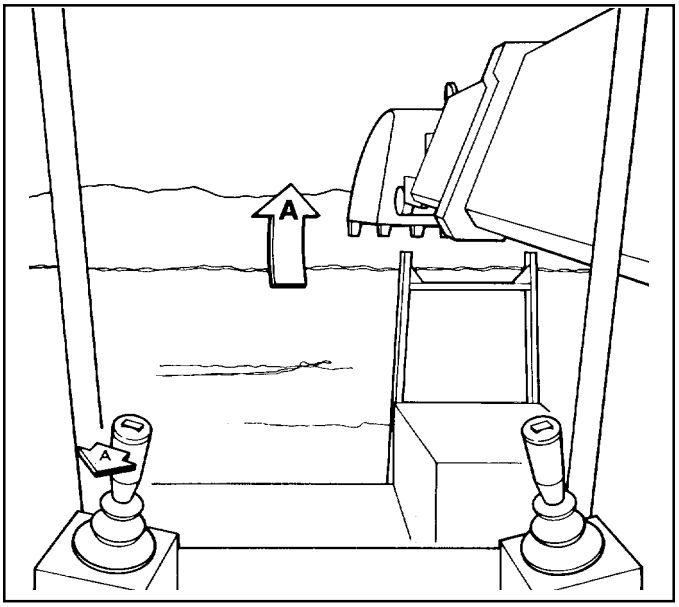


Joysticks return to neutral position when released.

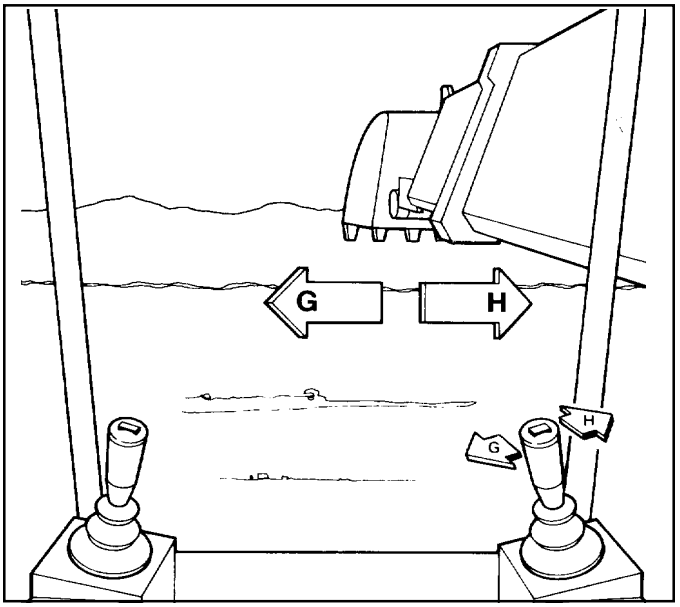
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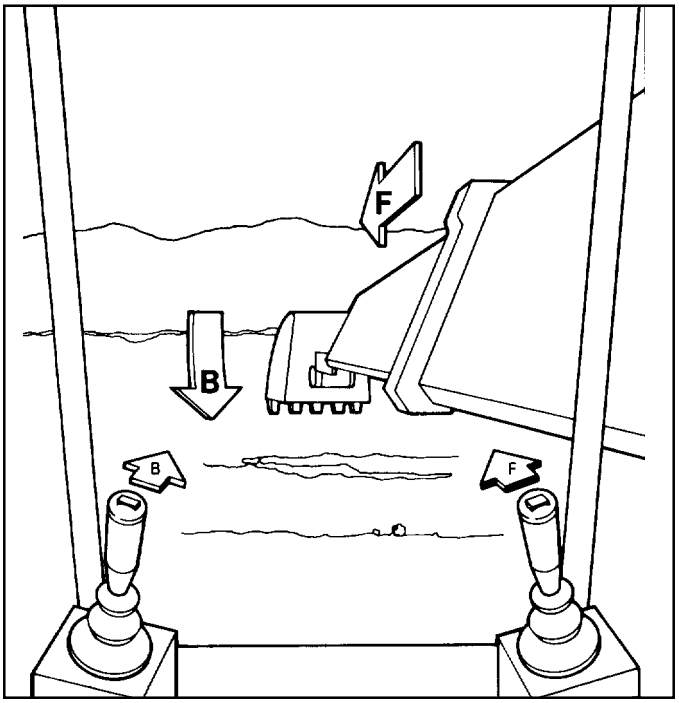
A TYPICAL G RADALL DIGGING CYCLE



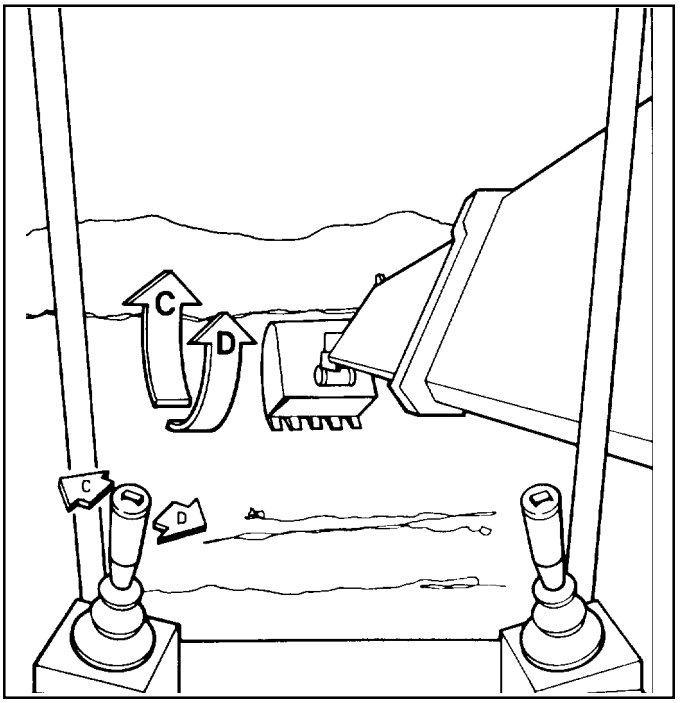
6. Pull back on left joystick (A) to raise boom from boom rest. Be sure to raise boom far enough to clear all obstructions.



7. Move right joystick to left (G) to swing left or to right (H) to swing right to digging site.



8. While pushing right joystick forward (F) to extend boom., push left joystick forward (B) to lower boom to position for start of cut.

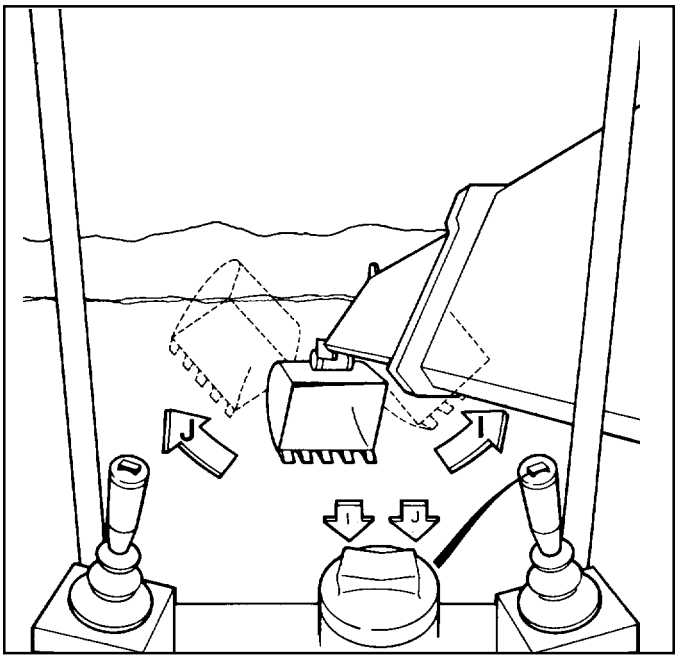


9. Move left joystick to left (C) to open bucket or to right (D) to close bucket for correct penetration. Teeth should angle downward slightly (about 5). Angle may be greater for soft digging.

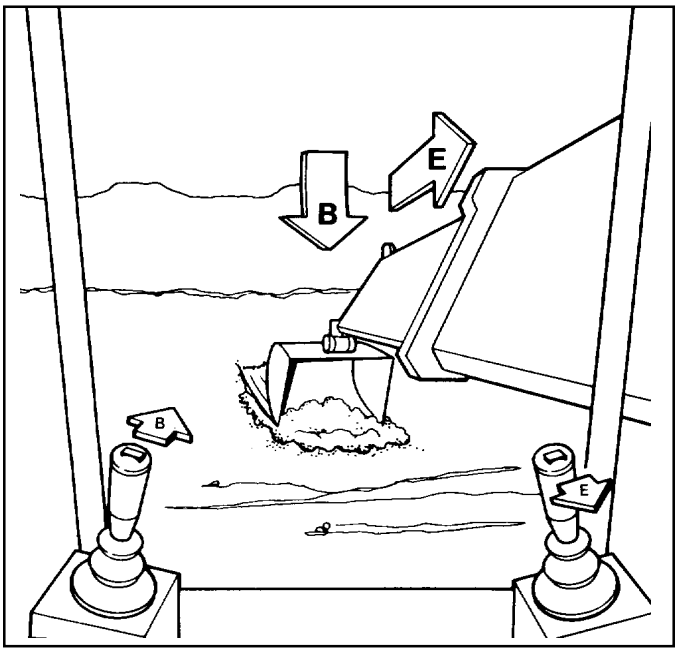
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A TYPICAL GRADALL DIGGING CYCLE

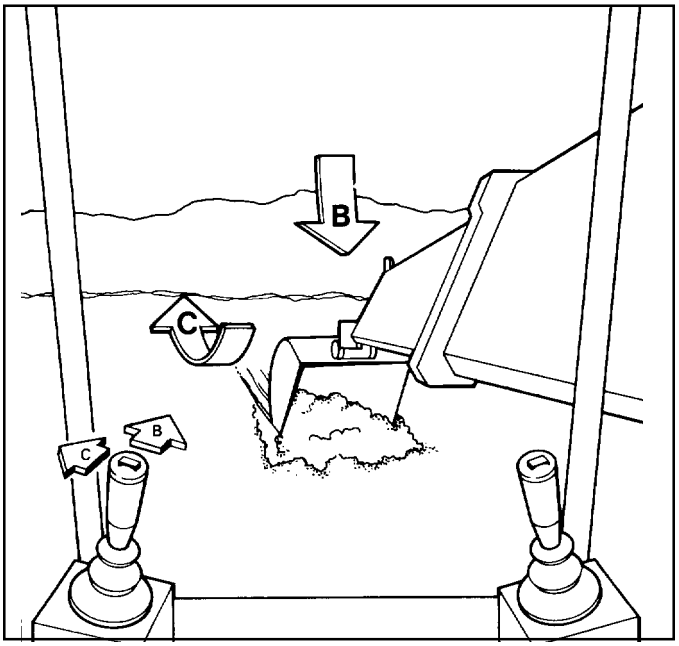
NOTE: Depth of cut depends on hardness of material. If bucket angle is too great or cut is too deep, hose relief valves will allow bucket to open to protect circuit.



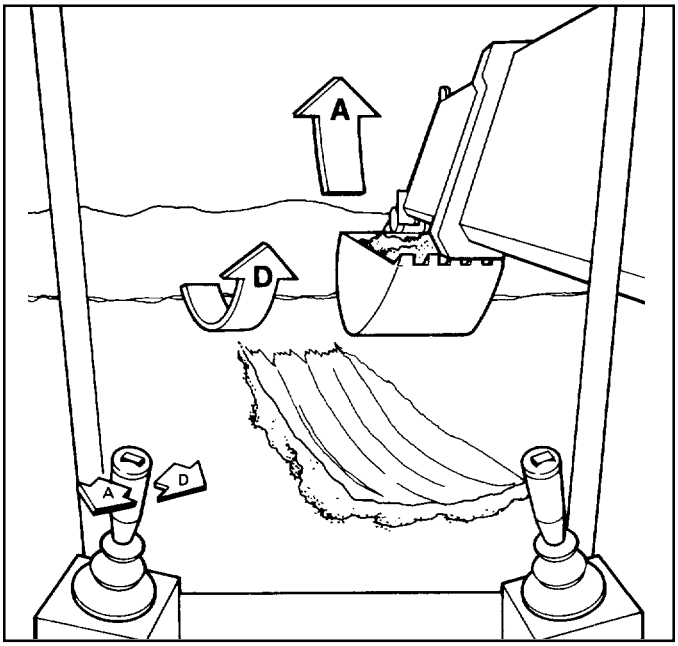
10. If required, press left side of tilt switch (I) to tilt counterclockwise or right side of switch (J) to tilt clockwise.



11. While pushing forward on left joystick (B) to lower boom and force bucket into ground, pull back on right joystick (E) to retract boom and fill bucket.



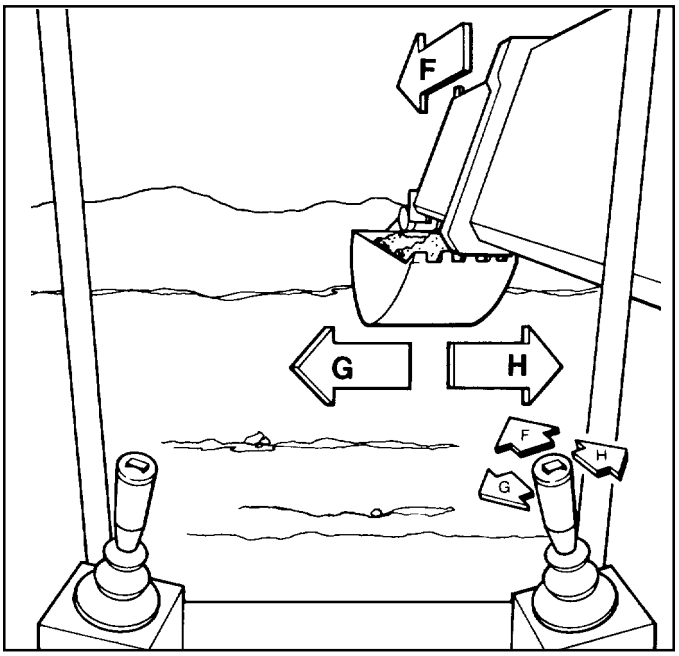
12. As bucket is filling, jog left joystick forward (B) to lower boom and maintain depth of cut. At same time jog left joystick to left (C) to open bucket and maintain proper bucket angle.



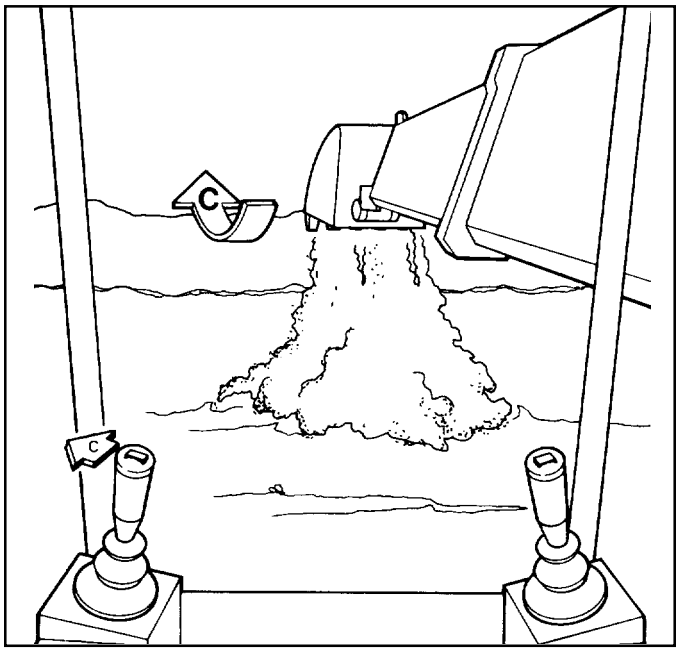
13. When bucket is full or when boom is fully retracted, move left joystick to right (D) to close bucket. At same time pull left joystick back (A) to raise boom. Raise boom only far enough to clear obstructions.

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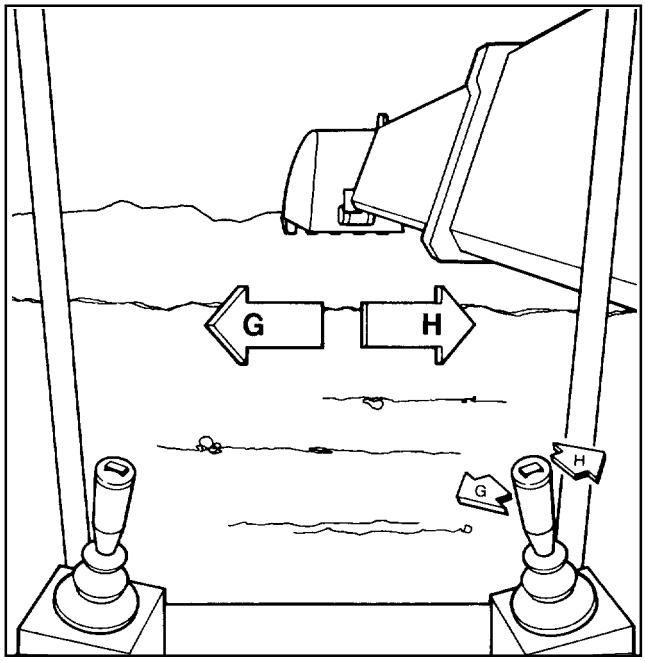
A TYPICAL GRADALL DIGGING CYCLE



14. Move right joystick to right (H) to swing right or to left (G) to swing left to dump site. If necessary, extend boom by pushing right joystick forward (F).



15. Move left joystict to left (C) to empty the bucket.



16. Move right joystick to left (G) or right (H) to align boom for next cut. Repeat steps 8 thru 16.

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LIFTING AND POSITIONING A LOAD

Precautions

Do not depend on machine tipping as a warning of overload. Some load ratings are based on hydraulic lift capacity, not stability.

Hydraulic relief settings must be correct when lifting and positioning loads.

Suspend loads only as shown. Passing line over bucket can cause uncontrolled movement of load.

Always operate at full engine RPM when handling a load. This keeps cylinders charged and prevents unexpected machine movements.

Keep everyone clear of machine, especially the boom and suspended load. Use guide ropes to position load.

Use stabilizers to level machine before handling a load.

Do not travel with a suspended load. Excavators are not designed for pick and carry lifts.

Sudden swing braking can cause unexpected movement of the load and tip the machine.

Be sure tires are properly inflated before handling a load.

Keep load line vertical. Side loads can cause structural damage and tip the machine.
Do not lift a load if unit has a boom extension attached.

General

The excavator can lift and position loads safety **ONLY IF YOU PLAN THE LIFT PROPERLY.**

DANGER

Failure to plan a lift properly can cause death or serious injury.

There is a great lift capacity difference between the excavator's best and worst lift positions. Just because it can lift a load from one point does not mean it can safely move the load to any other point.

For example, the best lifting position is with the excavator level and the boom fully retracted and horizontal. Assume that you have just lifted the maximum rated load from a truck with the unit in this position. You swing, but the only other thing you can safely do with the load is put it back on the truck. Lowering, or extending the boom will exceed the rated capacity of the unit.

The "common sense" and "feel" an experienced operator might apply in regard to "tipping loads" **DOES NOT APPLY** to loads limited by hydraulic lift capacity. Some loads shown on the chart in cab are Hydraulic Lift Capacities. Exceeding these capacities can cause a relief valve to open allowing the load to fall, or in some cases, the machine to tip.

To avoid exceeding capacities, the entire lift must be planned.

Positioning Machine For Lift

Before discussing the steps in planning a lift, let's consider the most favorable excavator positions for making a lift.

The shorter the load radius, the greater the lift capacity. Position the unit to minimize boom extension while keeping a safe distance from obstructions and excavations.

Position the unit to minimize boom travel above and below horizontal. For example, it may be necessary to use a short sling to move a load from a truck to the ground. Then use a longer sling to position load in an excavation.

Finally, position unit for maximum visibility. If conditions do not permit a clear view of the load through entire lift, use a signal man.

Planning a lift

1. Determine the weight of the load. Weight of slings, chains and auxiliary lifting devices must be added as part of the load. Refer to lift capacity chart for weight adjustment required for bucket.

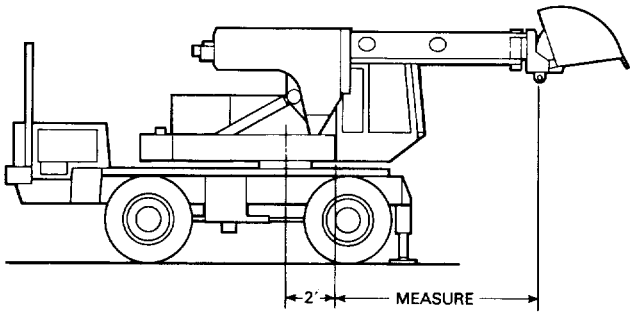
NOTE: Lift capacities are based on machine being leveled by stabilizers and also on load being freely suspended as shown.

2. Move the machine to the best probable position for making the lift.

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3. Perform an unloaded trial run of the lift to determine maximum load radius required and maximum boom height and depth required to complete the lift.

Measure load radius from front center of upper-structure frame to vertical load fine and add 2 feet (distance from front of frame to center of rotation).



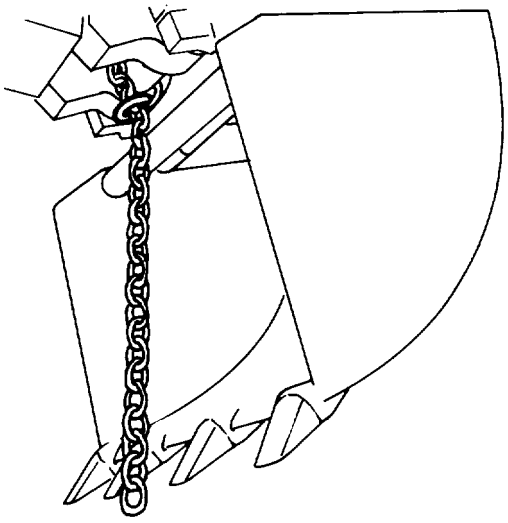
Measuring Load Radius

Measure boom height/depth from bucket adapter pivot shaft to ground level (same plane as stabilizer pads). Be sure to allow for length of sling and height of load.

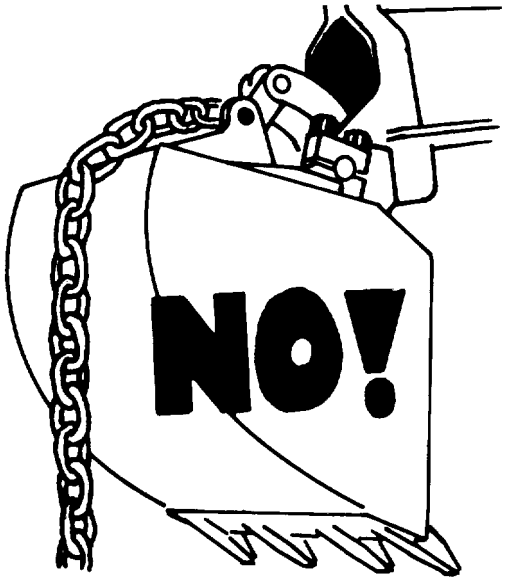
4. Refer to lift capacity chart column for the required load radius. If the required radius falls between columns use the column for the next large radius.

5. Check the appropriate capacities for the required boom height and depth. The smaller of these capacities is the maximum load permitted for lift conditions.

To determine practical working load limits the operator must also consider wind, hazardous conditions, experience of personnel and proper load handling.



Load Attachment Point



Never pass load line over bucket. Relief valves in bucket circuit could cause unexpected, dangerous movement of the load.

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OPERATING TIPS

When You’re Excavating

1. “Shave” thin cuts of dirt with the bucket instead of taking deep bites. You will maintain a more even grade and leave a smoother finish.
2. When digging basements, begin your first cut in one of the corners, straddling the line. You then will be able to work toward the center.
3. Speed up your digging cycle by doing several operations at one time. For example, extend the boom and open the bucket while swinging to dump.
4. When digging rock, pavement or frozen ground, combine boom and bucket functions to increase break out force. Imbed teeth in material then close bucket while extending boom.

When You’re Trenching

1. Determine the true location of all underground obstructions and service lines.
2. Do not remove more dirt than necessary. Match bucket width to required width of trench.
3. For harder materialsùuse a smaller bucket.
4. When the bucket is full, raise boom and swing to dump.
5. Keep the cutting edges on the bucket sharp.

When You’re Ditch Cleaning

1. Apply moderate down pressure (lower boom) when starting the cut. Use the boom and bucket action while retracting the boom to dig and shape the ditch in one operation.
2. When ditch cleaning along a road, position the unit with the front of the carrier facing traffic and the spoil truck at the rear of the carrier. Travel in reverse with traffic. This provides a clear view of ditch, road shoulder and spoil truck.
3. Overlap cuts about one foot. This allows you to watch the right-hand corner of the cutting edge and keep each new cut on the same level as the previous cut.
4. When water is in the ditch, work downstream to use the water as an aid in maintaining the effective grade.

When You’re Removing Pavement

1. Use the booming out action, as described in the excavating tips, for stubborn pavement. This develops great break-out pressure and leverage at the bucket teeth.
2. Use pavement removal bucket to hold pieces of pavement against boom when swinging to dump.

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General

1. Position the unit so that minimum swing is required. More digging cycles per minute will result from a well-positioned machine.

NOTE: If you have any special application problems, contact your Gradall Distributor.

ABOUT YOUR GRADALL

Tools

Standard tools that are common in tool boxes are not furnished with your Gradall. Tools especially designed for use with your machine are shipped with the unit. You should be familiar with these tools, and know where they are kept.

Emergency Parts Kits

Emergency parts kits are available and should be kept with the machine. Kits are available from your Gradall distributor.

PIN (Product Identification Number)

Know the product identification number and the lot number of your Gradall. If there are any questions about the machine or its operation, contact your Gradall distributor. The product identification number and the lot number of your machine must be given when requesting any information or ordering parts. The product identification number plate is located on the front of the upperstructure frame.

Warning Signals

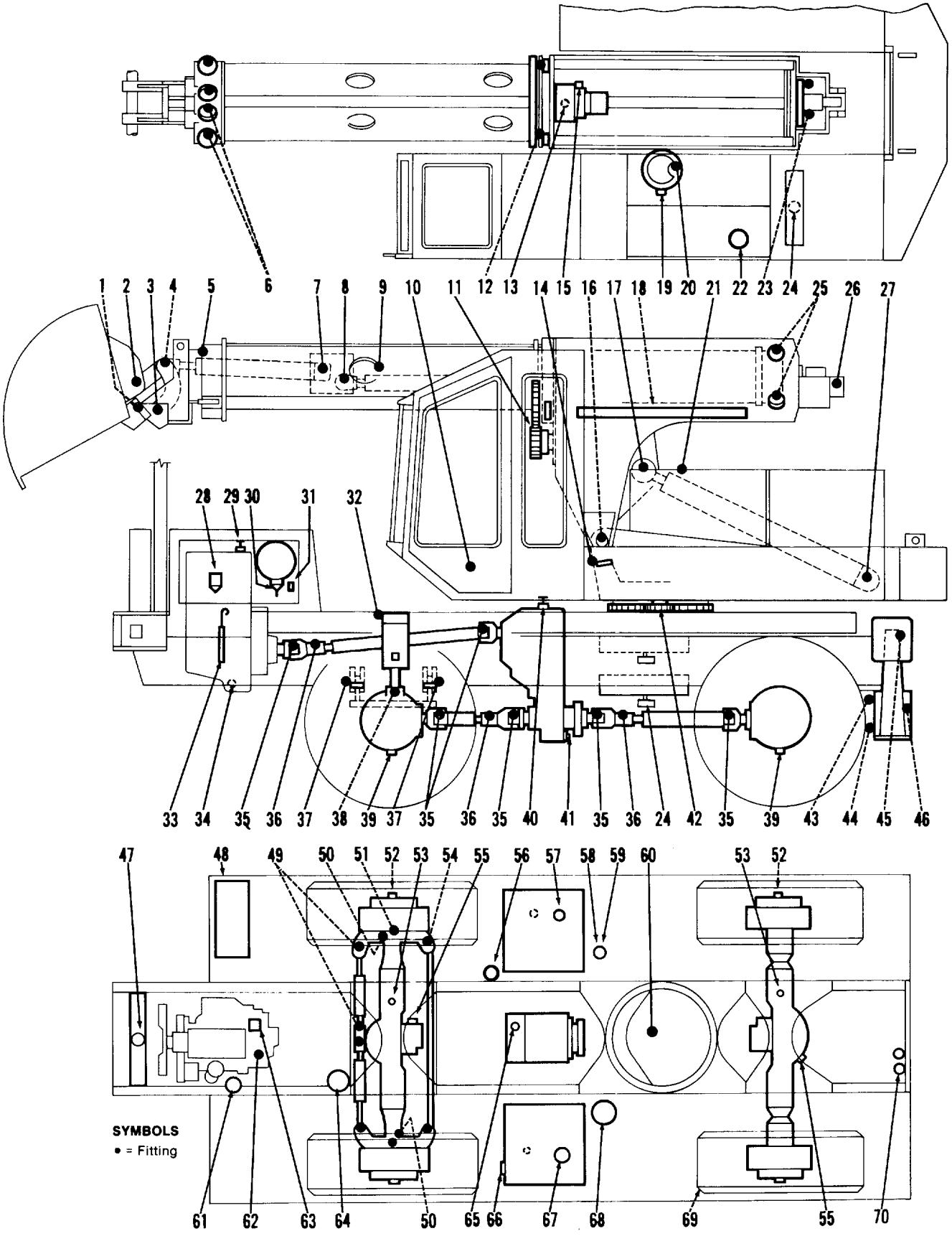
A Horn Button is located on the left joystick to be used by the operator to warn of **ANY MOVES.**

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LUBRICATION & MAINTENANCE DIAGRAM

For service, position fully extended boom over left side and rest closed bucket on ground. Stop engine.

Refer to vendor component literature in service manual for additional lubrication and maintenance requirements.



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LUBRICATION

REPLACEMENT FILTER ELEMENTS

Engine Air Cleaner	Donaldson P11-7439	Gradall 7717-4001
Primary Fuel Filter	Detroit Diesel 5574961	Gradall 8667-1613
Secondary Fuel Filter	Detroit Diesel 5573261	Gradall 8667-1614
	Detroit Diesel 5573263	Gradall 8667-1614
Engine Oil Filter (canister type)	Detroit Diesel 5573017	Gradall 8347-1255
Engine Oil Filter (spin-n type)	Detroit Diesel 5103762	Gradall 7717-1045
Air Compressor Air Cleaner	Bindix 239292	None
Hydraulic Filter (auxiliary - small)	Donaldson P16-3244	Gradall 7713-3070
Hydraulic Filter (main - large)	Donaldson P16-0216	Gradall 7713-3069
Transmission Oil Filter	Clark 215502	Gradall 7710-4001

CAPACITIES
(Capacities are approximate - check level)

Air System Oiler	1.00 oz.	(29.57 mL)
Brake Fluid REservoir (each)	.50 pt.	(.27 L)
Engine Cooling System	22.00 qt.	(20.81 L)
Engine Crankcase	13.00 qt.	(12.30 L)
Differential, Front	22.00 pt.	(10.41 L)
Differential, Rear	29.00 pt.	(13.72 L)
Fuel Tank	75.00 gal.	(283.87 L)
Hydraulic Reservoir	65.00 gal.	(246.02 L)
Hydraulic System	90.00 gal.	(340.65 L)
Planetary Drive (each)	5.00 pt.	(2.37 L)
Swing Transmission	6.00 pt.	(2.84 L)
Tilt Transmission	2.80 pt.	(1.32 L)
Transmission/Torque Converter	4.60 gal.	(17.40 L)

RECOMMENDED LUBRICANTS

ATF - Automatic Transmission Fluid - Refer to Clark Service Literature
BF - Brake Fluid - DOT-3
CG - Chassis Grease (high temperature) per MIL-G-24139
EO - Engine Oil - Refer to Detroit Diesel Service Literature
GL - Open Gear Lubricant - Gradall Par No. 8664-1024
GO - Gear Oil -Refer to Manufacturer's Service Literature
HF - Hydraulic Fluid -A.S.L.E. No H-215 - see specifications below*
MC - Dry Graphite Lubricant - Gradall Par No. 8664-1475
MO - Mineral Oil

*Hydraulic Fluid Specifications:

Viscosity ASTM:	(SSU at 100F.)	Rust Test (ASTM D 665):	Pass (Procedure A)
Viscosity #215:	ASTM D 88) 194-235 (Centistrokes at 100F.) ASTM D 445) 41.9-51.0	Oxidation Test (ASTM D 943):	1000 hr. min. to a Neut No. of 2 (See Notes 4 and 5 ASTM D 943)
Viscosity Index (ASTM D 567):	85 Min.	Pour Point (ASTM D 97):	-20 F. mix.
		Flash (ASTM D 92)	385 F. min.

LUBRICATIONS NOTES

Clean lubrication fitting before lubricating.
Intervals shown are for normal (8 hour day) usage and conditions Adjust intervals for abnormal usage and conditions.
Lubricate points indicated by dotted leaders on both sides of unit.
Drain engine and gear only after operation when lubricant is hot.
Check lubricant levels when lubricant is cool.
Clean filter and air cleaner housings and reusable elements using cleaning solvent or diesel fuel. Dry components thoroughly using a lint free cloth.
Apply a light coating of engine oil to all linkage pivot points.
See vendor component literature for additional lubrication and maintenance requirements.
Be sure machine is level when checking fluid levels.

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Daily Lubrication & Maintenance	LUBE SYM.	NO. OF PTS.
1. Bucket Pivot	CG	2
2. Adapter Link Pivot	CG	1
3. Connecting Link Pivot	CG	1
4. Tool Cylinder Rod Pivot	CG	3
6. Outer Boom Rollers	CG	6
7. Tool Cylinder Anchor Pivot	CG	1
8. Extension Cylinder Rod Pivot	CG	1
11. Tilt Pinion and Ring Gear Segment	GL	1
12. Tilt Rollers	CG	4
14. Swing Bearing	CG	2
16. Boom Cradle Pivot	CG	2
17. Boom Hoist Cylinder Rod Pivot	CG	1
18. Hose Trough (spray with dry type graphite lubricant)	MC	1
22. Auxiliary Circuit-Hydraulic Filter (observe filter condition indicator light in cab - replace filter elements at req'd)	-	1
23. Tilt Bearing	CG	2
25. Inner Boom Rollers	CG	3
26. Extension Cylinder Anchor Pivot	CG	1
27. Boom Hoist Cylinder Anchor Pivot	CG	1
31. Air Cleaner (observe air cleaner condition indicator and clean or replace element as req'd)	-	1
33. Crankcase Dipstick (check oil level and replenish as req'd - item 29 is oil filler cap)	EO	1
40. Transmission Dipstick and Filler Cap (with machine level, engine running at 500/600 RPM and trans. fluid at 180 to 200 F.(82.2 to 93.3 C). check fluid level and replenish as req'd)	ATF	1
42. Swing Pinion & Ring Gear	GL	1
43. Stabilizer Cylinder Anchor Pivot	CG	2
44. Stabilizer Pivot	CG	2
45. Stabilizer Float Pivot	CG	2
46. Stabilizer Cylinder Rod Pivot	CG	2
47. Radiator Filler Cap (check coolant level and replenish as req'd)	-	1
57. Fuel Tank Filler Cap (replenish fuel as req'd)	-	1
60. Hydraulic Swivel	CG	2
66. Hydraulic Reservoir (observe sight gages and replenish as req'd)	HF	1
68. Main Hydraulic Filter (observe filter condition indicator light in cab and replace filter element as req'd)	-	1
69. Tires (check pressures with tires cool)	-	4

Weekly Lubrication & Maintenance (include all daily service)		
24. Automatic Reservoir Drain Valve (refer to page 20 of this manual)	-	3
32. Oscillation Cylinder Anchor Pivot	CG	2
37. Oscillation Cradle Pivot	CG	2
38. Oscillation Cylinder Rod Pivot	CG	2
49. Steering Cylinder Pivot	CG	4
58. Air System Oiler (drain air system before removing bowl and refil oiler as required)	MO	1
59. Air System Filter (drain air system before removing bowl and clean filter as required)	-	1
70. Brake Hydraulic Reservoir (check level and replenish as req'd)	BF	2

Monthly Lubrication & Maintenance (includes daily and weekly services)	LUBE SYM.	NO. OF PTS.
5. Tool Cylinder Rod Wiper (apply lube to each ftting till clean grease emerges from wiper)	CG	2
9. Extension Cylinder Rod Wiper (apply lube to each fitting till clean grease emerges from wiper)	CG	2
10. Door Latch	CG	1
21. Boom Hoist Cylinder Rod Wiper (apply lube to each fitting till clean grease emerges from wiper)	CG	2
28. Secondary Fuel Filter (replace element)	-	1
30. Air Cleaner Dust Cup (check to be sure opening is unobstructed)	-	1
34. Crankcase Drain Plug (drain and refill to level on dipstick - item 29 is filler tube - Detroit Diesel recommends 150 hour oil changes)	EO	1
35. Propeller Shaft Universal Joint	CG	6
36. Propeller Shaft Spline	CG	3
48. Battery (check electrolyte level and replenish as req'd)	-	1
50. Cardan Joint (lubricate Cardan universal joint thru hole in axle housing)	CG	2
51. Steering Trunnions	CG	4
52. Planetary Fill, Level & Drain Plug (with arrow horizontal, check level and replenish as req'd)	CG	2
54. Tie Rod Ends	CG	2
55. Differential Fill and Level Plug (check level and replenish as req'd)	GO	1
56. Primary Fuel Filter (replace element)	-	1
61. Engine Oil Filter (Detroit Diesel recommends element replacement at each oil change - replace element every 150 hours)	-	
62. Throttle Linkage	CG	1
63. Air Compressor Air Cleaner (clean or replace elements as required)	-	1
64. Transmission Oil Filter (replace element every 250 hrs.)	-	1

Quarterly Lubrication & Maintenance (include all daily, weekly and monthly services)		
41. Transmission Drain Plug (refer to manufacturer's service literature for procedure - change oil every 500 hours)	ATF	1
65. Transmission Breather (remove, clean and replace)	-	1

Semi-Annual Lubrication & Maintenance (include all daily, weekly, monthly and quarterly services)		
13. Tilt Transmission Drain Plug (drain with boom in vertical position, clean plug and replace)	-	1
15. Tilt Transmission Fill and level Plug (refill to plug level with boom in horizontal position)	GO	1
19. Swing Transmission Drain Plug (drain, clean plug and replace)	-	1
20. Swing Transmission Fill Plug (refill to level just covering top gear)	GO	1
39. Differential Drain Plug (drain, clean plug and replace - 55 is level plug)	GO	2
52. Planetary Fill, Level & Drain Plug (drain, with drain plug in six o'clock position - fill with plug in three or nine o'clock position)	GO	4
53. Differential Breather (remove clean and replace)	-	2
67. Hydraulic Reservoir Fill Cap and Breather (remove cap, clean, dry thoroughly and replace)	-	1

LUBRICANT SYMBOLS

ATF - Automatic Transmission Fluid
BF - Brake Fluid
CG - Chassis Grease (high temperature)
EO - Engine Oil
GL - Oper Gear Lubricant
GO - Gear Oil
HF - Hydraulic Fluid
MC - Dry Graphite Lubricant
MO - Mineral Oil

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GRADALL®

Hydraulic Equipment

406 Mill Avenue, S.W.
New Philadelphia, Ohio 44663

PHONE: (330) 339-2211
FAX: (330) 339-8468
WEB SITE: www.gradall.com

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

CALIFORNIA

Proposition 65 Warning

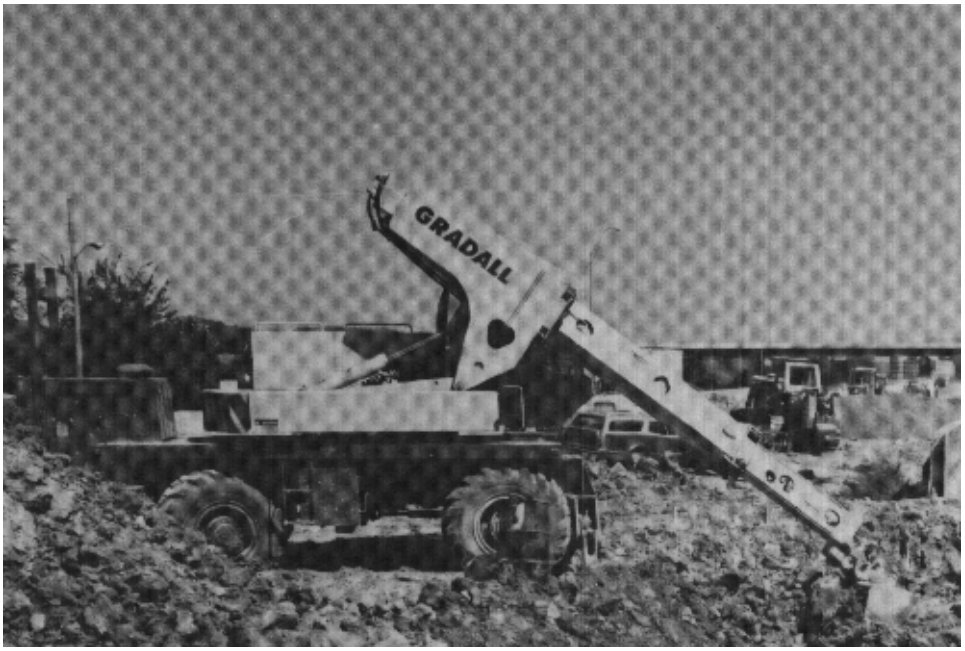
Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Wash hands after handling.

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HYDRAULIC SYSTEM OPERATION for G3R GRADALL®



FORM NO. 8362

Gradall is a registered trademark for hydraulic excavators built by The Gradall Co.

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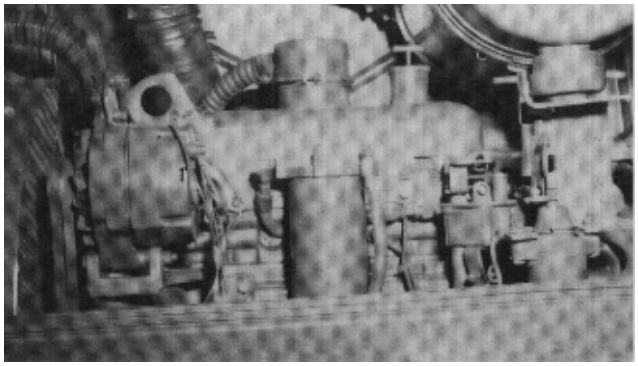
ENGINE

The G3R Gradall® hydraulic excavator is powered by a GM 3-53T turbocharged diesel engine with Clark Torque Converter and Transmission. The Gradall will travel up to 22 mph (35 km/h) on the highway. While digging the engine turns the hydraulic pumps at their rated speed.

Full instrumentation is located on the engine compartment and also in the cab. The engine has full flow oil filtration with spin-on cartridge. Two stage dry-type air cleaner, mechanical fuel pump and both primary and secondary fuel filters.

Engine crankshaft rotation is counterclockwise (viewed from flywheel end). A 75 gallon (284 L) fuel tank is located on the right center section of the carrier frame.

Read and study the engine manual provided with your Gradall.



TORQUE CONVERTER

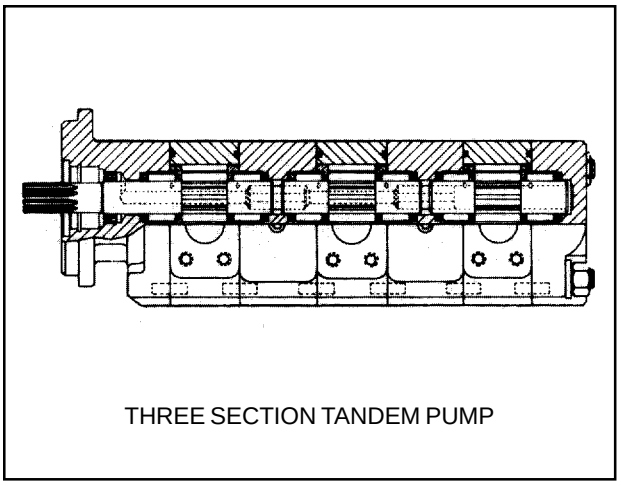
The torque converter is mounted to the flywheel housing of the engine and is used to deliver engine torque to the transmission. The three section tandem pump and the torque converter charging pump are driven directly by reduction gearing within the torque converter housing.

PUMPS

Excavator movements are powered by hydraulic flow from a three section, gear type, tandem pump which is flange mounted to the rear of the torque converter housing. Rated flow is 70 gpm (265 L/min) at 2200 rpm. Each gear section pumps oil with volumes in proportion to the width of the gear and the rpm which the pump is turning: 26 gpm for hoist circuit, 22 gpm for boom circuit and 22 gpm for stabilizer and swing, tilt and tool circuits.

There is also one auxiliary pump mounted on the engine accessory pad providing 14 gpm (53 L/min) at 2500 rpm. This pump provides oil for the pilot circuit and steering.

Oil from these pumps is routed to the upperstructure through a center pin. See the hydraulic schematic diagram included in the service manual.

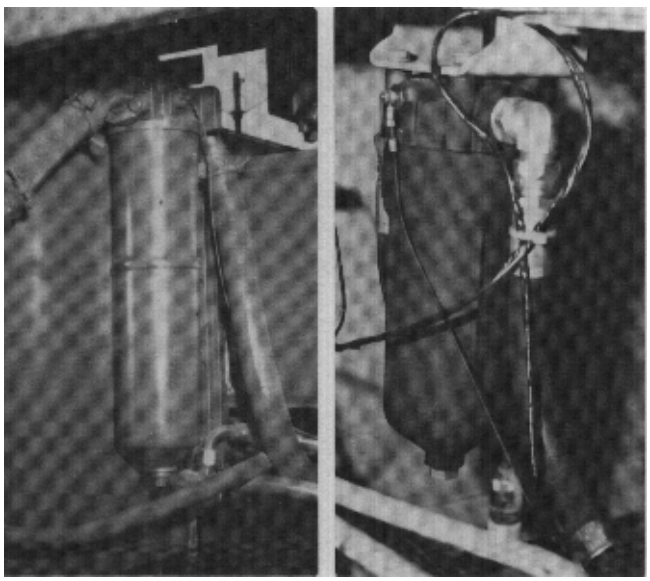


THREE SECTION TANDEM PUMP

HYDRAULIC SYSTEM FILTERS

The G3R is equipped with hydraulic filters for the pilot and main circuits. Check filter condition indicators with oil at operating temperature and the engine running at full throttle.

Filter elements should be replaced on a regular basis before the bypass condition is reached. The unit should not be operated if indicators remain in the bypass condition when the oil is at operating temperature.



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RESERVOIR

The hydraulic reservoir is located on the left side, under the frame. It holds the supply of hydraulic oil. The entire hydraulic system has a capacity of 90 gallons (341 L). The reservoir itself has a capacity of 75 gallons (284 L).

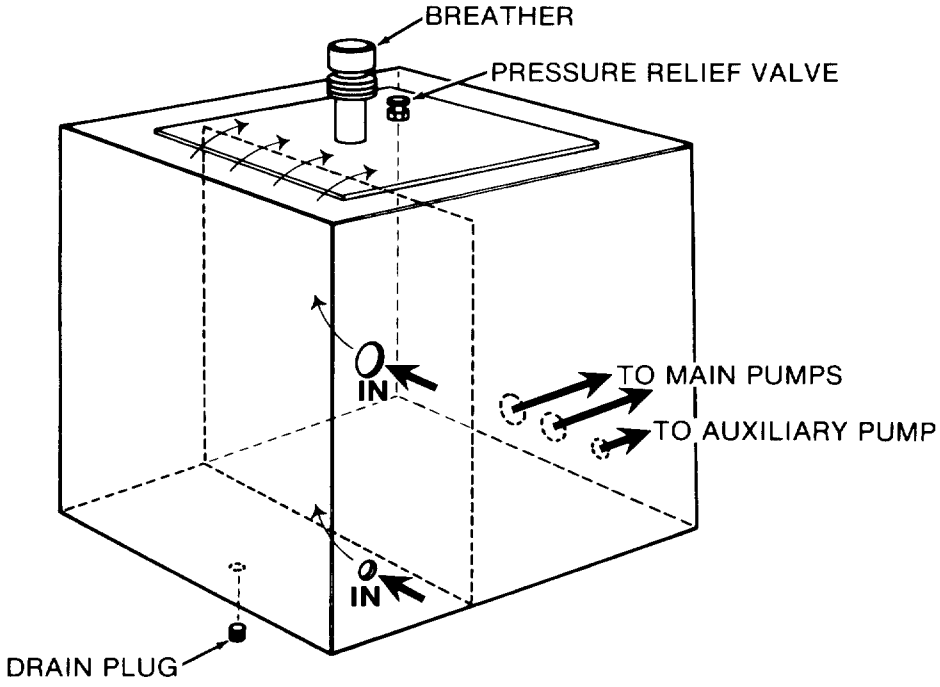
Two sight gages are provided on the side of the reservoir for checking oil level. Check fluid level with machine level, boom in rack and cylinders half way extended. With cold oil, fluid should be visible in the upper sight gage.



The reservoir is a closed system type that is pressurized to 5 psi (34 kPa). When adding oil to the system, or opening it for service, the pressure must be relieved, by depressing pressure relief valve, before removing the filler cap.

Air enters the reservoir breather and is filtered. The filter has a one-way check valve allowing air to enter, but must pass a relief valve set at 5 psi to exit the reservoir. Pressurizing the reservoir helps to charge the pumps.

Once a year a sample should be taken of the hydraulic fluid and an analysis made of it. If needed, the fluid should be replaced with new, clean fluid, and the reservoir and system cleaned. To clean the reservoir, first carefully clean the outside area of the reservoir, then relieve the pressure and remove the filler cap. Remove the drain plug from the bottom of the tank and drain reservoir. Next, remove cover plate and thoroughly clean the inside of the reservoir. The reservoir breather (15 micron) should also be cleaned or replaced at this time.



CAUTION: Do not operate Gradall unless hydraulic fluid is at proper level.

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TANDEM PUMP TO CONTROL VALVES CIRCUIT

Five pilot operated directional control valves are provided to direct hydraulic flow to and from the cylinders and motors which power excavator movements. Valve sections for the swing, tilt and tool functions are included in one valve bank and valve sections for boom in/out and hoist up/down are included in a second valve bank. These valve banks are located under the sheet metal behind the cab and include associated main (pump) and circuit relief valves.

A bank of two additional solenoid operated directional control valves is provided to direct hydraulic flow to and from the stabilizers. These valves are located in the right rear corner of the carrier frame and also include associated circuit relief valves.

The stabilizer valve bank receives 22 gpm (83.28 L/min.) from the end (outboard) section of the tandem pump. Stabilizer valves are connected in parallel which means that if both stabilizers are operated at the same time, the stabilizer offering least resistance will receive most of the available oil flow. Oil used by the stabilizers is returned to dump (reservoir). Oil not used by the stabilizers is available to the swing, tilt and tool valve bank.

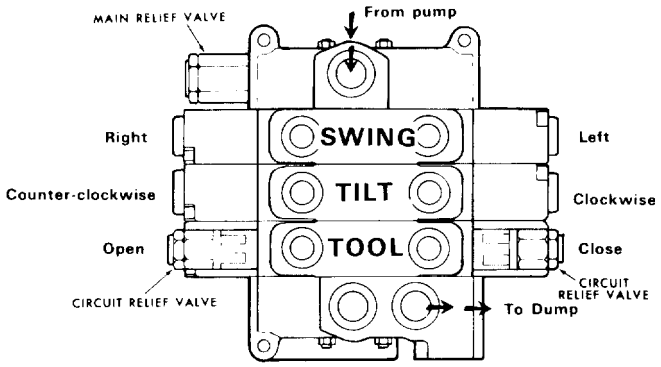
The swing, tilt and tool valves are connected in series which means that if these functions are operated at the same time, each function will receive the full 22 gpm available. However, the working pressures are cumulative; that is, when the combination of working pressures from these circuits reach the setting of the lowest relief valve involved, each of these circuits will stall and oil flowing over relief valve will be lost to these functions.

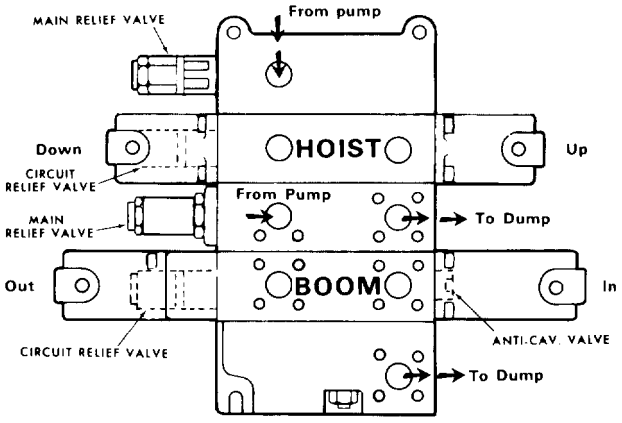
The boom in/out valve section receives 22 gpm (83.28 L/min.) from the middle section of the tandem pump.

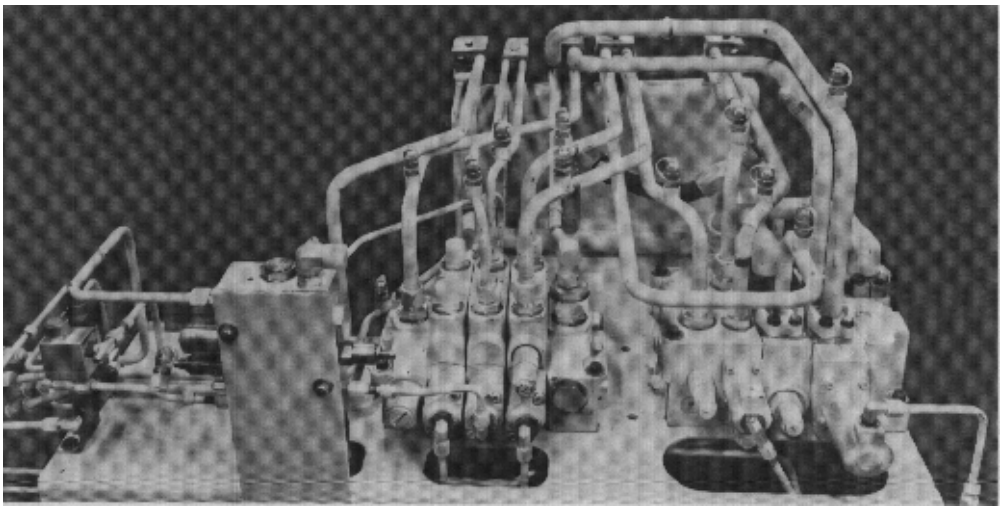
The hoist up/down valve section receives 26 gpm (98.42 L/min.) from the base section of the tandem pump.

Whether it is used or not, oil from the excavator control valve banks discussed above returns to dump (reservoir) through a spring loaded check valve (50 psi - 345 kPa) used to help prevent circuit cavitation. From the check valve, oil flows through a 10 micron filter and then to the reservoir.

Other valves in the system will be described in discussion of individual circuits.







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PILOT CONTROL CIRCUIT MANIFOLD

A 14 gpm (53 L/min.) auxiliary pump located on the rear of the engine provides hydraulic flow to the pilot control manifold. Oil flows from the pump, through port no. 7 of the center pin (hydraulic swivel) and then through a five micron filter to the pilot control manifold.

Oil entering the manifold is exposed to a 1/4 - 3/4 (3.5 - 10.5 gpm) flow divider valve and also to a 2000 psi steering circuit relief valve.

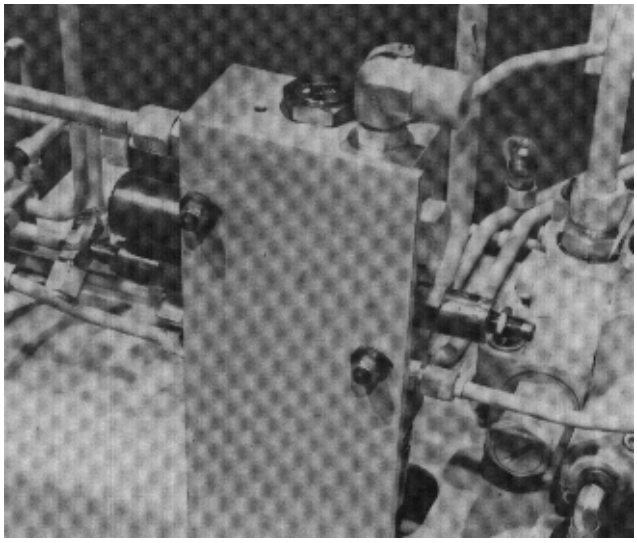
With the joystick solenoid valve in off position (joystick switch OFF) the full 14 gpm are available to the steering circuit.

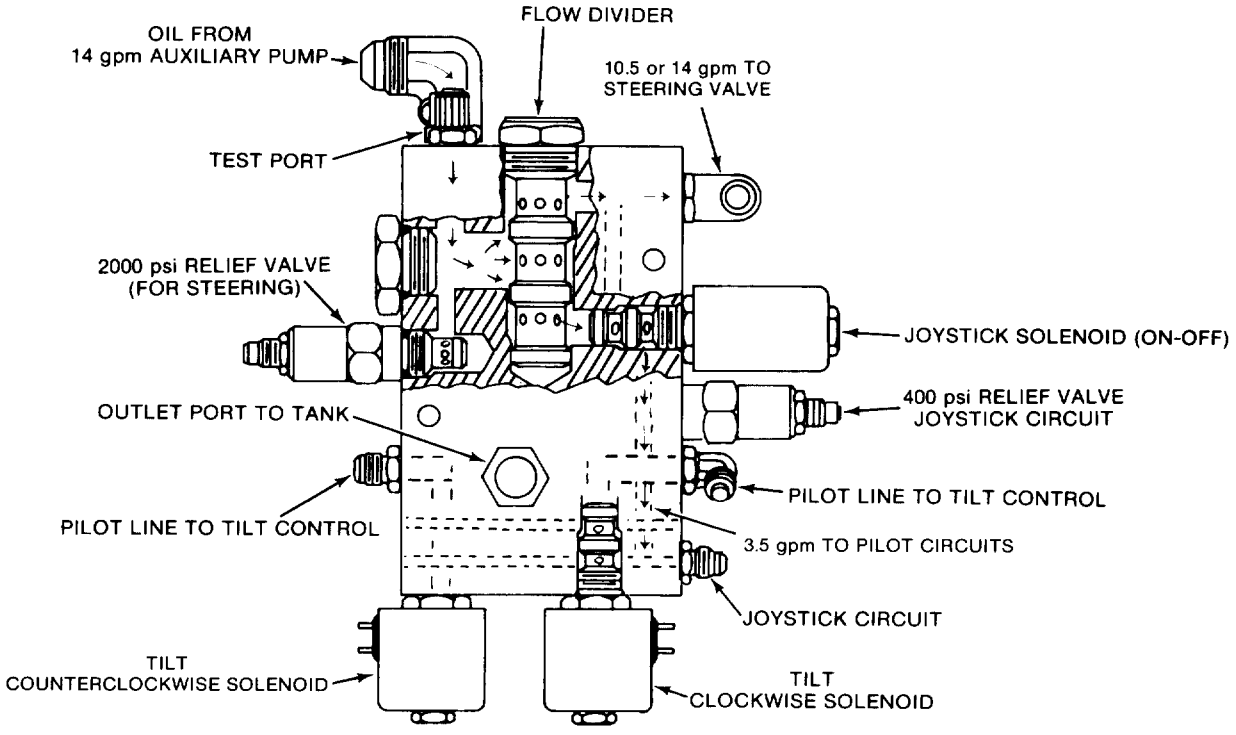
With the joystick solenoid valve in on position (joystick switch ON)* 10.5 gpm are available to the steering circuit and 3.5 gpm pilot flow is available to the joysticks and tilt circuit solenoid valves. The pilot flow is also used to release the swing parking brake.

A 400 psi pilot circuit relief valve is located just downstream from the flow divider valve to limit pressure available in the pilot circuits. When neither the joysticks nor the tilt solenoids are activated, the entire 3.5 gpm pilot flow is dumped over the 400 psi relief valve and returns to the reservoir by way of the oil cooler.

Whether used for steering or not, the entire flow available for steering returns from the steering control valve, through the oil cooler to the reservoir.

***NOTE:** Activation of the joystick solenoid valve is also dependent on the operator being seated in the operator's seat to close a switch located within the seat. Joysticks are inactivated when the operator rises from the seat.



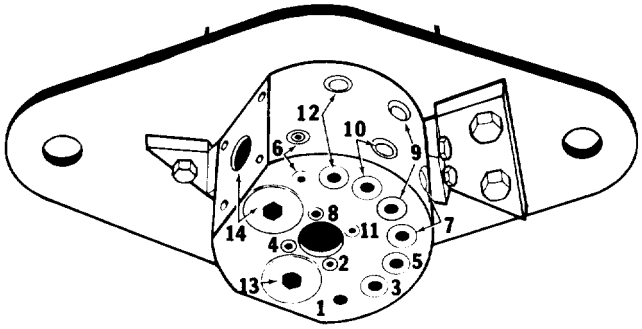


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CENTER PIN

The center pin (swivel joint) carries compressed air and hydraulic oil back and forth between components in the carrier and the rotating upperstructure. Seals between center pin chambers separate the various circuits from each other.

Electrical components in the carrier and upperstructure are connected through a slip ring mounted on the center pin.



Port 1 Low pressure dump from joysticks & motor drains to tee at bottom of reservoir

Port 2 Air pressure from bottom carrier air tank to air tank in upperstructure

Port 3 Air pressure from throttle control valves to throttle control cylinder

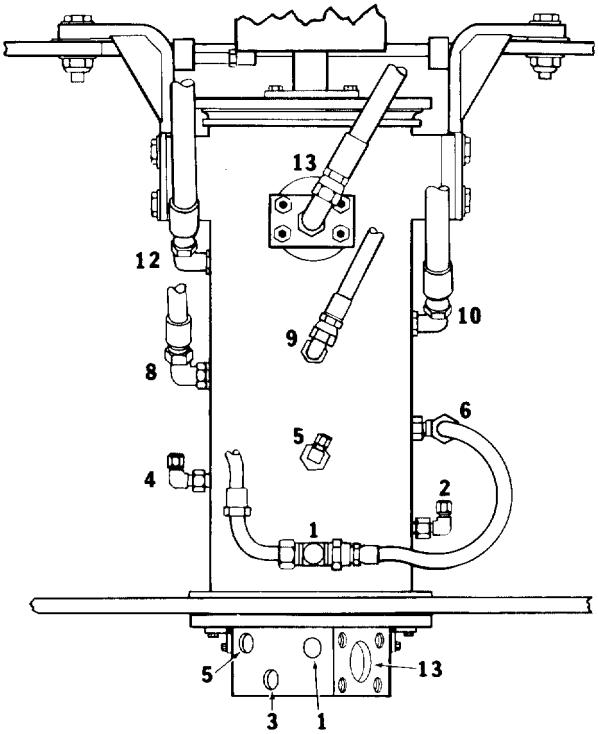
Port 4 Air pressure from service brake treadle to service brake relay valve

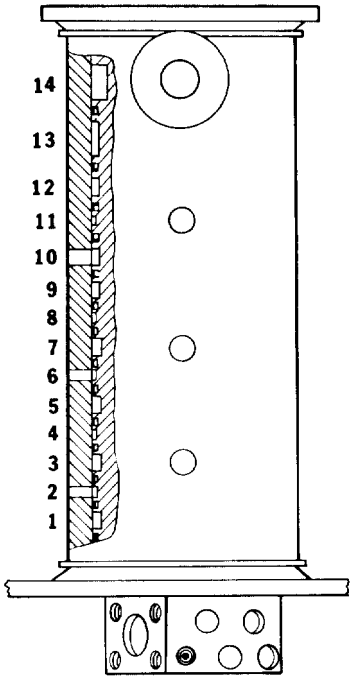
Port 5 Air pressure from parking brake control valve to quick release valve

Port 6 Low pressure dump from upperstructure port no. 1 jumper to oscillation cylinders

Port 7 Auxiliary pump flow (14 gpm) to pilot control manifold

Port 8 Steering control valve to steering cylinders (base of left and rod end of right)





Port 9 Dump from pilot control manifold and steering control valve through oil cooler to reservoir

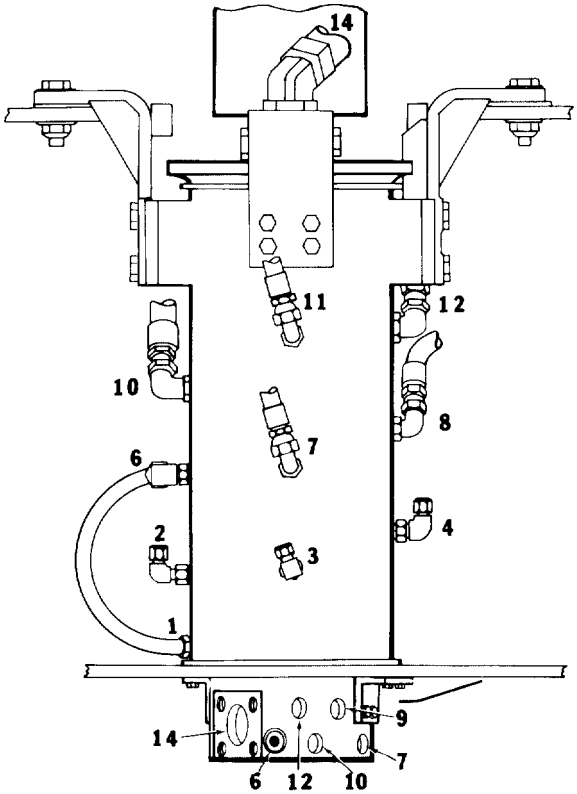
Port 10 End section of tandem pump (22 gpm) to stabilizer control valve to swing, tilt & tool valve bank

Port 11 Steering control valve to steering cylinders (rod end of left and base end of right)

Port 12 Center section of tandem pump to boom in/out control valve.

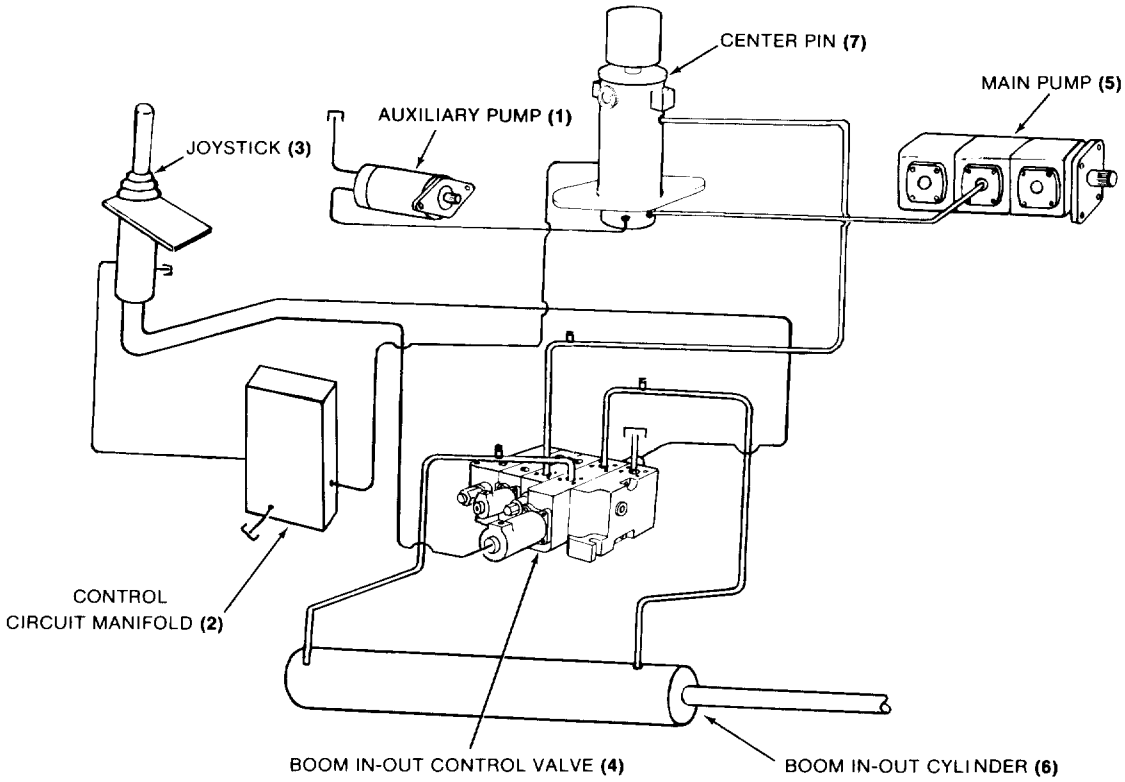
Port 13 Base section of tandem pump to boom raise/lower control valve

Port 14 Dump from all excavator control valves, through 50 psi check valve, through main filter, to reservoir



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BOOM IN-OUT CIRCUIT



AUXILIARY (Pilot) PUMP OIL ——
MAIN TANDEM PUMP OIL ═══

Pilot Control Oil Flow: Oil from the 14 gpm auxiliary pump (1) passes through port no. 7 of center pin (7), through pilot control manifold (2) to right joystick (3).

Moving right joystick rearward to retract boom directs flow of pilot oil to pressurize right end cap of boom in/out control valve (4) and shift valve spool to left.

Moving right joystick forward to extend boom directs flow of pilot oil to pressurize left end cap of boom in/out control valve and shift valve spool to right.

Oil from non-pressurized endF caps is returned to dump (reservoir).

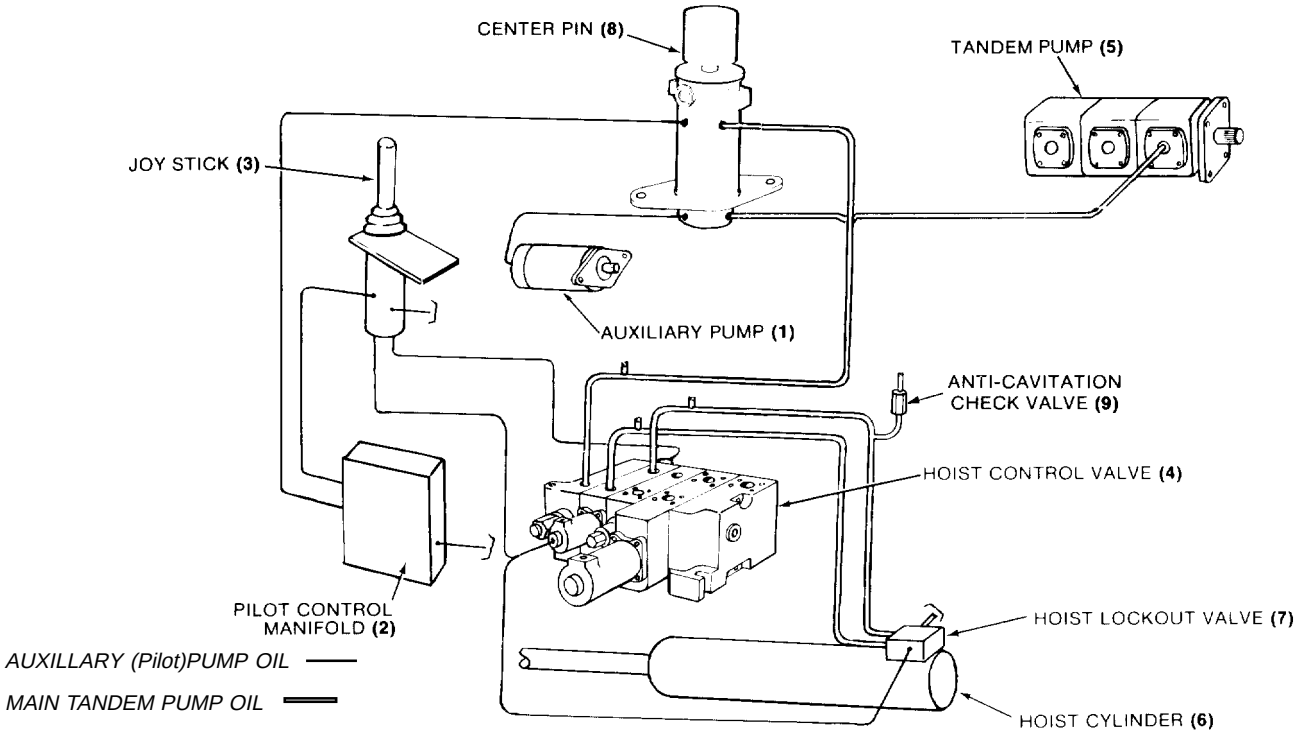
Main Pump Oil Flow: Oil from the 22 gpm center section of tandem pump (5) passes through port no. 12 of center pin (7) to boom in/out control valve. With control valve spool shifted to left to retract boom, oil is directed to rod end of boom in/out cylinder (6) to retract cylinder. Oil from barrel end of cylinder is returned to dump.

With control valve spool shifted to right to extend boom, oil is directed to barrel end of boom in/out cylinder to extend cylinder. Because boom extend function is regenerative, oil from rod end of cylinder is not returned to dump. Oil from rod end is returned to control valve and is directed through an internal chamber to join pump oil flowing to barrel end of cylinder. Increased flow to barrel end of cylinder causes cylinder to extend more rapidly.

Because rod end oil is joining oil to barrel end, pressure on both sides of cylinder piston is equal. The cylinder extends because more square inches of piston area are exposed to pressurized oil in the barrel end than in the rod end (rod cross section must be subtracted from piston area in rod side).

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HOIST CIRCUIT



Pilot Control Oil Flow: Oil from the 14 gpm auxiliary pump (1) passes through port no. 7 of center pin (8), through pilot control manifold (2) to left joystick (3).

Moving left joystick forward to lower boom directs flow of pilot oil to pressurize left end cap of boom hoist control valve (4) and shift valve spool to right. Pilot oil is also directed to pilot port of boom hoist cylinder lockout valve (7).

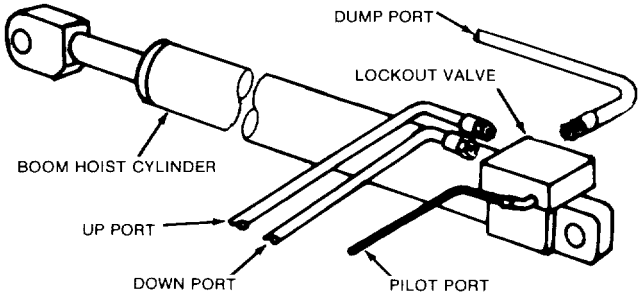
Moving left joystick rearward to raise boom directs flow of pilot oil to pressurize right end cap and shift valve spool to left. In this case, pilot oil is not directed to pilot port of boom hoist cylinder lockout valve.

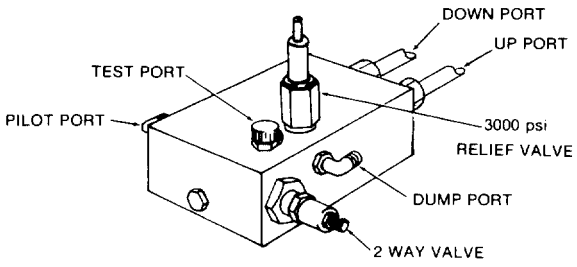
Oil from non-pressurized end caps is returned to dump (reservoir).

Main Pump Oil Flow: Oil from the 26 gpm base section of tandem pump (5) passes through port no. 13 of center pin (8) to boom hoist control valve (4). Oil pressure in circuit between pump and control valve is governed by a 2650 psi pump relief valve.

Hoist Lockout Valve: All oil entering and leaving the hoist cylinder must pass through hoist lockout valve (7) located at the base of hoist cylinder.

The lockout valve contains a one-way check valve and a pilot-operated two-way valve which combine to prevent oil flow from rod side of cylinder when two way valve is in its normally closed position. This





BOOM HOIST CYLINDER LOCKOUT VALVE

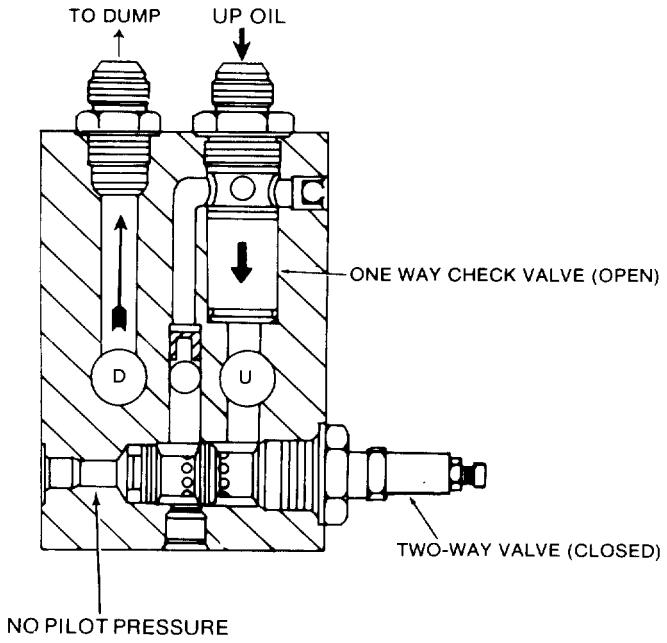
feature prevents boom from falling in event of line failure between control valve and cylinder. The two-way valve opens (internal plunger - not shown) to permit flow from rod side of cylinder when pilot pressure is present at pilot port.

The lockout valve also includes a 3000 psi circuit relief valve to protect rod side of hoist circuit. When opened, relief valve opens to permit flow from rod side of circuit through "DUMP" line as shown.

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HOIST CIRCUIT (continued)

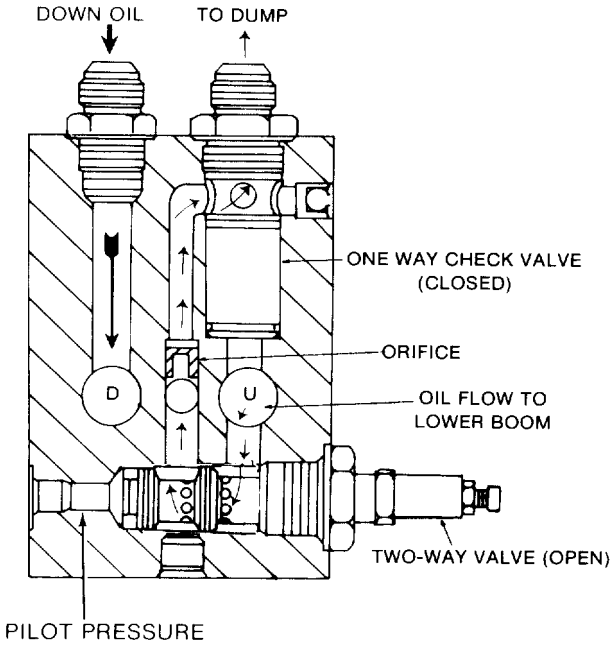
To Raise Boom: With Joystick pilot pressure applied to shift hoist control valve spool to left, main pump flow is directed to UP port of lockout



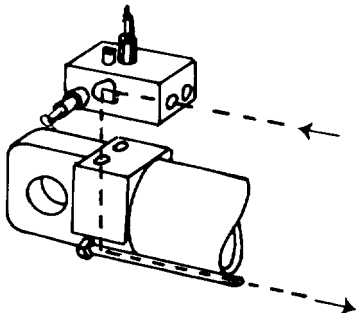
valve. Oil entering UP port passes through one way check valve to port U. In its normally closed position, the two way valve blocks flow to other chambers of lockout valve. Oil entering port U is directed to external tube leading to rod end of cylinder.

Return flow from barrel end of cylinder enters lockout valve at port D and returns to hoist control valve where it is directed to dump.

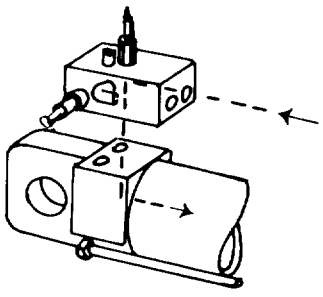
To Lower Boom: With joystick pilot pressure applied to shift hoist control valve spool to right, pilot pressure is also applied to pilot port of lockout valve. Main pump flow through boom hoist control valve is directed to DOWN port of lockout valve. Oil entering DOWN port flows through port D to enter barrel end of cylinder.



Pilot pressure at pilot port of lockout valve shifts two-way valve to its open position to permit return oil to flow from rod end of cylinder. Before leaving lockout valve, return flow passes through an orifice designed to control boom down speed. Oil exiting lockout valve returns to hoist control valve where it is directed to dump.



PUMP FLOW TO RAISE BOOM

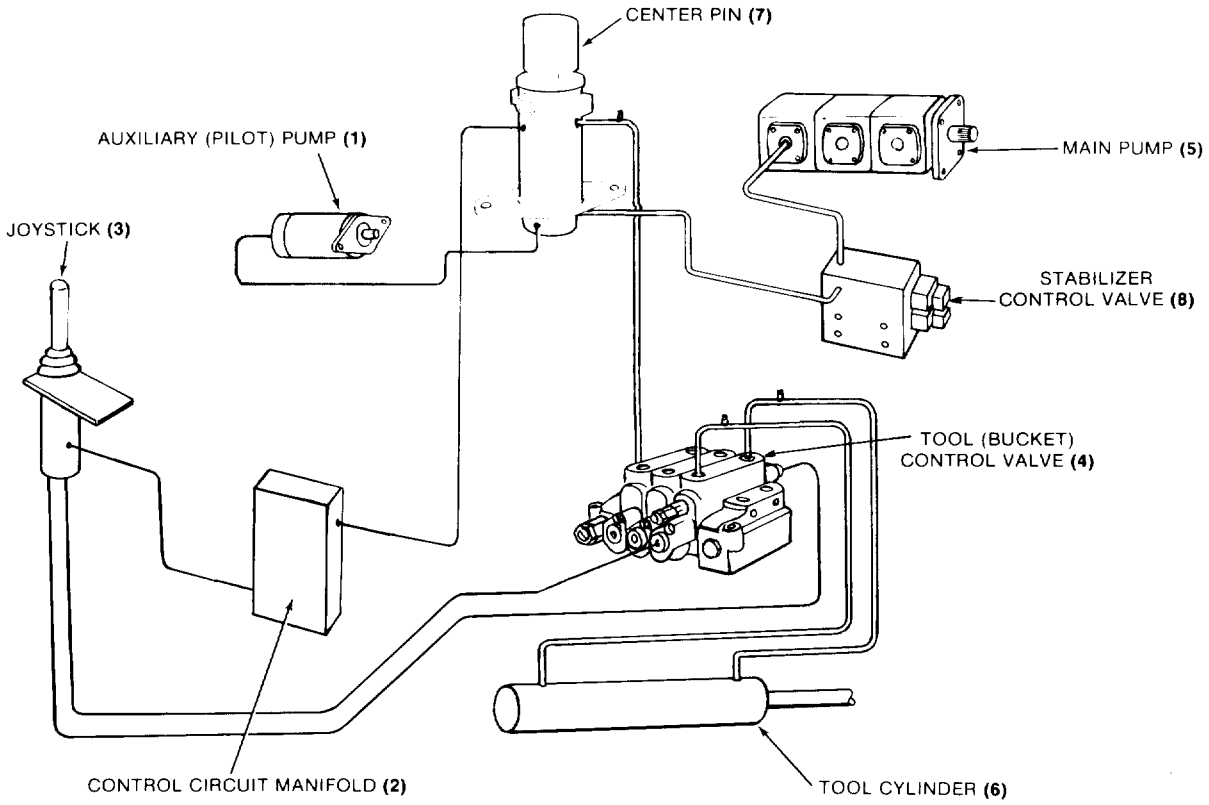


PUMP FLOW TO LOWER BOOM

Anti-Cavitation Check Valve: As mentioned earlier (page 4) 50 psi back pressure is maintained in dump flow from excavator circuits. This back pressure is teed to line leading to barrel end of hoist cylinder through a one way check valve (9). In the event of barrel cavitation, check valve opens to permit flow to fill barrel end of cylinder.

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BUCKET CIRCUIT



AUXILIARY (Pilot) PUMP OIL ——

MAIN TANDEM PUMP OIL ═══

Pilot Control Oil Flow: Oil from 14 gpm auxiliary pump (1) passes through port no. 7 of center pin (7), through pilot control manifold (2) to left joystick (3).

Moving left joystick to right to close bucket directs flow of pilot oil to pressurize left end cap of bucket (tool) control valve (4) and shift valve spool to right.

Moving left joystick to left to open bucket directs flow of pilot oil to pressurize right end cap of bucket (tool) control valve and shift valve spool to left.

Oil from non-pressurized end caps is returned to dump (reservoir).

Main Pump Oil Flow: Oil from 22 gpm end section of tandem pump (5) flows to stabilizer valve bank (8) at right rear of carrier. Oil not used for stabilizer operation flows from stabilizer valve bank outlet through port no. 10 of center pin (7) to inlet port of swing tilt and tool valve bank (4). Whether or not used for swing and tilt functions, the full 22 gpm is available for opening and closing the bucket.

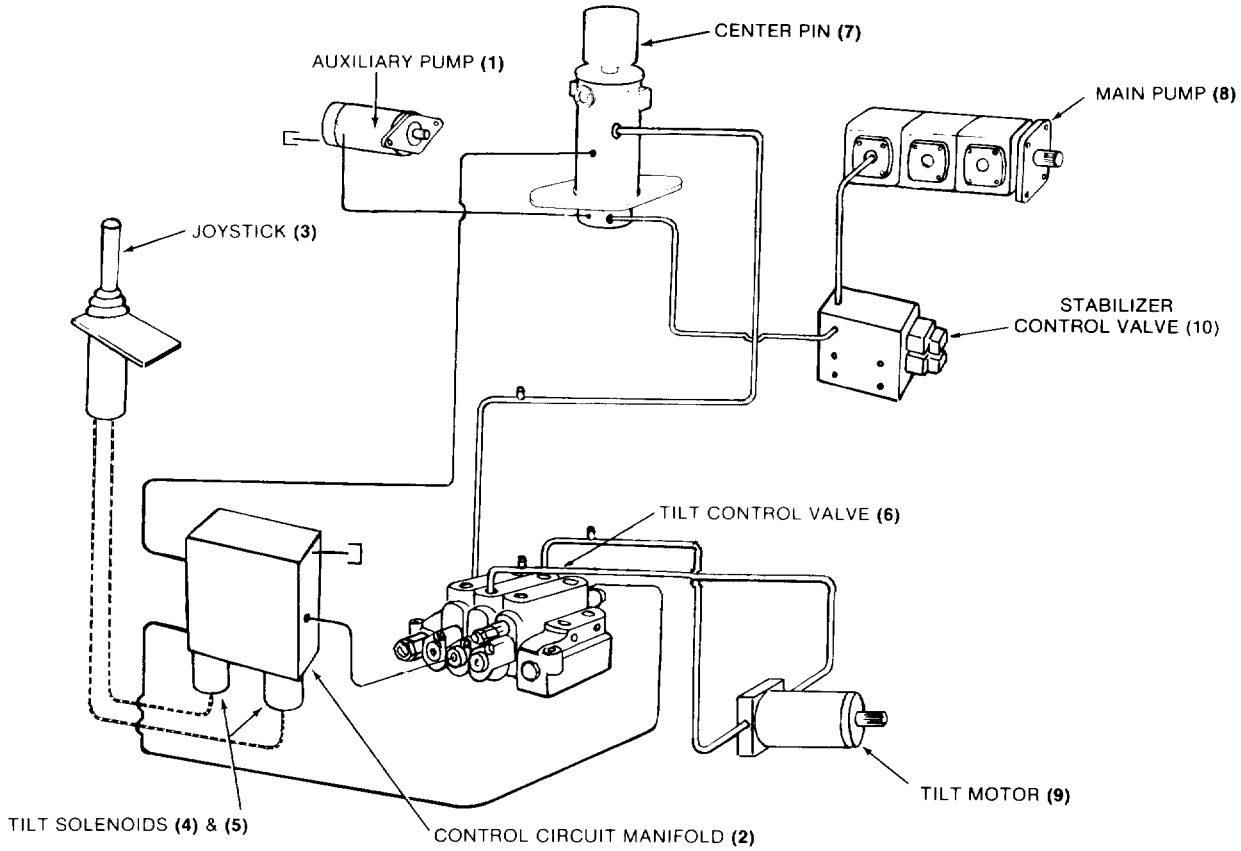
With control valve spool shifted to right to close the bucket, oil is directed to barrel end of cylinder to extend cylinder. Oil from rod end of cylinder is returned through the control valve to dump.

With control valve spool shifted to left to open the bucket, oil is directed to rod end of cylinder to retract cylinder. Oil from barrel end of cylinder is returned through the control valve to dump.

A 2750 psi pump relief valve protects hydraulic components from the pump to the control valve and 3000 psi circuit relief valves protect components between the control valve and the cylinder.

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TILT CIRCUIT



ELECTRIC — — — —

AUXILIARY (Pilot) PUMP OIL ————

MAIN TANDEM PUMP OIL ═══

Pilot Control Oil Flow: Oil from 14 gpm auxiliary pump (1) passes through port no. 7 of center pin (7), to pilot control manifold (2).

Tilt Control Switch: A tilt control switch (electrical) is located at top of right joystick (3) to operate tilt solenoid valves (4 and 5).

Depressing left side of tilt switch to rotate bucket counterclockwise activates (opens) a normally closed solenoid valve in the pilot control manifold to direct pilot flow to pressurize right end cap and shift control valve spool to left.

Depressing right side of tilt switch to rotate bucket clockwise activates a normally closed solenoid valve in the pilot control manifold to direct pilot flow to pressurize left end cap of tilt control valve and shift control valve spool to right.

Main Pump Oil Flow: Oil from 22 gpm end section of tandem pump flows to stabilizer valve bank (10) at right rear of carrier. Oil not used for stabilizer operation flows from stabilizer valve bank outlet through port no. 10 of center pin (7) to inlet port of swing, tilt and tool valve bank (6). Whether or not used for swing and tool functions, the full 22 gpm is available for tilting the boom.

Orifice check valves (3/32" orifice) are installed in circuit ports of tilt control valve to reduce speed of tilt function. These valves are designed to permit full flow to tilt motor but restrict flow returning to control valve. In effect, this restricts flow throughout entire tilt circuit and causes excess flow to be dumped over 2750 psi pump relief valve.

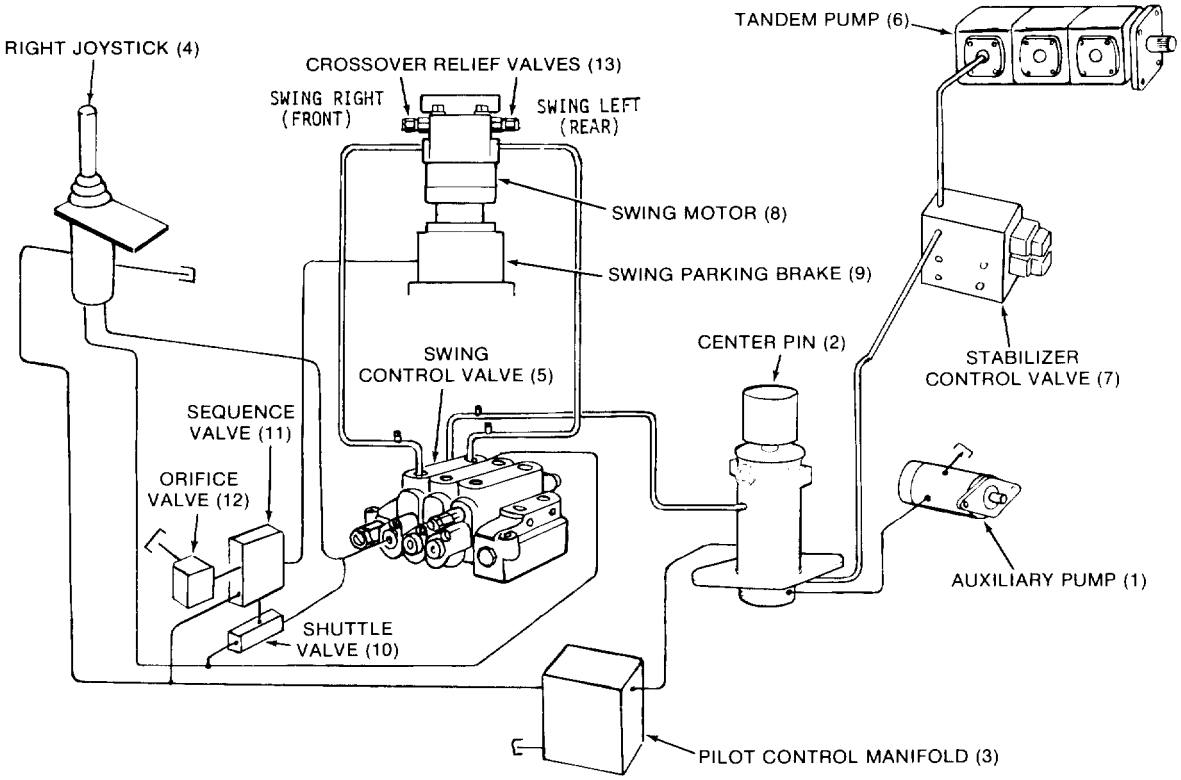
With control valve spool shifted to right to tilt clockwise, oil is directed to right side of tilt motor.

With control valve spool shifted to left to tilt counterclockwise, oil is directed to left side of tilt motor.

Oil returning from tilt motor to control valve is directed to carryover chamber for availability to tool function.

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SWING CIRCUIT



Pilot Control Oil Flow: Oil from 14 gpm auxiliary pump passes through port no. 7 of center pin (2), through pilot control manifold (3) to right joystick (4).

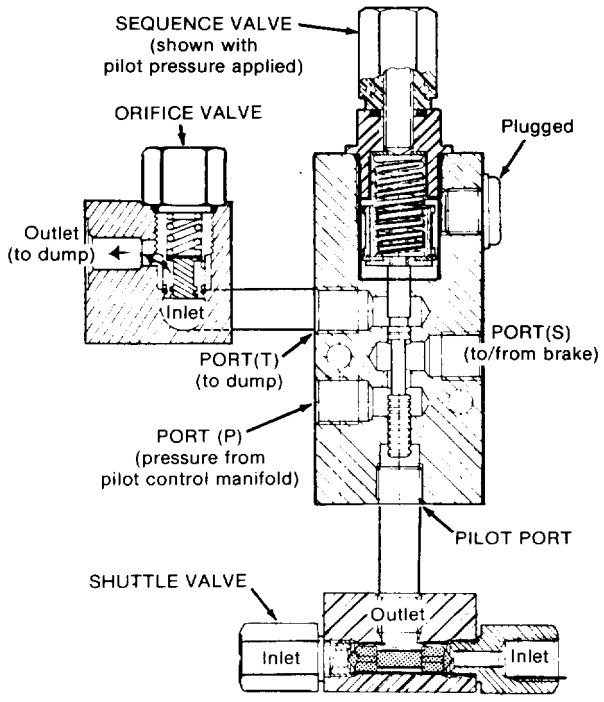
Moving right joystick to left to swing left directs flow of pilot oil to left end cap of swing control valve (5) to shift valve spool to right.

Moving right joystick to right to swing right directs flow of pilot oil to right end cap of swing control valve (5) to shift valve spool to left.

The swing parking brake (spring set - hydraulic release) is also controlled by pilot control oil:

Pilot oil pressure from pilot control manifold is always available at pressure port (P) of sequence valve (11).

With swing joystick actuated to swing either left or right, a portion of pilot oil flowing to shift control valve spool is directed to one of the inlet ports of shuttle valve (10). Oil entering shuttle valve shifts plunger to close opposite inlet port and is directed through outlet port to pilot port of sequence valve.



Portion of Flow From Joystick

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SWING CIRCUIT (continued)

Pilot pressure at pilot port of sequence valve shifts spring loaded plunger to connect port (P) to port (S) and permit flow from pilot control manifold to swing parking brake, overcoming brake springs and releasing brake.

When joystick is returned to neutral, pilot flow to sequence valve is stopped and sequence valve plunger returns to its normal position, port (S) connected to port (T) (parking brake connected to dump).

With pressure to spring brake discontinued (ports (P) and (S) are now sealed from each other) brake springs apply brake, expelling oil from brake.

Oil from brake flows through ports (S) and (T) of sequence valve to inlet port of orifice valve (12). The restriction within the orifice valve is designed to delay application of swing parking brake, until swing motion has stopped, by limiting oil flow from the brake. Flow from orifice valve outlet is directed to dump (reservoir).

NOTE: The swing parking brake is not designed to stop the upperstructure from swinging; its only purpose is to hold upperstructure in position after swinging motion has stopped. Early application could cause serious damage to brake.

Main Pump Oil Flow: Oil from 22 gpm end section of tandem pump flows to stabilizer valve bank (7) at right rear of carrier. Oil not used for stabilizer operation flows from stabilizer valve bank outlet through port no. 10 of center pin (2) to inlet port of swing, tilt and tool valve bank (5). Whether or not used for tilt and tool functions, the full 22 gpm is available for swinging left and right.

With control valve spool shifted to right to swing left, oil is directed to rear motor port.

With control valve spool shifted to left to swing right, oil is directed to front motor port.

Oil flow from swing motor is returned through the control valve to carryover chamber of valve bank for availability to tilt and tool operations.

Swing Braking: When swing joystick is released, the momentum of upperstructure causes continued swing motion. The continuing motion causes swing motor gears to continue turning. Now the motor is acting as a pump, trying to pump oil into downstream side of circuit and increasing pressure in that side of circuit.

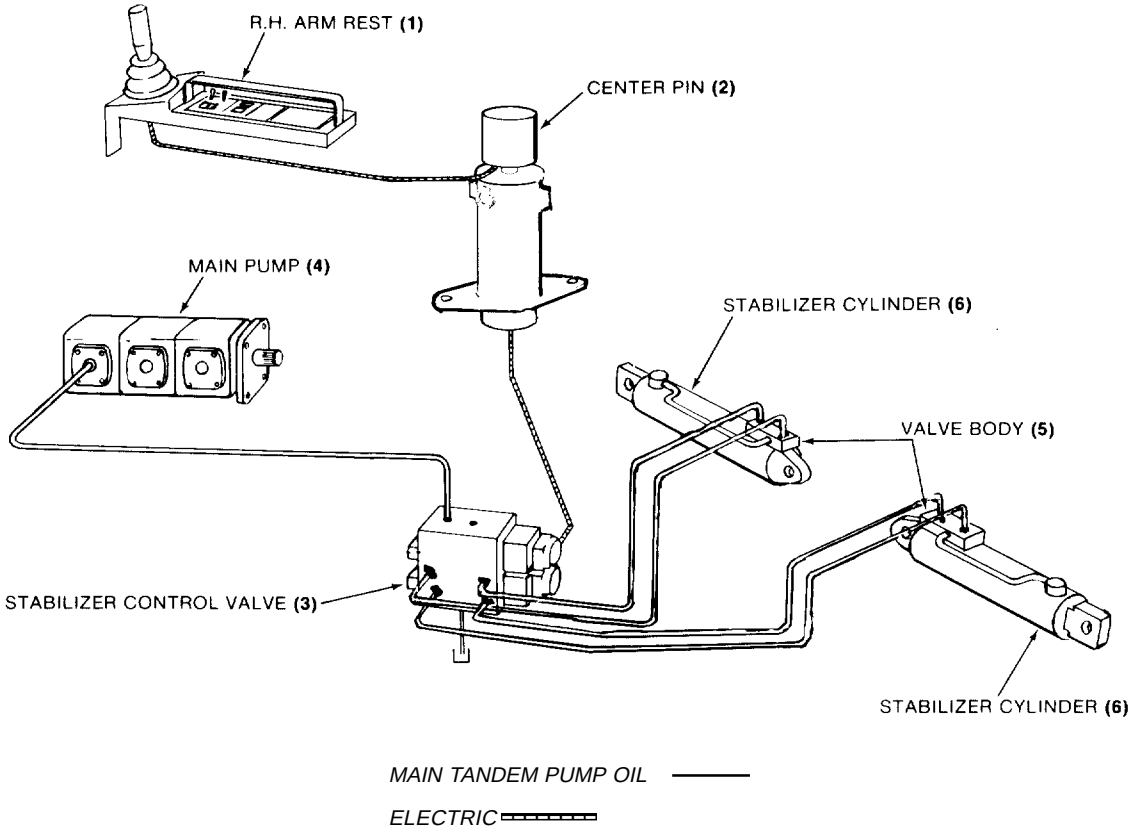
Because control valve spool has returned to neutral, all oil in both sides of swing circuit is trapped between control valve and motor. A pair of 2400 psi crossover relief valves (13) and a pair of one-way check valves are built into the swing motor to prevent damage from the increasing pressure and to use the pressure to stop swing motion.

Pressurized oil flows through one-way check valve to downstream crossover relief valve. As pressure increases to setting of valve, oil flows through valve from downstream (pressurized) side of circuit to upstream (non-pressurized) side of circuit. The energy of swing momentum is absorbed by relief valve and causes swing motion to stop.

The other check valve and crossover relief valve serve to stop swing motion in other direction.

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STABILIZER CIRCUIT



Stabilizer Control Valve Operation: Stabilizer control valve spools are shifted by air pressure in response to an electrical signal from stabilizer control switches located in right arm rest (1) of operator's seat. Actuation of stabilizer control switch sends an electrical signal through a slip ring located at top of center pin (2) to energize a normally-closed, double-acting solenoid valve in stabilizer control valve bank (3) located at right rear of carrier frame.

When energized in either direction, solenoid valve directs compressed air to appropriate end cap of control valve to shift control valve spool.

Main Pump Oil Flow: With control valve spool shifted, oil from 22 gpm end section of tandem pump (4) is directed through control valve (3) to appropriate port of check valve body (5) at base of stabilizer cylinder (6).

A pair of pilot-operated, one-way check valves are included within check valve body to permit free flow to cylinder but prevent flow from cylinder. This feature locks cylinders in position until control valve is actuated. For example, with control valve actuated to direct flow to rod end of cylinder, a portion of flow is diverted to shift a plunger to open check valve blocking flow from barrel end of cylinder, allowing cylinder to retract.

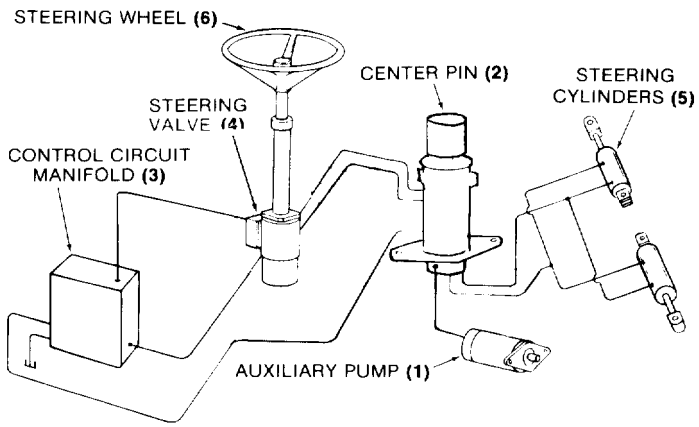
Return flow from cylinder is directed through control valve to dump (reservoir).

A 4000 psi relief valve is included in each check valve body to protect cylinders from possible damage by thermal expansion. With cylinder extended for a long period on a hot day, oil in barrel end of cylinder would expand. Since pilot check valves prevent any flow from cylinder, pressure from such expansion could cause cylinder to fail. The 4000 psi relief valve is designed to vent such pressure to dump.

Oil not used for stabilizer operation flows from stabilizer valve bank, through port no 10 of center pin (2) to swing, tilt and tool valve bank.

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STEERING CIRCUIT

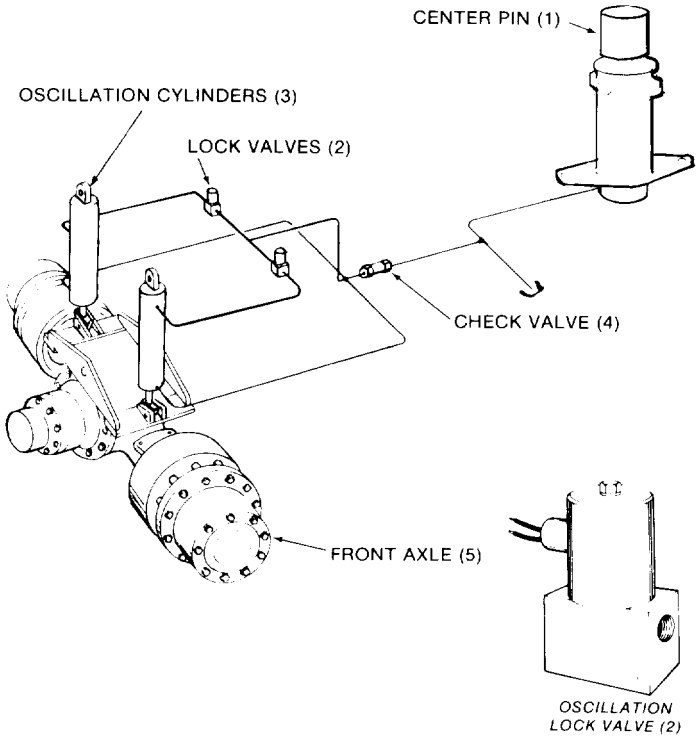


Oil for the steering circuit is supplied by the 14 gpm pump (1), through port 7 of center pin (2) to pilot control manifold (3) to the steering valve (4). It continues downstream through the center pin (Ports 8 and 11) to the steering cylinders (5).

Turning the steering wheel (6) to the left will send pressurized oil through port 8 of the center pin to the base end of the left cylinder and rod end of the right cylinder. Return oil flows from the cylinders through port 11 of the center pin to the steering gear, and to the reservoir.

Turning the steering wheel to the right routes the oil the opposite way.

OSCILLATION CIRCUIT



The oscillation circuit is supplied low pressure dump oil from port #6 of the center pin (1). Front axle (5) oscillation is provided to permit the axle to float and adjust over uneven ground, when traveling.

The circuit is controlled electrically. Whenever the transmission is shifted into forward or reverse the solenoid and oscillation lock valves (2) open allowing oil in the two cylinders (3) to flow unobstructed back and forth to each other, as dictated by the roughness of the terrain.

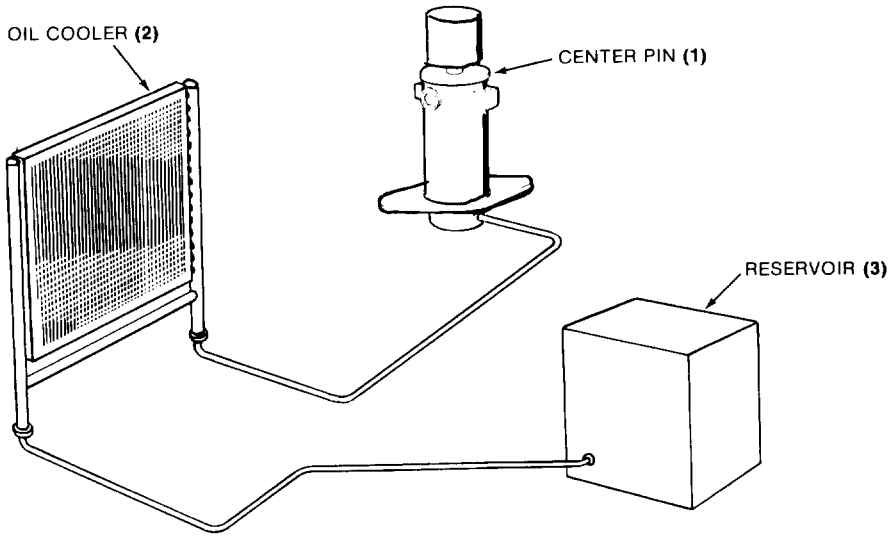
There is a one-way check valve (4) in the circuit which is upstream from oscillation lock valves. Oil is free flow to the cylinders through this check valve, but the return is blocked.

When digging, oil in the barrel end of each cylinder is trapped by the normally closed solenoid valve preventing oscillation.

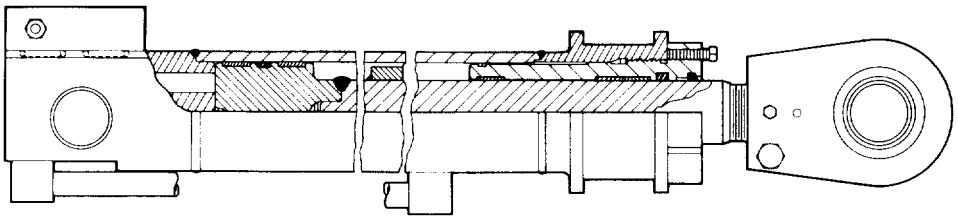
The lock valve (solenoid) (2) is a two-way, 2 position normally closed poppet design. Whenever It is electrically energized the poppet shifts to open.

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OIL COOLER CIRCUIT



The oil cooler circuit is used on the Gradall to help control the temperature of the hydraulic oil. Pilot return oil from the center pin (1) enters the bottom of the cooler (2) and circulates through the unit and leaves by a bottom port. Oil then returns to the reservoir (3). The oil cooler is mounted in front of the standard radiator of the carrier engine.



HYDRAULIC CYLINDERS

Nine hydraulic cylinders are used. All cylinders are the double acting type with oil on both sides of the piston.

	Bore	Rod	Stroke
Boom Hoist (1)	6″ 152 mm	3″ 76 mm	43.38″ 1102 mm
Boom Telescope (1)	3.5″ 89 mm	2.25″ 57 mm	126″ 3200 mm
Tool (1)	5″ 127 mm	3″ 76 mm	19.6″ 498 mm
Axle Oscillation (2)	5″ 127 mm	2.25″ 57 mm	7.13″ 181 mm
Stabilizer (2)	5″ 127 mm	2.25″ 57 mm	18.5″ 470 mm
Steering (2)	2.75″ 70 mm	1″ 25 mm	8″ 202 mm

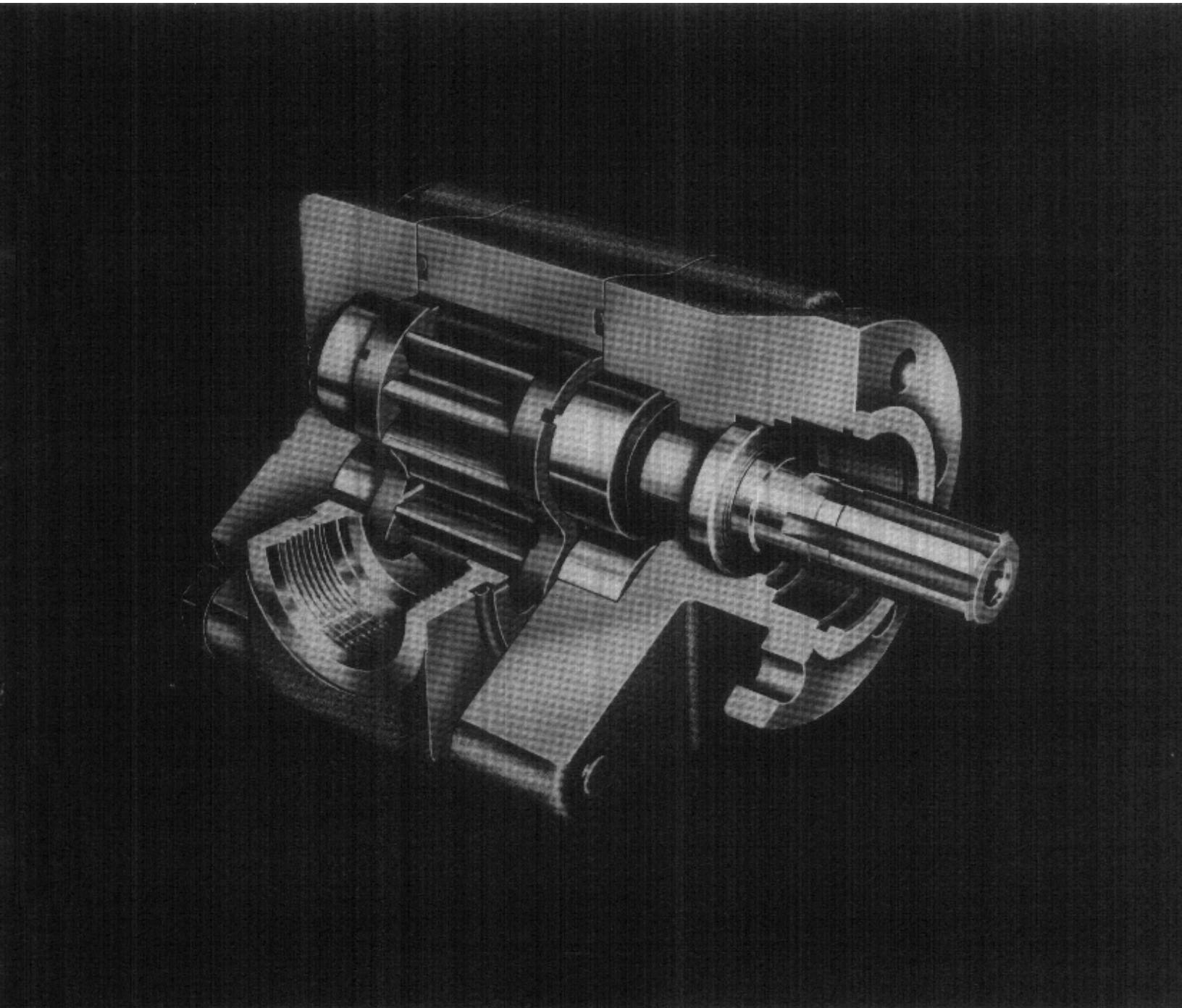
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P30/P31
P50/1251
SERVICE MANUAL

single
and tandem
oil hydraulic
pumps-motors

Commercial Intertech



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P30/P31/P50/P51
pump or motor service instructions

GENERAL INSTRUCTIONS

These service instructions will familiarize you with Commercial's single and multiple pumps and motors — their component parts — the relative position of each part — proper methods for assembly or disassembly of the units - care and usen of these oil hydraulic power units — so that best performance and longer working life will result for your benefit.

To facilitate the repair of these units — and before any work is done — we suggest that you first read all of the steps used in disassembly and all of the steps used in building up the unit.

Dirt is the enemy of any hydraulic system. The first requirement of good maintenance of hydraulic equipment is cleanliness. MAKE SURE YOU DISASSEMBLE AND ASSEMBLE YOUR HYDRAULIC EQUIPMENT IN A CLEAN AREA.

Our pictures show a Model P51. Notes in the text cover variations between this unit and the other models.

It is important to airblast all parts and wipe them with a clean, lintless cloth before assembly.

USE CAUTION IN GRIPPING ALL PARTS IN THE VISE TO AVOID DAMAGING MACHINED SURFACES.

A pump must be driven in the direction of rotation for which it was built; otherwise, pressure will blow the shaft seal. Check the exploded view below for proper direction of rotation.

COMMERCIAL'S REPLACEMENT PARTS

Commercial's replacement parts are of original equipment standards. For assured quality of material and workmanship, and for compatibility in assembly, USE ONLY GENUINE PARTS FROM COMMERCIAL.

It is a good idea to check all replacement parts closely before installing to ensure that no damage occurred during shipment.

EXPLODED VIEW AND PARTS LIST

PARTS LIST

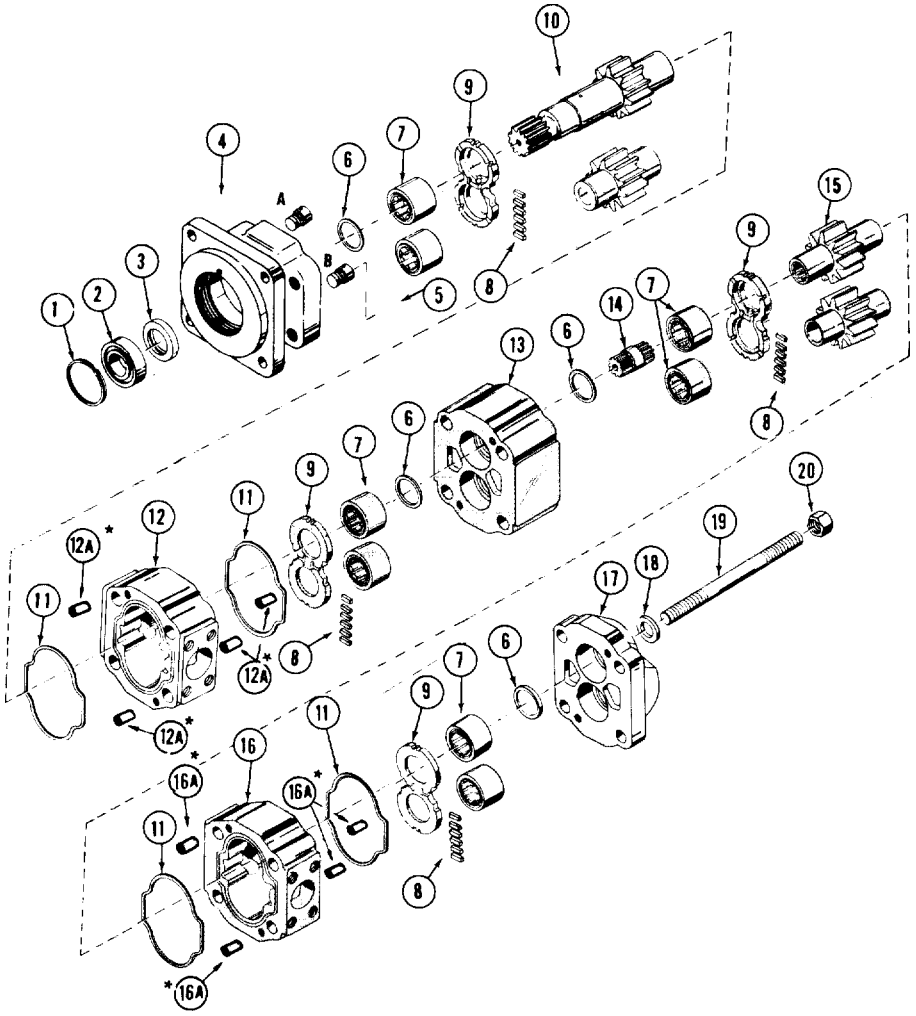
1. Snap Ring
2. Outboard Bearing
3. Seal
4. Shaft End Cover
5. Check Assemblies or Plug
6. Ring Seals
7. Roller Bearings
8. Pocket Seals
9. Thrust Plates
10. Integral Drive Shaft and Gear Set
11. Gasket Seals
12. Gear Housing

*12A. Dowel Pins (P31/P51 only)

13. Bearing Carrier
14. Connecting Shaft
15. Matched Gear Set
16. Gear Housing

*16A. Dowel Pins (P31/P51 only)

17. Port End Cover
18. Washers
19. Studs or Cap Screws
20. Nuts



Plug 5 in position B gives clockwise rotation.

Plug 5 in position A gives counterclockwise rotation.

Check valves in both positions give bi-directional rotation.

ITEMS SHADED APPLY TO MULTIPLE ASSEMBLIES ONLY.

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CAUTION:

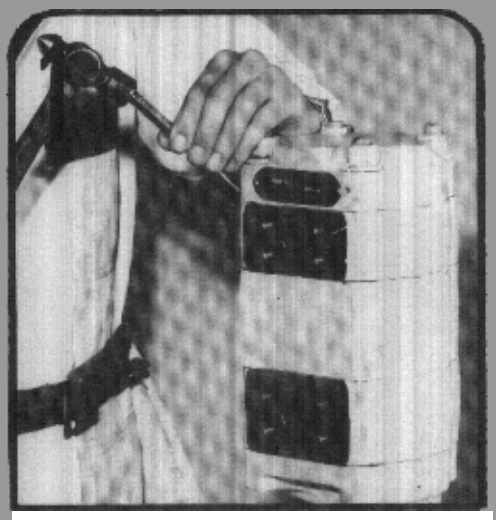
1. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and seriously damage parts.

2. If parts are stubborn during assembly, do not force them and never employ an iron hammer.

3. Gears are closely matched, therefore they must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth.

4. Never hammer roller bearings into bores. Use only an arbor press orother suitable tool.

start disassembly here



Mount the pump in a vise with the shaft end pointing down. Index mark all sections with a punch. Be sure to align these marks when reassembling.

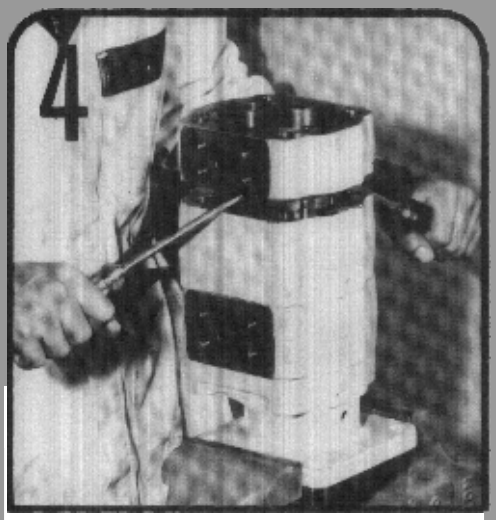


Remove the 4 cap screws on single units or the 4 hex nuts, studs, and washers on multiple units with a socket wrench.



Lift off the port end cover. If necessary to pry loose, refer to caution note.

If the thrust plate remains in the gear housing, it can be tapped out later with a wooden hammer handle. Be careful not to distort the thrust plate.



Lift the gear housing from the gears. Take care not to damage machined surfaces.

For P31/P51 — Pry the gear housing from the gears and off the dowels from opposite sides taking care not to damage machined surfaces.

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disassembly, continued



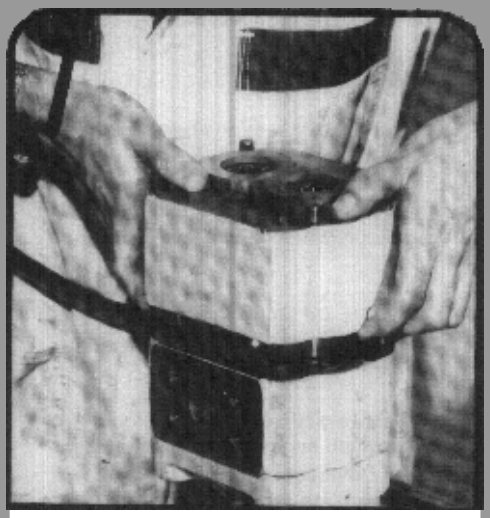
Carefully remove the drive and driven gears, not letting the teeth come into rough handling contact. Keep these gears together because they are a matched set. Examine and replace if necessary. See Pg. 10.

FOR MULTIPLE ASSEMBLIES ONLY.



Remove the drive gear connecting shaft.

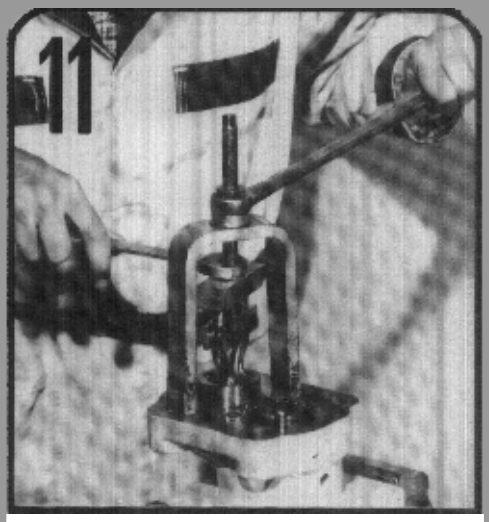
FOR MULTIPLE ASSEMBLIES ONLY.



Lift or pry off the bearing carrier carefully to prevent damage to contact face and edges.

For P31/P51, pry the bearing carrier off the dowels from opposite sides. Take care not to damage the machined surfaces. Lift off the bearing carrier.

FOR MULTIPLE ASSEMBLIES ONLY.



Examine all roller beaings for scoring, spalling, or pitting. If replacement is necessary, remove the bearings with a bearing puller.

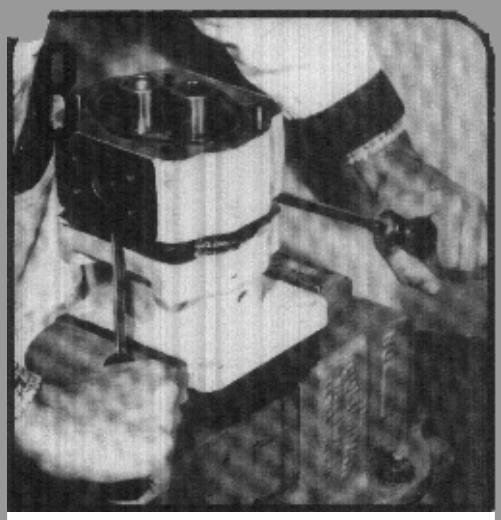


It is generally advisable to replace ring seals when rebuilding unit. To replace, remove the drive gear bearing with a bearing puller and remove ring seal from the bottom of bearing bore.



If the pump is equipped with an outboard bearing, place the shaft end cover in a vise with the mounting face up. Remove the bearing snap ring with a small screwdriver or awl.a

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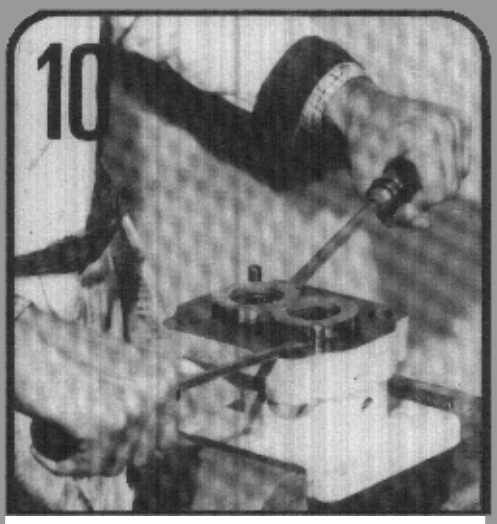


Lift or pry off the first section gear housing. Be careful not to damage machined surfaces. If the thrust plate remains in the gear housing, remove as described in Step 3.

For P31/P51, pry loose the first gear housing section. Be careful not to damage machined surfaces.



Remove the driven gear and the integral gear and drive shaft. Keep these together as they are a matched set. Examine and replace if necessary. See below.* Be careful not to damage the machined surfaces of the gears.



Pry the thrust plates from the shaft end cover, port end cover, or bearing carrier with a screwdriver or similar tool. Avoid distorting the thrust plates. Visually inspect thrust plates for wear or damage. Replace if necessary. See Pg. 11 . remove and discard all rubber pocket seals and gasket seals.



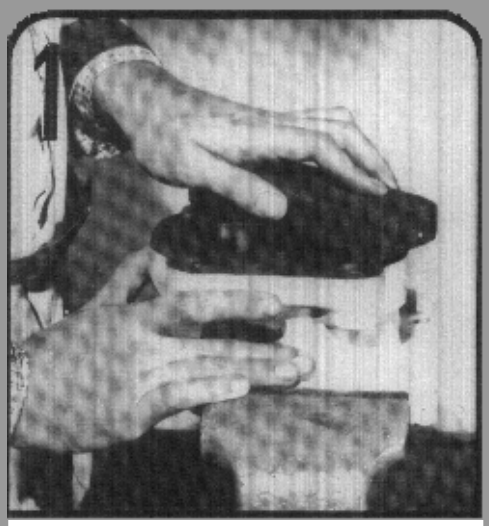
Use a bearing puller to remove the outboard bearing.



Grip the shaft end cover in a vise with the mounting face down. Remove double lip seal by inserting the special seal removal tool (see Tool List) into the notch between the double lip seal and the shaft end cover. Tap the seal out and discard.

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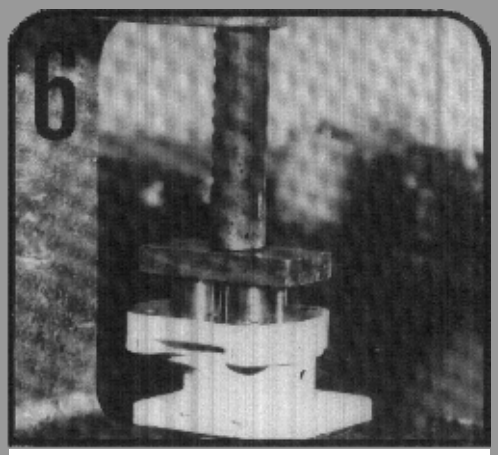
start assembly here



Stone off all machined surfaces with a medium grit carborundum stone.



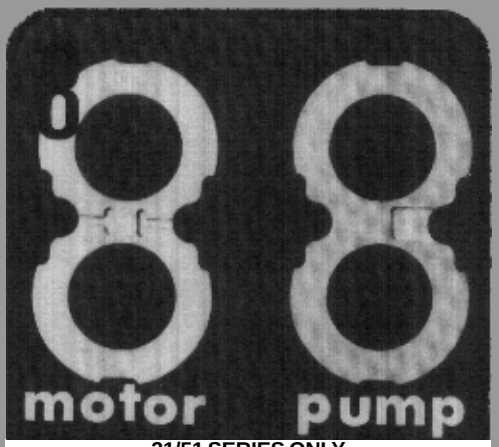
If bearings have been removed, deburr bearing bores. Rinse parts in a solvent. Air blast all parts and wipe with a clean lintless cloth before starting assembly.



If any bearings have been removed from the shaft end cover, port end cover, or bearing carrier, replace the bearings by pressing them into the bearing bore with an arbor press.



Before inserting a new lip seal in the shaft end cover, coat the outer edge of the lip seal and its recess with Permatex Aviation Form-A-Gasket No. 3 Non-hardening Sealant or equivalent. With the metal side of the lip seal up, press it into the mounting flange side of the shaft end cover with an arbor press and bar (see Tool List). On the P30/P31 series, make certain lip seal is fully seated in the recess. On the P50/P51 series, do not attempt to bottom-out seal; press in only until it is flush with the face of the recess. Wipe off surplus sealant.



31/51 SERIES ONLY

Check all thrust plates for wear. Replace if necessary (see below). Note that the thrust plates for pumps and motors are different. Pump thrust plates have a single relief pocket and must be installed with this groove on the high pressure side. Motor thrust plates are grooved on both sides.

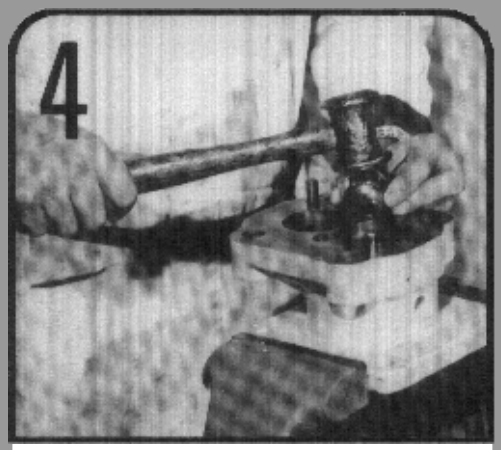
For P31/P511, the relief groove on all the unidirectional thrust plates must be towards the high pressure (outlet) side of the pump.

30/50 series pump and motor plates resemble the motor plates illustration.

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Grip shaft end cover in vise with mounting facedown. Examine plug or 2 check valves to be sure they're tightly in place. Replacement is necessary only if parts are damaged. Remove with screwdriver or special check valve tool (see Tool List).

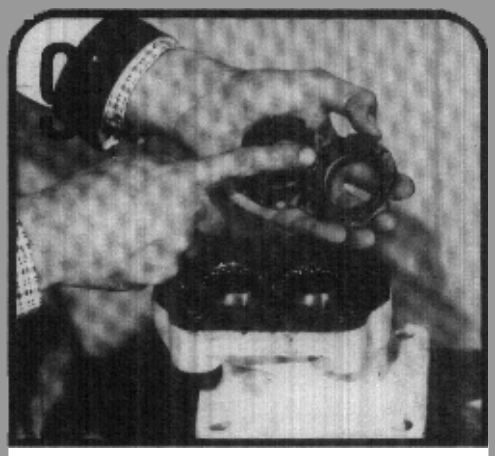


If plug or check valves are being replaced, screw in new parts tightly. Stake plug with prick punch at both ends of screwdriver slot and around edges. Screw check valves in tightly with tool. Peen edge of hole 1/32" to 1/16" with 1 1/2" diameter steel ball.

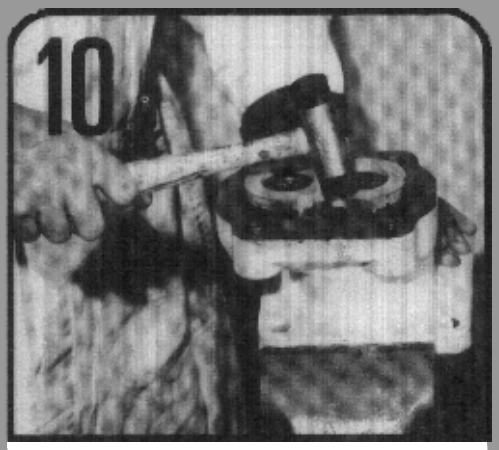


ASSEMBLY STEPS 5, 6, 7, 9 AND 11 APPLY TO SHAFT END COVER, BEARING CARRIERS, AND PORT END COVER.

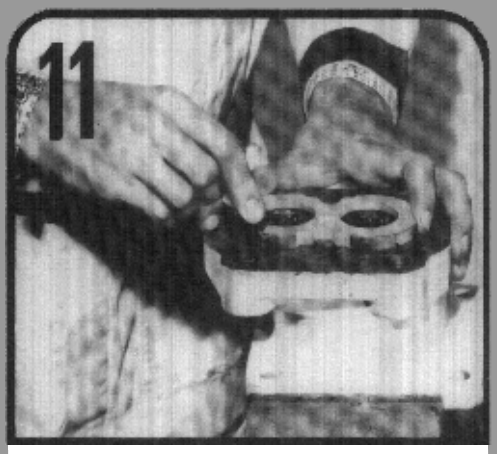
If ring seals are being replaced, insert into bottom of drive gear bearing bore. The notch in the ring seal MUST BE VISIBLE. This is a check to be certain the notched side is next to the bearing.



Grip the shaft end cover in a vise with the mounting face down. Cut 2 pocket seals 7/32" long from the pocket seal strip. Grease these pocket seals well and insert them into the middle slots on the reverse side of the thrust plate.



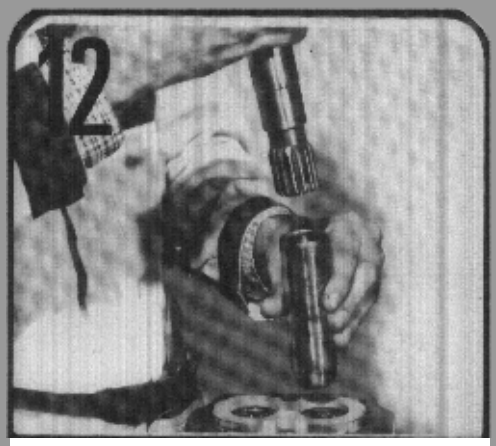
With the pocket seals facing down, place the thrust plate over the bearings in the shaft end cover. Tap thrust plate with a soft hammer to about 1/32" from the machined surface.



Cut 4 pocket seals approximately 1/4" long from the pocket seal strip. Insert one pocket seal into each of the slots in the thrust plate. Push each pocket seal all the way in so that it touches the roller bearings. Tap the thrust plate down firmly against the machined surface with a soft hammer. Use a sharp razor blade to trim exposed end of the pocket seal square and flush with the thrust plate.

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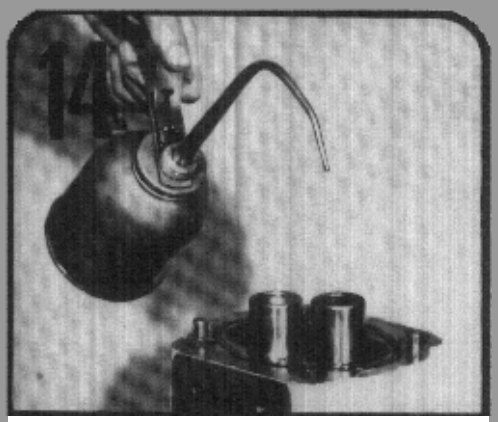
assembly, continued



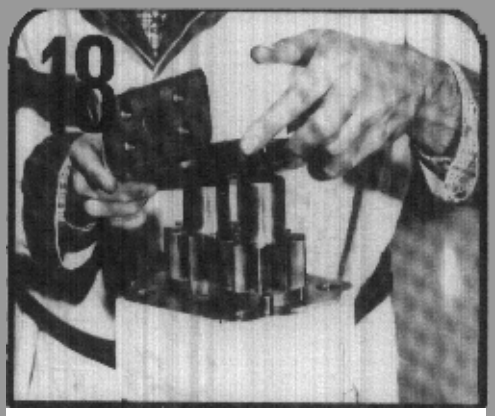
Insert the splined end of the drive shaft into the special steel sleeve (see Tool List). Lightly grease the drive shaft and sleeve. Insert the integral gear and drive shaft with sleeve into the shaft end cover with a twisting motion. Be careful not to damage the double lip seal. Push down carefully until the gear rests against the thrust plate. Remove the steel sleeve. Insert the driven gear.



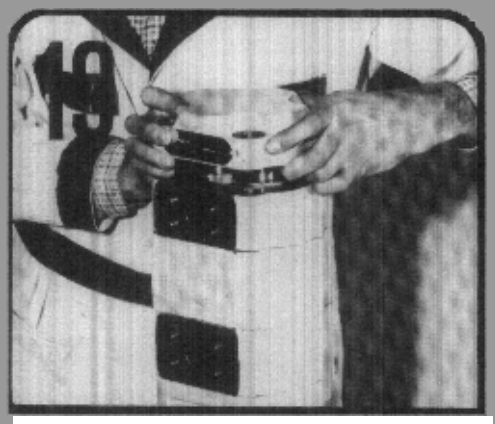
Grease the new gasket seals and insert them into the grooves in both sides of all gear housings.
For P31/P51-Examine all dowel pins. See Pg. 11.* Before inserting a pin, make certain the hole is clean and free from burrs. Start pin into hole gently and straight, tapping lightly with a soft hammer.



Slide the first section gear housing over the gears and tap it with a soft hammer until it rests tightly against the shaft end cover.
Be careful not to pinch the gasket seal. Squirt oil over the gears to provide initial lubrication when pump is started.
For P31/P51– Line up the dowels with the matching holes. When parts are parallel, squeeze them together or gently tap alternately over dowels with a plastic hammer until the parts become parallel and move smoothly together. **Do not force.**

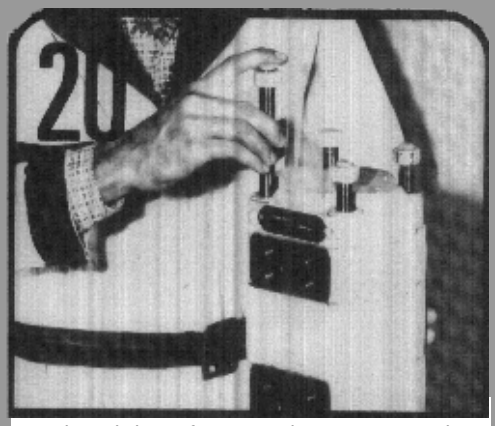


Slide the second section gear housing over the gears and tap it tight against the bearing carrier with a soft hammer. Be careful not to pinch the gasket seal. Squirt oil over the gears to provide initial lubrication when pump is started.
For P31/P51 line up the dowels and the holes in the 2 castings. When parts are parallel, squeeze them together or gently tap alternately over the dowels with a plastic hammer until parts move smoothly together.
Do not force.
Insert dowel pins (P31/P51 only),
FOR MULTIPLE ASSEMBLIES ONLY.



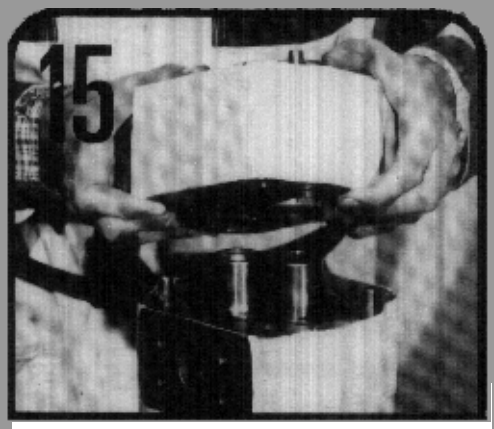
Place the port end cover over the gear journals and tap tightly against the gear housing. Be careful not to pinch the gasket seal.

For P31/P51 - Align the dowels with the holes in the mating casting. Being careful not to pinch the gasket seal, tap the port end cover lightly in the center between bearing bores to engage the dowels and to move parts together in final seating.



Thread the 4 fasteners (cap screws and washers, or studs, washers, and nuts) into the shaft end cover and tighten alternately or cross-corner. Rotate the drive shaft with a 6" wrench to make certain there is no binding in the pump.

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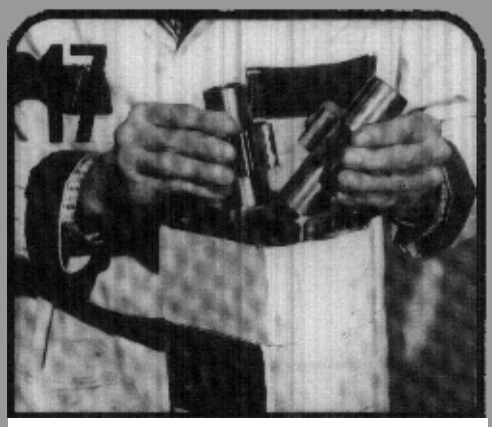
With the thrust plates mounted on the bearing carrier (as in steps 9, 10, 11), position it on the gear housing so that the roller bearings receive the journals of the drive and driven gears. Make sure that the drain port in the bearing carrier is on the suction or inlet side if the unit is being built as a pump. (Motors do not have drain vents in the bearing carrier.) Make sure that the index marks are properly aligned.
Insert dowel pins (P31/P51 only).

FOR MULTIPLE ASSEMBLIES ONLY.



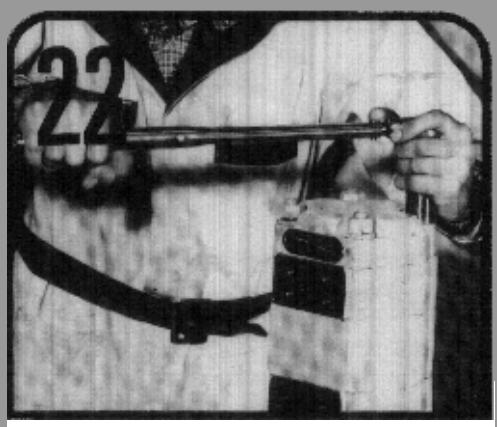
Insert the connecting shaft in the spline of the drive gear.

FOR MULTIPLE ASSEMBLIES ONLY.

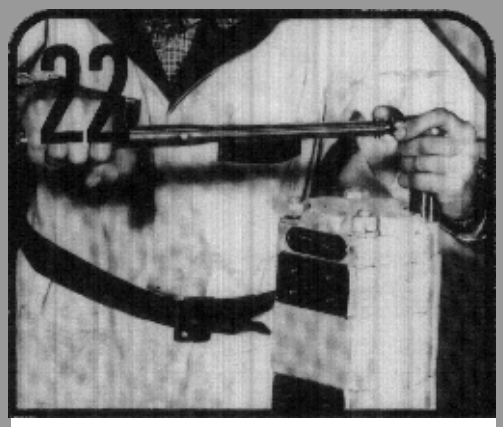


Insert the drive and driven gears of the second section in their respective bearings. Make certain gears are in contact with thrust plate face.

FOR MULTIPLE ASSEMBLIES ONLY.



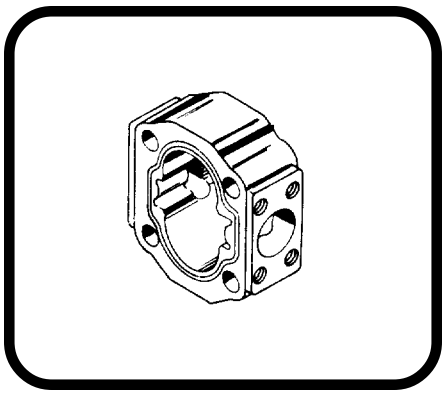
If the unit is equipped with an outboard bearing, guide the bearing into its recess in the shaft end cover. This is not a press fit. Insert the snap ring into its groove to retain the outboard bearing.



After the fasteners are tight and you are sure there is no internal binding, torque the diagonally opposite fasteners to 200 ft. lbs. (2400 in. lbs.).

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As a guide in answering the question, “How much wear is allowed before the part should be replaced?”, we offer the following suggestions...



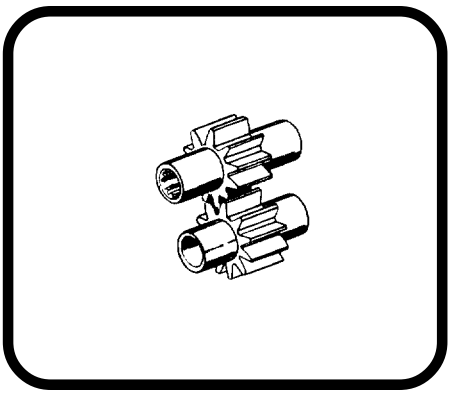
GEAR HOUSINGS:

Wear in excess of .005" cut-out necessitates replacement of the gear housing.

Place astraight-edge across bore. If you can slip a .005" feeler gage under the straight-edge in the cut-out area, replace the gear housing.

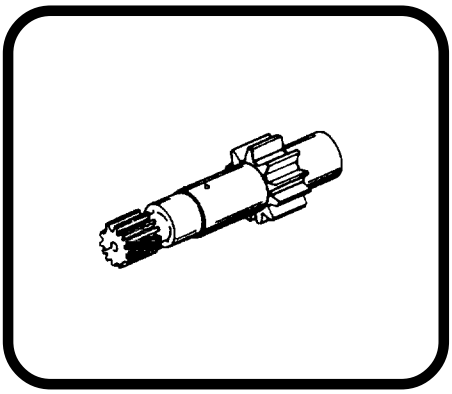
Pressure pushes the gears against the housing on the low pressure side. As the hubs and bearings wear, the cut-out becomes more pronounced. Excessive cut-out in a short period of time indicates excessive pressure or oil contamination. If the relief valve settings are within prescribed limits, check for shock pressures or tampering. Withdraw oil sample and check it and tank for dirt.

Where cut-out is moderate,.005" or less, gear housing is in good condition, and both ports are of the same size, housing may be flopped over and reused.



GEARS:

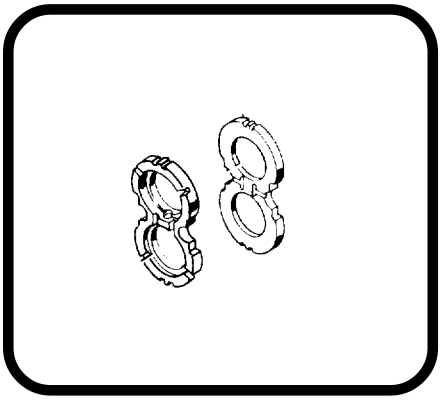
Any wear on gear hubs detectable by touch, or in excess of .002" necessitates replacement. Scoring, grooving, or burring of outside diameter of teeth requires replacement. Nicking, grooving, or fretting of teeth surfaces also necessitates replacement.



DRIVE SHAFTS:

Replace if there is any wear detectable by touch in the seal areas or at the drive coupling. .002" wear is the maximum allowable.

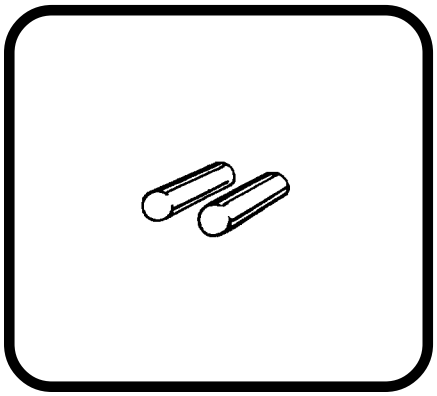
Wear in the shaft seal areas indicate oil contamination. Wear or damage to splines, keys or keyways necessitates replacement.



THRUST PLATES:

The thrust plates seal the gear section at the sides of the gears. Wear here will allow internal slippage, that is, oil will bypass within the pump..002" maximum wear is allowable. Replace thrust plates if they are scored, eroded or pitted. Check center of thrust plates where the gears mesh. Erosion here indicates oil contamination. Pitted thrust plates indicate cavitation or oil aeration. Discolored thrust plates indicate overheating, probably insufficient oil.

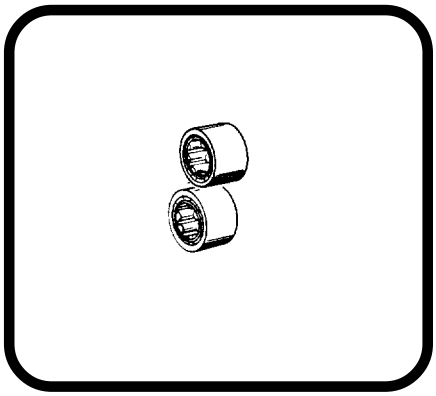
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DOWEL PINS:

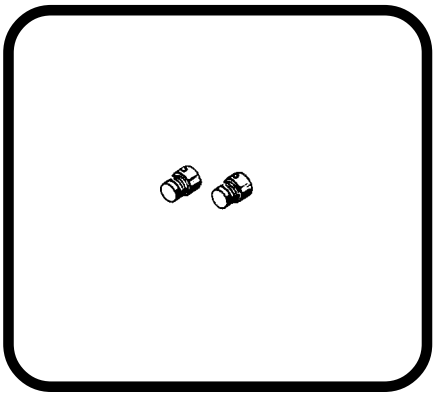
If either the dowel pin or dowel hole is damaged, the pin or machined casting, or both, must be replaced.

If more than reasonable force is required to seat dowels, the cause may be poorly deburred ordirty parts; cocking of dowel in the hole; or improper pin-to-hole fit.



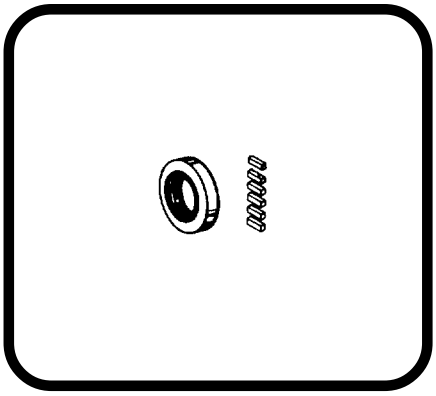
BEARINGS:

If gears are replaced, bearings must be replaced. Bearings should fit into bore with a light press fit. A neat hand fit is allowable. If bearings can fall out, bore may be oversize.



CHECK VALVES:

Examine small check valves in shaft end cover to make sure they are intact and functioning. If there are no check valves here, make sure the high pressure side of the shaft end cover is plugged.



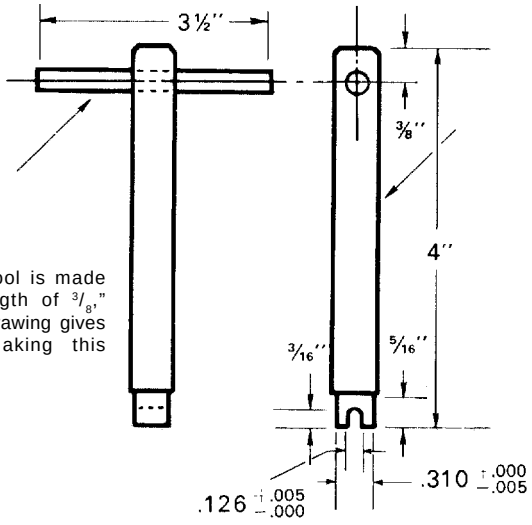
SEALS AND GASKETS:

Replace all rubber and polymer seals whenever disassembling pump. Include all “O” rings, pocket seals behind thrust plates, shaft sea] and gasket seals.

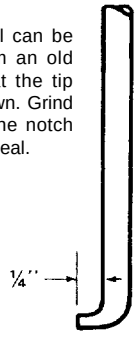
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tool list

- Arbor Press
- Awl
- 1½" Dia. Steel Ball
- Bearing Puller (Owatonna Tool Co. MD-956 or equivalent)
- Clean Lintless Cloths
- Deburring Tool (an old file with the cutting teeth ground off)
- Machinist's Hammer
- Soft Hammer
- Permatex Aviation Form-A-Gasket No. 3 Non-hardening Sealant or Equivalent
- Medium Grit Carborundum Stone
- Oil and Grease
- Snap Ring Pliers
- Prick Punch
- Sharp Razor Blade
- Scale ($^1/_{32}$" or $^1/_{64}$" graduations)
- Small Screwdriver
- Torque Wrench
- Vise with 6" Minimum Open Spread
- Bar for Lip Seal Installation
  Note For P30/P31, use $1^3/_4$- dia. by 2" bar.
  For P50/P51, use 2½," dia. by 2" bar.
- Special Steel Sleeve



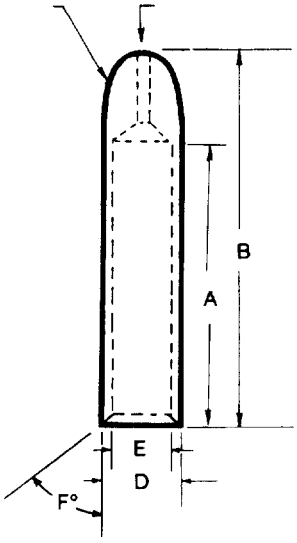
Check valve tool is made from a 4" length of $^3/_8$," drill rod. The drawing gives details for making this handytool.



Seal removal tool can be easily made from an old screwdriver. Heat the tip and bend as shown. Grind off the tip to fit the notch behind the shaft seal.

	A	B	C Radius	D Dia.	E Dia.	F° chamfer
P30/P31	3⅜''	4½''	⅜''	1.065 +.000 -.002	1.002 +.002 -.000	.015'' × 45°
P50/P51	4¼''	5⅜''	9/16''	1.290 +.000 -.002	1.250 +.002 -.000	.015'' × 60°

All external surfaces must be free of scratches and burrs.



The special steel sleeve is used to insert the drive shaft through the lip seal without damage and can be made from bar stock: For the P30/P31, use a $1\ ^1/_8$" or 1 ¼" diameter x $4\ ^3/_8$" bar; For the P50/P51, use a $1\ ^3/_8$" diameter x 5 ½" bar. The drawing and chart give details for making this tool.

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lubrication and oil recommendations

All parts, with the exception of the outboard bearing, are lubricated by the hydraulic oil in the circuit. Particular attention must be paid to keep the oil in the circuit system clean. Whenever there is a pump or motor failure, and there is reason to feel that metal particles may be in the system, the oil must be drained, the entire system flushed clean, and any filter screens thoroughly cleaned or replaced. New oil should be supplied for the entire system. Oil suitable and recommended for use in circuits involving Commercial's pumps and motors should meet the following specifications:

Viscosity:
- 50 SSU minimum @ operating temperature
  7500 SSU maximum @ starting temperature
- 150 to 225 SSU @ 100°F. (37.8°C.) (generally)
  44 to 48 SSU @ 210°F. (98.9°C.) (generally)

Oil Grade	Approximate SSU at. . . 100° F. (37.8° C.)	210° F. (98.9° C.)
SAE 10	150	43
SAE 20	330	51

Viscosity Index:. 90 minimum

Aniline Point: 175 minimum.

Recommended Additives: Foam Depressant
Rust and Oxidation Inhibitors

Other Desirable Characteristics:

- Stability of physical and chemical characteristics.
- High demulsibility (low emulsibility) for separation of water, air, and contaminants.
- Resistant to the formation of gums, sludges, acids, tars, and varnishes.
- High lubricity and film strength.

General Recommendations:

A good quality hydraulic oil conforming to the characteristics listed above is essential to satisfactory performance and long life of any hydraulic system.

Oil should be changed on regular schedules in accordance with the manufacturer's recommendations, and the system periodically flushed.

Oil temperature in reservoir must not exceed 200°F., (93.3°C) with a maximum temperature of 180°F. (82.2°C.) recommended. Higher temperatures will result in rapid oil deterioration.

Reservoir capacity should equal in gallons the pump output in gpm or the total gpm of all pumps where there is more than one in the system.

Oil poured into the reservoir should pass through a 100 mesh screen. Pour only clean oil from clean containers into the reservoir. A 100 mesh screen may be used in the suction line leading to the pump. A suction filter should be of sufficient size to handle twice the pump capacity. It must be cleaned and checked regularly to avoid damage due to contamination and cavitation.

Normal Temperatures:

0°F. (—18°C.) to 100 F. (37.8°C.) Ambient
100°F. (37.8°C.) to 180°F. (82.2°C.) System
Be sure your oil is recommended for the temperatures you expect to encounter.

Cold Weather Operation

Oils for use in cold weather should have a viscosity not exceeding 7500 SSU at the minimum start-up temperature. A pour point of at least 200°F. below start-up temperature is recommended. Start-up procedures should allow for a gradual warm-up until the oil reaches a reasonably fluid state.

The Use of Other Oils

- Automatic Transmission Fluid (ATF): General experience here has been satisfactory; however, ATF oils are sometimes too expensive for normal use in hydraulic systems.

- Diesel Fuel or Kerosene (Coal Oil): Sometimes used as dilutants for cold weather operations but are not recommended as they are not sufficiently refined products.

- Fire Resistant Fluids: Of the several different types, only the inverted emulsion types may be used without changing to special seal, packing, gasket, hose, etc., compositions. Their use may materially reduce pump life. Experience indicates that the use of FR fluids can be disastrous unless certain precautions are followed. DO NOT USE ANY FIRE RESISTANT FLUIDS OR NON-PETROLEUM OILS WITHOUT CONSULTING OUR TECHNICAL SERVICE DEPARTMENT.

- These suggestions are intended as a guide only. OBTAIN YOUR FINAL OIL RECOMMENDATIONS FROM YOUR OIL SUPPLIER.

recommended start-up procedure for new or rebuilt pump or motor

Before installing a new or rebuilt pump or motor, back off the main relief valve until the spring tension on the adjusting screw is relieved. This will avoid the possibility of immediate damage to the replacement unit in the event that the relief valve setting had been increased beyond the recommended operating pressure prior to removing the old unit.

Before connecting any lines to the pump or motor, fill all ports with clean oil to provide initial lubrication. This is particularly important where the unit is located above the oil reservoir.

After connecting the lines and mounting the replacement unit, operate the pump or motor at least two minutes at zero pressure at lowest possible rpm. During this break-in period, the unit should run free and not develop an excessive amount of heat. If the unit operates properly, speed and pressure can then be increased to normal operating settings.

Reset the main relief valve to its proper setting while the pump is running at maximum operating engine (motor) speed for the vehicle.

ALWAYS USE AN ACCURATE GAGE WHEN ADJUSTING
THE RELIEF VALVE PRESSURE SETTING.

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test procedure recommended

Be sure there is an adequate supply of oil for the pump, at least one gallon of oil for each gpm of pump capacity.

If one section of a tandem pump is being tested, make sure that all other sections not being tested are adequately supplied with oil. If any of the other sections run dry, or if plugs are left in ports, serious and permanent damage will result.

The oil should be a good quality hydraulic oil rated at 150 SSU at 100°F., with the oil temperature held at 120°F. plus or minus 5°F. (Test procedures are described in detail in SAE handbooks; see Hydraulic Power Pump Test Procedure, SAE J745c.)

The feed line must be of adequate size with no more than 5" mercury vacuum adjacent to the pump inlet. As a rule, the feed line must provide a feed flow velocity not in excess of 8 feet per second.

Hot oil must not be fed into a cold pump. It may seize. Jogging may prevent seizure.

Operate the pump at least two minutes at zero pressure and at moderate speed (not over 1500 rpm)

If pump becomes hot to touch, it is binding and may seize. This doesn't happen very often, but if it does, pump will have to be disassembled and rebuilt, with extra care taken to remove burrs and to assure freedom from binding.

Gradually increase pressure on pump, intermittently, until the desired test pressure has been reached. This should take about five minutes.

Delivery should run close to rated catalog performance figures which are averaged from testing several pumps. Something like a 5% lower reading may be used as a rated minimum if new or relatively new parts have been used. When rebuilding the pump with parts from the original pump, which, while worn, appear satisfactory for re-use, a 10% or 15% lower reading may be permitted, depending on the performance expected from the equipment. One's own experience will prove the best guide here.

Many repairmen measure the output at normal operating speed and at zero pressure, then again at 1000 psi (or the operating pressure of the equipment) and allow a volume decrease approximating the listing below. It is a suggested reference only which makes allowance for re-used parts.
P30/P50 pumps are generally tested to 2000 psi maximum.

GPM DELIVERY at 1800 rpm 100 psi	GPM DROP OFF AT. . . 1000 psi/70 bar	1500 psi/105 bar	2000 psi/140 bar	2500 psi/175 bar
5 — 14	2 to 3	2½ to 3½	3 to 4	3½ to 4½
15 — 25	2½ to 3½	3 to 4	3½ to 5	4 to 5½
26 — 50	3 to 4	4 to 5	4 to 6	4½ to 6½

At test speeds other than 1800 rpm, gpm delivery will vary almost proportionately, but the same (drop-off) figures should be used.

Be sure to run the pump in the direction for which it was designed and built. Driving pump in the wrong direction will build up pressure behind shaft seal, damaging it and necessitating replacement.

Since it is rarely feasible to test motors on dynamometers, the practical procedure is to test them as pumps, running complete testing procedures in each direction.

After completing testing procedures, pump is ready for installation and immediate duty operation on equipment. Again, it must be remembered that to prevent seizure, hot oil must not be fed into a cold pump.

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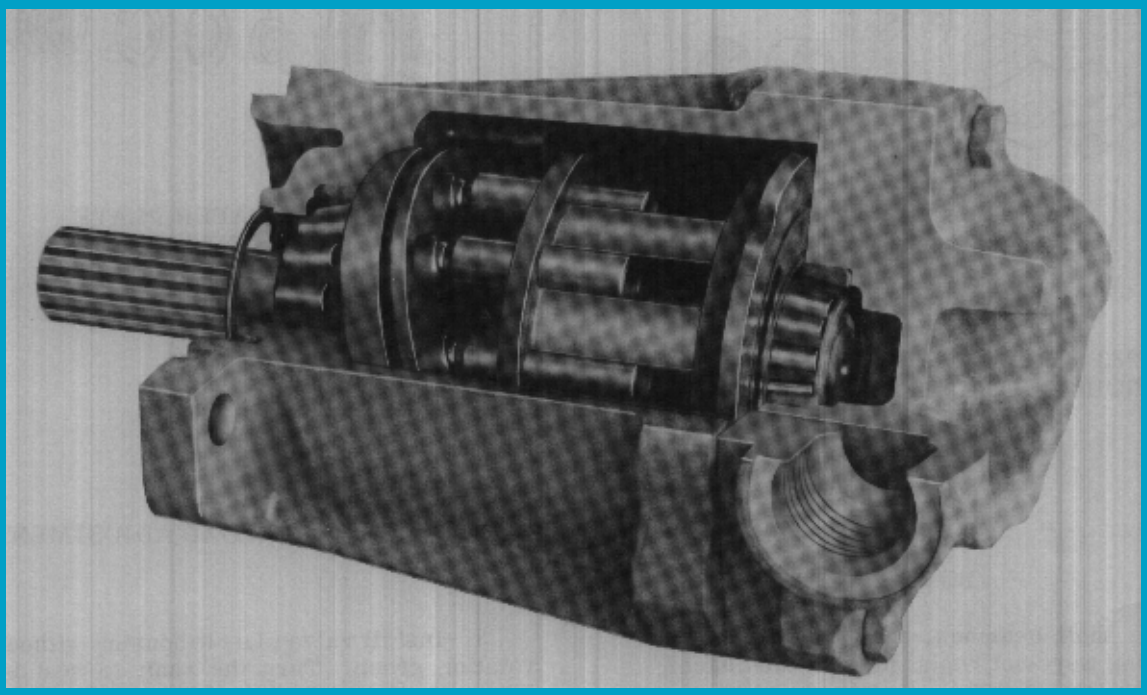
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Service Parts Information

Fixed Displacement Transmission Motors

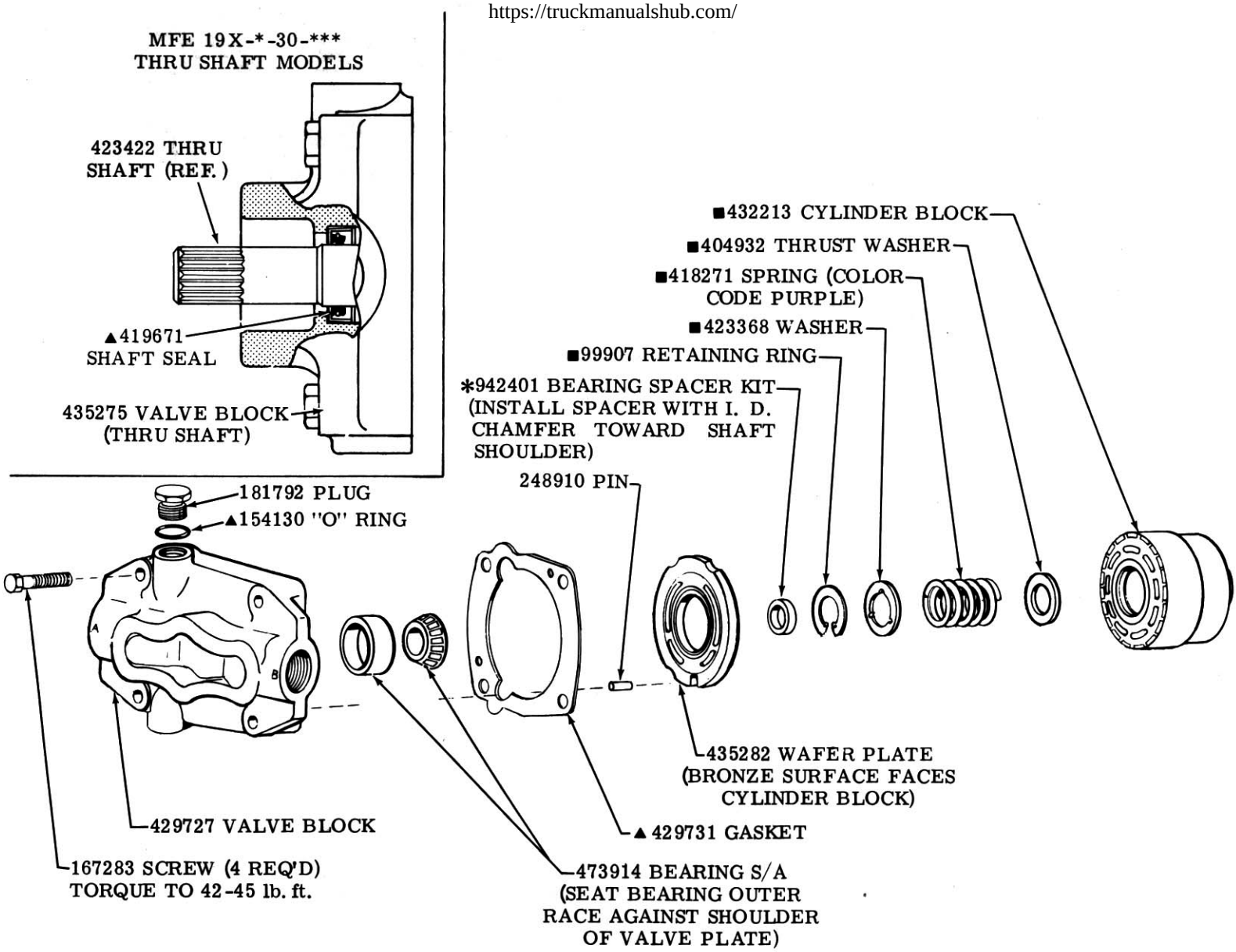
MFE15(X)-*-30
MFE19(X)-*-30



Vickers, Incorporated
P.O. Box 302
Troy, Michigan 48007-0302

Revised 11-1-85 **M-2837S**

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* SHAFT BEARING PRELOAD ADJUSTMENT PROCEDURE

NOTE

If the shaft bearings, shaft, valve plate or housing were not replaced, use the bearing spacer removed during the disassembly procedure to preload the shaft. If preload is necessary, perform the following steps:

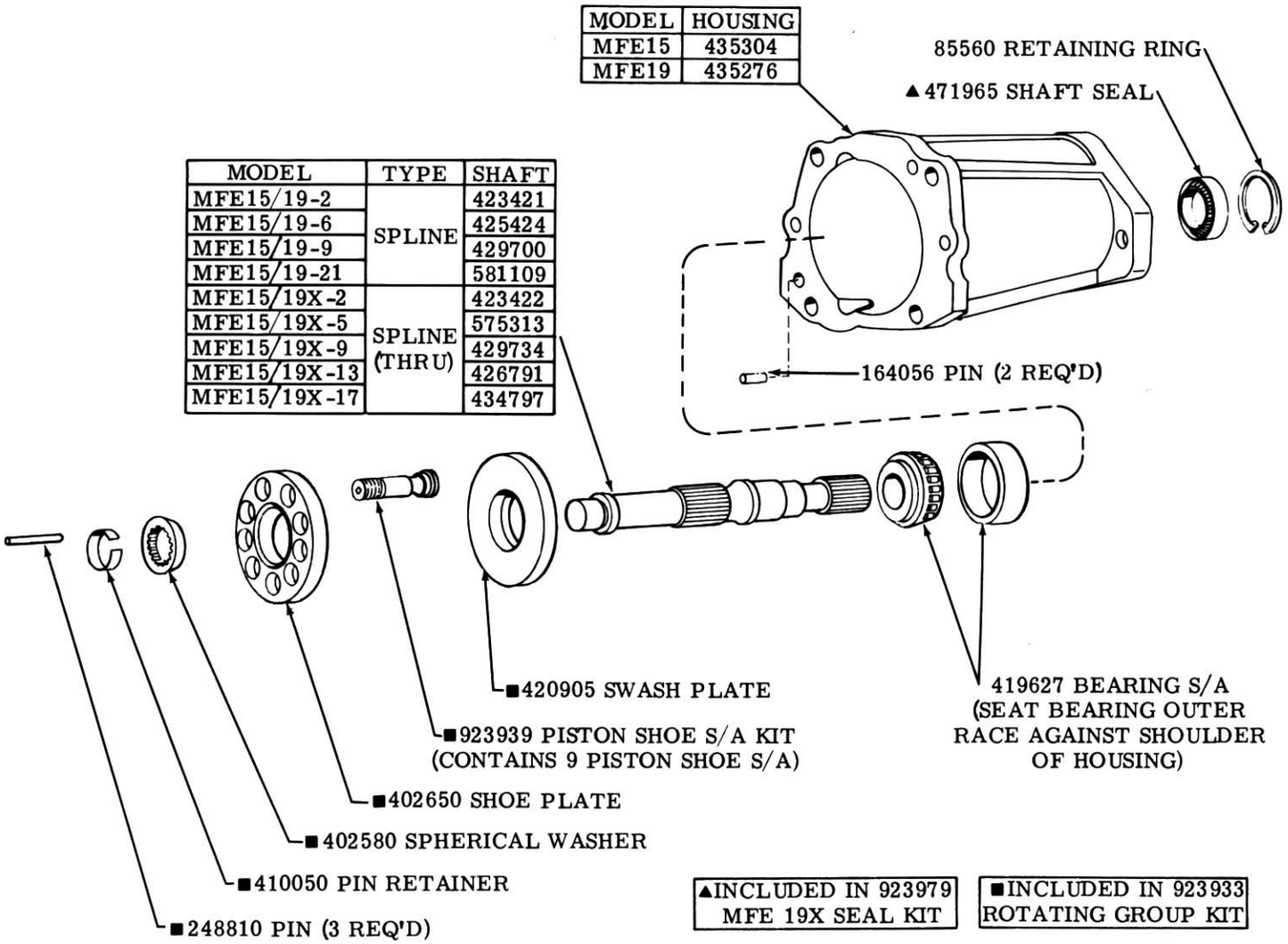
1. Install the thickest bearing spacer from the kit with chamfer facing toward shoulder of the shaft.

2. Slide tapered roller bearing over the shaft and up against the bearing spacer. The small diameter of the tapered roller bearing must face out of the housing.

3. Install valve plate to housing without gasket and rotating group. Turn the shaft to seat bearings then torque the four valve plate attaching screw to two (2) lb. in. Check the opening between the valve plate and housing to be as even as possible after tightening.

4. Use a feeler gage to measure the opening between valve plate and housing. Four (4) measurements should be obtained equidistant around the unit. A tapered feeler gage is especially useful for this purpose. Average the measurements by adding them together and dividing by four (4). Calculate thickness of the shaft bearing spacer as follows:

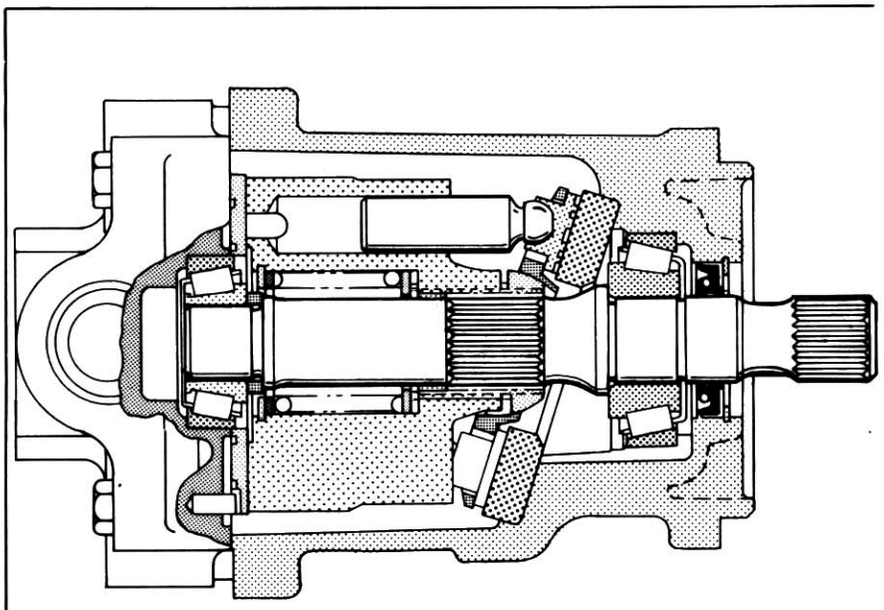
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+0.150	Measured thickness of bearing spacer
-0.027	Average gap (assumed)
+0.003 ± 0.001	Preload setting
+0.020	Compressed thickness of gasket
0.146 ± 0.001	Required thickness of spacer to provide a 0.001 to 0.003 bearing preload.

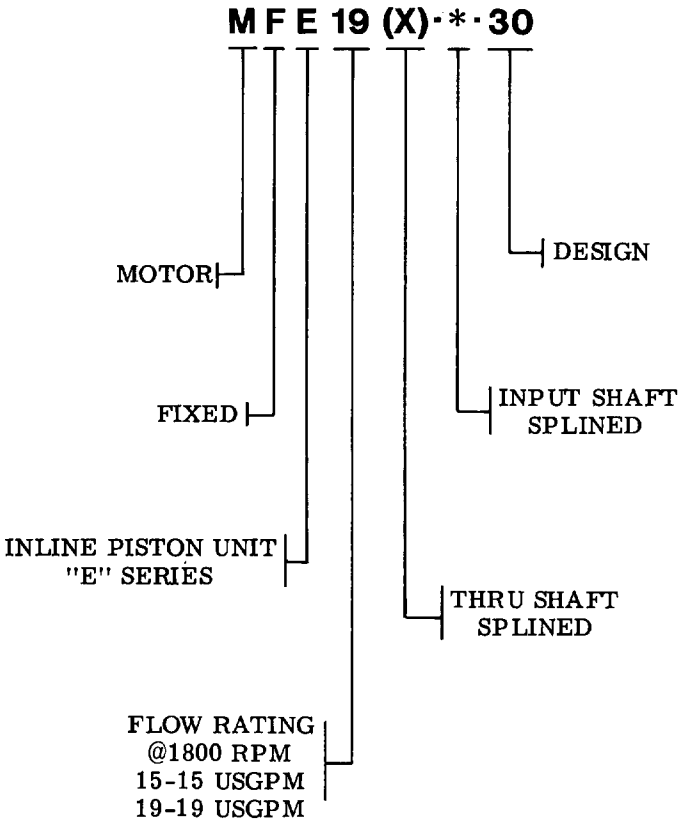
5. Remove the large spacer and replace with one having the calculated dimensions.

6. Assemble the motor with rotating group and a new gasket. Cross torque the valve plate screws to 42-45 lb. ft.



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MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

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HVP03 VALVES
SERVICE INSTRUCTIONS

Hand Operated

A. Removal

1. Relieve hydraulic pressure by working the control lever several times with engine off.
2. Thoroughly clean the valve and surrounding area. Label the the hydraulic lines for correct assembly. Disconnect and cap the lines. Plug the ports of the valve to help prevent entry of dirt.
3. Disconnect the electrical lead from the pushbutton switch in the control handle.
4. Remove the valve. Take the valve to a clean work area for disassembly.

B. Disassembly (see spare parts list)

Importance: The internal spring assemblies are individually fitted to their bores and must be returned to the same bores from which they were removed. If the assemblies are interchanged between bores, full stroke on stroke on the main control valve may not be attained.

1. Clamp the valve lightly in a vise. Mark the position of the
2. mounting plate relative to the valve housing.
   Peel back the protective boot from mounting plate groove.
3. Use a 4 mm hex-key to remove the four (4) capscrews from the mounting plate. Remove the mounting plate.

Important: Before removing, note the position of each bushing/ spring assembly relative to the valve housing. The assemblies are shimmed to match the individual spool/bore. If the bushing/spring assembly is being replaced, the shim pack must be transferred from the old assembly to the new assembly and returned to the same bore from which it was removed.

The internal spring assemblies can be removed as follows:

a. Lift out the bushing spring assembly. (Refer to “seal
b. replacement” for disassembly instructions.)
c. Lift out the internal spring assembly. Do not disassemble.
   To remove the lower spring and retainer assembly, remove
d. Push the spool out of the housing.

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C. Inspection and Repair

Clean parts in non-flammable solvent and try thoroughly. Spring assemblies can be rinsed in non-flammable solvent. Do not disassemble them for cleaning purposes.

Inspect the valve spool and housing bore for scoring. If any is noted, the entire valve must be replaced. The spools are matched to the corresponding housing bores and are not serviced separately.

Service kits are available for rebuilding the valve. The only seal that could be a problem is the lip seal in the bushing/spring assembly. The other seals are static seals. To replace the lip seal, refer to seal replacement instructions.

D. Assembly

Assembly valve in reverse order of disassembly. Be sure that the assemblies are returned to the same bores from which they were removed.

E. Seal Replacement-Bushing/Spring Assembly (Applies to both hand and foot operated valves.)

1. Remove the o-ring from bushing.
2. Remove the snap ring from bottom groove in pin. Remove the shim pack. Keep the shim pack together and retain for reassembly.

Important: The shims in the bushing/spring assembly control the override feature of the modulator valve. Always install the same number of shims as was removed. Do not interchange shims between the individual assemblies. When installing a new bushing/spring assembly, transfer the shim pack from the assembly being replaced. The shims are not included in the repair kits.

3. To remove the split retainer ring, lay the bushing/spring assembly upside down. Fit a 13/16 inch open end wrench around the bushing, press down on wrench and remove the retainer ring.
4. Remove the spring guide pin, spring and snap ring. Remove and discard the lip seal.

Important: The spring guide pin must be free to any surface scratches. If any are present replace the pin assembly. A kit is available. Also check the bushing for excessive wear and replace if necessary.

5. Press new scal into the bushing. The lip must face away from the bushing. Install the snap ring.

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GRADALL®
HYDRAULIC
TROUBLE SHOOTING
for

G3R Starting Lot 12
G3W " Lot 14
G660C " Lot 240
G880C " Lot 150

This material has been arranged to help locate the cause of a problem quickly. First, determine the nature of the malfunction and which circuits are involved. Then, find the heading which best describes the problem in the index below and turn to the page. Be sure to read TROUBLE SHOOTING TIPS on pages 2 and 3.

The General Trouble Shooting section covers symptoms pertinent to all circuits and miscellaneous. For information pertinent to an individual circuit not covered in the General Trouble Shooting section refer to the individual circuit.

CONTENTS

Trouble Shooting Tips	2 & 3
General	4, 5 & 6
Hoist Circuit	7
Boom Circuit	8
Bucket Circuit	8
Tilt Circuit	9
Swing Circuit	10
Swing Brake Circuit	11
Steering Circuit - Remote (Excluding G3R)	12
Travel Circuit - Remote	13
G3R Stabilizer Circuit	14
G3R Oscillation Circuit	15
G3R Steering Circuit	15

Form No. 8357

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TROUBLE SHOOTING TIPS

With an understanding of a few basic facts, even those having limited experience should have little difficulty isolating the cause of many hydraulic problems. It is recommended that the following material be read and understood before using the trouble shooting procedures in this section.

Most hydraulic system problems are the result of a leakage path which wastes hydraulic flow, a restriction which blocks hydraulic flow, or contamination, which can destroy system components as well as cause leakage or restrictions. There are other causes of hydraulic problems but these are the most frequent troublemakers.

Leakage falls into three main categories: external leakage from a damaged component, internal leakage which permits hydraulic flow to return to the reservoir without doing any useful work, and leakage of air into the system on the suction side of the pump.

Perhaps the worst kind of external leak is a small leak in a hidden area; machine performance may not change noticeably until the fluid level in the reservoir is reduced to a point where one or more pumps cavitate (become starved for fluid and run dry). A cavitating pump will be ruined in a very short period of time by inadequate lubrication.

If cavitation has occurred it may be necessary to replace one or more pumps and flush the system to eliminate metal particles released by the damaged pump. The operator should have noticed erratic operation and noise that sounded as if the pumps were filled with marbles if cavitation has occurred. If there is any doubt about the condition of the pumps, check them thoroughly before returning the machine to service.

Heavy external leakage (as from a ruptured hose) is usually an easy problem to locate and remedy. The wasted flow quickly affects machine function and the lost fluid makes an obvious mess. As long as an external leak is noticed before cavitation occurs the only problems are to repair the leak, replace the lost fluid and clean up the mess.

Leakage of air into the system on the suction side of the pump causes a condition called aeration (air bubbles are carried into the pump with the hydraulic fluid). Aeration has the same symptoms as cavitation (noisy pump and erratic operation) and can ruin a pump as quickly as cavitation.

Aeration can also be caused by loose or damaged cylinder packing which permits air to be drawn into the cylinder. This usually occurs when a load is forcing a cylinder to retract faster than the pump can fill the cylinder.

Other causes of aeration include use of the wrong type of hydraulic fluid in the system and low fluid level which can cause excessive sloshing in the reservoir.

Before considering internal leaks it will be helpful to review the relationship between a pump, flow and pressure in the system.

Remember, the function of a pump is to cause a flow of hydraulic fluid through the system Pressure in the system is a result of resistance to the flow created by the pump (a cylinder working against a load for example). Normal wear in a pump does not reduce flow noticeably, it reduces the pump’s ability to produce flow against resistance.

Under low resistance a worn pump may push almost as many g.p.m. (gallons per minute) as a new pump. The difference will show up when resistance is applied to the flow: the new pump will push its rated g.p.m. up to its rated resistance (specified in p.s.i.); the worn pump may have accumulated enough internal leakage (wear) to lose much of its flow under a resistance equal to normal working pressure.

Through most of the working life of a pump, wear occurs so gradually that the reduction in efficiency will not be noticed in day to day operation. Once wear progresses to a certain point it will occur more rapidly but it will still be difficult to detect a difference in day to day operation.

The point is, a hydraulic failure which occurs suddenly can seldom be traced back to the pump. When a pump fails suddenly, it will almost always make enough noise to eliminate any doubt concerning the source of the problem. Sudden failures are usually caused by leakage somewhere else in the system.

As stated earlier, an internal leak permits flow to return to the reservoir without performing any useful work; the flow of fluid will always take the path of least resistance.

In some instances the leak will be more or less continuous. Examples of this kind of leak include flow past a relief valve or check valve held in an open position by dirt, binding, or a damaged part. Other examples include worn or damaged cylinder packing, a damaged internal seal or o-ring, an internal crack in a housing, a broken poppet spring, a worn or scored valve spool or housing, a piston loose on its rod or a worn pump or motor. Depending on the size of the leak the machine may or may not have a noticeable loss of speed. Because this type of leak may occur in any one of several places, it will probably be necessary to check several points in the circuit to locate the leak.

A second type of internal leak is non-continuous; it occurs only when pressure in a circuit reaches a certain point and almost always involves a relief valve. The symptom indicating this kind of a leak is a “WEAK~ response to controls in one of more circuits. Think of weak response as a situation in which the machine function involved occurs at normal speed but then stops under a resistance which would not normally be a problem for the machine. In this case the leak occurs through an improperly adjusted relief valve (set too low). Because of the specific symptom involved, it is usually a simple matter to locate and remedy this type of problem.

It will be helpful to remember that a system having an internal leak large enough to cause a noticeable problem will sometimes show a higher than normal fluid temperature.
A restriction in the system is simply a condition where something is blocking normal flow. A partial restriction in a circuit may cause the machine function involved to be slowed because of the reduced flow.

A complete restriction in a circuit will probably result in one of two types of symptoms: First, if the restriction is downstream from a relief valve, one or more circuits will fail to respond because the flow involved is being bypassed through the relief valve. Second, if there is a complete restriction upstream from a relief valve the symptom will probably be a ruptured line or a broken pump.

Fortunately, though restrictions do occur, they are not a frequent problem. When they do occur they are usually the result of a badly damaged component, a kinked or pinched line or the installation of an inferior grade of hydraulic hose.

Contaminated hydraulic fluid (fluid containing particles of foreign matter) can cause a wide range of problems including rapid destruction of system components. Particles may be large enough to be seen by the naked eye or so tiny that they can only be seen under a microscope. Contaminants often include dust, sand, water, packing, and bits of metal worn from system components.

All foreign material trapped in hydraulic fluid causes excessive wear in system components, especially pumps. Tiny particles often become trapped between valve spools and poppets and their bores and cause binding and scoring. Larger particles can become stuck between valve poppets and their seats and cause an internal leak. Still larger particles can cause a restriction to flow anywhere in the system. Depending on the type of particle, its size and location, almost any kind of failure can occur.

If there is any reason to suspect that the system has become contaminated, check fluid thoroughly and flush as necessary before operating the system.

Probably the largest single cause of contamination is careless maintenance. Failure to change a filter when required, adding contaminated fluid to the system, use of dirty containers, funnels. etc., opening the system without taking proper precautions to prevent entry of foreign matter, failure to repair small leaks and failure to replace worn packing are some of the most common causes of contamination.

Hydraulic system maintenance or repair is never complete until you are sure the system is clean.

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General

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION	Upper clutch not engaged.....	Engage Clutch (G-660 & G-880)
	Joystick Switch not engaged.....	Engage
	Kill switch in operators seat not engaged	Correct Electric G3W & G3R Only
	Main Pump bypass.....	Rebuild or replace Pump
	Pilot Pump not delivering correct volume	Rebuild or replace Pump
	Main Control valve spool not shifting	Remove mechanical restriction
		Increase Pilot Control pressure if low
		Exchange Valve
		Control Valve Plunger end cap damaged
	Relief Valve bypass Main of Circuit, Joystick	Reseal or replace Valve
	Joystick handle not engaging valve	Correct mounting of handle to Joystick Base.
	Cylinder or motor bypass.....	Reseal or replace Cylinder or Motor
	Low Reservoir Oil Level.....	Add oil to Spec's.
	Suction Line Restricted.....	Check lines
	G3R Center Pin Leak.....	Reseal
	Incorrect Relief Valve setting.....	Adjust
NO POWER	Main and/or Circuit Relief bypass	Reseal or replace Valve
	Main Pump bypass.....	Rebuild or replace Pump
	Cylinder or motor bypass.....	Rebuild or replace Component
	Internal leak in main Control Valve	Correct or replace Control Valve
	G3R Center Pin Leak	*Reseal*
CIRCUITS SLOW	Upper Clutch Slipping.....	Adjust clutch (G-660 & G-880)
	Engine R.P.M. low.....	Correct to specs.
	Main pump bypass.....	Rebuild or replace pump
	Cylinder &/or Motor bypass	Rebuild or replace Component
	Main or Circuit Relief Valve bypass	Reseal or replace Valve
	Control Valve Plunger not stroking fully	Remove internal mechanical restriction
		Replace Control Valve
	Hydraulic oil system contaminated	Flush & rebuild System
		Replace damaged components
	Pilot Circuit Pressure Low.....	Adjust to specifications
	G3R Centrer Pin Bypass.....	Reseal
	Pilot Circuit oil flow lost through Two Speed Selector Valve.	*G660CR & G880CR only.* Shift plunger completely. Reseal or Replace

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PROBLEM	PROBABLE CAUSE	REMEDY
CIRCUIT CAVITATION	Anti-Cav. Valve malfunction.....	Repair or replace
	Backpressure valve..... malfunction	Repair or replace valve - *G3W*
	Air in hydraulic oil.....	Repair Center Pin
CIRCUIT DRIFT	Circuit or motor bypass.....	Rebuild or replace component
	Relief Valve bypass.....	Reseal or replace Valve
	Relief Valve pressure..... setting low	Correct to Specifications
	Spool or Housing..... worn excessively	Replace Section
PILOT CIRCUIT MALFUNCTION ALL CIRCUITS	Pilot Pump not delivering..... correct volume	Rebuild or replace Pump
	Joystick Solenoid valve..... not shifting	Correct electric problem Replace valve or electrical component
	Pilot Circuit Relief Valve..... low/bypass	Correct to Specifications/replace
	Joystick handle not..... activating valve	Correct handle mounting
	Line Restriction to end..... caps of Main Control Valve	Remove restriction
	G3R Center Pin Bypass	*Reseal*
HESITATION-ALL CIRCUITS & NO METERING CAPABILITIES	Pilot pressure signal..... not shifting main control valve	Adjust low pressure to specs. Remove mechanical internal restrictions/Replace Valve
	Pilot pressure low.....	Increase to specification
AIR IN HYD. SYSTEM	Center Pin bypass.....	Reseal Center Pin
HYDRAULIC OIL IN AIR SYSTEM	Center Pin Bypass.....	Reseal Center Pin
HYD. SYSTEM OVERHEAT	Oil Cooler blocked externally.....	Remove restriction
	Oil Cooler blocked internally.....	Remove restriction
	Incorrect spec. oil used.....	Drain & refill to correct spec. oil
	Relief Valve bypass.....	Reseal or replace valve
	Cylinder and/or motor..... bypass	Rebuild or replace component
	Hydraulic system..... contaminated	Flush & rebuild system Replace damaged components
	Low oil in reservoir.....	Add oil
	Engine R.P.M. to high.....	Adjust R.P.M. to correct specs.

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General (continued)

PROBLEM	PROBABLE CAUSE	REMEDY
SPRING CENTERED SPOOLS DO NOT RETURN TO NEUTRAL	Broken centering spring.....	Replace
LOAD DROPS WHEN SPOOL MOVED FROM NEUTRAL	Dirt or foreign particles..... lodged between check valve poppet and seal	Disassemble, clean and reassemble.
	Scored or sticking valve poppet.	Replace poppet
OIL LEAKS BETWEEN SECTIONS	Pinched/blow section seal.....	Replace seal
	Stud fasteners not..... correctly torqued	Replace seals and re-torque
	Mounting plate not level.....	Loosen mounting bolts and shim as required
OIL LEAKS AT EITHER END OF SPOOL	Worn or damaged spool seals...	Replace seals

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Hoist Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION UP OR DOWN		*See General - no action*
	External Anti-Cav. Valve..... malfunctioning	Repair or replace
NO DOWN ACTION ONLY	Two Way Valve in Hoist.....	Correct Pilot pressure G3W & G3R *Only*
	Lock Out valve not shifting	Remove restriction in Two Way Valve *G3W & G3R Only* Replace Two Way Valve
	Drain hole for Two Way valve in lock out valve body plugged not allowing plunger to shift	Remove restriction *G3W & G3R Only* Replace Valve body *G3W & G3R Only*
ERRATIC ACTION	Pump Relief & Hoist Relief..... pressure set close together	Adjust to Specifications
	Pilot control pressure too low or too high	Correct to specifications
	Spring tension in Two Way.....	Correct Two Way Valve adjustment *G3W & G3R Only*
	Valve in Lock Out Valve adjusted too high	High pilot back pressure
NO POWER (Hoist up only)		*See General - No Power*
	Relief Valve in Lock Out..... Valve bypass	Repack or replace *G3W & G3R Only*
	O Ring bypass in Two Way..... Valve in lock out valve	Reseal or replace Valve *G3W & G3R Only*
DUMP CIRCUIT	One way check malfunction.....	Correct to spec's
HESITATION		*See General Hesitation*
	Two Way Valve in Lock Out Valve not shifting	Increase Pilot Pressure to Specification *G3W & G3R Only* Remove Restriction *G3W & G3R Only* Adjust Spring Tension *G3W & G3R Only*
BOOM DRIFT		*See General*
	Relief Valve in Lock Out..... Valve bypass	Reseal or replace *G3W & G3R Only*
	"O" Ring bypass in Two Way Valve in Lock Out Valve to Body	Reseal *G3W or G3R Only*
	Two Way Valve Plunger..... stuck open	Free plunger *G3W & G3R Only* Replace Valve
	One Way check valve..... in Lock Out Valve bypass	Reseal or replace check valve *G3W & G3R Only*
	Cylinder bypass at piston.....	Reseal
SLOW BOOM UP		*See General Slow Circuit*
	"O" Ring bypass on Two..... Way Valve in Lockout Valve	Replace "O" Ring *G3W & G3R Only*
	Bypass in relief valve..... Lock-out Valve	Reseal or replace

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Boom Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION		*See General - No Action*
HESITATION		*See General - No Action*
NO POWER	Main Pump bypass	Rebuild or replace Pump
	Main or Line Relief Valve bypass	Reseal or replace Valve
	Cylinder bypass	Repack Cylinder
	Restriction in a hose	Remove restriction or replace hose
NO BOOM IN ONLY	Main Control Valve plunger not shifting	Remove mechanical restriction
	Pilot pressure too low to shift Main Control Valve plunger	Correct pilot pressure
DRIFT IN/OUT	Cylinder bypass	Repack Cylinder
	Line Relief bypass	Reseal or replace valve
BOOM SLOW		*See General - Circuit Slow*

Bucket Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION		*See General*
BUCKET DRIFT		*See Circuit Drift General*
NO POWER		*See General - No Power*
SLOW ACTION		*See General Circuit Slow*
HESITATION		*See General*
NO METERING		*See General*

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Tilt Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION		*See No Action General*
	Tilt Pedal malfunction.....	Correct or replace
	Wire broken to switch.....	Replace wire *G3R or G3W Only*
	Electric Switch in..... joystick malfunction	Correct G3W & G3R Only
	Tilt Solenoid in Pilot..... Manifold not working	Correct or replace *G3W & G3R Only*
	Tilt Motor shaft broken.....	Replace
	Tilt Transmission..... malfunction	Repair or replace transmission
TILT CHATTER/ EXCESSIVE NOISE	Circuit main relief valve..... setting too low	Increase relief pressure Replace valve
	Tilt Flow limiter valve..... shim pack dimension incorrect	Correct by removing or adding shims *G3W or G3R Only*
	"O" Ring bypass on tilt..... flow limiter valve	Replace "O" Ring *G3W & G3R Only*
TILT DRIFT		*See General Drift*
	Tilt Transmission failure.....	Correct
TILT SLOW		*See General Circuit Slow*
	Mechanical restriction..... in transmission	Remove restriction or replace transmission
	Tilt Rollers seizing up.....	Replace Rollers & Shaft
TILT TOO FAST	Engine RPM too fast.....	Correct to specifications
HESITATION		*See General Hesitation*
	Solenoid valve plunger..... restricted from shifting freely	Remove restriction/replace valve *G3W & G3R Only*

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SWING CIRCUIT

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION		*See General - No Action*
	G3R Stabilizer Valve not returning to neutral	Free up Stabilizer Control Valve Main Plunger
	Swing Motor drive shaft broken	Repair
	Swing Transmission malfunction	Repair Transmission
NO POWER		*See General - No Power*
SLOW ACTION	Swing Parking Brake dragging	Correct low Pilot pressure Free up mechanical drag in brake
	Swing motor bypass	Rebuild or replace motor
	Swing Cushion Relief "O" Ring	Replace "O" Ring
	Control Valve Main or Circuit Relief bypass.	Reseal, adjust or replace *G3W, G3R*
SWING DRIFT	Swing Parking Brake not setting mechanically	Mechanically Repair Brake
	Swing Parking brake not setting due to trapped hydraulic pressure	1. Remove dump oil restriction in pilot circuit 2. Orifice plugged in brake circuit.
	Swing Cushion Valve pressure setting low	Correct pressure to Specification
	Swing motor bypass	Rebuild or Replace Motor
ERRATIC SWING &/OR NO METERING OF SWING ACTION	Swing Sequence Valve spring setting too high	Lower valve setting
	Parking brake setting during Swing Cycle	Correct Pilot pressure setting to correct spec's. Systematically check complete circuit to determine area of pressure loss
	Joystick malfunction	Change Joystick
	Joystick plunger metering not correct.	Rebuild or replace joystick
	Pilot Circuit pressure too high.	Set to specifications
HESITATION	Main Control Valve plunger delay in shifting	Free up plunger
	Pilot oil signal delay to main Control Valve plunger	Insure pilot pressure to correct specifications
	Swing Brake not releasing	Correct problem (See Swing Brake section)

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Swing Brake Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
SWING BRAKE NOT RELEASING	Pilot pressure too low.....	Correct pressure to specifications
	Mechanical restriction.....	Remove restriction
	Shuttle Valve plunger..... bypass to dump	Replace Shuttle Valve
	Sequence Valve restriction.....	Remove restriction/replace valve
SLOW APPLICATION	Mechanical restriction.....	Remove restriction
	Swing Cushion Relief..... setting too low	Correct to Specification
	Orifice Valve restriction.....	Remove restriction/replace Valve
	Sequence Valve restriction.....	Remove restriction/replace Valve
ERRATIC APPLICATION WHILE SWINGING	Pilot pressure not constant.....	Correct Pressure Setting
	Swing Cushion Valve..... "O" Ring bypass	Replace "O" Ring
	Joystick Plunger hanging up.....	Free Plunger Replace Joystick
	Main Control Valve plunger..... sticking.	Free up
APPLIES TOO QUICK	Cushion Valve setting..... too high	Correct to Specifications
	Pilot Oil escaping Swing..... Brake Circuit too soon	Adjust or Replace Orifice
	Sequence Valve stuck open.....	Free up
SLOW RELEASE	Pilot pressure too low.....	Correct to Specifications
	Sequence Valve setting..... too high sticking.....	Reduce Spring Setting Free up
	Mechanical restriction..... internally	Remove Restriction

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Steering Circuit - Remote Mode (Excluding G3R)

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION		*See General - No Action*
	"O" Ring bypass on Flow.....	Replace "O" Ring
	Divider in Pilot Control Manifold Block	
	Flow Divider in front of..... upper steering valve not shifting	Free plunger/Replace valve (not on G-880)
	"T" Box frozen up.....	Free up or replace Torque motor
	Upper Steering Valve..... relief bypass	Correct Bypass
	Upper Steering Valve..... relief pressure low	Reset pressure to specifications
	Center Pin bypass.....	Reseal Center Pin
	Torque Motor frozen up.....	Free up or Replace Torque Motor (not on G-880)
	Steering gear relief valve..... set too low	Correct pressure to specifications
	Relief Valve in Pilot..... Manifold Block bypass	Reset or replace valve
	Relief Valve in Pilot..... Manifold Block set too low	Reset pressures to specifications
	Joystick not activating Circuit....	Check Pilot Pressure Check flow to control valve end cap joystick Repair or replace joystick
NO POWER		*See General - No Power*
	Relief Valve in Pilot..... Manifold set too low	Reset pressure to specifications
	Steering valve (upper)..... pressure set too low	Reset pressures to specifications
	Carrier Steering linkage..... adjusted incorrectly	Adjust linkage to specification
	"T" Box tight.....	Free up or replace
	Center Pin bypass.....	Reseal Center Pin
	Steering Gear relief valve..... set to low/bypass	Reset or replace Relief Valve
	Too low Engine R.P.M.....	Must be at high throttle

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Travel Circuit - Remote Mode

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION & HESITATION		*See General*
	Center Pin bypass.....	Reseal Center Pin
	Shuttle valve stuck not..... presurizing interface valve to release carrier brakes	Free up or replace shuttle valve
	Travel Joystick Valve not..... signaling main Control Valve plunger to shift (3W has Pedal)	Correct pilot Circuit
	Control Valve Circuit relief..... bypass or it is set too low.	Adjust or rebuild
	Brakes not releasing.....	See Brakes won't release problem
	Main or Auxiliary..... Transmission not engaged	Check for engagement
NO TRAVEL POWER		*See General - No Power*
	Control Valve Circuit relief..... bypass, or it is set too low.	Adjust or rebuild
	Wrong carrier transmission..... get selection	Shift to lower gear
	Travel motor bypass.....	Rebuild or replace motor
	Orifice check valves plugged.....	Remove restriction
CARRIER BRAKES WON'T RELEASE	Air Control Valve..... not receiving air.	Check Air Supply to the Push Valve on Interface Valve.
	Interface valve not shifting..... against air control valve	Correct alignment or clearance gap of cylinder
		Remove restriction in cylinder
		Free up or replace shuttle valve
		Check air flow to inversion valves
		Carrier inversion valves not shifting to allow air to escape from brake circuit
		Assure sufficient Air flow to Inversion Valve
		Free Plunger
		Replace Inversion Valve
		Check Inversion Valve Air Circuitry piped correct to specifications

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G3R Stabilizer Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION	Electrical switch malfunction.....	Change switch
	Solenoid or main control..... valve not activating	Run complete continuity check from switch thru slip ring to solenoid Replace solenoid Correct electrical problem
	Main control valve plunger..... not shifting	See plunger not shifting
	Relief valve bypass.....	Reseal or replace valve
	Relief valve pressure..... to low	Correct pressure setting to specifications
	Cylinder bypass.....	Reseal or replace cylinder
	Main pump bypass.....	Reseal or replace pump See general - no action
	Air pressure low.....	Correct pressure to specifications
MAIN CONTROL VALVE PLUNGER NOT SHIFTING	Solenoid not activating.....	Correct electrical problem Replace solenoid
	Air pressure low.....	Correct pressure to specifications
	Air pressure bypass..... at Control Valve	Correct air leaks
	Valve mounting bolts..... torque too high	Correct bolt torque to specifications
	Mechanical restriction..... in valve	Remove restriction Replace valve
	Relief valve bypass.....	Reseal or replace valve
	Relief valve setting..... too low	Correct setting to specifications
	Restriction in air/hydraulic..... feed lines	Remove restriction Replace line
CYLINDER DRIFT		See general - cylinder drift
	Check valve bypass.....	Replace check valve
	Cylinder bypass.....	Repack or replace cylinders
	Circuit partially open..... to pressure	Retime Control Valve plunger Replace control valve
SLOW CIRCUIT ACTION	Main Control Valve..... plunger not stroking fully	Remove restriction See Control Valve plunger not shifting section
	Engine RPM low.....	Correct rpm to specifications
	Cylinder bypass.....	Repack cylinder
	Relief valve bypass.....	Reseal or replace valve
	Relief valve setting low.....	Correct to specifications

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G3R Oscillaton Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
CIRCUIT WON'T LOCK IN DIGGING MODE	Solenoid valve malfunction	Replace solenoid Correct electrical problem (isolate by running continuity check)
	Cylinder bypass	Repack cylinder
CIRCUIT WON'T RELEASE FOR TRAVEL MODE	Solenoid valve malfunction	Replace solenoid Correct electrical problem (isolate by running continuity check)

G3R Steering Circuit

PROBLEM	PROBABLE CAUSE	REMEDY
NO ACTION	Pilot pump malfunction	Replace pilot pump
	Oil bypass in center pin	Reseal center pin
	Restriction in circuit hoses	Remove restriction
	Steering gear malfunction	Test Reseal gear Replace gear
	Steering cylinder bypass	Reseal cylinder
	Mechanical/Structural interference	Remove interference
	Relief in Pilot Block too low or bypass.	Adjust or rebuild
	Blocked circuit - hoses hooked up incorrectly	Hook up hoses to specifications
	Pilot manifold bypass	Reseal/replace manifold
	Flow divider (in pilot manifold) malfunction	Replace/repair flow divider
LOW POWER	Circuit relief valve pressure low	Correct to specifications
	Engine rpm low	Increase rpm
	Mechanical restriction	Remove restriction
	Circuit bypass	Reseal bypass area

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Trouble Shooting Joystick Controls (Monsun Tison HVP3)

Equipment

This leaflet
Precision gages 0-1000 psi (69 BAR) and 0-6000 psi (413.8 BAR)
Suitable tools for work with HVP3 and the directional control valve end caps.

Procedure

1. Check the input pressure to the HVP3, to be sure that correct input pressure is really available. The input pressure should read 400 psi (27.6 BAR) and should remain at that value when actuating several functions simultaneously. If not, there is either something wrong with the auxiliary pump or the pressure relief valve.

2. Now you can check the HVP3! Connect your gage (o-1000 psi) to the control lines between HVP3 and control object and check the output control pressure vs lever/pedal stroke as close to the control object as possible. Compare to the theorethical setting. A correct output pressure curve should look as follows:

   - At zero level stroke the output pressure should equal the pilot tank line pressure 40 psi (2.75 BAR).

   - At approx. 3,5° lever stroke, or 1,25mm plunger stroke the output pressure should equal “start Pressure” 70 psi (4.8 BAR).

   - For increasing stroke, the output control pressure should follow the lever (plunger) movement smoothly, up to “final pressure” 400 psi (27.6 BAR)

   If the output is not correct, the entire valve is best exchanged and returned to four nearest Monsun-Tilson representative for repair!

3. If you have not found anything wrong up to now, the error should be located in the main system. Look for

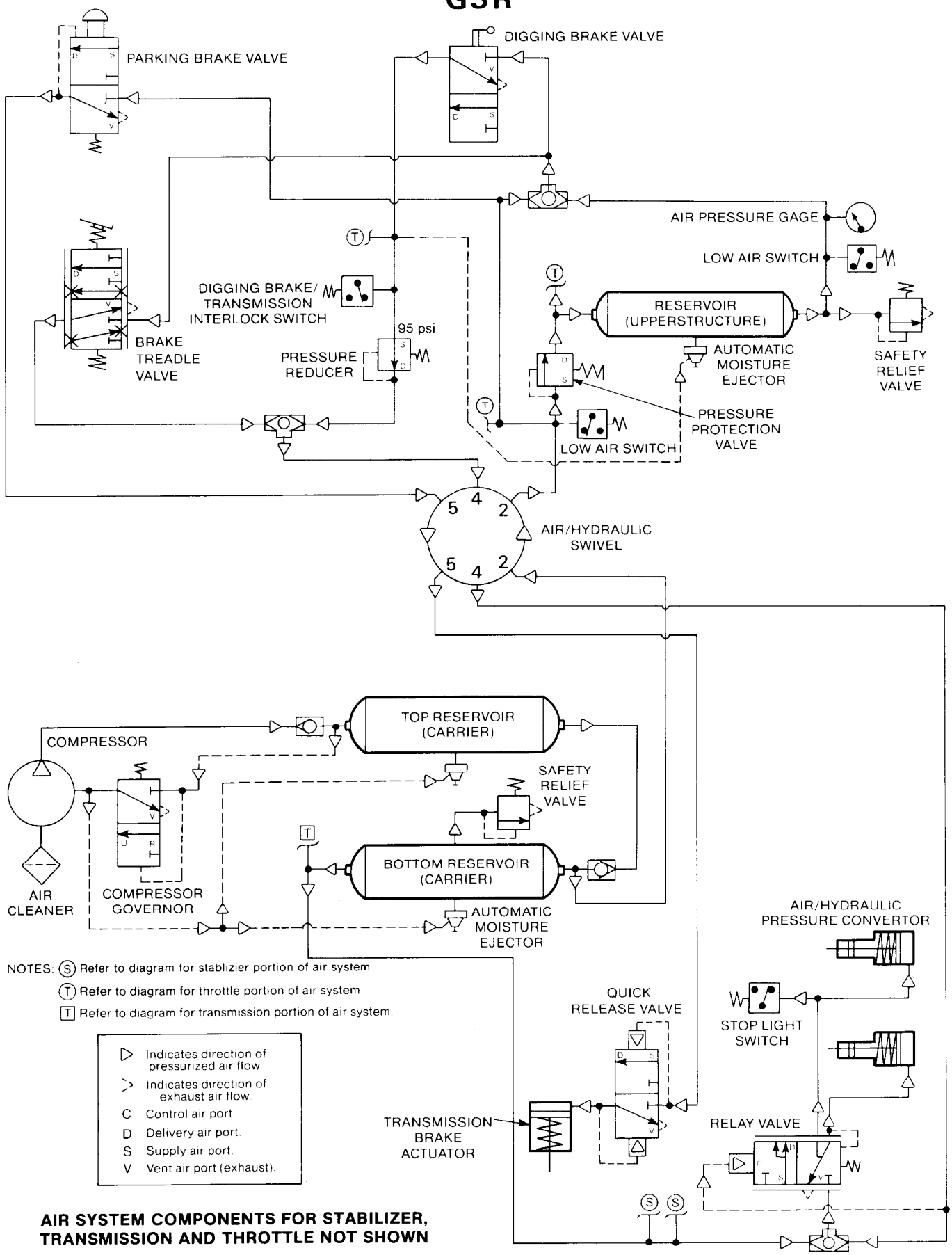
   Sticking main spools or spring packages
   Broken return springs
   Faulty shock valves or main relief valves
   Worn out main pumps or motors
   Broken cylinder seals
   And so on . . .

Monsun Tison ab
HK och fabrik: Viskastrandsgatan 10
Postadress: Fack, 501 01 Boras, Sverige
Telefon: 033-100 200. Telex: 360 79 hymotib s

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Brake Air Schematic Diagram
G3R



NOTES: (S) Refer to diagram for stablizier portion of air system
(T) Refer to diagram for throttle portion of air system.
[T] Refer to diagram for transmission portion of air system.

▷	Indicates direction of pressurized air flow.
>>	Indicates direction of exhaust air flow.
C	Control air port.
D	Delivery air port.
S	Supply air port.
V	Vent air port (exhaust).

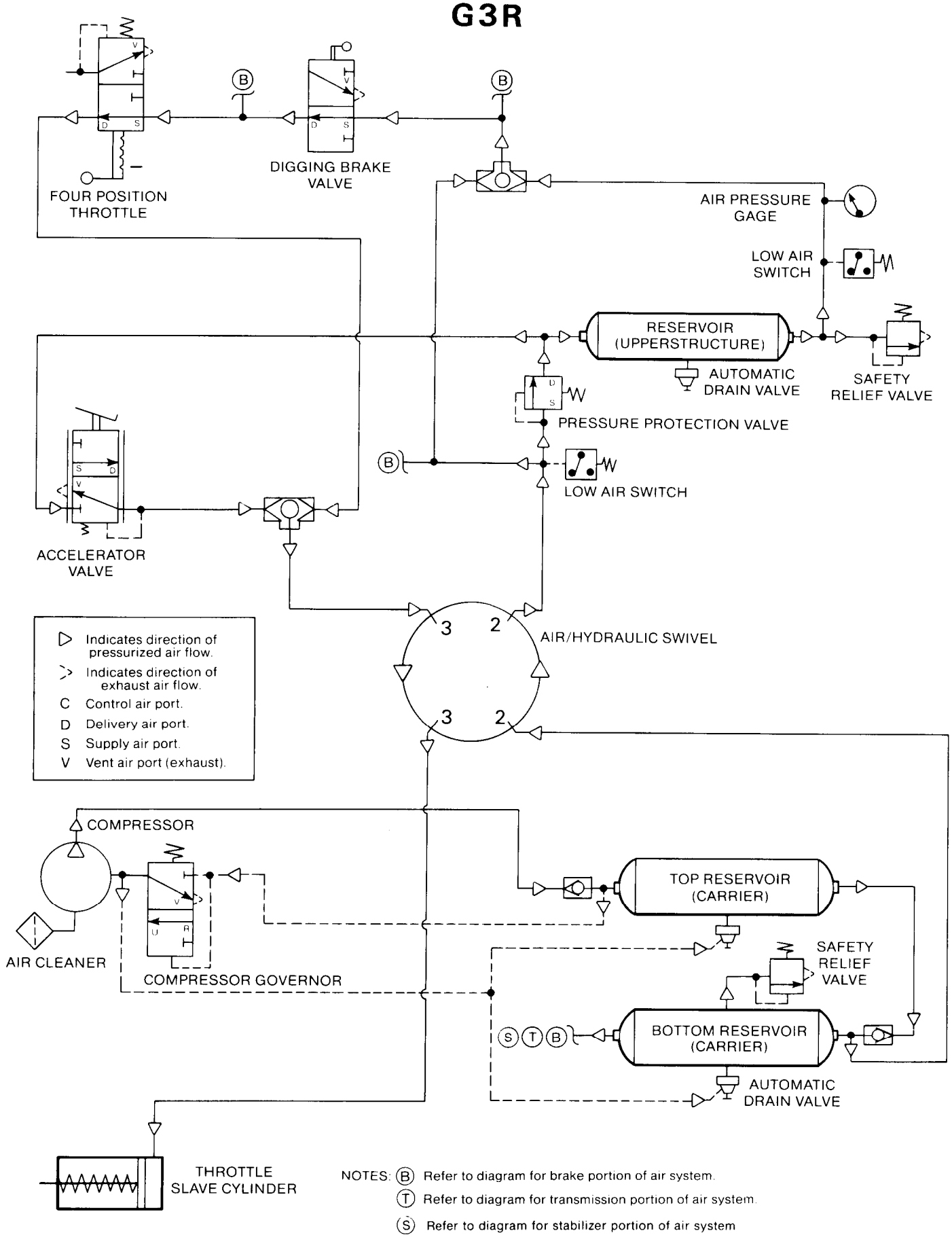
AIR SYSTEM COMPONENTS FOR STABILIZER, TRANSMISSION AND THROTTLE NOT SHOWN

Form No. 8105 Revised 4/62

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Engine Throttle Air Schematic Diagram
G3R

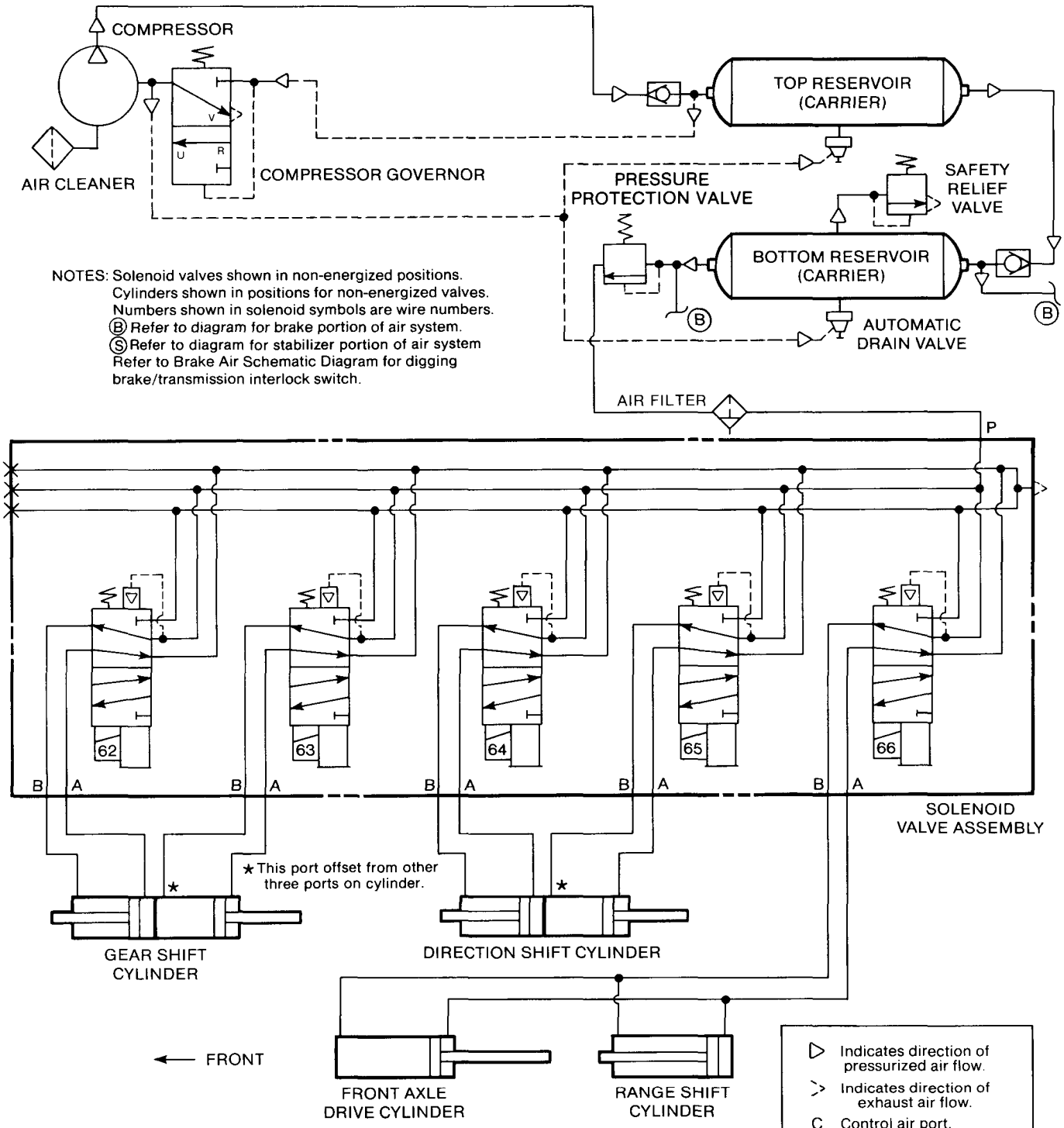


AIR SYSTEM COMPONENTS FOR BRAKES, STABILIZER AND TRANSMISSION NOT SHOWN

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Transmission Control Air Schematic Diagram



NOTES: Solenoid valves shown in non-energized positions.
Cylinders shown in positions for non-energized valves.
Numbers shown in solenoid symbols are wire numbers.
Ⓑ Refer to diagram for brake portion of air system.
Ⓢ Refer to diagram for stabilizer portion of air system
Refer to Brake Air Schematic Diagram for digging brake/transmission interlock switch.

GEAR SELECTION
1st Gear - Voltage at #62 - No voltage at #63
2nd Gear - No voltage at #62 or #63
3rd Gear - Voltage at #63 - No voltage at #62

RANGE SELECTION
Low Range - Voltage at #66
High Range - No voltage at #66

DIRECTION SELECTION
Forward - Voltage at #64 - No voltage at #65
Neutral - No voltage at #64 or #65
Reverse - Voltage at #65 - No voltage at #64

FRONT AXLE DRIVE SELECTION
Axle Engaged - Voltage at #66
Axle Disengaged - No voltage at #66

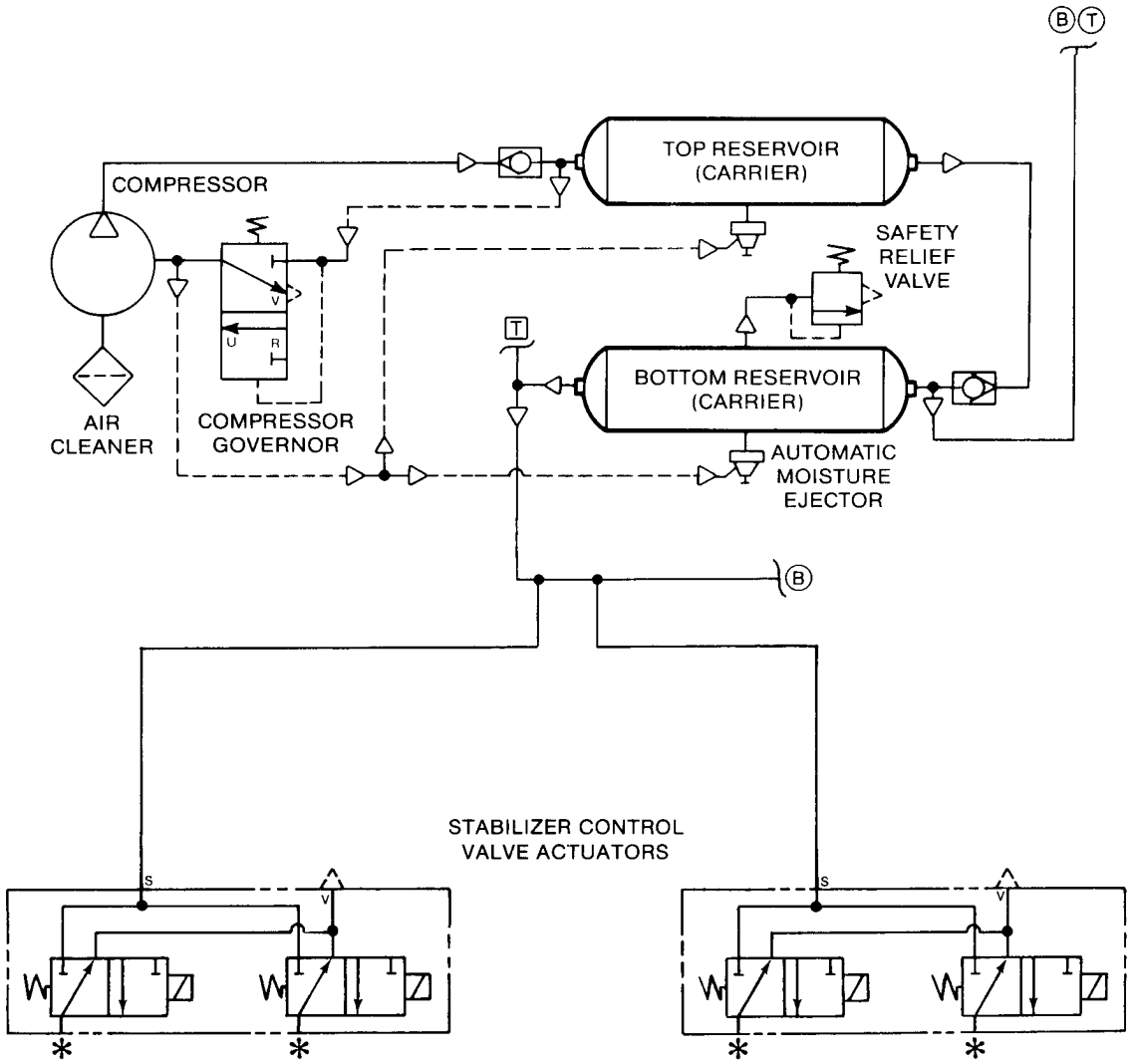
AIR SYSTEM COMPONENTS FOR BRAKES, STABILIZER AND THROTTLE NOT SHOWN

Form No. 8113 Revised 2/82

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Stabilizer Control Air Schematic Diagram



*Ported to end caps of stabilizer control valves

NOTES: (T) Refer to diagram for throttle portion of air system.
[T] Refer to diagram for transmission portion of air system.
(B) Refer to diagram for brake portion of air system

▷	Indicates direction of pressurized air flow.
>>	Indicates direction of exhaust air flow.
C	Control air port.
D	Delivery air port.
S	Supply air port.
V	Vent air port (exhaust).

AIR SYSTEM COMPONENTS FOR BRAKES, THROTTLE AND TRANSMISSION NOT SHOWN

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12-197

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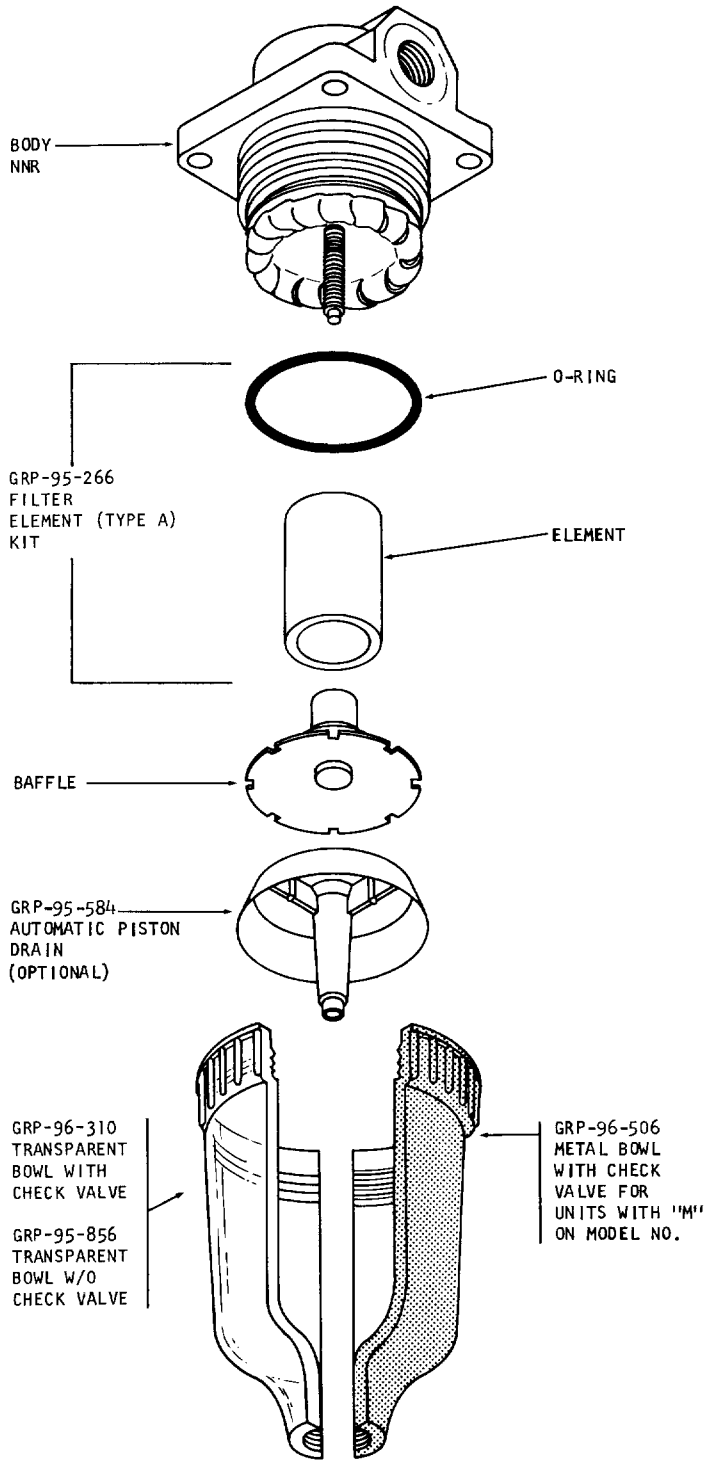
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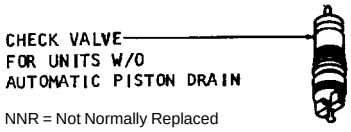
WILKERSON SERVICE MANUAL

FD-F00-9SM

REPLACES SERVICE MANUAL PAGES A14-1, B10-1C, B10-1D, BIO-1E, SM-1019, SMI-FOO, 9SM-BB-FOO, CJ-FOO-9SM and DE-FOO-9SM.

FILTER MODELS
F00-01-000 & FOO-02-000
WITH VARIATIONS AND ACCESSORIES





NNR = Not Normally Replaced

CAUTION

Certain compressor oils, chemicals, household cleaners, solvents, paints and fumes will attack plastic bowls and can cause bowl failure. Do not use near these materials. When bowl becomes dirty replace bowl or wipe only with a clean, dry cloth. Reinstall metal bowl guard or buy and install a metal bowl guard. Immediately replace any crazed, cracked, damaged or deteriorated plastic bowl with a metal bowl or a new plastic bowl and metal bowl guard.

SOME OF THE MATERIALS THAT WILL ATTACK POLYCARBONATE PLASTIC BOWLS

Acetaldehyde	Cresol	Methylene salicylate
Acetic acid (conc.)	Cyclohexanol	Milk of lime (CaOH)
Acetone	Cyclohexanone	Nitric acid (conc.)
Acrylonitrile	Cyclohexene	Nitrobenzene
Ammonia	Dimethyl formamide	Nitrocellulose lacquer
Ammonium fluoride	Dioxane	Phenol
Ammonium hydroxide	Ethane tetrachloride	Phosphorous hydroxy chloride
Ammonium sulfide	Ethyl acetate	Phosphorous trichloride
Antifreeze	Ethyl ether	Propionic acid
Benzene	Ethylamine	Pyridine
Benzoic acid	Ethylene chlorohydrin	Sodium hydroxide
Benzyl alcohol	Ethlene dichloride	Sodium sulfide
Brake fluids	Ethlene glycol	Styrene
Bromobenzene	Formic acid (conc.)	Sulfuric acid (conc.)
Butyric acid	Freon (refrigerant & propellant)	Sulphural chloride
Carbolic acid	Gasoline (high aromatic)	Tetrahydronaphthalene
Carbon disulfide	Hydrazine	Thiophene
Carbon tetrachloride	Hydrochloric acid (conc.)	Toluene
Caustic potash solution	Lacquer thinner	Turpentine
Caustic soda solution	Methyl alcohol	Xylene
Chlorobenzene	Methylene chloride	Perchlorethylene and others
Chloroform		

TRADE NAMES OF SOME COMPRESSOR OILS, RUBBER COMPOUNDS AND OTHER MATERIALS THAT WILL ATTACK POLYCARBONATE PLASTIC BOWLS.

Atlas "Perma Guard"	Parco #1306 Neoprene
Buna N	Petron PD287
Cellulube #150 and #220	Prestone
Crylex #5 cement	Pydraul AC
Eastman 910	Sears Regular Motor Oil
Garlock #98403 (polyurethane)	Sinclair oil "Lily White"
Haskel #568-023	Some Loctite Compounds
Hilgard Co.'s hil phene	Stauffer Chemical FYRQUEL #150
Houghton & Co. oil #1120, #1130 and #1055	Stillman #SR 269-75 (polyurethane)
Houtosafe 1000	Stillman #SR 513-70 (neoprene)
Kano Kroil	Tannergas
Keystone penetrating oil #2	Telar
Marvel Mystery Oil	Tenneco anderol #495 and #500 oils
Minn. Rubber 366Y	Titon
National Compound #N11	Zerex
"Nylock" VC-3	

WE CANNOT POSSIBLY LIST ALL HARMFUL SUBSTANCES, SO CHECK WITH A MOBAY CHEMICAL OR GENERAL ELECTRIC OFFICE FOR FURTHER INFORMATION ON POLYCARBONATE PLASTIC

CAUTION

Except as otherwise specified by the manufacturer, this product is specifically designed for compressed air service, and use with any other fluid (liquid or gas) is a misapplication. For example, use with or injection of certain hazardous liquids or gases in the system (such as alcohol or liquid petroleum gas) could be harmful to the unit or result in a combustible condition or hazardous external leakage. Manufacturer's warranties are void in the event of misapplication, and manufacturer assumes no responsibility for any resulting loss.

INSTALLATION

1. Refer to above warning.
2. Install as close as possible to point where air is being used.
3. Install the unit with the air flowing through the body in the direction indicated by the arrow.
4. Install a unit with the same pipe size as the line in use. Avoid using fittings, couplings,etc., that restrict airflow.
5. Mount the unit in vertical position.

Continue on reverse side.

WILKERSON CORPORATION
EAGLEWOOD, COLORADO 80150

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6. Do not install this unit in any application where pressure drop will exceed 20 psi. Downstream from a quick-opening valve, for example, could cause a momentary pressure drop in excess of 20 psi.

7. Maximum pressure and temperature ratings are: transparent plastic bowls, 150 psig (10,3 bar) and 125° F (51,7° C); metal bowls, 200 psig (13,8 bar) and 175° F (79,4¦° C).

MAINTENANCE

1. EACH TIME BOWL IS CLEANED OR THE FILTER ELEMENT REPLACED:
   A. Depressurize unit
   B. Inspect seals and replace crazed, cracked, damaged or deteriorated seals with original manufacturer's approved seals only.
2. **FILTER ELEMENT** - Clean periodically by removing filter, tapping on hard surface and blowing off with air blow gun. When cleaning or replacing element, blow off louvors with air blow gun.
3. **MANUAL DRAIN MODELS** - Drain sump whenever water can be seen in bowl by pushing up on the valve stem.
4. **AUTOMATIC DRAIN MODELS** - If automatic drain fails to keep bowl sufficiently drained of water, use a pencil or small screwdriver to push the piston up, allowing sediment or water to drain from bowl.
5. **TO CONVERT MANUAL DRAIN FILTER TO AUTOMATIC DRAIN -** The automatic piston drain accessory may be installed by removing the check valve, unscrewing the bowl and placing the piston in the bowl. The automatic drain requires at least S scfm at 10 psig to visibly raise the piston. The unit will self-drain even at I scfm at 40 psig.
6. Before placing unit in service, be sure the integral bowl/bowl guard is securely reinstalled.

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AUSCO®

"B" SERIES
FAILSAFE BRAKE

27798 32420
30188 32550
31131 33925
32040 34064

BRAKE FUNCTION

The Failsafe Brake is spring loaded to apply the brake and hydraulic pressure is required to release or "hold off" the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the release pressure of the brake, will cause a brake application.

The brake is designed to fit with a gear reducer and a hydraulic motor. The common mounting surfaces of the brake, the motor, and the gear reducer are machined to close tolerances and should be protected from damage during installation and removal.

INSTALLATION INSTRUCTIONS (Ref: Fig. 1)

1. Place the gasket onto the mounting face of the brake.
2. Place the brake shaft into the gear reducer with the brake bleeder screw in the vertical position.
3. Move the brake into position with gear reducer assuring proper gasket location. Align the mounting bolt holes by rotating the engaged brake into position. If this is not possible, the brake may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Similarly place a gasket onto the flange of the motor.
5. Insert the shaft of the motor into the brake and push into position, assuring proper gasket location.
6. Insert the two half-inch bolts (Grade 5) thru the motor flange, the gasket, the brake, the second gasket, and into the threaded hole in the gear reducer mounting flange. Insure that the bolts are not too long so that they do not bottom out in the reducer before clamping.
7. Run bolts in alternately to prevent binding, until snug. Then torque the bolts to 75-85 lb.ft.
   Note: Both Shafts must slide together freely - DO NOT use bolts to force the units together.
8. With motor and brake bolted into position, remove cap plug and connect "inlet" hydraulic line to brake. (If not done for shaft alignment - Step 3). Brake Inlet is .250 tubing O.D., Straight thread O-ring boss (.438-20, UNF 2B Thd.)
9. Bleed air from brake via bleeder screw.
   Note: Maximum pressure to brake is 3000 psi.

BRAKE DISASSEMBLY PROCEDURE: (Ref: Fig. 2)

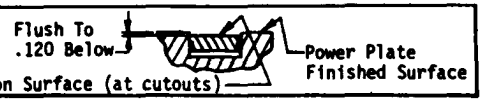
1. With shaft protrusion downward, disassemble in the following order:
2. Bolts (24) alternately, Power Plate (22), O-ring (6), Stationary Discs (15), Springs (13), Rotating Discs (14), Primary Disc (12), Pins (11), Springs (8 & 9), Spring Retainer (7).
3. Further disassembly is not recommended and should not be attempted unless necessary for the replacement of specific parts, i.e., Snap Rings (1 & 2), Bearing (4) and Shaft (10) from Housing (5), if necessary: proceed as follows:
   A) Remove Snap Rings (1 & 2), then Shaft (10) with Bearing (4) by lightly tapping the shaft with a plastic mallet. 32040 Brake only: Remove O-ring (3).
   B) Remove Shaft from Bearing by supporting the inner race of the bearing and applying pressure to the shaft.
4. Remove the Piston (16) from the Power Plate (22) by introducing low pressure air - 15 psi - into the hydraulic inlet. Make sure piston is directed away from the operator. Remove O-rings (18 & 20), and Back-up Rings (17 & 19) from the piston O.D. and I.D. grooves. Back-up Rings will be damaged and should not be removed if replacement is not planned.

ASSEMBLY

Use the reverse of the disassembly procedure with the following note and additions:

1. Worn O-rings and damaged or worn teflon back-up rings must be replaced prior to reassembly.
2. Cylinder of the Power Plate, Piston and O-rings must be clean prior to assembly, and pre-lubed with the system hydraulic fluid.
3. Assemble Piston (16) into Power Plate (22) using a shop press, being careful not to damage the O-rings or teflon back-up rings. Visually align the center of the cut-outs in the Piston with the Torque Pin (11) holes in the Power Plate (22).

Depth of piston installation into the power plate is critical. Do not exceed .120 depth.



4. Rotating Discs must be clean and dry. There should be no presence of oil on any lining material or mating surfaces of the Stationary Discs.
5. Alternately tighten bolts (24) and torque them to 50-60 lb.ft.

SERVICE KITS:

The following kits are available as service items. All other parts may be ordered individually.

	BRAKE ASSEMBLY				
	27798 30188 33925 34064	32040	32420	31131	32550
O-Ring Kit Consists of Items 3, 6, 17, 18, 19, 20	PK 661	PK 729	PK 661	PK 661	PK 661
Stack Kit Consists of Items 8, 9, 11, 12, 13, 14, 15	PK 662	PK 662	PK 728	PK 735	PK 758
Bearing Kit Consists of Items 1, 2, 4	PK 663	PK 663	PK 663	PK 727	PK 663
Gasket Kit Consists of Item 25	PK 664	PK 664	PK 664	PK 664	PK 664

Gradall models G3R and G3W use brake 32420.

Auto Specialties Manufacturing Co.
St. Joseph, Michigan 49085 • Phone 616/983-2373

Printed in U.S.A.

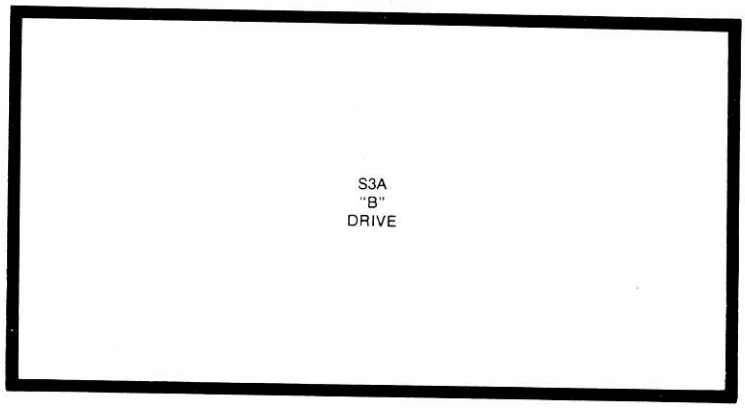
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Torque-Hub® Final Drives

Service Manual



Fairfield Manufacturing Company, Inc.
South Concord Road, Lafayette, Indiana 47902, U.S.A. 317/474-3474

Fairfield

THE DRIVE PEOPLE

https://truckmanualshub.com/

Introduction

This Service Manual is a step-by-step guide designed for the customer or shop mechanic who is servicing or repairing a particular model of Torque-Hub Final Drive. (The model covered by this copy of the Manual is specified on the Manual cover.)

Included are -

1. assembly and exploded view drawings
2. disassembly procedure
3. main assembly procedure (assuming all sub-assemblies to be intact)
4. sub-assembly procedures.

At the time of printing, this Manual was complete for the specific Torque-Hub model designated. However, Fairfield Manufacturing Co., Inc., reserves the right to update and improve its products at any time. All specifications and procedures are therefore subject to change without notice.

Safety

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn; heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see a caution symbol () . This symbol indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

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S3A-B Drive Disassembly Procedure

1. Loosen all 12 Cover Bolts [4 Shoulder Bolts (18), 8 Grade 8 (17)] and drain the oil from the unit.

2. Remove the 12 Cover Bolts and lift off the Cover (6). Discard the ‘O’ Ring Seal (5) from the Cover (6) counterbore.

   Remove Thrust Washer (8) from counterbore of the inside face of the Cover (6).

3. Lift out the Carrier Sub-Assembly (3A) and Thrust Bearing Set (15 & 16). A Thrust Washer (15) may stick inside the Cover (6).

4. Pry or tap the Ring Gear (4) loose and remove it. Discard the ‘O’ Ring Seal (5) from the Hub (1G) counterbore.

5. Remove the Input Gear (13).

6. Lift out the Internal Gear (2) and Thrust Bearing Set (15 & 16). A Thrust Washer (15) may stick to the bottom of the Carrier (3A).

7. Remove the Retaining Ring (1l) from the Output Shaft (1A) and discard; Remove Bearing Shim (1H) from the Output Shaft (1A).

⚠ Eye Protection should be worn during Retaining Ring removal

8. The Output Shaft (1A) may now be pressed out of the Hub (1G).

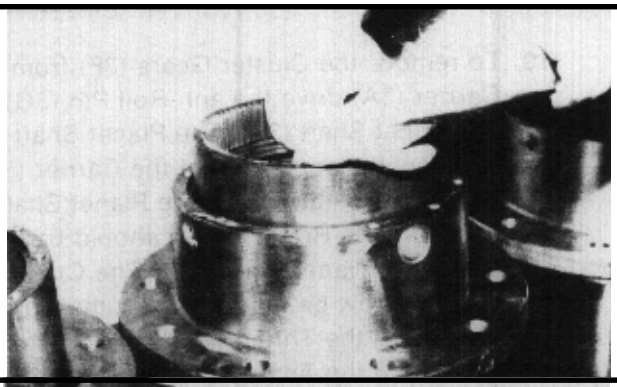
9. The Bearing Cups (1C) & (1E) will remain in Hub (1G) as will Bearing Cone (1F). Bearing Cone (1D) will remain on the Output Shaft (1A). Seal (1B) will be automatically removed during this procedure.

Note: If bearing replacement is necessary, the Bearing Cups (1C & 1E) can be removed with a “slide hammer puller’’ or driven out with a punch.

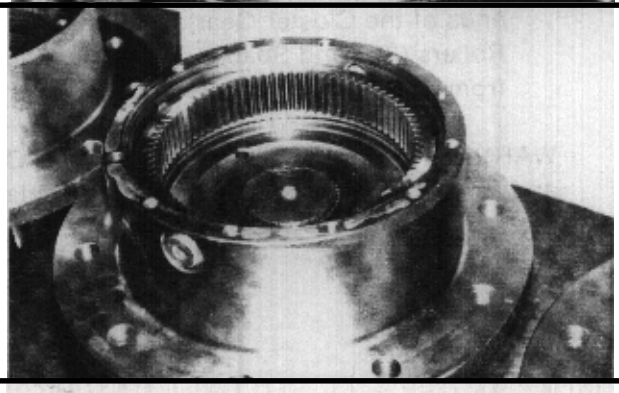
10. To remove the Cluster Gears (3F) from the Carrier (3A) drive the anti-Roll Pin (3G) into the Planet Shaft (3E). The Planet Shaft (3E) can now be tapped out of the Carrier (3A) and Cluster Gear (3F). After the Planet Shaft (3E) is removed, the Roll Pin (3G) should be driven out of the Planet Shaft (3E). The Cluster Gear (3F) can now be removed from the Carrier (3A) along with the Thrust Washer (3B). After separating the Thrust Washers (3B) from the ends of the Cluster Gear (3F), the Needle Rollers (3C) and Spacer (3D) can be removed from the Cluster Gear (3F) bore.

WARNING: When rebuilding the unit, the ‘O’ Rings and Retaining Rings should always be replaced.

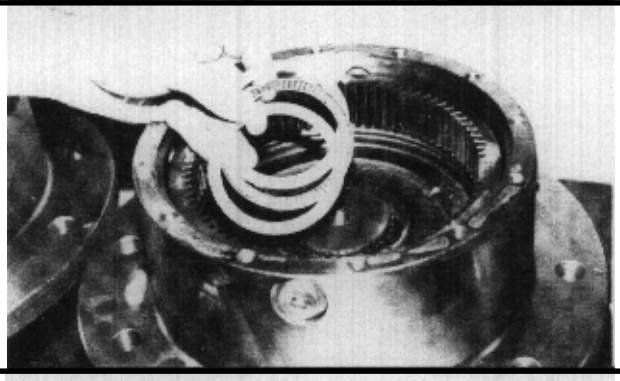
Main Assembly Procedure



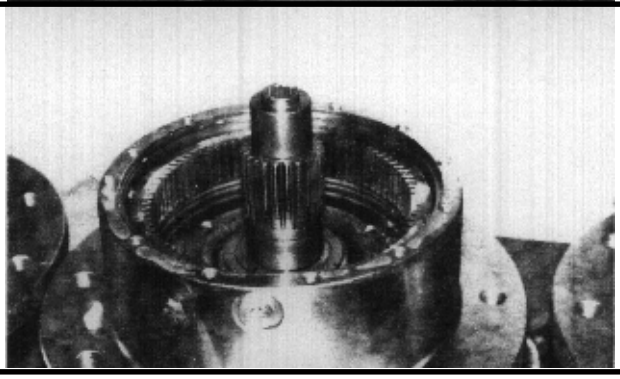
1. With the Hub Shaft Sub-assembly resting on the Shaft (1A) install Internal Gear (2). The Spline of the Internal Gear (2) bore will mesh with the Spline of the Output Shaft (1A).



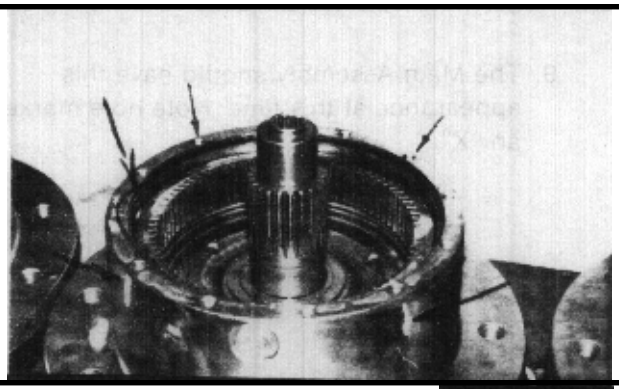
2. Inspect the location of the Internal Gear (2) on the Output Shaft (1A). The portion of the Output Shaft (1A) which does not have full Spline should protrude through the Internal Gear (2) bore.



3. The 2 Thrust Washers (15) and 1 Thrust Bearing (16) are installed on that portion of Output Shaft (1A) which protrudes through Internal Gear (2).



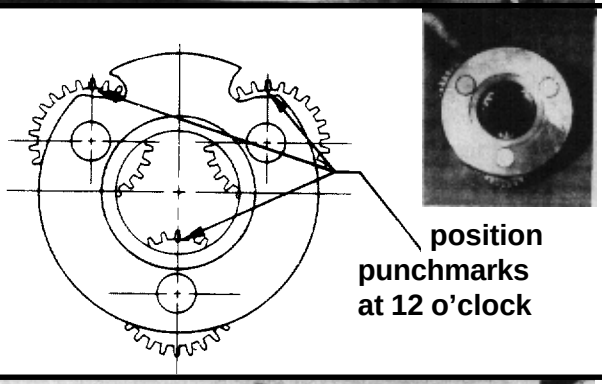
4. The Input Gear (13) is now located and centered large diameter down on the internal end of Output Shaft (1A).



5. Place “O” Ring (5) into Hub counterbore. Use petroleum jelly to hold “O” Ring in place.

   ⚠ Beware of sharp edges of the counterbore while seating this “O” Ring.

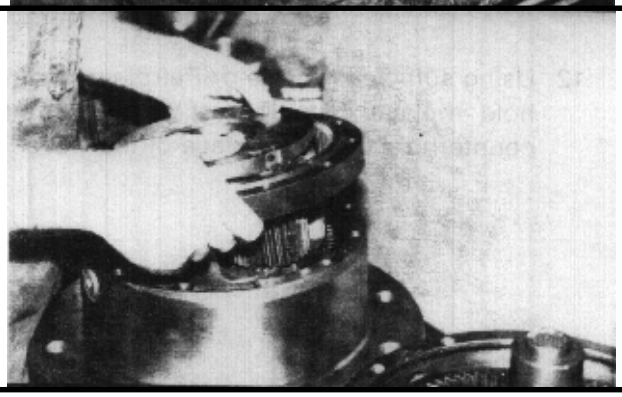
   Also at this time locate and mark the 4 counter reamed holes in the face of the Hub (1G). This is for identification later in the assembly.



6. Place Carrier Assembly on a flat surface with the large gears up and positioned as shown. Find the punch marked tooth on each large gear and locate at 12 o’clock (straight-up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears.

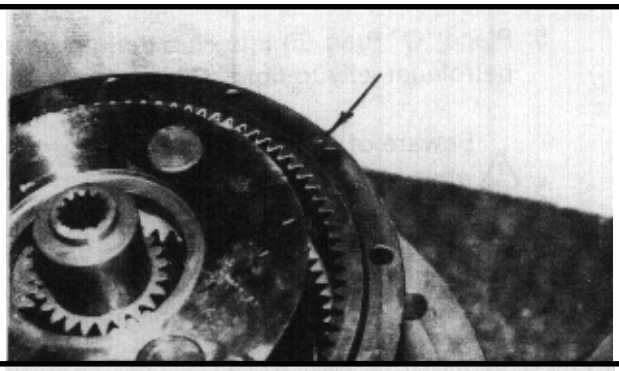


7. With large shoulder side of Ring Gear (4) facing down, place Ring Gear (4) over (into mesh with), large gears. Be sure that punch marks remain in correct location during Ring Gear (4) installation. The side of the Ring Gear (4) with an “X” stamped on it should be up.

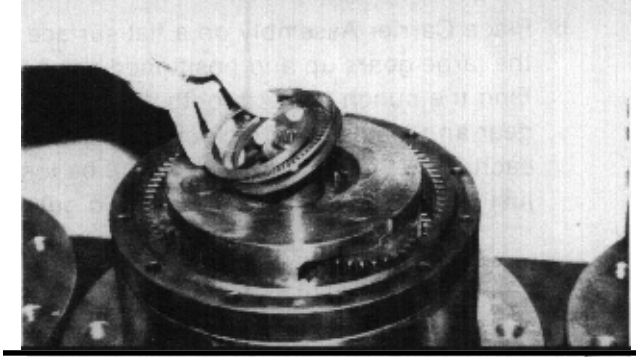


8. While holding Ring Gear (4) and Cluster Gears (3F) in mesh, place small side of Cluster Gears (3F) into mesh with the Internal Gear (2) and Input Gear (13). On the Ring Gear (4) locate the hole marked “X” over one of the marked counterbored holes (Step 5) in Hub (1G).

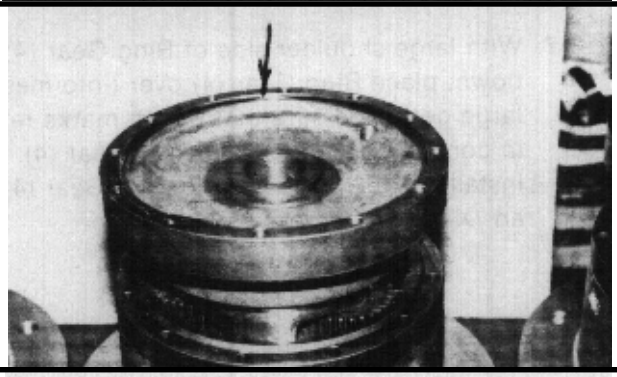
Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



9. The Main Assembly should have this appearance at this time. Note hole marked with an “X”.

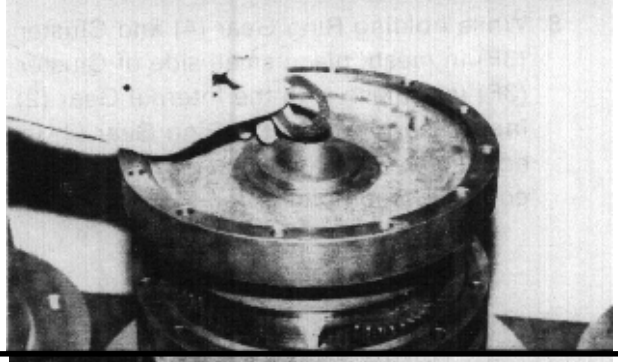


10. Another Thrust Washer (15)/Thrust Bearing (16) set is now installed into the counterbore in the face of the carrier. Use grease or Petroleum jelly to hold in place.

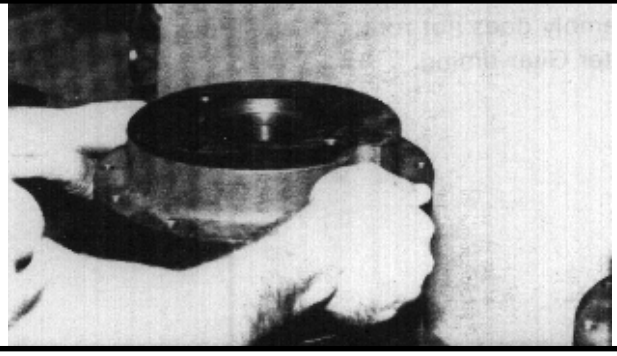


11. Place “O” Ring (5) into Cover (6) counterbore. Use grease or petroleum jelly to hold “O” Ring in place.

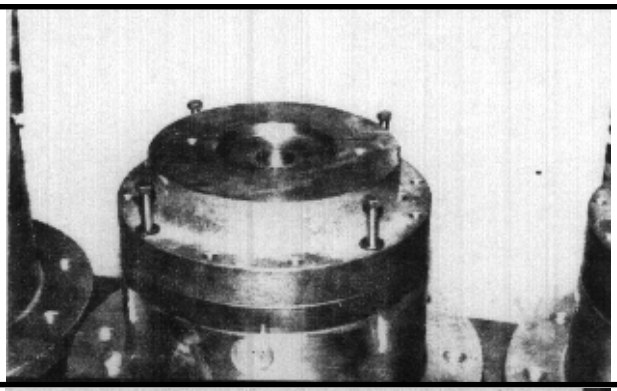
⚠ Beware of sharp edges of the counterbore while seating this “O” Ring.



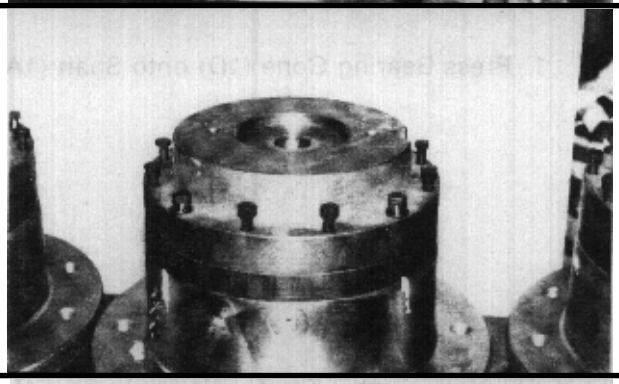
12. Using sufficient grease or Petroleum jelly to hold in place, install Thrust Washer (8) into the counterbore of the interface of the Cover (6).



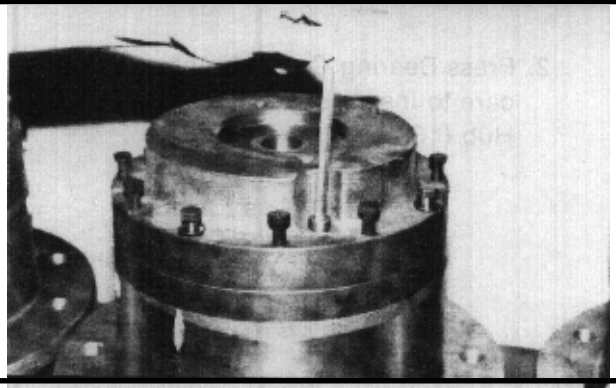
13. The Cover (6) is now installed, taking care to correctly align Pipe Plug Hole (20) with those in the Hub (1J), usually 90° to one another.



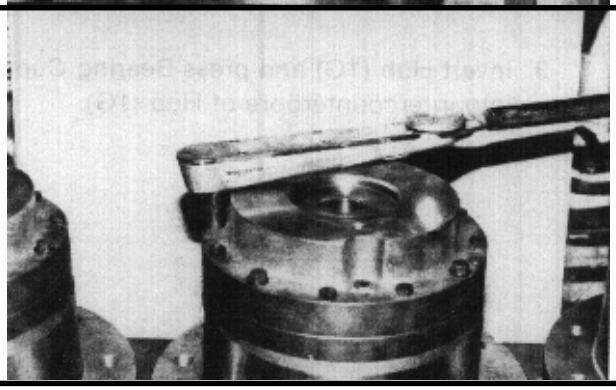
14. Locate the 4 counterbored holes in Hub (1G) [marked in Step 5] and install 4 Shoulder Bolts (18) with Lockwashers (19). A slight tap with a hammer may be necessary to align Shoulder Bolt with Hub (1G) counterbore.



15. Install regular Grade 8 Bolts (17) with Lockwashers (19) into remaining holes.



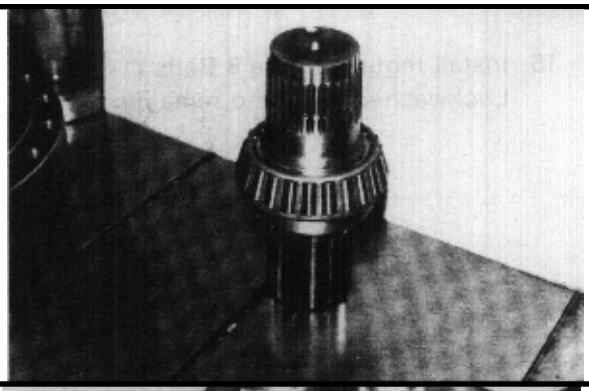
16. Pipe Plugs (20) are to be installed into Cover (6) using a lubricant seal of some sort.



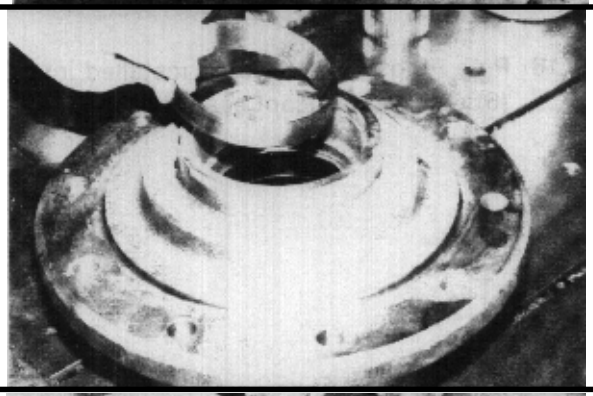
17. Torque Shoulder Bolts (18) to 43-47 ft.-lbs. and regular Grade 8 Bolts (17) to 43-47 ft.-lbs.

This completes the assembly. The unit must be filled one-half full of EP 90 lubricant before operation if the unit is mounted horizontally and completely filled if mounted vertically. In vertical mounting application circulation cooling of the oil is recommended.

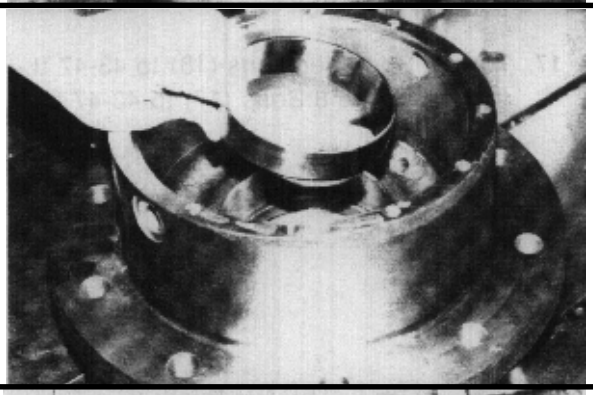
Hub Shaft Sub-Assembly



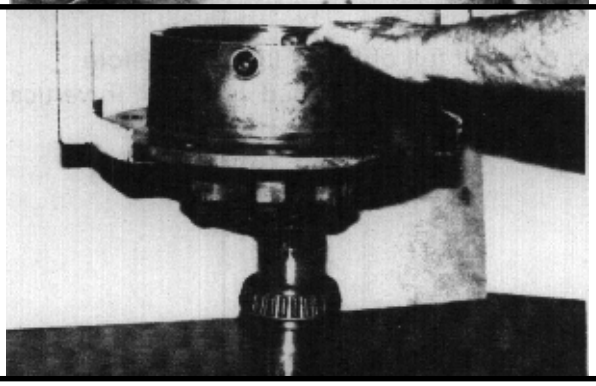
1. Press Bearing Cone (1D) onto Shaft (1A).



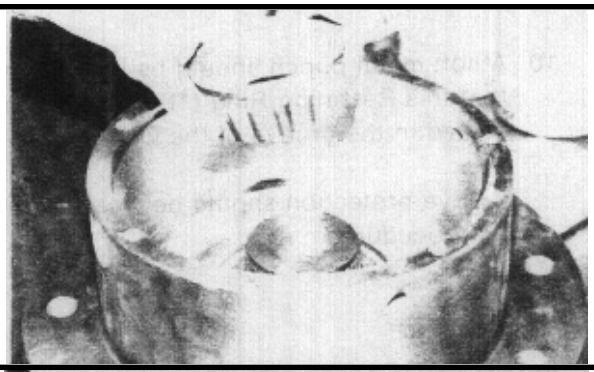
2. Press Bearing Cup (1C) into Hub (1G) taking care to insure cup start square with the bore of Hub (1G).



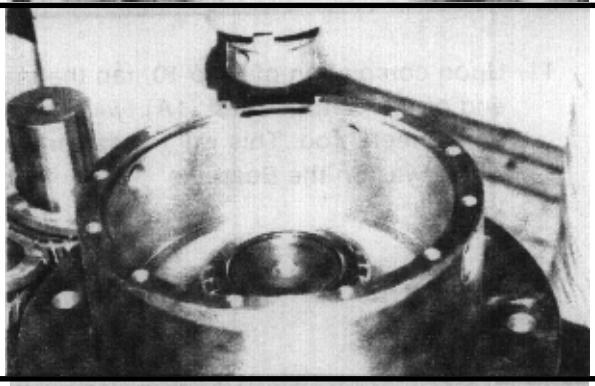
3. Invert Hub (1G) and press Bearing Cup (1E) into intercounterbore of Hub (1G).



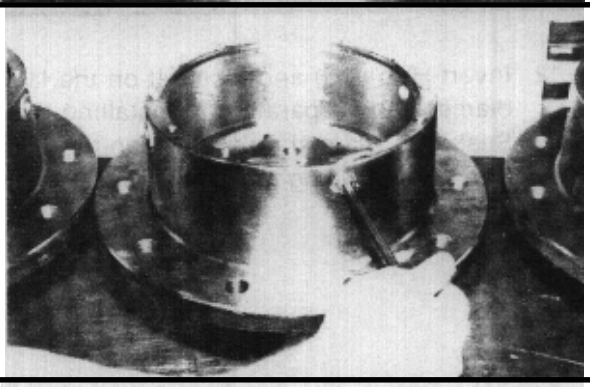
4. The Hub (1G) is now carefully lowered on to the output shaft (1A).



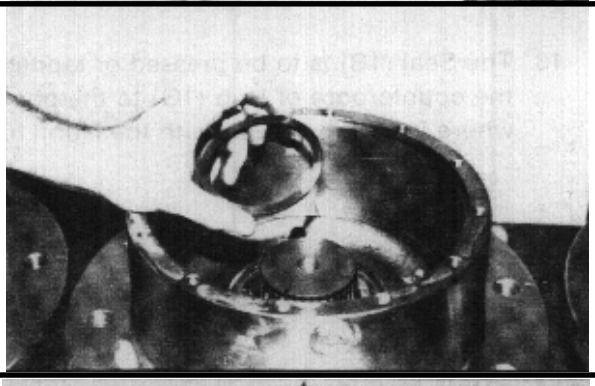
5. Bearing Cone (1F) is started on to the Output Shaft (1A).



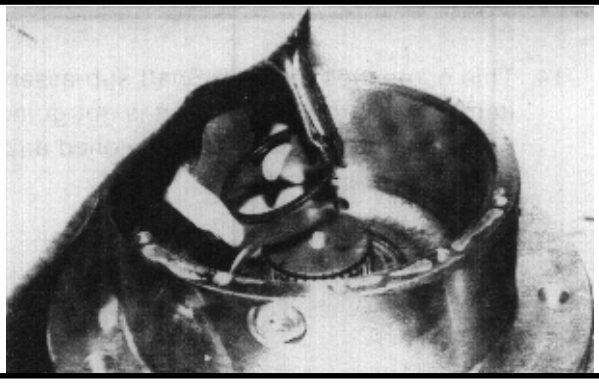
6. The Bearing Cone (1F) is an interference fit and has to be pressed or tapped on.



7. Pipe Plugs (1J & 1K) should be checked and/or installed using a lubricant seal.

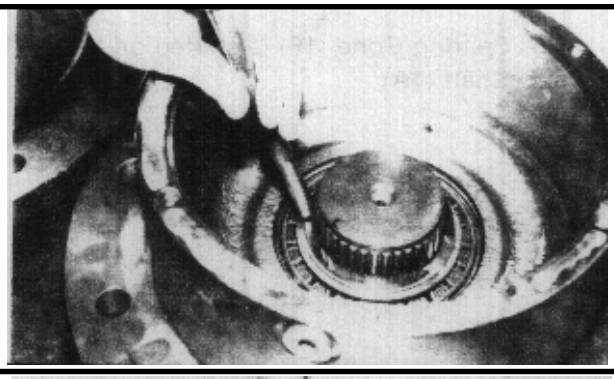


8. Bearing Spacer (1H) is installed around the Output Shaft (1A) and locates on Bearing Cone (1F).



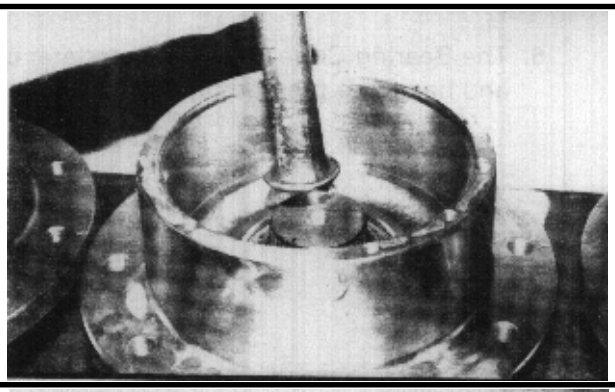
9. Retaining Ring (11) installed into the groove provided in the Output Shaft (1A). This Retaining Ring (1I) should never be reused in a repair or rebuild.

⚠ Eye protection should be worn during this procedure.

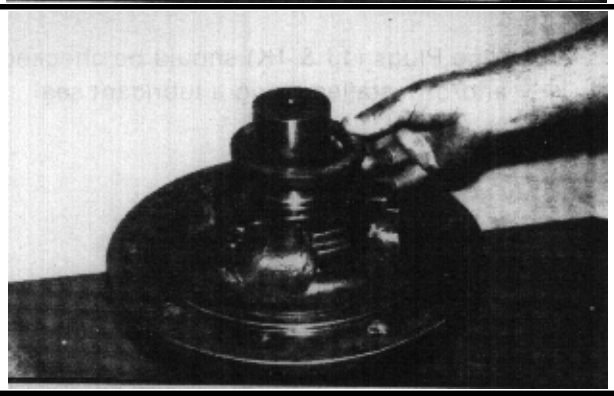


10. A soft metal punch should be used to insure that this Retaining Ring (1I) is completely seated in the groove of the Output Shaft (1A).

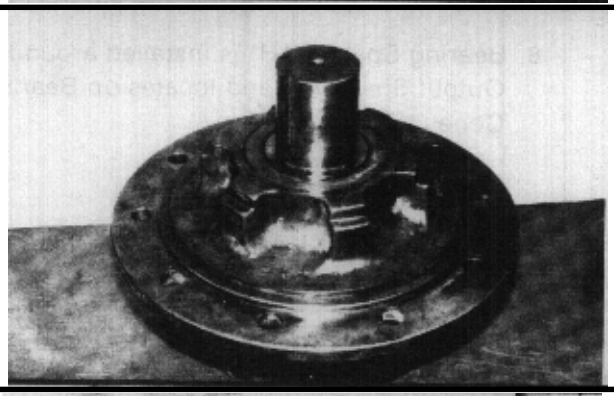
⚠ Eye protection should be worn during this procedure.



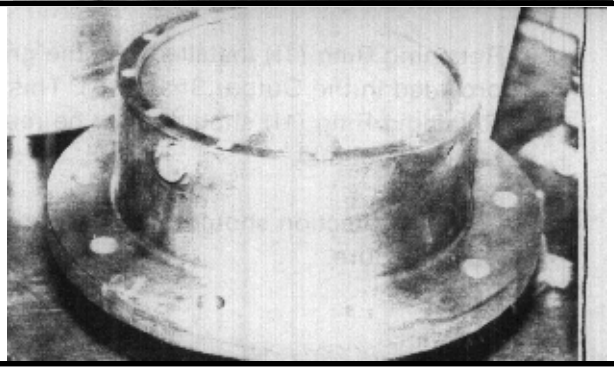
11. Upon completion of Step 10, rap the internal end of the Output Shaft (1A) twice with a piece of soft metal rod. This will release any preload which was on the Bearings.



12. Invert Hub (1G) and locate it on the large diameter in preparation of installing the Seal (1B). Care should be taken to insure Seal (1B) is being correctly installed (smooth face up).

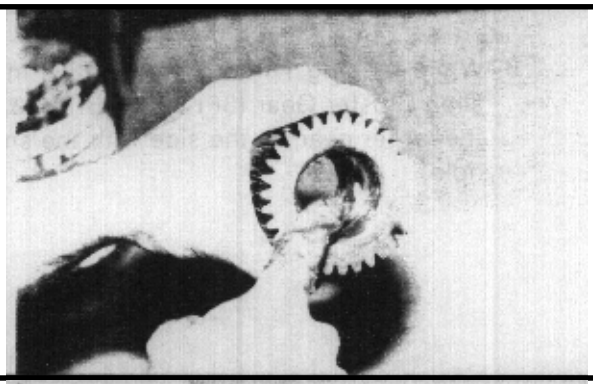


13. The Seal (1B) is to be pressed or tapped into the counterbore of Hub (1G) to the point where it becomes flush with the Hub (1G) face.

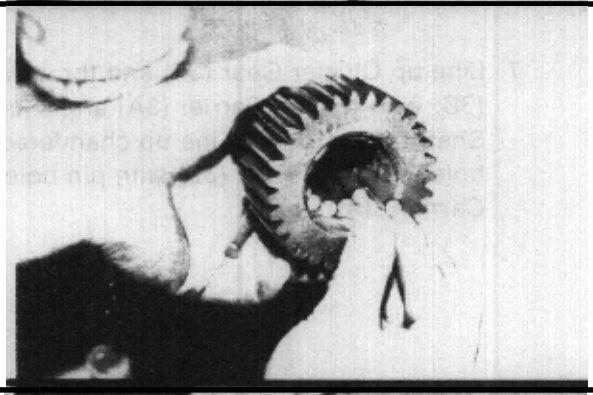


14. This completes the Hub Shaft sub-assembly - items (1A) through (1K.) If it is not going to be used immediately, it should be oiled and covered to help prevent rusting.

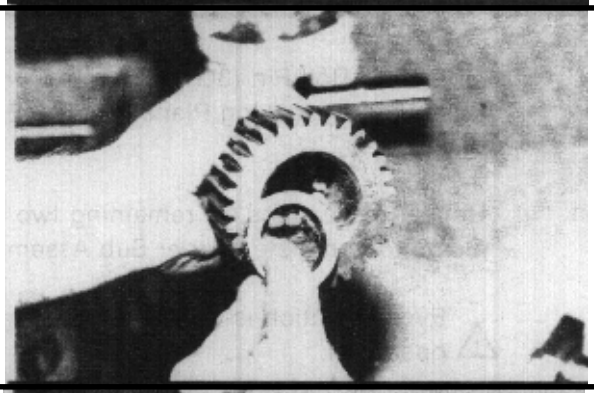
Carrier Sub-Assembly



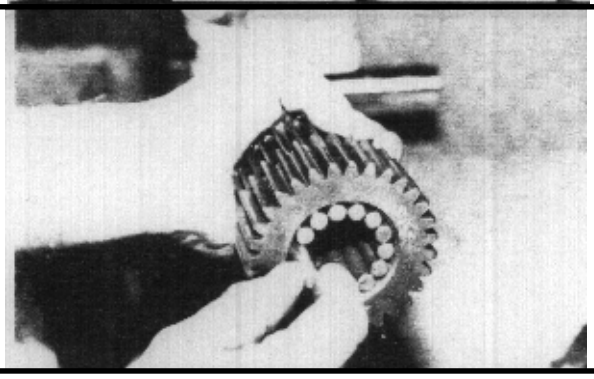
1. Apply a coat of grease or petroleum jelly to Cluster Gear (3F) bore.



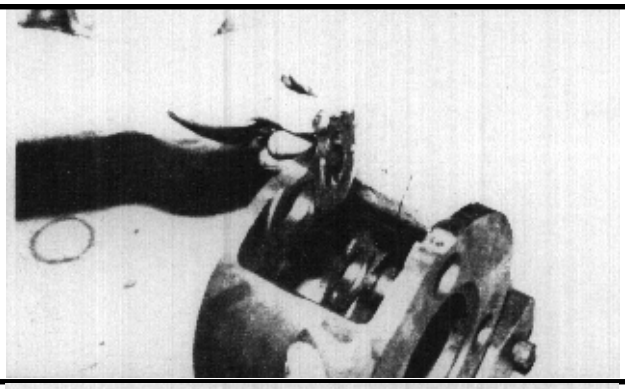
2. Place fourteen Needle Rollers (3C) into Cluster Gear (3F) bore.



3. Place Spacer washer (3D) into opposite side of Cluster Gear (3F) and against Needle Rollers (3C).

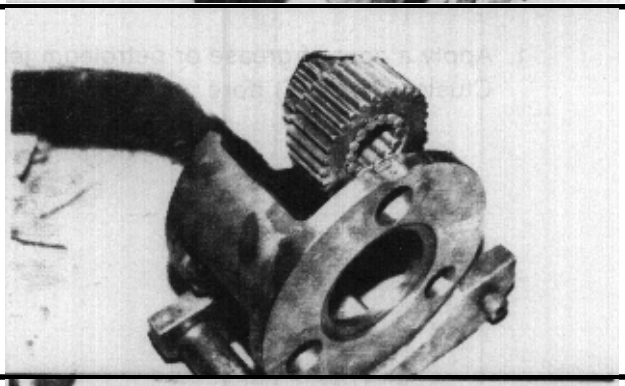


4. Place second set of fourteen Needle Rollers (3C) into Cluster Gear (3F).

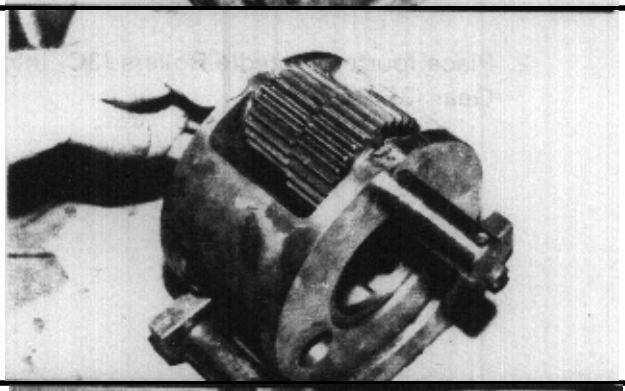


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers (3B). Place Thrust Washers (3B) against bosses in Carrier (3A) with washer tang fitting into slot in Carrier outside diameter.

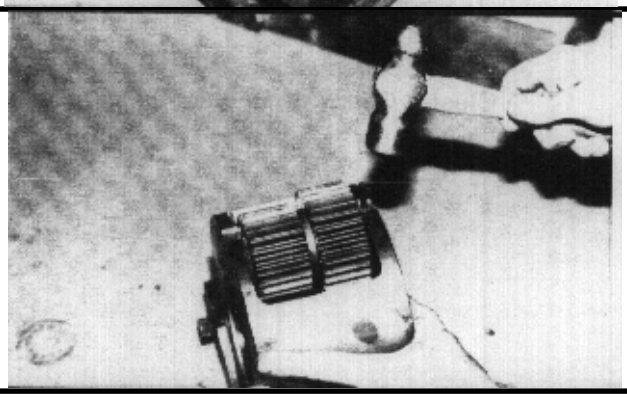
   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.



6. While keeping Thrust Washers (3B) in place, slide Cluster Gear (3F) into Carrier (3A) with the larger gear on the side with the small pin hole.



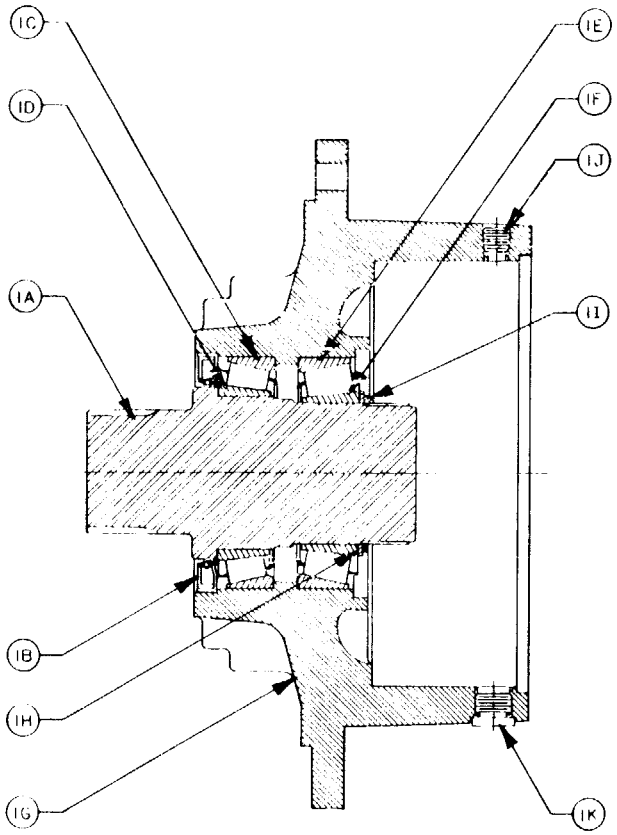
7. Line up Cluster Gear (3F) and thrust Washers (3B) with hole in Carrier (3A) and slide Planet Shaft (3E) through. Line up chamfered side of hole in Planet Shaft (3E) with pin hole in Carrier (3A).



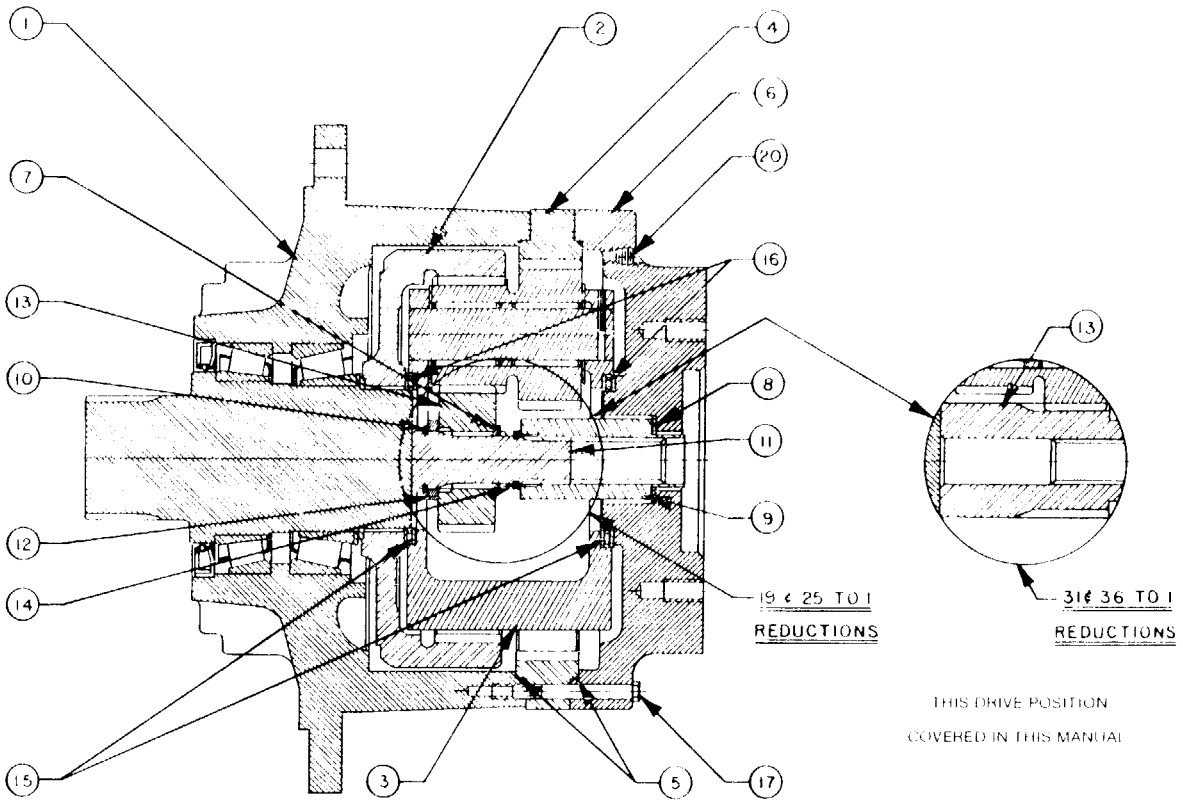
8. Drive Anti-Roll Pin (3G) flush into Carrier (3A) hole, thereby locking Planet Shaft (3E) into place.

   Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.

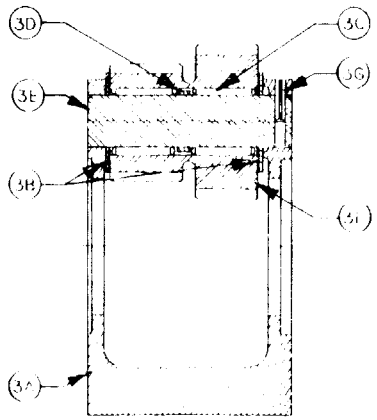
   ⚠ Eye protection is to be worn during this operation.



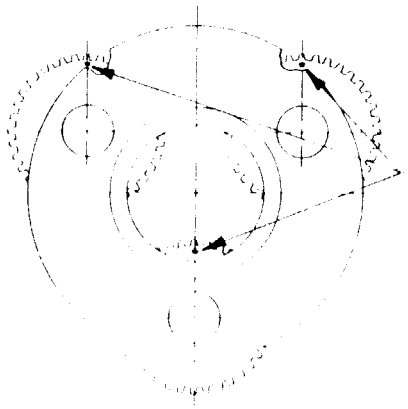
HUB SHAFT SUBASSEMBLY

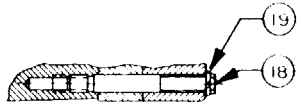


COMPLETE ASSEMBLY



CARRIER SUBASSEMBLY

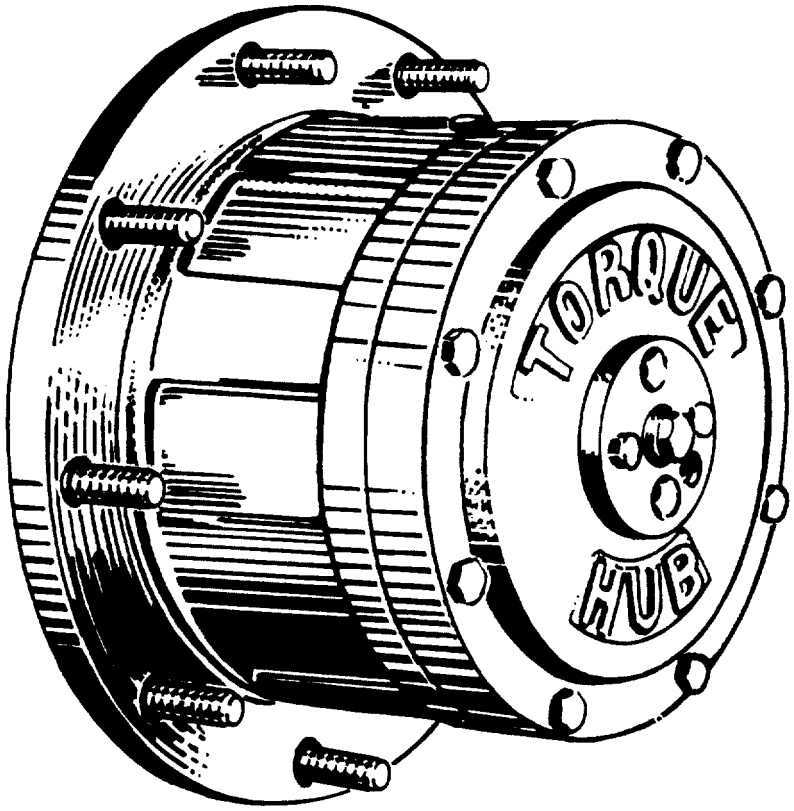




VIEW OF SHOULDER BOLT

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INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive. Users of this manual should note that each part mentioned is followed by an indentification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit. A print of each tool discussed in this manual is shown in the Tooling section. Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following two pages before getting started.

This manual includes the following sections.

1. Roll and Leak Testing Procedures

2. Bolt Tightening and Torquing Procedures

3. Disassembly Procedures

4. Sub-Assembly Procedures

5. Main Assembly Procedure

6. Drawings of all Essential Tools

7. Parts List

8. Cross-Sectional View of the Unit

SAFETY

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn. Heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see the word CAUTION. This indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

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ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

THE ROLL TEST

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

THE LEAK TEST

The purpose of a leak test is to make sure that the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskits are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskits meet the exterior of the unit then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gaskit, the part must be replaced.

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TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that bolts are not tightened beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts, all shoulder bolts should be tightened by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head cap screws in a bolt circle.

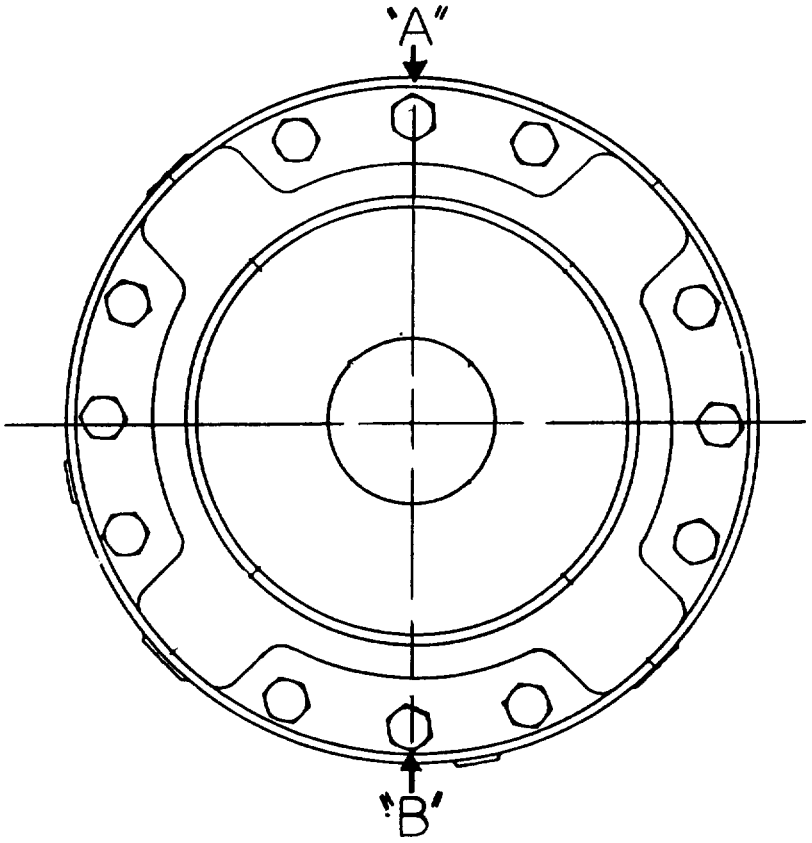
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

3. Continue around the bolt circle and tighten the remaining bolts.

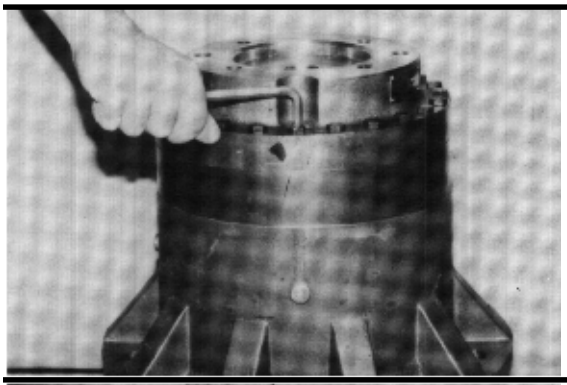
4. Now use a torque wrench to apply the specified torque to bolt "A"

5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



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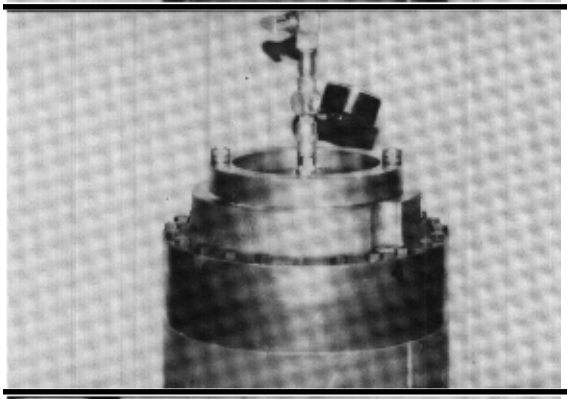
MAIN DISASSEMBLY



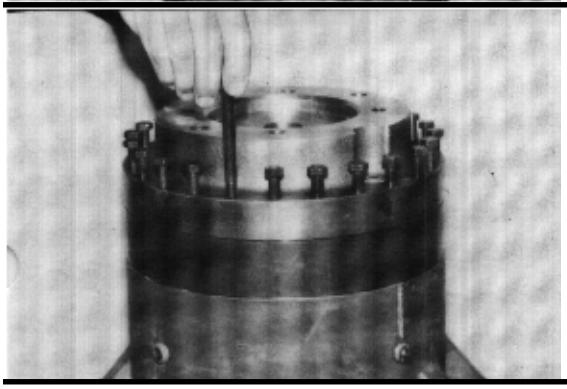
1. Remove **pipe plug (15)** from **cover(6)** and drain the oil from the unit.



2. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the ID tag of the unit.

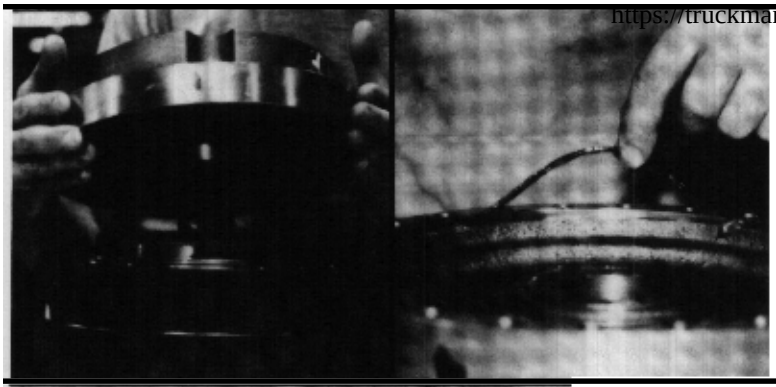


3. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



4. Remove all **24 grade 8 bolts(16)** from **cover(6).**

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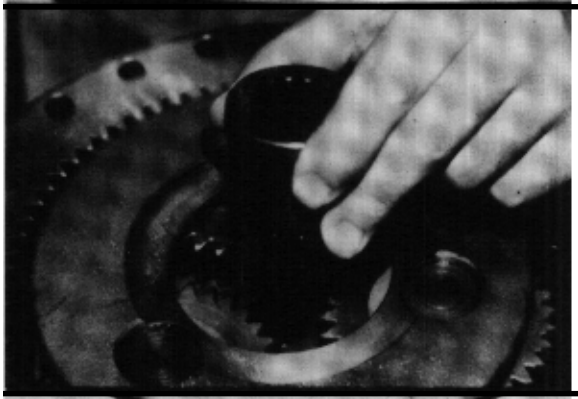
5. Lift **cover(6)** off of **hub(1G)** and remove **“O” ring(5)** from the counterbore in the cover. Discard the “O” ring.



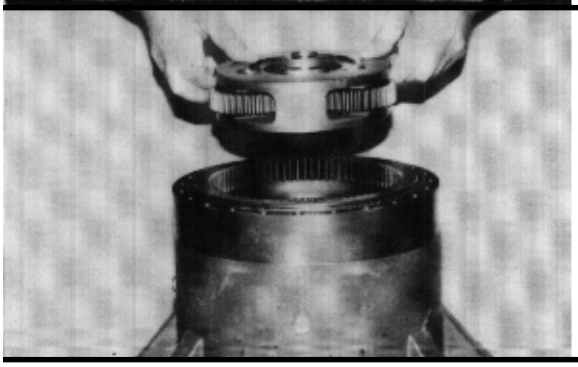
6. Remove small **thrustwasher(7)** from the counterbore in the center hole in **cover(6).**



7. Remove large **thrust washer(14), thrust bearing(13),** and large thrust **washer(12)** from the raised inside circular edge of **cover(6).**

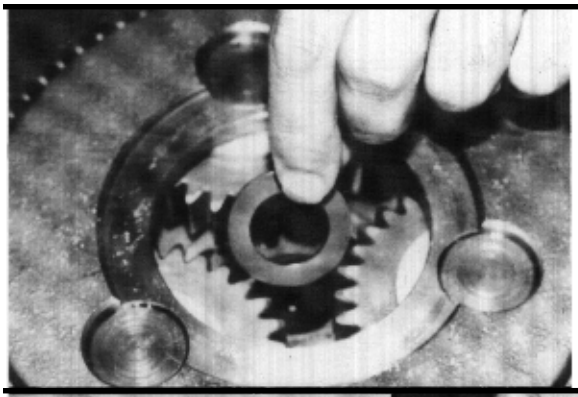


8. Remove **input gear(8)** from mesh with the planet gears in **first stage carrier assembly(3).**

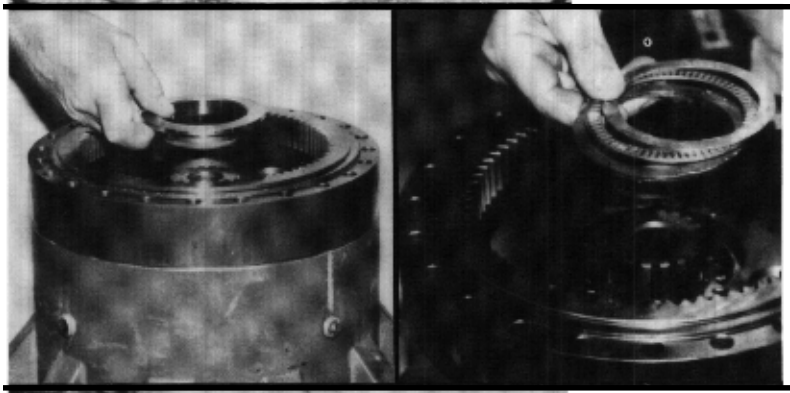


9. Lift out **first stage carrier assembly(3).**

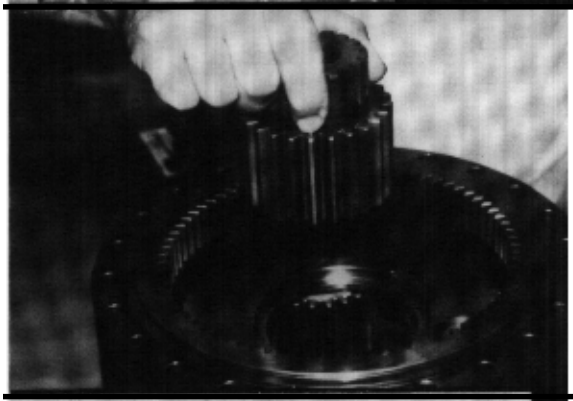
https://truckmanualshub.com/



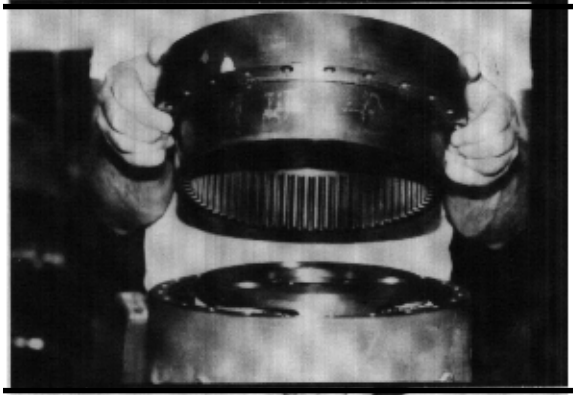
10. Remove small **thrust washer(9)** from the top of **second stage sun gear(11).**



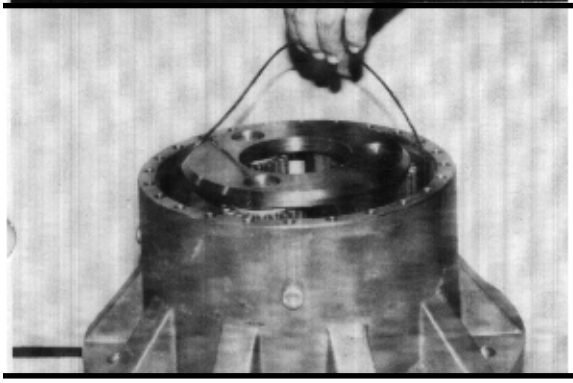
11. Remove **thrust bearing carrier(10),** large **thrust washer(14), thrust bearing(13),** and large **thrust washer(12)** from the counterbore of **second stage carrier assembly(2).**



12. Remove **second stage sun gear(11)** from mesh with **second stage carrier assembly(2).**

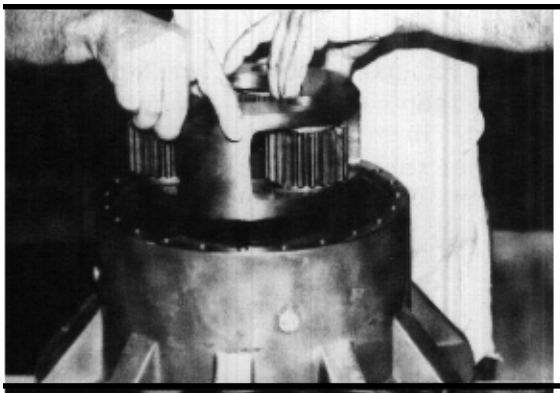


13. Lift out **ring gear(4).**



14. Remove **"O" ring(5)** from the counterbore in **hub(1G)** and discard.

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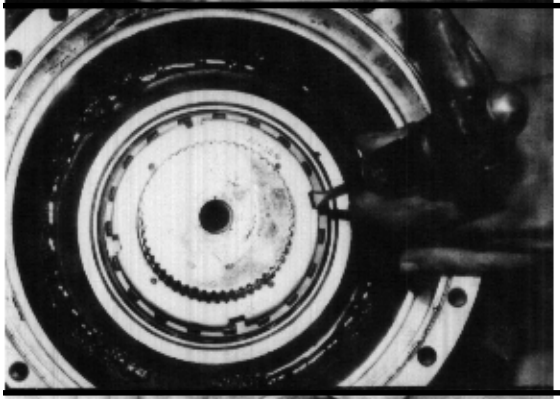


15. Lift out **second stage carrier assembly(2)** from mesh with **output shaft(1A).**

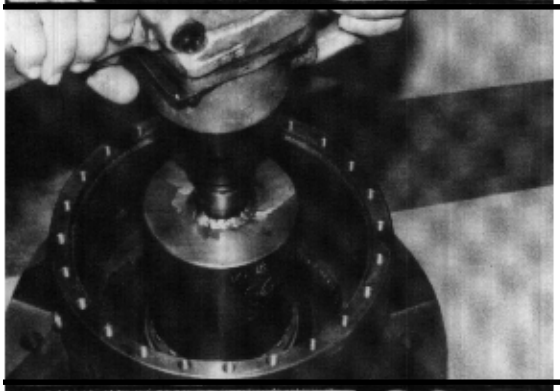


16. Using retaining ring pliers, remove **retaining ring(1L)** from groove around the outside of **output shaft (1A).**

CAUTION: Safety glasses should be worn during this procedure.

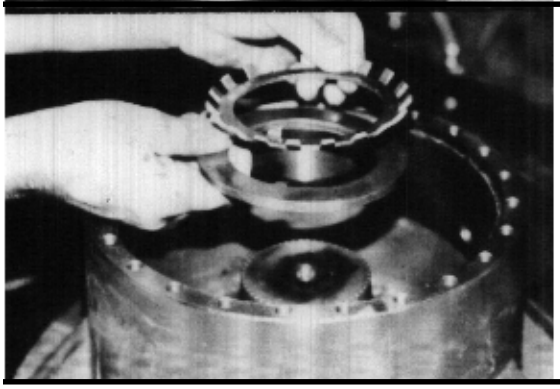


17. With a screwdriver or chisel and hammer, straighten out the tang on **lockwasher(1J)** which has been bent into the notch on **locknut(1K).**



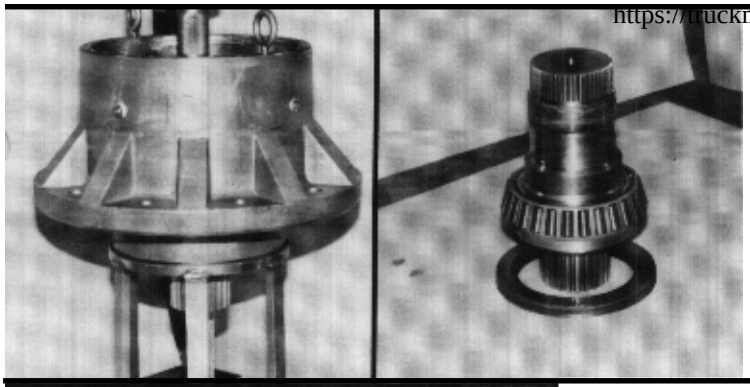
18. Using an AN-18 locknut wrench (tool no T-156766), loosen **locknuts (1K).** Remove the locknut from **output shaft(lA)** and discard.

NOTE: The output shaft must be held securely enough to resist turning when the locknut is loosened.

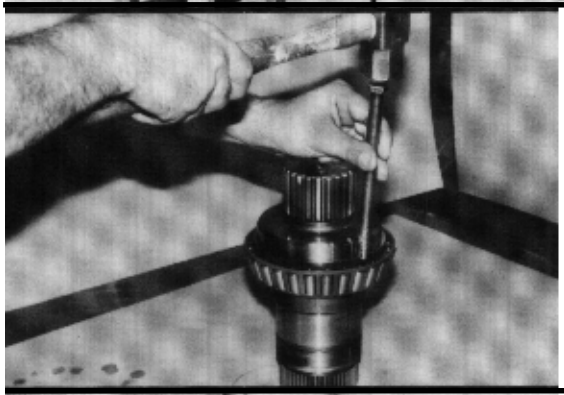


19. Remove **lockwasher(1J)** and **tanged washer(1H)** from **output shaft(1A).** Discard the lockwasher.

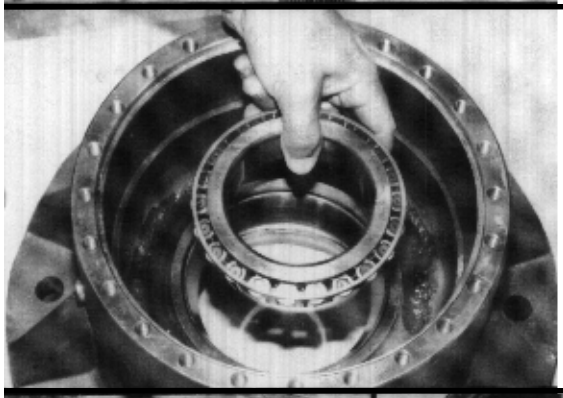
https://truckmanualshub.com/



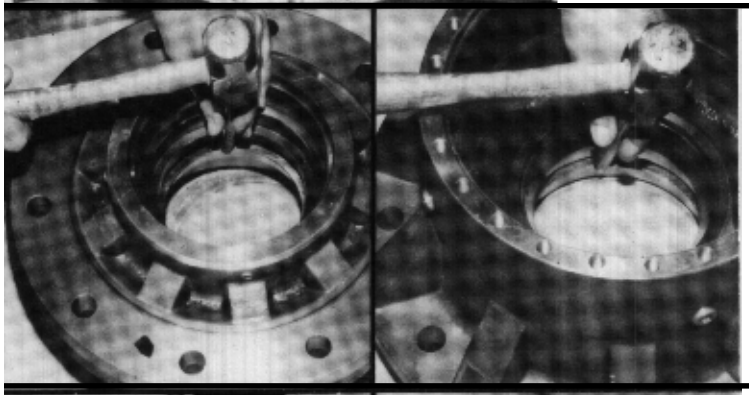
20. Raise **hub(1G)** above your work surface and support it from underneath in a manner that will allow **output shaft(1A)** to fall through the bottom. Press the output shaft out of the hub. The output shaft will come out with **bearing cone (1D)** attached and **seal(1B).** Discard the seal.



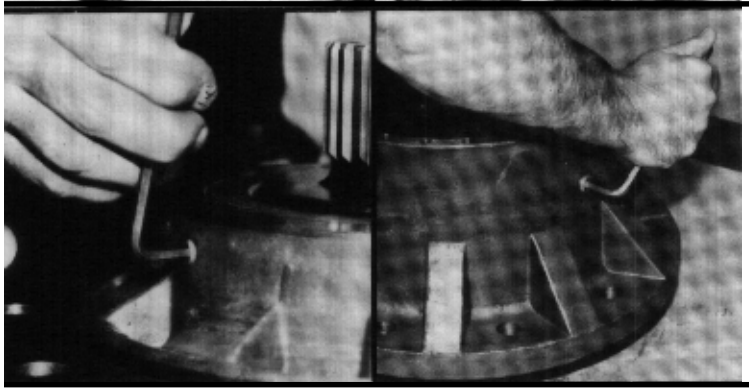
21. Remove **bearing cone (1D)** from **output shaft(lA).**



22. Lift bearing **cone(1F)** out of **hub(1G).**



23. Using a soft punch and hammer, remove **bearing cups (1E) and (1C)** from **hub(1G).** Be very careful not to strike the counterbores of the hub where these cups are located when using the punch.

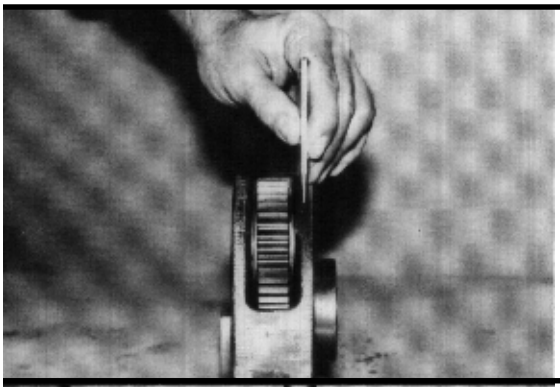


24. Remove all four **pipe plugs (1M), (1N), and (1P)** from **hub(1G).**

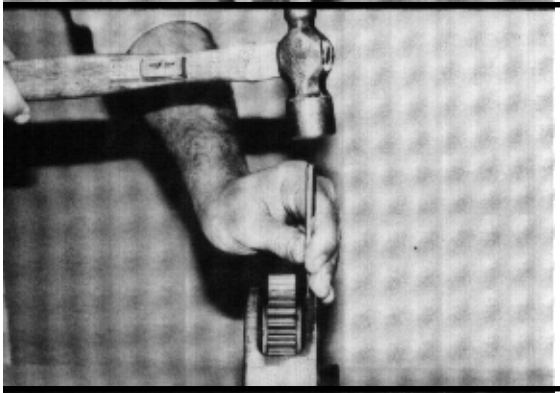
25. At this point the main disassembly is complete.

https://truckmanualshub.com/

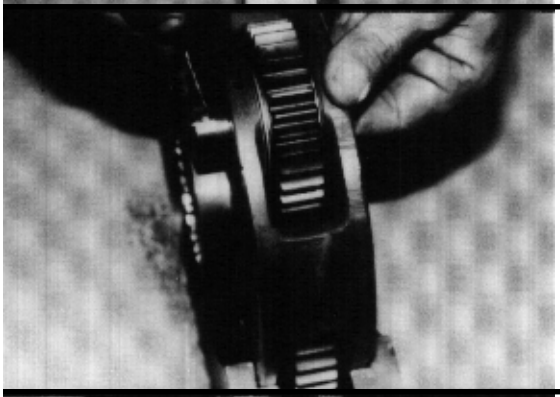
FIRST STAGE CARRIER DISASSEMBLY



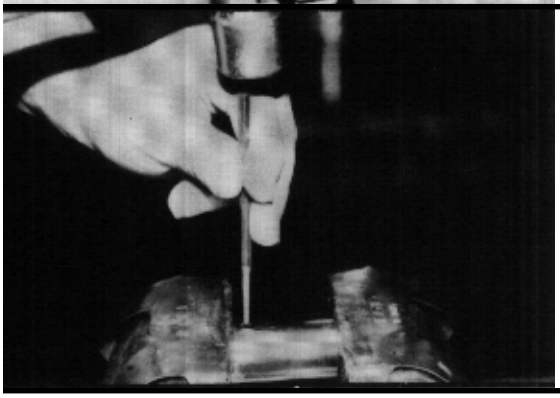
1. Locate **dowel pin(3D)** which holds **planes shaft(3E)** in **carrier housing (3A).**



2. Drive the **dowel pin(3D)** down into **planes shaft(3E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

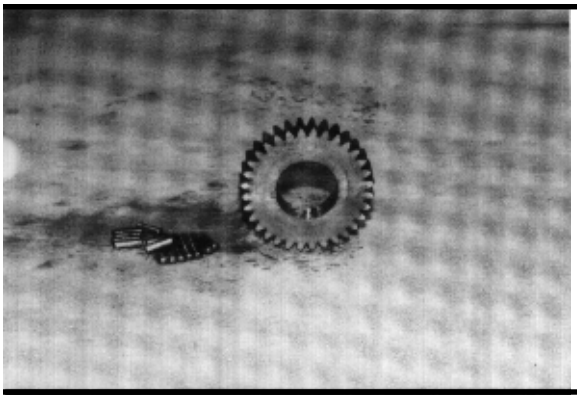


3. Remove **planet shaft(3E)** from carrier housing(3A). The four **thrust washers(3B)** and **planet gear(3F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(3D)** out through the end of the dowel pin hole in **planet shaft(3E)** that it originally went into.

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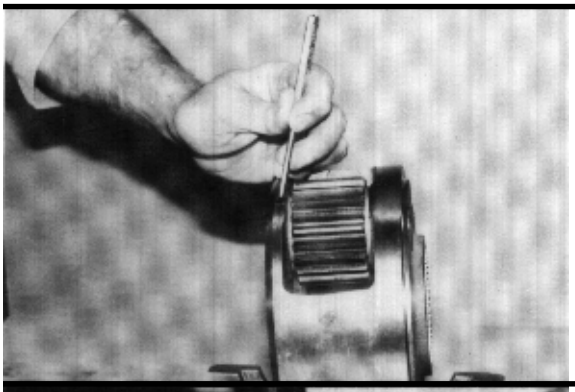
5. Remove **needle rollers(3C)** from inside **planet gear(3F).**

6. Repeat steps 1-5 to remove the two remaining planet gears.

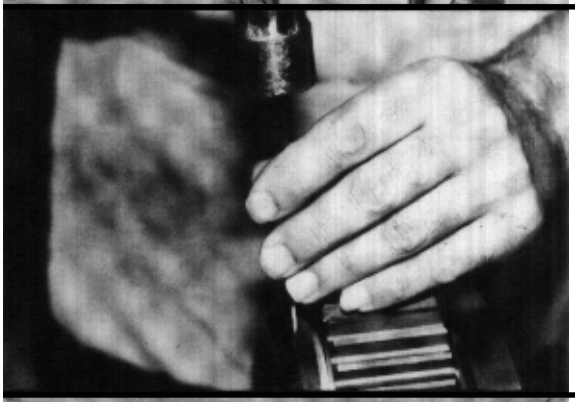
7. At this point the first stage carrier disassembly is complete.

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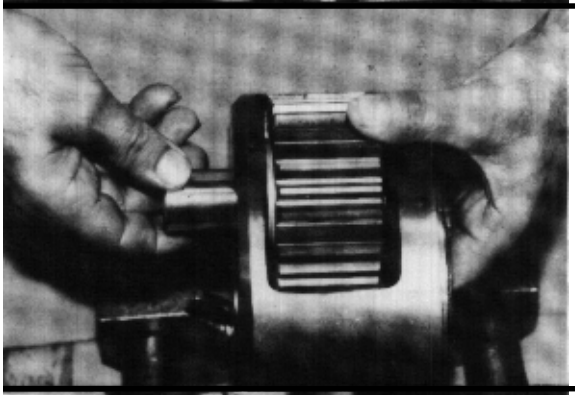
SECOND STAGE CARRIER DISASSEMBLY



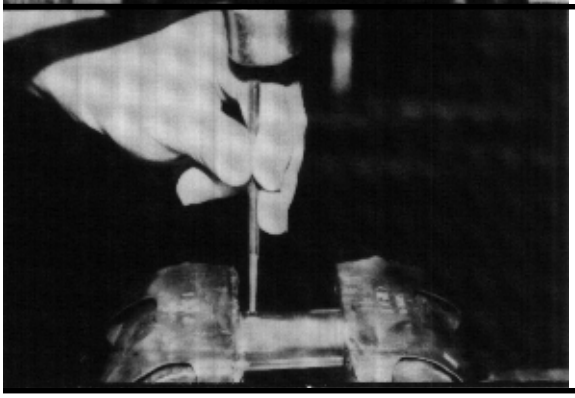
1. Locate **dowel pin(2G)** which holds **planet shaft(2E)** in **carrier housing (2A).**



2. Drive **dowel pin(2G)** down into **planets shaft(2E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

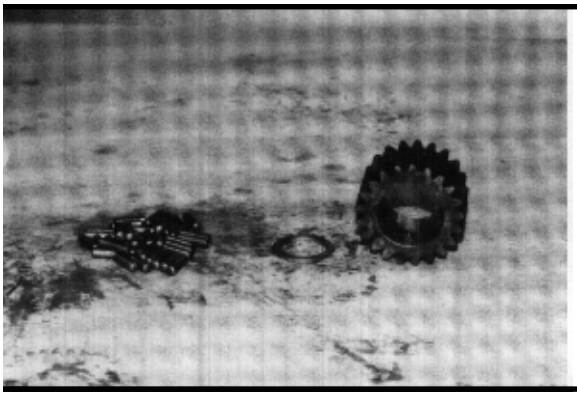


3. Remove **planet shaft(2E)** from **carrier housing(2A).** The four **thrust washers(2B)** and **planet gear(2F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(2G)** out through the end of the dowel pin hole in **planet shaft(2E)** that it originally went into.

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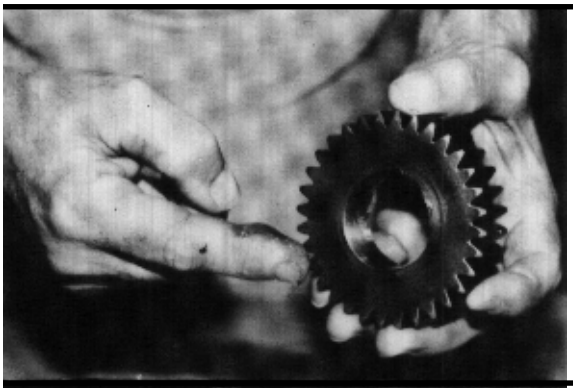
5. Remove **needle rollers(2C)** and **spacer(2D)** from inside **planes gear(2f)**

6. Repeat steps 1-5 to remove the two remaining planets gears.

7. At this point the second stage carrier disassembly is complete.

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FIRST STAGE CARRIER SUB-ASSEMBLY

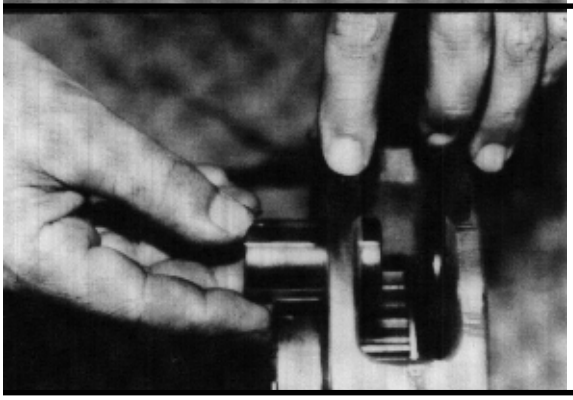


1. Apply grease to the inside of one **first stage carrier planes gear(3F).**



2. Line the inside of **planet gear (3F)** with **19 needle rollers(3C).**

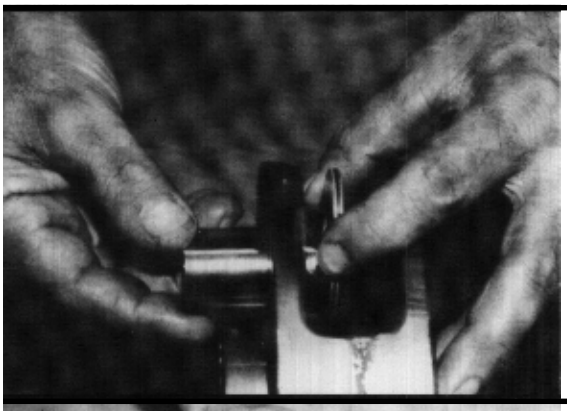
3.Stand **first stage carrier housing(3A)** in an upright position.



4. Insert a **planet shaft(3E)** into one of the planet shaft roles which has a dowel pin hole on **carrier housing(3A).** The end of the planet shaft that does not have the dowel pin hole should be inserted into the carrier housing first.

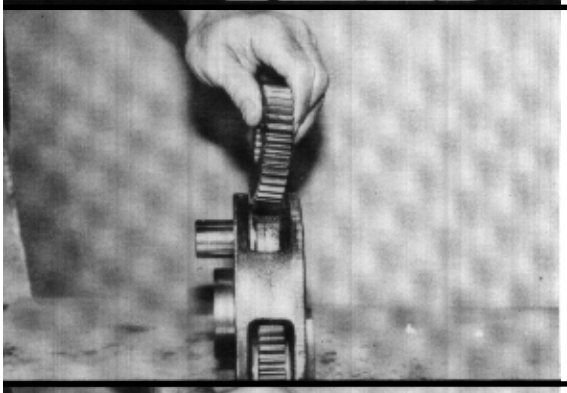
NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.

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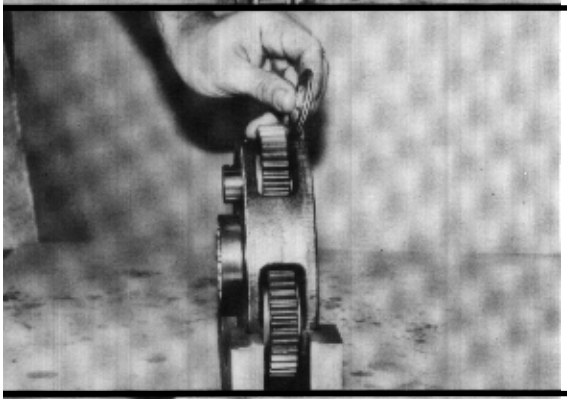


5. Place two **thrust washers(3B)** onto the end of **planet shaft(3E)** which has been inserted through the planet shaft hole in **carrier housing(3A).**

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

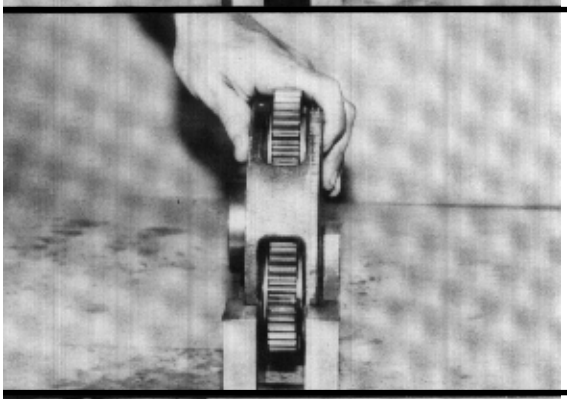


6. Following the thrust washers place **planet gear (3F),** with needle rollers, onto **planet shaft (3E).**

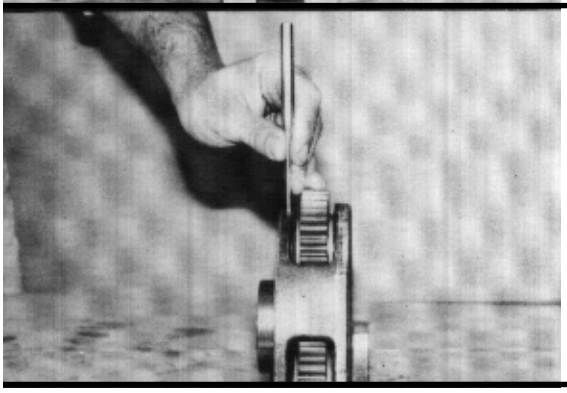


7. Following the planet gear, place two more **thrust washers(3B)** onto **planet shaft(3E).**

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

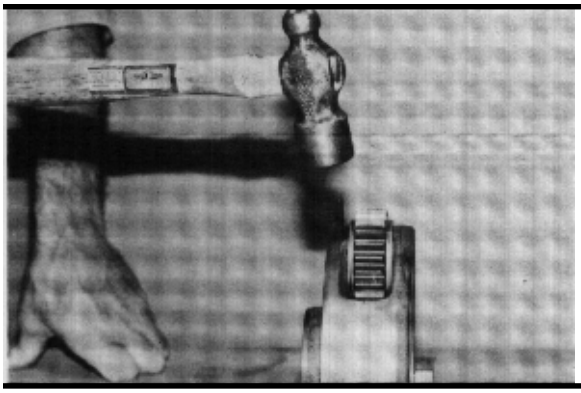


8. Now insert **planet shaft(3E)** through the opposite planet shaft hole on **carrier housing(3A).**



9. Using an alignment puch or similar tool, align the dowel pin holes on **carrier housing(3A)** and **planet shaft (3E).**

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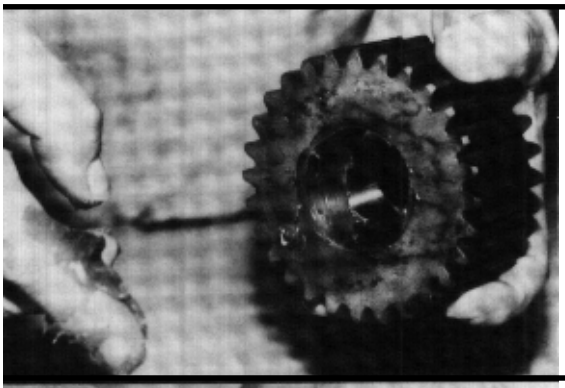
10. If you examine a **dowel pin (3D)** carefully, you will notice that one end is smaller than the other. Drive this end of the **dowel pin (3D)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

ll. Repeat the procedure in steps 1-10 for installation of the two remaining first stage planes gears(3F).

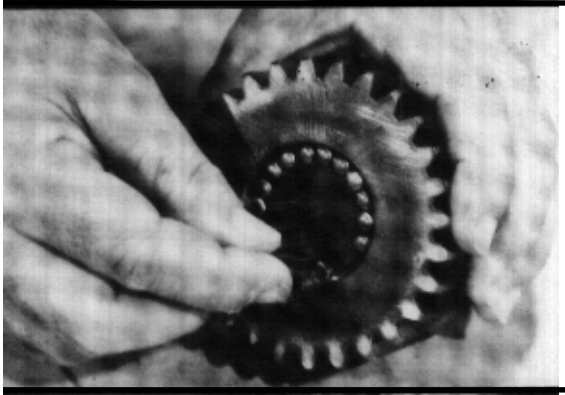
l2. At this point the first stage carrier sub-assembly is complete.

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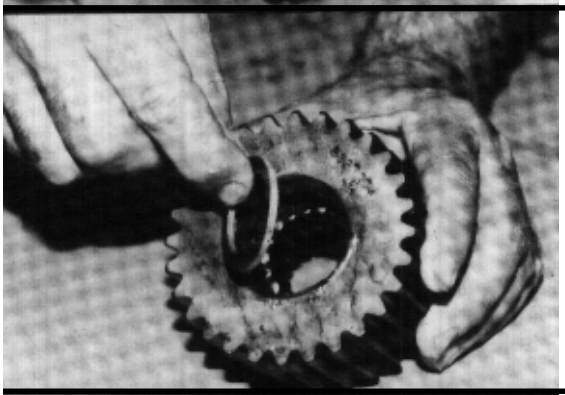
SECOND STAGE CARRIER SUB-ASSEMBLY



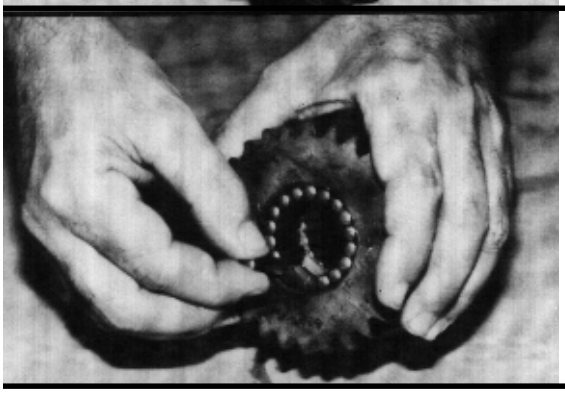
1. Apply grease to the inside of one **second stage planet gear(2F).**



2. Line one half of **planet gear(2F)** with 18 **needle rollers(2C).**



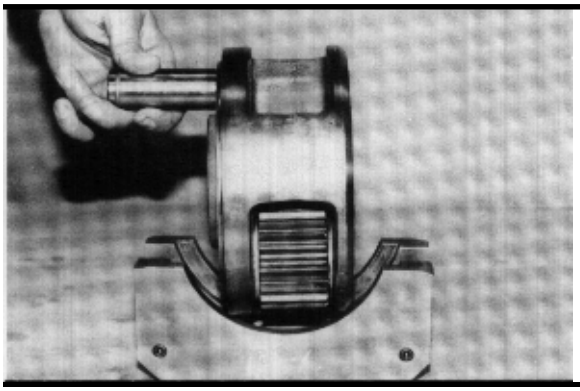
3. Place one **spacer(2D)** inside **planet gear(2F)** so that it rests on top of the **needle rollers (2C).**



4. Line the remaining half of **planet gear(2F)** with 18 **needle rollers(2C).**

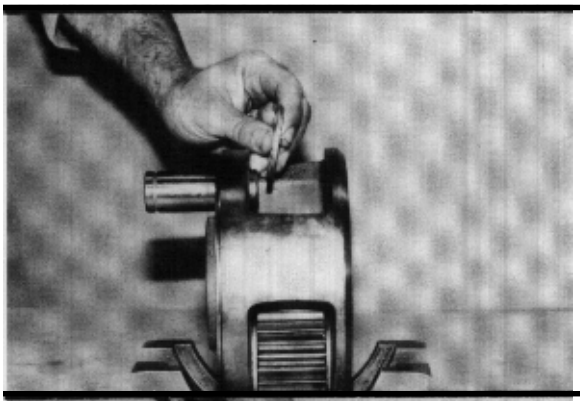
https://truckmanualshub.com/

5. Stand second stage carrier housing(2A) in an upright position.



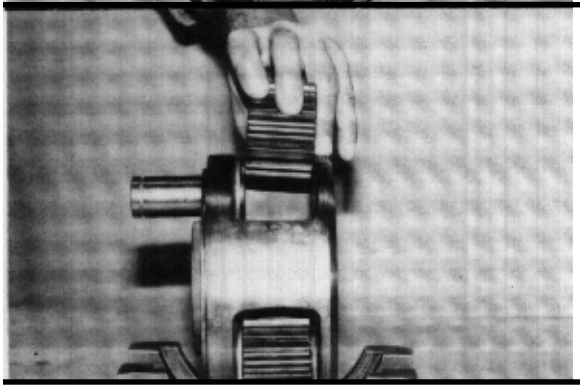
6. Insert **planet shaft(2E)** into a planet shaft hole that does not have a dowel pin hole on **carrier housing** (2A). The end of the planet shaft with the dowel pin hole should be inserted into the carrier housing first.

NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.



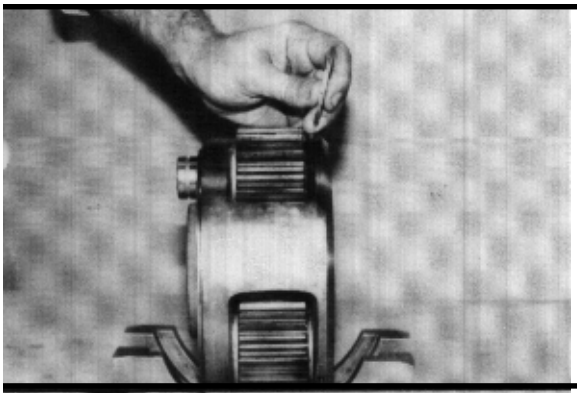
7. Place two **thrust washers(2B)** onto the end of the planet shaft which has been inserted through the planet shaft hole.

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



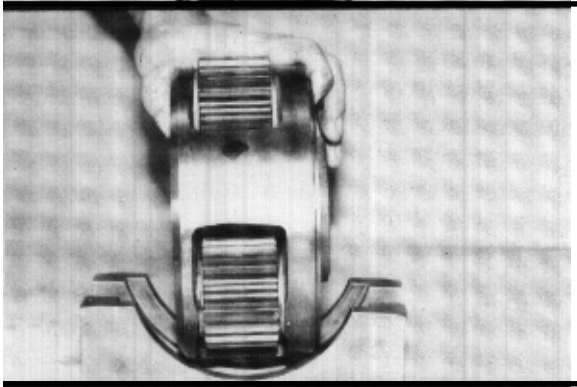
8. Following the thrust washers, place **planet gear(2F),** with needle rollers, onto **planes shaft(2E).**

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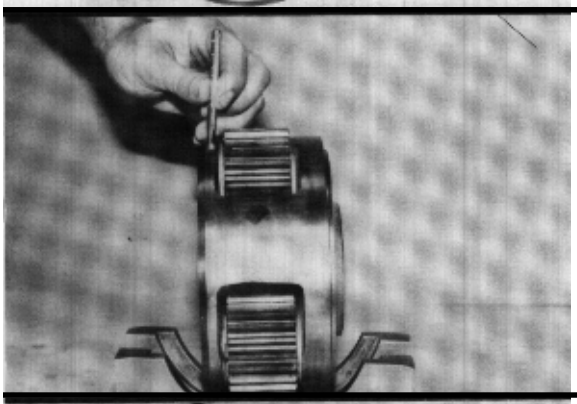


9. Following the planet gear, place two more **thrust washers(2b)** unto **planet shaft(2E).**

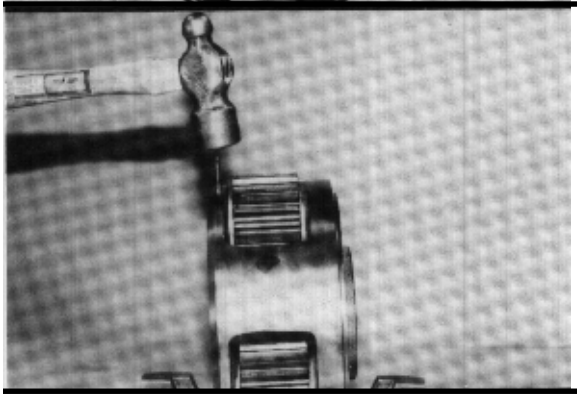
NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



10. Now insert **planet shaft(2E)** through the opposite planet shaft hole on **carrier housing(2A).**



11. Using an alignment punch or similar tool, align the dowel pin holes on the carrier housing and planet shaft.



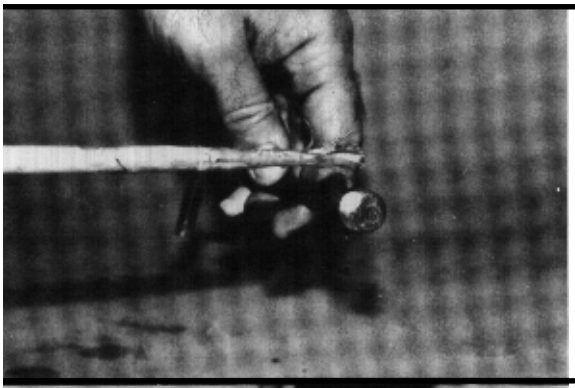
12. If you examine a **dowel pin(2G)** carefully, you will notice that one end is smaller than the other. Drive this end of **dowel pin(2G)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

13. Repeat the procedure in steps 1-12 for installation of the two remaining second stage planet gears(2F).

14. At this point the second stage carrier sub-assembly is complete.

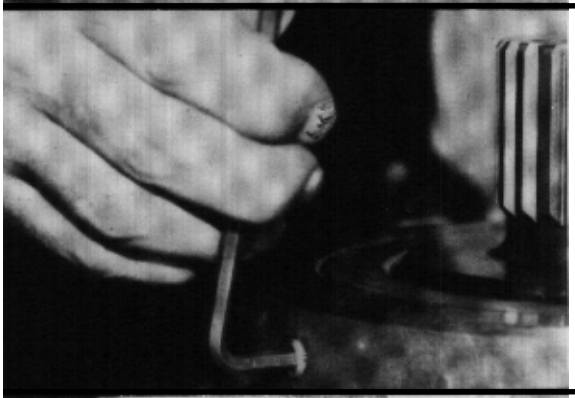
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HUB-SHAFT SUB-ASSEMBLY



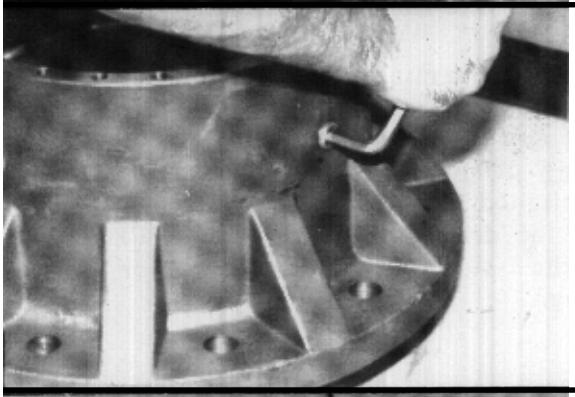
1. Apply a light coat of "Never-Seize" to the four hub **pipe plugs (1M), (1N), and (1P).**

Note: **Pipe plug(1P)** is a magnetic plug.

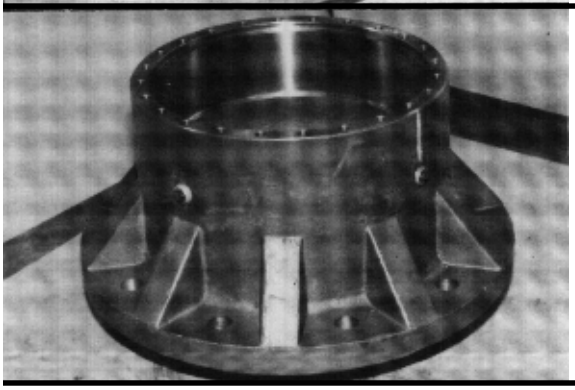


2. With **hub(lG)** standing on its large diameter end, tighten **pipe plugs(1M)** into the two pipe plug holes nearest the small diameter end of **hub(1g).**

NOTE: Notice that **pipe plugs(lM)** are much smaller than **pipe plugs (1N)** and **(1P).**



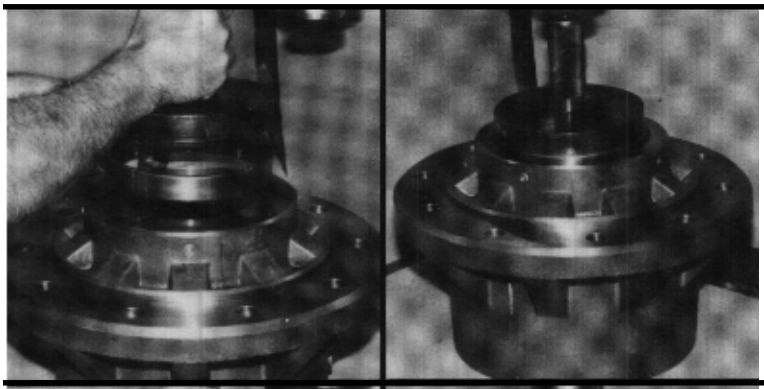
3. Turn **hub(1G)** over so that it rests on its small diameter end and the two pipe plug holes nearest the hub's large diameter and are facing you. Tighten **magnetic pipe plug(1P)** into the right-hand pipe plug hole.



4. Mark the location of magnetic pipe **plug(1P)** so that it may be aligned with the pipe plug hole in **cover(6)** in a later step.

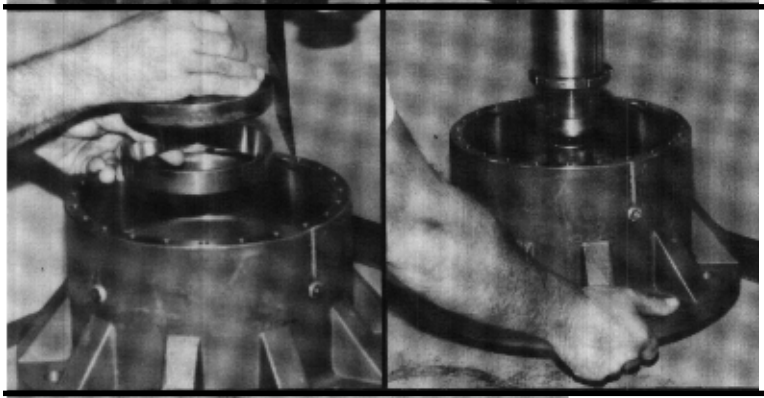
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5. Install **pipe plug(1N)** into the left-hand pipe plug hole nearest the large diameter end of **hub (1G).**



6. With **hub(1G)** still standing on its large diameter end, press **bearing cup(1C)** into the small diameter end of **hub(1G)** usina a bearing cup pressing fixture (tool no.T- 156792).

NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.

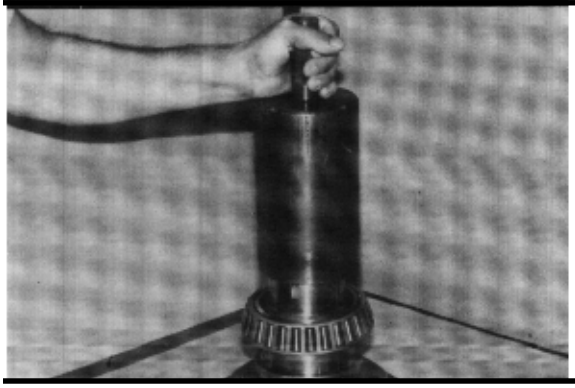


7. Turn **hub(1G)** over so that it rests on its small diameter end. Press **bearing cup(1E)** down into **hub(lG)** using a bearing cup pressing fixture (tool no. T-130717).

NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.

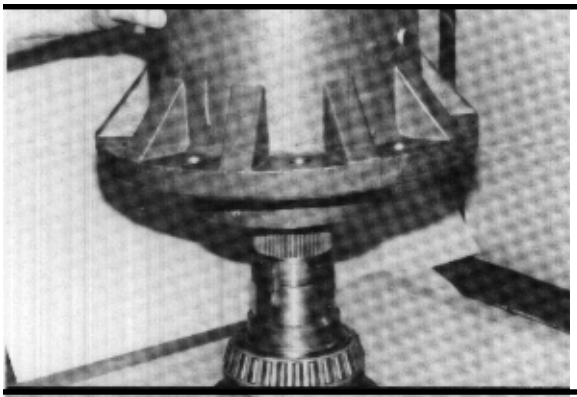


8. Spray the inside of **bearing cone(1D)** with oil.



9. Press **bearing cone(1D)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no.T-158049).

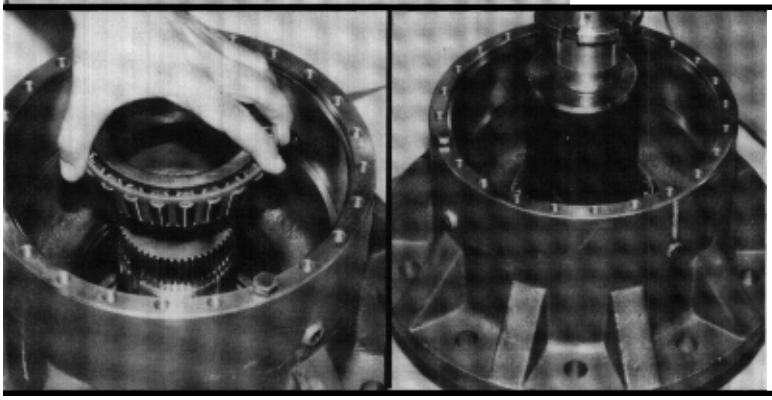
https://truckmanualshub.com/



10. With small diameter end down, lower **hub(1G)** onto **output shaft(1A).**

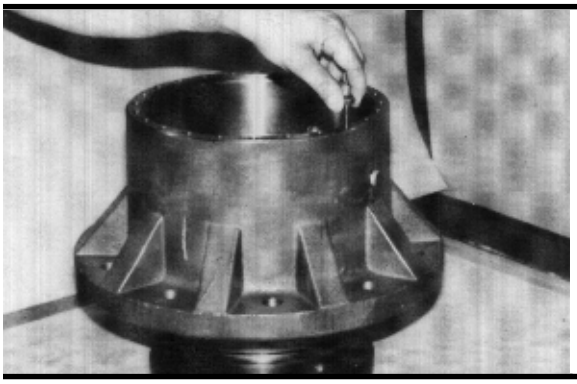


11. Spray the inside of **bearing cone(1F)** with oil.



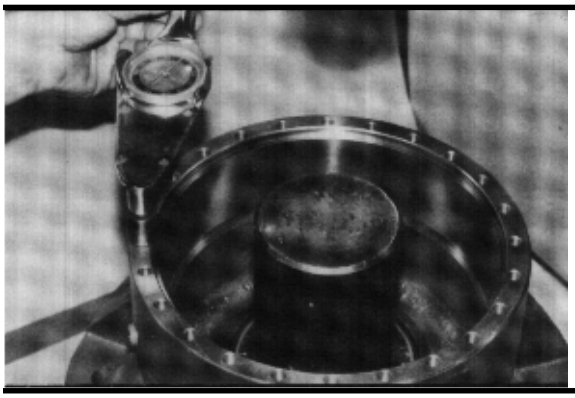
12. Press **bearing cone(1F)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no. T-146588). Reduce the pressure applied to the bearing cone and press the cone again. This time rotate the hub in both clockwise and counter-clockwise directions while pressing. Stop pressing when the hub starts to resist the rotation.

13. Now measure the initial rolling torque of **hub(1G).** To do this, follow steps a-d.



a) Tighten a bolt into one of the bolt holes on the hub. The bolt used should be one that fits the hole.

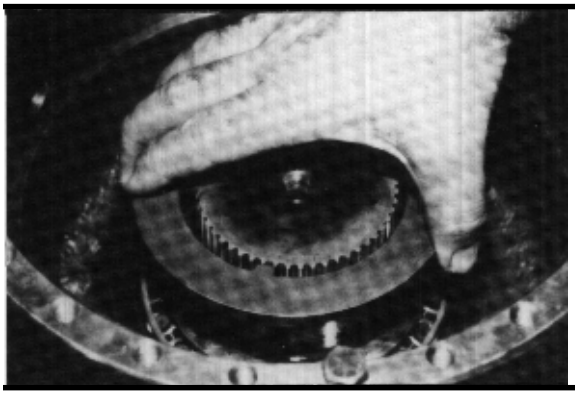
b) Place a torque wrench on the bolt so that the arm of the wrench lines up on a tangent to the circumference of the hub as shown in figure 1.



c) Keeping the wrench in this position at all times, use the arm of the wrench to guide the hub around in one rotation.

d) Read the gauge on the torque wrench. The initial rolling torque should be 25-30 in.-lbs. Measure the rolling torque several times to insure an accurate reading.

NOTE: If the initial rolling torque is less than 25 in.-lbs., apply more pressure to **bearing cone(1F).** If the initial rolling torque is higher than 30 in.-lbs., strike the top of **output shaft(1A)** with a soft face hammer to release the load on the shaft, then repeat steps 13b - 13d.



14. Place **tanged Fwasher(1H)** onto **output shaft(1A).**

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THE CORRECT READING CAN ONLY BE MADE IF THE TORQUE WRENCH IS PULLED SLOWLY (APPROX. 3.5 R.P.M.) AND SMOOTHLY TOWARDS YOU.

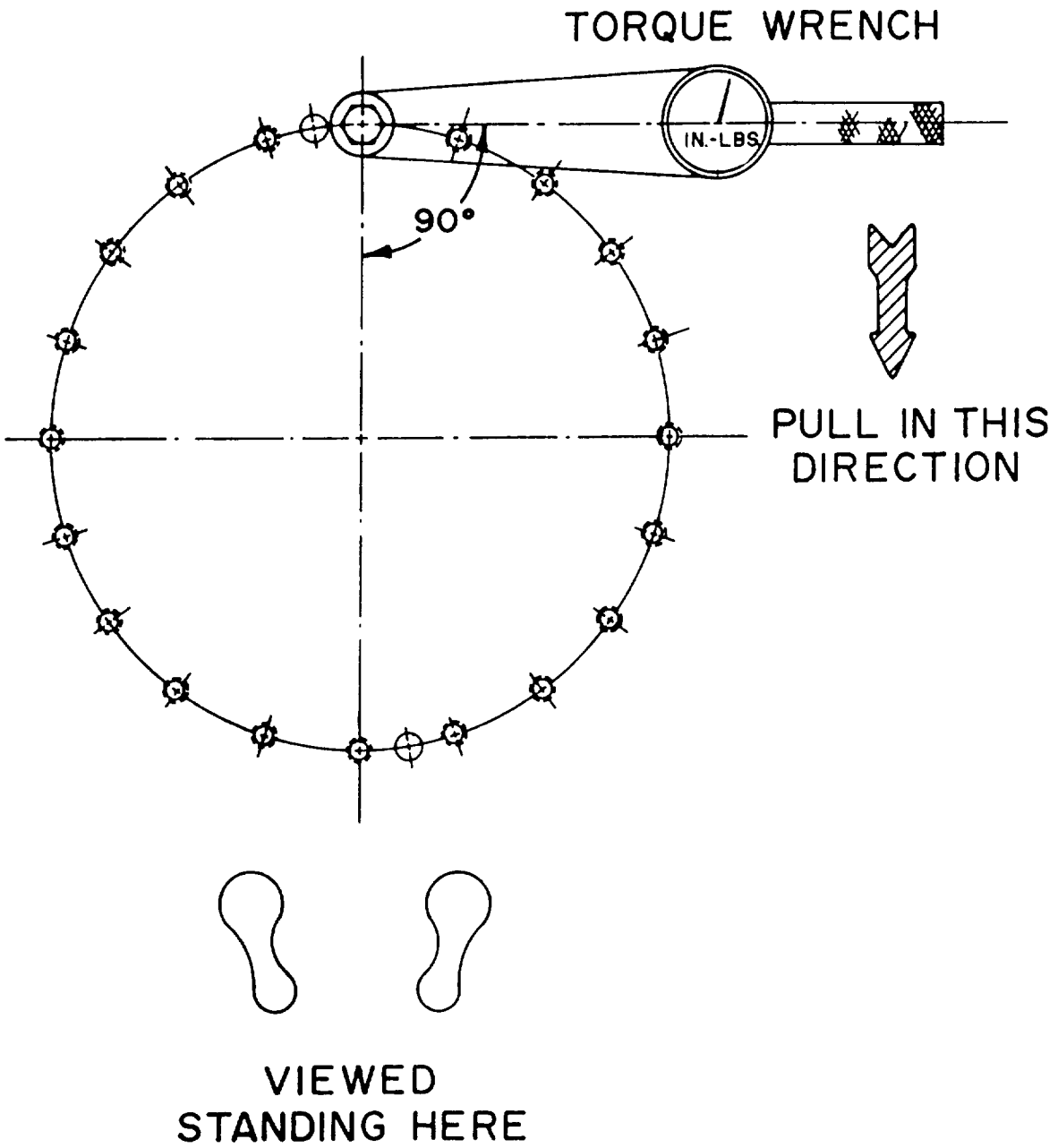
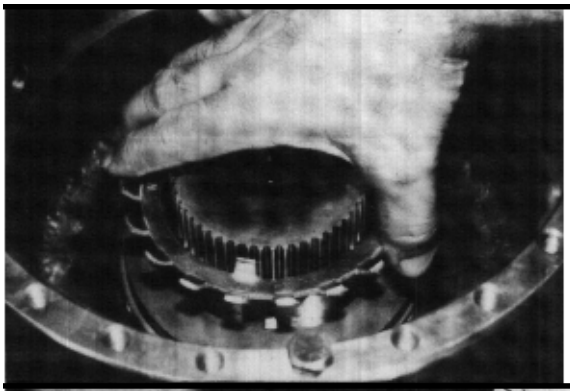


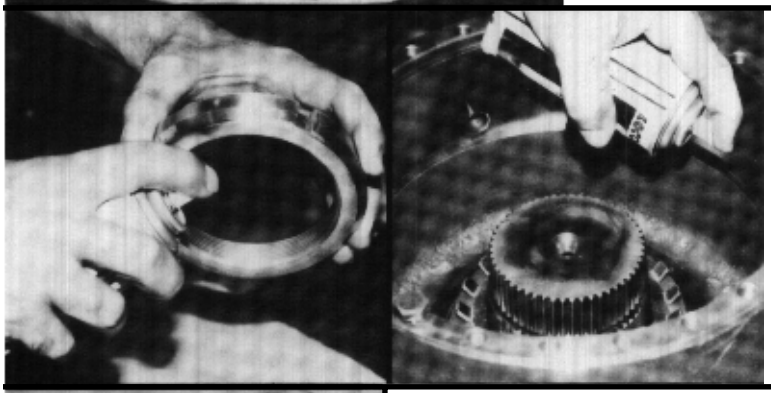
Figure 1.

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15. Place **lockwasher(1J)** onto **output shaft(1A).**

NOTE: Notice that **lockwasher(1J)** has tangs and **tanged washer(1H)** does not.



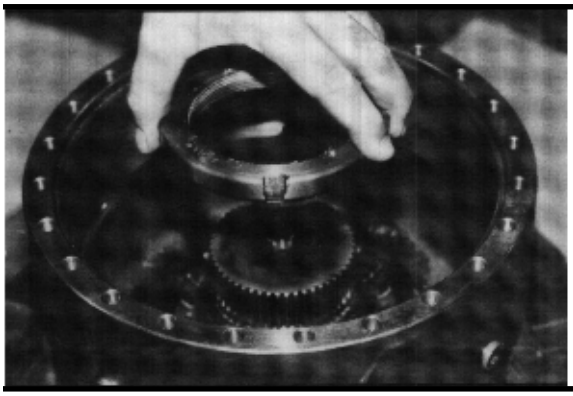
16. Spray the inside of **locknut(1K)** and the exposed sides of **output shaft(1A)** with Locquic Primer T. Allow two minutes drying time.



17. Apply Loctite 277 Adhesive/ Sealant to the second screwthread from the bottom of **locknut(1K).**

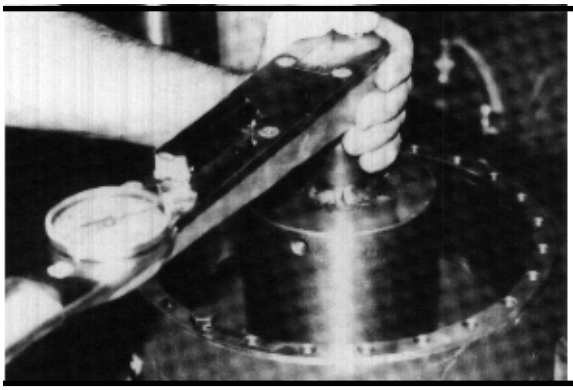
NOTE: The bottom of **locknut(1K)** has a chamfered or inward sloping edge.

NOTE: Loctite 277 is an anaerobic adhesive. Once it has been removed from air, it sets. Therefore, once the locknut has been placed on the output shaft, it must be torqued immediately or the adhesive will make it difficult to turn.



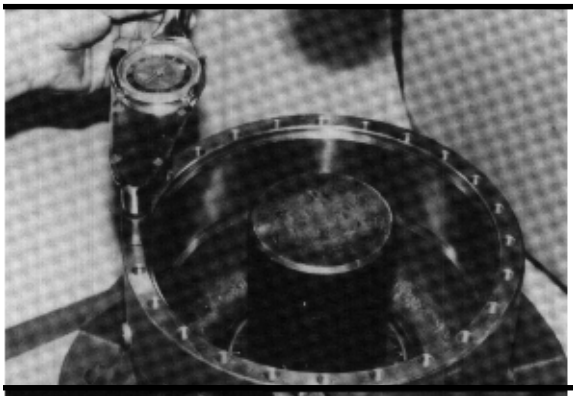
18. Place **locknut(1K)** onto **output shaft(1A)** and screw into place.

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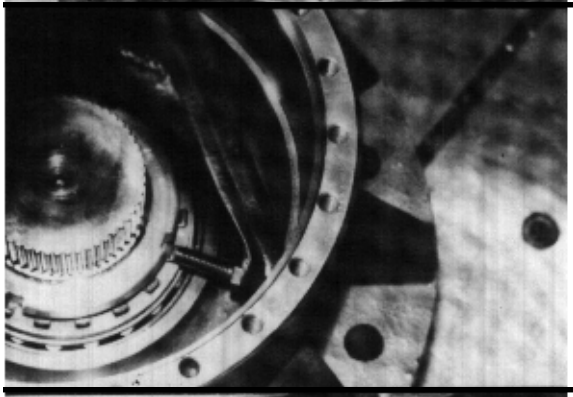
19. Using an AN-18 locknut wrench (tool no. T-156766) and a torque wrench, apply 225 ft.-lbs. of torque to **locknut(1K).**

NOTE: One tang on **lockwasher(1J)** must line up directly with one notch on **locknut(1K).** If one tang does not line up with a locknut notch, apply sufficient increased torque to the locknut until it does. Never loosen the locknut.

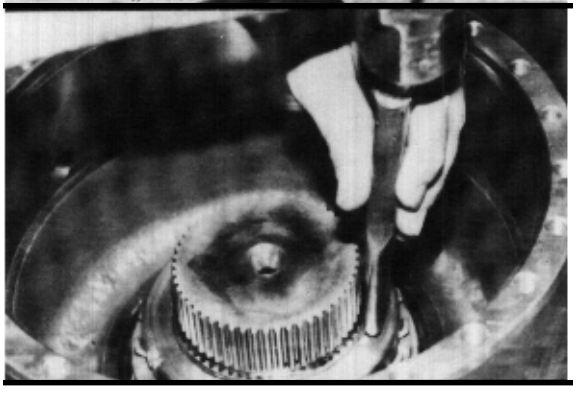


20. Measure the final rolling torque of **hub(1G)** using the same manner described in steps 13a - 13d. The final rolling torque should measure 35-60 in.-lbs.

NOTE: Remove the bolt from the hub.



21. Bend the aligned tang on **lockwasher(1J)** up into the notch on **locknut(1K).**



22. Using a center punch and hammer, stake **locknut(1K)** in four equally spaced positions around the circumference of the locknut and at a distance of 1/8 in. from the inside edge of the locknut.

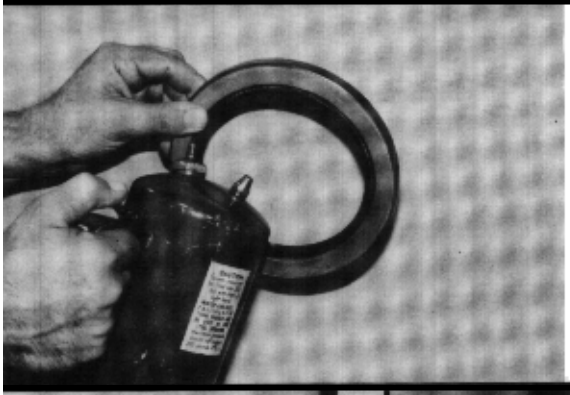
23. At this point the hub-shaft subassembly is complete.

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MAIN ASSEMBLY

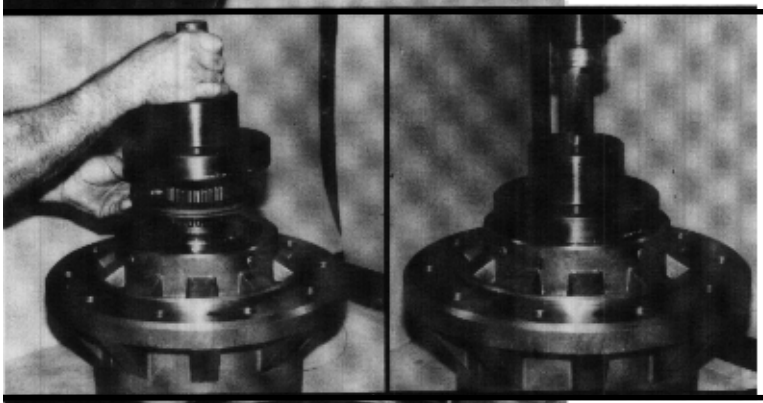


1. Turn **hub(1G)** over so that it rests on its large diameter end. Spray oil on all exposed surfaces inside the hub while turning **output shaft(1A).**



2. Spray the inside of **seal(1B)** with oil.

NOTE: The open face of the seal may have a waved surface. This is an intentional design used to keep dirt out.



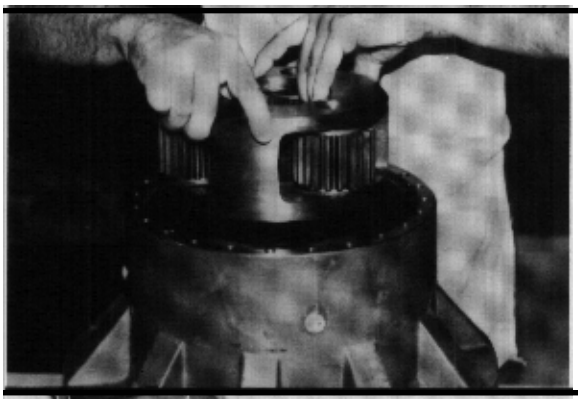
3. Press **seal(1B)** into the small diameter end of **hub (1G)** using a seal pressing fixture (tool no.T-156799).



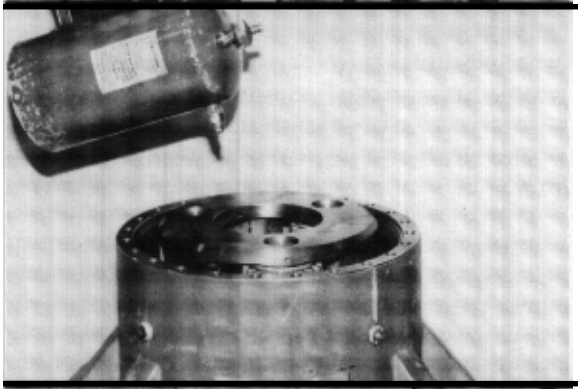
4. Turn **hub(1G)** over once again so that it rests on its small diameter end. Using retaining ring pliers, insert **retaining ring(1L)** into the groove on **output shaft(1A).**

CAUTION: Saftey glasses should be worn during this procedure.

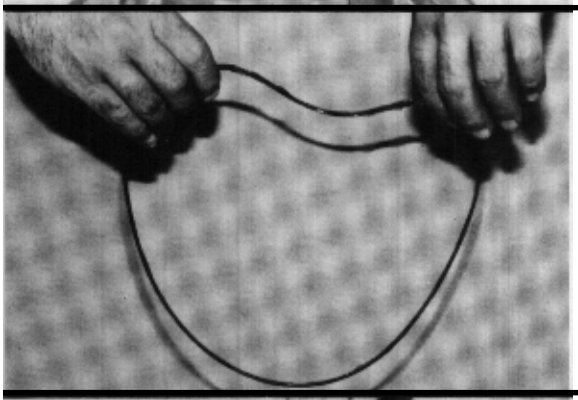
https://truckmanualshub.com/



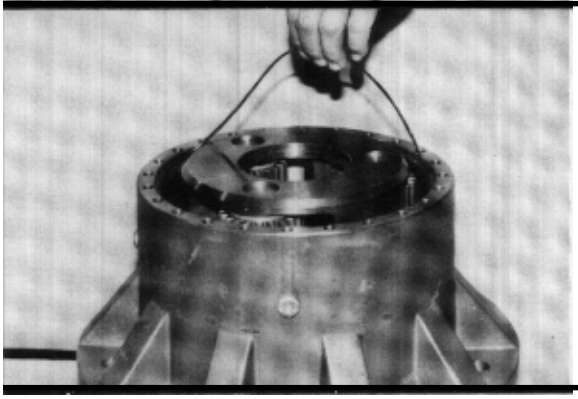
5. Place second **stage carrier assembly(2)**, with spline connections down, into **hub(1G)** so that the carrier's spline connections mesh with the spline connections on **output shaft (1A).**



6. Spray oil on all exposed surfaces inside **hub(1G).**



7. Grease **"O" ring(5).**



8. Place **"O" ring(5)** into the counterbore of **hub(1G).** Make sure that the counterbore is oil free before installing "O" ring.

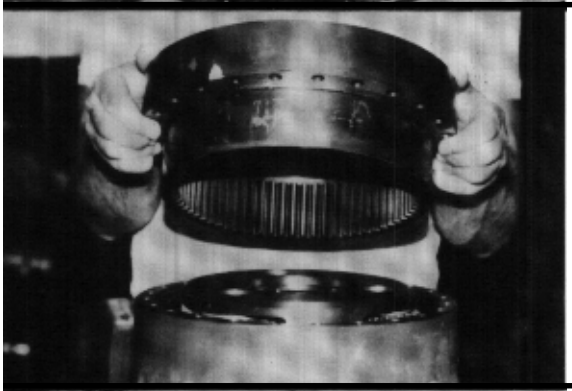
CAUTION: Beware of sharp edges and burrs in the counterbore while installing the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.

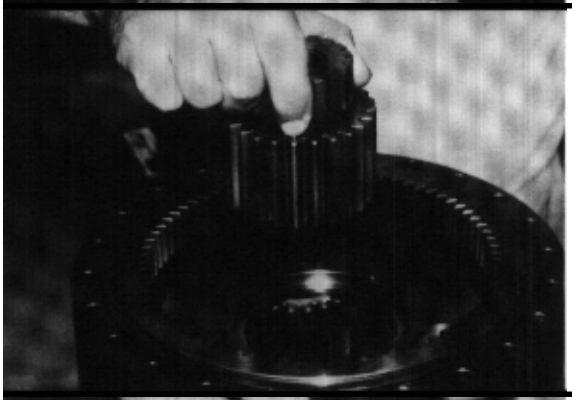
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9. Spary oil on the inside of **ring gear(4).**



10. Place **ring gear(4)** with small diameter end down, into **hub(lG)** so that it fits over **second stage carrier assembly(2).**

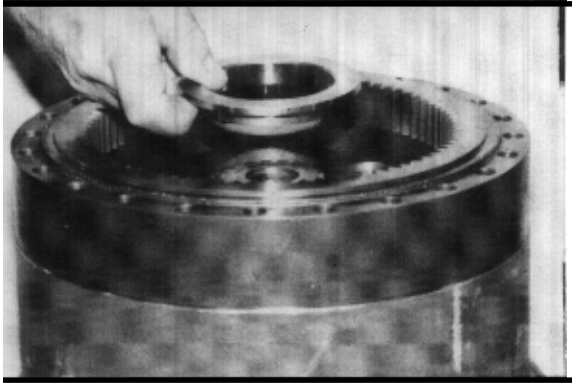


11. Place **second stage sun gear(11),** with large diameter end down, into mesh with the planet gears of the **second stage carrier assembly(2).**



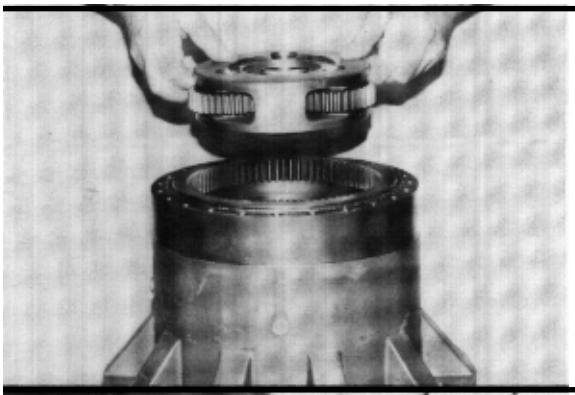
l2. Place large **thrust washer(14), thrust bearing(13)**, and large **thrust washer(12)** in that order into the counterbore of **second stage carrier assembly(2).**

NOTE: Notice that **thrust washer(14)** is much thicker than **thrust washer(12).**

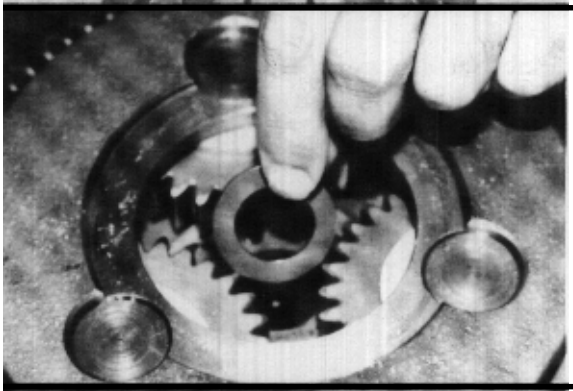


13. Place thrust bearing carrier (10), with small diameter end down, into the counterbore of **second stage carrier assembly(2).** It should fit over the thrust bearing set(12, 13, 14) described in step 12.

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14. Place **first stage carrier assembly(3)**, with spline connections down, into mesh with the **second stage sun gear(ll)** and the **ring gear(4).**



15. Place small **thrust washer(9)** on top of **second stage sun gear(ll).**



16. Place **input gear(8)**, with small diameter end down, into mesh with the planet gears of **first stage carrier assembly(3).** The input gear should be centered on the small **thrust washer(9).**

17. Set **cover(6)** down on its small diameter end.



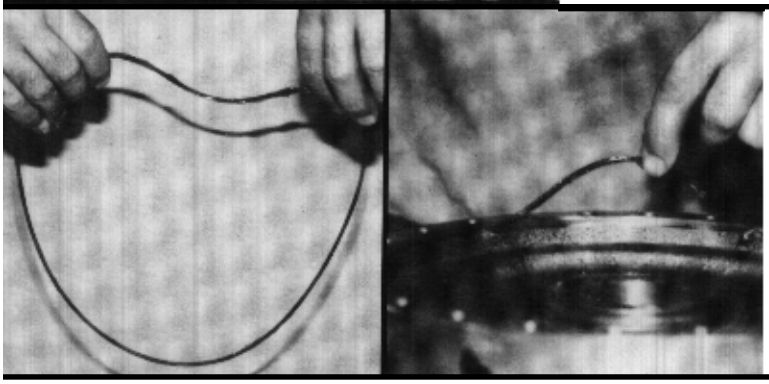
18. Grease one side of large **thrust washer(12), thrust bearing(13)**, and large **thrust washer(14)** and place them greased side down in that order over the raised inside circular edge of **cover(6).**

NOTE: Notice that **thrust washer(14)** is much thicker that **thrust washer (12).**

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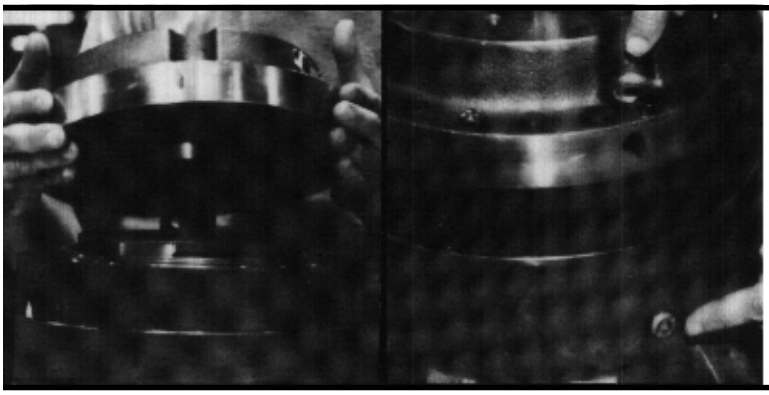
19. Grease small **thrust washer(7)** and place it in the counterbore of the center hole in **cover(6).**



20. Grease **"O" ring(5)** and place it around the counterbore in **cover(6).**

CAUTION: Beware of sharp edges and stalling the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



21. Place **cover(6)**, with large diameter end down, on top of **ring gear(4)** so that the cover's pipe plug hole aligns with the magnetic pipe plug hole in **hub(lG)** according to figure 2.

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This figure shows the most common pipe plug timing for this series. Pipe plug timings may vary among units with different model numbers. Refer to an original assembly print for your particular unit to determine its correct pipe plug timing.

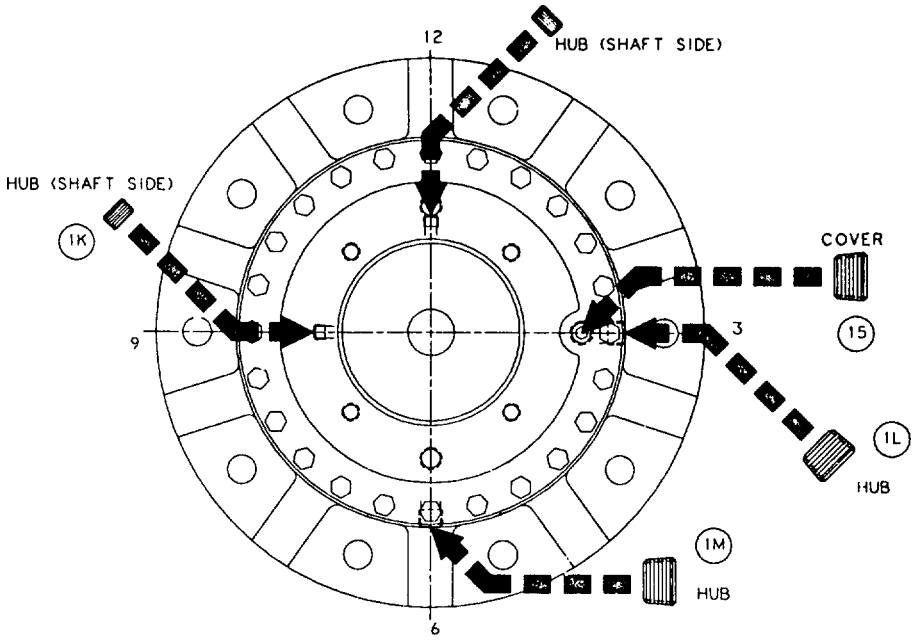
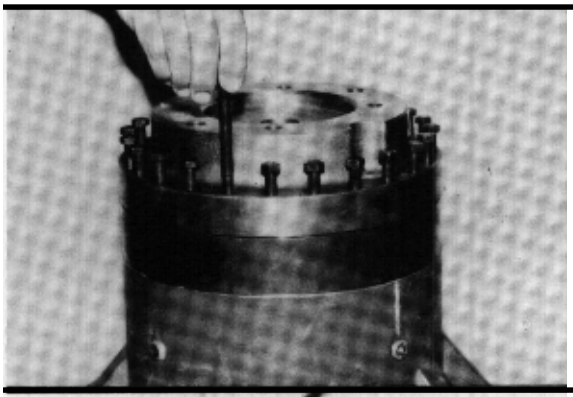
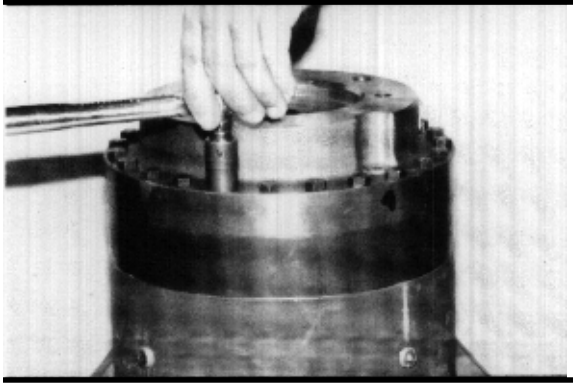


Figure 2.

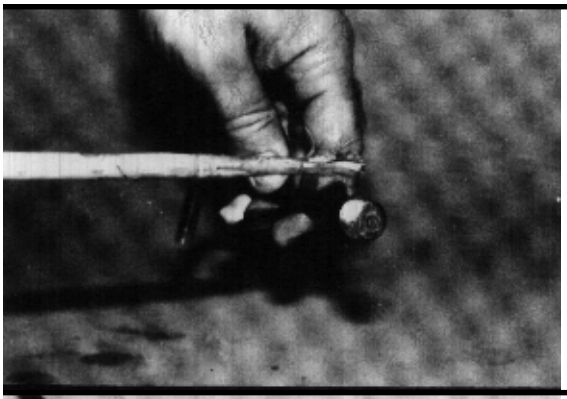


22. Place the 24 **grade 8 bolts(16)** into **cover(6)** and tighten.

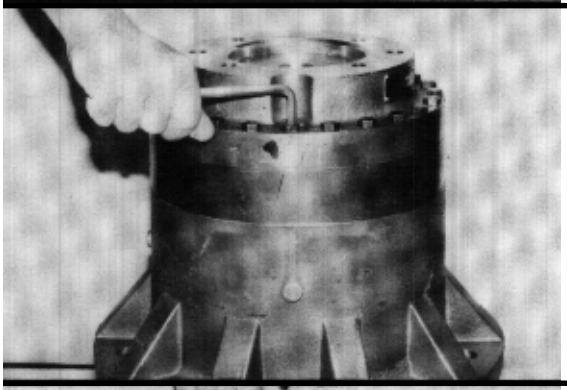


23. Using a torque wrench, apply 35-45 ft.-lbs of torque to each **grade 8 bolt (16).**

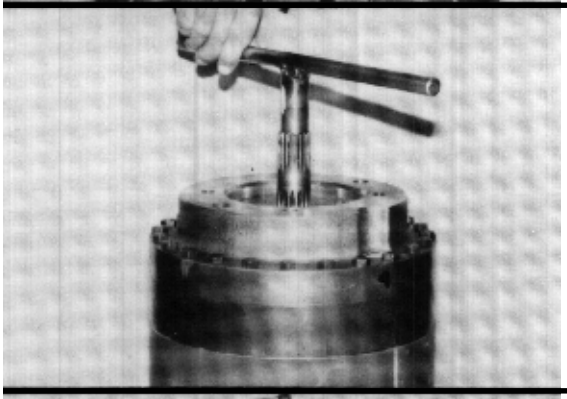
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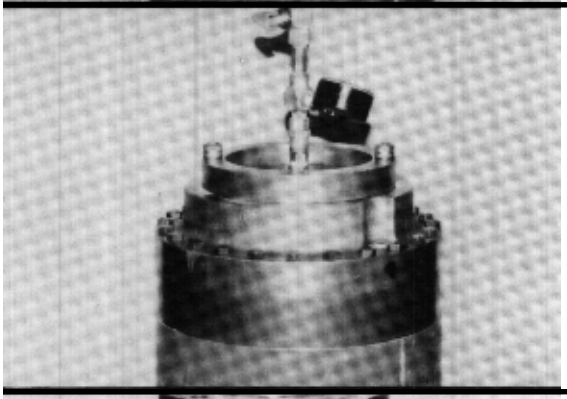
24. Apply a light coat of “Never-Seize” to **pipe plug(15).**



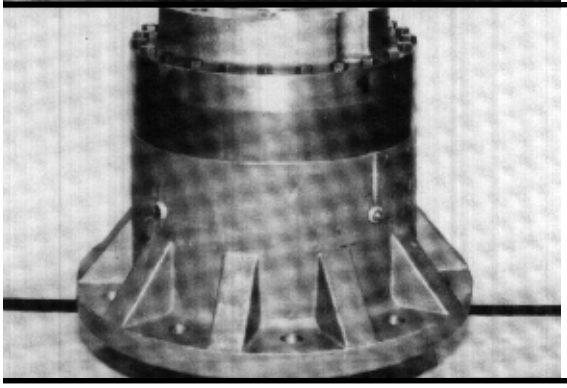
25. Tighthen **pipe plug(15)** into the pipe plug hole in **cover(6).**



26. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the **ID** tag of the unit.



27. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



28. At this point the main assembly complete.

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The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools must be made from mild steel. All dimensions are given in inches.

OPTIONAL: In order to improve tool life, tools may be carborized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a “G” on the tool diagram.

1. TOOL NO. T-130717
   BEARING CUP PRESSING FIXTURE for CUP(1E)

2. TOOL NO. T-156792
   BEARING CUP PRESSING FIXTURE for CUP(1C)

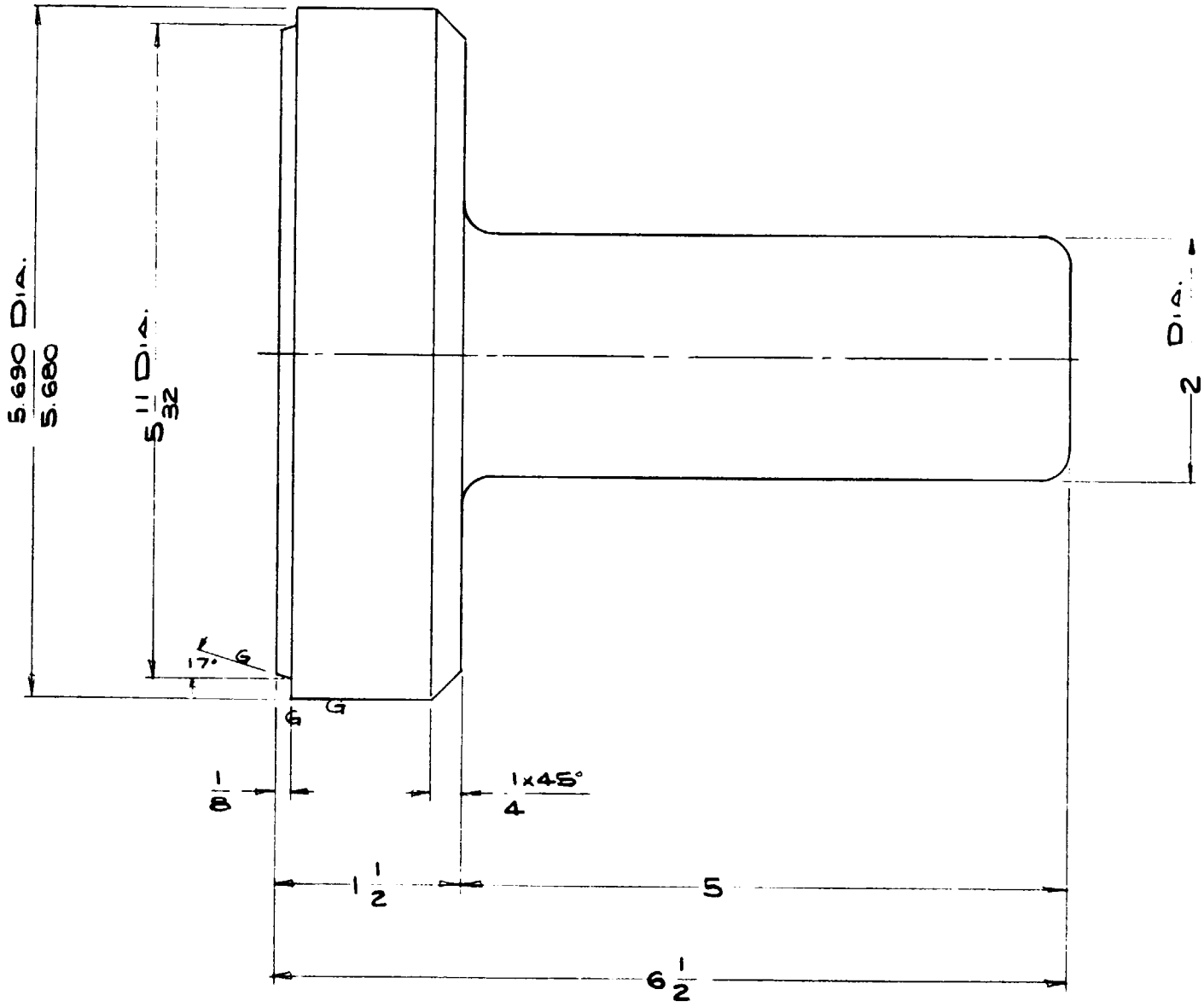
3. TOOL NO. T-158049
   BEARING CONE PRESSING FIXTURE for CONE(1D)

4. TOOL NO. T-146588
   BEARING CONE PRESSING FIXTURE for CONE(1F)

5. TOOL NO. T-156766
   AN-18 LOCKNUT WRENCH

6. TOOL NO. T-156799
   SEAL PRESSING FIXTURE

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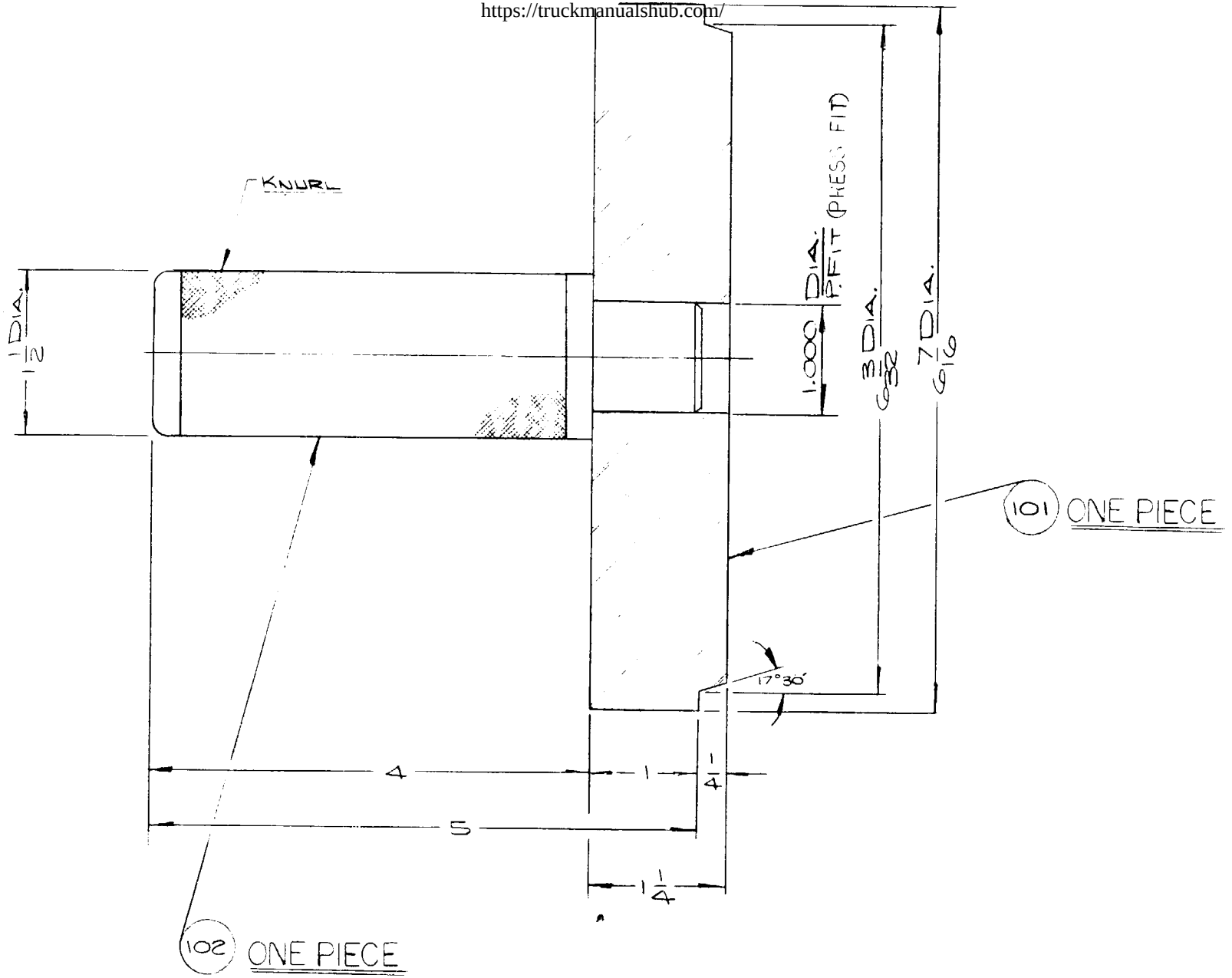


T-130717

SCALE: 3/4 ONE PIECE

BEARING CUP PRESSING FIXTURE
for CUP(1E)

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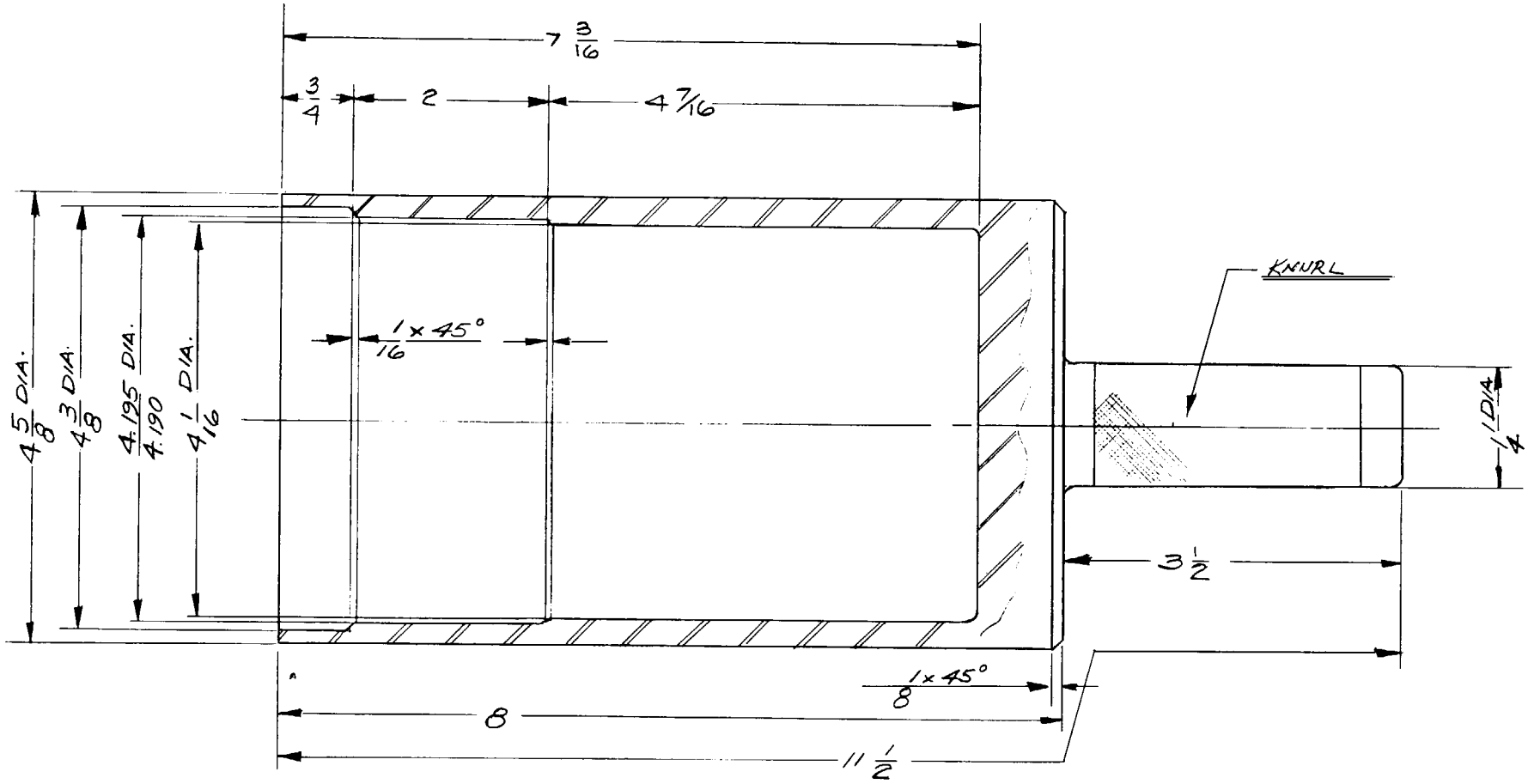


T-156792

SCALE: 3/4

BEARING CUP PRESSING FIXTURE
for CUP(1C)

https://truckmanualshub.com/

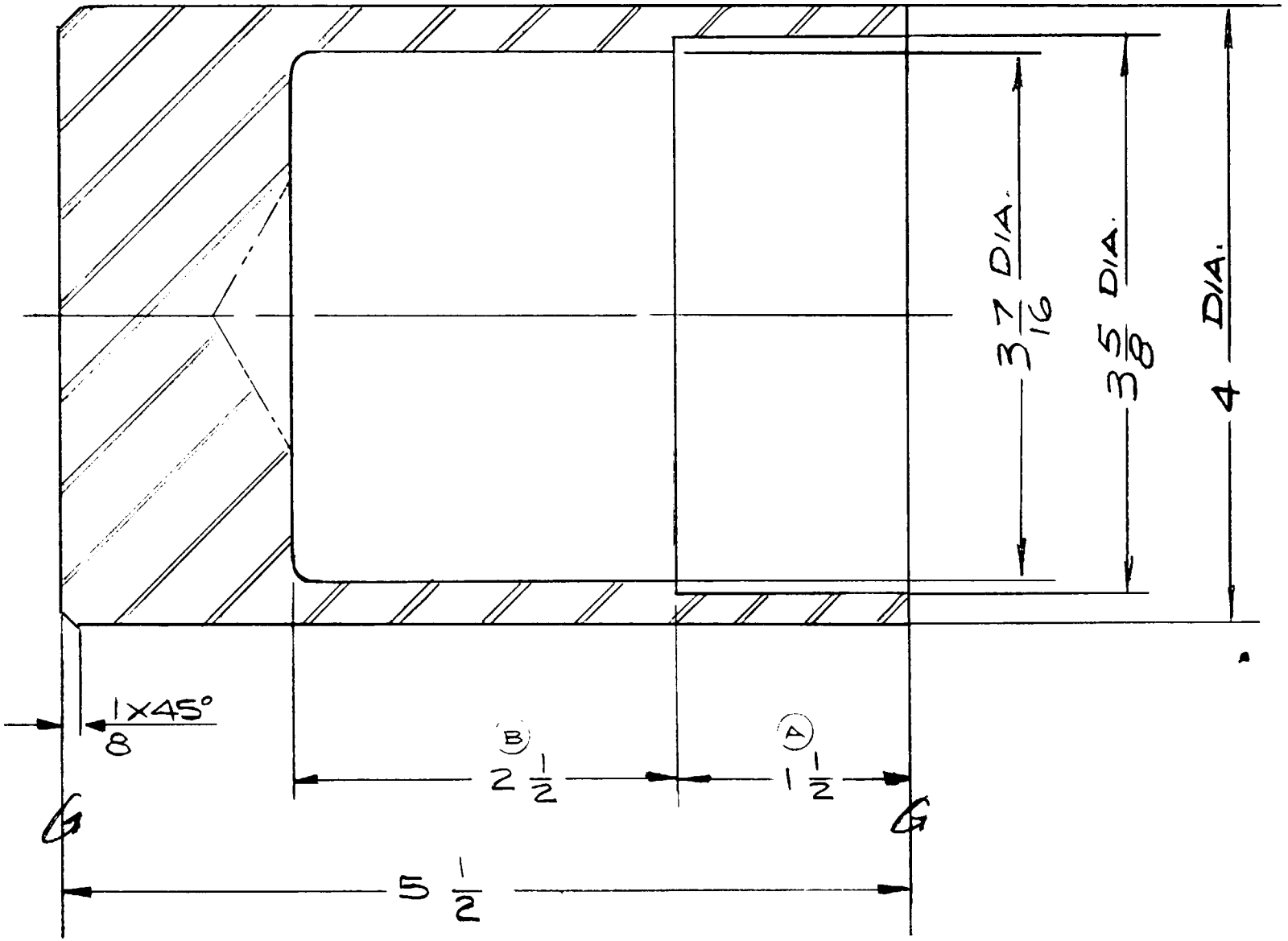


T-158049

SCALE: 3/4 ONE PIECE

BEARING CONE PRESSING FIXTURE
for CONE(1D)

https://truckmanualshub.com/

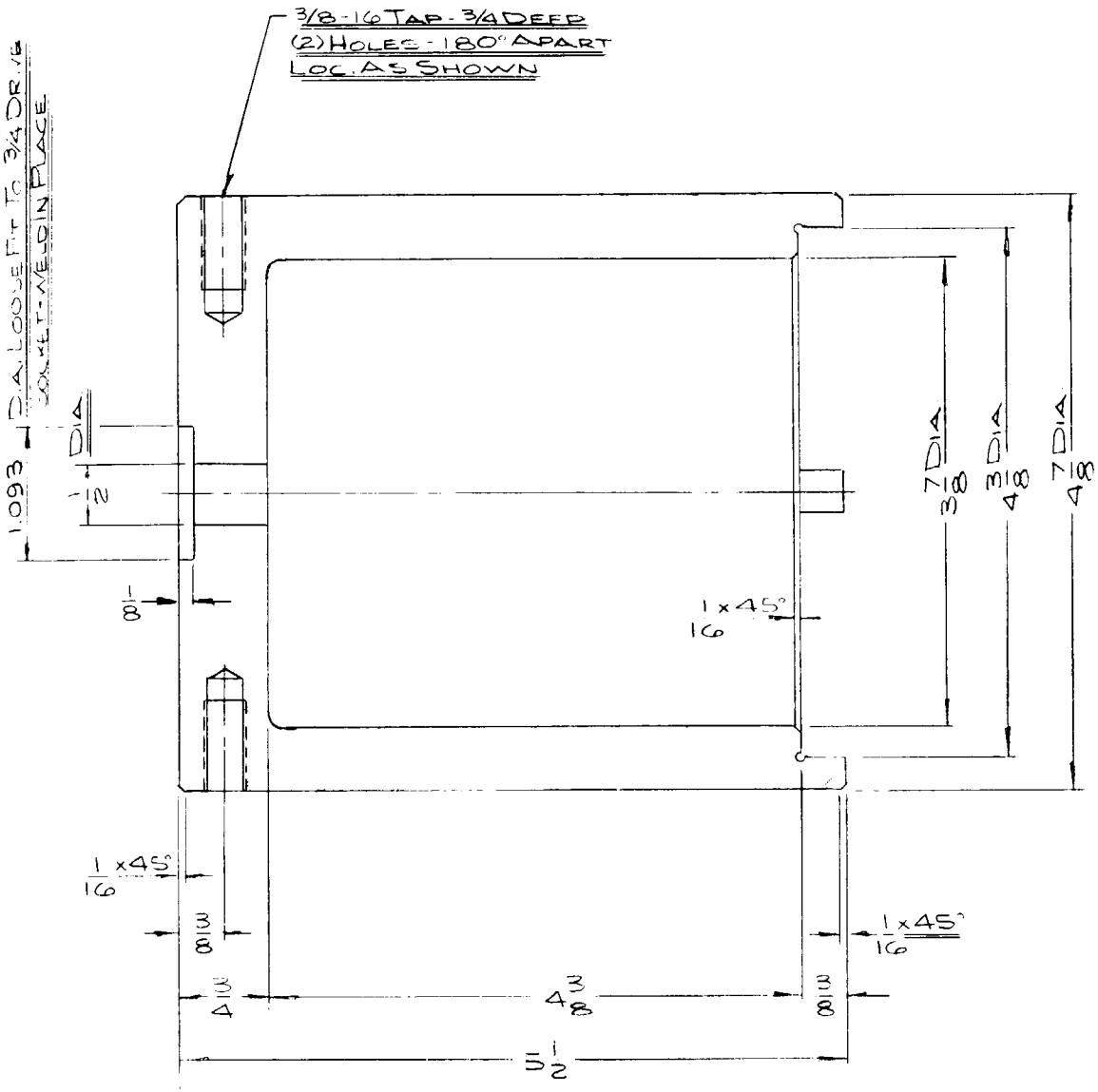


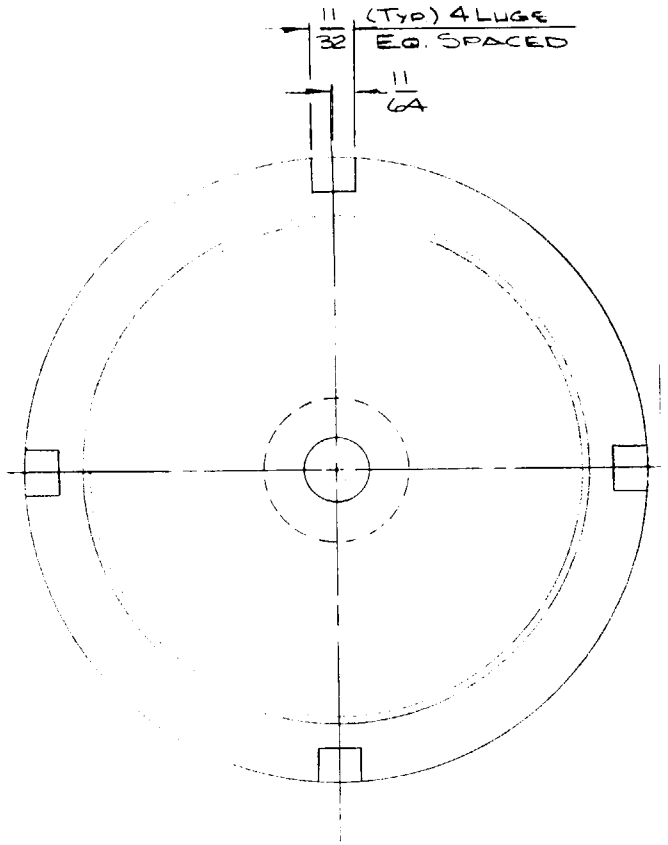
T-146588

SCALE: full ONE PIECE

BEARING CONE PRESSING FIXTURE
for CONE(1F)

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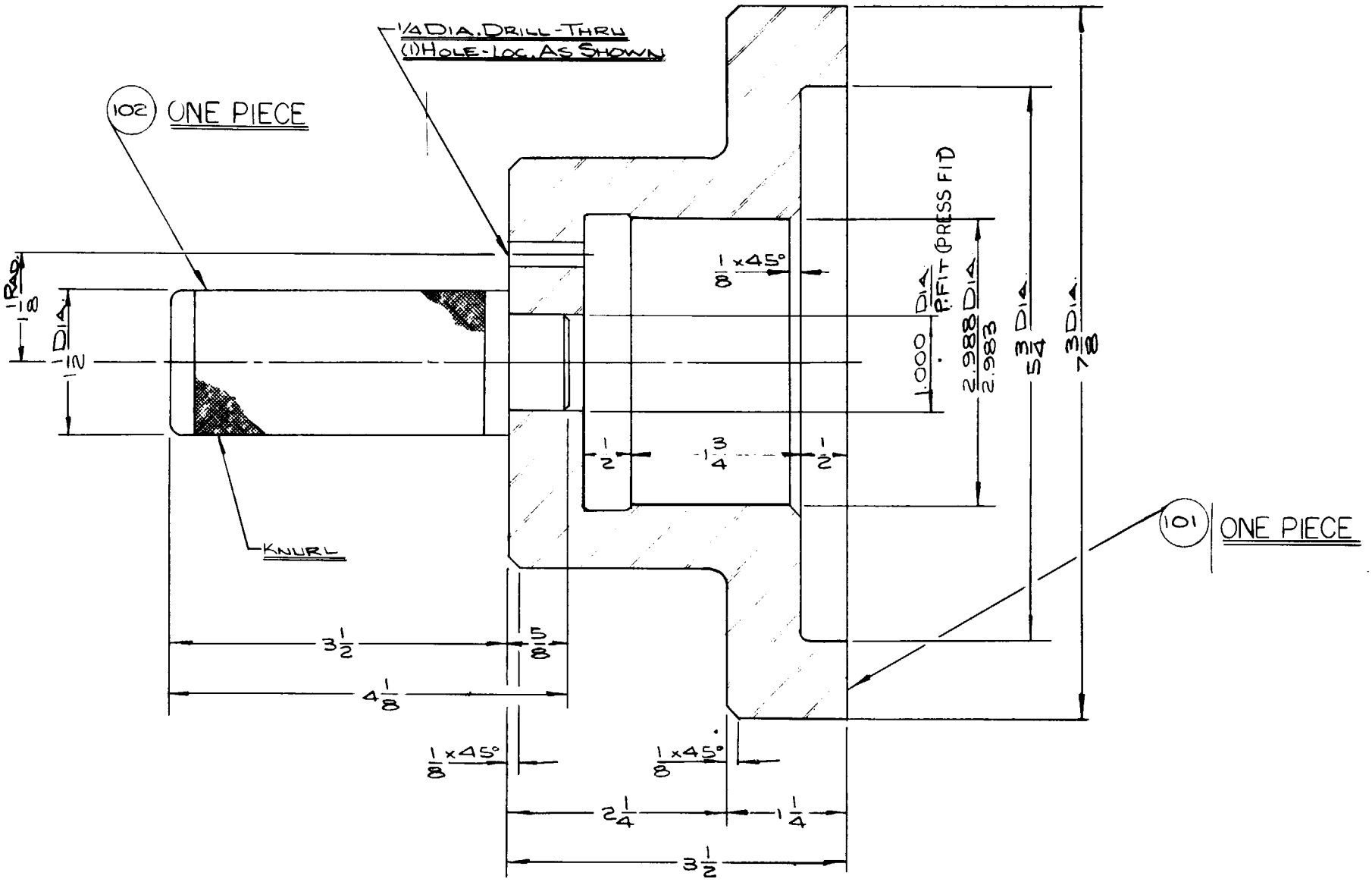
T-156766

AN-18 LOCKNUT WRENCH

SCALE: 2/3 ONE PIECE

USE 3/4 in. DRIVE SOCKET

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T-156799 **SCALE: 2/3**

SEAL PRESSING FIXTURE

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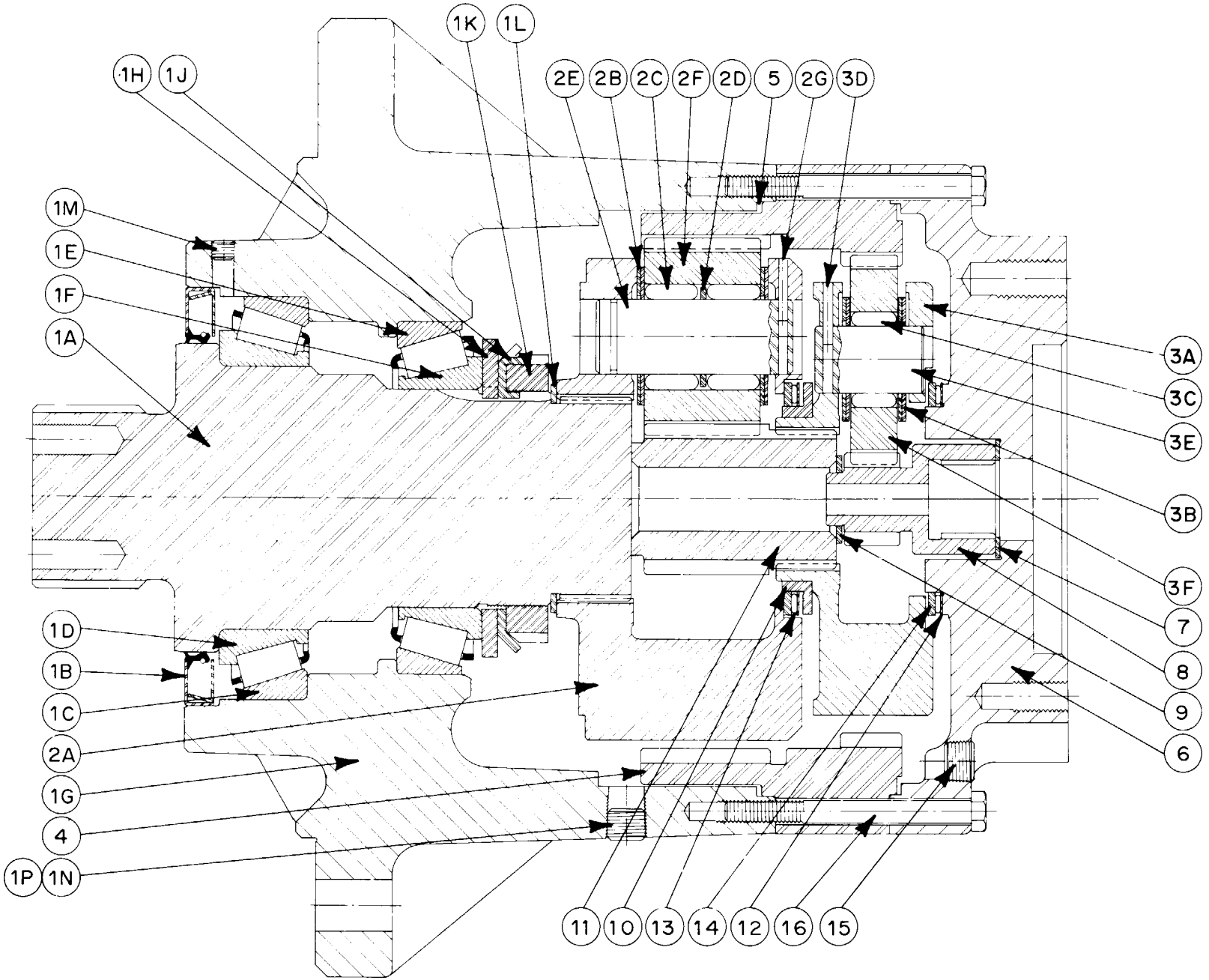
PARTS LIST

ITEM	QUANTITY	DESCRIPTION
1	1	hub-spindle sub-assembly
1A	1	output shaft
1B	1	seal
1C	1	bearing cup
1D	1	bearing cone
1E	1	bearing cup
1F	1	bearing cone
1G	1	hub
1H	1	tanged washer
1J	1	lockwasher
1K	1	locknut
1L	1	retaining ring
1M	2	pipe plug
1N	1	pipe plug
1P	1	magnetic pipe plug
2	1	second stage carrier sub-assembly
2A	1	second stage carrier
2B	12	thrust washer
2C	108	needle roller
2D	3	spacer
2E	3	planet shaft
2F	3	planet gear
2G	3	dowel pin
3	1	first stage carrier sub-assembly
3A	1	1 first stage carrier
3B	12	thrust washer
3C	57	needle roller
3D	3	dowel pin
3E	3	planet shaft
3F	3	planet gear
4	1	ring gear
5	2	“O” ring
6	1	cover
7	1	thrust washer
8	1	input gear
9	1	thrust washer

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ITEM	QUANTITY	DESCRIPTION
10	1	thrust bearing carrier
11	1	second stage sun gear
12	2	thrust washer
13	2	thrust bearing
14	2	thrust washer
15	1	pipe plug
16	24	bolt
17	4	drive screw
18	1	ID plate

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CROSS-SECTIONAL VIEW of S6A

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STEERING SYSTEM TROUBLE SHOOTING
(for systems having Char-Lynn Orbitroi)

Most steering problems can be corrected if the problem is properly defined. The entire steering system should be evaluated before removing any components. The steering control unit is generally not the cause of most steering problems. The following is a list of steering problems along with possible causes and suggested corrections.
Form No. V0015

Problem	Possible Cause	Correction
1. Slow steering, hard steering, or loss of power assist.	Worn or malfunctioning pump.	Replace pump.
	Stuck flow divider piston.	Replace flow divider.
	Malfunctioning relief valve allowing the system pressure to be less than specified.	Replace the relief valve.
2. Wander-Vehicle will not stay in a straight line.	Air in the system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	Correct
	Worn mechanical linkage.	Repair or replace.
	Bending of linkage or cylinder rod.	Repair or replace.
	Loose cylinder piston.	Repair or replace.
	Severe wear in steering control unit.	Replace the steering control unit.
3. Drift-Vehicle veers slowly in one direction.	Cylinder slowly extends without turning the steering wheel.	A small rate of extension may be normal on a load center system.
	Worn or damaged steering linkage.	Align front end.
4. Slip-A slow movement of steering wheel fails to cause any movement of steered wheels.	Leakage of cylinder piston seals.	Replace seals.
	Worn steering control unit meter.	Replace steering control unit.
DELETED	DELETED	DELETED
6. Erratic steering.	Air in system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	Correct condition and add fluid.
	Loose cylinder piston.	Replace cylinder.
	DELETED	DELETED
7. "Spongy" or soft steering.	Air in hydraulic system. Most likely air trapped in cylinders or lines.	Bleed air out of system. Placing ports on top of the cylinder will help prevent air trapping.
	Low fluid level.	Add fluid and check for leaks.
8. Free Wheeling-Steering wheel turns freely with no feeling of pressure and no action on steered wheels.	Steering column upper shaft is loose or damaged.	Tighten steering wheel nut.
	Lower splines of column may be disengaged or broken.	Repair or replace column.
	Steering control unit meter has a lack of oil. This can happen on start-up, after repair, or long periods of non use.	Usually starting engine will cure problem.
	No flow to steering unit can be caused by: 1. Low fluid level. 2. Ruptured hose. DELETED	1. Add fluid and check for leaks. 2. Replace hose. DELETED
9. Free Wheeling-Steering wheel turns with slight resistance but results in little or no steered wheel action.	Piston seal blown out.	Determine cause. Correct and replace seal.
10. Excessive free play at steering wheel.	Loose steering wheel nut. Steering column shaft worn or damaged. There should be very little free play in the unit itself.	Repair or replace steering wheel connection or column.
11. Excessive free play at steered wheels.	Broken or worn linkage between cylinder and steered wheels.	Check for loose fitting bearings and anchor points in steering linkage between cylinder and steered wheels.
	Leaky cylinder seals.	Replace cylinder seals.

Continued. . .

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12. Binding or poor centering of steering wheel.	Binding or misalignment in steering column or splined input connection.	Align column pilot and spline to steering control unit.
	High back pressure in tank line can cause slow return to center. Should not exceed 300 psi.	Revise circuit return line.
	Large particles can cause binding between the steering unit spool and sleeve.	Clean the unit and filter the oil. If another component has failed generating contaminents, flush the system while by-passing the steering control unit.
13. Steering unit locks up.	Large particles in gerotor section.	Clean the unit.
	Severe wear and/or broken pin.	Replace the unit.
	DELETED	DELETED
14. Steering wheel oscillates or turns by itself.	Parts assembled wrong. Steering unit improperly timed.	Correct timing.
	Lines connected to wrong ports.	Reconnect lines correctly.
15. Steered wheels turn in wrong direction when operator activates steering wheel.	Lines connected to wrong cylinder ports.	Reconnect lines correctly.
16. Steering wheel kicks at start of steering.	No inlet check valve on steering control unit.	Install a check valve.

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MERITOR™

A Heritage of Rockwell Technology

Cam-Master®
Cam Brakes

Maintenance Manual No. 4
Revised 10-98

- Q Plus™
- Cast Plus™
- Q Series
- P Series
- T Series

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Service Notes

MERITOR™

This maintenance manual describes the correct service and repair procedures for Meritor Cam-Master® cam brakes. The information contained in this manual was current at time of printing and is subject to change without notice or liability.

You must follow your company procedures when you service or repair equipment or components. You must understand all procedures and instructions before you begin to work on a unit. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as damage to equipment and components.

Meritor uses the following notations to warn the user of possible safety problems and to provide information that will prevent damage to equipment and components.

WARNING

A WARNING indicates a procedure that you must follow exactly to avoid serious personal injury.

CAUTION

A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components. Serious personal injury can also occur.

NOTE: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that will help to make service quicker and easier.

This symbol indicates that fasteners must be tightened to a specific torque.

Meritor's Drivetrain Plus™ Technical Electronic Library (TEL) on CD

This CD includes product and service information for Meritor's brake and automatic slack adjusters. $20. Order TP-9853.

Additional Publications

- *Paymaster® Automatic Slack Adjuster* Maintenance Manual No. 413
- *Q Plus™ LX500 and MX500 Cam Brakes* Maintenance Manual No. MM-96173

Videos

- *Meritor Cam Brake Maintenance* (Video 90233)
- *Automatic Slack Adjuster Installation and Maintenance* (Video 90234)
- *New Generation Automatic Slack Adjuster* (Video T-9443V)

How to Order

Order items from Meritor Literature Distribution Center, c/o Vispac, Inc., 35000 Industrial Road, Livonia, MI 48150. For videos, include a purchase order or check for $20 payable to Meritor Automotive, Inc., for each video.

Phone orders are also accepted by calling Meritor's Customer Service Center at 800-535-5560.

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Table of Contents

Asbestos and Non-Asbestos Fibers Warnings 1

Section 1: Exploded Views

15-Inch Q Plus™, 16.5-Inch Q Plus™ and Q Series Brakes with Cast Spiders 2
16.5-Inch Q Plus™ Brakes with Stamped Spiders 3
15-Inch Q Series Brakes 4
16.5-Inch P Series Brakes 5
15-Inch T Series Brakes 6

Section 2: Introduction

Meritor's Cam-Master® Brakes 7
Q Plus™
Q Plus™ LX500 and Q Plus™ MX500
Cast Plus™
Q Series Brakes 8
P Series
T Series
Differences Between Q Plus™ and Q Series Cam Brakes 9

Section 3: Disassembly

Remove the Wheel Components 10
Automatic Slack Adjuster
Brake Shoes 11
Remove the Camshaft and Automatic Slack Adjuster 13

Section 4: Prepare Parts for Assembly

Clean and Dry Parts 14
Corrosion Protection
Inspect Parts
Automatic Slack Adjuster 15
Brake Camshafts 16

Section 5: Assembly

Install the Camshaft 17
Q Series 16.5-Inch Cam Brake
Replacing a Q Series Camshafts with Q Plus™ Camshaft in all Front and Drive Axle
16.5-Inch Q Series Brakes
Replacing a Hammerclaw Camshaft with a Standard Q Plus™ Camshaft on Front Axles Only
Shoe Return Spring Installation 18
Automatic Slack Adjuster
Handed and Unhanded Automatic Slack Adjusters
Pull Pawls
Replace Conventional Pawls with Pull Pawls
Installing the Slack Adjuster Onto the Camshaft 19
Install the Clevis 20
Brake Slack Adjuster Position (BSAP) Method 21
Install the Brake Shoes 22
All Q Plus™ and Q Series 16.5-Inch Brakes
Q Series 15-Inch Cam Brake 23
P Series and Cast Plus™ Cam Brakes
T Series Cam Brake 24
Drum and Wheel

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Table of Contents

MERITOR™

Section 6: Adjust the Brakes

Automatic Slack Adjuster 25
Measure the Automatic Slack Adjuster
Adjust the Brake
Free Stroke Measurement
Commercial Vehicle Safety Alliance (CVSA) Guidelines to Measure Push Rod Travel (Adjusted Chamber Stroke) 27
Alternate Method for Determining Push Rod Travel (Adjusted Chamber Stroke)
Commercial Vehicle Safety Alliance (CVSA) North American Out-of-Service Criteria Reference Charts 28

Section 7: Reline the Brakes

Single or Tandem Axle 29
Use the Correct Lining Material
Single Axle
Tandem Axle
Combination Friction Linings
Primary Shoe Locations

Section 8: Lubrication and Maintenance

Camshaft Bushings 30
On-Highway Linehaul Applications
Off-Highway Applications
Automatic Slack Adjuster Maintenance
Anti-Seize Compound
Factory-Installed Automatic Slack Adjusters on Q Plus™ LX500 and MX500 Cam Brake Packages

Section 9: Inspection

Before You Return the Vehicle to Service 32

Section 10: Recommended Periodic Service

Recommended Periodic Service 33
Adjust
Lubricate
Reline
Inspect
At a Major Overhaul

Section 11: Torque Table

Fastener Torque Table for Cam Brakes 34

Section 12: Aftermarket Brake Conversion Kits

Q Plus™ and Q Series Brake Conversion Kits 35

Section 13: Cam Brake Tips 36

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Asbestos and Non-asbestos Fibers

ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos. Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either ofthe maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local -egulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some medical experts believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hourtime-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by MOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes

a) Enclose the brake assembly within a negative pressure enclosure, The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents,
flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

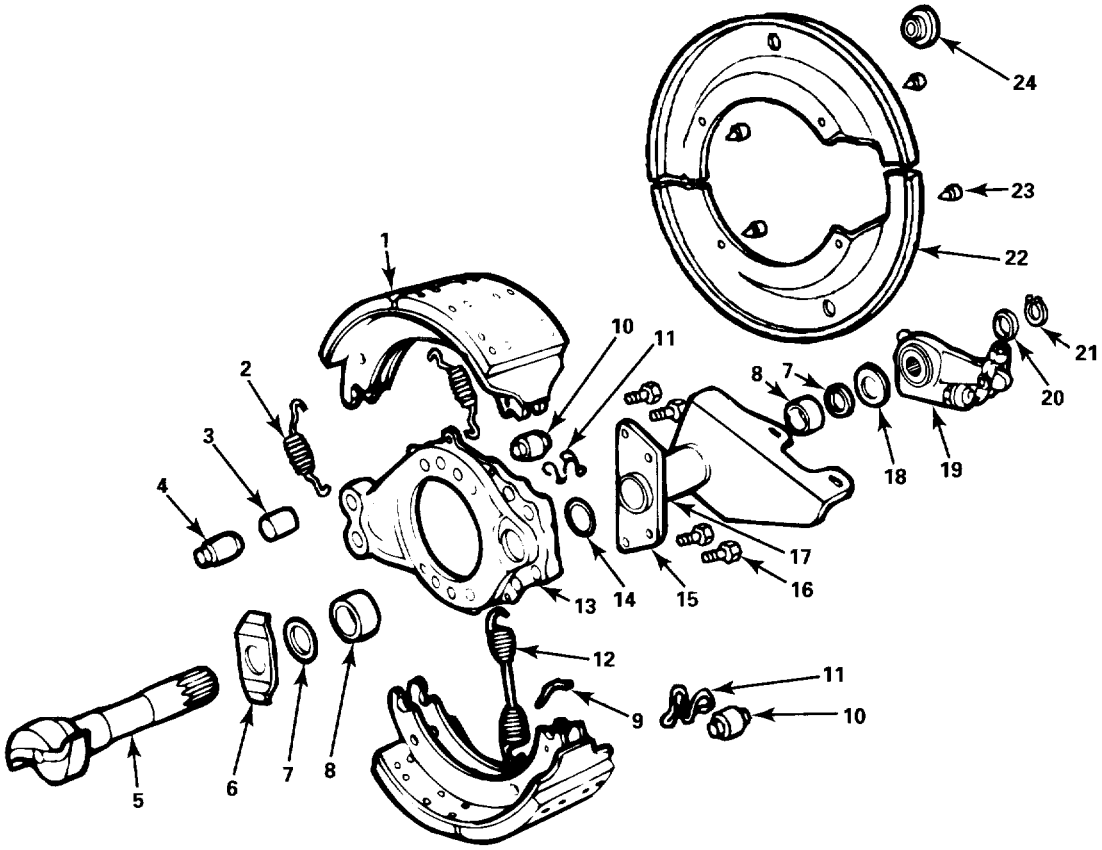
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA fifter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

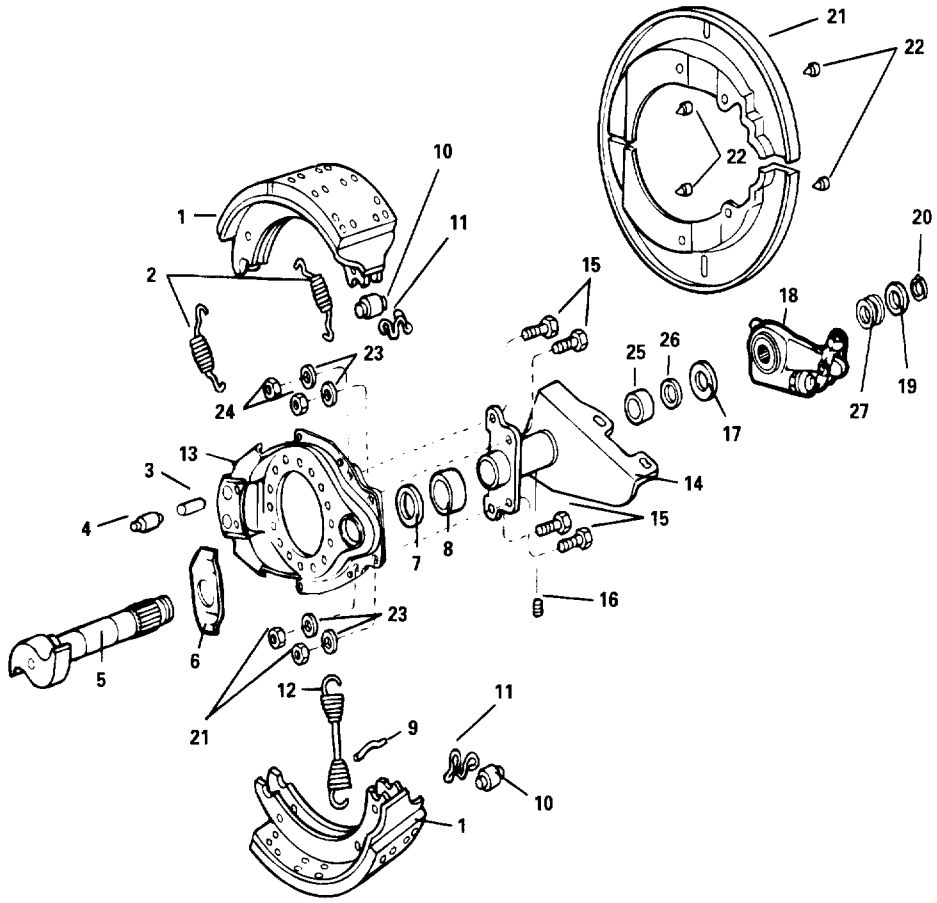
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15-Inch Q Plus™
16.5-inch Q Plus™ and Q Series Brakes with Cast Spiders

Item	Description
1	Shoe and Lining Assembly
2	Spring - shoe retaining
3	Bushing - anchor pin
4	Anchor Pin - brake shoe
5	Camshaft - “S” head
6	Washer - camhead
7	Seal - camshaft (grease)
8	Bushing - camshaft
9	Pin - return spring
10	Roller - brake shoe
11	Retainer - shoe roller
12	Spring - brake shoe return

Item	Description
13	Cast spider - brake
14	Seal - chamber bracket
15	Bracket - camshaft and chamber
16	Capscrew - chamber bracket
17	Fitting - grease
18	Washer - camshaft (thick)
19	Slack Adjuster - automatic
20	Washer - spacing
21	Snap Ring - camshaft
22	Dust Shield
23	Capscrew - dust shield
24	Plug

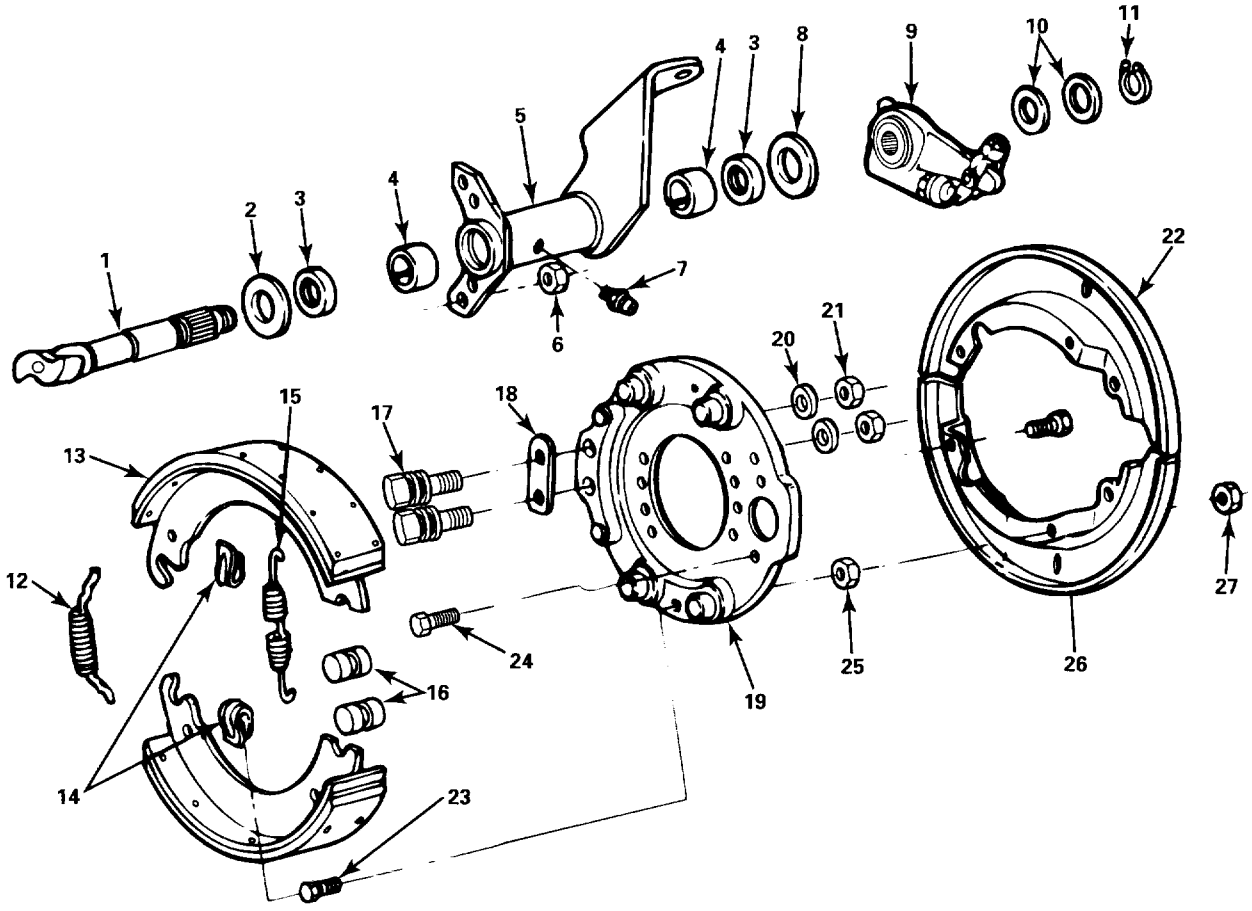


16. 5-Inch Q PLUS™ Brakes with Stamped Spiders

Item	Description
1	Shoe and Lining Assembly
2	Spring - shoe retaining
3	Bushing - anchor pin
4	Anchor Pin - brake shoe
5	Camshaft - “S” head
6	Washer - camhead
7	Orange seal - camshaft
8	Bushing - camshaft
9	Pin - return spring
10	Roller - brake shoe
11	Retainer - shoe roller
12	Spring - brake shoe return
13	Stamped spider - brake
14	Bracket - camshaft and chamber

Item	Description
15	Capscrew - Grade 8
16	Plug - pipe
17	Washer - camshaft (thick)
18	Slack adjuster - automatic
19	Washer - spacing
20	Snap ring - camshaft
21	Dust shield
22	Capscrew - dust shield
23	Washer (4) - hard
24	Nut (4) - Grade 8
25	Bushing - camshaft
26	Seal - camshaft
27	Washer - spacing (thin)

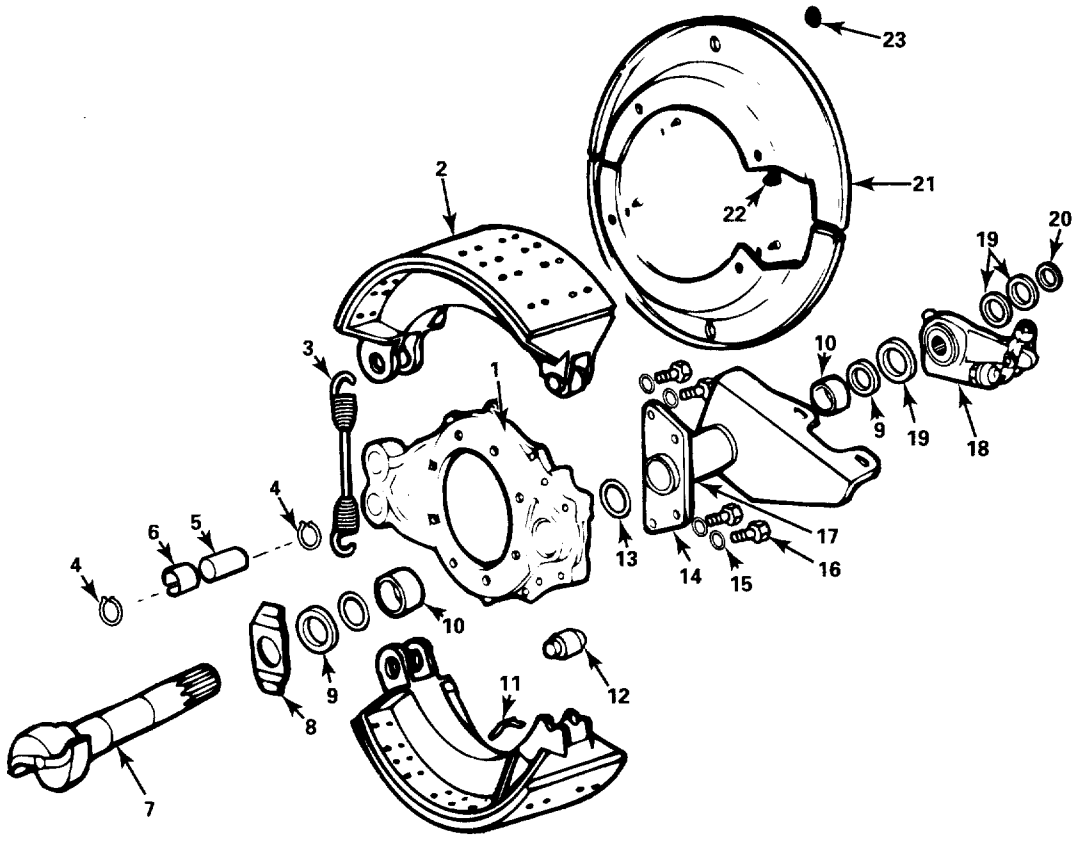
https://truckmanualshub.com/



15-inch Q Series Brakes

Item	Description
1	Camshaft
2	Washer - camhead
3	Seal - camshaft (grease)
4	Bushing - camshaft
5	Bracket - camshaft
6	Nut - camshaft bracket
7	Grease Fitting
8	Washer - spacing
9	Slack Adjuster - automatic
10	Spacers - camshaft
11	Snap Ring - camshaft
12	Spring - shoe retaining
13	Shoe and Lining Assembly
14	Clips - anti-rattle

Item	Description
15	Spring - shoe return
16	Rollers - brake shoe
17	Anchor Pins - brake shoe
18	Plate - support
19	Backing Plate
20	Washer - anchor pin
21	Nut - anchor pin
22	Dust Shield
23	Bolt - shoe clip
24	Bolt - camshaft bracket
25	Nut - clip to backing plate
26	Capscrew - dust shield
27	Nut - dust shield

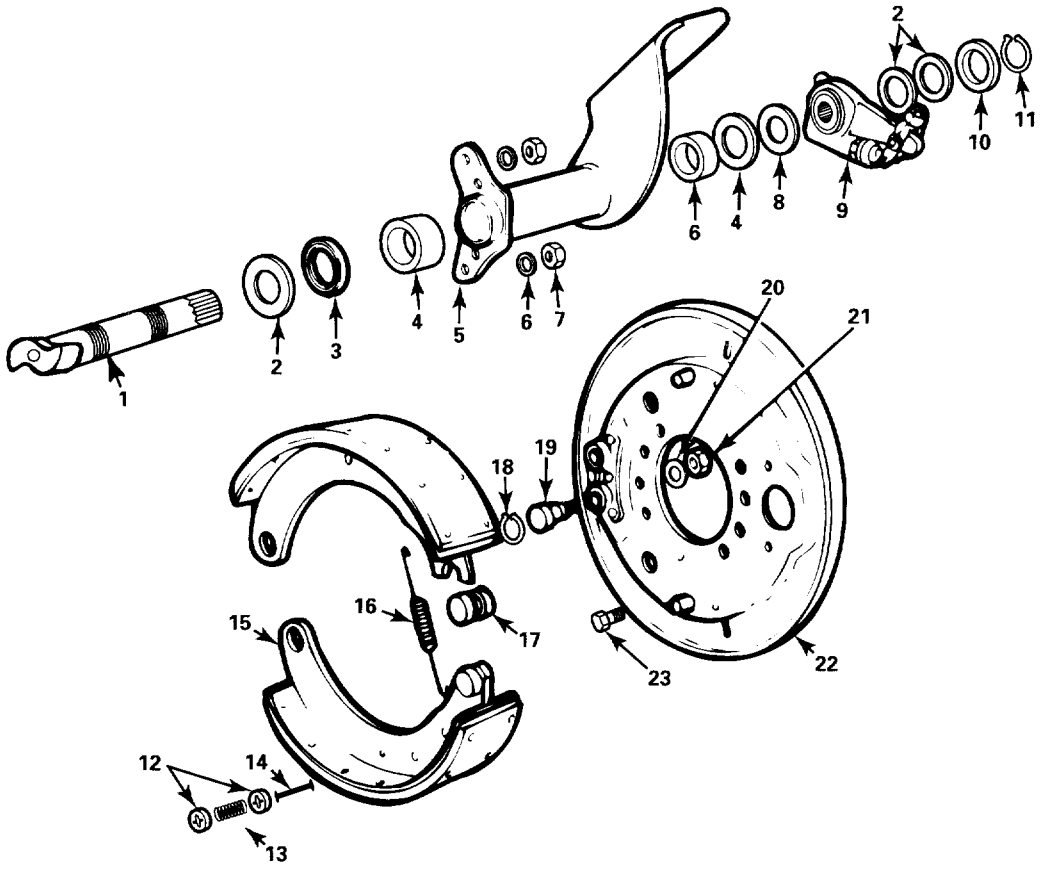


16. 5-Inch P Series Brakes

Item	Description
1	Spider - brake
2	Shoe and Lining Assembly
3	Spring - brake shoe return
4	Snap Ring - anchor pin
5	Anchor Pin - brake shoe
6	Bushing - anchor pin
7	Camshaft - “S” head
8	Washer - camhead
9	Seal - camshaft (grease)
10	Bushing - camshaft
11	Pin - return spring
12	Roller - cam

Item	Description
13	Seal - camshaft bracket
14	Bracket - camshaft and chamber
15	Washer - bracket capscrew
16	Capscrew - camshaft bracket
17	Fitting - grease
18	Slack Adjuster - automatic
19	Washer - spacing
20	Snap Ring - camshaft
21	Dust Shield
22	Capscrew - dust shield
23	Plug

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15-Inch T Series Brakes

Item	Description
1	Camshaft
2	Washer - camhead
3	Seal - camshaft (grease)
4	Bushing
5	Bracket - camshaft and chamber
6	Lockwasher - bracket
7	Nut - bracket
8	Washer - spacing
9	Slack Adjuster - automatic
10	Washer - spacer
11	Snap Ring - camshaft
12	Retainer - anti-rattle spring

Item	Description
13	Spring - anti-rattle
14	Rod - anti-rattle
15	Shoe and Lining Assembly
16	Spring - shoe return
17	Roller - brake shoe
18	Snap Ring - anchor pin
19	Anchor Pin - brake shoe
20	Washer - anchor pin
21	Nut - anchor pin
22	Backing Plate
23	Capscrew - dust shield

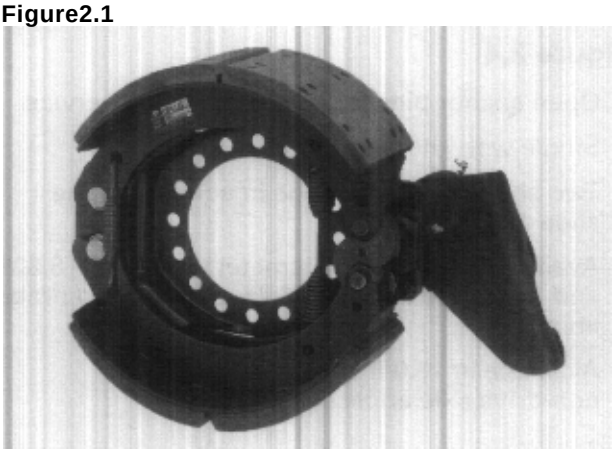
Meritor's Cam-Master ® Brakes

Q Plus™

Figure 2.1

- More lining thickness increases service life and mileage between relines.
- A redesigned S-cam and heavy-duty shoe return spring allow additional shoe travel.
- An improved camshaft bushing contributes to longer service life.
- The trailer axle version of the 16.5 x 7.0-inch Q Plus™ brake uses a heavy-duty, bolt-on camshaft bushing.

Figure2.1



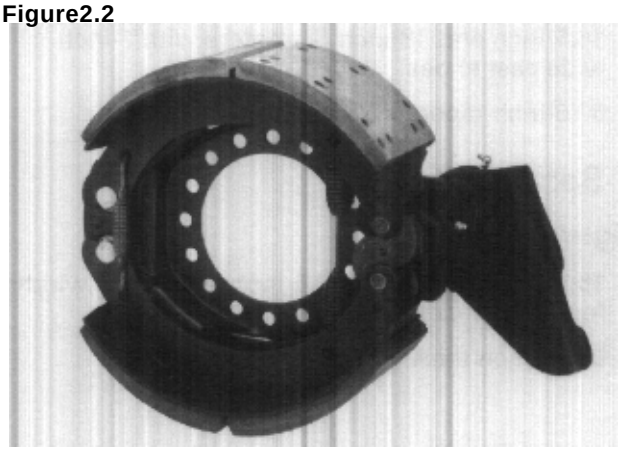
Q Plus™ LX500 and Q Plus™ MX500

Figure 2.2

For Complete maintenance and service information on Meritor's Q Plus LX500 and MX500 cam brakes, refer to Maintenance Manual No. MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes.* To order a copy of this publication call Meritor's Customer Service Center at 800-535-5560.

- The Q Plus™ LX500 cam brake and the Q Plus™ MX500 cam brake both include an Extended Lube Feature and Meritor factory-installed automatic slack adjusters.
- The Q Plus™ MX500 cam brake also includes all features found in the LX500 plus special long life brake shoes and linings.

Figure2.2

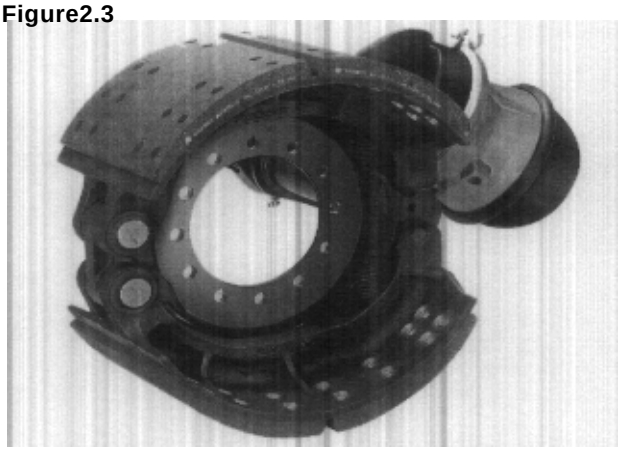


Cast Plus™

Figure 2.3

- Spec'd for heavy-duty, off-highway and people-mover applications.
- Uses Meritor's Q Plus™ cam brake linings. Providing increased service life and mileage between relines.
- A redesigned S-cam and heavy-duty shoe return spring allow additional shoe travel.
- An improved camshaft bushing contributes to longer service life.
- Uses Meritor's Cast P Series brake shoe design.

Figure2.3



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Q Series Brakes

Figure 2.4

- Open anchor pins for “Quick Change” service.
- Single web shoe (15-inch only).
- Two shoe retainer springs in addition to the shoe return springs.
- Available in 16.5-inch diameter with 5, 6, 7, 8.625 and 10-inch widths with 0.75-inch tapered brake lining.
- Available in 15.0-inch diameter for front non-drive axle applications.

P Series

Figure 2.5

- 16.5-inch and 18-inch diameters with 7-inch wide cast shoes.
- 0.75-inch tapered brake lining.

T Series

Figure 2.6

- 15-inch diameter with 3.5-inch and 4-inch widths for smaller capacity axles.
- 0.438-inch thick lining.

Figure2.4

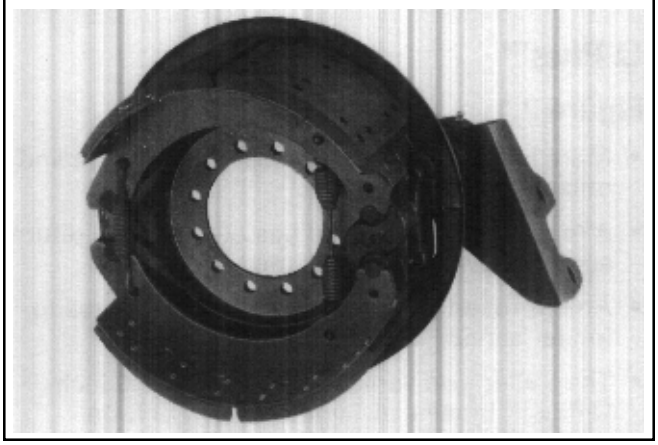


Figure2.5

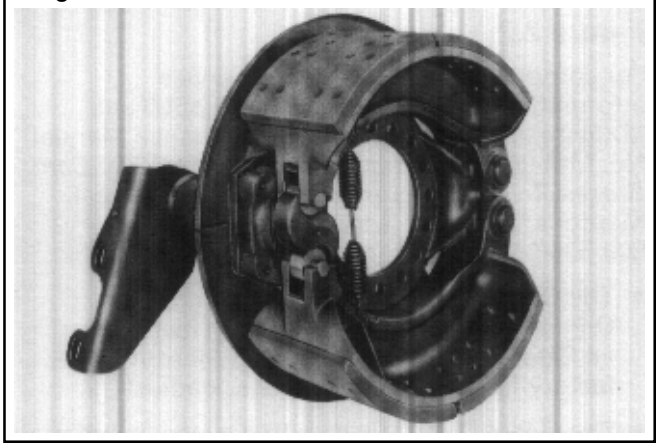
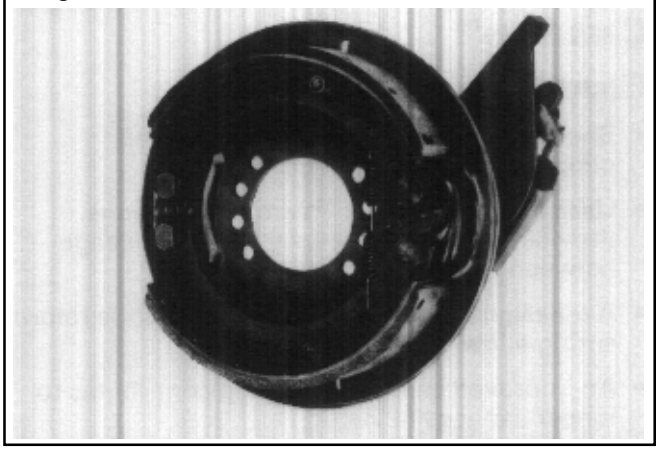
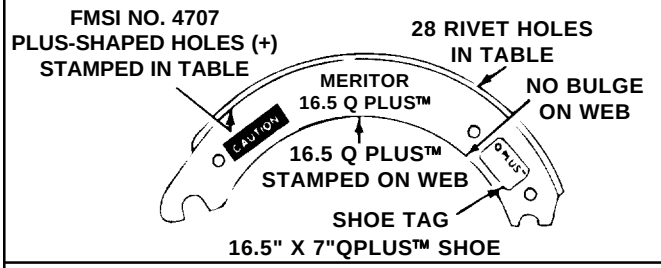
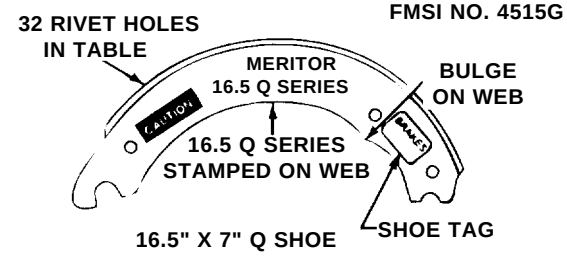
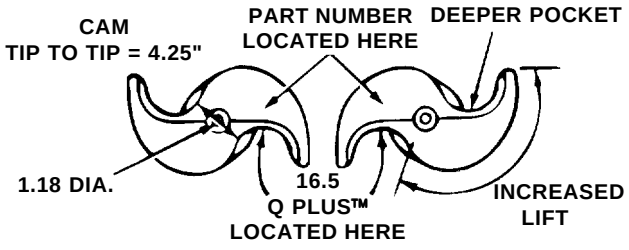
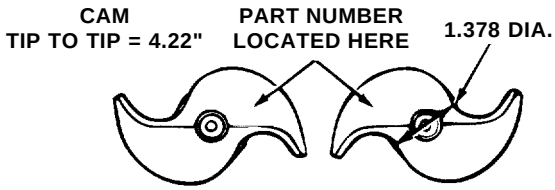
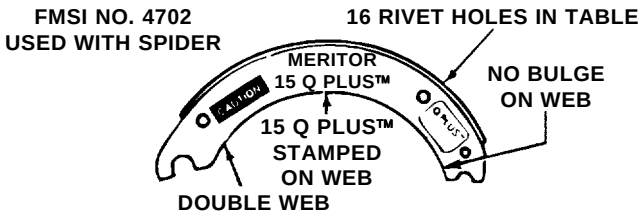
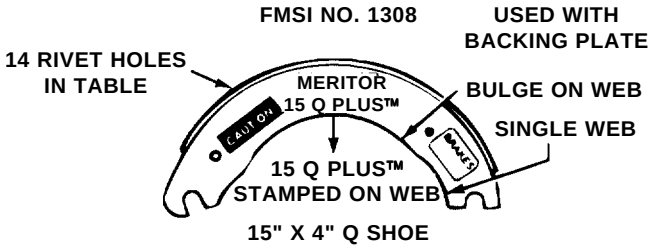
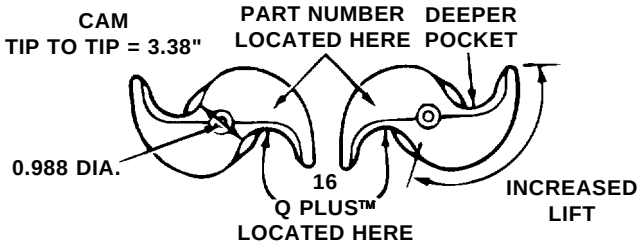
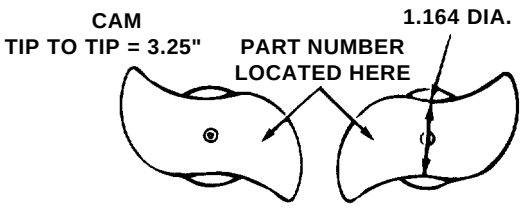


Figure2.6



Differences Between Q Plus™ and Q Series Cam Brakes

Q Plus Components	Q Series Components
 16.5" X 7"QPLUS™ SHOE	 16.5" X 7" Q SHOE
 16.5" Q PLUS™ CAMSHAFT (1.5" DIA.-28 SPLINES)	 16.5" Q CAMSHAFT (1.5" DIA.-10 OR 28 SPLINES)
 15" X 4" Q PLUS™ SHOE	 15" X 4" Q SHOE
 15" Q PLUS™ CAMSHAFT (1.5" DIA.-28 SPLINES)	 15" Q CAMSHAFT (1.25" DIA.-10 OR 24 SPLINES)

Camshafts	Shoes	Return Springs
Q Plus™	Q Plus ™	Heavy-duty (blue)
Q Plus™	Q Series	Standard
Q	Q Series	Standard

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Remove the Wheel Components

Asbestos and Non-Asbestos Fibers Warning

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury can result.

1. The vehicle must be on a level surface.
2. Put blocks under the wheels that will not be raised to keep the vehicle from moving.
3. Raise the vehicle, so that the area you will service is off of the ground. Support the vehicle with safety stands.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.

Automatic Slack Adjuster

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Maintenance Manual No. 4B, *Pay/Master® Automatic Slack Adjuster.* To order a copy of this publication, call Meritor's Customer Service Center at 800-535-5560.

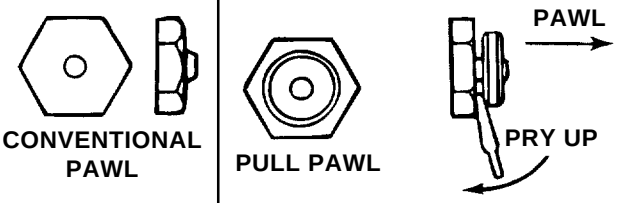
CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

1. **If the slack adjuster is equipped with a conventional pawl: Remove the pawl. Figure 3.1.**

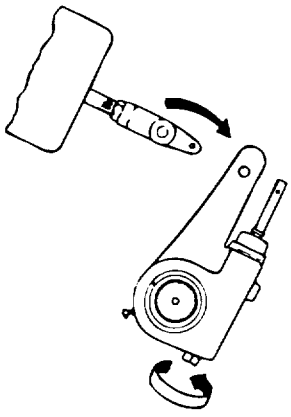
   If the slack adjuster is equipped with a pull pawl assembly: Use a screwdriver or an equivalent tool to lift the pawl button at least 1/32-inch from the actuator to disengage the pawl. **Figure 3.1.**

Figure 3.1



2. Use a wrench to turn the manual adjusting nut in the direction shown in **Figure 3.2** until the brake shoes are fully retracted and the drum clears the lining.

Figure 3.2



WARNING

When you remove a clevis pin that has a spring, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause serious personal injury.

3. Remove both clevis pins and retainer clips or cotter pins.
4. Move the slack adjuster away from the clevis.
5. Follow the manufacturer's instructions to remove the wheel and drum from the axle.

Brake Shoes

All Q Plus™ and Q Series 15-Inch and 16.5-Inch Brakes

1. Push **DOWN** on the **BOTTOM** brake shoe. Pull on the cam roller retainer clip to remove the **BOTTOM** cam roller. **Figure 3.3.**
2. Lift the **TOP** brake shoe and pull on the cam roller retainer clip to remove the **TOP** cam roller.
3. Lift the **BOTTOM** shoe to release the tension on the brake shoe return spring. **Figure 3.4.**
4. Rotate the **BOTTOM** shoe to release the tension on the brake shoe retainer springs. **Figure 3.5.**
5. Remove the shoe retainer springs and the brake shoes.

Figure 3.3

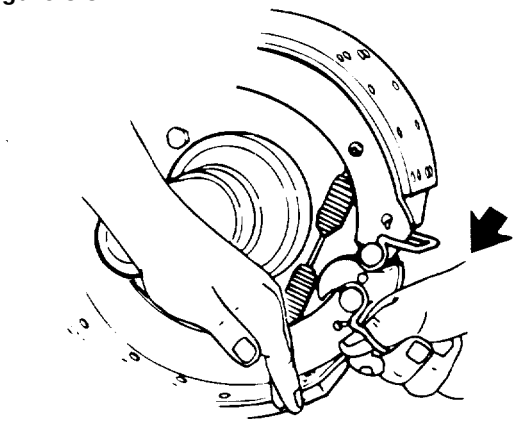


Figure 3.4

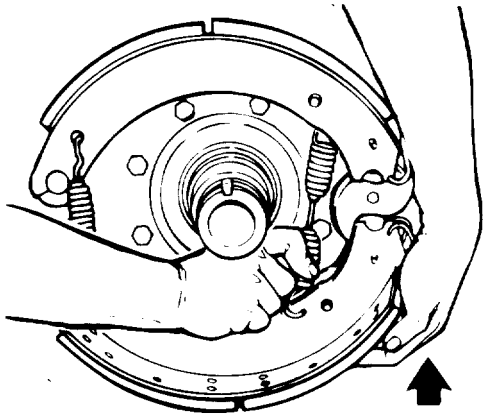
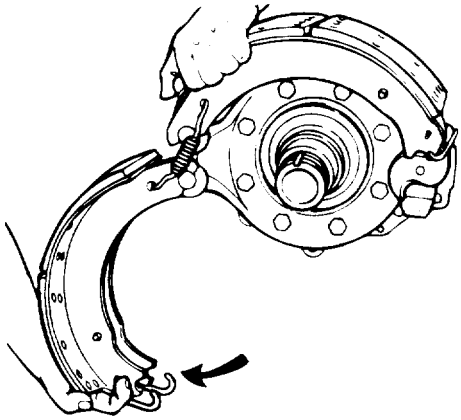


Figure 3.5

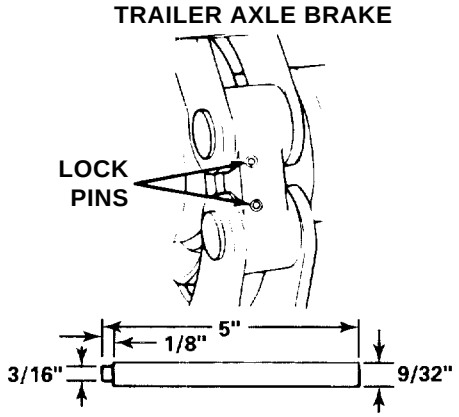


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P Series and Cast Plus™ Brakes

NOTE: Some trailer axle P Series brakes have anchor pins that are held in place with lock pins. You can use a steel rod to make a tool to drive out the lock pins. **Figure 3.6.**

Figure 3.6



NOTE: The current anchor pin arrangement is shown in **Figure 3.7.** Older P Series brakes can include additional parts.

1. Remove the anchor pin snap ring, washer, retainer, felts, seals or capscrews as required.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

2. Remove the **TOP** anchor pin with a brass drift. **Figure 3.8.**
3. Rotate the **TOP** shoe to release the tension on the brake shoe return spring. Remove the shoe. **Figure 3.9.**
4. Remove the **BOTTOM** anchor pin. Refer to Step 2, above. Remove the **BOTTOM** shoe.

Figure 3.7

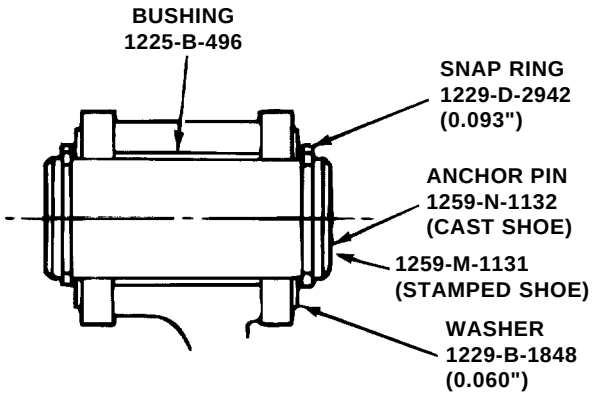


Figure 3.8

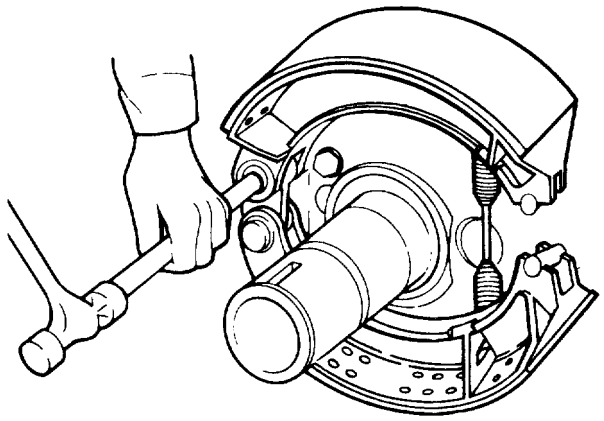
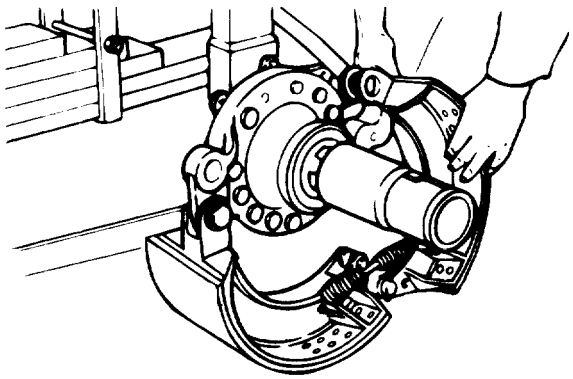
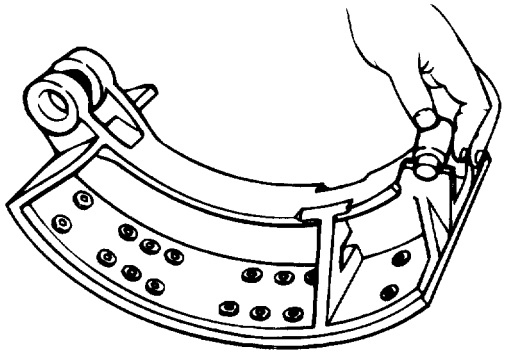


Figure 3.9



5. If necessary, remove the cam rollers. **Figure 3.10.**

Figure 3.4



T Series Cam Brake

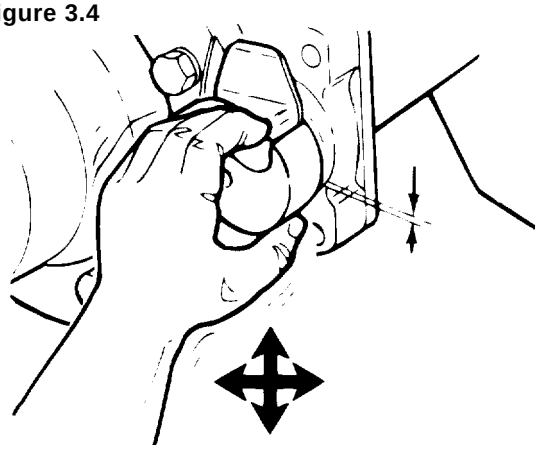
1. Remove the anti-rattle spring retainer and spring from the anti-rattle rod.
2. Push **DOWN** on the **BOTTOM** brake shoe to provide enough clearance to remove the **BOTTOM** cam roller. Remove the roller.
3. Lift the **TOP** brake shoe. Remove the **TOP** cam roller.
4. Remove the anchor pin snap ring and the anchor pin.
5. Rotate the **BOTTOM** shoe to release the tension on the brake shoe retainer springs.
6. Remove the shoe retainer springs and the brake shoes.

Remove the Camshaft and Automatic Slack Adjuster

NOTE: Meritor recommends that you check camshaft bushing end play at every reline to verify that end play is within specification.

1. At the first reline, inspect the cam-to-bushing radial free play and axial end play. Radial free play movement must be less than 0.030-inch (0.762 mm). **Figure 3.11.**

Figure 3.4



- **If radial free play movement is less than 0.030-inch (0.76 mm):** Do not replace the bushings and seals.
- **If radial free play movement exceeds 0.030-inch (0.76 mm):** Replace the bushings and seals.
- **If axial end play exceeds 0.030-inch (0.76 mm):** Remove the snap ring. Add the appropriate number of spacing washers between the automatic slack adjuster and the snap ring to achieve between 0.005-inch and 0.030-inch (0.127-0.762 mm) axial free play movement.

2. Remove the snap ring, washers and spacers from the camshaft.
3. **If the slack adjuster is equipped with a "Quick Connect" clevis:** Remove the clevis from the push rod if the gap between the clevis and the clevis collar exceeds 0.060-inch (1.52 mm). You do not have to remove the clevis if it is in good condition.
4. Remove the slack adjuster from the camshaft.
5. Remove the camshaft from the spider.
6. Use the correct size driver to remove the camshaft bushings from the spider and the spider bracket.

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts will result.

Clean and Dry Parts

1. Use soap and water to clean non-metal parts.
2. Use soft paper or cloth that is free from dirt, oil or abrasives to dry the parts completely.
3. Dry parts immediately after cleaning with clean paper or rags, or compressed air.

Corrosion Protection

NOTE: Parts must be clean and dry before you lubricate them.

1. **If you assemble parts immediately after you clean them:** Lubricate parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them.
2. **If you store parts after you clean them:** Apply a corrosion-preventive material. Store parts in a special paper or other material that prevents corrosion.

Inspect Parts

It is important to carefully inspect all parts before assembly. Check all parts for wear or damage. Repair or replace them as required.

1. Check the spider for expanded anchor pin holes and for cracks. Replace damaged spiders and anchor pin bushings.
2. Check the camshaft bracket for broken welds, cracks and correct alignment. Replace damaged brackets.
3. Check anchor pins for corrosion and wear. Replace damaged anchor pins.
4. Check brake shoes for rust, expanded rivet holes, broken welds and correct alignment. Replace a shoe with any of the above conditions.

   On 16.5-inch brake shoes only: Anchor pin holes must not exceed 1.009-inches (25.63 mm) in diameter. The distance from the center of the anchor pin hole to the center of the roller hole must not exceed 12.779-inches (32.46 cm). Replace any shoe with measurements that do not meet specifications.
5. Check the camshaft for cracks, wear and corrosion. Check the cam head, bearing journals and splines. Replace damaged camshafts.

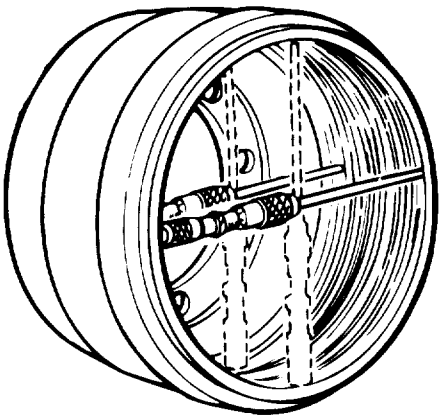
WARNING

Do not operate the vehicle with the brake drum worn or machined beyond the discard dimension on the drum. The brake system may not operate correctly. Damage to components and serious personal injury can result.

6. Check the drums:
   a. Check the brake drums for cracks, severe heat checking, heat spotting, scoring, pitting and distortion. Replace drums as required. Meritor recommends that you do **NOT** turn or rebore brake drums because it decreases the strength and heat capacity of the drum.
   b. Measure the inside diameter of the drum in several locations with a drum caliper or internal micrometer. **Figure 4.1.** Replace the drum if the diameter exceeds the specifications supplied by the drum manufacturer.

7. Check dust shields for rust and distortion. Repair or replace damaged shields as necessary.

Figure 4.1



Automatic Slack Adjuster

1. For slack adjusters with a “Quick Connect” clevis: Check the gap between the clevis and the collar. If the gap exceeds 0.060-inch (1.52 mm), replace the clevis with a one-piece threaded clevis design.
2. Check the clevis pins and the bushing in the arm of the slack adjuster. Replace the pins if they are worn. Replace the bushing if its diameter exceeds 0.531-inch (13.5 mm).

CAUTION

You must disengage a puff pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

3. Use a torque wrench that measures lb-in.
4. To turn the adjusting nut in the direction shown in **Figure 4.2,** read the torque scale and rotate the gear 360 degrees (22 turns of the wrench).

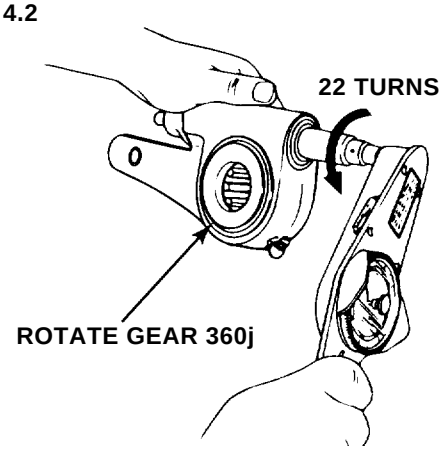
   The torque value must remain less than 25 lb-in (2.83 N•m) during the complete 360-degree rotation of the gear. T

   If the torque value remains less than 25 lb-in (2.8 N•m): The slack adjuster is working correctly.

   If the torque value exceeds 25 lb-in (2.8 N•m): The slack adjuster is not working correctly. Disassemble the slack adjuster.

   - Check that the slack adjuster is assembled correctly.
   - Check that parts are aligned correctly.

Figure 4.2



NOTE: Do not seal the boot to the tapered part of the actuator rod.

- **If the rod has a groove:** The top of the boot must fit into the groove.
- **If the rod does not have a groove:** Use silicone sealant to seal the top of the boot to the round part of the rod.

5. Fasten the bottom of the boot to the housing with a retaining clamp.
6. **Conventional Pawl:** Install the pawl assembly into the housing. Tighten the capscrew to 15-20 lb-ft (20-27 N•m). T
7. **Pull Pawl:** Remove the screwdriver or equivalent tool. The pull pawl will re-engage automatically.

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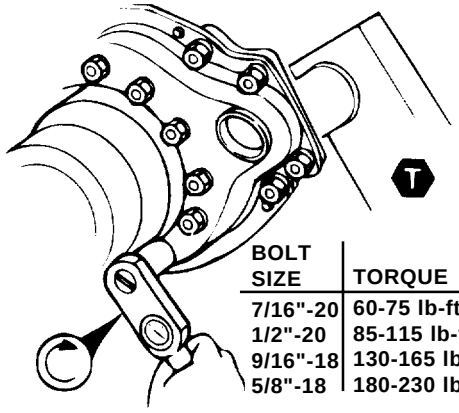
8. Use a grease gun to lubricate the slack adjuster through the grease fitting. If necessary, install a camshaft into the slack adjuster gear to minimize grease flow through the gear holes.
9. Apply lubrication that meets Meritor's specifications until new grease purges from around the camshaft splines and from the pawl assembly. Refer to Section 8.

Brake Camshafts

NOTE: Meritor recommends that you install new camshaft bushings whenever you install a new camshaft.

1. Tighten all of the spider bolts to the correct torque as shown in **Figure 4.3.** (T)

Figure 4.3



BOLT SIZE	TORQUE	
7/16"-20	60-75 lb-ft	81-102 N•m
1/2"-20	85-115 lb-ft	115-156 N•m
9/16"-18	130-165 lb-ft	176-224 N•m
5/8"-18	180-230 lb-ft	244-312 N•m

2. Use a seal driver to install new camshaft seals and new bushings in the cast spider and the camshaft bracket. If equipped with a stamped spider, install both bushings into the bracket. **Figure 4.4.** Install the seals with the seal lips **TOWARD** the automatic slack adjuster. **Figure 4.5**

Figure 4.4

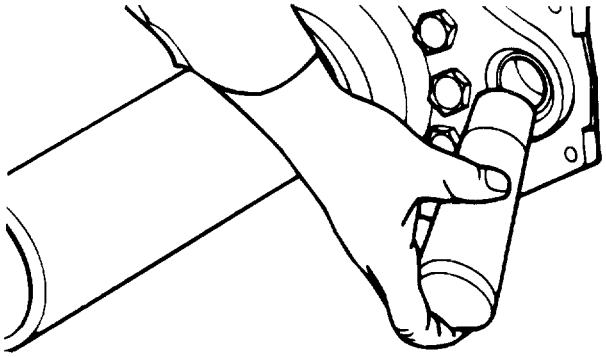
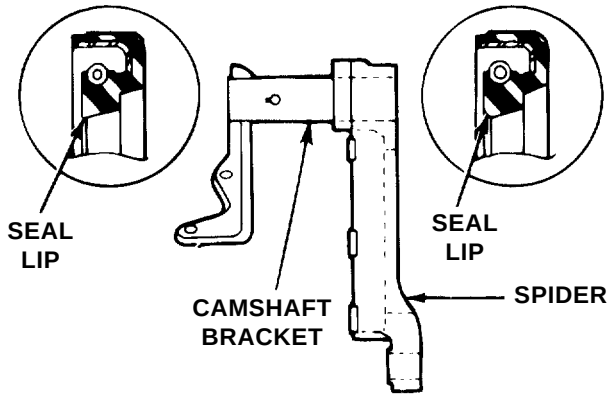


Figure 4.5



4. **If the camshaft bracket was removed:** Install the chamber bracket seal and bracket onto the spider. Tighten the capscrews to the torque specified in the "Fastener Torque Table for Cam Brakes" in Section 11. (T)

Install the Camshaft

Asbestos and Non-Asbestos Fibers Warning

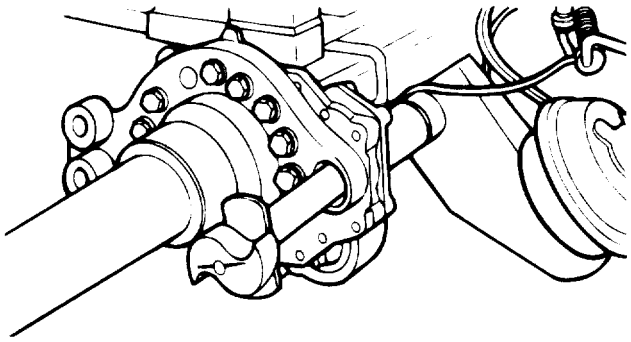
Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Install the cam head thrust washer onto the camshaft. Apply O-617-A or 0-617-B grease to the camshaft bushings and journals.
2. Install the camshaft through the spider and bracket so that the camshaft turns freely by hand. **Figure 5.1.**

Figure 5.1



Q Series 16.5-Inch Cam Brake

Replacing a Q Series Camshaft with Q PLUS™ Camshaft in all Front and Drive Axle 16.5-Inch Q Series Brakes

Meritor has implemented a replacement of the Q Series camshaft with the Q PLUS™ camshaft in all 16.5-inch Q Series brakes. Q Series brake installation and maintenance procedures are not affected by the replacement.

Replacing a Hammerclaw Camshaft with a Standard Q PLUS™ Camshaft on Front Axles Only

WARNING

Do not use the straight-center bar shoe return spring with the Q Plus™ camshaft. The shoe spring can interfere with the camshaft and affect braking performance. Serious personal injury can result.

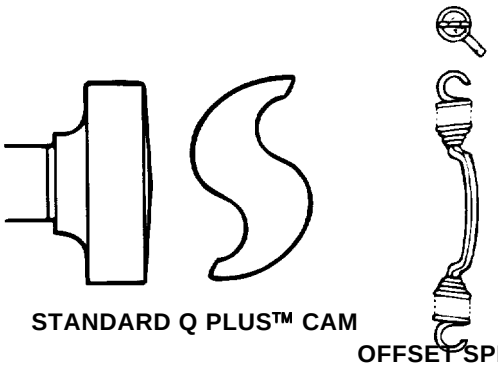
CAUTION

Only install a Q Plus™ camshaft in a Q Plus™ brake. A Q Series hammerclaw camshaft will not provide enough clearance between the brake shoe and the brake drum. Brake drag and damage to components can result.

To install a new brake drum so that it fits correctly over a Q Plus™ brake shoe, you must install a Q Plus™ camshaft. Damage to components can result.

A standard Q PLUS™ camshaft and a shoe return spring with an offset center bar replaces the hammerclaw Q Series camshaft and shoe return spring with a straight center bar on 16.5 x 5-inch and 6-inch Q Series can brake. **Figure 5.2** and **Figure 5.3.**

Figure 5.2

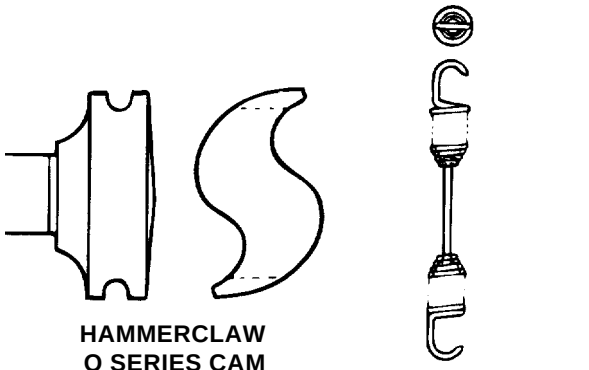


STANDARD Q PLUS™ CAM

OFFSET SPRING (P/N 2258-Y-1273)

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Figure 5.3



HAMMERCLAW
Q SERIES CAM

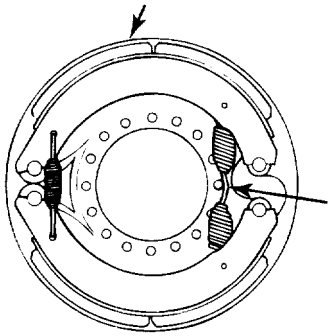
STRAIGHT SPRING
(P/N 2258-R-642)

A Q PLUS™ camshaft has deeper roller pockets than a Q Series camshaft and has “Q Plus” forged into one of the pockets. You may notice a larger gap between the brake lining and the drum after you assemble the brake shoe and shoe return spring with an offset center bar. The excess gap will be eliminated when you correctly adjust the brake. **Figure 5.4.** Refer to “Adjust the Brake” in Section 6.

1. Follow Steps 1-2 to replace a Q Series hammerclaw camshaft with a standard Q PLUS™ camshaft in a 16.5-inch Q Series brake.
2. Continue to follow service and maintenance procedures for a Q PLUS™ camshaft and Q Series brake.

Figure 5.4

The initial lining to drum clearance with a Q Plus camshaft is increased with both shoes fully retracted.

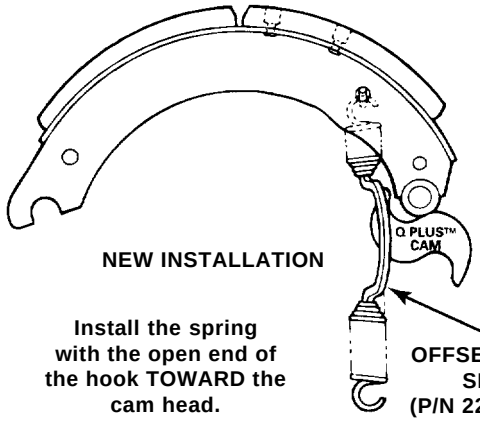


OFFSET SPRING

Shoe Return Spring Installation

Install the new offset shoe return spring with the open end of the spring hooks toward the camshaft. **Figure 5.5.**

Figure 5.3



NEW INSTALLATION

Install the spring with the open end of the hook TOWARD the cam head.

OFFSET RETURN SPRING
(P/N 2258-Y-1273)

Automatic Slack Adjuster

NOTE: As of January 1993 some parts of Meritor’s automatic slack adjuster are no longer serviceable and are not interchangeable with parts from earlier models. Refer to Section 6 for more information.

Handed and Unhanded Automatic Slack Adjusters

There are two automatic slack adjuster designs: **HANDED** and **UNHANDED.** For most applications, install a handed automatic slack adjuster so that the pawl faces **INBOARD** on the vehicle.

The pawl can be on either side or on the front of the slack adjuster housing. **Figure 5.6.**

Pull Pawls

Pull pawls are spring loaded. Pry the pull pawl at least 1/32-inch to disengage the teeth. **Figure 5.6B.** When you remove the pry bar, the pull pawl will re-engage automatically.

Replace Conventional Pawls with Pull Pawls

When you service an automatic slack adjuster, replace a conventional pawl with a pull pawl. **Figures 5.6A** and **5.6B.** Install the slack adjuster so that you can remove the conventional pawl or disengage the pull pawl when you adjust the brake.

Figure 5.6

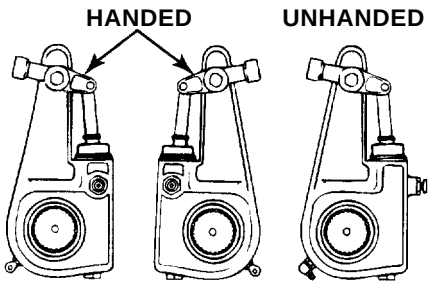
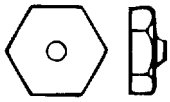
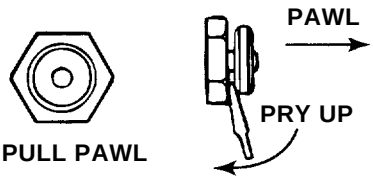


Figure 5.6A



CONVENTIONAL PAWL

Figure 5.6B



Installing the Slack Adjuster Onto the Camshaft

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. Check the camshaft and bushings and seals for wear and corrosion.
2. Turn the camshaft by hand to check for smooth operation.
3. Repair or replace parts as required.
4. Apply the service brake and spring brake several times. Check that the chamber return spring retracts the push rod quickly and completely. If necessary, replace the return spring or the air chamber.
5. The new automatic slack adjuster must be the same length as the one you are replacing. **Table A** shows the length of slack adjuster that is used with each brake chamber size.
6. Place blocks in front of and behind the vehicle's wheels to prevent it from moving.

Table A: Chamber and Automatic Slack Adjuster Sizes

Length of Slack Adjuster (inches)	Size of Chamber (Square Inches)
5	9*, 12*, 16,20,24,30
5-1/2	9*,12*,16,20,24,30,36
6	24,30,36
6-1/2	30,36

* Use an auxiliary spring on slack adjusters used with these size chambers. A size 9 or 12 chamber return spring cannot supply enough spring tension to completely retract the slack adjuster.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

7. If the brake has a spring brake, compress and lock the spring to completely release the brake. No air pressure must remain in the service half of the air chamber

CAUTION

Most Meritor automatic slack adjusters manufactured after January 1990 have lubrication holes in the gear splines. Do not operate the actuator before you install the slack adjuster. Lubricant can pump through the holes and onto the splines. Damage to components can result.

8. If the automatic slack adjuster gear has a 10-tooth spline, apply anti-seize compound to the slack adjuster and cam splines. Use Meritor specified 0-637, Southwest SA 8249496 or equivalent lubricants.

NOTE: Install the slack adjuster so that you can remove a conventional pawl or disengage a pull pawl when you adjust the brake.

9. Install the slack adjuster onto the camshaft. Position the slack adjuster so that you can remove the pawl when you adjust the brake.
10. If necessary, install spacing washers and the snap ring at a maximum clearance of 0.062-inch (1.57 mm).
11. Install the clevis onto the push rod. Do not tighten the jam nut against the clevis.

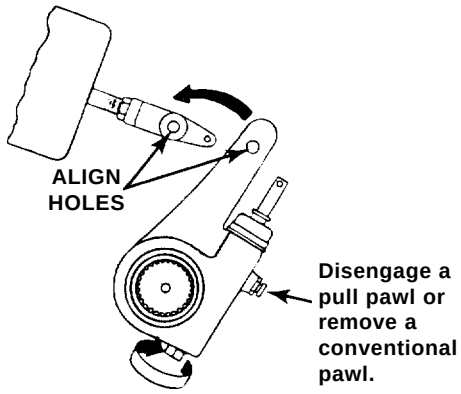
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⚠ CAUTION

You must disengage a pull pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust the brake clearance, Replace damaged pawls before returning the vehicle to service.

12. Disengage the pawl. Turn the manual adjusting nut to align the holes in the slack adjuster arm and the clevis. **Figure 5.7.**

Figure 5.7



Install the Clevis

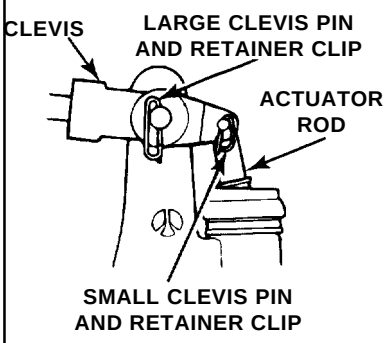
A Slack Adjuster with a Welded Clevis

⚠ CAUTION

Always replace used clevis pin retainer clips with new ones when servicing the automatic slack adjuster or chamber. Do not reuse clevis pin retainer clips after removing them. Discard used clips. When removed for maintenance or service, clevis pin retainer clips can be bent or "gapped apart- and can lose retention. Damage to components can result.

1. Check the clevis position. Apply anti-seize compound to the two clevis pins. Install the clevis pins through the clevis and the slack adjuster.
2. Install new cotter pins or clevis pin retainer clips to hold the clevis pins in place. **Figure 5.8.**

Figure 5.8

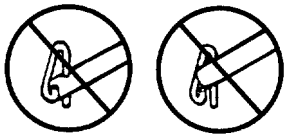




LARGE CLEVIS PIN RETAINER CLIP P/N 2257-D-1174



SMALL CLEVIS PIN RETAINER CLIP P/N 2257-C-1173

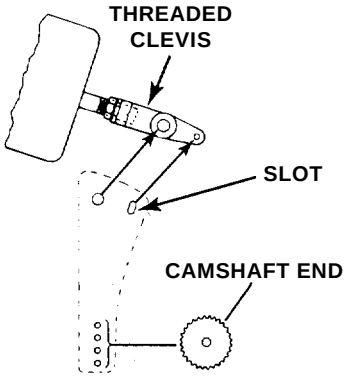


The clevis pin retainer clips must be fully installed and positioned around the side of clevis pin.

A Slack Adjuster with a Threaded Clevis

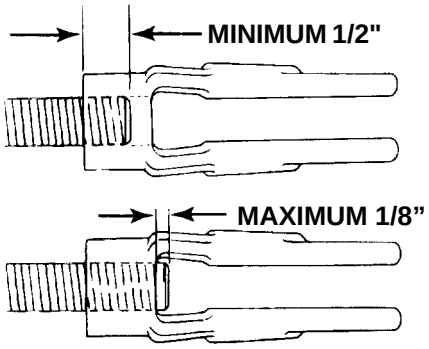
1. Install the large clevis pin through the large holes in the template and the clevis.
2. Select the hole in the template that matches the length of the slack adjuster. Hold that hole on the center of the camshaft.
3. Look through the slot in the template. If necessary, adjust the position of the clevis until the small hole in the clevis is completely visible through the template slot. **Figure 5.9.**

Figure 5.9



4. Check fot these specifications.
   - Thread engagement between the clevis and the push rod must be at least 1/2-inch (12.7 mm). **Figure 5.10.**
   - The push rod must not extend through the clevis more than 1/8-inch (3.18 mm). If necessary, cut the push rod, or install a new push rod with a new air chamber.
5. Tighten the jam nut against the clevis to torque specifications in **Table B.**

Figure 5.10



THREADED CLEVIS

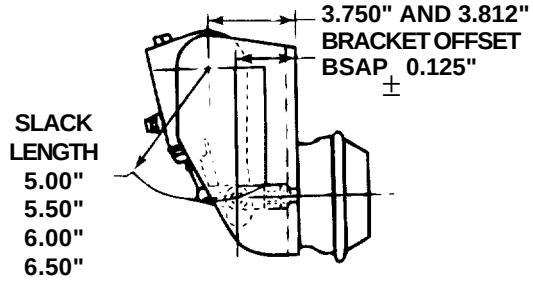
Table B: Jam Nut Torque Specifications

Threads	Torque (T)
1/2-20	20-30 lb-ft (27-41 N•m)
5/8-18	35-50 lb-ft (48-68 N•m)

Brake Slack Adjuster Position (BSAP) Method

When installing the automatic slack adjuster, verify that the BSAP dimension of the chamber matches the table in **Figure 5.11.**

Figure 5.11



SLACK ADJ. SIZE	± 0.125" BSAP	LONG STROKE
5.00"	2.75"	-
5.50"	2.75"	2.25"
6.00"	2.75"	-
6.50"	2.62"	-

Correct position of automatic slack adjuster: 3.750-inch and 3.812-inch offsets only. For other bracket offsets, refer to the vehicle manufacturer's specifications.

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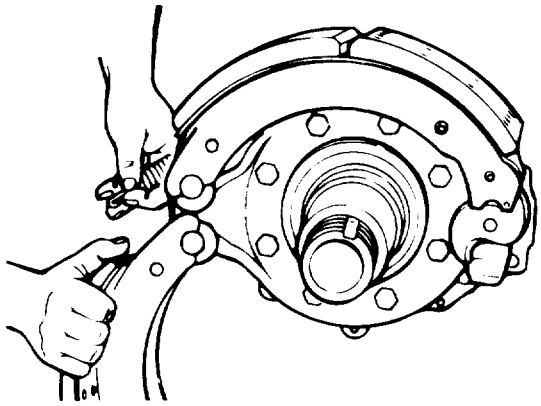
Install the Brake Shoes

NOTE: To help ensure maximum lining life, Meritor recommends that you replace springs, rollers, anchor pins and cam bushings at each reline.

All Q Plus™ and Q Series 16.5-Inch Brakes

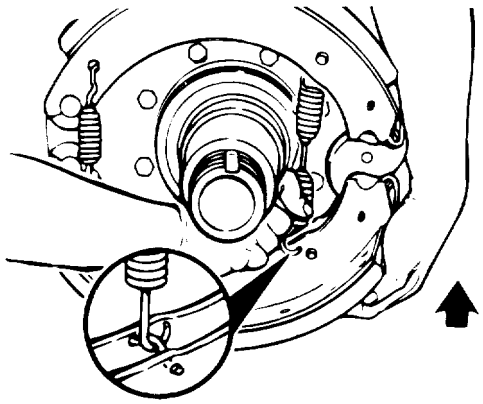
1. Place the **UPPER** brake shoe into position on the **TOP** anchor pin. Hold the **LOWER** brake shoe on the **BOTTOM** anchor pin. Install two new brake shoe retaining springs. **Figure 5.12.**

Figure 5.12



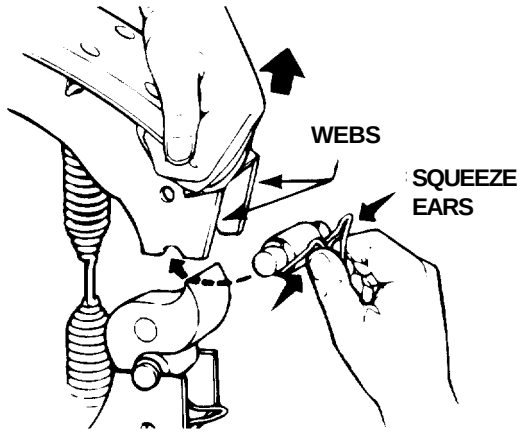
2. Rotate the **LOWER** brake shoe **FORWARD.** Install a new brake shoe return spring with the **OPEN** end of the spring hooks **TOWARD** the camshaft. **Figure 5.13.**

Figure 5.13



3. Pull each brake shoe **AWAY** from the cam to permit enough space to install the cam roller and cam roller retainer. Press the “ears” of the retainer to permit it to fit between the brake shoe webs. **Figure 5.14.**

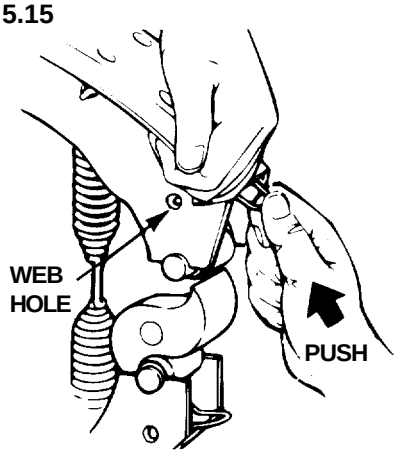
Figure 5.14



4. Push the cam roller retainer into the brake shoe until its “ears” lock in the shoe web holes. **Figure 5.15.**

5. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Figure 5.15

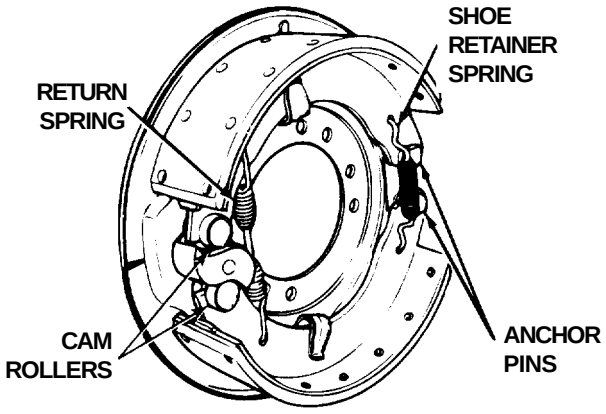


Q Series 15-Inch Cam Brake

1. Install the anchor pins, washers and nuts to the spider if these parts were previously removed. Tighten the anchor pin nuts to a torque of 325-375 lb-ft (441-509 N•m).

2. Install a new brake shoe return spring with the **OPEN** end of the spring hooks **TOWARD** the camshaft. Install the shoes on the anchor pins. **Figure 5.16.**

Figure 5.16



3. Hold the **BOTTOM** shoe in position. Install the shoe return spring.

4. Pull the brake shoe **AWAY** from the cam to permit enough space to install the cam roller and cam roller retainer.

5. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

P Series and Cast Plus™ Cam Brakes

1. Install the anchor pin bushings. If necessary, align the holes in the bushings with the holes in the spider.

2. Install a new cam roller and cam roller retainers.

3. Install the **LOWER** brake shoe in position on the spider.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

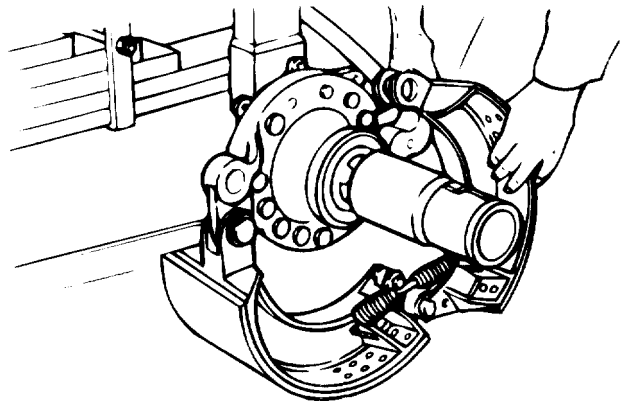
4. Use a brass drift to install the anchor pin. If necessary, align the groove on the anchor pin with the holes in the spider and bushing.

5. Install the anchor pin washers, felts, seals, retainers and snap rings if required. Install lock pins or lock screws if required. Tighten the screws to 10-15 lb-ft (13.6-20.3 N•m).

6. Install a new shoe return spring on the brake shoe. **Figure 5.17**. Place the **UPPER** brake shoe into position over the spider. Repeat Steps 4 and 5.

7. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Figure 5.17



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T Series Cam Brake

1. Install the anchor pins, washers and nuts to the backing plate if these parts were previously removed. Tighten the anchor pin nuts to 185-350 lb-ft (251-475 N•m). T
2. Install the anti-rattle rod. Install the brake shoe on the anchor pins and anti-rattle rod.
3. Install the anchor pin snap rings, the anti-rattle spring and the anti-rattle retainer spring onto the anti-rattle rod.
4. Pull the brake shoe away from the cam to permit enough space to install the shoe roller.
5. Install a new brake shoe return spring on the brake shoe.
6. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Drum and Wheel

Follow the manufacturer's instructions to install the drum and wheel onto the axle.

Automatic Slack Adjuster

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Measure the Automatic Slack Adjuster

CAUTION

There are three Meritor automatic slack adjuster installation templates for drum brakes: Truck or tractor, trailer and coach. These templates are NOT interchangeable. You must use the correct template and adjust the clevis position as described in this section.

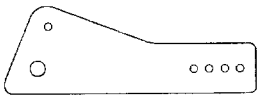
If you use the wrong template and install the clevis in an incorrect position, the automatic slack adjuster will not correctly adjust the brake. If the slack adjuster under-adjusts the brake, stopping distances will be increased. If the slack adjuster over-adjusts the brake, the linings can drag and damage the brake.

NOTE: For long-stroke chambers, use the Brake Slack Adjuster Position method to measure the automatic slack adjuster.

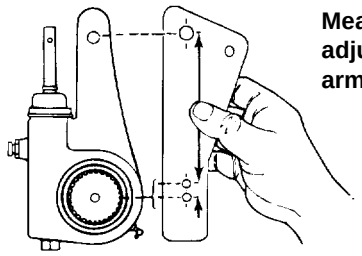
1. If necessary, order the correct automatic slack adjuster template from Meritor's Customer Service Center at 800-535-5560.

2. Use the correct Meritor automatic slack adjuster template to measure the length of the slack adjuster. The marks by the holes in the small end of the template indicate the length of the slack adjuster. **Figure 6.1**

Figure 6.1



Color of Template	Part Number	Applications
Dark brown	TP-4786	Truck or tractor drum brake
Tan	TP-4787	Trailer drum brake
White	TP-4781	Coach drum brake



Adjust the Brake

Free Stroke Measurement

CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

NOTE: During preventive maintenance on an in-service brake, check both the free stroke as described below and the adjusted chamber stroke as described on page 27.

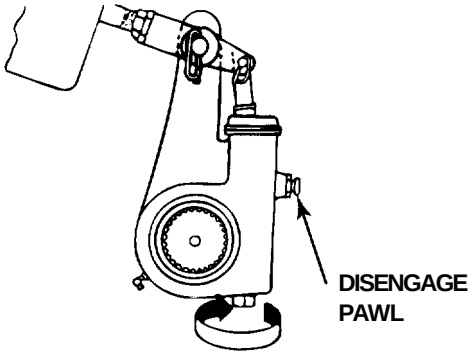
On some applications, you may find the in-service free stroke to be slightly longer than specified in Step 5. However, this is not necessarily a concern, as long as the adjusted chamber stroke is within the limits shown in the Commercial Vehicle Safety Alliance (CVSA) charts on page 28.

1. Disengage a pull pawl or remove a conventional pawl.

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2. Turn the adjusting nut in the direction shown in **Figure 6.2** until the linings touch the drum, and then turn the adjusting nut 1/2 turn in the opposite direction.

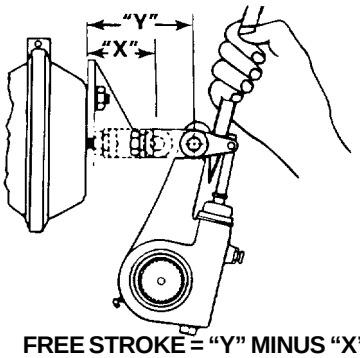
Figure 6.2



3. Measure the distance from the center of the large clevis pin to the bottom of the air chamber while the brake is released. Refer to "X" in **Figure 6.3.**

Figure 6.3

MEASURE "FREE STROKE"



FREE STROKE = "Y" MINUS "X"
Drum brake free stroke must be 1/2" - 5/8" (12.7-15.9 mm).
Disc brake free stroke must be 3/4" - 7/8" (19.1-22.2 mm).

4. Use a pry bar to move the slack adjuster so that the linings are against the drum (applying the brakes). Measure the same distance again while the brakes are applied. Refer to "Y" in **Figure 6.3.**

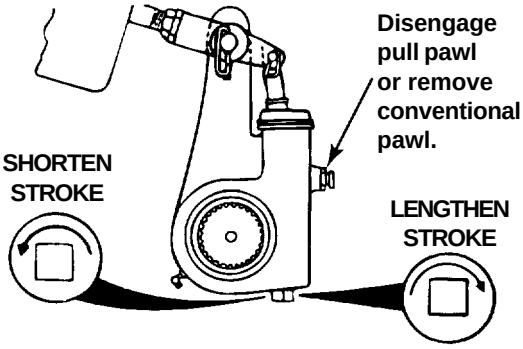
CAUTION

Do not set FREE STROKE shorter than specifications. If FREE STROKE is too short, linings can drag and damage the brake.

5. The difference between measurement "X" and measurement "Y" is the free stroke, which sets the clearance between the linings and drum. Free stroke must be within 1/2-inch - 5/8-inch (12.7-15.9 mm) for drum brakes. **Figure 6.3.**

6. If it is necessary to adjust the stroke, turn the adjusting nut 1/8 turn in the direction shown in **Figure 6.4** and check the stroke again. Continue to measure and adjust the stroke until it is adjusted correctly.

Figure 6.4



7. Release a pull pawl or install a conventional pawl.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

8. If the brake has spring chambers, carefully release the spring.

9. Test the vehicle to ensure that the brake system is operating correctly before you return the vehicle to service.

Commercial Vehicle Safety Alliance (CVSA) Guidelines to Measure Push Rod Travel (Adjusted Chamber Stroke)

Use the following procedures to check in-service push rod travel (adjusted chamber stroke) on truck or tractor air brakes with automatic slack adjusters.

Hold the ruler parallel to the push rod and measure as carefully as possible. An error in measurement can affect CVSA re-adjustment limits, which state that "any brake 1/4-inch or more past the re-adjustment limit, or any two brakes less than 1/4-inch beyond the re-adjustment limit will be cause for rejection."

WARNING
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

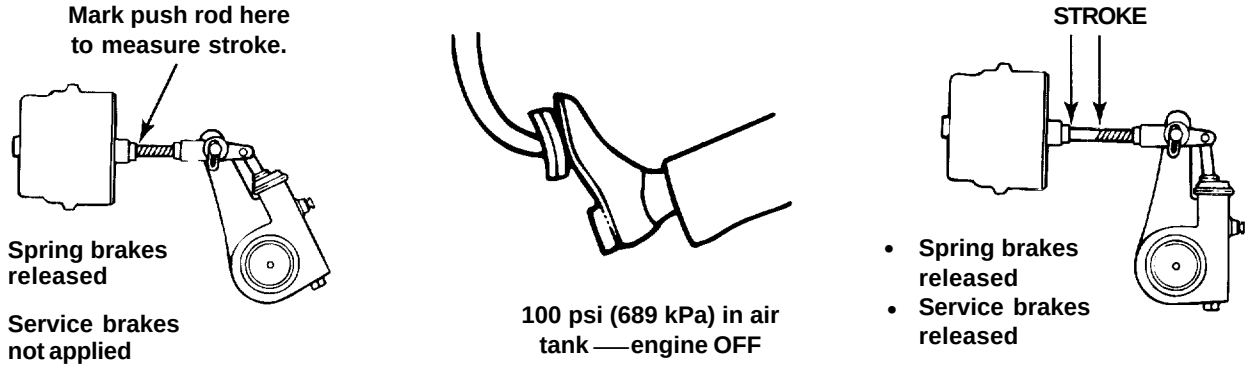
WARNING
When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

1. The engine must be **OFF.** If the brake has spring chambers, carefully release the spring.
2. Check the gauges in the cab to ensure that air pressure in the tanks is 100 psi (689 kPa).
3. Determine the size and type of brake chamber you are inspecting.
4. With the brakes released, mark the push rod where it exits the chamber. **Figure 6.5.** Measure and record the distance.
5. Have another person apply and hold the brakes one full application. **Figure 6.5.**
6. Measure push rod travel distance (adjusted chamber stroke) from where the push rod exits the brake chamber to your mark on the push rod. Measure and record the distance. **Figure 6.5.**
7. **To determine push rod travel (adjusted chamber stroke):** Subtract the measurement you obtained in Step 4 from the measurement you obtained in Step 6. The difference is the push rod travel (adjusted chamber stroke).
   a. Push rod travel (adjusted chamber stroke) must not be greater than the stroke length shown in the CVSA reference charts for the size and type of air chamber you are inspecting.
   b. If push rod travel (adjusted chamber stroke) is greater than the maximum stroke shown in the CVSA reference charts, inspect the slack adjuster and replace it if necessary.

Alternate Method for Determining Push Rod Travel (Adjusted Chamber Stroke)

Use the above procedure, except in Step 4 and Step 6, measure the distance from the bottom of the air chamber to the center of the large clevis pin on each of the brakes.

Figure 6.5



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Commercial Vehicle Safety Alliance (CVSA) North American Out-of-Service Criteria Reference Charts

NOTE: A brake found at the adjustment limit is not a violation.

Table C: "Standard Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
6	4-1/2	1-1/4	Should be as short as possible without lining to drum contact
9	5-1/4	1-3/8	
12	5-4/16	1-3/8	
16	6-3/8	1-3/4	
20	6-25/32	1-3/4	
24	7-7/32	1-3/4	
30	8-3/32	2	
36	9	2-1/4	

*For 3" maximum stroke type 24 chambers

Table D: "Long Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
16	6-3/8	2.0	Should be as short as possible without lining to drum contact
20	6-25/32	2.0	
24	7-7/32	2.0	
24*	7-7/32	2.5	
30	8-3/32	2.5	

Single or Tandem Axle

WARNING
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Use the Correct Lining Material

NOTE: The drums and linings on the front axle do not have to be the same as the drums and linings on the rear axle.

Use the lining material that is specified by the vehicle manufacturer to help ensure that the brake will perform as originally designed and meet Department of Transportation (DOT) performance regulations.

Single Axle

- Always reline both wheels of a single axle at the same time.
- Always install the same linings and drums on both wheels of a single axle.

Tandem Axle

- Always reline all four wheels of a tandem axle at the same time.
- Always install the same linings and drums on all four wheels of a tandem axle.

Combination Friction Linings

CAUTION
Only install combination friction linings in the correct location on a brake shoe. You must install a primary lining on a primary shoe. Carefully follow the instructions that are included with the linings to avoid damage to components.
Figure 7. 1.

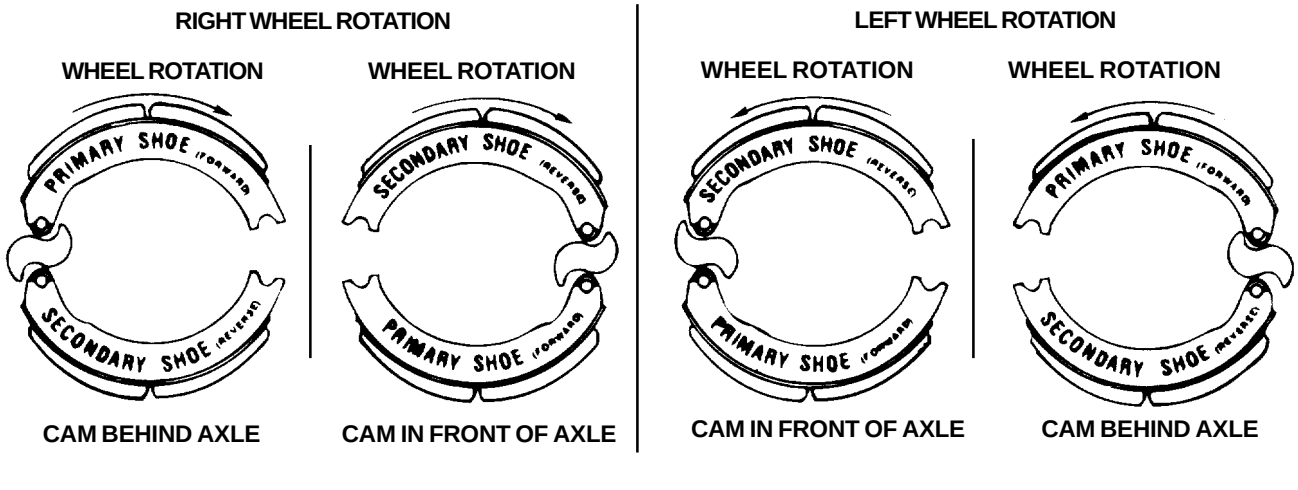
You can combine brake linings. This means that the lining set you install on the primary shoe will have a different friction rating than the lining set you install on the secondary shoe. Follow the instructions included with replacement combination linings to correctly install the primary lining on the primary shoe.

Primary Shoe Locations

The first shoe past the cam in the direction of wheel rotation is the primary shoe. Refer to **Figure 7.1** to determine primary and secondary shoe locations.

1. The primary shoe can be either at the **TOP** or the **BOTTOM** position, depending on the location of the cam.
2. If the cam is **BEHIND** the axle: The **TOP** shoe is the primary shoe.
3. If the cam is in **FRONT** of the axle: The **BOTTOM** shoe is the primary shoe.

Figure 7.1



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Camshaft Bushings

NOTE: Meritor recommends that you install new camshaft bushings whenever you install a new camshaft.

1. Refer to **Table E** for grease specifications.

WARNING
If grease flows from the seal near the cam head, replace the seal. Remove any grease or oil from the cam head, rollers and linings. Always replace contaminated linings. Grease on the linings can increase stopping distances. Serious personal injury and damage to components can result.

2. Lubricate through the fitting on the bracket or spider until new grease flows from the **INBOARD** seal.

On-Highway Linehaul Applications

- Q Plus™ and Q Series brakes: Every 100,000 miles (160,000 km).
- P Series brakes: Every 50,000 miles (80,000 km) or every six months, whichever comes first.

Off-Highway Applications

- At least every four months when you replace the seals and reline the brakes.
- During the first four month period: Inspect for hardened or contaminated grease and for the absence of grease every two weeks to determine lubrication intervals.
- Lubricate more often for severe-duty applications.

Automatic Slack Adjuster Maintenance

Inspect and lubricate the slack adjuster according to one of the following schedules. Refer to **Table F** for grease specifications. Use the schedule that requires the most frequent inspection and lubrication. Also inspect and lubricate the slack adjuster whenever you reline the brakes.

- The schedule of chassis lubrication used by your fleet.
- The schedule of chassis lubrication recommended by the chassis manufacturer.
- Every six months.
- A minimum of four times during the life of the linings.

Anti-Seize Compound

1. Use anti-seize compound on the clevis pins of all slack adjusters.
2. **Conventional automatic:** Use anti-seize compound on the automatic slack adjuster and cam splines if the slack adjuster gear has no grease groove and holes around its inner diameter.

Factory-Installed Automatic Slack Adjusters on Q Plus LX500™ and MX500 Cam Brake Packages

Q Plus LX500™ and MX500™ cam brake packages include factory-installed automatic slack adjusters that do not have grease fittings, and lubrication intervals differ from conventional slack adjusters. Refer to Maintenance Manual No. MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes,* for complete information. Order this publication by calling Meritor's Customer Service Center at 800-535-5560.

Table E: Cam Brake Grease Specifications

Components	Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
• Retainer Clips • Anchor Pins • Rollers (Journals Only) • Camshaft Bushings When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers where they touch the brake shoes. Do not allow grease to come in contact with the part of the cam roller that touches the cam head. Refer to the ***WARNING,*** on the previous page.	0-616-A	1	Clay Base	Down to -40°F (-40°C)
	0-617-A or 0-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
	0-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
Camshaft Splines	Any of Above	See Above	See Above	See Above
	0-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-641	—	Anti-Seize	

Table F: Automatic Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
• Automatic Slack Adjuster	0-616-A	1	Clay Base	Down to -40°F (-40°C)
	0-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
	0-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
• Clevis Pins	Any of Above	See Above	See Above	See Above
	C-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-641	—	Anti-Seize	

***Do not mix Meritor grease specification 0-637 (part number 2297-U-4571), a calcium-base, rust-preventive grease, with other greases.** The grease is also available as "Corrosion Control" (part number SA 8249496) from Southwest Petro-Chemical Division of Witco Chemical Corporation, 1400 S. Harrison, Olathe, KS 66061.

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Before You Return the Vehicle to Service

1. Check the complete air system for worn hoses and connectors. With air pressure at 100 psi, brakes released and engine off, loss of tractor air pressure must not exceed two psi a minute. Total tractor and trailer loss must not exceed three psi per minute.

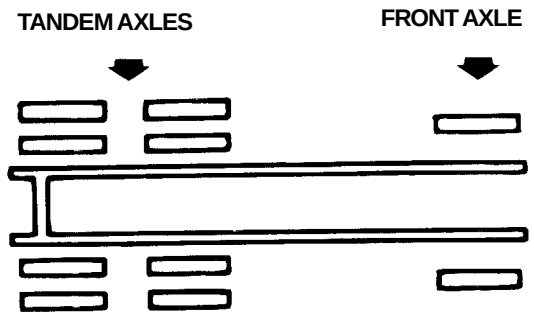
2. Check to see that the air compressor drive belt is tight. Air system pressure must rise to approximately 100 psi in two minutes.

3. The governor must be checked and set to the specifications supplied by the vehicle manufacturer.

4. Both the tractor and trailer air systems must match the specifications supplied by the vehicle manufacturer.

5. Both wheel ends of each axle must have the same linings and drums. All four wheel ends of tandem axles also must have the same linings and drums. It is not necessary for the front axle brakes to be the same as the rear driving axle brakes. **Figure 9.1.**

Figure 9.1



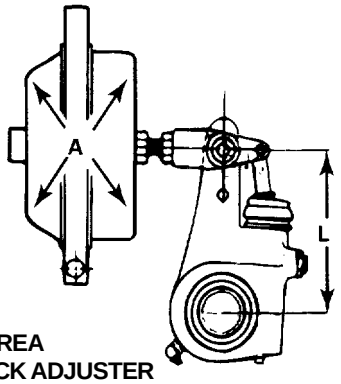
Both wheel ends of each axle must have identical drums and lining.

6. Always follow the specifications supplied by the vehicle manufacturer for the correct lining to be used. Vehicle brake systems must have the correct friction material and these requirements can change from vehicle to vehicle.

7. The return springs must retract the shoes completely when the brakes are released. Replace the return springs each time the brakes are relined. The spring brakes must retract completely when they are released.

8. The air chamber area multiplied by the length of the automatic slack adjuster is called the “AL” factor. This number must be equal for both ends of a single axle and all four ends of a tandem axle. **Figure 9.2.**

Figure 9.2



AL FACTOR = A x L
A = AIR CHAMBER AREA
L = LENGTH OF SLACK ADJUSTER

Recommended Periodic Service

WARNING
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

CAUTION
Do not let brake lining wear to the point that the rivets or bolts touch the drum. Damage to the drum will occur.

Adjust

1. Correctly adjust the wheel bearings before you adjust the brakes.
2. Clean, inspect and adjust the brakes every time you remove a wheel hub.
3. Adjust the brakes when the chamber stroke exceeds the limits shown in the tables in Section 6.
4. Adjust the brakes as frequently as necessary for correct, safe operation.
5. When you adjust the brakes, check for correct lining-to-drum clearance, push rod travel and balance between the brakes.

Lubricate

Lubricate the brake and automatic slack adjuster according to the schedules on page 31.

Reline

1. To help ensure maximum lining life, Meritor recommends that you replace springs, rollers, cam bushings and anchor pins at each reline.
2. Reline the brake when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point.
3. Replace shoe retainer springs, check the drum and perform a major inspection.

Inspect

Refer to Section 9 of this manual.

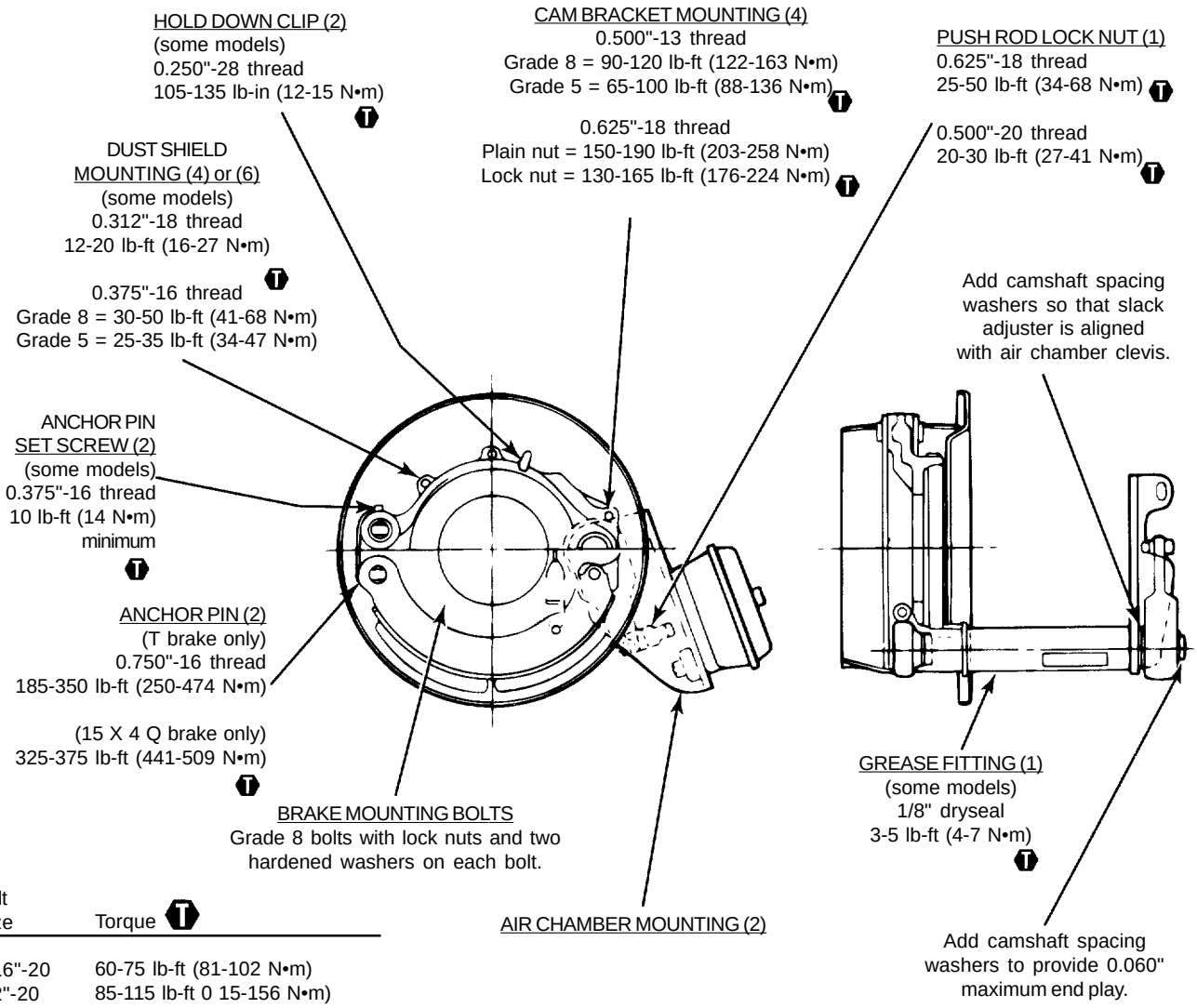
At a Major Overhaul

Carefully inspect the following parts when you perform a major overhaul at every second reline, or as necessary. Replace damaged or worn parts with genuine Meritor replacement parts.

1. Spiders for distortion and loose bolts.
2. Anchor pins for wear and correct alignment.
3. Brake shoes for wear at anchor pin holes or roller slots.
4. Camshafts and camshaft bushings for wear.
5. Replace shoe return springs.
6. Brake linings for grease on the lining, wear and loose rivets or bolts.
7. Drums for cracks, deep scratches or other damage.

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Fastener Torque Table for Cam Brakes



Bolt Size	Torque
7/16"-20	60-75 lb-ft (81-102 N•m)
1/2"-20	85-115 lb-ft 0 15-156 N•m)
9/16"-18	130-165 lb-ft (176-224 N•m)
5/8"-18	180-230 lb-ft (244-312 N•m)

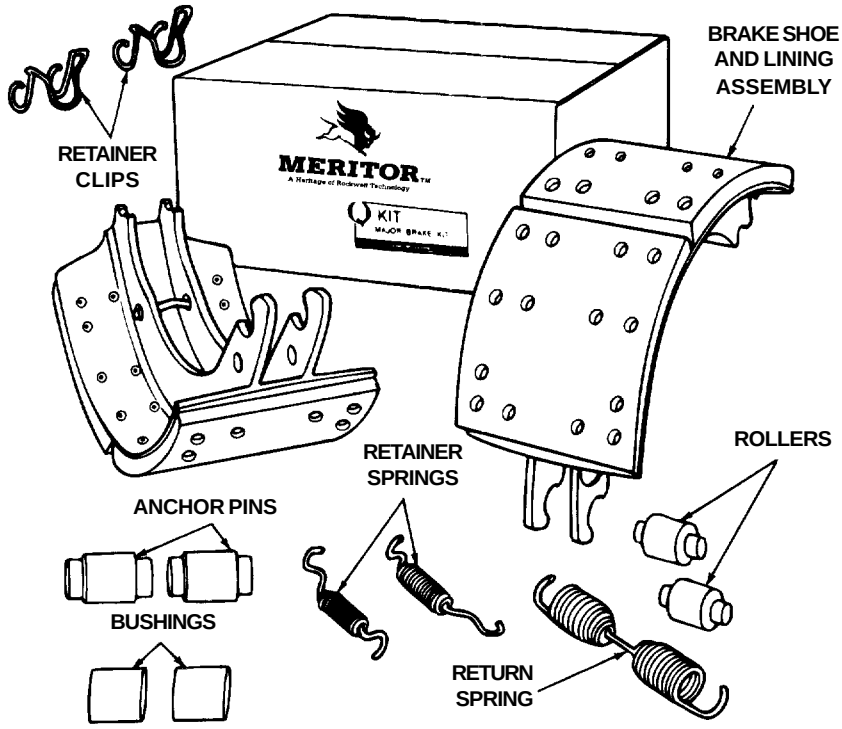
Grade 8 Nuts and Hard Flat Washers								
Chamber Size	**9**	**12**	**16**	**20**	**24**	**30**	**36**	**Spring Chamber**
Bendix	20-30 lb-ft (27-41 N•m)		30-45 lb-ft (41-61 N•m)			45-65 lb-ft (61-88 N•m)		65-85 lb-ft (88-115 N•m)
Midland	35-50 lb-ft (48-68 N•m)			70-100 lb-ft (95-136 N•m)				
MGM	35-40 lb-ft (48-54 N•m)			100- 115 1 b-ft (136-156 N•m)				
Anchorlok				110-115 lb-ft with hex nut and washer (149-203 N•m)				
				85-95 lb-ft with lock nut and washer (115-129 N•m)				

Q Series and Q Plus™ Cam Brake Conversion Kits

- Convert P Series cam brakes (except models with cast shoes) to Q Series brakes with "Quick Change" brake shoes.
- Convert standard 16.5-inch Q Series brakes to Q Plus™ brakes. A kit includes all hardware.

The brake conversion kits are available from Meritor's Aftermarket Services, 7975 Dixie Highway, Florence, Kentucky, 41042. For assistance, call 800-535-5560 in the United States and Canada.

Q Series Cam Brake Conversion Kit



Section 13
Cam Brake Tips

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MERITOR™

Air Chambers
To ensure correct brake balance, all brake chambers on the same axle must be the same size and type to help ensure a balanced brake system for maximum lining wear and drum life.

Brake Kits
Meritor brake shoes, rollers, camshafts and shoe return springs are designed to perform as a system. Always install OEM spec-level components during maintenance or when you upgrade from standard to long-life brakes to help ensure correct brake performance and maximum lining life.

Cam Heads
Cam heads can look the same, but that doesn't mean they will perform the same in your brake system. Two cam head profiles can appear to be identical, but very small differences in cams from different manufacturers can be significant enough to affect the performance of your brakes. To ensure a balanced brake system and optimum lining and drum life, always install the correct replacement cam.

Cam Rollers
To avoid flat spots, lubricate a cam roller directly in the web roller pocket and not at the cam-to-roller contact area. Flat spots can affect brake adjustment and result in premature brake wear or reduced braking performance.

Drums
To help ensure balanced braking, even lining and drum wear, and correct function of the automatic slack adjuster, do not install a cast drum and a centrifuse drum on the same axle.

A cast drum and a centrifuse drum each absorbs and dissipates heat differently. When drum types and weights are mixed, different rates of heat absorption and dissipation occur that can effect the brake system.

Hardware
When you service cam brakes, replace all the springs, anchor pins, bushings and rollers - not just the shoe return springs - to help ensure maximum braking performance.

Linings
Insist on the same brand of quality OEM friction lining material to help ensure fewer relines and greater compatibility with your present system.

Replacement Parts
Always use OEM quality standard parts. Meritor brakes work as a system, and when you replace original parts with "will-fit" parts, you can compromise the performance of the entire system.

Return Springs
Replace cam brake return springs at every cam brake reline. The return spring is critical to alignment, accurate return of the brake away from the drum and correct automatic slack adjustment.

Trailer Cam Brakes
Long-life bushings require correct lubrication for maximum performance and bushing life. Although you do not have to replace spider cam bushings on trailer axles as frequently, Meritor recommends that you lubricate the bushings at least four times during the life of your brake lining.

Automatic Slack Adjusters

- "Automatic" doesn't mean maintenance-free. Properly installed and lubricated automatic slack adjusters help to ensure maximum brake system performance.
- Never mix automatic slack adjusters on the same axle. When you replace automatic slack adjusters, always use replacement parts that were originally designed for the brake system to help ensure even brake wear, balanced braking and maximum brake performance.

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Notes

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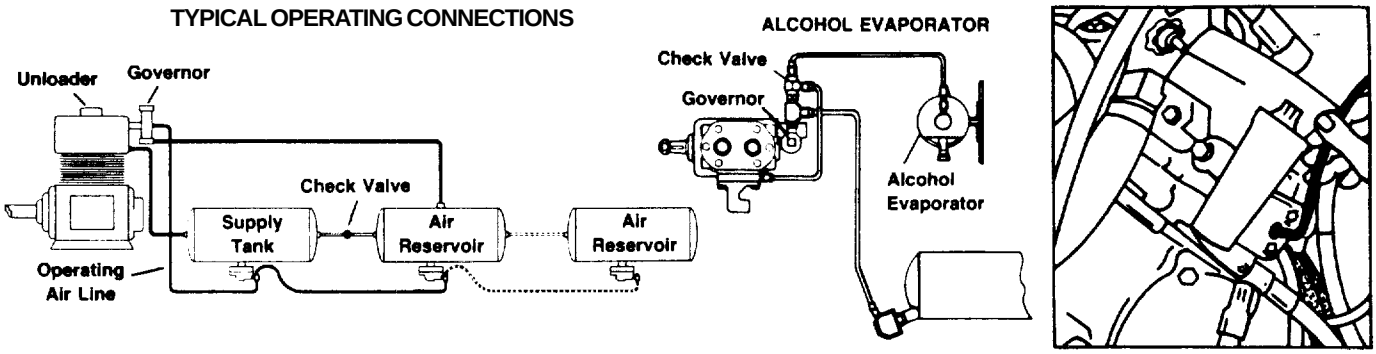
Maintenance Manual No. 4
Revised 10-98
16579/24240

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Gradall Air Tank Exhaust Valve

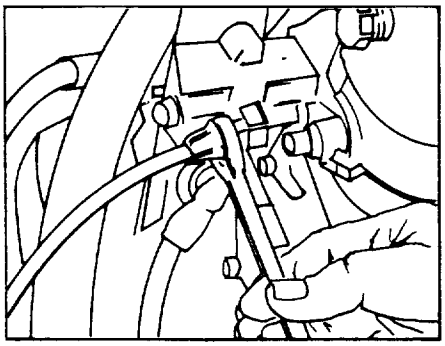
Part No. 8348-3098
(for All Rubber Tired Gradalls)

Step by Step Installation



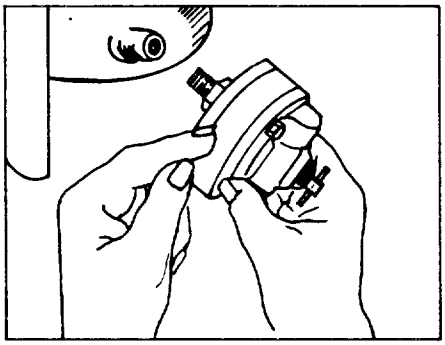
STEP 1

Remove the unloader port plug, or, put a tee into compressor unloader line between governor and the unloader. If alcohol evaporator is used, install a tee between unloader port and evaporator check valve. **MAKE SURE EVAPORATOR CHECK VALVE IS NOT REVERSED. Transit Coach Installations;** The actuating line may be connected into the air line leading to the door engine after the door pressure regulator.



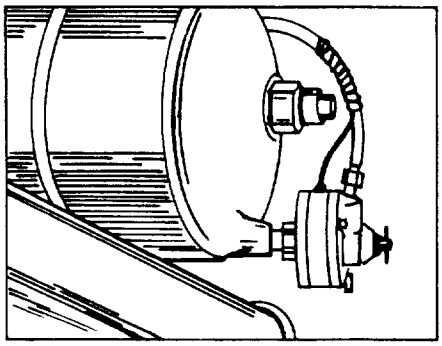
STEP 2

Attach connector and tubing and run tube to air valve. Warning: Keep tubing away from hot compressor line or exhaust pipes.



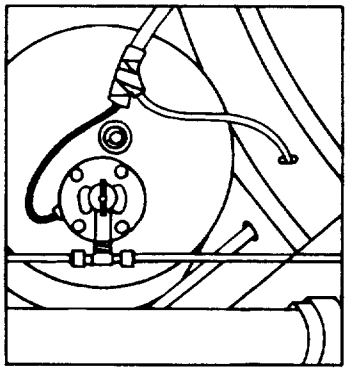
STEP 3

Don't put Exhaust Valve on dirty tanks.
First, thoroughly clean air tank; then install Exhaust valve in No. 1 or wet tank in place or petcock. Repeat for additional tank installations. (Step 7)



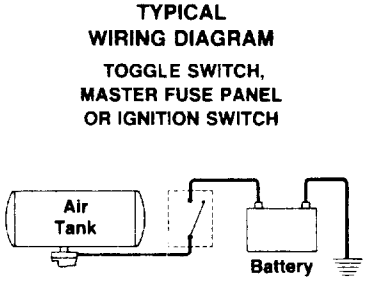
STEP 4

When tightening, leave Exhaust Valve positioned so that actuating line from governor can be easily connected to actuation port in lower valve body; and if wired, protect wire.



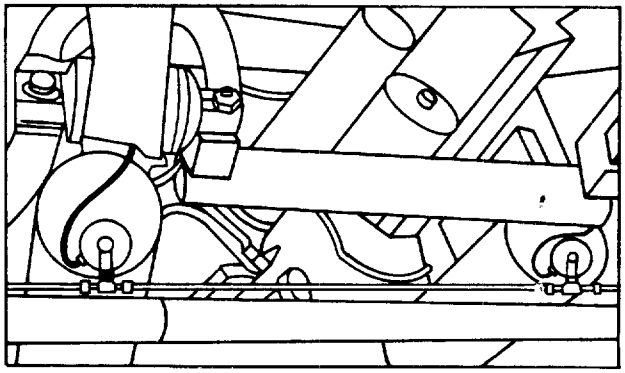
STEP 5

If single wire heater, additional ground strap may need to be used, if air tank in not a good ground Double wire heater, use one wire for ground.



STEP 6

Thread hot wire to power source. Run switch fuse box is recommended - avoid heater switch as current can be "OFF" when heat is needed. Insulate all exposed connections.



STEP 7

Install additional valves in other tank as needed. If Thermo-Exhaust Valve, connect as in Steps 5 & 6. Attach actuating line tubing from valve to valve using fittings. Connect and protect all wires and lines as needed.

PROBLEM	SOLUTION
Expello does not operate.	Improper connection of actuating line at governor. Check installation steps 2, 4, & 7.
Air leaks out condensate outlet when compressor cuts-out.	Improper actuating line connection at Expello. Check installation steps 2, 4, & 8.
Expello valve is continuously exhausting air when compressor tries to unload.	Alcohol injector check valve installed backwards, venting actuation line back into compressor line. To correct, reverse check valve connections. Check Step 1
Erratic compressor cut-in and cut-out.	Sensing line from reservoir (air tank) to governor leaks. Check (#2 tank to governor most likely).
GOVERNOR MALFUNCTION . . . SYMPTOMS & SOLUTIONS	
Governor may be worn internally and leaking through its unloader port. **A. Compressor cuts out at regulated setting (120 psi), but Expello ejects repeatedly.** **B. Compressor continously pumps air and the Expello continually exhausts it.** **C. Compressor appears to cut-out at regulated pressure but Expello does not operate.** **D. Compressor does not cut-out at regulated pressure and reservoir safety valve pops open.**	First check by installing a gauge on actuating line at Expello to observe pressure. When compressor is cut-in (pumping air) the pressure should be zero. When the compressor is cut-out (idling) the pressure should be at reservoir pressure. If the pressure does not quickly change from zero to reservoir pressure, or if the gauge shows pressure during the charge cycle, repair or replace the governor. *NOTE: A governor can often be rejuvenated by freeing-up the adjusting screws enough to blow out foreign objects; then resetting the screws as instructed.*
FAULTY EJECTIONS *(NOTE: To operate manual drain see "check operation" this page.*	
Passage or upper valve seat clogged with debris *NOTE: The manual drain will not operate if actuating line is under pressure.*	Attempt to dislodge particles by briefly opening manual valve. If this fails, remove valve and clean it, (pg. 8), be sure to clean out tank before re-installing valve; then check for leaks.
Air leak at manual drain.	Turn manual drain clockwise and then back to seat. Valve should seat with normal hand pressure. Do not use pliers. If leakage can't be stopped, remove lower body and check for small chip under valve seat or defective "O" ring. *See manual control check below.*
Air leak at other points or settings.	Remove valve, disassemble, clean, and repair. See parts diagram on pg. 1 if seat is defective.

OPERATION CHECKS

AUTOMATIC VALVE OPERATION CHECK

1ST - Start engine and build air pressure.

2ND - Check for air leaks by running fingers over all valves, valve ports, tubing, and connections.

Note: Valve should eject when compressor cuts out at full pressure. Note: Valve should eject again when compressor cuts in at low pressure (Pump brakes to achieve)

MANUAL CONTROL OPERATION CHECK

Important: Compressor must be cut-in to permit manual control.

1ST - Reduce air tank pressure to point where compressor cuts-in by pumping brakes.

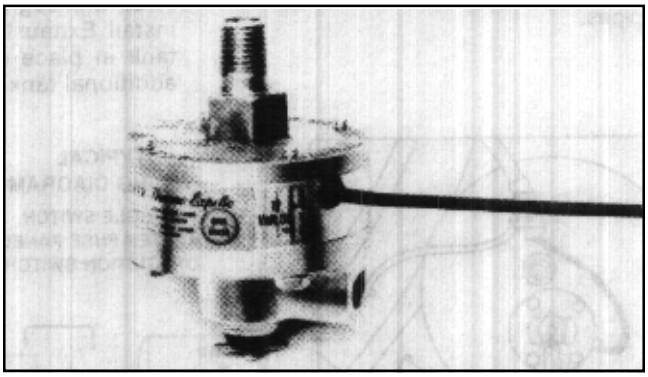
2ND - Turn manual drain control clockwise to drain position. Air and condensate will then expell from tank.

Important: Return manual drain to original automatic position.

ACTUATOR OPERATION CHECK

The exhaust valve should eject ONCE as air pressure rises; and ONCE as air pressure falls. If actuator hunts and/or chatters, raise the compressor governor pressure setting approx. 5 psi.

AUTOMATIC HEAT CHECK

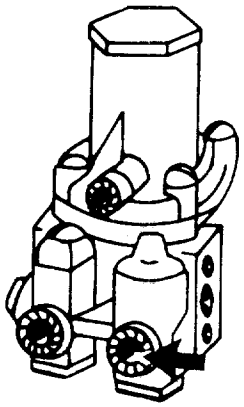


- VALVE TEMPERATURE MUST BE REDUCED TO FREEZING TO CHECK
- TO CHECK BY TOUCH, feel valve by hand for warmth.
- AS DOUBLE CHECK, check element electrically by measuring resistance and/or current.
- NOT OPERATING? Check power and ground connections.

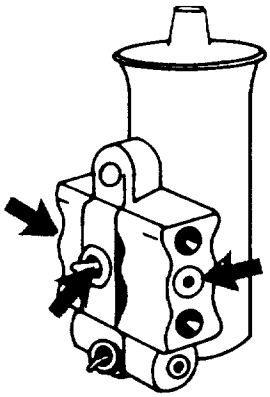
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DIAGRAMS TO AID IN THE PROPER CONNECTION OF EXPELLO DRAIN VALVES TO THE UNLOADER PORT OF COMPRESSOR GOVERNORS

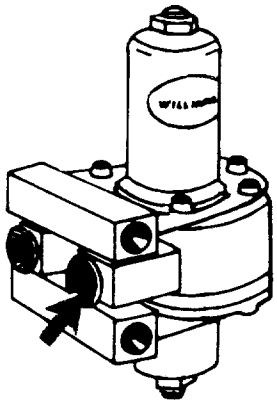
Six of the most commonly used compressor governors are illustrated here. Arrows show proper ports to which Expello automatic air tank drain valves should be connected.



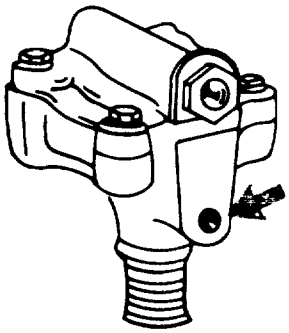
Bendix-Westinghouse
Type D Governor



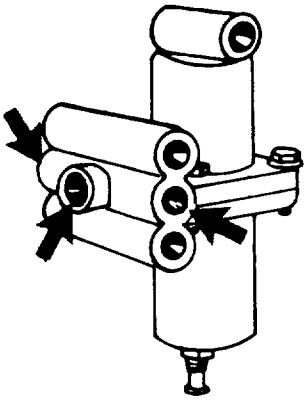
Bendix-Westinghouse Type D-2
Governor
Also used on Cummins Compressors



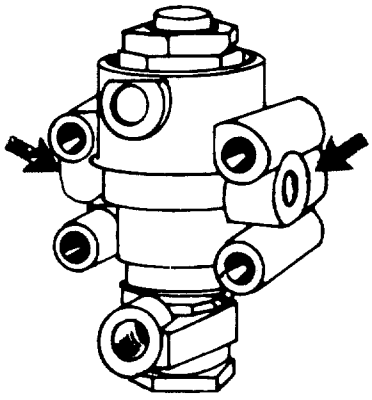
Williams WM 330 C



Midland 30090 or 30095



Sealco 1500 Governor



Midland 20856



Form 8361

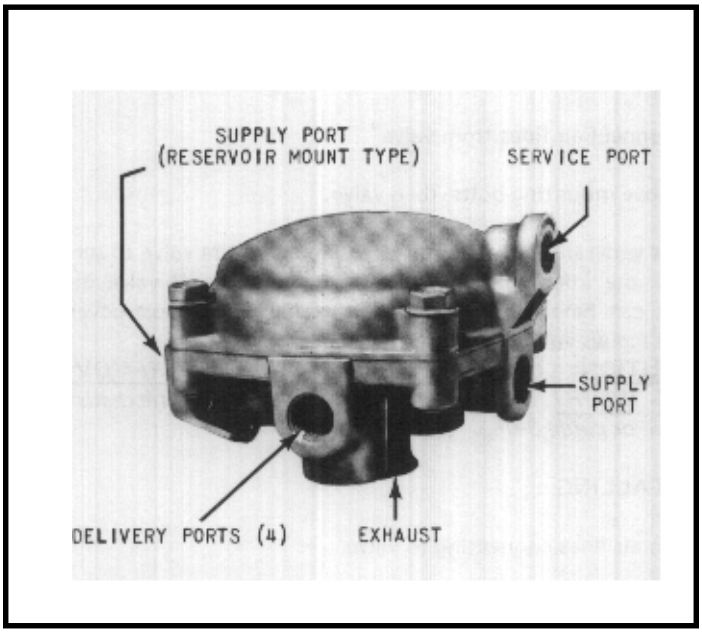
Gradall is a registered trademark for hydraulic excavators built by The Gradall Company, an Allied Corp. Company.

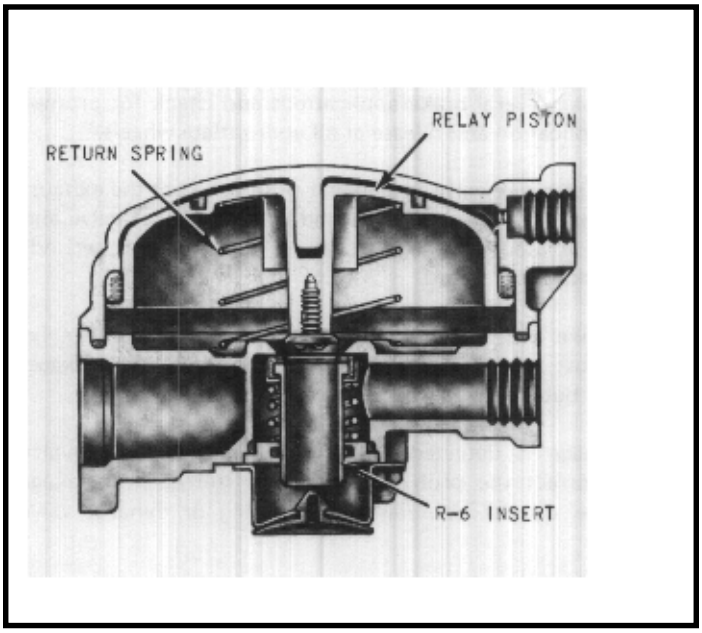
GRADALL

Hydraulic Equipment

New Philadelphia, OH 44663

R-6 RELAY VALVE





DESCRIPTION

The Relay Valve in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle in proximity to the chamber it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chamber in response to the control air delivered to it from the foot brake valve or other source. The R-6 Relay Valve is a piston operated valve For ease of servicing, an “insert” or “cartridge” type inlet/exhaust valve is employed. This feature permits service of the inlet/exhaust valve without line removal. The R-6 relay valve may be mounted directly to or remotely from the reservoir which provides its supply pressure. Standard porting consists of one (1) service port and four (4) delivery ports. There are two (2) supply ports in the reservoir mounted valve and one (1) supply port in the remote mount valve.

OPERATION

APPLYING

Air pressure delivered to the service port enters the small cavity above the piston and moves the piston down. The exhaust seat moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve, sealing off the exhaust passage. At the same time, the outer or in let portion of the inlet/exhaust valve moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the chambers.

BALANCED

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seas. The exhaust remains closed as the service line pressure balances the delivery pressure. (NOTE: Some valves are equipped with a piston return spring which will assist the lifting of the piston). As delivered air pressure is changed the valve reacts instantly to the change holding the brake application at that level.

RELEASING

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

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PREVENTIVE MAINTENANCE

Every 12 months, 100,000 miles or 3600 operating hours, disassemble, clean all metal parts in mineral spirits and wipe rubber parts clean. Replace all rubber parts and any part worn or damaged. Check for proper operation before placing vehicle in service.

OPERATING AND LEAKAGE TEST

1. Fully charge air brake system and adjust brakes.

2. Make, several brake applications and check for prompt application and release at all appropriate wheels.

3. With brake valve in released position, coat the exhaust port with soap solution and check for inlet valve and valve guide 0-ring leakage; 1" bubble in 5 seconds leakage permitted.

4. Make and hold a brake valve application; coat the exhaust port with soap solution and check for leakage; 1 " bubble in 3 seconds leakage permitted.

If leakage is detected, replacing the inlet/exhaust valve may correct the problem. If leakage still occurs, leakage may be caused by relay piston 0-ring or exhaust valve seat.

5. Make and hold a brake valve application; coat outside of valve body in area where cover joins the body for cover 0-ring leakage. No leakage permitted. If the valve does not function as described above, or if leakage is excessive, it is recommended that the valve be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at Bendix H.V.S.G. outlets.

REMOVING AND INSTALLING

REMOVING

Block and hold vehicle by means other than air brakes.

Drain air brake system reservoirs.

If entire valve is to be removed, identify air lines to facilitate installation.

Disconnect air lines from valve*.

*It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the two exhaust cover cap screws and cover. Insert then may be pulled out.
CAUTION: *DRAIN RESERVOIRS BEFORE REMOVING INSERT. Use care so as not to damage inlet/exhaust valve or guide O-ring.*

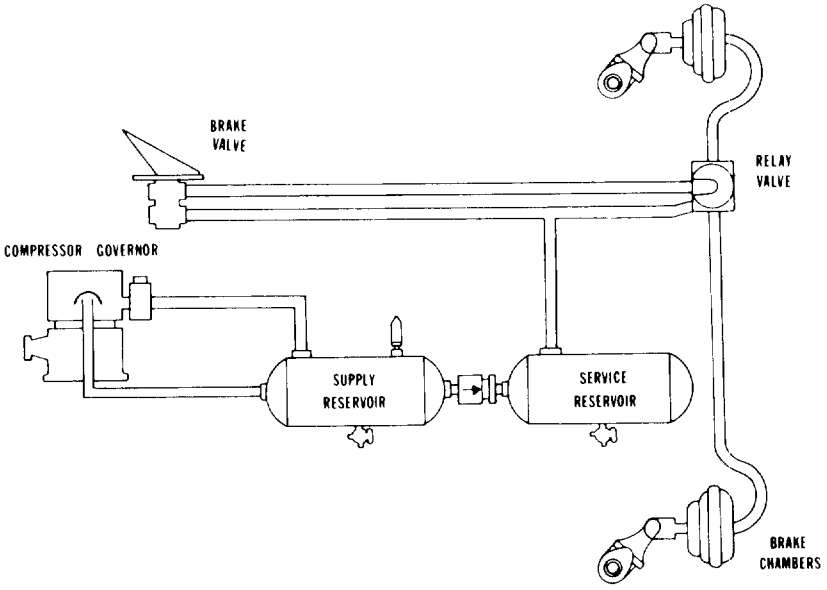
INSTALLING

Clean air lines connecting to valve.

Inspect all lines and/or hoses for damage and replace as necessary.

Install valve and tighten mounting bolts.

Connect air lines to valve (Plugh any unused ports).



TYPICAL RELAY VALVE PIPING
SINGLE CIRCUIT SYSTEM

https://truckmanualshub.com/

Test valve as outlined in “Operating and Leakage Tests.”

DISASSEMBLY

NOTE:
Prior to disassembly, mark location of cover to body to facilitate assembly.

1. Remove cover cap screws (1). Remove cover (2) with relay piston (4) and spring (6) (if so equipped).
2. Remove relay piston (4) from cover.
3. Remove piston O-ring (3) from piston (4) and cover seal O-ring from body.
4. Remove exhaust cover cap screws (19) exhaust cover and remove inlet/exhaust valve insert (8) from body (7).
5. Remove exhaust seat (5) from relay piston (4) and exhaust check valve (18). (Remove only if new parts are to be installed).

INLET/EXHAUST VALVE INSERT DISASSEMBLY

NOTE:
If complete inlet/exhaust valve is replaced, disregard steps 6 to 9.

6. Depress and hold valve guide down against valve spring tension and remove retainer (16).
7. Remove valve insert seal O-ring (13), valve guide (14), spring (12), and valve retainer (11).
8. Remove the inlet/exhaust valve (9) from its body (10).
9. Remove inner O-ring (15) from valve guide (14).

CLEANING AND INSPECTION

Wash all metal parts in mineral spirits; wipe all rubber parts dry. Inspect all parts for signs of wear and/or deterioration. Inspect springs for cracks, distortion or corrosion.
Inspect inlet seat and exhaust seat for nicks and burrs and replace as necessary. It is recommended that all rubber parts be replaced, and that any part showing signs of wear or deterioration be replaced.

ASSEMBLY

NOTE:
All torques specified in this manual are **assembly** torques and can be expected to fall off after assembly. **Do not retorque** after initial assembly torques fall. (For assembly, hand wrenches are recommended)

1. Prior to assembly, lightly lubricate the relay piston guide post, O-rings, cover bore and inlet body with Dow Corning Silicone 55-M Pneumatic grease (Bendix Pc. No. 291126).

INLET/EXHAUST VALVE ASSEMBLY

NOTE:
If new inlet/exhaust valve assembly insert is used, disregard Steps 2 to 6.

2. Install inlet/exhaust valve (9) over valve body (10), smooth surface up.
3. Position valve retainer (11) over inlet valve body (10) and valve.
4. Install inlet valve spring (12) over inlet body (10) and install O-ring (15) in the inner groove in the valve guide (14).
5. Depress and hold guide down against inlet spring and install retainer ring (16) (A 9/16" twelve point socket can be used to push the retainer ring down until it snaps in the groove in the inlet valve body).
6. Install valve insert seat O-ring (13).

COMPLETE VALVE ASSEMBLY

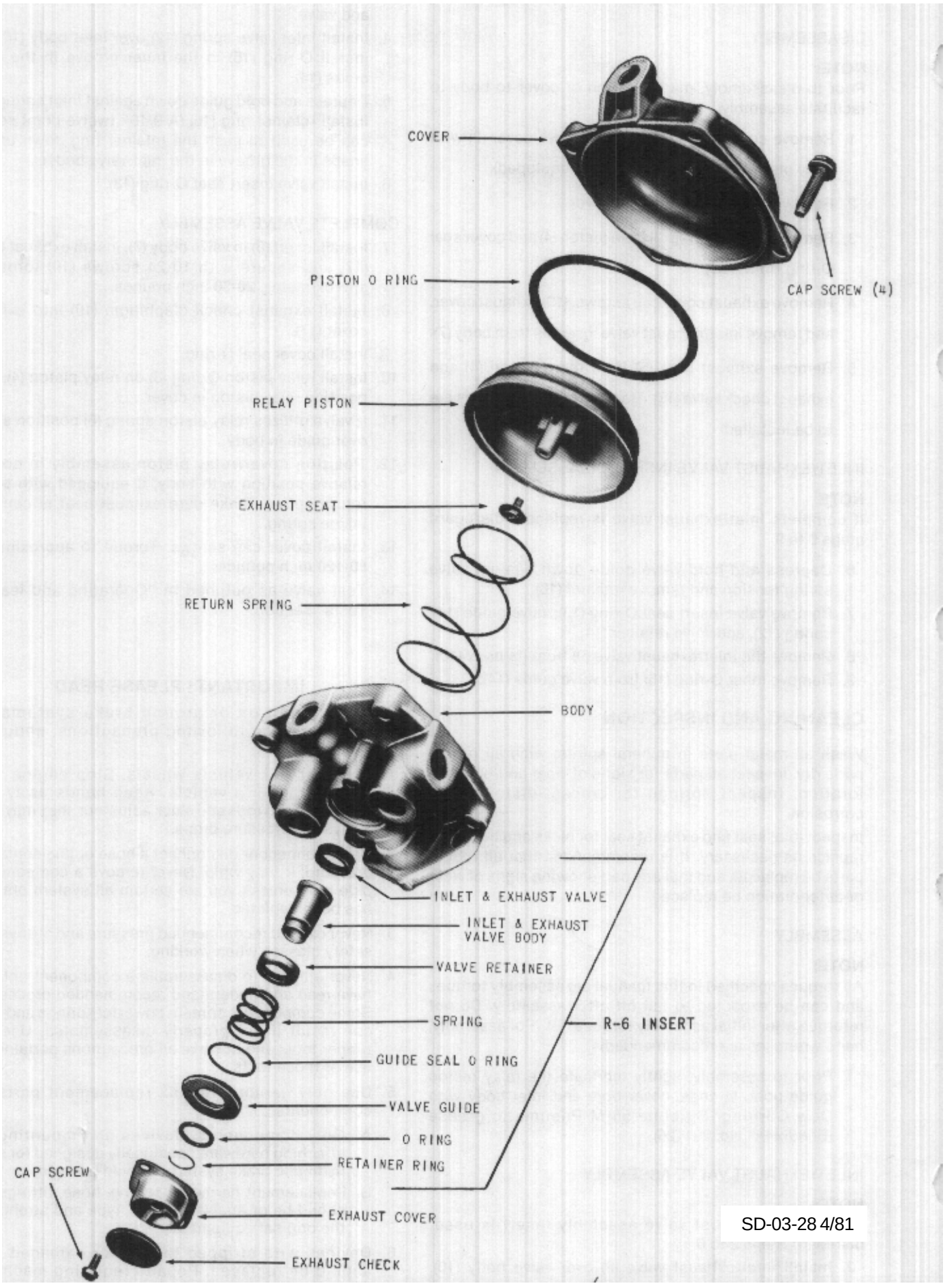
7. Install insert (8) in valve body (7), install exhaust cover (17) and secure with 10-24 screws (19) torque to approximately 20-30 inch pounds.
8. Install exhaust check diaphragm (18) into exhaust cover (17).
9. Install cover seal O-ring.
10. Install relay piston O-ring (3) on relay piston (4), then position relay piston in cover.
11. If valve utilizes relay piston spring (6) position spring over guide in body.
12. Position cover/relay piston assembly in correct relative position with body; if equipped with piston return spring, make sure exhaust seat is centered inside spring.
13. Install cover cap screws. Torque to approximately 80-120 inch pounds.
14. Test valve as outlined in “Operating and leakage Tests” section.

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

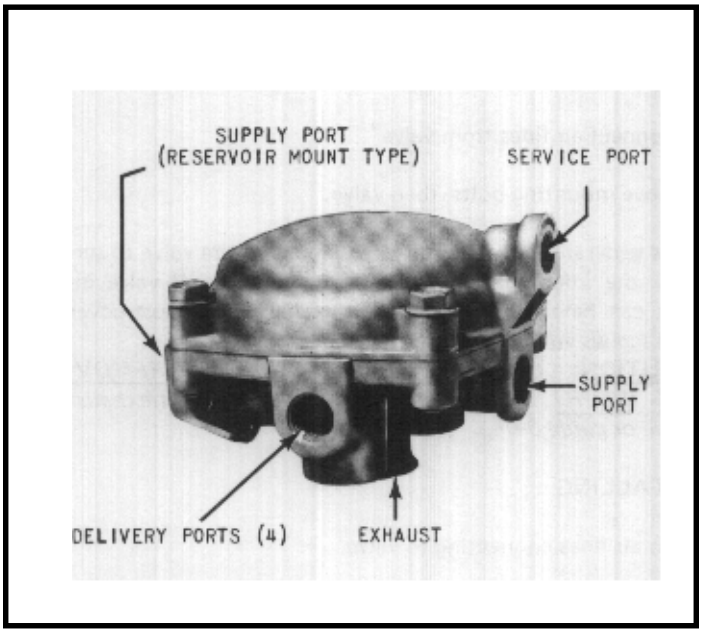
1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs end injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices and mounting and attaching hardware specifically designed **for use in hydraulic brake systems** should be used.
   B. Replacement hardware, tubing, hpose, fittings, etc. should be of equivalent size, type and strength as the original equipment.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

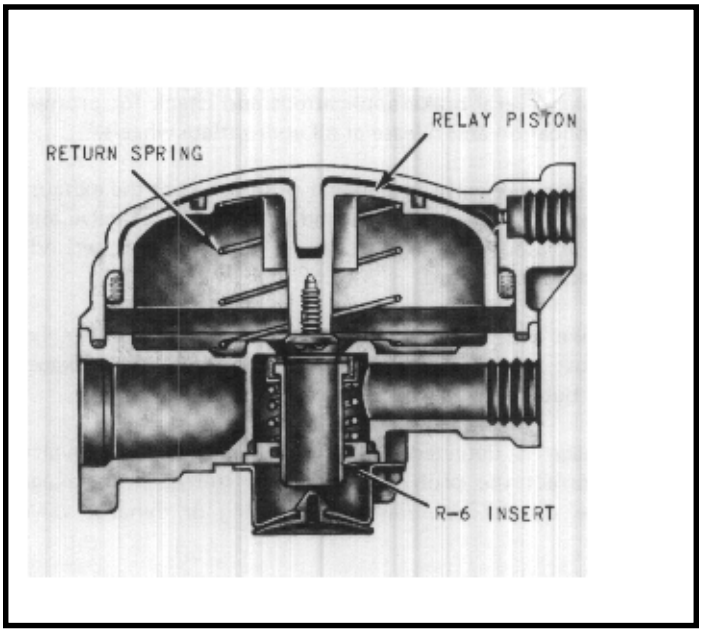
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SD-03-28 4/81

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BALANCED

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OPERATING AND LEAKAGE TEST

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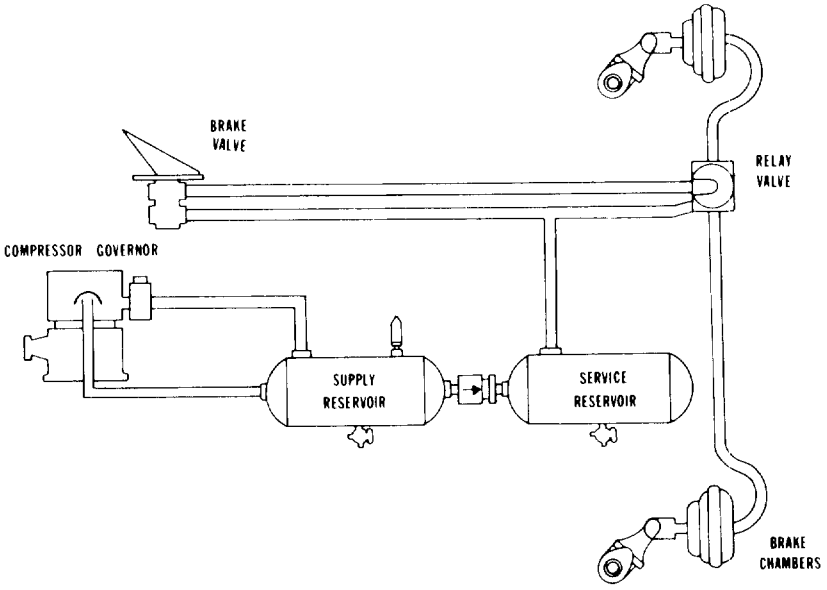
INSTALLING

Clean air lines connecting to valve.

Inspect all lines and/or hoses for damage and replace as necessary.

Install valve and tighten mounting bolts.

Connect air lines to valve (Plugh any unused ports).



TYPICAL RELAY VALVE PIPING
SINGLE CIRCUIT SYSTEM

https://truckmanualshub.com/

Test valve as outlined in “Operating and Leakage Tests.”

DISASSEMBLY

NOTE:
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CLEANING AND INSPECTION

Wash all metal parts in mineral spirits; wipe all rubber parts dry. Inspect all parts for signs of wear and/or deterioration. Inspect springs for cracks, distortion or corrosion.
Inspect inlet seat and exhaust seat for nicks and burrs and replace as necessary. It is recommended that all rubber parts be replaced, and that any part showing signs of wear or deterioration be replaced.

ASSEMBLY

NOTE:
All torques specified in this manual are **assembly** torques and can be expected to fall off after assembly. **Do not retorque** after initial assembly torques fall. (For assembly, hand wrenches are recommended)

1. Prior to assembly, lightly lubricate the relay piston guide post, O-rings, cover bore and inlet body with Dow Corning Silicone 55-M Pneumatic grease (Bendix Pc. No. 291126).

INLET/EXHAUST VALVE ASSEMBLY

NOTE:
If new inlet/exhaust valve assembly insert is used, disregard Steps 2 to 6.

2. Install inlet/exhaust valve (9) over valve body (10), smooth surface up.
3. Position valve retainer (11) over inlet valve body (10) and valve.
4. Install inlet valve spring (12) over inlet body (10) and install O-ring (15) in the inner groove in the valve guide (14).
5. Depress and hold guide down against inlet spring and install retainer ring (16) (A 9/16" twelve point socket can be used to push the retainer ring down until it snaps in the groove in the inlet valve body).
6. Install valve insert seat O-ring (13).

COMPLETE VALVE ASSEMBLY

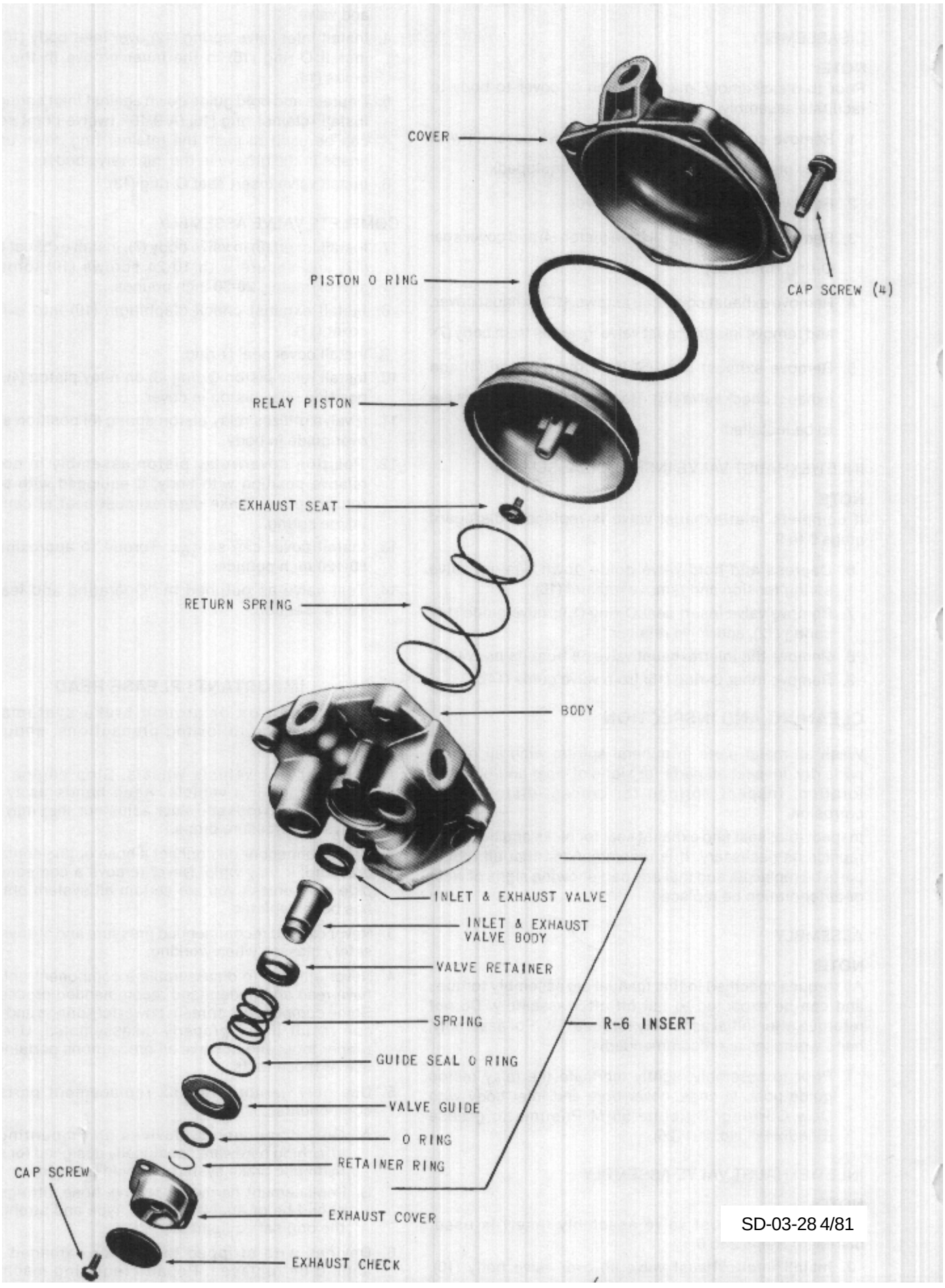
7. Install insert (8) in valve body (7), install exhaust cover (17) and secure with 10-24 screws (19) torque to approximately 20-30 inch pounds.
8. Install exhaust check diaphragm (18) into exhaust cover (17).
9. Install cover seal O-ring.
10. Install relay piston O-ring (3) on relay piston (4), then position relay piston in cover.
11. If valve utilizes relay piston spring (6) position spring over guide in body.
12. Position cover/relay piston assembly in correct relative position with body; if equipped with piston return spring, make sure exhaust seat is centered inside spring.
13. Install cover cap screws. Torque to approximately 80-120 inch pounds.
14. Test valve as outlined in “Operating and leakage Tests” section.

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs end injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices and mounting and attaching hardware specifically designed **for use in hydraulic brake systems** should be used.
   B. Replacement hardware, tubing, hpose, fittings, etc. should be of equivalent size, type and strength as the original equipment.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

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Bendix
Heavy Vehicle Systems Group

Service Data

SD-03-69

Formerly SD-29

QR AND QR-1 QUICK RELEASE VALVES

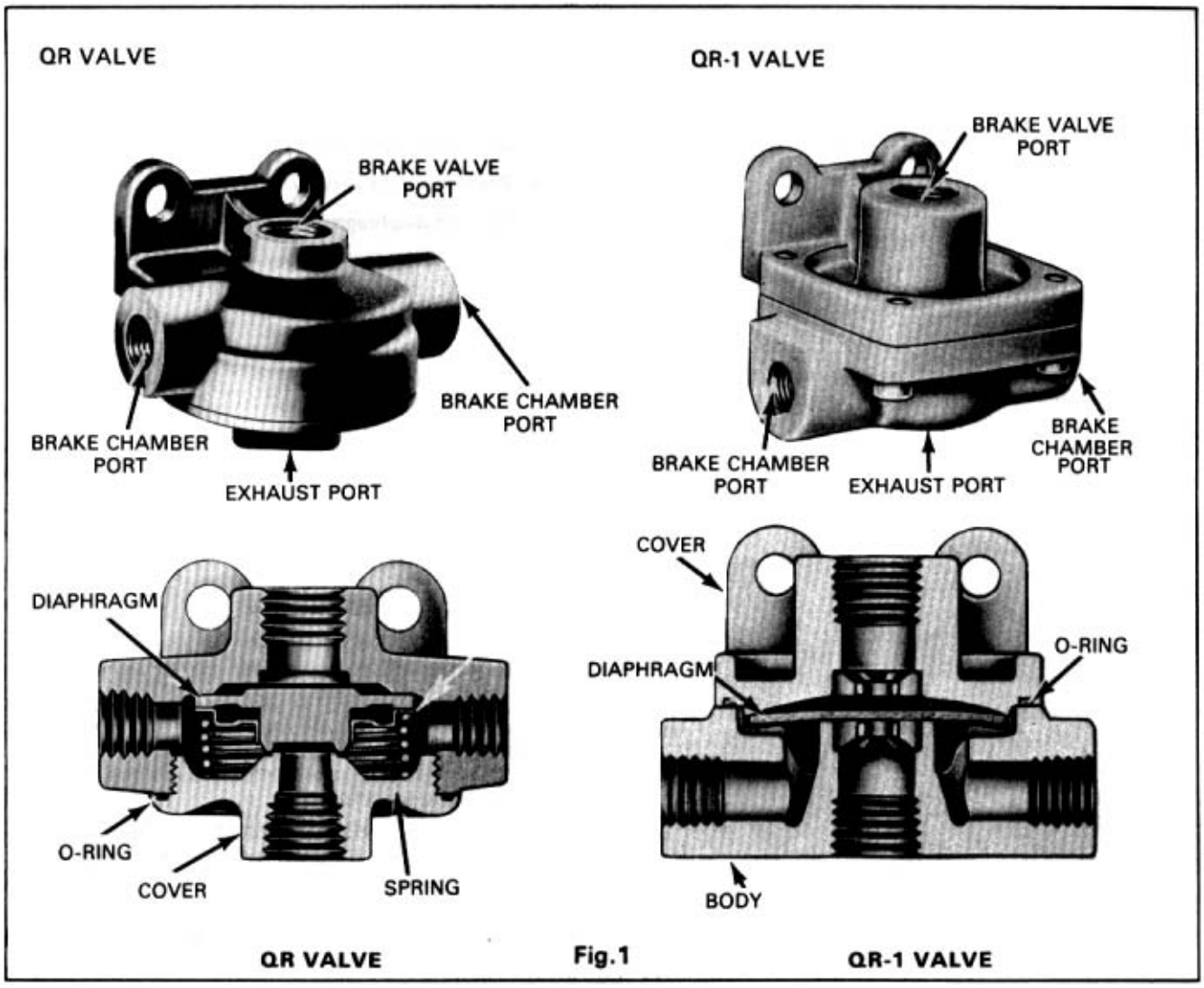


Fig.1

DESCRIPTION

The function of the Quick Release Valve is to speed up the exhaust of air from the air chambers. It is mounted close to the chambers it serves. In its standard configuration the valve is designed to deliver within one (1) psi of control pressure to the controlled device; however, for special applications the valve is available with greater differential pressure designed into the valve.

Reference Figure 1, two styles of Quick Release Valves are available and are functionally the same; the QR valve, which is of older design and utilizes a spring and spring seat, and the QR-1 valve, which in its standard configuration does not employ a spring or spring seat.

(Note: AR-1 Valves with a pressure differential employ a spring and spring seat.)

Porting consists of one (1) brake valve port, two (2) delivery ports and one (1) exhaust port.

OPERATION

When a brake application is made, air pressure enters the brake valve port; the diaphragm moves down, sealing the exhaust. At the same time, air pressure forces the edges of the diaphragm down and air flows out the delivery port.

When air pressure being delivered (beneath the diaphragm) equals the pressure being delivered by the brake valve (above the diaphragm), the outer edge of the diaphragm will seal against the body seat. The exhaust port is still

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sealed by the center portion of the diaphragm when the brake valve application is released; the air pressure above the diaphragm is released back through the brake valve exhaust; air pressure beneath the diaphragm forces the diaphragm to rise, opening the exhaust, allowing air in the chambers to exhaust.

PREVENTIVE MAINTENANCE

Every 12 months, 100,000 miles or 3600 operating hours; disassemble valve, wash metal parts in mineral spirits, wipe rubber parts dry. It is recommended that all rubber parts be replaced. Inspect all parts and replace any part showing signs of wear or deterioration.

OPERATING AND LEAKAGE TESTS

While holding a foot brake valve application;

1. Coat exhaust port with soap solution; leakage of a one (1) inch bubble in three (3) seconds is permitted.
2. Coat body and cover with soap solution. No leakage permitted between body and cover.

If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts

REMOVING AND INSTALLING

REMOVING

Block vehicle wheels and/or hold vehicle by means other than air brakes.

Drain all air brake system reservoirs.

Disconnect air lines from valve.

Remove mounting bolts, then valve.

INSTALLING

Mount valve with exhaust port pointing down; securely tighten mounting bolts.

Connect air lines to valve (brake valve application line to top port; brake chamber line to side ports.)

DISASSEMBLY

OR VALVE

1. Using wrench on square portion of exhaust port, remove cover.
2. Remove spring, spring seat and diaphragm. Remove cover O-Ring.

QR-1 VALVE

1. Remove four screws.
2. Remove spring and spring seat (if so equipped).
3. Remove diaphragm.
4. Remove cover O-Ring.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits. Wipe all rubber parts clean.

It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

ASSEMBLY

QR VALVE

1. Position spring seat over the diaphragm and then install into body.
2. Install spring and cover O-Ring.
3. Install cover; tighten securely. (Torque to 150-400 inch pounds.)

QR-1 VALVE

1. If valve is equipped within spring and spring seat:

a. Position spring in body.

b. Position diaphragm over spring seat.

c. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)

2. If valve is not equipped with spring and spring seat:

a. Install diaphragm.

b. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)

3. Perform tests as outlined in “Operating and Leakage Tests” section.

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.

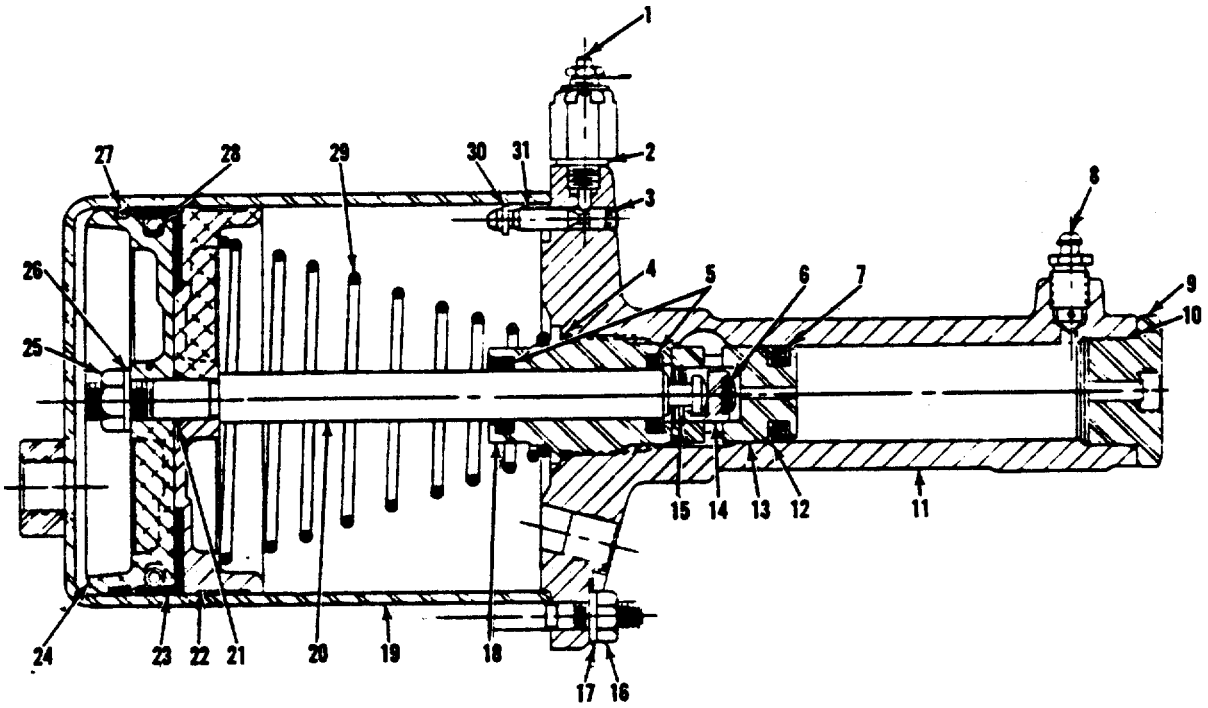
   A. Only components, devices and mounting and attaching hardware specifically designed **for use in hydraulic brake systems** should be used.

   B. Replacement hardware, tubing, hose, fittings, etc. shoud be of equivalent size, type and strength as the original equipment.

6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

MIDLAND-ROSS PRESSURE CONVERTER

www.turnpowerbrake.com



1. Contact Assembly
2. Shim
3. O-Ring*
4. O-Ring*
5. Vee Seal*
6. Seal*
7. Vee Seal*
8. Bleeder Screw
9. End Cap
10. Seal Ring*
11. Hydraulic Cyl. Body
12. Backup Ring
13. Hydraulic Piston
14. Valve Body
15. Retaining Ring*
16. Nut
17. Lockwasher
18. Bushing
19. Air Cylinder
20. Push Rod
21. O-Ring*
22. Air Piston
23. Leather Cup*
24. Piston Follower
25. Nut
26. Washer
27. Felt*
28. Expander Spring
29. Return Spring*
30. Retaining Ring*
31. Indicator Rod

* Component of parts kit

General

N-4185 series pressure converters are designed for use with DOT 3 BRAKE FLUIDS. DO NOT expose rubber components to mineral oils. When cleaning parts, mineral spirits may be used to clean the air piston components and the air cylinder. However, DO NOT clean hydraulic components with mineral spirits. Use isopropyl alcohol for cleaning hydraulic components.

Precautions

1. The illustration shows a pressure converter assembly, component names, and component locations within the assembly. Notice also throughout that items which are to be replaced are marked with an asterisk. When disassembling the pressure converter, these items are to be discarded.

2. When it is necessary to clamp the pressure converter in a vise or equivalent mechanism, do not clamp on the air cylinder (item 19) or on the cylindrical portion of the hydraulic cylinder body (item 11).

3. Avoid damaging seal grooves, cylinder bores, and the push rod, as defects on these surfaces will cause leakage. Also, take particular care to wash these areas with the proper fluid. Air dry or dry with lint-free wiping materials.

Disassembly Procedure

1. Wipe off all dirt and grease from the pressure converter.

2. Drain the hydraulic fluid from the pressure converter.

3. Remove contact assembly (item 1). Some pressure converters will have a shim (item 2) under the contact assembly. If the shim is present, remove and save for reuse.

4. Remove bleeder screw (8) and end cap (9). Discard seal ring (10).

5. Mark air cylinder (19) and hydraulic cylinder body (11) to show original alignment of these two items.

6. Remove six 9/16 nuts (16) and six lockwashers (17) and remove air cylinder (19).

7. Some pressure converters use a retaining ring (30) to retain the indicator rod (31). the retaining ring is present, remove it and discard. Remove the indicator rod. Discard O-ring (3).

8. The return spring (29) is under a load. Remove 11/16 nut (25) being careful to control the expansion of the spring and thus avoiding damage or injury. Remove washer (26), piston follower (24), leather cup (23), O-ring (21), air piston (22), return spring (29) and expander spring (28).

9. Remove felt (27) and discard. Discard leather cup (23), O-ring (21), and return spring (29).

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10. Unscrew bushing (18) and remove bushing, push rod (20), and hydraulic piston (13) as an assembly. Do not remove bushing from the push rod at this time.

11. Disconnect retaining ring (15). Remove hydraulic piston (13), valve body (14) and retaining ring, and now slide bushing off the hydraulic end of the push rod. Discard the retaining ring.

12. Read precaution #3, then proceed to remove O-ring (4) and two vee seals (5) from the bushing. Remove seal (6) from valve body and remove vee seal (7) from the hydraulic piston. Discard the rubber parts. Note - some hydraulic pistons will have a backup ring (12). Leave backup ring in place.

13. The following is a list of items that must be cleaned with the appropriate solvent and then inspected for leak-causing damage, such as nicks, scratches, grooves, wear, pits, corrosion, or foreign material:

ITEM	APPROPRIATE	SOLVENT
Air Cylinder (19)	Mineral	Spirits
Air Piston Follower (24)	"	"
Air Piston (22)	"	"
Expander Spring (28)	"	"
Hydraulic Cylinder Body (11)	Isopropyl	Alcohol
Push Rod (20)	"	"
Bushing (18)	"	"
Hydraulic Piston (13)	"	"
Valve Body (14)	"	"

14. If leak-causing damage exists in any of the above items, discard that item and order a replacement part.

Assembly Procedure

1. Lubricate repair kit vee seals (5&7) and seal ring (10) with the hydraulic fluid normally used in the pressure converter (i.e. Dot 3 brake fluid).

2. Read precaution #3, then proceed to install a new vee seal (7) on the hydraulic piston (13). Make sure the vee seal is installed in the direction shown in fig. 1.

3. Install two new vee seals (5) into bushing (18). Make sure the vee seal lips are facing opposite directions as shown. These seals are difficult to insert, therefore, exercise care to conform with precaution #3.

4. Install a new O-ring (4) on to the bushing.

5. Install a new seal (6) into the valve body (14). Make sure seal is installed as shown.

6. Lubricate the push rod (20) and the valve body (14) with the same lubricant used on the vee seals. Slide bushing (18) over hydraulic end of push rod, in the direction shown. Be careful to avoid damage to the vee seals.

7. Slip new retaining ring (15) over hydraulic end of push rod. Attach valve body (14) and then slide hydraulic piston (13) over the valve body and install the retaining ring such that the piston is now attached to the push rod. Double check the retaining ring installation to insure proper location within the retaining ring groove.

8. Lubricate the hydraulic piston with the same lubricant used on the vee seals. Insert the hydraulic piston into the bore of the hydraulic cylinder body. This is somewhat difficult, so be careful to avoid damaging the vee seal (7) and the hydraulic cylinder bore. Screw the bushing in place and torque to 20 to 40 ft. lbs.

9. Install seal ring (10) onto end cap (9), and insert end cap into hydraulic cylinder body. Torque to 60 to 80 ft. lbs.

10. Install new return spring (29), air piston (22). expander spring (28), leather cup (23), O-ring (21), piston follower (24), washer (26), and nut (25), in the manner shown. Extra help may be required to overcome the spring load. Be sure the expander spring (28) is properly located as shown and the leather cup (23) is centered. Then torque nut (25) to 5 to 10 ft. lbs. Apply a coating of general purpose chassis grease to felt (27) and install felt into piston follower (24) as shown.

11. Install new O-ring (3) into indicator rod (31) and insert indicator rod into the hydraulic cylinder body as shown. Insert contact assembly (1) into hydraulic cylinder body. If indicator rod originally had retaining ring (30) attached, attach new retaining ring. Double check the installation to insure proper location in the groove.

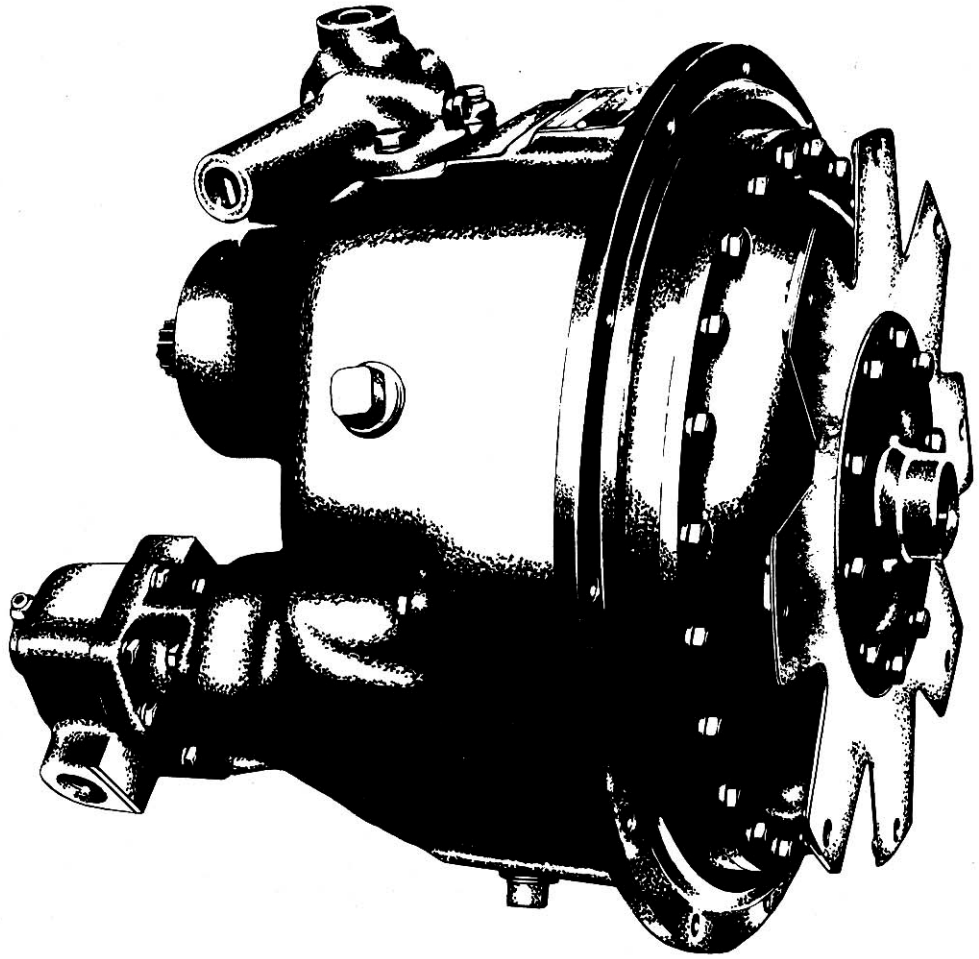
12. Apply a coating of chassis grease to leather cup (23), air piston (22), piston follower (24), and air cylinder bore (19). Slide the air piston assembly into the air cylinder. This is somewhat difficult, so be careful to avoid damaging the leather cup or the air cylinder bore. Push the air cylinder in place, with the six studs extending through the hydraulic cylinder body. Make sure alignment is correct. Install lockwashers (17) and nuts (16) and alternately torque to 10 to 20 ft. lbs.

13. Install bleeder screw (8) into hydraulic cylinder body. Torque to 10 to 20 ft. lbs.

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2000 torque converter

maintenance & service manual



CLARK COMPONENTS INTERNATIONAL

A Business Unit of Clark Equipment Company

SMC 2000 (Rev. 9-87)

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Service Publications
324 E. Dewey Street
Buchanan, Michigan 49107

TOWING OR PUSH STARTING

Before towing the vehicle, be sure to lift the rear wheels off the ground or disconnect the driveline to avoid damage to the transmission during towing.

NOTE: If the transmission has 4 wheel drive, disconnect both front and rear drivelines. Because of the design of the hydraulic system, the engine **cannot** be started by pushing or towing.

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FOREWORD

This manual has been prepared to provide the customer and the maintenance personnel with information and instructions on the maintenance and repair of the **CLARK** Torque Converter.

Extreme care has been exercised in the design, selection of materials and manufacturing of these units. The slight outlay in personal attention and cost required to provide regular and proper lubrication, inspection at stated intervals, and such adjustments as may be indicated will be reimbursed many times in low cost operation and trouble free service.

In order to become familiar with the various parts of the torque converter, its principal of operation, trouble shooting and adjustments, it is urged that the mechanic study the instructions in this manual carefully and use it as a reference when performing maintenance and repair operations.

Whenever repair or replacement of component parts is required, only Clark Components International-approved parts as listed in the applicable parts manual should be used. Use of “will-fit” or non-approved parts may endanger proper operation and performance of the equipment. Clark Components International does not warrant repair or replacement parts, nor failures resulting from the use thereof, which are not supplied by or approved by the Clark Components International. **IMPORTANT: Always furnish the Distributor with the Converter serial and model number when ordering parts.**

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TABLE OF CONTENTS

HOW THE UNITS OPERATE 1

TORQUE CONVERTER ASSEMBLY (CROSS SECTION) FIG. A 2

INTERNAL OIL FLOW — FIG. B 3

TORQUE CONVERTER ASSEMBLY — EXPLODED VIEW — FIG. C 4

ASSEMBLY INSTRUCTIONS — FIG. D 6

DISASSEMBLY OF TORQUE CONVERTER 7

CLEANING AND INSPECTION 14

REASSEMBLY OF TORQUE CONVERTER 15

ASSEMBLY INSTRUCTIONS — FIG. E 24

PRESSURE AND LUBRICATION SPECIFICATIONS 25

IRREGULARITIES IN PERFORMANCE 26

CONVERTER TO ENGINE INSTALLATION 28

NOTE: Metric Dimensions Shown in Brackets [ ].

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HOW THE UNITS OPERATE

The torque converter portion of the power train enacts an important role in delivering engine power to the driving wheels. In order to properly maintain and service these units it is important to first understand their function and how they operate.

The torque converter and transmission function together and operate through a common hydraulic system. To obtain maximum serviceability they have been designed and built as separate units. It is necessary, however, to consider both units in the study of their function and operation.

To supplement the text herein, and for reference use therewith, the following illustrations are provided.

Fig. A - Torque Converter Assembly - Cross Section
Fig. B - Internal Oil Flow - Torque Converter
Fig. C - Torque Converter Assembly - Exploded View
Fig. D - Assembly Instructions

The torque converter is composed of four members: The impeller which is the driving member, the drive disc or impeller cover, the turbine, which is the driven member and the reaction member. The reaction member option is splined to the converter support and does not rotate in either direction or can be free wheeling, depending on the application. The impeller and drive disc form the outer shell. The turbine runs within the outer shell and is connected to the output shaft. The oil is the only connection between the turbine and impeller member.

Three pump drive gears are bearing mounted in the converter housing and meshed with a gear on the impeller hub. With the engine running the pump drive gears rotate at engine speed. The pumps are externally mounted on the converter housing and are connected to the pump shafts by a pump drive sleeve.

With the engine running, the converter charging pump draws oil from the transmission sump and directs it through oil filters to the pressure regulating valve located on top of the converter. From the regulating valve it is then directed to the transmission clutches and into the converter.

The pressure regulating valve remains closed until required pressure is delivered to the transmission for actuating the direction and speed clutches. This regulator valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is backed up by a spring to hold the valve spool against its seat until the oil pressure overrides the spring force. The valve spool moves toward the spring until a port is exposed in the side of the bore. The oil can flow through this port into a distributor which directs the oil through a passage into the converter.

After entering the converter, the oil is directed into the converter support through the impeller bearing and to the converter cavity.

Three members of the torque converter are composed of a series of blades. The blades are curved in such a manner as to force the oil to circulate from the impeller to the turbine, through the reaction member and again into the impeller. This circulation causes the turbine to turn in the same direction as the impeller. Oil enters the inner diameter of the impeller and exits from the outer diameter into the outer diameter of the turbine, then exits from the inner diameter of the turbine and through the reaction member. The oil again enters the inner diameter of the impeller.

The oil exits between the turbine shaft and reaction member support and through an oil distributor which directs the oil out of the converter, and to the oil cooler. After leaving the cooler the oil is directed to the lubricating oil inlet on the transmission and through a series of tubes to the transmission bearings, and clutches. The oil is internally returned to the transmission sump.

The converter lube and leakage oil is returned to the transmission sump by a flexible hose installed in the lowest pipe tap hole in the converter housing. This line must have a continuous drop to allow by gravity flow, leakage oil to return to the transmission sump.

A safety valve is built in the pressure regulating valve and will open to bypass oil only if an excessive pressure is built up due to a blocked passage.

With the engine operating at any speed and the turbine and output shafts stationary, the converter is in a “stall” condition. Full power or wide open throttle “stalls” for more than 30 seconds at a time will generate excessive heat and may cause converter or transmission seal damage.

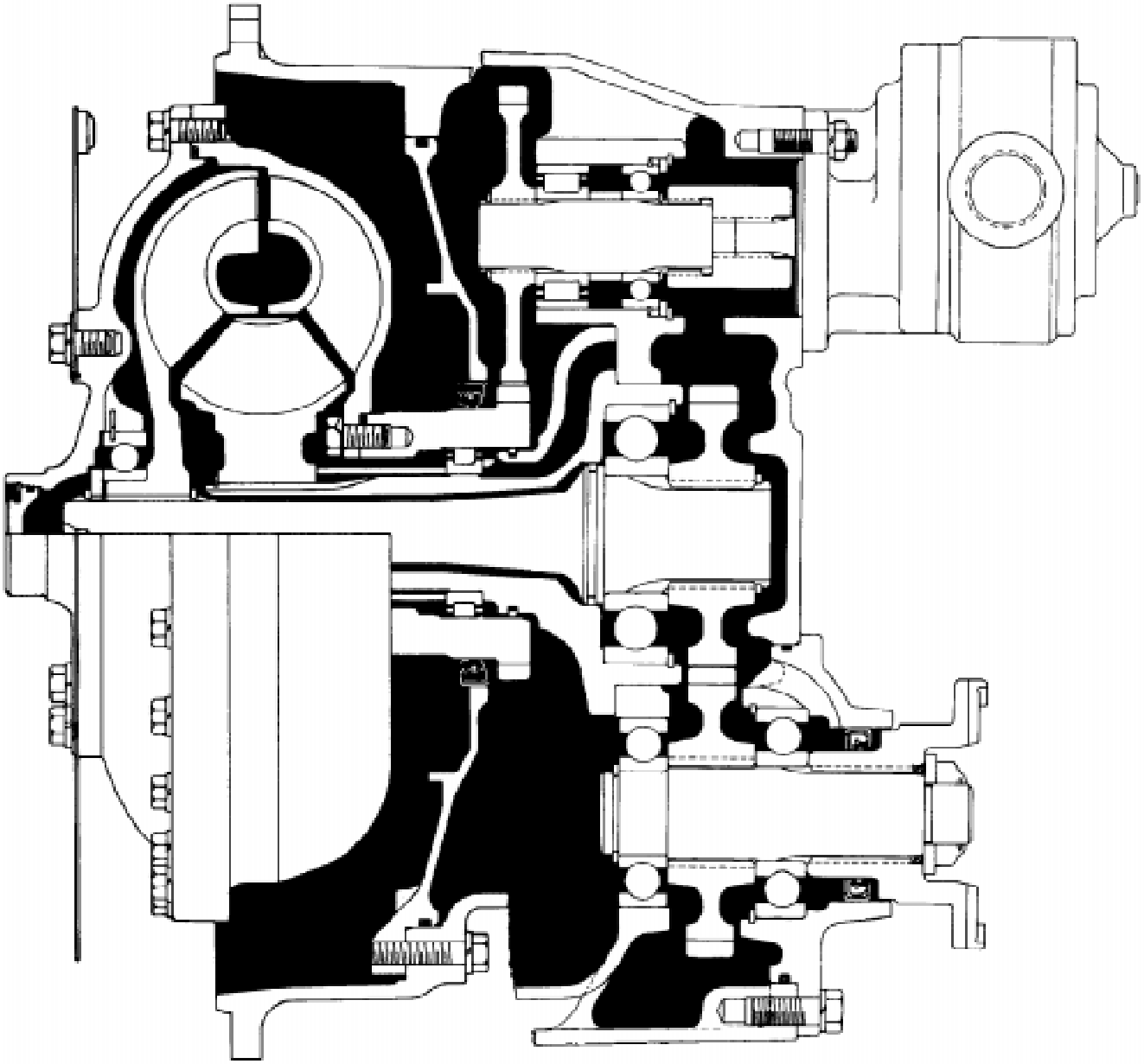


FIG. A-Torque Converter Assembly-Cross Section

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C2000 SERIES CONVERTER OIL FLOW DIAGRAM

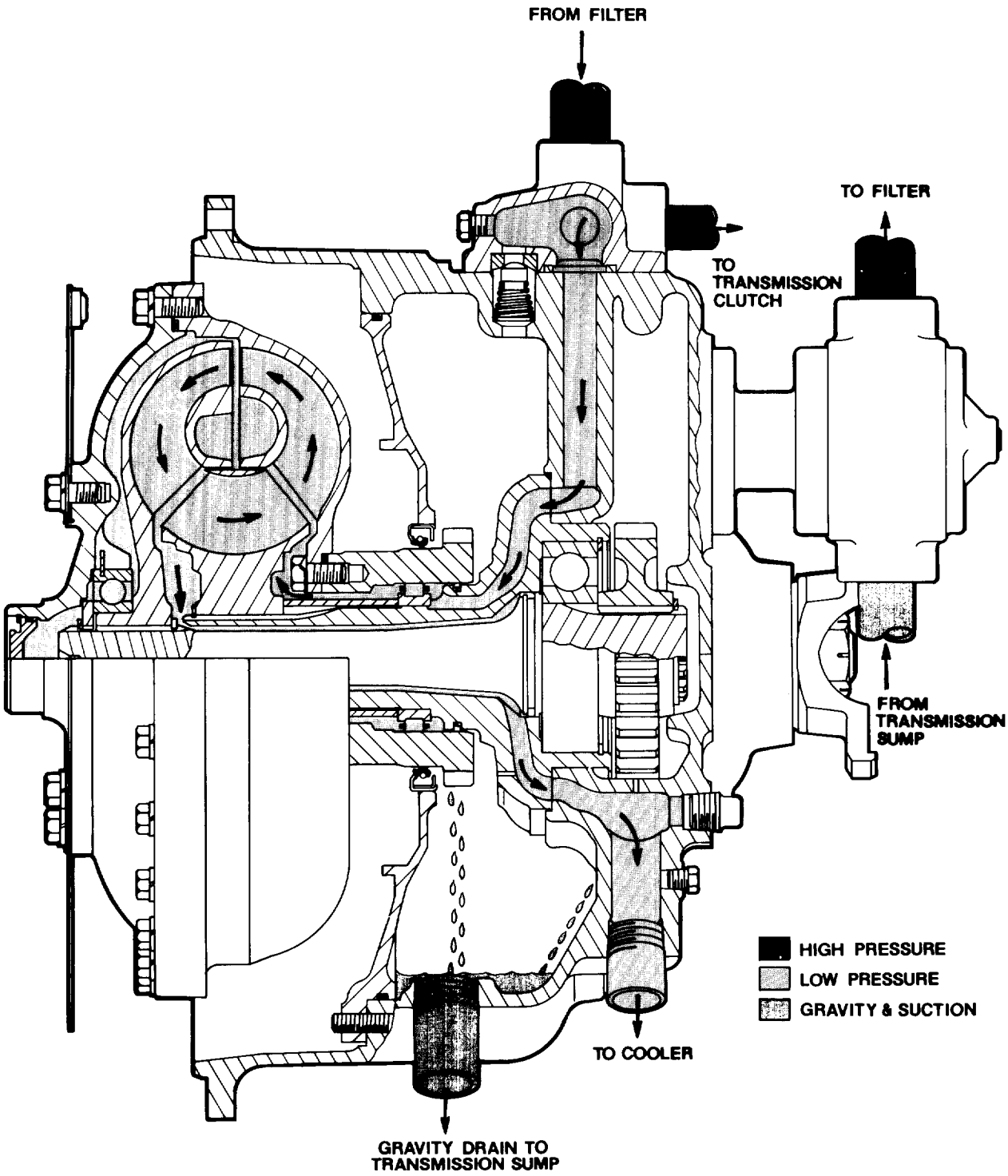


Figure B

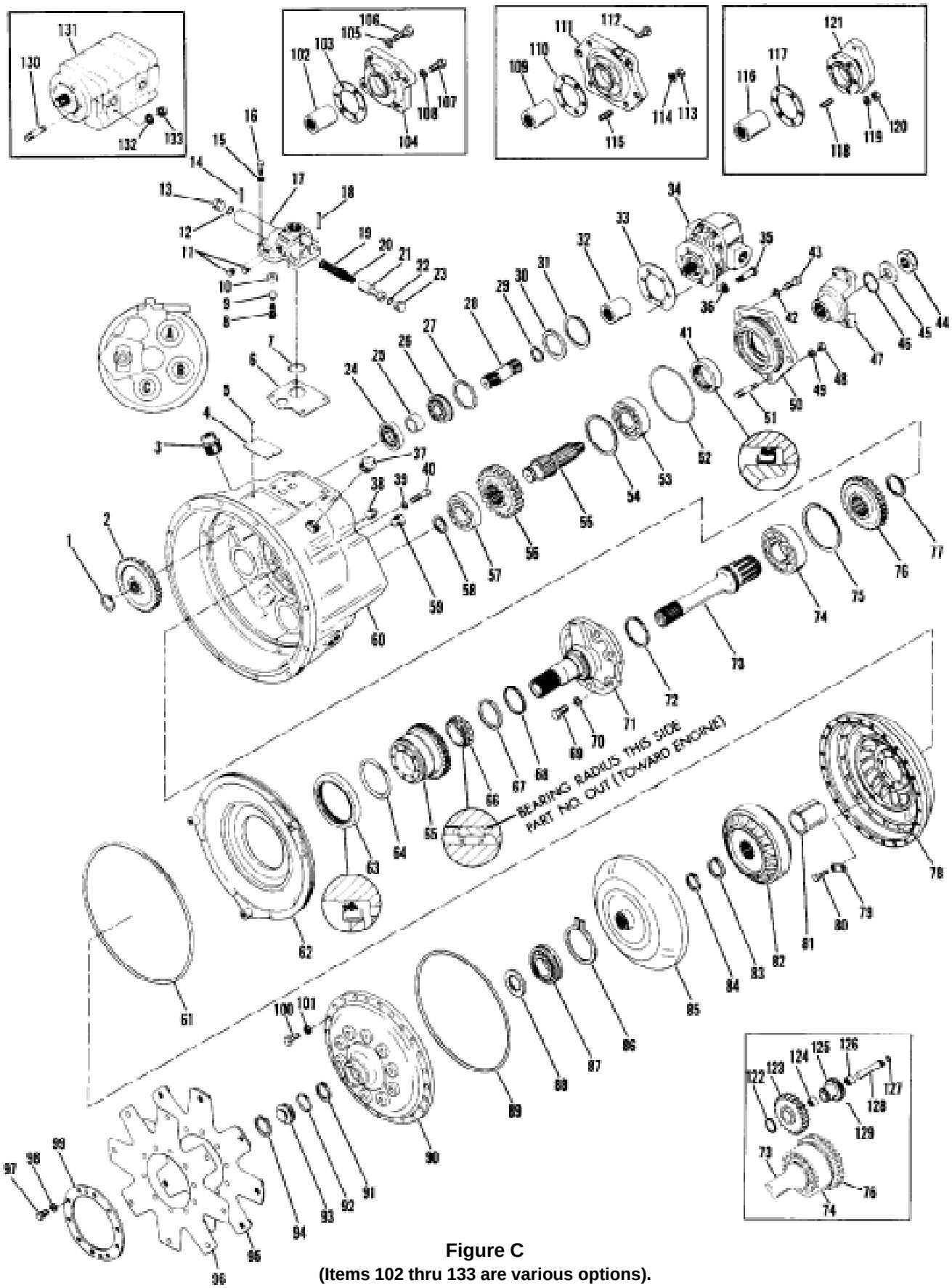


Figure C
(Items 102 thru 133 are various options).

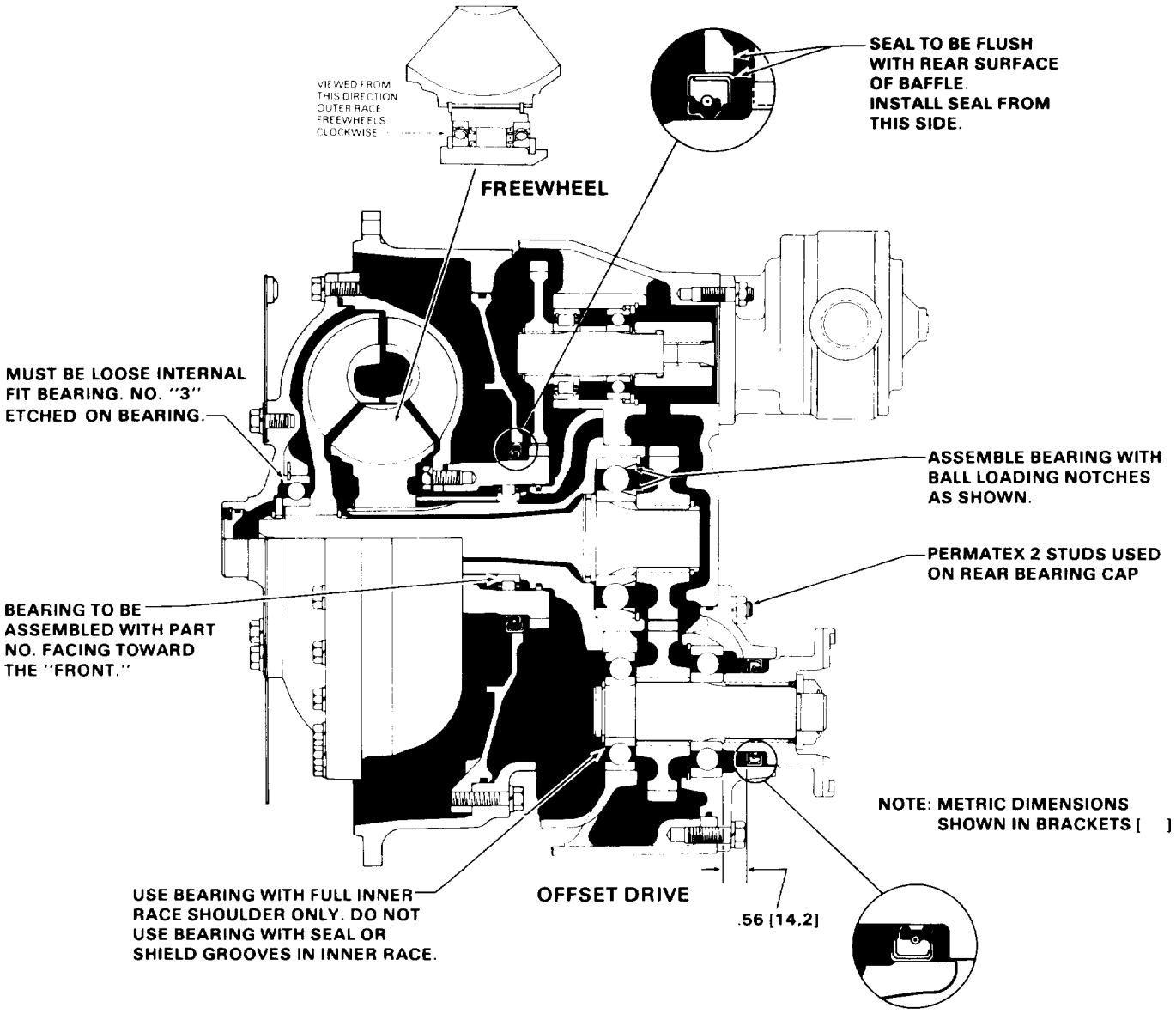
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C2000 CONVERTER WITH OFFSET OUTPUT

ITEM	DESCRIPTION	QTY.
1	Pump Gear Snap Ring	3
2	Pump Drive Gear	3
3	Breather	1
4	Name Plate	1
5	Name Plate Screw	2
6	Pressure Regulating Valve to Housing Gasket	1
7	Valve to Housing “O” Ring	1
8	Safety Valve Spring	1
9	Safety Valve Plunger	1
10	Safety Valve Seat	1
11	Pressure Port Pipe Plugs	2
12	Valve Stop “O” Ring	1
13	Valve Stop	1
14	Roll Pin	1
15	Regulating Valve to Housing Screw Lockwasher	4
16	Regulating Valve to Housing Screw	4
17	Regulating Valve Assembly	1
18	Roll Pin	1
19	Regulating Valve Spring (Outer)	1
20	Regulating Valve Spring (Inner)	1
21	Regulating Valve Piston	1
22	Valve Stop “O” Ring	1
23	Valve Stop	1
24	Pump Drive Front Bearing	3
25	Pump Shaft Spacer	3
26	Pump Drive Rear Bearing	3
27	Rear Bearing Locating Ring	3
28	Pump Drive Shaft	3
29	Rear Bearing Retainer Ring	3
30	Pump Shaft Retaining Washer	3
31	Pump Shaft Retaining Ring	3
32	Pump Drive Sleeve Assembly	1
33	Pump Gasket	1
34	Charging Pump	1
35	Pump Mounting Screw	3
36	Pump Mounting Screw Lockwasher	3
37	Pipe Plug	3
38	Converter “Out” Temperature Port	3
39	Oil Baffle Screw Lockwasher	1
40	Oil Baffle Screw	3
41	Output Shaft Oil Seal	1
42	Output Bearing Retainer Lockwasher	3
43	Output Bearing Retainer Screw	3
44	Output Flange Nut	1
45	Output Flange Washer	1
46	Flange Washer “O” Ring	1
47	Output Flange	1
48	Bearing Retainer Stud Nut	2
49	Bearing Retainer Stud Nut Lockwasher	2
50	Output Bearing Retainer	1

ITEM	DESCRIPTION	QTY
51	Output Bearing Retainer Stud	2
52	Output Bearing Retainer “O” Ring	1
53	Output Shaft Rear Bearing	1
54	Rear Bearing Retainer Ring	1
55	Output Shaft	1
56	Output Shaft Gear	1
57	Output Shaft Front Bearing	1
58	Front Bearing Retainer Ring	1
59	Converter Out Pressure Port	1
60	Converter Housing	1
61	Oil Baffle “O” Ring	1
62	Oil Baffle	1
63	Oil Baffle Oil Seal	1
64	Impeller Hub “O” Ring	1
65	Impeller Hub Gear	1
66	Impeller Hub Gear Bearing	1
67	Support Oil Sealing Ring	1
68	Sealing Ring Expander Spring	1
69	Support Screw	1
70	Support Screw Lockwasher	6
71	Reaction Member Support	6
72	Turbine Shaft Oil Sealing Ring	1
73	Turbine Shaft	1
74	Turbine Shaft Bearing	1
75	Bearing Retainer Ring	1
76	Turbine Shaft Gear	1
77	Gear Retainer Ring	1
78	Impeller	1
79	Impeller to Hub Screw Lock Tab	4
80	Impeller to Hub Screw	8
81	Reaction Member Spacer	1
82	Reaction Member	1
83	Reaction Member Retainer Ring	1
84	Turbine Locating Ring	1
85	Turbine	1
86	Turbine Hub Bearing Locating Ring	1
87	Turbine Hub Bearing	1
88	Bearing Retainer Washer	1
89	Impeller Cover “O” Ring	1
90	Impeller Cover	1
91	Turbine Retaining Ring	1
92	Bore Plug “O” Ring	1
93	Impeller Cover Bore Plug	1
94	Bore Plug Retaining Ring	1
95	Flexplate Assembly	1
96	Flexplate	1
97	Flexplate Mounting Screw	10
98	Flexplate Mounting Screw Lockwasher	10
99	Backing Ring	1
100	Impeller Cover to Impeller Screw	24
101	Impeller Cover to Impeller Screw Lockwasher	24

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Torque Specification for Lubricated or Plated Screw Threads

NOM. SIZE	Grade 5 FINE THREAD LB-FT	[N·M]	Grade 5 COARSE THREAD LB-FT	[N·M]	Grade 8 FINE THREAD LB-FT	[N·M]	Grade 8 COARSE THREAD LB-FT	[N·M]
.5625	91 - 100	[123,4 - 135,5]	82 - 90	[111,2 - 122,0]	128 - 141	[173,6 - 191,1]	115 - 127	[156,0 - 172,2]
.5000	64 - 70	[86,8 - 94,9]	57 - 63	[77,3 - 85,4]	90 - 99	[122,1 - 134,2]	80 - 88	[108,5 - 119,3]
.4375	41 - 45	[55,6 - 61,0]	37 - 41	[50,2 - 55,5]	58 - 64	[78,7 - 86,7]	52 - 57	[70,6 - 77,2]
.3750	26 - 29	[35,3 - 39,3]	23 - 25	[31,2 - 33,8]	37 - 41	[50,2 - 55,5]	33 - 36	[44,8 - 48,8]
.3125	16 - 20	[21,7 - 27,1]	12 - 16	[16,3 - 21,6]	28 - 32	[38,0 - 43,3]	26 - 30	[35,3 - 40,6]
.2500	9 - 11	[12,3 - 14,9]	8 - 10	[10,9 - 13,5]	11 - 13	[15,0 - 17,6]	9 - 11	[12,3 - 14,9]

Figure D

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OVERHAUL INSTRUCTIONS FOR TORQUE CONVERTER

The following instructions will cover the disassembly and reassembly of the torque converter in a sequence that would normally be followed after the unit is removed from the machine and is to be completely overhauled.

CAUTION: Cleanliness is of extreme importance and an absolute must in the repair and overhaul of this unit. Before attempting any repairs, the exterior of the unit must be thoroughly cleaned to prevent the possibility of dirt and foreign matter entering the mechanism.

DISASSEMBLY OF THE TORQUE CONVERTER

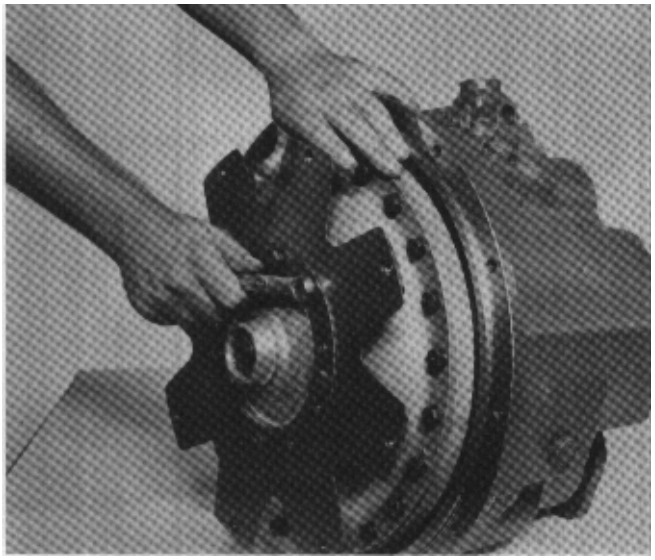


Figure 1
Remove flexplate mounting screws and washers.

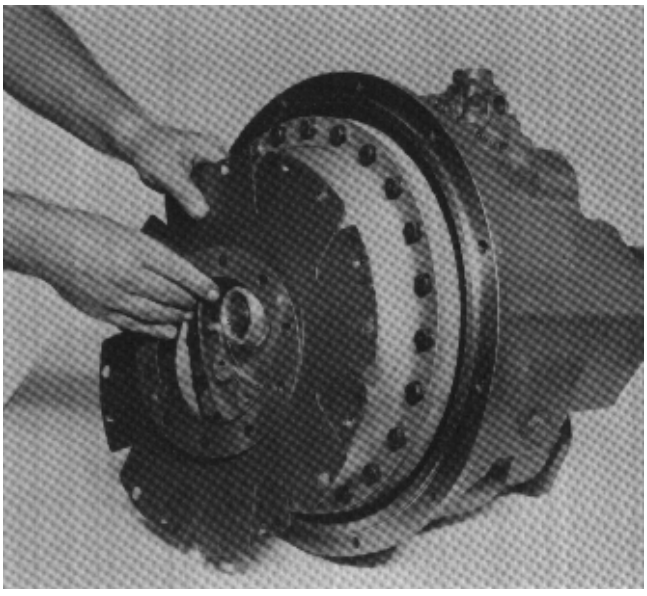


Figure 2
Remove flexplate and backing ring.

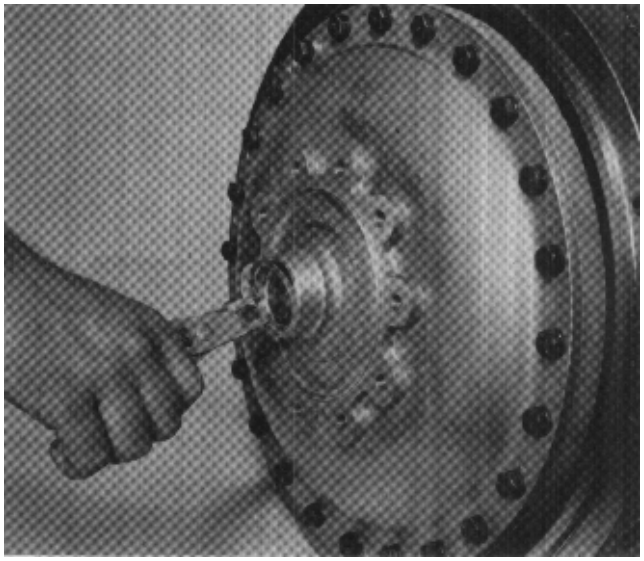


Figure 3
Remove impeller cover bore plug retainer ring.

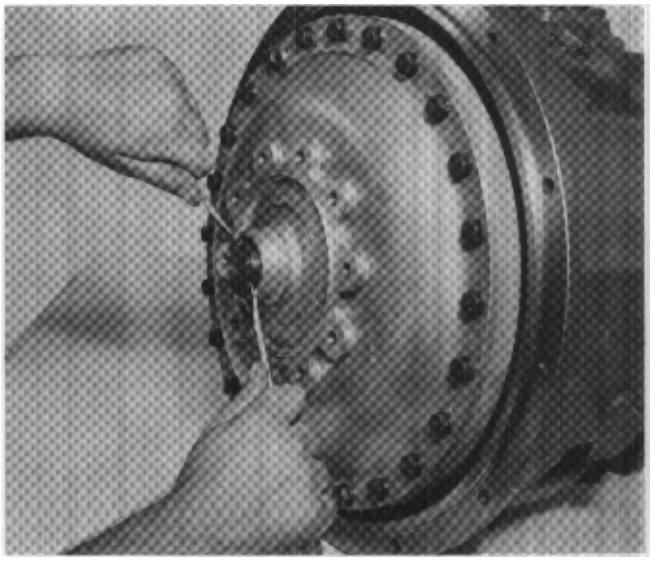


Figure 4
Using two small screw drivers as shown, remove bore

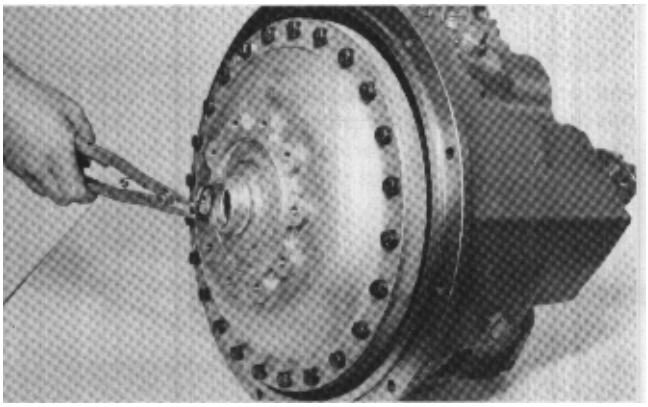


Figure 5
Through bore plug hole, turbine retaining ring.
See Figure 6.

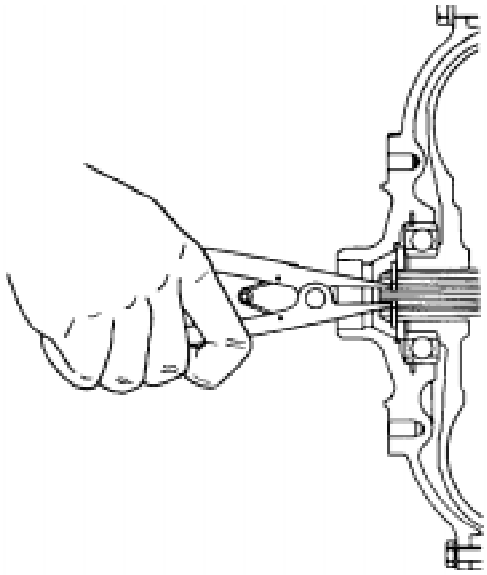


Figure 6.

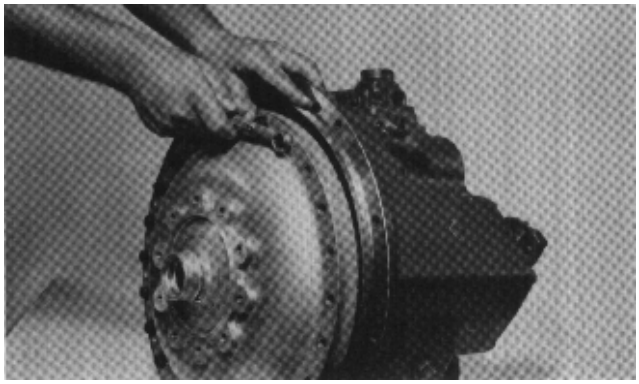


Figure 7.
Remove impeller cover to impleller bolts.

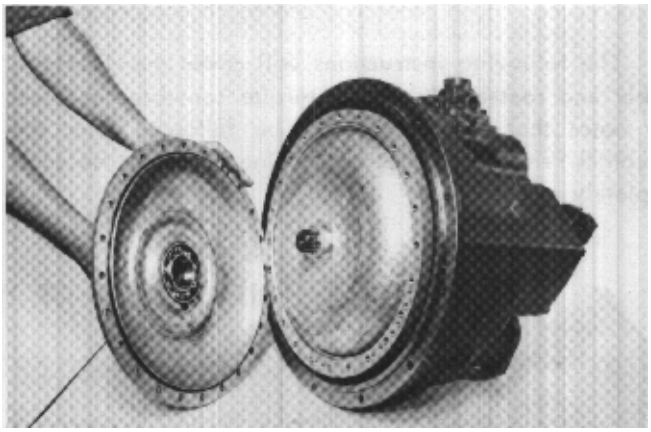


Figure 8
Remove impeller cover and bearing assembly.
Remove turbine.

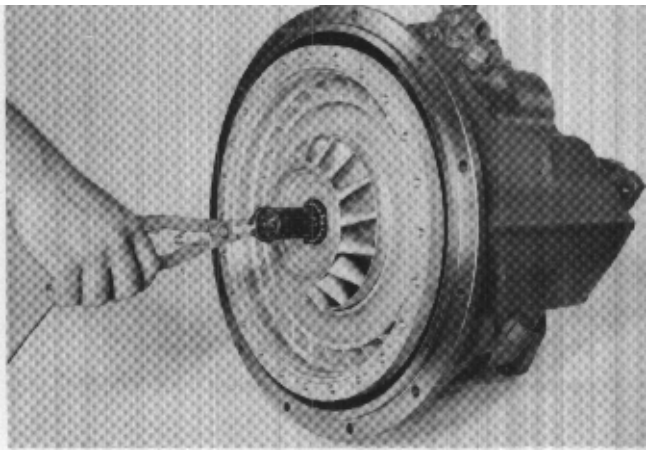


Figure 9
Remove turbine locating ring.

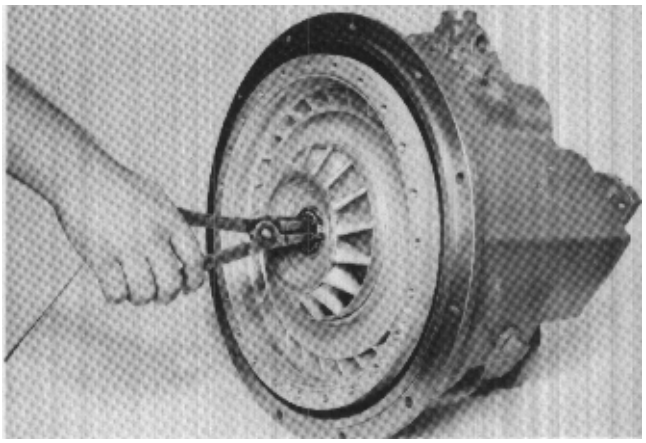


Figure 10
Remove reaction member retainer ring.

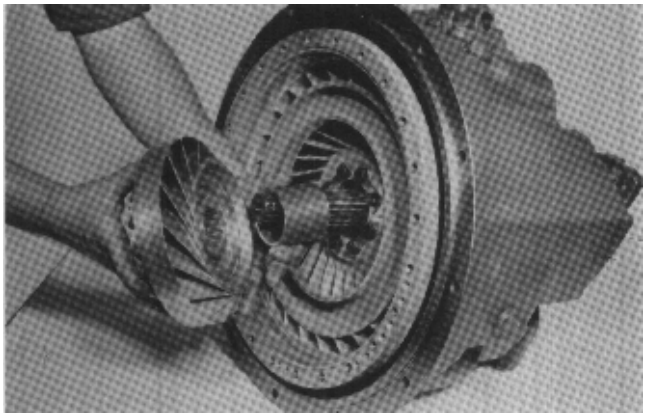


Figure 11
Remove reaction member and spacer. If reaction member is free wheeling remove as an assembly. (See Fig. 42 for freewheel disassembly).

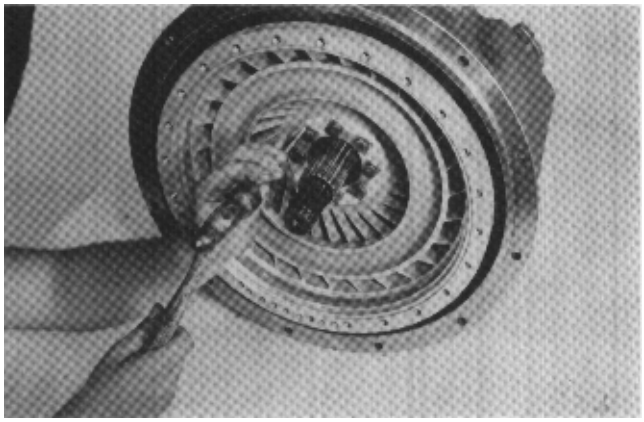


Figure 12
Straighten corner of impeller to hub screw lock tabs. Remove impeller hub bolts and lock tabs.

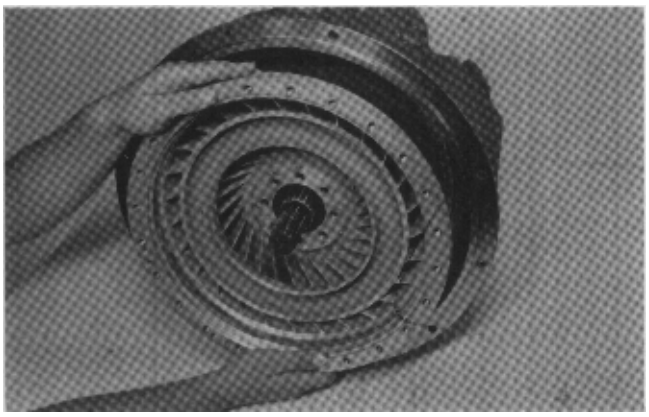


Figure 13
Remove impeller.

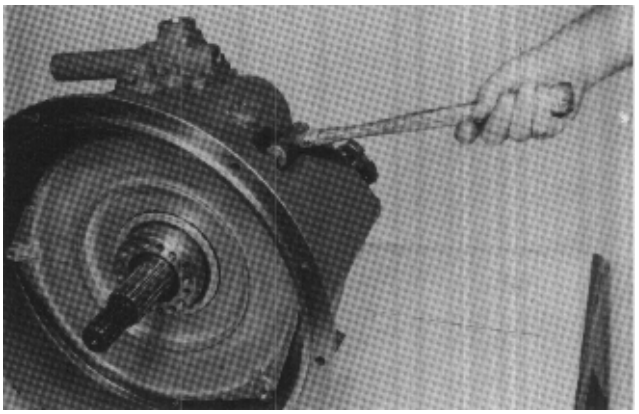


Figure 14
Loosen oil baffle bolts (qty. 3). Tap lightly on each bolt. This will loosen oil baffle from converter housing.

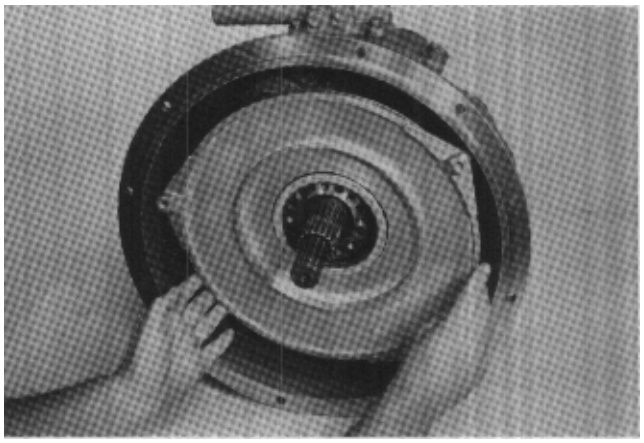


Figure 15
When baffle is loose remove baffle bolts. Remove oil baffle from housing.

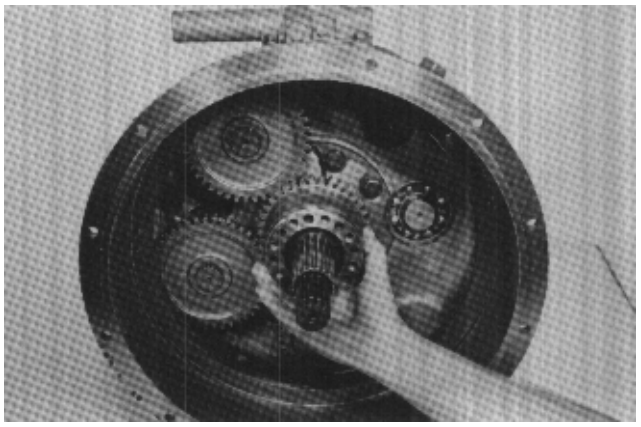


Figure 16
Remove impeller hub from housing.

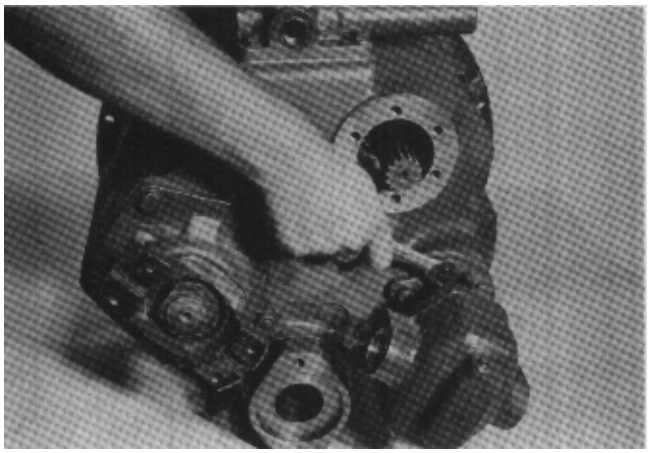


Figure 17
Remove charging pump to converter housing bolts.

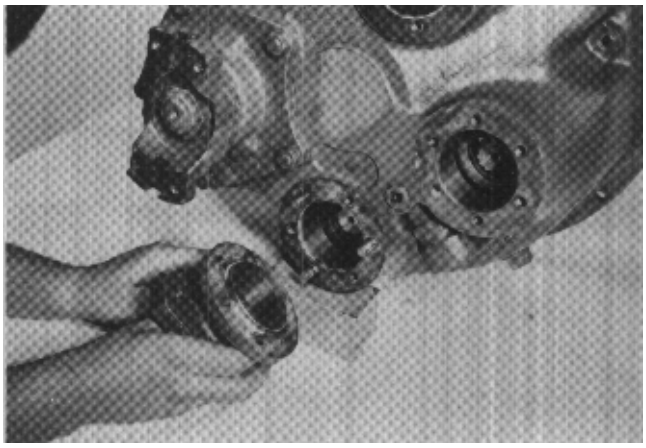


Figure 20
Remove adaptors

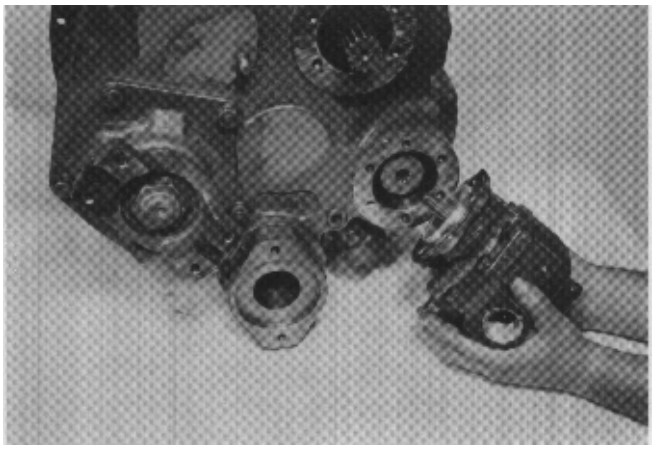


Figure 18
Remove charging pump.

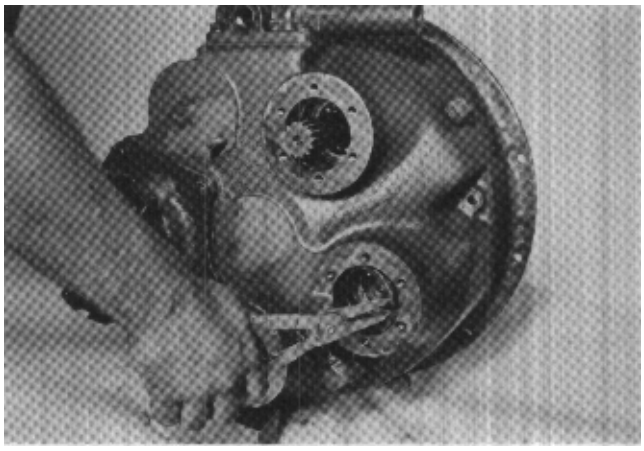


Figure 21
Remove pump shaft retaining ring.

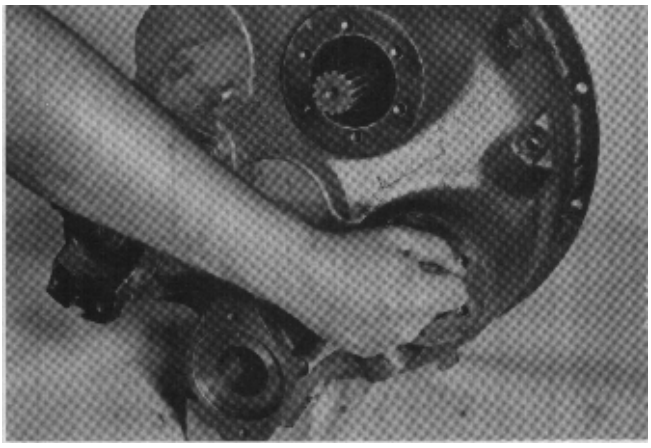


Figure 19
Remove accessory pump drive adaptor bolts.

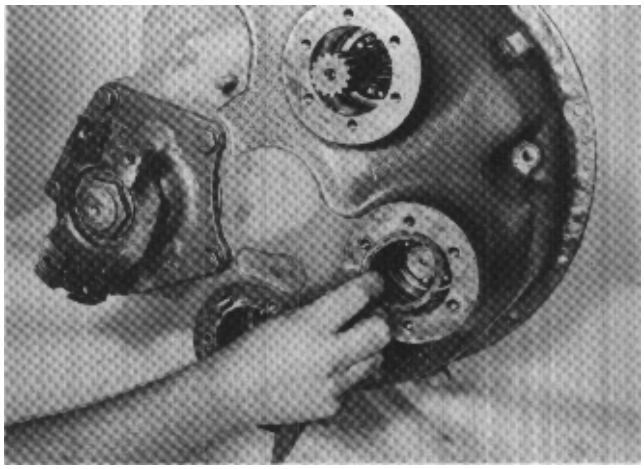


Figure 22
Remove pump shaft retaining washer.

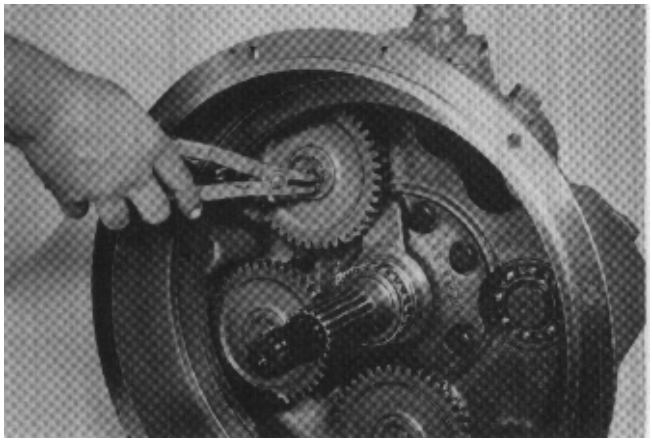


Figure 23

Remove pump drive gear retainer ring

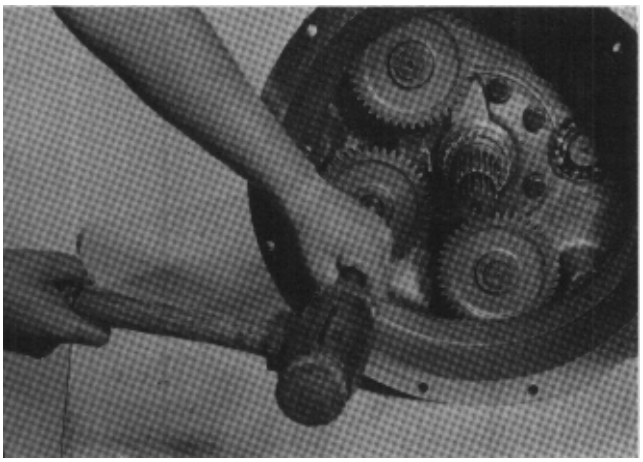


Figure 24

Tap on pump shaft. Remove pump drive gear.

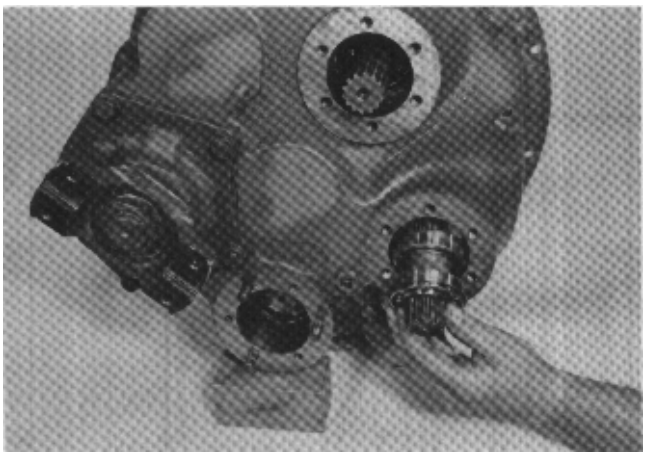


Figure 25

From rear of housing remove pump drive shaft and bearing assembly.

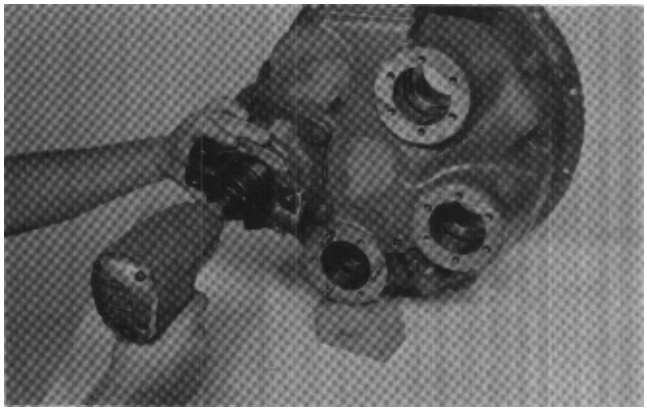


Figure 26

Using an impact wrench (if available) remove output flange nut. If impact wrench is not available a flange retainer bar must be used to hold flange from turning while removing flange nut.

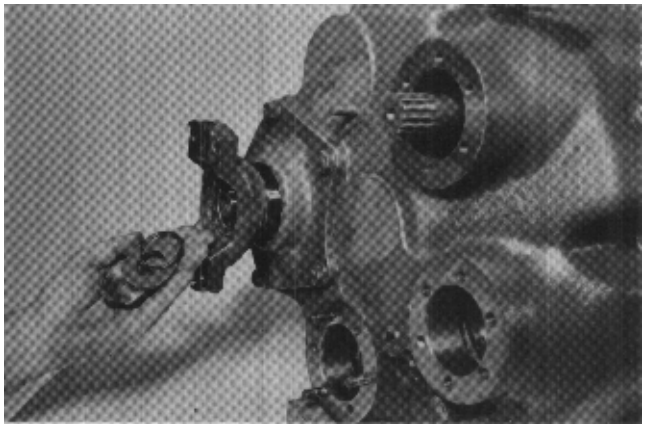


Figure 27

Remove flange nut, washer, “O” ring and flange from output shaft.

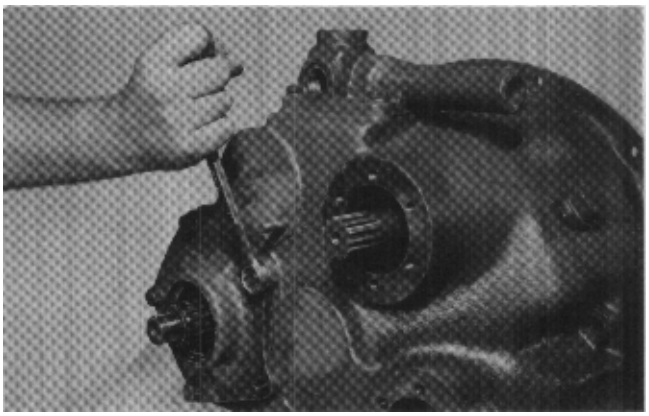


Figure 28

Remove output shaft bearing retainer bots stud nuts and washers.

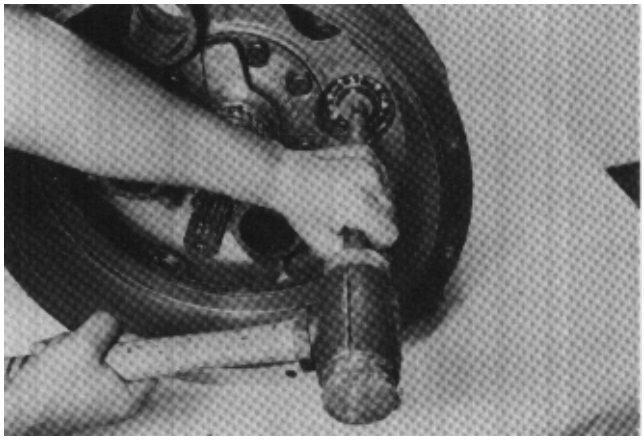


Figure 29

From front of housing drive output shaft assembly from converter housing.

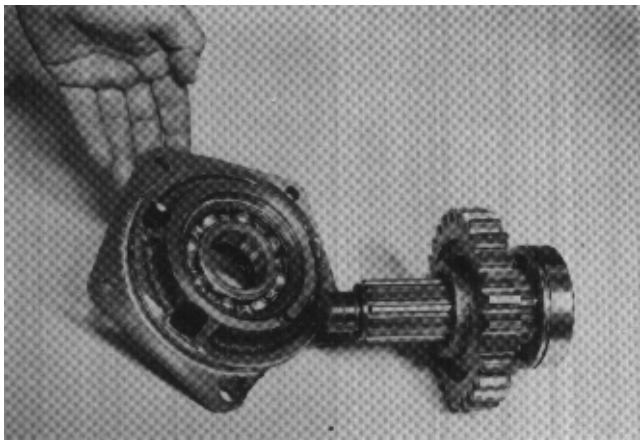


Figure 30

Output shaft, gear and bearing pressed from bearing retainer.

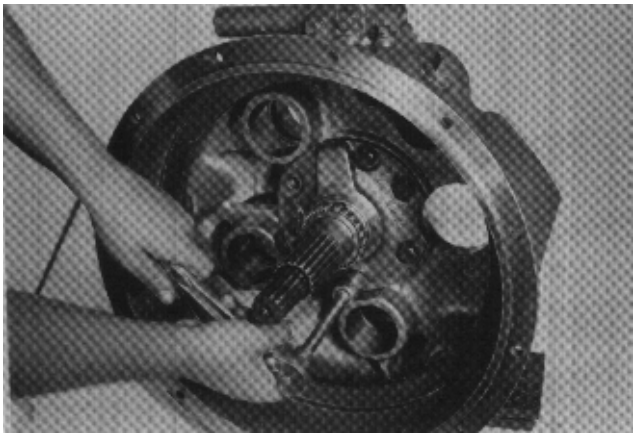


Figure 31

Remove reaction member support bolts.

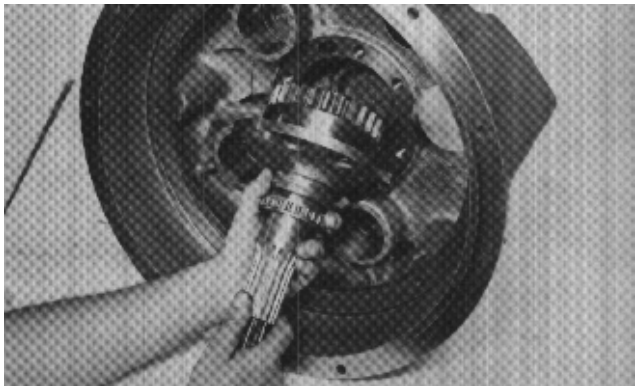


Figure 32

Remove support and turbine shaft assembly.

NOTE: If converter housing has a bore plug in the rear center line, remove plug. Remove turbine shaft gear retainer ring. Remove support and turbine shaft assembly. Turbine shaft gear will remain in rear of housing. This is a special ratio gear and is larger than the support bore.

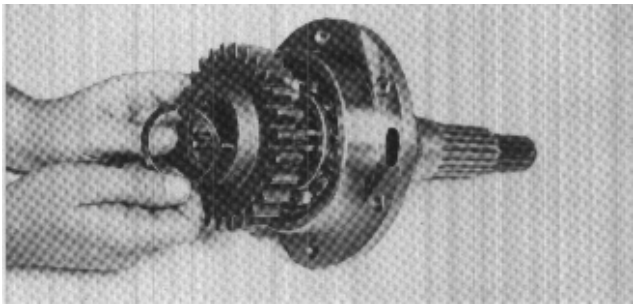


Figure 33

Remove turbine shaft gear retainer ring and gear. See note above.

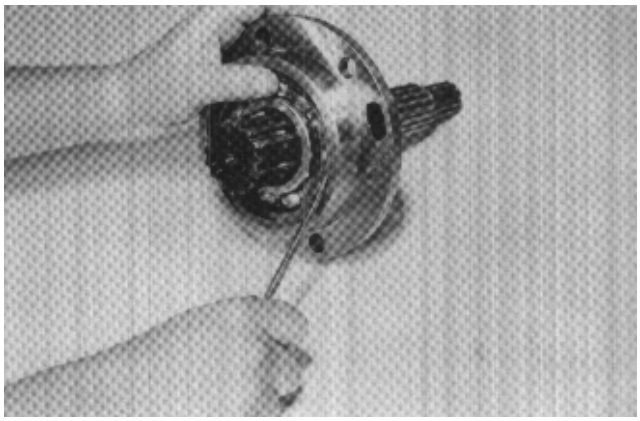


Figure 34

Remove turbine shaft bearing retainer ring from support.

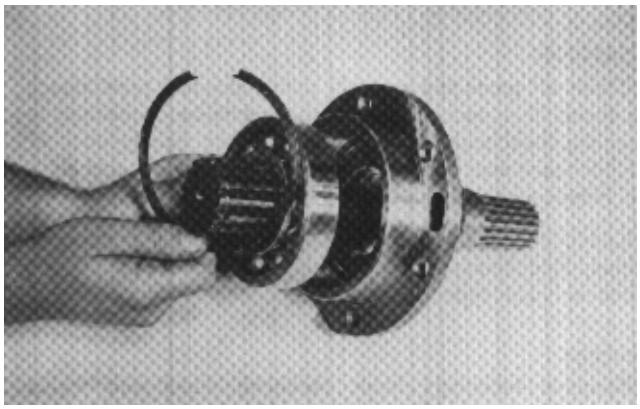


Figure 35

Remove turbine shaft and bearing from support.

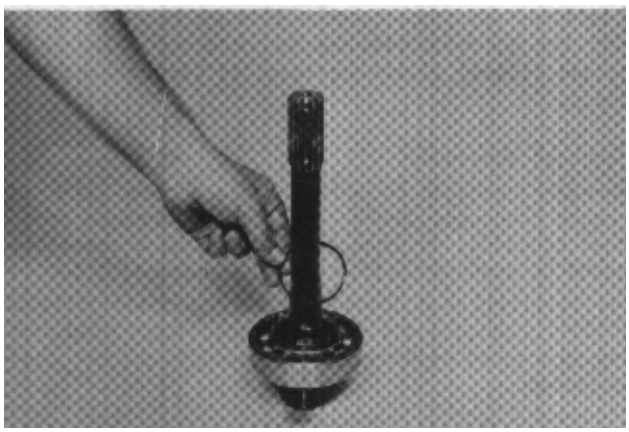


Figure 36

Remove turbine shaft oil sealing ring.

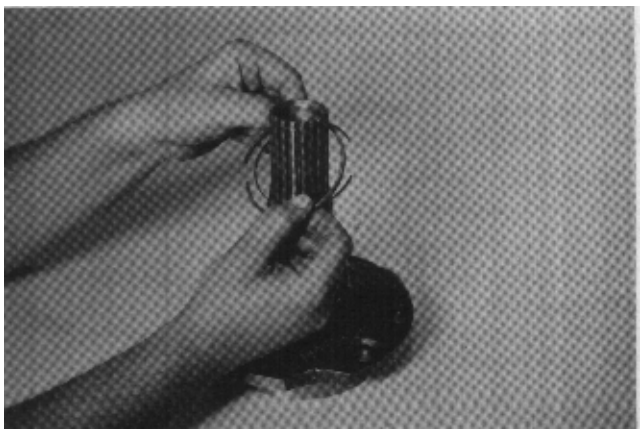


Figure 37

Remove support oil sealing ring and sealing ring expander spring.

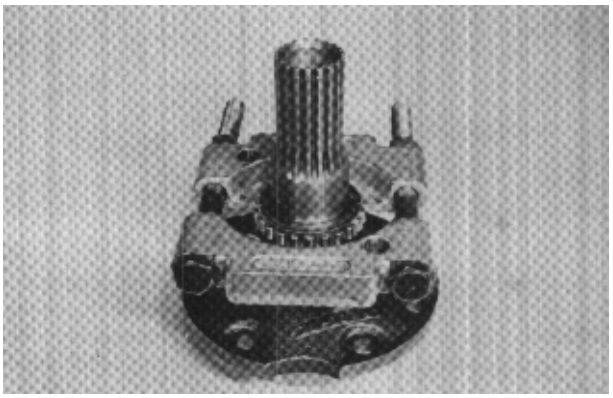


Figure 38

If support bearing is to be removed procedure shown with split puller is recommended.

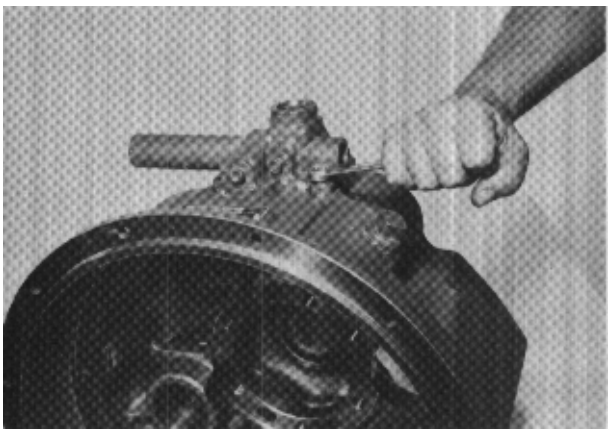


Figure 39

Remove pressure regulating valve to housing screws and lockwashers.

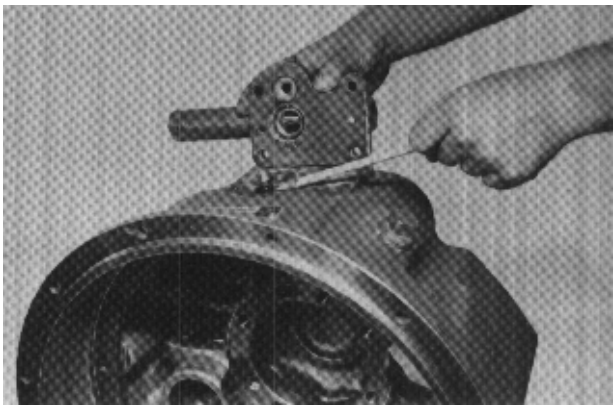


Figure 40

Remove pressure regulating valve, safety valve plunger and spring.

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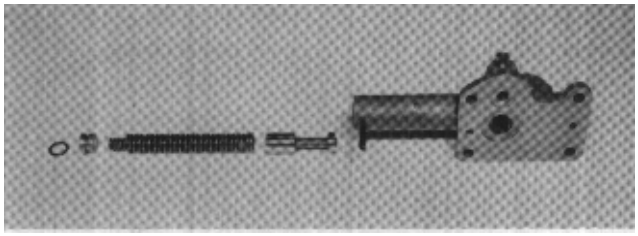


Figure 41

If pressure regulating is to be disassembled, compress valve spring stop. Tap roll pin from valve housing. **CAUTION:** Spring stop is under spring pressure. Remove spring stop, inner and outer spring and valve piston.

FREEWHEEL DISASSEMBLY

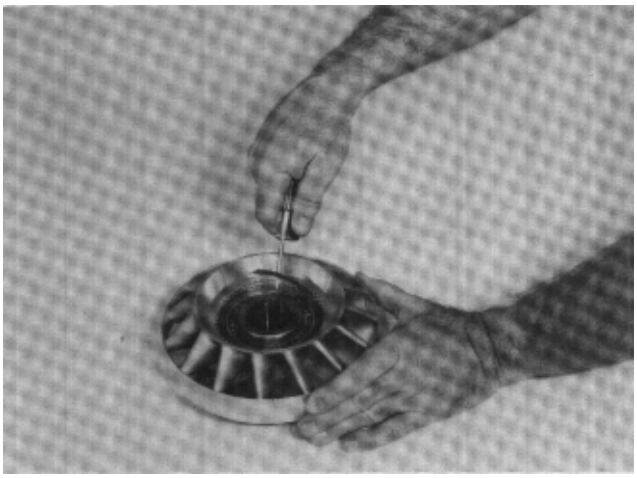


Figure 42

If either the reaction member or the freewheel assembly is to be replaced remove the front outer race to reaction member retainer ring.

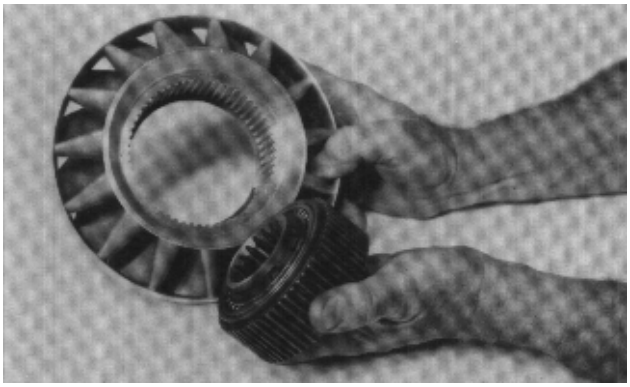


Figure 43

Remove freewheel assembly from the reaction member. NOTE: The freewheel assembly cannot be serviced. If the freewheel is damaged it must be replaced as an assembly.

CLEANING AND INSPECTION

Cleaning
Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

CAUTION: Care should be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Bearings
Remove bearings from cleaning fluid and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

Freewheel Assembly
Clean the complete freewheel assembly the same as cleaning bearings. **NOTE:** Do not disassemble freewheel assembly. **If freewheel assembly is damaged it must be replaced with a complete assembly.** After cleaning and drying freewheel assembly dip complete assembly in automatic transmission fluid and wrap in a clean lintless cloth or paper to protect until assembled.

Housings
Clean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.

CAUTION: Care should be exercised to avoid skin rashes and inhalation of vapors when using alkali cleaners.

Thoroughly dry all parts cleaned immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil or laping compound.

INSPECTION
The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

Bearings

Carefully inspect all rollers, cages and cups for wear, chipping or nicks to determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in clean light oil and wrap in clean lintless cloth or paper to protect them until installed.

Oil Seals, Gaskets, Etc.

Replacement of spring load oil seals, “O” Rings, metal sealing rings, gaskets and snap rings is more economical when unit is disassembled then premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency. Apply a thin coat of Permatex No. 2 on the outer diameter of the oil seal to assure an oil tight fit into the retainer. When assembling new metal type sealing rings, same should be lubricated with coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all “O” Rings and seals with Automatic Transmission Fluid before assembly.

Gears and Shafts

If magna-flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

Housing, Covers, etc.

Inspect housings, covers and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or conditions which would cause subsequent oil leaks or failures.

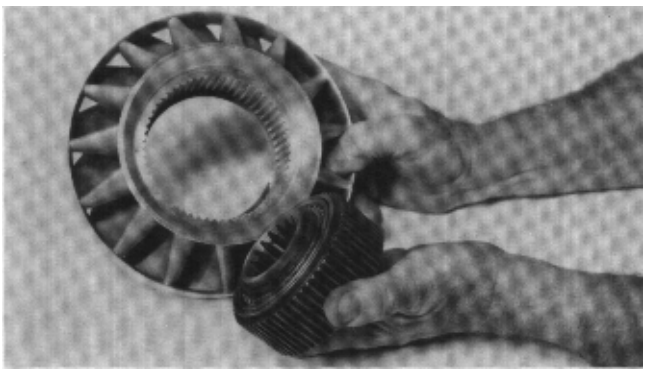


Figure 44

Install outer race and sprag assembly in reaction member. **NOTE:** Undercut shoulder of race must go toward the rear of the reaction member.

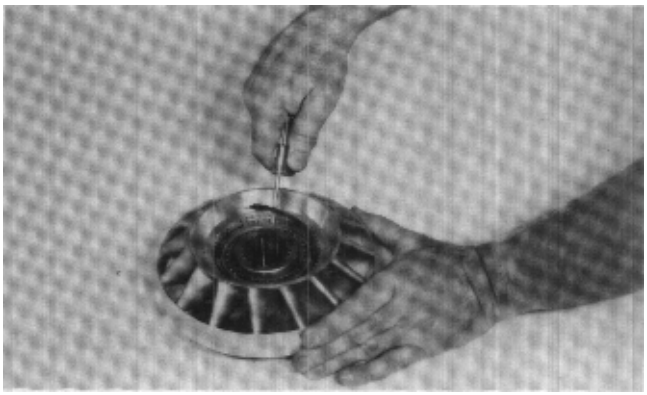


Figure 45

Install outer race to reaction member retainer ring.

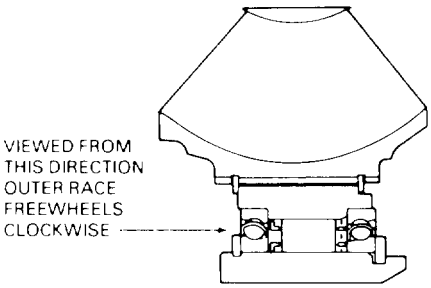


Figure 46

REASSEMBLY OF TORQUE CONVERTER

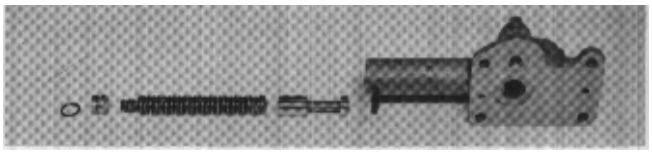


Figure 47

If pressure regulating valve was disassembled, reassemble as follows: Install new “O” ring on valve spring stop (one on each end, only one shown). Insert piston in housing. Install inner and outer valve springs. Install spring stop on spring. Depress spring stop and install spring stop roll pin.

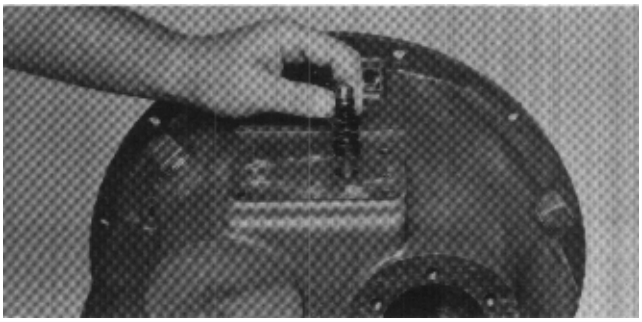


Figure 48

Position safety valve spring and plunger in converter housing.

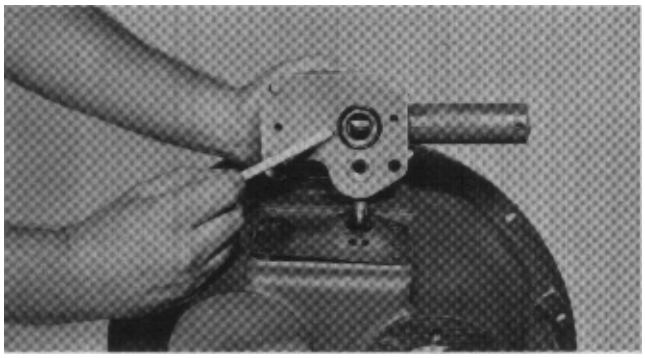


Figure 49

Install new gasket on converter housing, and new “O” ring on valve housing. Position valve assembly on converter housing.

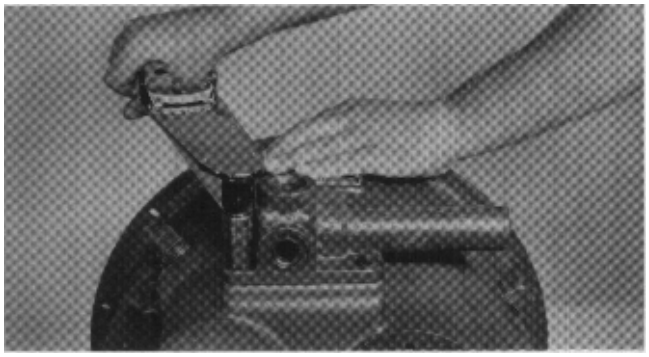


Figure 50

Install valve screws and lockwashers. Tighten 23 to 25 ft. lbs. torque [31,2 - 33,8 N.m.]

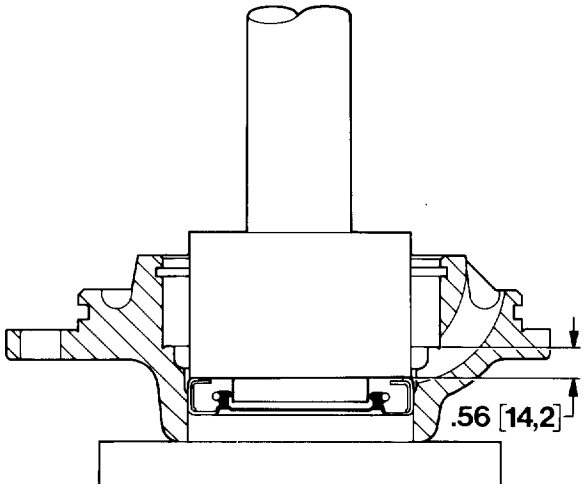


Figure 51

Apply a light coat of Permatex on the outer diameter of the output shaft oil seal. Press oil seal in bearing retainer from inside of retainer as shown and to dimension shown. See assembly instruction sheet, page 6.

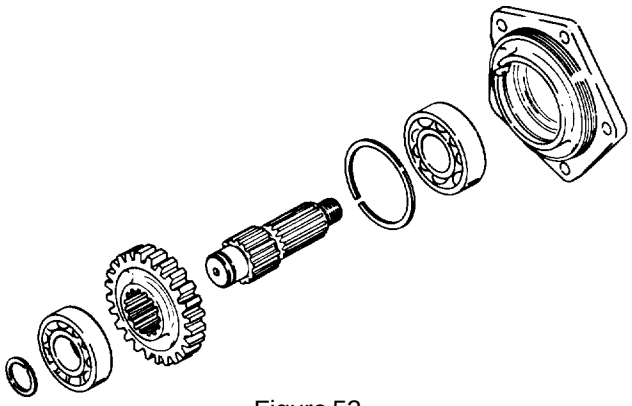


Figure 52

Press output rear bearing in bearing retainer. Secure with retainer ring. Press output shaft into bearing retainer. Use caution as not to damage oil seal. Position output gear on shaft. Press front output bearing on shaft. **NOTE: Use bearings with full inner race shoulder only. Do not use bearing with seal or shield grooves on inner race.** Install bearing retainer ring.

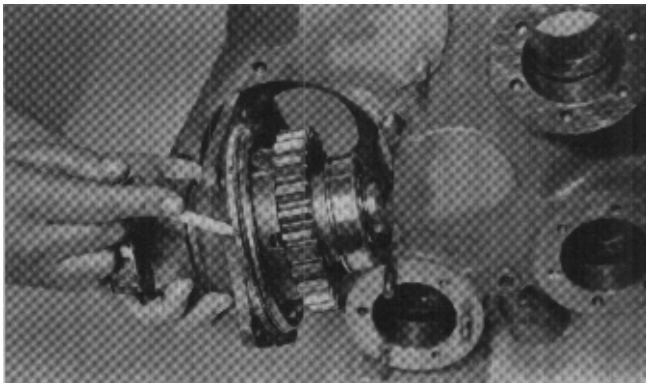


Figure 53

Install output flange, “O” ring, washer and flange nut. Tighten nut 200 to 250 ft. lbs. torque [271,2-338,9 N.m.] Install new “O” ring on output shaft bearing retainer. Position output assembly on converter housing.

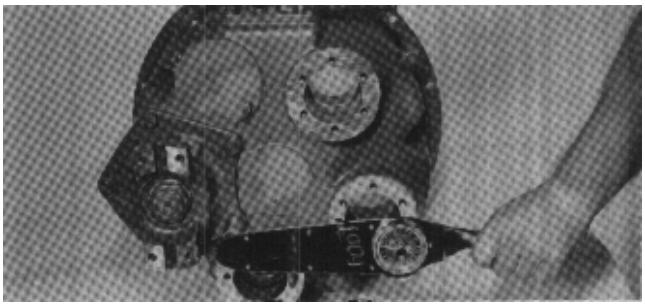


Figure 4

Install lockwashers, cap screws and stud nuts. tighten stud nuts 41 to 45 ft. lbs. torque [55,6-61,0 N.m.] Tighten capscrews 37 to 41 ft. lbs. torque [50,2 - 55,5 N.m.]

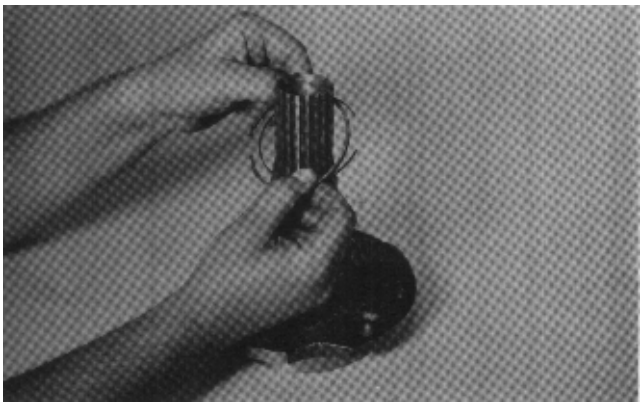


Figure 55
Install new oil sealing ring expander spring and oil sealing ring on reaction member support.

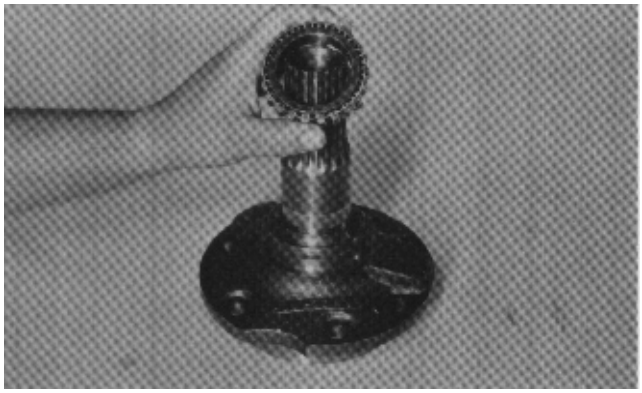


Figure 56
Install bearing on support. NOTE: Bearing part number must be up. Press bearing into position.

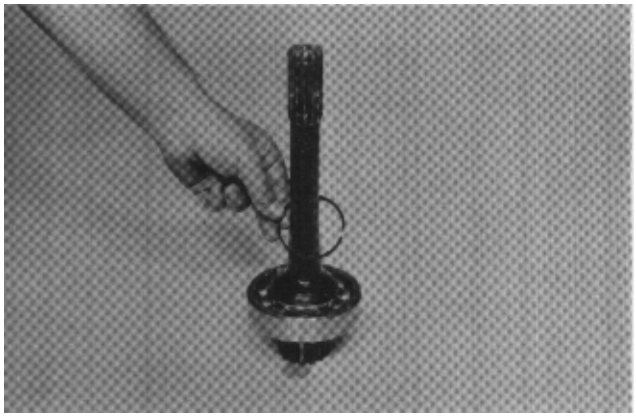


Figure 57
If turbine shaft bearing was removed, press bearing on shaft. **NOTE:** Ball bearing loading notches must be away from shoulder of turbine shaft. Install new turbine shaft oil sealing ring.

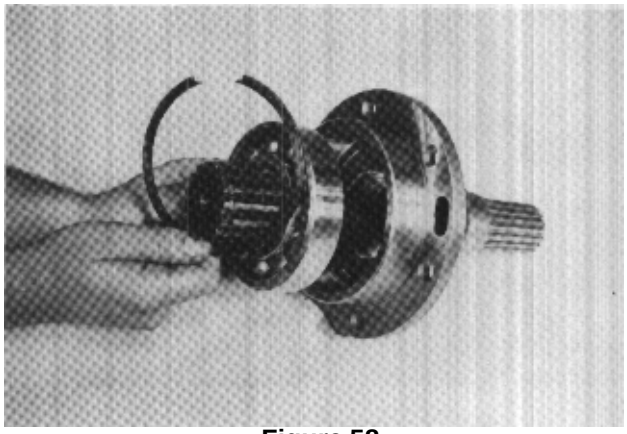


Figure 58
Install turbine shaft assembly in reaction member support. Use caution as not to damage turbine shaft oil sealing ring.

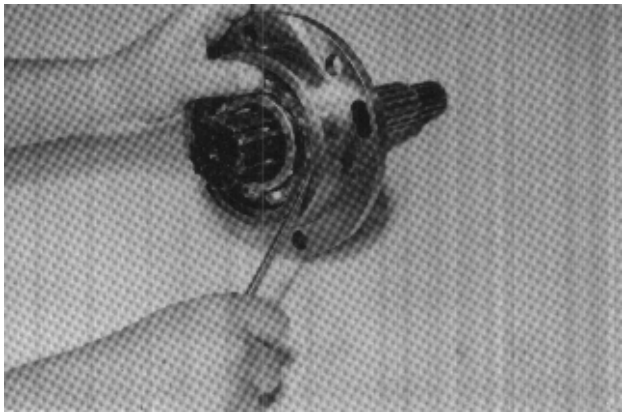


Figure 59
Install turbine shaft bearing retaining ring.

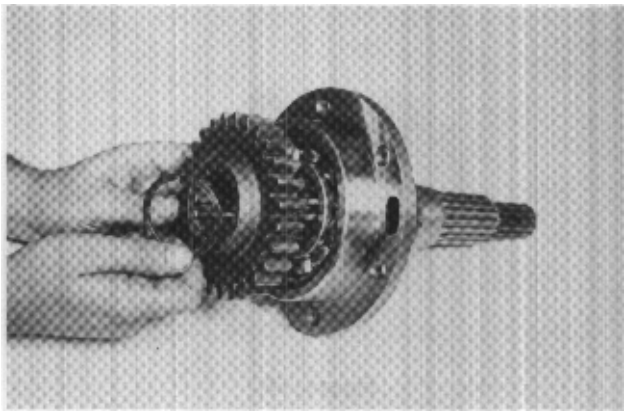


Figure 60
Position turbine shaft gear on shaft. Install gear retaining ring. See note on page 12 and reassemble accordingly.

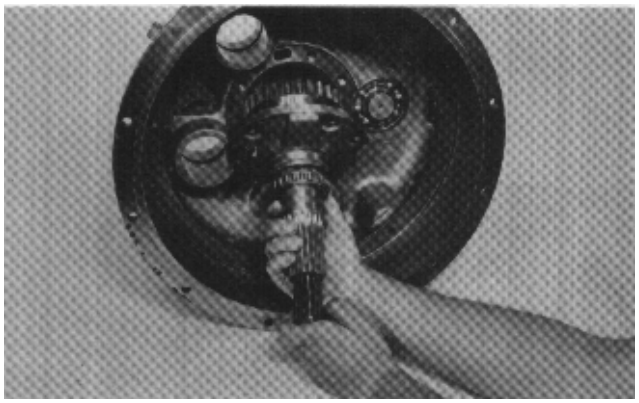


Figure 61
Install reaction member support and turbine shaft assembly in converter housing.

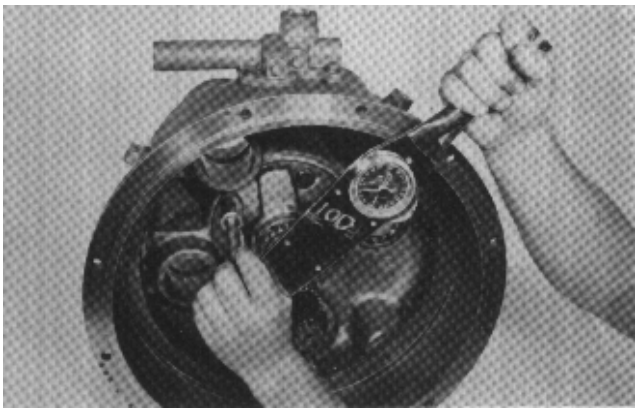


Figure 62
Install support washers and screws. Torque screws 57 to 63 ft. lbs. torque [77,3 - 85,4 N.m.]

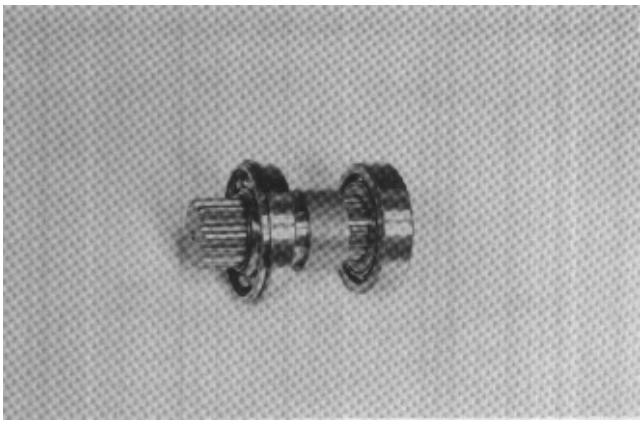


Figure 63
Install pump shaft rear bearing locating ring. Press rear bearing on pump shaft with bearing snap ring toward rear of shaft. Install bearing spacer and press front bearing on shaft until it shoulders against bearing spacer.

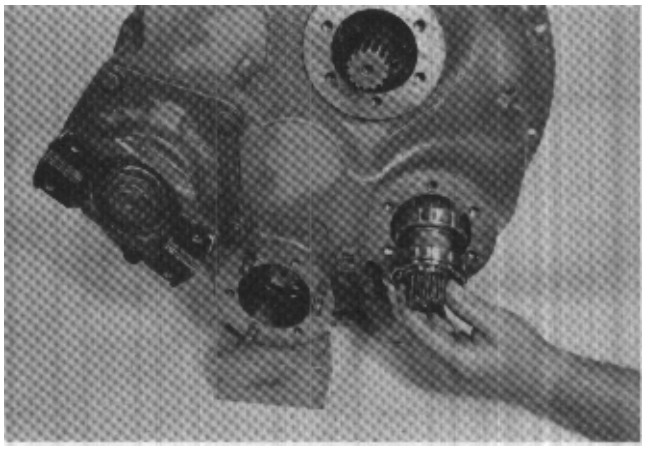


Figure 64
Install pump shaft and bearing assembly in converter housing. From front of converter housing start pump drive gear on shaft.

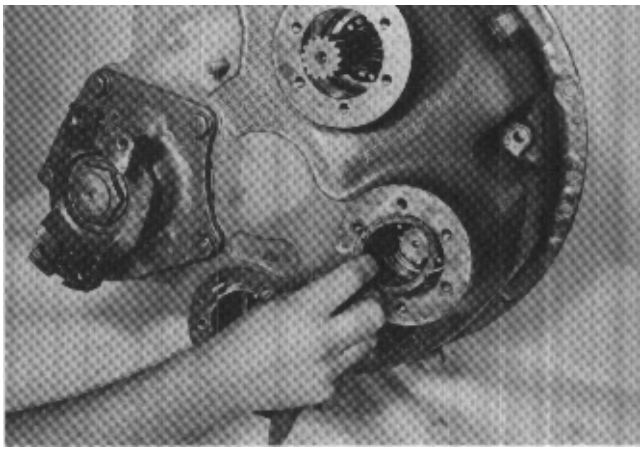


Figure 65
Install pump shaft rear bearing retainer washer.

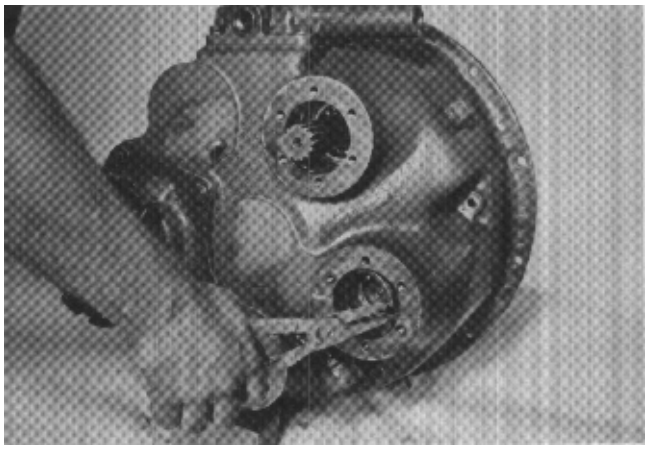


Figure 66
Install retainer washer snap ring.

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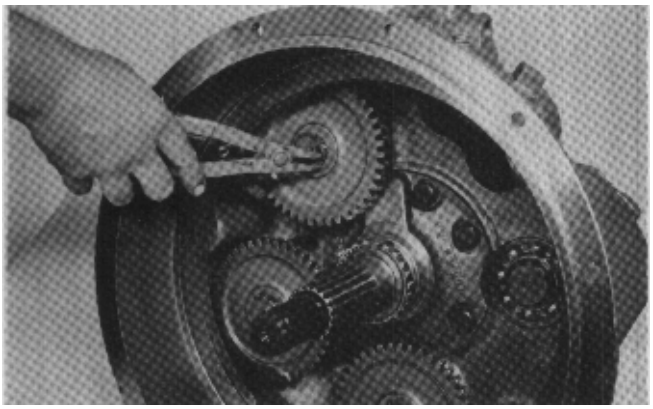


Figure 67
Install pump drive gear retainer rings.

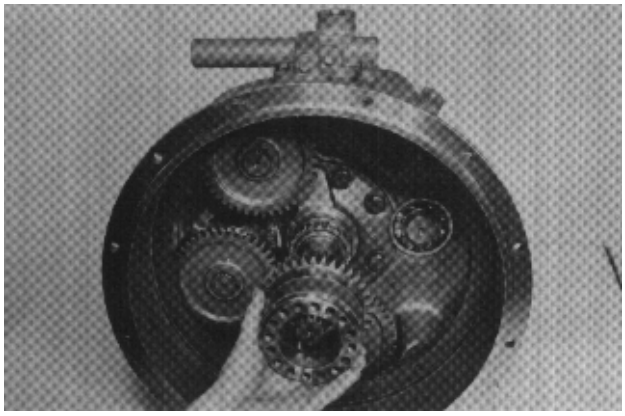


Figure 68
Position impeller hub gear on reaction member support. NOTE: Use extreme caution as not to cut, break or unhook the oil sealing ring on the support.

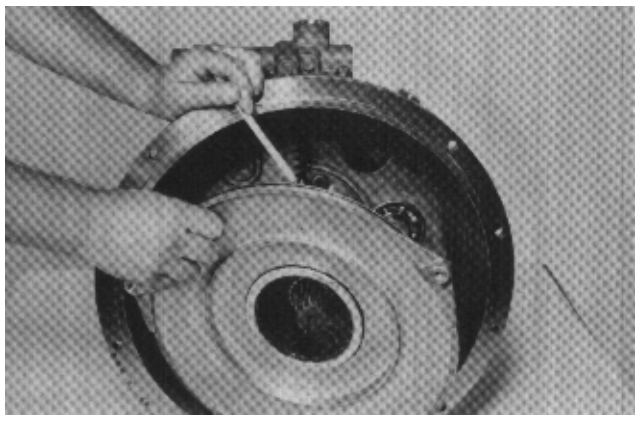


Figure 69
Install new oil baffle oil seal as shown in assembly instruction sheet on page 6. Install new oil baffle "O"' ring. Align three (3) oil baffle bolt troles with bolt holes in converter housing.

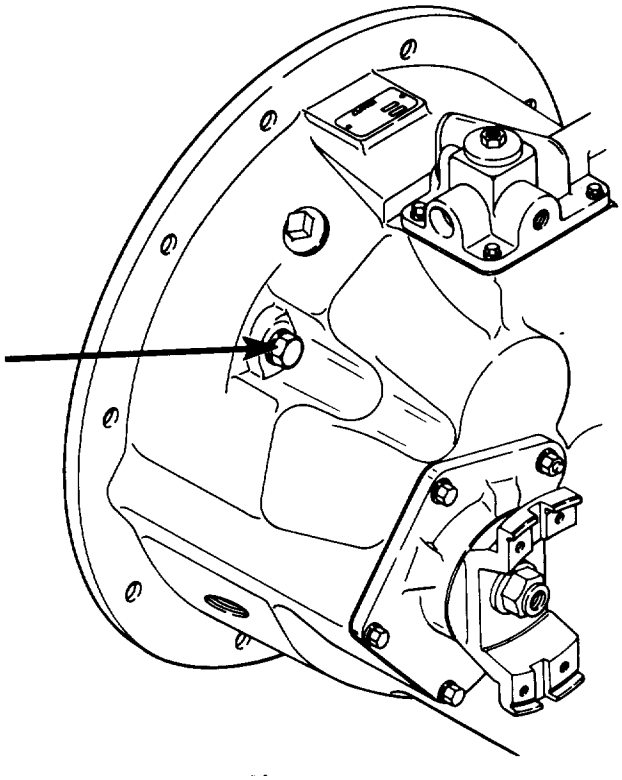


Figure 70
Install three (3) oil baffle bolts and lockwashers. Tighten baffle bolts evenly to prevent damaging oil baffle "O" ring.

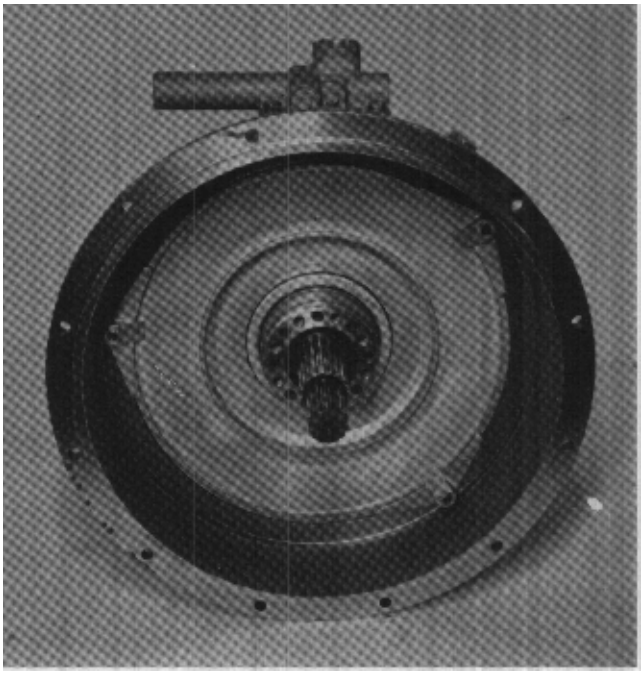


Figure 71
Oil baffle installed.

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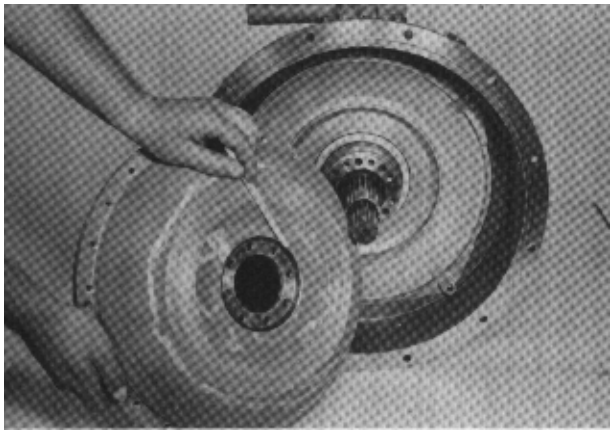


Figure 72
Install new impeller to impeller hub “O” ring.

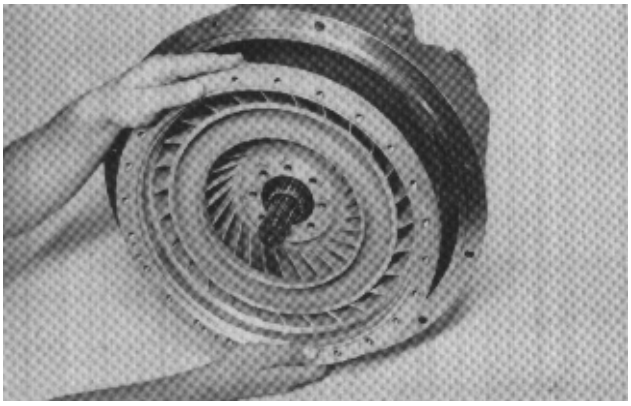


Figure 73
Install impeller on impeller hub. Use caution as not to damage “O” ring.

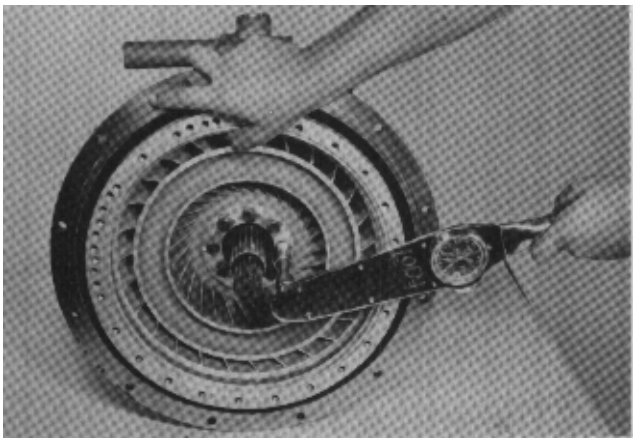


Figure 74
Install impeller to impeller hub lock tabs and cap screws. Tighten cap screws 23 to 25 ft. lbs. torque [31,2-33,8 N.m.]

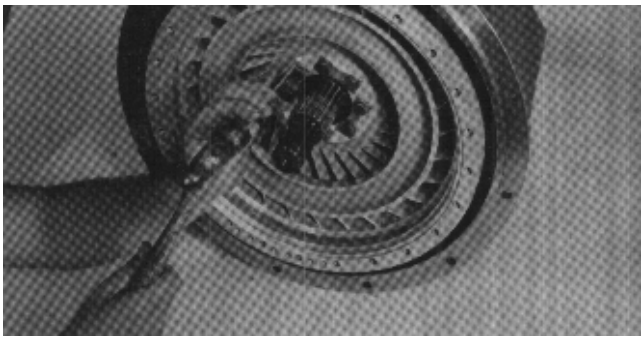


Figure 75
Bend one corner of the lock tab over a flat side of the impeller to hub screws to prevent screws from loosening.



Figure 76
Install reaction member spacer and reaction member on reaction member support. If freewheeling reaction member is used it will require a different space than the one used with a fixed reaction member.

MUST FREEWHEEL IN
CLOCKWISE ENGINE ROTATION

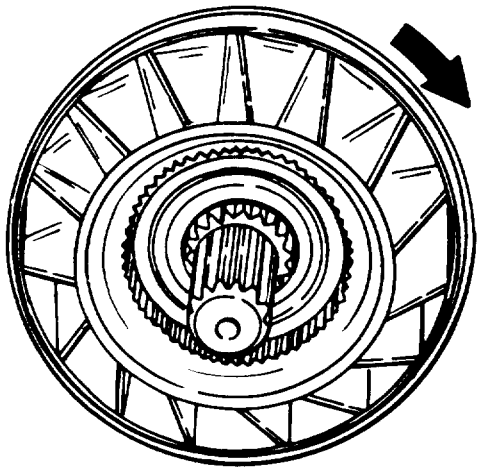


Figure 77
Check rotation of freewheeling reaction member to be sure of proper freewheel assembly.

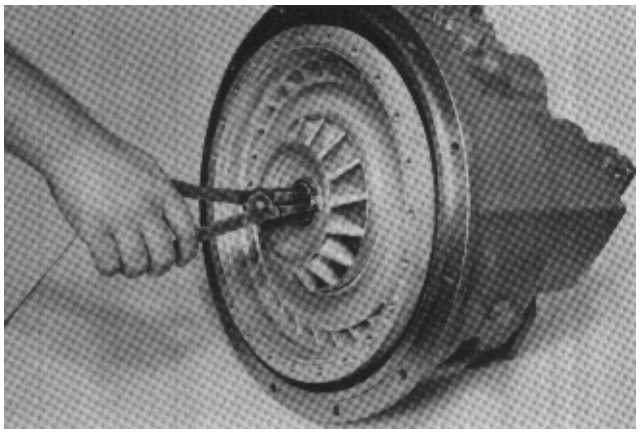


Figure 78
Install reaction member to support retainer ring.

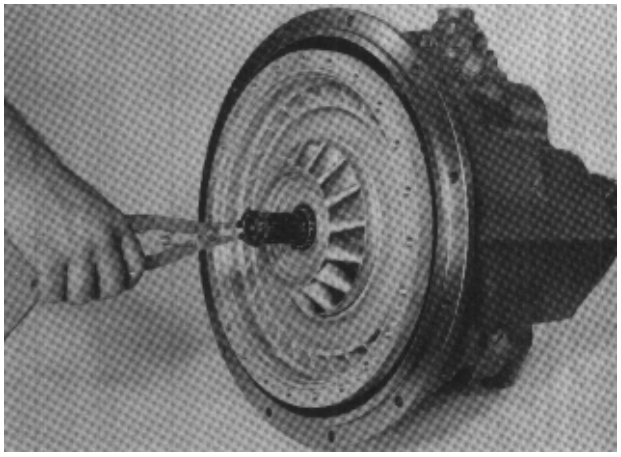


Figure 79
Install turbine locating ring on turbine shaft.

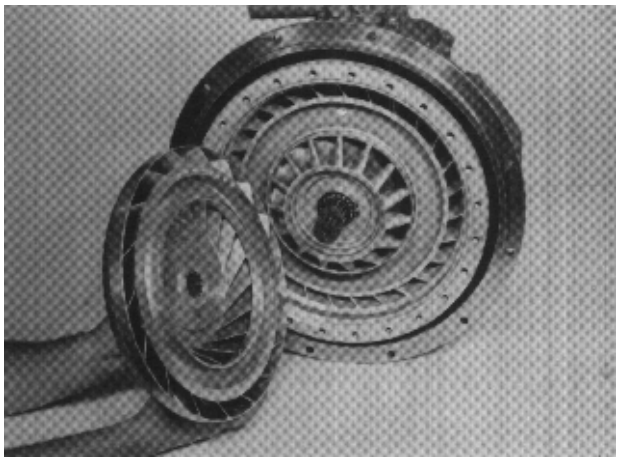


Figure 80
Install turbine on shaft.

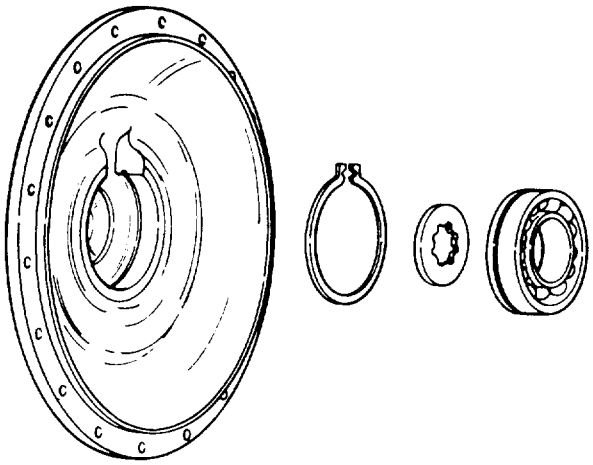


Figure 81
If the impeller cover bearing retaining washer or bearing was replaced, use the following procedure for reassembly. Heat cover 200° to 250° F [93°-121° C]. Position snap ring in groove. Place bearing retainer washer in cover. While cover is hot press bearing into position spreading ears on snap ring at the same time. Align snap ring groove in bearing with snap ring. Release snap ring. Check ring to be certain it is in full position in groove.

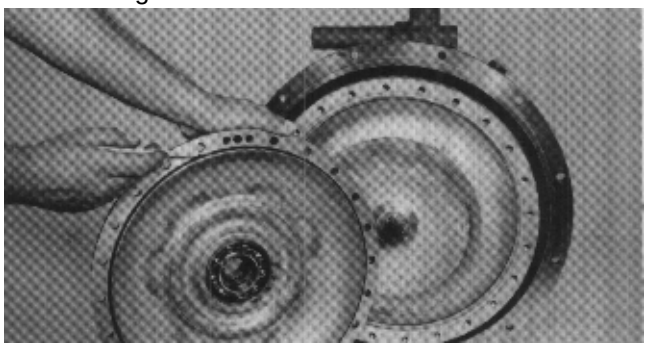


Figure 82
Position new “O” ring on impeller cover.

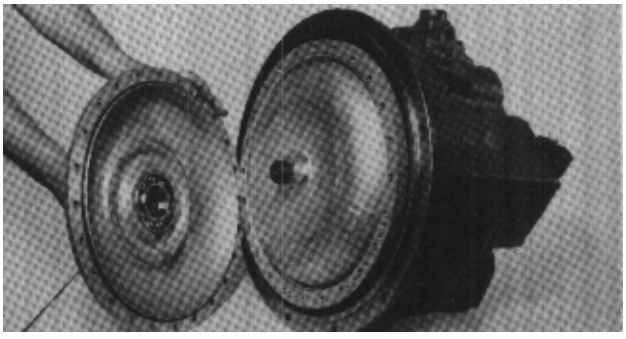


Figure 83
Install impeller cover assembly on impeller. Use caution as not to damage “O” ring. Bearing retainer plate must be aligned with turbine shaft.

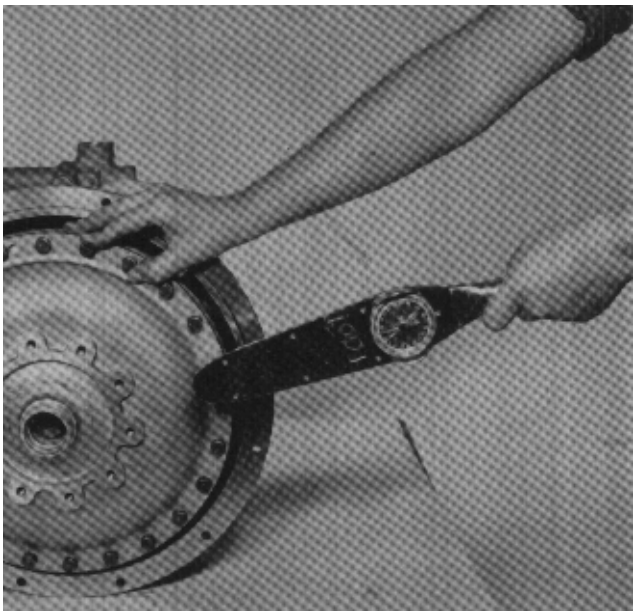


Figure 84

Install impeller cover to impeller capscrew and washers.

Tighten 11" impeller cover capscrews 12 to 16 ft. lbs. torque [16,3 - 21,6 N.m.]

Tighten 12" impeller cover capscrews 23 to 25 ft. lbs. torque [31,2 - 33,8 N.m.]

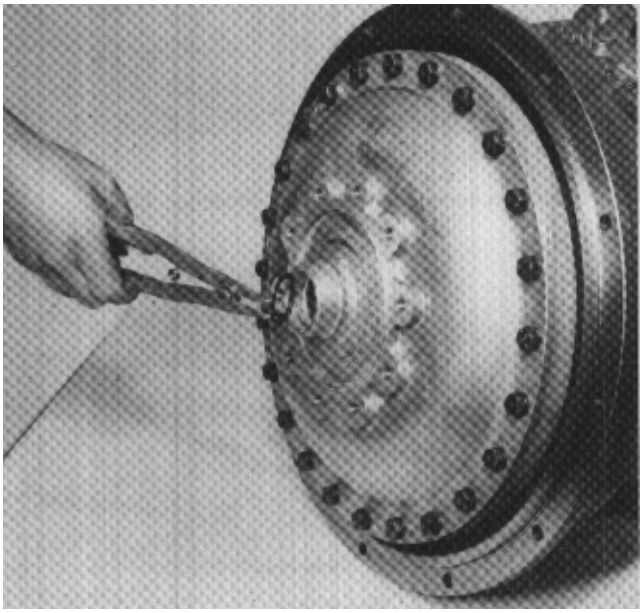


Figure 85

Install turbine retainer ring. See Figure 86.

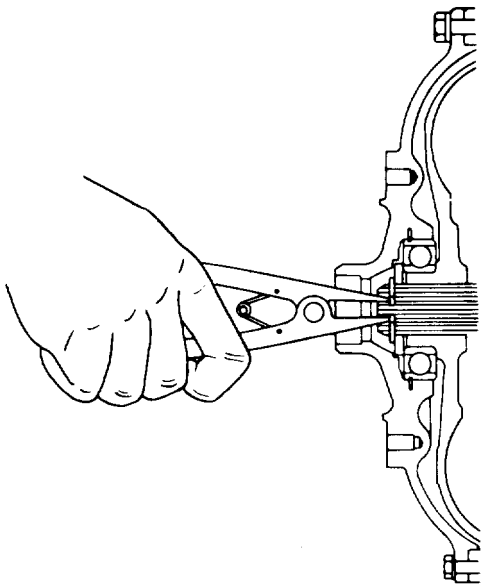


Figure 86

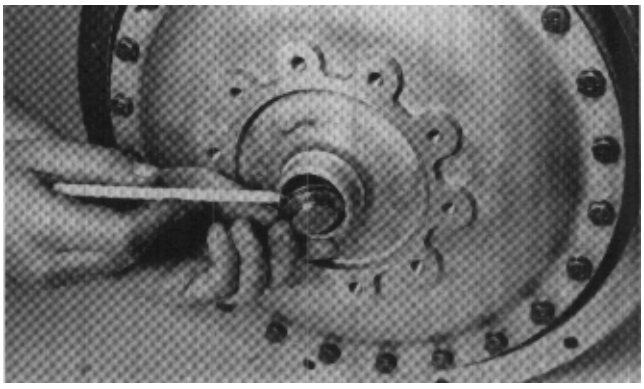


Figure 87

Position new “O” ring on impeller cover bore plug. Lubricate ring to facilitate assembly. Install plug in cover.

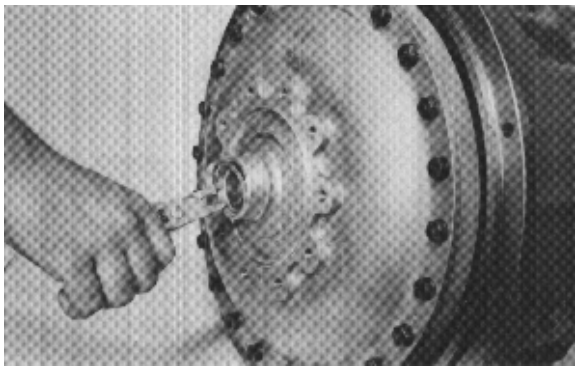


Figure 88

Install bore plug retainer ring.

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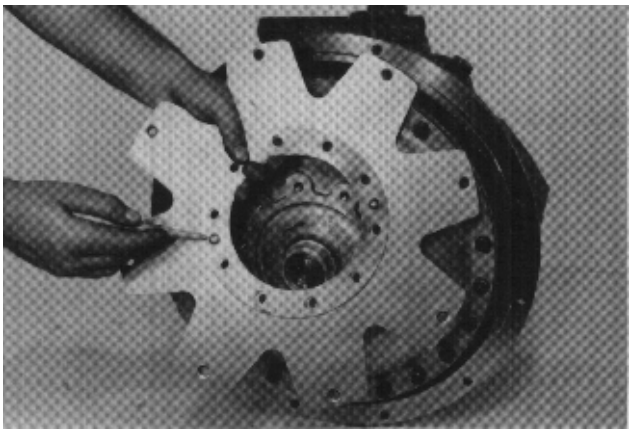


Figure 89

Position drive plate and weld nut assembly on impeller cover with weld nuts toward cover. Align intermediate drive plate and backing ring with holes in impeller cover. **NOTE:** Two dimples 180° apart in backing ring must be out (toward engine flywheel). Install capscrews and washers.

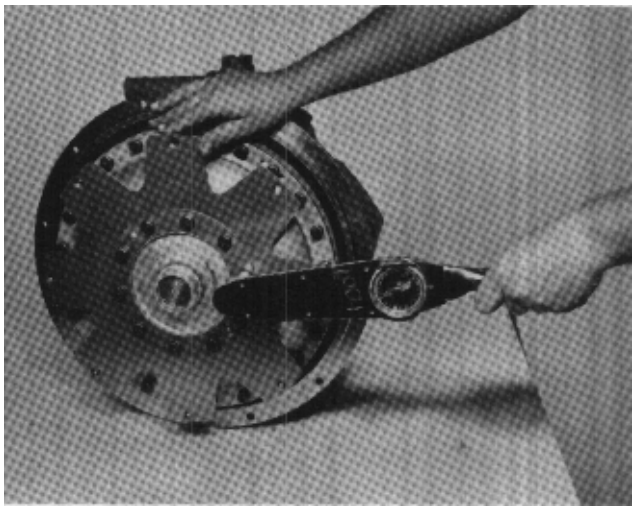


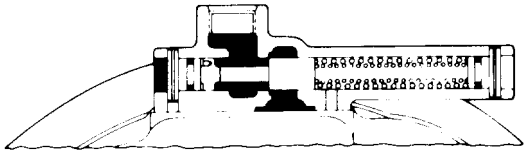
Figure 90

Tighten flex plate capscrews 23 to 25 ft. lbs. torque [31,2 - 33,8 N.m.]

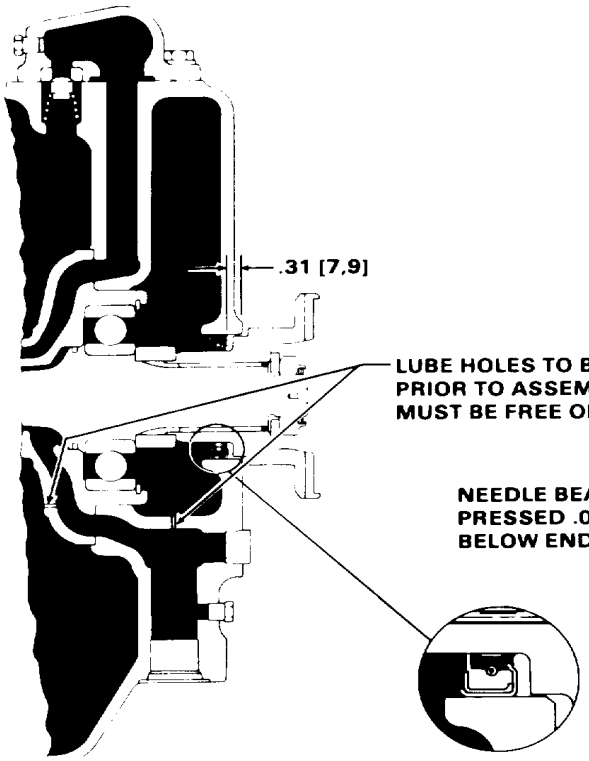
Install pump adaptors, charging and accessory pumps.

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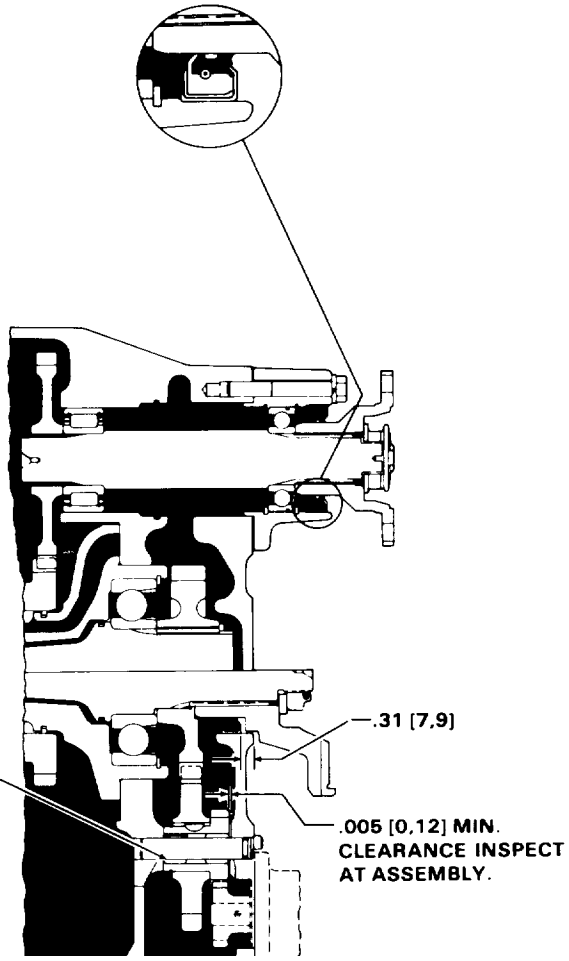
1. TIGHTEN OUTPUT OR TURBINE SHAFT NUT 200 TO 25O LBS. FT. [271,63-338,95 N M] TORQUE.
2. ALL LEAD IN CHAMFERS FOR OIL SEALS, PISTON RINGS & O-RINGS MUST BE SMOOTH AND FREE FROM BURRS. INSPECT AT ASSEMBLY.
3. LUBRICATE ALL PISTON RINGS & O-RINGS AT ASSEMBLY.
4. USE PERMATEX & CRANE SEALER ONLY WHERE SPECIFIED.
5. APPLY VERY LIGHT COAT OF PERMATEX NO. 2 TO O.D. OF ALL OIL SEALS BEFORE ASSEMBLY.
6. AFTER ASSEMBLY OF USING PERMATEX OR CRANE SEALER, THERE MUST BE NO FREE OR EXCESS MATERIAL THAT COULD ENTER THE OIL CIRCUIT.



REGULATOR VALVE



STRAIGHT THRU DRIVE



POWER TAKE-OFF & GOVERNOR DRIVE

NOTE: METRIC DIMENSIONS SHOWN IN BRACKETS [ ]

Figure E

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OIL PRESSURE AND LUBRICATION SPECIFICATIONS FOR C2000 SERIES CONVERTERS

Converter outlet oil temperature 180° - 200° F. [82,3° - 93,3° C]
Transmission in NEUTRAL.

Operating specifications:

CONVERTER OUT PRESSURE

25 P.S.I. [172,4 KPa] minimum pressure at 2000 R.P.M. engine speed AND a maximum of 70 P.S.I. [482,6 KPa] outlet pressure with engine operating at no-load governed speed.

Converter outlet pressure equals the total pressure drop of the cooler, cooler lines and back pressure of the transmission lubrication system.

Disconnect CONVERTER DRAIN BACK line at transmission with engine running at 2000 RPM and measure oil into a gallon container. Measure oil leakage for 15 seconds and multiply the volume of oil by four to get gallons per minute leakage.

Leakage in C2000 series not to exceed 2 gal. max.

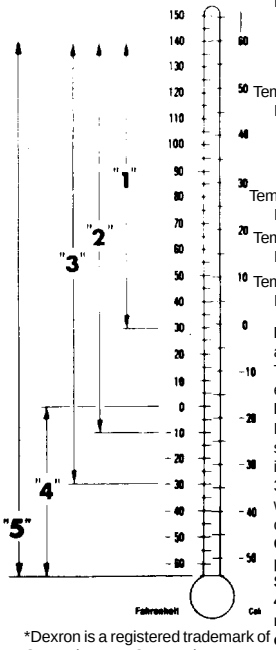
LEAKAGE IN CONVERTER

CONVERTER LUBE FLOW

LUBRICATION

RECOMMENDED UBRICANTS FOR CARK POWER SHIFTED TRANSMISSION AND TORQUE CONVERTERS

Prevaing Amblent Temperature



Temperature Range "1"	(a) C-2 Grade 30 (b) C-3 Grade 30 (c) Engine Oil:-Grade 30 API-CD/SE or CD/SF (d) MIL-L-2104C-Grade 30 (e) MIL-L-2104D-Grade 30
Temperature Range "2"	(a) MIL-L-2104C-Grade 10 (b) MIL-L-2104D-Grade 10 (c) C-2 Grade 10 (d) C-3 Grade 10 (e) Engine Oil:-Grade 10 API-CD/SE or CD/SF (f) Quintolubric 822-220 (Non Phosphate Ester Fire Resistant Fluid)
Temperatuure Range "3"	(a) *Dexron (b) *Dexron II D - See Caution Below
Temperature Range "4"	(a) MIL-L-46167 (b) MIL-L-46167 A
Temperature Range "5"	(a) Conoco Polor Start DN-600 Fluid

NOTES: Temperature ranges "2" and "3" may be used to lower ambient temperatures when sump preheaters are used. Temperature range "4" should be used only in ambient temperature range shown.

MODULATED SHIFT TRANSMISSIONS: H125, H200, H500, H600, 18000, 24000, 28000, 32000 34000 series transmissions with modulated shift use only C-3 or temperature range 3 items (a) (b) *Dexron or *Dexron II D. **SEE CAUTION BELOW.**

3000, 4000, 5000, 6000, 8000 16000 series transmissions with modulated shift use only C-3 or temperature range 3 items (a) only *Dexron. Do NOT use *Dexron II D. **SEE CAUTION BELOW.**

CAUTION: *Dexron II D is not compatible with graphitic clutch plate friction material UNLESS IT MEETS THE APPROVED C-3 SPECIFICATIONS. *Dexron II D cannot be used in the 3000, 4000, 5000, 6000, 8000 or 16000 series power shift transmissions, or the HR28000, HR32000 HR34000 series having converter lock-up, or the C270 series converter having lock-up UNLESS IT MEETS THE APPROVED C-3 SPECIFICATIONS.

*Dexron is a registered trademark of General Motors Corporation.

TYPE OF OIL — OIL See Lube Chart.

CAPACITY — Consult Operator's Manual on applicable machine model for system capacity. Torque Converter, Transmission and allied hydraulic system must be considered as a whole to determine capacity.

CHECK PERIOD — Check oil level DAILY with engine running at 500-600 RPM and oil at 180° to 200° F. [82,2 - 93,3° C]. Maintain oil level to FULL mark.

NORMAL * DRAIN PERIOD — Every 500 hours, change oil filter element. Every 1000 hours, drain and refill system as follows: Drain with oil at 150° to 200° F. [65,6 - 93,3° C].

NOTE: It is recommended that filter elements be changed after 50 and 100 hours of operation on new and rebuilt or repaired units.

(a) Drain transmission and remove sump screen. Clean screen thoroughly and replace, using new gaskets.

(b) Drain oil filters, remove and discard filter elements. Clean filter shells and install new elements.

(c) Refill transmission to LOW mark.

(d) Run engine at 500-600 RPM to prime converter and lines.

(e) Recheck level with engine running at 500 - 600 RPM and add oil to bring level to LOW mark. When oil temperature is hot (180-200° F.) [82,2-93,3° C] make final oil level check. BRING OIL LEVEL TO FULL MARK.

*** Normal drain periods and filter change intervals are for average environmental and duty-cycle conditions. Severe or sustained high operating temperatures or very dusty atmospheric conditions will cause accelerated deterioration and contamination. For extreme conditions judgment must be used to determine the required change intervals.**

IRREGULARITIES IN PERFORMANCE

C2000 Series Converters

Make all checks with converter outlet temperature at least 180° - 200° F. [82,3° - 93,3° C.]

	TROUBLE	PROBABLE CAUSE	REMEDY
1.	Low converter OUT pressure (Below 25 P.S.I. [172 4 kPa] with engine at 2000 RPM - NO LOAD) (See Converter Pressure Specifications).	Worn oil sealing and "O" rings	Trouble is internal and will require a complete tear-down of the converter.
		Worn oil pump.	Replace.
		Safety Valve stays open.	Clean and check valve spring and valve.
2.	Suction line taking air.	Low oil level.	Fill to proper level.
		Suction line connections taking air.	Check oil line connections and tighten securely.
		Worn oil pump.	Replace.
3.	High converter OUT pressure (Above 70 P.S.I. [482,6 kPa] with engine operating at no-load governed speed. (See Converter Pressure Specifications).	Oil cooler or oil lines restricted.	Check oil cooler line and oil cooler for restrictions. Clean or replace.
		Oil too heavy	Check oil weight. See oil recommendations.
		Cold oil.	Converter pressure in cold weather will vary. As soon as converter gets hot, pressure should drop.
4.	Over-heating	See items No. 1 & 2.	
		Oil cooler or oil cooler lines restricted causing safety valve to stay open.	Clean and check oil cooler and oil cooler lines. Replace if necessary.
		Oil cooler too small.	Replace with larger cooler.
		Worn oil pump	Replace oil pump.
		Converter drain line to transmission or oil sump not installed properly.	Install at lowest drain opening in converter housing. Line must maintain constant gradual drop to oil sump for gravity drain.
5.	Noisy Converter.	Worn oil pump	Replace.
		Damaged bearing.	A complete teardown will be necessary to determine this. Replace if necessary.
		Worn drive gears.	Replace.
6.	Low clutch pressure. (See pressure specifications)	Transmission malfunction.	Close pressure line to transmission control valve. If clutch pressure returns to normal, trouble is in transmission.
		Worn oil pump.	Replace.
		Regulator valve stuck open.	Clean and check valve for worn or dirty parts, replace if necessary.

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IRREGULARITIES IN PERFORMANCE (Cont'd.)

C2000 Series Converters

	TROUBLE	PROBABLE CAUSE	REMEDY
7.	High clutch pressure. (See pressure specifications)	Regulator valve stuck closed.	Clean and check valve for worn or dirty parts, replace if necessary.
8.	Lack of power.	Improper engine function.	Tune engine.
		Engine stall speed below normal.	Tune engine. Check governor.
		Low converter out pressure.	See item No. 1.
		Air in the oil.	See item No. 2.
		Improper oil.	See oil recommendations.
9.	Oil in engine flywheel housing.	"O" ring between impeller cover and impeller damaged.	Replace.
		Oil baffle "O" ring damaged.	Replace.
		Oil baffle oil seal damaged.	Replace.
		Impeller cover bore plug "O" ring damaged.	Replace.

GENERAL INFORMATION:

Use Clark 1533614 Oil Filter only.
Use Clark 215502 Oil Filter Element only.
Use minimum number of Pipe and Hose Fittings.
Gravity drain from Converter Sump to Transmission must be of minimum length and have no "U" bends to trap air or oil.
Cooler capacity for normal application, 30 per cent of net Engine Horsepower at Governed Speed.
Check oil level with engine idling and transmission in neutral.

TRANSMISSION CLUTCH OIL PRESSURE P.S.I.

The C2000 Converter will be equipped with one of three variations involving the clutch regulating valve. They are as follows:

1. Inlet cover for **Converter oil only** with clutch pressure valve in transmission control cover. **180 to 220 P.S.I. [1241,1 - 1516,8 kPa]** pressure range. (See note).

2. Pressure regulator valve on Converter with a **240 to 280 P.S.I. [1654,8 - 1930,5 kPa]** pressure range. (See note).

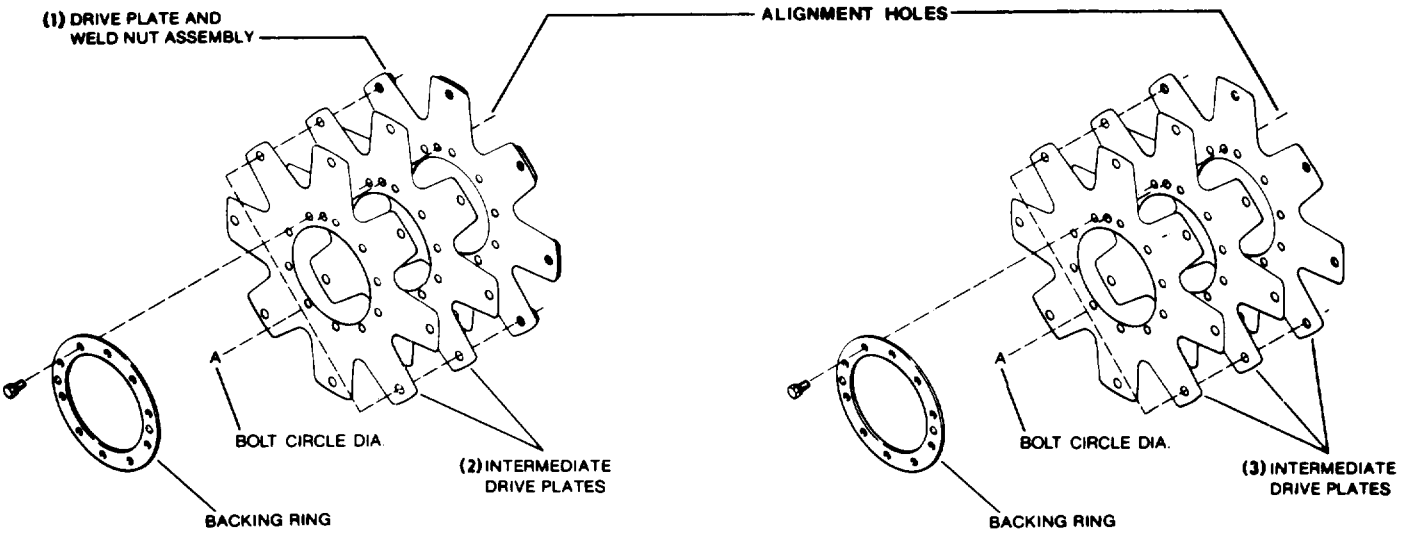
3. Pressure regulator valve on Converter with a **180 to 220 P.S.I. [1241,1 - 1516,8 kPa]** pressure range. (See note).

NOTE: All pressure must be equal within **5 P.S.I. [34,4 kPa].** If clutch pressure varies in any one clutch more than **5 P.S.I. [34,4 kPa]** repair clutch. All pressures must be taken with two clutches engaged.

CONVERTER TO ENGINE INSTALLATION PROCEDURE

Measure the “A” dimension (Bolt Circle diameter) and order Drive Plate Kit listed below.

Note three (3) kits have two (2) intermediate drive plates and one (1) drive plate and weld nut assembly.
One (1) kit with three intermediate drive plates.



“A” Dimension (Bolt Circle Diameter)
11.38" [288,9 mm] Diameter
Kit No. 802229
13.125" [333,375 mm] Diameter
Kit No. 802230
13.50" [342,900 mm] Diameter
Kit No. 802231
Each Kit will include the following parts:
2 Intermediate Drive Plates.
1 Drive Plate and Weld Nut Assembly.
1 Backing Ring.
10 Screw and Lockwasher Assembly.
1 Instruction Sheet.

“A” Dimension (Bolt Circle Diameter)
13.50" [342,900 mm] Diameter
Kit No. 802232
Kit will include the following parts:
3 Intermediate Drive Plates.
1 Backing Ring.
10 Screw and Lockwasher Assembly.
1 Instruction Sheet.

TO FACILITATE ASSEMBLY, ALIGN SMALL HOLES IN DRIVE PLATES - SEE ILLUSTRATION ABOVE.

Position drive plate and weld nut assembly on impeller cover with weld nuts toward cover. Align intermediate drive plate and backing ring with holes in impeller cover. NOTE: Two dimples 180° apart in backing ring must be out (toward engine flywheel). Install capscrews and washers. Tighten 23 to 25 ft. lbs. torque [31,2 - 33,8 N.m.]

1. Remove all burrs from flywheel mounting face and nose pilot bore. Clean drive plate surface with solvent.

2. Check engine flywheel and housing for conformance to standard S.A.E. #3 - S.A.E. J-927 tolerance specifications for pilot bore size, pilot bore runout and mounting face flatness. Measure and record engine crankshaft end play.

3. Install two 2.50 [63, 50 mm] long transmission to flywheel housing guide studs in the engine flywheel housing as shown. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing access hole.

*4. Install a 4.00 [101, 60 mm] long drive plate locating stud .3750-24 fine thread in a drive plate nut. Align the locating stud in the drive plate with the flywheel drive plate mounting screw hole positioned in step No. 3.

5. Locate transmission on flywheel housing aligning drive plate to flywheel and transmission to flywheel housing. **NOTE:** Fig. 4 installation, align drive plate holes with flywheel studs.

   Install transmission to flywheel housing screws. Tighten screws to specified torque. Remove transmission to engine guide studs. Install remaining screws and tighten to specified torque.

*6. Remove drive plate locating stud.

7. Install drive plate attaching screw and washer. Snug screw but **do not tighten. NOTE:** Fig. 4 installation, install drive plate attaching washers and nuts. Tighten each nut 28 to 30 ft. lbs. torque [38,0 - 40,6 N.m]. Some engine flywheel housings have a hole located on the flywheel housing circumference in line with the drive plate screw access hole. A screwdriver or pry bar used to hold the drive plate against the flywheel will facilitate installation of the drive plate screws. Rotate the engine flywheel and install the remaining seven (7) flywheel to drive plate attaching screws. Snug screws but do not tighten. After all eight (8) screws are installed torque each one 25 to 30 ft. lbs. torque [33,9 - 40,6 N.m]. This will require torquing each screw and rotating the engine flywheel until the full amount of eight (8) screws have been tightened.

8. Measure engine crankshaft end play after transmission has been completely installed on engine flywheel. This value must be within .001 [0,025mm] of the end play recorded in step No. 2.

   * Does not apply to units having 3 intermediate drive plates. See Fig. 4.

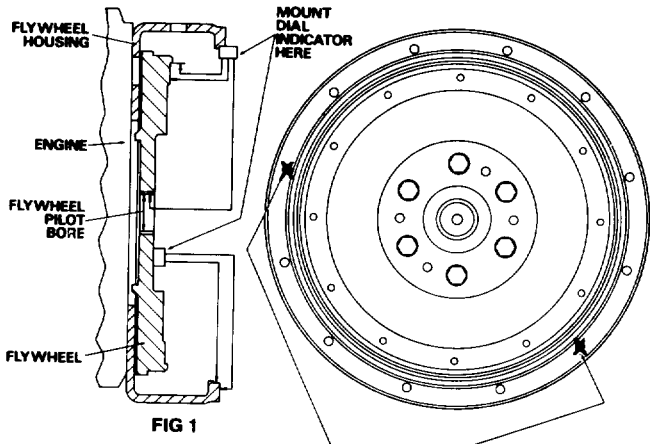


FIG 1

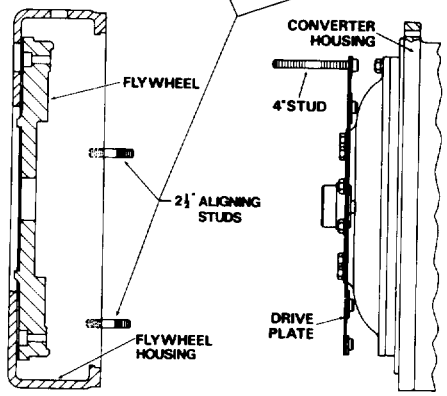
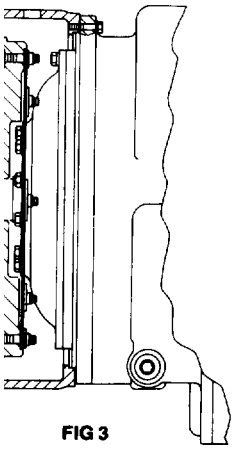


FIG 2


FIG 3

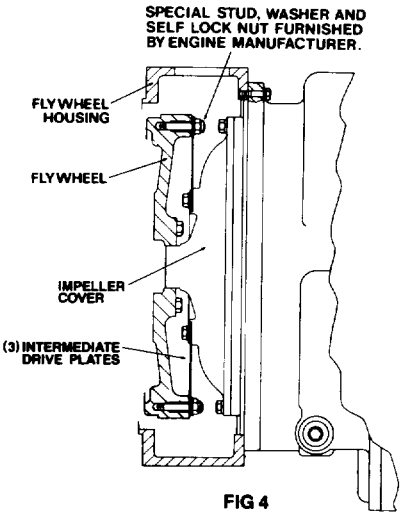
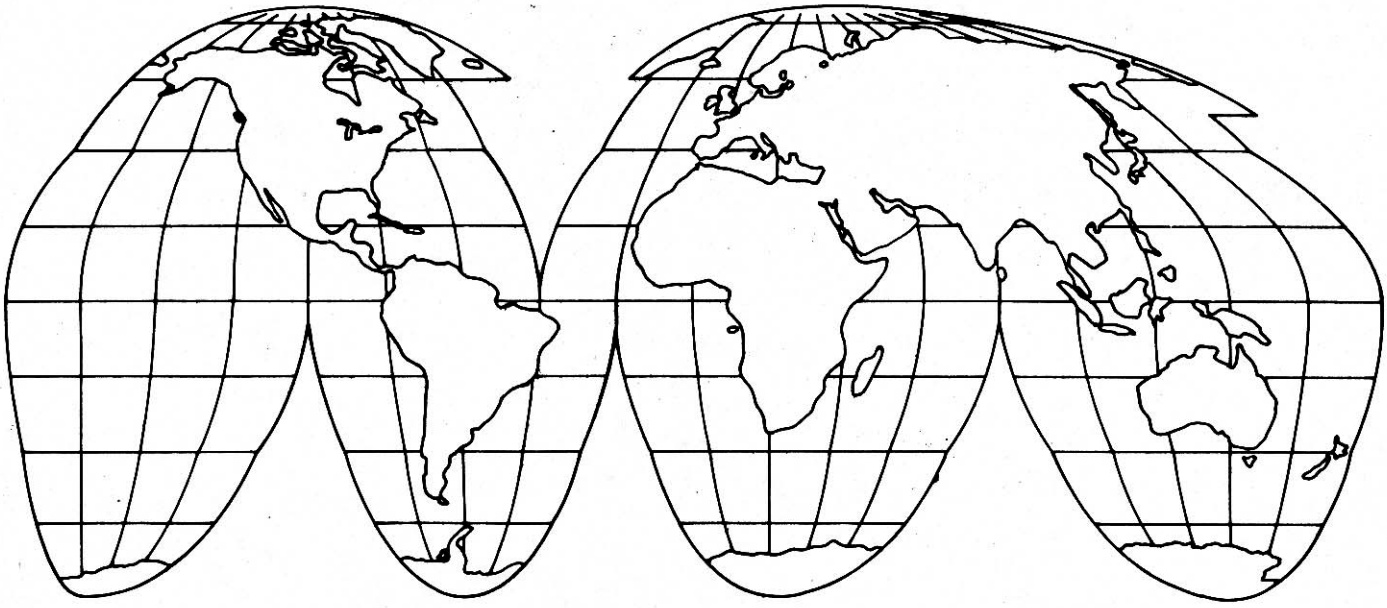


FIG 4

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18000 powershift transmission

maintenance & service manual

6 speed supplement

**to be used in conjunction with
R or HR 3 speed long drop
18000 maintenance & service manual.**

CLARK COMPONENTS INTERNATIONAL

A Business Unit of Clark Equipment Company

SM S-186 (Rev. 8-84)

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Service Publications

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TOWING OR PUSH STARTING

Before towing the vehicle, be sure to lift the rear wheels off the ground or disconnect the driveline to avoid damage to the transmission during towing.

NOTE: If the transmission has 4 wheel drive, disconnect both front and rear drivelines. Because of the design of the hydraulic system, the engine **cannot** be started by pushing or towing.

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TABLE OF CONTENTS

SIX-SPEED CLUTCH AND GEAR GROUP . . . . . FIG. A

TYPICAL SIX-SPEED LOW POWER FLOW . . . . . FIG. B

TYPICAL SIX-SPEED HI POWER FLOW . . . . . FIG. C

TYPICAL 18,000 SIX-SPEED ASSEMBLY INSTRUCTION SHEET . FIG. D

DISASSEMBLY 1

18,000 SERIES SIX-SPEED CLUTCH AND GEAR ARRANGEMENT . . 10

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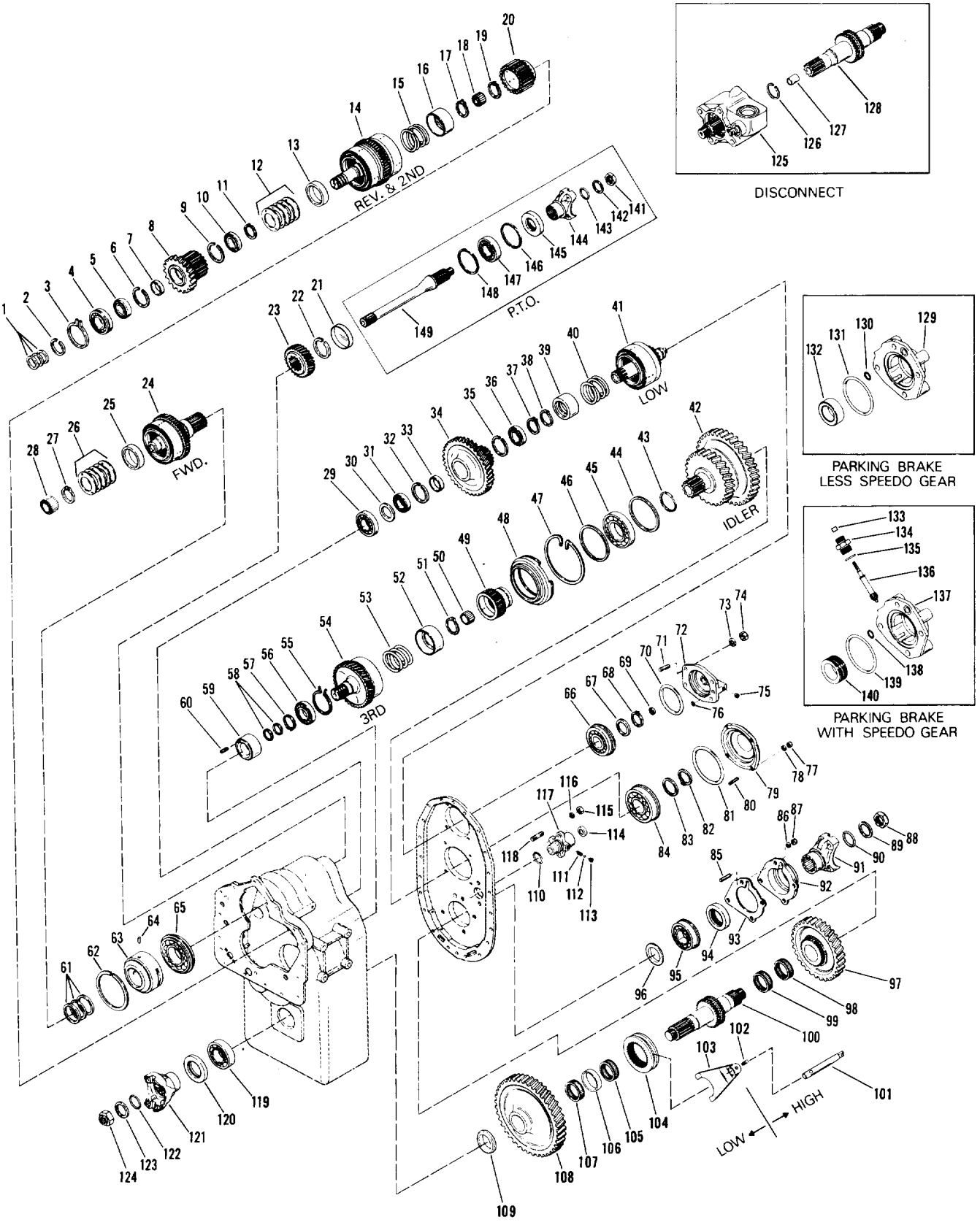


Figure A

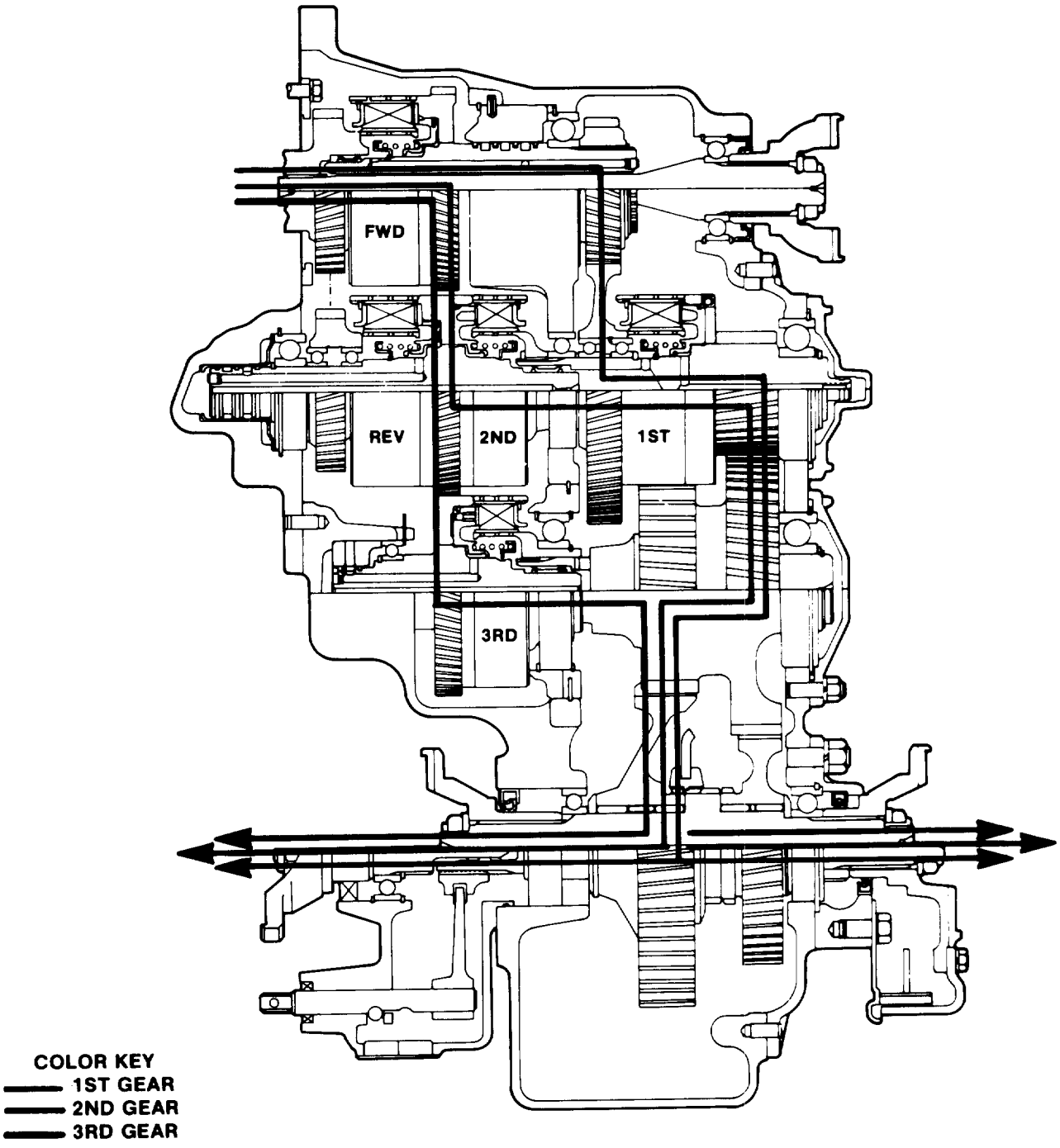
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6 SPEED CLUTCH AND GEAR GROUP

ITEM	DESCRIPTION	QTY.
1	Reverse and 2nd Shaft Piston Rings	3
2	Front Bearing Retaining Ring	1
3	Front Bearing Snap Ring	1
4	Reverse and 2nd Shaft Front Bearing	1
5	Clutch Driven Gear Bearing	1
6	Bearing Retaining Ring	1
7	Clutch Driven Gear Bearing Spacer	1
8	Reverse Clutch Gear and Hub Assembly	1
9	Bearing Retaining Ring	1
10	Clutch Driven Gear Bearing	1
11	Spring Retainer Snap Ring	1
12	Piston Return Belleville Springs	5
13	Piston Return Spring Spacer	1
14	Reverse and 2nd Shaft, and Clutch Drum Assembly	1
15	Piston Return Spring	1
16	Spring Retainer	1
17	Spring Retainer Snap Ring	1
18	Reverse and 2nd Shaft Rear Bearing	1
19	2nd Clutch Disc Hub Snap Ring	1
20	2nd Clutch Disc Hub	1
21	Bore Plug	1
22	Gear Retaining Ring	1
23	Forward Shaft Gear	1
24	Forward Shaft, and Clutch Drum Assembly	1
25	Piston Return Spring Spacer	1
26	Piston Return Belleville Springs	5
27	Spring Retainer Snap Ring	1
28	Forward Shaft Pilot Bearing	1
29	Low Speed Clutch Shaft Front Bearing	1
30	Front Bearing Spacer	1
31	Low Speed Gear Bearing	1
32	Low Speed Gear Bearing Locating Ring	1
33	Low Speed Gear Spacer	1
34	Low Shaft Gear and Hub Assembly	1
35	Low Speed Gear Bearing Locating Ring	1
36	Low Speed Gear Bearing	1
37	Low Gear Bearing Retaining Ring	1
38	Spring Retainer Snap Ring	1
39	Spring Retainer	1
40	Piston Return Spring	1
41	Low Clutch Shaft Drum Assembly	1
42	Idler Shaft	1
43	Bearing Retaining Ring	1
44	Bearing Locating Ring	1
45	3rd Clutch Disc Hub Bearing	1
46	Bearing Locating Ring	1
47	Bearing Carrier Locating Ring	1
48	Bearing Carrier	1
49	3rd Clutch Disc Hub	1
50	3rd Clutch Shaft Pilot Bearing	1
51	Spring Retainer Snap Ring	1
52	Spring Retainer	1
53	Piston Return Spring	1
54	3rd Clutch Shaft, and Drum Assembly	1
55	3rd Clutch Shaft Front Bearing Locating Ring	1
	3rd Clutch Shaft Front Bearing	1
56	3rd Clutch Shaft Front Bearing Retaining	
57	Ring	1
	3rd Clutch Shaft Piston Rings	2
58	Piston Ring Outer Race	1
59	Outer Race Roll Pin	1
60	Forward Shaft Piston Rings	3
61		

ITEM	DESCRIPTION	QTY.
62	Piston Ring Sleeve Retaining Ring	1
63	Piston Ring Sleeve	1
64	Sleeve Roll Pin	1
65	Forward Shaft Rear Bearing	1
66	Low Speed Shaft Rear Bearing	1
67	Rear Bearing Support Washer	1
68	Rear Bearing Retaining Ring	1
69	Low Shaft Piston Ring	1
70	Rear Bearing Cap “O” Ring	1
71	Bearing Cap Stud	4
72	Low Shaft Rear Bearing Cap	1
73	Bearing Cap Stud Lockwasher	4
74	Bearing Cap Stud Nut	4
75	Bearing Cap Plug	1
76	Bearing Cap “O” Ring	1
77	Rear Bearing Cap Stud Nut	4
78	Rear Bearing Cap Stud Lockwasher	4
79	Idler Shaft Rear Bearing Cap	1
80	Rear Bearing Cap Stud	4
81	Rear Bearing Cap “O” Ring	1
82	Idler Shaft Rear Bearing Retainer Ring	1
83	Rear Bearing Support Washer	1
84	Idler Shaft Rear Bearing	1
85	Bearing Cap Stud	4
86	Bearing Cap Stud Lockwasher	4
87	Bearing Cap Stud Nut	4
88	Flange Nut	1
89	Flange Washer	1
90	Flange “’O” Ring	1
91	Output Flange	1
92	Rear Bearing Cap	1
93	Bearing Cap Gasket	1
94	Rear Bearing Cap Oil Seal	1
95	Output Shaft Rear Bearing	1
96	Gear Thrust Washer	1
97	High Range Gear	1
98	High Gear Bearing	1
99	High Gear Bearing	1
100	Output Shaft	1
101	Hi & Low Shift Rail	1
102	High and Low Shift Rail Lockscrew	1
103	High and Low Shift Fork	1
104	Range Shift Hub	1
105	Low Gear Bearing	1
106	Bearing Spacer	1
107	Low Gear Bearing	1
108	Low Range Gear	1
109	Gear Thrust Washer	1
110	Range Shift Rail Housing “O” Ring	1
111	Mesh Lock Spring	1
112	Mesh Lock Ball	1
113	Housing Detent Plug	1
114	Shift Rail Oil Seal	1
115	Housing Stud Nut	1
116	Housing Stud Nut Lockwasher	2
117	Hi & Low Shift Rail Support	2
118	Range Shift Rail Housing Stud	1
119	Output Shaft Front Bearing	2
120	Output Oil Seal	1
121	Output Flange	1
122	Flange “’O” Ring	1
123	Flange Washer	1
124	Flange Nut	1
125	thru 149 Various Options	1

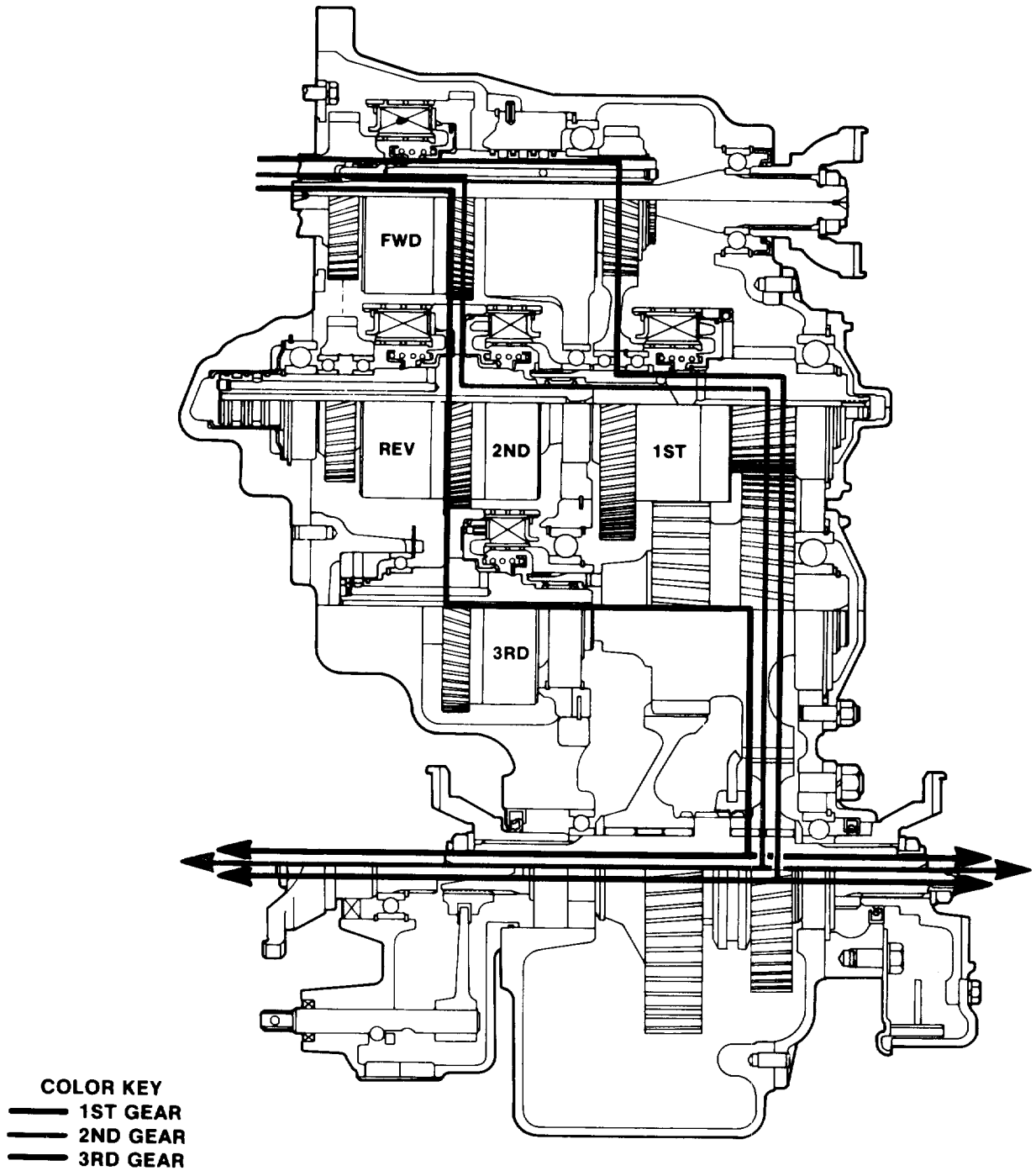
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6 SPEED 18000 TRANSMISSION POWER FLOW
LOW RANGE

Figure B

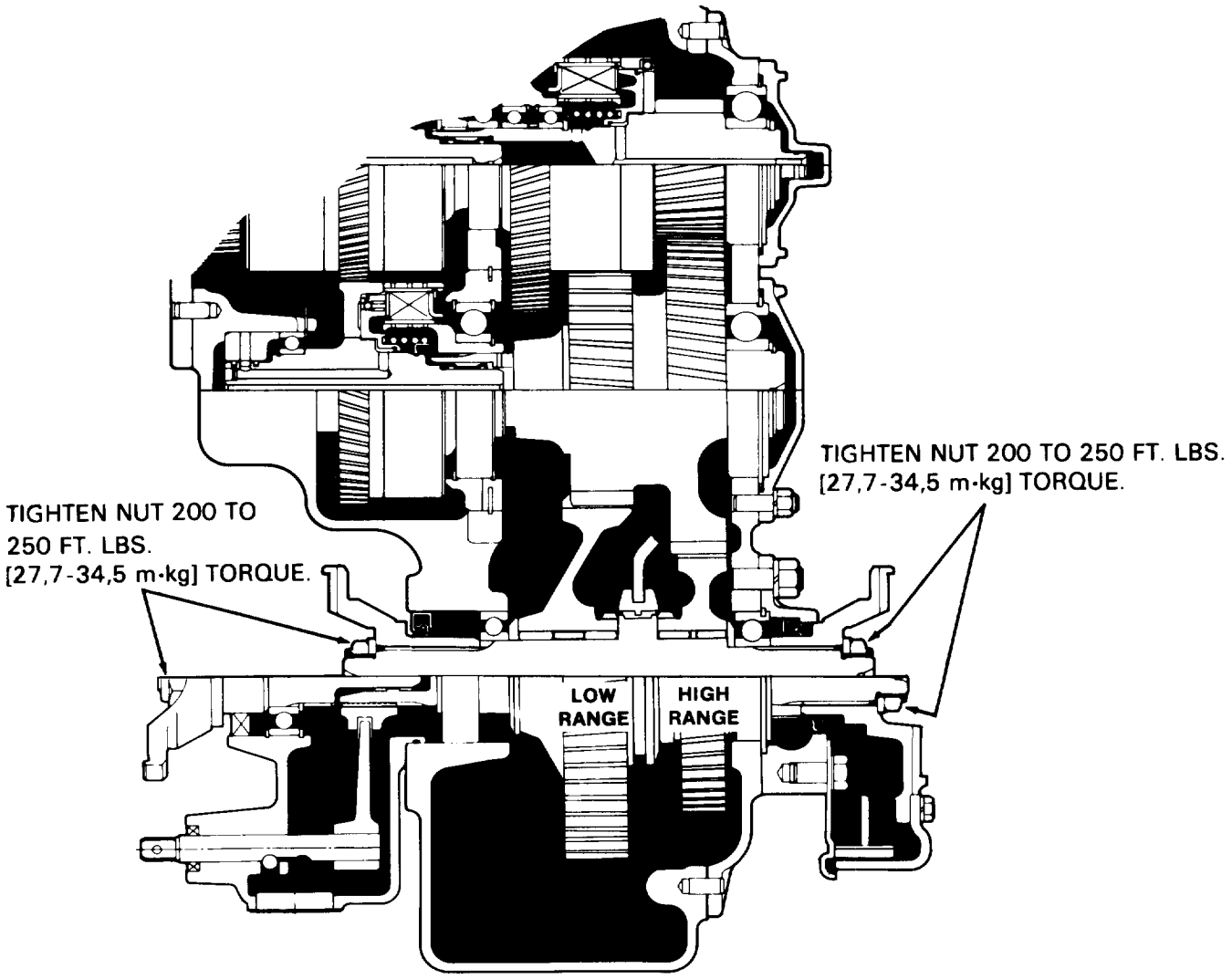
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6 SPEED 18000 TRANSMISSION POWER FLOW
HIGH RANGE

Figure C

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REFER TO R OR HR 3 SPEED MAINTEMANCE AND SERVICE MANUAL FOR OTHER ASSEMBLY INSTRUCTIONS

Figure D

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18000 SERIES 6 SPEED
To be used in conjunction with the 18000 3 Speed R or HR Long Drop Output Maintenance and Service Manual

The 6-speed transmission has 3 working range shifts and 3 travel range shifts.

Gear ratio determines working and travel ranges. They are as follows:

1st-2nd and 4th working ratio. 3rd-5th and 6th travel ratio.

NOTE: Range shift from low to high must be made with machine stopped.

DISASSEMBLY

Use the information in the 3-speed Long Drop Maintenance and Service Manual up to removing the low clutch rear bearing cap.



Figure 1

Remove low clutch rear bearing cap stud nuts and washers. Remove cap.



Figure 2

Remove idler shaft bearing cap stud nuts and washers.

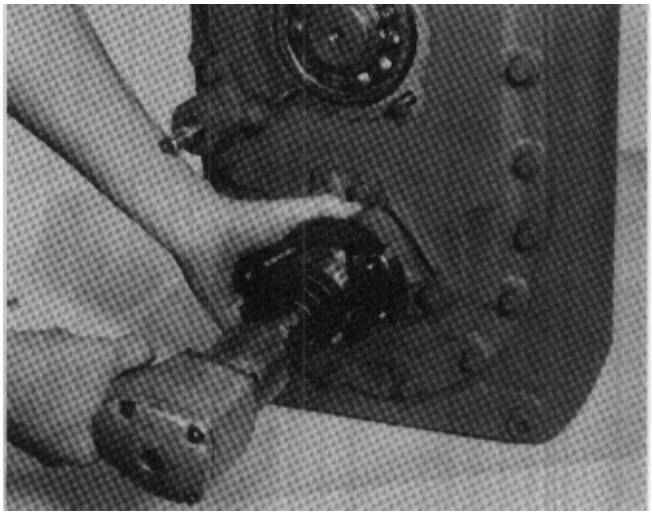


Figure 3

Using an impact (if available), if not a flange retainer bar must be used to hold the companion flange from turning, loosen output flange nut.

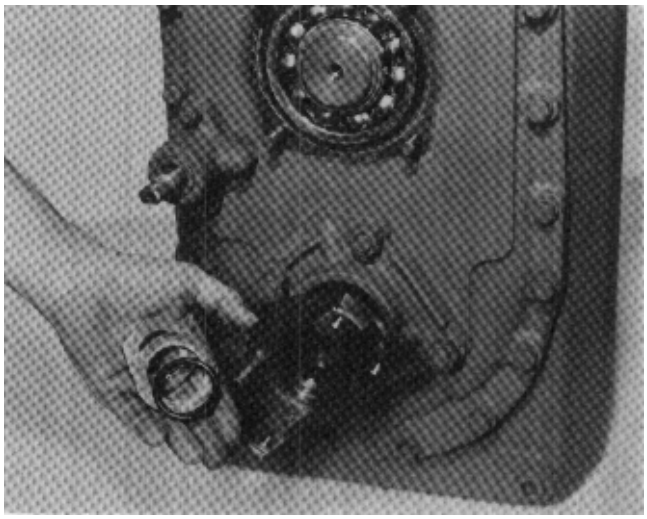


Figure 4

Remove flange nut, washer, “O” ring and flange. If a parking brake is used remove brake drum. Remove brake backing plate bolts and washers. Removeback-ing plate assembly.

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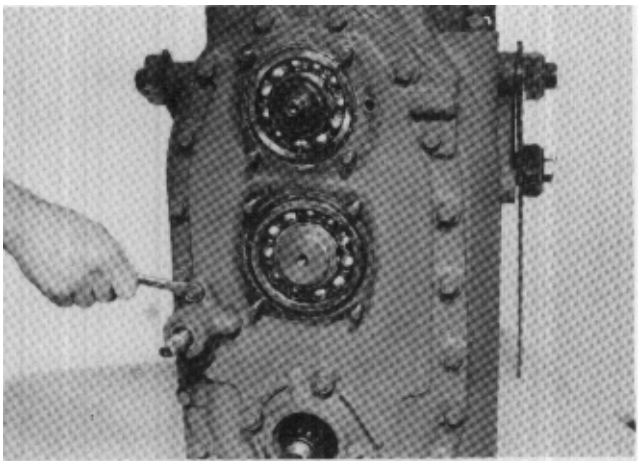


Figure 5

Remove range shift rail support stud nuts and washers.

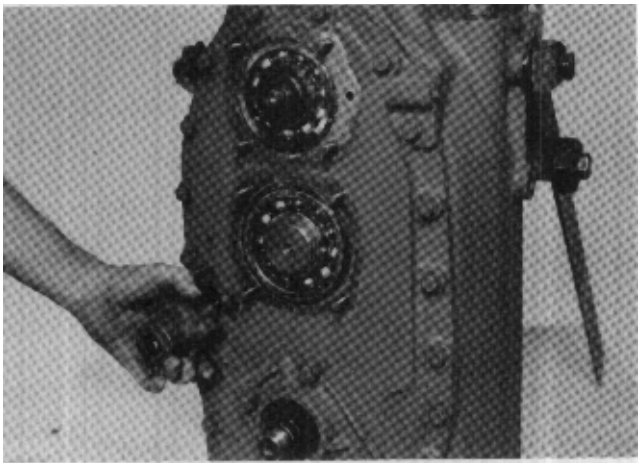


Figure 6

Slide rail support from rail. Use caution as not to lose shift rail detent ball.

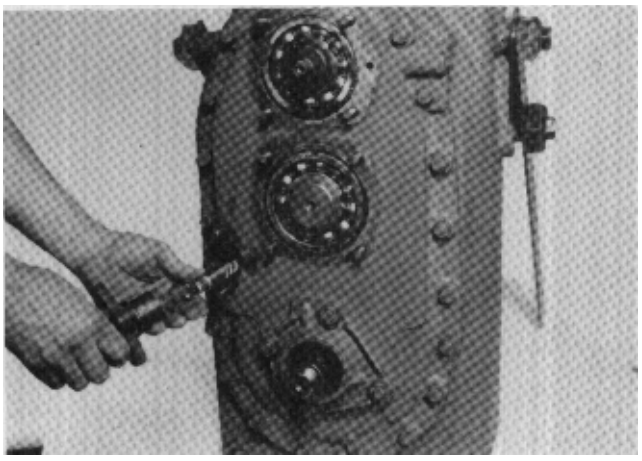


Figure 7

Support and detent ball removed.

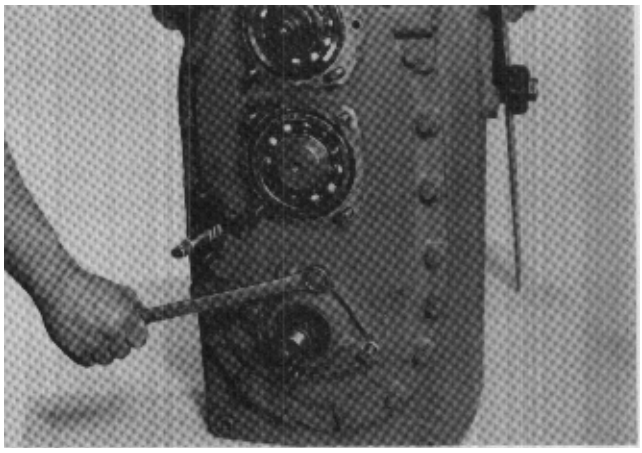


Figure 8

Remove output shaft bearing cap stud nuts and washers. Remove bearing cap.

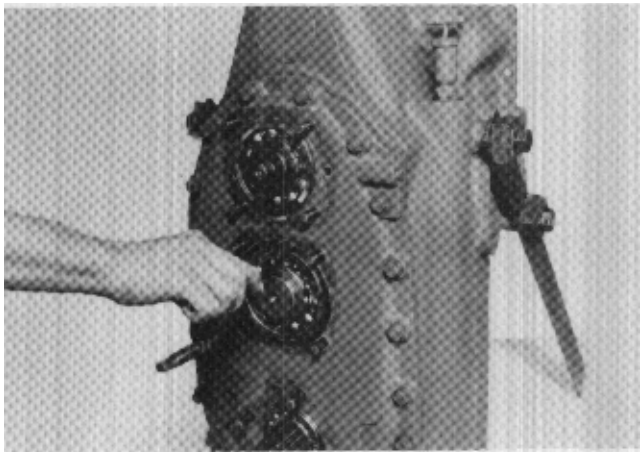


Figure 9

Remove low clutch, idler shaft and output shaft rear bearing, locating rings.

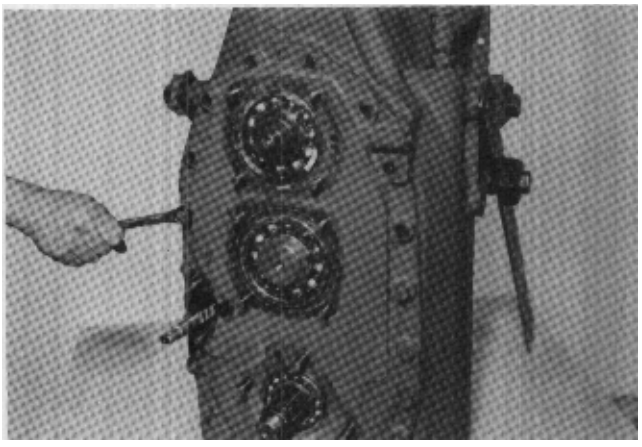


Figure 10

Remove rear cover bolts and washers.

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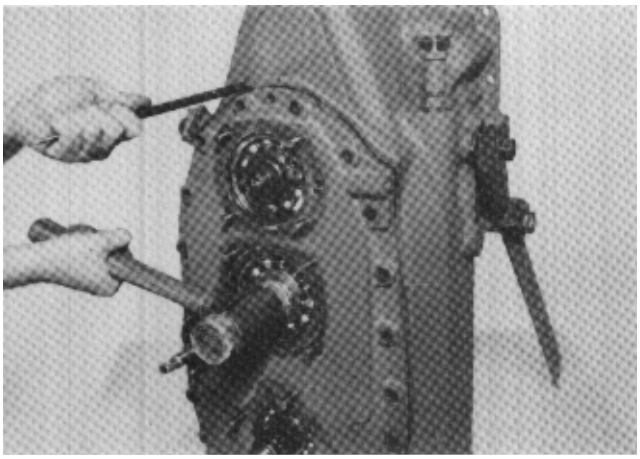


Figure 11

Using pry slots provided, pry cover from transmission housing. Using a soft hammer tap on low clutch, idler and output shafts to prevent cover from binding.

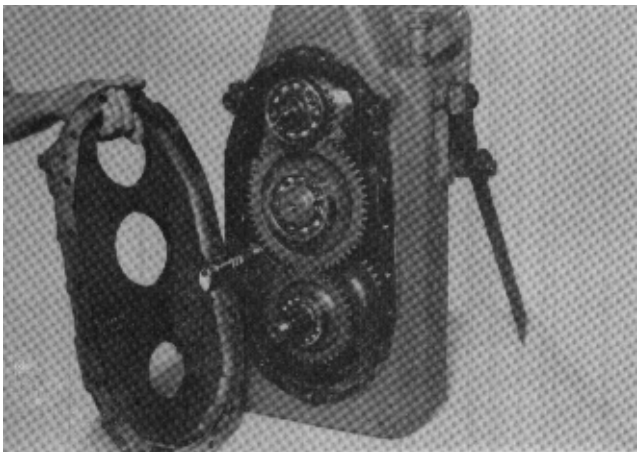


Figure 12

Rear cover removed.

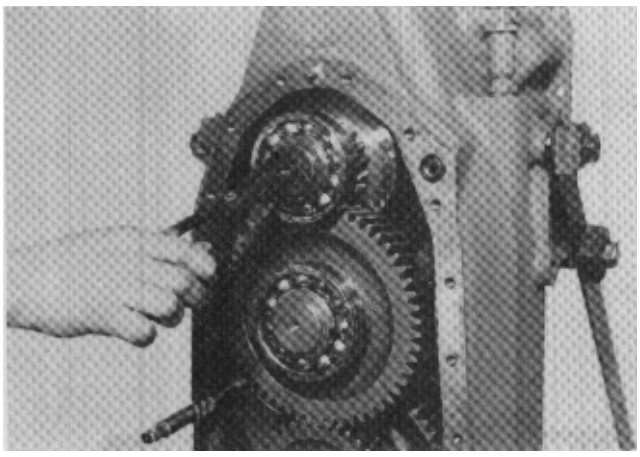


Figure 13

Remove low clutch rear bearing retainer ring.

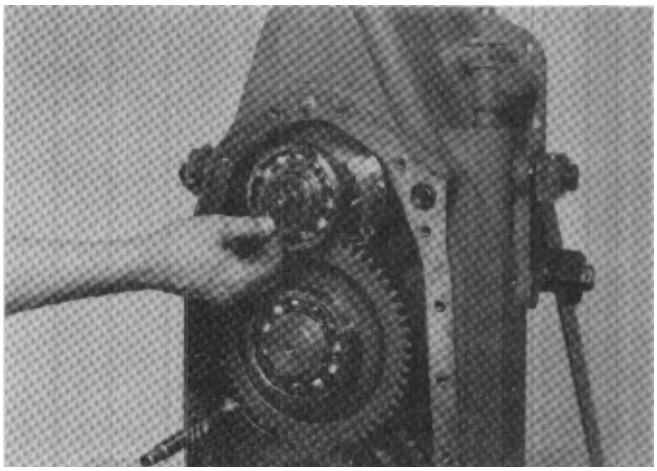


Figure 14

Remove bearing spacer.

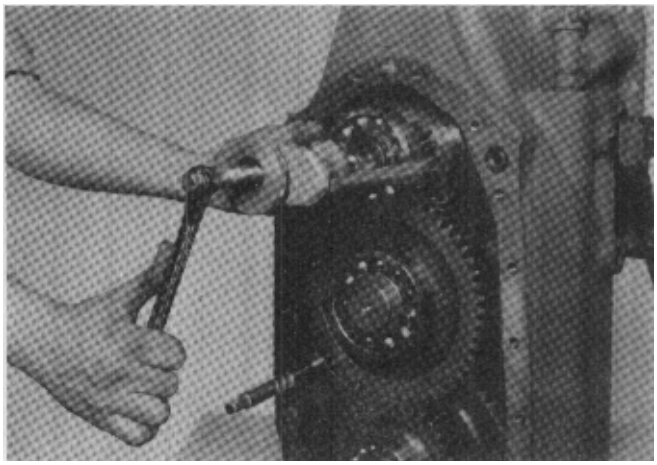


Figure 15

Remove low clutch rear bearing.

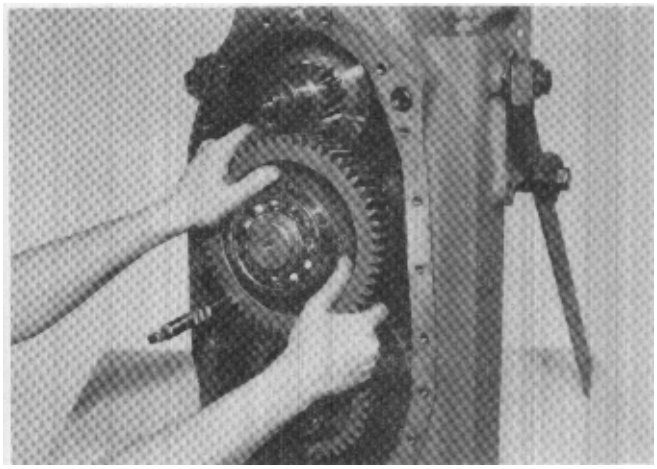


Figure 16

Remove idler and gear assembly

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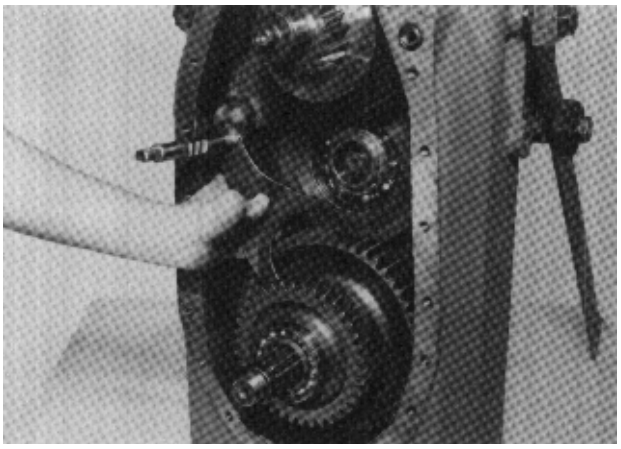


Figure 17

Remove range shift fork and rail from housing.

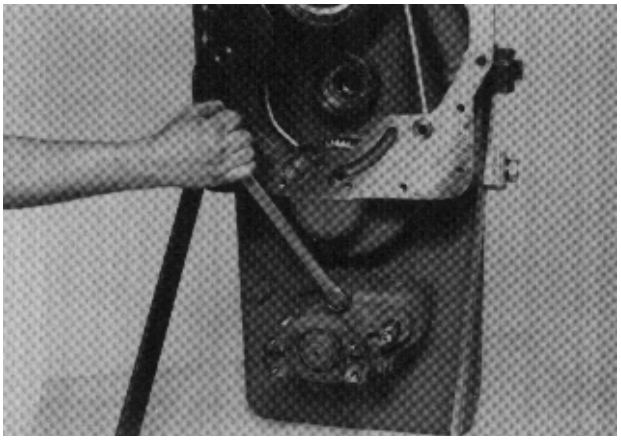


Figure 18

Remove axle disconnect stud nuts and washers.

NOTE: If disconnect is not used, remove output shaft front flange nut, washer, “O” ring and flange.

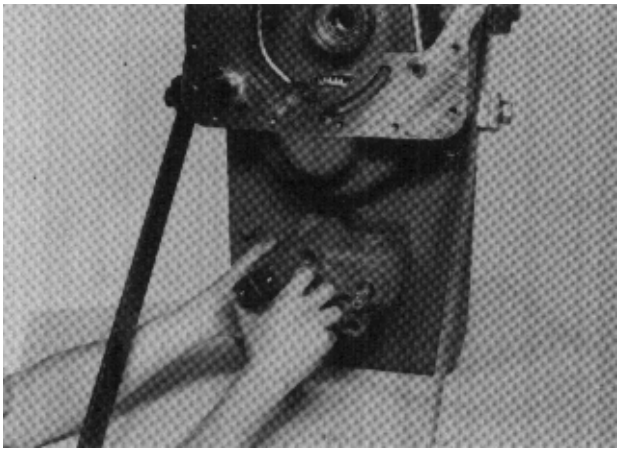


Figure 19

Remove disconnect assembly from studs.

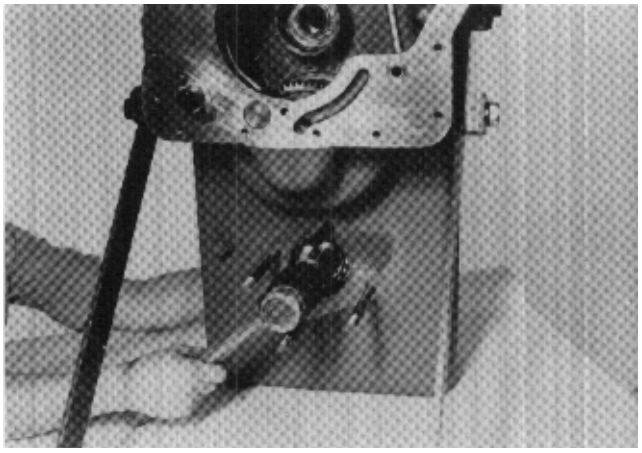


Figure 20

Tap output shaft to remove output shaft front bearing from bearing bore.

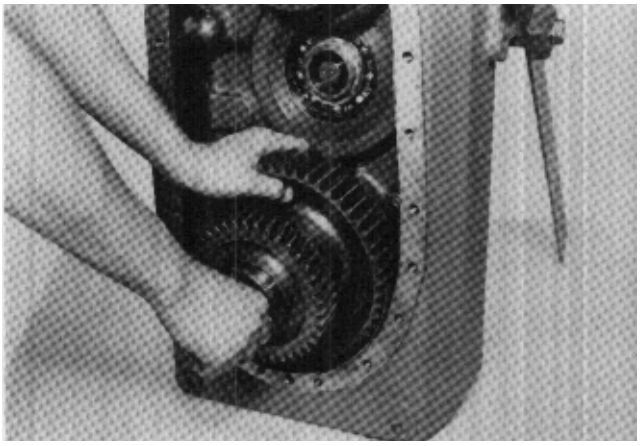


Figure 21

Remove output shaft assembly from housing.

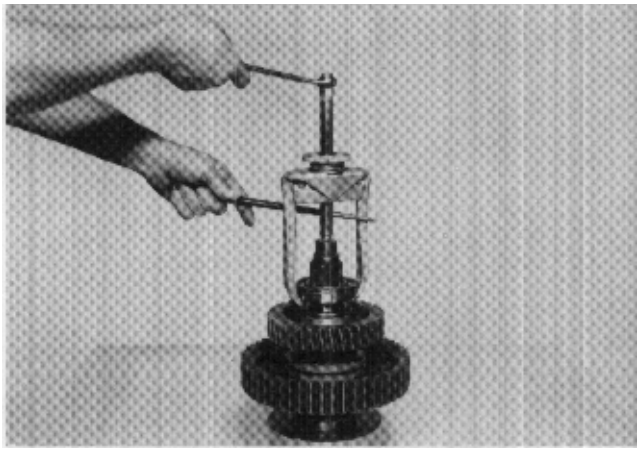


Figure 22

Remove output shaft rear bearing. Remove high range gear, bearings and shaft hub from shaft.

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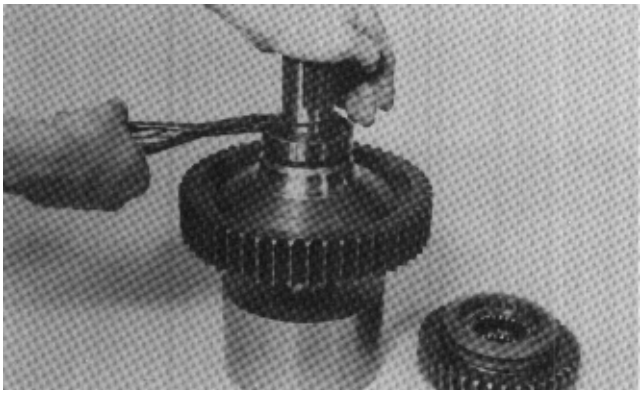


Figure 23

If unit has a disconnect, remove front bearing retainer ring.

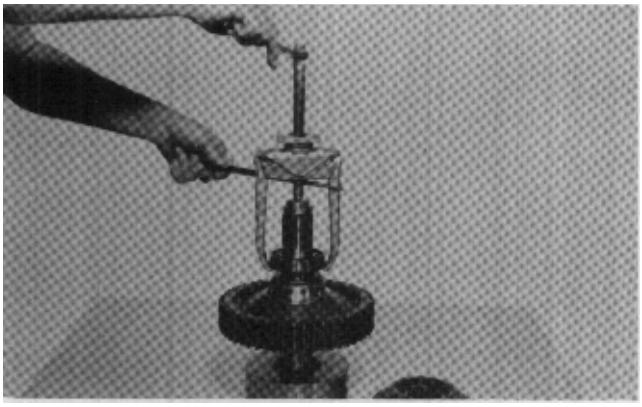


Figure 24

Refer to 3 speed long drop maintenance and service manual for cleaning and inspection of parts before reassembly

REASSEMBLY

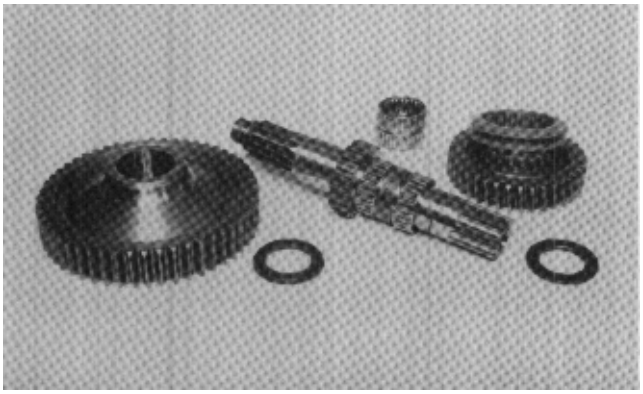


Figure 25

A bearing spacer is used in the output shaft low gear. Install inner needle bearing assembly, bearing spacer and outer bearing assembly.

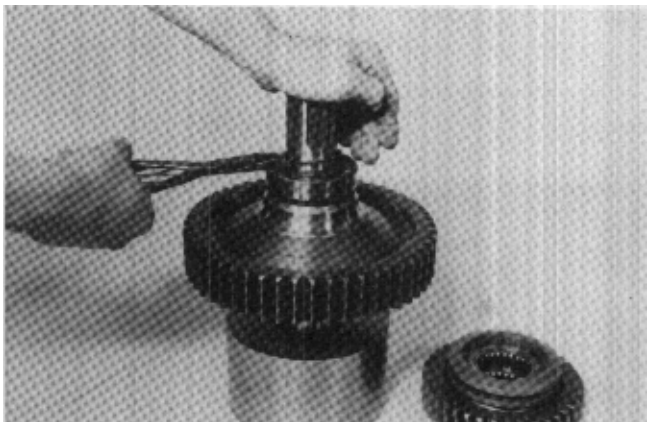


Figure 26

Position low gear on bearings and spacer. Use caution as not to damage bearings. **NOTE:** Long hub of gear up. Position thrust washer on shaft with bevel on washer up. Press front bearing on shaft. If disconnect is used install front bearing retainer ring.

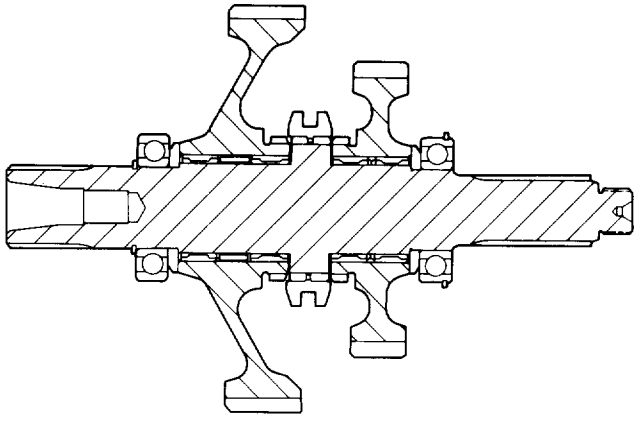


Figure 27

Cross section of output shaft showing stack up of parts.

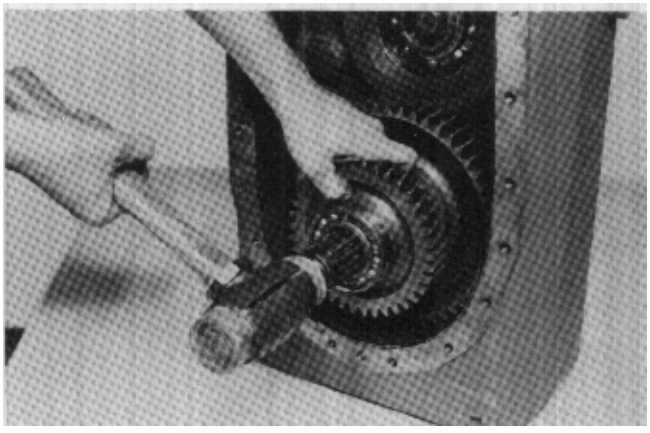


Figure 28

Install output shaft assembly in housing. Tap assembly into position.

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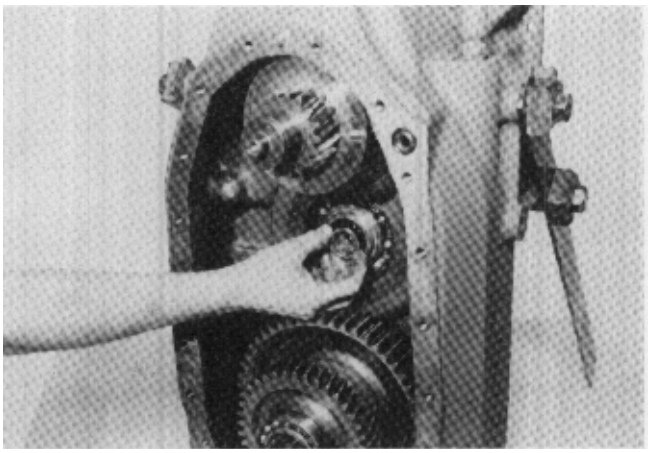


Figure 29

Insert idler shaft pilot bearing in 3rd speed clutch disc hub.

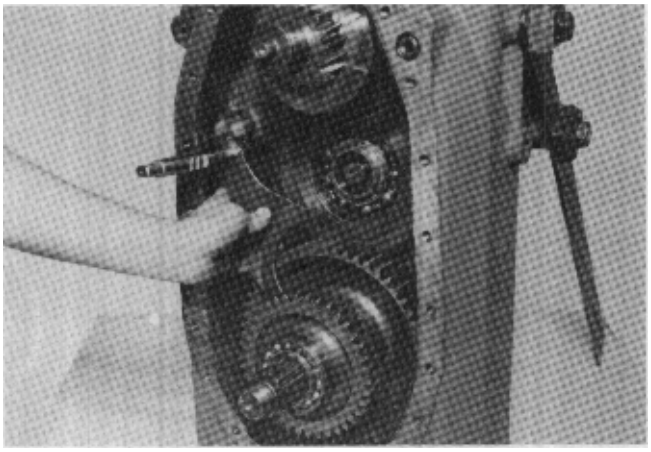


Figure 30

Position range shift fork and rail in range shift hub.

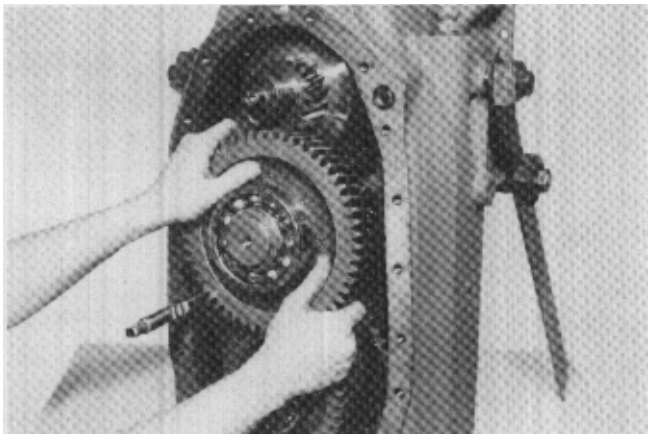


Figure 31

Install idler shaft and gear assembly in 3rd speed clutch disc hub by aligning splines on idler shaft with splines in clutch disc hub.

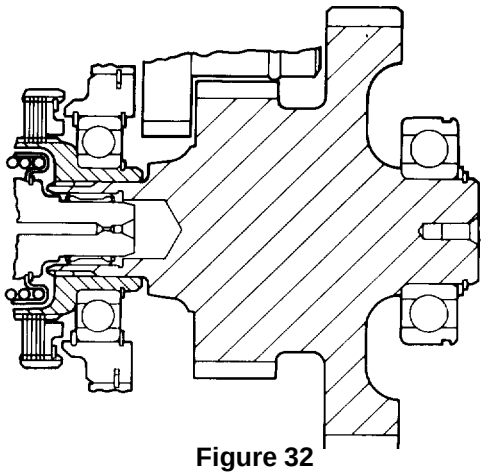


Figure 32

Cross section of idler shaft installed in 3rd speed clutch disc hub.

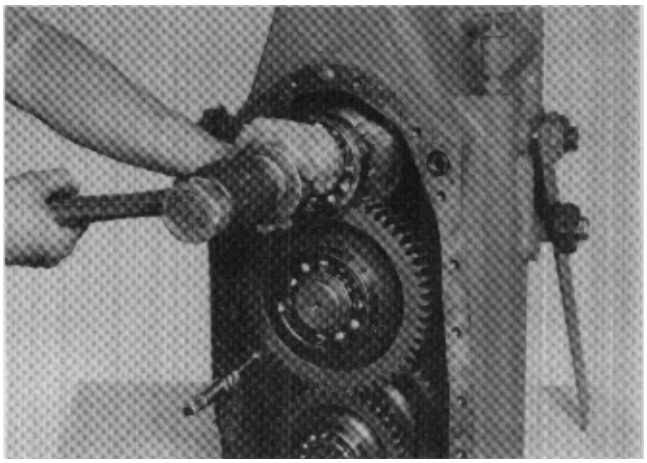


Figure 33

Install low clutch rear bearing.

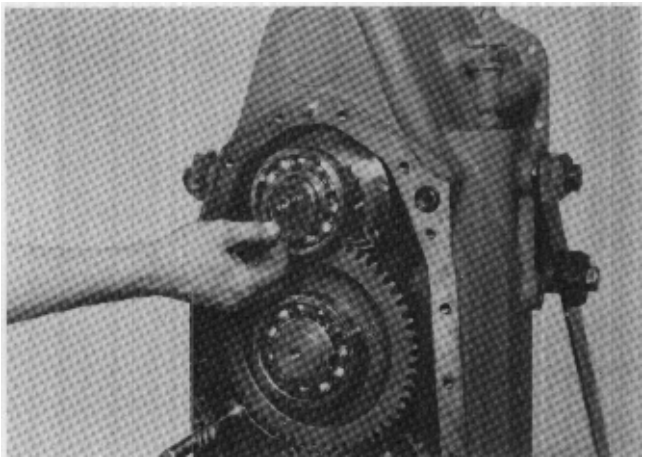


Figure 34

Install bearing spacer.

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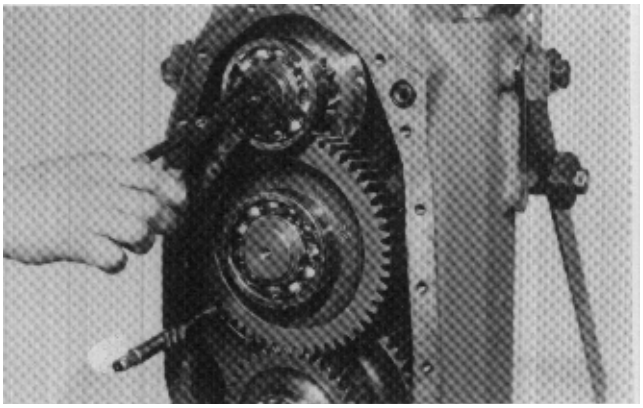


Figure 35

Install bearing retainer ring.

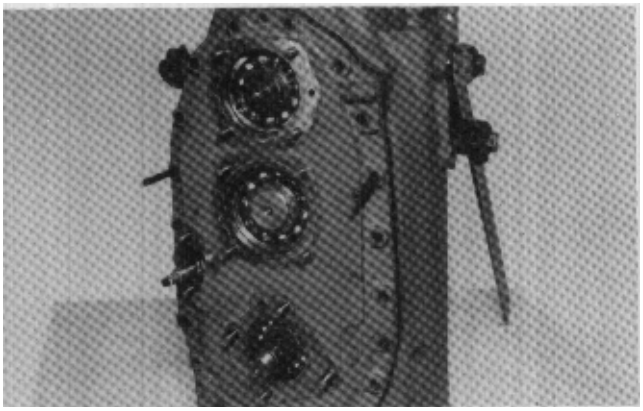


Figure 36

Position new gasket and “O” ring on rear of transmission housing. A thin coat of chassis grease will hold the gasket and “O” ring in place.

Install rear cover. Note two aligning studs to facilitate cover to housing assembly. Tap cover m place aligning shaft bearings with bearing bores. Remove studs and install cover bolts and lockwashers.

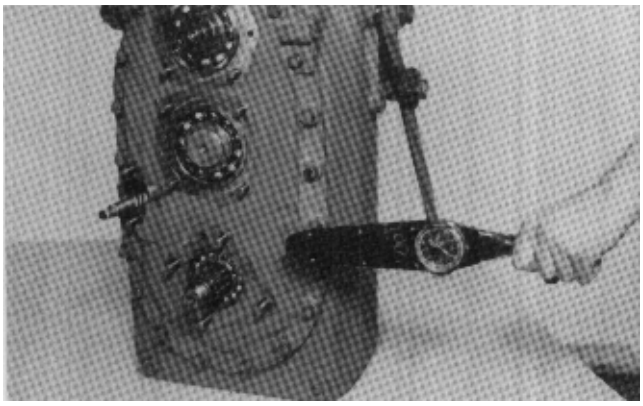


Figure 37

Tighten rear cover bolts 37 to 41 ft. lbs. torque [15,1 - 5,6 m.kgl].

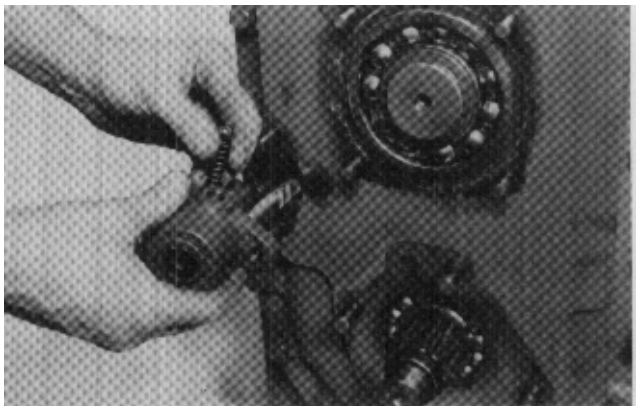


Figure 38

Position range shift rail support detent spring and ball in rail support.

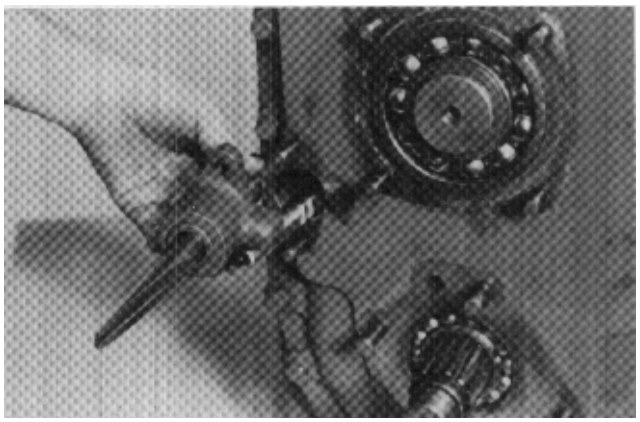


Figure 39

Detent ball and spring can be depressed with a blunt tool to hold in spring pocket until rail is in position. To facilitate assembly a taper rod was used to hold! the detent spring and ball in position while installing support on shift rail.

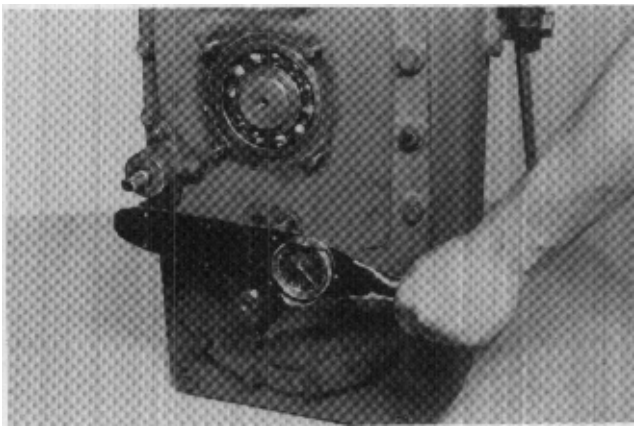


Figure 40

Install support washers and stud nuts. Tighten nuts 26 to 29 ft. lbs. torque [3,6 - 4,0 m.kg].

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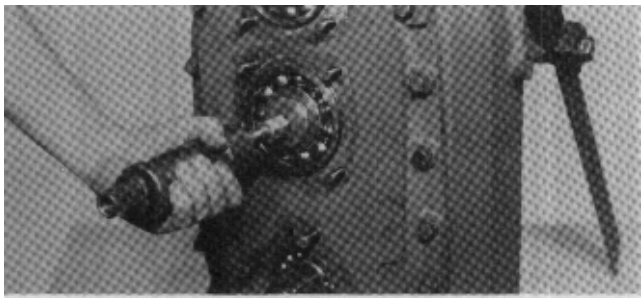


Figure 41

From the front of the transmission tap the low clutch and the output shaft to the rear far enough to install the rear bearing locating ring On the idler shaft a hammer puller was mace from a 3/8 - 24 threaded plug to pull the rear bearing to the rear far enough to install the locating rin

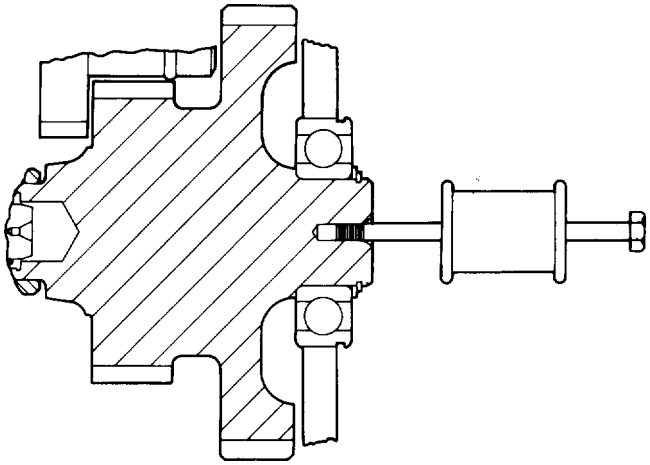


Figure 42

Cross section of hammer puller and idler shaft.
Install low clutch, idler shaft and rear output shaft bearing locating rings.

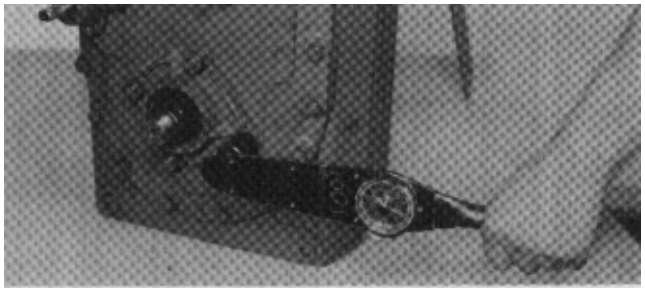


Figure 43

Apply a light coat of Permatex No. 2 to the outer diameter of the output of seal. Press seal in bearing cap with lip of seal toward bearing side of bearing cap. Position new “O” rings on bearing cap.

NOTE: Some units will have a gasket only between the cap and cover.

Install lockwashers and stud nuts. Tighten 91 to 100 ft. lbs. torque [12,6- 13,8 m.kg].

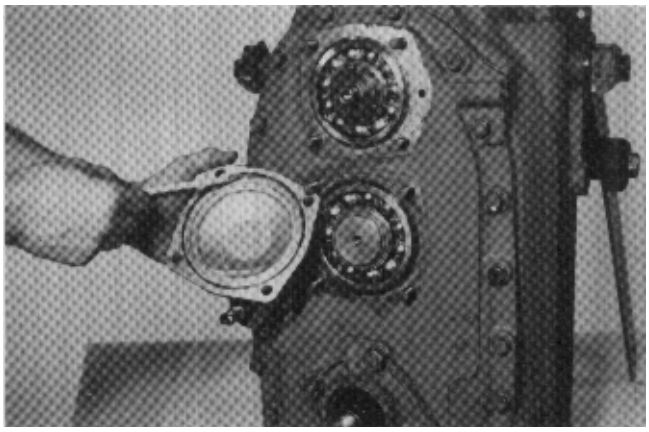


Figure 44

Position new “O” ring on idler shaft bearing cap. Install cap on studs and secure with lockwashers and nuts.

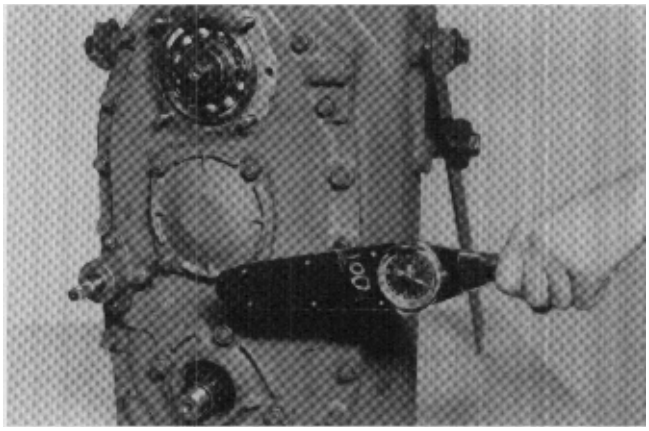


Figure 45

Tighten idler shaft bearing cap stud nuts 41 to 45 ft. lbs. torque [5,7 - 6,2 m.kg].

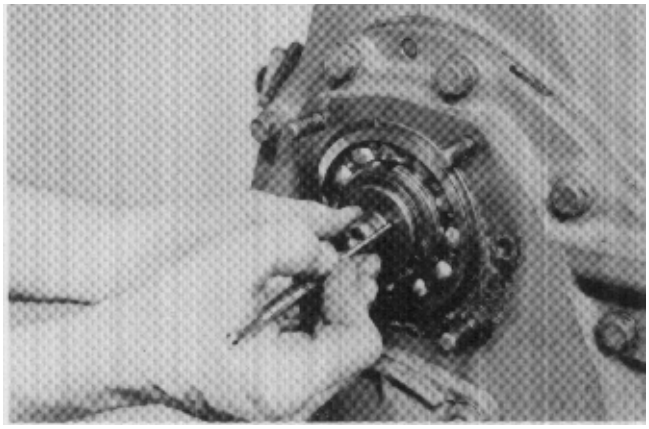


Figure 46

Install new low clutch oil sealing ring. **NOTE:** Sealing ring must be sized before installing bearing cap. Sizing can be done by using a round rod as shown and forcing ring into groove and back to original size.

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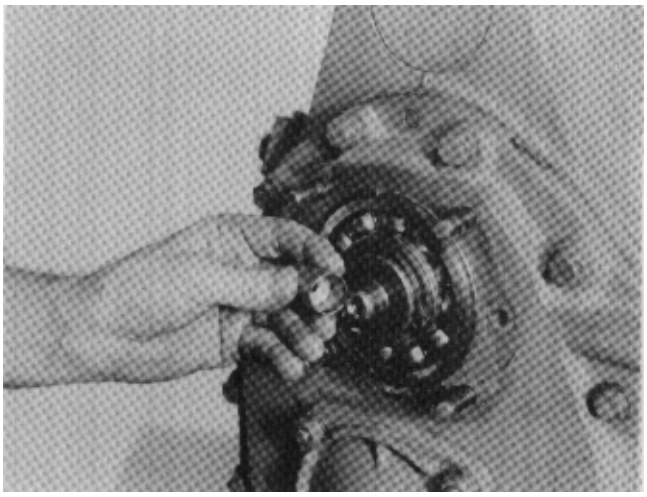


Figure 47

To facilitate bearing cap assembly a sizing tool can be mace for ease of sizing oil sealing ring. See Figure 48.

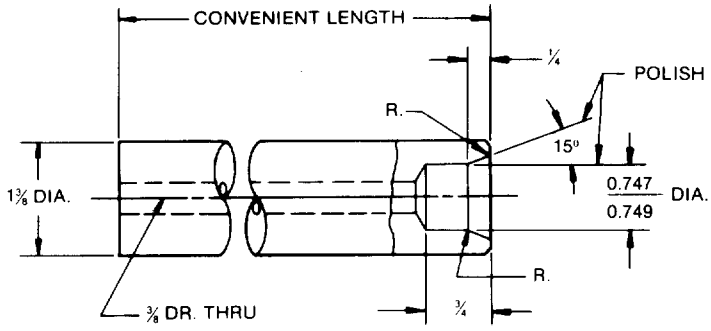


Figure 48

Low shaft oil sealing ring sizig tool.

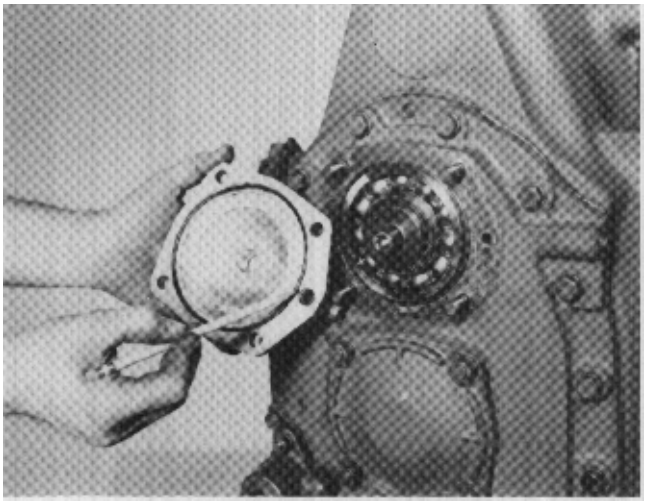


Figure 49

Install new bearing cap and low clutch pressure port “O’ rings on low shaft bearing cap. Position bearing cap on low shaft. Install washers and stud nuts.

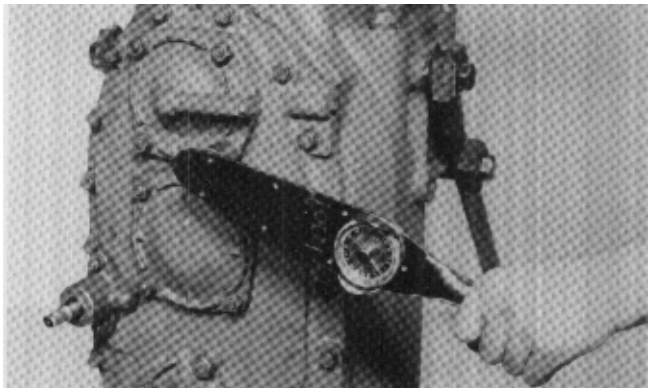


Figure 50

Tighten stud nuts 41 to 45 ft. lbs. torque [5,7 - 6,2 m.kg].

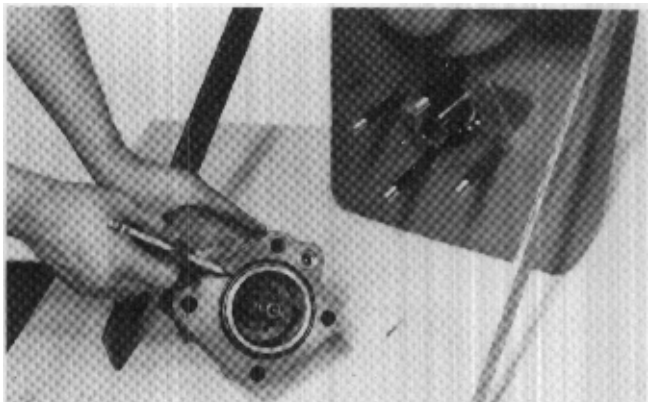


Figure 51

Position new “O” ring on disconnect housing. Install disconnect assembly on studs.

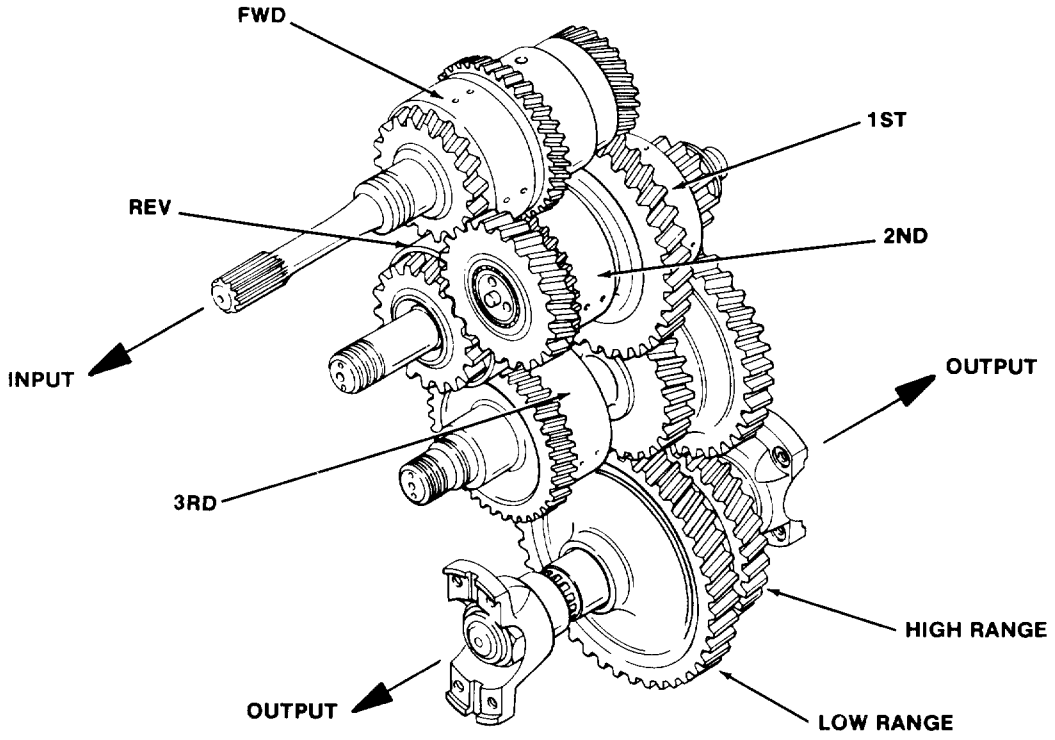


Figure 52

Install washers and stud nuts. Tighten 64 to 70 ft. lbs torque [8,9 - 9,7 m.kg]. Install rear output flange, “O” ring, washer and flange nut Block flange to prevent turning. Tighten flange nut 200 to 250 ft. lbs. torque [27 7 - 34 5 m.kg].

Refer to 3 Speed Long Drop 18000 Maintenance and Service Manual for further reassembly.

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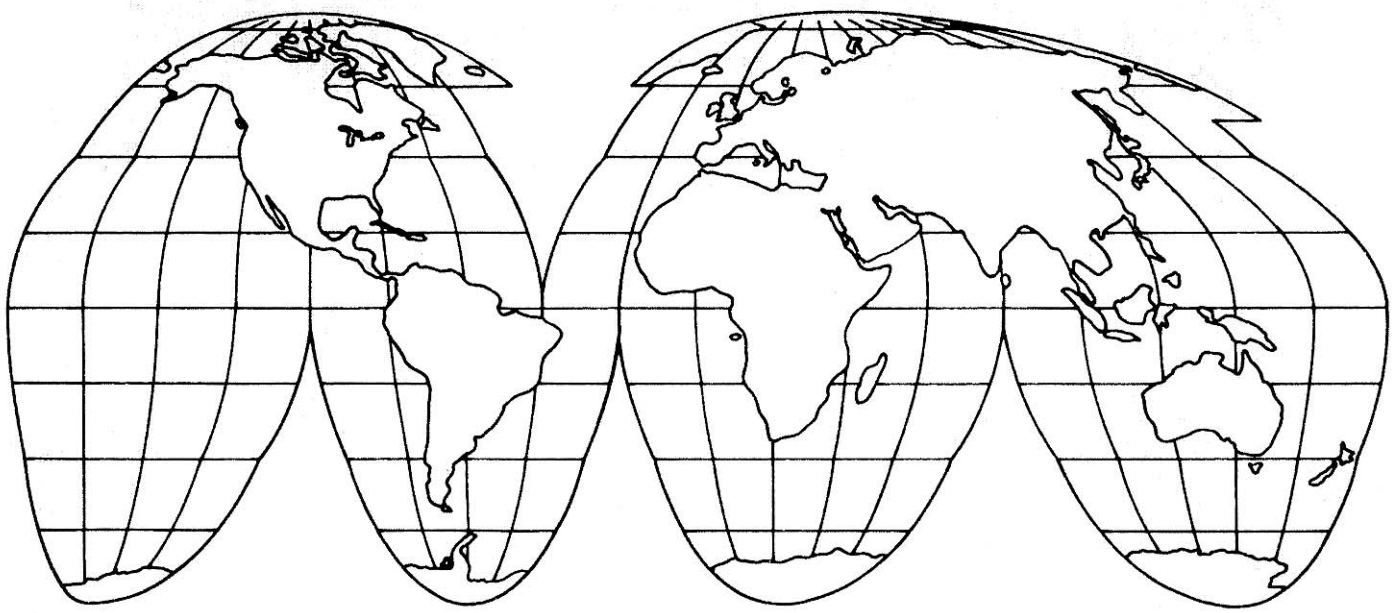


18000 SERIES 6 SPEED LONG DROP
CLUTCH AND GEAR ARRANGEMENT

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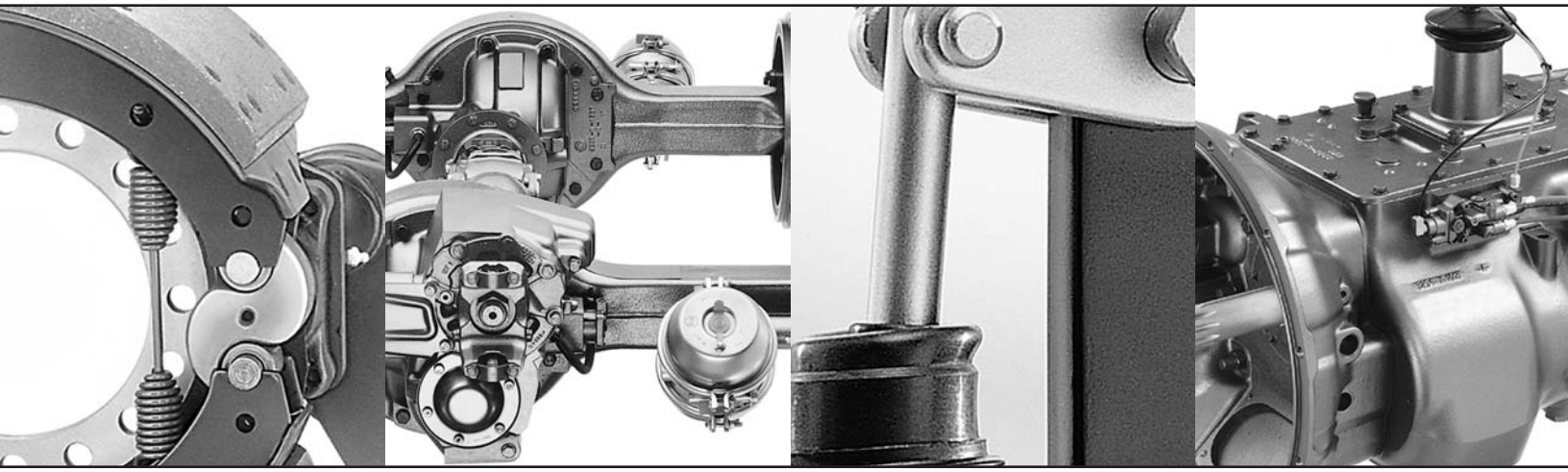
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Revised 02-01
$2.50

Lubrication

Maintenance Manual 1



- Q Plus™ Cam Brake
- Tandem Axle with Pump, Filter System and Driver-Controlled Differential Lock (DCDL)
- Automatic Slack Adjuster
- ZF Meritor Ten-Speed Transmission

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Before You Begin

This manual provides maintenance intervals and procedures, lubricant specifications, and product capacities for Meritor and ZF Meritor components.

1. Understand all procedures and instructions.
2. Follow your company's maintenance and service, installation, and diagnostics guidelines.
3. Use special tools when required to avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

⚠ ***WARNING***	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
⚠ ***CAUTION***	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious injury.
T	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

How to Obtain Additional Maintenance and Service Information for Components Included in This Manual

Contact Our Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order maintenance and service information for components included in this manual, as well as the following items.

- *Drivetrain Plus™ by ArvinMeritor Technical Electronic Library* CD features product and service information on most Meritor, ZF Meritor and Meritor WABCO components. $20. Order TP-9853.
- *Lubrication* video. $20. Order T-9398V.

Access Product and Service Information from the Technical Library on ArvinMeritor's Web Site

Visit the Technical Library section of our web site at www.arvinmeritor.com, which contains product and service information for ArvinMeritor's commercial vehicle systems lineup.

To access information on the site, click Products & Services/Tech Library Icon/HVS Publications. The screen will display an index of publications by type.

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Table of Contents

Section 1: Introduction

How to Obtain Additional Maintenance and Service Information for Components Included in This Manual 1
Introduction
Regularly-Scheduled Maintenance is Important
Oil Lubricants
Viscosity
Oil Change Schedules
Recommended Oil Drain Conditions Based on Used-Oil Analyses 2
Differential Oils (Hypoid Gear Oils)
Manual Transmission Oils
Grease Lubricants
National Lubricating Grease Institute (NLGI) Standards 3
Extreme Pressure (EP) Lubricants

Section 2: Clutches

Release Bearing 4
Bell Housing
Clutch Linkage 5

Section 3: Drivelines

Driveline Styles 6
RPL Series Permalube™ Driveline Universal Joint, Slip Yoke and Splines
Standard/Conventional Driveline Universal Joint
Standard/Conventional Driveline Slip Yoke and Splines
92N Permalube Driveline Universal Joint 7
92N Greaseable Driveline Universal Joint
92N Permalube and Greaseable Driveline Slip Yoke and Splines

Section 4: Front Driving Axles

Front Driving Axles 9
Magnets and Magnetic Drain Plugs
Breather
Seals
Temperature Indicators
Oil Level
Drain and Replace Oil
Wheel Bearings and Wheel-Ends
Knuckle King Pins 10
Camshaft Retainer Bushing and Cam Bushing
Drive Axle Shaft Universal Joint
Axle Shaft Spline and Thrust Washer
Cross Tube End Assembly
Knuckle Bushing

Section 5: Front Non-Driving Axles

King Pins 13
Conventional Front Axles
Sealed and Easy Steer™ Front Axles
Easy Steer Plus™ Front Axles 14
Ball Studs on the Steering Arm, Tie Rod Arm Ends and Drag Link
Conventional Front Axles, Easy Steer Front Axles, Easy Steer Plus Front Axles
Wheel Bearings and Wheel-Ends
Conventional Front Axles, Easy Steer Front Axles, Easy Steer Plus Front Axles

Section 6: On-Highway Brakes

Q Plus™ LX500 Cam Brake Package with the Extended Lube Feature 16
Available for On-Highway Linehaul and All Other Applications
Q Plus™ MX500 Extended Maintenance Package Option
Available for On-Highway Linehaul Applications Only
Identifying Q Plus™ LX500 and MX500 Cam Brakes
Lubricating the Q Plus™ LX500 and MX500 Cam Brakes and Automatic Slack Adjusters
After Specified Mileage or Time Intervals
Camshaft Bushings 17
Q Plus™, Cast Plus™, Q Series, P Series and T Series Cam Brakes

https://truckmanualshub.com/

Table of Contents

MERITOR®

Section 7: Planetary Drive Axles
Magnets and Magnetic Drain Plugs 20
Breather
Seals
Temperature Indicators
Check and Adjust the Oil Level
Drain and Replace the Oil 21
Section 8: Rear Drive Axles
Magnets and Magnetic Drain Plugs 24
Breather
Seals
Temperature Indicators 25
Advanced Lube Axles
For Meritor R-170 Axles Equipped With Traction Equalizer®
When to Use Limited Slip Friction Modifiers
Specifications
Oil Level
Check and Adjust the Oil 26
Drain and Replace the Oil
Inter-Axle Assemblies With Separate Housings
Section 9: Trailer Axles
TB Series Trailer Axles With Unitized Hub Assemblies 31
Comparing a Unitized Wheel-End to a Conventional Wheel-End
Identifying a Trailer Axle With Unitized Wheel-Ends 32
Wheel Bearings and Wheel-Ends
Camshaft Bushings
Conventional and TB Series
Section 10: Transfer Cases
Operating Information 35
Magnets and Magnetic Drain Plugs
Breather
Seals
Temperature Indicator
Check and Adjust Oil Level
Drain and Replace the Oil 36
Section 11: Transmissions
Recommended Oil Drain Conditions Based on Used-Oil Analysis 38
Manual Transmission Oils
Magnets and Magnetic Drain Plugs
Transmission Oil Coolers
Temperature Indicator
Oil Level
Before You Check the Oil Level
Check and Adjust the Oil Level 39
Drain and Replace the Oil
Service the Transmission if Necessary
Additional Specifications, Ratios and Steps 41
Section 12: Wheel Bearings and Wheel-Ends
Wheel Bearings 49
Grease the Bearings
Check the Oil Level
Drive Axle Hubs Without Fill Holes 50
Section 13: List of Lubricants 51

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How to Obtain Additional Maintenance and Service Information for Components Included in This Manual

Refer to the Service Notes page on the inside front cover of this manual.

Introduction

This manual provides Meritor's grease and oil lubricant specifications, procedures, service intervals and product capacities. Following these guidelines will enable you to correctly lubricate and maintain Meritor components, and help to ensure maximum component life.

- Always use the specified oil or grease lubricant from a manufacturer that provides quality products and complete application instructions.
- Always follow recommended lubrication intervals and procedures.

Regularly-Scheduled Maintenance is Important

Internal components can shed fine metal wear particles at a steady rate, especially during the break in period. If wear particles, moisture and other contaminants are allowed to circulate in the lubricant, the components will wear at a faster rate than normal.

Regularly-scheduled maintenance using the specified lubricants will help to ensure maximum component performance and life.

Oil Lubricants

There are three types of oil lubricants: petroleum oil, full synthetic oil and semi-synthetic oil. Both full synthetic and semi-synthetic oils retain their lubrication properties longer than petroleum oil.

- Petroleum oil is derived from crude oil. Crude petroleum oil also yields combustible fuels and a wide range of petroleum chemicals.
- Full synthetic oil uses a man-made-base oil with predictable physical properties. Full synthetic oil contains no refined petroleum-based fluids.
- Semi-synthetic oil contains a mixture of petroleum-based and synthetic fluids that can help extend service intervals, improve cold weather properties and reduce volatility.

Viscosity

CAUTION

Use correct viscosity lubricants recommended by Meritor. Do not lower the viscosity of specified lubricants by adding thinning agents, such as kerosene, gasoline or other dilutents. Damage to components will result.

Select the correct viscosity oil for a specific Meritor component from the charts in each section of this manual. When more than one lubricant is listed, choose an oil viscosity that is suitable for the expected outside temperature.

Oil viscosity grades and classifications are provided by the SAE (Society of Automotive Engineers) and the API (American Petroleum Institute).

- Use **multigrade oils** when vehicles operate in both cold and warm weather between oil changes.
- Use **low viscosity single grade oils** only in cold climates. **Single grade 75W oils are not approved for use in drive axles where ambient (outside) temperatures exceed 40°F (4°C).**
- Use **multigrade oil** for drive axles only. The hypoid gearing requires a GL-5 oil with Extreme Pressure (EP) additives to provide adequate lubricant film protection that prevents gear failure.

Oil Change Schedules

To determine an oil change schedule, take an oil sample at a specified interval or mileage recommendation. Analyze the sample to establish a schedule.

Often, however, service duty will dictate when to change the oil, regardless of mileage or a previously-established schedule.

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Recommended Oil Drain Conditions Based on Used-Oil Analyses

Differential Oils (Hypoid Gear Oils)

Drain and replace used differential oil that does not meet with the following used-oil analyses. Replace the drained oil with Meritor-specified oil for hypoid drive axle use.

Used-Oil Analyses (ppm=parts per million)

Iron (Fe)	If level is between 1000 ppm and 1500 ppm, resample the oil. If resampling indicates that iron level is above 1000 ppm, drain and replace the oil. If level is above 1500 ppm, drain and replace the oil.
Silicon (Si)	If level is greater than 100 ppm, drain and replace the oil.
Water (H_2O)	If level is greater than 0.3%, drain and replace the oil.
Phosphorus (P)	If level is less than 900 ppm, it is possible that the oil is not a GL-5 gear oil. Contact the lubricant manufacturer or Meritor Materials Engineering to determine the expected phosphorus level of a new oil sample. Only GL-5 type gear oils are approved for use in Meritor differentials.
Toluene Insolubles	If level is greater than 0.100 wt.%, drain and replace the oil.

Manual Transmission Oils

If used transmission oil analyses indicate that any one of these criteria is not met, drain the used oil and replace it with an oil that is recommended for manual transmissions.

Used-Oil Analyses (ppm = parts per million)

Iron (Fe)	If level is greater than 500 ppm, drain and replace the oil.
Silicon (Si)	If level is greater than 100 ppm, drain and replace the oil.
Water (H_2O)	If level is greater than 0.3%, drain and replace the oil.

Grease Lubricants

- Grease lubricants contain three substances: oil, a thickener base and additives.
- The oil lubricates. The thickener (base) holds the oil in place and releases it to provide the necessary lubrication. The additives enhance the characteristics of the oil and thickener. Extreme Pressure (EP) additives help prevent scoring, galling and welding of moving parts.
- The thickener may be a simple or complex soap (lithium, calcium, aluminum, etc.), organic (polyurea) or inorganic (clay).
- Do not mix different types of greases. The possibility of incompatible greases may reduce the lubricating ability of the greases.
- An important property of a grease is its dropping point, the temperature where grease changes from a semi-solid state to a liquid state. However, the operating temperature of a specific grease is not determined solely by the dropping point.

  Other properties such as resistance to change in consistency and chemical deterioration at high temperatures must be considered.

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National Lubricating Grease Institute (NLGI) Standards

The National Lubricating Grease Institute (NLGI) classifies and grades grease lubricants according to a grease's consistency and the application for which it is used.

The NLGI also issues licensed labels that identify approved grease lubricant applications.

Extreme Pressure (EP) Lubricants

CAUTION

Do not use multi-viscosity or Extreme Pressure (EP) GL-5 gear oils in a manual transmission. Damage to the transmission will result.

Extreme Pressure lubricants are often identified by the abbreviation "EP." Extreme Pressure lubricants contain additives that provide extra anti-wear protection to heavily-loaded parts. Meritor requires either EP greases or EP oils in various applications.

Approved hypoid gear oils contain EP additives that protect against tooth scoring and surface fatigue.



Labels licensed by the NLGI identify approved grease applications.

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

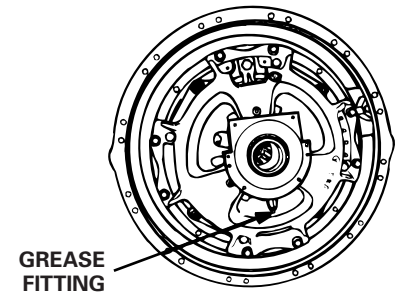
Release Bearing

CAUTION

Make sure the inspection cover on the clutch housing is used. If an inspection cover is not used, dirt and contaminants enter the clutch housing and damage the clutch.

1. Remove the inspection cover on the clutch housing.
2. Clean all grease fittings prior to lubrication.
3. Correctly lubricate the release bearing. Apply grease to the grease fitting on the release bearing until you can see a small amount of grease coming out of the bearing housing. Do not overgrease.
4. Apply grease to the release yoke tips where they contact the bearing housing. Also apply grease to the exposed transmission input shaft between the bearing housing and the transmission input bearing retainer to lubricate the release sleeve bushing.
5. If the release bearing is equipped with a lube tube, be sure that you can see grease coming out of the bearing housing, which ensures that lubricant is reaching the bearing. Be sure that the lube tube is secured and not damaged.
6. Use the same procedure for extended maintenance clutches.
7. Install the inspection cover. Meritor recommends using a high temperature, multi-purpose wheel bearing grease (Meritor Specification O-661), but use the lubricant recommended by the manufacturer of the vehicle. **Figure 2.1**.

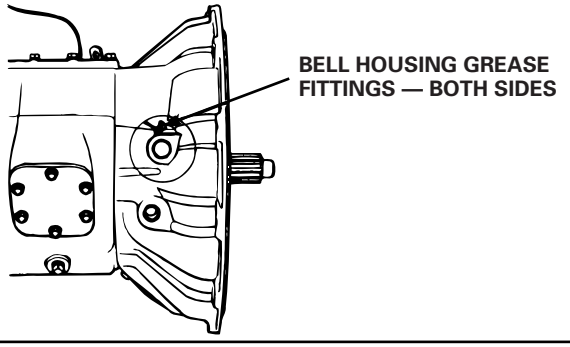
Figure 2.1



Bell Housing

1. Clean all grease fittings prior to lubrication.
2. Grease the release fork cross shaft by applying grease to each fitting on the bell housing until a small amount of grease purges out. Use the specified lubricant at the recommended interval. Refer to the lubricant specifications and maintenance intervals of the vehicle manufacturer. **Figure 2.2**.

Figure 2.2



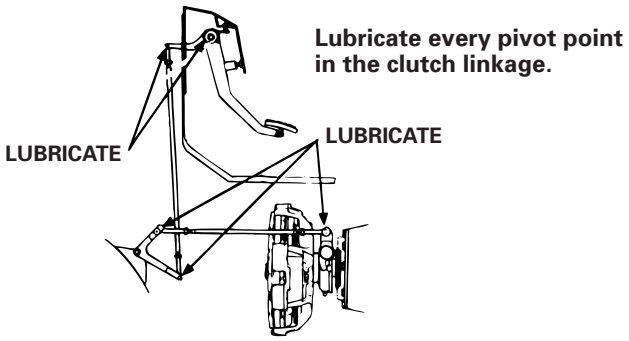
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Clutch Linkage

NOTE: Some vehicle manufacturers may use "lubed-for-life" ball joints in the clutch linkage. Refer to the vehicle manufacturer's instructions.

You must lubricate each pivot point on the linkage according to the vehicle manufacturer's procedure. **Figure 2.3**. Use the specified lubricant at the recommended interval. Refer to the lubricant specifications and maintenance intervals in the tables below.

Figure 2.3



Greasing Interval and Specifications

Component	Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Release Bearing	①	High Temperature Multi-Purpose Wheel Bearing Grease	O-661	3	Lithium Complex	Down to –40°F (–40°C)
Bell Housing	①	②	—	—	—	—
Clutch Linkage	①	②	—	—	—	—

① Use the interval specified by the vehicle manufacturer or the fleet, but make sure the release bearing is greased once per month.

② Use the grease specified by the vehicle manufacturer.

Approved Lubricants

Lubricant	Recommendation
Clutch Bearing Grease	Exxon Unirex N Grade 3 (NLGI Grade No. 3, Lithium Complex)

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Driveline Styles

Industry Name/ Description	Series	Type	Lubrication Requirements
Standard or Conventional Driveline	16N 17N 176N 18N	Full Round	Splines and Universal Joints
	16T 17T 176T 18T	Easy Service (1/2 Round)	
Wing Style Greaseable	92N	Wing Style	
Wing Style Permalube	92N	Wing Style	Splines Only
RPL Series (Meritor Permalube)	RPL 25 RPL 20	Combination Wing and Full Round	None

RPL Series Permalube™ Driveline Universal Joint, Slip Yoke and Splines

The universal joint, slip yoke and splines are permanently lubricated and sealed and do not require regular lubrication. **Figure 3.1**.

Standard/Conventional Driveline Universal Joint (Figure 3.2)

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the universal joint. Apply grease until new grease purges from all four seals.
   - **If new grease does not purge at all the seals:** Loosen the problem bearing cap bolts and regrease until all four cups purge.
   - **If new grease still does not purge:** Replace the universal joint.

Standard/Conventional Driveline Slip Yoke and Splines (Figure 3.2)

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Cover the vent hole in the welch plug with a finger.
3. Apply the specified grease at the grease fitting on the slip yoke until the grease purges from the dust seal.

Figure 3.1

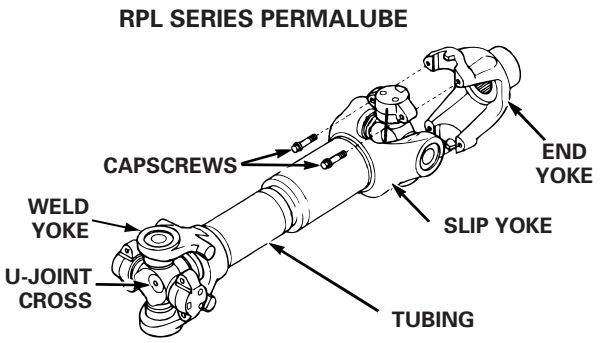
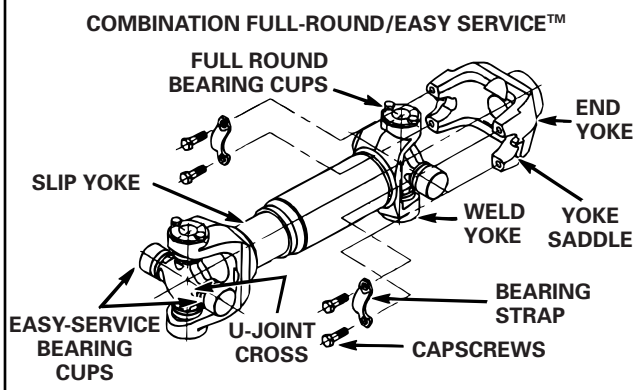


Figure 3.2

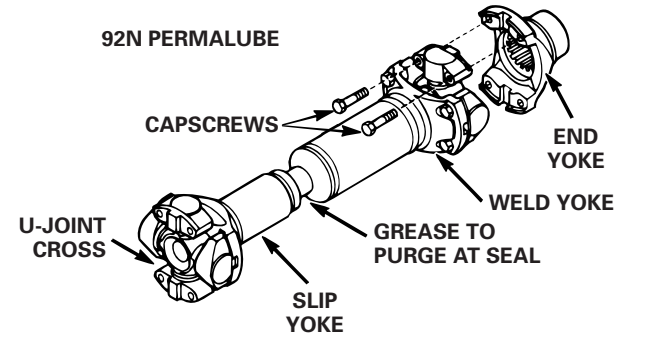


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92N Permalube Driveline Universal Joint

The universal joint is permanently lubricated and does not require regular maintenance. **Figure 3.3**.

Figure 3.3



92N Greaseable Driveline Universal Joint

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the universal joint. Apply grease until new grease purges from all four seals.
   - **If new grease does not purge at all the seals:** Loosen the problem bearing cap bolts and regrease until all four cups purge.
   - **If new grease still does not purge:** Replace the universal joint.

92N Permalube and Greaseable Driveline Slip Yoke and Splines

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Clean all grease fittings prior to lubrication.
3. Cover the vent hole in the welch plug with a finger.
4. Apply the specified grease at the grease fitting on the slip yoke until grease purges from the dust seal.

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Greasing Intervals and Specifications for Standard/Conventional Drivelines

Component	Application	Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Universal Joint, Slip Yoke and Splines	Line Haul	50,000 miles (80 000 km)	Universal Joint Grease	O-634-B	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	②
	Highway	16,000 miles (25 000 km)					
	City	6,500 miles (10 000 km)					
	Construction	①					

① The greasing interval depends on the individual operating conditions, speed and loads. To determine the interval, inspect for the presence of grease at all positions until an interval can be determined. Grease the assembly as necessary.

② Refer to the grease manufacturer's specifications for the temperature service limits.

Approved Lubricants

Lubricant	Recommendation
Universal Joint Grease	Must meet Meritor Specification O-634-B (NLGI Grade No. 2, Lithium 12-Hydroxy Stearate with Molybdenum Disulfide)
	Amalie All Purpose Grease with Moly-L1-2M
	Exxon 5160
	Shell Super Duty Special FF
	Marathon Maralube Molycode 529
	Phillips Petroleum Philube MW-EP2 Grease
	Shell Moly Poly Grease
	Kendall L424 Grease
	Amoco Super Chassis Grease
	Ford Specification M1C-75B or part number PN-C1AZ 19590

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⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Front Driving Axles

Magnets and Magnetic Drain Plugs

Meritor front driving axles are equipped with magnetic drain plugs that have a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

The magnetic drain plug can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

Breather

⚠ *CAUTION*

Cover the breather when steam cleaning the housing to prevent water from entering the housing and contaminating the oil. Damage to components can result.

Baffle-type breathers help keep Meritor axles free from external moisture and dirt, which can cause premature oil and component failure.

Seals

⚠ *CAUTION*

Always use the correct tools and procedures when replacing seals to ensure correct installation and help prevent seals from leaking.

Seals keep lubricant in and dirt out of a component. When they are worn or damaged, seals leak and produce low lubricant levels which may damage components.

Durable triple lip seals, standard in Meritor axles, protect the quality and levels of the lubricant and provide superior performance.

Temperature Indicators

⚠ *CAUTION*

Meritor axles can operate above 190°F (88°C) without damage. However, if the oil temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating. Damage to components can result.

Many Meritor axles have a tapped hole in the housing for the installation of a lubricant temperature indicator that will help reduce the failure of axle parts from overheated oil.

Oil Level

Check and Adjust Oil

1. Make sure the vehicle is parked on a level surface.
2. Remove the fill plug from the axle.
3. The oil level must be even with the bottom of the fill plug hole.
   - If oil flows from the hole when the plug is loosened, the oil level is high. Let the oil drain to the correct level.
   - If the oil level is below the bottom of the fill plug hole, add the specified oil.
4. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T

Drain and Replace Oil

1. Make sure the vehicle is parked on a level surface. Put a large container under the axle.
2. Remove the drain plug from the bottom of the axle. Drain and discard the oil properly.
3. Clean, install and tighten the drain plug to 35-50 lb-ft (48-67 N•m). T
4. Remove the fill plug from the axle.
5. Fill the axle to the bottom of the fill plug hole with the specified oil. Allow enough time for oil to circulate through the axle assembly.
6. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T

Wheel Bearings and Wheel-Ends

Refer to Section 12 for lubrication information on oil- and grease-lubricated wheel bearings and wheel-ends.

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Knuckle King Pins

With the vehicle weight on the wheel-end, pump grease through the grease (zerk) fittings located on the upper cap or steering arm and lower cap assemblies. Grease should purge through the seals and thrust bearing.

Camshaft Retainer Bushing and Cam Bushing

Pump grease until it purges through the seals.

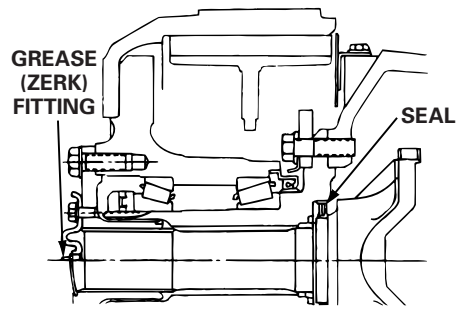
Drive Axle Shaft Universal Joint

1. Permanently-lubricated (Permalube™) joints do not have a grease fitting provided. Periodic greasing is not required for these parts. For serviceable universal joints (with grease fittings) follow Steps 2 and 3.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the universal joint. Apply grease until new grease purges from all the seals.
4. If new grease does not purge at every seal, move the driveline while applying grease at the fittings until new grease purges at every seal. If new grease still does not purge, disassemble the universal joint. Inspect the grease and the components. Service as necessary.

Axle Shaft Spline and Thrust Washer

On axles with greaseable drive flanges, pump grease through the grease (zerk) fitting until it purges at the axle shaft seal. **Figure 4.1**.

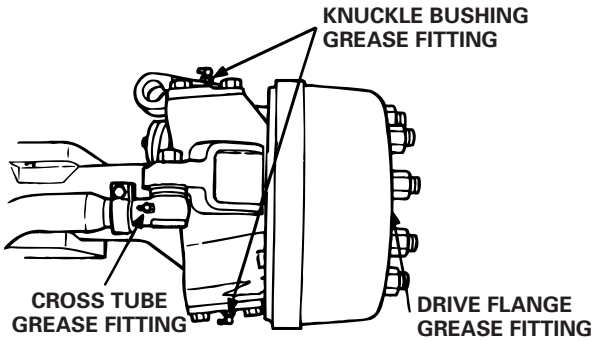
Figure 4.1



Cross Tube End Assembly

1. Check the cross tube for looseness of more than 0.060-inch (1.52 mm). **Figure 4.2**. If loose, service as necessary.
2. Apply the specified grease at the grease fitting on the cross tube. Apply grease until new grease purges from all the seals.
3. If new grease does not purge at the seals, move the cross tube while applying grease at the fittings until new grease purges from all the seals. If new grease still does not purge, disassemble the cross tube. Inspect the grease and the components. Service as necessary.

Figure 4.2



Knuckle Bushing

1. Check the knuckle for looseness. The correct end play is 0.005-0.015-inch (0.127-0.381 mm). **Figure 4.2**. If loose, service as necessary.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the knuckle. Apply grease until new grease purges from all the seals. Grease the lower pin cap with the vehicle weight on the wheel-end to ensure that the thrust bearing is completely greased.
4. If new grease does not purge at the seals, move the knuckle while applying grease at the fittings until new grease purges at the seals. If new grease still does not purge, disassemble the knuckle. Inspect the grease and the components. Service as necessary.

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Front Driving Axle Oil Change Intervals and Specifications*

Operation	On-Highway	Off-Highway
Initial Oil Change	3,000 miles (4800 km)	3,000 miles (4800 km)
Check Oil Level	3,000 miles (4800 km) or 200 operating hours (whichever comes first)	3,000 miles (4800 km)
Petroleum Oil Change	30,000 miles (48 000 km) or 2,000 operating hours (whichever comes first)	30,000 miles (48 000 km) or 2,000 operating hours (whichever comes first)
Synthetic Oil Change	—	—

Meritor Specifications	Specification Approval	Oil Description	Outside Temperature			
			F°		C°	
			Min.	Max.	Min.	Max.
O-76A Gear Oil	MIL-PRF-2105-E and SAE J2360	GL-5, SAE 85W/140	10	None	–12	None
O-76D Gear Oil		GL-5, SAE 80W/90	–15	None	–26	None
O-76E Gear Oil		GL-5, SAE 75W/90	–40	None	–40	None
O-76J Gear Oil		GL-5, SAE 75W	–40	35	–40	2
O-76L Gear Oil		GL-5, SAE 75W/140	–40	None	–40	None

* If the front drive axle is the only axle on the vehicle, change the oil every 15,000 miles (24 000 km) or 1,000 hours of operation, whichever comes first.

Front Driving Axle Greasing Intervals and Specifications

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Cross Tube End Assemblies, Knuckle Bushings and Drive Flange	3,000 miles (4800 km) or 200 hours of operation, whichever comes first.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
U-Joints		U-Joint Grease	O-634-B	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	

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Front Driving Axle Oil Capacities

Axle Model	Oil Capacity	
	Pints	Liters
FDS-75	13.0	6.2
FDS-78	13.0	6.2
FDS-85	13.0	6.2
FDS-90	13.0	6.2
FDS-93	13.0	6.2
FDS-750	13.9	6.5
FDS-1600	21.0	9.9
FDS-1800	28.0	13.2
FDS-1805	28.0	13.2
FDS-1807	28.0	13.2
FDS-1808	28.0	13.2
FDS-2100	28.0	13.2
FDS-2101	28.0	13.2
FDS-2102	43.0	20.3
FDS-2107	43.0	20.3
FDS-2110	43.0	20.3
FDS-2111	43.0	20.3
FDS-2117	43.0	20.3
RF-7-106*	14.0	6.6
RF-9-106*	14.0	6.6
RF-12-125*	15.3	7.2
RF-16-145*	36.4	17.2
RF-21-155*	27.9	13.2
RF-21-156*	27.9	13.2
RF-21-160*	43.7	20.7
RF-21-355*	28.0	13.2
RF-23-180*	39.3	18.6

* Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel-ends. These oil capacities will change if the track or the drive pinion angle is different.

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

King Pins

Conventional Front Axles

NOTE: This procedure applies to 901, 903, 910, 935 and 970 front conventional axles. Refer to the identification tag on the front of the axle beam.

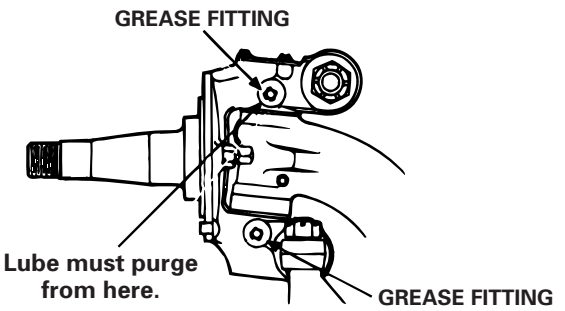
On conventional front axles, the grease fittings are on the side of the knuckle.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Lift the vehicle so that the tires are off the ground. The tires should always be off the ground when the king pins are lubricated. Support the vehicle with safety stands. Put blocks in front and in back of the rear wheels to keep the vehicle from moving.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the top and the bottom grease fittings on the side of the knuckle. **Figure 5.1**.
4. Apply lubricant to the top fitting until new lubricant purges from between the upper shim pack and thrust bearing seal.
5. Lower the vehicle so that the wheels touch the ground.
6. Apply lubricant to the bottom fitting until new lubricant purges and fills the thrust bearing.

Figure 5.1



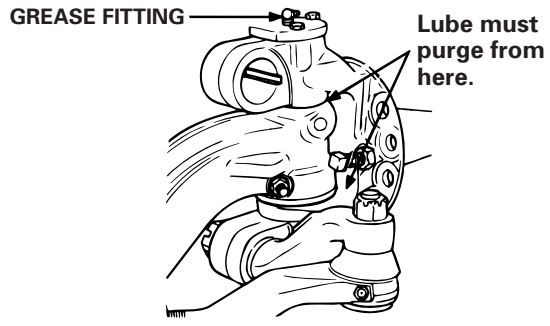
Sealed and Easy Steer™ Front Axles

NOTE: This procedure applies to 911, 921, 931, 932, 933, 934, 941, 942, 943, 944, 951, 952, 961, 963, 971 and 975 Series sealed front axles. Refer to the identification tag on the front of the axle beam.

On sealed and Easy Steer front axles, the grease fittings are on the top and bottom king pin caps of the knuckle.

1. Make sure the tires touch the ground. Do not elevate the vehicle.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 5.2**.
4. Apply lubricant until new lubricant purges from the thrust bearing seal and the upper shim pack.

Figure 5.2



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Easy Steer Plus™ Front Axles

NOTE: Removal of the long-life bearings, seals and lubricant from the hub assembly will void the warranty.

Meritor's Easy Steer Plus front axle features a permanently-sealed and lubricated truck hub unit designed to help reduce wheel-end maintenance. Refer to Maintenance Manual MM-99120 for service procedures.

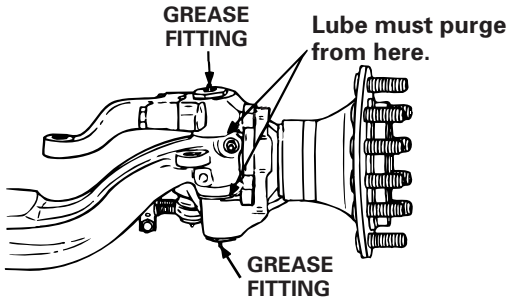
⚠ *CAUTION*

A unitized hub is permanently sealed and lubricated as an assembly. Do not attempt to remove the hub bearings, seals and lubricant. You cannot service or reinstall these components into a unitized hub assembly. Damage to components can result.

NOTE: On Easy Steer Plus front axles, the grease fittings are located on the top and bottom king pin caps.

1. Be certain that the tires touch the ground. Do not raise the vehicle.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 5.3**.
4. Force lubricant into upper and lower king pin grease fitting caps until new lubricant flows from between the following two areas:
   - Upper axle beam end and the knuckle. **Figure 5.3**.
   - Lower axle beam end and the knuckle. **Figure 5.3**.

Figure 5.3



Ball Studs on the Steering Arm, Tie Rod Arm Ends and Drag Link

Conventional Front Axles, Easy Steer Front Axles, Easy Steer Plus Front Axles

1. The tires must touch the ground. Do not raise the vehicle.
2. Clean and remove oil grease fittings prior to lubrication.
3. Apply lubricant at each grease fitting until new lubricant flows from the boot. **Figures 5.4 and 5.5**.

Figure 5.4

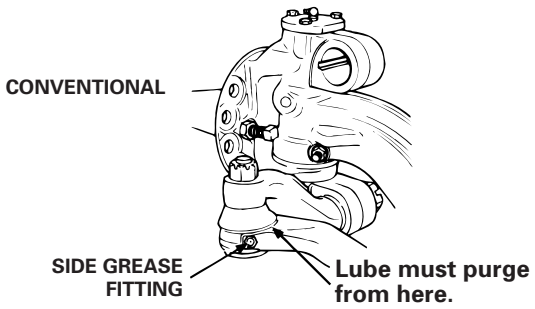
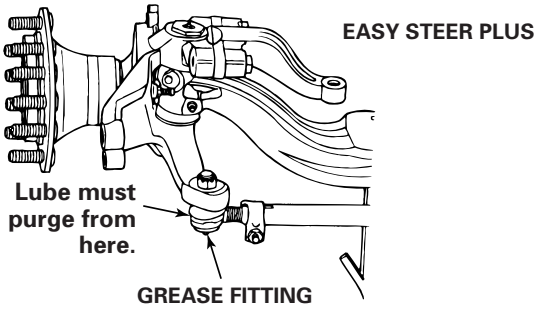


Figure 5.5



Wheel Bearings and Wheel-Ends

Conventional Front Axles, Easy Steer Front Axles, Easy Steer Plus Front Axles

Refer to Section 12 for oil and grease lubrication information.

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Conventional Front Non-Driving Axle Greasing Intervals and Specifications

Applies to all FF and FD Series axle models used in linehaul and city delivery vocations and including FD-931, FD-933 and FD-961 applications.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
King Pins and Bushings	100,000 miles (160 000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link*			O-617-B	2		

* Applies to ball studs on conventional and Easy Steer front axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154 000 km) for wear and damage. Service as necessary.

Conventional Front Non-Driving Axle Greasing Intervals and Specifications

Applies to all FF Series axle model used in other vocations (not linehaul) and including all FC-901, FC-903, FC-921, FC-941, FD-901, FE-970, FG-931, FG-933, FG-941, FG-943, FL-931, FL-941, FL-951, FU-910 and FU-935 applications.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
King Pins and Bushings	50,000 miles (80 000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link*			O-617-B	2		

* Applies to ball studs on conventional and Easy Steer axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154 000 km) for wear and damage. Service as necessary.

Easy Steer Plus Front Non-Driving Axle Greasing Intervals and Specifications

Applies to FF 981, FF 982, FF 983, FF 984 and FF 985 front non-driving steering axles in all vocations.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description
King Pins and Bushings	100,000 miles (160 000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link*			O-617-B	2	
Truck Hub Unit	No Lube to Hub	Unit sealed for life of component		NONE	DO NOT LUBRICATE

* Applies to ball studs on conventional and Easy Steer axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154 000 km) for wear and damage. Service as necessary.

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Q Plus™ LX500 Cam Brake Package with the Extended Lube Feature

Available for On-Highway Linehaul and All Other Applications

NOTE: You must continue to observe all other brake preventive maintenance schedules and procedures for Q Plus LX500 and MX500 cam brakes with factory-installed Meritor automatic slack adjusters. Refer to Maintenance Manual MM-96173, *Q Plus LX500 Cam Brakes*, and Maintenance Manual 4B, *Automatic Slack Adjuster*.

Meritor's new Q Plus LX500 cam brake package with the Extended Lube feature is available for on-highway linehaul and all other applications and includes:

- Q Plus LX500 cam brakes.
- Meritor factory-installed automatic slack adjusters.
- Extended Lube Feature: For on-highway linehaul applications, the Q Plus LX500 camshaft and slack adjusters do not require lubrication and reline for 3 years or 500,000 miles (800 000 km), whichever comes first. For all other applications, the lubrication interval is one year, regardless of mileage.

Q Plus™ MX500 Extended Maintenance Package Option

Available for On-Highway Linehaul Applications Only

Meritor's new Q Plus MX500 cam brake is available for on-highway linehaul applications only and includes:

- Extended Maintenance Package: Proprietary friction material on 5-inch wider shoes for front axles and 8-inch wider shoes for rear axles for more wearable volume than Q Plus LX500 brakes.
- Extended Lube Feature: The Q Plus MX500 camshaft and slack adjusters do not require lubrication and reline for 3 years or 500,000 miles (800 000 km), whichever comes first.
- Meritor factory-installed automatic slack adjusters.

Identifying Q Plus™ LX500 and MX500 Cam Brakes

NOTE: Do not remove the identification tag from the camshaft bracket during the extended maintenance period.

You can identify Q Plus LX500 and MX500 cam brakes by checking the identification tags affixed to the brake.

1. A brake shoe tag identifies the brakes as Q Plus brakes.
2. An additional identification tag imprinted with "SEE MERITOR MAINTENANCE MANUAL MM-96173 FOR LUBE INFO," which is affixed to the brake chamber bracket over the top of the plugged grease hole, identifies the brake as a Q Plus LX500 or MX500 brake.
3. Q Plus LX500 and MX500 brakes and automatic slack adjusters do not have grease fittings.

Lubricating the Q Plus™ LX500 and MX500 Cam Brakes and Automatic Slack Adjusters After Specified Mileage or Time Intervals

1. Remove the identification tag from the chamber bracket housing.
2. Remove grease plugs from both the chamber bracket and the automatic slack adjuster.
3. Install grease fittings and lubricate the brake assembly through the grease fitting in the bracket with Meritor-approved synthetic grease O-695 until new grease flows from the inboard seal.
4. Lubricate the automatic slack adjuster through the grease fitting until new grease flows out of the pull pawl or camshaft seal.
5. Replace the fittings with new grease plugs and cover the bracket plug with a new identification tag.

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Camshaft Bushings

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

CAUTION

When grease flows from the seal near the cam head, replace the seal. Remove any grease from the cam head, rollers and linings. Grease on the linings can increase stopping distances.

If grease flows from the seal near the cam head, replace the seal. Remove any grease or oil from the cam head, rollers and linings. Always replace contaminated linings. Grease on the linings can increase stopping distances. Serious personal injury and damage to components can result.

Q Plus™, Cast Plus™, Q Series, P Series and T Series Cam Brakes

Meritor cam brakes are air-actuated, cam-operated, two-shoe brakes with each shoe mounted on a separate anchor pin. The brakes are available with automatic or manual slack adjusters and can be assembled with spring brakes.

Wedge Brake Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
All Actuating Components, All Areas Where Shoes Contact Spider, Anchor Plungers, Adjusting Bolts or Retainer Hardware	O-616-A	1	Clay Base	Down to –40°F (–40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)

Conventional Automatic Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Automatic Slack Adjuster	O-616-A	1	Clay Base	Down to –40°F (–40°C)
	O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
Clevis Pins	Any of Above	Refer to Above	Refer to Above	Refer to Above
	O-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	—	Anti-Seize	

* Do not mix O-637 calcium-base, corrosion-control grease with other greases.

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Manual Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Manual Slack Adjuster	O-616-A	1	Clay Base	Down to –40°F (–40°C)
	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
	O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
Clevis Pins	Any of Above	Refer to Above	Refer to Above	Refer to Above
	O-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	—	Anti-Seize	

* Do not mix O-637 calcium-base, corrosion-control grease with other greases.

Cam Brake Grease Specifications

Components	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Retainer Clips Anchor Pins Roller (Journals Only) Camshaft Bushings When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers where they touch the brake shoes. Do not allow grease to come in contact with the part of the cam roller that touches the cam head.	O-616-A	1	Clay Base	Down to –40°F (–40°C)
	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
	O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
Camshaft Splines	Any of Above	Refer to Above	Refer to Above	Refer to Above
	O-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	—	Anti-Seize	

* Do not mix O-637 calcium-base, corrosion-control grease with other greases.

Air Disc Brake (1540, 1560, 1760) Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Caliper ①	O-616-A	1	Clay Base	Down to –40°F (–40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
Slide Pin Retainers	O-637 ②	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	—	Anti-Seize	
Powershaft Splines	Any of Above	Refer to Above	Refer to Above	Refer to Above

① The grease used inside the caliper must be non-melting and also allow proper brake function at the cold temperatures listed.

② Do not mix O-637 calcium-base, corrosion-control grease with other greases.

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Q Plus LX500 and MX500 Greasing Service Intervals and Specifications

On-Highway Linehaul Applications	3 years or 50,000 miles (80 000 km), whichever comes first
All Other Applications	One year, regardless of mileage

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Camshaft Splines and Clevis Pins	O-695	2	Synthetic Polyurea	–40°F (–40°C)
Anchor Pins When the brake is disassembled, or when necessary, lubricate the anchor pins where they touch the brake shoes.	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
	O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
Shoe Rollers When the brake is disassembled, or when necessary, lubricate the rollers where they touch the brake shoes. DO NOT get grease on the part of the roller that touches the cam head.	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Automatic Slack Adjusters	O-695	2	Synthetic Polyurea	–40°F (–40°C)

Approved Greases

Lubricant	Recommendation
O-616-A	Shell Darina Grease No. 1 Texaco Thermatex EP-1 Texaco Hytherm EP-1 Aralub 3837
O-617-A O-617-B	Multi-Purpose Lithium Chassis Grease
O-637*	Witco Chemical Corp. SA-824946
O-641	Never-Seez Anti-Seize
O-645	Mobilgrease 28 (Military) Mobiltemp SHC 32 (Industrial) Aerospace Lubricants Inc. Tribolube 12-Grade 1
O-692	Amoco Super Permalube #2 Citgo Premium Lithium EP-2 #2 Exxon Ronex MP-2 #2 Kendall L-427 Super Blu #2 Mobilith AW-1 #1 Sohio Factran EP-2 #2
O-695	EVO-LUBE TEK-615

* Do not mix O-637 calcium-base, corrosion-control grease with other greases.

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⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Refer to Section 1 for recommended oil drain conditions based on used axle oil analysis.

Magnets and Magnetic Drain Plugs

Planetary axles are equipped with magnetic drain plugs that have a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel. The drain plug must be checked for metal particles at every oil change interval.

Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The magnetic drain plug can be reused if, after cleaning, the plug has a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

Breather

⚠ *CAUTION*

Cover the breather when steam cleaning the housing. If the breather is not covered, water can enter the housing and contaminate the oil. Damage to components will result.

Breathers release pressure and vacuum condensation to help maximize oil and component life.

Seals

⚠ *CAUTION*

Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals.

Seals keep lubricant in and dirt out of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels that will damage components.

Temperature Indicators

⚠ *CAUTION*

Meritor axles can operate above 190°F (88°C) without damage. However, if the oil temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating to prevent damage to components.

Check and Adjust the Oil Level

For complete fill procedures for wet disc brakes, refer to Maintenance Manual 4L, *Wet Disc Brakes*.

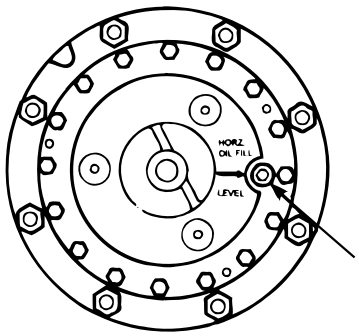
NOTE: Fill and drain plugs are located in the axle housing bowl and the wheel ends. Most axles have a common oil level. All steering axles and some rigid axles have separate oil levels in each wheel end and the axle housing bowl.

1. The vehicle must be on a level surface.
2. For an axle with a common oil level that has drain and fill plugs only in the axle assembly, proceed to Step 4.
3. Rotate the wheels so that the oil level lines on the wheel ends are parallel to the ground.
4. Clean the areas around the fill/level plugs. Remove the plugs from the wheel end and the axle housing bowl. **Figure 7.1**. The oil level must be even with the bottom of the fill/level plug.
   - **If oil flows from the hole when you loosen the plug:** The oil level is high. Drain the oil to the correct level.
   - **If the oil level is below the bottom of fill/level plug hole:** Add the specified oil according to one of the following procedures:
     A. **For axles with separate oil levels in the wheel ends and the axle housing bowl:** Fill each area with specified oil to the bottom of the fill plug holes.
     B. **For axles with a common oil level:** Fill the axle with specified oil at each wheel end and axle housing bowl to the bottom of the fill plug holes. Wait and allow the oil to flow through the axle. Check the oil level again and fill to the correct level, if necessary.

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5. Install and tighten the fill/level plugs to the correct torque specification.

Figure 7.1



Drain and Replace the Oil

NOTE: Fill and drain plugs are located in the axle housing bowl and the wheel ends. Most axles have a common oil level. All steering axles and some rigid axles have separate oil levels in each wheel end and the axle housing bowl.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. Make sure the vehicle is on a level surface. Put large containers under the axle and wheel ends.
2. Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
3. Rotate the wheels so that the "fill/level" plugs in the wheel ends are toward the ground.
4. Remove the drain plugs from the wheel ends. Drain the oil. Follow correct procedures to discard the oil. Clean the drain plug.
5. Install and tighten the drain plug in the axle housing bowl and the wheel ends to 35-50 lb-ft (48-67 N•m). T
6. Rotate the wheels so that the "oil level lines" on the wheel ends are parallel to the ground. Lower the vehicle.
7. Clean the area around the fill/level plug. Remove the fill/level plug from the wheel ends and the axle housing bowl.
8. Add the specified oil until the oil level is even with the bottom of the fill/level hole.
   - **For axles with separate oil levels in the wheel ends and the axle housing bowl:** Fill each area with specified oil to the bottom of the fill plug holes.
   - **For axles with a common oil level:** Fill the axle with specified oil at each wheel end and axle housing bowl to the bottom of the fill plug holes. Wait and allow the oil to flow through the axle. Check the oil level again and fill to the correct level, if necessary.
9. Install and tighten the fill/level plugs to the correct torque specification.

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MERITOR®

Planetary Drive Axle Oil Change Intervals and Specifications

Operation	On-Highway*	Off-Highway*
Initial Oil Change	2,500 miles (4000 km)	100 operating hours*
Check Oil Level	5,000 miles (8000 km)	250 operating hours*
Petroleum Oil Change	25,000 miles (40 000 km) or once a year (whichever comes first)	1,500 operating hours or twice a year (whichever comes first)*
Synthetic Oil or Semi-Synthetic Oil Change	Refer to Technical Publication TP-9303	3,000 operating hours or once a year (whichever comes first)

Meritor Specifications	Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A Gear Oil	MIL-PRF-2105-E and SAE J2360	GL-5, SAE 85W/140	10	None	–12	None
O-76D Gear Oil		GL-5, SAE 80W/90	–15	None	–26	None
O-76E Gear Oil		GL-5, SAE 75W/90	–40	None	–40	None
O-76L Gear Oil		GL-5, SAE 75W/140	–40	None	–40	None
O-76M Gear Oil		GL-5, SAE 75W/140	–40	None	–40	None
O-76N Gear Oil		GL-5, SAE 75W/140	–40	None	–40	None

* The interval depends on the individual operating conditions, speeds and loads. Severe operating conditions may require more frequent intervals.

Planetary Drive Axle Oil Capacities

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PR-53	33.0	15.6	3.0	1.4
PR-60	27.0	12.8	3.0	1.4
PR-100	22.0	10.4	3.5	1.6
PR-108	29.0	13.7	7.0	3.3
PR-111	27.0	12.8	4.6	2.2
PR-112	44.0	20.8	6.0	2.8
PR-145	32.0	15.1	5.0	2.4
PR-150	29.0	13.7	5.0	2.0
PR-151	30.0	14.2	8.0	3.8
PR-153	31.0	14.7	7.5	3.6
PR-200	40.0	18.9	6.0	2.8
PR-205	46.0	21.8	7.0	3.3
PR-207	45.0	21.3	6.0	2.8
PR-208	43.0	20.3	8.0	3.8
PR-209	56.0	26.4	5.0	2.4
PR-251	42.0	19.9	12.0	5.7

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PR-253	39.0	18.5	13.0	6.20
PR-256	44.0	20.8	18.0	8.50
PR-270	44.0	20.8	18.0	8.50
PR-350	28.0	13.2	14.0	16.60
PR-400	32.0	15.1	16.0	7.60
PR-500	56.0	26.5	28.0	13.20
PR-501	64.0	30.3	28.0	13.20
PR-502	62.0	29.3	31.0	14.70
PR-700	64.0	30.3	30.0	14.19
PRC-184	32.0	15.1	4.0	1.80
PRC-264	16.0	7.5	4.0	1.80
PRC-755	32.0	15.1	10.0	4.70
PRC-864	30.0	14.1	6.0	2.80
PRC-867	48.0	22.7	10.0	4.70
PRC-1925	32.0	15.1	16.0	7.57
PRC-3795	28.0	13.2	14.0	6.62

* Due to varied planetary drive axle specifications, these fill quantities are for reference only.

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Planetary Drive Axle Oil Capacities

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PRC-3796	48.0	22.7	28.0	13.20
PRC-3805	58.0	27.4	22.0	10.40
PRC-4805	60.0	28.3	31.0	14.60
PRC-5324	80.0	37.8	24.0	11.30
PRC-5334	80.0	37.8	24.0	11.30
PRC-7314	72.0	34.0	24.0	11.30
PRLC-344	44.0	20.8	6.0	2.84
PRLC-614	29.0	13.7	7.0	3.31
PRLC-675	56.0	26.5	5.0	2.37
PRLC-823	44.0	20.8	18.0	8.51
PRLC-1756	39.0	18.5	13.0	6.15
PRLC-1757	39.0	18.5	13.0	6.15
PRLC-1925	72.0	34.0	12.0	5.60
PRLM-855	28.0	13.2	8.0	3.70
PRM-672	29.0	13.7	5.0	2.37
PRM-673	29.0	13.7	5.0	2.37
PRM-676	46.0	21.8	7.0	3.31
PRM-677	46.0	21.8	7.0	3.31
PRM-1314	44.0	20.8	18.0	8.51
PRM-1315	44.0	20.8	18.0	8.51
PRM-1615	44.0	20.8	18.0	8.51
PRM-1756	43.0	20.3	13.0	6.15
PRM-1757	43.0	20.3	13.0	6.15
PRTA-134	14.0	6.6	4.0	1.80
PRTC-203	19.0	8.9	6.0	2.80
PRS-16	27.0	12.8	3.0	1.42
PS-100	20.0	9.5	3.5	1.66
PS-150	22.0	10.4	5.0	2.37
PS-200	38.0	18.0	6.0	2.84
PS-260	44.0	20.8	8.0	3.25
PS-270	44.0	20.8	8.0	3.78
PS-310	36.0	17.0	14.0	6.62
PS-500	58.0	27.4	29.0	13.72
PSC-204	29.0	13.7	6.0	2.80
PSC-593	28.0	13.0	4.0	1.89
PSC-594	28.0	13.2	4.0	1.89
PSC-1615	40.0	18.9	8.0	3.78
PSC-1617	40.0	18.9	8.0	3.78

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PSC-1875	56.0	26.4	20.0	9.40
PSC-4564	58.0	27.4	29.0	13.72
PSM-826	42.0	19.9	6.0	2.80
PSM-1044	44.0	20.8	6.0	2.80
PSM-1045	44.0	20.8	6.0	2.80
PSM-1614	44.0	20.8	8.0	3.70
PSTM-824	28.0	13.2	6.0	2.80
EPRC-1356				
Forward	32.0	15.1	14.0	6.60
Middle	32.0	15.1	14.0	6.60
Rear	32.0	15.1	14.0	6.60
SPRC-1356				
85" Track	32.0	15.1	14.0	6.60
90" Track	33.5	15.9	14.0	6.60
100" Track	36.0	17.0	14.0	6.60
SPRC-1357				
Forward	36.0	17.0	14.0	6.60
Rear	36.0	17.0	14.0	6.60
SPRC-1357				
85" Track	32.0	15.1	14.0	6.60
90" Track	33.5	15.9	14.0	6.60
100" Track	36.0	17.0	14.0	6.60
SPRC-1735				
85" Track	32.0	15.1	15.0	7.10
90" Track	33.5	15.9	15.0	7.10
100" Track	36.0	17.0	15.0	7.10
SPRC-1736				
Forward	36.0	17.0	15.0	7.10
Rear	36.0	17.0	15.0	7.10
SPRC-1736				
85" Track	32.0	15.1	15.0	7.10
90" Track	33.5	15.9	15.0	7.10
100" Track	36.0	17.0	15.0	7.10
SPRC-1926	32.0	15.1	16.0	7.60
SPRC-4806	64.0-72.0	31.0-34.0	32.0	15.10

* Due to varied planetary drive axle specifications, these fill quantities are for reference only.

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⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ *CAUTION*

You must fill Meritor axles with Meritor-specified lubricants only. Do not fill an axle with non-approved lubricants, which will void Meritor's warranty. Damage to axle components also can result.

To avoid axle component damage, fill Meritor axles with approved lubricants only. Using non-approved lubricants also will void Meritor's warranty.

NOTE: For information on lubricant suppliers, call ArvinMeritor's Customer Service Center at 800-535-5560 and order technical bulletin TP-9539. This bulletin is also available from the Technical Library section on ArvinMeritor's web site at www.arvinmeritor.com. Click Products & Services/ Tech Library Icon/HVS Publications/Technical Bulletins/Axles.

NOTE: Refer to Section 12 for information on wheel bearings and wheel-ends.

Magnets and Magnetic Drain Plugs

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

Although Meritor axles are normally equipped with magnetic plugs having a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel, Meritor Advanced Lube axles have stronger magnetic "cleansing" features.

These axles are equipped with strong five-pound (2.2 kilograms) pull magnets, and high grade magnetic fill and drain plugs that collect damaging particles at the bottom of the axle housing.

Tandem axles have four magnets in each housing and high grade magnetic fill and drain plugs. Single axles have six magnets in each housing and high grade magnetic drain and fill plugs.

Check the drain plug for metal particles every 100,000 miles (160 000 kilometers). You can reuse a magnetic drain plug if the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel after cleaning.

Breather

⚠ *CAUTION*

Cover the breather when steam cleaning the housing. If the breather is not covered, water enters the housing and contaminates the oil. Damage to components can result.

Baffle-type breathers release pressure and vacuum condensation to minimize premature oil and component failure.

Seals

⚠ *CAUTION*

Always use the correct tools and procedures when replacing seals to prevent incorrect installation, leaking seals and damage to components.

Seals keep lubricant in and dirt out of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels.

Durable triple-lip pinion seals, standard in Meritor axles, protect the quality and levels of the lubricant and provide superior performance.

Meritor Advanced Lube axles have triple-lip seals designed to work with current and future lubricants.

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Temperature Indicators

⚠ CAUTION

Meritor axles can operate above 190°F (88°C) without damage. However, if oil the temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating. Damage to components can result.

Some Meritor axles may have a tapped hole in the housing to install a temperature indicator. A temperature indicator monitors oil temperature and helps to maximize component life, which can be shortened by high oil temperatures that result from severe operating conditions, or unequally inflated and mismatched tires.

Advanced Lube Axles

Advanced Lube axles require different drain intervals than other axles. Refer to the Oil Change Intervals and Axle Oil Specifications tables in this section.

The vehicle manufacturer may attach a tag at the axle fill hole or on the inside of the door to identify an Advanced Lube axle. The tag specifies that the axle is filled with semi-synthetic or full-synthetic gear oil.

For Meritor R-170 Axles Equipped With Traction Equalizer®

Meritor's R-170 axles with Traction Equalizer normally operate with either standard petroleum, semi-synthetic or full-synthetic oils.

When to Use Limited Slip Friction Modifiers

Occasionally the Traction Equalizer will "slip" or "stick." When this happens, you will hear intervals of shrill noises when the vehicle operates at low speed or when the vehicle makes sharp turns. You can correct this condition by adding limited slip friction modifiers.

NOTE: Limited slip friction modifiers usually deteriorate more quickly than extreme pressure (EP) additives. Shorten the lubricant change schedule if you add a friction modifier.

- **At the initial lubricant change interval for an R-170 equipped with Traction Equalizer:** Replace the factory-installed lubricant with an approved lubricant and one of the additives specified in the table below.
- **After the initial change interval:** Change the lubricant and the additive at or before 50,000 miles (80 000 km).

Specifications

For all GL-5 oils (petroleum oil or synthetic), add one of the following limited slip friction modifiers specified in the table below.

Manufacturer	Specification
DSL-178	Guardsman Products
Equa-Torque #2411 and #2414	Sta-Lube Corporation
Lubrizol # 6178	Lubrizol Corporation

Quantities for R-170 Axles With and Without Traction Equalizer

WITH Traction Equalizer	WITHOUT Traction Equalizer
40 pints oil (18.9 liters) + 3 Pints additive (1.4 liters)	43 pints oil (20.3 liters)

Oil Level

Fill Plug Locations

1. If the fill plug is only in the axle-housing bowl, use that fill plug. Do not use the temperature sending unit hole. **Figure 8.1**.
2. If the drive pin angle is seven degrees or less, use the fill plug in the differential carrier. **Figures 8.2 and 8.7**.
3. If the drive pin angle is more than seven degrees, use the fill plug in the axle-housing bowl. **Figures 8.4 through 8.8**.

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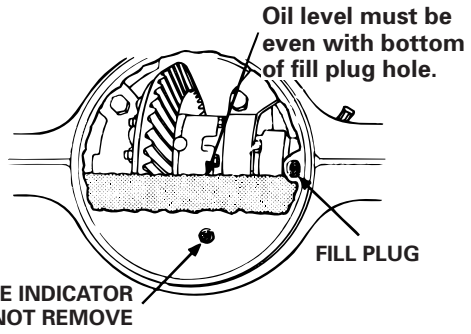
Check and Adjust the Oil

WARNING

Check the oil level when the axle is at room temperature. When hot, the oil temperature may be 190°F (88°C) or more and can cause burns. Also, a correct level is not obtained when the axle is warm or hot. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. The axle must be cold or near room temperature.
2. Clean the area around the fill plug. Remove the fill plug from the differential carrier or the axle-housing bowl (depending on the axle). Do not remove the temperature indicator plug. **Figures 8.2 through 8.8**.
3. Check the oil level. The level must be even with the bottom of the fill plug hole. **Figure 8.1**.
4. Install the fill plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T

Figure 8.1



Drain and Replace the Oil

NOTE: Drain the oil when it is warm. Remove and replace the oil filters each time you drain the oil.

1. Refer to Fill Plug Locations in this section.
2. Park the vehicle on a level surface. Put a large container under the axle.
3. Install the drain plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T
   - If an oil pump is used: Remove and replace the oil filters.
   - For Advanced Lube axles: Replace the oil filter every 100,000 miles (160 000 km).
4. Clean the area around the fill plug. Remove the fill plug from the differential carrier of the axle-housing bowl (depending on the axle). Do not remove the temperature indicator plug.
5. Add the specified oil until the oil is even with the bottom of the fill plug hole. Wait to allow the oil to flow through the axle.
   - **If the inter-axle differential has a top fill plug hole**: Add an additional two pints (0.946 liters) of the same oil into the inter-axle differential housing.
6. Check oil level again. If necessary, continue to add oil until it is even with the bottom of the fill plug hole.
7. Install the fill plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T

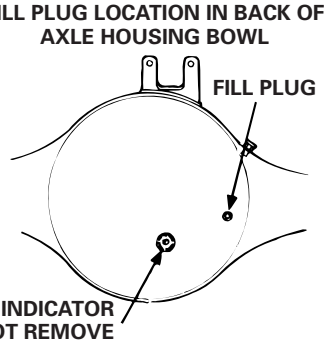
Inter-Axle Assemblies With Separate Housings

Meritor's SLHD, SQHD, STDD and SFDD forward-rear tandem axle carrier models include separate housings for inter-axle differential assemblies.

The baffles and dams used in these housings hold a reservoir of oil that can also trap wear particles and debris. Always purge the oil from these reservoirs when you change axle oil.

These carriers have separate drain and fill holes in either the inter-axle differential cover or housing.

Figure 8.2



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Figure 8.3

FRONT MOUNTED SINGLE REDUCTION AXLES

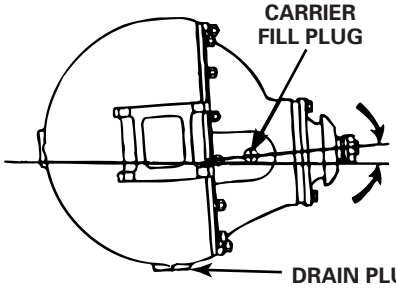


Figure 8.4

FRONT MOUNTED SINGLE REDUCTION AXLES

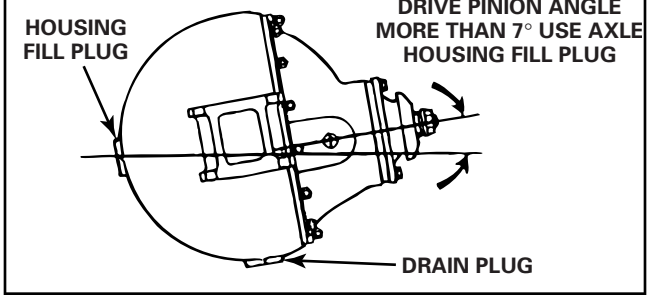


Figure 8.5

FRONT MOUNTED SINGLE REDUCTION TANDEM AXLES

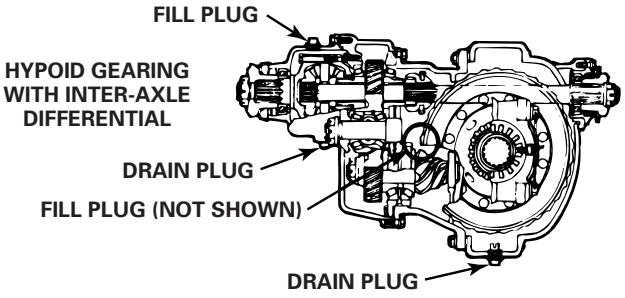


Figure 8.6

FRONT MOUNTED SINGLE
REDUCTION TANDEM AXLES

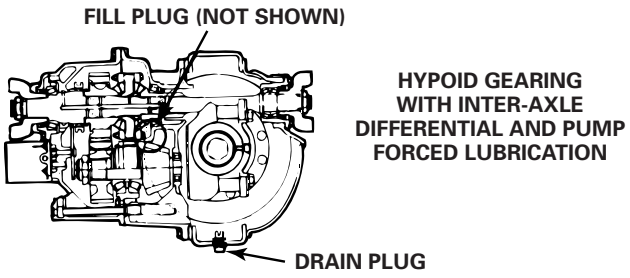


Figure 8.7

FRONT MOUNTED DOUBLE
REDUCTION AND TWO-SPEED AXLES

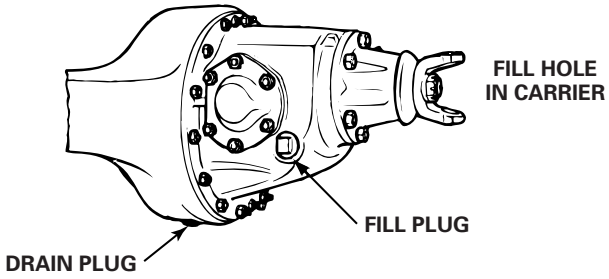
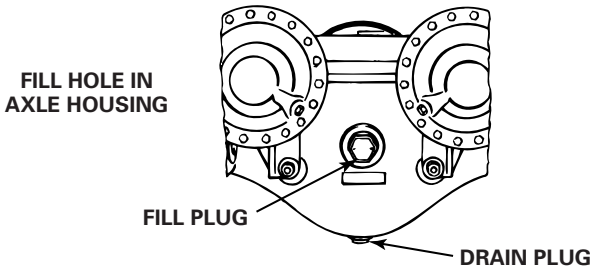


Figure 8.8

FRONT MOUNTED DOUBLE
REDUCTION AND TWO-SPEED AXLES



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Oil Change Intervals and Specifications for All Rear Drive Axles①

Vocation or Vehicle Operation	Linehaul Motorhome Intercity Coach	City Delivery School Bus Fire Truck	Construction Transit Bus Refuse Yard Tractor Logging Heavy Haul Mining Oil Field Rescue
Initial Oil Change	No longer required as of January 1, 1993		
Check Oil Level	Every 25,000 miles (40 000 km), or the fleet maintenance interval (whichever comes first)	Every 10,000 miles (16 000 km), once a month, or the fleet maintenance interval (whichever comes first)	Every 5,000 miles (8000 km), once a month, or the fleet maintenance interval (whichever comes first) ②
Petroleum Based Oil Change on Axle with or without Pump and Filter System	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first	Every 25,000 miles (40 000 km) or annually, whichever comes first
Synthetic Oil Change on Axle without Pump and Filter System ③	Every 250,000 miles (400 000 km) or annually, whichever comes first	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first
Synthetic Oil Change on Axle with Pump and Filter System ③	Every 500,000 miles (800 000 km)	Every 250,000 miles (400 000 km)	Every 100,000 miles (160 000 km)
Filter Change on Axle with Pump and Filter System	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)

① If a No-Spin differential is installed, change the oil (petroleum or synthetic) at minimum interval or 40,000 miles (64 000 km) or a maximum interval or 50,000 miles (80 000 km).

② For continuous heavy-duty operation, check the oil level every 1,000 miles (1600 km). Add the correct type and amount of oil as required.

③ This interval applies to approved semi-synthetic and fully synthetic oils only. For list of approved extended-drain axle oils, refer to TP-9539, *Approved Rear Drive Axle Lubricants*. To order this publication, call ArvinMeritor's Customer Service Center at 800-535-5560.

Axle Oil Specifications

	Gear Oil Type	A.P.I. Specification	SAE Grade	Meritor Specification	Military/SAE Specification	Outside Temperature
Non-Extended Drain Lubricants	Petroleum with EP Additives	GL-5	85W/140	O-76A	MIL-PRF-2105E and SAE J2360	Above +10°F (–12°C)
	Petroleum with EP Additives		80W/90	O-76D		Above –15°F (–26°C)
	Petroleum with EP Additives		75W/90	O-76E		Above –40°F (–40°C)
	Petroleum with EP Additives		75W	O-76J		From –40°F (–40°C) to 35°F (2°C)
	Petroleum with EP Additives		75W/140	O-76L		Above –40°F (–40°C)
Extended Drain Lubricants	Petroleum with Extended Drain Additives	GL-5	80W/90	—	MIL-PRF-2105E and SAE J2360	Above –15°F (–26°C)
	Semi-Synthetic		80W/90	—		Above –15°F (–26°C)
	Full Synthetic		75W/140	O-76M		Above –40°F (–40°C)
	Full Synthetic		75W/90	O-76N		Above –40°F (–40°C)

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Single Rear Drive Axle Oil Capacities*

	Oil Capacity*	
Axle Model	**Pints**	**Liters**
A-150	5.5	2.6
B-100	10.0	4.7
B-140	12.0	5.7
B-150	3.5	1.7
C-100	12.5	5.9
D-100	12.5	5.9
D-140	12.5	5.9
E-100	15.0	7.1
E-105	12.5	5.9
E-150	9.0	4.3
F-100	13.0	6.2
F-106	13.0	6.2
F-120	15.0	7.1
F-121	15.0	7.1
F-140	14.0	6.6
G-161	21.0	9.9
H-100	20.0	9.5
H-140	21.0	9.9
H-150	11.0	5.2
H-162	20.0	9.5
H-170	27.0	12.8
H-172	27.0	12.8
L-100	23.0	10.9
L-140	24.0	11.4
L-155	24.0	11.4
L-172	27.0	12.8
M-172	27.0	12.8
Q-100	31.0	14.7
Q-145	24.0	11.4
QT-140	24.0	11.4
R-100	30.0	14.2
R-140	28.0	13.3
R-155	28.0	13.3

	Oil Capacity*	
Axle Model	**Pints**	**Liters**
R-160	28.0	13.3
R-163	34.0	16.1
R-170	43.0	20.3
R-270	55.0	26.0
RL-170	48.0	22.7
RC-22-145	32.3	15.3
RC-23-160	41.0	19.4
RC-25-160	39.5	18.7
RS-13-120	18.4	8.7
RS-15-120	18.4	8.7
RS-15-210	14.3	6.8
RS-17-140	28.6	13.5
RS-17-145	33.6	15.9
RS-17-220	30.7	14.5
RS-19-145	33.2	15.7
RS-21-145	32.3	15.3
RS-21-230	38.9	18.4
RS-23-160	39.5	18.7
RS-23-161	37.2	17.6
RS-23-180	47.3	22.4
RS-23-186	47.3	22.4
RS-23-240	37.4	17.7
RS-23-380	63.6	30.1
RS-26-160	47.5	22.5
RS-26-180	46.6	22.0
RS-26-380	58.2	27.5
RS-30-180	46.6	22.0
RS-30-380	58.2	27.5
RS-38-380	53.1	25.1
S-170	43.0	20.3
U-140	24.0	11.4
U-170	43.0	20.3
U-270	55.0	26.0

	Oil Capacity*	
Axle Model	**Pints**	**Liters**
W-170	43.0	20.3
W-270	55.0	26.0
59722	30.5	14.4
59723	30.5	14.4
59732	30.5	14.4
59733	30.5	14.4
59843	30.5	14.4
61142	42.0	19.8
61143	41.0	19.3

* Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel ends. These oil capacities will change if the track or the drive pinion angle is different.

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Tandem Rear Drive Axle Oil Capacities

Axle Model	Carrier	Oil Capacity ①	
		Pints	Liters
RT-34-140	Forward Rear	26.0 35.0	12.3 16.6
RT-34-145	Forward Rear	29.6 25.4	14.0 12.0
RT-34-145P	Forward Rear	25.7 23.4	12.1 11.1
RT-40-140	Forward Rear	30.2 22.8	14.3 10.8
RT-40-145	Forward Rear	30.2 25.8	14.3 12.2
RT-40-160	Forward Rear	39.1 39.4	18.5 16.3
RT-44-145	Forward Rear	29.3 25.1	13.9 11.9
RT-44-145P	Forward Rear	25.2 22.9	12.0 11.0
RT-46-160	Forward Rear	39.1 34.4	18.5 16.3
RT-46-160P	Forward Rear	39.3 34.7	18.6 16.4
RT-46-164	Forward Rear	39.1 39.4	18.5 16.3
RT-48-180 ②	Forward Rear	61.1 36.8	28.9 17.4
RT-48-380 ②	Forward Rear	61.1 63.6	28.9 30.1
RT-52-160	Forward Rear	44.1 41.2	20.9 19.5
RT-52-160P	Forward Rear	44.1 41.2	20.9 19.5
RT-52-180 ②	Forward Rear	56.1 36.1	26.5 17.1
RT-52-185	Forward Rear	56.1 36.1	26.5 17.1
RT-52-380 ②	Forward Rear	56.1 58.2	26.5 27.5
RT-58-180 ②	Forward Rear	56.1 36.1	26.5 17.1
RT-58-185	Forward Rear	56.1 36.1	26.5 17.1
RT-58-380 ②	Forward Rear	56.1 58.2	26.5 27.5
RT-70-380 ②	Forward Rear	54.4 53.1	25.7 25.1
SFHD	Forward Rear	17.0 16.5	8.0 7.8
SL-100	Forward Rear	39.6 37.7	18.7 17.8
SLHD	Forward Rear	32.5 32.0	15.3 15.1
SQ-100	Forward Rear	39.6 37.7	18.7 17.8
SQ-100A	Forward Rear	39.3 37.6	18.6 17.8
SQHD	Forward Rear	34.0 31.0	16.0 14.7
SR-170	Forward Rear	55.0 43.0	26.0 20.3
SRHD	Forward Rear	39.0 36.0	18.5 17.0
SSHD	Forward Rear	34.0 28.0	16.0 13.2
ST-170	Forward Rear	55.0 43.0	26.0 20.3
STHD	Forward Rear	34.0 28.0	16.0 13.2
SU-170	Forward Rear	55.0 43.0	26.0 20.3
SUHD	Forward Rear	34.0 28.0	16.0 13.2
SW-170	Forward Rear	55.0 43.0	26.0 20.3

① Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel ends. These oil capacities will change if the track or the drive pinion angle is different.

② Forward carrier with oil pump system.

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⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

TB Series Trailer Axles With Unitized Hub Assemblies

⚠ *CAUTION*

Meritor TB Series trailer axles with unitized hub assemblies use conventional brakes and automatic slack adjusters, as well as conventional tire-wheel assemblies. Service these components as you would under normal operation conditions to avoid damage to components.

A unitized hub is permanently sealed and lubricated as an assembly. Do not attempt to remove the hub bearings, seals and lubricant. You cannot service or reinstall these components into a unitized hub assembly. Damage to components can result.

NOTE: Removal of the long-life bearings, seals and lubricant from the hub assembly will void the warranty.

Meritor's TB series trailer axle features a permanently sealed and lubricated unitized hub assembly designed to help reduce wheel-end maintenance.

The unitized hub is designed to remain in place on the axle for a minimum of five years or 500,000 miles (800 000 km).

For TB series unitized hub service procedures, refer to technical bulletin TP-96175, *Servicing Meritor's TB Series Trailer Axles with Unitized Hub Assemblies*. Call ArvinMeritor's Customer Service Center at 800-535-5560.

Comparing a Unitized Wheel-End to a Conventional Wheel-End

On a unitized wheel-end, you install the hub, seal, lubricant and bearings onto the axle spindle as an assembly. **Figure 9.1**.

On a conventional wheel-end, you install the hub, seal, lubricant and bearings onto the axle spindle as separate components. **Figure 9.2**.

Figure 9.1

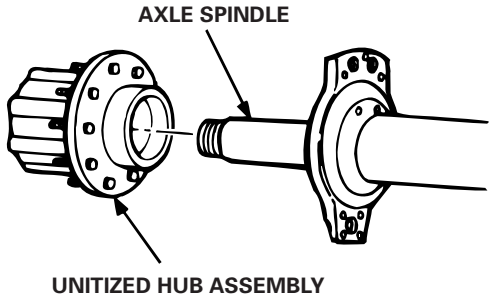
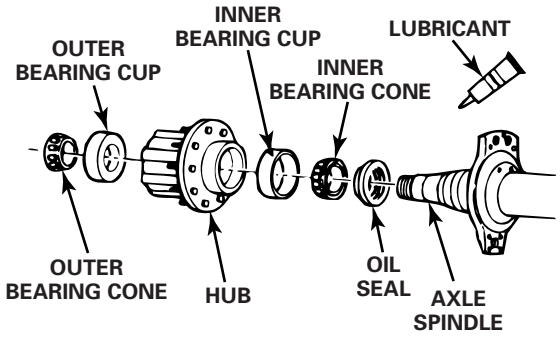


Figure 9.2



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Identifying a Trailer Axle With Unitized Wheel-Ends

- The model number designation for the TB series is prefixed with TB; for example, TB-4670 or TB-8670.
- The axle spindles are shorter with a single journal.
- The hubs contain non-serviceable bearings, seals and lubricant.
- The hubcaps screw onto the axle spindle and have no provisions for adding lubricant.
- The axle spindle retention hardware features a thicker inner nut and a bendable tab lockwasher.
- Warranty information is stamped on each unitized hub:

Important:

Removal of long-life bearings, seals or lubricant from the Meritor TB series trailer axle hub will void the warranty. Refer to Technical Bulletin TP-96175 or call 800-535-5560 for information.

MERITOR® TP-9700

Wheel Bearings and Wheel-Ends

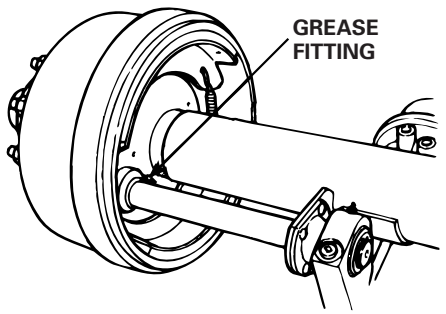
Refer to Section 12 for oil and grease lubrication information.

Camshaft Bushings

Conventional and TB Series

Apply the specified grease at the grease fitting on the spider. Apply grease until new grease purges from all the seals. **Figure 9.3**.

Figure 9.3



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Conventional and TB Series Camshaft Bushing Greasing Intervals and Specifications

Greasing Interval*	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Use the schedule below that gives the most frequent lubrication: • The lubrication schedule of the fleet. • The lubrication schedule of the vehicle manufacturer. • A minimum of four times during the life of the brake linings.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.

* Applies to standard-duty on-highway service. Lubricate more frequently for heavy-duty applications. Determine intervals by inspecting lubricant every two weeks for a four month period. Look for hard, contaminated or missing grease. Choose an interval based on the inspection.

Conventional Trailer Axle Wheel-End Oil Change Intervals and Specifications

Check Oil Level	Oil Change *	Meritor Specification	Specification Approval	Oil Description	Outside Temperature			
					°F		°C	
					Min.	Max.	Min.	Max.
1,000 miles (1600 km)	**General Service:** Change oil if the wheel-end is disturbed during wheel or hub removal or if the oil is contaminated. **Standard-Duty Service:** For 100,000 miles (160 000 km) or more a year, change the oil every 100,000 miles (160 000 km). For less than 100,000 miles (160 000 km) a year, change the oil once a year. **Heavy-Duty Service:** For 60,000 miles (96 000 km) or more a year, change oil every 30,000 miles (48 000 km). For less than 60,000 miles (96 000 km) a year, change the oil every 6 months.	O-76A Gear Oil	MIL-PRF-2105-E and SAE J2360	GL-5 SAE 85W/140	10	None	–12	None
		O-76D Gear Oil		GL-5 SAE 80W/90	–15	None	–26	None
		O-76E Gear Oil		GL-5 SAE 75W/90	–40	None	–40	None
		O-76J Gear Oil		GL-5 SAE 75W	–40	35	–40	2
		O-76L Gear Oil		GL-5 SAE 75W/140	–40	None	–40	None
		O-76M Full Synthetic Gear Oil		GL-5 SAE 75W/140	–40	None	–40	None
		O-76N Full Synthetic Gear Oil		GL-5 SAE 75W/90	–40	None	–40	None
		O-81 Full Synthetic Oil		SAE 50	–40	None	–40	None

* The recommended oil change interval is based on operating conditions, speeds and loads. Limited service applications may allow the recommended interval to be increased. Severe service applications may require the recommended interval to be reduced. For more information, contact ArvinMeritor's Customer Service Center at 800-535-5560.

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Conventional Trailer Axle Greasing Intervals and Specifications

Greasing Interval *	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
General Service: Grease the bearings if the wheel-end is disturbed during wheel or hub removal or if the grease is contaminated. **Standard-Duty Service:** For 100,000 miles (160 000 km) or more a year, grease the bearings every 100,000 miles (160 000 km). For less than 100,000 miles (160 000 km) a year, grease the bearings once a year. **Heavy-Duty Service:** For 60,000 miles (96 000 km) or more a year, grease the bearings every 30,000 miles (48 000 km). For less than 60,000 miles (96 000 km) a year, grease the bearings every 6 months.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	Trailer Axle Bearing	O-647	00	Lithium Complex	

* The recommended greasing interval is based on operating conditions, speeds and loads. Limited service applications may allow the recommended interval to be increased. Severe service applications may require the recommended interval to be reduced. For more information, contact an ArvinMeritor service representative.

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⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Operating Information

Magnets and Magnetic Drain Plugs

Most Meritor transfer cases are equipped with magnetic plugs having a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The magnetic drain plug can be reused if, after cleaning, the plug has a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

Breather

⚠ *CAUTION*

Cover the breather when steam cleaning the housing. If the breather is not covered, water enters the housing and contaminates the oil.

Breathers release pressure that builds up inside the transfer case during vehicle operation.

Seals

⚠ *CAUTION*

Always use the correct tools and procedures when you replace a seal to ensure that you correctly install the seal. A seal that is not correctly installed can leak. Damage to components can result.

Seals keep lubricant in and dirt out of a component. When they are worn or damaged, seals leak and produce low lubricant levels which may damage components.

Temperature Indicator

⚠ *CAUTION*

Meritor transfer cases may operate above 190°F (88°C) without damage. However, if the oil temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating. Maximum continuous running oil temperature should not exceed 225°F (107°C). Damage to components can result.

Check and Adjust Oil Level

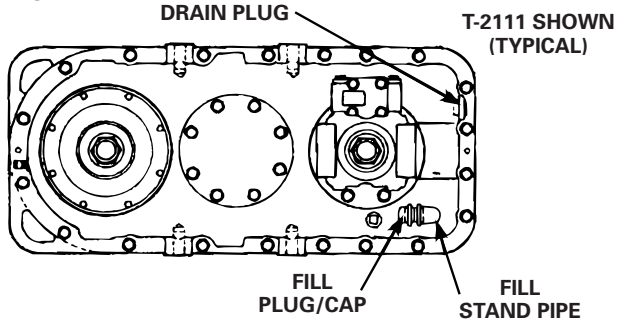
⚠ *CAUTION*

Use only SAE Grade 50W full synthetic oil, Meritor specification O-81, in the transfer case. Petroleum base oils and synthetic base oils can react against sealing materials. Damage to components can result.

Only use new lubricant when you change or adjust the oil in the transfer case. Do not reuse lubricant, which can contain metallic particles and other contaminants. Damage to components can result.

1. Park the vehicle on a level surface.
2. Clean the area around the fill plug/fill cap. Remove the fill plug/fill cap from the transfer case. **Figure 10.1**. The oil level must be even with the bottom of the fill plug hole or the top of the stand pipe.
   - **If oil flows from the hole when you loosen the plug:** The oil level is high. Drain the oil to the bottom of the fill hole.
   - **If the oil level is below the bottom of fill/level plug hole or stand pipe:** Add the specified oil until oil is even with the bottom of the fill hole.
3. Install and tighten the fill plug to 35-50 lb-ft (47-68 N•m). T

Figure 10.1



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Drain and Replace the Oil

1. Park the vehicle on a level surface. Put a large container under the transfer case.
2. Remove the drain plug from the bottom of the transfer case. Drain and discard the oil correctly. Clean the plug. **Figure 10.1**.
3. Install and tighten the drain plug to 35-50 lb-ft (47-68 N•m). T
4. Clean the area around the fill plug. Remove the fill plug from the transfer case.
5. Add the specified oil until the oil level is even with the bottom of the fill plug hole.
6. Install and tighten the fill plug to 35-50 lb-ft (47-68 N•m). T
7. Run the vehicle for 1/4 mile (0.4 km), then top off the oil level by adding oil to the fill opening.
8. Reinstall and tighten the fill plug to 35-50 lb-ft (47-68 N•m). T

Transfer Case Oil Change Intervals

Operation	On-Highway	Off-Highway
Check Oil Level	2,000 miles (3200 km)	40 operating hours
Initial Oil Change	2,500 miles (4000 km)	40-100 operating hours
Scheduled Oil Change	12,000-25,000 miles (19 000-40 000 km)	200-300 operating hours

Transfer Case Oil Specifications①④⑤

Oil Description	Meritor Specification	A.P.I. Specification	Military Specification	SAE Grade	Outside Temperature
Petroleum GL-1 Oil with Rust and Oxidation Inhibitor ②	—	A.P.I. GL-1	—	90W 80W	Above 10°F (–12°C) Above –15°F (–26°C)
Heavy Duty Engine Oil ②		A.P.I.-CD, CE, SF or SG ⑥		50W 40W 30W	Above 10°F (–12°C) Above 10°F (–12°C) Above –12°F (–26°C)
Full Synthetic Oil ③	O81	—	—	50W	Above –40°F (–40°C)
A.P.I. GL-5 (Axle Lube) ①	DO NOT USE IN TRANSFER CASES				

① Do Not use multi-viscosity (I.E. 80/90W) GL-5 Gear Oil (axle lube).

② 90W GL-1 or 50W motor oil is same viscosity and commonly used above 10°F (–12°C).

③ Meritor approved full synthetic oil for manual ZF Meritor transmissions is also approved for Meritor transfer cases. Use synthetic oil only if the transfer case was initially filled with synthetic oil.

④ Do not mix or switch oil types. Use the same oil that initially filled the transfer case.

⑤ Do not use multi-viscosity oils.

⑥ Current designations are acceptable.

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Transfer Case Oil Capacities

Transfer Case Model	Oil Capacity	
	Pints*	Liters*
T-32	2.0	0.95
T-136	14.0	6.62
T-215	3.0	1.42
T-221	4.0	1.89
T-223	5.0	2.37
T-226	6.5	3.07
T-228	21.0	9.93
T-232	6.2	2.93
T-1138	13.5	6.38
T-2111	3.0	1.42
T-2111-HD	5.0	2.37
T-2111-HT	5.0	2.37
T-2111-PD	10.0	4.73
T-2111-SD	5.0	2.37
T-2120	4.0	1.89
T-2120-RS	6.5	3.10
T-600	6.2	2.93

* Due to the varied transfer case configurations, these fill quantities are for reference only. The fill procedure for all transfer cases is as follows:

1. Fill to the top of the stand pipe or fill hole.
2. Run the vehicle for 1/4 mile (0.4 km).
3. Top off the oil level.
4. Check that the sump temperature does not exceed 225°F (107°C).

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE: For a list of synthetic oil suppliers, call ArvinMeritor's Customer Service Center at 800-535-5560 and order TP-2053. This bulletin is also available from the Technical Library section on ArvinMeritor's web site at arvinmeritor.com. Click Products & Services/Tech Library Icon/HVS Publications/Technical Bulletins/Transmissions.

Recommended Oil Drain Conditions Based on Used-Oil Analysis

Manual Transmission Oils

If used transmission oil analyses indicate that any one of these criteria is not met, drain the used oil and replace it with an oil that is recommended for manual transmissions.

Used-Oil Analyses (ppm = parts per million)

Iron (Fe)	If level is greater than 500 ppm, drain and replace the oil.
Silicon (Si)	If level is greater than 100 ppm, drain and replace the oil.
Water (H_2O)	If level is greater than 0.3%, drain and replace the oil.

Magnets and Magnetic Drain Plugs

All ZF Meritor transmissions have four magnets in the bottom of the main case. The magnets and magnetic plugs have a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

NOTE: ZF Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The magnetic drain plug can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

Transmission Oil Coolers

Required

- An engine has a rating of 399 HP or above.
- The transmission operating temperature is always above 225°F (107°C) at continuous operation or reaches 275°F (135°C) during intermittent operation.

Recommended

- An engine has a rating of 350 to 398 HP.
- Some aerodynamic vehicles that have engine ratings below 399 HP because of the amount of air that flows over the transmission to dissipate heat.

Temperature Indicator

The temperature indicator is optional on ZF Meritor transmissions. The temperature sending unit is on the bottom right side of the main case. The normal operating temperature range is less than 225°F (107°C).

Use the temperature indicator gauge to check transmission operation. For example:

- If the temperature suddenly rises to 275°F (135°C) or more, check the transmission for the cause of the increase.
- When operating a vehicle on a mountain grade, if the temperature increases 50-75°F but returns to the normal operating temperature, this indicates a normal operating condition. If the temperature does not return to the normal range, check the transmission.

Oil Level

Before You Check the Oil Level

1. The oil must be at room temperature.
2. The vehicle must be parked for at least 10 minutes.

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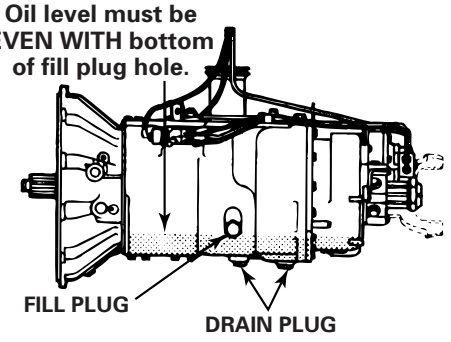
Check and Adjust the Oil Level

1. Park the vehicle on a level surface.

NOTE: If foam appears when you remove the fill plug, the oil is too hot to check. Install the oil plug and allow the oil to cool. If oil flows from the fill plug hole when you remove the plug, the oil level is too high. Drain the oil to the correct level.

2. Clean the area by the fill plug. Remove the fill plug from the side of the transmission.
3. Check for oil leaks. If a transmission oil leak is evident, refer to the Troubleshooting section of Maintenance Manual 26A, *9-, 10- and 13-Speed Transmissions*, for procedures. To order a copy of this manual, call ArvinMeritor's Customer Service Center at 800-535-5560.
4. Check the transmission oil level. Verify that it is EVEN WITH the bottom of the fill plug. If the oil level is BELOW the bottom of the oil fill plug, add the specified oil. **Figure 11.1**.

Figure 11.1



5. Install the oil fill plug and tighten it to 35-50 lb-ft (48-67 N•m). T
6. Operate the vehicle for 5 minutes. Check for transmission oil leaks and correct operation.

Drain and Replace the Oil

NOTE: Drain the oil when the transmission is hot.

1. Park the vehicle on a level surface. Place a large container under the transmission. Place a screen on top of the container.
2. Remove the drain plugs from the bottom of the transmission. Drain the oil. Follow United States Environmental Protection Agency (EPA) guidelines to recycle used oil.
3. Inspect the screen on top of the container for metal particles and damaged parts.

Service the Transmission if Necessary

1. If the transmission is disassembled or replaced and a transmission oil cooler is used, remove the cooler.
2. Remove the oil from the oil cooler and the oil lines. Follow United States Environmental Protection Agency (EPA) guidelines to recycle used oil.
3. Install the oil cooler and the oil lines. Tighten the fittings to the vehicle manufacturer's specifications.
4. Install the drain plug and tighten it to 35-50 lb-ft (48-67 N•m). T
5. Clean the air by the fill plug. Remove the fill plug from the side of the transmission.

CAUTION

Only use the specified oil. Do not use multi-viscosity engine oils or Extreme Pressure (EP) GL-5 gear oils. Damage to components can result. The use of multi-viscosity or EP oils will void ZF Meritor's warranty.

6. Add the specified transmission oil through the fill plug hole. Add the oil until the oil level is EVEN WITH the bottom of the fill plug hole.
7. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T
8. Operate the vehicle for 5 minutes. Check for correct operation.

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Oil Change Intervals

Manual Transmissions
Engine Synchro Shift™ (ESS™)
SureShift™

Check Oil Level	Approved Petroleum Lubricant Oil Change	Approved Synthetic Oil Change
10,000 miles (16 000 km)	50,000 miles (80 000 km)	500,000 miles (800 000 km) ①

Oil Change Specifications

Manual Transmissions②
Engine Synchro Shift™ (ESS™)
SureShift™

Oil Description	Meritor Specification	A.P.I. Specification	Military Specification Approval	SAE Grade	Outside Temperature
Heavy-Duty Engine Oil	—	A.P.I. -CD, -CE, -SG, -SH or SJ ③	MIL-L-2104 E or F ③	50	Above 10°F (–12°C)
				40	Above 10°F (–12°C)
				30	Above –15°F (–26°C)
Petroleum GL-1 Oil with Rust and Oxidation Inhibitor	—	A.P.I. - GL-1	—	90	Above 10°F (–12°C)
				80	Above –15°F (–26°C)
Full-Synthetic Oil	O-81	—	—	50	Above –40°F (–40°C)

① This interval is for linehaul applications.

② Do not use multi-viscosity or EP (Extreme Pressure) GL-5 gear oils. DO NOT MIX OILS IN THE TRANSMISSION.

③ Current designations are acceptable.

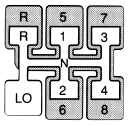
FreedomLine™ Transmission Oil Specification

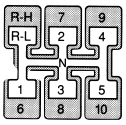
Oil Description	ZF Meritor Specification	A.P.I. Specification	Military Specification Approval	SAE Grade	Outside Temperature
Full-Synthetic Oil	Exxon Mobil SHC 50	—	—	50	Above –60°F (–51°C)

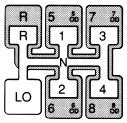
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Manual Transmissions

9-SPEED **10-SPEED** **13-SPEED**







9-Speed Manual

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			L % 1 % 2 % 3 % 4 % 5 % 6 % 7 % 8
9-Speed Direct Drive, A Ratio	M-11G9A-M11	1,150					
	M-12G9A-M12	1,250					
	M-13G9A-M13	1,350	13.41	13.17	13.17	3.73	13.41 48 9.05 39 6.51 37 4.74 34 3.53 38 2.56 39 1.84 37 1.34 34 1.00
	M-14G9A-M14	1,450					
	M-15G9A-M15	1,550					
9-Speed Overdrive, A Ratio	MO-12G9A-M12	1,250					
	MO-13G9A-M13	1,350	13.41	13.17	9.81	2.78	9.99 48 6.74 39 4.85 37 3.53 34 2.63 38 1.91 39 1.37 37 1.00 34 0.74
	MO-14G9A-M14	1,450					
9-Speed Overdrive, B Ratio	MO-11G9B-M11	1,150					
	MO-12G9B-M12	1,250					
	MO-13G9B-M13	1,350	17.74	17.42	12.60	3.24	12.83 67 7.69 40 5.48 41 3.89 38 2.81 42 1.98 40 1.41 41 1.00 38 0.72
	MO-14G9B-M14	1,450					
	MO-15G9B-M15	1,550					

9-Speed Manual — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G9A-M11		20.5	29.5	605	75.8
M-12G9A-M12		20.5	29.5	605	75.8
M-13G9A-M13		20.5	29.5	605	75.8
M-14G9A-M14		20.5	29.5	605	75.8
M-15G9A-M15	STD.	20.5	29.5	608	75.8
MO-12G9A-M12		20.5	29.5	605	101.7
MO-13G9A-M13		20.5	29.5	605	101.7
MO-14G9A-M14		20.5	29.5	605	101.7
MO-11G9B-M11		20.5	28.9	605	87.1
MO-12G9B-M12		20.5	28.9	605	87.1
MO-13G9B-M13		20.5	29.5	605	87.1
MO-14G9B-M14		20.5	29.5	605	87.1
MO-15G9B-M15	STD.	20.5	29.5	608	87.1

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

13-Speed Manual

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			L % 1 % 2 % 3 % 4 % 5 % 6 % 7 % 8 % 9 % 10 % 11 % 12
13-Speed Overdrive, A Ratio	RM013-145A	1,450	15.43	15.15	13.15	3.73	13.39 48 9.03 39 6.50 37 4.74 34 3.53 38 2.56 15 2.22 21 1.84 15 1.60 19 1.34 15 1.17 17 1.00 15 0.87

13-Speed Manual — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
RM013-145A		22	32.4	666	75.8

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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10-Speed Manual

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step																			
			FWD.	REV.			1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10	
10-Speed Direct Drive, A Ratio	M-11G10A-M11	1,150	15.02	16.71	16.71	3.73	15.02	35	11.14	35	8.26	37	6.02	34	4.48	34	3.35	35	2.48	35	1.84	37	1.34	34	1.00	
	M-12G10A-M12	1,250																								
	M-13G10A-M13	1,350																								
	M-14G10A-M14	1,450																								
	M-15G10A-M15	1,550																								
	M-14G10A-M16[1]	1,450																								
10-Speed Overdrive, A Ratio	MO-11G10A-M11	1,150	15.02	16.71	12.45	2.78	11.19	35	8.30	35	6.15	37	4.48	34	3.34	34	2.50	35	1.85	35	1.37	37	1.00	34	0.74	
	MO-12G10A-M12	1,250																								
	MO-13G10A-M13	1,350																								
	MO-14G10A-M14	1,450																								
	MO-15G10A-M15	1,550																								
	MO-14G10A-M16[1]	1,450																								
	MO-16G10A-M16	1,650																								
	MO-16G10A-M18[1]	1,650																								
10-Speed Overdrive, C Ratio	MO-11G10C-M11	1,150	17.53	19.49	14.15	2.88	12.72	38	9.23	37	6.75	37	4.92	38	3.57	38	2.58	38	1.88	37	1.37	37	1.00	38	0.73	
	MO-12G10C-M12	1,250																								
	MO-13G10C-M13	1,350																								
	MO-14G10C-M14	1,450																								
	MO-15G10C-M15	1,550																								
	MO-16G10C-M16	1,650																								
	MO-14G10C-M16[1]	1,450																								
	MO-16G10C-M18	1,650																								
	MO-17G10C-M17	1,750																								
	MO-17G10C-M19	1,750																								
	MO-18G10C-M18	1,850																								
	MO-18G10C-M20[1]	1,850																								

[1] Available with Torq-2 with either a 100 lb-ft or 200 lb-ft increase in the top two gears in CAT/Cummins engines.
Other Torq-2 combinations are available, call your OEM representative for details.

10-Speed Manual — Additional Specifications

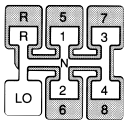
Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G10A-M11		20.5	29.5	605	75.8
M-12G10A-M12		20.5	29.5	605	75.8
M-13G10A-M13		20.5	29.5	605	75.8
M-14G10A-M14		20.5	29.5	605	75.8
M-15G10A-M15	STD.	20.5	29.5	608	75.8
M-14G10A-M16	STD.	20.5	29.5	608	75.8
MO-11G10A-M11		20.5	29.5	605	75.8
MO-12G10A-M12		20.5	29.5	605	75.8
MO-13G10A-M13		20.5	29.5	605	101.7
MO-14G10A-M14		20.5	29.5	605	101.7
MO-15G10A-M15	STD.	20.5	29.5	608	101.7
MO-14G10A-M16	STD.	20.5	29.5	608	101.7
MO-16G10A-M16	STD.	20.5	29.5	608	101.7
MO-16G10A-M18	STD.	20.5	29.5	608	101.7
MO-11G10C-M11		20.5	29.5	605	98.2
MO-12G10C-M12		20.5	29.5	605	98.2
MO-13G10C-M13		20.5	29.5	605	98.2
MO-14G10C-M14		20.5	29.5	605	98.2
MO-15G10C-M15	STD.	20.5	29.5	608	98.2
MO-16G10C-M16	STD.	20.5	29.5	608	98.2
MO-14G10C-M16	STD.	20.5	29.5	608	98.2
MO-16G10C-M18	STD.	20.5	29.5	608	98.2
MO-17G10C-M17	STD.	20.5	29.5	608	98.2
MO-17G10C-M19	STD.	20.5	29.5	608	98.2
MO-18G10C-M18	STD.	20.5	29.5	608	98.2
MO-18G10C-M20	STD.	20.5	29.5	608	98.2

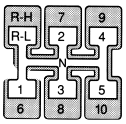
*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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ESS System Automated Transmissions

9-SPEED **10-SPEED**





9-Speed ESS

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			L % 1 % 2 % 3 % 4 % 5 % 6 % 7 % 8
9-Speed Direct Drive,	M-11G9A-X11	1,150					
A Ratio	M-12G9A-X12	1,250					
	M-13G9A-X13	1,350	13.41	13.17	13.17	3.73	13.41 48 9.05 39 6.51 37 4.74 34 3.53 38 2.56 39 1.84 37 1.34 34 1.00
	M-14G9A-X14	1,450					
	M-15G9A-X15	1,550					
9-Speed Overdrive,	MO-12G9A-X12	1,250					
A Ratio	MO-13G9A-X13	1,350	13.41	13.17	9.81	2.78	9.99 48 6.74 39 4.85 37 3.53 34 2.63 38 1.91 39 1.37 37 1.00 34 0.74
	MO-14G9A-X14	1,450					
9-Speed Overdrive,	MO-11G9B-X11	1,150					
B Ratio	MO-12G9B-X12	1,250					
	MO-13G9B-X13	1,350	17.74	17.42	12.60	3.24	12.83 67 7.69 40 5.48 41 3.89 38 2.81 42 1.98 40 1.41 41 1.00 38 0.72
	MO-14G9B-X14	1,450					
	MO-15G9B-X15	1,550					

FOR ENGINE TYPE:
X = Add "D" for Detroit Diesel or "E" for CAT/Cummins engine.

9-Speed ESS — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G9A-X11		20.5	29.5	605	75.8
M-12G9A-X12		20.5	29.5	605	75.8
M-13G9A-X13		20.5	29.5	605	75.8
M-14G9A-X14		20.5	29.5	605	75.8
M-15G9A-X15	STD.	20.5	29.5	608	75.8
MO-12G9A-X12		20.5	29.5	605	101.7
MO-13G9A-X13		20.5	29.5	605	101.7
MO-14G9A-X14		20.5	29.5	605	101.7
MO-11G9B-X11		20.5	29.5	605	87.1
MO-12G9B-X12		20.5	29.5	605	87.1
MO-13G9B-X13		20.5	29.5	605	87.1
MO-14G9B-X14		20.5	29.5	605	87.1
MO-15G9B-X15	STD.	20.5	29.5	608	87.1

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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MERITOR®

10-Speed ESS

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step																					
			FWD.	REV.			1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10
10-Speed Direct Drive, A Ratio	M-11G10A-X11	1,150	15.02	16.71	16.71	3.73	15.02	35	11.14	35	8.26	37	6.02	34	4.48	34	3.35	35	2.48	35	1.84	37	1.34	34	1.00
	M-12G10A-X12	1,250																							
	M-13G10A-X13	1,350																							
	M-14G10A-X14	1,450																							
	M-15G10A-X15	1,550																							
	M-14G10A-E16	1,450																							
10-Speed Overdrive, A Ratio	MO-11G10A-X11	1,150	15.02	16.71	12.45	2.78	11.19	35	8.30	35	6.15	37	4.48	34	3.34	34	2.50	35	1.85	35	1.37	37	1.00	34	0.74
	MO-12G10A-X12	1,250																							
	MO-13G10A-X13	1,350																							
	MO-14G10A-X14	1,450																							
	MO-15G10A-X15	1,550																							
	MO-14G10A-E16[1]	1,450																							
	MO-16G10A-X16	1,650																							
	MO-16G10A-E18	1,650																							
10-Speed Overdrive, C Ratio	MO-11G10C-X11	1,150	17.53	19.49	14.15	2.88	12.72	38	9.23	37	6.75	37	4.92	38	3.57	38	2.58	38	1.88	37	1.37	37	1.00	38	0.73
	MO-12G10C-X12	1,250																							
	MO-13G10C-X13	1,350																							
	MO-14G10C-X14	1,450																							
	MO-15G10C-X15	1,550																							
	MO-16G10C-X16	1,650																							
	MO-14G10C-E16[1]	1,450																							
	MO-16G10C-E18[1]	1,650																							
	MO-17G10C-X17	1,750																							
	MO-17G10C-E19	1,750																							
	MO-18G10C-X18	1,850																							
	MO-18G10C-E20[1]	1,850																							

FOR ENGINE TYPE: X = Add "D" for Detroit Diesel or "E" for CAT/Cummins engine. E = Available in CAT/Cummins engine only.

[1] Available with Torq-2 with either a 100 lb-ft or 200 lb-ft increase in the top two gears. Other Torq-2 combinations are available, call your OEM representative for details.

10-Speed ESS — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G10A-X11		20.5	29.5	605	75.8
M-12G10A-X12		20.5	29.5	605	75.8
M-13G10A-X13		20.5	29.5	605	75.8
M-14G10A-X14		20.5	29.5	605	75.8
M-15G10A-X15	STD.	20.5	29.5	608	75.8
M-14G10A-E16	STD.	20.5	29.5	608	75.8
MO-11G10A-X11		20.5	29.5	605	75.8
MO-12G10A-X12		20.5	29.5	605	75.8
MO-13G10A-X13		20.5	29.5	605	101.7
MO-14G10A-X14		20.5	29.5	605	101.7
MO-15G10A-X15	STD.	20.5	29.5	608	101.7
MO-14G10A-E16	STD.	20.5	29.5	608	101.7
MO-16G10A-X16	STD.	20.5	29.5	608	101.7
MO-16G10A-E18	STD.	20.5	29.5	608	101.7
MO-11G10C-X11		20.5	29.5	605	98.2
MO-12G10C-X12		20.5	29.5	605	98.2
MO-13G10C-X13		20.5	29.5	605	98.2
MO-14G10C-X14		20.5	29.5	605	98.2
MO-15G10C-X15	STD.	20.5	29.5	608	98.2
MO-16G10C-X16	STD.	20.5	29.5	608	98.2
MO-14G10C-X16	STD.	20.5	29.5	608	98.2
MO-16G10C-X18	STD.	20.5	29.5	608	98.2
MO-17G10C-E17	STD.	20.5	29.5	608	98.2
MO-17G10C-E19	STD.	20.5	29.5	608	98.2
MO-18G10C-E18	STD.	20.5	29.5	608	98.2
MO-18G10C-X20	STD.	20.5	29.5	608	98.2

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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SureShift™ Automated Transmissions (All J1939 Engines)

9-Speed SureShift

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			L % 1 % 2 % 3 % 4 % 5 % 6 % 7 % 8
9-Speed Direct Drive,	M-11G9A-S11	1,150					
A Ratio	M-12G9A-S12	1,250					
	M-13G9A-S13	1,350	13.41	13.17	13.17	3.73	13.41 48 9.05 39 6.51 37 4.74 34 3.53 38 2.56 39 1.84 37 1.34 34 1.00
	M-14G9A-S14	1,450					
	M-15G9A-S15	1,550					
9-Speed Overdrive,	MO-12G9A-S12	1,250					
A Ratio	MO-13G9A-S13	1,350	13.41	13.17	9.81	2.78	9.99 48 6.74 39 4.85 37 3.53 34 2.63 38 1.91 39 1.37 37 1.00 34 0.74
	MO-14G9A-S14	1,450					
9-Speed Overdrive,	MO-11G9B-S11	1,150					
B Ratio	MO-12G9B-S12	1,250					
	MO-13G9B-S13	1,350	17.74	17.42	12.60	3.24	12.83 67 7.69 40 5.48 41 3.89 38 2.81 42 1.98 40 1.41 41 1.00 38 0.72
	MO-14G9B-S14	1,450					
	MO-15G9B-S15	1,550					

9-Speed SureShift — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G9A-S11		20.5	29.5	605	75.8
M-12G9A-S12		20.5	29.5	605	75.8
M-13G9A-S13		20.5	29.5	605	75.8
M-14G9A-S14		20.5	29.5	605	75.8
M-15G9A-S15	STD.	20.5	29.5	608	75.8
MO-12G9A-S12		20.5	29.5	605	101.7
MO-13G9A-S13		20.5	29.5	605	101.7
MO-14G9A-S14		20.5	29.5	605	101.7
MO-11G9B-S11		20.5	29.5	605	87.1
MO-12G9B-S12		20.5	29.5	605	87.1
MO-13G9B-S13		20.5	29.5	605	87.1
MO-14G9B-S14		20.5	29.5	605	87.1
MO-15G9B-S15	STD.	20.5	29.5	608	87.1

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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10-Speed SureShift

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step																					
			FWD.	REV.			1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10			
10-Speed Direct Drive, A Ratio	M-11G10A-S11	1,150	15.02	16.71	16.71	3.73	15.02	35	11.14	35	8.26	37	6.02	34	4.48	34	3.35	35	2.48	35	1.84	37	1.34	34	1.00			
	M-12G10A-S12	1,250																										
	M-13G10A-S13	1,350																										
	M-14G10A-S14	1,450																										
	M-15G10A-S15	1,550																										
	M-14G10A-S16[1]	1,450																										
10-Speed Overdrive, A Ratio	MO-11G10A-S11	1,150	15.02	16.71	12.45	2.78	11.19	35	8.30	35	6.15	37	4.48	34	3.34	34	2.50	35	1.85	35	1.37	37	1.00	34	0.74			
	MO-12G10A-S12	1,250																										
	MO-13G10A-S13	1,350																										
	MO-14G10A-S14	1,450																										
	MO-15G10A-S15	1,550																										
	MO-14G10A-S16[1]	1,450																										
	MO-16G10A-S16	1,650																										
	MO-16G10A-S18[1]	1,650																										
10-Speed Overdrive, C Ratio	MO-11G10C-S11	1,150	17.53	19.49	14.15	2.88	12.72	38	9.23	37	6.75	37	4.92	38	3.57	38	2.58	38	1.88	37	1.37	37	1.00	38	0.73			
	MO-12G10C-S12	1,250																										
	MO-13G10C-S13	1,350																										
	MO-14G10C-S14	1,450																										
	MO-15G10C-S15	1,550																										
	MO-16G10C-S16	1,650																										
	MO-14G10C-S16[1]	1,450																										
	MO-16G10C-S18[1]	1,650																										
	MO-17G10C-S17	1,750																										
	MO-17G10C-S19	1,750																										
	MO-18G10C-S18	1,850																										
	MO-18G10C-S20[1]	1,850																										

[1] Available with Torq-2 with either a 100 lb-ft or 200 lb-ft increase in the top two gears with CAT/Cummins engines.
Other Torq-2 combinations are available, call your OEM representative for details.

10-Speed SureShift — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO Speed (% of engine)
M-11G10A-S11		20.5	29.9	605	75.8
M-12G10A-S12		20.5	29.9	605	75.8
M-13G10A-S13		20.5	29.5	605	75.8
M-14G10A-S14		20.5	29.5	605	75.8
M-15G10A-S15	STD.	20.5	29.5	608	75.8
M-14G10A-S16	STD.	20.5	29.5	608	75.8
MO-11G10A-S11		20.5	29.9	605	75.8
MO-12G10A-S12		20.5	29.9	605	75.8
MO-13G10A-S13		20.5	29.5	605	101.7
MO-14G10A-S14		20.5	29.5	605	101.7
MO-15G10A-S15	STD.	20.5	29.5	608	101.7
MO-14G10A-S16	STD.	20.5	29.5	608	101.7
MO-16G10A-S16	STD.	20.5	29.5	608	101.7
MO-16G10A-S18	STD.	20.5	29.5	608	101.7
MO-11G10C-S11		20.5	29.5	605	98.2
MO-12G10C-S12		20.5	29.5	605	98.2
MO-13G10C-S13		20.5	29.5	605	98.2
MO-14G10C-S14		20.5	29.5	605	98.2
MO-15G10C-S15	STD.	20.5	29.5	608	98.2
MO-16G10C-S16	STD.	20.5	29.5	608	98.2
MO-14G10C-S16	STD.	20.5	29.5	608	98.2
MO-16G10C-S18	STD.	20.5	29.5	608	98.2
MO-17G10C-S17	STD.	20.5	29.5	608	98.2
MO-17G10C-S19	STD.	20.5	29.5	608	98.2
MO-18G10C-S18	STD.	20.5	29.5	608	98.2
MO-18G10C-S20	STD.	20.5	29.5	608	98.2

*Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

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FreedomLine™ Automated Transmissions

12-Speed FreedomLine

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			1 % 2 % 3 % 4 % 5 % 6 % 7 % 8 % 9 % 10 % 11 % 12
12-Speed Direct Drive	M-13Z12A-A13	1,350	15.86	14.68	14.68	11.41	15.86 29 12.33 29 9.57 29 7.44 27 5.87 28 4.57 32 3.47 28 2.70 29 2.10 29 1.63 26 1.29 29 1.00
	M-14Z12A-A14	1,450					
12-Speed Overdrive	MO-13Z12A-A13	1,350					
	MO-14Z12A-A14	1,450	15.81	14.62	11.41	8.88	12.33 29 9.59 29 7.44 29 5.78 26 4.57 29 3.55 31 2.70 29 2.10 29 1.63 28 1.27 27 1.00 28 .78
	MO-15Z12A-A15	1,550					
	MO-16Z12A-A16	1,650					

12-Speed FreedomLine — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO
M-13Z12A-A13	STD.	23.25	31.7	565	Available
M-14Z12A-A14	STD.	23.25	31.7	565	Available
MO-14Z12A-A14	STD.	23.25	31.7	565	Available
MO-15Z12A-A15	STD.	23.25	31.7	565	Available
MO-16Z12A-A16	STD.	23.25	31.7	565	Available

*Weights are approximate, less shift controls, output yoke and lubricant.

16-Speed FreedomLine

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step
			FWD.	REV.			1 % 2 % 3 % 4 % 5 % 6 % 7 % 8 % 9 % 10 % 11 % 12 % 13 % 14 % 15 % 16
16-Speed Direct Drive	M-13Z16A-A13	1,350					
	M-14Z16A-A14	1,450	17.03	15.77	15.77	13.07	17.03 21 14.12 23 11.50 21 9.54 21 7.86 21 6.52 18 5.51 21 4.57 23 3.73 21 3.09 23 2.52 21 2.09 22 1.72 21 1.43 18 1.21 21 1.00
	M-14Z16A-A15	1,550					
	M-16Z16A-A16	1,650					
16-Speed Overdrive	MO-13Z16A-A13	1,350					
	MO-14Z16A-A14	1,450	17.01	15.75	13.07	10.81	14.12 21 11.68 22 9.54 21 7.89 21 6.52 21 5.39 18 4.57 21 3.78 22 3.09 21 2.56 22 2.09 21 1.73 21 1.43 21 1.18 18 1.00 20 0.83
	MO-15Z16A-A15	1,550					
	MO-16Z16A-A16	1,650					

16-Speed FreedomLine — Additional Specifications

Model	Optional Internal Oil Pump	Oil Capacity (pints)	Length (inches)	Weight (lbs.*)	PTO
M-14Z16A-A14	STD.	25.0	33.4	604	Available
M-15Z16A-A15	STD.	25.0	33.4	604	Available
M-16Z16A-A16	STD.	25.0	33.4	604	Available
MO-14Z16A-A14	STD.	25.0	33.4	604	Available
MO-15Z16A-A15	STD.	25.0	33.4	604	Available
MO-16Z16A-A16	STD.	25.0	33.4	604	Available

*Weights are approximate, less shift controls, output yoke and lubricant.

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Platform "F" Manual Transmission Oil Capacities ①

Model	Oil Capacity (Pints)	Length (In.)	Weight (Lbs.)	PTO (% of Engine)
RM9-115A ③	20.0	28.9	588	75.8
RM9-125A ③	20.0	28.9	588	75.8
RM9-135A ③	20.5	29.5	605	75.8
RM9-145A ③	20.5	29.5	605	75.8
RM9-155A ③	20.5	29.5	608	75.8
RMO9-125A	20.0	28.9	588	101.7
RMO9-135A	20.5	29.5	605	101.7
RMO9-145A	20.5	29.5	605	101.7
RMX9-125A ③	20.0	28.9	588	101.7
RMX9-135A ③	20.5	29.5	605	101.7
RMX9-145A ③	20.5	29.5	605	101.7
RMO9-115B	20.0	28.9	588	87.1
RMO9-125B	20.0	28.9	588	87.1
RMO9-135B	20.5	29.5	605	87.1
RMO9-145B	20.5	29.5	605	87.1
RMX9-115B ③	20.0	28.9	588	87.1
RMX9-125B ③	20.0	28.9	588	87.1
RMX9-135B ③	20.5	29.5	605	87.1
RMX9-145B ③	20.5	29.5	605	87.1
RMX9-155B ③	20.5	29.5	608	87.1
RMX9-115R ③	20.0	28.9	588	101.7
RMX9-125R ③	20.0	28.9	588	101.7
RMX9-135R ③	20.5	29.5	605	101.7
RMX9-145R ③	20.5	29.5	605	75.8
RM10-115A ③	20.0	28.9	588	75.8

Model	Oil Capacity (Pints)	Length (In.)	Weight (Lbs.)	PTO (% of Engine)
RM10-125A ③	20.0	28.9	588	75.8
RM10-135A ③	20.5	29.5	605	75.8
RM10-145A ③	20.5	29.5	605	75.8
M-14F10A-M16 ③	20.5	29.5	605	75.8
RM10-155A ③	20.5	29.5	608	75.8
RD10-145A	20.5	29.5	605	75.8
RMX10-115A ③	20.0	28.9	588	101.7
RMX10-125A ③	20.0	28.9	588	101.7
RMX10-135A ③	20.5	29.5	605	101.7
RMX10-145A ③	20.5	29.5	605	101.7
MO-14F10A-M16 ③	20.5	29.5	605	101.7
RMX10-155A ③	20.5	29.5	608	101.7
RMX10-165A ③	20.5	29.5	608	101.7
RMX10-115C ③	20.5	29.5	605	98.2
RMX10-125C ③	20.5	29.5	605	98.2
RMX10-135C ③	20.5	29.5	605	98.2
RMX10-145C ③	20.5	29.5	605	98.2
MO-14F10C-M16 ③	20.5	29.5	605	98.2
RMX10-155C ③	20.5	29.5	608	98.2
RMX10-165C ③	20.5	29.5	608	98.2
MO-16F10C-M18 ③	20.5	29.5	608	98.2
RMO13-145A ③	22.0	32.4	666	75.8

① Oil capacities are approximate. Fill the transmission to the bottom of the fill plug hole. On transmissions equipped with an oil pump and/or oil cooler, operate the engine for five minutes after the initial fill and check the oil level again.

② Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

③ Available with Meritor's Engine Synchro Shift™ (ESS™) System. For ESS transmission models, replace the "M" in the above model numbers with an "S".

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WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Wheel Bearings

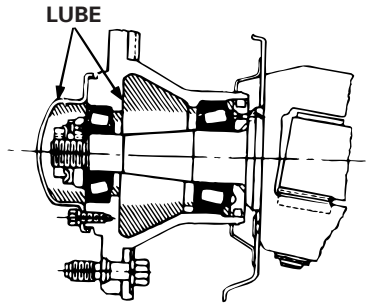
Grease the Bearings

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
2. Remove the tire and wheel assembly. Remove and dissemble the hub.
3. Use the correct cleaning solvent to remove the old grease from all parts. Discard the seals. Inspect the wheel bearings for wear or damage. Replace worn or damaged bearings.
4. Before installing the wheel bearings, lubricate the bearing journals on the spindle with the grease that is used for the bearings. **Figure 12.1**.
5. Use a pressure packer to force the specified grease from the large end of the cones into the cavities between the rollers and cage. Pack the hub between the bearing cups with grease to the level of the smallest diameter of the cups.
   - **If a pressure packer is not available**: Grease the bearings by hand.
6. Install the inner and outer bearing cones into the cups in the hubs. The bearing cups must be pressed tight against the shoulder in the hubs.
7. Install new wheel seals in the hubs.
8. Install the hub and the wheel and tire assembly. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
9. Adjust the wheel bearings.

Figure 12.1
TYPICAL GREASE-LUBRICTED WHEEL BEARINGS

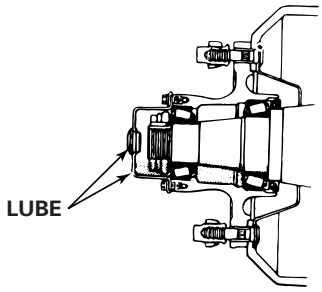


Check the Oil Level

NOTE: If you cannot observe the oil level because the sightglass is stained, remove the fill plug, check the oil level with your finger and follow the procedures for Step 2, below. Replace the stained sightglass as soon as possible.

1. Check the oil level on the cap.
2. If the oil level is more than 1/4-inch (6 mm) below the specified level on the cap, remove the fill plug.
3. Add the specified oil to the specified level. **Figure 12.2**.
4. Install the fill plug.

Figure 12.2
TYPICAL OIL-LUBRICATED WHEEL BEARINGS



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Drive Axle Hubs Without Fill Holes

1. Add the specified amount of lubricant through the carrier or housing bowl oil fill hole.
2. Tilt the axle to the right and to the left to let the oil flow into the hub cavities. Keep the axle tilted for one minute in each position.
3. With the axle in the level position, add the specified oil so that the level is even with the bottom of the fill plug hole.
4. Install and tighten the fill plug.

Wheel-End Axle Greasing Intervals and Specifications

Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Whichever comes first: Replacing Seals Relining Brakes On-Highway: 30,000 miles (48 000 km) On/Off Highway and Off-Highway: Twice a year	Multi-Purpose Grease	O-617-A (preferred) or O-617-B (acceptable)	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.

Wheel-End Oil Change Intervals and Specifications

Operation	On-Highway	Off-Highway
Check Oil Level	1,000 miles (1600 km)	1,000 miles (1600 km)
Petroleum Oil Change	Whichever comes first. Seals replaced. Brakes relined. 100,000 miles (160 000 km). Once a year.	Whichever comes first. Seals replaced. Brakes relined. Once a year.
Synthetic Oil Change	—	—

Meritor Specifications	Military/SAE Specifications	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A Gear Oil	MIL-PRF-2105-E and SAE J2360	GL-5, SAE 85W/140	10	None	–12	None
O-76D Gear Oil		GL-5, SAE 80W/90	–15	None	–26	None
O-76E Gear Oil		GL-5, SAE 75W/90	–40	None	–40	None
O-76J Gear Oil		GL-5, SAE 75	–40	35	–40	2
Heavy-Duty Engine Oil	MIL-L-2104 E or F	A.P.I. -CD, -CE, -SG, -SH or -SJ SAE 40 or 50 ①	10	None	–12	None
Heavy-Duty Engine Oil	MIL-L-210 E or F	A.P.I. -CD, -CE, -SG, -SH or -SJ SAE 30 ②	–15	None	–26	None

① Current designations are acceptable. Multi-grade engine oils are acceptable if the SAE rating ends in 40 or 50.

② Current designations are acceptable. Multi-grade engine oils are acceptable if the SAE rating ends in 30.

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Grease Lubricants①

Meritor Specification	Grease	Typical Application	NLGI Grade	Grease Description	Outside Temperature
O-616	Brake Grease	Cam Brake Anchor Pins, Mechanical Brake Anchor Pins	2	Clay Base	②
O-616-A	Brake Grease	Air Disc Brake Caliper, Automatic Slack Adjuster, Wedge Brake Components	1	Clay Base	Down to –40°F (–40°C)
O-617-A or O-617-B	Multi-Purpose Grease	Cam Brake Chamber Brackets, Cam Brake Hold Down Clips, Cross Tube Ends, Drag Link, Wheel Bearings, King Pins and Bushings, Knuckle Bushings, Manual Slack Adjuster, Steering Arm, Ball Studs, Tie Rod End Ball Studs, Trailer Axle Wheel Bearings, Wedge Brake Hold-Down Clips, Wedge Brake Shoe Contacts at Anchors.	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	②
O-634-B	Universal Joint Grease	Driveshaft Slip Yokes, Driveshaft Splines, Driveshaft Universal Joints	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	②
O-637 ③	Special Rust-Preventing Brake Grease	Air Disc Brake Slide Pin, Splines and Clevis Pins, Cam Brake Camshaft Splines	1-1/2	Calcium	②
O-645	Low-Temperature Brake Grease	Air Disc Brake Caliper, Automatic Slack Adjuster, Wedge Brake Components	2	Synthetic	Down to –65°F (–54°C)
O-647	Trailer Axle Bearing Grease	Trailer Axle Wheel Bearings	00	Synthetic	②
O-661	High-Temperature Multi-Purpose Wheel Bearing Grease	Clutch Release Bearing	3	Lithium Complex	②
O-692	Automatic Slack Adjuster Grease	Automatic Slack Adjuster	1 & 2	Lithium Base	Down to –40°F (–40°C)

① 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. When such products are recommended by reputable suppliers for the specific lubrication of our components, Meritor has no objections, provided that these substitute products are equal to or better than Meritor recommendations in lubrication properties, water resistance, corrosion protection, high and low temperature characteristics, oxidation stability, shear stability, etc. All substitute products are subject to Meritor approval. For more information, contact an ArvinMeritor service representative.

② Refer to the manufacturer's specifications for the temperature service limits.

③ Do not mix O-637 calcium-base, corrosion-control grease with other greases.

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Oil Lubricants

Meritor Specification	Oil	Typical Application	Military/SAE Specifications	Oil Description	Outside Temperature °F Min.	°F Max.	°C Min.	°C Max.
O-62	Petroleum Oil	Transfer Case	—	SAE 90	10	None	–12	None
O-63	Petroleum Oil	Transfer Case	—	SAE 140	40	None	4	None
O-76A	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings	MIL-PRF-2105-E and SAE J2360	GL-5 SAE 85W/140	10	None	–12	None
O-76D	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 80W/90	–15	None	–26	None
O76E	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 75W/90	–40	None	–40	None
O-76J	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 75W	–40	35	–40	2
O-76L	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 75W/140	–40	None	–40	None
O-76M	Full Synthetic Oil	Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 75W/140	–40	None	–40	None
O-76N	Full Synthetic Oil	Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5 SAE 75W/90	–40	None	–40	None
O-81	Full Synthetic Oil	Transmission	—	SAE 50	–40	None	–40	None
—	Heavy Duty Engine Oil	Transmission	MIL-L-2104 -E or -F*	A.P.I. -CD, -CE, -SG, -SH or -SJ; SAE 50*	10	None	–12	None
—	Heavy Duty Engine Oil	Transmission		A.P.I. -CD, -CE, -SG, -SH or -SJ; SAE 40*	10	None	–12	None
—	Heavy Duty Engine Oil	Transmission		A.P.I. -CD, -CE, -SG, -SH or -SJ; SAE 30*	–15	10	–26	–12
—	Petroleum Gear	Transmission		A.P.I.-GL-1; SAE 90	10	None	–12	None
—	Petroleum Gear	Transmission		A.P.I.-GL-1; SAE 80	–15	None	–26	None

* Current designations are acceptable.

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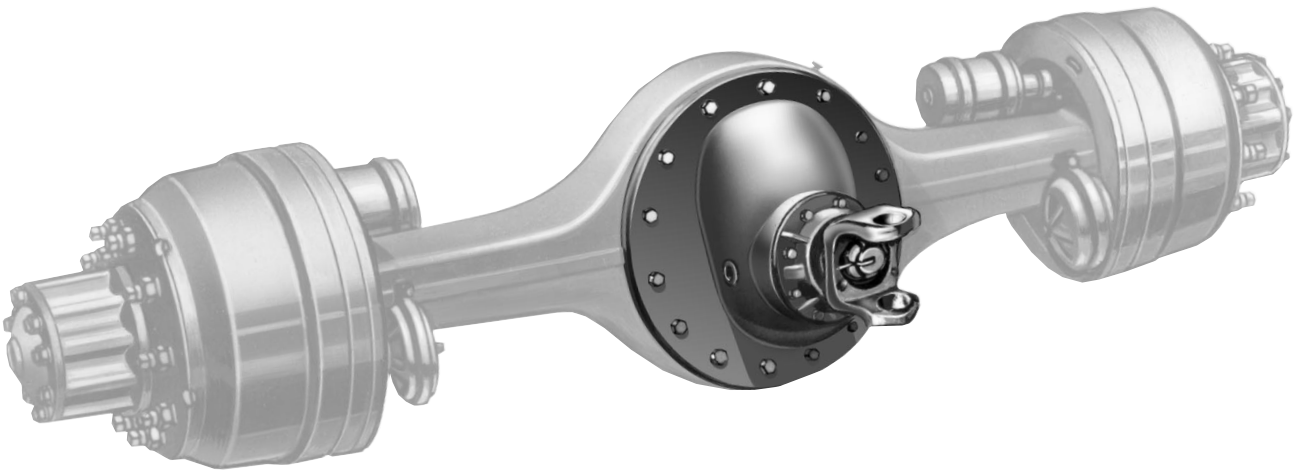
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MERITOR®

Revised 10-00
$2.50

Single Reduction Differential Carriers

Maintenance Manual 5



Standard Carriers Including: Single Axles, Rear of Tandem Axles, Front Drive Steering Axles

Excluding RS and RT Series (Rear Only), Single Reduction Axles and RF Series Front Drive Axles

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Service Notes

Before You Begin

This manual provides instructions for Meritor's early production non-RF, -RS or -RT Series axles. Before you begin procedures:

1. Read and understand all instructions an procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

WARNING	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
CAUTION	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious injury.
	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

Access Information on ArvinMeritor's Web Site

Additional maintenance and service information for ArvinMeritor's commercial vehicle systems component lineup is also available at www.arvinmeritor.com.

To access information, click on Products & Services/Tech Library Icon/HVS Publications. The screen will display an index of publications by type.

Additional Information

For complete maintenance and service procedures for all single reduction differential carriers, call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following publications.

- *Traction Controls* package contains two videos — *Splitting the Difference* T-87127V and *Driver-Controlled Full Locking Main Differential* T-9007V. $50. Order T-95125V for this package or each video is available individually as well.
- *Technical Electronic Library* on CD. Features product and service information on most ArvinMeritor, ZF Meritor and Meritor WABCO components. $20. Order TP-9853.

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Table of Contents

Exploded View 1

Section 1: Introduction

Standard Single Reduction Carriers 4
Axle Models Covered in This Manual 5

Section 2: Disassembly

Remove Differential Carrier from Axle Housing 6
Brass Drift Method 8
Air Hammer Vibration Method
Carrier Removal from Axle 9
Remove the Differential and Ring Gear from the Carrier 11
Disassemble the Differential and Ring Gear Assembly 13
Remove the Drive Pinion and Bearing Cage from Carrier 15
Disassemble the Drive Pinion and Bearing Cage 16

Section 3: Preparing the Parts for Assembly

Cleaning Ground and Polished Parts 20
Cleaning Rough Parts
Cleaning Axle Assemblies
Drying Parts After Cleaning
Preventing Corrosion on Cleaned Parts 21
Inspecting Parts
Repair or Replacement of Parts, General 23
Repair Axle by Welding 24
Bending or Straightening Drive Axle Housings 25
Removing Dri-Loc® Fasteners

Section 4: General Information

Installing Fasteners with Pre-Applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent 26
Installing New Fasteners with Pre-applied Adhesive Patches
Installing Original or Used Fasteners Using Meritor Liquid Adhesive 2297-C-7049 or Loctite® 680 or Equivalent
Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential
Application of Three Bond 1216 or Equivalent Silicone Gasket Material 27
Installing Tight Fit Yokes and POSE™ Seal 28
General Yoke and U-Joint Reassembly 29
Gear Set Information (Drive Pinion and Ring Gear Marks)

Section 5: Assembly

Assemble the Drive Pinion, Bearings and Bearing Cage 31
Adjusting Preload of Pinion Bearings 36
Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion) 41
Installing the Drive Pinion, Bearing Cage and Shim Pack into the Carrier 43
Installing Tight Fit Yokes and POSE™ Seal 44
Assemble the Main Differential and Ring Gear Assembly 45
Inspecting the Rotating Resistance of the Differential Gears 48
Install the Differential and Ring Gear Assembly 49
Adjust Preload of Differential Bearings 50
Method 1
Method 2 52
Inspect Runout of Ring Gear 53
Ring Gear Backlash Adjustment
Inspect Tooth Contact Patterns of the Gear Set 55
Install and Adjust the Thrust Screw 60
Install Differential Carrier into Axle Housing 61
Straight Holes, Nuts and Hardened Washers 63
Tapered Dowel, Hardened Washer and Hardened Nut

https://truckmanualshub.com/

Table of Contents

Section 6: Lubrication 64
Axle Lubricant Capacities 66
Section 7: Fastener Torque Information
Torque Values for Fasteners 67
General Information
American Standard Fasteners
Metric Fasteners
Section 8: Adjustments and Specifications 71
Section 9: Vehicle Towing Instructions (Non-DCDL)
Before Towing or Drive-Away 73
After Towing or Drive-Away 75

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Exploded View — Legend

1	Nut — Drive Pinion
2	Washer — Drive Pinion*
3	Input Yoke* or Flange*
4	Deflector
5	Oil Seal
6	Capscrew — Bearing Cage
7	Washer
8	Bearing Cone — Pinion Outer
9	Bearing Cup — Pinion Outer
10	Bearing Cage — Drive Pinion
11	Shims
12	Spacer— Pinion Bearing
13	Bearing Cup — Pinion Inner
14	Bearing Cone — Pinion Inner
15	Drive Pinion
16	Spigot Bearing
16A	Snap Ring
17	Carrier
18	Thrust Screw*
19	Jam Nut* — Thrust Screw*
20	Adjusting Ring — L.H.
21	Cotter* or Pin*
22	Caps — Differential Bearing
23	Washers
24	Capscrews — Differential Bearing Cap
25	Lock Plate* — Adjusting Ring
26	Washers* — Lock Plate
27	Capscrews* — Lock Plate*
28	Adjusting Ring — R.H.
29	Plug* — Oil Fill Hole (carrier)
30	Washer* — Capscrew/Plug*
31	Capscrew/Plug — Sensor Hole
32	Thrust Block*
33	Washers* — Differential Case
34	Nuts* — Differential Case
35	Bearing Cup — Differential L.H.
36	Bearing Cone — Differential L.H.
37	Nuts* — Ring Gear and Case Half
38	Case Half — Flange
39	Ring Gear
40	Bolts* or Rivets* — Ring Gear and Case Half
41	Side Gears —Differential
42	Thrust Washers — Differential Pinion
43	Pinions — Differential
44	Spider — Differential
45	Thrust Washers — Differential Side Gear
46	Capscrews — Differential Case
47	Bolts* — Differential Case
48	Bearing Cup — Differential R.H.
49	Bearing Cone — Differential R.H.
50	Case Half — Plain

* Some Meritor carriers do not have these described parts.

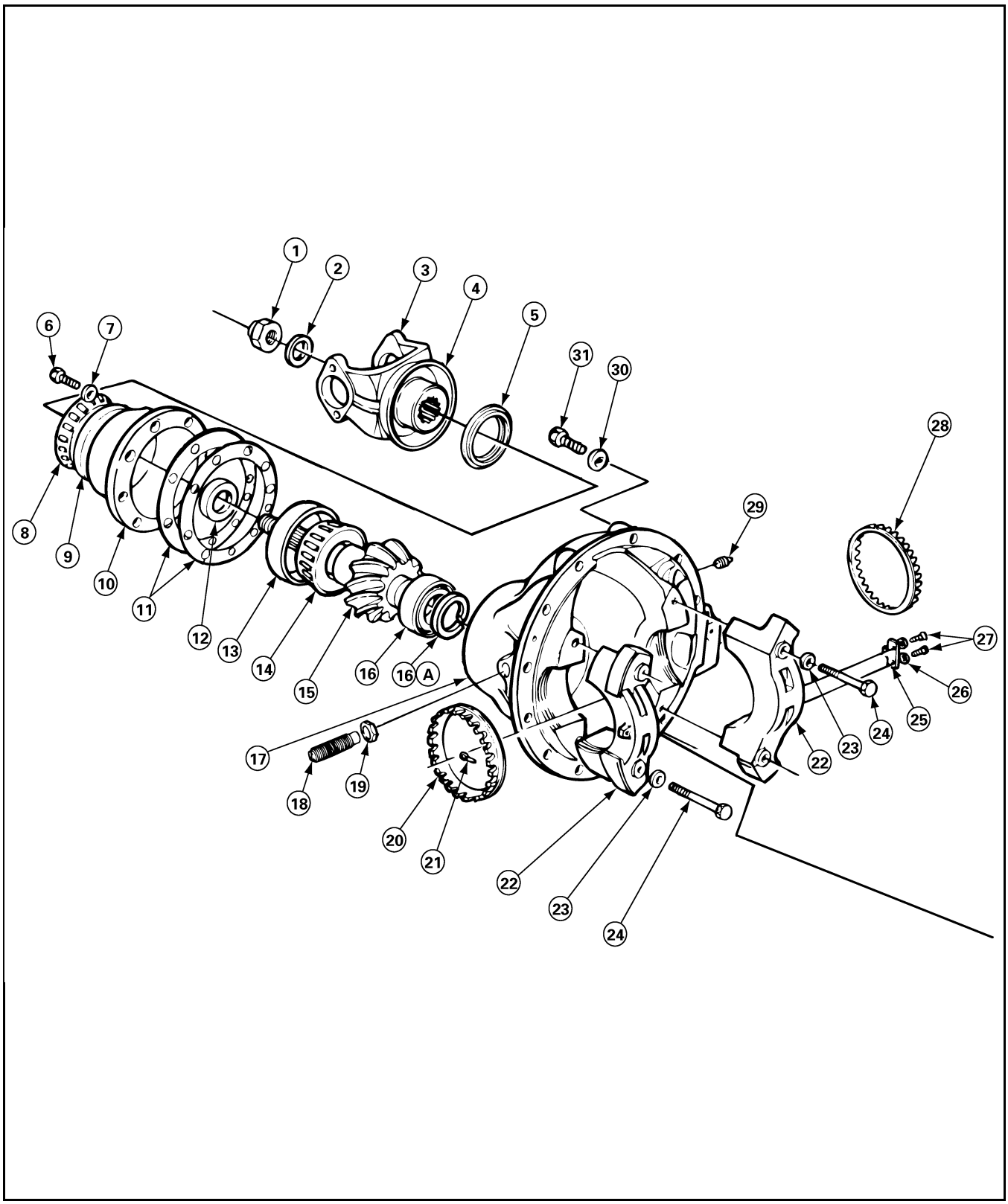
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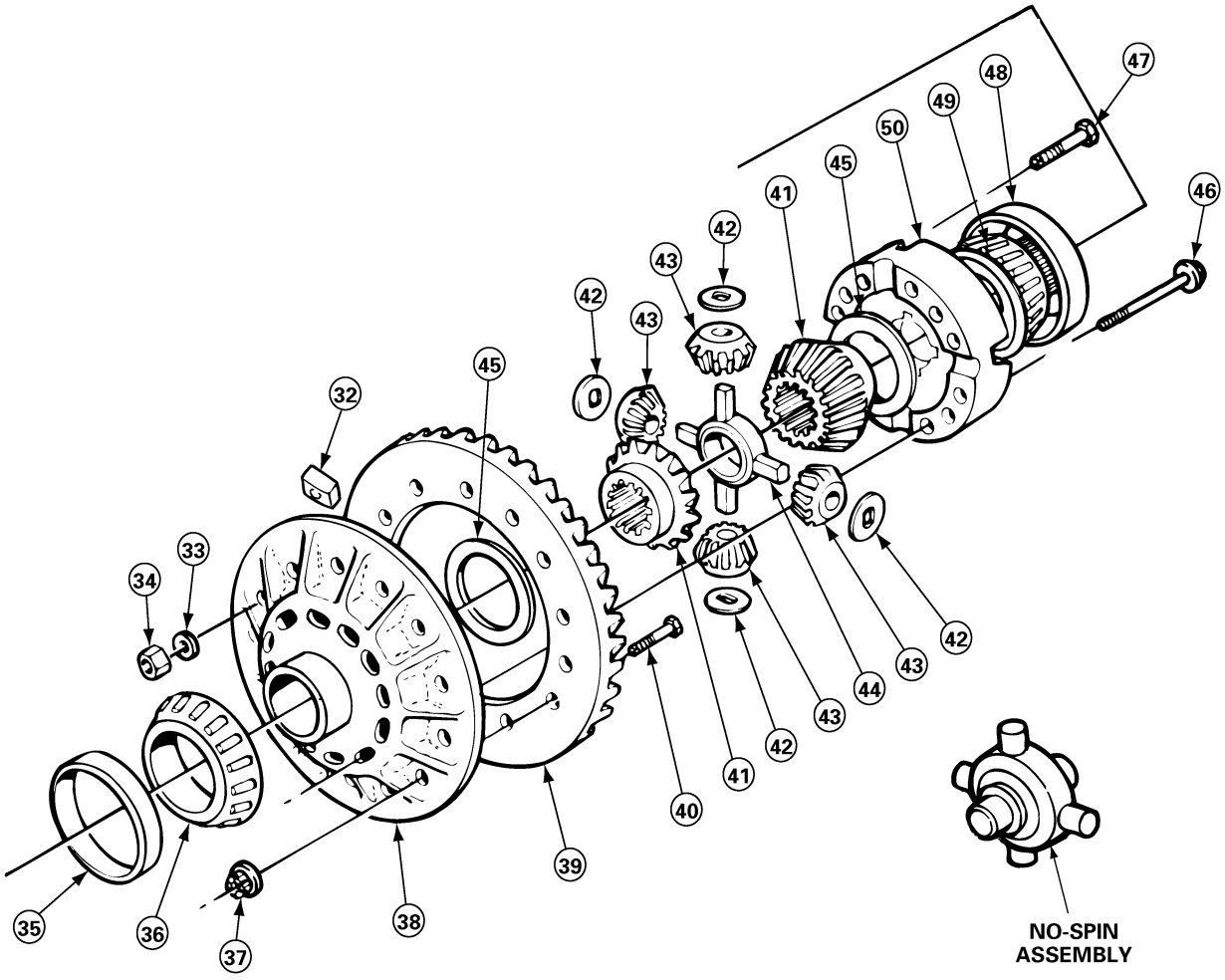
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Single Reduction Differential Carrier



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Standard Single Reduction Carriers

NOTE: For carriers with a differential lock, refer to Maintenance Manual 5A.

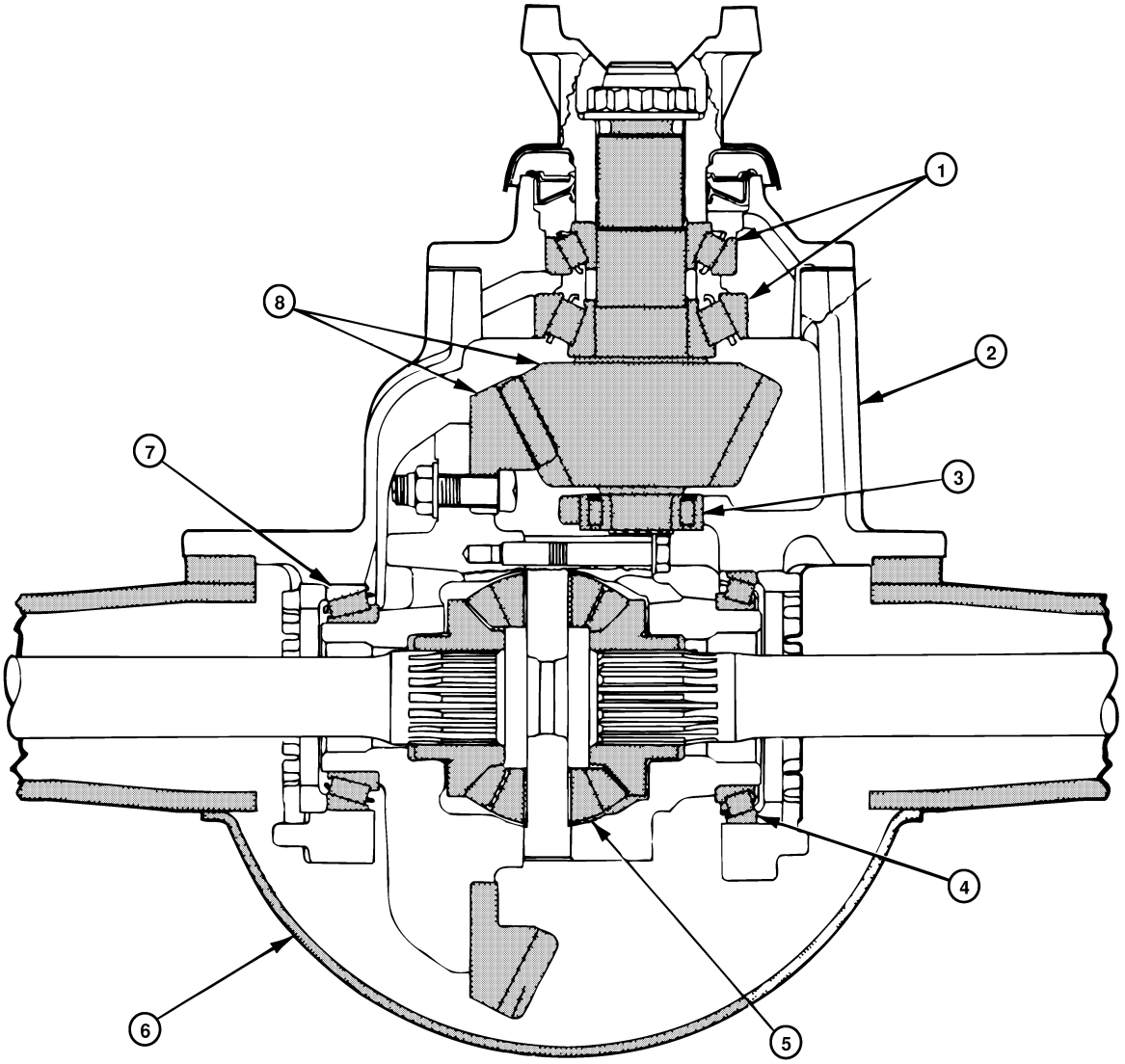
Meritor single reduction standard carriers, **Figure 1.1**, are used in most Meritor single axles, rear of tandem axles and front drive steering axles.

The single reduction carrier models are front mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels all the time.

Figure 1.1



1	TAPERED ROLLER BEARINGS
2	CARRIER
3	STRAIGHT ROLLER BEARING
4	TAPERED ROLLER BEARING
5	BEVEL DIFFERENTIAL GEARS
6	HOUSING
7	TAPERED ROLLER BEARING
8	HYPOID DRIVE PINION AND RING GEAR

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Axle Models Covered in This Manual

The following table lists all axle models covered in this manual.

Single Drive Axles:						**For All RS & RT Single Reduction Axle Model Series, Refer to Maintenance Manual 5A.**
A-150	E-100	F-140	H-172	Q-100	R-163	
B-100	E-105	G-161	L-100	Q-145	R-170	
B-140	E-150	H-100	L-140	RL-170	S-170	
B-150	F-100	H-140	L-155	R-100	U-140	
C-100	F-106	H-150	L-172	R-140	W-170	
D-100	F-120	H-162	M-172	R-155		
D-140	F-121	H-170	QT-140	R-160		
Rear Axle of Tandem Axles:						
SDHD	SL-100	SQHD	SSHD	SU-170		
SFHD	SLHD	SR-170	ST-170	SUHD		
SHHD	SQ-100	SRHD	STHD	SW-170		
Front Drive Steering Axles:						
FDS-75	FDS-85	FDS-93	FDS-1807	FDS-2100	FDS-2107	FDS-2111
FDS-78	FDS-90	FDS-1600	FDS-1808	FDS-2101	FDS-2110	FDS-2117

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Remove Differential Carrier from Axle Housing

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

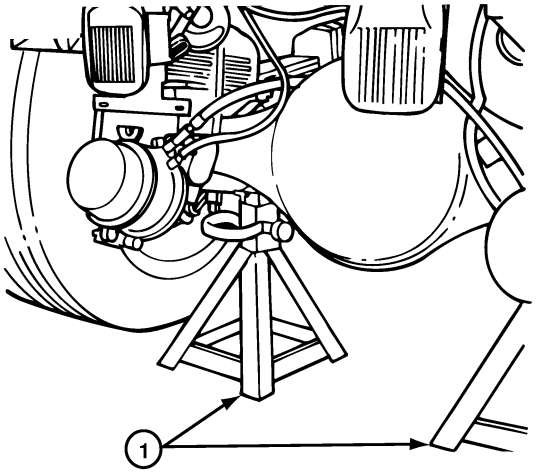
1. Raise the end of vehicle where the axle is mounted. Use a jack or other lifting tool, and place safety stands under each side of the axle. **Figure 2.1**.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury can result.

2. Place jack stands under each spring seat of the axle to hold vehicle in the raised position. **Figure 2.1**.

Figure 2.1



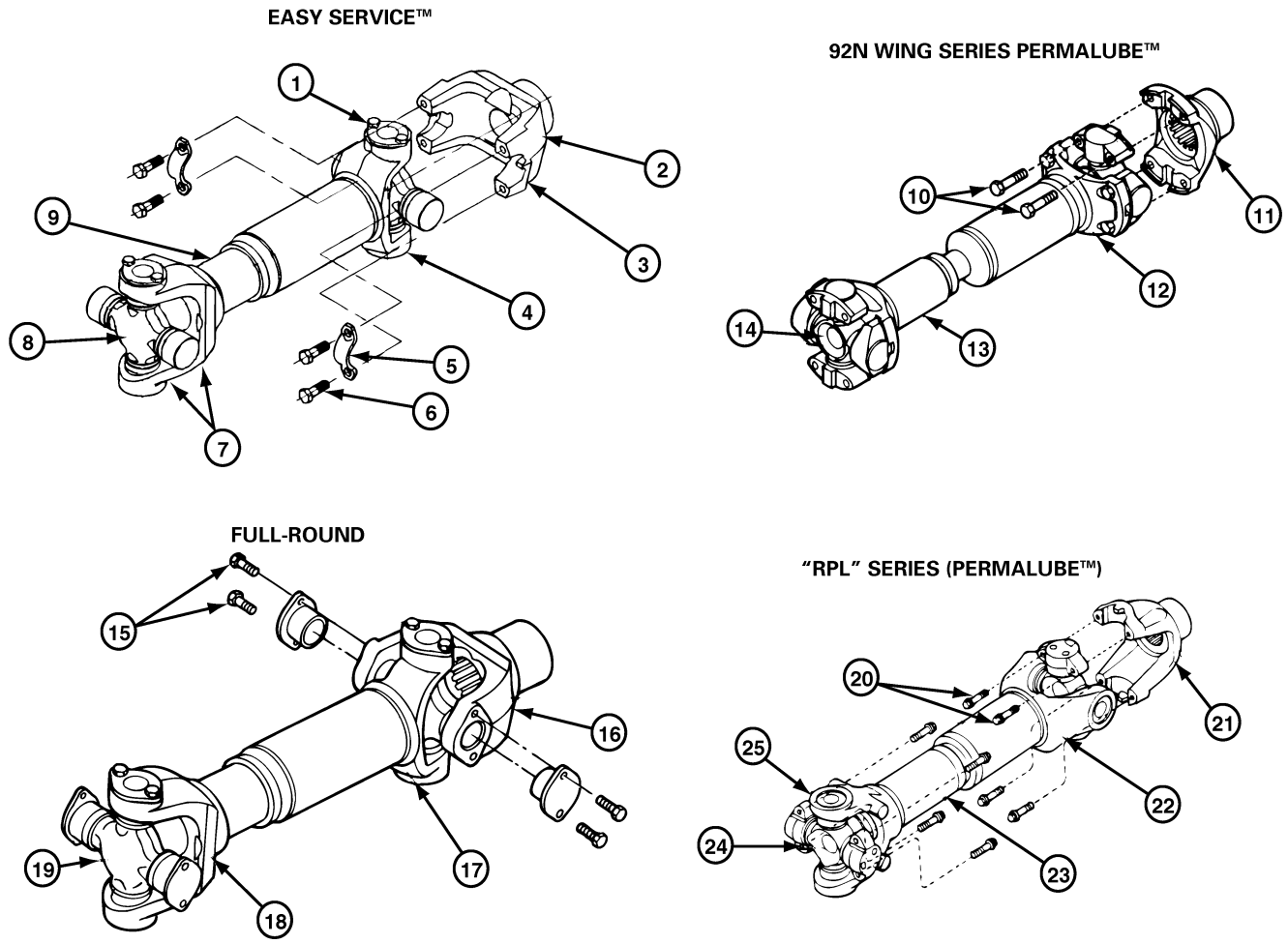
1 SAFETY STANDS

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3. Remove the plug from bottom of axle housing and drain lubricant from the assembly.
4. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier. **Figure 2.2**.
5. Remove the capscrews* and washers or stud nuts* and washers from the flanges of both axle shafts.*
6. Loosen the tapered dowels* if applicable, in the axle flanges of both axle shafts using either the ***Brass Drift*** or the ***Air Hammer Vibration*** method.

*Some Meritor carriers do not have these described parts.

Figure 2.2



1	FULL ROUND BEARING CUPS	10	CAPSCREWS	18	SLIP YOKE
2	END YOKE	11	END YOKE	19	U-JOINT CROSS
3	YOKE SADDLE	12	WELD YOKE	20	CAPSCREWS
4	WELD YOKE	13	SLIP YOKE	21	END YOKE
5	BEARING STRAP	14	U-JOINT CROSS	22	SLIP YOKE
6	CAPSCREWS	15	CAPSCREWS	23	TUBING
7	EASY-SERVICE BEARING CUPS	16	END YOKE	24	U-JOINT CROSS
8	U-JOINT CROSS	17	WELD YOKE	25	WELD YOKE
9	SLIP YOKE				

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Brass Drift Method

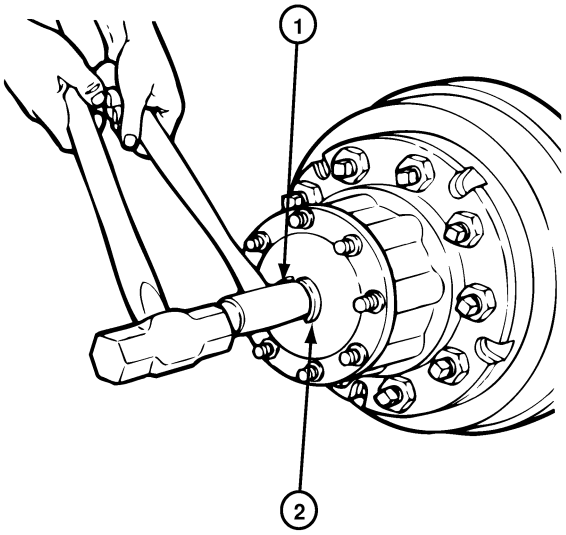
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

1. Hold a 1-1/2 inch diameter brass drift against the center of the axle shaft, inside the round driving lugs. **Figure 2.3**.

Figure 2.3

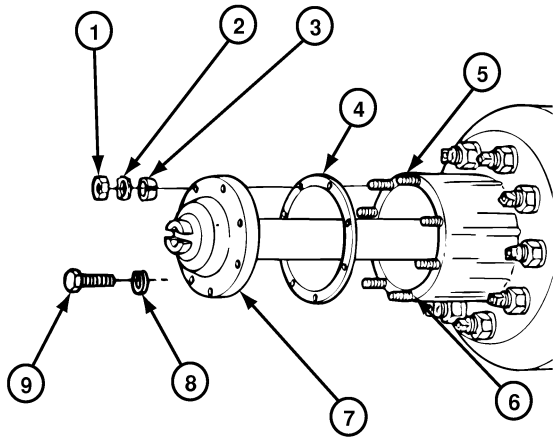


1 BRASS HAMMER
2 DRIVING LUGS

NOTE: A 1-1/2 inch diameter brass hammer can be used as a drift.

2. Strike the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.
3. Mark to identify each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shafts from the main axle hub assembly. **Figure 2.4**.

Figure 2.4



1 STUD NUT
2 WASHER
3 TAPERED DOWEL
4 GASKET
5 STUD
6 SHAFT HUB AXLE
7 AXLE SHAFT (FLANGE)
8 WASHER
9 CAPSCREW

5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

Air Hammer Vibration Method

WARNING

Wear safe eye protection when using an air hammer. When using power tools, axle components can loosen and break off causing serious personal injury.

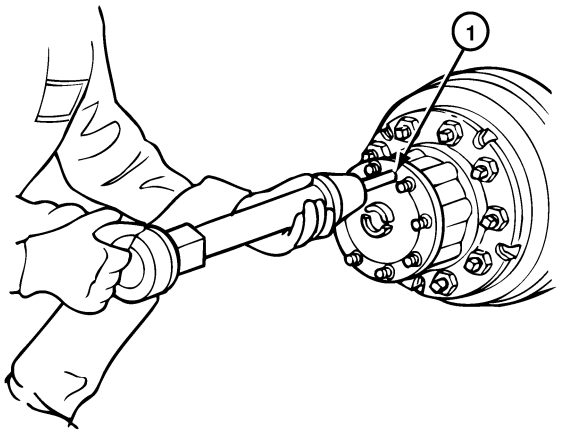
CAUTION

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

1. Use a round hammer bit and an air hammer such as Chicago Pneumatic CP-4181-PULER, or equivalent, to loosen tapered dowels and axle shaft.
2. Place the round hammer bit against the axle shaft (flange) between the hub studs. Operate the air hammer at alternate locations between the studs to loosen the tapered dowels and axle shaft from the hub. **Figure 2.5**.

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Figure 2.5



1 ROUND HAMMER BIT BETWEEN HUB STUDS

3. Mark to identify each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shaft from the main axle hub assembly. **Figure 2.4**.
5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

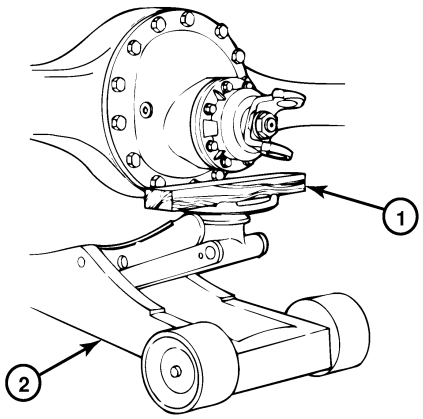
⚠ CAUTION

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

Carrier Removal from Axle

1. Place a hydraulic roller jack under the differential carrier to support the assembly. **Figure 2.6**.
2. Remove all but the top two carrier to housing capscrews or stud nuts and washers.
3. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.
4. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.
5. After the carrier is loosened, remove the top two fasteners.

Figure 2.6



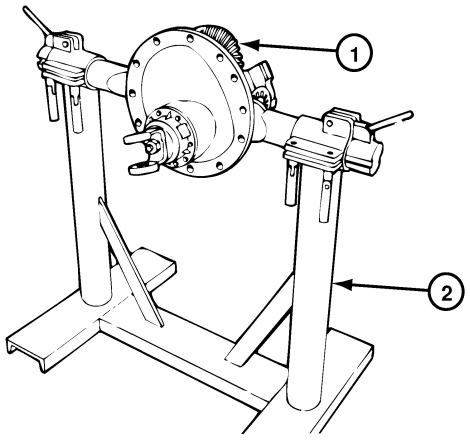
1 WOOD BLOCK
2 ROLLER JACK

⚠ CAUTION

When using a pry bar be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

6. Carefully remove the carrier from the axle housing using the hydraulic roller jack. Use a pry bar that has a round end to help remove the carrier from the housing.
7. Lift the differential carrier by the input yoke or flange and place the assembly in a repair stand. **Figure 2.7**. Use a lifting tool for this procedure. Do not lift by hand. A carrier stand can be built by referring to **Figure 2.8**.

Figure 2.7

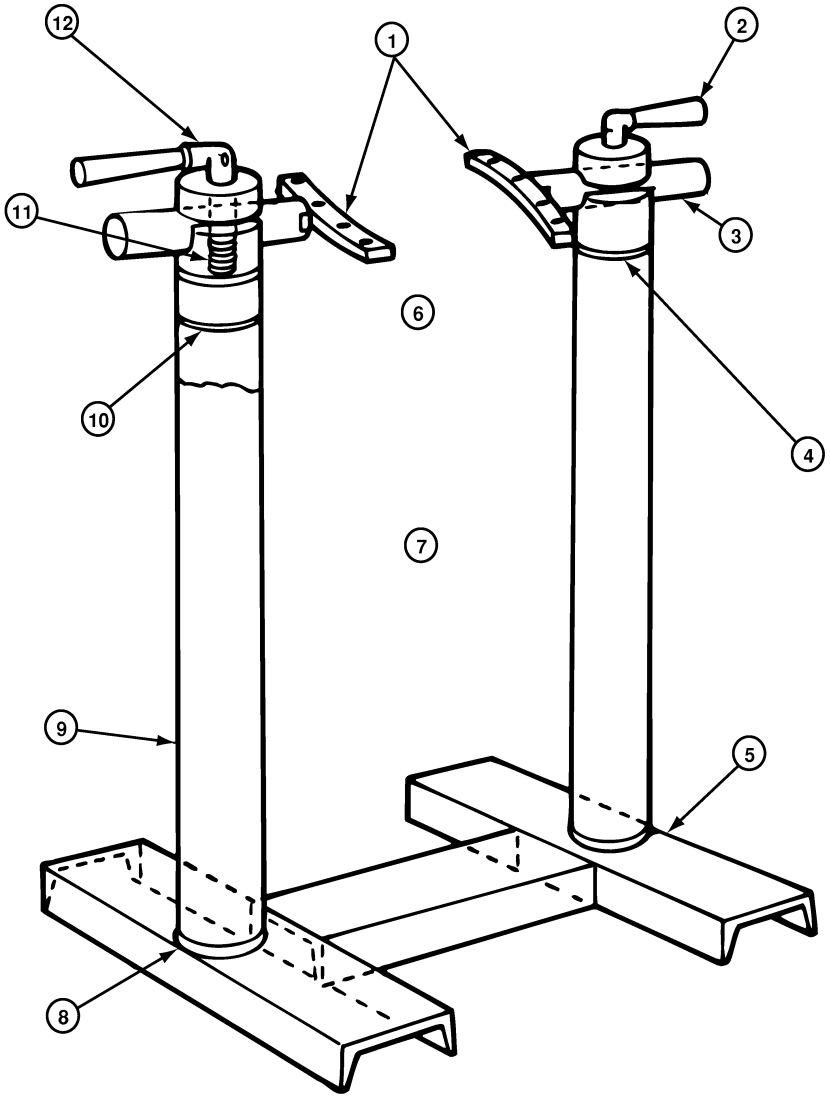


1 DIFFERENTIAL CARRIER
2 REPAIR STAND

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A carrier stand, part number J 3409-D is available from Kent-Moore, Heavy-Duty Division, 28635 Mound Road, Warren, MI 48092.

Figure 2.8



1 PLATES 8' LONG x 3/4" THICK x 1-1/4" WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR
2 HANDLE 7" LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW
3 BAR 2" DIAMETER x 9" LONG WITH ONE END SLOTTED TO FIT PLATE
4 WELD ALL AROUND AFTER PRESSING PLUG IN PIPE
5 WELD
6 SHAPE AND SIZE OF HOLES TO FIT CARRIER
7 23-1/2" CENTER TO CENTER OF PIPE
8 CHAMFER END OF PIPE FOR WELDING
9 4″ DIAMETER PIPE
10 PLUG 4" DIAMETER x 7" LONG WITH ONE END TURNED 3" LONG TO FIT PIPE. DRILL 2" HOLE AND MILL 3/16" WIDE SLOT 2" FROM TOP
11 SCREW 3-1/2" LONG x 5/8" DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2" LENGTH OF THREAD ON OTHER END
12 DRILL 3/8" HOLE THROUGH HANDLE AND SCREW

CARRIER STAND

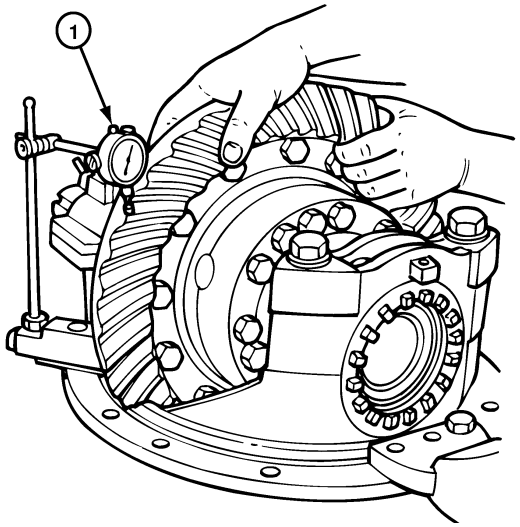
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Remove the Differential and Ring Gear from the Carrier

NOTE: Before working on the differential carrier, inspect the hypoid gear set for damage. If inspection shows no damage, the same gear set can be used again. Measure the backlash of the gear set and make a record of the dimension. **Figure 2.9**. (Refer to "Ring Gear Backlash Adjustment" in Section 5, Steps 1-5.) During differential reassembly, adjust the backlash to the original recorded dimension when the gear set is installed into the carrier.

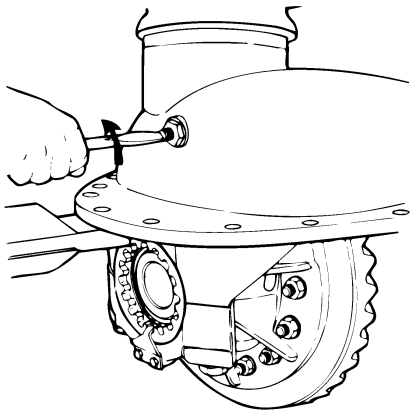
1. Loosen the jam nut* on the thrust screw*. **Figure 2.10**.

Figure 2.9



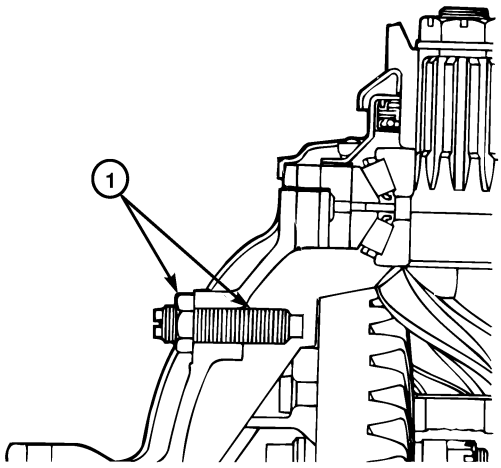
1 DIAL INDICATOR

Figure 2.10



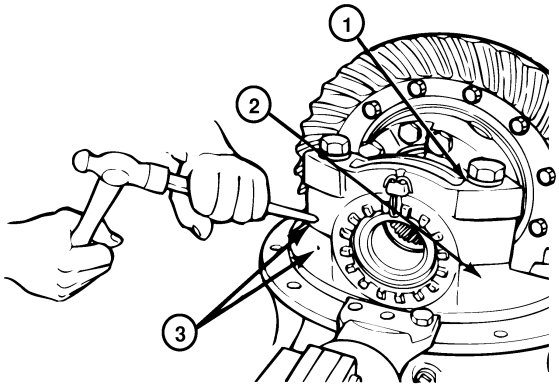
2. Remove the thrust screw* and jam nut* from the differential carrier. **Figure 2.11**.
3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.
4. Mark one carrier leg and bearing cap to correctly match the parts during carrier assembly. Mark the parts using a center punch and hammer. **Figure 2.12**.

Figure 2.11



1 THRUST SCREW AND JAM NUT

Figure 2.12



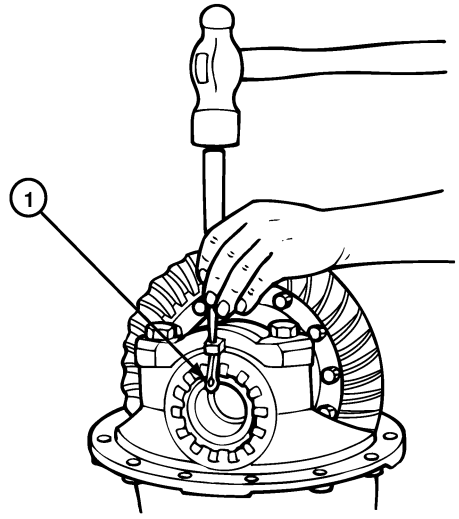
1 BEARING CAP
2 CARRIER LEG
3 MATCH MARKS

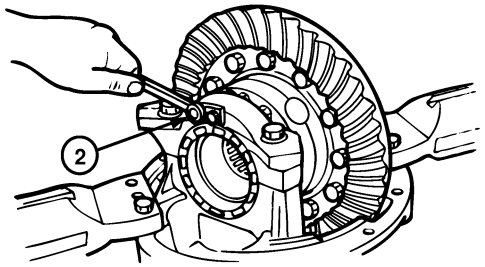
*Some Meritor carriers do not have these described parts.

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5. Remove the cotter keys*, pins* or lock plates* that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews. **Figure 2.13**.
6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers. **Figure 2.14**.
7. Remove the bearing caps and bearing adjusting rings from the carrier. **Figure 2.15**.
8. Safely lift the main differential and ring gear assembly from the carrier. Place the assembly on a work bench. **Figure 2.16**.

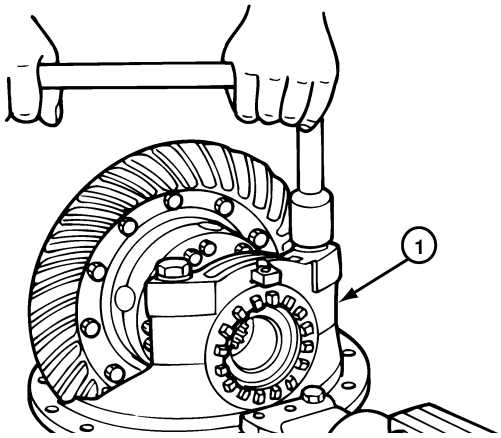
Figure 2.13





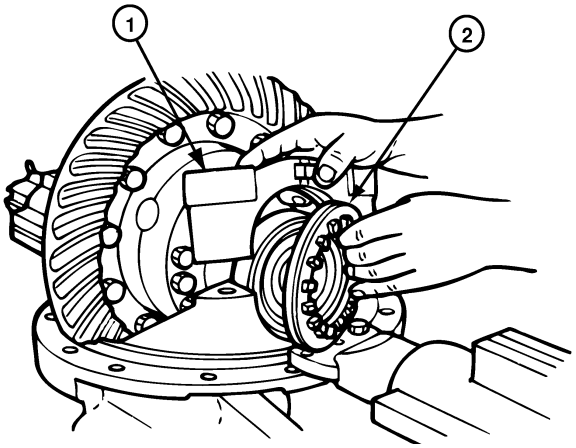
1 REMOVING COTTER KEY
2 REMOVING LOCK PLATE

Figure 2.14



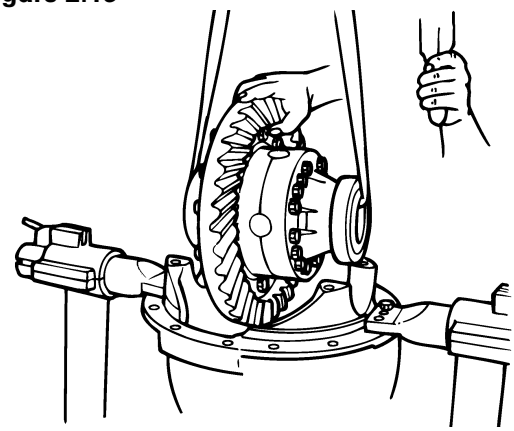
1 BEARING CAP

Figure 2.15



1 BEARING CAP
2 BEARING ADJUSTING RING

Figure 2.16



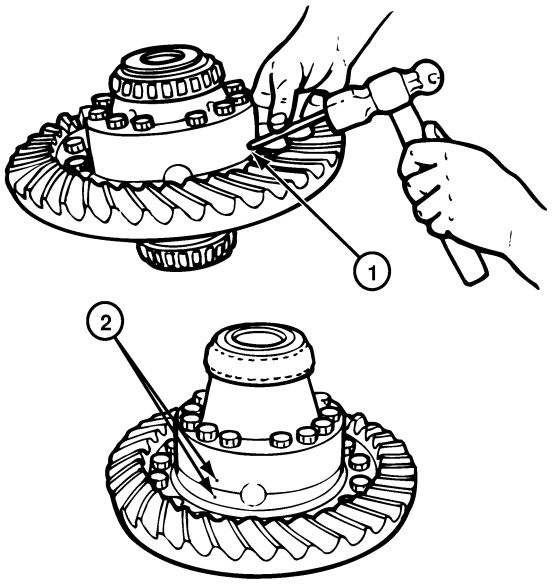
*Some Meritor carriers do not have these described parts.

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Disassemble the Differential and Ring Gear Assembly

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the carrier. **Figure 2.17**.

Figure 2.17



1 MATCH MARKS
2 MATCH MARKS

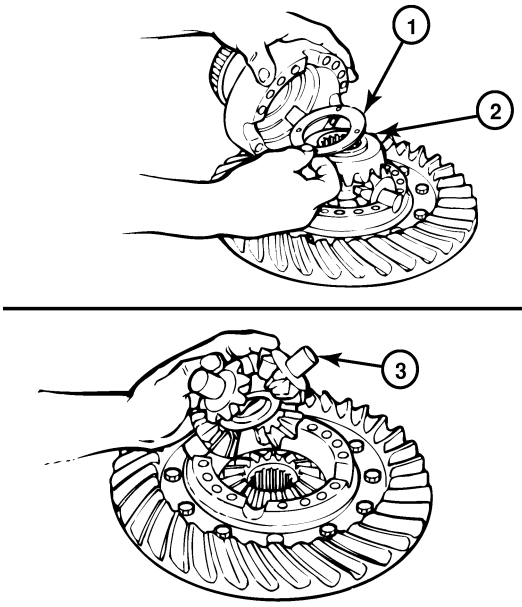
2. Remove the capscrews* and washers* or bolts*, nuts* and washers that hold the case halves together.

⚠ WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.
4. Remove the differential spider (cross), four pinion gears, two side gears and six thrust washers from inside the case halves. **Figure 2.18**.
5. If the ring gear needs to be replaced, remove the bolts*, nuts*, and washers* that hold the gear to the flange case half.

Figure 2.18



1 THRUST WASHER
2 SIDE GEAR
3 SPIDER, PINIONS AND THRUST WASHERS

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

⚠ CAUTION

Do not remove the rivets or rivet heads with a chisel and hammer. Using a flat edge tool can cause damage to the flange case.

6. If rivets* hold the ring gear to the flange case half, remove the rivets as follows:
7. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.

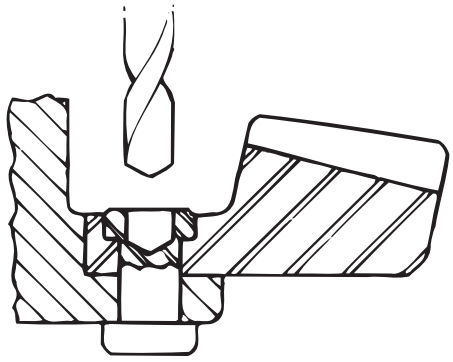
*Some Meritor carriers do not have these described parts.

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8. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 1/32 of an inch smaller than the body diameter of the rivets. **Figure 2.19**.

Figure 2.19

DRILLING RIVET FROM HEAD



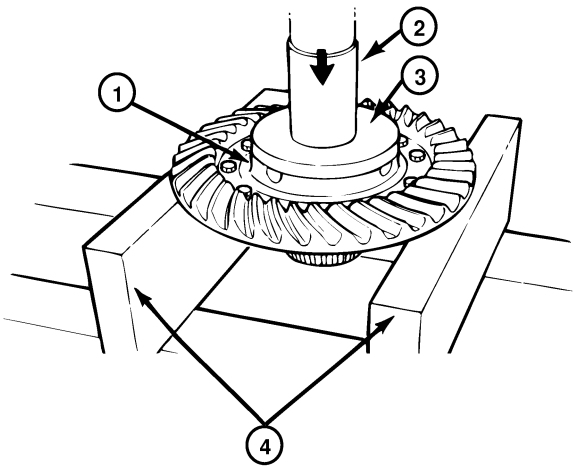
9. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

10. Separate the case half and ring gear using a press. Support the assembly under the ring gear with metal or wood blocks and press the case half through the gear. **Figure 2.20**.

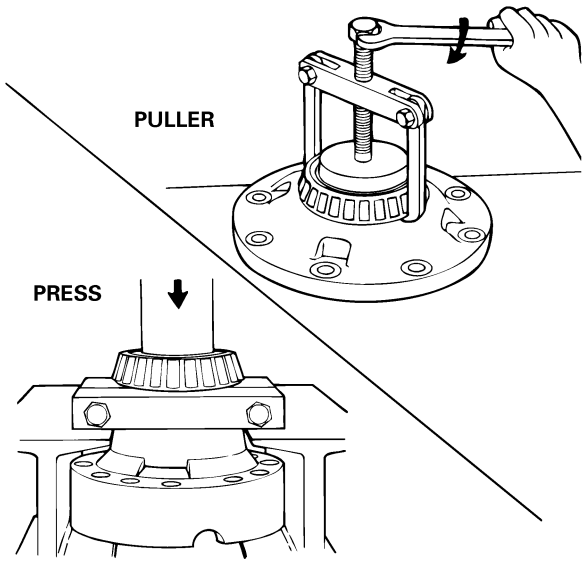
Figure 2.20



1 CASE HALF
2 PRESS
3 PLATE
4 SUPPORTS

11. If the differential bearings need to be replaced, remove the bearing cones from the case halves. Use a bearing puller or press. **Figure 2.21**.

Figure 2.21

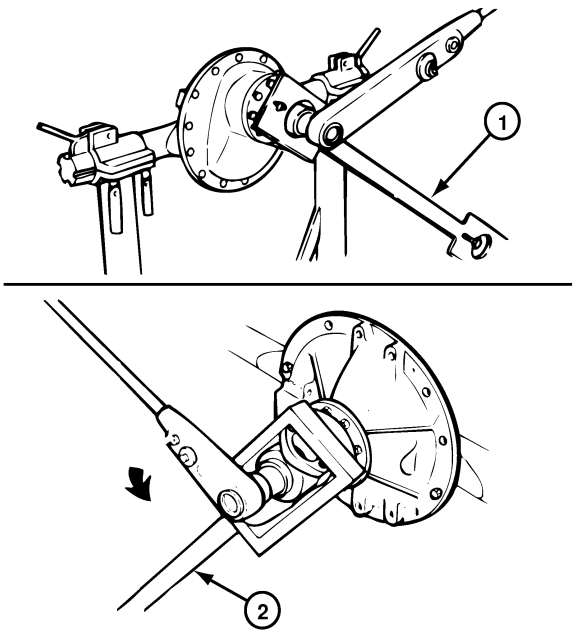


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Remove the Drive Pinion and Bearing Cage from Carrier

1. Fasten a flange bar to the input yoke or flange. When the nut is removed, the bar will hold the drive pinion in position. **Figure 2.22**.

Figure 2.22



1 FLANGE BAR
2 YOKE BAR

2. Remove the nut and washer* from the drive pinion. **Figure 2.22**.
3. Remove the yoke or flange bar.

⚠ *CAUTION*

Do not use a hammer or mallet to loosen and remove the yoke or flange. A hammer or mallet can damage the parts and cause driveline runout, or driveline imbalance problems after carrier to driveline assembly.

4. Remove the yoke or flange from the drive pinion. If the yoke or flange is tight on the pinion, use a puller for removal. **Figure 2.23**.
5. Remove the capscrews and washers that hold the bearing cage in the carrier. **Figure 2.24**.

*Some Meritor carriers do not have these described parts.

Figure 2.23

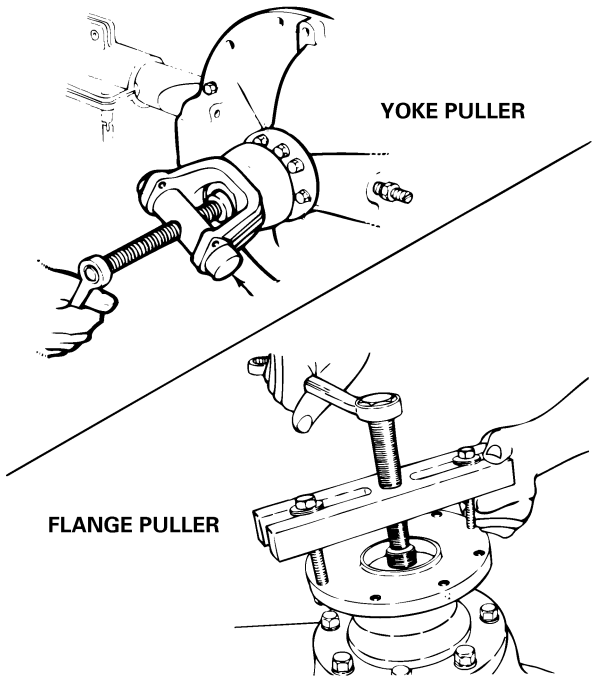
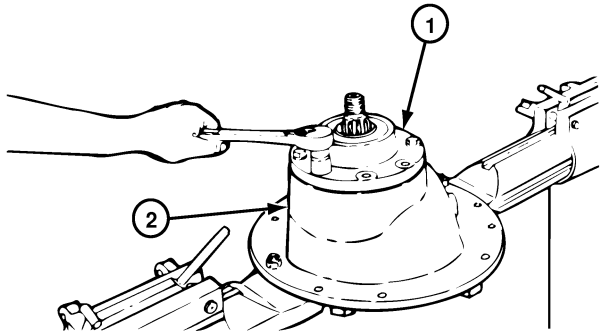


Figure 2.24



1 BEARING CAGE
2 CARRIER

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WARNING

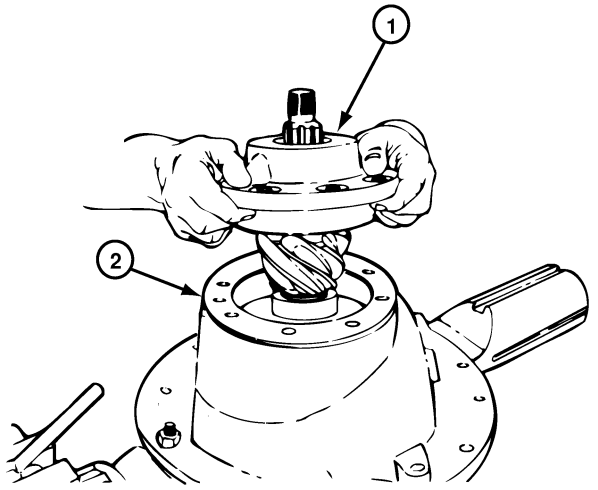
Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

CAUTION

Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing cage, shims and carrier.

6. Remove the drive pinion, bearing cage and shims from the carrier. If the bearing cage is tight in the carrier, hit the bearing cage at several points around the flange area with a leather, plastic or rubber mallet. **Figure 2.25**.

Figure 2.25

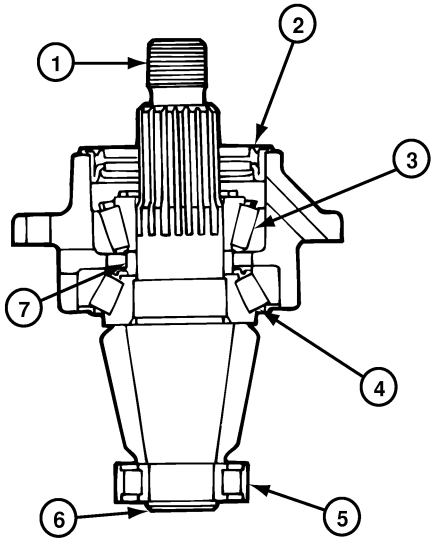


1 DRIVE PINION AND BEARING CAGE
2 SHIMS

7. If the shims are in good condition, keep the shims together for use later when the carrier is assembled.
8. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

Disassemble the Drive Pinion and Bearing Cage

Figure 2.26



1 DRIVE PINION
2 OIL SEAL
3 OUTER BEARING (CUP AND CONE)
4 INNER BEARING (CUP AND CONE)
5 SPIGOT BEARING
6 SNAP RING
7 BEARING SPACER

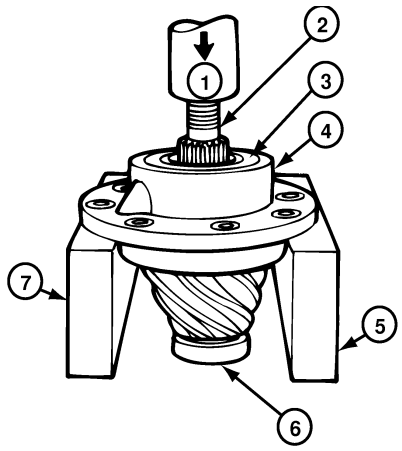
WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. Place the drive pinion and bearing cage in a press. The pinion shaft must be toward the top of the assembly. **Figure 2.27**.

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Figure 2.27



1 PRESS
2 DRIVE PINION
3 OIL SEAL
4 BEARING CAGE
5 SUPPORT
6 SPIGOT BEARING
7 SUPPORT

2. Support the bearing cage under the flange area with metal or wood blocks. **Figure 2.27**.
3. Press the drive pinion through the bearing cage. **Figure 2.27**.

⚠ *WARNING*

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

NOTE: The inner bearing cone and bearing spacer will remain on the pinion shaft.

4. If a press is not available, use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

⚠ *CAUTION*

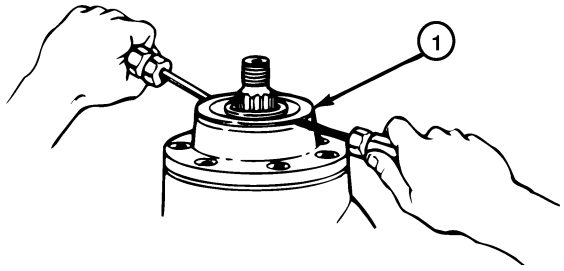
Be careful when removing the seal. Do not damage the wall of bore. Damage to the bore wall can result in oil leaks.

NOTE: When the oil seal has been removed, always replace it with a new triple-lip (main) seal during component reassembly.

5. If the pinion oil seal is mounted directly in the outer bore of the bearing cage, remove the seal at this time.

   Be careful that you do not damage the mounting surfaces of the bearing cage. **Figure 2.28**.

Figure 2.28



1 OIL SEAL

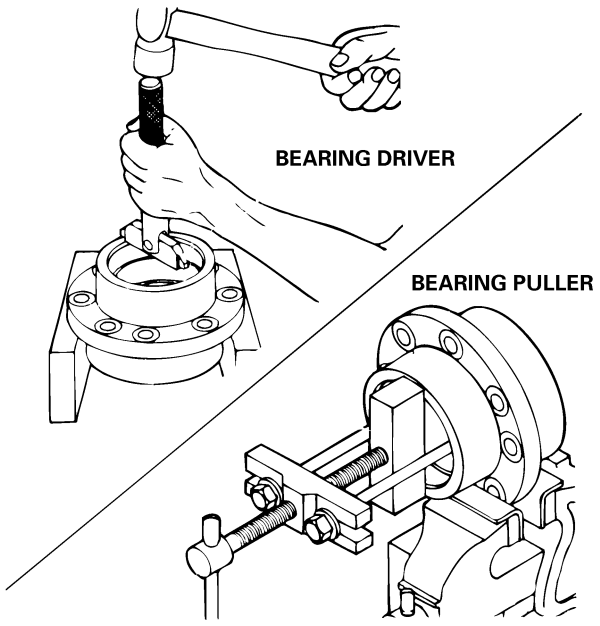
⚠ *WARNING*

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

6. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of cage. Use a press and sleeve, bearing puller, bearing driver or a small drift hammer. The type of tool used depends on the design of the bearing cage. **Figure 2.29**.

   When a press is used, support the bearing cage under the flange area with metal or wood blocks.

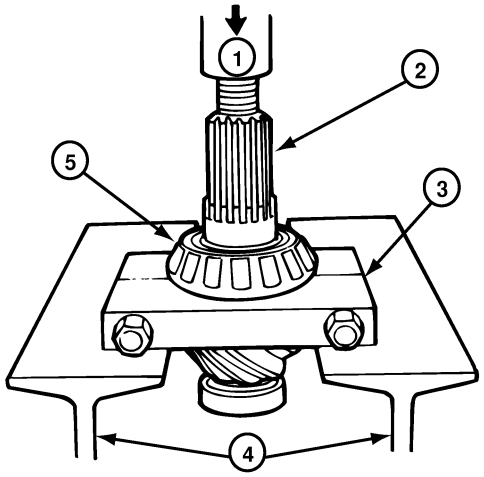
Figure 2.29



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7. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller **MUST** fit under the inner race of the cone to remove the cone correctly without damage. **Figure 2.30**.

Figure 2.30

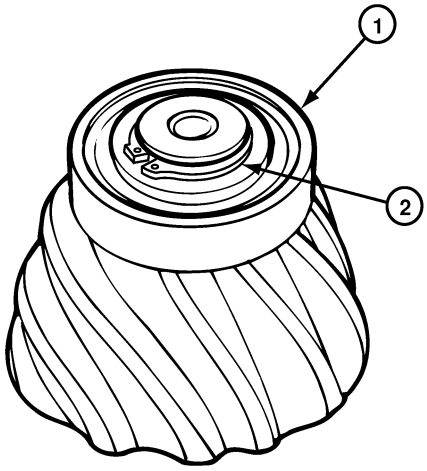


1 PRESS
2 DRIVE PINION
3 BEARING PULLER
4 SUPPORTS
5 INNER BEARING CONE

8. If the spigot bearing needs to be replaced, place the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.
9. Remove the snap ring* from the end of drive pinion with snap ring pliers that expand. **Figure 2.31**.

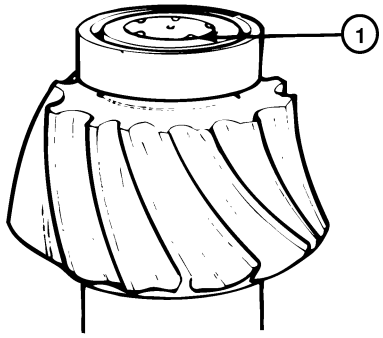
NOTE: Some spigot bearings are fastened to the drive pinion with a special peening tool. **Figure 2.32**.

Figure 2.31



1 SPIGOT BEARING
2 SNAP RING

Figure 2.32



1 PEENING POINTS

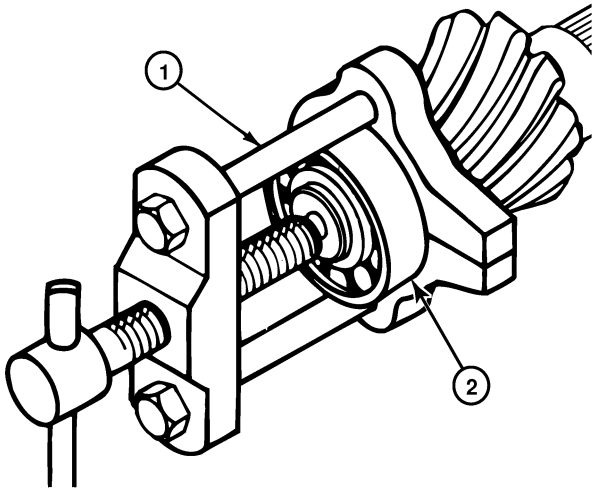
*Some Meritor carriers do not have these described parts.

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10. Remove the spigot bearing from the drive pinion with a bearing puller. **Figure 2.33**.

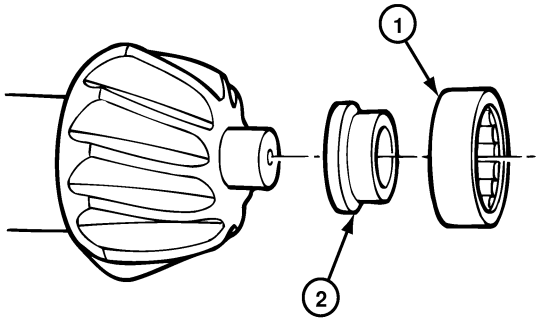
NOTE: Some spigot bearings are a two-piece assembly. Remove the inner race from the pinion with a bearing puller. Remove the outer race/roller assembly from carrier with a drift or a press. **Figure 2.34**.

Figure 2.33



1 BEARING PULLER
2 SPIGOT BEARING

Figure 2.34



1 REMOVE OUTER RACE AND ROLLER ASSEMBLY FROM CARRIER
2 REMOVE INNER RACE FROM PINION

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Cleaning Ground and Polished Parts

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

CAUTION

Use only solvent cleaners to clean ground or polished metal parts. Hot solution tanks or water and alkaline solutions will damage parts. Isopropyl alcohol, kerosene or diesel fuel can be used for this purpose. If required, use a sharp knife to remove gasket material from parts. Be careful not to damage the ground or polished surfaces.

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. ***Do not use gasoline.***
2. Use a tool with a flat blade, if required, to remove sealant material from parts. Be careful not to damage the polished or smooth surfaces.
3. ***Do not*** clean ground or polished parts with water or steam. Do not immerse ground or polished parts in a hot solution tank or use strong alkaline solutions for cleaning, or the smooth sealing surface may be damaged.

Cleaning Rough Parts

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean rough parts with the same method as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak or diluted alkaline solution.
3. Parts must remain in hot solution tanks until heated and completely cleaned.
4. Parts must be washed with water until all traces of the alkaline solution are removed.

Cleaning Axle Assemblies

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.
2. Before the axle is steam cleaned, close or place a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Drying Parts After Cleaning

CAUTION

Damage to bearings can result when they are rotated and dried with compressed air.

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.
3. Except for bearings, parts can be dried with compressed air.

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Preventing Corrosion on Cleaned Parts

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
2. To store parts, apply a special material that prevents corrosion to all surfaces. Wrap cleaned parts in a special paper that will protect the parts from moisture and prevent corrosion during storage.

Inspecting Parts

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Inspect all parts for wear and replace damaged parts. Replacement of damaged or worn parts now, will prevent failure of the assembly later.

1. Inspecting Tapered Roller Bearings:

   Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, the bearing **MUST** be replaced:

   a. The center of large-diameter end of rollers worn level with or below the outer surface. **Figure 3.1**.

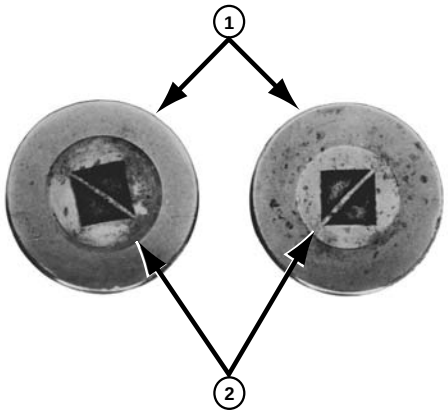
   b. The radius at large-diameter end of rollers worn to a sharp edge. **Figure 3.1**.

   c. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small- or large-diameter end of both parts. **Figure 3.2**.

   d. Deep cracks or breaks in the cup, cone inner race or roller surfaces. **Figure 3.2**.

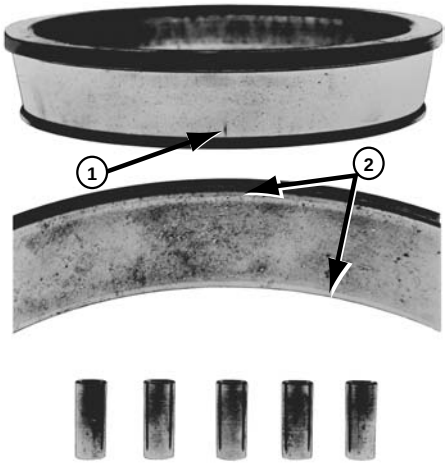
   e. Bright wear marks on the outer surface of the roller cage. **Figure 3.3**.

Figure 3.1



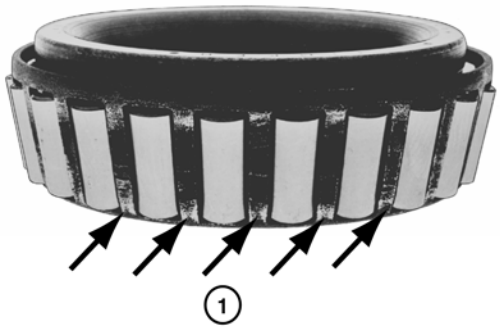
1 WORN RADIUS
2 WORN SURFACE

Figure 3.2



1 CRACK
2 WEAR GROOVE

Figure 3.3



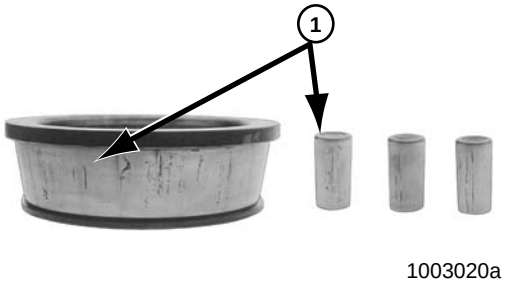
1 WEAR MARKS

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f. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 3.4**.

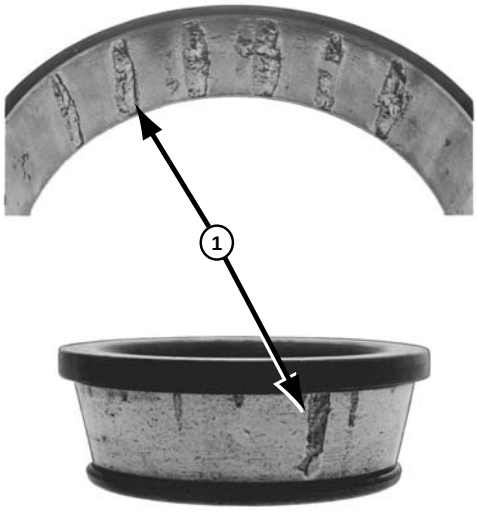
g. Damage on the cup and cone inner race surfaces that touch the rollers. **Figure 3.5**.

Figure 3.4



1 ETCHING AND PITTING

Figure 3.5



1 SPALLING AND FLAKING

CAUTION

Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both drive gear and pinion must be replaced at the same time.

2. Inspect hypoid pinions and gears for wear or damage. Gears that are worn or damaged **MUST** be replaced.

CAUTION

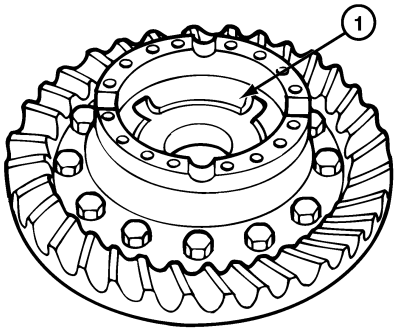
Always replace thrust washers, differential side gears and pinion gears in full matched sets. A higher stress on original parts and early failure of the entire assembly will result if a new part is used in combination with parts that are older or worn.

3. Inspect the Main Differential Assembly:

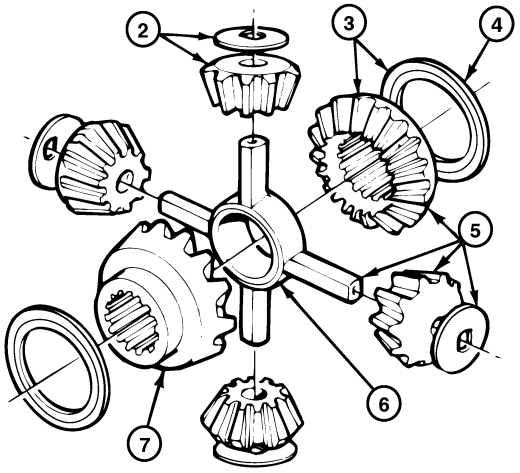
   Inspect the following parts for wear or stress. Parts that are damaged **MUST** be replaced. **Figure 3.6**.

Figure 3.6

DIFFERENTIAL CASE HALVES



DIFFERENTIAL GEAR NEST ASSEMBLY



1	**INSPECT INSIDE SURFACES**	**5**	**INSPECT**
2	**PINION AND THRUST WASHER**	**6**	**SPIDER (CROSS)**
3	**SIDE GEAR AND THRUST WASHER**	**7**	**INSPECT**
4	**INSPECT**		

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a. Inside surfaces of both case halves.

b. Both surfaces of all thrust washers.

c. The four trunnion ends of the spider (cross).

d. Teeth and splines of both differential side gears.

e. Teeth and bore of all differential pinions.

4. Inspect Axle Shafts:

   a. Inspect axle shafts for wear and cracks at the flange, shaft and splines.

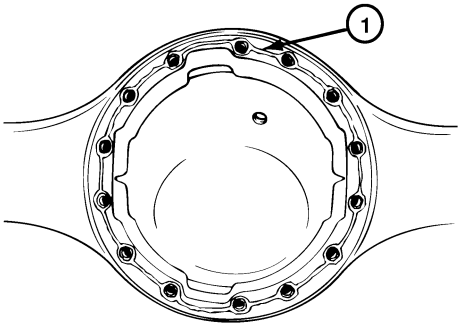
   b. Replace axle shafts, if required.

Repair or Replacement of Parts, General

Replace worn or damaged parts of an axle assembly. The following are some examples in inspecting for part replacement or repair.

1. Replace any fastener if corners of the head are worn.
2. Replace washers if damaged.
3. Replace gaskets, oil seals or grease seals at the time of axle or carrier repair.
4. Clean parts and apply new silicone gasket material where required when axle or carrier is assembled. **Figure 3.7**.

Figure 3.7



1 REMOVE SILICONE GASKET FROM PARTS

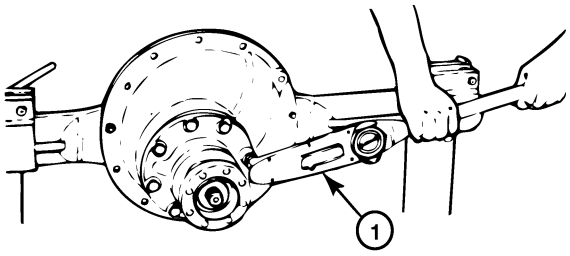
5. Remove nicks, mars and burrs from parts with machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.

CAUTION

Threads must be without damage and clean so that accurate adjustments and correct torque values can be applied to fasteners and parts.

6. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.
7. Tighten all fasteners to the correct torque values. Refer to **Table J** for torque values of fasteners. **Figure 3.8**.

Figure 3.8



1 ALWAYS USE TORQUE WRENCHES

8. **DO NOT** repair rear axle housings by bending or straightening.

WARNING

Repair of axle housings by bending or straightening will cause poor or unsafe vehicle operation and early failure of the axle.

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Repair Axle by Welding

1. ArvinMeritor Commercial Vehicle Systems will permit repairing drive axle housing assemblies by welding **ONLY** in the following areas:
   a. Snorkel welds.
   b. Housing seam welds between the suspension attaching brackets.
   c. Bracket welding to drive axle housing. Refer to TP-9421.
   d. Refer to Meritor Maintenance Manual 8 for approved axle welding procedures.
   e. Contact your Meritor representative for further or specific recommendations.

WARNING

Using wrong welding procedures or welding at locations other than the three areas permitted by ArvinMeritor will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the vehicle and early axle failure. The following procedure must be used.

CAUTION

Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A repaired housing must be used only in correct specified vehicle load applications.

2. Welding Procedure
   a. Drain the lubricant from the axle assembly.
   b. Remove hub, drum, wheel bearing and brake air chambers.
   c. Remove the axle shafts and differential carrier from the axle housing.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

   d. Clean the damaged area inside and outside the housing. Cleaning solvent can be used.
   e. Grind the damaged weld to the base metal.
   f. Warm the complete axle housing to a temperature of 70°F–80°F (21°C–27°C) or higher.
   g. Before you start welding, heat the damaged area to be repaired to approximately 300°F (149°C).
   h. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rods that can be used are E-7018 or ER-70S-3.

CAUTION

If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in the correct sealed containers must be heated at 700°F (371°C) for one hour before welding. Wet electrodes must be dried at 180°F (82°C) for one to two hours and then heated at 700°F (371°C) for one hour before welding.

   i. Fill in the weld gap as follows:
      1. The opening in cover welds **MUST** be filled level with the old weld.
      2. The opening in seam welds **MUST** be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.
      3. Clean the new weld area. Carefully remove all the rough weld material.
      4. Install the differential carrier and axle shafts.
      5. Fill the axle assembly with the correct amount of lubricant. Refer to Maintenance Manual 1, *Lubrication*, for information on lubricants.

CAUTION

Do not connect the ground cable at any point on the axle assembly that will place a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electrical arcing in the bearing and bearing track areas.

A good location to connect the ground cable is the spring mounting pad of the housing.

NOTE: Before welding brackets or other components to the axle housing, contact ArvinMeritor for proper welding procedures.

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Bending or Straightening Drive Axle Housings

ArvinMeritor Commercial Vehicle Systems strongly recommends against any attempt to correct or modify drive axle housings by bending or straightening. All damaged drive axle housings should be replaced.

WARNING

Do not bend or straighten damaged drive axle housings. Any bending or straightening process may result in misalignment or weakening of the axle housing and cause component damage and result in serious personal injury.

Removing Dri-Loc® Fasteners

If it is difficult to remove fasteners from components, the strength of Dri-Loc®, Meritor adhesive or Loctite® 277 can be decreased by heating. Use the following procedure:

1. Heat the fastener for three to five seconds **ONLY** and try to loosen the fastener with a wrench. **DO NOT** use an impact wrench to loosen the fastener or hit the fastener with a hammer.

CAUTION

Do not exceed 350°F (177°C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

2. Repeat Step 1 until the fastener can be removed.

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Installing Fasteners with Pre-Applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent

Installing New Fasteners with Pre-applied Adhesive Patches

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Clean the oil and dirt from threaded holes. Use a wire brush. There is no other special cleaning required.

CAUTION

Do not apply adhesives or sealants on new fasteners with pre-applied adhesive patches or inside closed threaded holes. If other adhesives or sealants are used, the new adhesive will not function correctly.

2. Assemble parts using the new pre-applied adhesive fasteners.

NOTE: There is no drying time required for fasteners with pre-applied adhesive.

3. Tighten the fasteners to the required torque value for that size fastener.

Installing Original or Used Fasteners Using Meritor Liquid Adhesive 2297-C-7049 or Loctite® 680 or Equivalent

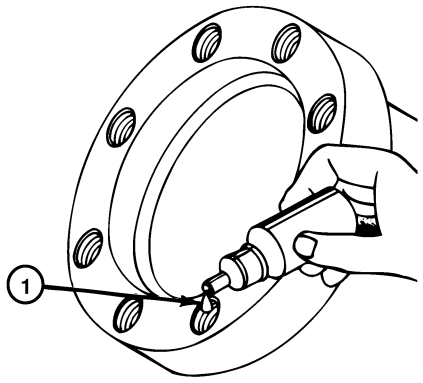
1. Clean the oil, dirt and old adhesive from all threads and threaded holes. Use a wire brush.

CAUTION

Do not apply adhesive directly to the fastener threads. Air pressure in a closed hole will push the adhesive out and away from mating surfaces as the fastener is installed.

2. Apply four or five drops of Meritor Liquid Adhesive, Loctite® 680 or equivalent inside each threaded hole or bore ONLY. Make sure the adhesive is applied inside to the bore threads. **Figure 4.1**.

Figure 4.1



1 4 TO 5 DROPS ON BORE THREADS

3. Tighten the fasteners to the required torque value for that size fastener.

NOTE: There is no drying time required for Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 or equivalent.

Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential

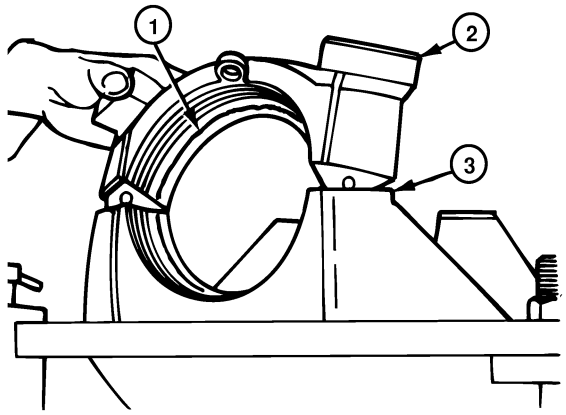
Use adhesive 2297-T-4180 for all axles.

1. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. **DO NOT** get oil on the outer diameter of the bearing cup and **DO NOT** permit oil to drip on the bearing bores.

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3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360° around the smooth, ground surfaces only. **DO NOT** place adhesive on threaded areas. **Figure 4.2**.

Figure 4.2



1 ADHESIVE
2 BEARING CAP
3 CARRIER LEG

NOTE: Meritor adhesive 2297-T-4180 will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the adhesive from the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure, refer to "Install the Differential and Ring Gear Assembly" in Section 5.
5. Adjust preload of the differential bearings, backlash and tooth contact patterns of the gear set as required using the normal procedures. Refer to "Adjust Preload of Differential Bearings" in Section 5.

Application of Three Bond 1216 or Equivalent Silicone Gasket Material

WARNING

Take care when you use silicone gasket materials to avoid serious personal injury. Follow the manufacturer's instructions to prevent irritation to the eyes and skin.

NOTE: The following silicone gasket products or equivalent are available in 3 oz (85 gram) tubes and can be used for Meritor components:

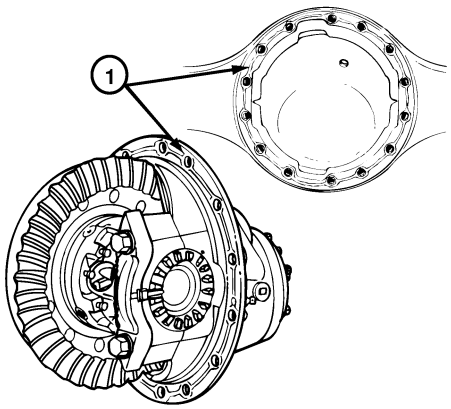
- Three Bond RTV No. TB 1216 (Grey) — Meritor Part Number 2297-Z-7098
- Loctite® Ultra Grey Adhesive/Sealant #18581 — Meritor Part Number 2297-A-7021

Also available in 120 oz (3.4 kg) cartridges:

- Three Bond RTV1216 (Grey) — Meritor Part Number 2297-A-7051

1. Remove all old gasket material from both surfaces. **Figure 4.3**.
2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture without damaging the mating surfaces. **Figure 4.3**.

Figure 4.3



1 REMOVE OLD SEALANT MATERIAL

HOUSING AND CARRIER SHOWN

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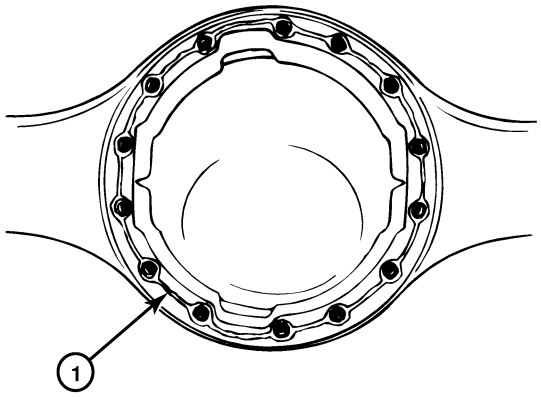
3. Dry both surfaces.

CAUTION

The amount of silicone gasket material applied must not exceed 0.125-inch (3 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the components.

4. Apply 0.125-inch (3 mm) diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes on that surface. **Figure 4.4**.
5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. There is no special procedure or additional torque value required. Refer to **Table J**.
6. Wait 20 minutes before filling the assembly with lubricant.

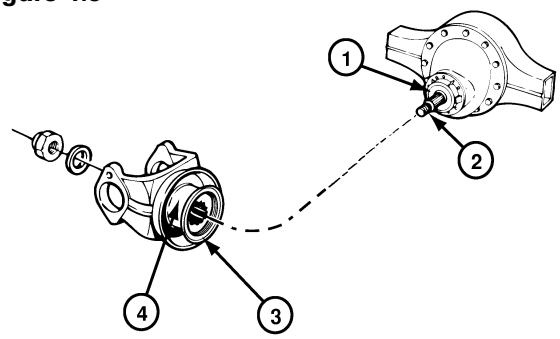
Figure 4.4



1 0.125" (3 MM) DIAMETER SILICONE GASKET BEAD

Installing Tight Fit Yokes and POSE™ Seal

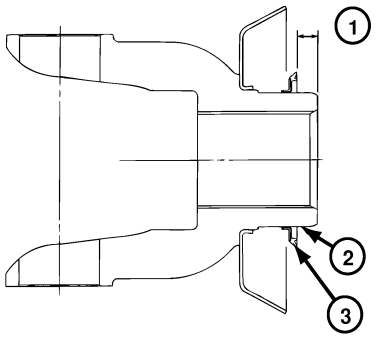
Figure 4.5



1 LUBRICATE TRIPLE-LIP (MAIN) SEAL
2 INPUT SHAFT (PINION)
3 POSE™ SEAL 0.25"–0.50" (6.4 MM–12.7 MM) ONTO HUB
4 INSPECT YOKE HUB

1. Apply the same lubricant used in the axle housing to the hub of the yoke or flange.
2. Inspect and make sure the lips of the POSE™ seal and the outer retainer of the triple-lip (main) seal are clean and free from dirt and particles that may cause lubricant leakage between the seals.
3. Install the POSE™ seal on the hub of the yoke or flange by hand. The lips of the seal must face toward the end of the hub (opposite shoulder). Slide the POSE™ seal on the hub until the lips are from 0.25-inch to 0.50-inch (6.4 mm-12.7 mm) from the end of the hub. ***Do not install the POSE™ seal against the shoulder.*** **Figure 4.6**.

Figure 4.6



1 0.25"–0.50" (6.4 MM–12.7 MM)
2 YOKE HUB
3 FACE SEAL ASSEMBLY (POSE™ SEAL ELEMENT)

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NOTE: The POSE™ seal will position itself correctly as the yoke or flange is pressed on the shaft.

4. Before you install the yoke or flange on the shaft, apply the same lubricant used in the axle housing to the hub.
5. Install the yoke or flange using the correct procedure.

NOTE: The yoke must be completely seated before tightening pinion nut to the input shaft.

General Yoke and U-Joint Reassembly

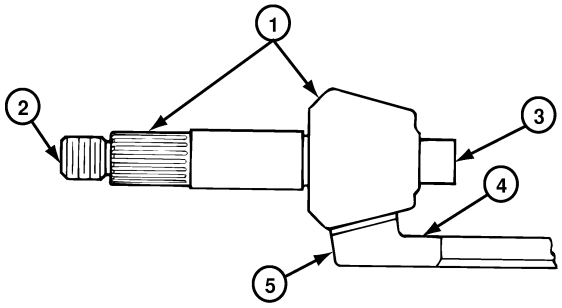
Install the end yoke hub capscrews by hand after seating the U-joint. Tighten the capscrews according to manufacturer's torque specifications.

Gear Set Information (Drive Pinion and Ring Gear Marks)

NOTE: Read the following information before installing a new gear set in the carrier. Always inspect the gear set for correct marks to make sure the gears are a matched set.

The locations of the marks are shown in **Figure 4.7**.

Figure 4.7



1 ALTERNATE LOCATIONS: PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO., PINION CONE VARIATION NO.

2 PART NO., TOOTH COMBINATION NO.

3 GEAR SET MATCH NO., PINION CONE VARIATION NO.

4 PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO.

5 PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO., PINION CONE VARIATION NO.

1. **Part Number**
   a. **Examples of gear set part numbers:**
      - Conventional ring gear, 36786.
      - Conventional drive pinion, 36787.
      - Generoid ring gear, 36786 K or 36786 K2.
      - Generoid drive pinion, 36787 K or 36787 K2.

NOTE: The last digit in part numbers for Generoid gears is a letter or letter and number.

   b. **Location on Drive Pinion:** End at threads.
   c. **Location on Ring Gear:** Front face or outer diameter.

2. **Tooth Combination Number**
   a. **Example of a tooth combination number:** 5-37.

NOTE: A 5-37 gear set has a 5-tooth drive pinion and a 37-tooth ring gear.

   b. **Location on Drive Pinion:** End at threads.
   c. **Location on Ring Gear:** Front face or outer diameter.

3. **Gear Set Match Number**

   Meritor drive pinions and ring gears are available only as matched sets. Both gears of a set have a match number.

   a. **Example of a gear set match number:** M29.

NOTE: A gear set match number has any combination of a number or letter and number.

   b. **Location on Drive Pinion:** End of gear head.
   c. **Location on Ring Gear:** Front face or outer diameter.

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NOTE: The pinion cone variation number is not used when inspecting for a matched gear set. The number is used when you adjust the depth of the pinion in the carrier. Refer to the procedure for adjusting the shim pack thickness under the pinion cage heading.

4. **Pinion Cone Variation Number**

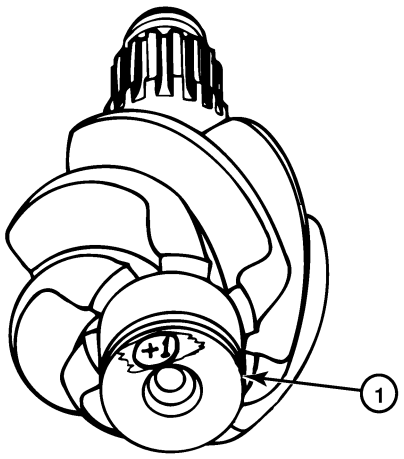
   a. Examples — refer to **Figure 4.8**.

   Pinion cone variation numbers:

   - PC+3
   - PC–5
   - +2
   - –1
   - +0.01 mm
   - –0.02 mm

   b. Location on Gear Set: End of pinion gear head or outer diameter of ring gear.

Figure 4.8



1 PINION CONE VARIATION NUMBER

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Assemble the Drive Pinion, Bearings and Bearing Cage

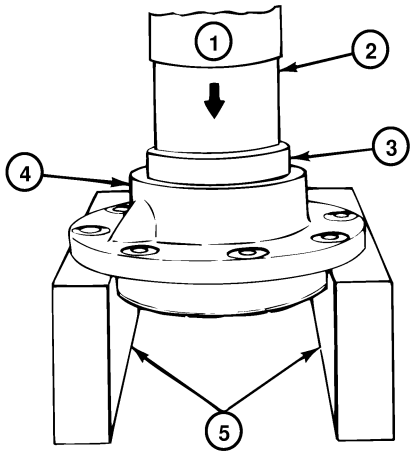
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. Place the bearing cage in a press. **Figure 5.1**.

Figure 5.1



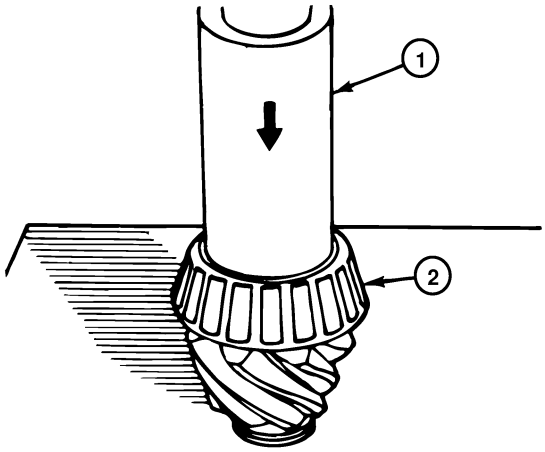
1 PRESS
2 SLEEVE
3 BEARING CUP
4 CAGE
5 SUPPORTS

2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup. **Figure 5.1**.

NOTE: Use the same procedure for both bearing cups.

4. Place the drive pinion in a press, gear head (teeth) toward the bottom. **Figure 5.2**.

Figure 5.2



1 SLEEVE
2 INNER BEARING CONE

5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

NOTE: Spigot bearings are usually fastened to the drive pinion with a snap ring. Some are fastened with a peening tool, and some are a two-piece bearing assembly with the inner race pressed on the nose of the pinion and the outer race pressed into its bore in the carrier. Use the following procedure to install the spigot bearing, then continue with Steps 9-12 under "Staking the One-Piece Spigot Bearing on the Drive Pinion (Without Snap Ring)."

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6. Installing the One-Piece Spigot Bearing on the Drive Pinion with Snap Ring:

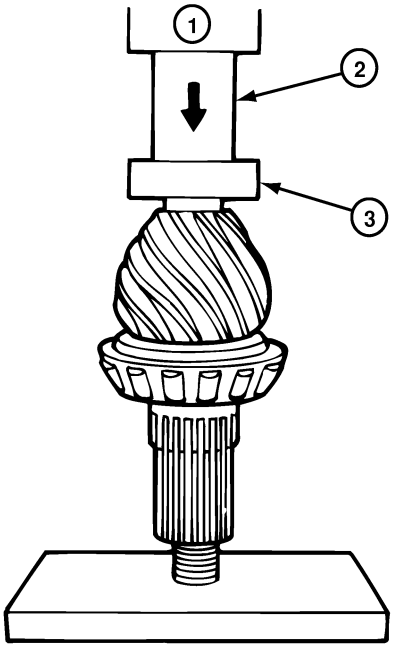
NOTE: This step applies to all axles except:

- Some 160 Series single axles may use snap rings.
- Some 160 and 180 Series rear rear tandem axles may use snap rings.

a. Place the drive pinion in a press, gear head (teeth) toward the top. **Figure 5.3**.

b. Press the spigot bearing on the end of drive pinion until the bearing is flat against the gear head. Use a sleeve of the correct size against the bearing inner race. **Figure 5.3**.

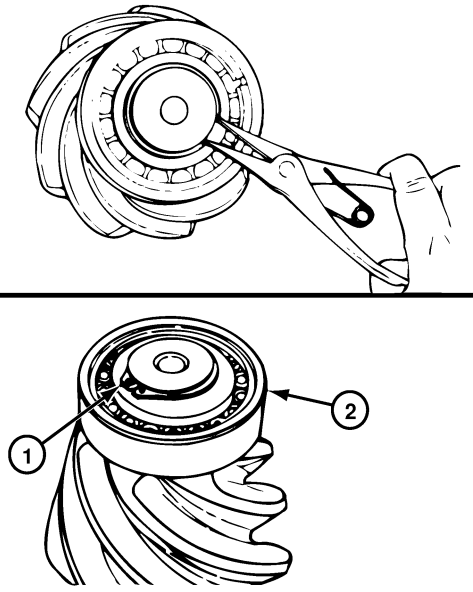
Figure 5.3



1 PRESS
2 SLEEVE
3 SPIGOT BEARING

c. Install the snap ring* into groove in end of drive pinion with snap ring pliers. **Figure 5.4**.

Figure 5.4



1 SNAP RING
2 SPIGOT BEARING

7. Staking the One-Piece Spigot Bearing on the Drive Pinion (Without Snap Ring):

NOTE: This procedure applies to some 180 Series rear rear tandem axles with existing snap ring components.

Specification

- Apply 6,614 lb. (3,000 kg) force on a 0.375-inch (10 mm) ball.
- Stake the end of drive pinion at a minimum of five points. **Figure 5.5**.

When using a staking tool and press, **Figure 5.6**, calculate the force required on the tool as follows.

6,614 lb. (3,000 kg) x amount of balls in tool = pounds or kilograms

*Some Meritor carriers do not have these described parts.

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Example

6,614 lb. x 3 balls = 19,842 pounds

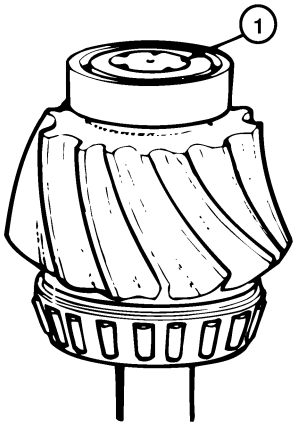
For information about the staking tool, contact your local Meritor representative. **Figure 5.6**.

a. Place the drive pinion and the tube of the staking tool in a press, spigot bearing toward the top. **Figure 5.7**.

b. Calculate the amount of force that will be required on the staking tool. Refer to specification and example calculation.

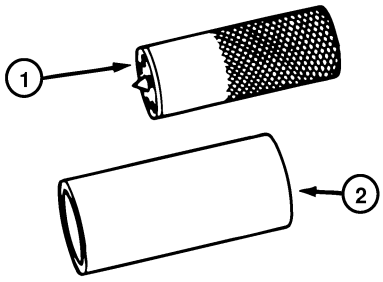
c. Place the punch of the staking tool over the end of the pinion and spigot bearing. Apply the required amount of force on the punch. **Figure 5.7**.

Figure 5.5



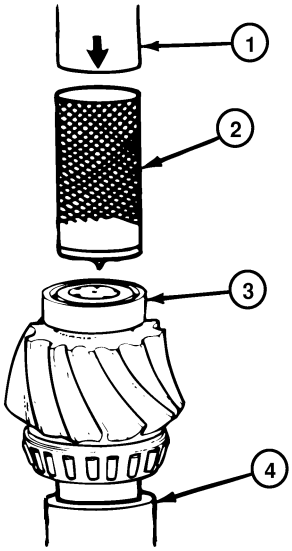
1 STAKING POINTS

Figure 5.6



1 PUNCH
2 TUBE

Figure 5.7



1 PRESS
2 INSTALL AND CENTER THE PUNCH ON THE END OF PINION.
3 SPIGOT BEARING
4 PUT THE SHAFT OF PINION INTO TUBE.

CAUTION

Do not align new points with grooves in end of drive pinion or in old points. If the new staked points are placed in the wrong areas, the spigot bearing will not be held correctly on the pinion shaft.

d. Rotate the punch as many times as required for a minimum of five points. Repeat Step **c** for each point.

NOTE: If a three-ball stake tool is used, rotate the tool 180° (degrees).

8. Installing and Staking the Two-Piece Spigot Bearing on the Drive Pinion:

NOTE: This procedure applies to some 160 Series single rear axles and rear rear tandem axles. These axles may also use a one-piece spigot bearing with a snap ring retainer.

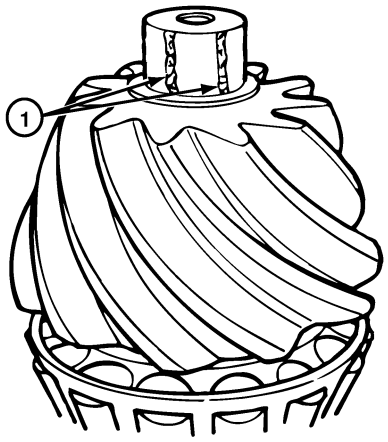
The inner race of two-piece spigot bearings may need to be staked in place on some R-160 series rear axles. Before you stake the pinion, you must heat the pinion stem to soften it.

Kent-Moore Kit J-39039 includes the staking tool, temperature indicating liquid, heating shield and plastigage needed for this job.

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a. Apply two stripes of temperature indicating liquid on the pinion stem from the top to the bottom. **Figure 5.8**. Apply a green stripe to indicate 400°F (205°C) and a blue stripe to indicate 500°F (260°C).

Figure 5.8



1 TEMPERATURE INDICATING LIQUID APPLICATION

WARNING

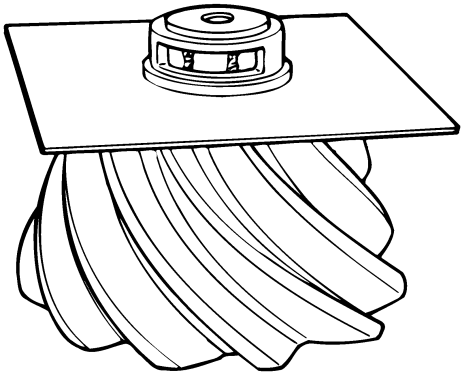
Always wear safe clothing, gloves and eye protection when working with a torch for heating parts to prevent serious personal injury during assembly.

CAUTION

Do not heat the pinion stem without the heat shield in place. Also, do not overheat the pinion stem or you will weaken the metal which can cause early failure. Correct heating will take approximately 25-35 seconds, depending on how hot the torch is.

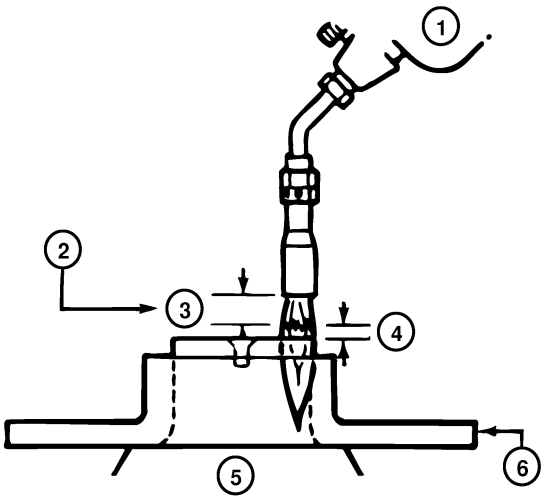
b. Place the heating shield over the pinion stem so that you can see the temperature indicating liquid through the hole in the shield. **Figure 5.9**.

Figure 5.9



c. Light and adjust the torch until the white part of the flame is approximately 1/4-inch long. Keep the white part of the flame approximately 1/8-inch from the top of the stem. **Figure 5.10**. Move the flame around the outer diameter of the top of the pinion stem. The green temperature indicating liquid will turn black before the blue liquid does. Heat the stem until the blue liquid turns black at a point in the middle of the window.

Figure 5.10



1 TORCH
2 WHITE PART OF FLAME
3 1/4"
4 1/8″
5 PINION
6 HEATING SHIELD

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d. Remove the flame and the heat shield from the pinion. Let the pinion air cool for 10 minutes. Use a razor blade to remove the temperature indicating liquid.

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

⚠ CAUTION

Do not press or directly strike the new inner race in Step e or damage to the bearing will result.

e. Use a press, if available, or a brass hammer to install the new inner race. Use the old inner race as a sleeve. The face is completely seated when you cannot fit a 0.002-inch feeler gauge between the race and the pinion shoulder.

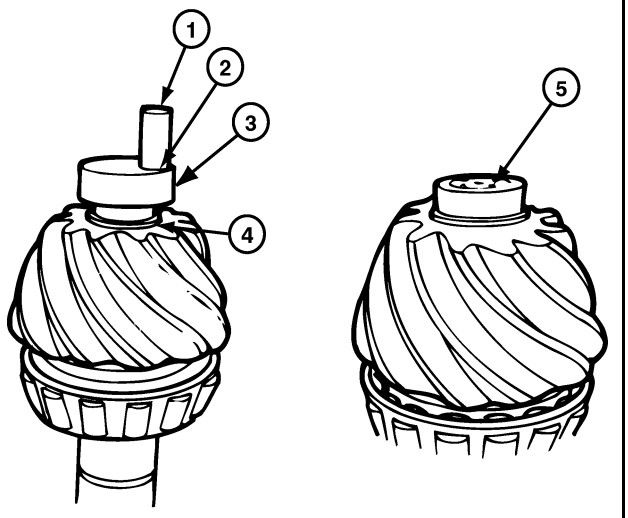
NOTE: To hold the races in place, use a staking tool, instead of the old race, to start the new race on the stem. The old race can be used to completely seat the new race.

In Step f, you do not need to use the plastigage for every stake. Use the plastigage until you are sure you are hitting the punch with the correct amount of force.

f. Place the staking tool over the bearing race. Cut a one inch piece from the green plastigage strip and place in between the punch and the staking tool. **Figure 5.11 — View A**.

g. Strike the punch with a two-three pound brass hammer to upset the end of the pinion stem. Then, remove the strip and measure its thickness against the gauge on the wrapper that the strip came in. The strip must not be less than 0.003-inch thick. This thickness indicates that you are using enough force when you hit the punch. If the strip is too thin, then you must hit the punch harder so the stake will hold the race in place. Rotate the tool and repeat this procedure until there are six evenly spaced stake marks around the stem. **Figure 5.11 — View B**.

Figure 5.11



VIEW A VIEW B

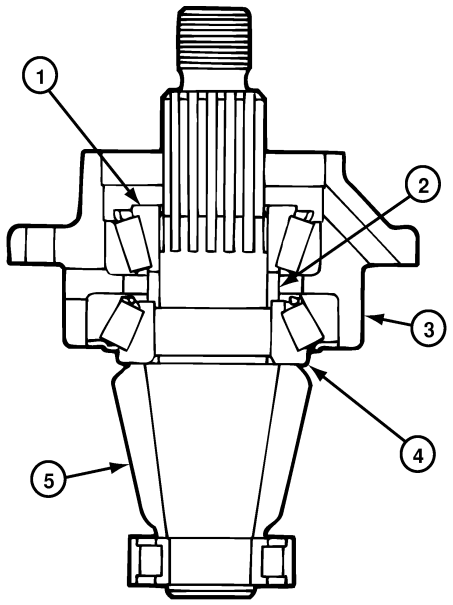
1 PUNCH
2 PLASTIGAGE
3 STAKING TOOL
4 BEARING INNER RACE
5 STAKES

h. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve that is the same size as the outer race and press the bearing until it is squarely against the shoulder in the bottom of its bore.

9. Apply axle lubricant to the bearing cups and to the bearing cones in the cage.
10. Install the drive pinion into the bearing cage.
11. Install the bearing spacer or spacers on pinion shaft against the inner bearing cone. **Figure 5.12**.

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Figure 5.12



1 OUTER BEARING CONE
2 BEARING SPACER
3 BEARING CAGE
4 INNER BEARING CONE
5 DRIVE PINION

NOTE: The spacer or spacers control the preload adjustment of the drive pinion bearings.

12. Install the outer bearing cone on pinion shaft against the spacer. **Figure 5.12**.

NOTE: DO NOT install pinion seal in bearing cage. Continue with adjusting preload of pinion bearings.

Adjusting Preload of Pinion Bearings

Specifications

- New pinion bearings — torque
  — 5 to 45 lb-in (0.56-5.08 N•m)
- Used pinion bearing in good condition — torque
  — 10 to 30 lb-in (1.13-3.39 N•m)

Press Method

NOTE: If a press is not available, or the press does not have a pressure gauge, use the yoke or flange method to adjust pinion bearing preload. Refer to "Yoke or Flange Method" in this section.

1. Place the drive pinion and cage assembly in a press, gear head (teeth) toward the bottom.
2. Install a sleeve of the correct size against the inner race of the outer bearing. **Figure 5.13**.
3. Apply and hold the correct amount pressure to the pinion bearings. Refer to **Table A**. As pressure is applied rotate the bearing cage several times so that bearings make normal contact.

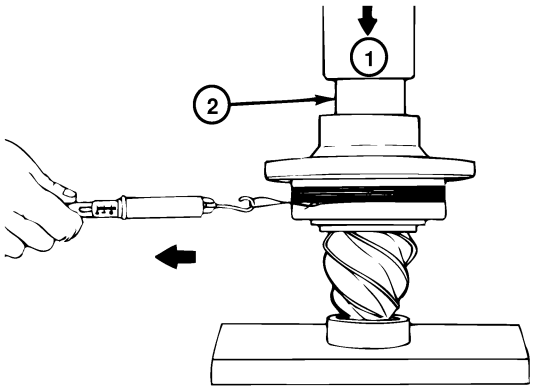
Table A: Pinion Bearing Preload Adjustment Values

Thread Size of Pinion Shaft	Press Pressure Needed on Bearings for Correct Preload.		Torque Value Needed on Pinion Nut for Correct Bearing Preload.	
	pounds/tons	(kg/metric tons)	lb-ft	(N•m)
7/8"-20	22,000/1	(9979/10)	200-275	(271-373)
1"-20	30,000/15	(13608/13.6)	300-400	(407-542)
1 1/4"-12	54,000/27	(24494/24.5)	700-900	(949-1220)
1 1/4"-18	54,000/27	(24494/24.5)	700-900	(949-1220)
1 1/2"-12	54,000/27	(24494/24.5)	800-1100	(1085-1491)
1 1/2"-18	54,000/27	(24494/24.5)	800-1100	(1085-1491)
1 3/4"-12	50,000/25	(22680/22.7)	900-1200	(1220-1627)
2"-12	50,000/25	(22680/22.7)	1200-1500	(1627-2034)

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4. While pressure is held against the assembly, wind a cord around the bearing cage several times.

Figure 5.13

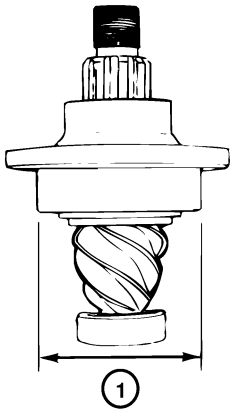


1 PRESS
2 SLEEVE

5. Attach a spring scale to the end of the cord.
6. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Write down and record the reading. **Figure 5.13**.

   NOTE: Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.
7. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters. **Figure 5.14**.
8. Divide the dimension in half to get the radius. Write down and record the radius dimension.

Figure 5.14



1 MEASURE DIAMETER OF CAGE.

9. Use the following procedure to calculate the bearing preload (torque).
   - Pounds Pulled x Radius (inches) = lb-in Preload

     — Preload x 0.113 = N•m Preload
   - Kilograms Pulled x Radius (cm) = kg-cm Preload

     — Preload x 0.098 = N•m Preload

   or

   Examples
   - Reading from spring scale = 7.5 pounds (3.4 kg)
   - Diameter of bearing cage = 6.62 inches (16.80 cm)
   - Radius of bearing cage = 3.31 inches (8.40 cm)

     7.50 lb. x 3.31 in. = 24.80 in-lb Preload

     Preload x 0.113 = 2.800 N•m Preload

     or

     3.4 kg x 8.4 cm = 28.6 kg-cm Preload

     Preload x 0.098 = 2.800 N•m Preload

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10. If the preload (torque) of pinion bearings is not within specifications, do the following procedure then repeat Steps **a** through **i**.

    To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

11. Inspect the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke or flange method.

Yoke or Flange Method

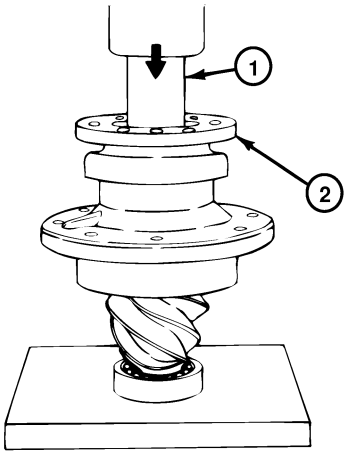
WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. Install the input yoke or flange, nut and washer* on the drive pinion. The yoke or flange **MUST** be seated against the outer bearing.

NOTE: Use a press to install the yoke or flange. **Figure 5.15**.

Figure 5.15



1 PRESS
2 INPUT FLANGE SHOWN

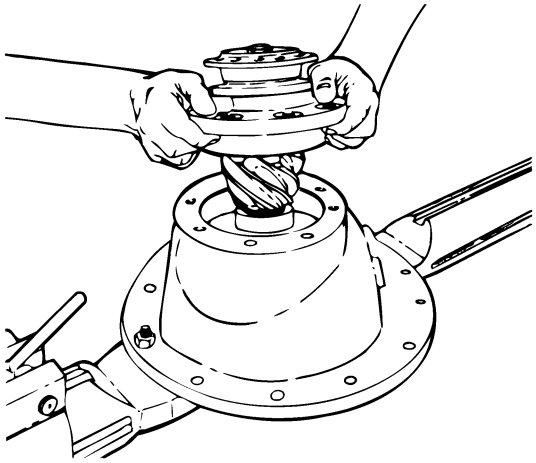
*Some Meritor carriers do not have these described parts.

CAUTION

Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

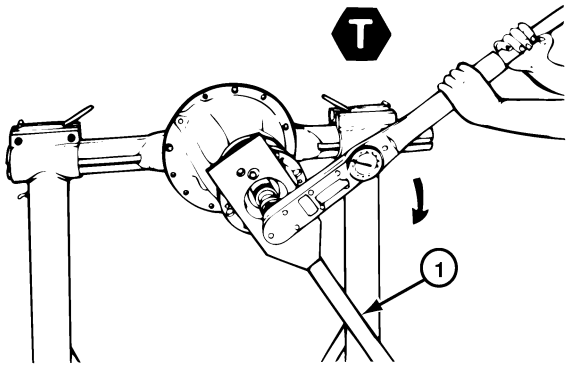
2. Temporarily install the drive pinion and cage assembly in the carrier. Do not install shims under the bearing cage. **Figure 5.16**.

Figure 5.16



3. Install the bearing cage to carrier capscrews. Washers are not required at this time. Tighten the capscrews by hand until snug.
4. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened. **Figure 5.17**.

Figure 5.17



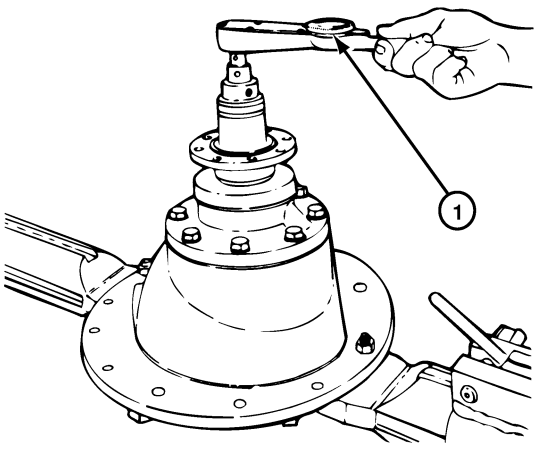
1 USE FLANGE OR YOKE BAR.

5. Tighten the nut on drive pinion to the correct torque value. **Figure 5.17**. Refer to **Table A**.

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6. Remove the yoke or flange bar.
7. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench. **Figure 5.18**.

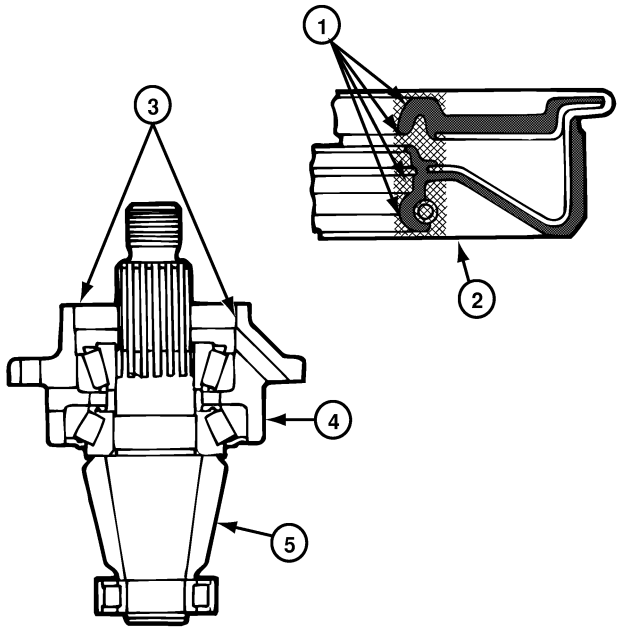
Figure 5.18



1 READ TORQUE VALUE.

8. If the preload (torque) of pinion bearings is not within specifications, remove the pinion and cage assembly from carrier. Do the following procedure, then repeat Steps **a** through **g**.
   - To **INCREASE** preload, install a thinner bearing spacer.
   - To **DECREASE** preload, install a thicker bearing spacer.
9. After adjusting preload of pinion bearings, remove the drive pinion and bearing cage from carrier. Follow Steps 1-5 under "Remove the Drive Pinion and Bearing Cage from Carrier."
10. Install a new triple-lip seal as follows.
    a. Apply the same lubricant used in the axle housing to the outer surface of the seal and the seal bore in the bearing cage. **Figure 5.19**.

Figure 5.19



1 APPLY GREASE.
2 TRIPLE-LIP (MAIN) SEAL
3 APPLY LUBRICANT TO SEAL BORE.
4 BEARING CAGE
5 DRIVE PINION

CAUTION

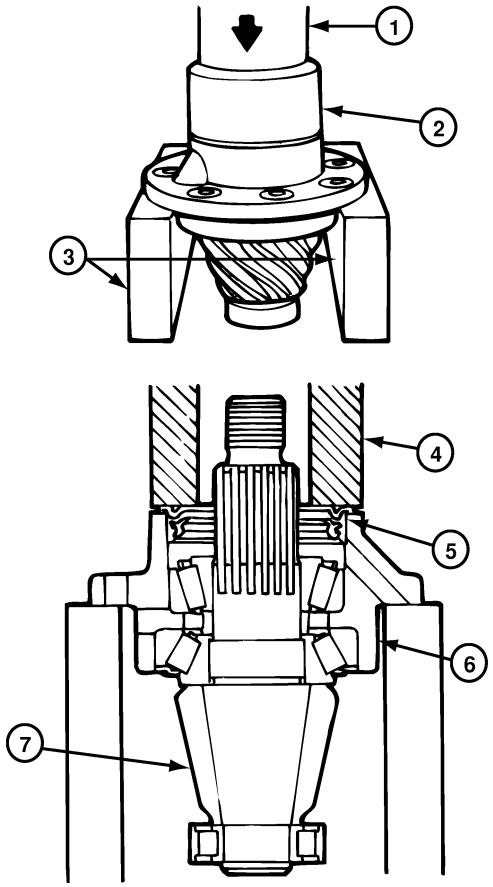
Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.

    b. Place the drive pinion and cage assembly in a press, seal bore toward the top.

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c. Press the seal into bearing cage until flange of seal is flat against the top of bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal flange of seal. The diameter of the sleeve or drive **MUST** be larger than the diameter of the flange. **Figure 5.20**.

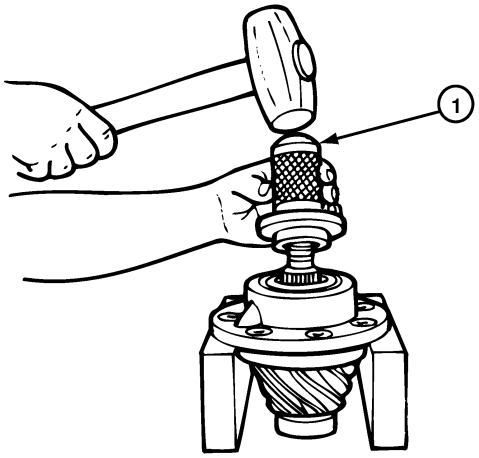
Figure 5.20



1 PRESS
2 SLEEVE
3 SUPPORTS
4 SLEEVE
5 SEAL
6 BEARING CAGE
7 DRIVE PINION

NOTE: If a press is not available, use a mallet and the sleeve or driver to install the seal. **Figure 5.21**.

Figure 5.21

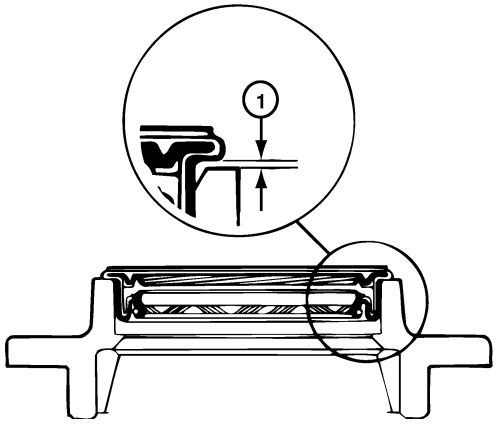


1 SEAL DRIVER

d. After the triple-lip seal is installed, a gap of approximately 0.015- to 0.030-inch (0.38-0.76 mm) between the flange and bearing cage is normal. **Figure 5.22**.

Inspect the gap with a feeler gauge at several points around the seal. The gap must be within 0.015- to 0.030-inch (0.38-0.76 mm). The difference between the largest and smallest gap measurement **MUST NOT** exceed 0.010-inch (0.254 mm).

Figure 5.22



1 0.015-0.030" (0.38-0.76 MM)

SHOWN WITHOUT BEARINGS AND PINION

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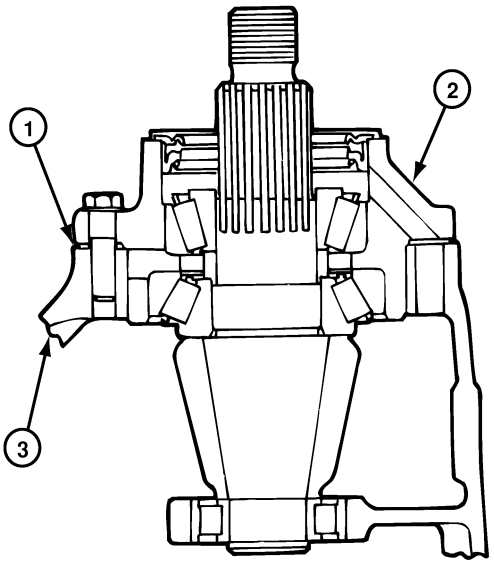
WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)

NOTE: Use this procedure if a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted. **Figure 5.23**.

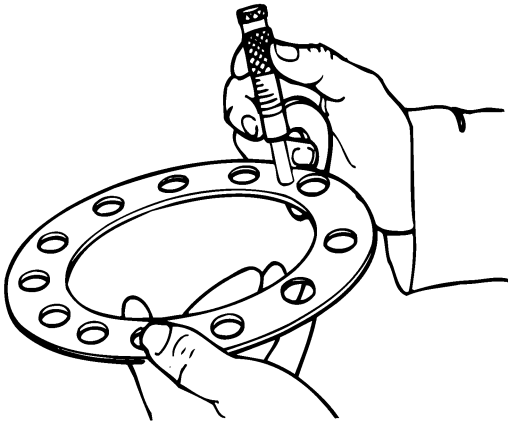
Figure 5.23



1 SHIM PACK CONTROLS DEPTH OF PINION.
2 BEARING CAGE
3 CARRIER

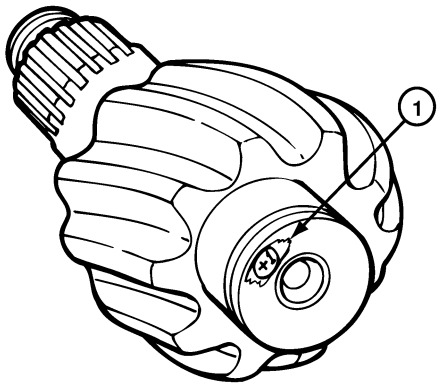
1. Measure the thickness of the old shim pack that was removed from under the pinion cage with a micrometer. Record the measurement for use later. **Figure 5.24**.

Figure 5.24



2. Look at the pinion cone (PC) variation number on the old drive pinion that is being replaced. Refer to "Gear Set Information," Step 4, in Section 4 for examples and location of the number. Record the number for later use. If (PC) variation number cannot be located, assemble gear set with shim pack thickness found in Step 1 under "Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)." **Figure 5.25**.

Figure 5.25



1 PINION CONE VARIATION NUMBER

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NOTE: The pinion cone number can be either 100ths of a millimeter or 1,000ths of an inch. Refer to the following examples.

PC +3, PC–3, +3 or –3 = 0.003 inch

PC +.03, PC–0.03 mm, +0.03 mm or –0.03 = 0.03 mm

To change millimeters to inches — millimeters x 0.039

To change inches to millimeters — inches x 25.40

3. If the old pinion cone number is a plus (+) number, subtract the number from the old shim pack thickness that was measured in Step 2.
4. If the old pinion cone number is a minus (–) number, add the number to the old shim pack thickness that was measured in Step 2.

NOTE: The value calculated in Step 3 or 4 is the thickness of the standard shim pack, without a variation.

5. Look at the pinion cone (PC) variation number on the new drive pinion that will be installed. Record the number for later use.
6. If the new pinion cone number is a plus (+) number, add the number to the standard shim pack thickness that was calculated in Step 3 or 4.
7. If the new pinion cone number is a minus (–) number, subtract the number from the standard shim pack thickness that was calculated in Step 3 or 4.

NOTE: The value calculated in Step 6 or 7 is the thickness of the new shim pack that will be installed. Refer to the following examples, **Table B**.

8. Install the drive pinion, bearing cage and new shim pack into the carrier.

Table B: Shim Pack Thickness Calculations

Examples:	**Inches**	**mm**
1. Old Shim Pack Thickness Old PC Number, PC +2 inches (+0.05 mm) Standard Shim Pack Thickness New PC Number, PC +5 inches (+0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 + 0.005 = 0.033	0.760 – 0.050 = 0.710 + 0.130 = 0.840
2. Old Shim Pack Thickness Old PC Number, PC –2 inches (–0.05 mm) Standard Shim Pack Thickness New PC Number, PC +5 inches (+0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 + 0.005 = 0.037	0.760 + 0.050 = 0.810 + 0.130 = 0.940
3. Old Shim Pack Thickness Old PC Number, PC +2 inches (+0.05 mm) Standard Shim Pack Thickness New PC Number, PC –5 inches (–0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 – 0.005 = 0.023	0.760 – 0.050 = 0.710 – 0.130 = 0.580
4. Old Shim Pack Thickness Old PC Number, PC –2 inches (–0.05 mm) Standard Shim Pack Thickness New PC Number, PC –5 inches (–0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 – 0.005 = 0.027	0.760 + 0.050 = 0.810 – 0.130 = 0.608

NOTE: Drive pinions and ring gears **MUST** be replaced as fully matched sets.

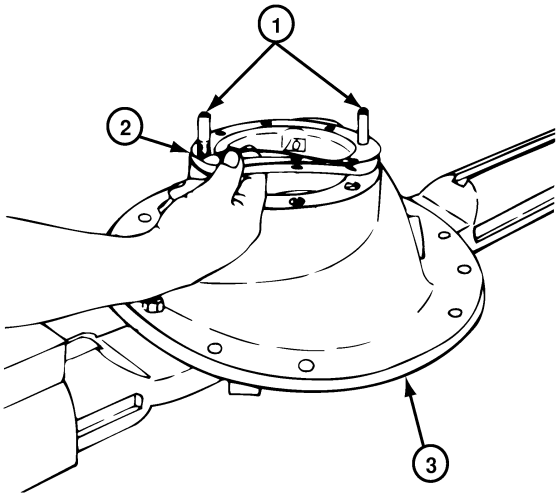
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Installing the Drive Pinion, Bearing Cage and Shim Pack into the Carrier

NOTE: If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. Refer to "Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)" in this section.

1. Select the correct shim pack between the bearing cage and carrier. **Figure 5.26**.
2. Apply Loctite® 518 Gasket Eliminator to face of carrier.
3. Align the oil slots in the shims with oil slots in the bearing cage and carrier. The use of guide studs will help align the shims. **Figure 5.26**.

Figure 5.26



1 GUIDE STUDS
2 THREE SHIMS MINIMUM
3 CARRIER

NOTE: If the pack is made from different thickness shims, install the thinnest shims on both sides of the pack for maximum sealing.

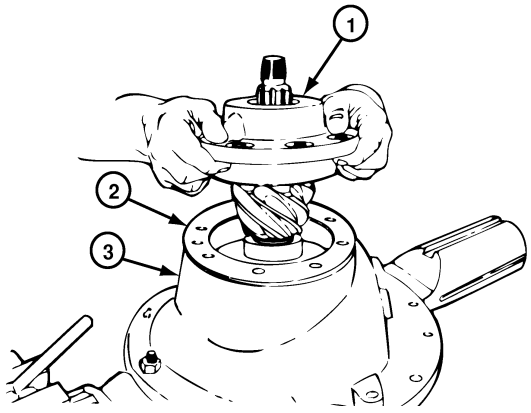
4. Apply Loctite® 518 Gasket Eliminator to top of shim pack.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

5. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to hit the assembly into position. **Figure 5.27**.

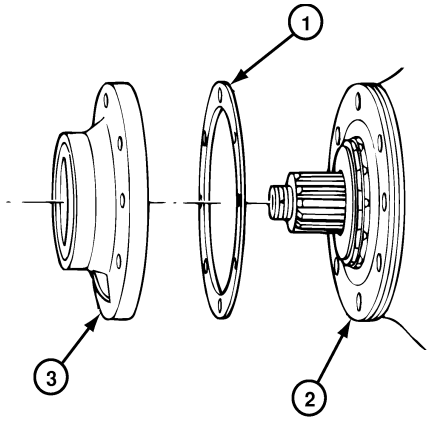
Figure 5.27



1 DRIVE PINION AND BEARING CAGE
2 SHIMS
3 CARRIER

6. If used, install the cover* and seal assembly and gasket* over the bearing cage. **Figure 5.28**.

Figure 5.28



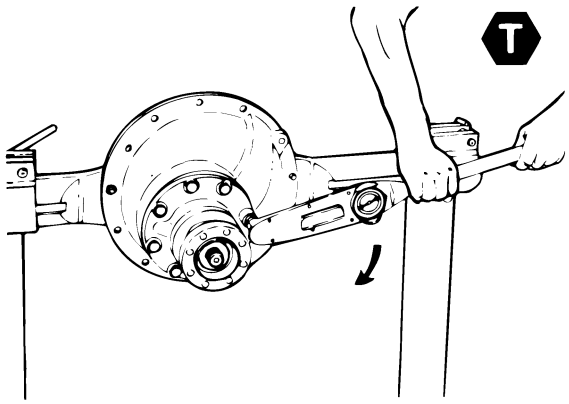
1 GASKET
2 BEARING CAGE
3 COVER AND SEAL ASSEMBLY

*Some Meritor carriers do not have these described parts.

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7. Align the oil slots in the cover* and gasket* with oil slot in the bearing cage.
8. Install the bearing cage to carrier capscrews and washers. Tighten capscrews to correct torque value. Refer to **Table J**. **Figure 5.29**.

Figure 5.29



Installing Tight Fit Yokes and POSE™ Seal

CAUTION

Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.

Do not install tight fit yokes on shafts using a hammer or mallet. Using a hammer or mallet can damage the yoke.

1. Apply axle lubricant on the yoke seal.
2. Inspect all surfaces of the yoke hub for damage.

   If carrier uses a POSE™ seal element, install a new POSE™ seal as follows:

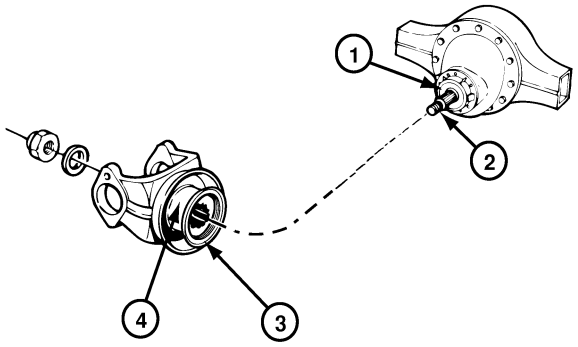
   a. Lightly lubricate yoke journal with same lubricant used in the axle housing.

CAUTION

Make sure that the seal lips are clean and free from dirt and particles that can cause a leak between the yoke and the POSE™ seal.

   b. Partially install the POSE™ seal onto the yoke to 1/4-inch – 1/2-inch as shown in **Figure 5.30**.

Figure 5.30



1 LUBRICATE TRIPLE-LIP (MAIN) SEAL.
2 INPUT SHAFT (PINION)
3 POSE™ SEAL 0.25”–0.50” (6.4 MM–12.7 MM) ONTO HUB
4 INSPECT YOKE HUB.

NOTE: DO NOT install POSE™ seal all the way against the yoke shoulder. This seal is designed to position itself as yoke is installed.

   c. Before installing the yoke onto the drive pinion, lubricate the yoke again with the same lubricant used in the axle housing.

3. Slide the yoke over the input shaft pinion. Align the yoke splines with the shaft splines.

CAUTION

Do not use a hammer or mallet to install the yoke to the input pinion shaft. Using a hammer or mallet can damage the yoke or flange.

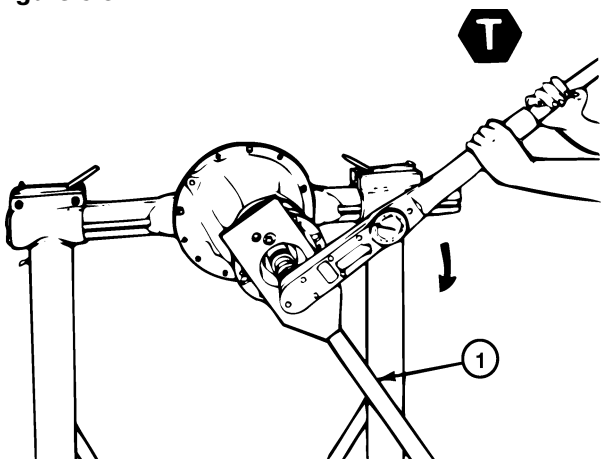
4. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing **BEFORE** the nut is torqued to specifications.

*Some Meritor carriers do not have these described parts.

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5. Install the drive pinion nut on the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. **Figure 5.31**. Refer to **Table J**.

Figure 5.31



1 USE FLANGE OR YOKE BAR.

Assemble the Main Differential and Ring Gear Assembly

CAUTION

Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit. Metal particles between the parts will cause gear runout that exceeds the Meritor specification of 0.008-inch (0.200 mm).

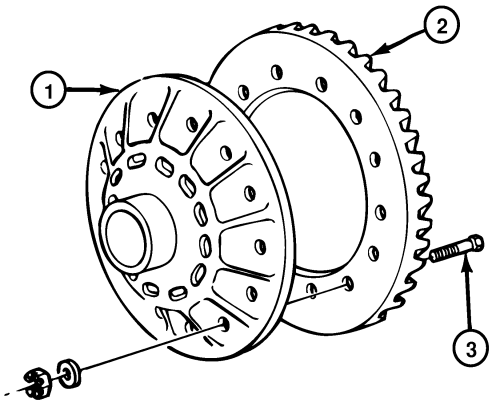
1. Expand the ring gear by heating the gear in a tank of water to a temperature of 160°F to 180°F (71°C-82°C) for 10 to 15 minutes.

WARNING

Wear safe clothing and gloves for protection from injury when working with the hot ring gear.

2. Safely lift the ring gear from the tank of water using a lifting tool.
3. Install the ring gear on the flange case half immediately after the gear is heated. If the ring gear does not fit easily on the case half, heat the gear again. Repeat Step 1.
4. Align fastener holes of the ring gear and flange case half. Rotate the ring gear as needed.
5. If rivets* were used to hold the ring gear to the flange case half, replace them with bolts, nuts and washers.
6. Install the bolts*, nuts* and washers* that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads **MUST** be against the ring gear. **Figure 5.32**.

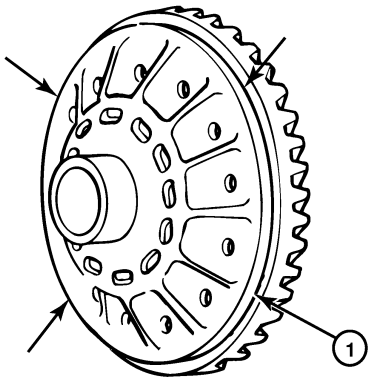
Figure 5.32



1 FLANGE CASE HALF
2 RING GEAR
3 BOLT HEAD AGAINST GEAR

7. Tighten the bolts* and nuts* to the correct torque value. Refer to **Table J**.
8. Inspect for gaps between the back surface of the ring gear and the case flange after the bolts are installed. Use an 0.003-inch (0.080 mm) feeler gauge and inspect at four points around the assembly. **Figure 5.33**.

Figure 5.33



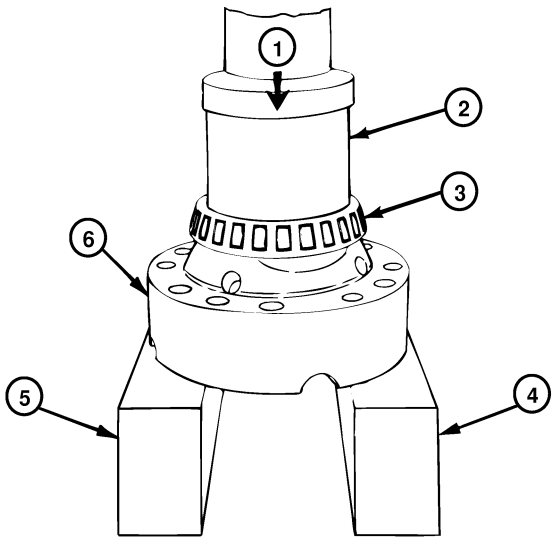
1 CHECK FOR 0.003" GAP AT FOUR LOCATIONS.

*Some Meritor carriers do not have these described parts.

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9. Inspect the flange case half and ring gear for the problem that causes the gap. Repair or replace parts that do not meet specifications.
10. Assemble the repaired or replaced ring gear on the flange case half. Repeat the Main Differential and Ring Gear Assembly procedure.
11. Install the bearing cones on both of the case halves. Use a press and sleeve of the correct size. **Figure 5.34**.

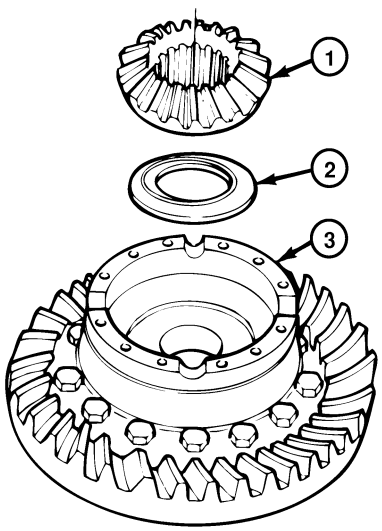
Figure 5.34



1 PRESS
2 SLEEVE
3 BEARING CONE
4 SUPPORT
5 SUPPORT
6 CASE HALF

12. Apply axle lubricant on the inside surfaces of both case halves, spider (cross), thrust washers, side gears and differential pinions.
13. Place the flange case half on a bench, ring gear teeth toward top.
14. Install one thrust washer and side gear into the flange case half. **Figure 5.35**.

Figure 5.35



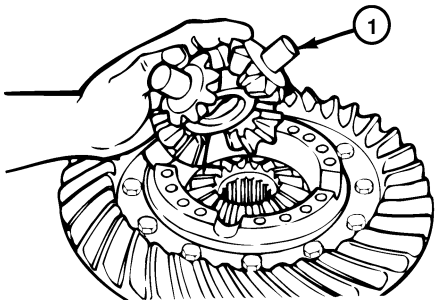
1 SIDE GEAR
2 THRUST WASHER
3 FLANGE CASE HALF

CAUTION

The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half.

15. Install the spider (cross), differential pinions and thrust washers into the flange case half. **Figure 5.36**.

Figure 5.36

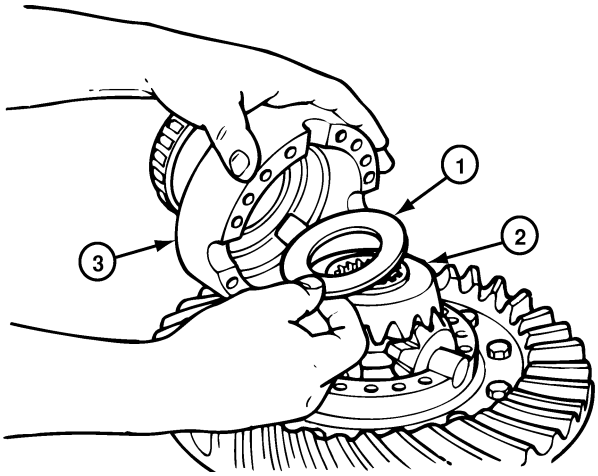


1 SPIDER, PINION AND THRUST WASHERS

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16. Install the second side gear and thrust washer over spider and differential pinions. **Figure 5.37**.

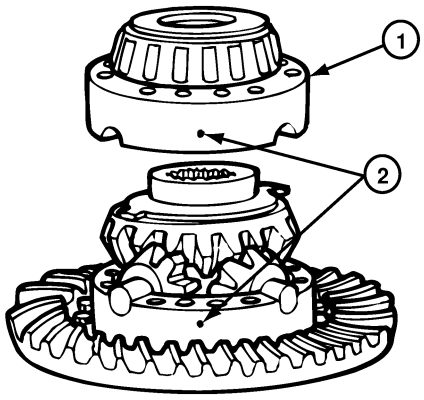
Figure 5.37



1 THRUST WASHER
2 SIDE GEAR
3 PLAIN CASE HALF

17. Place the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks. **Figure 5.37** and **Figure 5.38**.

Figure 5.38

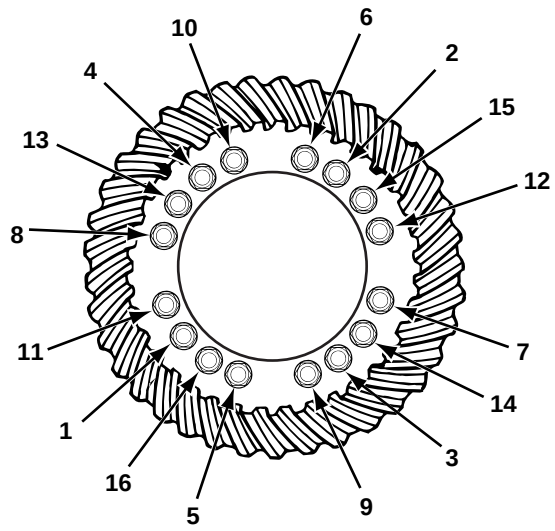


1 PLAIN CASE HALF
2 MATCH MARKS

18. Install Dri-Loc fasteners into the case halves. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material" in Section 4 and the following Steps **a** and **b**.

    a. Install four capscrews* and washers* or bolts*, nuts* and washers* into the case halves. The distance between the fasteners **MUST** be equal. Tighten the fasteners to the correct torque value in a progressive criss-cross pattern opposite each other. Refer to **Figure 5.39** and to **Table J**. T

Figure 5.39



    b. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. Refer to **Table J**. T

19. Inspect the rotating resistance of the differential gears. Use the following procedure.

*Some Meritor carriers do not have these described parts.

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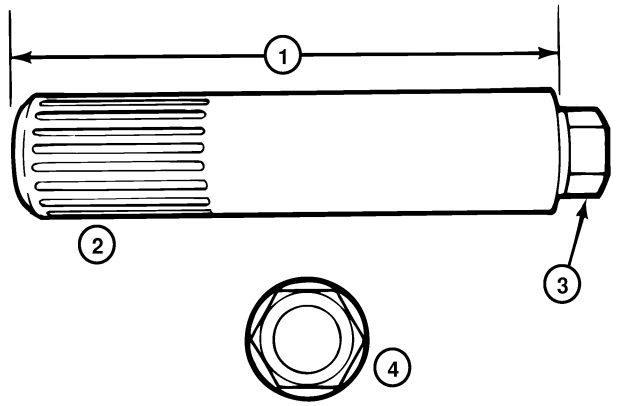
Inspecting the Rotating Resistance of the Differential Gears

Specification

- 50 lb-ft (67.8 N•m) maximum torque applied to one side gear. T

NOTE: Make a tool for inspecting the rotating resistance of the differential gears. The tool can be made from an axle shaft that matches the spline size of the differential side gear. Refer to **Figure 5.40** and **Figure 5.41**.

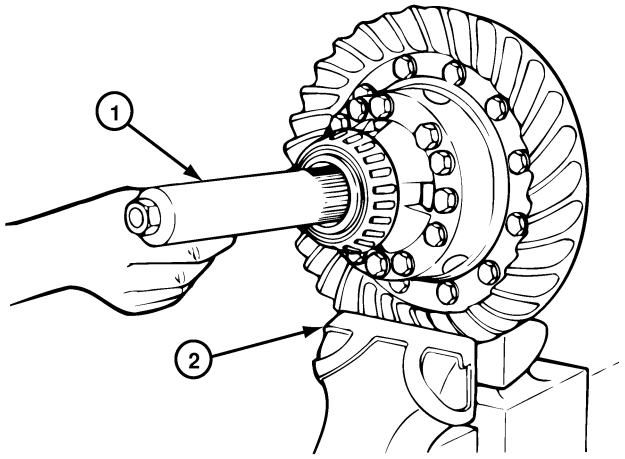
Figure 5.40



1 APPROXIMATELY 12-INCHES (304.8 MM)
2 SIDE VIEW
3 WELD NUT TO END OF SHAFT.
4 END VIEW

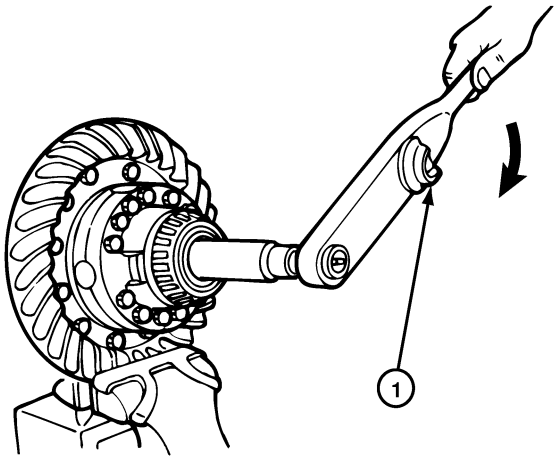
1. Install soft metal covers over vise jaws to protect the ring gear. **Figure 5.41**.
2. Place the differential and ring gear assembly in the vise and close the vise jaws.
3. Install the tool into the differential until the splines of the tool and one side gear are engaged. **Figure 5.41**.
4. Engage a torque wrench to the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench. **Figure 5.42**.

Figure 5.41



1 TOOL FOR CHECKING RESISTANCE
2 SOFT METAL COVER

Figure 5.42



1 READ TORQUE VALUE.

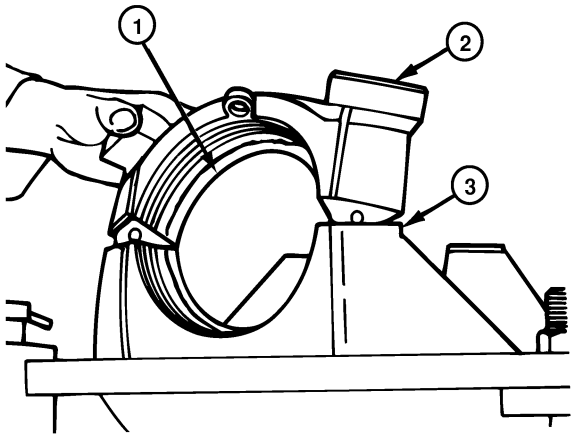
5. If the torque value exceeds the specification, disassemble the differential gears from the case halves.
6. Inspect the case halves, spider, gears and thrust washers for the problem that causes the torque value to exceed the specification. Repair or replace parts.
7. After all the differential assembly parts are repaired or replaced, assemble the parts and repeat Steps 1 through 7.

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Install the Differential and Ring Gear Assembly

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.
2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.
3. Apply Meritor Adhesive into the bearing bores of the carrier legs and bearing caps. Make certain not to allow adhesive to contact adjusting ring threads. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material" in Section 4. **Figure 5.43**.

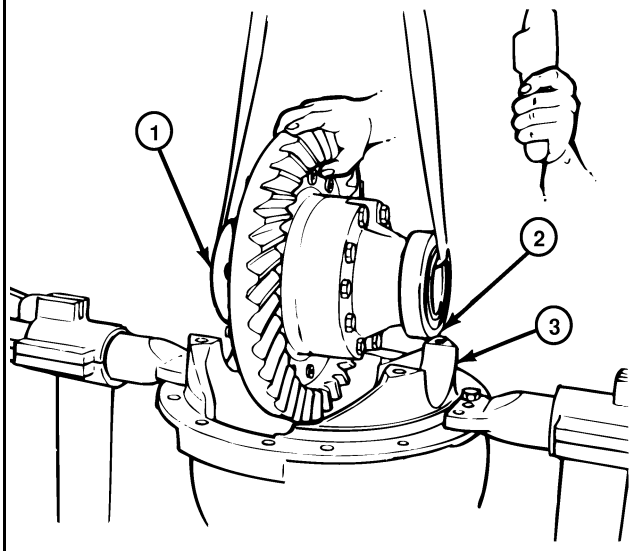
Figure 5.43



1 ADHESIVE
2 BEARING CAP
3 CARRIER LEG

4. Install the bearing cups over the bearing cones that are assembled on the case halves. **Figure 5.44**.
5. Safely lift the differential and ring gear assembly and install into the carrier. The bearing cups **MUST** be flat against the bores between the carrier legs. **Figure 5.44**.

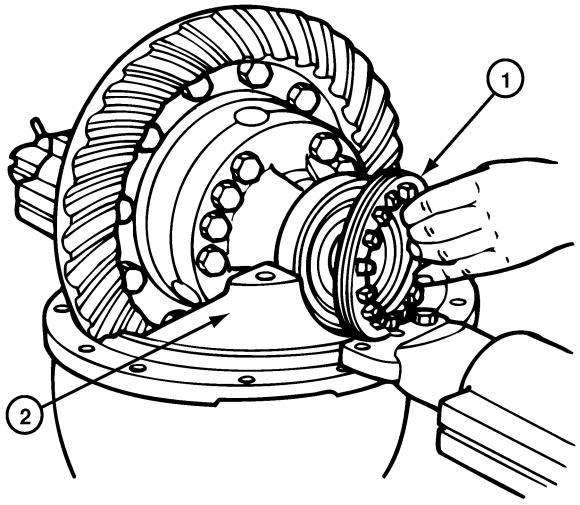
Figure 5.44



1 BEARING CUP
2 BEARING CUP
3 LEG BORE

6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand-tight against the bearing cup. **Figure 5.45**.

Figure 5.45

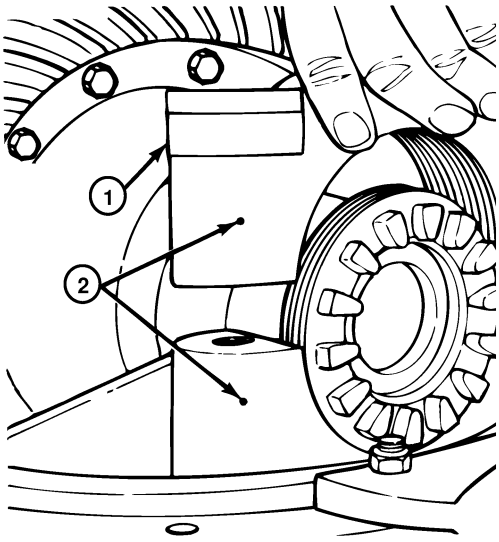


1 ADJUSTING RING
2 LEG

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7. Install the bearing caps over the bearings and adjusting rings in the correct location as marked before removal. **Figure 5.46**.

Figure 5.46



1 BEARING CAP
2 MATCH MARKS

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

8. Seat each bearing cap with a light leather, plastic or rubber mallet. The caps **MUST** fit easily against the bearings, adjusting rings and carrier. ***Do not force the bearing caps into position.***

CAUTION

If bearing caps are not installed in the correct original locations, the bores and threads in caps will not match the carrier. Assembling mismatched caps into the carrier can result in carrier damage after reassembly to axle and during vehicle operation. Do not force the bearing caps into unmatched bore locations in the carrier.

9. If bearing caps do not correctly fit into position, inspect the alignment of match marks between caps and carrier. Remove the caps and repeat Steps 6-8.

10. Install the capscrews and washers that hold bearing caps to the carrier. Tighten the capscrews by hand four to six turns, then tighten the capscrews to the correct torque value. Refer to **Table J**. T

NOTE: Do not install the cotter keys*, pins* or lock plates* that hold the bearing adjusting rings in position. Continue by adjusting the preload of differential bearings, adjust backlash of the hypoid gear and inspect tooth contact patterns.

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* Some Meritor carriers do not have these described parts.

Adjust Preload of Differential Bearings

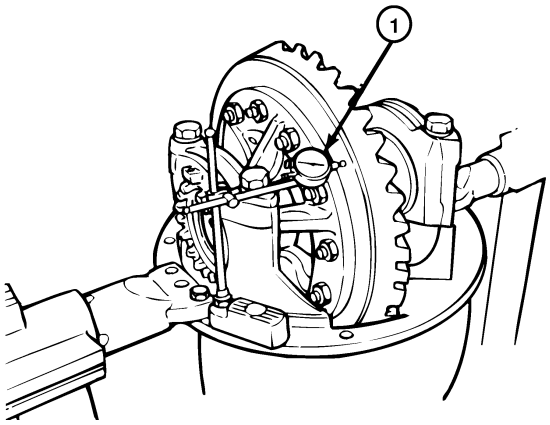
Specifications

- Preload of differential bearings (all carrier models)
  - — 15 to 35 lb-in (1.7-3.9 N•m) torque. T
- Expansion between bearing caps (leg spread)
  - — R-140, R-155 and R-160 carrier models: 0.002- to 0.009-inch (0.050-0.229 mm)
  - — R, S, U and W 120 series and most (check latest specifications) other carrier models: 0.00- to 0.013-inch (0.150-0.330 mm)

Method 1

1. Attach a dial indicator on the mounting flange of the carrier.
2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear. **Figure 5.47**.

Figure 5.47



1 DIAL INDICATOR

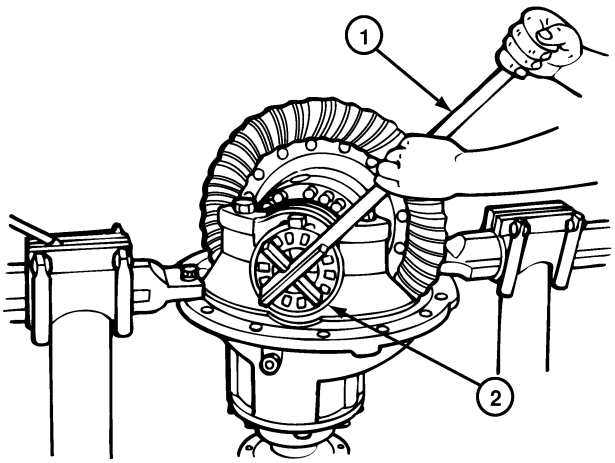
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⚠ CAUTION

When you turn the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur.
Figure 5.48.

3. Loosen the bearing adjusting ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator. **Figure 5.48**. Move the differential and ring gear to the left and right with pry bars while you read the dial indicator. Use the following Step **a** or **b**.

Figure 5.48

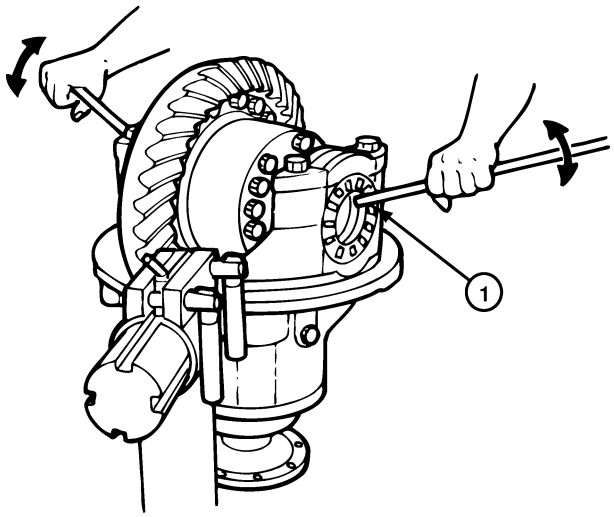


1 "T" BAR WRENCH
2 ADJUSTING RING OPPOSITE RING GEAR

   a. Use two pry bars that fit between the bearing adjusting rings and ends of the differential case. The pry bars **MUST NOT** touch the differential bearings. **Figure 5.49**.

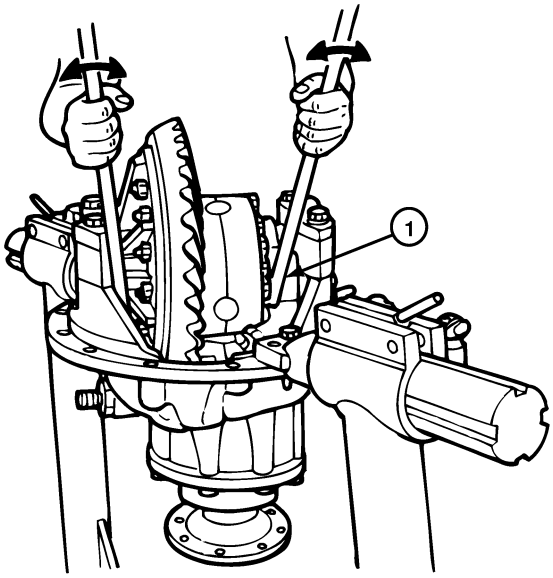
   b. Use two pry bars between the differential case or ring gear and the carrier at locations other than described in Step **a**. The pry bars **MUST NOT** touch the differential bearings. **Figure 5.50**.

Figure 5.49



1 BARS MUST NOT TOUCH BEARINGS.

Figure 5.50



1 BARS MUST NOT TOUCH BEARINGS.

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4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential and ring gear to the left and right as needed. Repeat Step **a** or **b**.
5. Tighten each bearing adjusting ring one notch from the zero end play measured in Step 4.
6. Continue by checking runout of the ring gear.

Method 2

A second method of inspecting preload is to measure the expansion between the bearing caps (leg spread) after the adjusting rings are tightened. Use the following procedure.

1. Turn both adjusting rings hand tight against the differential bearings.
2. Measure the distance X or Y between opposite surfaces of the bearing caps. Use a large micrometer of the correct size. **Figure 5.51** and **Figure 5.52**. Record the measurement.

Figure 5.51

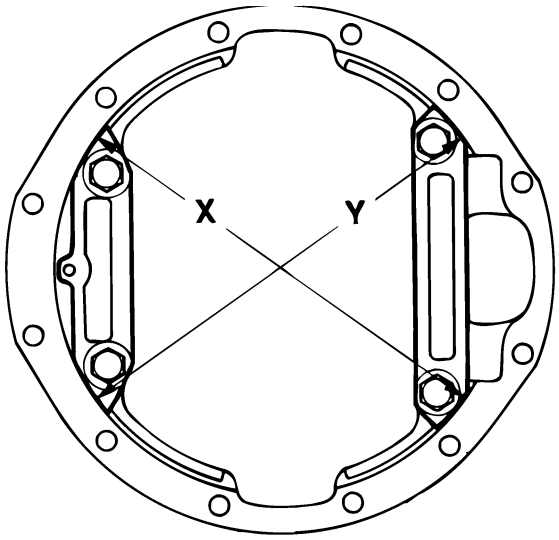
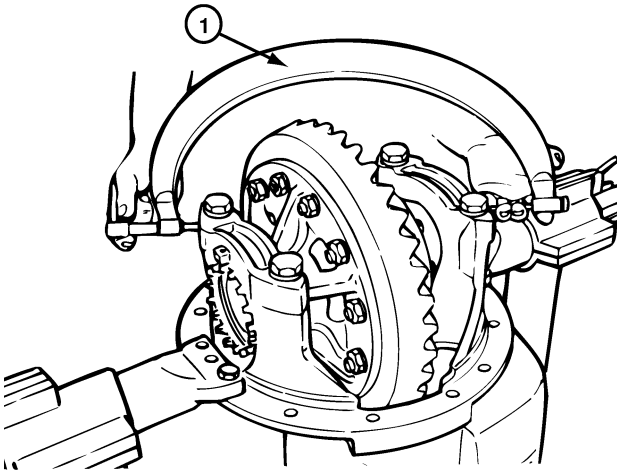


Figure 5.52



1 MICROMETER

3. Tighten each bearing adjusting ring one notch.
4. Measure the distance X or Y again. Compare the dimension with the distance X or Y measured in Step 2. The difference between the two dimensions is the amount the bearing caps have expanded.

Example

- Measurements of R-155 carrier
- Distance X or Y
  - — before tightening adjusting rings = 13.927-inch (353.740 mm)
- Distance X or Y
  - — after tightening adjusting rings = 13.936-inch (353.970 mm)
- 13.936-inch – 13.927-inch = 0.009-inch (0.230 mm) difference

If the dimension is within specifications, continue by checking runout of the ring gear. If the dimension is less than specifications, repeat Steps 3 and 4 as needed.

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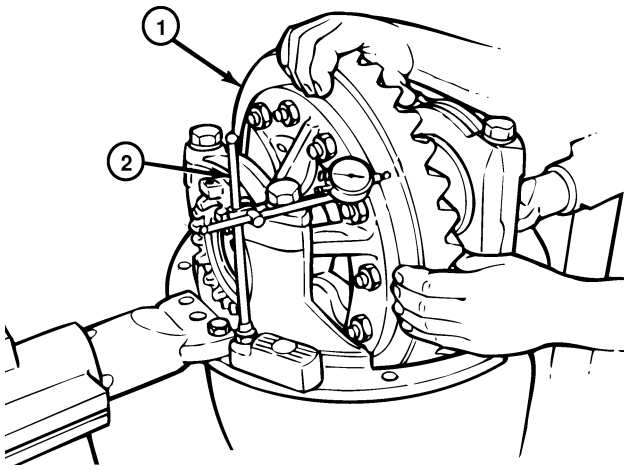
Inspect Runout of Ring Gear

Runout Specification

- 0.008-inch (0.200 mm)

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 5.53**.

Figure 5.53



1 ROTATE RING GEAR.
2 DIAL INDICATOR

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.
3. Set the dial indicator to zero (0).
4. Rotate the differential and ring gear and read the dial indicator. The runout of the ring gear **must not exceed** 0.008-inch (0.200 mm). **Figure 5.53**.

   If runout of the ring gear exceeds specifications, remove the differential and ring gear assembly from the carrier. Refer to "Remove the Differential and Ring Gear from the Carrier" in Section 2 and the following Steps 5 and 6.
5. Inspect the differential parts including the carrier for the problem that causes the runout of gear to exceed specifications. Repair or replace parts.
6. After the parts are repaired or replaced, install the differential and ring gear into the carrier. Refer to "Install the Differential and Ring Gear Assembly" in this section.
7. Repeat preload adjustment of differential bearings.

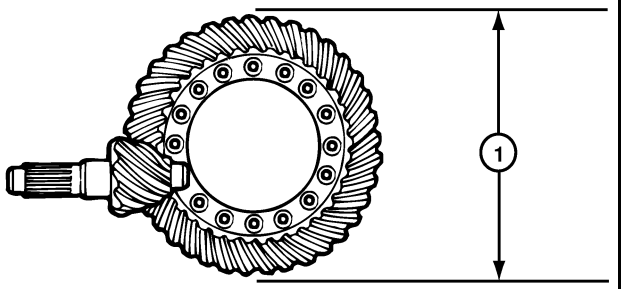
Ring Gear Backlash Adjustment

Specifications

- Ring gears that have a pitch diameter of less than 17-inches (431.8 mm)
  - — Range of backlash setting: 0.008- to 0.018-inch (0.200-0.460 mm).
  - — Backlash setting for new gear sets: 0.012-inch (0.300 mm)
- Ring gears that have a pitch diameter greater than 17-inches (431.8 mm)
  - — Range of backlash setting: 0.010- to 0.020-inch (0.250-0.510 mm)
  - — Backlash setting for new gear sets: 0.015-inch (0.380 mm)

NOTE: Measure the outer diameter of ring gear for approximate pitch diameter. **Figure 5.54**.

Figure 5.54



1 MEASURE OUTER DIAMETER FOR APPROXIMATE. PITCH DIAMETER

If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

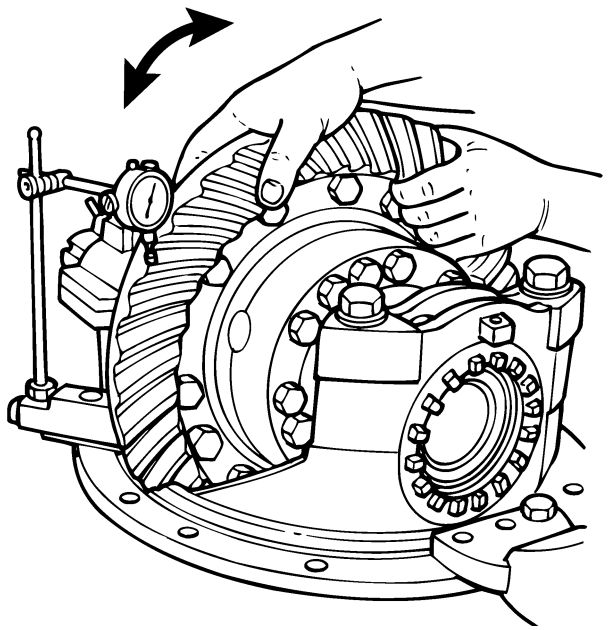
If a new gear set is installed, adjust the backlash to the correct specification for new gear sets.

After inspection of the tooth contact patterns, the backlash can be adjusted within specification limits, if needed. To change the location of the pattern use the following procedures.

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1. Attach a dial indicator on the mounting flange of the carrier. **Figure 5.55**.

Figure 5.55



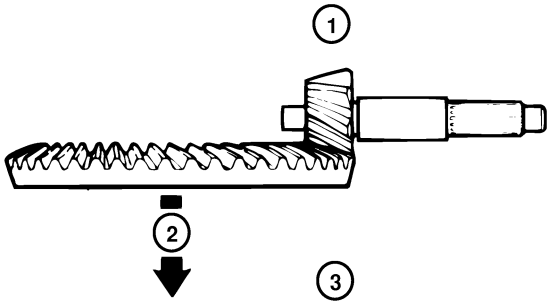
2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface. **Figure 5.55**.
3. Adjust the indicator dial to zero (0).
4. Hold the drive pinion in position.
5. After reading the dial indicator, rotate the differential and ring gear a small amount in both directions, against the drive pinion teeth. If the backlash reading is within specification, continue inspecting tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed. Continue following Steps 6 and 7.

NOTE: Backlash is increased by moving the ring gear away from the drive pinion. **Figure 5.56**.

Backlash is decreased by moving the ring gear toward the drive pinion. **Figure 5.57**.

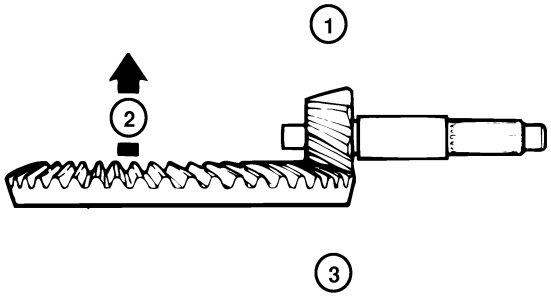
6. Loosen one bearing adjusting ring one notch then tighten the opposite ring the same amount. Refer to **Figure 5.56** and **Figure 5.57**.

Figure 5.56



1 TIGHTEN ADJUSTING RING THIS SIDE.
2 INCREASE BACKLASH.
3 LOOSEN ADJUSTING RING THIS SIDE.

Figure 5.57



1 LOOSEN ADJUSTING RING THIS SIDE.
2 DECREASE BACKLASH.
3 TIGHTEN ADJUSTING RING THIS SIDE.

NOTE: When you adjust backlash, move the ring gear **ONLY. DO NOT** move the drive pinion.

7. Repeat Steps 2-6 until the backlash is within specifications.

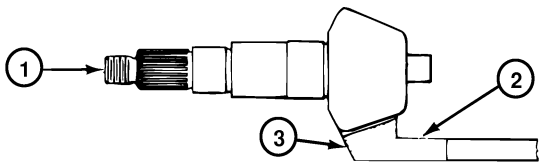
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Inspect Tooth Contact Patterns of the Gear Set

General Information

Meritor carriers can have a conventional **HYPOID** gear set or a **GENEROID** hypoid gear set. The tooth contact patterns for each type of gear set are different. Look at the part numbers to see what type of gear set is in the carrier. Refer to **Figure 5.58** for the location of part numbers.

Figure 5.58



1 PART NO.
2 PART NO.
3 PART NO. OPTION

Examples of part numbers for conventional **HYPOID** gear sets.

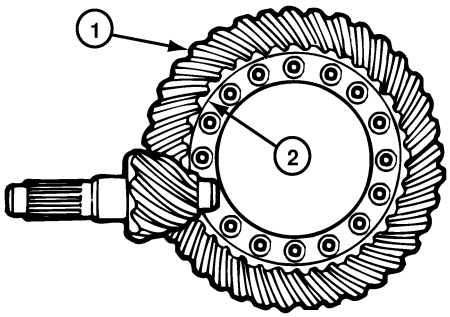
- 36786 for the ring gear.
- 36787 for the drive pinion.

Examples of part numbers for **GENEROID** gear sets.

- 36786-K or 36786-K2 for the ring gear.
- 36787-K or 36787-K2 for the drive pinion.

In the following procedures, movement of the contact pattern in the length of the tooth is indicated as, toward the “heel” or “toe” of the ring gear. **Figure 5.59**.

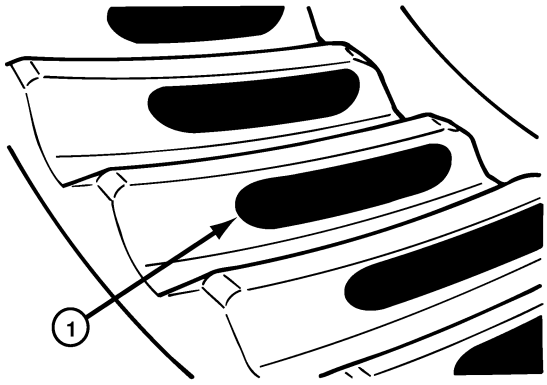
Figure 5.59



1 HEEL
2 TOE

Always inspect tooth contact patterns on the drive side of the gear teeth. **Figure 5.60**.

Figure 5.60



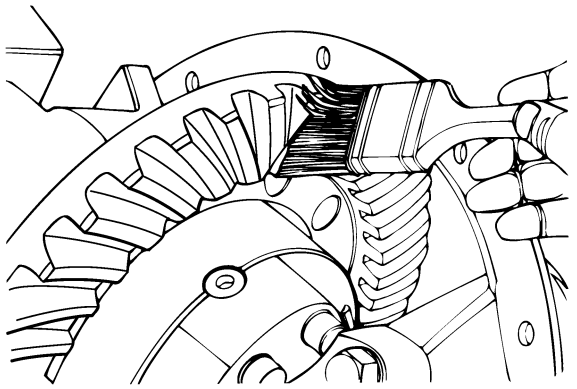
1 DRIVE SIDE (CONVEX)

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Tooth Contact Patterns of Conventional Hypoid and Generoid Hypoid Gear Sets

1. Adjust the backlash of a new gear set to either 0.012-inch (0.305 mm) or 0.015-inch (0.380 mm) depending on the size of the ring gear. Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. Refer to "Ring Gear Backlash Adjustment" in this section.
2. Apply a marking compound to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion. **Figure 5.61**.

Figure 5.61



3. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a more clear pattern.
4. Look at the contact patterns on the ring gear teeth. Compare the patterns to **Figure 5.62** or **Figure 5.65**, **Figure 5.63** or **Figure 5.66**, and **Figure 5.64** or **Figure 5.67**.

   The Location of Good Hand-Rolled Contact Patterns.

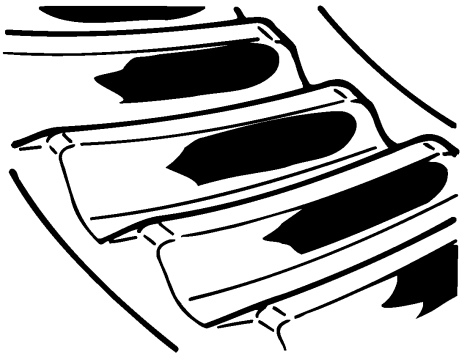
   New Conventional and Generoid Gear Sets — toward the toe of the gear tooth and in the center between the top and bottom of the tooth. Refer to **Figure 5.62** and **Figure 5.65**.

   When the carrier is being operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth. Refer to **Figure 5.68** or **Figure 5.69**.

The location of a good hand-rolled contact pattern for an old gear set **MUST** match the wear pattern in the ring gear. The contact pattern will be smaller in area than the wear pattern.

If the contact patterns require adjustment, continue by following Step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following Step 6.

Figure 5.62



Good Hand-Rolled Pattern/Conventional Gears

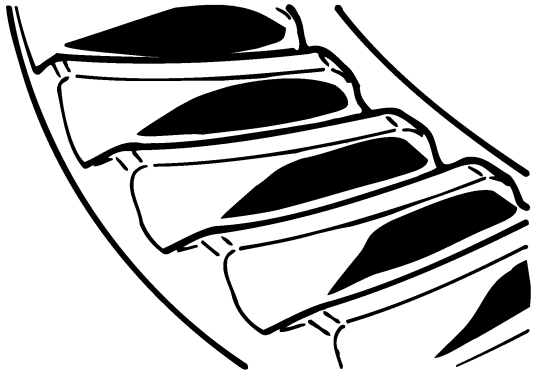
Figure 5.63



High Pattern/Conventional Gears

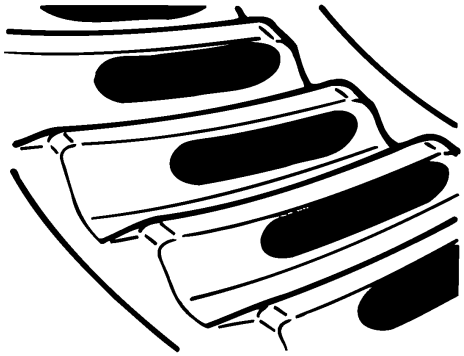
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Figure 5.64



Low Pattern/Conventional Gears

Figure 5.65



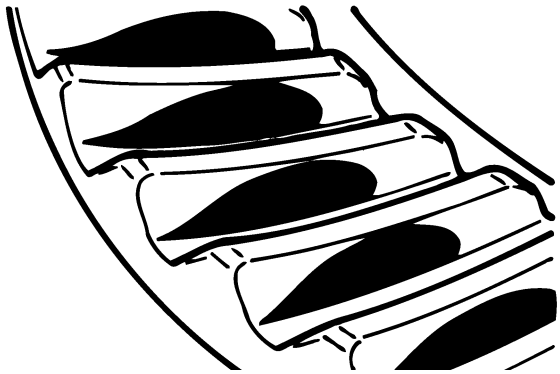
Good Hand-Rolled Pattern/Generoid Gears

Figure 5.66



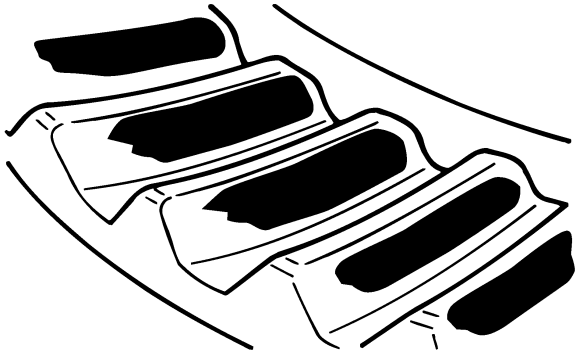
High Pattern/Generoid Gears

Figure 5.67



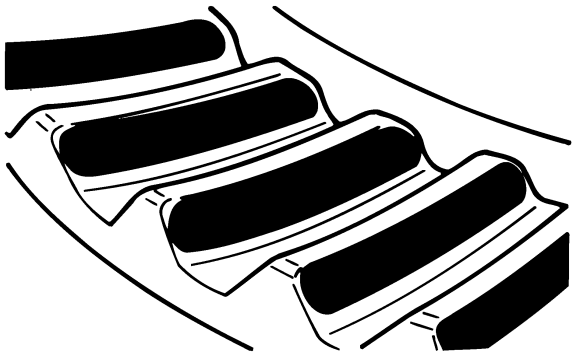
Low Pattern/Generoid Gears

Figure 5.68



Good Pattern in Operation Conventional Gears

Figure 5.69



Good Pattern in Operation Generoid Gears

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5. Change the thickness of the shim pack under bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.

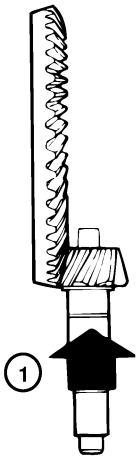
   a. Remove the drive pinion and bearing cage from the carrier. Refer to “Remove the Drive Pinion and Bearing Cage from Carrier” in Section 2.

NOTE: A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

   b. To correct a high contact pattern, **Figure 5.63**, decrease the thickness of the shim pack under the bearing cage. When decreasing the thickness of the shim pack, the drive pinion will move toward the ring gear. **Figure 5.70**.

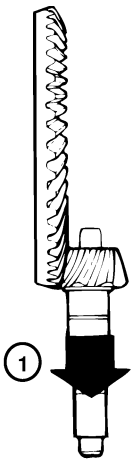
      To correct a low contact pattern, **Figure 5.71**, increase the thickness of shim pack under the bearing cage. When increasing the thickness of the shim pack, the drive pinion will move away from the ring gear. **Figure 5.71**.

Figure 5.70



1 DECREASE SHIM PACK.

Figure 5.71



1 INCREASE SHIM PACK.

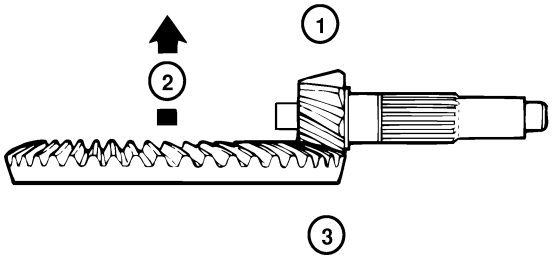
   c. Install the drive pinion, bearing cage and shims into the carrier. Refer to “Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)” in this section.

   d. Repeat Steps 2-5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teeth. Refer to “Ring Gear Backlash Adjustment” in this section.

   a. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth. **Figure 5.72**.

Figure 5.72



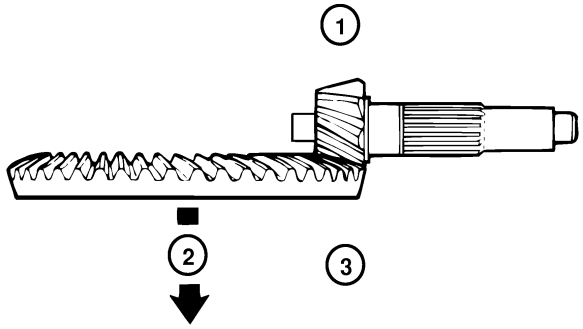
1 MOVE PATTERN TOWARD TOE, LOOSEN ADJUSTING RING THIS SIDE.
2 DECREASE BACKLASH.
3 TIGHTEN ADJUSTING RING.

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b. Increase backlash to move the contact patterns toward the heel of the ring gear teeth. **Figure 5.73**.

c. Repeat Steps 2-4 and 6 until the contact patterns are at the correct location in the length of the gear teeth.

Figure 5.73



1 MOVE PATTERN TOWARD TOE, LOOSEN ADJUSTING RING THIS SIDE.
2 DECREASE BACKLASH.
3 LOOSEN ADJUSTING RING.

CAUTION

If the carrier has cotter keys, lock the adjusting rings only with cotter keys. If your carrier has roll pins, reuse the roll pins or lock the adjusting rings with cotter keys. Do not force a roll pin into a cotter key hole.

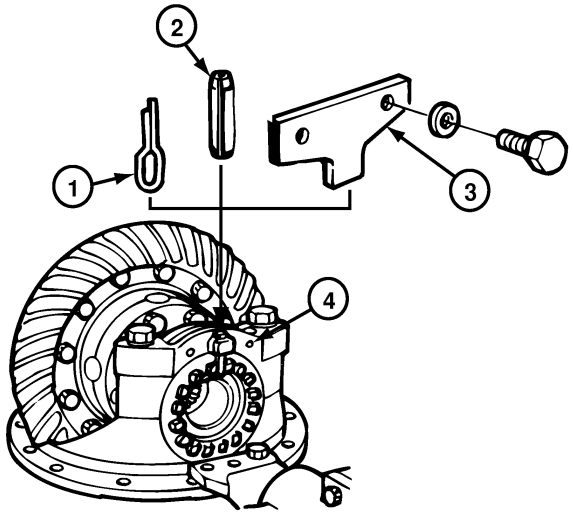
7. Install cotter keys*, pins*, or lock plates* that hold the two bearing adjusting rings in position. Use the following procedures.

   a. **Cotter Keys*** — Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss. **Figure 5.74**.

   b. **Pins*** — Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin. **Figure 5.74**.

   c. **Lock Plates*** — Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. Refer to **Table J**. **Figure 5.74**. (T)

Figure 5.74



1 COTTER KEY
2 PIN
3 LOCK PLATE
4 THREADED HOLES IN CAP WHEN LOCK PLATE IS USED

SHOWN WITH COTTER KEY INSTALLED

*Some Meritor carriers do not have these described parts.

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Install and Adjust the Thrust Screw*

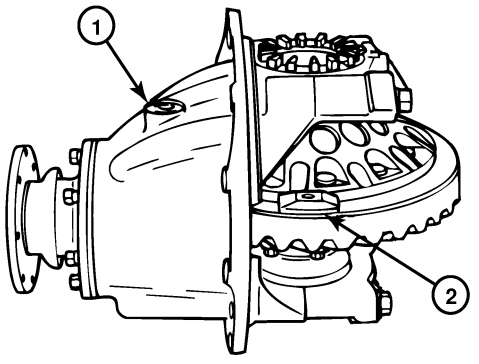
Specification

- Clearance between thrust screw and ring gear — 0.025- to 0.045-inch (0.650-1.140 mm).
- Loosen the thrust screw 1/2 turn or 180°.

If the carrier does not have a thrust block*, start at Step 4.

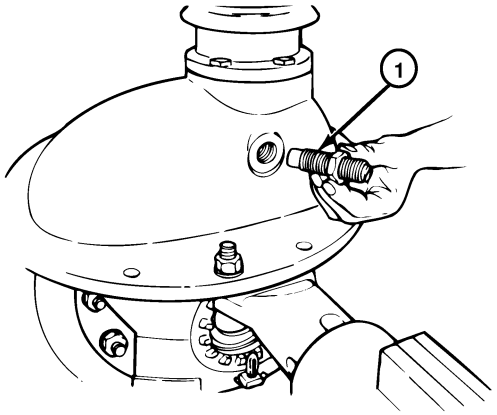
1. Rotate the carrier in the repair stand until the back surface of ring gear is toward the top. **Figure 5.75**.
2. Place the thrust block* on the back surface of the ring gear. The thrust block* **MUST** be in the center between the outer diameter of gear and differential case.
3. Rotate the ring gear until the thrust block* and hole for thrust screw, in carrier, are aligned. **Figure 5.75**.
4. Install the jam nut* on the thrust screw*, one half the distance between both ends.
5. Install the thrust screw* into the carrier until the screw stops against the ring gear or thrust block*. **Figure 5.76**.
6. Loosen the thrust screw* 1/2 turn, 180°. **Figure 5.77**.

Figure 5.75



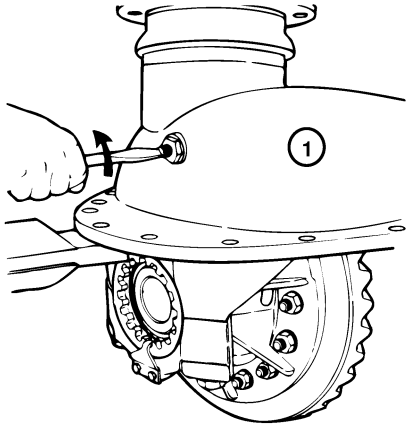
1 HOLE FOR THRUST SCREW
2 THRUST BLOCK

Figure 5.76



1 THRUST SCREW AND JAM NUT

Figure 5.77



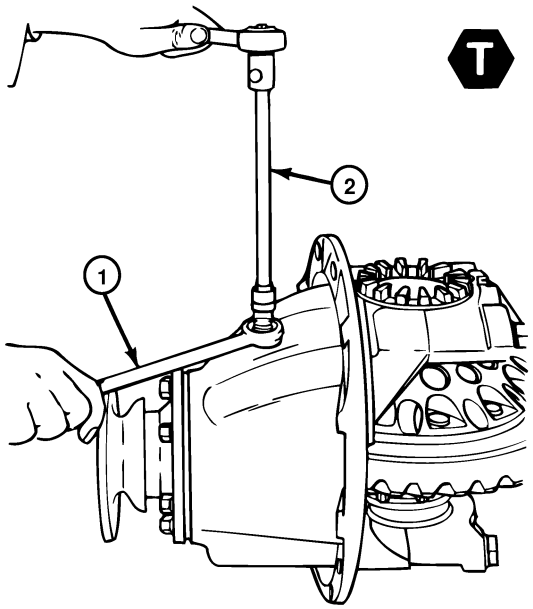
1 LOOSEN THRUST SCREW 1/2 TURN.

*Some Meritor carriers do not have these described parts.

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7. Tighten the jam nut* to the correct torque value against the carrier. Refer to **Table J**. **Figure 5.78**.

Figure 5.78



1 TIGHTEN JAM NUT TO CORRECT TORQUE VALUE.
2 HOLD THRUST SCREW IN POSITION.

Install Differential Carrier into Axle Housing

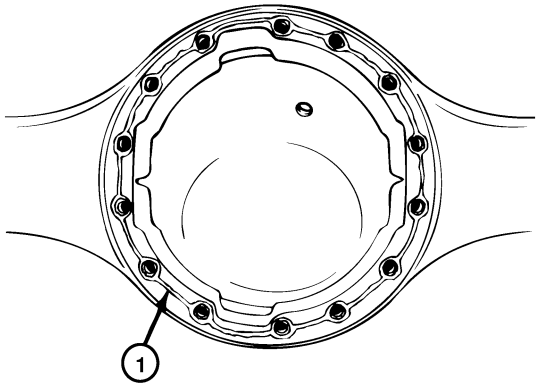
WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the inside of axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also refer to “Cleaning Axle Assemblies” in Section 3.
2. Inspect the axle housing for damage. Repair or replace the axle housing. Refer to “Repair or Replacement of Parts, General” in Section 3.
3. Inspect for loose studs* in the mounting surface of the housing where the carrier fastens. Remove and clean the studs* that are loose.
4. Apply liquid adhesive to the threaded holes and install the studs* into axle housing. Refer to “Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential” in Section 4. Tighten studs* to correct torque value. Refer to **Table J**.
5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. Refer to “Application of Three Bond 1216 or Equivalent Silicone Gasket Material” in Section 4. **Figure 5.79**.

Figure 5.79



1 1/8” (3.2 MM) DIAMETER SILICONE GASKET BEAD

*Some Meritor carriers do not have these described parts.

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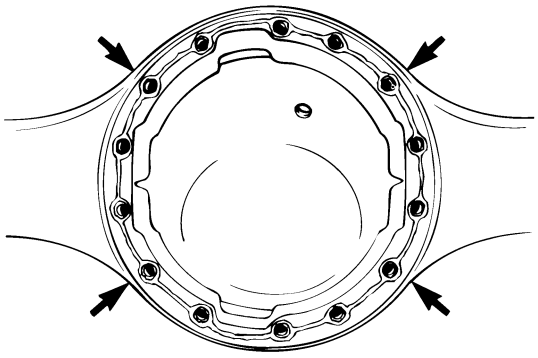
6. Install the carrier into the axle housing. Use a hydraulic roller jack or a lifting tool.

⚠ CAUTION

Do not use a hammer or a mallet to install the carrier. A hammer or a mallet will damage the mounting flange of the carrier and cause oil leaks.

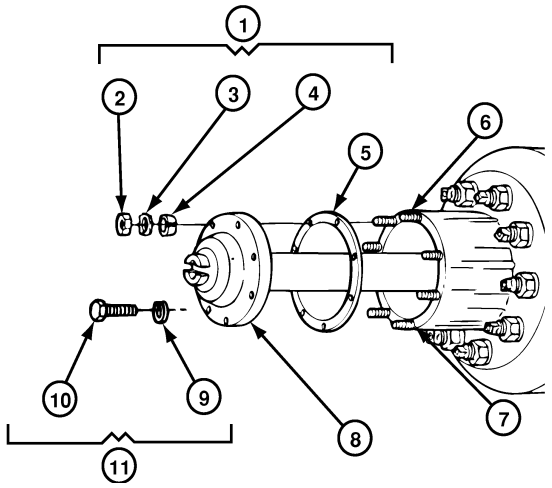
7. Install the nuts* and the washers or the capscrews and washers in the four corner locations around the carrier and the axle housing. Tighten the fasteners by hand. Do not tighten to the specified torque. **Figure 5.80**.
8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other. Refer to **Figure 5.80**.

Figure 5.80



9. Repeat Step 9 until the four fasteners are tightened to the correct torque value. (T)
   - **Fasteners with standard flat washers:** Tighten fasteners to 150-230 lb-ft (203-312 N•m).
10. Install the remaining fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. Refer to **Table J**. (T)
11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.
12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts **MUST** fit flat against the wheel hub. **Figure 5.81**.

Figure 5.81



1	TAPERED DOWEL RETENTION	7	SHAFT HUB AXLE
2	STUD NUT	8	AXLE SHAFT (FLANGE)
3	WASHER	9	WASHER
4	TAPERED DOWEL	10	CAPSCREW
5	GASKET	11	NON-TAPERED DOWEL RETENTION
6	STUD		

*Some Meritor carriers do not have these described parts.

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Straight Holes, Nuts and Hardened Washers

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 1/8-inch diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole in that surface.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft **MUST** fit flat against the wheel hub. Refer to **Figure 5.81**.
4. Install the Grade 8 nuts and hardened washers on the stud. (Lock washers are an acceptable alternative.) Tighten the stud nuts to the torque specified in **Table C**.

Tapered Dowel, Hardened Washer and Hardened Nut

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 1/8-inch diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole in that surface.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft **MUST** fit flat against the wheel hub. Refer to **Figure 5.81**.
4. Install solid tapered dowels over each stud and into the flange of the axle shaft. Use a punch or a drift and hammer, if necessary.
5. Install the Grade 8 nuts and hardened washers on the stud. (Lock washers are an acceptable alternative.) Tighten the stud nuts to the torque specified in **Table D**.

Table C: Shaft-to-Hub Torque Fastener — Non-tapered Dowel Applications

Fastener	Thread Size	Torque Value — Grade 8 Nuts lb-ft (N•m)	
		Plain Nut	Lock Nut
Stud Nut (Axle Shaft)	.62-18	150-230 (203-312)	130-190 (176-258)
	.75-16	310-400 (420-542)	270-350 (366-475)
Studs	All	Install the course thread end of stud into hub and tighten to last thread.	

Table D: Shaft-to-Hub Torque Fastener — Tapered Dowel Applications

Fastener	Thread Size	Torque Value — Grade 8 Nuts lb-ft (N•m)	
		Plain Nut	Lock Nut
Stud Nut (Axle Shaft)	.44-20	50-75 (81-102)	40-65 (67-88)
	.50-20	75-115 (115-156)	65-100 (102-136)
	.56-18	110-165 (176-224)	100-145 (149-197)
	.62-18	150-230 (203-312)	130-190 (176-258)
Studs	All	Install the course thread end of stud into hub and tighten to last thread.	

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Section 6
Lubrication

NOTE: For complete information on lubricating drive axles and carriers, refer to Maintenance Manual 1, *Lubrication*.

Refer to **Table E**, **Table F** and **Table I** for standard information on lubricants, schedules and capacities.

Table E: Lubricant Cross Reference (Viscosity) and Temperature

Meritor Lubricant Specification	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
O-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	+10°F (–12.2°C)	- - -**
O-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	–15°F (–26.1°C)	- - -**
O-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	–15°F (–26.1°C)	- - -**
O-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	–40°F (–40°C)	- - -**
O-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	–40°F (–40°C)	+ 35°F (+ 1.6°C)
O-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	–40°F (–40°C)	- - -**
There is no upper limit on these outside temperatures, but the axle sump temperature ***must never exceed* **250°F (+ 121°C).**				

Table F: Rear Drive Axle Oil Change Intervals and Specifications ①

APPLIES TO ALL REAR AXLES EXCEPT THE "ADVANCED LUBE" REAR AXLES.

On-Highway Operation Intervals				Off-Highway Operation Intervals ②				Meritor Specifications (Military)	Oil Description	Outside Temperature			
										F°		C°	
Initial Oil Change	Inspect Oil Level	Petroleum Oil Change	Synthetic Oil Change	Initial Oil Change	Inspect Oil Level	Petroleum Oil Change ③	Synthetic Oil Change			Min.	Max.	Min.	Max.
3,000 miles (4,800 km)	3,000 miles (4,800 km), once a month or the fleet maint-enance interval (whichever comes first)	If annual mileage is less than 100,000 miles (160,000 km) change oil once a year.	250,000 miles (400,000 km)	1,000 miles (1,600 km)	1,000 miles (1,600 km)	If annual mileage is less than 60,000 miles (96,000 km) change oil twice a year.	50,000 miles (80,000 km)	O-76A, Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 85W/140	10	None	–12	None
								O-76D, Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 80W/90	–15	None	–26	None
								O-76E, Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None
								O-76J, Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 75W	–40	35	–40	2
								O-76L, Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
								O-76M, Full Synthetic Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
		If annual mileage is more than 100,000 miles (160,000 km), change oil every 100,000 miles (160,000 km).				If annual mileage is more than 60,000 miles (96,000 km), change oil every 30,000 miles (48,000 km).		O-76N, Full Synthetic Gear Oil (MIL-L-2105D or MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None

NOTES

① If oil pump and filter is used, change filter every 100,000 miles (160,000 km). Inspect oil level. Add correct oil as required.

② Includes heavy-duty on-highway and on/off-highway applications.

③ For continuous heavy-duty operation, inspect oil level every 1,000 miles (1,600 kilometers).

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Table G: "Advanced Lube" Rear Drive Axle without Oil Pump and Filter Oil Change Intervals and Specifications①

APPLIES TO TANDEM REAR AXLES MANUFACTURED AFTER JANUARY 1, 1993 EQUIPPED WITH "MEMBRANE" TYPE BREATHERS AND ADVANCED MATERIAL TRIPLE-LIP SEALS.

On-Highway Operation Intervals			On-/Off-Highway Operation Intervals②			Meritor Specifications (Military)	Oil Description	Outside Temperature			
								F°		C°	
Inspect Oil Level	Petroleum Oil Change③	Synthetic Oil Change④	Inspect Oil Level⑤	Petroleum Oil Change③	Synthetic Oil Change④			Min.	Max.	Min.	Max.
3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	100,000 miles (160,000 km)	250,000 miles (400,000 km)	3,000 miles (4,800 km) or 200 hours of operation	40,000 miles (64,000 km)	80,000 miles (128,000 km)	O-76A, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 85W/140	10	None	–12	None
						O-76D, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 80W/90	–15	None	–26	None
						O-76E, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None
						O-76J, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W	–40	35	–40	2
						O-76L, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
						O-76M, Full Synthetic Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
						O-76N, Full Synthetic Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None

NOTES

① If a No-Spin differential is installed, oil (petroleum or synthetic) must be changed at minimum interval of 64,000 km (40,000 miles) or a maximum interval of 50,000 miles (80,000 km).
② Also applies to heavy-duty on-highway applications. Does not apply to off-highway applications.
③ For petroleum oil with extended drain additives, use the "Synthetic Oil Change" interval.
④ Applies to semi-synthetic oils and full-synthetic oils. For a list of approved synthetic oils, refer to Maintenance Manual 1, *Lubrication*.
⑤ For continuous heavy-duty operation, inspect the oil level every 1,000 miles (1,600 km). Add the correct oil as required.

Table H: Tandem "Advanced Lube" Rear Drive Axle with Oil Pump and Filter Oil Change Intervals and Specifications①②

APPLIES TO TANDEM REAR AXLES MANUFACTURED AFTER JANUARY 1, 1993 EQUIPPED WITH "MEMBRANE" TYPE BREATHERS AND ADVANCED MATERIAL TRIPLE-LIP SEALS.

On-Highway Operation Intervals			On-/Off-Highway Operation Intervals③			Meritor Specifications (Military)	Oil Description	Outside Temperature			
								F°		C°	
Inspect Oil Level	Petroleum Oil Change④	Synthetic Oil Change⑤	Inspect Oil Level⑥	Petroleum Oil Change④	Synthetic Oil Change⑤			Min.	Max.	Min.	Max.
3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	100,000 miles (160,000 km)	500,000 miles (800,000 km)	3,000 miles (4,800 km) or 200 hours of operation	50,000 miles (80,000 km)	100,000 miles (160,000 km)	O-76A, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 85W/140	10	None	–12	None
						O-76D, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 80W/90	–15	None	–26	None
						O-76E, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None
						O-76J, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W	–40	35	–40	2
						O-76L, Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
						O-76M, Full Synthetic Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/140	–40	None	–40	None
						O-76N, Full Synthetic Gear Oil (MIL-PRF-2105E)	GL-5, SAE 75W/90	–40	None	–40	None

NOTES

① Replace oil filter every 100,000 miles (160,000 km). Inspect oil level. Add specified oil as required.
② If No-Spin differential is installed, oil (petroleum or synthetic) must be changed at minimum interval of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).
③ Applies to heavy-duty on-highway applications and to on/off highway applications. Does not apply to off-highway applications.
④ For petroleum oil with extended drain additives, use the "Synthetic Oil Change" interval.
⑤ Applies to semi-synthetic oils. For a list of approved synthetic oils, refer to Maintenance Manual 1, *Lubrication*.
⑥ For continuous heavy-duty operation, inspect the oil level every 1,000 miles (1,600 km). Add the correct oil as required.

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Axle Lubricant Capacities

Use the following lubricant capacities as a guide only. The capacities are measured with the drive pinion in the horizontal position. When the angle of the drive pinion changes, the lubricant capacity of the axle will change.

Table I: Axle Lubricant Capacities

Axle Model	Capacity	
	U.S. Pints	Liters
Single Drive Axles		
A-150	5.5	2.6
B-100	10	4.7
B-140	12	5.7
B-150	3.5	1.7
C-100	12.5	5.9
D-100	12.5	5.9
D-140	12.5	5.9
E-100	15	7.1
E-105	12.5	5.9
E-150	9	4.3
F-100	13	6.2
F-106	13	6.2
F-120	15	7.1
F-121	15	7.1
F-140	14	6.6
FDS-75	14	6.6
FDS-78	14	6.6
FDS-85	15	7.1
FDS-90	14	6.6
FDS-93	14	6.6
FDS-750	7	3.3
FDS-1600	23	10.9
FDS-1800	35	16.6
FDS-1805	35	16.6
FDS-1807	27	13.2
FDS-1808	27.9	13.2
FDS-2100	27.9	13.2
FDS-2101	27.9	13.2
FDS-2107	43	20.3
FDS-2110	43	20.3
FDS-2111	43	20.3
FDS-2117	43	20.3
G-161	21	9.9
H-100	20	9.5
H-140	21	9.9
H-150	11	5.2
H-162	20	9.5
H-170	27*	12.8
H-172	27	12.8
L-100	23	10.9
L-140	24	11.4
L-155	24	11.4

Axle Model	Capacity	
	U.S. Pints	Liters
Single Drive Axles (Continued)		
L-172	27	12.8
M-172	27	12.8
QT-140	24	11.4
Q-100	31	14.7
Q-145	24	11.4
RL-170	48	22.7
R-100	30	14.2
R-140	28	13.2
R-155	28	13.2
R-160	28	13.2
R-163	34	16.1
R-170	43	20.3
S-170	43	20.3
U-140	24	11.4
U-170	43	20.3
W-170	43	20.3

* Includes 1 pint (0.97 liter) for each wheel end and with drive pinion angle at 3°.

Axle Model	Capacity	
	U.S. Pints	Liters
Rear Axle of Tandems		
SDHD (DHR rear)	16	7.6
SFHD (FHR rear)	16.5	7.8
SHHD (HHR rear)	26	12.3
SL-100 (LR-100 rear)	37	17.5
SLHD (LHR rear)	32	15.1
SQ-100 (QR-100 rear)	33	15.7
SQHD (QHR rear)	31	14.7
SQHP (QAR rear)	36	17
SR-170 (RR-170 rear)	43	20.3
SRHD (RHR rear)	36	17
SSHD (SHR rear)	28	13.2
ST-170 (TR-170 rear)	43	20.3
STHD (THR rear)	28	13.2
SU-170 (UR-170 rear)	43	20.3
SUHD (UHR rear)	28	13.2
SW-170 (WR-170 rear)	43	20.3

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Torque Values for Fasteners

General Information

1. The torque values in **Table J** are for fasteners that have a light application of oil on the threads.
2. If the fasteners are dry, increase the torque values by ten percent (10%).
3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by ten percent (10%).
4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

a. Measure the diameter of the threads in inches, dimension X. **Figure 7.1**.

b. Count the amount of threads there are in one inch (1.0 inch). **Figure 7.1**.

Example

- American Standard size fastener is .50-13.
  - — 0.50 is the diameter of the fastener in inches or dimension X.
  - — 13 is the amount of threads in one inch (1.0 inch).

Metric Fasteners

a. Measure the diameter of the threads in millimeters (mm), dimension X. **Figure 7.2**.

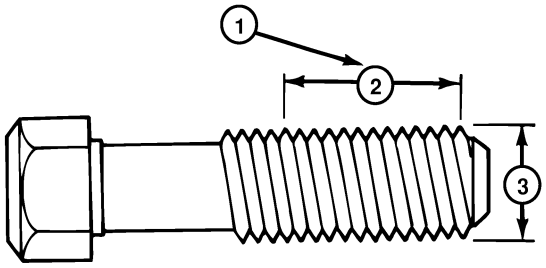
b. Measure the distance of ten (10) threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y. **Figure 7.2**.

c. Divide dimension Y by ten (10). The result will be the distance between two threads or pitch.

Example

- Metric size fastener is M8 x 1.25.
  - — M8 is the diameter of the fastener in millimeters (mm) or dimension X.
  - — 1.25 is the distance between two threads or pitch.
  - — Compare the size of fastener measured in Step 4 to the list of fasteners in **Table J** to find the correct torque value.

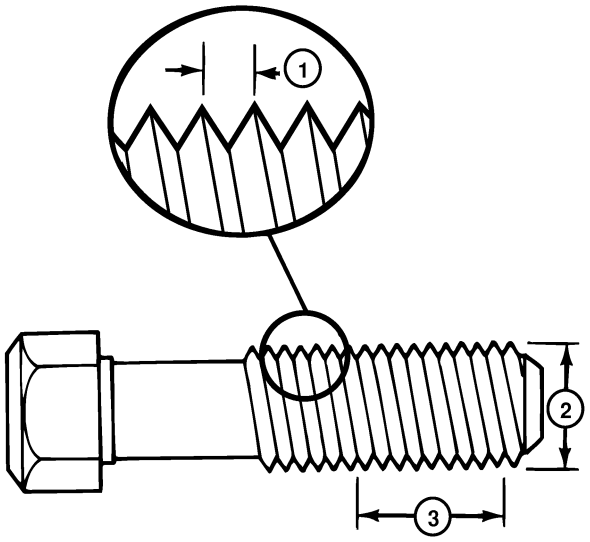
Figure 7.1



1 AMOUNT OF THREADS IN ONE INCH
2 1″
3 X

X DIMENSION = (EXAMPLE 1/2")

Figure 7.2



1 PITCH
2 X
3 Y

X DIMENSION = (EXAMPLE M8 OR 8 MM)
Y DIMENSION = DISTANCE OF 10 THREADS

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Figure 7.3

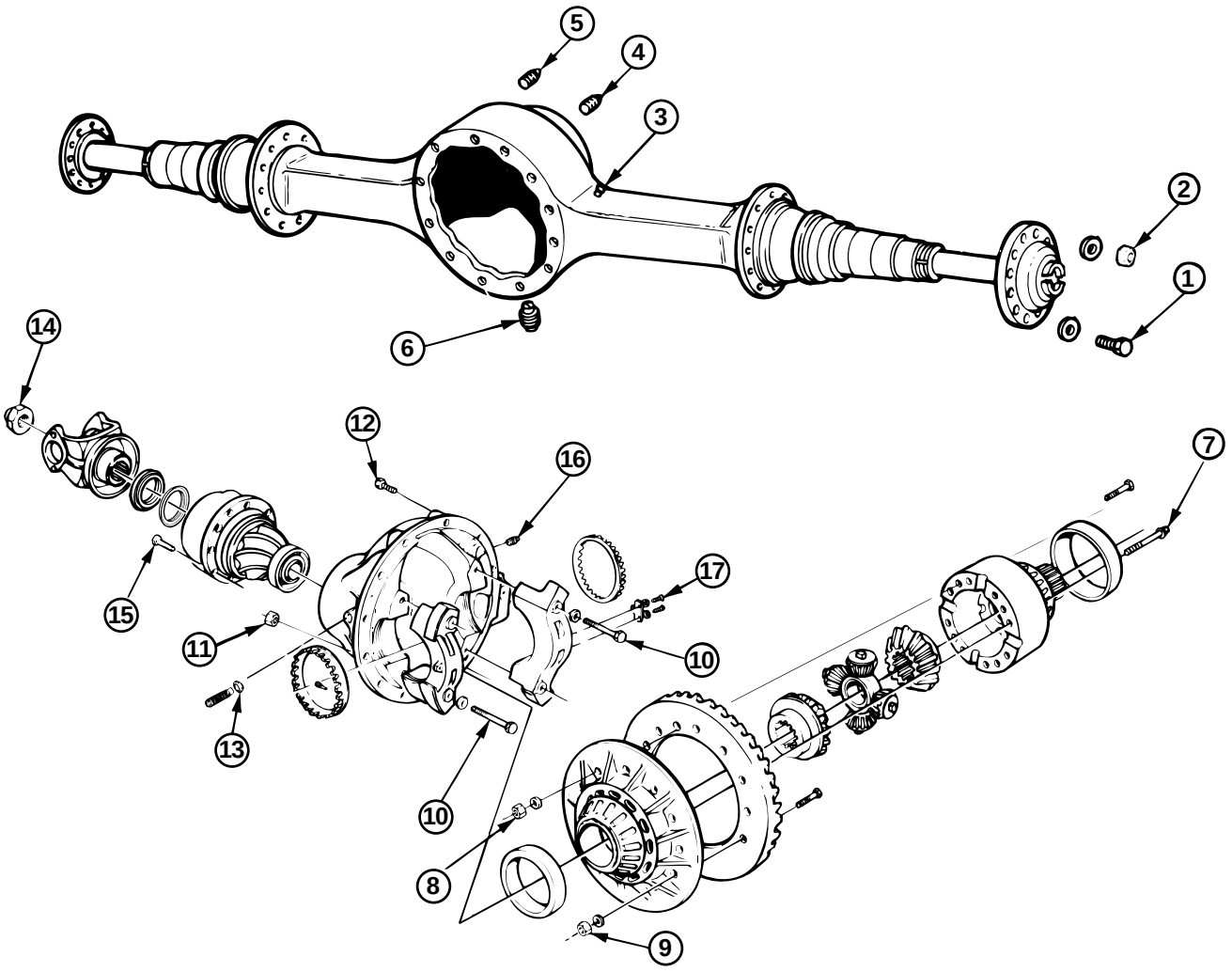


Table J: Fastener Torque Information

Fastener		Thread Size	Torque Value lb-ft (N•m) T	
1.	*Capscrew, Axle Shaft	.31-24 .50-13	18-24 85-115	(24-33) (115-156)
2.	*Nut, Axle Shaft Stud	Plain Nut .44-20 .50-20 .56-18 .62-18 Lock Nut .44-20 .50-20 .56-18 .62-18	 50-75 75-115 110-165 150-230 40-65 65-100 100-145 130-190	 (68-102) (102-156) (149-224) (203-312) (54-88)3 (88-136) (136-197) (176-258)

* Some Meritor carriers do not have these described parts.

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Table J: Fastener Torque Information

Fastener		Thread Size	Torque Value lb-ft (N•m) T	
3.	Breather	.38-18	20 minimum (27 minimum)	
4.	*Plug, Oil Fill (Housing)	.75-14	35 minimum (47.5 minimum)	
5.	*Plug, Heat Indicator	.50-14	25 minimum (34 minimum)	
6.	Plug, Oil Drain	.50-14	25 minimum (34 minimum)	
7.	Capscrew, Differential Case	.38-16	35-50	(48-68)
		.44-14	60-75	(81-102)
		.50-13	85-115	(115-156)
		.56-12	130-165	(176-224)
		.62-11	180-230	(244-312)
	Grade 10.9 Flange Head	M12 x 1.75	85-103	(115-140)
	Grade 10.9 Standard Hex Head	M12 x 1.75	74-96	(100-130)
	Grade 12.9 Standard Hex Head	M12 x 1.75	105-125	(143-169)
	Grade 12.9 Flange Head	M16 x 2	203-251	(275-340)
	Grade 12.9 Standard Head	M16 x 2	220-310	(300-420)
8.	*Nut, Differential Case Bolt	.50-13	75-100	(102-136)
		.50-20	85-115	(115-156)
		.62-11	150-190	(203-258)
		.62-18	180-230	(244-312)
		M12 x 1.75	74-96	(100-130)
		M16 x 2	220-310	(300-420)
9.	*Nut, Ring Gear Bolt	.50-13	75-100	(102-136)
		.50-20	85-115	(115-156)
		.62-11	150-190	(203-258)
		.62-18	180-230	(244-312)
		M12 x 1.25	66-81	(90-110)
		M12 x 1.75	77-85	(104-115)
	Flange Head	M16 x 1.5	192-214	(260-190)
	Standard Hex Head	M16 x 1.5	196-262	(265-355)
10.	Capscrew, Bearing Cap	.56-12	110-145	(149-197)
		.62-11	150-190	(203-258)
		.75-10	270-350	(366-475)
		.88-14	360-470	(488-637)
		.88-9	425-550	(576-746)
		M16 x 2	181-221	(245-300)
		M20 x 2.5	347-431	(470-585)
		M22 x 2.5	479-597	(650-810)
11.	Nut, Housing to Carrier Stud	.44-20	50-75	(68-102)
		.50-20	75-115	(102-156)
		.56-18	110-165	(149-224)
		.62-18	150-230	(203-312)
12.	Capscrew, Carrier to Housing	.44-14	50-75	(68-102)
		.50-13	75-115	(102-156)
		.56-12	110-165	(149-224)
		.62-11	150-230	(203-312)
		.75-10	270-400	(366-542)
		M12 x 1.75	74-89	(100-120)
		M16 x 2	181-221	(245-300)

* Some Meritor carriers do not have these described parts.

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Table J: Fastener Torque Information

Fastener		Thread Size	Torque Value lb-ft (N•m) T	
13.	*Jam Nut, Thrust Screw	.75-16 .88-14 1.12-16 M22 x 1.5 M30 x 1.5	150-190 150-300 150-190 148-210 236-295	(203-258) (203-407) (203-258) (200-285) (320-400)
14.	Nut, Drive Pinion	.88-20 1.00-20 1.25-12 1.25-18 1.50-12 1.50-18 1.75-12 M32 x 1.5 M39 x 1.5 M45 x 1.5	200-275 300-400 700-900 700-900 800-1100 800-1100 900-1200 738-918 922-1132 996-1232	(271-373) (407-542) (949-1220) (949-1220) (1085-1491) (1085-1491) (1220-1627) (1000-1245) (1250-1535) (1350-1670)
15.	Capscrew, Bearing Cage	.38-16 .44-14 .50-13 .56-12 .62-11 M12 x 1.75	30-50 50-75 75-115 110-165 150-230 70-110	(41-68) (68-102) (102-156) (149-224) (203-312) (90-150)
16.	*Plug, Oil Fill (Carrier)	.75-14 1.5-11.5 M24 x 1.5	25 minimum (34 minimum) 120 minimum (163 minimum) 35 minimum (47 minimum)	
17.	*Capscrew, Lock Plate	.31-18 M8 x 1.25	20-30 21-26	(27-41) (28-35)

* Some Meritor carriers do not have these described parts.

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Drive Pinion Bearings — Preload (Refer to Section 5)

Specification	New bearings — 5 to 45 lb-in (0.56-5.08 N•m) torque T Used bearings — 10 to 30 lb-in (1.13-3.39 N•m) torque T
Adjustment	Preload is controlled by the thickness of the spacer between bearings. — To increase preload install a thinner spacer — To decrease preload install a thicker spacer

Drive Pinion — Depth in Carrier (Refer to Section 5)

Specification	Install the correct amount of shims between the bearing cage and carrier. To calculate, use old shim pack thickness and new and old pinion cone numbers.
Adjustment	Change the thickness of the shim pack to get a good gear tooth contact pattern.

Hypoid Gear Set — Tooth Contact Patterns (Hand Rolled) (Refer to Section 5)

Specification	Conventional gear set — Toward the toe of the gear tooth and in the center between the top and bottom of the tooth Generoid gear set — Between the center and toe of the tooth and in the center between the top and bottom of the tooth
Adjustment	Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash — To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage — To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage — To move the contact pattern toward the toe of the tooth, decrease backlash of the ring gear — To move the contact pattern toward the heel of the tooth, increase backlash of the ring gear.

Main Differential Bearings — Preload (Refer to Section 5)

Specification	15 to 35 lb-in (1.7-3.9 N•m) torque T ***or*** Expansion between bearing caps — R-140, R-155 and R-160 carrier models — 0.002 to 0.009 inch (0.050-0.229 mm) — All other carrier models — 0.006 to 0.013 inch (0.150-0.330 mm)
Adjustment	Preload is controlled by tightening both adjusting rings after zero end play is reached

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Main Differential Gears — Rotating Resistance (Refer to Section 5)

Specification	50 lb-ft (68 N•m) torque applied to one side gear T

Ring Gear — Backlash (Refer to Section 5)

Specification	Ring gears that have a pitch diameter of less than 17 inches (431.8 mm) — Range: 0.008 to 0.018 inch (0.200-0.460 mm) 0.012 inch (0.300 mm) for a new gear set Ring gears that have a pitch diameter of 17 inches (431.8 mm) or greater — Range: 0.010 to 0.020 inch (0.250-0.510 mm) 0.015 inch (0.380 mm) for a new gear set
Adjustment	Backlash is controlled by the position of the ring gear. Change backlash within specifications to get a good tooth contact pattern. — To increase backlash, move the ring gear away from the drive pinion — To decrease backlash, move the ring gear toward the drive pinion

Ring Gear — Runout (Refer to Section 5)

Specification	0.008 inch (0.200 mm) maximum

Spigot Bearing — Peening on the Drive Pinion (Refer to Section 5)

Specification	Apply 6,614 lb (3,000 kg) load on a 0.375 inch or 10 mm ball. Peen the end of the drive pinion at a minimum of five points. Softening of the pinion stem end by heating may be required.

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SINGLE AXLE without Driver Controlled Main Differential Lock (DCDL)

TANDEM AXLE without Driver Controlled Main Differential Lock (DCDL), with Inter-Axle Differential (IAD)

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Meritor Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

Before Towing or Drive-Away

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.

NOTE: Single Axle continue with Step 5. Tandem Axle continue with Step 2.

2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the IAD to the unlocked (disengaged) position using the switch inside the cab of the vehicle. The indicator light in the cab will go off.
4. Stop the engine.

NOTE: Remove both axle shafts from the axle(s) that will remain on the road when the vehicle is transported. Continue with Step 5 for <u>both</u> axle shafts.

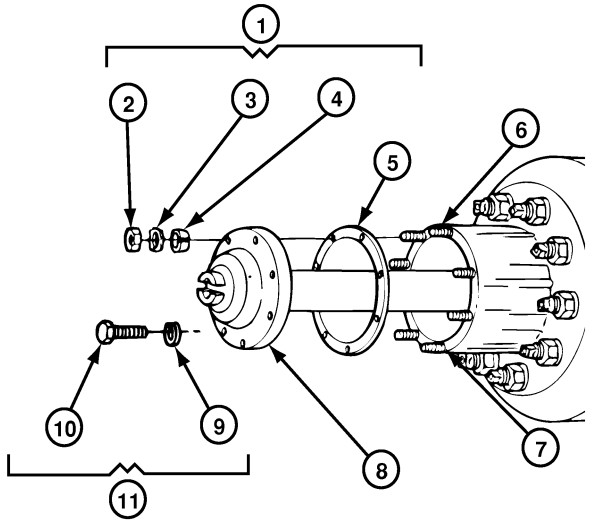
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 9.1**.

⚠ *CAUTION*

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 9.1**.

Figure 9.1



1	TAPERED DOWEL RETENTION
2	STUD NUT
3	WASHER
4	TAPERED DOWEL
5	GASKET
6	STUD
7	SHAFT HUB AXLE
8	AXLE SHAFT (FLANGE)
9	WASHER
10	CAPSCREW
11	NON-TAPERED DOWEL RETENTION

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7. **Brass Drift Method:**

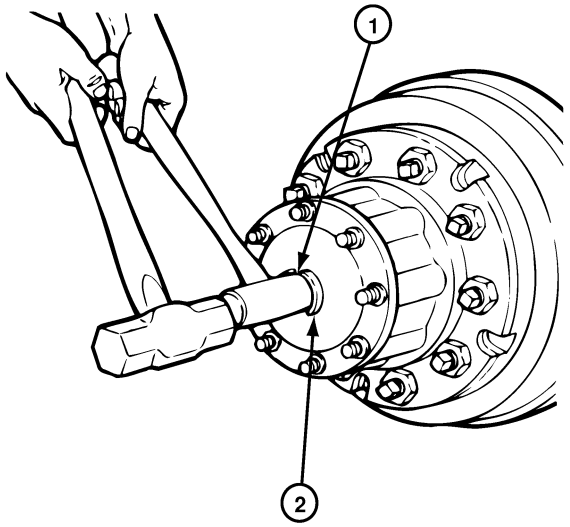
WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE: A 1.5-inch (38.1 mm) diameter brass hammer can be used as a drift.

a. Hold a 1.5-inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, **inside the round driving lugs**. **Figure 9.2**.

Figure 9.2



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

b. Hit the end of the drift with a large hammer (5 to 6 lbs, 2 to 3 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 9.2**.

WARNING

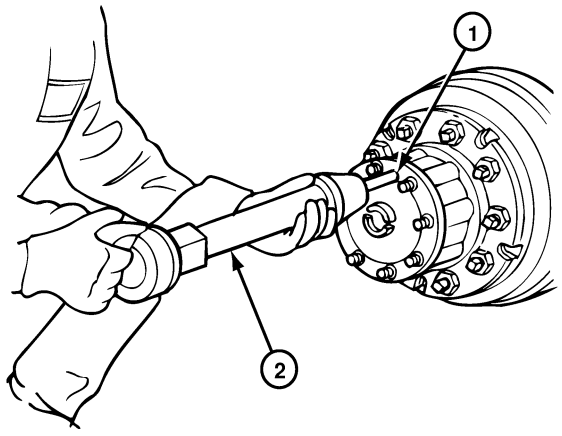
Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

8. **Air Hammer Vibration Method:**

a. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

b. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 9.3**.

Figure 9.3



1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

9. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)

10. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 9.1**.

11. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

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NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Steps 12 and 13, otherwise continue with Step 14.

12. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 14.
13. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 14 is not required.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

14. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

NOTE: Continue with Steps 5 through 7 to install all axle shafts.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 9.1**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in **Table K**.

Table K

Fasteners	Thread Size	Torque Value lb-ft (N•m) T
Capscrews:	0.31"-24 0.50"-13	18-24 (24-33) 85-115 (115-156)
Stud Nuts:		
(plain nuts)	0.44"-20 0.50"-20 0.56"-18 0.62"-18 0.75"-16	50-75 (68-102) 75-115 (102-156) 110-165 (149-224) 150-230 (203-312) 310-400 (420-542)
(lock nut)	0.44"-20 0.50"-20 0.56"-18 0.62"-18 0.75"-16	40-65 (54-88) 65-100 (88-136) 100-145 (136-197) 130-190 (176-258) 270-350 (366-475)

8. Inspect the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to Maintenance Manual MM 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

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Notes

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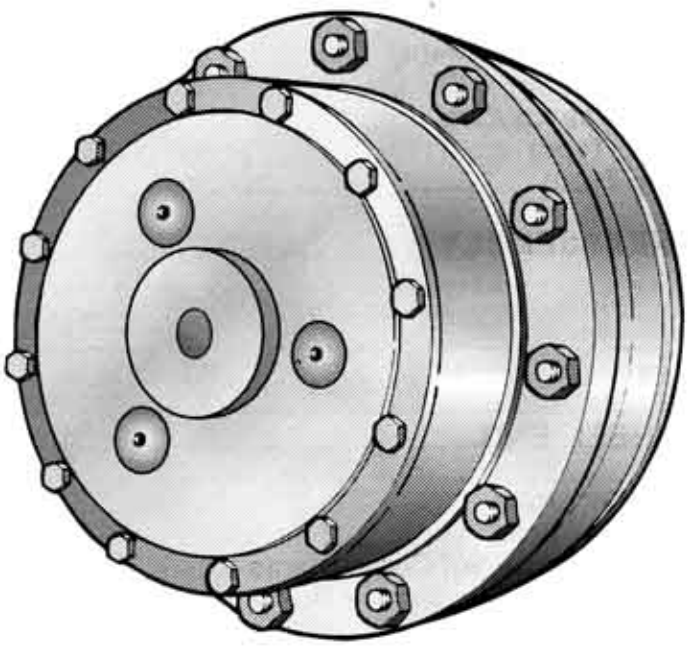
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Planetary Axle Wheel Ends

Maintenance Manual 9



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TABLE OF CONTENTS

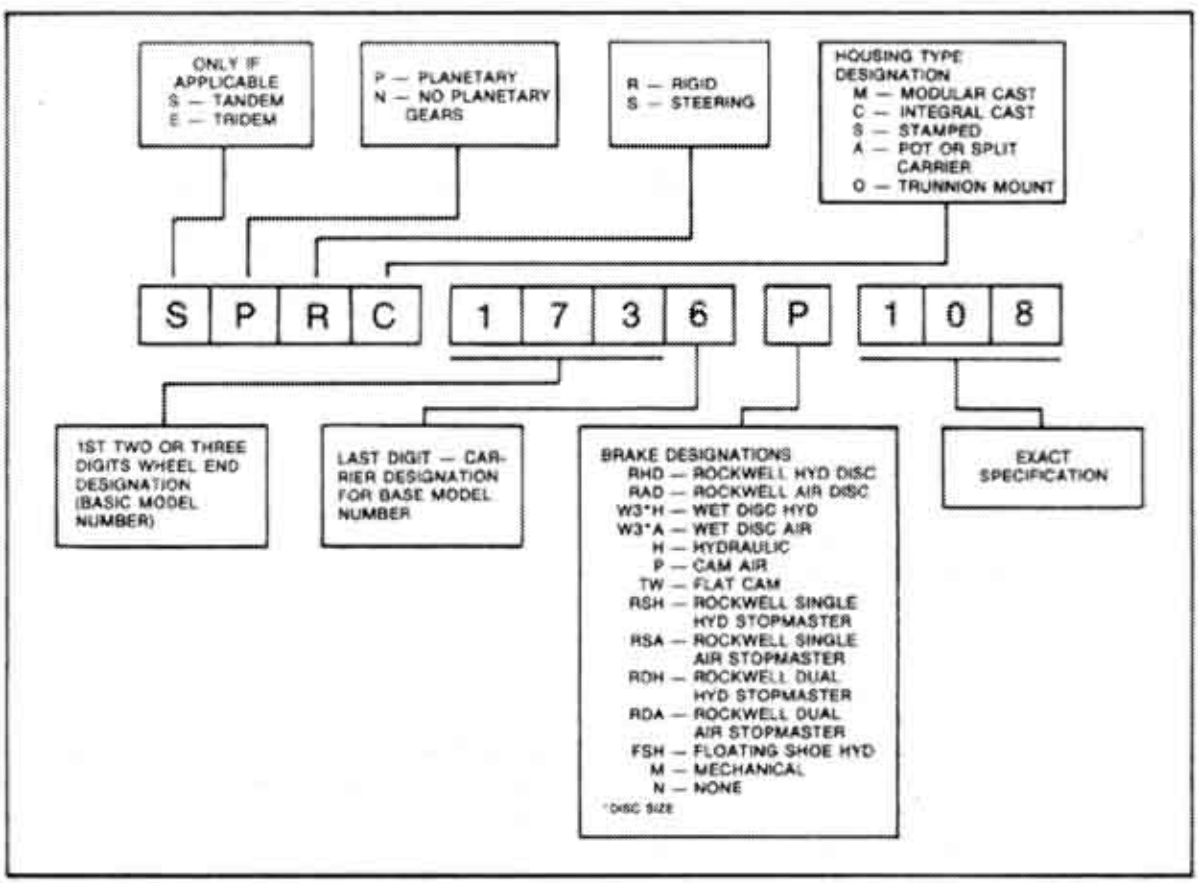
SUBJECT	PAGE
AXLE DESIGNATION CHART	3
AXLE DESCRIPTION	4
DISASSEMBLE WHEEL END	5
Prepare for Disassembly	5
Remove Spider Assembly	5
Disassemble Spider Assembly	6
Remove Ring Gear Assembly	7
Remove Hub and Drum Assembly	8
Disassemble Hub Spindle Assembly	8
Disassemble "Cardan" Steering Joint	9
Disassemble "Rzeppa" Steering Joint	10
Remove Axle Shafts	10
Universal Joint Disassembly	10
Remove Steering Knuckle Assembly (One Piece Construction)	11
Remove Trunnion Socket Assembly (Split Type Construction)	12
Disassemble Split Type Knuckle (Tapered Bearing Type)	12
(Bronze Bushing Type)	13
PREPARE FOR REASSEMBLY	13
Clean	13
Inspect	14
Repair	15
Dri-Loc Fasteners	15
REASSEMBLE WHEEL END	16
Install Oil Seal	16
Reassemble "Cardan" Joint	16
Reassemble "Rzeppa" Joint	16
Replacement of "Rzeppa" Joint Components	17
Install Trunnion Socket Pin Bearings or Bushings	18
Mount Trunnion Socket to Housing	18
Assemble Steering Knuckle	18
Adjust Steering Knuckle	18
Assemble Split Type Knuckle and Trunnion Socket	19
Adjust Steering Knuckle Bearings	19
Attach Components	19
Install Axle Shaft and Universal Joint Assembly	19
Install Hub Spindle Assembly	20
Assemble Ring Gear Hub Assembly	20
Assemble Axle Shaft in Rigid Axles	21
Assemble Hub, Bearings, Oil Seal and Drum	21
Wheel Bearing Adjustment	21
Install Ring and Sun Gears	23
Assemble Planetary Spider	23

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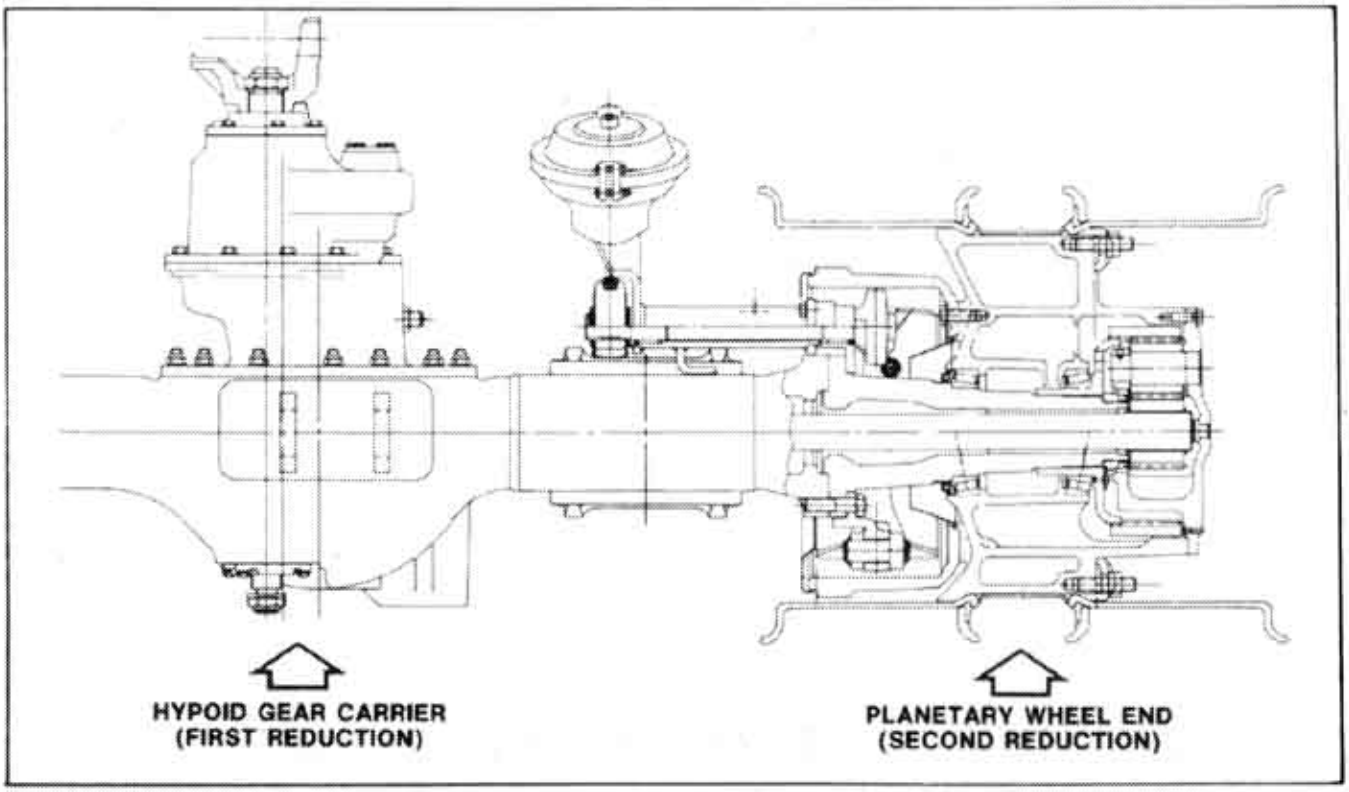
IMPORTANT

Follow all CAUTION and IMPORTANT Notes used throughout this manual to prevent personal injury and ensure mechanical integrity of components being serviced. The wearing of appropriate and safe eye protection is suggested while servicing and repairing components to prevent personal injury from chips or splinters.

MERITOR PLANETARY AXLE DESIGNATIONS



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DOUBLE-REDUCTION PLANETARY AXLES

Rockwell double-reduction planetary axles incorporate a single reduction carrier with hypoid or spiral bevel gearing mounted in the axle center. The second reduction is of planetary design spur gearing built into the wheel hubs.

There are three types of housings, cast, stamped and modular.

Rockwell Planetary Axles permit the bevel gearing of the carrier, and the axle shafts to carry nominal torsional load while providing the highest practical numerical gear reduction at the wheels.

The hypoid or spiral pinion and differential assembly of the first reduction are supported by tapered roller bearings. The pinion bearing preload is adjusted and maintained by a hardened precision spacer between the inner and outer bearings. The differential tapered bearing preload is adjusted and maintained by the positioning of the threaded adjusting rings in the carrier leg and cap bores.

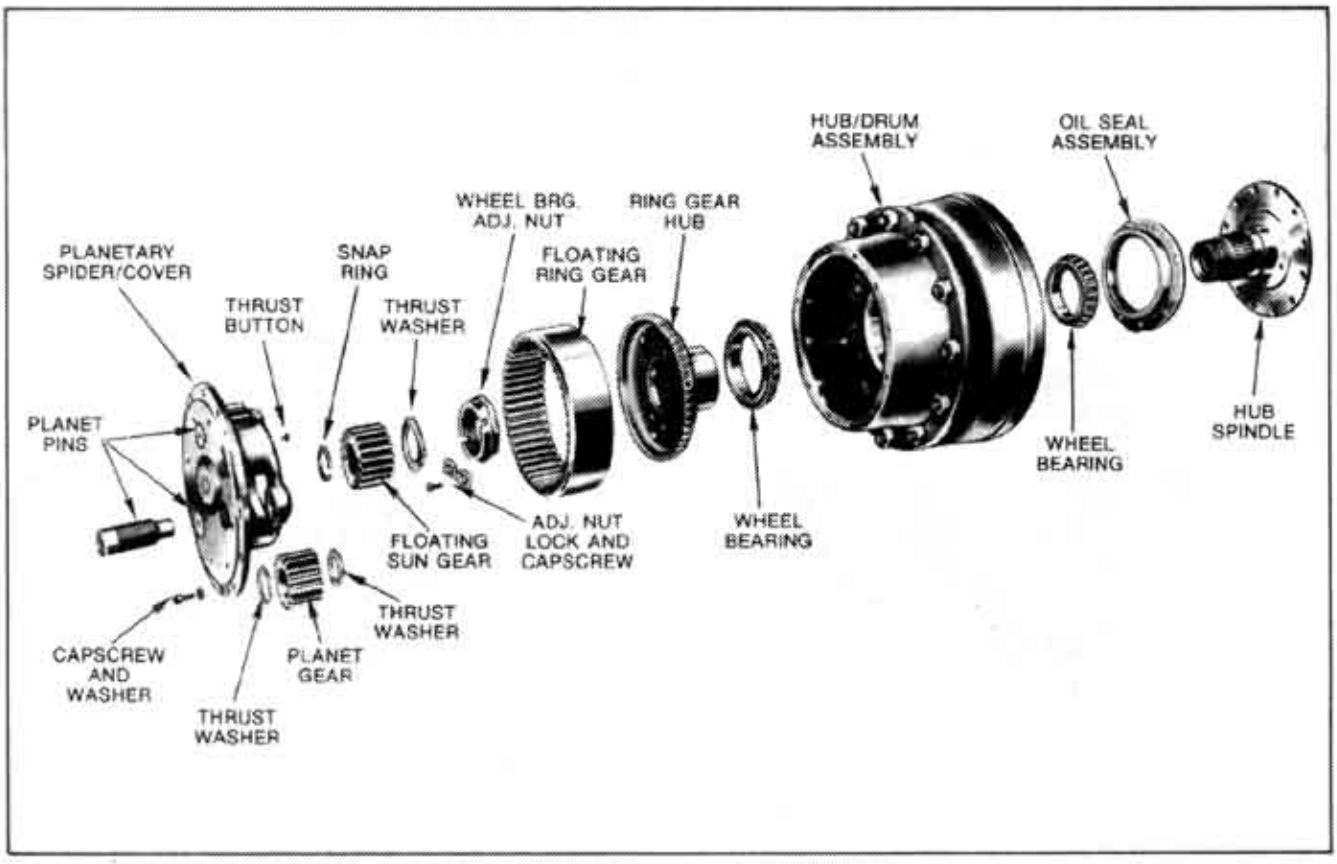
The spur teeth of the sun gear (which floats) mesh with teeth of the planet spur gears. The planet spur gears rotate on planet pins which are mounted in a spider. The planet spur gear teeth in turn mesh with teeth of the floating ring gear.

Power is transmitted by the first reduction bevel gear set in the carrier to the axle shafts and the sun gear of the planetary second reduction, through the revolving planet gears, and into the planetary spider which drives the wheel hub.

This manual covers the disassembly, inspection, reassembly and adjustment procedures of the planetary wheel end, steering joint and knuckle assembly.

NOTE: The servicing of the standard first reduction gear carrier assembly mounted in the axle center is thoroughly covered in our Field Maintenance Manual No. 5 (and 5C if drive unit is the through-drive tandem axle type).

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DISASSEMBLY OF PLANETARY WHEEL ENDS

PREPARE FOR DISASSEMBLY

NOTE: Unless service is planned for brakes and/or steering knuckles, it will not be necessary to remove the tire and rim from the planetary wheel end to service the planetary gearing.

Before starting the disassembly of the planetary wheel end the following procedure and precautions should be taken:

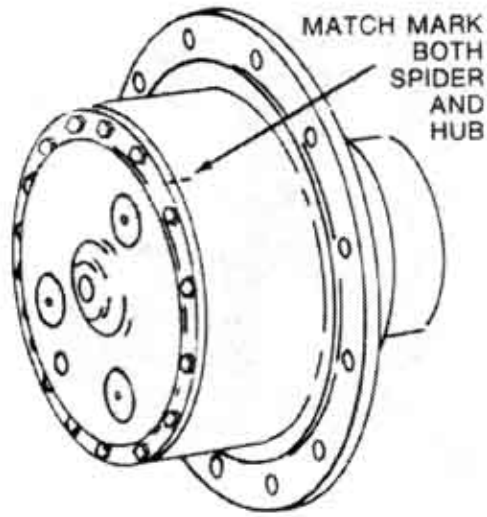
A. Jack up wheel end of vehicle just enough so the tire clears the ground.

B. Block up the axle in this position under the spring seat using a jack stand or other suitable fixture. After blocking up the vehicle remove the jacks.

⚠ CAUTION: Do not attempt to perform any type of service on the wheel end with the vehicle supported by jacks only.

C. Rotate the hub asembly so that the oil drain plug in the spider/cover is at the bottom. Remove the drain plug and drain the lubricant.

REMOVE PLANETARY SPIDER ASSEMBLY

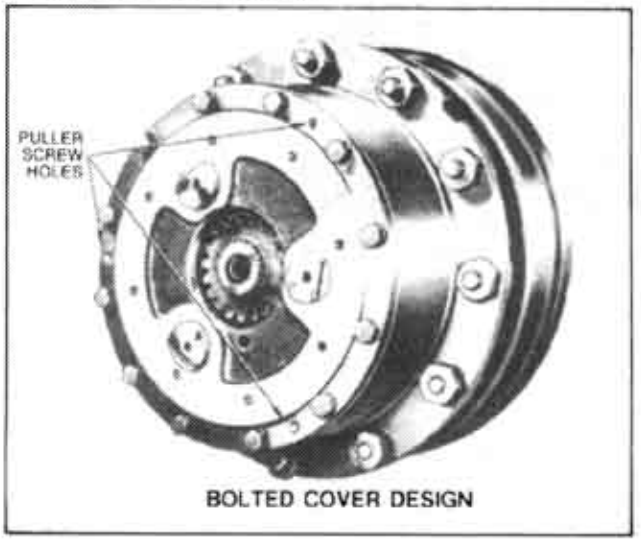


NOTE: Before disassembly match mark both the spider and wheel hub for identification of correct alignment when reassembling the unit.

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A. If wheel ends have a separate planetary spider and cover remove the spider cover capscrews and cover.

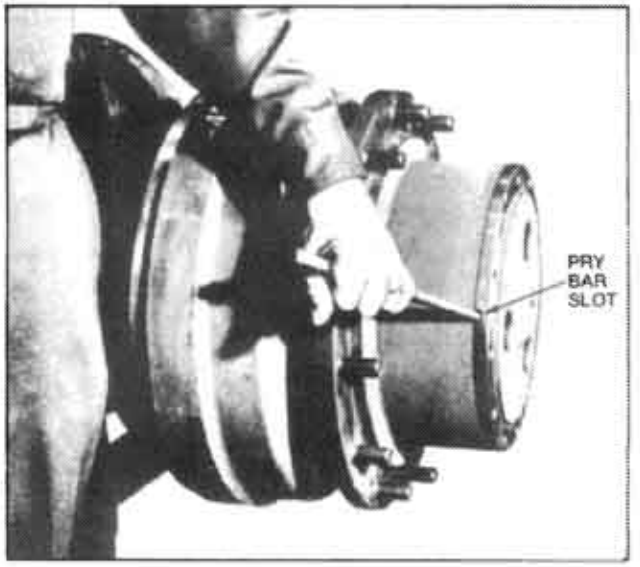
B. Remove the planetary spider to hub stud nuts or capscrews and washers.



BOLTED COVER DESIGN

C. Separate and remove planetary spider assembly from wheel hub assembly; use puller screws in threaded holes when provided in the spider flange.

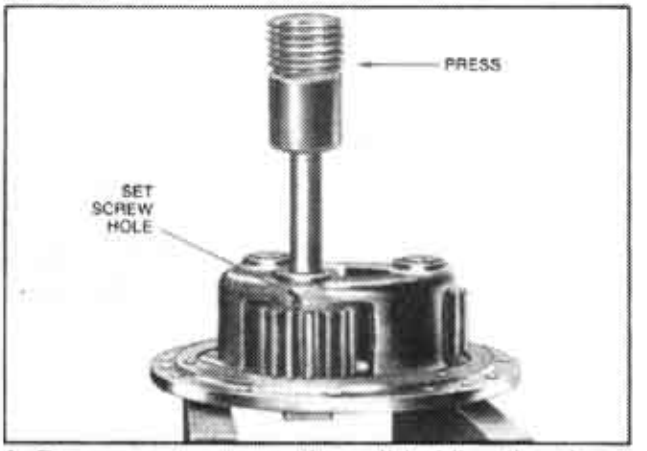
⚠ CAUTION: Rockwell planetary axles employ a floating ring gear. Care should be taken to prevent this gear from accidentally falling out when planetary spider is removed.



NOTE: The adhesive effect of the liquid gasket material may necessitate the use of the pry bar slots provided in some models to assist in loosening the spider. If there are no pry bar slots break the spider loose from the hub by striking it with a rawhide, plastic or rubber mallet.

DISASSEMBLE PLANETARY SPIDER ASSEMBLY

Planetary spur gears rotate on planet pins. Each gear rotates between hardened thrust washers.

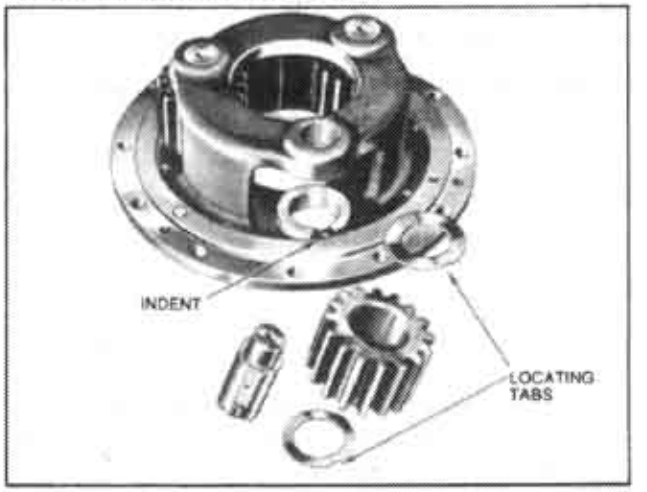


A. Remove set screws (if used) holding the planet pins in the spider. Set screws are located at the small diameter ends of the planet pins.

B. Support the spider assembly in a press, flange side down. Block up as required. To avoid damaging the pins place a block of wood under the press to cushion the pins as they are pressed out. Press the planet pins out through the spider and planet gears. (It is possible/acceptable to encounter a non-press fit condition on the bolted cover design).

NOTE: If a press is not available use a brass drift and mallet to tap out the pins.

⚠ CAUTION: Do not strike planet pins directly with a steel hammer. Personal injury from chips or splinters may result.

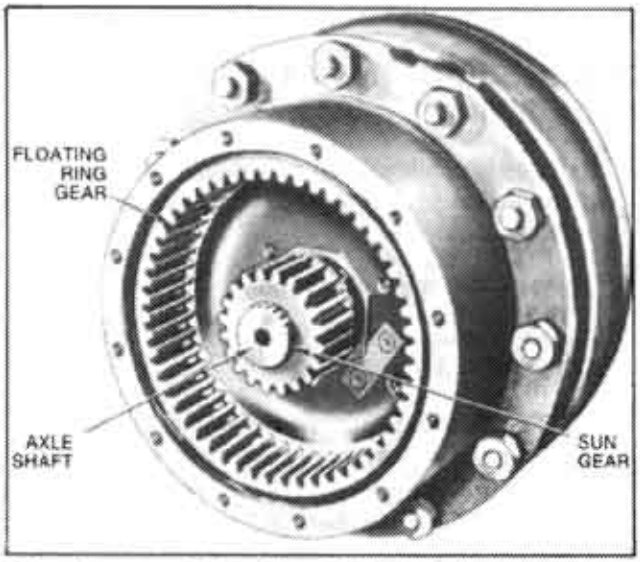


C. Remove the planet gears and their respective thrust washer.

NOTE: Thrust washers are designed for opposite sides of planet gears and can only be installed in their correct locations.

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REMOVE THE FLOATING RING GEAR ASSEMBLY



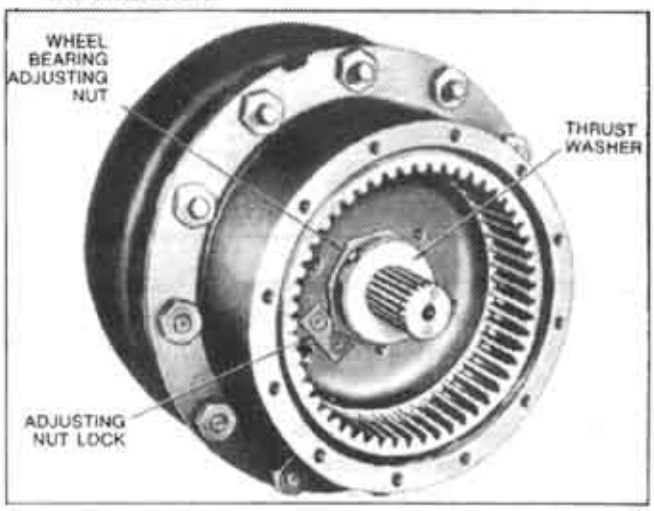
Steering and Smaller Rigid Models

A. Remove floating ring gear (on models where gear is not secured to ring gear hub).

B. Remove the snap ring from end of axle shaft.

C. Remove the axle shaft sun gear.

NOTE: On some of the larger rigid models the axle shaft and sun gear are integral. On these models remove the complete axle shaft, exercising care not to damage the oil seal. The sun gear thrust washer may then be removed from the axle shaft.



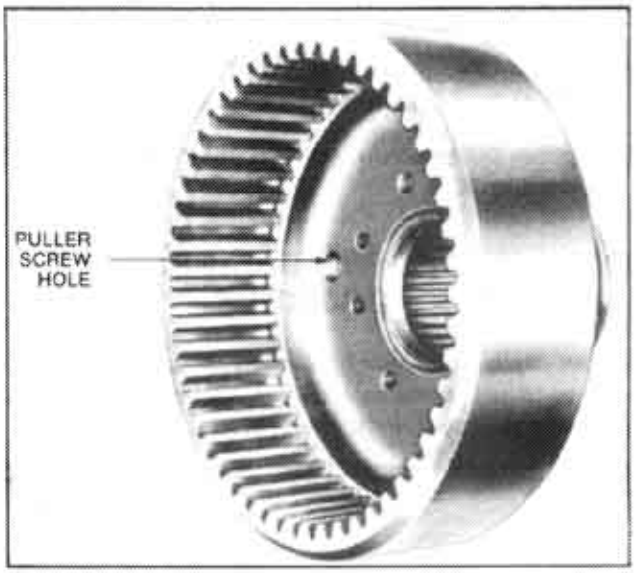
D. Remove the sun gear thrust washer.

E. Remove the axle shaft on rigid models that do not employ the integral sun gear.

F. Remove the wheel bearing adjusting nut lock. (Wheel bearing adjusting nuts can be of either single or double nut construction and may be locked to the hub spindle in different methods, depending upon the model.)

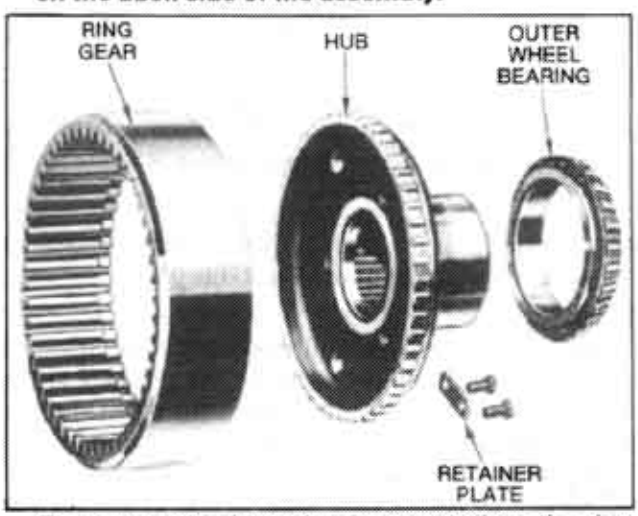
G. Remove the wheel bearing adjusting nut. Where double nuts are employed remove the jam nut, locking washer and the adjusting nut.

⚠ CAUTION: Before removal of ring gear hub assembly, be sure to provide a sling support for the wheel hub.



H. Remove the ring gear hub. Puller screw holes are provided on the larger models in the ring gear hub flange to aid in the removal of the hub.

NOTE: Some models may secure the ring gear to the ring gear hub with capscrews and plates on the back side of the assembly.



The outer wheel bearing is mounted on the ring gear hub.

J. Remove outer wheel bearing from ring gear hub.

NOTE: In some models the ring gear hub assembly is made up of the hub and a ring sleeve insert. These parts are not serviced separately.

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Larger Rigid Models

Larger rigid models are provided with threaded puller screw holes in the ring gear hub flange. There are also threaded holes of a smaller size in the wheel hub behind the ring gear hub.

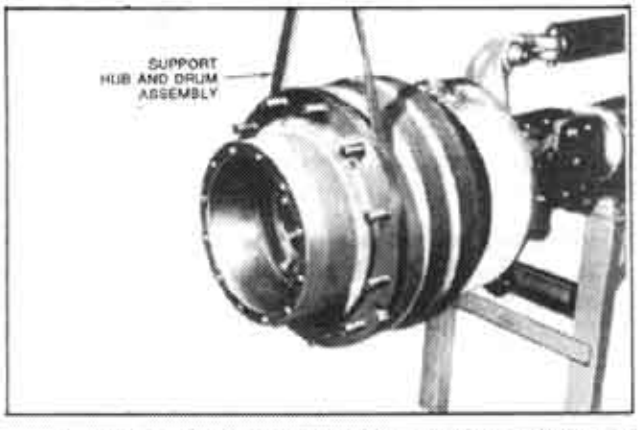
A. Turn the complete hub assembly so that the puller screw holes in the ring gear hub flange entirely miss the smaller holes of the wheel hub in back.

B. Install puller screws and turn in until they butt against the flat surface of the wheel hub.

C. Tighten puller screws alternately to pull ring gear assembly out.

REMOVE THE WHEEL HUB AND DRUM ASSEMBLY

A. Lift the hub and drum slightly to relieve the hub weight and drum to brake shoe drag and remove the assembly from the hub spindle.



⚠ CAUTION: Removal of hub and drum assemblies from larger model axles will require use of a chain fall.

B. If wheel bearings are to be replaced, remove wheel bearing cups with a suitable puller.

BRAKES

NOTE: In most cases, complete disassembly of the brake is not necessary for the removal of the hub spindle. Adequate working clearance is provided by removing the brake shoe return springs. If brakes are to be disassembled for service or inspection, refer to one of the following Rockwell Field Maintenance Manuals:

Hydraulic Brakes	**—**	**FMM#4**
Cam Brakes	**—**	**FMM#4**
Stopmaster Brakes (17"-36")	**—**	**FMM#4P**
Stopmaster Brakes (15")	**—**	**FMM#4R**
Dura-Disc Wet Disc Brakes	**—**	**FMM#4L**
Dura-Master Air Disc Brakes	**—**	**FMM#4M**

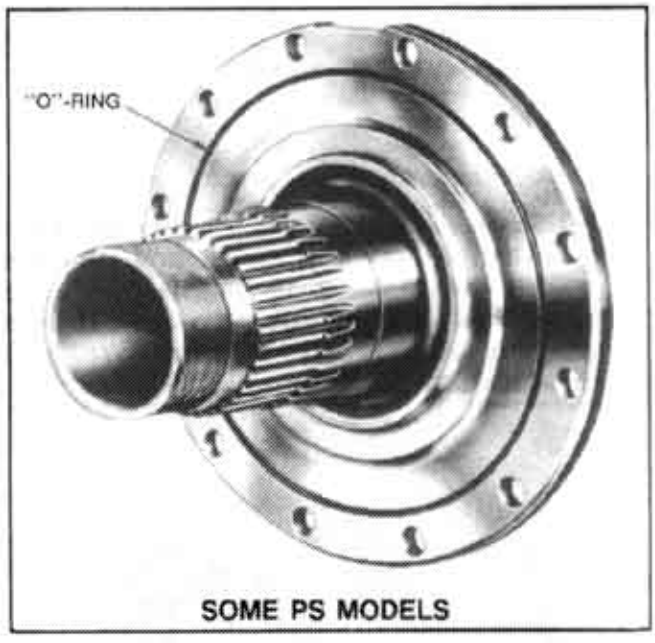
DISASSEMBLE HUB SPINDLE ASSEMBLY

A. Remove brake shoe return spring and push brake shoes aside to permit access to the hub spindle fasteners.

B. Remove the inner wheel bearing.

C. Remove the spindle stud nuts, bolts, and washers.

NOTE: You must remove the brake spider to allow removal of the spindle on certain models. All modular housing models have welded on spindles. Also, some rigid models utilizing a stamped axle housing have welded on spindles.



SOME PS MODELS

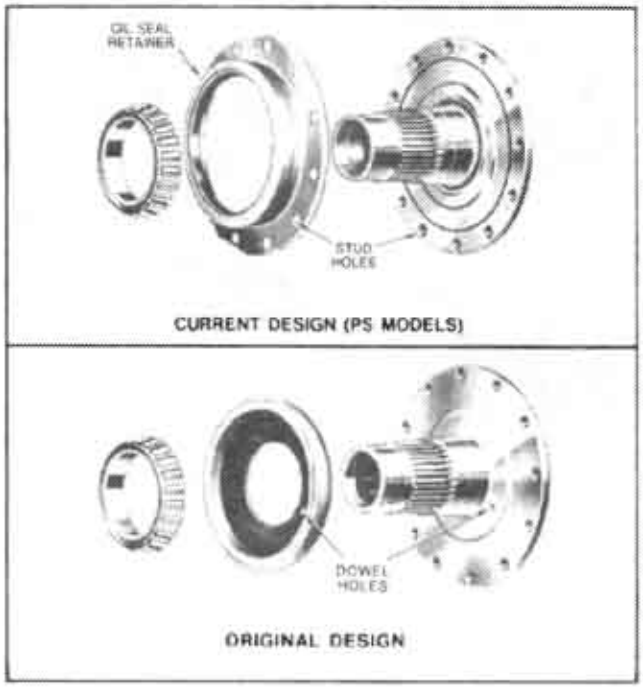
D. Remove the spindle. Care must be taken on some steering models not to damage the inner oil seal, in bore of spindle, while sliding past axle shaft splines.

NOTE: The wheel hub oil seal/retainer may adhere to the spindle flange due to liquid gasket in the joint on some PS models.

E. Remove the oil seal assembly. Original design models use a retainer held in position against the spindle flange by a dowel.

F. On all rigid and some steering models the oil seal and retainer assembly is located in the hub outside the hub rear bearing and wipes the hub spin-

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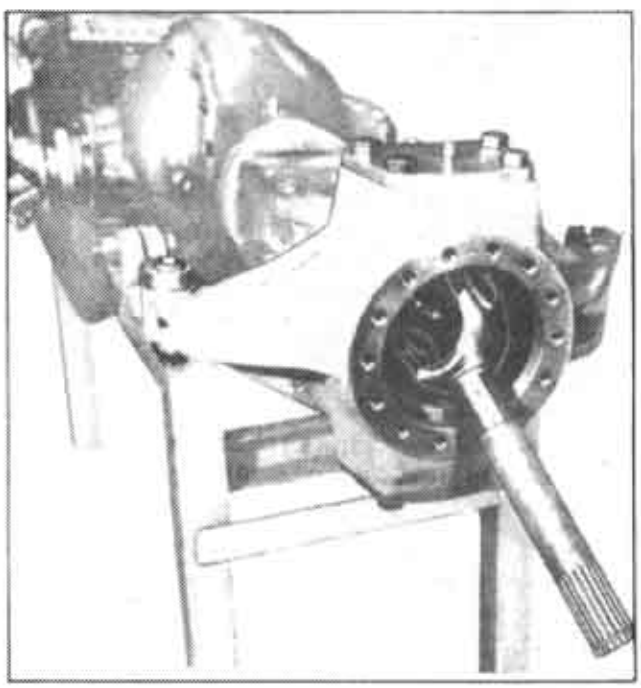


CURRENT DESIGN (PS MODELS)

ORIGINAL DESIGN

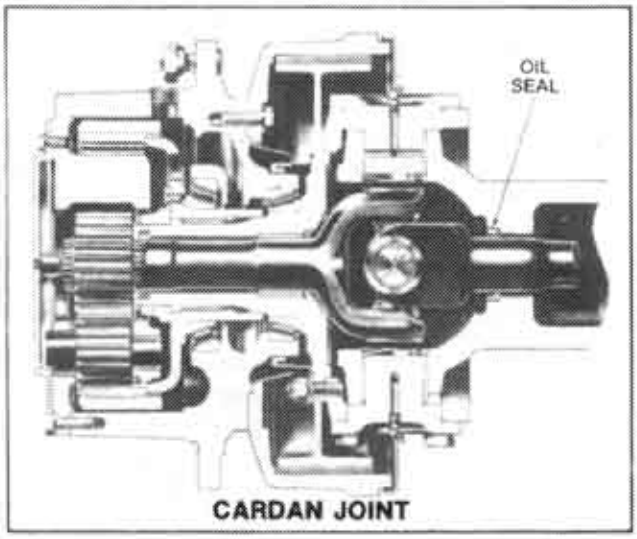
dle. Remove the retainer and seal assembly from hub with a suitable puller. Remove bearing.

NOTE: Do not remove the oil seal from the retainer unless replacement is necessary.



DISASSEMBLE "CARDAN" STEERING JOINT

Shown here is the standard "Cardan" steering joint. For service instructions on the "Rzeppa" or "constant velocity" joint move ahead to the Rzeppa Steering Joint section on page 10.

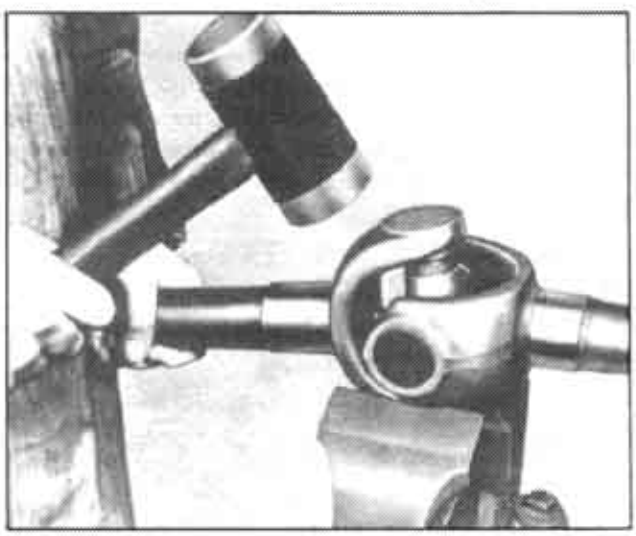


CARDAN JOINT

A. Remove the axle shaft and universal joint assembly from the housing assembly. Care must be excercised not to damage the oil seal in the housing.

B. If universal joints are disassembled for the purpose of cleaning, inspecting or replacing of individual components, use the following procedure.

1. Remove the snap rings from the two ears in each yoke, with a suitable tool.
2. Position the joint assembly in an open vise with one yoke "horizontal" and resting on top of the vise jaws (do not tighten the vise).

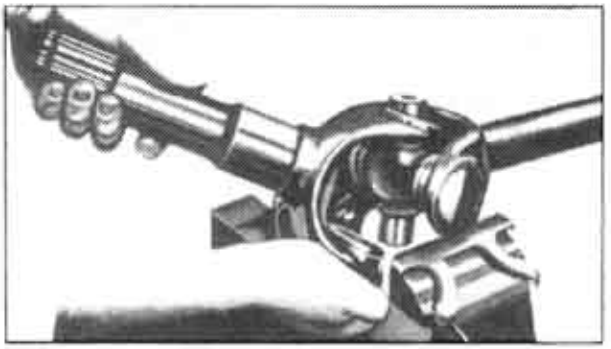


3. With a suitable soft mallet, tap the upper ear of the "vertical" yoke several times. This will drive the vertical yoke down and push out the upper needle bearing and cap (Bearing cap has a highly polished surface and care should be exercised not to mar or scratch surface during removal operation).

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4. If the metal retainers have worked free from the bearing caps, remove from the arms of the cross through the hole in the yokes.

5. Turn the "vertical" yoke upside down and remove the needle bearing and retainer on the opposite side following procedure outlined in items 3 and 4.



6. Remove "vertical" yoke by gently working yoke off arms of the cross.

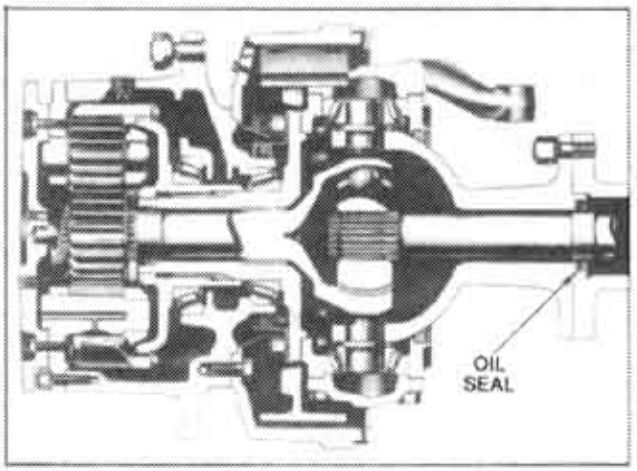
7. To complete the disassembly, hold the remaining yoke in a "vertical" position and rest the cross arms on top of the open vise. Repeat steps 3, 4 and 5.

8. Remove cross from yoke by gently working cross free.

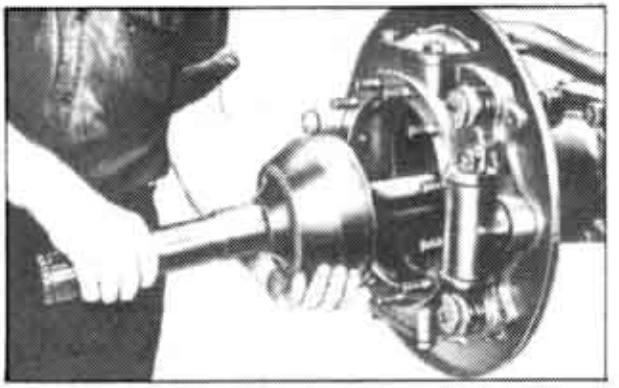
9. Clean and inspect all parts. When inspecting bearings, keep needles, caps and retainers together.

10. Replace parts that show excessive wear or damage. If it is necessary to use a new cross, the needle bearings should also be replaced. Do *not* mix new and used bearings together. Replacement should be made in sets of four.

DISASSEMBLE "RZEPPA" STEERING JOINT



REMOVE AXLE SHAFTS



Remove the axle shaft and ball joint assembly from the housing assembly. Care must be exercised not to damage the oil seal in the housing.

A. Clamp the inner shaft into a bronze jawed vise with outer race bell in downward position.



B. Drive off the shaft, bell, bearing and cage assembly by use of a bronze drift against end of inner race.

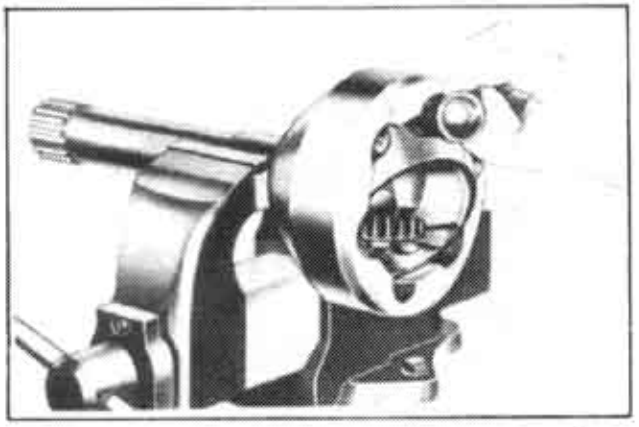
⚠ CAUTION: Do not strike these hardened steel pieces directly with a steel hammer. Personal injury from chips or splinters may result.

C. Remove the lock ring and discard. When shaft is reinstalled, a new lock ring should always be used.

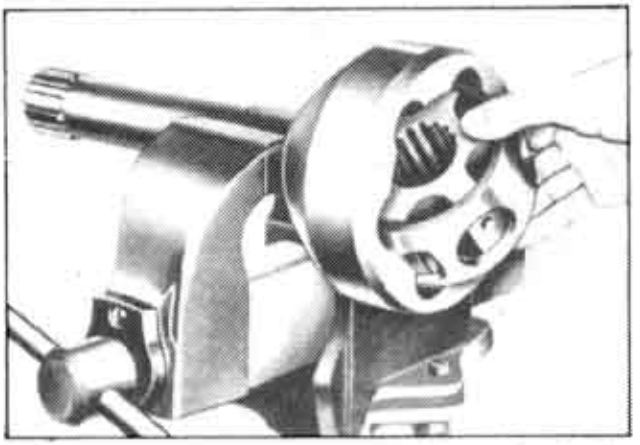
UNIVERSAL JOINT DISASSEMBLY

If universal joints are disassembled for the purpose of cleaning, inspecting or replacing of individual components, use the following procedure:

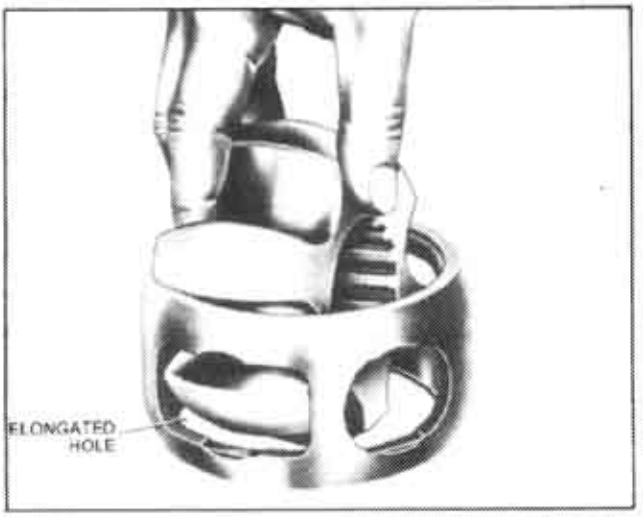
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A. Tilt the inner race in the outer race bell until one joint ball can be lifted out. Then tilt the inner race until the next ball can be lifted out, continue until all the balls are removed.



B. Roll the cage and inner race at right angles to the outer race bell with the two elongated openings in cage aligned with opposite teeth of bell. Then lift cage and inner race from the outer race bell.



C. To separate the inner race from the cage, turn race at right angle to cage, align tooth on race with elongated hole in cage and roll inner race from cage.

REMOVE STEERING KNUCKLE ASSEMBLY

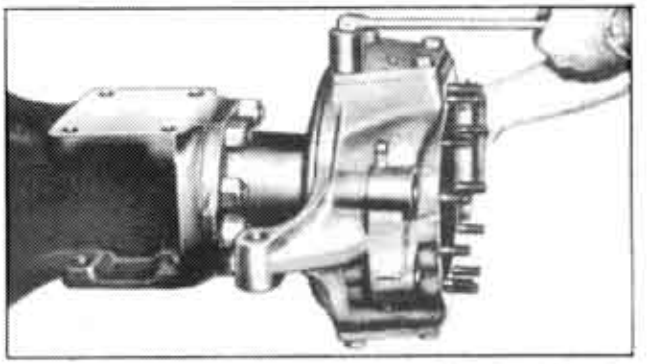
One Piece Construction

A. Disconnect the steering arm linkage.

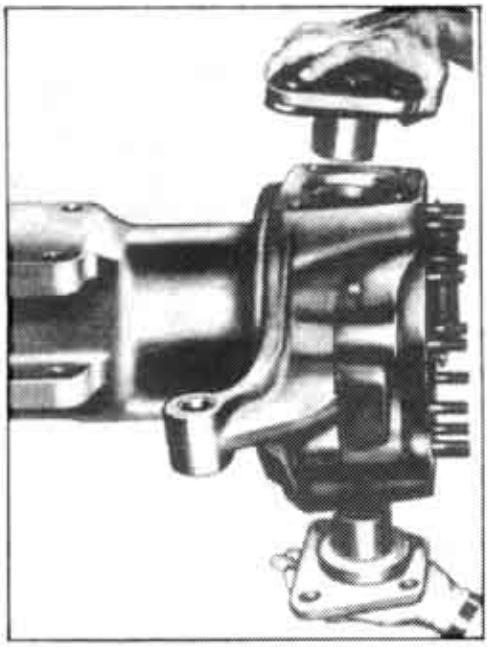
B. Disconnect the tie rod ends at clevis joint.

C. Remove dust shields where used.

D. Remove brake line from wheel cylinder inlet fitting.



E. Remove the steering arm cap and or knuckle pin capscrews.



F. Remove the lower knuckle pin cap, shims and thrust washer. Then remove the upper knuckle pin cap and shims. Keep the shims together for reassembly. (Do not mix the upper and lower shim packs).

G. Loosen the outer boot clamp wire and fold back the boot (where used).

H. Remove the steering knuckle from the socket. The knuckle can be tipped to clear the socket.

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REMOVE TRUNNION SOCKET ASSEMBLY

Bolted Type Construction

A. Disconnect the steering arm linkage.

B. Disconnect the tie rod ends at clevis joint.

C. Remove dust shields where employed.

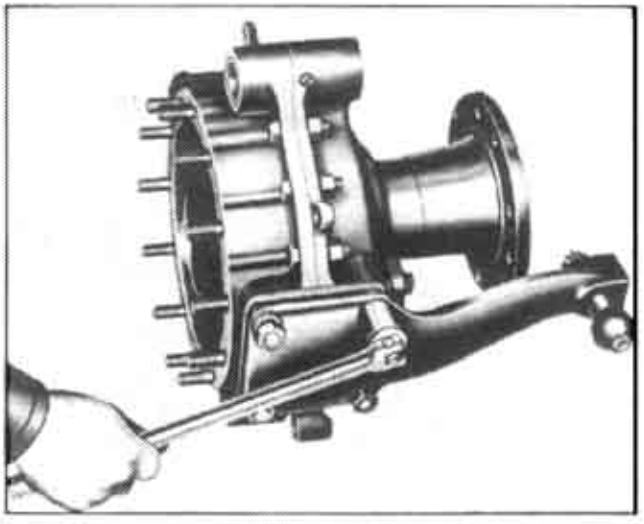
D. Remove the stud nuts and lock washers from the socket to axle housing flange.

E. Separate the trunnion socket assembly from the axle housing.

F. The trunnion socket assembly can be placed in a bronze jawed vise for further disassembly.

DISASSEMBLE THE SPLIT TYPE KNUCKLE ASSEMBLY

Tapered Bearing Type



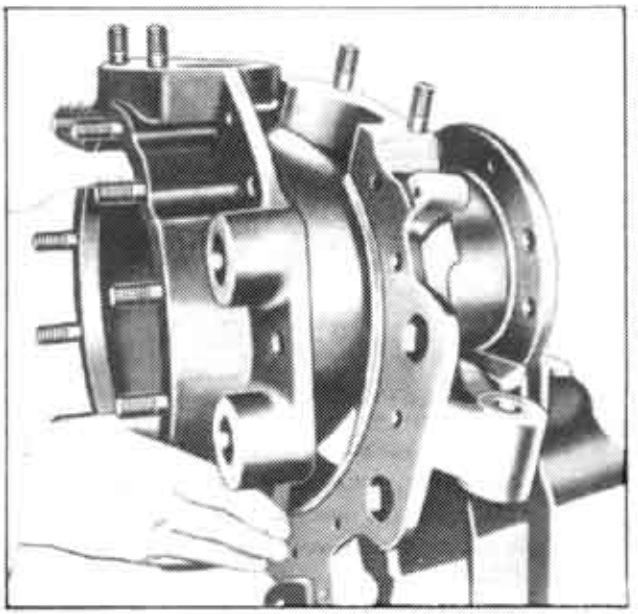
A. Remove the steering arm stud nuts and lock washers.

B. Remove the steering arm and shim pack. Shim pack should be wired together to keep intact to facilitate adjustment on reassembling.

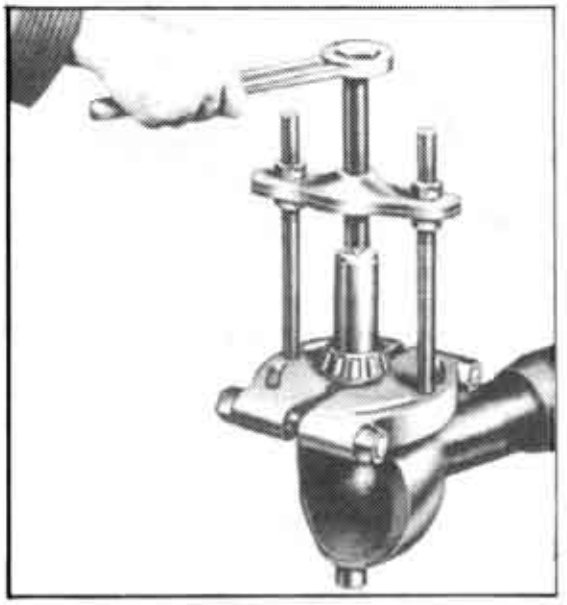
C. Remove the lower bearing cap stud nuts and lock washers.

D. Remove the lower bearing cap and shim pack. Wire shim pack together to keep intact to facilitate adjustment on reassembling.

E. Remove fasteners holding knuckle halves together.



F. Remove the bearing cups and separate the knuckle flange assembly. The inner half of knuckle flange may be tipped at an angle to clear inner connecting flange.



G. If bearings are to be replaced, remove the bearings with a suitable puller.

H. Remove the oil seal from the oil seal recess in the housing at connecting flange.

I. Remove the knuckle flange socket felt or oil seal. New felts or seals should always be used in knuckle rebuild.

NOTE: Some models may also have a hardened cover guide plate in front of the oil seal as a seal element protector during the installation and removal of the axle shafts. These guide plates

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are machined with an interference fit to the housing seal bore. To remove seals on axles that employ these guide plates, it is necessary to drive the plates out by means of a long bar from the opposite end of housing.

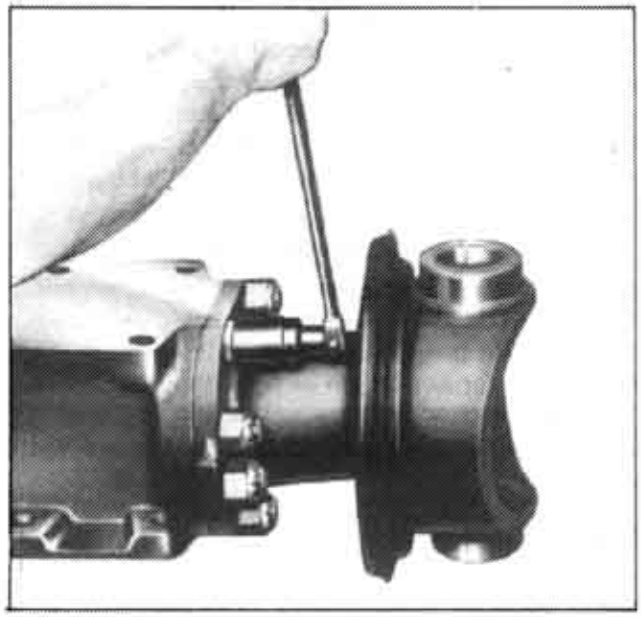
DISASSEMBLE THE TRUNNION SOCKET ASSEMBLY

Bronze Bushing Type

A. Remove the steering knuckle from the socket. The knuckle can be tipped to clear the socket.

B. Remove the stud nuts at the connecting flange and separate the trunnion socket from the axle housing.

C. Loosen inner boot clamp wire and remove boot.



NOTE: FLUSH TOTAL AXLE BEFORE REASSEMBLY. Most current rigid axles (PRC, PRM and PRS) do not utilize axle shaft oil seals; the lube is common to the wheel ends and the center section. Contamination from either wheel end or the carrier can spread to all other areas of the axle. Therefore the entire axle (both wheel ends and center section) should be thoroughly drained and flushed.

PREPARE FOR REASSEMBLY— CLEAN, INSPECT AND REPAIR

CLEAN

Parts having ground and polished surfaces, such-as gears, bearings, shafts and collars, should be cleaned in a suitable solvent, such as kerosene or diesel fuel oil.

Clean all mating surfaces where fiber or liquid gasket material is used. It may be necessary to use a scraper to completely remove gasket materials. Be careful not to damage mating surfaces.

⚠ CAUTION: Exercise care to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

GASOLINE SHOULD NOT BE USED AS A SOLVENT

DO NOT clean these parts in a hot solution tank or with water and alkaline solutions, such as sodium hydroxide, orthosilicates or phosphates.

DO NOT steam clean 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 a necessary requisite to thorough cleaning.

Rough Parts

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.

⚠ CAUTION: Exercise care to avoid skin rashes and inhalation of vapors when using alkali cleaners.

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.

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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

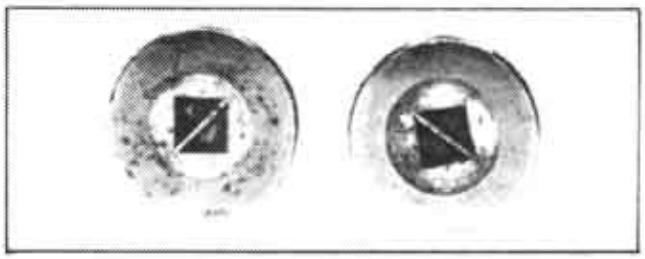
Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good *rust preventive* and wrapped in special paper or other material designed to prevent corrosion.

INSPECT

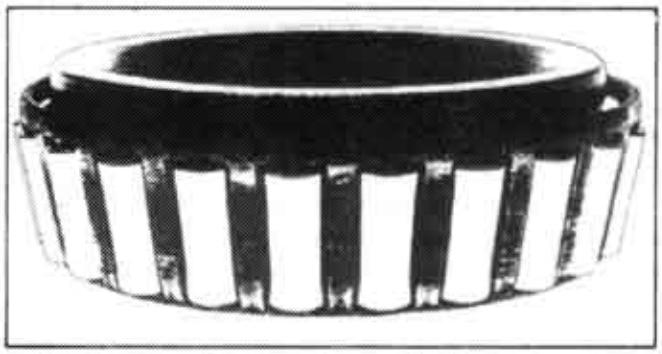
It is impossible to overstress the importance of careful and thorough inspection of parts prior to reassembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary will eliminate costly and avoidable failure.

A. Inspect all bearings, cups and cones, 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.

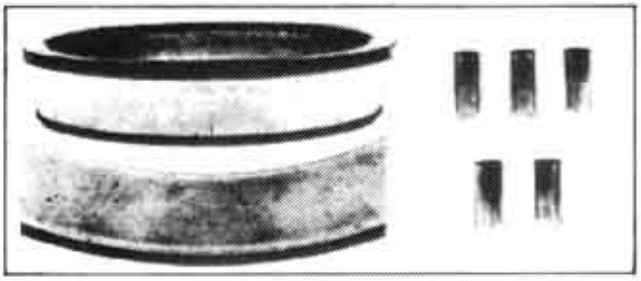
If any of the following bearing conditions exist, bearings must be replaced:



1. Large ends of rollers worn flush to recess or radii at large ends of rollers worn flat.



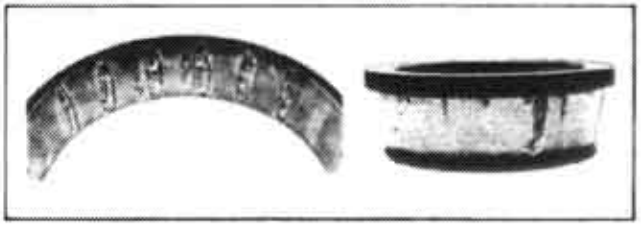
2. Bright rubbing marks on the dark phosphate surfaces of the bearing cage.



3. (a) Visible step wear, particularly at the small end of the roller track.
   (b) Deep indentations, cracks or breaks in bearing cup and/or cone surfaces.



4. Etching or pitting on functioning surfaces.



5. Spalling or flaking on bearing cup and/or cone surfaces.

B. Inspect the planetary reduction, planet gears, sun gear and ring gear assembly for wear or damage. Gears, shafts or thrust washers which are scored, pitted, ridged, chipped or worn should be replaced.

C. Inspect axle shafts for signs of torsional fractures or other indications of impending failure.

D. Inspect seals on tie rod ends for any indications of damage. Also check to make sure seal is securely seated on socket. If tie rod end has a grease fitting, replace damaged seals. Tie rod ends not having a greasing provision should be replaced if seals are damaged or loose.

IMPORTANT: Rockwell *does not* recommend attempts to salvage damaged ends by repacking and replacing the boot seal on nongreasable ends.

Check the turning torque value between the tie rod end assembly stud and the ball cavity. If torque value is less than five (5) inch pounds, the tie rod end assembly should be replaced. This is not to say the end assembly will fail at this point, but it can no longer provide the type of steering

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control designed into it once lateral movement develops between the stud and the ball cavity.

E. Inspect axle housing for cracks, loose studs and nicks or burrs at machined surfaces. Make all necessary repair or parts replacement.

REPAIR

A. Replace all worn or damaged parts. Trunnion sockets if scratched. Replace all hex nuts with rounded corners, distorted washers and snap rings, oil seals, gaskets and socket felts at time of overhaul.

IMPORTANT: Use only genuine Rockwell 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, and temperature extremes.

B. 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 reassembling the parts.

C. Tighten all the nuts and capscrews to the correct torque. (See torque limits on page 27).

USE OF DRI-LOC FASTENERS AND ROCKWELL LIQUID ADHESIVE 2297-C-3747 (LOCTITE #277)

Using New Dri-Loc Fasteners

1. Wipe excess oil and any residue from the threaded holes. The holes should be relatively oil free, however, no special cleaning is required.

2. Assemble the components using Dri-Loc fasteners. DO NOT APPLY ROCKWELL LIQUID ADHESIVE OR ANY OTHER TYPE OF FASTENER RETAINER MATERIAL, SEALANT OR ADHESIVE ON DRI-LOC FASTENERS OR IN THE THREADED HOLES.

3. Tighten the Dri-Loc fasteners to the specified torque value. Refer to Fastener Torque Chart at end of manual.

NOTE: No cure time is required for Dri-Loc fasteners prior to rebuilding the axle and returning it to service.

Reusing Dri-Loc Fasteners and Rockwell Liquid Adhesive 2297-C-3747 (Loctite #277) Application

1. Wipe excess oil residue from the fasteners and threaded holes. The fasteners and holes should be relatively oil free, however, no special cleaning is required. When reusing Dri-Loc fasteners, it is not necessary to remove the Dri-Loc residue from threads.

2. Apply Rockwell Liquid Adhesive to the threaded holes only, by letting four or five drops run down the side of each hole. Before threading in the fasteners, visually check to make sure that the adhesive has contacted the threads.

   IMPORTANT: Do not apply adhesive to the fastener, since trapped air in the hole will create back pressure and "blow out" the adhesive as the fastener advances.

3. Tighten the fasteners to the specific torque value recommended for that size fastener. Rockwell Liquid Adhesive will not alter the torque requirement. Refer to the Fastener Torque Charts on page 28.

   NOTE: No cure time is required for Rockwell Liquid Adhesive prior to rebuilding the axle and returning it to service.

   IMPORTANT: When servicing drive units assembled with Dri-Loc fasteners or with Rockwell Liquid Adhesive in Threaded holes where the fasteners do not require removal:

   —Check each fastener for tightness by applying the minimum amount of torque specified for that size fastener. If the fastener does not rotate, it is satisfactory. If the fastener rotates to any degree, it must be removed from the component and adhesive must be applied to the threaded hole. Use the procedures under "Reuse of Dri-Loc Fasteners and Rockwell Liquid Adhesive 2297-C-3747 (Loctite #277) Application."

   Further, if fastener removal becomes difficult due to worn heads or unusually high breakaway torques, the locking strength of either Rockwell Liquid Adhesive or Dri-Loc can be reduced by heating. Heat the fastener for only a few seconds at a time while trying to loosen it.

   DO NOT EXCEED 177°C (350°F) maximum. Heating should be done slowly to avoid thermal stresses in other components. Application of heat reduces the strength of the adhesive and Dri-Loc below recommended installation torque.

   Rockwell does not recommend removing fasteners with an impact wrench or by striking with a hammer. Damage to fastener heads can result.

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REASSEMBLE PLANETARY WHEEL END

INSTALL OIL SEAL IN HOUSING

A. Install oil seal in axle housing at the outer end with a suitable driver. Care must be exercised to locate the seal squarely against the seal recessed shoulder or shaft guide.

B. On units incorporating the axle shaft guide plate, start the plate into the end bore evenly with a mallet. Once plate is started square, drive the plate into position with a suitable driver.

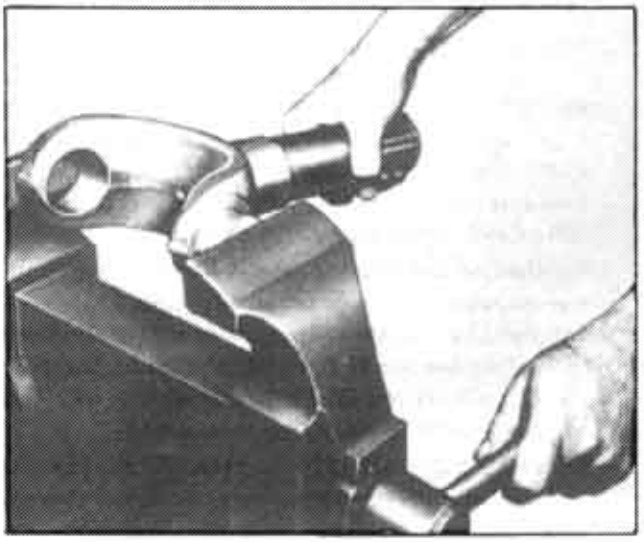
⚠ CAUTION: Do not strike hardened steel parts directly with a hammer. Personal injury from chips or splinters may result.

For steering axle models continue on for reassembling steering joints and knuckle assemblies. For rigid axle models proceed to "Install Hub Spindle Assembly" on page 20.

REASSEMBLY OF CARDAN JOINT

A. Insert needle bearing cap into ear of yoke.

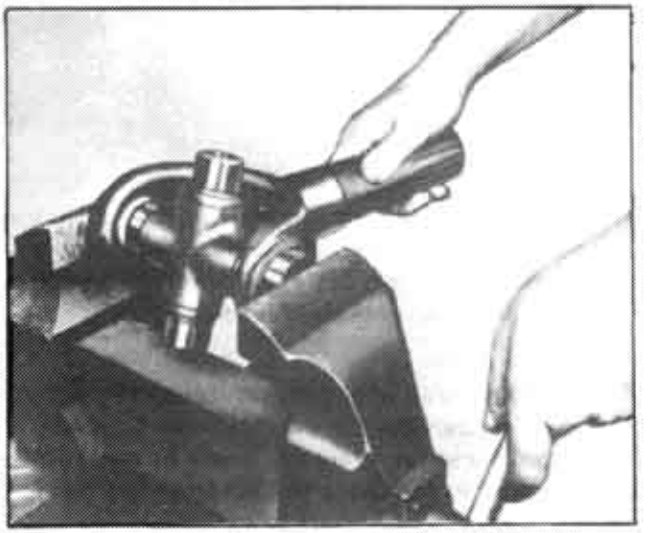
B. Place yoke in vise and press needle bearing cap into the proper position. Bearing cap has a highly polished surface and care should be exercised not to mar or scratch surface during installation operation.



C. Remove yoke from vise and gently work one arm of cross into the yoke and bearing cap.

D. Install opposite bearing cap by hand and line up cross arm.

E. Place yoke in vise and press needle bearing cap into the yoke and onto the arm of the cross. (Cross must move freely in both caps; if cross should bind, remove cap and check for upset needles).



F. With the aid of a short plug, move bearing caps past snap ring groove. Insert snap rings in grooves, one with each bearing cap.

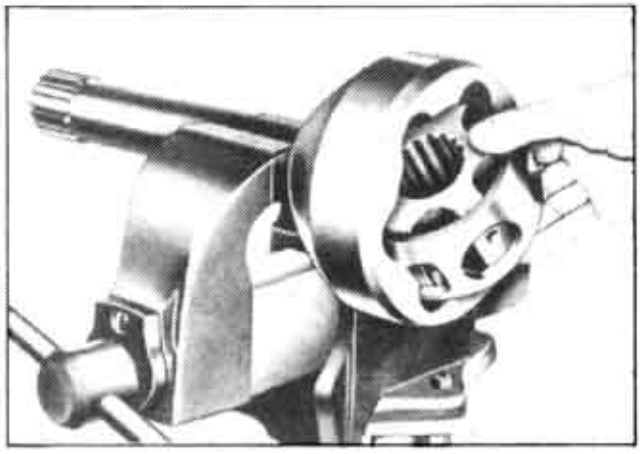
G. Repeat procedure as outlined in items A thru F for installing remaining caps and yoke.

REASSEMBLE "RZEPPA" STEERING JOINT

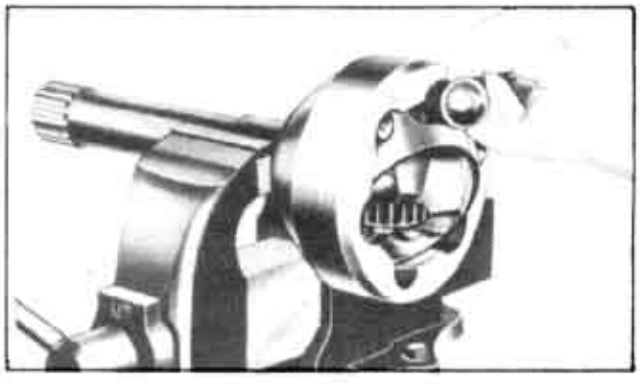


A. Install the inner bearing race into cage at right angle and align race teeth with elongated cage hole. Turn race within cage to position parallel with cage.

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B. Insert the race and cage into the universal bell at right angle and tilt into position while at the same time aligning bell teeth with elongated openings.



C. Tilt, in the bell, the inner race and cage until one joint ball can be inserted. Then tilt race and cage with aligning bell teeth until the next joint ball can be inserted. Continue until all the joint balls are in place.

D. Clamp the outer end of bell shaft in a bronze jawed vise or holding fixture with inner race splines parallel with the bell face.

E. Install a new locking ring in the inner shaft lock ring groove.

F. Align the splines of inner shaft with splines of the inner race, holding shaft in a vertical position so that lock ring rests in inner race entering chamfer.

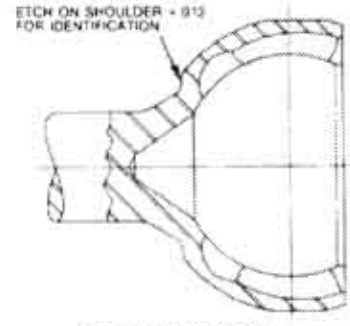
G. Tap the end of shaft with a rawhide mallet to collapse the lock ring.

H. Drive the shaft through the inner race until lock ring clears splines and opens, thus locking the shaft in place.

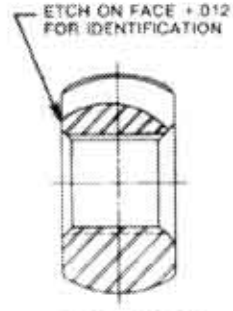
⚠ CAUTION: Do not strike these hardened steel pieces directly with a steel hammer. Personal injury from chips or splinters may result.

REPLACEMENT OF INDIVIDUAL COMPONENTS IN RZEPPA BALL JOINTS

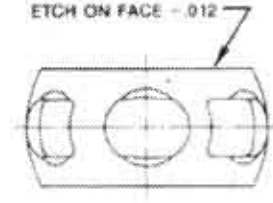
This will acquaint you with the fact that approximately 10% of original Rzeppa universal joints are made with .012" oversize balls, raceways and cages. All original joints that employ oversize components are marked on the individual pieces aside from the balls in the places noted on the following figures:



OUTER RACE BELL



INNER RACE



CAGE

When disassembling these universal joints for the purpose of cleaning, inspecting or replacing individual components, it is advisable to rework them one at a time and thus avoid a chance of mixing parts from standard and oversize assemblies.

If a considerable number of joints are to be reworked at one time, it will be necessary to segregate the components from standard and oversize joints.

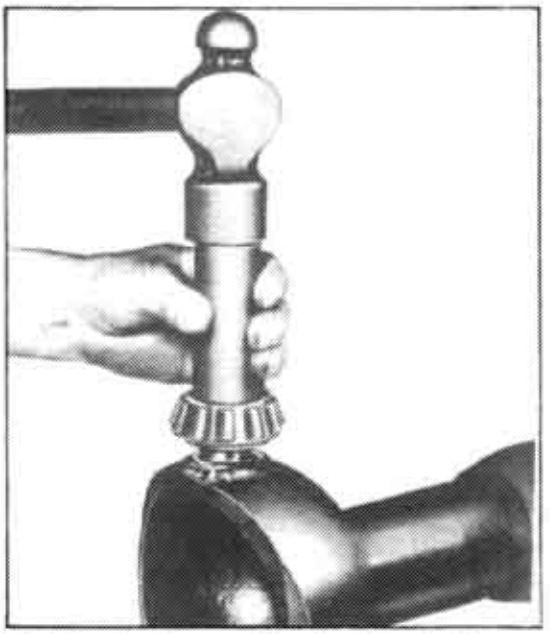
It should be noted further that only standard size components are furnished for service replacement. The standard size parts are to be used for replacement of either standard or oversize parts in the original assemblies. It should be noted, however, that if the outer race, the inner race or the cage in an original oversize joint is replaced, it will also be necessary to replace all the balls at the same time. If the original oversize balls were to be re-used, the resulting assembly would be too tight and would lead to hard steering and short life.

The use of standard size replacement balls in a joint having one or more of the other components oversize, will in no way affect performance or life though there will be slightly more backlash.

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INSTALL TRUNNION SOCKET PIN BEARINGS OR BUSHINGS

A. If trunnion socket pin bearings have been removed, place knuckle pin end of housing in a bronze jawed vise or other suitable fixture.



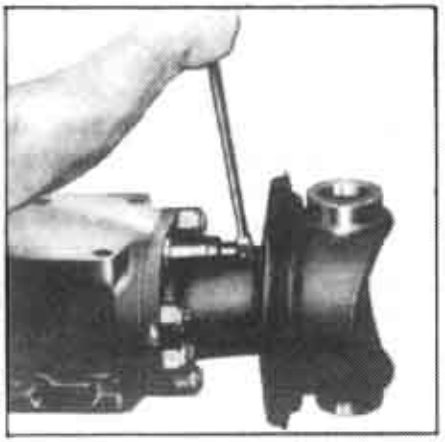
B. Install the bearing on the knuckle pin by use of a sleeve driver that bears against the bearing inner race, or . . .

C. Install bronze bushings with a suitable driver. Check fit of the knuckle pin caps in new bushings and ream if necessary.

MOUNT TRUNNION SOCKET ASSEMBLY TO HOUSING

Bronze Bushing Type

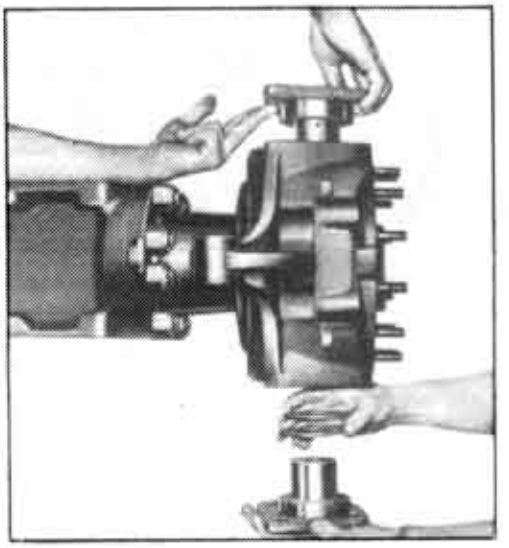
A. Slip the boot over the connecting flange of the trunnion socket.



B. Mount the trunnion socket on the axle housing studs and install the stud nuts. Tighten the nuts to specified torque.

C. Install the inner boot clamp wire in the trunnion socket groove.

ASSEMBLE STEERING KNUCKLE ASSEMBLY



A. Lubricate king pin bushing bores with grease (Rockwell 0-617-A or 0-617-B Spec.).

B. Install knuckle over trunnion socket.

C. Install upper king pin cap with original shim pack. It may be necessary to drive the cap into the knuckle by tightening the king pin capscrews alternately in small increments, keeping the king pin cap straight with respect to the knuckle bore.

D. Install lower king pin cap with original shim pack. The thrust washer must have tangs facing the trunnion socket.

NOTE: Apply grease to the grooved face of the thrust washer prior to installation on the king pin cap.

E. Make sure that the thrust washer tangs engage the slots in the trunnion socket boss before final tightening of the lower king pin cap fasteners.

ADJUST STEERING KNUCKLE

Steering knuckle adjustment is accomplished by use of shims located under the upper and lower king pin caps. The knuckle vertical end play specification is .005 to .013 inch.

A. Measure the vertical end play of the steering knuckle and *record*. This may be determined by using a feeler gauge to measure the gap between the upper king pin cap shoulder and the top surface of the trunnion socket king pin boss while

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the wheels are on the ground — or — if wheels are removed (axle supported on blocks) measure the gap with the knuckle assembly forced maximum upward (with hydraulic jack or pry bar), or check maximum vertical movement of knuckle with a dial indicator.

B. (1) If end play is .013 inch or less; no readjustment is necessary.

(2) If current end play exceeds .013 inch; continue the following steps.

C. Remove lower and upper king pin caps and measure the *total* current shim pack thickness (upper pack *plus* lower pack).

D. Subtract actual end play (value from step A) from the total shim pack thickness (value from step C) and divide this result by two.

E. Make the "new" *lower* shim pack thickness the same as the value from the step D calculation. If this thickness cannot be met exactly, choose the nearest thicker pack.

F. Make the "new" *upper* shim pack thickness the same as the value from the step D calculation *plus* .005 inch. If this result cannot be met exactly, choose the nearest thicker pack.

EXAMPLE:

Step A. Current end play = .020 inch

Step B. Conclude readjustment necessary

Step C. Current *total* pack thickness = .066 inch

Step D. .066-.020 divided by 2 = .023
(.046 divided by 2 = .023)

Step E. New *lower* pack = .023 inch

Step F. New *upper* pack = .023 + .005 = .028 inch.

ASSEMBLE SPLIT TYPE KNUCKLE AND TRUNNION SOCKET

A. Install the inner half of the knuckle flange by tilting and sliding it over the trunnion socket flange end.

B. Mount the trunnion socket onto housing studs and install washers and nuts.

C. Tighten nuts to correct specifications as listed on torque chart following service instructions.

D. Align mating outer knuckle flange with inner knuckle flange.

E. Join the two flanges together by installing the knuckle flange bolts, lock washers and nuts.

F. Tighten the knuckle flange nuts to correct torque.

G. Install the upper and lower bearing cups.

ADJUST STEERING KNUCKLE BEARINGS

Split Type Knuckle

A. Install the original shim packs between steering arm cap and lower bearing cap.

B. Install the caps, lock washers and nuts.

C. Tighten the nuts to correct torque and check for end play and oscillating freeness.

D. The knuckle should be adjusted by adding or removing shims as required.

E. After zero end play with oscillation has been established, remove a .005" shim from each shim pack.

F. Replace the caps, lock washers and nuts. Tighten nuts to correct torque. After this is done a small amount of drag in rotating the steering knuckle should be felt, but it should not bind.

G. The size of the shim pack at the top and the bottom should be nearly the same so as to center the joint assembly for proper shaft alignment.

H. Install the dust shields where used.

ATTACH COMPONENTS

All Knuckle Styles

A. Install brake line to wheel cylinder inlet fitting.

B. Attach power steer cylinder to knuckle arm.

C. Attach tie rod to knuckle, use correct specifications as listed in torque chart following service instructions.

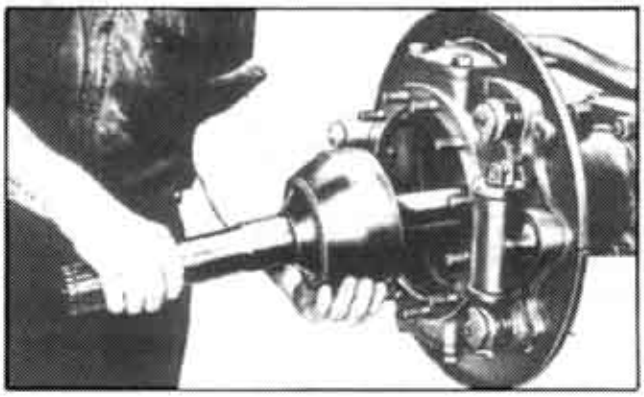
D. Install brake dust shields.

INSTALL AXLE SHAFT AND UNIVERSAL JOINT ASSEMBLY

A. Hand pack universal joint assembly by forcing grease into bell and race cavities. (Rzeppa only)

B. Hand pack inner walls of flange socket. (Rzeppa only)

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C. Insert axle shaft through housing and into side gear of carrier using care not to damage oil seal in housing end.

IMPORTANT: First apply a film of waterproof grease to housing oil seal lips, bronze bushing bore and oil seal journal on axle shaft long end.

INSTALL HUB SPINDLE ASSEMBLY

PS Models

A. If replacement of the spindle inner oil seal is necessary, install new seal from inner end with a suitable driver.

NOTE: Oil seal replacement should be made at regular maintenance intervals.

B. For models that *do not* have oil seal installed in wheel hub inner bearing bore, install the inner wheel bearing cone on the hub spindle and apply lube to bearing rollers.

C. Apply a film of waterproof grease to lips of oil seal in the spindle bore, the bore of the bronze bushing in the spindle and to the oil seal journal on the axle shaft short end. Then install the spindle by carefully sliding it over the end of the axle shaft.

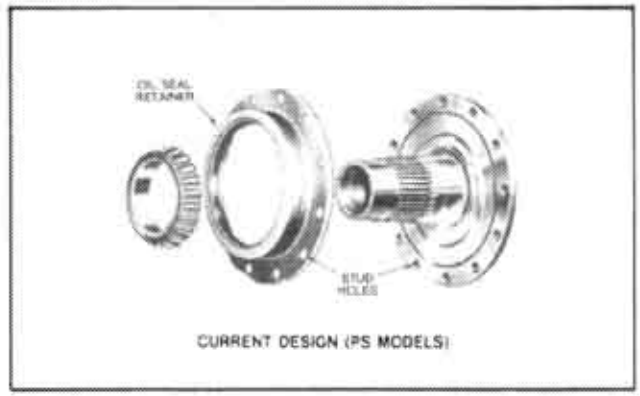
NOTE: Care must be exercised to avoid damage to seals.

(Steps D Through F For PS-166, 334, 824, 826 And 1044 Models Only)

D. Assemble O-ring, if used, in spindle face groove.

E. Where O-ring is not incorporated, apply a bead of liquid gasket (approximately .09 inch diameter) to the mounting face of the wheel hub oil seal retainers. The bead must go around the inner side of the bolt holes.

F. Place the oil seal and retainer assembly over the studs and install flat washers and nuts (where bolted type oil seal is used).



CURRENT DESIGN (PS MODELS)

Older models use oil seal and retainer assembly which is held in place against the spindle by means of a dowel.

G. On models with bolted brake spiders install brake spider to the spindle while supporting the spindle. Then install and tighten mounting fasteners.

Rigid Axle Models

H. On cast or stamped housing models mount spindle, "O"-ring and brake spider or backing plate to housing flange with bolts, washers, and nuts, if used (or with capscrews and washers where employed). Tighten nuts or capscrews to specified torque.

NOTE: On recent models liquid gasket is used in place of "O"-ring. Apply a continuous bead (approx. .09 in dia.) of liquid gasket around spindle flange between the mounting pilot and the bolt holes.

On modular models when the spindle is welded to the housing, mount brake spider to the flange on spindle or housing.

INSTALL BRAKE ASSEMBLIES

For brake installation details refer to the pertaining Rockwell Field Maintenance Manual. (See page 8).

ASSEMBLE RING GEAR HUB ASSEMBLY

A. On those models incorporating a planetary ring gear with tapped holes, lock plates and capscrews, the ring gear must be assembled to the ring gear hub at this time.

NOTE: Most models incorporate an axially floating ring gear (does not have tapped holes) which can be assembled later, just prior to assembly of the planetary spider.

B. Install the outer wheel bearing cone on ring gear hub journal squarely against hub shoulder and

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apply lubricant. The inner race of bearing is a slip fit over the spindle journal.

NOTE: *Do not* assemble onto spindle at this time.

ASSEMBLE AXLE SHAFT IN RIGID AXLES

On rigid planetary axles it is more convenient to assemble the axle shaft before the wheel hub assembly is installed. Insert axle shaft through spindle and housing and into side gear of carrier.

ASSEMBLE HUB, BEARINGS, OIL SEAL AND DRUM

A. If hub bearing cups have been removed for replacement, install new cups with a suitable driving sleeve.

B. Most models then require installation of the inner bearing cone prior to installation of wheel hub oil seal in bore of wheel hub. Apply lubricant to bearing rollers before installation.

C. Install new wheel hub oil seal with proper driver. Drive seal to same location as the original, this may be to bottom of bore in hub or flush with the bottom end face of hub. New wear sleeves are to be installed on the spindle where employed. Use extreme care to avoid any nicks on the sleeve end which can damage the seal lip during wheel hub installation.

D. Apply lubricant to lips of oil seal, or to inside diameter of unitized type of oil seal, or to interface area of metal rings of face seals. *Do not* lubricate any other part of face seals. Also apply a film of lubricant to the oil seal journal surface of the spindle (or wheel hub journal surface on certain PS models).

E. Install brake drum and oil slinger where applicable. If slinger fit is not tight between hub and drum, a bead of liquid gasket can be applied to prevent rattle. Install drum mounting capscrews and washers and tighten to proper torque.

NOTE: On dual tire models make sure the air valve clearance notch in drum O.D. aligns with notch in wheel hub.

Smaller Models

A. Lift the hub and drum assembly onto the hub spindle and position so that the inner cup rests on the inner bearing rollers.

NOTE: Alignment must be maintained during installation to prevent damage to hub oil seal.

B. Install the ring gear hub assembly, while at the same time lifting the weight of the hub and drum assembly to allow the outer bearing to mate with outer hub bearing cup.

C. Install the wheel bearing adjusting nut.

Larger Models

On larger models the ring gear hub assembly and bearing may be temporarily mounted to the wheel hub assembly by capscrews through the puller holes of ring gear hub flange, into the smaller threaded holes of the wheel hub.

A. Place hub and drum assembly on floor or bench vertically with brake drum up.

B. Install rear bearing in cup (with lube on rollers).

C. Install seal and retainer with suitable driver.

D. Invert the hub and drum assembly.

E. Install the ring gear hub assembly and outer bearing (with lube on rollers).

F. Align ring gear hub puller holes with hub threaded holes.

G. Install capscrews to temporarily hold the assemblies together.

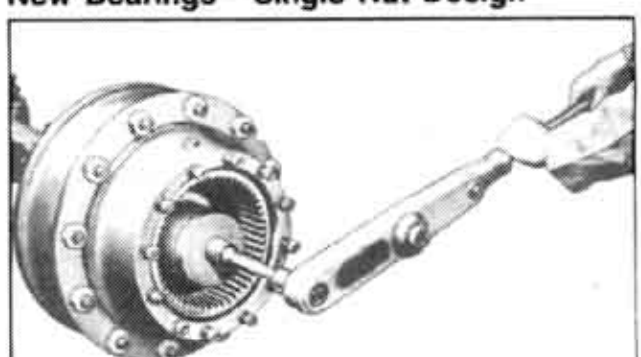
H. Supporting the weight by use of chain falls, locate the combined assembly on the spindle splines.

J. Install the wheel bearing nut and draw assembly into position.

K. Remove the temporary capscrews from the ring gear hub.

WHEEL BEARING ADJUSTMENT

New Bearings - Single Nut Design



ROTATE HUB IN BOTH DIRECTIONS

A. Seat the bearings and related components by tightening the adjusting nut to 400 lb. ft. *while hub is rotated in both directions.* Rap the hub

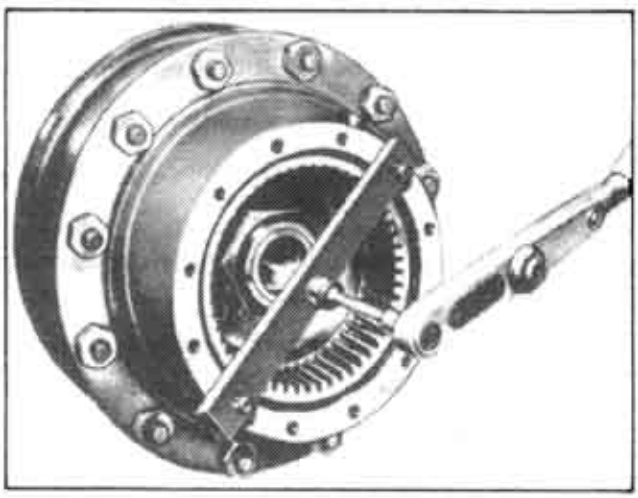
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several times with a brass or plastic mallet, then re-torque to 400 lb. ft. Repeat procedure until nut will not advance with application of 400 lb. ft.

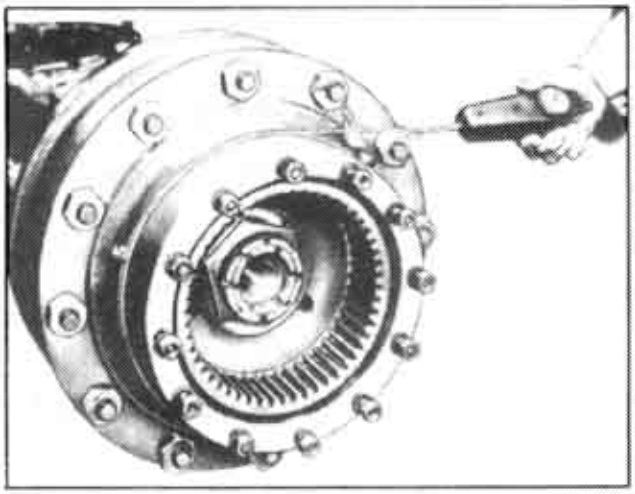
***EXCEPTION:* Seating torque on adjusting to be 100 lb. ft. for following models:**

PRA/PRS/PRLC-130 through 265 (PR-35 through 68) and PSC/PSS-165 through 200 (PS-50 through 60).

B. Back off adjusting nut to relieve preload on bearings. Torque on nut should be 0 lb. ft.

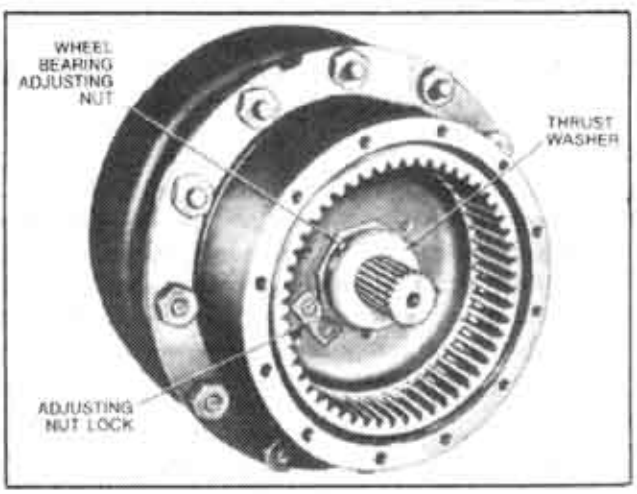


C. Determine the wheel hub rolling torque. Torque value must be obtained while hub is rotated at a *steady* rate (not starting torque). Rockwell recommends the use of a flat bar, with a welded nut in the center, attached to the planetary mounting face of the wheel hub; and a torque wrench to obtain rotation and the torque reading (see illustration above).



An alternate method for determining wheel hub rolling torque is to wrap a cord around hub barrel, attach a spring scale and pull straight out at a steady rate. Torque in units of lb. ft. = (lb. pull × inches of hub barrel radius) ÷ 12.

D. Tighten adjusting nut and re-check the hub rolling torque. The increase in rolling torque from that determined in step "C" (no preload position) should be as indicated in the chart below.



ORIGINAL AXLE MODEL	CURRENT AXLE MODEL	HUB ROLLING TORQUE INCREASE
PR-35 thru 68, PS-50 & 60	PR-130 thru 265, PS-165 thru 200	3 to 5 lb. ft.
PR-100, PS-100	PR-344 thru 614, PS-334	4 to 8 lb. ft.
PR-150 thru 200, PS-150 thru 200	PR-672 thru 677, PS-614 thru 825	5 to 9 lb. ft.
PR-250, PS-250 thru 270	PR-863 thru 1757, PS-826 thru 1614	6 to 10 lb. ft.
PR-300 thru 440, PS-350	PR-1923 thru 4025, PS-1874 & 1875	8 to 12 lb. ft.
PR-500, PS-500	PR-4264 thru 4807, PS-4564	10 to 14 lb. ft.
PR-700	PR-7314	14 to 18 lb. ft.

IMPORTANT: The final nut setting must result in a hub rolling torque which is the *sum* of the "initial" value from step "C" plus the "increase" from above chart.

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E. Install nut lockplate and capscrews. Tighten to grade 8 value (see page 27). There are several types of nut locks/lockplates used among the various axle series. The V-notch lockplates will allow use of the plate flat toward flat of nut if the V-notch does not properly engage a nut corner.

IMPORTANT: The lockplate assembly method chosen *must* prevent nut rotation.

If new screws (with pre-applied locking agent) are not used, then several drops of Loctite #277 must be applied to the internal threads in the planetary ring gear hub.

Flat head screws *must* be used in lockplates incorporating counter sunk holes.

NOTE: For models PR-130 through 265 and PS-165 through 200 ("original" models PR-35 through 68 and PS-50 through 60). Locking method is engagement of nut dowel pin into a hole in the planetary ring gear/hub which is installed *after* the final nut/bearing adjustment is made. The final nut position must orient the dowel pin with respect to a spindle spline same as "hole to spline" in the ring gear hub.

EXAMPLE:

Axle is PR-672 series.

Initial hub rolling torque from step C with zero adjusting nut torque = 8 lb. ft.

Final hub rotating torque after nut adjustment:

Min = 8 + 5 = 13 lb. ft.

Max = 8 + 9 = 17 lb. ft.

New Bearings — Double Nut Design

A. Seat the bearings and related components by installing the wheel bearing adjusting nut with the locking protrusion facing *outward*. Tighten the nut to 400 lb. ft. *while hub is rotated in both directions*. Rap the hub several times with a brass or plastic mallet, then re-torque to 400 lb. ft.

B. Back off adjusting nut to relieve preload on bearings. Torque on nut should be 0 lb. ft.

C. Determine the wheel hub rolling torque. Torque value must be obtained while the hub is rotated at a *steady* rate (not starting torque). See recommended procedure in step "C" under "Single Nut Design."

D. Tighten adjusting nut slightly (approximately 25 lb. ft.). Install the nut lock ring washer with the washer tang into the slot on the spindle and with a washer hole engaging the protrusion of the adjusting nut.

E. Install the jam nut and tighten to 800 lb. ft.

F. Re-check the wheel hub rolling torque. The "increase" from step "C" (no preload position) should be 5 to 9 lb. ft. If "increase" is out of this range, remove the jam nut and lock ring washer and readjust the inner adjusting nut in the appropriate direction. Repeat above procedure.

NOTE: The rolling torque check for "increase" must be performed *after* the jam nut is tightened since the bearing preload *is* increased by the jam nut tightening.

Reused Wheel Bearings

For both single nut and double nut designs the procedure is the same as for new bearings (pages 21 thru 23) *except* the "INCREASE" in hub rolling torque should be ½ the value specified for new bearings.

EXAMPLE:

Axle is PS-1614 series.

Initial hub rolling torque (step C pg. 22) = 2 lb. ft.

Final hub rotating torque after nut adjustment:

Min. = 2 + (6 ÷ 2) = 5 lb. ft.

Max. = 2 + (10 ÷ 2) = 7 lb. ft.

Wheel Bearing Adjustment For Axles With Wet Disc Brakes

Refer to Rockwell Field Maintenance Manual No. 4L.

INSTALL PLANETARY RING AND SUN GEARS

A. Install sun gear thrust washer, sun gear and axle shaft snap ring. Thrust washer tangs must engage slots in spindle or nut. Apply grease to washer for temporary retention, then push sun gear against the washer.

B. Install planetary ring gear onto ring gear hub (floating ring gear design).

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ASSEMBLE PLANETARY SPIDER

NOTE: Later axle models incorporate nylon coated steel planet pins. These pins are also used for service replacement of early model bronze planet pins. Utilize the following recommendations to obtain satisfactory component life and performance:

A. Carefully inspect bores of planet gears. *Do not* re-use planet gears with bore surface roughness from previous use. A smooth bore surface is essential for proper function.

B. When servicing an early axle model (bronze pin design) with new nylon coated planet pins, all three pins in the planetary spider should be changed. *Do not* mix bronze and nylon coated pins in the same spider. For optimum planet pin life, it is strongly recommended that *both* wheel ends are changed to the nylon coated pins simultaneously.

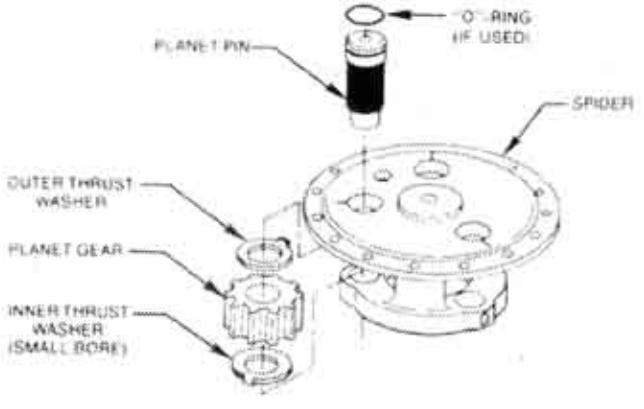
IMPORTANT: Debris from wear or failure *must* be thoroughly flushed from the wheel end (or from entire axle if common lube system is employed) as stated in previous section on "axle flush."

C. Use of nylon coated planet pins in early axle models (which utilized bronze pins) requires new outer thrust washers which are included in kits along with detailed instructions. The planetary spider requires minor re-work to provide a recess for the tangs of the new thrust washers.

If planet pins do not have "O"-ring grooves disregard step D.

D. Install the proper "O"-ring in the planet ring groove making sure that the "O"-ring is not twisted.

IMPORTANT: Chamfers on large bores must be smooth. Use an emery cloth to avoid damaging O-ring and/or nylon coating on planet pin during installation.



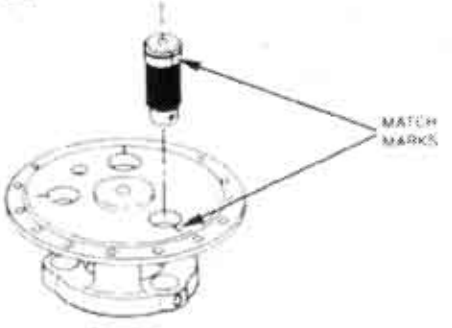
E. Place the spider in a press with the flange side up. Block up as required.

F. Install inner thrust washer with the washer tab engaged in the spider indent and the washer bore aligned with the spider bore.

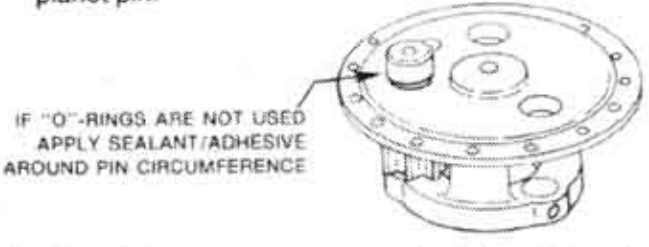
G. Coat the bore of the planet gear with a film of the same GL-5 gear lube used in the wheel end. Slide planet gear and outer thrust washer into the spider. Align the bores of the parts and engage the outer thrust washer tab in the spider indent.

H. Install the planet pin into the spider and through the planet gear and thrust washers by hand. The large end of the planet pin will bind in the spider bore due to an interference fit.

I. On axle models with one-piece integral spider and cover align the match mark on the large diameter of the pin with the match mark on the spider. These match marks provide proper alignment of the set screw hole in the small end of the pin and the tapped set screw hole in the spider boss.



J. Apply a film of non-hardening sealant (Permatex 51 or equivalent) to "O"-ring and large end of planet pin.



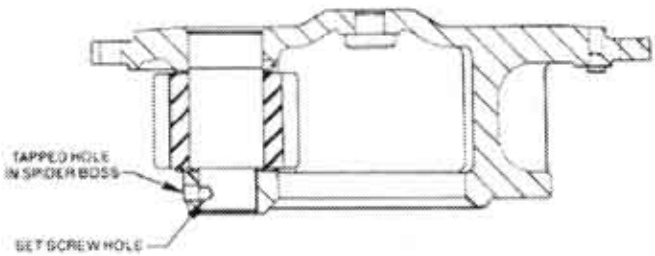
K. If "O"-rings are not used, brush Loctite 271 (Rockwell Part No. 1199-B-3720) sealant/ adhesive on the planet pin O.D. protruding from the spider.

L. Being careful to keep planet pin aligned, press pin into spider until the shoulder of the pin bottoms against the inner thrust washer.

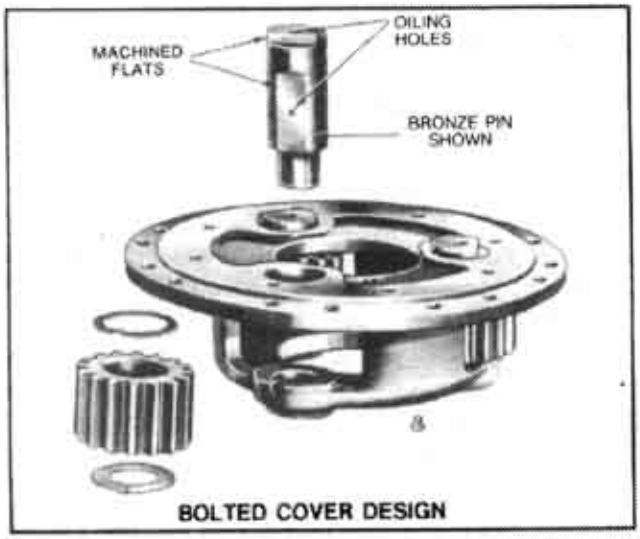
NOTE: If a press is not available use a brass drift and mallet to tap the pin through the spider and planet gear.

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⚠ CAUTION: Do not strike planet pins directly with a steel hammer. Personal injury from chips or splinters may result.



M. Install set screws (if used) into spider and planet pin. New set screws have a pre-applied locking agent on the threads. If original set screws are used, apply one or two drops of Loctite 277 (Rockwell Part No. 2297-C-3747) to threads of spider before installing. Tighten set screw to 15-25 lb. ft. torque.



BOLTED COVER DESIGN

On axle models equipped with planet pins with machined flats, the pin must be installed so the "flat" is facing the outside of the hub circle. This allows cover clearance and properly locates the pin oiling holes.

NOTE: Nylon coated replacement pins do not have flats nor oiling holes in the area of planet gear contact.

N. Repeat the reassembly procedures to install the second and third sets of planetary pins, gears and washers.

INSTALL SPIDER ASSEMBLY

A. Apply silicone RTV gasket material to spider flange at hub mounting face. Use silicone RTV gasket application procedures as follows:

SILICONE (RTV) GASKET APPLICATION

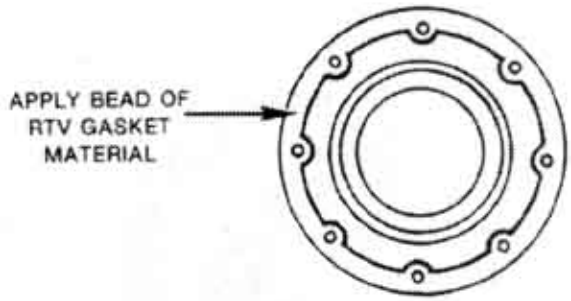
NOTE: Where silicone RTV gasket material is used, Dow Silastic No. RTV-732 Black and General Electric No. RTV-1473 Black meet our requirements. However, silicone RTV is also available in bulk under Rockwell part number 1199-Q-2981; in 10 oz. tubes, part number 1250-X-388, or in 3 oz. tubes, part number 1199-T-3842.

Service

Removal of all gaskets including silicone RTV is accomplished by peeling or scraping the used gasket off both mating surfaces.

Application of silicone RTV gasket material is as follows:

1. Remove dirt, grease or moisture from both mating surfaces.
2. Dry both surfaces.



3. Apply a continuous thin bead, approximately ⅛" diameter completely around one mating surface and around the inner edge of all fastener holes to assure complete sealing and prevent leakage.

⚠ CAUTION: Minor concentrations of acetic acid vapor may be produced during application of silicone RTV. Adequate ventilation should be provided when silicone RTV is applied in confined areas.

Further, eye contact with these silicone RTV gasket materials may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

4. Assemble the components immediately to permit silicone RTV gasket material to spread evenly.

   When rebuilding any assembly, always use torque values on fasteners as specified by either Rockwell or the vehicle manufacturer.

NOTE: Failure to use appropriate gasket material will cause axle to leak.

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B. Start the spider and pinion assembly, aligning teeth of planet gears with sun gear and ring gear teeth.

Align the match marks on the spider flange and the wheel hub as previously marked at disassembly.

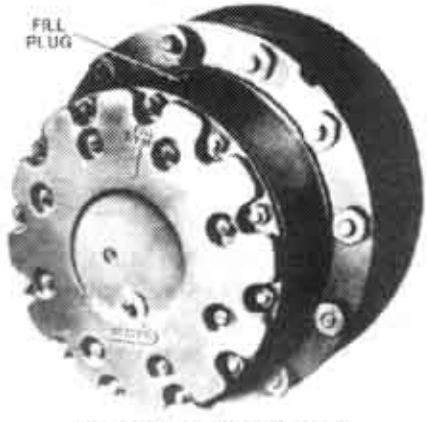
C. Align hub studs or holes with spider holes and push spider assembly against hub.

D. Install spider washers and nuts or washers and capscrews.

E. Tighten nuts or capscrews to specified torque.

INSTALL PLANETARY SPIDER COVER (Where applicable)

A. Apply silicone RTV gasket material to cover flange at spider mounting face. Use Silicone RTV gasket application procedure (see above).



BOLTED COVER DESIGN

B. Install the spider cover and capscrews. Fill arrow must be in line with hub fill plug.

C. Tighten cover capscrews to correct torque. (See page 28.)

LUBRICATION

NOTE: Correct types of lubrication and proper lubrication practices are specified in the Rockwell Field Maintenance Manual No. 1 on lubrication.

New planetary axles should be drained of initial lubricant after 75 to 100 hours of operation. Drain while the axle is still warm.

The regular change interval should be whenever seals are replaced, brakes are relined, every 1,000 to 1,500 hours of operation or twice a year (spring and fall).

FILL PROCEDURE

A. Rotate the wheel end to position the lube level hole at the horizontal centerline of the axle. Lower the vehicle to the ground.

B. For bolted cover design:
Remove "fill/drain" plug from barrel of wheel hub (should be at *top* position) and the "oil level" plug from the planetary cover.

For one piece spider/cover design:
Remove the "drain/level/fill" plug from the planetary spider (one plug serves all purposes). The level mark should be in horizontal position.

For *all* axle models:
Also remove the "fill/level" plug in the axle housing bowl or bowl area.

C. Make sure all magnetic plugs have been cleaned of metal particles and are securely reinstalled.

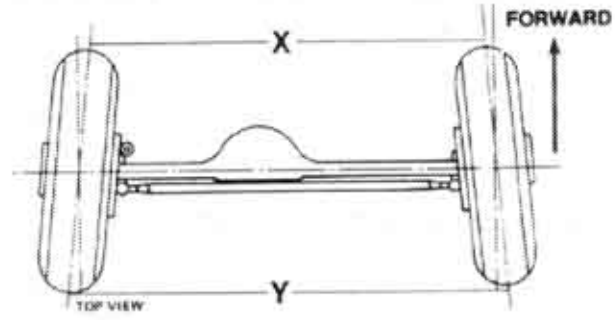
NOTE: Only certain special applications approved by Rockwell International employ the carrier fill/level plug.

D. Fill wheel ends and housing bowl with the recommended GL-5 gear lubricant to the bottom of the level/fill hole. Wait for lube to evenly distribute throughout the wheel end. Check lube levels and add more lube if necessary. Replace all plugs and tighten securely.

Most rigid axles have common wheel end/housing bowl oil and oil level (no axle shaft oil seals are employed). To assure proper oil level, oil should be added at each wheel end and to the bowl. Do not fill through bowl only.

E. For axles with separate housing bowl and wheel end lubricant (with axle shaft oil seals), fill each until lubricant appears at the level hole. Replace all plugs and tighten securely. For lubricant capacities refer to Rockwell Field Maintenance Manual #1 on Lubrication.

STEERING ALIGNMENT



Y MINUS X EQUALS TOE-IN

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Toe-in should be checked and adjusted on all front steering axles after being installed in a vehicle. Toe-in adjustment made by Rockwell on the assembly line is a single average setting. This will not be correct for all tire sizes and axle loadings. It is the OEM's responsibility to make the final setting.

Rockwell's practice for off-highway steer axles is 1/16" ± 1/16" toe-in based on a 24" radius (theoretical tire of 48" outside diameter).

Toe-in setting of new axles is performed with the axle in the unloaded condition.

TANDEM/TRIDEM AXLE TIRE MATCHING

Unmatched tires on either Tandem Drive Units or Tridem Drive Units will cause tire wear and scuffing and possible damage to the drive units. Consequently we recommend the tires be matched to within ⅛" of the same rolling radius, ¾" of the same rolling circumference.

Tandem Units:

IMPORTANT: The four largest tires should never be installed on one driving axle or the four smallest tires on the other driving axle. Such tire mounting will cause an inter-axle "fight," unusually high axle lubricant temperatures that result in premature lubricant breakdown and possible costly axle service.

In addition to matching individual tire rolling radii or rolling circumference, we recommend matching, as nearly as possible, the total tire circumference of one driving axle to the tire circumference of the other driving axle. This will usually result in satisfactory tandem axle lubricant temperatures that lengthen drive unit service with higher tire mileage.

Tridem Units:

When three driving axles are "hooked" together in a Tridem Series, unmatched tires will compound the problems described in the preceding paragraphs. Therefore, we recommend matching, as nearly as possible, the total tire circumference of each of the three driving axles.

HOW TO MATCH TIRES

Tandem Units:

The vehicle should be on a level floor, carrying a correctly distributed rated capacity load. Be sure all tires are the same size.*

1. Inflate all tires to the same pressure.
2. Carefully measure the rolling circumference of each tire with a steel tape.
3. Mark the size on each tire with chalk and arrange them in order of size, largest to smallest.
4. Mount the two largest tires on one side of one axle and mount the two smallest on the opposite side of the same axle.
5. Mount the four other tires on the other axle in the same manner.
6. Test run the vehicle to get accurate rear axle lubricant temperature readings on the two axle lubricant temperature guages.
7. Vary tire air pressure, within the tire manufacturer's recommended range, so the lubricant temperature of both axles is within 30°F of each other and not in excess of 200°F. This will usually result in uniform tire loading and good tire life.

Tridem Units:

Follow the same procedure (Items #1 through #7) for matching tires on a Tridem Unit. Arrange the tires in order of size. The two largest and two smallest go on one axle, the next two largest and smallest on the second axle, and the remaining four on the third axle.

*Measure new tires to be sure they will be correctly matched.

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TORQUE VALUES FOR CURRENT DESIGN PLANETARY AXLES (Axles Built Since 1978)

A. For select fasteners:

FASTENER	THREAD SIZE	TORQUE (LB. FT.) MIN./MAX.
Tie Rod Yoke Lock Nut	1" - 16	165 to 200
Tie Rod Yoke Lock Nut	1¾" - 16	165 to 200
Tie Rod Yoke Lock Nut	2" - 16	165 to 200
Tie Rod Clamp Bolt (Ball Joint End)	⅝" - 18	50 to 65
Tie Rod Yoke Clamp Bolt Nut	½" - 20	100 to 130
Tie Rod Yoke Clamp Bolt Nut	¾" - 16	125 to 175
*Tie Rod Yoke Bolt Nut	⅞" - 14	0 to 5
*Tie Rod Ball Stud Nut	⅝" - 18	60 to 85
*Tie Rod Ball Stud Nut	⅞" - 14	150 to 200
*Tie Rod Ball Stud Nut	1¼" - 12	400 to 550
*Steer Arm Ball Stud Nut	⅝" - 11	60 to 85
*Steer Arm Ball Stud Nut	¾" - 16	90 to 125
*Steer Arm Ball Stud Nut	1" - 12	250 to 350
*Steer Arm Ball Stud Nut	1⅛" - 12	350 to 490
*Steer Arm Ball Stud Nut	1¼" - 12	400 to 550
Wheel Bearing Nut Lock Screw	⅜" - 16	35 to 50
Wheel Bearing Nut Lock Screw	7/16" - 14	60 to 75
Steer Stop Bolt Jam Nut	⅞" - 14	150 to 190
Steer Stop Bolt Jam Nut	⅝" - 11	60 to 75
Steer Stop Bolt Jam Nut	½" - 13	50 to 65

*Use wrench torque shown and as much more as necessary to line up the next cotter pin hole. *Do not back off.*

B. For all other fasteners (except carrier components — see appropriate Field Maintenance Manual on carriers): Use appropriate GRADE 8 torque.

- Since 1978 all fasteners have been GRADE 8. See following torque chart for proper torque value based on thread size and type of fastener.
- Nuts used on double end studs should be tightened to the appropriate *coarse* thread torque. If nut is a locknut type, use coarse thread torque value under "locknut" heading.

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ROCKWELL TORQUE SPECIFICATIONS—STANDARD FASTENERS

Size	Series	Grade 5		Grade 6 and 7		Grade 8	
		Locknuts	Plain Nuts And Screws	Locknuts	Plain Nuts And Screws	Locknuts	Plain Nuts And Screws
1/4-20	UNC	75-100 Lbs.-In.	85-115 Lbs.-In.	85-115 Lbs.-In.	105-135 Lbs.-In.	105-135 Lbs.-In.	120-160 Lbs.-In.
1/4-28	UNF	85-115 Lbs.-In.	105-135 Lbs.-In.	105-135 Lbs.-In.	120-160 Lbs.-In.	120-160 Lbs.-In.	12-16 Lbs.-In.
5/16-18	UNC	12-16 Lbs.-Ft.	15-20 Lbs.-Ft.	15-20 Lbs.-Ft.	18-24 Lbs.-Ft.	18-24 Lbs.-Ft.	20-30 Lbs.-Ft.
5/16-24	UNF	15-20 Lbs.-Ft.	18-24 Lbs.-Ft.	18-24 Lbs.-Ft.	20-30 Lbs.-Ft.	20-30 Lbs.-Ft.	20-30 Lbs.-Ft.
3/8-16	UNC	20-30 Lbs.-Ft.	25-35 Lbs.-Ft.	25-35 Lbs.-Ft.	30-40 Lbs.-Ft.	30-40 Lbs.-Ft.	35-50 Lbs.-Ft.
3/8-24	UNF	25-35 Lbs.-Ft.	30-40 Lbs.-Ft.	30-40 Lbs.-Ft.	35-50 Lbs.-Ft.	35-50 Lbs.-Ft.	40-55 Lbs.-Ft.
7/16-14	UNC	35-50 Lbs.-Ft.	40-55 Lbs.-Ft.	40-55 Lbs.-Ft.	50-65 Lbs.-Ft.	50-65 Lbs.-Ft.	60-75 Lbs.-Ft.
7/16-20	UNF	40-55 Lbs.-Ft.	50-65 Lbs.-Ft.	50-65 Lbs.-Ft.	60-75 Lbs.-Ft.	60-75 Lbs.-Ft.	65-85 Lbs.-Ft.
1/2-13	UNC	60-75 Lbs.-Ft.	65-85 Lbs.-Ft.	65-85 Lbs.-Ft.	75-100 Lbs.-Ft.	75-100 Lbs.-Ft.	85-115 Lbs.-Ft.
1/2-20	UNF	65-85 Lbs.-Ft.	75-100 Lbs.-Ft.	75-100 Lbs.-Ft.	85-115 Lbs.-Ft.	85-115 Lbs.-Ft.	100-130 Lbs.-Ft.
9/16-12	UNC	75-100 Lbs.-Ft.	85-115 Lbs.-Ft.	100-130 Lbs.-Ft.	110-145 Lbs.-Ft.	110-145 Lbs.-Ft.	130-165 Lbs.-Ft.
9/16-18	UNF	85-115 Lbs.-Ft.	100-130 Lbs.-Ft.	110-145 Lbs.-Ft.	130-165 Lbs.-Ft.	130-165 Lbs.-Ft.	150-190 Lbs.-Ft.
5/8-11	UNC	110-145 Lbs.-Ft.	130-165 Lbs.-Ft.	130-165 Lbs.-Ft.	150-190 Lbs.-Ft.	150-190 Lbs.-Ft.	180-230 Lbs.-Ft.
5/8-18	UNF	130-165 Lbs.-Ft.	150-190 Lbs.-Ft.	150-190 Lbs.-Ft.	180-230 Lbs.-Ft.	180-230 Lbs.-Ft.	210-270 Lbs.-Ft.
3/4-10	UNC	180-230 Lbs.-Ft.	230-300 Lbs.-Ft.	230-300 Lbs.-Ft.	270-350 Lbs.-Ft.	270-350 Lbs.-Ft.	310-400 Lbs.-Ft.
3/4-16	UNF	210-270 Lbs.-Ft.	270-350 Lbs.-Ft.	270-350 Lbs.-Ft.	310-400 Lbs.-Ft.	310-400 Lbs.-Ft.	360-470 Lbs.-Ft.
7/8-9	UNC	310-400 Lbs.-Ft.	360-470 Lbs.-Ft.	360-470 Lbs.-Ft.	440-580 Lbs.-Ft.	440-580 Lbs.-Ft.	500-650 Lbs.-Ft.
7/8-14	UNF	360-470 Lbs.-Ft.	440-580 Lbs.-Ft.	440-580 Lbs.-Ft.	500-650 Lbs.-Ft.	500-650 Lbs.-Ft.	575-750 Lbs.-Ft.
1.0-8	UNC	440-580 Lbs.-Ft.	500-650 Lbs.-Ft.	575-750 Lbs.-Ft.	650-875 Lbs.-Ft.	650-875 Lbs.-Ft.	775-1000 Lbs.-Ft.
1.0-12	UNF	500-650 Lbs.-Ft.	575-750 Lbs.-Ft.	650-875 Lbs.-Ft.	725-950 Lbs.-Ft.	725-950 Lbs.-Ft.	850-1100 Lbs.-Ft.
1.0-14	UN	500-650 Lbs.-Ft.	575-750 Lbs.-Ft.	650-875 Lbs.-Ft.	725-950 Lbs.-Ft.	725-950 Lbs.-Ft.	850-1100 Lbs.-Ft.

Torques given apply to parts lightly covered with rust preventing oil, unplated and uncoated. For dry parts, increase torques 10%. For parts coated with multi-purpose gear oil, decrease torques 10%. Nuts used on double end studs require the appropriate coarse thread torque. Locknuts are normally coated with a lubricant (dry to the touch) which reduces friction, therefore less torque is required to produce the clamping load.

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TORQUE VALUES FOR ORIGINAL DESIGN PLANETARY AXLES
(Axles Built Prior to 1978)

A. For Tie Rod Yoke and/or Ball Joint Fasteners

Steer Arm Ball Stud Nuts
Steer Stop Bolt Jam Nuts
Wheel Bearing Nut Lock Screws

Use same torque as shown in part "A" of "Current Design Torque Values."

B. For all other fasteners (except carrier components — see appropriate Field Maintenance Manual on carriers) use appropriate torques for *size, grade* and type as shown on preceeding chart (page 28).

- Fastener Grade — the majority of threaded fasteners are grade 8, however, some grade 5 capscrews/bolts and grade 6 studs (double ended) were used.

GRADE IDENTIFICATION			
FASTENER	**GRADE 5**	**GRADE 6**	**GRADE 8**
CAPSCREW OR BOLT HEAD		NOT USED	
STUDS	NOT USED	 PLAIN END	 FIGURE 8 STAMPED

- Locations of GRADE 5 capscrews/bolts:

  Brake dust shield mounting
  Brake cylinder and actuator mounting
  Brake camshaft collar
  Housing flange half joint (PR-35 series)

- Locations of GRADE 6 studs (some axles):

  Carrier to axle housing mounting studs
  Brake camshaft support bracket mounting studs
  Hydraulic motor mounting studs
  Steer arm mounting studs
  Planetary spider to wheel hub mounting studs (PR-75 through PR-120).

- Proper nut torque is based on:

  Grade of stud or bolt
  Thread size (where used on double ended studs tighten to the appropriat coarse thread torque value).
  Type of nut (plain or self-locking type)

- Proper capscrew torque is based on:

  Grade of capscrew
  Thread size

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PLANETARY AXLE MODEL CROSS-REFERENCE CHART

Old	New	Old	New	Old	New
PR-30	PRA-104	PR-190	PRM-855	PS-50	PSS-165
PR-35	PRA-134[1]	PR-204	PRM-676, 7	PS-60	PSS-165
PR-35	PRA-164[2]	PR-205	PRM-676, 7	PS-61	PSS-165
PR-37	PRA-174	PR-207	PRM-676, 7	PS-101	PSS-334
PR-54	PRLC-176	PR-208	PRM-676, 7	PS-114	PSS-334
PR-60	PRS-165	PR-209	PRLC-675	PS-151	PSC-614
PR-62	PRC-184	PR-223	PRLC-1355	PS-157	PSM-824, 5
PR-65	PRS-204, 5	PR-235	PRC-1755	PS-201	PSC-616
PR-66	PRS-204, 5	PR-250	PRM-1756, 7	PS-205	PSC-616
PR-68	PRS-204, 5	PR-251	PRM-1756, 7	PS-210	PSC-826
PR-75	PRS-624, 5	PR-253	PRLC-1756, 7	PS-250	PSM-826
PR-76	PRS-624, 5	PR-256	PRM-1314, 5	PS-251	PSM-826
PR-78	PRC-574, 5	PR-256	PRM-1615[4]	PS-254	PSC-1045
PR-80	PRS-594	PR-258	PRM-1724, 5	PS-256	PSM-826
PR-106	PRS-344	PR-270	PRLC-823	PS-260	PSM-1044, 5
PR-107	PRS-344	PR-273	PRLC-1374	PS-261	PSM-1044, 5
PR-108	PRLC-614	PR-275	PRLC-824	PS-270	PSM-1614
PR-108	PRLC-794	PR-305	PRC-1935	PS-350	PSC-1874, 5
PR-112	PRLC-344	PR-311	PRLC-1935	PS-500	PSC-4564
PR-112	PRLC-596[3]	PR-313	PRLC-1935		
PR-114	PRC-345	PR-350	PRC-3795, 6		
PR-115	PRS-626	PR-351	PRC-3796	SPR-150	SPRC-671
PR-118	PRC-672	PR-352	PRC-4025	SPR-200	SPRC-1357
PR-120	PRS-596	PR-400	PRC-1925	SPR-250	SPRC-1734
PR-130	PRC-694	PR-408	PRC-1925	SPR-270	SPRC-1736
PR-150	PRM-672, 3	PR-502	PRC-4805	SPR-400	SPRC-1923
PR-151	PRM-672, 3	PR-503	PRC-4805	SPR-570	SPRC-4806
PR-153	PRM-672, 3	PR-504	PRC-4807		
PR-154	PRC-654, 5	PR-705	PRC-7314		
PR-158	PRC-863, 4				

[1]With welded spindle
[2]With bolted spindle
[3]PR-80 wheel end
[4]Wide planetary gearing

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MAINTENANCE MANUAL UPDATE

For Field Maintenance Manual No. 9
Planetary Axle Wheel Ends

Replacing Pinion Shafts With Roller Bearings

Planetary Axle Models SPRC-1927, SPRC-1736, PRC-1105 and PRC-1615 ONLY

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you replace the pinion shafts, you must replace the needle roller bearings, planetary gears and set screws. For maximum planetary gear life, change the pinion shafts and needle roller bearings on both wheel ends at the same time.

Disassemble the Planetary Spider

⚠ *WARNING*

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. Remove the planetary spider from the wheel hub. See pages 5 and 6 of Field Maintenance Manual No. 9.
2. Remove the set screws (when used) that hold the pinion shafts in the spider. Set screws are located at the small diameter ends of the pinion shaft.
3. Put the spider assembly in a press with the flange side **DOWN.**

NOTE: When a press is not available, use a brass drift and mallet to remove the pinion shafts.

⚠ *WARNING*

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

4. Place blocks under the spider. Blocks give you more room to remove the planetary pinion shafts.
5. Press the shaft out of the spider and planetary gear. Remove all three pinion shafts the same way.
6. Remove the planetary gears and thrust washers from the planetary spider.
7. Remove the needle roller bearings from the bore of the planetary gear.

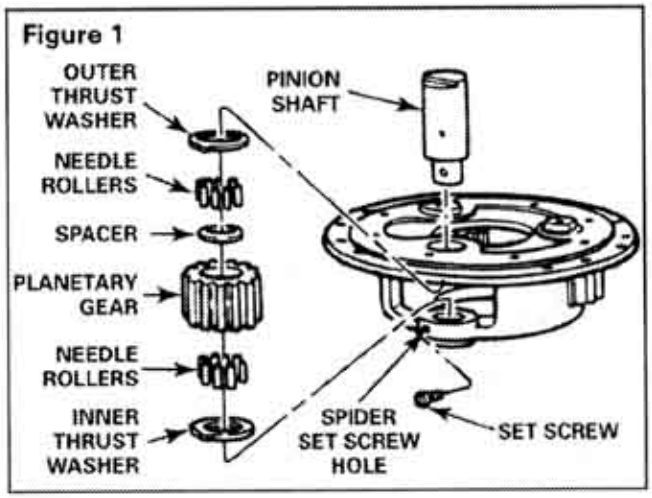
Assemble the Planetary Spider

1. Prepare the parts for assembly as described under "Prepare for Reassembly" on pages 13-15 of Field Maintenance Manual No. 9.

NOTE: Flush the complete axle before reassembly. Most current rigid axles (PRC, PRM and PRS) do not use axle shaft oil seals. The lube is common to the wheel ends and the center section. Contamination from either wheel end or the carrier can spread to all other areas of the axle. Therefore, the entire axle (both wheel ends and center section) must be thoroughly drained and flushed.

2. Apply Meritor-approved grease (O-617-A or B, NLGI Grade 1 or 2) to the side of the inner thrust washer that is opposite the tang. The inner thrust washer has a smaller inner diameter than the outer thrust washer. The greased side of the washer goes toward the gear. Tangs to the outside will fit in the spider grooves.
3. Put the washer on the end of the new planetary gear. **Figure 1.**

Figure 1



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4. Apply grease (O-617-A or B, NLGI Grade 1 or 2) to the bore of the planetary gear.

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NOTE: The number of needle roller bearings used is different for each axle model.

5. Install a row of needle rollers around the bore in the pinion. Install as many rollers as will fit. Refer to the Bill of Material to determine the correct number of rollers.

6. Put the spacer into the bore of the gear on top of the needle rollers. Put another row of needle rollers on top of the spacer.

7. Apply grease (O-617-A or B, NLGI Grade 1 or 2) to the side of the outer thrust washer opposite the tang. Put the washer on the end of the planetary gear. The tang must be aligned with the tang of the opposite washer.

8. Set the planetary spider on a level surface with the flange side **UP**. Carefully slide the loaded planetary gear assembly into position in the planetary spider.

   a. The outer thrust washer (large bore) must be on top of the gear assembly.

   b. The washer tangs must be in the planetary spider grooves.

   c. The needle roller bearings must be in place.

9. Install the pinion shaft through the spider, the planetary gear and thrust washers. An interference fit will bind the large end of the pinion shaft in the spider. When the shaft has a set screw hole, the shaft hole must align with the spider set screw hole.

NOTE: A shaft without a set screw must be aligned so that the flat surface on the large end is toward the outside of the hub. This alignment allows for spider cover clearance and prevents the shaft from rotating when the cover is installed.

10. Repeat Steps 1 through 8 to install the second and third sets of pinion shafts, gears, needle rollers and thrust washers.

11. Check the alignment of the pinion shafts.

    a. When the pinion shafts do not have set screws, put the spider cover in place. When necessary, rotate the shafts so the spider cover fits over the flats. Once the shafts are aligned, remove the cover.

    b. When the pinion shafts have set screws, the shaft and spider set screw holes must be aligned. Adjust the alignment as necessary.

⚠ *WARNING*

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

12. Use a press and sleeve to press each pinion shaft into the planetary spider. The pinion shaft is correctly installed when the shoulder of the shaft bottoms against the inner (bottom) thrust washer.

NOTE: When a press is not available, use a brass drift and mallet to install the pinion shafts.

13. When necessary, install the set screws in the spider and pinion shafts. When the screws have been used before, apply one or two drops of Loctite 277 (part no. 2297-C-3747) or an equivalent to the threads of the spider before installing the screws. Tighten the set screws to a torque of 15-25 lb-ft (20-33 N•m). T

14. Install the planetary spider on the wheel hub. See "Reassembly" on pages 25 and 26 of Field Maintenance Manual No. 9.

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TECHNICAL BULLETIN

Bushing and Seal Assembly Instructions for Axle Model PRC-1756-W2H

Special Tools

You must use a special bushing and seal driver to correctly perform the procedures contained in this publication. To make this tool, refer to the specifications shown in **Figure 11**.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Removing the Bushing and Seals

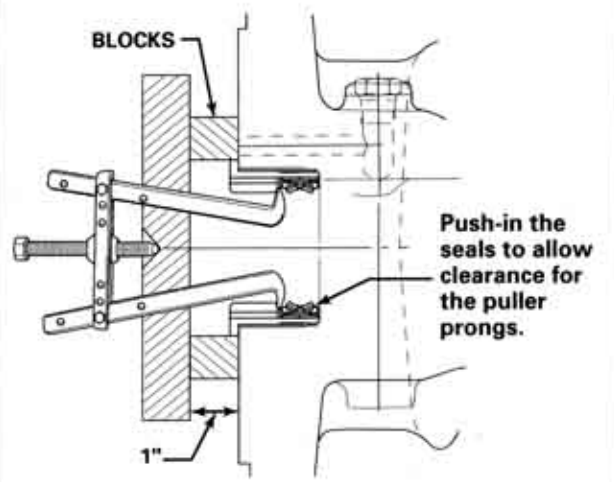
1. Remove the axle shaft. Refer to Maintenance Manual No. 9, *Planetary Axle Wheel Ends*. To order this publication, call Meritor's Customer Service Center at 800-535-5560.

CAUTION

Push in the seals just enough to provide clearance for puller prongs. Pushing the seals too far into the axle can cause the seals to fall into the axle housing. Damage to components can result.

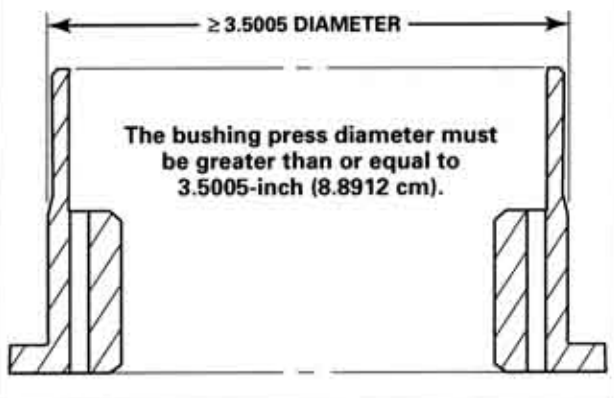
2. Before you remove the bushing and seals, carefully push in the seals with a chisel or punch to allow just enough clearance for puller prongs. Use a puller to remove the bushing and seals from the axle housing. **Figure 1.** Discard the seals after you remove them.

Figure 1



3. Use a wire brush to remove all remaining Loctite® residue from the bushing.
4. Measure the press diameter of the bushing.
   - **If the bushing press diameter is less than 3.5005-inch (8.8912 cm)**: Do not reuse the bushing. **Figure 2.**

Figure 2



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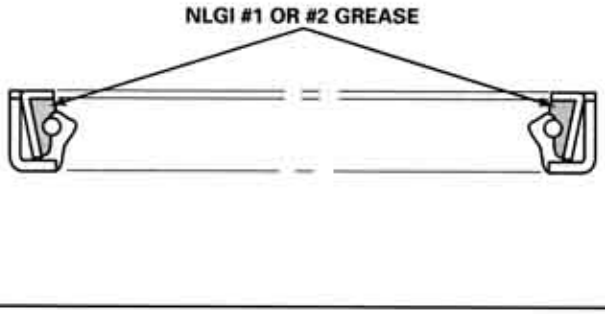
Installing the Bushing and Seal Assembly

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NOTE: To order the radial lip seals (part number A1225D2266) and the bronze bushing (part number 1225A1301) used in the following procedure, call Meritor Aftermarket Services at 888-725-9355. In Europe, call Meritor Heavy Vehicle Systems, LLC – St. Etienne S.A. at (33-477) 92 88 00.

1. Pack each seal cavity with NLGI number 1 or 2 grease. **Figure 3**.

Figure 3



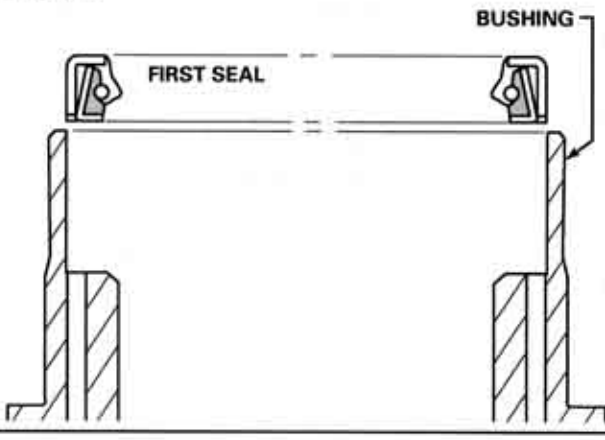
2. Apply Permatex number 51 sealer to the seal outer diameters.
3. Position the bushing on a flat surface with the seal bore pointing **UP**.

⚠ WARNING

You must correctly align the seal. A misaligned seal can cause seal leaks. Lubricant loss and damage to components can result.

4. Place a seal on the bushing. Position the seal as shown in **Figure 4**.

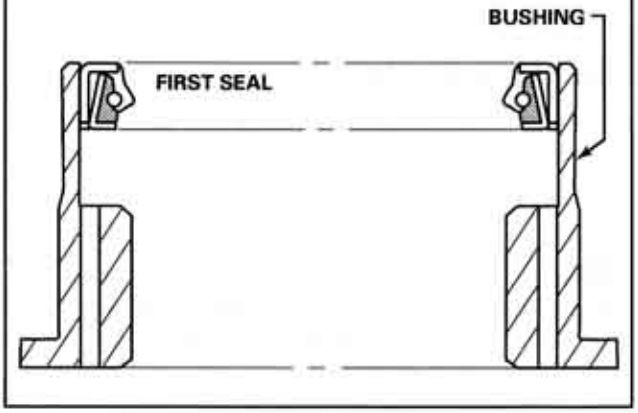
Figure 4



NOTE: To make the seal and bushing driver used in Step 5, refer to the specifications shown in **Figure 10**.

5. Insert the seal driver into the seal.
6. Align the driver into the bushing. Use a hammer to gently tap on the knurled end of the driver until the seal seats flush into the bushing. **Figure 5**.

Figure 5

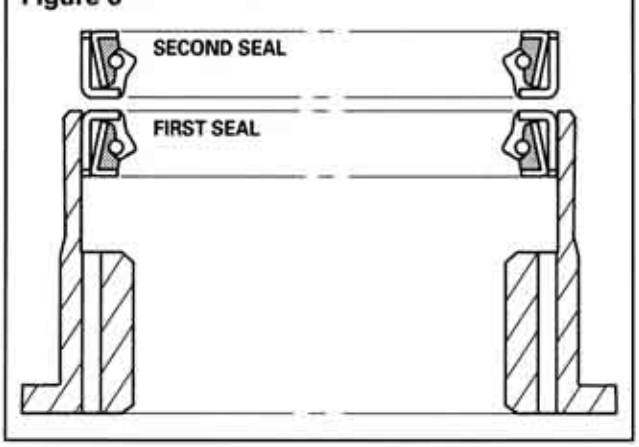


⚠ WARNING

You must correctly align the seal. A misaligned seal can cause seal leaks. Lubricant loss and damage to components can result.

7. Place the second seal on the bushing. Position the seal in the opposite direction of the first seal. **Figure 6**.

Figure 6



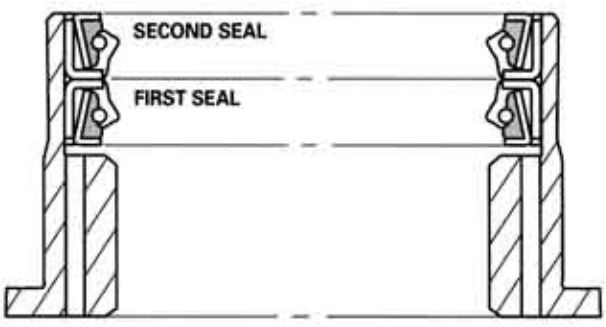
8. Insert the seal driver into the seal.

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9. Align the driver into the bushing. Use a hammer to gently tap on the knurled end of the driver until the seal seats flush into the bushing. **Figure 7**.

Figure 7

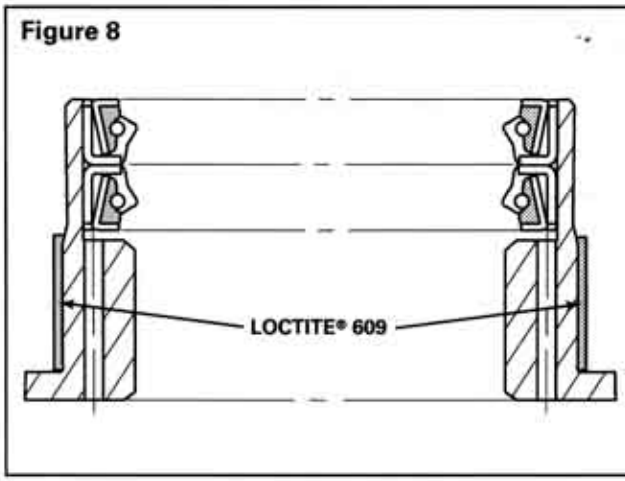


⚠ WARNING

Take care when using Loctite® to avoid serious personal injury. Follow the manufacturer's instructions to prevent irritation to the eyes and skin. If Loctite® gets into your eyes, flush them with water for 15 minutes. Have your eyes checked by a doctor as soon as possible.

10. Apply Loctite® 609 onto the bushing outer diameter where the bushing presses into the axle housing. **Figure 8**.

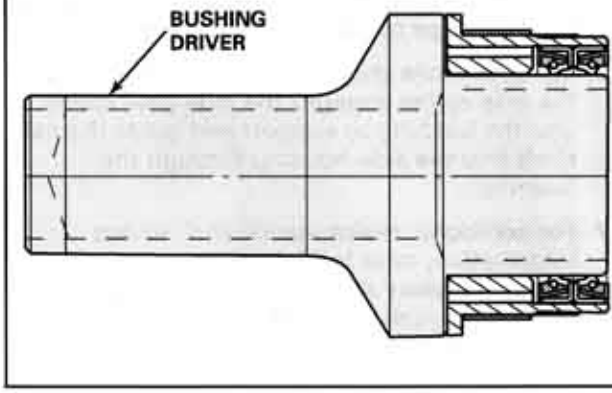
Figure 8



11. Apply NLGI number 1 or 2 grease on the driver's 2.5-inch diameter.

12. Insert the driver into the bushing and seal assembly. **Figure 9**.

Figure 9



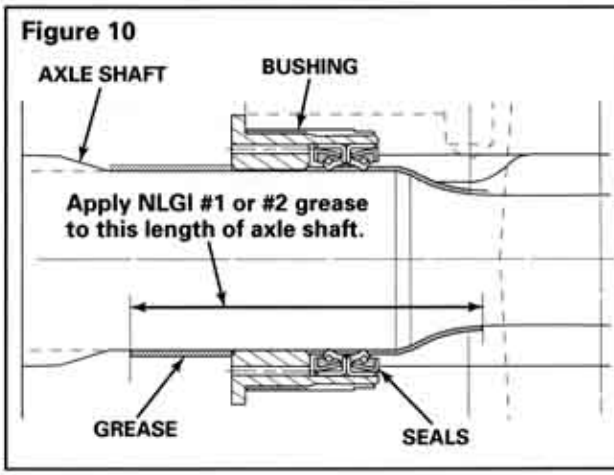
13. Insert the bushing and seal assembly into the axle housing end. Tap the driver with a hammer to drive the bushing and seal assembly into the axle housing end. Continue tapping the driver until the shoulder of the bushing fully contacts the axle housing.

14. Check that each seal spring remains inside the seal.

    - **If a seal spring is outside of the seal:** Use your finger to reposition the seal spring inside the seal.

15. Apply NLGI number 1 or 2 grease onto the axle shaft journal. **Figure 10**.

Figure 10



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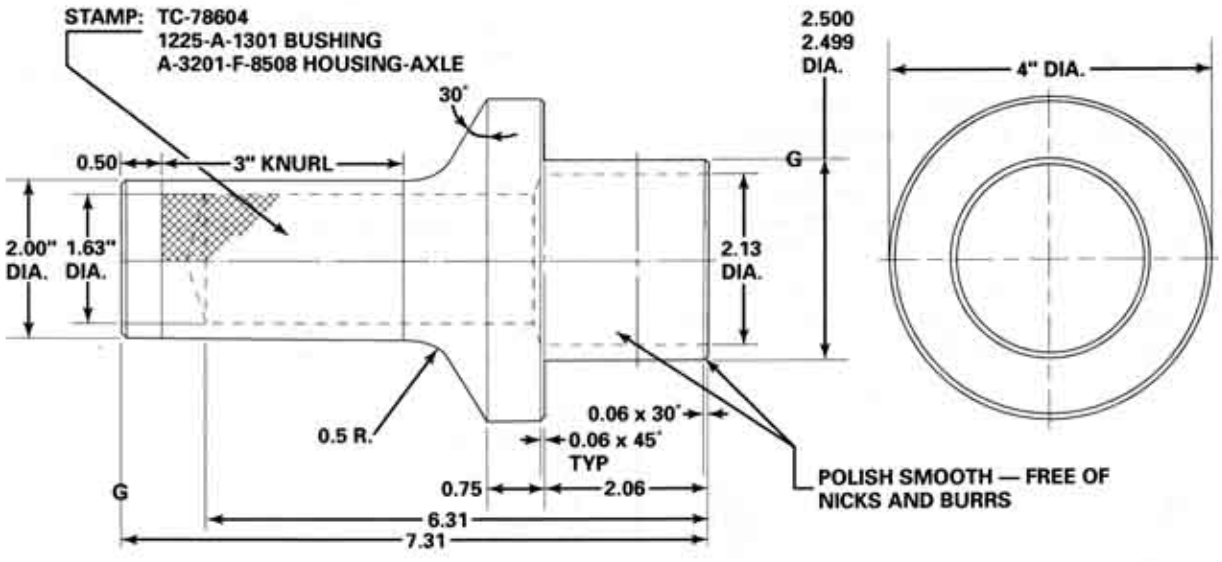
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⚠ WARNING

Carefully install the axle shaft into the axle housing. Do not slide the axle shaft across the seals. Sliding the axle shaft across the seals can damage the seals and cause seal leaks. Lubricant loss and damage to components can result.

16. Install the axle shaft into the axle housing until the axle spline engages the side gear spline. Use the bushing to support and guide the axle shaft into the axle housing through the bushing.
17. For additional maintenance and service information, refer to Maintenance Manual No. 9, *Planetary Axle Wheel Ends*. To order this publication, call Meritor's Customer Service Center at 800-535-5560.

Figure 11 — Bushing and Seal Driver Specifications



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noSPIN® / detroit® locker

automatic positive locking traction differential

OWNER'S MANUAL

WITH ⚠ WARNINGS and PRECAUTIONS ON BACK COVER

PREFACE

Tractech has been a leading manufacturer of premium quality traction-adding differentials for over 50 years. Each step in our manufacturing process, from design to final assembly and inspection, reflects the highest industry standards.

This manual is intended to help provide safe and trouble free operation of NoSPIN/Detroit Locker differentials for the life of the product. **We strongly recommend that all who come in contact with the products read this manual thoroughly.**

GENERAL INFORMATION AND RECOMMENDATIONS

To Contact Tractech

Telephone :	(810) 759-3850 USA
Telex:	211864 TRAC UR U.S.A.
FAX:	(810) 759-1645 U.S.A
Office Hours:	7:30 - 4:30 (ET) Mon. - Fri.
General Assistance:	Customer Service Dept.
Technical Assistance:	Engineering Dept.
Warranty Assistance:	Customer Service Dept.
Printed Matter:	Marketing Department

Glossary To assist the reader in understanding the language in this manual, a glossary appears on pages 21-22.

Limited Warranty The complete Tractech Limited Warranty appears on pages 26-27. Owners of NoSPIN/Detroit Locker differentials are encouraged to read this warranty carefully before putting the vehicle into service.

Technical Bulletins Tractech has published several Technical Bulletins which are helpful supplements to the information presented throughout this manual. Copies are available by writing to the Marketing Dept.

Application Approval It is essential that NoSPIN/Detroit Locker differentials be used only in applications approved by Tractech Engineering. Read pages 2-3 carefully and follow the stated guidelines.

Model Lists Refer only to approved Tractech model lists when ordering or specifying the products. Copies are available by writing to the Marketing Dept.

Vehicle Peformance The performance of a vehicle equipped with a NoSPIN/Detroit Locker differential is somewhat different from that of a vehicle equipped with a conventional differential. Read pages 3-4 carefully to assure proper understanding of the characteristics of the product.

Installation Before installing NoSPIN/Detroit Locker differentials, read pages 7-11 **Note:** Tractech recommends that a competent driveline mechanic perform the installation in that tools of the trade are required. **Note:** The vehicle/axle manufacturer's instructions for installing a conventional differential must be consulted when disassembling and reassembling axle components and when making all final adjustments.

Maintenance Refer to pages 13-17 for important information regarding proper maintenance of your NoSPIN/Detroit Locker differential. Carefully follow the recommended lubrication, service and inspection procedures.

Trouble Shooting Information on pages 18-20 will help owners and operators of NoSPIN equipped vehicles diagnose and correct problems related to vehicle performance.

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APPLICATION APPROVAL

Over the past 50 years, the optimum NoSPIN differential has been successfully utilized by a variety of on/off road vehicle/axle manufacturers. Traditional applications are Medium/Heavy Truck, Construction, Mining, Forestry, Agricultural, Military and Specialty Vehicles.

To ensure successful application of our product, Tractech Engineering requires approval for each new vehicle/axle application. The following guidelines are examples of successful NoSPIN differential applications:

- **6 x 4 (tandem-drive axle) Trucks** Primary location - forward rear. Both rear axles for maximum mobility if used 75% off-road.
- **4 x 4 Off Road Vehicles** Farm tractors (articulated & rigid) front axle. Also rear axle for maximum traction (Consult Tractech Engineering.)
- **Farm Tractors (straight frame with front-wheel-drive) -** front axle only (cannot be used in rear axle with individual wheel brakes).
- **Loader -** One axle only, either front or rear.
- **Trencher -** One or both axles.
- **Front drive axles of Light Trucks.** While successful in specialty vehicles, this application must be reviewed and approved by Tractech Engineering.

It is important when considering the use of a traction device to review key vehicle parameters i.e., loading, geometry, power requirements, duty cycles (miles/hours) etc.

The following marginal applications must be reviewed with Tractech Engineering and our Differential Application Approval Form No. 7003 is required. Successful field testing must be performed by the customer prior to production approval by Tractech.

Examples are:

- Transit Busses - NoSPIN should not be used when operated in cities where sharp turns are required continually changing lanes, as in leaving bus stops to avoid parked vehicles.

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Transit busses utilized in non city operations **are** an acceptable application. School busses have also proven to be another successful application for NoSPIN.

- **Yard Tractors (Spotters)**

  Light-duty Pickup Trucks-Equipped with fifth wheels to pull "gooseneck" trailers in **pickup and delivery** operations unless equipped with automatic transmission.

- **Small Fork Lift Trucks -** with short wheelbase and high turn angle capability utilized inside buildings on smooth surfaces.

- **Highway Tractors - with less than 120" wheelbase (see page 4 for details).**

CAUTION:
ANY INCREASE IN THE SIZE OF THE VEHICLE'S ENGINE, TIRES, WEIGHT, ETC., MAY PROHIBIT USE OF A NoSPIN DIFFERENTIAL IN A HERETOFORE APPROVED APPLICATION. ANY SUCH MODIFICATION SHOULD BE REVIEWED BY TRACTECH ENGINEERING BEFORE CONTINUING TO USE THE PRODUCT.

THE NoSPIN DIFFERENTIAL DOES NOT INCREASE THE LOAD-CARRYING CAPACITY OR PAYLOAD RATING OF THE VEHICLE OR VEHICLE COMBINATION.

- **Model Lists**
  Refer only to approved Tractech model lists when ordering or specifying NoSPIN/Detroit Locker differentials. Copies are available by writing to the Marketing Dept.

VEHICLE PERFORMANCE

- The performance of a vehicle equipped with a NoSPIN/Detroit Locker differential is somewhat different from that of a vehicle equipped with a conventional differential. For example:

  When turning a corner, the sound of component disengagement and re-engagement may be audible, and the transfer of driving torque from both wheels to one wheel may be noticeable.

  When going from drive (acceleration) to coast (deceleration) in a turn, a "metallic" sound may be heard as torque flow is reversed (inside wheel engaged during acceleration; outside wheel engaged during deceleration).

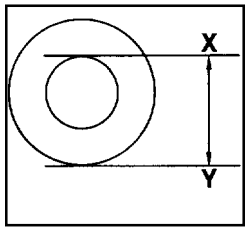
  These characteristics are normal because of backlash designed into the NoSPIN differential, which is of a fixed amount (1 to 2 inches of rotation at the tire tread).

  Backlash or slack between the driving and driven clutch teeth is an inherent part of the NoSPIN and necessary to permit automatic operation when driving in forward and reverse. The total backlash in the driveline is increased by the amount of the reduction between the ring gear and pinion. If the ring gear-pinion ratio is 5 to 1, the total backlash in the driveline with the NoSPIN would be about 30ø. This in turn is increased by clearances between planetary gear, sliding splines and the ring and pinion gear. We feel that the total driveline slack can amount to as much as 1/4th turn of the driveline without being abnormal, but if it exceeds 1/4 turn, other parts in the drivetrain could be checked. Further clarification of operational and performance characteristics is available through Technical Bulletin No. 81-1044. A copy is available by writing to our Marketing Dept.

- Anything that improperly causes a difference in individual wheel speeds such as **mismatched tire** diameters due to differences in tire wear or tire pressure, or **unbalanced loading** of the vehicle (especially cargo vehicles, or vehicles operated on a side slope) can cause the NoSPIN differential to deliver power to only one side of the vehicle and thus cause steering problems.

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The diameter of the tires can be adjusted by varying the air pressure of the tires. Match the distance from the top of each tire rim to the pavement.



When negotiating a turn (outside wheel disengaged), the inside wheel under conditions of poor traction, may receive excessive torque, which could cause it to break traction momentarily until its speed is equal to the outside wheel. This will result in re-engagement of the outside wheel thus allowing both wheels to be driven. This condition is most noticeable with lightly loaded axles.

Certain vehicles equipped with NoSPIN differentials, such as short wheelbase trucks (e.g., under 120" wheelbase) and four wheel drive trucks with a NoSPIN diflerential in the front steering axle, can experience "understeer" when negotiating a turn underpower. Releasing the accelerator will reduce the torque and improve steering.

Use extreme caution when accelerating or decelerating on slippery or unstable surfaces. Vehicles/axles equipped with traction differentials are inherently more sensitive to side-slip than vehicles equipped with conventional differentials. Stability can be retained if side-slip occurs by decelerating (letting off the accelerator). **⚠CAUTION: DO NOT APPLY THE BRAKE. TO DO SO MAY RESULT IN LOSS OF VEHICLE CONTROL.**

Braking capacity is reduced when a NoSPIN differential equipped vehicle makes a turn while coasting downhill in that the inside wheel is then disconnected from the driveline. Operating in low gear will allow the engine to act as a retarder and will improve braking capacity.

If the vehicle is **stationary** on a dry surface, easier steering can beachieved by moving thevehicle slightly in either forward or reverse. (Assure that proper steering pressure is maintained.)

NOTE:
If replacing limited-slip differentials in Rockwell, Eaton or Dana axles with NoSPIN differentials, also replace the differential case halves with the axle manufacturer's standard differetial case halves. NoSPIN differentials are designed to fit standard differential case halves. NoSPIN differentials will not fit properly into limited-slip differential case halves.

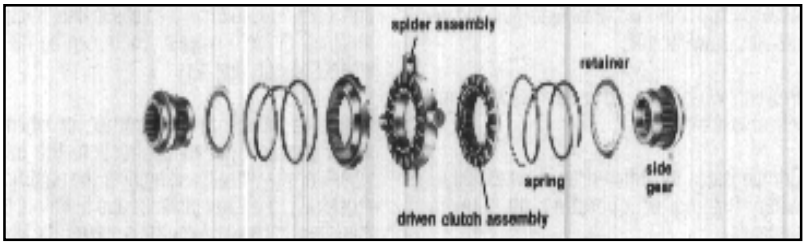
THE NoSPIN DIFFERENTIAL DOES NOT INCREASE THE LOAD-CARRYING CAPACITY OR PAYLOAD RATING OF THE VEHICLE OR VEHICLE COMBINATION.

IMPORTANT! READ THE CAUTIONARY NOTICES REFERENCED ON THE BACK COVER.

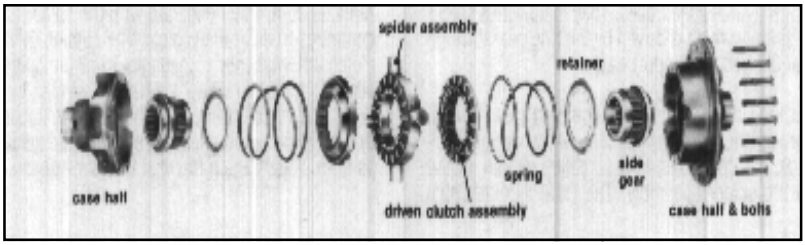
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EXPLODED VIEWS OF REPRESENTATIVE ASSEMBLIES

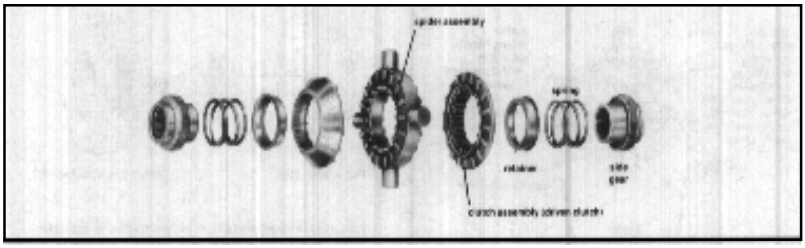
The following exploded views of NoSPIN differentials (there are five "styles")* illustrate the various components that make up the complete assembly. Certain components differ slightly in appearance between style, but their function - and the function of each of the five style NoSPIN differentials - is the same.



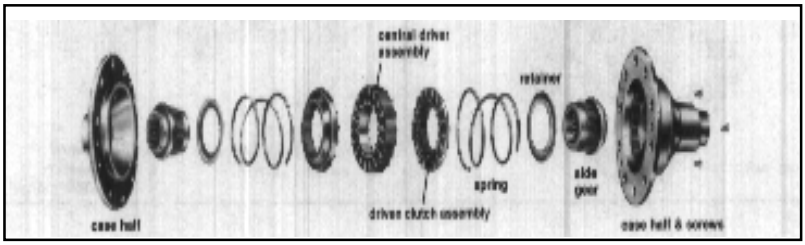
NoSPIN differential with spider assembly and internal springs and retainers; fits support case in vehicle.



NoSPIN differential with spider assembly and external springs and retainers; supplied with support case.



NoSPIN differential with spider assembly and external springs and retainers; fits support case in vehicle.



NoSPIN differential with central driver assembly and external springs and retainers; supplied with support case.

- Assembly style not shown:

New IMPROVED Detroit Locker - See page 21
Models with central driver, external springs and retainers without support case.
Copies of style not shown are available by writing to the Marketing Dept.

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OPERATION

The NoSPIN differential powers both wheels yet freely permits wheel speed differentiation when required.

Prime functions

1. Assures 100% of the available torque and increases drawbar pull.

2. Prevents wheel spin and power loss when one wheel loses traction.

3. Compensates for differences in wheel travel when turning or operating on uneven surfaces.

The drive axle illustrated below (Fig. 1) is equipped with a NoSPIN differential. Note that there are no spider gears, but rather two drive members, called driven clutch assemblies. They mate with a spider assembly which is driven by the ring gear through the differential support case.

As long as the vehicle is operated in a straight forward or reverse direction over a smooth surface the driven clutch assemblies remain locked to the spider assembly. The NoSPIN differential allows the vehicle to perform as if the axle half-shafts had been welded - the axle is completely locked. This means both wheels turn at the same speed if one wheel loses traction or leaves the ground the opposite wheel which still has traction, continues to drive the vehicle until traction is regained by both wheels. There can be no one-wheel spinout. (Fig. 2)

When the vehicle turns a corner or when one wheel passes over an obstruction the outside wheel, or the wheel passing over the obstruction, must travel a greater distance and therefore faster than the other wheel. When this occurs, the NoSPIN differential automatically allows for the necessary difference in wheel speed.

During a turn (Fig. 1), the inside driven clutch remains completely engaged with the spider and continues to drive the vehicle. The outside driven clutch automatically disengages from the spider, allowing the outer wheel to turn freely in the turn. When the vehicle completes the turn, the outside driven clutch automatically reengages the spider, as both wheels again travel at the same speed.

Fig. 1

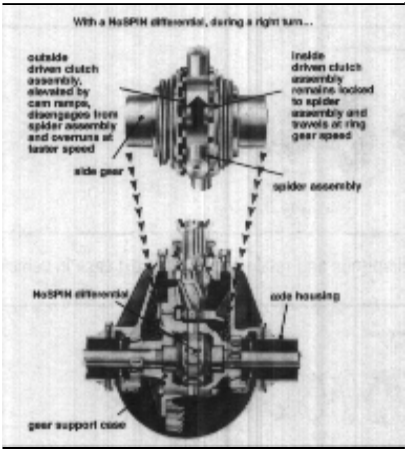
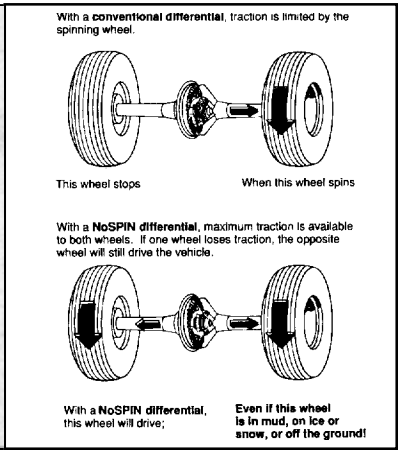


Fig. 2



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INSTALLATION

Refer only to an approved Tractech model list when ordering or specifying the product. Copies are available by writing to the Marketing Department.

It is essential that NoSPiN/Detroit Locker differentials be used only in applications approved by Tractech Engineering. Read pages 2-3 carefully and follow the approved guidelines.

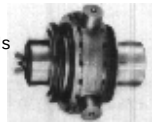
The installation procedure presented on pages 8-11 applies to all NoSPIN differentials (except 'R' Model NoSPIN Differentials). However, the procedure will differ slightly depending upon the specific vehicle. Therefore **it is essential to consult the vehicle/axle manufacturer's instructions for installing a differential.**

Most NoSPIN/Detroit Locker differentials are designed to fit directly into the standard differential support case in the vehicle. Where it is not possible to fit the standard support case manufactured by the vehicle/axle maker, the NoSPIN differential is supplied with a case manufactured by Tractech. Therefore, two sets of installation instructions are provided.

NoSPIN differentials are easily installed in the field. However, it is recommended that a **competent driveline mechanic do the work in that tools of the trade are required.**

The NoSPIN differential is designed to fit the components in the axle. No machining is required. The procedure is the same as it is for installing the original differential. A competent mechanic can install the NoSPIN in the same time required to replace the original differential. ⚠ **Caution: It is recommended every safety precaution be practiced while performing the work when disassembling and reassembling axle components and when making all final adjustments.**

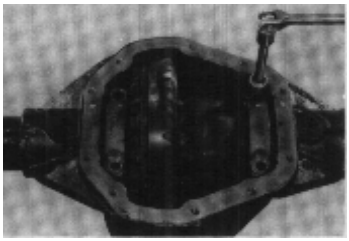
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For New IMPROVED Detroit Locker - See page 21

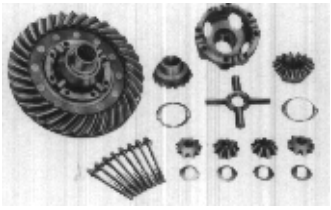
Disassembly: (Steps 1-5)

Step 1 Refer to the vehicle/axle manufacturer's recommendations for removing the differential assembly from the axle. Ensure that all safety precautions are implemented.

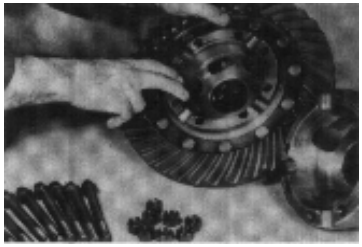


Step 2 Following the procedure recommended by the vehicle or axle manufacturer, remove the ring gear and differential case assembly from the axle carrier.

⚠ **CAUTION: Do not use heat to disassemble drive axles. To do so can destroy heat treat properties, weaken or distort axle components or result in a mishap which can cause injury, even death.**



Step 3 Mark the differential case halves so they may be reassembled in their original position. Open the case. Remove and store the original differential components. Retain the original differential case, ring gear, and differential case bolts. Do not remove bearing cone assemblies from the case halves; do not remove the ring gear from the case half.



Step 4 Wash the differential case, ring gear, differential case bolts and bearing assemblies using a non-flammable, non-toxic cleaning solvent that will not etch, scratch or oxidize the components. Rinse in clean solvent and dry. Inspect for damage, wear or corrosion. **Replace if necessary with identical, axle/vehicle manufacturer approved components. NOTE: BE SURE ALL THRUST WASHERS HAVE BEEN REMOVED FROM THE DIFFERENTIAL CASE. FAILURE TO DO SO WILL CAUSE THE NoSPIN DIFFERENTIAL TO MALFUNCTION.**



Step 5 Clean and examine the splined ends of the axle shafts. Remove any roughness or burrs with a file or stone. Examine the shafts for straightness, cracks or other damage. Replace if necessary. Make sure splines on axle match the splines on NoSPIN differential side gear.

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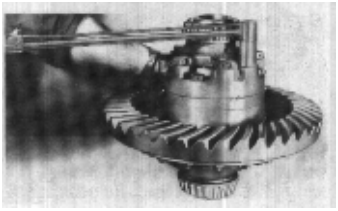


Installation: (Steps 6-14)

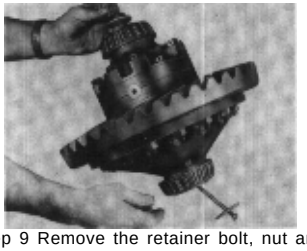
Step 6 Position the NoSPIN differential assembly in the case half which is attached to the ring gear.
⚠ CAUTION: DO NOT REMOVE THE RETAINER BOLT, NUT AND WASHERS AT THIS TIME. To do so will release the compressed springs, which can cause injury.



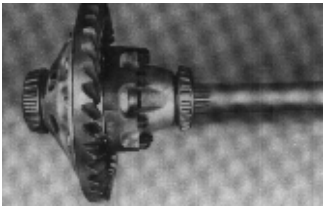
Step 7 Position the remaining differential case half over the NoSPIN differential. BE SURE ROTH CASE HALVES ARE IN THE ORIGINAL (MARKED) POSITION.



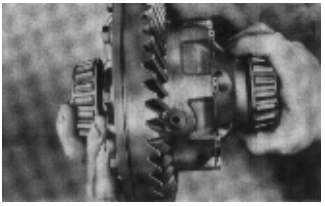
Step 8 Using a torque wrench tighten the differential case bolts securely to the torque limit recommended by the vehicle/axle manufacturer's instructions. Assure that there is a tight fit between the spider trunnions and the case. (A loose fit between the spider and the case can cause malfunction of the NoSPIN differential.)



Step 9 Remove the retainer bolt, nut and washers. (Retain for future service work.)



Step 10 Insert axle shafts into splined side gears of the NoSPIN differential. The shafts should slide in freely but fit correctly.



Step 11 Install the differential and ring gear assembly in the axle housing. Complete the reassembly of associated componente as recommended by the vehicle/axle manufacturer's instructions. **Note: Contamination such as metal particles in the differential case, can cause the differential to malfunction. Be sure the axle housing is clean before proceeding.**

Step 12 Refill the axle housing with lubricant recommended for differentials by the vehicle/axle manufacturer.

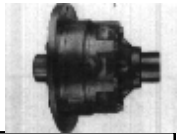


Step 13 Apply ⚠ Caution Label to instrument panel in full view of operator or mechanic. If you did not receive this label, contact Tractech's Marketing Department.

Step 14 Follow the test procedures outlined on page 12 to assure proper installation and operation of the NoSPIN differential.
NOTE: IF THE NoSPIN DIFFERENTIAL IS DISASSEMBLED, be sure to reassemble both clutch assemblies to the spider assembly with the 'slot' in each holdout ring over the long tooth of the spider.

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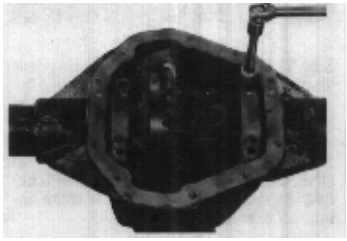
Installation Instructions for NoSPIN/Detroit Locker Differentials Supplied **With** a Support Case



FOR NEW IMPROVED Detroit Locker ™ - See page 21
FOR NEW Detroit C-Locker TM - See page 22

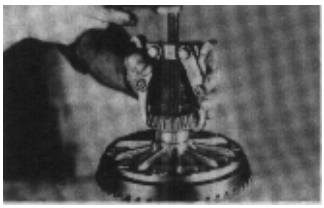
Disassembly: (Steps 1-5)

Step 1 Refer to the vehicle/axle manufacturer's recommendations for removing the differential assembly from the axle. Ensure that all safety precautions are implemented.

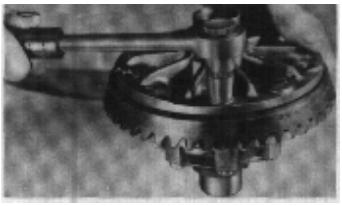


Step 2 Following the procedure recommended by the vehicle or axle manufacturer, remove the ring gear and differential case assembly from the axle carrier.

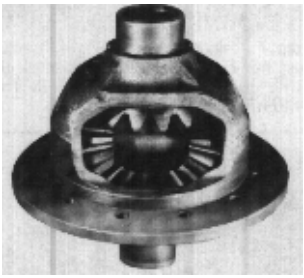
CAUTION: Do not use heat to disassemble drive axles. To do so can destroy heat treat properties, weaken or distort axle components or result in a mishap which can cause injury, even death.



Step 3 Using the proper bearing puller, carefully remove the bearing cone assemblies from the original differential case. **Replace bearings if worn or damaged during disassembly.** If shims are used behind the bearing cone assemblies, record the amount shim pack under each bearing.



Step 4 Remove the ring gear from the original differential case. Record the dimension from the ring gear frange face to the nearest bearing shoulder. Record the dimension from one bearing face to the other.



Step 5 Store the original differential and case for use if the NoSPIN differential requires service. Protect parts from damage or corrosion.

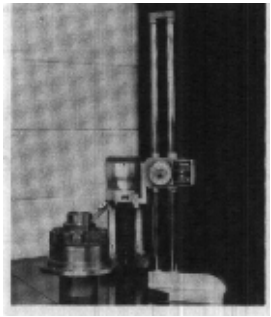


Step 6 Wash the ring gear, ring gear bolts, shims, and bearing races using a nonflammable, non-toxic cleaning solvent that will not etch, scratch or oxidize the parts. Rinse in clean solvent and dry. Inspect for damage, wear or corrosion. Replace if necessary with identical axle/vehicle manufacturer approved components.

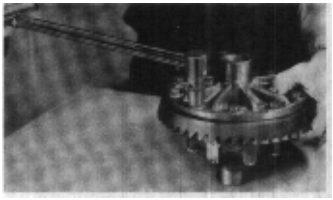
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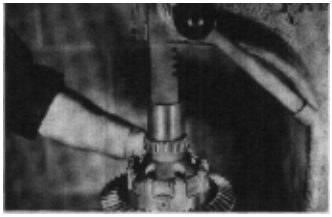
Step 7 Clean and examine the splined ends of the axle shafts. Remove any roughness or burrs with a file or stone. Examine the shafts for straightness, cracks or other damage. Replace if necessary. Make sure splines on axle match splines on NoSPIN differential side gear.



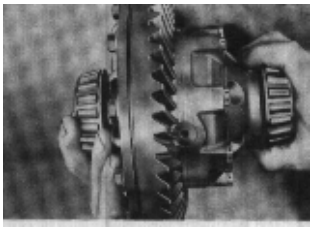
Step 8 If shims are used behind the bearing cone assemblies, measure the NoSPIN differential support case from the ring gear flange face to the nearest bearing shoulder and from one bearing shoulder to the other. Adjust the shim pack at each bearing journal to the dimension recorded previously from the original differential case.



Step 9 Using a torque wrench, bolt the ring gear to the NoSPIN differential and case assembly. Tighten the ring gear bolts securely to the torque limit recommended by the vehicle/axle manufacturer.



Step 10 Using an arbor press with an arbor of the correct size, press the bearing cone and roller assemblies onto the hubs of the NoSPIN differential support case until they are properly and squarely seated.



Step 11 Install the differential and ring gear assembly in the axle housing. Complete the reassembly of associated components as recommended by the vehicle/axle manufacturer's instructions. Note: Contamination, such as metal particles in the differential case, can cause the differential to malfunction. Be sure the axle housing is clean before proceeding.

Step 12 Refill the axle housing with lubricant recommended for differentials by the vehicle/axle manufacturer.



Step 13 Apply ⚠Caution Label to instrument panel in full view of operator or mechanic. If you did not receive this label, contact Tractech's Marketing Department.

Step 14 Follow the test procedures outlined on page 12 to assure proper installation and operation of the NoSPIN differential. **NOTE: IF THE NoSPIN DIFFERENTIAL IS DISASSEMBLED, be sure to reassemble both clutch assemblies to the spider assembly with the 'slot' in each holdout ring over the long tooth of the spider.**

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INSTALLATION TEST

Step 1
With the engine turned off, raise NoSPIN equipped driving axle(s) until all wheels are out of contact with any surface. Place the transmission in gear or park so that the drive-shaft is locked and does not rotate.

Test for **forward disengagement:**

Step 2
With two people, rotate both wheels rearward, as far as possible to lock both wheels.

Step 3
With the left wheel securely held in the rearward direction, rotate the right wheel slowly forward. A taint indexing or clicking sound should be heard as the NoSPIN disengages on the right side.

Step 4
With the right wheel slowly rotating forward, the left wheel should be rotated slightly forward. This will lock both wheels.

Step 5
Again, rotate both wheels rearward, as far as possible to lock both wheels.

Step 6
With the right wheel securely held in the rearward direction, rotate the left wheel slowly forward. A faint indexing or clicking sound should be heard as the NoSPIN is disengaged on the left side.

Step 7
With the left wheel slowly rotating forward, the right wheel should be rotated slightly forward. This will lock both wheels.

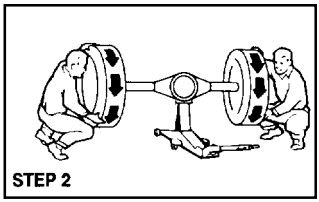
Repeat steps 2-7 except, test for **reverse disengagement.** If the above steps are completed successfully and rotating wheels disengage easily by hand, rotate freely and evenly, lock both wheels when required, and produce a faint indexing or clicking sound, then the NoSPIN is properly installed and is functioning correctly.

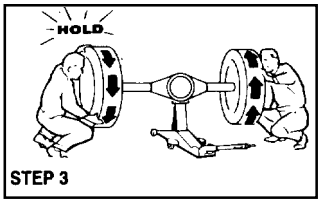
IF EITHER WHEEL DOES NOT ROTATE FREELY IN EITHER DIRECTION or does not lock both wheels as required, re-check the installation of the NoSPIN in the axle. Also, check hand and foot brakes for possible drag caused by improper adjustment. Be sure that all thrust washers have been removed from the standard differential support case. To check normal NoSPIN operation, drive the vehicle on a flat surface with good traction, in a right or left circle in forward and reverse to be sure that the outside wheel is free to overrun (i.e. that the outside tire does not scuff). A clicking or indexing sound may be heard. The sound of gear re-engagement may also be heard upon completion of the turn. This is normal.

OPERATION TEST

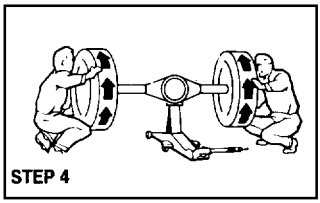
Check to see that both wheels of each NoSPIN differential equipped axle are driving. Make this test under load, so that engine torque is applied through the NoSPIN differential with the wheels on the ground. One way to achieve this load is to drive up against a solid obstruction (on loose dirt or gravel, if possible) and attempt to spin both wheels together. Perform this test in forward and reverse. (Exercise caution when performing this test to avoid damage to vehicle or obstruction.) ⚠ CAUTION: DO NOT **OPERATE THE VEHICLE IF BOTH WHEELS OF A NoSPIN/DETROIT LOCKER EQUIPPED AXLE ARE NOT DRIVING. POWER TO ONLY ONE WHEEL CAN CAUSE SERIOUS STEERING PROBLEMS AND LOSS OF VEHICLE CONTROL AND RESULT IN A MISHAP WHICH CAN CAUSE PROPERTY DAMAGE, INJURY, EVEN DEATH.**

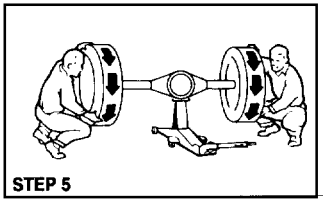
LOOKING FORWARD FROM THE REAR

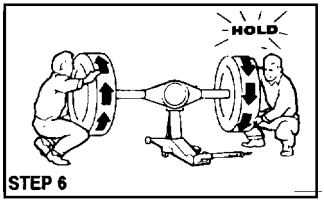

STEP 2



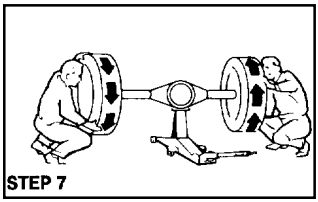
STEP 3


STEP 4


STEP 5



STEP 6


STEP 7

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⚠ Caution: When servicing any driveline components of a NoSPIN differential equipped axle, ensure that the engine is switched off and all wheels are free of the ground to prevent the vehicle from moving. Axles equipped with NoSPIN/Detroit Locker differentials deliver power to both wheels - even when only one wheel is on the ground. Failure to observe these cautionary measures may cause the vehicle to move which can result in a mishap which can cause property damage, personal injury, even death.

⚠ Caution Label
Vehicles equipped with NoSPIN differentials should be identified by a Caution label mounted on the instrument panel.

Lubrication
All NoSPIN differentials are designed to operate in those lubricants recommended by the vehicle/axle manufacturer. No special lubricant is needed. For very cold weather applications, use the lightest oil the axle manufacturer will allow to overcome possible sluggish re-engagement of the driven clutch assemblies.

Routine Inspection
Carefully follow the recommended lubrication, preventative maintenance and inspection procedures of the vehicle/axle manufacturer as part of all NoSPIN differential preventative maintenance. Except for testing for proper operation, and a possible change in the way brake adjustments are made (as explained below), maintenance, inspection and lubrication requirements of NoSPIN differential equipped vehicles are the same as for vehicles with standard differentials.

Check for Proper Operation of NoSPIN Differential
At 90 day intervals, the drive axles should be raised and the NoSPIN differential checked (see page 12) to be sure it is operating properly. This test will also determine if both axle shafts are intact.

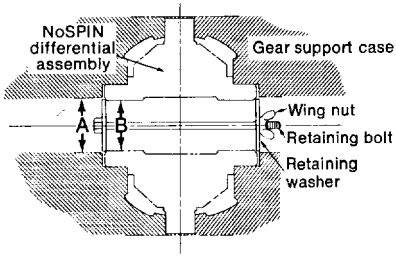
Adjustments
No adjustments or alterations should be made to the NoSPIN differential. Refer to the vehicle/axle manufacturer's instructions for adjustments to other components in the axle.

When making brake adjustments, the wheels on both sides of the vehicle must be raised and the transmission placed in neutral so that the ring gear and opposite wheels are free to rotate with the wheels on the side being adjusted.

Servicing NoSPIN Differentials
Any decision to disassemble the axle for inspection should be made only after performing the installation and operation tests stated on page 12 and after consulting the vehicle/axle manufacturer's manual and determining that the NoSPIN differential, or some other axle component, is not working properly. Review the "Trouble shooting" section on pages 18-20 to determine whether the situation requires removal of theNoSPIN differential from the vehicle.

Removal of the NoSPIN Differential From the Axle
Refer to the vehicle/axle manufacturer's instructions. The procedure for removing the NoSPIN differential case and ring gear assembly is the same as for the original differential. It is not necessary to remove the ring gear from the differential case half unless the standard support case is being replaced or the NoSPIN, differential was supplied with a case manufactured by Tractech.

Retaining Bolt
A retaining bolt, washers and wing nut are useful to keep the NoSPIN differential assembly intact when removing it from the differential case and when reinstalling it in the axle housing. **⚠ CAUTION: FAILURE TO USE A RETAINING BOLT OR SOME OTHER RESTRAINING MEANS WHEN SEPARATING THE DIFFERENTIAL CASE HALVES CAN CAUSE INJURY IN THAT NoSPIN DIFFERENTIALS HAVE COMPRESSED SPRINGS.**



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The bolt, washers and wing nut used to retain the NoSPIN differential assembly when it was shipped from the factory, as illustrated on page 13, are best for this purpose. You will note that the retaining washers must be small enough to pass through the case ends (dimension "A"), yet large enough to restrain the two side gears (dimension "B") and the balance of the NoSPIN differential assembly when all parts are assembled and the springs are compressed.

Disassembly of the NoSPIN Differential

1. Mark the differential case halves so they can be reassembled in their original position when repair or inspection is completed.

2. Insert the NoSPIN differential retaining bolt and washer assembly. Thread the nut fingertight against the washer. (Fig. 3) If a retaining bolt and washer assembly are not available, hold the differential case **firmly as the last bolts are being removed from the case halves to absorb spring pressure and prevent possible iniury.**

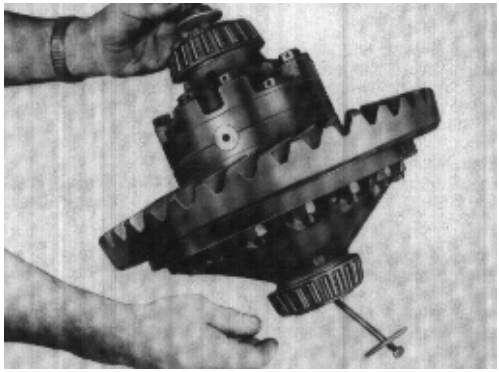


Fig. 3

3. Separate the case halves and remove the NoSPIN differential assembly.

4. Release the retaining bolt and washer assembly while firmly holding the NoSPIN differential to absorb the spring pressure.

5. Remove side gears, springs, spring retainers, driven clutch assemblies and spider assembly.

Inspection of Components

1. Wash all components thoroughly with a non-flammable solvent that will not etch, scratch or oxidize the parts. Rinse in clean solvent and dry.

2. Inspect the splines on the driven clutches. Remove any burrs or small chips with an abrasive stone or electric burr grinder. If sections of the spline are broken away, replace the components.

   Inspect the teeth on the driven clutches. If wear or chipping is present, replace the component.

   Check holdout rings for fractures and chipping or excessive wear of the lugs. Replace as required.

   NOTE: The holdout ring and driven clutch are serviced as an assembly.

3. Inspect the teeth on the spider and center cam. If wear or chipping is present, replace the component.

   Check the center cam for free movement.

   NOTE: The spider and center cam are serviced as an assembly.

4. Inspect the splines on the side gears. Remove any burrs or small chips. If splines are broken or badly chipped, or if hub walls are fractured, replace the component.

   Inspect the side gear spline fit on its mating axle shaft. Be sure the splines do not bind.

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5. Check the spring load at the operating height. (See chart on page 17)

6. Carefully examine the differential case. If worn or scored, the case should be replaced.

7. Examine the bearings, ring gear, ring gear bolts and nuts. Replace if necessary with new components that meet the vehicle/axle manufacturer's specifications.

⚠ CAUTION:
If major components (e.g. spider assembly or driven clutch assemblies) show excessive wear, the complete NoSPIN differential should be replaced. If a component is replaced, mating components should also be replaced in that it is likely that they too are damaged. Use of worn or damaged components can lead to a recurrence of the original problem. NOTE: Use only Tractech approved components when repairing NoSPIN/Detroit Locker differentials.

Reassembly Procedure for NoSPIN Differentials

Assemble a spring retainer over the side gear splines with the retaining lip pointed up. It should seat against the side gear shoulder.

Place a spring over the side gear spline and against the retainer lip with the smaller diameter of the spring against the retainer (Fig. 4).

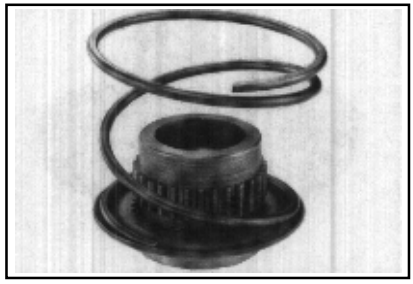


Fig. 4

NOTE: Verify that the spring is functioning freely. Be sure the spring is not binding, that the coils do not overlap and that there is good contact between the coil and the spring retainer

Assemble the two clutch assemblies to the spider assembly.

IMPORTANT:
Be sure the 'slot' in each holdout ring is properly aligned over the long tooth of the spider assembly. Position the spider assembly and clutch assembly on top of the spring.

Assemble the other retainer and spring on the other side gear as previously indicated, and position on top of the spider and clutch assembly.

Using a mechanical press (or other safe means) compress the springs and fasten the NoSPIN together with a retaining bolt, washers and wing nut (Fig. 5). Be sure the side gear splines are completely meshed with the clutch spline.

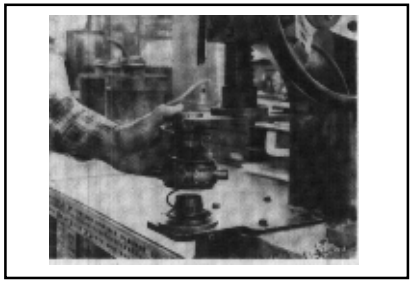


Fig. 5

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⚠ CAUTION:
Failure to use a retaining bolt or some other restraining means when assembling the NoSPIN can cause injury in that all NoSPIN differentials have compressed springs.

6. Lay the ring gear and flanged half of the differential case on a bench with the bearing end of the case hub down and the inner case facing up. ENSURE NO THRUST WASHERS ARE INSIDE THE CASE.
7. Install the NoSPIN differential in the flanged differential case half.
8. Mount the plain case half over the side gear. **ENSURE NO THRUST WASHERS ARE INSIDE THE CASE.**
9. Position the case halves firmly together with the punch marks aligned and install the case bolts.
10. Tighten case bolts to the torque specified by the vehicle/axle manufacturer. Check to be certain of a tight fit between the two case halves at all points and between the trunnion mounts in the case and the spider trunnions (Fig. 6).

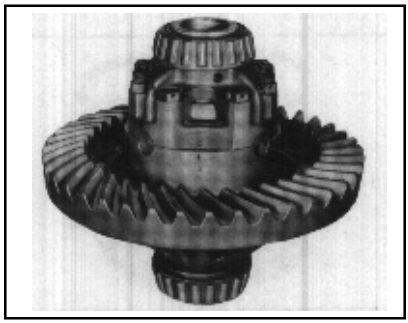


Fig. 6

11. Remove the wing nut, washers and retainer bolt.
12. Follow the vehicle/axle manufacturer's instructions for reinstallation of the ring gear and differential case assembly into the axle carrier.
13. **BEFORE OPERATING THE VEHICLE PERFORM INSTALLATION AND OPERATION TEST STATED ON PAGE 12 TO ENSURE CORRECT RE-ASSEMBLY OF COMPONENTS.**

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SPRING LOAD (in lbs. minimum)
AT OPERATING HEIGHT

Model Series	Part No.	Operating Height	Load (lbs. Minimum)
137S	69978	.45"	40
162S	69427	.54"	45
187S	68264	.61"	46
187S	69076	.61"	72
187S	69119	.51"	55
225S	66622	.73"	53
225S	69640	.73"	52
250S	67085	.62"	61
275S	67115	.86"	69
306S	66842	.90"	104
350S	67204	1.04"	101
400S	65461	1.41"	144
450S	64718	1.30"	162
550S	65423	1.43"	198
600S	68707	1.56"	297

Spring load should be checked at the operating height specified in the above table for an approximate reading. A dial indicator type spring tester is the best tool for this procedure. However, if one is not available, a weight equal to the load specified in the table can be placed on the spring and the height can be measured with the weight in place on the spring. Tech Data Report #80-1038 can be used to assist in making a decision as to whether the spring should be replaced.

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TROUBLE SHOOTING

An important function of an owner/operator in the field is that, one of the many hats he is required to wear is the one labeled "trouble shooter."

Trouble shooting can be a very frustrating, elusive job. However, if some basic rules are followed in a systematic order, solutions can be easily obtained.

The following guidelines can be utilized for trouble shooting both on and off highway vehicle applications. However, some techniques used for on/highway vehicles are not as important for off/highway vehicles:

1. Before tearing down an axle and differential make sure you get the correct "story" from a reliable source. Then actually try the vehicle yourself inspect any previously removed components question associated failures ask if it has occurred before. In other words, get the facts and don't over-react.

2. Read the **Trouble** Shooting Section. (Enclosed)

3. Perform a **Functional Check.** (Enclosed)

4. Check tire rolling radii. Assure that all tires are within specifications. (This applies primarily to on/highway vehicles.)

5. If all the previous checks do not reveal the problem or offer a solution, then the NoSPIN must be removed. Upon removal, look for the following:

   A. Contamination in the oil or on the components.

   B,. Obvious broken or worn parts.

   C. Mis-assembly i.e., retainers installed backwards, thrust washers left in, spring jumpea over retainer, etc.

   D. Heavy wear on spider and clutch drive teeth i.e., Tooth rounding, 5 degree negative angle gone, corner chipping of teeth. (These components are usually the main areas of wear.)

   E. Telltale signs of eccentric wear, patterns on components, indicating possible cause of shaft problems.

   F. Check NoSPIN assembly for pair-up, hand cam, H.O.R. tension, backlash, etc.

6. After inspection of the NoSPIN and associated axle components, a new unit should be installed and a complete functional check and vehicle performance check should be made.

7. If during the visual inspection a solution to the problem is not obtained, the unit should be returned to Tractech, attention of the Customer Services Manager. Call first for a return authorization number.

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The following chart will assist owners and operators of NoSPIN differential equipped vehicles diagnose and correct problems related to vehicle performance. Potential problems are stated on the left; possible causes for those problems are listed, by number, on the right. The explanation of these "possible causes" follows on page 20.

PROBLEM	POSSIBLE CAUSE(S)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hub studs shearing; rear tire scuffing; axle shaft breakage	●	●			●			●	●					●	
Steering difficulty; vehicle pulls on straight forward driving or tends to go straight when making turns	●	●	●	●	●		●		●				●	●	
No differential action; binding in turns	●			●	●	●			●					●	●
Excessive driveline noise*	●	●	●	●	●		●		●					●	
Excessive tire wear	●	●	●	●	●	●	●							●	●
Grinding noises	●			●	●			●	●	●				●	
Continuous "clicking" sound in straight forward driving	●	●	●		●										
Excessive backlash in vehicle drivetrain; engine lug or vehicle surge during turns	●					●		●		●					
Tendency to side-slip or "fishtail" on icy roads											●				
Sluggish reengagement of NoSPIN differential clutch assemblies									●			●			
Difficulty in turning vehicle from standing start	●			●	●								●	●	
Erratic operation of NoSPIN differential; premature wear or failure of NoSPIN differential components	●	●	●	●	●			●	●	●		●		●	

*** NOTE: NoSPIN differentials will emit occasional "metallic" sounds due to backlash built into the unit. This is normal! See backlash under Vehicle Performance on pages 3-4.**

TROUBLE SHOOTING - Cont'd.

Possible Causes for Vehicular Problems

1. **Improper installation; defective NoSPIN differential.** Follow test procedures outlined on page 12. Correct installation or repair or replace the NoSPIN differential if the vehicle fails any step of the test procedure.

2. **Overloading and/or improper weight distribution.** Remove excess weight and redistribute the load from side to side, according to the vehicle/axle manufacturer's instructions.

3. **Unequal rolling radii of the drive wheel.** A smaller rolling radius tire will cause the tire to overrun constantly when power is applied. The other tire (with the larger rolling radii) will do all the driving. Replace tires or adjust tire pressures until rolling radii are equal.

4. **Broken axle shaft.** Replace. **NOTE:** It is possible to operate a NoSPIN equipped vehicle on one axle shaft. However, this practice is not recommended in that serious damage can occur to other axle components.

5. **Bent axle shaft or housing; axle shafts on different center lines.** Replace bent axle shafts or housing, or realign hub faces and bolt circles in both the differential carrier and axle housing.

6. **Larger than normal steering angle; short turning radius.** Vehicles designed with high turning angles may surge, have steering difficulty and cause tire wear during sharp turns. Reduce maximum turning angle and have the driver decelerate when engine surge begins.

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7. **Incorrect wheel alignment.** Correct as required.

8. **Worn or defective axle components.** Check the condition of the ring gear, pinion gear, bearings, seals, etc. Replace as required.

9. **Foreign matter in axle housing or improper assembly of axle components.** Inspect for contamination. Check assembly of axle components.
-
10. **Incorrect ring and pinion adjustments, worn driveline components** (transmission gears, U-joints, etc.). Replace or adjust components as required.

11. **High crown in road, poor traction surface under all drive wheels.** The tendency to side-slip or "fishtail" on icy roads sloping toward the curb is more pronounced when using a traction differential than when using a conventional differential. Stability can be retained when side-slip occurs by decelerating (letting off the accelerator).⚠ **CAUTION: Do not apply the brake. To do so may result in loss of vehicle control.**

12. **High Viscosity Lubricant.** In very low temperatures, gear lubricant can thicken and impede the normal function of the NoSPIN differential. Tractech recommends that the axle oil be changed for very cold weather operation to the lightest acceptable lubricant allowable by the axle/vehicle manufacturer. Heat control devices, garaging and a warm up period may also provide relief from this problem in extreme low temperatures.

13. **Low steering cylinder pressure, undersized steering cylinder, excessive angle of articulation, excessive vehicle weight.** Correct as required.

14. **Improper application of product.** Review application guidelines on pages 2-3.

15. **Insufficient front axle overrun ratio (lead) for farm tractors (straight frame with front wheel assist power).** Take physical measurement, increase to minimum of plus three (+3) percent by increasing tire pressure in front tires and/or reducing tire pressure in rear tires, within the tire manufacturer's recommendations.

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NEW IMPROVED Detroit Locker ™ DIFFERENTIAL

SPECIAL INSTRUCTIONS

TO IDENTIFY

New IMPROVED Detroit Locker differential models in the 187S and 225S series' have an "L" added to the model number, such as **187SL-16A.** They replace the previous model.

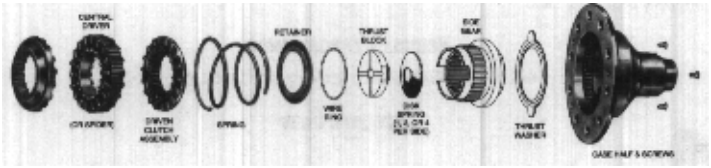
APPLICATIONS

These units are designed for light trucks including 2 wheel drive and 4 wheel drive vehicles, and high performance passenger cars.

VEHICLE PERFORMANCE

Performance is similar to that of NoSPIN/Detroit Locker - equipped light trucks, pages 3-4. The new IMPROVED Detroit Locker operates in the drive - coast mode without the familiar harsh feel and sound. Everyday driving is quieter and smoother, yet maximum traction is immediately available.

EXPLODED VIEW



Note the additional parts compared to NoSPIN/Detroit Locker differentials, page 5. New IMPROVED Detroit Locker models are supplied with either a spider or central driver and a support case.

OPERATION

Operation is identical to that of NoSPIN/Detroit Locker - equipped vehicles, page 6.

INSTALLATION

Installation of a new IMPROVED Detroit Locker is similar to that of a NoSPIN/Detroit Locker differential, pages 7, 10 and 11. Important: Thrust washers are supplied installed inside the support case. **The instructions on pages 8, 12 and 16 to "Be sure all thrust washers have been removed" DOES NOT APPLY** to the two thrust washers supplied with the new IMPROVED Detroit Locker models.

⚠ **Caution: If for any reason the thrust washers supplied have been removed from the support case halves supplied, reinstall only the two thrust washers supplied by Tractech by locating the tabs in slots, with the oil groove facing you.**

⚠ **Caution: If for any reason the new IMPROVED Detroit Locker unit is disassembled, reinstall the disc (Belleville) springs - there will be one, three or four on each side - with the large diameter against the side gear.**

Be sure to install the Caution label and this Manual in the vehicle.

TEST FOR PROPER INSTALLATION AND OPERATION

Perform this test as described on page 12.

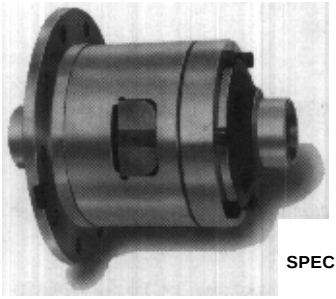
MAINTENANCE

Follow the instructions and cautions as described on pages 13-16 except that the Instruction on page 16 to "Be sure all thrust washers have been removed" DOES NOT APPLY to the thrust washers supplied with the new IMPROVED Detroit Locker models.

TROUBLE SHOOTING

The help provided on pages 18-20 apply to the new IMPROVED Detroit Locker differential.

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NEW Detroit C-Locker ™ DIFFERENTIAL for C-Clip Retained Axles

SPECIAL INSTRUCTIONS

TO IDENTIFY

Detroit Lockers for C-Clip retained axles in the 187 and 225 series have a "C" instead of an"S~ in their model number, such as **187C-145A.**

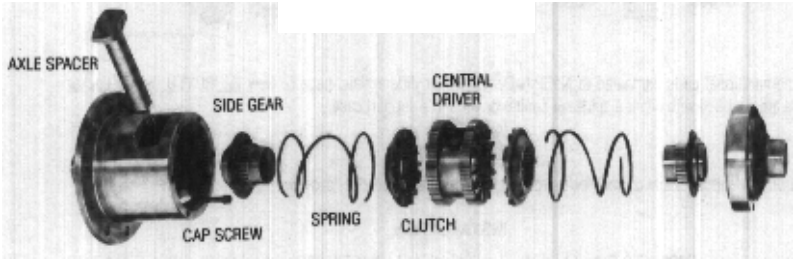
APPLICATIONS

These units are designed for light trucks including 2-wheel-drive and four-wheel-drive vehicles, and high performance passenger cars.

VEHICLE PERFORMANCE

Performance is identical to that of NoSPiN/Detroit Locker - equipped vehicles, page 3-4.

EXPLODED VIEW



OPERATION

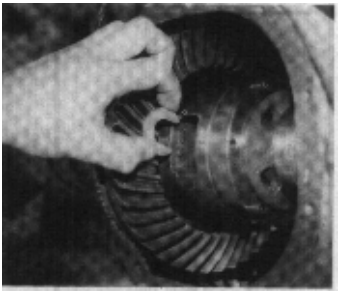
Operation is identical to that of NoSPIN/Detroit Locker - equipped vehicles, page 6.

INSTALLATION

Installation of a Detroit C-Locker for differential is similar to that of a Detroit Locker differential, pages 10 and 11 **up to Step 11.** The following steps must be carried-out before proceeding to **Step 12.**

Step 11a Install the differential and ring gear assembly in the axle, setting pre-loaded and backlash per the vehicle manufacturer's instruction's. **Note: Contamination, such as metal particles in the differential case, can cause the differential to malfunction. Be sure tha axle housing is clean before proceeding.**

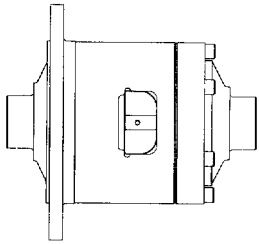
Step 11b Install the C-Clips as in a conventional differential utilizing the window in the side of the differential case.

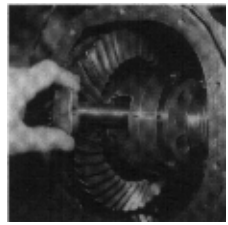


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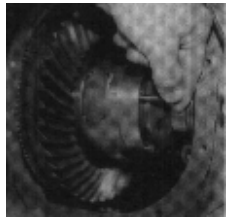
Step 11c If the plain side (the side opposite the ring-gear side) bearing cap has already been installed, it will be necessary to remove it before proceeding.

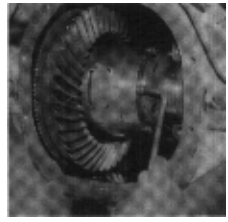
Step 11d Install the spacer pin (in plastic bag) through the case and between the ends of the axle shafts.





Step 11e Insert the long socket-head cap screw (in plastic bag) through the differential plain-side cover and thread into differential housing. The end of the screw will engage the hole in the spacer pin thus holding it in place. Torque the screw to 23-25 ft.-lbs. (31-34Nm). **Note: this screw has a thread locking patch pre-applied to it. If for any reason it is removed after installation, a thread locking compound must be re-applied before re-assembly.**





Step 11f Install the plain-side bearing cap and torque per the vehicle manufacturer's instructions. Bearing cap bolts must have a thread locking compound applied to them.

Step 11g Complete the reassembly of the associated components as recommended by the vehicle manufacturer's instructions.

Complete Steps 12, 13, and 14 on page 9. Be sure to install Caution Label and this Manual in the vehicle.

TEST FOR PROPER INSTALLATION AND OPERATION

Perform this test as described on page 12.

MAINTENANCE

Follow the Instruction and Cautions as described on pages 13-16.

TROUBLE SHOOTING

The help provided on pages 18-20 apply to the Detroit C-Locker for C-Clip retained axles.

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GLOSSARY

ARTICULATED - Refers to vehicles that are joined in the middle and turn around this joint, as in "articulated farm tractor"

AXLE CARRIER - The differential and ring and pinion gears are mounted on the axle carrier; the "center section" of the axle housing.

AXLE GEAR RATIO - The ratio between the number of teeth on the ring gear and the number of teeth on the pinion gear (e.g., 3.92:1.00).

AXLE HOUSING - The support member of the axle which sustains the weight of the vehicle and houses the axle carrier assembly.

BACKLASH - The designed clearance between mating components in the driveline (e.g., gear sets, spline couplings, etc.).

CASE ASSEMBLY - The differential housing (usually consisting of two case halves; contains the differential assembly).

CASE BEARING (CARRIER BEARING) - The bearings that mount to the hubs on the differential support case.

CASE PILOT BORE - The locating diameter in the differential case from which the differential side gear is installed.

CENTER CAM - The control element of the NoSPIN differential. The center cam is used to lift the drive members from engagement by means of cam ramps.

CENTRAL DRIVER - An outer splined member (similar to the spider) having torque carrying teeth on both sides; the "center piece" of the NoSPIN differential.

CLUTCH PACK DIFFERENTIAL - A limited-slip differential which uses friction clutch plates and/or springs to partially reduce wheel spin.

DETROIT LOCKER DIFFERENTIAL - Trademark given to "light duty" NoSPIN differentials. (NoSPIN and Detroit Locker are operationally identical.) Manufactured by Tractech.

DIFFERENTIAL - Axle gear assembly which allows one axle shaft and wheel to turn slower or faster than the other when negotiating a turn.

DIFFERENTIATION - The different rate of speed between two wheels of an axle when making a turn or over uneven surfaces.

DRIVELINE - Components used to propel the vehicle driveshaft and universal joints transmitting torque from transmission to drive axle (same as drivetrain).

DRIVEN CLUTCH - Member that is used to provide torque to another member, such as to the side gear. Each NoSPIN differential has two driven clutches.

DRIVETRAIN - A series of components which transmit power from the engine to the wheels/tires (i.e., transmission, propeller shafts, transfer case, axle, differential, shafts, etc.).

DOUBLE REDUCTION - Dual gear reduction used in rear axles.

FISHTAILING - Side slipping of the vehicle caused by traction instability.

G.C.W. - Gross Combination Weight. G.V.W. plus vehicle weight and payload of towed vehicle.

G.V.W. - Gross Vehicle Weight. Total weight of vehicle and payload.

GEAR SUPPORT CASE - Case used to support the differential. Same as case assembly.

GROUND COEFFICIENT - The horizontal force required to move a body, divided by the weight of the body. The amount of friction at the ground the "quality" of the ground surface (e.g., ice, snow, dirt, etc.).

HELICAL - "Angled" gear tooth form.

HOLDOUT RING - Ring which assembles to NoSPIN differential clutch; maintains clutch disengagement in a turning mode.

INDEXING - A passing of one member over another causing a slight audible sound from their contact (usually associated with NoSPIN differential).

INPUT TORQUE - Measurement of available power.

LEAD RATIO - On unequal wheeled four wheel drive tractors the transmission is so geared that any difference in road speed of the two axles results in a faster speed for the front wheels (lead or overrun), this prevents the front wheels from being pushed.

LIMITED-SLIP DIFFERENTIAL - A differential which utilizes some means of partially reducing, but not totally eliminating individual wheel spin (e.g., clutches, springs, biasing pinion gears, etc.).

LOCKING DIFFERENTIAL - A differential that provides a locked axle condition. Can be manual or automatic, as in hydraulic locking differential or NoSPIN differential.

MACHINED SPLINES - Splines that have been manufactured by shaping, hobbing, broaching, or slotting.

NoSPIN DIFFERENTIAL - Trademark of automatic, positive-locking differential. Manufactured by Tractech.

OVERRUN RATIO - On unequal wheeled four wheel drive tractors the transmission is so geared that any difference in road speed of the two axles results in a faster speed for the front wheels (overrun or lead), this prevents the front wheels from being pushed.

PARALLEL SPLINES - Series of parallel keys cut along the axle shaft which mate with corresponding slots in the differential side gear.

PAYLOAD - Actual weight of useful cargo carried by vehicle.

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PINION (INPUT) GEAR - The gear that is directly connected to the driveshaft which propels the differential and ring gear and provides power to the axle.

PLANETARY AXLE - Axle having a gearset arrangement in a concentric pattern; consisting of a sun gear surrounded by pinion gears which mesh with an annulus ring gear. This gearset provides torque multiplication in a reduced area on the same center line as the axle shaff usually located on the hub ends of axle.

PRE-LOAD - Differential bearing adjustment achieved by adding or subtracting shims. R.P.M. - Revolutions Per Minute. Term used to define rotation.

RING GEAR - The gear that is attached to the differential case and driven by the pinion gear.

ROLLED SPLINES - Splines that are manufactured by use of rolling dies to form the spline configuration.

SHIM - "Spacer" used to achieve differential bearing adjustment.

SIDE GEAR - The gear that is mounted in the differential case; has the axle shaft splined to it; driven by the pinion gear.

SINGLE SPEED - Axle or transfer case having a single gear ratio.

SHOCKLOAD - A force caused by sudden impact.

SPIDER - The "center piece" of a standard, clutch-pack or NoSPIN differential; having a spider-like shape.

SPIDER CROSS - Two or four armed member used to mount the standard differential pinion gears.

SPIDER GEAR(S) - Bevel pinion gears that are mounted on spider cross that drive the side gears of standard or clutch type differentials.

SPLINES - "Teeth" on axles that mate with "teeth" (splines) on differential side gear.

SNAP RING - A circular expandable rinq that is used to retain two members together, as the snap ring in a NoSPIN differential that retains the spider and center cam.

STANDARD DIFFERENTIAL - Open or conventional differential with no means of traction control.

TAG AXLE (TANDEM) - Non-powered rear axle which follows drive axle. Provides additional load-carrying capacity and distribution.

TAPERED SPLINES - Cone shaped spline configuration.

THRUST BLOCKS - Support mechanism used to prevent ring and pinion gear deflection.

THRUST WASHER - Used in conventional differential to reduce wear to the support case.

TORQUE - Force having a twisting or turning effect. Also used in conjuction with the term "power".

TRUNNION - Journals allowing pivoting or turning, such as on a spider cross. On a NoSPIN differential, the arm (there are four) which supports the differential in the case assembly.

TWO-SPEED - Axle or transfer case having two selective gear ratios.

UNDERSTEER - The condition of steering when making a turn that causes the vehicle to go straight rather than turn freely.

WHEELBASE - Distance between center lines of front and rear axles or to the center line of tandem axles.

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TRACTECH DIFFERENTIAL LIMITED WARRANTY, AND LIMITATIONS

Tractech (TRACTECH) expressly warrants each TRACTECH product or part to be free from defects in materials and workmanship under NORMAL USE AND SERVICE.

A. Differentials

1. In new vehicles

   a. For licensed vehicles, when not used in competition of any type for the lesser of: 1) the same period (of time, mileage or hours of use) as the other drive axle parts are warranted by the axle manufacturer in that vehicle or 2) one year from date of delivery or 100,000 miles of differential use by the first user; or

   b. For non-licensed vehicles, for the same period (of time, mileage or hours of use) as the other drive axle parts are warranted by the axle manufacturer in that vehicle.

2. In used vehicles

   a. For licensed vehicles, when not used in competition of any type, for the earlier of 100,000 miles of differential use or one year from the date of delivery to the first user; or

   b. For non-licensed vehicles, for the same period (of time, mileage, or hours of use) remaining, if any, as the other drive axle parts are warranted by the axle manufacturer in the vehicle.

3. For vehicles used in competition of any type, for 30 days from the date of delivery to the first user.

B. Clutches and Brakes

For six (6) months from date of delivery.

There exist specific MANUALS for each TRACTECH differential indicating the appropriate application, operation, inspection and maintenance criteria. IT IS MOST IMPORTANT THAT ANY SELECTOR, PURCHASER, INSTALLER, MAINTAINER OR USER CAREFULLY READ the relevant MANUAL before any application is selected or any operation or maintenance is attempted.

Also TRACTECH strongly encourages each designer, prospective customer or user to submit an application approval request using TRACTECH Differential Application form 7003, Clutch Application form 3003, or Brake Application form 8003 as applicable.

NORMAL USE AND SERVICE means that:

A. The product or part will be applied, installed, operated, inspected and maintained in accordance with the TRACTECH Operation and Maintenance Manual, and Owner's Manuals for the specific product;

B. The maintenance of the product must meet or exceed the level specified by the vehicle or equipment manufacturer for the TRACTECH product or similar product; and

C. The product will be applied and operated within the boundaries of any written TRACTECH APPLICATION APPROVAL by the TRACTECH Engineering Department.

EXCLUSIONS

THE FOREGOING WARRANTY IS EXCLUSIVE, AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED (WHETHER ORAL OR WRITTEN), INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. No person, including any dealer or representative of TRACTECH, except the President of TRACTECH, is authorized to make any representation or warranty concerning TRACTECH products on behalf of TRACTECH or to assume for TRACTECH any obligation not contained in this warranty, including a warranty of fitness for any particular purpose. This warranty gives you specific legal rights and you may also have other rights which vary from state to state. ANY IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY, OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, TO THE EXTENT THE SAME CANNOT BE DISCLAIMED UNDER APPLICABLE LAW, ARE LIMITED IN DURATION TO THE EXPRESS WARRANTIES SET FORTH ABOVE EXCEPT IN THOSE STATES THAT DO NOT ALLOW TIME LIMITATIONS ON IMPLIED WARRANTIES. THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY PURPOSE WHEN THE PRODUCT IS PUT TO AN INDUSTRIAL, COMMERCIAL OR RENTAL USE.

In no event does any warranty, express or implied, apply to loss, harm or damage to the extent caused by any or all of the following, wear to or failure of other drive train parts; freight damage; use of components, parts and/or accessories not obtained from or approved by TRACTECH or which do not meet TRACTECH quality and performance specifications; improper installation, maintenance, repair, misuse, or abuse, normal wear of moving parts or components affected by moving parts; and/or unauthorized alterations or modifications.

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TRACTECH SHALL NOT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OR EXPENSE ARISING DIRECTLY OR INDIRECTLY FROM A DEFECT IN PRODUCTS MANUFACTURED OR SOLD BY IT OR FROM THE USE OF ANY SUCH DEFECTIVE PRODUCT, INCLUDING BUT NOT LIMITED TO LOSS OF USE, LOSS OF PROFITS, LOSS OF SALES, INCREASED COSTS OR ANY OTHER SPECIAL DAMAGES, EXCEPT TO THE EXTENT THAT EXCLUSION OR LIMITATION OF INCIDENTIAL OR CONSEQUENTIAL DAMAGES IS PROHIBITED BY APPLICABLE LAW.

TRACTECH RESERVES THE RIGHT TO MAKE CHANGES IN DESIGN AND OTHER CHANGES, MODIFICATIONS, ALTERATIONS OR IMPROVEMENTS TO ANY OF ITS PRODUCTS WITHOUT THERE RESULTING ANY OBLIGATION UPON TRACTECH TO FURNISH OR INSTALL THE SAME UPON ANY PRODUCTS PREVIOUSLY SOLD AND DELIVERED OR PRODUCTS THEN IN PROCESS, MANUFACTURE OR DISTRIBUTION.

LIMITATION OF REMEDIES

At TRACTECH'S option, TRACTECH will credit the buyer's account for the purchase price of, or repair or replace without charge for materials, any TRACTECH product that failed within the warranty period that is finally determined by TRACTECH to have been defective in material or workmanship.

Any suit or action arising out of or relating to this Warranty or the breach thereof, must be commenced within one (1) year after the cause of action has accrued. The foregoing shall not limit the time within which any suit or action must be brought to collect an amount agreed to be paid by the buyer or to enforce a judgement for or to collect any such amount.

It is expressly agreed that the liability of TRACTECH is limited, and TRACTECH does not function as an insurer. All buyers of TRACTECH products waive subrogation on all claims covered under their own or any other insurance.

If TRACTECH should be found liable to anyone on any theory (except breach of any express warranty, where the exclusive remedy is as set forth above), the liability of TRACTECH shall not exceed the purchase price of the involved TRACTECH product (or service) when sold (or when service is performed) by TRACTECH to the first buyer. THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER REMEDIES, EXPRESS OR IMPLIED, regardless of theory, cause or origin of any loss, harm or damage resulting directly or indirectly to any person, organization, entity or property, including without limitation: the performance or non-performance of any obligation set forth in this Warranty; breach of any agreement (oral or written including specifications) between TRACTECH and its customer or the buyer; negligence, active, passive or otherwise, of TRACTECH or any of its distributors, agents or employees; breach of any warranty or covenant implied or imposed by law misrepresentation; and/or strict liability.

The sole purpose of the stipulated exclusive remedies shall be to provide the buyer with a credit or replacement for, or the repair of, defective products or services in the manner provided herein. The exclusive remedies shall not be deemed to have failed of their essential purpose so long as TRACTECH is willing to credit the buyer's account for the purchase price of, provided replacement for, or repair, the defective products or services in the manner prescribed herein.

ADJUSTMENTS

When adjustment is sought under this Warranty, a claim should be made within six (6) months of the date of failure, as follows:

A. Users in North America

1. If the product or part was purchased installed by the original equipment manufacturer (or its dealer), follow the manufacturer's procedures for warranty claims; or

2. If the product or part was purchased through a distributor of TRACTECH products, have the distributor write or phone TRACTECH Customer Service Department and ask for an Authorization to Return Materiai number. Supply the distributor with all requested information. Have the distributor ship the entire product (freight prepaid) to our Warren, Michigan factory. Evaluation of claims take 4-6 weeks from the time the unit is received.

B. OEM's in North America

Contact TRACTECH to receive a written Authorization to Return Material with number. Then return material to TRACTECH (freight prepaid) and include a copy of Authorization to Return Material and reason for return. NOTE: At the option of TRACTECH, material may not need to be returned, but written confirmation must be obtained prior to TRACTECH'S approval of a credit memo.

C. Outside North America

Follow the procedure in Paragraph A or B immediately above but do not return product or part. You will be contacted regarding your claim.

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NoSPIN® / detroit® locker

automatic positive locking traction differential

OWNER'S MANUAL

WITH ⚠ WARNINGS and PRECAUTIONS

Mechanic:

Any increase in the size of the vehicle's engine, tires, weight etc., may prohibit use of a NoSPIN/ Detroit Locker differential in a heretofore approved application. Any such modifications should be reviewed by Tractech Engineering before continuing to use the product.

Do not use heat to disassemble drive axles. To do so can destroy heat treat properties and weaken or distort axle components.

Turn the engine off and raise all driving wheels of a NoSPIN/Detroit Locker differential equipped axle when servicing wheels brakes axles or tires to prevent the vehicle from moving. Axles equipped with NoSPIN/Detroit Locker differentials deliver power to both wheels - even when only one wheel is on the ground.

NoSPIN/Detroit Locker differentials have compressed springs. Use a retaining bolt or some other restraining means when separating the differential case halves. (See pages 13-14) Do not lift the heavier (75 lbs. or over) units by the retaining bolt, as the washers may collapse or the threads may strip.

When repairing NoSPIN/Detroit Locker differentials, if major components show excessive wear, the complete differential should be replaced. If a component is replaced, mating components should also be replaced in that it is likely that they too are damaged. Use of worn or damaged components can lead to a recurrence of the original problem. (See page 15) Note: Use only Tractech approved components when repairing NoSPIN/Detroit Locker differentials.

Operator:

All NoSPIN/Detroit Locker differential equipped vehicles must be identified by a Caution Label, mounted on the instrument panel. Contact Tractech if this label was not received.

Do not operate the vehicle if both wheels of a NoSPIN/Detroit Locker differential equipped axle are not driving. Power to only one wheel can cause serious steering problems. Perform the installation and operation tests illustrated on page 12 betore putting the vehicle into service.

Use extreme caution when accelerating or decelerating on slippery or unstable surfaces. Vehicles/axles equipped with traction differentials are inherently more sensitive to side-slip.

Distribute the load evenly side-to-side; do not exceed the vehicle's rated payload capacity; keep the diameter of the tires equal. Failure to observe these measures can create a difference in individual wheel speeds which can cause the NoSPIN/Detroit Locker differential to deliver power to only one side of the vehicle and thus cause steering problems.

Turn the engine off and raise all driving wheels of a NoSPIN/Detroit Locker differential equipped axle when changing tires to prevent the vehicle from moving. Axles equipped with NoSPIN/Detroit Locker differentials deliver power to both wheels - even when only one wheel is on the ground.

Operate in low gear when coasting downhill into a turn. Braking capacity is reduced when a NoSPIN/Detroit Locker differential equipped vehicle makes a turn while coasting downhill.

IMPORTANT! RE-READ THE WARNING NOTICES REFERENCED ABOVE. IN ADDITION TO THE CONSEQUENCES NOTED, FAILURE TO OBSERVE ANY OR ALL OF THESE MEASURES CAN CAUSE PART FAILURE OR RESULT IN A MISHAP WHICH CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY, EVEN DEATH.

AXLE MANUFACTURER:
Attach this envelope to axle assemblies equipped with NoSPIN/Detroit Locker differentials

CHASSIS ASSEMBLY PLANT:
Attach the enclosed Caution label to the instrument panel of NoSPIN/Detroit Locker diflerential equipped vehicles in plain view of operator or mechanic. Place this manual in glove compartment of the vehicle

Tractech
A Titan Wheel Company
11445 Stephens Dr. - P0. Box 882
Warren, Michigan 48090 U.S.A.
(810) 759-3850
Telex 211864 TRAC UR
Fax (810) 759-1645

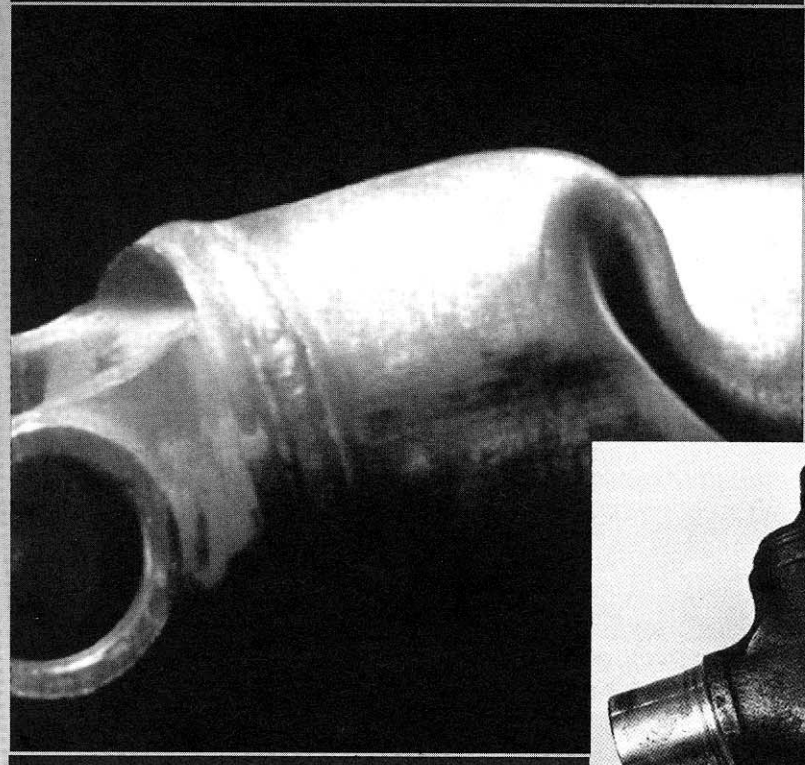
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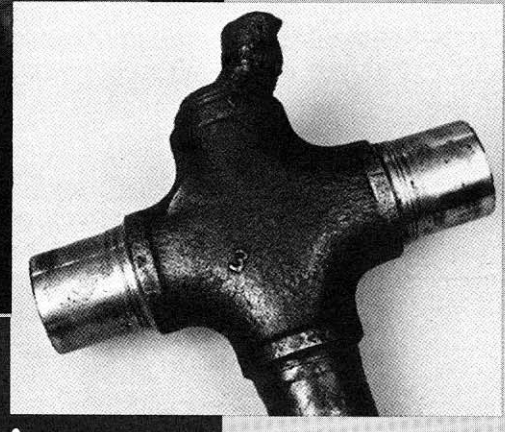
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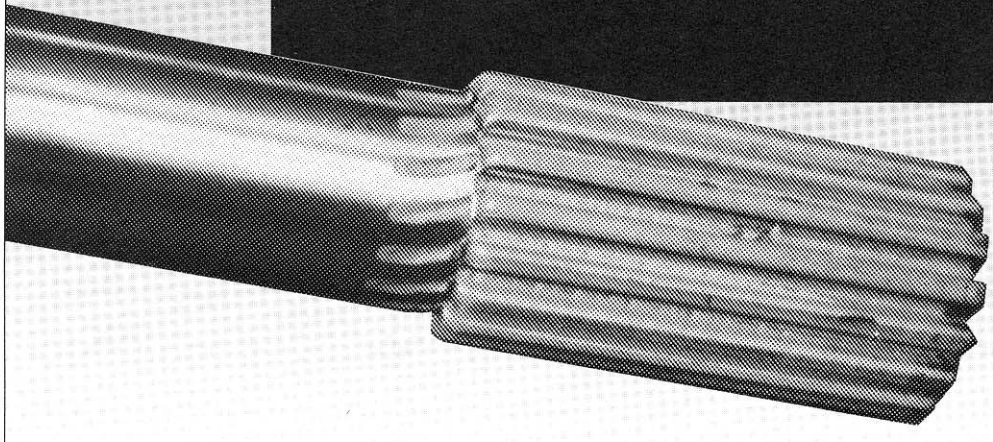
SPICER DRIVELINE COMPONENTS

TROUBLESHOOTING GUIDELINES





Causes and Solutions To Field Problems



SPICER®

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SAFETY PRECAUTIONS

GENERAL SAFETY INFORMATION

To prevent injury to yourself and/or damage to the equipment:

- Read carefully all owners manuals, service manuals, and/or other instructions.
- Always follow proper procedures and use proper tools and safety equipment.
- Be sure to receive proper training.
- Never work alone while under a vehicle or while repairing or maintaining equipment.
- Always use proper components in applications for which they are approved.
- Be sure to assemble components properly.
- Never use worn-out or damaged components.
- Always block any raised or moving device that may injure a person working on or under a vehicle.
- Never operate the controls of the power take-off or other driven equipment from any position that could result in getting caught in the moving machinery.



WARNING: ROTATING DRIVESHAFTS

- Rotating auxiliary driveshafts are dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.
- Do not go under the vehicle when the engine is running.
- Do not work on or near an exposed shaft when engine is running.
- Shut off engine before working on power take-off or driven equipment.
- Exposed rotating driveshafts must be guarded.

WARNING: GUARDING AUXILIARY DRIVESHAFTS

We strongly recommend that a power take-off and a directly mounted pump be used to eliminate the auxiliary driveshaft whenever possible. If an auxiliary driveshaft is used and remains exposed after installation, it is the responsibility of the vehicle designer and PTO installer to install a guard.

WARNING: USING SET SCREWS

Auxiliary driveshafts may be installed with either recessed or protruding set screws. If you choose a square head set screw, you should be aware that it will protrude above the hub of the yoke and may be a point where clothes, skin, hair, hands, etc. could be snagged. A socket head set screw, which may not protrude above the hub of the yoke, does not permit the same amount of torquing as does a square head set screw. Also, a wire, will prevent loosening of the screw caused by vibration. Regardless of the choice made with respect to a set screw, an exposed rotating auxiliary driveshaft must be guarded.

THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.

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INTRODUCTION

Universal joint failures, as a rule, are of a progressive nature, which, when they occur, generally accelerate rapidly resulting in a mass of melted trunnions and bearings.

Some recognizable signs of universal joint deterioration are:

(1 Vibrations - Driver should report to maintenance.
(2 U-joint Looseness - End play across bearings.
(3 U-joint discoloration due to excessive heat build-up.
(4 Inability to purge all four trunnion seals when relubing U-joint.

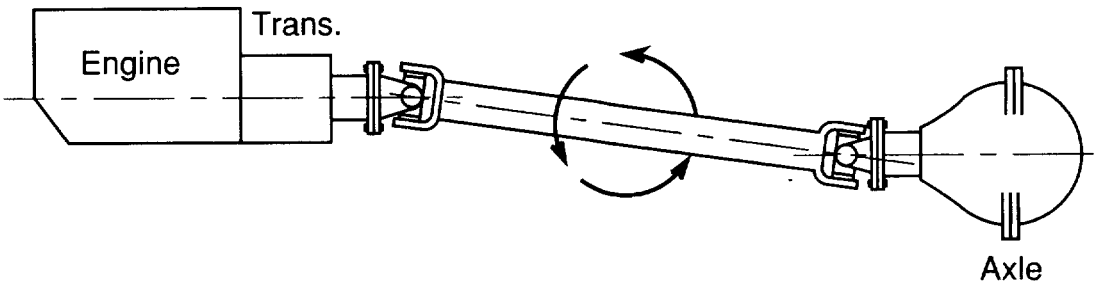
Items 2) thru 4) should be checked at re-lube cycle and if detected, reported to the maintenance supervisor for investigation. Experience with universal joint failures has shown that a significant majority are related to lubricating film breakdown. This may be caused by a lack of lubricant, inadequate lube quality for the application, inadequate initial lubrication or failure to lubricate properly and often enough.

Failures which are not the result of lubrication film breakdown are associated with the installation, angles and speeds and manufacturing discrepancies.

Driveshaft failures through torque, fatigue and bending are associated with overload, excessively high U-joint angles and drive shaft lengths excessive for operating speeds.

The trouble shooting chart in this bulletin is intended to provide service people with an aid to enable them to associate complaints with some of the **probable causes** and **probable corrections.** Through normal vehicle maintenance and recognition of discrepancies, this may enable them to make necessary corrections to ward off a serious breakdown.

DRIVESHAFT TORQUE



Twisted driveshaft tube?
Broken yoke shaft?

Usually a result of torque overload- How much torque can be generated in your application?

Here is how to figure torque:

L.G.T. = N.E.T. x Trans L.G.R. x .85 (efficiency factor)

$$\text{D.L.T. (to Slip Wheels} = \frac{W_R \times C.O.F. \times R.R}{12 \times A.R.}$$

A.R. = Axle ratio
C.O.F. = Coefficient of friction (.7)
D.L.T. = Drive line torque
L.G.R. = Low gear ratio
L.G.T. = Net engine torque
R.R. = Tire loaded rolling radius
WR = Weight on drive axle

Relate the lesser of above to Spicer U-joint ratings. If your torque exceeds the Spicer rating for the U-joint used in your application, switch to a size with a rating compatible to your calculation.

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U-JOINT OPERATING ANGLES

U-joint operating angles are a primary source of problems contributing to:

- Vibrations
- Reduced U-joint life
- Problems with other drivetrain components that may include:

  - Transmission gear failures
  - Synchronizer failures
  - Differential problems
  - Premature seal failures in axles, transmissions, pumps or blowers
  - Premature failure of gears, seals and shafts in
  - Power Take-Offs

Every U-joint that operates at an angle will vibrate.

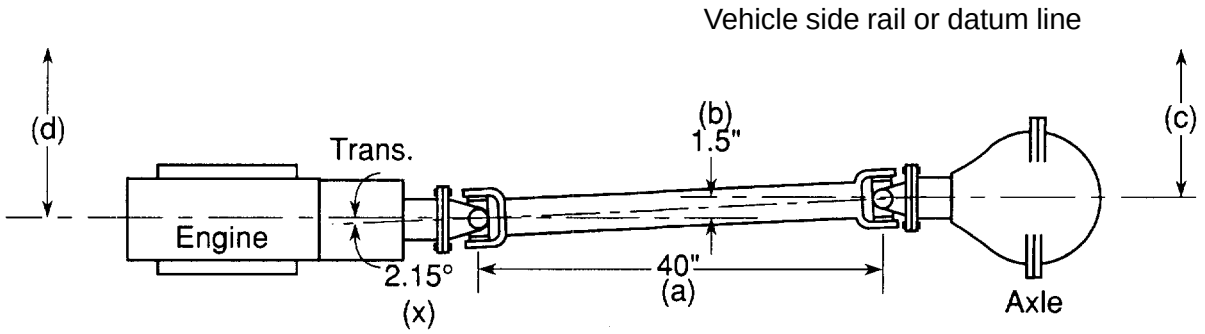
U-joint operating angles are probably the most common causes of driveline vibrations in vehicles that have been re-worked or in vehicles that have had auxiliary equipment installed.

To correct or eliminate these causes of driveline vibrations from your vehicle or new installation, you must determine the TRUE OPERATING ANGLE of each U-joint in your system.

The TRUE OPERATING ANGLE of a U-joint is a combination of the angle that occurs in the top view and the angle that occurs in the side view.

To determine the TRUE OPERATING ANGLE of a U-joint you must follow the instructions outlined in the following sections, numbered I and II, and calculate the TRUE OPERATING ANGLE using the information detailed in Section III.

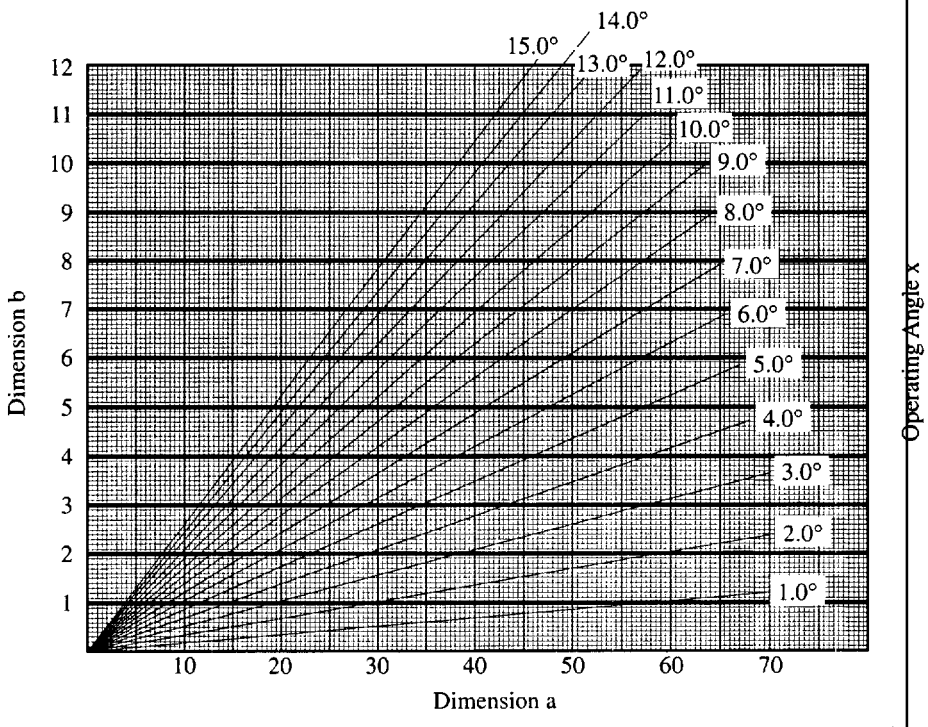
I. TO DETERMINE OPERATING ANGLES IN TOP VIEW



1. From side rail or convenient datum, measure offset dimensions c & d.
2. Calculate dimension b = d - c
3. Measure dimension a
4. Using dimensions a & b, determined through measurement calculate U-joint angle x by using the chart provided.

Example:

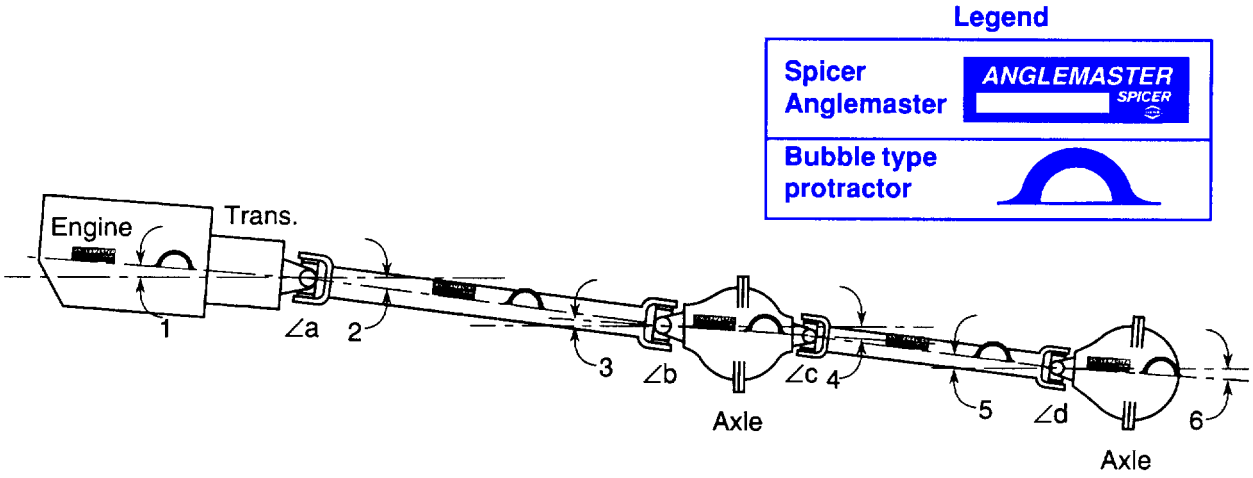
Where a = 40.0"
b = 1.5"
X = 2.15° operating angle



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U- JOINT OPERATING ANGLES

II. TO DETERMINE OPERATING ANGLES IN SIDE VIEW



The most convenient way to determine U-joint angles in the side view is through use of a Spicer Anglemaster TM or a bubble type protector. Procedure is as follows:

Step I. Using an Anglemaster or a bubble protector, record inclination angles of drivetrain components. Set Anglemaster or protector on machined surfaces of engine, transmission, axle or on machined lugs of transmission output and axle input yokes.

Note: U-joint angles can change significantly in a loaded situation. Therefore, check vehicle loaded and unloaded to achieve the accepted angle cancellation. (See Step IV.)

Example:

Eng-Trans Output	4°30' Down (1)
Main Drive Shaft	7°00' Down (2)
Input 1st Rear Axle	4°00' Up (Input Shaft Nose Up) (3)
Output 1st Rear Axle	4°00' Down (4)
Inter-axle Shaft	7°00' Down (5)
Input 2nd Rear Axle	4°15' Up (Pinion Shaft Nose Up) (6)

Note: If inclination of driveshaft is opposite connecting component, add angles to obtain the U-joint operating angle.

∠a = (2) - (1) = 7°00' - 4°30' = 2°30' (2.50°)
∠b = (2) - (3) = 7°00' - 4°00' = 3°00' (3.00°)
∠c = (5) - (4) = 7°00' - 4°00' = 3°00' (3.00°)
∠d = (5) - (6) = 7°00' - 4°15' = 2°45' (2.75°)

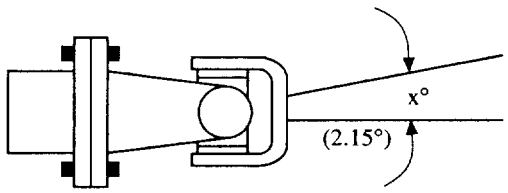
III. CALCULATING THE TRUE U-JOINT OPERATING ANGLE

The true U-joint operating angle is the sum of the U-joint angles in both the top view and the side view. The true U-joint operating angle is calculated in the following manner:

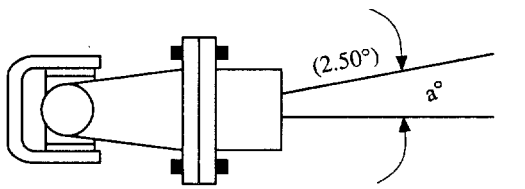
True operating angle = $\sqrt{x°2 + a°2}$
Where x = 2.15° as determined by use of chart in Section I.

a = 2.5° as determinad in Section II.

True operating angle = $\sqrt{2.152 + 2.52}$
= 3.297° or 3°18'



ANGLE IN TOP VIEW (FROM CHART)



ANGLE IN SIDE VIEW (MEASURED)

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After calculating the TRUE OPERATING ANGLE of each U-joint in your driveline:

- Make sure the inboard yoke ears of each driveshaft are in line within each other.
- Compare the TRUE OPERATING ANGLE of each U-joint on each end of each shaft. They must be within one degree of each other or they will be a potential source of vibration.

For Two Joint Shafts with Equal or Intersecting Angles When you settle on a true operating angle that is correct, make sure it doesn't exceed the angles shown in this chart for the driveshaft RPM.

If adjustments must be made to the system:

- Install shims between the axle housing and springs to rotate the axle input yoke to change operating angles.
- Change operating angle on torque arm type suspensions by lengthening or shortening torque arms.
- Raise, lower, or shift side to side a pump, blower or other piece of auxiliary equipment to change operating angles.

IMPORTANT TO REMEMBER: Keep the centerlines of two components that are connected by a driveshaft parallel in both the top and side views, so the operating angles will ALWAYS be equal.

V. Maximum True Operating Angles*

For Two Joint Shafts with Equal or Intersecting Angles

When you settle on a true operating angle that is correct, make sure it does'nt exceed the angles shown in this chart for the driveshaft RPM.

R.P.M. is the main factor in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart below.

Driveshaft RPM	Max. Normal Operating Angles	Driveshaft RPM	Max. Normal Operating Angles
5000	3.2°	3000	5.8°
4500	3.7°	2500	7.0°
4000	4.2°		8.7°
3500	5.0°	1500	11.5°

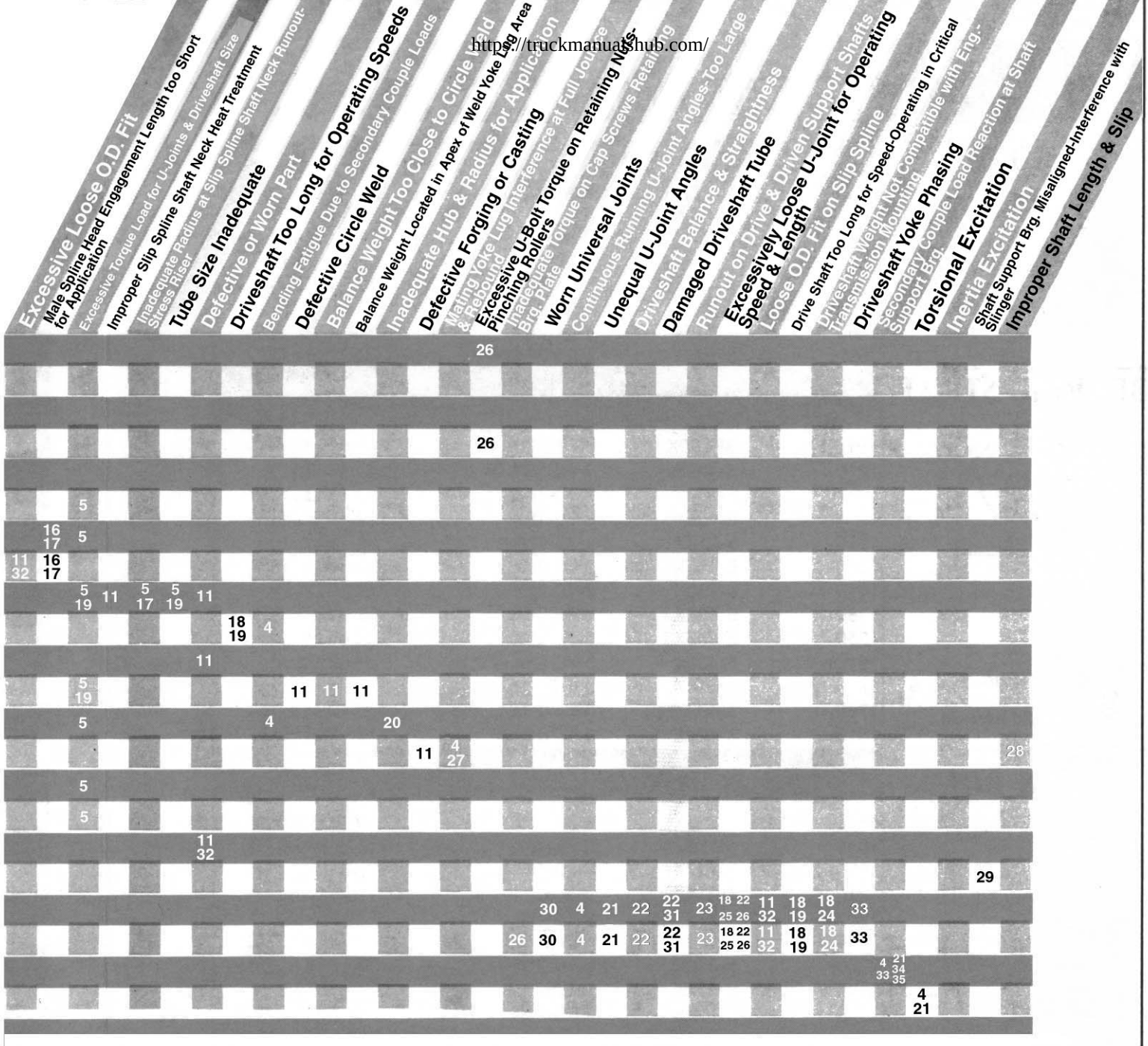
Universal Joints Trouble Shooting Chart

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Complaints	Probable Causes: Lack of Lubrication	Inadequate Initial Lubrication	Inadequate Grease Quality for Application	Inadequated Relube Cycles for Application Environment	Failure to Lubricated Properly	Defective or Worn Seals	Yoke Distortion Due to Initial Failure	Continuous Operation at High Angle-High Speed	Excessive Continuous Running Load	End Galling of Cross Trunnion & Bearing Cup	Contamination (Abrasion)	Lubricating Film Breakdown	Excessive Thrust Fit	Yoke Cross Hole Alignment	Yoke Lug Face Squareness	No U-Joint Operating Angle	Long Shaft with Loose U-Joint Thrust Fit & Unbalance	Roller Lock	Roller Skewing	Frettage Corrosion Due to Yoke Working Under Load	Galling (Adhesive Wear)	Slip Member Working In Extreme Extended Position
Low Mileage U-Joint Failure	1	1	1 6	1	1	2 11		4	5	1 6 14 7												
Repeat U-Joint Failure	1	**1**	1 6	**1**	1	**2 11**	13 3	**4**	5	1 6 14 7												
End Galling Of Cross Trunnion & Bearing Cup								4			1 8 11	1 6	7	7	7							
Frettage (Also: False Brinelling, Wear Oxidation, Friction Oxidation, & Chaffing Fatigue)											1 8 11	1 5 6 8				**10**	18 25 22 26	**11 13**	11 12 13			
Bearing Race O.D. Seizure in Yoke Cross Holes																				9		
Slip Spline Seizures	1	**1**	1	**1**	1						8	1 6 8									1 5 6 8 14	**15**
Slip Spline Galling											8	1 6 8										**15**
Slip Spline O.D. Wear at Extremities and at 180°																						**15**
Slip Spline Shaft or Tube Broken in Torsion																						
Shaft Broken In Bending																						
Tube Split in Longitudinal Seam Weld																						
Tube Circle Weld Failure																						
Yoke Broken in Hub																						
Yoke Broke at Ear Tip																						
Broken Cross or Cups																						
Needle Rollers Brinelled Into Cups and Cross Trunnion																						
Shaft Support Brg. Failure	11 32	11				11 32					11 32											
Shaft Support Rubber Insulator Failure																						
Transmission Extension Bell Housing & Clutch Housing Failures																						
Vibrations																						
Low Gear Shudder																						
Vibrations In Short Speed Ranges Under Full Drive or Full Coast																						

1. See Spicer Universal Joint Lube specs #3306.
2. If new kit…Replace seals. If used…Replace complete kit.
3. Replace yoke if distorted.
4. Reduce U-Joint's continuous running angles.
5. Replace with higher capacity U-joint and driveshaft.
6. Use Hi-Temp grease.
7. Check U-joint flex effort. If sticks, binds or grabs…Replace U-Joint kit. If still sticks, binds or grabs…Check yokes for span, lug squareness, cross hole alignment, etc. Replace as needed.
8. Check components. If serviceable…Clean and relubricate per lube specs. If not serviceable…Replace.
9. No immediate fix. Anti-seize lubricant on bearing O.D. will initially help.
10. Re-align for a minimum 1° running angle.
11. Replace.
12. Replace roller lock assembly.
13. Yoke deflections under load…Use larger joint.
14. Use Spicer "Glidecote" on slip spline.
15. Increase driveshaft assembly length. Position slip spline head towards U-joint.
16. Check for male slip member with longer spline.
17. Design is inadequate for application.

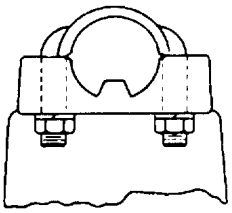
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18. Install two piece driveshaft with shaft support bearing.
19. Use larger diameter tube.
20. Design limitation due to axle's or transmission shaft's requirement.
21. Shim drivetrain components to equalize U-joint angles.
22. Straighten and balance.
23. Check with transmission or axle manufacturer …Replace shaft bearing.
24. Revise power plant mounting scheme.
25. Check U-joint flex effort for looseness.
26. Torque bearing retention to spec.
27. Use wide angle yokes.
28. Check installed length. Adjust driveshaft length to provide proper slip conditions.
29. Re-align mounting bracket to frame cross member and eliminate interference.
30. Replace U-joint kits.
31. Replace tube.
32. If normal wear…Replace.
33. Check O.E.M. maintenance manual or alignment arrows on slip yoke and male slip shaft for correct yoke phasing.
34. If 2 piece-3JT driveshafts…Adjust shaft lengths to 50-50 or 40-60 split.
35. Re-position shaft support bearing.

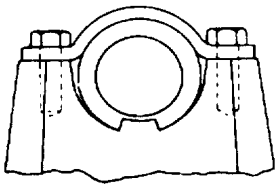
SPICER UNIVERSAL JOINT KIT ATTACHING HARDWARE & TORQUE SPECIFICATIONS CHART

U-BOLT



Series	Spicer Kit No.	U-Bolt Ass'ys.	Recommended Nut Torque
1280	5-200X	2-94-28X	14-17 Lb.ft
1310	5-153X	2-94-28X	14-17 Lb.ft
1330	5-213X	2-94-28X	14-17 Lb.ft
1350	5-178X	3-94-18X	20-24 Lb.ft
1410	5-160X	3-94-18X	20-24 Lb.ft
1480	5-188X	3-94-28X	32-37 Lb.ft
1550	5-155X	3-94-28X	32-37 Lb.ft

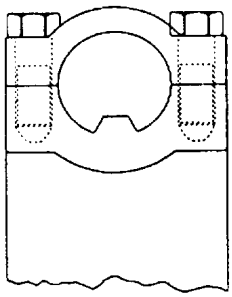
BEARING STRAP



WARNING: Bearing Strap Retaining Bolts Should **NOT** Be Reused.

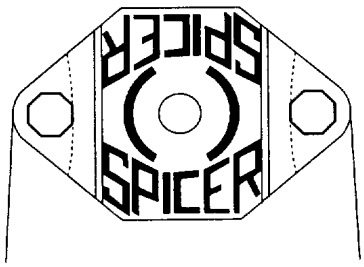
Series	Spicer Kit No.	Strap Kit Ass'ys	Recommended Bolt Torque
SPL90	SPL90X	90-70-28X	45-60 Lb.ft
1210	5-443X	2-70-18X	13-18 Lb.ft
1280	5-200X	2-70-18X	13-18 Lb.ft
1310	5-153X	2-70-18X	13-18 Lb.ft
1330	5-213X	2-70-18X	13-18 Lb.ft
1350	5-178X	3-70-28X	30-35 Lb.ft
1410	5-160X	3-70-28X	30-35 Lb.ft
1480	5-188X	3-70-38X	55-60 Lb.ft
1550	5-155X	3-70-38X	55-60 Lb.ft
1610	5-438X	5-70-38X	55-60 Lb.ft
1710	5-515X	6.5-70-18X	130-165 Lb.ft
1760	5-469X	6.5-70-18X	130-135 Lb.ft
1810	5-510X	6.5-70-18X	130-135 Lb.ft

CAP & BOLT



Series	Spicer Kit No.	Cap & bolt Ass'ys.	Recommended Bolt Torque
1650	5-165X	5-70-18X	77-103 Lb.ft
1850	5-185X	8-70-18X	110-147 Lb.ft
1850	5-227X	8-70-18X	110-147 Lb.ft
1910	5-316X	N.S.S.	110-147 Lb.ft
1950	5-339X	9-70-18X	271-362 Lb.ft
2010	5-371X	N.S.S.	102-118 Lb.ft
2050	5-340X	9-70-28X	744-844 Lb.ft
2110	5-372X	N.S.S.	171-197 Lb.ft
2150	5-298X	9-70-38X	744-844 Lb.ft
2210	5-373X	N.S.S.	260-298 Lb.ft

BEARING PLATE



WARNING: Self Locking Bolts Should **NOT** Be Reused

Series	Spicer Kit No.	Bolt Part No.	Lockstrap Part No.	Recommended Bolt Torque
1610	*5-279X	5-73-709	N.A.	26-35 Lb.ft
1710	*5-280X	6-73-209	N.A.	38-48 Lb.ft
1760	*5-407X	6-73-209	N.A.	38-48 Lb.ft
1810	*5-281X	6-73-209	N.A.	38-48 Lb.ft
1880	*5-308X	7-73-315	N.A.	60-70 Lb.ft
New part nos. for kits with lockstraps available after Spring, 1994				
1610	5-654X	5-73-109	98-1741	17-24 Lb.ft
1710	5-656X	6-73-109	230323	32-42 Lb.ft
1760	5-658X	6-73-109	230323	32-42 Lb.ft
1810	5-660X	6-73-109	230323	32-42 Lb.ft
1880	5-668X	7-73-115	231009	50-66 Lb.ft

*THES U-JOINT KITS WILL USE SELF-LOOKING BOLTS WITH LOCK PATCH TM AFTER SPRING, 1994. A LOCKSTRAP WILL NO LONGER BE NEEDED.

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SPICER FLANCE BOLT INFORMATION

Series	Part Numbers			Diameter, Thread, & Length Under Head	Recommended Torque
	Bolt	Washer	Nut		
1000/1100	5-73-414	500357-10	231421-2	.312" - 24 x 0.875"	22-26 Lb. Ft.
1350/1410/1550	5-73-2216	"	"	- 24 x 1.000"	"
1550 *	5-73-1125	"	"	- 24 x 1.562"	"
1280/1310	6-73-316	500357-11	231421-3	.375" - 24 x 1.000"	40-48 Lb. Ft.
SPL90/1610	6-73-1219	"	"	- 24 x 1.188"	"
1710	6-73-220	"	"	- 24 x 1.250"	"
SPL90/1610 *	6-73-325	"	"	- 24 x 1.562"	"
1710 *	6-73-1227	"	"	- 24 x 1.688"	"
1350/1410	7-73-219	500357-12	231421-4	.438" - 20 x 1.188"	63-75 Lb. Ft.
1810	7-73-122	"	"	- 20 x 1.375"	"
1350/1410 *	7-73-126	"	"	- 20 x 1.625"	"
1760/1810 *	7-73-228	"	"	- 20 x 1.750"	"
1480/1550	8-73-122	500357-13	231421-5	.500" - 20 x 1.375"	97-116 Lb. Ft.
1650	8-73-123	(Bearing Race Cap)		- 20 x 1.438"	"
1480/1550 *	8-73-228	500357-13	231421-5	- 20 x 1.750"	"
1880/1910	10-73-131	500358-15	231421-7	.625" - 18 x 1.938"	194-232 Lb. Ft.
1950	12-73-140	500358-17	231421-8	.750" - 16 x 2.500"	341-409 Lb. Ft.
2010	9.55-73-11	——	231483	18mm x 75mm	277-319 Lb. Ft.
2050	14-73-264	500358-19	231421-9	.875" - 9 x 3.500"	543-652 Lb. Ft.
2110	9.60-73-11	——	231482	20mm x 80mm	397-457 Lb. Ft.
2150	16-73-164	500358-21	231421-10	1.000" - 12 x 4.000"	810-976 Lb. Ft.
2210	9.65-73-11	——	231481	22mm x 90mm	534-575 Lb. Ft.

* - Tru Stop Brake Applications

Spicer Flange Bolts are **Special, Heat Treated, Grade 8 Bolts.**
Do not substitute inferior grade bolts.

Dana Corporation
Drivetrain Service Division
P.O. Box 321
Toledo, Ohio 43697-0321

3119-5 DSD 4/94

SPICER®

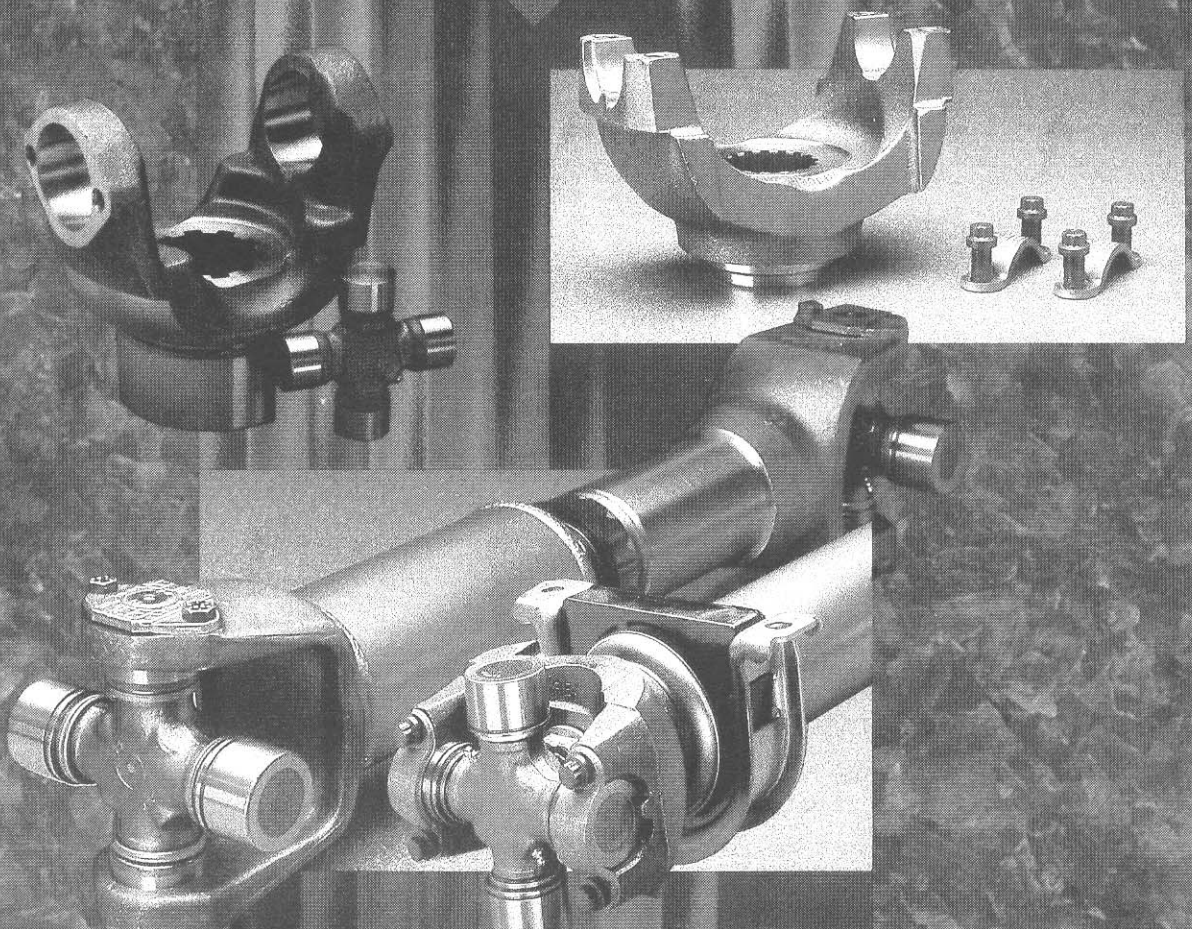
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SERVICE MANUAL

SPICER® UNIVERSAL JOINTS AND DRIVESHAFTS

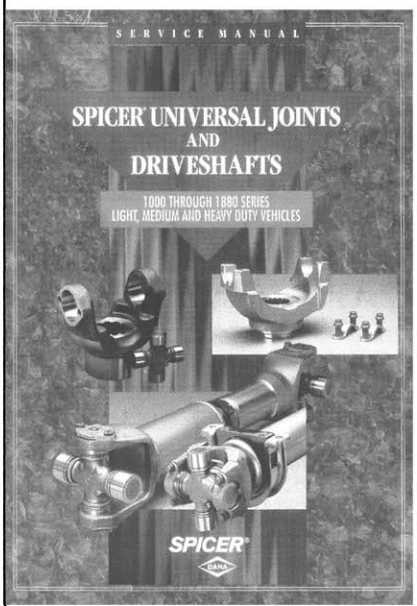
1000 THROUGH 1880 SERIES
LIGHT, MEDIUM AND HEAVY DUTY VEHICLES



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ABOUT THIS MANUAL...

Because of the many similarities between light, medium and heavy duty drivelines, this manual will present information as it relates to all three types. However, there are some basic differences among the three. Where this occurs it will be clearly noted.

Failure to follow procedures, recommendations and caution statements outlined in this manual may void the product warranty and could result in serious personal injury.

INDEX

Function of driveshaft 1
Components of driveshaft 2
Construction of driveshaft 4
Inspection and Lubrication 4
Service Instructions
Heavy Duty – removal, disassembly, reassembly and installation 8
Medium and Light Duty –
removal, disassembly, reassembly and installation 15
Double Cardan Constant Velocity Type Joints –
lubrication, disassembly and reassembly 18
Spicer Lite™ Aluminum and Graph-Lite™ Driveshafts –
lubrication, disassembly and reassembly 22
Rebuilding and Balancing 24
Checking Driveshaft Angles 25
Field Problem Analysis 28
Troubleshooting 30
Glossary 32

SAFETY PRECAUTIONS

Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

Do not work on the shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

In order to avoid becoming entangled, install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install guard.

Install a support strap when servicing a driveshaft to prevent personal injury. See pages 9, 13, 15, & 17.

A serious or fatal injury can occur...
- ▲ if you lack proper training
- ▲ if you fail to follow proper procedures
- ▲ if you do not use proper tools and safety equipment



- ▲ if you assemble driveline components improperly
- ▲ if you use incompatible driveline components
- ▲ if you use worn-out or damaged driveline components
- ▲ if you use driveline components in a non-approved application

This manual contains detailed safety instructions. Read, understand and follow this manual.
- ▲ Get proper training
- ▲ Learn and follow safe operating procedures
- ▲ Use proper tools and safety equipment
- ▲ Use proper components in good condition

Refer to the pages listed for more detailed instructions.
- ▲ Inspection and Lubrication – See pages 4 - 8
- ▲ Servicing the Driveshaft
  - – heavy duty – pages 8 - 15
  - – light and medium duty – pages 15 - 17
  - – double cardan driveshafts – pages 18 - 21
- ▲ Straightening and Balancing – See page 24

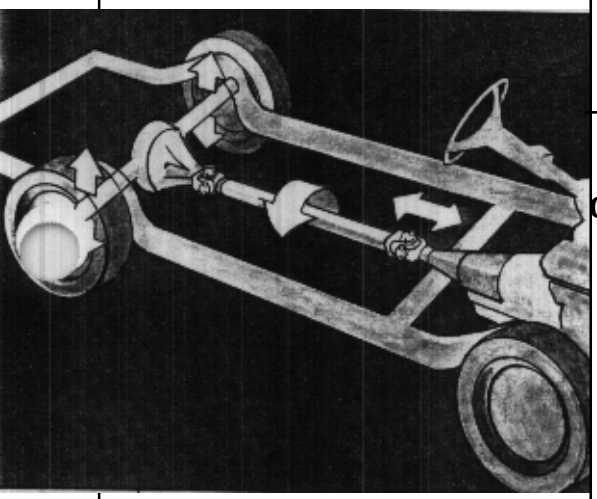
This symbol warns of possible personal injury.

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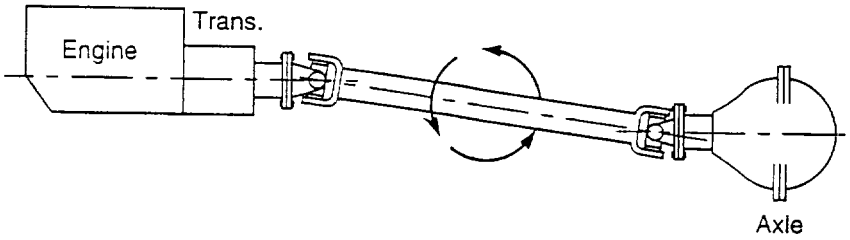
THE FUNCTION OF A DRIVESHAFT

The basic function of a driveshaft is to transmit power from one point to another in a smooth and continuous action. In automobiles, trucks and construction equipment, the drivetrain is designed to send torque through an angle from the transmission to the axle (or auxiliary transmission).

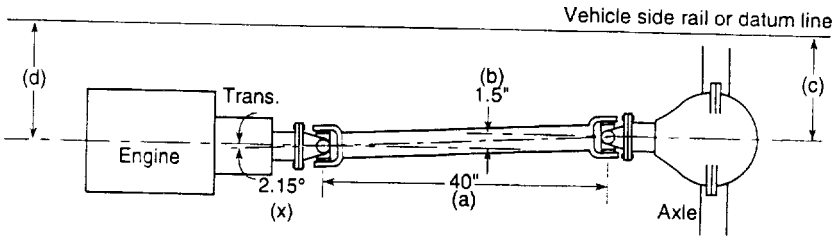
The driveshaft must operate through constantly changing relative angles between the transmission and axle. It must also be capable of changing length while transmitting torque. The axle of a vehicle is not attached directly to the frame, but rides suspended by springs in an irregular, floating motion.



This means the driveshaft must be able to contract, expand and change operating angles when going over bumps or depressions. This is accomplished through universal joints, which permit the driveshaft to operate at different angles, and slip joints, which permit contraction or expansion to take place.



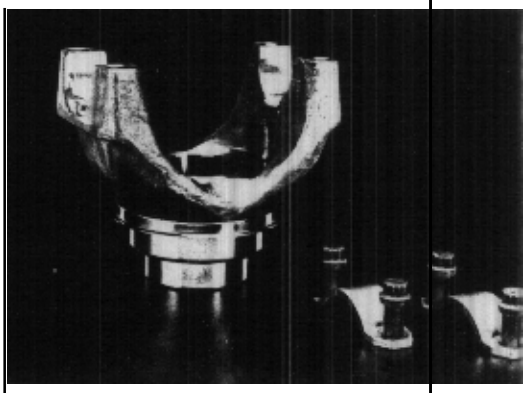
The geometry of a driveshaft in side view - vertical offset



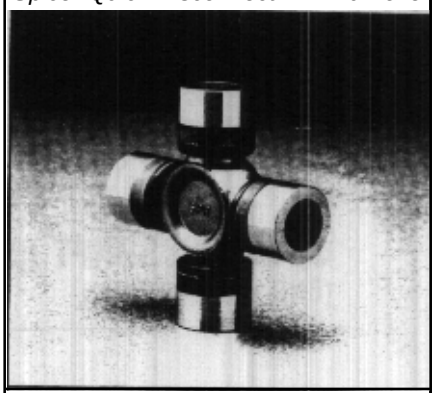
The geometry of a driveshaft in plan view - horizontal offset

CONSTRUCTION OF A DRIVESHAFTS (ALL TYPES)

To transmit required torque loads, the driveshaft must be durable and strong. Forged steel and high strength cast yokes, including the Spicer Quick Disconnect™ end yoke for heavy duty necessary rigidity required to maintain bearing alignment under torque loads. Spicer heavy-duty u-joint kits and Low Effort™ light-duty u-joint kits are designed to give extended driveshaft life.



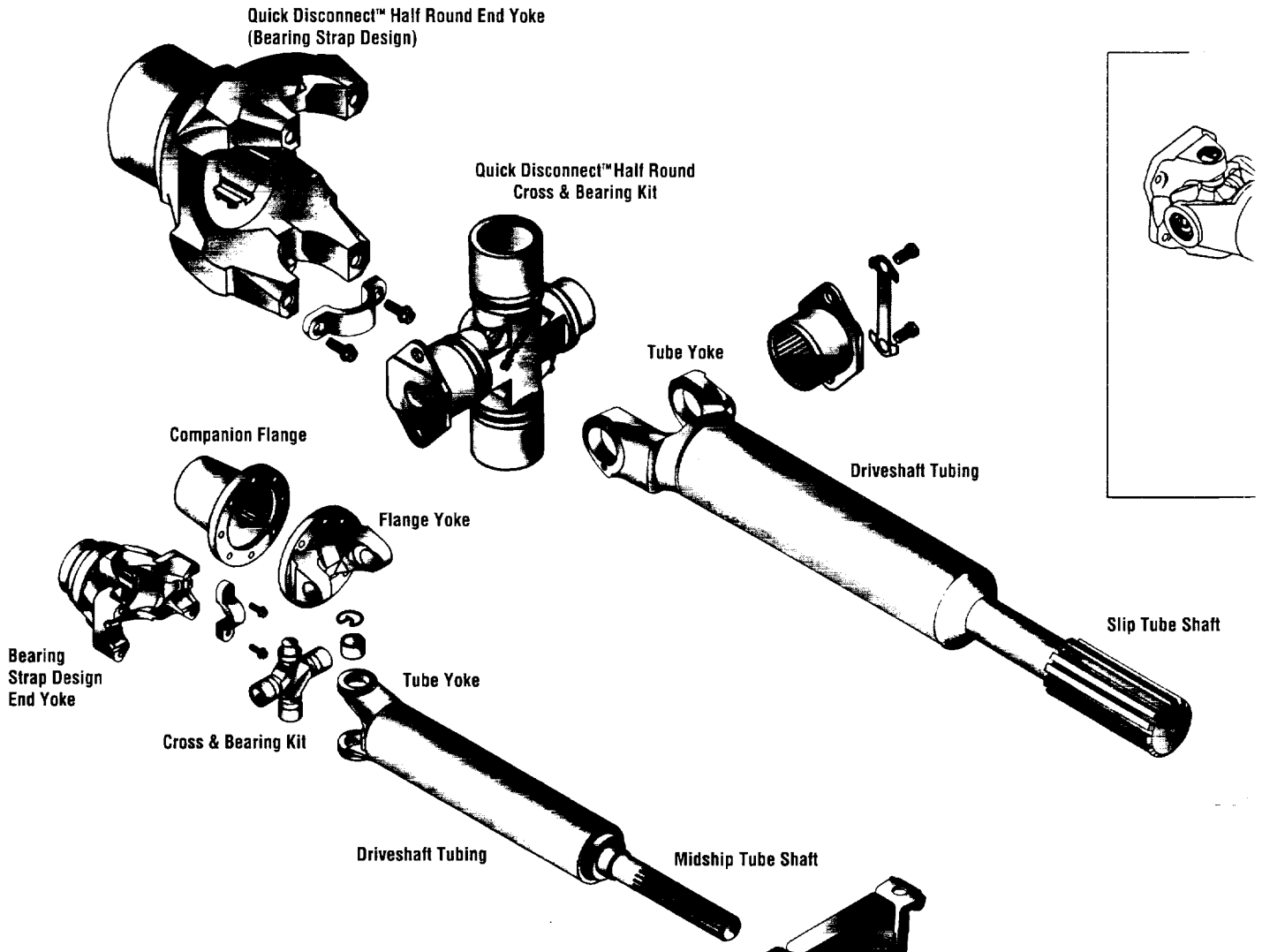
Spicer Quick Disconnect ™ End Yoke



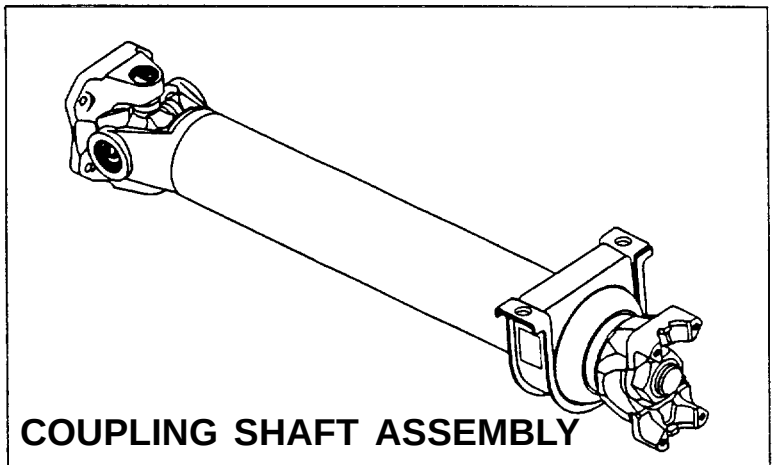
Spicer Low Effort™ U-Joint Kit

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DRIVESHAFTS PARTS LISTING

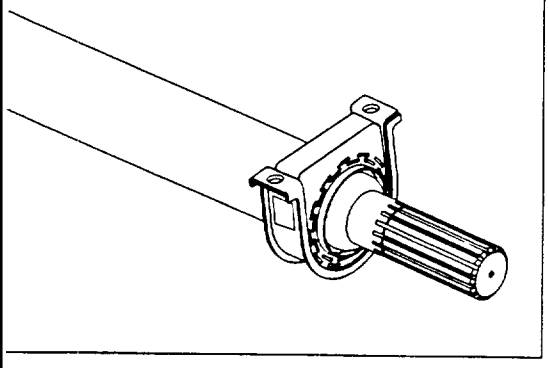


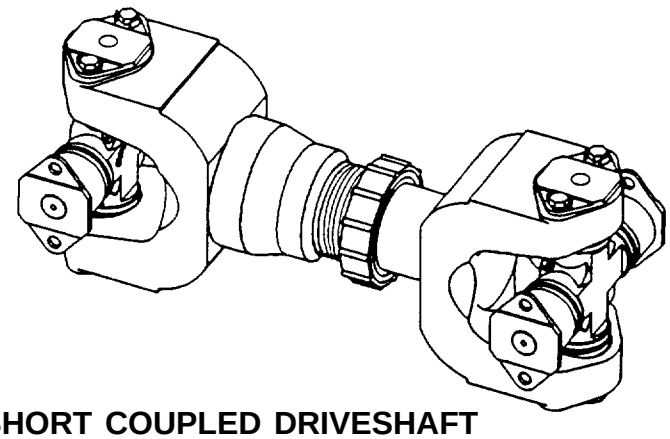
3 JOINT ASSEMBLY DRIVESHAFT



COUPLING SHAFT ASSEMBLY
(END YOKE STYLE)

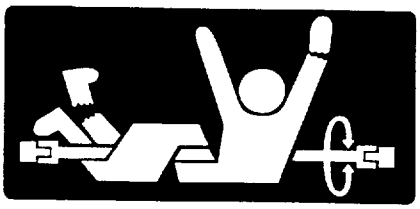
COUPLING SHAFT ASSEMBLY
(SLIP YOKE STYLE)



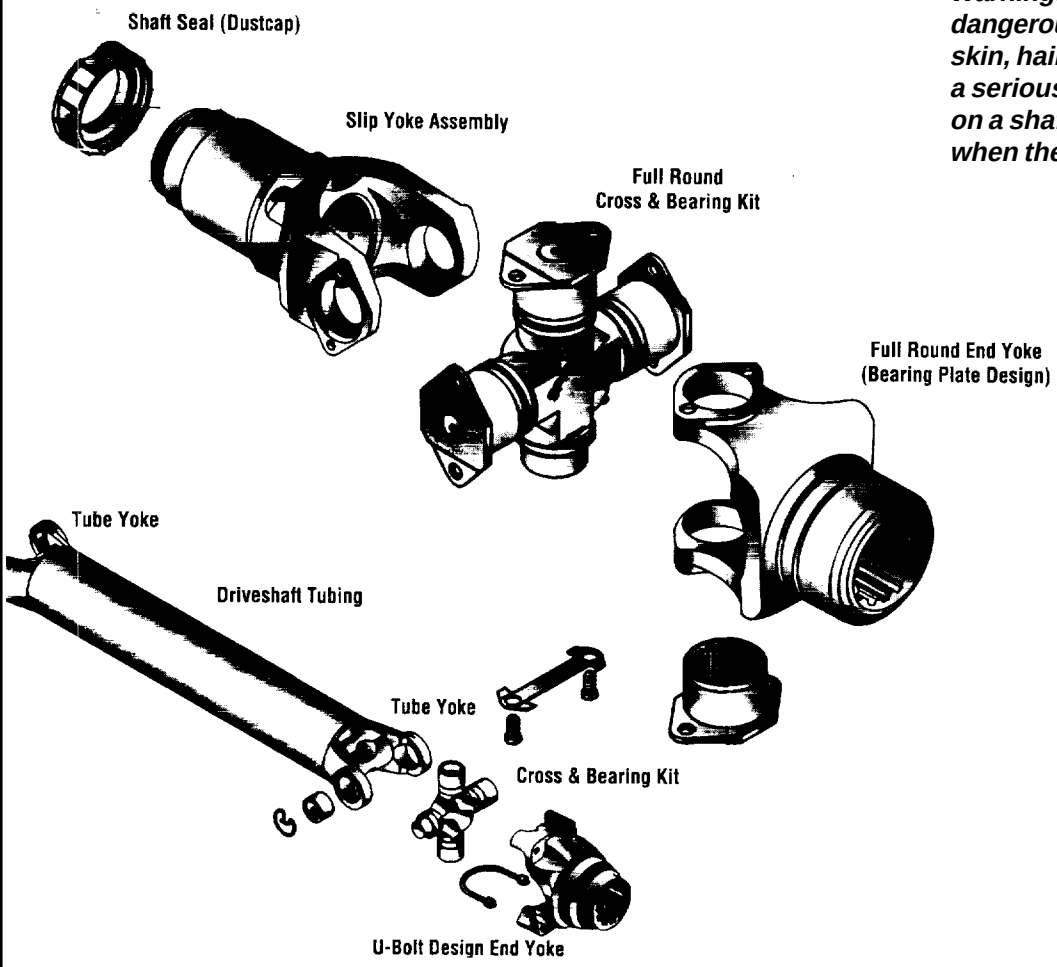


SHORT COUPLED DRIVESHAFT

2 JOINT ASSEMBLY DRIVESHAFT



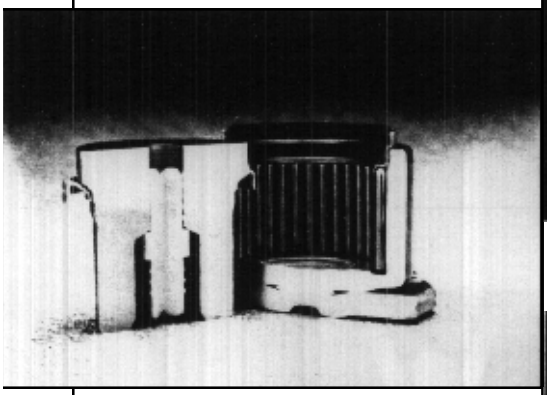
Warning: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause a serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.



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CONSTRUCTION OF A DRIVESHAFT

Anti-friction bearings are used to withstand required oscillating loads while the driveshaft is rotating at high speeds. The needle roller bearings on the trunnions of the cross carry large loads and are used because of their high capacity in a limited space.

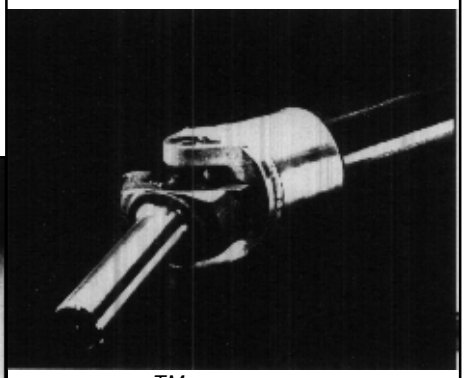


Spicer Positive Purging valve and exclusive crowned bearing race inside diameter.

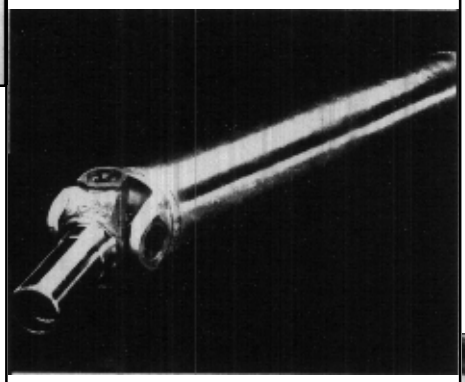
Spicer's exclusive bearing assembly inside diameter crowning and tapered thrust pads distribute loads more evenly on needle roller bearings and cross trunnion ends to significantly reduce end galling. Bearing assemblies are individually sealed to provide retention of lubricants and prevent the entry of foreign material. If lubricants become contaminated with water or abrasive matter, needle roller bearing life is seriously affected.

Abrasive material is a major problem when a vehicle operates under conditions of extreme moisture and dirt. To combat this problem, synthetic rubber seals were developed and resulted in increased life, ability to withstand high temperature and a less critical relubrication cycle for driveshafts.

Special high-strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. In addition to steel tubing in use for many years now, Spicer Lite™ aluminum and Graph-Lite™ composite (aluminum wrapped in graphite) driveshafts have been developed to meet the vehicular industry needs.



Spicer Lite™ Aluminum Driveshaft



Spicer Graph™ Lite Driveshaft

The sliding splines between slip joint and permanent joint must support the driveshaft and be capable of sliding under full torque loads. To aid in this axial or slip movement, Spicer Glidecote™ was developed to reduce sliding friction thereby reducing thrust loads under high torque. This non-metallic coating also prevents spline galling and extends spline life.

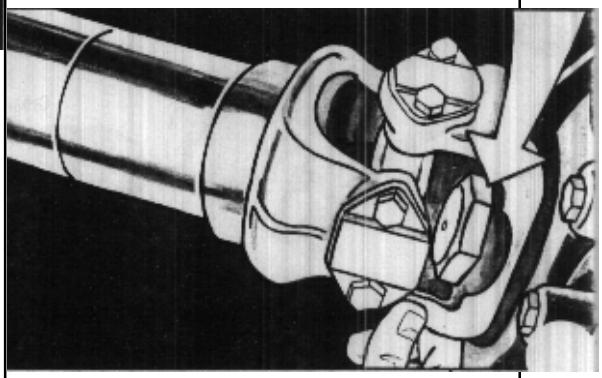
INSPECTING AND LUBRICATING THE DRIVESHAFT (All Types)



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

INSPECTION

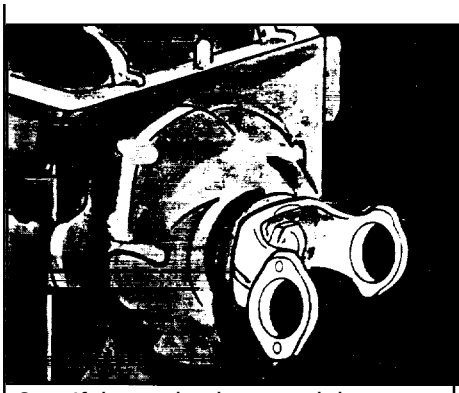
To keep a vehicle operating smoothly and economically the driveshaft must be carefully inspected at regular intervals. Vibrations and u-joint and shaft support (center) bearing problems are caused by such things as loose end yokes, excessive radial (side to side or up and down) looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.



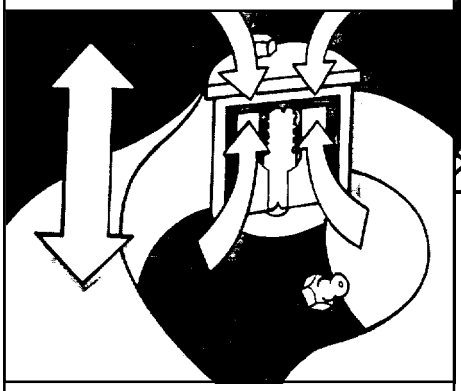
1. Check the output and input end yokes on both the transmission and axle, or axles, for looseness. If loose, disconnect the driveshaft and retorque the end yoke retaining nut to specification. If yoke replacement is required, check for manufacturer's recommendation regarding replacement frequency of the end yoke retaining nut.

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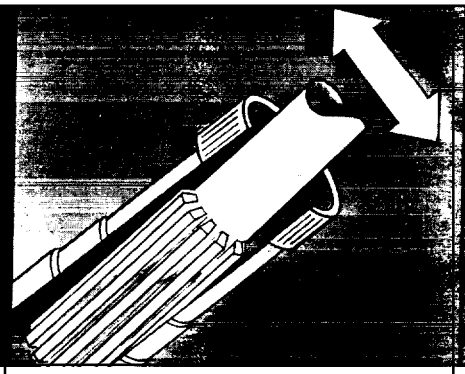
INSPECTING AND LUBRICATING THE DRIVESHAFT (ALL TYPES)



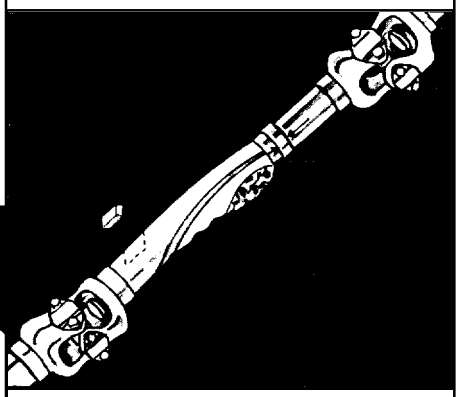
2. If the end yokes are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shafts in their respective bearings. Consult transmission and axle manufacturer's specifications for acceptable radial looseness limits and method of checking.



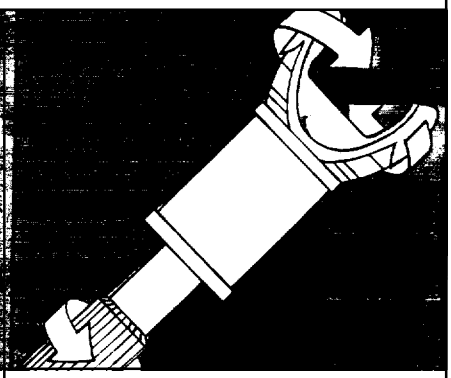
3. Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006 inches maximum.



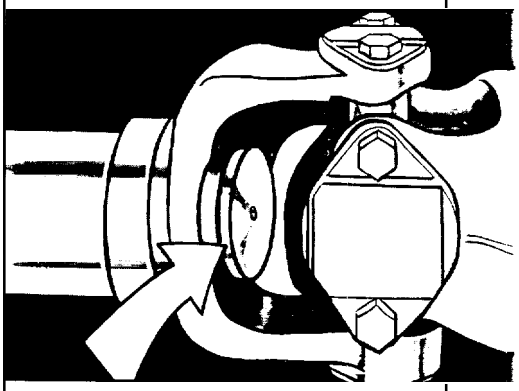
4. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .077 inches.



5. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft, such as undercoat or concrete. If found, they should be removed carefully to avoid damage to the driveshaft.



6. If runout readings are required, they should be taken with the driveshaft mounted in the vehicle with the transmission in neutral and the axle shafts pulled, or by jacking rear wheels off the ground and placing axles on jack stands. This will allow rotating the driveshaft by hand to check indicator readings. The runout readings taken at the various locations should not exceed an additional 0.010 T.I.R. over the manufacturer's specified runout. (See page 24)



7. For an inboard and outboard slip yoke assembly design, check to be sure the plug is not loose or missing ... if it is, repair or replace it. Loose or missing plugs are commonly caused by not enough driveshaft slip capability.

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LUBRICATION

Among the most common causes of joint and slip problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately relubricated at recommended intervals will normally meet or exceed vehicle operation requirements. Relubrication flushes the joints thus removing abrasive contaminants from the bearings.

LUBRICANTS FOR UNIVERSAL JOINTS

For a standard application, use a good quality E.P. (extreme pressure) grease (Timkin Test Load 45 Ibs. min) meeting *N.L.G.I. Grade 2 specifications. Grease must have an operating range of +325°F/+163°C to -10°F/-23°C and be compatible with commonly used multi-purpose greases such as Lithium Soap Types.
For driveshaft applications involving shaft speeds below 500 RPM, a mineral oil in the SAE 140 to 250 viscosity range should be used.
Consult your local lubricant source for greases that meet these specifications.

N.L.G.I. *E.P. Grade 2 Lubricating Grease

*National Lubricating Grease Institute

INITIAL LUBRICATION AND RELUBE CYCLES

Spicer replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the yokes. Each cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease, filling all the cavities between the needle rollers and applying a liberal grease coating on the bottom of each bearing assembly. Too much grease may cause hydraulic "lock-up", making installation difficult. After the kits are installed into the yokes and prior to placing into service, they should be relubed, through the lube fitting, using the same grease.



Relubrication cycles vary depending on the service requirements and operating conditions of the vehicle. A recommended relube cycle for various types of service is shown below.

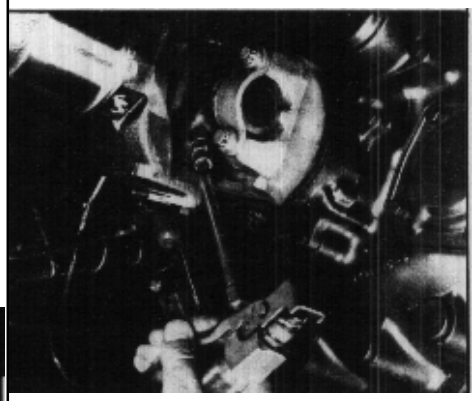
NOTE: On-highway is defined as all applications equiring less than 10% of operating time on gravel, dirt or unimproved roads. If longer than 10% operating time off-highway, use off-highway recommendations.

TYPE 0F SERVICE	MILES or	TIME
CITY	5000/8000	3 MONTHS
ON HIGHWAY (LINE-HAUL)	10,000/15,000	3 MONTHS
ON HIGHWAY LINE-HAUL	10,000/15,000	30 DAYS
ON/OFF HIGHWAY	5,000/8,000	3 MONTHS
OFF HIGHWAY/ INDUSTRIAL		500/200 HRS.

Relubrication cycles for off highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication should occur every 500 hours for normal service and every 200 hours for continuous service or severe environmental condition.

LUBRICATION PROCEDURE FOR U-JOINTS

(Except Constant Velocity Type Joints)





WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take off and/or shaft are still exposed after installation, install a guard.

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INSPECTING AND LUBRICATING

1. Use the proper lubricant to purge all four seals of each u-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Spicer seals are made to be popped.

2. On center twin zerk design or single zerk kits, if any of the seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. For light-duty kits, check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

3. Because of the superior sealing capability of the Spicer Seal design on the 1610,1710,1760,1810 and 1880 Series, there will occasionally be one or more bearing assembly seals that will not purge. Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1/16 inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

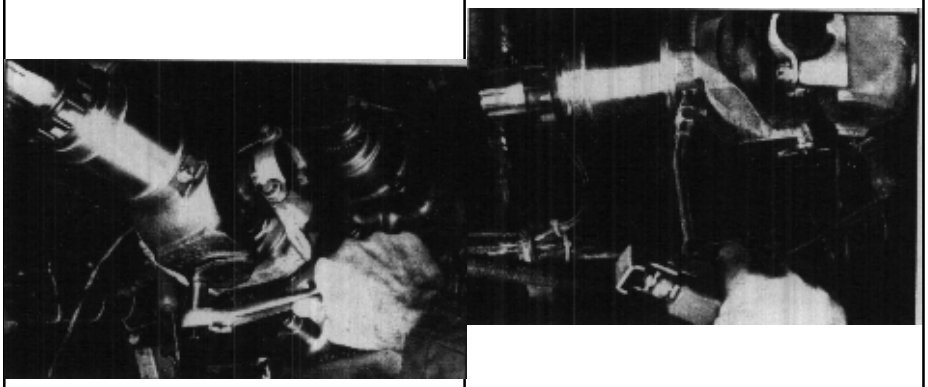
4. Install new bolts and torque to specifications.

CAUTION: *Retaining bolts should not be reused. If loosening or removal of bolts is necessary, install new bolts and torque to specification.*

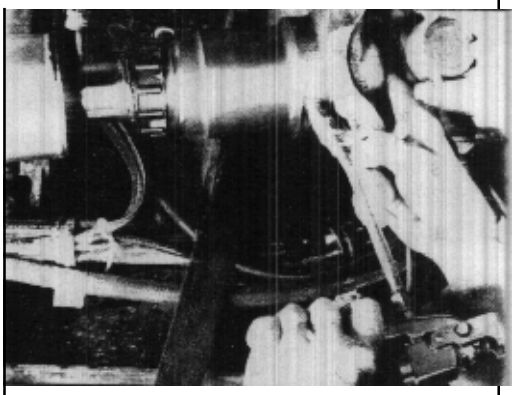
LUBRICATION FOR SLIP SPLINES

The lubricant used for u-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting N.L.G.I. Grade 2 specifications.

Relube splines at the intervals recommended in the chart for u-joints.



1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.



2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

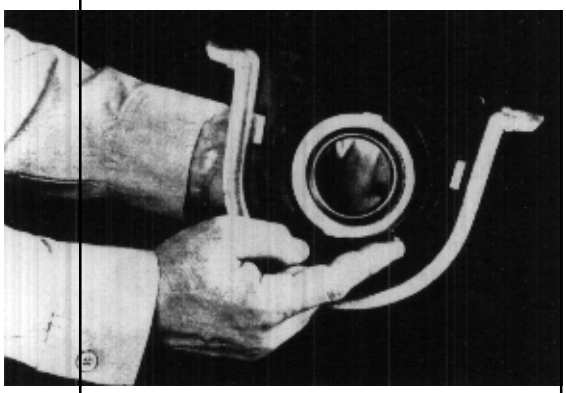
CAUTION*: In cold temperatures be sure to drive the vehicle immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.*

SHAFT SUPPORT BEARING ASSEMBLIES

Bearing manufacturers do the initial lubrication and all Spicer shaft support (center) bearings are lubed for life. When replacing a shaft support bearing assembly, be sure to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. Enough grease must be put in to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants must be waterproof. The following chart lists recommended waterproof lubricants for use with center bearings.

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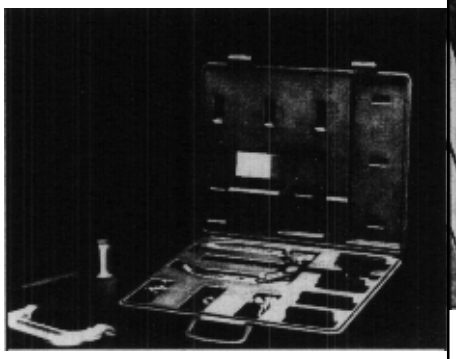
SERVICING THE DRIVESHAFT



***NOTE**: There are numerous instances when special lubrication is required by vehicle specification or customer request. The lubrication recommendations listed in this manual are what Spicer U-Joint engineers suggest. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.*

Recommended Lubricants
-Source

Rykon Premium No. 3
-Amoco Oil Company
Sun C-34 Grease (Cup No. 4)
-Sun Oil Company
Amolith 8516
-Amoco Oil Company
Van Talgar No. 4
-Exxon Company



SERVICING THE DRIVESHAFT

Heavy Duty Application

Cross and Bearing Kit Replacement
Bearing Plate Design

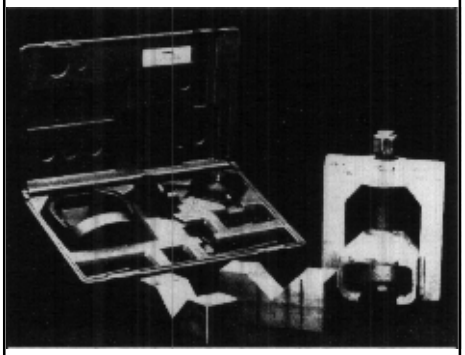
Full Round and Quick Disconnect End Yoke Designs

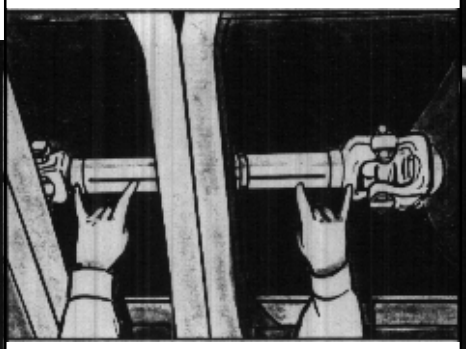
Special Tools:

Torque wrench (125 lb./ft.)
Journal locator
U-joint press
V-block
* Alignment bar/No Go wear gauge
Common hand tools

One of the following is recommended:
Owatonna tool kit (#7057) (Two-jaw puller)
Tiger tool kit
JJAG tool kit
J & J tool kit

*Available only from Dana Corporation Spicer Service Representatives.





***NOTE**: Before removal of the driveshaft set the brakes, block the wheels, and mark the slip yoke assembly and tube shaft with a marking stick or paint to assure proper alignment when reassembled. This is known as keeping the driveshaft yokes "In Phase."*

CAUTION: Never heat components or use sledge hammers and floor jacks to disassemble driveshaft. This can result in damaged, weakened or bent components.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

REMOVAL

(Full Round End Yoke Style)

1. The method of driveshaft removal should be one that assures safety and ease of removal to the mechanic without damage to the driveshaft, transmission or axle component. Suggested method is use of a u-joint puller: Owatonna tool kit #7057, Tiger tool kit, JJAG tool kit, or J&J tool kit.

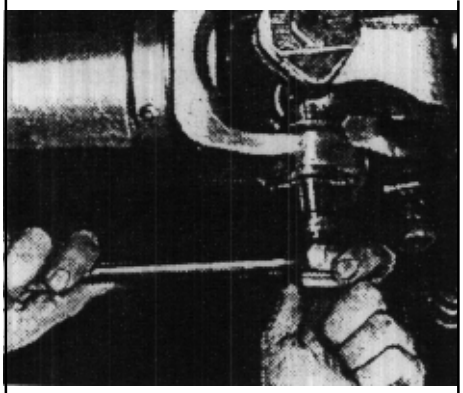


2. Bend tabs of lock straps away from bolt heads with

***NOTE:** The self-locking bolt design for full-round end yokes uses serrated bolts with lock patch and DOES NOT require a lock strap.*

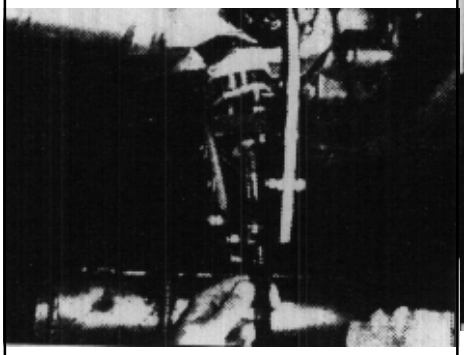
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SERVICING THE DRIVESHAFT

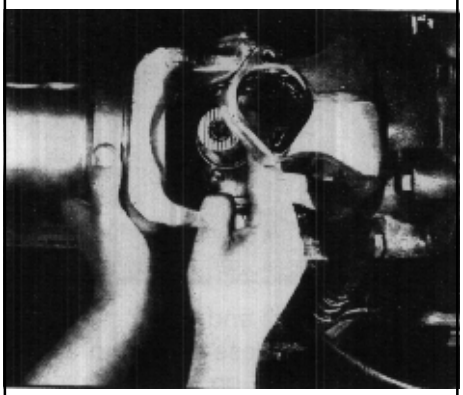


3. Remove bolts (four) from each bearing assembly connected to the transmission and axle end yoke.

CAUTION: *If a u-joint kit is to be reused, care should be taken not to nick trunnions or damage slingers.*



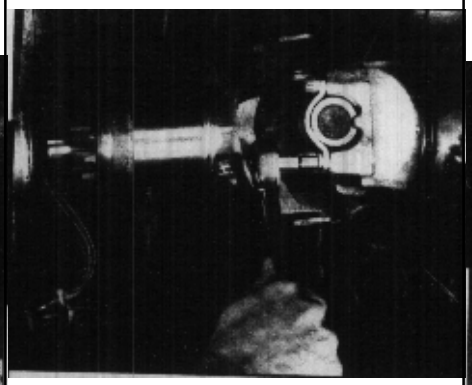
4. Remove bearing assemblies from the yoke cross holes using a u-joint removal tool kit.



5. Free the trunnion from the end yoke by tilting the trunnion and collapsing the driveshaft.

NOTE*: If only one end of the driveshaft requires service, disconnect that end, unscrew the slip shaft seal (dustcap) from the slip yoke assembly, and then pull apart or slide off the assembly. When removing the entire driveshaft, disassemble one end at a time, laying the disconnected end on the floor carefully. When reassembling, BE SURE that the marks on the shaft and slip joint are in line to keep the driveshaft yokes in phase.*

REMOVAL (Quick Disconnect™ Half Round End Yoke Style)



For half round end yoke disassembly install a nylon support strap, remove the bearing strap and release the driveshaft.

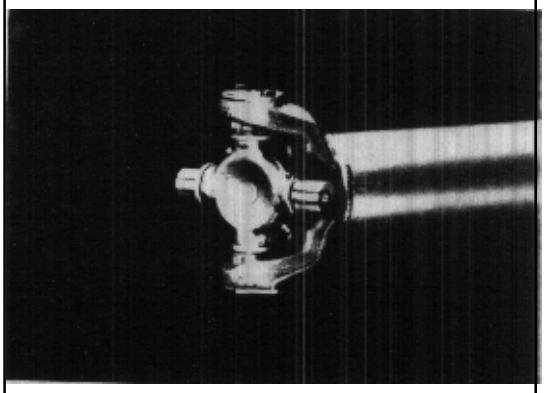
REMOVAL (Flange Yoke Style)

1. Install nylon support strap. Loosen and remove nuts and bolts securing flange yoke to transmission or axle companion flange. and the tube yoke (and

2. Holding driveshaft firmly, tap loose and compress from one end and lower floor.

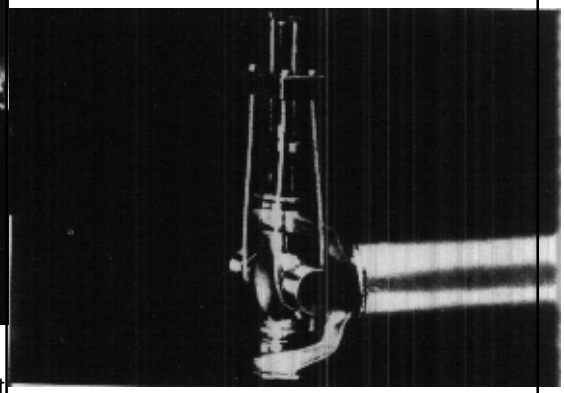
3. Repeat at other end.

DISASSEMBLY (Full Round Style)



1. Place the driveshaft in v-blocks to remove the cross and bearing assemblies.

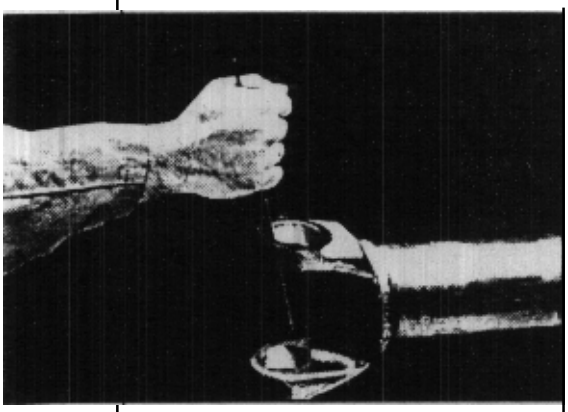
CAUTION: *Do not distort the tube with excessive grip*

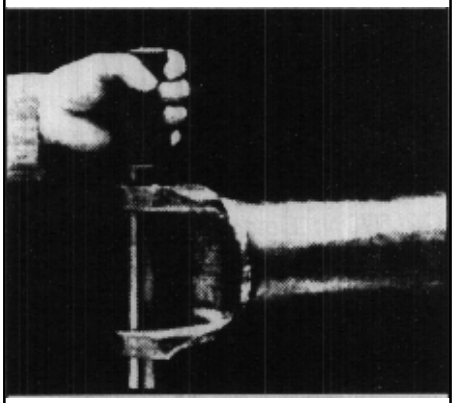


2. Completely remove the cross and bearings from both ends of the driveshaft by disassembling the bearing assemblies from the slip yoke and the tube yoke (and flange yoke where applicable) using a tool kit.

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SERVICING THE DRIVESHAFT





3. After removing the cross and bearings, both ends, inspect the cross hole surfaces for damage or raised metal. Raised metal can be removed with a rat tail or half round file and emery cloth. Check the yoke lug crossholes with a No-Go Wear Gauge and then use a Spicer Alignment Bar to inspect for damage by sliding through both cross holes simultaneously. The alignment bar will identify yoke lugs that have taken a set because of excessive torque. The raised metal or distorted lugs can be a cause of premature cross and bearing problems.

   At this time, clean the cross holes of the yokes on the transmission and axle and inspect with an alignment bar gauge as described above.

If after proper cleaning of the cross holes the alignment bar will not pass through simultaneously. the yoke lugs are distorted and the yoke or yokes should be replaced.

***CAUTION**: Use a journal locator to avoid nicking journal cross trunnions or damaging of oil seal slingers.*

DISASSEMBLY

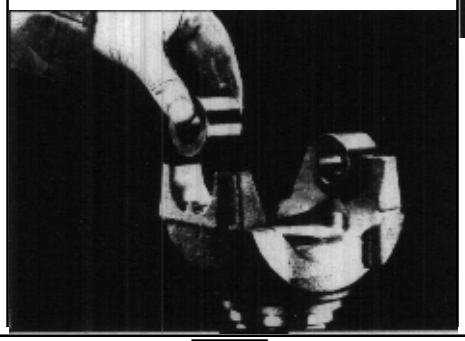
(Quick Disconnect Half Round End Yoke Style)

1. Place the driveshaft in v-blocks to remove the cross and bearing assemblies.

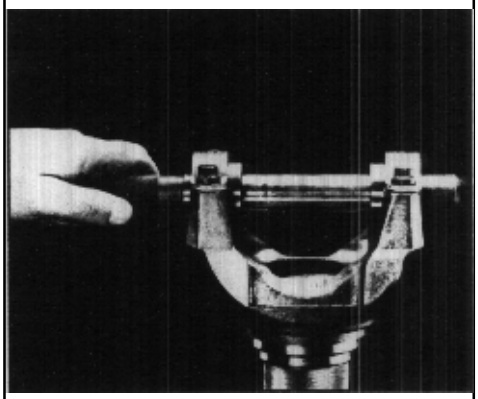
2. Completely remove the cross and bearings from boths ends of the driveshaft by removing the bolts and bearing straps.

3. Remove the end yoke from the driveshaft and place in a soft jawed vise to inspect the crosshole surfaces. Raised metal can be removed with a rat tail or half round file. Emery cloth should be used to remove all rust and corrosion from crosshole bores.

4. Check the yoke for crosshole alignment using the Spicer Alignment gauge. Place the correct bushing in each lug ear allowing a .03 to .06 clearance between the tang and the bushing.

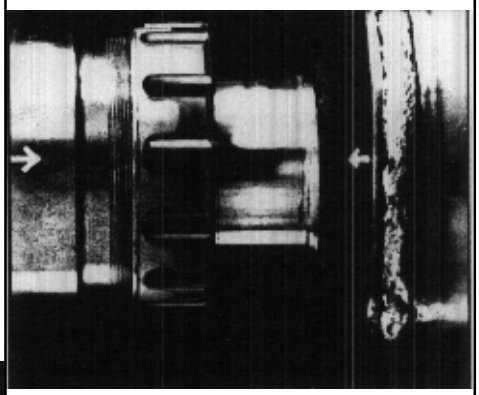


Assemble bearing straps and bolts, tightening bolts a minimum of 30 ft. lbs. Insert the alignment gauge into one crosshole. If the gauge enters and passes through the opposite crosshole, alignment is correct. If the alignment gauge will not enter the opposite crosshole reinspect for burrs.



If, after proper cleaning, the alignment gauge still does not pass through both crossholes, the yoke lugs are distorted and the yoke should be replaced.

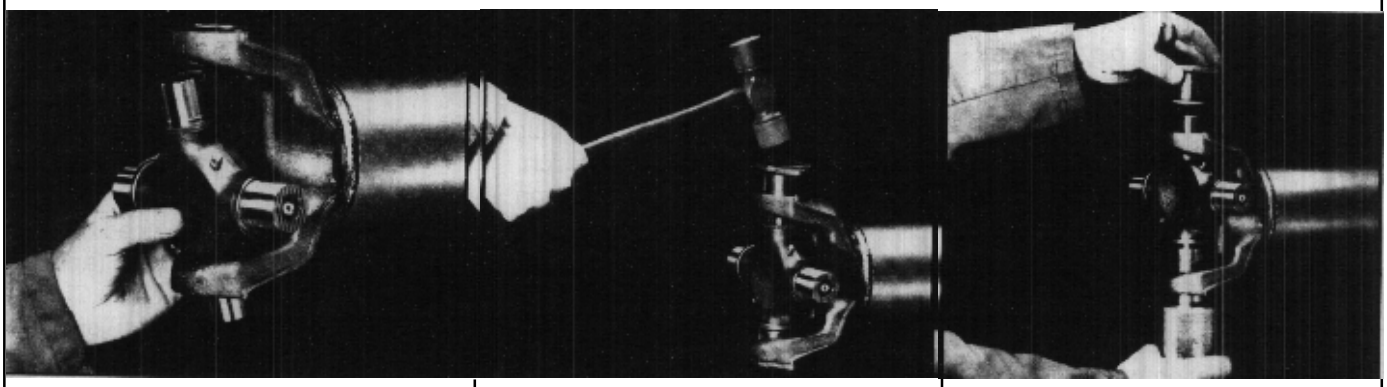
REASSEMBLY



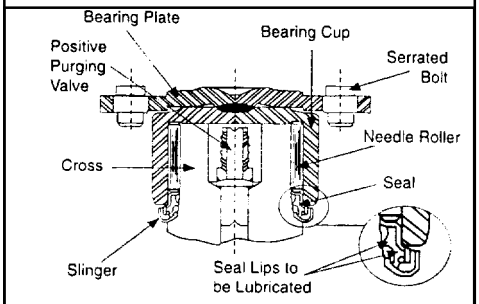
1. Place each end of the driveshaft, less cross and bearing kits, on v-blocks. Check the paint making placed on the tube and slip yoke assembly prior to removing from the vehicle to be sure they are lined up or “in phase.”

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SERVICING THE DRIVE SHAFT



2. Remove the cross and bearings from the box and remove all four bearing assemblies.
   Rotate the cross to inspect for presence of the positive purging valve in each lube hole of all four trunnions. Then position the cross into the end yoke with its lube fitting in fine as near as possible with the sip spline fitting on the inboard side.



3. The lips of the seal on the u-joint **must** be lubricated with a light weight oil to prevent the seal from turning inside out upon installation. Also, each cross reservoir must be packed with grease and **each** cap bearing wiped with grease prior to assembly.

4. Move one end of the cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole.

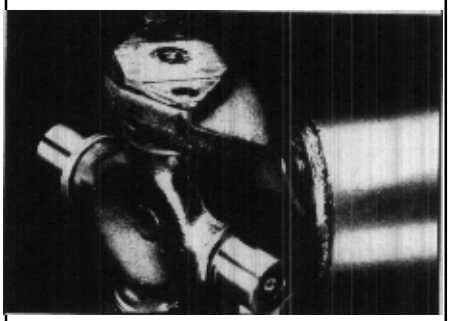
   Holding the trunnion in alignment with the cross hole, using the journal locator press bearing assembly flush to face of end yoke by hand.

   A journal locator should be used to prevent damage to the u-joint trunnions and slingers. If the u-joint bearing cap is pressed into place, the bearings and bearings surfaces could be damaged.

   If bearing assembly binds in cross hole, tap with soft hammer directly in center of bearing assembly plate. Do not tap outer edges of bearing plate.

   Exact fit of all driveline components is extremely important. The correct parts and clean mating surfaces essential for safe operation and good repair.

5. When the bearing assembly is completely seated. put the lock plate tab in place and use the “Grade Eight” cap screws that are furnished with the kit and insert them through the cap screw holes in both the lock strap and bearing assembly. Thread with hand or wrench into tapped hole in yoke.
   Do not torque down bolts.



NOTE: *The self-locking bolt design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining bolt. If loosening or removal of a bolts is necessary, replace with a new one.*

6. Move the cross laterally to the opposite side and through the cross hole beyond the machined surface of the yoke lug. Place a bearing assembly over the cross trunnion and slide it into the cross hole, seating the plate to the face of the lug. Put the lock plate tab in place and thread the bolts with hand or wrench into tapped holes in yoke.

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SERVICING THE DRIVE SHAFT

***NOTE**: Projecting the trunnion through a cross hole beyond the machined surface of the lug will provide a surface to help align the bearing assembly with the cross hole. This method should also be followed when assembling driveshaft to yokes of vehicle at transmission and axle or axles.*

7. Repeat process of installation of cross and bearing kit at opposite end of the driveshaft. Make sure to position the cross in the yoke so that the tube fitting is in line with the tube fitting at the other end.

8. For flange yoke applications, install the flange yoke, bearing assemblies and bolts at this time.

***CAUTION:** Worn bearing assemblies used with a new cross or new bearing assemblies used with a worn cross will wear rapidly making another replacement necessary in a short time.*

Always Replace the Cross, Four Bearing Assemblies and Bolts as a Unit.

INSTALLATION IN VEHICLE

The installation of a driveshaft does not present any unusual mechanical difficulties. Before actual installation the driveshaft should be checked for the following items:

- ✓ Damage or dents on the driveshaft tubing.
- ✓ Splines should slide freely with slight drag from slip shaft seal.
- ✓ Cross should flex and be free from excessive bind. A slight drag is the most desirable condition on a new cross and bearing kit. Excessive looseness is not desirable and will result in an unbalanced driveshaft.
- ✓ Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

When servicing system balanced assemblies it is imperative that the following rules be strictly adhered to:

1. Sleeve yokes to midship shafts, end yokes, companion flange, etc. must not be rotated from their original position during reassembly.
2. It is strongly recommended that an indexing mark or fine be painted down the entire length of all assemblies prior to removal from the vehicle.
3. Upon reassembly, all components must be Reinstalled exactly as removed. Do not turn yokes or sleeves from their original position.

   For Spicer slip yoke interaxle applications, the slip yoke should be installed with the yoke ears “up hill” from the seal. In main driveshaft applications, the slip yoke seal should be up hill or with the slip yoke at the transmission in transmission-to-axle applications.
4. If at all possible, do not remove boots or dust caps from sleeve assemblies.
5. Inspect boots for any damage (rips or holes). If boot is damaged, it must be discarded. Do not reuse clamps.
6. Push on dust caps are not serviceable. If dust cap must be removed, replace it with a new one.
7. If a boot must be disconnected, remove the clamp at the sleeve end and leave the other end attached. Do not reuse clamp.
8. IMPORTANT: If any major component is replaced on any of the assemblies (any component other than boots, dust caps, or u-joints), the entire system balanced assembly must be rebalanced by a competent driveshaft repair facility capable of system balancing.

Failure to adhere to these recommendations can cause excessive driveline vibration and/or premature component failure.

***NOTE:** The unitized one piece seal now used on Spicer driveshafts is not intended to be removed in service. When servicing drivestafts with the pop on seal, DO NOT remove the seal from the slip yoke. Pull the tube shaft out of the slip yoke and carefully realign the splines of the tube shaft with the slip yoke upon reassembly. To separate the tube shaft from the slip yoke, pull the tube out of the slip yoke, leaving the seal in place. A significant amount of force will be required to remove as well as reinstall the tube shaft through the seal. Removal of the unitized seal causes damage to the seal lip where it contacts the slip yoke. If removal of the seal is absolutely necessary, it should be replaced with a new unit.*

To remove the old seal, hold the yoke assembly firmly in a vise. Using a large chisel, drive the seal off of the yoke. To install a new seal, generously lubricate the seal lip and press the new seal into place using a small arbor press or equivalent.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

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SERVICING THE DRIVESHAFT

Do not go under the vehicle when the engine is running.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

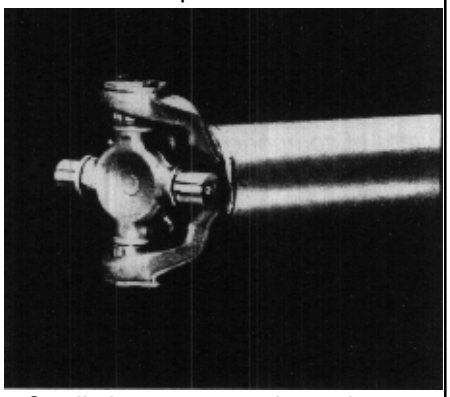
In order to avoid becoming entangled, install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

Install a support strap when servicing a driveshaft to prevent personal injury.

FULL ROUND END YOKE STYLE

1. Rotate the transmission end yoke by putting transmission in neutral and the axle end yoke by Jacking up one rear wheel, so the cross holes are in a horizontal position.



2. Tilt the cross trunnions of the driveshaft, both ends, with trunnions pointing toward each other from end to end, one side. Install with the slip joint nearest the source of power. Use a nylon support strap to aid in handling the driveshaft.

CAUTION: *Use a Journal cross locator to avoid nicking journal cross trunnions or damaging oil seal slingers.*

3. Holding the driveshaft firmly, proJect a trunnion in an outward position between the lugs of either the axle or the transmission end yoke and through a cross hole. Repeat at opposite end. The driveshaft is being supported at each end by one trunnion surface in a cross hole and the nylon support strap.

   Tilt a cross trunnion until the opposite side can be inserted through a cross hole. Repeat at opposite end. The driveshaft is now being supported at each end by two trunnion surfaces in the cross holes and the nylon support strap.

4. Move one end of the shaft to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole.

   Holding the trunnion in alignment with the cross hole, press bearing assembly flush to face of end yoke by hand.

   If bearing assembly binds in cross hole, tap with soft hammer **directly in center** of bearing assembly plate. Do not tap outer edges of bearing plate.

5. Slide the shaft to project an opposite trunnion through the cross hole beyond the face of the end yoke. Again, place a bearing assembly over the trunnion, align and place hands on opposite bearing assembly, and press both inward flush to yoke faces. If assembly binds, tap with soft hammer as outlined above. Put the lock plate tab in place and insert the "Grade Eight" cap screws through the holes in the lock plates and bearing assemblies. Thread cap screws into end yokes. Tighten with wrench until plates are flush against end yoke faces.

6. Lubricate the cross and bearing assembly until tube appears at all four seals. If any seal fails to purge, see "Lubrica"ion Procedure for U-Joints." Also check slip yoke lubrication.

7. Torque all eight bolts to specification (see chart below). Bend lock plate tabs to fiat of cap screwheads to lock in place.

NOTE: *The self-locking bolt design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining bolts.*

8. Repeat at opposite end. Remove nylon support strap.

FULL ROUND END YOKE

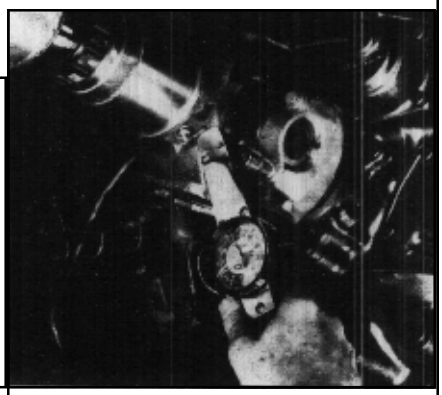
SERIES	THREAD SIZE	TORQUE					
		LOCK STRAP DESIGN			SERRATED BOLT w/LOCK PATCH		
		(Lb./Ft.)	(NM)	Bolt P/N	(Lb./Ft.)	(NM)	Bolt P/N
1610	.312-24	26-35	35-48	5-73-109	26-35	35-48	5-73-709
1710	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1760	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1810	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1880	.438-20	60-70	81-95	7-73-115	60-70	81-95	7-73-315

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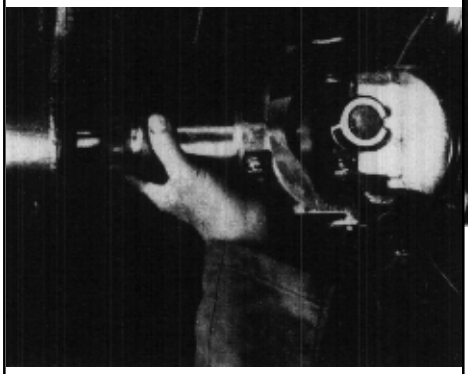
SERVICING THE DRIVESHAFT

QUICK DISCONNECT™ HALF ROUND END YOKE

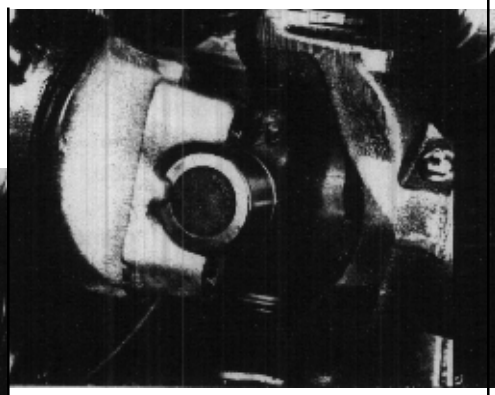
SERIES	THREAD SIZE	BOLT P/N	BOLT TORQUE (Lb./Ft.)	(NM)
SPL90	.375-24	6-73-412	45-60	61-81
1610	.375-24	6-73-412	45-60	61-81
1710	.500-20	8-73-316	115-135	156-183
1760	.500-20	8-73-316	115-135	156-183
1810	.500-20	8-73-316	115-135	156-183

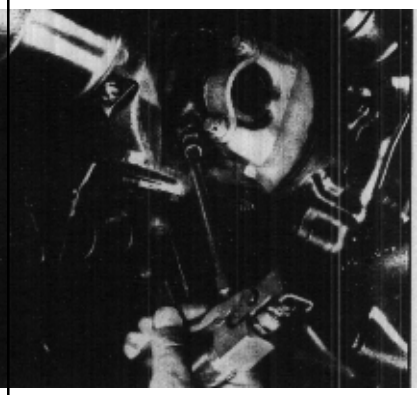


On Quick Disconnect applications, the bearing saddles of the end yoke must be clean and free of any contaminants.



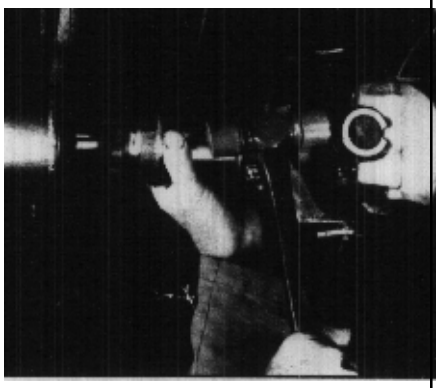
Using a soft hammer, tap the bearing assemblies until they are fully seated into the end yoke. Check to be sure the cups are fully seated in the bearing saddles of the yoke behind the yoke tabs as shown below.

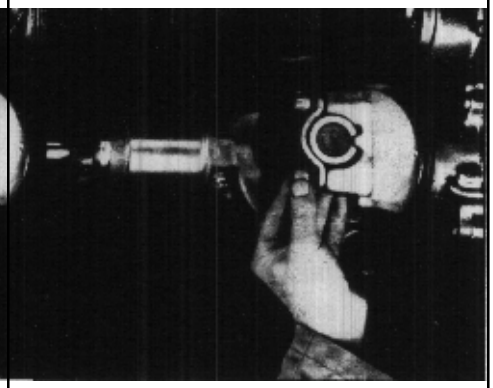




Install the bearing straps and bolts and torque all eight bolts to the proper specification. Bend lock plate tabs to flat of cap screwheads to lock in place.

NOTE: *The self-locking bold design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining. bolts.*





Lubricate the cross and bearing assembly until lube appears at all four seals. If any seal fails to purge, see “Lubrication Procedure for U-Joints.” Also check slip yoke lubrication.

CAUTION: *Excessive bearing rotation could cause premature wear of components involved. The causes of rotation are:*

1. Use of non-Spicer parts with Genuine Spicer components.
2. Improper torque on retaining strap bolts.
3. Failure to firmly seat both bearing assemblies in the end yoke saddles before the strap bolts are tightened.
4. Dirty bearing saddles.

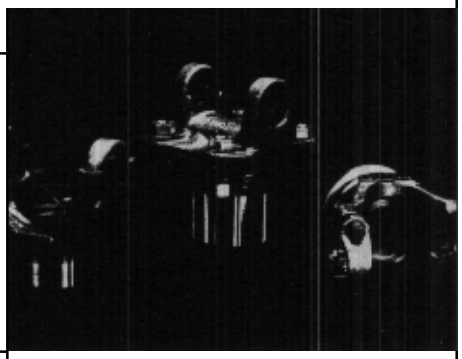
CAUTION: *Half Round self-locking retaining bolts should not be reused. Follow instructions implicitly to prevent danger of serious personal injury or death from loss of driveshaft function.*

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FLANGE YOKE

SERIES	THREAD SIZE	BOLT TORQUE (Lb./Ft.)	(NM)
SPL90	.375-24	40-48	54-65
1610	.375-24	40-48	54-65
1710	.375-24	40-48	54-65
1760	.438-20	63-75	85-102
1810	.438-20	63-75	85-102
1880	.625-18	194-232	263-315



FLANGE YOKE STYLE

With nylon support strap in place and holding the driveshaft firmly, align the (permanent end) flange pilots of the driveshaft flange yoke and axle companion flange with each other. Align bolt holes and install bolts, lock washers and nuts to temporarily secure driveshaft to axle. Compress the slip assembly to position the opposite end of the driveshaft to the transmission companion flange. Align bolt holes and install bolts, lock washers, and nuts. Torque to specifications, both ends.

NOTE: *1650 Series Bearing Assemblies with Locking Plats. When installing new bearing assemblies into cross holes, the locking fiat on the bearing assembly must be aligned with the locking fiat in the yoke cross hole. Proper location of locking flats will assure that the bearing assembly will not rotate.*

LIGHT AND MEDIUM DUTY APPLICATION

Cross and Bearing Kit Replacement

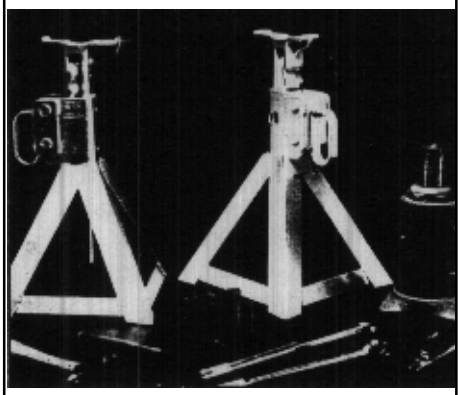
Inside and Outside Snap Ring, U-Bolt and Bearing Strap Design



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

TOOLS (1000 - 1500 SERIES):

Common Hand Tools
Soft Hammer



REMOVAL

Procedures for removing the driveshaft from light and medium duty vehicles are nearly the same as for heavy duty applications. One difference is that the cross and bearings vary in the method of attaching to the vehicle. Methods of attachment include u-bolt, bearing strap and flange yoke design.

For heavy driveshafts, support with a nylon support strap. Remove the u-bolts or strap cap screws from the end yoke. Slide the slip yoke toward the shaft to free the bearings from their seats between the yoke tabs in the end yokes. Care should be taken to avoid dropping the bearing assemblies. Repeat at opposite end.

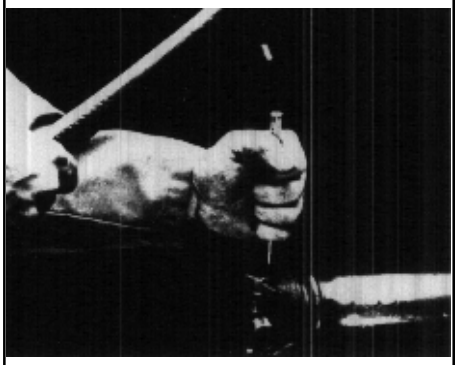
For double flange applications, disassemble as a complete assembly by removing the companion flange bolts.

For flange yoke and end yoke combination-type driveshafts, remove as described above for whatever design applies.

OUTSIDE SNAP RING DESIGN (RELUBABLE)

Disassembly

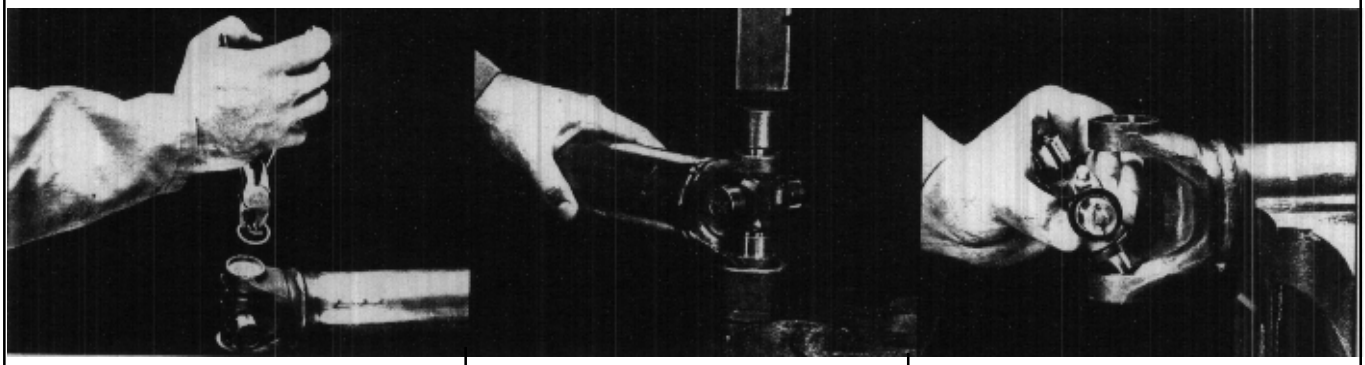
With the shaft removed, the I following procedure should be followed:



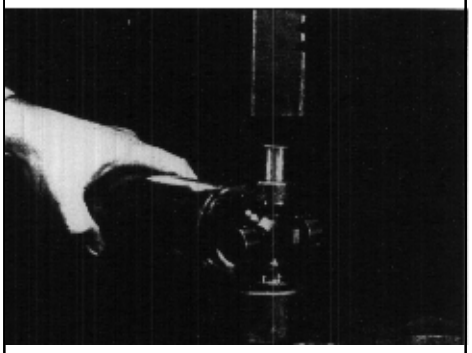
1. Using a soft drift, tap the outside of the bearing assembly to loosen snap ring. Tap bearing only hard enough to break assembly away from snap ring.

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2. Remove snap ring from yoke. Turn joint over, tap bearing away from snap ring, then remove opposite snap ring.



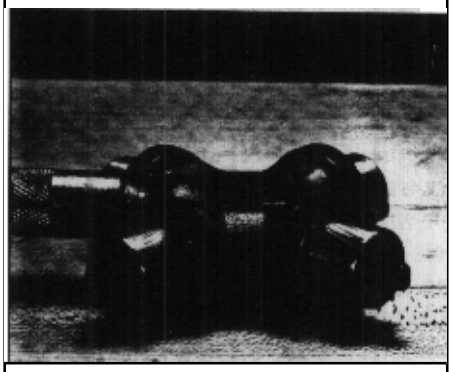
3. Set the yoke in the arbor press with a piece of tube stock beneath it. Position the yoke with the lube fitting pointing up to prevent interference during disassembly. Place a solid plug on the upper bearing assembly and press it through to release the lower bearing assembly.

4. if the bearing assembly will not pull out by hand after pressing, tap the base of the lug near the bearing assembly to dislodge it.

5. To remove the opposite bearing assembly, turn the yoke over and straighten the cross in the open cross hole. Then carefully press on the end of the cross so the remaining bearing assembly moves straight out of the bearing cross hole. If the cross or bearing assembly are cocked, the bearing assembly will score the walls of the cross hole and ruin the yoke.

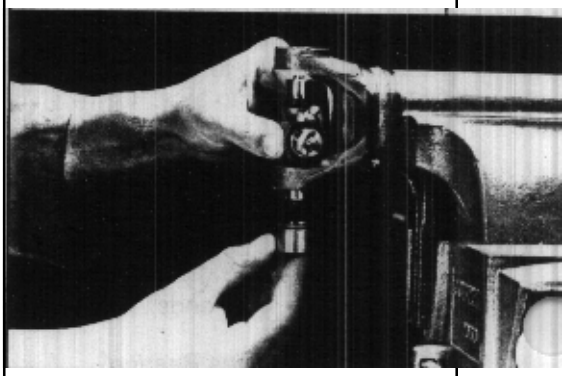
6. Repeat this procedure on the remaining bearing assembles to remove the cross from the yoke.

Reassembly



7. Pack the four grease cavities of the cross with a high quality extreme pressure N.L.G.I. Grade 2 grease (refer to page 6). Also pack each bearing assembly approximately 1/4 full with this grease.

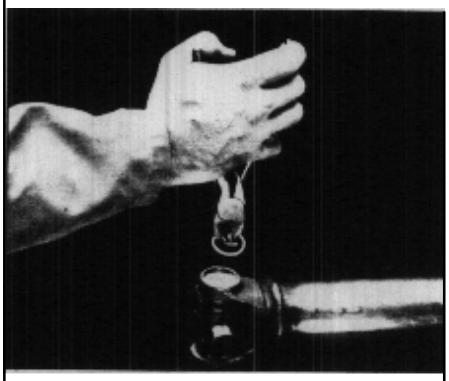
2. Position the cross in the yoke with its lube fitting on the inboard side (toward driveshaft).



3. Move one end of the cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole. Using an arbor press, hold the trunnion in alignment with the cross hole and place a solid plug on the upper bearing assembly. Press the bearing assembly into the cross hole enough to install a snap ring.

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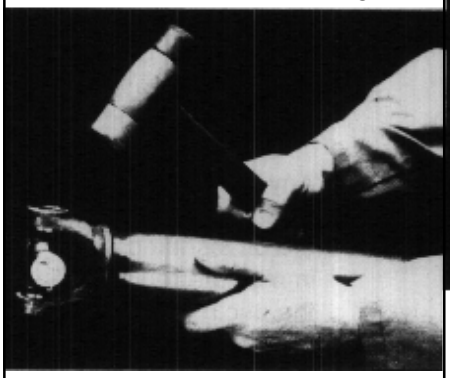
SERVICING THE DRIVESHAFT



4. Install a snap ring.



5. Repeat steps 3 and 4 to install the opposite bearing assembly. If the joint is stiff, strike the yoke ears with a soft hammer to seat the needle bearings.



CAUTION: *Be sure snap rings are properly seated in grooves.*

6. Repeat steps 2 - 5 at the opposite end of the drive shaft if installing a second kit. Make sure to keep lube fittings at each end of the driveshaft in line.

7. Install the reassembled driveshaft in the vehicle. If bearing straps or u-bolts hold the shaft in vehicle, be certain the bearing assemblies are fully seated between bearing locating shoulders.

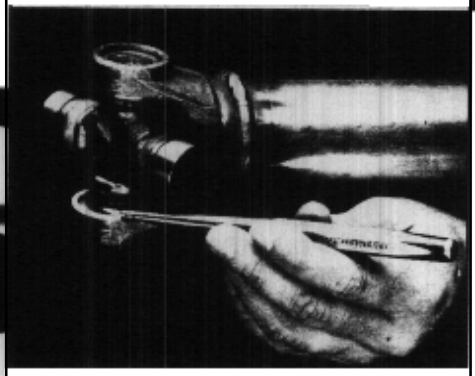
8. Torque bolts to specification.

CAUTION: *Self-locking bolts used with bearing straps should no be reused. Follow instruction implicit to prevent danger of serious personal injury or death from loss of driveshaft function.*

9. Apply more grease through the lube fitting until grease appears at all four bearing seals.

INSIDE SNAP RING DESIGN (RELUBABLE)

Disassembly



Removing an inside snap ring.

Repeat outside snap ring design disassembly instructions.

Reassembly

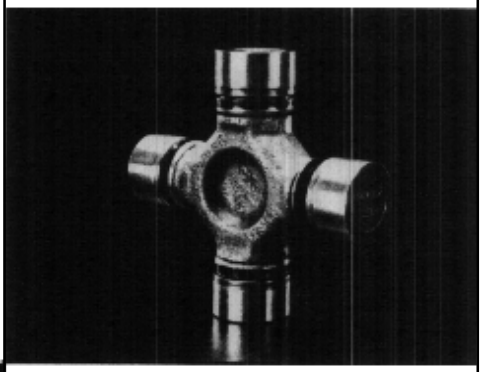
Repeat outside snap ring design reassembly instructions.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etch. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc. If power take-off and/or shaft are still exposed after installation, install a guard.

PRELUBE OR LUBE-FOR-LIFE™ DESIGNS



Spicer Prelube or Lube-for-Life™ U-joint Kit

Some Spicer crosses and designs and have no lube fittings. Since lubrication is critical, special seals are used to contain the lubricant in the cross/bearings in this design.

Service instructions are nearly the same for relubable and prelube or lube-for-life design, whether it is inside or outside snap ring u-bolt or bearing strap design.

The difference is that lifetime lubrication is done by Spicer at the time of manufacture and relubrication should not be necessary. Replacement of the cross and bearing kit rather than relubrication is recommended.

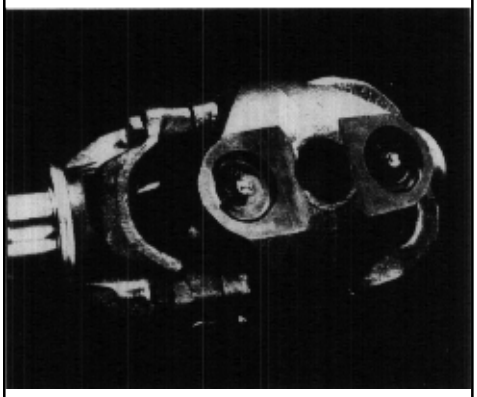
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TORQUE SPECS FOR LIGHT AND MEDIUM DUTY

POSITION	BOLT SIZE	(Lb./Ft.)	(NM)
U-Bolts	(5/16) .312-24	14-17	19-23
	(3/8) .375-24	20-24	27-33
	(7/16) .438-20	32-37	43-50
Bearing Strap	(1/4) .250-28	13-18	18-24
	(5/16) .312-24	25-30	34-41
	(3/8) .375-24	45-60	61-81
Flange Bolts	(5/16) .312-24	22-26	16-35
	(3/8) .375-24	40-48	54-65
	(7/16) .438-20	63-75	85-102

DOUBLE-CARDAN CONSTANT VELOCITY TYPE JOINT (Light Duty)



The double-cardan constant velocity (CV) type u-joint is a special design to accommodate necessary installation angles not compatible with single-cardan u-joints. The CV joint also requires special attention. Neglect is its main enemy.

The CV joints need lubrication to live. Some of the older assemblies using flush-type fittings require special lube gun fittings, such as a needle nose attachment. The crosses may or may not have lube fittings.

The centering socket and ball is critical to proper function of the CV joint and smooth operation. Without lubrication it will wear out, causing vibration and serious damage. Rebuilding the CV joint will be necessary.

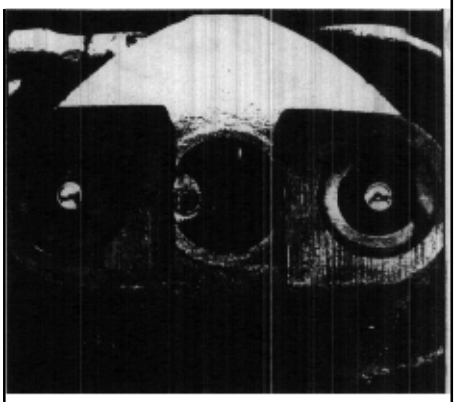
LUBRICATION

The lube fitting for the centering socket in the CV joint can be difficult to reach and requires a special lube technique. it is necessary to rotate the driveshaft to a position with the flush type lube fitting in the centering socket up toward the floor board. The yokes spread or open in this position to allow access with the needle nose tip. It is still an awkward and blind procedure. That explains why neglect is so common.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc This can cause serious injury or death Do not work on a shaft (with or without a guard) when the engine is running.

A more positive, less frustrating approach is to disconnect the driveshaft. The lube fitting will come into view but it may be necessary to jack one front wheel and rotate the driveshaft. This can be done to all 4WD vehicles with the double-cardan u-joint.



Lubrication access hole in late-design Spicer Double Cardan Joints

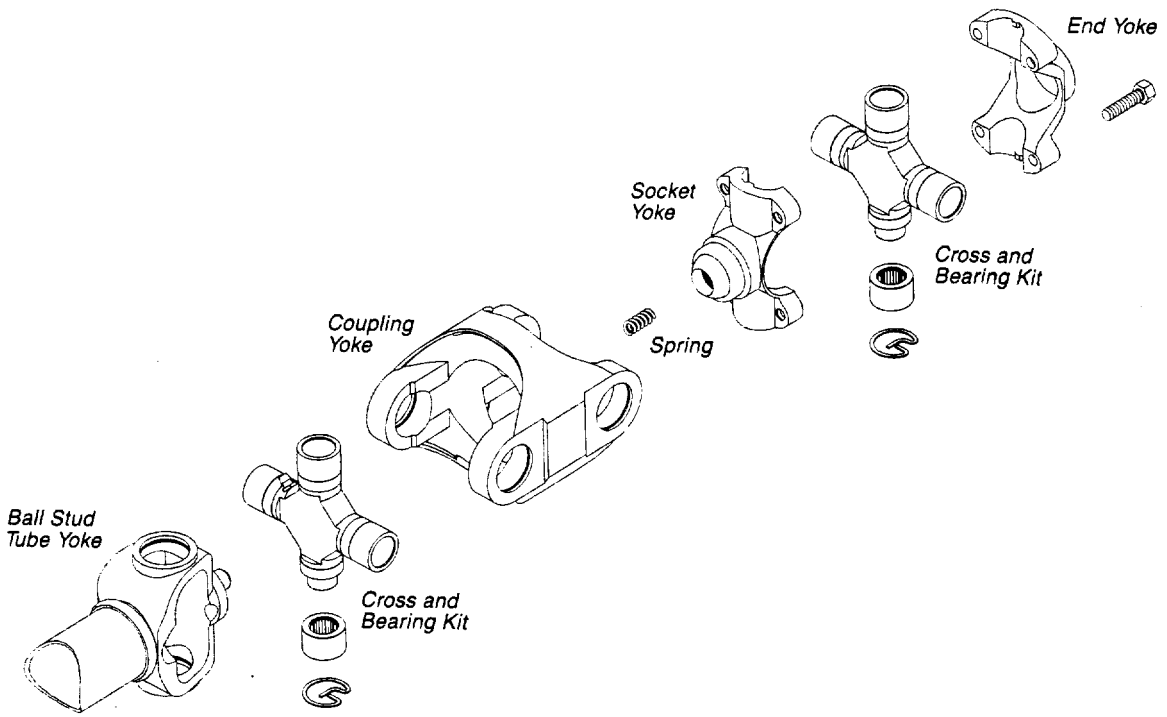
The later-design Spicer CV joints simplify lubrication by making easy access to the lube fittings. Service replacement kits have been modified with a lube fitting in one or more bearing assemblies to aid in lubrication access. Also, an access hole has been provided in the center yoke for easy lubrication of the centering ball. This new design eliminates the need to disconnect the shaft and puts the fittings in plain view.

Look for signs of u-joint trouble when lubricating u-joints:

- ✓ Lube spray from a leaky seal indicates need for u-joint replacement.
- ✓ Any looseness or noticeable “slop” at a u-joint in the driveshaft calls for immediate replacement of the u-joint, assuming the snap rings or bolts are already in place or torqued down.

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Spicer Double Cardan Constant Velocity Type Joint

SPICER STYLE REPAIR KIT

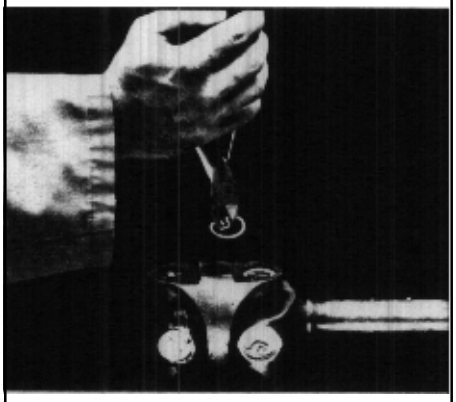
The Spicer style double cardan CV joint has outside snap rings. CV joint repairs should be made whenever inspections show any noticeable sign of loose fit, corrosion or loss/lack of lube at u-joint or centering ball.

Centering socket/ball repair kits are available from Spicer with installation instructions for replacement. The correct repair kit depends on whether the CV joint is the older or newer types. The advantage of easy access lube fittings for the new style center kit would be lost when installed in an old style u-joint. The centering kits have a different location for the lube fitting.

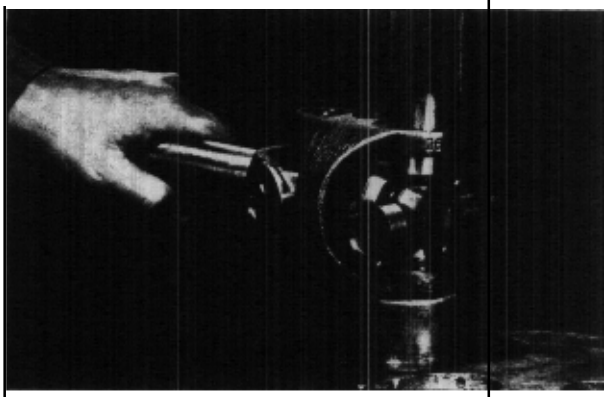
The disassembly and reassembly of both types is basically the same procedure. It is important that both styles be reassembled with all lube fittings aligned on the same side. This will make service lubrication more convenient and reduce the possibility of overlooking lube points.

DISASSEMBLY

1. Disconnect u-bolts or bearing straps at the single-cardan end yoke position. Disconnect cap screws from the CV end yoke or flange bolts from the CV companion flange. This will allow driveshaft removal from the vehicle.



2. Remove all snap rings from the bearing assemblies.

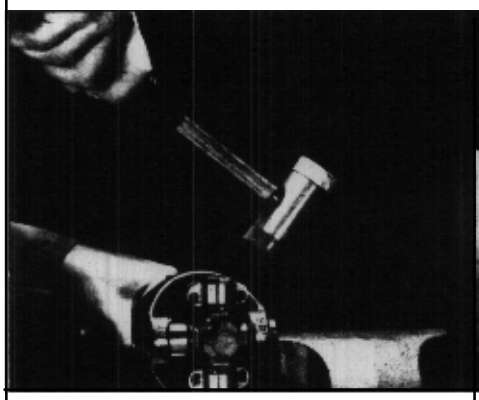


3. Press the bearing assembly partially from the outboard side of the center yoke - enough to grasp by vise jaws. Do not press the bearing assembly completely through.

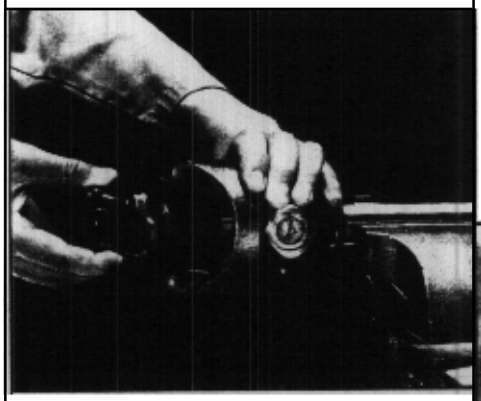
NOTE: *Be sure to remove lube fitting if it interferes with bearing assembly press-out.*

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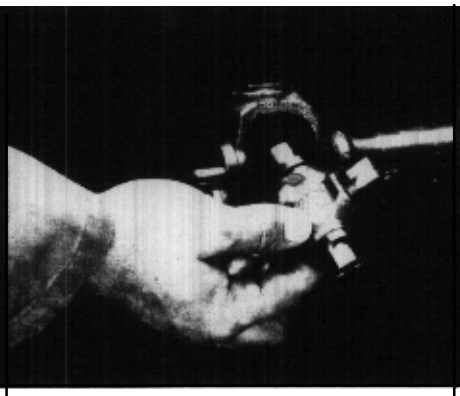
4. Grasp the protruding bearing assembly by vise jaws. Tap the tube yoke with a mallet and drift to dislodge the bearing assembly from the yoke hole.



5. Flip the assembly and repeat steps 3 and 4 for removing the opposite side bearing assembly. This will then allow removal of the cross centering kit assembly and spring.

6. Press the remaining bearing assemblies out on the other cross as described above to complete disassembly.

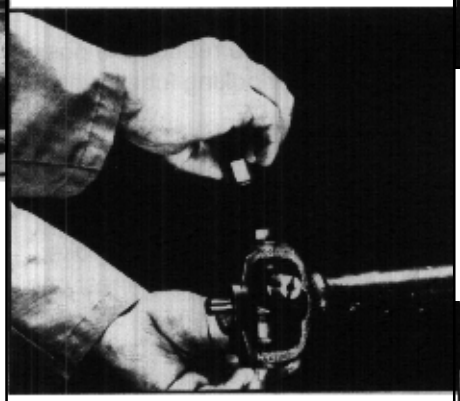
CAUTION: *Tap in the center of the "H" yoke. Never strike the yokes at the bearing assembly holes because the snap ring grooves may collapse and make reassembly impossible.*



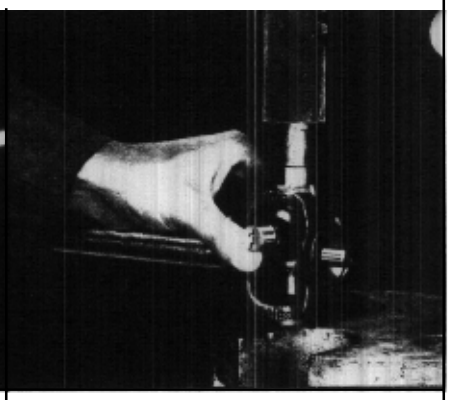
REASSEMBLY

1. Fit a cross into the tube yoke.

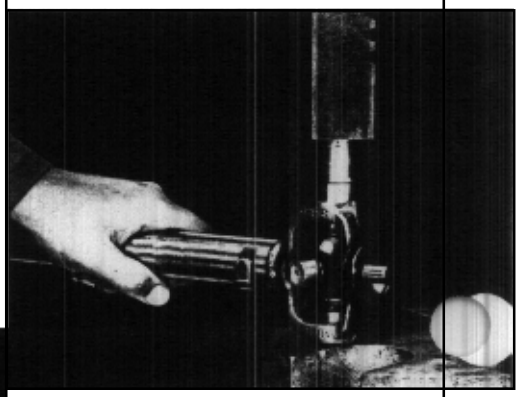
2. Place a bearing assembly in a tube yoke hole and over a trunnion. Keep the needle rollers upright in the bearing assembly. A needle roller lying at the bottom of the bearing assembly will prevent proper assembly.



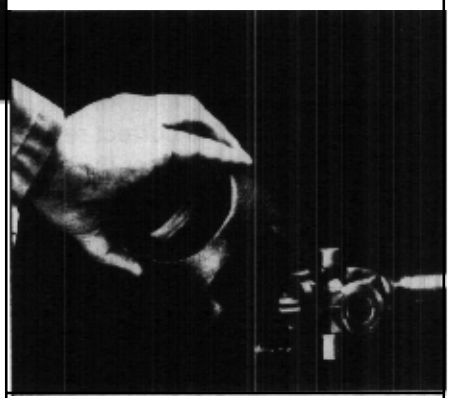
NOTE: *Be sure to remove the lube fitting if it interferes with bearing assembly press-up.*



3. Press the bearing assembly in place and install a snap ring.



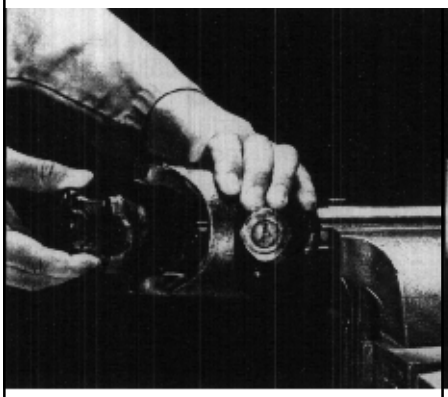
4. Flip the tube yoke and repeat bearing assembly installation on the opposite trunnion. Install a snap ring.



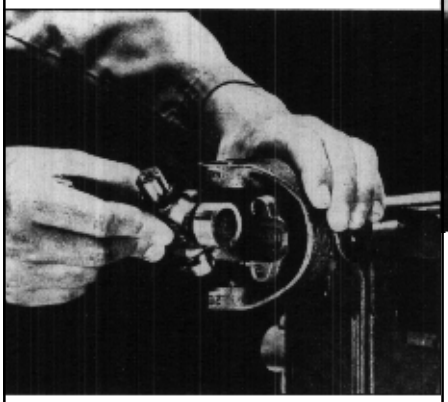
5. Fit the center yoke on the remaining two trunnions and press bearing assemblies in place, both sides. Install snap rings.

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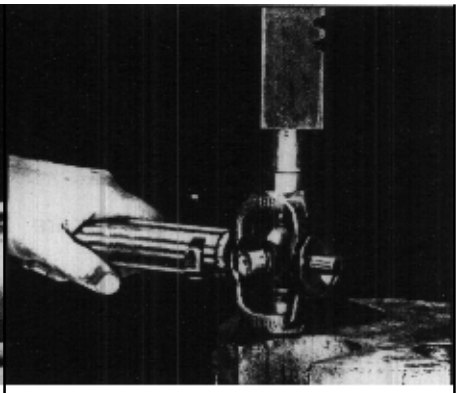
SERVICING THE DRIVESHAFT



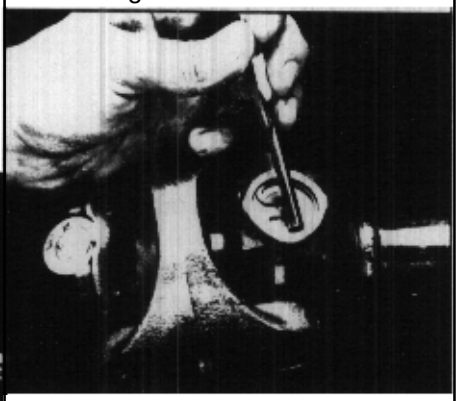
6. Next install the centering kit assembly inside the center yoke making sure the spring in the tube yoke is in place. Align the lube fitting on the centering kit assembly with the lube fitting on the installed cross.



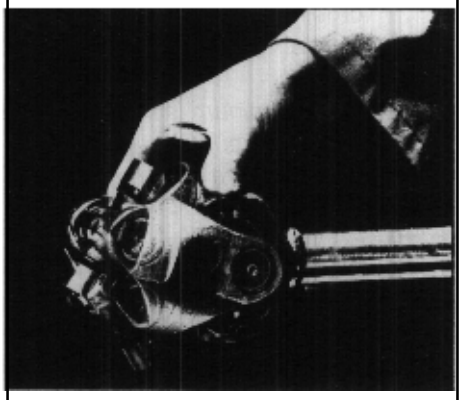
7. Place two bearing assemblies on the remaining cross (opposite sides). Fit the open trunnions into the center yoke holes and the bearing assemblies into the centering kit assembly. Make sure the lube fitting on the cross is in live with the other two lube fittings.



8. Press the remaining two bearing assemblies into place and install snap rings.



9. Tap the snap rings to allow them to set into the grooves. A bearing cup from a used u-joints works well for this.



10. Check for proper assembly. Flex the CV joint beyond center. It should snap "over center" in both directions when all needle rollers and components are correctly assembled.

11. Reinstall in the vehicle.

12. Torque all bolts and cap screws to specifications shown below.

13. Add grease to all three lube fittings.

TORQUE SPECIFICATIONS FOR DOUBLE-CARDAN CONSTANT VELOCITY TYPE JOINTS

1210CV-Standard Grade Eight Bolts
Bolt Torque - 13-18 lb./ft.
(.250-28)
1310/1330CV-Standard Grade Eight Bolts
Bolt Torque - 22-26 lb./ft.
(.312-24)

CAUTION: *Self-locking bolts used with bearing straps should not be reused. Follow instructions implicitly to prevent danger of serious personal injury or death from loss of driveshaft function.*



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

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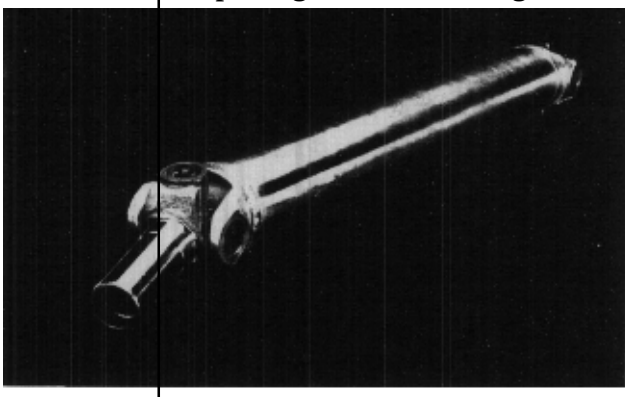
SERVICING THE DRIVESHAFT

Assembly and disassembly procedures for Spicer Lite™ aluminum and Spicer Graph-Lite™ driveshafts are similar to those of other driveshafts. However, some

unique instructions **must be** followed to service advanced technology materials.

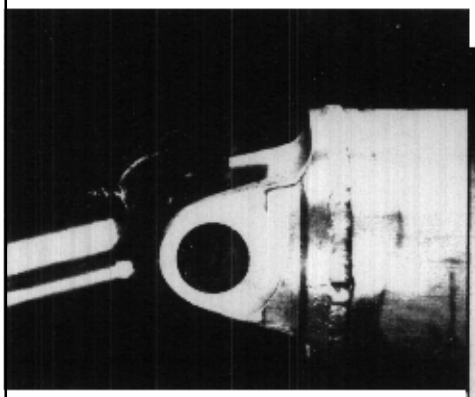
SPICER LITE™ ALUMINUM DRIVESHAFT

Inspecting and Lubricating



1) Inspect Spicer Lite* aluminum driveshafts following the same procedures for steel driveshafts as outlined on pages 4 - 7.

2) Inspect the aluminum tubing for surface scratches and dents. These scratches may **not** exceed 0.008 inches in depth.



3) Visually inspect the circle welds and end fittings for any signs of cracks or signs of deterioration. If there are any cracks that exceed 0.008 inches in depth, the assembly must be replaced.

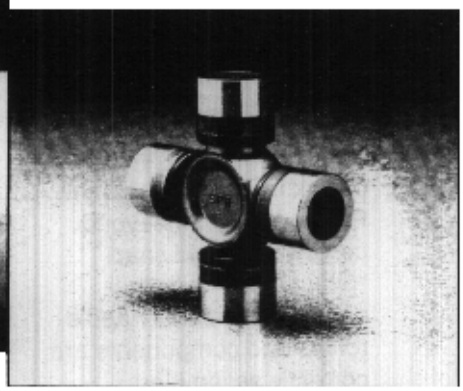
4) Check to be sure there are no missing balance weights. If balance weights are missing and a void has occurred in the aluminum tubing greater than 0.008 inches, the assembly must be replaced.

SERVICING

1) Service Spicer-Lite™ aluminum driveshafts following the same procedure for steel driveshafts as outlined on pages 13 - 15.

2) After removing the cross and bearings from both ends of the driveshaft, inspect the cross hole surfaces for damaged or raised metal. Raised metal can be removed with an emery cloth. The raised metal can cause premature cross and bearing problems.

CAUTION: *Aluminum is softer than steel. Care must be taken not to remove excessive material or damage cross holes.*



3) If the universal joint kit is replaced, it must be replaced with a kit designed specifically for use with aluminum. The use of non-endurion coated kits will result in damage to the driveshaft through galvanic corrosion.

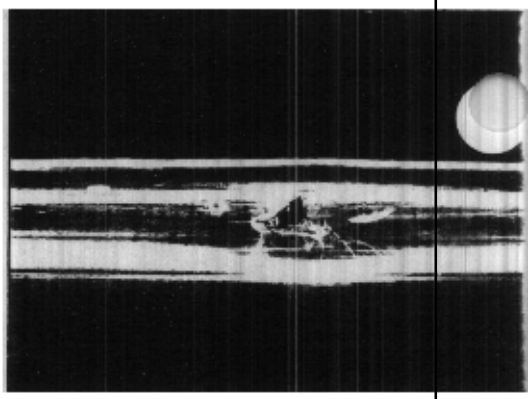
CAUTION: *When replacing universal joint kits in aluminum driveshafts, use kits designed specifically for aluminum to avoid galvanic corrosion.*

Straightening and Balancing

1) Our Spicer Lite™ aluminum driveshaft can be straightened following the same procedure for steel driveshafts as outlined on page 24.

GRAPH-LITE™ DRIVESHAFTS

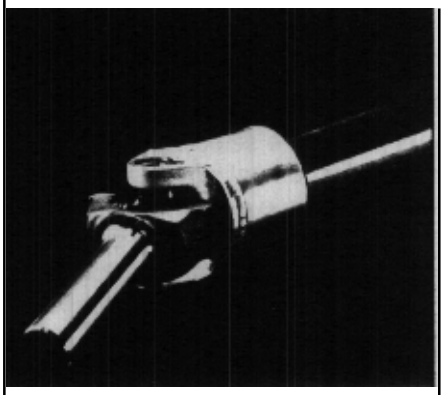
Inspecting and Lubricating



1) Inspect driveshaft for any surface imperfections in the black graphite covering. Look for torn graphite near the ends of the covering and surface scratches or cracks deeper than 0.008 inches along the length of the covering. If any imperfections such as these exist, the assembly must be replaced. The black graphite must be securely attached to the aluminum tubing in all areas. If there is any relative movement between the two materials (aluminum and carbon graphite), the assembly must be replaced.

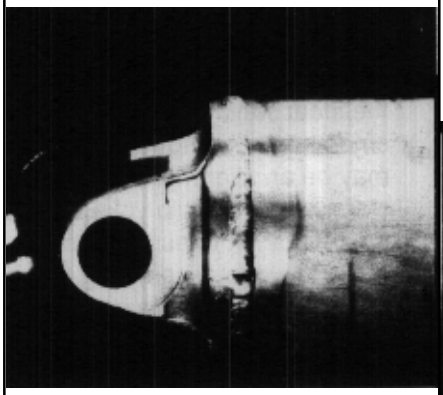
https://truckmanualshub.com/

SERVICING THE ADVANCED MATERIALS DRIVESHAFT



2) Inspect the driveshaft following the same procedures for steel driveshafts as outlined on pages 4 -7.

3) Inspect the aluminum tubing for surface scratches and dents deeper than 0.008 inches.



4) Visually inspect the circle welds and end fittings for any signs of cracks or deterioration. If there are any cracks that exceed 0.008 inches-in depth, the assembly must be replaced.

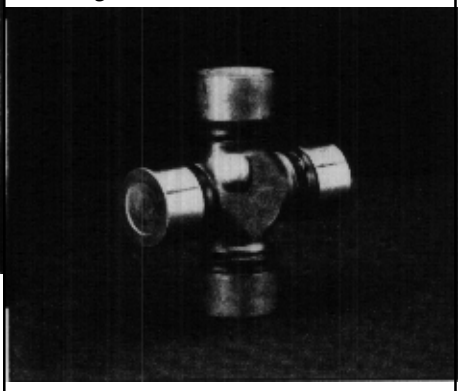
5) Check for any missing balance weights. If balance weights are missing, and a void has occurred in the aluminum tubing greater than 0.008 inches, the assembly must be replaced.

Servicing

1) Service Spicer Graph-Lite™ driveshafts following the same procedure for steel driveshafts outlined on pages 13 - 15.

2) After removing the cross and bearings from both ends of the driveshaft, inspect the cross hole surfaces for damaged or raised metal. Raised metal can be removed with an emery cloth. The raised metal can cause premature cross and bearing problems.

CAUTION: *Aluminum is softer than steel. Care must be taken not to remove excessive material or damage cross holes.*



3) If the universal joint kit is replaced it must be replaced with a kit designed specifically for use with aluminum. The use of non-endurion coated kits will result in damage to the driveshaft through galvanic corrosion.

CAUTION: *When replacing universal joint kits in Graph-Lite™ driveshafts, use kits designed specifically for aluminum to avoid galvanic corrosion.*

Straightening and Balancing

DO NOT, UNDER ANY CIRCUMSTANCES, ATTEMPT TO STRAIGHTEN ALUMINUM GRAPHITE DRIVESHAFTS. Any attempt to do this will cause damage to the carbon graphite covering resulting in decreased performance of the driveshaft. The entire driveshaft assembly must be replaced if the tubing is bent or twisted.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

In order to avoid becoming entangled install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

Install a support strap when servicing a driveshaft to prevent personal injury.

A serious or fatal injury can occur...
- if you lack proper training
- if you fail to follow proper procedures
- if you do not use proper tools and safety equipment
- if you assemble driveline components improperly
- if you use incompatible driveline components
- If you use worn-out or damaged driveline components
- if you use driveline components in a non-approved application

This manual contains detailed safety instructions. Read, understand and follow this manual.
- Get proper training
- Learn and follow safe operating procedures
- Use proper tools and safety equipment
- Use proper components in good condition

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STRAIGHTENING AND BALANCING ANGLES AND PHASING

STRAIGHTENING AND BALANCING THE DRIVESHAFT

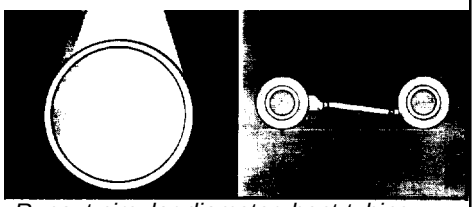
(Excluding Aluminum)

The rebuilding of a driveshaft assembly usually consists of replacing worn cross and bearing assemblies with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The potential off-center condition present in the cross and bearing assemblies makes it desirable to balance every assembly after installing new cross and bearing kits.

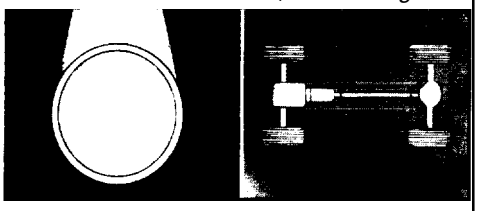
When the tubing is bent or twisted or the tube fittings are distorted, it will be necessary to replace the damaged parts.

Properly assemble the new components into the tube and straighten the shaft assembly before tack welding, to be sure the parts are on center. This can be done by mounting the complete assembly in the appropriate tooling and straightening until the ends of the tube run concentric within 0.005 T.I.R. Recheck for runout.

RUNOUT VERSUS OVALITY



Runout-circular diameter, bent tubing

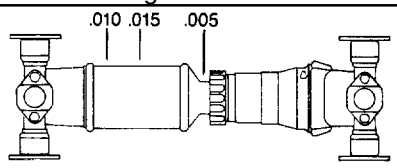


Ovality-oval diameter straight tubing

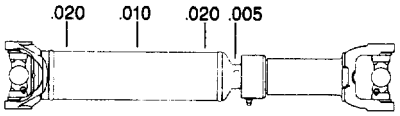
When checking for runout, it is important to distinguish between runout and ovality. Runout is when the tube is slightly bent but still maintains its circularity throughout the tube. During dynamic balancing, a dial indicator will show runout ONCE per revolution.

Ovality occurs when the tube is not circular but oval in shape. During dynamic balancing, a dial indicator will display ovality TWICE per revolution. Even though a tube may be straight, ovality will make it seem bent. A tube with ovality may be used up to a 0.010 T.I.R. runout reading. Beyond this limit the tube must be discarded for driveshaft purposes.

After welding, the entire driveshaft should be straightened to the following limits:



Heavy Duty Driveshaft Runout Limits



Light and Medium Duty Driveshaft Runout Limits for Unbalanced Driveshaft

Heavy Duty

0.005 T.I.R. on the neck of the slip tube shaft
0.010 T.I.R. on ends of tubing 3" from welds
0.015 T.I.R at linear center of the tube.

Light and Medium Duty

0.005 T.I.R. on the neck of the slip tube shaft
0.010 T.I.R. on ends of tubing 3" from welds
0.015 T.I.R. at linear center of the tube
0. 015 T.I.R. for full length of tube with 30" or less

(T.I.R. - Total indicator Reading)

These runouts should be taken with entire driveshaft assembly mounted on master tooling which locales on the outboard bearing assemblies of the u-joint kit (light and medium duty), or the trunnions of the outboard u-joint kit (heavy duty) or on selected flange yokes or yokes.

All flange yokes or yokes should be selected for dynamic balance to eliminate as much unbalance as possible. During balancing, the driveshaft again should be mounted on the same master tooling or selected flange or yokes.

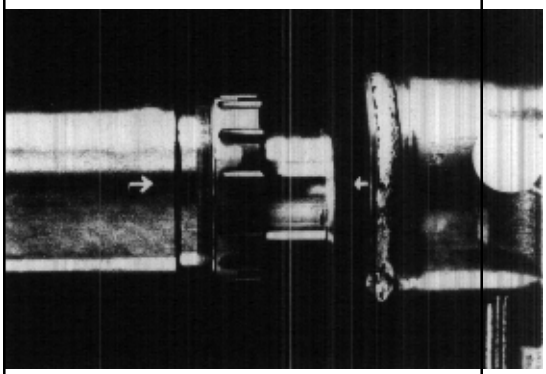
After straightening, balance the entire assembly to Original Equipment Manufacturer specifications.

ANGLES AND PHASING

(All Types)

Proper driveshaft angles and correct phasing of the yokes are very important in maintaining long life and quiet running shafts.

When in phase, the slip yoke lugs (ears) and tube yoke lugs (ears) are in fine. Normally, this is the ideal condition and gives the smoothest running shaft. There may be an alignment arrow stamped on the slip yoke and on the tube shaft to assure proper phasing when assembling these components. If there are no alignment marks, they should be added before disassembly of the shaft to assure proper reassembly.



An " In Phase" Driveshaft

Phasing is relatively simple on a two-joint set be sure that the slip yoke lugs and the tube yoke lugs are in fine. Driveshaft angles are a little more complicated.

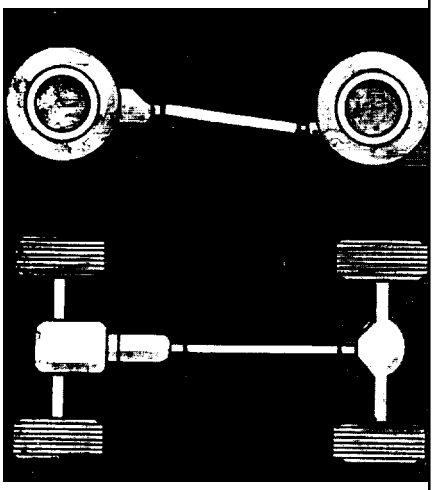
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ANGLES AND PHASING

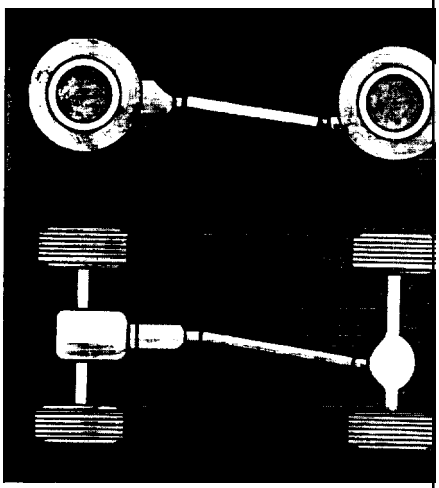
The u-joint operating angle is the angle formed by two yokes connected by a cross and bearing kit. There are two kinds of u-joint angles.

The simple one plane angle found in most installations has all driveline slope confined to one plane, usually the vertical plane.

The other type of driveline angle is the compound angle in two planes. This is found in driveline designs where offset exists in both the vertical and horizontal planes. For detailed information on troubleshooting compound angles, contact your Spicer Service Representative.



One Plane Angle Driveshafts, Side and Top View



Two Plane Angle Driveshaft, Side and Top View

High angles combined with high R.P.M. is the worst combination, resulting in reduced u-joint life. Too large and unequal u-joint angles can cause vibrations and contribute to u-joint, transmission and differential problems. The improper u-joint angles must be corrected.

Ideally, the operating angles on each end of the driveshaft should be equal to or within 1 degree of each other, have a 3 degree maximum operating angle and have at least 1/2 of a degree continuous operating angle. R.P.M. is the main factor though in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart listed.

Tube diameter and normal operating RPM determine maximum allowable tube length. If “critical length” is reached, a three-joint driveshaft with center support or a Spicer Graph-Lite™ driveshaft must be used. Refer to the Spicer “Driveshaft Speed Calculator” - Form M3-11 TRNG.

When the transmission output shaft centerline and axle input shaft centerline are parallel, the u-joint operating angle permissible is length of driveshaft divided by five. Example: A short coupled driveshaft with a 15" length would be limited to 3 degrees maximum operating angle. A 30" shaft would be limited to 6 degrees.

When the transmission output shaft centerline and axle input shaft centerline intersect midway of the driveshaft, the joint angles are equal. However, due to the change to unequal joint angles during up and down axle movement, this is a more undesirable condition than parallel centerlines.

In this case, the maximum u-joint operating angle is determined by dividing length of driveshaft by ten. Example: A 30" driveshaft with intersecting angles would have a 3 degree permissible operating angle.

CHECKING DRIVESHAFT ANGLES IN THE VERTICAL OR HORIZONTAL PLANE



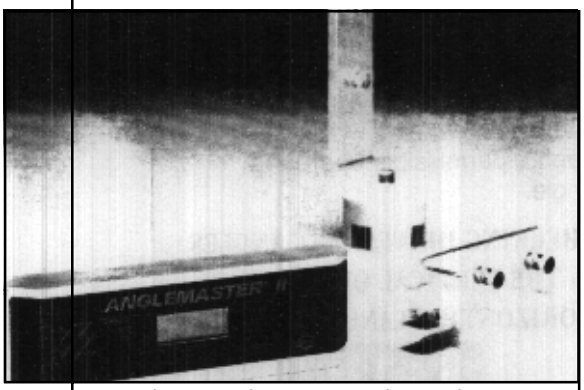
WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Use the following procedure to check driveshaft angles for proper u-joint operating angles.

1. Inflate all tires to the pressure at which they are normally operated. Park the vehicle on a surface which is as level as possible both from front-to-rear and from side-to-side. Do not attempt to level the vehicle by jacking up the front or rear axles. Shift the transmission to neutral and block the front tires. Jack up a rear wheel.

2. Rotate the wheel by hand until the output yoke on the transmission is vertical, and lower the jack. This simplifies measurement later. Check driveshaft angles in the same loaded or unloaded condition as when the vibrations or noise occurred. Always try to check driveline angles in both loaded and unloaded conditions.

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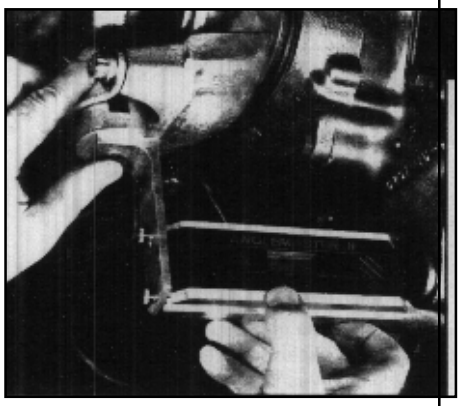
Spicer "Anglemaster II Electronic Driveline Inclinometer with available attachments

3. To determine driveshaft angles, a spirit level protractror or Spicer Anglemaster II Electronic Driveline Inclinometer is required. On a protractor, when angles are read from the 0 degree mark (horizontally - on the driveshaft) record and use the angle shown. When angles are read from either of the 90 degree marks (vertically - on the flange) do not record the angle shown on the protractor since the 90 degree marks must be understood to be the same as 0 degrees on the horizontal plane. Thus, if a vertical reading is 85 degrees, the angle being measured is 5 degrees (90 -85 = 5 degrees).

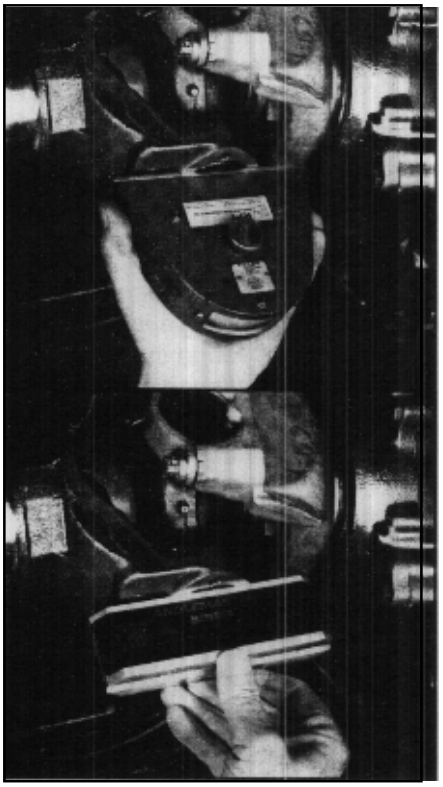
   To use the Spicer Anglemaster® II Electronic Driveline Inclinometer, simple plane the sensor on the component to be measured. A display module will show what the angle is and in which direction it slopes.

   (Available only from Dana Corporation and your Spicer Service Representative.)

If using a protractor, all angles should be read within 0.25 degree and get should be measured with the protractor held plumb on a clean flat surface. The Spicer Anglemaster II Electronic Driveline Inclinometer is automatically accurate to within 1/10 of 1 degree. Always measure the slope of the drivetrain going from front to rear. A component slopes downward if it is lower at the rear than the front. A component slopes upward when it is higher at the rear than it is in front.



4. Check and record the angle on the main transmission. This reading can be taken on the end yoke lug, with the bearing assembly removed or on a flat surface of the main transmission parallel or perpendicular to the output yoke lug plane. Record your readings on a sketch.

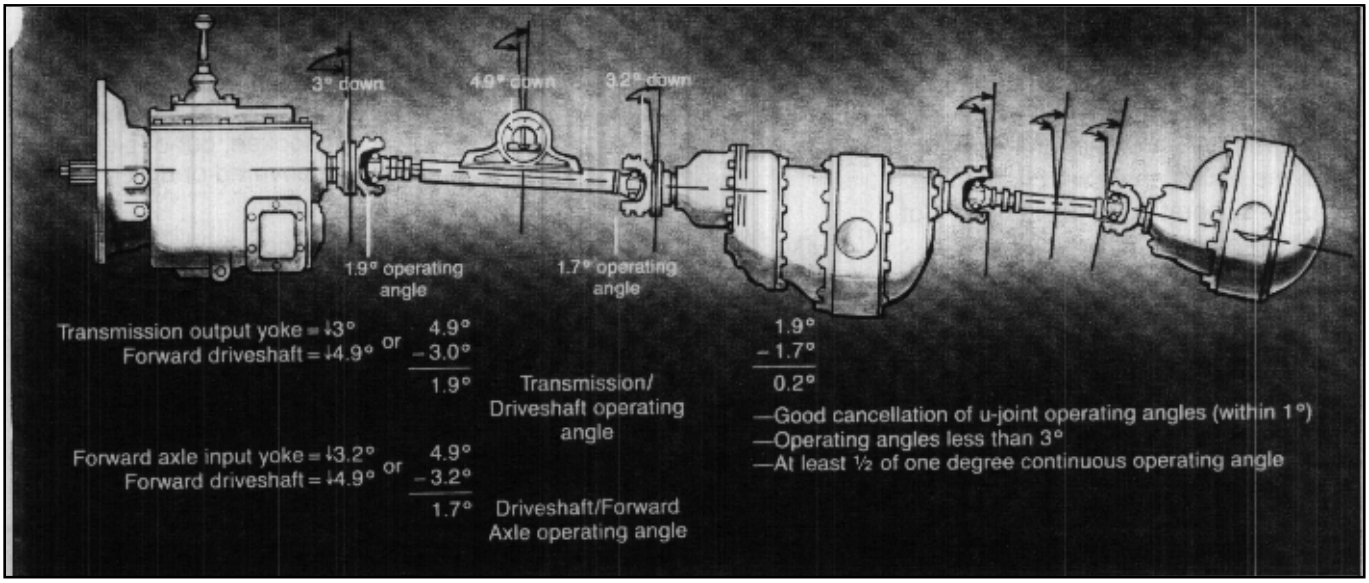


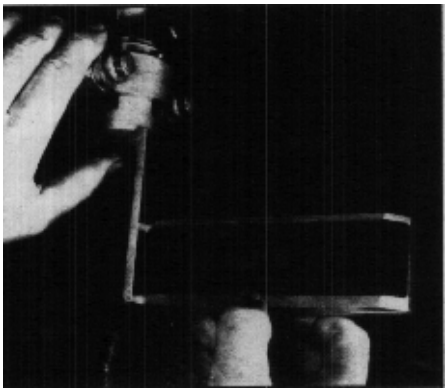
5. Now check the driveshaft angle between the transmission and axle or forward axle. On short tube length driveshafts, check the angle of the driveshaft on either the tube or slip yoke lug with the bearing assembly removed. On long tube length driveshafts, measure the angle on the tube at least 3" away from the circle welds or at least 1" away from any balance weights. Be sure to remove any rust, scale or sound deadening compounds from the tube to obtain an accurate measurement.

As 5 minute videotape that outline instructions for "Measuring and Calculating Driveline Operating Angles" is available at $60.00 from:

Spicer Universal Joint Division
Dana Corporation
P.O. Box 955
Toledo, Ohio 43695
Attn: Advertising Department

https://truckmanualshub.com/



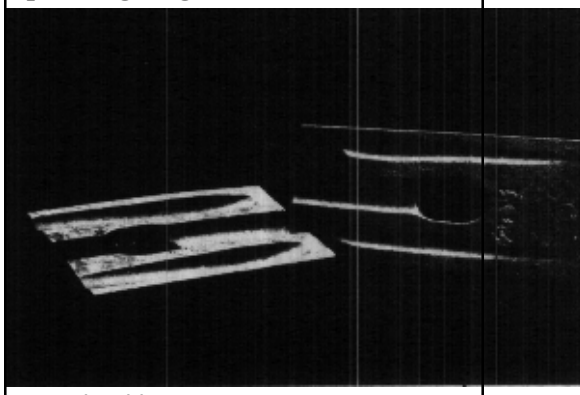


6. Check the forward axle input yoke angle by removing a bearing assembly and measuring the angle on the yoke lugs or on a flat surface of the angle housing parallel or perpendicular to the input yoke lug plane.
7. If applicable, measure the output yoke angle of the forward axle, the angle of the tandem driveshaft between the forward axle and the rear axle, and the rear axle input yoke angle.

With all of the angles recorded, complete a drawing as shown. There are no u-joint operating angles in your drawing at this time, just the slope of the components and their direction. To determine u-joint operating angles, simply find the difference in the slopes of the components.

When the slopes are in the **Same** direction on two connected components, **Subtract** the smaller number from the larger to find the u-joint operating angle. When the slopes are in the **Opposite** direction on two connected components, **Add** the measurements to find the u-joint operating angle. Now compare the u-joint operating angles on your drawing to the rules for ideal operating angles mentioned above.

Correcting U-Joint Operating Angles



Axle Shims

The recommended method for correcting severe u-joint operating angles depends on the vehicle suspension or driveline design.

On vehicles with leaf spring suspension, thin wedges called axle shims can be installed under the leaf springs of single axle vehicles to tilt the axle and correct u-joint operating angles. Wedges are available in a range of sizes to change pinion angles.

On vehicles with tandem axles, the torque rods can be shimmed. Torque rod shims rotate the axle pinion to change the u-joint operating angle. A longer or shorter torque rod may be available from the manufacturer if shimming is not practical. Some torque rods are adjustable.

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FIELD PROBLEM ANALYSIS

As a general rule, the addition or removal of a 1/4" shim from the rear torque arm will change the axle angle approximately 3/4 of a degree. A 3/4 of a degree change in the pinion angle will change the u-joint operating angle about 1/4 of a degree.

Always take the time to call the vehicle manufacturer if there are unusual u-joint operating angle problems. For detailed information on troubleshooting three u-joint or multiple-shaft driveline arrangements, contact your Spicer Service Representative.

What Causes U-joint Operating Angle To Change

- ✓ Suspension changes caused by:
  - worn bushings in the spring hangers
  - Worn bushings in the torque rods
  - incorrect airbag height
- ✓ Revisions in components of the driveline
- ✓ Stretching or shortening the Chassis
- ✓ Adding an auxiliary transmission or transfer case in the main driveline
- ✓ Worn engine mounts

Driveshaft Brake

When a driveshaft brake is used, care must be taken to see that the brake drum is properly piloted, runs true and is in balance.

FIELD PROBLEM ANALYSIS (All Types)



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

U-joint problems, as a rule, are of a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of u-joint deterioration are:

1. Vibration
2. U-joint looseness
3. U-joint discoloration due to excessive heat buildup
4. Inability to purge all four trunnion seals
5. An audible noise or squeal from the driveline

Lubrication-Related Problems

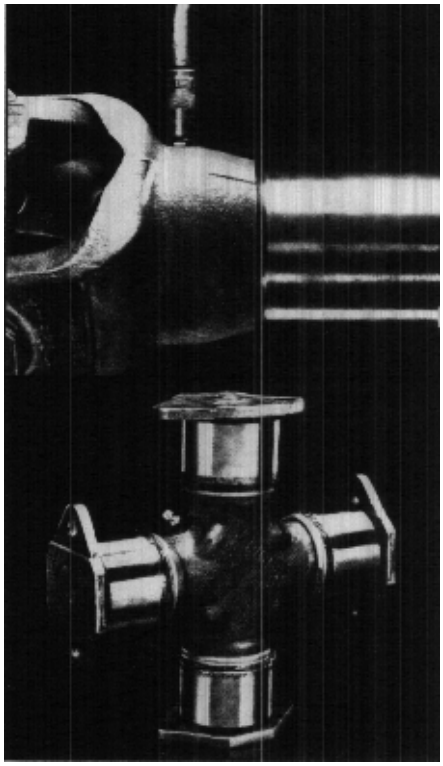
The most common reasons for u-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough.

On Quick-disconnect* applications, excessive bearing rotation could cause premature wear of components involved. The causes of rotation are:

1. Use of non-Spicer parts with Genuine Spicer components.
2. Improper torque on retaining strap bolts.
3. Failure to firmly seat both bearing assembles in the end yoke saddles before the strap bolts are tightened.
4. Dirty bearing saddles.

To avoid lubrication-related problems:

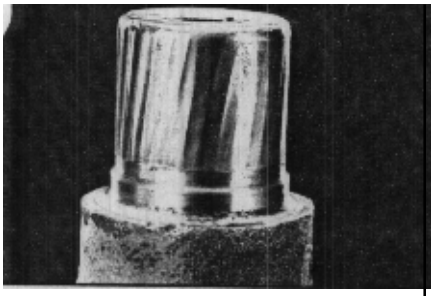
1. Lube all fittings including those that are often over looked, out-of-sight, dirt-covered or difficult to reach.
2. Know how some lube fittings appear different from regular chassis lube fittings and require a needle nose attachment needle nose attachment for the grease gun.
3. Don’t overlook slip yoke lubrication.



4. Use correct lube technique. N**ew Lube Must Flow From All Four Bearing Seals.**
5. Use correct lubricant. It should be a recommended type, such as N.L.G.I. Grade 1 or 2 with E.P. additives and high temperature resistance.
6. New u-joint must be lubricated when assembled into the driveshaft yokes.
7. Observe recommended lubrication cycle.
See chart of page 6.

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FIELD PROBLEM ANALYSIS



Brinelling

Generally, a lubrication problem is one of two types– brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling. Brinelling can also be caused by too much torque for the capacity of the u-joint used. End galling is a displacement of metal at the end of the trunnion and can also be related to angularity problems. Both of these problems can be caused by lack of lubrication.

Problems which are not a result of lubrication are associated with the installation, angles and speed of the driveshaft. Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high u-joint angles and driveshaft exceeding critical speed limitations.

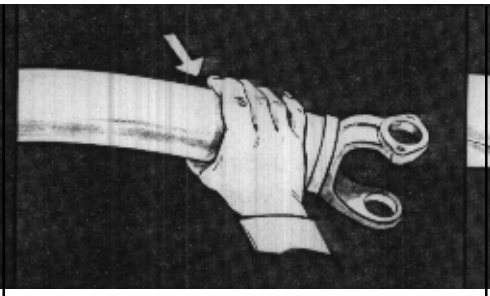


End Galling

VIBRATION-RELATED PROBLEMS

Vibration is a driveshaft problem that can be either transverse or torsional.

Transverse vibration is the result of unbalance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is



Transverse Vibration

created that increases with the square of the speed. The faster the shaft turns, the greater the unbalance force acting on the shaft.

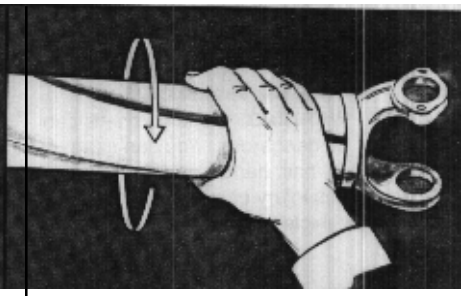
The force produced by this out-of-balance condition tends to bend the supporting members. As the supporting members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and the natural frequency of supports coincide.

Each end of the shaft must be balanced individually as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound wave that you can hear and mechanical shaking that you can feel. The force from out-of-balance increases with speed, not torque load. The driveshaft speed is determined by vehicle speed and the vibration is demonstrated best by rode testing the vehicle to operating speed, disengaging engine, and checking noises eliminated.

Torsional vibration, although similar in effect to transverse vibration, is an entirely different motion. The transverse vibration is a bending movement whereas torsional vibration is a twisting motion.

The energy to produce torsional vibration can occur from the



Torsional Vibration

power impulses of the engine or from improper u-joint angles. This type of vibration is difficult to identify in road testing but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

Torsional vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load (part-to-full throttle) usually affect the vibration. The nonuniform velocity obtained when a u-joint operates at an angle produces torsional vibration. In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimizes nonuniform velocity characteristics over the system.

It is practically impossible to maintain the desired joint angles throughout the operating range. Therefore, it is necessary to determine some maximum limit of torsional excitation which can be considered as generally acceptable.

The amount of torsional excitation which can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures and other units in the driveline and drivetrain system.

Other vibrational problems in a driveshaft could be caused by worn or damaged u-joints. These joints must be constantly maintained according to manufacturer's lubrication specifications.

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WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hands, etc. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

Complaints

VIBRATION

Low gear shudder
At certain speeds under full drive or full coast
Under light loaded conditions

Causes

Secondary couple load reaction at shaft support bearing
Improper phasing
Incompatible driveshaft
Driveshaft weight not compatible with engine-transmission mounting
Driveshaft too long for speed
Loose outside diameter fit on slip spline.
Excessively loose u-joint for speed
Driveshaft out of balance, not straight
Unequal u-joint angles
U-joint angle too large for continuous running
Worn u-joint
Inadequate torque on bearing plate cap screws
Torsional and/or inertial excitation

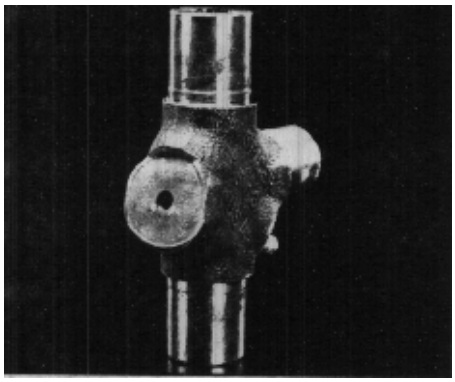
Corrections

Reduce u-joint continuous running angle
Replace u-joint
Install two piece driveshaft with shaft support bearing
Use larger diameter tube
Shim drivetrain components to equalize u-joint angles
Straighten and balance shaft
Check with transmission or axle manufacturer-replace shaft bearing
Inspect u-joint flex effort for looseness-torque to specification
Check driveshaft for correct yoke phasing.

Complaints

PREMATURE WEAR

Low mileage u-joint wear
Repeat u-joint wear
End galling of cross trunnion and bearing assembly
Needle rollers brinelled into
Broken cross and bearing assemblies



Broken Cross

Causes

End yoke cross hole misalignment
Excessive lubrication
Improper lubrication
Excessive u-bolt torque on retaining nuts
Excessive continuous running load
Continuous operation at high angle/high speed
Contamination and abrasion
Worn or damaged seals
Excessive torque load (shock loading) for u-joint and driveshaft size

Corrections

Use Spicer alignment bar to check for end yoke cross hole misalignment, replace end yoke if misaligned
Check u-Joint operating angles with a spirit level protector or Spicer Anglemaster II Electronic Driveline Inclinometer, reduce excessive u-joint operating angles
Lubricate according to Spicer specifications
Replace u-joint kit.
Reduce u-joint continuous running angle
Replace with higher capacity u-joint and driveshaft
Check u-joint flex effort–replace Joint or yoke if necessary
Clean and relubricate u-joint
Realign to proper running angle –minimum 1/2 degree
Torque bearing retention method to specification

Complaints

SLIP SPLINE WEAR
Seizure
Galling
Outside diameter wear at extremities and at 180 degrees
Spline shaft or tube broken in torsion

Causes

Improper lubrication
Worn or damaged part
Tube size inadequate
Excessive torque load for u-joints and driveshaft size
Male spline head engagement length too short for application
Excessive loose outside diameter fit
Slip member working in extreme extended or fully collapsed position
Contamination

Corrections

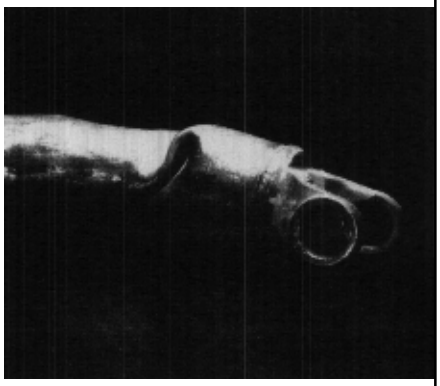
Lubricate slip spline according to Spicer specifications
Replace with higher capacity u-joint and driveshaft
Check u-joint flex effort-replace joint or yoke if necessary
Clean and relubricate according to Spicer specification
Replace spline-check design for application
Use Spicer Glidecote slip spline
Increase driveshaft assembly length to position slip spline head towards u-joint
Check for male slip member with longer spline
Use larger diameter tube

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Complaints

SHAfT AND/OR TUBE

Shaft support bearing wear or fracture
Shaft support rubber insulator wear or fracture
Tube circle weld fracture

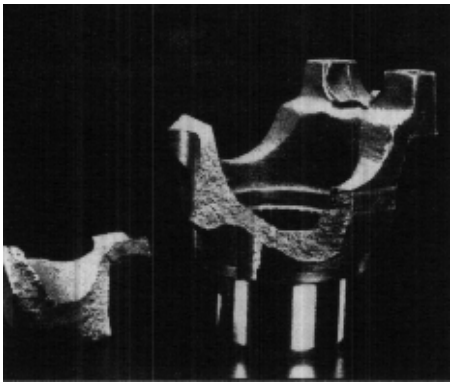


Causes

Balance weight located in apex of weld yoke lug area
Balance weight too close to circle weld
Improper circle weld
Bending fatigue due to secondary couple loads
Driveshaft too long for operating speeds
Worn or damaged parts
Excessive torque load (shock loading) for u-joint and driveshaft size
Improper lubrication of bearings
Shaft support bearing misaligned –interferes with slinger

Corrections

Reduce u-joint continuous running angle
Replace with higher capacity u-joint and driveshaft
Install two piece driveshaft with shaft support bearing
Use larger diameter tube
Normal bearing wear-replace
Realign mounting bracket to frame cross member to eliminate interference with slinger



Complaints

YOKE FRACTURE

Yoke broken in hub
Yoke broken at ear tip

Causes

Mating yoke lug interference at full jounce and rebound
Excessive torque load for u-joint and driveshaft size
Improper shaft length and slip
Bending fatigue due to secondary couple loads

Corrections

Reduce u-joint continuous running angles
Replace with higher capacity u-joint and driveshaft
Replace yoke–check design for application
Use wide angle yokes
Check installed lengths and adjust driveshaft length to provide proper slip conditions



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Refer to safety precaution section on inside front cover.

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GLOSSARY

ALIGNMENT BAR-a device (gauge) used to check yoke cross hole alignment.

BEARING ASSEMBLY-a hollow cup containing the needle roller bearings that ride on the cross trunnion.

BRINELLING-grooves from needle rollers marking and burning into trunnion. Usually caused by improper angles, lack of lubrication or too much load.

CARDAN-TYPE U-JOINT-a non-constant velocity u-joint which consists of two yokes connected by a cross through four bearings.

COMPOUND ANGLE-a driveline angle that is offset both vertically and horizontally.

CONSTANT VELOCITY (CV) U-JOINT-a u-joint which uniformly transmits motion at an angle without speed changes in the driven shaft.

CONTINUOUS OPERATING TORQUE- represents the constant torque load that a respective driveshaft or joint series will transmit over long periods of time, such as a direct drive installation.

COUPLING SHAFTS-are essentially extension members to the total drivetrain. In automotive applications these units are inserted ahead of the two joint assemblies and lead out of the power source, usually supported by a shaft support bearing. Used where one piece shafts would be too long.

CRITICAL SPEED-this is a phenomenon associated with any elastic shaft rotating at a high speed. At some specific speed the shaft will start to vibrate and, in some instances, the vibrations are so severe that the shaft will “whip” resulting in premature wear or fracture in the drivetrain system.

CROSS-the central component of the u-joint, connecting the input and output yokes.

CROSS HOLE-two parallel machined holes in the yoke lugs, which accept u-joint bearing assemblies.

DOUBLE-CARDAN CV JOINT - consists of two u-joints connected by a coupling yoke (double yoke) with internal supporting and centering means. The torsional vibrations of the two joints are cancelled so that power is transmitted smoothly.

DRIFT - a soft metal, usually brass, tool used to assist in removal of bearing assemblies from full round cross holes.

GALLING- a displacement of metal, usually caused by lack of lubrication, angularity problems, or over capacity loads.

GLIDECOTE - Dana patented coating for slip splines that extends life through reduction of friction.

HORSEPOWER - a unit of measure that denotes the amount of work done in a given period of time. 1 H.P = 550 lbs./ft. per second. The formula for horsepower is: H.P. = Torque x R.P.M./5252.

INCLINOMETER - an instrument for indicating the inclination of a driveline from the horizontal.

LUBE CYCLE - recommended time period for relubrication.

NEWTON-METERS (nm) - a unit of measurement for torque, comparable to lb./ft. One (1) lb./ft. = 1.355818 nm. One (1) nm = .73756 lb./ft.

PHASING (IN-LINE) - a relationship that exists between the yokes when they are in-line from “ear-to-ear” and their centerlines are parallel.

PHASING (OUT-OF-LINE) - a relationship that exists between the yokes when they are not in-fine from “ear-to-ear,” but are rotated relative to one another.

POSITIVE PURGING VALVE (PPV) - a lube valve that is pressed into the cross assembly of Genuine Spicer U-Joints. The PPV provides ease of purging and eliminates inadvertent dislocation from the cross when assembling or disassembling.

PURGE - completely flush out the clean, fresh lube at all four seals.

R.P.M. - revolutions per minute. R.P.M.= H.P. x 5252/Torque.

RENOUT - applies to the allowable off-center limits of a driveshaft.

SERRATED BOLT WITH LOCK PATCH - a bolt, identified by the under-head serrations and the lock patch coating on the threads, that replaces the lock strap design.

SHAFT SUPPORT (CENTER) BEARING ASSEMBLY - a mounted bearing assembly used when two or more driveshafts are required to reduce driveshaft length– supports the coupling shaft.

SHORT COUPLED JOINT - a driveline of yoke shaft and slip yoke construction similar to a two-joint assembly, used where space is restricted.

SHORT DURATION TORQUE - represents the u-joints capability to withstand momentary loading accompanying start-stop service.

SLIP YOKE (ALSO SLEEVE YOKE) - it is that component of the driveshaft that absorbs the axial movement of the vehicle thus allowing for length changes in the driveshaft.

T.I.R.- Total Indicator Reading, a measure of driveshaft runout.

TORQUE - twisting effort caused by the application of force. The formula for torque is: T = H. P. x 5252/R . P.M.

TORSIONAL ELASTIC LIMIT - represents the maximum torque load the u-joint or shaft will transmit instantaneously, without yield in any part.

TRUNNION - the four machined posts of the u-joint cross which serve as the inner bearing race.

TUBE (WELD) YOKE - permanent fitting at one or both ends of a driveshaft designed to fit a specific tube and u-joint assembly.

TWO-JOINT ASSEMBLY - these assemblies are in essence a complete driveshaft. The front end of the unit contains the slip joint while the rear is fitted with a permanent type joint.

U-JOINT COUPLING - consists of two yokes and a cross and bearing kit, a type of flexible coupling which can transmit torque and/or rotary motion from one shaft to another with fixed or changing angular misalignment.

U-JOINT DRIVESHAFT - a rotating shaft used for the transmission of torque and consisting of one or two u-joint couplings and a center section. It is capable of operating at an angle and usually with changes in length.

YOKE AND TUBE ASSEMBLY - a weld yoke and a piece of tubing attached at the factory available in various length and capacities suitable for field specialist tailoring.

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SPICER END YOKE CROSSHOLE ALIGNMENT AND WEAR GAUGES

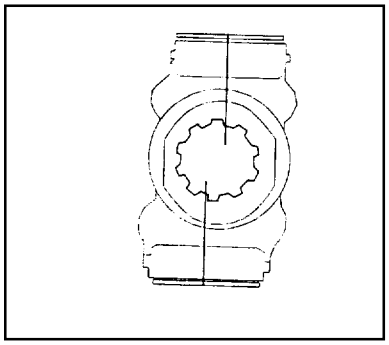
Now, it's easy to check crosshole alignment and wear on conventional full round and half round end yokes.

Spicer has developed two simple gauges to assist you in identifying out-of-spec u-joint componentry and increase parts sales.

Many times a u-joint kit premature failure is not the fault of the kit itself, but was caused by misalignment or worn crossholes can also be a contributing factor to driveshaft vibration, which can cause damage to both the transmission and the axle bearings.

Order Spicer alignment gauges today for your shop in-house maintenance or for resale to your customers.

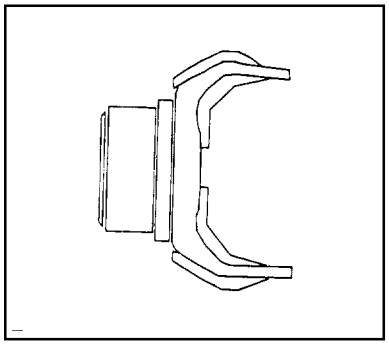
CAUSE AND EFFECT OF END YOKE CROSSHOLE MISALIGNMENT AND WEAR



CAUSE:
1. Excessive torque (overload)
2. Previous u-joint kit failure (heat distortion)

EFFECT:
1. Bearing misalignment
2. U-joint kit premature failure
3. Driveshaft vibration

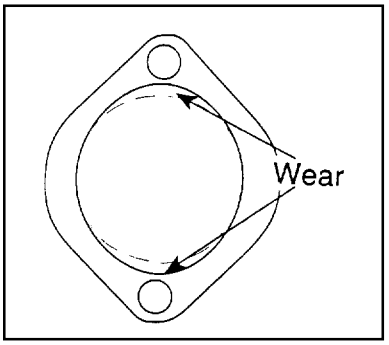
REMEDY:
1. Replace with new Spicer Yoke



CAUSE:
1. Improper u-joint kit disassembly procedures
2. Previous u-joint kit failure (heat distortion)

EFFECT:
1. Bearing misalignment
2. U-joint kit premature failure
3. Driveshaft vibration

REMEDY
1. Replace the Spicer Yoke



CAUSE:
1. Loose bearing plate cap screws (improper assembly)
2. Torsional Wear
3. Rust and corrosion

EFFECT:
1. Broken bearing plate weld (full round end yoke only)
2. Broken cap screws
3. Bearing misalignment
4. Continuing u-joint kit premature failures
5. Driveshaft vibration

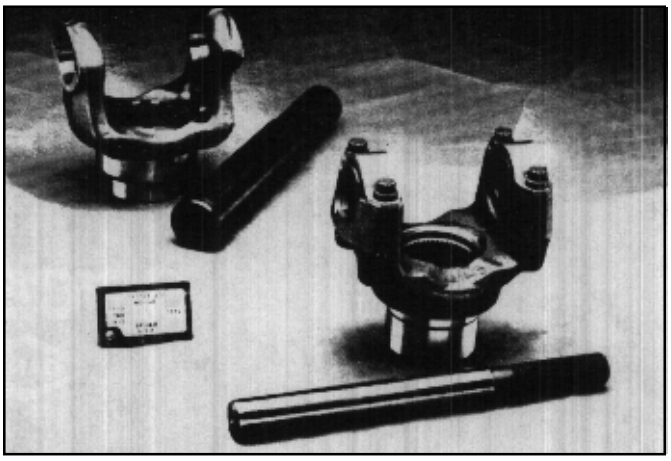
REMEDY:
1. Replace with new Spicer Yoke

Full Round End Yoke Gauges
Description

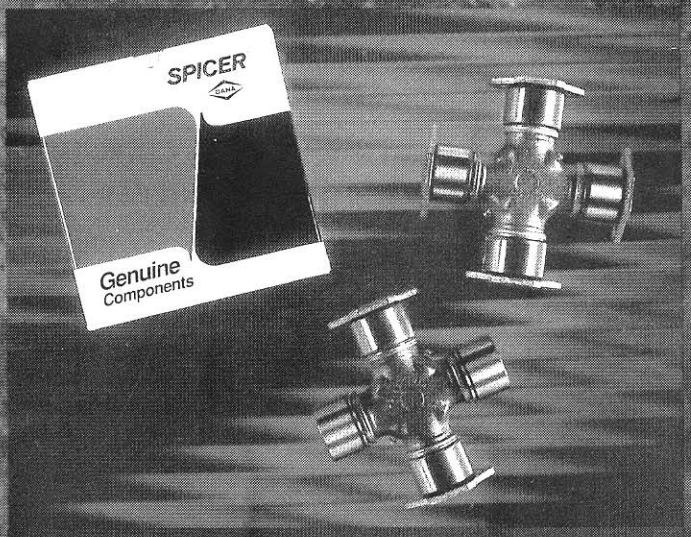
Gauge Set
1710 Alignment Gauge Only
1610 Alignment Gauge Only
Wear Gauge Only

Quick Disconnect™
Half Round End Yoke Gauges
Description
Gauge and Bushings Set (1610 -1810)

For further information, see your Spicer representative.



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Spicer...The name that guarantees you're buying the best.

Spicer Universal Joint Division
Dana Corporation
P.O. Box 955
Toledo, Ohio 43697-0955

SPICER®

DANA

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Form #3264-2 5/94

SERVICE MANUAL
SPICER® UNIVERSAL JOINTS AND DRIVESHAFTS
INDUSTRIAL APPLICATIONS

SAFETY PRECAUTIONS

This manual contains detailed safety instructions. Read, understand and follow this manual.

- ▲ Get proper training
- ▲ Learn and follow safe operating procedures
- ▲ Use proper tools and safety equipment
- ▲ Use proper components in good condition

A serious or fatal injury can occur...

- ▲ if you lack proper training
- ▲ if you fail to follow proper procedures
- ▲ if you do not use proper tools and safety equipment
- ▲ if you assemble driveline components improperly
- ▲ if you use incompatible driveline components
- ▲ if you use worn-out or damaged driveline components

in a non-approved application

Rotating driveshafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on driveshaft *(with or without a guard)* when machinery is operating.

If driveshaft is still exposed after installation, install a guard.

Guards cannot contain a driveshaft should it twist and separate.

Carefully read this service manual before beginning any work on your Spicer driveshaft.

Throughout this literature, you will see symbols that warn of potential physical danger or product damage if the accompanying instructions aren't followed. Here are the symbols and their meanings.

This symbol indicates a potentially hazardous situation. If the instructions aren't followed, the result could be death or serious injury. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc.

This symbol indicates that you must do something in order for the transmission to function properly. For example, you must use only one gasket underneath the shift tower. If it is eliminated, or more than one gasket is used, binding can occur. This would prevent proper shifting of the transmission and could damage the unit.

This symbol indicates that you must NOT do something in order to avoid damaging the transmission. For example, you must not use sealant underneath the shift tower. Using sealant underneath the tower will prevent proper interlock functioning and could damage the unit.

Be sure you understand all procedures and instructions in this manual before you begin working on your Spicer Driveshaft. If you have any questions, contact your Spicer representative.

ABOUT THIS MANUAL

Because of the many similarities between light, medium and heavy duty drivelines, this manual will present information as it relates to all three types. However, there are some basic differences among the three. Where this occurs it will be clearly noted.

Failure to follow procedures, recommendations and caution statements outlined in this manual may void the product warranty and could result in serious personal injury.

BASIC RULES TO UNIVERSAL JOINT DRIVESHAFTS

Even though driveshafts have the unique capability of accepting both axial and offset movements, the following precautions must be taken:

1. They must work in pairs.
A universal joint, working at an angle, will vibrate if it is not cancelled by another joint, at the opposite end of the shaft, working at the same angle and in the same plane. *(See Figures 1 and 2)*

SINGLE SHAFT STANDARD INSTALLATION PARALLEL

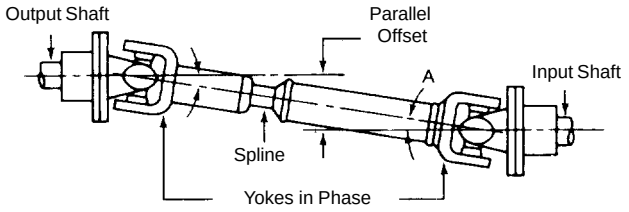


Figure 1

In the standard installation the output and input shafts must be parallel.

SINGLE SHAFT ALTERNATE INSTALLATION

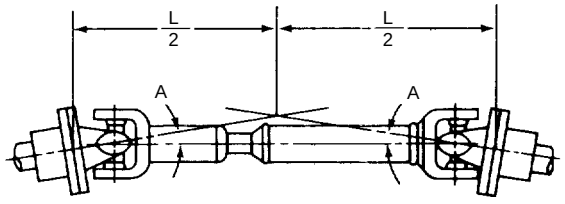


Figure 2

In the alternate installation the centerlines of the output and input shafts must intersect at the center of the driveshaft.

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2. Joint angles must be equal to within one degree. Joints, working in pairs will vibrate if they are not working at the same angle to within one degree.

3. Yokes must be in phase *(Figure 1)*

Joints, working in pairs, will vibrate if their yoke ears are not in the same plane to within two degrees.

4. In the standard installation *(Figure 1)* the output and input shafts must be parallel.

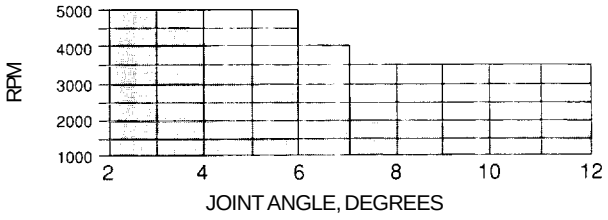
5. In the alternate installation *(Figure 2)* the centerlines of the output and input shafts must intersect at the center of the driveshaft.

6. Slight working angles *(approx 1/2 to 1 degree)* are preferred to provide needle bearing rolling action. Working angle should be 2° if prime mover is an internal combustion engine.

⊘ Never run a u-joint at 0 angle for long periods of time. Premature failure will occur.

7. Maximum joint angle and RPM combination cannot be exceeded.
A shaft, between two joints working at an angle, will accelerate and decelerate as the shaft rotates. The higher the RPM and the greater the angle, the higher the rate of acceleration and deceleration. As the rate increases it will cause a vibration. (*See Graph 1*)

MAXIMUM JOINT RPM & ANGLE COMBINATIONS



Graph 1

8. To calculate actual working angle refer to Figure 3. Determine the length in inches from centerline of yoke holes and parallel offset in inches. Refer to *(Table 1)* for actual working angle of your application. *(Contact Spicer application engineering for assistance.)*

FIGURE 3

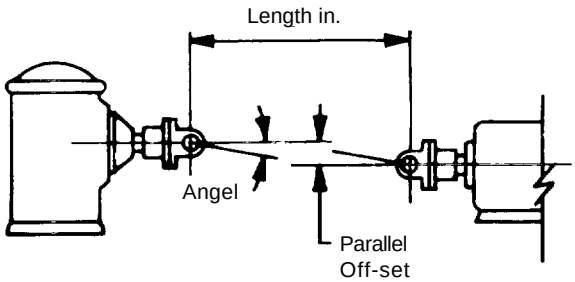


TABLE 1

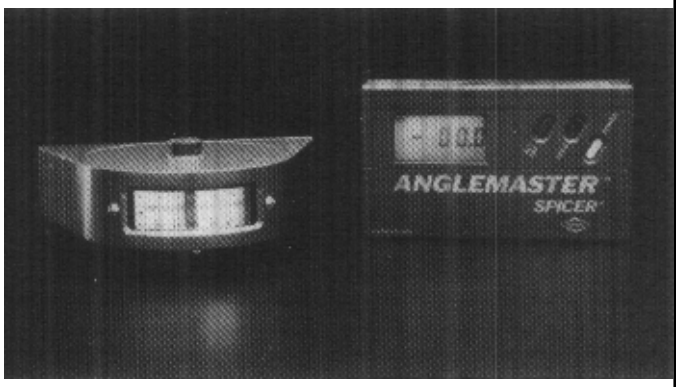
DEGREES

HORIZONTAL LENGTH BETWEEN JOINT CENTERS INCHES	1	2	3	4	5	6	7	8	9
12	**.2**	**.4**	**.6**	**.8**	**1.0**	**1.2**	**1.5**	**1.7**	**1.9**
24	.4	.8	1.3	1.7	2.1	2.5	2.9	3.3	3.7
36	.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.6
48	.8	1.7	2.5	3.1	4.2	5.0	5.8	6.7	7.5
60	1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.3	9.4
72	1.3	2.5	3.8	5.0	6.3	7.5	8.8	10.0	11.3
84	1.5	2.9	4.4	5.9	7.3	8.8	10.2	11.7	13.1
96	1.7	3.4	5.0	6.7	8.4	10.0	11.7	13.4	15.0
108	1.9	3.8	5.6	7.5	9.4	11.3	13.2	15.0	16.9
120	2.1	4.2	6.3	8.4	10.5	12.5	14.6	16.7	18.8

OFFSET IN INCHES

Use this table to determine joint angle or offset

9. To determine driveshaft angles, a spirit level protractor or Spicer Anglemaster® Electronic Driveline Inclinometer is required *(See Photo).* On a protractor, when angles are read from the o degree mark (horizontally—on the driveshaft) record and use the angle shown. When angles are read from either of the 90 degree marks (vertically—on the flange) do not record the angle shown on the protractor since the 90 degree marks must be understood to be the same as 0 degrees on the horizontal plane. Thus, if a vertical reading is 85 degrees, the angle being measured is 5 degrees (90-85=5 degrees).



Spirit Level Protractor and Spicer "Anglemaster® " Inclinometer

To use the Spicer Anglemaster Electronic Driveline Inclinometer, simply place the sensor on the component to be measured. A display module will show what the angle is and in which direction it slopes. *(Available only from Dana Corporation and your Spicer Service Representative.)*

If using a protractor, all angles should be read within 1/4 degree and they should be measured with the protractor held plumb on a clean flat surface. The Spicer Anglemaster Electronic Driveline Inclinometer is automatically accurate to within 1/10 of 1 degree.

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TRANSPORT AND STORAGE

Universal shafts are delivered as complete units.

Care should be taken with the following points:

The shafts should be transported in horizontal position. *(Figure 4)* For vertical installations additional protection must be provided in order to eliminate the possibility of driveshaft from coming apart at the Spline connection *(Slip Joint Figure 5).* Hemp or nylon rope should be used (for small shafts only).

⊘ ***CAUTION:*** *The dust cap and spline seal could be damaged by incorrectly hanging the driveshaft in a vertical position.*

A SPICER HORIZONTAL SLUNG SHAFT

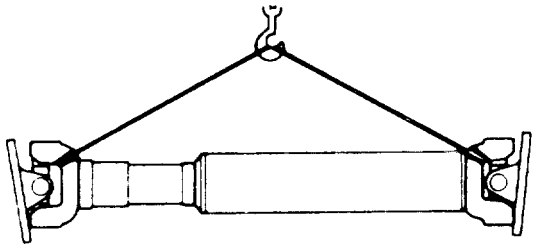


Figure 4

Shocks and bumps should be avoided during transport and storage, because the end cap could be pressed out.

Balance weights should not be removed. Unbalance will cause uneven running and premature wear of the universal shaft and the bearings of the connected units.

Shocks, bumps, and mishandling must be avoided to assure proper performance. Abuse could result in bending the driveshaft causing whipping and unbalance problems. Damage of this nature will VOID the warranty.

VERTICAL

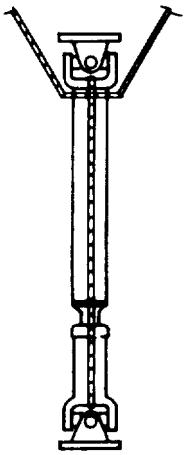


Figure 5

Damage to cartons or crates during shipping is the responsibility of the freight carrier and consignee and must be noted or reported at time of receipt of shipment.

Driveshafts which have been stored for a long period of time, should be re-greased in working position prior to start up. See Lubrication section.

COMPANION FLANGE INSTALLATION

Spicer manufactures a complete line of companion flanges to allow Spicer driveshafts easy connection to driver and driven shafts.

Stock bored flanges are bored with a plus .001 " minus .000" tolerance and should be a slip fit over mating shaft. Align keyways in both the flange and shaft and gently tap flange on.

The shaft should not extend beyond flange face. The **recommended** amount of shaft engagement with flange hub is 1.5 times the bore diameter. Less than this could lead to premature failure. After flange is correctly positioned on shaft, tighten all set-screws to proper torque specification. *(Table 2)*

SET SCREW TIGHTENING TORQUES

KEY WIDTH	SIZE	SET SCREW TORQUE
Below .313 in.	1/4-28 x .375 in.	6 lb.ft.
.313 to .500	3/8-16 x .500 in.	20 lb.ft.
.501 to .750	1/2-13 x .750 in.	50 lb.ft.
Over .750	3/4-10 x 1.00 in.	170 lb.ft.

Table 2

After installing companion flange, check runout of companion flange pilot *(.003 T.I.R. maximum permissible) (See Figure 6)*

FLANGE & SHAFT

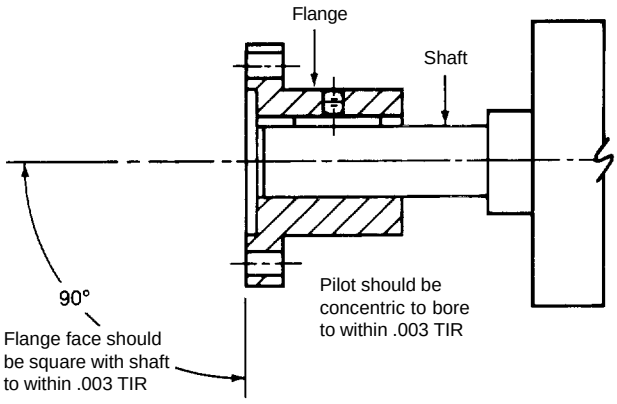


Figure 6

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There are two types of standard Spicer industrial companion flanges. *(Figure 7)*

FRICTIONAL FACE DRIVE DESIGN

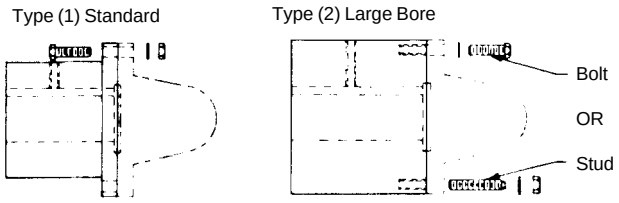


Figure 7

Type 1: Utilizes bolt, nut and lockwashers which are installed after seating the driveshaft on the pilot diameters.

Type 2: Utilizes either bolts with lockwashers or a stud with lockwasher and nut. This special large flange allows for larger bore capacity than standard type 1 flanges.

⊘ Do not paint or lubricate the face of companion flanges or driveshaft flanges. Remove any paint or oil before final assembly. This type of driveshaft connection transmits torque through friction **not the bolts.** Failure to properly clean flange faces **and** torque flange bolts to proper specifications (Table 3) will lead to premature failure of flange connection.

FLANGE BOLT SPECIFICATIONS

Bolt Size	Grade	Used on Series	Tightening Torque
5/16-24NF	8	1000-1550	22-26 Lb.Ft.
3/8-24NF		1310 1610 1710	40-48 Lb.Ft.
7/16-20NF		1350 1410 1810	63-75 Lb.Ft.
1/2-20NF		1480 1550	97-116 Lb.Ft.
5/8-18NF		1880 1910	194-232 Lb.Ft.

Table 3

Interference or shrink fits require heating the flange uniformly *(preferably submerged in oil not exceeding 350°F)* to expand the bore. Align the keyways in both the shaft and flange onto shaft and allow to cool. Tighten set screws to recommended torque *(Table 2)* Check run-out of flange pilot. *(Figure 6)*

To properly install tapered bore flanges a great deal of care is necessary to insure a proper interference fit exists between shaft and flange. All Spicer tapered bores are S.A.E tapers *(1 1/2" per ft.)* and require an interference fit of .001" to .002" for shafting series 1710 and smaller.... and .002" to .004" for shafting 1810 and larger. *(Graph 2)* shows the amount the flange has to be advanced to maintain a given interference. Use a dial indicator as shown in *(Figure 8)* to measure advancement.

GRAPH 2

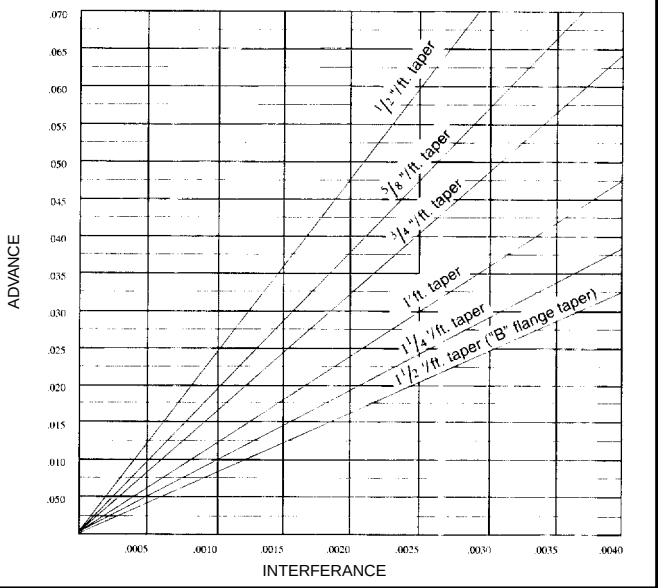
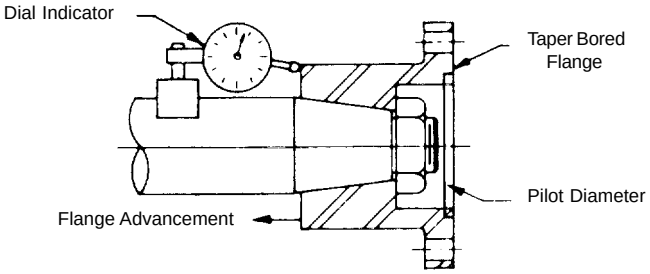


FIGURE 8



Note: *To facilitate installation and removal, it is recommended that a light oil be used on shaft and threads.*

1. Install tapered flange onto shaft.

2. Attach dial indicator *(Figure 8)* to shaft and begin tightening nut until proper advancement is obtained.

3. Tighten all set screws to recommended torque values. *(Table 2)*

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In vertical applications, most of the shaft weight is supported from the upper companion flange. We recommend that when a driveshaft or multiple section driveshaft installation weighs over 150 lbs., it be supported in one of the following ways:

1. Use flanges with an **extra set screw** 90°F from the keyway *(Do not use with driveshafts weighing over 300 lbs.).*

2. Use special bored flanges with the bore machined undersized for a shrink fit *(refer to instructions above for proper installation of shrink fits.)*

3. Use flanges with a counter bore for a split ring adapter. *(Consult Spicer Engineering)*

4. Use flanges with a taper bore. *(Consult Spicer Engineering)*

INSTALLATION OF DRIVESHAFT

Spicer industrial driveshafts are manufactured and assembled to exacting standards. Care should be taken not to drop or mishandle as precision components (spline, bearings, etc.) may be damaged voidiing your warranty

Before installing a Spicer Industrial Driveshaft:

1. Check that spline moves smoothly in and out. *(on shafts with in-board slip only)*

2. Check that all u-bolts and bearing straps are properly torqued *(Table 4)* or that all snap-rings are fully seated in yokes.

3. Remove all paint and solvents from flange yoke face. The flange connections transmit torque through friction. Failure to properly clean and torque flanges can result in premature failure of the driveshaft connection. *(Table 3)*

TORQUE SPECS FOR LIGHT & MEDIUM DUTY

TYPE	BOLT SIZE	TORQUE(LB./FT.)
U-Bolts	(5/16) .312-24 (3/8) .375-24 (7/16) .438-20	14-17 20-24 32-37
Bearing Strap	(1/4) .250-28 (5/16) .312-24 (3/8) .375-24	13-18 25-30 45-60

Table 4

HORIZONTAL APPLICATION (Single Section)

HORIZONTAL APPLICATION SINGLE SECTION

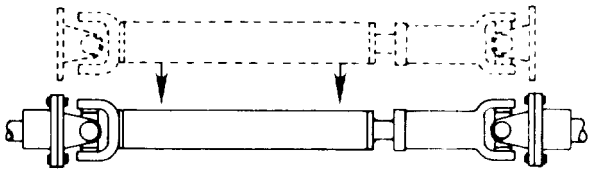


Figure 9

To install driveshaft:

1. Check that flanges are properly installed.

2. Check that working angles are within specifications.

3. Compress driveshaft and lower into position between companion flanges. Extend ends so that flange yoke pilot is seated firmly into mating companion flange and bolt holes are lined up. Insert bolts, nuts, and lock washers *(depending on flange design).* Torque flange bolts to specified torque indicated in *(Table 3).*

4. Lubricate all joints, splines and steady bearings before start up. Pressure lube cross until lube appears at all four needle bearing seals. *(See lubrication section)*

5. Foundations for all installations must be adequate since most power units will vibrate to some extent. Proper steel beams or concrete foundation, with hold down bolts, are necessary to maintain alignment and to eliminate damaging vibrations. Inadequate foundations will void the warranty.
Check that all support bolts are properly torqued.

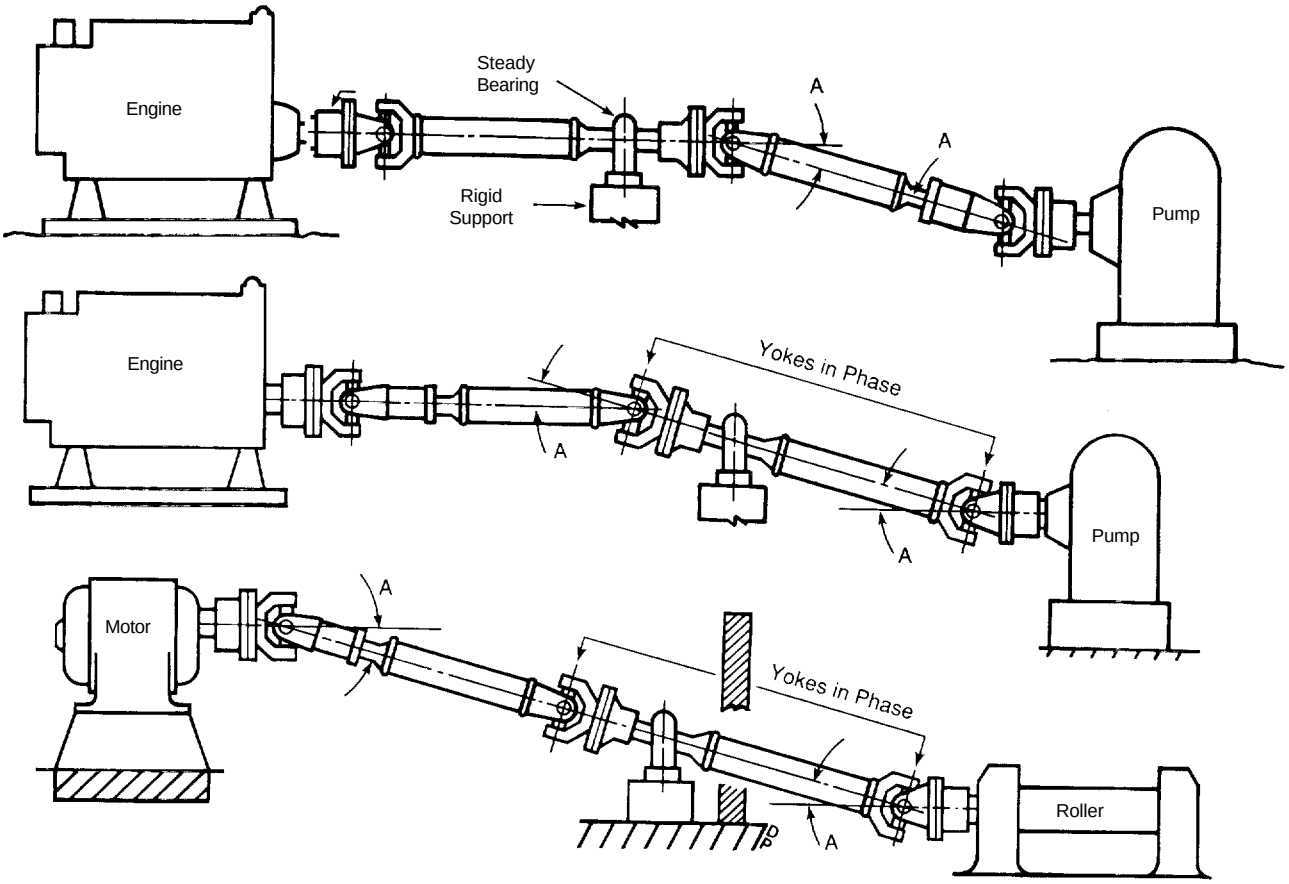
6. Before start-up, replace shaft guard. If no guard exists, **install one!**

7. With shaft guard installed and all bolts torqued to specification, the shaft may now begin rotating. If possible, run at low speed for few minutes. Observe driver and driven equipment for any unusual vibration. Your Spicer industrial driveshaft is pre-balanced at the factory. Should shaft vibration become excessive, stop prime mover and contact Spicer Application Engineering.

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MULTIPLE SHAFT HORIZONTAL APPLICATIONS

FIGURE 10



Joint angles "A" must be equal to within one degree and yokes are in phase.

Horizontal Application *(Multiple sections)* Where a single section driveshaft can not be used because of length or other restrictions, multiple driveshafts of two or more sections may be used.

In this type of installation, it is important that the ears on the yokes are in line after assembly as shown *(also referred to as Phasing). (See Figure 10)*

Multiple shaft applications require great care in design and installation. Most importantly, the supporting structures need special attention.

Supporting Structures:

a. Foundations for all installations must be adequate since most power units will vibrate to some extent. Proper steel beams or concrete foundation, with hold down bolts, are necessary to maintain alignment and to eliminate damaging vibrations. Inadequate foundations will void the warranty.

b. Steady bearing supports must have enough rigidity to avoid vibrations. It is recommended that the following suggestions be observed:

1. Keep spans as short as possible.
2. Make end connections rigid.
3. Use rigid beams and install so that the principal section modulus opposes the applied forces.
4. Beam size should be selected so that the horizontal and vertical natural frequency of the beam is 4 times greater than the maximum system R.P.M.

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All members *(shafts, foundations, supports, motors and pumps, etc.)* have a natural frequency at which they will vibrate *(resonate)*. This frequency with the drive train fully assembled, must not coincide with the operating R.P.M. Contact Spicer Application Engineering for assistance in analysis of system natural frequency.

To Install Multiple Section Driveshafts:

1. Mount companion flanges on input and output shafts per instructions on page 3.

2. Bolt down steady bearings.

3. Slide "B" stub driveshaft into bearing and connect to companion flange. Torque flange mounting bolts to specifications in *(Table 3).*

4. Continue assembly of remaining driveshafts by connecting flanges and torquing to specification in (Table 3).

5. Install shaft guards. If no guard exists, **Install One!**

6. With shaft guards securely mounted and all bolts torqued to specifications, the driveshaft may now begin to rotate. If possible, run at low rotating speed for a few minutes and observe for any unusual vibrations. Contact Spicer Application Engineering for assistance.

INSPECTION AND LUBRICATION

To keep your machinery operating smoothly and economically, the driveshaft must be carefully inspected and lubricated at regular intervals. Vibrations, u-joint and center bearing problems are caused by such things as loose companion flanges, excessive radial looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.

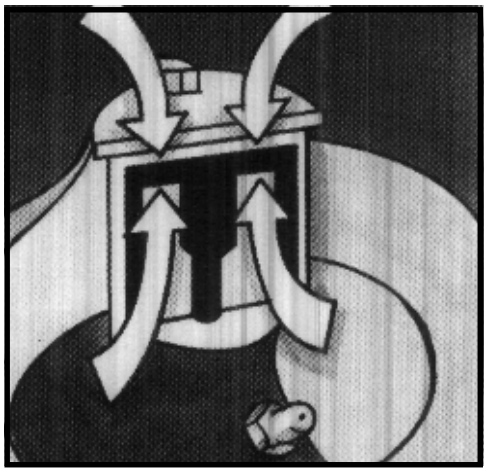
Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on a shaft (with or without a guard) when the engine is running.

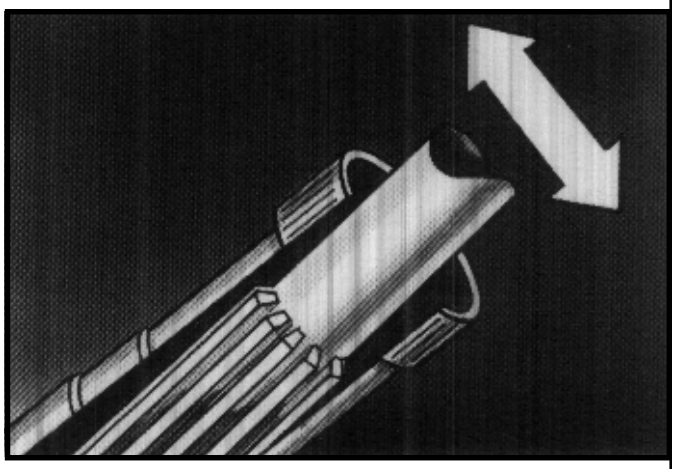
GENERAL INSPECTION

1. Check companion flanges on both input and output for looseness.

2. Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006 inches maximum.



3. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .007 inches.



4. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft. If found, foreign material should be removed carefully to avoid damage to the driveshaft.

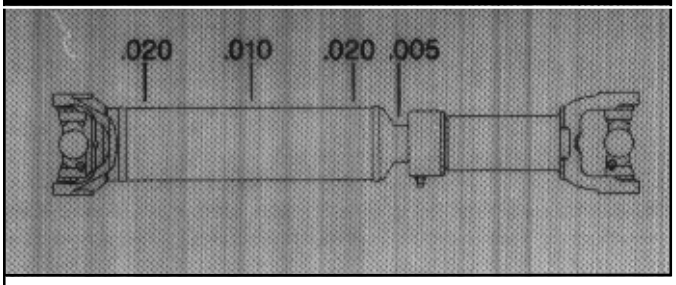
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5. If runout readings are required, they should be taken with the driveshaft mounted such that it will rotate by hand.

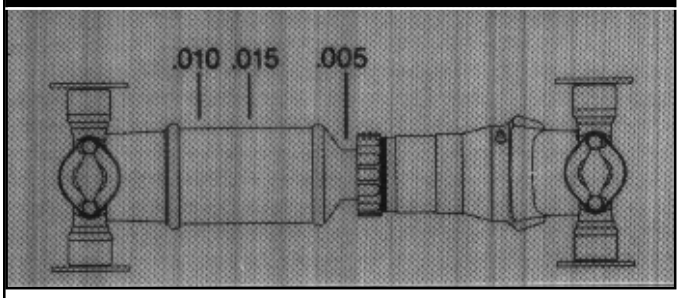
The runout readings taken at the various locations should not exceed an additional 0.010 T.I.R. over the manufacturer's specified runout.

Do not try to take runout readings from a rotating driveshaft under power!

HEAVY DUTY DRIVESHAFT RUNOUT LIMITS



LIGHT & MEDIUM DUTY DRIVESHAFT RUNOUT LIMITS FOR UNBALANCED DRIVESHAFT



HEAVY DUTY (1610-1880)

0.005 T.I.R. on the neck of the slip tube shaft.

0.010 T.I.R. on ends of tubing 3" from welds.

0.015 T.I.R. at linear center of the tube

LIGHT AND MEDIUM DUTY

0.005 T.I.R. on the neck of the slip tube shaft.

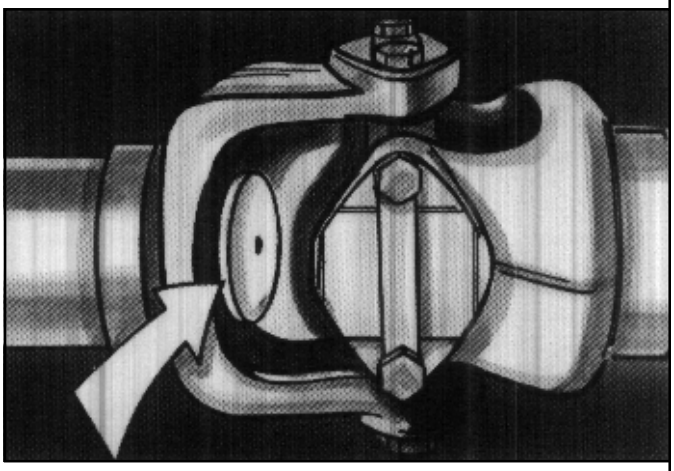
0.020 T.I.R. on ends of tubing 3" from welds.

0.010 T.I.R. at linear center of the tube.

0.020 T.I.R. for full length of tube with 30" or less.

(T. I. R. —Total Indicator Reading)

6. For inboard and outboard slip yoke assembly designs, check to be sure the plug is not loose or missing...if it is, repair or replace it. Loose or missing plugs are commonly caused by not enough driveshaft slip movement.



LUBRICATION

New universal shafts are supplied with grease lubrication only.

Lubrication
Among the most common causes of joint and slip spline problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately relubricated at recommended intervals will meet or exceed Spicer's performance specifications. Relubrication flushes the joints thus removing abrasive contaminants from the bearings.

Lubricants for Universal Joints
For a normal application, use a good quality high temperature lithium soap base extreme pressure (E.P.) grease meeting the *N.L.G.I. Grade 2 specifications. Grades 3 and 4 are not recommended because of their greater thickness.

For a severe application, use a good quality lithium soap base or equivalent E.P. grease. In addition, the grease should meet the N.L.G.I. grade 2 specifications.

Consult your local lubricant source for greases that meet these specifications.

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Recommended Greases:

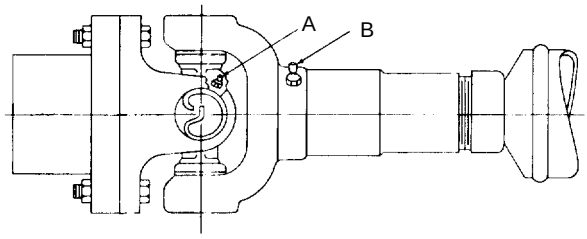
	NLGI*	
Chevron Heavy Duty Grease	2*	Chevron Oil Company
Rykon Premium Grease No. 2	2*	Amoco Oil Company
JT6 Hi-Temp	2*	Cato Oil
Chevron Ultra Duty Grease 2	2*	Chevron Oil Company
Mobil L199	2*	Mobil Oil Corporation
Chemplus EP-2BG	2*	Chemtool, Inc.

* National Lubricating Grease Institute

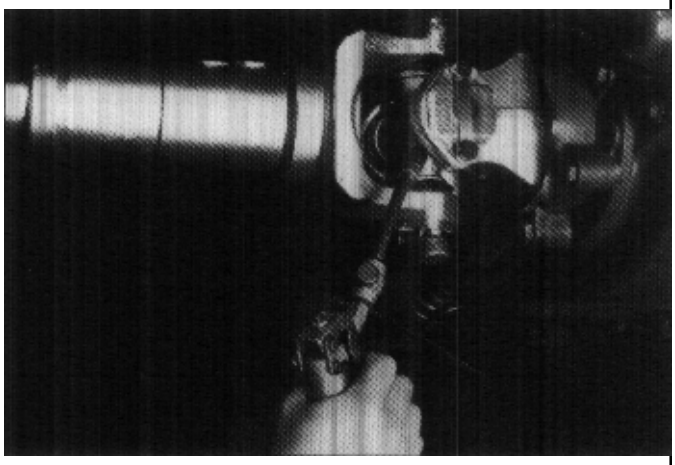
LUBRICATION PROCEDURE

Relubrication cycles vary depending on the application and operating conditions. In general, to obtain maximum life of Spicer industrial driveshaft components, lubricate points A and B *(Figure X)*. Every 500 hours of normal service or every 200 hours of continuous service.

FIGURE X

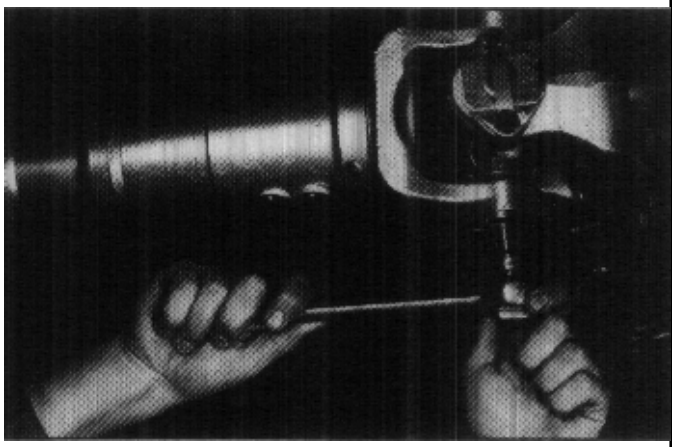


1. Use the proper lubricant to purge all four seals of each u-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Spicer seals are made to be popped.



2. On center twin zerk design or single zerk kits, if any seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. For light-duty kits, check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

3. Because of the superior sealing capability of the Spicer seal design on the 1610, 1710, 1760, 1810, and 1880 Series, there will occasionally be one or more bearing assembly seals that will not purge.



Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1/16 inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

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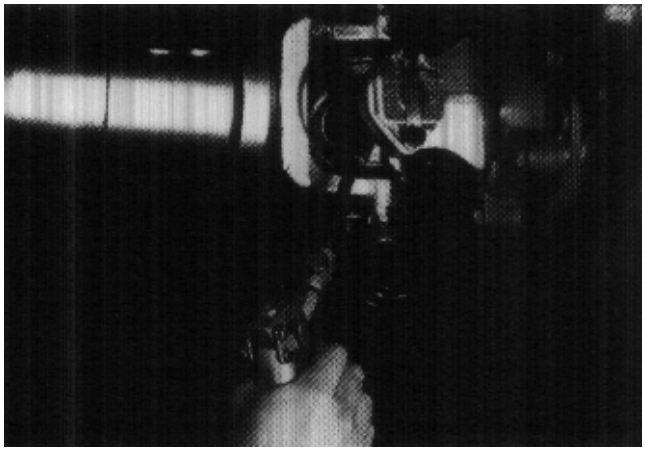
SERIES	THREAD SIZE	CAP SCREW TORQUE (lb./ft.)
1610	(5/16) .312-24	15-26
1710	(3/8) .375-24	28-48
1760	(3/8) .375-24	28-48
1810	(3/8) .375-24	28-48
1880	(7/16) .438-20	48-75

CAUTION: *Half Round End Yoke self-locking retaining bolts should not be reused more than (5) five times. Follow instructions implicitly to prevent serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.*

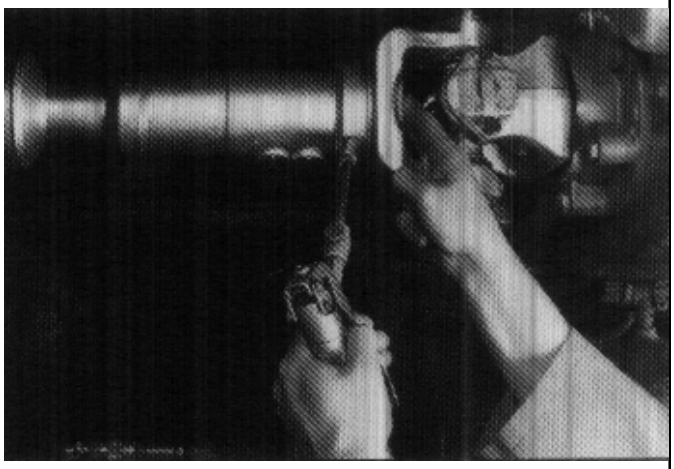
Lubrication for Slip Splines

The lubricant used for u-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting N.L.G.I. Grade 2 specifications.

Relube splines at the intervals recommended for u-joints.



1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.



2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

CAUTION: *In cold temperatures be sure to operate your machine immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize. Personal injury or death may result from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.*

FIELD PROBLEM ANALYSIS

U-joint problems, as a rule, are of a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of u-joint deterioration are:

1. Vibration
2. U-joint looseness
3. U-joint discoloration due to excessive heat build-up
4. Inability to purge all four trunnion seals
5. An audible noise or squeal from the driveline

Lubrication-Related Problems

The most common reasons for u-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough. To avoid lubrication-related problems:

1. Lube all fittings including those that are often overlooked, out-of-sight, dirt-covered or difficult to reach.

2. Know how some lube fittings appear different from regular lube fittings and require a needle nose attachment for the grease gun.

3. Don't overlook slip yoke lubrication.

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4. Use correct lube technique. ***New Lube Must Flow From All Four Bearing Seals.***

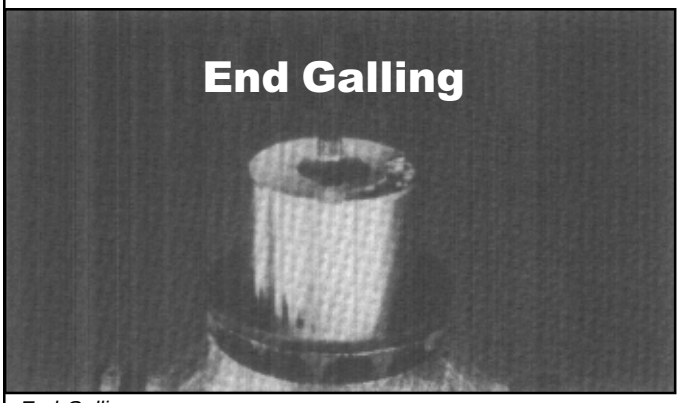
5. Use correct lubricant. It should be a recommended type, such as N.L.G.I. Grade 1 or 2 with E.P. additives and high temperature resistance.

6. New u-joints must be lubricated when assembled into the driveshaft yokes.

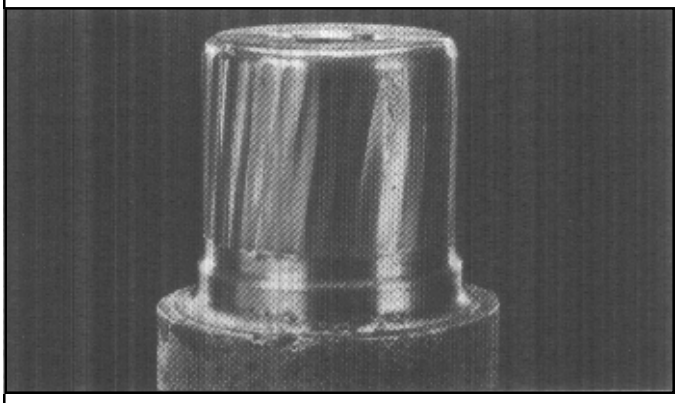
7. Observe recommended lubrication cycle.

Generally, a lubrication problem is one of two types- brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling. Brinelling can also be caused by too much torque for the capacity or the u-joint used. End galling is a displacement of metal at the end of the trunnion and can also be related to angularity problems. Both of these problems can be caused by lack of lubrication.

Problems which are not a result of lubrication are associated with the installation, angles and speed of the driveshaft. Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high u-joint angles and driveshaft lengths exceeding critical speed limitations.



End Galling

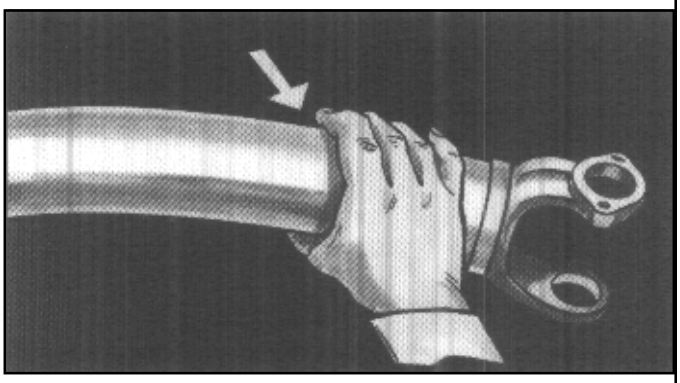


Brinelling

FIELD PROBLEM ANALYSIS (All Types)

Vibration Related Problems

Vibration is a driveshaft problem that can be either transverse or torsional.



Transverse Vibration

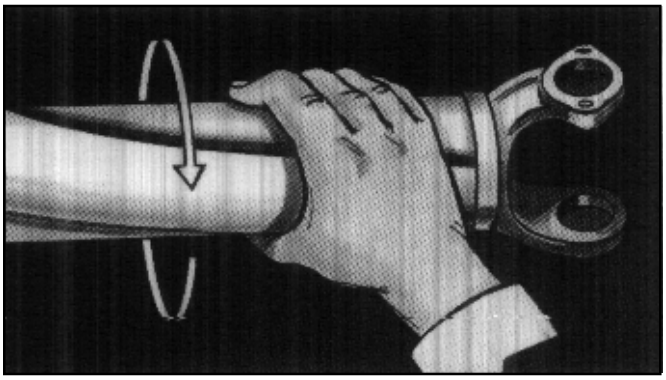
Transverse vibration is the result of unbalance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is created that increases with the square of the speed. The faster the shaft turns, the greater the unbalanced force acting on the shaft.

The force produced by this out-of-balance condition tends to bend the supporting members. As the members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and the natural frequency of supports coincide.

Each end of the shaft must be balanced individually as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound waves that you can hear and mechanical shaking that you can feel. The force from out-of-balance increases with speed, not torque load.

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Torsional vibration, although similar in effect to transverse vibration, is an entirely different motion. The transverse vibration is a bending movement, whereas torsional vibration is a twisting motion.

The energy to produce torsional vibration can occur from the power impulses of the engine or from improper u-joint angles. This type of vibration is difficult to identify but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

Torsional vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load usually effect the vibration. The nonuniform velocity obtained when a u-joint operates at an angle produces torsional vibration. In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimizes nonuniform velocity characteristics over the system. The amount of torsional excitation which can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures and other units in the driveline and drivetrain system. Other vibrational problems in a driveshaft could be caused by worn or damaged u-joints. These joints must be constantly maintained according to Spicer lubrication specifications,

Repair

The repair of universal shafts should be carried out by our universal driveshaft service experts. Here the overhaul is done by using genuine parts. The repair of universal shafts in the user's own workshop should be undertaken for emergency only and can be done for equipment only where the working speed does not exceed 300 rpm. Above 300 rpm the universal shafts must be balanced. Contact your local Spicer Distributor for Quality Repair Service.

SPICER®

DANA

Spicer Driveshaft Division
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Toledo, Ohio 43612
Telephone (419) 727-2660 Fax (419) 727-2666

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Important rim and wheel safety precautions

NOTICE!

An inflated tire and rim can be very dangerous if misused or worn-out. Many accidents, some fatal, have resulted from improper handling and operation of truck rims and wheels. It is, therefore, of the utmost importance that the precautions outlined on this page be carefully followed by all persons servicing truck rims and wheels to avoid personal injuries and costly damage.

How to prevent rim accidents during tire mounting

Always inflate tire in safety cage or use a portable lock ring guard. This is a safeguard against improper assembly, inadvertently mismatched parts, and other assembly errors. Remember, an inflated tire contains potentially explosive energy that can blow improperly assembled rings loose. In emergency situations, where a safety cage or portable safety device is not available, use a clip-on type air chuck so that the operator can stand clear during tire inflation. **Important,** when clip-on air chuck is used, line pressure must be restricted to maximum inflation capacity of tire.

Use properly matched parts only. Rim base and rings must be matched according to size and type. This information is stamped on each Firestone part.

Replace damaged parts. Abuse during road operations or in mounting the tire can cause dents, cracks, or distortions which weaken the parts. Inspect for and replace damaged parts.

Periodically inspect and remove rust and other foreign matter. Accumulation of such material in the rim gutter can prevent the proper fitting of rings. Parts that are excessively corroded are weakened and should be replaced. Use of a rust preventative compound (not containing water) during mounting will minimize rusting.

Do not use over-size or over-inflated tires. Use only recommended size rims for tires and do not exceed maximum inflation pressure for the rim.

Follow manufacturer's recommended mounting procedures.

ADDED PRECAUTION: **Re-check assemblies just prior to inflation, particularly if they have been rolled across the floor or have received rough handling between mounting and inflation.**

During tire demounting

Completely deflate tire prior to demounting. The tire should be deflated prior to removal of the tire and rim assembly from the vehicle. Remove the valve core to insure complete deflation.

DO NOT STAND IN FRONT OF RIM/TIRE DURING DEFLATION.

Follow recommended demounting procedures.

Check for damaged or worn parts. Mark defective parts for destruction to preclude their future use.

During vehicle operation

Before putting new vehicles into service, clamps and wheel nuts should be checked for proper torque.

Do not overload rims or wheels. Insure that the combination of load and vehicle weight does not exceed the rated load of the rims or wheels used. Rims and wheels are designed to sustain their rated load using the maximum tire size recommended for that rim width by the Tire & Rim Association.

Inspect rims and wheels for damage during tire checks and at periodic maintenance intervals. Remove and replace defective parts.

Do not exceed maximum inflation pressures. This is determined by the size and ply rating of the tire, but is not to exceed the maximum inflation listed for the rim or wheel. It is also important to maintain uniform inflation in both tires of a dual assembly so that weight is equally sustained.

Do not run vehicle on one tire of dual assembly. When there is loss of air in a dual tire the carrying capability is reduced and the load must be sustained by the other tire and rim. Both tires should be inflated to balanced, recommended pressures before further operation.

Never re-inflate a tire that has been run flat or seriously underinflated without first breaking rim down and reassembling rim. It is especially important to make sure the lock ring is secure in the gutter and has not been damaged prior to re-inflation.

After first 50 to 100 miles of service re-check clamp and wheel nut torque. Loose wheel nuts can cause excessive wear around bolt holes, dangerous wheel vibration, and metal fatigue failure. Excessive torque is also dangerous in that it can cause stud or wheel breakage.

THE GRADALL COMPANY
406 Mill Ave., S.W. New Philadelphia, Ohio 44663

Form No. 0009

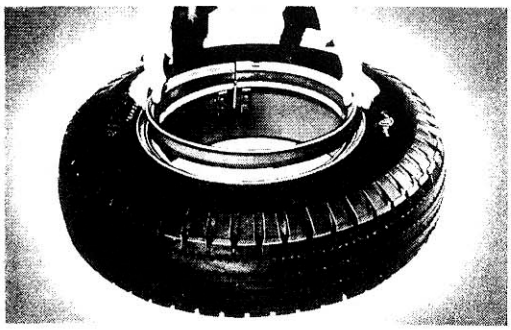
https://truckmanualshub.com/

How to mount and demount ACCU-RIDE 5° Commander and 3-piece convertible rims

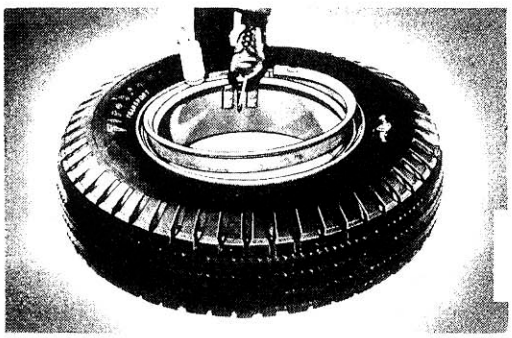
(Procedure applies to tires on both demountable rims and disc wheels)

Tools required: 1 rim mallet / 1 rim tool

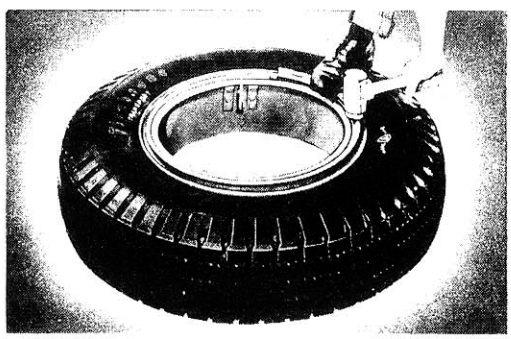
MOUNTING



After applying tire and tube in usual manner, place removable side ring (flange) on bead of tire. Then insert tapered toe of lock ring between side ring and rim base.

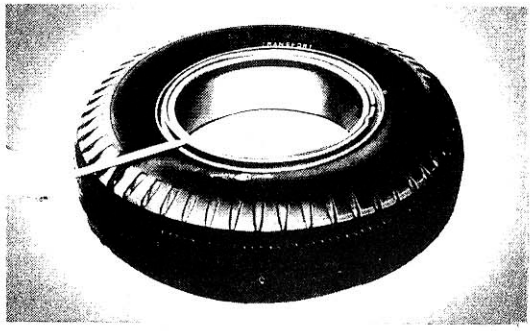


To fasten lock ring, hold with foot at one end of split and hammer end of ring into place with rim mallet.

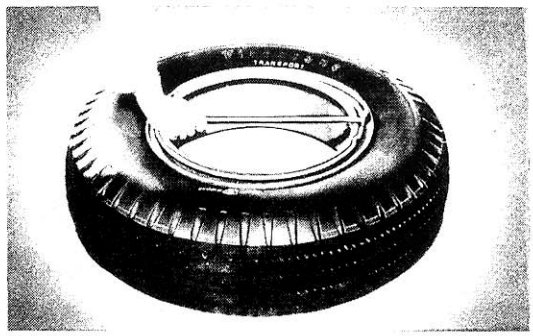


Continue progressively around the rim, holding ring with foot and hammering until entire ring is seated. Check seating of rings and inflate tire to recommended pressure.

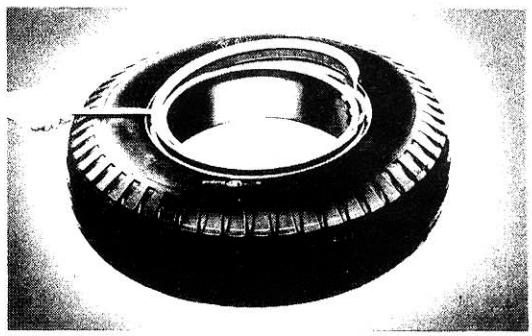
DEMOUNTING



Standing clear of rim, completely deflate tire by removing valve core or using deflator cap. Place tapered end of rim tool in depression in lock ring, or between rings, and press down on side ring to free bead. Continue downward pressure on side ring progressively around the tire until the bead is completely freed from the bead seat.



To disengage lock ring from the gutter, insert rim tool in removing notch, near split in the ring, and push downward. If desired, a second similar tool may be used to facilitate removal.



Insert the rim tool between the lock ring and side ring and press downward to pry ring up. Move progressively around the rim until lock ring is free, then lift off lock and side rings. Turn assembly over, unseat tire bead, stand tire up and remove rim base.

SAFETY PRECAUTIONS

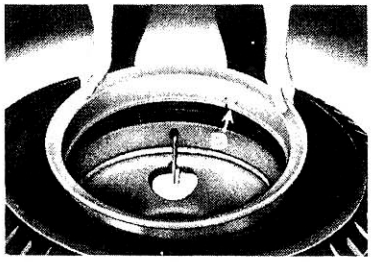
1. **Use only parts free from damage or heavy rust.**
2. **Insure that lock ring is completely installed before inflating tire. Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand clear during inflation.**
3. **Insure that tire is completely deflated prior to removal of rings.**
4. **Split lock rings used with continuous side rings must not butt.**
5. **Do not inflate a flat or seriously underinflated tire while tire is on vehicle. Remove and make sure all parts are serviceable and fully reassemble before reinflating tire.**

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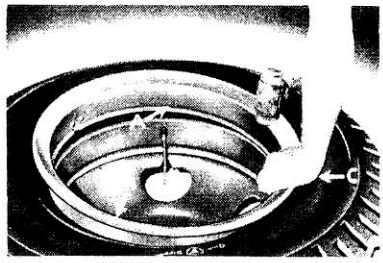
How to mount and demount ACCU-RIDE RH5° rims

Tools Required: 1 Rim Mallet
1 Rim Tool

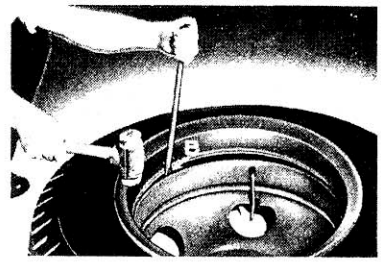
MOUNTING



Place disc portion of wheel on floor with rim gutter up. Apply tire with valve pointing in direction desired. Place side ring in position with operating notch located between two embossings (point B) approximately three inches from valve, on either side.

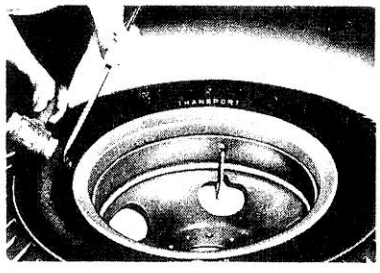


The two cutaway portions opposite each other in the inner diameter of the ring (points A) are placed so as to span the rim gutter. At point C, opposite valve, force half of ring into the gutter as far as possible using hand and rim mallet.

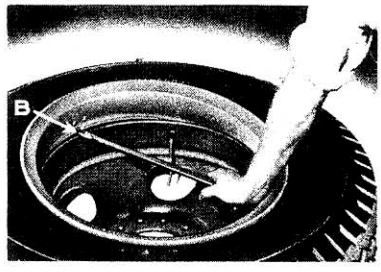


Insert straight end of rim tool in operating notch (point B), then pull in direction indicated by arrow. Retain pressure with tool and strike ring downward with mallet at point between tool slot and cutaway portion, thereby engaging ring over rim gutter at that point. Remove tool and strike additional blows progressively toward other cutaway portion until entire toe of ring has passed over the rim gutter. Check seating of ring as shown below and inflate tire to recommended pressure.

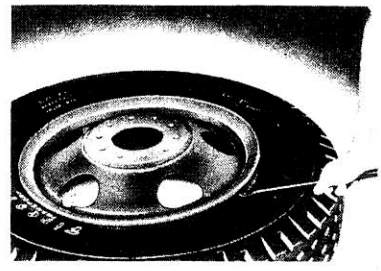
DEMOUNTING



CAUTION: Staying clear of rim, make certain tire is completely deflated. To loosen tire bead from side ring, drive curved bead-loosening end of above recommended rim tool, or a larger tire tool, between ring and bead. Pry downward on bead and repeat this operation around the ring until bead is loose.



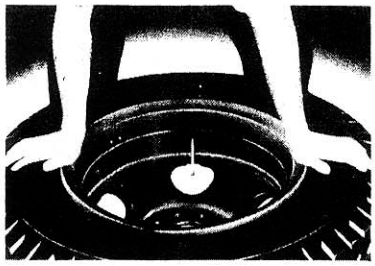
Remove ring by putting straight end of rim tool into notch in ring located between embossings (point B). Push ring downward at point opposite operating notch. Force tool handle downward as illustrated, causing ring to disengage from rim gutter. Continue operation, prying away from rim gutter with flat end of tool until free.



Turn assembly over and unseat tire bead from back flange in same manner as loosening bead from side ring in first step. Stand tire up and remove rim base.

NOTE: It is unnecessary to free the side ring from the tire bead if tire is to be removed for tube repair and immediately replaced. Simply loosen bead from back (permanent) flange as in third demounting step. Then turn the assembly over and remove ring, with tire attached, as in second demounting step.

IMPORTANT: RH-5° side rings are not interchangeable on other size RH-5° bases. Make certain side ring is right size for the rim base you are using.



SAFETY PRECAUTIONS:

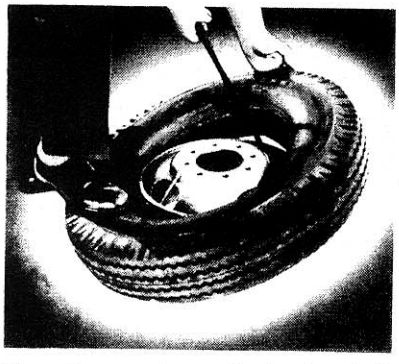
1. **Before inflating tire, be certain side ring has completely cleared the gutter of rim base. In this position, the side ring can be depressed by hand. This can be easily felt and seen. DO NOT INFLATE IF SIDE RING DOES NOT MOVE FREELY.**
2. **Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand aside during inflation.**
3. **Use only parts free from damage or heavy rust, especially at the area of contact between the rim base and side ring.**
4. **Insure that tire is completely deflated prior to removal of side ring.**
5. **Do not inflate a flat or seriously underinflated tire while tire is on vehicle. Remove and make sure all parts are serviceable and fully reassemble before reinflating tire.**

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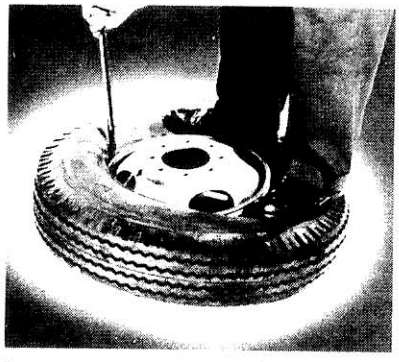
How to mount and demount ACCU-RIDE RHP rims

Tools required: 2 rim tools
1 rim mallet
1 tire tool (thin end)

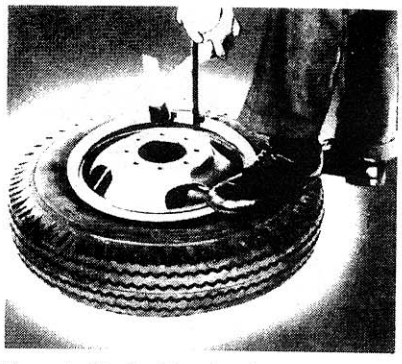
MOUNTING



Place tire on rim so that valve is in line with valve hole and insert valve through valve hole. Force first bead down into well of rim just to side of valve with foot. Mount first bead over rim gutter with rim tool progressing from each side of foot to point approximately opposite foot.

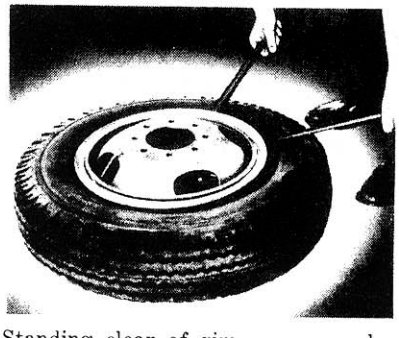


To apply second bead, start at point opposite valve and press bead toe over rim gutter and into rim well with foot pressure. Mount remainder of bead over rim gutter by means of thin tire tool, being careful not to pinch tube.

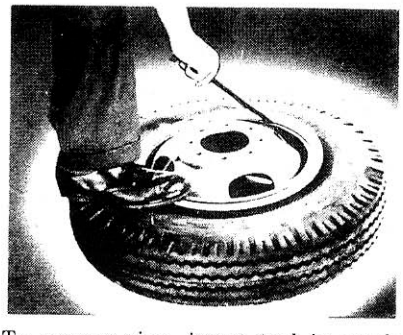


Place half of side ring in rim gutter with cutaway portions in position as shown. Insert thin end of rim tool or heavy screw driver and pull ring outward toward centered position. Strike with mallet, forcing rim into gutter.

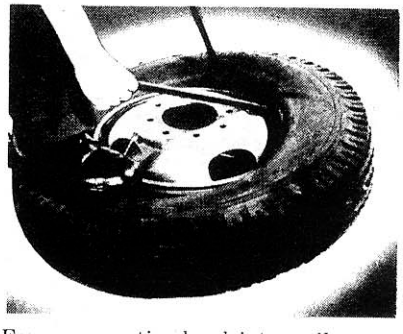
DEMOUNTING



Standing clear of rim, remove valve core to completely deflate tire. Place tire and wheel on floor with side ring up. To loosen first bead, drive hooked end of rim tool between tire and rim flange and press downward on bead. Progress around rim, using 2 tools, as shown.



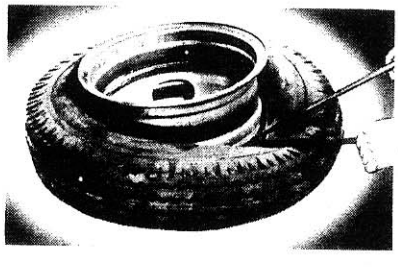
To remove ring, insert tool in notch and force ring opposite of notch into gutter, then pry off. Pry out and up on side ring, carefully but firmly. (Be careful not to bend side ring.)



Force upper tire bead into well opposite the valve slot and with tire tool pry opposite portion of bead over edge of rim.

Turn tire over and by means of rim tools, loosen bead on opposite bead seat. This can be further aided by using foot pressure.

Make sure one portion of second bead is still in the rim well, then pry opposite portion of bead over edge of rim. This will free the tire from the rim.



SAFETY PRECAUTIONS:

1. **Use only parts free from damage or heavy rust.**
2. **Insure that side ring is completely seated before inflating tire.**
3. **Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand aside during inflation.**
4. **Insure that tire is completely deflated prior to removal of rings.**
5. **Do not mount 16.5 diameter tubeless tires on 16" diameter rims.**

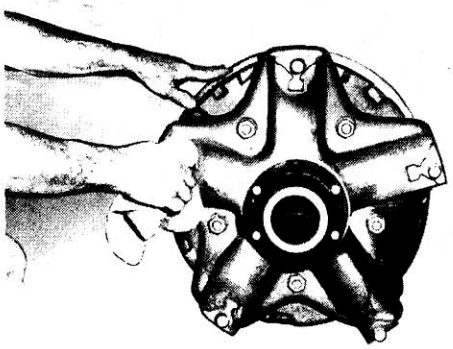
https://truckmanualshub.com/

How to properly install ACCU-RIDE rims and wheels

Proper installation of rims and wheels on a vehicle is essential to safe, economical, trouble-free service. Use only the specified sizes of studs, nuts and clamps.

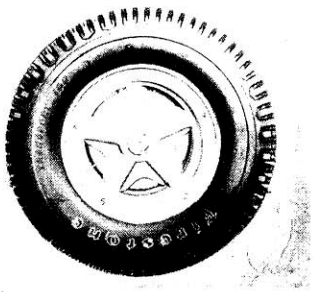
RECOMMENDED INSTALLATION PROCEDURE

DEMOUNTABLE RIMS



Make sure that all parts, including rims, rings, spacer bands and cast wheel studs are free from damage, dirt or rust. Replace any defective parts.

Place rims and spacer band on wheel. Secure clamps evenly in position and draw up nuts alternately in the sequence shown at right. Do **not** tighten them fully, however. This procedure will permit the inside rim to properly align itself on the 28° mounting bevel on the back of the cast wheel, thus avoiding damaging wheel wobble.



Then, tighten nuts fully, using same alternate sequence. Be sure to tighten these nuts **only** to the torque level recommended in the table below and to maintain them at that level through planned, periodic checks.

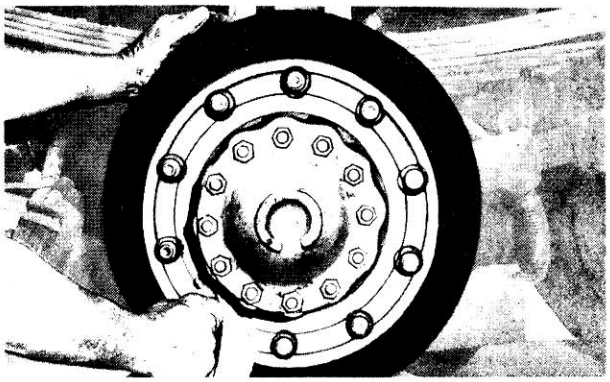
SPOKE WHEELS*	
Thread Size	Torque Ft.-Lbs. (Dry)
5/8 - 11	150 - 175
3/4 - 10	200 - 250
1 - 8	400 - 450
1 - 14	400 - 450

CAUTION: *Insufficient* mounting torque can cause rim slippage, resulting in broken valves, worn parts and damaged tires. *Excessive* mounting torque can cause damage by stripping studs, collapsing spacer bands or forcing rims into an out-of-round condition.

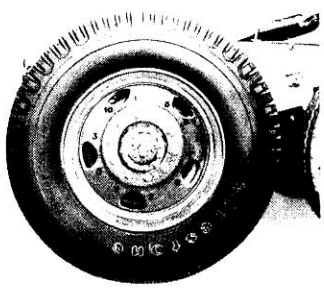
Wrenches for Demountable Rims and Disc Wheels: Double-end socket wrenches for rims and disc wheels normally are adequate to install and remove Accu-Ride rims and wheels, when used with a 3-foot bar. A 150-pound man, exerting his entire weight, 2.5 feet out on a bar, can apply 375 foot-pounds of torque to a wrench (150 x 2.5). Air wrenches, however, sometimes are used to save time and labor. The torque they deliver depends on the air line pressure from which they operate. Periodic checks by torque wrench, or other means, should be made to insure accuracy of these air wrenches.

***NOTE: After first 50 to 100 miles of service re-check clamp & wheel nut torque.**

DISC WHEELS



Check all parts for damage, including wheels and rings. Insure that studs, nuts and mounting faces of hub and wheels are clean and free from grease. Replace any defective parts.



Mount single wheel or inner dual wheel (also, outer dual wheel for hub - type mounting) over studs, being careful not to damage stud threads. Draw up nuts alternately in the sequence shown at left. Do **not** tighten them fully, however. This procedure will permit the uniform seating of nuts and insure the even, face-to-face contact of wheels and hub.

Tighten nuts fully, using the same alternate sequence. Mount the outer wheel (for double cap mounting) and repeat the entire procedure. In each case, be sure to tighten wheel nuts only to the torque level recommended in the table below and to maintain them at that level through planned, periodic checks.

Note: When inner cap nuts are re-tightened, be sure first to loosen outer cap nuts several turns; then, re-tighten them.

DISC WHEELS*		
Application	Thread Size	Torque Ft.-Lbs. (Dry)
Passenger Type Mtg.	7/16-20	80-90
	1/2-20	80-90
	9/16-18	110-120
	5/8-18	125-140
In-Out Coined Mtg.	9/16-18	175-200
	5/8-18	175-200
		1-pc. nut / 2-pc. nut
Piloted Mtg.	11/16-16	300-350 / 200-250
	3/4-16	450-500 / 300-350
	7/8-14	..... / 350-400
Ball Seat Mtg.	3/4-16	450-500
	1-1/8-16	450-500
Heavy Duty Ball Seat Mtg.	15/16-12	750-800
	1-5/16-12	750-800

CAUTION: *Insufficient* mounting torque can cause wheel shimmy, resulting in damage to parts and extreme tire tread wear. *Excessive* mounting torque can cause studs to break and discs to crack in the stud hole area.

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Proper maintenance of ACCU-RIDE rims and wheels

Accu-Ride rims and wheels are thoroughly tested in Firestone laboratories, on Firestone test tracks and by both small and large fleets on the highways of America. All these tests, plus a rigid quality-control program, insure maximum performance of all Accu-Ride rims and wheels. In order, however, to maintain their built-in quality and to insure maximum service and safety a continuous maintenance program is advisable. Maintenance procedures should be carried out during all tire inspections and changes and at periodic maintenance intervals depending upon road and environmental conditions of operation.

RIM AND WHEEL MAINTENANCE DURING TIRE INSPECTIONS

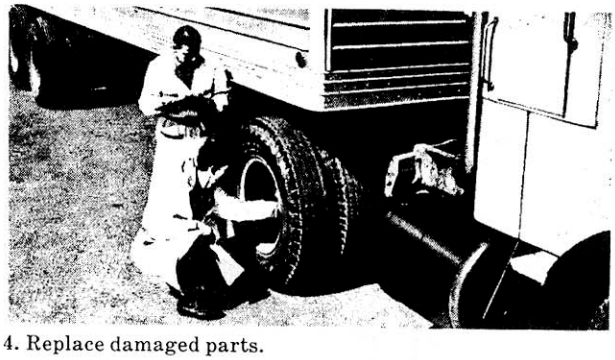
1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:

excessive rust or corrosion build-up
cracks in metal
bent flanges, resulting from road obstructions
deep rim tool marks on rings or in gutter areas
loose, missing or damaged nuts or clamps
bent or stripped studs
damaged or missing rim drive plates
matched rim parts

2. Pull damaged rims or wheels.

CAUTION: Excessively corroded or cracked rims or rings can be dangerous. Deflate tires prior to the removal of rims or wheels from the vehicle.

3. Mark damaged or hazardous areas with chalk so that part will be removed from service.



4. Replace damaged parts.

CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

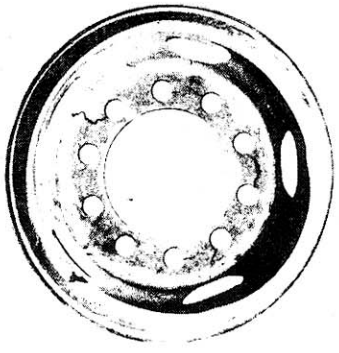
5. Inflate tires only to recommended air pressures.

RIM AND WHEEL MAINTENANCE DURING TIRE CHANGES

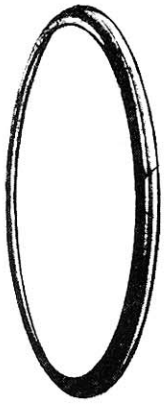
1. Check all metal surfaces as in No. 1, above. A more thorough check may be made, however, after the tire has been demounted. Watch particularly for the damages illustrated below and refer to recommendations in this section of the catalog if corrective measures are required.



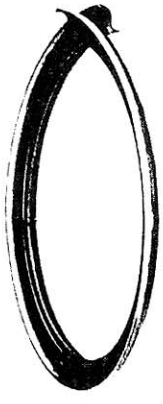
Cracks in the rim base, in the back flange and gutter areas. These are caused by deep rim tool marks, overloading and overinflating tires and using larger than recommended tire sizes.



Cracks in the wheel disc, between stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures and use of incorrect sizes or types of attaching parts.



Cracks through side ring, spreading laterally through the entire section. These are caused by improper mounting and demounting techniques, impact with road obstructions, and excessive clamping torques.



Sprung side ring, resulting from improper mounting procedures.



Erosion and chipping of bead seat of lock ring, resulting from excessive corrosion. This may occur with this part as well as others if protective measures described on following page are not taken.

2. Replace damaged parts.

CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

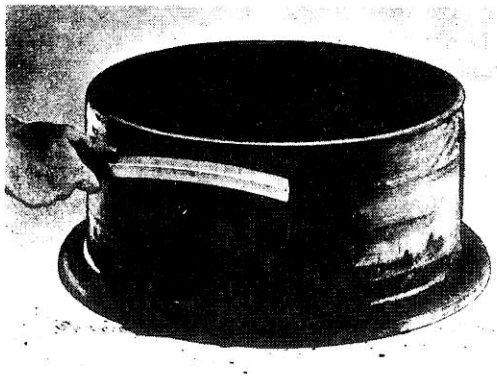
NOTE: Openings between ends of split side rings must not be less than 3/32" except where the ring design calls for an abutting condition, or more than 5/16" after ring is seated-in during operation. Split lock rings used with endless side rings must not butt.

(Continued)

Proper maintenance of ACCU-RIDE rims and wheels

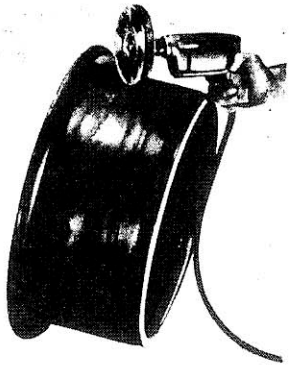
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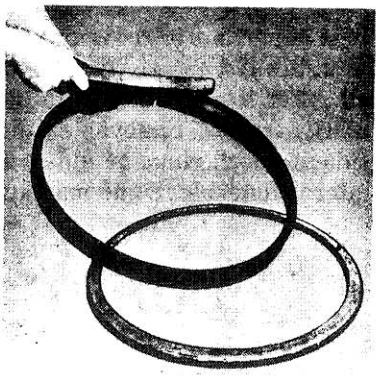


3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

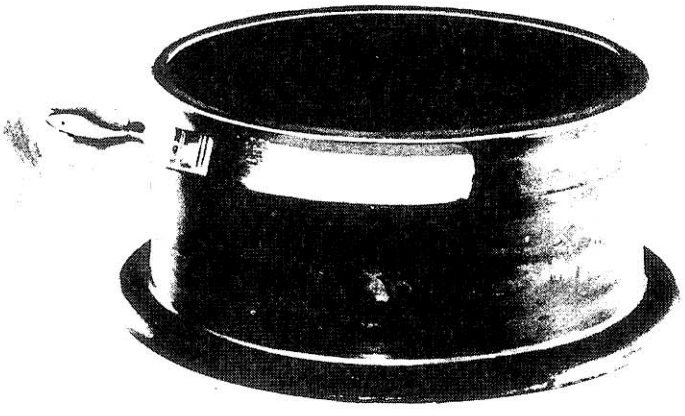
Gutter of rim base should be cleared of rust and other materials obstructing safe, positive seating of rings.



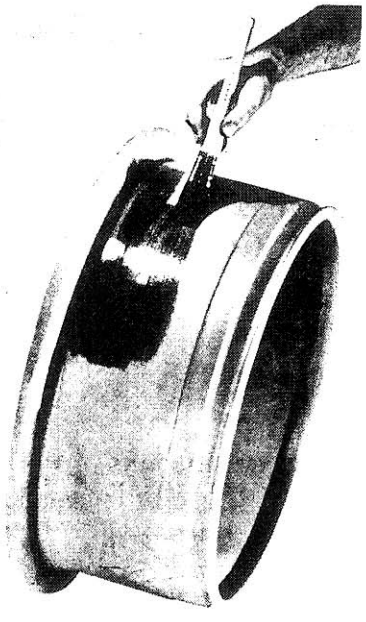
Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.



Rings should be cleaned with wire brush. Pay particular attention to seating surfaces and bead seat areas.



4. Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Insure that bare metal areas on outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.

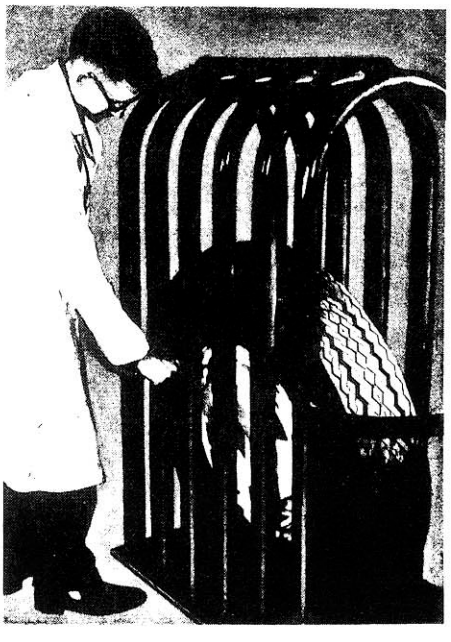


5. Lubricate tire side of rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless rims as the air in the tire is contained by the tire-side rim surface.

6. Inflate tire only to recommended air pressure.

SAFETY PRECAUTIONS

1. **Insure that rings are properly seated, prior to inflation.**
2. **Use safety cage or lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck, so that operator may stand aside during inflation. When clip-on air chuck is used, pressure must be restricted to max. inflation capacity of tire or rim, whichever is lower.**
3. **Air tank should incorporate moisture trap when used with drop-center tubeless rims in order to reduce the moisture in contact with the metal rim surfaces.**



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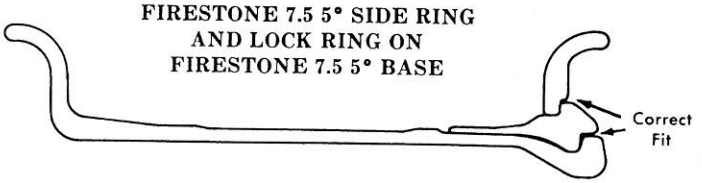
How to Insure Greater Safety and Service by Properly Matching Side and Lock Rings

It is important to recognize that the various types of highway rims produced by their manufacturers all differ to some degree in design. This is particularly true of removable rings and, as a result, side and lock rings of different rim types are not interchangeable. Some may appear to be, but they actually do not fit properly on the rim base. Serious accidents to personnel have resulted from the use of mismatched rings.

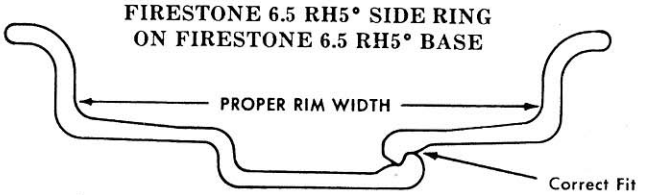
The drawings below illustrate a few of the potentially dangerous conditions which can result from the mismatching of rings and bases.

CORRECT

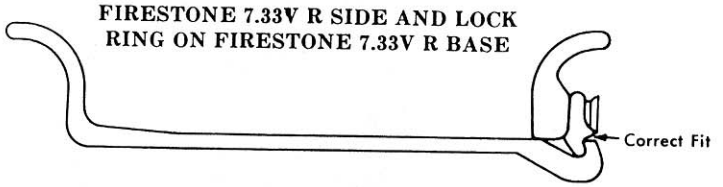
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.5 5° BASE



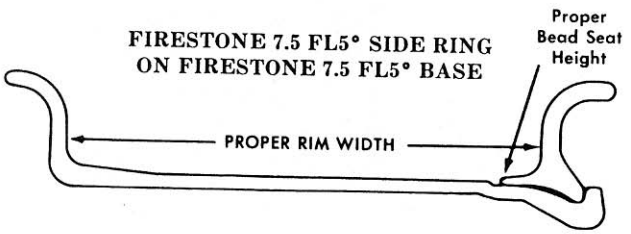
FIRESTONE 6.5 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.33V R BASE

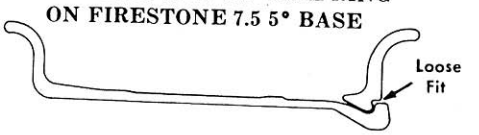


FIRESTONE 7.5 FL5° SIDE RING ON FIRESTONE 7.5 FL5° BASE

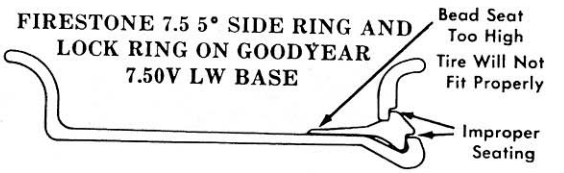


INCORRECT

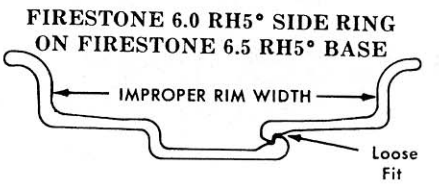
GOODYEAR 7.50V LW SIDE RING ON FIRESTONE 7.5 5° BASE



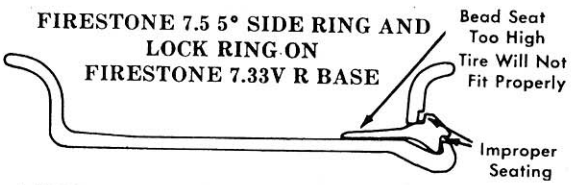
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON GOODYEAR 7.50V LW BASE



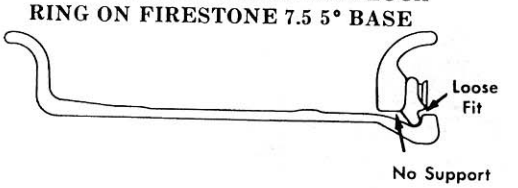
FIRESTONE 6.0 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



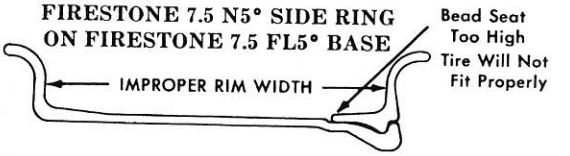
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.33V R BASE



FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.5 5° BASE



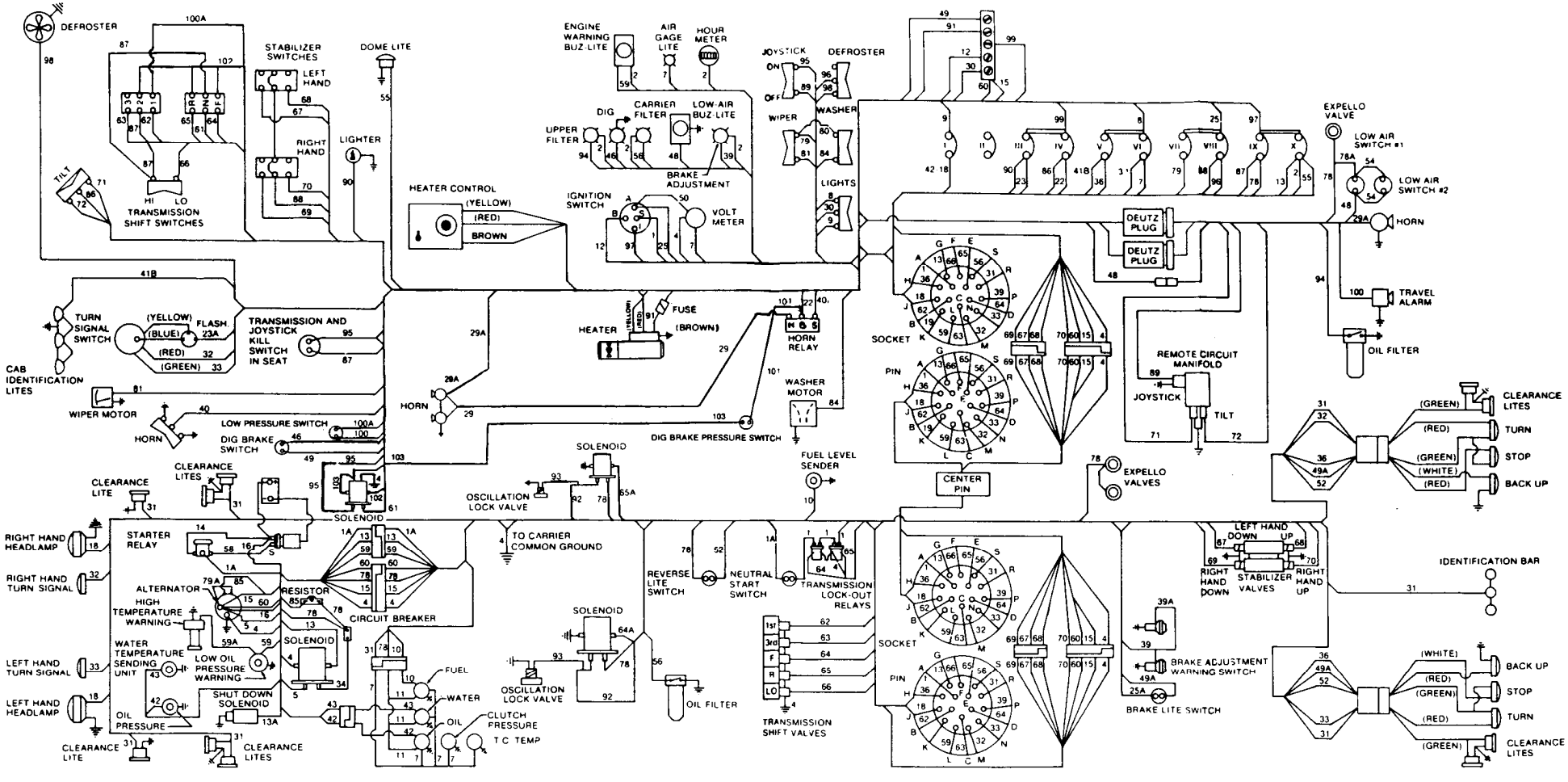
FIRESTONE 7.5 N5° SIDE RING ON FIRESTONE 7.5 FL5° BASE



NOTE: When in doubt of component compatibility, refer to the U.S. Department of Transportation, National Highway Traffic Safety Administration's Multipiece Rim / Wheel Matching Chart. Chart is available from D.O.T. NHTSA Office of Defect Investigation, all rim and wheel distributors and all Firestone Sales Offices.

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G3R Electrical Wiring Diagram (Starting Lot 1)



WIRE	LOCATION
1	NEUTRAL START SWITCH TO "S" ON IGNITION SWITCH
1A	NEUTRAL START SWITCH TO STARTER RELAY
2	NO. 10 BREAKER TO INSTRUMENT PANEL ASSORTMENT
4	COMMON GROUND TO CARRIER
5	"B" ON ALTERNATOR TO CHASSIS SOLENOID
7	NO. 6 BREAKER TO INSTRUMENT PANEL LITES
8	NO. 6 BREAKER TO LITE SWITCH
9	LITE SWITCH TO NO. 1 BREAKER
10	FUEL LEVEL SENDER TO FUEL GAGE
11	FROM NO. 13 WIRE TO CARRIER GAGES
12	TERMINAL BLOCK TO "B" ON IGNITION SWITCH
13	CHASSIS SOLENOID TO NO. 10 BREAKER
13A	WIRE NO. 78 TO SHUT DOWN SOLENOID
14	STARTER SOLENOID TO STARTER RELAY
15	"B" ON ALTERNATOR TO TERMINAL BLOCK
16	"B" ON ALTERNATOR TO STARTER
42-18	HEADLITE TO NO. 1 BREAKER
22	NO. 4 BREAKER TO "B" ON HORN RELAY
23A	NO. 3 BREAKER TO TURN SIGNAL FLASHER
25	NO. 8 BREAKER TO "A" INGITION SWITCH
25A	FROM NO. 60 WIRE TO BRAKE LITE SWITCH
29	"H" ON HORN RELAY TO CAB HORN
29A	"H" ON HORN RELAY TO REAR HORN
30	TERMINAL BLOCK TO LITE SWITCH
31	CLEARANCE LITES AND CARRIER GAGE LITES TO NO. 6 BREAKER
32	RIGHT HAND TURN SIGNAL TO "RED" ON TURN SIGNAL SWITCH
33	LEFT HAND TURN SIGNAL TO "GREEN" ON TURN SIGNAL SWITCH
34	CHASSIS SOLENOID TO CIRCUIT BREAKER
36	TAIL LITES TO NO. 5 BREAKER
39	BRAKE ADJUSTMENT WARNING SWITCH TO BRAKE ADJUSTMENT WARNING LITE
40	HORN BUTTON TO HORN RELAY
41B	NO. 5 BREAKER TO CAB I.D. LITES
42	OIL PRESSURE SENDER TO GAGE
43	WATER TEMP SENDER TO GAGE
44	NO. 10 BREAKER TO LOW-AIR SWITCH
46	DIG BRAKE SWITCH TO DIG BRAKE WARNING LITE
48	LOW-AIR SWITCH TO LOW-AIR BUZ-LITE
49	TERMINAL BLOCK TO DIG BRAKE SWITCH
49A	BRAKE LITE SWITCH TO BRAKE LITES
50	"A" ON IGNITION SWITCH TO VOLT METER
52	PRESSURE SWITCH ON TRANSMISSION TO BACK-UP LITES
54	JUMPERS BETWEEN LOW-AIR SWITCHES
55	NO. 10 BREAKER TO DOME-LITE
56	MAIN HYDRAULIC FILTER TO WARNING LITE
58	"S" ON STARTER SOLENOID TO "S" ON STARTER RELAY
59	LOW-OIL PRESSURE SENDER TO BUZ-LITE
59A	HIGH-TEMP SENDER TO LOW-OIL PRESSURE SENDER
60	"B+" ON ALTERNATOR TO TERMINAL BLOCK
61	DIG SOLENOID TO "N" ON TRANS SHIFT SWITCH
62	1st GEAR SOLENOID TO TRANSMISSION SHIFT SWITCHES
63	3rd GEAR SOLENOID TO TRANSMISSION SHIFT SWITCHES
64	"F" SOLENOID AND TRANSMISSION LOCK-OUT RELAY TO TRANSMISSION SWITCH
64A	NO. 64 WIRE TO LEFT HAND OSCILLATION CYLINDER SOLENOID
65	"R" SOLENOID AND TRANSMISSION LOCK-OUT RELAY TO TRANSMISSION SWITCH
65A	NO. 65 WIRE TO RIGHT HAND OSCILLATION CYLINDER SOLENOID
66	TRANSMISSION RANGE SELECTOR SWITCH TO "LO"
67	SOLENOID AND TRANSMISSION SWITCH LEFT HAND STABILIZER SWITCH TO "DOWN" ON STABILIZER VALVE
68	LEFT HAND STABILIZER SWITCH TO "UP" ON STABILIZER VALVE
69	RIGHT HAND STABILIZER SWITCH TO "DOWN" ON STABILIZER VALVE
70	RIGHT HAND STABILIZER SWITH TO "UP" ON STABILIZER VALVE
71	TILT SOLENOID TO TILT SWITCH
72	TILT SOLENOID TO TILT SWITCH
78	FROM CIRCUIT BREAKER TO EXPELLO'S & OSCILLATION SOLENOID
79	NO. 7 BREAKER TO WIPER SWITCH
79A	JUMPER "B+" ON ALTERNATOR TO "2" ON ALTERNATOR
80	WIPER SWITCH TO WASHER SWITCH
81	WIPER SWITCH TO WIPER MOTOR
84	WASHER SWITCH TO WASHER MOTOR
85	"I" ON ALTERNATOR TO RESISTOR
86	NO. 4 BREAKER TO TILT SWITCH
87	NO. 9 BREAKER TO TRANSMISSION SWITCHES AND SEAT SWITCH
88	NO. 8 BREAKER TO STABILIZER SWITCH
89	JOY STICK SOLENOID ON REMOTE MANIFOLD TO JOY STICK SWITCH
90	NO. 3 BREAKER TO LIGHTER
91	TERMINAL BLOCK TO HEATER
92	"H" ON LEFT HAND OSCILLATION RELAY TO "H" ON RIGHT HAND OSCILLATION RELAY
93	"H" ON OSCILLATION RELAYS TO OSCILLATION VALVES
94	AUXILIARY HYDRAULIC OIL FILTER TO AUXILIARY FILTER WARNING LITE
95	KILL SWITCH ON SEAT TO JOYSTICK SWITCH AND DIG SOLENOID
96	NO. 8 BREAKER TO DEFROSTER SWITCH
97	NO. 9 BREAKER TO "I" ON IGNITION SWITCH
98	DEFROSTER SWITCH TO DEFROSTER MOTOR
99	NO. 4 BREAKER TO TERMINAL BLOCK
100	LOW AIR SWITCH TO TRAVEL ALARM
100A	1st GEAR TERM ON TRANS SHIFT SWITCH TO LOW PRESS SWITCH
101	"B" ON HORN RELAY TO DIG BRAKE PRESS SWITCH
102	TRANSMISSION SWITCHES TO DIG SOLENOID
103	DIG BRAKE PRESSURE SWITCH TO DIG SOLENOID

Form No. 8106 Revised 10/82

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Cyclopac® Service Procedures

Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save time and money by maximizing filter life and dust cleaning efficiency.

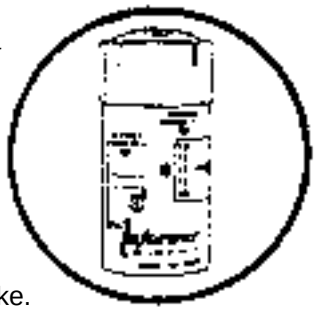
Two of the most common problems:

A) Over Servicing. New filter elements increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance.... the filter should look dirty. By using proper filter measurement tools you will use the full life of the filter at maximum efficiency.

B) Improper Servicing. Your engine is vulnerable to abrasive dust contaminants during servicing. The most common cause of engine damage is careless servicing procedures. By following the steps shown, you can avoid unnecessary risk to the engine.

Measure Restriction

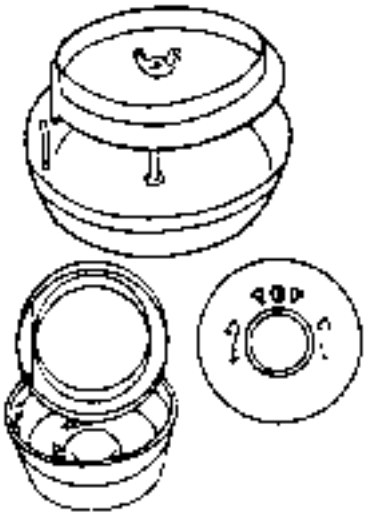
Measure the restriction of the air cleaner with a Donaldson restriction indicator, such as The Informer, a service gauge, or water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake.



One of two conditions will exist
(1) If the reading indicates the maximum restriction (per engine manufacturer's recommendations), change out the filter.
(2) If the reading shows below the maximum, the filter still has life left and should not be touched.

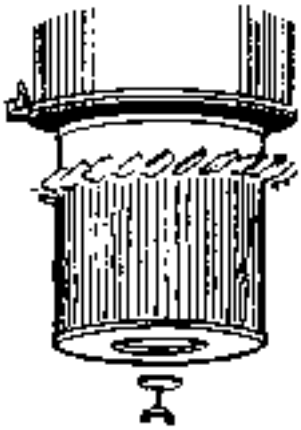
Empty the Dust Cup

Dust should not be allowed to build up closer than one inch from the baffle. On models equipped with a Donaldson Vacuator valve, dust cup service is cut to a minimum; all that is necessary is a quick check to see that the Vacuator valve is not inverted, damaged, or plugged.



Filter Servicing

When restriction indicates that filter servicing is required, loosen the wingnut and remove the primary filter. Before installing new filter, inspect the filter and gasket for shipping or storage damage. (See service tips on reverse side of this document.) Carefully install new element and wingnut.



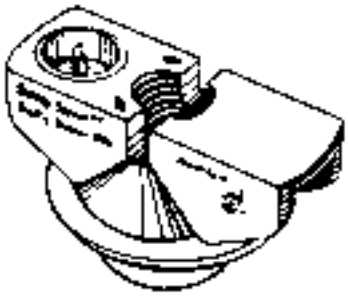
Always use authentic replacement Donaldson filters, which have been engineered to fit the air cleaner and engine intake system exactly.

Cover the Inlet

Don't leave the air inlet exposed! If the new filter won't be installed immediately, cover the opening to prevent stray contaminant from entering the induction system.

Safety Element Service

For Maximum engine protection and air cleaner service life, replace the safety filter **every third** primary filter change or cleaning, or as indicated by the Donaldson Safety Signal service indicator. Note that the safety element is not intended to be cleaned.



Reinstall the Dust Cup

Be sure the dust cup is sealed 360° around the air cleaner body. Reset the restriction indicator to green.

Check Connections

Ensure that all connections between the air cleaner and the engine are tight and leak-free.

Donaldson®

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Air Filter Service Tips

7 Important Steps to Follow

(1) Remove the old element gently to prevent knocking dust off of it.





2) Always clean the inside of the housing carefully



3) Always clean the gasket sealing surfaces of the housing



4) Check for uneven dirt patterns in your old filter that indicate gasket leakage



5) Press your fresh gasket to see that it springs back



6) Make sure the gasket seats evenly



7) Ensure an airtight fit on all connections and ducts

T

The Important "Don't"

<u>Don't</u> remove filter for inspection.



Never rap a filter to clean it. Rapping only damages the filter.



<u>Never</u> judge the filter's life by looking at it. Measure how restricted its airflow is.





<u>Never</u> leave an air cleaner open longer than necessary.

<u>Don't</u> ignore a worn or damaged gasket in the housing....replace it!





Don't use a damaged or bunched filter.



Never use a warped cover on a housing.



Never substitute an incorrect filter model number.

Brochure No. F114004 (4/96) Replaces 1400-23

For more Information, Contact:

Donaldson

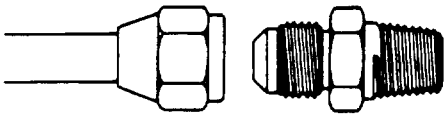
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FLUID SYSTEM LEAKAGE

SAE 37° FLARE CONNECTION



CAUSES:

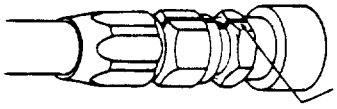
Most of the leaks on this connection are due to the lack of tightening or human error. You can't tell if the nut has been tightened by just looking at the connection. It it is more than tinger tight, you can't tell from observation how much.

Torque wrenches are good only when they are used. You must rely on the user to be sure they get used on all joints. The user must depend on tris memory to know it he has tightened all of the joints.

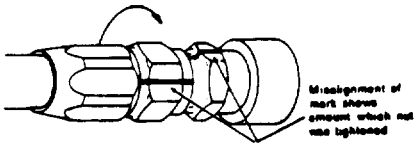
CURES:

Here is a foolproof method of tightening. Anyone can tell if the joint was tightened and how much:

Tighten nut finger tight until it bottoms the seats.



Mark a line lengthwise on the nut and extend it onto the adapter. Use an ink pen or marker.



Using a wrench, rotate the nut to tighten. Turn the nut the amount shown in thc chart.

Line Size	Rotate No. of Hex Flate
- 4	2 1/2
- 5	2 1/2
- 6	2
- 8	2
-10	1 1/2 - 2
-12	1
-16	3/4 - 1
-20	3/4 - 1
-24	1/2 - 3/4

Note: *The misalignment of the marks will show how much the nut was tightened and, best of all, that it has been tightened.*

What to do if the joint leaks after it has been tightened property

Disconnect the line and check for:

1. Foreign particles in the joints . . . .**Wash them off**
2. Cracked Seats . . . . . .**Replace them**
3. Saet mismatching or not concentric with the threads. . . . . .Replace the adapter
4. Deep nicks in the seats. . . . . .Replace faulty part
5. Excessive seat impression. This indicates too soft a material for high presures. Threades will stretch under high pressure. . . . . .**Replace the part**
6. Phosphate treatment. This is an etching process which if overdone leaves a rough sandpaper-like surface. . . . . .**Replace faulty parts**
7. Chatter or tool mark-High and low spots on seats. . . . . .**Replace faulty part**
8. SAE 45° nuts-When connected to an SAE 37° male flare fitting will leak. The SAE 45° nut is too long and will bottom on adapter hex in sizes 8 and 10 before the seats are tight. . . . . .**Use all SAE 37° flare parts**

SAE STRAIGHT THREAD "O" RING SEAL

CAUSES:

1. Elbows loosen up after short service.
2. "O" ring leakage after short service.
3. "O" ring leakage after long service.
4. instant leakage upon start up.

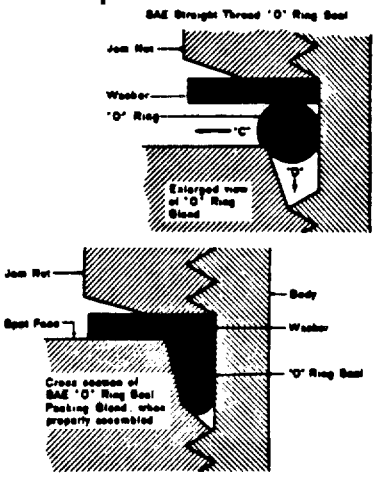
CURES:

Replace "O" ring seals and start over.

1. Jam nut and washer must be to the back side of the smooth portion of the elbow adapter.
2. Lubricate the "O" ring-Very important
3. Thread into port until washer bottoms onto spot face.
   Note: *Is the spot face large enough for the washer? Does hex of the straight adapter fit into spot face?*
4. Position elbows by backing up the adapter.
5. Tighten jam nut.

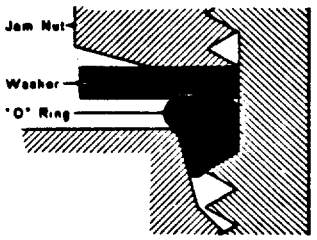
Why "O" ring lubrication is important:

1. Fitting engaged to point where "O" ring touches face of boss. Lubrication on "O" ring permits it to move in direction "D".
2. When "O" ring the boss are dry, rotary motion of assembly can cause friction and "O" ring can move in direction "C".
3. Jam nut and washer cannot bottom fully if the "O" ring is between the washer and the face of the boss.

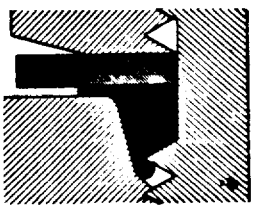


What happens when the jam nut and washer are not backed up prior to assembly.

1. When jam nut and washer have not been backed up, there is not enough room for the "O" ring seal when the squeeze takes place.



2. Washer can't seat property on the face of the boss. The compressed rubber between the washer and the boss face will cold flow out from compression and the fitting will be loose and usually leak.



SAE 4-BOLT SPLIT FLANGE CONNECTION

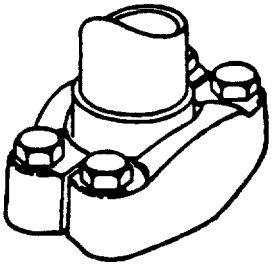
how it works:

The SAE 4-bolt split flange connection is a face seal. The shoulder which contains the seal must fit squarely against the mating surface and be held there with even tension on all botts.

Thc shoulder protrudes peat the flange halves by .010 to .030.

This is to insure that the shoulder will make contact with the mating access-sory surface before the flange does

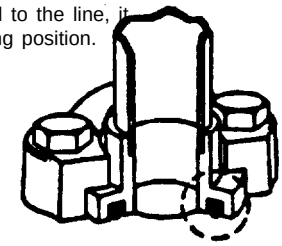
The flange halves overhang the shoulder on the ends so that the lights will clear the shoulder.



causes:

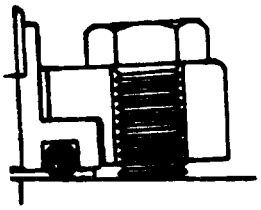
This connection is very sensitive to human error and bolt torquing.

Because of the shoulder protrusion and the flange tightened on one end, in a seesaw fashion. This pulls the opposite end of the flange away from the shoulder and when hydraulic pressure is applied to the line, it pushes the shoulder back into a cooking position.



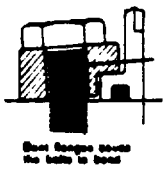
cure:

All bolts must be installed and torqued evenly. Finger tightening with the use of feeler gauges will belp to get the flanges and shoulder started squarely.

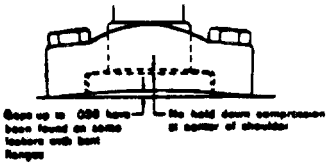


a second cause:

When the full torque is applied to the bolts, the flanges often bend down until they bottom on the accessory. This also causes the bolts to bend outward.

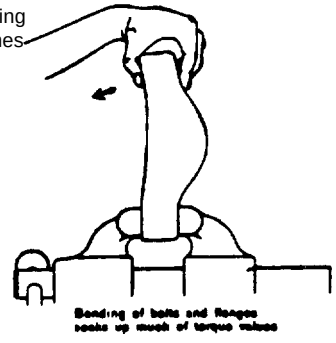


Bending of the flanges and bolts tends to lift flange off the shoulder in the center area between the long spacing of the bolts.



When pipes and/or hose are joined together with this connection, the conditions become more severe because the spacing between mating flanges now is doubled and becomes .020 to .06O gap. All conditios are now multiplied 100%.

High torque is required on all bolts which must be Grade 5 or better because much of the torque is lost In overcoming the bending of the flanges and bolts



cure:

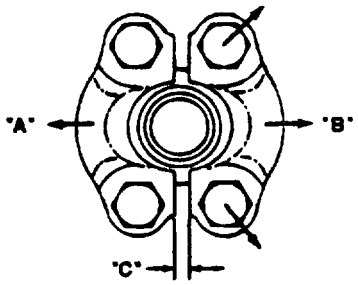
Lubricate the “O” ring before assembly. All matting surfaces must be clean. All bolts must be evenly torqued. Don’t tighten any one bolt fully before going to the next one.

RECOMMENDED TORQUE VALUES (USE GRADE 5 BOLTS)

Connection Size	Torque Foot Pounds
- 8	21
-12	40
-16	40
-20	60
-24	90
-48	175

Note: *Air wrenches tend to cause flange tipping.*

Because of the tolerance build up in all component parts plus the bolt bending, the flange halves can move sideways in direction “A” and “B”. This can lessen the shoulder contact with the flange to zero in the center area between the long bolt spacing.



PIPE THREAD LEAKS:

Pipe threads tend to leak more at high pressures than any other style of connection.

National standard pipe threads leak much more than the dry seal pipe thread.

Symbol . . . National Pipe Thread-NPT
Dry Seal Pipe Thread-NPTF

Either kind of pipe thread will leak if under-torqued or over-torqued. Use a good pipe dope on the NPT threads. When applying pipe dope do not put any on the first two threads from the end. Always put dope on the male thread - never on the female thread.

causes:	cure:
1. Connector not tight.	.Tighten
2. Cracked port or connector	.Check for cracks and replace defective parts
3. Oversized threads in port	.Inspect for proper thread size
4. Undersize threads on connector . .	.Inspect for proper thread size
5. Galled threads (torn threads) . . .	.Inspect and replace if necessary
6. Damaged threads, nicks, cutts, etc.	.Replace if damaged
7. Threads not dry-seal standard for hydraulics	.Use “NPTF DRYSEAL” standard
8. Straight pipe threads instead of tapered	.Use “NPTF DRYSEAL” standard
9. Contaminated threads, dirt, chips, etc.	.Clean and inspect
10. High vibration loosening	.Retighten connector-Check
connection.	with engineering
11. Heat expansion of	
12. female threads.	.Retighten while hot
Too tight, causing thread	.distortion Check, replace